

Multi-Service Access Nodes (MSANs): Gateways to Next-Generation Network (NGN)

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(Manuscript received April 13, 2006)

While it is possible to envisage a Next-Generation Network (NGN) solution with a heterogeneous core, the same cannot be said for the fixed access network. Multiple legacies and new technologies must continue to be supported, delivering the widest range of services and adapting them so they can be carried over the NGN core. This paper considers the range of services and technologies that have to be handled by the access network and how a single solution — the Multi-Service Access Node (MSAN) — can be cost-effectively developed and deployed to meet the challenge of providing an access gateway to the NGN core. It then looks at an MSAN solution called GeoStream Access Gateway that was developed by Fujitsu Telecommunications Europe Limited and chosen by British Telecom (BT) for their “21st Century Network” in the UK.

1. Introduction

Traditionally, fixed access networks have been developed to deliver specific services, for example, public switched telephone networks (PSTNs) and private circuit (leased line) networks. In general, this has led to a proliferation of access network technologies, each linked to a subset of the total set of communications services. One of the fundamental principles of a Next-Generation Network (NGN) is the ability to offer services independent from the underlying delivery technology, and in the main this means converging on IP as the common network layer protocol for everything.

However it is not possible, except in pure greenfield applications, to simply remove and replace all the existing end-user terminals in the network — the cost of doing so would far outweigh the benefits gained by moving to an NGN. This creates a requirement to maintain support for legacy access technologies and to convert to IP as close to the edge of the network as possible, as

defined by network economics. There is also the question of how far into the access network the IP-layer intelligence needs to reach.

In order to flexibly meet these requirements, network operators need a Multi-Service Access Node (MSAN), which is a platform capable of supporting all the widely deployed access technologies and services as well as the newly emerging ones, while simultaneously providing a gateway to an NGN core. To support the migration of operators to NGN, Fujitsu Telecommunications Europe Limited has developed the GeoStream Access Gateway. This gateway is a complete MSAN solution that can cost-effectively deliver a combination of traditional and emerging services over a variety of access technologies (Plain Old Telephone System [POTS], Integrated Service Digital Network [ISDN], Asymmetric Digital Subscriber Line [ADSL], Symmetric Digital Subscriber Line [SDSL], and Synchronous Digital Hierarchy [SDH]), interfacing to both legacy and NGN cores.

2. PSTN migration challenge

For many traditional network operators (former post, telephone, and telegraph [PTT] operators), the PSTNs were the origin of their business and remain a key, if declining, source of revenue. Over many years, PSTNs have evolved a wide range of services and features, all designed to be delivered over the existing copper access infrastructure. When such an operator decides to deploy an NGN, retaining the existing PSTN services is likely to be a priority. This could be achieved by maintaining a parallel PSTN infrastructure, but this is not always sensible economically, and so migration of PSTN services to an NGN becomes necessary.

Large, national carriers may have many millions of PSTN customers, which makes upgrading every end user terminal unrealistic in the short term. This means that an MSAN must support existing access interfaces, including analogue POTS, basic rate ISDN, and primary rate ISDN. On top of these, there are often other legacy access interfaces, for example, ISDN in Europe based on pre-ETSI standards, as well as other special services delivered over the copper access such as meter pulses for payphones and connections for intruder alarm systems. The challenge in creating a solution to meet all these service requirements is considerably more arduous than simply deploying an overlay Voice over Internet Protocol (VoIP) solution.

As well as supporting the whole range of PSTN services, there are often legal and other regulatory requirements that must be met. For example, many carriers are obliged to supply a lifeline telephony service; that is, their standard POTS (and indeed basic-rate ISDN) service must continue to function in the event of a power failure at the customer's premises so that calls to the emergency services can be made. Effectively, this often means that terminal devices must be powered from the network. Consequently, MSANs deployed to support POTS and ISDN services must also provide this feature.

There are many competing and/or complementary VoIP solutions, some of which have been available for several years. However, when considering a complete PSTN replacement solution (rather than a simple, "basic call" only model) the choices are not so wide. Fujitsu has played an active role in the development of the standards required to deploy such a solution through the Multi-Service Forum,¹⁾ IETF,²⁾ ETSI,³⁾ and ITU-T⁴⁾ — specifically helping to define H.248 as a suitable protocol for control of MSANs supporting a full range of PSTN services. The use of a stimulus-based protocol with service intelligence residing in centralised call servers is advantageous when compared with the alternative option of re-developing existing services to operate in a more distributed environment (e.g., by using Session Initiation Protocol [SIP]).

3. Continuing and enhancing deployment of xDSL services

The MSAN must support existing, widely deployed, xDSL access technologies (e.g., ADSL, ADSL2, ADSL2+, READSL, SHDSL, and VDSL) and be able to support future technologies, for example, VDSL2, with minimal upgrading. To create the GeoStream Access Gateway, Fujitsu built on its Digital Subscriber Line Access Multiplexer (DSLAM) expertise to develop a solution that can be cost-competitive in the commoditised DSLAM market — where the price per port has fallen dramatically over the past five years — and yet still be capable of supporting the full MSAN service/technology set. As well as delivering typical, high-bandwidth, best-effort Internet access services over xDSL, the MSAN must also be able to deliver high-quality additional services such as broadcast and on-demand television, video telephony, and other interactive multimedia applications.

MSANs for the NGN must also take into account that every copper access line can be used for POTS/ISDN, xDSL, or a combination of both of these at the same time.

4. Adding fixed-wireless access

It is anticipated that fixed-wireless access using 802.16-based technology⁵⁾ will be used to provide broadband connectivity in some regions where xDSL cannot reach. While standalone Worldwide Interoperability for Microwave Access (WiMAX) systems can be used for this, there are considerable operational advantages for the network operator in using the access platform that is already being used to deliver fixed line services: for example, backhaul interfaces and operational procedures can be reused and/or shared. The business case for deploying a wireless solution can be considerably improved by using MSANs that support both wired and fixed-wireless access simultaneously, allowing the additional cost per customer of wireless access to be amortised across a wider user base.

5. Increasing fiber penetration

Many large operators, and smaller ones focusing on particular market segments, already have fiber connections to some of their customer premises — typically to large business customers who require very high bandwidth connections for their voice and data services. Operators are also continually investigating the feasibility of bringing fiber closer to smaller customers by fiber-to-the-kerb or even fiber-to-the-home solutions — sometimes with direct fiber or more generally by using Passive Optical Network (PON) architectures (Gigabit PON [G-PON])⁶⁾ in particular). Once again, the MSAN needs to support the existing fiber access solutions and provide a platform to deliver deeper fiber penetration as the access network evolves.

As already discussed in relation to WiMAX, deployment of FTTx solutions can become more economically attractive when resources can be shared with equipment deployed for existing mass-market services. For example, the integration of a G-PON solution into the MSAN means that all features and services that have evolved for delivery over ADSL2+ can also be provided over

fiber access networks, and common resources, for example, for switching, multicasting, and back-hauling, can be reused.

6. Meeting deployment requirements

When considering the implementation of a large-scale NGN consisting of connections to millions of end-users, the target is for the NGN to reach as close to the customer as economically feasible. When large corporate customers are involved, the business case for installing fiber-to-the-premises makes sense. At the opposite end of the spectrum, for residential users it will usually be necessary to maintain the existing last-mile technology, although fiber may gradually be installed closer to the end-user as time progresses.

This means that for different areas of deployment, different MSAN configurations will be required. Some technologies will be required in one area but not in another. In other words, the MSAN is not a “one-fits-all” solution, but must be tailored for appropriate, cost-effective deployment in line with the operator’s NGN plans.

Small MSANs will be required in areas currently served by telephone exchanges with up to a few thousand customer lines. In these areas, there may be very few large business customers and so there is no need to deploy the business fiber access solution. (For customers that do need a fiber solution, they can be directly connected to the nearest larger MSAN.) Even smaller MSANs may be required for installation in street cabinets or other similar enclosures where exchange buildings are no longer required.

Very large MSANs will be required in areas currently serving 10s of thousands of customer lines from an exchange. These will need to support a full range of services over copper and fiber today, with rapid evolution to other technologies in the future.

There will, of course, be a complete range of MSAN sizes required to meet the requirements

of the small sites, large sites, and sites in between. Similarly, evolution to new technologies may take place in some areas before others; therefore, support features such as WiMAX and G-PON need to be options on top of the basic MSAN with its POTS and ADSL capabilities.

Unless an operator is deploying a greenfield NGN, or creating an overlay network to coexist with its legacy platforms, there will be an additional requirement for the MSAN to support simultaneous connectivity to both NGN and legacy core networks. This could, for example, mean supporting multiple types of backhaul connections (e.g., Ethernet and SDH) either as separate interfaces or mixed onto a common fiber. In larger sites, the backhaul may also carry multiple trans-

port protocols over a single WDM connection.

7. GeoStream Access Gateway

Fujitsu's GeoStream Access Gateway is an MSAN solution developed by Fujitsu Telecommunications Europe Limited to meet the market requirements described above. It is a platform composed of multiple modules that can be used to build a variety of MSAN solutions that are customised to specific deployment requirements. **Figure 1** shows a high-level overview of the GeoStream Access Gateway architecture.

The access gateway comprises three main building blocks:

- 1) **FDX:** This element can be a standalone MSAN for access services delivered over

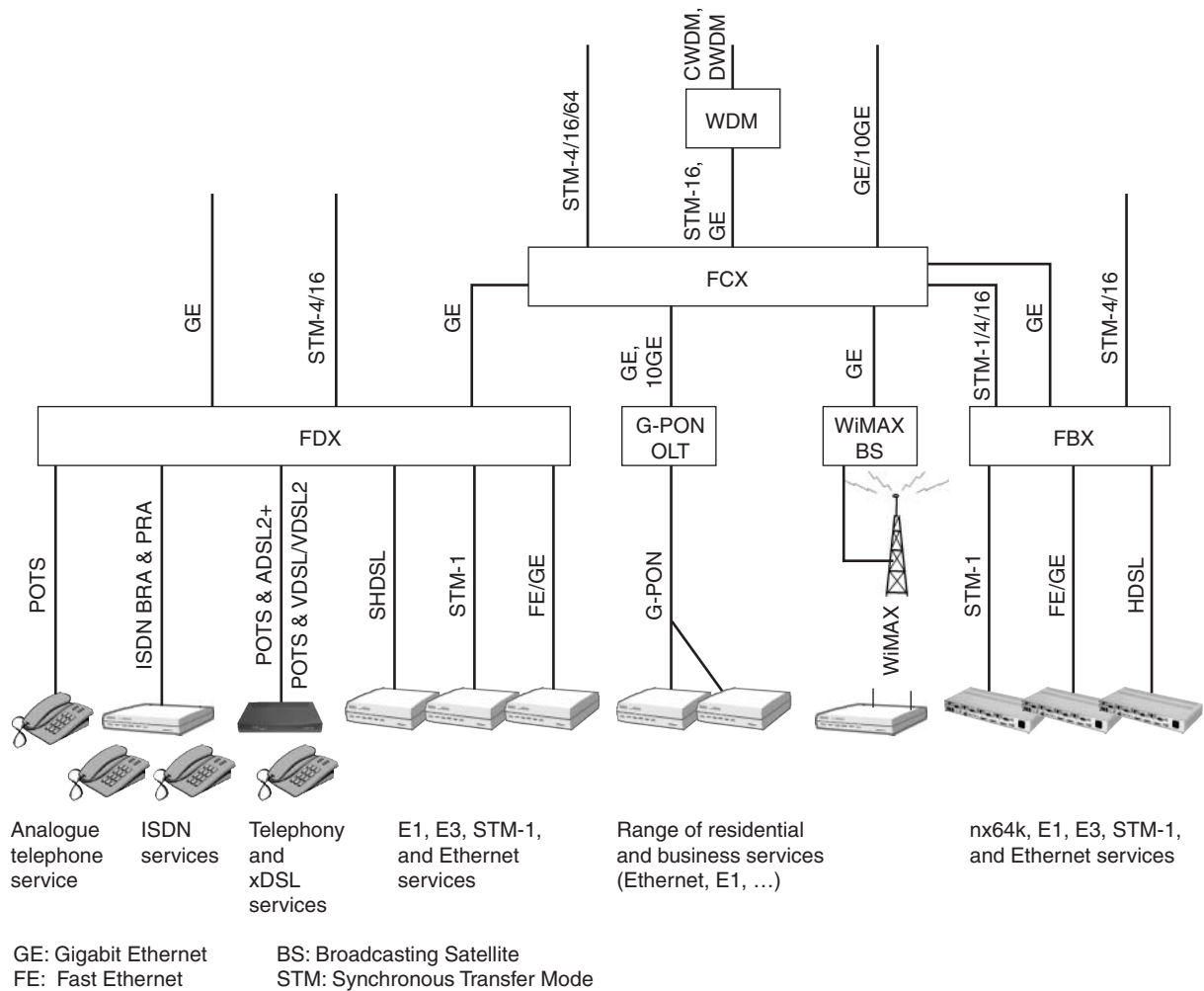
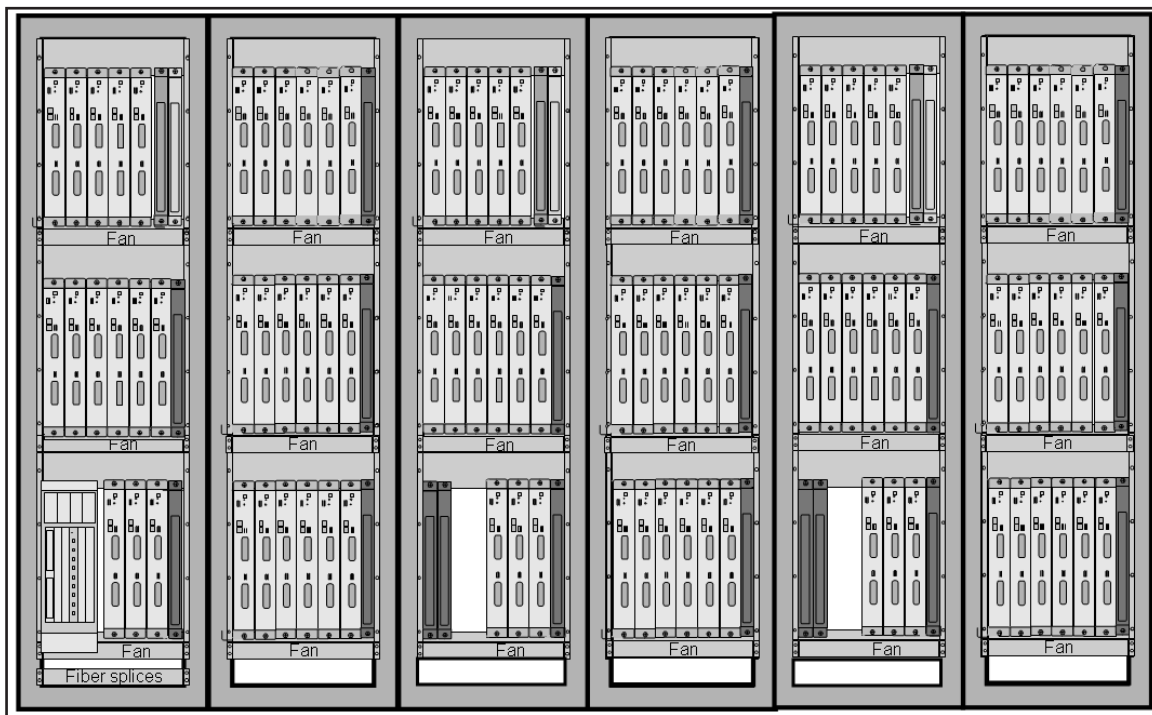


Figure 1
GeoStream Access Gateway architecture.

copper lines or part of a larger MSAN configuration. It can support multiple xDSL technologies and offers traditional POTS and ISDN customer interfaces. The built-in Access Gateway Signalling Function enables FDX to support multiple Virtual Access Gateways, each controlled independently by centralised call servers using H.248 signalling. Over 10 000 lines can be supported on a single node, including simultaneous support for ADSL2+ and POTS on every line if required. The multicasting features allow delivery of entertainment services such as broadcast television with rapid processing of channel change requests handled by individual line cards. Ethernet and Asynchronous Transfer Mode (ATM) services can be supported at the same time over the 40 Gb/s packet switching fabric, with options to deploy multiple SDH ATM and Gigabit Ethernet interfaces to the core network or to

the FCX module. FDX can also support small numbers of fiber access services (SDH and Ethernet based) alongside the mass-residential copper access capabilities. Smaller versions of FDX are also provided for deployment in street cabinets. **Figure 2** shows the rack layout of the GeoStream Access Gateway (FDX).

- 2) FBX: This element provides business fiber access services using SDH and Ethernet in the access network. With a set of complementary customer-premises network terminating equipment (NTE), a wide range of business services can be delivered, including $n \times 64$ kb/s private circuits, $n \times E1$, E3, STM-1, and multi-port Ethernet. Both SDH and Ethernet based network interfaces are supported for connectivity to legacy and NGN core networks or to the FCX module. Additionally, Time Division Multiplexing (TDM) and Ethernet services can be mixed on the



GeoStream Access Gateway supporting 6144 ADSL + POTS lines

Figure 2
Rack layout of GeoStream Access Gateway (FDX).

same SDH backhaul network using Virtual Concatenation (VCAT).⁷⁾

- 3) FCX: In larger MSAN configurations, FCX is used to concentrate traffic from one or more FDX or FCX modules and provide direct access interfaces for Gigabit Ethernet services. The FCX has a switching capacity of 160Gb/s and can support multiple network interfaces, including mixed Ethernet and TDM traffic over STM-64 VCAT.

FCX (or FDX if appropriate) can be used to subtend additional access modules that are not necessarily integrated within the current FDX and FBX elements; examples of this include options for G-PON and WiMAX. These new technologies might not be deployed on a network-wide scale from day one. It therefore makes sense to adopt a modular approach, so they can be added just in the nodes where they are required and also can share a common infrastructure, service logic, and network connectivity with the other elements of the MSAN.

As described above, a range of backhaul options for the GeoStream Access Gateway are provided. These options allow the network operator to make the best use of existing and developing core networks, while migrating from legacy networks to the NGN core at an appropriate pace. FCX, FBX, and FDX all support SDH and Ethernet based network interfaces, with the option to use SDH VCAT in situations where TDM, Ethernet, and ATM need to be mixed onto a single backhaul network connection. In addition to these interfaces, a wavelength division multiplexing (WDM) option is available, allowing traffic from very large MSANs to be aggregated onto wavelengths in a metro network.

The GeoStream Access Gateway is a layer-1 and layer-2 access platform, with support for layer-3 functionality when appropriate. For example, IGMP⁸⁾ control of multicasting is supported (as used in a broadcast TV over DSL service), and Bidirectional Forwarding Detection⁹⁾ can be used to implement IP-layer protection for selected

services.

8. Conclusion

Fujitsu's GeoStream Access Gateway is a true gateway to the NGN. It is a multi-service access node that can be deployed to support the migration of current services to a new network as well as the introduction of new services over multiple access technologies. Operators using Fujitsu's MSAN can retire legacy access networks but maintain the revenue-generating services that run over them, creating a more cost-effective business model for NGN evolution.

The FDX module of the GeoStream Access Gateway supports a fully standards-based, carrier-class solution for migration of PSTNs, including support for analogue POTS, ISDN, and lifeline requirements. Existing fiber-access services are supported by the FBX element, with a modular upgrade path for introduction of deeper fiber using G-PON, and fixed wireless access with WiMAX. While FDX can be scaled down to support small MSAN configurations, including street cabinet deployments, FCX provides a solution for the largest installations, with massive switching capacity and options for WDM backhaul.

The modular architecture of the GeoStream Access Gateway, coupled with its network-processor-based implementation, scalability, and support for multiple technologies, allows network operators to create appropriate MSAN configurations to match their NGN migration needs. At the same time, it enables operators to future-proof their access network to cope with the introduction of new services.

In the UK, British Telecom (BT) has selected Fujitsu to provide MSANs for their 21st Century Network, which is a migration of BT's complete infrastructure, including the PSTN, to an all-IP NGN to be deployed between 2006 and 2010. During this period, all existing POTS and ISDN telephone lines, which go to over 25 million connections, will be disconnected from the traditional PSTN network equipment and connected

to NGN MSANs, including Fujitsu's GeoStream Access Gateway.

References

- 1) The Multi-Service Forum (MSF).
<http://www.msforum.org>
- 2) IETF RFC3015 Megaco Protocol.
- 3) TISPAN; PES; NGN Release 1 H.248 Profile for Controlling Access and Residential Gateways. ETSI ES 283 002 V1.1.1 (2005-06).
- 4) ITU-T Recommendation H.248.
- 5) IEEE 802.16-2004.
- 6) ITU-T Recommendation G.984.
- 7) ITU-T Recommendation G.707.
- 8) IETF RFC 2236 - Internet Group Management Protocol, Version 2.
- 9) Internet Draft: Bidirectional Forwarding Detection draft-ietf-bfd-base-04.txt.



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