IPv6 Tutorial and Address Allocation Plan

February 22, 2007

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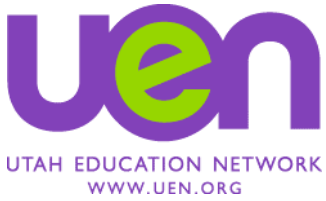
Agenda

- Current State of IPv4
- Introduction to IPv6
- UEN IPv6 Plans
- UEN IPv6 Address Allocation Plan

Current State of IPv4



Current State of IPv4

Overview

- IPv4 uses 32 bit address space (ex. 192.168.1.1)
- IPv4 protocol was published in 1981 and designed to connect Government and Research networks
- IPv4 was NOT designed to support global communications infrastructure
- IPv4 has 2^32 IP addresses with a theoretical limit of 4.29 Billion IP addresses

Current State of IPv4

The Bad News

- IPv4 practical limit is 250 Million end devices (RFC 3194)
- IPv4 address space is approximately 2/3 assigned
- IPv4 space will run out eventually….It will not last forever

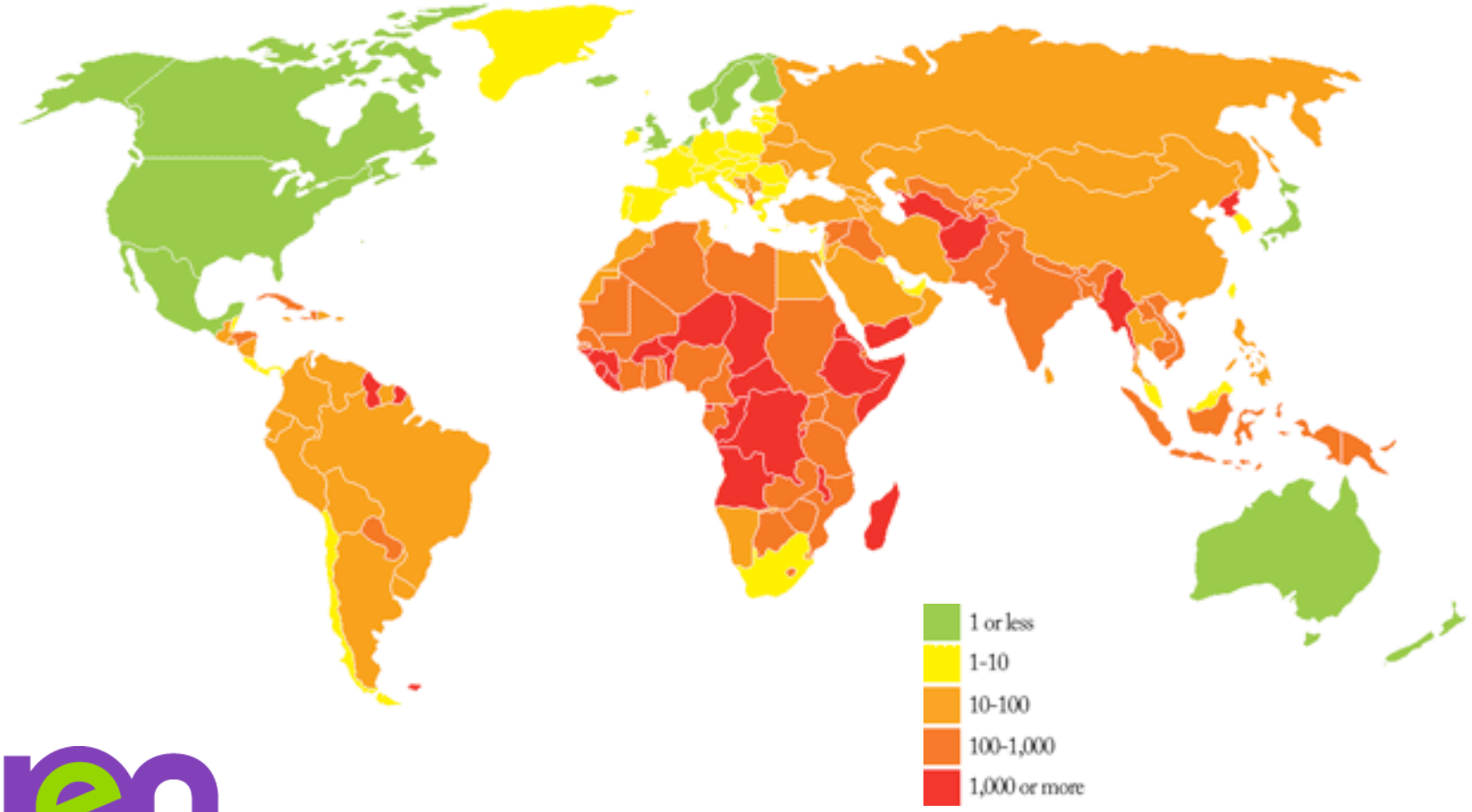
Current State of IPv4

The Good News

- It is projected that IPv4 space will not be EXHAUSTED until 2013
- DHCP address sharing, CIDR, IP Address reclamation, and NAT will continue to prolong the life of IPv4
- IPv4 works very well and has scaled to support the Internet
- IPv4 may last longer than projected. Nobody knows for sure. These are only projections!

Current State of IPv4

IPv4 Assignments Per Capita



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Current State of IPv4

Why not continue to NAT?

- They break many existing applications (IP phones, Video devices, etc)*
- They do not work for servers*
- They do not work with IP multicast*
- They limit the market for new protocols and services
- They compromise performance/scaling issues

*There are exceptions

Introduction to IPv6

Introduction to IPv6

Why a new protocol???

- IPv4 address space is running out
- We need more IP addresses!
  - Billions of new devices: Cell Phones, Gaming systems, DVRs, DVD Players, Security systems, HVAC, Vending machines, Cars, GPS Devices, (Your electronic device here), etc.
  - Billions of new users in developing countries: China, India, etc.
  - Always on technologies: Cable modems, DSL, WAN Ethernet, Wifi, etc.

Introduction to IPv6

Who is using it?

- Japan and Korea are leading deployment and research
  - Japanese are a fixture in IPv6 research community
- Asia Pacific is leader out of necessity
  - Majority of population with minority of IPv4 space
- Western European countries are solidly behind adoption
  - France Telecom producing good research
    http://www.forward.rd.francetelecom.fr

Introduction to IPv6

Who is using it?

- United States is not seen as a leader in IPv6 adoption
  - Comparatively we have an abundance of IPv4 space
  - No current commercial requirements
  - Research and Government leading adoption
  - Internet2 is largest IPv6 network
  - Chicken and the egg….If no one is using IPv6 why adopt?
  - Comcast to begin deploying IPv6 to manage nationwide network
  - The tide may be turning

Introduction to IPv6

Main IPv6 Benefits

- Expanded addressing capabilities
- Server-less autoconfiguration and reconfiguration (DHCP not required)
- Built-in IP-layer encryption, authentication, and privacy extensions
- Streamlined header format
- Improved support for header extensions

Introduction to IPv6

IPv6 Address Format

- IPv6 Address is 128 bits long
- 340,282,366,920,938,463,463,374,607,431,768,211,456 possible addresses!!!!
  - or .34 Duodecilion (.34 x 10^39)
- 64 bits are for Network ID
- 64 bits are for Interface ID
- RFC 2460 – IPv6 Specification

Introduction to IPv6

- IPv6 Addresses are represented in hexadecimal notation
  - Address is 128 bits long, written as eight sets of four hex digits (16 bits each), separated by colons
  - 2001:1948:7654:FEDC:3210:BA98:7654:3210
  - The first four sets are network ID (64 bits)
  - The last four sets are interface ID (64 bits)

- IPv6 prefix representation is similar to IPv4 CIDR notation
  - IPv6-address/prefix length
  - 2001:1948:5F0:12::1/56

Introduction to IPv6

- IPv4 CIDR vs. IPv6 “Fixed” LAN size
  - In IPv4 CIDR LAN sizes typically varied from /24 to /30 size depending on host requirements
  - In IPv6 all LANs are size /64 regardless of host requirements
- IPv6 /64 LANs are basically unlimited size
  - LAN space is 2^64
- Technically IPv6 LANs can be any size
  - In practice LANs are /64
  - Router Loopbacks are typically /128

Introduction to IPv6

Interface Identifier

- Last 64 bits are the interface identifier
- Guaranteed unique on subnet
- Formula for mapping IEEE 802 MAC address into interface identifier
- Privacy addresses
  - Concern about MAC addresses being public
  - Response was a standardized privacy address
  - These are random 64-bit numbers

UEN IPv6 Plans

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UEN IPv6 Plans

- UEN has obtained a /32 IPv6 allocation from ARIN
  - This is 4.3 Billion /64 networks
  - Remember each /64 network has 18 quintillion IP addresses
- UEN has successfully deployed IPv6 in EBC, SLCC, and UVSC hubs
- University of Utah only current IPv6 customer
- Only provider IPv6 connection is with Internet2
- Several institutions have expressed interest in limited IPv6 deployments

UEN IPv6 Plans

UEN IPv6 Address Space

- UEN has been allocated 2001:1948::/32 from ARIN
  - This is 4.3 Billion /64 Networks
  - Looked at another way….we have as many /64 networks as IP addresses exist in IPv4
- A typical /48 allocation would give an organization 65,536 /64 networks
  - Remember….each /64 network has more IP addresses than you will ever use…….18 quintillion or 2^64

UEN IPv6 Plans

2007 Goals

- SURIN Approval for an IPv6 address allocation plan
- Additional UEN IPv6 hub rollouts as required
- DNS/Tools Support
- Bring on early adopters
- Do not break IPv4 to implement IPv6!

UEN IPv6 Plans

2008 Goals

- Complete UEN Backbone Support
- Upgrade Internet provider connections to support IPv6
- Full tools/monitoring support
- Additional customer rollouts as requested

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UEN IPv6 Address Allocation Plan

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UEN IPv6 Address Allocation Plan

ARIN IPv6 Policies

- Unlike current IPv4 practices ARIN will only allocate IPv6 to Internet Service Providers
  - Under ARIN definitions UEN is classified as an ISP
- All end-sites must go to upstream provider for IPv6 addressing
- Any entity who connects to UEN must get IPv6 allocations from UEN
  - This includes: State DTS, Higher Education, Public Education, Libraries, etc.

UEN IPv6 Address Allocation Plan

- Why do we need a good policy now?
  - IPv4 lifetime will likely be 40-50 years before it run its course
  - IPv6 lifetime could be 50-100 years
- UEN is seeking approval for an IPv6 address plan that scales for the future
- The best thing we can do now is reserve the bulk of IPv6 address space for the future

UEN IPv6 Address Allocation Plan

- UEN was allocated a /32 of IPv6 address space
  - A /32 is 4.2 Billion /64 networks
    - UEN controls as many networks in IPv6 as IPv4 addresses exist!
  - A /32 contains 16 - /36's
  - UEN proposes to start allocation using only the first 2- /36s
  - This will leave the remaining 14 - /36s (87.5%) reserved for future use

UEN IPv6 Address Allocation Plan

- How large is a single /36?
  - An IPv4 /16 (Class B) contains 256 - /24 networks or 65,536 IP addresses total
  - A /36 contains 268,435,456 networks, each of size 18 quintillion
  - A /36 has 1 Million times more networks than a Class B!
  - We propose to allocate 2 - /36's or 536,870,912 networks, each of size 18 quintillion, for initial use
  - This is only 12.5% of the total space we have been granted from ARIN

UEN IPv6 Address Allocation Plan

- Allocation Plan Highlights
  - State DTS assigned a /40 or 16,777,216 networks
  - Large Universities and School Districts assigned a /44 or 1,048,576 networks
  - Remaining School Districts, Colleges, and other medium sized Institutions assigned a /48 or 65,536 networks
    - A /48 contains as many networks as a Class B has IP addresses
  - Smaller entities will receive a block size between /49 - /60 depending on requirements
  - This plan allows UEN to assign any entity additional blocks of size /40, /44, 48, or longer depending on requirements
  - It is important to note that these initial allocations are just that, we will give anyone as much IP space as they require

IPv6 References

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