Cellular Networking Perspectives

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Full Text Index of Back Issues… Now Available

We are pleased to announce the availability of a free, full-text index for *Cellular Networking Perspectives* back issues. It provides for simple or sophisticated full-text searches of all back issues (even issues that you have not yet purchased). It is created using Adobe Acrobat Catalog and is available at:

ftp://studio.cadvision.com/catalog.zip

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Quote of the Month

"[TIA] Subcommittee TR-45.2 represents the most talented collection of telecommunications systems engineers in the world"

Matthew J. Flanigan
President, TIA

(as part of the TIA argument to the FCC that its standards subcommittee TR-45.2 should continue to develop standards for CALEA electronic surveillance)

How Iridium Got Its Name

Most people know by now that Iridium was named because it was originally planned to have 77 satellites, which is the Atomic Number of the element Iridium. As an aside, the current configuration contains only 66 satellites, but somehow it is doubtful that Dysprosium will ever be used as a marketing name.

What is less known is who came up with the name. We have recently confirmed that this person was Jim Williams, one-time Motorola representative to TIA subcommittee TR-45.2, also known within Motorola CIG (Cellular Infrastructure Group) as the 'official namer'. According to Jim, "It occurred to me that my mental image of the system resembled a model of an atom with electrons orbiting a nucleus so I looked up the element with 77 electrons which turned out to be Iridium."

The full story is available at:

http://www.cnp-wireless.com/iridium.html

Good-bye Astronet

One of the historical names in the MSC marketplace ceased to exist at the end of 1998. Astronet used to be a big player in the MSC market in the US, but now joins other names such as Celcore (purchased by DSC, which was then purchased by Alcatel) and Plexsys, that ceased to operate (at least as independent entities) in 1998.

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A-Interface Alphabet Soup… It's for dinner

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The TIA TR-45.4 standards sub-committee is in the throes of publishing a new ANSI standard, TIA/EIA/-634-B. This is the ANSI revision of interim standard TIA/EIA/IS-634-A, the open interface between the MSC and the BSC. The new protocol builds on the earlier IS-634-0 and TSB-80 specifications. It arrives on the scene, heralded by an international fanfare, with major parts played by the TTC of Japan and the TTA of Korea (national standards development organizations). Through it all, TR-45.4 continues to build the A-interface into something that can be used by the broader IMT-2000 (3G) wireless community.

Yet, for all the international attention that IS-634 receives, and despite the best efforts of its contributors, this revision takes more than the usual engineering savvy to decipher. What started out as an update to the specification has turned into a complex series of documents that require a roadmap to navigate.

This is the first in a two-part series on the A-Interface. To help identify just exactly what soup is on the boil, we will start with an overview of TIA/EIA/634-A. We will look at how it got here and why. Next month, we will wrap up with a discussion of what the industry is actually implementing as it makes sense of the protocol, and stop to peek at the *de-facto* standard looming on the sidelines.

Why TIA/EIA-634-A?

One of the few constants besides death and taxes these days is that digital air-interface technologies continue to mature. The biggest benefit of the new A-interface revision is support for the latest CDMA soft handoff techniques, which should improve the quality of service experienced by CDMA mobile users. And I do mean mobile. 75 m.p.h. (120 km/h) in a multi-cell boundary area can knock the stuffing out of soft handoff performance. Not to mention inter-system "hard" handoff performance.

IS-634 was initially published (as Revision 0) at the end of 1995. Early proponents of this open interface included vendors of MSCs and of BSCs, and carriers who wanted the opportunity to mix and match equipment in their network. The protocol made good use of its older cousin GSM A-interface specification from Europe.

As is common with early revisions of standards, a TSB was published a year later with corrections. TSB-80 fleshed out the A-interface with initial wisdom gained in the field. Through it all, business partnerships were formed and re-formed, taking advantage of the availability of a published, open interface between MSCs and BSCs. Early product was in the field, and not just in the USA. New partners continued to meet at field trials and negotiate corrections for the next full revision.

The third iteration, which was finally published as IS-634 Rev. A in October 1998, was slated to continue to build out the requirements of the TIA A-interface, maintaining backward compatibility with the preceding protocols. However, during the intervening two years since TSB-80 was published, the protocol enjoyed attention from major new players. The new contributors did not have product in the field utilizing the existing A-interface, but they did have MSC and BSC products, and were seeking markets where IS-634 was a contractual requirement. Soon, the document took on a new flavor, incorporating two unlike – in fact, downright incompatible – architectures.

Architecture, Schmarchitecture

What is so important about a network reference model (aka network architecture) when building a standard? At its best, it defines a set of network elements, with clearly circumscribed functional capabilities, which can be supported by well-defined interfaces along which discrete protocol entities can be delivered. During 1997 and 1998, the A-interface network architecture attempted to encircle two competing camps, those with voice coders and selection/distribution functions at the BSC, and those with these functions bundled as SDUs at or near the MSC.

There are some who weathered the storms of those two years who might complain that a more accurate characterization of the two camps would be between those with A-interface product in the field, and those seeking the cachet of an open A-interface label. In any event, drawing upon the naming convention of its interface, the two architectures were published within IS-634-A, as "Architecture A" and "Architecture B". However, the most alarming aspect of the new revision was not the nomenclature for the two architectures. No. It was the indelicate fact that they are to a large extent incompatible with each other in the real world. It may be an open interface, but it ain't necessarily standard. Too many cooks had begun to spoil a pretty promising broth.

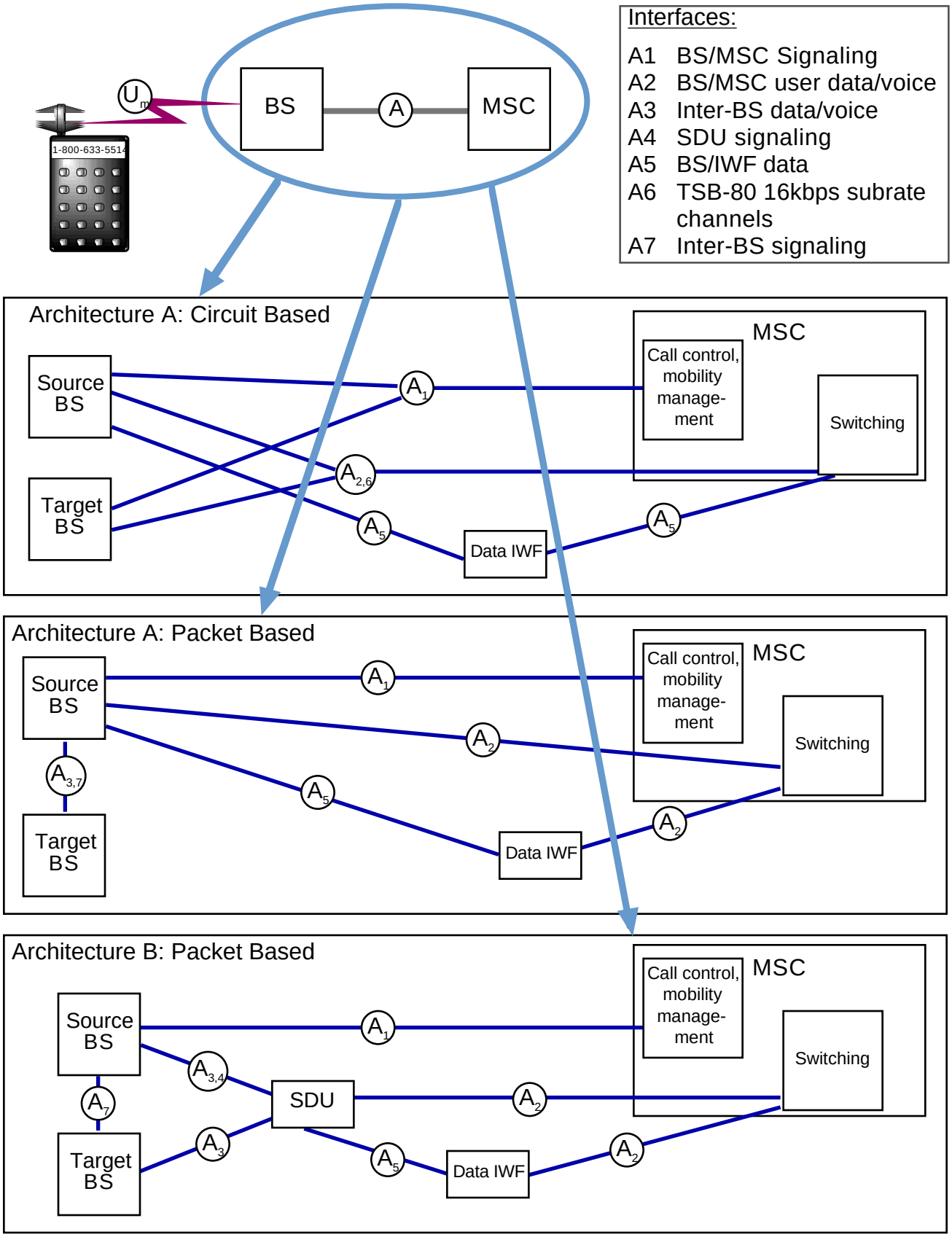
Cutting Teeth and Splitting Hairs

Not to take away too much suspense if you do choose to read the standard itself, IS-634-A, and its ANSI clone, TIA/EIA-634-B required the creation of sub-interfaces (named A_1 – A_7) to distinguish between the different functional capabilities of the A-interface within the context of the two incompatible architectures. Figure 1 shows that all seven sub-interfaces reside within the previously labeled "A-interface" in the current TIA Network Reference Model. Note that there is a new BSC-BSC interface, to support the new soft-handoff magic, which *did* add value for the industry. Remember those 75 m.p.h. mobiles served by BSCs with border cell problems, or rather, soft-handoff opportunities?

TIA/EIA-634-B is a sound protocol, with portions of it running in US networks and abroad. It shines with IMT-2000 promise. But, lo, what is this? Just after the new ANSI standard was published, after it had been painstakingly (in truth, painfully) sliced and diced to support various competitors' product architectures, and chopped into multiple sub-interfaces, the protocol itself shredded and partitioned accordingly, a force emerges from the shadows to join the banquet. And it has a menu of its own. Guess who's coming to dinner? And it ain't Santa. He's gone back to the North Pole!

To be continued…

Figure 1: Three TIA/EIA-634 Revision A Architectures



US Number Conservation

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According to the North American Numbering Plan Administrator (NANPA), over 40% of the total area codes in existence have been allocated since the pool was expanded from less than 160 to almost 800 on January 1, 1995. While the assignment rate has recently slowed significantly, there is a valid concern regarding the status of public numbering resources. Most state commissions and the FCC are becoming increasingly involved in conservation methods that might maximize the remaining resources at minimum cost and inconvenience to carriers and consumers.

On March 23, 1998, Richard Metzger, Chief of the FCC's Common Carrier Bureau, directed the North American Numbering Council (NANC) to submit a report that would provide technical and operational details to permit implementation of uniform, nationwide number pooling by December, 1999. Input regarding other number conservation measures was also requested.

The *Number Resource Optimization Working Group Report* was presented to the FCC in October 1998. It summarized nearly nine months and hundreds of days of meetings by industry experts and is divided into solutions that require the local number portability (LNP) infrastructure (e.g. number pooling) and those that do not.

In response to this report, the FCC released a "Notice of Inquiry" (DA 98-2265) seeking feedback in several areas:

- Conservation measures that the FCC believes will be most effective: Thousands Block Number Pooling, Individual Telephone Number Pooling (ITN), Unassigned Number Porting (UNP), Extended Local Calling Areas (wireless and wireline), mandatory ten-digit dialing, and Modification to industry number assignment guidelines.
- Information on "the societal costs and benefits as well as which costs would be borne by end users and carriers and if any specific industry segment would disproportionately bear a larger burden in implementing any particular measure."
- Comments on how auditing and enforcement should be performed, and what the role of States and the NANP administrator should be.
- Implementation issues, including the geographic scope of measures, the possibility of staggered implementations, and interactions between different measures.
- Suggestions to improve the nationwide number database (that does not yet exist) and identification of any possibile improvements to phone number utilization in the USA.

The FCC's Favorite Methods

Three of the six measures that the FCC believes will be most effective, rely upon Local Number Portability:

- Thousands block pooling
- Individual number pooling (ITN)
- Unassigned number porting (UNP)

Thus, cellular and broadband PCS service providers cannot participate in these measures until they implement wireless number portability (currently mandated for March 31, 2000). Wireless carriers outside the LNP mandate are unlikely to be forced to implement these methods, and even more unlikely to implement them voluntarily.

Number Pooling or Number Puddling?

LNP, to some experts, stands for *Lots of Network Problems.* In the near future, it will also be an acronym for *Loads of Number Pools.* Number pooling has proven to be of dubious value where trialed by wireline providers and represents a serious challenge for wireless providers for several reasons:

- Administration of pooled numbers is more complex and costly than of full NXX blocks, especially when individual numbers are ported (ITN and UNP). Many wireless providers report that their number assignment, administration and activation systems, as well as switch processes must be significantly modified or replaced if they participate in number pooling.
- Wireline number activation in LNP areas usually takes at least three business days while wireless carriers (and their customers) are accustomed to virtually instant activation. If number pooling becomes the sole method by which numbers can be obtained, either this interval must be significantly shortened, or wireless conventions might have to change.
- The Industry Numbering Committee (INC) has agreed that a nine-month service provider inventory is reasonable, but individual number pooling (ITN and UNP) does not permit building the inventories that are crucial to instant activation, resale preprogramming, and to meet sales promotions and holiday season demands.
- Only service providers that share identical rate center boundaries can share the same number pool. This means that wireless providers will almost certainly share pools only with other wireless providers. Number pools could quickly become number puddles, greatly evaporating their efficiency.
- The industry and most regulators recognize that wireless providers already use numbers quite efficiently, by serving large areas with single NXX codes. Considering that number administrators report that 40%-60% of all new NXXs are assigned to wireless providers, number pooling measures may simply not be effective.
- Participation in number pooling will be inordinately expensive for wireless providers. Each of the three number pooling options requires a different third party administrator and database. Wireless providers that serve multiple States may have to make arrangements

to interface with, and pay for more than one pooling administrator. While all three measures are based on LRN LNP, there are significant architectural differences that could be disastrous for wireless providers that serve multiple states with a single network.

- Whether or nor wireless service providers participate in pooling, they will bear its incremental expense. The current cost recovery recommendation is for the entire industry to pay for number pooling.
- Some industry experts have expressed concerns that the planned LNP infrastructure, and perhaps the SS7 network, are inadequate for the increased volume that LNP and number pooling will produce. Where LNP is operating, it has already become apparent that the Number Portability Administration Center (NPAC) is challenged by the number of change record transactions due to LNP. High wireless churn volumes and use of the NPAC for assignment of most new numbers would present unanticipated, likely unmanageable, volumes. The entire industry will be burdened with any common costs associated with LNP, including NPAC upgrades or enhancements
- Some switch types have limited capacity to house NXX codes. In at least one case, the limit is 12 individual NXX codes. All forms of pooling, especially ITN and UNP, will exponentially increase the number of NXXs that must reside on a given switch. In addition, some switches allocate the same amount of memory to a single number as to an entire NXX code. These switches will rapidly run out of memory with the introduction of pooling. Number Resource Optimization working group participants could not agree to grant even a temporary dispensation for affected switches.

Most States view number pooling as a quick and simple alternative to frequent area code relief and 10-digit dialing. Since most area code exhaust situations occur in geographic areas scheduled for LNP, number pooling has become a very popular concept. In fact, some States believe that number pooling should trigger LNP implementation even in those areas where LNP is not scheduled to occur. This nuance changes most of the variables associated with making the "build or buy" LNP infrastructure decision for wireless carriers. Carriers in areas believed to be immunized from LNP may quickly find themselves coming down with the LNP disease due to number pooling.

Three Highly Ineffective Number Conservation Measures

The other three measures favored by the FCC promise little or no number efficiencies and could prove problematic for the wireless industry.

- Mandatory 10-digit dialing will only free telephone numbers in those few geographic areas where NXX codes are *protected* (code protection is a method used to preserve 7 digit dialing by assigning the same NXX in two adjacent NPAs). Theoretically, this would allow the first and fourth (A and D) digits of the NANP dialing format to be expanded to include 0 and 1 but, this modification cannot be made on a widescale basis for at least 10 years.
- Expanded Local Calling Areas (ELCAs) are also known as Wide Area Calling Plans, Land to Mobile Options, etc. and permit wireline callers to contact wireless subscribers without incurring a toll charge. Instead, the wireless carrier pays the interconnected Local Exchange Carrier (LEC) a per-minute rate for this service. Most LECs are withdrawing ELCAs for regulatory reason. In addition, since they are optional, ELCAs do not optimize number use since most wireless carriers also request geographic NXXs as well as ELCA codes. Curiously, the FCC requests input on allowing ELCAs for use by wireline carriers as well.
- Modification of the Numbering Guidelines to tighten assignment procedures, ensure better utilization, and mandate forecasts may stop abuse demonstrated by some entities. However, this is unlikely to produce meaningful results. A real consequence, nonetheless, will be that efficient carriers will be forced to comply with more stringent and burdensome processes to obtain telephone numbers.

The Real Problem: Rate Centers

The root cause of the current number crunch is the convention that each wireline carrier obtains a full NXX in each Incumbent LEC *Rate Center.* In many areas, this results in enough numbers being assigned to carriers to provide tens or even hundreds of telephone numbers for each actual subscriber.

Rate Center Consolidation (RCC) might solve the number conservation crisis by itself, and with minimal impact. RCC, which has been successfully implemented in several states, merges many wireline rate centers into one. RCC essentially makes wireline carriers as efficient as wireless by permitting them to serve multiple rate centers with a single NXX.

Obviously, interexchange carriers and LECs insist that RCC (which eliminates much intra-LATA toll revenue) must be implemented in a revenue neutral fashion. This position has resulted in significant delays of RCC implementation and will continue to do so.

The FCC may also avoid Rate Center Consolidation because Rate Centers are defined by each state.

Consequently, the industry, including efficient wireless carriers, will spend billions of dollars placing numbering band-aids on the festering wound for years to come.

To be continued…

In the next issue of *Cellular Networking Perspectives*, Michele Young will provide a matrix summarizing all the number conservation methods that are being considered.

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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 Rev. 0	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 (SP-3798)	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**
EIA/TIA-690	**SP-3495**	**Mobile minimum performance standards (prev. IS-19-C)**	**In press**
EIA/TIA-691	SP-3665	Enhanced analog ANSI version of IS-91-A (w/o IS-680 cordless)	Post-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-xxx	PN-42xx	Portable wireless phone to vehicle interface: Architecture (PN-4204), Connector (PN-4205), Electrical (PN-4207), Latch (PN-4208) and Test (PN-4209)	Development
	PN-4373	**Expanded ESN (56 bit) support in analog air interfaces**	**Development**
	PN-4375	**IMSI support in analog air interfaces**	**Development**

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.

- Thanks to Bob Slocum of Ericsson, Charles Teising of Lucent and John Kay of Motorola for their assistance compiling this information.