Hilbert Curve Rendering Regional Area Network - Taiwan ROC

Presentation to

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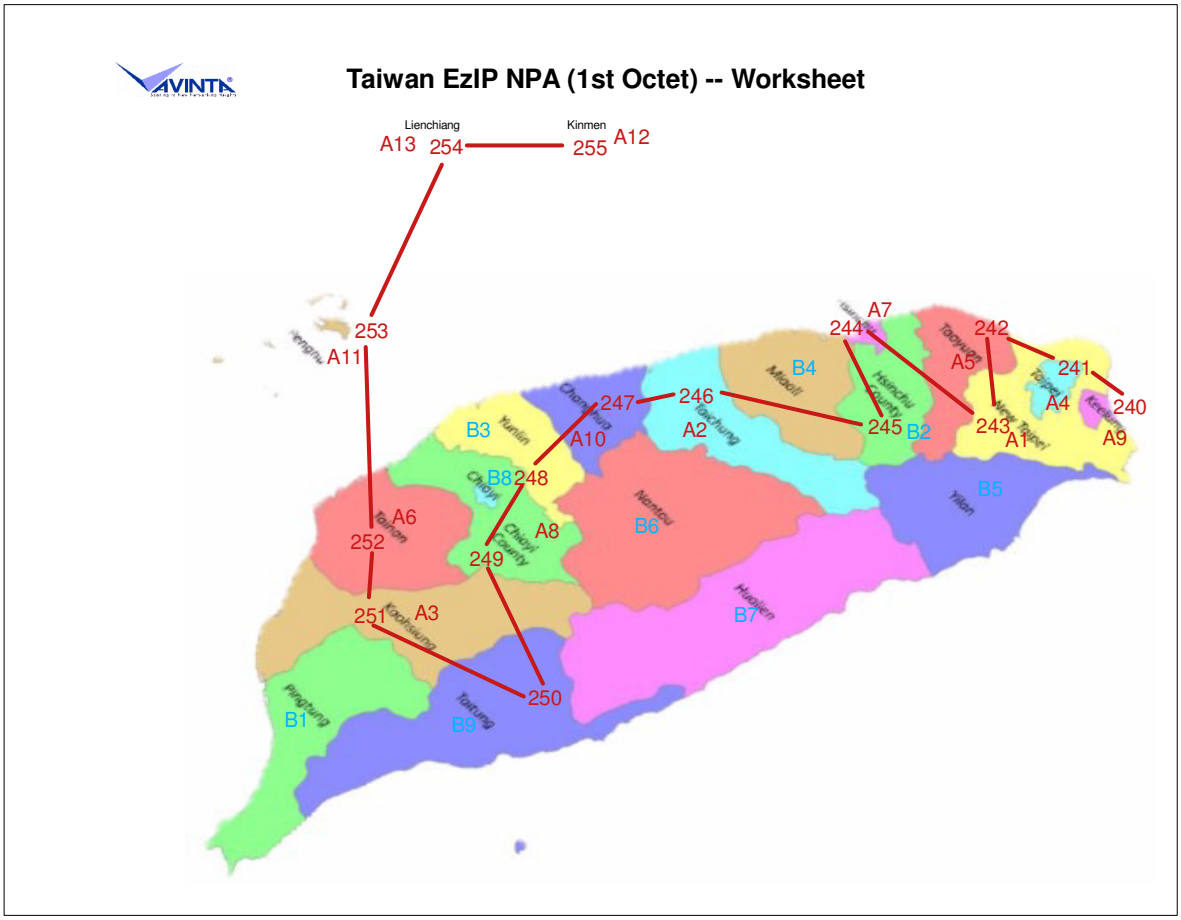
AYChen@Avinta.com

Avinta Communications, Inc.
142 N. Milpitas Blvd., #148, Milpitas, CA 95035-4401 U.S.A.
Tel: +1 (408) 942-1485 Web: www.Avinta.com

- 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) for a Country or a State: 240-255
- DST (DiSTrict) for a County or a City: 0-255
- NHD (NeighborHooD) For a section of a City: 0-255
- NBR (NumBeR): Individual subscriber identification: 0-255



- Taiwan is an island nation. The 256M addresses of one 240/4 netblock is over 9 times of her 28M population. There are much more than enough spares for this case, so that we can focus on the process of allocating the 16 data points in the first octet of the EzIP address.
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- There is a "Administrative Structure" based population spreadsheet on the below webpage that we will utilize for this exercise:
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- http://www.geo-ref.net/ph/twn.htm
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- We will go through the following steps:
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- A. Sort by "Type" which gives us 6 "Special municipalities", 3 "Municipalities" and 13 "Districts" for a total of 22 Municipalities.
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- B. By including Changhua District having a fairly large population (1,186,795) and 3 remote islands, there are 13 municipalities that will be tagged as EzIP Group A (A1 - A13). Each will be allocated one EzIP address prefix.
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- C. The remaining 9 municipalities are tagged as EzIP Group B (B1 - B9). Each EzIP prefix will serve three of these.
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- D. Place these 22 tags against the associated "Provinces" names in the map.
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- E Next, assign the sixteen EzIP prefixes sequentially to the tags keeping an eye for optimizing the distance to the next tag.
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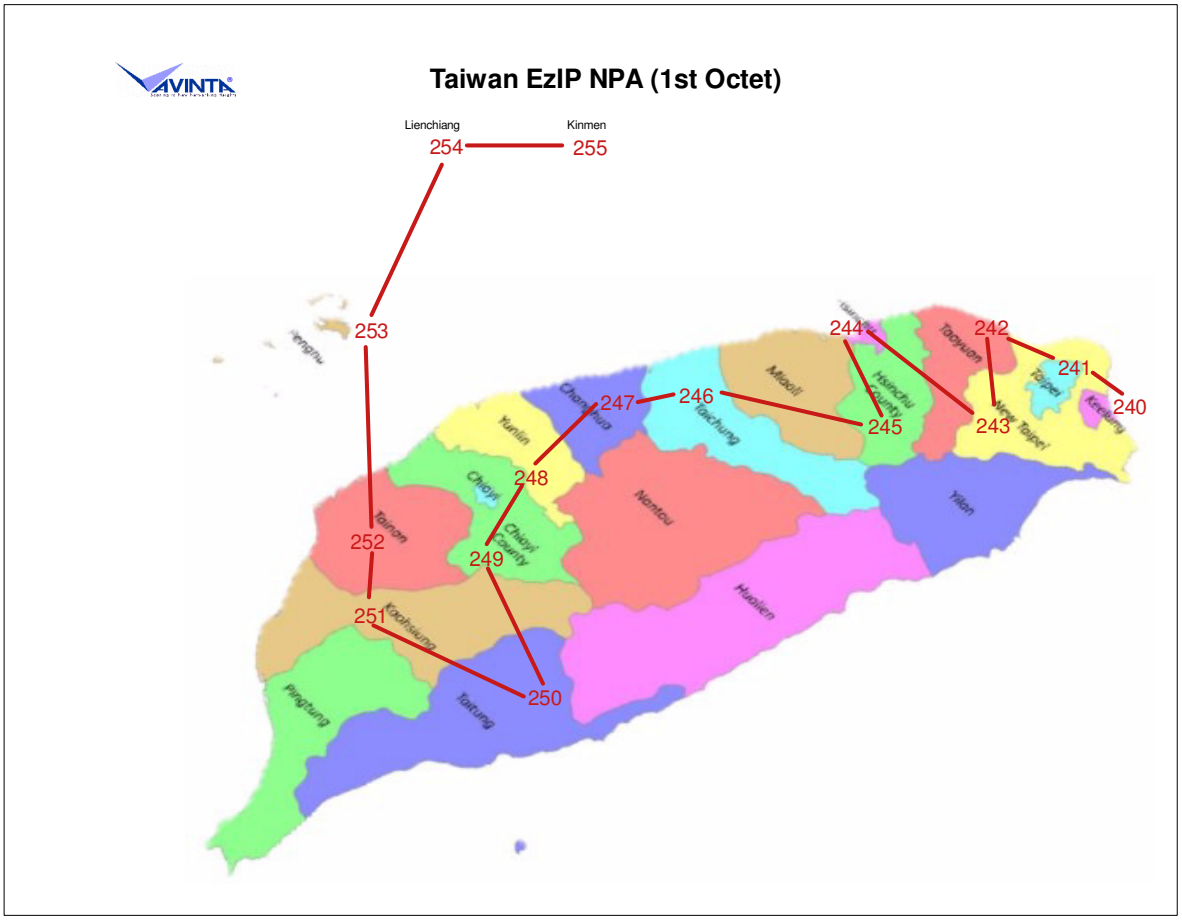
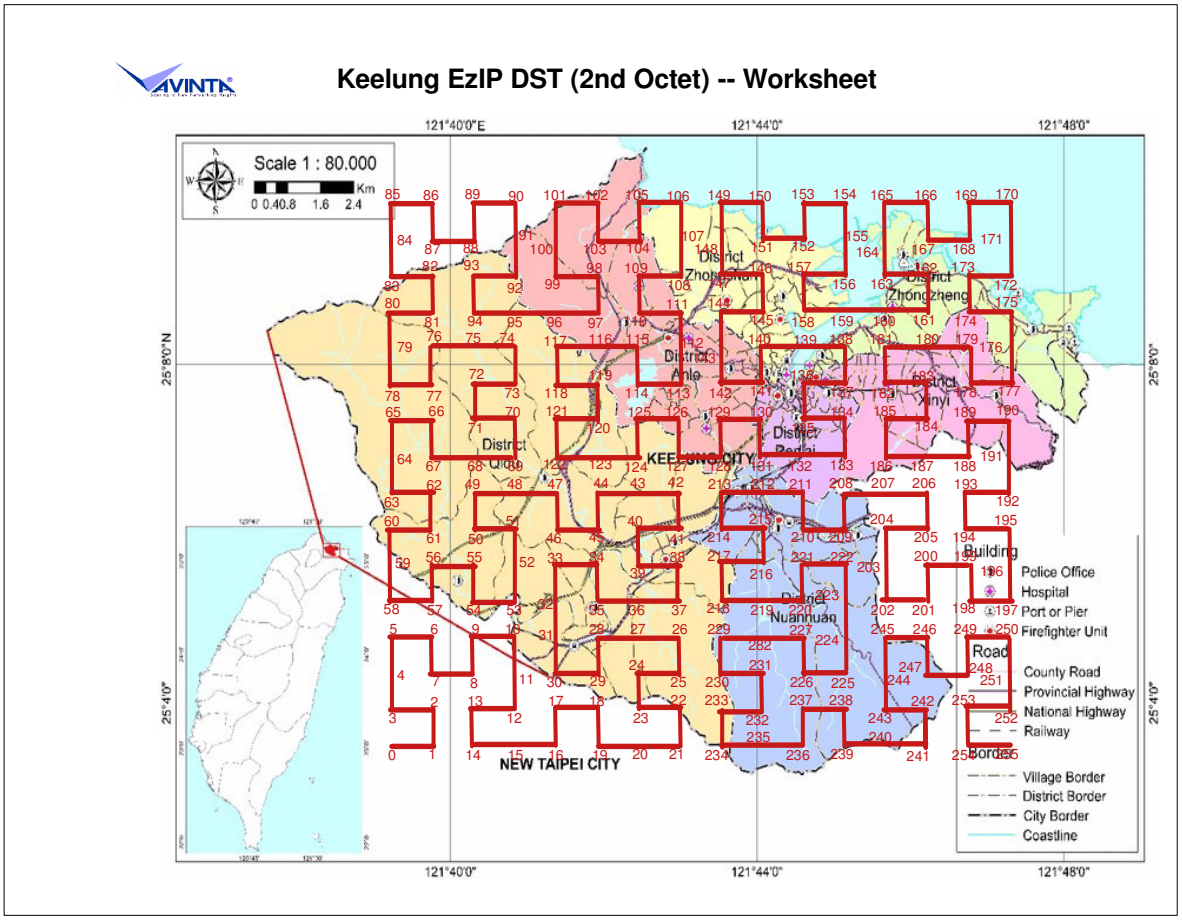
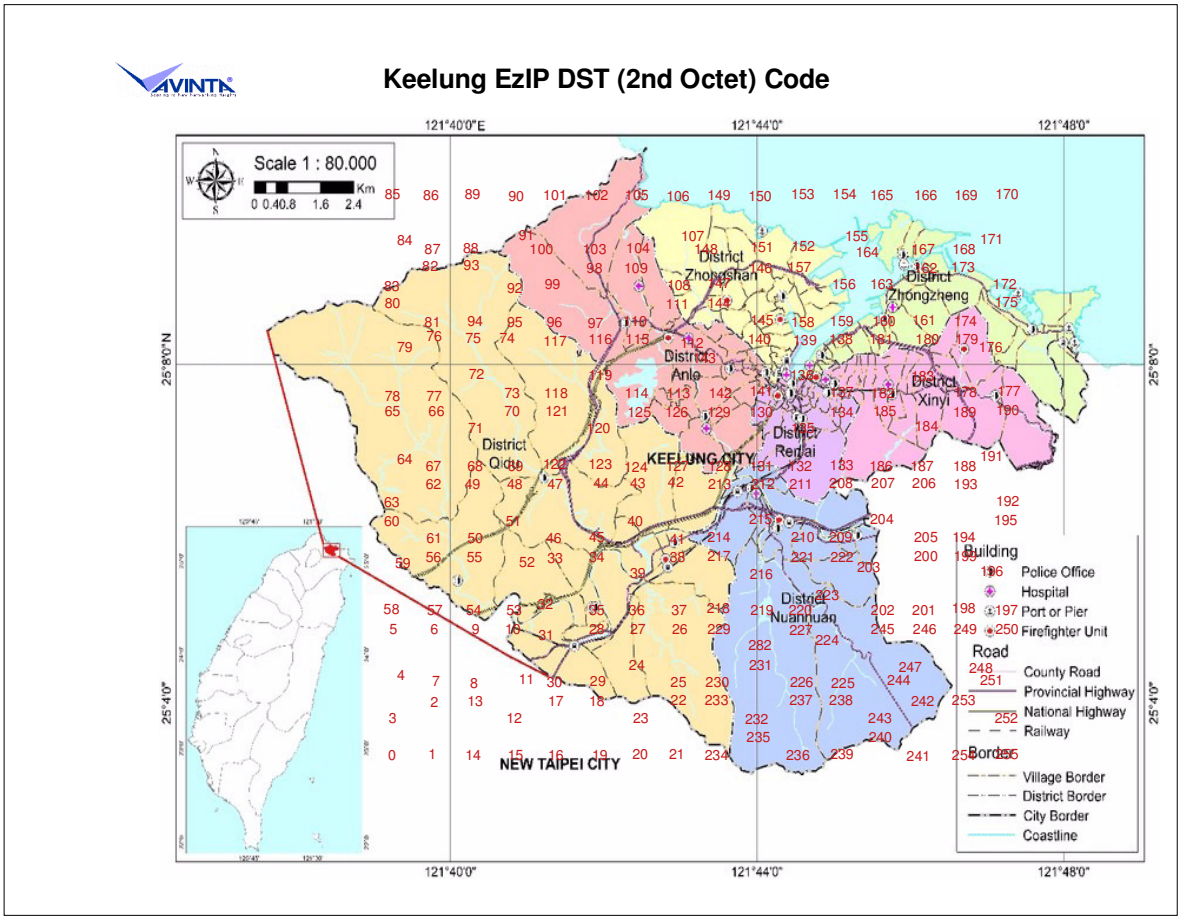
- F. Draw Hilbert Curve segment lines between the EzIP prefix values sequentially to complete this process.



Here is a view with only the essential information for guiding the next allocation process.



- Let's go through the next level exercise by looking at one particular municipality, Keelung City.
- EzIP prefix 240 represents 16M addresses that are over 43 times of the population of Keelung which is only 367,264. within a 133 Sq. Km. area.
- This 4th order Hilbert Curve represents the EzIP 2nd Octet address values. Each data point is associated with 64K EzIP addresses. Since we have abundance of addresses, we do not need to go through the trouble of shaping the curve to conform to the contour of the Keelung map. We can just go straight to make use of its data points that fall within the City outlines for assigning to subscribers.
- There are a lot data points in this Hilbert Curve that fall into the neighboring municipality - New Taipei City, or simply into the ocean. These may be left alone for now to serve as spares for future growth from either municipality.



- After removing the interconnecting segment lines, this is a lookup table type map serves a a guideline for allocating the 2nd Octet of EzIP addresses to Keelung City subscribers.
- By identifying a subscriber's location on the map, the red numbers around that area are candidates to be assigned to the subscriber as the EzIP address 2nd Octet.
- For example, subscribers located around the area on the map labeled, "District Qidu" would be assigned with EzIP address in the form of NPA.DST.NHD.NBR. Where NPA (Numbering Plan Area) is 240 for Keelung. DST (DiSTrict) could be 69, 48, 49, 68, 122 or 47.
- The 3rd Octet addresses NHD Neighborhood) may be assigned similarly by utilizing more specific NHD level maps which should have better accuracy and resolution of demographic data related to communities, streets, buildings, etc.
- Notes:
- For practical purposes, there is likely no need to carry this process down to the 4th Octet NBR (NumBeR), because its total capacity of 256 can only serve a fraction of a large high rise building.
- For Keelung, this DST level map having a grid resolution of better than 1 Km. should be sufficient.
- In terms of GeoLocation, this exercise facilitates the hierarchical route setups, The specific correlation between a static EzIP address and a subscriber's service location will be created by the IAP (Internet Access Provider) and kept in the subscription record.
- Only a handful out of 58 African countries have population more than one quarter of the 240/4 capacity (256M). So, most countries can be served with just one RAN. The address allocations and assignments may be carried out by following the process suggested above.
    - https://www.worldometers.info/population/countries-in-africa-by-population/