Cellular
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Perspectives

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Glossary

For any terms you are unfamiliar with, please consult:

www.cnp-wireless.com/glossary.html

Next Issue: June 2nd, 2003

The Goods on Mobile IP

Mobile IP is a protocol defined by a set of IETF specifications that aims to provide true mobility for Internet terminals. The core specification for Mobile IP was first published as RFC[1] 2002 in October, 1996, replaced by RFC 3220 in January, 2002 and published again as RFC 3344 in August, 2002.

Mobility is the capability of a device to initiate services in many different systems, to maintain sessions while travelling between systems, and to have others initiate services to the device without being aware of its current location.

Mobility requires communications between carriers to provide a number of capabilities, including:

- Origination of services from any system.
- Location tracking of the device (determining the current serving system).
- Provision of a permanent external address for the device.
- Redirection of services terminating at this address.
- Authentication of the device and subscriber.
- Validation of the services to which the device and subscriber are entitled.
- Handoff of active services between systems.
- Exchange of billing information between the visited and home systems.

Mobile IP provides a solution only for addressing and routing. Although it solves this partial problem, it also suffers from a number of efficiency, security and compatibility problems. These have seriously delayed widespread commercial implementations.

Nomadicity

The ability to originate services in many different systems can simulate mobility, but the lack of true terminating services and handoff becomes more frustrating as systems and their users become more sophisticated.

The Internet has grown up with nomadicity, because of the lack of true mobility. Dial-up modems allowed early Internet 'road warriors' to access the Internet from virtually anywhere on the globe through a local access number, without exorbitant long distance charges. Once connected and assigned a local IP address, they could simultaneously check email, surf the web, download files and chat with friends and colleagues. All this, without anyone else being aware of their actual location.

This is not true mobility because all services have to be initiated by the nomad, and there is no provision for handoff.

This was not a problem with dial-up access, because true mobility was physically impossible. Wireless communications makes mobility possible (but not easy). It is theoretically possible for someone to wander into a WiFi or Cellular data coverage area and immediately be sent a high priority email. It will soon be technically possible for emails to continue being downloaded to the device while it is carried outside and seamlessly handed off to a GPRS or CDMA2000 system.

However, this type of mobility is not possible today without Mobile IP because the IP address that the device is assigned is local, and other elements in the Internet have no way of determining what it is and routing traffic to it.

1. A 'Request for Comments', a specification which is effectively an IETF standard.

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The Mobile IP Concept

The Mobile IP concept is very simple. A device is assigned a single Home Address (a static IP address), which most Internet applications will use to communicate with it. While roaming, the mobile will share a foreign 'Care-of' address, which can be used to send it traffic. This is illustrated in Figure 1.

Network Elements. Mobile IP requires two different network elements, the Home Agent (HA) and the Foreign Agent (FA). The Home Agent is controlled by the home carrier, and acts as a proxy for the Home Address (static IP address) of the Mobile Node (MN). The Foreign Agent represents the current serving system. It makes the Home Agent aware of the current location of the MN, and helps handle packets being sent to and from the MN.

Uncovering a Foreign Agent. Mobile Nodes wait until they receive an 'advertisement' from a Foreign Agent. This tells them they are in a new system, and it also identifies the care-of address that they can use, and the optional capabilities that the Foreign Agent supports. MNs can then initiate a Registration Request message to their Home Agent via the Foreign Agent.

Without a Foreign Agent. Mobile IP can still operate without a Foreign Agent. In this case, an MN obtains an address by DHCP or PPP (RFC 1661). To avoid assigning a unique PPP address, RFC 2290 (Mobile-IPv4 Configuration Option for PPP IPCP) can be used, allowing the MN's Home Address to be used instead. This avoids the need to assign a second IP address (an increasingly scarce resource) for every roaming MN.

Forward Tunneling. Packets directed at the MN are sent to its Home Address, which means that they end up at the Home Agent. The Home Agent then prefixes the packet with another IP layer, this one including the Care-of address. This can then be routed through the Internet to the Foreign Agent or directly to the mobile (if a Co-Located Care-of Address). If directed to a Foreign Agent, it will then strip off the outer IP header and direct the packet to the MN.

This process of adding an additional IP header to allow a message to be routed to its current location (rather than to its home location) is known as 'tunneling'. In its simplest form, two full IP headers are included (RFC 2003). More efficiently, the inner header can be compressed by RFC 2004 Minimal Encapsulation or by RFC 1701 Generic Routing Encapsulation.

Routing all forward messages through the Home Agent is inefficient but necessary to avoid changes to all Internet applications and to fundamental Internet routing methodologies. This can be avoided if the Correspondent Node (a device that the MN is communicating with) is Mobile IP aware, in which case it can tunnel traffic to the FA without going through the HA.

Direct Routing. Packets from the MN can sometimes be sent directly to the destination, without the need for tunneling. This is increasingly less likely, as firewalls will usually reject packets coming from a network with a foreign address. In the case of Mobile IP, a packet from the MN will have the 'From' address set to the mobile's static address, which belongs to the Home system, not the current serving system.

Reverse Tunneling. When direct routing is not possible, reverse tunneling must be used. This is very similar to forward tunneling, but the 'From' address of the tunnel will be the Foreign Agent's Care-of address, and the 'To' address will be the Home Agent's address (which must be supplied by the MN upon registration).

Security. Exchanges of information between the Home Agent and the Foreign Agent must be secured. This includes a 'nonce', a random number that each side must echo back (to prove that they were the recipient of the previous message) and a 128-bit HMAC-MD5 'digest' of most fields of the message.

An extension to Mobile IP (RFC 3012, being replaced by a draft) offers Challenge/ Response authentication of a MN. The agent advertisements will contain a random number that the MN can send to the HA as an extension to the Registration Request message, along with a response computed using a key that both the valid MN and HA are aware of.

Handoff. Mobile IP supports a primitive form of handoff. The MN will register its association with a new Foreign Agent with the Home Agent, and packets will then be redirected. However, there is a considerable window period (up to 100 milliseconds) where packets are being sent to the old Foreign Agent and discarded. The old FA has no ability to forward packets to the new. Handover relies on retransmission by Internet applications (which are aware that the underlying transport protocol is unreliable).

A subset of this problem has been described by a draft entitled "Localized Mobility Management Requirements". This describes the characteristics of a solution that would improve the performance of handover within a local network having multiple Foreign Agents, but it does not recommend a specific solution.

IPv6 Support. Mobile IP is currently designed to work on IPv4, but several drafts exist to provide IPv6 support. Currently, most of the Internet, and most private IP networks, use IPv4.

The Protocol

Mobile IP consists of only one type of transaction composed of two messages: Registration Request and Registration Reply. The Registration Request is sent by a mobile, via a Foreign Agent (if one is being used), to the Home Agent. It includes the Home Address (the static IP address of the MN, used as identification), the Home Agent Address (the IP address of the Home Agent used for reverse tunneling) and the Care-of address being used. It indicates whether minimal encapsulation or GRE should be used by the Home Agent, whether the Care-of address belongs to a Foreign Agent or is uniquely assigned to the Mobile, and whether reverse tunneling will be used.

The Registration Reply simply indicates whether the registration was accepted.

A special type of registration is Deregistration. This is sent by an MN when it returns to its home system. Unfortunately, this is not sent to the Foreign Agent, so it does not allow those resources to be released after the mobile moves. Also, a mobile moving between two foreign systems will be unable to de-register.

This problem is resolved by an Internet Draft entitled "Registration Revocation in Mobile IPv4". This new Registration Revocation transaction allows the foreign system to release resources, and provides more accurate accounting for the length of sessions. The transaction is initiated by a Registration Revocation message (probably from the Home Agent, when it receives a Registration Request from a new system), and is acknowledged by a Registration Revocation Acknowledgement message.

Advertising Extensions. Mobile Agent advertisements are an extension to the Mobile IP protocol. They are broadcast messages (addressed to all devices on a shared resource, such as a radio interface or ethernet) to indicate whether the source is acting as an FA or HA (or both). If it is acting as a Foreign Agent, they also indicate whether it is too busy to serve more MNs, and whether it supports

Minimal Encapsulation (RFC 2004), GRE (RFC 1701), reverse tunneling and Registration Revocation.

AAA Addressing Extension. The Mobile Node NAI extension (RFC 2794) to the Registration Request message identifies the MN's Network Access Identifier (RFC 2486), which is a name – often an email address – used to identify a client to a AAA (Authentication, Authorization and Accounting entity). This can be used as an alternative in the Registration Request instead of the Home Address, and allows the Home Agent to determine the AAA used for tracking usage of resources during the session.

To be Continued…

This article will be continued in future issues. Aspects of mobility not solved by Mobile IP, including billing, will be discussed, and the protocol will be compared with cellular MAP. A list of challenges will be provided, and alternatives will be considered.

Figure 1: Mobile IP Signaling and Data Flow

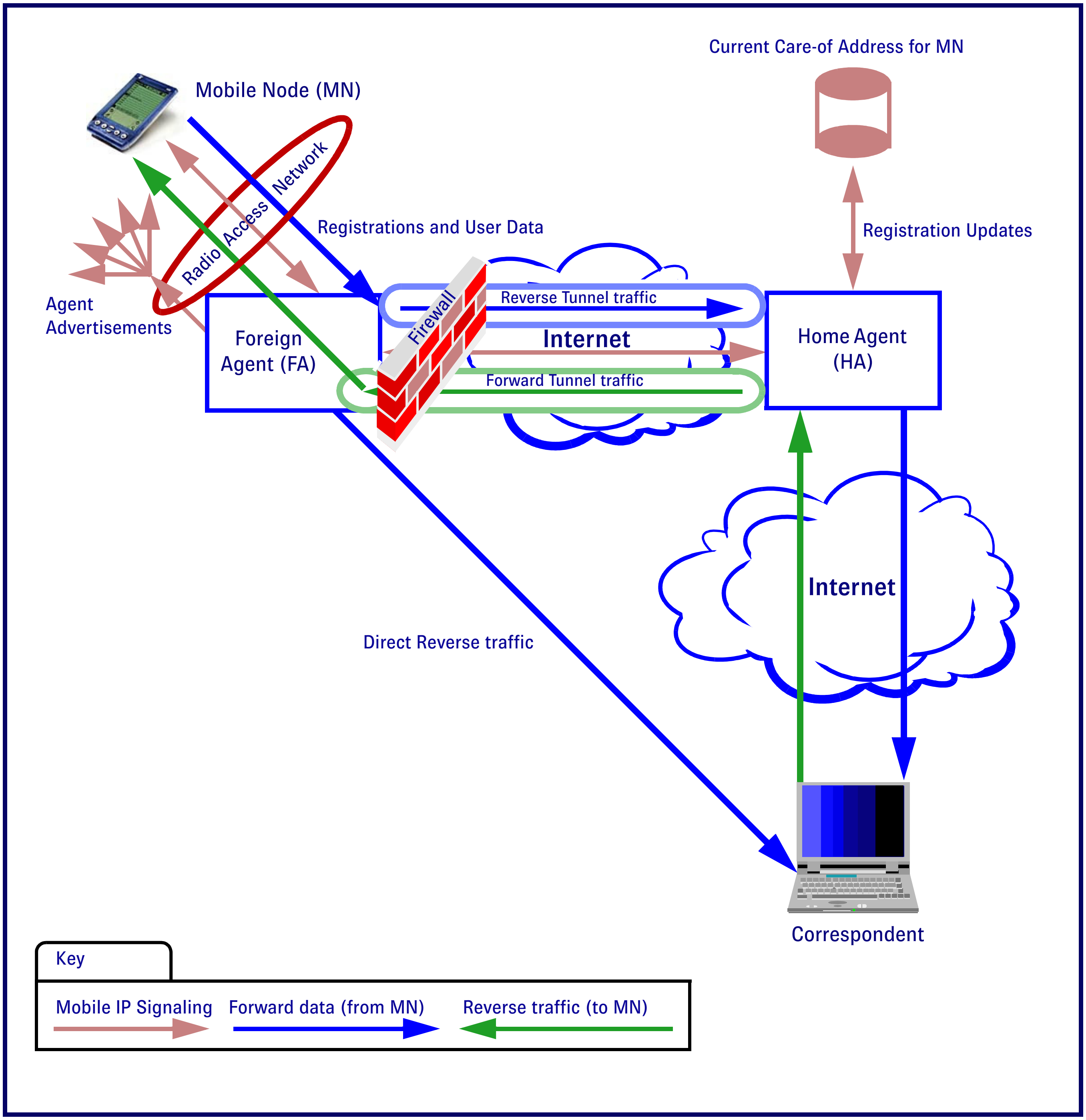

Table 1: Mobile IP RFCs (Request for Comments) and Drafts

Document	Title (obsolete documents in italics)	Status
RFC 1701	Generic Routing Encapsulation (GRE)	Published October, 1994
RFC 2002	*IP Mobility Support*	Replaced by RFC 3220
RFC 2003	IP Encapsulation within IP (Tunneling)	Published October, 1996
RFC 2004	Minimal Encapsulation within IP	Published October, 1996
RFC 2005	Applicability Statement for IP Mobility Support	Published October, 1996
RFC 2006	The Definitions of Managed Objects for IP Mobility Support using SMIv2	Published October, 1996
RFC 2290	Mobile-IPv4 Configuration Option for PPP IPCP	Published February, 1998. Updated by RFC 2794.
RFC 2344	*Reverse Tunneling for Mobile IP*	Replaced by RFC 3024
RFC 2486	The Network Access Identifier (NAI)	Published January, 1999
RFC 2794	Mobile IP Network Access Identifier (NAI) Extension for IPv4	Published March, 2000
RFC 2977	Mobile IP Authentication, Authorization, and Accounting (AAA) Requirements	Published October, 2000
RFC 3012	*Mobile IPv4 Challenge/Response Extensions*	Being replaced by a new draft.
RFC 3024	Reverse Tunneling for Mobile IP	Published January, 2001
RFC 3025	Mobile IP Vendor/Organization-Specific Extensions	Published February, 2001
RFC 3115	Mobile IP Vendor/Organization-Specific Extensions	Published April, 2001
RFC 3220	*IP Mobility Support for IPv4*	Replaced by RFC 3344
RFC 3344	IP Mobility Support for IPv4	Published August, 2002
Internet Drafts	AAA NAI for Mobile IPv4 Extension	Last updated March, 2003
	AAA Registration Keys for Mobile IP	Last updated March, 2003
	Fast Handovers for Mobile IPv6	Last updated March, 2003
	Hierarchical Mobile IPv6 mobility management (HMIPv6)	Last updated October, 2002
	Localized Mobility Management Requirements	Last updated March, 2003
	Mobile IP NAT/NAPT Traversal using UDP Tunnelling	Last updated November, 2002
	Mobile IPv4 Challenge/Response Extensions (revised)	Last updated December, 2002
	Mobile IPv4 Traversal Across IPsec-based VPN Gateways	Last updated April, 2003
	Problem Statement: Mobile IPv4 Traversal of VPN Gateways	Last updated April, 2003
	Registration Revocation in Mobile IPv4	Last updated February, 2003
	Mobility Support in IPv6	Last updated March, 2003
	Using IPsec to Protect Mobile IPv6 Signaling between Mobile Nodes and Home Agents	Last updated March, 2003

3GPP TSG T (Terminal) Update

3GPP TSG Terminals (TSG T) specifies terminal interfaces (logical and physical), capabilities (such as execution environments), performance and testing. It leaves the radio aspects of terminals to TSG-RAN and codecs for speech and multimedia codecs to SA4.

TSG T Plenary Discussions. The Open Mobile Alliance (OMA) is a growing threat to the power of TSG T. TSG T held a long discussion on improving cooperation with OMA and to discuss TSG T's future role. There was no unanimous support for having a joint leadership meeting.

T2 continues to lose some of its key delegates at the rate of about three per meeting. Many are now attending OMA meetings instead. This trend is also being felt, to a lesser extent, in other working groups.

The lack of a candidate for T1 RF SWG chair positions is another indicator of problems, and there has been discussion about eliminating sub-working groups entirely.

TSG T Election Results. The new chair is Sang-Keun Park of Samsung. Vice-chairs are Ed Ehrlich of Nokia and Kevin Holley of mmO2.

The new chair of Working Group 1 (T1) is Phil Brown of 3 (formerly Hutchinson). Vice-chairs are Dan Fox of Anritsu and Hisashi Nakagomi of NTT DoCoMo. Since there were no candidates for the T1 RF sub-working group, it will continue to be managed by the outgoing chair and vice-chair.

T2 elections will occur in May 2003.

The new chair of T3 is Nigel Barnes of Motorola. Vice-chairs are Paul Jolivet of DoCoMo and Jean Francois Rubon of Gemplus. The API SWG chair is Paul Jolivet of DoCoMo.

T1 – Conformance Testing

3GPP TSG T WG1 (T1) specifies User Equipment (UE, i.e. terminal) conformance testing based on requirements from other groups such as RAN WG4 for radio tests, and RAN WG2 and CN WG1 for signalling and protocols tests. T1 is organized into two subgroups, RF and Signalling.

T1 is continuing work on Radio Resource Management (RRM) test cases. The Rel 99 test specifications are about 85% completed and the Rel 4 specifications are still only at early stages of development.

Table 2: 3GPP TSG T Working Group 1 Terminal Conformance Testing Specification Update

Document	Title	Status
tbd	General changes to TS 34.121 and TS 34.122, corresponding to release 5	New Work Item
tbd	General changes to TS 34.121, corresponding to release 4	New Work Item
TS 34.108	Common Test Environments for User Equipment (UE) Conformance Testing	Rel 99 and Rel 4 versions being revised.
TS 34.121	Terminal Conformance Specification; Radio Transmission and Reception (FDD)	Rel 99 version being revised.
TS 34.122	Terminal Conformance Specification; Radio Transmission and Reception (TDD)	Rel 99 and Rel 4 versions being revised.
TS 34.123-1	User Equipment (UE) Conformance Specification; Part 1: Protocol Conformance Specification	Rel 5 version being revised.
TS 34.123-2	UE Conformance Specification; Part 2: Implementation Conformance Statement (ICS) pro forma specification	
TS 34.123-3	UE Conformance Specification; Part 3: Abstract Test Suites (ATSs)	Rel 99 version being revised.
TR 34.901	Test Time Optimization Based on Statistical Approaches	The Rel 99 version will be submitted at the June 2003 meeting.

T2 (Mobile Terminal Services & Capabilities)

3GPP TSG T WG2 (T2) defines the Services and Capabilities to be delivered by 3GPP Terminal Equipment, ensuring that terminals meet 3GPP objectives. It is responsible for terminal-based applications, features and interfaces. T2 is organized into 3 subgroups: SWG1 - MExE; SWG2 – User Equipment (UE) Capabilities and Interface; and SWG3 – Messaging.

SWG1 – MExE (Mobile Execution Environment) . This group provides a standardized execution environment in UE, and the ability to negotiate capabilities with a MExE service provider, allowing applications to be developed independently of any UE platform.

SWG1 did not meet, but the chair offered to work on some small editorial improvements to the MExE Stage 2 specifications. There were no documents submitted. A work item for Rel 6 improvements has been closed.

SWG1 will eventually be dissolved, but no date has been set, because of its maintenance responsibilities.

SWG2 – UE Interfaces and Capabilities. This group defines the Generic User Profile (GUP). At the most recent meeting, the proposed structure of TS 23.241 GUP Stage 2 Data Description Framework was agreed, and it should be completed by September 2003.

There has been no progress on User Equipment Management (UEM) due to insufficient support from T2 delegates. OMA plans to have the Device Management Requirement Documents available very soon.

SWG3 – Messaging . This group defines the Multimedia Messaging Service (MMS). A list of new work items were proposed, however some had no supporting companies. Discussions will continue in TSG-T to determine which have enough support to proceed.

There has been difficulty making a decision on MMS parameter storage on the SIM/USIM. It has not been decided whether an example should be included in the MMS stage 2 TS 23.140 (under T2 control) or TS 31.102 (under T3 control). A joint meeting will be held to resolve this.

T2 wanted to investigate potential MMS interoperability problems 3GPP and 3GPP2, but there are neither requirements nor work items in T2 yet. TSG T has indicated that T2 should use existing mechanisms of cooperation, such as having interested delegates attend each other's meetings.

Table 3: 3GPP TSG T Working Group 2 Terminal Conformance Testing Specification Update

Document	Title	Status
TS 23.041	Technical Realization of Cell Broadcast Service (CBS)	Rel 4, Rel 5 and Rel 6 version being revised
TS 23.140	Multimedia Messaging Service (MMS); Functional Description; Stage 2	Rel 5 and Rel 6 versions being revised.
TS 27.007	AT command set for User Equipment (UE)	Rel 99, Rel 4, Rel 5, and Rel 6 versions being revised.

T3 – Subscriber Identity Module 'Smart Card'

3GPP TSG T WG3 (T3) specifies the 2G Subscriber Identity Module (SIM) and the 3G USIM (Universal SIM) with the exception of the security algorithms, which are developed by SA WG3. T3 also maintains specifications and test cases for the 3G USIM and its interface with the Mobile Terminal.

T3 decided to keep the Universal PIN feature mandatory for backward compatibility.

The group also held discussions on IMS access utilizing the SIM, and concluded that there is no Rel 5 SIM. This meant that IMS access utilizing the SIM has to be based on the fields and functions already specified.

Table 4: 3GPP TSG T Working Group 3 SIM/USIM Specification Update

Document	Title	Status
tbd	2G/3G Java Card™ API Based Applet Interworking	New Work Item.
TS 23.048	Security Mechanisms for the (U)SIM Application Toolkit; Stage 2	Rel 4 and Rel 5 versions being revised.
TS 31.102	Characteristics of the USIM Application	Rel 99, Rel 4, Rel 5, and Rel 6 versions being revised.
TS 31.103	Characteristics of the ISIM Application	Rel 5 and Rel 6 versions being revised.
TS 31.111	USIM Application Toolkit (USAT)	Rel 99, Rel 4, and Rel 5 versions being revised.
TS 31.113	USAT Interpreter Byte Codes	Rel 5 and Rel 6 versions being revised.
TS 31.114	USAT Interpreter Protocol and Administration	Rel 5 being revised.
TS 31.116	Remote APDU Structure for (U)SIM Toolkit Applications	Rel 6 versions being revised
TS 31.121	UICC-Terminal Interface; USIM Application Test Specification	Rel 99 and Rel 4 versions being revised.
TS 31.122	USIM Conformance Test Specification	Rel 99 version being revised.
TS 31.131	'C' language binding to (U)SIM API	Rel 6 version being revised.
TR 31.900	SIM/USIM Internal and External Interworking Aspects	Rel 5 version being revised.
TS 34.131	Test Specification for 'C'-language binding to (U)SIM API	Rel 6 version being published.
TS 43.019	SIM Application Programming Interface (SIM API) for Java Card; Stage 2	Rel 5 version being revised.
TS 51.011	Mobile Equipment (SIM – ME) Interface	Rel 4 version being revised.
TS 51.014	SIM Application Toolkit	Rel 4 version being revised.

Meetings

The most recent plenary meeting of TSG T was held March 11-14, 2003 in Birmingham, UK. The next plenaries will be held June 3-6, 2003 in Hammenlinna, Finland, September 16-19, 2003 in Berlin, Germany, and December 9-12, 2003 in Hawaii, USA.

The 3GPP TSG T meeting calendar can be found under the heading 'T' at:

www.3gpp.org/Meetings/meetings.htm

TIA TR-45.1 Analog Cellular Air Interface Standards

Cellular Networking Perspectives

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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.

Thanks to John Kay (Motorola) for his assistance compiling the information in this table.

Collector's Item: Last Publication!

First Generation: Basic Analog

Standard	Description	Status
EIA/TIA-553	Analog air interface	Published 09/89
IS-19-B	Mobile minimum performance standards	Published 06/88 Rescinded 02/02
IS-20-A	Base station minimum performance standards (replaced by TIA/EIA-712)	Published 05/88 Rescinded 07/97
IS-3-A,B,C,D	Original analog air interface standards (see EIA/TIA-553-0)	Rescinded 09/89
TSB-16	Assignment of access overload classes	Published 03/85
TSB-35	Cellular mobile receiver dynamic range	Published 04/92
TSB-39	Message type assignment for extended protocol	Published 03/93

Second Generation: NAMPS, In-Building, Residential, Authentication

Standard	Description	Status
TIA/EIA-89	Elevate IS-89 to ANSI standard	Development
TIA/EIA-90	Elevate IS-90 to ANSI standard	Ballot 05/01
IS-88	Narrowband (3:1) analog air interface ("NAMPS")	Published 02/93 Being rescinded
IS-89	IS-88 base station performance standards	Published 02/93
IS-90	IS-88 mobile performance standards	Published 02/93
IS-91	Analog air interface (including "NAMPS" and authentication)	Published 10/94
IS-94	In-building analog air interface ("CAPS")	Published 05/94 Rescinded 10/00
IS-680	Residential ("cordless") interface between Wireless Residential Extension (WRE) and PSTN	Published 05/96
TSB-70	Cross reference for FSK control channel	Published 12/95 Rescinded 09/99
TSB-83-A	Additional modem options for IS-680 ("cordless")	Published 04/97

Third Generation: Isolation of “Core” Control Channel Capabilities

Standard	Description	Status
TIA/EIA-553-A	Analog air interface (including authentication, alert/flash with info, abbrev. alert, message waiting indicator and protocol capability indicator (PCI))	Published 11/99
TIA/EIA-690	Mobile minimum performance standards (previously IS-19-C)	Published 11/00
TIA/EIA-712	Base station minimum performance standards (prev. IS-20-A)	Published 07/97
TSB-16-A	Assignment of access overload classes	Published 06/01
TSB-39-A	Message type assignment for extended protocol (analog, TDMA and CDMA standards)	Published 10/94
TSB-39-B	**Message type assignment for extended protocol (analog, TDMA and CDMA standards)**	**Ballot 04/03**
TSB-70-A	Updated version of TSB-70 cross reference	Published 09/99
TSB-71	IS-94 enhancements and issues	Published 10/95

Fourth Generation: Advanced Capabilities

Standard	Project	Description	Status
TIA/EIA-691	SP-3665	Enhanced analog ANSI version of IS-91-A (w/o Wireless Residential Extension)	Published 11/99
IS-91-A	PN-3476	Revised IS-91 air interface (including IS-94 functionality and sleep mode)	Published 11/99
IS-91-B	SP-3666	Revised version of IS-91 (including IMSI, OTA, priority access, 911, cryptosync and Expanded ESN)	Project cancelled
IS-713	PN-3668	1900 MHz upbanded AMPS (based on IS-91-A)	Published 11/99
IS-788	PN-4205	Portable wireless phone to vehicle interface: Connector	Published 06/99
IS-788-A	PN-4660	IS-788 including IDB (ITS Data Bus)	In press
IS-789	PN-4207	Portable wireless phone to vehicle interface: Electrical Interface	Published 07/99
IS-789-A	PN-4629	Modification to IS-789 to support SAE J2366 ITS Data Bus (IDB)	Published 04/00
IS-790	PN-4208	Portable wireless phone to vehicle interface: Latch	Published 03/00
IS-791	PN-4209	Portable wireless phone to vehicle interface: Test Specifications	Project cancelled
IS-798	PN-4527	Portable wireless phone to vehicle interface: Mounting Envelope	Published 06/01
IS-816	PN-4630	IDB message set definition for IS-789. Publication held up by a copyright issue.	In press
IS-817	PN-4662	Geo-location for analog cellular phones	Published 01/01
IS-817-1	PN-4862AD1	Geo-location for analog cellular phones, Addendum 1	Published 02/02
IS-822	SP-4560	"+" (Plus Code) dialing for international calling from analog cellular phones and Enhanced 911	Project cancelled
TSB-119	PN-4559	"Intelligent Retry" for improved access to emergency calling	Published 10/00
TSB-121	PN-4558	Interface between wireless phone and Telephony Device for the Deaf (TDD) - 2.5 mm jack	Published 06/01
TSB-121-A	**PN-4558**	**Revised TSB121 based on input from ATIS TTY group**	**Ballot 12/02**
	PN-4373	Analog Air Interface Support of Expanded ESN (56 bit ESNX)	Project cancelled
	PN-4375	Analog air interface support of International Mobile Station Identity (IMSI)	Project cancelled 03/00