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NEXT GENERATION TELECOMS NETWORKS

Traditional telecommunications (telecoms) networks were developed to carry a single type of service, such as voice calls. In contrast, Next Generation Networks (NGNs) carry all types of services, including voice, video and e-mail, on a common platform. BT's planned roll-out of its £10bn '21st Century Network' (21CN) by 2012 will make the UK the first country to replace its incumbent telephone network with an NGN. NGNs offer significant cost savings to operators and new services to consumers, but there are also challenges in maintaining the quality, reliability and security of communications. Their introduction has been described as "the most significant change to telecoms networks since competition was introduced two decades ago".[1]

What is a Next Generation Network?

Since the telecoms age began, networks using different technologies have been developed to carry different types of communication. For example, BT maintains 16 separate communications networks in the UK, including the Public Switched Telephone Network (PSTN) that carries voice calls. The PSTN is a traditional 'circuit-switched' network, in which data travels along a single path that is defined at the start of the call and reserved until it ends. By contrast, the Internet is a 'packet-based' network. Messages are split up into many packets that may travel along different routes and are reassembled when they reach their destination. The technology used to do this is known as Internet Protocol (IP).

The fundamental idea of NGNs is to carry all types of service on a single packet-based network. This 'network convergence' allows operators to save money by having to maintain only one network platform, and to provide new services that combine different types of data (Box 1). NGNs are more versatile than traditional networks because they do not have to be physically upgraded to support new types of service. The network simply transports data, while services are controlled by software on computers that can be located anywhere. This means that third parties can easily launch new services, not just the network operators themselves. NGNs are based on IP, like the Internet, but they build in features that the Internet does not have, such as the ability to guarantee a certain quality of service and level of security.

Most definitions of NGN also include the principle of 'nomadicity'. This means that a user can access personal network services from different locations using a range of devices such as fixed-line phones, mobile phones and computers.

Box 1. NGN services

Types of services that can be offered by NGNs include:

- voice services. It will be possible to make calls over an NGN from either a telephone or a 'softphone' on a PC. Calls are carried more efficiently because they no longer each need their own dedicated line and can share bandwidth with other types of data;
- digital television delivered using IP (known as IPTV). IPTV is expected to be a major commercial driver for NGNs worldwide, although the UK already has relatively high penetration of non-IP digital TV services through Freeview, cable and satellite;
- converged services. These combine different services running on the NGN. For example, a customer could have a single mailbox that collects together voicemail, text messages, e-mails and video mails;
- personalised services. Communications providers are already offering 'bundles' that combine broadband, TV, phone and mobile services. With NGNs, customers can have finer control over the services that they purchase, and be billed for all services through a single system;
- mobility services. The ability to access services from anywhere enhances flexible working. An employee could have much easier remote access to work telephone and data systems and choose whether to have calls routed to a fixed line, mobile or laptop.

Box 2. Communications infrastructure

Communications networks are designed hierarchically.

- The consumer **access network** links homes and small businesses to local exchanges. Currently this is through copper wires installed by BT or coaxial cables supplied by Virgin Media. Large businesses often have their own, faster, access arrangements.
- The **core network** links together the exchanges with high-speed optical fibres that interconnect at 'core nodes'. BT's core network has the largest geographical reach in the UK.

In this note, 'Next Generation Network' refers to the convergence of multiple services into a single packet-based core network. This is sometimes confused with 'Next Generation Access' (NGA), which means upgrading the access network to support higher data transfer speeds. There are many options for NGA, including optical fibre links to homes and wide-area wireless networks.

BT does not currently plan to deploy fibre to homes in the UK, except in some new-build sites. However, in parallel with 21CN, BT will upgrade equipment in exchanges to increase the maximum broadband access speed it can offer by up to three times. The Broadband Stakeholder Group (a government-industry forum) recently expressed concern that the UK is falling behind in NGA deployment[2] and Ofcom launched a consultation on NGA in September 2007.[3]

The transition to NGNs

BT's 21st Century Network

In 2004, BT announced that it would deploy an NGN known as the 21st Century Network across the UK. This will cost £10bn but is intended to allow BT to save £1bn in annual operating costs by turning off its traditional networks. Initially a 5-year timetable was announced for roll-out, but the current estimate for all customers to be switched over to 21CN is 2012.

The first few customers had their phone service switched from the PSTN to 21CN in November 2006 as part of BT's PSTN Pathfinder trial in south Wales. These customers were reverted to the PSTN after technical problems, but have now been switched back. In November 2007 the first customers began using BT's new broadband service over 21CN in the West Midlands. Nationwide migration of customers from the PSTN to 21CN is due to begin in summer 2008.

Other NGNs

Several network operators in the UK, such as Thus, Cable & Wireless and Sky have their own NGNs serving mainly business customers. They argue that they are already delivering new NGN-enabled services to customers, while 21CN is just a cost-savings exercise for BT, designed to deliver current services more efficiently. However, 21CN will be by far the largest deployment of an NGN in the UK, serving all of BT's over 20m residential and business customers as well as customers of other providers that use BT's network. The migration to 21CN does not directly affect cable or mobile users, as they have their own core networks. However, these networks may also be upgraded to NGNs in the future.

The transition to NGNs is happening worldwide, but the UK will be the first country to replace completely the incumbent operator's telephone network with an NGN. In other countries, such as France and Germany, NGNs will initially run alongside traditional networks. This will not bring the operational cost savings that BT is aiming for, but will reduce the risks involved in the transition. There is some debate about whether the full benefits of new NGN services will be achieved without also upgrading the access network to support faster data transfer, and some countries are prioritising investment in the access network over upgrading the core network (Box 2).

Issues

Two sets of issues arise from the transition to NGNs in the UK: those that concern BT switching the UK's incumbent telecoms infrastructure on to 21CN and turning off the PSTN; and those that concern the impact of NGNs in general. The communications regulator Ofcom has a role both in protecting consumers and businesses during the transition and in maintaining effective competition in the telecoms market.

Switching to 21CN

Managing the transition

In 2004, BT established the Consult21 programme to work with industry to identify and prepare for issues that may arise during the transition. BT, with the support of other operators and Ofcom, has recently launched a national communication campaign to inform residential and commercial customers about the transition.[4]

Switching to 21CN does not require engineers to visit customers' premises because the access network that connects them to their exchange will not change and they will continue to use the same handsets. Instead, 21CN involves installing new network equipment at local exchanges and core nodes. Customers will be notified through local advertising and mail drops before their exchange is switched over. 21CN's schedule requires switching an average of 115,000 customers per week, and BT says it has used a simulation of the process to prove that it can achieve up to 150,000.

Switching will happen between midnight and 6am, and BT promises that the break in service will be no more than 3 minutes for outgoing calls and 30 minutes for incoming calls (typical outages for PSTN Pathfinder customers were around 10 seconds). BT will ensure that it does not cut off calls already in progress to emergency numbers, and the mail drop will advise customers to use mobile phones during any outage.

Business customers

The telecoms needs of businesses are more complex than those of residential customers. The Communications Management Association has expressed concern that many businesses were not being made sufficiently aware of the implications of 21CN. Together with Ofcom, they have run a series of workshops to raise awareness, and say that the issues are being slowly resolved. Some businesses are concerned that PSTN Pathfinder has focused on residential customers and that businesses may not have enough time to absorb the results of the trial before the nationwide roll-out begins.

Support of legacy services and equipment

Some outdated equipment in customer premises may not be compatible with 21CN. BT have tested a range of recent equipment from leading manufacturers and listed the results on the Consult21 website.[5] Most equipment will continue to work, but some problems have been identified and many businesses are still using older equipment that has not been tested.

The utility industries have serious concerns about services that 21CN will not support. For example, BT 'leased lines' are used to signal faults in high-voltage electricity lines and shut them down before damage occurs or customers lose their electricity supply. 21CN can not guarantee to send the signal fast enough to meet the industry's requirements, but BT has offered to maintain the legacy service only until 2014. BT will report the results of a consultation on this issue by February 2008. One electricity company has estimated that it will cost the industry over £300m to solve this problem, which will ultimately have to be passed on to the electricity consumer. The water industry has indicated that it has similar problems.

21CN will use fewer core nodes than BT's traditional networks. Since competing operators interconnect with BT at these nodes, some may be left with 'stranded' equipment. In these cases, BT has undertaken to provide its competitor with an equivalent connection.

Maintaining quality of voice service

The PSTN is a resilient and reliable network that is trusted by the public to provide a high-quality voice service. By contrast, increasingly popular internet telephony services do not guarantee quality and reliability. Network congestion can cause calls to break up and broadband connections are frequently lost.

Calls on NGNs will be transported using a similar protocol to internet telephony (called VoIP), but Ofcom requires that 21CN provides a quality of service for voice calls at least as good as the PSTN. To guarantee quality of service for voice and other real-time services such as video, NGNs use technology that prioritises packets based on the type of information they are carrying. This is unlike the Internet, which treats all packets equally whether part of a voice call, video or webpage.

Network resilience and security

The telecoms network is one of nine components of the UK's critical national infrastructure, so the resilience of 21CN, during normal use or under malicious attack, is a national security issue. NGNs, by their very nature, reduce the diversity of the UK's communication infrastructure. Because NGNs are based on IP, they could be vulnerable to the same threats already prevalent on the Internet, such as denial of service (a deliberate attempt to overload the network) and viruses. On the other hand, packet-based networks were designed to be more resilient to single physical points of failure than circuit-switched networks because packets can be re-routed to follow unaffected paths.

Several government organisations have worked with BT on the resilience of 21CN, including the Central Sponsor for Information Assurance in the Cabinet Office and the Centre for Protection of National Infrastructure. BT says it will make 21CN resilient by providing several levels of redundancy. For example, each core node will have at least three separate physical connections to other core nodes, and all key network equipment will be duplicated with independent power supplies. BT highlights that 21CN is a private network, which can be controlled more closely than the public Internet. There will be state-of-the-art security measures to protect against attacks at the points where 21CN is connected to the Internet.

Potential security risks in NGNs include services being provided from overseas, and the devices used by customers to connect to the network becoming more complicated and thus more susceptible to viruses. Concerns have also been raised about relying on network equipment from suppliers who do not have a long track record in telecoms. The Office of Government Commerce has produced a guide to procuring secure NGN equipment for public sector buyers.[6]

Broader NGN issues

Lawful interception

Under the *Regulation of Investigatory Powers Act* 2000, communications providers must allow lawful interception by police and intelligence services where reasonably practicable. This may become more difficult with NGNs. A phone call over the PSTN can be intercepted with a tap anywhere along the line dedicated to the call, but in an NGN, packets may travel along many different paths. However, there are points where traffic can be intercepted, and 21CN will allow lawful interception. The Home Office's Interception Modernisation Programme aims to ensure that NGNs and other developments in communications do not impede lawful interception.

Emergency services

The nomadicity of NGNs makes it harder to link a telephone number to a physical location. Providers are required to supply location information to emergency services where technically feasible. Ofcom are tackling this issue in two ways: by working with the Network Interoperability Consultative Committee (NICC) on a technical solution, and by ensuring that customers are made aware when they are making a call for which location information can not be provided automatically.[7]

Authentication

The nomadicity of NGNs makes it more difficult to authenticate users. For example, it may be possible to identify a call falsely as coming from somebody else, known as 'spoofing'. Mobile phones use SIM (Subscriber Identity Module) cards for authentication but there is no corresponding system for fixed-line phones or computer 'soft phones'. The availability of cheap voice calls that can be automated by computers may also encourage unsolicited 'spam' calls, known as SPIT (Spam over Internet Telephony).

Numbering and portability

NGNs combine a number of different networks, so a new approach to assign numbers or addresses in the network may be desirable. In particular, numbers could be assigned to individual users, rather than to devices. Ofcom has also proposed that the transition to NGNs offers an opportunity to make number portability (retaining your number when you change provider) more efficient. Currently, the original provider is responsible for forwarding the call, causing problems if it goes out of business. This arrangement could be replaced by a centralised database linking a number to the customer's current provider.

Competition and regulation

Ofcom encourages competition between separate NGNs, but, as is the case with current networks, it is unlikely that there will be another core network in the UK as large as BT's 21CN. As well as competition between NGNs, there will be competition between network operators and third party service providers to deliver services over NGNs. To compete effectively, alternative NGN operators will need to interconnect their networks with 21CN. There is still considerable uncertainty over the technical and commercial arrangements for NGNs to connect with each other and with service providers (Box 3). NGNs combine aspects of traditional telecoms networks with aspects of the Internet, which have very different commercial models.

Box 3. Interconnection of NGNs

As NGNs are introduced, they will connect with traditional networks through 'gateways' that translate signals in and out of IP. This is not technically difficult, but quality may be lost if a call travels through several such gateways. A more difficult problem is defining the technical standards and commercial model for 'all-IP' interconnects between competing NGNs and service providers.

UK, European and global standards bodies work to define open technical standards for interconnections, to allow, for example, the quality of a call to be guaranteed even if it travels across several networks.

In 2006, Ofcom established an industry body, NGNuk, to define the long-term commercial model for NGN interconnection. Commercial issues arising from NGN interconnection that may require regulatory input include:

- how network operators should charge for transporting different types of data. Charging purely for the amount of data transferred in a given time (bandwidth) would make voice calls very cheap compared with video, whereas currently the opposite is true. Charging will probably be based not just on bandwidth but also on the quality and security of service that is required;
- which network information competing network operators and service providers should be allowed to access, and on what commercial basis. Service providers argue that they need more than just the ability to transport data over the network; in order to compete effectively they also need access to information such as the current location of the customer;

NGNuk aimed to deliver a commercial framework for NGN interconnection by January 2008, but says it has made slow progress due to insufficient input from its members.

There are other challenges for regulators posed by the nature of NGNs.

- NGNs will allow services to be provided with a wide range of levels of quality and security. Regulators need to ensure that customers are aware of these differences rather than choosing service providers purely on the basis of cost. In 2007, Ofcom introduced a mandatory consumer code setting out the information that service providers should offer.
- NGNs allow data to be prioritised based on their type. There is debate about whether network operators should also be permitted to treat data differently if they originate from a competing operator or service provider, or whether they should respect the principle of 'network neutrality'.
- NGNs allow services to be provided from servers located abroad, where regulation might be less rigorous.

Overview

- A Next Generation Network is a telecoms network that can carry a wide range of services that are currently provided by separate networks.
- NGNs offer cost savings to operators and potential new services to consumers, as well as the promise of ubiquitous access to services regardless of location or device.
- BT's 21st Century Network, due to be completed by 2012, will make the UK the first country to use an NGN for its national communications infrastructure.
- Challenges arising from switching to 21CN include maintaining the quality and security of the UK's telecoms network and communicating the implications of the transition to consumers and businesses.
- The broader impact of NGNs on the telecoms industry is not clear and there are a number of technical and commercial issues under debate.

Endnotes

1 *Next Generation Networks: Developing the regulatory framework*, Ofcom, March 2006
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4 www.switchedonuk.org
5 www.btwholesale.com/consult21
6 *Next Generation Networks: Procurement Standards, Guidance and Model Clauses*, Office of Government Commerce, March 2007
7 *Regulation of VoIP Services: Access to the Emergency Services*, Ofcom, July 2007

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POST is grateful to all contributors and reviewers. For further information on this subject, please contact the author, Dr Martin Griffiths, at POST.

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