Cellular Networking Perspectives

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ESN Expansion Tossed to new TR-45 Ad Hoc Group

At the June 1999 TR-45 meeting, a new *ad hoc* group was formed to study ESN expansion and, in future, potentially other numbering and identification issues. While the original plan was to expand the ESN from 32 bits to 56 bits to obtain more manufacturer codes, the focus now is widening to include the less expensive (but quite possibly ineffective) reclamation of allocated, but unused ESN codes. Other solutions that may be considered by this group are expansion of the manufacturer's code to allow more (albeit smaller) blocks to be allocated, and even toleration of some degree of non-uniqueness, as long as the ESN is not used alone to identify a phone or subscriber (except for non-revenue generating services such as 9-1-1 calls).

This new group will be led by Terry Watts of SBC Technology Resources, a long time veteran of TR-45, TR-45.2 (network standards) and TR-45.3 (TDMA digital air interface standards).

Congratulations

Two TIA standards representatives recently discovered that they were interoperable, and were married on June 18, 1999 (to each other). We wish Kirk Carlson and Brye Bonner a life together that exceeds all industry norms. Happy interworking!

FCC Moves Ahead on Calling Party Pays – CTIA Moves Back

The US FCC will soon be releasing a Notice of Proposed Rule-Making (NPRM) on Calling Party Pays. The June 10, 1999 news release that announced this was good news for the wireless industry because it asserted Federal control over the service, including the provision of uniform notification requirements. State control could have created such a patchwork of incompatible notification requirements that it would have been impossible to create a nationwide service. The FCC will be soliciting comments on whether notification creates an implied contract between the caller and the terminating wireless carrier, and how to ensure that billing and collection of CPP charges is feasible. We will examine the CPP NPRM in more detail after the full text becomes available.

Meanwhile, the CTIA has cancelled a July forum that was to examine technical issues related to CPP, notably how to obtain information about the calling party, and how to exchange billing records between wireless and landline carriers. The foremost issue to be resolved was whether calling party information should be obtained using ISUP signaling or via the LIDB database maintained by most landline carriers. Perhaps the CTIA is waiting for the FCC NPRM to complete before moving forward.

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Rate Centers: The Key to Number Conservation

The US FCC has released the text of their Number Conservation Notice of Proposed Rulemaking (NPRM). It is clear from this document that the fundamental numbering problem in the US is the Rate Center concept. The question that the FCC is wrestling with is whether to work around the problem with Number Pooling, or resolve the issue through Rate Center consolidation. Other actions are under consideration, but are less likely to have a major impact.

Number Pooling using LNP…

Number pooling takes advantage of the Local Number Portability infrastructure to allow blocks of numbers smaller than 10,000 to be assigned to carriers. When a carrier gives, say, 2,000 numbers out of a 10,000 number block to the pool, the entire block will be made portable. An attempt to terminate to any of the numbers will result in an NPDB query. Only those numbers that have been pooled will return an LRN, to cause redirection of the call to the switch to which the numbers have been given.

Number pooling can be limited to the level of 1,000's blocks or can be applied at the individual telephone number level. The smaller the size of blocks that are used, the greater the resource management and coordination effort.

Number pooling has a number of limitations:

a. Numbers can only be pooled between carriers that share the same rating boundaries (e.g. rate centers). Wireless carriers usually provide local calling areas considerably larger than a rate center.

b. It dramatically increases the fraction of calls that result in LNP queries,

c. Carriers may not volunteer to fragment blocks that they are currently assigned, and may not want to receive partial blocks, and it is not clear that the FCC will want to force them to.

d. Wireless carriers have not yet implemented the ability to have Mobile Directory Numbers ported (Phase II Number Portability)

e. The FCC has not committed to forcing carriers to choose a particular method of number conservation. Yet without most carriers choosing Number Pooling, it would not work for any carriers.

…and Without LNP

It is possible to achieve at least thousands block pooling without use of the LNP infrastructure, merely by extending the number of digits that have to be examined during routing from 6 to 7. Prior to number portability, the North American Numbering Plan demanded that switches that do not own a telephone number examine its first 6 digits (NPA-NXX) to perform routing. Only the terminating switch need examine the remaining digits.

By extending the number of digits examined from 6 to 7 (e.g. NPA-NXX-X), blocks of 10,000 numbers could be shared in multiples of 1,000 among several carriers.

Apart from an inability to perform pooling below blocks of 1,000 numbers, this solution will also increase the size of routing tables in switches. This could be beyond the capabilities of some older switches (but then, so is local number portability). Software or hardware changes beyond those required to allow routing tables to be enlarged, such as memory upgrades, are not likely to be required.

Rate Center Consolidation

Rate Centers are the fundamental geographical area for billing by LEC's in the North American Numbering Plan, and have a significant impact on interexchange and wireless carrier billing practices, although flat-rate billing plans have reduced that significantly over time. For a LEC, Rate Centers define:

a. The distance between the calling and called party,

b. The name of the location of the called party (and possibly the calling party, depending on the type of call) as recorded on the bill.

Rate center consolidation is the simple process of merging two or more neighboring rate centers into one. This immediately allows phone numbers to be shared, whereas before a rate center boundary prevented it.

Rate Center consolidation raises a number of potential problems for LEC's. These are relevant for wireless carriers, because they are some of the reasons why LEC's resist this process:

a. Intra-LATA toll is not possible within a rate center. This will reduce the revenues of the carrier.

b. Intra-LATA toll will increase in some areas, and decrease in others, because the charges will be calculated from a new location.

c. Dialing practices may differ between rate centers.

Local Service Areas: A Compromise

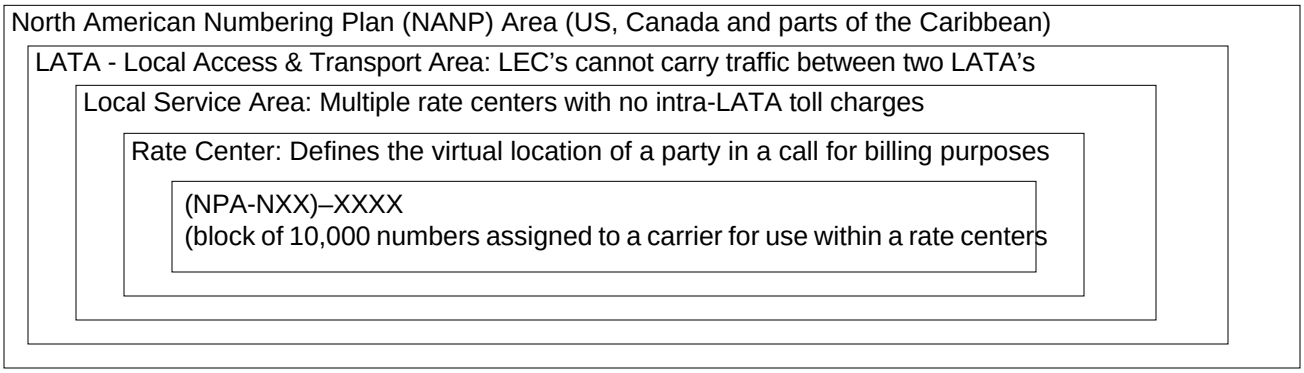
It has been recognized by some observers (including Michele Young, a consultant and writer whose articles have appeared here before) that Rate Center Consolidation may be overkill. Most of its benefits can be gained, and most of its problems avoided, if consolidation is limited to Local Service Areas.

A Local Service Area (LSA) is a group of neighboring rate centers that share similar dialing practices and between which toll charges do not apply. If the rate centers within an LSA are consolidated, consumers do not experience changes in dialing patterns and the powerful LEC's do not experience a signifi-

CDMA Technology Conference

The "1999 CDMA Technology Conference", produced by the Wireless Institute of Technology, will be held on September 20th-21st 1999 in New Orleans. For more information contact WIT at +1-210-344-6660, by email to witmail@bigfoot.com or at www.bigfoot.com/~witmail.

Figure 1: Rate Centers and Related Numbering Concepts



cant loss of revenue. There may be some temporary billing confusion, because the names of individual rate centers will no longer appear as the point of call origination or termination on bills, being replaced by the name of the LSA. Intra-LATA toll charges will change slightly, because charges will be calculated from the center of the LSA, and not from the centers of the old rate centers. Some charges will go up, and some will go down, so it is unlikely that many consumers will experience a significant increase in overall toll charges or that LEC's will experience a drop in revenue.

Other Conservation Approaches

The FCC is also considering two other approaches to number conservation: tighter control over numbers and mandatory 10 digit dialing.

Tighter Control over Numbers

The FCC is examining whether the allocation of numbers should be under tighter control (i.e. FCC regulation). This would allow for record-keeping and reporting requirements, enforcement with more teeth, and possibly would require justification of all requests for more numbers, or even for keeping blocks of numbers that had previously been allocated. A different approach would be to charge a fee for every number allocated, providing a financial incentive for carriers to return numbers that are not being used, and which are not creating any revenue.

While this approach might have some limited successes, it could also incur enormous manpower expenses for potentially little gain in reclaimed numbers.

Mandatory 10-Digit Dialing

Mandatory 10-Digit Dialing would allow for the re-use of "protected codes" and the opening of the first digit of the office code (currently NXX) to be 0-9 (e.g. XXX).

Protected Codes

Protected Codes are office codes that are reachable from one area code to another to preserve 7 digit local dialing. These occur after an area code split and could, presumably, be phased out over a period of time (with or without mandatory 10 digit dialing).

Allowing First Digit of Office Code

Allowing the first digit of the office code to be a 0 or 1, instead of just 2-9, would increase the number of available North American Numbers by 20%. And, because these numbers would be in new office codes, this solution is independent of rate center consolidation.

However, this solution is *not* compatible with 7 digit dialing because of ambiguity with the use of 0 and 1 for operator assisted and direct-dialed long distance calling. Furthermore, consumers are never happy with a switch from 7 to 10 digit dialing, particularly the elderly and disabled.

Which Way to Turn?

Number Pooling and Rate Center Consolidation are the only two number conservation methods that may be able to stave off a crisis in the North American Numbering Plan. The main reasons to do Number Pooling are, in fact, reasons to avoid the political challenges associated with Rate Center Consolidation. Local Exchange Carriers will likely oppose any mechanism that threatens their intra-LATA toll revenues, consumers may well oppose changes in intra-LATA toll charges and dialing plans not realizing that the costs of Number Pooling will eventually hit them in their wallets. And, some States may see rate center consolidation as a jurisdictional threat.

One of the questions that the FCC asks in the NPRM is whether carriers should have to achieve certain number utilization thresholds before more resources will be allocated. Ironically, this is not asked of the States which have considerable control over the efficiency of number allocation. If it was, the most likely reaction would be to implement Rate Center Consolidation, to ensure the continued availability of new area codes.

Local Number Portability Phase III: Enhancements

The third phase of number portability for wireless systems is to address issues that were not mandated by the FCC, but are required for efficient and complete operation of a wireless system in a number portability environment. This largely boils down to ensuring that Short Message Service (SMS) and other services continue to work for ported subscribers.

Work on optimizations to number portability (largely to reduce the number of queries that are required to process calls) is not proceeding. This is both because delays in the mandate to 2002 have moved field experience out further into the future, and because some optimizations can be performed based on information that is already in the TIA/EIA-41 intersystem messages.

SMS (Short Message Service)

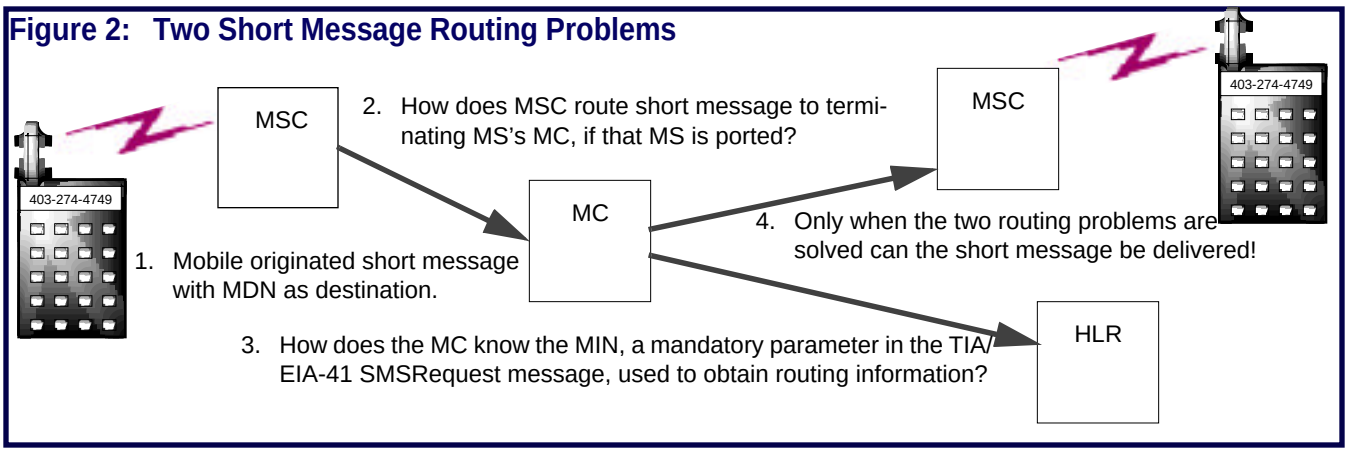
SMS was originally developed to add pager-like services to cellular phones, allowing the delivery of short numeric and text messages. It has been expanded to allow the delivery of other services, such as over-the-air activation of mobiles and service provisioning of data such as preferred system lists, somewhat transparently to the intervening network.

The problems with SMS are best illustrated by Mobile-to-Mobile short message communications. It is only necessary for a mobile originating a short message to provide the identity of the terminating mobile. This could be the MIN of the terminating mobile, but this is unlikely because of the confusion that this would cause among customers. It is much more logical to use the MDN (Mobile Directory Number), but here TIA/EIA-41 has two problems, illustrated by Figure 2.

The first problem is that the MSC handling the originating mobile has the MDN as the only piece of information to identify the destination mobile's Message Center (MC). If the MDN is ported, analyzing the digits cannot identify the MC correctly. This is the global title routing problem, discussed in the following section.

The second problem is that, even when the correct MC is reached, the existing TIA/EIA-41 intersystem message (SMSRequest) that is used by the MC to obtain routing information from the HLR, requires MIN as a mandatory parameter. The TR-45.2 group investigating Phase III of number portability, is considering whether to downgrade MIN to an optional parameter, and allow MDN to be used instead. Another solution, which does not require modifications to standards, is to maintain a MDN-to-MIN mapping table at the MC. While this is possible, it will require more expense at the MC, and more maintenance to ensure that the table is always up to date.

Figure 2: Two Short Message Routing Problems



Global Title Routing

SS7 is a signaling network used in both wireline and landline telecommunications networks. The basic address in this network is the Point Code – a 14 to 24 bit number (with the size dependent upon the national network). Alternatively, global title routing can be used, based upon a phone number, credit card number, etc. This routing can be used when the point code is not known initially, but must be determined during routing. Global title routing based on a NANP phone number currently needs to examine only the first 6 digits, but number portability will require analysis of the full 10 digits for numbers in portable blocks.

Figure 3 illustrates the process of global title routing in a number portability environment. The example of Calling Name database querying is used, but a similar process is required for some Call Delivery applications (routing a TIA/EIA-41 LocationRequest message from the Originating MSC to the HLR based on the dialed digits) and for SMS, as described above (routing a short message from the Originating MSC to the MC).

1. An MSC determines that an operation is required that will require global title routing using a directory number (Calling Name retrieval, in this case).
2. The SCP uses the received directory number as the global title and sends the message to an STP (SS7 Signaling Transfer Point).
3. STP's, except the one closest to the destination, need to examine only the first 6 digits of the directory number (e.g. NPA-NXX) to route to another STP.

4. The final STP, the one closest to the destination, examines the first 6 digits and determines that the global title is at the final stage of translation. Normally, this would be enough to determine the link connected to the final destination, but in this case the global title is within a ported block, and might be served by a different switch.

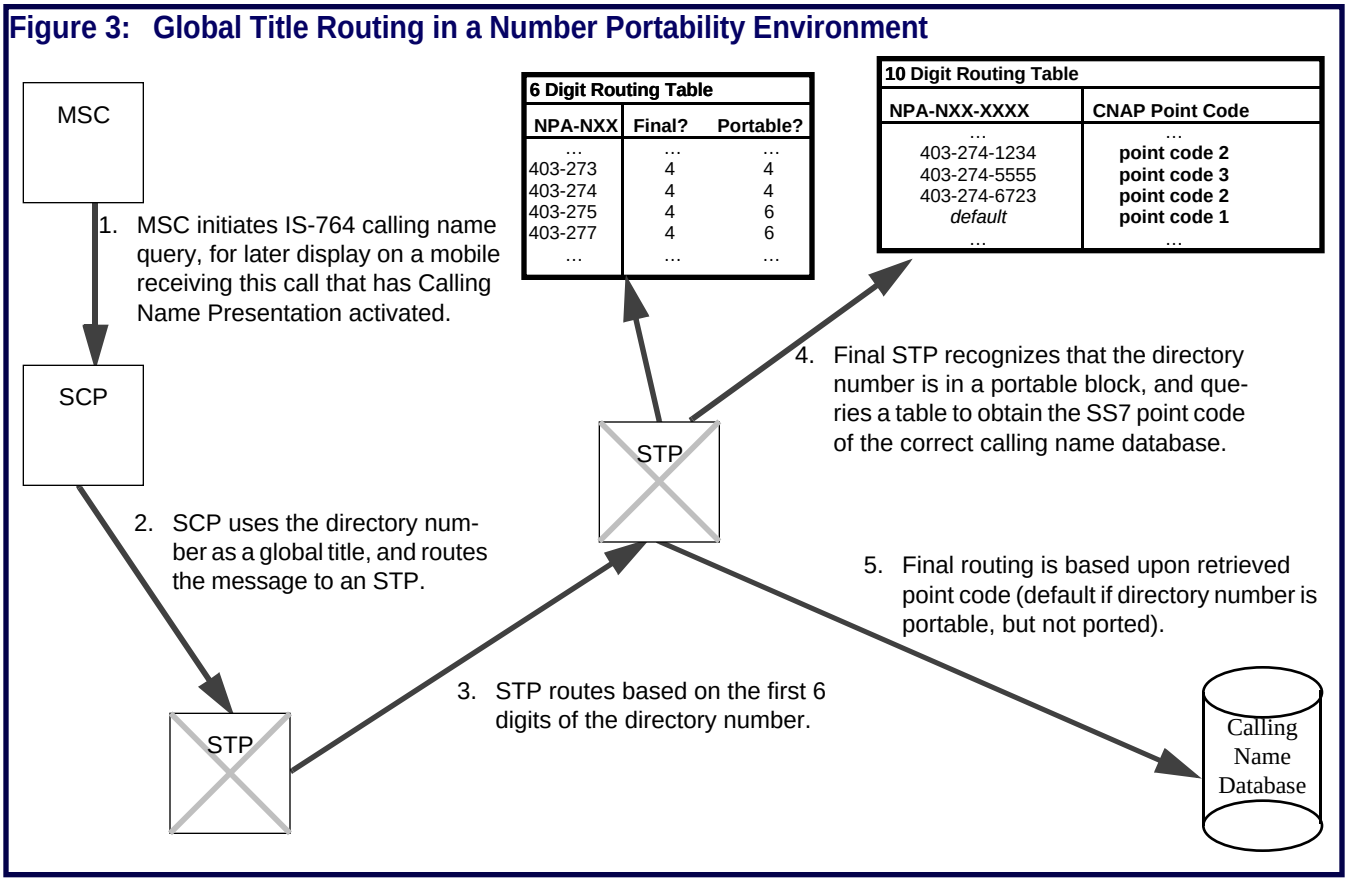
   Consequently, a second table must be consulted (which might reside within the STP, or in an external SCP) that contains the final destination point code for each ported global title *for each service*. There is also a point code for use for routing to numbers that are within a portable block, but which are not actually portable (again, repeated for each service).

5. Final routing of the message is based on the point code (and, to be precise, subsystem number) extracted from the 10 digit routing table.

Translation Type Value

There are several translation types based on directory numbers. To distinguish them, each is allocated a unique translation type value. The current plans for global title translation types for use in TIA/EIA-41-based wireless systems are to use ANSI SCCP translation type 10 for MDN-to-HLR routing and 14 for MDN-to-MC routing. However, this conflicts with planned T1P1/GSM usage (which will use translation type 14 for MDN-to-HLR routing). Since GSM systems are currently using global title routing, and TIA/EIA-41 systems are not believed to be, it is expected that TR-45.2 standards will be aligned with T1P1/GSM. This will require the use of translation type 14 for MDN-to-HLR routing and a new translation type for MDN-to-MC routing. GSM systems will use translation type 10 for node-to-node routing, with a non-portable pseudo-directory number as the global title.

Figure 3: Global Title Routing in a Number Portability Environment



Conclusions

Phase III of the TR-45 number portability effort should allow wireless systems to support calls to ported wireless phones and from wireless phones to ported landline phones, as well as the most significant advanced services. Although there are technical solutions for all recognized problems caused by number portability, the impact on network efficiency and reliability cannot be determined until number portability is actually in commercial service, which is not scheduled until November 2002 (although this may be moved up by the FCC to speed the implementation of Number Pooling or delayed if they feel that number portability will not increase competition in wireless).

After field experience with wireless number portability, it may well be necessary to make further modifications to standards to increase the efficiency of the protocol (by reducing the number of NPDB queries).

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First Generation: Basic Analog

Standard	Description	Status
IS-3 (Rev. A,B,C,D)	Original analog air interface standards (see EIA/TIA-553-0)	Rescinded 09/89
EIA/TIA-553 Rev. 0	Analog air interface	Published 09/89
IS-19-B	Mobile minimum performance standards	Published 06/88
IS-20-A	Base station minimum performance standards	Published 06/88
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
IS-88	Narrowband (3:1) analog air interface ("NAMPS")	Published 02/93
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
IS-680	Residential ("cordless") base station PSTN interface	Published 05/96
TSB-70	**Cross reference for FSK control channel**	**Published**
TSB-83-A	Additional modem options for IS-680 ("cordless")	Published 04/97

Third Generation: Isolation of “Core” Control Channel Capabilities

Standard	PN- #	Description	Status
EIA/TIA-553-A	**SP-3598**	**Analog air interface (including auth'n, alert/flash with info, abbreviated alert, msg. waiting indicator, protocol capability indicator (PCI) and "core" FSK control channel**	**In press**
TIA/EIA-690	**SP-3495**	**Mobile minimum performance standards (prev. IS-19-C)**	**4th ballot**
TIA/EIA-691	**SP-3665**	**Enhanced analog ANSI version of IS-91-A (w/o IS-680)**	**re-ballot**
EIA/TIA-712	PN-3597	Base station minimum performance standards (prev. IS-20-A)	Published 09/97
IS-91-A	PN-3476	Revised IS-91 air interface (including IS-94 & sleep mode)	Post-ballot
IS-713	PN-3668	1900 MHz upbanded AMPS (based on IS-91-A)	Pub. pending
TSB-70-A	PN-3610	Updated version of TSB-70 cross reference	Second ballot
TSB-71	PN-3477	IS-94 enhancements and issues	Published 10/95

Fourth Generation: Advanced Capabilities

Standard	Project	Description	Status
IS-91-B	SP-3666	Revised version of IS-91 (including IMSI, OTA, priority access, 9-1-1, enhanced security & Expanded ESN)	Development
IS-788	**PN-4205**	**Portable wireless phone to vehicle interface: Connector**	**in press**
IS-789	**PN-4207**	**Portable wireless phone to vehicle interface: Electrical**	**Ballot**
IS-790	**PN-4208**	**Portable wireless phone to vehicle interface: Latch**	**Development**
IS-791	**PN-4209**	**Portable wireless phone to vehicle interface: Test Spec.**	**Development**
	PN-4373	**Expanded ESN (56 bit) support in analog air interfaces**	**On hold**
	PN-4375	**IMSI support in analog air interfaces**	**On hold**

Note: 1. IS- TIA Interim Standard, PN- TIA Project Number, SP- ANSI Standards Proposal, TIA/EIA- ANSI approved TIA standard, TSB- TIA Telecommunications Systems Bulletin.
2. **Bold Type** indicates modification since the previous publication of this report.