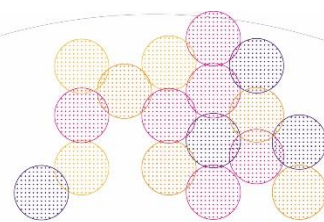


Mobile network termination: calling time on 2G and 3G

Yi Shen Chan, Sarongrat Wongsaroj



As operators start planning their 5G deployment, one important question that should not be overlooked is what should be done about existing 2G and 3G networks. The rationale for phasing out legacy networks is to ensure that spectrum is refarmed to the most efficient technology and by doing so reduce operating costs and optimise the cost base of the mobile network business. This is multi-faceted problem – aside from the business aspects such as competitive positioning and the implications on cost and revenues relating to service offerings, there are also wider policy issues such as the protection of consumers and key user groups, as well as the provision of public services.

The next phase of mobile evolution

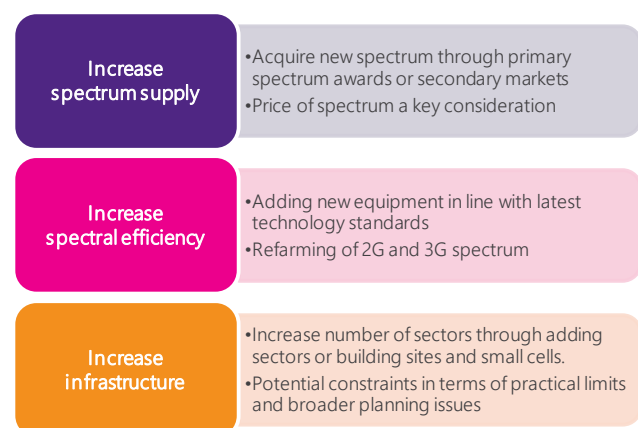
Over the last two decades, mobile networks have evolved from 2G to 3G and 4G. Alongside this mobile data traffic has grown exponentially as consumers have bought increasingly capable devices (e.g. smartphones and tablets) and gained access to a wide range of applications accessible via mobile data networks. In contrast, growth in voice traffic has been much lower.

The growth in demand for bandwidth has been driven primarily by streaming and sharing of video content. With each generation, mobile operators have invested in more spectrum resources to meet the growing demand. Now, with 5G on the horizon, this cycle is expected to continue with even more bandwidth-hungry immersive, multimedia AR/VR applications¹ as well as new enterprise and industry use cases.

Options for increasing capacity

Serving a rapidly increasing demand for mobile data (and an increased desire for enhanced speed by some applications) requires an expansion of throughput and capacity provided by mobile network infrastructure. There are three common ways to increase mobile radio network performance.

Figure 1: Expanding mobile network capacity

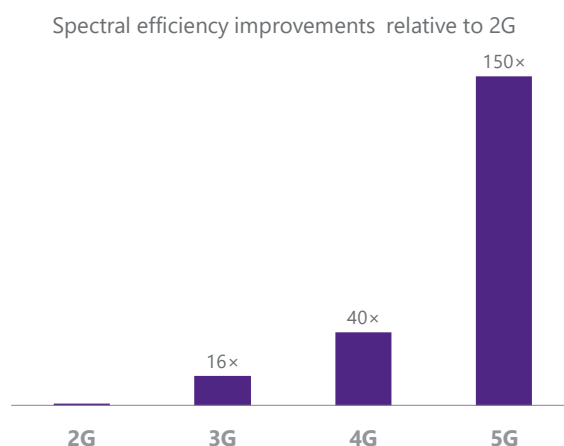


In with the new, out with the old?

The challenge for mobile operators is to manage the evolution of network technology to deliver a high spectral efficiency across network resources while catering to user demand and requirements.

With each generation comes significant improvements in spectral efficiency as shown below. In practice, such improvements are usually seen progressively across a network as the technology is rolled out. However, software enabling of new bands on equipment may allow this to happen quicker if the hardware base is already present in the network.

Figure 2: Efficiency improvements by generation



In most countries today, 4G (LTE) is responsible for carrying the majority of the mobile data traffic with utilisation of 2G and 3G on the decline. The refarming of 2G and 3G spectrum by operators has been ongoing for a number of years and this allows operators to increase spectral efficiency and lower cost of carrying each unit of mobile traffic. The final step will be the shutdown of these legacy networks but so far this has only been carried out in a few markets.

International experiences

The first mobile operator to shut down 2G services was Japan's KDDI in 2008. Since then, a number of operators, particularly those in more advanced markets such as Australia, Canada, Japan and the US, have followed suit as shown below.

Figure 3: Status of 2G shutdown globally

Market	Date of 2G network shutdown
Australia	Telstra (12/2016) Optus (08/2017) Vodafone (04/2018)
Canada	Bell (04/2019) Telus (05/2017)
Japan	KDDI (03/2008) Softbank (03/2010) NTT Docomo (04/2012)
South Korea	KT (03/2012)
New Zealand	Spark (07/2012) 2degrees (03/2018)
Singapore	M1, Singtel, StarHub (04/2017)
Taiwan	Chunghwa Telecom, Far Eastone, Taiwan Mobile (07/2017)
United States	A&T (12/2016)

Elsewhere, various operators across Asia, Europe and North America have announced plans to decommission 2G or 3G networks. While most of the network shutdown have been 2G so far, there is also increasing focus on 3G.² At the end of 2018 Taiwan became the first market where 3G has been effectively phased out.³

Getting the right balance

While there are clear incentives and advantages for operators to move away from legacy networks, this needs to be kept in step with the availability of user device and service evolution on the network. Technology adoption generally occurs in several phases⁴:

- Early adopters (usually within the first year of introduction),
- Mass adoption (which could extend over a period of several years), and
- Late adopters.

There may also be a segment of the market that will be reluctant to migrate to new devices and technologies for various reasons. Some users simply see no need to switch to a new technology or cannot afford to upgrade their existing devices. Others, such as legacy M2M devices, may face difficulties in migrating.

Refarming spectrum too quickly may lead to congestion in bands used by legacy devices (or which are carrying spill over traffic from later technology bands). The retirement of legacy networks requires a clear migration path for all traffic and users currently using the technology.⁵

Voice services

The provision of voice services is a key consideration for refarming and retirement of legacy networks. At present, most voice traffic is supported on circuit switched (CS) facilities (using 2G and 3G technology). VoIP (e.g. VoLTE, VoWiFi and Vo5G) is still not widely deployed across mobile networks and it is required to support voice services when CS voice is turned off. Although VoIP technology has been developed for mobile networks it is not yet at a mature stage of rollout and adoption rates are still low.

There are two barriers to consider.

- The availability of VoIP-enabled devices – most new smartphones on the market now support VoLTE and VoWiFi.
- Provision of the VoIP capability in the mobile network infrastructure (e.g. using IMS⁶ which involves expenditure on software licenses).

When considering migration to VoIP on mobile networks, a small amount of spectrum may still need to be retained to support CS voice until it is feasible to transition to a fully VoIP-only network.

Additionally, inbound roamers may have devices or contracts that do not support VoIP. For this user group, it is necessary to retain some CS voice capability to continue to service inbound roaming voice traffic. While it is possible to manage migration to VoIP in an operator's own customer base through the application of appropriate incentives, this option is not available when dealing with inbound roamers. For operators this means a choice in terms of whether to provision for the inbound traffic or to cease serving it (with the traffic potentially being serviced by competitor networks).

M2M services

Traditional machine-to-machine (M2M) services are often supported using 2G spectrum (primarily GPRS). These services are usually low data rate transmitting with a low duty cycle. The devices are often embedded in other equipment (e.g. electricity meters or tracking equipment) and have asset replacement cycles that are significantly longer than those for most consumer mobile devices.

Migrating these M2M devices could require considerable effort in liaison with other agencies (who may have to meet additional costs arising from early obsolescence). Further, some of these users could be utility service providers (electricity, gas and water) or public safety agencies (police, fire, emergency medical

services) which means both economic and social benefits need to be taken into account.

Options for dealing with these services could include:

- Ceasing of deployment of new devices using the legacy technologies.
- Migration of existing devices to newer standards (e.g. NB-IoT).
- Retention of a small amount of spectrum to support the services until it is possible to phase them out.

NB-IoT technology and future 5G networks may be a substitute for legacy narrow band M2M services. NB-IoT is an open 3GPP standard, which can be deployed on existing networks and it shares features with LTE (e.g. authentication and encryption). Other substitutes could include eMTC, LTN, LoRA, Weightless and other technologies. The way forward is a strategic decision for network operators based on the position of M2M in their product portfolio.

Implications of 5G

The arrival of 5G is another factor for consideration. While 5G offers potential revenue opportunities for operators, it comes with significant costs which include new sites and equipment upgrades, additional spectrum fees, device and network management costs, marketing and associated expenses.

There are various options for the deployment of 5G, and LTE will be a key part of the network evolution path in most cases.⁷ At a time when huge capital outlay is anticipated, maintaining multiple generations of technologies adds to the complexity of network management operations and increases operating expenses. The drive for cost efficiency means that a roadmap for phasing out 2G, 3G networks or both becomes an imperative for mobile operators.

Strategy for mobile network operators

The objective for operators is to reduce long-term total cost of ownership (TCO) by having to maintain fewer generations of networks while minimising the risks in terms of revenue impacts of phasing out 2G and 3G networks.

The roadmap to the decommissioning legacy networks comprises three main stages – planning, transition, switch-off. The activities involved are:

1. **Planning:** activities relating to the planning and decision-making process (including the cost-benefit analysis of options for 2G/3G switch-off).
2. **Transition:** preparation and migration phase involving cessation of new SIM registrations or activation for legacy networks, upgrade processes for existing customers (retail & wholesale) and consumer awareness campaigns to ensure minimal disruption ahead of switch-off.

3. **Switch-off:** the actual shutdown and this is typically done in stages to allow operators to better manage the switch-off process and to address any potential issues that may arise during the switch-off.

Stage 1: Planning

As part of the planning stage and the prioritisation of options, an assessment of current and future demand and supply situations is required and this should consider current network congestion issues, spectrum utilisation, technology evolution and future spectrum availability. Other factors that need to be taken into account include:

- Device capability and the rate at which this is evolving
- Voice traffic technologies and spectrum required to continue to serve CS voice over time
- Handling of legacy M2M devices and substitutes for.
- Roaming utilising legacy technology.

The available options⁸ will depend on market and technology circumstances and could include 2G-led, 3G-led or 2G-and-3G strategies and there could be additional variations in terms of timing and geography. The impacts in terms of benefits and costs, as illustrated below, will then need to be assessed to identify the optimal approach to network decommissioning.

Figure 4: Benefits and costs of network shutdown

Benefits	Costs
<ul style="list-style-type: none"> • Increased network capacity and QoS improvement, potential revenue uplift • Network cost savings • Reduced need for additional spectrum 	<ul style="list-style-type: none"> • Network investment/ upgrades • Customer migration • Risk of increased churn during transition • Loss of roaming revenue

Stage 2: Transition

The transition stage could take a significant period of time depending on the customer base and the pace of migration. International experience suggests a minimum of two years in line the typical length of mobile contracts.⁹ However, in other instances, a longer lead time may be required, particularly if there is a large base of M2M devices which tend to have a longer refresh cycle than handsets.¹⁰

The steps that need to be taken during the transition phase to encourage migration include:

- Cease activation of 2G/3G customers and non-VoLTE devices,
- Launch consumer awareness campaigns (e.g. advertising, letters and text messages to customers to notify on shutdown dates),

- Work with regulators/governments to identify vulnerable customer groups (e.g. seniors) and develop initiatives to help,
- Provide discounts or free equipment (e.g. handsets) for existing 2G/3G customers, and
- Work with wholesale customers/IoT solutions providers to upgrade M2M customers to alternative solutions.

Stage 3: Network switch-off

The switch-off is typically done in stages and by region. This is to minimise the risk of interference between sites, and ensure sufficient resources are available to address any unexpected issues. The length of this final stage differs depending on country circumstances and operator needs – this could range from a matter of weeks to several years.¹¹

In some cases, it may be prudent to have safeguard measures in place as part of the switch-off. For example, AT&T put a 'soft lock' on its 2G network for a period of four to six weeks during which it would be able to re-activate the network if necessary, in the event certain critical services were affected.¹²

Regulatory aspects

Ultimately the decision to phase out legacy networks should rest with mobile operators though there may be a need to engage with national regulators, particularly if there are technology-specific licence conditions or other regulatory considerations (e.g. spectrum fees). Given that the decommissioning of legacy networks aligns with a regulator's duty to promote efficient use of spectrum resources, this should be welcomed and facilitated by national regulators.

At the same time, regulators have to ensure there is adequate protection of consumers and the impacts of service disruption or loss of service are minimised during the phasing out of legacy networks. This is especially important in cases where there are general interest services involved¹³ and where the shutdown is a coordinated move involving all operators in the market.

Aside from granting approval of requests from operators to switch off their networks, the regulator's role typically involves

ensuring adequate preparations and appropriate measures are taken ahead of network shutdown to minimise consumer harm which could result from the shutdown. These may include:

- publicity efforts and provision of sufficient notice and regular updates ahead of shutdown
- ensuring provision of suitable alternative solutions or migration programmes for users affected
- measures to deal with key user groups (elderly, low income groups or emergency users)
- monitoring pricing of services.

For operators, working closely with regulatory authorities can help to speed up the shutdown of legacy networks through increased public awareness and quicker adoption of newer handsets and technologies.

Concluding thoughts

At a time when operators are viewing 5G with much trepidation, one of the important first steps on the road to 5G should be to identify the right approach to the phasing of legacy 2G and 3G networks. Getting this right will not only minimise the burden of having to support legacy technologies, but also improve efficiency and smooth the transition to 5G.

About Plum

We are a leading independent consulting firm, focused on the telecommunications, media, technology, and adjacent sectors. We apply extensive industry knowledge, consulting experience, and rigorous analysis to address challenges and opportunities across regulatory, radio spectrum, economic, commercial, and technology domains.

For more information contact Plum at:

www.plumconsulting.co.uk

+44 20 7047 1919

¹ Ericsson expects the share of video traffic to grow from 60% of total mobile data in 2018 to 74% in 2024. Source: Ericsson Mobility Report, June 2019.

² In India Bharti Airtel is planning to start switching off 3G in 2020. Vodafone is planning to switch off its 3G network in the UK within three years.

³ However, there is still some provision for CSFB on 3G networks in Taiwan.

⁴ Based on the theory of diffusion of innovations as described by sociologist Everett Rogers.

⁵ There may also be outdated services which are no longer viable and need to be phased out.

⁶ IMS – IP Multimedia Subsystem. An architecture for offering multimedia and VoIP services, defined by 3GPP.

⁷ GSMA. Road to 5G: Introduction and migration. April 2018.

⁸ These could include: 2G-led, 3G-led, 2G-and-3G strategies and variations in terms of timing and geography.

⁹ For example, Telstra announced its 2G switch off plans in July 2014 while before switching off in December 2016. In Singapore there was also a two-year gap between announcement and switch-off.

¹⁰ In the US, AT&T took five years to complete its 2G shutdown.

¹¹ In Singapore, the shutdown of 2G by the three operators was achieved in less than three weeks, while in Canada and the US the process of decommissioning 2G has taken several years.

¹² <https://www.fiercewireless.com/wireless/at-t-s-donovan-2g-network-soft-lock-decommissioning-to-begin-coming-months>

¹³ Services which are subject to public service obligations such as utilities and emergency services.