TOMORROW starts here.

Cisco Connect
Praha, Česká republika
24.–25. 3. 2015
Intelligent WAN 2.0 principles and components and Cisco ISR 4000

Introduction

Tech-WAN

Jaromír Pilař
Consulting Systems Engineer, CCIE #2910
## Disruptions Driving Innovation at the Branch
Cloud, Mobility, and Next-Generation Apps

Are you meeting your business and user expectations?

### Application Delivery
Public, private, hybrid clouds are redefining the data center

### Application Consumption
Mobility is redefining network architecture

### Next-Generation Applications
HD video, immersive web apps, and SaaS are consuming more bandwidth
Intelligent WAN: Leveraging the Any Transport
Secure WAN Transport and Internet Access

- Secure **WAN transport** for private and virtual private cloud access
- Leverage **local Internet** path for public cloud and Internet access

- Increased **WAN transport** capacity and cost effectively
- Improve application performance (right flows to right places)
Intelligent WAN: Leveraging the Any Transport

So what is new here?

- Internet as WAN with High Reliability
- SLAs for Business-Critical Applications
- Centralized Security Policy for Internet Access
- Dramatically Lower WAN Costs Without Compromise
Intelligent WAN Solution Components

Transport Independent
- Consistent operational model
- Simple provider migrations
- Scalable and modular design
- DMVPN IPsec overlay design

Intelligent Path Control
- Application best path based on delay, loss, jitter, path preference
- Load balancing for full utilization of all bandwidth
- Improved network availability
- Performance Routing (PfR)

Application Optimization
- AVC: Application monitoring with Application Visibility and Control
- Per-tunnel Hierarchical QoS
- WAAS: Application Acceleration and bandwidth savings
- WAAS: Intelligent Edge Caching with Akamai Connect

Secure Connectivity
- Certified strong encryption
- Comprehensive threat defense with ASA and IOS firewall/IPS
- Cloud Web Security (CWS) for scalable secure direct Internet access
Intelligent WAN Deployment Models

**Dual MPLS**
- Highest SLA guarantees
- Tightly coupled to SP
- Expensive

**Hybrid**
- More BW for key applications
- Balanced SLA guarantees
- Moderately priced

**Dual Internet**
- Best price/performance
- Most SP flexibility
- Enterprise responsible for SLAs

Consistent VPN Overlay Enables Security Across Transition
Intelligent WAN: An Architectural and Systems Approach

- IWAN is a Solution Architecture
  - Solves a network problem
  - Use Case Driven
  - Systems Development Approach
- Prescribed. Tested. Interoperable.
  - Bounded Scope and Complexity
  - Enables Automation and Quality
- Delivers Business Outcomes
  - Reduce WAN costs. Increase bandwidth
  - Improve and Protect application performance
  - Direct Internet Access
  - Guest Access Offload
  - IT Simplification (Cost reduction)
# Intelligent WAN Architecture - Evolution

<table>
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<tr>
<th>IWAN 1.0</th>
<th>IWAN 2.0 Automation</th>
</tr>
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<tr>
<td>Domain Scale</td>
<td>Large Scale (2000 Branches)</td>
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<td>Transport Independence</td>
<td>VPN Scalability (DMVPN Phase 3) User Aware Transport (SGT Transport)</td>
</tr>
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<td>Intelligent Path Control</td>
<td>Simplified Path Control – PfRv3 (Centralized Provisioning, Large Scale)</td>
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<td>Application Optimization</td>
<td>Adaptive AVC (Performance Optimization) Internet QoS Mgmt (Adaptive Shaping, Local PFA) Akamai Connect</td>
</tr>
<tr>
<td>Secure Connectivity</td>
<td>Key Management Automation (PKI Certificate/Trust Automation)</td>
</tr>
</tbody>
</table>

IWAN 1.0
- Intelligent Virtualization
- IWAN 2.0
- Automation
- Evolution
Transport Independent Design
Simplifying Internet-Based WANs
Flexible Secure WAN Design Over Any Transport
Dynamic Multipoint VPN (DMVPN)

**Transport-Independent**

**Simplifies WAN Design**
- Easy multi-homing over any carrier service offering
- Single routing control plane with minimal peering to the provider

**Flexible**

**Dynamic Full-Meshed Connectivity**
- Consistent design over all transports
- Automatic site-to-site IPsec tunnels
- Zero-touch hub configuration for new spokes

**Secure**

**Proven Robust Security**
- Certified crypto and firewall for compliance
- Scalable design with high-performance cryptography in hardware

---

**Transport**
- Independent

**Data Center**
- Branch
- ISR-G2/4xxx
- MPLS
- Internet
- ASR 1000
- ASR 1000
- Data Center
Hybrid WAN Designs
Traditional and IWAN

Active/Standby WAN Paths
Primary With Backup

Two IPsec Technologies
GETVPN/MPLS
DMVPN/Internet

Two WAN Routing Domains
MPLS: eBGP or Static
Internet: iBGP, EIGRP or OSPF
Route Redistribution
Route Filtering Loop Prevention

Active/Active WAN Paths

One IPsec Overlay
DMVPN

One WAN Routing Domain
iBGP, EIGRP, or OSPF
Over-the-Top WAN Design with Dynamic Multipoint VPN (DMVPN)

- Branch spoke sites establish an IPsec tunnel to and register with the hub site
- IP routing exchanges prefix information for each site
- BGP or EIGRP are typically used for scalability
- Only the WAN IP addresses need to be known by the WAN transport
- WAN interface IP address can be used for the tunnel source address
- Data traffic flows over the DMVPN tunnels
- When traffic flows between spoke sites, the hub assists the spokes to establish a site-to-site tunnel
- Per-tunnel QOS is applied to prevent hub site oversubscription to spoke sites
Best Practice – VRF-aware DMVPN
Keeping the Default Routes in Separate VRFs

- Different default routes possible within global table and towards SP infrastructure
- Configuration towards SP simplified, allows for simple swap

```cisco
ip vrf FVRF
    rd 100:1
    !
crypto keyring DMVPN vrf FVRF
    pre-shared-key address 0.0.0.0 0.0.0.0
cipher cisco123
    !
Interface Tunnel0
    ip address 172.50.1.1 255.255.255.0
    ip nhrp authentication HBfR3pl
    ip nhrp map multicast 3.3.3.3
    ip nhrp map 172.50.1.254 3.3.3.3
    ip nhrp network-id 1
    ip nhrp nhs 172.50.1.254
    ip nhrp shortcut
tunnel source GigabitEthernet0/0
tunnel mode gre multipoint
tunnel vrf FVRF
tunnel protection ipsec profile dmvpn
    !
Interface GigabitEthernet 0/0
description WAN interface to ISP in vrf
    ip address dhcp
    ip vrf forwarding FVRF
    !
Interface GigabitEthernet 0/1
description LAN interface In Global Table
```

Customer routing context (Global table)
- FVRF SP1 (SP1 routing context)
- FVRF SP2 (SP2 routing context)
Intelligent Path Control
Improving Application Delivery and WAN Efficiency
“Performance Routing (PfR) provides additional intelligence to classic routing technologies to track the performance of, or verify the quality of, a path between two devices over a Wide Area Networking (WAN) infrastructure to determine the best egress or ingress path for application traffic.”

- Cisco IOS technology
- Two components: Master controller and border router
PfR Enhances Classical Routing

**Classical**
- Topological state
- Least cost path
- Static user preference
- Path cost
- Interface state

Responds To:
- Link and node state changes (up/down)

**PfR**
- Application-aware
- Policy controlled
- Measured performance
- Delay
- Jitter
- Bandwidth

Responds To:
- Measured performance changes (degradation)
Intelligent Path Control with PfR
Enterprise Use-Case

- PfR monitors network performance and routes applications based on application performance policies.
- PfR load balances traffic based upon link utilization levels to efficiently utilize all available WAN bandwidth.

Voice, video and critical applications take the best delay, jitter, and/or loss path.

Other traffic is load balanced to maximize bandwidth.

Voice, video and critical applications will be rerouted if the current path degrades below policy thresholds.
PfRv3 – How it Works

Define your Traffic Policy

Define path optimization policies on the Hub MC
- load balancing,
- path preference, application metrics

DSCP Based Policies
Application Based Policies

Learn the Traffic

Traffic flowing through the Border Routers (BRs) that match a policy are learned Traffic Classes

Unified Performance Monitor

Measurement

Report the measured TC performance metrics to the Master Controller for policy compliance

Unified Performance Monitor

Path Enforcement

Master Controller directs BR path changes to keep traffic within policy

Route Enforcement module in feature path
PfRv3 – Topologies

- Concept of Enterprise Domain
- MC on all sites – Distributed Model
- Hub MC vs Branch MC
- DSCP and Application Policies (NBAR2)
- IPv4 and IPv6 (not at FCS)
- VRF Aware
- MC controls local BRs only
- Optimize by:
  - Throughput, Delay, Jitter,
  - Packet Loss Rate, Byte Loss Rate
  - Additional Metrics (optional)
PfRv3 – Traffic Class (aggregation of flows)

- Works on Traffic Classes
- What is a Traffic Class (TC)?
  - Destination Site Prefix
  - DSCP value
  - Application Name
  - Application is unknown if DSCP based policies

<table>
<thead>
<tr>
<th>Prefix</th>
<th>DSCP</th>
<th>AppID</th>
<th>Dest Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.10.0/24</td>
<td>EF</td>
<td>N/A</td>
<td>Site10</td>
</tr>
<tr>
<td>10.1.10.0/24</td>
<td>AF31</td>
<td>N/A</td>
<td>Site 10</td>
</tr>
<tr>
<td>10.1.10.0/24</td>
<td>0</td>
<td>N/A</td>
<td>Site 10</td>
</tr>
<tr>
<td>10.1.11.0/24</td>
<td>AF31</td>
<td>Skype</td>
<td>Site 11</td>
</tr>
</tbody>
</table>
Distribution: Policy

• Single policy administration point per service
  Single Touch Provisioning
  – Domain policies are configured on the Hub MC.

• These policies are then distributed to branch MCs using the peering infrastructure.

• Pre-defined policies or custom policies
  – Voice
  – Real time video
  – Low latency data
  – Bulk Data
  – Best Effort
  – Scavenger
Distribution: Performance Monitors

- Unified Performance Monitors configured and activated in the background
  - No need for manual configuration

- Performance Monitors are defined automatically on the Hub MC.
  - These Monitors are then distributed to branch BRs using the domain infrastructure.

- Performance Monitors:
  - To learn site prefixes
  - To monitor bandwidth on egress
  - To monitor performance on ingress
Monitoring – Threshold Crossing Alerts (TCA)

• Performance record exported when there is a violation
  – Notifications generated from Performance Monitoring that attaches on BRs and Smart-Probing.

• Destination BR
  – Forwards the performance TCA notifications to the selected source MCs that actually generate the traffic crossing thresholds
  – Via multiple paths for reliable delivery.

• Source MC
  – Receive the TCA notifications from destination BR
  – Can make a policy decision
Path Enforcement – PfR Phase 3

- Route Enforcement module in feature path
  - Activated on all but External interface
  - Maintains a single database of traffic-class
  - Each traffic-class entry contains output interface and a nexthop ip address.

- Lookup per packet - output-if/next hop retrieved
  - Packet Forwarded
  - If no entry – Uses RIB entry
Application Optimization

Improving Application Performance and Bandwidth Utilization
Today’s Network is an IT Blind Spot

- Static port classification is no longer enough
- More and more apps are opaque
- Increasing use of encryption and obfuscation
- Application consists of multiple sessions (video, voice, data)
- What if user experience is not meeting business needs?

HTTP is the new TCP
Make Your IWAN Application Aware – Add Cisco AVC

Cisco AVC

No Probes
- Rich data collection using NetFlow v9/IPFIX
- No additional hardware (and included in AX license)
- Easy to integrate into many reporting tools

Smart Capacity Planning
- Better use of costly bandwidth
- Per-branch and per-application level reporting

Business Aligned Privacy Enforcement
- No need for complex IP and port ACLs
- See inside HTTP flows to identify specific Cloud applications

60% of IT Professionals Cite Performance as Key Challenge for Cloud
Leverage Deep Packet Inspection - NBAR2

- Provides Advanced Application Classification and Field Extraction capabilities
- In-service upgradable Protocol Definitions
  - No IOS upgrade or reboot for new Protocol Packs
- Backward compatibility to preserve existing NBAR investments
- NBAR2 Protocol List
Performance Collection & Exporting

**Integrated** performance monitoring and advanced metrics for different type of applications and use cases

**Advanced Monitoring**
- Voice and Video Performance (Media Monitoring)
  - 30% of traffic is voice and video
- Critical Applications Performance (Application Response Time)
  - 40% of traffic is critical applications

**Basic Monitoring**
- What applications, how much bandwidth, flow direction?
  - (NBAR2 and Flexible Netflow)

Images of various applications and tool logos are displayed, including Citrix, Oracle, Skype, MySQL, Google Talk, McAfee, webex, VOIP, BitTorrent, YouTube, Netflix, and Exchange.
Bandwidth Management Challenges – Degrading Application Experience in Non-SLA Environments

- **Available Link BW Can Change (Internet)**
  - Static Bandwidth Provisioning (QoS) not accurate
  - Shapers become inaccurate due to BW fluctuation
  - Cannot predict BW changes at configuration

- **Application & User Impact**
  - Applications tune based on static shape rate
  - Indiscriminate traffic drops - SAP instead of YouTube!!
  - New calls/flows admitted can degrade performance of existing ones

- **How can QoS improve user experience?**
IWAN Adaptive QoS
How Does It Work?

Adapt Sender shape rate based on the available bandwidth to Receiver

- Configure MQC Policy with Adaptive Shaping
- Collect Periodic bw Stats on received traffic
- Calculate Available Bandwidth over the WAN
- Adjust Egress Shaper to observed rate
Add WAN Optimization
Speed and Bandwidth Benefits on Top of the IWAN

Faster Applications, More Users, Less Bandwidth
- 90% HD Video optimization and better user experience
- Twice as many Citrix users over same WAN, 70% faster

Easy to Deploy
- Works with existing branch routers (and existing AX license)

Scalable
- AppNav Controller and WAVE pool is scalable
- Native HA capability
Cisco WAAS
Enhancing User Experience and WAN Efficiency

**Problem**
- Application latency
- WAN bandwidth inefficiencies

**Solution**
- **Reduce load**
  - Data redundancy elimination (DRE), compression, and TCP optimization
- **Application optimization**
  - Fewer protocol messages and metadata caching

- Application bandwidth natively
- Application bandwidth with Cisco® WAAS
- Application latency natively
- Application latency with Cisco WAAS

![Graph showing reduction in bandwidth and latency with Cisco WAAS](image-url)
Akamai Connect Caching & Prepositioning

Caches HTTP Content

Prepositioning of internet and Private cloud content, including dynamic URLs like YouTube

Cached & Prepositioned content improves application response time dramatically

Akamai Connect works over WAN and directly from the Internet

WAAS Optimization + Akamai Connect improves both Private and Public Cloud performance
Securing your Intelligent WAN
Secure Infrastructure and Direct Internet Access
Intelligent WAN: Secure Connectivity
Securing the network and users

Two areas of concern
- Protecting the network from outside threats with data privacy over provider networks
- Protecting user access to Public Cloud and Internet services; malware, privacy, phishing,…
Securing the IWAN Transport
IPSec VPN and Access Control

- **Step 1: Secure Transport**
  - IPSec with DMVPN overlay
  - Secure transport independent overlay
  - Add Strong Cryptography: IKEv2 + AES-GCM 256
  - F-VRF to isolate internal routing domain

- **Step 2: Access Control**
  - IOS Zone-based Firewall or ACLs
  - Minimize exposure
    - DHCP addressing for Internet and tunnel interfaces
    - Don’t put tunnel addresses into DNS

- **Step 3: Choose your performance level**
  - Size router based on Encryption with Services and WAN bandwidth
    - Head-end: ASR1000 or ISR4451X
    - Branch: ISR-G2 or ISR-4000
Add Network Integrated Threat Defense
IOS Zone-Based Firewall

- **Control the Perimeter:**
  - External and internal protection: internal network is no longer trusted
  - Protocol anomaly detection and stateful inspection

- **Communicate Securely:**
  - Call flow awareness (SIP, SCCP, H323)
  - Prevent DoS attacks

- **Flexible:**
  - Split Tunnel-Branch direct Internet access
  - Internal FW—addresses regulatory compliances

- **Integrated:**
  - No need for additional devices, expenses and power
  - Works with other IWAN Services: CWS, WAAS, UCS-E,…

- **Manageable:**
  - Supports CLI, SNMP, CCP, and CSM
  - Supports Cisco Configuration Engine
Securing IWAN Transports with Front-door VRF
Isolation of external networks

- Virtual Route Forwarding (VRFs) create multiple logical routers on a single device
  - Separate control/forwarding planes per VRF
  - No connectivity between VRFs by default
  - Provider side VRF (yellow) for external networks, Global VRF (blue) for internal networks

- Provider VRF minimizes threat exposure
  - Default routing only in Provider VRF
  - Provider assigned IP addressing hides internal network
  - Provider IP address used as IPSec tunnel source
  - Only IPsec allowed between internal Global and Provider Front Side VRFs
Protecting Public facing IWAN Interfaces

- Use ACLs, ZBFW or ASA to block all traffic except the DMVPN tunnel traffic to routers
- Zone Based Firewall (ZBFW) at the branch if there are plans for direct Internet access
- Typical ACL for protecting the Internet interface

```conf
interface GigabitEthernet0/0
  bandwidth 10000
  ip vrf forwarding INET-PUBLIC1
  ip address dhcp
  ip access-group ACL-INET-PUBLIC in
duplex auto

ip access-list extended ACL-INET-PUBLIC
permit udp any any eq non500-isakmp
permit udp any any eq isakmp
permit esp any any
permit udp any any eq bootpc
permit icmp any any echo
permit icmp any any echo-reply
permit icmp any any ttl-exceeded
permit icmp any any port-unreachable
permit udp any any gt 1023 ttl eq 1
```

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Intelligent WAN—Direct Internet Access

**Requirements**
- Leverage for Public Cloud and Internet access
- Improve application performance (right flows to right places)

**Solutions**
- On Premise – Zone Based Firewall
- Cloud Based – Cloud Web Security
Secure Internet Access with Cisco Cloud Web Security (CWS)

- **ISR Connector to CWS Firewall towers**
- **IOS Firewall to protect Internet Edge**
- **WAN1 (IP-VPN)**
- **WAN2 (Internet)**
- **Secure Public Cloud and Internet Access**
- **I WAN IPsec VPN for Private Cloud Traffic**
- **Web Filtering, Access Policy, Malware Detect**
- **CWS**
- **Private Cloud**
- **Public Cloud**
- **Internet**
IWAN Orchestration and Automation
Cisco IWAN Management

On-Prem Management

Prime Infrastructure 2.2

End-to-End Assurance of Application Experience

- Single-pane view of IWAN
- IWAN deployment workflows
- Plug and Play
- DMVPN, QoS, AVC deployment and monitoring
- PfR v3 in Q1 2015
- License includes IWAN App and APIC-EM controller!

Specialized Management

Application Aware Network Performance Management

- Integrates with Cisco AVC and PfR
- Monitor and analyze application traffic
- End-to-end flow visualization
- Flow & App-based Troubleshooting
- Fix and Verify in Realtime

Cloud-Based Management

Automates Deployment and Lifecycle Management

- Eliminates manual building of WANs
- Automated SD-WAN orchestration
- Centralized hybrid WAN management
- Quick config updates and IOS upgrades
- Leverages onePK and REST APIs
Prime Infrastructure 2.2 for IWAN

- IWAN workflow wizard with PnP
- Template-based IWAN configs
- PfRv3 Domain, MC and BR
- AVC One-Click provision
- QoS Provisioning
- Single or Dual Router Branch
- CVD-based, Customizable
- AVC Readiness Assessment
- AVC, QoS, PfR Visibility
- Leverages APIC EM services
IWAN Management with Application aware Network Performance Management + QoS Control

- Flow: End-to-End topology, flow and trace visualization
- QoS Configure: QoS/ACL graphical configurator, Customized policies with 25+ QoS templates, Apply policy to multiple devices with single click, CLI preview
- LAN: LAN path and Spanning Tree connections, Trunk and access bandwidth, Layer 2 QoS stats, VLAN filtering in topology view
- Routing: Topology view of active routes, Graphical Policy Based Routing, Trace path to destination with return route
- IP SLA: IP SLA topology view, IP SLA dashboard, Graphical IP SLA configurator, Support all IP SLA tests including Video Operations

See Visualize, Point Troubleshoot, Decision Making, Click Control, Deploy, Fix Improve
Glue Networks IWAN Orchestration

- Cloud-based SaaS subscription model
- Eliminates manual building of WANs
- Automated WAN orchestration and management
- Quick configuration updates and IOS upgrades
- Rapidly delivers nextgen and IWAN features
- Forward compatible with SDN and OnePK for app aware WANs
- Broadband and MPLS support for centralized hybrid WAN management for IWAN
Cisco IWAN Product Portfolio
Start with Cisco AX Routers
IWAN Capabilities Embedded in the Router

One Network
UNIFIED SERVICES

Simplify
Application
Delivery

Visibility

Control

Optimization

Transport
Independent
Secure
Routing

Cisco AX Routers 800 | 1900 | 2900 | 3900 | 4000 | ASR 1000
IWAN Branch Services Routers

**APPLIANCE LEVEL PERFORMANCE**
- Service-Aware Dataplane
- Resilient Service Virtualization
- Multi-gigabit Fabric

**APPLICATION CENTRIC**
- App/User policy-driven deployment
- APIC EM Automation: deploy in minutes
- Pay-as-you-grow
- Up-to-75% cost savings

**INTEGRATED IWAN SERVICES**
- IOS Firewall, VPN, IPSec, PfRV3, NBAR2, AVC, AppNav, VRF, MPLS
- Scalable on-chip service provisioning

### ISR Models
- **ISR4451**: 1-2Gbps
- **ISR4431**: 500Mbps/1Gbps
- **ISR 4351**: 200/400Mbps
- **ISR 4331**: 100/300Mbps
- **ISR4321**: 50/100Mbps

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IWAN Aggregation Border Routers

**COMPACT, POWERFUL ROUTER**
- Line-rate performance 2.5G to 200G+ with services enabled
- Crypto performance from 2G to 60G+
- Flexible I/O: SPAs and Ethernet LCs

**BUSINESS-CRITICAL RESILIENCY**
- Separate control and data planes
- Hardware and software redundancy
- In-service software upgrades

**INTEGRATED IWAN SERVICES**
- IOS Firewall, VPN, IPSec, PfRV3, NBAR2, AVC, AppNav, VRF, MPLS
- Scalable on-chip service provisioning

**ASR1001-X**
- 2.5G Upgradeable to 5G, 10G, 20G
- Up to 8G Crypto Throughput

**Modular ASR1006**
- Modular, Redundant up to 200G
- Up to 60G Crypto Throughput

**ASR1002-X**
- 5G Upgradeable to 10G, 20G, 36G
- Up to 4G Crypto Throughput
ISR 4000 Introduction
Cisco Branch Router Evolution

- **Cisco 2500**
  - Cisco’s first family of branch routers for 23 different deployments

- **Cisco 2600**
  - Superseded 2500. Considered one of Cisco’s premier products.

- **ISR G1 family 1800, 2800, 3800**
  - The first architecture custom designed for integrated services

- **ISR G2 family 800, 1900, 2900 & 3900**
  - Taking ISR G1 architecture to the next level

- **ISR 4451**
  - First ISR based on IOS XE

- **ISR 4431 & 4300 family**
  - Making a complete ISR 4000 family

- **ISR G2 family**
  - 800, 1900, 2900 & 3900
  - Taking ISR G1 architecture to the next level

- **2014**

- **2013**

- **2009**

- **2004**

- **1998**

- **1993**

- Not shown here: 700, 1600, 1700, 4000/4500, 3600 & 3700 series routers
Pay-As-You-Grow with Cisco ISR 4000 Series

Investment Protection Without oversubscription

4-10X Faster
Add performance and services anytime
Flexible consumption options

ISR 4321
50-100 Mbps
3x GE (dual+RJ)
2x NIM

ISR 4331
100-300 Mbps
3x GE (dual+RJ+SFP)
2x NIM
1x Enh SM

ISR 4351
200-400 Mbps
3x GE (all dual)
3x NIM
2x Enh SM

ISR 4431
500-1000 Mbps
4x GE (all dual)
3x NIM
2x Enh SM

ISR 4451
1-2Gbps
4x GE (all dual)
3x NIM
2x Enh SM
## ISR G2 and ISR 4000 Platform Pricing Overview

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Bandwidth</th>
<th>Price Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3945E</td>
<td>3RU</td>
<td>350 Mbps</td>
<td>$18,000 or $22,000-AX</td>
</tr>
<tr>
<td>3925E</td>
<td>3RU</td>
<td>250 Mbps</td>
<td>$15,000 or $19,000-AX</td>
</tr>
<tr>
<td>3945</td>
<td>3RU</td>
<td>150 Mbps</td>
<td>$13,000 or $17,000-AX</td>
</tr>
<tr>
<td>3925</td>
<td>3RU</td>
<td>100 Mbps</td>
<td>$9500 or $13,500-AX</td>
</tr>
<tr>
<td>2951</td>
<td>2RU</td>
<td>75 Mbps</td>
<td>$7500 or $10,200-AX</td>
</tr>
<tr>
<td>2921</td>
<td>2RU</td>
<td>50 Mbps</td>
<td>$3695 or $5295-AX</td>
</tr>
<tr>
<td>2911</td>
<td>2RU</td>
<td>35 Mbps</td>
<td>$2695 or $4295-AX</td>
</tr>
<tr>
<td>2901</td>
<td>1RU</td>
<td>25 Mbps</td>
<td>$1995 or $3595-AX</td>
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<tr>
<td>1941</td>
<td>2RU</td>
<td>25 Mbps</td>
<td>$1595 or $2995-AX</td>
</tr>
<tr>
<td>4451</td>
<td>2RU</td>
<td>1 or 2Gbps</td>
<td>$18,000 to $20,000-AX</td>
</tr>
<tr>
<td>4431</td>
<td>1RU</td>
<td>500 or 1000 Mbps</td>
<td>$11,000 to $13,000-AX or $16,000-AX or $18,000-AX</td>
</tr>
<tr>
<td>4351</td>
<td>2RU</td>
<td>200 or 400 Mbps</td>
<td>$8000 to $9500</td>
</tr>
<tr>
<td>4331</td>
<td>1RU</td>
<td>100 or 300 Mbps</td>
<td>$3300 to $4800</td>
</tr>
<tr>
<td>4321</td>
<td>1RU Desktop</td>
<td>50 or 100 Mbps</td>
<td>$1995 to $2995</td>
</tr>
<tr>
<td>AX:</td>
<td></td>
<td></td>
<td>$23,000 to $25,000</td>
</tr>
<tr>
<td>AX:</td>
<td></td>
<td></td>
<td>$11,000 to $13,000-AX or $16,000-AX or $18,000-AX</td>
</tr>
<tr>
<td>AX:</td>
<td></td>
<td></td>
<td>$12,000 to $13,500</td>
</tr>
<tr>
<td>AX:</td>
<td></td>
<td></td>
<td>$5,300 to $6,800</td>
</tr>
<tr>
<td>AX:</td>
<td></td>
<td></td>
<td>$3495 to $4495</td>
</tr>
</tbody>
</table>
Cisco ISR 4000 Family I/O Design

Management Interface
- out-of-band control plane
- connection directly to a management network

Front-Panel GE
- RJ45/SFP GE Interfaces
- PoE+ available on some models

Network Interface Modules (NIMs)
- Larger and more powerful than EHWICs
- Up to 8 ports per module
- DSPs directly on modules

Optional Drive NIM for Embedded Applications
- RAID 1 for data protection
- Single HD (future) and dual SSD options

USB Connections
- 2 times type A for file storage
- USB type B console in addition to RJ45 console and aux ports

Enhanced Service Modules
- Compatible with Cisco® ISR G2
- Up to 10-Gbps connection to system
- Faster and more powerful than SMs
## Cisco ISR 4451

### Entity | ISR 4451
--- | ---
CPU architecture | 4 core control/services 10 core data plane
Network Interface Modules | 3
Enhanced Service Modules | 2
Front-Panel Ethernet | 4 GE (all dual-phy RJ45 or SFP)
ISC slot | 1 for all ISC cards
USB type A ports | 2
Power | Dual internal AC or DC
Control/services memory | Base 4 GB; max 16 GB 1600 MHz DIMMs 2 DIMM slots
Mgmt Ethernet | 1 Gbps
## Cisco ISR 4431

### Entity | ISR 4431
--- | ---
CPU architecture | 4 core control/services 6 core data plane
Network Interface Modules | 3
Enhanced Service Modules | 0
Front-Panel Ethernet | 4 GE (all dual-phy RJ45 or SFP)
ISC slot | 1 for all ISC cards
USB type A ports | 2
Power | Dual internal AC or DC
Control/services memory | Base 4 GB; max 16 GB 1600 MHz DIMMs 2 DIMM slots
Mgmt Ethernet | 1 Gbps

**500 Mbps or 1 Gbps Performance**

**Migrate from Cisco® 3900 Series ISR**
## Cisco ISR 4351

### 200 Mbps or 400 Mbps Performance

### Migrate from Cisco® 2951 ISR

<table>
<thead>
<tr>
<th>Entity</th>
<th>ISR 4351</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU architecture</td>
<td>8-core CPU</td>
</tr>
<tr>
<td>Network Interface Modules</td>
<td>3</td>
</tr>
<tr>
<td>Enhanced Service Modules</td>
<td>2</td>
</tr>
<tr>
<td>Front-Panel Ethernet</td>
<td>3 GE (all dual phy RJ45 or SFP)</td>
</tr>
<tr>
<td>ISC slot</td>
<td>1 for all ISC cards</td>
</tr>
<tr>
<td>USB type A ports</td>
<td>2</td>
</tr>
<tr>
<td>Power</td>
<td>Single internal AC or DC</td>
</tr>
<tr>
<td>Control/services memory</td>
<td>Base 4 GB; max 16 GB 1600 MHz DIMMs 2 DIMM slots</td>
</tr>
<tr>
<td>Mgmt Ethernet</td>
<td>1 Gbps</td>
</tr>
</tbody>
</table>
# Cisco ISR 4331

100 Mbps or 300 Mbps Performance

Migrate from Cisco® 2911 or 2921 ISR

<table>
<thead>
<tr>
<th>Entity</th>
<th>ISR 4331</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU architecture</td>
<td>8-core CPU</td>
</tr>
<tr>
<td>Network Interface Modules</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced Service Modules</td>
<td>1</td>
</tr>
<tr>
<td>Front-Panel Ethernet</td>
<td>1 dual-phy (SFP or RJ45)</td>
</tr>
<tr>
<td></td>
<td>1 RJ45 only</td>
</tr>
<tr>
<td></td>
<td>1 SFP only (copper SFP supported)</td>
</tr>
<tr>
<td>ISC slot</td>
<td>1 for all ISC cards</td>
</tr>
<tr>
<td>USB type A ports</td>
<td>1</td>
</tr>
<tr>
<td>Power</td>
<td>1 internal AC</td>
</tr>
<tr>
<td>Control/services memory</td>
<td>Base 4 GB; max 16 GB</td>
</tr>
<tr>
<td></td>
<td>1333 MHz DIMMs 2 DIMM slots</td>
</tr>
<tr>
<td>Mgmt Ethernet</td>
<td>1 Gbps</td>
</tr>
</tbody>
</table>
**Cisco ISR 4321**

<table>
<thead>
<tr>
<th>Entity</th>
<th>ISR 4321</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU architecture</td>
<td>4-core CPU</td>
</tr>
<tr>
<td>Network Interface Modules</td>
<td>2</td>
</tr>
<tr>
<td>Enhanced Service Modules</td>
<td>0</td>
</tr>
<tr>
<td>Front-Panel Ethernet</td>
<td>2 GE (1 dual-phy, 1 RJ45 only)</td>
</tr>
<tr>
<td>ISC slot</td>
<td>1 for all ISC cards</td>
</tr>
<tr>
<td>USB type A ports</td>
<td>1</td>
</tr>
<tr>
<td>Power</td>
<td>1 external AC</td>
</tr>
<tr>
<td>Control/services memory</td>
<td>Base 4 GB; max 12 GB 1333 MHz DIMMs 2 DIMM slots</td>
</tr>
<tr>
<td>Mgmt Ethernet</td>
<td>1 Gbps</td>
</tr>
</tbody>
</table>

**50 Mbps or 100 Mbps Performance**

**Migrate from Cisco® 1941 or 2901 ISR**
## Cisco 4300 Comparison to 4400: Differences

<table>
<thead>
<tr>
<th>4400 Family Benefits</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Redundant power</td>
</tr>
<tr>
<td></td>
<td>Ability to physically separate control, services, and data plane CPU sockets</td>
</tr>
<tr>
<td></td>
<td>Additional service container capacity through faster CPUs</td>
</tr>
<tr>
<td></td>
<td>Higher throughput for base and performance licenses</td>
</tr>
</tbody>
</table>
ISR 4000 Architecture
Revolutionary Platform Architecture
Architected for the Optimal Application Experience

Pay as You Grow
Performance and services

Service-Aware Data Plane
For efficient traffic handling

Virtualized Services Framework
Appliance-level performance

Converged Branch with UCS® E-Series
Integrated compute
Up to 8 cores

Native L2-7 Services
Security, optimization

4-10 Times Faster Than ISR G2 at similar price

Powering the Intelligent WAN

Cisco ISR 4000

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ASIC-Like Experience with New Services
Appliance-Level Performance

Miercom Testing: Cisco® 4451 ISR

Enabling Technologies
- Multicore architecture
- Service-aware data plane
- Multigigabit fabric

Benefits
- Up to 10 times faster performance
- Scalability
- Layer 7 services
- Steady performance curve maintained with new additive services

Additive features and services
- 4451-X no-perf license
- 4451-X perf license
- Software-only router

Cisco ISR 4400 Series Architecture

Service containers live here

Control Plane (1 core) and services plane (3 cores)

Data Plane (6 or 10 cores)

IOSd

Multigigabit Fabric

FPGE

ISC

SM-X

NIM

KVM - Hypervisor

ISR-WAAS

Services Plane (Control Plane CPU)
Cisco ISR 4300 Series Architecture

- **IOSd**
- **Service Container**
- **ISR-WAAS**
  - KVM - Hypervisor
  - Services Plane (Control Plane CPU)
- **Data Plane Cores**
- **Multigigabit Fabric**
- **NIM**
- **FPGE**
- **ISC**
- **SM-X**

Note: 4321 uses 2DP, 1CP & 1SC cores
Service Integration
World’s Broadest Service Offerings in One Box
Simplified Services Integration

The Ultimate Converged Branch – No More Appliances

Native, Full Featured Security, AVC, WAN Opt, UC
Ease of Service Deployment – No Truck Rolls
Network, Compute, and Storage
Service Virtualization for Networking

Service Containers

- Dedicated virtualized compute resources
- CPU, disk, memory for each service
- Easily repurpose resources
- Industry-standard hypervisor

Benefits

- Better performing network services
- Ease of deployment with zero footprint; no truck roll
- Greater security through fault isolation
- High reliability
- Flexibility to upgrade network services independent of router IOS® Software
Modules
ISR G2 Module Compatibility

- ISR G2:
  - EHWIC
  - ISM
  - PVDM-3
  - SM
  - SM-X

- ISR 4000:
  - NIM
  - ISC
  - PVDM-4
  - SM-X (not backward-compatible)
  - SM-X (backward-compatible)
Connectivity Options

**Outside the office**
- **PSTN**
  - T1/E1
  - FXO, PRI
  - BRI (voice only, roadmap early 2015)

- **WAN/Internet**
  - T1/E1, T3/E3, serial
  - ADSL, VDSL, SHDSL (roadmap, June 2015)

- **Backup**
  - 3G/4G – By 819
  - 3G/4G built in (roadmap, June 2015)

**Inside the office**
- **Analog Voice**
  - FXS, E/M
  - SRST
  - CME

- **Ethernet / Switching**
  - SM 16/24/48 port switch module
  - SM routed ports (6xGE or 4xGE/1x10GE) CU/SFP module
  - NIM 4 and 8 port switch module (roadmap, June 2015)
  - NIM 1 and 2 port routed module (roadmap, June 2015)

- **Cisco UCS® E-Series**
  - 2, 4, 6 and 8-core Intel® Xeon® processors
  - Up to 3 TB storage and 48 GB DRAM

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UCS E-Series Portfolio – M2

- **Scalability**
  - **Cisco UCS-EN120S**
    - Service Module
    - VMware and Hyper-V Certified
    - Network Compute Applications – vWLC, vWAAS

- **Cisco UCS-E140S**
  - Service Module
  - VMware, Hyper-V, Citrix Certified
  - Intel E3 4 Core Processor
  - vWLC, vWAAS, Physical Security

- **Cisco UCS-E160D**
  - Service Module
  - VMware, Hyper-V, Citrix Certified
  - Intel E5 6 Core Processor
  - vWLC, vWAAS, Virtual Desktops, Physical Security

- **Cisco UCS-E180D**
  - Service Module
  - VMware, Hyper-V, Citrix Certified
  - Intel E5 8 Core Processor
  - vWLC, vWAAS, Virtual Desktops, Physical Security, Security applications

**Feature Richness**
Software and Management
Cisco 4000 Series
Packaging and License Model
Cisco ISR 4000 Series
Purpose-Built for the Ultimate Branch Application Experience

High Performance
For Optimal User Experience
- 4-10X faster
- Virtualized services

Greater Agility
For Better Business Outcomes
- Revolutionary architecture
- Innovative services
- Pay as you grow

IT Simplicity
Drive to Lowest TCO
- Automation / programmability
- App and user-centric policy
- All-in-one box

ISR 4321
(50-100 Gbps)
ISR 4331
(100-300 Mbps)
ISR 4351
(200-400 Mbps)
ISR 4431
(500-1000 Mbps)
ISR 4451
(1-2 Gbps)