Perspectives on the Feasibility and Advisability of Transitioning IoT Device Usage of NANP Numbers to Alternative Addressing and Viability of Potential Options

Final Report and Recommendations

of the North American Numbering Council

November 18, 2024

Perspectives on the Feasibility and Advisability of Transitioning IoT Device Usage of NANP Numbers to Alternative Addressing and Viability of Potential Options

I. INTRODUCTION AND BACKGROUND

Assignment

In an August 14, 2023 Letter from Trent Harkrader, Chief of the FCC's (Commission) Wireline Competition Bureau to the Honorable Karen Charles, NANC Chair re: Internet of Things Numbering Usage Working Group (IoTNU WG) the NANC was assigned with evaluating the viability and feasibility of using addressing alternatives to North American Numbering Plan (NANP) numbering resources for IoT devices (including alpha numeric addresses) and providing a written report on perspectives coming out of those evaluations.[1] Specifically, the NANC was tasked with this broad request as well as answering the following questions.

1. Why and how IoT devices use NANP numbering resources;
2. Whether and to what extent there are alternatives to using NANP numbering resources for IoT;
3. How such alternatives might best be adopted and encouraged;
4. Whether and to what extent numbering industry guidelines (such as those of the ATIS Industry Numbering Committee), the Technical Requirements Document of the North American Numbering Plan Administrator contract, and/or FCC rules should be revised to encourage or require such alternatives and/or to bar or restrict certain usage of NANP numbers; and
5. The degree to which reduction in use of numbering resources by IoT devices might aid in numbering resource conservation.

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[1] August 14, 2023, Letter from Trent Harkrader, Chief, Wireline Competition Bureau (WCB), FCC to the Honorable Karen Charles, Chair, North American Numbering Council (NANC), ("IoTNU Working Group Charge Letter"), https://www.fcc.gov/sites/default/files/IoT%20WG%20Referral%20Letter%208%2014%2023%20PDF.pdf.

The NANC was not tasked with making broader recommendations on which NANP numbers are assigned to IoT devices or other potential NANP conservation options within the confines of the traditional numbering system. As such, the NANC has generally, but not entirely, refrained from discussing NANP-based modifications (including reclamation) that may help alleviate some of the pressure that IoT devices.

Background

Webster defines "Internet of Things (IoT) as: "The networking capability that allows information to be sent to and received from objects and devices (such as fixtures and kitchen appliances) using the Internet". For the purposes of this discussion, it's useful to break down these devices into two categories: 1) Devices that are connected to the internet via wi-fi or dedicated connections; and 2) Devices that are connected to the internet via the mobile telephony networks. It is often not possible for mobile devices to connect using fixed networking. For example, it is not possible for a vehicle to utilize a physically cabled internet connection (cable modem, DSL, etc.). Fixed networking using IP addresses allows devices to connect to the internet without the use of NANP numbering resources and therefore are not part of the consideration of our charge letter. Therefore, the focus of our analysis has been on devices that rely on numbering resources to bill for and provision the underlying connectivity.

To understand why mobile devices are the focus, it's important to understand how these devices are provisioned on a wireless network. Much of how this is done today is a consequence of how mobile devices, and the services they support, have evolved over the years. Before the ubiquity of mobile internet access, mobile devices were voice only. As technology evolved, data connectivity was overlaid on top of the voice network. Because of this, the data connectivity was dependent upon provisioning of the voice connectivity as well. Additionally, with the development of roaming technologies that are also dependent upon routing of the underlying provisioned voice services, it would be a complicated task to decouple the underlying voice services from the data services. Because of the history and the tight coupling of the voice and data services, many Operational Support Systems (OSS)/Billing Support Systems (BSS) used to provision individual wireless connections use the phone number of the provisioned voice services as a primary identifier. This fundamentally creates the situation where mobile devices are dependent upon NANP resources for the provisioning of data services, even when the voice services are either not needed or even unsupported. While it may be possible to decouple the voice from the data services on mobile networks, there would be serious implications that require global technical solutions for mobile roaming, provisioning, and billing (including intercarrier billing).

Scope of Potential Addressing Options

This report is focused solely on data only cellular-based IoT devices which currently require the use of a 10-digit number to connect to the Cellular Network or are needed for billing or provisioning purposes. All other connectivity types are excluded. The NANC did not analyze whether it would be possible to make hardware or software changes in network equipment to accommodate a de novo alpha-numeric address in 64-bit format. This is outside the expertise of the NANC or the resources we able to bring to bear on the issue. That said, it is the general belief of many members of the group that the magnitude of changes required to implement any alternative addressing solution not based on the E.164 standard (the internationally recognized standard for global telephone numbering developed by the International Telecommunications Union) would be so costly as to render it infeasible.

The NANC also did not specifically address option sets related to overall NANP expansion (e.g., the 12-digit numbering plan recommended to the Commission)[2] or number conservation through changes to number assignment practices.[3]

The NANC notes that all potential options described in this report could require significant changes to the Technical Requirements Document (TRD) for the NANPA and INC Guidelines, and/or entirely new databases (that may or may not be managed in conjunction

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[2] See ATIS-0300071(2001-12), *Recommended Plan for Expanding the Capacity of the North American Numbering Plan (NANP)*, available at https://access.atis.org/higherlogic/ws/public/document?document_id=46545.

[3] See *NANC Report and Recommendation on the Feasibility of Individual Telephone Number (ITN) Pooling Trials and Alternative Means for Conserving Numbering Resources*, available at https://www.fcc.gov/sites/default/files/Final%20NAOWG%20NANC%20ITN%20Approved%20Report%2002282023.pdf.

with the 10-digit NANP). Further, any alternative will require major changes in service providers' and their roaming partners' networks, OSS/BSS, and processes. These significant and potentially costly implications, along with expediency, should be prominently considered when choosing among options.

II. RESPONSES TO CHARGE LETTER QUESTIONS

In its Charge Letter to the NANC, the Commission postulates that *"Many modern carrier network architectures (beyond time-division multiplexing (TDM) technology), including most wireless networks, may not require use of NANP numbers for the addressing and routing of Internet of Things (IoT) device communications."*[4] Certain types of IoT device communications may not need to be routed over the public switched telephone network (PSTN), remaining on the originating service provider's network. Those devices typically *do*, however, need a NANP number to connect to the mobile network and for billing and provisioning purposes. As such, a system grounded in an E.164 compliant solution is required.

The Commission also posits that *"In communications with IoT devices over such networks, where there is no human involvement in the communications traffic after device configuration, it may be unnecessary in most cases to draw and use NANP numbers for addressing. Other addressing formats might be used instead such as, for example, IP addresses or alphanumeric addresses utilizing a combination of numbers and letters."*[5] The understanding of the NANC is that an E.164 number is typically needed for a an IoT device to be provisioned and its usage billed on the wireless network.

As such, the NANC found that attempting to develop and implement an alternate addressing space (that could possibly contain alpha numeric characters) is impractical in the foreseeable future, and would be incompatible with existing OSS/BSS and the network

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[4] See IoTNU Working Group Charge Letter, available at https://www.fcc.gov/sites/default/files/IoT%20WG%20Referral%20Letter%208%2014%2023%20PDF.pdf.

[5] See IoTNU Working Group Charge Letter, available at https://www.fcc.gov/sites/default/files/IoT%20WG%20Referral%20Letter%208%2014%2023%20PDF.pdf.

elements in use by mobile access operators.[6] The potential cost of replacing existing E.164 based systems to accommodate a new identifier was not readily calculable but anticipated to be cost-prohibitive.

The Charge Letter then states that *"The Commission would greatly benefit from the NANC's expertise on the nature and scope of this issue and viability of potential solutions, including the feasibility and advisability of transitioning IoT device usage of NANP numbers to alternative addressing."*[7] With many members believing implementation of alpha-numeric addressing to be infeasible due to the potentially significant and costly changes that would be needed to accommodate it in service providers' networks and OSS/BSS, the NANC researched and analyzed other potential options. In effort to provide the Commission with useful input, the NANC interpreted "alternative addressing" to encompass options that continue to utilize the E.164 standard that is the basis for 10-digit NANP numbers today. Three potential long-term options described as "NANP-adjacent" are discussed below in response to Question 2.

Question 1: Why and how IoT devices use NANP Numbering Resources.

As is discussed above, there are several categories of IoT devices, some of which do not require a 'telephony' component per se.[8] Regardless of the need for communications from the IoT device to traverse the PSTN, service providers in the US use E.164-based 10-digit NANP numbering resources in IoT devices for identification, provisioning and billing purposes when those devices connect to the mobile access network used for both voice telephony and data transmission. Most, if not all, service providers' operational support systems (OSS), billing support systems (BSS), and network elements rely on NANP telephone numbers as a key identifier for both telephony and IoT purposes. Some IoT customers' operational support systems are designed around NANP numbers as well. Further, Short Message Service (SMS) is

[6] First a Standards Development Organization would have to be selected and in all likelihood would be 3GPP which would entail cooperation with the EU, Russian and Chinese operators.
[7] See IoTNU Working Group Charge Letter, available at https://www.fcc.gov/sites/default/files/IoT%20WG%20Referral%20Letter%208%2014%2023%20PDF.pdf.
[8] This discussion is limited to IoT devices that *do* use NANP numbers at present. The NANC did not investigate nor document IoT devices that do not use NANP numbers.

often used to “wake up” or communicate with an IoT device to prompt it to send data, for example. Some SMS requires a telephone number while others may be done through peer-to-peer protocols. Some IoT devices may have a voice component as well requiring a telephone number for PSTN connectivity and E911 purposes.

Examples of IoT device and service types that utilize 10-digit NANP numbers

One example of how service providers use telephone numbers in IoT devices is fixed wireless broadband from mobile wireless providers. As noted above, services associated with many IoT devices do not include a telephony component, yet today 10-digit NANP numbers are used in those devices for identification and to generally provision service. For many mobile wireless providers, fixed wireless allows service providers the capability to leverage robust 4G and 5G wireless broadband networks to offer an alternative to wired broadband for homes or businesses.

Based upon the one state’s research, it appears that most service providers offering fixed wireless broadband use geographic numbers to provision and bill that service. Recent quarterly reports from the three major wireless service providers reveal that fixed wireless home internet is a growing part of their broadband deployment strategies. Based on the reported data from the three major wireless service providers, there is at least the equivalent of one full area code that may be in use across the NANP to fulfill the needs of IoT for fixed wireless use. At the end of the second quarter of 2024 there were at least 10 million fixed wireless devices, with growth of approximately 1 million devices per quarter.[9] This does not account for the forecasted demand for numbering resources that are needed to provision service. Ultimately, demand for fixed wireless broadband is likely to grow as the wireless service providers continue to expand 4G and 5G access.

Another example is transportation-related IoT devices. New cars sold in the United States often come equipped with a 10-digit NANP number provided by the mobile wireless

[9] T-Mobile US Inc Q2 2024 Investor Factbook (at 21 of 28); Verizon Communications Inc. Q2 2024 Earnings Call (at 6 of 19); AT&T 2024 Trending Schedule; (at 10 of 13).

providers to their car partners/manufacturers.[10] Geographic numbers are sometimes used.[11] Examination of several mobile wireless providers websites' Frequently Asked Questions reveal that they all appear to follow the same general activation process. Generally, "connected car" wireless services are activated for a free trial at the dealership when a customer is taking possession of a new vehicle. The service will lapse at the end of the free trial unless the customer chooses to pay to have it continue.

Question 2: Whether and to what extent there are alternatives to using NANP numbering resources for IoT devices.

As is discussed above, the NANC found that implementing a new addressing space for use by IoT devices that is not based in E.164 standard would not be feasible in the foreseeable future due to the potentially significant and costly changes that would be needed to accommodate it in service providers' networks and OSS/BSS, as well as those of their roaming partners. As discussed above, the group is instead reporting here on potentially feasible changes to NANP numbering assignment rules that would segregate and treat differently numbers being assigned for use by IoT devices that do not require any telephony functionality.[12]

[10] In one report a service provider indicated that "As 5G expands, it will be able to support massive IoT connections at scale, allowing vehicles to connect with nearly everything around them. [See AT&T Blogpost dated December 8, 2022 *at* *Driving Connected Transportation to the Next Level*]. Vehicle manufacturers have also indicated that they will continue to require numbers in the future. According to GM OnStar and Ford Sync, vehicles – while currently assigned a 10-digit telephone number – no longer use the vehicle and its number for Hands-Free calling or contacting emergency services. Instead, they rely on Bluetooth pairing from the vehicle to a compatible phone to initiate voice calls [*See* OnStar notification stating Hands-Free Calling discontinuance https://www.onstar.com/support/faq/hands-free-calling#: and Ford discussion of 911 Assist setup for Ford Sync utilizing Bluetooth pairing to compatible phone for make 911 calls https://www.ford.com/support/how-tos/sync/getting-started-with-sync/how-do-i-use-911-assist-with-sync/].

[11] Field research revealed a new vehicle purchased in Maine was provisioned with a 10-digit South Carolina number , but it is not known whether the number was pre-provisioned in the vehicle or activated upon purchase, nor whether or for how long the number remained connected with the account if the consumer did not activate service.

[12] Industry would need to work out details on many aspects of each of these options to determine true viability of each. This would presumably be done through an NOI or NPRM.

Three potential long-term options based on the E.164 standard, solutions described as "NANP-adjacent", are discussed below.[13] First, building in part on work undertaken by the Canadian Steering Committee on Numbering (CSCN) in work it has been conducting for the past few years, the NANC is presenting here two potential options that would assign data only IoT devices E.164-based numbers utilizing 14-digits rather than the 10-digits used for telephony applications today. While working within the construct of the NANP 1+ dial plan, these potential options adjust assignment and use rules to dramatically increase the number of devices that can be accommodated within that system with no or minimal negative impact on the quantity of NANP numbers that will be available for traditional telephony services. The final potential option identified may require the FCC to engage the U.S. Department of State to obtain a new country code from the ITU-T to be used exclusively by data only IoT devices so that remaining resources in Country Code 1 are maintained for voice applications.

The NANC attempted to estimate that aggregate volume of new IoT-specific numbers (addresses) that could be accommodated by each of the potential options. The potential options are discussed below.

Potential Option	**Total Quantity of new numbers for IoT devices**
Potential Option 1: Subordinate Numbering (1+14 digits)	~78 Trillion
Potential Option 2: Option 7 from the CSCN Report (1+14 digits) (per NPA)	~80 Billion
Potential Option 3: Obtain New Country Code (3+10-digits)	~1 Trillion

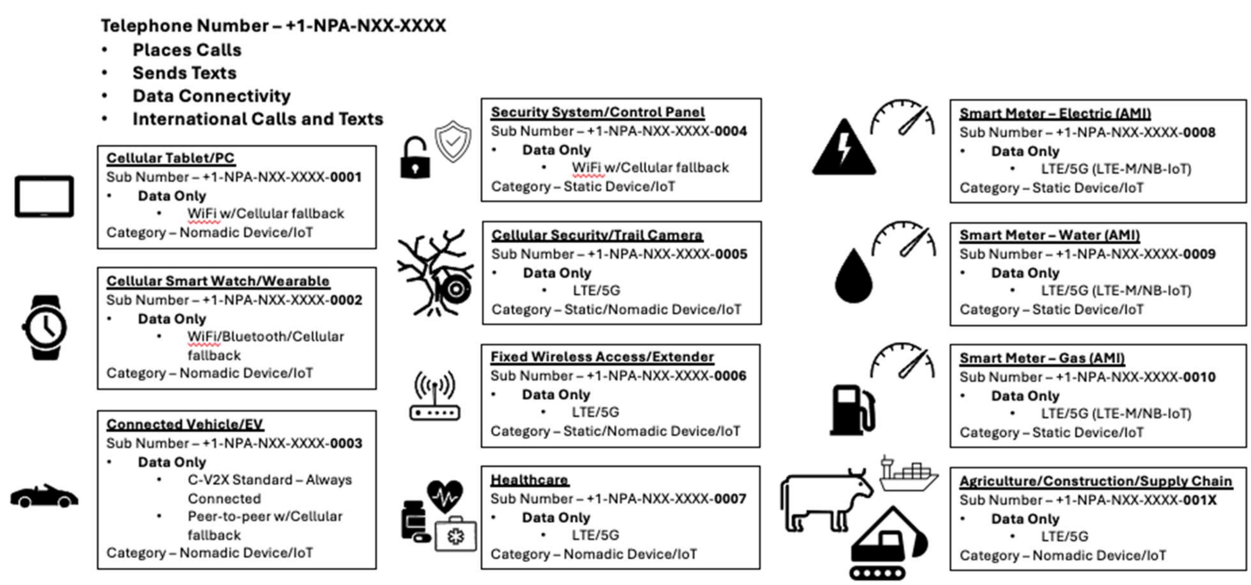
Potential Option 1: Institute Subordinate Numbering: IoT/M2M specific 1+14-digit address space

Subordinate Numbering (Subordinates) would allow for every existing 10-digit telephone number to be extended by a factor of 10,000, without impacting or disrupting traditional 1+10-digit numbers and the telephony network. Subordinates would be used for

[13] None of the potential solutions would impede the possibility of future NANP expansion.

non-telephony devices that require data only service and do not require a “true” telephone number (TN) for placing and receiving calls within the PSTN. Traditional telephony devices and services would follow that current numbering schema of 1+10-digits ([+] 1 –NPA –NXX -XXXX) and IoT/M2M devices requiring data only, non-telephony services would utilize the extended, subordinate schema of 1+14-digits ([+] 1 -NPA-NXX-XXXX-XXXX), thus separating telephony services from data only. By creating separate number addressing spaces for telephony and non-telephony services, this will in turn reduce the quantity of active, “true” telephone numbers within the voice ecosystem that can be used for spoofing or malicious intent.

Subordinates would be classified as non-telephony and follow ITU standards’ E.164 format of 15 digits (+1+14 in North America), leveraged by 3GPP and SIM card telephone number parameter.[14] This allows for these data only devices to continue to roam – domestic and international. Introduction of a 4-digit Subordinate Number, for devices requiring data only services, would extend the current NANP from 10Bn numbers to 100Tn (or ~78Tn if leading digits of 0 and 1 for NPAs and NXXs remain invalid).



Examples of IoT devices leveraging Subordinate Numbers within the 5G/LTE ecosystem

[14] Some 3GPP standards and/or ATIS INC guidelines work may be necessary.

The Subordinate schema can be leveraged for IoT devices, regardless of consumer or business vertical. Where a business or fleet would like to subtend an existing 1+10-digit main number or Billing Telephone Number (BTN) affiliated with the business, if the service provider wishes to corelate IoT devices to that business entity that could be done. Consumer IoT devices could be subordinate to any 1+10-digit number. However, subordinate numbers do not have to have any relationship to a specific 1+10-digit "true" telephone number and can be assigned per the providers discretion and policy.

According to CTIA's – 2022 Annual Survey, as of 2021, data only connections made up 42% or 208M of wireless connections within the U.S.[15] This means, in its simplest form, it would require three Central Office (CO) Codes to provide 300M subordinate numbers to account for the current demand (10,000 x 10,000 x 3). Since there are many service providers that provide IoT/M2M services, each service provider needs the ability to assign subordinate numbers from existing NANP numbers assigned to them.

As subordinate numbers (1+14) are assigned as an extension to existing 10-digit telephone numbers, number assignment for subordinate numbers may be assigned and maintained by the original Code Holder leveraging existing NANP assets. This means that only the original Code Holder may assign subordinate numbers to a 10-digit number within that CO Code, thus reducing the duplication of subordinate number assignment if a 10-digit number has been ported to another provider.[16]

Example: Code Holder subordinate number assignment range from a single assigned CO Code telephone number range [+] 1 NPA NXX 0000-9999

- Subordinate (one) [+] 1 NPA NXX 0000 0001
- Subordinate (two) [+] 1 NPA NXX 0000 0002

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[15] See *CTIA – 2022 Annual Survey Highlights,* available at https://www.ctia.org/news/2022-annual-survey-highlights.

[16] However, the potential for duplicate subordinate number assignments still exists if a particular CO code is transferred to another service provider and that new code holder is unaware that the original code holder is assigning subordinate numbers from that code. These situations would need to be addressed in INC guidelines.

- Subordinate (*100M*) [+] 1 NPA NXX 9999 9999

Since Local Number Portability (LNP)-capable switches within the PSTN have unique number ranges (CO Codes) where the LRN for said switch is assigned at inception, these are examples of CO Codes that can be leveraged for assigning subordinate numbers. Thus, protecting all number ranges within those CO Codes used for subordinate number assignment from being returned, even if 1K blocks are returned to the NANPA or individual telephone numbers are ported out from the CO Code. Each CO Code (NPA-NXX) would allow 100M (10,000 x 10,000) subordinate number assignments – meaning each service provider providing IoT/M2M service could assign one LNP-capable switch CO Code to allow for 100M subordinate number assignments, adding additional LNP-capable CO Codes as needed.

Example: Service Provider -A establishing 300M subordinate assignments using CO Code from established LNP-capable switch(es)

- LNP-capable switch CO Code (one) = 100M [+] 1 NPA NXX XXXX XXXX
- LNP-capable switch CO Code (two) = 100M [+] 1 NPA NXX XXXX XXXX
- LNP-capable switch CO Code (three) = 100M [+] 1 NPA NXX XXXX XXXX

By leveraging existing NANP assets within a service provider's established network, this could minimize the efforts of introducing a separate addressing space for IoT/M2M, while allowing for the management and administration of subordinate numbers to be maintained by that given service provider.

Potential Option 2: NANP-adjacent 1+14 Option identified in the CSCN Report to the CRTC

The Canadian Steering Committee on Numbering (CSCN)[17] issued a report to the Canadian Radio-television and Telecommunications Commission (CRTC)[18] on the similar issue in Canada on non-geographic 6YY NPA exhaustion that explicitly address various issues of IoT numbering. That report is attached here as *Attachment 1*.[19] The CSCN looked at various issues that are similar to those identified in the Charge Letter issued to the NANC by the FCC Wireline

[17] See https://crtc.gc.ca/cisc/eng/cisf3f.htm.
[18] See https://crtc.gc.ca/eng/home-accueil.htm.
[19] Also available at https://crtc.gc.ca/public/cisc/cn/CNRE138B.docx.

Competition Bureau. Of interest to the NANC, the CSCN report discussed and analyzed seven options in total, including Option 7 that would extend the format of Canada's non-geographic 6YY NPAs. The CSCN report concluded:

> *"There is consensus that Option 7 is the best solution for the long term, as it would increase supply sufficiently to comfortably meet demand until the anticipated NANP expansion (NANPE). However, further industry discussion is required before the various alternatives within Option 7 can be recommended. Nonetheless, consensus was reached to reserve NPA 677 and NPA 688 for extended digit formats and also to implement two partial solutions that will make additional 6YY NXXs available prior to the implementation of the long-term solution."*
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> *"Option 7B makes more TNs available in unused 6YY NPAs by expanding the number of digits from 1+10 to 1+14 (i.e., 1-6YY-**N**XX-XXXX-XXXX). This is compliant with ITU-T E.164 standard. This would increase the quantity of telephone numbers by a factor of 10,000, so each 1+14 digit 6YY NPA would have about 80 billion TNs."*
>
> *"Even more TNs can be made available by unlocking the D-digit so that it can be any value from 0 to 9 (i.e., 1-6YY-**X**XX-XXXX-XXXX). This is compliant with ITU-T E.164 standard. This would increase the quantity of telephone numbers by an incremental 20 billion so each affected 6YY NPA would have about 100 billion TNs."*[20]

A similar option could be implemented by expanding the remaining non-geographic 5XX NPAs to a 1+14-digit format to create a new NANP addressing space for IoT/M2M applications for data-centric, nomadic as well as static, applications to relieve the pressure on traditional NANP 10-digit geographic numbers, and to help enable innovative 4G/5G network applications.

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[20] However, unlocking the D-digit is not compliant with the industry's recommended 2001 NANP expansion plan. See ATIS-0300071(2001-12), *Recommended Plan for Expanding the Capacity of the North American Numbering Plan (NANP)*, available at https://access.atis.org/higherlogic/ws/public/document?document_id=46545.

The system of +1 14 would remove all the existing restrictions on number allocations that currently involve geographic or non-geographic 5XX numbers.

Example: [+] 1 588 NXX XXXX XXXX

Potential Option 3: Obtain a new International Country Code

In addition, the NANC briefly discussed the possibility of the NANP member countries applying for an entirely new country code directly from the ITU-T itself for the purpose of IoT/M2M number allocations. There are 83 three-digit ITU country codes still available.

This would be quite similar to the other options being presented and in full compliance with ITU E.164 recommendations. This three-digit country code + 12-digit addressing space would possibly open up to 1 trillion numbers to be used for IoT purposes.

The presentation of this option would be in the following format:

[+] CCC XXXXXXXXXXXX

The acquisition of a new country code must, by definition, be a direct request from a ITU member state and would likely need to involve the Canadian government and other NANP member states. In addition, the FCC would need to engage the International Bureau as well as the US Department of State that governs US relations with International Organizations such as the ITU.

Question 3: How such alternatives might best be adopted and encouraged.

The NANC presumes that the parameters of adoption of a new addressing space for use by non-telephony mobile IoT devices would be developed through the Commission's standard processes (i.e., Notice of Inquiry (NOI), Notice of Proposed Rulemaking (NPRM)). Coordination with other NANP member countries would also be a necessary step, and standards bodies such as 3GPP and ATIS INC may need to be involved as well to ensure any new standards are written or existing standards updated. Beyond this the NANC has a few specific recommendations on adoption. Making the system as simple and straightforward as possible will encourage adoption by service providers.

First, relative to the question of how use of any new addressing space might best be encouraged, discussions focused primarily upon the use of incentives to encourage use of any new addressing space for connectivity for non-telephony mobile IoT devices. Specifically, the possibility of exempting numbers in any new addressing space from any numbers-based charges such as the annual Commercial Mobile Radio Service (CMRS) regulatory fee.[21] State-specific surcharges could also not apply, given the data-only non-telephony use of the IoT numbers in the new addressing space.

Second, it is recommended that any solution introduced to the industry shall be implemented in a "Cap and Grow" methodology. This allows for service providers to transition from assigning 10-digit telephone numbers to assigning numbers from the new NANP-adjacent solution as IoT devices are upgraded, reactivated or when new devices are added. In other words, service providers would not be required to change the number in any existing IoT device, but would adopt the new solution on a going forward basis. Through the NOI and NPRM process the Commission could gather information on what an appropriate "cap" deadline is, giving service providers enough time beforehand to prepare to use the new solution.

Third, it is recommended that the Commission exempt the porting of numbers within any new IoT number assignment system. For IoT devices that are data only and do not place PSTN calls, there is not an explicit need for numbers associated with those IoT devices to be ported as with traditional voice services. Most users with IoT devices are currently unaware of what the actual device telephone number is, other than an identifier on their bill. Similar to how a device changes address when moved from one Wi-Fi network to another – unbeknownst to the user, when an IoT device is moved from Provider A to Provider B a new number can be assigned by Provider B and the previous number can be disconnected and returned to the unassigned pool of Provider A. This policy would simply extend the current regulatory framework for non-geographic 5XX-NXX numbers, as those numbers are not portable.

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[21] See https://www.fcc.gov/licensing-databases/fees/regulatory-fees.

Question 4: Whether and to what extent numbering industry, the TRD of the NANPA contract, and/or FCC rules should be revised to encourage or require such alternatives and/or to bar or restrict certain usage of NANP numbers.

To the extent that the Commission may contemplate a rule to *restrict the* future use of 10-digit geographic NANP numbers to "traditional" telephony applications (which in some cases may include IoT devices that include voice-telephony functionality) the NANC urges the Commission to exercise the following cautions:

- Ensure that an alternative numbering mechanism, as discussed in Question 2, for IoT devices is operational prior to implementing any restrictions on geographic 10-digit numbers;
- Ensure that any limitation is properly defined to apply only to data only IoT devices originating and receiving communications that don't otherwise traverse the PSTN.

Such a restriction would need to be codified in the operating rules, documented in industry guidelines, and documented in the TRD of the NANPA contract.

The question of how to restrict usage to telephony functions is also made particularly difficult by the proliferation in the assignment of 10-digit NANP numbers to non-service providers that may then further allocate numbers to other non-service providers and end users (an issue under discussion in multiple NANC WGs).[22] Moreover, some service providers may require their wholesale customers to draw from their stock of geographic 10-digit NANP numbers rather than allocate each wholesale customer a separate inventory of numbers, to ensure scarce numbering resources are used most efficiently. But that efficiency also makes restricting the use of those numbers to voice telephony applications more complicated. Some service providers may not presently have procedures in place to ascertain whether the numbers being utilized by wholesale providers are for voice-telephony or IoT applications. Any

[22] The service provider membership of the IoTNU WG was limited to only a handful so it was difficult to ascertain other types of IoT use cases beyond wireless.

restriction that may be implemented would likely need to be applicable to the IoT wholesale customer activating a number for an IoT application, not just the service providers themselves. Toward that end, the NANC recommends that service providers make numbers from any new IoT addressing space available to their wholesale customers in the same manner that 10-digit NANP numbers are today, to ease the transition.[23]

Finally, in order for the implementation of any new IoT addressing space to be successful and adopted by both the service provider and IoT application community, steps taken to encourage usage of that space are likely to be just as important as any restrictions the Commission may impose.

Question 5: The degree to which reduction in use of numbering resources by IoT devices might aid in numbering resource conservation.

Because such information is not publicly available, it is virtually impossible to know how many IoT devices are currently assigned NANP telephone numbers, or to estimate what the growth trajectories for those numbers may be. Indeed, there is no *current* data on the total quantities of numbers assigned in the US that is publicly available – the most recent data published by the Commission dates back to 2019.[24] As a result, it is virtually impossible to determine how much of the current demand for geographic CO codes or NANP numbers in general is related to IoT device uses, or how eliminating that portion of overall demand would impact the life of the NANP.

However, a partial indicator may be the growth in the utilization of the non-geographic 5XX NPAs since those numbering resources are designated for machine-to-machine types of

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[23] Any incentives to utilize IoT-specific numbers, such as avoidance of per number charges discussed in response to Question 3 above should also incent those wholesale customers to choose IoT numbers if they are made available as easily as traditional 10-digit NANP numbers are today.

[24] See the Commission's *Numbering Resource Utilization in the United States, Status as of December 31, 2019* report, available at https://docs.fcc.gov/public/attachments/DOC-381124A1.pdf.

services.[25] To date, a total of 33 NPAs have been designated for non-geographic 5XX-NXX services.[26] Of the 33 non-geographic 5XX NPAs, 15 NPAs are now in service, leaving 18 NPAs for future use. According to NANPA's latest non-geographic 5XX NPA exhaust projections released in October 2024, the average annual demand for 5XX-NXX codes for the next five years is 1,400 NXX codes, resulting in a forecasted need for nine 5XX NPAs in the next five years, and exhaust of the 33 designated 5XX NPAs in the next ten years.[27]

In comparison, the growth rate for geographic NPAs has significantly outpaced that for non-geographic NPAs, but again, geographic NPA exhaust cannot be solely due to IoT device uses and there is no reporting mechanism to distinguish that use. In the last ten years, 84 new geographic NPAs were placed into service compared to 11 non-geographic 5XX NPAs.[28] There are currently 80 General Purpose Code NPAs that are available for future assignment.[29] NANPA's latest NANP exhaust projection of 2053 is a projection for the entire NANP, not exclusively for geographic NPAs.[30]

Some members suggested there is a need for a method of identifying numbers being used for IoT devices and offered potential methods of doing so, such as a change to the FCC Form 502s for NRUF reporting, or a change to the geographic number request process to direct applicants to use non-geographic 5XX-NXX resources or any new NANP-adjacent structure

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[25] See the ATIS INC *Non-Geographic 5XX-NXX Code Assignment Guidelines*, available at https://access.atis.org/higherlogic/ws/public/document?document_id=73149. "Non-geographic 5XX-NXX codes are used for applications which are non-geographic in nature, are not assigned to rate centers and may or may not traverse the PSTN, but do require an E.164 addressing scheme. Calls to 5XX-NXX codes may not be dialable from the PSTN and route only within the assignee's network. The use of this NANP numbering resource is to communicate with both fixed and mobile devices, some of which may be unattended. This resource may be used for applications enabling machines, which would include but not be limited to wireless devices and appliances, the ability to share information with back-office control and database systems and with the people that use these. Service is limited only by terminal and network capabilities and restrictions imposed by the service provider."

[26] See NANPA's 5XX-NXX resources webpage, available at https://www.nanpa.com/numbering/5xx-nxx-codes.

[27] See NANPA's *October 2024 5XX NPA Exhaust Analysis*, available at https://www.nanpa.com/sites/default/files/2024-10/October_2024_5XX_NPA_Exhaust_Analysis.pdf.

[28] See NANPA's *NPAs Introduced over the Last 10 Years* report, available at https://secure.nanpa.com/public-report/npa/introduced-over-last-10-years.

[29] See NANPA's *NPA Database*, available at https://reports.nanpa.com/public/npa_report.csv, for the status of each of the 800 NPAs valid in the NANP.

[30] See generally NANPA's latest NANP Exhaust Analysis, available at https://www.nanpa.com/sites/default/files/2024-10/October_2024_NANP_Exhaust_Analysis_Final.pdf.

developed in the future for data-only IoT uses. Other members cautioned that changes to either the NRUF reporting process or the number application process could be highly disruptive and potentially costly to the entire industry. Many service providers have built highly automated processes for both NRUF and numbering resource application processing. There was no consensus to recommend such changes.

In summary, while it seems reasonable to presume that the use of NANP numbers by IoT devices contributes to NANP exhaust, and that slowing or eliminating the assignment of numbers to IoT devices that do not need them will aid in numbering resource conservation, the extent to which such a policy would meaningfully slow NANP exhaust is simply unknown. While the Bureau's charge letter did not directly raise the issues, two conservation ideas were discussed and are noted below.

Federal rules require that service providers maintain no more than a six-month inventory and INC guidelines require that service providers review their inventories at least semi-annually to identify any thousands-blocks or central office codes that can be returned to the NANPA.[31] The NANC recommends that the NANPA request that service providers conduct an internal audit to determine if any thousands-blocks or central office codes from geographic NPAs could be returned to the numbering pool and non-geographic 5XX numbers be used instead for IoT services. Further, the NANC recommends that service providers examine their wholesale number allocation practices, to determine where and when non-geographic 5XX numbers can be utilized instead of geographic numbers, and then take the necessary steps to implement "guardrails" so that geographic numbers are only allocated when truly needed.[32] There is no requirement to use geographic numbers exclusively for voice products, so forecasts

[31] See 47 CFR § 52.15 (g) (4) (iii) and the latest version of the ATIS INC *Thousands-Block (NPA-NXX-X) & Central Office Code (NPA-NXX) Administration Guidelines*, available at https://access.atis.org/higherlogic/ws/public/document?document_id=77538.
[32] That examination and any guardrails should be extended to wholesale activities as well.

and requests for geographic resources may include demand for both voice products and IoT products.[33]

Finally, some members suggested that the states could petition the Commission to authorize implementation of a specialized or technology-specific overlay ("specialized overlay") to be used for IoT services, where non-geographic 5XX numbers are not being used, as a short-term option. The NANC evaluated and discussed this proposal but was unable to reach consensus on including it as an option in this report. While some members feel strongly that implementing such an overlay[34] in advance of a longer term option is needed to preserve remaining geographic numbers for non-IoT uses, other members noted that such a specialized overlay had a number of technical questions and routing challenges to overcome first, and could cause service providers to undertake what some may view as a significant amount of effort and funding for a temporary solution, when those resources would be better spent on implementation of a longer-term option. There is currently no absolute prohibition against a specialized overlay, but states may only implement a specialized overlay if the Commission grants them delegated authority to do so.[35] The Commission would review any requests on a case-by-case basis. The criteria[36] to be addressed in each request for delegated authority to implement a specialized overlay is documented in the Commission's Third Numbering Resource Optimization Order.[37]

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[33] Service providers could be encouraged to have non-geographic numbers available at retail locations as well.
[34] The specialized overlay might include data-only applications such as fixed wireless access and connected vehicles. From field research, it appears that fixed wireless access and connected vehicles are often assigned geographic numbers, but could perhaps use non-geographic 5XX numbers instead.
[35] The history, benefits and costs of specialized overlays is documented in FCC 01-362, ¶67-79 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.
[36] See FCC 01-362, ¶80-81 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.
[37] See Attachment 2 for more information on specialized (technology-specific) overlays.

III. CONCLUSION

The NANC appreciates this opportunity to provide its perspectives on the potential viability of transitioning data-only IoT devices to an alternative NANP-adjacent addressing mechanism and stands ready to address any further questions. None of the material herein is meant to offer a recommendation pro or con relative to continued use of NANP-based assignment of numbers for IoT devices or any of the potential options outlined herein.

ATTACHMENT 1:
Canadian Steering Committee on Numbering (CSCN) Report to the Canadian Radio-television and Telecommunications Commission (CRTC) – CNRE 1388 “Methods to Address the High Assignment Rate of Non-Geographic (6YY) CO Codes”

Attachment 2

Background on the Specialized (Technology-Specific) Overlays Documented in the Second and Third Numbering Resource Optimization Report and Orders

The Commission has considered technology-specific overlays as far back as the year 2000 in its Second Numbering Resource Optimization (NRO) Report and Order[1] in which it posed several questions about its viability. Later in 2001, in the Third NRO Report and Order, the Commission determined that a ban on technology-specific overlays should be lifted and approved on a case-by-case basis.[2] The Commission stated:

> *. . . in recent years, there has been a proliferation of new telecommunications services that use vast amounts of numbering resources but do not necessarily need numbering resources from a particular geographic area. If, through the use of service-specific overlays for such services, geographic identity for some areas can be preserved, that too might outweigh any potential discrimination*.[3]

The Commission's principal concern with technology-specific overlays traditionally has been whether the practice was discriminatory to wireless customers. Implementation of a specialized (technology-specific) overlay for IoT services may not engender the same potentially discriminatory outcomes, since the primary purpose of the numbers for many IoT devices is for provisioning purposes and billing services, and customers are generally unaware of the numbers in their IoT devices. However, any potentially disparate impacts on wireless service providers, and the actual impact on exhaust for the NPA(s) in question, would need to be taken into account.

According to the Third NRO Order, state commissions currently have the ability to request delegated authority to implement a technology-specific overlay.[4] The Commission

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[1] 16 FCC Rcd 306 (2000) (*Second Report and Order*) available https://docs.fcc.gov/public/attachments/FCC-00-429A1.pdf.

[2] The history, benefits and costs of specialized overlays is documented in FCC 01-362, ¶67-79 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.

[3] FCC 01-362, ¶72 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.

[4] The criteria for such requests are available in FCC 01-362, ¶80-81 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.

even suggested that technology-specific overlays covering more than one area code could be a prudent approach.

> *We find that SOs [service overlays] that cover more than one area code are superior from a numbering resource optimization perspective because they would reduce the demand for numbers in multiple area codes, and the increased number of subscribers included in the SO would lead to better utilization of numbering resources in the SO NPA*.[5]

As the demand for IoT numbers grows, use of a specialized (technology-specific) overlay could reduce IoT number demand in geographic area codes in which IoT services currently are being assigned geographic numbers. There are a number of possible paths for that to happen:

- The Commission could order carriers using telephone numbers for non-telephony IoT services to use a newly assigned technology-specific overlay, but the specifics on IoT device capabilities and requirements would need to be clearly delineated, and the interconnection and routing issues would need to be resolved.[6]
- Carriers, or other high-volume users of telephone numbers for IoT services eligible for direct number assignment could utilize a newly assigned geographic area code for IoT services that for one technical reason or another cannot utilize a non-geographic number.
- State commissions could seek a technology-specific IoT overlay that could encompass their own state. Or,
- Multiple state commissions could also petition the Commission to request a technology-specific overlay for their geographic areas.[7]

[5] FCC 01-362, ¶83 available at https://docs.fcc.gov/public/attachments/FCC-01-362A1.pdf.

[6] How such a technology-specific overlay would differ from the already established non-geographic 5XX NPAs designated for machine-to-machine and IoT purposes would need to be identified so that service providers would have a clear understanding of what numbering resources they should use for each type of product.

[7] There are currently 11 single area code states left, and those states could petition the Commission for a joint technology-specific overlay.

CRTC INTERCONNECTION STEERING COMMITTEE

TIF REPORT

Date Submitted: **2 April 2024**

WORKING GROUP: **CSCN**

REPORT #: **138B** **File ID:** **CNRE138B**

REPORT TITLE:
Methods to Address the High Assignment Rate of Non-Geographic (6YY) CO Codes

OUTCOME: **CONSENSUS**

RELATED TASK(s) #: **n/a**

BACKGROUND:

In mid-2022, the Canadian Numbering Administrator (CNA) compiled an updated Non-Geographic (6YY) Numbering Resource Utilization Forecast (NRUF) based on revised data that had been received. The updated forecast indicated a significant acceleration in the rate of Non-Geographic NXX assignments that would substantially impact both the number of NPA Codes reserved for Non-Geographic assignments in Canada and the North American Numbering Plan as a whole.

The CNA notified Canadian Radio-television and Telecommunications Commission (CRTC) staff in a letter and suggested that CRTC staff direct the CNA to publish the updated NRUF and request that the Canadian Steering Committee on Numbering (CSCN) convene a meeting to discuss the Non-Geographic forecast results and to develop possible solutions for decreasing the demand for 6YY NXXs.

On 8 August 2022, CRTC staff advised the CNA via letter to proceed with the CNA's suggestions.

On 15 August 2022, the CNA published the July 2022 Non-Geographic NRUF aggregate results on the CNA website (https://cnac.ca/NRUF/NRUF.htm#2022) and sent a letter to the CSCN which was also posted on the CNA website (https://cnac.ca/cscn/drafts.htm#documents).

The CSCN noted that some initial work related to this topic was conducted and captured in section 7.5 of CSCN report CNRE135A (Potential Remedies for CO Code and NPA Exhaust) from TIF 110 (Identify Solutions to Mitigate NPA and NXX Numbering Exhaust). CNRE135A was submitted to the Commission. On 23 March 2023, the Commission released Notice of Consultation CRTC 2023-92, "Call for comments – Implementing thousand-block pooling."

The CSCN met on 24 August 2022 to review the Non-Geographic NRUF aggregate results which were posted on the CNA website on 15 August 2022. The CSCN agreed to draft and open TIF 112 (CNTF112A) – "*Address assignment rate of Non-Geographic (6YY) CO Codes*."

The CNA notified NANPA on 29 November 2022, of this Non-Geographic NRUF aggregate result.

The CNA conducted another G-NRUF in January 2023 and a S-NRUF in July 2023 and published the results, which are included in this report. The CSCN also requested that the CNA conduct Non-geographic NRUFs of the 6YY resources twice per year.

POTENTIAL IMPACTS:

- Availability of sufficient non-geographic numbers to satisfy demand.
- CRTC-approved guidelines associated with NPA and NXX assignment.
- Internet of Things (IoT)/Machine to Machine (M2M) network address structures.
- Consumer impacts of expanded or different network address schemes.
- Carrier infrastructure impacts of expanded network address schemes, if implemented. Carrier infrastructure includes network elements or platforms, carrier Operational Support Systems (OSS), carrier Billing Support Systems (BSS) and the CNA's number administration system.

ALTERNATIVES:

Many alternatives are considered and analyzed in this report. The alternatives include those that may be implemented in the near term or long term. The alternatives make available either a nominal number of new numbering resources or many new numbering resources.

CONCLUSIONS:

The CSCN concludes that demand for IoT/M2M is growing at a rate that will quickly exhaust available numbering resources and that relief for Non-Geographic NPAs is required.

RECOMMENDATIONS:

The attached report includes recommendations to prevent the exhaust of currently available numbering resources for non-geographic NPAs for the foreseeable future.

ATTACHMENTS:

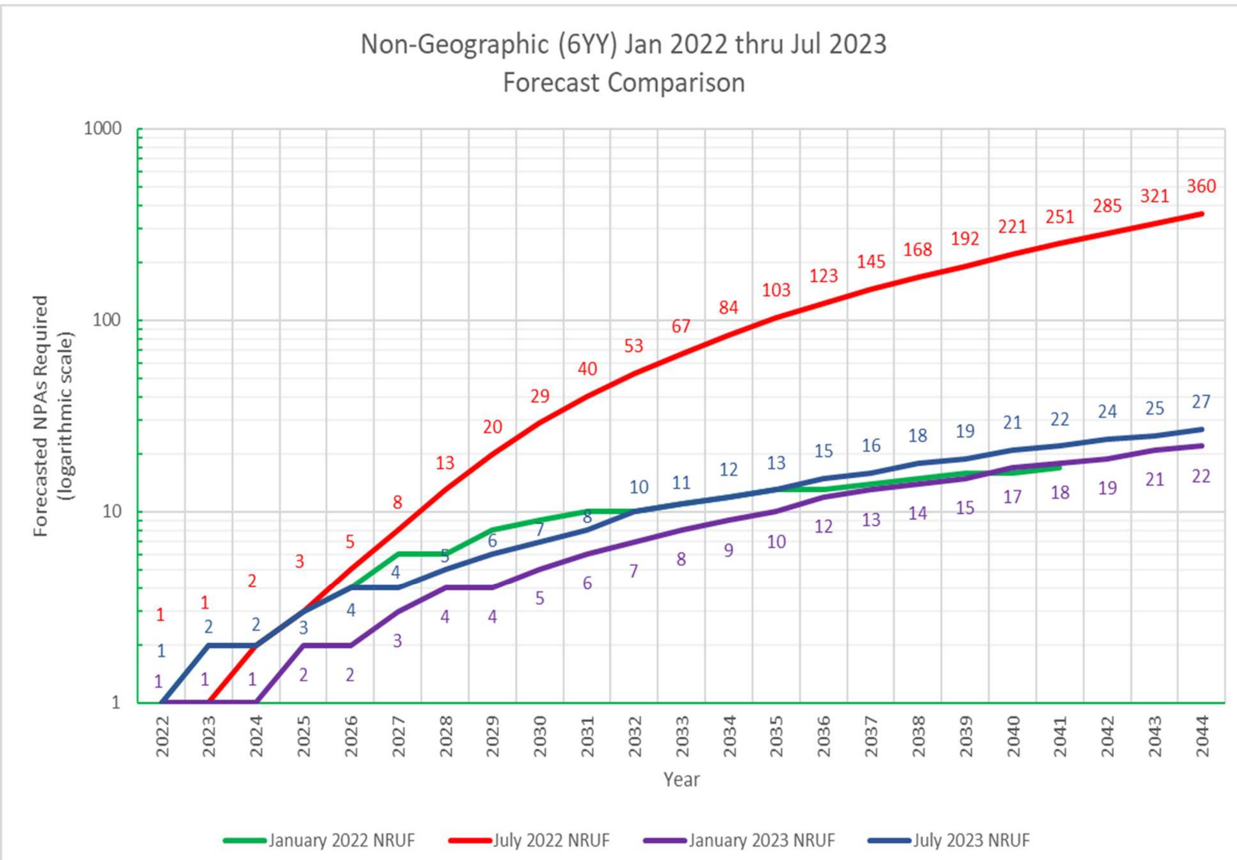
TIF 112 Consensus Report CNRE138B Non-Geographic 6YY NPA Exhaust Mitigation

Canadian Interconnection Steering Committee (CISC)

Canadian Steering Committee on Numbering (CSCN)

TIF 112 Consensus Report **CNRE138B**

Non-Geographic 6YY NPA Exhaust Mitigation



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Executive Summary

In mid-2022, the Canadian Numbering Administrator (CNA) compiled an updated Non-Geographic (6YY) Numbering Resource Utilization Forecast (NRUF) based upon industry input. This NRUF indicated a significant acceleration of the rate of 6YY numbering block assignments which would exhaust the pool of available 6YY Area Codes or NPAs. The CNA proposed actions which CRTC Staff approved and CSCN TIF 112, "*Address assignment rate of Non-Geographic (6YY) CO Codes*," was opened. The CSCN met frequently to review proposed solutions requested by TIF 112 and solicited technical input from the NTWG which opened TIF 43 and provided it. This report adopts information and recommendations from both CSCN TIF 112 and NTWG TIF 43.

The growth of IoT/M2M services is high and forecasts vary from year to year. This places a high demand on IoT/M2M numbering resources and requires that any recommendations consider the possibility that demand may increase beyond currently forecasted levels. In addition, fundamental changes to the entire North American Numbering Plan (NANP) are expected to take effect by 2051, to accommodate rapid demand for geographic and non-geographic numbers. Exactly what those changes will be and when they must be implemented are currently unknown.

The following options are discussed and analyzed:

1. Obtain Additional Non-Geographic NPAs
2. Utilize 010 NPAs
3. Alternative numbering scheme
4. Partition NPA 600
5. Remove N11 and 555 NXX restrictions in 6YY NPAs
6. New IoT/M2M Network Addressing Standards
7. Extended 6YY NPAs

There is consensus that Option 7 is the best solution for the long term, as it would increase supply sufficiently to comfortably meet demand until the anticipated NANP expansion (NANPE). However, further industry discussion is required before the various alternatives within Option 7 can be recommended. Nonetheless, consensus was reached to reserve NPA 677 and NPA 688 for extended digit formats and also to implement two partial solutions that will make additional 6YY NXXs available prior to the implementation of the long-term solution.

Given the technical and timing constraints of the above options and the CSCN's intention to finalize a recommendation with respect a long-term solution using an extended digit format, the CSCN recommends that the CRTC direct the CNA to:

1. allocate 768 NXX codes in NPA 600 as non-geographic within 6 months of the CRTC's directive;
2. eliminate the restriction on the assignment of NXXs 211, 311, 411, 511, 555, 611, 711 and 811 in all non-geographic NPAs within 6 months of the CRTC's directive; and
3. reserve NPAs 677 and 688 for extended digit format.

In addition, it is recommended that the CRTC request that the CSCN amend the following guidelines as required to reflect (1) the allocation of 768 NXX codes in NPA 600 as non-geographic and (2) the elimination of restrictions on the assignment of NXXs 211, 311, 411, 511, 555, 611, 711 and 811 in all non-geographic NPAs within 6 months of the CRTC's directive:

- Central Office Code (NXX) Assignment Guideline;
- Canadian Non-Geographic Code Assignment Guideline; and
- Canadian NPA 600 NXX Code Assignment Guideline.

TIF 112 will remain open and a follow-up report will be filed no later than 31 December 2024 to resolve the details of Option 7.

1. Scope

For the purpose of this report, 6YY NXX codes are to be used for applications which are non-geographic in nature, are not assigned to Rate Centers and may or may not traverse the PSTN, but do require an E.164 addressing scheme. Calls to 6YY-NXX codes may not be dialable from the PSTN and route only within the assignee's network. The use of this NANP numbering resource is to communicate with both fixed and mobile devices, some of which may be unattended. This resource may be used for applications enabling machines, which would include but not be limited to wireless devices and appliances, the ability to share information with back-office control and database systems and with the people that use these. Service is limited only by terminal and network capabilities and restrictions imposed by the service provider.

This report pertains to the assignment of 6YY resources and is not intended to constrain in any way how individual Carriers may implement the solutions within their own networks and systems.

2. Background

2.1. North American Numbering Plan (NANP)

Canada obtains its numbering resources from the North American Numbering Plan Administrator (NANPA). The NANPA provides telephone numbering resources to 20 North American countries[1] and comprises international telephone dialing World Zone 1 (WZ1). The NANP numbering format complies with the International Telecommunication Union (ITU) Recommendation E.164, namely a framework for international numbering.

ITU Recommendation E.164 requires[2] that telephone numbers be a maximum of 15 digits and be comprised of a country code (CC) of 1 to 3 digits and the remainder comprises the destination (DN) number. Canada is a member of WZ1 and has the country code 1.

The NANP destination network telephone number currently consists of ten digits in the format NPA-NXX-XXXX, where NPA is the regional Number Plan Area or Area Code, the NXX or Central Office Code (CO Code) is the 10,000 block of telephone numbers, and XXXX is the line number. In the last 7 digits of the number (NXX-XXXX), N represents a digit between 2 and 9 and X represents a digit between 0 and 9. Within each NPA, there are approximately 800 CO Codes available for assignment. (In geographic NPAs, certain NXXs are set aside for N-1-1 services, meaning only 791 are available for general use. Setting aside these codes may not be necessary in non-geographic NPAs.) In Canada, geographic telephone numbers are currently assigned to Carriers on a CO Code basis. Each CO Code provides 10,000 telephone numbers and is confined to an Incumbent Local Exchange Carrier (ILEC) geographic Exchange Area.

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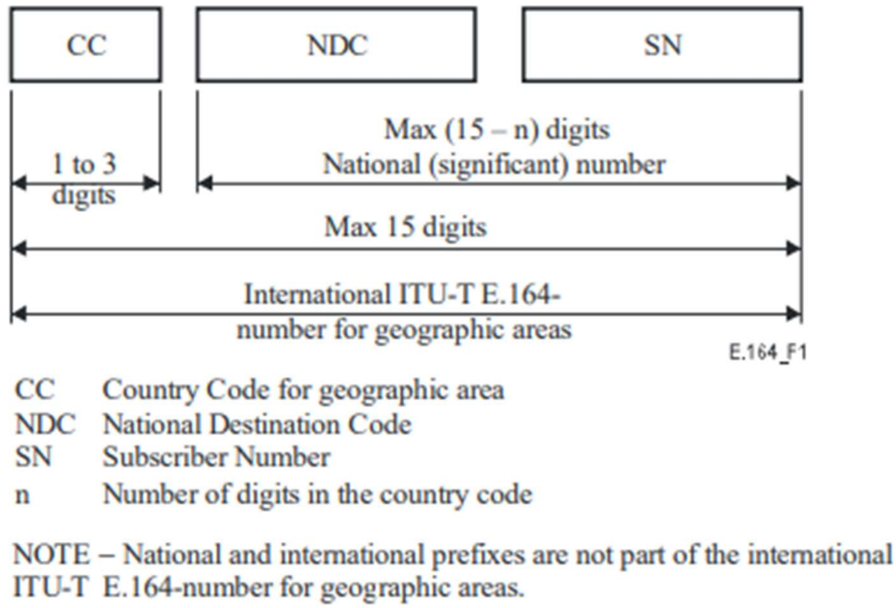
[1] NANPA : North American Numbering Plan Administration - About Us (nationalnanpa.com)

[2] E.164 : The international public telecommunication numbering plan (itu.int)

Figure 1: International ITU-T E.164-Number Structure for Geographic Areas



Canada is part of Country Code 1.

2.2. Canadian Numbering Plan and Dialling Plan

The Canadian Numbering Plan and Dialling Plan[3] is consistent with ITU E.164 and NANP. The numbering plan is recommended reading and the CSCN assumes that the reader is familiar with this document.

The Canadian numbering plan is best known by its area codes (national destination codes or NPAs) which are assigned to Canada. Area codes are assigned to geographic areas, such as 416 (Toronto), 613 (eastern Ontario), and 604 (Vancouver).

The default dialling plan in Canada is currently 1+10 digits, referring to the country code plus 3 digits for the NPA, 3 digits for the NXX and 4 digits for line number. The exceptions are for local calls where the country code, and possibly the NPA, are not required. Certain alternatives in this report contemplate using additional digits.

2.3. Numbering Resource Utilization Forecast (NRUF)

The Canadian Numbering Administrator (CNA) conducts annual (or more frequent) telephone Numbering Resource Utilization Forecasts (NRUFs)[4] to estimate the exhaust of numbering resources such as Numbering Plan Areas (NPAs) over a period of six years. The CNA extrapolates the aggregate forecast beyond six years to align with NANPA processes.[5] This

[3] Microsoft Word - Canadian_Numbering_and_Dialling_Plan_2022-04-13.doc (cnac.ca)
[4] CNA - Numbering Resource Utilization Forecast (cnac.ca)
[5] NANPA 2022 Annual Report: https://nationalnanpa.com/reports/2022_NANPA_Annual_Report.pdf

aggregate forecast allows the estimation of exhaust dates for various numbering resources to guide relief planning activities, which take years of preparation and implementation by the telecommunication industry.

The NRUF is a forward-looking forecast and the challenge with a forward-looking forecast is that the uncertainty increases as the time out from the forecast survey increases. In other words, there is no data that suggests that the forecast in six years will be accurate or higher or lower than predicted.

2.4. North American Numbering Plan Expansion

The North American Numbering Plan Expansion (NANPE) is the anticipated expansion of the NANP dialing plan from 1+10 digits to 1+ more than 10 digits. It will be triggered by the projected exhaust of NANP area codes (NPAs) which is currently forecasted to happen in 2051[6]. This exhaust date is re-calculated regularly by the NANP Administrator (NANPA) from NRUF results from countries such as Canada and the US.

NANPE has been examined by the Alliance for Telecommunications Industry Solutions Inc. (ATIS) Industry Numbering Committee (INC) which published the NANP Expansion Plan and Reference Documents ATIS-0300071 and ATIS-0300072 in August 2002, 22 years ago. The documents assess important topics such as existing and future NANP Functionality, human factor needs, options analysis, transition strategies, trigger points and dependencies, and recommends a new format and numeric structure of the NANP to expand its capacity.

The recommended plan, ATIS-030071, states that the plan is, "intended to be a living document to be kept current by the industry through regularly scheduled updates or action trigger mechanisms which are identified and maintained in the document."[7] The CSCN is not aware of any updates to the plan since the August 2002 release of the plan.

In any event, the NANPE plan of record states that the NANP dial plan be extended from 1+10 digits to 1+12 digits. This would be compliant with ITU Recommendation E.164 that allows for a maximum length of fifteen digits. The transition to 1+12 digits would impact all areas of the PSTN and it was estimated to take approximately ten years to implement. The plan recommends introduction of more digits during phases such as "digit detection" and "digit unlocking."[8]

CSCN tracks issues such as this through INC updates presented by the CNA at CSCN plenary meetings.

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[6] April 2022 NANP Exhaust Analysis (nationalnanpa.com) The analysis predicts exhaust between 2045 and 2051. This report uses 2051 as a latest relief date expected from NANPE.

[7] https://www.atis.org/committees-forums/inc/documents/

[8] "Digit detection" is the act of assigning a specific number to a specific position in the numbering sequence, e.g., zero in the fourth or "D" digit, to indicate to telecommunications systems that the numbering sequence is other than the standard NANP 1+10 digits. "Digit unlocking" is the act of removing the specific number restriction from a specific position in the numbering sequence. With respect to NANPE, unlocking the D digit would mean permitting any number from 0-9 in the 4th digit.

3. Introduction

The following sections discuss (1) the factors which affect the demand for non-geographic (6YY) NPA and their NXXs; (2) the forecast for 6YY NXX demand nationally; and (3) how service characteristics determine whether public telephone numbers (TNs) are required and how use of certain numbering schemes can defer the exhaust of the current supply of Canadian NPAs.

3.1. Internet of Things (IoT) / Machine to Machine (M2M)

The Internet of Things (IoT), also known as Machine-to-Machine (M2M) communication, is the service category for autonomous devices. They are data-oriented devices, i.e., they utilize little or no human input. IoT/M2M devices communicate with each other or with centralized computing systems or edge computing to process commerce-related or control transactions. These include commercial transactions (e.g., for parking machines and retail dispensing machines), geographic tracking (e.g., truck or container real-time tracking), and control (e.g., machine monitoring or telemetry, and process monitoring). IoT/M2M is growing because it saves labour costs, is inexpensive, is available 24x7, and is further enabled by mobile wireless data access services such as Wi-Fi, Bluetooth, and 4G and 5G. The growth projection of IoT/M2M is extraordinary. The global IoT/M2M market was valued at US$ 478.36 billion in 2022 and is projected to become US$ 2,465.26 billion in 2027, which is a growth rate of 26.4%.[9]

IoT/M2M devices may be found on wireline or wireless (mobile) networks. IoT/M2M devices require network addresses to send data from point to point. In many cases, IoT/M2M devices require NANP-based telephone numbers to be compatible with Carrier Network Elements (NEs) or platforms and Operational Support Systems (OSS) and Billing Support Systems (BSS) (collectively “support systems”). OSSs provide network provisioning, surveillance, alarms, and maintenance functions. BSS systems support assignment and billing functions and are often TN-centric. In some cases, IoT/M2M services utilize the mobile Short Message Service (SMS), and it is not inconceivable that they may support voice communications.

3.2. Non-Geographic Telephone Numbers

Voice service telephone numbers must be assigned a geographic telephone number that is assigned to a specific ILEC exchange. This is required for calls to be completed and to support services such as the billing of long-distance services, local number portability, and call routing for N-1-1 services.[10]

[9] Internet of Things [IoT] Market Size, Share & Trends, 2029 (fortunebusinessinsights.com)

[10] Some Voice over IP (VoIP) technology-based voice services are assigned geographic telephone numbers however they may be located far from the telephone number’s geographic ILEC exchange assignment due to the reach of IP networks such as the Internet. In this case of distant VoIP, the service provider must make special accommodations to provide location-based services such as 9-1-1 to the distant VoIP subscriber.

Data services such as IoT/M2M generally do not require geographic TNs that reflect the location of the devices or allow communication with the PSTN. Instead, they can use non-geographic numbers that only indicate which Carrier is providing the connectivity to the devices.

In 2015, the CRTC approved[11] a Canadian Steering Committee on Numbering (CSCN) recommendation to deploy and administer six non-geographic "6YY" NPAs (namely: 622, 633, 644, 655, 677, and 688) for the purposes of supporting data services such as M2M.[12] 6YY telephone numbers are described as being non-geographic because they are assigned to Canada but not to a specific geographical area within Canada. 6YY numbers are compatible with both NANP and E.164. In the United States, a number of NPA codes have been assigned for the same purpose. These are referred to as 5XX NPAs in this report. No communication between 6YY and 5XX devices is contemplated as part of this report.

6YY numbers can support inter-network communication, i.e., devices on one Carrier's network can communicate (including by SMS or possibly voice over IP) with devices on another Carrier's network by using the assigned TNs. In the case of wireless IoT devices this is particularly important because it will allow continuous connectivity even if the device roams to another Carrier's network. Currently, inter-network communication arrangements are bilaterally negotiated.

3.3. IoT/M2M Numbers and Network Platforms

The CSCN consulted the Network Working Group (NTWG) to obtain insight of the network address needs of IoT/M2M services. The NTWG opened TIF 43 and received and reviewed contributions and held discussions. The NTWG advised that many Carrier network infrastructure platforms, including support systems,[13] require telephone numbers in a NANP format due to their software architecture. Support systems can be modified, but such changes would affect interoperability, billing, activation, maintenance and regression testing. Such extensive changes would be resource intensive and require years to implement. In some cases, devices require wireless Short Message Service (SMS) services to activate the device, which in turn require NANP-compatible TNs.

3.4. IoT/M2M use of Alternative Addressing methods

Some IoT/M2M devices and systems do not require NANP or E.164-compatible TNs. In this case, the service provider may develop its own network address scheme that does not follow the NANP or E.164 TN format – referred to as Alternative Numbering Schemes. The schemes may be based upon almost anything, e.g., a derivative of a wireless device's SIM card IMSI number. This report assumes that the use of alternative numbering schemes will be confined to the sponsoring Carrier's network (i.e., intra-network communication only) because the absence of unique addresses would make inter-network communication difficult to arrange. This limitation is significant if there is a chance that connectivity with the PSTN or other Carriers' IoT devices may be desired in the future.

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[11] Telecom Decision CRTC 2015-4 | CRTC

[12] See "Non-Geographic Code Assignment Guideline" and other related information at CNA - Non-Geographic (6YY) Code Assignment Guideline (cnac.ca).

[13] See section 3.1.

3.5. 2022 and 2023 6YY NPA NRUF

The CNA extrapolates the demand for non-geographic NPAs to the year 2045. The demand predicted by the July 2022 forecast was alarming and because of this, the CSCN initiated CSCN Task 112 to undertake the development of exhaust mitigation methods for the 6YY NPAs.

The CSCN has chosen to disregard the July 2022 NRUF, based on the consistency of the other three forecasts, including two subsequent forecasts. The analysis in this report will use the July 2023 forecast as the total demand.

The July 2023 NRUF of 6YY NPAs indicates that the last Canadian 6YY NPA will be assigned in 2029. Unless mitigation measures are taken, it will exhaust in 2030. The resulting exhaust date is not alarming but is nonetheless concerning.

As mentioned above, the current NANPA forecast identifies NANP exhaust in 2051. Before exhaust, NANP Expansion (NANPE) must be implemented. Early visions of NANPE involves a 4th NPA digit and a 4th NXX digit, which would severely impact Carrier network elements, end-user devices, support systems and the CNA's number administration system.

The CSCN expects that NANPE will require a lengthy implementation period, the timing of which is driven largely by the anticipated NANP exhaust date. Since this implementation period has not yet begun, CSCN has no confidence that NANPE will provide relief for non-geographic numbers in Canada before 2030.

Figure 2 illustrates the approximate assignment of the 6YY NPAs reserved for Canada, under the assumptions that no mitigation measures are taken and that there are 800 assignable NXXs per NPA (some alternatives in this report use a different assumption).

Figure 2 also identifies the year in which each 6YY NPA will be activated. This is important in that certain measures discussed in this report may require industry activities before the NPA is activated. E.g., if a certain measure is to be applied to NPA 677 and it will take two years' advance notice to make the necessary changes, the associated directive must be issued no later than 2025. This will allow the measure to be in place in the beginning of 2028, the year that 677 will need to be activated.

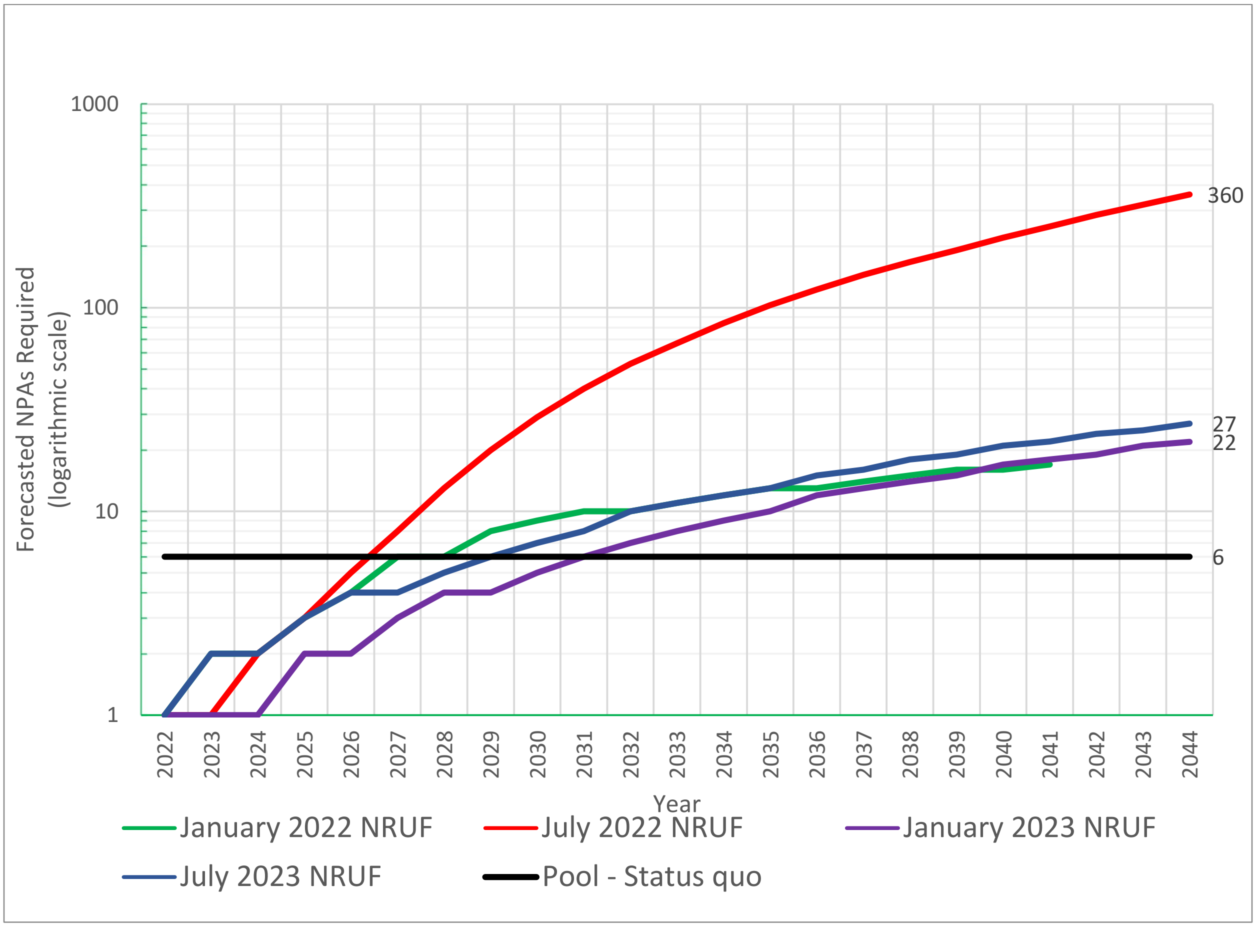
Figure 2: *July 2023 NRUF of 6YY NPA Consumption*

Years	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Total # of NPAs assigned by end of year	**2**	**2**	**3**	**4**	**4**	**5**	**6**
NPAs in service by end of year (new NPA bolded)	622 633	622 633	622 633 **644**	622 633 644 **655**	622 633 644 655	622 633 644 655 **677**	622 633 644 655 677 **688**

The current and previous NRUFs are plotted in Figure 3 below.[14] Also shown (the black line) is the current pool of 6YY NPAs, under the same assumptions as for Figure 2.

[14] CNCO208A can be found at [CRTC – CSCN Contributions]

***Figure 3**: Comparison of NRUF values and current pool of 6YY NPAs*



Where the NRUF forecast curve crosses the black pool line indicates when the last of the 6YY NPAs is opened for assignment.

4. Potential 6YY Exhaust Deferral Methods

The CSCN has analyzed seven methods to defer 6YY exhaust. Due to complexities associated with already distributed SIM cards, contracts and network implementations, any methods adopted should be prospective (i.e., going forward). These methods may defer 6YY exhaust by expanding the number of 6YY NPAs, by using 6YY codes more efficiently or by using an addressing scheme that does not use TNs (i.e., alternative numbering scheme). More than one method may be chosen.

The methods are listed in Figure 4 and discussed below.

Figure 4: Mitigation methods for 6YY NPAs

Section	Option	Method

3.1	1	Obtain Additional Non-Geographic NPAs
3.2	2	Utilize NPA 010
3.3	3	Alternative numbering scheme
3.4	4	Partition NPA 600
3.5	5	Remove N11 and 555 NXX restrictions in 6YY NPAs
3.6	6	New IoT/M2M Network Addressing Standards
3.7	7	Extended 6YY NPA (more than 1+10 digits)
3.7.1	7A	Apply NANP Expansion Plan of Record (1+12 digits) to Unused 6YY NPAs
3.7.2	7B	Expand Unused 6YY NPAs to Utilize Full ITU E.164 Number Range (15 digits)

4.1. Option 1: Obtain Additional Non-Geographic NPAs

Option 1 requires that NANPA assigns additional NPAs to Canada for use as non-geographic NPAs. Option 1 would delay the potential exhaust date by making more codes available for assignment in Canada. The CRTC would have to make a formal request to NANPA to request additional codes.

Option 1 involves no new processes nor would it require CNAC or the industry to make equipment or software upgrades. As a result, it would be simple and inexpensive to implement.

However, Option 1 does not improve numbering efficiency. As a result, each new NPA obtained would only add 791 NXXs to the current inventory (possibly more, subject to section 3.5).

The CSCN is not in a position to estimate how long it will take for the CRTC to obtain NANPA's agreement to assign additional NPAs to Canada. Once these unused NPAs are reserved in the Canadian non-geographic NPA pool, the CSCN would expect the CNA to be able to have an NPA activated and available for assignment to Carriers as required in approximately one month.

There are limited NPAs left for NANPA to assign, and there is demand for these codes in the other countries within the NANP, most notably the United States.

4.2. Option 2: Utilize NPA 010

Option 2 is for Carriers to activate NPA 010 within their own networks and use these numbers for IoT devices.

NPA 010 is currently available to each Carrier for intra-network data services and its use is limited only by the ability of a Carrier's network to utilize NPA 010.[15] Each Carrier can adopt

[15] The Canadian Non-Geographic (6YY) Code Assignment Guideline states that, "Intra-network TNs are TNs that are "not-dialable" from the PSTN and are routed only within the Carrier's network, e.g., telephone numbers that use NPA 010." CNA - Non-Geographic (6YY) Code Assignment Guideline (crtc.gc.ca)

NPA 010 independently of other Carriers and no resource code application to the CNA is required. The use of NPA 010 by Carriers for intra-network data services could divert demand of TNs away from 6YY NPAs. The entire NPA 010, if used with the current NANP 1+10-digit numbering format, would provide each Carrier choosing to utilize NPA 010 with 1,000 NXXs or 1,000 * 10,000 = 10,000,000 TNs.

Further, the Carriers could unilaterally extend the length of their NPA 010 numbers to as many as 1+14 digits, providing even more available TNs. Different Carriers can choose different TN length approaches based on their network equipment. A 2-digit extension to the current NANP 1+10-digit TN format would yield up to 100 times the TNs for each Carrier using NPA 010. A 4-digit extension (to a total of 1+14 digits) would yield 100 times more TNs than a 2-digit extension.

A barrier to inter-Carrier utilization of NPA 010 numbers could be Carrier support systems. This barrier could be significant and could vary by Carrier. Additionally, an application for fixed-location devices could eventually evolve to include a requirement for mobility. There is no centralized mechanism to coordinate the sharing of NPA 010 resources for communication between different Carriers' networks.

4.3. Option 3: Utilize Alternative Addressing Formats

Option 3 is for Carriers to use another addressing scheme instead of TNs.

Option 3 is available today and involves Carriers developing their own numbering scheme for IoT/M2M outside the PSTN. Non-dialable numbering schemes exist today, for example wireless Emergency Service Routing Digits (ESRD).[16] Non-dialable IoT/M2M telephone numbers may be based upon SIM card IMSI codes, serial numbers or upon any method that the Carrier desires. Carriers must design and implement their own numbering system, which their network elements and support systems must accommodate.

The quantity of available numbers depends on the number of digits in the addressing scheme. A Carrier could conceivably create a billion numbers for its own use using IMSIs.

As with Option 2, Option 3 is easily applied for devices that are always serviced by a single Carrier and have no reason to communicate with another Carrier's devices or devices with geographic numbers. If the application may eventually evolve to include any of these requirements, then Carriers will view Option 3 as less desirable.

When Carriers implement alternative numbering schemes (e.g., IMSI-based), they are responsible to ensure that there are no conflicts with NANP numbering resources.

4.4. Option 4: Partition NPA 600

Option 4 is to re-purpose most of the unused NXXs in NPA 600 as non-geographic NXXs. NPA 600 is in service today as a Service Access Code (SAC) in accordance with the *Canadian NPA 600 NXX Code Assignment Guideline*.[17] NXX Codes in NPA 600 may be assigned to Carriers

[16] CNA - ESRD Assignment Guideline (https://cnac.ca/esrd_codes/esrd_codes.htm)

[17] Canadian NPA 600 NXX Code Assignment Guideline (crtc.gc.ca)

for the provision of non-geographic services, i.e., TNs in NPA 600 are assignable anywhere in Canada.

Non-geographic services are defined in the *Canadian NPA 600 NXX Code Assignment Guideline* as services that:

a) are provided by Canadian [Carriers],

b) are made available to customers located in Canada,

c) use telephone numbers in NPA 600 NXX Codes,

d) are accessible from public networks that have arranged to route calls to the NPA 600 NXX numbers used for the non-geographic services, and

e) are approved by the CRTC, where the CRTC determines that such approval is necessary.

NPA 600 currently has 16 NXXs assigned (to six different Carriers)[18] out of a possible total of 798 available NXXs.[19] Option 4 contemplates reserving 14 additional NXXs for future use for SAC services and making the remaining 768 NXXs available for IoT.[20]

Given the limited forecasted demand for NPA 600 SACs under the current guidelines, and the relatively large number of unassigned NPA 600 NXXs, then Option 4 would make almost an entire NPA (96%) available for use by IoT devices in a manner identical to that permitted for *Canadian Non-Geographic Code Assignment Guideline*[21].

Revisions to the applicable guidelines and changes to CNA processes to enable a partitioned portion of NPA 600 to be assigned pursuant to the *Canadian Non-Geographic Code Assignment Guideline* could be implemented within 12 months of the release of a Commission determination to partition NPA 600.

4.5. Option 5: Remove N11 and 555 NXX Restrictions in 6YY NPAs

Option 5 is to make eight NXXs (i.e., 211, 311, 411, 511, 555, 611, 711 and 811 but not 911) available for assignment within 6YY NPAs.

[18] 600 NXX Service Access Code (SAC) (https://cnac.ca/data/ServiceAccessCode_600.htm)

[19] 800 NXXs minus “600-555” and “600-911” yields 798 NXXs.

[20] In the last 20 years there has only been 1 600 NPA NXX assignment, which took place in 2016. There has been no demand since then. (The 600 NXX assignment listings for Ligado Networks Corp. indicate a date in 2023, but the date is the result of corporate merger and acquisition activity for NPA 600 resources originally assigned in 1994.)

[21] *Canadian Non-Geographic Code Assignment Guideline* (crtc.gc.ca)

Telecom Decision CRTC 2018-51 states in paragraph 8:

> Since the rest of the countries that are members of the NANP, i.e., the United States and many Caribbean countries, do not use these N11 codes as NXXs, it would be unreasonable to request that they modify the database system to accommodate such use by Canadian TSPs only. Therefore, the Commission considers it appropriate to identify all N11 codes as unassignable in the Guideline consistent with the rest of the NANP.

However, the services associated with these NXX codes have no relevance to non-geographic IoT devices and assigning these codes in non-geographic NXXs would not interfere with geographic 555[22] or N11 services. In light of this, the assignment of these codes for IoT devices is now permitted in the US and the BIRRDS database has since been modified accordingly.

If assignment of 555 and seven N11 NXX codes were permitted in Canada, eight incremental NXXs would be made available for assignment in each 6YY NPA. Consistency with the updated BIRRDS database would also be achieved.

Option 5 would require amendments to the *Canadian Non-Geographic Code Assignment Guideline*, for which the CSCN would recommend new language regarding the reservation of NXX codes.

4.6. Option 6: New IoT/M2M Numbering Resource Standards

Option 6 is to use new IoT/M2M numbering resource standards for IoT, when they become available.

New standards from Standards Development Organizations (SDOs) such as ITU, 3GPP or guidelines from organizations such as GSMA or IETF would accommodate the need for many numbering resources for IoT.[23] However, the standards would not be realized nor implemented in network infrastructure and IT systems for several years.

The North American Numbering Council (NANC) is establishing a new "Internet of Things" numbering usage working group[24] to investigate why and how IoT devices use NANP numbering resources. The working group will consider whether there may be preferable alternatives to using NANP numbering resources for IoT device needs. This may present an opportunity to track the development of IoT numbering resource standards development.

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[22] "555 line numbers (LNs) were a unique resource assigned on a national or non-national basis for public information services." A subset (555-0100 to 555-0199) is reserved for use by the television/movie industry and 555-1212 is used for long distance directory assistance. All other 555 line numbers have been reclaimed and the 555 assignment guidelines in Canada and the US have been sunset. | *Canadian Adjunct to the 555 NXX Line Number Reference Document* (crtc.gc.ca)

[23] Generic Public Subscription Identifier (GPSI) is a public identifier that can take different formats and it is used both inside and outside of a 3GPP system. It is needed for addressing a 3GPP subscription in different data networks outside of the 3GPP system. Ref. 3GPP TS 23.003, 3GPP TS 23.501, TS 23.682, IETF RFC 4282 and shows promise for Option 6.

[24] Working Group Membership Directories | Federal Communications Commission (fcc.gov)

In any event, the CSCN estimates that it would take 2 to 5 years for SDOs to develop a new numbering scheme. The commercial availability of network equipment supporting these standards could be several years later, which may be beyond the current Canadian projected exhaust.

4.7. Option 7: Extended 6YY NPAs

Option 7 makes more TNs available in unassigned 6YY NPAs by extending the number of digits from 1+10 to 1+12 (Option 7A) or 1+14 (Option 7B). Several European countries have adopted a form of this method for IoT/M2M services.[25]

Both Options 7A and 7B would require at least two to three years to implement. This is due to required upgrades to Carrier network elements and support systems, and the CNA's number administration system. During this time period, more 6YY NPAs will be assigned, leaving fewer available 6YY NPAs for extension. However, the quantity of additional TNs that can be made available by extending the unused 6YY NPAs would be very high.

Both Options 7A and 7B would require that the CSCN consider the optimum block size for assignment.[26] Also, NRUFs would have to be adjusted to accommodate the large volume of TNs that would become available.

4.7.1. Option 7A: Use 1+12-digit TNs in unused 6YY NPAs

Option 7A makes more TNs available in unused 6YY NPAs by expanding the number of digits from 1+10 to 1+12 (i.e., 1-688**X-X**NXX-XXXX.) Option 7A uses the fourth digit excluding the Country Code (the D-digit) to identify an extended number format. This option aligns with the 2002 NANPE plan.

Option 7A would be implemented in two phases. Phase 1 would be applied only to unassigned NPAs (i.e, 1-688**0**-XNXX-XXXX). The "0" in the D-digit (the fourth digit in a TN, excluding the Country Code) would allow for the ready detection of an expanded TN across any expanded-digit 6YY NPAs. Phase 1 would increase the number of phone numbers in an NPA by a factor of 10 (i.e., from 8,000,000 TNs to 80,000,000 TNs).

Phase 2 would unlock the D-digit to be any number from 0 to 9. The resulting format would be 1-688**X**-XNXX-XXXX. This is, in effect, implementation of the NANPE solution and would increase the quantity of telephone numbers by a factor of 10 compared to Phase 1, or a factor of 100 (i.e. from 8,000,000 TNs to 800,000,000 TNs) compared to 1+10. However, phase 2 can only be implemented after a 1+12-digit dialling plan has been implemented across all 6YY NPAs including assigned 6YY NPAs, thus implementation of phase 2 would entail extensive industry

[25] CSCN TIF 112 Serial 6 (2022-Oct-11) and Numbering: The IoT SIM move to 15 digits (https://www.orange-business.com/en/numbering-iot-sim-move-15-digits)

[26] Too long a block would be wasteful for Carriers with few devices to support. Too short a block would be inefficient in terms of assignment and would make it difficult to find large blocks of numbers for very large IoT applications. Further, it would be desirable for an extended 6YY code to align with the anticipated NANP Expansion (NANPE) format (e.g., phase 1: 1-688(0 or 1)-XNXX-XXXX phase 2: 1-688X-XNXX-XXXX).

coordination and expense. Since the NANPE solution could be changed upon the next industry review, it would be prudent to defer the implementation of phase 2 to avoid unnecessary expenditure of resources.

4.7.2. Option 7B: Use 1+14-digit TNs in unused 6YY NPAs

Option 7B makes more TNs available in unused 6YY NPAs by expanding the number of digits from 1+10 to 1+14 (i.e., 1-6YY-**N**XX-XXXX-XXXX). This is compliant with ITU-T E.164 standard. This would increase the quantity of telephone numbers by a factor of 10,000, so each 1+14 digit 6YY NPA would have about 80 billion TNs.

Even more TNs can be made available by unlocking the D-digit so that it can be any value from 0 to 9 (i.e., 1-6YY-**X**XX-XXXX-XXXX). This is compliant with ITU-T E.164 standard. This would increase the quantity of telephone numbers by an incremental 20 billion so each affected 6YY NPA would have about 100 billion TNs.

5. Analysis

The following analysis estimates by how much each of the various options presented above will delay the exhaust date of current Canadian non-geographic 6YY NPAs (the last 6YY NPA is forecast to be assigned in 2029 based on the July 2023 NRUF) and, in particular, whether they would delay the exhaust until 2051. This is the predicted exhaust date of the entire NANP, by which time some sort of relief is expected for the entire NANP. Although relief of the NANP will be planned for an effective date before 2051, the following analysis assumes that it will not be ready by 2030, which is the current exhaust date for the Canadian 6YY NPAs.

This analysis categorizes each option by one of the following solution types.

- **Full solutions** are those that are expected to provide sufficient non-geographic numbers for Canada's needs until the NANPE relief date, that support inter-network communication between non-geographic IoT applications and that can be achieved by the Commission and the Canadian industry independently (i.e., with no reliance on NANPA).

- **Partial solutions** are those that support inter-network communication; but that cannot necessarily be achieved by the Commission and the Canadian industry independently and/or that provide only limited relief. Partial solutions may be quicker to implement, giving them the potential to delay the exhaust of the 6YY NPAs until a full solution can be implemented.

- **Other remedies** are those options that make TNs available for IoT, but either are risky due to an uncertainty in implementation or timing such that they cannot be considered reliable options (at least without further exploration); or do not support inter-network communication, which limits their utility. Nonetheless, to the extent that they are implemented by Carriers, they would defer the exhaust of 6YY NPAs.

5.1. Full Solutions

Option 7 (Extended 6YY NPAs) is the only full solution identified, and as discussed above in section 3, provides for the following 2 sub-options: (a) use of 1+12-digit telephone numbers in one or more unused 6YY NPAs or (b): use of 1+14-digit telephone numbers in an unused 6YY NPA. As further discussed below both Options 7A and 7B would extend the life of 6YY non-geographic NPAs to beyond 2050. Applying Option 7B to a single NPA would provide 100 times more numbers than Option 7A, many more than forecasted demand. The salient question in choosing one over the other is whether the uncertainty in forecasting and the date of relief through NANPE can justify any additional time, resources or risk associated with Option 7B.

Option 7A (one or more NPAs using 1+12 digits) is compatible with the 2002 NANPE plan and would provide 100 times more TNs per 6YY NPA than 1+10 digits. It also provides a standard way to detect expanded non-geographic TNs. Alternatively, Option 7B provides 100 times more numbers than Option 7A but is not compatible with the 2002 NANPE plan. NANPE has not been reviewed for over 20 years and it is not known if the format of the solution will remain at 1+12 digits the next time it is reviewed. Therefore, NANPE compliance is considered but is not heavily weighted in this analysis.

Options 7A and Option 7B are expected to require similar levels of investment and effort in network infrastructure, support systems and the CNA's number administration system, but there is some risk that Option 7B will be more difficult to implement for some Carriers, and some consideration should be given to its incompatibility with the 2002 NANPE plan. It is expected that it would take Carriers 2-3 years from the date of a CRTC directive to implement either option.

Applying Option 7A to a single 6YY NPA would extend the life of the non-geographic resources to beyond 2050. Applying it to a second 6YY NPA would provide a generous safety margin without any additional costs or resources. However, if the costs and timing of implementing Option 7B are comparable, it may be a preferable solution, even if it is not justified by the current forecast.

Given the importance of this recommendation, the CSCN has chosen to examine Options 7A and 7B in greater detail. Accordingly, the CSCN proposes:

- that NPAs 677 and 688 be reserved for extended digits; and
- to continue to work toward a recommendation regarding the implementation of Option 7A or Option 7B.

5.2. Partial Solutions

Implementation of Option 7A will provide relief when NPA 677 is implemented, and this can optimistically be expected in 2027. (See Figure 5, below.) However, should this relief be delayed or should demand for 6YY NXXs increase beyond current forecasts, Canada could face a temporary unavailability of 6YY NXXs. (See Figure 6, below.) For this reason, partial solutions should be considered as a means of providing short-term relief.

Three partial solutions have been identified. They are:

- Option 1: Obtain Additional Non-Geographic NPAs
- Option 4: Partition NPA 600
- Option 5: Remove N11 and 555 NXX restrictions in 6YY NPAs

Option 1 is the simplest and likely the least expensive. If even a single additional NPA is obtained, it will provide more relief (791 NXXs) than either Option 4 or Option 5. NANPA's position is uncertain, but asking would not present any apparent risk. Should additional NPAs be obtained, it will reduce the risk of exhaust being reached in the event of implementation problems for the full solution.

Option 4 would provide nearly a full NPA (768 NXXs) of relief with a straightforward implementation. Option 5 would provide much less relief (8x6=48 NXXs if the N11 NXXs and 555 are assigned), but also has a straightforward implementation and has the additional benefit of aligning Canada's 6YY assignment guideline more closely with that for the USA's 5XX guideline. Since both require changes to the *Canadian Non-Geographic Code Assignment Guideline* and within the Canadian networks, there would be an efficiency to doing both at once, and obtaining more than the equivalent of an additional NPA through more efficient use of the NPAs currently available.

The CSCN estimates that Options 4 and 5 could be implemented within 1 year from the date of CRTC approval of the recommendations in this report. With implementation of partial solutions, the CSCN does not expect that 6YY NPAs will exhaust before relief comes in the form of a full solution.

Accordingly, the CSCN proposes that:
- Options 4 & 5 be implemented; and
- the CRTC pursue Option 1.

5.3. Other Remedies

Three other remedies have been identified by the CSCN. They are:
- Option 2: Utilize NPA 010
- Option 3: Utilize alternative numbering scheme
- Option 6: New IoT/M2M Network Addressing Standards

Option 2 is for Carriers to activate NPA 010 within their own networks if their support systems can support NPA 010. Some Carriers could potentially implement NPA 010 in a very short time while others may encounter internal issues relating to their own support systems.

Use of NPA 010 is suitable for IoT/M2M devices that operate only on that Carrier's network unless there are bi-lateral agreements between Carriers to share a single NPA 010 number plan. Sharing a NPA 010 number plan would likely be difficult to implement. As a result, many IOT/M2M applications may not be candidates for use of NPA 010 because they are required to function across Carrier network boundaries (e.g., tracking devices, or devices that require SMS messaging).

Due to varying implementation periods by Carriers, and the limitation of NPA 010 to intra-Carrier applications, it is not possible to estimate the possible 6YY NXX savings. However, the use of NPA 010 by all Carriers wherever possible is recommended. Such implementations can involve 1+10 digits to up to 1+14 digits depending on individual Carrier preference.

Option 3 is for Carriers to use another addressing scheme instead of TNs. This option is available today and includes mechanisms such as the use of IMSIs or IP addresses. The use of alternate numbering schemes can operate across networks if there is a carrier identification component to address scheme (e.g., the unique Mobile Network Code forming part of an IMSI or the mechanisms for IP address administration). It is not known to what extent the use of alternative addressing schemes is currently relieving pressure on 6YY NXXs, and how it will impact future demand for 6YY NXXs. Use of alternative addressing schemes should be encouraged where suitable for the IoT/M2M application and some Carriers have already begun doing so.

Option 6 is to use new IoT/M2M network addressing standards for IoT/M2M when they become available. New standards for addressing IoT/M2M addressing have yet to be finalized by SDOs, and once finalized would take several years for commercial deployment. As a result, waiting for the availability of new IoT/M2M addressing standards and commercial implementation will not happen before the requirement for 6YY NPA relief. As a result, waiting for new standards to be implemented is not a viable option.

Options 2 and 3 should be encouraged, so that Carriers are aware of these alternatives which not only save public numbering resources but give Carriers more freedom to implement IoT services without dependence on the availability of industry codes. The current forecast already takes into account the use of NPA 010 and alternative numbering schemes. Accordingly, the numerical analysis that follows assumes that Options 2 and 3 will offer no additional relief beyond what may already be reflected in the demand (which would otherwise be higher).

The CSCN proposes that Options 2 and 3 be encouraged when inter-network communication is not an anticipated requirement.

5.4. Calendar of Solutions

In Figure 5, the forecasted demand for non-geographic NPAs and estimated activations dates of the remaining 6YY NPAs are mapped onto calendar years up to 2030. The effect of the recommended solutions on the supply of NPAs (or equivalent NPAs) is shown. Figure 5 includes the expected relief from Phase 1 of Option 7A, for the CRTC's information. If either Phase 2 of Option 7A or Option 7B is selected, additional supply would be made available.

Figure 6 shows the supply of NPAs (or equivalent NPAs) assuming the implementation of the recommended solutions versus forecasted demand up to 2044. Figure 6 also assumes Phase 1 of Option 7A will be implemented.

***Figure 5**: Calendar of Solutions*

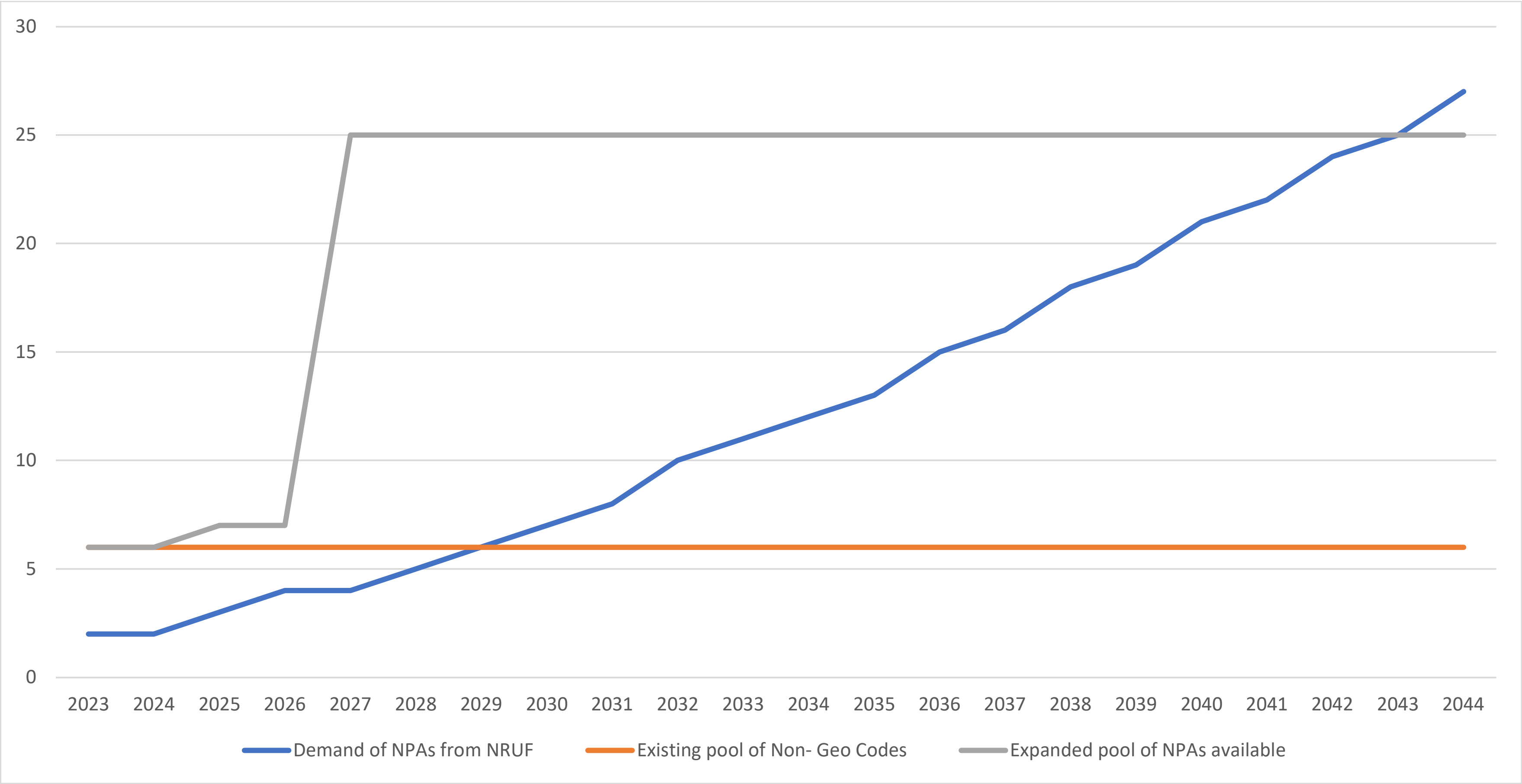
Years	2023	2024	2025	2026	2027	2028	2029	2030	NOTES
“Demand” Total # of NPAs assigned by end of year from July 2023 NRUF	2	2	3	4	4	5	6	7	Note A
“Existing Pool” NPAs in service by end of year (new NPAs bolded)	622 633	622 633	622 633 **644**	622 633 644 **655**	622 633 644 655	622 633 644 655 **677**	622 633 644 655 677 **688**	Need an incremental NPA	Note B
Industry Actions from this report			Implement Partial Measures (NPA 600 etc.)		Extended digit NPAs 677 and 688 ready for deployment				Note C
“Expanded Pool” Equivalent number of 1+10 digit NPAs available	6	6	7	7	25 or more	25 or more	25 or more	25 or more	Note D
“New view of in-service NPAs” NPAs in service by end of year (new NPAs bolded)	622 633	622 633	**600** 622 633	600 622 633 **644**	600 622 633 644	600 622 633 644 **655**	600 622 633 644 655 & **extended digit 677**	600 622 633 644 655 & extended digit 677	Note E

Notes to Figure 5

A. “Demand” row: This forecast is based upon the July 2023 NRUF. In any event, the 6YY NPA rollout plan (or, “roadmap”) must be flexible and reflect the most current NRUF because the NRUF is an extrapolated forecast and when time from the present increases, extrapolated forecasts decline in accuracy.
B. “Existing Pool”: Newly deployed NPAs are **bolded**. The existing six 6YY NPAs will exhaust in 2030.
C. “Industry Actions from this report”: the recommended timing of new measures is listed. They include the introduction of a partitioned NPA 600 and Option 7 (extended digit 677 and 688)
D. “Expanded pool of in-service NPAs,” is the equivalent number of phone numbers expressed in quantity of 1+10-digit NPAs. Initially, there are six 6YY NPAs, namely 622, 633, 644, 655, 677, and 688. The introduction of a partitioned NPA 600 and other interim measures provides approximately another NPA’s worth of telephone numbers which we name “NPA 600.” NPAs 677 and 688, when expanded, will each provision the equivalent of ten or more 1+10-digit NPAs. Therefore, the number of equivalent 1+10-digit NPAs in the 6YY pool becomes 7 NPAs – 2 NPAs + equivalent of 20 = equivalent of twenty-five or more 1+10-digit NPAs.
E. “New view of in-service NPAs” is the implementation estimates of the various NPAs resulting from implementation of the interim and long-term measures described in this report. We note that there is some flexibility in the 2027+ time frame for the implementation of NPAs 677 and 688 to accommodate any changes in the NRUF.

Extrapolating the NRUF forecast out to 2044 and plotting this forecast and supply of non-geographic NPAs yields the following graph (see figure 6). The blue curve is the extrapolated NRUF, the orange line is the current pool of six 6YY NPAs and the grey curve reflects the expanded pool assuming implementation of Options 4, 5 and Option 7 for 2 NPAs (which would bring the Non-Geographic pool size to 25 or more NPAs.

Figure 6: *Graph of Extrapolated Demand and Supply*



6 Conclusions

The CSCN concludes that IoT/M2M services are growing at a significant rate that will exceed current supply. The supply of non-geographic TNs must be increased to meet this demand for IoT/M2M network addresses.

NANPE should be considered and accommodated in ongoing CSCN analysis.

7 Recommendations

In consideration of all the above, the CSCN recommends that the CRTC direct the CNA to:

1. allocate 768 NXX codes in NPA 600 as non-geographic within 6 months of the CRTC's directive;
2. eliminate the restriction on the assignment of NXXs 211, 311, 411, 511, 555, 611, 711 and 811 in all non-geographic NPAs within 6 months of the CRTC's directive; and
3. reserve NPAs 677 and 688 for extended digit format.

In addition, it is recommended that the CRTC request that the CSCN amend the following guidelines as required to reflect (1) the allocation of 768 NXX codes in NPA 600 as non-geographic and (2) the elimination of restrictions on the assignment of NXXs 211, 311, 411, 511, 555, 611, 711 and 811 in all non-geographic NPAs within 6 months of the CRTC's directive:

- Central Office Code (NXX) Assignment Guideline;
- Canadian Non-Geographic Code Assignment Guideline; and
- Canadian NPA 600 NXX Code Assignment Guideline

8 Matters for Further Consideration

TIF 112 will continue working on this task to resolve the particulars of the Extended 6YY NPAs solution (Option 7). Another report will be filed no later than 31 December 2024. This new report will include a recommendation for the implementation of 1+12 digits (with or without digit locking) or 1+14 digits.

9 Terms and Acronyms

***Figure 7**: Terms and Acronyms*

Term	Definition
5G	Fifth-generation technology standard for broadband cellular networks. 5G has faster download speeds than 4G.
6YY	A Canadian non-geographic area code, i.e., 622, 633, 644, 633, 677, 688.
BIRRDS	Business Integrated Routing and Rating Database System
BLIF	Basic Listing Interchange File
BSS	Billing Support Systems
Carrier	A Canadian carrier as defined by the Telecommunications Act
CC	Country Code
CISC	CRTC Interconnection Steering Committee
CLIF	Complex Listing Interchange File
CNA	Canadian Numbering Administrator
CNAC	Canadian Numbering Administration Consortium[27]
CO	Central Office. Usually used in the context of "Central Office Code." see NXX.
CRTC	Canadian Radio-television and Telecommunications Commission
CSCN	Canadian Steering Committee on Numbering
D-digit	The fourth digit in a TN, excluding the Country Code, e.g. 1-ABC-**D**EF-GHIJ or 1-ABC**D**-EFGH-IJKLMN.
DA	Directory Assistance
DN	Destination Network
E.164	ITU numbering plan that ensures that each device on the PSTN has a globally unique number with a maximum 15 digits
ESRD	Emergency Service Routing Digits
GPSI	Generic Public Subscription Identifier
GSMA	Global System for Mobile Communications Association
IETF	Internet Engineering Task Force
ILEC	Incumbent Local Exchange Carrier
IMSI	International Mobile Subscriber Identity

[27] CNA - CNA Consortium

INC	NANP Industry Numbering Committee
IoT	Internet of Things (also, M2M)
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IS	Information System
IT	Information Technology
ITU	International Telecommunications Union
LERG	Local Exchange Routing Guide
LNP	Local telephone Number Portability
M2M	Machine to Machine
MSISDN	Mobile Station International Subscriber Directory Number
N	A digit in a telephone number where N = 2 to 9.
NANP	North American Numbering Plan
NANPA	NANP Administrator
NANPE	NANP Expansion project
NDC	National Destination Code (area code)
NE	Network Element
NPA	Number Plan Area or area code
NTWG	CISC Network Working Group
NoC	Notice of Consultation
NPA	Number Plan Area or Area Code. Its format is NNX.
NRUF	Numbering Resource Utilization Forecast
NXX	The 4th, 5th, and 6th digit of a telephone number. It is sometimes called a Central Office (CO) code and refers to a 10,000 number block.
OSS	Operational Support Systems
OTT	Over The Top
SAC	Service Access Code[28]
SDO	Standards Development Organization
SIM	Subscriber Identity Module
SMS	Wireless Short Message Service

[28] 600 NXX Service Access Code (SAC) (cnac.ca)

SN	Subscriber Number (7-digit TN)
SP	Service Provider
TIF	CISC Task Identification Form
TN	Telephone number sourced from the North American Numbering Plan.
UDP	Uniform Dialing Plan
VoIP	Voice over Internet Protocol
WZ1	World Zone 1 (the NANP is identified as WZ1)
X	A digit in a telephone number where X = 0 to 9.

10 Contributions

***Figure 8**: Contributions*

Contribution Name	Submitter	Date Posted
(Proposed) CNTF112A - Address assignment rate of Non-Geographic (6YY) CO Codes	CSCN	2022-08-25
CNCO198A - CNA contribution - January 2023 NRUF contribution	CNA	2022-08-30
CNCO199A - Rogers contribution - TIF 112 - Initial thoughts	Rogers	2022-09-07
CNCO201A - Rogers contribution - TIF 112 - Chronology and Proposal for Services Grouping	Rogers	2022-11-04
CNCO202A - CSCN contribution - TIF 112 - Letter from CSCN to NTWG	CSCN	2022-12-01
CNCO203A - CNA contribution - TIF 112 - Comparison between January 2022 and July 2022 Non-Geographic NRUF forecasts	CNA	2022-12-07
CNCO202B - CSCN contribution - TIF 112 - Letter from CSCN to NTWG	CSCN	2022-12-07
CNCO203B - CNA contribution - TIF 112 - Comparison between January 2022 and July 2022 Non-Geographic NRUF forecasts	CNA	2022-12-15
CNCO204A - Rogers contribution - TIF 112 - Draft TIF report for TIF 112	Rogers	2022-12-15
CNCO204B - CSCN contribution - TIF 112 - Draft TIF report for TIF 112	CSCN	2023-01-12
NTCO0736 - NTWG contribution from COMsolve - Request from CSCN regarding assistance with CSCN TIF 112	COMsolve	2023-02-08
CNCO205A - Comparison between 11-digit numbering and 15-digit numbering pools	CNA	2023-03-06
CNCO206A - TIF 112 – report planning	Rogers	2023-03-16
CNCO207A - TIF 112 Request from CSCN regarding assistance with CSCN TIF 112 Part 2	COMsolve	2023-03-16
CNCO208A - CNA contribution - TIF 112 – Comparison of Non-Geographic NRUF from January 2022 through January 2023	CNA	2023-03-29
CNCO204C - Rogers contribution - TIF 112 – Draft TIF report for TIF 112	Rogers	2023-04-03
CNA Contribution - April 2023 North American Numbering Plan (NANP) Exhaust Analysis	CNA	2023-05-10
CNTF112F - Address Assignment rate of Non-Geographic (6YY) CO Codes - REVISED	CSCN	2023-06-21
CNCO204D - Rogers contribution - TIF 112 – Draft TIF report for TIF 112	CSCN	2023-06-27
CNCO204E - Rogers contribution - TIF 112 – Draft TIF report for TIF 112	CSCN	2023-06-30
CNCO204F - Rogers contribution - TIF 112 – Draft TIF report for TIF 112	CSCN	2023-07-10
CNCO204G - CSCN contribution - TIF 112 – Draft TIF report for TIF 112	CSCN	2023-07-19
CNCO220A - CNA contribution - TIF 112 – Non-Geographic NRUF comparisons up to July 2023	CNA	2023-08-18

11 CSCN TIF 112 Participants

The CSCN recognizes the participation and contributions from the following participants:

***Figure 9**: CSCN TIF 112 Participants*

Organization	Name & Specific Roles
Bell Canada	Joey-Lynn Abdulkader – Writing Committee Marie-Christine Hudon Mohammad Tabari Francis Fernandes
CNA	Kelly T. Walsh – CSCN Chair – CNCO203A/B, CNCO206A David Comrie – Writing Committee, CSCN Secretary – CNCO197A, CNCO202B, CNCO205A, CNCO208A Fiona Clegg – Writing Committee Suresh Khare – Writing Committee, NRUF Forecasting – CNCO198A/C/D John Jennings
CNAC	Glenn Pilley Bill Barsley
COMSolve	Edward Antecol – Writing Committee
CRTC	Alexander Pittman Michel Murray Étienne Robelin
Eastlink	Lindsay Thorne
Freedom Mobile	Dilraj Suri
Quadro Communications	Darryl Evans – Writing Committee
Railway Association of Canada	Enzo De Benitti
Rogers	Arturo Arreaga
SaskTel	Tammy Wilson
Shaw	Graham LeGeyt
TELUS	John MacKenzie – Writing Committee Martin Laroche Olena Bilozerska Peter Szabo
Independent	Gerry Thompson – TIF 112 co-sponsor, Writing Committee Lead, CNCO199A, CNCO201A, CNCO204A/B/C, CNCO206A/B/C/D Karen Robinson – TIF 112 co-sponsor, Writing Committee

12 NTWG TIF 43 Participants

The NTWG recognizes the participation and contributions from the following participants:

***Figure 10**: NTWG Participants*

Organization	Name & Specific Roles
AT&T	Martin Dolly
Bell Canada	Joey-Lynn Abdulkader Sefiu Ibikunle Jake Hwang Mohammad Tabari Thomas Rumball Mohanraj Sivagnanasundaram ("Siv")
CityWest	Paul Fleming
CNA	Kelly T. Walsh – CSCN Chair David Comrie – CSCN Secretary Fiona Clegg Suresh Khare
CNAC	Glenn Pilley Bill Barsley
COMSolve	Edward Antecol – NTCO0736, NOCO0741
CRTC	Sebastien Garsuault Imran Gill Vish Iyer Nilesh Joshi James Ndirangu
Eastlink	Russel DeLong
Freedom Mobile	Muhammad Uppal
Neustar	Marcel Champagne
Rogers	Arturo Arreaga Pavlo Nebesny Jennifer Mack
SaskTel	Garey Schlecter Mark Miles
Shaw	Graham LeGeyt
TELUS	Martin Laroche Richard Polishak
TekSavvy	Diane Dolan
Independent	Karen Robinson Gerry Thompson – TIF 43 sponsor, NTCO0729

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