May | 09

Enterprise Options for Fixed Mobile Convergence and Mobile UC

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Introduction

One of the most exciting developments to come about from the new generation of wireless communications technologies is the idea of fixed-mobile convergence. Fixed-mobile convergence or FMC describes the ability to integrate cellular and private network services allowing calls to be transparently handed off between them. While FMC is often portrayed as a mechanism to hand off calls between Wi-Fi-based wireless LANs and cellular services, in reality the "fixed" element in FMC can be any private network, wired or wireless.

It is no secret that mobile cellular telephone service has revolutionized the way that people communicate. Millions of consumers have chosen to do without wired telephone service for their personal use, and for many business people, their cellular number has become their primary number. For enterprise users who must rely on both a wired office phone and cellular service, the ultimate combination would be a service that would allow them to be reached on a single number regardless of where they were located, passed calls transparently between cellular and any other wired or wireless networks with no interruption in the connection, and extended all of the functionality of the wired environment to the mobile.

Many have assumed that providing this type of service would require that the cellular carriers fully embrace the concept and integrate non-cellular technologies with their services. In particular, the cellular carriers would have to treat those other networks like additional cells and handoff calls to/from them in the same way they pass calls between base stations within their own networks. The larger US cellular carriers have not embraced FMC for enterprise customers, though the smaller national carriers, Sprint and T-Mobile , have introduced FMC services in some form. In the meantime, manufacturers of business telephone equipment and equipment adjuncts have developed a number of solutions that deliver many of the capabilities of FMC in spite of the cellular carriers' reluctance.

In this paper we will provide a structure for understanding and evaluating the various enterprise- and carrier-based FMC solutions that have been introduced. We will begin by looking at the overall benefits that can be derived from an FMC solution, and then describe and categorize the various FMC products and services. In each case we will examine the configuration and operation of the solution, and identify the benefits it can provide. The goal is not to "sell" any particular implementation, but rather to provide enterprise users with a background and a level of understanding they can use in evaluating solutions that fit their particular needs.

Why Use FMC?

When the idea of FMC is introduced, the most obvious benefit that emerges is cost savings, particularly the ability to reduce cellular charges. However, many of the existing solutions are likely to increase rather than decrease those costs. Users should focus on productivity, control, reliability, and cost savings, as a well-executed FMC solution can yield benefits in all of those areas.

- Cost Savings on Cellular: There are two major areas for potential cost in an FMC implementation: moving cellular traffic onto wireless LANs (WLANs) and from avoiding outrageous international calling charges cellular carriers by routing those calls onto wireline networks. Not all FMC solutions incorporate WLANs, and for those that depend exclusively on cellular services, we should anticipate increased rather than decreased cellular usage.

- Accessibility: Often grouped under the general heading of "productivity", the first major advantage of FMC would be improved accessibility. One of the greatest inhibitors to productivity in a modern business environment are situations where critical people cannot be reached at critical times. An FMC solution can allow key personnel to be reached with one call to one number regardless of where they are located.

- User Productivity: Along with improving accessible, FMC can enhance user productivity in a number of other ways. By having a single phone number, the user can have a single voicemail to check for all of their messages. Calls in progress need not be terminated when the user leaves the facility. Many of our current solutions allow a variety of unified communications capabilities like presence, visual voicemail, and directory access to be extended to mobile users.

- Control of the Telephone Number: While often overlooked, control of the telephone number is a critical issue for many enterprises. Today outside sales and support personnel often use their personal cell phones for routine contacts with customers. However, what happens if that person leaves the company? If a salesperson goes to work for a competitor, their customers will continue to call them at that number. If customers or prospects are calling, the enterprise needs to own the number or risk having those calls go to a competitor or to a disgruntled former employee.

- Improved Indoor Service: In an indoor environment, wireless LANs can provide significantly better quality and coverage than cellular. Cellular carriers attempt to address this problem with distributed antenna systems, but even with good radio coverage, digital cell phones can barely deliver a Mean Opinion Score of 4.0. A well-designed WLAN voice solution can deliver enterprise-grade voice quality.

FMC Solutions Overview

Fixed-mobile convergence (FMC) describes communications solutions that will integrate carrier-provided cellular services with private communications networks, either wired and wireless, allowing users to be accessible via a single number and with the ability to pass calls back and forth between the two environments.

The confusion that surrounds FMC today stems from the variety of ways in which it might be implemented and the fact that most discussions address only a subset of those options. The major dividing line in FMC solutions is based on whether they are controlled by the cellular carrier (cFMC) or by the enterprise's private telephone system (eFMC). Within those broad categories, there will be a number of important differences, particularly with regard to how the calls are handed off between the two environments and the level of user functionality they can deliver.

The initial interest in FMC was driven by the idea of dual-mode solutions that integrated Wi-Fi and cellular (typically GSM cellular) capability into the handset and featured a controller that would transparently transfer calls from one network to the other. For a variety of reasons those products have been slow to take off, and now the interest has shifted to solutions that link the user's desk phone to their mobile and depend on cellular service exclusively. Independent of that, the use of simple voice handsets that operate over wireless LANs or wireless systems that operate on the DECT standards continues to grow, particularly in defined verticals like health care, big-box retail, and materials handling.

With regard to functionality, fixed-mobile convergence originally dealt with the basic task of handing off voice calls between cellular and private networks. The advent of unified communications (UC) has now expanded the scope to include email, text, and collaboration as well as the other productivity-enhancing functions of UC.

As the US carriers have been slow to introduce FMC services for enterprise users, business telephone equipment suppliers, either directly or in conjunction with partners, have introduced a range of FMC-type solutions that provide many of the desired capabilities. The most important attribute of the enterprise-controlled (eFMC) solutions is that they can be implemented today with virtually no involvement on the part of the cellular carrier, and most will operate over any cellular carrier's network.

Enterprise-Controlled (eFMC) Solutions

The primary difference among the enterprise-controlled solutions lies in the wireless networks they operate on and how (or if) they hand off calls between those networks.

Non-Integrated Dual-Mode Handsets

The first class of solutions incorporates no network integration and no handoff capability. Cellular and WLAN functionality can be built into the same handset, and the user can manually choose the network on which to place the call. The WLAN capability may act like a wireless PBX station, though in some cases, the handset may be capable of operating over public Wi-Fi Hot Spots. If it does support Hot Spot calling, it is important to ensure that there is a mechanism to ensure security.

Unless these dual-mode handsets are utilized in conjunction with one of the other solutions, the user will have two phone numbers and two voicemails, one on the cellular network and one on the WLAN. Also, the cellular carriers typically do not subsidize the cost of dual-mode handsets, so the enterprise will be paying the full cost. Finally, with this solution there is no way of insuring that the user will actually choose the WLAN to place calls when its available. In short, dual mode handsets by themselves address none of the key enterprise requirements.

Simultaneous Ring/Extension-To-Cellular

In this type of solution, the customer's IP PBX is programmed so that all incoming calls to the user's business number ring simultaneously on both their cellular phone and their wired or WLAN phone number; the call can be answered on either (See Figure 1). There are also a number of third-party adjuncts (e.g. BlackBerry MVS, CounterPath EMG, or OnRelay MBX) that can provide that simultaneous ring function in conjunction with any PBX system.

This IP PBX feature is alternately called *Simultaneous Ring* or *Extension-To-Cellular*, and a subset of these systems allow the user to transfer a call in progress from the IP PBX station to a cellular connection and vice versa. Virtually all IP (and some TDM) PBX systems can provide simultaneous ring, though some opt for a "preferred number" the user selects. Another nice feature about simultaneous ring is that it does not require dual mode Wi-Fi/cellular handsets and will operate over any cellular carrier's network.

While not as elegant as an automatic handoff, these solutions do provide many of the required features including:

- One number accessibility
- Single voicemail
- Integration of wired and cellular services

Importantly with these systems, the caller is dialing the user's business number; the user's cellular number is stored in the IP PBX. So when the employee leaves the company, their business calls stay with the business. However, in order to fully protect the number we will also require the capability to route all of the user's outgoing mobile calls through the PBX as well or the caller ID will provide the cellular number to any business contacts who are called. The dual mode Wi-Fi cellular and mobile UC clients described below can provide that capability.

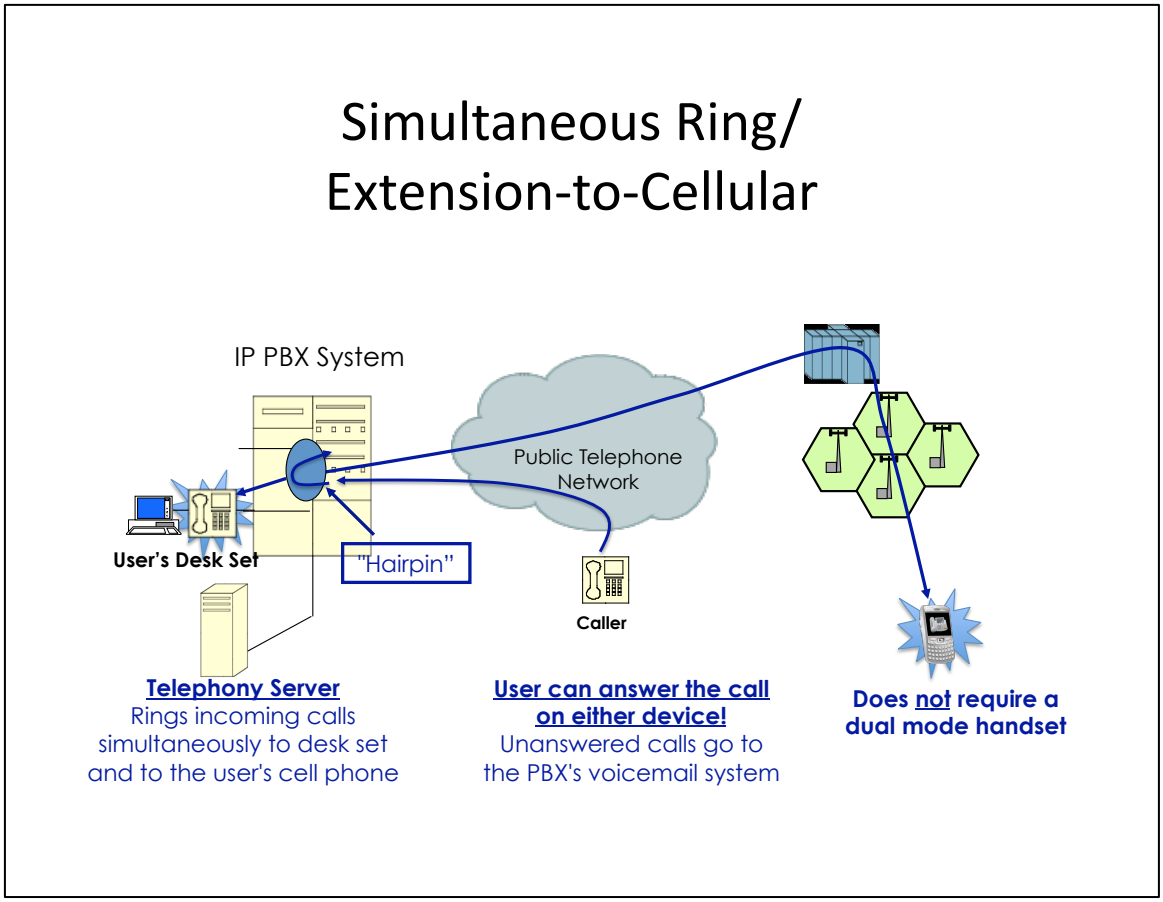

FIGURE 1: Simultaneous Ring/Extension-to-Cellular Feature

One problem that persists with simultaneous ring is enforcement. If the user is sitting at their desk, they could still answer the call on their cell phone which would result in the call costing more than if it were placed directly to their cellular number.

Dual Mode Wi-Fi/Cellular With Automatic Handoff

Automatic handoff systems utilize dual-mode WLAN/cellular handsets, where the WLAN capability in the handset is essentially a wireless PBX station. The handsets have special software that works in conjunction with a mobility controller connected to the customer's PBX. When the dual mode handset comes within range of the WLAN, it alerts the mobility controller that it is available to receive calls over that path. The mobility controller in turn works in conjunction with the PBX to handle the user's calls appropriately. When a call is received (or if the user initiates a call) while in the WLAN coverage area, it is automatically routed over the WLAN so no cellular usage charges are incurred.

The mobility controller continuously monitors the stations that are reachable over the WLAN. Most systems do this by querying the station regarding the strength of the WLAN signal it is receiving, though some can utilize sensors at all building exits or other metrics to recognize when a user is leaving the WLAN coverage area. When the user moves out of WLAN range, the mobility controller and the PBX will deliver that user's calls via the cellular network. Further, if there is a call in progress when the user leaves, a call is automatically placed to their mobile number and the connection is transparently transferred to it (See Figure 2).

Like the simultaneous ring solution, the user gets one-number accessibility, single voicemail, and in all cases the business maintains full control of the number. Besides the convenience factor, the other major capability of this implementation is assured compliance. If the handset is within range of the wireless LAN, the user's calls are automatically routed that way, so the user is not free to ignore the availability of the more cost effective solution.

The downside is that the user must have a voice-capable wireless LAN providing coverage throughout the facility and one with sufficient capacity to handle the voice calls as well as the data traffic. Further, the vendors have a limited range of dual mode cell phones on which they can install their software. Typically there are implementations for Nokia and Windows Mobile devices. There is very limited support for dual-mode CDMA handsets, and most importantly, there is no support for dual mode BlackBerry smartphones (GSM or CDMA).

Dual mode Wi-Fi/cellular FMC solutions are provided primarily by third-party adjunct vendors like Agito, DiVitas Networks, and Varaha, though Siemens manufactures their own dual mode solution called Mobile Connect. Most PBX manufacturers partner with one or more of the third-party solution providers, for a dual mode solution though the UC functionality is typically limited.

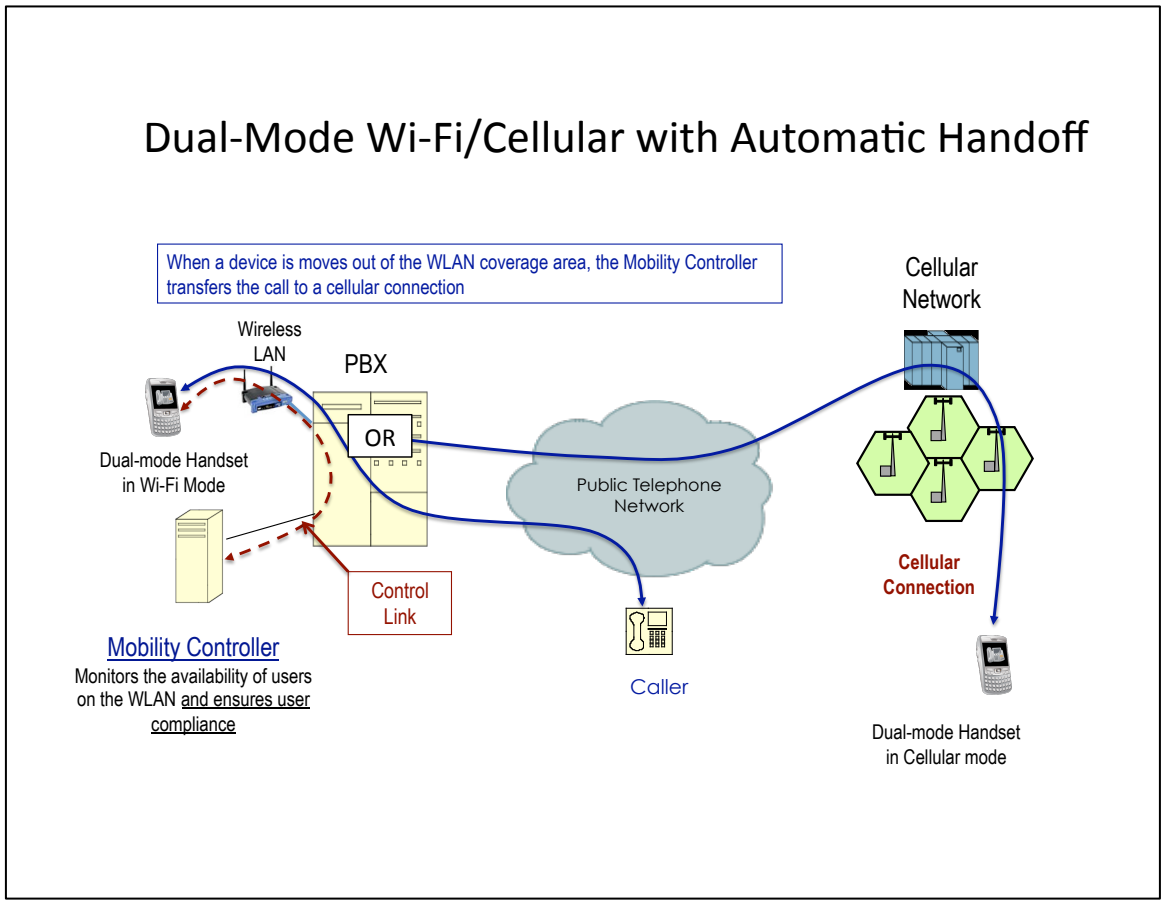

FIGURE 2: Dual Mode Wi-Fi/Cellular with Automatic Handoff

Mobile Unified Communications

Mobile Unified Communications (mUC) solutions would incorporate the basic capabilities of FMC but would expand the scope beyond simple voice connections allowing enhanced features like directory access, presence, and visual voicemail to be extended to mobile users.

Thus far we have focused on the task of handing off basic voice calls between cellular and other networks, but the other important development in enterprise networking is *Unified Communications* (UC). Marty Parker of UniComm Consulting defines UC as: *Communications integrated to optimize business processes*. The vision in UC is to provide the user with a single interface to all of their voice, data, video, and collaboration tools and access to them through an intuitive, integrated dashboard.

Initially this enhanced functionality was limited to desk-bound users, but one of the great promises of UC is to extend those same capabilities to mobile users as well. The user's network and applications access would have two focal points, a desktop hard or softphone and an associated mobile device. These Mobile UC solutions work primarily on cellular services, though a limited set of these features is available on the dual-mode Wi-Fi/cellular systems.

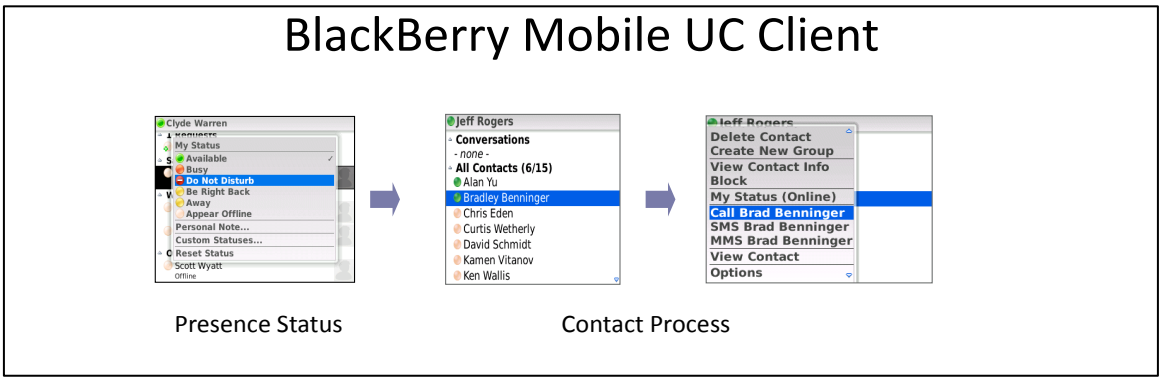

Figure 3: BlackBerry Mobile UC Client

The cellular-based UC solutions typically depend on out-of-band signaling where the user's voice calls are carried over the regular cellular voice service, and signaling messages are exchanged in parallel over a cellular data service (See Figure 4). In all cases it is important to ascertain how the solution will operate if the cellular data service is not available.

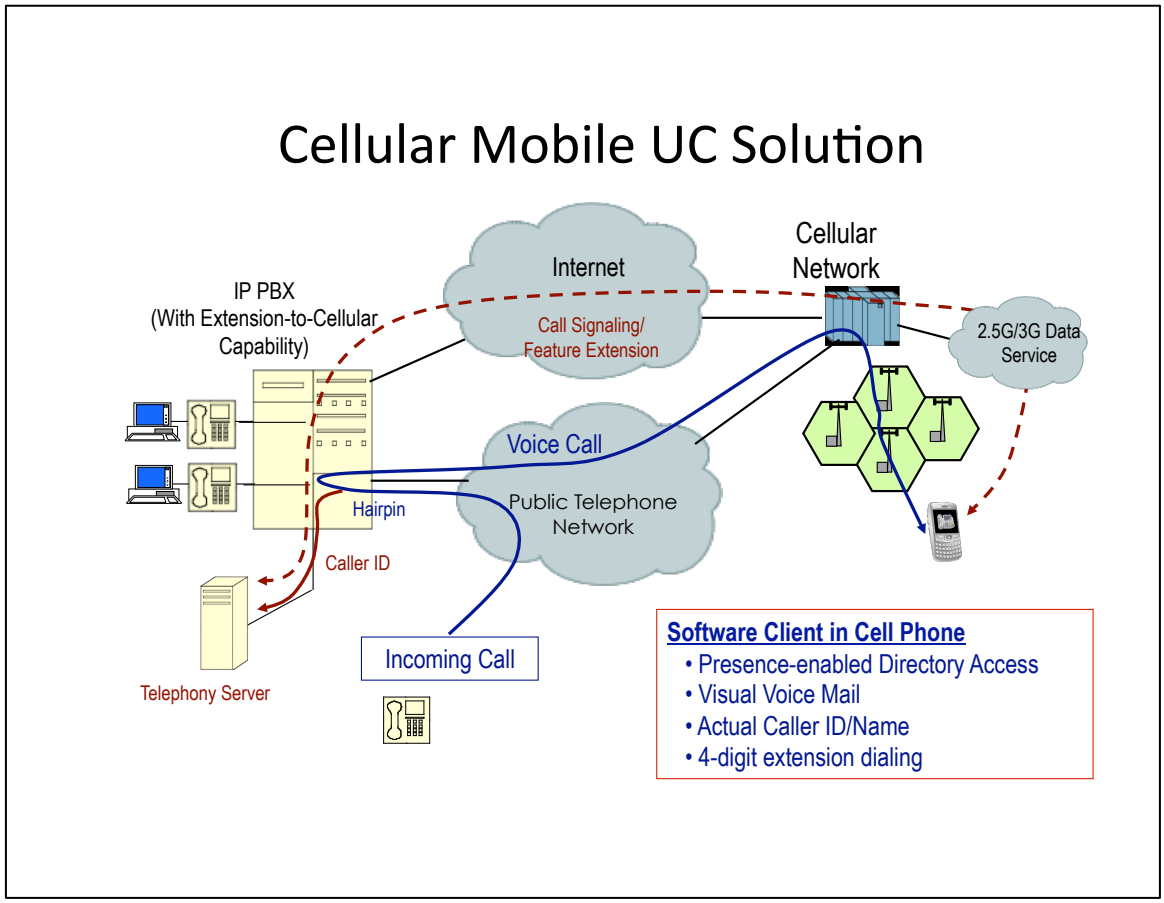

FIGURE 4: Cellular Mobile Unified Communications

Among the mobile unified communications features we typically see are:

- Presence: In UC, presence refers to the capability to view a correspondent's availability status (e.g. on/off phone, in/out of office, etc.) and the types of communication for which they are accessible (e.g. voice, video, text, or email). The user can typically tailor their presence availability to different contacts (e.g. boss, customers, co-workers, etc.), and may provide a more detailed description of their availability (e.g. "With customer"). The presence status is monitored by a presence server on the IP PBX or by a UC platform like Microsoft's Office Communications Server (OCS) or IBM's Sametime.

- Corporate Directory Access: Allows a mobile user to get access to the online corporate telephone directory on a mobile handset and then click to dial.

- True Caller ID: True caller ID provides the mobile user with the name and number of the actual caller rather than the PBX number when a call is forwarded

to the mobile.

- Visual Voicemail: Allows the mobile user to view voicemail messages as alerts and play them in any order they choose. Some consumer FMC services (e.g. Google Voice) have taken this a step further and provide speech-to-text translation so users can "read their voicemails" unobtrusively.

- Four-Digit Dialing: The mobile user can call another station on the PBX by simply dialing the four-digit extension number, just as they would when making a station-to-station call on their PBX desk set.

- Desk Set Features: Mobile users can get access to the major desk set features available through the PBX including hold, conference, and transfer. Access to those in-call features may be unavailable if the user is in an area with 2G (e.g. GPRS or EDGE) rather than 3G cellular data service.

The other important feature afforded by these Mobile UC solutions is full control of the telephone number. When an outgoing call is placed from the mobile, the call is automatically routed through the PBX (i.e. "hairpinned") and the PBX provides the user's desk phone number to the called party. The user also has the ability to make and receive personal calls directly to/from the mobile, a capability called *dual persona*.

To implement mobile UC over cellular networks, the handsets require client software that often calls for a special server on the PBX. The handset selection is wider than we find with the dual mode solutions and typically includes BlackBerry, Nokia, Windows Mobile, and in some cases iPhone. Some manufacturers like Avaya, Cisco, and Siemens provide their own mobile UC clients, but there are third-party adjuncts available from companies like BlackBerry, CounterPath, and OnRelay. The major options are summarized in Table 1.

Table 1: Selected Mobile UC Solutions

Vendor	Mobile UC Product
Avaya	oneX Mobile UC
Cisco	Unified Mobile Communicator
Nortel	MC-3100 (CounterPath EMG)
Siemens	OpenScape Mobile
NEC Unified	MC530 (CounterPath EMG)
Mitel	Unified Mobile Client
ShoreTel	Mobile Call Manager
BlackBerry	Mobile Voice System (MVS)
IBM	Sametime Mobile
Microsoft	Office Communicator Mobile
OnRelay	Mobile Business Exchange (MBX)

Detailing the Costs

Along with the cost of the servers and PBX connections required, each of the enterprise-controlled FMC capabilities will involve a different set of elements that contribute to the cost of the calls made and received by the mobile user. Whether the call is forwarded by a manual or an automatic process, the cost elements involved will typically be the same:

Incoming Call to the Mobile:

1. Outgoing local call to the mobile from the PBX
2. Cellular usage for the incoming call to the mobile
3. "Hairpinning": The call will also tie up two trunks on the PBX, one to carry the incoming call and one to carry the outgoing call to the mobile number.

Outgoing Call From the Mobile:

1. Cellular usage for the outgoing cellular call to the PBX (in some cases the PBX calls out to the mobile, but in the US and Canada, the cellular usage would be the same)
2. Outgoing local or long distance call from the PBX to the called party. That outgoing call will be billed at the standard wired call rate but calls can be routed over any discounted long distance services connected to that PBX. This can be particularly cost effective for avoiding cellular carrier charges on international calls.
3. "Hairpinning": The call will also tie up two trunks on the PBX, one to carry the incoming cellular call and one to carry the outgoing local or long distance call.

Mobile-to-Mobile Calls

In most corporate cellular contracts, on-net mobile-to-mobile calls are free. In any of these arrangements however, those calls would involve an outgoing and an incoming cellular call charge as well as a hairpinning connection through the PBX.

Voicemail Retrieval

As the mobile UC solutions typically send all of the user's voicemail messages to the PBX's voicemail system, the user must now use cellular minutes to check for and retrieve those messages (calls to the cellular voicemail are typically free). Mobile UC solutions that provide message waiting indication and visual voicemail can greatly reduce those costs.

In short, when estimating the cost of a PBX-based FMC solution it is important to ascertain the actual cost of each of these elements, estimate the number of calls in each of these categories, and then determine what the total cost of the solution will be.

Carrier-Controlled (cFMC) Solutions

There are fewer FMC options on the carrier side, and they fall into three primary categories: Unlicensed Mobile Access (UMA), femtocells, and IP Multimedia Subsystem (IMS). In evaluating these it is particularly important to recognize whether the service is targeted at consumers or enterprise customers. One major issue to consider is whether the enterprise has the ability to maintain control of the telephone number. In a UMA solution for example, the caller is typically dialing the cell phone number. However, the carriers now offer UMA in combination with other eFMC solutions (e.g. BlackBerry MVS or Avaya oneX Mobile UC) to address those enterprise requirements.

Whichever FMC solution the carrier is deploying, it will utilize voice over IP (VoIP) technology as part of the solution. When the call is transitioned off the cellular network it is converted to VoIP in a gateway, and the packet stream is carried over an Internet service and a broadband access connection. In UMA, the final delivery uses wireless LAN technology, while a femtocell employs cellular technology (See Figure 5). Sprint's IMS-based Mobile Integration service uses an IP Multi-Protocol Labe Switching (MPLS) based network connection.

As we noted earlier, there has been far more interest in providing enterprise FMC services among the smaller national carriers, Sprint and T-Mobile. In their public comments on the potential for FMC, the larger carriers have expressed concerns that call quality might suffer if the calls are handed off to a poorly designed wireless LAN- as if their service quality was that good to begin with! Their bigger concern seems to center on the potential impact on their revenue stream and how they will be compensated for traffic that finds its way onto another network service. At the root it appears that the cellular carriers feel that they have a unique franchise and fear any development that might put that franchise in jeopardy. The smaller carriers are more willing to take the chance to improve their market positions.

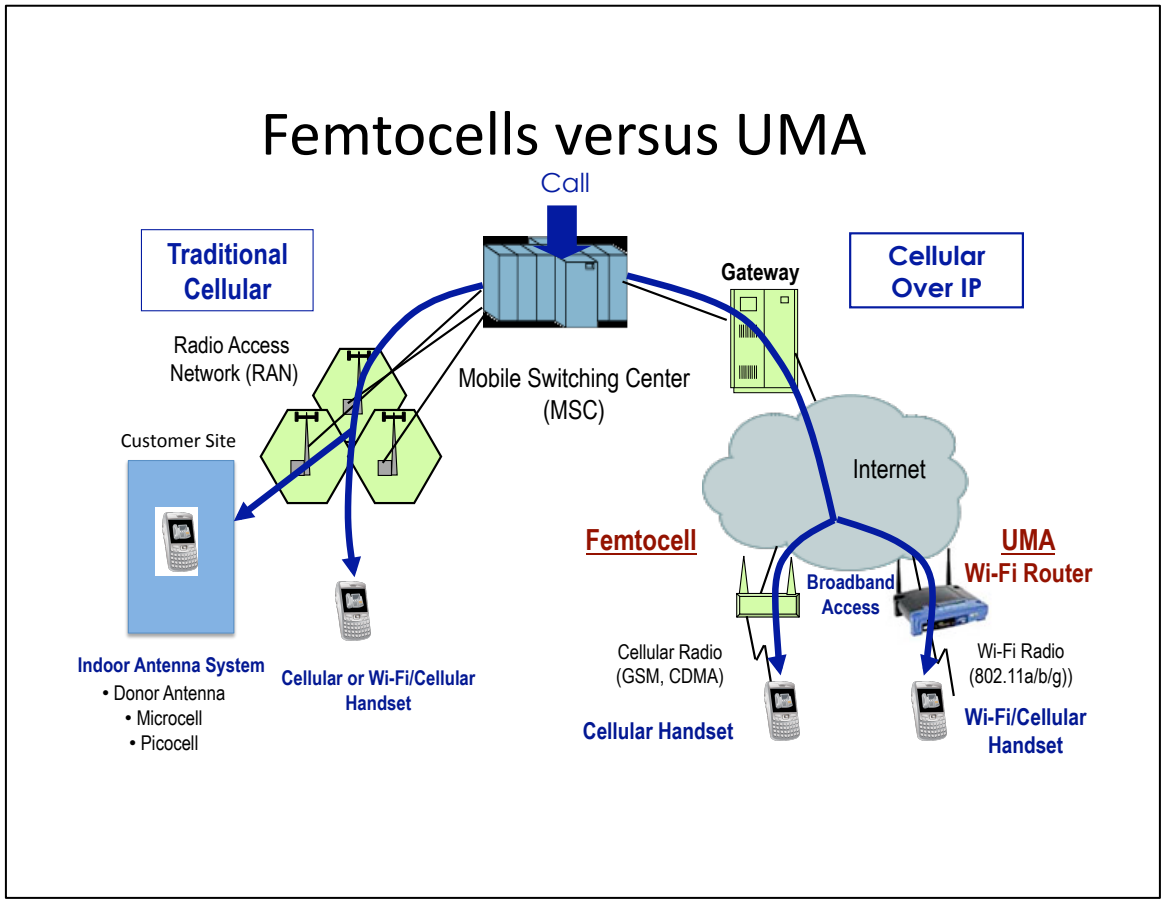

FIGURE 5: Femtocells versus UMA

Unlicensed Mobile Access (UMA)

Kineto Wireless pioneered the UMA concept and introduced the first UMA Controller. UMA has now been adopted by the 3G Partnership Project (3GPP), and incorporated into the 3G standards; there are equivalent standards in the CDMA environment, however there are no reported deployments. UMA is the basis for the first commercial FMC service in the US, T-Mobile's Unlimited HotSpot Calling ® (formerly HotSpot@Home®). Rogers Wireless offers a similar service called TalkSpot® in Canada.

UMA combines cellular service with Wi-Fi and offers transparent handoffs between the two environments. In the consumer offering, T-Mobile charges an additional $10 per month for Unlimited HotSpot Calling ®, and all usage over the Wi-Fi connection is free. The service will operate over any Wi-Fi network the UMA-capable handset can associate on.

To utilize the UMA service the customer must have broadband Internet service (ADSL or cable modem) and a Wi-Fi router. The service supports a small number of UMA-capable Wi-Fi/cellular handsets including models from Nokia, Samsung, and BlackBerry (e.g. the 8220 Pearl flip-phone). Besides the Wi-Fi/cellular capability the handset also requires UMA software (i.e. not just any dual-mode Wi-Fi/cellular handset).

To provide the service, the carrier installs a UMA Controller or *gateway* at their central office or mobile switching center (MSC). That controller provides the conduit between the cellular network and the Internet. When the user comes within range of an accessible wireless LAN, the UMA software in the handset automatically sends a registration message through the Wi-Fi/Internet link to the UMA Controller alerting the carrier that this subscriber is now available to make and receive calls over the VoIP service. If there is a call in progress, the connection is handed off to the VoIP service, and the cellular billing stops.

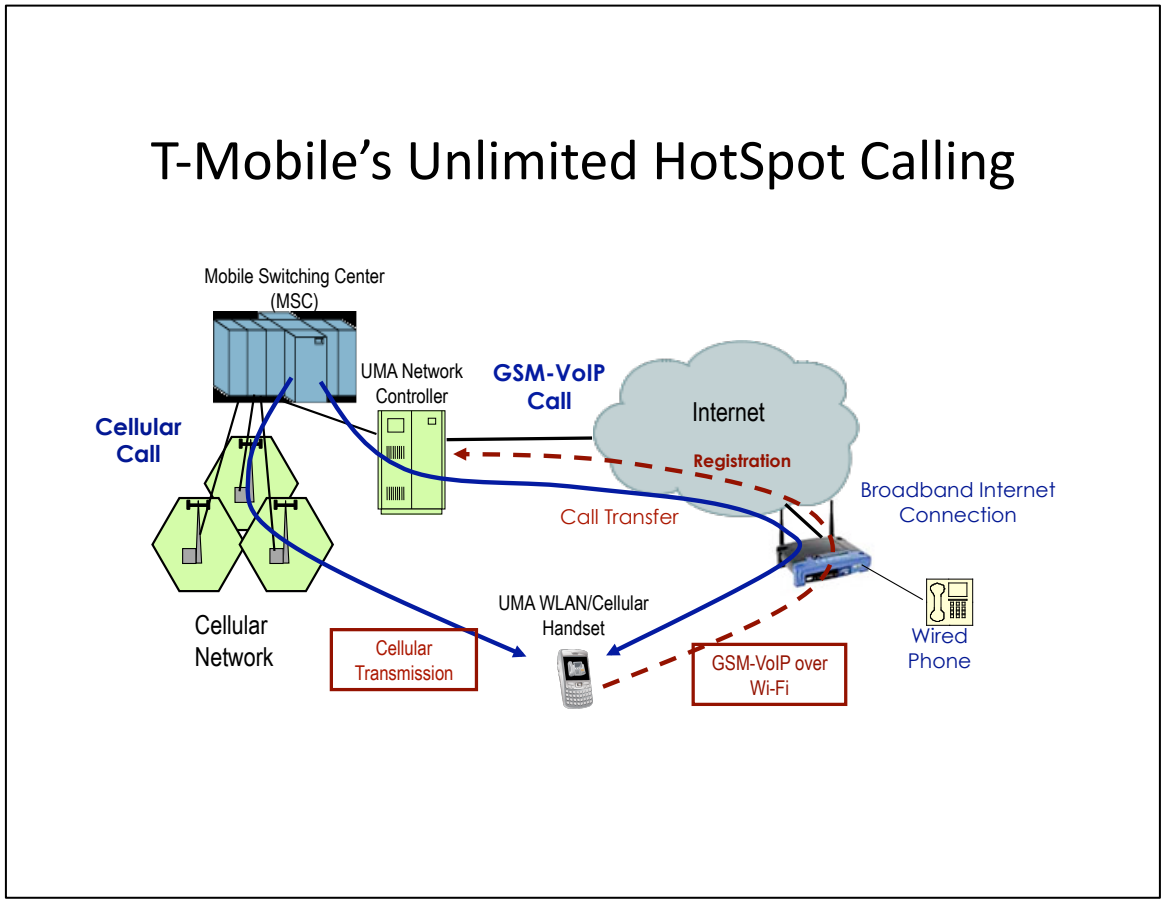

FIGURE 6: T-Mobile's Unlimited HotSpot Calling

Unlike an enterprise WLAN VoIP implementation, UMA uses a technique best described as *GSM over VoIP*. The UMA controller takes the GSM encoded voice (i.e. AMR coding), signaling, encryption, and SIM-based authentication and sends it in a string of IP packets. Those packets are forwarded through the Internet to the user's Wi-Fi router that sends them to the UMA handset in Wi-Fi frames (See Figure 6). It is not using the G.711/G.729a voice coding, SIP/H.323 signaling, or other standards typically found in enterprise VoIP implementations. The UMA handset does use the standard IP protocols for the voice packets (i.e. RTP, in UDP, in IP) and provides the RTP sequencing and jitter removal functions.

The key feature is that while the user is within range of their wireless LAN, all calls will automatically be routed via the Wi-Fi/Internet path, and there is no charge for those calls. The UMA handset can also associate on other WLANs and get access to the no-cost mobile voice service in that way.

Wi-Fi Calling For Business/Enterprise UMA

For enterprise users the primary problem with UMA is that it is tied to the cellular number with no integration to the wired PBX. So the user will have two phone numbers, two voicemails, and their contacts will typically be calling the cellular number. In essence, it does not meet any of the defined goals for *enterprise* FMC.

To address this, the T-Mobile has been marketing the idea of an enterprise version of UMA, which combines BlackBerry UMA-capable smartphones with the BlackBerry MVS mobile UC solution; they call the solution *Wi-Fi Calling for Business*. As with any BlackBerry MVS implementation, the customer would install the MVS server in their facility and connect it to the PBX and to the BlackBerry Enterprise Server (BES). As with other enterprise FMC implementations, business contacts would call the desk set, and the MVS would simultaneously ring the desk set and the mobile device, and the user could answer on either. In progress calls can be transferred from the desk set to the mobile and vice versa

When the user comes within range of an accessible wireless LAN, the UMA-capable device would associate with it, and register with the carrier's UMA controller signaling that it is available to make/receive calls over the WLAN/Internet connection. As with the consumer UMA offering, there would be no cellular usage charges for those WLAN/Internet routed calls. Further, if the enterprise WLAN is a centrally controlled implementation like those from Cisco, Aruba, or Meru, the user could roam from WLAN access point-to-access point and the call would be transparently handed off within the

WLAN coverage area.

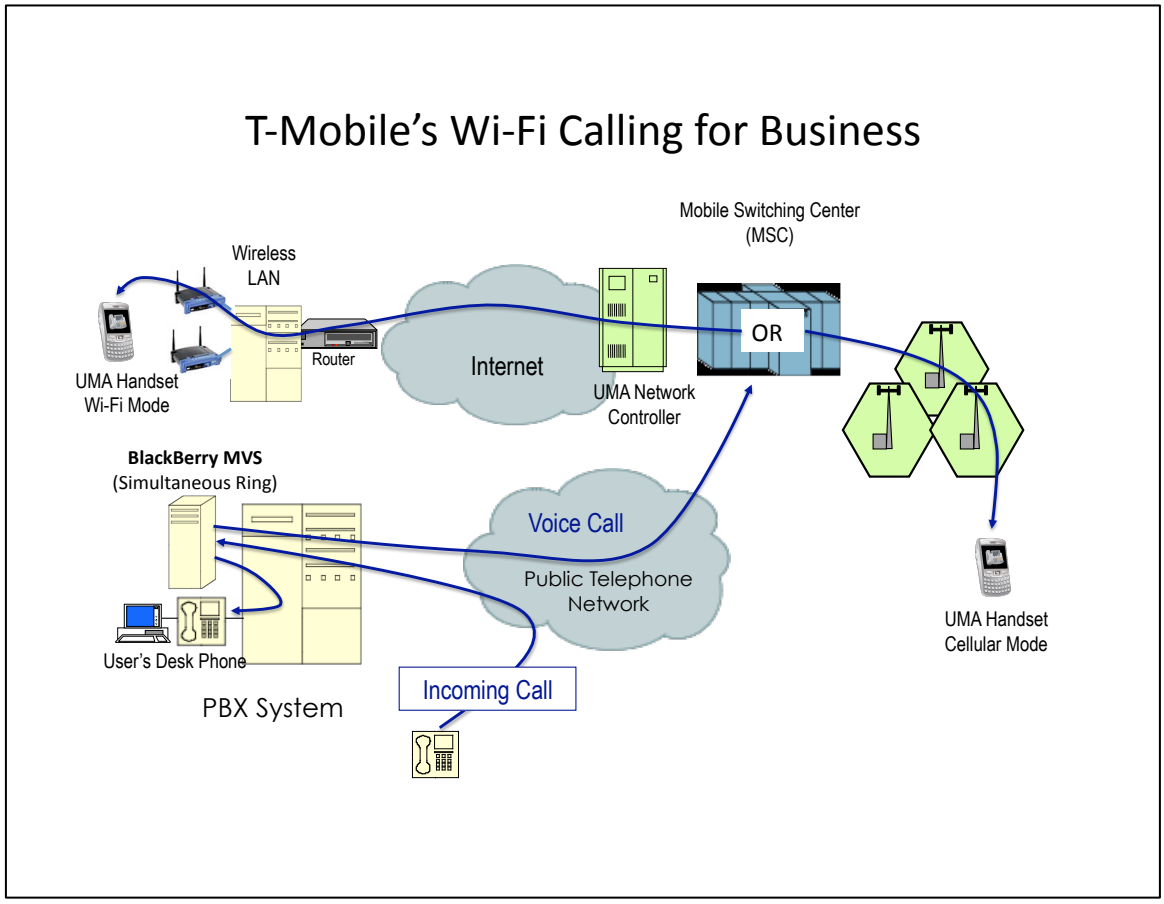

Figure 7: T-Mobile's Wi-Fi Calling for Business/Enterprise UMA

As we show in Figure 7, the path of an outgoing mobile call is rather challenging to follow.

1. The BlackBerry device's call request would be sent over the cellular data service (or through the Wi-Fi connection if the user is in the WLAN coverage area) through the BES to the MVS.
2. The MVS would place an outgoing call to the cellular number.
3. On receiving the call request, the cellular carrier would determine if the subscriber was reachable over the cellular network or the Internet/Wi-Fi connection.
4. The cellular carrier would complete the call over the appropriate path while the MVS places the other side of the call.

Besides the savings on call placed while the user is connected over the office WLAN, UMA can also allow for much cheaper Wi-Fi based calls through public Hot Spots; that is particularly attractive if the user is traveling internationally and placing calls to numbers in their home country. Those calls would be completed as no-cost Internet/WLAN calls rather than international cellular roaming calls. Calls to numbers in the country the user is visiting would be billed at the rate for US-originated wired international calls.

The downside of the Enterprise UMA approach is that it is only offered by T-Mobile, and provides a fully functional interface only when used in conjunction with BlackBerry handhelds and a BlackBerry Enterprise Server (BES). There is no support for non-BlackBerry devices, so it is a poor choice for environments with a mix of cellular handsets. Like the dual-mode eFMC solutions, it also requires a voice-capable wireless LAN.

Femtocells

While T-Mobile has been pursuing UMA, the other carriers have opted for the alternative consumer-oriented FMC configuration, the femtocell. Sprint introduced the first US femtocell called Airave® in mid-2008, and both Verizon and AT&T are starting femtocell trials in 2009 under the names Network Extender® and MicroCell® respectively. As we showed in Figure 5, the femtocell configuration looks much like UMA, only the in-home wireless link is cellular rather than Wi-Fi. There is some concern that femtocells could interfere with the public cellular coverage in an area, however we will have to wait until there is some base of femtocell deployments to determine if those concerns are justified. The bigger concern is the interference created among the femtocells themselves when several are installed in a multi-tenant building.

A femtocell is essentially a small cellular base station that is installed in the customer's home and connected back to the cellular carrier over the customer's broadband Internet connection. When the user is out, their phone works on the cellular network. When they come home, the handset automatically registers with the femtocell and reports to the cellular carrier that they are now available to make and receive VoIP calls through the Internet and their home base station.

Femtocells typically provide a relatively short transmission range and a maximum of 2- to 8-handsets so they are clearly not intended for enterprise use. As they include none of the RF management capabilities we find in enterprise WLAN switching systems, femtocells are the equivalent of a 1990s-vintage WLAN with stand alone access points. Hence, if a cellular carrier needs to improve radio coverage in a large facility, they will likely opt for a distributed antenna system rather than attempting to address the problem with femtocells.

IP Multimedia Subsystem

IP Multimedia Subsystem is a major infrastructure development in the cellular network to deliver voice and multimedia applications access across both wireless and wireline networks. IMS defines an IP-based core network that can support Session Initiation Protocol (SIP) based signaling as well as the traditional carrier-oriented Signaling System 7 (SS7). The network architecture will incorporate session border controllers and media gateways to translate between any of the supported network interfaces.

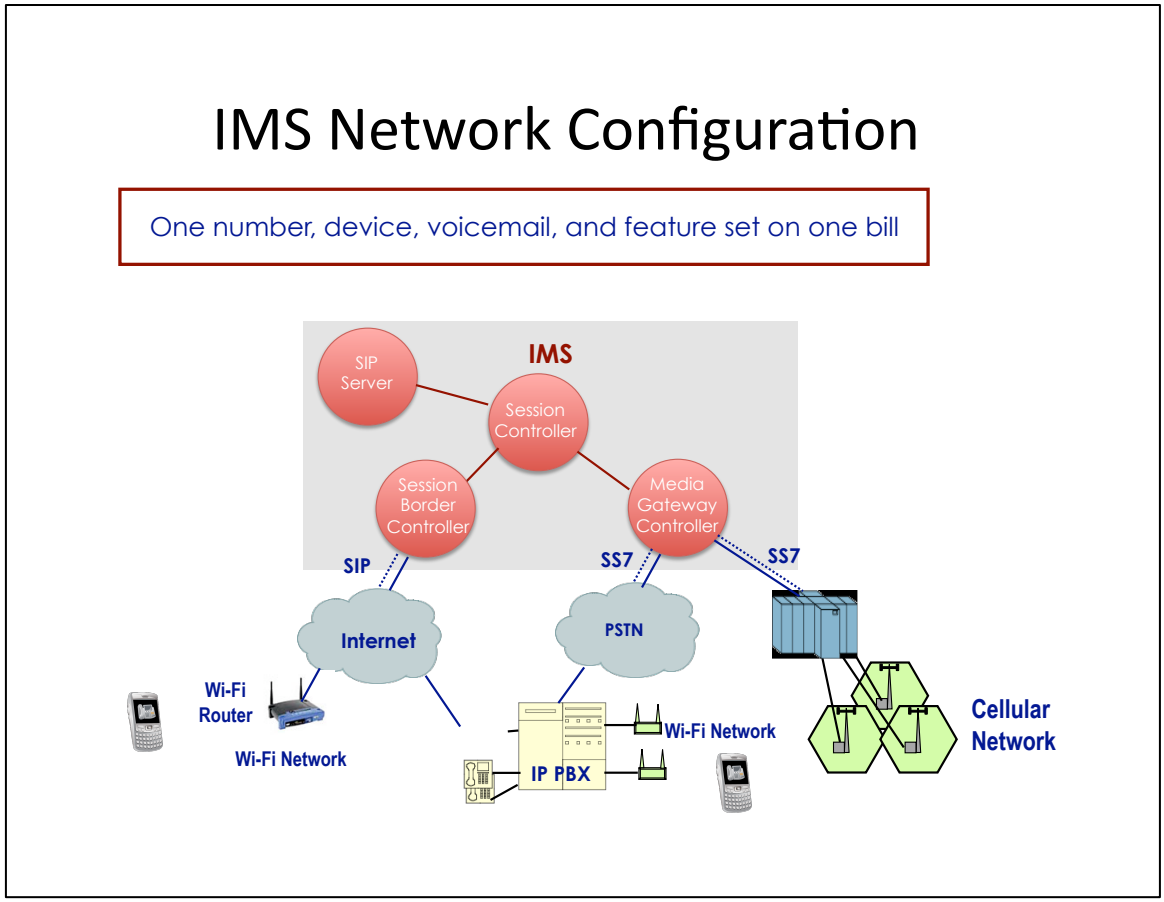

FIGURE 7: IMS Network Configuration

The overall goal of IMS is: One number, one device, one voicemail, one feature set, and one bill. The FMC functionality is covered in what the IMS literature refers to as virtual call continuity (VCC). While the cellular carriers are making investments in IMS, it is important to recognize that does not signal a commitment to actually deliver an FMC service. IMS provides another way by which the carriers could deliver FMC service, but they still must decide if they will do so. Thus far only Sprint has introduced an IMS-based FMC service called *Mobile Integration*, and notably, it is the first carrier-based FMC service that was targeted specifically at enterprise users.

Sprint's Mobile Integration

Introduced in conjunction with Avaya in 2007, Sprint's Mobile Integration is now available to both Avaya and Cisco IP PBX users. In either implementation, the service configuration requires a special set-up in the Sprint MSC, an MPLS network connection between the Sprint wireless network and the customer, and a Sprint provided router on the customer's site to interface with the Avaya or Cisco IP PBX. The MPLS network connection between the customer and the Sprint network has quality of service (QoS) capability, and is used to exchange both signaling messages and to carry the actual voice traffic.

In Mobile Integration, the user's desk number is their primary number. As shown in Figure 8, if a call is placed to a Mobile Integration subscriber (at their desk number), the IP PBX rings the call to the user's desk set and simultaneously sends a call request over the MPLS network to the Sprint's MSC that rings the user's mobile number. When the call is answered on one, the ringing is stopped on the other.

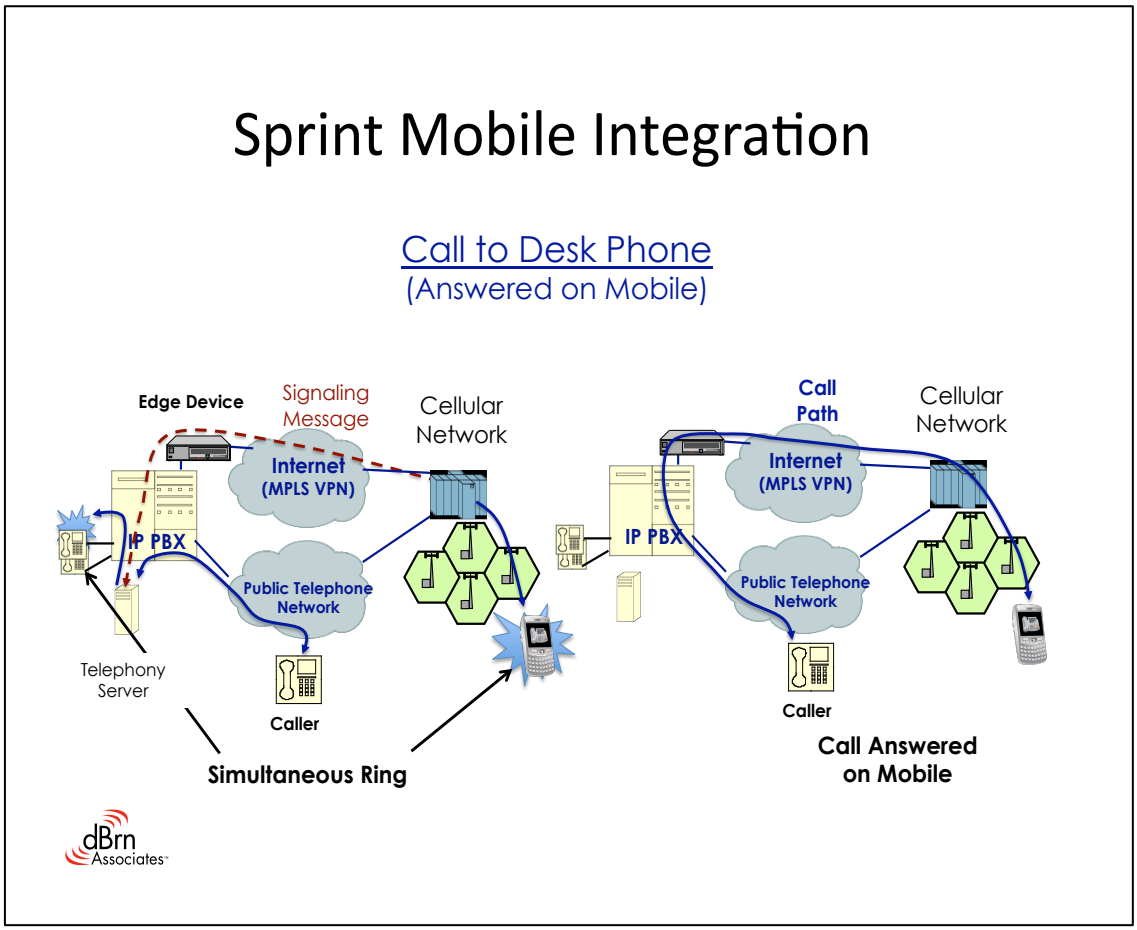

Figure 8: Sprint Mobile Integration- Wired to Mobile Call

As we show in Figure 9, if one Mobile Integration user calls another, they too will dial the user's desk number. The Sprint MSC will recognize the two users as Mobile Integration subscribers and ring the user's mobile number while sending a signaling message over the MPLS network to the IP PBX to ring the user's desk phone. When the called party answers on the mobile, Sprint's MSC will send a signaling message over the MPLS network to the IP PBX so the call record can be captured by the call detail recording. No inbound or outbound trunks would be tied up for the duration of that mobile-to-mobile call.

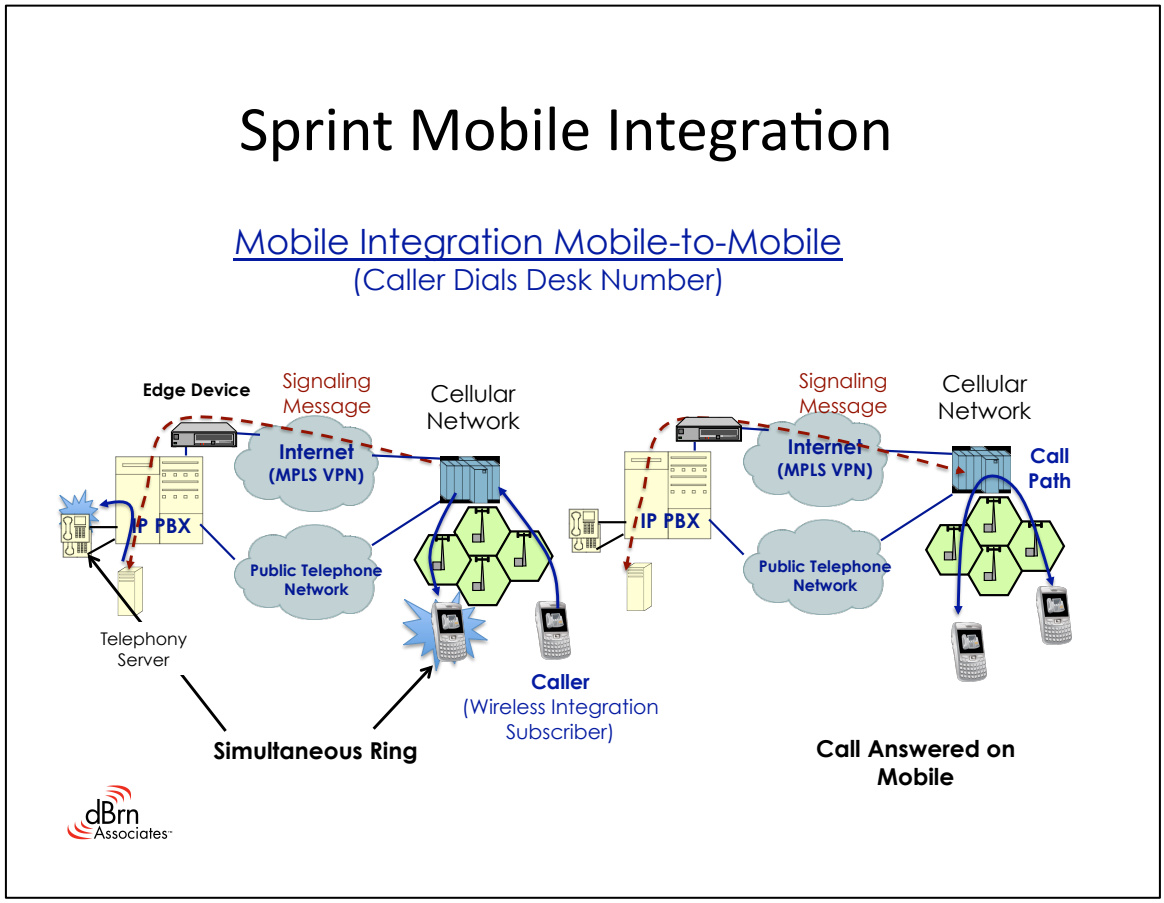

Figure 9: Sprint Mobile Integration- Mobile to Mobile

The key feature of the Mobile Integration offering is that there is no wireless usage charge for calls routed over the MPLS connection to/from Sprint; those connections are treated as on-net-to-on-net cellular calls. So there is no mobile usage on calls that are forwarded to the Mobile Integration subscriber from the PBX. Further, calls between Mobile Integration subscribers are also free as they are by definition on-net cellular calls. Finally, only one PBX trunk would be used on a wired-to-mobile call and no PBX trunks would be tied up for mobile-to-mobile calls.

In the end, the cFMC offerings require that you have a specific carrier, in combination with a particular PBX, use a specific handset model, and providing any UC-type capabilities still requires an eFMC solution as part of the installation. Clearly, much work needs to be done to bring the carriers' implementations up to the enterprise user's requirements.

On the plus side, having the smaller carriers challenging the majors by introducing some version of FMC for enterprise customers does change the competitive picture. While the current crop of offerings may not be ideal, potentially these initial forays could lead to more functional competitive offerings somewhere down the road. For the most part the strategy of the major carriers has been to offer more cost effective pricing plans for mobile calls placed to/from the corporate PBX to lessen the customer's incentive to move that usage from cellular to Wi-Fi. Hopefully they will eventually come to the realization that enterprise customers look at their network investments as more than simple "cost centers".

Conclusion

As you can see, there's a lot more to FMC than meets the eye. There are other potential cFMC solutions from companies like Tango Networks and CounterPath, however it is impossible to cover every potential implementation in a single paper. Initially the model for FMC entailed dual-mode Wi-Fi/cellular handsets and automatic hand-offs between the networks, but that implementation is now one of many. Today FMC can be implemented in a number of different ways using a mix of cellular, WLAN, and even wired telephone services, each with vastly different levels of functionality. At the same time customers are refining their buying criteria and expanding the focus from potential cellular cost savings to include the productivity enhancements of mobile UC.

As the major US cellular carriers have done little on the enterprise FMC front, the PBX and adjunct manufacturers jumped in with a number of solutions to meet those requirements. Certainly what we are seeing from Sprint and T-Mobile is encouraging, but they seem to lack a clear understanding the requirements and trends in enterprise networking. To be sure, the cellular carriers could deliver far more functional solutions than anything we have today if they chose to embrace the concept. That is particularly true when you consider the new developments in cellular technology like the Next Generation Networks and the Telecommunications and Internet-converged Services and Protocols for Advanced Networking (TISPAN) standards, which dovetail nicely with enterprise plans for UC. However, the carriers do not seem to have made that connection.

The challenge for enterprise users will be to understand the functionality their users require and determine the most effective way to deliver those capabilities in this highly volatile environment. Further, it is essential to understand the capital and operating costs involved and budget accordingly. As an FMC solution will likely result in an increase rather than a decrease in net costs, a project justification based on productivity savings might also be required to win management approval.

Fixed-mobile convergence and mobile UC represent an important development in network services and one that has generated considerable interest with our increasingly mobile workforce. However, good information and a thorough analysis will be needed to insure that the full benefit is received.

dBrn Associates, Inc. is an independent consulting/analyst firm specializing in wireless networks and technologies. This paper is excerpted from a recent multi-client study conducted on the US Market for Enterprise Fixed-Mobile Convergence and Mobile UC Products and Services.

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