A Deterministic Internet

Presentation to

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2024 October 02

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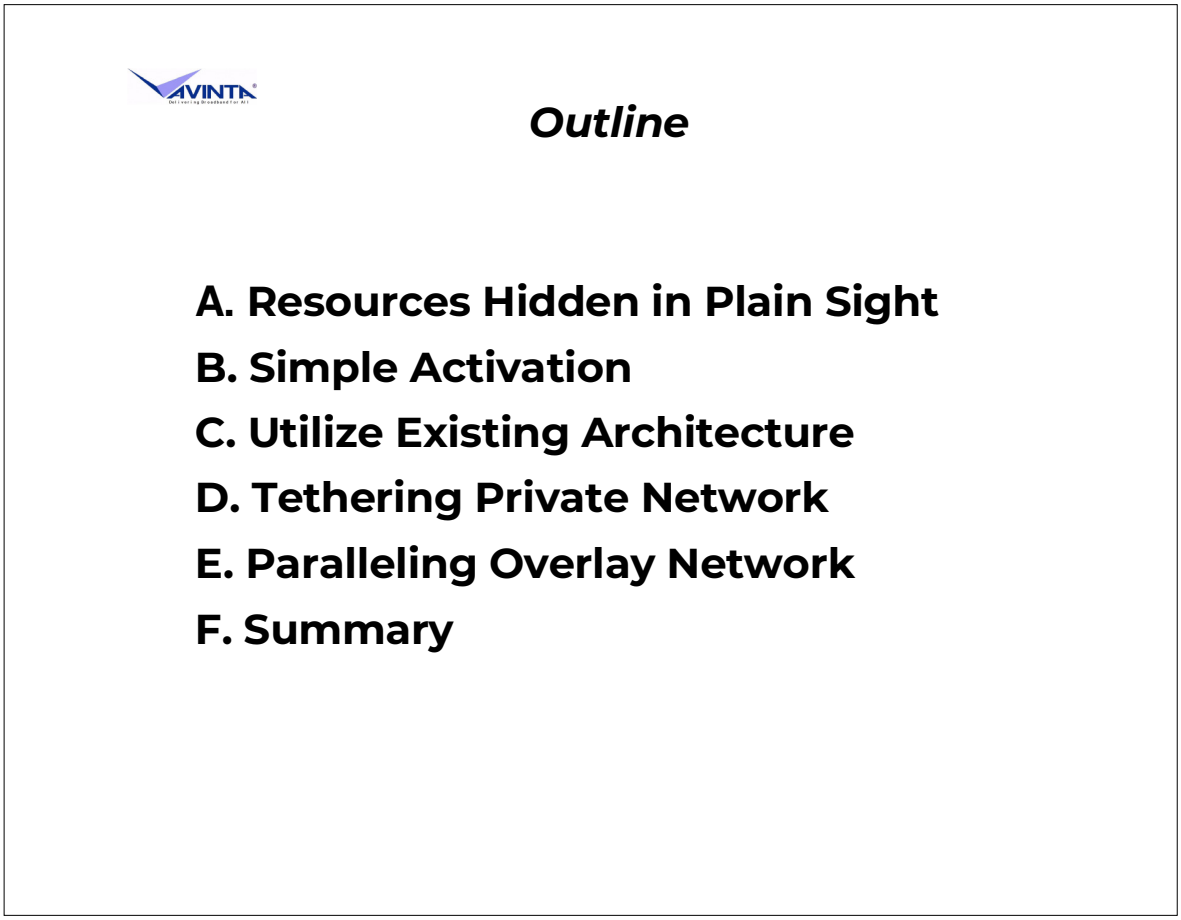
- Although the Internet achieved phenomenal advances during the last few decades, it is full of ***confusions, contradictions, or even convolutions***, depending on one's perspective. For example,
- The Internet promotes ***leveling the playing field*** for everyone. But, ***US gets 4.91 IPv4 addresses per capita,*** while ***Zambia gets only 0.01***. The ratio is nearly 500:1, or ***2.6 orders of magnitude*** apart. ***Over a dozen entities get no allocation, while Vatican City gets 21.4.*** - This is far from equity.
- The Internet promised **end-to-end connectivity**. But, its current predominate operation model, ***Content Delivery Network*** based on ***master-slave architecture*** impedes such goal, ***even within a local community.***
- The Internet took issue with ***telco monopoly and government regulation on PSTN***. Yet, we now have ***multinational conglomerates*** that each **dominates** a respective business sector to the point of ***ignoring responsibilities and evading regulations.***
- Also, the potential of roughly ***195 nations fragmenting*** the Internet to a ***geopolitical Splinternet*** is criticized while the ***ASes*** have already created an ***Onion-net*** with ***76K layers***.
- Overall, the Internet is ***vulnerable to security breaches***, ranging from harassment to ransomware.
- Since the lengthy IPv6 address format is not user-friendly, we will leave it alone today.
- A revisit of the overall environment suggests that there might be ***a fresh alternative*** to the above.
- Today's talk, ***"A Deterministic Internet"*** is the result of a study program, called EzIP (phonetic for Easy IPv4) that is part of Avnta's ***Project Phoenix.***



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►With limited time, this presentation will focus on ***general concepts and system analyses***. This allows us to see the whole picture first. The cited references will provide the details.
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►(Like the common wisdom of seeing a forest from an ***airplane at 35K ft up in the sky***. Today, we will do so from even farther away, perhaps more like ***10K miles away in the space***.)
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■**A.** **.....**
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■**B.** **.....**
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■**C.** **.....**
►Practically ***no development*** investment, ***only deployment*** effort.
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■**D.** A ***local example*** provides a general idea about the scheme.
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■**E.** A ***global view*** of the general deployment and a ***potential use case***.
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■**F.** **.....**
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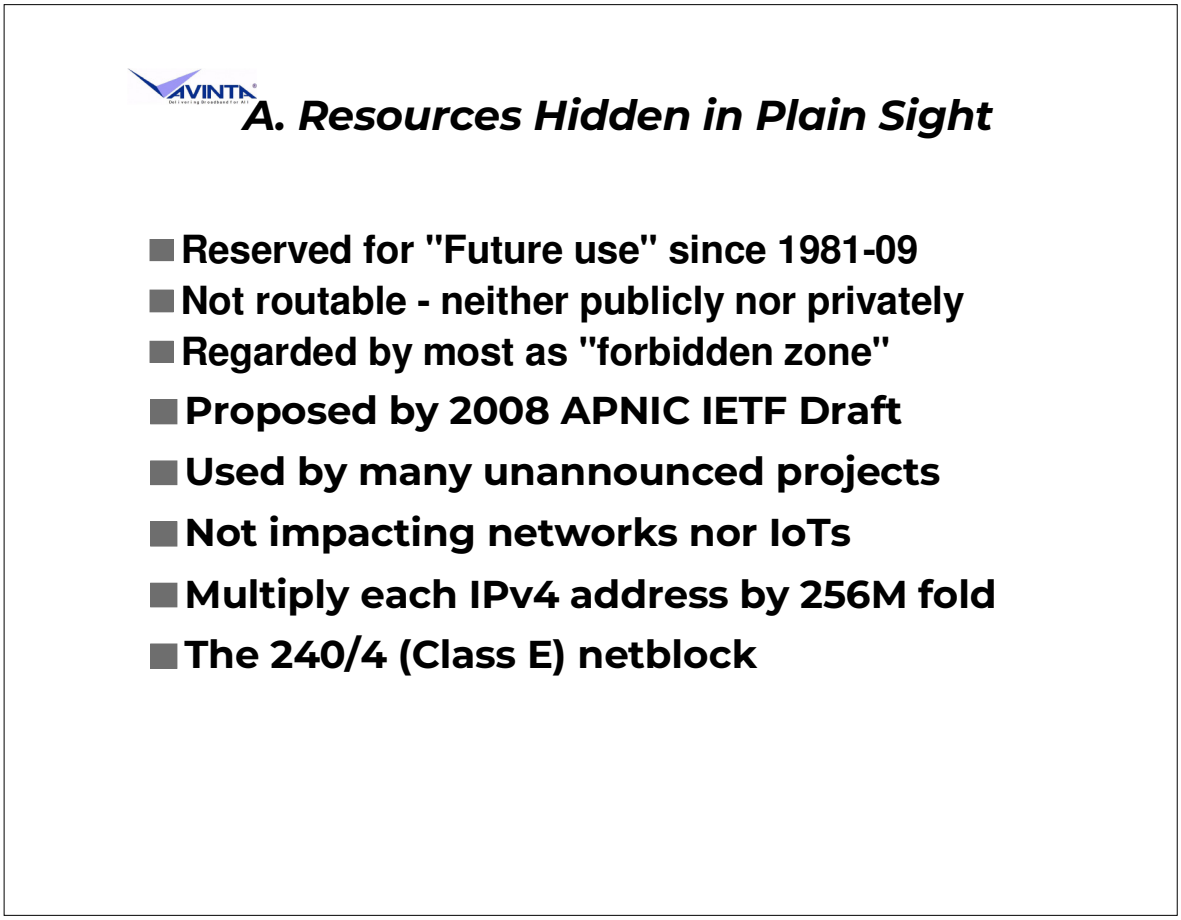

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► ***How many in the audience were born after 1981?***
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■ **L**imited to private use which already had too many IoTs to change.
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■ In a sense, the uncoordinated uses through the years are fragmenting the Internet.
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■ The alternative implication is ***no need to get IETF approval***.
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■ **.....**
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■ **.....**
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► **Related netblock sizes:**
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► **RFC1918 - Private:**
► **10/8: 16M**
► **172.16/12: 1M**
► **192.168/16: 64K**
► **Total: 17.064M**
►
► **RFC 6598 - CG-NAT:**
► **100.64/10: 4M**
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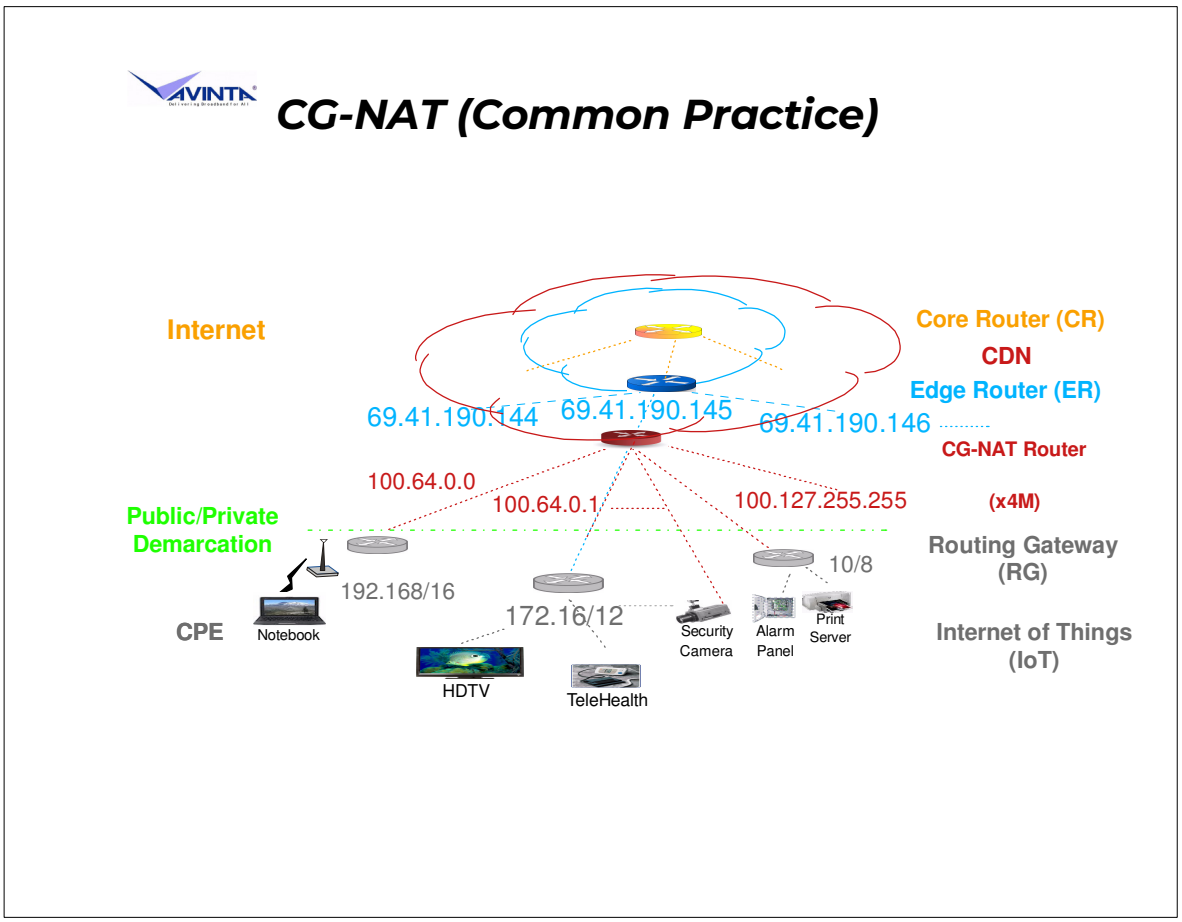

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►Let's start with a couple graphic diagrams to get a ***genral visual*** of what we are talking about.

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■This is the basic Internet configuration: ***CR (Core Router) -> ER (Edge Router) -> RG (Routing / Residential Gateway) -> IoTs (Internet of Things)***.

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■Inserting a ***CG-NAT router (using RFC6598 100.64/10 netblock)*** between ER and RG, each public IPv4 address can be ***expanded by 4M fold.***

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■Deploying CG-NAT around the globe, the current predominate Internet architecture, ***CDN (Content Delivery Network)*** is formed.

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■Within each isolated CG-NAT cluster with ***fewer than 4M subscribers, peer communication*** is possible.

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►Attempting to serve more population within ***each CG-NAT cluster,*** by ***dynamic reuse*** of 100.64/10 netblock, however, ***defeats the peer communications*** goal.

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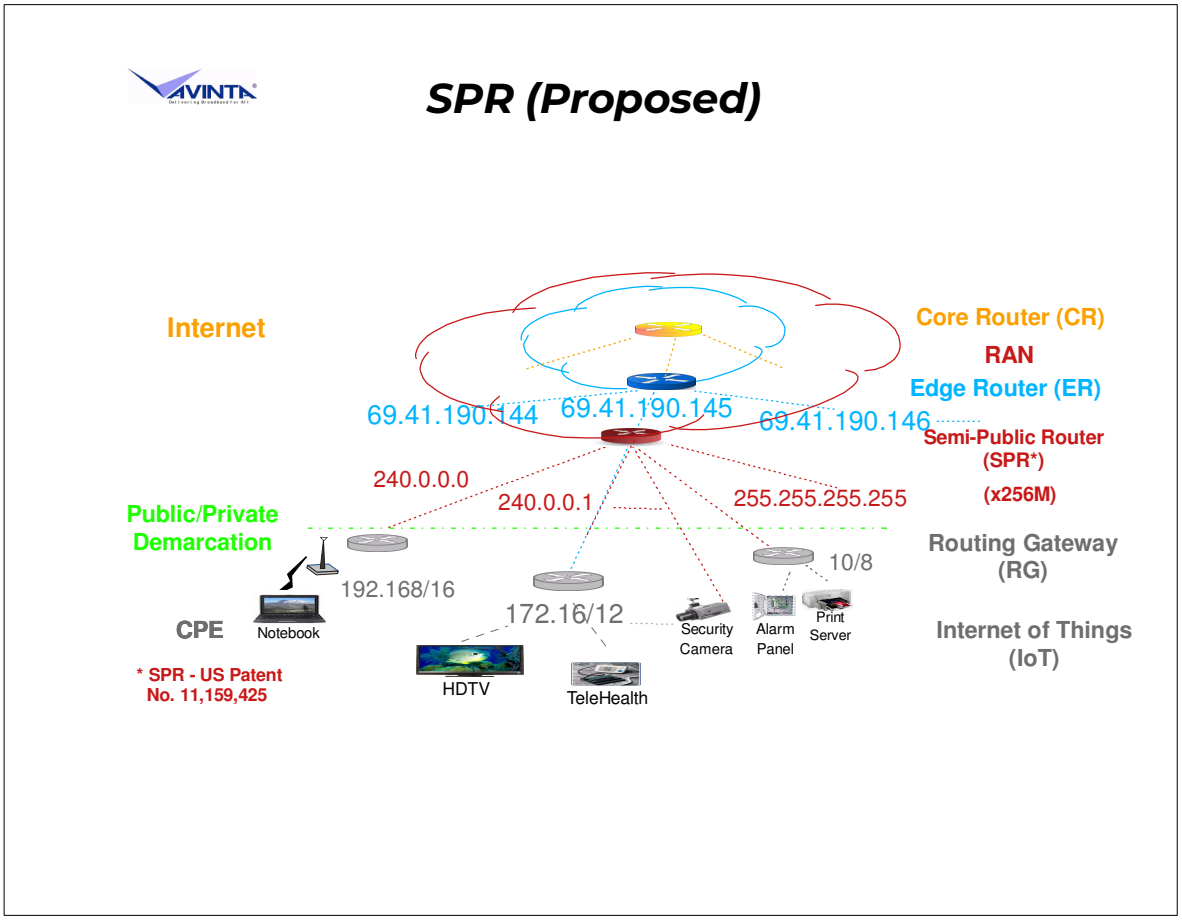
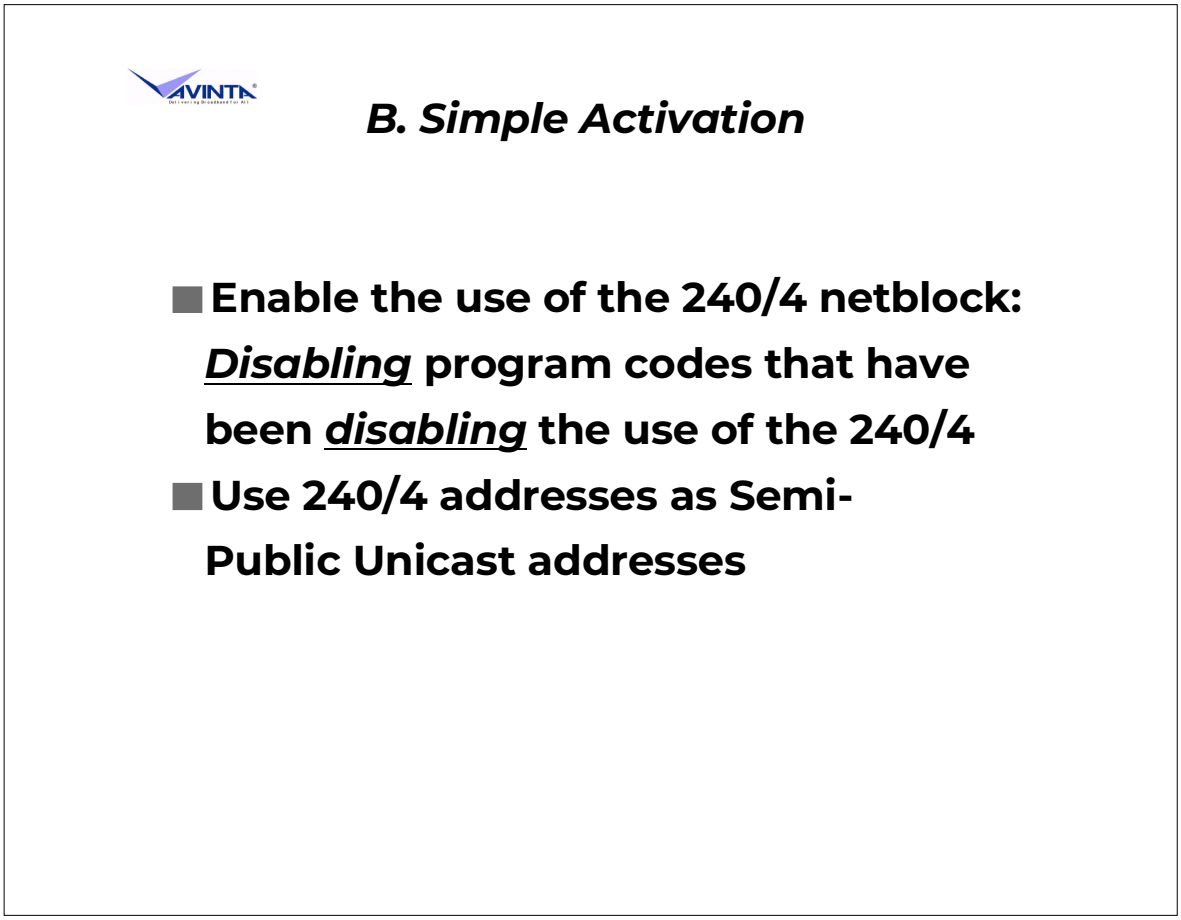


- Let's start from the basic Internet again.
- By applying 240/4 to CG-NAT routers, CG-NATs become ***SPRs, each having 256M address*** capacity.
- Deploying ***SPR all around the world, a new layer of routers forms RAN (Regional Area Network).***
- This ***64 fold addressing capability increase*** is significant. For example, if each person is assigned with one 240/4 address, ***only 4 countries (India, China, US ad Indonesia)*** in the world have population exceeding the capability of one SPR.
- If SPRs focus on serving premises, using US statistics of ***each household consists of three residents, only India and China have more premises than the capacity of one SPR.***
- Note that these numbers are ***ball park estimate***s for orienting our minds about the ***order of magnitude of a practical IP address pool*** may be***.***



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►Next, let's look at how this can be done.
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►For a long time, networking equipment blocked packets with 240/4 address, making this netblock appear to be ***a mystery***. The actual mechanism is likely ***a very short screening code that recognizes the 240/4 address in an IP header and then drops the packet.***
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■We have identified ***one such example,*** that is, by ***commenting out one line code*** that has been disabling 240/4 addressed packets, the 240/4 is enabled.
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►So, we should keep a mental note that software engineers claiming this is a complicated task may not know enough about their own program codes. Or, their code is not concise.
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■The 240/4 netblock should be used primarily for basic user identifications.
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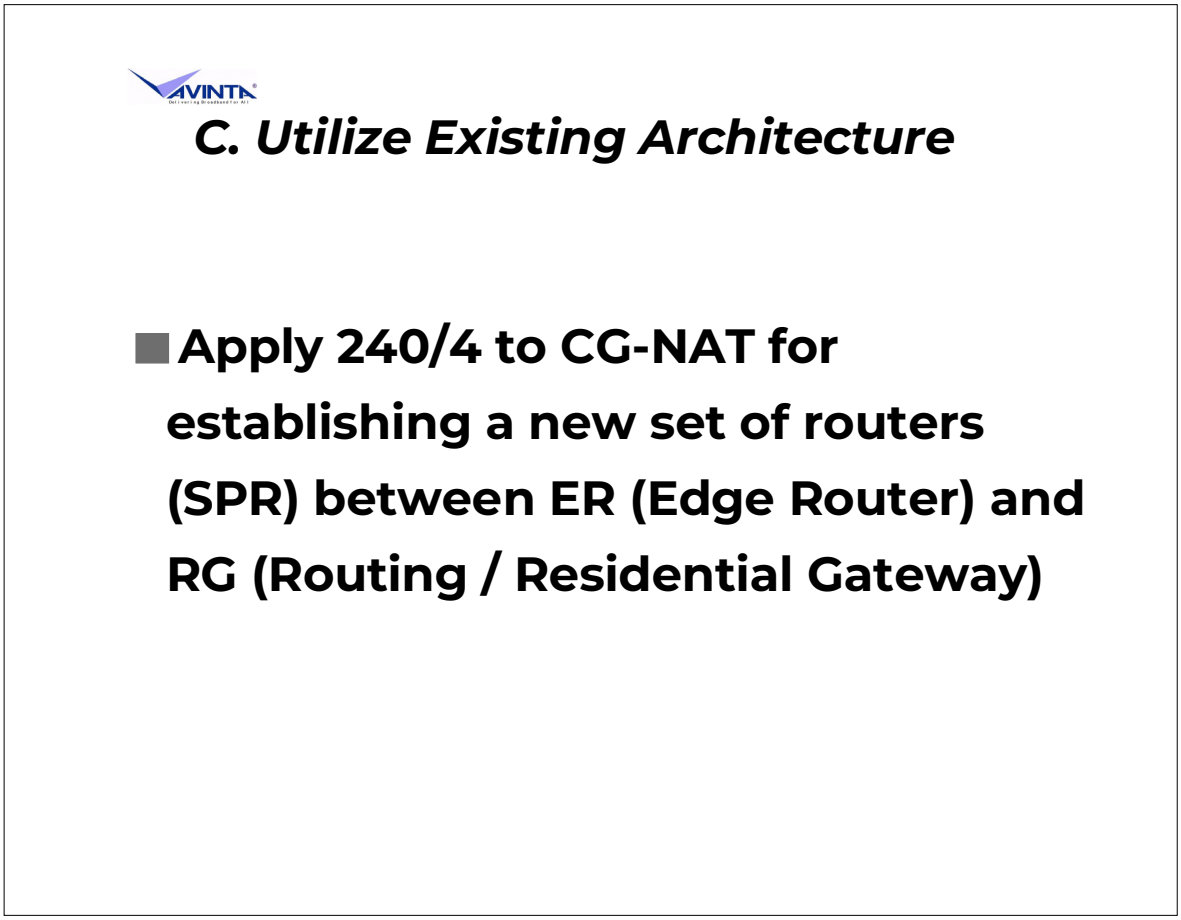
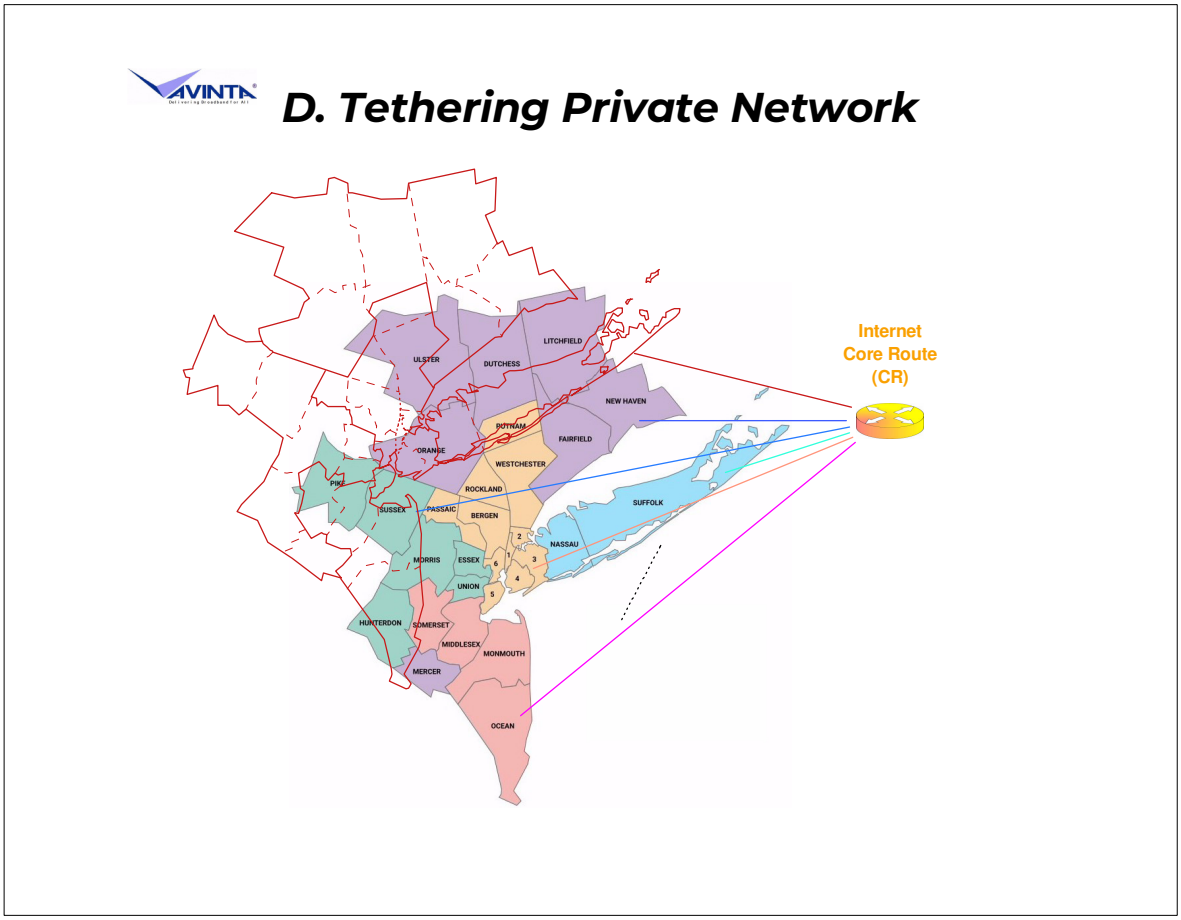


- Enhance CG-NAT routers to use 240/4 netblocks in addition to 100.64/10 to ***provide service in parallel***.
- Address pool of each SPR using 240/4 is large enough to cover up to ***64 CG-NAT clusters***.
- ***Static*** 240/4 address assignment ***simplifies record keeping and administration***.
- ***Static addressing supports hierarchical and mesh routing***.
- Note that ***dynamic addressing can not support hierarchical routing.***

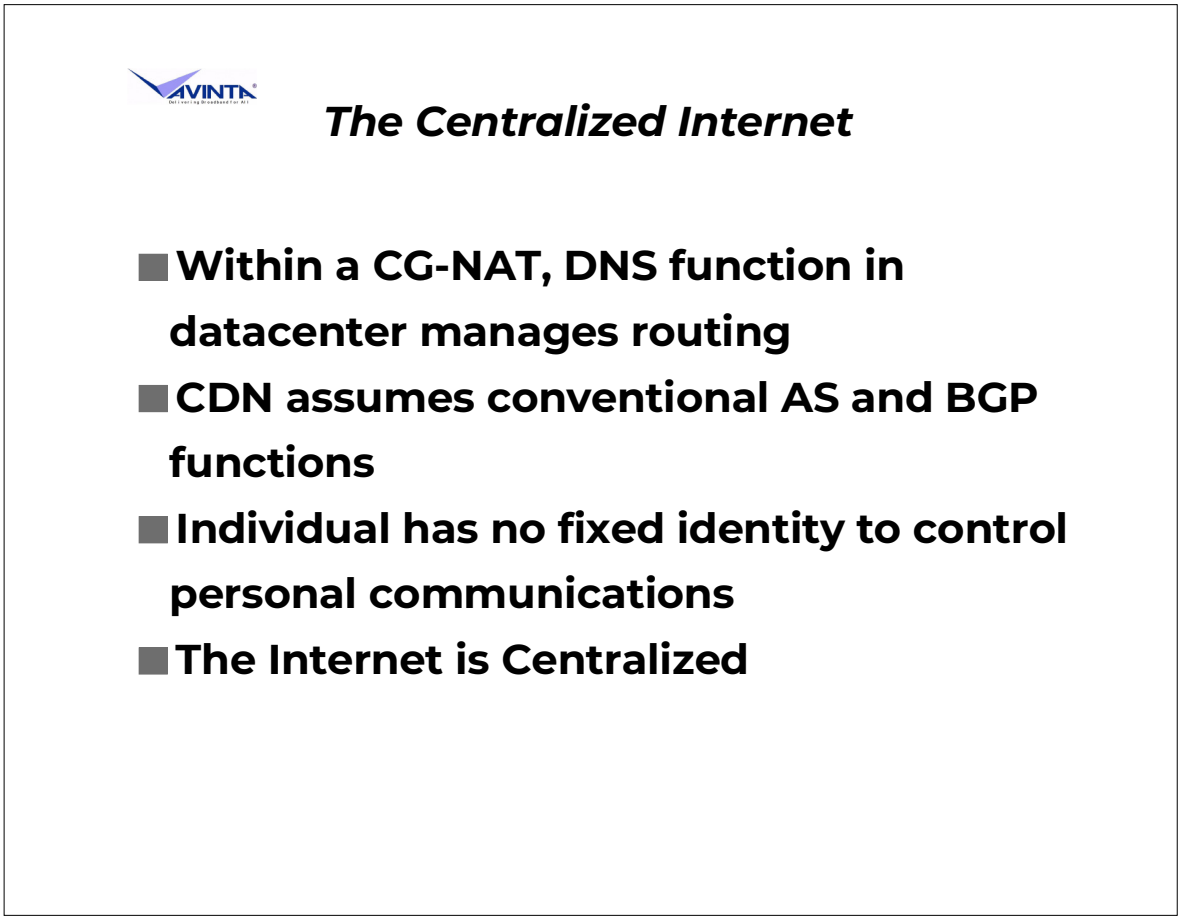


- One of the most ***rudimentary*** communications system functions is to provide ***peer communication (or end-to-end connectivity)*** for every subscriber. It requires every participant to have ***an unique / static address.***
- ***NYC Metro area*** consists of ***NYC five boroughs*** plus nearby counties in New York state as well as adjacent states of ***Connecticut, Pennsylvania and New Jersey***, with a ***total population of 23.5M***.
- ***NYC itself*** with five boroughs, Bronx: 1.3M, Brooklyn: 2.7M, Manhattan: 1.7M, Queens: 2.2M, Staten Island: 0.5M, ***totaling 8M*** already exceeds the 4M capacity of RFC6598 100.64/10 netblock. With the tight knit municipalities across NYC Metro, everyone within NYC Metro must have an IP address from the same address block to initiate communication to one another directly at will. (Note: Hudson County, NJ is shown as the 6th part of NYC because it very much integrated in daily life.)
- Even with ***dynamically assigned 4M addresses*** requires ***multiple CG-NAT clusters*** to ***serve NYC Metro, let alone supporting peer communication.***
- An ***SPR island*** with ***one set of static 240/4 addresses*** is capable of serving ***the entire NYC Metro tethering over the existing Internet, with spare addresses.***
- Depending on the population of an intended service area, a ***RAN*** (Regional Area Network) consists of a group of ***one or more SPRs***

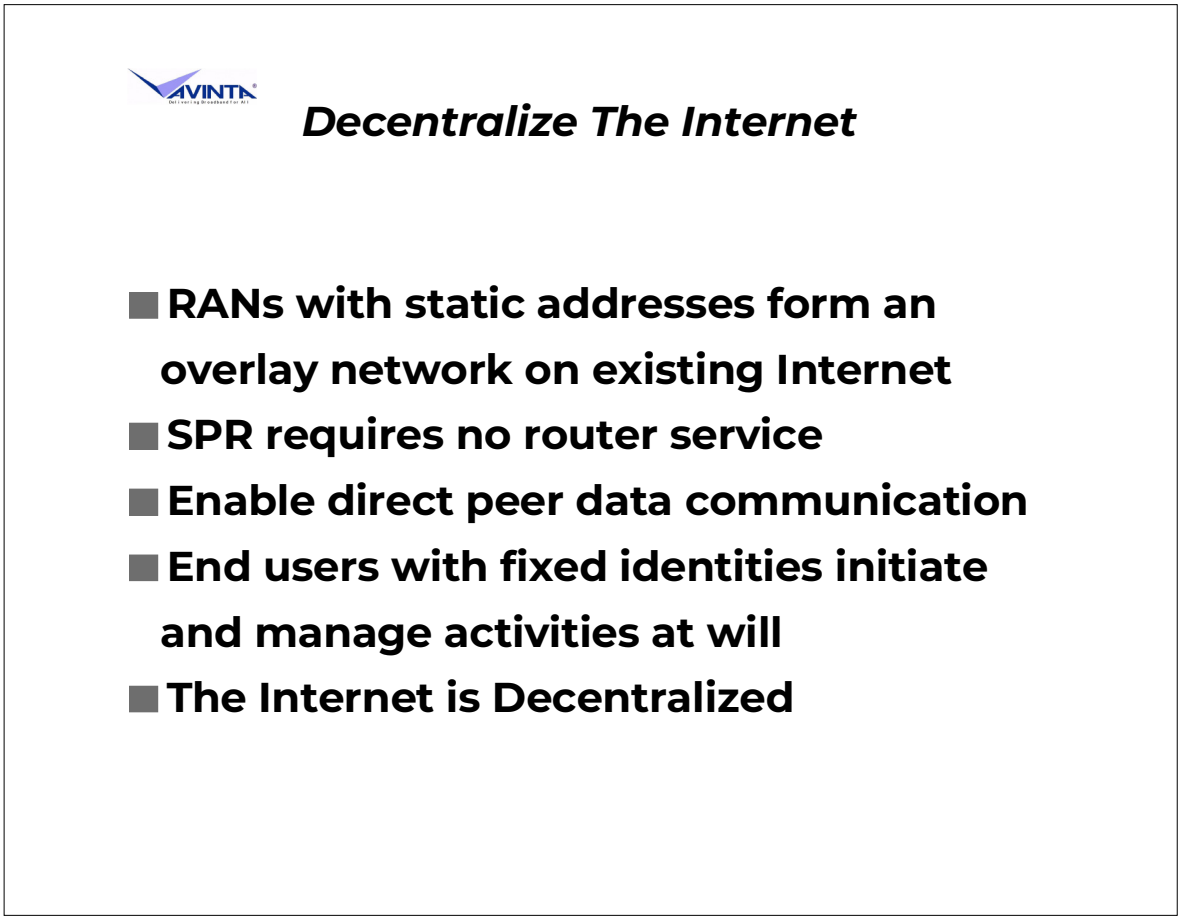
E. Overlay Network to The Internet

RANs form a Sub-Internet
called EzIP Network
Overlay the Internet core

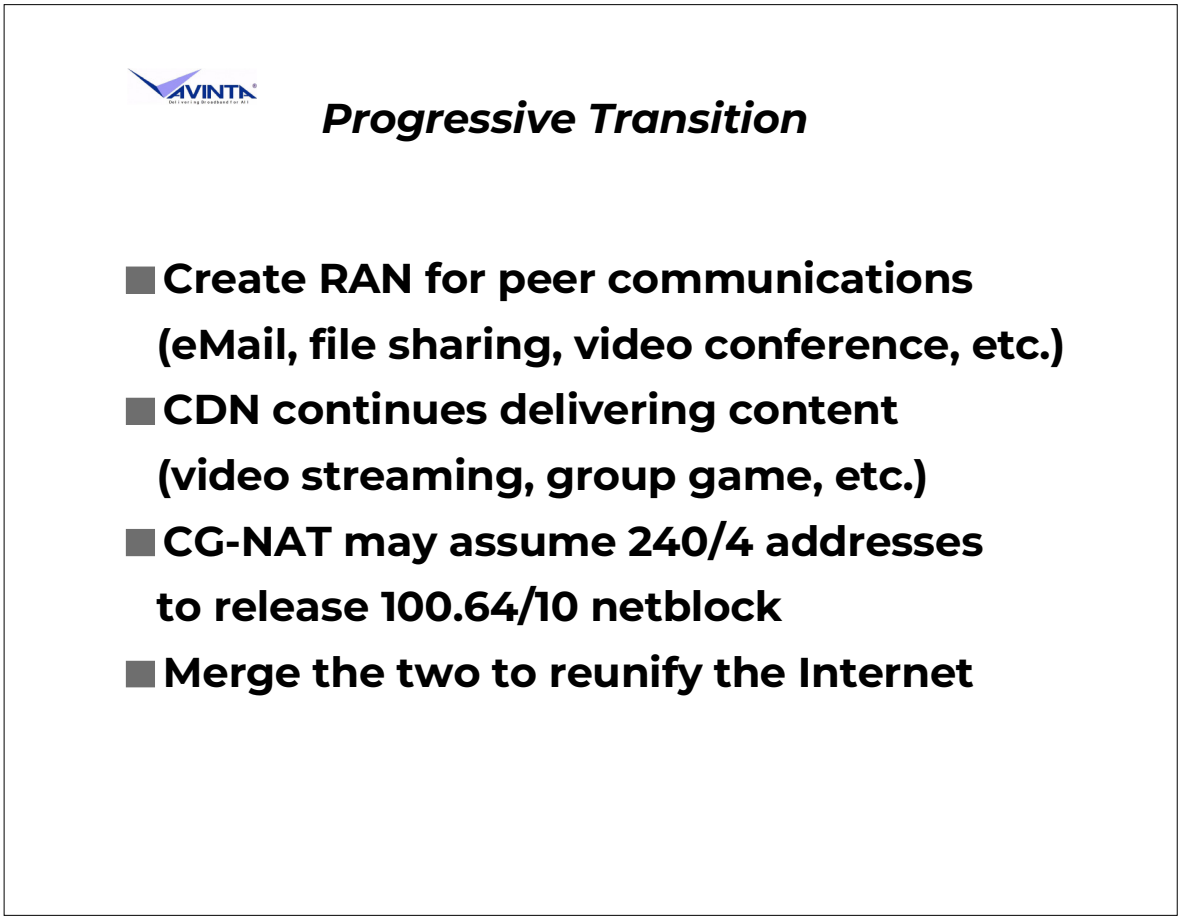
- Each country has its respective ***RAN*** (Regional Area Network), most consisting of ***one SPR***. Combining ***RANs*** around the world ***form*** the ***EzIP Network*** which is ***a sub-Internet,***
- that overlay the Internet Core, allowing capabilities and functions ***within each RAN be independently developed***, as long as there are ***arm's-length links*** among them through the CR for ***inter-RAN communication***.
- To visualize this, let's look at this situation in ***a big picture,*** say from ***10K miles above the earth***.
- This graphics created by ***Dot-Connect-Africa*** reflects their long time ***disputes with ICANN about address allocation*** related issues. The floated African continent in the sky implies the disagreement.
- Upon a closer look, ***continents other than Africa are also floating in the sky***. So, this graphics may be interpreted as the ***EzIP Network*** (bronze-colored continents) hovering above ***the existing Internet*** (the blue-colored globe).



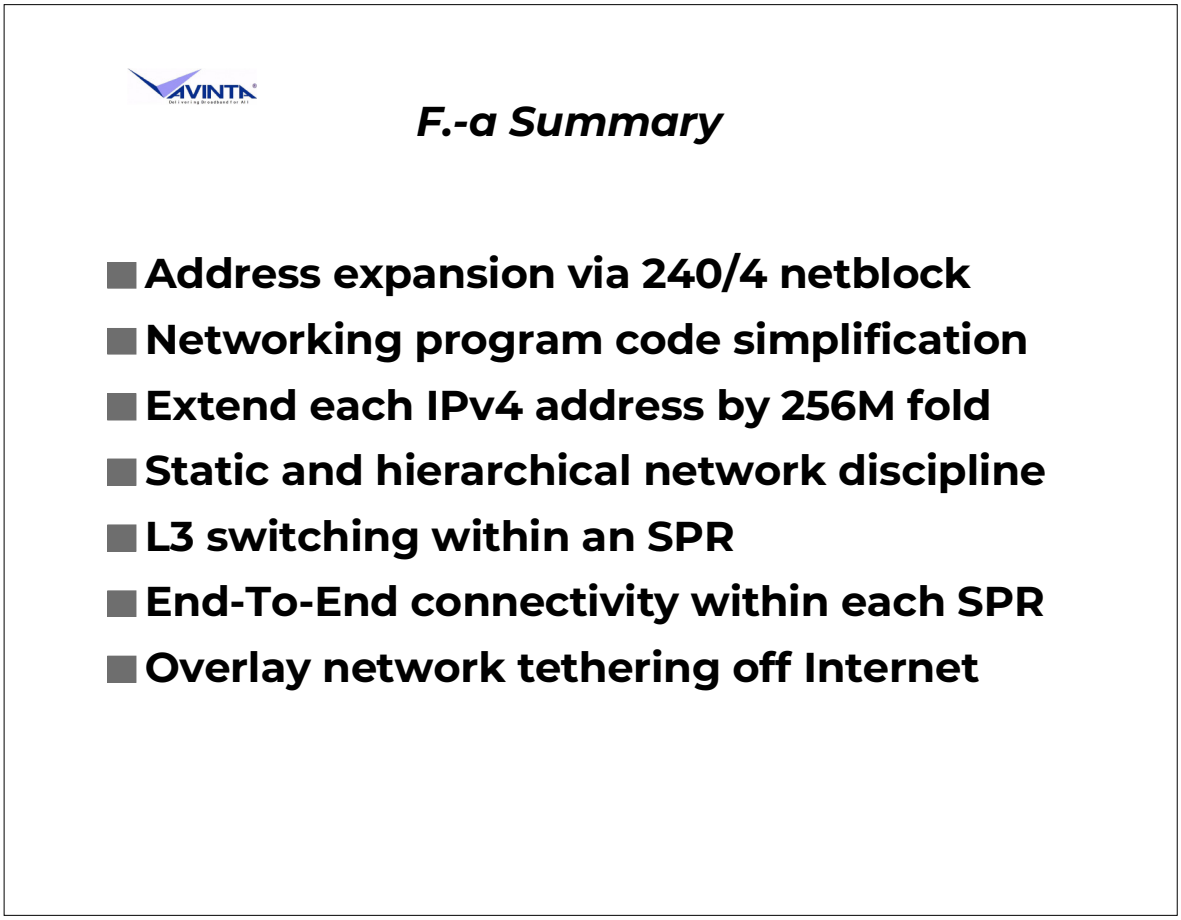
- ***How many in the audience have heard of an Internet research activity, called "Decentralized the Internet?" If so, have you wondered why such a need? Wasn't everything in the Internet supposed to be dynamic and distributed, thus already decentralized?***
- Originated by search engines, ***distributed data centers were placed in or near key market***s for faster and more efficient response, etc. It was then adopted by content delivery services. This configuration serves CDN well by ***not only improving performances, but also lowering cost***.
- The side effect of this setup ***consolidates the routing services*** such as DNS into a local process in the CDN Gateways, with little reliance on AS and BGP functionality.
- From a casual user point of view, this configuration is fine for ordinary purposes such as ***entertainment.*** However, this scheme ***deprives users of the Individual identity*** that is essential to initiate and manage ***personal communication*** with one another ***directly***, let alone the ***freedom to innovate independently.***
- Consequently, ***the Internet is centralized.***



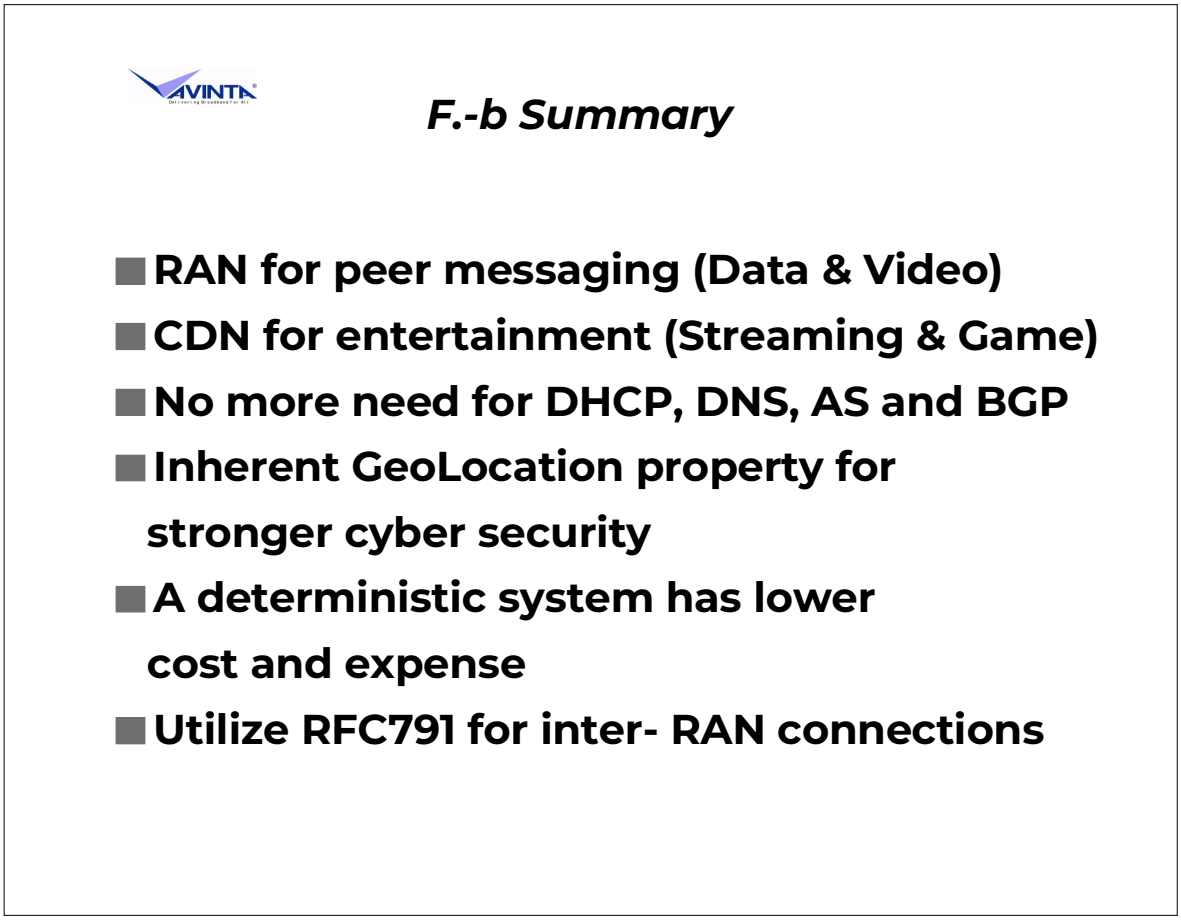
- Each SPR uses an IPv4 addressed transmission channel as an umbilical cord to access the Internet core.
- Unique static addresses enable ***direct L3 switching*** among subscribers without relying on router service.
- ***How many in the audience used or knew about Dial-up Modems over PSTN?***.
- Individuals are free to ***communicate with one another*** at will and to innovate.
- From a user's perspective, the Internet becomes truly a ***communication backbone supporting individualism***



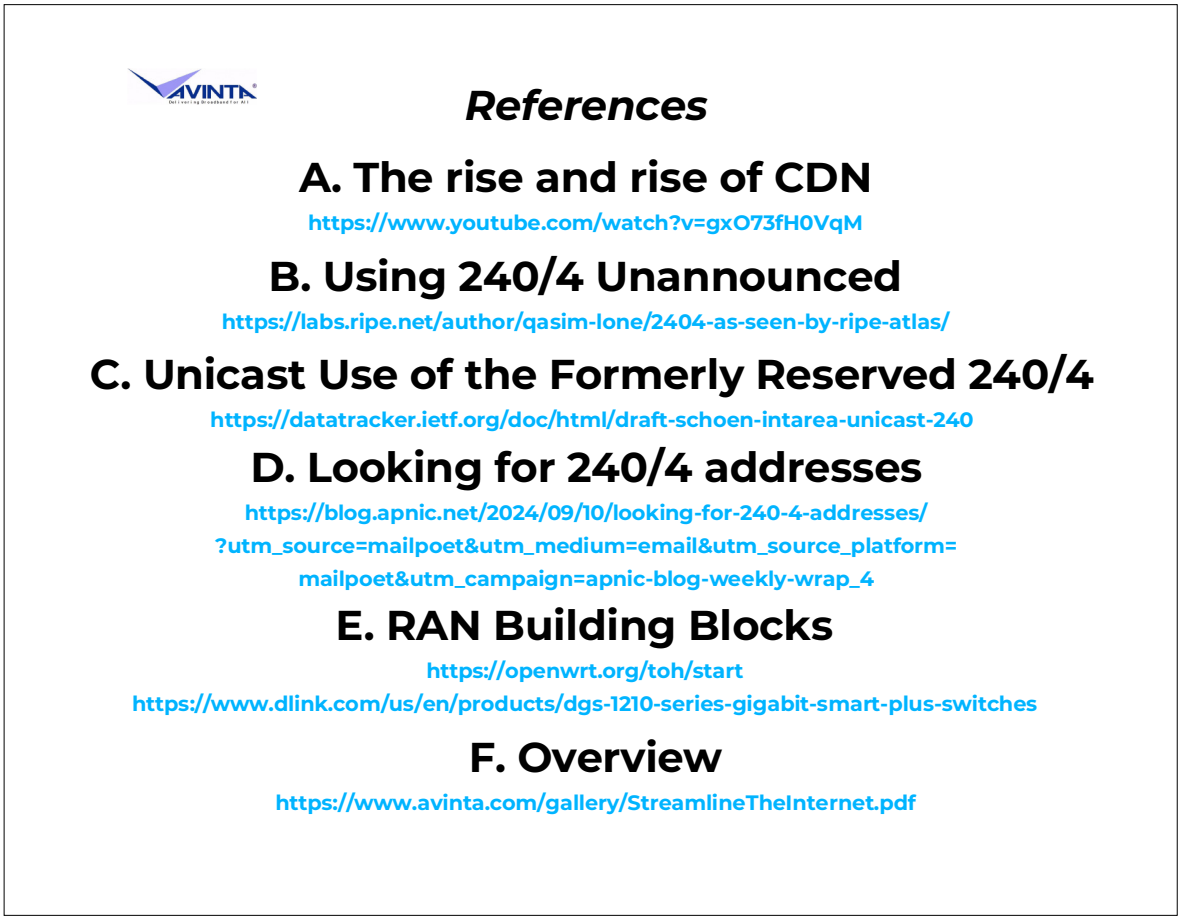
- A ***RAN*** based facility is like the ***traditional postal and telephony*** message (Peer-to-Peer) services.
- While the ***existing Internet*** can focus on media distributions like the ***traditional broadcast and cable TV entertainment*** (Master-Slave) services.
- Since ***dynamic based operations*** do not mind using static address, ***CG-NAT could adopt the same static 240/4 addresses*** that subscribes have been assigned by the RAN operation.
- The ***100.64/10 netblock*** can then be ***released*** back to the ***general public address pool*** (originally allocated to ARIN).
- Once each subscriber is assigned with ***the same IP address for both RAN & CDN*** services, the two networks can be **coordinated and merged,** as if they were one..



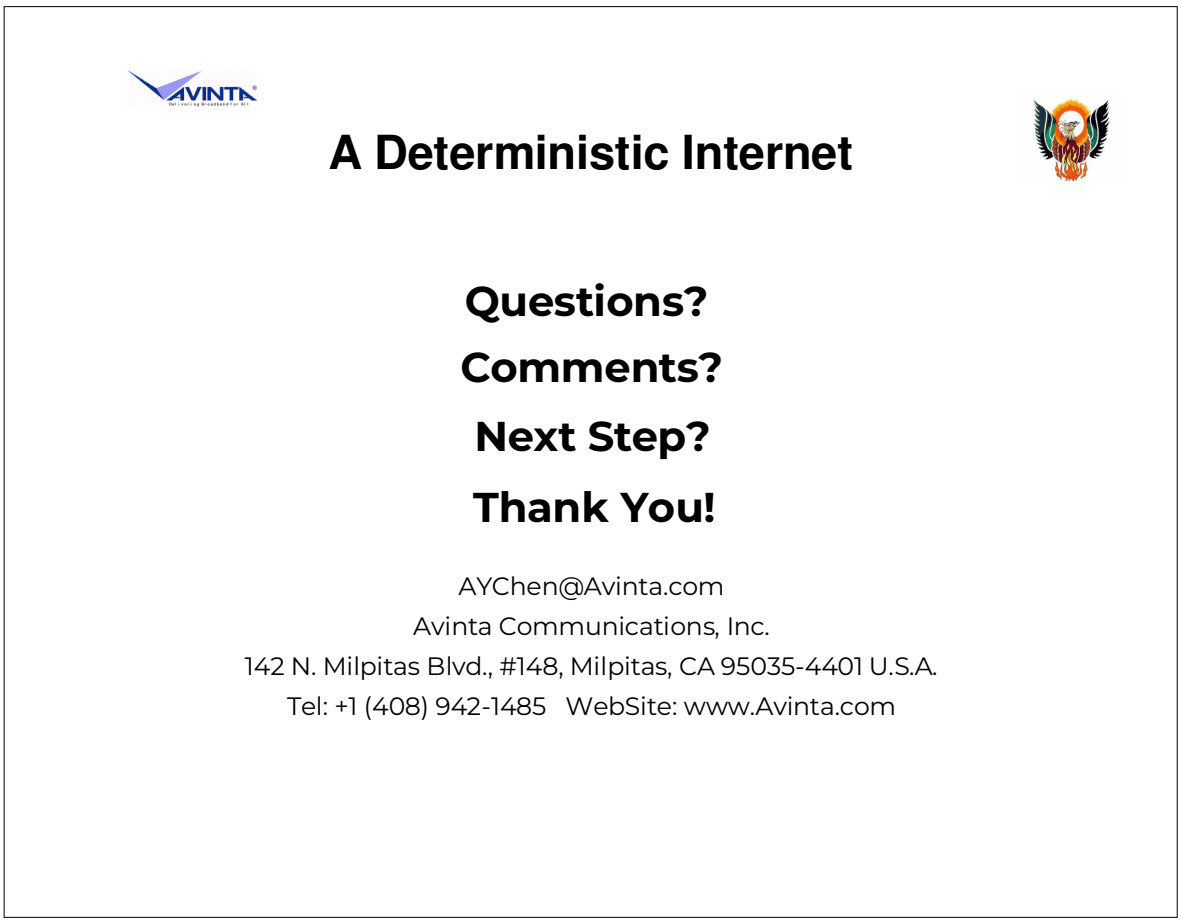
- Note that 240/4should be regaredes as shared public resources, instead of ***commercialized*** as private properties by ***IAP (Internet Access Provider)***,
- Commenting out one line code that has been disabling the 240/4.
- 240/4 has the capacity of serving 256M premises from one public IPv4 address. The RFC1918 private network addresses (17.06M) can then be utilized by individual subscribers to expand respective private networks to handle on-premises IoTs.
- Static addressing supports hierarchical routing. But, dynamic addressing can not.
- Flat static address playing field allows routing by IP address or Level 3 switching.
- Within each SPR, direct connection becomes feasible.
- RAN appears to be tethering off the Internet with an umbilical cord and operating in parallel to while independent of the Internet core.



- RAN provides personal communications.
- CDN continues by focusing on entertainment.
- DHCP will still be useful for configuring new client devices. DNS degenerates to a quasi-static database equivalent to an electronic telephony WhitePages for lookup when needed. SPR will not need AS nor BGP.
- Properly administrated static address provides GeoLocation information to make it harder for perpetrators to hide.
- ***Static addressing sets the foundation*** for a deterministic system. So that the overall cost and expense are reduced.
- Utilize ***RFC791 Option Word mechanism*** to route packets among RANs via ***two-level of IPv4 addresses (total of 64 bits)***. This is the same scheme as the ***country code prefixes for international telephony***. Since there are only ***about 200 sovereign jurisdictions*** (nations and entities) worldwide, ***two octets*** or half of one IPv4 address (64K combination) will be more than sufficient ***to identify all RANs***. The rest (the majority) can be used for identifying test beds each within an isolated / controlled environment.



- A. This ***APRICOT 2024 YouTube*** video describes the public communication evolution to become ***centralized around CDN***.
- B. This RIPE NCC (Réseaux IP Européens Network Coordination Centre -- ***Regional Internet Registry for Europe) - Lab*** article reports that ***multinational conglomerates*** have been using 240/4 unannounced. Since they are ***difficult to detect,*** it demonstrates that using ***240/4 is not perturbing normal Internet operations***.
- C. ***IPv4 Unicast Extension Project*** proposes to ***reclassify 240/4 formerly Class E***, among a few other netblocks, as ***Unicast*** for better utilization.
- D. This blog recounts the ***history of the 240/4 events***, reports recent measurements and concludes that it can be used as is, that is, without IANA re-designation, since ***the existing Internet operations will not be disrupted***.
- E. These are ***off-the-shelf networking equipment*** supported by open source code from ***OpenWrt*** to operate with 240/4 netblock. The first are ***near 2.5K RG level devices***. These will ***buffer on-premises IoTs (including PCs)*** from the 240/4 environment. The ***D-Link GigaBit smart switch*** (up to 48+4 ports) can be used to start ***experimenting SPRs and forming RANs*** for guiding the upgrade of **current CG-NAT routers**.
- F. This whitepaper summarizes the ***contradictions*** around the Internet and then outlines a ***RAN Simulator*** as the reference for deploying the EzIP solution to streamline the Internet.



►
►
■ **Questions? .....**
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►
■ **Comments? .....**
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■ **Next Step?**
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► With ***building blocks available***, any technically competent person can ***deploy a RAN***, based on a static IPv4 address even by starting from one's basement or backyard, since the use of the ***240/4 netblock will not disturb the current Internet nor private network.*** This is analogous to how ***UNIX based network routers quietly replaced those based on Windows***.
►
► Please ***drop a line to us*** about your thoughts and activities, so that your experiences may be ***shared among parties with similar interests.***
►
►
■ Lastly, allow me to share a ***layman's naive perspective***. That is, if we treated the Internet as ***a packetized PSTN, most of the Internet could become Deterministic, so that it may be more secure against cyber intrusions.***
►
► **Thank You!**
►
►