Transforming the Wan Edge
Unified WAN Services & Cisco ASR 1000 Series Aggregation Services Router
New Business Challenges Leading to Infrastructure Challenges

- Operational complexity
- Demand on network
- Infrastructure cost

- Frequent network upgrades
- Time to deploy new services
- Secure and resilient network

Enterprise WAN—A Critical Part of Network Infrastructure
Enterprise WAN Challenges

Major CIO Objectives

- Service Levels
- Flexibility and business relevance
- IT operational expenses
- Client privacy and regulatory compliance
- Business productivity

Top IT WAN Careabouts *

- Higher performance and scalability
- Network resiliency—availability and security
- Service capabilities and quality
- Configuration flexibility and scalability
- Cost and complexity

*IDC WAN Survey Study, Jan 2008
WAN Edge Transformation

WAN Edge Functionalities
- WAN Services Aggregation
- Secure Internet Gateway
- Branch Concentration
- Bandwidth/Traffic management
- Metro Ethernet Services

WAN Edge Challenges
- Bandwidth requirements
- Device interoperability
- Configuration complexity
- Incremental services cost
- Operational complexity and cost

Remote Worker
Partner
Mobile
Internet
Private Line/MPLS VPN
WAN Router
WAN Edge Functionalities
L2 Box-Box Redundancy (HSRP)
Campus/Data Center
VPN Termination
Unified WAN Services Framework for the Next Generation WAN

High-Performance Services
- Anytime, everywhere access
- System scalability
- Embedded services

Operational Efficiency
Consolidation
Aggregation

Integrated Security
- Network Foundation Protection
- Unified Threat Management
- Encryption Services

Non-Stop Communications
- In-Service upgrade
- System redundancy
- Application availability

Application Intelligence
- Bandwidth management
- Application optimization
- Service-level intelligence
## Cisco: History of Innovation

### Getting Ahead of Market Trends

<table>
<thead>
<tr>
<th>Then</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1984</strong> Cisco founded by two people, developing the first mainstream IP router</td>
<td>Employees exceed 63,000</td>
</tr>
<tr>
<td><strong>1986</strong> Ships first router</td>
<td>More than 60 million routers shipped</td>
</tr>
<tr>
<td><strong>1995</strong> Cisco introduces 7200 series optimized WAN aggregation router</td>
<td>Shipped in excess of 350,000 units</td>
</tr>
<tr>
<td><strong>2001</strong> Cisco introduces 7600 series, establishing Carrier Ethernet</td>
<td>More than 50,000 shipped, $1B annual run rate</td>
</tr>
<tr>
<td><strong>2004</strong> CRS-1 introduced for core, declared overkill by some with predictions of no more than 50 ever needed</td>
<td>More than 1000 shipped in less than three years</td>
</tr>
<tr>
<td><strong>2004</strong> Integrated services router introduced for CPE</td>
<td>More than 2,000,000 shipped in first two years</td>
</tr>
<tr>
<td><strong>2008</strong></td>
<td><strong>Cisco Aggregation Services Router Series Introduced for Edge</strong></td>
</tr>
</tbody>
</table>

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Introducing...

Industry’s Most Powerful, Compact Aggregation Routers

Cisco ASR 1000 Series

Transforming and Extending the Network Edge
Cisco ASR 1000 Series
Powered by Cisco QuantumFlow Processor

Technical Benefits
- 40 independent processors
- 160 threads in parallel
- Services without penalty

Business Benefits
- High performance embedded services
- User/Application optimization
- Platform longevity

Massive Parallel Processing
Advanced Memory Management
Customized Quality of Service
Integrated Services and Programmability

World’s Most Advanced Piece of Networking Silicon
ASR 1000 Series Innovations
Cisco QuantumFlow Processor (QFP)

World’s Most Advanced Piece of Networking Silicon

<table>
<thead>
<tr>
<th>Performance</th>
<th>40Gbs Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale</td>
<td>Over 1.3 Billion Transistors</td>
</tr>
<tr>
<td>Availability</td>
<td>Customized QoS</td>
</tr>
<tr>
<td>Services</td>
<td>Integrated and Programmable</td>
</tr>
</tbody>
</table>

Instant-on Service Delivery
Low Touch Deployment
Faster Qualification
Future Ready Technology

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Cisco Routing Portfolio

- ISR Series
  - 7200/7300 Series
  - ASR 1000 Series
    - with ESP-5G
  - New
- ASR 1000 Series
- New
- ASR 1000 with ESP-10G

- Catalyst 6500 Series

- Cisco 10000 Series

- Cisco 12000 Series

- Cisco 7600 Series

Branch

Head Office / WAN Aggregation
# ASR 1000 Series Product Family

<table>
<thead>
<tr>
<th>SPA Slots</th>
<th>3-slot</th>
<th>8-slot</th>
<th>12-slot</th>
</tr>
</thead>
<tbody>
<tr>
<td># of ESP Slots</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td># of RP Slots</td>
<td>4</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td># of SIP Slots</td>
<td>Integrated (RP1)</td>
<td>Integrated (SIP10)</td>
<td>Integrated (SIP10)</td>
</tr>
<tr>
<td>IOS Redundancy</td>
<td>S/W</td>
<td>S/W</td>
<td>H/W</td>
</tr>
<tr>
<td>Built in GigE</td>
<td>3.5” (2RU)</td>
<td>7” (4RU)</td>
<td>10.5” (6RU)</td>
</tr>
<tr>
<td>Height</td>
<td>5-10 Gbps</td>
<td>10-40+ Gbps</td>
<td>10-40+ Gbps</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>Front to Back</td>
<td>Front to Back</td>
<td>Front to Back</td>
</tr>
<tr>
<td>Air Flow</td>
<td>470</td>
<td>765</td>
<td>1275</td>
</tr>
<tr>
<td>Power Supply (Watts)</td>
<td>4</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Numbering Convention

- SIP 2
- SIP 1
- SIP 0
- F1
- F0
- R1
- R0
- USB 0
- USB 1
- PWR 0
- PWR 1
- SPA 0
- SPA 1
- SPA 2
- SPA 3
# RP1 Faceplate & LED Indications

<table>
<thead>
<tr>
<th>LED</th>
<th>COLOR</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR</td>
<td>Green</td>
<td>All power rails are within spec</td>
</tr>
<tr>
<td>STAT</td>
<td>Green</td>
<td>IOS Booted</td>
</tr>
<tr>
<td></td>
<td>Yellow</td>
<td>Rommon Loaded</td>
</tr>
<tr>
<td></td>
<td>Red</td>
<td>System Failure</td>
</tr>
<tr>
<td>ACTV</td>
<td>Green</td>
<td>Active RP</td>
</tr>
<tr>
<td>STBY</td>
<td>Yellow</td>
<td>Standby RP</td>
</tr>
<tr>
<td>CRIT</td>
<td>Red</td>
<td>On @ powerup, turned off by IOS SW</td>
</tr>
<tr>
<td>MAJ</td>
<td>Red</td>
<td>Major alarm indicator</td>
</tr>
<tr>
<td>MIN</td>
<td>Amber</td>
<td>Minor alarm indicator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LED</th>
<th>COLOR</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD</td>
<td>Flashing Green</td>
<td>Activity Indicator. Off – No Activity</td>
</tr>
<tr>
<td>HDD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USB</td>
<td>Flashing Green</td>
<td>Activity Indicator. Off – No Activity</td>
</tr>
<tr>
<td>BF</td>
<td>Flashing Green</td>
<td>Activity Indicator. Off – No Activity</td>
</tr>
<tr>
<td>Link</td>
<td>Flashing Green</td>
<td>Activity Indicator. Off – No Activity</td>
</tr>
<tr>
<td>Mgmt Eth.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrier</td>
<td>Flashing Green</td>
<td>In Frame / Working. Off – No Activity</td>
</tr>
<tr>
<td>BITS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACO</td>
<td></td>
<td>Recessed Button to cut off Audible Alarm. This will get triggered when crit/maj/min LED is set.</td>
</tr>
</tbody>
</table>

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Cisco ASR1002 Router

- Integrated RP1 and SIP
- Exact same hardware features as RP1 module with following exception
  - 4GB DRAM by default
  - 8 GB eUSB for mass storage + NVRAM (2X32MB NVRAM)
- Support of modular ESP-5G and ESP-10G
- Built-in 4XGE ports (same as 4port GE SPA)
ASR 1006 Series Building Blocks

- **RP (Route Processor)**
  - Handles control plane traffic
  - Manages system

- **ESP (Embedded Services Processor)**
  - Handles forwarding plane traffic

- **SIP (SPA Interface Processor)**
  - SPAs provide interface connectivity

**Centralized Forwarding Architecture**
- Processes all traffic
- Standby is synchronized with all flow state with dedicated 10Gbps link

**Distributed Control Architecture**
- All major system components have a powerful control processor dedicated for control and management planes
ASR 1000 Route Processor

RP1

General Purpose CPU  1.5GHz

Memory

- DRAM: Default: 2 GB; Max: 4 GB
- 1GB of Internal Flash
  - For code storage, boot, config, logs, etc.
  - 2X32 MB of NVRAM are partitioned

Management Interfaces

- Ethernet management port, auxiliary port, console port

Storage

- Default: 40 GB Hard Disk Drive
  - 2X32 MB NVRAM are partitioned
- Option: 32 GB Solid State Drive (Post – FCS)
- For core dumps, failure capture, etc
- **External USB flash** for IOS configurations or File copying
ASR 1000 Embedded Services Processor

ESP-5G, ESP-10G

Cisco QFP engine
- Centralized forwarding engine
- Programmable providing full-packet processing

Cisco QFP Traffic Manager
- Packet buffering and queuing/scheduling
- For output traffic to carrier cards/SPA’s
- For special features such as input shaping, reassembly, replication, punt to RP, etc.

Interconnect providing data path links (ESI) to/from other cards over mid-plane
- Transports traffic into and out of QFP
- Input scheduler for allocating BW among links

ESP CPU managing QFP, crypto engine, mid-plane links, etc
# ASR 1000 ESP Generations

<table>
<thead>
<tr>
<th></th>
<th>ESP-5G</th>
<th>ESP-10G</th>
<th>ESP-20G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bandwidth</strong></td>
<td>5Gbps</td>
<td>10Gbps</td>
<td>20Gbps</td>
</tr>
<tr>
<td><strong>Based on</strong></td>
<td>QFP</td>
<td>QFP</td>
<td>QFP</td>
</tr>
<tr>
<td><strong># of Processors</strong></td>
<td>20</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td><strong>Clock Rate</strong></td>
<td>900 Mhz</td>
<td>900 Mhz</td>
<td>1.2 Ghz</td>
</tr>
<tr>
<td><strong>Crypto Engine BW</strong></td>
<td>~1Gbps</td>
<td>3Gbps</td>
<td>8Gbps</td>
</tr>
<tr>
<td><strong>QFP Memory</strong></td>
<td>256MB</td>
<td>512MB</td>
<td>1GB</td>
</tr>
<tr>
<td><strong>Packet Buffer</strong></td>
<td>64MB</td>
<td>128MB</td>
<td>256MB</td>
</tr>
<tr>
<td><strong>TCAM</strong></td>
<td>10MB</td>
<td>10MB</td>
<td>40MB</td>
</tr>
</tbody>
</table>
ASR 1000 System Bandwidth

- ESP bandwidth denotes the total ‘output’ bandwidth of the system, regardless of the direction
- High priority traffic (as long as it is not over-subscribed - Example: <=10G for ESP-10G) will not be affected by this bandwidth limit
- ESP-10G Examples:

1. **5G Unicast in each direction**
   - Total Output bandwidth 5+5=10

2. **5G Unicast in one direction & 6G Unicast in the other direction**
   - Total output bandwidth (5+6=11) exceeds 10G; Only 10G will go through

3. **1G Multicast with 8X replication in one direction**
   - 2G unicast in the other direction
   - Total Output bandwidth 8+2=10G

4. **1G Multicast with 10X replication in one direction**
   - 1G Unicast in the other direction
   - Total bandwidth (10+1=11) exceeds 10G; only 10G will go through
Cisco QuantumFlow Processor (QFP)

QFP Engine
Multi-Core (40) Packet Processor

QFP Traffic Manager

+ +

Quantum Flow Processor Software

1. Scale → 100s of resources & massive feature scale
2. Performance → Designed to deliver 5-40 Gbps (up to 10 Gbps at FCS)
3. Feature Velocity → Software designed to deliver a common forwarding plane for multiple systems
Data Packet Flow: Through ESP10

1. Packet arrives on QFP
2. Packet assigned to a PPE thread.
3. The PPE thread processes the packet in a feature chain similar to 12.2S IOS (very basic view of a v4 packet):
   A. **Input Features applied**
   - Netflow, MQC/NBAR Classify, FW, RPF, Mark/Police, NAT, WCCP etc.
   
   B. **Forwarding Decision is made**
   - IPv4 FIB, Load Balance, MPLS, MPLSoGRE, Multicast etc.
   
   C. **Output Features applied**
   - Netflow, FW, NAT, Crypto, MQC/NBAR Classify, Police/Mark etc.
   
   D. **Finished**

4. Packet released from on-chip memory to Traffic Manager (**Queued**)
5. The Traffic Manager schedules which traffic to send to which SIP interface (or RP or Crypto Chip) based on priority and what is configured in MQC
6. SIP can independently backpressure ESP via ESI control message to pace the packet transfer if overloaded.
ASR 1000 SPA Interface Processor
SIP-10G

Physical termination of SPA
Supports up to 4 SPAs
4 half-height
2 full-height
2 half-height+1 full-height
Full OIR support

Offers Ingress QoS
Ingress packet classification – high/low
Ingress over-subscription buffering (low priority) until ESP can service them

Captures stats on dropped packets
Distributes Network Clock to SPA’s
Manages Midplane links, SPA OIR, SPA drivers (via IOCP CPU)
Software Architecture – IOS XE

- IOS XE = IOS + IOS XE Middleware + Platform Software
- Operational Consistency - same look and feel as IOS Router
- IOS runs as its own Linux process for control plane (Routing, SNMP, CLI etc). Capable of 64bit operation.
- Linux kernel with multiple processes running in protected memory for
  - Fault containment
  - Re-startability
  - ISSU of individual SW packages
- ASR 1000 HA Innovations
  - Zero-packet-loss RP Failover
  - <50ms ESP Failover
  - “Software Redundancy”
ASR 1000 → Scalable IOS Services Delivered

ASR 1000 RESOURCES

**QFP Resources:**
- 1.5 GHz PowerPC CPU
- 2-4 GB SDRAM
- 1 GB eUSB Flash
- 32 MB NVRAM
- 40 GB HDD (non-critical ops)
- 10Gbps path to ESP used for network control and to scale features.

**ESP 10**
- QFP Resources:
  - 160 ~1Ghz Threads
  - 10Mbit TCAM, QOS
  - 512 MB (Flow DB)
  - 10Gbps Forwarding Capacity
- 800MHz PowerPC CPU
- 2 GB SDRAM
- 8 Core Crypto Engine

**SIP 10**
- SPA Resources:
  - 4 x 10Gbps SPA Bays
  - Ingress QOS & 128 MB ingress buffer
  - Egress Queue Status
- 800MHz PowerPC CPU
- 10Gbps dedicated datapath to ESP

**RP1**
- 10 Gbps (Data)
- GE Control Plane
- 10 Gbps (Data)
**ASR 1000 → Scalable IOS Services Delivered**

- IOS Services are integrated with Platform Adaptation Layer (PAL) and inbox HA infrastructure here.

- Adaptation Layer extends to ESP to incorporate all of the respective service databases used by the QFP. E.g. FW session state, Netflow caches, Voice terminations, IPsec SA DB …
- The QFP is fed and/or can build these databases on the fly while it is processing flows.
- Significant offload of RP resources (flow exports, logs)

- The SIP enhances operational efficiency of all services:
  - Oversubscription
  - SPA Drivers & ISSU
  - Optimal Link Utilizations
Unified WAN Services
Framework for the Next Generation WAN

High-Performance Services
- Anytime, everywhere access
- System Scalability
- Embedded Services

Integrated Security
- Network Foundation Protection
- Unified Threat Management
- Encryption Services

Non-Stop Communications
- In-Service Upgrade
- System Redundancy
- Application Availability

Application Intelligence
- Bandwidth Management
- Application Optimization
- Service-level Intelligence

Operational Efficiency
Consolidation
Aggregation
High Performance Services

Challenges
- Business agility
- Web2.0 & collaborative tools
- Accessibility vs. security
- Infrastructure costs

ASR Benefits
- Instant-on services
- Future-ready provisioning
- Wire-speed secure services
- Reduced IT OpEx and CapEx

Built-in, Instant-on, High Performance Features

![Graph showing Throughput in Gbps for Bandwidth, Firewall, NAT, GRE/Multicast]
Integrated Security

**Challenges**
- Security breaches, sophisticated attacks
- Security management, complexity
- Regulatory compliance
- Liability and reputation

**ASR Benefits**
- Instant-on highly available security services
- Tight integration of routing & security services
- Standards based, certified security services
- Auditable security services

**Built-in, Instant-on, Full WAN Protection Features**

**Network Foundation Protection:** Scalable Control Plane Policing, Full Netflow

**Access control:** Up to 10Gb Firewall Services

**Encryption services:** Up to 3.5Gb IPsec VPN encryption
# Application Intelligence

<table>
<thead>
<tr>
<th>Challenges</th>
<th>ASR Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Latency</td>
<td>Ensures mission-critical application performance</td>
</tr>
<tr>
<td>Misbehaving applications</td>
<td>Controls non-business applications</td>
</tr>
<tr>
<td>User and application visibility</td>
<td>Full-circle optimization: Monitor, classify, control</td>
</tr>
<tr>
<td>Regulatory Compliance</td>
<td>Meets compliance requirements</td>
</tr>
</tbody>
</table>

## Built-in, Instant-on, Application Intelligence Features

- **Application Intelligence**: Multi-Gigabit Deep Packet Inspection, Performance Routing
- **QoS services**: 128K queues with hierarchical QoS, Netflow
- **Traffic monitoring**: Scalable ERSPAN, Netflow event logging, Embedded Event Manager
Non-Stop Communications

Challenges
- Business responsiveness
- Network outages
- Investment Protection
- Operational Efficiency

ASR Benefits
- Rapid failover without service disruption
- In-service maintenance
- Reusable hardware
- Complete hardware, software redundancy

Key High-Availability Features
- Separate control and forwarding planes
- Redundant control and forwarding plane
- Redundant software on non-redundant hardware
- Modular IOS XE —re-startability, fault containment
- In-service upgradeable, reusable SPAs
**ASR 1000 → Unified WAN Services, Scalable & Secure**

**Solution Objective**
- Offer a full-service IPsec VPN Aggregation Router which scales to meet new BW demands of SP IP VPNs

**Solution Benefits**
- Consolidate a stack of 7200s into 1 ASR 1000
- Investment protected by smooth transitions to more Crypto Bandwidth as requirements change
- No service blades
- Optimized for QoS & Multicast

**ASR 1000 delivers… (IOS XE RLS2.1 First Customer Ship)**
- 1000s of Sites / 2-4K IPsec tunnels (up to 50tps)
- Up to 3 Gbps crypto BW + 7 Gbps non-crypto (FCS)
- 3DES/AES/SHA-1/IKEv1
- DMVPN Phase 2

**Managed FR / ATM (higher BW)**
Going to → Managed L2VPN / L3VPN

HQ / Regional HQ → Branch Offices
Full T1’s w/ satellite, DSL etc. backup
Going to multiples of Ethernet/DSL/Wireless…
**ASR 1000 → Zone-Policy Firewall**

**WAN Aggregation Head-end or Internet Gateway**

**Solution Objective**
- Being able to scale IOS FW in a router to multi-gigabit BW

**Solution Benefits**
- Multi-Gigabit IOS FW in a router
- IOS Firewall supported on all interfaces in the router
- No service blades required
- IOS ZPF uses CPL for: L4, L7 (HTTP, IM, P2P…), Self, URL Filter, DOS Params & more

**ASR 1000 delivers…(IOS XE RLS2.1-First Customer Ship)**
- ALL FW processing is done within QFP up to 5/10Gbps
- High-Speed Logging (40K/sec) via NetFlow v9
- 2 Mpps+ with all baseline services combined & FW enabled
Solution Objective
- Utilize expensive WAN more efficiently by minimizing amount of data and optimize TCP sessions transparently.

Solution Benefits
- Centralize more servers & storage
- Improve Large/Regional branch network responsiveness
- ASR 1000 can redirect traffic to Wide Area Application Engines (WAE) inline with IOS FW & QOS

ASR 1000 delivers… (IOS XE RLS2.2)
- L2 and GRE redirection performance expected to be in 8Mpps range
- Priority will be to offer as input feature first with both Hash & Mask based Load Balancing in QFP.
- Supports 256 Services
ASR 1000 → WAN Optimization → Measuring Performance

Solution Objective
- Offer a full service Path Optimized treatment of all WAN traffic

Solution Benefits
- Improve network performance
- Route around problems at first sign of (soft error) trouble
- Path Selection based upon Application requirements
- Business critical applications (ie: ERP, CRM, Oracle) & Voice over IP can enjoy dynamic optimization that is constantly being tracked.

ASR 1000 delivers … (IOS XE RLS 2.3)
- Tracks TCP Header to provide DLY/Loss/Reachability metrics for applications & Throughput for prefixes
- QFP has a huge flow cache & NBAR classification capability that can be leveraged by PFR (2M).
- Able to optimize Private and Public WANs (IPsec) w/o Service Blades
Solution Objective
• Interface with existing and next generation Enterprise, ASP & SP provided Voice and Multimedia services.

Solution Benefits
• ASR 1000’s shown provide for a gateway from/to other media terminations (e.g. IP phone call) in other domains:
  • Signaling and Data Border Controllers (SBC)
  • Policy Enforcement
  • Accounting
  • Trans-coding
• Flexible Deployment Models
  • This same device supports data, voice and video
• Aligns with several key industry architectures:
  • Cisco Unified Communications

ASR 1000 next gen voice + multimedia deployments targeted for CY2009
Summary

Cisco transforms and extends the Enterprise WAN & SP Edge

Cisco ASR 1000 Series Routers deliver instant-on, secure, and reliable services

Cisco ASR 1000 Series simplifies operation and delivers increased return on investment

Cisco ASR 1000 Series is part of Cisco TMP + and bundle availability is scheduled for Q2CY08

ASR 1000 Series Routers Services .. without compromise or complexity