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FULL SERVICE BROADBAND ARCHITECTURE

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White Paper

Gives users convenient access to any broadband service, from any device, anywhere. It gives operators new cost-effective growth opportunities, based on open-standard solutions.

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TAKING YOU FORWARD

Contents

1 Executive summary ... 3

2 Key challenges and drivers ... 4
2.1 Capitalizing on Full Service Broadband connectivity ... 4
2.2 The importance of user convenience ... 5
2.3 Managing cost of ownership ... 5

3 The Full Service Broadband architecture ... 6
3.1 Architecture overview ... 6
3.2 Building a transport infrastructure for flexibility ... 8
3.3 Connecting devices and users ... 9
3.4 Evolving access networks for Full Service Broadband ... 11
3.5 The importance of the multi-access edge ... 12
3.6 IMS as an enabler of personalized communication services ... 13

4 Recommendations and conclusions ... 14

5 Glossary ... 15

6 References ... 16

1 Executive summary

After years of talk about fixed–mobile convergence (FMC) and next-generation networks (NGN), technology solutions are now ready to give fixed and mobile operators a major leap forward in their Full Service Broadband offerings. Operators have an opportunity to deploy an open, standards-based combined fixed and mobile architecture that offers a cost-effective, evolutionary route to new Full Service Broadband opportunities.

Operators need an evolved network architecture to provide users with service connectivity from any device, wherever they are. For users, convenience is a key success factor: converged services need to be seamlessly and intuitively accessible across all devices and networks. For operators, the introduction of new services and additional network capacity must incur minimal additional cost of ownership.

Full Service Broadband architecture is designed to meet these needs across residential and enterprise service offerings. At its core is a reliable, secure and cost-optimized transport network. Overlaid on this are a variety of access technologies, each evolving in support of Full Service Broadband, with access heterogeneity handled through multi-access edge capabilities. IMS (IP Multimedia Subsystem) supports the development and deployment of end-to-end services. User mobility and convenience are enabled through consistent and open User-to-Network Interfaces (UNI), while open Network-to-Network Interfaces (NNI) ensure interoperability with partners such as other operators and enterprises.

Such an evolved, open-standard architecture is essential to build a profitable and sustainable Full Service Broadband business. It provides the consumer electronics industry with the required economies of scale. It drives usage by offering the user transparency and convenience, by enabling anyone to reach anybody (or any device) at any time, and by making the same services accessible anywhere. It improves cost-efficiency by stimulating competition and simplifying interoperability and management. Above all, it encourages a common ecosystem that is beneficial to all parties involved.

2 Key challenges and drivers

2.1 Capitalizing on Full Service Broadband connectivity

Users will increasingly expect all their services to be accessible anywhere and from any device. They want to feel constantly connected with friends, family and co-workers. While working, they need to be connected to their enterprise network environment, to access email and files. Outside work, they will want to be able connect to residential networks to access their personal media collections and other content.

Today's multi-play approach does not provide the full answer to meeting these user needs. Triple-play leaves the mobile broadband service revenue up for grabs by competitors, while quadruple-play does not provide sufficient integration to reach the full potential of Full Service Broadband in terms of revenue growth and reduced churn.

What's needed is an architecture that enables seamless connectivity across fixed and mobile access boundaries. This architecture needs to deliver broadband connectivity to a wide range of devices, including media servers, video cameras and portable media players, as well as PCs and mobile phones. The architecture must be able to satisfy the consumer electronics industry's need to achieve economies of scale, while also providing smooth integration with enterprise environments. It must deliver a solution based on open standards that is acceptable to all parties, and which cultivates a common ecosystem – just like the mobile industry today.

Ubiquitous availability of any service increases its value to users, and therefore their willingness to pay a premium. The value of the service also increases with the number of connected users. The success of the open standards-based GSM network is proof of these two tenets.

In the new Full Service Broadband architecture (FSBA), basic IP/Ethernet connectivity needs to be cost-efficient, secure and reliable. This is particularly important for enterprises, but also for services like TV..

In order to capture the revenue potential and the competitive edge associated with mobile broadband, the scope of broadband connectivity needs to be extended to mobile as well as fixed access. New quality assurance measures are also needed to deliver a mix of Internet, IP-VPN and IMS-enabled services. The new architecture must provide a sound foundation for both retail and wholesale broadband service offerings, and must support user mobility with consistent capabilities that enable connectivity services to be charged for.

2.2 The importance of user convenience

User convenience is fundamental to taking broadband penetration past one billion users, especially as the variety of devices and services grows. User convenience encompasses security, simplicity, personalization, as well as look-and-feel. For example, the ability to connect a device to a wireless or wired premises network, or to a mobile network, in a simple, convenient way is key to enhancing user satisfaction and minimizing interactions with support centers. The value of such factors grows with the number of devices supported.

Standard network interfaces like Ethernet, WiFi and High Speed Packet Access (WCDMA/HSPA) are increasingly being integrated into devices. Open standards should boost user convenience further by making service activation uniform, and service usage seamless and simple.

2.3 Managing cost of ownership

The Full Service Broadband architecture needs to support services that are both affordable for users and profitable for operators.

The growth of enterprise and video traffic – for TV services and user-generated video – over fixed and mobile networks is driving demand for higher network capacity. The moves to interactive and personalized High Definition TV (IPTV/HDTV) services will require high-throughput deep fiber access networks, and higher bandwidth requirements are driving access technology evolution, for example through VDSL2, Gigabit Passive Optical Networks (GPON) and 3G Long Term Evolution (LTE).

The transport networks underlying Full Service Broadband services therefore face significant challenges in the form of huge increases in scale, massive new bandwidth demands and the need to reduce the cost per transported bit. This means savings need to be found in network deployment and operation. Moreover, there is uncertainty about the size, shape and timing of these new requirements, primarily because of TV. Therefore, it is crucial to maintain network flexibility to be able to respond to changes.

Telecom management is another key factor in managing cost of ownership, especially in deployment and provisioning. In the Full Service Broadband architecture, a particular challenge is that some functions are access-specific while some are common.

The Full Service Broadband architecture must be designed to minimize the cost of introducing new services and new access technologies. It must offer the flexibility to allow for the incremental addition of services and accesses. Using open standards will drive volumes, increase competition and reduce cost of ownership.

3 The Full Service Broadband architecture

3.1 Architecture overview

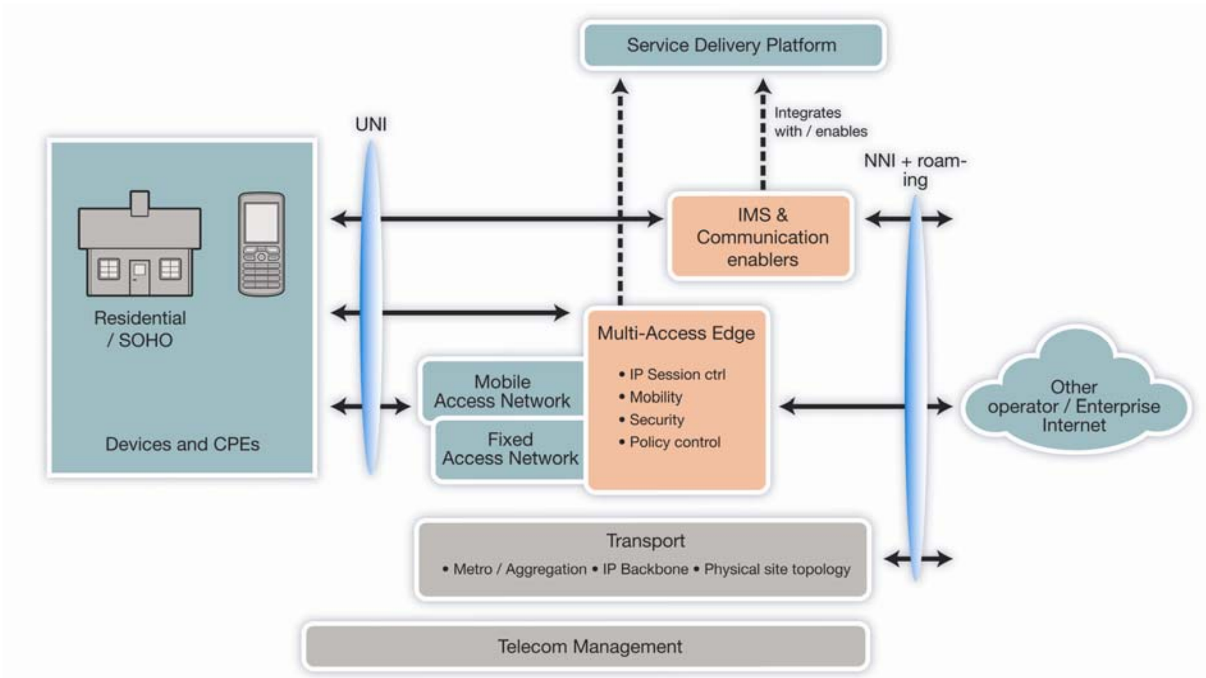

Figure 1.Full Service Broadband architecture.

The basic Full Service Broadband architecture, as shown in Figure 1, delivers a consistent, multi-layer UNI. This is a prerequisite for users to be able to access any broadband service anywhere, using any device, as well as to achieve the desired economies of scale. The NNIs and roaming interfaces drive usage by enabling anyone to reach any other device, network or service anywhere.

Access networks implement technology-specific functions, for example in the Radio Base Station (RBS) or Digital Subscriber Line Access Multiplexer (DSLAM). The evolution of access technologies enables and drives the evolution of services. The Multi-Access Edge domain contains access specific as well as common capabilities that support mobility– including authentication, 3GPP mobility, IP-level mobility, roaming, converged policy control and charging capabilities. 3GPP Policy and Charging Control (PCC) and System Architecture Evolution (SAE) provide the foundation for integrating 3GPP and non-3GPP accesses.

IMS & Communication Enablers include functions for establishing and maintaining end-to-end communication sessions, as well as standard applications such as multimedia telephony and interactive and personalized TV services.

The IMS & Common Enablers, along with the Multi-Access Edge, interface with the operator Service Delivery Platform (SDP), which contains the operator business processes for managing and selling services. The SDP also connects those business processes into customer relationship managment, billing, network and other essential supply chain elements such as residential and enterprise self-service portals. For more information on SDP, see Reference [1].

The common transport layer is designed for carrier-class, cost- and performance-optimized routing and switching. It is kept independent of service delivery capabilities, so that these can be independently introduced, scaled and distributed. The transport layer provides transmission and IP-VPN services to higher-layer services and external networks, for example for enterprises. The routing and switching are access technology-independent, enabling different access technologies to co-exist and be upgraded or introduced easily. The need for this separation is even more evident when considering how to map functionality on to the topological site structure, as shown in Figure 2.

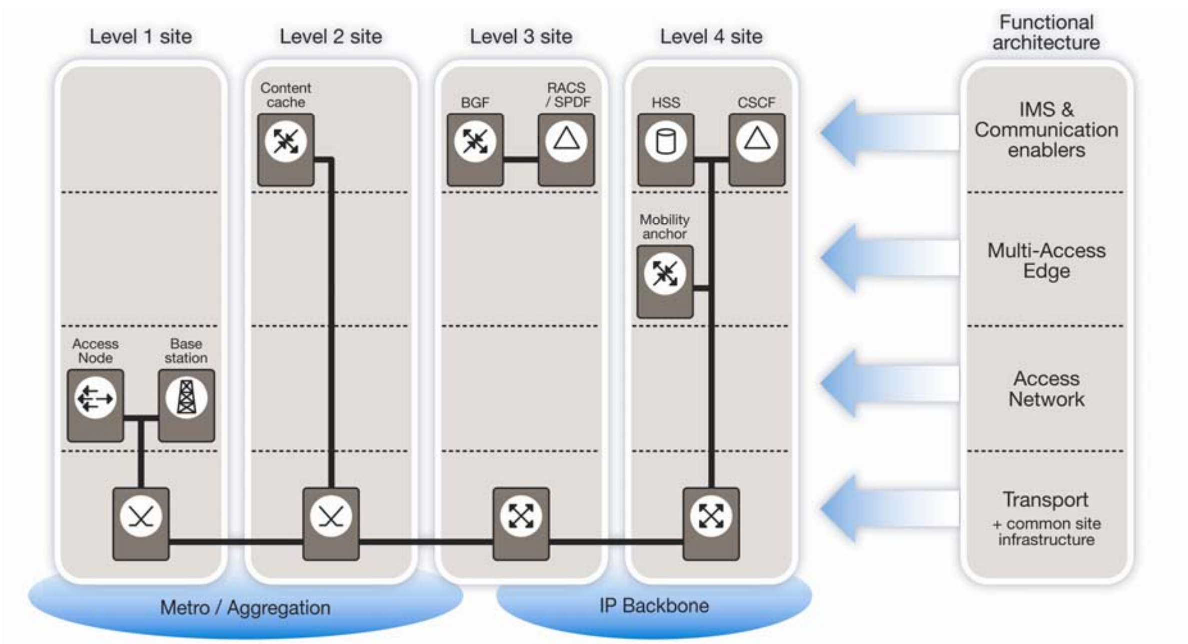

Figure 2. Example of mapping architectural elements to topological site structure.

The physical location of functionality depends on several factors, including: site topology and costs; geographical distribution of users; service utilization transport costs versus site OPEX and CAPEX; level of mobility; and the location of peering points. All in all, this calls for flexibility, so that functions can be optimally distributed using open IP protocols. One example is the deployment of a multi-edge solution, where content caches are distributed as the service grows in popularity. For further guidance on how distributed co-sited functionality can be managed, and how migration of functionality between topological levels is enabled, see Reference [2].

Each area needs to be managed, and ties into the overall Telecom Management structure. For more detailed views on Telecom Management, please refer to Reference [3].

3.2 Building a transport infrastructure for flexibility

The aggregation and transport parts of the Full Service Broadband architecture are designed to be common to all fixed and mobile access technologies. They are designed for low cost of ownership and based on carrier-grade Ethernet and deep fiber topologies.

The fundamental concept within the Full Service Broadband architecture of separating the service and access parts from the transport network elements helps deliver a cost-optimized transport network without sacrificing flexibility. Common transport is aided by the fact that services are becoming increasingly homogeneous, independent of access type: the main payload will be IP packets, carried by Ethernet frames.

In the Full Service Broadband aggregation architecture, Ethernet is the uniting link-level protocol, whether as Ethernet over Optical Transport Hierarchy (OTH) or Synchronous Digital Hierarchy (SDH) and switched Ethernet. Carrier-grade Ethernet is about adding – primarily software – components to Ethernet to handle issues like fault tolerance, scalability, fault location, network migration and transport of timing information for RBSs.

Above the physical layer, there will continue to be a number of architectural alternatives for traffic separation, quality of service maintenance and local delivery of services. However, the services provided in the aggregation network seem likely to converge on the Metro Ethernet Forum definitions of Ethernet Services, such as ‘E-Line’, ‘E-LAN’ and their variants. Transport services can be provided using these internally within the operator and to enterprises alike.

Mobile networks will also adopt these standards, and migrate from a world of predominantly leased circuits. A common control plane – working over Ethernet or optical transport technologies – will be essential. The Full Service Broadband aggregation architecture is flexible in terms of packet forwarding and traffic separation, and supports pure Ethernet switching, tunneling techniques such as Multi Protocol Label Switching (MPLS) and the use of IP routing protocols.

Fiber access networks such as point-to-point Ethernet and different flavors of Passive Optical Network (PON) are being built out to support advanced media delivery (such as TV/HDTV). In combination with the build-out of remote VDSL2 sites, this creates a deep fiber aggregation architecture that is one of the cornerstones of the Full Service Broadband aggregation and transport architecture. As fiber technologies have long reach, this creates a strong trend – particularly in urban areas – of aggregation networks going from several aggregation stages towards a flatter optical network with fewer active nodes. This, in turn, opens up opportunities for cost reduction in network operation and real estate consolidation. The separation of transport functions from service and access enables such consolidation to be carried out incrementally.

In rural areas or developing countries, the fiber trend will be weaker and multi-level aggregation topologies will still be the preferred solution. Here, microwave technologies will also have a crucial role to play.

One crucial way to reduce OPEX in the transport network is through a unified management view. More automated procedures are needed, for example, for flexible sharing of capacity between multiple business roles. This includes auto-discovery of equipment and connectivity, as well as monitoring and reporting of Service Level Agreements (SLA).

3.3 Connecting devices and users

For residential and SOHO access, Full Service Broadband demands a shift to supporting individualized services, rather than delivering services to ports, as depicted in Figure 3.

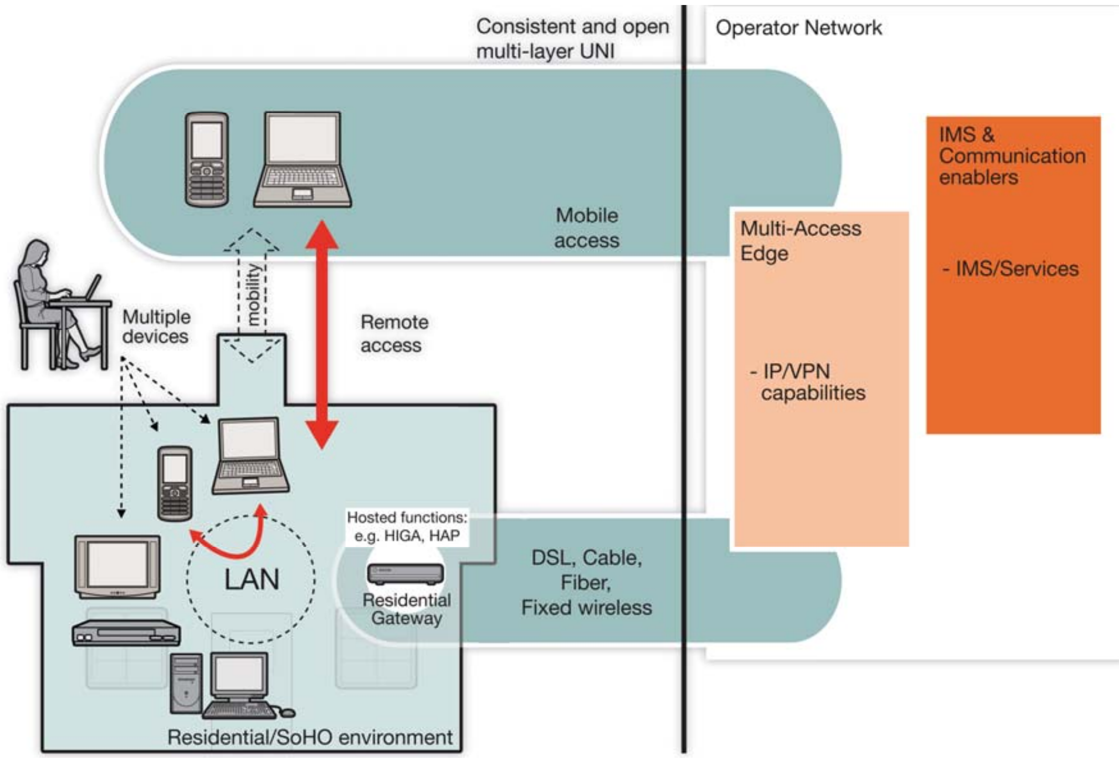

Figure 3. Connecting homes and mobile users.

Users increasingly want to do more on the move, and they use a plethora of devices, including portable media players, gaming devices and set-top boxes. They want all services to be available to them, wherever they are, from any device and independent of access. Likewise, user devices need to be connected to other devices in the residential network, wherever they are – for example, for remote access to personal media. Emerging standards like Digital Living Networking Alliance (DLNA) will play a central role here.

With a consistent and open UNI, service usage is made convenient for users. From a consumer electronics industry perspective, this uniformity delivers economies of scale. IMS is a cornerstone for this UNI, along with standard IP/Ethernet and VPN capabilities. For multi-access mobility, 3GPP SAE is expected to provide the baseline.

The ability to provide services into residential or SOHO networks – and to the consumer electronics devices connected to them – is crucial to the success of Full Service Broadband. The Full Service Broadband architecture takes a pragmatic approach that fits a variety of operator strategies. For example, it allows for gateway functionality supporting interoperability between IMS services and non-IMS capable consumer electronics devices, through a Home IMS Gateway (HIGA). It also supports operator-provided Home Access Points (HAP). To counter the risk of escalating cost of ownership, the architecture also supports a more network-centric approach, where the operator-provided residential network functionality is kept to a minimum.

The Full Service Broadband architecture is designed to make the user experience transparent and painless – for example, by avoiding the need for hands-on configuration, with the operator as an enabler.

3.4 Evolving access networks for Full Service Broadband

Full Service Broadband services – especially video services – are enabled by and drive advances in access technologies, both in terms of increased bandwidth and reduced packet delays. The most important examples are VDSL2 (see Reference [4]), FTTH technologies, WCDMA/HSPA and 3G LTE (see Reference [5]). Wireless accesses will be used both for mobile and fixed wireless (for stationary access).

Although these technologies will be competing with each other, it is also increasingly important that they can be used in a complementary way in a single solution to satisfy different economic needs. In some cases, FTTH may be the most cost-effective solution, especially where the cost of fiber deployment is comparatively low. In other cases, VDSL2 will make the most economic sense, for instance as an intermediate step. If the copper loops cannot be made short enough in an economically justifiable way, the use of fixed wireless access, such as WCDMA/HSPA or LTE, may be more cost-optimal.

If the same services are to be provided across multiple access technologies, the delivered capabilities – especially maximum bit-rate – need to be comparable across these accesses. A competitive mobile broadband solution becomes a necessity for a successful Full Service Broadband business.

The advances in access technology also open new opportunities when used in combination. For instance, an existing GPON solution could be used to backhaul traffic from RBSs and DSLAMs.

The Full Service Broadband architecture is designed to simplify co-existence of access technologies and to simplify changes such as the addition of new technology. This is accomplished through access-agnostic transport layer and service delivery capabilities.

3.5 The importance of the multi-access edge

The access heterogeneity of Full Service Broadband must be managed to give users the best possible convenient connectivity, with low cost of ownership for operators. The multi-access edge capabilities, shown in Figure 4, have a key role to play here.

The multi-access edge comprises both individualized user/service capabilities, as well as functions for interfacing the access network and dealing with the delivery of packets to a port. A service interface ensures that access dependencies are hidden from higher-level services such as IMS. The user/service control, and associated gateways and anchors, deal with essentially access-independent capabilities – including multi-access mobility, IP services and deep packet inspection, and real-time charging. They also coordinate functions like policy/resource control and location management across accesses. The architecture allows these functions to be consistently applied across accesses. 3GPP PCC (see Reference [6]) is expected to be the foundation for these functions.

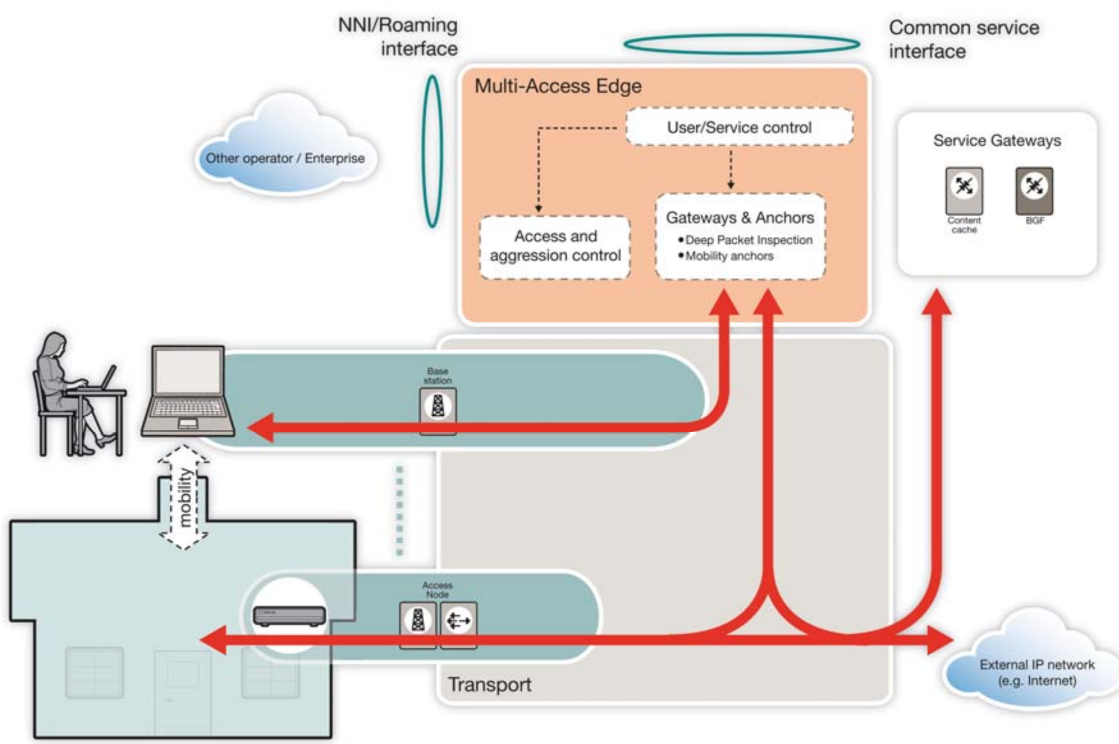

Figure 4. Multi-Access Edge.

Both nomadic mobility and IP mobility will be supported. For user convenience and cost control, a consistent approach to authentication is needed, and this is typically achieved through credentials that are tied to the user – such as a SIM card – and are used across access technologies. Roaming and other forms of business interworking will also be key. All these capabilities are based on 3GPP SAE (see Reference [7]).

Access and aggregation resources such as admission control also need to be managed, and will, to a large extent, be access-dependent. For fixed access, TISPAN RACS (see Reference [8]) is the baseline, while mobile access will use inherent 3GPP capabilities.

A multi-edge approach is adopted for the data plane. The transport network provides resilient and cost-efficient routing and switching of packets. Different gateways and anchors are overlaid on this, and process data when needed (depending on the service) – improving flexibility and scalability. These arbitrarily distributed functions are controlled by the same control framework as described above. This is done in line with DSL Forum TR-101 and its foreseen evolution, see Reference [9].

3.6 IMS as an enabler of personalized communication services

Open and standardized UNIs and NNIs are prerequisites for communication services between end-points (devices or servers). The UNI ensures volume availability of devices, and drives usage by making the services available anywhere. The NNI enables communication end-points to be reachable even if they belong to a different operator domain, which also drives usage.

IMS has been adopted as the common framework for building a variety of communication services based on these principles. IMS also provides end-to-end quality of service control and, for this purpose, integrates with the multi-access edge and control capabilities. The common IMS standard enables communication services that are built on it to be used across access technologies. An example is MMTel for multimedia telephony services – used for both mobile and fixed access. For more information on IMS, see Reference [10].

IMS is a key enabler in the delivery of user convenience across access technologies, and for seamless mixing of services. With Full Service Broadband architecture, the user can access his or her personal TV services – such as broadcast, video on demand, and network personal video recorder – independent of whether he or she is using a mobile device on the train or watching a flat-screen TV in the living room. Also, the TV services can be seamlessly combined with other services like IMS-based chat or messaging, presence and buddy-lists, as well as other Internet-based services. The personalization of TV services and their combination with communication services paves the way for interactivity in areas such as advertising and game shows. For more details on IMS-based interactive and personalized TV, see Reference [11].

The use of IMS functions and interfaces for billing and provisioning cuts the time and costs involved in introducing new services like interactive and personalized TV, and helps reduce operational costs. TV benefits from the generic IMS mechanisms of bandwidth negotiation and end-to-end quality of service control. This provides a simple means to optimize quality for TV sessions.

4 Recommendations and conclusions

When deploying transport networks, it is recommended to balance the short-term needs of optimizing fixed broadband networks with the flexibility required for Full Service Broadband. It must be simple and cost-efficient to add multi-access mobility, new access technologies and new services. Sacrificing flexibility by tight bundling of functionality into the transport functions is a deviation from the route to Full Service Broadband. The transport network should be optimized for secure, reliable and cost-efficient packet delivery.

Services should be built in such a way that they can later be made available to mobile as well as fixed users. It is important to recognize that Full Service Broadband, unlike fixed broadband, is about providing individualized services to users, not to a particular residence or a port.

It is worth preparing for changes in topology and site structure. As bandwidth demand grows and fiber is deployed deeper into the network, the economics will change. It should be possible to move higher-layer functions such as multi-access edge and IMS over time.

Finally, operators should prepare for adding multi-access capabilities that will enable convenient connectivity for users. Operators should move towards standards that are driven in the direction of Full Service Broadband, including IMS, 3GPP SAE, 3GPP PCC, TISPAN RACS. And they should be prepared to upgrade/add accesses and extend the reach of services through business-to-business arrangements in areas such as roaming.

The Full Service Broadband network – in which all services are made available, anywhere, anytime and to any device – represents a tremendous opportunity for the industry. This paper has outlined the feasibility of Full Service Broadband, and an architecture to support it. This architecture can be built using components that are already, or soon will be, available based on open standards.

It is crucial that operators consider their route towards Full Service Broadband as they deploy fixed or mobile broadband networks. If the right initial steps are taken now, they will enjoy smooth and cost-efficient migration to Full Service Broadband.

5 Glossary

BGF	Border Gateway Function (ETSI TISPAN entity)
CSCF	Call Session Control Function (part of IMS; P-CSCF is Proxy-CSCF)
DSLAM	Digital Subscriber Line Access Multiplexer
FTTH	Fiber To The Home
GPON	Gigabit Passive Optical Network
GSM	Global System for Mobile communications
HSPA	High Speed Packet Access. Part of 3GPP WCDMA standard
HSS	Home Subscriber System. Part of IMS
IMS	IP Multimedia Subsystem
LTE	(3G) Long Term Evolution
NNI	Network-to-Network Interface
PCC	Policy and Charging Control (3GPP work item)
PON	Passive Optical Network
RACS	Resource and Admission control Subsystem (ETSI TISPAN)
SAE	System Architecture Evolution (3GPP study item)
SOHO	Small Office/Home Office
SPDF	Service Policy Decision Function (ETSI TISPAN entity)
UNI	User-to-Network Interface
VDSL2	Very High bit-rate Digital Subscriber Line (DSL)
VPN	Virtual Private Network
WCDMA	Wideband Code Division Multiple Access
WiFi	Wireless Local Area Network technology (WiFi Alliance)

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