Next generation networks: next generation regulation?

Annexes to a report for **OFTA**

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Table of Contents

Annex A Australia

A1 Rollout of NGNs

Existing fixed and mobile networks

Telstra, the fixed-line incumbent, has been privatised in tranches from the initial share sale in November 1997. The remaining Government shareholding of 16.6% was effectively put in trust with the Future Fund in 2006. The Future Fund has traded in the shares and sold down considerably since then.

As at June 2010 Telstra had a share of the 10.59 million fixed line market of 82% with the balance shared between Optus and some other fixed operators.[1]

The only other full-service operators with PSTN access networks are:

- Optus (owned by SingTel) with a market share of 13%; and
- AAPT (owned by Telecom Corporation of New Zealand - TCNZ) and Primus Telecom with a combined market share of around 5%.

There are three mobile network operators in Australia:

- Telstra – with GSM and WCDMA networks and 39.2% market share by subscribers;
- Optus – with GSM and WCDMA networks and 32.6% market share by subscribers; and
- Vodafone Hutchison Australia – with GSM and WCDMA networks and 28% market share by subscribers.[2]

As at June 2010 there were 177 licensed carriers in Australia.[3] Carrier licences under the *Telecommunications Act 1997* authorise the provision of all telecommunications services and are not service specific. With the exception of those noted above, most of the 177 licensed carriers are small regional or local operators serving niche markets . Some are non-operational.

Implementation of NGNs – status

Public attention has centred on the approach being taken to NGN implementation by Telstra. Most of this attention is concerned with NGA, and the fibre rollout plan.

The other areas of NGN transformation have not attracted the same level of political or regulatory scrutiny, perhaps because they have not yet directly affected major regulatory decisions.

The copper-based PSTN access is used for telephony, ISDN, dial-up Internet, and DSL for residential customers. Current DSL speeds offered by Telstra range up to 8 Mb/s downstream (typically 1.5 Mb/s). ADSL2+ has been deployed to a majority of Telstra's 600 exchanges in the cities and major regional centres. Telstra also offers a fibre based service of up to 100 Mbit/s in areas served by

[1] ACMA *Communications Report 2009-10*, p. 29

[2] As at September 2010

[3] ACMA *Communications Report 2009-10*, p. 21

its cable networks (in Melbourne only at this stage) and business service delivered via Ethernet platforms.

As noted in more detail below, in November 2005 Telstra proposed to the Government a plan that would enable it to roll out a NGN with fibre access to a large majority of Australian homes and businesses. The roll out timetable associated with that plan is set out in Figure A1 below. However this graphic notes that the proposed NGA (FTTN) was, at that stage, on hold. The FTTN NGA plan has been subsequently abandoned by Telstra.

Figure A1: Telstra Planned NGN Rollout (2005)

Source: Telstra

This plan has been substantially achieved, although, for strategic regulatory reasons, Telstra has been reluctant to declare or demonstrate the readiness of the NGN capabilities in its fixed network. This reluctance has not extended to its Next G Mobile network which was launched with much fanfare in 2006. It was built to replace Telstra's CDMA network which operated from 1999 until 2008. Telstra opted to use the 850 MHz band for Next G in preference to the more common 2100 MHz band, since it requires fewer base stations to provide coverage, and therefore could be deployed at lower capital cost. The network was implemented under contract by Ericsson and launched on 6 October 2006. HSPA technology was included in the network to provide the country's first wide area wireless broadband network.

Other carriers have also made substantial progress in implementing their NGN plans. Optus has implemented its NGN platform and is providing IP services under the brand name *Evolve*. This is a NGN with Ethernet interfaces. It was launched in June 2008 and has been marketed as a business IP VPN solution. Optus currently provides VOIP call termination services using Nortel CS2K soft switches and Cisco customer edge equipment.

Figure A2 Telstra NGNs vs legacy networks in 2011

Network	Network component	Legacy	NGN
Fixed	Core	Tandem circuit switches for voice Separate networks for frame relay, ATM etc.	IP routers plus soft switches Some separate networks still operating
	Local termination of access	Local exchanges, cross connects etc.	MSANs and NGA not introduced pending roll out of National Broadband Network by Government
	Access network	Copper loops	Progressive transfer to NBNCo planned – yet to be agreed[4]
Mobile	Core	Circuit switched GMSCs, MSCs	IP routers for Next G. Yet to be integrated with other networks
	BTS concentration	Base station controllers	Information not available
	Radio access	GSM, W-CDMA	LTE trials continuing

NGNs over the period to 2015

As noted above, Telstra had planned to integrate all of its fixed network services on NGNs before 2011. This plan was considered by market analysts to be ambitious and its timely implementation was considered to be a major risk factor for Telstra securities in stock markets. In the event, the plan has not been achieved. This is partly because of the major impact of the Government's plans to build a National Broadband Network using a Government-owned vehicle, NBN Co Limited ("NBN Co"). More detail on NBN Co and its relationship with Telstra is set out later in this study.

It is expected that all fixed carriage services will run over the NGN when completed, such as voice, frame relay, ATM, best efforts Internet, and IPTV. In terms of Telstra's own platforms this will be within the next four years. These platforms are separate from the IP networks used for best efforts Internet services.

Other operators who have not already done so are also expected to complete the establishment of their NGNs within the same period.

Telstra is moving to NGN operation to reduce its costs of maintaining and operating a number of separate networks, including the back office billing and other support. Integration of billing onto a

[4] Telstra shareholders agreed to the arrangements negotiated with the Government and NBN Co for customer transfer, copper access network decommissioning and compensation, at the Telstra AGM on 18th October 2011. However the other agreement that needs to be in place is the assessment and acceptance by the ACCC of the NBN Co Access Undertaking and the NBN Co / Telstra agreement. The ACCC has indicated that its assessment may not be completed in the current calendar year.

single platform has been an obsession in Telstra since the early 1990s. The NGN initiative will help in the focus that brings that closer to fruition.

Rollout of NGA

The NGA, defined as the FTTH service that is provided under the national broadband policy by NBN Co, has only rolled out to initial (trial) locations in Tasmania and selected mainland city and regional communities. These initial locations are referred to as First Release Sites.

The NBN Co rollout plan is to connect 93% of Australian households and business premises over the next eight (8) years with the balance being connected by wireless technologies.

NBN Co has published its First Release and Second Release Sites. The table in Figure A3 below shows the sites and premises covered by the currently released rollout plans.

Figure A3: Currently announced NBN Co Rollout Plans

Plan	Sites /Premises	Population	Comments
Tasmania	10 / 20,000	60,000	Completion planned in 2011-12
Mainland First Release Sites	5 / 15,000	32,000	Completion planned in 2011
Second Release Sites	14 / 42,000	85,000	Commenced in Q2 2011 with completion in 2012
Totals	29 / 77,000	177,000	0.8% of population

Source: NBN Co and NBN Tasmania

The speeds on offer via the fibre service are 100 Mbit/s, but have higher potential for the future. The 7% of premises served by other technologies will have a reduced service speed of at least 12 Mbit/s.

The population covered in the announced plans reflected in Figure A3 relate only to the period up to and including the first part of 2012. Further release sites will be announced on a progressive basis and it is expected that the rollout will be substantially completed by 2018. Tasmania has received priority because the Tasmanian State Government was prepared to directly back the plan when tenders were first called in 2008. Other bidders in that process were all commercial companies and consortia.

NGN Interconnection

At present NGNs are interconnected by both C7 TDM and IP network-to-network interfaces (NNI). This is expected to change to IP network interfaces over time.

The website of the Australian Competition and Consumer Commission (ACCC) notes: "The *ACCC has been involved in various forums discussing next generation networks (NGN) and interconnection between those networks. The discussions have identified that the current regulatory regime may not*

be appropriate in a NGN environment." This indicates that no regulatory framework on the interconnection of NGNs has yet emerged.

NGN points of interconnection

The ACCC has considered the location of Points of Interconnection (POIs) for connection to the National Broadband Network operated by NBN Co in response to formal complaints from existing facilities based operators about the initial POI plans released by NBN Co.

In early 2010 NBN Co proposed that it there should be 14 "Aggregation" POIs for the whole country. One of the rationales for this approach was that it should only permit interconnection to competitive locations – that is, at places where there were at least two carriers present at present. Some smaller carriers with limited fibre networks considered that this approach would lead to existing infrastructure being bypassed. NBN Co considered that it should not adopt a widely distributed approach to POIs because that would be intruding excessively into the value chain.

The matter was referred for advice by the Government to the ACCC who published a discussion paper for public comment. In November 2010 the ACCC provided its findings and advice to Government. Those findings included:

- that the implementation of a semi-distributed approach is likely to best promote retail and wholesale competition across all geographic markets; and
- that the implementation of a semi-distributed approach (as articulated by the ACCC) would be likely to result in optimal outcomes for competition in transmission markets.

The ACCC concluded: "*The ACCC's preliminary analysis is that the application of the semi-distributed approach as proposed by the ACCC is likely to amount to a total number of mainland state metropolitan CSA[5] POIs in the range of 108 – 130. The ACCC does not expect that the implementation of a semi-distributed approach would result in a significant increase in the number of CSA POIs for the proposed 81 regional CSAs and 6 non-mainland state metropolitan CSAs (i.e. for the capital cities of the Northern Territory, ACT and Tasmania).*"

In December 2010, NBN Co developed a list of 120 initial POIs to the NBN based on the Competition Criteria and the Planning Rules administered by the ACCC. This list was further refined and some of the POIs relocated in subsequent negotiations.

The revised list of POIs is likely to better serve the needs of all interconnected operators and the larger ones in particular. It reduces the potential for NBN Co to be involved in the backhaul market competing with other operators in this part of the value chain. However the revised list of POIs has the potential to establish the NBN as a collection of segregated NGN "islands" rather than as an integrated national network.

[5] Connectivity Serving Area

A2 Measures to facilitate the rollout of NGNs

Government funding NGA rollout

The current and previous governments have been involved in (initially) the partial funding and (now) the full funding of the NGA roll out.

OPEL Networks Pty Ltd was a joint venture company formed by Optus and Elders (a rural services provider). It was awarded funding from the previous government in June 2007 of $A958M to support the rollout of a new broadband network for regional and rural Australia.

OPEL planned to use a combination of fibre, DSL (mainly ADSL2+) and WiMAX to provide a wholesale broadband infrastructure in regional and rural areas. Coverage was planned to be up to 99% of the Australian population in an area of 638,000 square km.

When the current government was elected in November 2007 it moved to quickly cancel the OPEL arrangement before contracts were signed. Instead it proposed to contribute significantly to the funding of a FTTN NGA estimated to cost $A14.3B. The Government sought partners in the venture by a tender process that was completed at the end of 2008. None of the tenders was considered to be satisfactory or to offer value for money. Telstra's tender was ruled non-compliant early in the process.

In April 2009 the Government announced a new plan for the provision of a National Broadband Network based on FTTH, at a total cost estimated at up to $A43B. The network would be built by the Government over eight years and the Government would seek to sell down its interest after five years. In the meantime the funding is direct to NBN Co, the Government's vehicle.

NBN Co will not seek to enter competitive wholesale and retail markets. It will confine itself to the provision of Level 2 services to carriers and service providers. Services at higher levels in the OSI hierarchy will be undertaken competitively.

What measures have the authorities taken to cut the costs of NGA roll out?

The Government and NBN Co are concerned to cut the costs of the NGA roll out associated with the NBN. This has a number of elements including reducing infrastructure competition as well as direct cost containment. The measures adopted include:

- Negotiating a deal with Telstra for the long term lease of Telstra ducts, the progressive transfer of Telstra copper-connected customers to NBN Co fibre, and the progressive retirement of the copper access network; and
- Negotiating with a single contractor to implement the NBN for the next two years. The contractor, (Silcar Pty Ltd, a Siemens-Leighton joint venture), is structured to resist union wage demands that have led to substantial cost over-runs for many other large infrastructure projects. Silcar will be responsible for rolling out the NBN in the next 19 release sites and its contract may be extended as required.

In-building wiring access

Rival operators' access to in-building wiring for next generation broadband services is, so far, no different from the access arrangements pre-NBN.

Access is facilitated by guidelines that have been developed between carrier organisations and building owner and manager groups, and supported by ACMA.

In 2006, the Australian Building Codes Board published the Guideline on Digital Buildings Telecommunications Access Guideline (Digital Building Guideline) as a best practice guide to help facilitate and manage arrangements for access to buildings when providing telecommunications services to tenants.

The Digital Building Guideline aims to support more competitive broadband services and focuses on increasing awareness and education about carrier telecommunications infrastructure in CBD multi-tenant buildings. It includes guidelines to manage the various expectations and outcomes for tenants, building owners and managers and telecommunication carriers and services providers. There are guiding principles for building spaces and services and telecommunications access, along with suggestions for communication network architecture within buildings, and checklists. Where appropriate, the guide refers to standards applying to size and spacing of the communication network architecture.

Carriers and carriage service providers are encouraged to negotiate fairly the terms of access with building owners or managers. They have rights of access and entry under the *Telecommunications Act 1997*. The Digital Building Guideline provides a guide to the types of issues that could be addressed in any building access agreement and sets out some optional terms and conditions. None of those suggestions is mandatory, with the terms of any agreement ultimately for the parties to decide.

Plans for LTE Deployment

Plans for LTE deployment are not yet fixed because they are spectrum dependent and the situation in relation to the release of new spectrum, reuse of existing spectrum allocations and refarming possibilities is uncertain.

The ACMA plans to allocate new spectrum through auctions in the 700 MHz (2x45 MHz) and 2500 MHz (2x70 MHz) spectrum bands towards the end of 2012. This timetable is itself not firm and may slip. Various high level usage proposals are in consideration and are presently subject to public consultation.[6]

Reuse of existing spectrum allocations for LTE is also underway. Telstra has announced that it will deploy LTE at 1800 MHz, and is now implementing this plan.

Vividwireless owns the licences for between 70MHz and 100MHz of 2.3 GHz and 3.5 GHz spectrum in every Australian capital city (except Hobart and Darwin). It uses the 2.3 GHz spectrum for its high speed WiMAX network which it announced in February 2011. Vividwireless is rolling out its network in Perth and Brisbane, followed by other capital cities in which it has spectrum holdings. Vividwireless could refarm the spectrum for LTE use.

[6] www.acma.gov.au/WEB/STANDARD/pc=PC_312514

The ACMA has undertaken analysis of current availability and future needs for mobile broadband spectrum as follows:[7]

"Analysis undertaken by the ACMA and presented at the RadComms2010 conference identified a shortfall of approximately 150 MHz of spectrum which will be required to meet demand for mobile broadband services out to 2015; however, any estimation of spectrum requirements beyond this timeframe is notional.

"The ACMA expects that the demand for spectrum to support mobile broadband services will increase over time in response to the increased proliferation of machine to machine (M2M) interactions but that the level of spectrum demand from portable screens will flatten or plateau. Significant and continuing advances in the spectrum efficiency offered by mobile broadband technologies, that is its capacity to carry data, have occurred since 2005 and these advances are expected to continue until at least 2020. The ACMA also expects industry to deploy infrastructure more extensively in order to ease the pressure on spectrum.

"The ACMA has undertaken further analysis of spectrum demand out to 2020. The assumptions for this analysis were complex, looking at a combination of coding efficiencies, additional infrastructure and fixed-to-mobile convergence whereby data is offloaded from the mobile network using very small 'WiFi' like cells.

"From this analysis, the ACMA estimates that an additional 150 MHz of spectrum will be required by 2020. This estimate takes into account the 800 MHz of spectrum already dedicated for operation by mobile communications services; and includes the 150 MHz previously identified by the ACMA as being required by 2015.

"Delivering on this estimation would ensure that approximately 1100 MHz of spectrum is available in the Australian communications environment to support mobile broadband services by 2020. However, it is the issue of identifying which frequency bands and how the spectrum may be made available for use by future mobile broadband services that will take time and careful consideration."

A3 Regulation of next-generation network interconnect

Charging Methods for Interconnection:

Between NGNs

The regulator, ACCC, has not provided guidance on NGN-and-NGN interconnection at this time. Operators are encouraged under the Act and via policy to negotiate commercial agreements between themselves.

Between a NGN and a circuit switched fixed network

For interconnection between an NGN and a circuit switched fixed or mobile network the parties will typically interconnect via a C7 circuit-switched facility and if the parties fail to agree the ACCC may respond to a request to arbitrate the dispute. If so it will do so in accordance with principles that it has already developed and published.

Between a NGN and a circuit switched mobile network

[7] ACMA, *Towards 2020—Future spectrum requirements for mobile broadband*, May 2011, p.2

As above

Any-to-any interconnect principle

Standard access obligations under Section 152AR of the *Competition and Consumer Act 2010* (formerly the *Trade Practices Act 1974*) at sub-section 3 provide for the Australian equivalent of the any-to-any connectivity principle, as follows:

"(3) An access provider must, if requested to do so by a service provider:

(a) supply an active declared service to the service provider in order that the service provider can provide carriage services and/or content services; and

(b) take all reasonable steps to ensure that the technical and operational quality of the active declared service supplied to the service provider is equivalent to that which the access provider provides to itself; and

(c) take all reasonable steps to ensure that the service provider receives, in relation to the active declared service supplied to the service provider, fault detection, handling and rectification of a technical and operational quality and timing that is equivalent to that which the access provider provides to itself."

Terminating access services of fixed and mobile network are declared services. However, it is unclear whether further declarations are required in the case of terminating access on NGNs. An NGN could be regarded as a form of fixed or mobile network.

Calling party pays is the principle currently employed to determine who should pay interconnection charges, and the application is based on the long run incremental cost of the service together with contribution to fixed and common costs. It is unclear how these principles might be amended or applied in the NGN era.

Regulation to ensure minimum end-to-end quality

The regulator has not yet determined what standards should be applied, if any, to ensure minimum end-to-end quality. In all likelihood the matter will be referred by operators for industry examination and recommendation of a Code of Practice to the Communications Alliance, the industry forum established to examine such matters and to recommend voluntary and mandatory codes to ACMA. However it is a policy matter to determine the extent to which the market will be left to competitively set quality and performance levels.

A4 Other possible NGN regulation

Access to Emergency Services

The issue of access to emergency call services has received special attention as a result of a child's death in 2006 (telephone service out of service awaiting maintenance) and the destruction of telecommunications network equipment in the Victorian bush fires of February 2009. In the latter crisis

many deaths were subsequently attributed to failures of telecommunications and broadcast warning systems.

The *Telecommunications (Emergency Call Service) Determination 2009 (as amended)* sets out requirements for service providers for access to emergency call services, including developing suitable plans and complying with procedures for transferring calls to emergency service organisations. The Determination provides at section 39 that:

"If a carriage service provider supplies an emergency telephone service to a customer and the provider is able to identify, at all times, the location of the service, the provider must ensure that the IPND [Integrated Public Number Database] Manager receives a record of the public number, name and service address of the customer."

Section 40 deals with services that are *not* location-specific:

"*(1) This section applies if a carriage service provider supplies an emergency telephone service to a customer and:*

(a) the service is not a public mobile telecommunications service; and

(b) the provider is not able to identify, at all times, the location of the service; and

(c) the provider has issued a public number to the customer.

"(2) The provider must ensure that the IPND Manager receives:

(a) the public number, name and service address of the customer; and

(b) advice that:

(i) the service may not be at the customer's service address; and

(ii) an emergency call made using the service may be of uncertain origin; and

(c) if the customer has multiple services with the provider — a contact number for the customer."

The Dictionary section of the Determination defines ***IPND*** thus:

*"**IPND** means:*

(a) the Integrated Public Number Database established and maintained by Telstra under the Carrier Licence Conditions (Telstra Corporation Ltd) Declaration 1997 as in force on the commencement of this Determination; or

(b) if the Minister has determined, under subsection 472 (1) of the Telecommunications Act 1997, that a specified person other than Telstra is to provide and maintain an integrated public number database — that database."

Under sub-section 53(2) the "*provider must give each end-user of the service access to emergency call services free of charge*". This continues a long-standing policy of free calls to emergency service organisations.

It is not expected that the overall approach or the obligations in the Determination will change with the migration to NGNs although the ability of providers to obtain, keep and advise contact and location information may become more difficult. As noted above, section 40 already recognises in principle the issues of emergency service response to calls from services that are not location-specific.

Regulatory principles to protect consumers migrating to NGNs

Under the in-principle deal struck between NBN Co and the Government, on the one hand, with Telstra and Optus, separately, on the other, on 23 June 2011, Telstra and Optus will be compensated for transferring their access network customers progressively to the NBN as it is rolled out over the next eight years. During that time Telstra will decommission its copper and HFC (hybrid fibre coax) cable networks and lease ducts and other infrastructure to NBN Co. Optus will also decommission its HFC cable network.

The Government, NBN Co and the industry talk in terms of a seamless migration, and clearly that would be desirable from all perspectives and especially the customers'. However there is no regulation or other instrument in place that requires the functionality experienced pre-migration to be replicated in all respects after connection to the NBN. There is no obligation in place that ensures or requires that consumers (either collectively or individually) will not be worse off from the migration in terms of range of services available and/or prices.

There are no obligations yet in place on NGN operators to preserve key legacy services through emulation or otherwise. However the NBN Co / Telstra agreement on migration of services will be examined by the ACCC. The ACCC will examine the agreement to determine whether it is consistent with the objectives of the Act and also the guidelines provided in June 2011 by the Minister. The Act requires that consideration be given to the interests of consumers and, in taking regulatory decisions, to the long-term interests of end-users. This requirement does not mean that the features of key legacy services will need to be guaranteed, but it does mean that consumer interests in such matters will likely be part of the mix of considerations that the ACCC has regard to in examining the agreement.

Universal service obligation

Current USO

Under the current universal service regime Telstra is the Primary Universal Service Provider. The *Telecommunications (Consumer Protection and Service Standards) Act 1999* requires the Primary Universal Service Provider to fulfil the universal service obligation, which in turn includes ensuring Standard Telephone Services are available to all people in Australia on an equitable basis wherever they reside or carry on business. The Minister is empowered to determine what constitutes reasonable access. The Standard Telephone Service means in effect a voice telephony service.

Telstra receives a contribution or subsidy to the cost of the universal service obligation. The amount of the subsidy is determined by the Minister on the advice of the ACMA. The Universal Service Obligation subsidy for 2009-10 was set at approximately $A145 million. Other carriers contribute to the subsidy in proportion to their share of eligible industry revenue.

As Primary Universal Service Provide, Telstra is also obliged to provide payphone services (call box services) on an agreed basis. The payphone element in the 2009-10 subsidy was $A13.9 million.

A standard telephone service is has other characteristics including access to emergency call services. Telstra's net costs of providing access to emergency call services is not included in the USO subsidy. Telstra as the Emergency Call Person for Triple Zero (000) and (112) recoups some of the costs of operating these services from the interconnection fees paid by other carriers who terminate calls on these services.

It is over 10 years since the USO subsidy was last intended to cover the costs actually incurred in discharging the Universal Service Obligation. The amount now determined by the Minister is based on a notional amount determined in 1999, subject to various forms of projection and indexation since then.

The USO does not currently cover mobile or broadband services. It relates to voice telephony only.

USO and NGN

On 23 June 2011 the Australian Government published a discussion paper seeking responses from interested parties on the way forward with the USO in the NGN era. The paper was published on the day that Telstra and NBN Co concluded an in-principle agreement to permit customers to be progressively migrated to the NBN as it is rolled out, and to withdraw the copper access network from service.

Complementary to the NBN Co-Telstra agreement, the Government has also reached agreement with Telstra on the future provision of the USO and other public interest services from 1 July 2012.

The Government's intention is to have a new entity, the Telecommunications Universal Service Management Agency (TUSMA) administer contracts for the provision of appropriate services from 1 July 2012.

The Government is now preparing three bills for legislative enactment:

- A bill to establish and empower TUSMA;
- A bill containing necessary legislative amendments to the current regulatory scheme governing the USO, Emergency Call Service (ECS), National Relay Service (NRS) for the deaf and speech impaired, and the industry levy (or subsidy) arrangements as a result of changes in the USO scheme; and
- A bill imposing a Telecommunications Industry Levy to replace the current USO and National Relay Service (NRS) schemes.

The approach that is being considered and which has been detailed for public consultation is as follows:

- USO and related public interest services will be provided under contract to TUSMA;
- Funding will be via a combination of industry contribution and dedicated Government funding;
- The roles of TUSMA and the ACMA shall be distinct and without duplication;
- From 1 July 2014 the responsibility for the provision of the USO standard telephone service will be progressively removed from Telstra and the USO for payphone provision will cease on that date and be replaced by a contractual agreement for a term of 20 years with Telstra;
- The ECS will continue to be administered by the ACMA; and
- To the extent necessary, targeted arrangements should be established by TUSMA to facilitate the transition of voice-only (non-broadband) services from the copper network to the NBN fibre network and to support the ongoing provision of public interest services (traffic lights and public alarms) over the NBN.

From 1 July 2012 Telstra will have a contractual obligation to ensure that standard telephone services are reasonably accessible to all Australians on an equitable basis. Telstra will receive funding to maintain and operate its existing copper network in areas outside NBN Co's fibre footprint and to

provide voice services. Within NBN Co's fibre footprint Telstra will be required to be the retail provider of last resort to provide the standard telephone service over NBN Co's fibre network on request.

The Government expects that most customers who receive a voice service over the Telstra copper network will take up a NBN Co broadband service when their copper access line is decommissioned. However some may elect not to do so and will prefer to retain a voice-only fixed service. In such cases the TUSMA will provide assistance to Telstra to migrate such customers to the NBN and to provide them with a voice-only service.

Universal broadband policy

There are no plans in the suite of documents published by the Government on 23 June 2011 that suggest the inclusion of broadband services in the universal service scheme. Clearly the move to the NBN has triggered a review of the way the universal scheme will be implemented in the future, but has not resulted in any review of the service scope of the scheme. It remains a voice telephony scheme.

Nevertheless it is intended that the coverage of the NBN should be the whole of the population of the country by 2018, comprising 93% by FTTH, 7% by wireless technologies and a very small residual group by satellite. Broadband fibre customers will receive 100 Mbit/s download speed; and broadband wireless customers will receive at least 12 Mbit/s download speed.

The Government will fund 100% of the NBN rollout, either through initial grants or through the initial revenues. The original estimate of the capital cost of the NBN was $A43B. That has now been revised downwards to $36B.

A5 Summary

The clear emphasis in Australia is on NGN access – or NGA. The NGN core networks do not raise issues that stir public debate; NGA does. The key issues then relate to the Government's resolve to see the project through and its arrangements to require Telstra, as the fixed line incumbent, to transfer customers to the NBN and to decommission its copper network progressively as the NBN is implemented.

The structure of the NBN, and the remit of NBN Co to provide services that might complete with other licensed operators, have been initial matters of concern. They are both effectively resolved for now. However other competition issues may arise in the course of the ACCC assessment of the NBN Co / Telstra and NBN Co / Optus agreements[8].

The other major issue, of much longer duration, was the ability of Telstra to complete with the new NBN and to effectively destroy its commercial prospects from the outset. This risk has been removed by the Government's actions to effectively force Telstra, on pain of structural separation and denial of necessary additional LTE radiofrequency spectrum, to enter into a deal with NBN Co and with the Government itself on matters relating to the progressive migration of customers from the copper access network to NBN Co's fibre network, and the progressive decommissioning of the copper network. An agreement in principle on these matters, and on compensation to Telstra for the use of its

[8] For example, in the course of the Senate review of the agreements in October 2011 concerns have been raised about the possible anti-competitive effect of clauses in the NBN Co agreements with both Telstra and Optus for the operators not to promote their mobile broadband services as alternatives to the NBN.

ducts and its maintenance services, was entered into on 23 June 2011. This agreement will be submitted to the ACCC and separately to Telstra shareholders later in the year for their approvals. The expectation is that both approvals will be forthcoming.

The key issues for NBN Co will be:

- Making a layer 2 wholesale only business model work;
- Keeping the construction programme costs within budget and to timetable; and
- Keeping wholesale prices of NGN access to retail service providers sufficiently low that, when a retail margin is added, the retail prices to customers will meet public and industry expectations that have been formed in the current ADSL environment.

Annex B Japan

B1 NGN regulation

Consultations and Outcomes

In 2006, Japan began "promoting the 'u-Japan Policy' to realize the ubiquitous network society by 2010 as the world's most advanced ICT nation."[9] By 2010 the policy aimed for 100 percent broadband coverage and improvements in digital literacy such that 80 percent of the population feels comfortable with ICT and can use it to resolve issues in their daily lives.[10]

Japan made much progress on part u-Japan, with one of the most advanced broadband infrastructures in the world. NTT's fiber reaches about 90 percent of the Japanese population, and ADSL services are available to 99 percent of the population.[11] Cable broadband, including DOCSIS 3.0 technology capable of 160 mbps (with four bonded channels), is widely available, 3G coverage is ubiquitous, and mobile providers are rolling out LTE service.

Yet, use of this infrastructure has been somewhat disappointing. NTT has so far found little market for its NGN services. Japan has no world-class Internet companies, little video streaming other than YouTube, and social goals laid out by u-Japan related to e-government, medicine, and education remain largely unmet.

To attempt to address these issues, in 2010 Japan adopted its "New Broadband Super Highway (Hikari no Michi)" plan. As the implementation document explains, the plan

aims at further economic development in Japan through accelerating the development and use of a broadband infrastructure and realizing an affluent society in which the benefits of ICT can be rapidly, fairly, and sufficiently felt/enjoyed through optimal use of ICT while still protecting the communication rights of everyone. Securing openness within and between layers and establishing the above mentioned organic collaboration is considered important in promoting the plan.[12]

Whether these plans succeed remains to be seen.

This paper addresses issues more closely related to infrastructure and its regulation.

[9] http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/Releases/Telecommunications/news060601_2.html

[10] Regulatory Affairs Advisory Committee, *Regulatory Challenges: Migration to the Next Generation Network (NGN)*, RAAC Paper (Hong Kong: Office of Telecommunications Authority, April 23, 2009).

[11] Hiroki Kuriyama, *Regulatory Environment and Rollout of NGN in Japan* (Tokyo, Japan: Nippon Telegraph and Telephone Company, June 27, 2011), 17.

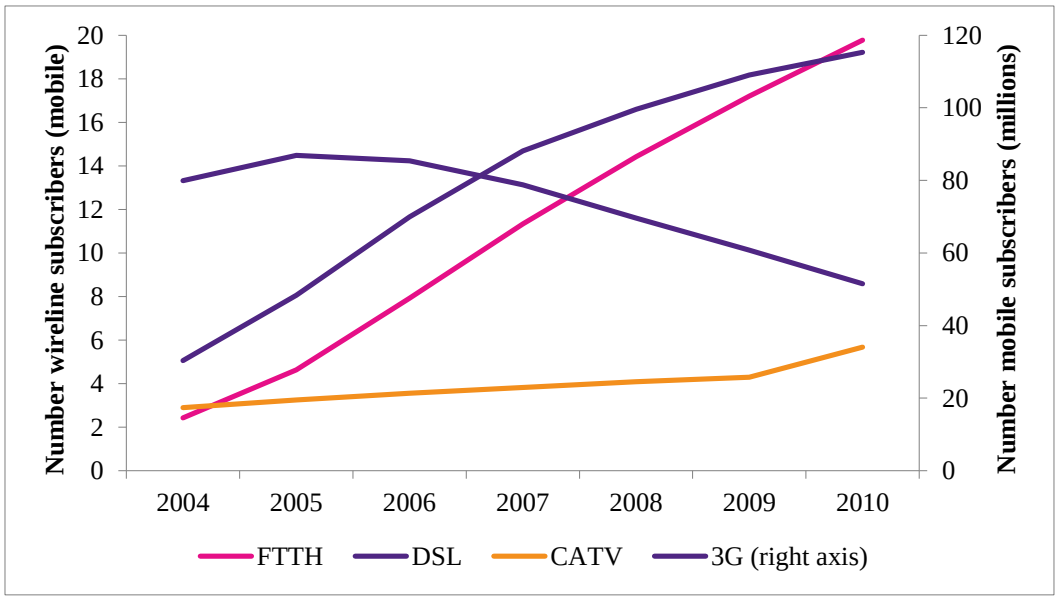
[12] ICT Policy Task Force for a Global Era, *Toward Realization of the "New Broadband Super Highway (Hikari no Michi)" Plan Final Report (Draft)* (Ministry of Internal Affairs and Communications, November 30, 2010), 2, http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/councilreport/pdf/101130_2.pdf.

B2 Roll out of NGNs

Current status of core and NGA rollout

While the government tends to focus heavily on fiber, NGN infrastructure in Japan includes not just FTTH, but also cable (hybrid fiber-coax, HFC) and wireless (LTE and WiMAX). As Figure B1 shows, by 2007 the number of FTTH subscribers exceeded the number of DSL subscribers. While DSL is still ubiquitously available, its share continues to decrease primarily in favor of FTTH, but also towards broadband provided over cable TV infrastructure and possibly wireless. While 3G mobile does not substitute for fixed line penetration, the figure also shows its rapid growth.

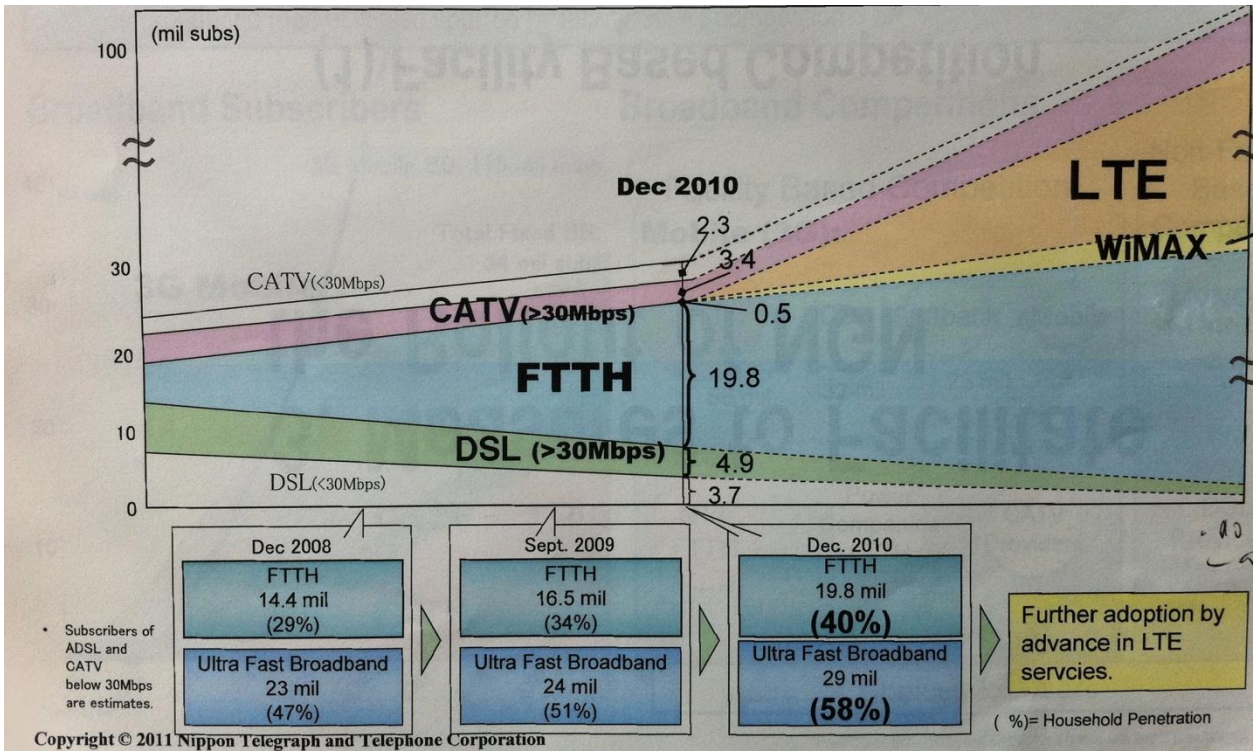
Figure B1: Number of Broadband Subscribers



Sources: fixed line data: http://www.soumu.go.jp/johotsusintokei/field/data/gt010103.xls; mobile data: http://www.soumu.go.jp/johotsusintokei/field/data/gt01020101.xls

Figure B2 shows NTT's expectations regarding rollout of NGN networks (its own and others). The figure shows somewhat limited expected additional growth in fiber connections relative to growth in LTE and WiMAX services.

Figure B2: Expected NGN Rollout



Copyright © 2011 Nippon Telegraph and Telephone Corporation. Used with permission.[13]

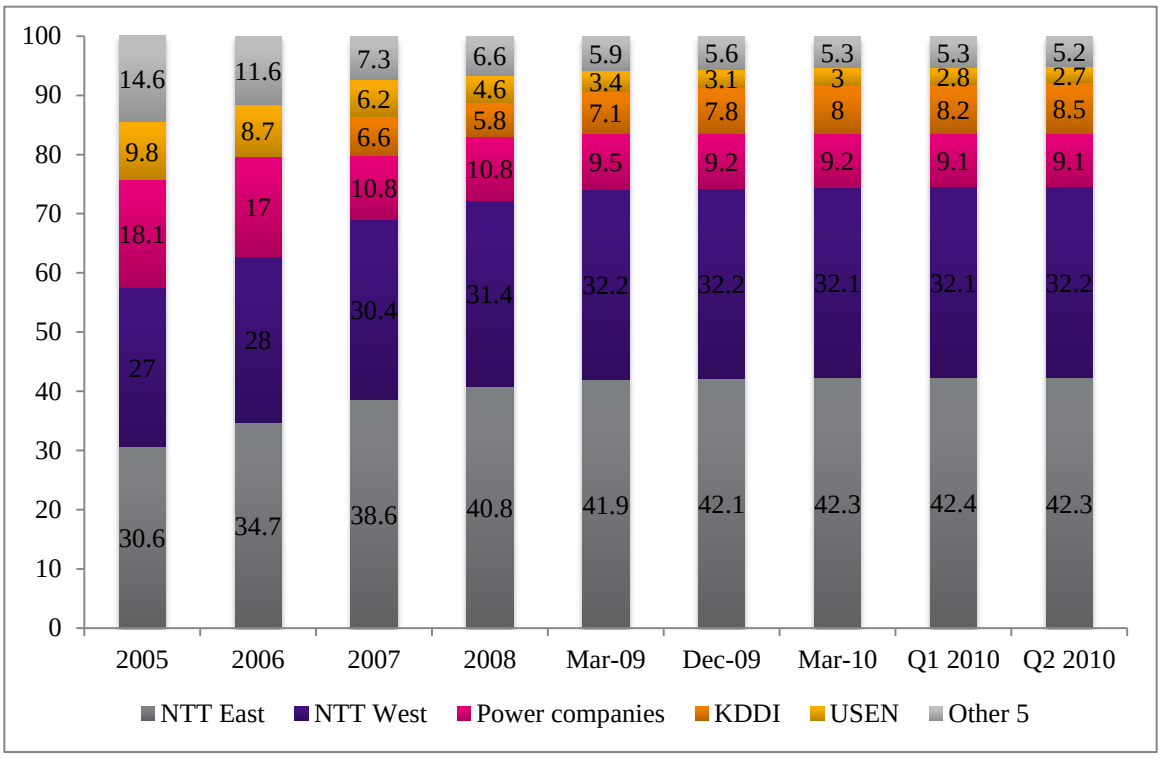
The remainder of this section discusses FTTH, cable, and wireless in more detail.

FTTH

Fiber and copper are both unbundled in Japan. However, while unbundled copper generated a great deal of competition among ISPs, fiber unbundling has not. Instead, competition for ultra-high speed services remains largely facilities-based rather than service-based. Figure B3 shows the share of fiber connections by provider. The figure shows that NTT has about three-quarters of all FTTH connections, with most of the balance provided by power companies and KDDI.

[13] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*.

Figure B3: Share of FTTH Connections by Provider

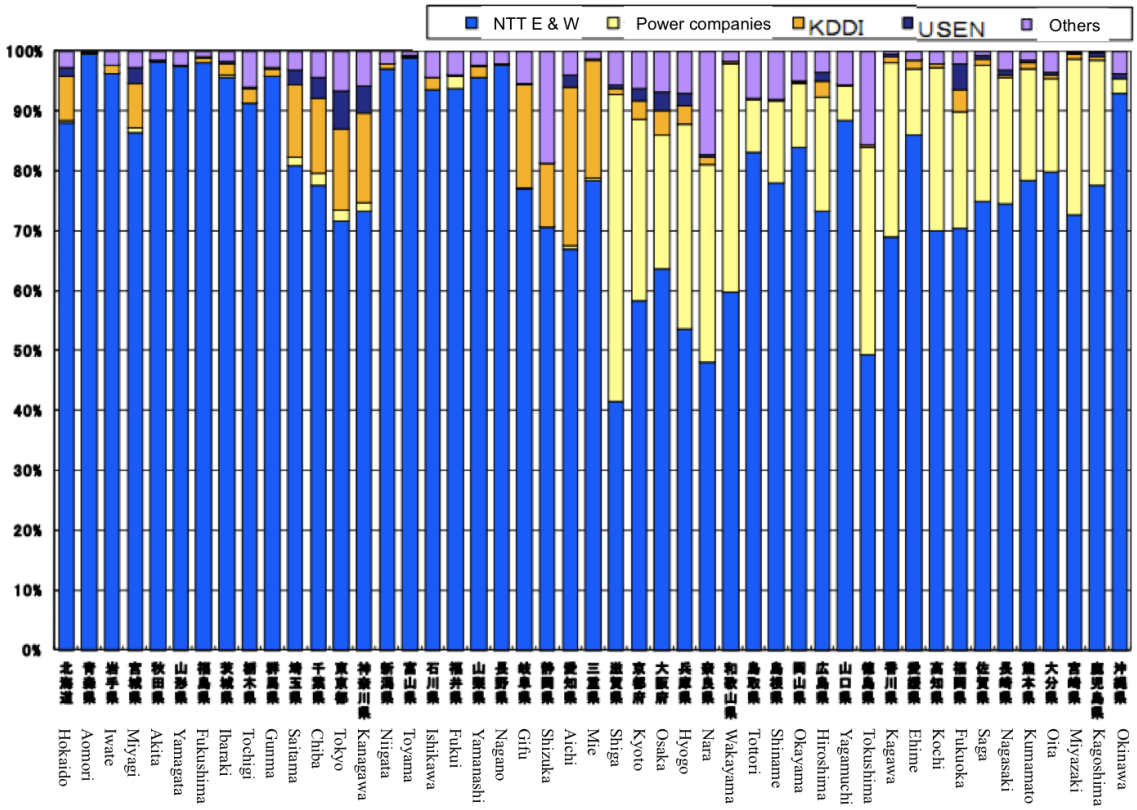


Source: http://www.soumu.go.jp/main_content/000096907.pdf, p.8

While Figure B3 shows the share of FTTH across the country, Figure B4 shows the extent of head-to-head competition within prefectures. The figure shows NTT's dominant position in most of the country, it also shows that significant competition exists in some places. The figure shows, for example, the strong role played by power companies in certain prefectures, including Osaka. Some analysts note that the providers do not appear to set different prices in different regions, meaning that significant competition in major regions can help bring competitive discipline to other parts of the country.[14]

[14] Comments from GLOCOM.

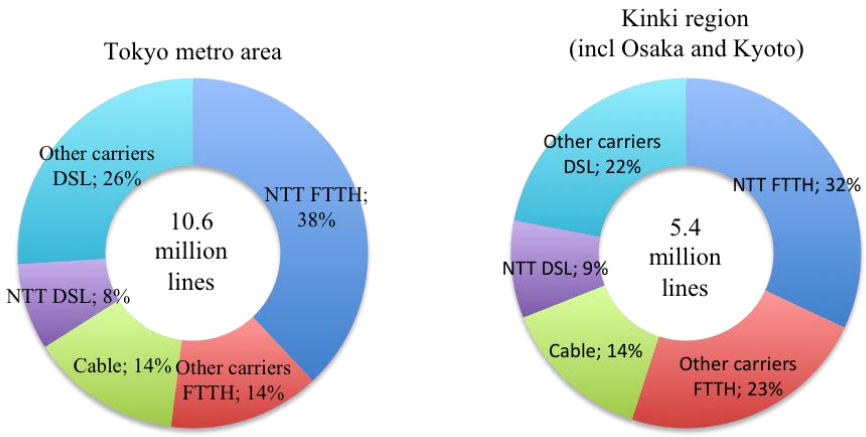
Figure B4: FTTH Share by Prefecture, 2010



Source: http://www.soumu.go.jp/main_content/000096907.pdf, p.10

The figure does not include cable operators, which provide additional facilities-based competition in many regions. Figure B5 shows fixed line market shares for Tokyo and the Kinki region, which includes Osaka and Kyoto. The figure reveals substantial facilities-based competition in these areas.

Figure B5: Broadband Market Shares 2009



Source: NTT.[15]

Fiber investment has not been especially profitable. NTT has been investing about 300 billion yen per year in its fiber network.[16] In 2011 NTT East's income before taxes was about five percent of revenues while NTT West's income was about four percent of revenues.[17] By comparison, in 2010 NTT Docomo (NTT's wireless company) invested about 400 billion yen in its 3G/3.5G/LTE networks,[18] and Docomo's income before taxes was about 20 percent of revenues.[19]

Similarly, KDDI has reported disappointing results on its wireline business. It has reported net losses on its wireline business every year since 2007.[20] By comparison, its wireless operating income margin consistently exceeds 15 percent.[21]

Cable

While the government appears largely focused on fiber, cable is becoming an increasingly important part of the NGN landscape. As Figure B1 showed, Japan has about 5.8 million subscribers to cable Internet. J:COM is the largest cable operator. Based on cable TV subscriptions, J:COM represents about 36 percent of all cable subscriptions.[22] The other approximately 500 cable companies are much smaller, with J:COM four times the size of the second-largest cable company, JCN.[23]

J:COM offers three bandwidth tiers: 160 mbps, 40 mbps, and 12 mbps. Among new subscribers, slightly more than one-third choose the fastest tier, and the remainder split approximately evenly across the 40 and 12 mbps tiers.[24]

Wireless

As discussed above, wireless service remains highly profitable. NTT launched its LTE service, branded "Crossy," in 2010. LTE services in Japan are called 3.9G rather than 4G because they are not upgrades to the ITU "LTE Advanced" standard. By the end of 2010 NTT had obtained 8 percent coverage with 1,100 base stations in Tokyo, Nagoya, and Osaka. It hopes to cover 20 percent of the population by the end of 2011, 40 percent by the end of 2012, and 70 percent by the end of 2014.[25]

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[15] NTT Corp., *In the Matter of Broadband Study Conducted by The Berkman Center for Internet and Society*, 2009, fig. 2.

[16] NTT Corp., *Financial Results for the Year Ended March 31, 2011 and Financial Forecasts for the Year Ending March 31, 2012*, May 13, 2011, 13, http://www.ntt.co.jp/news2011/1105ezqg/pdf/rhqy110513a_all.pdf.

[17] Ibid., 30.

[18] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*, 18.

[19] NTT Corp., *Financial Results for the Year Ended March 31, 2011 and Financial Forecasts for the Year Ending March 31, 2012*, 30.

[20] KDDI, *Annual Report: Financial Section*, 2010, http://www.kddi.com/english/corporate/ir/library/annual_report/pdf/kddi_ar2010_e14.pdf.

[21] Ibid.

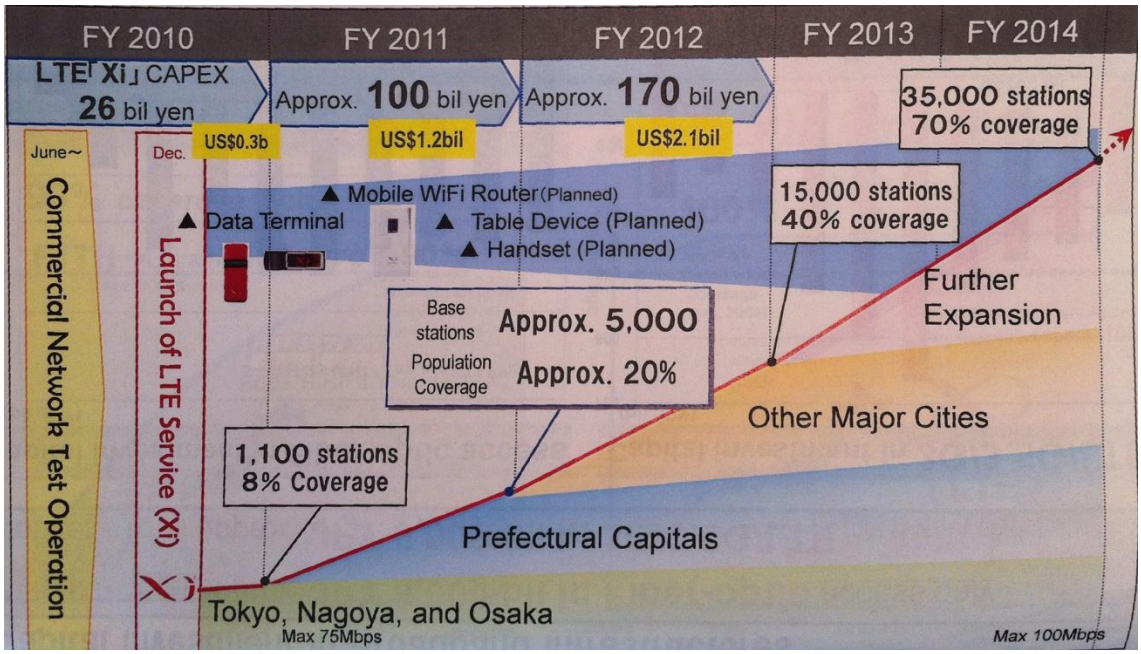
[22] Jupiter Telecommunications Co., Ltd., "J:Com Product Strategy" (Tokyo, Japan, June 28, 2011).

[23] Ibid.

[24] Personal communication with J:COM, June 29, 2011.

[25] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*.

Figure B6: NTT DOCOMO LTE Rollout Plan



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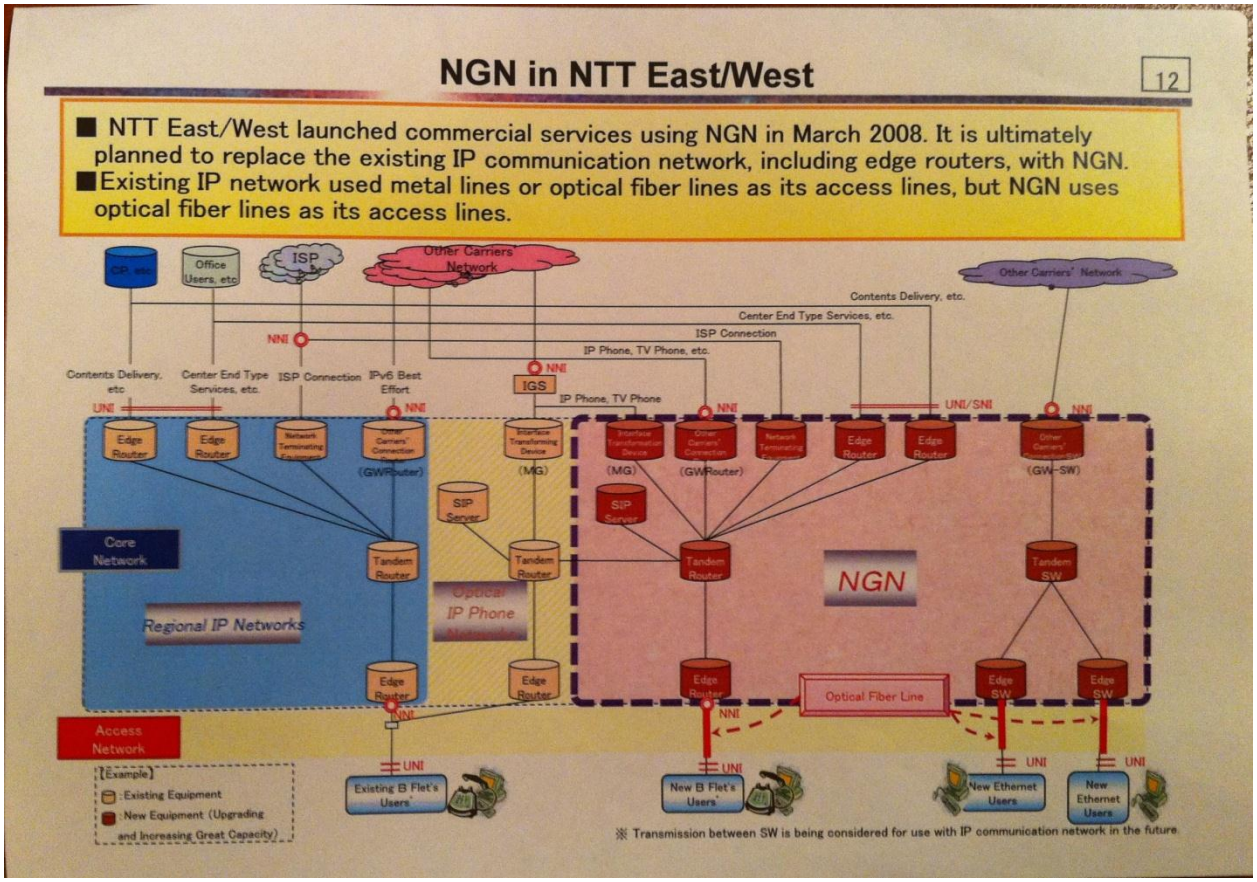
Similarly, in March 2011 KDDI announced its plans to introduce LTE beginning at the end of 2011. According to the company, its service will allow for downlink speeds of up to 9.3 mbps[27]

[26] Ibid.

[27] KDDI, *Annual Report: Financial Section*.

Relationship of NGN to internet networks and NGN Architecture

Figure B7: NTT's NGN Network



Source: Ministry of Internal Affairs and Communication.[28]

B3 Measures to facilitate rollout of NGNs

The Japanese government has encouraged NGN rollout, but most of that encouragement appears to have taken occurred via its close relationship with NTT and its u-Japan policy statements beginning in 2006[29] rather than funding or regulation. The net effects are mixed. On the one hand, ultra-fast (above 30 mbps) broadband is ubiquitous in Japan. On the other hand, while 70 percent of households subscribe to broadband, use of that infrastructure is quite low, and the various government goals for broadband use remain largely unmet.

[28] Takanori Ando, *Competition Policy in Japan: Next Generation Network (NGN)* (Telecommunications Bureau, Tariff and Telecommunications Access Policy Division, Ministry of Internal Affairs and Communications, June 30, 2011).

[29] http://www.soumu.go.jp/menu_seisaku/ict/u-japan_en/index.html

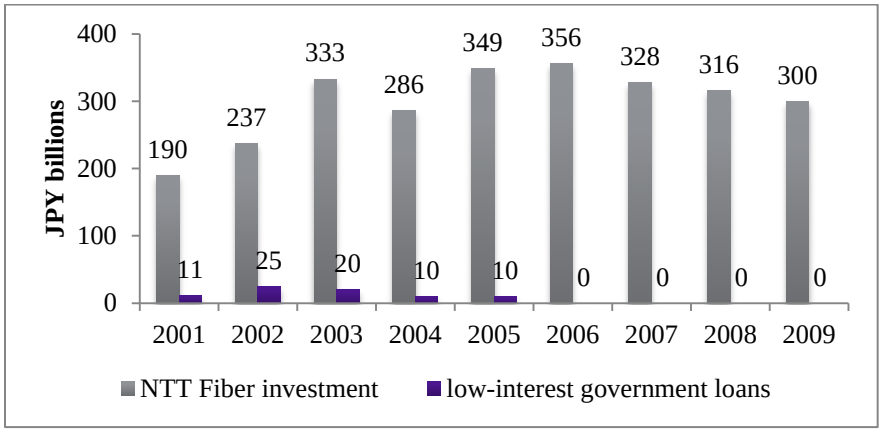
Additionally, no online applications make use of the high speeds available subscribers, no major streaming video except YouTube and a Japanese video-sharing site ("Nico Nico Douga")[30] is available, and Japan has produced no major Internet companies.

To the extent that the presence of the infrastructure itself is an accomplishment it is not clear to what extent the Japanese approach is applicable to other countries. While NTT is no longer owned by the government, it appears to be heavily influenced by government objectives.

Government funding for NGN

The Japanese government has directly invested relatively little money in NGN infrastructure (Figure B8). The majority of government investment has been "grants-in-aid" targeted at the last one percent of areas not yet served by a broadband network.[31] The government provides these grants directly to municipalities.[32] These grants, which total about JPY2.4 billion (about $30 million) per year, are intended to cover one-third of the one-time cost of laying fiber.[33]

Figure B8: NTT and Japanese Government NGN Investment



Source: NTT.[34]

Achieving efficient NGN costs

Rolling out fiber is not cheap, but costs have fallen due to economies of scope and scale and improved efficiencies due to experience. According to NTT, the cost per fiber access fell from about JPY 17,600 ($220) per month in 2001 to JPY 4,700 ($58) per month in 2009.[35] While those costs have fallen, they are still significantly more than cable operators spend to upgrade their networks to

[30] This site was launched in 2007 and now has 1.2 million subscribers to its $6.00/month premium service, which allows movie streaming. Tatsuo Takita, *Broadband Situation in Japan: Past, Present, and Future* (ICR InfoCom Research, Inc., June 6, 2011).

[31] NTT Corp., *In the Matter of Broadband Study Conducted by The Berkman Center for Internet and Society*.

[32] Personal communication with NTT and GLOCOM.

[33] Personal communication with Infocom staff.

[34] Nippon Telegraph and Telephone, *Comments on Broadband Study Conducted by the Berkman Center for Internet and Society*, 2010, fig. 3.

[35] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*, 9.

DOCSIS 3.0. One report suggests that upgrading to DOCSIS 3.0 costs as little as $20 per house passed.[36]

In building wiring

For its FTTH access to multi-dwelling units (MDUs), NTT

"developed compact optical splitter modules that provide greater installation flexibility and indoor optical cabling that can be installed on the building's exterior walls. They overcome problems encountered in providing optical fiber cabling systems to MDUs and installing splitter modules in the limited space available in main-distributor-frame boxes as well as other difficulties caused by a lack of space in conduits or the absence of conduits."[37]

The Ministry notes that "issues involving access to apartment buildings and indoor wiring for switching business operators hav[e] also being pointed out in recent years," but does not appear to have passed specific rules to address those issues.[38]

Spectrum release plans

Japan has allocated 320 MHz of spectrum for 3G and LTE services, including spectrum in the 800 MHz band as well as 1.5, 1.7, 1.9, 2, and 2.5 GHz bands. Of that, NTT DOCOMO has 140 MHz, KDDI 90 MHz, Softbank 60 MHz, and eMobile 30 MHz.[39]

Japan has not used auctions to allocate spectrum, relying instead on "beauty contests" and license rules that specify which services are allowed. Providers pay annual spectrum fees rather than purchasing licenses. The Ministry of Internal Affairs and Competition has ongoing discussions on how to allocate spectrum:

Since October 2008, the MIC has held a Spectrum Policy Round-Table Conference for studies on the future vision and possible uses of radio communication systems and services in the 2010s and published the results as the Spectrum Policy Round-Table Conference Report: Strategy for Generation of Spectrum Business. Possible new applications harnessing wireless communication technology include systems and services such as non-colliding vehicles and comfortable, fully cordless living environments. It is estimated that the market for new spectrum- related services and systems could be worth 50 trillion yen by 2020.[40]

Currently, the ministry plans to make an additional 100 MHz available for mobile broadband but is still deciding on how whether to use beauty contests, auctions, or other methods. Figure B9 shows each operator's plan for rolling out LTE.

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[36] Saul Hansell, "World's Fastest Broadband at $20 Per Home," *The New York Times Bits Blog*, April 3, 2009, http://bits.blogs.nytimes.com/2009/04/03/the-cost-to-offer-the-worlds-fastest-broadband-20-per-home/.

[37] Hayato Minami et al., *Cabling Technologies Providing More Optical Cabling Potential in Multi-Dwelling Unit Buildings* (Tsukuba-shi, Japan: NTT Access Network Service Systems Laboratories, 2010), https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201106ra1.html.

[38] ICT Policy Task Force for a Global Era, *Toward Realization of the "New Broadband Super Highway (Hikari no Michi)" Plan Final Report (Draft)*, 8.

[39] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*, 27.

[40] Ministry of Internal Affairs and Communications, *Information and Communications in Japan* Chapter 5, p.53.

Figure B9: LTE (3.9G) Deployment Plans in Japan

Operators		EM emobile	docomo	SoftBank	au by KDDI
Requested band		1.7GHz band/10MHz	1.5GHz band/15MHz	1.5GHz band/10MHz	1.5GHz band/10MHz
3.9G and others	Adopted technology	DC-HSDPA LTE(5MHz,2×2MIMO)	LTE(15MHz,2×2MIMO)	DC-HSDPA LTE(5MHz,2×2MIMO)	LTE(10MHz,2×2MIMO)
	Introduction band	1.7GHz band (DC-HSDPA,LTE)	1.5GHz / 2GHz band (LTE)	1.5GHz band(DC-HSDPA) 2GHz band(LTE)	800MHz / 1.5GHz band (LTE)
	Pilot launch	September 2010~	July 2010~	January 2011~	November 2011~
	Commercial launch	September 2010~	December 2010~	July 2011~	December 2012~
	Number of BSs/ Area cover ratio (till 2014)	6,388 / 75.2%	20,700 / 51.10%	9,000 / 60.63%	29,361 / 96.5%
	Capital investment (till 2014)	64.4 billion yen	343 billion yen	207.3 billion yen	515 billion yen
	Subscribers (till 2014)	2.95 million	17.7 million	5.41 million	9.84 million
1.5 GHz / 1.7 GHz band	New System	HSPA,DC-HSDPA LTE	LTE	HSPA,DC-HSDPA	LTE
	Pilot launch	January 2010~	May 2012~	December 2009~	November 2011~
	Commercial launch	January 2010~	three quarters of 2012~	April 2010~	December 2012~
	Number of BSs/ Area cover ratio (till 2014)	6,676 / 75.2%	5,700 / 50.62%	10,000 / 81.47%	6,361 / 53.0%
	Capital investment (till 2014)	66.0 billion yen	115.1 billion yen	210.0 billion yen	131.5 billion yen

Source: Ministry of Internal Affairs and Communications.[41]

B4 NGN Interconnect

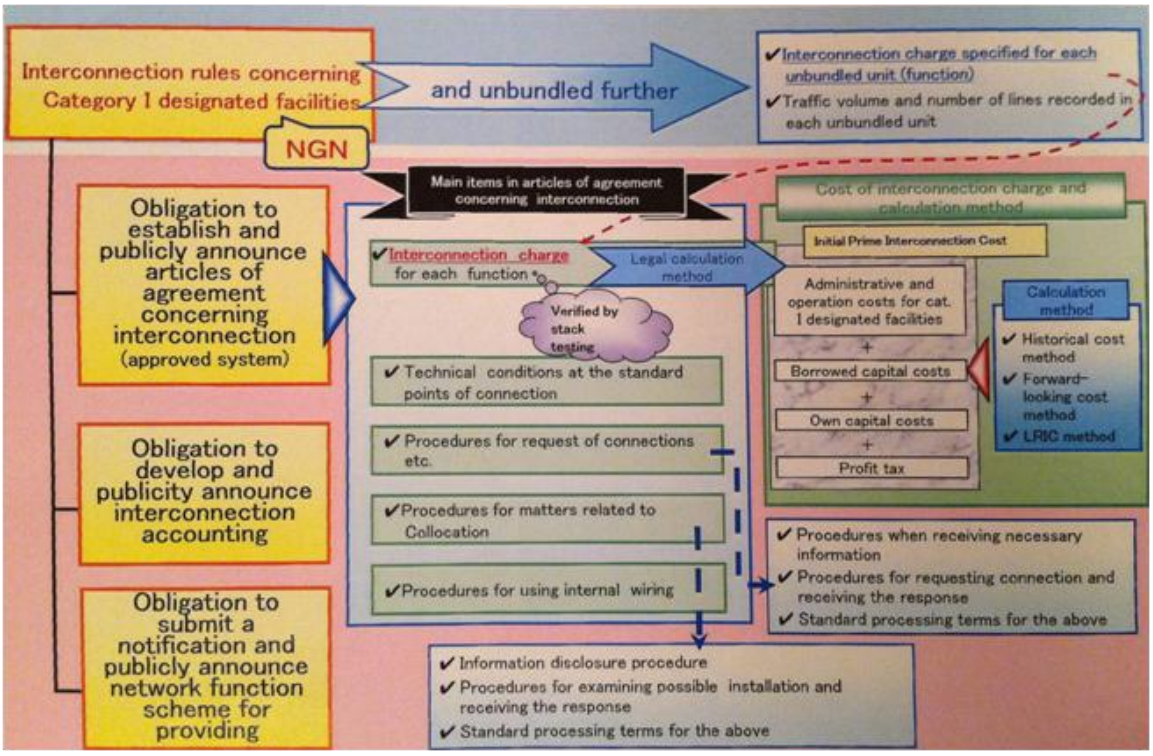
The MIC outlined NGN interconnection principles in a November 2010 report.[42] The rules focus explicitly on NTT as the dominant carrier. For example, NTT is allowed to charge JPY10 per minute for other providers to terminate calls on its network while other providers' charges to NTT are not regulated.[43] Figure B10 provides details on NGN interconnection rules.

[41] Ministry of Internal Affairs and Communications, "Outline of 3.9G Deployment Plans" (Tokyo, Japan, June 30, 2011).

[42] ICT Policy Task Force for a Global Era, *Toward Realization of the "New Broadband Super Highway (Hikari no Michi)" Plan Final Report (Draft)*.

[43] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*, 11.

Figure B10: Wireline NGN Interconnection Rules



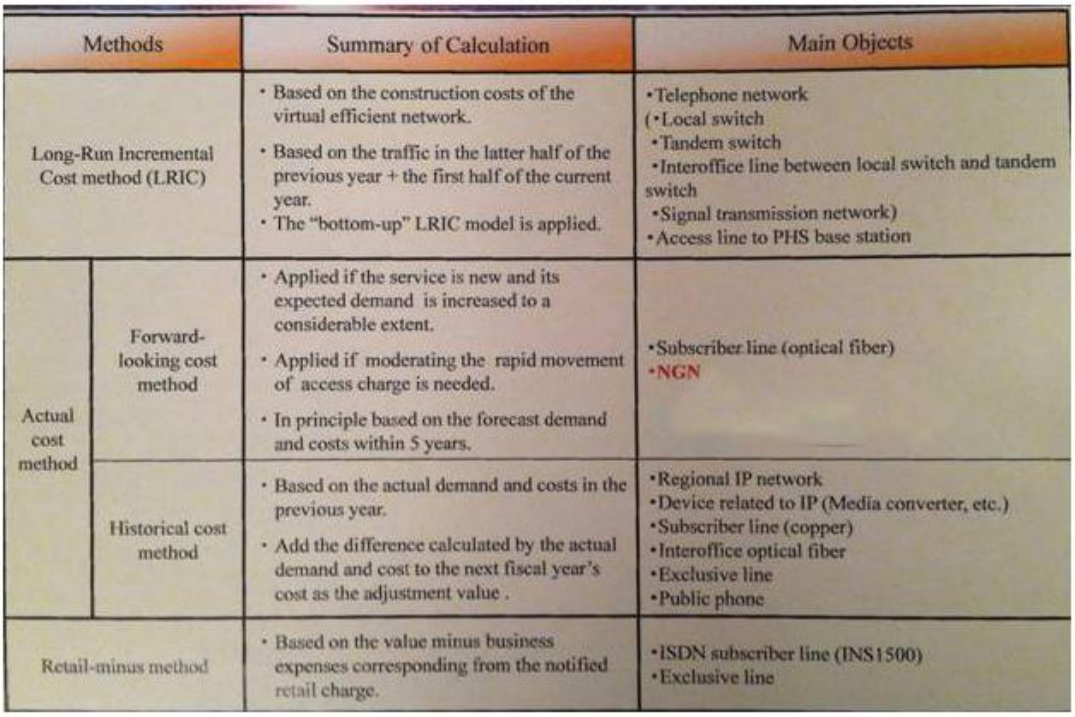
Source: Ministry of Internal Affairs and Communication.[44]

Setting termination charges

NGN interconnection charges are based on forward-looking costs. As Figure B11 shows, fiber and NGN are the only services in which forward-looking costs are used to calculate access charges.

[44] Ando, *Competition Policy in Japan: Next Generation Network (NGN)*.

Figure B11: Methods of Calculating Access Charges in Japan



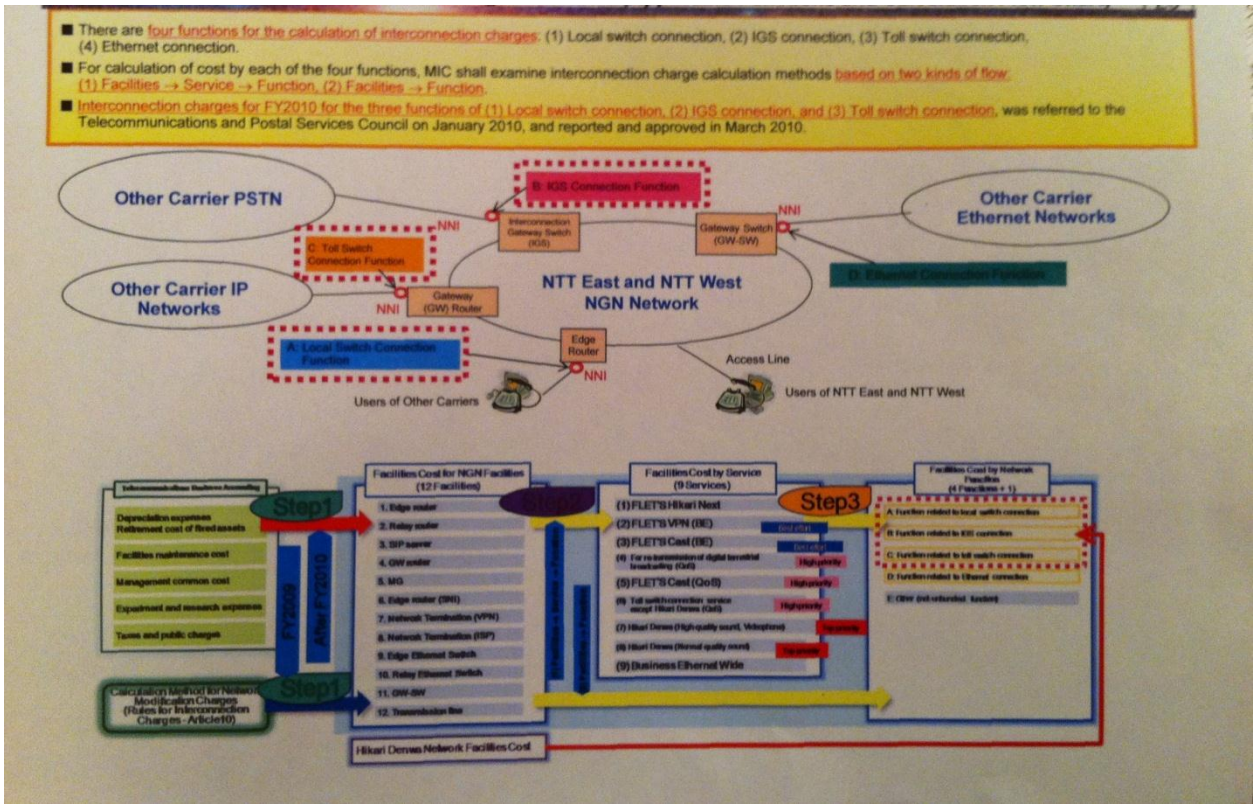
Methods		Summary of Calculation	Main Objects
Long-Run Incremental Cost method (LRIC)		• Based on the construction costs of the virtual efficient network. • Based on the traffic in the latter half of the previous year + the first half of the current year. • The "bottom-up" LRIC model is applied.	•Telephone network (•Local switch •Tandem switch •Interoffice line between local switch and tandem switch •Signal transmission network) •Access line to PHS base station
Actual cost method	Forward-looking cost method	• Applied if the service is new and its expected demand is increased to a considerable extent. • Applied if moderating the rapid movement of access charge is needed. • In principle based on the forecast demand and costs within 5 years.	•Subscriber line (optical fiber) •NGN
	Historical cost method	• Based on the actual demand and costs in the previous year. • Add the difference calculated by the actual demand and cost to the next fiscal year's cost as the adjustment value .	•Regional IP network •Device related to IP (Media converter, etc.) •Subscriber line (copper) •Interoffice optical fiber •Exclusive line •Public phone
Retail-minus method		• Based on the value minus business expenses corresponding from the notified retail charge.	•ISDN subscriber line (INS1500) •Exclusive line

Source: Ministry of Internal Affairs and Communication.[45]

Figure B12 shows how those forward-looking costs are estimated.

[45] Ibid.

Figure B12: Calculation of NGN Interconnection Charges



Source: Ministry of Internal Affairs and Communication.[46]

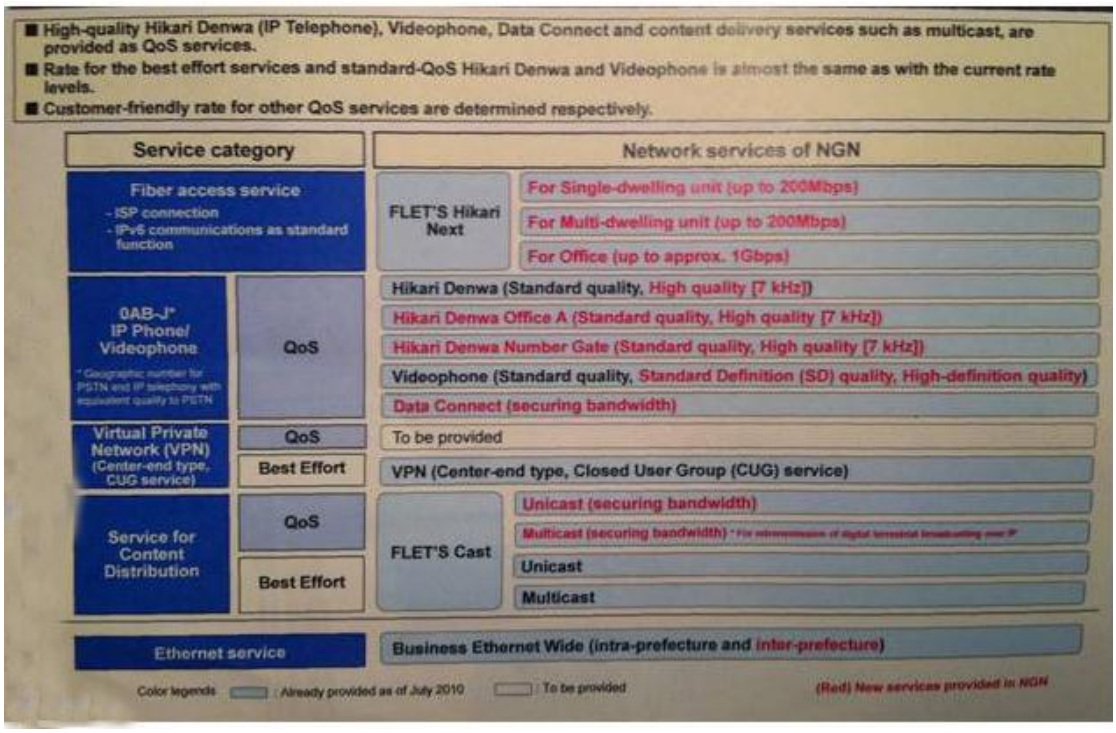
End to end QOS

NTT has been attempting to introduce NGN services based on guaranteed QOS but has to date had little success in attracting subscribers to those services.[47]

[46] Ibid.

[47] Personal communications with MIC and Infocom.

Figure B13: NGN Network Services



Source: Ministry of Internal Affairs and Communication.[48]

B5 Other possible NGN regulation

Calls to emergency services

Two types of IP phone services are available in Japan. “050 IP” phones are those that provide voice services based on “best-effort.” “OAB to JIP” phones offer quality similar to legacy voice lines. High-quality phones must be able to connect to emergency services, while the best-effort phones are not required to be able to make emergency calls.[49]

Obligations to continue legacy services

Although NTT’s fiber network is essentially complete, it is planning to begin phasing out its copper network only in 2020.[50] Regulators and analysts offer two possible reasons why NTT wants to maintain its copper network as long as possible. First, it uses its copper to meet its universal service obligations. Presumably, retiring its copper would necessitate rolling out fiber to the few areas that do not have fiber, which presumably are the most expensive to serve. Second, it still provides some

[48] Ando, *Competition Policy in Japan: Next Generation Network (NGN)*.

[49] Personal communications with MIC.

[50] Personal communications with MIC and Infocom.

services over its copper lines that are a legacy of NTT's history as a state-owned company. Some of those, such as traffic light controls, may be costly to transition to fiber.

Removal of existing regulations

n/a

Universal broadband policy

Universal service in Japan is based on the premise that basic telecommunications services are "essential to the life of every person," must be "affordable for everyone," and must be "available everywhere without differences between regions."[51] Currently it subsidizes subscriber line access (voice), public telephone service, and emergency call service.[52]

Universal service is funded by a fee on each telephone number serviced by any provider with revenues exceeding JPY 1 billion. Table shows the amount of money spent on universal service from 2006-2010 as well as the monthly subscriber contribution.

Table B1: Universal service fee and expenditures

Fiscal Year	2006	2007	2008	2009	2010
Support for NTT East & West (unit: billions Yen)	15.3	13.6	18.1	18.8	15.2
Monthly contribution per telephone number (unit: Yen)	7	6	8	8	7

Source: Ministry of Internal Affairs and Communications.[53]

Any carrier can apply to become eligible to receive universal service funds, but to date no carrier has—only NTT receives these subsidies. NTT contends that these subsidies cover "only a limited part" its costs in providing service in high-cost areas.[54] The lack of applications for universal service support lends credibility to NTT's claim.

With one small exception, Japan does not yet have any policy related to universal broadband service. As Hong Kong's OFTA noted, the MIC "submitted an inquiry on 27 July 2010 to the Information and Communications Council of Japan concerning the status of the basic telecommunications service (universal service) system in the transitional period until broadband services reach all parts of Japan."[55]

[51] Ministry of Internal Affairs and Communications, "Universal Service Policy in Japan", 2008, http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/presentation/pdf/080129_2.pdf.

[52] Ibid.

[53] Ando, *Competition Policy in Japan: Next Generation Network (NGN)*.

[54] Kuriyama, *Regulatory Environment and Rollout of NGN in Japan*, 40.

[55] Regulatory Affairs Advisory Committee, *Universal Service Obligation in the Era of Next Generation Network*, NGNWG Paper (Hong Kong: Office of Telecommunications Authority, September 17, 2010).

The exception is that MIC now allows OAB-J IP phones—the high-quality IP phone service—to satisfy universal service obligations. MIC notes that "it is not necessary to provide new metal [copper] subscription telephones in areas where a carrier provides an optical IP telephone service satisfying [these] conditions."[56]

B6 Key regulatory issues to resolve

Access and use of broadband

Japan has comprehensively available fibre access services, which now cover a high proportion of the population. However, the usage of these connections is significantly below the capacity available to consumers resulting in a situation where the Japanese Government's goals in respect of broadband remain largely unmet. While not strictly a regulatory issue there remains a question as to whether the "New Broadband Super Highway" plan proposed in 2010 will deliver the further economic development Japan seeks through accelerating and further developing the use of its broadband infrastructure.

Universal broadband service

At present Japan's universal service requirement is limited to subscriber line access (voice), public telephone services and emergency call services and this is funded by a fee levied on each telephone number provided by a provider with revenues exceeding JPY 1 billion. So far there has not been a definition of universal service for Japan for the broadband era. However, the Broadband Super Highway plan gives rise to consideration of this question at some time in the future, a matter that is currently being considered by the Ministry of Internal Affairs and Communications[57].

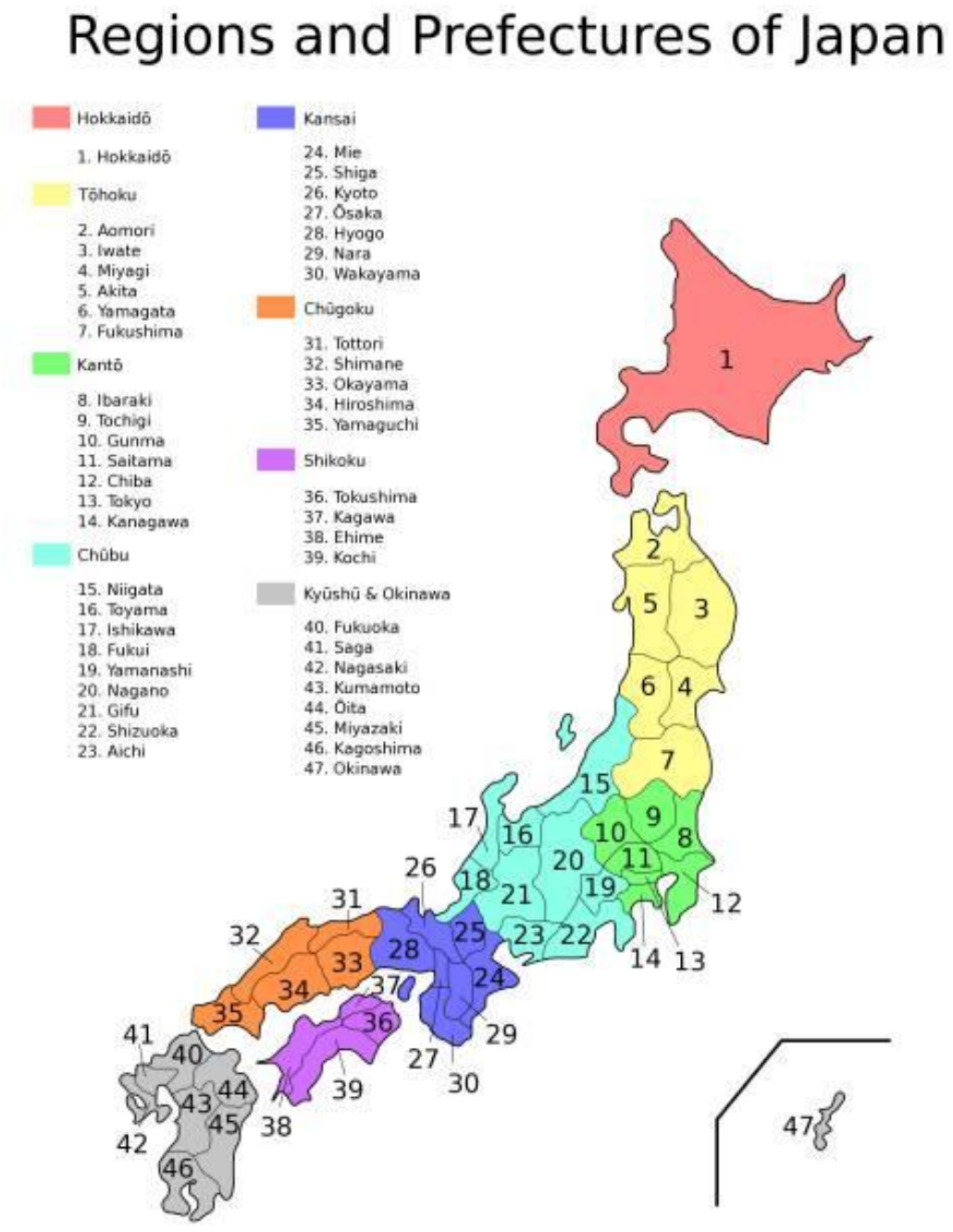
Access to radio spectrum

A decision still has to be taken on how to allocate 100MHz of radio spectrum for mobile broadband use. So far Japan has not used auction for spectrum and has preferred use of a "beauty contest".

[56] Ando, *Competition Policy in Japan: Next Generation Network (NGN)*, 24.

[57] http://www.soumu.go.jp/main_sosiki/joho_tsusin/eng/councilreport/pdf/101026_1.pdf

Appendix A: Map of Japan



Source: http://en.wikipedia.org/wiki/File:Regions_and_Prefectures_of_Japan.svg

Annex C Korea

C1 NGN regulation

The BcN (Broadband Convergence Network), a Korean version of NGN, was initiated and actively promoted by government through the MIC (Ministry of Information and Communication), the Korean telecoms regulator, which is now the KCC (Korea Communications Commission). The government actively promoted NGN as they believed it is essential for Korea to have access to converged and innovative services through a common IP-based network.

To promote a nationwide BcN in the shortest time the MIC established a plan for BcN build-out in February 2004 and set up several enabling bodies

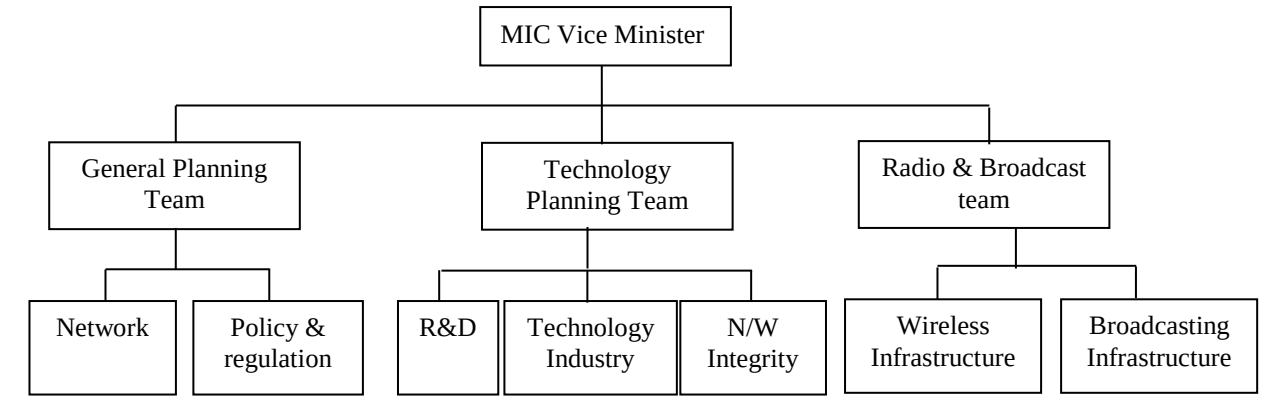
- The BcN build-out planning board
- BcN promoting bodies by sector
- An advisory committee on BcN.

The MIC consulted extensively with industry, other relevant public authorities or academic experts and held public hearings on decisions for the BcN agenda. For example, when it drafted the Basic Plan on BcN Build-out in November 2003, it held an e-public hearing the outcome of which was reflected in the confirmed plan in February 2004. In practical terms, the government has sought opinions from major stakeholders and held public hearings by stage.

BcN Build-out Planning Board(March 2003)

To set up the Basic Plan for the BcN Build-out, the NRA established a Board in March 2003, which was headed by the Vice Minister of the MIC. Several task forces were also formed. After establishing the board the Basic Plan for the BcN Build-out was established in February 2004.

Figure C1: Organization chart of the BcN Build-out Planning Board



Source: KCC, ICT Korea (2010)

BcN Promoting Bodies(March 2004)

To promote the Basic Plan for BcN Build-out the NRA designated specific promoting bodies by sector in March 2004 in accordance with the article 27 of the Law on Promoting Informatization. Figure C2 shows details on various promotion bodies by sector.

Figure C2: Promoting bodies for BcN designated by the NRA

Sector lead	Responsibility	Promoting body
Standard model development	Study & draw draft for BcN standard model Promote domestic & international standardization	ETRI58
Enhancement of high speed public network	Promote provision of high quality IP network & service to public network used by public authorities	NIA59
Develop quality management system	Build authentication and approval system of telecoms network Study on the law and arrangement relating to telecoms network quality	NIA
Build & operate open service platform	Support build of open API environment for various services interoperable over heterogeneous networks	ETRI
Finance fixed subscriber loop build	Finance high speed network build in rural and remote area	KTOA60
Upgrade in-building network	Develop standard architecture for FTTH build Study on technology standard for in-building networks	Designated by bid
Broadband R&D network	Build & operate broadband R&D network Promote co-study of IT technology and applications in domestic & overseas countries	NIA
	Cooperation for international R&D including APII/TEIN61	KISDI62
Technology Development	Development of fibre-based transmission & switching equipment, FTTH subscriber network etc.	ETRI etc
Evolve law and arrangement	Study on telecoms, broadcast law and arrangement for BcN	KISDI etc.
General support for BcN agenda	Manage & evaluate BcN build Trace trends relating to BcN as well as file statistics	NIA

Source: KCC, ICT Korea (2010)

[58] Electronics and Telecommunication Research Institute

[59] National Information Society Agency

[60] Korea Telecommunications Operators Association

[61] APII: Asia-Pacific Information Infrastructure, TEIN: Trans-Eurasia Information Network

[62] Korea Information Society Development Institute

BcN Advisory Committee (June 2004)

In addition the BcN Advisory Committee was set up in June 2004. The Committee's main role was high-level to review short term and mid-term planning of BcN. In terms of the organizational structure of the committee, the Minister of the MIC chaired the committee and relevant industry leaders, equipment manufacturers, R&D organizations and academic experts were key players.

Figure C3: Participants in BcN Advisory Committee

Sector	Participants
Government	Minister, Vice Minister & major Directors of the MIC
Public organization	6 organizations including ETRI, KISDI & NIA
Telecom operators	7 network operators including KT, SK Telecom, LGU+
Broadcasters	3 terrestrial broadcasters(KBS, MBC, SBS) & 4 CATV operators(T-Broad, CJ Hello vision, C&M etc)
Manufacturers	8 vendors including Samsung Electronics and LG Electronics
Academy	6 academies including Korea Telecoms Academy

Source: KCC, ICT Korea (2010)

While the Government took action there was also action at industry level:

First, the MIC designated 3 BcN pilot consortia for BcN services: Octave Consortium led by KT, the fixed incumbent; Ubinet Consortium led by SK Telecom, the leading mobile operator; and Kwangaeto consortium led by Dacom[63], an alternative fixed operator established in August 2004. The winners built BcN in pilot areas and provided BcN service to 1,350 households (including VoIP, hi-definition video telephony, IP-TV & T-Commerce at speeds between 50~100Mbps). The MIC also designated a Cable BcN consortium in March 2005.

Second, the Strategic Advisory Committee on IT839 infrastructure was set up in September 2004. Its main role was to ensure successful ICT infrastructure build out. As a reference, IT839 Strategy is a representative ICT agenda in Korea where BcN was a component of 3 strategic infrastructure build out projects along with IPv6 and USN.

Third, the government supported the BcN forum which was established in October 2002. The BcN forum's main role was review of network evolution, standards & related policies.

In summary, NGN in Korea was led by government as a policy agenda which was assisted by various organizations in both government and industry. The scope of the Korean NGN was intended to cover the broadcast sector as well as telecoms as part of the BcN agenda.

Outcomes of various actions for NGN

Firstly, the MIC unveiled its draft version of the Basic Plan for BcN Build-out in November 2003. The vision contained in the plan was to become a first-mover globally in broadband convergence thereby promoting Broadband ICT Korea. Of course, its ultimate goal was ensure a universal environment for

[63] Dacom was a significant operator in fixed telephony sector at that time, now merged into LGU+

Korean citizens to have access to information services. This plan was actually an evolution of a previous agenda for high-speed information and communications networks, which was promoted from 1995, with 3 stages.

Figure C4: Pre-BcN project in Korean ICT sector

Sector	Stage 1(1995~1997)	Stage 2(1998~2000)	Stage 3(2001~2005)
Backbone	Fibre-based transmission in major cities & provinces	Extension of fibre-based transmission to rural and remote areas	Transmission capacity extension
Subscriber network	FTTO in major buildings	ADSL/CATV for end-users (FTTC 10%)	ADSL, CATV, FTTH for end-users(FTTC 90%)

Source: KCC, ICT Korea (2010)

Based on the high-speed information and communications network, the MIC set out the BcN plan, which also involved 3 stages, where by 2010 it aimed to provide BcN to 20 million subscribers for multi-media services with 50~100 Mbps. Details of BcN features were as below:

Figure C5: Roadmap of BcN in Korea

Stage 1(2004~2005)	Stage 2(2006~2007)	Stage 3(2008~2010)
Ensure groundwork for BcN deployment Aim at fixed-mobile interoperability and early version of telecom-broadcast convergence service	BcN build and commercial launch in some areas	Complete convergence among telecoms, internet & broadcast network thereby provide truly converged service Extend commercial service nation-widely

Source: KCC, ICT Korea (2010)

Figure C6: Details of BcN projects by stage

Sector		Stage 1	Stage 2	Stage 3
Service conversion	Convergence between voice & data	Soft switch Access G/W VoIP with MOS64 3.6	VoIP with MOS 3.8	VoIP with MOS 4.0
	Convergence between fixed & mobile	Broadband, WLAN, fixed-mobile interoperable video telephony & VoD service	Convergence among Broadband, WLAN, Wibro, mobile service	Convergence among 4G, FTTH service etc
	Convergence between telecoms & broadcast	DMB, Near-VoD, T-commerce, T-Gov65	Hi quality VoD, Interactive DMB	HD QoS guaranteed multi-media service
Transmission network	QoS	QoS service based on MPLS for some subscribers	Extend MPLS-based QoS network and introduce GMPLS66 network	Extend GMPLS network Ensure end-to-end quality
	Security	Build security monitoring system for addressing over loading traffic etc	Build response system for addressing harmful traffic etc	Build active security system for controlling abnormal traffic etc
	IPv6	Support parallel IPv4/IPv6 at end-user terminal and subscriber network	Extend IPv6 to subscriber network and partly to transmission network	Apply to all layers
	Open API	Open API67 G/W by fixed and mobile network	Open API G/W for converged network between fixed and mobile	Open API G/W for converged network between telecoms and broadcast networks
Subscriber network	Fixed	Extend FTTC(VDSL, HFC) and introduce FTTH for service with 50~100Mbps	Extend FTTC(VDSL, HFC) and FTTH for service with 50~100Mbps	Enhance FTTH for service with 50~100Mbps
	Mobile	Build 3G network Extend build of WLAN with 11~54 Mbps	Introduce Wibro network for 50Mbps service	Introduce 4G network for 50Mbps service
	Broadcasting	Build digital CATV, terrestrial radio, satellite DMB network	Converge with telecoms network for interactive service	Enhance network for universalizing HD-level service
	Home network	Provide home G/W to 3 million households	Provide home G/W to 10 million households Introduce USN68	Universalize digital home and extend USN

Source: KCC, ICT Korea (2010)

[64] Mean Opinion Score

[65] T-Gov: eGovernment based on TV

[66] GMPLS: Generalized Multi-Protocol Label Switching

[67] API: Application Programming Interface

[68] Ubiquitous Sensor Network

In summary, the NGN agenda in Korea, BcN, was initiated and led by the Korean government with its strong belief in the digital economy and the ICT sector in Korea. The Korean government approached this in a systematic manner by setting up several task forces, advisory committees and cooperation bodies among government, industry and consumer. These delivered several key outcomes including the basic plan, roadmap and detailed list of tasks by sector.

In terms of legislation, the Telecom Business Act and Law on promoting Informatization played key roles for the Korean NGN agenda. The Telecom Business Act established the ground for easy access to facilities, which are crucial for NGN roll out, by designating operators and facilities to be provided. The Law on promoting Informatization has enabled government-led NGN policy to align with the Informatization agenda in Korea.

TheTelecom Business Act addresses issues such as authorization, interconnection, facility sharing, universal service, merger & acquisition among telecoms operators and consumer protection. The Law on promoting Informatization in Korea is a basic act for Informatization in Korea. Its first article sets out the goal of a basic policy of national Informatization thereby contributing to a knowledge-based society and enhancing citizen's quality of life[69]. Propagation of the Internet throughout the country, combating the digital divide and protection of personal data are major components of this Law. In addition, as described below, the Radio Act also played a role for the Korean NGN agenda in that it enabled allocation of spectrum for LTE services.

More recently the Korea Communications Commission has published its blueprint for "A Smart Korea For All"[70]. This document details aspirations to reinforce broadcasting and communications welfare benefits to give everyone access to quality and reliable IT and communications services at an affordable price.

C2 Roll out of NGNs

Current status of core and NGA rollout

The current status of core and NGA rollout in Korea is as below;

Core networks gradually migrated to IP-based networks from legacy circuit switched based networks. The core networks of fixed, mobile and internet services have been progressively converged onto IP since 2005. So far, 30% of fixed local network and 100% of long distance network have become IP-based at the end of 2010. VoIP service was launched commercially and there are already around 10 million subscribers, more than 50% of PSTN subscribers. Mobile operators have also deployed IP networks but they still carry voice traffic on legacy TDM. Mobile operators are expected to fully migrate to IP when LTE is into mass deployment.

Access network deployment outperformed the initial NGN plans. For example the detailed plan for building NGA was changed at stage 3 as it was outperforming the plan. As Figure C7 shows the initial target number of BcN users at stage 1 was 2 million but when the government changed its plan at

[69] Law on promoting Informatization was renamed by Basic Act for National Informatization in 2009

[70] http://eng.kcc.go.kr/user.do?mode=view&page=E04010000&dc=E04010000&boardId=1058&cp=1&boardSeq=31647

stage 3 the actual number of subscribers was 3.12 million. The goal at the end of stage 3 has been increased from 20 million to 35 million users.

Figure C7: Changes target BcN subscribers from stage 1 to stage 3 (million)

Sector		Stage 1 (2004-2005)	Stage 2 (2006-2007)	Stage 3 (2008-2010)
Target service (example)		Video telephony VoIP	Wibro Interactive DMB	HD multimedia service guaranteeing QoS
Plan at Stage 1	Fixed	1.5	4.5	10
	Mobile	0.5	3.5	10
	Sum	2.0	8.0	20
Performance & plan at Stage 3	Fixed	2.56	7.01	12
	Mobile	0.56	5.63	23
	Sum	3.12	12.64	35

In terms of BcN subscribers by technology, LAN & FTTH are prevalent for fixed while the majority of mobile subscribers enjoy HSDPA technology for wireless.

Figure C8: Fixed BcN subscribers by technology as of September 2010 (> 50 Mbps, million)

Technology	VDSL	LAN	HFC	FTTH	Sum
Fixed	1.74	5.84	2.58	3.22	13.37
% over total subscribers					78.7%

Source: KCC, ICT Korea (2010)

Figure C9: Wireless BcN subscribers by technology as of September 2010 (>1Mbps, million)

Technology	Wibro	HSDPA	Sum
Wireless	0.414	29.14	29.55
% over total subscribers			68.8%

Source: KCC, ICT Korea (2010)

What progress have the main fixed and mobile networks made implementing NGNs?

Currently, there are major 3 telecom groups in Korea where each group provides fixed, mobile and internet service: KT group, SKT group and LG U+ group. In fixed KT is the incumbent with market dominance for telephony service as well as being the leading operator for broadband internet. In mobile, SK Telecom has maintained the largest market share at around 50%. In every sector, LGU+ is positioned as the 3rd player. In addition to the traditional telecoms operators, CATV operators are positioning as alternative telecom operators with their provision of broadband internet and VoIP services delivered through their evolving core and subscriber networks.

In the fixed sector, KT is more active in deploying NGN than other telecom operators as its current networks are inefficient legacy networks. As a result, KT has realized its IP-based network ahead of rival operators and 30% and 100% of local and long distance networks respectively have become IP-based.

In the mobile sector, LGU+, the 3rd player has a plan to start commercially rolling out LTE in July 2011 and complete a nation-wide network in July 2012. LGU+ announced it will provide both voice and data service over its LTE network. SK Telecom, Korea's leading mobile operator, also has a plan to roll out a LTE network from July 2011 and complete nation-wide network coverage by 2012. SK Telecom only plans to provide data services over the LTE network – it will continue to carry voice service over current 3G networks. KT has a relatively conservative position for LTE build out as it considers it has stronger presence in Wifi and Wibro services. KT plans to introduce LTE later 2012[71]. It is expected that LGU+ may be the first player to launch genuine IP-based NGN services in Korea.

An ad on LGU+ LTE deployment, Source: Digital Times, 2011.6.6

How will this position change over the next four years?

The KCC, the successor of the MIC, announced a plan on the mid & long term evolution of telecom & broadcast networks in January 2009 after it considered network evolution in 2008, where it took account of the opinions of experts in industry, academics and citizens[72].

KCC's goal is to build a genuine all-IP-based ultra-BcN, which will provide 10 times higher access speeds than existing networks. That is 1Gbps for fixed and 10 Mbps for wireless.

Looking at core networks the expectation is for fixed IP-based networks to reach 70% by 2013 and 100% by 2015 while mobile would reach 15% by 2013. An interviewee from a mobile operator says slower progress in wireless BcN core networks would be for two main reasons: one is technological constraints and the other is carrier strategy. Although LTE would enable migration from a TDM voice service to IP-based service with IMS, it will take a few years to achieve this while technology issues stabilize. Also, slower evolution for wireless BcN is in part driven by mobile operator strategy to maximize the return on current 3G technology.

In terms of subscriber networks, by 2013, fixed BcN subscribers with speeds of 50Mbps to100Mbps is expected to be 14.5 million (85% of total households) while BcN subscribers in the mobile sector with speeds of 1Mbps~2Mbps is expected to be 46 million (93% of total subscribers). In addition, the plan projects 0.2 million users enjoying the maximum 1Gbps service in the fixed sector and 0.3 million users with the maximum of 10 Mbps service in the mobile sector. Once LTE deployment is complete, mobile operators expect to provide wireless service with average speed of 50 Mbps.

Figure C10: KCC UBcN plan in 2009

Section	2009~2010	2011~2013

[71] However, according to a press release recently, KT announced its commercial LTE service in November 2011 to counter rivals' dash into LTE service. Source: Digital Times, 23 June 2011

[72] KCC, Press release, February 2009

Section			2009~2010	2011~2013
Core network	IP-based fixed network		30%	70% (100% by 2015)
	IP-based mobile network		-	15%
Access network	Fixed subscribers	50~100Mbps	12 million	14.5 million
		1Gbps	-	0.2 million (commercial launch:2012)
	Mobile subscribers	1-2Mbps	28 million	46 million
		10Mbps	-	0.3million (commercial launch: 2013)

Source: KCC, Press release, February 2009

However, although the plan set a goal of mobile IP core network as 15% by 2013, it is expected that this number will substantially increase as mobile operators speed up deploying LTE. For example, when SK Telecom and LGU+ complete LTE nationwide network rollout by 2012, the portion of core IP-enabled network would be around 80%, far ahead of the KCC target.

Relationship of NGN to internet networks

Currently, there are several services running over BcN in Korea including VoIP, mobile video telephony and IP TV and once BcN build completes, it is expected that almost all legacy and new services will be carried over BcN. However, as BcN envisages QoS-guaranteed services based upon all-IP packet networks, it will not accommodate current broadband internet services, which are based on best-efforts.

Are the NGNs separate from the IP networks used for best efforts Internet services?

As BcN needs to ensure QoS, NGN separates from IP networks for best efforts internet services. However, whether all the NGN services are carried over NGN may depend on operator strategy, at least for the time being. For instance, it's known that KT operates a separate network, i.e. NGN for delivering NGN services like IPTV or VoIP, while other operators provide VoIP over best efforts internet. Logically, the gradually exploding traffic would require operators to serve new convergent services over only NGN as this would increase efficiency of network management. However, there are few plans for them to do so available in public at present.

Why are operators moving/not moving to NGNs?

The main motive to move to NGN has been to realize efficiencies at the operator level through the implementation of multi-service platforms. However, as stated above, this basic motive is expected to be reconciled in terms of the speed or extent of the urgency of NGN implementation by operator.

NGN network architecture

BcN network comprises 4 layers which are service & control layer, transmission layer, subscriber network layer and home & terminal layer[73].

- Service & control layer: service control by soft switch and interface to application servers
- Transmission layer: BcN core network with QoS guaranteed Service Edge Node and Label Switch
- Subscriber network layer: Access network deploying FTTH, HFC based Common Access Node for ensuring end-to-end QoS
- Home & terminal layer: intelligent home server and ubiquitous home network

NGN interconnect architecture

There is little or no available information on the future Korean NGN interconnection architecture envisaged at the moment. As discussed below the interconnect regime for NGN has been mainly driven by government-sponsored research institutes and internally by government.

C3 Measures to facilitate roll out of NGNs

Government funding for NGN

There is both industry and government funded BcN deployment where a government fund was put in place to facilitate BcN build while industry rolled out commercial BcN. The Governement intention was that BcN investment would be conducted on an industry-led basis which means industry would develop BcN technology, build a commercial BcN network and run pilot projects, while the government would fund R&D, develop ground technology and run pilot projects.

Figure C11: Government and industry funding for BcN deployment by year (billion won)

Section	Stage 1		Stage 2		Stage 3	Sum
	2004	2005	2006	2007	2008~2010	
Government	1,807	2,046	1,349	933	3,672	9,807
Industry	1,610	1,624	1,609	1,245	4,420	10,508
Sum	3,417	3,670	2,958	2,178	8,092	20,315

Source: KCC, ICT Korea (2010)

In addition, the plan released in 2009 for post-BcN build says total investment fund will be 34,100 billion won for 5 years by 2013 where government funds 1,300 billion.

[73] KCC, ICT Korea (2010)

Achieving efficient NGN costs

For the promotion of NGN deployment in an easy and competitive manner, the KCC amended the Telecom Business Act in September 2010 to allow facility owners other than telecom operators (electric power company, express way company, provincial authorities or public co-operations) to provide their facilities to telecom operators. The Ordinance on Facility Sharing amended in December 2010, following the TBA amendment, sets out the facilities to be leased, which include transmission facilities, premises or right of way (eg railway, subway, express way, tunnel, pedestrian overpass etc)[74].

In addition, the KCC designated an agency, 'Support centre for facility sharing', to promote telecom operators' networks by supporting transactions between telecom operators and facility owners other than telecom operators[75]. And, by locating the centre at the KTOA (Korea Telecom Operators Association) whose members are telecom operators, the KCC promotes more actively facility provision from those owners.

Therefore, though not specifically addressed for NGN, these two arrangements would stimulate telecom operators to deploy NGN in a more aggressive manner.

In building wiring

Traditionally, telecom operators in Korea have focused on deploying their own access network. Thus even in the case of in building wiring, those operators did so when it was possible to do in a physical manner. However, in practice there were many difficulties for access to in building wiring as it's not easy to access, especially in old buildings without enough space or where there is building owner's resistance to do so.

Therefore, the KCC has established a regulatory regime on facility sharing since telecoms liberalization in 1990s, which covered in build wiring facilities. Specifically the Telecom Business Act and Ordinance on Facility Sharing stipulates in particular rules for fibre and duct.[76] Firstly, KCC imposed a condition on KT to provide its space for in building wiring to rival operators on request in accordance with the Telecom Business Act. In terms of facility type to be shared the Ordinance on Facility Sharing set out as below:

- Fiber access lines (beyond lines already used by KT) and 35% of used lines (spare ratio) by KT. For example, if there are 100 lines owned by KT in total where 40 lines are used by KT, then fiber access lines available for rival operators will be 46 lines (100 – 40(used by KT)) – 14(40*0.35, spare lines)). Rational for spare lines concerns maintenance & repair of lines used by KT.
- Ducts beyond ducts used by KT and spared 1 duct. For instance, if there are 5 ducts owned by KT in total where 2 ducts are used by KT, ducts available for rival operators will be 2 ducts (5 – 2(used by KT) - 1(spare duct)). Rational for spare duct is same as fiber access lines.
- Poles

[74] KCC, Ordinance on Facility Sharing, Article 34, No.2010-55, December 2010

[75] KCC, Ordinance on Facility Sharing, Article 53, Article 54, No.2010-55, December 2010

[76] KCC, Ordinance on Facility Sharing, No.2010-55, December 2010

However, to promote KT's incentives to invest in access facilities in build wiring as well as establish a fair competition environment, the NRA allowed KT not to provide following fiber access lines and ducts in the access network.

- Fiber access lines which was newly deployed since 2004
- Ducts where there are alternative ducts available for rival operators

In addition to regulatory measures for promoting NGA, the KCC introduced a certification system for a broadband-equipped building in May 1999 when broadband services were being rolled out across the country. Its goal was to promote buildings to equip with broadband facilities and acquire space to locate them when new apartments or office buildings are being built.

Actually, it is known that habitants at apartments or owners of buildings have sought the certfication to increase the value of their buildings and, as a result, telecom operators have easily installed in builing wiring facilities in those buildings or apartments.

Currently the KCC classifies and certifies those buildings according to the extent of meeting listed criteria set by "Code on certification of broadband-equipped building" which was established in September 2010.

The criteria for grading buildings includes building wiring lines, ducts, space, etc and grades are classified as superior, 1st, 2nd and 3rd grade.

An example of the Certification of broadband-equipped building

Spectrum release plans for LTE

The KCC is responsible for spectrum planning and management including spectrum allocation in Korea. Currently, the KCC is considering spectrum release plans for LTE deployment as follows;

- Firstly, KCC announced a notice for auction of spectrum in 2.1 GHz and 1.8 GHz bands (each 20 MHz) and in the 800 MHz band(10MHz), 50MHz in total, at the end of June 2011 and required candidates to apply within one month. The usage period for the spectrum will be 10 years and maximum bandwidth per operator is 20MHz. The result of the auction is expected to be known in August 2011.
- Secondly, KCC has an intention to re-assign 700 MHz band(108 MHz) previously used for broadcasting for LTE service when analogue broadcasting service is phased out at the end of 2012. However, the prospect is not certain as broadcasters are proposing these spectrum bands for state-of-the-art broadcasting service in the future.

Spectrum exploitation plan for LTE by mobile operator

Currently, SK Telecom, LGU+ and KT have plans to start deploying LTE through their existing spectrum, that is, 800MHz, 900MHz and 1800MHz respectively (see Figure C12 below). It is noticeable however that when the auction for LTE spectrum, 2.1Ghz and 1.8Ghz for instance, is completed in July 2011, they are supposed to exploit this spectrum for LTE deployment as well[77].

Status of spectrum allocation for mobile operators

As of June 2011, 3 mobile operators in Korea exploit 270 MHz in total where SK Telecom, KT and LGU+ have 120MHz, 110MHz and 40MHz respectively. LGU+ has smaller spectrum resource than rivals as it gave up 2.1 GHz band for 3G service a few years ago.

Figure C12: Status of mobile operators spectrum exploitation in Korea (as of June 2011)

Operator	Band	Service	Capacity	
SKT	800 MHz	Cellular/4G	30 MHz	120 MHz
	2.1GHz	HSDPA	60 MHz	
	2.3 GHz	Wibro	30 MHz	
KT	1.8 GHz	PCS	20 MHz	110 MHz
	2.1 GHz	HSDPA	40 MHz	
	2.3 GHz	Wibro	30 MHz	
	900 MHz	4G	20 MHz	
LGU+	1.8 GHz	PCS	20 MHz	40 MHz
	800 MHz	4G	20 MHz	

Source: Digital Times, 9 June 2011

C4 NGN Interconnect

Interconnect principles

In legal terms, the Telecom Business Act and a specific Ordinance have governed the interconnect regime in Korea. The Telecom Business Act stipulates the interconnect regime among telecom operators in high-level terms while the Ordinance on Interconnect sets out specific details on interconnect including technical and economic terms and conditions.

[77] According a recent press release, it is known that 2.1GHz band for LTE service is expected to be actually allocated to LGU+ as the KCC excludes KT and SK Telecom for that band where the rationale is to promote fair competition level in mobile telecoms. Currently, other rivals, KT & SK Telecom has already exploited 2.1GHz band for 3G services. Source: Chosun Daily, 23 June 2011

The Telecom Business Act outlines interconnect principles such as operators' obligation to provide interconnection on request and fair & reasonable interconnect charges[78]. Thus the Korean interconnect regime ensures any-to-any connectivity principles between calling party & called party.

The current interconnect regime is based on traditional telecoms and the KCC did not specify and announce any new interconnect regime for NGN. However, any new interconnect regime is believed to ensure that the current any-to-any connectivity principle is carried forward as this principle is the core of interconnect regime itself.

Obligations on dominant operators

The Telecom Business Act sets out some further obligations on dominant operators. Article 39 of the Act says operators having market dominance or essential facilities are obliged to offer interconnect on request. Currently KT and SK Telecom are designated as those having market dominance or having essential facilities. However, in terms of achieving interconnect, the Korean experience has shown that every telecom operator had interconnected with each other irrespective of having market dominance or not. Furthermore, there are no additional regulations on dominant operators for termination charge calculation.

It could be said that the Korean interconnect regime has maintained very stringent requirements on interconnect among telecom operators in terms of interconnect provision and cost-based termination charges with very few exceptions.

Changes to interconnection as a result of NGN

As the current interconnect regime does not envisage a NGN environment, there are no clear-cut stipulations on who has a burden for changes at point of interconnect (POI) in the NGN environment. The current regime sets out that the originating operator shall bear interconnect line charges between POIs in principle[79]. And when an operator requests changes in network at counter-operator side, the requesting operator shall bear costs incurred in principle but may share it when the KCC considers it necessary in terms of ensuring equal access[80].

Thus, in principle, when operators transform their legacy network to NGN and change POIs, it could be said they would bear the costs. However, KCC did not decide on this issue yet.

As a reference, under the current legacy network interconnect regime, it is known that, when an operator changes POIs at its side through closing down a switching office, the operator bears costs by the interconnect agreement.

Charging methods

Traditionally, Korea has maintained calling party pay system. As a result, the interconnect regime has stipulated the originating operator paying termination charges to terminating operator.

[78] The Telecom Business Act, Article 39, Article 40, 2010.12

[79] KCC, Ordinance on Interconnect, Article 20, 2010.12

[80] KCC, Ordinance on Interconnect, Article 21, 2010.12

The charging method for termination charges in the NGN era has been considered and reviewed since the regulator announced a roadmap on wholesale regulation in telecoms industry in 2007. KISDI, an institute of government, studied this and compared strengths and weaknesses among various options for NGN interconnect including Bill & Keep or calling party pay etc. However, the regulator has not published any formal decision on interconnect charging methods in the NGN era. There may be several reasons for this and some interviewees say that incomplete NGN roll out or uncertain technological prospects would explain this.

Therefore, though the KCC has reviewed charging systems for NGN interconnect every year; it has made no formal decision as of yet. However, it is known that the KCC envisages lower termination charges for NGN so it makes efforts to set reasonably low termination rate for legacy interconnect for the time being.

Setting termination charges

Currently, termination charges for NGN in Korea are set based on the legacy network on a cost-oriented basis. Article 22 and Article 22-5 of the Ordinance on Interconnect provide a legal rational on this system. That is, Article 22 sets out that the termination charges of VoIP networks should be based on cost-oriented but, until specific details are determined, the KCC shall set the charges considering market competition and expert opinions and Article 22-5 says termination charges of network components for VoIP shall be based on PSTN network with similar functions.[81]

The basis for setting current termination charges is efficient cost oriented, that is a LRIC approach.

End to end QOS

The Ordinance on Interconnect sets out quality of service for interconnect in Korea.

Specifically Article 14 of the Ordinance says operators providing or seeking interconnect shall adopt measures against impaired function or break down interconnect facility by ensuring detour interconnect or emergency interconnect route, prior to interconnection with each other[82]. In addition, Article 17 of the Ordinance stipulates that KCC's Ordinance on Technical Standards, domestic or international standards shall apply to technical issues on interconnection. However, the Ordinance does not directly specify services which need particular attention.

In the case of NGN interconnect, as there is no decision yet for QoS.

C5 Other possible NGN regulation

Calls to emergency services

Though there is little available information on calls to emergency services in a NGN environment, when VoIP service is considered. The status is as follows;

[81] KCC, Ordinance on Interconnect, Article 22, Article 22-5, 2010.12

[82] KCC, Ordinance on Interconnect, Article 14, 2010.12

- Like any emergency service call in the legacy network, calls to emergency services over VoIP network are charged free.
- When a call to emergency services takes place, the call is forwarded to KT's legacy PSTN network then forwarded to the emergency authorities through hotline.

On a VoIP service, the location of caller placing emergency calls is recognized initially based on the location of the site where the VoIP terminal is installed when the initial subscription was placed. However, when the VoIP caller moves to another place the operator or emergency authorities will only recognize the callers' new location provided the caller informs them the changed location. Considering this fact, VoIP service providers are trying to ensure that VoIP subscribers enroll their location in various situations. For instance, the operators put a notice on the VoIP terminal or use a screen notice when VoIP subscribers turn on the terminal.

Consumer protection

There are no decided principles yet on protecting consumers for NGN migration. However, in the case of VoIP services, KCC has imposed conditions on VoIP operators to ensure quality of service and availability of emergency calls.

Obligations to continue legacy services

There is no formal decision yet for NGN operators to preserve key legacy services.

Removal of existing regulations

Changes in legal sector for NGN

For facilitating effective NGN migration, the regulator in Korea aligned legal arrangements.

Firstly, the regulator reclassified the types of carrier services which previously attributed to service-intrinsic characteristics into 3 simple categories reflecting technical traits, that is, transmission service, service exploiting spectrum and facility-lease service. Those changes were stipulated and entered into force in December 2005. This change changed the regulatory paradigm from vertical regulation to horizontal regulation due to convergence in the telecom and broadcast sectors.

In legal terms, Article 7 of the Enforcement Ordinance of the Telecom Business Act sets out this change. As a result, the license system in Korea transformed from individual licensing to class licensing. For instance, for any applicant to be an operator they had to get a licence by service, e.g. local telephony, long-distance or international telephony before amendment in the past. But after the amendment, when an applicant gets a licence for transmission service, he/she can provide every transmission service without separate approval processes.

Secondly, following abolition of the Article 7 of the Enforcement Ordinance on Telecom Business Act in October 2010, licensing scheme was further streamlined.

Thirdly, the government established and implemented laws on convergence services, such as IPTV and DMB (Digital Multimedia Service) for promoting NGN-based services.

Any existing regulations which need to be removed to enable efficient migration to NGNs?

According to some interviews, the Interconnect Ordinance and Numbering plan would be high-priority items, which need to be amended soon for accommodating the NGN environment.

Universal broadband policy

Current status of universal service obligation

In Korea, the Universal service regime is covered through the Telecoms Business Act, the Enforcement Ordinance on the Telecom Business Act and the Ordinance on Universal Service where each law or regulation differs in terms of scope and details. The Telecom Business Act stipulates universal service at a high level such as the definition of universal service, operators' obligation to provide universal service or contribution to losses from universal service provision. The Enforcement Ordinance on the Telecom Business Act sets out the scope of universal service, designation of universal service providers, service for loss contribution and criteria for sharing losses from universal service among telecoms operators. The Ordinance on Universal Service covers most detailed issues on universal services which are referred from The Enforcement Ordinance on Telecom Business Act.

Scope of universal service

The Enforcement Ordinance on the Telecom Business Act sets out the scope of universal service as fixed telephony service, emergency call service and social tariffs for the disabled and low income people[83].

- Fixed telephony service is further classified into fixed local telephony, fixed local public payphone and island telecoms service.
- Emergency service is further classified into special numbers for emergency service and marine telecom service
- Services for social tariffs cover fixed local/long distance service, fixed directory enquiry service, mobile telephony and broadband internet services

Universal service provider

Article 4 of the Telecoms Business Act and Article 3 of the Enforcement Ordinance on the Telecom Business Act describe the designation of universal service provider. Current status of universal service providers by service type is as shown in Figure C13.

[83] Enforcement Ordinance on Telecom Business Act, Article 2, December 2010

Figure C13: Universal service provider in Korea

Universal service	Universal service provider designated
Fixed local/payphone, island & marine telephony	KT, fixed incumbent
Emergency service	All operators
Social tariffs for the disabled and the low income	All operators

Source: KCC

Funding universal service costs

Since the USO regime was established, any losses or costs from providing universal service have been funded by the industry. In terms of services for contributions these have mainly been fixed local telephony and fixed local public payphone services[84].

Current criteria for sharing universal service cost are each operator's revenue where operators with less than 30 billion won are exempt from the contribution.

Plans to change universal service policy with the move to broadband/NGNs

For the past few years, there have been discussions on the future of universal service. However, there has been little formal or active review by the government or regulator up to now.

Targets for universal broadband

Universal broadband service in Korea has been promoted its NGN agenda, i.e. BcN, especially for NGA. For example, according to the UBcN plan in 2009, by 2013, it is expected that over 85% households will enjoy fixed broadband internet service with more than 50Mbps speed while over 90% end users will be provided mobile broadband service with more than 1 Mbps.

To accomplish the target in UBcN plan, KCC envisages 34 trillion won will be spent in total by 2013 where the government share will be around 1.3 trillion won.

Regarding universal broadband in rural and remote areas, telecom operators deployed universal broadband in a selective manner a few years ago where the financial sources were from government mainly and operators partly.

Universal broadband and universal service

As mentioned above, universal service and universal broadband policies in Korea have been addressed separately. That is, the universal service regime has been developed to ensure accessibility to basic telephony service for Korean people in a ubiquitous manner while universal broadband has been promoted as part of the BcN policy agenda of which the goal was to ensure accessibility to the broadband internet, as a basis of the digital economy for Korean people.

[84] Enforcement Ordinance on Telecom Business Act, Article 5, December 2010

They may be related in terms of 'universality' in ICT, but they have been, at least so far, separately managed.

C6 Key regulatory issues to resolve

Short term

Several interviews revealed that regulations such as Interconnect, Universal service and numbering are to be changed soon for accommodating a NGN environment, following amendment of the Telecom Business Act or Enforcement Ordinance on Telecom Business Act. For instance;

- The Current Ordinance on Interconnect maintains a framework for a pre-NGN network. As a result, termination rates for NGN service such as VoIP are set by benchmarking equivalent components for PSTN without calculating costs for VoIP network components directly, which are considered cheaper than those of PSTN. In addition, mobile operators' recent speed into LTE deployment would trigger a review of the Interconnect Ordinance as mobile operators are expected to carry voice traffic over an IP-based LTE network once LTE deployment completes.
- The Ordinance on Universal Service also has kept existing legacy telephony services. With popularity or possible prevalence of NGN service like VoIP[85] in the near future and strong competition among services, it is said the Ordinance needs to be reviewed in the near future.

In short, changes to relevant Ordinances would be needed for promoting NGN as well as ensuring regulatory certainty to industry.

Longer term

Again some interviews show that establishing effective competition policies would be one of the top priorities in the longer term regulatory analysis. Though Korea has shown very aggressive facility-based competition, the market has shown rather stable fragmentation among the operators. For instance, 3 mobile operators have maintained very stable market shares over time of around 50%, 32% & 18% respectively. In particular, as fixed operators and mobile operators have been merged the telecoms market in Korea is becoming a competition among 3 telecom groups: KT Group, SK Telecom Group and LG U+ group. Furthermore, there is concern that operators' strategy of locking in subscribers with bundling and handset subsidies would make dynamic competition in the telecoms market worse. In those senses, it would be certain that designing more effective and dynamic competition policy would be necessary as a longer term regulatory issue.

[85] News papers in Korea report the number of VoIP subscribers is over 9.5 million as of March 2011 which is about 50% of PSTN subscribers. According to the KCC, subscriber number of PSTN as of April 2011 is around 19 million. Source: KCC

Annex D Singapore

D1 Background

Singapore's Next Generation Nationwide Broadband Network (NGNBN) is a project under the iN2015[86] – a 10-year masterplan developed in 2005 to grow the infocomm sector and to use infocomm technologies to enhance the competitiveness of key economic sectors and build a well-connected society. The goals of iN2015 include:

- To be No.1 in the world in harnessing infocomm to add value to the economy and society
- To realise a 2-fold increase in the value-add of the infocomm industry to S$26 billion
- To realise a 3-fold increase in infocomm export revenue to S$60 billion
- To create 80,000 additional jobs
- To achieve 90% home broadband usage
- To achieve 100% computer ownership in homes with school-going children

The key strategies of iN2015 are:

- To establish an ultra-high speed, pervasive, intelligent and trusted infocomm infrastructure
- To develop a globally competitive infocomm industry
- To develop an infocomm-savvy workforce and globally competitive infocomm manpower
- To spearhead the transformation of key economic sectors, government and society through more sophisticated and innovative use of infocomm
- The telecom market statistics in Singapore are provided in the following tables.

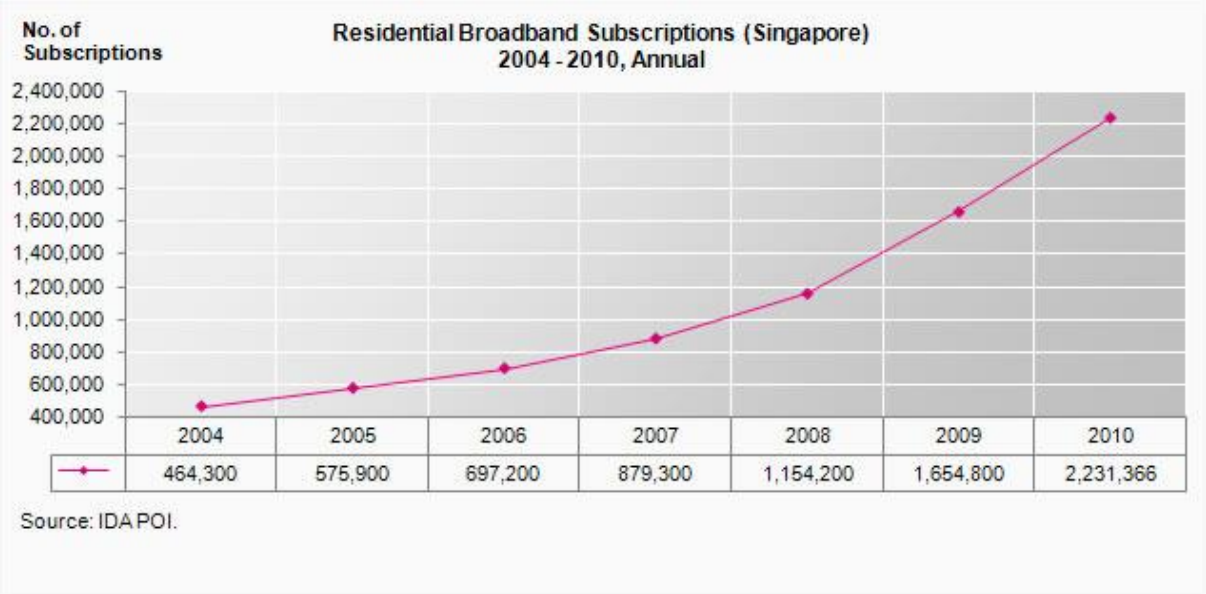
Table D1: Telecom service providers in Singapore

Service providers	No. of operators
Fixed Line Telephony Providers	2
Mobile Telephony Providers[a]	5
Internet Services Providers	95
Voice Services Providers[b]	436
IP Telephony Providers[c]	40

Source: IDA. Notes: [a] Includes MVNOs. [b] Excludes fixed line telephony services, mobile telephony services, and IP telephony services, but includes all other voice-related services such as call-back services, international simple resale services, Internet-based voice and data services and international calling card services. [c] VoIP services utilising Level "3" or Level "6" E.164 telephone numbers.

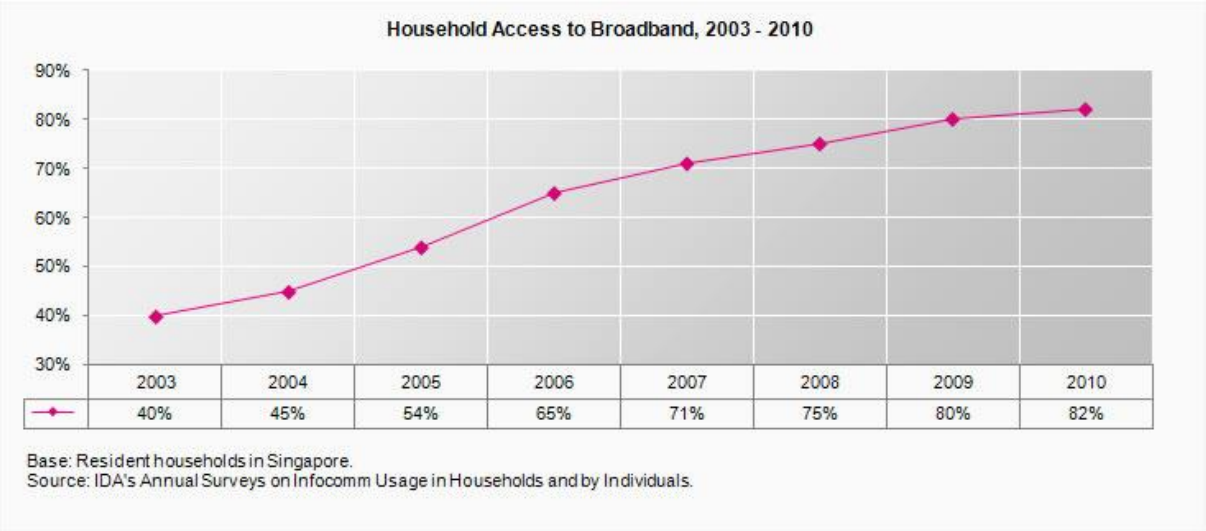
[86] http://www.ida.gov.sg/About%20us/20100611122436.aspx

Table D2: Residential broadband subscriptions in Singapore



Source: IDA POI.

Table D3: Household broadband access in Singapore



Base: Resident households in Singapore.
Source: IDA's Annual Surveys on Infocomm Usage in Households and by Individuals.

Table D4: Residential broadband speeds in Singapore

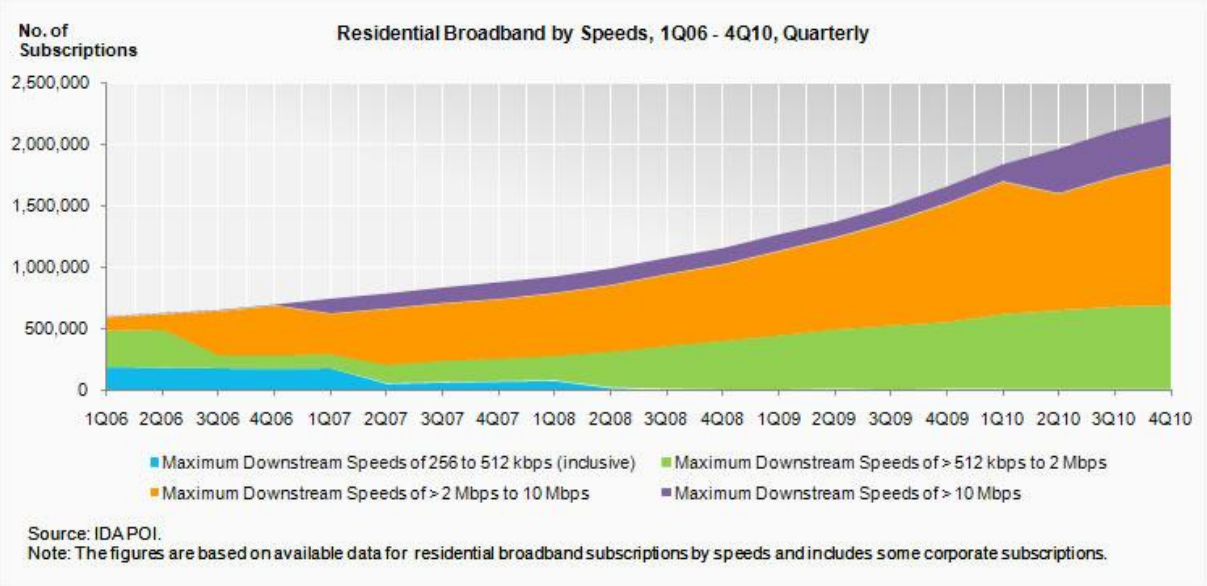
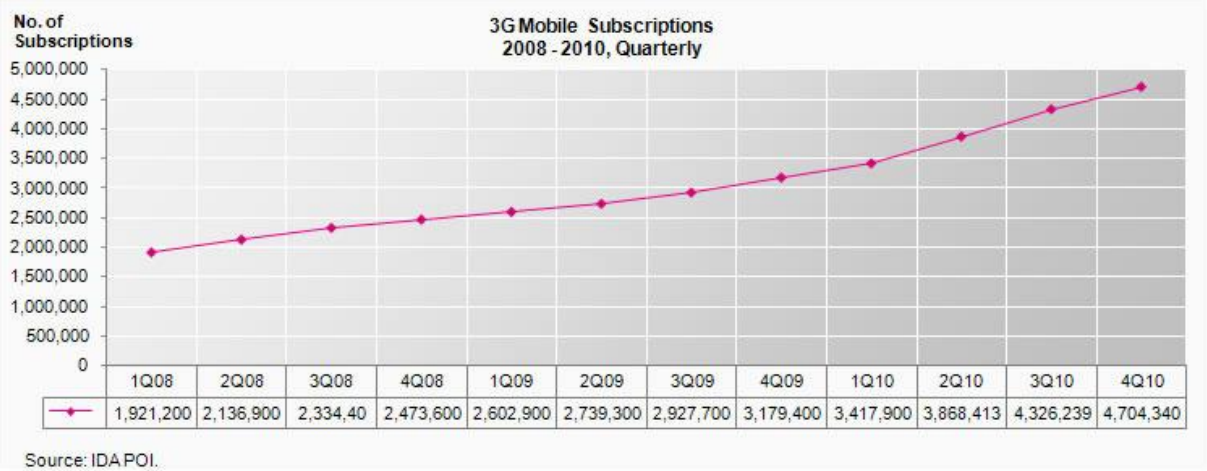


Table D3: 3G mobile subscriptions in Singapore



D2 NGN regulation

Consultations and outcomes

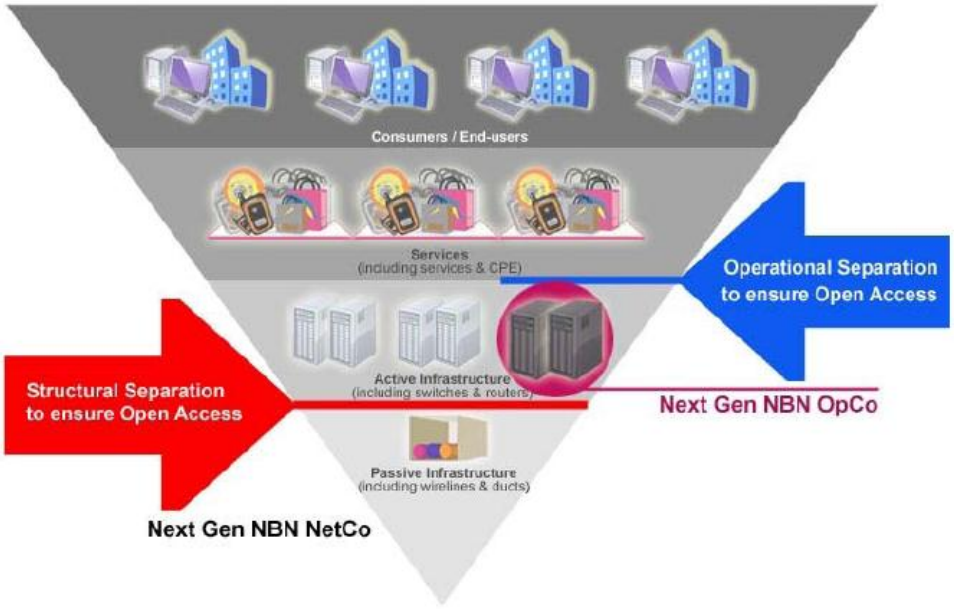
To facilitate the development of the NGNBN, the Singapore government adopted a public-private partnership approach. A Request-for-Concept (RFC) was launched by the IDA in March 2006 seeking industry inputs on key issues such as network capability, interconnection, market coverage, timing, rollout strategy and construction and installation techniques[87]. (See 0 for list of key consultations)

[87] http://www.ida.gov.sg/Programmes/20061214194207.aspx?getPagetype=36

Following the initial phase of pre-qualification and competitive dialogue, the government unveiled the NGNBN industry structure plans in December 2007 (See Figure D14). To achieve effective open access to facilitate competition in the downstream market, it was mandated that the **Network Company** (NetCo) which would build the passive infrastructure (including ducts and wirelines) would have to be structurally separated from downstream operators, and vice versa[88]. The **Operating Company** (OpCo) which would operate the active infrastructure of the NGNBN including switches and transmission equipment would have to be operationally separated from other retail service operators[89]. Both NetCo and OpCo would be subject to price control and universal service obligations.

Retail service providers (RSPs) purchase bandwidth connectivity from OpCo and compete with each other in providing services to end-users. In this model, only RSPs can provide retail services.

Figure D14: NGNBN industry structure



The Requests for Proposal (RFPs) for the NetCo and Opco were launched in December 2007 and April 2008 respectively. In September 2008, OpenNet – a consortium of Axia NetMedia, SingTel, Singapore Press Holdings and SP Telecommunications – was selected as the NetCo[90], while Nucleus Connect – StarHub's wholly-owned subsidiary – was selected as the OpCo.[91]

[88] http://www.ida.gov.sg/News%20and%20Events/20071211184512.aspx?getPagetype=20

[89] http://www.ida.gov.sg/News%20and%20Events/20080407164702.aspx?getPagetype=20

[90] http://www.ida.gov.sg/News%20and%20Events/20080926174755.aspx?getPagetype=20

[91] http://www.ida.gov.sg/News%20and%20Events/20090403155250.aspx?getPagetype=20

D3 Roll out of NGNs

Current status of core and NGA rollout

OpenNet started fibre deployment to homes from July 2009. As part of its rollout, OpenNet is deploying its fibre network and other fibre installations to the Main Distribution Frame Room (MDF Room) or Telecom Equipment Room (TER) for residential and non-residential buildings and to the first Termination Point (TP) within the home for residential premises.

As of end 2010, 60% of Singapore's residential and non-residential buildings have been installed with Singapore's ultra-high-speed, fibre broadband network.[92] The rollout is expected to achieve the target of 95% total coverage by middle of 2012 (See Table D6). Under a Universal Service Obligation (USO), which will take effect from 2013, OpenNet will also fulfil all subsequent requests to install fibre termination points in homes, offices and buildings.

Table D6: Projected timeline for fibre rollout coverage

30 Sep 09	31 Dec 09	30 Jun 10	31 Dec 10	30 Jun 11	31 Dec 11	30 Jun 12
5%	15%	37%	60%	72%	84%	95%

Source: OpenNet

On 31 Aug 2010, Nucleus Connect commenced commercial operations by unveiling five RSPs – LGA, M1, Singtel, StarHub and SuperInternet – who have signed up to the master interconnection offering with Nucleus Connect.[93] Official figures for the take-up of these services are not available but according to local news reports, more than 10,000 consumers have signed up for superfast fibre broadband services[94].

In terms of existing networks and services, SingTel provides ADSL 2+ broadband, fixed telephony and IPTV services over its copper network while StarHub provides broadband, fixed telephony and cable TV services over its hybrid fibre-coaxial (HFC) network which was upgraded to DOCSIS 3.0 in 2006. Both SingTel and StarHub are quad-play operators offering broadband, fixed voice, television and mobile services over their own nationwide networks. The other major operator in Singapore is MobileOne (M1) which offers mobile voice and data services over its own GSM network and fixed broadband over ADSL, cable and fibre over its competitors' networks and the NGNBN. M1 also offers an over-the-top (OTT) pay TV service.

Relationship of NGN to internet networks

The deployment of the NGNBN means that relationships between networks are in a state of flux at the moment. With the creation of the OpCo layer (i.e. Nucleus Connect), new interconnection and peering arrangements between existing networks and service providers, as well as new RSPs, are required.

[92] http://www.opennet.com.sg/press-release/singapore%E2%80%99s-optical-fibre-coverage-hits-60/

[93] http://www.nucleusconnect.com/press-310810-Commencement.php

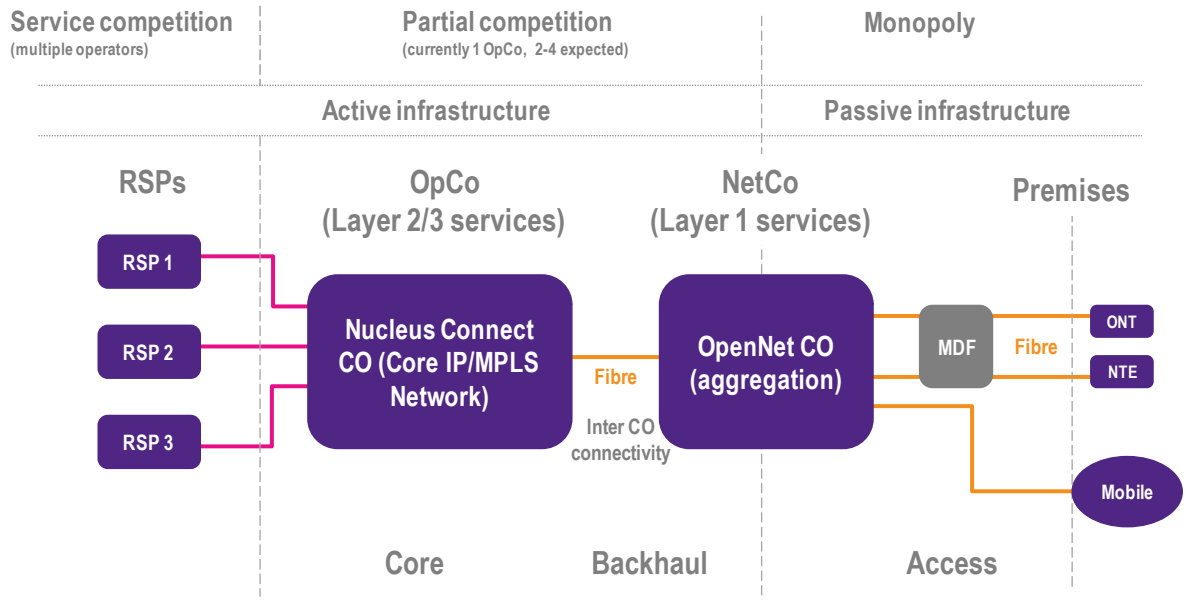
[94] OpenNet damaged cables: StarHub, *Straits Times*, April 1, 2011

Under IDA's interconnection regulatory framework, all licensees are required to interconnect with each other, whether directly or indirectly, to ensure seamless any-to-any communications throughout Singapore. Interconnection arrangements are typically left to commercial negotiations with the exception of dominant licences which are required to publish a Reference Interconnection Offer (RIO). See Section 4 below.

NGN network architecture

The overall NGNBN network architecture is shown in Figure D**Error! No text of specified style in document.**. In general, the active network architecture is based on Carrier Ethernet transport technology. The end-user traffic is carried from the access network comprising of the Optical Line Terminal (OLT) or Active Ethernet (AE) Node, to the Aggregation Layer, to the Core Layer and to the Provider Edge (PE) Router facing the RSP. The Carrier Ethernet transport is able to provide a deterministic end-to-end path to ensure a scalable, reliable and open access network (See Figure D**Error! No text of specified style in document.**).

Figure D Error! No text of specified style in document.**: Overall NGNBN network architecture**



The **access network** consists of two technologies – Gigabit Passive Optical Network (GPON) which provides multi-point access for residential and non-residential users and non-building access points; and Active Ethernet (AE) which provides symmetrical bandwidth to non-residential subscribers in high-rise buildings and industrial buildings. GPON is supported wherever there is NetCo fibre coverage, while AE is supported at selected locations. At the GPON ONT (Optical Network Terminal) or AE NTE (Network Terminal Equipment), there are service ports to interface to the Access Network.

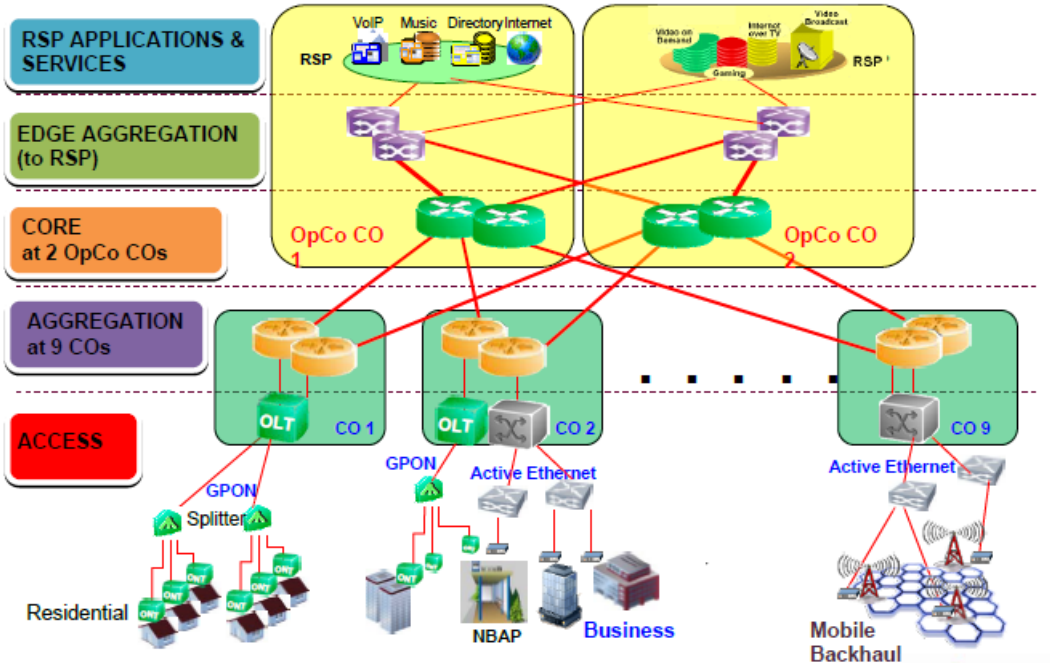
From the access network, traffic is aggregated at the **aggregation network** (located at the NetCo's 9 Central Offices[95]) and delivered to Nucleus Connect's **core network**. There are two Core Networks operated by Nucleus Connect which are geographically apart and interconnected to provide diversity

[95] Central Office refers to OpenNet's premise at the telephone exchanges where OpenNet offers access to its infrastructure and co-location facilities.

and resiliency. Both the aggregation and core networks deploy a Multi-protocol Label Switching (MPLS) network.

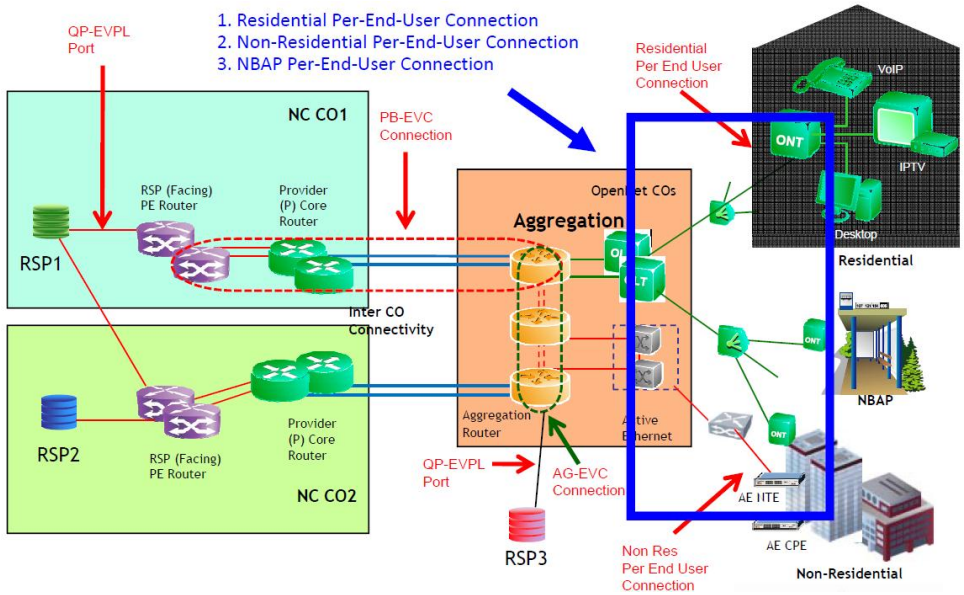
NGN interconnect architecture

Figure D3: Overview of NGNBN's interconnection architecture



Source: Nucleus Connect

Figure D4: Nucleus Connect's wholesale bandwidth and services (Layers 2 and 3)



Source: Nucleus Connect

D4 Measures to facilitate rollout of NGNs

Government funding for NGN

The Singapore government adopted a public private partnership approach to develop the NGNBN. Government funding for the project is capped at S$1 billion, S$750 million for the NetCo and $250 million for the OpCo.

According to Nucleus Connect, it expects to spend about S$1 billion for the active network over the 25-year period of the licence[96]. StarHub's investment in Nucleus Connect is estimated to be around S$100 million. Details on OpenNet's investment are not publicly available.

To encourage connection to the NGNBN, OpenNet is required to waive installation charges for the fibre termination box for home and building owners. Installation charges will be waived for the first 15 metres of fibre run using surface trunking, measured from the main door (for high-rise premises) or gatepost (for landed premises). For fibre installation that requires the use of deployment technique other than surface trunking (i.e., deployment technique like concealed wiring), home owners will have to engage their own contractors to perform the hacking and concealment works and to liaise with OpenNet for the installation of fibre and fibre termination box.

Achieving efficient NGN costs

The public-private partnership approach to the NGNBN project and the specific structural and operational separation requirements on NetCo and OpCo respectively are effectively attempts by the Singapore government to facilitate a more rapid and cost efficient rollout of NGN services and avoid any replication of infrastructure investment by operators.

Furthermore the decision to select OpenNet as the NetCo means that existing ducts, manholes and exchanges, belonging to OpenNet's partner SingTel, are being used to deploy its fibre network, thus reducing cost and wholesale prices and minimising public inconveniences during roll-out.

The IDA was also active in pushing for the establishment of an open, non-profit neutral internet exchange – the Singapore Internet Exchange[97] (SGIX) – to facilitate the deployment of services of the NGNBN by enabling efficient interconnectivity, reducing latency and ensuring sustainable performance for bandwidth intensive services to be optimally delivered to end-users.

In building wiring

Guidelines for in building wiring are provided under the Code for Practice for Infocomm Facilities in Building (COPIF) which was revised in 2008. To facilitate the provision of broadband services to residential buildings through the NBN, developers were required to provide space and facilities for:

- Horizontal cable distribution
- Cabling distribution for landed dwelling-houses

[96] http://www.nucleusconnect.com/press-030409-NGNBN.php?navid=2&itemID=6

[97] http://sgix.sg/en/about/

- Cat 6 UTP cables for internal cabling
- Electrical power supply

Despite the guidelines, the rollout of the NGNBN fibre network faced problems when as many as nine in 10 condominiums refused to be connected for aesthetic reasons. According to local news reports[98] [99], many owners complained that the plastic cable piping on walls were ugly and wanted the cables hidden in walls or false ceilings, but baulked at the cost. The impasse had threatened to cut off about 20% of Singapore's one million households from the network and delay the rollout process. This eventually prompted the IDA to intervene and warn that condominiums will have to allow OpenNet to install the fibre optic cables or face fines of up to $1,000 a day for non-compliance.

Spectrum release plans

Analogue switch-off for broadcasting in Singapore is expected to take place by 2015 although availability of 700 MHz band would depend on coordination with neighbouring countries. The analogue switch-off/digital switchover process for ASEAN countries[100] is expected to complete by 2020[101].

In Jan 2011, the IDA published its interim decision on the spectrum framework for 4G services. Existing 2.3 GHz and 2.5 GHz bands which are allocated for wireless broadband access (WBA) will expire in 2015 but IDA has signalled intentions to reallocate them for 4G services (including LTE and WiMAX) as early as 2012. The IDA also stated that 900 MHz and 1800 MHz bands, currently allocated for public cellular mobile telecommunications services (PCMTS), can be used to deploy 4G services provided operators meet requirements for PCMTS provision on the bands.

In June 2011 M1, utilising the 1800 MHz and 2.6 GHz bands, launched the first LTE service in Singapore offering theoretical downlink speed of 75 Mbps and uplink speed of 37.5 Mbps[102] . Both SingTel and StarHub have announced that they will roll out their LTE networks in late 2011.

The frequency bands available for 4G mobile services in Singapore are summarised in Table D7.

Table D7: Spectrum available for 4G services

Frequency band	Amount of spectrum available	Current use	Availability for 4G
700 MHz	90 MHz?	TV broadcasting	2015 earliest
900 MHz	60 MHz	PCMTS (2G)	Available now but subject to PCMTS requirements[103]
1800 MHz	140 MHz	PCMTS (2G)	

[98] http://160.96.186.100/lib/pdf/2010/Nov/ST1710.pdf

[99] http://www.asiaone.com/Business/My+Money/Property/Story/A1Story20101210-252054.html

[100] The 10 ASEAN countries are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

[101] http://www.aseansec.org/24089.htm

[102] M1 to launch LTE-based Next Generation Mobile Network, *Channels Newsasia*, 20 June 2011 http://www.channelnewsasia.com/stories/singaporebusinessnews/view/1136213/1/.html

[103] Both the 900 MHz and 1800 MHz spectrum rights expire in 2017 but can be used for 4G services provided operators offer as a minimum a publicly available mobile telephony service and ensure that there is no degradation of existing services when $G services are implemented.

Frequency band	Amount of spectrum available	Current use	Availability for 4G
2.3 GHz	50 MHz	WBA	Auction likely in 2012
2.5 GHz	190 MHz	WBA	Auction likely in 2012

Source: IDA

D5 NGN Interconnect

To ensure the deployment of an integrated "network of networks" that provides seamless any-to-any communications throughout Singapore, the IDA has laid out key guidelines for interconnection in the Telecom Competition Code (TCC) – a subsidiary legislation under the TA.

Interconnect principles

Under Section 5 of the TCC[104], all licensees have a duty to interconnect with other licensees either direct or indirect. The IDA generally will not intervene in interconnection negotiations between non-dominant licensees. However, every interconnection agreement must be in writing and licensees must submit to IDA a copy of all interconnection agreements which they enter into.

The minimum duties for interconnection agreements include:

- Duty to establish compensation arrangements governing origination, transit and/or termination of telecommunication traffic
- Duty to provide non-discriminatory interconnection quality (facility-based licensee must provide sufficient points of interconnection and take measures to ensure that, on a service-to-service basis, the services provided to other licensees are at least equivalent in quality to that provided to itself, its affiliates or any other licensee)
- Duty to prevent technical harm to network
- Duty to provide billing information
- Duty to obtain IDA approval for suspension or termination

In the context of the NGNBN both OpenNet and Nucleus Connect are required to publish detailed information on their wholesale wirelines and bandwidth services respectively. The service details of the NetCo and OpCo interconnection offers are listed in Appendix B.

Obligations on dominant operators

Under the TCC, a Licensee will be classified as dominant if:

- it is licensed to operate facilities used for the provision of Services in Singapore that are sufficiently costly or difficult to replicate such that requiring new entrants to do so would create a

[104] http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level3/TCC/TCC2010.pdf

significant barrier to rapid and successful entry into the telecommunication market in Singapore by an efficient competitor; or

- it has the ability to exercise Significant Market Power (SMP) in any market in which it provides services pursuant to its licence

Currently the IDA currently classifies OpenNet, SingTel and StarHub Cable Vision as dominant licensees under the TCC[105]. A dominant licensee must offer to allow facilities-based[106] and services-based[107] licensees to physically and logically interconnect their respective networks with the dominant licensee's network for the purpose of exchanging telecommunication traffic. At a minimum, a dominant licensee must offer to allow interconnection to occur at the following points of interconnection (POI):

- Interconnect gateway switches (IGS)
- Local switches (line side and trunk side)

Dominant licensees are required to provide all services:

- at just and reasonable prices, terms and conditions
- on a non-discriminatory basis
- on an unbundled basis

They are also required to file tariffs with the IDA and publish the information on their services on their websites.

On interconnection, there are more stringent rules on dominant licensees than non-dominant licensees to ensure the adoption of just, reasonable and non-discriminatory interconnection agreements involving a dominant licensee.

Under Section 6 of the TCC, a dominant licensee must provide interconnection related services and mandated wholesale services to other licensees. A dominant licensee is required to develop a Reference Interconnection Offer (RIO)[108], subject to IDA's approval, and offer it for a period of 3 years. Extension of the RIO is subject to IDA approval. Any form of discrimination is prohibited in the RIO which must contain a detailed list of technical and operational requirements as well as terms and conditions which the dominant and requesting licensees must fulfil.

In the context of the NGNBN, there are additional codes of practice[109] governing the interconnection to NetCo and OpCo which spell out in greater detail the pricing, terms and conditions for access and connectivity to the NGNBN, the obligations and responsibilities of both licensees and qualifying persons in relation to take-up of services and also enforcement measures for any breaches of the codes.

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[105] http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level3/TCC/CDLN2011.pdf

[106] A facilities-based licensee is an operator intending to deploy any form of telecommunication network, systems and facilities to offer telecommunication switching and/or telecommunication services to other licensed telecommunication operators, business, and/or consumers.

[107] A service-based licensee is an operator intending to lease telecommunication network elements such as transmission capacity, switching services, ducts and fibre from any facilities-based operator (FBO) licensed by IDA to provide telecommunication services to third parties or resell the telecommunication services of FBO.

[108] The RIO must contain a comprehensive and complete written statement of the prices, terms and conditions on which the Dominant Licensee is prepared to provide Interconnection Related Services and Mandated Wholesale Services to any Requesting Licensee.

[109] See NetCo Interconnection Code http://www.ida.gov.sg/Policies%20and%20Regulation/20090224150729.aspx, OpCo Interconnection Code http://www.ida.gov.sg/Policies%20and%20Regulation/20060929180143.aspx

Charging methods

Under IDA's interconnection framework which was updated in 2008[110], licensees may enter into any mutually acceptable compensation arrangements. However where issues of disagreement arise, the following interconnection regime applies:

- **For call origination from and termination into IP telephony operators' (IPTO) networks**: IPTOs need not be compensated for call origination and termination.
- **For call origination from and termination into network of the Dominant Operator using level 6 numbers**[111]: The Dominant Operator would be compensated and the origination and termination rates set out in its RIO would apply (Call Party Pays with network origination/transmit/termination rates payable)
- **For call origination from and termination into network of a non-dominant operator using level 6 numbers**: the non-dominant operator would be compensated and non-discriminatory rates shall apply.
- **For call origination and termination into network of FMOs using level 8 and/or 9 numbers**: the operator would not be compensated for call origination and termination (existing Mobile Party Pays regime applies).

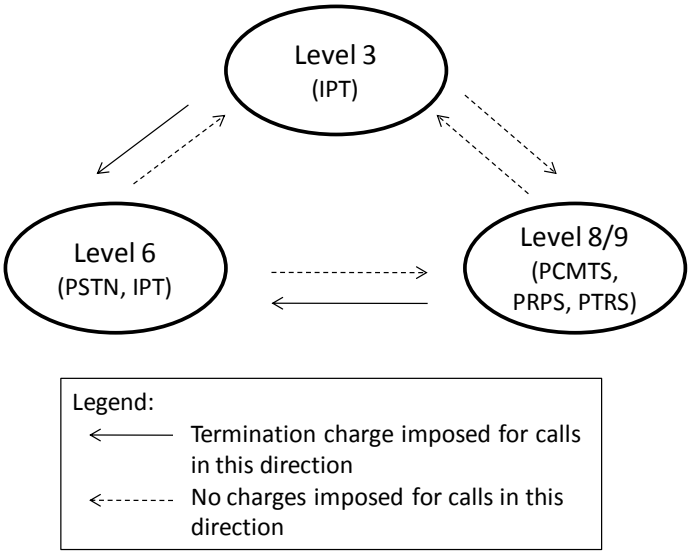
Table D8: Interconnection settlement regime based on number level assignment

	Level 6	Levels 3, 8 and 9
Interconnection settlement regime	Calling Party Pays (with network origination/transmit/termination rates payable)* * includes any local, international and ISDN calls requiring PSTN for completing transmission	No origination, transit or termination charges payable to operators providing telephony services based on these number levels

[110] http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level2/20070705095743/EMWBAVOIPFramewk.pdf

[111] Level '6' numbers are allocated to PSTN services (including Public Switched Telephone Services (PSTS) and Public Switched Integrated Services Digital Network Services), and IP Telephony (IPT) service as 8-digit numbers.

Figure D5: Interconnection settlement regime for telephony services



Source: IDA

In its explanation on adopting the above framework, the IDA was of the view that it might be premature to prescribe a "Bill and Keep" (BAK) arrangement given that IP telephony traffic was still relatively low, the development of IP-based NGN networks was still in its early stages and the appropriate interconnection models in the IP-based NGN environment was uncertain. However, it also noted that it will monitor industry developments and international best practices to assess the appropriate long term interconnection approach.

Interconnection related services

Cost bases

Unless otherwise directed by the IDA, the prices at which a dominant licensee offers to provide all interconnection related services must be cost-based using a forward looking economic cost (FLEC) methodology. FLEC are the prospective costs a licensee would incur in producing a service using best-in-use technology and product practices. In establishing FLEC-based costs:

- capital assets employed in providing Interconnection Related Services must be valued at the current replacement cost of an asset with the same or better functionality; and
- costs incurred must reflect best-in-use technology and product practices based on that of an efficient network architecture, but may include inefficiencies that could only have been avoided in retrospect.

In cases where appropriate, IDA may use an alternative methodology to reflect added risk of investment.

Cost standards

In cases where IDA requires a Dominant Licensee to use a FLEC methodology to establish the cost of an Interconnection Related Service, a Long Run Average Incremental Cost (LRAIC) must be used to compute the price of the service.

LRAIC consists of all variable costs and those fixed costs that are directly attributable to the incremental change in the interconnection related services and the share of indirect costs that are discernibly caused by the provision of those services.

Structure of charges

In establishing interconnection related services charges, a dominant licensee must ensure that the structure of charges mirrors the cost behaviour of interconnection related services provision, where material. This means that costs that behave differently must remain segregated in the charging structure and must be recovered differently.

Responsibility for interconnection related services charges must be based on the principle of cost-causality. A licensee will be responsible for the costs that the other licensee incurs in order to provide interconnection related services to it.

Physical interconnection, unbundled network elements and essential support facilities

A dominant licensee must offer to pay the initial costs of establishing a Point of Access (POA). These may be recovered through the prices that it charges requesting licensees to which it provides Essential Support Facilities and Unbundled Network Elements.

The dominant licensee may require requesting licensees to compensate it for the costs incurred in establishing and maintaining POAs, or in using facilities, based on relative use. The costs must be:

- based on the expected number of users and the duration of use.
- allocated equally for non-traffic-sensitive facilities
- allocated based on the number of connections, actual usage and capacity requested for traffic-sensitive facilities

Each facilities-based licensee is responsible for the provision and maintenance of the transmission links on its "side" of the Point of Interconnection (POI).

Wholesale mandated services

Whenever IDA directs a dominant licensee to offer a mandated wholesale service, IDA will specify the basis on which the dominant licensee must set the price. Where appropriate, IDA may require the dominant licensee to provide the mandated wholesale service:

- at cost-oriented rates (i.e. based on cost, which may include a reasonable profit to reflect the risk of investment);
- at retail-minus prices based on "avoidable cost" study, which determines the actual costs that the Dominant Licensee will avoid by providing the service on a wholesale, rather than retail basis; or
- at retail-minus prices based on a "proxy discount". In this case, IDA will direct the Dominant Licensee to set the price of the mandated wholesale service at a specific discount (expressed as a percentage) below the price that the dominant licensee charges its retail customers for the service.

Detailed pricing lists for NetCo and OpCo's wholesale services are listed in the respective ICOs

Setting termination charges

Under the respective interconnection codes, both NetCo and OpCo are required to provide in their ICOs termination procedures and disconnection costs. The early termination charges for both NetCo and OpCo services are set at 100% of the remaining contract value.

End to end QOS

The Interconnection Codes for NetCo and OpCo require the NetCo and OpCo to specify service level guarantees (SLGs) for each mandated service in respect of:

- the Licensee's performance in relation to the ordering, provisioning and deactivation of the Mandated Service (the "**Provisioning SLG**");
- the availability of the Mandated Service (the "**Service Availability SLG**"); and
- the Licensee's performance in the rectification of any faults in relation to the ordering, provisioning or availability of the Mandated Service (the "**Fault Rectification SLG**").

Each of these SLGs is required to address:

- The parameters used to measure the specified service levels;
- The mechanism by which service levels are to be monitored;
- When failure to meet a particular service level is deemed to occur;
- How any failures may be rectified;
- How and when a service is deemed to be restored; and
- The consequences of, and remedies for, any breach of the service level guarantee.

Performance parameters for all Nucleus Connect's Layer 2 and 3 wholesale services are published in the OpCo ICO.

D6 Other possible NGN regulation

Calls to emergency services

The obligations on emergency services are listed in the licences of the NetCo and OpCo. In general, they must ensure that any person, through customer premises equipment or public payphones, may at any time and without charge, contact the relevant police service, the fire and ambulance services and any other national emergency services, for the purpose of notifying them of any emergency.

They are also required to ensure to provide without charge, access to distress, urgency and safety services for notification of shipping emergencies, and also cooperate with relevant government departments for the provision of national security and emergency services.

The TCC requires dominant licensees to provide facilities-based and service-based licensees with access to emergency services call centres and the ability to add local telephone location data to the emergency services database.

Under the licensing framework, all licensees which provide its subscribers access to public emergency services are also required to comply with the following technical requirements for emergency calls:

- The Licensee shall pass Calling Line Identity ("CLI") for all calls;
- Licensees shall not manipulate the CLI of the original calling party and the original calling party CLI shall be passed on in the conveyance of a call accordingly;
- Licensees shall not, in the handling of outgoing traffic, manipulate the access code dialled by the calling party; and
- The A-bit of the Forward Call Indicator ("FCI") of the Initial Access Message ("IAM") on the ITU-T Signalling System Number 7 ISDN User Part ("ISUP") signalling should be set to the value "1" to identify an international incoming call for systems inter-working. Where the Licensee operates a system which does not support ITU-T Signalling System Number 7 signalling, then the Licensee shall route such international incoming calls on specified circuits/trunks.

Consumer protection

Contract period and early termination charges

In Jan 2011, the IDA issued guidelines on contract period and early terminal charges (ETCs)[112]. , Contract periods for end user services are capped at 24 months to protect consumers and promote more rigorous competition. According to the IDA, the 24-month cap allows licensees sufficient flexibility to innovate and devise different types of service plans to compete, while ensuring sufficient protection for consumers from being locked-in to unduly long service agreements.

Under the subsection 3.2.3 of the Telecom Competition Code, early termination charges must be reasonably proportionate to any discounts or special consideration given and the amount of time that the end user has completed on the contract. In IDA's view, fixed or flat-rate ETCs, and ETCs that do not exclude avoidable costs (i.e. costs that the Licensee will not need to incur when they cease the provision of the service to the End User) are disproportionate.

The new guidelines stipulate that:

- ETCs should be graduated on a month-by-month basis for all end user service agreements with a contract period of more than 3 months, taking account into the number of months left on the agreement
- ETCs should exclude any costs that will be avoided when the end user service agreement (with contract period exceeding 3 months) has been terminated. Any ETC imposed should be reasonably below that of the sum of the monthly fee for the remaining months of the contract period. In all cases, the ETC cannot be higher than the sum of the monthly fees for the remaining months.

[112] http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level3/TCC/CPETCG.pdf

Transparency of Internet broadband speeds

In March 2011, the IDA introduced new measures requiring local Internet service providers to measure and publish the typical download speeds that consumers can expect to experience, which will enable consumers to make better-informed choices when selecting their broadband plan[113].

Currently, Internet service providers generally advertise their fixed-line and mobile Internet broadband access plans using theoretical maximum download speeds. However, consumer feedback is that actual speeds are often lower than advertised speeds. The IDA is finalising broad measurement parameters (e.g. type of broadband plans, devices and websites to be covered) and the publication requirements. Operators are expected to start publishing the typical download speeds by early 2012.

Obligations to continue legacy services

The situation on continuation of legacy services over existing networks is unclear although the government has been actively encouraging the use of the NGNBN for the provision of services.

SingTel has a 25-year facilities-based licence expiring in 2017 to provide a range of services including public basic international and domestic telecommunications, mobile and wireless broadband access services. StarHub's licence for its fixed services expires in 2020. While both have launched services over the NGNBN, there are no obligations placed on the operators to either continue legacy services or to migrate existing services over to the NGNBN.

SingTel has said that it is considering setting up its own OpCo without committing to any timeline[114].

Removal of existing regulations

While the TCC is revised on a triennial basis, there has not been any commitment by the Singapore government to remove existing regulations under the Telecommunications Act (TA). Instead, the Singapore Ministry of Information, Communications and the Arts (MICA) is considering amendments to the TA to include legislative powers to ensure the continuity of key telecom networks and services and to impose structural or operational separation of vertically integrated operators controlling essential upstream inputs or wholesale products[115].

Universal broadband policy

Basic universal service obligations (USO) are listed in OpenNet and Nucleus Connect's licences. OpenNet's USO requires it to meet all requests, from 1 January 2013, to install fibre termination points in homes, offices and buildings. Nucleus Connect's USO requires it to meet all requests, from 1 January 2013, to activate wholesale bandwidth services over OpenNet's fibre in homes, offices and buildings. OpenNet is expected to achieve 95% coverage by mid 2012 ahead of the deadline for USO.

[113] http://www.ida.gov.sg/News%20and%20Events/20110314122636.aspx?getPagetype=20

[114] SingTel mulls setting up own OpCo which may rival Nucleus Connect, *Channel Newsasia*, May 13, 2010 http://www.channelnewsasia.com/stories/singaporebusinessnews/view/1056386/1/.html

[115] http://www.ida.gov.sg/Policies%20and%20Regulation/20060929173038.aspx

Billing guidelines

General guidelines for billing among licensees (i.e. NetCo, OpCo and RSPs) are provided by the IDA[116]. Billing arrangements and processes for handling billing disputes are listed in the ICOs for OpenNet and Nucleus Connect.

As for billing end users, IDA has stipulated that NetCo and OpCo should not have direct billing relationships with the end users. The RSP is responsible for presenting a single bill to the end user for Next Gen NBN services, including any applicable charges imposed by OpenNet and/or Nucleus Connect that the RSP has decided to on pass to its end users.

Net neutrality

In June 2011, the IDA outlined its policy framework position on net neutrality following a consultation late 2010. In its explanatory memorandum[117], it reiterated its three-pronged approach based on:

- Facilitating competitive Internet market access, thus reducing incentives for operators to engage in blocking/discriminatory conduct
- Improving information transparency to allow consumers to understand various broadband service choices when selecting a package
- Protecting consumer interests through:
  - QoS requirements on network availability and latency on fixed broadband services;
  - Prohibiting the blocking of legitimate Internet content (applicable to fixed, wireless and mobile services)

IDA also clarified that ISPs and network operators are allowed the flexibility to manage their network or differentiate their service offerings provided they abide by IDA's competition rules, information transparency and QoS requirements and do not block legitimate Internet content.

In the memorandum, the IDA stated that it would consider mandating QoS requirements on mobile broadband services and requiring mobile broadband providers to disclose their network management practices. It would also assess the feasibility of introducing a "cooling down" period after consumers have purchased their broadband service during which they can terminate the service if they are unsatisfied about the impact of the ISPs' traffic management practices on their Internet surfing experience.

Following the announcement, SingTel launched what it terms "Asia's first premium priority mobile broadband service"[118] while at the same time publishing the typical speeds of its mobile broadband services in line with new transparency measures introduced by IDA in March 2011.

[116] See IDA Guidelines for Service Provisioning over the Next Generation Nationwide Broadband Network, http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level2/20080627155616/Guidelines_SP_NGNBN.pdf

[117] http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level2/20070612111424/NetNeutralityExplanatoryMemo.pdf

[118] http://info.singtel.com/node/8140

D7 Key regulatory issues to resolve

Short term

Project NIMS (Next Generation Interactive Multimedia, Applications and Services)[119] is a initiative led by IDA and MDA to develop a strategy to build up capabilities, infrastructure and the industry ecosystem in the area of interactive multimedia, applications and services. The goal is to develop an open access common feature set-top box for the delivering over-the-top (OTT), digital terrestrial transmission (DTT) and end-to-end managed IPTV services over the NGNBN with the aiming of fostering innovation and increasing business opportunities for stakeholders.

In early 2011 a RFP was launched to select an operator to design, finance, build and operate a platform for the delivery of interactive video-based services and provide services on a wholesale basis to RSPs on non-discriminatory and non-exclusive terms. Three bids (M1, SingNet and StarHub) were received but the winning party has not been announced as of July 2011.

Longer term

The longer term regulatory issues need to be addressed include:

- Award of digital dividend spectrum – the analogue switch-off/digital switchover for ASEAN countries due to be completed by 2020
- Competition policy issues – review of market developments in wake of full NGNBN deployment and possible removal of ex ante regulations on Dominant Licensees (e.g. tariff obligations on retail and wholesale services)
- Migration of services to NGNBN / continuation of legacy services on existing networks.

[119] http://www.ida.gov.sg/Infrastructure/20090807131841.aspx

Appendix List of key consultations

Consultation documents (IDA unless stated)
Review of SingTel's Reference Interconnection Offer (RIO) [120] • Consultation paper (21 Jan 2011) • IDA decision and explanatory memorandum (22 June 2011)
Policy Framework for Net Neutrality[121] • Consultation paper (11 Nov 2010) • IDA decision and explanatory memorandum (16 Jun 2011)
MICA – Amendments to Telecommunications Act[122] (decision pending) • Consultation paper (27 Aug 2010)
Spectrum framework for 4G services mobile communications systems[123] • Interim position (24 Jan 2011) • Consultation paper (29 Mar 2011)
Second Triennial Review of Code of Practice for Competition in the Provision of Telecommunications Services (TCC)[124] • Revised TCC (22 Dec 2010) • Consultation paper and proposed revised code (23 Nov 2009) **Interconnection Offer (ICO) for the Provision of Services on the Next Generation Nationwide Broadband Network - Operating Company**[125] • Consultation paper not available (18 Aug 2009) • NucleusConnect ICO (6 May 2010)[126]
Interconnection Offer (ICO) for the Provision of Services on the Next Generation National Broadband Network – Network Company[127] • Consultation paper (25 Feb 2009) • OpenNet ICO (26 Apr 2010)[128] **Review of the Code of Practice for Info-communications Facilities in Buildings ("COPIF") for the Next Generation National Broadband Network**[129] • COFIP 2008, guidelines (21 Aug 2008) • Consultation paper (20 Nov 2007)
Industry Structure for Next Generation Access Networks[130] • Consultation paper (17 Apr 2008) • See MICA consultation on proposed amendments to Telecommunications Act[131] (ongoing)

[120] http://www.ida.gov.sg/Policies%20and%20Regulation/20060613111018.aspx
[121] http://www.ida.gov.sg/Policies%20and%20Regulation/20070612111424.aspx
[122] http://www.ida.gov.sg/Policies%20and%20Regulation/20060929173038.aspx
[123] http://www.ida.gov.sg/Policies%20and%20Regulation/20100329151251.aspx
[124] http://www.ida.gov.sg/Policies%20and%20Regulation/20081111104551.aspx#issue
[125] http://www.ida.gov.sg/Policies%20and%20Regulation/20060907155854.aspx#18Aug09
[126] http://www.ida.gov.sg/Policies%20and%20Regulation/20100503153659.aspx
[127] http://www.ida.gov.sg/Policies%20and%20Regulation/20090224174101.aspx#25Feb09
[128] http://www.ida.gov.sg/Policies%20and%20Regulation/20100205131156.aspx
[129] http://www.ida.gov.sg/Policies%20and%20Regulation/20071119174519.aspx#issue
[130] http://www.ida.gov.sg/Policies%20and%20Regulation/20080417153248.aspx#issue

Consultation documents (IDA unless stated)
Next Generation National Broadband Network (NBN) for Singapore[132] • Request for Concept (23 Mar 2006) • Summary of responses (14 Aug 2006) • Pre-qualification, competition dialogue and internal project approvals (Dec 2006 – Nov 2007) • NetCo Request for Proposal (11 Dec 2007)[133] • OpCo Request for Proposal (7 Apr 2008)[134] • OpenNet selected as NetCo (26 Sep 2008)[135] • Nucleus Connect selected as OpCo (3 Apr 2009)[136]

Appendix Interconnection Offers (ICOs)

NetCo Interconnection Offer[137]

Basic mandated services

The NetCo ICO offers the provision of Layer 1 Services to both Residential Premises and Non-Residential Premises:

- on a per End-User Connection basis:
  - for each access technology supported by the Network. The pricing for each access technology may be different taking into consideration additional components, such as those required to achieve splitting; and
  - the Qualifying Persons shall not be unreasonably restricted from locating any active equipment/components at intermediate points between the two end points required by the Qualifying Persons to achieve the split ratios as stipulated in the terms and conditions of the Layer 1 Services. Such intermediate points shall, at the minimum, be offered at the MDF Rooms, TERs or equivalent; and
- between any Connectivity Points within the Network deployed by the Licensee, such as: (i) from an MDF in a CO to the 1st TP of a Residential Premise or a Non-Residential Premise;
  - from an MDF in a CO to an NBAP TP;
  - from an MDF in a CO to an MDF in an MDF Room;
  - from an MDF in a CO to an MDF in an Outdoor Cabinet;
  - from an MDF in an MDF Room to the 1st TP of a Residential Premise or a Non-Residential Premise;

[131] http://www.ida.gov.sg/Policies%20and%20Regulation/20060929173038.aspx#27Aug10

[132] http://www.ida.gov.sg/Programmes/20061214194207.aspx?getPagetype=36

[133] http://www.ida.gov.sg/News%20and%20Events/20071211184512.aspx?getPagetype=20

[134] http://www.ida.gov.sg/News%20and%20Events/20080407164702.aspx?getPagetype=20

[135] http://www.ida.gov.sg/News%20and%20Events/20080926174755.aspx?getPagetype=20

[136] http://www.ida.gov.sg/News%20and%20Events/20090403155250.aspx?getPagetype=20

[137] http://www.ida.gov.sg/Policies%20and%20Regulation/20100205131156.aspx

- from an MDF in an Outdoor Cabinet to the 1st TP of a Residential Premise or a Non-Residential Premise;
- from an MDF in a CO to an MDF in another CO;
- from an MDF in an MDF Room to a fibre-to-the-building node at a TER Room/void deck;
- from a fibre-to-the-building node to a DP;
- from an MDF in a CO to an NBAP DP serving an NBAP TP; and
- from an NBAP DP to an NBAP TP.

Connectivity points

The NetCo shall offer to allow interconnection at the following Connectivity Points:

- MDFs at the CO;
- DFs at TERs/MDF Rooms of Residential Premises and Non-Residential Premises;
- 1st TPs of Non-Residential Premises and Residential Premises; and
- any other Connectivity Points that the Licensee may propose.

Ancillary mandated services

The ancillary mandated services provided by the NetCo include:

- OSS/BSS Connection Services
- Patching Services
- Co-location services in the CO
- Layer 1 redundancy

OpCo Interconnection Offer[138]

Basic mandated services

The OpCo ICO offers provision of the following Layer 2 and Layer 3 services:

- Residential per-end-user connection
- Non-residential per-end-user connection
- Non-building address points (NBAP) per-end-user connection
- QP Ethernet Virtual Private Line Service Port (QP-EVPL service port)
- Provider Backbone Ethernet Virtual Connection (PB-EVC)
- Aggregation Ethernet Virtual Connection (AG-EVC)
- L2 VPN Service
- E-LAN Service

[138] http://www.ida.gov.sg/Policies%20and%20Regulation/20100503153659.aspx

- L3 VPN Service
- IP Multicast Connection

Service ports

The OpCo ICO also provides access to service ports to any Qualifying Person that wishes to connect to the active network for the purposes of obtaining basic mandated services.

Ancillary mandated services

The ancillary mandated services provided in the OpCo ICO are:

- Co-location service
- Patching service
- Platform connection service
- L3 Virtual Routing Domain Setup Service
- Interoperability Testing Service (IOT Service)

Table D9: Nucleus Connect ICO services overview

		Type of ICO services
Segment-by-Segment Services	Access Network	• Residential Per-End-User Connection • Non-Residential Per-End-User Connection • NBAP Per-End-User Connection
	Core and aggregation network	• QP Ethernet Virtual Private Line Service Port (QPEVPL • Service Port) • Provider Backbone Ethernet Virtual Connection (PBEVC) • Aggregation Ethernet Virtual Connection (AG-EVC) • IP Multicast Connection
End-to-End Services (Managed Service)		• L2 VPN Service • E-LAN Service • L3 VPN Service
Ancillary Mandated Services		• Co-location Service • Patching Service • Platform Connection Service (Upcoming) • L3 Virtual Routing Domain Setup Service • Interoperability Testing Service (IOT Service)

Source: Nucleus Connect ICO

Annex E UK

E1 NGN Regulation

Consultations

In November 2004 Ofcom published a consultation titled "Next Generation Networks - Future arrangements for access and interconnection"[139]. The document focussed on BT's roll out of its core NGN, 21st Century Network (21CN), and the implications on competition and regulation. The document expressed a desire to solve many of the issues raised by the paper through industry negotiation rather than regulation. Ofcom set out how it hoped the network would operate to comply with its regulatory principles and was prepared to regulate where commercial negotiation failed.

In June 2005 Ofcom published a follow up paper to its initial consultation, "Next Generation Networks – Further Consultation"[140]. The document develops a set of governing policies to help resolve some of the issues arising from NGNs, these include:

- *"Our proposed approach for next generation narrowband voice interconnect is that where Significant Market Power (SMP) is found, reasonable charges should take account of the need to avoid creating artificial arbitrage opportunities by taking a holistic approach to cost recovery that avoids distorting incentives, and the need to allow an appropriate return on BT's investment in NGNs."*
- *"To ensure a timely move to next generation interconnect we propose that legacy products should be withdrawn once there is no longer reasonable demand or when next generation products provide an adequate replacement that providers are able to migrate to."*
- *"To avoid this foreclosure [of unbundled network access], we propose that BT should ensure that other providers can purchase SMP products for accessing BT's 21CN that allow other providers to effectively compete with BT's end-to-end services. In addition, BT should not make any design decisions, the effect of which would be to prevent the provision of future SMP products, without first consulting other communications providers and Ofcom."*
- *"… we propose that BT's charges for regulated products [SMP products] delivered over 21CN should be set on the basis of efficiently incurred costs."*
- *"… where BT's ability to deliver a downstream service is dependent on the availability of an upstream input, and where BT has SMP in the relevant upstream market or can reasonably be expected to have SMP in the future, BT must not launch the new downstream service until it has also provided access to the upstream input."*

These policies will be implemented by Ofcom's existing powers or though undertakings which BT has entered into. A number of proposed industry led processes are also discussed to help smooth the transition to NGNs.

In March 2006 Ofcom published a Regulatory statement relating to the 2005 consultation. It outlined the set-up of a new industry body, NGN UK, which is to focus on three main areas; IP interconnect

[139] http://stakeholders.ofcom.org.uk/consultations/ngn/

[140] http://stakeholders.ofcom.org.uk/consultations/nxgnfc/

architecture, IP interconnect commercial model and network intelligence interoperability. The document also aims to clarify Ofcom's position on ex-ante regulation in four areas; initial continuity of existing products; clarity on issues related to current industry negotiations; issues to be addressed this year; and identification of more fundamental long term changes. Finally the document presents Ofcom's view on consumer issues, it expects to take a joint role with industry and where intervention is required will outline the overall objective allowing industry the flexibility on how to meet these objectives.

In 2009 Ofcom published a new consultation[141] examining how opinions on NGNs had changed since their original consultation. BTs rollout of its 21CN has progressed much slower than planned and has been scaled back so it no longer looks set to be the complete transition originally planned. In general the move to NGNs looks like it will be a gradual transition with more focus now being placed on NGA. These changes mean that TDM and IP-based interconnection will now coexist for the foreseeable future. BTs new plans involve a much shorter planning horizon and this has increased uncertainty, which could potentially discourage investment by other providers; the consultation looks at ways to mitigate this. The slower roll-out of NGNs has allowed more time to deal with any consumer issues that have arisen; including some compatibility issues. In January 2010 Ofcom published a statement concluding the consultation; it covered the main points of the consultations and outlined some of the responses.

Looking into the future; in May 2011 the Department for Culture, Media and Sport published an open letter[142] to begin discussions on a new communications review, culminating in a new communications framework by 2015. The aim of the review is to put the UK on a path to long term sustainable growth and make it a leading country in the EU and the World. NGNs are certain to play an important role in any future framework. The timeline for the project is to publish a green paper in early 2012, and then, after an extended consultation period to publish a white paper and draft bill by mid 2013.

Industry Bodies

Next Generation Networks UK (NGNuk) is an industry body established in 2006 as a forum to enable the discussion of issues relating to NGNs. In its early days NGNuk published a number of papers on interconnection charging; however since then its activity has declined with it mainly acting as a forum for discussion now.

NICC is an independent organisation, owned and managed by its members; it acts as a forum that develops interoperability standards. They have released a number of publications on their website[143] setting out standards for NGN interconnect and interoperability standards.

Consult 21 was set up in 2004 to consult between BT and other communication providers overs BTs 21CN plans. Its main aims were to make sure the industry was aware of everything BT was planning and giving the industry an input into 21CN developments. Consult 21 held a number of working groups and published documents relating to NGNs, however since May 2010 all activity has ceased.

[141] http://stakeholders.ofcom.org.uk/consultations/ngndevelopments/

[142] http://www.culture.gov.uk/images/publications/commsreview-open-letter_160511.pdf

[143] http://www.niccstandards.org.uk/publications/releases.cfm

The European Union

The issue of the transition to NGNs has been discussed at the EU level. From 2002 to 2006 a number of consultations and workshops were commissioned on the transition to NGNs[144] and the role of VoIP[145]. In 2009 the European parliament published a paper on Next Generation Networks[146] which looked at both core NGNs and NGA. The report focussed on NGA as this was viewed to be the area where competitive bottlenecks would continue to exist. However the need to monitor the interconnection architecture and consider Bill and Keep voice interconnection arrangements were considered. As in the UK the focus is now firmly on NGA, with NGN development being left to commercial paths.

Summary

The view on NGNs has changed from one of great expectation - at one point they were described as the biggest change to the telecoms market since privatisation - to one far more subdued. Whereas in 2004 it was anticipated nearly all services would be provided over a core NGN by 2010, it is now unclear if this will happen in the foreseeable future. The relative importance of conveyance (core) has faded as connectivity (access) has become the focus of regulators and providers. However, throughout, the view of regulators has generally been to allow industry to negotiate any changes and only intervene when commercial negotiation fails. So far there have been no major changes to the regulatory framework.

E2 Roll out of NGNs

Current status of core and NGA rollout

The Ofcom 2009 consultation charts how BT's core NGN plans, 21CN, have changed since there conception in 2004. The original plan was to transfer BTs multiple core networks to a single multi-service network, with the main reason being potential cost savings. The proposed network structure was much simpler than the existing legacy network.

It was planned that by 2008 50% of PSTN lines would have been transferred to the 21CN, however due to difficulties in testing; by 2009 just 75,000 lines in Wales had been connected. In 2008 BT introduced a new strategy moving away from its voice 21CN and placing more emphasis on NGA, it is now expected the PSTN will exist for much longer than anticipated and the transition will happen at a much slower pace. The reason that BT has given for this change is that with its new emphasis on fibre investment it makes little sense to invest in the 21CN; which may be superseded in the near future by fibre alternatives. In April 2010 BT announced that it has halted the migration of voice users to 21CN[147], effectively ending their original 21CN plans.

[144] http://ec.europa.eu/information_society/policy/ecomm/library/public_consult/ngn/index_en.htm

[145] http://ec.europa.eu/information_society/policy/ecomm/doc/library/working_docs/406_14_voip_consult_paper_v2_1.pdf

[146] http://www.europarl.europa.eu/document/activities/cont/201106/20110629ATT22907/20110629ATT22907EN.pdf

[147] https://www.btwholesale.com/pages/downloads/21_Century_Network_Community/Monthly_summary_Industry_Engagement_May10.doc

BT has shifted its focus from core NGN rollout to NGA rollout, with the aim of offering two thirds of homes superfast broadband (download speeds of at least 40 Mbps) by 2015. The plan was to have 4 million homes connected by 2010 and 10 million homes by 2012[148]. Of connected homes approximately one quarter will be FTTP (offering download speeds of 100 Mbps) and the rest will be FTTC. However reports suggest that BT may not be meeting their own goals[149], especially on FTTP. BT has more recently announced that it will be increasing the bit rate available on its FTTC products from 40 Mbps to 80Mbps and that it will be introducing at 110Mbps FTTP service. BT also plans to introduce a 300Mbps FTTP product in the future.

TalkTalk Group maintains two networks a traditional legacy network and a NGN[150]. The NGN is used for the majority of TalkTalk's broadband and voice services, while the legacy network is maintained to allow connection to BTs PSTN. Cable and Wireless completed the rollout of its NGN, known as the Multi-Service Platform, in the UK in 2006[151]. While Virgin Media Business invested £13 billion in what they say is the UKs largest next generation network[152]. Virgin Media has also rolled out NGA using its cable network. It already offers speeds of 50 Mbps to all homes passed by cable, 46% of households, and is starting to rollout speeds of 100 Mbps[153].

Relationships of NGN to internet networks

One of the main reasons for investing in NGNs is the potential cost savings from maintaining a single network. The original plan behind most NGNs in the UK was that they would carry all types of data including voice and internet traffic. It is now unclear if this is still the plan, however it seems that most operators have transferred the entirety of their core networks to IP based services.

NGN network architecture

As mentioned above one of the justifications for NGNs were potential cost savings, the proposed network structure was flatter compared to the existing legacy network. BTs plans for its 21CN consisted of just 3 layers; the core nodes (approximately 10), the metro nodes (approximately 120) and the main access nodes where the MDFs and MSANs would be located (approximately 6000). The original plan was to use MSANs to deliver both voice and broadband services together. However, there is now uncertainty over what technology will be used; the exiting trials run voice and broadband services in parallel as non-converged services.

As BT has decided to end the migration of PSTN voice calls to IP-based services all of the access network will remain legacy, with the exception of those customers who request VoIP services. In the core and the backhaul network there is a combination of legacy and next generation networks, and this looks set to be the case for the foreseeable future. This hybrid network, where legacy and NGN exist side by side, seems to be the standard in the UK, with Virgin, TalkTalk and Colt all confirming that they have a similar infrastructure.

[148] http://www.btplc.com/ngb/Rolloutprogress/index.htm

[149] http://www.totaltele.com/view.aspx?ID=464839

[150] http://www.talktalkgroup.com/corporate-information/group-talktalk-networks.html

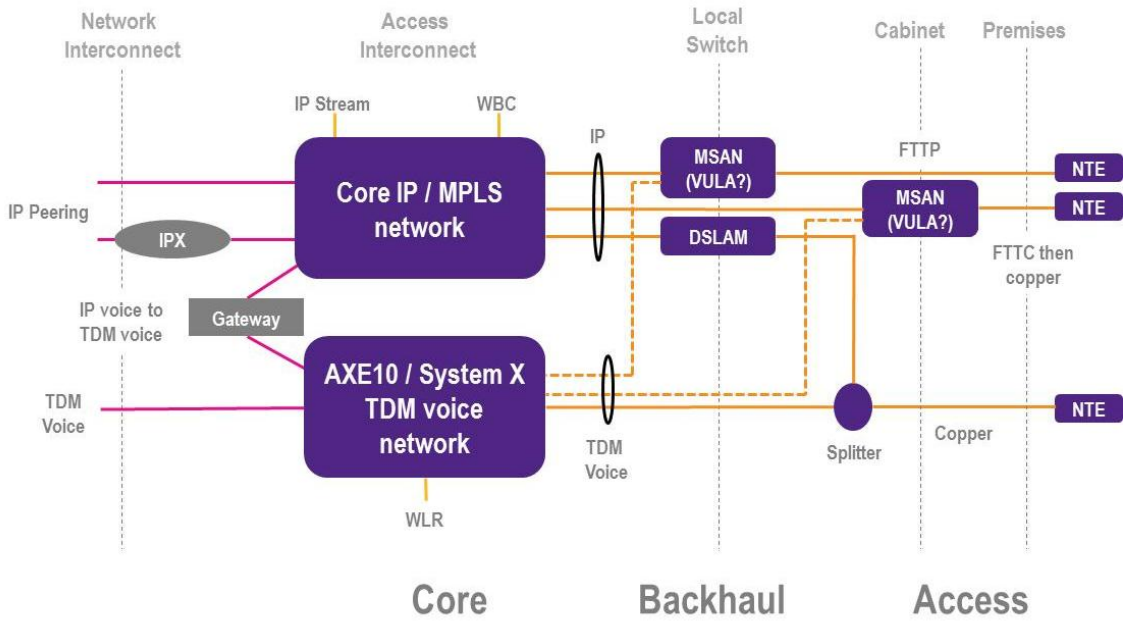
[151] http://www.pcpro.co.uk/news/258691/cable-and-wireless-promises-network-upgrade

[152] http://www.virginmediabusiness.co.uk/business_needs/operational_efficiency/next_generation_networds.aspx

[153] http://stakeholders.ofcom.org.uk/binaries/consultations/wla/annexes/context.pdf

The variation in network architecture can be seen in the following diagrams, figure E1 shows our perception of BT's network architecture:

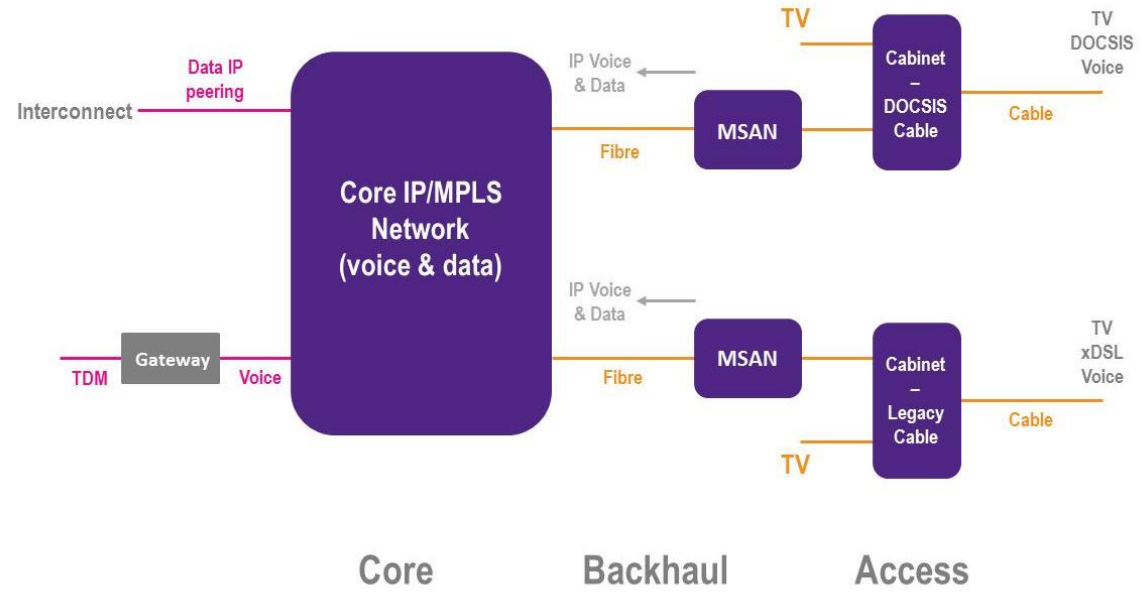
Figure E1: BT network architecture



It is clear that a legacy TDM network is being run in parallel to an IP NGN; however it is unclear what percentage of the network has transitioned to NGN. Any customers who connect to a DSLAM (the majority of residential customers) have their voice and data traffic split, each going to a separate core network. Most customers with FTTP or FTTC will use voice over fibre routed over the IP network, however there is the potential for this to be routed to the TDM network at the MSAN. Virtual Unbundled Local Access (VULA, fibre's answer to LLU) is likely to be located at the MSAN but there are still questions to resolve before it is rolled out. Wholesale Line Rental (WLR) is still provided on the TDM network and also emulated on the IP network.

Figure E2 shows our interpretation of information available on Virgin's network Architecture.

Figure E2: Virgin network architecture

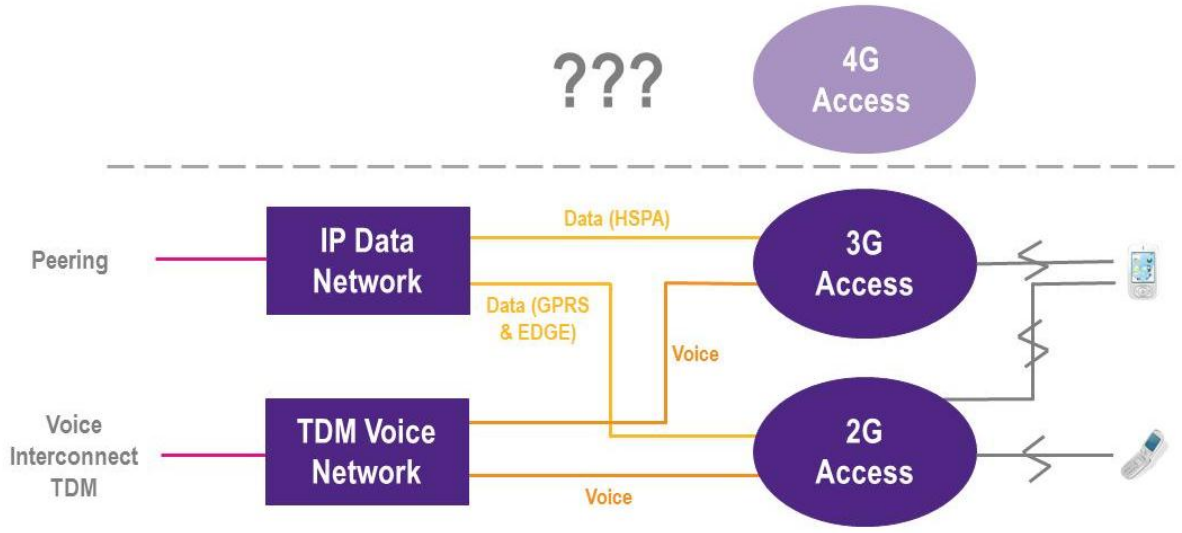


Note: TV headend not shown

Virgin are running a single IP core network; however they are also running parallel legacy and NGN backhaul and access networks. Everything is converted to IP traffic by the time it reaches the MSAN and conveyed back to the core. All voice is converted back to TDM for interconnection with other voice networks.

Figure E3 shows our understanding of O2's network architecture.

Figure E3: O2 network architecture



Note: VoIP delivered through phone based clients carried as IP traffic

O2 (we believe that other mobile operators have a similar architecture) runs two separate core networks; one IP based and one legacy TDM, the two are broadly separate only meeting at a point in

the access network. All voice traffic is carried over the TDM network while all data is carried over the IP network. It is currently uncertain how O2 (and other mobile operators) will run their 4G network and how this will interconnect.

As demand for increased bandwidth continues to grow the demand for different leased lines services is changing. BT expects that the Digital Private Circuit Network platform will be nearly unused by 2012/13, while it continues to develop its Alternative Interface Symmetric Broadband Origination portfolio that allows it to offer Ethernet Backhaul and other high bandwidth services. Ofcom regulates certain leased lines; charges are set on an RPI – X% basis, most recently set out in the 2009 charge control[154]. Whether or not leased line services are subject to charge control was determined by Ofcom in a previous consultation[155] where it was decided which services showed evidence of SMP.

NGN interconnection architecture

When BT proposed the 21CN in 2004 the lifetime of the PSTN network was expected to be limited, with eventually all voice traffic being moved towards IP interconnection in the long run. The plan was to transition connections from Digital Local Exchanges (DLE) to MSANs, and DLEs would gradually be removed from the system. In 2007 BT agreed with other operators that providers would be able to route traffic through the existing TDM at the tandem exchange or via IP connections.

The agreed proposal included 27 (+2) Point of Service Interconnections (POSIs) for voice interconnection. 27 POSIs would allow for full national coverage, with 2 additionally planned for resilience and diversity reasons. This was significantly down from the 770+ points of interconnect that exist in the legacy network. Since BTs 2008 strategy review it has not been clear how the situation will continue to develop. It seems that the number of interconnection points has continued to fall and is now somewhere between the original 770+ points of interconnect and the 27 POSIs that were planned under 21CN, however at this point in time it is unclear what the final number will be.

The above network diagrams show that the type of interconnection depends almost entirely on the type of data. Nearly all voice data is interconnected via TDM even if this mean it has to be converted from IP to TDM to IP (this would be the case with Virgin to BT), the exception is BTs IPX which currently accounts for about 8% of BTs total voice traffic. While all other data is connected via IP peering.

E3 Measures to facilitate rollout of NGNs

Government funding for NGN

BT has committed £2.5 billion to rolling out super-fast broadband; however it expects that this will only cover two thirds of the population. The remaining third of the population are in rural areas and will only receive NGA with some form of government subsidy. In December 2010 the UK Government launched Broadband Delivery UK (BDUK) with access to £530 million to help stimulate investment in broadband[156]. One of BDUKs main goals is to encourage investment in superfast broadband in rural

[154] http://stakeholders.ofcom.org.uk/consultations/llcc/statement/

[155] http://stakeholders.ofcom.org.uk/consultations/bcmr/?a=0

[156] http://www.culture.gov.uk/what_we_do/telecommunications_and_online/7781.aspx

areas; the first funds were allocated in May 2011[157]. BDUK has now published its delivery model and framework[158].

BDUK is running four pilot schemes to test how super-fast broadband can be delivered to a variety of rural areas. This includes joint work in North Yorkshire with the county council and NyNet, a scheme in the Highland and Islands of Scotland, a partnership with Herefordshire and Gloucestershire councils and finally a scheme with the Cumbria council. The funds allocated in May 2011 (£49 million), were awarded to three councils which would be commercially ignored - Devon and Somerset, Norfolk and Wiltshire – they now have to tender for contractors to carry out the work.

Achieving efficient NGN costs

Ofcom and the UK government have taken a passive role in the role out of NGNs, leaving the market to determine the structure and timing of any investment. This has led to a rather inefficient network structure as legacy and NGNs exists side by side for an extended period. Ofcom have taken small steps, with help from the NICC, to ensure that interoperability standards exist to ensure that this issue is not holding back investment. There is evidence that some operators are considering outsourcing their core network (O2 is considering outsourcing its core to BT); this should lead to an efficient number of core networks and could result in long run cost savings.

In building wiring

In the UK in building wiring has been de regulated for a long time. Ofcom now takes a non-interventionist role in the matter, only offering guidelines when it seems necessary. The last case of this was the 2008 new build consultation[159] which looks at fibre network deployment in new developments. Ofcom's approach was to outline its objectives rather than directly regulate; it expects providers to install spare capacity in their ducts and use sub-ducting to ensure sufficient capacity for duct sharing exists.

Spectrum release plans

Despite being one of the first countries to auction off its 3G spectrum the UK has yet to release any new spectrum for 4G use[160] because of legal disputes between operators over their spectrum holdings. However, in March 2011 Ofcom published a consultation[161] for an upcoming spectrum auction of "digital dividend" and 2.6GHz bands planned to take place in early 2012, which has now been further delayed to Q4 2012[162]. The auction will include 60 MHz (2x30 MHz) of paired spectrum at the 800 MHz band, and 50 MHz of unpaired spectrum and 140 MHz (2x70 MHz) of paired spectrum at the 2.6GHz band. It is anticipated that the primary use of this spectrum will be for 4G (LTE) technology. To ensure there is competition in the market Ofcom has proposed auction floors and caps,

[157] http://www.zdnet.co.uk/news/networking/2011/05/27/government-hands-out-first-funds-for-rural-broadband-40092920/

[158] Broadband Delivery Framework Summary http://www.culture.gov.uk/publications/8512.aspx

[159] http://stakeholders.ofcom.org.uk/consultations/newbuild/

[160] Operators may refarm their existing holdings to 4G e.g. at 1800 MHz.

[161] http://media.ofcom.org.uk/2011/03/22/ofcom-prepares-for-4g-mobile-auction/

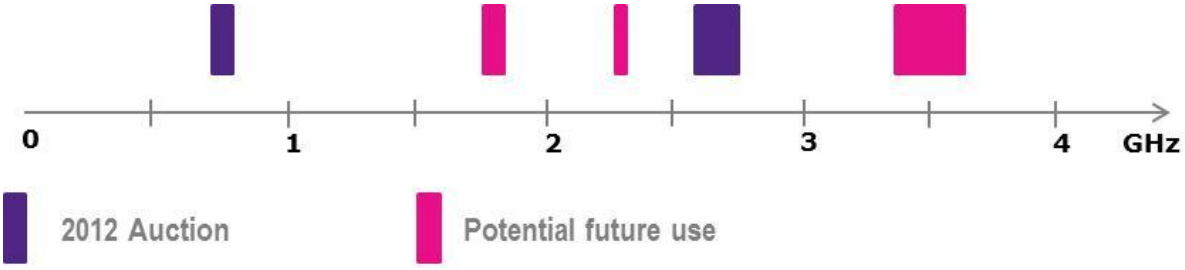
[162] http://media.ofcom.org.uk/2011/10/07/update-on-plans-for-award-of-800mhz-and-2-6ghz-spectrum/

there are also proposed conditions on the 800 MHz band for providing coverage. The current proposal is to require a sustained downlink of at least 2 Mbps with a 90% probability of indoor reception for 95% of the UK population[163].

The 2012 auction is the UK's main plan for releasing more spectrum for 4G use, however there are a number of other bands that may be used. The UK government has announced plans to release 500 MHz of spectrum below 5 GHz by 2020, which is currently held by the public sector. The first stage of this plan is to release up to 160 MHz of spectrum in the 2.3 GHz and 3.4 – 3.6 GHz bands (40 MHz and 120 MHz respectively), both of which could be used for deployment of 4G technology[164]. UK Broadband (owned by PCCW) recently announced plans to use some of it existing holding of 3.5 – 3.6 GHz spectrum to deploy a 4G network in urban areas[165], these services could be operational by 2012.

Using newly acquired spectrum is not the only option for deploying 4G networks; it is possible to refarm existing bands currently used for 2G and 3G services. The 1800 MHz band is being considered for this in a number of countries (e.g. Poland, Australia). In the UK Ofcom has given all operators permission to refarm their 1800 MHz spectrum from January 2011. At the moment it is unclear if or when the 1800 MHz will be available for 4G use. The matter is complicated as Everything Everywhere is being forced to sell off some of its holding to meet requirement laid down by the EU regulators for agreeing to the merger of Orange and T-Mobile. Figure E4 summarises the potential spectrum available for 4G use in the UK.

Figure E4: Spectrum potentially available for 4G



E4 NGN Interconnect

Interconnect principles

Any-to-any interconnect is a requirement at the EU level[166], and the UK level as dictated by the 2003 communications act[167]. Ofcom has decided that where there is evidence of SMP then interconnect charges should be regulated; this has always been done by regulating termination and origination charges. Investment in NGNs potentially changes the interconnect architecture and the optimum

[163] http://stakeholders.ofcom.org.uk/consultations/combined-award/summary

[164] "Enabling UK growth – Releasing public spectrum, Making 500 MHz of spectrum available by 2020", March 2011, Department for culture, media and sport

[165] http://www.ft.com/cms/s/0/9d43cf30-96ba-11e0-baca-00144feab49a.html#axzz1QYaNXxwy

[166] http://ec.europa.eu/information_society/policy/ecomm/doc/140access.pdf See article 4, point 1.

[167] http://www.legislation.gov.uk/ukpga/2003/21/section/74

regulation; Ofcom has investigated this but so far there have been no regulatory changes. For those markets where Ofcom does not see evidence of SMP interconnection charges are usually determined through commercial negotiation; in IP networks this is normally IP peering.

In a world where NGNs exist alongside legacy (TDM) networks there is a need for all interconnection to take place on the same technology. To do this the TDM operator must convert its traffic to IP or the NGN operator must convert its traffic to TDM. When deciding whether to invest an operator must consider both the interconnection charge and the cost of interworking. In the UK the issue of interworking is reduced because many operators have decided to operate both NGN and legacy networks so they don't have to face the interworking problem, however it is still important in some situations. Currently all interconnection with fixed line legacy networks occur via TDM so NGN operators bear the full cost of interworking. At the moment all interoperability standards are supervised by the NICC.

Obligations on dominant operators

BT has an obligation to not deny interconnection to any communication providers without reasonable reason; this is specified in the 2003 communications act[168]. Other than this the regulator has imposed no obligations on BT. In the early consultations there was concern that with the reduction in points of interconnection it may be necessary to require BT to operate some TDM interconnections while the transition was on going. However as BT has not decreased the number of points of interconnection as quickly as originally planned this issue has been largely forgotten. The Ofcom 2009 consultation considered imposing requirements on interworking, to minimise the overall cost, however no regulation was levied.

Charging methods

In designing a charging structure there are two issues to consider; who should be charged and how they should be charged. The issue of who should be charged is an economic problem which will determine how efficient the final allocation will be. The two current systems of determining who pays are known as; calling part pays and bill and keep.

Calling party pays is traditionally used by all voice and messaging services, the basic idea is that the calling parties network pays the whole cost of the call or message to the receiving parties network. Bill and keep is traditionally used by internet based services, in bill and keep a network is responsible for all of its costs and makes no payments to other networks based on traffic exchange. For bill and keep to be economically viable both parties must have similar volumes of traffic, where traffic is not symmetric it is necessary for one network to make a payment to the other.

In the UK all traffic that is regulated, for example fixed and mobile voice, is calling party pays. While most traffic where charges are reached by commercial negotiation are bill and keep. This looks set to continue for the foreseeable future. NGNuk published a paper[169] on which charging method would be most likely to achieve dynamic and static efficiency in NGNs. It determined that calling party pays was most likely result in efficient investment because the party who benefits the most from the call (usually the calling party) pays. Ofcom consider bill and keep in their 2009 consultation on mobile termination

[168] http://www.legislation.gov.uk/ukpga/2003/21/section/87

[169] http://www.ngnuk.org.uk/uploads/NGNuk_Charging_Principles__12072007.pdf

rates[170], they highlight the point that bill and keep is efficient when there are significant internalised call externalities. However without clear evidence on the magnitude of these externalities there is no justification for changing to a bill and keep system.

The problem of how networks should be charged is usually solved by usage based charging however there are alternatives, primarily capacity based charging (CBC). Usage based charging is where parties are charged based on the volume of their traffic this might be number of voice minutes or volume of data transferred. In capacity charging parties are charged based on their volume of traffic at the peak time, any increase in traffic outside of peak hours is not charged, but any increase during peak hours may be charged highly. In the UK all regulated traffic is billed on a usage based system, based on termination and origination charges, and this looks set to continue for the foreseeable future.

NGNuk published a 2007 paper examining the different charging mechanisms; usage-based, port (wholesale customers pay a charge per port) and capacity charging[171]. Using a survey of NGNuk members they found that usage-based charging was the preferred choice in an NGN world, with capacity charging coming second. Generally respondents recognised that in the long run capacity charging will be the most efficient however it is not feasible to implement at the moment. The paper recommended an interim charging framework with the eventual goal of moving to capacity charging. Ofcom also considered capacity charging in their 2009 consultation on mobile voice termination rates and decided that capacity charging would be efficient, however practical issues would make implementation complicated and disruptive.

One of the advantages of capacity based charging (CBC) is that it is more aligned with the underlying costs a network faces. Upstream costs are generally driven by the demand for capacity, so CBC should be more economically efficient. It also has the advantage that usage and capacity charges can be separated removing the need to "convert" capacity charges into volume based price per minute charges. As networks move to an NGN world where all traffic is conveyed over the same IP network the benefits of CBC are likely to become more pronounced. The main disadvantage of CBC would be in the implementation, a move to capacity charging would need a fundamental change in how network capacity is measured and require capacity usage to be actively monitored. Finally setting capacity charges (either through commercial negotiation or regulation) is likely to be both difficult and highly contentious.

Setting termination charges

In the UK Ofcom has decided to regulate any charges in markets in which it believes SMP exists. Any charges that are not regulated by Ofcom are either determined by reciprocity agreements or through commercial negotiation.

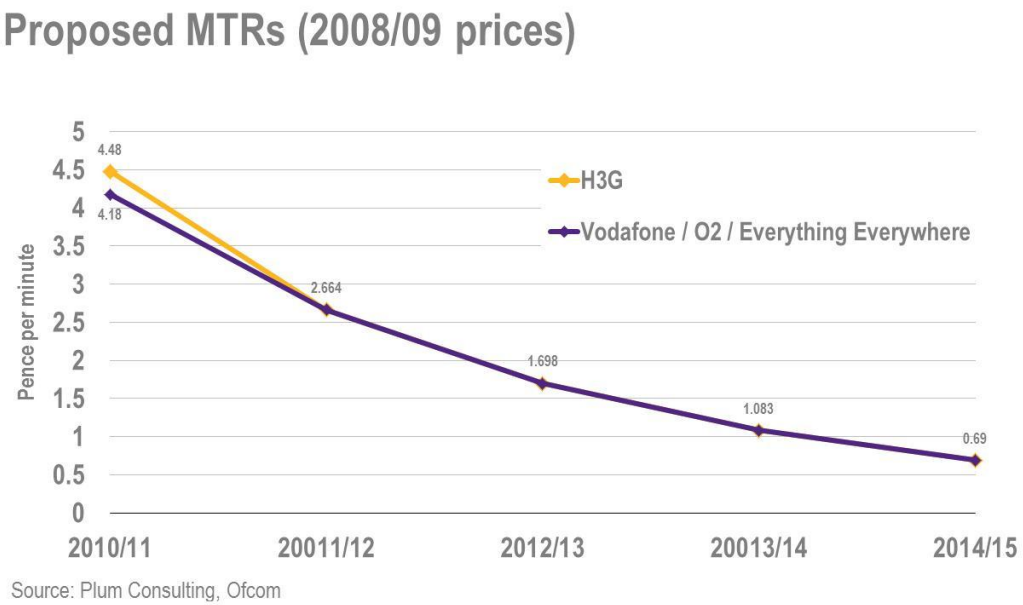
On March 31 2011 the rules regulating mobile termination charges expired and so prior to this Ofcom launched two consultations on how charges should be regulated between 2011 and 2015. The consultations discussed six possible methods of setting termination charges, but only two were favoured by respondents; pure LRIC and LRIC+. LRIC+ was the approach used to set charges previously and allows for the recovery of fixed and common costs. Pure LRIC or Long Run Marginal Costs (LRMC) does not have an allowance for the recovery of common costs. The European Commission has issued a recommendation to use the pure LRIC methodology for setting charges;

[170] http://stakeholders.ofcom.org.uk/consultations/mobilecallterm/

[171] http://www.ngnuk.org.uk/uploads/NGNuk_Potential_Charging_Mechanisms_Summary.pdf

Ofcom is not obliged to follow this recommendation but should take it into account. Ofcom's final decision was to use the pure LRIC methodology to set maximum charges for the four national providers by 2014. The charge cap is set on a four year glide path; other operators are required to set prices on a fair and reasonable basis. Figure E5 shows the proposed path for MTRs, they fall quickly and by the end of the period are below one pence per minute.

Figure E5: Proposed MTR glide path



Source: Plum Consulting, Ofcom

In Ofcom's 2009 Review of BT's Network Charge Controls[172] it was decided that BT has SMP in the markets for wholesale fixed call origination and geographic call termination and so these markets should continue to be regulated. Charge controls will also apply to interconnection circuits necessary for wholesale call origination and geographic call termination and to the component in the charges for these services to cover Project Management, Policy and Planning (PPP). Charge controls are set on an RPI – X% basis, with the charges to apply from 2009 – 2013 shown in table E1.

Table E1: BT Network Charge Controls 2009 - 2013

Service/technical area/component	NCC 2009-2013
Call termination	RPI + 3.75%
Call origination	RPI + 2.75%
Interconnection circuits (ISB)	RPI + 3.75%
PPP	RPI + 1.50%

Given the uncertainties of BT's 21CN plans at the time of the charge control, NGN costs were not predicted into the future. It was also deemed inappropriate to set charge controls on future 21CN voice services as it was unclear if these services would have SMP.

[172] http://stakeholders.ofcom.org.uk/binaries/consultations/review_bt_ncc/statement/nccstatement.pdf

End to end QoS

To make sure the transition to NGNs does not result in reduced QoS; Ofcom have asked BT to publish regular QoS measurements. NICC have suggested that in a mixed TDM NGN world there may be some end-to-end quality issues due to repeated conversion. The slower transition to NGNs means these quality issues could exist for the foreseeable future; however industry views on whether conversion reduces quality are mixed. Ofcom have admitted that calls to ported numbers may experience greater delay, but have decided that the costs of intervention do not outweigh the potential benefits[173].

E5 Other possible NGN regulation

Calls to emergency services

In the UK emergency services can be reached by calling either 999 or 112 (the EU wide number) from both fixed and mobile phones. Although the transition to NGNs is occurring at a much slower and fragmented pace than originally planned the move from PSTN voice service to VoIP presents potential problems for calls to emergency services. Ofcom has been aware of the issue facing VoIP service since 2004, as many consumers were unsure if the services they used provided access to emergency calls. After a 2006 consultation Ofcom tried to increase awareness of the issue by requiring communication providers to inform their customers what access to emergency calls they provided. However research in 2007 suggested information alone would not be enough to tackle the problems of under provision and customer confusion.

In 2007 Ofcom published a consultation and subsequent statement[174] requiring that all VoIP services that allow users to make traditional calls to fixed or mobile phones (with the exception of so called "click to call" and international only services) allow users to call 999/112 at no charge. Providers are also required to, where possible; provide location information for the network connection of the call to the emergency services. Ofcom did not impose an auto-location requirement because it did not view it to be technically feasible; it will keep what is technically feasible under review. Type 4 VoIP providers (services that allow users to make and receive calls from fixed and mobile phones) are obliged to comply with GC 3 which requires uninterrupted 999/112 calls. All other VoIP services that provide emergency calls must perform a formal risk assessment for that service and implement a risk mitigation strategy.

So far the migration to NGNs has not had a huge impact on calls to emergency services because the majority of calls are still provided by the PSTN network and all interconnection to emergency call centres is via TDM. However, VoIP services are growing and Ofcom has put in place regulation to ensure access to emergency calls is available.

Consumer protection

Ofcom has set out three proposals on how consumer protection should be governed, these are:

[173] http://stakeholders.ofcom.org.uk/consultations/gc18_routing/statement/

[174] http://stakeholders.ofcom.org.uk/consultations/voip/

- The services offered to consumers on NGNs should at least be equivalent to their existing services;
- Consumers should suffer no detriment during the transition to NGNs, for example due to loss of access to emergency services, or degraded call quality; and
- Any changes to end user services are fully explained to consumers.

Ofcom's approach going forward will be one of critical observation; where operators have a natural incentive to provide better services there should be no reason to intervene, however there may be some other situations where regulation is warranted. In regards to customer migration, Ofcom holds the view that providers have an incentive to minimise any disturbances from migrations and therefore there has been no need for intervention. With the exception of alarm systems the transition to NGNs has not produced any major consumer protection issues.

One issue that arose when BT began its trials for 21CN was the incompatibility of certain alarm systems with NGNs. Many fire, security and telecare alarm systems don't work correctly on NGNs because of the increased end-to-end delays compared to the legacy network; although some equipment can be reconfigured, some will have to be replaced. As BT has scaled back the rollout of 21CN the size of the problem has been reduced, however it is estimated that there are up to 3.5 million of these alarm systems; of which a significant proportion could need replacing. It is Ofcom's view that the providers of alarms should be responsible for informing which consumers need to reconfigure or replace their systems. During the transition period communication providers should keep the alarm community up to date on the implications of the transition to NGNs.

Obligation to continue legacy services

Point one of the consumer protection proposals above addresses the issue of continuing legacy services:

- The services offered to consumers on NGNs should at least be equivalent to their existing services.

However some communication providers were concerned that this proposal was too restrictive and keen to point out that it did not imply NGN services must be identical to legacy services. TalkTalk was particularly concerned that it might imply that all legacy services would have to be emulated regardless of cost or demand. Ofcom clarified that it did not expect all legacy services to be emulated, but consumers should not face inferior services on NGNs and where there are any changes consumers should be duly informed.

Removal of existing regulation

One of Ofcom's regulatory principals is "as soon as competitive conditions allow, withdraw from regulation at other levels". In the original 2004 consultation Ofcom saw NGNs as offering the potential for regulation removal. This was thought to be the case because of two possible effects of NGNs; improved equivalence and convergence. If 21CN enabled effective equivalence then it may be possible to remove some downstream regulation in retail markets, and a general move to equivalence of inputs would allow for existing regulations to be simplified. While, convergence may mean that it is possible to remove some service specific regulation, for example voice and leased lines.

However, the slow pace of transition to NGNs and the development of a world in which legacy networks exist alongside NGNs mean that there has been no removal of existing regulations. It seems that this legacy and NGN coexistence will continue for the foreseeable future, effectively ruling out the removal any regulation as a direct result of NGN development.

Universal broadband policy

In the UK universal service obligation is governed by the EC Universal Service Directive and the Universal Service Order specified by the Secretary of State for Trade[175]. The services that are covered by the universal service obligation are:

- Special tariff for low income customers;
- Connection to a fixed network;
- Including functional internet access;
- Reasonable geographic access to public call boxes;
- Text relay service for customers with hearing difficulties.

The functional internet service requirement has a minimum speed of just 28.8 kbps. The Universal Service Order is implemented by Ofcom through impositions on the two fixed line service providers; BT and KCom. Currently all the costs of meeting the universal service obligations are met by BT and KCom, in the 2006 statement Ofcom decided that this would remain the case as it did not put undue financial burden on operators.

Targets for the provision of universal broadband are outlined at the UK and EU level. In 2009 the UK government released the Digital Britain paper[176]; setting the course for Britain to become a global leader in the digital world. One of the goals set out in the report was to deliver speeds of 2 Mbps to 100% of the population by 2012; this was to be financed from a £200 million government fund. However, since the Digital Britain report was published this target has been pushed back to 2015[177]. The digital Britain report also had a goal of providing superfast broadband to the one in three individuals who will not be provided for by the market, this has led to the creation of BDUK (see above).

The Europe Commission Digital Agenda[178] has set out two goals relating to universal broadband:

- 100% of the population with access to speeds of 30 Mbps by 2020
- 50% of European households receiving speeds of 100 Mbps by 2020

To help move towards these ambitious targets the EU is looking to set up a number of funds to compensate for the lack of private sector funding in certain areas. EU member states are expected to complete a number of actions to keep on track; develop a comprehensive national broadband strategy by 2012, take measures to facilitate investment in superfast broadband and implement the European

[175] http://stakeholders.ofcom.org.uk/consultations/uso/uso_statement/

[176] http://www.official-documents.gov.uk/document/cm76/7650/7650.pdf

[177] http://www.culture.gov.uk/images/publications/britainsSuperfastBroadbandFuture.pdf

[178] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:FIN:EN:PDF

Radio Spectrum Policy programme. On 19th October 2011 the European Commission announced a proposal for over €9bn for broadband investment[179].

E6 Key regulatory issues to resolve

Short Term

By 2014 many of Ofcom's current charge controls and regulated termination charges will have expired, in deciding whether or not to continue to regulate these services the role of NGNs must be reconsidered. In determining the correct regulatory device Bill and Keep and Capacity Based Charging must both be re-examined to determine whether they are more appropriate as the transition to an NGN world has progressed further. In setting the level of any regulated charges NGN costs must be carefully considered. So far this issue has been sidestepped; any regulated charges have been set on the basis of legacy costs, however by 2014 this is unlikely to be efficient as NGNs will be an ever more important part of the network.

The network diagrams in section 2 highlight the convoluted path that some VoIP traffic has to traverse. Currently the majority of VoIP traffic passes through a gateway and is converted to TDM for interconnection with other networks, it is often then converted back to IP traffic to be conveyed through the core or back to the consumer. As VoIP traffic continues to grow and voice over fibre products are developed this inefficient network architecture will need to be addressed.

Longer Term

Virtual Unbundled Local Access (VULA) is BT's temporary solution to providing wholesale access to fibre networks. Compared to physical LLU BT maintains control of the physical line but gives competitors more freedom over how they use the connection. Ofcom has decided that the regulation of non-physical NGA products is not necessary at this stage[180], however a number of potential pricing methods have been discussed. One idea that has gained prominence is the use of anchor products to control prices[181]. The idea behind anchor pricing is that a basic product is regulated and then any higher bandwidth products are not subject to any ex-ante regulation because the anchor product will cap the price they can charge.

The VULA approach was approved by the European Commission in 2010[182] as long as prices for VULA services were cost orientated (contrary to Ofcom's original proposal). Digital Agenda Commissioner Neelie Kroes said:

"In this specific instance, virtual unbundling seems the best option to safeguard competition and enable consumers to benefit from a wider range of services provided over next generation fibre infrastructure. However, this interim solution is not a long term alternative to physical fibre unbundling, which should be imposed as soon as possible."

[179] http://ec.europa.eu/information_society/newsroom/cf/itemlongdetail.cfm?item_id=7430

[180] http://stakeholders.ofcom.org.uk/binaries/consultations/wla/summary/wlacondoc.pdf

[181] Brian Williamson. 2008. "Next generation networks: why a fresh regulatory approach is required" http://www.plumconsulting.co.uk/pdfs/Plum_June08_Next_generation_networks.pdf

[182] http://www.eubusiness.com/news-eu/telecoms-uk.206/

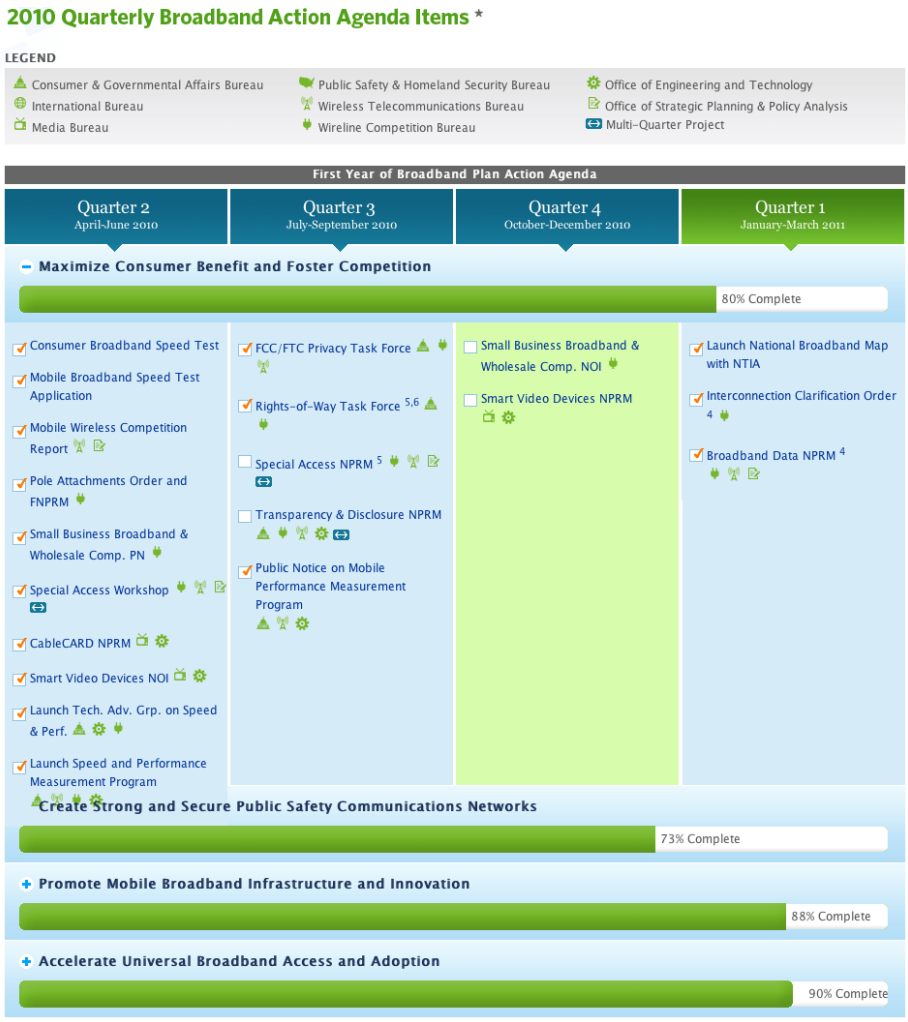
This highlights a wider issue in Europe which is how to deal with those who currently benefit from unbundling (e.g. TalkTalk, Sky etc.). Many incumbents, including BT, want the regulatory requirement of unbundling to be removed but regulators seem unlikely to comply. It will be necessary to find a solution relevant to fibre that will satisfy all parties involved.

Annex F USA

F1 NGN regulation

The U.S. does not have NGN regulations or laws, *per se*. The FCC's National Broadband Plan, released in early 2010, best encapsulates the current U.S. policy approach to broadband.[183] The FCC website www.broadband.gov tracks progress on the plan and related broadband issues. Figure F1 shows progress on the plan.

Figure F1: Tracking Progress on National Broadband Plan



Source: http://www.broadband.gov/plan/broadband-action-agenda-items.html

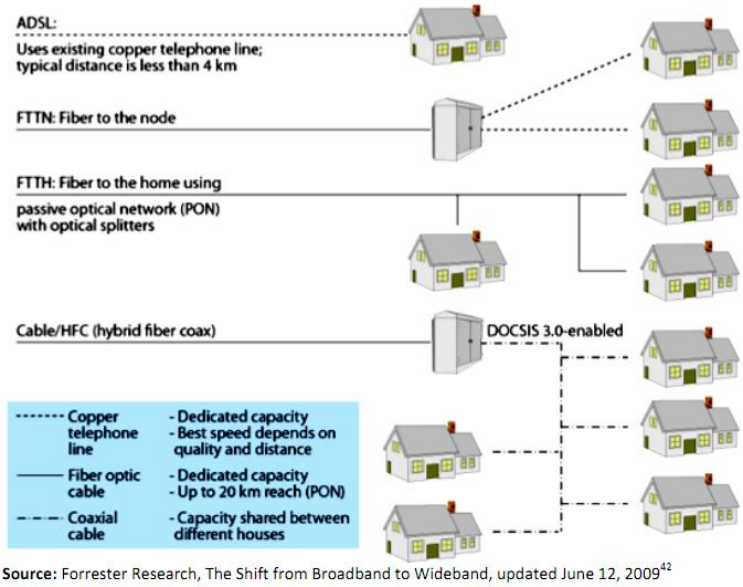
[183] Federal Communications Commission, *National Broadband Plan: Connecting America* (Washington, DC, March 2010), http://www.broadband.gov/.

F2 Roll out of NGNs

Current status of core and NGA rollout

NGA in the U.S. involves several technologies. NGA wireline services are provided by cable's DOCSIS 3.0, FTTH, and FTTN, as shown in Figure F2.

Figure F2: Wireline Broadband Technologies



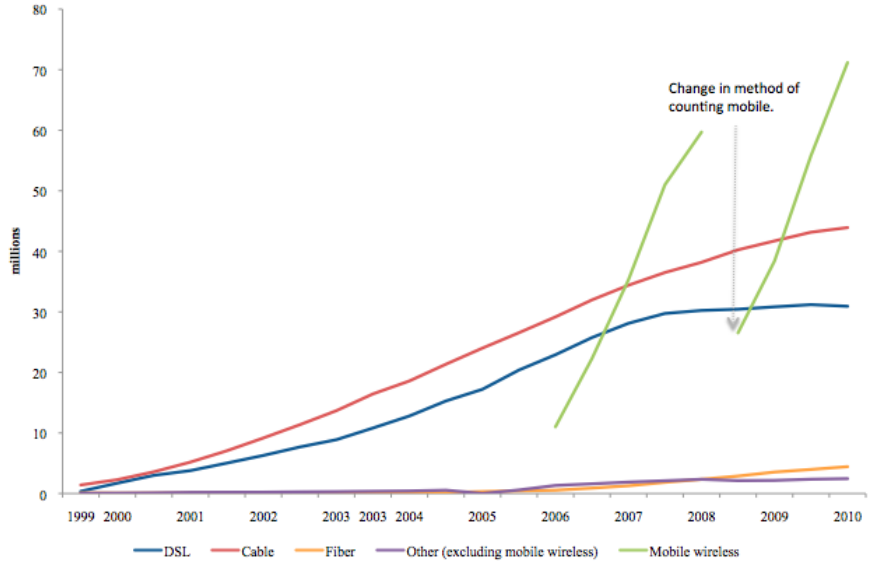
Source: Forrester Research, The Shift from Broadband to Wideband, updated June 12, 2009[42]

Source: Atkinson, et al (2011), Figure 1.[184]

Wireless NGA includes LTE and some WiMAX. Figure F3 shows the number of connections for different broadband technologies in the U.S.

[184] Robert C. Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)* (Columbia Institute for Tele-Information, May 2011), http://www4.gsb.columbia.edu/null/download?&exclusive=filemgr.download&file_id=738763.

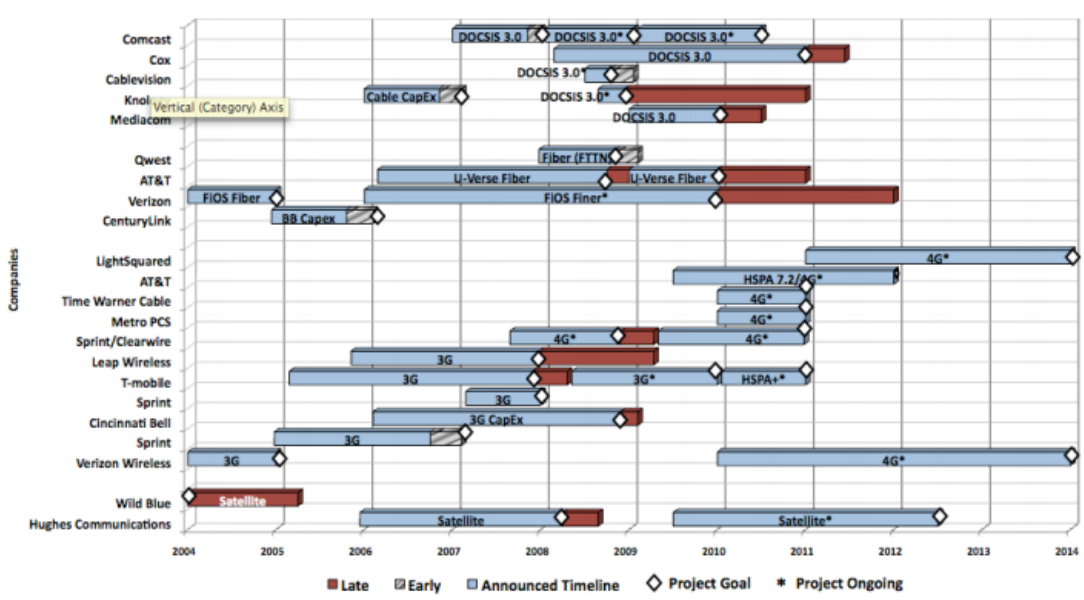
Figure F3: Broadband Connections in the U.S. by Technology



Source: Federal Communications Commission.[185]

Figure F4 shows the timeline of broadband deployment by company from 2004 through deployment expected by 2014. This section discusses the rollout of each technology and their collective implications.

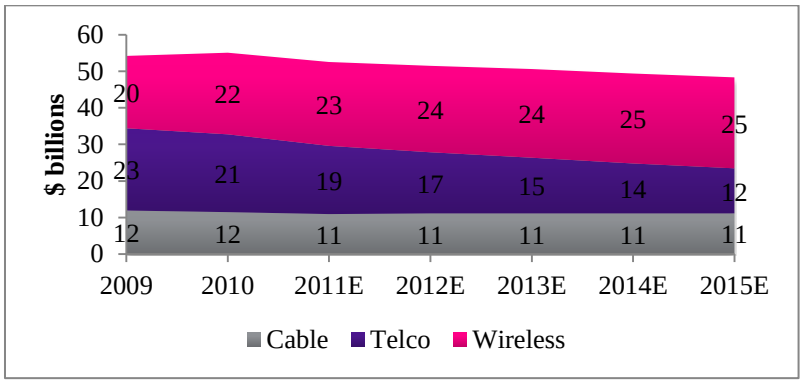
Figure F4: Broadband Deployment Timeline



Source: Atkinson, et al (2011) Table 10.[186]

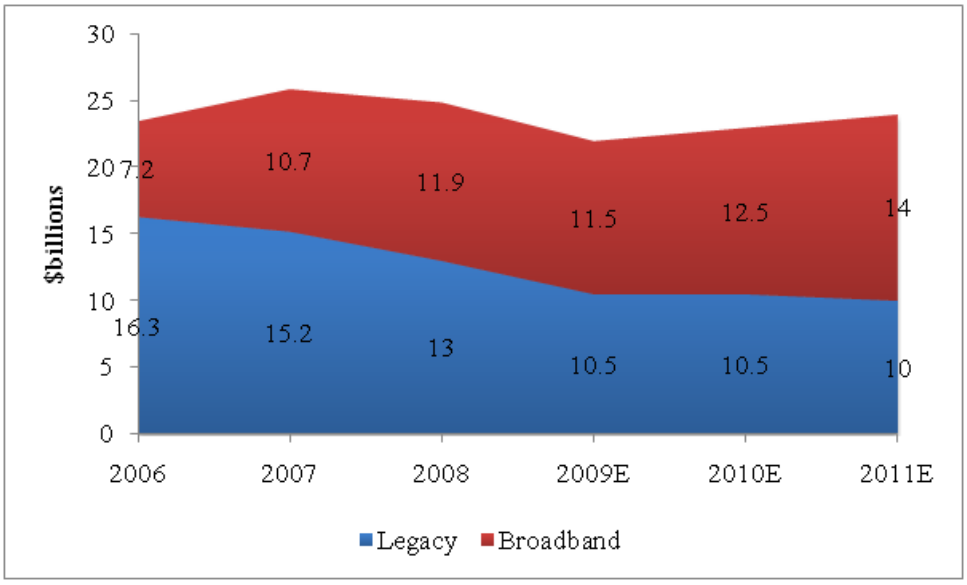
[185] Industry Analysis and Technology Division, Wireline Competition Bureau, *Internet Access Services: Status as of June 30, 2010* (Federal Communications Commission, March 2011); Federal Communications Commission, *High-Speed Services for Internet Access: Status as of June 30, 2007* (Washington, DC, 2008).

Figure F5: Predicted Total Capital Expenditures by Major Providers



Source: Atkinson et al (2011), Table 13.[187]

Figure F6: RBOC Investment in Legacy and Broadband Networks



Source: Atkinson et al (2011), Table 14.[188]

Cable DOCSIS 3.0

An important difference between broadband access in the United States relative to the rest of the world is that the majority of connections in the U.S. are provided by cable, rather than telephone, networks. Cable's prominence in U.S. last-mile networks means that upgrades to NGN in the U.S. rely less on fiber investments than in most other countries.

[186] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*.

[187] Ibid.

[188] Ibid.

Cable companies' broadband typically uses fiber to a neighborhood node and coaxial cable from the node to households (and, hence, is called hybrid fiber-coax or HFC) and is available to 93 percent of the U.S. population.[189] Although cable has always had more broadband Internet subscribers than did telco firms, partly due to asymmetric regulatory requirements imposed on telcos but not cablecos,[190] until early 2010 much of the discussion of U.S. ultra-high speed broadband focused on a supposed need for fiber investments with little emphasis on cable.[191] However, as cable began to take advantage of the low cost of DOCSIS 3.0 upgrades (estimated at less than $100 per home, including the necessary modem)[192] and its ability to deliver up to 160Mbps, sentiment began to change. The U.S. National Broadband Plan, for example, expressed concern that cable's advantage would mean that in the near future 75 percent of the population would have 50Mbps+ speeds available only from cable.[193]

DOCSIS 3.0 upgrades have proceeded relatively quickly. Table shows the status of DOCSIS 3.0 upgrades for cable companies reflecting about three-quarters of all homes passed by cable. To date, however, DOCSIS 3.0 has involved upgrading only downstream connections, with most upstream connections still limited by DOCSIS 2 technologies and upgrades scheduled to begin in 2010.[194]

[189] http://www.ncta.com/StatsGroup/Availability.aspx

[190] Thomas Hazlett, "Rivalrous Telecommunications Networks With and Without Mandatory Sharing," *Federal Communications Law Journal* 58, no. 3 (June 2006): 477-510.

[191] Yochai Benkler et al., *Next Generation Connectivity: A review of broadband Internet transitions and policy from around the world* (The Berkman Center for Internet & Society, 2010), http://cyber.law.harvard.edu/publications/2010/Next_Generation_Connectivity.

[192] Stacey Higginbotham, "DOCSIS 3.0: Coming Soon to a Cableco Near You," *GigaOM Network*, April 30, 2009, http://gigaom.com/2009/04/30/docsis-30-coming-soon-to-an-isp-near-you/; Saul Hansell, "World's Fastest Broadband at $20 Per Home," *The New York Times Bits Blog*, April 3, 2009, http://bits.blogs.nytimes.com/2009/04/03/the-cost-to-offer-the-worlds-fastest-broadband-20-per-home/.

[193] Federal Communications Commission, *National Broadband Plan: Connecting America*, 42.

[194] Robert C. Atkinson and Ivy E. Schultz, *Broadband in America: Where It Is and Where It Is Going (According to Broadband Service Providers)* (Columbia Institute for Tele-Information, May 2011), 27, http://www4.gsb.columbia.edu/null/download?&exclusive=filemgr.download&file_id=738763.

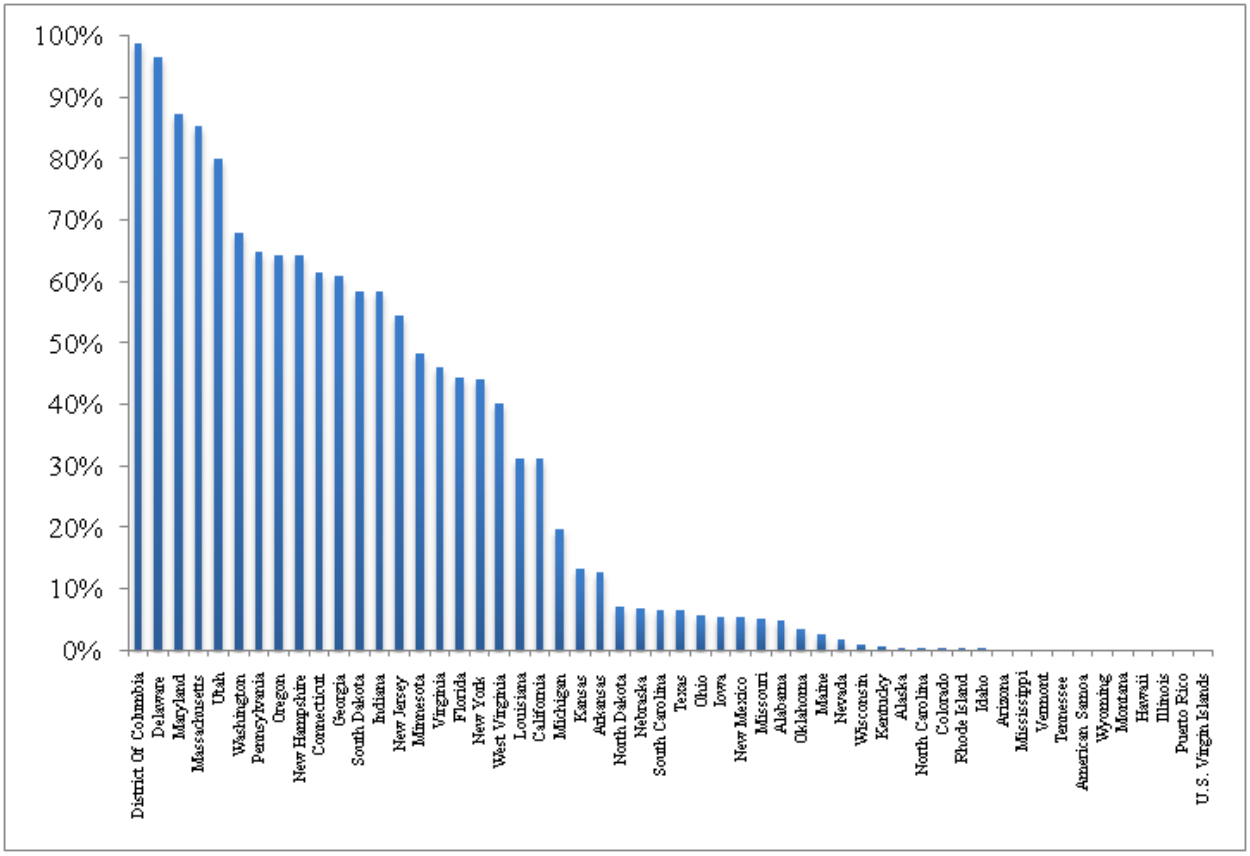
Table F1: Share of Territory Upgraded to DOCSIS 3.0

Comcast	100%
TimeWarner Cable	"Surgical"
Cablevision	100%
Mediacom Cable Company	50%
Cox	67%+

Source: Atkinson and Schultz (2011), Figure 10.[195]

Figure F7 shows the share of each state's population with access to DOCSIS 3.0 technology

Figure F7: Share of Population With Access to Cable DOCSIS 3.0 by State, 2010



Source: National Broadband Map (2011).[196]

[195] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*.

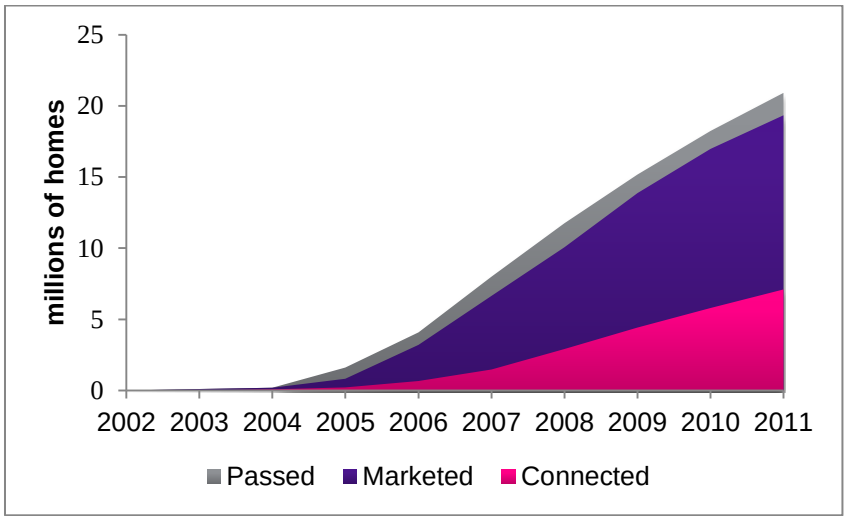
[196] http://www.broadbandmap.gov/rank/all/state/percent-population/within-nation/technology-wireline-optical-carrier-fiber-to-the-end-user/descending/technology-wireline-cable-modem-docsis-3.0/demographics-population

Fiber

Not including the fiber component of HFC connections, fiber connections come in two flavors: fiber to the home (or premises) or FTTH, and fiber to the node (or neighborhood) or FTTN.[197]

FTTH was available to about 20 million homes in the U.S. (Figure F8).

Figure F8: FTTH Penetration in North America



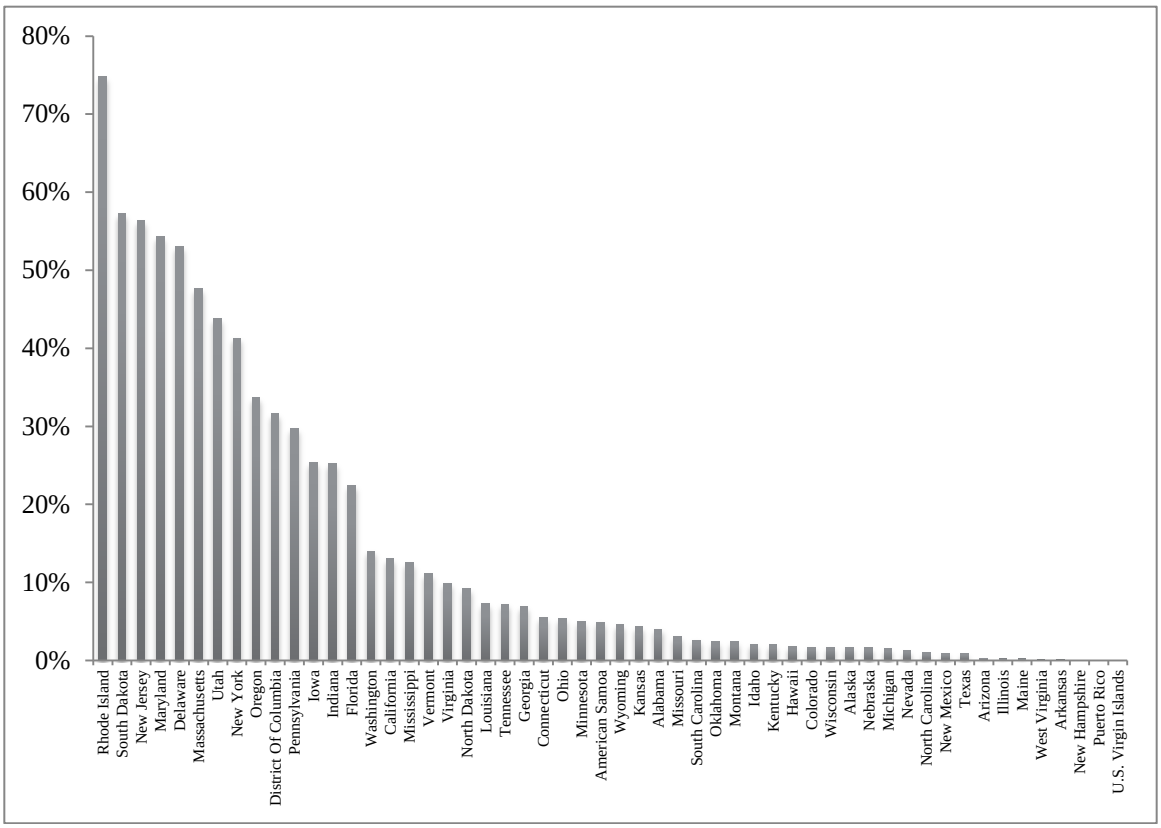
Note: Data as of first quarter each year. The U.S. represents 97 percent of FTTH rollout. Source: RVA Market Research (2011), Appendix.[198]

Figure F9 shows that these connections tend to be concentrated in certain states.

[197] HFC is also technically FTTN, but colloquially FTTN has come to mean fiber to the node (neighborhood) and copper to the house, while HFC uses coaxial cable from the node to the house.

[198] RVA Market Research and Consulting, *North American FTTH Status - March 31, 2011* (FTTH Council, March 31, 2011), http://telecomthinktank.com/wp-content/uploads/downloads/2011/04/rva_ftth_status_april_2011_final_final.pdf.

Figure F9: Share of Population With Access to FTTH by State, 2010



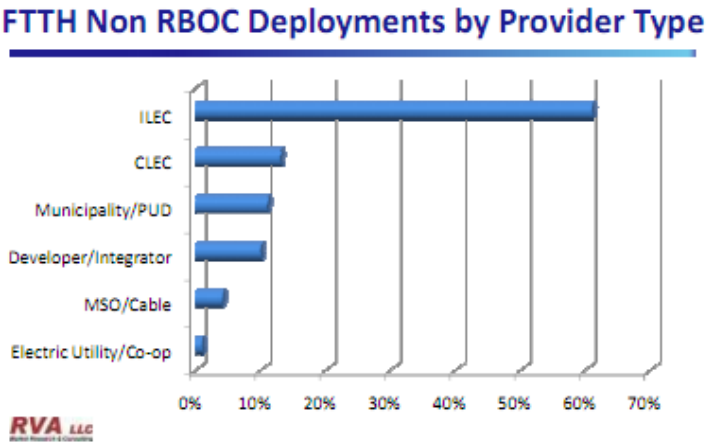
Source: National Broadband Map (2011).[199]

This concentration is not surprising given that Verizon represents more than 73 percent of all FTTH connections, but "more than" 770 providers offer FTTH in North America.[200] The majority of these are smaller incumbent telcos, but also include municipalities, real estate developers, and others (Figure F10).

[199] http://www.broadbandmap.gov/rank/all/state/percent-population/within-nation/technology-wireline-optical-carrier-fiber-to-the-end-user/descending/technology-wireline-cable-modem-docsis-3.0/demographics-population

[200] RVA Market Research and Consulting, *North American FTTH Status - March 31, 2011*, 3.

FigureF10: FTTH Deployment by Providers Other Than Verizon



Source: RVA Market Research (2011)[201]

The FTTH Council reports that 70 percent of non-RBOC telephone companies[202] plan to continue investing in FTTH.[203] Nevertheless, given that Verizon has announced that its rollout is complete, and the second- and third-largest telcos (AT&T and Centurylink) have no public plans to build FTTH, it is unlikely that the share of the population with access to FTTH will increase significantly in the near future.

Major telcos that have not invested in FTTH are, instead, pushing fiber closer towards end-users and using copper to cover the final distance. AT&T says that its FTTN service, dubbed "U-Verse," will be available to all 30 million households in its territory.[204] AT&T's U-Verse currently offers top speeds of only 24Mbps downstream and 3Mbps upstream, but reportedly has plans to employ technology allowing up to 80Mbps.[205]

LTE and WiMAX

Several providers, including Verizon, AT&T, Sprint, T-Mobile, and regional provider MetroPCS, have begun rolling out 4G wireless technologies. Verizon, AT&T, and MetroPCS are or will be using LTE technology. T-Mobile is upgrading its 3G network to HSPA21+ and announced its intention to begin LTE upgrades but no timeline and, in any event, its proposed merger with AT&T (see below) make

[201] Ibid.

[202] "RBOCs" refer to Regional Bell Operating Companies, which were formed following the breakup of AT&T in 1984. Originally there were seven RBOCs, but mergers have reduced that to three: Verizon, AT&T, and CenturyLink.

[203] RVA Market Research and Consulting, *North American FTTH Status - March 31, 2011*, 5.

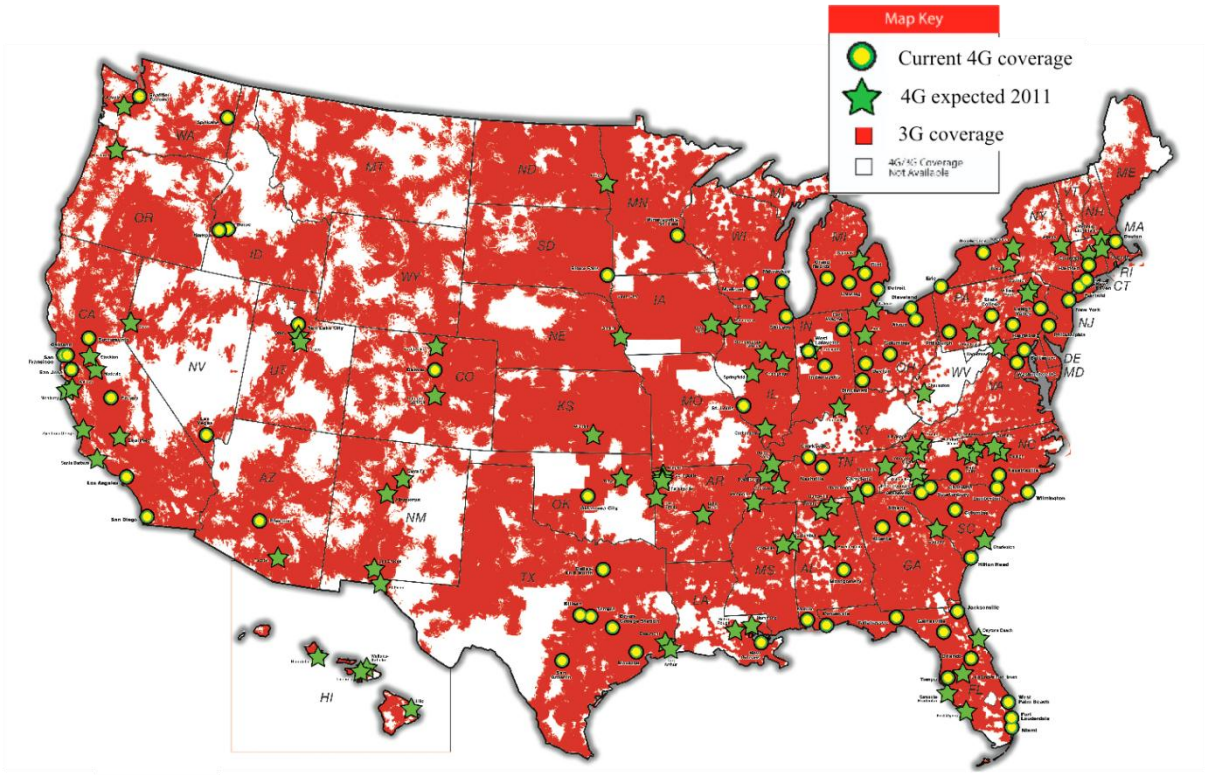
[204] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*, 42.

[205] Ibid., 23, 45.

those upgrades less likely. Sprint currently uses WiMAX with its partner ClearWire though has expressed interest in turning to LTE.[206]

Verizon has had the most aggressive LTE rollout, already offering LTE service to a large number of cities (Figure F11).

Figure F11: Verizon 4G Coverage as of July 2011



Source: Verizon (2011).[207]

The wireless market is subject to three sources of uncertainty in the near- and medium-terms.

First, AT&T and T-Mobile intend to merge. The merger is subject to approval by the U.S. Department of Justice (DOJ) and the FCC. AT&T contends that the merger would accelerate and deepen its 4G rollout,[208] but others argue that AT&T is unlikely to increase its investment and that the merger would be likely to reduce net investment.[209] Approval by the DOJ and FCC would almost certainly involve the parties agreeing to certain concessions, including divesting themselves of some spectrum.

[206] Phil Goldstein, "Sprint CFO remains noncommittal on Clearwire funding, hints at LTE," *FierceWireless*, May 24, 2011, http://www.fiercewireless.com/story/sprint-cfo-remains-noncommittal-clearwire-funding-hints-lte/2011-05-24.

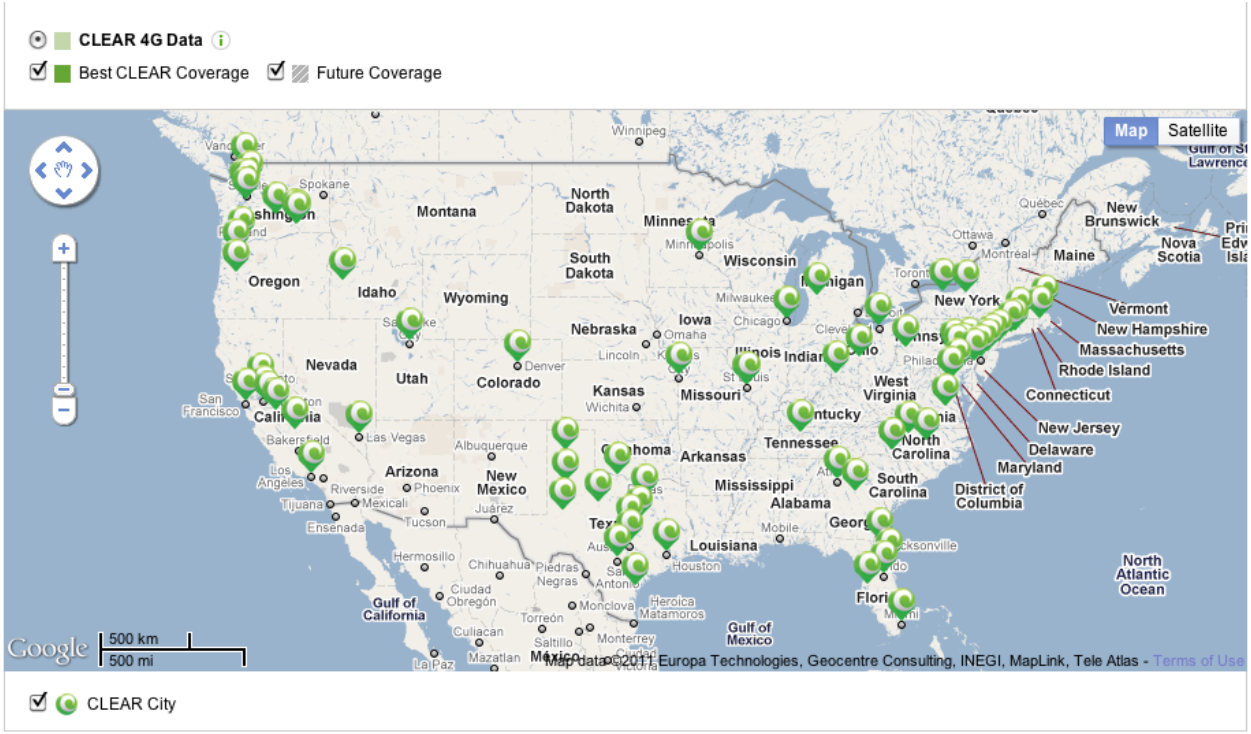
[207] http://network4g.verizonwireless.com/pdf/VZW_4G_LTE_Coverage_Map.pdf

[208] AT&T and T-Mobile, *Acquisition of T-Mobile USA, Inc. by AT&T, Inc. Description of Transaction, Public Interest Showing and Related Demonstrations*, April 21, 2011, http://fjallfoss.fcc.gov/ecfs/document/view?id=7021240421.

[209] Harold Feld, "The AT&T/T-Mobile Fine Print," *Tales of the Sausage Factory*, July 5, 2011, http://tales-of-the-sausage-factory.wetmachine.com/content/the-attt-mobile-fine-print.

Second, Clearwire has been expanding its WiMAX services rapidly, which are now widely available (Figure F12). The company has approximately 140 MHz of spectrum in the 2.5GHz band.[210] Clearwire, however, has experienced growing losses[211] and is having difficulty raising additional investment funds.[212]

Figure F12: Clearwire Coverage as of July, 2011



Source: Clear (2011).[213]

Third, Lightsquared is building a LTE network and has stated its intention to cover 92 percent of the population by 2015.[214] They plan to offer only wholesale rather than retail access and have announced deals with Sprint, Best Buy, Open Range (a rural wireless broadband provider), and Leap Wireless.[215] Lightsquared's plans are currently subject to some controversy due to its apparent interference with GPS services.[216]

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[210] Clearwire Corporation, *Clearwire 2010 Annual Report*, 2011, 49, http://files.shareholder.com/downloads/CLWR/1322550545x0x463919/9C8D0AA3-9C20-41C2-8E81-DB3500576E35/FY_2010_Annual_Report.pdf.

[211] Ibid.

[212] Goldstein, "Sprint CFO remains noncommittal on Clearwire funding, hints at LTE."

[213] http://www.clear.com/coverage, accessed July 13, 2011.

[214] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*, 53.

[215] AT&T and T-Mobile, *Acquisition of T-Mobile USA, Inc. by AT&T, Inc. Description of Transaction, Public Interest Showing and Related Demonstrations*, 13; Mobiledia, "Sprint, LightSquared Team Up On 4G," *Forbes*, June 20, 2011, http://blogs.forbes.com/mobiledia/2011/06/20/sprint-lightsquared-team-up-on-4g/.

[216] http://tales-of-the-sausage-factory.wetmachine.com/content/my-insanely-long-field-guide-to-lightsquared-v-the-gps-guys

Satellite

Two companies—ViaSat (formerly Wildblue and still marketed under that name) and Hughes—offer broadband over satellite. Currently available service is relatively slow (less than 2Mbps downstream and 300kbps upstream) and expensive ($89.00 per month from Hughes for 2Mbps/300Kbps service).[217]

Nevertheless, both companies are in the process of launching and activating new "high-throughput" satellites that will offer much faster service. ViaSat says it will offer speeds of 2-10Mbps and Hughes says it will offer speeds of 5-25Mbps.[218] While these speeds are slower than those available via cable DOCSIS 3.0 or fiber, they may compete favorably with LTE and, more importantly, offer service in very rural areas comparable to urban areas in terms of which online services are possible to use.

Core NGN

The internet backbone carries internet traffic across long distances using high-speed fiber optic cables, generally bundles of OC-3 (155mbps), OC-48 (2.48gpbs), and OC-768 (40gbps, soon up to 100gpbs) fibers.[219] To transfer traffic around the country and globe, the individual networks that make up this backbone must connect with each other. These interconnections are either direct between two networks or indirect via additional networks that agree to transfer the traffic. The arrangements that allow networks to interconnect directly and indirectly are called "peering" and "transit." Peering describes an agreement between two or more networks to interconnect directly to exchange traffic, often without charging any fees. Transit describes an arrangement in which a network charges a transit fee to carry traffic between another network and all other networks.

Top global backbone operators today include Level 3 Communications, Global Crossing, AT&T, Sprint, Verizon, and others.[220] These companies operate "Tier 1" networks that can reach every other network on the internet without paying for transit. Other backbone operators include "Tier 2" networks and "Tier 3" networks, which generally pay transit fees to at least some other networks for the right to transport information over those networks.

U.S. Internet transit prices have fallen dramatically—from about $1,200 per mbps in 1998 to $5 per mbps in 2010 (Figure F13).[221]

[217] http://consumer.hughesnet.com/plans.cfm?WT.mc_id=05141PPChncom3, last accessed July 14, 2011.

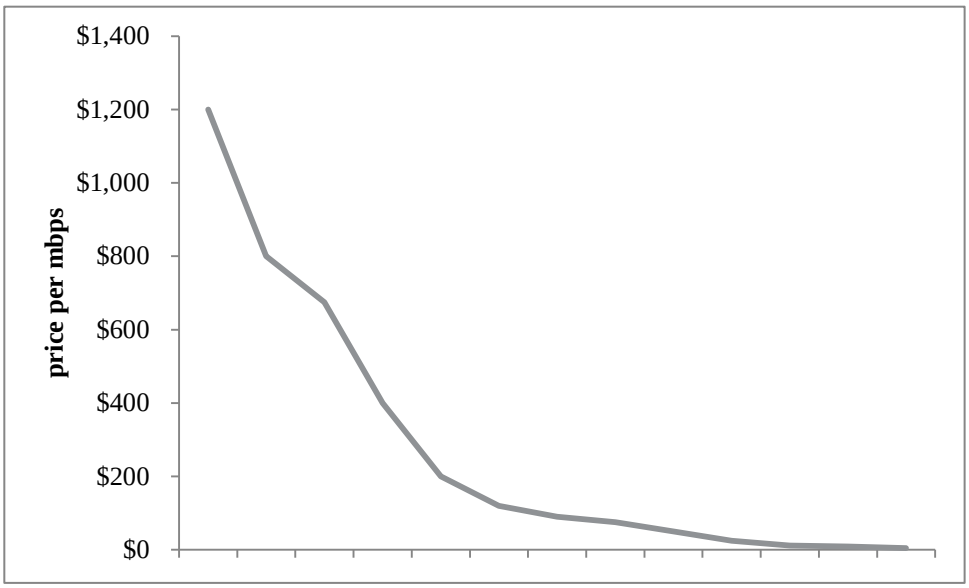
[218] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*, 68.

[219] Ibid., 31.

[220] C. Labovitz et al., *ATLAS Internet Observatory 2009 Annual Report* (University of Michigan, Arbor Networks, merit Network Inc., 2009), http://www.nanog.org/meetings/nanog47/presentations/Monday/Labovitz_ObserveReport_N47_Mon.pdf; Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)*, 31.

[221] http://drpeering.net/white-papers/Internet-Transit-Pricing-Historical-And-Projected.php

Figure F13: U.S. Internet Transit Prices



Source: http://drpeering.net/white-papers/Internet-Transit-Pricing-Historical-And-Projected.php, last accessed July 13, 2011.

Perhaps not surprisingly given the rapid price decreases, the Internet backbone in the U.S. is highly competitive—no single company handles more than 10 percent of total internet traffic.[222] The market also changes rapidly: in 2009 both Comcast and Google ranked among the top 10 in backbone traffic, while in 2007 neither did (Figure F14).

Figure F14: Top 10 U.S. Internet Backbone Operators

Rank	Provider	Percentage
1	Level(3)	5.77
2	Global Crossing	4.55
3	ATT	3.35
4	Sprint	3.2
5	NTT	2.6
6	Cogent	2.77
7	Verizon	2.24
8	TeliaSonera	1.82
9	Savvis	1.35
10	AboveNet	1.23

(a) Top Ten 2007

Rank	Provider	Percentage
1	Level(3)	9.41
2	Global Crossing	5.7
3	Google	5.2
4	Cogent	5.0
5	TeliaSonera	3.22
6	Comcast	3.12
7	Sprint	3.08
8	NTT	2.32
9	ATT	2.05
10	Verizon	1.89

(b) Top Ten 2009

Source: Labovitz et al (2009).[223]

Traffic flowing over these networks continues to increase dramatically. Average traffic over the highest-capacity U.S. routes increased from 1,525 Gbps in 2007 to 3,039 Gbps in 2009, with peak

[222] Labovitz et al., *ATLAS Internet Observatory 2009 Annual Report*.

[223] Ibid.

traffic increasing from 2,182 Gbps in 2007 to 4,393 Gbps in 2009.[224] Projections of future growth vary from 40 percent to 60 percent per year.[225]

The FCC does not currently regulate backbone networks at all.

Relationship of NGN to Internet Networks

Nearly all policy discussion in the U.S. has focused on upgrades to last-mile networks and only in terms of bandwidth those upgrades can provide. That is, while the ITU defines NGN as "a packet-based network able to provide Telecommunication Services to users and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent of the underlying transport-related technologies,"[226] NGN discussions in the U.S. tend to focus solely on how new technologies increase available bandwidth and avoid discussion of QOS.

In other words, aside from the technologies employed, there is no difference between NGN and legacy Internet networks in the U.S.

NGN network architecture

n/a

NGN interconnect architecture

n/a

F3 Measures to facilitate rollout of NGNs

Government funding for NGN

The federal government has subsidized broadband buildout through three programs, although direct subsidies were fairly small until passage of the American Recovery and Reinvestment Act (ARRA) of 2009. The first source of subsidies is the universal service program. Universal service officially funds only voice service, but convergence means that the infrastructure subsidized for voice use can also be used for broadband. Two federal programs officially fund broadband: the Rural Utilities Service (RUS) and the ARRA. The broadband component of ARRA is called the Broadband Technology Opportunity Program (BTOP).

[224] Atkinson et al., *Broadband in America - 2nd Edition : Where It Is and Where It Is Going (According to Broadband Service Providers)* Table 2.

[225] Ibid., 31.

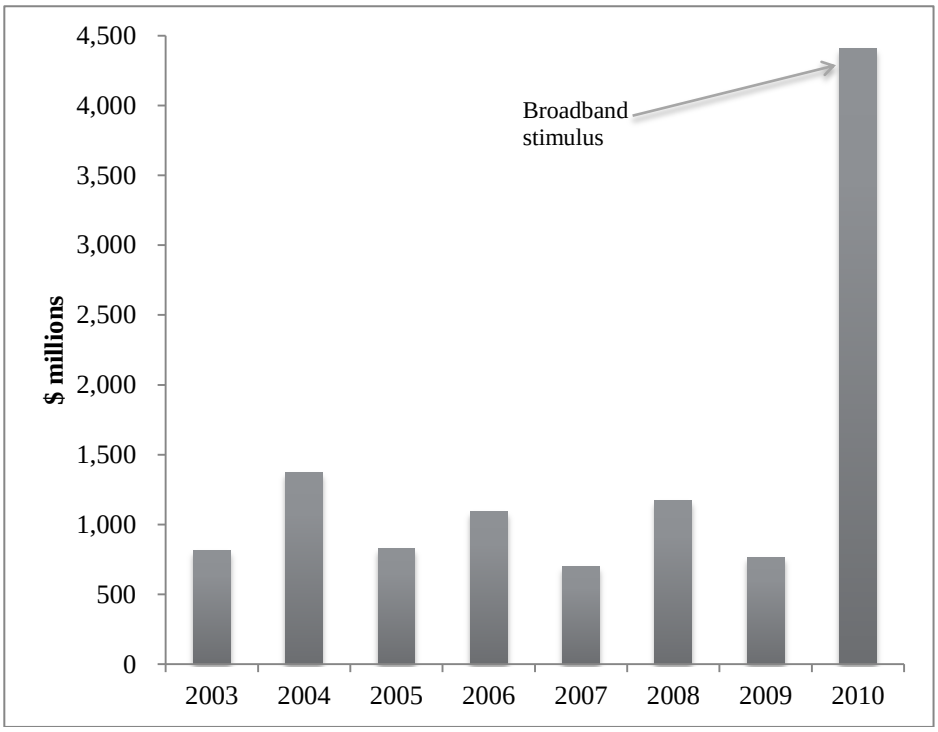
[226] http://www.itu.int/en/ITU-T/gsi/ngn/Pages/definition.aspx

Rural Utilities Service (RUS)

The RUS, operated by the U.S. Department of Agriculture (USDA), is intended to subsidize electricity, telephone, water, and waste disposal in rural areas.[227] In 2002 the Rural Electrification Act of 1936 was amended to allow for a program to subsidize broadband investments in rural areas.[228]

This support averaged around $1 billion per year until 2010 when the broadband stimulus program gave RUS substantial additional funds to distribute (Figure F15). RUS's program is called the Broadband Initiatives Program (BIP). The stimulus program is discussed below.

Figure F15: RUS Telecommunications Loans and Grants



Source: USDA Rural Development (2011).[229]

ARRA – Broadband Stimulus

The broadband stimulus program was signed into law on February 17, 2009 and provided $7.2 billion for broadband programs.[230] It is now called the "Broadband Technology and Opportunity Program" (BTOP). The National Telecommunications and Information Administration (NTIA) at the U.S.

[227] http://www.rurdev.usda.gov/Utilities_LP.html

[228] Kruger, Lennard G., *Broadband Loan and Grant Programs in the USDA's Rural Utilities Service*, CRS Report for Congress (Congressional Research Service, The Library of Congress, January 9, 2008).

[229] Rural Development, *USDA Rural Development 2010 Progress Report* (U.S. Department of Agriculture, 2011), 32, http://www.rurdev.usda.gov/supportdocuments/ProgReport2010.pdf.

[230] Regulatory Affairs Advisory Committee, *Development of Broadband Infrastructure in Hong Kong*, RAAC Paper (Hong Kong: Office of Telecommunications Authority, August 31, 2009), 21-22.

Department of Commerce was given $4.2 billion and the remainder to RUS. NTIA was to fund three categories of programs: community infrastructure, public computer centers, and adoption programs.[231] The vast majority of the funds were for infrastructure, with $250 million devoted to adoption programs and $350 million for developing a detailed broadband map (now available at broadbandmap.gov).

By June 2011 BTOP had awarded $4 billion in 233 projects.[232] Figure F16 provides some details regarding funded projects, and Figure F17 provides details on FTTH projects in particular.

Figure F16: BTOP Funding Details

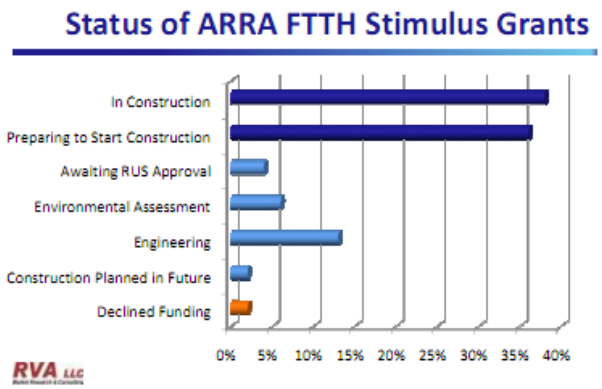
BTOP Nationwide Funding Summary

Funding Type	Recipients and Projects	Total Award
State Data and Development	56 Total Recipients, 56 Total Projects	$292,820,018
Infrastructure	112 Total Recipients, 121 Total Projects	$3,484,813,380
Sustainable Adoption	64 Total Recipients, 65 Total Projects	$200,504,996
Public Computer Centers	44 Total Recipients, 45 Total Projects	$251,199,099

Source API Call

Source: National Broadband Map.[233]

Figure F17: Status of BTOP FTTH Grants



Source: RVA Market Research (2011).[234]

Some U.S. states provide fairly small subsidies for broadband, and several municipalities have subsidized FTTH and wifi networks.

[231] http://www2.ntia.doc.gov/about

[232] National Telecommunications and Information Administration, *Broadband Technology Opportunities Program (BTOP) Quarterly Program Status Report* (U.S. Department of Agriculture, June 2011), 1, http://www.ntia.doc.gov/recovery/BTOP/BTOP_QuarterlyReport_jun_2011.pdf.

[233] http://www.broadbandmap.gov/summarize/nationwide

[234] RVA Market Research and Consulting, *North American FTTH Status - March 31, 2011*.

Achieving efficient NGN costs

Making it easier to employ spectrum in high-value uses such as broadband is probably the principle way the FCC can help reduce costs. However, other major costs include the costs of accessing supporting infrastructure, like poles, rights-of-way, and ducts. The National Broadband Plan recommended that the government

- **Establish low and more uniform rental rates for access to poles,** and simplify and expedite the process for service providers to attach facilities to poles.
- **Improve rights-of-way management for cost and time savings,** promote use of federal facilities for broadband, expedite resolution of disputes and identify and establish "best practices" guidelines for rights-of-way policies and fee practices that are consistent with broadband deployment.
- **Facilitate efficient new infrastructure construction,** including through "dig-once" policies that would make federal financing of highway, road and bridge projects contingent on states and localities allowing joint deployment of broadband infrastructure.[235]

However, most of the relevant rules are extremely detailed and not federal, which can limit the ability of the FCC and the federal government to make changes. For example, while the federal government can ease use of federal rights-of-way, more rights-of-way are managed by states, counties, and cities.

Nevertheless, the FCC recently passed orders to "comprehensively revise our pole attachment rules to improve the efficiency and reduce the potentially excessive costs of deploying telecommunications, cable, and broadband networks, in order to accelerate broadband buildout."[236] These new rules establish a timeline for pole owners to respond to attachment requests and begin to equalize rates charged to different types of companies.

In building wiring

In 2008 the FCC banned exclusive contracts for providing telecommunications service in apartment buildings, contending that "exclusive agreements between carriers and building owners hurt consumers and harm competition, with little evidence of countervailing benefits."[237]

Spectrum release plans

In the U.S. spectrum can be allocated for broadband in two principle ways: from the government via the FCC and potentially NTIA, and private trades of spectrum licenses in secondary markets. Due to

[235] Federal Communications Commission, *National Broadband Plan: Connecting America*, sec. Executive Summary.

[236] Federal Communications Commission, *In the Matter of Implementation of Section 224 of the Act A National Broadband Plan for Our Future*, Report and Order on Reconsideration, April 7, 2011, para. 1, http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0407/FCC-11-50A1.pdf.

[237] Federal Communications Commission, *FCC bans exclusive contracts for telecommunications services in apartment buildings*, March 19, 2008, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280908A1.pdf.

growing mobile use, the National Broadband Plan recommended making an additional 500 MHz of spectrum available for wireless broadband.[238]

To date, the FCC has identified 300 MHz of spectrum to make available. Figure F18 Figuredetails this spectrum and the plans for releasing it. As the figure shows, some of it has already been auctioned. The biggest block of spectrum—the broadcast TV band—is also the most controversial. The FCC hopes to use what it is calling "incentive auctions" to make it available. That issue is discussed below.

Figure F18: New Spectrum for Mobile Broadband

Band	Key Actions and Timing	Megahertz Made Available for Terrestrial Broadband
WCS	2010—Order	20
AWS 2/3[2]	2010—Order 2011—Auction	60
D Block	2010—Order 2011—Auction	10
Mobile Satellite Services (MSS)	2010—NPRM 2010—L-Band and Big LEO Orders 2011—S-Band Order	90
Broadcast TV[3]	2010—NPRM 2011—Order 2012/13—Auction 2015—Band transition	120
Total		**300**

Source: http://www.broadband.gov/plan/broadband-action-agenda.html

Incentive Auctions

The current policy focus is on moving spectrum in the 700 MHz band from being tied to television broadcasting to higher-valued uses through auctions. Making this happen requires a regulatory change and a new (or revised) law. The regulatory change is to allow the spectrum to be used for any purpose rather than only broadcasting. While some believe that change alone might be sufficient by stimulating secondary trades for the spectrum, others believe the transactions costs, including overcoming opposition from broadcasters, would be so high that the FCC must coordinate an auction instead.[239]

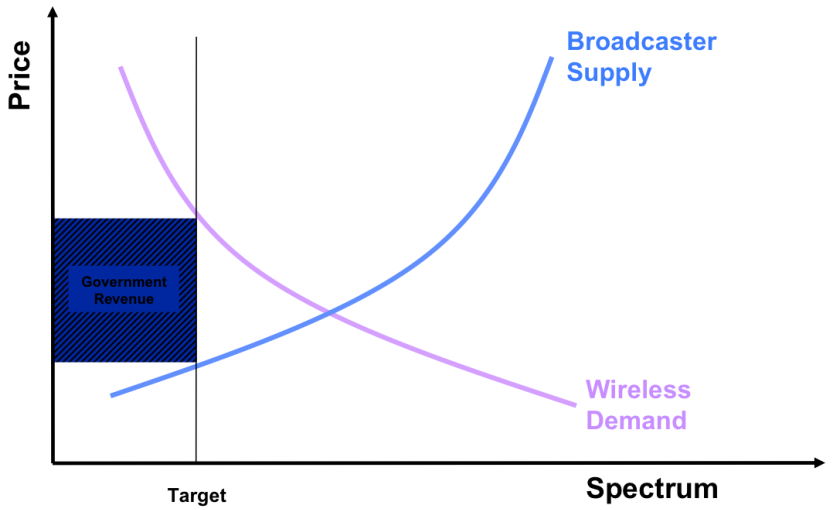
The FCC wants to overcome broadcasters' reluctance to part with their licenses by giving them incentives to participate in a reallocation plan—hence the name "incentive auctions." The FCC's current working proposal is to have broadcasters in each market bid the amount the must be paid in order to give up their licenses. No broadcaster would be required to participate. At the same time, potential purchasers of spectrum would bid the amount they are willing to pay. The FCC accepts bids that yield the desired amount of spectrum, pay the broadcasters what they asked and send the remaining amount of the proceeds to the U.S. Treasury. Broadcasters who chose to keep their

[238] Federal Communications Commission, *National Broadband Plan: Connecting America*.

[239] Jeffrey A. Eisenach, *Spectrum Reallocation and the National Broadband Plan* (Navigant Economics, LLC, October 2010); Paul Milgrom, Gregory Rosston, and Andrzej Skrzypacz, "Letter from 110 Economists to President Obama Regarding Incentive Auctions", April 6, 2011.

licenses would be “repacked” at government expense. Figure F19 shows a stylized example of how this two-sided auction would work.

Figure F19: Incentive Auction Where Clearing Costs are Less Than Revenues



Source: Evan Kwerel, “Incentive Auctions for Repurposing Broadcast Spectrum” (presented at the Spectrum Incentive Auctions: the Nuts, Bolts and Economics, Washington, DC, May 23, 2011).

The FCC does not, however, currently have the authority to conduct this auction because the law that allows it to conduct auctions for spectrum says it must give all proceeds to the Treasury. In other words, under current law the FCC would not be allowed to pay the broadcasters. As of July 14, 2011 the U.S. House of Representatives had introduced a draft bill that would give the FCC permission to do the auction, but controversial other aspects of the bill make its chances of passage uncertain.[240]

Secondary Markets

Secondary spectrum markets are well-developed in the U.S. relative to the rest of the world.[241] Secondary markets are important because while they do not release additional spectrum into the market, they ensure that spectrum can move to higher-value uses as market conditions change. Some hoped that secondary markets would yield a spectrum spot-market and that has not yet happened despite attempts by Cantor Fitzgerald and Spectrum Bridge to build trading platforms. Nevertheless, significant amounts of spectrum change hands in the private market.

[240] Phil Goldstein, “House lawmakers consider new spectrum auction bill,” *FierceWireless*, July 14, 2011, http://www.fiercewireless.com/story/house-lawmakers-consider-new-spectrum-auction-bill/2011-07-14.

[241] John Mayo and Scott Wallsten, “Enabling Wireless Communications,” *Information Economics and Policy* 22, no. 1 (March 2010): 61-72.

For example, Qualcomm bought spectrum and tried to build a mobile TV service (FLO TV) on it, but was not successful. In December 2010 AT&T purchased that spectrum—12 MHz in certain major cities and 6 MHz elsewhere—from Qualcomm for $1.925 billion to use for its LTE network.[242]

F4 NGN Interconnect

Because peering and transit issues have been handled through private contracts, there has so far been almost no official regulatory activity surrounding it. Perhaps the closest to direct regulation of interconnection occurred in 2005 when the FCC ordered a small ISP, Madison River, to cease blocking Vonage (a VOIP provider) from offering service over its network.. Nevertheless, two issues may bring more official attention to the issue of NGN interconnection: the implications of voip for legacy intercarrier compensation, and growing broadband traffic.

Intercarrier compensation

The current intercarrier compensation regime, based on PSTN circuit-switched networks, sets how much carriers must pay to terminate calls on each others' networks. The Commission recognizes that the system needs reform. The FCC explains,

Intercarrier compensation refers to the charges that one carrier pays to another carrier to originate, transport, and/or terminate telecommunications traffic. Although the same or similar facilities are used to originate, terminate and transport all types of traffic, the rates for intercarrier compensation vary based on several factors:

- *Where the call begins and ends (whether the call is local or long distance, and whether it is interstate or intrastate)*
- *What types of carriers are involved (incumbent local carriers, competitive local carriers, long distance providers, wireless carriers)*
- *What type of traffic (wireline voice calls, wireless calls, data bound for an Internet service provider)*

Intercarrier compensation payments are governed by a complex system of federal and state rules. There are two major forms of intercarrier compensation - access charges and reciprocal compensation.

***Access charges** generally apply to calls that begin and end in different local calling areas. Interstate access charges apply to calls that originate and terminate in different states, and intrastate access charges apply to calls that originate and terminate in different local calling areas within the same state. The Commission oversees interstate access charge rates, and the states oversee intrastate access charge rates. Access charges do not apply to Internet service providers under an exemption for enhanced service providers that use the facilities of local telephone companies.*

***Reciprocal compensation** generally applies to calls that begin and end within the same local calling area. Historically, reciprocal compensation rates have been lower than access charge rates, and interstate access charge rates have been lower than intrastate access charge rates. The difference between these rates can be large, with some reciprocal compensation rates as low as $0.00 per minute, and some intrastate access charge rates greater than $0.30 per minute.*

The Commission initially crafted its interstate access charge rules to facilitate payments between local telephone companies and long-distance companies after the 1984 breakup of the former AT&T

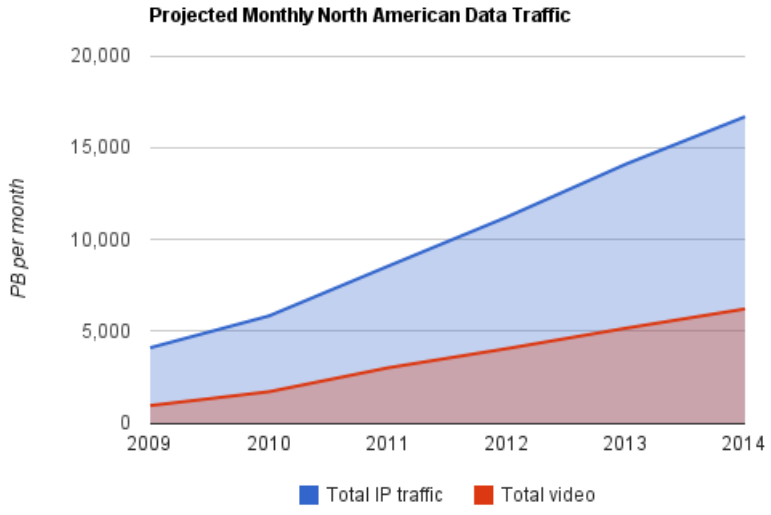
[242] Vlad Savov, "AT&T buys Qualcomm's FLO TV spectrum for a cool $1.9b, promises 4G awesomeness," *engadget*, December 20, 2010, http://www.engadget.com/2010/12/20/atandt-buys-qualcomms-flo-tv-spectrum-for-a-cool-1-9b-promises/.

monopoly. The agency modified and expanded its intercarrier compensation rules following passage of the Telecommunications Act of 1996. Dramatic changes in the marketplace since that time, however, have placed increasing strains on the existing intercarrier compensation system. For example, most wireless services were not available in the 1980s. ***More recently, the introduction of bundled service offerings and new services, such as voice-over-Internet protocol (VoIP) technology, have blurred traditional industry and regulatory distinctions, and posed questions that were not contemplated when the intercarrier compensation rules were initially created.***[243] [emphasis added]

Intercarrier compensation is related to universal service reforms because rural telephone companies charge high interconnection fees, making it a significant source of revenue for them. Rural companies are, therefore, concerned about the transition to VoIP service and want VoIP traffic to follow the same rules as switched traffic.[244] The larger carriers do not want to continue providing these hidden subsidies to rural carriers.

Growing broadband traffic

Growing traffic—and especially growing peak-time traffic—is already straining some interconnection agreements. Analysts expect data demands on networks to continue rapid growth. Cisco (2010), for example, projected a 30-percent compound annual growth rate for data in North America through 2014, suggesting that interconnection disputes may increase.



Source: Cisco (2010)[245]

[243] http://transition.fcc.gov/wcb/ppd/IntercarrierCompensation/

[244] http://www.telecompetitor.com/rural-telecom-groups-take-on-inter-carrier-compensation/

[245] Cisco, 2010. Cisco Visual Networking Index: Forecast and Methodology, 2009–2014.

The video component of the growth may be especially problematic given that it is concentrated at particular times of day. Sandvine Networks (2010) found that video traffic (real-time entertainment) peaked during peak hours, with Netflix alone responsible for about 20 percent of all download traffic.[246]

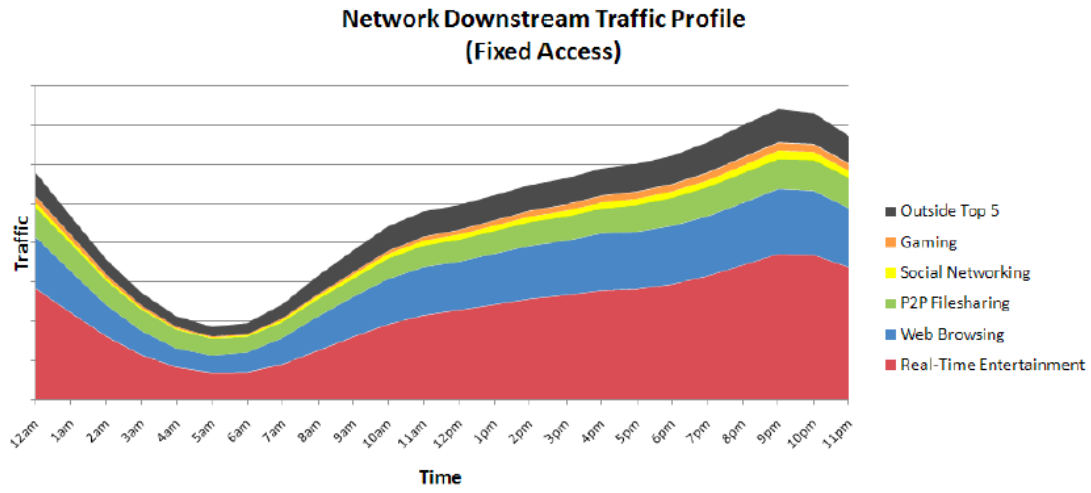
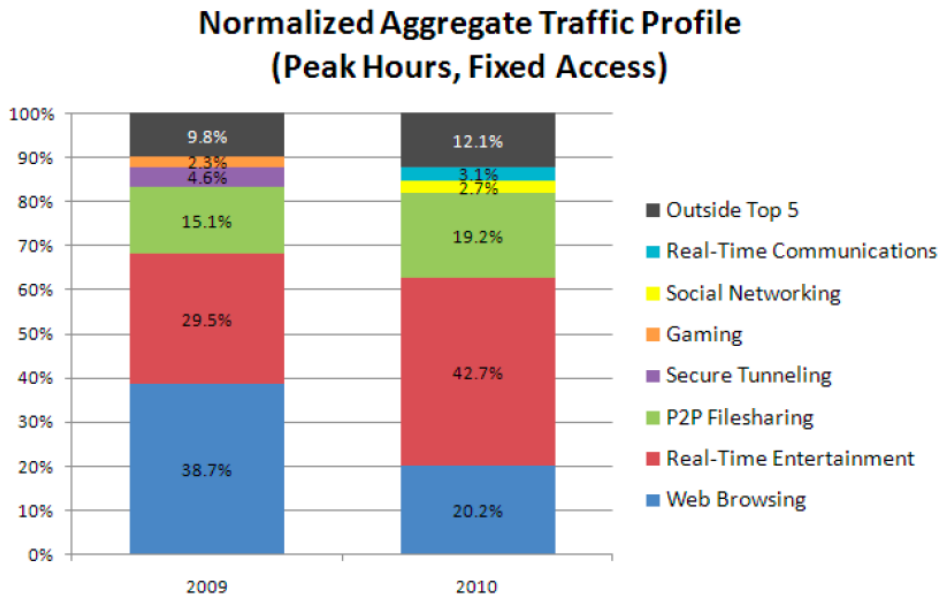


Figure 5 - North America - Network Downstream Traffic Profile (Fixed Access)

Source: Sandvine (2010)

This traffic as a share of peak hours increased significantly from 2009 - 2010.



Source: Sandvine (2010)

Level3, a Tier 1 backbone provider, and Comcast recently clashed over their interconnection agreement when Level3 began delivering Netflix content. The issue was that Level3 had a peering agreement in place with Comcast in which it exchanged traffic without payment. By winning the right to

[246] Sandvine Intelligent Broadband Networks, *Fall 2010 Global Internet Phenomena Report*, 2010.

stream Netflix (away from Akamai), Level3's traffic flow to Comcast increased significantly. Comcast argued that the peering arrangement was invalid under those circumstances.

- Obligations on dominant operators
- Charging methods
- Setting termination charges
- End to end QOS

F5 Other possible NGN regulation

Calls to emergency services

The FCC has imposed certain rules on VOIP providers with respect to emergency services. In particular, the Commission currently requires that

- All interconnected VoIP providers must automatically provide 911 service to all their customers as a standard, mandatory feature without customers having to specifically request this service. VoIP providers may not allow their customers to "opt-out" of 911 service.
- Before an interconnected VoIP provider can activate a new customer's service, the provider must obtain from the customer the physical location at which the service will first be used, so that emergency services personnel will be able to locate any customer dialing 911. Interconnected VoIP providers must also provide one or more easy ways for their customers to update the physical location they have registered with the provider, if it changes.
- Interconnected VoIP providers must transmit **all** 911 calls, as well as a callback number and the caller's registered physical location, to the appropriate emergency services call center or local emergency authority.
- Interconnected VoIP providers must take appropriate action to ensure that their customers have a clear understanding of the limitations, if any, of their 911 service. All providers must specifically advise new and existing customers, prominently and in plain language, of the circumstances under which 911 service may not be available through the interconnected VoIP service or may in some way be limited in comparison to traditional 911 service. They must distribute labels to all customers warning them if 911 service may be limited or not available and instructing them to place the labels on and/or near the equipment used in conjunction with the interconnected VoIP service.
- Interconnected VoIP providers must obtain **affirmative** acknowledgement from all existing customers that they are aware of and understand the limitations of their 911 service.
- In some areas, emergency service providers are not capable of receiving or processing the location information or call back number that is automatically transmitted with 911 calls. In those areas, interconnected VoIP providers must ensure that a 911 call is routed to the appropriate PSAP.[247]

[247] http://www.fcc.gov/guides/voip-and-911-service

The FCC is currently conducting an investigation into future rules regarding emergency calls from VoIP phones.[248] In particular,

the Commission is seeking comment on whether it should apply existing 911 rules that cover two-way interconnected VoIP services to "outbound-only" interconnected VoIP services, which allow users to place outbound telephone calls but not to receive inbound telephone calls. The Commission is also asking for ways it might ensure that all interconnected VoIP providers can provide automatic location information for VoIP 911 calls, rather than relying on the subscriber to register his or her location with the VoIP provider. This includes considering mechanisms that would enable "over-the-top" interconnected VoIP service providers and underlying network access providers to jointly support the provision of location accuracy information to PSAPs.[249]

The FCC has other rules regarding emergency calls from mobile devices:

- **The FCC's basic 911 rules** require wireless service providers to transmit all 911 calls to a PSAP, regardless of whether the caller subscribes to the provider's service or not.
- **Phase I Enhanced 911 (E911) rules** require wireless service providers to provide the PSAP with the telephone number of the originator of a wireless 911 call and the location of the cell site or base station transmitting the call.
- **Phase II E911 rules** require wireless service providers to provide more precise location information to PSAPs; specifically, the latitude and longitude of the caller. This information must be accurate to within 50 to 300 meters depending upon the type of location technology used.

The FCC recently required wireless carriers to provide more precise location information to PSAPs. As a result, wireless carriers will be required to comply with the FCC's location accuracy rules at either a county-based or PSAP-based geographic level. The new standards apply to outdoor measurements only, as indoor use poses unique obstacles.[250]

In particular, in July 2011 the FCC announced that it is phasing out the network-based e911 location rules in favor of handset-based rules. The network-based rules allow carriers to identify 911 calls to within 100-300 meters of the caller. By 2019, however, the network approach will no longer be allowed and all providers must use handset-based location information that identifies the caller's location to within 50-150 meters.[251]

Consumer protection

Both the FCC and the Federal Trade Commission (FTC) undertake consumer protection activities, though neither has focused on NGN issues in particular.

[248] Federal Communications Commission, *In the Matter of Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules Wireless E911 Location Accuracy Requirements E911 Requirements for IP-Enabled Service Providers*, Notice of Proposed Rulemaking, Third Report and Order, and Second Further Notice of Proposed Rulemaking, July 12, 2011, http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0713/FCC-11-107A1.pdf.

[249] Federal Communications Commission, *FCC Strengthens Enhanced 911 Location Accuracy Requirements for Wireless Services*, Press Release, July 12, 2011, http://www.fcc.gov/document/fcc-strengthens-e911-location-accuracy-wireless-services.

[250] http://www.fcc.gov/guides/wireless-911-services

[251] Federal Communications Commission, *In the Matter of Amending the Definition of Interconnected VoIP Service in Section 9.3 of the Commission's Rules Wireless E911 Location Accuracy Requirements E911 Requirements for IP-Enabled Service Providers*.

The FCC has a "consumer and governmental affairs bureau," which is "develops and implements the Commission's consumer policies, including disability access. We serve as the public face of the Commission through outreach and education, as well as through our Consumer Center, which is responsible for responding to consumer inquiries and complaints."[252] The bureau has not focused on NGN issues, per se, instead focusing on "bill shock" (wireless bills higher than expected) and early termination fees for wireless contracts.[253]

The biggest issue at least partly related to NGN is a focus on online privacy. The FTC has taken the lead on investigating whether additional government involvement is necessary. In December 2010 it issued a staff report offering a number of recommendations regarding consumer data privacy.[254] Some have criticised the report for offering no analysis of either costs or benefits of its proposals.[255]

Obligations to continue legacy services

The FCC has so far required firms building fiber networks to maintain their legacy networks, but in 2009 asked for comments regarding how to move from a circuit-switched network to all-IP networks.[256] AT&T and Verizon have both advocated for being allowed to retire their copper networks as soon as possible.[257] The primary opponents to copper retirement are CLECs who use the incumbents' copper networks and are concerned that they would not be able to use the new fiber.

Removal of existing regulations

n/a

Universal broadband policy

The existing universal service program officially supports only voice service. It consists of several components and now is about $8 billion annually (Figure F20).

[252] http://transition.fcc.gov/cgb/cgb_offices.html#CGB

[253] http://transition.fcc.gov/cgb/policy/

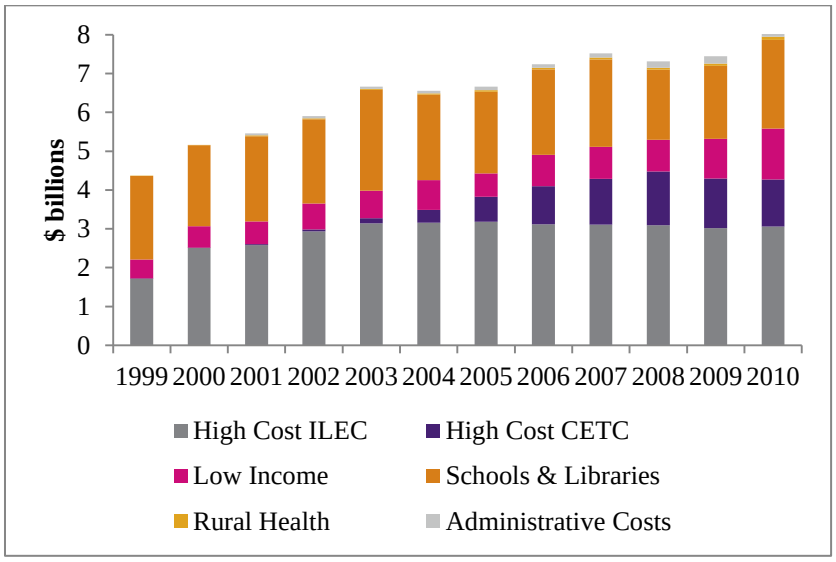
[254] FTC Staff, *Protecting Consumer Privacy in an Era of Rapid Change: A Proposed Framework for Business and Policymakers*, Preliminary FTC Staff Report, December 2010, http://ftc.gov/os/2010/12/101201privacyreport.pdf.

[255] Thomas M. Lenard, *Comments regarding FTC report, Protecting Consumer Privacy in an Era of Rapid Change* (Technology Policy Institute, February 16, 2011), http://www.techpolicyinstitute.org/files/lenard_ftcprivacycomments.pdf.

[256] Federal Communications Commission, *Comment sought on transition from circuit-switched network to all-IP network*, December 1, 2009, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-09-2517A1.pdf.

[257] AT&T, Inc., *COMMENTS OF AT&T INC. ON THE TRANSITION FROM THE LEGACY CIRCUIT-SWITCHED NETWORK TO BROADBAND*, December 21, 2009, http://www.honeywellpower.com/techdocs/ATT%20Public%20Notice%2025.pdf; Donna Epps, *Re: National Broadband Plan, GN Docket No. 09-51; Petitions for Rulemaking and Clarification Regarding the Commission's Rules Applicable to Retirement of Copper Loops and Copper Subloops, RM-11358* (Verizon Communications, Inc., March 2, 2010), http://fjallfoss.fcc.gov/ecfs/document/view?id=7020393147.

FigureF20: Universal Service Expenditures



Source: Universal Service Administrative Company.

In addition to reforming intercarrier compensation, The National Broadband Plan recommended eliminating the current universal service program over a ten year period and replacing it with a "Connect America Fund" (CAF) and a "Mobility Fund." In particular, it recommended that the FCC

- **Create the Connect America Fund (CAF)** to support the provision of affordable broadband and voice with at least 4 Mbps *actual* download speeds and shift up to $15.5 billion over the next decade from the existing Universal Service Fund (USF) program to support broadband. If Congress wishes to accelerate the deployment of broadband to unserved areas and otherwise smooth the transition of the Fund, it could make available public funds of a few billion dollars per year over two to three years.
- **Create a Mobility Fund to provide targeted funding** to ensure no states are lagging significantly behind the national average for 3G wireless coverage. Such 3G coverage is widely expected to be the basis for the future footprint of 4G mobile broadband networks.
- **Transition the "legacy" High-Cost component of the USF** over the next 10 years and shift all resources to the new funds. The $4.6 billion per year High Cost component of the USF was designed to support primarily voice services. It will be replaced over time by the CAF.[258]

In February 2011 the FCC released a Notice of Proposed Rulemaking regarding the Connect America Fund.[259] The comment period ended in July and the FCC is expected to move forward in the Fall.

[258] Federal Communications Commission, *National Broadband Plan: Connecting America*.

[259] Federal Communications Commission, *In the Matter of Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers High-Cost Universal Service Support, Developing an Unified Intercarrier Compensation Regime, Federal-State Joint Board on Universal Service Lifeline and Link-Up*, NPRM, February 9, 2011, http://www.fcc.gov/Daily_Releases/Daily_Business/2011/db0209/FCC-11-13A1.pdf.

F6 Key regulatory issues to resolve

Short term

The FCC faces three key short-term regulatory challenges: incentive auctions, universal service reforms, and network neutrality. Incentive auctions and universal service were discussed above. This section provides more details on net neutrality.

In December 2010 the FCC passed an order, "Preserving the Open Internet," which was an attempt to regulate net neutrality.[260] The order prevents ISPs from blocking access to legal websites or "unreasonably" discriminating against particular traffic. It allows "reasonable" network management as well as leaving the door open for metered traffic. Its rules apply primarily to wireline networks because "mobile broadband presents special considerations that suggest differences in how and when open Internet protections should apply."[261]

Although the Commission passed the order in December, it is in a state of legal limbo. The rules are not considered official until they are published in the Federal Register, which has not happened yet. As a result, the order can neither be enforced nor challenged in court.[262] The FCC finally submitted the rule to the Office of Management and Budget in July, which must approve them before they can published in the Federal Register.[263]

Once the rules become official they will surely be challenged in court.

Longer term

Net neutrality has been an issue in the U.S. for many years, and it is likely to remain an issue whether or not the FCC's rules are upheld by the court.

The FCC will also eventually have to make decisions regarding transitioning away from the legacy switched network.

[260] Federal Communications Commission, *In the matter of preserving the open internet, broadband industry practices*, Report and Order, December 23, 2010, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-201A1.pdf.

[261] Ibid., para. 94.

[262] Verizon and MetroPCS challenged the rules in court, but the case was dismissed due to their not yet being official. Cecilia Kang, "Court dismisses Verizon lawsuit against FCC net neutrality rules," *The Washington Post*, April 4, 2011, http://www.washingtonpost.com/blogs/post-tech/post/court-dismisses-verizon-lawsuit-against-fcc-net-neutrality-rules/2011/04/04/AFfxDNdC_blog.html.

[263] Gautham Nagesh, "FCC delivers net-neutrality rules to OMB," *The Hill* (Washington, DC, July 7, 2011), http://thehill.com/blogs/hillicon-valley/technology/170285-fcc-delivers-net-neutrality-rules-to-omb.

Annex G NGN technology issues

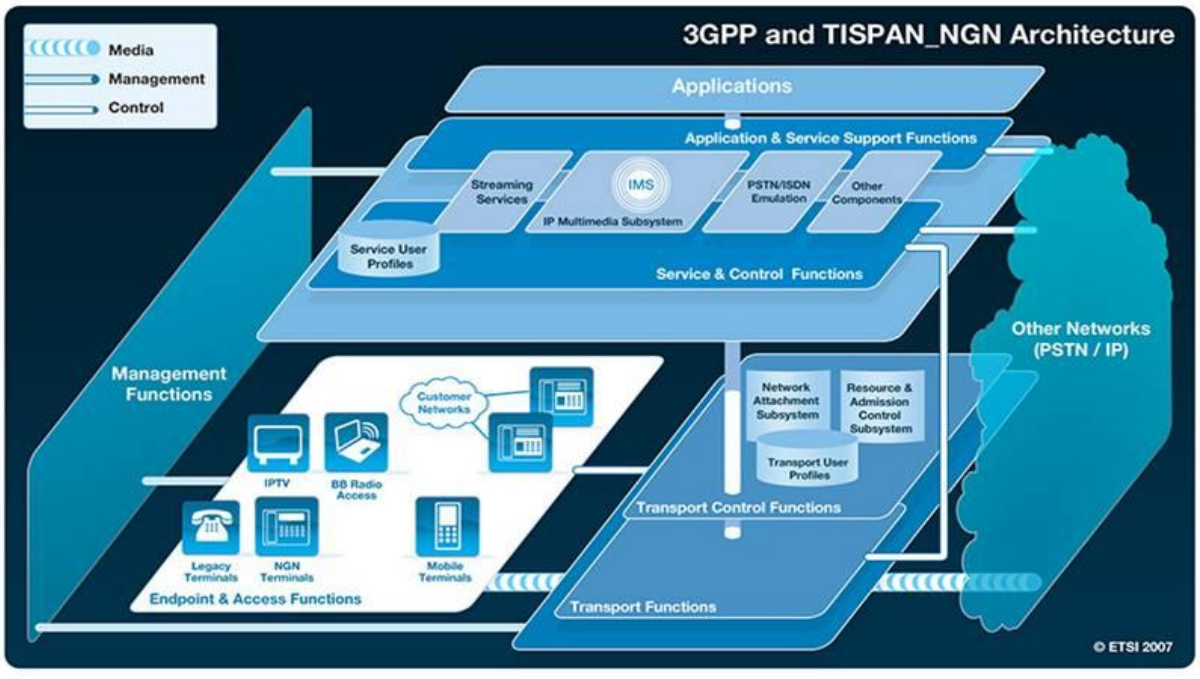
G1 Standardisation and the regulatory framework

The NGN model

The concept of NGNs was first developed over 10 years ago, largely by telcos and their equipment vendors. It envisaged:

- Closed networks with vertical integration between transport and services and guaranteed quality of service.
- Interconnection via gateways which carry out security, charging and signalling functions.
- A walled garden of services delivered to customers by each NGN operator.
- Large-scale emulation of legacy services plus a range of new services.

Figure G15: NGN architecture



This vision formed the basis of much of the standards activity for NGN that has taken place up until now, notably through the ITU, ETSI and the IETF. Many of these standards are now fully mature and implemented by vendors, yet evidence of their use "in the wild" remains scarce. Why is that?

The "end game" of the original NGN vision is exemplified by the IP Multimedia Subsystem (IMS). This is an architectural framework for delivering internet protocol (IP) multimedia to mobile users, but has also been promoted as a suitable longer term architecture for fixed network delivery of such services. It was originally developed by the mobile group 3rd Generation Partnership Project (3GPP), as a part

of the vision for evolving mobile networks from GSM to “3G” and beyond. The initial iteration (3GPP R5) focused on delivering "Internet services" over GPRS. This concept was updated by 3GPP, 3GPP2 and the ETSI TISPAN programme through the development of support for networks other than GPRS, such as Wireless LAN, CDMA2000 and fixed line.

IMS as far as possible uses IETF (i.e. Internet) protocols such as Session Initiation Protocol (SIP), to facilitate convergence with the Internet and services commonly delivered over it. IMS is not intended primarily to standardise applications itself but to aid the access of multimedia and voice applications across wireless and wire line terminals, in other words to aid a form of fixed mobile convergence (FMC) with services being seamlessly available across multiple access networks. This is done by having a horizontal control layer that isolates the access network from the service layer. In this core NGN concept, services need not have their own control functions, as the control layer is a common horizontal layer.

This goal has generated a number of alternative and overlapping technologies for access and provision of services across wired and wireless networks, depending on the actual service requirements, which revolve around combinations of access technology independent bearers, soft switches and "naked" SIP. Partly in consequence of this proliferation, market take up of IMS has been slow, as, without compelling core service propositions, which have been slow to emerge, the virtues of "integrated services” are difficult to sell.

In the meantime, it is becoming increasingly easier to access content and participate in rich multimedia communications using mechanisms outside the control of traditional wireless/fixed operators, mainly using the Internet to access services by non-traditional telco players, many with global reach. Whilst it is still expected that IP will be the dominant bearer network technology, it is not clear how much of the 3GPP/3GPP2/TISPAN IMS as it exists today will be deployed, as the “internet” oriented service delivery model becomes more and more successful in the market[264].

Internationally, the emerging pattern is that some network operators have implemented core NGNs to replace the circuit switched trunk networks so as to reduce costs, but few have made any real progress in implementing the original multi-service concept. This broadly mirrors the current situation in Hong Kong. We have also seen rapid growth in the use of the Internet for a wide range of existing and new services and rapid take-up of broadband access - based initially on copper loops, but increasingly on fibre and new wireless access technologies such as LTE and WiMAX. As a result, a new NGN model may be emerging which is characterised by:

- A focus on “Next Generation” broadband access to a two tiered Internet consisting of the traditional best efforts Internet and managed services running in parallel over the same infrastructure.
- Open interconnect with other NGNs and with pre-NGN legacy networks.
- Services delivered over these NGNs by both the network operator and by third parties. In particular we have seen substantial success for (US-based) global players, which enjoy global economies of scale in service and content delivery.
- An emphasis on innovative new services with emulation of a limited range of legacy services.

[264] More recently, in the context of the emergence of so-called “4G” mobile network technologies under the “Long Term Evolution” (LTE) umbrella, the Voice over LTE (VoLTE) concept has been developed that aims to be a more “internet native” means of delivering advanced voice services over such networks. It remains to be seen whether this will gain advantage over already established proprietary technologies such as those discussed in sections 1.4 and 1.5.

Evidence suggests that it is this latter, amended model that is succeeding. Many telcos are altering their plans in the lights of market developments and even the most enthusiastic proponents of the original, "integrated NGN" vision are reconsidering their position.

G2 NGN deployment in practice – the UK experience

BT 21 CN

Probably the most high profile project that adhered to the original ITU NGN model was the BT 21st Century Network (21CN) programme. This pioneering, if not misplaced, venture, envisaged 8 or more system element suppliers, with no overall project lead or nominated systems integrator, delivering a complete replacement for up to 17 "silo" legacy networks, with a stated intention of delivering annual opex savings of over £1 billion. The original timetable was for the programme to be essentially complete by the end of 2011.

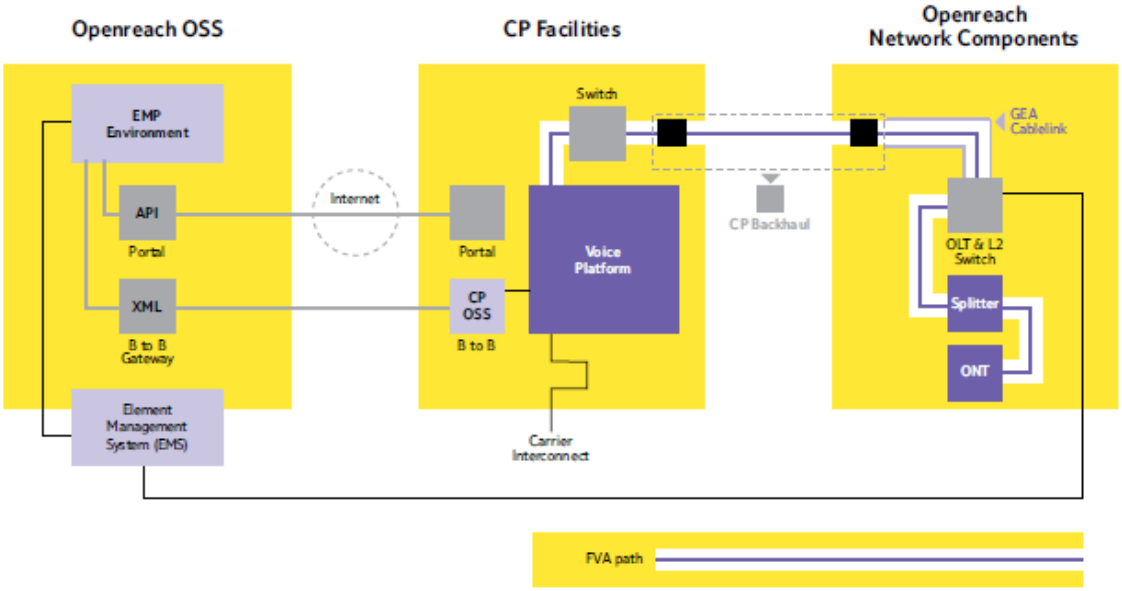
In practice, this timetable never looked likely to be achieved. Initial "Pathfinder" roll-out phases in and around Cardiff were bedevilled by reliability, performance and interworking problems, particularly with the key callserver and MSAN elements. In 2008, BT announced a "review" of their voice strategy which led to a freeze on further roll-out of their original call server solution, the abandonment of the original overall timetable and a commitment to continue operating existing legacy TDM voice and transmission for an indefinite period. The outcome of the review remains unclear, other than the effective abandonment of the original voice strategy with no indication of what will replace it.

Today's 21CN bears little or no resemblance to the original vision and BT has been reticent in defining how, if ever, it will deliver the original aims of reducing the operational cost base by consolidation of network infrastructure. Instead, BT, like many telcos, both incumbent and new entrant, has switched focus to a more "Internet centric" capital investment programme and product strategy.

BT NGA voice

For the foreseeable future, the BT FTTC deployment will offer baseband POTS as its default voice service. This is possible as BT have extended the life of their legacy System X voice switch considerably by re-negotiating support arrangements with Telent that run until 2020. The pilot FTTP trials feature a VoIP solution, presented via an ATA integrated into the NTE/CPE unit that BT are deploying. This solution is, in principle, call server agnostic and, via a combined NNI/UNI service known as "Fibre Voice Access"(FVA), other operators with SIP compliant capability can deliver their own voice service to FTTP connected customers, rather than rely on "white labelling" of BT's own VoIP service.

Figure G2 – BT "Fibre Voice Access"



At the moment, however, BT are not committed to a commercial deployment of FTTP, despite last year increasing the forecast proportion of FTTP to 25% of their total roll-out, rather than the initially announced target of 10%. There are a number of factors believed to be involved in this, notably uncertainty on Ofcom's regulatory position on "battery back-up" for the voice service[265], difficulties under the UK planning regime for extensive aerial fibre deployment, and, most recently, information gleaned from their trials that "brownfield" deployment of fibre into existing access ducts requires much more work and hence cost than estimated.

G3 NGN interconnect standards in the UK

Given BT's pioneering vision of early and comprehensive NGN deployment via 21CN, it is not, perhaps, surprising that regulatory thinking and stakeholder engagement in the UK are well advanced. The resulting institutional arrangements and regulatory positioning offer some useful pointers to what might be "best practice".

From around 2005 onwards, Ofcom dedicated considerable resources to investigate the implications of NGN adoption for the regulatory framework and, specifically, with regard to interconnection between communications providers. This led to the establishment of Next Generation Networks UK ('NGNuk')[266] as an independent industry body, with a view to creating an improved framework for industry engagement. Its mission was to act as a co-ordination forum in which key investors in NGN infrastructure and services could discuss, research, consider and, where possible, agree the direction

[265] [265] Currently, this requires a capability of maintaining voice service for a minimum period of 4 hours in the event of a loss of mains power to the ONT/ATA. This is Ofcom's interpretation of the requirements of the EU USO Directive with respect to "PATS" voice. Ofcom are now consulting on this, with a proposed reduction to 1 hour. BT have made it clear that the physical manifestation of the 4 hour requirement leads to a customer installation that they think is unacceptable to the average mass market consumer.

[266] http://www.ngnuk.org.uk/

for NGNs in the UK and communicate such direction to other players in the telecommunications industry and the general public.

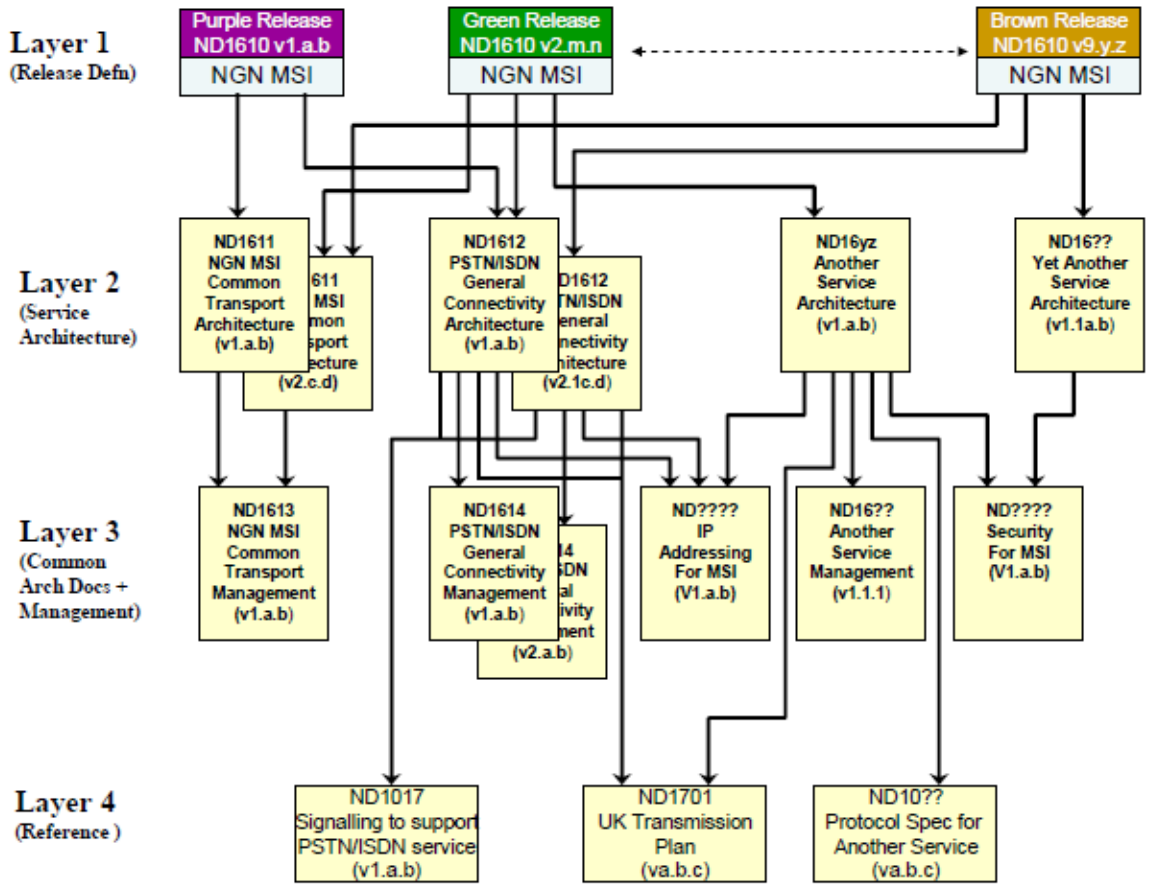
It was envisaged that NGNuk would have an overall coordinating role for industry stakeholders, liaising with and advising, as appropriate, Ofcom, the well-established technical standards body NICC[267], and the BT sponsored Consult 21programme, itself set up to liaise with industry over the 21CN project. Its initial target was the establishment of a Reference Model which would lead to the identification of areas of commercial and technical work that could be encouraged and sponsored. Whilst a significant amount of work was undertaken in developing this model, it became clear that different market sectors had very different views on the priorities and drivers for NGN deployment and interconnectivity, other than for maintaining current "any to any" expectations for voice. Consequently, to all intents and purposes, NGN UK is now dormant, other than sponsoring the valuable work on developing IP inter-network security arrangements that are defined in the NICC standard, ND1643[268].

NICC has, however, continued to work on a range of NGN interconnect issues. With relevant ITU and IETF standards now being almost fully mature and routinely implemented by mainstream vendors, it has developed a range of predominantly voice oriented UK specific "standards" that recommend particular options in the various international standards and create a comprehensive test and service assurance framework. This has centred on SIP-I, allowing full legacy to NGN connectivity for ISUP voice services, but has now moved on to consider both native SIP interconnection, enterprise connectivity to SIP networks and the wider issue of NGA telephony. The intention is to continue to work on additional NGN interconnect standards as and when industry demand becomes apparent, with individual "NGN service interconnection standard sets" being developed using the model illustrated below:

[267] http://www.niccstandards.org.uk/

[268] Minimum Standards for Interconnecting Communications Providers - http://www.niccstandards.org.uk/files/current/ND1643v2.1.4.pdf?type=pdf

Figure G3 – UK NICC NGN standards structure



BT's original 21CN programme envisaged an early transition to SIP-I, but, with the halting of their mainstream voice migration, because of call server/MSAN interworking and reliability issues, that is not being pursued at the moment. The SIP-I standard is fully adopted, however, and has been proved through trials for both NGN to NGN interconnect and NGN to legacy ISUP via a gateway. Indeed, some CPs in the UK, both large and small are having to use the latter mode for their default interconnect with BT as they have implemented full NGN cores[269]

From a commercial perspective, Ofcom have been under considerable pressure for the last three years by communications providers such as TalkTalk who are already "native NGN" to encourage direct IP interconnect by allowing differentiated termination rates and topologies. That initiative seems to have failed, as a result of both a regulatory complaint / dispute made by TalkTalk that did not go in their favour[270], and a more general consideration of "reciprocal termination rates"[271]. In the UK Ofcom look like they will effectively maintain a position of "technology neutrality" for some time.

[269] TalkTalk being the most obvious.

[270] http://stakeholders.ofcom.org.uk/enforcement/competition-bulletins/closed-cases/all-closed-cases/cw_01027/

[271] http://stakeholders.ofcom.org.uk/consultations/fair-reasonable-charges/statement/

G4 Overview of current NGN interconnect practice

More generally, most MNOs are still interconnecting voice using TDM and are only slowly migrating voice onto NGN platforms as their network builds require. However, even where investment has been made in IP voice, most voice interconnection for both fixed and mobile is TDM with, in some instances, traffic being put through a gateway function at the network edge. Where IP voice is being interconnected directly, it is predominantly SIP in a peering environment. These arrangements are becoming more common, but appear to suffer from incomplete Call Data Record (CDR) availability and problems with QoS.

The immaturity of operational and commercial implementations of the base SIP standards may explain this. The CDR problem may not be an issue for billing, as peering implies "Bill and Keep", but may cause problems over data retention obligations under legislation requiring the provision by operators of "communications data" for law enforcement purposes, such as the EU wide Data Retention Directive. That may well limit its adoption by mainstream carriers who are subject to orders under relevant national legislation, and need to provide complete CDRs for traffic received from other networks.

QoS across individual networks again does not pose any fundamental issues, with the use of MPLS providing sufficient prioritisation capabilities to meet customer service expectations and SLAs. However, the implementation of QoS between peered IP networks, whilst having been technically feasible for many years and fully documented in IETF standards, is not standard practice in an environment conditioned by the "best efforts" approach that has typified the development of the Internet to date. Without the cultural and commercial framework to incentivise the multiple parties in the delivery of an end to end service to stand behind a cascade of SLAs, it seems very unlikely that this situation will change[272].

G5 Implications for NGN regulation

This has important implications for the regulatory framework for NGNs in general, and the approach to NGN standardisation in particular. There is an apparent assumption that service interoperability and connectivity that depend on legacy network interconnection can be successfully emulated and / or replaced in an NGN world purely by developing, introducing or mandating appropriate technical standards. The reality is that these standards must be complemented by a comprehensive operational and contractual framework to be effective. Internet "interconnection" has been based on a *de minimis* approach to such needs, with both "peering" (paid or otherwise) and "transit" agreements offering very little of the operational and commercial assurances that conventional telco interconnect agreements are based on. It can be argued that, in the absence of market based solutions to these "failures", to ensure that efficient use can be made of emerging technologies, policy makers and regulators should seek to intervene to ensure that appropriate frameworks are put in place. Indeed, this intervention may be of much more value than seeking to ratify or develop the technical standards themselves[273].

[272] In practice, IP voice suppliers thus only guarantee QoS on their own network and use a TDM gateway to provide equivalent SLA assurance for interconnected traffic.

[273] It should be noted that, despite claims to the contrary from some quarters, particularly some proponents of "net neutrality", IP based network connectivity does not have to be on the traditional Internet "best efforts" basis. Suitable QoS and prioritization capabilities were developed over 30 years ago. AT&T last year input a series of comments on this topic as part of the ongoing

It is worth noting that BEREC, the statutory EU body of telecoms regulators, in its programme of work on "net neutrality" has identified this topic as a key deliverable:

"*Besides the identified key-issues, BEREC will also look into the current IP interconnection agreements (peering/transit) between market parties (not necessarily with SMP), which will have to cater with demands of content and application providers. Both regulated and commercial agreements will be looked into.***"**[274]

The Digital Agenda for Europe EU policy programme[275] has also increasingly identified IP interconnection and other regulatory standards issues as an important enabler of continuing effective competition and of NGN/NGA investment. In early 2011 the EU Commissioner with responsibility for ICT issues, Neelie Kroes, instigated a series of workshops and roundtables involving the CEOs of many of the most important vendors, service providers and other stakeholders in the European ICT industry to investigate how such investment could be encouraged. At the second plenary roundtable on the 13th of July, she accepted a number of key recommendations that included the following statement:

"There is a need to develop open and interoperable standards for next generation products. This is good for the efficient use of the networks, allowing operators to develop their business models availing themselves of standardised wholesale products, thereby driving innovation and competition."[276]

In parallel in the USA, Google has recently made an interesting intervention into the FCC programme on "inter carrier compensation" and related interconnection issues. In a letter following on from a meeting with the FCC they stated:

"Specifically, we agreed that the FCC has correctly focused its universal service and ICC reform proposals on promoting the deployment and use of all-IP broadband networks, and ensuring adequate market-based incentives and government support for such networks. The Commission found last year in the National Broadband Plan that broadband increasingly serves as a platform over which multiple IP-based services – including voice, data and video – converge, creating extraordinary opportunities to improve American life and benefit consumers. We noted that the record before the FCC underscores that IP networks are far more efficient and less costly for carriers, and are driving the deployment of innovative enhanced services that benefit carriers and consumers alike…….

FCC debate on net neutrality. This notes that the relevant IETF standards documents describing the widely used DiffServ protocol expressly allow for this:

"As explained in RFC 2474, "the primary goal of differentiated services is to allow different levels of service to be provided for traffic streams on a common network infrastructure. RFC 2475, which defines the architecture for implementing DiffServ and is referenced extensively in RFC 2474, further expounds on the purpose of DiffServ: "The history of the Internet has been one of continuous growth in the number of hosts, the number and variety of applications, and the capacity of the network infrastructure, and this growth is expected to continue for the foreseeable future. A scalable architecture for service differentiation must also be able to accommodate this continued growth." To facilitate the continued growth of the Internet, RFC 2475 states that "[s]ervice differentiation is desired to accommodate heterogeneous application requirements and user expectations, and to permit differentiated pricing of Internet service." In short, one of the fundamental reasons that the IETF created DiffServ was to facilitate paid prioritization as a means for encouraging the further growth and development of the Internet."

[274] BEREC Work Programme, 2011 – see http://berec.europa.eu/workprog/index_en.htm

[275] http://ec.europa.eu/information_society/digital-agenda/index_en.htm

[276] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/508&format=HTML&aged=0&language=EN&guiLanguage=en

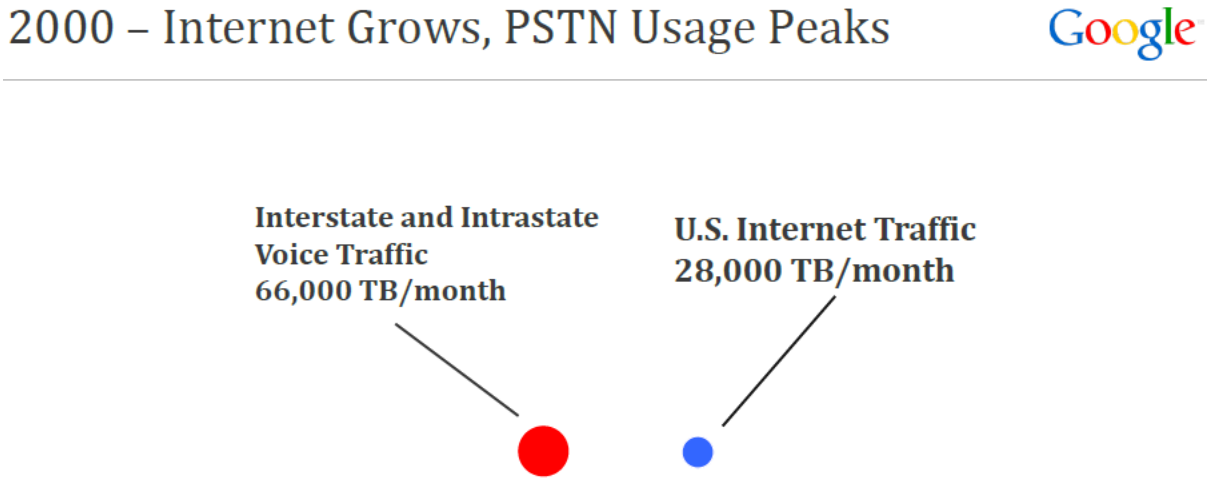
As the Commission previously has warned, carrier compensation regimes should not become a significant drag on the necessary transition to broadband and away from legacy TDM voice-centric networks. To the contrary, it is entirely appropriate for the agency to make one of its priorities encouraging a more modern and efficient use of carrier network resources. Notably, the implications of FCC action on ICC reform will be broad, and, if implemented in a forward-looking manner, could have a positive impact on non-wireline traffic exchange, such as mobile. Standalone voice traffic already is decreasing markedly relative to other forms of communications traffic; in fact, as depicted in the attached, the majority of voice traffic will be IP-based in just a few years. Accordingly, the FCC should not allow what amounts to the very small tail of legacy voice wireline services to wag the very large dog of all communications traffic exchange. In particular, per-minute voice traffic origination and termination charges are a persistent but unwelcome relic from the circuit-switched telephony era, and not best-suited for modern IP traffic and networks. However the FCC decides to alter the current access charge regime for wireline TDM traffic, such a regime should not be applied for the first time to IP traffic.

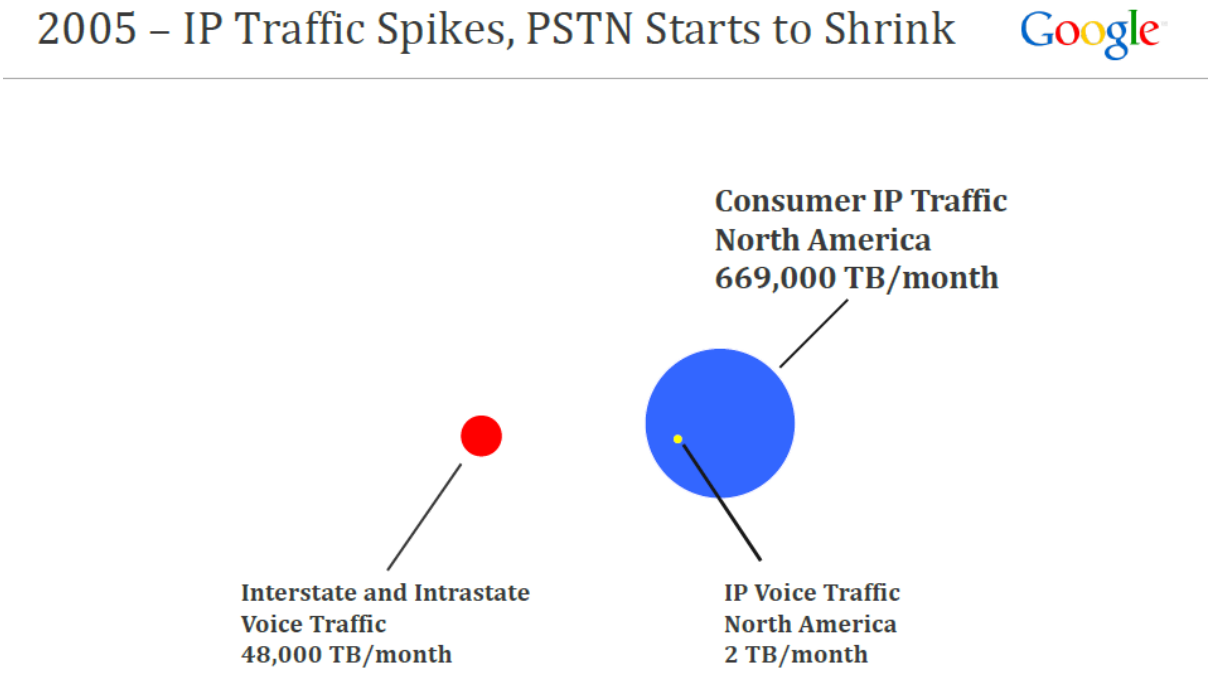
The Google representatives also explained that a future-focused traffic exchange system should be aligned with modern network cost drivers, such as a system based upon capacity used or reserved in the local network for the exchange of IP voice traffic, rather than per-minute charges. Indeed, market-based arrangements for transport of IP-based traffic typically focus on capacity or port size because actual network costs of originating and terminating IP voice traffic are better reflected by port capacity (which is based on peak hour traffic requirements) than minutes of use. Rather than relying solely on prescriptive rates, the Commission also should seek to move to a progressively more deregulatory framework for IP traffic encompassing market-based arrangements combined with a regulatory "backstop."

We also urged the FCC to clarify the nature of IP traffic interconnection between carriers, and develop a deregulatory framework that will encourage carriers to move to more efficient IP infrastructure."

The attachments referred to provide a powerful illustration of how they see trends in voice and other traffic developing:

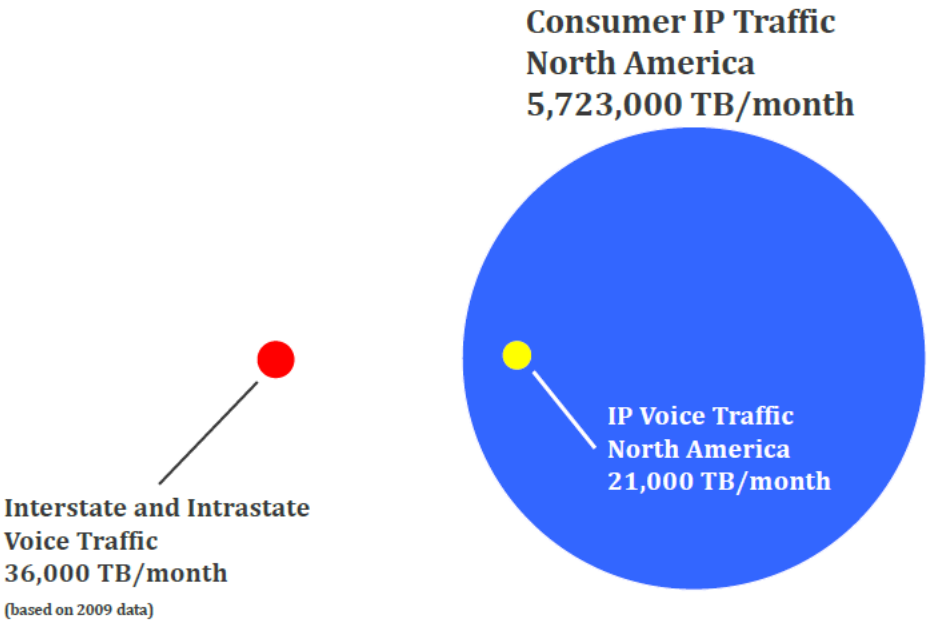
Figure G4 – USA traffic trends





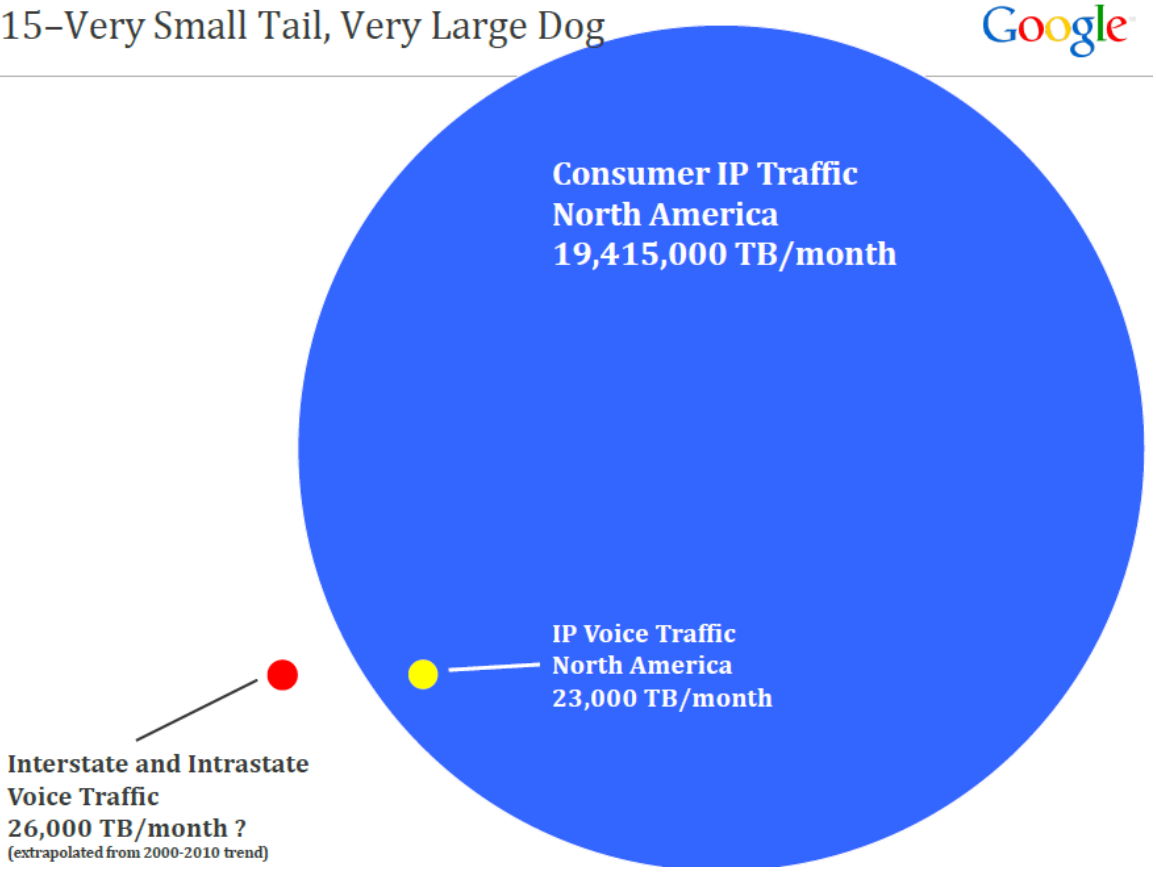
2010 – IP Voice Begins Catching Up to PSTN

Google



2015–Very Small Tail, Very Large Dog

Google



This rapidly changing overall pattern of public network traffic has clear implications for future approaches to both standardisation and regulation. NGNs do offer opportunities to deliver a wide

range of new services to end users who clearly have an appetite for a wide range of innovative communications applications. The key issue emerging is that it is much more likely that these applications will **not** be part of the NGN/IMS vision, but will emerge from global providers implementing essentially proprietary “OTT” (Over The Top) technology via a basic level of Internet access provided by a local, regional or national infrastructure based communications provider.

The Microsoft acquisition of Skype is an important signpost of how innovation at the edge of the network, both in client applications and “shared server” architectures can deliver an effective, well featured and cheap service without massive investment in infrastructure. The fact that one of the largest global ICT corporations chooses then to purchase the company and its technology to replace its own long standing attempts to enter the “integrated communications” sector (via Microsoft OCS, Messenger, Lync etc) emphasises that the battle for this sector has already been lost by the telcos and their apparent reliance on the NGN/IMS model. Consequently, industry stakeholders and regulators alike need to identify what elements, if any, of the NGN model are still relevant and concentrate effort and regulatory intervention where necessary, on those areas that will have most end user benefit.

G6 NGN standardisation and competitive markets

OFTA's own **NGNWG Paper No. 2/2010** for the Regulatory Affairs Advisory Committee (RAAC) Next Generation Network Working Group (NGNWG) offers a comprehensive overview of recent progress in relevant ITU, IETF and ETSI NGN standards. As has been noted in the UK case study, these offer complete and effective models for NGN NNI interconnection for voice services using SIP and are capable of maintaining "backward compatibility" with legacy networks via SIP-I and suitable gateways. Adoption of suitable SIP and SIP-I profiles as "national standards" does, therefore ensure that "any to any" connectivity for PSTN voice can continue to be guaranteed as NGN cores are implemented by both fixed and mobile network operators.

However, this runs the risk of neglecting what may, in the longer term, be the more important UNI arena. If the original NGN model of essentially an infrastructure based operator "walled garden" of vertically integrated services is doomed by the success of the wider "internet application" model, it may be more important to shift emphasis to enabling effective competition in services by ensuring that the UNI is properly defined and "open". This would allow the development of a "tiered" market, allowing competition at the infrastructure level, at the "core service" level for guaranteed assurance of voice for instance, and for customer premises equipment, whilst still retaining the overarching competitive market for internet delivered services. This "open access" model is gaining increasing traction in regulatory policy making and, perhaps more importantly, in the market.

Open access models in practice

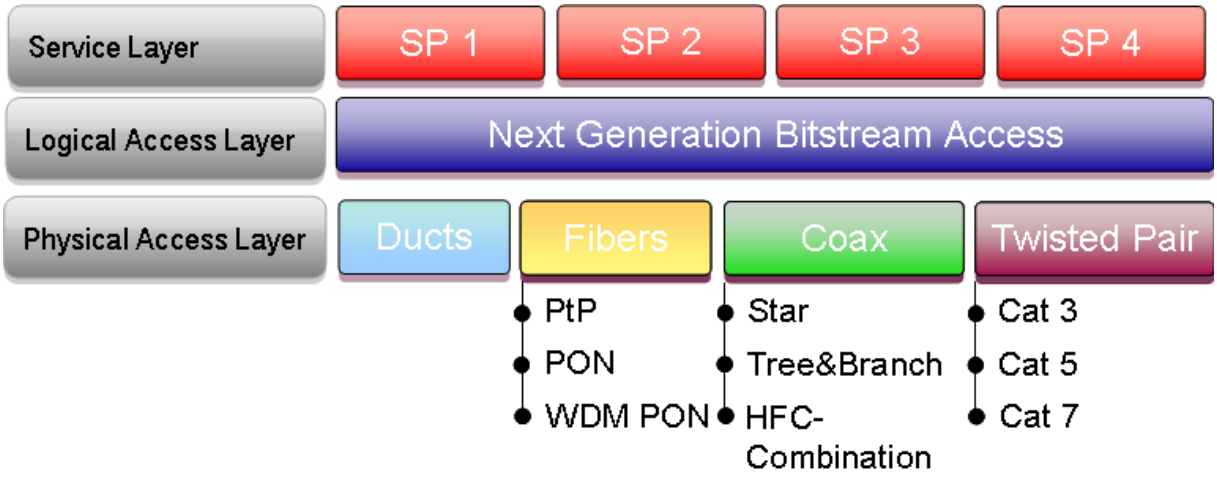
Probably the best example of this in practice, albeit using competing, semi-proprietary formats, is the growing popularity of "smartphones" and their associated applications eco-systems. Competition between the underlying mobile networks exists in most markets, as does competition between the three main "smartphone" protagonists – Apple with the iPhone, RIM with the Blackberry and Google with Android[277]. Whilst the first two are essentially vertically integrated at the hardware level, with no competition between handset manufacturers, Android based models are available from a variety of vendors. Applications have been developed by a wide range of suppliers, with varying degrees of control imposed by the vendor that developed the platform. In many cases these applications have been ported between the different platforms. The result has been the rapid emergence of a vibrantly competitive market that has resulted in an enthusiastic consumer response and very high penetration levels being achieved remarkably quickly.

Apart for sounding the effective death knell for most of the mobile operators aspirations for dominating the user experience with IMS based, vertically integrated service platforms, this does offer an interesting insight into what could work effectively in fixed markets. This theme has been picked up and strongly endorsed by the "CEO roundtable" work programme under the auspices of the EU Digital Agenda. It is understood that two key recommendations around the basic theme of standardisation for facilitating investment and innovation in NGA/NGN and the Internet Ecosystem have been made.

[277] Microsoft have yet to establish an equivalent position with its own mobile eco-system although the closer relationship announced recently with Nokia may establish them as a fourth major player in this market.

The first is the promotion of “Open Access” concepts for Next Generation Access which enables every operator to target all customers and which thereby offers the customers the widest choice of services possible. The Open Access concept envisages a tiered range of options from the physical up to the service interoperability levels which should be considered or applied, as necessary, so as to encourage both network investment and competition. It is unlikely that the regulatory interventions proposed at the physical layer (mandatory duct access and new forms of fibre/wavelength unbundling) are at all relevant to Hong Kong, which already has healthy NGA infrastructure based competition, but the position taken on both a mandatory and uniform bearer service (akin to the Virtual Unbundled Local Access product gaining general support across Europe) and specific interoperability requirements across key network interfaces offer an attractive new model for encouraging sustainable and effective completion in services. This is illustrated below:

Figure G5: Tiered Open Access



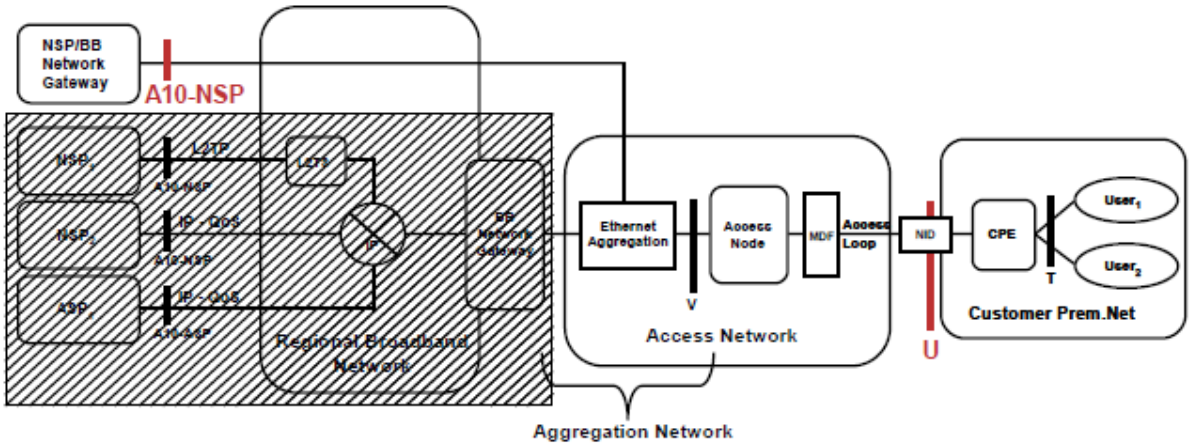
Some regulators such as Ofcom have already attempted to develop a standards model that would encourage the development of such a tiered competitive market, hinging on the Active Line Access (ALA) concept.[278]

This envisages a technology neutral Ethernet bearer service that can provide a uniform means of delivering next generation services across varying underlying NGN/NGA infrastructure. Ofcom’s aim in developing the concept was to try to maintain the level of competitive intensity that infrastructure based competition using Local Loop Unbundling (LLU) had created in the UK market. This would allow the service providers the continuing ability to innovate and differentiate their service propositions to better meet emerging customer needs and expectations. In the current, “CGA” world, their ability to do so has been enabled by the availability of basic upstream access network services that have allowed them to develop their own service portfolio with no constraints on what can be delivered other than those dictated by the underlying technology options and cost base. In an NGA world, where it was likely that network economics would not justify the level of competitive overbuild seen previously, a neutral bearer allowing the creation of homogenous services that could be delivered over any underlying infrastructure was seen as the best way to preserve this.

[278] See http://stakeholders.ofcom.org.uk/telecoms/policy/next-generation-access/ethernet-active-access/ethernet-active/

The basic ALA concept has been adopted by industry in the UK and is now recognised as an important and pioneering approach to the development of a more open NGN model that encourages the deployment of innovative and interoperable services that are capable of being accessed across many physical networks[279]. At the same time, since it leverages existing open standards and protocol stacks, it offers much greater levels of service assurance between networks and reduces the threat of proprietary technology control by a single vendor. NICC have developed a full suite of standards, starting with ND1644 "Architecture for Ethernet Active Line Access".[280] The generic model for service interoperability in this context is illustrated below, derived from the work of the Broadband Forum TR-101.

Figure G6: NG Bitstream Access Interface Reference Architecture



For an "open access" NG Bitstream Access product to be effective, clearly defined A10-NSP and U interfaces are needed to ensure the freedom of technology choice for the access network provider and the assurance of interoperability in order to deliver end to end service and processes for the service provider. The interface description must:

- give a view of the delivery from the service provider's customer side, interface "U"
- describe the expectations of the access network provider for the signalling and media traffic of the service provider, interface "A10-NSP"

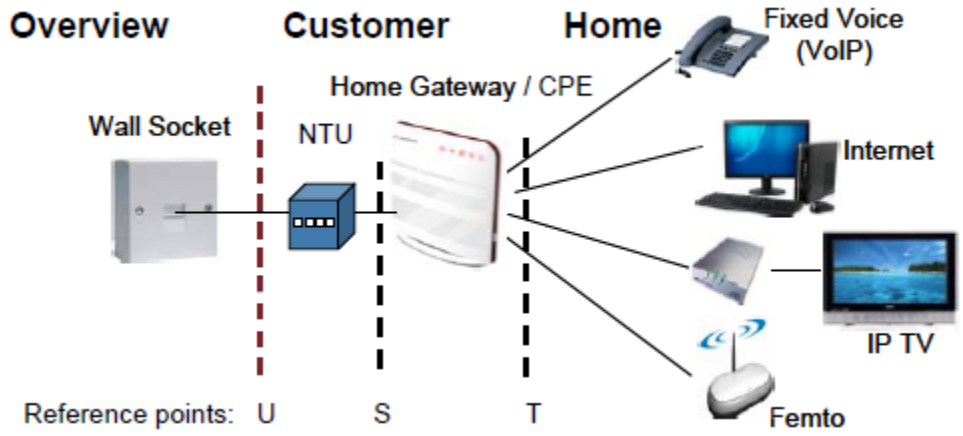
This model also envisages a "wires only"[281] option when relevant access technology standards are sufficiently stable. Operators always have more control over the service if they can select their own CPE (subject to standards compliance constraints). A "wires-only" option would allow use of CPE with other service functionality, such as a wireless router, integrated into the consumer package, which would allow more control still. There is a global market for this CPE and no reason for it to be controlled by infrastructure provider.

[279] There are indications that New Zealand authorities are examining its relevance to their market.

[280] See http://www.niccstandards.org.uk/files/current/ND1644v1.1.1.pdf?type=pdf

[281] Allowing open market sourcing of combined NTE/CPE which would connect to a "dumb" copper, co-ax or fibre interface.

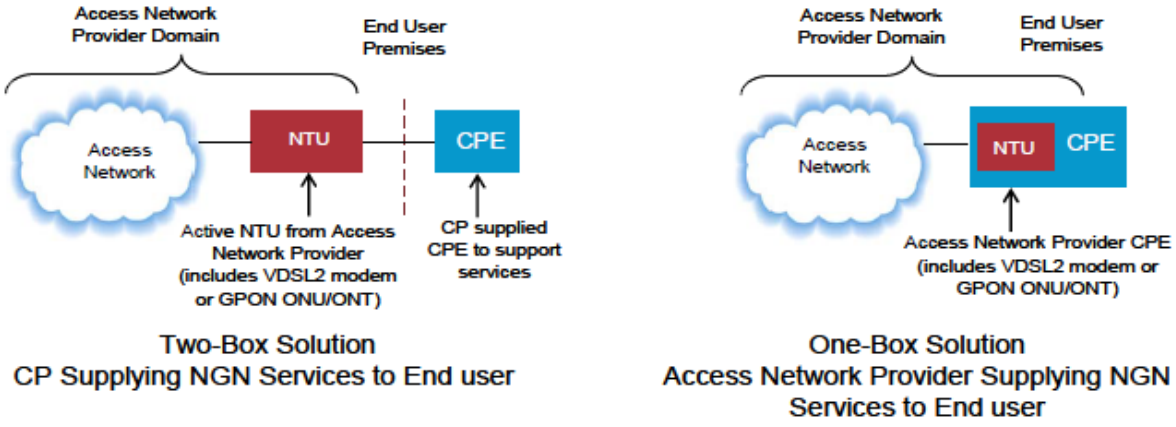
Figure G7: In-house reference points



The figure illustrates the different reference points of the in-house network, some parts of which can be deployed outside the house or appartment boundary. The NTU is the access network provider demarcation point. The NTU provides only a standardized LAN interface like Ethernet. All other interfaces like WLAN or POTS-Interfaces, IPTV-Interface etc., are provided by the Home-Gateway, usually supplied by the end to end service provider. The Home Gateway or CPE is the service delivery point for the end customer.

The access network provider needs to ensure the NTU deployed at the user premise is compatible with the equipment deployed at the access node. In this way the access provider can configure, manage and monitor the NTU. Both one and two box solutions are possible, but, when initially deploying new technologies it is difficult to guarantee the interoperability of different vendors of NTU and access network node equipment. Initially therefore, a two box solution will be deployed and used by the customers of the access network providers and OTT service providers. Once interoperability across differing access node and NTU equipment manufacturers is achieved the one box solution could be adopted.

Figure G8: “Wires-only” and device integration



Historically, a number of common trends have been seen in the access technology and services market, from which a generic “road map” of deployment, standardisation based interoperability and development of different modes of competition can be derived:

Phase 1:

- Access Infrastructure Provider (AIP) supplies, installs and maintains CPE.
- Usually CPE vendor is the network equipment vendor.

Phase 2:

- AIP may introduce a limited range of CPE options (all thoroughly pre-tested).
- Over time this approved range grows.
- ISP/Content Providers may have the option to have their CPE approved
- Self-install options may be developed.

Phase 3:

- As interoperability, standards and self-install practices mature**:**
- The AIP can move to a full retail model.
- CPE is then additionally ‘off-the-shelf”.

In order to determine the level of development of any market or technology against this roadmap, it is possible to establish a set of criteria against which to judge the status of current mainstream next generation access network technologies as candidates for “wires only” status. These are:

Stable Standards:

- Published by a recognised standards body/Forum.

Interoperability Test Plans:

Test plan documented by a recognised standards body/Forum and available for use by vendors.

Industry Plugfest Event Support

- A series of interoperability plugfests have been organised with the support of a recognised standards body/Forum.
- Multiple vendors representing equipment for both ends of the transmission link have been involved.
- The interoperability plug fest events have encompassed both chip-level and system level vendors.

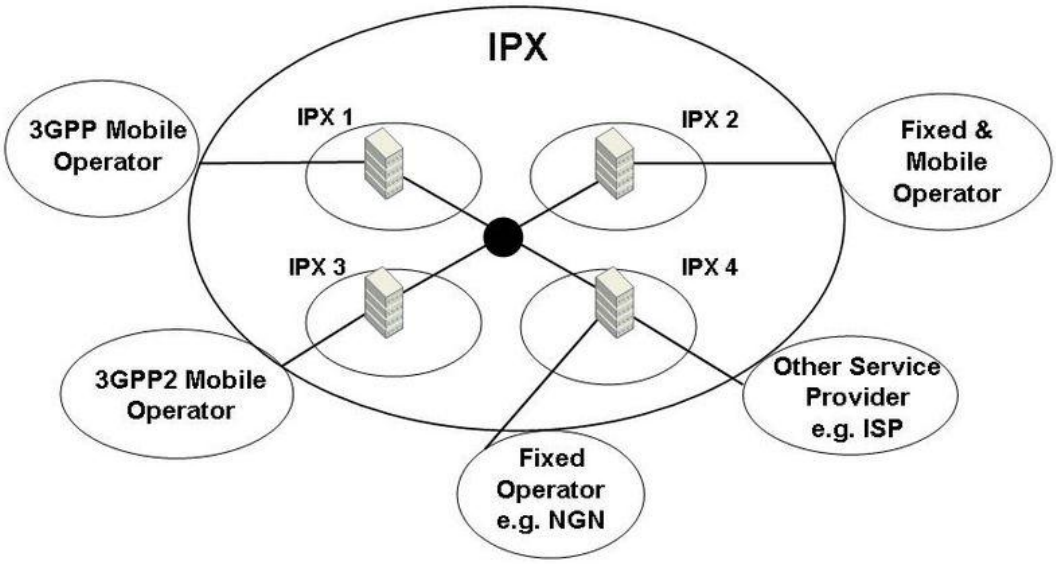
The need for QoS based Interconnection

As noted earlier, a key problem in an IP environment is an effective "interconnect" framework that provides appropriate commercial incentives and operational tools to allow reliable end-to-end service delivery. The problem is not that there is an absence of candidate technical solutions, rather that there is no overall consensus of which to choose and how to implement them. At the heart of this is the fact that the standards developed tend to adopt differing approaches to how QoS is assigned to particular classes of traffic and how, subsequently, such traffic can be managed across network boundaries. Thus the key seems to be, as recognised by the EU "CEO" work:

"….the definition of a basic set of "quality classes" and the adoption of a roadmap for their wide implementation in order to enable new Internet business models and guaranteeing the security and quality of service delivery."

The second key recommendation from this work is therefore that an approach based on the GSM Association's IP eXchange (IPX)[282] concept is adopted. IPX was originally developed by the GSM Association as an interconnect service based on common agreed technical specifications and using consistent commercial models. It provides a secure environment for delivery of traffic managed with QoS levels and performance to mutually agreed service level agreements. IPX can be used to interconnect any IP service, including voice. To give full interoperability and end-end guaranteed quality, these services are standardised. Non standardised services can also be carried by providing a transport only interconnect which could also support Quality of Service classes.

Figure G9: High level IPX architecture

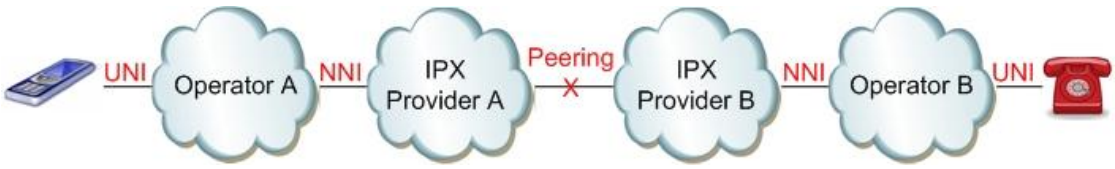


The IPX architecture consists of different IPX Providers connecting together via an IPX peering point for traffic exchange. Both signalling (such as SIP) and media (such as RTP) is transported end-to-end

[282] See http://www.gsmworld.com/our-work/programmes-and-initiatives/ip-networking/index.htm

in accordance with IPX specifications. A typical end-to-end path of traffic in a fixed to mobile interconnection scenario is illustrated below:

Figure G10: End to end service delivery



X is a peering point where IPX Provider A and IPX Provider B exchange traffic

IPX offers both bilateral and multilateral interconnection. Bilateral means the traditional model of two operators bilaterally writing an interconnection contract prior to setting up a connection to each other themselves. Multilateral on the other hand means that the IPX provider to some extent takes care of both handling the contract and connectivity set-up on behalf of the operators. Setting up bilateral interconnection contracts & connections with tens/hundreds of other operators can be a major burden. Therefore the multilateral option, which allows an operator to open multiple connections by making a single contract and single technical connection with the IPX provider, makes interconnection deployment easier and faster.

Key principles of IPX

- **Quality** - support for QoS is provided through both technical features implemented in the connected networks and an enforceable contract model among all the players involved (end-to-end Service Level Agreements)
- **Cascading Payments** – the cascading SLA and contractual responsibilities in IPX mean each party is responsible for the performance of the next party in the transit chain. Because all participants make this commitment, the financial benefits of providing the service are cascaded through the value chain, enabling all those involved to receive a commercial return for their participation and a consequent incentive to participate
- **Efficient Connectivity** - operator connecting to IPX can choose a multilateral interconnection mode where one interconnection contract and point of presence establishment provides access to multiple interconnection partners (typically supported by a neutral hosting venue/Internet Exchange
- **All IP** - supporting natively IP based protocols (such as SIP, RTP, GTP, SMTP, SIGTRAN etc.)
- **Secure** - completely separate from the public internet, both logically and physically
- **Global** - not necessarily restricted to a particular geographical area
- **Backwards Compatible** - IPX specifications are already compliant with existing public IP based network specifications and recommendations. For example, a 3GPP compliant IMS core system is capable of the implementation of an IPX compliant Network-to-Network Interface (NNI) with no upgrade.
- **Common Technical Specifications** used end-to-end

The use of a common approach to IP interconnect through IPX enables full global interoperability by a progressive implementation and rollout in local markets, across regions and leading to global

interconnection. There are a number of carriers and "Internet Exchanges"[283] that have publicly announced the launch of IPX services and they are currently promoting their service. Currently there would seem to be more active connectivity in Asia than in Europe.

G7 NGA Telephony

In order to illustrate how the ALA can be implemented in a way that encourages a greater level of competitive intensity for a given service, it is useful to examine how it can be applied to the delivery of voice telephony over NGA. NGA sees existing access technologies replaced or augmented by modern variants that provide higher bandwidth, for example Fibre to the Home (FTTH). With FTTH, in green field sites there may be no copper lines deployed, and even in brownfield locations it may make sense to carry the voice service using the fibre and let the copper wither on the vine, potentially to be recovered in the future. But with no copper, the ability to convey voice as an analogue signal disappears.

NGA-Telephony (NGA-T) accommodates this by migrating voice to be just another IP-enabled application alongside others such as broadband internet access, albeit one needing QoS support. This is accomplished by deploying Analogue Telephony Adaptors (ATAs) to customer homes, which deliver standard telephony connectors to the customer, converting to Voice over IP (VoIP) in the direction of the network. The ATAs could be freestanding, or more commonly will be incorporated into the Network Terminating Equipment (NTE) that terminates the fibre. These ATAs in the customer home operate under the control of VoIP call servers in operator networks, so it is essential that there are technical standards for how the ATA and call servers interoperate.

[283] http://ams-ix.net/ams-ix-to-offer-inter-ipx-services-in-2011/

Annex H Delivery of calls to emergency services

H1 Delivery of calls to emergency services

The ability to make calls to the Emergency Services with a high degree of confidence that a call will both be made **and** successfully routed to the right organisation with minimum delay, irrespective of the amount of traffic across the network, is rightly viewed by policy makers and consumers as a fundamental requirement of voice communications networks.

In the past, conforming to relevant ITU Recommendations, particularly with regards to "C7" signalling, meant high reliability from traditional circuit switched digital voice networks, and assurance of effective emergency call prioritisation both within a network and across network interconnects. The "best efforts" Internet can provide no such guarantees for voice services. How can appropriate minimum quality of service standards guarantee reliable services over NGNs that are capable of delivering "emergency services calls" without unduly constraining the operators in their service innovation? What role should OFTA play in ensuring that this happens?

In our view, there are essentially three issues to be considered, which mirror topics that we are aware are being discussed in the sub-group set up under the NGNWG to address emergency service calls284:

a. Can voice call prioritisation be supported within and across NGNs?

b. Does the ultimately "transportable" nature of VoIP threaten the utility value of conventional emergency service calling, particularly with regard to potential loss of location data for routing and efficient despatch?

c. In the light of a and b, do alternate means of "calling" exist that can usefully complement or even replace conventional calls?

H2 Voice call prioritisation for NGNs

In practice, the use of SIP-I to provide backwards compatibility with ISUP based network networks offers an easy short term mechanism for ensuring emergency services calls can be transported across networks with guaranteed levels of priority to ensure delivery. The conventional C7 Priority markings that are applied to Emergency Services Calls can be maintained across an IP NNI as the basic ISUP message is encapsulated in the SIP-I signalling. The interworking between the protocols will then allow the continuation of existing assured delivery as described, for instance in the NICC standard, ND1017[285] "Interworking between Session Initiation Protocol (SIP) and UK ISDN User Part (UK ISUP)".

If, as is likely in the longer term, CPs wish to move to a "native SIP" NNI, Emergency Service call prioritisation is still feasible. Judicious use of Bandwidth Management protocols[286] at the NNI will allow

[284] "Provision of Emergency Call Services Towards the Era of Next Generations Services – Report of the Subgroup on Emergency Call Services" – June, 2011

[285] See http://www.niccstandards.org.uk/files/current/nd1017_2006_07.pdf?type=pdf

[286] As noted in the earlier section on NGN standards, numerous internationally recognised and implemented standards options based on IETF RFCs are available to facilitate such prioritisation.

the reservation of dedicated bandwidth between networks so that Emergency Service Calls can be given priority and routed through a special virtual channel. Whilst, in principle, this seems wasteful of bandwidth, with current network element economics and a compact market, such as Hong Kong, it seems eminently practicable[287].

In both the SIP-I and "native" SIP modes, there is, of course a need to ensure that there is sufficient capacity available in all parts of an individual communications provider's network that may, in principle, encounter congestion. Again, bandwidth management tools, based on prioritisation of particular types of traffic and/or reservation of dedicated capacity in VLANs used for QoS "guaranteed" voice allow this to be achieved. Dependent on how the service is presented to the consumer, there is still a risk of unsuccessful call attempts if, for instance, there is no QoS guarantee offered at the access level, and bandwidth is being fully consumed by other services. UNI models such as the NICC "NGA Telephony" implementation for ALA offer a comprehensive "end to end" QoS which would ensure capacity for emergency calls is always maintained.

Guaranteeing emergency service call delivery for non-SIP based voice services is more problematic. Whilst, in principle, similar prioritisation techniques could be utilised, the lack of interworking standards would probably preclude direct connectivity to the emergency services, necessitating some form of gateway function being used.

H3 Location issues with VoIP transportability

The NGNWG Subgroup on Emergency Call Services paper provides a good overview of this issue. Efficient despatch of emergency services responders is facilitated by the ability of the control centre to easily access precise location information for the caller. Indeed, in some circumstances, it is used to ensure that the call is routed to the most appropriate agency, particularly for larger countries or regions – this is obviously of most importance for mobile or transportable services. Cell location solutions for mobile services are a well-established means of solving the most obvious problem in this context but the increasing use of VoIP solutions that are inherently transportable as substitutes for traditional wireline services has posed other problems. In the USA, there have been instances where early adopter users of VoIP have taken advantage of this transportability, made emergency calls and then encountered difficulties as their call was routed according to a fixed "area code" within the conventional number format and was handed off to an emergency dispatcher in another State, based on the interpretation of the "area code" rather than any updated information of where the caller was actually situated. In at least one instance, this led to an avoidable fatality, and the investigation of the circumstances of this and other cases then led to eventual FCC intervention.

This initial call routing problem is not the only issue – in some cases, the caller cannot be relied upon to give accurate location information themselves if, for instances, they are incapacitated or a very young child. This leads to a broader need for location information to be available, independent of the caller to facilitate efficient and effective despatch. Again, base station derived information[288] provides an appropriate starting point for mobile networks and, conventionally, installation address for wireline

[287] Note that emergency service access is an integral part of the "Basic SIPP NNI" standards that NICC are working on in the UK.

[288] Although, in the medium term this is likely to be augmented/replaced by GPS based location data being made available from the handset.

services[289]. This information can be accessed in two ways – firstly, by providing easy access to a contact within the relevant provider so that the information can be provided to the emergency call handler, or, secondly, through some form of automated database access, either directly by the emergency service or through an intermediary.

The former approach becomes increasingly cumbersome in a competitive environment, as the call handler has to determine which communications provider to contact, and relies upon all providers having effective "24/7" contact points. Increasingly, automated solutions are being adopted, which allow database queries to be generated by the emergency services to interrogate a suitable central repository of permanent location information, and/or the base station information generated and held by mobile networks. In many cases, these queries are in turn automatically triggered by the CLI received in the out of band signalling provided between the networks and the call handling agency[290].

Obviously, this database still is subject to any inaccuracies of location information held by the communications provider. The optimum solution appears to be the mandatory imposition, though regulation or statute, of a requirement on all Communications Providers to populate and update relevant customer information in a centralised database which the emergency services call handling agency can access both manually and through the type of automated process described above. In Europe, this is now a requirement of the EU Telecoms Framework which is implemented in the UK by Ofcom, for instance, via General Condition 4, which states, *inter alia*:

"4.2 The Communications Provider shall, to the extent technically feasible, make accurate and reliable Caller Location Information available for all calls to the emergency call numbers "112" and "999", at no charge to the Emergency Organisations handling those calls, at the time the call is answered by those organisations.

4.3 Where a Communications Provider provides an Electronic Communications Service:

(a) at a fixed location, the Caller Location Information must, at least, accurately reflect the fixed location of the End-User's terminal equipment including the full postal address; and

(b) using a Mobile Network, the Caller Location Information must include, at least, the Cell Identification of the cell from which the call is being made, or in exceptional circumstances the Zone Code.

4.4 For the purposes of this Condition, (a) "Caller Location Information" means any data or information processed in an Electronic Communications Network indicating the geographic position of the terminal equipment of a person initiating a call; (b) "Cell Identification" means the geographic coordinates of the cell which is hosting the call, and where available, an indication of the radius of coverage of the cell;"

BT provide a service to all communications providers to host this information in its Emergency Services Data Base (ESDB) which is then accessible to the emergency services via BT operators or the automated Enhanced Information Service for Emergency Calls (EISEC) capability.

Whilst this does provide an easy to use "look up" facility which can be easily updated by communications providers if, for instance, their end customers volunteer information that they are exploiting the transportable nature of VoIP by relocating, permanently or temporarily, it does still rely

[289] The NGNWG Subgroup report makes an appropriate distinction between the installation address and any other address held by the communications provider such as billing address. The potential need to be able to hold multiple addresses for specific purposes may be a limiting factor for some providers' customer care systems.

[290] In some cases, this automated approach to getting initial location information is used for all calls and used as part of an automated despatch system via some form of mobile data interface to the emergency service vehicles in the field, so that despatch can start before the call is terminated, improving response times.

on this data being provided accurately and reliably updated. Experience to date suggests that this is inadequate and more automatic means of generating accurate VoIP service location are being developed. In the main these rely on the IP address of the location generating the call being made visible to the VoIP service provider and/or the emergency services call handler so that this can be used to identify the actual geographic location. However, with dynamic IP allocation being the norm for many consumer services and with the added complication of both proxy servers and private IP addressing, this is by no means a trivial problem to solve. However, progress has been made in both Europe and the USA in establishing an appropriate architectural model[291], as illustrated below, and attention is now turning to implementation issues.

The most challenging of these is the need to develop a comprehensive database of all localised IP addresses across all communications providers that provide public services that can provide an association with a physical location. In order to cope with dynamic IP address allocation, this database would have to be capable of being upgraded in near real-time by all of the relevant internet access **and** voice communications network providers. The IETF GEOPRIV working group has defined a suite of protocols that allow broadband providers to provide location information to subscribers' devices through standard protocol interfaces. One governing principle might be that when a VoIP user accesses the Internet to place an emergency call, the underlying broadband provider must be capable of providing location information regarding the access point being used by the device or application, using industry-standard protocols[292] on commercially reasonable and non-discriminatory terms.

It is certain that this issue will continue to receive both standards body and regulatory/policy making attention in the near term. It is worth noting that, in the USA, the FCC has recently announced its initial conclusions on the need for enhanced emergency services access[293] and has signaled its intention of extending current obligations on network operators to ensure that changes in modes of voice communications do not undermine the welfare benefits of effective "911" or equivalent services.

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[291] See, for instance, NICC ND1638; **VOIP - Location for Emergency Calls (Architecture) -** http://www.niccstandards.org.uk/files/current/ND1638%20V1.1.2.pdf?type=pdf

NENA i2 schema

http://www.nena.org/technical-xml-schemas

NENA 08-001 (Issue 1, December 6, 2005) "NENA Interim VoIP Architecture for Enhanced 9-1-1 Services (i2)" http://www.nena.org/standards/technical/voip/interim-voip-architecture-i2

NENA XML specifications

http://www.nena.org/technical-xml-schemas

IETF RFC XXXX "HTTP Enabled Location Delivery (HELD)" Ed,MBarnes,August 2009

http://tools.ietf.org/html/rfcXXXX

(Currently Geopriv Internet Draft in RFC Editor's queue : http://tools.ietf.org/html/draft-ietf-geopriv-http-locationdelivery-16)

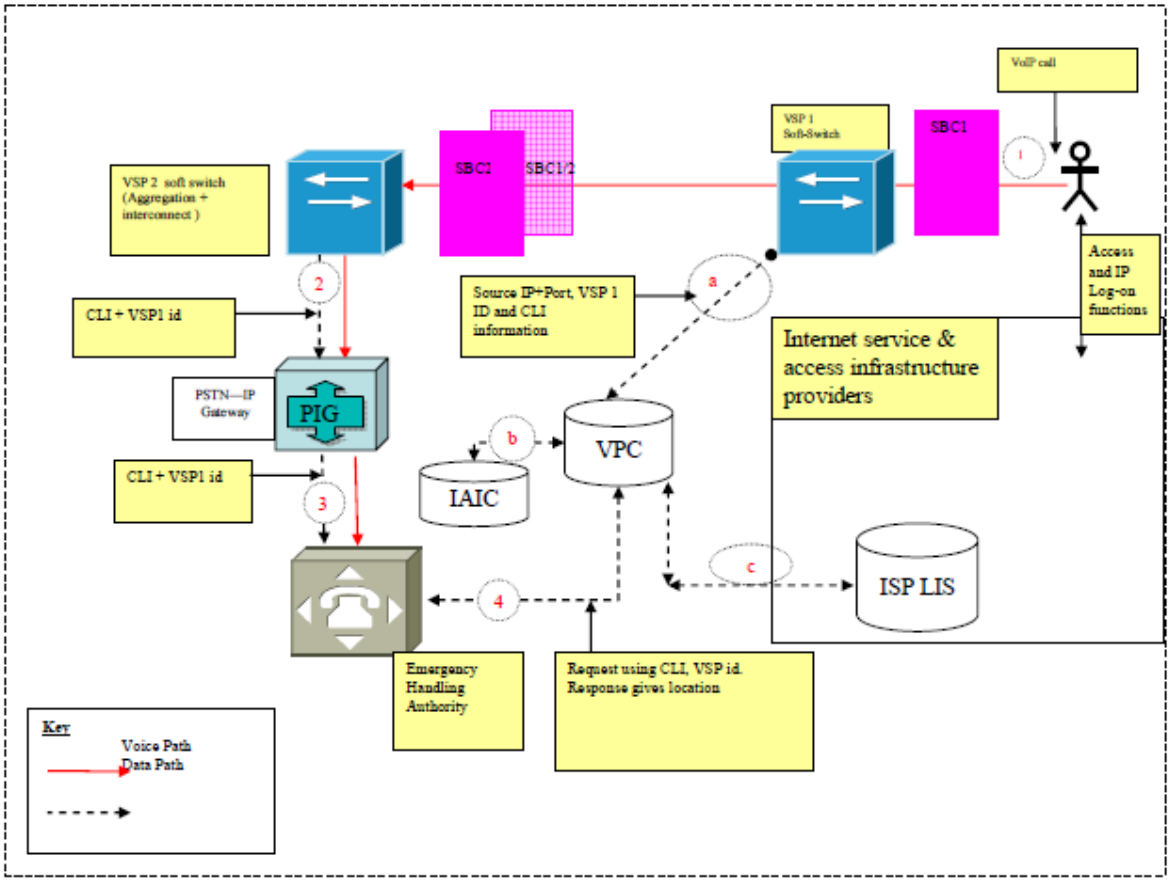
IETF RFC 5139 "Civic Location Format for PIDF-LO" , M. Thomson, J. Winterbottom, February 2008

http://tools.ietf.org/html/rfc5139

[292] These protocols have been designed for use by any endpoint (stationary, nomadic, or mobile), in any IP network, including both wired networks (*e.g.*, cable, DSL, Ethernet, and fiber-optic) and wireless networks (*e.g.*, WiFi, WiMAX, 3G, and 4G).

[293] AMENDING THE DEFINITION OF INTERCONNECTED VOIP SERVICE IN SECTION 9.3 OF THE COMMISSION'S RULES; WIRELESS E911 LOCATION ACCURACY REQUIREMENTS; E911 REQUIREMENTS FOR IP-ENABLED SERVICE PROVIDERS. FCC Strengthens Enhanced 911 Location Accuracy Requirements For Wireless Services. Seeks Comment on Improved 911 Availability and E911 Location Determination For VoIP. by 3RD R&O AND 2ND FNPRM. (Dkt No. 05-196 07-114 11-117). Action by: the Commission. Adopted: 07/12/2011 by NPRM.

Figure H16: Centralised caller location database architecture supporting IP address based location



H4 Alternative approaches to emergency service access

Some Governments and emergency authorities are now recognising that many users have substituted some form of text based service (SMS, IM or e-mail) for much of their previously voice based communications needs. Consequently, a number are already experimenting with accepting requests for assistance in these various formats. Whilst this should be welcomed, it is vital to recognise that these forms of communications may be very much less reliable than conventional voice, particularly with regard to delivery delays. In addition, the location information issues discussed at 2.2 are also applicable.

Consequently, at this stage text based emergency services access can be used to complement voice access but it cannot be viewed as an effective substitute until such time as delivery delays can be minimised and assured, and automated location solutions such as those identified in 2.2 are implemented[294].

[294] This does not apply to dedicated emergency text access solutions that have been implemented in some jurisdictions to serve the need of the deaf.

Annex I Network Security

I1 Network Security

It is a fundamental truth that Information and Communications Technology (ICT) is now a key enabler in any economy. Businesses rely on ICT to operate efficiently and to access a wide customer base and consumers rely on e-communication in their daily activities. A reliable communications infrastructure is also critical to the functioning of Government and the delivery of emergency services. The security and integrity of telecommunications is therefore an issue of increasing national and international prominence.

This is driven by increased dependency on complex communication systems, as well as a changing national security agenda. The Internet has quickly grown into an essential platform for individuals to interact with friends, family, businesses and governments. Usage has grown by six per cent per annum since 2007 in the developed world, to 64.2% of the population. Younger and better-educated adults are overwhelmingly Internet users: within the EU, for example, this includes 89% of university-educated individuals and 91% of those aged 15-24 (ITU, 2010). In the same time period Internet usage grew annually by over 21% in the developing world, to 17.5% of the population (ITU, 2010). Globally, developing countries now account for over half of the Internet's users (UNCTAD, 2009). The United Kingdom‘s Cyber Security Operations Centre predicts that by 2015, high-speed Internet access will be essential to people‘s ability to carry out their daily lives and that service interruptions will have a serious impact on the economy and public wellbeing. Non-availability would reduce people‘s ability to purchase goods and services; to carry out financial transactions; to plan and book travel; and to communicate with family and friends. In an emergency, it would also impair their ability to receive up-to-date information and hence co-ordinate their response appropriately.

Internet-specific businesses have become a significant contributor to advanced economies. The European Commission estimated the European e-commerce market in 2006 to be worth EUR 106 billion, with 70% of revenues concentrated in the UK, Germany and France (2009). Clearly, any disruption in consumer access to online services has the potential to cause significant immediate losses to these businesses. E-commerce levels have continued to grow despite a corresponding increase in fraud levels, which so far have been borne largely by businesses and payment intermediaries.

Beyond the e-commerce market, networked systems are involved in some part of the value chain of virtually every transaction, whether in networked cash registers, payment systems or logistics firms delivery route optimisation. Industry supply chains are critically dependent on the information systems used to monitor stock levels, place orders, and coordinate the movement of products from factory floors to retail outlet shelves. More broadly, ICT has had a significant impact on productivity growth across the OECD. In some Member countries such as Austria, Denmark and Spain, it contributed over 100% of productivity growth between 1995 and 2004.

Most OECD governments are moving to take advantage of the efficiency and performance improvements available through using online channels to deliver services to citizens and businesses, and to modernise their own internal processes. In 2007 32% of citizens in OECD Member countries interacted with public authorities using the Internet. Top-performing states such as Norway, Iceland and Denmark dealt with almost 60% of citizens electronically.

Telecommunications networks possess high levels of inherent integrity and generally have good levels of in-built security. However, there remain significant concerns where network and information security are at risk, whether from deliberate or accidental disruption. Incidents involving the loss of business critical IT systems or an equivalent loss of telecommunications services are becoming increasingly common. The causes of such outages vary from equipment theft or damage, environmental threats such as flooding, and electronic network attacks such as Denial of Service attacks. Threats to security and integrity have a major impact on public service delivery, such as medical and police emergencies. They also continue to grow as a terrorist enabler and a military weapon.

Will NGNs offer sufficient network security in terms of the confidentiality and integrity of the data carried, and in terms of resilience against malicious attack? One of the key concerns about NGNs based on the underlying IP technology of the Internet is that, unlike the "closed" nature of their predecessor legacy networks, their very openness of architecture and technology makes them more vulnerable to attack and disruption. We note the work that OFTA has already undertaken with regard to NGN security, building on the recommendations of the ITU and other international agencies and standards groups to develop its **Security Guidelines for Next Generation Networks**. This provides a comprehensive regulatory framework within which to address the complex and evolving nature of IP based network risk management. However, the process of both network and threat evolution is continuing and international best practice will change over time to keep pace.

I2 Drivers for network security and the need for Government intervention

The security of public communications networks and services has thus far been driven entirely by commercial requirements. These typically take the form of contractual Service Level Agreements (SLAs) with suppliers or with wholesale or business customers. In the retail sector they take the form of internal customer satisfaction measures and retention targets. Market failures can occur in instances where free and competitive markets do not lead to an efficient outcome from a societal point of view. In the telecommunications sector there are two prevailing features, identified below, that may prevent economically efficient decisions being made with regards to security and integrity. In order to remedy this outcome, well designed government interventions may be required.

Security and integrity of telecoms infrastructure could be considered to have the characteristics of a public good, like national defence. It is "non rival" – consumption of the good does not reduce availability for others and "non excludable" – no one can be excluded from consuming the good. Therefore, there is a free rider problem, as there is limited incentive for consumers to pay for the good, which could lead to under provision of security and integrity, hence the need for government involvement to ensure optimal security and integrity.

During the past two decades, in most countries, both developed and developing, an increasing number of Communications Providers have rolled out their own telecommunications infrastructure, meaning that networks have become more interconnected. A security threat to one network therefore has a direct impact on others, making it crucial that all networks maintain a certain level of resilience. Furthermore, any threats to network security and integrity have an impact on the vast majority of the households and businesses that are reliant on communications, be it fixed/mobile telephony or broadband. Individual firms equate private costs with private benefits, and they will not factor in the potential cost of a network breakdown on the economy as a whole.

Scale of the issue

Communications networks and services face a number of threats and incidents that do occur on a regular basis. This section provides a summary of the nature of network incidents that occur and the common threats to which networks are exposed. Incidents broadly fall into three tiers:

- Faults – These are high frequency, low impact incidents. In a network serving tens of millions of customers, these occur relatively regularly (on the order of 1000s per month), but the effect may be negligible or only impact a small group of customers (typically 50 to 2000). Faults may be resolved before customers notice a problem, but in some cases may last several hours and be reported in the local press. A common cause is cable damage or theft.
- Significant Incidents – These are incidents likely to impact, or threaten to impact, of the order of 10,000 customers or more for the typical network noted above, and/or are likely to effect multiple Communications Providers. They probably occur of the order of 20 per month and are often referred to internally by organisations as "major" incidents. It is estimated that approximately a quarter are due to network failures and the rest service failures.
- Major Incidents – These are extended outages or network failures (lasting 24 to 48 hours or more) requiring major redirections and typically effecting entire regions (note that the distinction between Significant and Major Incidents is not a 'hard' threshold and is likely to be determined in each case). Relevant media coverage would suggest that they occur roughly twice per year, for our typical network, but the level of occurrence could be higher than this and unreported.

Targeted equipment theft

Whilst theft of "commodity" ICT equipment (such as laptop and desktop PCs) is both well established and also on the rise, theft of telecoms network equipment is a relatively recent phenomenon. Legacy telecoms network systems were very bulky, relatively specialist by nature and usually of limited value to other network operators, because of the need for bespoke configuration and specialist support contracts. This all but eliminated the potential development of an illegal "black market" in stolen goods and, consequently, the motivation for targeted theft. However, with the increasing use of compact "blade server" hardware and the development of a complex and competitive support industry for the products of some key vendors, most noticeably Cisco, international "grey markets" for both enterprise and telco routers and other systems have developed. This has led to an increasing amount of targeted theft from both enterprise and public networks, leading to significant network outages in some cases.

Cable theft

The price of copper rose by 30 per cent in 2010, and entered 2011 at a record high [295]. Strong industrial output in China, India and Brazil, as well as the impact of industrial disputes and natural disasters on supply, has seen demand outstrip supply.

[295] See http://www.bbc.co.uk/news/business-12098576

The surge in the value of this metal is having a significant impact on communication network providers in some countries. Traditional telephone circuits comprise pairs of copper cable, and thieves are increasingly targeting these in an attempt to sell the copper for scrap. This has led to a large number of localised outages across the UK and elsewhere. Networks relying on copper are not the only ones at risk. Fibre optic cables are regularly targeted and damaged by copper thieves unaware of the nature of the cables.

Cable damage

Cables are also frequently damaged by accident. Construction work is a major contributor, with diggers frequently responsible for severed cables. Another cause is damage caused by maintenance works to utilities supplies. A major vulnerability in the cabling infrastructure is its complex development over the decades. Due to the high costs and disruptive effects of street works, it has been commonplace for network providers to install cables in ducts owned by water and gas companies when these companies are carrying out their own maintenance. Attempts to develop inventories of this infrastructure to support risk assessment have usually met with insurmountable complexities and incomplete information.

Environmental threats

Equipment damage at exchanges caused by local environmental incidents has been known to cause major disruption in the past. In both March/April and December of 2010, local flooding in parts of the UK caused electrical fires at communications exchanges that led to wide-spread outages effecting tens of thousands of customers, with the impact being felt in areas of the country distant from the effected exchange itself. Other fixed and mobile CSPs frequently observed knock-on disruption and in some cases disruption has also been reported within the card payment systems in the area.

Human Error

Given the considerable work involved in maintaining a telecoms networks there is always the potential for human error to cause an outage, particular where work is being performed on core network elements. There are a number of procedural controls that reduce the likelihood of this occurring, for instance a full configuration and change management process, training for engineering and maintenance staff, and restricting and segregating logical access as far as possible.

Major national events

Major national events can pose a significant threat to the provision of telecommunications services. These events can impact on telecommunications networks in a number of different, though generally indirect ways.

The “9/11” incidents in New York damaged significant fixed and mobile network assets which meant that, in the aftermath, disaster recovery was hampered by the lack of communications capabilities. On the other hand, the 2005 London Bombings did not damage physical infrastructure, but networks were quickly overwhelmed by the volume of traffic. The floods in 2007 in the North East and South West of

the UK the caused wide-spread disruption to power supplies which in turn required CSPs continuity plans to be enacted. This emphasises the interrelated nature of what is commonly termed "Critical National Infrastructure" and that damage to one element may well catastrophically impact others.

Denial of Service attacks

Denial of Service (DoS) attacks attempt to effect disruption by flooding networks and services with excessive traffic in an attempt to overwhelm them. These attacks often take the form of "Distributed" sources of DoS traffic (termed DDoS), and these days usually originate from networks of infected PCs known as botnets.

Typically DoS and DDoS attacks target websites. However, in 2002 and again in 2007 a subset of the main Internet root servers came under attack in an attempt to disrupt the Internet backbone. In both cases the disruption appears to have been minimal, and lessons learned in the 2002 attack informed better mitigation ahead of the 2007 one.

Motivations behind DoS attacks vary, and sometimes remain unclear. Often they are politically motivated, such as the attacks on Estonia in 2007, the attacks on Georgia during the 2008 South Ossetia crisis, and the attacks on South Korea in 2009. Most recently in 2011, the Tunisian and Egyptian governments have been targeted during the ongoing periods of unrest.

A recent trend is the rise of a cyber protest phenomenon known as "hacktivism". This is often ideologically motivated. At the end of 2010 during the US Diplomatic Cables leak by WikiLeaks, a disparate group of supporters launched DDoS attacks against companies that were seen to be withdrawing resources from the organisation. In this case widely available software was modified to allow sympathetic users to contribute their computers to a botnet carrying out the DDoS attacks. Both the "Anonymous" group that were allegedly behind these attacks and the more recently active "LulzSec" remain essentially unidentified and have made threats that they will continue their activities.

ID Theft

It is widely recognised that one of the major areas of risk presented by the internet is that of identify theft. In particular there is believed to be a considerable economic impact, on the individual as well as on businesses. While identity theft is frequently committed using mechanisms such as DoS and malicious software propagated across telecoms networks, it is primarily aimed at the end-point content providers (ie website themselves) rather than at the network elements.

I3 Emerging perspectives on "cyber security" and risk management

As part of the joint OECD/IFP Project on "Future Global Shocks", a report entitled "Reducing Systemic Cybersecurity Risk"[296] was published earlier this year. The authors concluded that:

[296] See - www.oecd.org/dataoecd/57/44/46889922.pdf

"very few single cyber-related events have the capacity to cause a global shock. Governments nevertheless need to make detailed preparations to withstand and recover from a wide range of unwanted cyber events, both accidental and deliberate. There are significant and growing risks of localised misery and loss as a result of compromise of computer and telecommunications services. In addition, reliable Internet and other computer facilities are essential in recovering from most other large-scale disasters."

They identified that a range of catastrophic events that could include successful attack on one of the underlying technical protocols upon which the Internet depends, such as the Border Gateway Protocol[297] which determines routing between Internet Service Providers and a very large-scale solar flare which physically destroys key communications components such as satellites, cellular base stations and switches. More prosaically, for the most likely breaches of cybsersecurity such as malware, distributed denial of service, espionage, and the actions of criminals, recreational hackers and "hacktivists", most events will be both relatively localised and short-term in impact.

Nevertheless, the deployment of cyberweapons is already widespread and in an extensive range of circumstances. Cyberweapons include unauthorised access to systems (hacking), viruses, worms, trojans, denial-of-service, distributed denial of service using botnets, root-kits and the use of social engineering. Outcomes can include compromise of confidentiality / theft of secrets, identity theft, web-defacements, extortion, system hijacking and service blockading.

However, the rates of change in computer and telecommunications technologies are so rapid that threat analyses must be constantly updated. To be successful, counter measures need to be considered within an Information Assurance engineering framework, in which preventative and detective technologies are deployed alongside human-centred managerial policies and controls. This would include managerial measures such as risk analysis supported by top management, secure system procurement and design as retrofitting security features is always more expensive and less efficient, facilities for managing access control, end-user education; frequent system audits data and system back-up disaster recovery plans, an investigative facility, and, where appropriate, standards compliance.

Constant vigilance is required to ensure that new threats can be responded to as they arise. This means applying the latest patches to operating systems and applications, the deployment of anti-malware, firewall and intrusion detection products and services and the effective use of load-balancing services as a means of thwarting distributed denial of service attacks.

Three current trends in the delivery of ICT services gave the authors of the OECD report particular concern:

- World Wide Web portals are being increasingly used to provide critical Government-to-citizen and Government-to-business facilities. Although these potentially offer cost savings and increased efficiency, over-dependence can result in repetition of the problems faced by Estonia in 2007.
- A number of OECD governments have outsourced critical computing services to the private sector; this route offers economies and efficiencies but the contractual service level agreements may not be able to cope with the unusual quantities of traffic that occur in an emergency.

[297] This is also a key risk that is identified by the pan-European agency ENISA in their report "Inter- X: Resilience of the Internet Interconnection Ecosystem" published in April 2011 – see http://www.enisa.europa.eu/act/res/other-areas/inter-x/report/interx-report/at_download/fullReport

- Cloud computing also potentially offers savings and resilience; but it also creates security problems in the form of loss of confidentiality if authentication is not robust and loss of service if internet connectivity is unavailable or the supplier is in financial difficulties.

The authors also point out that large sections of the Critical National Infrastructure of most OECD countries are not under direct government control but in private ownership. Governments tend to respond by referring to Public Private Partnerships but this relationship is under-explored and full of tensions. The ultimate duty of a private company is to provide returns for its share-holders whereas a Government's concern is with overall public security and safety.

In the light of these issues, the report offers a comprehensive check list for relevant Government agencies:

- Ensure that national cybersecurity policies encompass the needs of all citizens and not just central government facilities
- Encourage the widespread ratification and use of the CyberCrime Convention and other potential international treaties
- Support end-user education as this benefits not only the individual user and system but reduces the numbers of unprotected computers that are available for hijacking by criminals and then used to mount attacks
- Use procurement power, standards-setting and licensing to influence computer industry suppliers to provide properly tested hardware and software
- Extend the development of specialist police and forensic computing resources
- Support the international Computer Emergency Response Team (CERT) community, including through funding, as the most likely means by which a large-scale Internet problem can be averted or mitigated
- Fund research into such areas as: Strengthened Internet protocols, Risk Analysis, Contingency Planning and Disaster Propagation Analysis, Human Factors in the use of computer systems, Security Economics
- Attempts at the use of an Internet "Off Switch", even if localised, are likely to have unforeseeable and unwanted consequences.

International initiatives

The United Nations International Telecommunication Union is in the course of producing a toolkit to help its members develop their national cybercrime legislation. This includes model legislative provisions based heavily on the Council of Europe Cybercrime Convention, as well as a comprehensive analysis of existing national and EU laws. This follows UN resolutions 55/63 and 56/121 on combating criminal misuse of information technologies and resolutions 57/239, 58/199 and 64/211 on protecting critical information infrastructures.

In the Asia-Pacific region, APEC has set up a Security and Prosperity Steering Group to coordinate its members cybersecurity work. It has run workshops on submarine cable protection and cybersecurity awareness, and also undertakes work on ICT in disaster preparedness and recovery, cybercrime prevention and the development of Computer Emergency Response Teams. APEC leaders have

committed to enact comprehensive cybercrime laws consistent with the Cybercrime Convention; create national cybercrime units and points of contact; and establish institutions to exchange threat and vulnerability assessment

The EU's legislative framework on network and information security is in two parts. In the former judicial and home affairs "third pillar", the Council passed a framework decision on attacks against information systems . This closely follows the Cybercrime Convention in harmonising criminal offences and penalties related to access to, and interference with, information systems and data, and reinforces procedures for exchange of information. In the former single market "first pillar", the Council and Parliament passed a major update of the legislation governing electronic communications in 2009. This adds a new Article to the Framework Directive (2009/140/EC) on security and integrity of networks and services. It strengthens network operators obligations to ensure that appropriate technical and organisation security measures are taken, guarantee the continuity of supply of services and notify security breaches to national regulators.

The implementation of this Article 13 of the EU Amended Framework Directive is now being undertaken in Europe with coordination through both the Commission and the network security agency ENISA. The revised Framework was agreed in November 2009 and must be implemented by Member States by 25 May 2011. The amended Framework Directive introduces new provisions on security and integrity – Articles 13a and 13b. These place obligations on public electronic communications network and service providers to take appropriate steps to ensure the security and integrity of public networks and services, and defines a new role for the National Regulatory Authority (NRA) in terms of monitoring and enforcement.

The primary intent of the Article 13 "Security and Integrity" provisions is to drive improvement in the availability of communications networks and encourage pan-European harmonisation of measures taken to safeguard such availability through a common regulatory framework. A further expectation is that the provisions will improve the transparency of security and reliability of the Publicly Available Electronic Communications Services to the customer, potentially enabling a greater understanding of the availability levels of a service at the point of purchase.

Much of the interpretation of these provisions is being left to Member States and their respective National Regulatory Authorities (NRAs), although the relatively newly formed ENISA[298] is developing a perspective of what constitutes best practice and will be issuing guidelines for Member States in 2012.

I4 Relevant standards and institutional processes for NGN security

There is a developing view of how network security risk assessment can best be carried out for NGNs, building on generic information security assurance and audit standards such ISO 27001, with applications already in place for network interconnection and public sector use of such networks through ND1643 and the CESG[299] "IL 2-2-4" benchmark in the UK. Incident reporting and coordination processes are also developing under ENISA auspices, with national models such as the UK EC-RRG and CPNI.

[298] http://www.enisa.europa.eu/media/press-releases/cyber-security-agency-enisa-maps-good-practice-in-europe

[299] The UK Government Information Assurance Agency – see http://www.cesg.gov.uk

There are a number of national and international standards that concern information security and integrity; some apply to all sectors and some are specific to telecommunications:

- ISO/IEC 27001 is an international standard that defines an information security management system (ISMS) providing a framework for security risk management within an organisation. It can be applied to any organisation and it is possible to obtain certification against the standard. It does not stipulate any specific technical measures.
- ISO/IEC 27002 complements the ISO27001 standard by listing a control set comprising 133 technical, procedural, personnel and physical controls that can be selected to manage risk, and includes implementation guidance on each. It is not possible to certify against this standard.
- BS25999 is a British standard that defines a business continuity management system. It can be applied to any organisation and it is possible to obtain certification against the standard.
- ISO/IEC 27011 (also known as X.1051) is an international standard that builds upon and extends the ISO/IEC 27002 control set aimed at the telecommunication industry. It tailors guidance to the telecommunications providers and adds 12 new controls specific to the sector, including guidance on security in co-location situations.
- ND1643 **(Minimum Security Standards Between Interconnecting CPs)** is an NICC developed 23-control subset of ISO/IEC 27002 tailored to telecommunication interconnects. It aims to represent a minimum standard required to protect the UK national telecommunications infrastructure. The key areas of control are: general security and incident management, physical security, logging and auditing, control of data flows across interconnects, and vulnerability management. Following the revised EU Electronic Communications Directive, it is proposed in the UK that Ofcom will use ND1643 as a tool to assess compliance with General Condition 3, which sets out requirements regarding network integrity.
- The CESG Security Procedures – Telecommunications Systems and Services is a security standard for operating telecommunications networks to the “2-2-4” Impact Levels. This refers to the CESG Business Impact Levels for Confidentiality, Integrity and Availability respectively. It mandates ISO27001 compliance and stipulates specific details of the compliance such as a minimum scope and minimum threat assessment. It also presents a control set drawn from ISO/IEC 27002 and 27011, but actually mandates the implementation of most (107) of them. 32 remain optional (intended to be driven by risk assessment). It is possible to obtain certification against this standard for networks operating in the UK.

These standards are now being implemented and form an effective checklist of good practice. However, the institutional framework within which they are applied is of equal importance and, to date has had less consideration.

Annex J Numbering

J1 Introduction

There are five key numbering questions to address in the NGN era:

- Will E164 numbering schemes be widely used in an NGN era?
- Do other addressing schemes need to be considered in addition to, or as a replacement for, E164 schemes?
- Will the industry implement public or carrier ENUM?
- If public ENUM is implemented who should be entitled to number blocks?
- Is number portability required for a public ENUM service to be adopted?

In this paper we present research which addresses these five questions. The research is based on:

- A review of relevant published papers
- Discussion with three numbering, naming and addressing experts – John Horrocks, Robert Milne and Claire Milne - in addition to the author's own knowledge of the subject
- Discussions with Scott Wallsten, the project team member responsible for the US case study, on numbering developments in the US.

J2 Will E164 numbers be used in an NGN era?

Our research indicates that E164 numbers will continue to play a central role in telecommunications for the next 10 to 20 years. There are two main reasons for this:

- E164 numbers are used by a wide range of simple devices that are ubiquitous across both the developed and developing world
- E164 numbers are globally unique and are recognised internationally as a way of identifying network termination points and routing calls to them

A number of recent reviews of numbering, naming and addressing have reached this conclusion. For example:

- The ACMA in Australia concludes[300] as follows:

  > *"In the short to medium term the ACMA believes the use of Internet names and addresses and application-specific identifiers for a diverse array of communications services (including but not limited to voice) will grow, but remain complementary to telephone numbers in this period [the next 20 years]"*

- The Electronic Communications Committee (ECC) of the CEPT carried out a review in 2006[301]. While it made a number of recommendations to change E164 plans and their administration, it did not detect any major threat to the future of E164 numbering plans

[300] Numbering: structure *of Australia's telephone numbering plan*, ACMA, October 2010

- Robert Milne, of Antelope Consulting, recently carried out a review of numbering plans in 10 countries. He concluded that numbering authorities were making only piecemeal modifications to the numbering plans as a result of their reviews and were not planning for any major changes.

J3 Do other addressing schemes need to be considered?

We need to distinguish between naming and addressing schemes for our analysis

- A ***name*** is a unique identifier of an entity that may be communicated with via a network. It does not normally indicate explicitly which network, or exactly where the entity is located. The name is used for identifying the calling and called parties within the service that is being provided. A name may contain some location information but this is not precisely related to the network structure. It is often used directly by end users
- An ***address*** is a specification of the location of the entity in terms of network structure. It includes the identity of the network to which it is connected and some information about the location of the entity within that network. It is usually hidden from end users.

There are four main naming and addressing schemes in common use around the world. They are:

- E164 numbers. These are names[302] which provide a unique identifier for a network termination point in a public network e.g. *[country code] [national destination code] [subscriber number]*
- Domain names. These are names which are used as a basis for locating Web services e.g. *www.ofta.gov.hk* or *person@domain.com*
- IP addresses. IPv4 addresses contain 32 bits and there are $4.3x10^9$ them. IPv6 addresses contain 128 bits and there are $3.4x10^{38}$ of them. An end user uses a domain name which is translated into an IP address by a domain name server located in the Internet
- Application-specific identifiers. These are names used by application service providers (like Skype) to identify individuals using their services e.g. *dlewin1*. They are specific to the application.

Our research suggests that no new naming or addressing schemes are likely to emerge for the next 10 to 20 years, although the balance of use of the four schemes listed above may change.

One important development which needs to be considered is a possible explosion in the use of machine-to-machine communications. This could lead to a very substantial additional demand for E164 numbers. The ECC considered this problem in a recent report[303] and reached a number of conclusions:

- Demand for machine-to-machine communications in a country with the population of Hong Kong could reach 10 to 20 million devices by 2020
- Mobile rather than fixed networks are likely to provide the most flexible and cost efficient connectivity for the bulk of applications
- Machine-to-machine communication currently uses E164 numbers and is likely to use more in future

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[301] *The future of E164 numbering plans and allocation arrangements*, ECC Report 87, September 2006

[302] Although they are often used also as addresses if used with routing prefixes

[303] *Numbering and addressing in machine-to-machine communications*, draft ECC report 153, June 2010

- Use of E164 numbers for machine-to-machine communications could quickly exhaust a country's existing number plan
- One solution to this problem is to assign specific number ranges for machine-to-machine communications which use up the full 15 digits allowed under the E164 Recommendation[304].
- Another solution, recommended by the ECC for the long-term, is to move to use of domain names and IPv6 addresses.

J4 Prospects for implementation of ENUM

ENUM is a set of standards for a service which:

- Transforms telephone numbers to routable IP addresses
- Enables routing between circuit switched and IP networks e.g. for voice services
- Allows the number holder to control the device and service to which a call to an ENUM number is directed.

There are two main types of ENUM service[305]:

- ***Public or User*** ENUM in which individual users opt in to use the ENUM service. The service typically uses an E164 number from a dedicated ENUM range
- ***Carrier or infrastructure*** ENUM in which groups of carriers agree to share subscriber information for routing purposes, usually through a trusted third party. Unlike public ENUM, carrier ENUM does not require the reservation of specific number ranges. Instead operators use the ENUM functionality to manage the routing of calls to services which use existing numbers.

There is a consensus that public ENUM is of limited market appeal. When numbering authorities have launched public ENUM services they have found little demand. For example the regulator in Austria, the RTR, launched a public ENUM service in 2004. By 2009 there were less than 1000 customers[306]. There were a number of reasons for this disappointing demand:

- Users were required to opt in and to pay a charge to use the service.
- Callers to the ENUM specific ranges (+43 780 in Austria) were charged a high tariff within Austria and were not connected from outside Austria
- There were problems in establishing a critical mass for the service
- There were concerns about abuse of ENUM data, given the open nature of the service.

The proposals for carrier ENUM look more promising. Proponents of carrier ENUM[307] argue that it offers:

- Lower costs in terms of more efficient routing of calls to other networks

[304] Numbers for machine- to-machine communication are not used by end users. So relatively unfriendly, long, numbers can be used

[305] There is also private ENUM, which an operator or ISP might use within its own network

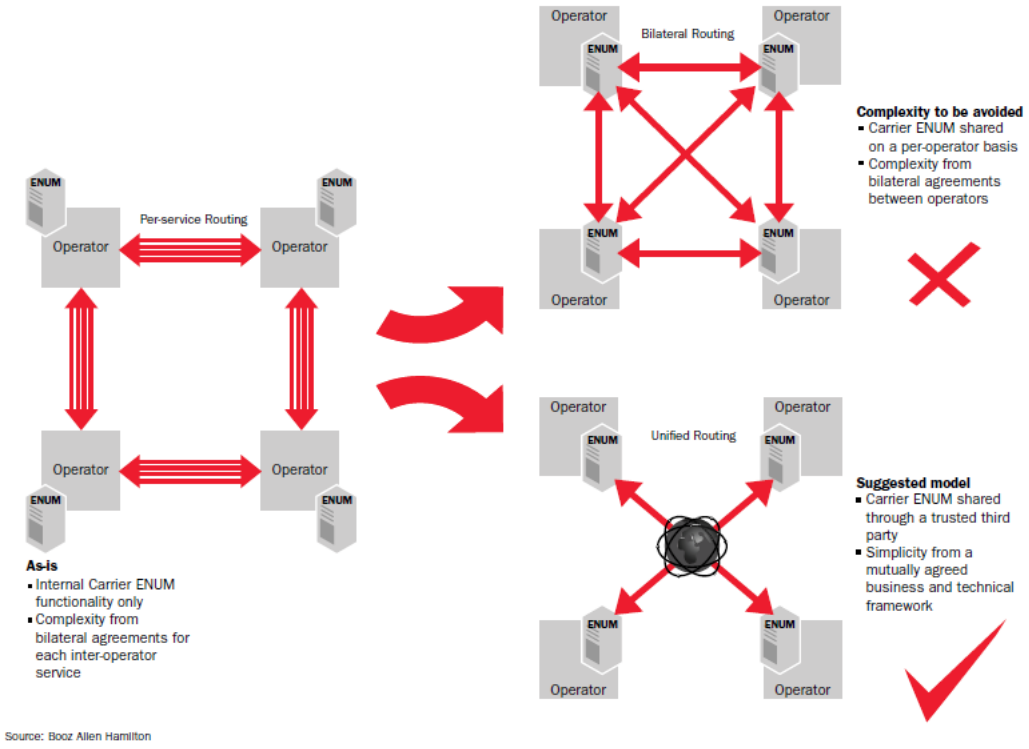
[306] *ENUM in Austria: the story of high expectations and low usage figures*, Karl Reichinger, May 2009

[307] *Inter-Operator Carrier ENUM: leveraging ENUM to unlock the Value Behind Communications Over IP*, Acker and Friedrich, Booz and Co, 2008

- A higher success rate for calls or sessions, leading to greater revenue and/or subscriber satisfaction
- The functionality to enable new, revenue generating, services.

Figure J1 shows how carrier ENUM might simplify interoperability between operators for a range of end user-to-end user services.

Figure J1: Possible use of carrier ENUM



The GSMA is promoting carrier ENUM through its Pathfinder service which is operated by Neustar. The idea is to provide an inter-operator service for mobile operator members to use as they move to IP. It is not yet clear whether the project will succeed. But a number of vendors have certified their equipment for use with the service. The latest addition in June 2011 was Huawei.

The analysis set out above suggests that:

- Many operators are unlikely to introduced public ENUM services
- Use of carrier ENUM may promote public benefit.

Given these incentives there is no need for OFTA to intervene. But OFTA might wish to play a facilitating role in the introduction of carrier ENUM, if and when there is a critical mass of Hong Kong operators wanting to implement it.

J5 Is number portability required for public ENUM?

Our research indicates that:

- The probability that operators will introduce ***public*** ENUM services is low
- If public ENUM is introduced, end-user demand for it will also be low.

In these circumstances it is likely that imposing a requirement for number portability would not be a proportionate measure. The costs of implementation could well outweigh the benefits.

We note however that ***carrier*** ENUM is seen by many as a way of providing cost effective number portability in future as voice services migrate from circuit switched to IP networks. In the UK for example the operators planned an ENUM-based number portability service when Ofcom introduced a requirement for two hour mobile number portability. (This requirement was subsequently withdrawn by Ofcom, following an appeal by the mobile operators to the Competition Appeals Tribunal and the Competition Commission).