Cellular
Networking
Perspectives

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In This Issue...

Phones & PDA's: Can the Marriage Ever Work?.......... p. 1

Phones and PDA's have had an on-again, off-again relationship for several years. We identify one flaw that is common to all attempts to merge these devices – and an easy way to make the relationship work.

The Changing Role of Network Interconnection .... p. 2

P.J. Louis, an author and expert on telecommunications interconnection, describes how competition is generating new protocols faster than standardization can make them work together.

E911 Phase II, Part II: Network Interconnection .... p. 3

Emergency Services is an example of the problems caused by network interconnection. When there is a choice between enhancing existing protocols and inventing new protocols, the decision is often not very easy.

Comments

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Next Issue: July 5, 2000

Phones & PDA's: Can the Marriage Ever Work?

The marriage of the wireless phone with a PDA has been attempted several times, but has never been properly consummated. Usually, the arrival of a new integrated phone/PDA is announced with a flurry and lots of confetti only to slowly sink from view along with diminishing sales. We believe that there is a simple explanation for this – the placement of the microphone and speaker on the PDA. Luckily, there is also a simple solution.

Since one of the favorite applications on a PDA is contact management, it seems obvious that one should be able to access records for contacts, place a call to them, review and make notes related to each call, and control the calls from the PDA. But, just make a call with a phone/PDA and you will see this is impossible, for the very simple reason that the microphone and speaker are on the PDA. As soon as you pick up the PDA the screen becomes invisible, and the ability for integrated PDA/telephony applications is lost, or at least vastly diminished.

With the trend towards personal hands-free devices (earphone with dangling microphone), the solution to this problem is to dump the microphone and speaker from the PDA and only provide a jack for an external earphone/mike. This will allow people to look up a contact, tap on an icon to call them, review information recorded to prepare for the call and take notes during the call.

Another capability that could be provided simply and conveniently is the ability to generate DTMF tones for services such as personal banking. Currently, this requires taking the phone away from your ear, pressing a key (which means that audible feedback from the key is lost), bringing the phone back up to your ear quickly to catch the next prompt in the interactive dialog and then repeating the process. This is not a problem with most landline phones because the earpiece and keypad are separate. It would not be a problem if the DTMF keypad was just a software application on a PDA (but only if the PDA could be in continuous view of the user during the call).

More sophisticated applications can be envisioned, such as two people talking and typing at the same time, exchanging short messages during their conversation. A viable marriage of the PDA and phone would finally result in a usable interface for generating short messages (whether during a call or not), getting away from the telephony keyboard which, no matter how clever the software, is simply not a desirable text input device.

For many PDA users, their phone would physically disappear (one less thing to carry around), yet the resulting functionality would be enhanced. For people that mostly want to talk, traditional wireless phones will continue to be the most useful devices, but for those who are already wedded to their PDA, the new *ménage à trois* will add spice to their relationship.

Cellular Networking Perspectives (issn 1195-3233) is published monthly by Cellular Networking Perspectives Ltd., 2636 Toronto Cresc. NW, Calgary AB, T2N 3W1, Canada.
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Subscriptions: CDN$300 in Canada (incl. GST), US$300 in the USA and US$400 elsewhere. Payment by cheque, bank transfer, American Express, Diners Club, MasterCard or Visa.
Delivery: Email or 1st class mail. **Back Issues:** Available individually for $35 in the US and Canada and $40 elsewhere, or in bulk at reduced rates. **Discounts:** Educational and small business discount: 25% off any order. **Copies:** Each subscriber is licensed to make up to 10 copies of each issue or back issue. Please call for rates to allow more copies.

The Changing Role of Network Interconnection

The author of this article, P.J. Louis, is also author of "Telecommunications Internetworking – Delivering Services Across The Networks", published by McGraw-Hill. The book can be found at major booksellers such as Amazon.com, Barnes & Noble and their website – BN.com, Borders Books and, in Canada, the book is available at major booksellers such as indigo.ca

Network interconnection plays a pivotal role in today's networks. It has both a technical and regulatory aspect and is pivotal in the convergence of network technologies which is playing a key role in the growth and evolution of the telecommunications industry. However, the convergence occurring today is largely without industry-approved standards. To date, competition has driven all of the standards work affecting efforts such as 2.5G, 3G, Wireless Intelligent Networking (WIN), and Wireless Access Protocol (WAP).

Network interconnection joins two or more networks to one another. Telecommunications interconnection has a long history starting with the PSTN as it interconnected to other carriers and to other types of networks. There are two aspects to interconnection: physical and protocol. The physical interconnection refers to the type of network transmission facility being used, with each grade of facility being capable of exchanging information at different speeds. The protocol refers to the network language used to communicate information between two or more networks.

Convergence

Wireless and Landline Network Interconnect is the first step towards convergence and thereby creating new value from the network. We see this new network value today in the mergers and acquisitions that are taking place. A current, broader and possibly more realistic view of interconnection would include the business relationship between the service providers. In most cases the business issues define and dominate the relationship. The technical aspect of network interconnect appears secondary to the business aspect of network interconnect. There is nothing wrong with "business" – every engineer on Earth pays their bills with money, not good intentions. What is wrong with the current change in telecommunications is the speed at which it is taking place without proper industry standardization.

As an example, WAP-enabled product is showing up in the marketplace before the foresters over intellectual property rights and standardization has burned out. The situation that WAP and the wireless Internet could be facing may be similar to the situation faced by the ISDN community. ISDN began development work in 1976, yet it was not until the early 1990s when standards were completed and agreed upon! During the 1980s and 1990s large volumes of ISDN equipment was sold, even though the increasingly large embedded base was not fully compatible with standards. In the end the ISDN customer suffered. Wireless internet could face such a situation. The only thing that can save it is a close consideration experiences such as ISDN.

Interconnect Specifications

There are two documents that serve as the wireless industry's principal source of technical information for network interconnection. One document is produced by Telcordia (formerly known as Bell Communications Research or Bellcore) and the other by the Telecommunications Industry Association (TIA). The Bellcore document is called Generic Reference GR-145-CORE and the TIA document is ANSI standard TIA/EIA-93.

Both documents were written to support technical and business perspectives and objectives of their respective interest groups: GR-145-CORE supports the objectives of the landline carrier community and TIA/EIA-93 those of the wireless industry (specifically the Cellular Telecommunications Industry Association (CTIA) and the TIA). TIA/EIA-93 is a standard, while GR-145-CORE is a company proprietary document sold for profit.

Given its long history, Telcordia's GR-145-CORE is still the predominant wireless-landline industry specification. The landline carrier community's network interconnect needs are met via the standardization work of Committee T1 and the specifications (aka, de facto standards) of Telcordia.

The real question facing wireless and landline network interconnect is whether current specifications are sufficient for today's and tomorrow's telecom visions. New network signaling technologies are being deployed to meet the needs of the growing broadband marketplace in both the wireless and landline communities. New music and video formats are being created independent of the work taking place in the traditional telecom standards forums. People active in the creation of telecommunications standards are constantly working on establishing liaisons with other standards bodies or other public forums. The energy and dedication of resources needed to maintain basic communications between groups of interested parties is enormous.

Future Vision

Network interconnection standards have grown beyond the Type 1 or Type 2A analog-based protocols of yore (e.g. two-way Multi-Frequency (MF) or DID trunks). Network interconnection is being governed by the multiplicity of business interests of the different carrier types. Today there are incumbent local telephone companies (ILECs), long distance telephone companies (IXCs), cellular carriers, PCS carriers, wireless local loop carriers, Internet Services Providers (ISPs), cable television companies offering entertainment and Internet access, and CLECs. The CLEC (Competitive Local Exchange Carrier) is a carrier type and designation that fits all of the aforementioned carrier types. The number of competing business interests has made it difficult for the standards community to meet the needs of the telecommunications industry.

The dynamic nature of the telecommunications market may have reduced the value of the old ways of creating standards and the value of the existing network interconnect standards.

The need for industry standardization will be even greater in the future than it is today. The complexity of the terminal device and network elements will create an overwhelming need for standards. However, the need to be competitive will create a difficult environment for standardization. The future of standards will be very dependent on the balance between competition and meeting the needs of the customer.

E911 Phase II, Part II: Network Interconnection

It may seem to an outside observer that the challenge in locating a mobile phone that is being used to make an emergency call is to do it quickly, accurately and economically. But, there is another substantial challenge, and that is to get the position information to the emergency call taker (PSAP; Public Service Answering Point), either through existing PSTN connections, or over new network connections. This gauntlet is picked up for Phase I by published TIA TR-45.2/ATIS T1P1 joint standard J-STD-034 and for Phase II by J-STD-036 which was nearing completion at press time.

One of the reasons that merely getting position information from the wireless network to the emergency services network is such a challenge is because commonly used protocols do not have the capability to send this information, the emergency services community has limited money to perform major upgrades, and because they generally rely on Local Exchange Carriers to provide interconnection, companies that are generally very slow moving, yet very difficult to replace.

Location versus Position

In this article we will follow the convention of using the term *Location* to refer to Phase I location (the cell that an emergency call was made from) and *Position* to refer to Phase II location (the latitude and longitude that the call was made from, accurate to within the FCC requirements described in our May issue).

Identifying the Caller and Phase I Location: ESRK or ESRD/MDN?

Although Phase II demands more stringent positioning of mobiles making emergency calls, Phase I requirements still have to be met. These include the abilities to:

- Identify the mobile making an emergency call,
- Call back the mobile,
- Determine the location of the mobile (cellsite or sector), and
- Route to the appropriate PSAP based on the Phase I location.

For Flexibility and Robustness: ESRD/MDN

The original Phase I E911 standard, J-STD-034 assumed that two digit strings could be passed through to the PSAP. Even the old-fashioned MF tone-based signaling allows the dialed digits and ANI (Automatic Number Identification, often the calling phone number) to be transmitted, while SS7 ISUP allows even more information to be passed.

ANI: MIN or MDN? It seems (and is) obvious that the ANI should identify the mobile, although it is not so clear whether it should be the MIN (Mobile Identification Number) or MDN (Mobile Directory Number). The MIN is available to all wireless systems, but it is not necessarily a dialable number if Local Number Portability or certain other conditions are in effect. Consequently, ANI should be programmed with the MDN, even though it is only available for roamers on systems that have implemented at least part of IS-41 Rev. C or higher. The MDN will ensure that callback is possible.

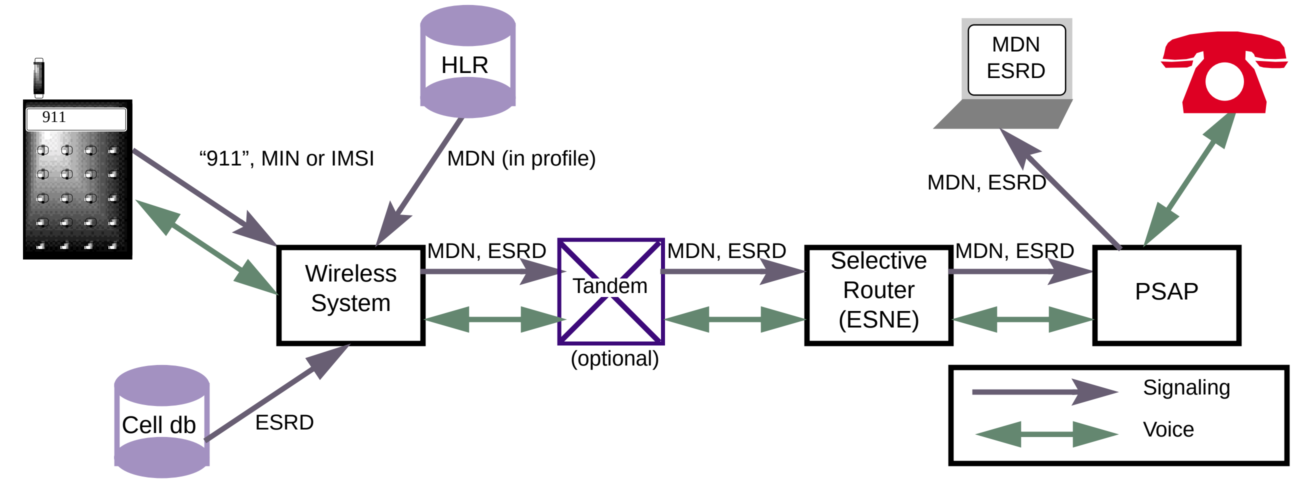
Dialed Digits: 911 or Location Identifier? In the past, the dialed digit string for emergency calls has simply been “911” (or “11” or “1”), but this does not convey the needed Phase I location information. J-STD-034 recommended that a digit string representing a new concept should be included. This ESRD (Emergency Services Routing Digits) performed two functions, identifying the cell used to make the call (Phase I Location) and allowing routing. Because of this dual role the assignment of ESRD numbers is counter-intuitive. Because it identifies a cell, it would seem to make sense to allocate them from a pool of wireless phone numbers. But, this would not be correct. The ESRD must be allocated from numbers belonging to the emergency services network to allow routing from the wireless carrier to the emergency services network via intermediate switches. This is so the call can be ‘pulled’ towards the destination identified by the ESRD. There certainly is no point having the call pulled back to the cell where the call was made!

The ESRD can be provisioned by the wireless system by obtaining a value from emergency services personnel for each cell (cellsite or sector). It is unlikely that each cell’s ESRD would change often, although each additional cellsite (or increase in sectorization) would require a new one.

For systems interconnecting with SS7 ISUP, more parameters can be included, and in this case J-STD-034 recommends that the *Generic Digits* parameter be used instead of the *Called Party Number* parameter (equivalent to the dialed digits in MF signaling). This recommendation makes little sense when MF interworking needs to be considered, and will probably result in both the *Generic Digits* and *Called Party Number* parameters being programmed with ESRD.

The ESRD/MDN approach is illustrated in Figure 1.

Figure 1: The ESRD/MDN Approach to Phase I E911 Compliance



For Compatibility: ESRK

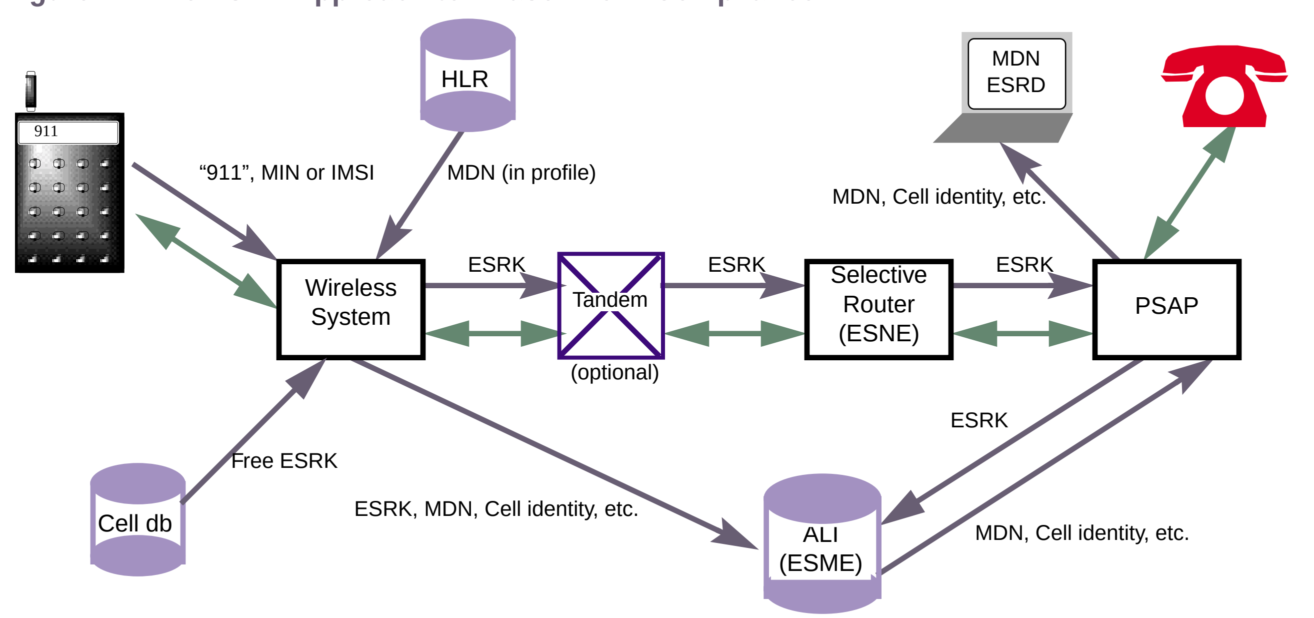
The ESRD/MDN approach has a major flaw, however. It assumes that the Selective Routers (generally LEC equipment) and the PSAP's will be upgraded beyond the CAMA interfaces most commonly supported today that only pass a single meaningful (7) digit string. However, for a variety of reasons this upgrade has generally not occurred, meaning that only one digit string can be transmitted to the PSAP.

An alternative approach is to assign a special phone number, known as ESRK (Emergency Services Routing Key) to identify each call, and then use it to query the ALI (Automatic Location Information) database that can be programmed by an external network. This is more compatible than the ESRD/MDN approach, but is less robust, because loss of the ALI database (or failure to program an ALI record) means that no useful information will be transmitted. This method also requires an external network that allows the wireless carrier to program the MDN and Phase I cell location into the ALI where it can be queried by the PSAP upon receipt of the ESRK.

Furthermore, the ESRK method requires management of a pool of ESRK numbers. Each call must be uniquely identified by an ESRK, so after the emergency call is disconnected, the ESRK has to be returned to the idle list. Exhaustion of the ESRK list due to a major emergency, under-provisioning, or software errors will also cause a loss of Phase I location information.

The ESRK approach is illustrated in Figure 2.

Figure 2: The ESRK Approach to Phase I E911 Compliance



Phase II Position Transmission: NCAS or CAS?

Phase II information can be transmitted to the PSAP through extensions to the SS7 ISUP IAM (Initial Address Message), known as the call-associated signaling (CAS) method, or through a separate network connection, known as the non-call-associated signaling (NCAS) method. There are parallels with Phase I location, as ESRD/MDN is a CAS method, and ESRK is NCAS.

The trade-offs are unfortunately also similar. The CAS method requires modifications to ISUP (being defined in ATIS T1.628), whereas the NCAS method can use existing SS7 interconnection, but requires use of a new network protocol defined within J-STD-036 by the emergency services network. Although the pure CAS method is most streamlined, it is also restrictive, only allowing the initial position of the emergency caller to be obtained, for example.

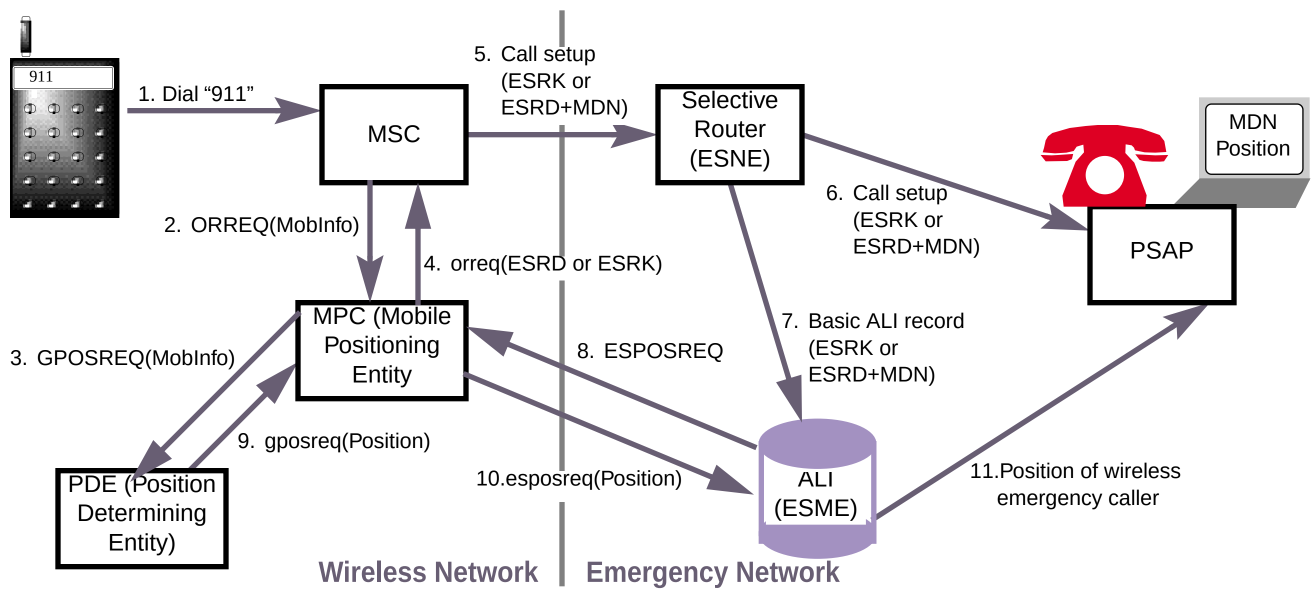
Basic NCAS - Non-Call Associated Signaling

An NCAS solution requires coordination between the call-associated information (e.g. ESRD and MDN) and that sent over the separate data (NCAS) network. This is a significant problem, because the end-point of an emergency call can move due to transfers between agencies (e.g. from police to ambulance) or between jurisdictions. The J-STD-036 solution provides enough information in call-setup (CAS) signaling to allow the emergency services network to request ("pull") location from the wireless carrier. A central hub for the management of Phase II information, known as the MPC (Mobile Position Center), has been defined, separating the process of obtaining position from the process of providing it to the PSAP.

A basic NCAS Phase II Position scenario is shown in Figure 3, and described below:

1. The scenario is initiated by a wireless phone being used to make an emergency call (e.g. dialing 911).
2. The Wireless System (MSC) initiates an ORREQ (TIA/EIA-41 OriginationRequest INVOKE) to the MPC.
3. The MPC initiates a request for Phase II position to the PDE (Position Determining Entity – a standardized interface to a proprietary or standard location system).
4. Since it may take some time for position to be determined, the MPC immediately responds with an orreq, containing a Phase I ESRD or ESRK identifier.
5. The MSC initiates call setup using either Phase I method (see Figure 1 for ESRD/MDN or Figure 2 for ESRK).
6. The Selective Router (known as ESNE in J-STD-036) delivers the emergency call to the appropriate PSAP, based on Phase I location (i.e. cell from which the call was originated).
7. The Selective Router programs a basic wireless ALI record containing the information received during call setup (e.g. MDN and ESRD).
8. The ALI (known as ESME in J-STD-036) initiates an ESPOSREQ (EmergencyServicesPositionRequest INVOKE) message to the MPC identified by the ESRK or ESRD.
9. The position of the mobile may already be available (and stored) at the MPC. If not, the MPC will wait until the PDE does provide it.
10. When position is available, it is forwarded to the ALI, where it is stored for the duration of the call.
11. The ALI then makes the position available to the emergency call taker.

Figure 3: Basic NCAS Method to Transmit Phase II Position



Basic CAS - Call Associated Signaling

The CAS method for Phase II position delivery can only be used if these prerequisites are met:

- ISUP upgraded to support position (e.g. with T1.628 support) is available to the MSC.
- Selective Router supports upgraded ISUP and interfaces to the PSAP and ALI.
- Position can be determined quickly enough that call setup will not be excessively delayed.

The CAS method still involves the MPC, although the ALI/MPC interface is not required unless updated position is needed. It is illustrated in Figure 4, and described below:

1. The scenario is initiated in the same way as NCAS, by a wireless phone being used to make an emergency call (e.g. dialing 911).
2. The Wireless System (MSC) initiates an ORREQ (TIA/EIA-41 OriginationRequest INVOKE) to the MPC.
3. The MPC initiates a request for Phase II position to the PDE (which is a standardized interface to a proprietary or standard location system).
4. In this case the MPC must wait for position to be provided, as it will be included in call setup signaling.
5. The MPC returns the Phase II position (i.e. latitude and longitude), along with Phase I information (ESRK or ESRD and MDN) to the MSC.
6. The MSC initiates call setup using an SS7 ISUP IAM including the position in the CGLP (Calling Geodetic Location Parameter) along with Phase I data.
7. The Selective Router delivers the emergency call to the appropriate PSAP, based either on Phase I location (i.e. cell from which the call was originated) or on the often more accurate Phase II position.
8. The Selective Router also programs an ALI record with all the information that it has available, including Phase II position.
9. The PSAP can now obtain the position of the emergency caller from the ALI. This can be used to display the estimated location of the caller on a map or even converted to an approximate street address.

Cleanup: Call Termination Report

In both CAS and NCAS Scenarios the MPC plays a critical role in managing Phase II position information, yet is not directly involved in call processing. It must be informed when an emergency call is disconnected, so that resources such as stored position information can be erased, ESRK's can be returned to the idle list and timers can be cancelled. This is not only important to ensure that MPC resources are not exhausted, but perhaps more importantly to ensure that information is not re-used inappropriately (e.g. in the case of a mobile making a second emergency from a different location).

J-STD-036 provides a CallTerminationReport message for this purpose, allowing the MSC to inform the MPC of the identity of each recently disconnected emergency services call (through use of the BillingID parameter, which contains a unique call sequence number) and of the identity of the mobile initiating the call (MSID – either MIN or IMSI).

To be Continued…

We will continue this article in our July issue by discussing some variants on the NCAS method: more accurate ways to determine the PSAP to route to, how the PDE can "push" position to the MPC, how updated position and position following an inter-MSC handoff can be obtained. We will also discuss the impacts of network-based versus mobile-assisted positioning on emergency services interconnection.

Figure 4: CAS Method to Transmit Phase II Position