Cellular Networking Perspectives

David Crowe [Editor] • Phone: 1-800-633-5514 • Fax: 403-289-6658 Vol. 5, No. 5 May, 1996

In This Issue...

Look forward to your next issue on: June 3, 1996

TR-46 Reinflates

In an April, 1996 article entitled "TR-46 implodes" the impression was given that this TIA committee responsible for 1800 MHz PCS standards might go the way of the Passenger Pigeon. However, according to Chris Wallace of Nokia, the new chair of TR-46, the suspension of subcommittee activities was just to allow a complete reorganization of TR-46 now that AMPS related PCS standardization activities have moved to TIA committee TR-45.

TR-46 work has been continuing at the plenary (i.e. committee) level rather than at the subcommittee level. Following the reorganization, which should be complete by May 3, work will be allocated to a new set of subcommittees.

TR-46 will continue to work closely with the ATIS committee T1P1, meeting during the same week, and at the same location. These committees will work cooperatively on the development of standards related to the GSM based PCS1900 standard, PACS and others. TR-46 and TR-45 will work jointly on radio interface independent network projects such as lawfully authorized electronic surveillance and enhanced wireless 9-1-1. ❒

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Phil Audino on the Ramifications of the US Telecommunications Act of 1996

With the passage of the telecommunications bill in February by the Congress and President Clinton, the era of a new and fully competitive telecommunications environment has finally arrived in the US. This landmark legislation promises to introduce sweeping changes for the communications industry and the American consumer.

The bill, which passed both houses of Congress with overwhelming bi-partisan support, allows local telephone, long distance and cable television companies to compete in each others' markets. It represents the first comprehensive reform of US telecommunications laws in more than sixty years, and replaces the MFJ consent decree that broke up the Bell telephone system (AT&T) more than twelve years ago.

Once the appropriate state and federal approvals are secured, regional telephone companies can provide out-of-region long-distance and long-distance services associated with cellular, information services and video programming. Additionally, expect interexchange carriers like AT&T, MCI, & Sprint to charge into the local exchange business, first targeting large businesses, then residential markets.

The bill has the potential to reshape the entire communications industry, promoting a competitive free-for-all among regional telephone companies, long-distance carriers, cable television companies and perhaps some utility companies.

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These are fundamental changes which offer unprecedented opportunities for existing companies and new startups. Yet there are risks for companies ill-prepared to compete in an open environment.

To illustrate the size of the stakes, the long distance market represents a high-growth opportunity estimated at over $120 billion annually, with a growth rate nearing 10%. Estimates for the entertainment and information services are over $15 billion a year, and growing as rapidly as long-distance. Even the annual local exchange telephone market is estimated to be in the 'not so shabby' neighborhood of $90 billion.

Essentially, the bill replaces monopolies with competition and makes one-stop-shopping available to the telecommunications consumer. However, this does not mean that the industry is deregulated. There are hundreds of new rules and regulations that will govern the transition from a monopolistic marketplace, to a competitive environment. These new regulations generally require the regional telephone companies to treat their competitors just like any other customer.

The End of MFJ Restrictions

For the remaining MFJ restrictions to be lifted, a regional telephone company demonstrate to the FCC that:

- it has opened up its local network to competition by meeting a checklist of criteria outlined in the legislation. For each item on the checklist, access must be provided with rates, terms and conditions that are just, reasonable and nondiscriminatory. Access to one item cannot be bundled with unrelated items. Regional carriers cannot provide a better deal to themselves than to any other carrier. This "competitive checklist" of items that must be made available to any carrier, includes:

  (1) Interconnection of facilities and equipment at any technically feasible point.

  (2) Access to network elements.

  (3) Access to poles, conduits, and right-of-ways.

  (4) Local loop transmission from the central office to the customer's premises.

  (5) Local transport from the trunk side of a local exchange carrier's switch.

  (6) Local switching unbundled from transport, local loop transmission, or other services.

  (7) Nondiscriminatory access to 911 and E911 services, directory assistance and operator call completion services.

  (8) White page directory listings for customers of the other carrier's telephone exchange service.

  (9) Access to telephone numbers for assignment to the other carrier's customers.

  (10) Access to databases and associated signaling for call routing and completion.

  (11) Interim telecommunications number portability through remote call forwarding, direct inward dialing trunks, or other comparable arrangements.

  (12) Access to information needed to implement local dialing parity.

  (13) Reciprocal compensation arrangements for the transport and termination of telecommunications.

  (14) Resale of telecommunications services at rates, terms and conditions that are just, reasonable and nondiscriminatory.

- there is a competitor offering local services over its own network to business and residential customers in the regional phone company's territory

- the regional carrier's entrance into long distance, according to the FCC's analysis, is in the public interest.

The MFJ ban on manufacturing will be lifted once a company receives in-region long distance relief. However, immediately upon passage of the legislation a regional telephone company is allowed to provide long-distance service incidental to wireless, video, information and on all calls originating outside of its operating territory. A cellular subsidiary can offer a package of local and long-distance wireless services to its customers, right now.

Tower Siting

The act strikes a balance between the interests of the wireless industry and local government zoning bodies regarding tower sites. It preserves local authority over siting decisions, but bars rulings based on alleged health concerns associated with RF emissions. It also allows wireless carriers to appeal these rulings in fed-eral or state court.

The Role of the FCC

The Federal Communications Commission is the US government agency responsible for shaping the regulatory policies that will give form to the Telecommunications Act of 1996. It is interesting to note that prior to passing the legislation, Congress allocated only $188 million to the FCC for 1996; $10 million less than the commission requested. The commission has stated that this should not hinder its efforts, but industry analysts doubt the FCC can tackle the volume of issues the act encompasses unless the budget is increased. The act does transfer some regulatory policies from the federal to the state level, (e.g., pricing, resale costs and interconnection negotiations) which will relieve some of the FCC's burden, but this will not likely compensate for the responsibilities that have been added.

Consolidation of RBOCs Predicted

As a result of the legislation, the most dramatic changes predicted are a consolidation of the Bell companies (RBOCs), quick entry into the long-distance market by local exchange carriers, even quicker entry into the local exchange market by the interexchange carriers, and greater pricing flexibility for the cable companies. However, if all of these companies were to provide similar full service packages, what would drive a customer to choose one company over another?

Winners and Losers

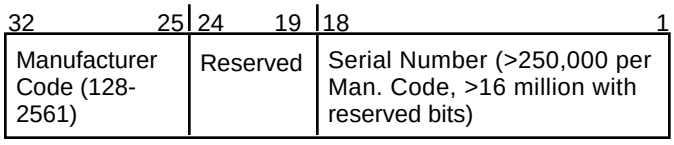
Clearly, the successful companies will be those that build strong customer relations by giving them what they need, when they need it, and at competitive pricing. But stay tuned telecom enthusiasts, it will be interesting to see how things shake-out over the next few months. Personally, I just can't wait to receive all those additional sales calls at the dinner hour!

About the Author

Phil Audino is a telecommunications consultant with PJ Comm & Associates. He has 27 years experience in wireline and wireless telecommunications, including several years representing NYNEX on TIA standards committees. ❒

Rejiggin' the ESN

We have talked at length in previous issues about the problems with the AMPS MIN identifier, but the equally important ESN also has fragmentation and administration problems, potentially leading to ESN ambiguities. In the past, the FCC (US Federal Communications Commission) allocated ESNs, but companies producing AMPS mobiles for foreign markets obviously were under no obligation to conform to the FCC format, and the level of compliance is unknown. The FCC format (also described in EIA/TIA-553 and other air interface standards) divides the 32 bit ESN into an 8 bit Manufacturer Code, allocated by the FCC, and an 18 bit serial number, allocated by the manufacturer, leaving 6 reserved bits (which may very well be utilized by some manufacturers to extend the serial number):



The ESN is supposed to be unique. Although this is not essential, non-unique ESNs may trigger fraud detection algorithms that are based upon examination of an ESN only. A large number of mobiles with the same ESN could reduce the benefits of near-uniqueness, in particular lowering the effectiveness of validation and authentication algorithms. The manufacturer code allows uniqueness to be maintained autonomously by each manufacturer, assuming that they follow the written, but non-binding, rules, and assuming that there are enough manufacturer codes to go around!

Running out of Manufacturer Codes

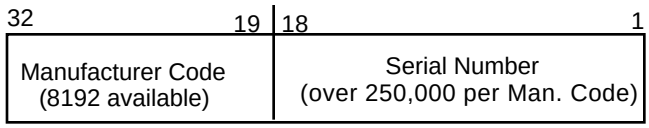
The current format allows for 256 manufacturer codes, of which the upper half (128-256) have almost all been allocated. Due to the vagaries of manufacturing, some manufacturers have used most of their codes, while others went out of the business after manufacturing only a few terminals. If the remaining half of the manufacturer codes are allocated, they will soon be all given away to new manufacturers and for expansion room for the most prolific manufacturers.

Solution #1: Expand the ESN

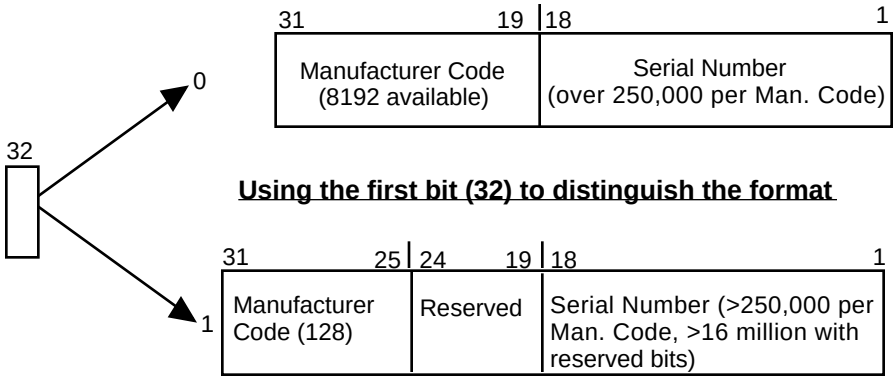
One solution that has been proposed is to expand the ESN to as many as 64 bits. While this will provide a huge expansion in the number of ESNs available, it will also result in a huge compatibility problem. All air interfaces will have to be modified to support the new ESN. Procedures will have to be provided to only transmit half of the ESN when a mobile or a base station does not support the expanded value. Network signaling protocols will be affected, most notably IS-41, and also proprietary and standard call detail and billing record formats (such as TIA IS-124 and CIBER). This is really an option of last resort.

Solution #2: Expand the Manufacturer's Code

This solution uses the lower half of the manufacturer's codes (0-127), along with the reserved bits, to provide many more manufacturer codes. While the reserved bits could also be used to expand the serial number, this would not solve the basic problem (the lack of manufacturer codes) and would only exacerbate the waste of ESN's by small manufacturers. Since the top half of the manufacturer code range has not been used, these 128 8-bit manufacturer code values could be expanded to 8192 14-bit manufacturer codes.



How can these two formats be distinguished? This can easily be done using the first bit of the ESN, 0 meaning an expanded manufacturer code and 1 meaning a short manufacturer code:



Who Wants the ESN Job?

At a meeting between TIA and FCC representatives, during Wireless'96, the FCC indicated that they would be happy if the industry took over the job of allocating ESN manufacturer codes. This would probably mean the TIA or the CTIA (through CIBERNET Corporation, its subsidiary). Stay tuned for the final resolution of this issue. ❒

Life on the Border, Part I: Introduction to Border Cell Problems

Life near the border of two countries can be rough if the countries do not get along. In cellular systems, life on the border is rough even if the two neighbouring systems maintain good relations. The problem lies in bugs in the AMPS family of air interface standards. While some have been corrected as the analog and digital standards have matured, a small number of new problems have been added. Although, ideally the problems should be fixed in the air interface standard, they are not serious enough to warrant a recall of millions of cellular phones. On many cellular phones, software updates to correct such problems would not even be possible. Standardized network solutions to these problems were first explored in a 1992 TIA Joint Expert's Meeting in Niagara Falls, Canada. This eventually resulted in the publication of recommended network solutions in TIA TSB-65 (an addendum to IS-41 Rev. B) and in TIA standard IS-41 Revision C.

A Problem or a Challenge?

As any management consultant will tell you, there is no such thing as a problem, there are just challenges and a challenge is just an opportunity! This is true of border cell problems … er, challenges. Overcoming them is part of the process of continuously improving the quality of service in wireless systems. These problems should not be avoided, but tackled head on. They should not be fixed just as an interesting technical challenge, but when a business case can be made that the quality of service improvement will bring greater returns than allowing the problem to continue.

The original border cell problem was that calls could not be maintained across a system boundary. This was fixed in IS-41 Revision 0 through its inter-system handoff procedures. It is inconceivable that a system could be designed without this capability today. Was handoff a problem or an opportunity? The same will be asked about some currently obscure border cell problems in a few years after they have all been characterized and fixed.

An interesting example of the blurring between problem and opportunity in border cell issues is soft handoff in CDMA systems. Proponents of this new digital technology consider soft handoff to be one of its strengths, virtually eliminating intra-system handoffs, at least as far as the customer is concerned. Yet, critics of CDMA claim that it is an insurmountable challenge to get soft handoff to work. A problem of any sort is only a mountain that has not yet been climbed.

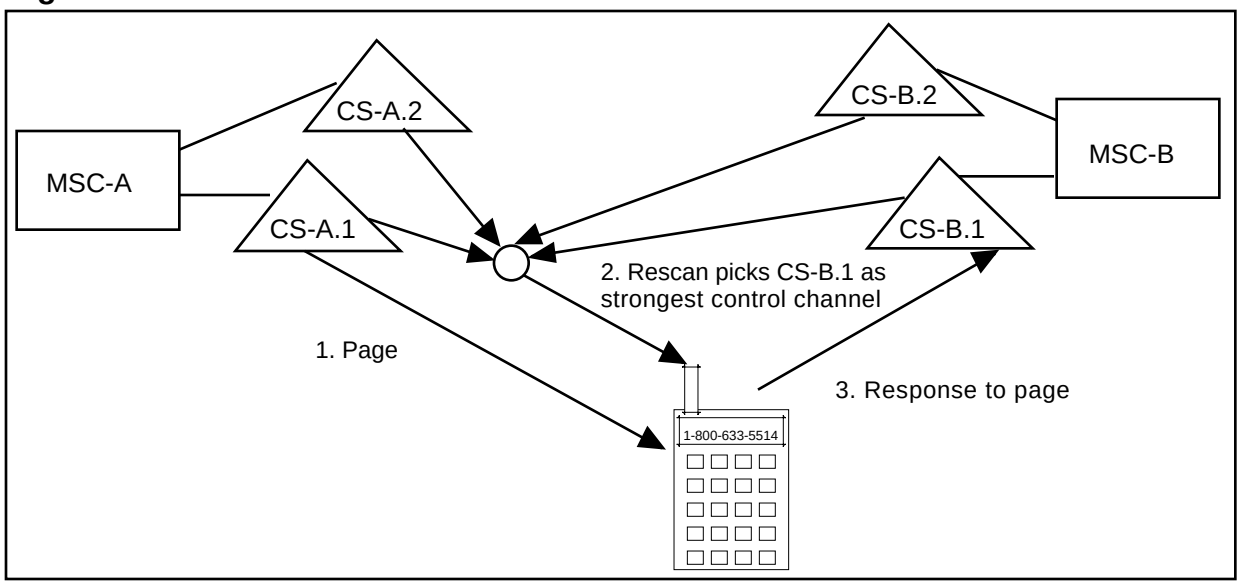
Rescan Problems

The largest number of Border Cell problems arise from the rescanning that is mandated by air interface standards at different times. Taking a simple example, if a mobile is paged in several cells, it will not necessarily receive the page message from the best cell. This is because an idle mobile will remain on a control channel as long as it can remain synchronized with it, checking for the strongest control channel usually only every few minutes. When the page is received, the signal strength could be quite low (see Figure 1). To correct this, the air interface standards require the mobile to rescan for the strongest control channel signal before responding to the page. Consequently, the page response may be received in a different cell. If the cell is connected to the same MSC, no harm is done. However, if the cell is connected to a neighbouring system it will not even be aware of which system initiated the page. This problem has several manifestations (see Table 1).

Table 1: Summary of Border Cell Rescan Problems

Rescan Problem	Description	Problem	Resolution
Unsolicited Page Response	Page received in one system but, due to rescan, response is transmitted to a neighboring system.	Termination unsuccessful.	TSB-65
Registration	Registration stimulated in one system, but due to rescan, response is transmitted to a neighbor.	Mobile lost.	EIA/TIA-553 Rev. 0
Origination	Mobile originates a call in a system it is not registered in and, after the call, returns to the original system.	Mobile lost.	TSB-65
Authentication RANDC	Mobile transmits authentication data (RANDC) from a neighbor system.	Authentication fails. Call denied or fraud allowed.	IS-41 Rev. C
Orders	Order received in one system but response is transmitted to a neighbor.	Operation fails.	None
Non-preferred System	Mobile accesses a system with the strongest signal, while the home system (or other preferred system) has an adequate signal level.	Call may cost more, and fewer services may be provided.	IS-41 Rev. D (NDSS feature)
Handoff while Alerting	Inter-system handoff is not possible during alerting.	Call gets noisy or is dropped.	IS-41 Rev. C

Figure 1: The Genesis of a Rescan Problem



Multiple Access Problems

A mobile message, particularly a registration, origination or page response, may be received by multiple control channels. A message received on the wrong control channel can sometimes be filtered out by the accompanying SAT Color Code. However, there are only four different codes on analog systems (64 in TDMA digital systems). In heavily populated areas, with many different cellular systems and topographical features such as lakes that allow the excess propagation of radio signals, the same message can be accepted by different systems. This can result in conflicting actions being taken in each system. The problems created are different in each case:

Registration

A registration by a roamer in the system that they are currently registered in will likely be absorbed by the MSC or VLR, based on the logic that the HLR only needs to know which system a roamer is in, and not which cell. A registration received by a far away system, while weaker, will be transported to the HLR, which will cause a registration cancellation to be sent to the system actually serving the mobile.

This problem is resolved in TSB-65 by more complex IS-41 registration notification and cancellation procedures, and the optional addition of signal strength information to the related IS-41 messages. This requires the HLR to wait for a cancellation to be accepted before responding to the registration, which may lengthen call setup.

Origination

An origination received from a roamer in two different systems will be detected when the mobile is assigned to a voice channel. Since the weaker originations are almost certainly in systems that the mobile is not registered in, the origination can cause an implicit IS-41 registration, causing the same problem as multiple registrations, described above. This problem can be avoided if the mobile is placed on a voice channel prior to validation (which can suppress the weaker registration when the mobile fails to appear).

Termination

A page response received from a roamer in two different systems can only cause a problem if it can be correlated with the system that initiated the page. This was not possible prior to TSB-65, as no inter-system operations for this were defined. If the page response is forwarded to the system that initiated the page (using TSB-65 or IS-41-C messages), this problem can only be resolved by placing the mobile on a voice channel to verify its presence in the system. Unfortunately, this causes yet another problem, because it requires the mobile to occupy a voice channel until call delivery is completed (which may take several seconds). For the carrier, this extends the amount of non-revenue producing voice channel occupancy and, for the mobile user, it puts the mobile into a strange state where it will not respond to a command to originate a call.

Off to the Registration Races

A mobile may be in the process of registering in a new system when a call is being delivered to it. The call will be lost unless inter-system paging procedures defined in TSB-65 are implemented and inter-system paging is attempted in the new system.

A similar problem occurs when a mobile registers in a new system and returns to the original system before the IS-41 registration cancellation message reaches it. The original system will filter out the local registration, and will delete the mobile's record when the Registration Cancellation is received. This will prevent call delivery, as the HLR will have the mobile's location recorded as the new system. This problem is not specifically addressed by standards, as local mitigation is possible (e.g. by not accepting a Registration Cancellation that is received within a few seconds of a local registration).

To be continued…

In our next issue, we will continue our discussion of Border Cell 'Challenges' with a description of the new network capabilities introduced by TSB-51 and enhanced in IS-41 Rev. C, that can ameliorate many border cell problems. ❒

TIA TR-45.2
Cellular Intersystem Operations
Working Group/Task Group Report

Cellular Networking Perspectives

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	II	Lawfully Authorized Electronic Surveillance	Peter Musgrove	3580	Law Enforcement Intercept Requirements	Kirk Carlson
I		Stage I Development (User Perspective)	Terry Watts	3362	Cellular Features Description (Rev. B)	Terry Watts
II		Stage II Development (Network Perspective)	Cheryl Blum, Gustavo Pavón		IS-41 Rev. D	Terry Watts
	I	IS-41 Application Test Plan	*inactive*	-	TSB-56	
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				n/a	Dialing Plan (IS-52)	Steve Jones

Notes: n/a - PN not assigned by TIA yet.
WG - Working Group number (assigned by TIA TR-45.2 sub-committee).
TG - Task Group or Ad Hoc Group number.
PN - Project Number (assigned by the TIA).