# Next generation networks: next generation regulation?

A report for **OFTA**

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# Executive Summary

## S1 Introduction

10 years ago telecommunications operators across the developed world planned to replace traditional networks with next-generation managed IP networks (NGNs). Since then progress in implementing NGNs has been both limited and variable for two main reasons:

- The technical difficulties of replacing a range of traditional networks with a single NGN, which would substantially reduce costs, has been greater than originally anticipated
- The new services, which NGNs were designed to carry to generate additional revenues, have largely been implemented on the best efforts IP networks of the Internet instead. As a result the Internet now generates over 99% of telecommunications traffic in the developed world.

Despite these difficulties operators are now gradually implementing NGNs. The pace remains uncertain. But, in Hong Kong:

- PCCW is around halfway through migration of its voice network to an NGN
- Hong Kong Broadband Network built a full multiservice NGN when it entered the telecommunications markets in Hong Kong
- CSL uses a managed IP core network for both voice and data
- Other mobile operators expect to migrate their core networks from circuit switched to IP technologies in the next few years, as they implement voice-over-LTE.

Given these developments OFTA commissioned Plum Consulting to:

- Assess how NGN rollout might impact on telecommunications in Hong Kong
- Identify where OFTA should regulate, and forbear from regulation, of these NGN developments
- Identify longer term issues which arise with the move to NGNs and which might require changes in government policy.

The focus of the study is on the regulation of the core IP network of an NGN. But we also consider whether changes are required to the way next-generation access to high-speed broadband services is regulated.

## S2 Where should OFTA regulate interconnection between NGNs?

We can find no reason to regulate interconnection between the best efforts IP networks of the public Internet in Hong Kong. But there is a clear case for requiring any-to-any (A2A) connectivity between an NGN and other networks for voice services. There is also a good case for OFTA to provide guidance to Hong Kong's operators on when it might require A2A connectivity for other services in future. This should increase regulatory certainty. We therefore recommend that OFTA should:

- Impose any-to-any interconnection requirements for voice services on NGN operators as well as circuit switched operators

- Forbear from implementing any-to-any interconnection requirements for other services unless they pass tests on economic welfare, increased costs, competition problems and incentives for innovation, as set out in this report.

## S3 What should OFTA do to ensure interoperability between NGNs and other networks?

Standards are required if NGNs are to interoperate efficiently with other NGNs and with traditional circuit switched networks. A wide range of international standards are now available. But these offer many options which reflect the different commercial interests of those who developed the standards. There is therefore a need for specific profiles of these standards for effective interoperability in Hong Kong. We recommend that OFTA should:

- Ask the TSAC to take responsibility for developing the appropriate standards profiles for Hong Kong so as to enable interoperability between NGNs
- Forbear from imposing minimum quality of service requirements for NGN services
- As appropriate, ask the NGN Working Group and/or the TSAC to:
  - Develop a Hong Kong version of the SIP-I standard for signalling between NGNs and circuit switched networks, and appropriate NNI signalling for direct NGN interconnection, that provide for the effective prioritisation of emergency calls
  - Develop a specification for reservation of IP transport capacity in NGNs for emergency calls
  - Consider what quality classes Hong Kong might use so as to enable minimum quality of service for end to end services involving interconnected NGNs
  - Consider the most appropriate interconnection architecture for NGNs in Hong Kong.

## S4 Should OFTA change its guidance on charging for interconnection to reflect NGN developments?

With the withdrawal of OFTA guidance on fixed-to-mobile interconnection, the industry in Hong Kong has moved largely to bill and keep arrangements for interconnect charging between networks for voice services. Fixed-to-fixed interconnection is an exception. At the same time there is a need to consider whether the current arrangements, whereby the NGN rather than the circuit switched operator bears the cost of a TDM-to-IP gateway, are in the long-term best interests of Hong Kong, or whether they represent a barrier to NGN migration. With these considerations in mind we recommend that OFTA should:

- Withdraw guidance on interconnection charging arrangements for fixed-to-fixed interconnection as soon as possible. This recommendation is independent of the pace at which the migration to NGNs occurs.
- Consider the case for revision of Section 36A of the Ordinance, when it is next reviewed, to allow the TA to determine interconnection charges on grounds of economic efficiency rather than simply based on costs.

- Consider issuing guidance on the way TDM-IP conversion costs are to be borne by operators in the event that the issue cannot be resolved by the industry or the industry does not act in the public interest.
- Forbear from intervening on an ex-ante basis to give service based operators access to NGNs and leave them to negotiate charging arrangements with potential host NGN operators.

## S5 Should Hong Kong change its policy on in-building access to promote next-generation access?

Next-generation access to high-speed broadband services is the subject of intense debate on appropriate policy and regulation across the developed world. In Hong Kong the main issues centre around in-building distribution systems (IBDS). In particular should Hong Kong require operators to share IBDS as governments and regulators do in other jurisdictions? We find that, with minor exceptions, the current policy and regulations work well. We therefore recommend that OFTA should:

- Continue to support the current policy which has led to effective tenant choice of broadband supplier for a high proportion of end users
- Enhance Hong Kong's voluntary registration scheme for fibre connected buildings so as to give building owners stronger incentives to allow in-building access to telecommunications operators
- Consider whether it is appropriate to change Section 14 of the Ordinance, so as to give operators the same access rights to buildings in single ownership as they currently enjoy for buildings in multiple ownership
- Ask the TSAC to consider whether standards are required at the U and V interfaces for effective sharing of IBDS for high-speed broadband

## S6 The long-term future of universal service policy in Hong Kong

Hong Kong currently operates a universal service policy in which universal service is restricted to narrowband voice, in which the universal service obligation is funded through an industry levy based on the number of E.164 numbers allocated, and in which the obligation to meet the universal service obligation is restricted to fixed operators. We find that, while such a policy has served Hong Kong well in the past and will continue to function effectively in the short term, there are strong and growing arguments for the Government to develop a universal broadband policy which will ensure affordable broadband for all residents in Hong Kong.

In the light of these developments we recommend to OFTA that it should:

- Continue with the existing universal service policy and procedures in the short term.
- Consider whether implementation of the existing universal service policy needs to be adapted in the short to medium term to deal with problems which arise in estimating net universal service costs and cost sharing contributions, following the migration to next-generation networks
- Recommend that the relevant policy bureaux of the Government undertake a study to consider whether there is a need for a universal broadband policy in Hong Kong. The study should consider:

- The objectives which a universal broadband policy might meet
- The social and economic case for implementing such a policy
- The extent to which commercial services offer affordable broadband
- The nature and extent of the gap between the requirements of affordable broadband and what commercial services can deliver
- The most efficient and cost-effective way to fill and to fund this gap
- The relationship between this universal broadband policy and the existing universal service policy.

## S7 Emergency call service (ECS) and NGNs

We find that current arrangements for emergency call service in Hong Kong do not meet international best practice. This requires that accurate caller location information is, wherever possible, provided automatically to the ECS centre when the call is made. Anecdotal information provided to the Consultants suggests that such information typically takes up to 30 minutes to provide in Hong Kong after it has been specifically requested. This level of delay may well be critical in emergency situations where rapid response is required and where either the caller is unable to provide accurate location information, or the information provided is unreliable.

Recommendations on how to deal with this issue are outside the scope of our study, which focuses on those issues which arise as operators move from traditional to next-generation networks. But we believe it is an important issue for the Hong Kong police to consider when it reviews emergency call service arrangements in 2012.

Moving to NGNs raises issues of how to ensure that emergency calls reach the ECS centres in a reliable way and of which operators should connect directly to ECS centres.

We recommend that OFTA should:

- Provide the analysis in this report to the Hong Kong police force as an input to its study
- Reiterate that NGN operators are obliged to provide free ECS to the public
- Ensure that each operator demonstrates to the relevant authorities that its NGN will deliver emergency calls reliably and immediately across both its network and its network gateways. This might be achieved by providing sufficient capacity or through standardised call prioritisation mechanisms
- Ask the TSAC to consider the development of standards to enable such prioritisation, both in terms of NGN signalling standards for Hong Kong and standards for the reservation of capacity for emergency calls
- Work with the police and other relevant authorities to designate at least one operator as a transit operator of last resort which is interconnected with the three ECS centres
- Subject to the outcomes of the Police review and the capacity of the ECS equipment in each area, work with the police and other relevant authorities to allow operators who wish to interconnect directly with the ECS centres to do so, provided they meet the same minimum requirements as are met by the transit operator of last resort.

## S8 Network security and NGNs

The move to NGNs increases security threats to the networks in Hong Kong. OFTA has already done significant work to ensure that networks in Hong Kong are secure against theft, malicious attack, accident and natural disasters – for example through the publication of its security guidelines, through its initiatives on consumer education, and through its work in running a 24/7 emergency response team. But there are, as yet, no minimum standards which all networks should meet to ensure that the weakest link in Hong Kong's network of networks is sufficiently secure. We therefore recommend that OFTA should:

- Ask the industry to establish:
  - Minimum security standards which should apply to all operators in Hong Kong and
  - A mechanism for ensuring compliance with these standards.
- Ensure that the arrangements proposed by the industry meet the public interest.

## S9 Numbering, naming and addressing and NGNs

OFTA needs to continue to:

- Monitor its E.164 numbering plan for exhaustion
- Consider how best to deal with the demand put upon this numbering plan by machine-to-machine services.

But we can find no specific numbering, naming and addressing issues which arise as a result of the migration to NGNs. We therefore make no recommendations.

## S10 Consumer protection

We conclude that market mechanisms are the best way to deal with most issues of consumer protection which arise during the migration to NGNs. But we also believe that OFTA should now consider whether there is a requirement to impose obligations on operators to protect consumers if and when they retire their copper access networks and replace them with fibre. Such obligations might include:

- A minimum service set to be offered over fibre at a maximum price
- A requirement for standby power supply to terminals and network equipment on customer premises.

We therefore recommend that OFTA should consider, in discussion with the industry, and in particular with PCCW, whether consumer safeguards are required now for the retirement of the copper access network.

## S11 Net neutrality

The move to next-generation networks raises fresh concerns about whether OFTA should provide guidance to the industry on access to legitimate Internet content and services, degradation of service, and/or price discrimination by NGN operators. We conclude that OFTA should forbear from any direct regulation but should instead:

- Monitor the market to ensure that operators do not block access to legal applications, content and service on the public Internet. This prohibition does not apply to NGNs, provided that end-users have open access to services offered over the public Internet
- Review the traffic management policies of the operators to see that they are both sufficiently specific and understandable for the average consumer.
- Require the operators to publish their traffic management policies in a manner which is suitable to consumers. There may also be a case for making more detailed traffic management policies available to ISPs[1]
- Ensure that the best efforts Internet continues to function effectively alongside NGNs. In particular it is important, when operators run their NGN and Internet access services on the same infrastructure, that prioritisation of NGN traffic does not substantially degrade the quality of the public Internet.

## S12 Spectrum requirements for NGNs

Our research suggests that Hong Kong lags other developed countries in the supply of sub-1GHz spectrum for mobile broadband. We also note stakeholder arguments that inappropriate conditions are applied to the use of spectrum between 4 and 18 GHz for fixed links which could substantially raise the cost of mobile broadband roll out. Given these findings, we recommend that OFTA should:

- Do all it can, in its negotiations on coordination of spectrum use with mainland China, to accelerate release of the UHF digital dividend spectrum.
- Ask the RSAC to review its policy on the allocation of spectrum for fixed links, given the future importance of mobile broadband for economic and social development in Hong Kong and the desirability of taking account of economic as well as technical factors in setting the rules.

[1] We note that OFTA has now implemented the first part of this recommendation through the publication of guidelines on fair usage policy in November 2011. We suggest that OFTA keeps these guidelines under review in the light of international developments. For example the EU's regulators have, through BEREC, recently launched a consultation on traffic management policies. See http://erg.ec.europa.eu/doc/berec/consultation_draft_guidelines.pdf

# 1 The purpose and structure of the report

## 1.1 Purpose

In this report we:

- Identify how rollout of next generation networks (NGNs) might impact the development of telecommunications in Hong Kong
- Identify developments where action by OFTA might be required to:
  - Ensure efficient migration from traditional[2] networks to NGNs
  - Provide competition safeguards in an NGN world
  - Ensure consumers are adequately protected during and after the migration to NGNs
- Analyse where intervention by OFTA might be required to ensure that these developments are in the public interest
- Identify long-term public interest issues which arise as a result of the move to NGNs and high-speed broadband and which might require changes in government policy
- Set out specific recommendations to OFTA on what it should do and, where appropriate, the criteria that should guide its actions.

The report draws on six main sources in its analysis:

- The interviews held with OFTA during our kick-off visit
- The papers published by the RAAC and its NGN Working Group (NGNWG)
- Country case studies. These are documented in Annexes A to F[3]. They look at NGN developments and how NGNs are regulated in Australia, Japan, Korea, Singapore, the UK and the US
- Detailed analysis of global technical developments in the areas of standards and interoperability, calls to the emergency services, network security, and numbering, naming and addressing. These are set out in Annexes G to J
- Interviews with key stakeholders in Hong Kong as listed in Figure 1-1
- Feedback from OFTA staff on a working paper which has analysed key issues.

We use the term NGN to refer to both the core networks and next generation high speed broadband access (NGA). Given the high level of competition in the supply of next generation ***access*** (NGA) in Hong Kong, we focus our analysis on ***core*** NGNs. But we also raise a number of issues related to NGA, especially in Chapter 4.

[2] For example, circuit switched and ATM networks. These are also often referred to as "legacy networks".

[3] The annexes are provided in a separate volume

Figure 1-1: The stakeholders interviewed

| Stakeholder | Stakeholder |
|---|---|
| China Mobile HK | HK Police Force |
| CSL | Hutchison |
| ETS Society | New World Telecommunications |
| HK Broadband Network | PCCW |
| HK Cable TV | SmarTone |
| HK Internet Exchange | Telstra International |
| HK Fire Services Department | Wharf T&T |

## 1.2 Structure

Chapter 2 considers the way in which NGNs are being deployed, both in Hong Kong and in the case study countries, the drivers for that deployment, and the relationship between NGNs and the public Internet. It then looks at the implications of these developments for the study.

Chapter 3 considers issues relating to the interconnection of NGNs, both with other NGNs and with other networks. In particular it covers:

- The public interest case for regulating NGN interconnect
- Interoperability between NGNs, including quality of service and interconnection architectures
- Interconnection charging and NGNs
- Access by service-based operators.

Chapter 4 examines in-building access issues which arise as a result of a move to next-generation access, while Chapter 5 considers the long-term future of the universal service policy, Chapter 6 emergency call services, and Chapter 7 network security issues in an NGN world.

Finally Chapter 8 deals with a range of other issues which arise with the migration to NGNs. These include:

- Numbering, naming and addressing
- Consumer safeguards during the migration to NGNs
- The impact of NGNs on requirements for spectrum
- Net neutrality and NGNs

We have summarised our study recommendations to OFTA at the conclusion of each relevant chapter.

# 2 The nature and role of NGNs

## 2.1 The drivers for NGN deployment

NGNs are being rolled out across the developed world and it is important to understand the market context in which they are being implemented before we can consider possible regulatory implications. The move to NGNs is driven by:

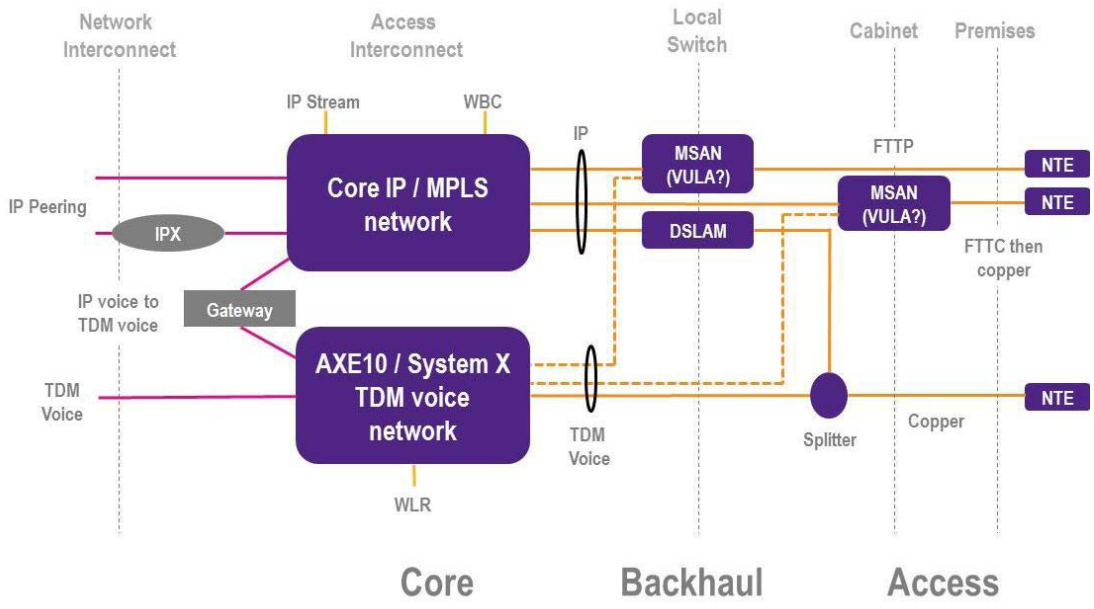
- The need to deploy a suitable network infrastructure to support the rapidly growing use of high-speed broadband access. Much of the traffic generated by next generation access (NGA) is carried over the public Internet. But some require managed services if end-user demands are to be met
- The growing cost of maintaining traditional circuit switched networks, which vendors no longer support and for which the maintenance staff required are increasingly hard to find
- The desire to reduce costs by combining logically separate traditional networks, such as the public-switched telephone network (PSTN), frame relay and asynchronous transfer mode (ATM) networks, onto a single infrastructure with common operational and customer support systems
- An expectation that NGNs, which enable new services to be developed more quickly and cheaply than on traditional networks, will generate additional revenues for the operators.

## 2.2 The implementation of NGNs

The way in which operators have implemented core NGNs to date varies considerably – both between the case study countries and between operators within Hong Kong. For example:

- The transmission infrastructure of the public Internet and an NGN may be combined in a single multi-protocol label switching (MPLS) Internet Protocol (IP) based network or kept separate. Figure 2-1 shows our understanding of how BT, in the UK, has implemented its NGN using the former approach. In Hong Kong PCCW keeps its NGN and best efforts IP networks separate.
- The extent to which time-division multiplex (TDM) or IP interconnection is used for interconnection between networks varies. In some countries, such as Australia, all interconnection continues for now to use TDM gateways, even when two NGNs interconnect. In other countries, including Hong Kong, IP interconnection is sometimes used between NGNs
- The extent to which an NGN is simply used to carry voice and the extent to which it operates as a multi-service network. Currently PCCW uses its NGN for voice only, while Hong Kong Broadband Network operates a multi-service NGN
- Whether operators which run both fixed and mobile access networks carry the traffic on the same core NGN or use separate networks.

Figure 2-1: The use of a common IP network for NGN and public Internet services in the network of BT in the UK




In Hong Kong the move to NGNs is underway, but the operators tell us that the pace of the migration is uncertain and that it will be many years before migration is complete. At the moment:

- PCCW is in the process of migrating its circuit switched voice network to an IP multimedia subsystem (IMS)-based NGN. PCCW is around halfway through the migration and plans to complete the process by 2015. It may then start to use its NGN, currently deployed only for voice, for other services
- In contrast Hong Kong Broadband Network offers fixed telecommunication services over a full, multi-service, NGN
- Other fixed operators are at varying (early) stages in the rollout of NGNs
- The mobile operators mostly carry their voice traffic on TDM networks, although some, such as CSL, now use an IP-only core network. For most of them the trigger to move to NGNs is likely to be the deployment of voice over LTE services in a few years' time.

It is clear from the case studies that the original concept of NGNs, first developed at the end of the 1990s, and summarised in Box 2-1, has not been fully implemented. In particular the concept has failed to reach its full potential in two important respects:

- The scope for cost reduction which results from combining traditional networks into a single multi-service platform is much less than originally envisaged. For example BT announced plans to roll out an NGN across the UK in 2005. These plans would deliver a complete replacement for up to 17 networks by 2011 and save £1 billion per year in operating costs. BT is reluctant to talk about the extent to which it has achieved its plan. But most observers believe the project has failed, largely because of the technical difficulties of replacing so many networks and services.
- There is little evidence of the development of new NGN services and additional service revenues for the telecommunications operators. Many of the new services which have materialised are

carried on the public Internet[4], and the revenues which they generate flow to players other than the telecoms operators.

In practice many operators have simply implemented core NGNs as a replacement (or to provide additional capacity) for their traditional circuit switched networks.

**Box 2-1: The original NGN concept**

A closed network with vertical integration between transport and services

Interconnection via gateways which carry out security, charging and signalling functions

Services delivered to customers by each NGN operator and by third parties using a controlled API

Large-scale emulation of traditional services and a range of new services

A layered approach with access, transport, service control and application layers – allowing integration of fixed and mobile networks so as to enable a common transport network and common communications services

## 2.3 NGNs versus the public Internet

The concept of NGNs was developed in the late 1990s, largely by traditional telecommunications operators. One of its perceived advantages was its ability to enable the NGN operator to deliver a wide range of new, revenue generating, services from within a walled garden created by its gateways to other networks. The Internet was seen as a complement to NGNs.

But over the last decade the Internet has, in practice, delivered a wide range of services which have substituted for many of these expected walled garden services from the telecoms operators. Figure 2-2 lists the different characteristics of NGNs and the public Internet and helps explain why this has happened. The public Internet, unlike NGNs:

- Locates intelligence at the network edge in the servers and clients of end-users, and provides an open transport network to link them together
- Allows the end-users who provide services over the Internet to “innovate without permission”. This has led to a high level of innovation
- Allows service providers to scale up successful services rapidly on a global basis.

[4] Such as user generated content services, photo sharing, email, and file back-up services

Figure 2-2: NGNs versus the public Internet

| Factor | NGN | Public Internet |
|---|---|---|
| IP based? | Yes | Yes |
| Interconnection | Closed via gateways for security, quality of service and charging purposes | Open |
| Intelligence | Centralised and controlled by the NGN operator | At the network edge and implemented by end-users |
| Innovation | By NGN operators and third parties over controlled APIs | By users of the network edge – innovation without permission |
| Ability to roll out services | Local | Global |
| Management of quality of service | Through central control of resource allocation for intra-NGN services<br>Competing solutions for inter-NGN services with limited implementation to date | Best efforts service<br>Build additional capacity to avoid congestion<br>Traffic management at network edge |

The net result is that the Internet has grown far more strongly than NGNs over the past 10 years and far more strongly than NGN planners and strategists have anticipated. At the same time the vendors who supply Internet equipment, such as Cisco and Juniper, have flourished, while the traditional telecommunications suppliers have consolidated e.g. Alcatel and Lucent, Nokia and Siemens.

Figure 2-3 illustrates how the public Internet has come to dominate telecommunications over the last decade. It compares the traffic carried over the Internet with voice traffic in the US for the period 2000 to 2010, with a projection to 2015.

Figure 2-3: Internet versus voice traffic in the US

| Year | Traffic in PB per month | | |
|---|---|---|---|
| | Circuit switched voice | Internet | Voice over IP (VoIP) |
| 2000 | 66 | 28 | Negligible |
| 2005 | 48 | 669 | 2 |
| 2010 | 36 | 5723 | 21 |
| 2015 | 26 | 19415 | 23 |

*Source: Google*

It is possible that we will see the emergence of a managed layer within the public Internet which may further weaken the market position of NGNs. But there is, as yet, little sign of this and, given the global nature of the public Internet, there are major challenges to overcome if this layer is to be implemented. A more likely development is that NGNs will deliver services which require guaranteed quality of service and that the public Internet will continue to deliver best efforts services.

## 2.4 Implications for the study

The analysis set out in this chapter has a number of implications for the study:

- We need to look at how NGNs fit within IP-based telecommunications services as a whole, rather than just at the NGNs
- The future role of NGNs versus the public Internet is uncertain. This increases the probability of (damaging) unforeseen consequences from the early introduction of any ex-ante regulation for NGNs
- Uncertainty over the pace at which the migration to NGNs proceeds also means that it is important for market players to determine the pace of change. This, in turn, means that OFTA should not impose regulatory changes before they are shown to be clearly warranted.
- The relatively slow pace of migration to NGNs means that we need to consider long-term issues, where legislative change might be required, as well as issues where the current legislative framework is sufficient.

# 3 Interconnecting core NGNs

## 3.1 The public interest case for regulating interconnection between IP networks

In considering the case for regulating interconnection arrangements between IP networks we need to distinguish interconnection between the networks of the public Internet and next-generation networks offering managed services.

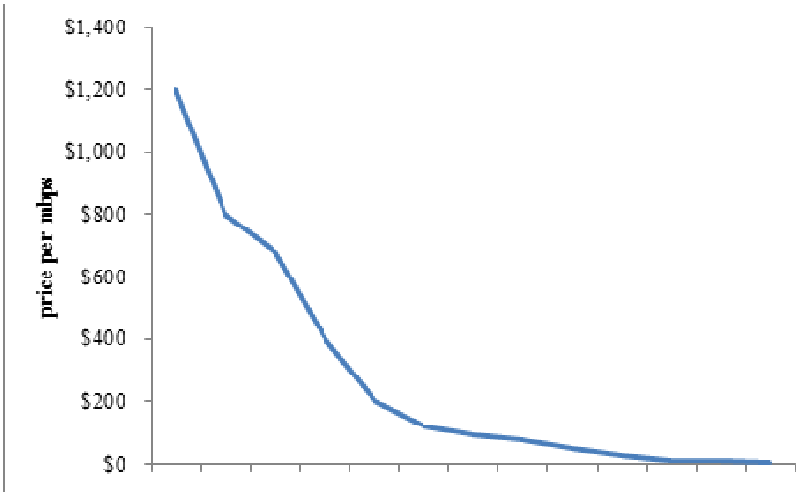
### Regulating interconnection between the networks of the Internet

The case for regulating the networks of the public Internet on an ex-ante basis is weak given that:

- Market mechanisms appear to be working well[5]. In the US for example no operator has a market share of more than 10% and Internet transit prices, which are a key component of the costs of the public Internet, have fallen rapidly. Figure 3-1 illustrates
- The market is dynamic, and the probability of damaging, unintended, consequences from ex-ante regulation is high
- There is no demand for such regulation from stakeholders in Hong Kong
- The Internet functions on a global basis. Any attempt by OFTA on its own to deal with potential market failures is likely to be ineffective.

We discuss broader issues relating to the possible regulation of the Internet in Hong Kong in the net neutrality section of this report.

**Figure 3-1: Internet transit charges in the US 1998 to 2010**




*Source: drPeering*[6]

[5] See for example *Overview of recent changes in the IP interconnect ecosystem*, Analysys Mason, May 2011

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

## Regulating interconnection between NGNs

There is a public interest case for regulating interconnection between NGNs. This is as follows:

- There is a public interest case for requiring interconnection between circuit switched networks for any-to-any connectivity so as to ensure the delivery of end-to-end voice services. Such a requirement is included in the licences of all Hong Kong operators as well as in the Code of Practice relating to the Use of Numbers and Codes in the Hong Kong Numbering Plan.[7][8] Equivalent conditions are imposed on operators throughout the world.
- These obligations rest on the argument that economic welfare is maximised if networks interconnect so as to allow the subscribers on one network to call subscribers on all other networks. Any-to-any connectivity is clearly desirable for some services to maximise economic welfare. For basic voice services, an any-to-any obligation is clearly required for the avoidance of doubt. It is often mandated through regulation. It might also be provided by the market, but there are incentives for larger networks not to provide it for competitive reasons. If this were to happen for voice services, the loss of welfare would be substantial, and the risk is too great to leave any-to-any connectivity for voice services to the market.
- There is no reason why any-to-any requirements should be withdrawn when voice services are carried on NGNs rather than circuit switched networks. The change of network technology does not change the case for any-to-any connectivity.

This does not mean that all services offered over NGNs should be regulated. For many there are good opportunities to negotiate commercially for interconnection arrangements. The case for regulating on an ex-ante basis the interconnection between an access network provider with directly connected customers and an upstream content or service provider so as to ensure access to IPTV or other walled garden services is poor. Market mechanisms appear to be feasible in that an NGN operator has a range of options available to it. For example it might:

- Interconnect directly with (say) Google or Facebook at the Hong Kong Internet Exchange (HKIX)
- Contract with content providers to supply the service from a server directly connected to its NGN
- Use a content delivery network to improve and/or manage quality of service.

In these circumstances ex-ante regulation could damage economic welfare – for example by constraining innovation.

Overall our analysis suggests that there is a public interest case for imposing any-to-any connectivity requirements on NGNs for voice services. But what other, non-voice, services running on NGNs might require any-to-any connectivity? We propose that OFTA uses the following tests to consider whether it is in the public interest to impose an any-to-any obligation for access to a telecommunications service:

- *Does the imposition of any-to-any connectivity requirements substantially increase economic welfare?* In the case of voice services the case is clear. Requiring any-to-any connectivity between networks in Hong Kong increases the calling opportunities for subscribers several-fold, when compared with the situation in which networks are not interconnected. In contrast the

[7] http://www.ofta.gov.hk/en/code/cop20100929.pdf

[8] OFTA has the power to require holders of fixed, mobile and unified carrier licences to implement any-to-any connectivity for all types of telecommunications services. So far it has chosen to implement this requirement only for voice services.

increase in economic welfare is likely to be insignificant in the case of end-user-to-server services like IPTV

- *Does the imposition of any-to-any connectivity requirements reduce potential competition problems?* There are theoretical grounds for believing that removing the any-to-any requirement could lead to market failure for some services. When one operator has close to 50% of a particular market, while its rivals are fragmented, it has incentives to refuse to interconnect with rivals. Customers are then attracted to the larger network which grows in size, making it even more attractive. This can lead, in the absence of regulatory intervention, to a monopoly. There are precedents from early in the 20th century. At that time in the US the Bell Operating Companies refused to interconnect with their rivals. This lead to monopolisation of the America telephone system
- *Does the imposition of any-to-any connectivity requirements lead to only a small increase in industry costs?* Such a requirement might raise the cost of providing points of interconnect. But the use of transit arrangements by small operators could mitigate any increases
- *Does the imposition of any-to-any connectivity requirements leave incentives for innovation largely unchanged?* Imposing the any-to-any requirement could mean that innovative new services developed by one operator are available to all. This undesirable situation could arise for many end-user-to-server services.

It is important to note that:

- The tests are designed to apply only to interconnection between telecommunications networks. For example we do not intend that they should apply to issues such as access to content, where there may, or may not, be public interest grounds for universal access. Such issues would be subject to other tests which are outside the scope of our study
- The tests are based on a review of relevant literature and on our own economic analysis. As far as we are aware, they have not yet been considered elsewhere in the world in this comprehensive form.
- The tests are objective and clear. But the detailed way in which the tests are formulated will depend on the service to which they are applied. Specifying them with greater precision now, without taking into account the nature of the different types of services, could lead to tests which are too narrow in scope.

Given these considerations there would be a need to conduct regular reviews and make appropriate modifications to the tests as the market evolves. But setting out the tests at a high-level now helps give market participants certainty about how regulation of interconnection involving NGNs might develop.

We note that:

- Very few services, other than voice, appear to pass these tests right now
- Real-time video is a possible future candidate, but one which is too embryonic to be considered yet
- The tests are more likely to lead to any-to-any requirements for ***end-user-to-end-user*** services than for ***end-user-to-server*** services.

Tele-health services are an example of end-user-to-server services for which universal access could bring significant public benefits. But, if significant public benefits arise from such services, any-to-any

connectivity is unlikely to be required, since each NGN operator would wish to make this service accessible to its customers. Furthermore the absence of an any-to-any requirement may enhance competition and innovation in tele-health applications as each NGN uses these services to attract new subscribers to its network. In this case imposing the any-to-any requirement may reduce economic welfare.

## 3.2 Interoperability between NGNs

### The need for NGN standards

The Internet Engineering Task Force (IETF), the European Telecommunications Standards Institute (ETSI), and the International Telecommunication Union (ITU) have now developed a full suite of stable standards for NGN network and customer interfaces. These offer a wide range of options and it is important that the operators in Hong Kong agree on which subset to implement in order to ensure full interoperability. It is not yet clear that a market-driven consensus on an agreed set of options will emerge.

Given this situation we consider six key questions in this section:

- What is the current status of NGN standards for interconnection?
- How are NGN standards being developed, and what role should regulators play in this process?
- What institutional arrangements are required to make the appropriate choice of standards profiles for Hong Kong?
- Where are standardised interfaces required?
- Should OFTA mandate minimum quality of service for any NGN services?
- What architecture should Hong Kong's operators use for the interconnection of NGNs to enable interoperability and guaranteed quality of service?

We consider each of these questions in turn below.

### The current status of NGN standards for interconnection

There are currently four main sets of standards for interconnection which involves NGNs. The functionality and status of these standards are tabulated in Figure 3-2. We note that:

- NGN standards for network interfaces exist for a number of services, developed by the various global and regional bodies, notably the ITU, ETSI's Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN) group and the 3rd Generation Partnership Project (3GPP).
- In practice, there are very few NGN standards currently in use for the interconnection of significant networks.
- There are two exceptions:

- Session initiation protocol (SIP) with encapsulated Integrated Services Digital Network user part or ISUP (SIP-I), because of the need to maintain interoperability between PSTN and NGN based voice services
- The use of IP exchange (IPX), and its predecessor general packet radio service (GPRS) roaming exchange (GRX), to support roaming and interconnectivity between 3G mobile networks, predominantly for data services.

- The IMS suite of standards, which offers a prescriptive, top-down, integrated set of standards for a wide range of NGN services has, so far, failed to gain widespread acceptance
- There are now calls, within the European Union (EU), for operators to proceed with NGN interconnection using the GSM Association (GSMA)'s IPX implementation, perhaps once it has been better aligned with the quality classes of the i3Forum. This implementation offers a more generic and less prescriptive approach to IP services interconnection than the IMS approach.

**Figure 3-2: The main standards sets for NGN interconnect**

| Standard set | Developed and supported by | Function | Interconnection status |
|---|---|---|---|
| SIP | IETF<br>ITU, ETSI, 3GPP and some national agencies | A basic protocol to provide VoIP over an IP network at the same standards as (or better than) circuit switched telephony | In use on a bilateral basis by VoIP providers but not widely adopted by mainstream telcos as QoS enabled NNIs are still being developed |
| SIP-I | ITU, ETSI and national agencies | Ensures compliance between SIP - based IP voice networks and traditional TDM networks which use ISUP signalling | Widespread |
| IMS | 3GPP | A complete set of standards for multi-media services, including voice, IPTV and corporate services | Not in significant use, though network implementations are growing |
| IPX | GSMA | An architecture for IP interconnection which enables end-to-end services with defined quality levels | Growing between 3G networks, as an evolution from GRX |

## The procedure for developing NGN standards

Global standards for network interconnection are developed with inputs from vendors and service providers with differing views on both technical and operational issues. Consequently they almost invariably contain multiple options to allow for the differing ways that vendors and service providers design and operate their relevant systems and networks. As such, no standard is capable of being implemented within either an individual network or between two or more networks without specific decisions being made as to which particular options to choose.

In an individual network, such choices will be driven both by the design decisions of the vendor chosen to supply the relevant system elements, and by the commercial and operational priorities of the service provider themselves, some of which may be driven by traditional service perspectives and/or regulatory obligations. These will obviously vary from place to place, and consequently different countries and regions may see benefits in developing specific implementation profiles to suit local

market and regulatory conditions, as this will aid the process of negotiating and operating inter-network interconnects, end-to-end service interoperability between networks and, indeed, the ability for end-users to seamlessly switch from one network to another. This is the case with ITU SIP-I for example. ETSI has developed and published its own pan-European SIP-I documents and, in the UK, the NICC has derived a country specific sub-set, described in ND1017, ND1610, ND1612 and elsewhere[9].

This global/regional/national hierarchy of standards documentation is typical and does not denote any problem of incompatibility or lack of harmonisation between the differing levels. Rather, it reflects the choices amongst the various options that have been taken in the light of prevailing "local" conditions, both for the ISUP service set that is translated or "encapsulated" into SIP-I and the configuration of the IP bearer services, gateways etc. that carry it.

For cost effective standards development it is appropriate to not just ***adopt*** existing global standards, but also to ***adapt*** them to reflect local conditions, rather than spend an excessive amount of time and resource in duplicating work done adequately elsewhere. Reliance on the top level of global standard (such as the ITU SIP-I base standard) alone is likely to result in protracted negotiations over interconnection between networks with a possible need for regulatory intervention to resolve, and/or a possible loss of beneficial service attributes.

Given this analysis, it makes sense for regulators to allow industry to make such decisions, in the light of their own requirements and strategies, intervening only if necessary to ensure preservation of essential service attributes that are recognised as necessary to support mandatory regulatory obligations. For example a regulator would want to ensure that any local implementation of SIP-I enables support for priority voice calling across interconnects to ensure emergency service access is guaranteed.

## Institutional arrangements in Hong Kong

As discussed above, international standards making is a complex process involving a wide range of international, regional and national entities with overlapping jurisdictions and contradictory or competing goals and visions. This complexity may lead to situations in which it is difficult to reach consensus on how best to connect networks even when there is agreement that interconnection is essential. Consequently, there is a need for a national standards forum that has a formal role in developing consensus positions on which standards should be adopted and how they should be implemented. In the UK for example this role is fulfilled by the NICC – a standing committee, with membership drawn mainly from UK telecommunications engineers and established by the professional body the Institute of Engineering and Technology. Ofcom is an observer on this committee and, at the same time, seeks its formal advice from time to time.

Hong Kong already has the basis for such a standards forum in the form of its Telecommunications Standards Advisory Committee (TSAC). Established by OFTA, this body draws on the resources of all the key stakeholders in its membership. We suggest that:

- The TSAC takes responsibility for choosing the appropriate standards profiles for Hong Kong so as to ensure interoperability between NGNs

[9] See http://www.niccstandards.org.uk/publications/pstn.cfm

- The TSAC should task a working group to carry out this work. It is important that the industry takes ownership of the output. We therefore suggest that both the chair of the working group and its members are chosen with this objective in mind, with OFTA participating largely to facilitate progress and to observe
- The working group should:
  - Focus on using the work of the ITU, IETF, Broadband Forum, and GSMA
  - Reach agreement on which options are relevant to the national situation
  - Focus initially on the finalisation and testing of the standardised implementation of SIP-I and the development of an effective SIP network to network interface. This provides a secure fall-back position for NGN voice interconnection signalling – both for commercial services and for prioritisation of calls to the emergency services centres.
  - Develop clearly documented positions on how standards should be implemented
  - Make these documents publicly available.
- OFTA should use the working group to seek advice on standards related issues, including which specific issues to incorporate into its work programme to meet regulatory needs and priorities.

## Where are standardised interfaces required?

As the NGN Working Group recognises in its paper on NGN standardisation and interoperability:

- There is a clear need to implement standardised network to network interfaces (NNIs) between NGNs
- The primary focus should be on providing interoperability for voice services – both between pairs of NGNs and between an NGN and a PSTN.

Elsewhere in the world there is also activity underway to standardise user to network interfaces (UNIs) for NGNs. Here there is often a requirement on dominant operators, and those who supply access networks using public funds, to do so on an ***open access*** basis. This might involve:

- The access network operator offering active line access products which competing operators can use to reach customers from a point of presence within the access network. This requires standardised interfaces at the access node and at the U-interface to the customer equipment. The UK is an example of such an approach
- The operator which upgrades the in-building wiring of a high-rise building offering open access over this wiring to other operators who locate an access node in the building's basement. The regulator in France has developed such requirements.

We consider the need for such standardised interfaces in Hong Kong in Chapter 4.

## Standards for quality of service

There is also a need to agree on quality classes which can be used by interconnected NGNs to ensure end-to-end quality for key services. These quality classes might define transport services rather than end-user services. To quote from a recent report to the European Commission[10]:

> *The mapping of IP traffic in different classes of quality is an important first step for enabling the differentiation and management of quality also between IP networks. However, this feature alone is not able to guarantee an absolute end-to-end quality (from an end-user to another end-user, or from a service centre to an end-user). In fact, the interconnection is not aware of the service (e.g. SIP sessions) transported by IP packets, so it's not possible to give any guarantee on the level of quality associated with each single service. It is reasonable to say that the diversification of IP traffic at transport level in classes of quality enables a relative quality of IP services/applications, which means that the quality could be associated to an IP*

This report concluded that there were two standards groups which have defined "complete and clear" quality classes:

- The GSMA with its IPX specifications. As shown in Figure 3-3 the GSMA has defined four quality classes for transport services and is discussing a signalling class. The definitions are mobile oriented
- The i3Forum[11] which has defined two quality classes for transport services (voice and other) and two signalling classes.

The GSMA and i3Forum are now working together to align their models[12].

[10] See in particular Working Group 2 report on the Technical Framework for Digital Delivery, 13 July 2011, p20-27 at http://ec.europa.eu/information_society/newsroom/cf/itemdetail.cfm?item_id=7211

[11] A global group of 37 telecommunications companies which is "*developing collaborative recommendations for industry-wide transition of voice and related services to IP* "

[12] More details on these two sets of quality classes are available from the European Commission website. See WG2: *Technical Framework for Digital Delivery – Open Access, Interoperability and Connectivity*
http://ec.europa.eu/information_society/newsroom/cf/item-detail-dae.cfm?item_id=7211

Figure 3-3: The four quality classes of IPX

| Class | Description |
|---|---|
| Conversational | Typically in this class are placed services that needs tight delay and jitter values |
| Streaming | Normally expectations are not as tight as in conversational class as UE normally buffering |
| Interactive | Corporate sensitive traffic which needs reserved bandwidth to guarantee service requirements |
| Background | Typically the packet size in background class is pretty big, and traffic is not that much affected by delay and jitter, as long as packets are not dropped in network to avoid retransmissions and extra load to network. |

## The case for regulating quality of service

Few of the case study countries impose regulatory requirements for minimum quality of service on NGN based services. In Korea there is a requirement that the quality of service for NGN voice is no worse than it is for TDM voice, while in the UK the regulator has stipulated that consumers should not suffer any detriment due to degraded voice call quality. Should OFTA do the same?

For many of the services which are carried over managed IP networks, the operators are best placed to decide on the appropriate quality of service to offer. They might do this on a unilateral basis for intra-NGN services, and on a bilateral or multilateral basis for services which involve interconnection between NGNs. But are there services for which OFTA might, in the public interest, impose a minimum quality of service?

There is an argument in favour of this position. For those services where an any-to-any obligation is appropriate and where best efforts IP transport may be inadequate, such as real-time voice, it may also be necessary to require minimum quality of service standards across the interconnected networks in order to preserve consumer welfare. For the moment this argument applies only to voice services. Other services may become candidates in future – provided they pass the tests of Section 3.1 and there are quality of service issues which market mechanisms will not resolve.

Even though there is a public interest case for OFTA to impose minimum quality of service requirements for real-time services requiring any-to-any connectivity, it is preferable that industry players should determine the quality of service standards. Moreover there are good theoretical arguments which suggest that market players will have strong incentives to maintain quality of service for NGN voice at levels close to the current quality standards for circuit switched voice. As networks transition to NGN, circuit switched quality standards continue to provide a baseline for voice services. The market in Hong Kong is sufficiently competitive that any operator who fails to provide the baseline level of quality demanded by consumers will tend to lose customers to other operators that do meet this quality standard. It is therefore not surprising that NGN working group members, mainly Hong Kong's operators, have expressed a preference for a quality of service offered to customers which is "*at least equivalent to their existing services using [traditional] networks*"[13]. They realise that if they fail

[13] See NGNWG Paper 3/2009

to match existing quality standards it will be difficult to persuade customers to switch to IP-based voice services.

The obvious way for market players to do this is to use appropriate existing international standards which are, or will be, implemented by equipment vendors. Just as quality of service for circuit switched voice was implemented when operators used equipment which meets technical standards established by ITU Recommendations[14], so minimum quality of service for end-to-end services over IP networks can be ensured by choosing an appropriate set of network interface standards for NGNs.

At the same time it would be difficult for OFTA to impose appropriate quality standards on the industry. It could require operators to maintain circuit switched quality for voice on NGNs, as the regulator in Korea has done. But it is unclear what any theoretical minimum quality of service should be, and it is too early for OFTA to pick a set of quality classes for managed IP services which is clearly superior to any other.

We conclude that:

- There is a theoretical case for OFTA imposing minimum quality of service on market players
- In practice market players have strong incentives to maintain quality of service, at least for voice. So OFTA does not need to impose any requirement here
- The operators should decide on quality classes as a way of guaranteeing end-to-end quality of service carried over NGNs where appropriate.

## NGN interconnection architectures

Traditionally, the choice of interconnection architectures has been driven by commercial factors more than by technology issues. Decisions on where communications providers have sought to establish interconnection with others have been based on where their respective network facilities are located, and what are the countervailing costs and revenues from interconnecting at particular physical locations.

Thus, if the costs of building (or buying) network connectivity to a particular point is outweighed by the commercial benefits (such as lower net out-payments or higher net in-payments) of interconnecting at that point, operators generally would favour doing so. Clearly, in assessing net commercial benefits, the operators also have to consider both the one-off costs of negotiation and the on-going costs of contractual and operational administration.

Consequently, where interconnection involves significant interconnection charges, bilateral interconnection between pairs of communications providers has been the norm. Where differentiated charges are available or mandated by regulation for connection at different points in a hierarchical network topology, such interconnection arrangements can become complex and involve multiple physical/logical points of connection.

The corollary is that, where interconnection charges are minimal or zero, there is often little appetite for either complex interconnection topologies or individually negotiated commercial agreements. This has meant that, for instance, most Internet peering[15] takes place at Internet exchanges or other

[14] We note that, as a result of such mechanisms, OFTA has never found it necessary to implement minimum quality of service standards for voice services in Hong Kong

[15] This need not be entirely symmetrical in practice, despite this being a common interpretation of the term.

neutral shared co-location facilities. These facilities are also commonly used for other forms of internet service connectivity such as:

- Access provider connection to Tier 1 carriers providing commercial Internet transit
- More specialised content delivery network (CDN) services, whether provided by Tier 1 players or niche players such as Akamai.

These arrangements, which use a common interconnection location, are often convenient for all parties concerned. From a public interest perspective they have the benefit of ensuring that all players in the market face similar costs to interconnect to others, with little opportunity for the exercise of market power to influence interconnection location to a particular player's commercial benefit.

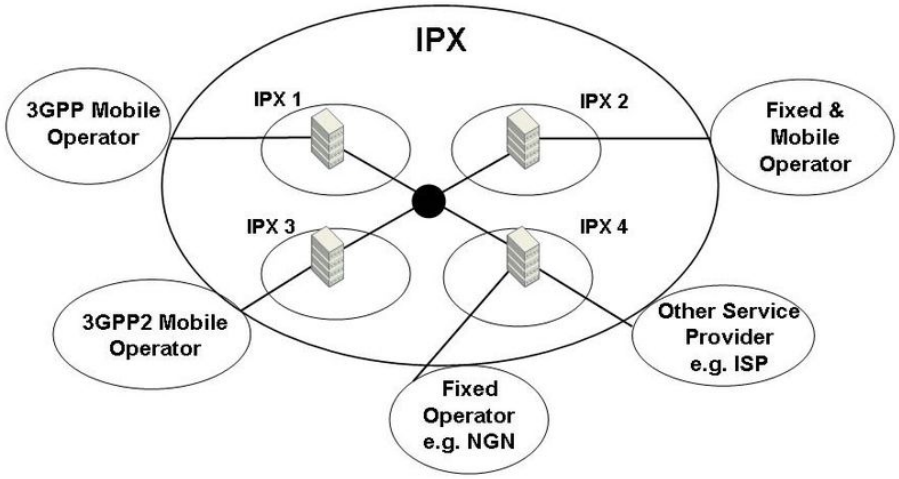
Both operational and commercial arrangements at such common locations can, however, maintain their traditional, one-to-one bilateral nature, with both parties using the common facility for convenience. Increasingly, however, Internet exchanges offer a one-to-many multilateral connectivity option, in which a service provider is able to connect to a high capacity local virtual local area network (VLAN) that then provides connectivity to a number of other service providers without the need for separate bilateral connections. The commercial and contractual arrangements for the exchange of traffic can also follow the one-to-many model, with the Internet exchange operator acting as a contractual intermediary. Or it can rely upon bilateral, but often standardised, agreements. The logical conclusion of this type of arrangement is the implementation of an IPX architecture at the exchange, with the local VLAN offering a range of QoS classes for differing traffic types covered by a single multilateral service contract. An example of this is the Amsterdam Internet Exchange Inter-IPX solution[16].

Overall there are three types of NGN interconnection architecture which are possible in Hong Kong:

- Direct bilateral interconnection between NGNs in a similar fashion to today's circuit switched interconnection. However if bill and keep charging arrangements are used for NGN interconnection in future, then this form of NGN interconnection may be less attractive to Hong Kong's operators than others but may still exist for convenience
- Use of a common location with bilateral arrangements for interconnect
- Use an IPX, in which networks interconnect at a common location, and in which both data packets for signalling and transported media are conveyed end-to-end using IPX specifications. In this option the IPX operator may act as a contractual intermediary or provide functionality to enable cost-effective bilateral interconnect. Figure 3-4 illustrates.

[16] See for example http://ams-ix.net/inter-ipx/.

Figure 3-4: High level IPX architecture




The advantages and disadvantages of the three types of NGN interconnection architectures are tabulated in Figure 3-5.

We suggest that the NGNWG should consider what mix of the three types of interconnection architectures is appropriate in Hong Kong. For examples market players may wish to retain traditional bilateral interconnection arrangements or move towards a single point of interconnect, using the second or third of the options of Figure 3-5.

OFTA has a role here, both as the chairman and facilitator in the NGNWG and, potentially, as the body which ultimately might consider how to proceed if it appears that one of the approaches is clearly in the public interest. For example, OFTA might establish guiding principles which create commercial incentives for its implementation.

Figure 3-5: The advantages of different types of NGN interconnect

| Type of interconnect | Advantages | Disadvantages |
|---|---|---|
| Direct bilateral between NGNs | Flexible technical and commercial arrangements<br>Potentially multi-site to provide resilience and security<br>Multi-level interconnection possible at various logical/physical points to match network economics and/or differentiated regulated prices | Cost of connectivity to other NGNs networks<br>Negotiation costs and contract administration overheads rise with number of interconnects |
| Internet exchange or "carrier hotel" based hybrid (bilateral only) | Maintains flexibility of bilateral technical and commercial arrangements<br>Common secure physical location<br>Easy access to multiple service providers | Still have multiple contracts with associated upfront and on-going costs<br>Not suited for "multi-level" interconnection with differentiated pricing |
| IPX – multilateral | Easy access to wide range of service providers<br>Common secure physical location<br>Common commercial framework with little or no cost sensitivity to scaling<br>Attracts new entrant providers, adding value to existing "tenants" | Not suited for "multi-level" interconnect<br>Potential lack of flexibility over commercial and technical arrangements |

## 3.3 Interconnection charging and NGNs

### Introduction

Should OFTA modify its interconnection charging guidance as market players move to NGNs? In this section we consider both the empirical evidence on what other regulators are doing and the theoretical arguments which underpin the current interconnection charging regime in Hong Kong.

### The position in the case study countries

The position taken by regulatory bodies in the case study countries on the best interconnection charging mechanisms for NGNs varies:

- In Korea the regulator has undertaken several studies but has yet to reach any conclusions
- In Australia the ACCC concluded that the current regime[17] may not be appropriate for NGN interconnect but has not yet formulated a way forward

[17] Calling party pays plus cost-oriented termination rates

- In the US the issue has yet to be given serious consideration, given the lack of NGN implementations, and the separate regulatory regimes for Internet-based services and traditional circuit switched based services[18]
- In the UK, the industry body NGNUK and the regulator Ofcom, both see merit in capacity-based charging, in which the originating party pays a periodic fee for busy hour capacity on the terminating network, rather than usage-based charging for NGN interconnect. In 2009 Ofcom[19] concluded that capacity-based charging was more likely to lead to efficient wholesale and retail pricing and reflects better the underlying cost structure of NGNs. But it was concerned about the difficulty of calculating regulated prices for cost-based charging and the danger of regulatory error.
- In a study for the European Commission in 2008, the consulting company WIK concluded that bill and keep offered the best option for IP interconnect[20]. Its arguments for reaching this conclusion are similar to those set out in Box 3-1. The European Commission then went some way towards implementing this conclusion when it recommended that mobile termination rates in the EU should move to a new costing standard which is now substantially reducing them.

The overall message from the case studies is that regulators see a need to move away from usage-based charging and cost-oriented termination rates. Hong Kong is already a long way from this position for fixed-to-mobile, mobile-to-fixed and mobile-to-mobile interconnect.

## Type I versus Type II interconnect

OFTA's interconnection charging principles[21] currently cover:

- Type I interconnect, in which operators exchange traffic
- Type II interconnect, in which one operator rents access from another.

We consider Type I interconnect here and Type II interconnect in Chapter 4 on in-building access. For Type I interconnect we need to consider:

- Charges for interconnection links and network conditioning, where the current principles require each operator to bear its own costs. We agree that these principles remain sound in an NGN world [22]
- Termination charges. Here the current principles require an originating operator to pay a cost-based termination charges for fixed-to-fixed interconnect
- Who should bear the cost of TDM to IP conversion during the migration to an all-NGN world.

We consider these last two points below.

[18] The US has so far maintained a strict distinction between enhanced services, which includes Internet based services, and basic telecommunications services in its regulatory legislation

[19] *Mobile call termination review*, Ofcom, May 2009

[20] *The future of IP interconnect –technology, economic and public policy aspects*, WIK, January 2008

[21] See NGNWG paper 4/2010 for example

[22] See NGNWG Paper 4/2010

## Termination charges

OFTA currently:

- Imposes an any-to-any connectivity obligation for voice services, although it has the power to impose this obligation for other services as well
- Imposes regulatory guidance in favour of a calling party's network paid model and cost-based termination charges for fixed-to-fixed voice interconnect
- Imposes no regulation on operators for mobile-to-mobile, fixed-to-mobile or mobile-to-fixed interconnect.

The net result of this regulation is that, while operators continue to pay cost-based call termination charges for fixed-to-fixed voice calls, they use a bill and keep regime for other types of voice calls which require interconnect. For these latter categories of calls:

- The terminating operator may seek to negotiate a call termination charge
- The originating operator knows that the terminating operator must terminate the calls under the any-to-any connectivity requirement
- This gives the originating operator a strong bargaining position in any negotiation
- The net result is that voice traffic is normally exchanged on a bill and keep basis.

The current guidance on fixed-to-fixed interconnection was issued a long time ago when market conditions were very different from those of today. It now looks increasingly out of place. We believe that there is a strong case for withdrawing it, while maintaining the any-to-any connectivity requirement on such interconnection. Such a move:

- Has worked well for fixed-to-mobile interconnection where OFTA's guidance on charging was withdrawn in April 2009
- Has the support of a substantial number of stakeholders in Hong Kong
- Brings fixed-to-fixed interconnection charging in line with other forms of voice interconnection charging in Hong Kong
- Avoids the problem of making cost allocations to estimate the cost of voice termination on a multi-service NGN. This is considerably more difficult than making cost allocations for a voice oriented PSTN.

It is likely that withdrawal of guidance on fixed-to-fixed interconnection charging would lead to an outcome of bill and keep. When compared with calling party's network paid charging arrangements, bill and keep, which requires operators to generate all their revenues through charges to their own customers, has a number of advantages:

- It is likely to be more economically efficient, given reasonable assumptions about call externalities. Box 3-1 sets out economic arguments as to why bill and keep is likely to be more efficient as an interconnection charging regime than a regime in which the calling party's network pays for voice calls

### Box 3-1: Economic efficiency arguments for bill and keep

A Calling Party Network Pays (CPNP) approach is justified using the cost causation principle. This requires that *"The party which causes the cost should bear the cost".*

Applying this principle we assume that, since the caller makes the call, the caller causes the cost and should bear the full cost of the call. This then leads to a CPNP system in which the originating network pays the terminating network a cost-based termination charge.

As competition has developed, and as interconnection between mobile and fixed networks and between competing mobile networks has become more important, economists have developed their theories about what level of termination charges maximise economic welfare and thinking has changed as set out below.

Both the calling (A) and called (B) parties to a call play a part in causing the cost of the call. The calling party A generates an initial cost by initiating the call but the called party B can minimise the cost by refusing the call (e.g. by looking at the CLI) and both A and B can terminate the call at any point in the conversation. Laffont and Tirole refer to this as the "receiver sovereignty" property of calls.

From this perspective the cost causation principle leads not to cost-based termination charges but to a system in which the A and B parties share the costs in some way.

Laffont and Tirole[23] conclude that, for calls between interconnected networks:

- There is an efficient equilibrium for sharing the end-to-end cost of calls between the calling and receiving parties
- This equilibrium is a function of the utility which the calling and receiving parties extract from the call. It is not a function of the costs incurred by the two networks.

Operators in the market implement such a principle when they offer freephone services. These recognise that, for some calls, it is the receiving party which derives the bulk of benefit. So the operator establishes a set of freephone numbers which, when called, involve the B party bearing the full cost of the call.

Economic welfare is maximised when the cost of each call is split in proportion to the benefit each party derives from the call. If the costs are not shared then the network operator who does not pay does not have the incentive to signal to his subscribers through retail prices the costs that they cause.

The split of benefits between the two parties varies considerably. In some cases the A party receives the bulk of benefits. But in other cases (for example a builder who relies on his mobile phone to receive calls asking him for quotations) the bulk of the benefits flows to the B party.

It is not practical to charge so as to divide costs between A and B in line with benefits received for each individual call. But it is clear that a bill and keep system, in which the cost of the calls is split evenly between the two networks[24], comes closer to meeting this rule than existing arrangements, in which the calling network bears 100% of the cost for all calls.

- It reduces the transaction costs of interconnection billing. The reconciliation of interconnection bills between operators and the likelihood of regular disputes generates costs which are largely eliminated under a bill and keep regime
- It substantially reduces the transaction costs of negotiating and/or determining termination charges. There are significant challenges in estimating termination costs for a multi-service NGN given that the fixed and common costs are a high proportion of total network costs, and that there

[23] *On the Receiver Party Pays Principle*, D S Jeon, J J Laffont and J Tirole, March 2001

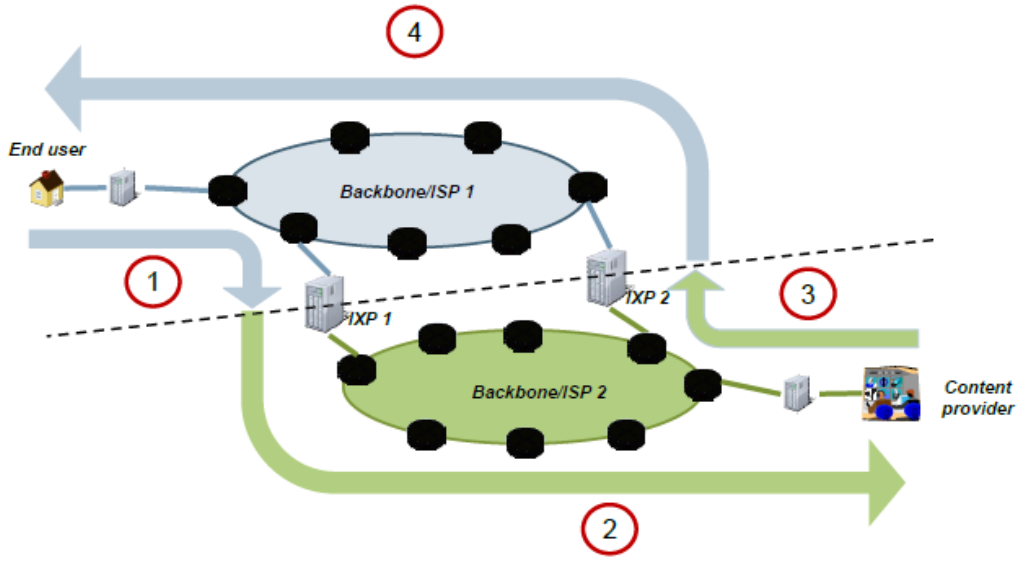
[24] Assuming that the costs of conveyance is roughly the same in each network

is a variety of ways in which they might be recovered which lead to very different levels of termination charges

- It gives operators greater pricing freedom at the retail level. Moving to bill and keep removes a floor on the retail prices which operators can charge their customers
- It gives an operator stronger incentives for cost efficiency than other interconnection charging arrangements. Under bill and keep the operator must recover all its costs from its customers. In a competitive market this gives it strong incentives to minimise its unit costs. Under a traditional calling parties network pays (CPNP) model the operator receives a substantial portion of its revenues from call termination prices which are set by negotiation or determination and where incentives for regulatory gaming rather than cost efficiency dominate.

The main objection to bill and keep arises when traffic is significantly out of balance and there is substantial opportunity for hot potato routing. Figure 3-6 illustrates.

**Figure 3-6: Hot potato routing**




*Source: Analysys Mason*

In this diagram

- The primary customers of ISP1 are end-users while
- The primary customers of ISP2 are content providers
- Both ISPs use hot potato routing. ISP1 hands over traffic flowing from the end-user to the content provider as soon as it can at Internet exchange point 1 (IXP1), while ISP2 hands over traffic flowing from the content provider to the end-user as soon as it can at IXP2
- The traffic which flows from the content provider to the end-user is many times greater than that flowing in the opposite direction
- This traffic is carried principally by ISP1, which bears a high proportion of the total costs of the interaction between the end-user and the content provider. But, under bill and keep arrangements, it receives no compensation for these additional costs.

Such objections to bill and keep are certainly valid. But they are unlikely to apply to the carriage of voice traffic over NGNs in Hong Kong where:

- The traffic flowing in each direction for a voice call is roughly balanced
- The opportunity for hot potato routing, given the geographic size of Hong Kong, is limited.

Given the arguments set out above we conclude that:

- There is a strong case for OFTA to remove its current guidance on fixed-to-fixed interconnection charging
- The case is strong even without the move to NGNs, and should be made as soon as possible
- The case is strengthened by the move to NGNs, given the problem of setting cost-based termination charges for a multi-service NGN.

These conclusions prompt us to suggest possible changes to the Telecommunications Ordinance ("the Ordinance") when it is next reviewed. At the moment Section 36A gives the Telecommunications Authority ("TA") the powers to determine the terms and conditions of interconnection between operators. In particular Section 36A(3B) requires that:

> *The charges in a determination shall be based on the relevant reasonable costs attributable to interconnection and, in determining the level, or method of calculation, of the relevant reasonable costs attributable to interconnection, the Authority may select from among alternative costing methods what he considers to be a fair and reasonable costing method.*

If the TA is to make a determination on interconnection charges under Section 36A, he is currently required to set cost-based charges. To allow flexibility to determine more economically efficient models for interconnection charges, which may or may not be cost based, it makes sense to consider a revision of Section 36A when the opportunity arises, so that the TA has the power to set ***economically efficient*** interconnection charges in the future.

It is possible that the courts would consider current charging arrangements, such as bill and keep, as cost based. But, given the current wording in the Ordinance, there is also a good chance that they would not. Some of the key stakeholders in Hong Kong have expressed concern about the regulatory uncertainty which this current wording creates.

Stakeholders might argue that moving from *cost-based* to *economic efficiency* as the basis for determining termination rates gives too much regulatory discretion and may increase uncertainty as a result. But we note that:

- The work and time involved in changing the Ordinance is considerable. So it is important that any revision to Section 36A is one which will last. We believe that the proposed change meets this requirement
- Economic thinking on charging arrangements has evolved considerably over the past 15 years. In particular:
  - There are now strong arguments, on grounds of economic efficiency, for regulating interconnection charges for the exchange of traffic between networks differently from access charges, where an access seeker rents a facility of service from an access provider
  - There are strong economic arguments for bill and keep arrangements, rather than cost based termination rates, for interconnection charging

- It is possible, so as to increase regulatory certainty, for the TA to issue guidelines on what is meant by economic efficiency when determining interconnection charging arrangements. Such guidelines might set out the factors - such as maximising economic welfare, encouraging efficient investment and promoting efficient entry - which should be taken into account when determining whether charges are economically efficient.

Given this analysis we propose that OFTA should consider recommending to the Government a review and possible revision of Section 36A of the Ordinance, so that the basis for determining interconnection charges could reflect ***economic efficiency*** - a term which includes, but is not limited to, cost-based.

## Charging for TDM to IP conversion

There are views from members of the industry, as stated in Paper 3/2009 of the NGNWG, that the operators which implement NGNs should have the responsibility to ensure interconnection with traditional circuit switched networks. If Hong Kong's goal is to encourage the transition to NGN, then we question whether imposing the cost of TDM to IP conversion solely on the operators that implement NGN is in the best long term public interest of Hong Kong. Such costs sharing arrangements act as a disincentive to NGN migration.

A move from traditional networks to NGNs is likely to be in the long term public interest – since it reduces network costs and enables the development of richer end-user services more quickly and at lower cost. So it makes sense, as more networks in Hong Kong are upgraded to NGNs, to remove or reduce this barrier to NGN migration by changing the way the costs of conversion are borne. For example:

- The circuit switched operator, rather than the NGN operator, might bear the conversion costs or
- The NGN and operators of traditional network might share the costs of conversion.

The question then arises as to when OFTA should issue guidance on changing the way conversion costs are borne by the operators.

Ofcom in the UK has considered this subject in detail[25]. It argues that, if the operator which bears the conversion costs is the one that invests in the gateway, then it is economically efficient to put the cost burden on the TDM network operator. It reasons that investment in a gateway by an NGN operator is eventually stranded, once all operators have moved to IP, but that investment in a gateway by a TDM operator can largely be reused within an IP network when that operator switches to IP. Overall Ofcom has concluded that:

- Until NGNs are seen as the most efficient proven technology, the costs of interworking should be borne by the NGN operators. In other words the early adopters of NGN have to factor in the costs of interworking as part of their investment.
- As more operators move onto NGNs a tipping-point will be reached at which the NGN may be seen as the most efficient and proven technology. At this point IP becomes the default interconnection arrangement, and any conversion costs have to be borne by the traditional network operator. The optimum point to make the change is likely to occur when less than 50% of

[25] *Next Generation Networks, responding to recent developments to protect consumers, promote efficient competition and secure efficient investment, Ofcom*, July 2009, p30-41.

voice traffic is generated on NGNs, because of the need to create incentives for forward-looking NGN investment, and the need to minimise the value of stranded equipment for IP-TDM conversion.

- TDM interconnection could continue to be offered alongside IP interconnection, but Ofcom did not decide whether this would be mandated or whether the prices should be regulated once IP interconnection was considered the default option.

In the UK, Ofcom concluded that TDM interconnection would continue to be the default arrangement at least for the 4-year duration of network charge controls imposed on BT in 2009.

There is a public interest case for switching the burden of conversion costs to the TDM operators. But will the market do this itself? For example, as more networks are upgraded to NGNs, NGN operators might have stronger bargaining power to shift the costs of conversion to circuit-switched operators and the issue of conversion costs might be resolved by the industry with no need for OFTA's intervention.

Given this analysis we believe that OFTA should:

- Decide for itself whether a shift in which operators bear the conversion costs is in the public interest and, if so, at what point in the migration to NGNs such a shift might reasonably occur
- Monitor how quickly the industry is moving to NGNs for voice services. We suggest that OFTA collect information on the balance of voice traffic originating on NGNs and circuit switched networks in Hong Kong and on the number of points of interconnect which are IP-to-IP, IP-to-circuit switched, and circuit switched-to-circuit switched. These factors will help establish the speed with which the operators in Hong Kong are moving to pure NGN interconnection and the point at which it is in the public interest to switch the burden of conversion costs to the TDM network operators. It would be reasonable to make this change once a substantial proportion of voice traffic originates on IP networks. But this may be an issue for discussion with the operators
- In the event that the operators do not act in the public interest, or that there is dispute amongst operators on the issue of conversion costs, OFTA should consider issuing guidance on the way conversion costs are to be borne by the operators.

It is important not to issue any guidance until there is an agreed way forward on standards for IP-to-IP voice interconnect, on quality service for voice services carried over interconnected NGNs, and on interconnection charging for end-to-end IP voice services. TDM-based operators could reasonably argue that switching the conversion cost burden to them, before there is an agreed path for voice IP interconnect, would be premature.

## Interconnection charges for quality of service

Guaranteed quality of service may require reservation of more network resources than a best effort service. So interconnecting operators may wish to charge each other a premium to recover these additional costs. In general they are free to negotiate commercial rates. But in the case of voice services, and possibly other services in future, we propose that OFTA should consider:

- Maintaining any-to-any interconnection requirement to maximise consumer welfare
- Withdrawing guidance requiring operators to pay cost-based termination charges for fixed-to-fixed interconnect

- Encourage the industry to choose quality classes to enable minimum quality of service for end-to-end services.

The question then arises as to whether these regulatory constraints affect charging arrangements in a way which is economically inefficient.

As far as we can tell none of the case study countries have considered this issue yet. As we discuss in the previous section, the regulators and operators in most countries are still struggling to decide what quality classes and what standards should be used for NGN interconnection. We conclude that it is too early for OFTA to consider this issue in detail. But, as we note below, it may not be significant in Hong Kong.

Our proposals on termination charges will, we believe, lead to a system of bill and keep. At the same time requiring specific services to be carried on transport networks at a given quality class may lead to additional termination costs, which the terminating operator must then recover from its customers. But Hong Kong's operators face a similar problem of cost recovery when they interconnect voice services over circuit switched networks today. These arrangements appear to work well and there are strong arguments that they are economically efficient. We see no good reason why the same arguments should not apply in an NGN world.

## 3.4 Should there be any regulation for access by service-based operators to NGNs?

### Introduction

Service-based competition has existed alongside infrastructure-based competition in Hong Kong since the market was first liberalised in the 1990s. Initially OFTA required the incumbent fixed network operator, then PCCW, to provide service-based operators (SBOs) with access to its network at regulated prices. But, with the development of infrastructure-based competition to PCCW, regulation on the level of interconnection charges payable by SBOs to PCCW has largely been withdrawn[26]. SBOs are still required by regulation to pay interconnection charges on international call forward service (ICFS)[27] to mobile network operators (MNOs). Today we understand that SBOs negotiate hosting arrangements with network operators and agree charges as part of these negotiations, so that they can access the host operator's network and, through that network, the customers of other operators in Hong Kong.

[26] Tariffs for interconnection charges paid by SBOs to PCCW for the conveyance of value added services (VAS) like dial-up Internet were previously subject to ex ante approval by OFTA. The approval requirement was withdrawn in June 2010 under the new unified carrier licence issued to PCCW. A local access charge (LAC) paid by SBOs to PCCW for conveying the traffic of external telecommunications service (ETS) operators was also previously set by OFTA. After conclusion of the LAC review, which was published on 23 December 2011, it was decided that the level of LAC payable to PCCW would be determined by the market with a transitional period of 18 months from the issue date of the relevant TA statement. LAC payable to other fixed network operators and mobile network operators has been and will remain to be determined by commercial negotiations among the market players.

[27] A form of mobile roaming substitute

## Issues for the study

Should OFTA mandate access by SBOs to NGNs as the network operators migrate from circuit switched networks to NGNs?

We can find very little evidence from our case studies which deals with this issue. As far as we can tell only Ofcom in the UK has considered the issues. It has tentatively concluded that regulatory intervention would not be appropriate in the foreseeable future.

> *Intense competition in value added services that run over networks, which has been made possible by the Internet, is a powerful force that will shape a market-led outcome without a need for regulatory intervention*[28].

We can see no reason why OFTA should intervene on an ex-ante basis to give SBOs access to Hong Kong's NGNs. Our arguments are as follows.

- We can see no good reason why SBOs should not be able to negotiate hosting arrangements with NGN operators (using either TDM-based or IP-based interfaces) in the same manner as with circuit switched operators. For example Hong Kong Broadband Network is an NGN only operator which can provide access for SBOs via its TDM/IP gateway.
- Maintaining the current regulatory regime for SBO access and leaving the matter to commercial negotiations does not slow the migration to NGNs. It is reasonable to assume that the unit costs of carrying SBO traffic over an NGN are lower than the unit costs for a circuit switched network. Ofcom, for example, talks about "*the efficiency savings provided by the new technology*"[29]. We also note that
  - Voice calls carried on packet switched networks require fewer, cheaper, resources than circuit switched networks
  - A very substantial number of operators have, over the past few years, replaced their core circuit switched networks with NGNs, largely on cost reduction grounds
  - The unit costs of circuit switched voice are rising as equipment vendors discontinue circuit switched equipment and those with the ability to maintain it retire.

  So moving to an NGN, while preserving the current SBO charging regime, would increase an operator's profits and act as an incentive for migration.
- We do not see a case for OFTA mandating NGN operators to provide TDM/IP conversion to SBOs. As more operators migrate to NGNs, so the case for maintaining TDM/IP gateways weakens, especially if, as we suggest elsewhere, the burden of all or part of the costs of these gateways may shift from the NGN operators to the remaining circuit switched operators. This raises the question of whether OFTA should oblige operators to continue to provide these gateways so that SBOs can continue to provide their current, circuit switched based, services. It is possible that such an obligation would be in the public interest. But there are strong arguments which suggest otherwise. In particular:
  - An obligation of this kind raises industry costs and, ultimately, end-user prices

[28] *Next Generation Networks: a response to recent developments to protect consumers, promote effective competition and ensure efficient investment*, Ofcom, July 2009

[29] *Next Generation Networks: a response to recent developments to protect consumers, promote effective competition and ensure efficient investment*, Ofcom, July 2009, P35

– There may be a commercial case for at least one operator continuing to operate a TDM gateway for a long time to come

– By that time the volume of circuit switched traffic generated by SBOs could be close to zero.

Given these arguments, we do not see a case for OFTA intervening on this matter in the foreseeable future.

Our overall conclusion is that SBOs should negotiate commercial charging arrangements with NGN operators, as they do now with circuit switched operators. We do not see a need for regulatory intervention or for the development of regulatory charging principles or cost models for the foreseeable future.

## 3.5 Recommendations to OFTA

**Recommendation 3.1**: Impose any-to-any interconnection requirements for voice services on NGN operators as well as circuit switched operators

**Recommendation 3.2:** Forbear from implementing any-to-any interconnection requirements for other services unless they pass the tests on economic welfare, increased costs, competition problems and incentives for innovation set out in this report.

**Recommendation 3.3:** Ask the TSAC to take responsibility for developing the appropriate standards profiles for Hong Kong so as to enable interoperability between NGNs.

**Recommendation 3.4:** Forbear from imposing minimum quality of service requirements for NGN services.

**Recommendation 3.5:** As appropriate, ask the NGN Working Group and/or the TSAC to:

- Develop a Hong Kong version of the SIP-I standard for signalling between NGNs and circuit switched networks, and appropriate NNI signalling for direct NGN interconnection, that provide for the effective prioritisation of emergency calls
- Develop a specification for reservation of IP transport capacity in NGNs for emergency calls
- Consider what quality classes Hong Kong might use so as to enable minimum quality of service for end to end services involving interconnected NGNs
- Consider the most appropriate interconnection architecture for NGNs in Hong Kong.

**Recommendation 3.6:** Withdraw guidance on interconnection charging arrangements for fixed to fixed interconnection as soon as possible. This recommendation is independent of the pace at which the migration to NGNs occurs.

**Recommendation 3.7:** Consider the case for revision of Section 36A of the Ordinance, when it is next reviewed, to allow the TA to determine interconnection charges on grounds of economic efficiency rather than simply based on cost.

**Recommendation 3.8:** Consider issuing guidance on the way TDM-IP conversion costs are to be borne by operators in the event that the issue cannot be resolved by the industry or the industry does not act in the public interest. In considering the appropriate guidance, take into account the pace at which Hong Kong networks migrate to NGNs.

**Recommendation 3.9:** Forbear from intervening on an ex-ante basis to give SBOs access to NGNs and leave SBOs to negotiate charging arrangements with potential host NGN operators.

# 4 In building access issues with NGA

## 4.1 The scope of our analysis

There are two main issues of in-building access which are relevant to the development of telecommunications services in Hong Kong:

- Access to buildings so that operators can install and upgrade wiring to connect their network facilities in the basement of a building to individual tenants. We refer to this wiring as an in-building distribution system or IBDS from now on. Such in-building access rights are granted by the TA to fixed network operators under Section 14(1) of the Ordinance. The IBDS is an essential component of a telecommunications access network and a high speed IBDS is needed for the provision of NGA and high-speed broadband. Given that governments and regulators in the case study countries have all put considerable effort into stimulating investment in NGA, we consider that this is a central issue for the study. It is especially important in Hong Kong where a very high proportion of people live and work in multi-tenanted buildings
- Access to buildings so that mobile operators can install equipment and provide mobile services. Currently, mobile network operators may request authorisation from the TA under section 14(1A) of the Ordinance to place and maintain radio-communications installation in, over or upon any land for provision of mobile services to a public place. Mobile operators argue that they should have the same access rights as that provided to fixed network operators under Section 14(1) so as to maximise cross-platform competition between fixed and mobile networks.

The second problem existed before the migration to NGNs and NGA. For example it was raised by consultants in the 2006 study on fixed mobile convergence[30]. As such it is out of scope for this study.

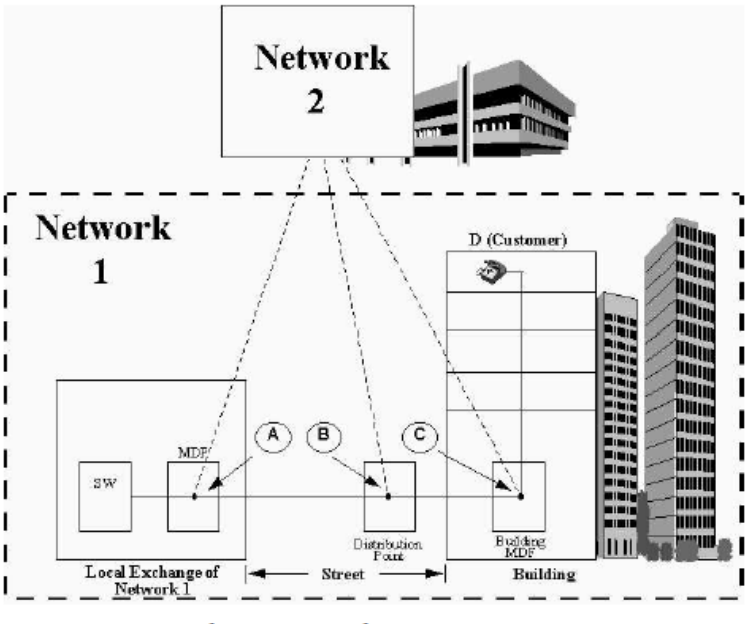
## 4.2 The current regulation of IBDS

Section 36B of the Ordinance gives the TA the powers to direct networks to interconnect with each other (including but not be limited to Type II interconnect) and Section 36A gives the TA the powers to determine the terms and conditions of interconnection. This enables an access seeker to rent access network facilities from their owner. The powers apply on a technology neutral basis to both copper and fibre facilities. In addition Section 36AA gives OFTA the power to require sharing of facilities such as the lead-in ducts to a building and the ducts within the building.

In order to decide where to apply its powers for Type II interconnect, OFTA has defined four reference points for potential interconnection as shown in Figure 4-1.

[30] *Review of the Regulatory Framework for Fixed-Mobile Convergence in Hong Kong*, Ovum for OFTA, 2006

Figure 4-1: The reference architecture tor Type II interconnect




The four points are:

- Point A at the local exchange level
- Point B at the distribution point within the access network
- Point C in the basement of the building
- Point D at the tenant's premises.

The Hong Kong Government took a policy decision in 2004 not to extend the requirement of mandatory Type II interconnection from copper to fibre facilities. It also gave four years notice of its intention to withdraw requirements for mandatory Type II copper interconnection at Point A, which took full effect in 2008. Requirements for mandatory Type II copper interconnection at Points B and C remained.

There are two main situations where a telecommunications operator might wish to use an IBDS owned by another entity:

- Where the IBDS is owned by the building owner. In this case the building owner is a class licensee and is required, under Section 7 of the relevant class license, to interconnect its IBDS with telecommunications operators on a non-discriminatory basis
- Where the IBDS is owned by a telecommunications operator. Here the operator can be subject to Type II interconnection requirements at Point C as described above.

In addition to these regulations, OFTA has promulgated three codes of practice for the installation and maintenance of in-building telecommunications systems:

- The Code of Practice for the Installation and Maintenance of In-Building Telecommunications Systems and In-Building Access by Telecommunications Network Operators (CoP-05/2004)

- The Code of Practice for the Installation and Maintenance of In-Building Telecommunications Systems by Class Licensees (CoP-07/2005)
- The Code of Practice for the Provision of Access Facilities in Buildings for the Supply of Telecommunications and Broadcasting Services (CoP-01/2011)

The latest of these, CoP-01/2011, recommends the provision of separate conduit, duct, channelling and trunking systems for optical fibre cables as far as possible. It also specifies recommendations on the bending radius requirements of the latest optical fibre cables and for separate wall boxes for the termination of optical fibre cables.

In November 2010, OFTA introduced a voluntary registration scheme for fibre connected buildings, under which building owners can register their fibre connected buildings. The scheme is designed to give members of the public information about the availability of broadband networks installed in individual buildings.

## 4.3 The current state of IBDS for broadband

Given this regulatory environment, telecommunications operators have largely rolled out parallel IBDSs within buildings, sharing facilities where they can. The market statistics are as follows:

- By June 2011 85% of households in Hong Kong, and very substantial proportion of businesses, were connected to fixed broadband services
- As of March 2011, 86.2% of households had a choice of two or more self-built broadband customer access networks[31] and 75.5% had a choice of three or more.

This tenant choice of broadband suppliers is achieved largely in one of two ways:

- In some cases the network operator builds its own IBDS to Point D
- In other cases the self built network terminates at Point C. and the competing operators use a shared IBDS to reach the tenant.

Feedback from the operators suggests that the former method, with full infrastructure-based competition to Point D, predominates. For example Hong Kong Broadband Network tells us that it directly passes over 80% of households with its own infrastructure.

Operators report that they can work effectively within this regulatory environment, as long as they have permission from the building owner to gain access to the building. For example there are relatively few problems of access to space in basements or vertical risers. But there are major problems in getting access permission from the building owner. The main problems have been described to us as follows:

- Many months of mediation are often required between the operator and the building owner before the operator receives a Section 14 permission to gain access to the building. This might involve OFTA in sending three letters to the building owner

[31] The transmission capacity of a self-built customer access network shall be capable of meeting the expectation of users who are subscribing to broadband services in Hong Kong. The transmission capacity shall support the transmission rate per subscriber downstream of not less than 1.5 Mbps over the link provided by the customer access network. (http://www.ofta.gov.hk/en/tas/interconnect/ta20040719.pdf)

- Gaining access to buildings with multiple tenants but a single owner is often very difficult. Section 14 of the Ordinance gives telecommunications operators access to common parts. But in a single-owner building it is very difficult to demonstrate that there are any common parts[32]
- Gaining the necessary consents for access to government buildings can be very time consuming.

It is difficult to judge the extent to which the process might be speeded up, given the need to balance the rights of the tenants, the requesting operator and the building owner. But there is a strong case for reviewing and modifying the legislation at the next available opportunity to deal with the issues which arise when a building is in single ownership. We recommend accordingly.

## 4.4 The position in the case study countries

Access to IBDSs is an important issue in the development of high-speed broadband services in all of the case study countries. We summarise below the basic position in each country and highlight important issues for IBDSs.

- In Singapore where, like Hong Kong, a high proportion of people live and work in high-rise buildings, the Government has created a monopoly operator, OpenNet, to supply a single passive fibre access network to all households and businesses. There is a code of practice which governs the installation of in building distribution systems[33] and building owners can be subject to a fine of $1000 per day for non-compliance.
- In Australia there is also a monopoly supplier of passive NGA infrastructure, NBNCo, from Point A to Point C of Figure 4-1. NBNCo is the main body which requires access to in-building wiring, provision of which is covered in a code of practice. This code is designed to balance the rights of tenants, landlords and telecommunications operators. But the code is for guidance only. Terms are set by negotiation.
- In the UK BT is often the only supplier of broadband access networks[34] and rival broadband service providers interconnect with the BT access network at Point A. Access to in-building wiring is largely unregulated.
- In Korea the regulator, KCC, requires the incumbent operator, Korea Telecom, to provide spare ducts and wiring to its rivals on a facilities sharing basis. Fibre installed by Korea Telecom since 2004 is excluded from this requirement. KCC also introduced a certification scheme for broadband equipped buildings in 1999. This has proved a great success. Building owners now actively seek certificates on the grounds that the certificates increase property values. As a result telecommunications operators find it easy to get in-building access. The scheme involves classifying a building as superior, first, second, or third grade, according to specified criteria.
- In the US the FCC banned exclusive contracts between landlords and telecommunications operators in 2008. It believes that such exclusive deals could harm both tenants and competition
- In Japan the Ministry has highlighted problems of in-building access in recent years but does not appear to have regulated to solve these problems. The industry has however developed compact

[32] The problem addressed by Section 14 is where there are multiple owners of a building. In such cases there will be areas that are used in common, or where access is shared rather than exclusive to an individual tenant.

[33] See for example *Clarification of the code of practice for info-communication facilities in buildings*. IDA, September 2011

[34] Virgin Media provides infrastructure-based competition, typically to Point D, in the consumer sector

optical splitters and optical cabling for installation on the outside of buildings to make installation of IBDSs easier.

- In France the Government and the regulator, ARCEP, have developed a set of regulations whereby the first operator to fibre a building is required to provide access to rivals at cost-oriented prices. Figure 4-2 provides details.

This review of in-building access in the case study countries raises two main issues:

- In Australia, Singapore and the UK there is a move to a single next-generation access network from Point A to Point D. This includes a single IBDS in each building. Equally in France, where there is a policy of infrastructure-based competition to Point C in urban areas, the regulatory authorities envisage a single IBDS in each building. What is the public interest case for following this policy in Hong Kong? We discuss this question below.
- In Korea the voluntary registration scheme appears to have worked well. We know that OFTA has already launched such a scheme in Hong Kong. But feedback from stakeholders suggests that there is considerable scope for enhancing it and, perhaps, learning from the Korean experience.

**Figure 4-2: French measures for in-building wiring**

In its law on modernisation of the economy of August 2008 the French Government required that every residential user should have the right to obtain access to a fibre network (the droit au très haut debit or right to fibre). To do this it has decreed that:

- Any reasonable request by an operator to deploy fibre in existing buildings should in principle be met
- Owners of buildings may only oppose the request if a fibre network has been or is being deployed in the building
- Operators and owners of buildings should follow a mandatory convention, aimed at regulating their mutual obligations when deploying fibre in-building wiring
- If a fibre network has already been deployed by an operator, the latter should, regardless of its significant market power status, grant other operators access to its in building network under reasonable conditions, for the purpose of providing services to end-users, giving priority to commercial agreements between operators.
- Access must be subject to an agreement between operators, aimed at determining the financial and technical conditions of access. The NRA has been granted the power to set rules regarding sharing obligations, and to resolve disputes between operators.

## 4.5 The case for mandating shared IBDSs in Hong Kong

The current policy and regulations have led to a position in which there is effective choice of broadband supplier in the majority of buildings in Hong Kong. As Hong Kong upgrades to high-speed broadband, what is the case for an alternative policy, in which shared use of IBDS by rival operators is mandated? There are two main public interest arguments in favour of such a policy:

- It ensures that all tenants have a choice of high-speed broadband provider and increases the level of retail competition

- It reduces the overall costs of in-building distribution. A single IBDS avoids the cost of duplicated systems and could, depending upon its design, lead to lower costs when an end-user switches between suppliers.
- Governments and regulators in Australia, Singapore, and many EU member states have given these arguments enough weight to adopt such a policy.

But there are also strong counter arguments:

- The current policy in Hong Kong appears to work well in terms of giving tenants choice. Less than 14% of households did not have an effective choice of self-built broadband customer access network in early 2011
- The cost of duplicated systems, at least for basic broadband, is already sunk and is not relevant to a decision on future policy
- The small proportion of households which do not have a choice of self-built broadband customer access network may enjoy a significant share of the benefits of competition, as long as their broadband supplier does not raise prices for buildings where it is the sole supplier. In these circumstances, which may prevail for marketing and administrative purposes, tenants without choice enjoy broadband prices which are set through competition for the revenues of tenants in other buildings
- The competitive forces that have led to over 86% of households (and tenants) having access to two or more self-built broadband customer access networks and 76% having access to three or more are still active. We may reasonably assume that these proportions will continue to rise in future, especially if the barriers which currently prevent access to buildings in single ownership are removed
- The rollout of LTE will strengthen cross-platform competition between fixed and mobile broadband over the next few years and increase tenant choice
- The current policy of infrastructure-based competition to the tenant, which encourages rival IBDSs within each building, should lead to more technology innovation in cabling systems than a policy of a single IBDS supplier per building
- This policy also avoids the need for price regulation for access to IBDS and the consequential possibility of regulatory error. Such regulation may be required if there is a single IBDS owner in a building.

We conclude that the balance of arguments weighs in favour of continuing with the present policy rather than moving to one of mandated shared IBDSs.

## 4.6 Voluntary measures

Enhancing the voluntary registration scheme for fibre connected buildings is one way to increase the incentives for building owners to cooperate in upgrading IBDSs for high-speed broadband. This might help reduce many of the problems described in Section 4.3. Enhancements might include:

- Differentiating within the scheme so as to classify buildings according to the speed of service offered and the number of broadband suppliers from whom the tenant can choose

- Establishing and, if possible, quantifying the effect of high-speed broadband connectivity and supplier choice on the value of building leases. It might for example be possible to gather evidence on these effects in Korea and elsewhere, to survey property agents and tenants in Hong Kong, or even to carry out econometric analysis to isolate the impact of fibre connectivity on Hong Kong property prices.[35]
- Actively encouraging building owners to register with the scheme
- Publicising the scheme with prospective tenants and making the scheme readily accessible to them online.

## Standards for in-building access

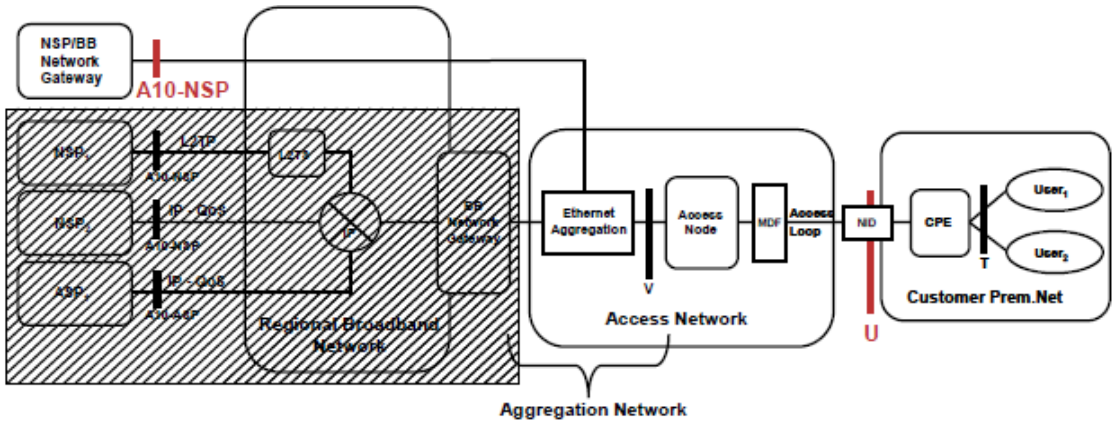
If operators decide that they want to share in-building distribution systems in an efficient way then standards might be required:

- At the U interface between the in-building distribution system and the customer's premise. Such standardised interfaces might include a wires only presentation, an Ethernet presentation for GPON and point to point fibre and a VDSL2 presentation over copper wiring
- At the V interface in the basement of the building where each operator's facilities are connected to the in-building distribution system. The standards required will depend upon the in-building wiring system used. With copper wiring an interface to an active bitstream service might be required; with GPON fibre optical splitters might be used; and with point to point fibre simple optical termination might be deployed.

[35] We recognise that there are many factors that could or do impact on property prices and that in some circumstances the contribution of broadband access may be minor. Nevertheless it may be worth offering evidence-based analysis on this to encourage good broadband outcomes as a result.

Figure 4-3 illustrates. We suggest that the appropriate TSAC working group considers whether there is a need to develop such standards.

Figure 4-3: The U and V interfaces




## 4.7 Recommendations to OFTA

**Recommendation 4.1:** Continue to support the current policy which has led to effective tenant choice of broadband supplier for a high proportion of end users

**Recommendation 4.2:** Enhance the voluntary registration scheme for fibre connected buildings (along the lines set out in Section 4.6) so as to give building owners stronger incentives to allow in-building access to telecommunications operators

**Recommendation 4.3**: Consider whether it is appropriate to change Section 14 of the Ordinance, so as to give operators the same access rights to buildings in single ownership as they currently enjoy for buildings in multiple ownership. Such a change would then give tenants of buildings in single ownership a similar choice of broadband suppliers as is currently enjoyed by tenants in other buildings

**Recommendation 4.4:** Ask the TSAC to consider whether standards are required at the U and V interfaces for effective sharing of IBDS for high-speed broadband

# 5 The long-term future of universal service policy in an NGN world

## 5.1 The current universal service policy in Hong Kong

The existing objectives for universal service policy in Hong Kong are:

- To ensure access to affordable basic telephone service for all people in Hong Kong irrespective of where they reside or carry on business; and
- To ensure that the costs of providing "basic service" are fairly borne by the users of network services.[36]

The legislation does not specify that there must be a universal service obligation or a universal service funding scheme. It provides OFTA with the authority and discretion to impose universal service obligation on one or more "fixed carrier licensees", and, on the normal rules of statutory interpretation, authority to modify or withdraw arrangements once they are in place.[37]

"Basic service" is defined by the Telecommunications Ordinance to include, amongst other things, a public switched telephone service and public payphones, but does not include broadband services.[38] Under the legislative scheme therefore, the scope is defined in terms of voice (PSTN and public payphone) services, subject to amendment if OFTA considers that to be appropriate. This is the second important statutory discretion afforded to OFTA to determine universal service arrangements. To date OFTA has not exercised this second discretion, although it has formally considered the possibilities[39], and the primary focus of the universal service policy remains PSTN (voice) service and public payphone service.

### The universal service provider

Section 35B of the Ordinance limits the choice of universal service provider(s) to one or more "fixed carrier licensees". OFTA has placed the obligation on PCCW. It is required to ensure that affordable basic service is reasonably available to all persons within Hong Kong. The term "fixed carrier licensee" is defined as a holder of a fixed carrier licence, issued for communication between fixed locations[40]. This term is one that reflects the history of telecommunications generally and may prove problematic in an era of increasing convergence and service-agnostic licensing. At present, OFTA also applies the term to holders of unified carrier licences (UCL) which authorise the provision of fixed services.

[36] Telecommunications Ordinance, section 35B; also see paragraph 5 of the Statement of the TA, 8 June 2007: Review of the Regulatory Framework for Universal Service Arrangements

[37] Telecommunications Ordinance, section 35B (1)

[38] Telecommunications Ordinance, section 2 (1)

[39] For example in the 2007 review of universal service policy OFTA considered whether broadband services should be included and decided against doing so at that time.

[40] Telecommunications Ordinance, section 2 (1)

## 5.2 Costing and funding the USO

### Current methods of estimating universal service costs

The universal service costs (USC) results for 2005 were based on a detailed analysis of the net costs involved in accordance with the calculation methodology stipulated in the TA statement entitled "Universal Service Contribution Calculation Methodology" issued on 13 July 2000. In 2006/07, the USC calculation was based on a projection method taking into account the 2005 results and the fluctuations in line numbers and average costs. From 1 July 2007[41], further adjustments have been made to reflect the decision in 2007 to (i) change the aggregation basis for fixed lines from 'customer-by-customer' to 'distribution point'; (ii) exclude USC for buildings connected by at least one alternative self-built fixed customer access network capable of providing basic telephone service; and (iii) exclude USC for public payphones in areas where there is competitive and alternative service in the vicinity.[42]

### Funding arrangements

The net cost to PCCW in fulfilling its universal service obligation is met through a universal service fund to which contributions are made by operators in proportion to the number of E164 numbers allocated to them.

### Universal service costs are small

Figure 5-1 below shows the levels of universal service costs for both the PSTN and public payphone components in recent years, and estimates these costs as a proportion of total industry revenues.

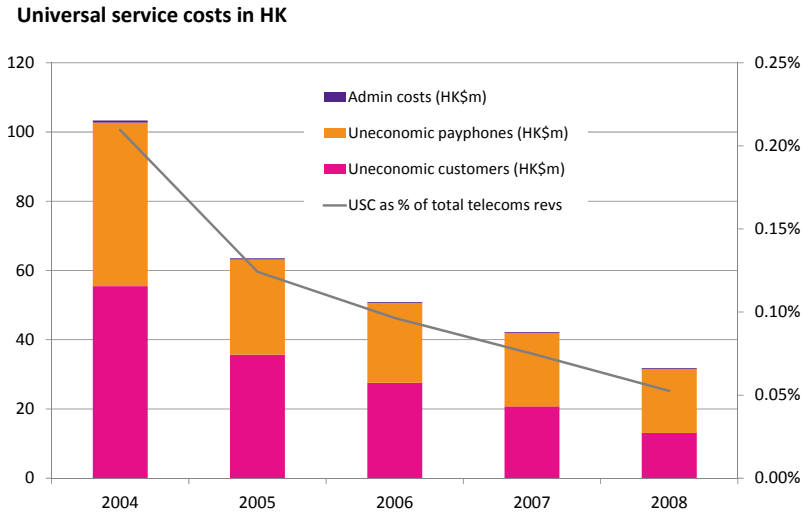
We conclude that:

- Universal service costs in both absolute terms and as a proportion of industry revenue have fallen significantly in recent years
- The universal service costs are small in absolute terms when considered in the context of industry revenues
- As Figure 5-2 shows, universal service costs as a share of revenue in Hong Kong are small by international standards.

[41] See for example the Statement of the TA, 27 April 2010: Universal Service Contribution - Confirmed Level for the Period from 1 July 2008 to 30 April 2009, and Provisional Level from 1 May 2009

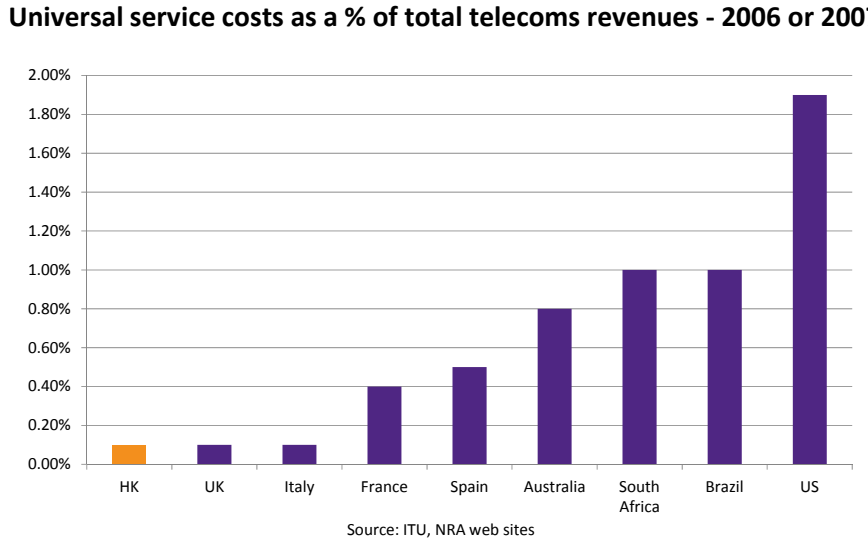
[42] Statement of the TA, 8 June 2007: Review of the Regulatory Framework for Universal Service Arrangements

Figure 5-1: Universal service costs in




*Source: OFTA*

Figure 5-2: Universal service costs as a share of industry revenues in selected countries




## 5.3 Impact of NGNs on universal service policy

### Key issues

The roll out of NGNs, and the associated shift from narrowband usage charges to broadband access charges, raises a number of questions about the future of universal service policy. In particular we need to consider whether the current policy is sustainable in the long term.

It is important to determine the policy first and the means of implementing the policy second. It is therefore important to consider first the scope of universal service – that is the services that it might be considered as basic services and the criteria for inclusion or exclusion of services. We argue below that:

- The criterion of social inclusion is the main consideration in determining universal service scope.
- Over time, the pressure to include broadband service in Hong Kong as a basic or essential service for reasons of social inclusion will increase substantially and may become irresistible.

We note that the issue of what kind of services should be included in universal service for ensuring social inclusion extends beyond considerations of telecommunications policy alone.

The second consideration is how the universal service policy is to be implemented. In a market economy such as Hong Kong, the first matter to consider is the extent to which the market itself will deliver the services in an affordable way. Only after the possibility of market delivery is assessed should additional measures, involving regulation, be considered.

## Universal service policy in the case study countries

All of the case study countries plan to continue with a universal service policy. But all now have a universal broadband policy as well. The relationship between these two policies, and the extent to which universal service is expanded to include broadband, varies:

- The two policies are kept separate in Japan, Korea and Australia[43]. Universal service policy is designed primarily to ensure the availability of affordable voice telephony everywhere, while universal broadband policy is designed primarily to promote economic growth
- In Singapore the scope of universal service is being expanded to include broadband and there are obligations in the licences of OpenNet and Nucleus Connect to connect households, offices and buildings to the national fibre network by 2013
- In the US the Government has set a target of at least 4 Mbps broadband for all by 2020. At the same time it hopes to cut back significantly on the costs of its traditional, voice oriented, USO which have escalated over the years. Figure 5-2 illustrates the scale of universal service costs in the US
- The EU has set a target of 30 Mbps broadband for all by 2020, and is in the middle of consulting on the expansion of universal service to cover broadband
- In Australia the Government has set a minimum target of 12 Mbps for all[44].

## Universal service policy in Hong Kong in the short term

Hong Kong does not have a universal broadband policy and, for the immediate future, OFTA plans to retain its existing definition of the scope of universal service which excludes broadband. OFTA's current position is that:

[43] This approach is being reviewed in Australia at present.

[44] With 93% of the population connected to the national fibre network enjoying speeds of 100 Mbps plus by 2018

- The market delivers affordable broadband for all, except those living on remote islands, where the cost of supply can be prohibitively expensive
- Hong Kong has one of the highest broadband penetration levels in the world, given the combination of its demographics and its policy of pure infrastructure-based competition
- The market will deliver further growth in broadband take-up and there is no need for the Government to intervene.

This position seems to us to be a reasonable one given:

- The reach of broadband services in Hong Kong
- The choice that most households and businesses have between suppliers of fixed broadband services provision[45]
- The robust competition in retail broadband services markets which is reflected in strong price competition[46]
- The low price of broadband access, particularly for entry level products, relative to the average income levels in Hong Kong
- The Government initiatives on the demand side, for example in providing direct subsidies for the usage of broadband services by children from low-income families and providing free Wi-Fi services at designated government premises

## Universal service policy in Hong Kong in the long term

In the long term we believe that the current universal service policy in Hong Kong will become increasingly difficult to sustain. There are four main reasons.

***First***, the Government will come under increasing pressure to include use of basic broadband within the scope of universal service. A fundamental concept underlying universal service is to make telecommunication services affordable to those on the lowest incomes so as to avoid social exclusion.[47] It was reasonable to argue that lack of broadband did not lead to social exclusion in Hong Kong in 2007. It will be more difficult to maintain this position in a decade from then when a greater proportion of Hong Kong residents consider broadband to be an essential service for them to be able to be involved as fully participating members of society[48]. Governments around the developed world

[45] With 86% of households having a choice of at least two broadband service providers

[46] We are told that basic packages for voice and broadband are available from as little as HK$ 145 per month. This represents 5.9% of the median income of households in the lowest income decile. For comparison we estimated, in a recent study for Vodafone (*Are telecommunications services universally affordable across the EU?* Plum for Vodafone, September 2010) that a broadband and voice telephony package is affordable if it represents less than 6% of the median income of households in the lowest income decile. http://www.plumconsulting.co.uk/publications.asp?year=2010

[47] The term 'social exclusion' and the related term, 'social inclusion', have the standard meanings that apply to the words used. Social exclusion is the inability of members of society to participate fully in that society and to both contribute to and be sustained by it. Participation is in economic (commercial) and non-economic (including cultural) dimensions.

[48] The key point is that people have the means of participating fully and then the choice as to whether they do so. It is also important to recognise that what is considered to be an essential service – or a service that is basic to social inclusion – will change over time. In 1930 postal services were considered to be basic services in this sense, while telephone services were not. Even before this century that had changed. Telephone services are now considered to be basic, as well as postal services. The way to find out what is considered to be basic or essential is to survey the whole of the population from time to time – see Footnote 49 as well.

are increasingly convinced that some minimum level of use of broadband is now socially necessary and this is reflected in our case study findings. In the UK, for example, a recent survey by the Joseph Rowntree Foundation[49] found that the adult population now regards broadband as a basic essential of modern life. Findings such as these have prompted a number of governments to conclude that basic broadband now lies with the scope of universal service.

***Secondly***, the most cost-effective way to deliver low-volume use of both voice telephony and broadband is through mobile rather than fixed networks. In a fixed network the incremental cost of access is high and the incremental cost of use is low. In a mobile network the reverse is true. The cost of adding an additional subscriber is very low and the incremental costs are generated almost entirely through usage, as subscribers contend to use scarce and expensive radio access network resources. In the case of low income households, which might generate low volumes of broadband voice telephony traffic for socially necessary use, the cost-effective solution is now the mobile network[50]. Yet the current legislation in Hong Kong restricts provision of universal service to fixed carrier licensees.

***Thirdly***, the move from voice oriented circuit switched networks to multi-service NGNs will make it increasingly difficult to isolate the net costs of the universal service obligation. Hence the universal service costs will become increasingly unreliable, irrespective of the assumptions and modelling used, and will be open to challenge from operators who must fund them.

***Finally***, while the current arrangement for determining contributions to the universal service fund on the basis of the share of E164 numbers allocated is expeditious in the short term, it will be increasingly difficult to justify. There is a general move within the telecommunications sector away from generating revenues from narrowband usage and towards generating revenues from broadband access. So there is a danger that those service providers paying contributions to the universal service fund on the basis of some measure of voice revenues, will no longer be those most able or appropriate to pay for this social obligation.

The first of these developments raises the issue of whether the Hong Kong Government needs to develop a universal broadband policy which sets as its prime objective the provision of affordable broadband for all. Hong Kong already has high levels of broadband take-up, which are the envy of much of the developed world. But there are still segments of the population which cannot afford broadband services[51]. At the same time, as we indicated above, access to the broadband Internet is becoming necessary for social inclusion.

Given these considerations we suggest that the relevant bureaux of the Government undertake a study to consider:

- Whether Hong Kong should introduce a policy of affordable broadband for all
- Whether, if such a policy is to be implemented, it should be done on a technology neutral basis. For example should mobile as well as fixed technologies be considered?

[49] A recent Joseph Rowntree Foundation study shows that home internet access (at broadband speeds) is now regarded as a basic essential in the UK for everyone of working age. http://www.jrf.org.uk/publications/minimum-income-standard-2010

[50] See *Are telecommunication services universally affordable across the EU*, Plum for Vodafone, September 2010

[51] Even though the Hong Kong Government has launched a number of initiatives to address this issue, including the granting of a cash subsidy on Internet access charges, offering low cost computer equipment and Internet access service to low-income families with children, funding the provision of broadband services in schools and public libraries, and the provision of Wi-Fi coverage on Government premises

- What constitutes affordable broadband. This might, for example, relate to the price paid for socially necessary use of universal services as a proportion of the income of the poorest households in Hong Kong
- The extent to which commercial services, and especially commercial mobile broadband services, meet the affordability test. Work in the EU[52] suggests that commercial prepay mobile services for broadband already deliver services which the poorest households can afford in many member states
- The nature of the gap between what is needed to meet the goal of universal broadband and what commercial services can deliver. It is reasonable to expect that this gap will centre on the provision of broadband in high-cost areas rather than the provision of broadband services to uneconomic customers in urban areas
- The most effective way to fill this gap, in terms of efficient supply at lowest subsidy and the best way to fund it
- How implementation of this universal broadband policy might relate to the existing universal service policy.

## 5.4 Recommendations to OFTA

**Recommendation 5.1:** Continue with the existing universal service policy and procedures in the short term.

**Recommendation 5.2:** Consider whether implementation of the existing universal service policy needs to be adapted in the short to medium term to deal with problems which arise in terms of:

- Estimating net universal service costs following the migration to next-generation networks
- The basis for determining contributions towards the cost of universal service.

If OFTA undertakes such an exercise we suggest that it should be done in a way which feeds into the review of the Broadcasting and Telecommunications Ordinances, which we understand will follow the formation of the Office of the Communications Authority.

**Recommendation 5.3:** Recommend that the relevant policy bureaux of the Government undertake a study to consider whether there is a need for a universal broadband policy in Hong Kong. The study should consider:

- The objectives which a universal broadband policy might meet
- The social and economic case for implementing such a policy
- The extent to which commercial services offer affordable broadband. This will require a definition of affordability
- The nature and extent of the gap between the requirements of affordable broadband and what commercial services can deliver
- The most efficient and cost-effective way to fill this gap

[52] *Are telecommunication services universally affordable across the EU*, Plum for Vodafone, November 2010, www.plumconsulting.co.uk/publications.asp

- How the gap might best be funded if required
- The relationship between this universal broadband policy and the existing universal service policy

# 6 Emergency call services and NGNs

## 6.1 The practices of emergency call services (ECS) in Hong Kong and overseas

### International best practice

All the case study countries require operators, including mobile operators and certain VoIP service providers:

- To provide an emergency call services to end-users free of charge
- To prioritise emergency calls to ensure they reach the ECS centres.

They also require caller location information to be available, wherever possible, to the ECS centres at the time the call is made. For example this requirement is embedded in EU legislation. The specific arrangements differ in detail, but collectively they constitute international best practice.

### The practice in Hong Kong

In Hong Kong:

- Mobile operators at present provide cell location (cell identification) information to the ECS centres upon request. Best practice requires such information to be provided automatically to the ECS centre when the call is made. Anecdotal information provided to the Consultants suggests that such information typically takes up to 30 minutes to provide. This level of delay may well be critical in emergency situations where rapid response is required and where either the caller is unable to provide accurate location information, or the information provided is unreliable.
- Cell identification is not the same as detailed positioning information and is less useful to ECS than the software routines based on multiple cell registrations used in some overseas countries, such as the UK and Australia. However, in many situations in Hong Kong in-building and in-fill cells may have such small coverage areas that cell identification alone could provide adequate location information.
- Fixed operators other than PCCW do not interconnect with the ECS centres directly. Currently only PCCW provides caller address information to the ECS centres through automatic means. Other fixed operators do not directly interconnect with the ECS centres and also do not provide caller address information to the ECS centres via PCCW. This has the potential to increase the time of the response to emergencies where emergency calls are made using other fixed operator services.

We can see that current practice in relation to the quality and adequacy of location information provided by operators to ECS centres in Hong Kong does not measure up to international best practice.

To deal with this problem in the case of fixed operators, a central database could be established to which all operators contribute location information for their customers. Some overseas administrations regard this as an important and obvious solution to the problems associated with a reluctance to share

subscriber information with competitors. Under current interconnection arrangements PCCW is the obvious entity to operate such a database. But the other fixed operators are concerned that such information could be used for commercial purposes and resist such a role for PCCW. There is a public interest issue involved here which exists independently of the move to NGNs.

The Hong Kong police force plans to review the operation of the emergency call services (ECS) in 2011. It is especially concerned that OFTA should establish a legal basis for the supply of accurate caller location information so that:

- Emergency calls are routed to the preferred ECS centre[53]
- The dispatcher at the ECS centre has accurate information on the location of the caller at the time of the call which is independent of any information supplied by the caller.

In addition the police force is concerned that there should be alternative routing between networks and each call centre to allow for network failure. At the moment all emergency calls are routed via the PCCW network, and PCCW is connected to each call centre.

## 6.2 Will NGN have impacts on caller location information in Hong Kong?

The implementation of NGNs will lead to substantial increases in the level of VoIP traffic. To the extent that this includes nomadic VoIP traffic in Hong Kong, the move to NGNs will have impacts on caller location information being provided to the ECS centres. In our view the implementation of NGNs will exacerbate these pre-existing problems.

A number of case study countries recognise the problem of supplying caller location information from *nomadic VoIP services*, but deal with it in different ways:

- In Australia, the *Telecommunications (Emergency Call Service) Determination 2009* requires that the VoIP service provider must supply a national database with the public number, name and address of the customer, advice that the call may be coming from a different address, and an appropriate contact number for the customer
- In the UK, Ofcom requires the VoIP service provider to provide location information to the ECS centre if possible. It is keeping what is technically feasible under review
- In Korea, the VoIP service provider is required by the KCC to provide location information to the ECS centre[54]. It is also required to ask customers to update this information if they move location.
- In the US, the FCC requires a VoIP service provider to collect information on the location from which the service will first be used before it can initiate the service. It must also make the customer aware of any limitations on use of the service for emergency calls, send him or her labels summarising these limitations, and receive acknowledgement from the customer that they understand them.[55]

[53] There are three centres in Hong Kong

[54] The KCC has designated the Korea Telecom Operators Association to set out how nomadic VoIP service providers should deal with change of subscriber location in an operational guide

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

We note that none of these methods is entirely satisfactory. Nor is the approach currently used in Hong Kong. The Unified Carrier Licence and Services-Based Operator Licence for Hong Kong cover the issue of nomadic VoIP. In accordance with its licence conditions, the services-based operator is required to remind customers to update their location information every time they change their location. But in practice customers often fail to do so.

## 6.3 Issues for the study

We confine our analysis of ECS issues to those which relate to NGNs. We have identified four such issues.

***Issue 1***: *Should obligations to provide an ECS, free of charge to subscribers, be maintained for NGN operators?*

There is a strong case for OFTA maintaining such obligations for NGN operators given that:

- It is generally agreed that free emergency calls are in the public interest. At the same time, it is highly likely that most, if not all, voice services will be carried over NGNs in Hong Kong in the long-term
- There is general support for this position from regulators and operators in the case study countries.

***Issue 2***: *Should NGNs support priority treatment for the delivery of emergency calls?*

Again there is a strong case for NGN operators, given the strong public interest values at stake, to ensure delivery of emergency calls. They might do this in one of two ways:

- They might use standards to ensure prioritisation of emergency calls, whether originating on or transiting an NGN. Such standards are not yet defined for Hong Kong. There are three main requirements:
  - The SIP-I standard has the functionality to alert a circuit switched network using ISUP, which receives an emergency call from an interconnected NGN, to the fact that the call requires prioritisation across the network and delivery to the relevant emergency service[56]. This is likely to be a key requirement in the short to medium term as the emergency call centres remain connected only to traditional circuit switched public networks.
  - Standards within SIP for prioritising emergency calls within an NGN. Again international standards are available here from both ETSI and the IETF
  - A mechanism to reserve capacity in the IP transport networks of the NGNs to ensure that the emergency call can be carried with appropriate levels of assurance on an end-to end basis between the NGN and ISUP networks. This involves reservation of a relatively small proportion of overall capacity and should not be a problem. But there is a need for all NGNs to meet this requirement and there is a good case for adopting a standardised means of achieving it, both at the point of interconnect and, more fundamentally, across the originating

[56] See for example the UK standard published by NICC ND1017, *Interworking between Session Initiation Protocol (SIP) and UK ISDN User Part (UK ISUP),* Section 6.1.3.2

IP bearer network, to ensure that network congestion or service degradation does not prevent effective call delivery.[57].

- They might deliver emergency calls reliably and promptly simply by ensuring that there is sufficient surplus capacity in both their networks and their network gateways at all times.

We suggest that OFTA and the relevant authorities should ensure that reliable and immediate delivery of emergency calls are demonstrated by NGN operators, but leave it to each NGN operator to decide how it meets these requirements.

***Issue 3**: How do the relevant authorities ensure that ECS centres receive the best possible information about caller location?*

It is relatively straightforward for the traditional fixed operators and the mobile operators to provide accurate location information. It is much more difficult for service-based operators, offering VoIP services which include free emergency calling, to do so. Such services can be used, with the same number, from a range of locations. In accordance with its licence conditions, the service-based operator is required to remind customers to update their location information every time they change their location. But in practice customers often fail to do so.

There are a variety of options open to the authorities to deal with this problem. For ***voice services*** offered by fixed and mobile operators they might mandate the establishment of a central database to hold customer location information for all fixed operators and to provide a portal into mobile operator caller location information. This might deliver network cell identification and, in future, handset driven information derived from Global Positioning Systems (GPS).

If a central database is to be used then the obvious operator to run it is PCCW, because PCCW has most of the information required to populate the database. But, as we already note, lack of trust of PCCW means that other operators oppose this arrangement. In these circumstances the best approach might be for another party to manage the database. That other party might be:

- The police; or
- Another trusted third party, not being a provider of telecommunications services in Hong Kong.

This then raises the issue of who should bear the costs of the database - the telecommunications industry, the Government or the Hong Kong police force?

For ***nomadic VoIP*** calls the authorities might:

- Follow the Australian approach. This requires service-based operators which provide nomadic VoIP services offering ECS access, to supply a central database with:
  - the public number, name and address of the customer
  - advice that the call may be coming from a different address
  - an appropriate contact number for the customer
- Follow the US approach and require that VoIP service providers must collect information on the location from which the service will first be used before it can initiate the service. It must also

[57] See for example UK standards published by NICC and specifically Section 5 of ND1612, *Generic IP Connectivity for PSTN / ISDN Services between Next Generation Networks* and Section 8 of ND1614 *NGN Interconnect: PSTN/ISDN Service; General Connectivity Management*. Work is continuing in the IETF, TISPAN, NICC and elsewhere to ensure that a consistent approach to call prioritisation across IP networks can be adopted, using native IP signalling options such as RFC4412 as appropriate.

make the customer aware of any limitations on use of the service for emergency calls, send him or her labels[58] summarising these limitations, and receive acknowledgement from the customer that they understand them

The more fundamental option of restricting nomadic VoIP service providers from offering emergency calls as part of their products could be considered but that would be dependent on a wider consideration of public policy objectives. The Government would need to consider whether or not it is in the public interest to do so and how it should be implemented.

***Issue 4:*** *As operators move to NGNs, how should they connect to the ECS centres and who should bear the cost of the interface between the ECS centres and the NGNs?*

At the moment PCCW is the only operator which interfaces with the three ECS centres. It uses TDM interfaces. However:

- The Hong Kong police are concerned that the centres should connect directly with other networks, to create more resilience in the ECS system. This requirement may be satisfied by having two operators interconnect to each of the three ECS centres. In other bigger countries, such as the UK, the police force was originally satisfied with two points of interconnection to independent networks from the ECS system. This number is now three.
- Some operators want to interconnect directly with the ECS centres so as to reduce their costs when compared with transiting via PCCW. For others there are significant net costs in interconnecting directly with the three ECS centres. This suggests that the police might wish to designate at least one voice services provider as a provider of last resort for wholesale transit emergency call service access, so that smaller providers are not forced to provide uneconomic direct connection to the emergency services authorities. At the same time the police may wish to specify minimum criteria which operators must meet before they are permitted to connect directly with the ECS centres.

In the long term the ECS centres will need to migrate from TDM to IP interfaces. But we believe that this time is still some way off. For example:

- PCCW currently carries a substantial majority of its voice traffic over its TDM-based fixed network
- There are a number of issues to be resolved before NGN interfaces to the ECS centres are appropriate. This includes resolving issues of interconnection charging and quality of service between NGNs and prioritising emergency calls carried over NGNs. How to resolve these issues is discussed elsewhere in this report. The specific case of operator direct-connection to ECS sites is a matter which we understand will be included in the Hong Kong Police review as mentioned in Section 6.1 above.

We conclude that OFTA should not take any action on this latter issue for the time being.

## 6.4 Next steps

As noted above, there is an important public interest issue associated with having caller location information on all calls provided in a useful and timely manner to the ECS centres. The issue transcends NGN but may be exacerbated by it. Elsewhere in the world the telecommunications

[58] For attachment to the VoIP equipment

industry has often dealt with this issue by constructing a central database of caller location information. Given this situation:

- Hong Kong will need to consider the feasibility of the approach of building and maintaining a single, centralised database. The money for such a database could come from the Government or from the industry[59].
- The issue of a centralised database is likely to be a key matter for the review of ECS arrangements that the Hong Kong police force is intending to conduct in its review.
- It would be inappropriate for us to anticipate the results of the review being undertaken by the Police, which will focus more resource on the issues than is appropriate for our study. In addition the review will have a wider focus and will therefore establish a broader context than the scope of the present study permits.

## 6.5 Recommendations to OFTA

In drafting our recommendations we note that:

- They relate only to possible impacts of NGNs and not to ECS issues as a whole. In particular they do not consider the key issue of delivering accurate caller location information at the time an emergency call is made
- OFTA, as the body responsible for regulating the telecommunications industry in Hong Kong, and the Police and other relevant authorities, as the bodies responsible for provision of emergency services and operation of ECS centres, will both have important roles to play in ensuring the satisfactory future performance of ECS. In the case of the latter, it is important to highlight that these emergency services agencies should ensure that sufficient capacity and capability be developed in order to keep up with the market changes and technological development (e.g. allowing NGN operators to direct interconnect with ECS centres).

Our recommendations to OFTA are as follows.

**Recommendation 6.1:** Reiterate that NGN operators are obliged to provide free ECS to the public

**Recommendation 6.2:** Ensure that each operator demonstrates to the relevant authorities that its NGN will deliver emergency calls reliably and immediately across both its network and its network gateways. This might be achieved by providing sufficient capacity or through standardised call prioritisation mechanisms

**Recommendation 6.3:** Ask the TSAC to consider the development of standards to enable such prioritisation, both in terms of NGN signalling standards for Hong Kong and standards for the reservation of capacity for emergency calls

**Recommendation 6.4:** Provide the analysis in this chapter to the Hong Kong police force as an input to its study

**Recommendation 6.5:** Work with the police and other relevant authorities to designate at least one operator as a transit operator of last resort which is interconnected with the three ECS centres

[59] As in the case of the EU

**Recommendation 6.6:** Subject to the outcomes of the Police review and the capacity of the ECS equipment in each area, work with the police and other relevant authorities to allow operators who wish to interconnect directly with the ECS centres to do so, provided they meet the same minimum requirements as are met by the transit operator of last resort.

# 7 Network security and NGNs

## 7.1 The importance of network security

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 while 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 importance.

Securing networks against theft of equipment and cables, unauthorised entry, terrorist attacks, natural disasters, and human error has always been a problem for operators. But the move to IP-based networks, whether the public Internet or NGNs, introduces new threats such as distributed denial of service (DDOS), theft of information and/or identity, and infection of software. In a recent report the OECD highlighted three import recent trends which are of particular concern:

- World Wide Web portals are 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 problems such as those faced by Estonia in 2007[60].
- 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.
- Cloud computing 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.

In the light of these issues, the OECD report offers a comprehensive checklist for relevant government agencies:

- Ensure that national cyber security 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

[60] Which suffered a massive DDOS attack from Russia

- Fund research into areas such as: Strengthened Internet protocols, Risk Analysis, Contingency Planning and Disaster Propagation Analysis, Human Factors in the use of computer systems, and Security Economics.

## 7.2 International measures to increase cyber security

Governments around the world have launched initiatives to respond to the growing threats to cyber security. In particular:

- APEC, in the Asia-Pacific region, has set up a Security and Prosperity Steering Group to coordinate its members' cyber security work. It has run workshops on submarine cable protection and cyber security awareness, and also undertakes work on ICT in disaster preparedness and recovery, cybercrime prevention and the development of Computer Emergency Response Teams.
- The EU has added a new Article to the Framework Directive (2009/140/EC) on security and integrity of networks and services. This strengthens obligations on network operators to ensure that appropriate technical and organisation security measures are taken, to guarantee the continuity of supply of services, and to 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 had to be transposed into national legislation by Member States by 25 May 2011.

## 7.3 The position in Hong Kong

Network security is a major concern for all Hong Kong operators. Several report that they, and their customers, have suffered recent attacks in terms of hacking and DDOS. All claim to have made serious investment in staff and systems to deal with these threats. The Hong Kong operators have strong incentives to safeguard their reputation by ensuring that their networks and customers remain safe. So they believe that the prime responsibility for network security lies with them. But they also believe that OFTA has a potentially important role to play here.

OFTA, in collaboration with relevant stakeholders, has already done work on network security for NGNs which culminated in the *Security Guidelines for Next Generation Networks*. These guidelines are fully in line with the general principles that are being adopted worldwide to protect against the threats identified. These guidelines do not however:

- Provide an appropriate level of risk assurance or incident management effectiveness by Hong Kong's operators
- Effectively position network security within an overall territory-wide scheme aimed at protecting "critical infrastructure"
- Specify how operators might share best practice on network security and co-ordinated threat responses.

## 7.4 OFTA's future role in ensuring networks security

Given the analysis set out above we propose that OFTA should consider playing some or all of the following roles in ensuring networks security for NGNs:

- Ensure that network operators are dealing effectively with the key network security issues. If all the relevant stakeholders – customers, other network providers, and Government – are to be confident that the "network of networks" is secure, some visible level of security assurance is justified. OFTA might wish to wait for further international guidance, such as that which ENISA will provide in 2012 before acting[61]. Or it might like to adopt a more proactive approach such as that taken by Ofcom in the UK. Under this approach OFTA might:
  - Set up an appropriate operators' forum to decide on security standards with which operators should comply. This might include ISO/IEC 27001 obligations, complemented by telecoms specific ISO/IEC 27011 and/or a national checklist/standard equivalent to the UK's ND1643, selecting from the options in ISO/IEC 27002 where relevant. Box 7-1 provides a brief description of each of these standards
  - Leave it, as now, to communications providers to specify in relevant bilateral or multilateral contracts that other providers must meet these standards prior to entering into interconnection or facilities sharing.[62]

  Whichever approach is used, it is important that minimum security standards are established, and that a mechanism for ensuring compliance by all Hong Kong operators is put in place. Determining that the ensuing arrangement is on the overall public interest from a telecommunications perspective is a matter on which OFTA will need to be satisfied.
- Continue to monitor international best practice, and to update its guidelines as and when required. This may then necessitate some alterations to the obligations on operators
- Continue to play an appropriate role in extending the critical territory-wide infrastructure plan to telecommunications. Such a plan should aim to establish a common understanding of what level of service assurance can be expected for each infrastructure element and provide a mechanism to ensure incidents and threats that impact on one or more of these elements are handled in the most effective way, with appropriate communications channels and contingency plans already in place. This is clearly outside the remit of OFTA but, equally clearly, a telecoms specific network security framework is incomplete without these wider linkages and this contingency planning
- Continue to facilitate effective operator liaison and coordination so as to enable operators to share best practice in network security and coordinate threat responses. OFTA has already issued a number of guidelines under which telecommunications network operators report to OFTA when congestion, outage or other network security incidents occur[63]. OFTA also runs a 24/7 emergency response team which is the contact for operators and which coordinates the emergency response among operators. The Internet Infrastructure Liaison Group (IILG) hosted

[61] The European Network an Information Security Agency (ENISA) was set up to carry out specific technical tasks in the field of Information Security and to assists the European Commission in the technical preparatory work for updating and developing Community legislation in the field of Network and Information Security.

[62] Terms and conditions of interconnection or facilities sharing between operators and service providers are subject to commercial agreement unless it is determined by TA in some cases. Specification of security standard is not prohibited in such terms and conditions. Nevertheless in a guidance note OFTA might encourage communications providers to explicitly consider including network security standards in their interconnection agreements.

[63] See for example http://www.ofta.gov.hk/en/report-paper-guide/guidance-notes/gn_201106.pdf

by the Office of Government Chief Information Officer plays a coordination role on issues relating to Internet Infrastructure while the HKCERT responds to security incidents

- Provide consumer education. OFTA already plays a central role here. But stakeholders are especially concerned to raise awareness of network security threats among SMEs in Hong Kong.

**Box 7-1: Standards relevant to ensuring compliance with network security requirements**

| Standard | Description |
|---|---|
| ISO/IEC 27001 | 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. |
| ISO/IEC 27011 | Also known as X.1051. 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 | A minimum set of security standards between interconnecting operators in the UK. Developed by the NICC it offers a 23-control subset of ISO/IEC 27002 which is 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. |

## 7.5 Recommendations to OFTA

**Recommendation 7.1**: Ask the industry to establish:

- Minimum security standards which should apply to all operators in Hong Kong and
- A mechanism for ensuring compliance with these standards.

**Recommendation 7.2:** Ensure that the arrangements proposed by the industry meet the public interest.

# 8 Other issues

## 8.1 Numbering, naming and addressing

To what extent will a move to NGNs impact on the demand for telecommunications numbers, names and addresses over the next 10 to 20 years? Will likely changes lead to problems for telecommunications services in Hong Kong? We have carried out a review of relevant long-term trends. The findings are documented in Annex J. We conclude that:

- E164 numbers will continue to play a central role in Hong Kong telecommunications for the next 10 to 20 years
- No new naming and addressing schemes, beyond the existing E164 numbers, IP addresses, domain names and application-specific identifiers[64], are likely to become important in this period
- There is likely to be little latent demand for number blocks from service providers which are not currently entitled to apply for them
- Operators may have a substantial demand for numbers and number blocks for machine-to-machine communications. This could reach 20 to 40 million numbers in Hong Kong[65]
- There is no demand for user ENUM, which enables end-users to make voice calls between circuit switched and IP networks, and allows the number holder to select how inbound calls are routed
- Carrier ENUM is already used in Hong Kong within NGNs and for some international functions
- There is a prospect that Hong Kong operators will want to implement a common carrier ENUM service in future to enable more cost effective interoperability between NGNs and/or number portability. But we can see no reason why OFTA should intervene to promote or prevent such a move.

Overall we see few issues here where OFTA might need to act, beyond its current close monitoring of the numbering plan as it approaches exhaustion. But OFTA will need to consider the creation of specific number ranges for machine-to-machine communications[66]. These might use the full 15 digits allowed under the E164 Recommendation. We understand OFTA has tabled a paper on numbering arrangements for machine-to-machine communications in Hong Kong to the Telecommunications Numbering Advisory Committee. Given this action we believe that there are no new initiatives which OFTA need take to deal with the impact of NGNs on numbering, naming and addressing in Hong Kong.

[64] Such as a Skype name

[65] Assuming these number ranges are 50% utilised when they reach exhaustion

[66] At least one operator has indicated that it would like to be able to allocate 10,000 number blocks to corporate customers for machine-to-machine communications

## 8.2 Safeguards for consumers

### The position in the case study countries

Should OFTA impose obligations on operators during the migration to NGNs so as to safeguard the interests of consumers in Hong Kong? The case study countries vary in their approach here:

- Korea established obligations to meet minimum quality of service requirements for voice services over NGNs and to provide continued access to the emergency services
- Australia has no specific regulations to safeguard the interests of consumers. But the ACCC has a duty to consider whether NGN services are being provided in ways that are in the long-term best interests of consumers
- In the UK Ofcom has established three principles which operators should follow when migrating to NGNs[67]:

  *"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 should be fully explained to consumers".*

In practice the biggest problem detected so far[68] in moving to NGNs relates to alarm systems. Many of these no longer work because the NGN cannot meet latency requirements for polling the alarms. In the UK a substantial proportion of the 3.5 million alarm systems in use may require replacement. Ofcom has imposed an obligation on the operators to inform customers when alarm systems need replacing. But the operators are not required to bear the cost of replacement.

### Options for OFTA

OFTA might issue guidance to the operators along the lines of the Ofcom principles. Or it might simply remind operators that it will monitor NGN service offering and intervene when there are sustained complaints, arguing that the operators have strong commercial incentives to keep customers satisfied.

Whatever approach is taken, there is a difficult balance to be struck here between safeguarding consumers and unnecessarily raising the costs to the industry, and ultimately end-user prices, during the migration.

### Retirement of copper

The move from copper to fibre, as part of the migration to next-generation access, raises another consumer protection issue for OFTA to consider. What, if any, obligations should be put on Hong Kong operators when they retire parts of their copper access network and replace them with fibre.

[67] See Annex E

[68] Given the relatively early stage of NGN rollout there may be other, as yet undetected, major issues

Copper retirement has started in the US [69]and will happen progressively in Australia and Singapore as the fibre-based National Broadband Network replaces the copper network. OFTA may wish to consider imposing minimum conditions on operators when they discontinue copper access in a part of their network[70]. This might include:

- A minimum service set to be delivered over fibre when it replaces copper
- Prices for this minimum service set to ensure affordability for the consumer
- Requirements for standby power of terminals and network equipment in customer premises[71].

It may be the case that retirement of copper is not yet relevant in Hong Kong. But, if it is, then putting consumer safeguards in place now would enable operators to plan for copper replacement with a greater degree of regulatory certainty. Such requirements are likely to be relevant only to PCCW, as the de facto carrier of last resort.

## 8.3 The impact of NGNs on requirements for spectrum

### The position in the case study countries

Spectrum authorities around the world are now putting considerable effort into releasing substantially more spectrum for mobile broadband. This is reflected in the findings from the case studies:

- In the US mobile technology is seen as essential for achieving the national broadband plan. In 2010 the FCC called for 500 MHz of additional spectrum for telecommunications use and has identified likely sources for 300 MHz. The current focus is on refarming spectrum at 700 MHz from broadcasters to mobile broadband operators, using incentive auctions under which broadcasters receive a proportion of auction proceeds if they voluntarily release spectrum
- Australia plans to auction 90 MHz of spectrum at 700 MHz and 140 MHz of spectrum of 2.5 GHz in 2012
- Korea plans to release 100 MHz spectrum at 700 MHz in 2012 for 4G mobile services
- The UK is typical of the EU as a whole in terms of spectrum release for mobile broadband. It plans to auction 60 MHz at 800 MHz and 190 MHz at 2.5 GHz in early 2012
- Japan plans to assign additional spectrum, probably using beauty contests rather than auctions, to mobile operators in the near future. Details of these assignments are not yet clear
- Singapore plans auctions of 2.3 and 2.5 GHz spectrum in 2012. But its digital switchover will not be completed before 2015. So additional, sub 1 GHz, spectrum will not be available for mobile broadband before this date.

[69] http://www22.verizon.com/regulatory/pdf/Bartonville-TX.pdf

[70] Operators may offer copper and fibre access in parallel for a period of time. But this arrangement is not efficient in the long run and retirement of copper is required. At this point consumers who wish to retain wireline service have no option but to switch to fibre access.

[71] In the UK terminals are currently required to maintain voice services for a minimum of four hours in the event of a loss of mains electricity. This period is likely to be reduced to an hour or less following a consultation by Ofcom. In Hong Kong, operators providing telephony services by broadband networks need to observe a code of practice for back-up power supply under which network equipment installed in customer buildings should be able to continue operation for at least one hour during outage of public electricity.

## The position in Hong Kong

In Hong Kong the position on spectrum supply for mobile broadband is as follows:

- According to several of the operators to whom we spoke, there is plenty of spectrum available for mobile broadband at frequencies over 1 GHz, following the 2009 auction of 2.5 GHz spectrum
- There are plans for further auctions at 2.3 GHz (90 MHz) and 2.5/2.6 GHz[72]
- There are no immediate plans for release of additional sub 1 GHz spectrum, beyond the 20 MHz auctioned in 2011
- Digital dividend spectrum is now not likely to be available for mobile broadband before 2015 at the earliest, given slow progress on digital switchover of TV.

When compared with the case study countries, it appears that Hong Kong lags in terms of the supply of sub-1 GHz spectrum for 4G technologies. This could affect the development of mobile broadband in Hong Kong relative to other developed countries. Our stakeholder interviews confirm this tentative conclusion – that lack of sub-1 GHz spectrum for 4G use is a problem. In Hong Kong the main benefit of using such spectrum is to provide better in-building coverage when compared with spectrum in the higher frequency bands. Given the complex radio network environment created by the multiple high-rise buildings in Hong Kong, it is especially difficult to get good in-building coverage without a substantial supply of sub-1 GHz spectrum. Operators are disappointed that the date for release of digital dividend spectrum has slipped and remains uncertain[73].

Stakeholders also raised one other problem which relates to the impact of NGNs on the use of spectrum. They argue that inappropriate conditions are attached to use of spectrum at 4 GHz plus which make its use for mobile broadband backhaul problematic. The issue, as outlined by stakeholders, is as follows:

- OFTA has established policies for assignments of frequency bands based on path lengths of fixed links.
- The Radio Spectrum Advisory Committee (RSAC) has estimated that microwave technology at 18 GHz can provide the kind of bandwidth and capacity required for mobile broadband backhaul[74], with an acceptable performance given the rain fade problems in Hong Kong, for fixed links with lengths of up to 6 km[75]
- Most fixed links deployed in mobile backhaul networks do not exceed 6 km in length
- On the basis of these findings, OFTA has decided not to assign spectrum below 18 GHz for fixed links shorter than 6 km to provide the kind of bandwidth and capacity required for mobile broadband backhaul

[72] The exact amount of spectrum to be auctioned at these frequencies has yet to be determined)

[73] One option to achieve good in-building coverage is use of femto cell technology. While this solution would provide good in building coverage where it is deployed, it only provides coverage for the customers of the service provider of the network supporting the femto cell. Hence there is still a requirement for in building coverage via other means for customers unable to use the in-building solution. Femto cells could become a viable in-building solution if they are operated by a neutral wholesaler with roaming agreements with all mobile operators.

[74] I.e. 100 Mbps or more

[75] RSAC Papers 6/2009 and 4/2010

- Currently the mobile operators in Hong Kong mainly use 0.3 m microwave dishes for backhaul. Use of a dish of this size using 18GHz spectrum means a substantial reduction in link length and/or bandwidth
- Moving to 0.6 m dishes so as to enable backhaul for mobile broadband is challenging. There is strong resistance from landlords in Hong Kong to installation of 0.6 m dishes on aesthetic grounds, there is a need to comply with building regulations, and space is often too limited to allow use of bigger dishes.
- As a result, retaining the current rules on spectrum use for high capacity fixed links would substantially increase the costs of providing backhaul for mobile broadband.

We believe that it may be in the public interest for OFTA to review this decision. We note that:

- The rules on allocation of spectrum for fixed links at frequencies above 4 GHz were established following detailed ***technical*** studies and consultation with the RSAC. The path length policy is intended to retain low frequency bands for long links that would not be technically feasible in higher frequency bands due to heavy rain loss in Hong Kong
- These rules allocate the lower frequency bands to long fixed links which offer a cost-effective solution for serving remote areas and Islands
- Mobile broadband is of rapidly growing importance for economic and social development around the world
- Economic aspects were not explicitly taken into account when setting the current rules.

Given these points, we believe that there is a good case for the RSAC to review its rules and take account of the economic as well as the technical dimensions of the problem. For example it might wish to consider:

- What additional spectrum might be made available for fixed links over the next five years?
- What fixed link capacity is required to provide basic services to remote areas?
- What set of rules, which both provide these services and meet future demand for mobile broadband, would lead to minimum costs?

## 8.4 Network neutrality

### Key issues

The net neutrality debate is largely about the public Internet rather than about managed NGNs. But rollout of NGNs complicates the debate – especially if the best efforts Internet and the NGN are implemented on a common IP transport network.

The RAAC has identified[76] three main aspects to the debate:

- Should network operators be allowed to block access by consumers to (legal) applications, content and services of their choice?

[76] See RAAC Paper 2/2009

- Should network operators be allowed to degrade certain services and/or applications relative to others?
- Should networks be allowed to charge more for some services than others?

We consider these three questions in turn below.

## Access to legal services and content

Governments and regulators in most developed countries now agree that consumers should have access to all legal applications, content and services over the Internet. For example this requirement is built into the revised EU regulatory framework of 2009. This requires NRAs to ensure "*the ability of end-users to access and distribute information or run applications and services of their choice*".

## Degradation of service

The position of regulators around the world on degradation of service is more nuanced.

There is a growing consensus that operators should be allowed to operate traffic management policies in which they throttle back applications which are delay tolerant[77] so as to allow other applications which are delay sensitive[78] to function satisfactorily at peak times. Such practices enhance economic welfare and many regulators now accept them as legitimate, subject to operators making these policies known to their customers. They are, for example, embedded in FCC regulation[79].

In contrast degradation of an Internet-based service by an access network operator, relative to a competing service run by its own downstream arm, is generally considered to be undesirable. It may be judged anti-competitive and banned, if the operator is considered to be dominant in the relevant market. Otherwise consumers might switch to another access network provider which does not discriminate in this way. Constraints on operators in Hong Kong degrading services in this way are particularly strong, given the high level of infrastructure-based competition in the supply of broadband services.

Finally there is the question of how managed services offered over an NGN might impact on the quality of best efforts Internet services, when both sets of services use the same IP transport network. The fear is that the traffic generated by those using the managed service will take priority over Internet traffic and the quality of the best efforts Internet service will fall to unacceptable levels. With this concern in mind, the EU revised regulatory framework now includes a provision which allows NRAs to impose minimum quality of service standards for the public Internet. Several of the operators to whom we spoke during the case study believe that such regulation is unnecessary. They argue that there are strong commercial incentives to maintain reasonable quality of service on the best efforts Internet and that regulation is not required.

[77] Such as file transfer

[78] Such as real-time voice

[79] See *Report and order on the matter of preserving the open Internet and broadband Internet practices*, FCC, 2010.

### Price discrimination

Debate on the third aspect of net neutrality, price discrimination, is also complex. Our research reveals two main current issues:

- Should operators be allowed to charge a premium for managed IP services, running on NGNs, when compared with the best efforts public Internet? Economic theory suggests that such discrimination is welfare enhancing and should be allowed, especially if the public Internet remains as a satisfactory alternative. To quote from Au (2011)[80]:

  *"as long as the best efforts Internet performs adequately as an open communications infrastructure, discriminatory practices on the managed networks should not raise public interest concerns"*

  With such a safeguard Au argues that regulators can be relaxed about NGN operators blocking access to selected applications and services as well as about price discrimination

- Should operators be allowed to discriminate in charging for end-users to receive certain types of content and not others? This issue arose recently in the EU where certain access network operators[81] proposed to charge content providers[82] to terminate downloads on the networks. Economists[83] argue that:

  – Such proposals are essentially a battle over the rents in the value chain which delivers Internet-based services

  – It is not clear where the rent should go in the public interest

  – Negotiation rather than regulation should settle the outcome.

  Neelie Kroes, the EU Commissioner responsible for telecommunications, took a similar position at the end of the CEO Broadband Summit in July 2011[84].

## 8.5 Recommendations to OFTA

The analysis set out above suggests that OFTA should forbear from any direct net neutrality regulation. Instead our recommendations here are as follows.

**Recommendation 8.1:** Monitor the market to ensure that operators do not block access to legal applications, content and service on the public Internet. This prohibition does not apply to NGNs, provided that end-users have open access to services offered over the public Internet

**Recommendation 8.2:** Review the traffic management policies of the operators to see that they are both sufficiently specific and understandable for the average consumer.

**Recommendation 8.3:** Require the operators to publish their traffic management policies in a manner which is suitable to consumers. There may also be a case for making more detailed traffic management policies available to ISPs[85].

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[80] *Network neutrality – Hong Kong's perspective*, MH Au, June 2011

[81] Including France Telecom, Telefonica and Telecom Italia

[82] Such as Facebook, Google and video on demand suppliers

[83] See for example *Net neutrality and the false promise of zero price regulation*, Hamphill, 2008

[84] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/508

**Recommendation 8.4:** Ensure that the best efforts Internet continues to function effectively alongside NGNs. In particular it is important, when operators run their NGN and Internet access services on the same infrastructure, that prioritisation of NGN traffic does not substantially degrade the quality of the public Internet. Market forces should deal with the situation in which a single operator degrades its public Internet service in this way. But public interest issues would arise if this degradation were widespread across the bulk of operators.

Based on the analysis of Sections 8.1 to 8.3 we make the following additional recommendations:

**Recommendation 8.5:** Consider, in discussion with the industry, and in particular with PCCW, whether consumer safeguards are required now for the retirement of the copper access network.

**Recommendation 8.6:** Do all it can, in its negotiations on coordination of spectrum use with mainland China, to accelerate release of the UHF digital dividend spectrum.

**Recommendation 8.7**: Ask the RSAC to review its policy on the allocation of spectrum for fixed links, given the future importance of mobile broadband for economic and social development in Hong Kong and the desirability of taking account of economic as well as technical factors in setting the rules.

[85] We note that OFTA has now implemented the first part of this recommendation through the publication of guidelines on fair usage policy in November 2011. We suggest that OFTA keeps these guidelines under review in the light of international developments. For example the EU's regulators have, through BEREC, recently launched a consultation on traffic management policies. See http://erg.ec.europa.eu/doc/berec/consultation_draft_guidelines.pdf