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Fixed Mobile Convergence

In this issue

Evolution of mobile technologies with increasing performance in terms of speed, proliferation of mobile broadband devices such as smart phones, tablets, wireless dongles and new data intensive applications have fueled the increase in data usages. As per the recent report released by Cisco, global IP traffic has increased eightfold over the past 5 years, and overall, IP traffic will grow at a compound annual growth rate (CAGR) of 29 percent from 2011 to 2016. Annual global IP traffic will surpass the zettabyte threshold by the end of 2016 and will reach 1.3 zettabytes per year. A growing amount of IP and Internet traffic is originating with non-PC devices like smart phones, tablets etc. In 2011, 22 percent of IP traffic originated with non-PC devices, but by 2016 the non-PC share of IP traffic will grow to 31 percent. Traffic from wireless devices will exceed traffic from wired devices by 2014. Traffic from tablets, smart-phones, will grow at a CAGR of 42 percent and 116 percent respectively between 2011 and 2016 [1].

Increase in mobile data usage puts a lot of pressure on the capacity of the existing network. Adding further capacity to the wireless network is a significant investment. Further, spectrum is a finite precious natural resource. With limited amount of spectrum available for running mobile services, increased demand for data services on the wireless networks may lead to network congestion and deterioration of quality of service. As the demand for wireless connections continues to grow, service providers need to efficiently utilise the available spectrum to alleviate some of the bandwidth demand by offloading traffic onto fixed networks. Another challenge for mobile operators is to improve the indoor coverage. On the other hand consumers are expecting seamless connectivity, convenience i.e. one number, one handset, one bill and freedom of movement. They are also expecting the personalized services of the wireless world with the high quality and speed of fixed communications. Currently, due to availability of services on multiple platforms consumers are having different subscription for services from each network like fixed network, mobile network, data network etc and also different devices like land phone, mobile phone, data dongle etc.

Fixed mobile convergence (FMC) is an emerging technology, which aims at integration of fixed and mobile networks and creation of a unified communication infrastructure which provides advantage to both consumers and service providers. FMC impacts almost all communications and telecom industries, promising great changes to the way customers consume communications services – anytime, anywhere and from any device. For telecom operators, FMC has provided bundling of fixed and mobile services. It reduces the stress on the available spectrum and last mile access network and also improves

wireless service quality in the home, which relieves network congestion, expands coverage and extends revenue-generating service offerings. FMC also leads to cost savings, by eliminating redundancies and harmonizing the network and service management, which may decrease operational costs by using common resources - transport, Operations, administration & Maintenance etc.

For enterprise, FMC has provided new business opportunities by making business operation more efficient, presenting business model innovations, and reducing costs. For customers, FMC provides same service environment across access networks, simplicity (single unified billing) by using single number, one voicemail, new services, different types of mobility (seamless and easy services access) and cost reduction.

As per the IDATE consulting & research report, the Fixed-Mobile Convergence market (FMC) could generate revenue of 900 million EURO in 2013 in Western Europe's five largest markets, and so accounting for 4% of total mobile services revenue. Around the world, various FMC services were launched by the telecom operators. A few examples of such services are as follows:

1. UK (BT Fusion): British Telecom (BT) launched world's first FMC service called 'Fusion' in June 2005. In this service, outside home, the users uses Vodafone's mobile network and once the user's gets within range of BT Hub, the call automatically switches over to BT's wireless broadband network. The BT Hub supports blue tooth &WiFi enabled handsets.

2. Korea Telecom (Onephone): This FMC service was started by KT Corp. In this service user uses Cordless Telephony Profile (CTP) technology. In this service subscriber has used a dual-mode Bluetooth/CDMA handset that connects to a fixed-line network when at home but automatically switches to a mobile network when the subscriber is outside, using Bluetooth technology.

3. Japan NTT DoCoMo's (PASSAGE DUPLE) : In this service, single converged handset as a 3G mobile phone is used when user is outside of the office and as an IP Cordless phone is used when users is inside the office. Calls made within the office wireless environment are free of charges. In this service, functions like call hold and call transfer are possible in the wireless LAN mode.

4. Brazil Telmar (Oi Flex): It is personal handyphone service (PHS) called Oi Flex. It is based on cordless telephony profile (CTP) technology. CTP technology allows up to three handsets to simultaneously use an access point.

5. IMS-VCC (Voice Call Continuity) service: Various telecom vendors ("Huawei") has launched the commercial IMS based VCC (Voice Call Continuity) solution including Huawei and Nortel. The solution is 3GPP compliant and supports a voice connection continuity feature for seamless bidirectional handover between the IMS and Circuit Switched (CS) domains. As a consequence, dual-mode end-users can roam between WiFi/WiMAX hot spots and cellular GSM/CDMA/UMTS networks maintaining perfect quality calls

Apart from above, various operators like Vodafone Germany, T-Mobile USA, and SFR in France have launched mobile-based home zone services respectively in 2005, 2006 and 2007. As per the OECD report October 2012, eight operators in six countries i.e. Canada, France, Japan, Korea, Sweden and the United States are offering dual mode single phone service to their customers. Four operators in these countries offer unlimited call plans for home originated Wi-Fi calls with their basic plans (Orange, T-Mobile USA) or additional monthly fees (Rogers Wireless, NTTDoKoMo). Other operators reduce the price for calls by treating these as fixed calls, although, in fact, these are mobile-originated VoIP calls [2].

Overview of Fixed Mobile Convergence (FMC)

Convergence in the telecom industry occurs at many different levels including network convergence, service convergence, Industry/market convergence and device convergence. Fixed mobile convergence or FMC is a specific subset of convergence that focuses on fixed and mobile networks and access to these networks becoming indistinguishable from the perspective of the user and of services.

Based on the ETSI FMC ad hoc workgroup documents , FMC is defined as "*Fixed and Mobile Convergence (FMC) is concerned with the provision of network and service capabilities, which are independent of the access technique. This does not necessarily imply the physical convergence of networks. It is concerned with the development of converged network capabilities and supporting standards. This set of standards may be used to offer a set of consistent services via fixed or mobile access to fixed or mobile, public or private networks".*

In FMC, as shown in Figure 1, the most appropriate network can be used according to the situation without users being aware of when the terminal switches between fixed and mobile nodes. FMC also enables automatic network selection for incoming and outgoing calls, roaming and handover between networks, and integrated billing services. A single device can connect through and be switched between wired and wireless networks.

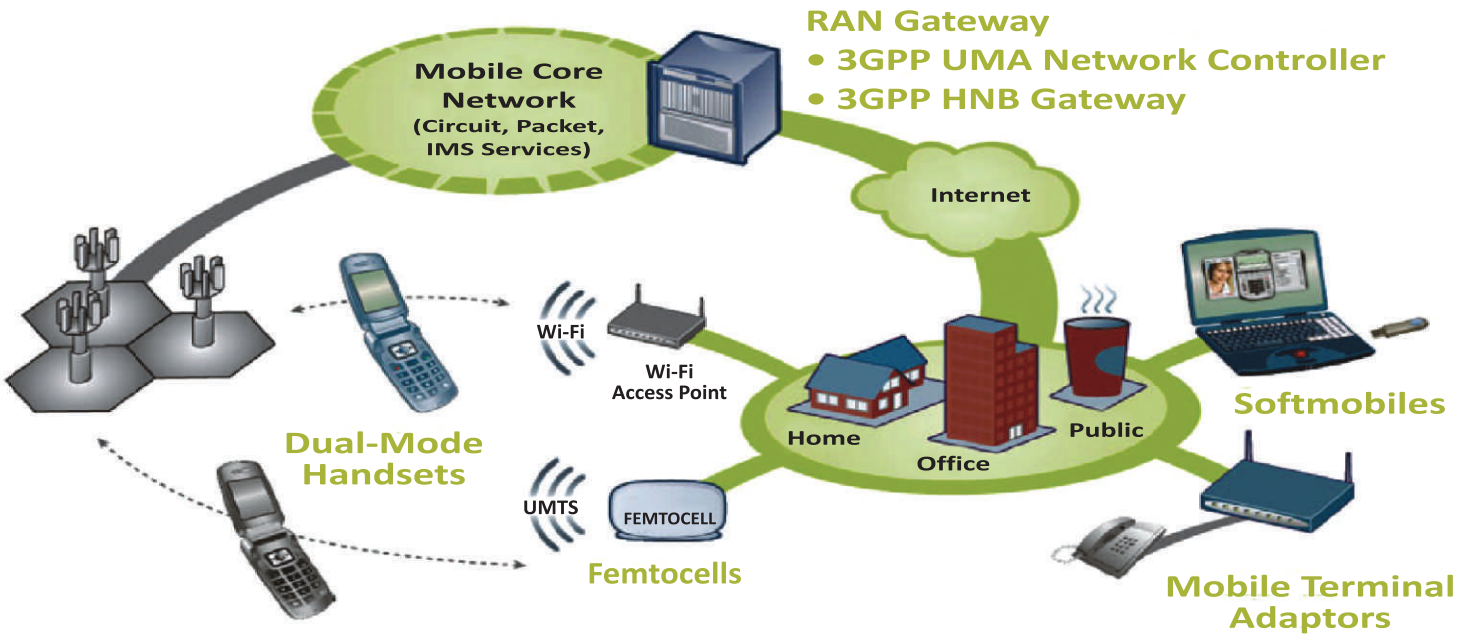

Figure 1: The Fixed Mobile Convergence (FMC)

FMC support different types of mobility i.e. ability to maintain the same identity irrespective of the terminal used (Terminal may be of different types), capability to move to an active session between terminals, ability of a terminal to change its location and the ability of a user to use the same Service irrespective of the location of the user and terminals. [7]

Stages of FMC

To achieve FMC, there are four main stages i.e. commercial convergence, service convergence, device convergence and network convergence as shown in below Figure 2.

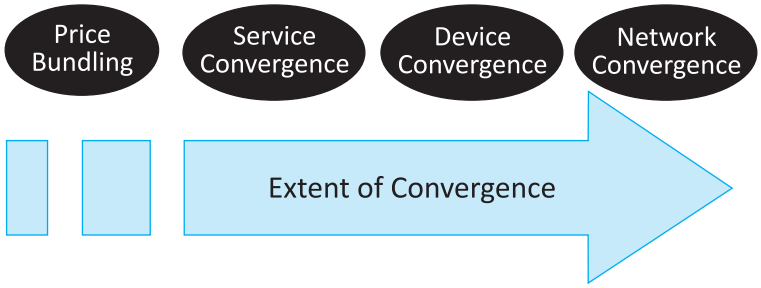

Figure 2: Four main stages of FMC

In the first level, commercial convergence occurs through price bundling of fixed and mobile subscription with the linked or unified billing to provide a single bill, a single point of sale, a unified account management etc. A second level of integration occurs when common services are offered regardless of whether they are using a fixed and mobile networks e.g. a single voice mailbox or linked email. The first two stages i.e. price bundling and service convergences are generally called pre-convergence stages which mainly depend upon how the services are offered to the subscribers. In the device convergence, a common device enables both fixed and mobile network access with seamless handover. The final stage i.e. network convergence is the most important. In network convergence, fixed and mobile services run over a common IP transport network and use a common platform for service creation and control - the IP multi-media sub-system (IMS).

FMC Technologies

For implementing FMC, operators are using different technologies i.e. Unlicensed Mobile Access (UMA)/ Generic Access Network (GAN), Femtocell and IMS.

Unlicensed Mobile Access (UMA)/Generic Access Network (GAN)

UMA Technology Group was initiated in January 2004, with participation from operators and suppliers. It published initial specifications before transitioning activities to 3GPP in June 2005. In order for UMA to fulfill its role as a truly convergent technology the standardisation work was undertaken through the 3GPP (3rd Generation Partnership Project). The resultant standard was ratified as "Generic Access Network" (GAN) in 3GPP TS43.318 as a release 6 feature in April 2005. Although the term GAN is used in 3GPP parlance, the term UMA is normally used in marketing material.

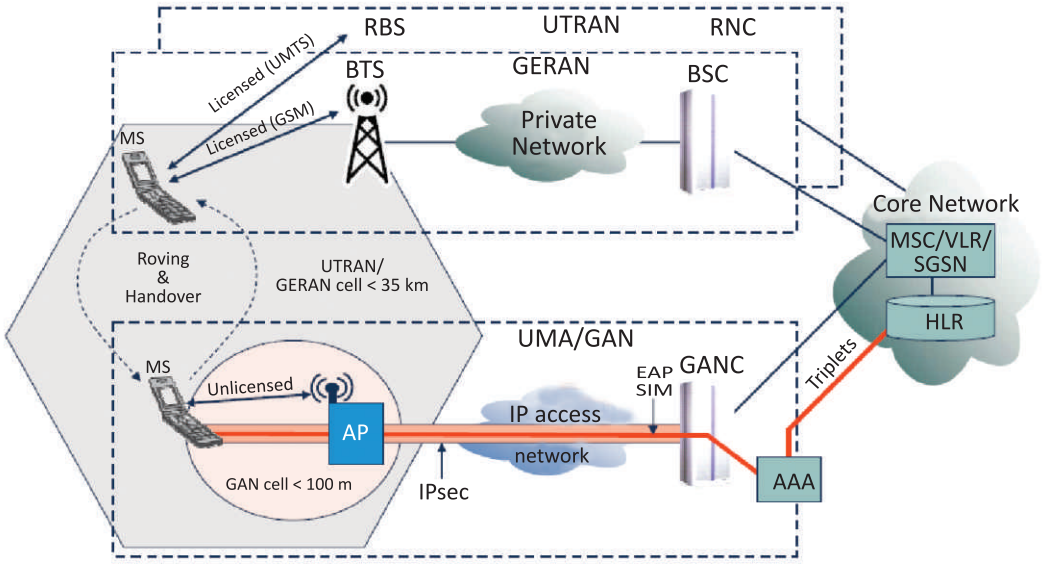

Figure 3: Basic UMA/GAN Architecture

The basic architecture of UMA/GAN is shown in Figure 3. It is a mechanism at the access network, which enables the seamless provisioning of circuit-switched (CS) services (Such as GSM voice calls) over packet-switched (PS) unlicensed WLANs and broadband networks. In the wireless system, Access Point (AP) i.e. Wi-Fi or Bluetooth, operates at the unlicensed 2.4 GHz and 5 GHz band offering a local area network access to mobile handsets. These Access Points (APs) support IEEE 802.11 standards. A single site may have one or more APs depending on the capacity of each AP and the traffic demand. A Gateway is also used between mobile operator's core network and the Internet called Generic Access Network Controller (GANC). GANC is the equivalent of Base Station Controller (BSC) in GERAN. A GANC acts as an aggregator of APs and performs Authorization, Authentication and Accounting (AAA) functionalities for the customers accessing services through APs.

For core mobile network, the GANC emulates a standard Base Station Controller (BSC), while on the Internet side it supports IP protocols, notably IPSec. When a UMA phone connects over Wi-Fi, it must first authenticate via the GANC to the mobile core network: this happens based on its Subscriber Identity Module (SIM), the small card identifying the user in GSM networks. Following authentication, a UMA phone establishes an IPSec tunnel to the GANC for GSM signaling, while voice conversations are carried using VoIP technology. The GANC translates these streams (signaling and bearer) back into the protocols recognized by the mobile core network.

In UMA/GAN, a GAN-enabled handset phone, which works in dual-mode, can be used by the end user irrespective of the network with which user is currently attached. When users are moving outside the home/office then they can communicate over cellular networks (GSM, CDMA, etc.) through BSC/RAN. For example, if a user initiates a call over GSM network and walks into the range of home's Wi-Fi network then the calls switches from the GSM network to the home's WiFi network and once the user moves out the range of the home's WiFi network, the connection is roamed back to the wireless GSM Network.

It was first introduced as Fusion by British Telecom in 2005; this version worked with Bluetooth, but was discontinued. Other mobile operators however do offer the service, for example Orange, who calls it Signal Boost in the UK. Other operators who offer it are T-Mobile US and Rogers Canada who call it "Wi-Fi Calling". The main benefit from the system is that the customer may get better coverage in the home and that the mobile network is released from a call. Some operators like T-Mobile and Orange also offer users lower calling rates when using the system at home. However, it is not supported on all mobile phones, for example it is not available on the iPhone, but is supported by most Blackberries, some Android phones and Nokia products [7].

Femtocells

The higher frequencies associated with 3G network do not work well indoors due to high attenuation from walls. As a result operators are deploying new 3G in-home base stations, or femtocells, to address this problem. A femtocell is an access point or small base station that connects to a fixed broadband land line allowing indoor cellphone calls to be routed over the land line thereby eliminating the critical coverage issue, as shown in Figure 4.

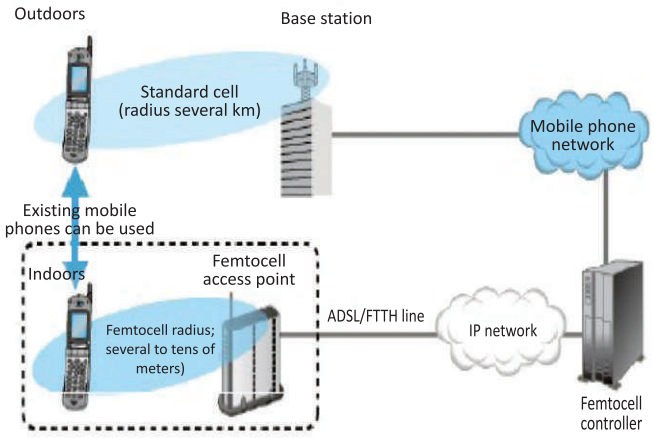

Figure 4 : Femtocell

In Femtocell, most of the functionality of a complete 3G cell site has been miniaturized onto a chip, which looks and operates like a WiFi access point. A femtocell is installed at home or office and connected to mains power and a standard broadband IP connection (typically DSL) through to the mobile operator's core network. Voice calls, text messages and data services are provided by the same systems.

Femtocells operate at very low radiation power levels (50 milliwatt peak output during a call, much lower when idle), and typically have a range of 200 meters. The signals do not travel through walls particularly well, but this is a benefit because it allows the frequency to be reused for other calls in nearby building. Where users walk outside or out of range, calls are automatically handed over to the external mobile network. Any standard 3G phone can be used on the femtocell if permitted by the mobile operator. Unlike WiFi access points, 3G Femotcells operate using licensed spectrum.

In comparison to UMA services, which require compatible dual-mode handsets, femtocells can be used with any device that supports the femtocell's air interface. Internationally various operator are using Femtocell , for example Sprint in USA. In late 2008 and in 2009, a number of commercial W-CDMA femto small cell network launches were announced worldwide: three in Asia (NTT DoCoMo and Softbank in Japan, China Unicom), one in the United States (AT&T) and three in Europe (Vodafone UK, SFR in France and Optimus in Portugal).[3]

IP Multimedia Subsystem (IMS)

IMS is the envisioned solution that will provide new multimedia rich communication services by mixing telecom and data on an access independent IP based architecture, defined in 3rd Generation Partnership Project (3GPP), 3rd Generation Partnership Project 2 (3GPP2) and Internet Engineering Task Force (IETF) standards. For IMS, similar activities are also carried out by other standardizing bodies like ETSI TISPAN and ITU NGN Focus Group.

The IMS architecture is shown in Figure 5. The heart of the IMS system is the call session controller function (CSCF). CSCF is a SIP (Session Initiation Protocol) server which processes SIP signaling in the IMS. CSCFs are dynamically associated, service-independent and standardized access points. It distributes incoming calls to the application services and handles initial subscriber authentication. There are three types of CSCFs depending on the functionality they provide i.e. P-CSCF (Proxy-CSCF), I-CSCF (Interrogating-CSCF) and S-CSCF (Serving-CSCF).

CSCF is connected to a home subscriber server (HSS) and two media controllers: the media resource function controller (MRFC) and media gateway controller (MGC). Voice call continuity (VCC) (3GPP, 2005) functions are provided for seamless voice call handover in different access networks both in circuit switch (CS) and packet switch (PS) domains.

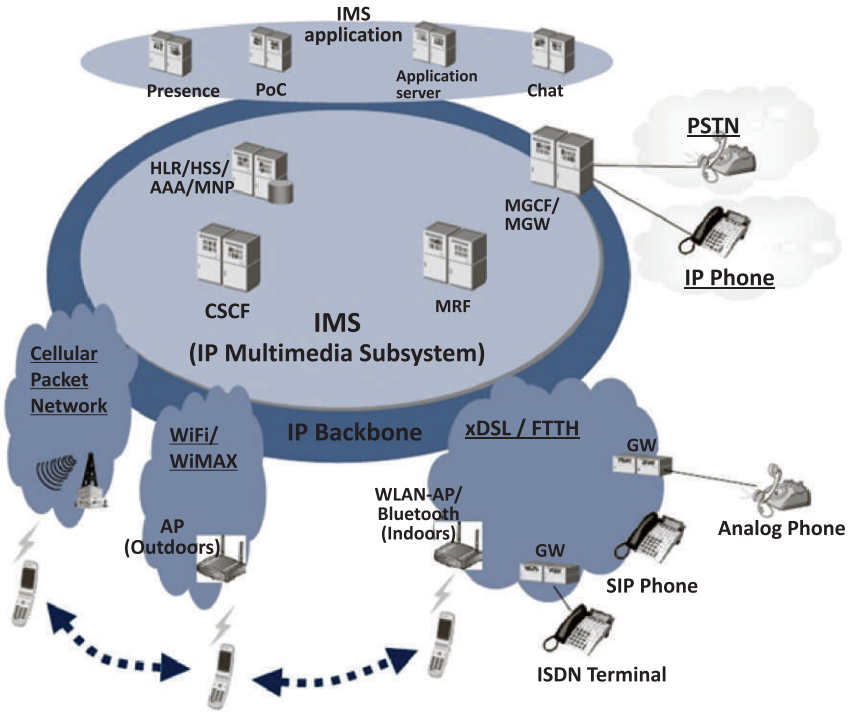

Figure 5: IP Multimedia Subsystem (IMS)[7]

The aim of IMS is to provide all the services, current and future, that the Internet provides with roaming facilities. To achieve these goals, IMS supports peer-to-peer IP communications between existing technology standards while providing a framework for inter-operability of voice and data services for both fixed (POTS, ISDN) and mobile users (802.11, GSM, CDMA, UMTS). It provides session control, connection control and an application services framework with both subscriber and services data, while allowing interoperability of these converged services between subscribers. IMS truly merges the Internet with the cellular world; it uses cellular technologies to provide ubiquitous access and Internet technologies to provide appealing services.

Based on IMS, IMS-VCC (Voice Call Continuity), is an FMC service which extends an IMS network to cellular coverage and addresses handover. It provides seamless voice call continuity between the cellular domain and any IP-connectivity access networks that support VoIP. It's the most comprehensive of converged service approaches in that it can work between any cellular technology (GSM, UMTS, CDMA) and any VoIP-capable wireless access [8]. IMS-VCC provides for the use of a single phone number (or SIP identity) as well as handover between WLAN and cellular. It also provides key advantages:

- A single solution to target multiple markets and segments
- Enhanced IMS multimedia services, such as greater personalization and control
- Seamless handover of voice calls between a circuit-switched domain and IMS
- Seamless integration with other VoIP networks
- Access to service from any IP device [8]

IMS is considered as the key platform required for migration to a fully-functional FMC.

Conclusion

Users are using various broadband devices such as smart phones, tablets, and wireless dongles leading to unprecedented growth in data traffic on the mobile network. This is leading to increased demand from operators for spectrum, which is in limited supply. Consumers are expecting seamless connectivityacross terminals and networks. Fixed mobile convergence (FMC) is an emerging technology, which enables seamless connectivity between fixed and wireless telecommunication networks and is advantageous to both consumers and service providers. For consumers, FMC can enable the seamless services, regardless of type of network. FMC provided, simplicity to the end users i.e. one number, one handset and one bill. For operators it provides for better spectrum management, increased data capacity of the network and opens up new market opportunity with unique list of services and high revenue potential.

In this paper different FMC solutions are discussed. UMA/GAN and Femtocell are providing the Fixed Mobile convergence in the access domain and may be seen as the short term solution. However, IMS solution is providing the Fixed Mobile convergence in the core and may be seen as long term solution.

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