Hilbert Curve Rendering
Regional Area Network
- Canada -

Presentation to

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2025 February _____

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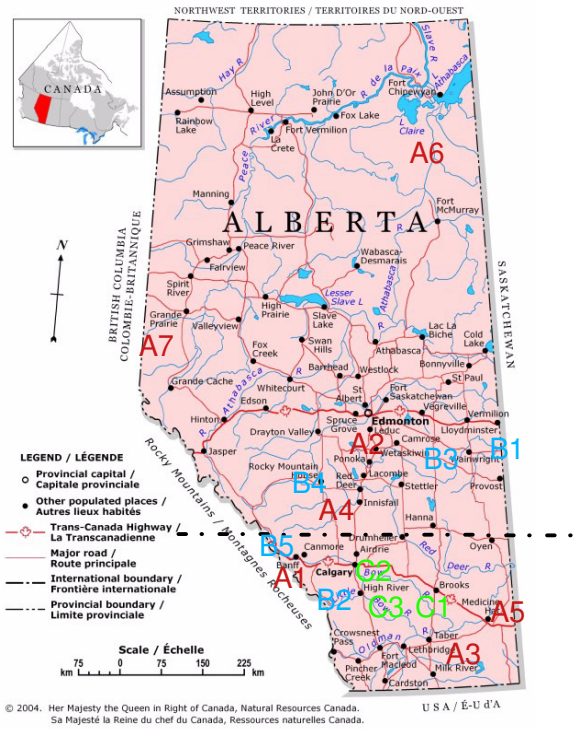
- Contrary to the implication of its name, telephony started with fairly short service ranges by contemporary standards. It was only through interconnecting, with continuously improved technology, to ever farther distance communities that the worldwide PSTN was established. This growth naturally preserved the GeoLocation properties that are crucial for a trustworthy worldwide communication backbone. The current Internet lacks these characteristics, perhaps due to its explosive deployment over the well-established PSTN,
- This document describes a technique that utilizes Hilbert Curve to allocate EzIP addresses by mimicking, with progressively better association with population density distribution. This top-down approach establishes a numbering plan to enable ad hoc local deployments, while retaining the global perspective. So that, a RAN (Regional Area Network) can be started anywhere desired with the assurance that its numbering plan will be compatible with other RANs as they begin to interconnect.
- Reference:
- https://en.wikipedia.org/wiki/Hilbert_curve
- The Hilbert Curve renders a set of linear (1D) data points into a squarish (2D) graph, packing the nearby data points close to one another.
- A. Applying this technique to IP address allocation, all neighboring subscribers receive IP addresses with the same network prefixes, thus preserves the GeoLocation properties for supporting efficient hierarchical routing.
- B. By reserving spares at desired levels, future growth within a community as well as developments in the between areas will have low impact to already assigned IP addresses, preserving the full benefit of static address to subscribers.
- Nomenclature:
- IPv4: xxx.xxx.xxx.xxx Where xxx = 0-255
- EzIP: NPA.DST.NHD.NBR
- NPA (Numbering Plan Area) About a Country or a State: 240-255
- DST (DiSTrict) About a City: 0-255
- NHD (NeighborHooD) About a section of a City: 0-255
- NBR (NumBeR): Individual subscriber identification: 0-255

- Canada population is about 37M which is only 14.5% of the 256M address capacity of a 240/4 netblock. So, there are sufficient spares by establishing one RAN for the entire country.
- We will manipulate a spreadsheet based on the information in the below webpage to organize the data points that represents the population concentration points:
- https://en.wikipedia.org/wiki/Population_of_Canada_by_province_and_territory
- Group A (A1-A14) consists of top four Provinces (6 for Ontario, 4 for Quebec, 2 for British Columbia, and 2 for Alberta) Each is allocated one NPA. These takes NPAs 241-250 & 252-255, total of 14 NPAs.
- The remaining 2 NPAs will be shared among the smaller 9 provinces / territories as Group B.
- The actual sub-grouping is determined by the actual geographic in proximity to one another. It turns out that B11, B12 & B13 are physically next to B5 & B6. Five of them can naturally be grouped together under one EzIP NPA Code 251.
- The rest four (B7, B8, B9 & B10) of Group B are in close vicinity to one another. They are grouped together and assigned EzIP NPA Code 240.
- Since the majority of Canadian population lives along the southern areas bordering with USA, the Canada NPA Map following Hilbert Curve turns out to be practically a straight line.

For clarity, this slide is a duplicate of the last one showing only the 16 EzIP NPA assignments, connected by Hilbert curve lines, with the intermediate data points removed.

Alberta, Canada EzIP DST (2nd Octet) Code - worksheet



- Alberta Province with population of 3.5M.
- We will manipulate a spreadsheet based on the information in the below webpage to organize the data points that represents the population concentration points:
- https://www12.statcan.gc.ca/census-recensement/2021/as-sa/fogs-spg/page.cfm?lang=E&topic=1&dguid=2021A000248
- Upon placing the population centers grouped in three categories (A, B &C) and then sum them up in two parts, North and South, a horizontal line drawn just north of Canmore pretty much divided Alberta into two even halves, each with roughly equal population (1.77M each)
- Since Edmonton that is north of this line while Calgary is on the south side and each are well-known population centers, this division line is natural for assigning one EzIP NPA to each.

Alberta Canada EzIP NPA codes (252 & 253)

- This is the simple Alberta EzIP NPA Map. That is:

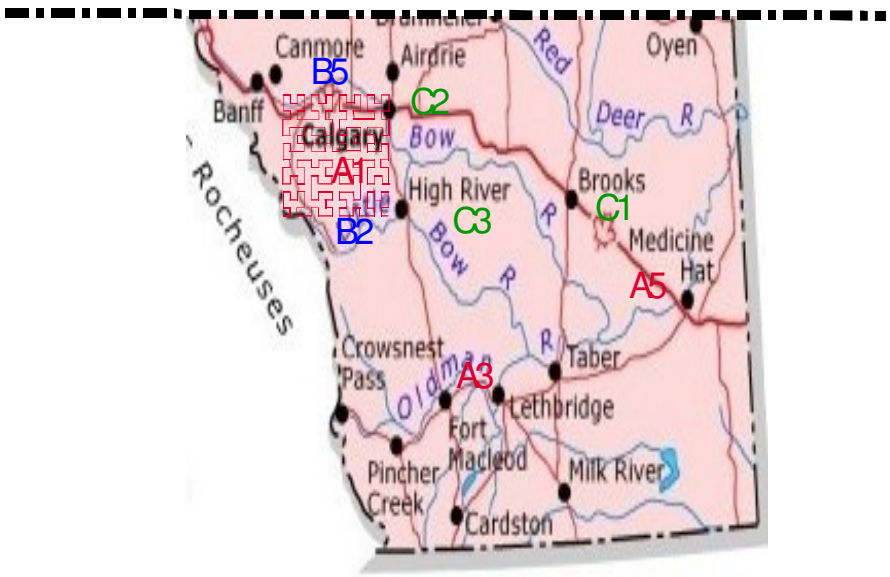
- EzIP NPA 253 is assigned to Alberta-N represented by Edmonton.

- EzIP NPA 252 is assigned to Alberta-S represented by Calgary.

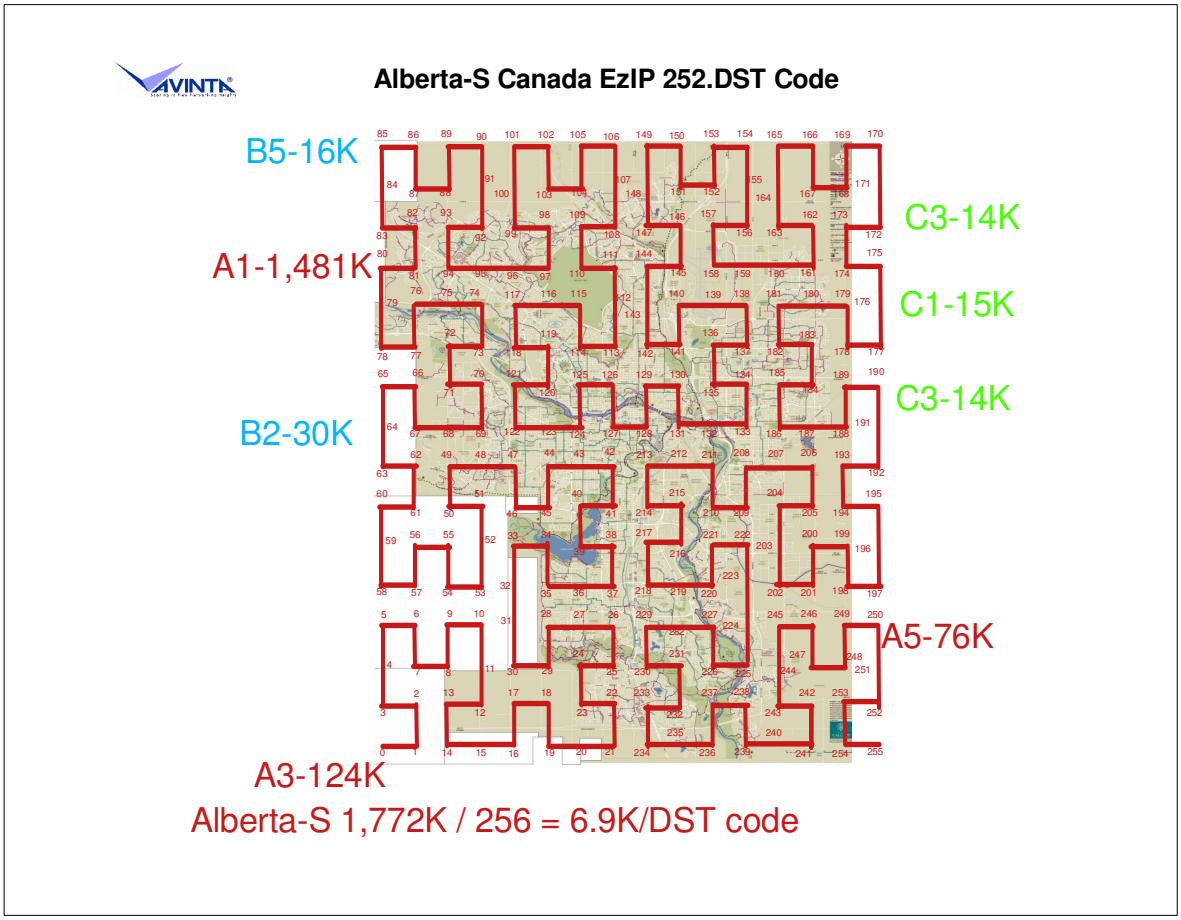
- Alberta population is 3.5M.

- Each EzIP Prefix 252 & 253. has 16M address capacity. Combined, it is 8.98 times of the population. So, there is plenty of spares that eases allocation process.

Alberta-S Canada EzIP 252 (DST) Code - Worksheet



- Let's go through the next level exercise by looking at allocating EzIP DST (2nd Octet) codes for Alberta-S.
- Since over 80% of the population resides in Calgary, we will start with placing a 4th Order Hilbert Curve graph over Calgary.
- It is apparent that this is difficult to make use of the Hilbert Curve characteristics in this form, because there is no resolution in visibility by being applied to a very small portion of the map.
- Since the rest of CMAs and CAs combined represents only 20% of the population, we should start from a different perspective.
- That is, we should focus the allocation exercise on Calgary while treating the need of the smaller communities as peripheral applications.



- This is a map of the City of Calgary. Its population is denoted with the marker A1-1,481K. It is placed at the northwest corner of the map to reflect its relative location in Albert-S.
- The smaller CMAs and CAs are represented by their respective population density markers and placed at respective peripheral locations relative to City of Calgary.
- Upon placing a 4th Order Hilbert Curve on this map and adjusted its dimensions to fit over the outlines of Calgary, we can begin the allocation exercise.
  - A. Each of the smaller CMAs and CAs gets its EzIP DST allocation by picking up the nearby Hilbert Curve data points that fall off the Calgary City boundary line (white background).
  - B. Within the City proper, we can zoom in to a general location of interest, such as a potential subscriber looking for the EzIP DST allocation. For example, if we zoom in to "47" in the graph, we will come upon a street named "SIGNAL HILL DR". This means that all subscribes residing around this DRIVE have been assigned with EzIP DST code 47.
- Combined with the EzIP NPA code 252 assigned to Alberta-S, EzIP prefix 252.47 is assigned to subscribers around "SIGNAL HILL DR". The remaining tow Octets, .NHD.NBR for completing an individualized EzIP address are open for a subscribers to choose will at this moment, as long as no one has already chosen it.
- Just like any pioneering communication operations, such as HAM Radio operating in advanced unallocated radio spectrum, the last step is open for everyone at the beginning. In the long run, Alberta-S Government should set up an administrative operation to be sure that there is no duplicated use of any full EzIP addresses.
- Note that the map used here is a low resolution version of a work file. The master is available for download from the below URL for anyone who may be interested in the hand-on exercise:
  - https://www.dropbox.com/preview/Alberta-S%20Canada%20EzIP%20DST%20Code.pdf?context=file_uploader_preview_file&role=personal