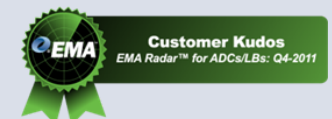**Customer Driven Innovation**

IPv6 Migration Overview and Solutions

José Luis Serrano

May 2014

Agenda

- ✓ **Technology Overview**

- ✓ **Application Delivery**

- ✓ **A10 Networks Product Overview**

Why IPv6?

IPv4 Exhaustion

- More people & devices connected requiring an IP address

IPv6 Adoption

- More adoption in 2011 than all previous years combined
- Increased attention - World IPv6 Day
- 31 billion connected devices by 2020 (Intel study)

IPv4 Blocks Available

Source: ARIN

Cellphone | TV | Surveillance Camera | Game Console | eBook

Heart Rate Monitor | Digital Weight Scale | Digital DVD Recorder | Car
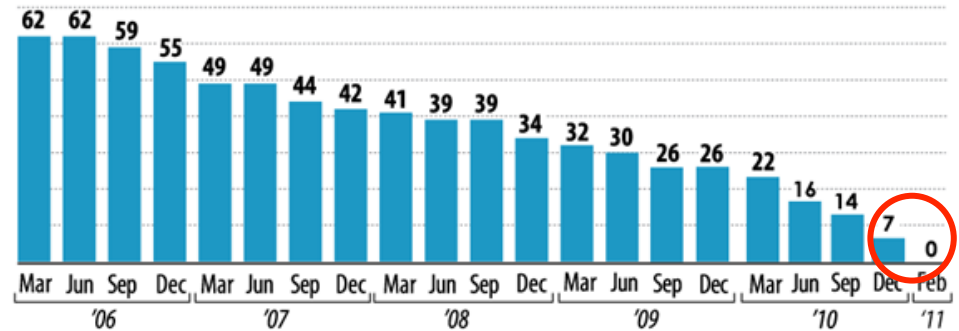
IPv6 Website Reachability

IPv6 Reachability Among Top 1M

Source :Comcast IPv6 Adoption Monitor

Why is IPv6 not Already Widely Used Today?

➤ **IPv6 requires a full IPv6 chain of communication**

- ◆ From **End Devices / Clients** (desktop, laptop, game device, smartphone)
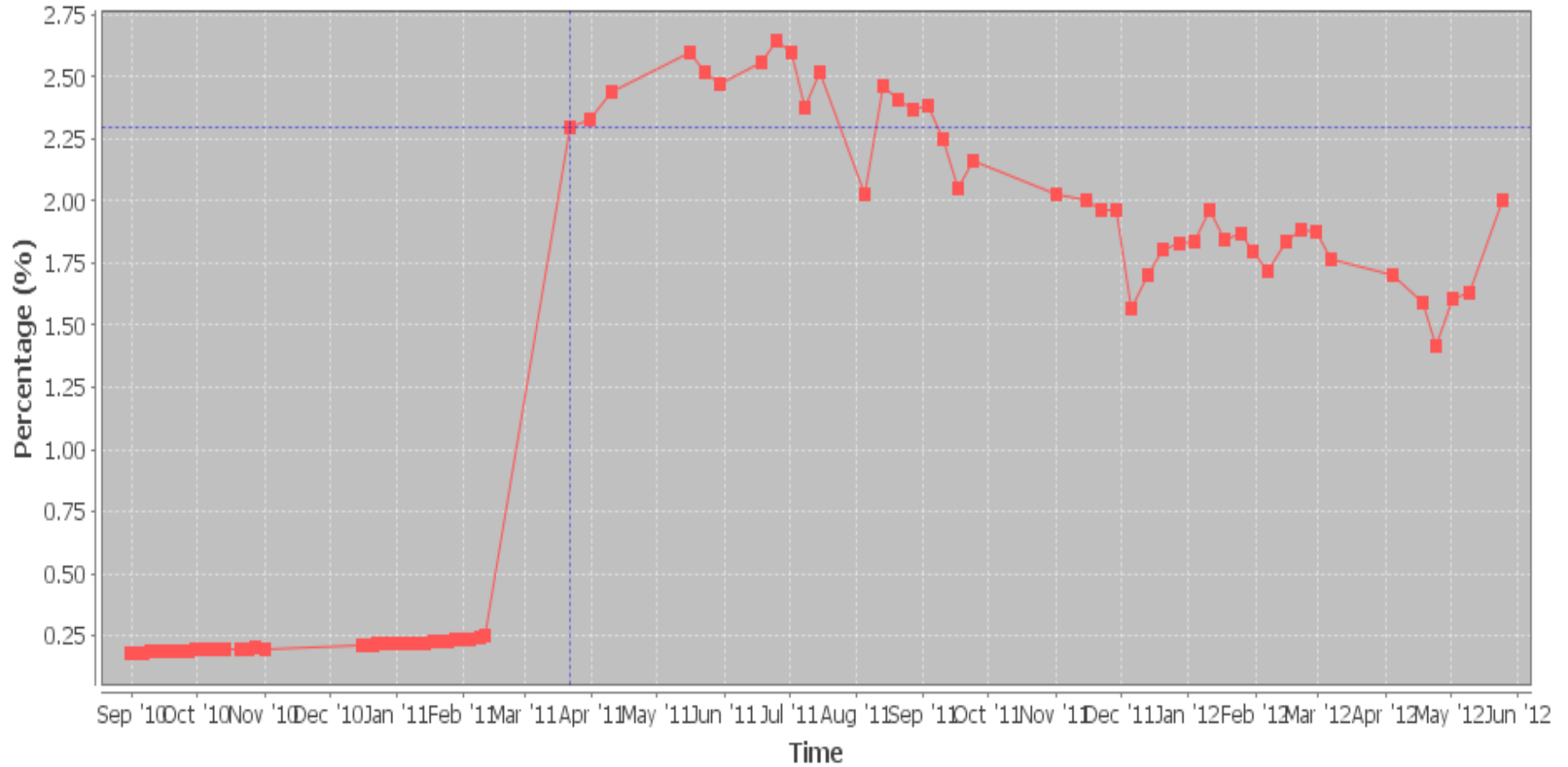- ◆ To **Service Providers** (Internet Service Providers, Mobile Network Operators)
- ◆ To **Enterprise / Content Providers**

Challenges

➤ **Relatively low percentage of V6 content availability**

➤ **Lack of Home CPE device support**

➤ **IPV4 backwards Compatibility**

➤ **IPV4/V6 Migration Deployment and Scale**
  - ◆ Throughput
  - ◆ NAT sessions
  - ◆ ALG support
  - ◆ Logging

IPv4 Clients

IPv6 Clients

IPv4 Network

IPv6 Network

No access

IPv4 Servers

IPv6 Servers

A10 *Customer Driven Innovation*
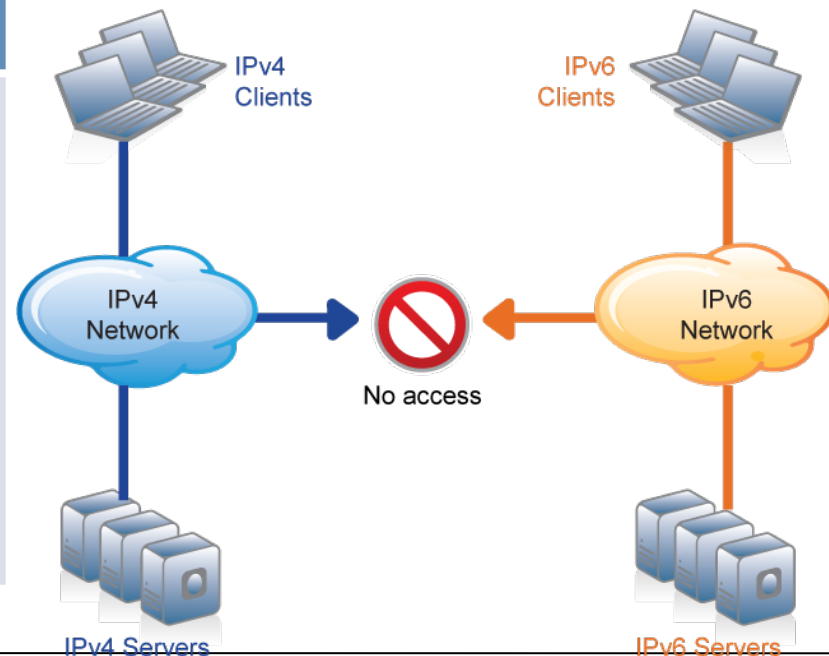
Transition to IPv6

> **Carrier Grade NAT (CGN)**

◆ Flexibility, Adaptability and transparency

> **IPv6 Migration - No one migration solution fits all**

◇ Each solution has its own pros & cons
◇ Standards proposals are dynamic

LSN/CGN/NAT444
NAT64/DNS64
DS-Lite 6rd

AX Series

Technology Overview

A10 IPv6 Migration Solution
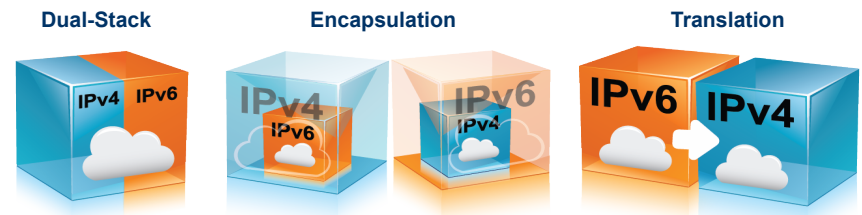
- ➤ **IPv4 Preservation**
  - ◆ Technology: **CGN**
  - ◆ Deployment Models: **NAT44** (Mobile), **NAT444** (Wireline)

- ➤ **IPv6 Migration Technologies**
  - ◆ Stateful
    - ◇ **DS-Lite**
    - ◇ **NAT64 / DNS64**
  - ◆ Stateless
    - ◇ **6rd**
    - ◇ **Stateless NAT46**
  - ◆ Lightweight
    - ◇ **DS-Lite LW4o6**

Dual-Stack   Encapsulation   Translation

CGN (IPv4 Extension)

Carrier-Grade NAT (CGN)

- **Requirements for an ISP NAT device**
  - **Highly transparent**
    - *existing user applications continue to work*
    - Minimal to no impact on customers
  - **Well defined NAT behavior**
    - *new user applications can easily be developed*
    - Consistent
    - Deterministic
  - **Fairness in resource sharing**
    - User guarantees and protection
  - **Works for both client-server (traditional) and client-client (P2P) applications**

Carrier-Grade NAT (CGN)

> **Based on the following IETF RFCs and Drafts**
>
> - BEHAVE-TCP (RFC 5382)
> - BEHAVE-UDP (RFC 4787)
> - BEHAVE-ICMP (RFC 5508)
> - CGN (draft-ietf-behave-lsn-requirements-08)

> **Primary Features**
>
> - Sticky Internal IP to External IP mapping
> - Endpoint-independent mapping & filtering
> - Hair-pinning support
> - Fairness in sharing the resources
>   - User quota and connection limits
>   - Session limits
>   - Extended quota for "always-available" services e.g. DNS, Email, etc.

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Large Scale NAT Topology (NAT44)

> **Single Layer of NAT**

  - ◆ Provider assigned end devices
  - ◆ Ideal for mobile handsets

Public IPv4 Internet

Large Scale NAT

Provider Private IPv4 Network
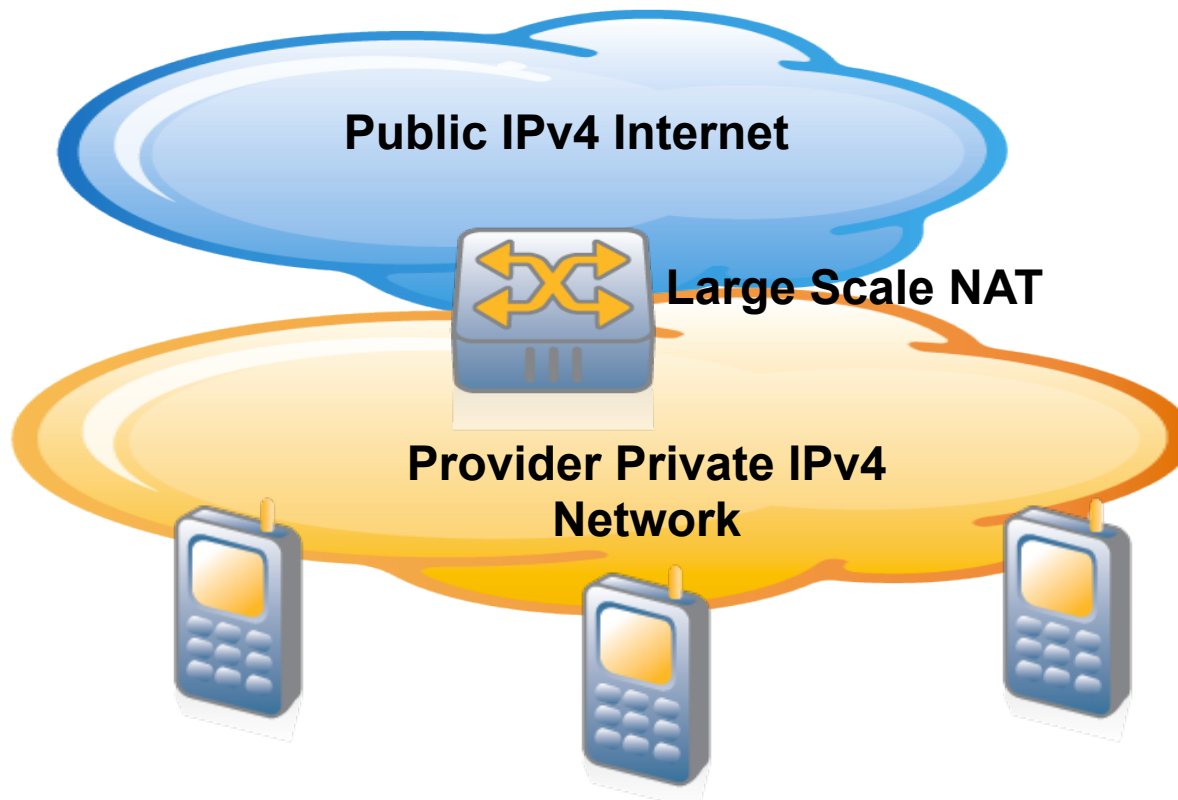
CGN/LSN – Topology – NAT444

NAT444 Deployment
(Double NAT)

- Provider NAT (IPv4-IPv4)
- Consumer NAT (IPv4-IPv4)

IPv4 Content

IPv4 Internet

Public IPv4 Addresses

LSN Device

Provider NAT

Provider Network – IPv4

LSN Scoped Address

Consumer NAT

IPv4 Clients

IPv4 Clients

IPv4 Clients
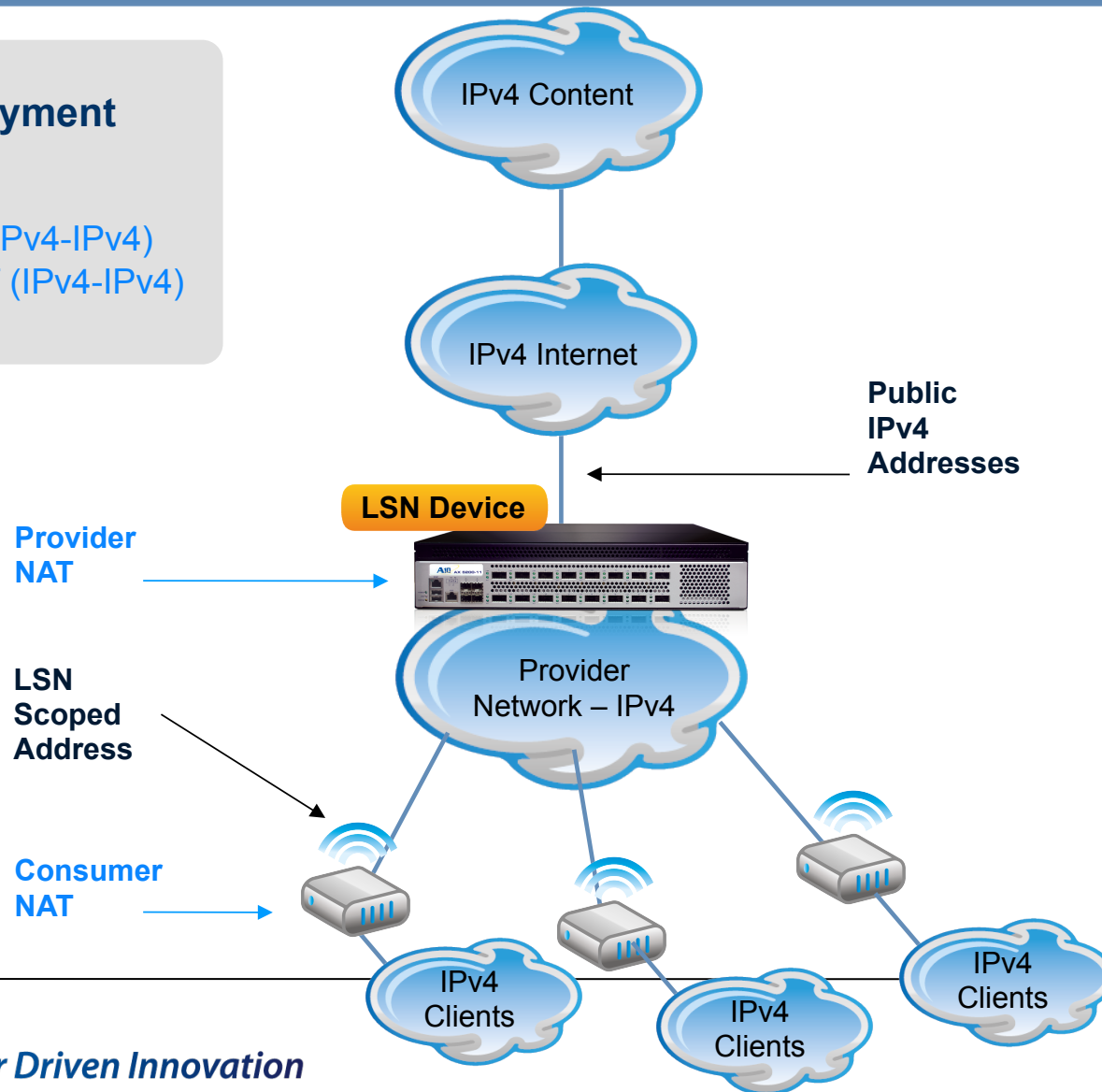
Customer Driven Innovation

Application Delivery

Carrier Grade NAT

Source IP	Dest IP
172.16.204.35	186.212.8.189

Source IP	Dest IP
70.132.116.89	186.212.8.189

Host X

Inside   Outside

Host Y1
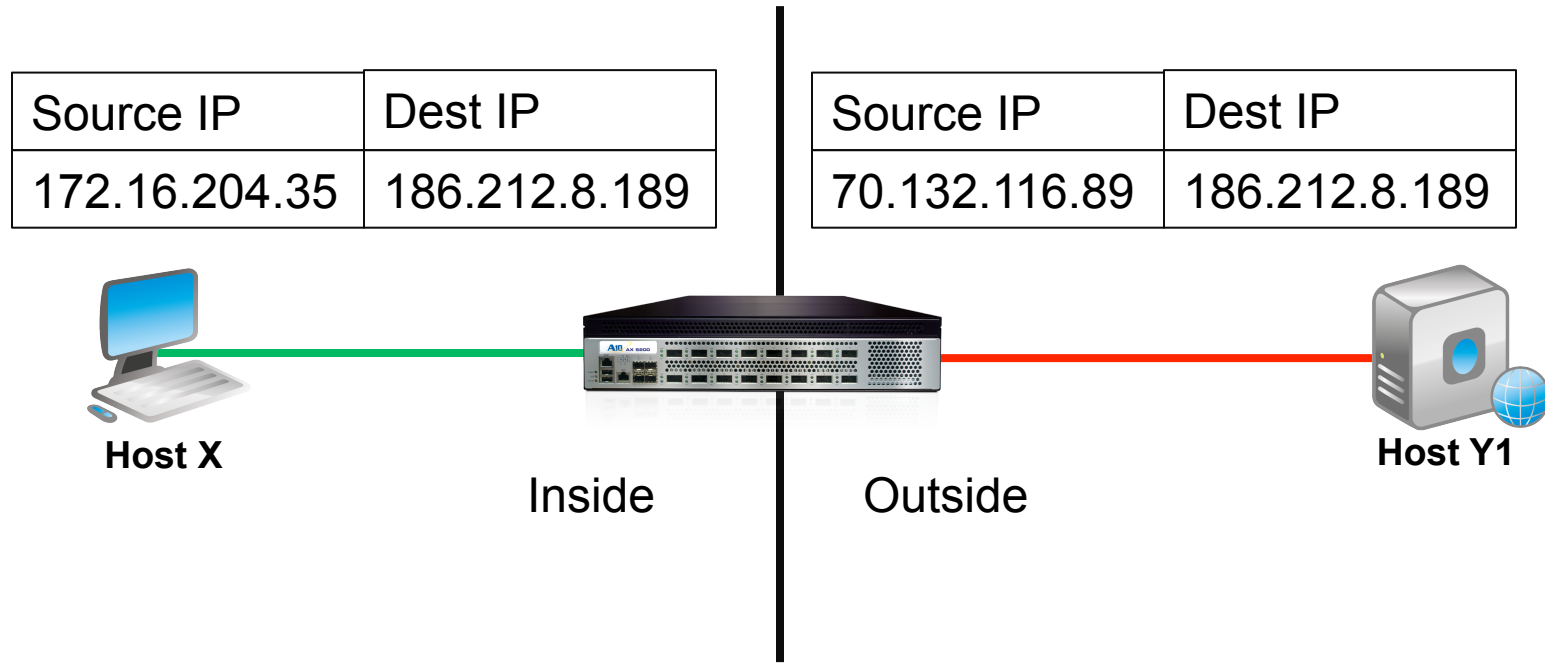
Protocol	Inside Global	Inside local	Outside Local	Outside Global
UDP	70.132.116.89	172.16.204.35	186.212.8.189	186.212.8.189

End Point Independent Mapping (EIM)

Source IP: Port	Dest IP:Port
X:x	Y1:y1

Source IP: Port	Dest IP:Port
X1:x1	Y1:y1

Host X

Host Y1

Host Y2

Inside   **Outside**
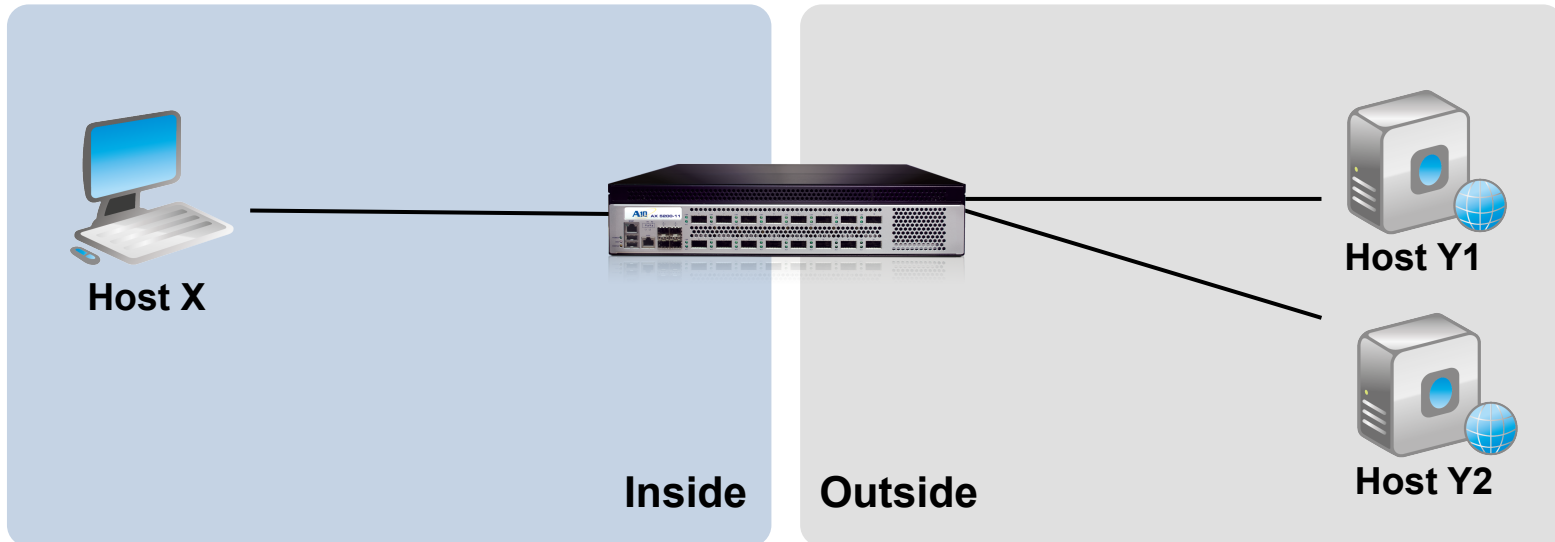
Source IP: Port	Dest IP:Port
X:x	Y2:y2

Source IP: Port	Dest IP:Port
X2:x2	Y2:y2

EIM→X1:x1 = X2:x2 for all Y:y (Y1:y1 and Y2:y2)

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End Point Independent Filtering
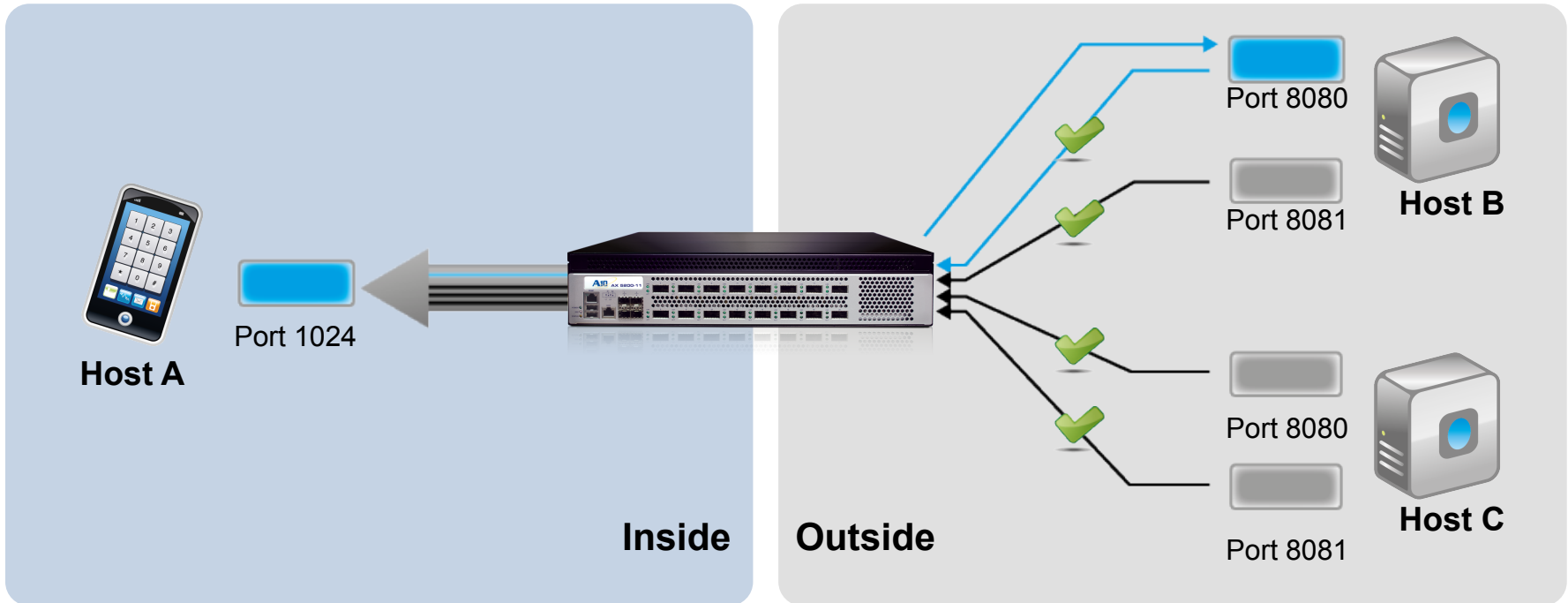
Internal	External	Filter
A:1024/B:8080	X:9001/B:8080	*:*/X:9001

AX(config)#ip nat lsn endpoint-independent-filtering enable

Hair pining

- **Two clients Host A and Host B behind a common NAT device**

- **Host A to Host B communication using the external binding**

Source: S:8080
Dest: X :9001

Source: S:8080
Dest: X :9002

Host S

Internal	External	Filter
A:1024/S:8080	X:9001/S:8080	*:*/X:9001
B:1024/S:8080	X:9002/S:8080	*:*/X:9002

NAT Device

Source: A :1024
Dest: S :8080

Source: B :1024
Dest: S :8080

Source: A :1024
Dest: X:9002

Source: B :1024
Dest: X:9001

Host A

Host B

Customer Driven Innovation
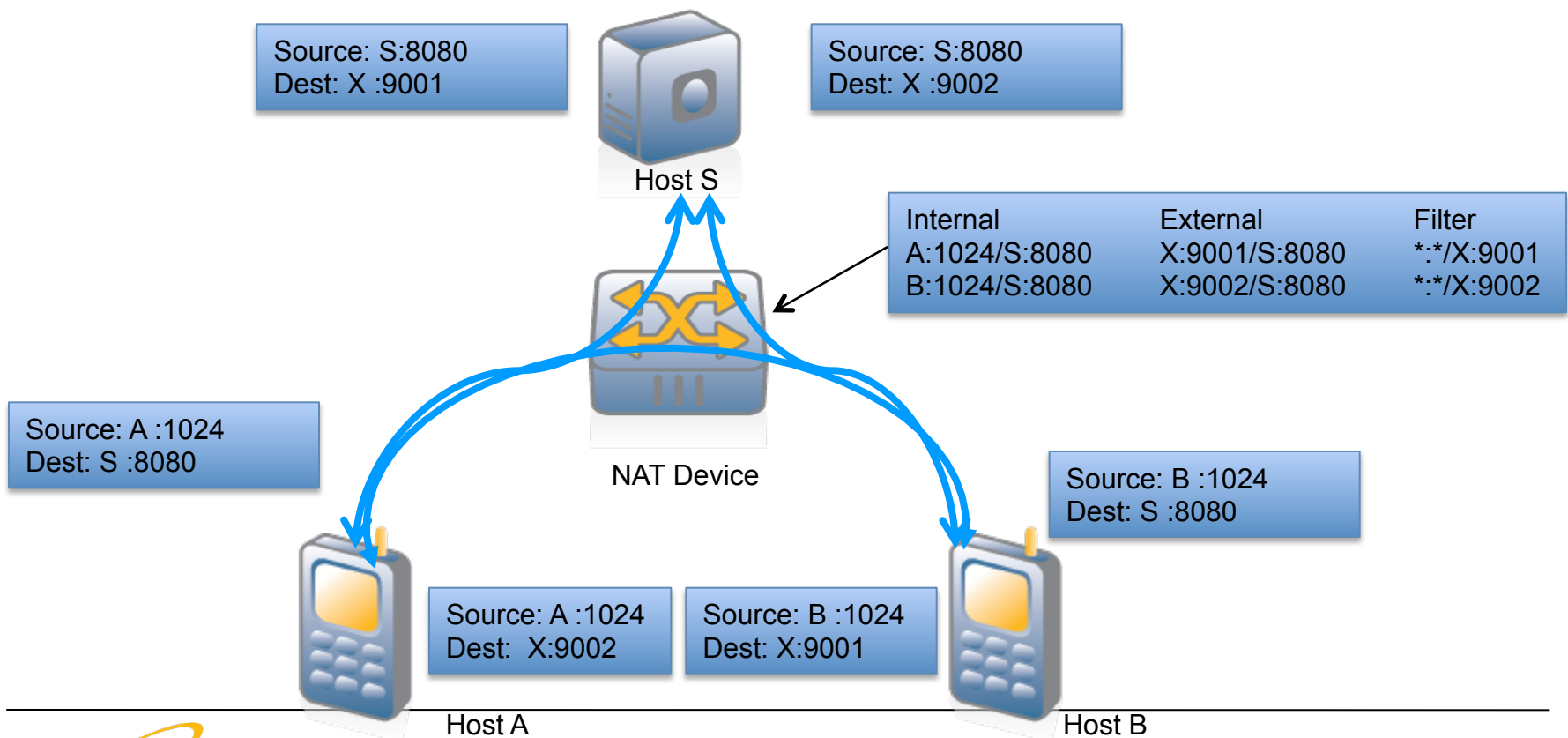
NAT Transversal applications

> ## P2P - NAT Transversal mechanisms

- ◆ <u>STUN Servers.</u>
- ◆ Hole punching
- ◆ TURN
- ◆ ICE

Validated Applications over A10 CGN

- Bit Torrent/uTorrent file leeching
- Bit Torrent/uTorrent file seeding
- PJSIP
- SIP
- Skype text chat
- Skype video chat
- X-Lite (for SIP calls)
- H.323v2
- Internet Archive - audio streaming
- Internet Archive - file download
- Internet Archive - video streaming
- LG BR DVD online streaming
- MS Smooth streaming
- Pandora internet radio
- REALAUDIO
- SlingCatcher
- Video streaming over Joost
- Video streaming over Netflix
- Video streaming over YouTube
- Web conferencing (GTM)
- Webcam

- DCE RPC Services
- ICMP
- LG remote Telnet/SSH
- MGCP
- Multiple IPsec ESP Tunnels
- NetBIOS
- PPTP
- RSH
- SNMP
- Sun RPC/RPC Port Map Services
- TFTP
- Traceroute
- Unix Remote Shell Service
- WINFrame
- DNS
- FTP
- AIM Downloads
- MSN, Yahoo Messenger.
- NetMeeting
- NetMeeting Directory
- NETSHOW
- Facebook

- Netflix Party
- Nintendo WII
- Team Fortress 2
- Xbox Peer to Peer
- CuSeeMe
- Iclips
- IIOP
- ILS
- LG- Home Monitoring
- MMS
- Oovoo
- QQ
- RAS
- RTSP
- SQLNET
- Stream Works

Customer Driven Innovation

IPv6 Migration Technologies

Dual-Stack Lite (DS-Lite)

- **IETF Draft – RFC 6333**

- **Leverages LSN to scale IPv4 addresses**
  - But provides a strong IPv6 migration path

- **Alleviates the addressing issues with native LSN**

- **Single NAT device (only in the ISP domain)**

- **Enables incremental IPv6 deployment**

- **Simplifies management of the service provider network**
  - Only one layer of NAT
  - More IPv6-only equipment in the network

DS-Lite Network

Legend:
- IPv6 ——————
- IPv4 Private ——————
- IPv4-in-IPv6 Tunneled — — — —
- IPv4 Global ——————
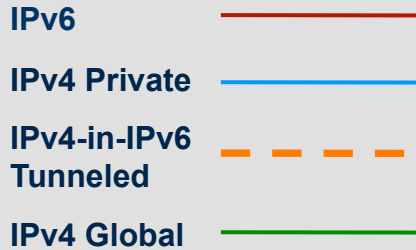
- ➤ Carry IPv4 packet over IPv6 tunnel(IPv4-in-IPv6), on "IPv6 ONLY" Access Network
- ➤ Provide Tunnel De-capsulation and IPv4-to-IPv4 Address Translation on AFTR Element (Concentrator)
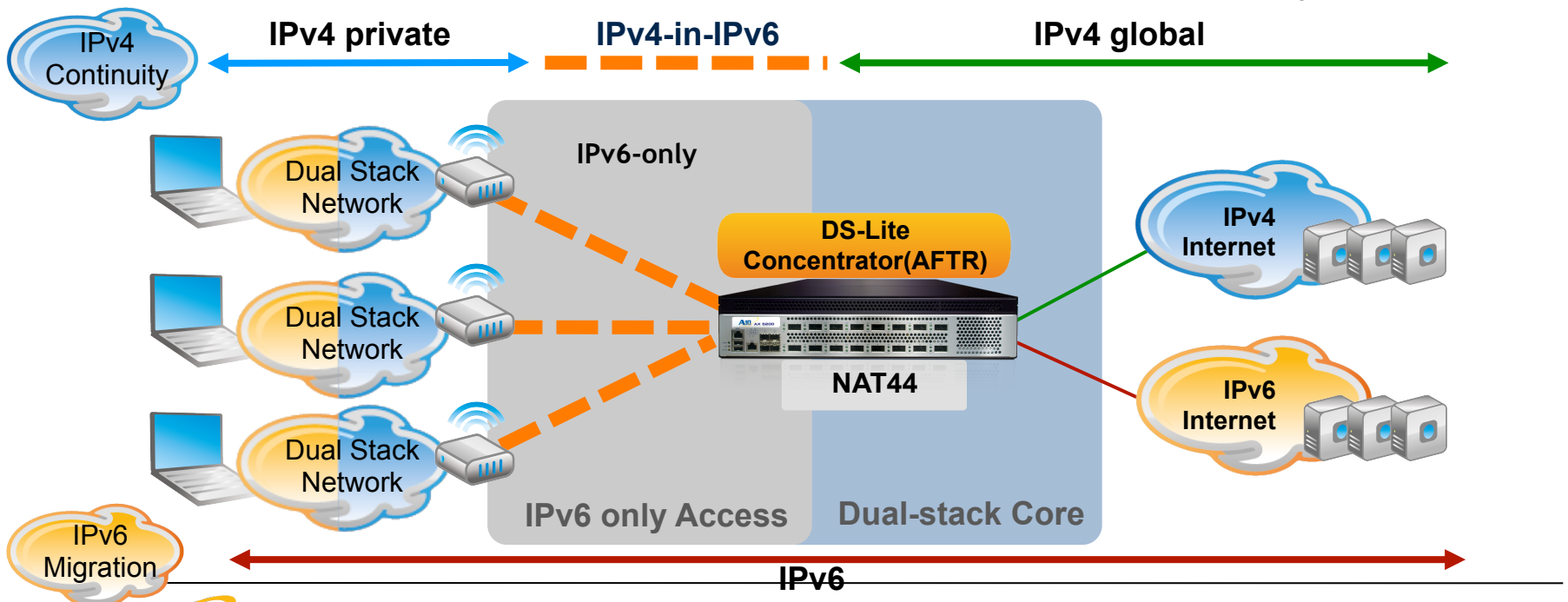- ➤ Global IPv4 address saving by sharing the addresses among multiple users.
- ➤ Reduce Management/Operational cost
- ➤ CPE must support DS-Lite Client (B4 element) functionality

IPv4 private — **IPv4-in-IPv6** — **IPv4 global**

IPv4 Continuity

Dual Stack Network

IPv6-only

DS-Lite Concentrator(AFTR)

NAT44

IPv4 Internet

IPv6 Internet

IPv6 only Access — Dual-stack Core

IPv6 Migration

IPv6

Customer Driven Innovation

NAT64

- **Connectivity between IPv6 clients and IPv4 destinations**

- **Translation between IPv6 and IPv4**

- **Used with DNS64**

- **Used for IPv6 migrated clients to connect to IPv4-only content, to maintain user experience**

- **Other primary features:**
  - **Full-Cone NAT**
  - **Hairpinning support**
  - **A10 Added**
    - **Session Sync**
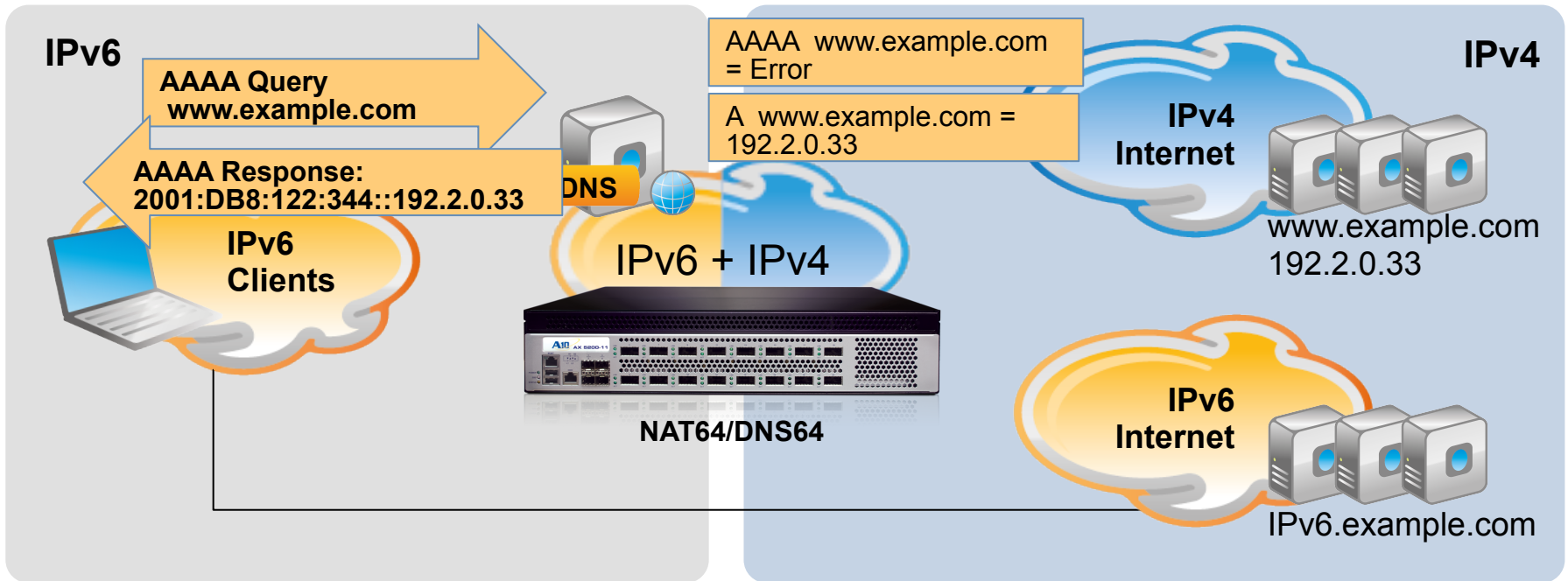   - **Logging**
    - **User Quotas**

NAT64

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- **Translation between IPv6 and IPv4**

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    - **Session Sync**
    - **Logging**
    - **User Quotas**

Customer Driven Innovation

NAT64 & DNS64 – DNS Flow

IPv6

AAAA Query
www.example.com

AAAA Response:
2001:DB8:122:344::192.2.0.33

IPv6
Clients

DNS

IPv6 + IPv4

NAT64/DNS64

AAAA www.example.com
= Error

A www.example.com =
192.2.0.33

IPv4

IPv4
Internet

www.example.com
192.2.0.33

IPv6
Internet

IPv6.example.com

NAT64/DNS64 device owns IPv6 Prefix 2001:DB8:122:344::/96

NAT64 & DNS64 – Packet Flow

IPv6

IPv4

DNS

IPv6 Clients

IPv6 + IPv4

NAT64/DNS64

IPv4 Internet

www.example.com
192.2.0.33

SIP, SPort: 2002:ACE:888:007::101, 1024
DIP, DPort: 2001:DB8:122:344::192.2.0.33, 80

SIP, SPort: 204.16.75.101:12129
DIP, DPort: 192.2.0.33:80
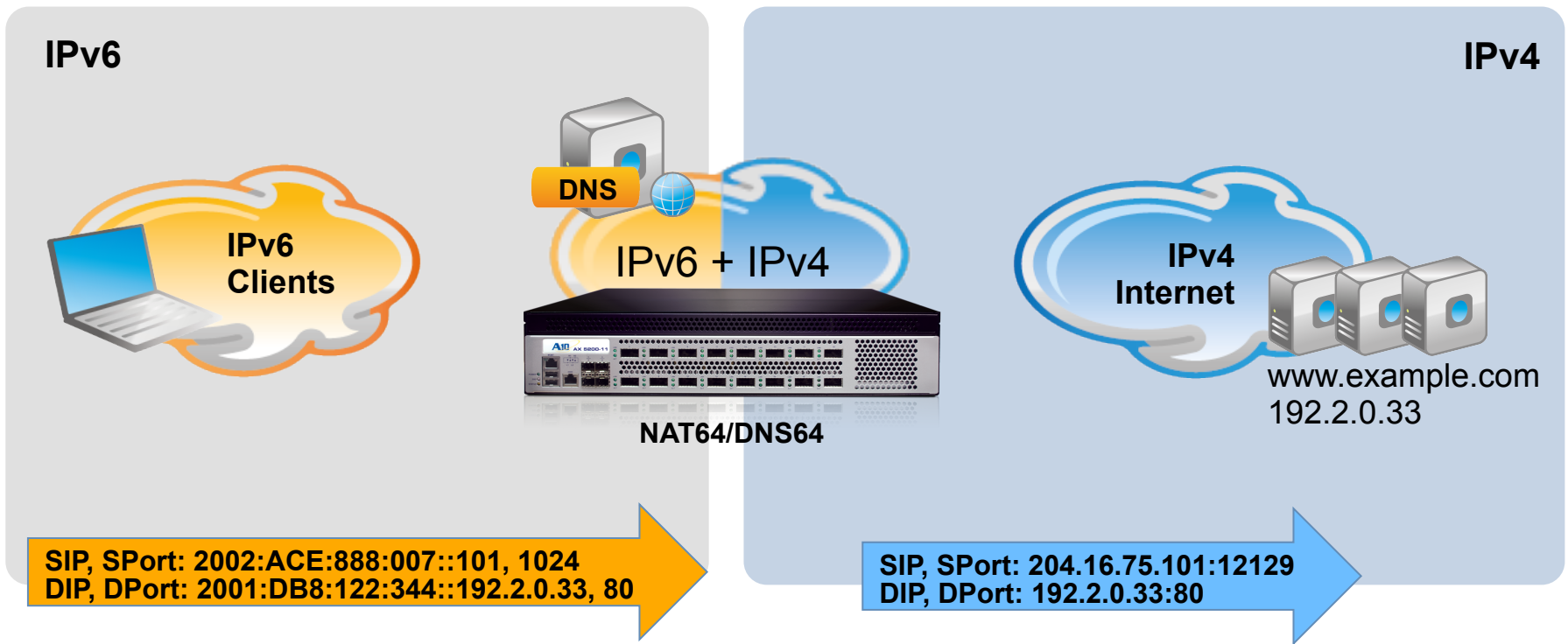
NAT64 owns IPv4 Address Pool 204.16.75.0/24

Customer Driven Innovation

IPv6 Rapid Deployment (6rd)

- **RFC 5569**

- **Enables IPv6 connectivity over IPv4 networks**

- **Based on 6to4 (RFC 3056), but addresses issues with 6to4 deployments**

- **Stateless technology – uses 6rd CPEs & 6rd Gateways**

- **Changes over 6to4**
  - Standard 6to4 prefix 2002::/16 replaced by ISP prefix (<= /32)
  - 6to4 anycast address replaced by another address

- **Considerations:**
  - Requires CPEs to be upgraded
  - Tunneling - fragmentation

Customer Driven Innovation

6rd - Topology

Native IPv6 Packets ──────────

Native IPv4 Packets ──────────

IPv6-in-IPv4 Tunneled Packets ─ ─ ─ ─

➤ **6rd does not provide IPv4 preservation**

➤ **Nat444 can be deployed concurrently with 6rd gateway to extend IPv4 service life**

A10 **Customer Driven Innovation**
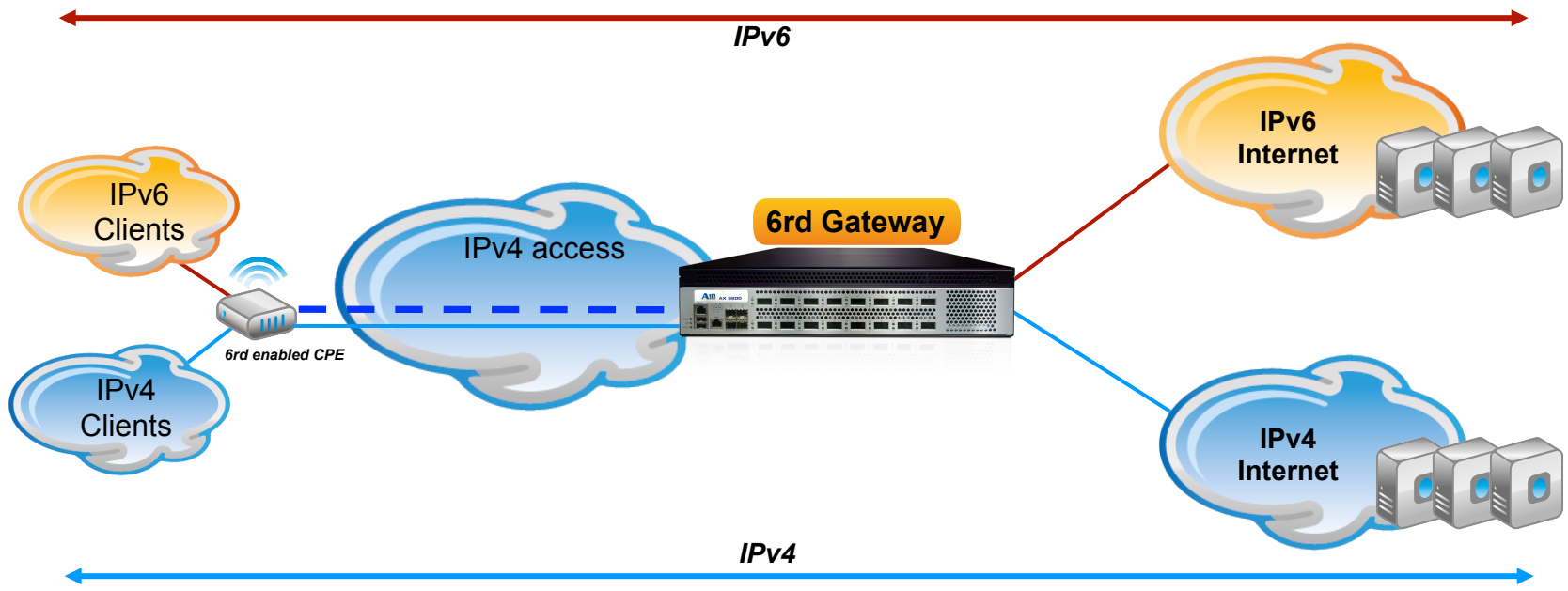
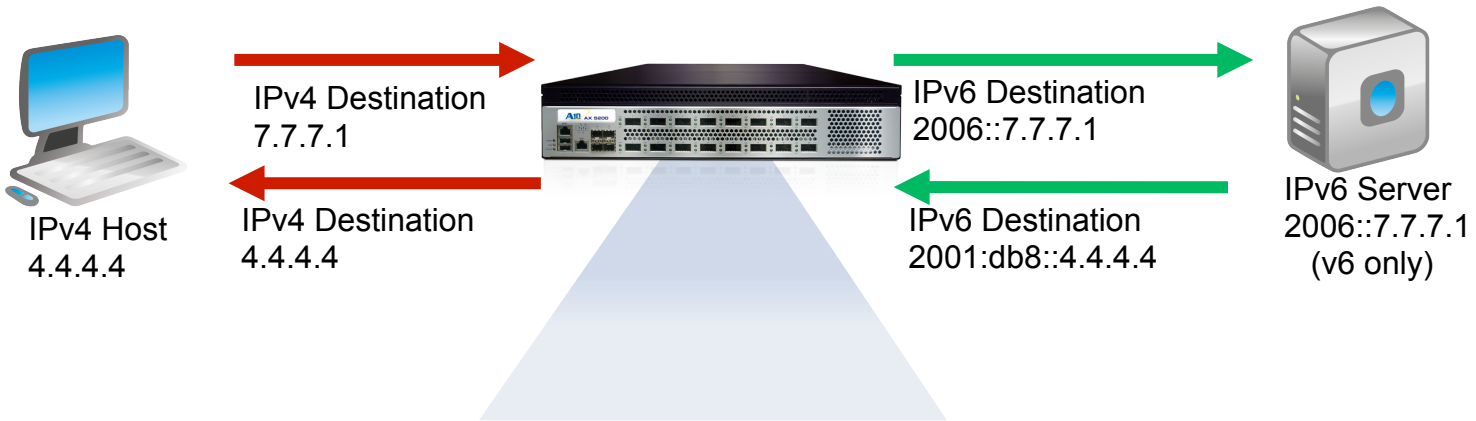# Stateless NAT46

- **Allows IPv4 clients to connect to IPv6 servers**

- **Stateless IPv4<->IPv6 Translations**

- **Server IPv6-IPv4 address mappings statically configured by administrator**

- **96-bit IPv6 prefix configured for Source IPv4 address translations**
  - e.g. 2001:db8::/96

- **AX will support up to 8192 static mappings**

- **IPv4<->IPv6 translations performed using RFC 2765, 6145**

Stateless NAT46 – Packet Flow

IPv4/v6 Static Mappings	
Server IPv6 Address	NAT46 IPv4 Address
2006::7.7.7.1	7.7.7.1
2004::11.11.11.2	11.11.11.2

IPv4 Destination
7.7.7.1

IPv4 Destination
4.4.4.4

IPv4 Host
4.4.4.4

IPv6 Destination
2006::7.7.7.1

IPv6 Destination
2001:db8::4.4.4.4

IPv6 Server
2006::7.7.7.1
(v6 only)

NAT46 device owns IPv6 Prefix 2001:DB8::/96

IPv4 Preservation and IPv6 Migration Paths for SPs

	NAT44(4)	6rd	DS-Lite	NAT64/DNS64
IPv4 Exhaustion	✓	✗	✓	✗
IPv6 Content Access	✗	✓	✓*	✗
IPv6-Only-Client Access to IPv4	✗	✗	✗	✓
Access network	v4	v4	v6	v6
Destination	v4	v4/v6	v4/v6	v4/v6
CPE	v4	v4/v6	v4/v6	v4/v6
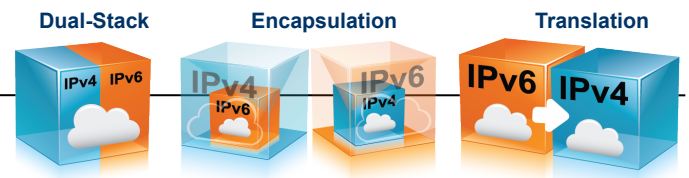
A10 Product Overview
Super-Computing Gateways

A10 Company Overview

Founded in Late 2004

CEO & Founder
Lee Chen
Co-founder of Foundry Networks, Centillion Networks

Headquarters in San Jose

Offices in 23 countries; customers in 43 countries

ACOS Platform

THUNDER SERIES

ADC   CGN   TPS

ACOS

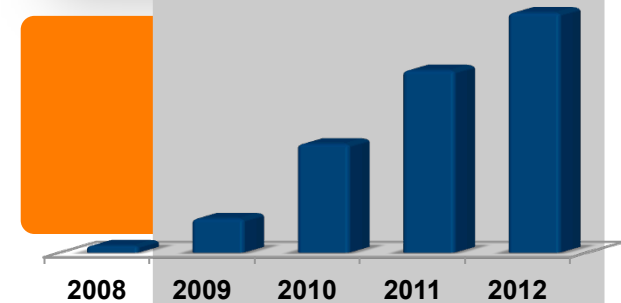**Leader in Application Networking**

Optimizing the performance and security of data center applications and networks for *web giants, enterprises and service providers*

2006   2007   2008   2009   2011   2012

Consistent Revenue Growth

2008   2009   2010   2011   2012

Customer Driven Innovation

Benefits of ACOS Shared Memory
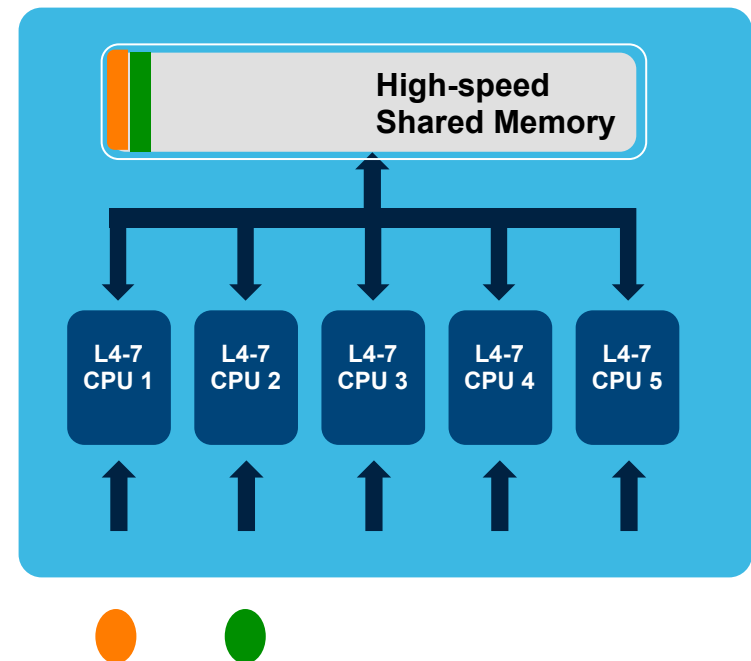
Conventional IPC Architecture
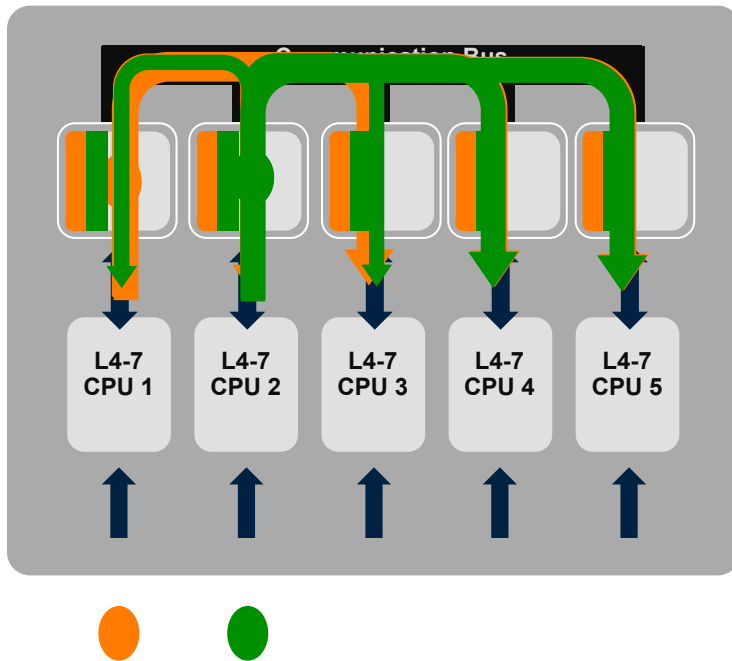
ACOS Shared Memory

Benefits of ACOS Shared Memory

➤ **Zero Memory Duplication**

➤ **Zero IPC**

➤ **Zero Locking**

➤ **Zero Scheduling**

➤ **Zero Interrupts**

ACOS Shared Memory

High-speed Shared Memory

L4-7 CPU 1	L4-7 CPU 2	L4-7 CPU 3	L4-7 CPU 4	L4-7 CPU 5

Customer Driven Innovation
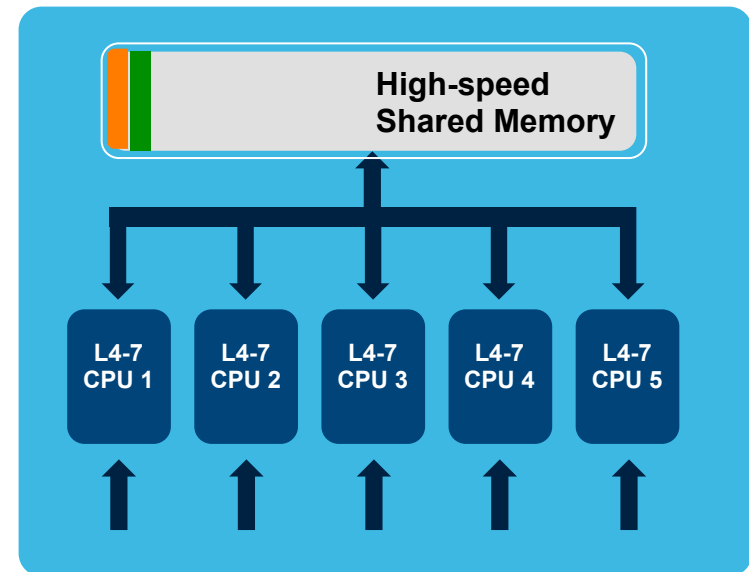
ACOS Platform: High Performance Application Networking

Efficient & Accurate Memory Architecture

Shared Memory Architecture

Application Acceleration

64-Bit Multi-Core Optimized

CPU 1 CPU 2 CPU 3 ● ● ● CPU N

Application Security

Optimized Flow Distribution

Flexible Traffic Accelerator

Application Availability

Switching and Routing
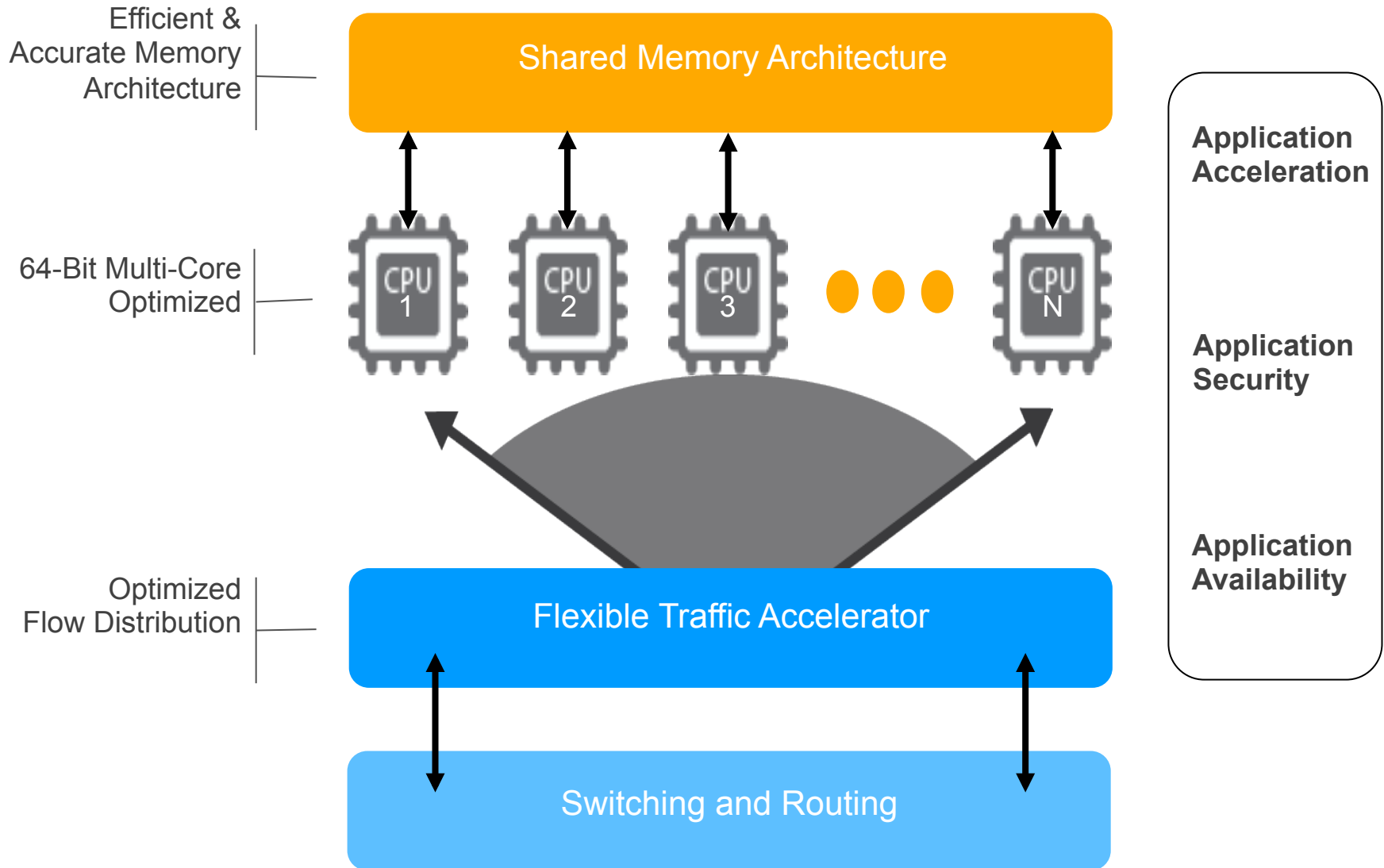
Linear Scaling – Shared Memory Architecture

Benefits:

- Cost
- Power
- Heat
- Size

Resource Efficiency

# of CPU Cores

Conventional
IPC Memory
Architecture

A10 ACOS
Shared Memory
Architecture

Customer Driven Innovation

Redundant Power Supply

Tamper Detection

Hot Swap Smart Fans

4 x NITROX III SSL

2 x Octo-core Intel Xeon CPU

ECC Memory

4 x Flexible Traffic ASIC-3 (FTA-3)

Switching and Routing (S+R) ASIC

Front to Back Air Flow

1U Form Factor

Mgmt 1 x 1 Gb

Console Port

Lights Out Management (LOM)

Solid-state Drive (SSD)

16 x 1/10 Gb SFP/SFP+

4 x 40 Gb QSFP+

Customer Driven Innovation

Recent Accolades

Honoree 2011
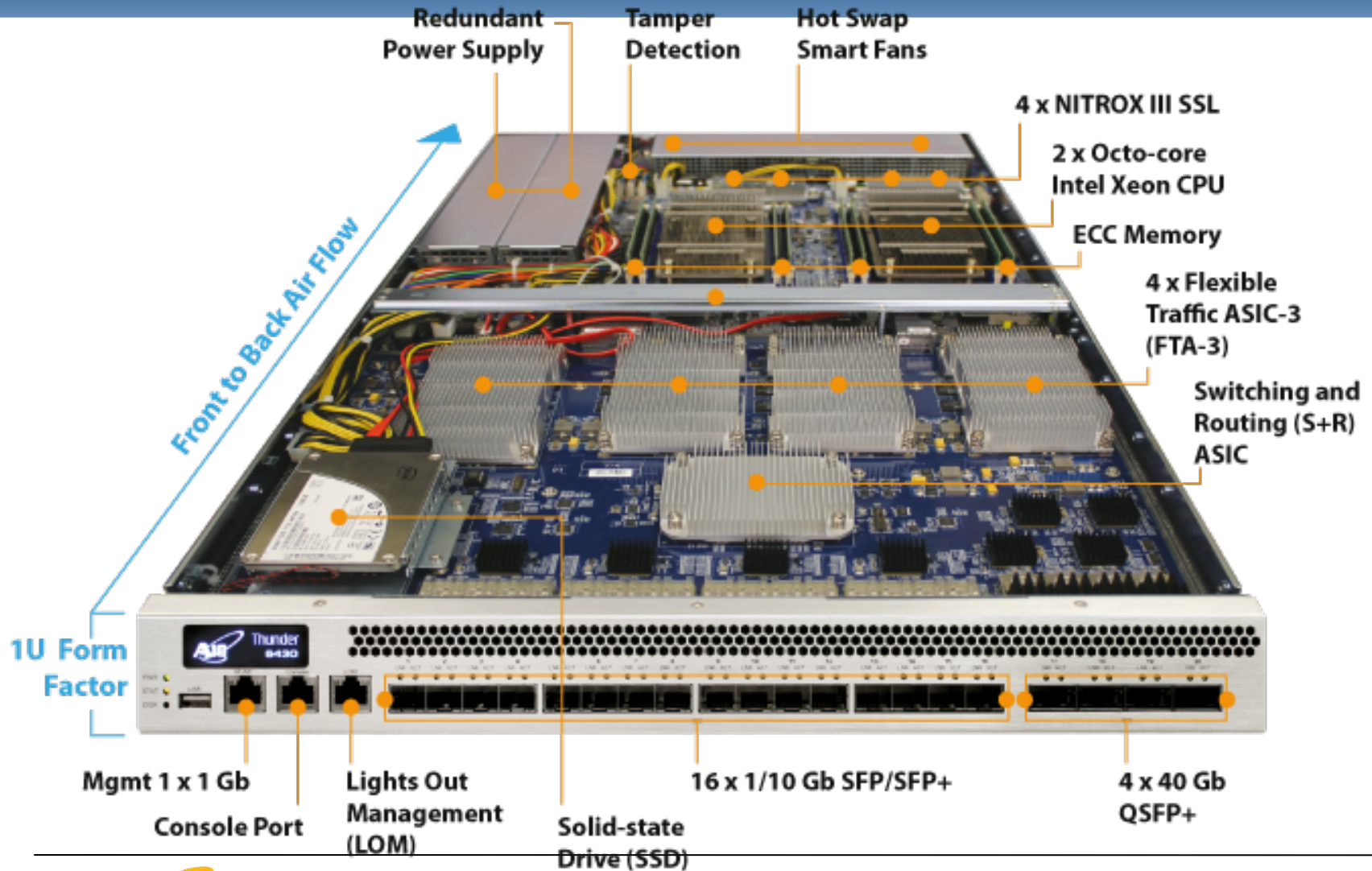
Ranked as #2 fastest growing private company in Silicon Valley
- 1,352% 3-year percent change in revenue
- Winner for third consecutive year (#2 in 2011), (#4 in 2010), (#13 in 2009)

Inc. 500

Ranked as #1 Computer Hardware company

- Listed 2 consecutive years
- Top 10 Internet Company
- Top 10 East Asian Entrepreneur

TOP WORK PLACES 2012 · BayAreaNewsGroup

Ranked #3 in Midsize category.
Winner for three consecutive years.
Top technology company in category.

BEST OF SHOW AWARD INTEROP

AX 3530 won two Grand Prize awards for: Performance Optimization with aVCS and ShowNet Demonstration for IPv6 Migration solutions.

A10 *Customer Driven Innovation*

Service Provider & Telecom :

A10 Customers

Some specific LSN/CGN + NAT64 references:

Just few specific LSN/CGN + DS-Lite references:

Additional Solution Highlights

- ➤ **Logging**
  - ◆ Scalable, low impact, high performance and highly configurable
  - ◆ Advanced features (Fixed-NAT/Zero-Logging, Port Batching, policy-based logging, compact logging, binary logging and others)

- ➤ **High Availability**
  - ◆ Fully stateful
  - ◆ Active-Standby or Active-Active
  - ◆ Session synchronization for uninterrupted service following failover
  - ◆ Multiple High Availability sets in the same network for greater service protection

- ➤ **Flexibility of Deployment**
  - ◆ Inline Mode
  - ◆ One-armed Mode

- ➤ **Management Through IPv6**
  - ◆ Full native IPv6 and IPv4 management and feature support
  - ◆ SSH, HTTP, HTTPS, SCP, and SFTP support

- ➤ **IPv6 Routing**
  - ◆ Static IPv6 route and neighbor configuration
  - ◆ Dynamic routing - OSPFv3, IS-IS, RIPng, BGP4+

- ➤ **Application Level Gateways (ALGs)**
  - ◆ FTP, TFTP, RTSP, PPTP, SIP, ICMP, DNS

A10 *Customer Driven Innovation*

A10 LSN innovation

ACOS
64-bit

R2.6.6	R2.6.6P1	R2.6.6P2	R2.6.6P3	R2.6.6P4
Oct 11	Dec 11	Feb 12	May 12	Nov 1

IPv6 Migration Enhancements

- Concurrent CGN, DS-Lite, NAT64 and 6rd with full RFC compliance
- Stateless NAT46
- Port Control Protocol (PCP)
- Port Overloading
- Configurable data session limits
- NAT64 special fragment handling
- TCP maximum segment size (MSS) clamping for LSN
- IPv6 Duplicate Address Detection and logging
- Session quotas with reserve
- LSN Rule Lists for Matching and Traffic Handling based on destination IP address, L4 protocol or L4 port
- Per Protocol/Port EIM/EIF, STUN, and translation timeouts
- IPv6 Ready Certification

Logging Enhancements

- Log size reduction
  - Compact/Hex logging format
  - Binary logging format
- Log Volume reduction
  - Port Batching
  - Fixed NAT
- Port batching support for batch size 1024
- External Logging over TCP
- External Logging to RADIUS server
- RFC 5424 syslog and customizable log format
- Netflow V9 and sFlow support

Purpose Built Hardware

- Ax-3530
  - 256M concurrent sessions
  - 115GPS
  - 1.125M CPS
  - 20K outside IP addr
- Ax-5200-11
  - 256M concurrent sessions
  - 40 GPS
  - 1.8M CPS
  - 20K outside IP addr

A10 **Customer Driven Innovation**

Thank You

Any App

Any Cloud

Any Size

www.a10networks.com

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