Wireless Vertical Handover Between Gsm And Wi-Fi Standards Using Uman

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ABSTRACT
Vertical Handover techniques deal with the scenario in which the user can move between different network access technologies. UMAN (Unlicensed mobile access network) is one such technology that supports handovers to and from Wi-Fi networks. It is also referred to as GAN (generic access network). By supporting handovers to and from Wi-Fi networks, UMAN seems to be a perfect solution as new mobile services requires performance and seamless mobility. This research paper discusses the technical implications of UMAN and also an implementation technique of unlicensed mobile access. We have used two android phones to demonstrate the UMAN technique. Also, as contrary to traditional server-client approach to implement UMAN, we will be using p2p approach.

Keywords – GAN, UMAN, Wi-Fi, Sever-Client Approach.

1. Introduction
UMAN or Unlicensed mobile access network is a telecommunication system that extends mobile voice, data and IP Multimedia Subsystem/Session Initiation Protocol (IMS/SIP) applications over IP networks. It is a new technology that complements an operators' network coverage with unlicensed wireless technologies, such as WLAN or Bluetooth. In particular, the UMAN technology provides a way to access the core GSM network through Wi-Fi. It opens a new range of opportunities for both consumers and operators.

It allows consumers to enjoy the benefits of better indoor coverage using WLAN radio access. UMAN is a cost-effective way to expand cellular coverage for voice and data services to homes and enterprises where it might be too difficult or expensive to build cellular coverage indoors. The cheaper rates for 802.11 usages, coupled with better coverage at home, make more affordable and practical the use of cell phones instead of land lines. Using IP over 802.11 eliminates expensive charges when roaming outside of a carrier's network. Roaming charges outside the mobile service provider's network are eliminated since calls can be initiated within free unlicensed wireless LANs.

UMAN is currently the only commercial technology available that combines GSM and 802.11 into a service that uses a single number, a single handset, a single set of services and a single phone directory for all calls.

UMAN serves to give operators the ability to fully leverage their cellular assets via alternative radio access methods. With the help of UMAN, the cellular network operators, can extend their network coverage through Wi-Fi hotspots with minimal additional investment. Carriers can set up Wi-Fi hotspots in network coverage holes, instead of investing on expensive wireless WAN hardware. Congestion on GSM and other wireless WAN networks are relieved with part of the traffic toggled to unlicensed wireless LANs.

Networks like Wi-Fi are better off for carrying other types of media apart from voice, instead of traditional GSM. Thus, providers can design communication packages that include more than voice. This is especially interesting for Internet service providers. . UMA operates at the IP network layer in the protocol stack and is therefore open to many protocols in the interface layer - put simply, it is not restricted to one network, but can work on Wi-Fi, Bluetooth etc. Moreover in rural areas where satellite connectivity is low, operators can expand their network by setting up Wi-Fi hotspots. Also they can reduce the number of mobile towers which are a major cause of health concern these days.

2. UMAN Overview
The core idea of UMAN is to provide an access to the operator's network through not only cellular, but also through unlicensed radio access technologies such as Wi-Fi. It lets mobile operators deliver voice, data and IP Multimedia Subsystem/Session Initiation Protocol (IMS/SIP) type applications to mobile phones. Its ultimate goal is the convergence of mobile, fixed and Internet telephony (Fixed Mobile Convergence). On the cellular network, the mobile handset communicates over the air with a base station, through a base station controller, to servers in the core network of the carrier.

Under the UMAN system, when the handset detects a LAN, it establishes a secure IP connection through a gateway to a server called a UMAN Controller (UMANC) on the carrier's network. The UMANC translates the signals coming from the handset to make it appear to be coming from another base station. Thus, when a mobile moves from a GSM to a Wi-Fi network, it appears to the core network as if it is simply on a different base station.

UMAN provides four possibilities to manage/prioritize cellular and unlicensed access networks:

- GERAN-only: uses only cellular networks
- GERAN-preferred: uses cellular networks if available, otherwise the 802.11 radio
- UMAN-preferred: uses a 802.11 connection if an access point is in range, otherwise the cellular network
- UMAN-only: uses only the 802.11 connection

3. Introducing UMAN to a network

The introduction of UMAN by a network operator is relatively low cost and straightforward. While GSM and UMTS require relatively expensive and complicated backhaul circuits as well as costly base stations, the addition of UMAN only requires the users to additionally utilize their existing broadband connections.

This means that the network operator only needs to introduce one major element to the network. This is the UMAN Controller or UMANC. This can be considered as being much like a Base Station Controller (BSC) but for the UMAN functionality. One side of the UMANC is connected to the Internet giving connectivity for the WLAN access points, and the other side of the UMANC uses a standard A interface for the circuit-switched communications through to the mobile services switching centre (MSC) and a Gb interface for the packet switched connectivity through to the serving GPRS support node (SGSN).

By using the UMANC, it means that when a device hands over from a GSM to a WLAN, it appears to the core network as just a different base station.

4. System level choices

We have used android framework at the system level in order to implement the handover. A specific application is written in this framework which deals with both GSM and Wi-Fi hardware and helps to interconnect these two standards at system level using various API's. The handover process takes place by following the below mentioned approach.

4.1 GSM channel

The first step is includes the conversion of voice down-link and up-link packets coming from GSM channel into the raw audio data which can be further processed. As shown in figure-1, Android as a framework is used to implement the handover from GSM standard to the Wi-Fi. Android framework uses java as developing platform. In our case, AudioRecorder class will provide the necessary functionalities for the processing of voice data packets. Following steps were required while processing the voice.

1. We instantiated the AudioRecorder class object by the selecting 8000 Hz as the sample rate, 256 bytes as the buffer size, channel configuration as Mono and 16 Bit PCM encoding to get the best results.
2. Next step is to specify the recording source. This is the most crucial part while dealing over the cellular channel.
3. We specified voice call as the recording source. It is worth mentioning that we chose AudioRecorder class over MediaRecorder because it is more flexible. The latter produces audio in a compressed 3GPP or MPEG format and hence is less flexible. Whereas AudioRecorder produces raw Audio data which can be further processed and it is because of this flexibility we chose android as a tool to implement the handover.

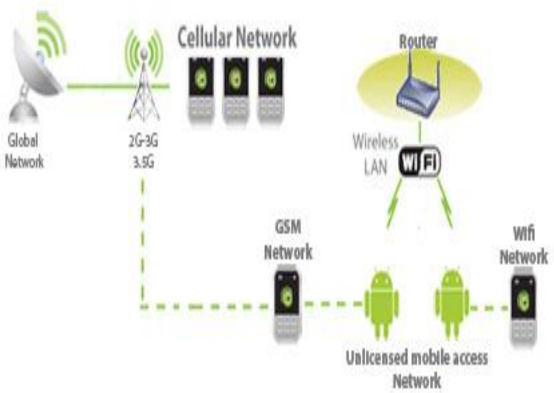

Figure-1: System Architecture: Wireless handover from GSM standard to local WLAN.

4.2 Handover

In the second step, the actual handover between two different standards takes place. The handover occurs in the following steps.

1. The raw voice data packets are stored in the buffer and are now ready to be transmitted over the Wi-Fi network. The IP address and port number of the destination is required in order to send these packets. It is also necessary in our system that both the receiver and transmitter should be on the same network. However, there is a scope for multiple handover between different Wi-Fi networks to provide the user with extra mobility.
2. As shown in figure-2, the required IP address is typed in the field, DatagramSocket creates a socket object using the given IP address and a fixed port number. The address of the memory buffer containing raw voice call data is also passed while instantiating the socket object.
3. As we click on start button, a thread is created which continuously stores the voice data packets into buffer, converts it into the datagrams and finally send it to the destination IP address.

Figure-2: Sender interface: The interface on the sender side to initiate the handover.

4.3 Voice data transmission and reception

1. At the receiver side, activity started listening on the same port number as specified on the server side.
2. We instantiated the object of Audio Track class using the same configuration as used in 4.1 and in the process increased the buffer size by a factor of 10 so as to make sure no packet loss occurs. The mode parameter was set to stream mode.

3. An object of DatagramSocket class received the packets on the specified port number, decompressed the packets into the buffer and this buffer was passed to the play functionality of the AudioTrack class.

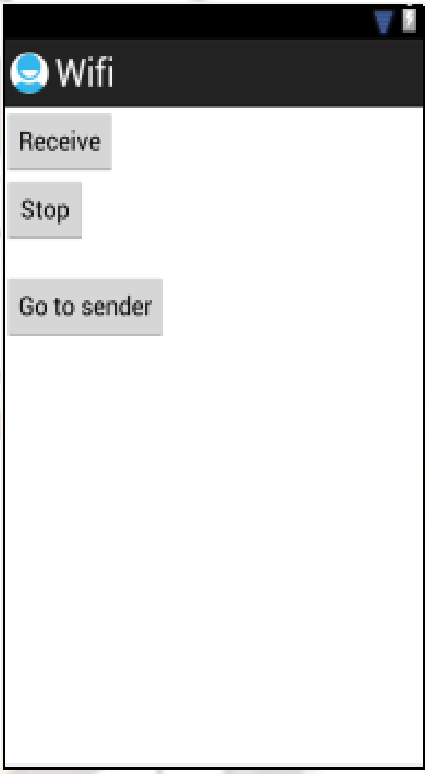

Figure-3: Receiver interface: The interface on the receiver side to receive the voice data.

Table 1 draws a comparison between the advantages and disadvantages of this handover using UMAN. The Wi-Fi route could be more receptive and efficient to the user but it has a major drawback as it needs to be available all the time during a connection. Also, all the peers have to be on the same network and if not then system has to bear an extra overhead of handover between various Wi-Fi networks. The table also compares the specifications of both GSM and WLAN standards and shows some of the probable complications which can arise during the handover.

Table-1: Advantages and Disadvantages of UMAN

Advantages
1. The voice communication will not be restricted to mobile cell phones, user with PDA, Laptops and even PC will be able to communicate using UMAN and WI-FI to GSM handover. 2. In areas of poor indoor connectivity, UMAN can provide users with enhanced reception. As WI-FI has sufficient bandwidth and good signal reception within closed areas, call drop and noise interference can be reduced. 3. Peer to peer network built using Ad-hoc networking can take advantage of UMAN to connect to internal network.
Disadvantages
1. Due to high differences between the standards of GSM and Wi-Fi, wireless handover is not a smooth process. 2. The handover process and communication has to be duplex in order to take the full advantage of UMAN. 3. UMAN require continuous availability of Wi-Fi network. Call break will occur if Wi-Fi is stopped.

5. Measurements and Results

The results of the measurements are analyzed and compared with the GSM system in sections 5.1 and 5.2.

5.1 Handover Performance Results

	GSM-to-UMA	UMA-to-GSM
UMA Registration	442 ms	-
Handover Request	157 ms	290 ms
Voice Connection Setup	77 ms	62 ms
Voice Connection Transfer	27 ms	199 ms
Connection Release	10 ms	208 ms
Total Handover Time	271 ms	759 ms

Table 2: GSM-UMAN Handover Measurements

It is important to note that the voice break that occurs due to the handover only takes place during the voice connection transfer. Furthermore, since the measurements were based on message capturing, the time between messages is not an absolute value for the voice break. Regardless of this, the measurements reveal that the possible voice break in UMA-GSM handovers are in line to typical breaks in GSM inter-BSC handovers (120-220ms).

5.2. Packet Data Performance Results

The results from the packet data performance tests are summarized in the following equation. Average TCP Throughput = 268kbps The results show that even though UMA originally seemed to be a potential candidate for boosting data rates while Wi-Fi coverage was available, the average throughput is not as high as expected. However, the

Average throughput of 268kbps is considerably higher than what is available via GPRS or EDGE in GSM networks. Current GSM and EDGE networks provide throughputs around 30kbps and 120kbps respectively. UMA data throughput is in fact; very similar to the data rates available in WCDMA (3G) networks.

Therefore, UMA technology is able to improve the user experience and performance for data services from GPRS or EDGE to WCDMA-like kind of service. From the operator's point of view, this means UMA can provide an additional value to its current services with a minimal investment.

The reason the very high Wi-Fi data are not possible is due to several factors both in the wireless network and the mobile terminal. Some of the current bottlenecks that we have detected that can limit data performance are:

1. Mobile Terminal processing power
2.Gb interface (between UNC and SGSN), which is normally based on T1 lines with a maximum bandwidth of 2 Mbps to be shared among all subscribers served by the UNC.
3. Subscriber's data throughput limit defined in the Home Location Register by the operator. This limit is usually assigned based on the service subscription type and can vary from very low rates such as 64kbps to several Megabits (e.g. 8Mbps for HSDPA subscribers).
4. GPRS theoretical data limit, which is around 600kbps.

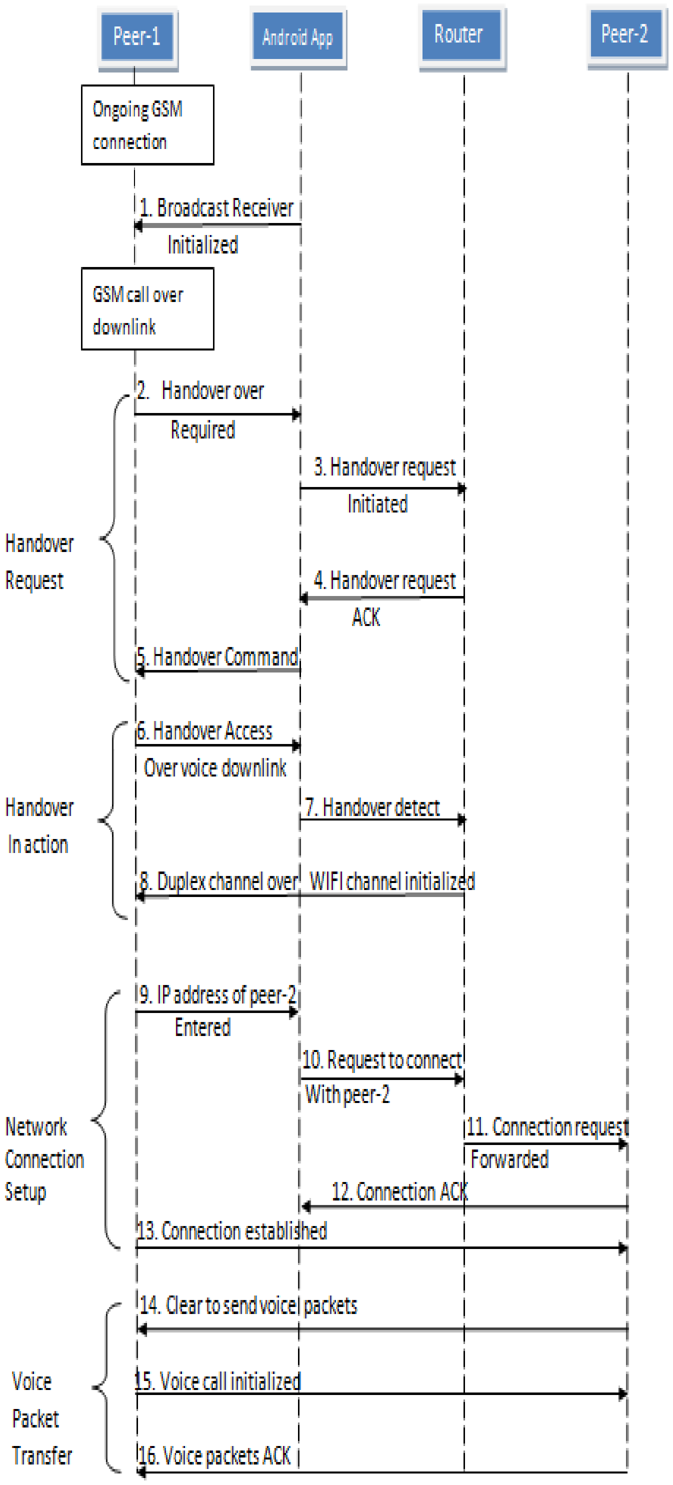

Figure-4: GSM-UMAN Handover Procedure

5.3 Accuracy and Security Results

As we can infer from the Figure-4 that the accuracy of the captures measurements would be improved if voice data packet captures were performed at the ends of the network. That is, directly from the Wi-Fi and GSM interfaces directly. However, this would require specialized software in the mobile devices that can interact directly with the internal and external hardware and additional deciphering tools. Therefore, this approach is not feasible in practice. Also security can be an issue due to the involvement of many interfaces in the process. Hence system level security has to be implemented to provide a secure communication.

6. Conclusion

The technical measurements of UMAN performance provide evidence that the solution is really helpful. The time taken for handover between UMAN and GSM is similar to typical inter-BSC handovers in GSM system. It provides us with various advantages of UMAN for both subscribers as well as operators and therefore describes UMAN as a very advantageous technology to be implemented in the daily lives of people. The measurements
Show that throughput is twice or more than the data rates available in GSM networks. The promising measurement results suggest that there is a lot of potential to extend network coverage and deploy hotspot kind of access points in special circumstances. At the same time, the cellular network operator control over subscribers and traffic flows.

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