MARKETING REPORT

MR-235

Considerations in Broadband Architecture Moving to FMC

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Executive Summary

The Broadband Forum (BBF) works towards aligning the telecom industry by defining the interworking requirements between 3GPP Evolved Packet Core architecture and the Broadband Forum architecture. This work addresses the industry trend called Fixed/Mobile Convergence. The main convergence aspects addressed in this document are:

- Converged business and services
- Converged network and infrastructure
- Converged user management and terminals

While the technical work is developed in parallel in the BBF Technical Committee and in 3GPP, MR-235 highlights industry trends and business opportunities driving Fixed/Mobile Convergence. This document presents several technical evolution steps that can be taken from the present non-converged fixed and mobile networks towards a Fixed/Mobile Converged network. It also provides an overview of the standardization organizations active in defining the open-standards that are an essential component to build a profitable and sustainable converged network, enabling feature rich, interoperable solutions and smooth deployment of novel customer services.

1 Introduction

Fixed/Mobile Convergence, Broadband Convergence, network transformation, interworking are terminologies frequently used by the telecommunication industry. The purpose of this Broadband Forum marketing document is to shed light on this highly popular topic.

MR-235 covers several areas including:

- What is Fixed Mobil Convergence from the Broadband Forum perspective?
- Industry trends and business opportunities when introducing Fixed/Mobile Convergence?
- Why are open-standards essential when building a profitable and sustainable converged network?
- What role does the Broadband Forum play in Fixed/Mobile Convergence?
- What steps to take from present dedicated separate fixed and mobile networks towards convergence?
- The role 3GPP - BBF interworking plays towards achieving Fixed/Mobile Convergence
- Connectivity relation between fixed and mobile architectures

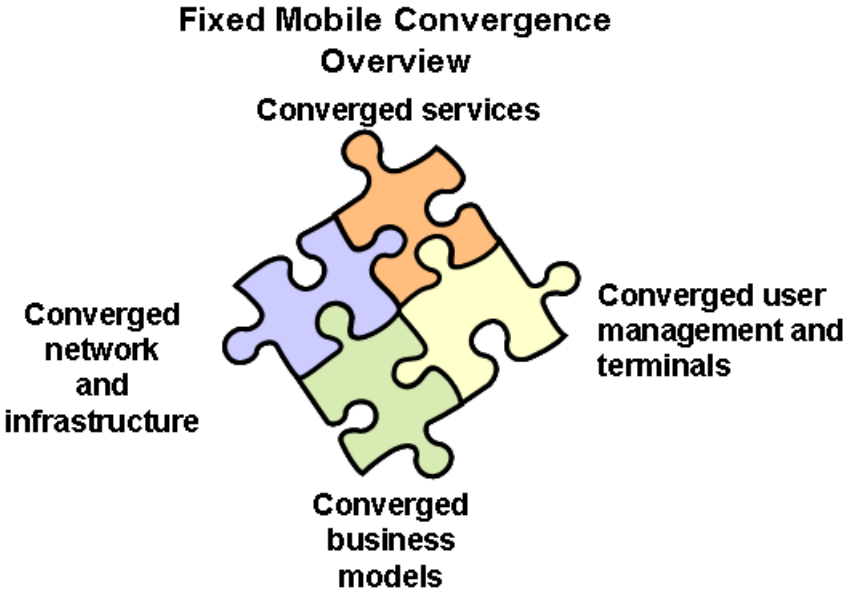

Figure 1-1. Representation of the multiple aspects included in the Fixed/Mobile Convergence area

The Broadband Forum aim is to align the industry e.g. the interworking between 3GPP Evolved Packet Core architecture and the Broadband Forum architecture. The Broadband Forum and 3GPP have agreed on a set of use cases to describe possible converged services. MR-235 focuses on the Broadband Forums activities to create specifications for architectures fulfilling the requirements from the use cases described in WT-203, *Interworking between Next Generation Fixed and 3GPP Wireless Access* [11].

The Broadband Forum's approach to specifications has historically been vertical in its nature (access, technology or service specific) but for convergence a comprehensive end-to-end horizontal approach, that considers the entire telecom ecosystem, is needed. Bound to its remit, the Broadband Forum is taking an active part bringing the industry together, aligning the Fixed/Mobile Convergence (FMC) work.

Interworking has been commonly used by operators to link networks of different types. FMC is now adding a new dimension on how networks are evolving to reduce cost of ownership and enabling new business models. Combining network operation and user management subscription databases offers a number of benefits e.g. simplified charging and billing. Service providers offering both fixed and mobile services can also benefit by utilizing the same transport network infrastructure for both kinds of traffic e.g. backhauling mobile broadband. The Broadband Forum has two marketing documents on this topic:

- MMBI White Paper on Use of MPLS in LTE, *February 2010*, [1], and
- Use of MPLS Technology in Mobile Backhaul Networks, *February 2008*, [2].

Fixed/Mobile Convergence means ease of use, a richer telecommunication experience from new attractive service offerings, and "a life without barriers" for the consumers. For the service provider, Fixed/Mobile Convergence is the ability to deliver any service, anywhere and via any access technology. It allows the service provider to apply the best connectivity for optimal network utilization and enhanced user experience... Full scope of convergence involves many aspects but the foundation is IP. FMC standardization work is actively ongoing in the Broadband Forum, 3GPP and IETF.

2 Opportunities for Fixed/Mobile Convergence

The current mega trends can be described as going from single to multiple choices, with many social communities to choose from, a multitude of devices to fit different personal preferences, multi heterogeneous networks with a broad service mix, and many business models existing in parallel. But it all starts with the consumer. The consumer wants a life without barriers. This is where FMC comes in.

Figure 2-1. Representation of the end user benefits from Fixed/Mobile Convergence

2.1 A life without barriers, user convenience

User convenience is a fundamental part of driving the mass marketing of broadband services, especially as the variety of devices and services continues to grow. User convenience is about security, simplicity, personalization and look-and-feel. It is about being able to communicate and reach services in a consistent and intuitive way, irrespective of how the user is gaining access. It is also about the ability to connect a device to a wireless or wired premises network, or to a mobile network, in a simple, convenient way. These factors are key to enhancing user satisfaction and minimizing interactions with support centers. The value of such factors grows with the number of devices supported

2.2 **A life without barriers, seamless user experience**

Converged services must be seamlessly and intuitively accessible across all devices and all networks. For operators, the introduction of new services and additional network capacity must incur minimal additional costs.

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

The architecture needs to support services that are both affordable for users and profitable for operators. This means savings must be made in network deployment and operation. There are fast changes in the Web economy. Therefore, it is crucial to maintain network flexibility to be able to quickly respond to market demand.

The Broadband Forum and 3GPP have agreed on a set of Fixed/Mobile Convergence use cases. These use cases are described in the 3GPP liaison [3] to the BBF and the subsequent BBF working text addressing the technical challenges required to realize such use cases, WT-203. The following are some of the use cases addressed by 3GPP and BBF

- Internet access with parental control and personal firewall
- Voice / multimedia and charging
- Video
- 3G Femto cell
- Application mobility
- Dual-WAN connected device

2.3 FMC Evolution

To reach full convergence, several network functions need to be implemented in a uniform fashion independent of the access type (fixed or mobile). The introduction of converged network features can happen in a stepwise process creating the converged user experience in a gradual way.

In this section we discuss individual network features required for convergence. It is difficult to give a timeline of introduction, since features can be introduced many different ways depending on the strategy of the service provider. Not only the order of feature introduction is flexible, but also the level of integration. Functions common to both fixed and mobile networks can be first made to interwork between the two parts of the network with a later upgrade to a converged solution. Alternatively, either a converged solution can be deployed from day one, or interworking can be kept for very long time.

FMC, by its nature is an area spanning multiple SDOs. Timing is right for the standardization community to develop standards enabling feature rich, interoperable solutions and smooth deployment of novel customer services.

2.4 Separate fix networks and mobile networks

From a network infrastructure perspective, Fixed-line Networks and Mobile Networks have often been built separately, as illustrated in Figure 2-2 below.

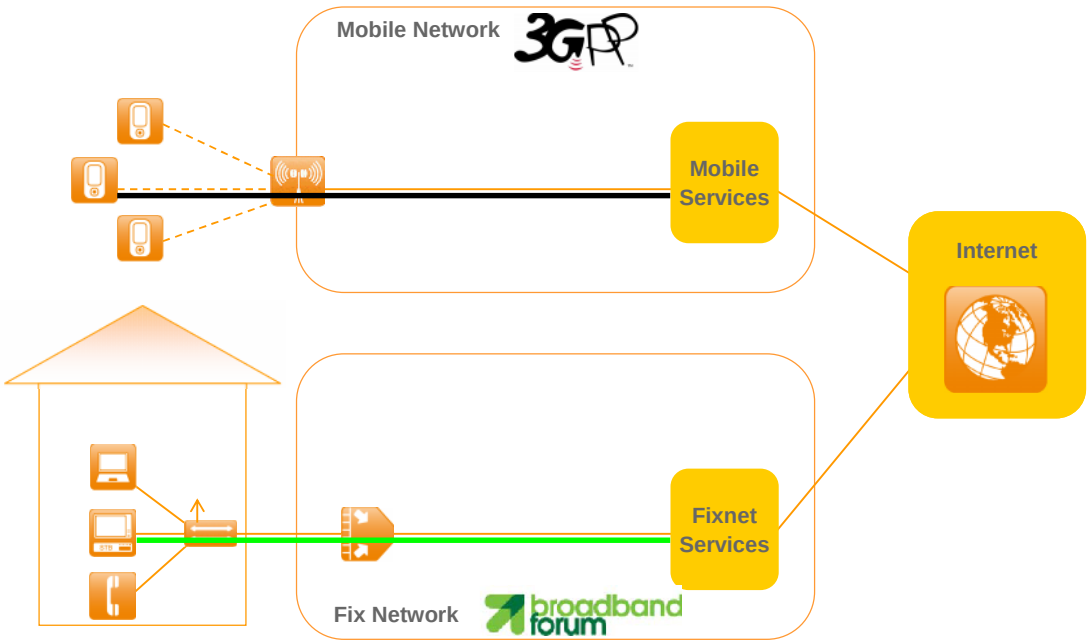

Figure 2-2. Separated fix networks and mobile networks

Here fixed networks are typically owned and operated by fix network operators offering their dedicated services such as triple-play to their subscribers. In contrast, mobile networks are typically owned and operated by mobile network operator also offering their dedicated services to their subscriber. Even in case of a converged network operator, we initially find dedicated networks that are operated separately.

2.5 Common Transport

Service providers offering both fixed and mobile services can benefit by utilizing the same transport network infrastructure for both kinds of traffic. Albeit this often represents a significant organizational and technical challenge, cost reduction can be significant. Not only by reducing network management complexity and removing network redundancy, but also via enabling better capacity planning and more flexible provisioning. These improvements contribute to reducing both CAPEX and OPEX. One example of such common transport is mobile backhauling as defined in the BBF white papers [1] and [2].

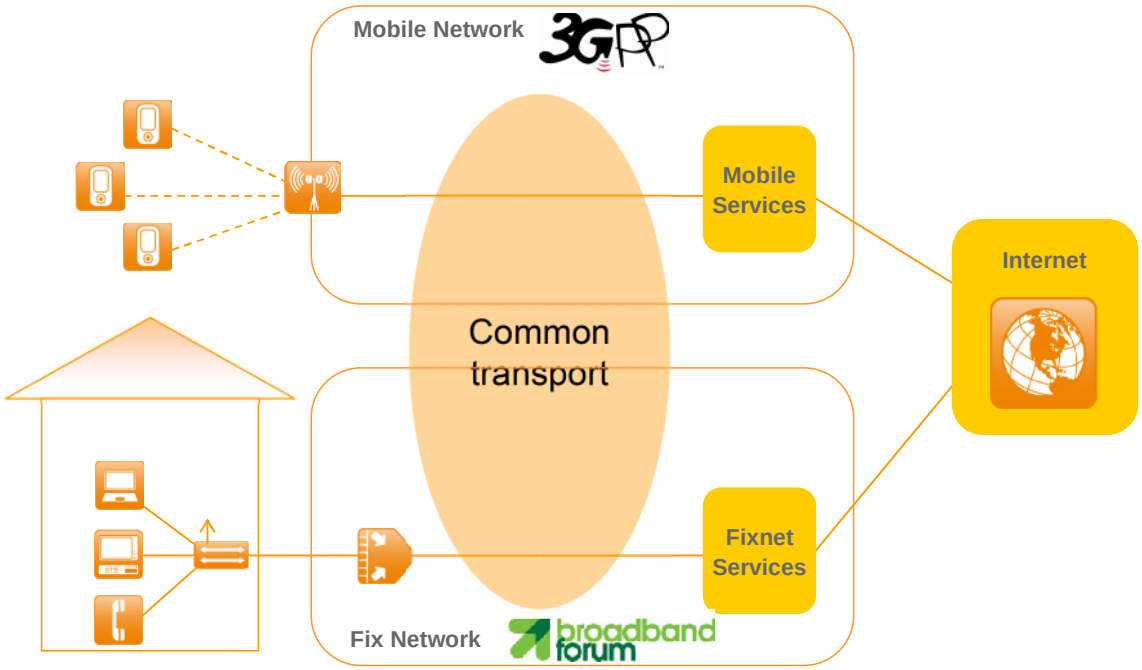

Figure 2-3. Separated fix and mobile access networks sharing a common transport

2.6 FMC Connectivity

A first important step towards FMC network convergence appears with the evolution of smartphones and the demand to increase their coverage into residential homes or other fixed broadband networks bound locations such as hotspots and enterprises..
Assuming that a smartphone subscriber moves from a 3G macrocell into his home, this device can now continue service via WiFi or a Femtocell. In this basic FMC scenario the fixed

broadband networks offers connectivity to the mobile network but provides "best effort" packet transport only. Dedicated QoS measures may become deployed at very specific points in the network leading to improved QoE but we are far away from providing carrier grade end-to-end guaranteed QoS/QoE. As this basic scenario does not require additional measures in the fixed broadband networks, early availability in the market can be assumed.

Connectivity to the mobile network can be realized as a simple nomadic access. It can also be enriched by additional features such as mobility support, session continuity and automated access selection. Certain use cases would require mobility or even session continuity. In addition, since the traffic is going through the same service network, some packet services such as personal firewalls, header enrichment services (e.g. adding location information) and customized charging can be continued to be provided to mobile terminals irrespective of access.

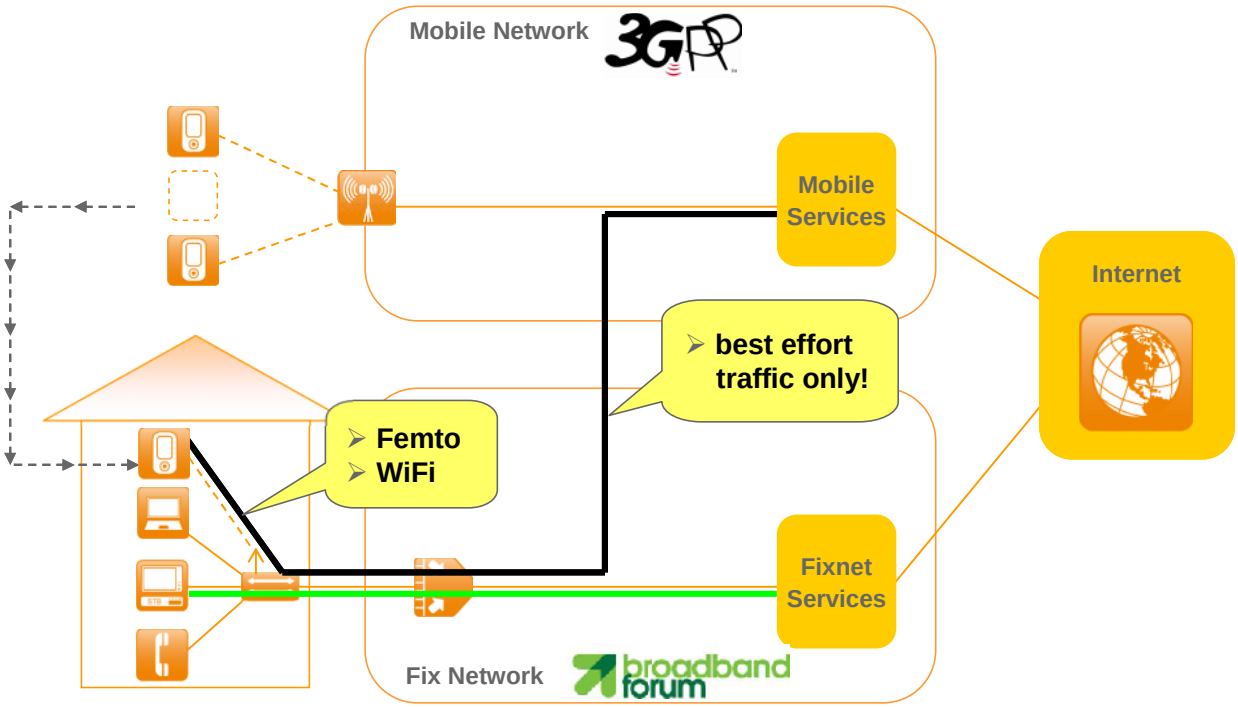

Figure 2-4. Connectivity over femto and WiFi

The fixed network can take different roles in providing the connectivity, i.e. it can be a simple bit-pipe or it can be more involved. Currently the 3GPP Evolved Packet Core standard offers the following connectivity over alternative access networks.

- Treating the access network as untrusted using an IPsec overlay to reach the mobile core network. This allows a user to reach mobile network services with little involvement from the fixed operator.
- Treating the access network as trusted. A trusted scenario enables a more converged solution for a co-operating fixed and mobile operator, not requiring an IPsec overlay.
- Applying a Home eNodeB (femto cell). Using the access network as a backhauling service between a 3GPP access network and the mobile core.

2.7 User subscription management

If an operator operates both fixed and mobile access networks, combining the subscription databases offers a number of quick benefits, such as lowered OPEX, simplified charging and billing, better customer experience through a single bill and the ability to offer tariff packages including fixed and mobile services.

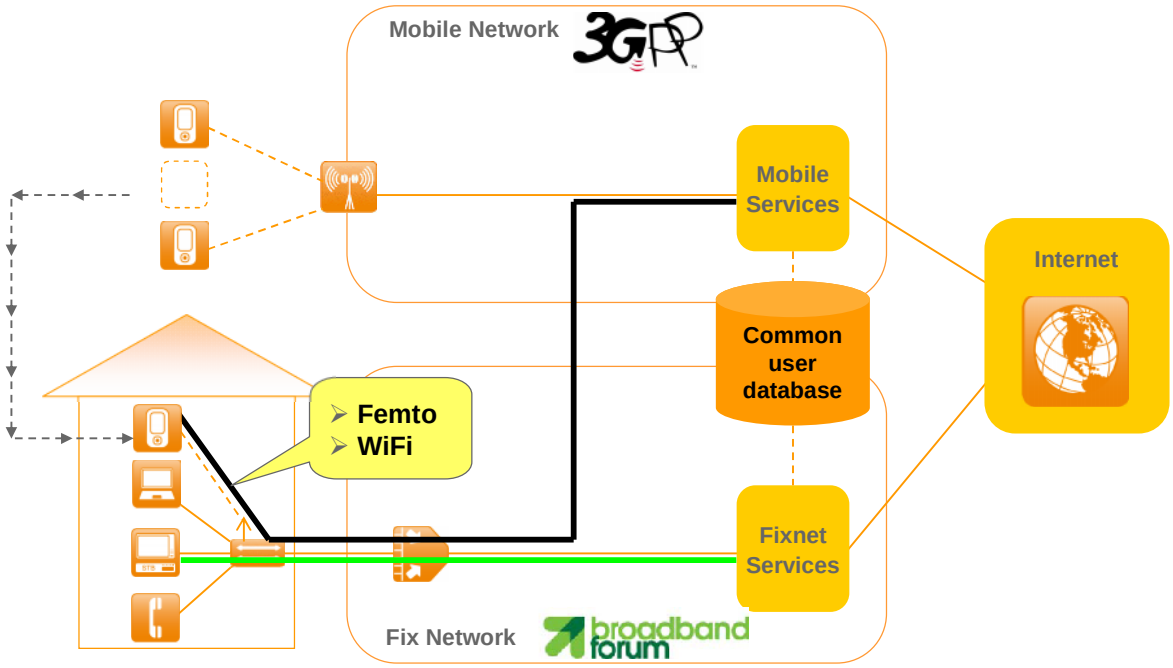

Figure 2-5. Common user subscription

2.8 Traffic Offload

Traffic in a converged network is potentially processed by more entities and travels a longer distance due to the converged functions, such as an anchor point in the mobile network. It may therefore be desirable to make smart decisions about traffic routing to avoid unnecessary processing and cost.

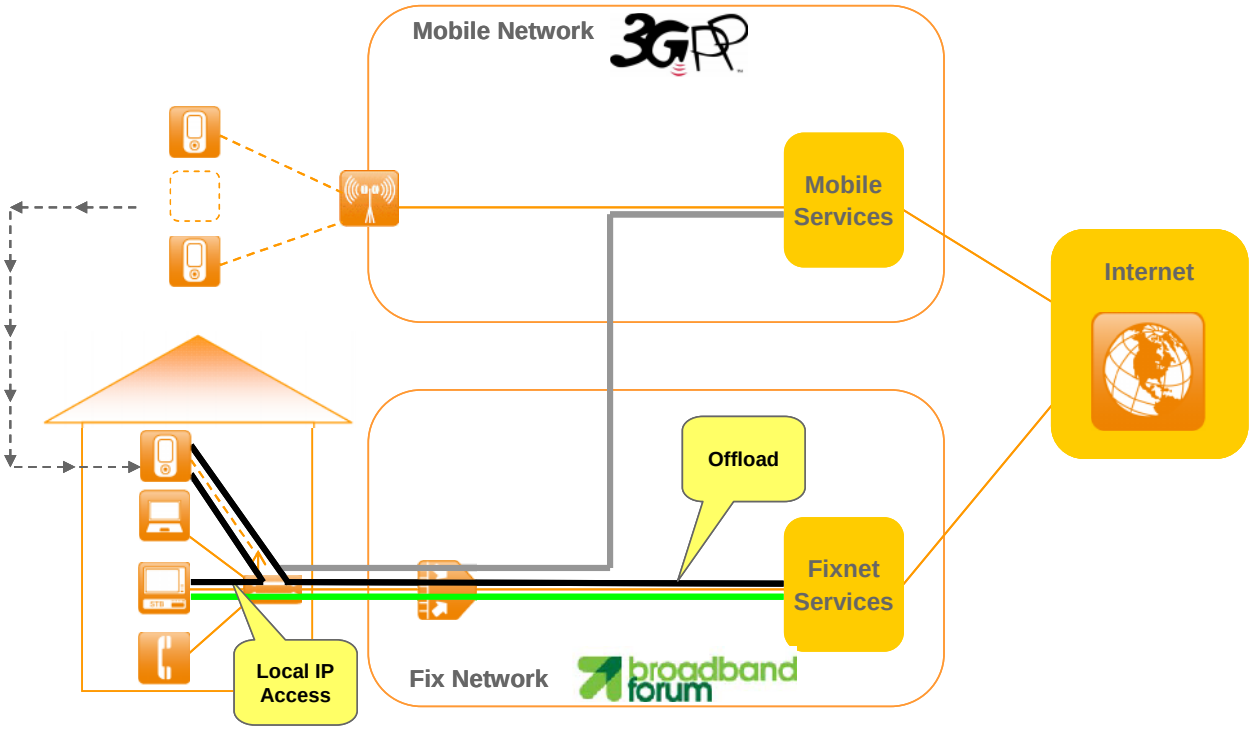

Figure 2-6. Traffic offload possibilities between fixed and mobile networks

There are a number of techniques to offload traffic in a controlled fashion.

- The anchor point nodes in Mobile Core Networks often provide a rich set of packet control and charging functions not routinely deployed in fixed networks. If such control is not desired for traffic coming from a fixed access network, it can be more efficient to avoid going through the Mobile Core Network. For example, in a scenario with Femto, 3GPP defines Selective IP Traffic Offload (SIPTO) for offloading selected traffic from the mobile network.
- User devices on a campus or home network may wish to have access to local devices. Such local access must be possible locally without involving the infrastructure of the operator. For the Femto case 3GPP has defined Local IP Access (LIPA) allowing UEs (User Equipment) to connect to local resources (e.g. printer, storage …) while using external connectivity (such as web surfing) in parallel.

2.9 Simultaneous Multi-Access

If a terminal device has access to both a fixed and a mobile access network at the same time, it is logical to provide the ability to use both networks at the same time. If implemented in a seamless fashion, simultaneous multi-access offers higher overall throughput, more robust networking experience and allows providing different services over different accesses. The latter may be used to offer real-time communication services through the mobile access and high volume data services over the fixed access network if both are available at the same time.

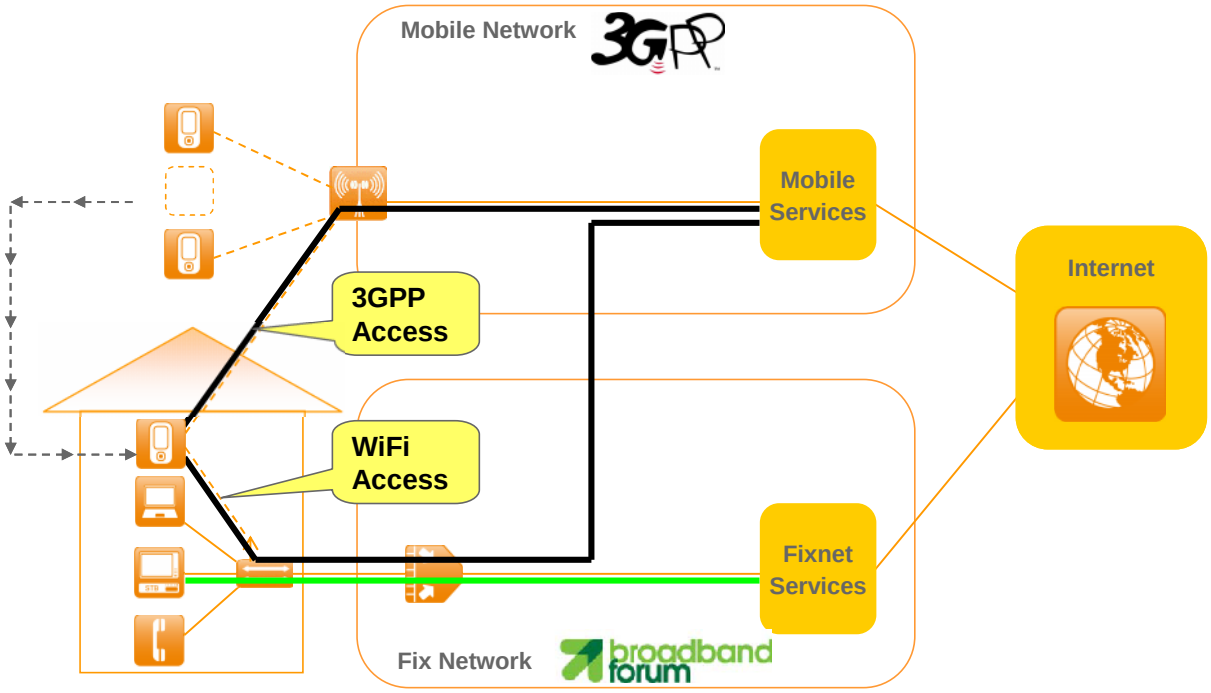

Figure 2-7. Simultaneous multi-access

Most terminals capable of connecting to a cellular access and WiFi at the same time implement the two radios in parallel, which if the network supports it, allows simultaneous multi-access through 3GPP and BBF access. It should be noted in these scenarios, the terminal has two IP interfaces, one for each access.

2.10 Policy Control and Resource Management

An important aspect of packet networking is to control resource utilization. On one hand this is important to be able to provide the right quality of service for each application. On the other hand it is also important for service providers to manage resources according to their business policies. Without proper policy control, an operator neither can allow a delay- or bandwidth-sensitive application such as telephony or video to enjoy sustained high quality, nor can it ensure the fair use of its network resources or fulfill its SLAs.

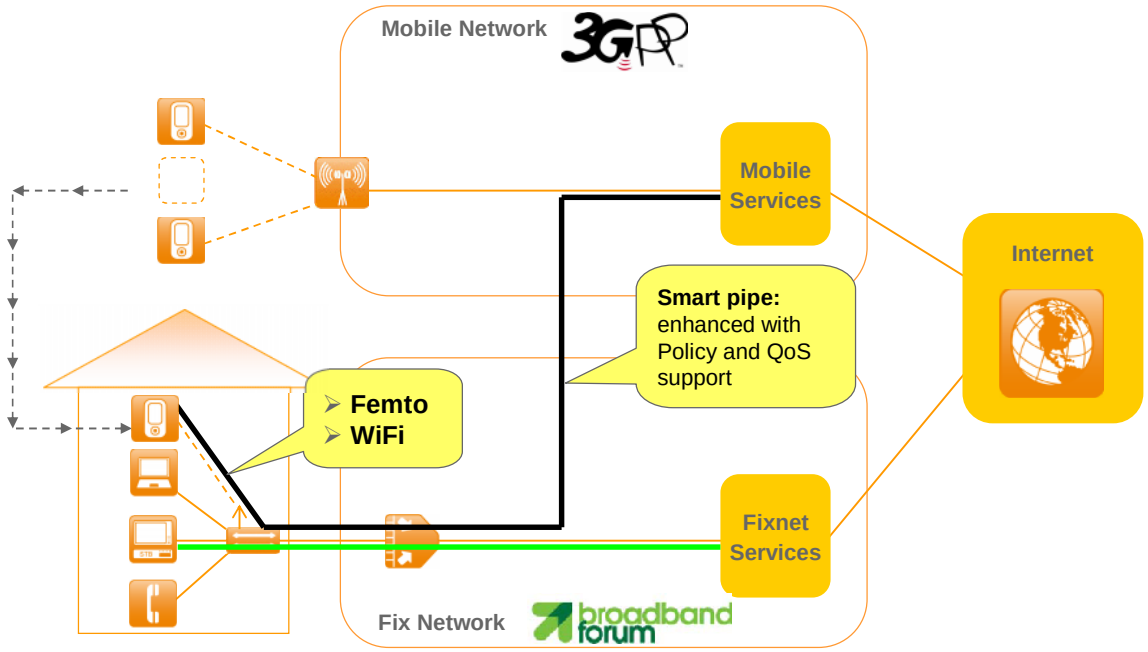

Figure 2-8. Policy control and resource management enhanced networks

A proper policy control interworking architecture also allows for providing value-added services such as parental control or virus filtering irrespective of mode of access.

Interworking between or convergence of the policy control systems of the fixed and mobile accesses enables to have uniform Quality of Experience for subscribers and consistent control over operator resources. Interworking or convergence is also a critical element to provide a smart pipe securely, with requested Quality of Service, across all access networks.

2.11 Full Convergence Vision

The ultimate vision of convergence is a scenario where all the above functions are implemented by a single, converged solution.

- A single subscriber database storing uniform identifies, allowing customers to use their credentials for accessing any service or access.
- A common policy control function governing resource use in all accesses in a uniform manner.
- A single, converged transport network under unified management.
- Converged services available in all accesses the same way.

Depending on business models and agreements between service providers, convergence can be composed of a subset of those major components. In cases where full convergence is not achievable, interworking functions are deployed.

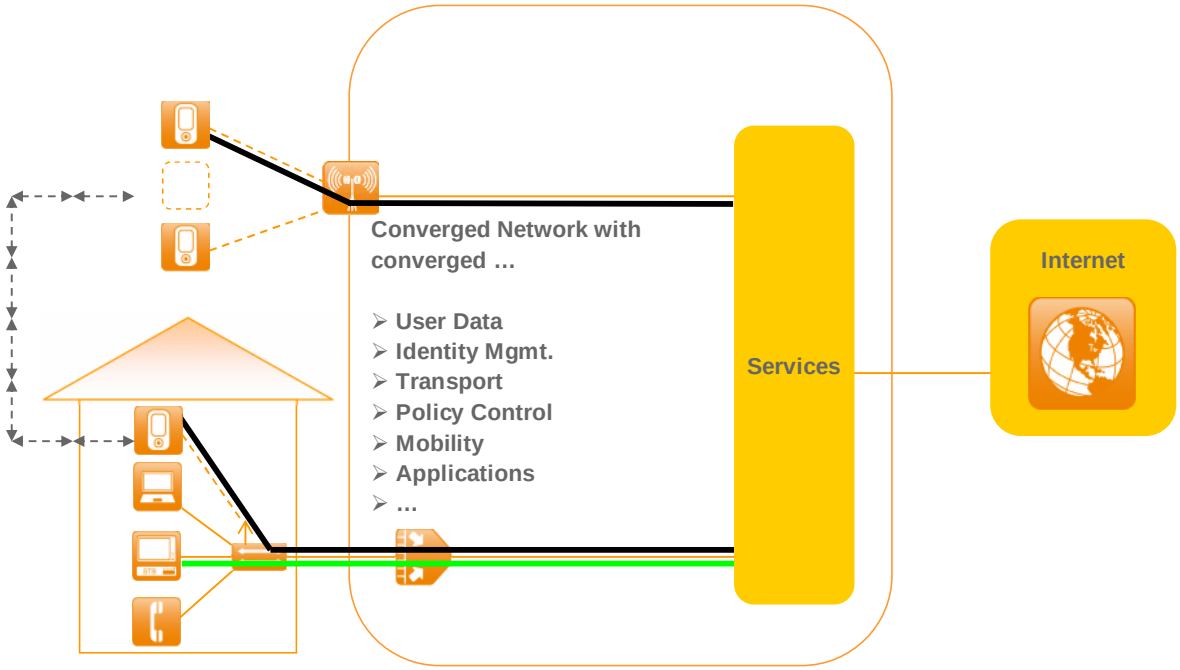

Figure 2-9. Full convergence vision

3 Standards and global specifications to assist development of FMC

Fixed/Mobile Convergence (FMC) has been a key topic in several telecom SDOs for a number of years now. Recently, the 3GPP and the Broadband Forum brought together experts from 3GPP, BBF, ETSI TISPAN, ATIS and other standards bodies, with a shared goal: to start the process of aligning FMC-related work in each organization to best address both fixed and wireless networks requirements. A summary of the relevant activities in each of the aforementioned SDOs follows..

3.1 Broadband Forum

In the context of the multi-services architecture, the Broadband Forum is a standards integrator. The BBF does not specify protocols or produce primary specifications in general. The BBF basically makes specifications "work together" by documenting the systems and liaising with other SDOs to fill identified gaps. In this context, the BBF has engaged in broadband convergence activities from the perspective of supporting the capability of delivering any service, anytime, anywhere, via any-access technology.

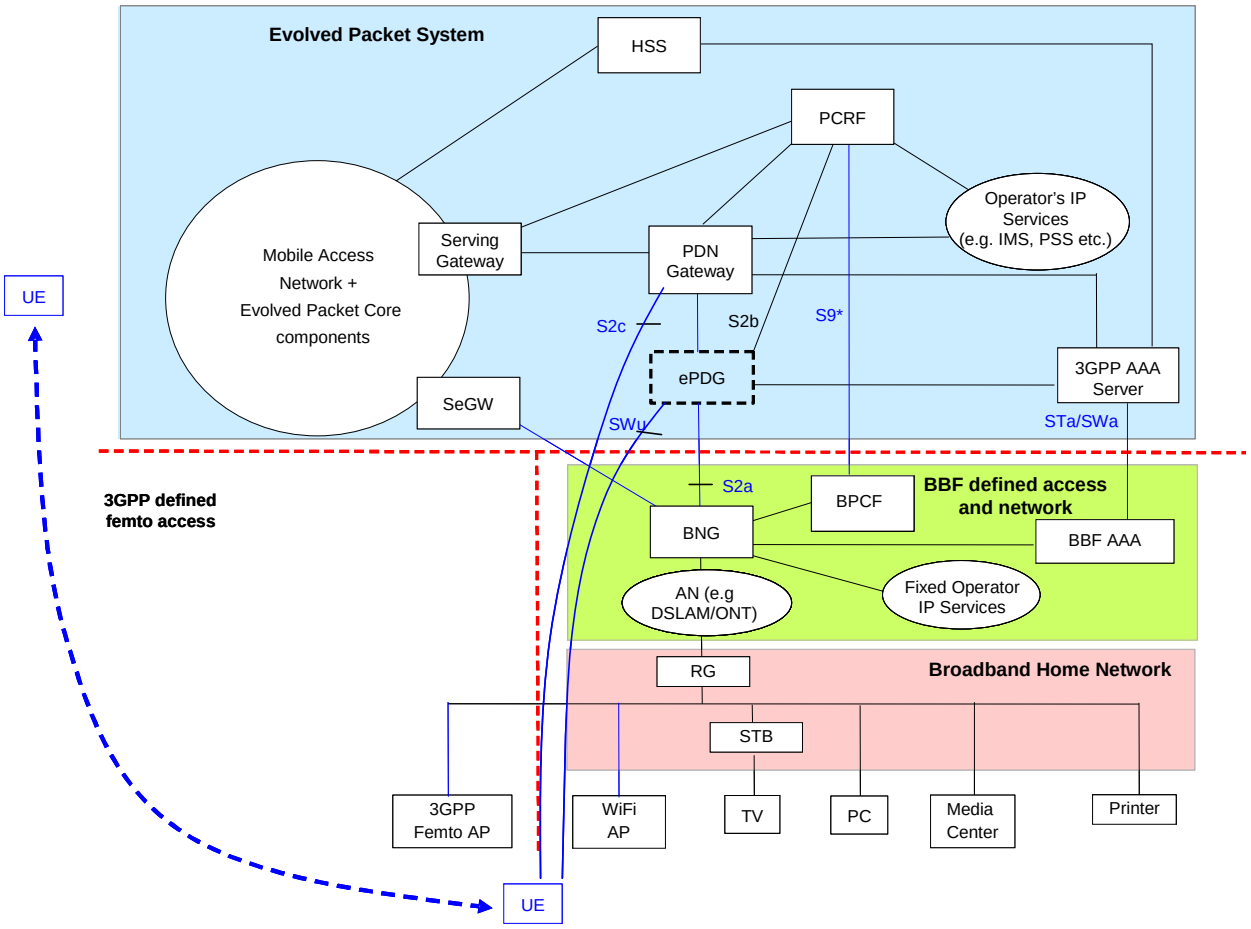

Figure 3-1. Illustration of the agreed architecture for interworking between 3GPP and BBF (for details see WT-203)

The full scope of broadband convergence involves many aspects ultimately dependent on a common Internet Protocol (IP).

- Devices
- Access networks
- Core networks
- Services and applications

The BBF is focusing its present activities on fixed broadband access / mobile broadband core interworking initiatives (for details see 3GPP TR23.839). For full broadband convergence approach, including all possible combinations of the abovementioned aspects a comprehensive end-to-end or horizontal approach that considers the entire telecom ecosystem is needed. However, this is beyond the scope of BBF activities at the present time.

3.2 **3GPP**

3GPP is responsible for defining the requirements, architectures and protocols of the mobile network starting from GSM to future LTE. In respect to past GSM and UMTS network, from Rel-8 3GPP defined the Evolved Packet System composed by a new LTE radio access technology and by an evolution of mobile core network, the Evolved Packet Core [5], capable of supporting the so-called “non-3GPP access system” [6]. These technologies are all access technologies not defined by 3GPP, such as WiFi, WiMAX, fixed access, etc. The EPS supports the session continuity between the 3GPP radio access and the non-3GPP access by means of the IP-based mobility protocols.

The PCC, which resides in the core network, is the subsystem providing the support for flow based dynamic QoS and charging providing rules to the access network for managing the mobile traffic [7]. The PCC is mainly focused on the need of the radio part, where the management of the resources is more critical due to propagation condition, user mobility, limited bandwidth, etc.

Although the PCC enables the control policy for those non-3GPP technologies, it is assumed that the SDO responsible for the non-3GPP access endorse the PCC model, or interconnect with it. Otherwise the policy control is quite limited and only enforced within the mobile core network. Hence Broadband Forum and 3GPP started the cooperation to enhance the end-to-end policy control when a 3GPP terminal is connected to a BBF access network. The 3GPP work was initiated in Release-10 and continues in Release-11.

3.3 **ATIS**

ATIS took a multi-prong approach to convergence with the establishment of the Exploratory Group on Convergence (EGC) in 2006 the chartered to define the requirements, architecture and signaling for convergence to ensure a consistent approach to a converged NGN.

ATIS released the EGC Report and Recommendation, Sept. 2007, providing conclusions and delineating network requirements needed to enable converged services. The EGC Report has been applied by ATIS’ committees as the Packet Technologies and Systems Committee (PTSC) in the development of standards across technology and/or service domains to attain a consistent approach to convergence.

In June 2009, ATIS established the Policy Management Focus Group (PM-FG) to address specific issues related to Packet Processing, Convergence and Policy Charging Control and issues that have been identified in the ATIS NGN, Convergence efforts, but not addressed by established ATIS committees. The initial scope of the PM-FG was expanded to consider the application of operator's dynamic and provisioned policies in Residential Access Gateways connecting to user's home networks (or HNET). In September 2010, ATIS PM-FG released the final report defining the following architectural framework for consideration of policy requirements.

Figure 3-2. Illustration of ATIS PM-FG general network-policy architectural framework

3.4 **ETSI-TISPAN**

TISPAN (Telecoms & Internet converged Services & Protocols for Advanced Networks) is the technical committee within ETSI defining Next Generation Networks (NGNs), Customer Premises Networks (CPNs) and application subsystems for fixed line networks. TISPAN defines requirements, architectures and protocols and is currently completing its third release. The TISPAN architecture is functional, i.e. not bound to specific network nodes. BBF TR-101 [8] network architecture served as one of the reference architectures for nodal implementations the functional architecture has to support.

The TISPAN NGN architecture [9] distinguishes between transport and service layer functionality, consisting of subsystems controlling the transport layer (NASS, Network

Attachment Subsystem and RACS, Resource and Admission Control Subsystem) and subsystems providing service layer functionality. NGN Services can either be realized stand-alone using only transport functionality or on top of these service subsystems. In particular, the core IMS defined by 3GPP [10] represents a converged service layer subsystem. Since 2008, TISPAN shares with 3GPP a "common IMS".

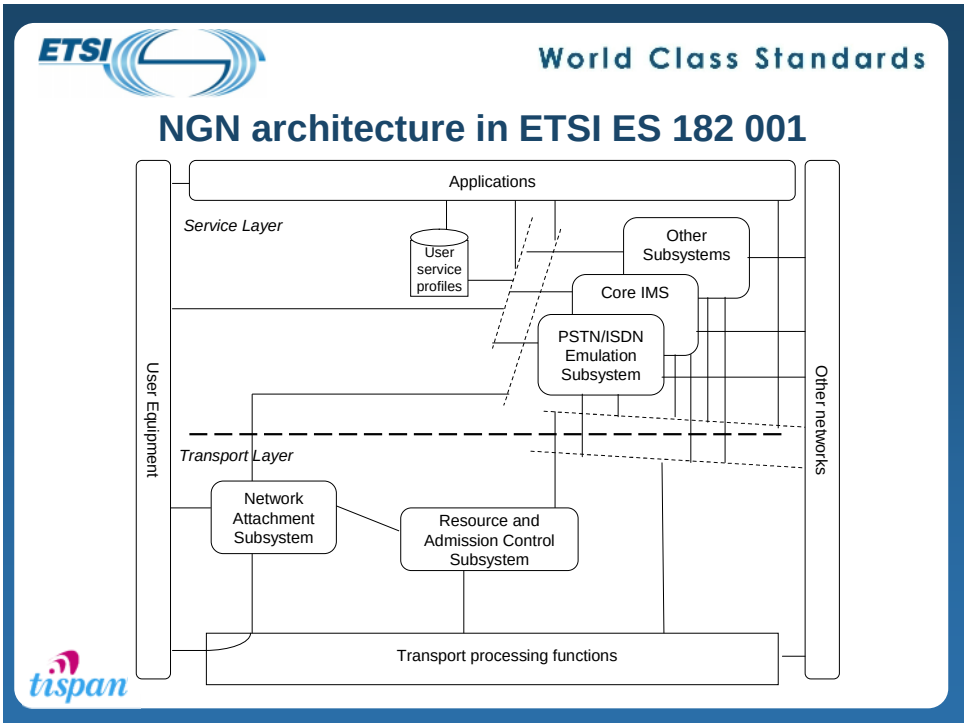

Figure 3-3. Illustration of the ETSI TISPAN NGN architecture.

The RACS – residing in the transport layer – is the NGN Subsystem providing policy control, resource reservation and admission control to the service layer. It enables the request for and reservation of transport resources from access and core transport networks it is in charge of based on dynamic operator policies. RACS functions can be mapped to fixed line network architectures where needed, depending on network setup and business models. In particular, the resource control provided by RACS includes points of network interconnection. This enables end-to-end QoS control across different network domains such as FMC interconnection scenarios where the TISPAN NGN could serve as backhaul network.

In addition, RACS supports core Border Gateway Services (BGS) including Network Address Translator (NAT) mechanisms. Sharing the IMS with 3GPP, TISPAN covers fixed line network aspects for operators that use the same converged application platform for both, fixed and mobile access.

4 Conclusion and Outlook

The ongoing collaboration between BBF and 3GPP, with support of TISPAN and ATIS, is targeted to provide an enhanced FMC architecture that can enable both fixed and mobile operators to manage their networks to deliver services, which are access technology agnostic. This architecture, combining the 3GPP evolved packet core and BBF multi-service architecture, allows interworking between mobile and fixed networks in a seamless manner. The main motivation behind this architecture is to support fixed-mobile convergence (FMC). The ultimate vision of convergence is a network where all functions are implemented by a single, converged solution.

This architecture will ultimately implement a single subscriber database storing uniform identities, allowing customers to use their credentials for any service using any access technologies, a common policy control function governing resource used in all access technologies in a uniform manner, and a single converged transport network under unified management.

The architecture – whether fully converged or including interworking functions –will open the door for new access independent services. Fixed network operators, mobile network operators, as well as converged operators will benefit from these services and generate new revenue streams. The operators can use FMC to its full extent to create differentiated services and utilize it as a powerful tool to challenge the competition, increase market share and raise ARPU by becoming a converged telecom infrastructure supplier across fixed and mobile networks and related services. This is, indeed, the main objective of the BBF ongoing effort in developing such a unified framework for the industry.

However, depending on business models and regulatory requirements, the target for convergence between individual mobile and fixed operators need not necessarily be a single, fully converged network. It may just as well comprise a subset of the steps presented in this white paper. Interworking functions will then provide the same end user experience.

5 References and Terminology

5.1 References

The following references are of relevance to this Marketing Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Marketing Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

Broadband Forum Marketing Reports can be accessed at www.broadband-forum.org/marketing/marketingdocuments.php and a list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

[1]	MR-238, MMBI White Paper on Use of MPLS in LTE	Broadband Forum	2010
[2]	Use of MPLS Technology in Mobile Backhaul Networks	Broadband Forum	2008
[3]	3GPP document 22278_CR0058R1_(Rel-9)_S1-084363	Broadband Forum	2008
[4]	3GPP TS 29.061	3GPP	
[5]	3GPP TS 23.401	3GPP	
[6]	3GPP TS 23.402	3GPP	
[7]	3GPP TS 23.203	3GPP	
[8]	TR-101: *Migration to Ethernet Based DSL Aggregation*	Broadband Forum	2006
[9]	ETSI ES 282 001	ETSI	
[10]	ETSI ES 282 007	ETSI	
[11]	WT-203: *Interworking between Next Generation Fixed and 3GPP Wireless Access*	Broadband Forum	

5.2 Definitions

The following terminology is used throughout this Marketing Report.

Wi-Fi Wi-Fi is a trademark of the Wi-Fi Alliance. The Alliance has generally enforced its use to describe only a narrow range of connectivity technologies including wireless local area network (WLAN) based on the IEEE 802.11 standards, device to device connectivity, and a range of technologies wide area network (WAN) connections

5.3 **Abbreviations**

This Marketing Report uses the following abbreviations:

3GPP	3rd Generation Partnership Project
AAA	Authentication, Authorization and Accounting
ARPU	Average Revenue Per User
ATIS	Alliance for Telecommunications Industry Solutions
BBF	Broadband Forum
BGS	Border Gateway Services
CAPEX	Capital Expenditure
CPN	Customer Premises Networks
EGC	Exploratory Group on Convergence
ETSI	European Telecommunications Standards Institute
EPC	Evolved Packet Core
EPS	Evolved Packet System
FMC	Fixed/Mobile Convergence
GSM	Global System for Mobile Communications
HNET	ATIS home networks
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LIPA	Local IP Access
LTE	3GPP Long Term Evolution
MD	Marketing Draft
MMBI	MPLS Mobile Backhaul Initiative
MPLS	Multiprotocol Label Switching
NASS	Network Attachment Subsystem
NAT	Network Address Translator
NGN	Next Generation Networks
OPEX	Operational Expenditure
PCC	Policy and Charging Control
PM-FG	Policy Management Focus Group
PTSC	Packet Technologies and Systems Committee
QoE	Quality of Experience
QoS	Quality of Service
RACS	Resource and Admission Control Subsystem
SDO	Standards Development Organization
SIPTO	Selective IP Traffic Offload
TISPAN	Telecoms and Internet converged Services & Protocols for Advanced Networks
TR	Technical Report
UMTS	Universal Mobile Telecommunications System
WG	Working Group
WiMAX	Worldwide Interoperability for Microwave Access
WT	Working Text

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