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Introductory Note: The 99-200 NOPR and all first round comments by all prior commenting parties implicitly assume that each telephone line must consume one distinct telephone number. No prior comment has suggested a technological method to make more effective use of existing telephone numbers by sharing one distinct telephone number among several different telephone lines of the same subscriber, as System Beta does. System Beta is a software-based method that, for example, initially increases the capacity of a single area code from 7,920,000 lines and numbers to 160,329,375 lines by means of switching software upgrades. System Beta also provides a superior method for "stranded" number portability; a method that does not require the controversial step of forced consolidation of distinct rating centers. System Beta is simpler to use than any other proposed approach, since it allows ultimate restoration of 7-digit local dialing for almost all calls everywhere in North America. Most significantly, implementation of System Beta in the US public switched telephone network is authoritatively estimated to cost about $7 Billion in one-time total costs to all parties. This is a significant saving compared to competitive estimates of $50 Billion to $150 Billion ongoing costs to all parties for continuing area code splits and overlays. The cost analysis report is attached. Further technical information is also available on Internet web page www.Betalab.org

Attachment: System Beta Brief Description and Cost Estimates (32 pp.)

System Beta
Brief Description and Cost Estimates

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EXECUTIVE SUMMARY:

System Beta uses new software technology (patents pending) and solves the problem of number exhaustion in the public switched telephone network (PSTN) in two ways. First, System Beta allows individual subscribers to have unlimited multiple lines for diverse purposes (ordinary wired voice line, cellular/PCS, fax, voice mail, radio pager, data terminal, teenager line, teletypewriter for the deaf, etc.) but all these lines have the same ordinary decimal telephone number (TN). A typical head-of-household individual would use one telephone number for *all* of his/her business lines, and a second distinct telephone number for *all* residential lines. Second, System Beta allows porting of so-called "stranded" unused TNs, either locally or non-locally, while unambiguously identifying the true physical origin and destination rating centers, independent of the decimal central office code, for use of both human users and rating and billing systems. System Beta is extremely simple to use for people with ordinary voice services, yet it permits optional highly flexible and sophisticated controlled network routing for highly technical users. A sample eight year installation schedule is shown for System Beta, having a total one-time cost of under $7 Billion to the US telephone industry. (Canadian and other non-US telephone industry costs are not explicitly estimated but are likely under US$700 Million.) In this plan, the 20 largest US cities (and 8 largest Canadian cities) are upgraded in the first two years. System Beta then stops the need for further area code changes. The ongoing spending rate of approximately $1 Billion per year for the telephone industry's present program of area code splits and overlays would also stop. The currently estimated industry cost of over $7 Billion for eventual conversion to 4-digit area codes and/or 8-digit local numbers would not occur. System Beta also allows eventual re-consolidation of areas previously split or overlaid, and ultimately restores local seven-digit dialing. The related end user costs (extra dialing, dialing errors, changes in signs and stationery, etc.) of area code changes would also stop. The FCC has estimated that the total cost to the public due to these splits and overlays, together with the eventual 4-digit area code change, may eventually lie between $50 Billion and $150 Billion. *System Beta stops almost 100% of these costs.* We submit that System Beta is the best, fastest, simplest and least costly technological solution to this problem. System Beta has been studied in the ATIS ANSI T1S1.3 standards committee. It has been tabled since April 1999 due to two issues: 1) no existing member of that committee would sponsor further standards development, and 2) automatic caller ID service would eventually require more than 10 characters for secondary System Beta lines, with a related internal call-back change also needed. However, the recently revised ANSI/TIA/EIA-716-1998 standard for caller ID equipment issued by TIA standards committee TR41.3, now permits up to 23 calling number characters, for other reasons unrelated to System Beta. There are thus several methods to resolve issue 2 technologically, although the calendar for the necessary steps remains to be set. Resolving issue 1 requires an organization with appropriate standing in the telecommunications industry to request the T1S1.3 committee to once again take up the standardization of System Beta.

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Brief Description of System Beta

System Beta (patents pending) has two major distinctions compared to prior North American PSTN telephone network signaling. First, in the existing PSTN, each dialable destination telephone line is identified by a unique 10-digit decimal telephone number (TN). In System Beta, one of the methods for identifying a destination line is a network-internal 10-digit 15-symbol "PN" (pseudo number). In a pseudo number, one or more of the digit symbols can be a non decimal symbol. The existing standard world-wide SS7 telephone signaling system uses a 4-bit binary code for each digit. This binary code permits 16 symbols, of which only 10 are used for the decimal digits, one is used for a STOP or END code mark (actually needed only for international calls), and the other 5 are not presently used in North America. Thus, in a pseudo number we may use 13 (so-called triskadecimal) or 15 (quincedecimal) symbols internally to start, and even more later. The use of triskadecimal internal network (not discussed in this document) permits up to 56,807,829 internally distinguishable telephone lines in each area code. The use of quincedecimal internal network addressing permits up to 160,329,375 internally distinguishable telephone lines in each area code. Later improvements (not described here) can expand this number without limit, yet have no change in the human interface or user perception of System Beta. Compare this to the present limit of 792 decimal CO codes and 7,920,000 decimal telephone numbers in each area code. Furthermore, use of quincedecimal internal pseudo number network addressing permits a total of 3375 pseudo number internal area codes and 3375 pseudo number CO codes per area. These internal network "phantom" area codes and CO codes may also be put in place to increase the previously stated PSTN capacities in densely populated areas. Alternatively, some of these internal area codes and CO codes can be used to permit direct and simple rating and billing for special service lines as well.

Keep in mind that *the end user or subscriber never sees nor dials these pseudo numbers!* They are only used internally in the network.

The second distinction is that, in System Beta, a subscriber has a *group* of telephone lines with the *same* decimal telephone number. Only the primary line (typically an ordinary voice wired line) actually uses that decimal telephone number internally. Each secondary telephone line is distinguished by means of pre-set functional purpose (FP) codes which the subscriber can set or change from the dial, usually just once in a lifetime. Then a caller normally dials a decimal telephone number appropriate for a *group* of related destination subscriber lines, dialing just seven decimal digits for a local call (or just 10 digits with a digit "1" prefix when the call is non-local). System Beta then directs the call to the appropriate destination based on the pre-set FP codes. The correct destination pseudo number is found via a data base[4] query using both the dialed telephone number and the pre-coded originating FP codes of the calling line. Destination

FP codes for each line in a group are pre-stored in the translation data base. A query is performed at the data base just after the call is dialed. The input parameters of the query (the dialed telephone number together with origination FP codes) are translated into a unique output, the destination pseudo number. This destination pseudo number is then used by the origination switch for all subsequent network routing of the call. In some instances, a transit switch, such as the so-called N-1 switch, rather than the originating end switch, can do the data base query and use the resulting pseudo number to complete the call.

Subscribers who have plain ordinary telephone service (POTS) exclusively for voice calls, with no non-voice uses, do *not* need to pre-code their lines. Subscribers who have lines used primarily or exclusively for certain pre-determined purposes may pre-code these lines by lifting their telephone handset, dialing one or more FP codes, and then hanging up. For example, a subscriber who wants a specific combination of two FP codes will dial *333 *354 (or dial 11333 11354 from a rotary dial), and then hang up[5]. This indicates to the network, for *all* subsequent calls, that the caller prefers to reach the fax machine of the financial department at the destination location. In this example, it also indicates that this line itself is a fax machine of the financial department at the originating location as well. Other code combinations can be used to set distinct *different* FP codes for outgoing vs. incoming calls, and to forbid certain codes or to absolutely require certain other codes. *The vast majority of subscribers will seldom if ever change their FP codes.* Those few "high tech" users who have very complicated desires for continual and complex modifications of the routing of each call can make use of the telephone dial or a graphic user interface to pre-set, modify, and display their FP code status. This can be done via a personal computer, among other devices.

For all callers, a dialed prefix can be used when a call is made with a different destination choice than the pre-set default. Callers only dial a special prefix when calling a specific *secondary* line, which does not match their pre-set choice, such as an adult calling a teen age line. For example, a small business office which uses only one line for both voice and fax can pre-code that line to *receive* both voice and fax calls, but pre-code the default originating function to be voice (if that is indeed the most frequently used purpose). Then, when the line is used for an outgoing fax call, this can be indicated *for just that one call* by dialing *333 765 4321 to reach the fax machine at destination line group 765 4321. At the conclusion of the call, the pre-coded FP origination code(s) is/are automatically restored[6]. Upon the installation of System Beta, we can expect that fax and data terminals will soon be available which can be pre-set to always dial the appropriate prefix automatically, so that the human user never needs to dial it manually.

System Beta is easier to use than the present PSTN for ordinary POTS users. In the present PSTN, *all* callers must dial at least ten digits for *all* local calls in most major North American cities, due to pre-existing area code splits and overlays. In System Beta, well over 95% of all callers will ultimately dial just seven digits for well over 95% of their local calls. Because System Beta allows so many lines to be served with less than 7.92 Million decimal telephone numbers, most large cities can return to effectively having only one area code and thus seven digit local dialing. Pre-existing geographically overlapping area codes become aliases for each other under System Beta, so nobody is required to change their telephone number on signs, stationery, etc. Extra manually dialed digits (keystrokes) will be needed *only* when an unusual call is dialed, such as when a caller from a primary non-coded line or a public coin telephone wishes to call a teenager's line. The users with the greatest need for simple dialing, such as the

elderly or the handicapped, will be able to dial virtually 100% of their calls in a simpler way than the prior art. They will dial seven digit local calls virtually every time[7].

A more complete description is available on the Internet at web site URL www.Betalab.org

Cost Estimates and Preferred Schedule

The total cost estimates for installation of System Beta are summarized in Table 1. The cost estimate is analyzed into several sectors, and a high and low estimate is given for each sector. The background of each estimate is given in the following text. The time schedule for the expenditures from Table 1 are described in Figures 1 and 2.

Table 1: US Upgrade Costs for System Beta Installation[8]

Item	Low Estimate (Million $)	High Estimate (Million $)	Comments
1.Planning (8 years)	4	7	Same cost for area code expansions.
PSTN first 2 years, comprising:	-	-	
2.IXC S/W upgrades	40	50	Same cost for area code expansions.
3.SCP S/W upgrades	4	5	Central and regional data bases.
4.Largest 20 MSAs S/W upgrades	1350	1420	Same cost for area code expansions.
5.E-911 S/W upgrades	8	12	Same cost for area code expansions.
6.Billing, OAM&P S/W upgrades	8	20	Same cost for area code expansions.
7.Craftsperson training	600	800	pseudo number appearance on service order documents in place of TN.
8.Non-technical staff training	300	400	Extra staff time to identify all lines of one subscriber on different switches, etc.
9.Last 6 years, comprising remaining MSAs S/W upgrades	2000	2300	Same cost for area code expansions.
Remaining items show 8 year Sub-totals:	-	-	Payout rate is mostly constant each year for remaining items.
10.One-time Customer Service Rep. Service setup	800	1200	
11.Subsidized Caller ID replacements	300	500	Same cost for area code expansions.
12.Subscriber non-subsidized Caller ID upgrades	3	4	Same cost for area code expansions.
13.Subscriber PBX upgrades (total)	30	60	Same cost for area code expansions.
Total: comprising telephone industry vs. subscriber separate costs.	**5447**= 5414 telco + 33 subscriber.	**6778**=6714 telco + 64 subscriber	Note that no additional public costs occur since there are no forced immediate telephone number changes.
Total: comprising costs unique to System Beta vs. Common Cost items.	**5447**= 1704 Beta + 3710 common costs	**6778**= 2405 Beta + 4373 common costs	Many items are common costs for both System Beta and for continued split/overlays with 4-digit NPAs.

Notes for Table 1: Items marked “Same cost for area code expansions.” will also occur *without* System Beta, primarily because of planned 4-digit area codes. Corresponding Canadian costs are not shown, but can be approximated as 10% of the US costs estimated here.

Certain near term cost estimates related to software upgrades could also be reduced further in these estimates, but we have not done so here. It has been a general practice in the industry to upgrade the software in all switches in the major MSAs at least once in each two-year interval. This is done partly to provide the latest new switching features (such as Caller ID, to give just one example) and partly to correct software “bugs” that have been discovered in the working software since the last upgrade. Because the software in telephone switches is reaching a stage of “maturity,” as a result of over 20 years of refinement, the rate of such upgrades is now being reduced so it is less frequent than once each 2 years. However, one could legitimately argue that the 2+6 year installation plan proposed here does not require any more frequent software upgrades than is presently performed by most telephone service providers (unlike the flash cut required for 4-digit area codes). Thus one could make the case that many of the items presented in this table (such as items 1, 2, 4, and 9) could validly be reduced even further. This is because much or all of their related costs would have been spent in the normal course of business anyway, regardless of System Beta. Although this is a valid argument, we have not used it here in the cost estimates for several reasons. Our main reason is to provide a very conservative and totally visible cost estimate rather than taking advantage of the many real situations in which the relevant costs would occur with or without System Beta.

We have made no attempt to estimate the cost savings to the subscribers or to the general public in Table 1. It is clear that there are significant costs to the public due to present area code splits and overlays, and due to the resulting mandatory 10-digit local dialing. Ultimately, System Beta clearly stops all of these costs. Consider an area which previously had an area code split or overlay, and has 10-digit mandatory local dialing. Within 2 to 8 years after the installation start of System Beta, that area can return to seven-digit local dialing. The prerequisite for this is that there are no telephone numbers in service in that area that duplicate each other in the last seven digits. In most cities, about 5% of existing telephone numbers are returned from service each year regardless of System Beta, because of customer moves and relocations. During the first years of System Beta installation, a much larger percentage of decimal telephone numbers will be returned, as described below.

Recurring operating costs to the telephone service providers involve such costs as more discussion time between the subscriber and a telco service representative to handle an order for a new line. This is represented in item 10 of Table 1. This cost pro-rates at about $750,000 per year per LATA. However, we believe that the opportunity exists for more income in the multi-Billion dollar annual range, from optional vertical services arising from System Beta. This extra income is much more than the alleged higher recurring costs.

Under System Beta every call from a line which has been pre-coded with origin FPs requires a data base query message and a reply. From this, one can argue that there will be a greater costs related to additional SS7 traffic caused by System Beta. However, if all such pre-coded System Beta lines make calls to telephone numbers in LRN LNP “Donor” switches, then such a data base query would be required anyway! This occurs because most such both LRN LNP donor switches and System Beta originating lines will both be prevalent first in the larger MSAs. Therefore, one can argue that there is no significant increase in SS7 message traffic due to System Beta. Considering the worst case assumption that there is no correlation between the switch location of System Beta lines and LRN LNP donor switches, the worst case cost increase

in SS7 query messages would likely not exceed $150 Million annually for added SS7-related costs for the entire USA. This illustrates the benefit of implementing System Beta on the same hardware platform, and using the same SS7 links, which are in place or committed for LRN LNP[9].

The two previous estimates together total approximately $300 Million added annual cost. In our opinion, just one optional vertical service, such as selective blocking of all calls of a certain FP type, could compensate for this. For example, many subscribers would pay a fee of $0.25 per line per month ($3 per year) to block all unsolicited sales calls. This proposed service would have an appeal somewhat similar to Caller ID, but would not require any added customer premises equipment or costs. The operational cost to the service provider is almost nil. Once it is in place, legitimate telemarketers would have the result that only those people who do not object to unsolicited telephone sales would be reached, which would greatly increase the productivity of the telephone sales force. Clearly, such a service requires the caller to honestly label their originating line with the FP code indicating "unsolicited sales call." We can realistically expect a certain small amount of mendacity from the really "bad apples" among the telephone sales organizations. However, existing FCC rules require unsolicited sales callers to permanently refrain from calling any subscriber who requests them to desist, and the record of compliance with this existing rule is well over 99.99% of all telemarketing calls. From this example, we can expect an adequate level of compliance on the part of the telemarketers so that the proposed service is not futile. With approximately 200 Million lines in the USA, telephone service providers could realize an income of $300 Million per year from just this one service alone if only *half* of all subscribers bought it.

There are also many other cost reductions in the installation, further development and testing of several existing features due to System Beta. Just one example is automatic intercept service (AIS), the interception of calls placed to a telephone number not currently in service, and then giving the caller the new telephone number of the person they are trying to reach.

The bottom line of this aspect of the cost estimate is that the added income from such optional services alone (not counting the cost savings from integration of existing services into System Beta at lower operating costs) could compensate for whatever added operational recurring costs may exist. We have therefore shown the total cost curve as a "flat" horizontal line after year10 in Figure 2, below.

"Same cost as area code expansion" items in Table 1 also occur in the split/overlay case, because eventually the North American Numbering Plan will need to be modified to allow 4-digit area codes and/or 8-digit "local" numbers. In contrast, System Beta cancels the need for 4-digit area codes or 8-digit local numbers, if it is installed in time.

According to the present split/overlay plan for the NANP, the digit "9" is presently reserved in the second digit position of existing 3-digit area codes so it can eventually be used to phase in the first 4-digit area codes. When this occurs (which is currently planned for about the year 2006, depending on the rate of telephone number consumption) a "flash cut" synchronized upgrade to *all* telephone switch software in North America will be needed. This software upgrade is somewhat less conceptually complex than the upgrade required for System Beta, but the installation will be equally or more costly than System Beta, because of the need for extensive testing and a properly coordinated "flash-cut" installation. In contrast, System Beta does *not* require a flash-cut installation. Note that 4-digit area codes also imply mandatory 11-digit local dialing in most large cities, even if 8-digit "local" numbers are not used, and imply 12-digit local dialing if they are used. Thus common cost items that would occur with or without

System Beta constitute 60% to 70% of the total estimated s in Table 1, with the *true* costs attributable to System Beta alone comprising only 30% to 35% of the total cost estimates in Table 1.

The telephone industry costs for an area code split or overlay (still using only 3-digit area codes) are known to be in the range of $16 Million to $27 Million for each event (split or overlay)[10]. The industry has been averaging about 50 such events per year for the last two years, and expects to continue at approximately the same rate. Therefore the average cost to the telephone industry is approximately $1 Billion per year. This annual expenditure rate is expected to decrease slightly in the future due to procedural improvements and certain non-repeating cost items. For example, after mandatory 10-digit local dialing is in place in an area due to an area code overlay, some of the associated costs are not repeated for the third, fourth, or further area codes! However, the FCC itself[11] has quoted an industry estimate placing the total industry and public costs of the present area code splits and overlays, together with the planned 4-digit area code change or other digit changes, between $50 Billion and $150 Billion. Resulting costs to the public include: more worker time required for telephone dialing, a greater number of wrong number events, mandatory immediate changes in all documents, stationery, signs, identified trucks and other vehicles. (Many states require commercial vehicles to bear the correct visible telephone number.) Other public costs comprise reprogramming of alarm and other automatic dialers, and programming changes in the call restriction of private branch exchanges and other customer telephone equipment. Existing Caller ID units and systems, which only handle 10-digit telephone numbers, will no longer work correctly with either 4-digit area codes, 8-digit local numbers, or with some System Beta calls.

Example of System Beta Impact on a Typical MSA:Time Schedule of Expenditures and Number Use

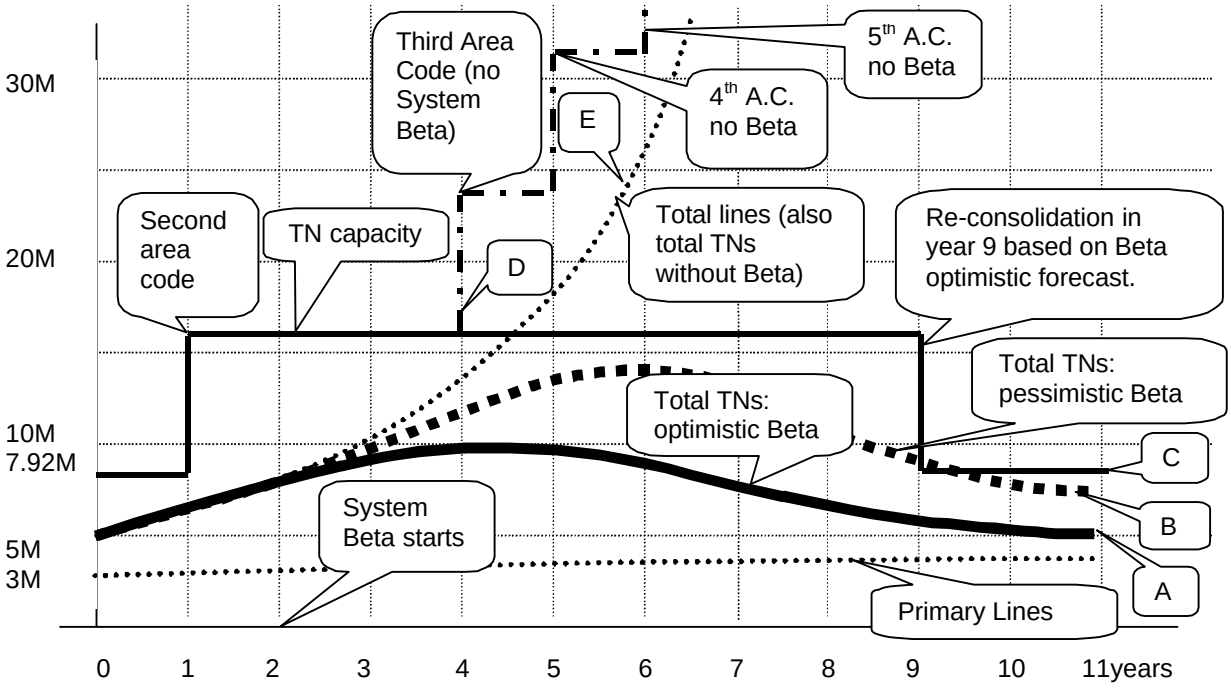

Figure 1: Schedule of Telephone Lines and Telephone Numbers vs. Time in One Hypothetical Area Code

Fig. 1 shows a preferred System Beta installation schedule and its effects on available telephone lines and telephone numbers in one hypothetical area code among the top twenty MSAs in the US. The corresponding estimate of total nationwide costs is shown in the form of a graph of cumulative telephone industry expenditures in Figure 2. Each of these figures also illustrates comparative capacity and cost for the present industry approach of repeated area code splits and overlays.

The schedule in Fig. 1 is based on a population and usage model that is a very severe test of System Beta. The initial use of telephone lines and Telephone numbers in year zero in this area code is assumed to comprise two distinct parts. The first part is 3 Million primary lines at year zero, which grow at a compound annual net rate of 3% per year, a net growth rate slightly greater than the net population growth of any of the fastest growing major MSAs in North America[12]. This 3% net compound annual growth rate takes into account both new population growth and also moves and changes. Each primary line retains its own distinct decimal telephone number throughout the process.

The second part is 2 Million secondary lines in year zero. Secondary lines are those additional lines (like cellular, fax, radio pager, voice mail, etc.) installed for the use of a subscriber who already has a primary line. Secondary lines are assumed to have an annual compound growth rate of 50%, a far more severe growth rate than any real situation in industry experience[13]. A smaller and more usual line growth rate, such as 10% to 30% per year, would produce a smaller growth in both decimal telephone numbers and total lines in use. But 30% annual growth would not be such a striking example of how System Beta can cope with a truly serious problem growth rate.

The total consumption of lines and Telephone numbers is shown by curve E, which illustrates jeopardy of exhaustion in year 1. Therefore the carriers in this area code perform a split or overlay at year 1, increasing the available quantity of Telephone numbers from 7.920 Million to 15.84 Million. (In fact, at the end of 1998, Tampa-St. Petersburg, Florida, the 20th rank MSA, was overlaid with a second area code. Many of the larger MSAs have already had two or three added area codes.) If System Beta is not used, this continuing 50% annual growth rate for secondary lines will *again* approach exhaustion in year 4, requiring a third area code (and a total line and telephone number capacity of 23.76 Million). Exhaustion will occur again in year 5 and yet again in year 6 (shown by rectangular segment line D). This need for increasingly frequent splits and overlays to avoid number exhaust is a result of the 50% annual growth model for secondary lines. An alternative (not shown in Fig. 1) to adding just one new individual area code at closer time intervals is to add two or more area codes at once. This second alternative eventually produces the same equivalent increase of 10-digit Telephone numbers, but by advancing the in-service dates of numerous area codes all over the nation, it would require 4-digit area codes at an even earlier date. The actual addition of another digit (via a 4 digit area code or 8-digit “local” numbers) is not illustrated in Fig. 1 because curve E goes “off the top” of the graph before this will happen in most planning scenarios, if year zero represents the current year, 1999.

Fig. 1 illustrates the effects of the preferred scenario on this particular area code for a nationwide System Beta software upgrade. Alternative scenarios, in which only portions of an area code or only portions of the IXC networks are upgraded, are also feasible. Such a scenario is primarily of interest for interim proprietary service offerings, in which only one or a limited number of IXCs and/or LECs install the service to gain a competitive advantage over other service providers. The details of this competitive strategy are not discussed here. The preferred

non-proprietary nationwide scenario calls for substantially all US IXC transit switches, IXC STPs and all relevant SCPs to be software upgraded during years 2 to 4. During this same 2-year interval, the transit and end switches in the 20 largest US MSAs (such as the one described by Fig. 1) are likewise upgraded. During this same 2-year interval, all other North American IXC transit switches and the 8 largest non-US MSAs would likewise be upgraded, but these and other North American non-US (e.g. Canadian and Caribbean) changes are not reflected in Figure 1. Forty five percent of the total North American population resides respectively in the top 20 US and the top 8 non-US MSAs. During the subsequent 6-year interval, culminating in year 10, all remaining MSAs, RSAs and area codes in North America are likewise upgraded with System Beta software.

Thus, during this first 2-year interval, *all* local calls, and *at least* 45% of non-local calls (actually closer to 75% of non-local calls, due to the well-known disproportionately greater amount of inter-LATA traffic which originates and terminates on the top-20 MSAs) would become accessible to System Beta. During the succeeding 6 years, 100% of North American lines will eventually have access to the features of System Beta, although many of the primary lines never need to be coded with FP codes. This gradual introduction of System Beta permits gradual recovery of a portion of the secondary line telephone numbers, culminating with *almost* all secondary lines having no distinct telephone number in year 10 or year 11.

Recovery of Unused Decimal Telephone Numbers: When System Beta is installed, a certain first quantity of telephone numbers is immediately retired by *some* multi-line subscribers, and these numbers are aged and then reassigned. Another, second quantity will be retired later during or after the initial 2-year interval, when they can be reached via the features of System Beta. All of these retired telephone numbers will be eventually re-used by other subscribers after appropriate aging. The first quantity of immediately returned telephone numbers are those used for lines which no longer need to be dialed distinctively by *non-Beta* callers. Examples in these categories include:

1) Secondary residential lines used *only* to provide extra traffic capacity, such as a simultaneous telephone conversation and Internet (or other) data connection, but not used to support distinct inward calls to different members of the family or firm;
2) Certain radio pager or voice mail lines;
3) Cellular or PCS lines for which the destination subscriber is either adequately protected from undesired calls by existing selective call acceptance[14], or cellular or PCS lines for which the caller is willing to accept all calls;
4) Public coin telephones in many areas that are now used for originate-only service.
5) Any other secondary lines for which multiple lines of the same FP type are used because of heavy incoming or outgoing traffic only, such as multiple fax lines or multiple data terminals, etc (similar to category (1) above, but not voice). Many PBX and CENTREX extensions, some sources indicate perhaps 5% to 20% or more, fall into this category.

All of these types of lines can be included in SHG or RACO line groups so that non-Beta callers can reach them in the manner desired by the destination subscriber.

The number of distinct decimal telephone numbers in service thus declines, leading to two desirable results. 1) No further area code splits or overlays are required after year 1. 2) Eventually, when the total number of distinct decimal telephone numbers in use in this area again falls sufficiently below 7.92 Million, and use of duplicate seven-digit decimal telephone numbers has been eliminated, the two area codes can be “re-consolidated” again. This is illustrated by

curve C, which drops back to 7.92 Million distinct decimal telephone numbers in year 9, based on the most optimistic forecast. The exact time required to eliminate duplicate last-seven-digit telephone numbers under System Beta depends primarily upon the diligence of the local telephone service provider(s) to avoid the issuing of decimal telephone numbers which match in the last seven digits. Once there are no ambiguous seven-digit telephone numbers, it is well known to those skilled in switching technology that the re-integration of an area which has previously had multiple area codes is free of the many problems which occurred when the new area codes were first introduced. The most significant benefit of re-consolidation is that *optional* seven-digit local dialing can be resumed. This has important cost benefits since the number of tone receivers provisioned in all switches can be reduced, the quantity of wrong number dialing events will decrease, and so forth. All the existing area codes may be retained indefinitely as aliases for each other, and *optional* 10-digit local dialing can continue to be supported indefinitely. Thus, in a city like Dallas, Texas -- which now has the three area codes: 214, 972 and 469 -- after System Beta installation and a suitable time interval to remove duplicate seven-digit Telephone numbers, callers can reach a desired telephone number (or its secondary lines) by dialing in four different ways.

For example, from *other* area codes, one can dial either 214 234 4552 or 972 233 4552 or 469 233 4552, and *within* the city one could reach that same destination by dialing *any* of these three choices. Most important, other callers *within* the same city area can optionally dial merely 233 4552. No alarm dialing equipment needs to be re-programmed. No PBXs need to have dial restrictions re-programmed. No immediate changes in signage or stationery are needed. Telephone numbers used temporarily for secondary lines can be phased out over an interval of zero to 8 years, and these numbers can be removed from signs and stationery without any cost impact, according to normal replenishment schedules for ordering new stationery or repainting or replacing trucks and other vehicles.

Caller Usage Notification of Subscribers: The top 20 MSAs in the US contain 45% of the US population, and according to some sources, originate and terminate over 75% of all IXC traffic. The remaining 25% of IXC traffic either originates or terminates on one of the smaller MSAs, RSAs, or outside North America[15]. Because of the inclusiveness of traffic within and between these largest MSAs, many lines will soon receive *no* calls from areas un-equipped with System Beta[16]. Ultimately, of course, after the completion of the eight-year installation schedule, *all* of North America will be equipped with System Beta, but even before this many destination lines will have no potential non-Beta callers. To aid the subscriber to make a fully informed choice regarding when to return a distinct secondary line telephone number, the service provider can make use of a little-known existing PSTN billing capability. Consider, for example, a System Beta subscriber who has a fax line[17] which temporarily retains its original distinct decimal TN, 214 233 6329. At the same time, this destination subscriber, whose main line number is 214 233 4552, has also tagged that fax line with the fax FP code *333 as described previously. Consequently, anyone having System Beta origination capability can also call this fax line by dialing 214 233 4552 from an originating *fax* line (a line that has been pre coded as a originating fax line), or by dialing *333 1 214 233 4552 from *any* line.

Existing telephone switching and billing systems have the capability to inform subscribers, via their printed monthly telephone bill, how many calls are received using the old distinct decimal telephone number rather than the features of System Beta. This is explained in Appendix B.3.

The goal at the end of this 8-year interval (year 10) is that each subscriber typically has one distinct business number, if their work requires business telephone lines. Also each residential subscriber has one distinct residential service number, and each business firm has one distinct main telephone number for general incoming call handling, typically by an operator or attendant. Each of these customer types may have as many additional telephone lines as they need, each secondary to the appropriate primary line. Certain secondary lines may be linked to more than one primary line. For example, a subscriber may use the same fax line as both their residential fax line and their business fax line.

Foreign callers from national telephone systems which do not support System Beta can be *permanently* accommodated by use of a special international dialing plan for specific types of lines which still receive significant number of foreign incoming calls via one of a limited number of international gateway switches[18]. These methods are not as convenient for the foreign caller as for a System Beta caller, but they do not require any hardware or software change in a foreign national telephone network which conforms to current ITU recommendations. For example, consider the subscriber described above that *formerly* used 214 233 6329 for a fax line. North American callers can reach the subscriber's voice line by dialing 214 233 4552 from a voice line. After System Beta is installed in North America, all of his/her North American callers can reach that fax line via System Beta by dialing 214 233 4552 from an originating *fax* line. We assume that the pseudo number of this destination fax line is a non-dialable PN like 214 233 t3h5, although of course this is not known to the ordinary subscriber.

There are several general ways to accommodate foreign callers desiring the user's fax line. We will describe just one of these. The North American Numbering Plan currently requires both the first and fourth digits of a decimal telephone number to not use 0 or 1, as represented by the letter N in the symbolic format NXX NXX XXXX. These two locations allow the interposition of a non-ambiguous single FP code provided the interpolated digits begin with 0 or 1. Therefore, one way to allow foreign callers to dial the fax line of this hypothetical North American subscriber is for the foreigners to dial +1 133 214 233 4552. (The + sign represents the international access prefix in the foreign originating national telephone network, such as 010- in the UK. This international access prefix, like the analogous 011- prefix in North America, is not carried through the international signaling, and the remaining 14 digits shown here are within the ITU regulations' maximum length for international calls, even though they are not useable *inside* the North American PSTN.) In this first example method, the international gateway switch recognizes the "133" digits as a special service prefix, since the digit 1 is clearly not permissible in a North American number in that location. The remaining two digits 33 are then translated into a functional purpose code, and the digits "133" are removed from the incoming telephone number. The call is then routed internally in the North American System Beta equipped network by means of the telephone number 214 233 4552 together with the functional purpose code 33, indicating a fax. Then a query to a standard North American System Beta translation data base will produce the correct pseudo number 214 233 t3h5. The connection within North America is then achieved in the normal way.

Note that we could alternatively design the system to use the interpolated digits *after* the valid area code but before the "local" number part of the entire telephone number, thus: +1 214 133 233 4552. This second method is not so convenient for use with automatic dialers, since the "normal" dialed digit sequence is interrupted by the interpolated extra digits. Both of these examples are limited to a single FP code, but other methods allow the use of compound FP codes. The details are not given here but will be disclosed in a future document.

Fig. 2 illustrates the cumulative expenditures of the telephone service providers to install System Beta vs. continuing with the present process of area code splits and overlays, including the eventual inclusion of an extra digit. The upper curve in Fig. 2 illustrates the cost of $1Billion each year for the existing practice of ongoing splits and overlays.

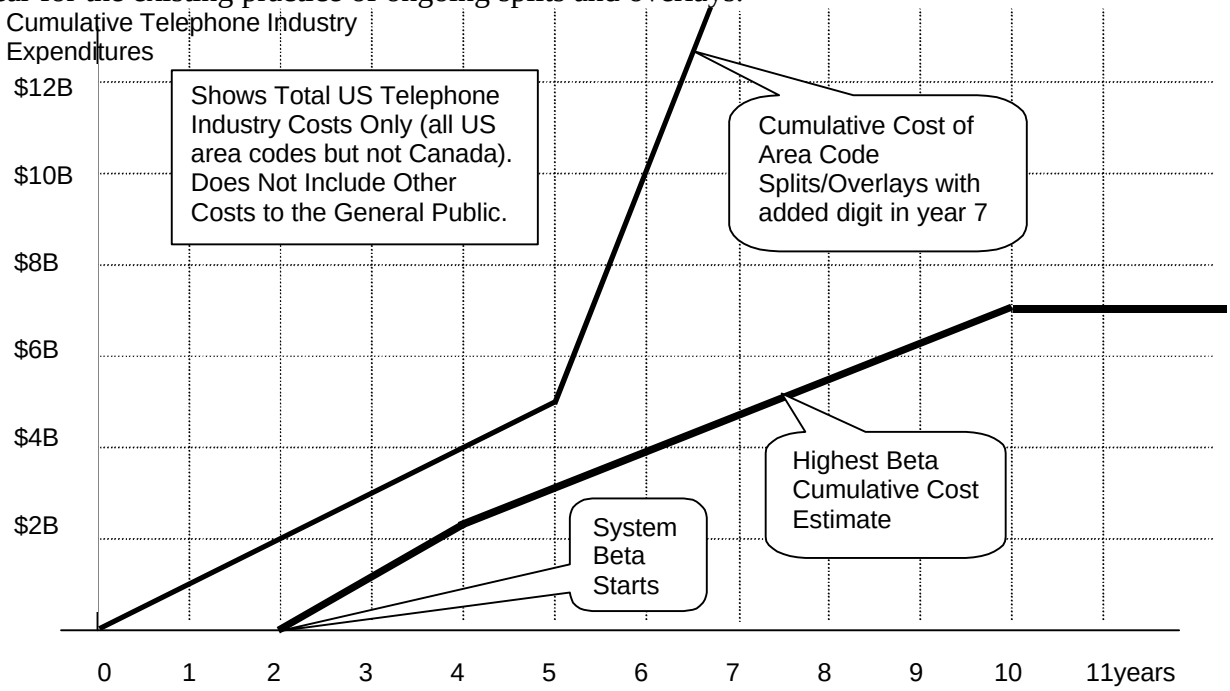

Figure 2: Cumulative US Telephone Industry Total Cost vs. Time for Prior Method of Operation vs. System Beta

If the current year 1999 is taken as year zero in Fig. 2, then:

1) More than $3 Billion of unrecoverable expenses (not shown) have already been spent on prior year splits and overlays by the telephone industry, and another $2 Billion or more must still be spent for area codes which are in jeopardy of number exhaustion before System Beta software is available in year 2 (a total unrecoverable cost of at least $5 Billion);

2) The cost of a nation wide software upgrade for increasing the number of digits in the NANP is $7 Billion or more, and is assumed completed in calendar 2006, corresponding to year 7 on Fig. 2. The total $9 Billion increase from year 5 to year 7 includes the customary $2 Billion ($1 Billion annually for two years) for ongoing area code splits and overlays as well.

Now that a technological alternative is available, there is a clear cost of delay, which is *approximately* $1 Billion annually to the telephone industry, for each year following year 2 that System Beta is delayed. There is also a larger annual cost to the public in addition. Like the prior unrecoverable costs, further area code split or overlay costs are unrecoverable regardless of which year they are spent.

There is thus a much larger unrecoverable resulting total cost to the public, which is not indicated on Fig. 2.

The estimated cost of the national software upgrade and associated cost component to accommodate the increased number of digits in the NANP is estimated as slightly larger than the software upgrade cost of System Beta. For almost every element of installation of System Beta, there is a parallel and equal or greater cost for installing longer area codes. The only software development cost in System Beta which has no parallel for increasing the number of dialed digits

is the number translation data base software for translating the combination of a dialed telephone number with origination FP codes into a destination pseudo number (item 3 in Table 1). This is a very small component of the $ 7 Billion System Beta development and installation cost. In contrast, the present procedure leading to longer area codes has two unique strikes against it. First, unlike System Beta, it requires a nationwide synchronized "flash cut" changeover of the software in all transit and end switches, which is inherently more costly and complex. Second, there is much greater complexity in human terms. After a brief interval of permissive dialing using either 7 or 10 digits locally, the existing method leads ultimately to a mandatory or "hard" requirement to use at least 10 digits locally, and a mandatory use of even more digits in either the area code or the "local" part of the number. In contrast, System Beta permits most ordinary callers continue to dial just as they did before and a mixture of different dialing lengths (7 or 10 digits for local dialing) can be tolerated indefinitely.

If 4 digit area codes or 8 digit local numbers are introduced, all of the unpleasant problems previously experienced in MSA-wide changeovers to mandatory 10 digit local dialing will be revisited on a nationwide scale. The cost of "subscriber education" will be immensely greater than for System Beta. *Everyone* must know how to dial the new longer area codes on the same day, and exceptions or errors will not be tolerated. This causes a much higher telephone industry cost since they will be held accountable for dialing problems experienced by the public.

It is true that the *conceptual* complexity of merely adding a digit to the existing area code or "local" number is simpler than the conceptual internal complexity of System Beta. However, the actual cost and complexity of the software design, code, test, and its installation and data fill are easily as complex as System Beta, if not more so. For example, there is a tremendous amount of feature interaction. Every feature that depends on digit analysis of the telephone number must be revised, upgraded and tested if an extra digit is added to the area code and/or the "local" telephone number. Some of the comparative software details are summarized in Appendix C of this report.

Finally, please note that the software upgrade used to add extra decimal digits in the NANP does *not* stop the proliferation of area codes. It merely gives the industry more area codes to work with as raw material for continuing to split and overlay area codes. In contrast, once the nationwide software upgrade installation for System Beta is merely begun, further area code changes may be stopped and no further area code changes are needed.

Non-Network Software Upgrades

There are three major types of software which are not part of the PSTN which must be upgraded to work with PNs in addition to Telephone numbers.

1. E-911 systems must accept and suitably display non-decimal pseudo number digits indicating the caller's exact originating line. For example, an alphabetic symbol can be used for each of the non-decimal digits. Thus an emergency 911 call from a secondary line like a fax machine, comprising some non-decimal digits, could display as 214 3t2 h4r3. (The use of specific letter symbols for the non-decimal digits, such as t, h, and r, are arbitrary and the final choice will be determined by the relevant standards organizations.) The E-911 answering position must also have the capability to call back the indicated pseudo number via direct access to the network using SS7, PRI, MF, DTMF, or other standard network signaling. Specific workable software mappings of the non-decimal digits used in a pseudo number have

been proposed in the T1S1.3 standards committee for all of the signaling methods listed in this paragraph, without technical objections.

2. Billing Systems Software. There is no fundamental change in such software. Each AMA record produced by a System Beta call contains the originating ANI decimal number and dialed destination decimal number (just as at present) and also the originating pseudo number and destination pseudo number as well. All rating and billing algorithms based on the true geographic origin and destination thus have the necessary data available. In addition, the voluminous quantity of permitted quincedecimal codes permit additional area codes and central office codes to be defined for special billing purposes and features even when they apply to the exact same geographic rating areas. This actually simplifies the billing of special services because all special service billing is derived from the same basic table of NPA and NXX (although it is a larger table due to the use of quincedecimal numbers). This is simpler than designing, coding and testing special software to cover exceptional cases as was done in the prior art. The many interesting ramifications arising from this superior aspect of System Beta over LRN LNP with regard to porting stranded numbers across rating zone boundaries are not described here in detail for reasons of brevity.

3. Operations, Administration, Maintenance and Provisioning software. This covers service and repair orders and related activities. There is no fundamental change in such software. Because telephone lines are traditionally identified by their telephone numbers for these purposes, such software must be upgraded to use PNs rather than only decimal Telephone numbers to identify each line. As describe above, each secondary telephone line can then be represented by a 10-character symbol such as 214 3t2 h4r3.

Conclusions and Recommendations

One of the main reasons for current lack of development of System Beta is the mere fact that there is an apparent lack of development! Many potential users have indicated that this “self fulfilling prophecy” is the main reason why they do not consider System Beta among their current immediate technical alternatives for addressing the number exhaustion problem. The T1S1.3 standards committee has tabled System Beta indefinitely because no member organization has stepped forward to officially “sponsor” the concept nor request the T1S1.3 committee to take it up as a work project. (It is historically interesting to note that no member organization stepped forward to sponsor local number portability when it was first discussed in the T1S1 committee several years ago.) After almost a year of deliberations in this standards committee, there have also been objections of real substance regarding technical points such as compatibility with existing caller ID, discussed above. However, these same issues also exist, almost point for point, with the prior art and with the present course of area code splits and overlays, leading eventually to 4-digit area codes. The difference between the two cases is that the problem with 10-digit CPE caller ID devices is relatively immediate (perhaps 2 to 4 years in the future) with System Beta. In contrast, it may not appear for 6 to 7 years with 4-digit area codes (although some industry sources predict that 4-digit area codes may be needed as soon as the year 2003 or 2004).

The T1S1.3 standards committee is clearly the technologically proper venue for System Beta. The action needed to put System Beta back on the T1S1.3 agenda is a formal written request for standards development of System Beta, from an organization having proper standing, to the chair[19] of the T1S1 standards committee group. Such an organization could be any North American telephone network service provider, or a governmental regulatory body such as the FCC.

No past technological improvement in the telephone industry, that impacted the human user interface, has been without some controversy, dissent, or criticism. Some readers will recall the strong organized opposition in the 1960s to the simple non-technical change of listing directory numbers in an all-number form rather than the prior letter-number form. From our present historical perspective in 1990, one can place the benefits and objections to this in historical perspective. The convenience of international calls would have been greatly hindered if letter dial labels continued to be used for telephone number listings. How will our decisions today regarding the development and implementation of System Beta be regarded 30 years from today? We invite readers to critically examine the consequences of System Beta versus the consequences of the present industry course of area code splits and overlays, and also the remaining issues, and draw their own conclusions.

We recommend that System Beta be expeditiously standardized, developed and implemented in the North American telephone network. This conclusion is based on the superior economy, simplicity and benefits to the general public and to the telephone industry arising from System Beta.

Glossary

ADSL	Asymmetrical Digital Subscriber Line, a technology that transmits very high bit rate digital signals via telephone subscriber loop wires.
AIOD	Automatically Identified Outward Dialing, describes a signal passed by a calling PBX to the PSTN to identify the extension number of the originating caller.
AIS	Automatic Intercept Service, a service to intercept calls to a number which is not currently in service, and announce the new telephone number of the former subscriber. Some versions give the caller the option of automatically connecting to the new number for a fee. This is one of many pre-existing features which can be implemented via System Beta rather than using separate switching software.
AMA	Automatic Message Accounting, describes the process of recording the billing related details of a call (originating and destination Telephone numbers, time of call, etc.) and also describing the data record produced for that purpose.
ANI	Automatic (originating) Number Identification.
ANSI	American National Standards Institute
ATIS	Alliance for Telecommunications Industry Solutions
BCS	Batch Change Supplement. A major revision or upgrade in switching software (Nortel terminology)
BRI	Basic Rate Interface, an ISDN interface used for one or two line equipment channels, and/or the call processing signals used therein.
Caller ID	Identification of the calling telephone number (and optionally, caller directory listing name) via a pre-answer burst of modem data sent from the central office switch during the interval between the first two ring bursts on an incoming call.
CENTREX	A marketing name for a set of PBX-like services provided from a telephone service provider switch to a multi-line subscriber. Many different marketing names such as PULSAR, ESSX, etc. are used by different LECs for this product.
CLEC	Competitive Local Exchange Carrier, usually a new entry services provider providing LEC service.
CO	Central Office (code)
CPE	Customer Premises Equipment, Customer Provided Equipment.
Decimal	Base 10 numbering system, in which each digit has one of 10 distinct values.
DTMF	Dual Tone Multi-Frequency signaling. (also called Touch Tone)
FCC	Federal Communications Commission
FP	Functional Purpose (code(s))
Generic	A major revision or upgrade in switching software (Lucent terminology)
ID	See Caller ID
ILEC	Incumbent Local Exchange Carrier, the previous local monopoly LEC.
ITU-T	International Telecommunications Union, Telecom Sector, a standards organization formerly known as CCITT.
IXC	Inter-Exchange Carrier, a telephone service provider who transmits calls from one LATA to another.
LATA	Local Access and Transport Area.
LEC	Local Exchange Carrier, a telephone service provider who completes calls only within a LATA.

LNP	Local Number Portability, is the name for both the method and the service of "porting" or transferring the physical appearance of a telephone number from a "donor" switch to a "recipient" switch. The recipient switch has a different central office code than the central office code of the "donor" switch and the ported number itself.
LRN	Location Routing Number, describes both a "dummy" routing number used for this particular method of number porting, and also the name of the method itself.
MF	Multi-Frequency Signaling.
Modem	Modulator-Demodulator, a device for transmitting digital information via a modulated sinusoidal carrier waveform, typically over a voice-grade telephone channel.
MSA	Metropolitan Statistical Area.
N-1 Switch	A transit switch, typically but not exclusively operated by an inter-exchange carrier, which can query the data base and work with the pseudo number resulting from the consequent translation to complete the connection, instead of doing so at the originating switch.
NPA	Numbering Plan Area, Numbering Plan Area code (the first 3 digits of a 10-digit North American telephone number); Numbering Plan Administration.
PAT	Post Answer Transfer
PBX	Private Branch Exchange.
PCS	Personal Communication System, a form of cellular radio telephone service.
PRI	Primary Rate Interface, an ISDN interface used for PBX equipment, and/or the call processing signals used therein.
Quincedecimal	Base 15 number system, in which each digit has one of 15 distinct values.
PN	Pseudo Number, an internal network address having the 10-digit form of a telephone number but comprising one or more non-decimal digit symbols as well as decimal digit symbols.
POTS	Plain Ordinary Telephone Service, a term used in this document to distinguish a subscriber with just one voice line who does not need to make use of the capabilities and features of System Beta in most instances, but is permitted to do so when desired.
PSTN	Public Switched Telephone Network
RACO	Ring All Connect One, a call handling process for a set of destination lines in which all lines are rung simultaneously and the first to answer is connected while the other calls are automatically abandoned. This term is used in this document to provide a non-proprietary term equivalent to the Nortel term MADN (Multiple Address Directory Number) or the Lucent term CGA (Calling Group Address).
RSA	Rural Statistical Area.
SCP	Service Control Point, a point (message switching node) in the SS7 telephone signaling network at which a service control data base is located and acts, typically by translation of a network address. Note that some enhanced STPs may also have such a data base and perform this operation.
SHG	Sequential Hunt Group, a call handling process for a set of destination lines in which each member of the set is rung in pre-designated sequential order if the prior members of the set have not answered after a pre-designated time interval or are busy.

SPC	Stored Program Control(ed).
SS7	Common Channel Signaling System Number 7.
STP	Signal Transfer Point, a message switching network node in the SS7 telephone signaling network.
TDD	Teletypewriter Device for the Deaf.
TIA	Telecommunication Industries Association
TN	A traditional decimal telephone number.
Triskadecimal	Base 13 numbering system, in which each digit has one of 13 distinct values.
TTY	Teletypewriter
US, USA	United States of America
VoIP	Voice over Internet Protocol, a method for transmitting digitally coded voice in packet format.

Appendix A: Assessment According to INC Criteria

A.0 ASSESSMENT CRITERIA - This appendix reviews System Beta according to the criteria which have been established by the industry to assess the various NANP expansion options in the INC NORTH AMERICAN NUMBERING PLAN (NANP) EXPANSION REPORT (March 1999 Revisions). The material here is somewhat repetitive of similar material in the main text, but is included for those readers who wish to evaluate System Beta according to the same criteria as the INC report.

A.1 Human Factors Needs - Any expansion plan will have some impact on the users (e.g., the general public) of the numbering plan. Therefore, the expansion plan should be examined based on the degree of impact from the perspective of the general public. The following four areas are examined to understand this impact:

A.1.1 Degree of Stability - The expansion plan, including any transitional steps, should minimize the frequency and extent of number changes required to implement the new plan (e.g., Minimize changes to the basic numbering structure (NPA-NXX-XXXX) where the geographic NPA/NXX portion represents the geographic area associated with the destination address of a call and the last four digits represent the subscriber line number. System Beta has the advantage over all proposals which involve changes in the number of dialed digits. First, there is no fundamental change in the number or significance of the dialed digits. The quantitative internal capacity of System Beta is so large that there will be no future changes needed in the dialed numbers or other human interface aspects at any time after full System Beta installation. The only significant change which System Beta permits (but does not mandate) in the largest North American cities are a return to seven-digit local dialing, which is already familiar to most subscribers. The NPA portion of the dialed number still represents the geographic area, and all the various NPAs which have already been introduced into a given area due to past splits and overlays can remain, as part of a permitted optional use of ten-digit local dialing, as well. No automatic dialing equipment such as alarm systems needs to be reprogrammed. More examples are given in the main text.

A.1.2 Easy to Understand - Acceptance by the general public of any new numbering plan starts with a complete understanding of what is changing in the numbering plan and why it is changing**.** As an objective, an expansion plan, should be relatively simple, without multiple, complex activities that may be difficult to explain to the general public. Any changes should be applied consistently, uniformly and ubiquitously to all end users to avoid confusion, disruption and resistance to its implementation.

System Beta is one of the simplest proposals to understand for the general public. First, most users of POTS telephone service have nothing new to understand. POTS users make their ordinary voice calls just as they always have, with the benefit in major cities of once again being able to dial seven-digit local numbers. Second, for those users who have secondary lines which must be FP encoded, the process of encoding and the concept that the PSTN then has internal codes for each line which distinguish one line from another is easy to understand. The significance of the various codes are not abstruse but represent clear and well-understood functional uses of a telephone line, such as fax machines, data terminals, cellular/PCS telephones, preference for various human languages, radio pagers, teenager lines in the residence, various business organizational departments such as customer service, repair,

personnel, sales, etc. Once a person understands the "philosophical" distinction that multiple lines under System Beta share the same TN but are distinguished via their internally stored FP code(s), the concepts are readily understandable. A list of standard FP codes can be printed in the front of every telephone directory on just one page for ready reference.

A.1.3 Easy to Use - Any new numbering plan must be easy to use by end users. Ease of use is affected by how the new numbering plan differs from the existing NANP format and the quantity of new digits required to be dialed by the end users.

Under System Beta there is no change in the prime dialed TN itself. All other proposals mandate ten-digit local dialing. Only System Beta allows return to local seven-digit dialing. System Beta is thus superior to all other proposals with regard to the quantity of new digits required to be dialed by the end users. Instead of all users dialing 10 digits or more for every call, the *vast majority* of users will dial seven digits for the *vast majority* of all calls. In a very few calls, a prefix comprising 4 button strokes (5 dial pulls for a rotary dial) such as *354 (or 11354 for a rotary dial) will be used as explained in the main text. Even more rarely, multiple prefixes are dialed. Most cases in which such prefix characters are dialed involve calls made from a machine such as a fax or a data terminal, which can be pre-programmed to automatically dial the prefix. The small special class of users who wish to change their FP codes frequently in complicated ways can make use of various types of graphic user interfaces to facilitate this.

A.1.4 Service Identification - NANP numbers conveys to the end user certain information regarding the types of services and rating / billing to be applied to a call. For example, there are the geographic "POTS" numbers, toll free services (e.g., 800), pay-per call services (e.g., 900), emergency services (e.g., 911) and personal communications services (e.g., 500). System Beta maintains the relationship of such service prefixes to their customary meaning, without any changes.

A.2 Impact on Call Processing and Network Operations - The current 10 digit format of the NANP is inherent in all phases of call processing and, therefore, embedded in the functions provided in all network elements. The major areas/elements potentially impacted by a change in the NANP format include the digit analysis and translation required for call routing, the signaling associated with call set-up and the use of special features, the functions supported by operations support systems (OSSs), the services offered by operator services systems, the recording and billing necessary for preparation and the rendering of customer charges, and the provision of emergency services (E911).

We submit that System Beta affects all of these network operations in a less extensive, and thus a simpler, faster to implement, and less costly way than any of the alternative proposals.

A.2.1 Digit Analysis and Translations - Digit analysis and translations are required for call routing. Within the current 10-digit format of the NANP three-digit analysis is typically performed on all calls and is sufficient to identify the NPA of a 10 digit dialed call or the NXX of a seven-digit dialed call. Also, three-digit analysis of a seven-digit dialed call will, in a non-portable environment, identify the end office to which the call must be terminated. In those situations in which three-digit analysis is not adequate to effect proper call routing, six-digit analysis (NPA-NXX) is performed to further identify the disposition of the call.

System Beta retains the existing 3-digit or 6-digit translation methods wherever they are presently used. We submit that the enlargement of the relevant translation tables to accommodate quincedecimal digits is a simpler, quicker, and less costly software modification to design, code, test and implement in the network than any alternative proposal using more than 10 digits. The software details supporting this claim are not stated here for the sake of brevity but are available upon request.

System Beta does not change the present restriction on the use of leading 1 or 0 in the seven-digit local number nor as a dialed area code. Therefore all the special cases of test codes, "pseudo NPA codes," special inwats and outwats billing numbers, special automatic call distribution numbers, and special Caribbean national routing codes (cited in the INC document) are preserved intact and no network changes are required to accommodate them

In System Beta specifically does not alter the reserved status of 1 or 0 as a leading digit of the seven-digit local number for several additional reasons: First, System Beta allows return of seven-digit local dialing, and thus use of a

leading 1 or 0 digit value in this context would be ambiguous. Second, there is no quantitative need for 1 or 0. Allowing one additional leading decimal digit (such as 1) in the local number adds only 1,000,000 TNs; allowing two additional leading digits (both 1 and 0) adds only 2,000,000 TNs. But changing to System Beta in a single area code allows up to 152,409,375 additional lines of capacity (that is 160,329,375total lines minus 7,920,000 lines), without the wasteful use of additional decimal digits in the TN. Third, we purposely reserve 1 and 0 as leading digits of the seven-digit local number to allow foreign inbound calls from national systems which do not use System Beta to directly address fax machines or other secondary lines, as described in the main text.

A.2.1.1 Digit Analysis on Inbound International Calls – System Beta retains 10 digits for the national number portion of inbound international calls to primary lines, and thus the changes to inbound digit analysis are far simpler and less extensive. The translation is virtually unchanged (non-decimal values will not occur in inbound international calls). The most frequently used services, voice and fax, can be readily accommodated by means of interpolated 3-digit strings before the area code or before the first digit of the "local" North American number (the D digit). In general any single FP code can be handled in this way. Combinations of FP codes can also be accommodated, although the specifics are not stated here. We submit that these methods are a simpler, quicker, and less costly software modification to design, code, test and implement in the network than any alternative proposal using more than 10 digits for the basic TN. Moreover, such a change would allow the total length of the digit string dialed by foreign callers to remain within the digit limitation prescribed by E.164 ITU standards, and thus is less likely to conflict with any existing pre-connection digit analysis performed by a foreign originating network. This implies that such a step is less likely to require modification to existing international standards bodies such as ITU-T.

A.2.2 Signaling

A.2.2.1 SS7 Standards Impact

There is an impact from System Beta on SS7 signaling, since additional information parameters must be added to certain messages such as the data query and initial address messages. These new parameters would comprise the originating pseudo number and destination pseudo number, and the set of orignation FPs and destination FPs. (The origination FP codes are used for CPE caller ID as described below.) However, the decimal digit TNs (called and calling numbers) now used in SS7 messages would *not* be affected in either length (still 10 digits) or content (still all decimal digits). the jurisdiction information parameter (JIP) and the Global Title parameter, noted in the corresponding section of the INC report, would not require modification according to the present design of System Beta.

Relevant ITU and ANSI standards require that all message switching nodes in the SS7 network should treat any unrecognized parameter having explicit length by passing it through without modifying or discarding it. It has come to our attention that there are some very few SS7 nodes in the field which do not conform to this requirement. Since our preferred installation plan (described in the main text) calls for a specific software upgrade of all affected IXC transit switches as the first step, this should not have any impact on System Beta. However, objections have been raised against System Beta because of this existing problem with a very small part of the network, which could theoretically have the effect of mangling SS7 messages which inadvertently pass through such non-standard switches. Our response to this is, first, the alleged problem can only happen in the highly improbable case of compound errors in *both* routing *and* pre-existing erroneous operation of non-standard software. Second, many other network features in the future will require additional new parameters in SS7 messages. If the problem of dropped message parameters is not fixed for the sake of System Beta now, it must eventually be fixed for the sake of some other network feature eventually. Therefore, all SS7 switches should be brought up to standard with regard to passing unrecognized parameters, regardless of the fate of System Beta, and this tenuous objection then evaporates.

A.2.2.2 SS7 Applications Impact

SS7 network features which have existing limitations of 10 decimal digits for various parameters must only be modified to the extent that some of these digits are now permitted to be quincedecimal. No increase in the number of digits is required. Aside from the parameters mentioned in the INC report, the calling line pseudo number must be used instead of the calling line TN for network provided automatic call back features (such as *66 and *69). This change is judged to be relatively minimal, simple and straightforward within the SS7 software. In order to

accommodate 23-digit CPE caller ID equipment, the relevant FP destination codes of the call-back line must also be carried in a new parameter of the IAM SS7 message as noted above. Then the call back number can be displayed in a dialable form using prefixes such as *354. During the transition interval in the installation plan of the main text, secondary lines which anticipate calls from non-Beta areas can temporarily retain their old decimal TN. In this way, older systems and equipment which do not accommodate PNs, and older Caller ID equipment which only stores and displays 10 digits, can still function during the transition. Even in the "worst case" temporary situation where a secondary Beta line having no distinct decimal TN must be called back from a switch in an area having absolutely no Beta software upgrades, the prime line would be called back instead of the secondary line, and the human or appropriate equipment at that prime line could then perform a post-answer transfer to direct the call-back to the desired secondary line.

A.2.3 Recording and Rating - Call detail recording, performed in network switches and operator systems, is currently designed to accommodate the current 10 digit number format. In addition, downstream rating processes, which collect the call detail and develop the charge associated with the call are also built upon the current number structure. Specifically, call rating is typically performed by the recognition of the location associated with Central Office Codes (NPA-NXX) of the calling and called number, the computation of call distance and time, and the association of the related charge.

System Beta calls for each call detail record to contain both the originating pseudo number and the destination pseudo number, in addition to the originating and destination TNs. Unlike the TNs, each pseudo number is an absolutely correct representation of the originating rating center and destination rating center, respectively. The rating and billing processes therefore are qualitatively simple and require no translations or digit examination beyond the first 3 or 6, as is done today.

The rating and billing complications which occur due to ported numbers identified by the LRN do not occur in System Beta. When a single switch covers multiple rating zones, under System Beta it is *not* necessary to assign three distinct decimal CO codes to that switch, thus creating stranded TNs. Instead, all of the lines in the different rating zones of that switch may have the same decimal CO code, but each rating zone can be assigned a distinct non-decimal pseudo number CO code, and the originating lines in each of the three zones thus can have a distinct pseudo number which is directly and uniquely related to the originating rating zone via a simple 3 or 6 digit translation. A very complicated 10 digit translation would be needed if we attempted to do this without System Beta. It is likewise simple to determine in real time whether a call is local (non-toll) vs. non-local (toll), via a simple 3 or 6 digit translation, and thus give the caller a warning tone or announcement. In addition, the informative value of a mandatory dialed "1" prefix for non-local calls can be supported under System Beta, thus giving an unambiguous and already well-known interaction with the user regarding a full informed choice when dialing a non-local call.

A.2.4 Operations Support Systems - OSSs support a multitude of functions including, for example, repair and provisioning. These areas, along with almost all other areas that involve the use of support systems, use the existing numbering plan for identification of the customer and/or a network switch. System Beta assigns a unique pseudo number to each line, which can be used in all OSS applications in place of the TN. The non-decimal digits in the pseudo number must be represented by some non-numeric symbols as described in the main text.

A.2.5 Operator Service Systems - Operator Service Systems combine many of the functions described above. That is, these systems perform digit analysis and translation to support call completion on operator handled calls. Further, signaling capabilities are inherent to these systems, not only for call completion, but also for processing associated with alternate billed calls, which are routed through the operator systems. Finally, operator systems may perform recording and can provide real time rating information to callers. We again submit that operator systems (like other aspects of the network) will require simpler and less costly software modifications to support System Beta than any of the alternative proposals.

In general, the pseudo number of a line will appear at an operator service position in addition to the decimal TN. Almost all operator service positions today use display screens. The software modifications to support this are included in the estimates in the main text. The operator will be able to dial a pseudo number directly from the alphanumeric keyboard of a service position

A.2.6 Emergency Systems - E911 systems direct emergency calls to a central location (the Public Safety Answering Point or PSAP) and identify the location of the calling party. This identification is typically resident in a database that lists the location for the calling number. The major change due to System Beta is the display and lookup of the calling address based on the calling pseudo number rather than on just the calling TN. Similar comments apply as were stated for operator service positions.

A.3 Life Expectancy of Expanded NANP - A primary goal of any expansion plan is to maximize the life of the expanded NANP numbering resource. This is a function of the quantity of numbers created and the rate of consumption of those numbers. Any expansion plan should maximize the quantity of numbers.

As described above, System Beta creates up to 160,329,375 total addressable telephone lines in a single area code, while retaining seven-digit local dialing. Use of unrestricted decimal digits in the first digit position (the so-called "D" digit) allows less than 10,000,000 (actually 9,920,000 if the N11 codes like 911 are reserved). Use of eight-digit "local" TNs allows less than 100,000,000 (again actually 99,920,000). Because System Beta has greater capacity than any of the alternate proposals requiring extension of the number of decimal digits in the "local" TN, it will have the longest life expectancy in the "local" situation.

System Beta also creates 3375 area codes as well. However, the design objective of System Beta is not to increase the number of area codes, but instead to increase the number of distinguishable lines within an area code. Therefore, local seven-digit dialing can be restored to large cities, which is clearly a desirable objective in itself. Installing a second decimal area code in a city via a split or overlay only increases the number of decimal TNs by 7,920,000. Twenty-one area codes would be required using seven-digit "local" TNs to equal the 160,329,375 line capacity of System Beta having just *one* area code. In addition, if 160,329,375 total addressable telephone lines is deemed insufficient, System Beta can be expanded internally to support even more distinctly addressable lines in one area code without any change visible to the subscriber. The details are omitted for the sake of brevity.

A.4 Numbering Resource Utilization/Efficiency - The expansion plan must support the efficient assignment and utilization of numbers in order to increase the life expectancy of the new numbering plan (e.g. to support number portability, number pooling, rate center consolidation etc).

System Beta supports all of the cited services, since there is no fundamental change or restriction on the decimal TNs beyond what already exists compatibly with these features and services. System Beta can co-exist with LRN LNP, and in fact it provides important improvements in porting across rate zone boundaries as noted elsewhere. Rate centers need not be consolidated under System Beta, since the pseudo number of each line uniquely identifies the associated rate center via the first 3 or 6 digits, even when the different rate centers are all assigned the same decimal CO code. However, if rate center consolidation is desired, System Beta can support this as efficiently as the existing numbering plan since the underlying exhaustion problem is relieved. System Beta uses TNs more efficiently in the sense that one TN is assigned to a subscriber for a group of business lines (and a distinct TN for that person's group of residential lines). Thus the ratio of lines to TNs is far larger as a measure of efficiency, and in fact can be as large as is practically desired.

System Beta also uses TNs efficiently in a second sense as well: The large line capacity in one area code (160,329,375 lines as noted above) does not require the installation of a large amount of hardware, nor the use of a large amount of computer memory, nor longer connect time for telephone calls. Each of these properties can be optimized so that there is no "wasted" system capacity due to the use of System Beta. For example, using quincedecimal PNs, a single CO code on a switch can *numerically* support up to 50,625 lines (this number is 15 raised to the 4th power). However, when it is known in advance that this switch only needs to support a smaller number of lines, due to a limited subscriber population in the wiring service area, or a physical limit on the switch capacity, it is simple to configure the software so that only the necessary computer memory (among other resources) is used. Because the pseudo number is not known to the subscriber, the actual in-service PNs can be chosen (or changed at will when required) so that they all stand within a pre-specified contiguous range of internal binary numerical values and therefore they can use the available translation table computer memory efficiently. In contrast, it is definitely *not* simple to arbitrarily change the ordinary decimal TN of many subscribers when the same result is desired using decimal TNs. Subscribers object vociferously when a service provider tries to arbitrarily change the subscriber's TN. This may seem to be a small thing, since the cost of memory hardware is constantly dropping, but there are often memory size limitations for various switches which make this an important capability.

A.5 Accommodating Future Network Requirements - There are a number of services such as data, packet and voice which may require a numbering plan that is compatible with the NANP and which accommodates all such future network and service requirements. Under System Beta, new physical access lines or ports, such as those mentioned and also others such as Voice over Internet Protocol (VoIP), ADSL lines, and the like, can all be subsumed under the one pre-existing TN of a subscriber, merely by defining new appropriate FP codes to distinguish these lines. Of course, there must be physical connections to telephone networks and support for SS7-compatible messages in the new networks, but System Beta can support such new networks more easily and with greater flexibility than any plan involving a distinct decimal number for each such service.

A.6 Requirements Between Countries Served By The NANP - The plan should continue to allow for identification of and ubiquitous connectivity between countries served by the NANP. System Beta has the same compatibility with further development of services and special codes as the existing NANP, so there are no problems foreseen regarding this topic. In the long term, the best solution to continued inter-working among all nations in the NANP is clearly the adoption of System Beta in all these nations. All the relevant national telephone systems in the Caribbean and other smaller participating nations have SPC switches and can upgrade to System Beta. The schedule described in this document gives them adequate time to subsume the cost of the software under their normal software upgrade schedule. Even if some smaller national systems do so merely to allow their callers to dial secondary lines in other larger NANP national telephone systems, the full compatibility is straightforward to support.

A.7 Consistency With Public Policy - An expansion plan should not interfere with the public policy goals and requirements of all of the countries served by the NANP. In order to support a competitive market structure, it is essential that the expansion alternative, in and of itself, introduce no discrimination between or among service providers and the services that they offer. System Beta supports competition more effectively than any other proposal. For example, a subscriber can have several different lines, each on different switches operated by different service providers. One might be the main voice line, another might be a radio pager, a third might be a cellular or PCS line, and so forth. All of these lines can use the same TN, but of course different FP codes. Many new competitive services and opportunities are opened by the installation of System Beta in the PSTN.

System Beta also handles emergency and widespread disaster situations more effectively than the prior network. System Beta also provides several other capabilities that enhance the network without extra cost for other governmental and public purposes. The details are omitted here for the sake of brevity.

A.8 Uniform Availability of Numbers - The expansion plan must provide additional numbering capacity which can be used by all segments of industry. The plan should not disadvantage one industry segment over another. In addition, any expansion plan needs to consider national, intra-NANP and international inbound calling requirements.

System Beta addresses these issues in several ways. First, by significantly relieving the overall TN exhaustion problem, the frequency and severity of un-availability of TNs to one service provider or another are relieved. Second, since a subscriber can add an unlimited number of secondary lines (each with its own pseudo number) without requiring any additional TNs, and since there is no reason to reserve a particular pseudo number for a particular subscriber, there will be no problems of the type now seen regarding TN availability in order to give such a subscriber an additional secondary line.

A.9 Additional Digits - Each digit added to the 10-digit NANP number format will add additional capacity and may add additional functionality. The capacity and functionality gained is subject to a cost/benefit analysis. The expanded plan must continue to support existing functions.

As described above, System Beta generates more capacity using 10-digit PNs than is generated by using an additional decimal digit, and at a lower system cost. Because there is no new restriction on the numbering plan, all existing functions are still supported.

As described above, existing 10-digit CPE Caller ID is not compatible with either System Beta directly nor with increasing the number of decimal digits in a TN. System Beta can accommodate existing Caller ID equipment for those calling lines which temporarily retain a 10-digit decimal TN for the transition interval, but ultimately they

must be replaced or upgraded with equipment that stores more digits (permitted by the new 23-digit standard). If, instead, 4-digit are codes are used, there must be a complete equipment change out before the "flash-cut" date, since there is no provision for even temporary backward compatibility. Such a forced changeover is more expensive to the consumer (or whoever pays for the new equipment), because of the tight schedule requirements.

A.10 Evolution/Transition - The transition plan should be relatively simple, without multiple complex activities which add layers of difficulty. The sample transition plan presented in the main text of this document is, we believe, such a plan. It provides a generous transition interval, yet gives subscribers in the equipped areas the benefits of System Beta from the beginning.

The transition plan for 4-digit area codes must use a nationwide flash cut conversion at a date certain including a common permissive dialing period throughout the NANP area. In contrast, System Beta can be installed gradually over an 8-year interval, although each individual area code is preferably upgraded in a synchronized operation. However, the previous dialing formats can be supported as an optional alternative indefinitely in System Beta. Only the IXC transit switches must be completely upgraded "together." Even these IXC transit switches do not require a simultaneous flash cut, provided that all IXC network paths between LATAs that have System Beta in place are equipped with pseudo number translation.

A flash cut is generally considered to be undesirable compared to a gradual upgrade. It is a necessary part of a change to 4-digit area codes, but flash cuts in large systems have many negative features. First, when the complete schedule preceding a flash cut is done rapidly it requires a more intensive and extensive effort before the cut-over date. This leads to higher costs and the need for more resources, and the personnel involved in the preparation for the flash cut are often forced to leave other ongoing problems unattended during this time, which can lead and often has led to other network problems. Second, when there is instead a need to work with limited installation resources, the installation of the upgraded network resources often must be begun long before the cut-over date. This implies that significant funds are sunk into this installed upgrade, but it is not functioning yet and there is no immediate benefit from it. If there is no cost savings nor added income until the completion of the entire network installation, then there may be a significant economic carrying cost for the funds needed to finance the installation effort. Third, there is a technological risk with a large system flash cut. Despite the most careful testing, certain problems may not be visible until the system is running on a large scale. A gradual upgrade provides the opportunity to see the effect of real system problems (such as message delay, alternate message routing, etc.), but with a flash cut there is no real full-scale system experience until the day of the cut-over. In the worst case, when an extremely serious unforeseen problem arises after a flash cut, the system must be returned to its previous configuration so that it will continue to provide service until the problem is fixed. When this affects the human interface of millions of callers, this can be very serious.

Another important negative aspect of the change to 4-digit area codes is that it does not mean that the splitting and overlay of new area codes will stop. Instead, it just gives the industry more "raw material" with which to make new area code splits or overlays. The new area codes still have only 7,920,000 lines or TNs, so their individual effect on number exhaustion is no better than before. The ongoing cost of area code changes continues unabated. Changing to a 4-digit area code is merely a necessary and expensive step along the way. In contrast, System Beta, once installed in a particular area, stops the need for new area codes in that area.

A.11 Administration - Administration of the 10-digit NANP number has been based primarily on the elements in the number (e.g., NPA or area code, NXX or Central Office Code and XXXX or line number). Industry assignment guidelines have been developed to administer these resources. System Beta is compatible with all known administrative procedures for assignment of numbers. As noted above, System Beta also reduces the magnitude of this problem because no decimal TN is needed for a secondary line, and a non-decimal pseudo number may be changed at will with no effect on the subscriber, when this is necessary to modify or relocate a line from one switch to another.

Appendix B: Special Transition Notes

B.1 Temporary Retention of Distinct Decimal TNs – During the transition interval while System Beta is being installed in various parts of the country, some secondary lines (like a fax line) must be reachable from callers in areas not yet having System Beta. In this case that line can (at least temporarily) retain its pre-existing distinct

decimal telephone number for a transition interval of up to 2 years, or occasionally more. Such a line, or any of its secondary sub-group lines (which are reached via RACO or SHG), can thus be reached from *any* non-Beta calling telephone during the transition interval. Caller ID display and automatic call back features for any secondary line related to that sub-group prime line will remain compatible with existing equipment and use the pre-existging distinct telephone number of the sub-group prime line, which is the logically desired call back telephone number. (A more specific example of a sub-group prime line is given in End Note 17.) Ultimately, when all callers who are likely to call that particular secondary line are equipped with System Beta, the distinct decimal telephone number for that particular secondary line is returned. There is nothing particularly novel or sophisticated about retaining certain selected distinct decimal TNs longer than others. The quantity of such lines is small enough that the recycling of returned TNs from other lines is not significantly affected. In other historical cases where a new feature or capability was introduced into the telephone network, selective retention of older equipment or services has been used to retain backward compatibility. For example, telephone lines which respond to Touch Tone dialing will also respond to rotary dial pulses as well. The method for showing the subscriber that a distinct decimal TN is no longer needed is described in Appendix B.3 below. The procedure described in this paragraph is different from the treatment of foreign callers who presumably never have System Beta origination capabilities.

B.2 – Post Answer Transfer – In certain cases secondary lines may very occasionally receive a call from a non-Beta originator, but this does not happen sufficiently enough to justify retaining a separate distinct decimal TN, or it is not intentional. For example, even today callers trying to reach a fax line sometimes make errors reading a business card or letterhead and dial the voice line TN instead of the desired fax line TN. This can be an aggravating experience for the destination person, since most fax machines automatically redial repeatedly when they are not answered by a fax machine, and the answering person cannot “talk” to the caller on the fax line to tell them they dialed incorrectly. In such a case, System Beta provides a post answer transfer (PAT) capability, which can be used by either a human who answers, or by an appropriate future electronic device connected to the line. Upon answering a call which is determined to be better handled by a different line, the answering party (or equipment) can perform a cradle switch “flash” (momentary depression of the cradle switch) which causes the incoming call to be placed on “hold,” and a dial tone is heard. The answering party or equipment then dials the FP code of the desired better destination line, and then hangs up. For example, dial *333 for a fax line. Since speed is important, when most calls of this type have the same destination, the *abbreviation* *3 alone can be pre-defined by the answering subscriber in System Beta for any FP or combination of FPs, to be used only in this situation. The incoming call then rings the line selected by this FP code, and the original answering line is again free for further calls. PAT capability is a straightforward outgrowth of the switching software already available in existing telephone switches, but in System Beta it is restricted to those lines in that subscriber’s line group which can be dialed using one or more FP codes. Availability of PAT in this situation does not prevent System Beta subscribers from also optionally using the existing unrestricted call transfer, if they desire it, based on what they dial after the cradle switch “flash.” PAT capability will be retained forever in System Beta because of its general usefulness, and is not only a transition capability.

B.3 Peg Count Printed on Telephone Bill - In the situation described in Appendix B.1 where the same destination line can be called in two ways, existing telephone switches and billing systems can inform the subscriber when the old decimal TN is no longer needed. Existing systems can accumulate, and print on the customer’s telephone bill, a so-called “peg count” of the number of calls which came in to that line from callers who dialed the distinct decimal number 233 6329, in contrast to those who called the “main” number 233 4552 from an originating line which was FP coded to select the same destination line. Both Lucent and Nortel switches are already capable of preparing such a peg count, and existing billing software is capable of printing it on the monthly bill statement. Samples of such a monthly billing statement are available from the first author. A subscriber is normally fully aware that they are actively receiving many calls each month on that fax line. When the monthly peg count of incoming calls via the old decimal telephone number is down to less than 1 or 2 per month, it is clearly time to return that telephone number and accept calls only via System Beta addressing. Such a small number of calls via the old distinct decimal telephone number may be, in fact, wrong number calls! At this point, the subscriber will generally be agreeable to returning the old decimal telephone number, and it can be appropriately aged and then returned to service.

Appendix C: Summary of Software Changes and Special Issues

C.1 Network Software Changes - There are no hardware changes required in either the service provider nor the customer side of the North American telephone network, with the exception of certain customer premises equipment (CPE) caller ID devices. It is even questionable whether any System Beta software upgrades are needed for PBX equipment, but to be conservative a cost estimate has been included in Table 1 to generously cover this contingency. The necessary software upgrades are neither particularly complicated nor extensive, as the reader can judge from the brief summary description here. In most cases, well-tested software modules already exist in the industry (partly in CENTREX software) to perform the functions required for System Beta. Because of the high standards of reliability placed on PSTN network switching software, even the simplest feature must be thoroughly tested to ensure that there is no undesired or unanticipated feature interaction. This is a primary reason why these particular System Beta software upgrades will require similar development and testing resources compared to other Generic or BCS rollouts. By the same token, however, these System Beta upgrades can be integrated into the normal production of new BCS and Generic software releases from the switch vendors without special difficulties.

The network data bases to be used for System Beta are preferably the same ones (national and regional SCP data bases) now used or committed for future installation to support local number portability (LNP). The timely mandate to the telephone industry to support LNP on this particular hardware and data communications platform allows System Beta to ride the coat-tails of this same hardware platform, with great economic benefit to both the industry and the general public.

In general, the software in all PSTN stored program controlled (SPC) switches in the North American PSTN must ultimately be upgraded. By the starting date of this installation effort (likely not earlier than the year 2001) substantially all PSTN switches in North America will be SPC. (If there *are* still any non-SPC affected switches, a technical method exists to support them via the existing "gateway" switches which each non-SPC switch must use anyway to participate in the North American SS7 signaling network, but the details are not discussed here because the need is so improbable.)

End office switches must have the following basic software modifications:

1. Incoming call translation tables must be enlarged in the number of entries to accommodate triskadecimal/quincedecimal destination numbers when all the non-decimal digit values are used. For example: Consider a switch having a single central office (CO) code and thus capable of terminating up to 10,000 lines when used only with decimal telephone numbers. This same switch (assuming no limitation due to hardware) would be capable of terminating 28,561 lines ($=13^4$) when triskadecimal station numbering is used, or 50,625 lines ($=15^4$) with quincedecimal numbering. (This switch can also handle additional telephone numbers as well when additional CO codes or LRN LNP ported recipient numbers are used. For comparison to the triskadecimal/quincedecimal numbering capacities just stated, note that use of one extra decimal digit enlarges the number-related line capacity of a 10,000 line switch to 100,000. This number, while larger than the others, is perhaps larger than the optimal line capacity of a single switch in most wiring zones.)
2. The switch software must analyze dialed digit strings and support entry of FP codes from the telephone dial. The switch will also reject inconsistent combinations of FP codes, and give the subscriber feedback regarding incorrect and/or inconsistent entries, and also "read back" the current status of FP codes when desired.
3. Storage of origination FP codes accessible to the originating switch.
4. Capability to send a data base query to the relevant SCP containing the decimal destination telephone number with the appropriate originating FP codes, and capability to use the resulting pseudo number(s) from the SCP translation in an AIM message to set up a call. In cases of multiple lines in an SHG or RACO group, appropriate calling procedure must be supported.
5. Transmission of destination FP codes, whenever modified, for storage at the relevant SCP network translation point.
6. Upgrade of existing features (for example, caller ID and automatic callback) for compatibility with System Beta.
7. Rating tables must be enlarged to handle the larger range of pseudo number area codes and central office codes. Because the origination and destination PNs are absolutely unambiguous both geographically and with regard to rating zones, a number of existing rating and routing problems (which particularly occur when LRN number porting is used across rating zone boundaries) are actually solved by this change.

8. The AMA record produced for a measured call must contain the originating ANI decimal number and dialed destination decimal number (just as at present) and *also* the originating pseudo number and destination pseudo number as well.

Transit or tandem switches and SS7 Signal Transfer Points (STPs) must have the following modifications:

1. Routing translation tables must be enlarged in the total number of entries to accommodate triskadecimal or quincedecimal numbers. For example, a transit switch or STP which determines routes based on a 3 digit area code or 3 digit central office code having 792 distinct codes of the decimal type, will recognize and route up to 2197 distinct 3-digit triskadecimal codes or will recognize and route based on up to 3375 distinct 3-digit quincedecimal codes.
2. In some installations, rating tables must also be enlarged similarly.
3. In those tandem switches which optionally perform in the role of an N-1 switch to do the appropriate translation and calling, the relevant features (namely features 4, 6, 7, and 8) from the end office list above must also be implemented.

The relevant SCPs (or certain enhanced STPs or certain enhanced transit/tandem switches) must have the following basic modifications:

1. For each destination line in the geographic scope of that SCP, the current destination FP codes for such line are stored in the SCP.
2. Capability to translate each data base query message based on the best match of the FP codes in the query message with the FP destination FP codes on the individual lines in the line group having the same decimal telephone number. The specific details of the matching process will be determined by the relevant standards committee. In essence, forbidden destinations are omitted and mandatory or best match destinations are examined to obtain the best match. Line groups having the same or related functions (for example, the subset consisting of all voice-related lines, or the set of multiple lines equipped with fax for an installation anticipating heavy incoming fax traffic) that have been pre-designated by the destination subscriber for SHG or RACO treatment are all returned in the translation result message.
3. Capability to exchange data base entry information with sources (end switches) and destinations (other SCP data bases of different geographical scope). These capabilities are similar to the analogous data exchange capabilities which these SCPs already have for implementing LRN LNP.

C.2 Possible CPE Software Changes - Certain CPE switching equipment must have a software upgrade. Only a minority of CPE switching needs to be upgraded in this way. Most small to medium PBX installations such as electronic key systems or small business telephone systems which have permanently assigned telephone numbers on each line to the PSTN (the vast majority of such installations) do not need any software changes for signaling. Their signaling interaction with the PSTN is like an ordinary single line telephone. Some small business installations may optionally install a software upgrade only to meet current requirements for caller ID (described below). Many large PBX installations having extension-specific AIOD capability can also function without internal software upgrades, since all of the necessary System Beta functions can be performed by their PSTN end switch.

Those PBX installations which do require a software upgrade essentially need a subset of the features listed above for the end switch. Specifically, they need features numbered 1,2,3,5,6, and 8. The network signaling required for features 2 and 5 can be implemented by means of any existing network signaling standard such as SS7, BRI, PRI, MF, DTMF, or enhanced decadic pulsing, to match whatever signaling method is in place on the trunks between that PBX and the PSTN. Specific methodology for use of these pre-existing alternative signaling methods for the non-decimal digits in System Beta have all been presented to the T1S1.3 standards committee without any objections.

C.3 Caller ID and Related Topics - CPE Caller ID equipment must ultimately be replaced or upgraded to store more than 10 digits according to the most recent TIA TR41.3 standards[20]. At the time of writing, all existing North American Caller ID equipment in the field stores and displays only 10 digits, in accordance with an earlier TIA standard. There are more than 60 Million such devices in the field at this time. This upgrade is needed regardless of System Beta, since several other forthcoming alternative network changes will mandate the storage of more than 10 digits. These include international caller ID service and 4-digit area codes.

The specifics of a plan and calendar for such an upgrade of equipment by vendors and service providers is not yet publicly known. However, we can surmise that there will be many parallel situations to the initial introduction of existing Caller ID service and equipment. The majority of existing CPE Caller ID devices, and a sizeable fraction of the single line caller ID telephones, were originally either given to the customer at no cost or sold at a low subsidized retail price by the LECs. For example, a "feature 'phone" with caller ID, two line capability, automatic redial, speed dialing, etc., is sold by the LEC (or its agent) for a $10 to $20 price, when caller ID service is retained by the subscriber for a full year. Currently, the typical recurring cost of Caller ID service is in the range of $3 to $6 per line per month in various jurisdictions. At the same time, the manufactured or wholesale cost of a simple caller ID box is under $5. This leads to the conclusion that the most economical strategy is perhaps for the LECs and CLECs to *again* give the customer a "free" caller ID box or sell a similar subsidized feature 'phone. The main purposes of free or subsidized distribution of such CPE hardware are to accelerate the introduction of caller ID using longer digit strings, and to preclude the customer from discontinuing the highly profitable caller ID service due to technological incompatibility with prior CPE caller ID boxes. Because this process will be needed sooner (for System Beta) or later (for 4-digit area codes if System Beta is not implemented) it is a common cost element in both choices and therefore not a distinguishing cost aspect of the two choices.

For more costly CPE equipment, such as certain key systems or small business telephone systems, which sell for $200 or more per station, the history of their installation of caller ID is quite different. These have never been subsidized financially by the LECs. Their initial purchase and any needed upgrade has fallen and will continue to fall completely on the end subscriber, mostly on business subscribers. There are far fewer lines fitting into this category, and the hardware upgrade cost per line is quite low. For example, a small CPE switch (key system or PBX) would require a firmware or software upgrade and, in some cases, a modem plug in card. The total one-time cost of such an upgrade might be several hundred dollars, but when pro-rated over all such lines or stations in all installations, is typically about $1 or less per line or per station. Again, it is a common cost and not a distinguishing cost aspect of System Beta vs. 4-digit area codes.

C.4 Specific Issues Regarding System Beta - This section summarizes specific issues previously raised against System Beta and our replies:

1. System Beta cost vis-à-vis the cost of the area code split/overlay and eventual 4-digit area code changes have been analyzed thoroughly in this document, and show a very significant cost saving for System Beta, even when only the telephone industry costs (and not the total cost to the public) is examined.

2. Objections have been raised regarding the alleged complexity of using System Beta for the proverbial "little old lady in Pasadena" (a subscriber who is unable or unwilling to perform complex dialing operations). The example often cited is the video recorder which is still flashing the time "12:00" because programming it is too complicated for the consumer! We reply that System Beta is simpler to use than 4-digit area codes and 10 (or 11 or 12) digit local dialing for users with simple needs, but it is sufficiently versatile that sophisticated users can do very sophisticated things. In System Beta, a person who only makes ordinary voice calls to others who are also single line voice subscribers need not be aware that System Beta exists, and will have the benefit of seven-digit local dialing once more. In most cases where a line has particular FP code(s), the line will be pre-coded with FP codes that the originating caller need not remember nor dial each time they make a call. System Beta will be very beneficial for handicapped or impaired callers. In most cases when special dialing prefixes are needed, they are dialed via electronic equipment such as fax or data terminals that can be made to do so automatically. In our example, "grandma" must dial a prefix only very *occasionally*, such as dialing *356 765 4321 in order to reach, for example, a teenager's line. We submit that this is far less onerous and difficult than requiring grandma to *always* dial 214 765 4321 for the main residential number and 214 765 2345 for the teenager's line. At the same time, the "high tech" subscriber will have tremendous flexibility and capability to do interesting and complicated call routing.

3. Caller ID with System Beta requires that the CPE caller ID equipment store more than 10 symbols. As noted elsewhere, the newest 1999 product standard for such equipment now permits up to 23 digits, which is sufficient to display the call back number with appropriate FP prefixes (such as 11333) to prevent ambiguity. Although none of the new Caller ID equipment is presently in the field, it will be available by the end of this year (1999), and whatever strategy the industry follows to disperse new CPE equipment should cover the System Beta situation as well. As an interim transition method, any decimal Telephone numbers which are retained temporarily for secondary lines (described above) also serve the purpose of providing a valid call back number for existing 10-digit Caller ID devices.

For network provided automatic call back service (using the dialed service codes *66 and *69), these decimal Telephone numbers will also serve the proper purpose during the transition. Ultimately, the pseudo number (rather than the telephone number) of each specific secondary line will be used in network-based call back services, so there will be no ambiguity regarding which specific line to address for the call back. Meanwhile, there are many more aspects to automatic call back as it is today in which the actual original caller is not reached as desired, and which will work correctly under System Beta. The details are not described here for the sake of brevity.

4. Automatic Call Back services provided by the network (using vertical service codes *66 and *69) return calls to the line designated by the originator's decimal TN in existing switching software. During a period of transition, when only part of the North American PSTN is equipped with System Beta, a call originating from a System Beta secondary line (having no distinct decimal TN of its own) into a non-Beta area would lead to a call return (*69) or automatic call back (*66) directed to the prime or sub-prime System Beta line, rather than the actual originating line. We respond that the temporary use of a distinct decimal TN, as described in other parts of this report, would handle this situation both qualitatively and quantitatively during the calendar years of transition. As noted elsewhere, a distinct decimal TN is only retained temporarily on those lines for which the subscriber expects incoming calls, including automatic call backs. Other lines which *intentionally* do not have distinct decimal TNs also do not have any situation in which they would expect an automatic call back. Examples include secondary lines installed for extra traffic capacity and not intended to receive incoming calls dialed distinctly from their prime line (in SHG or RACO groups for both voice, cellular/PCS, fax, Internet, and other data communications applications), radio pagers, voice mail, public coin telephones, and the like.

5. The only alternative *technological* proposal for relief of number exhaustion is based on porting so-called "stranded" telephone numbers using LRN LNP. This presumes that there is an adequate supply of stranded telephone numbers within the same rating zone, since LRN LNP has serious problems with regard to rating and billing when porting a call across a rating zone boundary. System Beta gives the industry an alternate method for porting telephone numbers (if so desired), in addition to its ability to group multiple lines under one telephone number. Compared to LRN LNP, System Beta is superior with regard to the application of porting numbers across rating zone boundaries. A System Beta call has a unique origination pseudo number and destination pseudo number (rather than a common LRN for all numbers ported to a given recipient switch), and thus there is no question about the rating zone of each. Even when a single end switch serves multiple rating zones, it is not necessary to assign multiple decimal CO codes to that one switch. Instead, the switch can retain a single decimal CO code and can be assigned multiple non-dialable pseudo number CO codes to distinguish portions of the wiring plant which serve different rating zones. With 3375 total pseudo number CO codes in an area code, there is no practical shortage of such codes for special billing and rating situations.

6. Some people in the industry express a "philosophical objection" to System Beta, since they are used to having one decimal telephone number correspond to each telephone line. Philosophical bases for disagreement are often like the basis of religious wars in history. There is no rational argument that can reverse "philosophically" based options! System Beta must be evaluated on the basis of its costs and benefits, and its ease of use for the public. If there is a clear advantage to System Beta over the alternatives, then it is the best choice.

7. System Beta has been alleged to require service providers to "give away" switching features such as RACO and SHG to subscribers. While the necessary penetration of System Beta is posited on the assumption that service providers will not charge customers extra to use it, the alleged loss of potential income must be examined in perspective. Other than the items described in this report, no new hardware or transmission facilities or other network resources are needed to implement System Beta with "free" RACO or SHG for just those destination subscribers having multiple line sub-groups that require RACO or SHG. These subscribers are, in general, not using RACO or SHG today, so there is no truly "lost" income. In return for implementing System Beta, the telephone industry is saving about $900 Million in annual operating costs *forever*, or at least for as long as the ratio of lines to subscribers continues to increase. And, under System Beta, it is still permissible to charge extra for SHG or RACO services for distinct different telephone number line groups, just as is done today.

End Notes

[1] Richard C. Levine, Sc.D., P.E., is the principal engineer and business head of Beta Scientific Laboratory. He is also Adjunct Professor of Electrical Engineering in the graduate telecommunications program at Southern Methodist University, Dallas, Texas, and the inventor of system Beta. He has over 30 years of telecommunications and defense electronics industry experience. His prior positions include delegate from Nortel Networks to the TR45.3 standards committee, where he was the founding chair of the authentication working group which developed the standards for authentication of North American digital cellular radios to combat billing fraud.

[2] Charles L. Richoz, M.B.A., B.S.B.A. is a telecommunications consultant with over 29 years of telephone industry experience with GTE. His prior positions of national scope include Manager of Architecture Planning and Manager of Switching Standardization for GTE Telephone Operations, Irving, Texas.

[3] Charles R. Wiebe, B.Sc., M.Sc., is currently a telecommunications industry consultant. He has over 18 years experience at Nortel Networks, where his prior positions included Director of North American AIN SSP Development, and Director of AT&T (Lucent) Competitive Information. He spearheaded the development of Local Number Portability for the DMS-100 and related telephone switches.

[4] The data base will be stored at one or more SS7 Service Control Points (SCPs). Because of the pre-existing installation and commitment of the North American telephone network to install SCP data bases and associated SS7 channel capacity to support LNP, which is already mandatory, there is virtually no extra hardware cost nor call processing signal traffic due to System Beta when LNP is also in place.

[5] The actual entry format codes are proposed to begin with *3- and have two additional digits, but the actual digits to be used for each code and their internal format remain to be determined by the appropriate standards committees.

[6] The subscriber has the option (chosen via another dialed code entry, not illustrated here) of either *replacing* the pre-set FP codes with the prefix code dialed for one call (described in the text), or alternatively *combining* the non-conflicting pre-set FP codes with the prefix code dialed for one call. Voice FP codes conflict with fax FP codes for origination use, but neither is conflicting with the purchasing department code. Thus, the user who always wants to reach the purchasing department can do so via a preset FP code regardless of whether a particular call is voice or fax. Likewise, a user who normally wants the purchasing department for voice calls but when dialing a fax call wants to reach a fax *not* particularly associated with the purchasing department, can also be served properly.

[7] To illustrate only one of several ways in which System Beta can aid the handicapped, a deaf telephone subscriber can have two separate lines with the *same* decimal TN. One line is a TDD line and its FP codes are set to indicate this. The other line is for voice, and can be preset to forward all calls to the appropriate relay service for the deaf. Calls from TDD callers will automatically come in on the TDD line. Ordinary (non-TDD) callers will be automatically connected to the relay service, while the deaf subscriber still has a separate line free for his/her TDD.

[8] The range of uncertainty between the high and a low figure for each item in Table 1 reflects the difficulty of accurately determining important underlying factors, such as the precise number of telephone switches of each type now in service in the USA, the number of craftspersons and service representatives who will need to be trained, and other factors. After checking with many diverse sources in both the telephone industry and the government, we feel confident that the correct estimate is within the range of figures given in Table 1. Because of the approximate nature of the estimates, we do not carry out individual costs beyond an accuracy of two significant figures. However, the addition of items having very different magnitudes produces a total which gives a false impression of many decimal places of accuracy, when this is not the case.

[9] A “donor” switch has at least one TN ported from itself to a distinct “recipient” switch via LRN LNP technology. Once just one such TN has been ported, the NPA and CO code of the donor switch is then “marked” in a nationwide set of data bases so that every call to that donor NPA/CO must make a data base query to determine if the dialed TN is one of the ported TNs from that particular donor CO switch. As a practical matter, because porting activity is most active in the major MSAs where System Beta would first be installed as well, almost every data base query would be required anyway due to LRN LNP, regardless of System Beta. Ultimately (perhaps in 6 to 10 years) one can reasonably expect that substantially *every* call dialed in North America will require a data base query, just because of LRN LNP, so that no added SS7 message traffic can then be “blamed” on System Beta.

[10] This cost range comes from sworn testimony of incumbent telephone service providers before the Texas Public Utilities Commission in 1995-96.

[11] FCC press release 27 May 1999, titled "FCC Considers Strategies to Address United States Telephone Numbering Exhaust."

[12] Several very small MSAs and RSAs are growing at a compound annual rate exceeding 3%, but they are not in area codes which are in danger of number exhaust during the next 20 years. Bear in mind that a population growth of 1000 in a year is a 100% growth rate for an RSA with an initial population of 1000 but the same absolute growth is only a 1% increase for a MSA with an initial population of 100,000.

[13] This 50% annual growth model clearly is not realistic over an long time interval, since it grows without limit. However, the 160,329,375 line capacity of System Beta in a single area code permits support of this model for up to 10.5 years after System Beta installation, which more than covers the time interval illustrated in the two figures. Keep in mind that a second pseudo number area code can be overlaid on the first decimal area code to provide an additional 160,329,375 secondary lines, since there are a total of 3375 such 3-digit quincedecimal area codes. This number may appear to be an excessive capacity to some readers. However, we contend that the majority of the number exhaustion problem is due to the growth of secondary lines for new uses such as fax and cellular/PCS lines. A new technological innovation which requires another telephone line equivalent (such as Internet telephone, or ASDL) for each subscriber could easily double or triple the quantity of lines desired in an area code.

[14] Existing selective call acceptance allows the subscriber to specify up to 10 acceptable originating TNs. Callers from all other originating TNs are blocked automatically. Several improvements on this type of capability, some based on System Beta and some not, are under development for near future availability as well.

[15] Similar percentages of population and traffic are believed to apply to the top 8 cities in Canada.

[16] Based on well-known traffic patterns, service providers may also quickly install System Beta in specific areas of the non-top-20 parts of the nation which are known to originate large amounts of traffic toward the top-20 areas, so as to optimize the rapid return of TNs in the top 20 areas. This is a well-known method in good traffic engineering and merely echoes the same techniques used 30 years ago when direct long distance dialing was installed.

[17] Just to clarify the previous discussion of sub-group prime lines by an example, assume that this particular subscriber also had a *second* fax line due to high incoming fax traffic, which had the original TN of 214 233 8921. This second fax line was always set up in a SHG with the first fax line, and only the first fax number 214 233 6329 was told to correspondents. When System Beta is first installed, the subscriber keeps both fax lines connected, but immediately stops using the TN 214 233 8921, which can then be aged and eventually returned to service by the local service provider. The two fax lines form a sub-group, and 214 233 6329 is *the sub-group prime* line. Callers can reach the second fax line if they dial the sub-group prime line TN, 214 233 6329 when that sub-group prime line is busy. Both lines can also make simultaneous outgoing calls.

[18] There are only a limited number (less than 10) of such international gateway switches serving North America, so the total cost of their software upgrade installation is relatively small. International dialing (in contrast to domestic dialing) is already set up (according to ITU-T standards) to pass the longer dialed digit strings which will accommodate the extra digits described here. The software handling (translation of interpolated digits) of such calls is straightforward once the significance of each such international code is standardized. For example, if 133 represents the fax code (as in the main text example), then the gateway switch translates that code into the same internal FP code which a domestic North American caller would produced by dialing *333 to preset the FP code in previous examples. (The internal network representation of FP codes will most likely not be the same as their dialed representation. If System Beta is ever implemented in foreign telephone networks which do not conform to the North American Numbering Plan, the entry forms used there may not be *3--, for example.) Then the gateway switch makes a standard System Beta data base query to translate the dialed TN together with this FP code into the proper pseudo number destination code, and connects the call as described in other examples. No separate data base need be maintained for international calls. Of course, foreign callers must know the proper extra included digits to dial for specific types of calls to North America.

[19] The current chair of the T1S1 standards committee is Mr. Wayne Zeuch; Lucent Technologies (Room 4L-326); 101 Crawfords Corner Road; Holmdel, NJ 07733; e-mail: Zeuch@Lucent.com

[20] ANSI/TIA/EIA-716-1998, Telecommunications- Telephone Terminal Equipment – Type 1 Caller Identity Equipment Performance Requirements. (Also the forthcoming TIA/EIA –777-1999 describing off-hook caller ID). Both of these standards permit up to 23 stored digits.

END