

Cellular Networking Perspectives

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The latest status of standards that support analog (AMPS and NAMPS), TDMA (TIA/EIA-136) and CDMA (TIA/EIA-95 and IS-2000) cellular and PCS systems, including projects under development and standards just recently published.

For a Good Chuckle...

www.cnp-wireless.com/acronyms.html

...has a collection of humorous definitions for many telecom and computer acronyms. If you suspect one has been contributed by a competitor to belittle your favorite technology, get even by submitting your own barb directed at their IPR!

Next Issue: September 15, 2000

J-STD-036 Published!

A joint standard for E911 Phase II interconnection between positioning networks, wireless systems, the PSTN and emergency services networks has been approved for publication. TIA TR-45.2 and ATIS T1P1 are the joint authors of J-STD-036, which was described in our May, June and July issues.

The current status of all TR-45.2 projects, including J-STD-036, is shown in a report later in this issue.

IS-801: Mobile Assisted Positioning

This article was written by Ie-Hong Lin, John Cunningham and Len Sheynblat of SnapTrack (recently purchased by Qualcomm), one of the leading handset-based positioning companies.

The TIA has adopted a new wireless location services standard, TIA/EIA/IS-801, the world's first cellular and PCS phone location standard. It allows for the use of the Global Positioning System (GPS) to locate cellphones and is the benchmark the CDMA industry will use as it deploys wireless location technology for Enhanced 911 and commercial location services. The adoption of IS-801, which is compatible with the CDMA industry's TIA/EIA-95 and IS-2000 (cdma2000) standards, promotes industry growth and competition by ensuring that wireless carriers can

build interoperable location systems using products from competing vendors.

IS-801 is expected to accelerate the deployment of emergency wireless calling services, and support the FCC E911 Phase II requirements. Currently, U.S. emergency dispatchers cannot automatically locate the estimated 100,000 wireless 911 calls made each day. By FCC mandate, wireless carriers must install location technology to overcome this problem. Phase I of the FCC's E911 rules requires that a dialable number accompany each 911 call, which allows the PSAP dispatcher to call back if the call is disconnected or to obtain additional information. It also gives the dispatcher the location at the cell site that received the call as a rough indication of the caller's location. Phase II of the FCC's wireless 911 rules allows the dispatcher to know more precisely where the caller is located, a capability called Automatic Location Identification (ALI).

For more information on E911 Phase I requirements and network protocols consult our May through July 1998 issues and for Phase II our October 1999 and May through July 2000 issues.

IS-801, *Position Determination Service Standard for Dual-Mode Spread Spectrum Systems*, was accepted by the TIA for publication in October 1999. It is the culmination of efforts by a number of member companies of TR-45.5 (Wideband Spread Spectrum Digital Technology). The first Position Location *ad hoc* group was formed under TR45.5.2.3 (the signaling and protocol task group) in late

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1998. The result, IS-801, was created with the prime objective of supporting E911 Phase II requirements. However, it also establishes a flexible and adaptable protocol and technology framework to support other location services like CDMA tiered services, online navigation, fleet management, personnel tracking and security.

Currently, there are two basic types of location technologies in the market: handset-based and network-based. To date, *handset-based* solutions largely use GPS information to assist with calculating the handset's position, and they require that the handset perform radio signal measurements, and exchange geolocation information with the network. *Network-based* solutions require that the network perform radio signal measurement (e.g. Time of arrival (TOA) and/or Angle of Arrival (AOA)) and do not require message exchanges between the network and handset. The FCC recognized the differences in achievable accuracies between handset-based and network-based wireless location approaches, and mandated the following performance levels for E911 Phase II:

- Network-based solutions: 100 meters for 67% of calls, 300 meters for 95% of calls
- Handset-based solutions: 50 meters for 67% of calls, 150 meters for 95% of calls.

IS-801 Capabilities

IS-801 defines the messages and procedures that support the following handset-based technologies:

1. GPS autonomous acquisition and GPS assisted acquisition (such as Wireless Assisted GPS™)
2. Advanced Forward Link Trilateration (AFLT) using CDMA pilot phase measurement
3. Hybrid techniques that combine GPS measurements with AFLT measurements.

The resulting location capability defined in IS-801 supports 2- or 3-dimensional position (latitude, longitude and optionally height) with an associated uncer-

tainty ellipsoid, and optionally speed (vertical and horizontal) and heading.

Classification of Services

The messages and procedures in IS-801 are designed to suit various location request and response needs. Location requests can be classified by the alternatives chosen from each of four different categories below. IS-801 supports different combination of these four categories. For example, emergency service could be executed as a Network-Initiated (A.1), Single-shot (B.1) service requested when the mobile is in Active Traffic (C.2), with the result going to the network (D.1). The four categories are:

- A. Originating side:
 1. Network side – The location-based application resides at the MSC.
 2. MS side – autonomous navigation. The location based application resides in the MS.
- B. Type:
 1. Single-shot – Only the current location is needed.
 2. Tracking – Multiple location estimates for an MS are needed, extending over a time interval.
- C. MS mode:
 1. Idle – A traffic channel is not available; however, the MS monitors the Paging Channel and can respond through the Access Channel.
 2. Traffic – A full-duplex (forward and reverse) traffic channel is available for exchanging geolocation messages.
- D. Destination of location information – In most cases, the application that originates the geolocation request is the one that receives the results; however, sometimes it is necessary to ensure that different applications receive identical geolocation information:
 1. Single – Geolocation results are returned to the requestor.
 2. Multiple – Geolocation results are returned to multiple applications.

Messages and Procedures

A new type of Data Burst Message (BURST_TYPE = 000101₂) is defined over the air-interface to convey the *Position Determination Data Message* (PDDM). The MS and the network use the request and response elements within the PDDM to exchange geolocation information. The size of a PDDM cannot exceed 200 bytes.

As mentioned in the *Classification of Services* (see above), IS-801 defines procedures that enable location services in both MS idle mode and MS conversation mode. For conversation mode, either a shared voice/data traffic channel (service option 1 or 3) or a dedicated data channel (service option 34 or 35) can be set up to exchange PDDM.

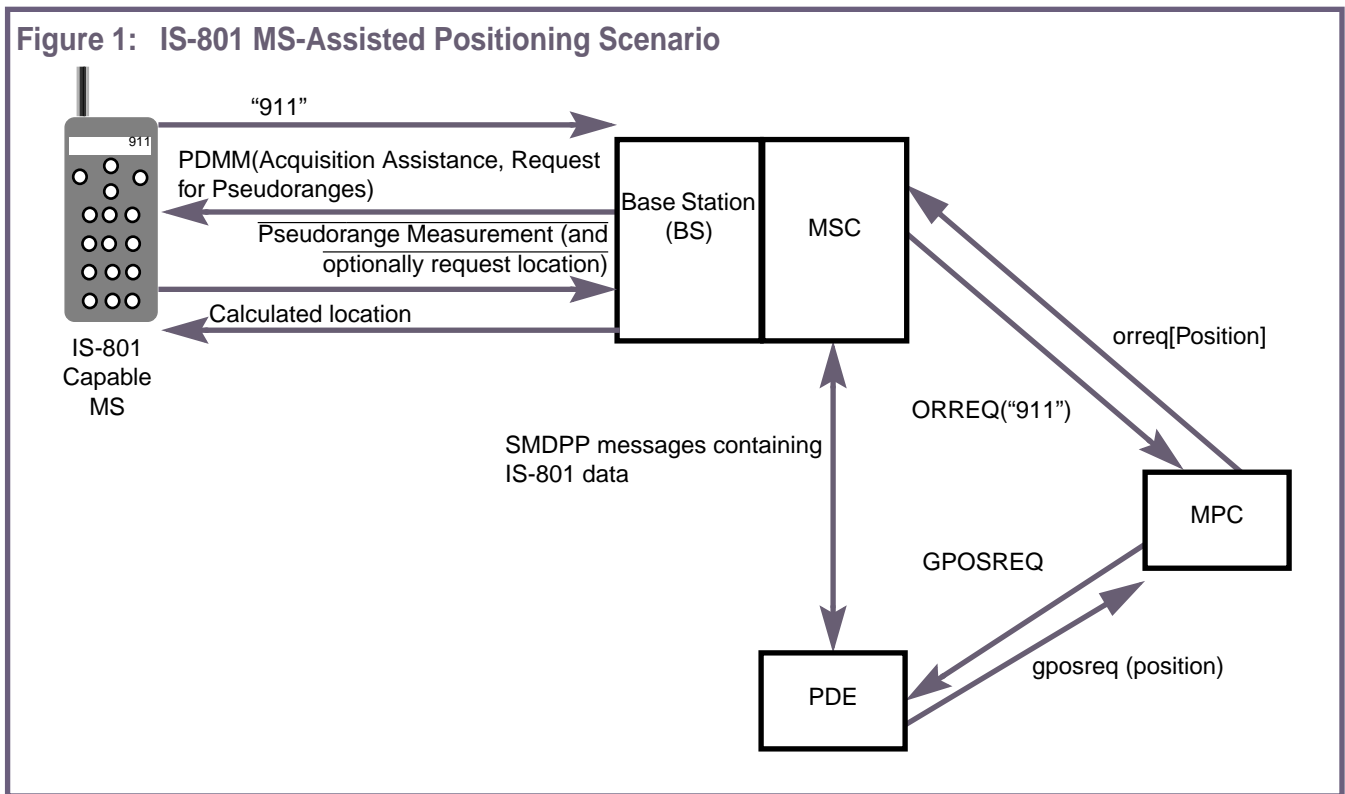
Based on where the location is computed, the location technologies can also be categorized into MS-Based (location computed in the MS) and MS-Assisted (location computed in the network). IS-801 supports both MS-based and MS-assisted location technologies.

Scenario

The following text and Figure 1 illustrate geolocation information exchange for a Wireless Assisted GPS-based system (an MS-Assisted scenario) during an emergency service call. Since exchange of voice and data traffic must alternate, only service option 1 or 3 can be used for an emergency service call. In other words, for emergency services, a traffic channel for a regular voice call is established and dim-and-burst is used to exchange geolocation data. As a first step to initiate the location determination transaction, the network can send to the MS two elements contained in a single PDDM:

1. An unsolicited *Acquisition Assistance* response element to help the embedded GPS sensor reduce the GPS acquisition time.
2. *Request for Pseudoranges* request element to ask the MS to perform and return the pseudorange measurements (equivalent to the distance from the GPS satellites to the MS, computed by measuring time of arrival (TOA) of the satellite signal).

Figure 1: IS-801 MS-Assisted Positioning Scenario



After acquiring the satellite signal and performing the pseudorange measurement, the MS may respond by sending to the network a PDDM that contains

1. *Pseudorange Measurement* response element
2. Optionally, it may also include a *Request Location* request element.

Upon receipt of pseudorange information, the network computes the MS position and if requested, sends to the MS a PDDM containing the *Location* response element.

An Example

SnapTrack's Wireless Assisted GPS system (WAG) is an example of how IS-801 based systems can improve upon conventional GPS by combining information from GPS satellites and wireless networks to accurately and reliably pinpoint a wireless phone. While traditional GPS receivers may take several minutes to provide a location fix, WAG generally locates callers within a few seconds. Callers are typically located to within 3 to 20 meters in a wide range of challenging call environments where normal GPS will not work inside houses and moving

vehicles, under heavy foliage, and in downtown urban street canyons. SnapTrack's multimode SnapCore™ WAG solution combines several GPS modes into a single package, and uses a dynamic smart-location feature that enables a device to choose the appropriate location mode for a user at any given time. It supports both MS-based and MS-assisted modes of operation, and provides out-of-network location coverage. Furthermore, the technology is air-interface neutral and is applicable in any two-way wireless system: cellular/PCS, satellite, or paging; 800/900 MHz or 1800/1900 MHz; GSM, CDMA, TDMA, PDC or 3G air interfaces.

Table 1 summarizes test results of the Wireless Assisted GPS technology from seven test locations around the world with major carriers.

Broadcast Mode

GPS assistance data can be conveyed to the MS via broadcast or point-to-point transmission. IS-801 defines the procedures and messages in support of point-to-point location services. The corresponding procedures and messages to support broadcast mode will be defined

in the next revision of IS-801 by 3GPP2 TSG-C.

Related Standards Activities

IS-801 contains the detailed procedures and messages for location services in CDMA mode. Its analog counterpart, IS-817, was accepted for publication by the TR45.1 plenary on July 10, 2000.

The standardization of location services for TDMA and W-CDMA are also in progress. TR45.3 is currently in the V&V stage of defining TIA/EIA-136-740 – the System Assisted Mobile Positioning through Satellite (SAMPS) location services standard for TDMA. 3GPP TSGs are also in the process of defining the location services standards for W-CDMA based on the GSM location services standards defined by T1P1.5.

About the Authors

Ie-Hong Lin is a staff engineer at SnapTrack Inc., helping to develop LCS standards for cdma2000 and W-CDMA. He received the PH.D. degree in Electrical Engineering from University of Maryland, College Park, and previous position

Table 1: Test Results for SnapTrack Wireless Assisted GPS (WAG)

Environment	Conditions	Yield	68.3% Horizontal Error (in meters)
Outdoors	Open site	100%	4
Urban Street, Shinbashi, Tokyo	2 to 10 story buildings, narrow streets and alleys	100%	15
Inside Sport Utility Vehicle	Parking lot surrounded by red wood trees and two-story buildings. Antenna placed on inside shoulder	100%	17
Two Story House	Center of basement	100%	20
Two Story Office Building	1 st floor, interior room	94%	22
Urban Canyon, Denver, CO	20 to 30 story buildings, wide streets, altitude aided	98%	29
50-Story Building	Glass/Steel building, 21 st floor, 14 feet (~4.25 m) from outside wall	89%	84

include a senior engineer at Comsearch where he helped develop the network performance prediction tool, consultations for Nortel and AirTouch as a principal engineer in cellular network build-up and optimization and lead engineer at GTE where he helped develop the CDMA system in the SFO bay area.

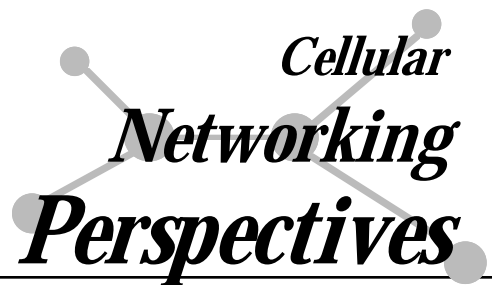
Len Sheynblat is a Location Technologies Manager and Architect at SnapTrack developing advanced signal processing algorithms for enhancing GPS performance and managing location service related standardization activities. Previously, Len was a Technical Product Manager at Trimble Navigation. His education includes an M.S. in Systems Engineering from Boston University.

John Cunningham joined SnapTrack in 1999, and is the manager of marketing communications. Previously, he managed public relations for Globalstar and the Space Transportation Association (where he also served as a legislative assistant). Mr. Cunningham has worked as a free-lance reporter for telecommunications trade magazines, and was a contributing radio broadcast correspondent for the America's Network program. He earned a bachelor's degree in international relations from the University of California, and a master's degree in science, technology and public policy from George Washington University.

Other GPS-based MS Positioning Companies

SnapTrack (now owned by Qualcomm) is not the only company designing GPS-based MS positioning equipment. Other companies that have announced products are SiRF Technologies (www.sirf.com) and Trimble (www.trimble.com). Major phone manufacturers, including Motorola, Nokia and Ericsson are considering the integration of GPS into their phones. Tandler Cellular (www.fonefinder.com) produces a completely standalone GPS receiver for cellular phones that uses synthesized voice to transmit location and therefore does not conform to the IS-801 standard.

TIA TR-45.2 Wireless Network Standards



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- Note:
1. IS- Interim Standard, TSB- Telecommunications Systems Bulletin, PN- Project Number, SP- ANSI Standards Proposal.
 2. Bold Type indicates a modification since the previous publication of this information.
 3. Published TIA standards can be obtained from TIA at www.tiaonline.org/standards/search_n_order.cfm.

Superseded Interim Standards

Standard	Description	Status
IS-41-C	Cellular Radio Telecommunications Intersystem Operations	Published 02/96
IS-52-A	Uniform Dialing Procedures for use in Cellular Radiotelephone Systems	Published 03/95
IS-53-A	Cellular Features Description	Published 04/95
IS-725	IS-41 support for Over-the-air Service Provisioning (OTASP)	Published 09/97
IS-756	Wireless Number Portability (WNP), Phase I (database query)	Published 04/98
TSB-29-A	International Implementation of Cellular Systems Compliant with TIA-553	Rescinded
TSB-29-B	International Implementation of Wireless Systems	Rescinded
TSB-29-B.1	TSB-29-B addendum including IFAST#6 updates (11/97)	Rescinded
TSB-29-B.2	TSB-29-B addendum, including IFAST #7 updates (02/98)	Rescinded
TSB-41	Technical Notes for IS-41 Revision B	Published 11/94
TSB-51	Inter-System Authentication, Signaling Message Encryption and Voice Privacy	Published 05/93
TSB-55	IS-41 Rev. A/B Forward Compatibility ("Tech Notes")	Published 05/94
TSB-64	Wideband Spread Spectrum Intersystem Operations	Published 02/94

ANSI Standards and Annexes

ANSI Std.	Description	Status
TIA/EIA-41-D	Intersystem Operations	Published 12/97
TIA/EIA-93-A	Ai and Di Interfaces Standard (including 9-1-1 Phase I cell/sector location)	Published 11/98
TIA/EIA-124-B	Cellular Inter-System Non-Signaling Data Communications	Published 07/99
TIA/EIA-124-C	Support for WIN and CIBERNET NSDP-B-and-S protocol	In press
TIA/EIA-660	Cellular Dialing Plan (formerly IS-52)	Published 07/96
TIA/EIA-664	Cellular Feature Descriptions (formerly IS-53)	Published 06/96
TIA/EIA-664-A	Cellular features Stage I description (formerly PN-3362)	In press

Published TIA/EIA Interim Standards

Standard	Description	Status
J-STD-025	CALEA surveillance support (joint with ATIS T1) - interim standard	Published 12/97
J-STD-025-A	CALEA surveillance support (joint with ATIS T1) including FCC Report and Order requirements	In press
J-STD-034	Enhanced Wireless 9-1-1, Phase I: identify mobile and cell/sector location	Published 12/97
J-STD-036	Enhanced 9-1-1 (E911), Phase II (125 m. location accuracy)	In press
TIA/EIA-664-536	Analog Group III Fax for CDMA Wireless Local Loop Systems (Stage I description)	In press
IS-725-A	IS-725 enhanced to include Over-the-air Parameter Administration (OTAPA)	Published 07/99
IS-728	Inter-System Link Protocol (ISLP). Supports data calls after inter-MSC handoff.	Published 04/98
IS-730	TIA/EIA-41 Support for IS-136 DCCH (TDMA digital control channel)	Published 10/97
IS-735	TIA/EIA-41 Support for IS-95-A (advanced CDMA)	Published 02/98
IS-737	TIA/EIA-41 support for circuit switched data services for CDMA and TDMA terminals	Published 05/98
IS-751	TIA/EIA-41 support for International Mobile Station Identity (E.212 IMSI)	Published 02/98
IS-756-A	Wireless Number Portability (WNP), Phase II (MDN/MIN separation to allow porting to or from wireless phone numbers)	Published 12/98
IS-764	Calling Name Presentation/Restriction (Stage II, III)	Published 06/98
IS-771	Wireless Intelligent Network (WIN)	Published 07/99
IS-778	Authentication enhancements	Published 03/99
IS-807	Internationalization of TIA/EIA-41	Published 08/99
IS-807-1	Updates global title translation types in IS-807	Published 06/00
IS-812	TIA/EIA-41 message segmentation (to overcome SS7 network packet size limitations)	Published 08/99
IS-824	Broadcast/Multicast Short Message Service (BTTC)	Published
IS-826	WIN Phase II: Prepaid calling	In press
IS-837	Answer Holding (AH)	In press
IS-838	User Selective Call Forwarding (USCF)	In press
IS-841	MDN Based Message Centers (formerly WNP Phase III)	In press

Current Telecommunications Systems Bulletins

TSB	Description	Status
TSB-29-C	International Implementations of Wireless Systems	Published 09/99
TSB-29-C-1	Addendum to international Implementations of Wireless Systems	Published 12/99
TSB-56-A	Application Level Testing for IS-41 Rev. B, IS-53 Rev. 0 and TSB-51	Published 06/94
TSB-76	PCS Multi-Band Support	Published 09/96
TSB-114	Broadcast of emergency alert messages to wireless phones (EAS)	Published 12/99

Balloting TR-45.2 Projects

Standard	Project	Description	Status
J-STD-025-A	SP-4464	ANSI version of J-STD-025-A	Ballot 08/00
J-STD-025	PN-4846	ANSI version of J-STD-025	Ballot 07/00
IS-786	PN-4410	Automatic Code Gapping (ACG) Overload Control	Ballot 07/00

IS-808	PN-4582	User Identification Module (R-UIM) for use in 3G systems	Ballot 04/00
IS-848	PN-4289	WIN Phase II: Premium Rate Charging, Wireless Freephone	Ballot 03/00

Developing TR-45.2 Projects

Standard	Project	Description	Status
TIA/EIA-41-E	PN-3590	Intersystem Operations	Development
TIA/EIA-93-B	PN-4206	Ai and Di Interfaces Standard (including JIP and 9-1-1 Phase II location)	Development
TIA/EIA-124-D	PN-4853	Further enhancements to call detail and billing records	Development
IS-843	PN-4818	WIN Phase III: location based services	Development
IS-847	PN-4785	VLR Roamer Database Query	Development
TSB-29-C.2	PN-4761	Addendum to International Implementations of Wireless Systems	Project cancelled
TSB-29-D	PN-4609-RV	TSB-29 revision with IFAST-assigned IRM codes removed	Development
	PN-3362	See TIA/EIA-664-A (PN-4652)	(replaced by PN-4652)
	PN-4177	Enhanced Surveillance Services (non-CALEA "punch-list" items)	Project cancelled 04/00
	PN-4284	TIA/EIA-41 and TIA/EIA-124 modifications for expanded ESN (Electronic Serial Number)	On hold
	PN-4285	Calling Party Pays (CPP)	Project cancelled 05/00
	PN-4288	Enhanced Emergency Services (E9-1-1), Phase III: Optional features beyond FCC mandate	Development
	PN-4371	Personal Mobility	Project cancelled (see PN-4582)
	PN-4392/3	Enhanced Security (authentication and encryption) for TIA/EIA-41	Development
	PN-4610	Optimal routing to roamers.	Project cancelled 07/00
	PN-4615	Out-of-band feature control (i.e. GSM-compatible)	Project cancelled 07/00
	PN-4616	3G circuit switched data	Development
	PN-4720	Intersystem support for 3G packet data, Phase I	Development
	PN-4746	Location services authentication, privacy and security	Development
	PN-4747	Location service enhancements	Development
	PN-4755	Intersystem support for 3G packet data, including simultaneous voice and data	Development
	PN-4853	Further enhancements of call detail and billing records	Development
	PN-4863	Network based enhancements for international dialing, calling number id and callback	Development