IPv6 Deployment Guidelines

http://tools.ietf.org/html/draft-arkko-ipv6-transition-guidelines

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Outline

- Introduction
- Principles
- Deployment Models
  - Native Dual Stack
  - Connecting IPv6 Islands
  - IPv6-Only Core
  - Unilateral Deployment
- Applying this to 3G

Reasons for Writing This Document

- Numerous ways to deploy IPv6
- Ongoing work in the IETF to developed new deployment tools
- Confusion about what tools are needed

- Disclaimer: This draft is a personal opinion but based on what IETF has adopted as standards track mechanisms and history of discussions in various IETF working groups

Goals

- Continued growth of the networking industry and deployment of Internet technology at relatively low capital and operational expense
- This is at risk with IPv4 due to the address runout
- IPv4 clearly will not scale to meet our insatiable requirements, the primary technical goal is the global deployment of IPv6
- … and obsoleting IPv4
- … and obsoleting any transition tools

Now You Got Me Scared – Is It Painful?

- Major networks have done this surprisingly easily (Google, Free, various transit operators, etc.)
- Generally speaking, all the technology exists and most of the effort is practical – network component choices, network management, planning, implementation
- Maybe we should flip the switch and spend less time talking about it
- There are issues, such as making sure that firewall or the accounting server supports IPv6
- But the process can generally be handled as a part of the normal network evolution process

Co-Existence with IPv4

Most networks care about co-existence with IPv4 for some period of time:

- It is important to be able to reach the IPv4 Internet
- Or you need to allow legacy IPv4 devices
- There may be exceptions – such as an all-new sensor network that only needs to communicate with its own servers
- In these exceptional situations there absolute control by a central authority – for most networks such control is unattainable

Principles

- Solutions must turn on IPv6 and cause it to be used
  - Something that lets us delay this is not a solution
- Solutions must enable communication
  - This is silly and basic, but solutions really need to work
  - Optimizations are not so important (and transition is temporary anyway)
  - Perfect is the enemy of good
- Solutions must not leave unnecessary baggage once transition to IPv6 has been completed
  - ”Temporary” changes to IPv6 are undesirable
- Solutions must be reliable and maintainable
  - Networks need to be maintained, serviced, diagnosed and measured

Lessons from Deploying the Internet

Internet was successful because of

- A valuable service, connectivity
- Incremental deployability
- Simplicity of the technical solutions
- Robust interoperability vs. mere correctness
- Openly available implementations
- Scalable architecture (limits hit much later)

Common Deployment Models

I will talk about these models for IPv6 deployment:

- Native Dual Stack
- Connecting IPv6 Islands
- IPv6-Only Core
- Unilateral Deployment

These are the current recommended models

- They are supported by standard IPv6 mechanisms
- There is also significant practical experience from the first two deployment models

Other Deployment Models

Other models are possible, but generally not recommended

- There is far less experience about their use, there are no supporting standards, and there can be issues

There are also deployment models and tools that are known to be problematic

- NAT-PT (rationale in RFC 4966)
- NAT646

Native Dual Stack

- Turn on both IPv4 and IPv6
- RFC 4213
- Makes minimal assumptions about the capabilities of the communicating hosts
- Maximizes connectivity
- Native connectivity minimizes MTU problems
- This is the recommended default deployment model, suitable for many different types of networks

Challenges in Native Dual Stack

There are three challenges, however:

- Actual use requires all participants have IPv6

  Hard to ensure this universally, but as shown by the YouTube case, upgrading significant global destinations can have a major effect

  - Operational advice: enroll in Google over IPv6 and similar programs
- Bad IPv6 connectivity upstream can lead to long timeouts in applications

  Content providers generally employ opt-in at this time; this is expected to improve with the quality of IPv6 routing and better application APIs
- Not enough public IPv4 addresses to number all devices

  Dual stack + NAT44 is a very common model

  Where private address space is insufficient other mechanisms may also be employed (overlapping private address space, per-interface NAT bindings)

Connecting IPv6 Islands

- Tunneling can establish IPv6 connectivity over IPv4
- Manually configured tunnels (RFC 4213), automatically setup tunnels (RFC 4380), VPN (RFC 4301) or mobility tunnels (RFC 5555), Softwire mesh-based tunnels (RFC 5565)
- Tunneling is very widely used technology, and the world has learned to use it well – minor challenges include MTU issues and in some cases, the possibility of configuration mistakes
- For communication between IPvX peers over IPvY network, the recommended model is tunneling, not translation

IPvX-IPvY-IPvX Scenario Comparison

Double Translation

- ✓ Gets IPv6 Deployed
- Enables communication?
- ✓ Deploys IPv6 unchanged
- Reliability & maintainability?

Issue: translation requires gateway code for some applications

Has similar issues to NAT44

Encapsulation

- ✓ Gets IPv6 Deployed
- ✓ Enables communication
- ✓ Deploys IPv6 unchanged
- ✓ Reliability & maintainability

Issue: standard MTU problems similar to VPNs

We have solutions for that

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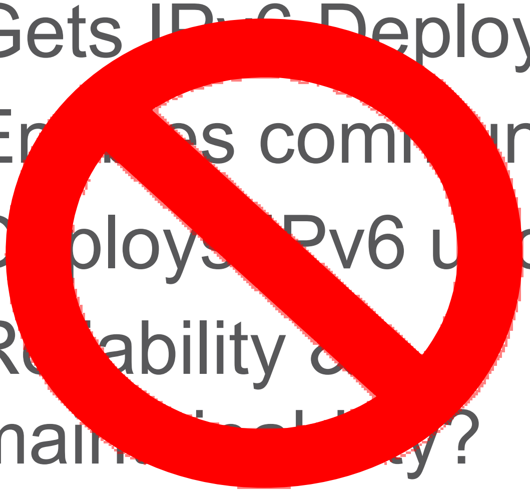

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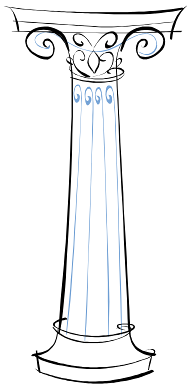
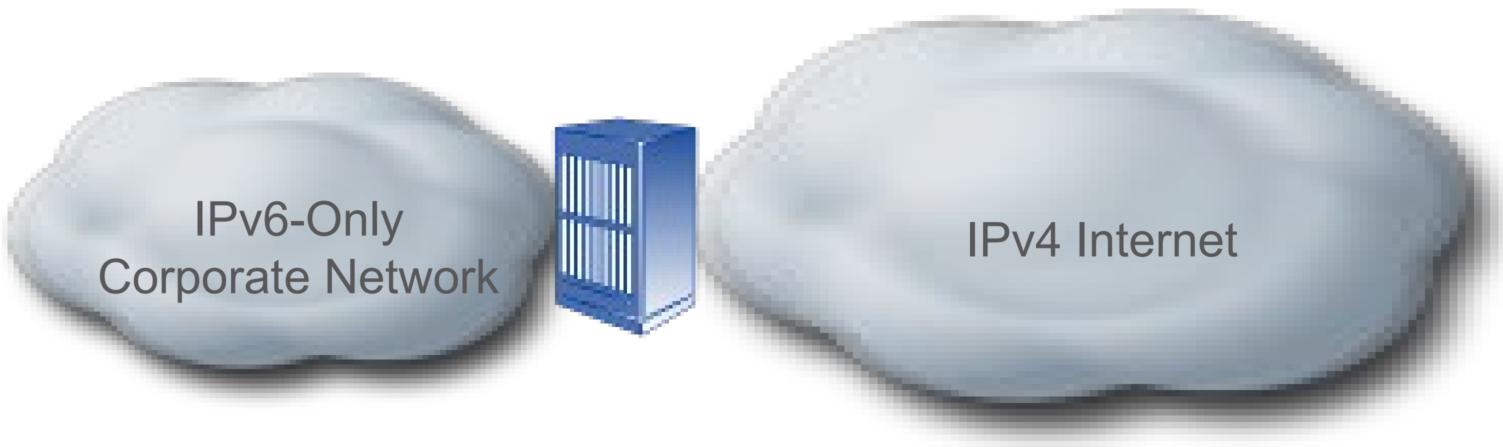
IPv6-Only Core



- An emerging deployment model is for a service provider to use an all-IPv6 core network and provide IPv4 services as an overlay on top of it
- Makes it possible to address any number of devices, share public IPv4 addresses between subscribers, and to simplify the network
- Dual Stack Lite (draft-ietf-softwire-dual-stack-lite) is the recommended transition mechanism for this
  - Employs tunneling and NAT44 as components
  - Other tools exist as well (GTP in 3G networks)

Unilateral Deployment



- It is possible to break the constraint that everyone between two peers has to upgrade to IPv6 in order to actually use IPv6
- This is useful when there is an IPv6-only network and a need for it to communicate with the IPv4 Internet

Unilateral Deployment

- The reason for an IPv6-only network can be a desire to test such a configuration, the desire to simplify the network, or the desire to avoid effects of NATs and overlapping address space
- An IPv6-only network sets strict requirements on how well controlled the network is
- Translation is the recommended mechanism for this model (draft-ietf-behave-*)

Application to Cellular Networks

- First observation: we need more focus on practical aspects – much of the technology exists, we need to turn it **on**
- Second observation: the 3GPP architecture is great from an IPv6 deployment perspective
  - Mobility tunnels separate underlying networks and user traffic
  - Can progress IPv6 deployment independent on each
  - Protocols and network product support dual stack
- Third observation: A lot of implementation and specification effort already – needs to be complemented by actual commercial usage

Application to Cellular Networks Cont'd

- Fourth observation: deployment model applicability
  - ✓ Native dual stack: its there – next step turning on
  - ✗ Connecting IPv6 islands: not relevant
  - ✓ IPv6-Only Core: being pursued by operators
    - New specification work may not be needed
  - ✓ Unilateral deployment: maybe more relevant later
    - For now, it seems very important to support

      (a) IPv4 Internet destinations

      (b) Hosts that cannot yet do IPv6
    - But turning off of IPv4 is the logical next step after dual stack

Questions? Comments?