Next-Generation Access Architectures and Distributed MSAN Concept

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Within Europe network operators are starting to consider the deployment of deep fibre infrastructure (either fibre to the home [FTTH] or fibre to the cabinet [FTTC]) to deploy high-speed broadband services. The decision on FTTH or FTTC will be dependent on territory and regulatory environments and a range of solutions including direct fibre, PON and xDSL will be required. Fujitsu's existing Multi Service Access Node (MSAN) "GeoStream Access Gateway" has been developed by Fujitsu Telecommunications Europe Ltd. and is currently deployed in BT's 21st Century Network where it provides integrated Public Switched Telephone Networks (PSTN), Integrated Services Digital Network (ISDN), and Digital Subscriber Line (DSL) access from the central office. There are a number of features of GeoStream Access Gateway that make it possible to distribute its functionality within a network, creating a distributed MSAN. This mode of deployment is particularly suitable for those carriers wishing to deploy an FTTC solution and Fujitsu's strong track record in baseband voice support provides a unique selling point for carriers looking to migrate existing infrastructure to an FTTC infrastructure.

1. Introduction

The current fixed line telecommunications industry faces a number of significant challenges if it is to compete with cable operators and the emerging mobile network operators in the area of broadband services. Within Europe there is a perception that existing central-office-based broadband solutions based around Asymmetric Digital Subscriber Line (ADSL) technology will not provide sufficient bandwidth moving forward to meet the projected customer demand. The solutions adopted to tackle this problem vary according to territory. Operators who have deployed deep fibre networks, for example the United Kingdom (UK) cable operator Virgin Media, have a significant advantage over incumbent fixed line telecommunications operators because they are already able to offer higher bandwidth services. For example in the UK, Virgin Media is offering a premium 50 Mb/s service, whereas the best that is currently offered over a central office ADSL2+ services is 24 Mb/s and relatively few subscribers are close enough to the exchange to take advantage of this rate. In order to compete with existing deep fibre deployments, or to provide higher bandwidth services incumbent operators must either deploy a fibre to the home (FTTH) or fibre to the cabinet (FTTC).

2. FTTH or FTTC

There is no one answer to whether the long-term solution is FTTH or FTTC simply because the economic model is different in each country. The reasons for this country dependence are many and varied but include the following:

- Population density and the number of multi-tenanted buildings.
- Deployment practises, for example above-ground or duct deployments.

- The services environment, for example can the network operator offer a credible TV and video service or is it limited to broadband and voice services?
- The regulatory environment.

These varying factors go some way to explaining the wide variations of penetration of fibre to the premises services worldwide as shown in the recent Fiber-to-the-Home Council study (**Figure 1**).

3. Next-generation access within the UK

To illustrate the issues that can arise in a country when considering the drivers for deploying a next-generation access network it is instructive to examine the situation in the UK, which is almost uniquely hostile to next-generation network spend from a business viewpoint.

- The UK population density is such that there are relatively few multi-tenanted buildings.

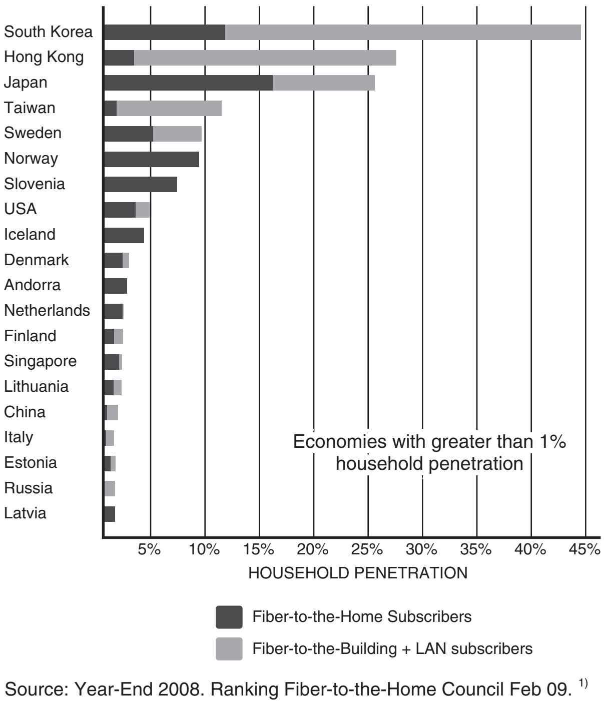

Figure 1
Economies with the Highest Penetration of Fiber-to-the-Home/Building+LAN.

- Planning laws generally drive new infrastructure to be delivered underground (maximising dig costs).
- The UK has a large and dominant satellite TV provider making any competitive TV product from network operators challenging.
- Bandwidth growth in the UK is being driven by free TV over the Internet provided by applications such as the BBC iPlayer service, and replicated by its broadcasting rivals.
- The regulatory regime is uncertain, with the regulator proposing both passive unbundling and active unbundling to the cabinet.

Added to this business environment is a recent survey by the Broadband Stakeholder Group[2] which estimated that the cost of deploying FTTH in the UK would be £28.8 bn as opposed to £5.1 bn for an FTTC infrastructure.

Given the limited revenues and service options available to next-generation network providers and given the disparity of costs between FTTH and FTTC solutions, the UK has chosen to concentrate efforts on FTTC solutions.

4. Fujitsu and next-generation access

Fujitsu through its UK-based subsidiary Fujitsu Telecommunications Europe Ltd. currently provides a product called GeoStream Access Gateway. This is a Multi-Service Access Node (MSAN) that supports both xDSL services and base band POTS services over an Ethernet-based infrastructure, as defined by the Broadband Forum in its technical standard TR101.[3] GeoStream Access Gateway is deployed in local exchanges and is made up of the components shown in **Figure 2**.

A key feature of the GeoStream Access Gateway product that is unique in a central-office-based DSL solution is the highly distributed nature of the architecture. This architecture divides the existing product into two distinct

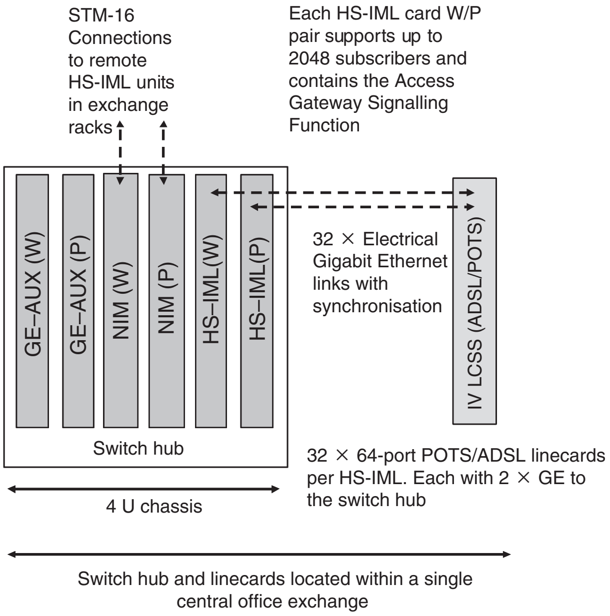

Figure 2
Components of GeoStream Access Gateway.

elements, the switch hub and the linecard subsystem (LCSS). The LCSS units provide the ADSL2+, Very High bitrate Digital Subscriber Line (VDSL) or SDSL interfaces. The switch hub provides a switch fabric (the NIM), Gigabit Ethernet interfaces (the GE-AUX cards) and High-Speed Inter-Module Link (HS-IML) cards. The HS-IML card provides connectivity between the hub and the linecards and also runs the voice control function for baseband services. This is called the Access Gateway Signalling Function.

The connection between the HS-IML card and the linecards (the inter-module link) is a version of an electrical Gigabit Ethernet interface with the addition of synchronisation, and for VDSL cards is an optical Gigabit Ethernet link supporting the new Synchronous Ethernet standard. The linecards themselves contain the analogue and Integrated Services Digital Network (ISDN) port control functions, and provide data services support. The Plain Old Telephone Service (POTS) and ISDN functions are controlled by the Access Gateway Signalling Function (AGSF) using Fujitsu's POTS and ISDN Port Control Interface (PPCI). Within the wider network context the AGSF is itself controlled using the ITU-T H.248 protocol by a POTS/ISDN call server located further back in the network.

The challenge that Fujitsu faces is how to migrate the existing mature product so that it can offer the same blend of next-generation services from within an FTTC deployment whilst still being able to leverage the expertise gained from supporting a fully resilient PSTN grade voice solution. Fortunately it is possible to extend the existing distributed GeoStream Access Gateway architecture to produce an MSAN that is fully distributed within a network.

5. Distributed MSAN concept for FTTC

The starting point for any street cabinet solution must be flexibility because the environmental, spatial and regulatory environment differs so much within each territory. At the same time, cost will continue to be the major differentiator in the marketplace and since environmentally hardening equipment tends to add significant cost an intelligent approach to the problem is required.

Another question that is currently unanswered is what sort of bandwidths are actually going to be required for the service. Within the UK there is significant competition on headline rates to the customer premises with the launch of 50 Mb/s services, but it is less clear what level of contention will be offered by network providers. For example, assuming a conservative estimate of 30 Mb/s per subscriber and a 3:1 overbooking ratio provides 640 Mb/s of downstream traffic for a 64-port linecard. Assuming a street cabinet of 512 customers would result in 5 Gb/s of traffic per street cabinet, this represents an increase of over an order of magnitude from today's broadband architectures and it seems likely that only operators with an appropriately engineered core network will be able to provide this sort of bandwidth.

Because of the distributed architecture of the GeoStream Access Gateway product Fujitsu is proposing to solve these problems by deploying a distributed MSAN. The distributed MSAN explodes the existing architecture, centralising the control and voice access gateway components of the solution, since these are processing-intensive and not bandwidth-intensive, whilst distributing the linecards and allowing high-bandwidth broadband traffic to be broken out into a separate optimised switching and transport infrastructure.

This concept as it applies to GeoStream Access Gateway is shown in **Figure 3**.

The components of the solution are as follows.

The access gateway hub component provides the voice transport and aggregation functions and the MSAN management functions. This component would typically be located in the central office of the customer and control a number of separate street cabinets. One benefit of this solution is overload control, which is described later in this article.

The linecards (LCSS) reside in the street cabinet, each linecard can offer 64 ports of negotiated VDSL/ADSL2+ capability (VDSL linecard) or 64 ports of ADSL2+ capability (ADSL linecard). Each linecard also has the option to support baseband voice which is controlled in real time by the Access Gateway Signalling Function located within the access gateway hub.

The 10GE synchronous Ethernet switch is an option in the street cabinet. This switch is capable of providing cost effective aggregation of synchronous Ethernet linecard backhaul from multiple Gigabit Ethernet links from the linecards into a single protected 10GE link back into the network. There are alternative backhaul options which will be considered later.

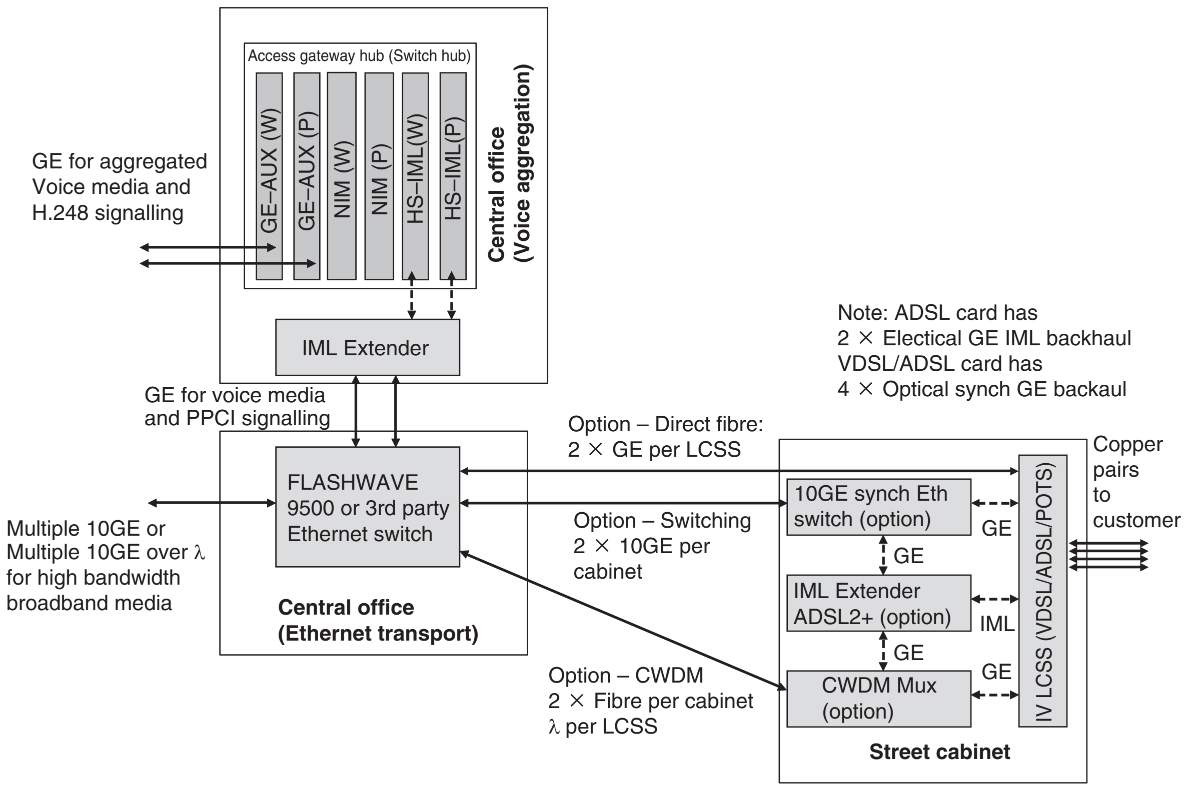

Figure 3
Concept of distributed MSAN as applied to GeoStream Access Gateway.

The network Ethernet aggregation switch can be an industry standard Ethernet switch, capable of providing synchronous Ethernet interfaces to the cabinet and into the network. This allows Fujitsu's distributed MSAN solution to fit into an operators' network where they have an established Ethernet transport infrastructure. Where Fujitsu wishes to offer an integrated access and transport solution then FLASHWAVE 9500 is an excellent fit for the Ethernet aggregation switch because of its scalability and closely integrated transport and switching functions.

An additional component in the solution is the introduction of an IML extender, this element provides a capability to connect existing GeoStream Access Gateway IML links which are electrical GE interfaces with a pre-standard synchronisation solution to industry-standard synchronous GE links, this allows Fujitsu to re-use the existing GeoStream Access Gateway hardware for a distributed MSAN.

6. Cabinet backhaul options

The distributed MSAN allows network operators flexibility in how they handle backhaul from the cabinet. For very small deployments, one option is to just connect fibre directly to the linecard if spare fibre is available. For small to medium-sized deployments, a Coarse Wavelength Division Multiplexing (CWDM) solution may be an option permitting a number of linecards' worth of traffic to be backhauled over a single fibre. This solution is more attractive where there is limited fibre availability at the cabinet, however it must be balanced against the cost in GE switch ports at the network Ethernet aggregation switch and the costs of the WDM optics. For larger deployments therefore it is envisaged that a small Ethernet switch would be deployed within the cabinet to provide (typically) a protected 10 Gigabit Ethernet backhaul into the network.

7. Fujitsu's next-generation voice solution

One of the major advantages of the distributed MSAN is that it is able to support a baseband voice solution at minimum additional cost per line over a data-only solution. There are a number of reasons why a network operator may wish to deploy a baseband voice solution rather than relying on a VoIP solution.

Where a network operator wishes to upgrade its existing network to an FTTC solution, or replace an ageing voice infrastructure that is already deployed in street cabinets, offering baseband voice allows them to do this without requiring residential voice gateway equipment in the customer's premises.

For an incumbent telecommunications operator there is a significant amount of legacy equipment that must be supported, this equipment includes (but is not limited to) security systems, medical alert systems, point of sales systems and even lift systems. This equipment frequently connects to the network using non-standard interfaces that were developed over many years. This means that off-the-shelf residential gateway solutions simply will not support this subscriber equipment. While it is in theory possible to leave these services on the legacy PSTN it is not always clear where this legacy equipment resides (particularly medical alert systems and security systems) and in today's competitive environment any disruption of the customer is an invitation to "churn" i.e. move to another provider.

Given that it is not practical for an incumbent to stop supporting legacy equipment, providing a cabinet solution for baseband voice also means that the network operator can look to close down the exchange buildings that previously housed PSTN local exchanges and concentrators. This may represent a significant OPEX saving if the space is rented, or it may allow them to sell off surplus assets if the building space is owned.

A major advantage offered by Fujitsu's baseband voice solution is its robustness to focussed overload events which may be caused in one extreme by natural or man-made disasters, and in the other extreme by radio and television phone-in competitions. These disruptive events can cause the call control functions in the network to become congested unless mechanisms exist to throttle the end user traffic. In the case of regulated voice services there may be an additional constraint that where possible calls to the emergency services should be prioritised over other reasons for congestion (i.e. emergency calls should be carried unless they themselves are the cause of the overload).

When faced with an overload scenario, a derived voice solution with a large number of individual one-line gateways provides very poor performance, and it is not possible to easily throttle calls because it is hard to signal a percentage reduction to a single-line gateway. Even in small, street cabinet solutions there may be an issue in reducing the overall rate of calls into the network at a suitably granular level.

Fujitsu's solution uses an access gateway hub which provides for management of individual linecards and with its Access Gateway Signalling Function provides a point of voice service control. The AGSF communicates with the operators call server using H.248 and communicates with the individual linecards using PPCI. The AGSF is able to aggregate multiple linecards into a single virtual access gateway (VAG) and even multiple street cabinets into a single VAG. The VAG represents a set of voice lines that can have overload control applied to them and this allows a large number of small cabinets to be aggregated into (for example) a 2000-line VAG. It is considerably easier to apply sensible overload control algorithms to a 2000-line voice gateway (located at Fujitsu's Access Gateway Hub) than 2000 one-line voice gateways (located in the customer's premises). This effectively provides the best aspects of a central-office-based MSAN with the benefits of a distributed street cabinet MSAN. It allows network operators to take advantage of the excellent overload control performance seen in testing and in the field of Fujitsu's GeoStream Access Gateway product.

8. Conclusions

The distributed nature of Fujitsu's existing GeoStream Access Gateway MSAN product has made it possible to extend this approach to provide a true distributed MSAN solution that is able to meet the needs of incumbent and competitive carriers offering FTTC solutions. Fujitsu's solution allows for very high speed largely uncontended broadband access whilst providing a proven cost-effective solution for NGN voice. It has the additional benefit that it can be deployed either as part of a complete Fujitsu access network or it can be integrated into previously deployed metro Ethernet infrastructures.

References

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