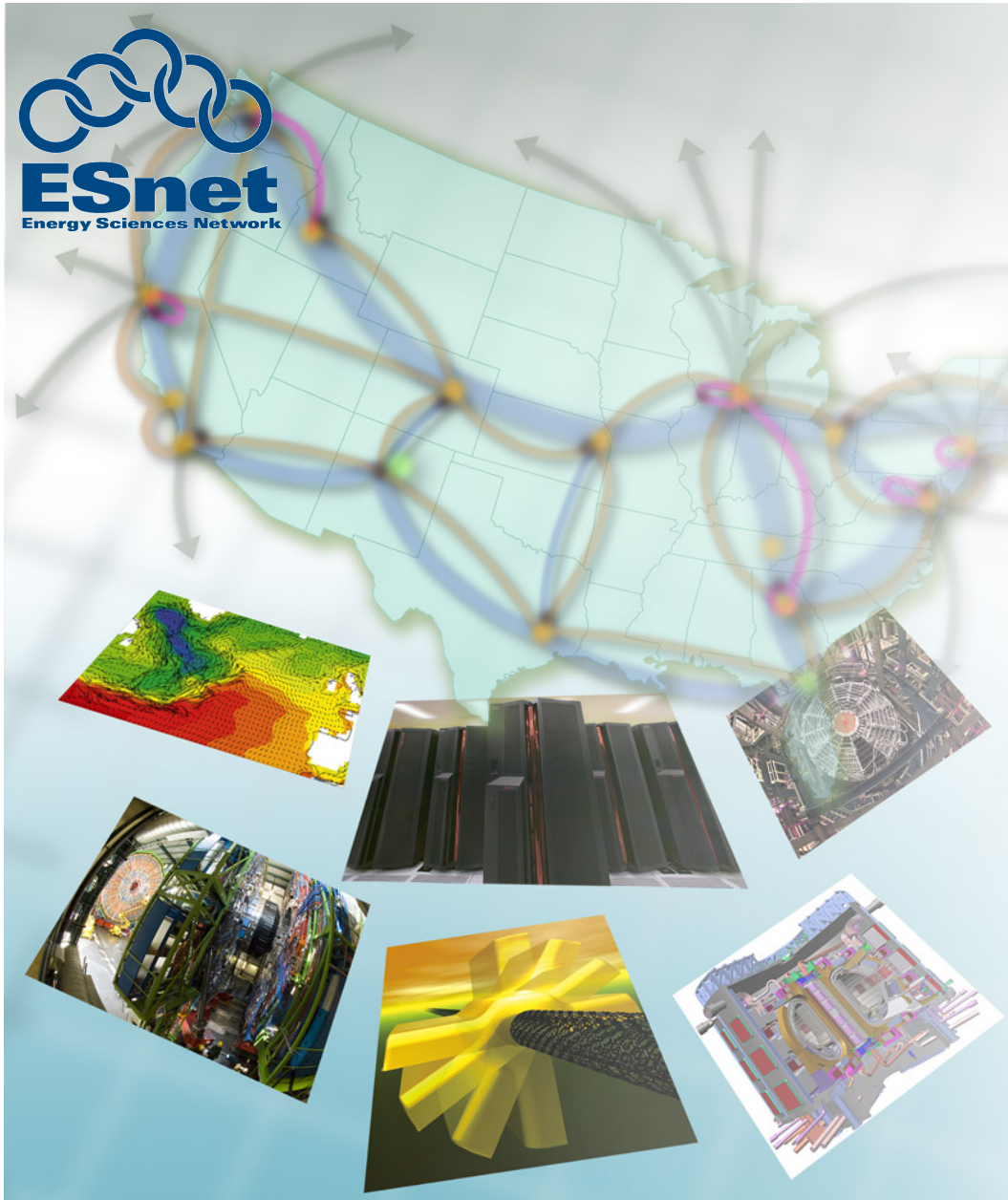

The Gathering Storm: The Coming Crisis in the Internet

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Networking for the Future of Science

Overview: The Clouds Gather

- IPv4 address space exhaustion
- Continued growth in the DFZ
- Hardware limitations
  - DFZ FIB approaching capacity of many popular routers
  - RIB size now often exceeds router capacity
  - Routing table recalculations exceeding time between updates
- IPv6 to the rescue?
  - Should have been able to fix many of the concerns
  - Very limited implementation
  - No evident transition plan
- Where do we go from here?

It's the end of the world...as we know it

But NOT the end of the world!

- We are not running out of address space...just a way to use it effectively
- Likely to lead to a market in address space
- Will massively grow the number of routes in the DFZ
- Will lead to increased breakage of peer to peer model
  - not to be confused with file sharing P2P networking which is only a sub-category
  - More likely to affect the R&E community than the typical user

IPv4 Address Exhaustion

- In May of last year ARIN announced the approaching exhaustion of IPv4 address space
  - Less than 18% of the space remains unallocated
  - Called for transition to IPv6
  - Called for policy changes for handling the exhaustion
- IPv4 address space remains fairly sparse, though it continues to grow less so
  - Several /8 prefixes are largely unused
  - Many /16 prefixes are either unused, abandoned, or hidden on private/classified networks
  - Many old /24 networks are no longer in use
- These networks will re-appear when they develop value

Continued Growth of the DFZ

- Default Free Zone (DFZ) growth has shown no tendency to slow
  - DFZ exceeds 240,000 prefixes (or will when you get home)
  - Will pass 244K routes in a month (More on this later)
- Myth that running out of allocatable space will slow the growth of the DFZ
  - Scarcity will generate increased demand for ever smaller pieces of address space
  - Demand will produce an exchange for address space
  - Abandoned space will reappear as corporate asset

Hardware Limitations are approaching (1/2)

- Many popular routers in the DFZ are approaching Forwarding Information Base (FIB) capacity
  - Cisco 6500/7600 routers (excluding Sup750-3BXL) can support 244K FIB entries
    - That is just over a month form now! (What's in your TCAM?)
- RIB growth is pressing route processor capacity
  - Highly configuration dependent
  - May already exceed capacity
  - May have reasonable headroom
  - Some routers allow DRAM expansion to accommodate growth
  -

Hardware Limitations are approaching (2/2)

- Route churn is approaching the point where routes will never completely converge
  - This way lies madness (rather literally)
  - Routing loops
  - Black holed traffic
  - Complete loss of state
- Routers typically don't use the fastest processors
  - Upgrades will be possible and fairly painless
    - *Except to your budget!*
  - Optimization of protocol stacks may buy capacity
  - May not be enough as the RIBs grow and churn increases

IPv6 to the Rescue?

- IPv6 will probably come, but when?
  - Standards are many years old but there is almost no traffic
  - Implemented on most hosts (and often enabled!)
  - Implemented on most R&E and a few commercial nets
  - **Almost no services are available!**
  - Brokenness of IPv6 stacks discourages services implementation
    - Reports on NANOG of 10% traffic drops when IPv6 is enabled for a service
    - Web is too valuable to risk such losses

No viable transition plan

- You won't see services without IPv6 customers
- You won't see IPv6 customers without services
- No way exists for IPv6 customers to reach IPv4 services
  - NAT-PT was the proposed solution
  - NAT-PT has been deprecated
    - RFC now listed as “historical”
- Only solution is universal dual-stack capability
  - **But...**

IPv6 to the Rescue (Part Deux)?

- Universal dual stacks will blow up the FIB
  - IPv6 entries require 2-4 times the space in the FIB
  - Equivalent to 720K prefixes in the FIB
  - Will soon exceed the capacity of even very large routers
- Routing dual protocols will vastly increase CPU requirements to converge the RIBs
  - IPv6 stacks are often not as carefully optimized as IPv4
  - Twice as many routes to converge
  - Increased complexity of multiple RIBs to converge?

Where do we go from here? (1/2)

- Retirement?
  - Probably not that bad
- Watch the budget!
  - New routers may be needed
    - At least major upgrades required
    - If you have Sup2 systems, things may get dicey
      - When TCAM is full, new routes are passed to the SUP for forwarding
      - Router dies an ugly death

Where do we go from here? (2/2)

- We need a viable transition to IPv6 now
  - See http://www.civil-tongue.net/clusterf/
    - Contribute ideas
    - Prepare to feel Randy's wrath :-)
- Look for ways to limit FIB growth (e.g. LISP)
- Look around for unused address space
  - Maybe you can sell it to get the budget for Sup750-3BXL upgrades
- **Don't panic!** *(Note the large, friendly letters)*
  - The answer is 42

Recommended Reading

- Talks from NANOG41
  - http://www.nanog.org/mtg-0710/bush.html
  - http://www.nanog.org/mtg-0710/bicknell.html
  - http://www.nanog.org/mtg-0710/farinacci.html
  - http://www.nanog.org/mtg-0710/meyers.html
  - Both slides and RealMedia recordings available
- RAM mailing list
  - http://www.ieft1.org/mailman/listinfo/ram/

➢Summary

- Yes, we have a problem here
  - The Galactic Construction Corps is not about to start an intersteller bypass (The world is not about to end)
- If nothing is done the FIB and RIBs will continue to grow
  - This will at least require some re-design and some new hardware
- IPv6 is not just around the corner
  - It is coming...but not this week
- IPv6 will not solve all of our problems

Thank You to (in no particular order)

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You, who have to deal with these problems and listened to me babble on about it