Cellular Networking Perspectives

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Comments

We welcome comments on the format or contents of *Cellular Networking Perspectives*. We can be reached via email at:

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Next Issue: October 2nd, 2002

Response to 3G Americas Report on GSM Capacity

The response to a 3G Americas report prepared by Peter Rysavy claiming that GSM voice capacity can meet or exceed that of CDMA2000 has been muted. The most comprehensive response is in a Deutsche Bank report from July 22, 2002, entitled *Alice in GSM Fantasyland.*

The bank's analysis supports the obvious points that GSM is currently the world's most widely used wireless technology, and that its voice capacity can be improved.

Deutsche Bank heavily criticizes Rysavy for using unproven and optimistic estimates of how GSM voice capacity *might* be improved in the future, and for including some technologies, such as AMR (Adaptive Multi-Rate voice coder) and DFCA (Dynamic Frequency and Channel Allocation) that have been talked about for a long time, but not yet implemented. Even if these new technologies are implemented, it will take a long time to obtain the promised improvements, as many only work with new mobiles.

The bank also criticizes the report for using 'ultra-conservative' assumptions for calculating CDMA2000 capacity, and for ignoring emerging technologies such as 1XEV-DV.

Real-world experience in Korea and elsewhere has convinced Deutsche Bank analysts that CDMA can currently provide a 26 times the capacity of analog (AMPS), and it estimates that 47-times capacity gains are realistic in the near future. By contrast, it is skeptical of the 19-times capacity increase for GSM, which assumes the use of several unproven new technologies and ignores negative interactions between them.

Bank analysts have measured data speed on live networks, measuring top speeds of around 25 kbps on the Cingular GPRS network, although with many drop-offs due to congestion. In comparison, they have measured average speeds of 60 kbps on the Verizon CDMA network, with performance sometimes as high as 112 kbps.

IP Header Compression Specifications for Wireless

Effnet

IP (Internet Protocol) signaling is being increasingly touted as a single method to transfer signaling (instead of SS7), voice (instead of TDM or analog voice circuits) and user data. Due to the large volume of IP traffic this would generate, efficiency is a prime concern.

A header is the portion of an IP packet preceding the actual data. It contains source and destination addresses, checksum, ports, protocol, and other information that is key to the operation of the Internet.

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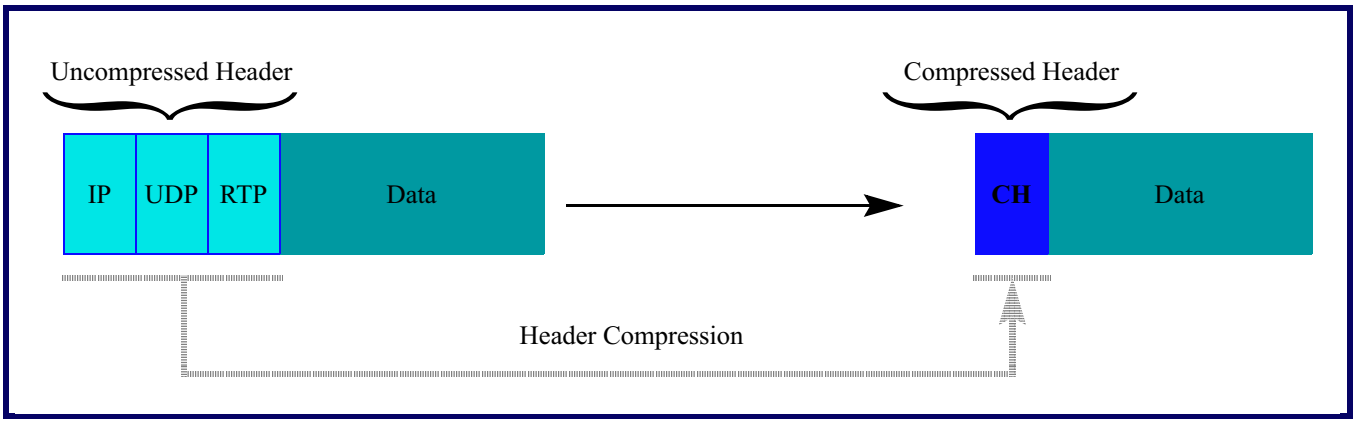
Figure 1: IP Header Compression



The need for high-link efficiency, good interactive response on links with low data-rate capabilities (e.g. radio links), and reduced packet loss rates over lossy links provides a motivation for header compression (HC). Real-time, delay-sensitive applications, such as voice over IP (VoIP), use small packets to minimize the end-to-end-delay. The header becomes a significantly large part of the total packet and begins to dominate the consumption of bandwidth.
IP header compression reduces the size of the packet headers by removing or shrinking redundant fields in the header — without touching the data. IP header compression reduces overhead, improves performance and interactivity, and makes VoIP and video conferencing in 3G networks possible.

Advantages

To wireless network equipment and processor developers, header compression means fewer lost packets, less waste of bandwidth, more users per cell, and an improved CDMA code spreading factor. End users will be able to employ new interactive multimedia (IM) applications, and will benefit from increased handset battery life. Header compression also improves:

- Error tolerance (small packets and small headers are less susceptible to bit errors).
- Scalability (enables small packets by reducing per-packet header overhead, thus reducing latency).
- Link efficiency (recovers the bandwidth that was consumed to transmit IP headers).

Principles

Many fields in a stream of IP packet headers are constant or seldom changing. While fields that change often and randomly need to be transmitted in every header, fields that do not change between packets only need to be transmitted once.

For some header compression specifications (RFC 1144, RFC 2507, and RFC 2508), fields that change often with small or predictable values are replaced with information representing the change (delta value), as shown in **Figure 1**.A newer method (RFC 3095) uses Window-Based Least Significant Bit (W-LSB) encoding when transferring the information representing the changes in the header fields.

The compressor and decompressor update their context when certain events occur. Channel impairment events and their resulting bit errors may lead to inconsistencies between the context of the compressor and decompressor leading to incorrect decompression. The different header compression specifications have various mechanisms for avoiding context inconsistencies, and they also have mechanisms for making the context consistent again after inconsistencies occur.

The general case of a bi-directional link, in which both sides require a compressor and decompressor pair in the network is shown in **Figure 2**.

IP Header Compression Types and Specifications

CTCP (Compressed TCP)

This method compresses headers of TCP/IP datagrams to improve performance.

Link type: Low speed (300 to 19,200 bps) serial links.

Benefits: The most commonly used header compression in IP-stacks today

Specification: RFC 1144

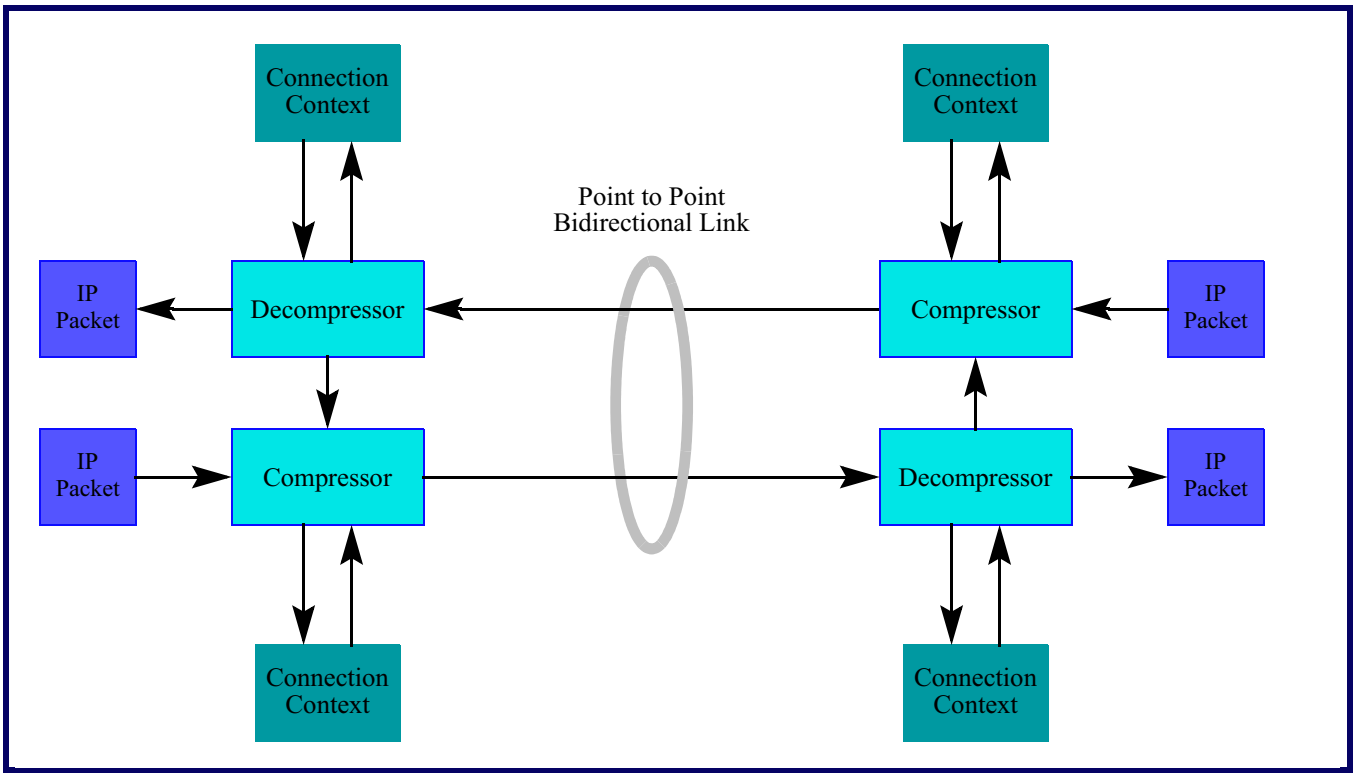
Recovery mechanism: When a packet is lost or damaged, CTCP simply relies on the TCP retransmission facility to recover it. There are no recovery mechanisms between the compressor and decompressor. Although the RFC 1144 header compression is the most widely used in current IP-stacks, the evolution towards “all-IP networks” has created new demands on header compression. Consequently, the newer specifications such as RFC 2507 and RFC 3095 have developed superior error recovery mechanisms.

Year developed: 1990

IPHC (IP Header Compression)

This method is a software implementation designed for 2.5G and 3G infrastructure and handset equipment manufacturers. IPHC compresses multiple IP headers, and TCP and UDP headers per hop over point-to-point links.

Figure 2: IP Header Compression Block Diagram



Link type: Low and medium speed links with appreciable packet-loss rates.

Benefits:

- Improves interactive response time for wireless operators.
- Uses small packets for bulk data with good efficiency for delay sensitive, low data rate applications.
- Decreases header overhead and reduces packet loss rate over lossy links for applications using IP.
- Improves performance and throughput efficiency.

IETF Specification RFC 2507

This method compresses multiple IP headers, and TCP and UDP headers per hop over point-to-point (PPP) links.

Recovery mechanism: TWICE and Header Request.

The TWICE algorithm relies on the decompressor computing a checksum to determine if its context information has been updated properly. The context data is adjusted by adding the current packet delta. The decompressor then recomputes the checksum, and packets are delivered as if nothing happened.

If this is not successful, the delta is applied a second time, hence the name TWICE.

The Header Request recovery mechanism is available to repair the context at the decompressor if TWICE fails. The decompressor requests the complete header from the compressor (bi-directional links). The decompressor sends a context state message to the compressor including all compressed packet streams needing a context update.

Year developed: 1999

CRTP (Compressed Real-Time Transport Protocol)

This method was developed for real-time applications such as interactive audio and video over local low and medium speed wired links. Used on a hop-by-hop (link-by-link) basis to compress IP/UDP/RTP headers from 40 bytes down to 2-4 bytes on average, CRTP performs best on local links with low round-trip times.

Link type: Audio and video over 14.4 to 28.8 kbps links.

Benefits:

- Reduces bandwidth.
- Improves voice quality by allowing bigger voice samples for a given bandwidth.
- Adapts easily to a variety of operating systems and hardware platforms.

IETF Specification: RFC 2508. It fits within the more general compression framework specified in RFC 2507, with RTP supported as a new “non-TCP” packet stream.

Recovery mechanism: Same as RFC 2507.

Year developed: 1999

Glossary

For any terms you are unfamiliar with, please consult:

www.cnp-wireless.com/glossary.html

IP Header Compression over PPP

RFC 2509 specifies how a compressor and decompressor negotiate certain parameters when the link is activated, by using lower layer protocols (PPP/IPCP). Two more important parameters are the

maximum number of flows that can be used at the same time (CIDs) and the maximum header size that can be compressed.

The RFC 2509 specification applies to RFC 2507 and RFC 2508.

Year developed: 1999

ROHC (Robust Header Compression)

This method is designed for 2.5G and 3G infrastructure and handset equipment manufacturers. ROHC is currently the cutting-edge header compression technology for cellular IP telephony.

Benefits:

- Supportive of multimedia applications using IP over cellular radio links.
- The header compression specification for the cellular links in 3G mobile networks.
- A required part of the specification for 3GPP UMTS (Universal Mobile Telecommunications System) Release 4.
- Part of the specification for the IMS (Interactive Multimedia Subsystem) in UMTS Release 5.

ROHC solves the major problem with CRTP: that it is not sufficiently robust in a mobile environment against packets being damaged or lost between compressor and decompressor. It achieves its compression gain by establishing state information at both ends of the link. ROHC then compresses and decompresses IP packet headers as they traverse the link, thus reducing the bandwidth required to transmit the headers by a factor of 40 to 60.

ROHC uses profiles to specify how various types of headers will be compressed. Profiles are currently defined for IP/UDP/RTP, IP/UDP, and IP/ESP (Encapsulating Security Payload) headers. The IETF ROHC working group is in the process of defining profiles for TCP, SIP and other header types.

Link type: Low bandwidth links with significant error rates and long round-trip times, such as radio links used for cellular telephony.

Benefits:

- Improves the efficiency of transmitting IP traffic over wireless telephone networks.
- Allows more users and a greater area of coverage per cell.
- Increases handset battery life.
- Makes multimedia performance for 3G wireless links up to 3 times faster.
- Results in fewer lost packets.
- Operates with 2G, 2.5G and 3G networks.

IETF Specification RFC 3095

Recovery mechanism: Header request is used in the two bi-directional modes. TWICE is not applicable for ROHC since delta values are not transferred between the compressor and decompressor. Instead, W-LSB encoding is used to transfer the compressed information, making ROHC significantly more robust.

Year developed: 2001

Mobile Network Standards

Header compression has been incorporated into several mobile network standards, primarily due to the significant reduction of the bandwidth and infrastructure needed to support VoIP, video conferencing, interactive gaming, streaming media and other mobile Internet applications.

GPRS (General Packet Radio Service)

IP Header Compression (IPHC) was incorporated into GSM Release 99.

GPRS paved the way for widespread usage of mobile data devices. It is designed for deployment on mobile networks that are based on the GSM digital mobile phone standard. Header compression addresses the limitations of GPRS, which include limited cell capacity for users and lower data speeds. This enables networks to offer "always-on", higher capacity Internet-based content and packet-based data services such as e-mail, remote LAN access, home monitoring and location-based services.

W-CDMA (Wideband Code-Division Multiple Access)

3GPP (the Third Generation Partnership Project) has incorporated Robust Header Compression (ROHC) into UMTS Releases 4 and 5.

W-CDMA is expected to offer much higher data speeds to mobile and portable wireless devices than currently available. It is intended to support mobile/portable voice, images, data, and video communications at up to 2 Mbps (local area access) or 384 Kbps (wide area access). The input signals are digitized and transmitted in coded, spread-spectrum mode over a broad range of frequencies. A 5 MHz-wide carrier is used, as compared to the 1.25MHz-wide carrier used for narrow-band CDMA (cdmaOne/CDMA2000).

CDMA2000 (Code Division Multiple Access)

CDMA2000, being standardized by 3GPP2, is a 3G mobile wireless technology supporting mobile data communications at speeds ranging from 144 Kbps to 2 Mbps. By minimizing the impact on cell-site equipment and handheld devices, header compression optimizes systems for high-speed packet data services.

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IETF Specifications

The Internet Engineering Task Force (IETF) is a self-organized collaboration formed in 1986 to foster the development and evolution of internet related networking technologies. IETF makes recommendations to the Internet Engineering Steering Group (IESG) regarding the specification of protocols and protocol usage in the Internet.

The following **chart** illustrates accepted IETF header compression specifications with compression ratio examples.

Table 1: IETF Header Compression Specifications with Compression Ratio Examples

IETF Specification	IP Version	Header Type	Full Header Size (Bytes)	Minimum Compressed Header Size (Bytes)	Header Compression Ratio
RFC 1144 (CTCP)	IPv4	TCP	40	3	13:1
RFC 2507 (IPHC)	IPv4	TCP	40	4	10:1
	IPv6		60		15:1
	IPv4	UDP	28		7:1
	IPv6		48		12:1
RFC 2508 (CRTP)	IPv4	UDP	28	2	14:1
	IPv6		48	4	12:1
	IPv4	UDP/RTP	40	2	20:1
	IPv6		60	4	15:1
RFC 3095 (ROHC)	IPv4	UDP	28	1	28:1
	IPv6		48	3	16:1
	IPv4	UDP/RTP	40	1	40:1
	IPv6		60	3 (1)	20:1 (60:1)

Summary

IP header compression reduces the size of packet headers by removing or shrinking redundant fields: The upstream compressor removes redundant information and the downstream decompressor restores it. Since the number of bytes per packet transmitted is smaller, fewer packets are lost, less bandwidth is needed, and the CDMA code spreading factor is improved. Better efficiency and better interactive response on links with low data-rate capabilities makes it more feasible for wireless systems to offer VoIP, video conferencing, interactive gaming and other real-time, delay-sensitive applications. Header compression also improves error tolerance, scalability and link efficiency.

Due to its significant impact on bandwidth, header compression has been incorporated into several mobile network standards: GPRS, W-CDMA, and CDMA2000. The IETF has accepted RFC 1144 (CTCP), RFC2507 (IPHC), RFC2508 (CRTP), and RFC 3095 (ROHC) as header compression specifications.

About Effnet

Effnet (www.effnet.com) develops and sells embedded software to manufacturers of network products that increases the efficiency, speed and security of IP traffic on fixed and mobile networks. Effnet techniques enable optimal performance for IP packet processing. The company was founded by leading researchers in the Header Compression field. It has operations in Stockholm, Sweden and Tucson, Arizona.

TIA TR-45.2/3GPP2 TSG-N 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 Standards

Standard	Description	Status
J-STD-025	CALEA surveillance support (joint with ATIS T1) - Interim Standard	Published 12/97 Rescinded 05/01
J-STD-025-1	Addendum to J-STD-025	Published 07/00 Rescinded 05/01
J-STD-025-2	Addendum to J-STD-025	Published 07/00 Rescinded 05/01
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
TSB29-A	International Implementation of Cellular Systems Compliant with TIA-553	Rescinded
TSB29-B	International Implementation of Wireless Systems	Rescinded
TSB29-B.1	TSB-29-B addendum including IFAST#6 updates (11/97)	Rescinded
TSB29-B.2	TSB-29-B addendum, including IFAST #7 updates (02/98)	Rescinded
TSB29-C	International Implementations of Wireless Systems	Published 09/99 Rescinded 12/00
TSB29-C-1	Addendum to international Implementations of Wireless Systems	Published 12/99 Rescinded 12/00
TSB41	Technical Notes for IS-41 Revision B	Published 11/94
TSB51	Inter-System Authentication, Signaling Message Encryption and Voice Privacy	Published 05/93
TSB55	IS-41 Rev. A/B Forward Compatibility ("Tech Notes")	Published 05/94
TSB64	Wideband Spread Spectrum Intersystem Operations	Published 02/94
TSB65	Border Cell Problems	Replaced by TIA/EIA-41-D

ANSI Standards and Annexes

ANSI Std.	Description	Status
J-STD-025	ANSI version of J-STD-025	Published 12/00
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-93-B	Ai and Di Interfaces Standard (including JIP and 9-1-1 Phase II location)	Published 07/01
TIA/EIA-124-B	Cellular Inter-System Non-Signaling Data Communications	Published 06/99
TIA/EIA-124-C	Support for WIN and CIBERNET NSDP-B-and-S protocol	Published 09/00
TIA/EIA-124-D	**Further enhancements to call detail and billing records**	**Published 12/01**
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	Published 12/00

Published TIA/EIA Interim and TIA Standards

Standard	Description	Status
J-STD-025-A	CALEA Surveillance Support (joint with ATIS T1) including FCC Report and Order Requirements	Published 05/00
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)	Published 08/00
J-STD-036-1	Corrected and enhanced emergency services support for SMS, inter-system handoff and SAMPS	Published 12/00
IS-725-A	IS-725 enhanced to include Over-the-air Parameter Administration (OTAPA)	Published 07/99
IS-771	WIN (Wireless Intelligent Network) Phase I: voice controlled services and call screening	Published 07/99
IS-771-1	WIN Phase I addendum	Published 08/01
IS-778	Authentication Enhancements	Published 03/99
IS-786	Automatic Code Gapping (ACG) Overload Control	Published 11/00
IS-807	Internationalization of TIA/EIA-41	Published 08/99
IS-807-1	Updates global title translation types in IS-807	Published 03/00
IS-808	User Identification Module (R-UIM) for use in 3G systems	Published 12/00
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 11/99
IS-826	WIN Phase II: Prepaid calling	Published 08/00
IS-837	Answer Hold (AH)	Published 07/00
IS-838	User Selective Call Forwarding (USCF)	Published 08/00
IS-841	MDN Based Message Centers	Published 09/00
IS-847	VLR Roamer Database Verification (RDV)	Published 03/01
IS-848	WIN Phase II: Enhanced Charging Services (Premium Rate Charging, Wireless Freephone)	Published 12/00
IS-875	Network Based Enhancements for International Dialing, Calling Number ID and Callback	Published 05/01
TIA-728	**Inter-System Link Protocol (ISLP). Supports data calls after inter-MSC handoff.**	**Published 04/98**
TIA-730	**TIA/EIA-41 Support for IS-136 DCCH (TDMA digital control channel)**	**Published 08/97**
TIA-735	**TIA/EIA-41 Support for CDMA (Network directed system selection (NDSS) and Temporary MS Identifiers (TMSI))**	**Published 02/98**
TIA-737	**TIA/EIA-41 Support for Circuit Switched Data Services for CDMA and TDMA Terminals**	**Published 04/98**
TIA-751	TIA/EIA-41 support for International Mobile Station Identity (E.212 IMSI)	Published 02/98
TIA-756-A	**Wireless Number Portability (WNP), Phase II (MDN/MIN separation to allow porting to or from wireless phone numbers)**	**Published 12/98**
TIA-764	**Calling Name Presentation/Restriction**	**Published 06/98**

Current Telcommunications Systems Bulletins

TSB	Description	Status
TSB29-D	TSB-29 revision with IFAST-assigned IRM codes removed	Published 12/00
TSB56-A	Application Level Testing for IS-41 Rev. B, IS-53 Rev. 0 and TSB-51	Published 06/94
TSB76	PCS Multi-Band Support	Published 09/96
TSB114	Broadcast of Emergency Alert Messages to Wireless Phones (EAS)	Published 12/99
TSB124	Support for WIN Prepaid (IS-826)	Published 10/00

Balloting TR-45.2 Projects

Standard	Project	Description	Status
J-STD-025-A	**SP-4464**	**ANSI version of J-STD-025-A**	**Ballot 11/02**
J-STD-036-A	**PN-3890-URV**	**Enhanced 9-1-1 (E911), Phase II (125 m. location accuracy)**	**Published 06/02**
TIA/EIA-41-D-AD1	**PN-3588-AD1**	**Addendum to TIA/EIA-41-D**	**In press**
TIA/EIA-41-E	PN-3590-RV5	Intersystem Operations, including TSB76, IS-730, 735, 737, 751, 756-A, 764, 771, 778, 807, 812, J-STD-034, N.S0015	Ballot
IS-847-A	**PN-4785-RV1**	**RDV, allowing MDN range verification and query of nodes other than VLR**	**In press**
IS-872	**PN-4934**	**IP Core Network Support for Legacy Mobiles (LMSD)**	**Ballot 09/02**
IS-880	**PN-4720**	**Intersystem Support for 3G Packet Data, Phase I**	**Published 07/02**
TIA-756-A-1	**PN-4186-AD1**	**Allow emergency numbers to be portable**	**Ballot 08/02**
TSB29-E	**PN-4609-RV5**	**TSB-29 revision with SID block assignments removed**	**Ballot 09/02**

Developing TR-45.2 Projects

Standard	Project	Description	Status
J-STD-025-B	PN-4465-RV1	Surveillance of Packet Data Communications (Wireline and Wireless)	Development
TIA/EIA-41-F	PN-3590-RV6	Intersystem Operations, including IS-786, 808, 824, 826, 837, 838, 841, 847, 848, 880, J-STD-036	Development
TIA/EIA-124-E	**PN-xxxx**	**Further enhancements to call detail and billing records, including support for location services and IP-based**	**Development**
TIA/EIA-660-A	PN-3544RV1	Cellular Dialing Plan	Development
IS-843	PN-4818	WIN Phase III: Location Based Services	Development
IS-847-A-1	**PN-4785-RV1**	**Erratum to correct error code handling tables**	**Development**
IS-868	PN-4925	SIM roaming from TIA/EIA-41 (CDMA) to GSM	Development
IS-873	PN-4935	IP Core Network Support for Multimedia Terminals (MMD)	Development
IS-881	PN-4747	Location Service Enhancements, Including Security	Development
IS-884	PN-0013	CDMA IP Requirements and Network Architecture	Development
TIA-906	PN-0045	Secure Mode Over-the-Air Service Provisioning (OTASP) and Parameter Administration (OTAPA)	Development
TIA-917	PN-0054	Wireless Priority Service	Development

PN-4288	Enhanced Emergency Services (E9-1-1), Phase III: Optional features beyond FCC mandate	On hold
PN-4393	Enhanced Security (authentication and encryption) for TIA/EIA-41	Development
PN-4755	**Intersystem support for 3G packet data, including simultaneous voice and data**	**Project cancelled**
PN-4926	**TIA/EIA-41/CDMA roaming to a GSM network [being reviewed by TR-46.3]**	**Completed**
PN-4927	**Interworking and interoperability (IIF) enhancements to support IS-868 [being reviewed by TR-46.3]**	**Completed**
PN-xxxx	**Circuit Call (e.g. voice) Precedence over CDMA Packet Data**	**Development**
PN-xxxx	**Multimedia Messaging Service (MMS)**	**Development**

TSG-N Specifications (N.Sxxxx)

Specification	Description	Status
N.S0003	User Identity Module (UIM)	Published 04/01
N.S0004	WIN Phase II	See IS-848
N.S0005	Intersystem Operations	See TIA/EIA-41-E
N.S0006	PCS Multi-band Operations	See TSB76
N.S0007	DCCH (Digital Control Channel for TDMA)	See IS-730
N.S0008	Circuit Mode Services	See IS-735
N.S0009	IMSI Support in TIA/EIA-41	See IS-751
N.S0010	Advanced CDMA Features	See IS-735
N.S0011	OTASP and OTAPA	See IS-725-A
N.S0012	Calling Name Presentation (CNAP) and Restriction (CNAR)	See IS-764
N.S0013	WIN Phase I	See IS-771
N.S0014	Authentication Enhancements	See IS-778
N.S0015	TIA/EIA-41-D Miscellaneous Enhancements	Development
N.S0016	TIA/EIA-41-D Internationalization	See IS-807
N.S0017	International Implementations of Systems Compliant with TIA/EIA-41	See TSB29-C
N.S0017-A	International Implementations of Systems Compliant with TIA/EIA-41	See TSB29-D
N.S0018	Prepaid Charging (WIN Phase II)	See IS-826
N.S0019	Intersystem Link Protocol (ISLP)	See IS-728
N.S0020	Segmentation and Reassembly	See IS-812
N.S0021	User Selective Call Forwarding	See IS-838
N.S0022	Answer Hold	See IS-837
N.S0023	Automatic Code Gapping (ACG)	See IS-786
N.S0024	MDN-based Message Centers (MC)	See IS-841
N.S0025	Roamer Database Verification	See IS-847
N.S0026	Near Real-Time Call Detail/Billing Record Transfer	See TIA/EIA-124
N.S0027	Enhanced International Dialing, Calling Number Identification, Callback and Calling Party Category Identification	See IS-875
N.S0028	CDMA IP Network Requirements and Architecture Model	See IS-884
N.S0029	Inter-System Operations for Roaming and Mobility	See TIA/EIA-41-F
N.S0030	Enhanced Security Services based on AKA	See PN-4393
N.S0032	Mobile Application Part, Revision F	See TIA/EIA-41-F
N.S0033	Addendum 2 for Enhanced Emergency Services Phase II	See J-STD-036-A
N.S0034	Emergency Services beyond US FCC Mandate	See PN-4288
N.S0035	Lawfully Authorized Electronic Surveillance	See J-STD-025-A

N.S0036	Semi-Realtime Call Detail and Billing Record Transport	See TIA/EIA-124-C
N.S0038	Secure Mode OTASP and OTAPA	See TIA-906

TSG-N Projects (N.Pxxxx)

Specification	Project	Description	Status
	N.P-0009	CDMA Packet Data Service, Phase I	See IS-880
	N.P-0010	CDMA Packet Data Service, Phase I	See PN-4755
	N.P-0011	WIN Location Based Services	See IS-843
	N.P-0013	Location Services	See IS-881
	N.P-0019-A	Enhancements to VLR roamer database verification	See IS-847-A
	N.P-0020	IP-based Data Tansfer Services	Project cancelled
	N.P-0021	WIN ACG Enhancements	See IS-786-A
	N.P-0022	WIN Prepaid Charging Enhancements	See IS-826-A
	N.P-0023	IP Core Network - Legacy MS Domain (LMSD)	See IS-872
	N.P-0024	IP Core Network - Multimedia Domain (MMD)	See IS-873
	N.P-0025	CDMA SIM roaming to GSM	See IS-868
	N.P-0026	IIF Enhancements for Two-way CDMA SIM Roaming to GSM	See PN-4926
	N.P-0027	IIF Enhancements for One-way CDMA SIM Roaming to GSM	See PN-4927
	N.P-0029	TIA/EIA-41-E Integration	See TIA/EIA-41-E
	N.P-0030	Enhanced Security Services using AKA	See PN-4393
	N.P-0032	TIA/EIA-41-F Integration	See TIA/EIA-41-F
	N.P-0033	Emergency Services Phase II	See J-STD-036-A
	N.P-0034	Emergency Services beyond US FCC mandate	See PN-4288
	N.P-0037	Uniform Dialing Plan	See TIA/EIA-660-A
	N.P-0038	Secure mode OTASP and OTAPA	See TIA-906
	N.P-0039	Accounting and Auditing System Requirements	See PN-xxxx
	N.P-0040	Wireless Priority Service (WPS)	See TIA-906