Cisco IPv4 – IPv6 Transition Architecture (CGNv6)

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Agenda

- Introduction
  - Why do we need IPv6?
  - The Promise of IPv6
- The Cisco 346 Transition Framework
  - NAT444
  - 6rd – Border Relay + NAT444
  - DS-Lite + NAT 444
- CGv6 Implementation
  - CGSE
  - IPv6TS Software
- Summary
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• Summary
Internet growth – in terms the number of connected devices - is accelerating at an exponential rate

§ India added 15 million new subscribers in August – more than the population of Greece¹

§ China Mobile has surpassed 500 million subscribers – more than the population of North America²

§ The ‘Embedded Internet’ will consist of over 15 billion devices by 2015³

¹ – Indian Regulator TRAI
² – China Mobile
³ – Intel Embedded Internet Projections
The Growing Internet Challenge

The gap between supply and demand for IP addresses – the key Internet resource – is **widening**

The pool of IPv4 address blocks is **dwindling rapidly**

While the number of new Internet devices is **exploding**

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1 – Geoff Huston, APNIC, www.potaroo.net, tracking /8 address-blocks managed by the Internet Assigned Numbers Authority

2 – Cisco Visual Networking Index / Intel Embedded Internet Projections
Why Begin at Core / Edge?

Key requirements for scale, performance and impact are **maximized** in the core and edge.

- Cost and operational impact are reduced
- Platforms are inherently reliable, scalable
- Coverage, flexibility, and ROI are maximized

Translations:
- Home Scale: \(x \times 1000\)
- Enterprise Scale: \(x \times 100,000\)
- Carrier Scale: \(x \times 10\text{ Million}\)
- Coverage / Speed: \(x \times 1\text{ Billion}\)
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“346”: A 3 Tier Transition Framework for Moving from IPv4 to IPv6

IPv6

Services & Applications running over IPv6

IPv4/IPv6 Coexistence Infrastructure

Preserve IPv4

IPv4

Today

IPv4 Run-Out

2009 2011 2020+

IPv6 Internet
346 Technology Buckets

Services over IPv6

IPv4/IPv6 Coexistence Infrastructure

Preserve IPv4

IPv6 Internet

6TS plays here
Where to Start?

• In the backbone where a reasonable dual-stack capability exists
  
  Many have turned on dual-stack or some variant of dual-stack edge + tunnels (e.g. 6PE, 6VPE)
  
  Establish v4/v6 coexistence infrastructure

• From backbone it becomes possible to “launch” IPv6 connectivity and/or IPv6 transition “initiatives” into the adjacent customer address realms

• It is much more difficult to build the IPv6-capable access infrastructure (home networks, RGs, AAA systems, BNGs, provisioning, etc)
IPv6 “Backbone-First” Solutions – 2010-2011

Wireline
- Consumer Home
  - 6rd
  - Dual-stack/Softwires Mesh
  - DS-Lite

Peering/ Enterprise Edge
- Dual-Stack PE
- VRF
- Enterprise v6
- Enterprise v4 & v6
- CGN
- 6rd

Mobility / Wireless
- Mobility / Wireless
- IP4 Internet
- IPv4 Internet
- IPv6 Internet
- CGN NAT44
- BRAS CMTS OLT
- DS-Lite
- CGN 6rd

Data Center
- Dual-Stack AFBR
- IPv6 Service/Content Provider
IPv6 “Backbone-First” Solutions – 2010-2011

Wireline

- Consumer Internet
  - IPv6 in the Home
  - BRAS
  - CMTS
  - OLT

Peering/ Enterprise Edge

- Dual-Stack
  - PE
  - VRF
  - Enterprise v6
  - Enterprise v4 & v6

Mobility / Wireless

- 4G/LTE IPv6 Mobile

Data Center

- IPv6 Peering
- IPv6 Data Center

IPv4 / IPv6 Masquerading (CGN)
- NAT44
- 6rd

IPv4 / IPv6 Softwires
- Dual-stack

IPv6 Peering
- IPv6 Service/Content Provider
- IPv6 in the Home
- IPv6 Data Center
- IPv6 Mobile
- 4G/LTE
- Mobility / Wireless
One Strategy for Dealing with the IPv4 Address Run-Out Problem

Customers
- IPv4
- IPv4
- IPv4

SP Network
- IPv4_public

Post IPv4 Address Completion

Public Internet
- Public IPv4 Internet

Carrier Grade NAT
- Public IPv4 Internet

CGN
- = public IPv4
- = NOT public IPv4
What is a Carrier Grade NAT?

• “..A NAT or NAPT device used by many subscribers, where 'many' would be on the order of dozens to hundreds of thousands of subscribers. This might NAT between any combination of IPv4 and IPv6..”*

• O(20M) translations (sessions)

• O(Thousands) private IP addresses (depending on sessions per user. A “user” could be a home napt box)

• O(10Gb/sec) Performance – Full Duplex

• Scenarios

  Double NAT444
  Dual-Stack Lite (softwire 4over6 tunnel for access)
  6rd Border Relay (softwire 6over4 tunnel for access)
  Stateful/Stateless IPv4/IPv6 Translator (like NAT64)

• CGN Bypass (route around NAT)

• Must be Carrier-Grade in Scale and Performance

* source: draft-wing-nat-pt-replacement-comparison
CGN – Double NAT444

- CGN does NAT44 or O(large number) of private IPv4 end-points
- No need for IPv6 anywhere
- Compliant with standard NAT behaviors (RFC4787, RFC5382, RFC5508)
- Challenge: CGN never deployed with this scale in SP networks
CGN – 6rd Border Relay

- No change to IPv4-based access infrastructure
- IPv6 address in derived from ISP IPv6 prefix and CPE IPv4 address; RG and 6rd BR perform automatic IPv6/IPv4 encap/decap
- CGN becomes 6rd Border Relay- NO NAT or XLAT performed
- Simple, stateless, automatic IPv6-in-IPv4 encap and decap function on CPE/RG
- Based on 6to4 (RFC 3056) and draft-despres-6rd-03.txt + CGN/NAT444 extensions
- draft-ietf-softwire-ipv6-6rd
Gory Details:
Three parts of the “6rd” Mechanism

• IPv6 Prefix Delegation derived from IPv4
  Global IPv4 or Natted IPv4 in same deployment

• Stateless mapping and Encapsulation of IPv6 over IPv4 (RFC 4213)
  IPv4 encapsulation automatically determined from each packet’s IPv6 destination
  No per-subscriber tunnel state or provisioning

• IPv4 Anycast to reach Border Routers
Packet Flow and Encapsulation

IPv4 + IPv6
IPv4 + IPv6
IPv4 + IPv6

CE

IPv4

6rd

6rd Border Relays

IPv4 + IPv6
Core / Internet

Dest = Inside 6rd Domain

IF 6rd IPv6 Prefix Positive Match

THEN Encap in IPv4 with embedded address

 ELSE (6rd IPv6 Prefix Negative Match)

ENCAP with BR IPv4 Anycast Address

IPv6 Dest = Outside 6rd Domain

“Not 2001:100...”
# 6rd vs 6to4

<table>
<thead>
<tr>
<th>Attribute</th>
<th>6rd</th>
<th>6to4</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPv6 Address</td>
<td>SP’s IPv6 Address Prefix</td>
<td>2002::/16</td>
</tr>
<tr>
<td>SP-managed service</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Always Route thru SP’s network</td>
<td>Yes</td>
<td>Maybe</td>
</tr>
<tr>
<td>IPv6 Address “Reputation”</td>
<td>Excellent, it is an ISP IPv6 Prefix</td>
<td>It is “6to4” and everybody knows that</td>
</tr>
<tr>
<td>RG Support</td>
<td>Under development</td>
<td>Supported</td>
</tr>
<tr>
<td>Cisco Products</td>
<td>IOS and Linksys Prototypes; planned for 6TS (ASR1K, CRS-1)</td>
<td>IOS</td>
</tr>
<tr>
<td>Doc</td>
<td>draft-ietf-softwire-ipv6-6rd</td>
<td>RFC3056</td>
</tr>
</tbody>
</table>
CGN - Dual-Stack Lite

- Employs softwire 4over6 tunnels plus CGN-NAT44 to support private IPv4 connectivity to public IPv4 Internet
- IPv6 hosts use native IPv6 routing to public IPv6 Internet
- Challenge is laying out IPv6 access network
- draft-ietf-softwire-dual-stack-lite

* AKA Softwires + NAT = SNAT
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CRS-1 IPv6 Transition Services
Solution Components

CRS-1 with IOS XR

- High-capacity, carrier-class SP platform with Cisco IOS/XR
- Leverages previously developed XR infrastructure to divert packets to Multi-Service PLIM
- Provides single, integrated configuration & management infrastructure for Service PLIM

Carrier Grade Service Engine (Roddick)

- Leverages existing 40G MSC hardware & software
- Rapid and flexible Linux-based development & test environment
- Supports required CGN – NAT44 performance & scale
- Cornerstone of 346 Backbone First IPv6 Transition Strategy
CGSE (Roddick) PLIM and IPv6 Transition Services (6TS)

- **Hardware**

  6TS function resides on Multi-Service PLIM
  Quad Octeon multiprocessor architecture, 64 CPU cores
  Standard interface to MSC, 10 Gbps full-duplex nominal

- **Software**

  - IOS-XR on MSC, Linux on Octeon CPUs
  - Leverages XR App SVI to divert packets to/from CGN function
  - Leverages Vector Packet Path (VPP) for NAT application
  - Integrated configuration & management via IOS XR
CGN Packet Walk-Thru

From Subscribers

- Packets enter from private network
- VLAN
- Tunnel

To Core

- Packets egress to public network
- VLAN
- Tunnel

iMetro ingress lookup maps VLAN or tunnel to VRF
Applies ingress features
Routes to CGN

Other packets may bypass NAT entirely
Packets routed to CGN pass XR App SVI, forwarded to CGN eMetro
CGN eMetro filters based on protocol
Load balance selects Octeon & core

Octeon CPU performs NAT, PT, and/or tunnel encaps
Forwards packet to CGN iMetro

CGN iMetro performs ingress lookup, selects output LC, forwards through fabric

Multiple Roddick CGN blades support good scaling and/or 1:1 redundancy

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CRS-1 6TS Project Update (September 2009)

• Demo Topology active and operational in SJ – currently testing applications
• Preliminary Performance Measurements:
  6.7Mpps (IMIX) → 10Gbps full-duplex tput
  1 + 1 Warm Standby Switchover measured to be < 1 sec
• Logging to external server based on Netflow9 records
• Analysis of deployment scenarios with customers
• Customer Demo/EFT engaged & planned – End of Nov/Early Dec. 2009
• IPv6 Features in development - will align with IETF BEHAVE docs
• External Launch planned for this Fall
• FCS in IOS-XR Release 3.9.1 (April 2010)
CGN Connectivity Models

Subscriber to/from CGN; remote attachment

<table>
<thead>
<tr>
<th>CGN-remote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Subs</td>
</tr>
<tr>
<td>Public Subs</td>
</tr>
<tr>
<td>BRAS/CMTS</td>
</tr>
<tr>
<td>Penultimate Hop Router</td>
</tr>
<tr>
<td>CGN</td>
</tr>
<tr>
<td>Global</td>
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</tbody>
</table>

Subscriber to/from CGN; local attachment

<table>
<thead>
<tr>
<th>CGN-local</th>
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<tbody>
<tr>
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<td>CGN</td>
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<tr>
<td>Global</td>
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# 6TS Roadmap

<table>
<thead>
<tr>
<th>6TSv1 NAT44</th>
<th>IPv4/IPv6 Coexistence</th>
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<tbody>
<tr>
<td>4Q2009</td>
<td>1H2010</td>
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<tr>
<td>EFT</td>
<td>FCS</td>
</tr>
<tr>
<td>NAT44</td>
<td>Instrumentation &amp;</td>
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<tr>
<td></td>
<td>Management Enhancements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>XR Infra</th>
<th>IPv6 SVI Testing</th>
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<tbody>
<tr>
<td></td>
<td>XML Interface</td>
</tr>
<tr>
<td></td>
<td>IPv6 SVI</td>
</tr>
<tr>
<td></td>
<td>TE into VRF (CGN-remote)</td>
</tr>
<tr>
<td></td>
<td>1 + 1 Hot Standby</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6TSv2 IPv6 Features/Services</th>
<th>6rd Demo/EFT v4/v6 xlat Coding/Demo</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>DS-Lite TC Coding</td>
</tr>
<tr>
<td></td>
<td>6rd Border Relay</td>
</tr>
<tr>
<td></td>
<td>Stateless IPv4/IPv6 XLAT</td>
</tr>
<tr>
<td></td>
<td>Stateful IPv4/IPv6 XLAT/DNS64</td>
</tr>
<tr>
<td></td>
<td>DS-Lite TC</td>
</tr>
<tr>
<td></td>
<td>ServiceWire</td>
</tr>
</tbody>
</table>
ASR1000 IPv6 Broadband Solution

IPv6 Broadband

- IPv6 Prefix Pools
- IPv6 RADIUS
- (Cisco VSA and RFC 3162)
- IPv6 LNS (RLS6 February 2010)
- Stateless DHCPv6
- IPv6 ISG (Roadmap)
- CGN (in Planning)

- IPv6 PTA (RLS5 November 2009)
- IPv6 LAC (RLS5 November 2009)
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Preserve

IPv4 infrastructure, assets, and service offerings

Large-Scale Translation (LSN)

Cisco CGv6

Continue and accelerate subscriber and device growth using **Private-IP**

Internet

IPv4

Existing Customers

New Customers

Private-IP

Today

With Cisco CG6
Prepare, with 6rd (6-over-4)

Subscriber IPv6 traffic is **tunneled** over IPv4 to gateways within the IP-NGN while IPv6 grows.

IPv6 moves out to subscribers

IPv6 Rapid Deployment (6rd) defines such a 6-over-4 model
Remaining subscriber IPv4 traffic is **tunneled** over IPv6 to gateways within the IP-NGN.

Dual-Stack Lite (DS-Lite) defines such a 4-over-6 model.
Q and A