



IPv6 Transition Strategy

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Establishing Focus



- IPv6 technology is an 'enabler' of new business opportunities. The technology itself is not a 'market driver'.
- *IPv6 is NOT a feature.* It is about the fundamental IP network layer model developed for end-to-end services and network transparency.
- With the exhaustion of the IPv4 free pool, IPv6 deployment enables ***business continuity.***



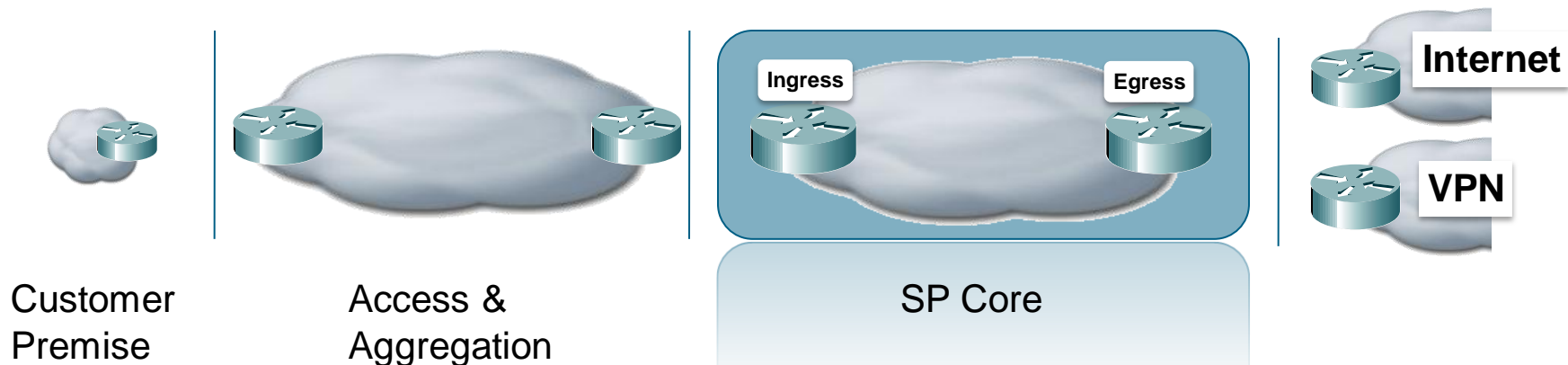
Context & Scope

- How to prepare the SP core infrastructure for IPv6 transport

IPv6 Transport prerequisite for IPv6 based services

IPv6 Transport transparent to IPv6 based services

SP core infrastructure covers the segment between the ingress edge router (service creation point) and the egress edge router



Objective

- Provide Deployment Guidelines for the given Context including:
 - Address Plan
 - IGP Routing
 - BGP Routing
 - Carrier-class Optimizations

Starting Point – The Network Today

- IPv4 core + MPLS forwarding
- IGP + BGP + LDP
- Each node hosts a loopback address as unique ID
- All WAN links are p2p and configured with /30 or ideally /31 addresses
- All WAN links are of POS or GE type
- The Core is the transport platform for multiple service like Internet, L3VPNs, VPWS, VPLS, IPv4 based Wholesale services like L2TP, etc.

IPv6 Services

- IPv6 Internet Transit
- IPv6 Internet for residential subscribers
- IPv6 L3VPNs
- IPv6 Wholesale Services
- IPv6 based Infrastructure Services e.g. DOCSIS 3.0

Minimum Support Requirements

- Ingress and Egress devices need to understand and support IPv6

Transport Requirement is that the device can read the IPv6 header, maintains a IPv6 RIB/FIB, can do lookup for the Next-Hop, forward the packets to the correct Next-Hop

- Between Ingress and Egress it requires IPv6 transport

Tunneled – works for all services

Native – works for Internet Transit and Subscribers, but not VPN services

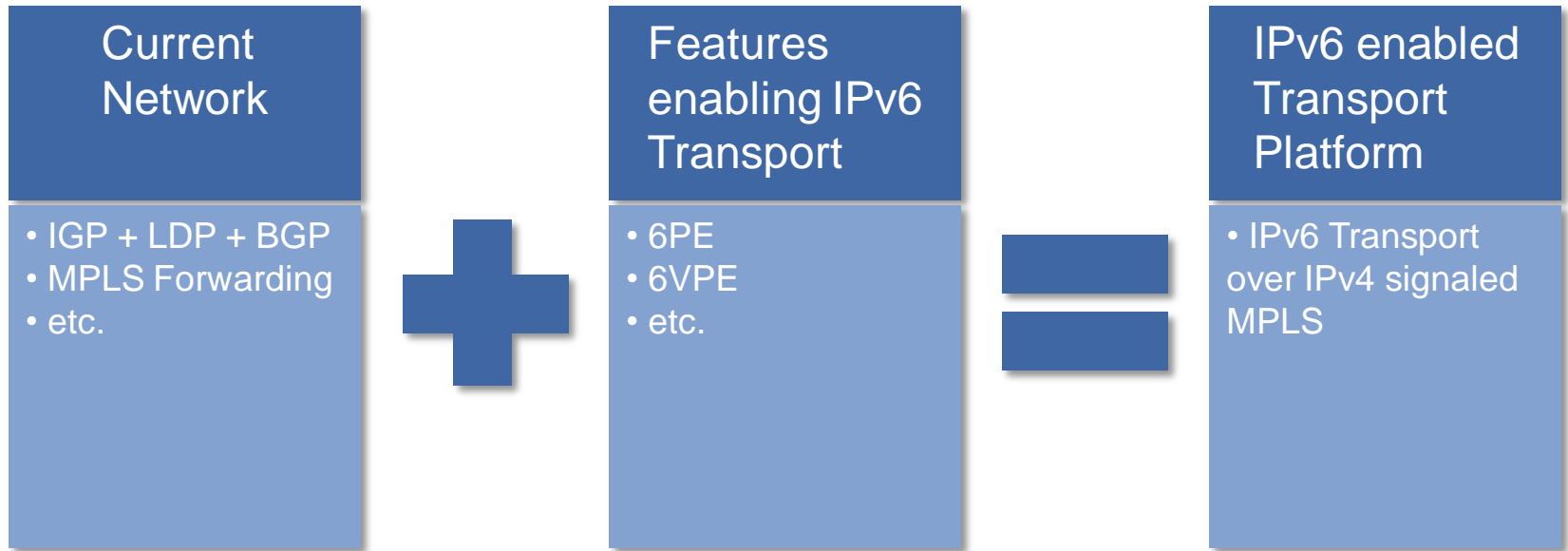
The Final Goal

- A pure IPv6 Infrastructure

First priority is to support IPv6 based services

Second priority is to simplify the transport platform and remove redundant control and forwarding planes over time

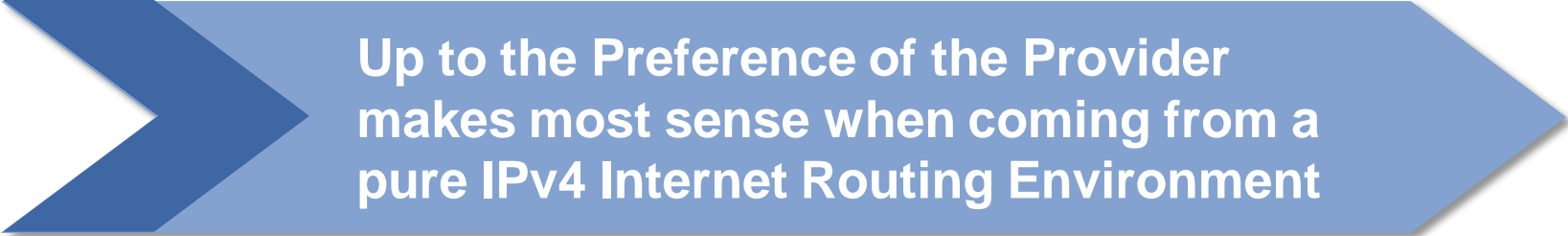
Pragmatic Approach for the 1st Step



Final Goal: Pure IPv6 Transport Infrastructure

What about a Dual-Stack Approach?

- Is Dual-Stack in the IP NGN Core desirable?
 - Dual-Stack would mean per-hop IPv6 Internet routing
 - Full IPv6 Internet Routing Table on each Hop
 - Full external Reachability of each Infrastructure Hop
 - Transparency of the internal Topology
 - Higher Resource Requirements on Core Routers wrt CPU and Memory on RP and LC
 - Different Forwarding Paradigms for Internet and VPNs

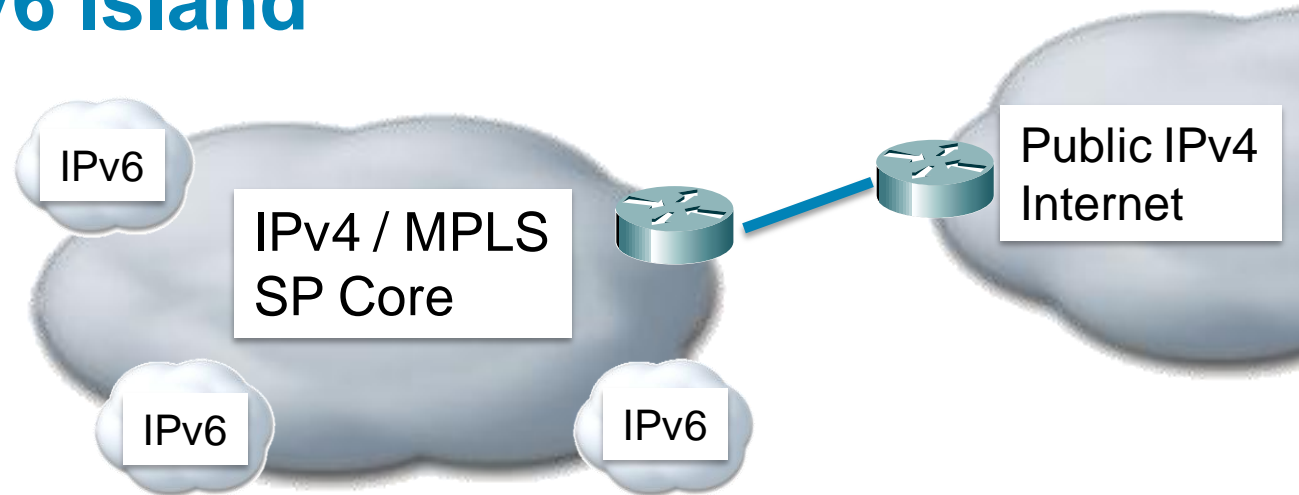


**Up to the Preference of the Provider
makes most sense when coming from a
pure IPv4 Internet Routing Environment**

IPv6 Transition Strategy Requirements

- Must be low-cost and low-risk
- Must co-exist with existing IPv4 infrastructure
- Must allow access to public IPv4 Internet
- Must be incrementally deployable

Fundamental IPv6 Transition Notion – The IPv6 Island



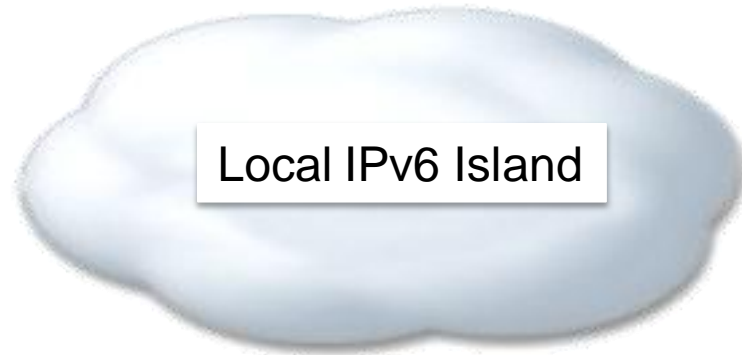
- What is an IPv6 Island?
 - Contiguous set of IPv6-only or dual-stack IPv4/IPv6 hosts/routers configured to talk IPv6 to each other
 - Can be large, medium or small in size
 - Primarily deployed around the edges of an SP IPv4 backbone network (i.e. campuses, VPN sites, home networks, etc.)
- The value of IPv6 Islands
 - easy and well-understood to configure and deploy
 - start small and grow/expand or merge with other IPv6 islands

Most Critical Element in all IPv6 Transition Strategy Discussions to Date

- How to exit the IPv6 Island to connect to:
 - Remote IPv6 islands
 - Public IPv4 Internet
 - Remote private IPv4 islands
 - and how to visit the IPv6 island from remote public IPv4 networks
- We know/learnt how to build native IPv6 and dual-stack Island Networks that talk IPv6 – see IETF section above
 - But without the ability to enter and exit the IPv6 island they are of no use and thus not really deployable

Island Connectivity Requirements (1)

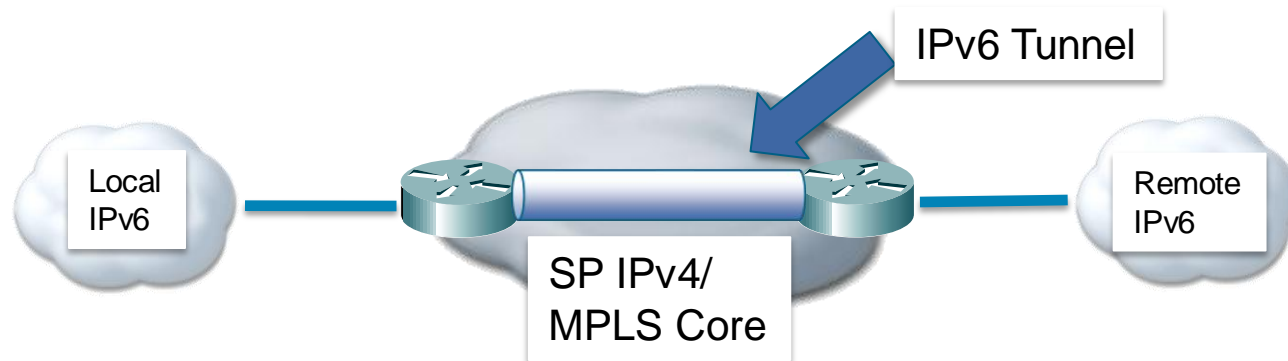
Local IPv6



- Not a problem, it is done using IPv6
- Simple examples are home networks (i.e. airport extreme) to small campus networks
- Another example could be an SP Backbone running dual-stack

Island Connectivity Requirements (2)

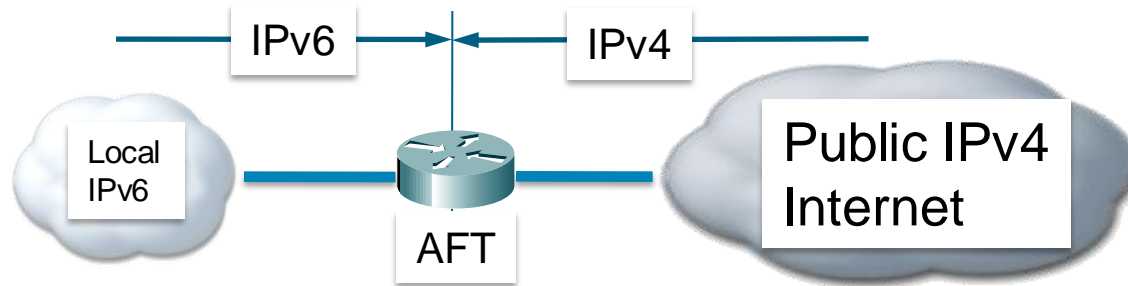
Local IPv6-to-Remote IPv6



- Local and remote IPv6 islands connected to a common IPv4/MPLS cloud
- Hosts in the local IPv6 island want to talk to hosts located in a remote IPv6 island using of course IPv6
- IPv6 packets need to exit the island
- Thus we need to tunnel IPv6 packets thru the IPv4 cloud

Island Connectivity Requirements (3)

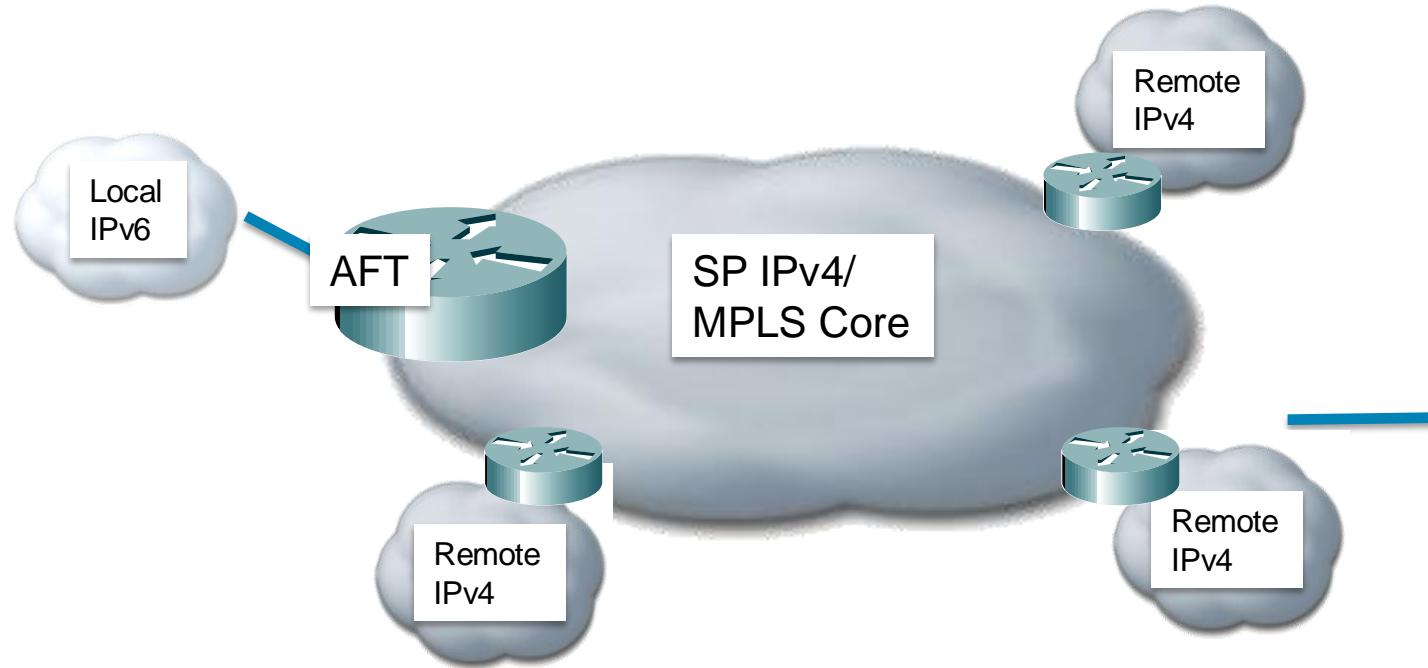
Local IPv6-to-Public IPv4 Internet



- Remote IPv6 islands connected to a common IPv4 cloud
- Hosts in the local IPv6 island need to talk to public IPv4 hosts (and vice-versa)
- IPv6 packets need to exit the island and must be translated to public IPv4
 - likewise IPv4 packets entering the island must be translated to IPv6
- Address Family Translator (AFT) does this

Island Connectivity Requirements (4)

Local IPv6-to-Remote IPv4 in VPN



- SP offering classic IPv4 VPN service to enterprise that now wishes to add a new IPv6 VPN site
- SP can perform AFT function in the cloud so that local IPv6 island can talk with remote IPv4 islands within the same VPN (and vice-versa)

Business - Costs

- The largest cost for most network managers will be training.

It is packet based, and starts with the letters IP, but other than that it is a different protocol.

- Another major cost will be retooling custom apps and scripts.

Frequent coding shortcuts assume an address will always be 32 bits.

- Is IPv6 deployment an opportunity to integrate other engineering changes that have not been large enough to justify by themselves?

What costs will be attributed to IPv6 vs. general evolution?

Timing - Evolution or Revolution??

- Integrate dual-stack and tunneling as appropriate within the existing network.

Minimize expense by multiplexing protocols where possible, and/or running one over the other when necessary.

- Greenfield deployment of new services on IPv6-only network.

Completely isolated network ensures no disruption to existing revenue stream. Potentially complications from managing two networks.

- Use CGN to raise the customer cost for IPv4.

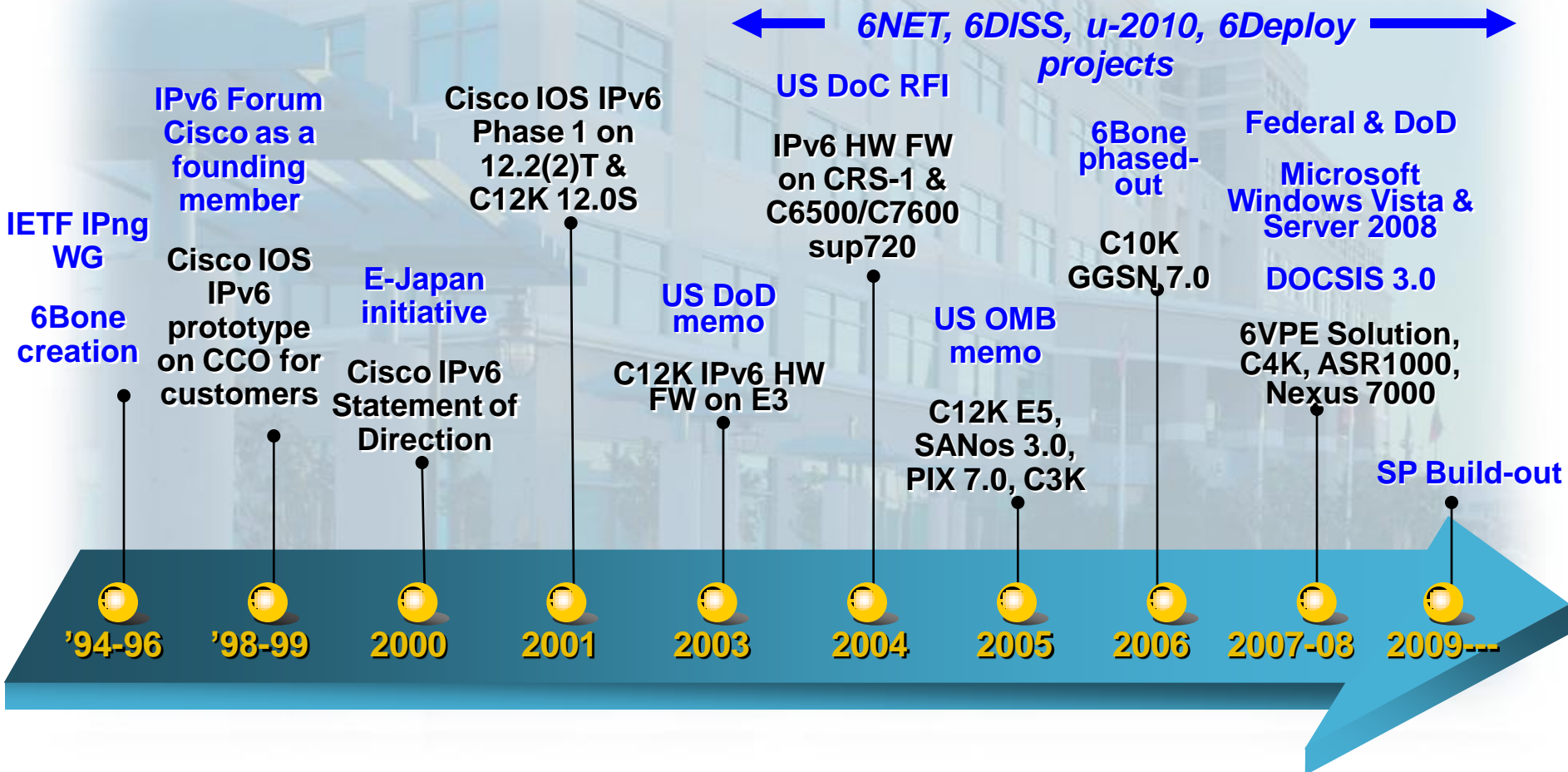
Deploy CGN to break everything except simple e-mail / web, or client/server on IPv4. Offer native IPv6 alongside at the base price, then charge extra to restore the IPv4 path using a public address for those that want advanced applications without moving to IPv6.

IPv6 Deployment Plan Example

- Train the architects
 - Protocol differences create an operational experience vacuum
- Develop addressing plan
 - use the initial /32 for infrastructure ; get a real block for customers
 - customer prefix delegation on nibble boundary to align with ptr authority
- Enable core & PE routers
 - dual-stack, with tunneling where necessary to align with life-cycle
- Enable support services
 - dual-stack the servers, populate DNS AAAA, configure AAA, deploy management and monitoring tools
- Establish peering
 - encourage content sites to deploy to minimize the need for IPv4/IPv6 nat
- Enable customers
 - tunnel over legacy distribution media where necessary

Cisco IPv6 History

Scaling the Internet for our Future Generations



← Cisco Leadership: IETF IPv6, NGtrans, DHCP, MIPv6, v6Ops co-chairs →

Cisco IOS IPv6 Status

<u>Positioning</u>	<u>Cisco IOS Release</u>	<u>Notes</u>
General Production	12.3 – 12.4	CY08
Technology development	12.2T – 12.3T – 12.4T – Next	CY09
Core	12.0S – 12K, 10720	Feb 2002
	IOS-XR – CRS-1, 12K	May 2004
Edge & Enterprise Infrastructure	12.2SB – 7304, 10000 12.2SR – 7600, 7200, ASR1000	12.2SRC for 7200 support IOS-XE on ASR1000 gets subset of 12.2SR feature set
L3 switches	12.2SX – 6500 12.2SG – 4500 12.2SE – 3750/3560	Initially 12.2SX also supported 7600

http://www.cisco.com/en/US/technologies/collateral/tk648/tk872/tk373/technologies_white_paper_09186a00802219bc.html

Industry's Broadest Platform Support



Cisco IOS 12.0S

Cisco 12000 Series Routers

Cisco 10720 Series

Cisco IOS 12.4/12.4T

Cisco 800 Series Routers

Cisco 1700 Series Routers

Cisco 1800 Series Routers

Cisco 2600 Series Routers

Cisco 2800 Series Routers

Cisco 3600 Series Routers

Cisco 3700 Series Routers

Cisco 3800 Series Routers

Cisco 7200 Series Routers

Cisco 7301 Series Routers

Cisco 7500 Series Routers (EoL)

Cisco IOS-XR

CRS-1, Cisco 12000

Cisco IOS 12.2S family

Cisco ASR1000 series

Cisco 72/7300 Series Routers

Cisco 75/7600 Series Routers

Cisco 10000 Series Routers

Catalyst 3750/3560/2960 Series

Catalyst 4500 Series

Catalyst 6500 Series

Cisco Product Portfolio

ASA Firewall (8.x), FWSM 4.0,

LMS 2.5, CNR 7.0, NFC 5.x, NAM 3.x,

MDS9500 series, Nexus 7000, GGSN 8.0

Cisco IOS – IPv6 Feature Overview

Security

IPv6 std, extended, reflexive & enhanced extended ACL, IPsec AH parsing
IPv6 IPsec – OSPFv3 authentication, site-to-site tunnel, DMVPN
IPv6 Firewall

Integration

Configured & Automatic Tunnels (RFC 2893)
6to4 (RFC 3056 & 3068)
IPv6 over GRE/IPv4 (Pr. SW)
IPv6 over MPLS (6PE)
IPv6 VPN over MPLS (6VPE)
ISATAP
NAT-PT (RFC 2765 & 2766)
IP over IPv6 Tunnels

Routing

RIPng
OSPFv3
IS-IS & MT IS-IS for IPv6
EIGRP for IPv6
MP-BGP IPv6 Unicast
MP-BGP IPv6 Multicast
Policy Based Routing

Core

IPv6 (RFC 2460)
ICMPv6 (RFC 2463)
Neighbor Discovery (RFC 2461)
Stateless Auto-Configuration
Anycast
CEFv6/dCEFv6
uRPF Strict & Loose Mode
CEFv6 Switched Tunnels
HSRP & GLBP for IPv6
Default Router Selection

**Cisco IOS
Software
Release 12.4(20)T**

Applications & Mgmt

Telnet, TFTP, DNS resolver, HTTP, Ping, Traceroute, SSH, NTPv4
Cisco IP & IP-Forwarding MIBs
Flexible Netflow for IPv6
SNMP over IPv6
Syslog over IPv6
CNS Agents, Config logger, Netconf, SOAP, TCL

Broadband Access

Cisco VSA AAA
Radius AAA (RFC 3162)
PPPoA, PPPoE, RBE and ATM 1483 encapsulations
DHCPv6 Prefix Delegation (RFC3633), DHCPv6 Relay
Stateless DHCP (RFC 3646)
Generic Prefix

Multicast

MLDv1, v2, Access Group
PIMv2 SM, SSM, Bi-Dir
PIM Embedded RP
IPv6 MC over IPv4 tunnels
Scope Boundaries
Static mRoutes
BSR

IPv6 QoS (MQC)

Mobile IPv6

MIPv6 Home Agent
Lite Authentication
NEMO

Cisco IPv6 compliance

- Conformance tests + Interoperability tests

 - IPv6 Ready Logo – www.ipv6ready.org

 - US DoD JITC conformance - <http://jitc.fhu.disa.mil/apl/ipv6.html>

 - Cable Labs DOCSIS 3.0 conformance

 - Microsoft Vista/Server 2008 interoperability – *Vista logo*

- Cisco IOS Release certification

 - Cisco IOS 12.4(11)T, C7600, C6500, C4500, IOS Firewall achieved JITC certification

 - Cisco IOS 12.3, 12.3T, 12.2SX, 12.0S and XR (3.2) are compliant with the IPv6 Ready Logo Phase I

 - Cisco IOS 12.4(9)T is compliant with IPv6 Ready Logo Phase II core specs

 - DOCSIS 3.0 Bronze qualified

 - Effort ongoing to have Catalyst product applying for Logo Phase II



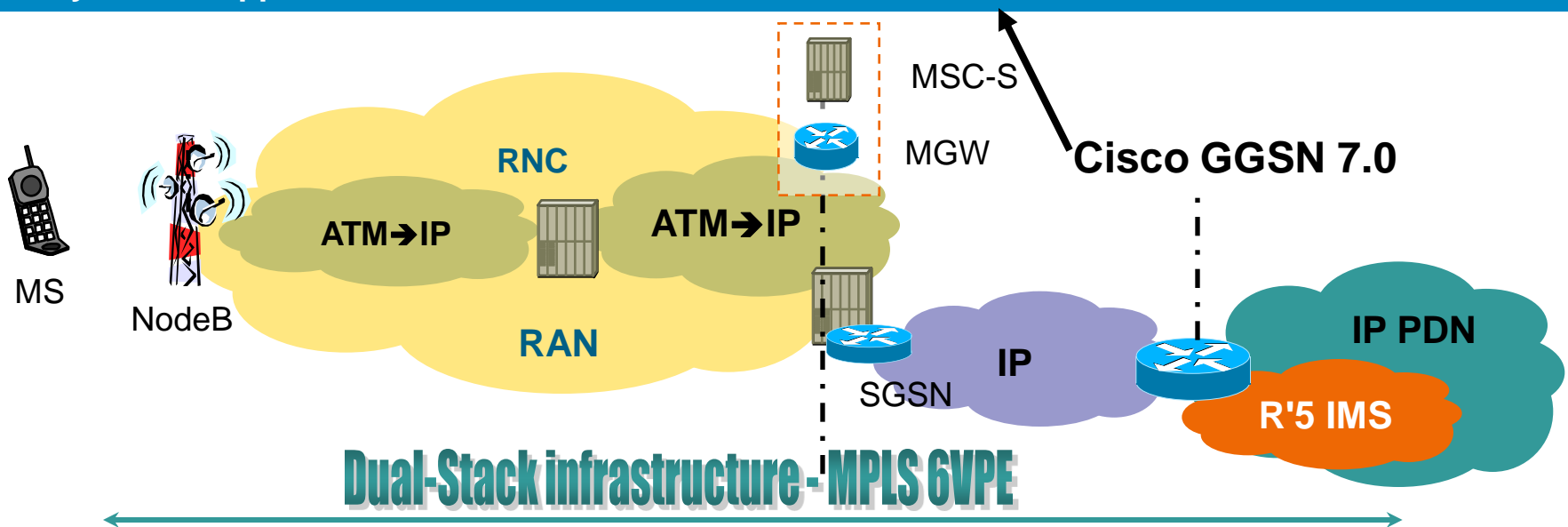
High Capacity IPv6 Platforms

- **Cisco CRS-1**
OC-768, OC-48, 10GE and GE line cards
- **Cisco 12000 series**
Internet Service Engine 3 – up to 3.8Mpps per LC
Internet Service Engine 5 – Up to 16Mpps per LC
- **Cisco 10000 PRE2/PRE3/PRE4**
- **Cisco ASR 1000 series**
- **Cisco 7600 and Catalyst 6500 series**
Sup. Engine 720, 720-3BXL, 32W, 32/PISA,
RSP720 – up to 200Mpps (EANTC report)
IPv6 tunneling—Configured, Automatic, 6to4 and
ISATAP tunnels in hardware
- **Nexus 7000 series, MDS 9500 series**
- **Catalyst 4500 series**
Supervisor Engine 6E
- **Catalyst 3750/3560 & 3750E/3560E series**

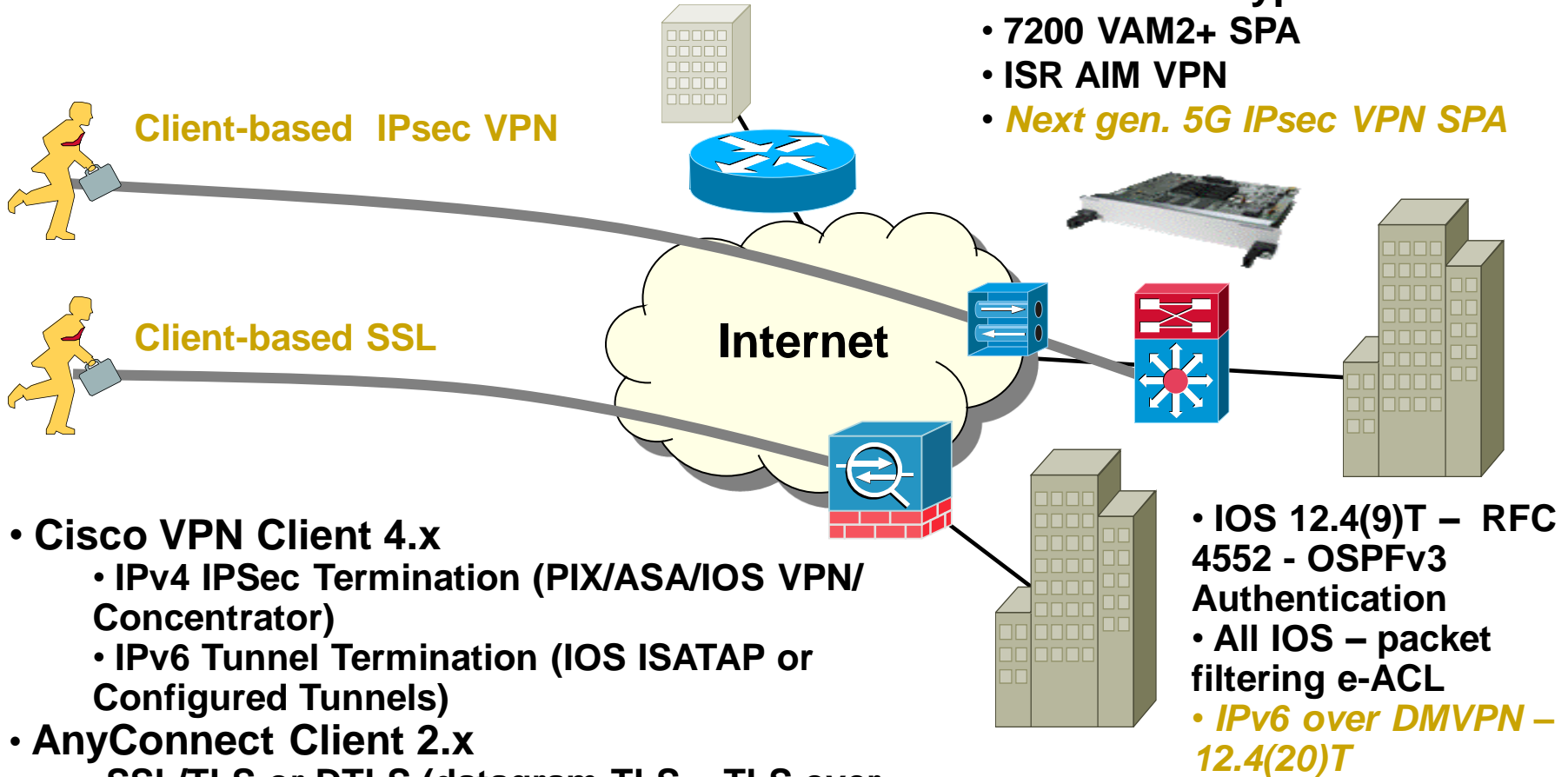


IPv6 Solutions for Mobile

- IPv6 GTPv0 and GTPv1 PDP establishment via IPv6 stateless autoconfiguration.
- IPv6 prefix allocation from a locally configured 64-bit prefix pool.
- The GGSN sends RAs and answers router solicitation messages from MSs.
- IPv6 G-CDR generation.
- Dual-stack APN (both IPv4 or IPv6 PDPs supported simultaneously).
- IPv6 DNS address configuration per APN for IPv6 DNS address allocation if requested.
- RADIUS authentication, accounting, and IPv6 address allocation from RADIUS server.
- Per-APN RA timers. These timers includes the RA interval and life time intervals, and the initial interval before sending the first RA.
- Standard and extended ACL support for IPv6 APNs
- GPRS-specific security features (address verification and mobile-to-mobile traffic redirection features).
- QoS (marking and call admission control).
- Proxy-CSCF support for IPv6 servers.



Cisco IPv6 Security



IPv6 IPsec Tunnels

- IOS 12.4(4)T

IPv6 HW Encryption

- 7200 VAM2+ SPA
- ISR AIM VPN
- *Next gen. 5G IPsec VPN SPA*

- **Cisco VPN Client 4.x**
 - IPv4 IPsec Termination (PIX/ASA/IOS VPN/ Concentrator)
 - IPv6 Tunnel Termination (IOS ISATAP or Configured Tunnels)
- **AnyConnect Client 2.x**
 - SSL/TLS or DTLS (datagram TLS = TLS over UDP)
 - Tunnel transports both IPv4 and IPv6 and the packets exit the tunnel at the hub ASA as native IPv4 and IPv6.

- IOS 12.4(9)T – RFC 4552 - OSPFv3 Authentication
- All IOS – packet filtering e-ACL
- *IPv6 over DMVPN – 12.4(20)T*

IPv6 Firewall

- IOS Firewall 12.3T, 12.4, 12.4T
- FWSM 4.x
- PIX 8.x, including ASA 5500 series
- *IDS in the future*

Network Management & IPv6

- In a dual-stack network, both IPv4 and IPv6 environments must be managed with the best optimization to decrease the cost of operations
- IPv6 impacts 3 areas of Network Management
 - Instrumentation (MIBs, Netflow record, IPv6 SLA,...)
 - Updated IP MIBs, RFC 4001 compliancy,...
 - Applications running over IPv6 (SNMP, TFTP, Syslog, Telnet, SSH, NTP, CNS Agents, Config logger, HTTP, Netconf, SOAP, TCL ...over IPv6)
 - NMS & Tools for IPv6
 - DNS/DHCP server (CNR 6.2), Netflow Collector 5.x, Ciscoworks LMS 2.5 (Topology, User Tracking,...), NAM

The Scope of IPv6 Deployment

Web Content Management

Applications & Application Suites

Data Center Servers

Client Access (PC's)

Printers

Collaboration Devices & Gateways

Sensors & Controllers

Networked Device Support

DNS & DHCP

Load Balancing & Content Switching

Security (Firewalls & IDS/IPS)

Content Distribution

Optimization (WAAS, SSL acceleration)

VPN Access

Networked Infrastructure Services

Deployment Scenario

IPv6 over IPv4 Tunnels (Configured, 6to4, ISATAP, GRE)

Dual-Stack

IPv6 over MPLS (6PE/6VPE)

IP Services (QoS, Multicast, Mobility, Translation)

Hardware Support

Connectivity

IP Addressing

Routing Protocols

Instrumentation

Basic Network Infrastructure

Staff Training and Operations

Roll-out Releases & Planning



Questions?

More Information

- CCO IPv6 - <http://www.cisco.com/ipv6>

- Cisco IPv6 Solutions

http://www.cisco.com/en/US/tech/tk872/technologies_white_paper09186a00802219bc.shtml

- Deployment guides

http://www.cisco.com/en/US/products/ps6553/products_data_sheets_list.html

- IPv6 Application Notes

http://www.cisco.com/warp/public/732/Tech/ipv6/ipv6_techdoc.shtml

- Cisco IOS IPv6 manuals

http://www.cisco.com/en/US/products/ps6441/products_configuration_guide_book09186a008049e1d7.html

Cisco Press Books

