Cellular Networking Perspectives

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Glossary

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Question about SOC Codes

Reader Eduardo Henriques Resende in Planejamento de Rede (Network Planning) for Maxitel in Brazil asks:

> "I work for MAXITEL S.A., a cellular operator in Brazil, and we need some information about the parameter SOC (Service Operator Code). Could you help us?"

The SOC (System Operator Code) is defined for TDMA systems in IS-136 and in the most recent ANSI versions in the TIA/EIA-136 series. The codes are assigned by TIA Standards Subcommittee TR-45.3 to carriers. Unlike the SID, the SOC code identifies a carrier, and can make intelligent roaming databases more compact as fewer entries are required. As SOC codes are 12 bits in length, there are 4,096 to choose from, although it may only be the 2,048 international codes (800_{16}-FFF_{16}) that are useful, as there are some signaling problems with the national range of codes (see TIA/EIA-136-123 for details).

TIA/EIA-136 also allows for carrier specific signaling using SOC code, although it is not expected that this will be extensively implemented.

SOC codes can be obtained by application to:

Editor, ANSI TIA/EIA-136
Committee TR45
c/o TIA
2500 Wilson Blvd. Suite 300
Arlington, VA 22201, USA

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Question about SID Codes

Tim McCaffrey of Anritsu asks:

> "I would like to find a listing of all SIDs. For example: Sprint - 4188. This will speed fault screening handsets"

An AM or FM radio station broadcasts a unique call sign, while a cellular or PCS base station (AMPS, TDMA or CDMA) broadcasts a unique SID (System Identifier). SID codes are a global resource which is allocated in blocks to countries. Individual SID codes are assigned nationally. The ranges assigned to each country are listed in TIA TSB-29 and at www.ifast.org. The best resource for individual SID codes is probably the CIBER manual, published by Cibernet Corporation (phone: +1-202-785-0081), although it may not have information about carriers that do not participate in CIBER billing record exchange. In these

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cases, national authorities (such as the FCC in the United States) or individual carriers may have to be consulted.

Some SID codes are never broadcast by a base station, but are only used in network and billing messages for accounting purposes (e.g. to identify markets within a system identified by a single SID). These codes, known as BIDs (Billing IDs) are assigned upon request by Cibernet Corporation.

Air interface standards treat the SID as a 15 bit number (0..32,767). These SID codes are in relatively short supply due to the inefficient allocation scheme that was originally used. Since network and billing SID codes are transmitted and stored as 16 bits numbers, there is no shortage of these codes (i.e. there are 32,767 codes that can be used on the network, but not on the radio interface).

International Update: SS7 Global Title Routing

International roaming is definitely one of the weaknesses of cellular and PCS systems connected by the TIA/EIA-41 ("ANSI-41") standard for inter-system operations, and one of the strengths of GSM. This reflects the birthplaces of the two families of standards. GSM was created specifically to facilitate a seamless pan-European cellular system, while AMPS was designed for use solely within the United States. However, TIA/EIA-41 is growing into an international standard, with international roaming becoming a necessity, not a luxury. It is not that many years since roaming within the US was considered a luxury, yet it is now considered essential by many wireless consumers.

International Mobile Identifiers

One of the challenges with international roaming is to ensure that every mobile has a unique identity, and that this also identifies its home system. The MIN, the most prevalent phone identifier in TIA/EIA-41 systems is used for this purpose, but with significant difficulties. Systems outside the United States need to use International Roaming MINs (IRMs), of which 50% have been taken, 10% having been allocated by IFAST (www.ifast.org) within the past year. The 15 digit IMSI provides a much greater number of unique identifiers. Further, they can be allocated independently by each country, without need for international coordination, unless a country needs a new Mobile Country Code. IMSI is universal in GSM, and is now an option in TDMA (TIA/EIA-136) and CDMA (TIA/EIA-95) digital standards as well as the TIA/EIA-41 standard (through IS-751). It is not available in any analog (AMPS) standards. IMSI has not yet been widely implemented in systems other than GSM, although this is expected to change in 2000.

International Signaling

IMSI helps systems identify international roamers, and their home systems, but it cannot solve the problem of communicating with the home system over the SS7 signaling network (although it is part of the solution). Currently, most international roaming solutions simply extend the ANSI SS7 signaling network into countries outside North America instead of using native SS7 protocols. This is frowned upon by North American SS7 standards organizations (e.g. T1S1) and resource assignment authorities because it could lead to wireless systems in other countries exhausting a North American resource. It is also undesirable for other countries, because it means that they have to implement two parallel SS7 networks, and their access to the ANSI network could be terminated at short notice.

The lowest level SS7 address is the point code, but it definitely *cannot* be used for international roaming. Not only is the address space re-used in each country with a distinct SS7 network, but the sizes of point codes varies from 14 bits in many countries, 16 bits in a few (e.g. Japan) and 24 bits in others (e.g. China, USA and Canada). An indirect form of addressing known as global title must be used instead.

Global Titles

A global title allows routing based on a numeric string, such as a calling card number, phone number (ITU-T Recommendation E.164) or IMSI (ITU-T E.212). The original node places a global title in the Call*ed* Party Address field (CdPA) of the SS7 SCCP layer, and each STP resolves the address into either the point code address of the next STP, or the actual destination address. A global title may also be included in the Call*ing* Party Address field (CgPA) for routing of replies. Global titles can be used for international routing as long as:

- A compatible global title exists in both SS7 networks, and
- International gateways support the global title.

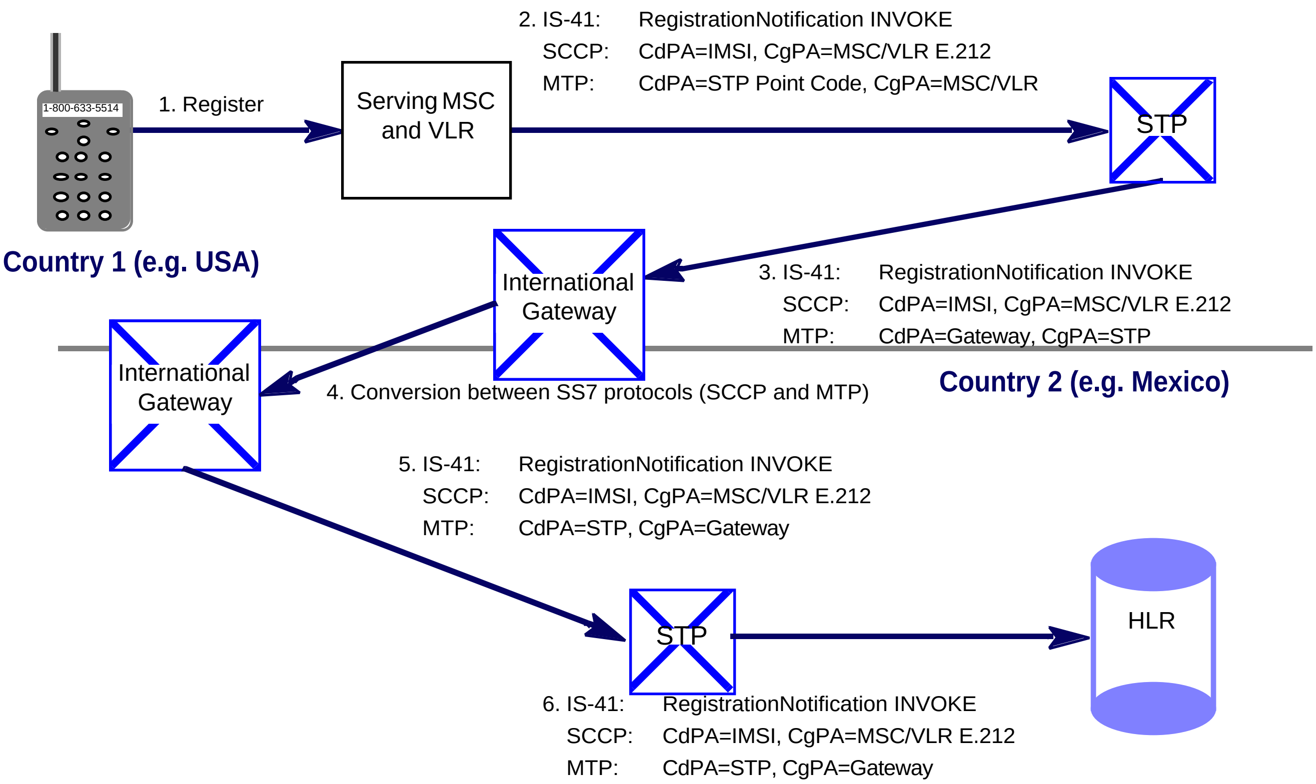
IS-807, a recently published TIA standard, has provided guidelines for international global title routing in TIA/EIA-41 networks, although a recent change of direction has required the publication of an addendum to the original recommendations. IS-807 is not a complete solution, however, as it does not identify a full set of global titles for use outside the ANSI SS7 network. Figure 1 illustrates the international routing of a TIA/EIA-41 operation assuming that all the pieces are in place.

Choice of Global Titles

Not all TIA/EIA-41 signaling messages can use the same type of global title and, in some cases there are a variety of choices for the global title for an individual signaling message. Identifying a single choice simplifies network design by limiting the scope of modifications to network elements that may have to originate, route or respond to TIA/EIA-41 messages.

In the case of a mobile registration, the choice is relatively simple, because the only identifier available is the one that the mobile transmitted over the radio interface. If the mobile transmitted a MIN, which is not an internationally recognized address format, there is no standardized global title that can be used. In the case of IMSI, GSM systems map these numbers onto pseudo-E.164 num-

Figure 1: International TIA/EIA-41 Message Routing



Note: The message is returned by setting the SCCP CdPA to the received CgPA (MSC/VLR E.212 global title) and the CgPA to the E.212 address of the HLR.

bers to avoid implementing E.212 global title routing. This is a kludge (formalized as E.214) that works in Europe where there is a 1:1 correspondence between E.212 Mobile Country Codes and E.164 Country Codes, but not in North America which has one E.164 country code and over 20 Mobile Country Codes. Consequently, the most robust solution (as recommended by IS-807) is to use the IMSI as an E.212 global title to route RegistrationNotification INVOKE messages.

Routing responses (such as RegistrationNotification RETURN RESULT messages) is more complicated since they must go back to the Serving MSC, which is not normally identified by either an E.212 number an E.164 number. The choice of global title is therefore somewhat arbitrary. After lengthy debates over the merits of E.164 (phone numbers), E.212 (IMSI) and SANC (an international extension for a point code), the E.212 address format was chosen for network element identification in IS-807. Network element can fill the SCCP Calling Party Address (CgPA) with an E.212 global title that identifies itself, allowing the recipient to move this global title to the Called Party Address (CdPA) to route the response.

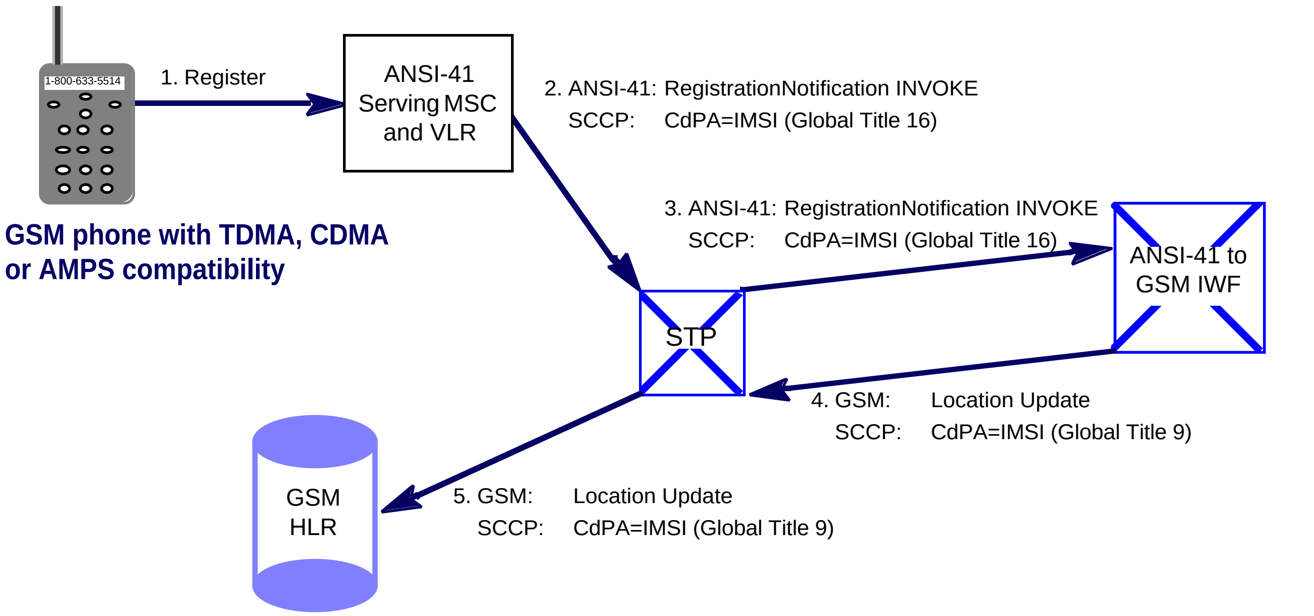
Although IS-807 recommends E.212 global titles for most situations, E.164 global title routing is required when the network element initiating an operation has only a phone number, and not a MIN or IMSI. Examples of this are the routing of a LocationRequest INVOKE from an Originating or Gateway MSC to an HLR and the routing of an SMSRequest INVOKE from a Message Center to an HLR. In both cases, the mobile directory number (e.g. derived from dialed digits) is likely the only information that is available for routing.

The Mixed MAP Mess

IS-807 initially recommended that E.212-based routing use ANSI SS7 translation type 9, the same as is used by North American GSM networks. However, the use of the same translation type for two different MAPs (Mobile Application Parts) makes inter-MAP conversion very difficult. If a message is initiated from a TIA/EIA-41 MSC toward a GSM HLR it must be routed by the SS7 network (via STPs) toward an interworking function for protocol conversion. However, if the interworking function initiated the resulting GSM MAP message using the same translation type and same address (e.g. the IMSI of a mobile) the message would be routed right back to itself. Consequently, it is necessary for every global title to be replicated for each MAP (of which there are, at present, luckily only two). The addendum to IS-807 (currently in press) recommends that E.212 routing for TIA/EIA-41 messages use the new translation type 16.

Figure 2 illustrates how inter-MAP routing would utilize the two different translation types.

Figure 2: Multiple MAP Madness (Cross-Protocol Routing)



ITU C7: A Better Way?

There is currently a proliferation of global title translation types occurring in ANSI SS7. Reasons for duplicating global titles include local number portability (one translation types for global titles that may require a number portability database query, and one that guarantees that the dip will not occur), the multiple MAP problem described above and the need to route to different network elements using the same address (e.g. either the HLR or the MC). This could become a management nightmare because each STP will have to maintain a table for every translation type.

An example of global title duplication that occurs because of number portability occurs with North American GSM systems which use E.164 global titles to identify network elements. Since network element addresses are not assigned to telephones, there is no reason for them to be portable. Using translation type 14 would sometimes result in number portability database queries, which would reduce the efficiency of signaling. Consequently, translation type 10 (also E.164) must be used to ensure that extraneous queries do not occur. Translation type 14 does need to be used when the global title is a Mobile Directory Number (known as MSISDN in GSM) or signaling for ported numbers would be directed to the wrong place in the network.

ITU C7 does not rely on translation types, but uses the Subsystem Number (SSN) instead. This may occasionally require the definition of new subsystem numbers (e.g. different subsystem numbers to distinguish TIA/EIA-41 and GSM HLRs), but the management load for STP's should be less. This is because intermediate routing entries for all global titles based on the same numbering plan (e.g. E.164 or E.212) could be included with a zero SSN, or other mechanism to identify that the routing entry applies to all SSN's. Furthermore, once an SSN is defined, it can be used with multiple numbering plans (e.g. both E.164 and E.212).

Internet: An Even Better Way?

Global titles perform a similar function as internet domain names (e.g. cnp-wireless.com). Both types of address are indirect, and must be translated into lower layer addresses (Point Code/Subsystem Number for SS7 and IP addresses for the internet). However, the method of translation is very different. Internet systems use a two phase process. First the domain name is resolved into an IP address by a domain name server, and then the originating node initiates a message using this address. IP routers need only understand numeric IP addresses. The IP addresses can also be cached to minimize domain name queries.

SS7, by comparison, integrates address resolution and routing. The originating node never knows the result of the translation, and therefore cannot cache it for future use (although with the national scope of point codes, caching would be ineffective for international routing anyway). Furthermore, every STP has to have translation tables for every type of global title that might come its way.

Conclusions

Global title routing, building on implementation of IMSI, is a necessary step toward truly seamless international roaming. Carriers that are serious about winning over international travellers should take heed. Global titles have problems, but they are not insurmountable. Until the internet has significantly matured, and provides support for international address, global titles will remain the only game in town for international routing of wireless signaling traffic.

TIA TR-45.3 TDMA Digital Air Interface Standards

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First Generation - IS-54

TIA Standard	ANSI	Description	Status
IS-54-B	TIA/EIA-627	Original TDMA Dual-Mode Air Interface Standard. Including one addendum (TIA/EIA-627-1)	**Being rescinded**
IS-55	TIA/EIA-628	TDMA mobile station minimum performance standards	**Being rescinded**
IS-56	TIA/EIA-629	TDMA base station minimum performance standards	**Being rescinded**
IS-85	TIA/EIA-635	TDMA full-rate voice coder (3:1)	**Being rescinded**
TSB-46		Verification of Authentication for IS-54-B Mobiles (replaced by IS-137-A)	Published 03/93
TSB-47		IS-54 Implementation Issues (replaced by TIA/EIA-627)	Published 05/94
TSB-50		User Interface for Authentication Key Entry	Published 03/93

Second Generation - IS-136 Revision 0 (Digital Control Channel)

TIA Standard	Description	Status
IS-130-0	Data services radio link protocol	Published 04/95
IS-135-0	Asynchronous data and fax services	**Being rescinded**
IS-136.1 Rev. 0	Digital Control Channel (DCCH)	Published 12/94
IS-136.1-1	Addendum to IS-136.1 Rev. 0 (DCCH)	Published 12/94
IS-136.2 Rev. 0	FSK control channel, analog voice channel, TDMA traffic channel	Published 12/94
IS-136.2-1	Addendum to IS-136.2 Rev. 0 (Analog voice channel and FSK control channel)	Published 12/94
IS-137-0	TDMA/analog mobile minimum performance standards	Published 12/94
IS-138-0	TDMA/analog base station minimum performance standards	Published 12/94

Third Generation - IS-136 Revision A (ACELP Voice Coder)

TIA Standard	Description	Status
IS-130-A	Radio Link Protocol 1 (data services)	**Being rescinded**
IS-136.1-A	Enhanced digital control channel (9-1-1, OTA, Calling Name ID, One–button Callback, Private Networks (enhanced), PACA). Addendums published in 11/96 and 12/97.	Published 10/96
IS-136.2-A	FSK control channel, analog voice channel, TDMA traffic channel. Addendum 12/97.	Published 10/96
IS-137-A	Mobile minimum performance standards for IS-136-A. Addendum with revised transmission tests published 08/97.	**Being rescinded**
IS-138-A	Base station minimum performance standards for IS-136-A	**Being rescinded**
IS-641-A	Enhanced full-rate voice coder (ACELP)	Published 05/96
IS-684	Radio Link Protocol 2 (for STU-III)	**Being rescinded**
IS-686	Enhanced full rate voice coder (ACELP) performance standards	**Being rescinded**
IS-727	Discontinuous transmission (DTX) with ACELP (IS-641) voice coder, including generation of comfort noise	Published 07/98
TSB-73	IS-136 Rev. 0/Rev. A compatibility issues	Published 07/96
TSB-77	IS-641 implementation issues	Published 12/96
TSB-105	Audit order clarification	Published 03/99
TSB-108	Determining when R-DATA is encrypted	Published 03/99

Fourth Generation - TIA/EIA-136 Revision 0

TIA Standard	Description	Status
TIA/EIA-136-000	Introduction and list of document parts	Published 03/99
TIA/EIA-136-010	Optional mobile station facilities	
TIA/EIA-136-020	SOC, BSMC and carrier specific HLPI assignments	
TIA/EIA-136-100	Introduction to channels	
TIA/EIA-136-110	RF channel assignments	
TIA/EIA-136-12x	Digital control channel (DCCH) layer 1 (136-121), 2 (136-122) and 3 (136-123)	
TIA/EIA-136-13x	Digital traffic channel (DTC) layer 1 (136-131), 2 (136-132) and 3 (136-133)	
TIA/EIA-136-140	Analog control channel	
TIA/EIA-136-150	Analog voice channel	
TIA/EIA-136-210	ACELP voice coder minimum performance requirements	
TIA/EIA-136-220	VSELP voice coder minimum performance requirements	
TIA/EIA-136-2x0	Mobile station (136-270) and base station (136-280) minimum performance requirements	
TIA/EIA-136-420	VSELP voice coder	
TIA/EIA-136-510	Authentication and encryption of signaling information, user data and voice	
TIA/EIA-136-7xx	Short Message Service: Introduction to teleservices (136-700), text/numeric messaging (136-710), Over-the-Air Activation (OATS, 136-720) and Over-the-Air Programming to support intelligent roaming (OPTS, 136-730)	
TIA/EIA-136-910	Informative information	

Fifth Generation - TIA/EIA-136 Revision A

TIA Standard	Description	Status
TIA/EIA-136-000-A	Introduction, list of document parts, and revision marker	**In press.**
TIA/EIA-136-005-1	Introduction, identification and semipermanent memory	
TIA/EIA-136-010-A	Optional mobile station facilities	
TIA/EIA-136-020-A	SOC, BSMC and other code assignments	
TIA/EIA-136-100-A	Introduction to channels	
TIA/EIA-136-121-A	Digital control channel (DCCH) layers 1 (121-A), 2 (122-A) and 3 (123-A-1)	
TIA/EIA-136-131-A-1	Digital traffic channel (DTC) layer 1	
TIA/EIA-136-133-A-1	DTC layer 3	
TIA/EIA-136-140-A-1	Analog control channel	
TIA/EIA-136-150-A	Analog voice channel	
TIA/EIA-136-2x0-A-1	Mobile station (270-A-1) and base station (280-A-1) minimum performance requirements	
TIA/EIA-136-310-1	Radio link protocol 1 (for data services)	
TIA/EIA-136-350-1	Data services control	
TIA/EIA-136-410-1	ACELP voice coder	
TIA/EIA-136-430	US1 voice coder (GSM compatible)	
TIA/EIA-136-510-A	Authentication and encryption of signaling information, user data and voice	
TIA/EIA-136-511	List of messages subject to encryption	
TIA/EIA-136-620-1	Teleservice allowing segmentation and reassembly (TSAR)	
TIA/EIA-136-630	Broadcast short message teleservice transport (BATS)	
TIA/EIA-136-700-A	Introduction to teleservices	
TIA/EIA-136-710-A	Short message service (text/numeric messaging teleservice)	
TIA/EIA-136-720-A-1	Over-the-Air Activation teleservice (OATS)	
TIA/EIA-136-730-1	Over-the-Air Programming teleservice to support intelligent roaming (OPTS)	
TIA/EIA-136-750	General UDP transport service (GUTS)	
TIA/EIA-136-910-A	Informative information	
TSB-117	**Clarification of DTX Receive Handling in TIA/EIA-136**	**Ballot**

Sixth Generation - TIA/EIA-136 Revision B - UWC-136 - ITU-R 3G Specification

TIA Standard	Description	Status
TIA/EIA-136-000-B	Introduction, list of document parts, and revision marker	
TIA/EIA-136-005-A	Introduction, identification and semipermanent memory	
TIA/EIA-136-010-B	Optional mobile station facilities	
TIA/EIA-136-020-B	System Operator Code (SOC), Base Station Manufacturer Codes (BSMC), etc.	
TIA/EIA-136-100-B	Introduction to channels.	
TIA/EIA-136-110-A	RF channel assignments	
TIA/EIA-136-122-B	DCCH layer 2	
TIA/EIA-136-123-B	DCCH layer 3	
TIA/EIA-136-131-B	Digital traffic channel (DTC) layers 1 (-131-B), 2 (-132-A) and 3 (-133-B)	
TIA/EIA-136-140-B	Analog (FSK) control channel	
TIA/EIA-136-150-B	Analog voice channel	
TIA/EIA-136-210	ACELP voice coder minimum performance (formerly IS-686)	
TIA/EIA-136-220	VSELP voice coder minimum performance (formerly IS-85)	
TIA/EIA-136-230	Minimum performance requirements for US1 voice coder (GSM)	
TIA/EIA-136-270-B	Mobile station minimum performance requirements	
TIA/EIA-136-280-B	Base station minimum performance requirements	
TIA/EIA-136-290	RF minimum performance for 200 kHz and 1.6MHz bearers	
TIA/EIA-136-310-A	Radio Link Protocol - 1 (user data)	
TIA/EIA-136-320	Radio Link Protocol - 2 (STU-III encrypted voice). Formerly IS-684.	
TIA/EIA-136-330	Packet data service - overview	**Most of this document is in press. Sections 123-B, 133-B and 720-A are currently being reballoted.**
TIA/EIA-136-331	Packet data service - physical layer	
TIA/EIA-136-332	Packet data service - medium access control (MAC)	
TIA/EIA-136-333	Packet data service - logical link control. Based on GSM 04.64.	
TIA/EIA-136-334	Packet data service - subnetwork dependent convergence protocol. Based on GSM 04.65.	
TIA/EIA-136-335	Packet data service - radio resource management	
TIA/EIA-136-336	Packet data service - mobility management	
TIA/EIA-136-337	Packet data service - tunneling of signaling messages. Subset of GSM 09.18.	
TIA/EIA-136-34x	Outdoor high-speed packet data service - Overview (-340), Physical layer (-341) and Medium access layer (-342)	
TIA/EIA-136-350-A	Data service control	
TIA/EIA-136-36x	Indoor high-speed packet data service - Overview (-360), Physical layer (-361) and Medium access layer (-362)	
TIA/EIA-136-420-A	VSELP voice coder	
TIA/EIA-136-510-B	Authentication, and encryption of signaling information, user data and voice	
TIA/EIA-136-511-A	Messages subjection to encryption	
TIA/EIA-136-610	R-DATA/SMDPP Transport	
TIA/EIA-136-700-B	Teleservices: Introduction (-700-B), Over-the-Air activation teleservice (OATS, -720-B), Over-the-Air Programming Teleservice (OPTS, -730-A), Broadcast Short Messages (-740) and Charge-rate indication teleservice (CIT, -760)	
TIA/EIA-136-900	Introduction to Annexes and Appendixes	
TIA/EIA-136-905	Normative Information	
TIA/EIA-136-910-B	Informative Information	
TIA/EIA-136-932	Packet data services - Stage 2 descriptions	
TIA/EIA-136-933	Packet data services - Description of MAC layer	
TIA/EIA-136-940	Capacity and Performance Characteristics of UWC-136 (TIA/EIA-136-B)	
PN-4602	**How the use of ORYX data encryption may breach security by revealing part of SSD-B.**	
IS-823/PN-4614	**Modifications to ACELP voice coder to transport TTY/TDD tones**	**Ballot**
IS-840/PN-4721	**Minimum performance standards**	**Ballot**

Seventh Generation - TIA/EIA-136 Revision C

TIA Standard	Description	Status
TIA/EIA-136-000-C	**Introduction, list of document parts, and revision marker**	
TIA/EIA-136-010-C	**Optional mobile station facilities**	
TIA/EIA-136-020-C	**SOC, BSMC and other code assignments**	
TIA/EIA-136-100-C	**Introduction to channels**	
TIA/EIA-136-110-C	**RF Channel Assignments**	
TIA/EIA-136-122-C	**Digital control channel (DCCH) layer 2**	
TIA/EIA-136-123-C	**Digital control channel (DCCH) layer 3**	
TIA/EIA-136-131-C	**Digital traffic channel (DTC) layer 1**	**Development**
TIA/EIA-136-132-B	**DTC layer 2**	
TIA/EIA-136-133-C	**DTC layer 3**	
TIA/EIA-136-140-C	**Analog control channel**	
TIA/EIA-136-150-C	**Analog voice channel**	
TIA/EIA-136-210-A	**ACELP voice coder minimum performance requirements**	
TIA/EIA-136-290-B	**RF minimum performance for 200 kHz (GSM) and 1.6 MHz (wideband) bearer channels.**	
TIA/EIA-136-940-B	**Capacity and performance characteristics of UWC-136**	

Note:
1. IS- TIA Interim Standard, TSB- TIA Telecommunications Systems Bulletin, PN- TIA Project Number, SP- ANSI Standards Proposal. Parts ending in “-A” or “-B” have been revised, and those ending in “-1” have had to be reballoted once.
2. Bold Type indicates a modification since the previous publication of this information.
3. Published TIA standards can be purchased from www.tiaonline.org.

Thanks to Peter Nurse (Chairman of TR-45.3) and Al Sacuta (Next Generation) for their assistance compiling the information in this table.