Cisco CRS-3 (140G)

Foundation for the Next-Generation Internet

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Product Manager - CRBU
September 2010
Cisco CRS Platform
Accelerating Customer Momentum

Over 5500 units shipped
Over 350 customers globally within 6 years
Cisco Core and Edge Routing Portfolio Evolution and Positioning

Future

<table>
<thead>
<tr>
<th>CRS-1/3</th>
<th>ASR 9000</th>
<th>ASR 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASR 9000</td>
<td>ASR 1000</td>
</tr>
</tbody>
</table>

Today

- CRS-1
- Cisco 7600
- GSR / XR12K
- ASR 9000
- C10K ASR 1000

Services:
- Core
- Thin Core
- Peering
- E-MSE
- MSE
- CE
- Mobility
- Broadband
CRS Key Investments

- Evolving the Edge Architecture
- Scaling the Network with Multi-chassis
- Optimizing costs with IPoDWDM
- Scaling the core with 100GE
- Enabling the transition to IPv6
Architectural Differentiation w/ Multi-chassis
Driving Leadership Economies of Scale

5T Core Node Example

<table>
<thead>
<tr>
<th></th>
<th>CRS Multi-Chassis</th>
<th>'Mesh of Routers'</th>
</tr>
</thead>
<tbody>
<tr>
<td># Chassis</td>
<td>4LCC + 1FCC</td>
<td>14 Chassis</td>
</tr>
<tr>
<td># Ports required</td>
<td>256 – All usable</td>
<td>768 (256 Usable + 512 Interconnect)</td>
</tr>
<tr>
<td>Routing</td>
<td>Single Node</td>
<td>3 hops, 14 Adjacencies</td>
</tr>
<tr>
<td>Power</td>
<td></td>
<td>1.85x Higher</td>
</tr>
<tr>
<td>Cost per Usable Port</td>
<td>54% Reduction</td>
<td>Costly interconnect Ports</td>
</tr>
<tr>
<td>Traffic Management</td>
<td>None Required</td>
<td>Very Complex</td>
</tr>
</tbody>
</table>
CRS IPoDWDM
Seamless scale for your network

- Integrated Management or Separated Management
  - Provisioning of boxes, LCs & Connectivity
  - Visibility at Optical & IP layers
  - Trouble Shooting Optical & IP layers

- WDM PLIM (10G & 40G Lambdas)
  - Fully tunable
  - 50 GHz spacing
  - EFEC for >1000 km

- Optical bypass – without OEO conversion for lowest cost

- Innovative extensions to GMPLS
  - DWDM aware
  - Optical Auto Discovery
  - Fast restoration

- Open architecture to inter-operate with 3rd party DWDM systems
Visibility of router into transmission layer performance allows for superior protection compared to transponder based networks.
IPoDWDM Innovations
Virtual Transponder Management

- **Pioneering** feature: Virtual Transponder Protocol (VTXP)
  - Full FCAPS Management for Router WDM interfaces
  - Secure session between router and optical NE
  - Router reflected as a transponder shelf
  - WDM i/f reflected as a transponder
  - No change to NMS/OSS

- **Open standards** (XML) based interoperating with 3rd party MSTP

- Supported in XR 3.6.2 + CTC 9.0.1

**Flexible Management**
- Segmented: No change to existing NMS/OSS, operational models
- Integrated Management
CRS Product Family
Foundation for the IP NGN Core

Single Chassis to Multi-Chassis
- Single architecture from 320 Gbps to 92 Tbps (increasing 3x+ with CRS-3)
- Investment protection—common forwarding engines and I/O modules
- Flexible/programmable control and data plane to meet evolving service requirements
- Intelligent multicast support with fabric based multicast
- IOS-XR Fully modular OS w/ In-Service Software Upgrades
Cisco CRS Platform
Interface Breath

- Modular & Fixed Interfaces from DS3/E3 to OC768/STM256

## POS/DPT/RPR
- 4-Port OC-3/STM-1 POS SPA
- 8-Port OC-12c/STM-4 Multi-rate POS SPA
- 2-Port and 4 Port OC-48c/STM-16 POS SPA
- 1-Port OC-192/STM-64 POS/RPR SPA
- 16-Port OC-48c/STM-16c POS/DPT Interface Module
- 4-Port OC-192c/STM-64 POS/DPT Interface Module
- 1-Port OC-768c/STM-256c POS Interface Module

## Ethernet
- 10, 8, 5-Port Gigabit Ethernet SPA
- 1-Port 10 Gigabit Ethernet SPA
- 1-Port 10 Gigabit Ethernet WAN/LAN-PHY SPA
- 8-Port 10 Gigabit Ethernet Interface Module

## WDM (IPoDWDM)
- 4-Port 10GE Tunable WDMPHY Interface Module
- 1-Port OC-768c/STM-256c Tunable WDMPOS Interface
- 1-Port OC-768c/STM-256c Tunable WDMPOS Interface (DPSK+)

## ATM
- 3-Port OC3/STM-1 ATM SPA
- 1-Port OC12/STM-4 ATM SPA

## Copper and Channelized
- 4-Port, 2-Port T3/E3 Clear Channel SPA
- 1-Port Channelized OC-12/STM-4 to DS1 SPA

* Planned for future release
Scale with Investment Protection
Cross platform integration

Reduced Opex spares inventory across the Edge/Aggregation and Core network

Shared Port Adapters (SPA)

SPA Interface Processor (SIP)
Carrier Card
Cisco CRS System Architecture
Distributed Basics of the Architecture

FLEXIBLE FORWARDING PLANE
Up to 1152 Line Cards (Independent Forwarding)
Highly programmable SPP supporting Line Rate performance
Robust Queuing with 8K per ingress/egress

DISTRIBUTED CONTROL PLANE
Multiple control processors (minimum of 144 Processors)
Control SW distributed across all processors

MULTISTAGE SWITCH FABRIC
1296x1296 non-blocking buffered fabric
1:N Redundancy
Service Intelligence with hi/lo priority unicast/multicast recognition
CRS Multi-chassis Architectural Advantages

- Single & multi-chassis use same fabric architecture
  - Line cards (MSC), S1, S3 stages stay on LCC
  - S2 Stage moves to the FCC
  - Array Cables interconnect fabric stages
  - Non-blocking, Redundant fabric planes
  - Efficient QoS & Multicast in fabric

- Multi-chassis migration is hitless, can be done in services
  - S2 stage can be moved to FCC one plane at a time
  - LCC requires new fabric cards that have just the S1 & S3 stages

- 100G Capable
  - 100G MC backward compatible with 40G CRS-16 Chassis
  - In-service non-impacting upgrade to 100G (plane by plane)
Secure Domain Routing
Flexible, Scalable and Fault tolerant

- **Flexible configuration**
  LCs added to system can be dynamically assigned to any SDR
  DRPs and LCs can be dynamically reassigned to meet changing service & b/w needs

- **Scalable**
  Additional DRPs can be added - in service - to increase control plane scale of any SDR
  Up to 8 SDRs supported per (multi) chassis

- **Fault tolerant**
  Single-system simplicity, with multi-box fault and administrative isolation
  DRP pairings can be configured across chassis boundaries for increased redundancy
Why CRS-3?
What problems are we trying to address with CRS-3?

- Bandwidth and cost scaling in the core
  Link scaling with 100GE
  System scale with Multi-chassis
  Unit cost reduction with Ethernet interfaces and FP linecards
  Opex reduction with industry’s lowest power solution

- Integration with emerging Cloud Services
  Network positioning system for optimized traffic flow
  Cloud VPNs to integrate Cloud Computing with Enterprise VPN

- Service Evolution
  Pseudo-wire Head-end architecture for NG Edge
  mLDP for Label Switched Multicast
A Fundamental Change
The Future of Bandwidth

Result: Explosive Growth of IP Traffic
Video, Mobile and Cloud to Dominate Growth 2008–2013

2/3rd Zettabyte

525% Growth

Traffic Mix of Tomorrow Fundamentally Different

Source: Cisco Visual Networking Index—Forecast, 2008-2013
Revenue balance is shifting

**Traditional Services**
VPN, Hosted Services, Voice, Internet

**New Services**
IaaS, PaaS, SaaS
Content-aware
Mobile Internet
Rendering

Current models uncertain

Incremental Compute & Storage Services to trusted Voice/VPN

Tie Infrastructure to Real-Time Communication Services

End to End Service Assurance

Bandwidth on Demand for Traffic Spikes

Global reach with Local response times

IP NGN 2.0

Cloudware Networking

SPs must transition from today’s Uni-directional to a Multi-directional Traffic Model
Next-Generation Internet
Multi-directional Networking
Next-Generation Internet Attributes
Multi-directional Networking

What's Needed?

Scale
Respond to accelerating bandwidth requirements

Service Intelligence
Make IP NGN and DC/Cloud to work as one

Savings
Reduce CapEx and OpEx

Scale + DC/Cloud Services + Savings
Introducing CRS-3 = 3x CRS-1

Unmatched Scale
3x CRS-1 = CRS-3 = 322Tbps
Industry’s highest 10GE density

Unique Service Attributes
2x Intelligence (Core/IPv6 + Data Center/Cloud)

Unprecedented Savings
1x CRS Family Protecting Investments
Lowest power, rack-space

Foundation for the Next-Generation Internet
Scale
Scale with CRS-3

Policy Control Plane

Mobile

Portal Monitoring Billing Subscriber Database Identity Address Mgmt Policy Definition

Access

Residential

STB

Business

Corporate

DSL

ETT

PON

WIMAX

Aggregation

Ethernet MPLS

Distribution

Edge

MPLS/IP

National /International Peer

Regional Peer

Residential Corporate

STB

CRS-3

IP

Regional Peer

PSTN

CRS-3

Data Center

BSC RNC VOD TV SIP
Place in Network OS Requirements
Modular IOS-XR

- Real-Time Modular Micro-Kernel Architecture
- Distributed Processing
- Carrier-Class Non-Stop Operations
- High Scalability
- Separate Planes for Control, Management & Forwarding
- Usability Enhancements
Scaling with 100GE

IEEE 802 Plenary
San Francisco, CA, July 2009

Interfaces
- Packet over SONET/SDH (POS)
  - Capped at 40G
  - No 100G or beyond development
- Ethernet
  - Being standardized for High Speed Interfaces for LAN and WAN
  - 40GE & 100GE ratification: Jun 2010

Standards
- IEEE 802.3ba
  - Defining 40GbE, 100GbE; MAC/PHY (Layer 2) focused
- ITU Study Group 15 (SG15)
  - Mapping 40GbE, 100GbE into OTN; Transport (Layer 1) focused
- OIF
  - Defining 100GbE interop over 50Ghz optical channels, DWDM focused

Cisco leads standardization across all bodies: Mark Nowell, Mark Gustlin, Gary Nicholl, etc.
Cisco’s Plan for High Speed Interfaces

Why 100GE

- **Ethernet Ubiquity**
  - Serial WAN technology not being developed beyond 40Gbps
  - Ethernet no longer just for LAN
  - High industry cooperation amongst IEEE, ITU, OIF to develop 100GE

- **Link Aggregation Inefficiencies**
  - Core networks typically need 4x-10x highest speed user interface
  - Lower speed interface bundling scales poorly, management challenges

- **Infrastructure Consolidation**
  - Expense reduction with saving multiple links, platforms and inter-connects
  - Peering Points, Cloud infrastructure demanding significant bandwidth today
High Speed & Dense Interfaces

Place in the Network (PIN)

- Peering Edge
- Data Center
- Core
- Aggregation / Edge

- Dense 10GE Ethernet Peering
- Intra-POP 100GE
- DC – POP Interconnect 100GE
- End to end 100G solution with Cisco Routing & Optical Platforms
- Long Haul 100GE IPoDWDM
- Dense 10GE Aggregation

- 100GE PIN
  - Intra-POP
  - Long Haul
  - Data Center – POP
  - Aggregation Ethernet Peering
Unmatched Scale
CRS-3 Features

- **3.5x Capacity Upgrade**
  - From 40G/Slot to 140G/Slot in existing chassis, same power profile
  - In-service upgrade in all form-factors for operational ease
  - Dense 10GE, Standards-based 100GE modules

- **Video Leadership**
  - Built-in hardware video monitoring for rich experiences

- **Superior 100GE Implementation**
  - Single flow at Layer 3 (not 2x50)
  - Fully redundant config (no active-active fabric need)
Compare CRS-1 (Today) to CRS-3
The Industry’s Highest Performing/Most Robust Routing System

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Existing</th>
<th>CRS-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot Capacity</td>
<td>40G</td>
<td>140G</td>
</tr>
<tr>
<td>Logical Interface Scale</td>
<td>2,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Packet Per Second (for Ethernet)</td>
<td>60 Mpps</td>
<td>125 Mpps</td>
</tr>
<tr>
<td>QoS Scale</td>
<td>8,000 queues; 3 levels</td>
<td>64,000 queues; 3 levels</td>
</tr>
<tr>
<td>Prefix Scale</td>
<td>2M IPv4</td>
<td>3M+ IPv4</td>
</tr>
</tbody>
</table>

Greater than 3x capacity and capability upgrade for CRS-1 in the same power, space and cooling footprint
# System Attributes Comparison

<table>
<thead>
<tr>
<th></th>
<th>MSC40</th>
<th>MSC140</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bandwidth</strong></td>
<td>40 Gbps</td>
<td>140 Gbps</td>
</tr>
<tr>
<td><strong>Max Packet per second</strong></td>
<td>80 Mpps</td>
<td>125 Mpps</td>
</tr>
<tr>
<td><strong>FIB Scalability</strong></td>
<td>2M IPV4, 1M IPV6</td>
<td>4M IPV4, 2M IPV6</td>
</tr>
<tr>
<td><strong>BW Modes</strong></td>
<td>20/40 Gbps</td>
<td>40/140 Gbps</td>
</tr>
<tr>
<td><strong>Queues/Groups/Ports</strong></td>
<td>8k/2k/768</td>
<td>64k/16k/128</td>
</tr>
<tr>
<td><strong>Supported Fabric Cards</strong></td>
<td>40G and 140G fabric</td>
<td>140G fabric only</td>
</tr>
<tr>
<td><strong>PLIMs</strong></td>
<td>8 x 10GE</td>
<td>14 x 10GE</td>
</tr>
<tr>
<td></td>
<td>16xOC48, 4xOC192, 1xOC768</td>
<td>20 x 10GE (oversubscribed)</td>
</tr>
<tr>
<td></td>
<td>Modular 6 x SPA</td>
<td>1 x 100GE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SONET and Modular PLIMs (future)</td>
</tr>
<tr>
<td><strong>Ethernet Feature Set</strong></td>
<td>Minimal</td>
<td>MTP support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shaped and CBFC pause frame</td>
</tr>
<tr>
<td><strong>Other HW features</strong></td>
<td>None</td>
<td>Timestamping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stateful feature support</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>LC (MSC + PLIM): 530W</td>
<td>LC (MSC + PLIM): 600W</td>
</tr>
<tr>
<td></td>
<td>Switch Card (4/8/16 slot):</td>
<td>Switch Card (4/18/16 slot):</td>
</tr>
<tr>
<td></td>
<td>102/185/206W</td>
<td>49/90/94W</td>
</tr>
</tbody>
</table>
Unmatched Scale
CRS-3 Features

New Capabilities
- All models (4, 8, 16 slot, Multi-chassis)
- **Line-cards**: 1x100GE, 14x10GE, 20x10GE
- **Service Cards**: MSC140, FP140
- Service Cards supported on all models
- **Fabric**: Redundant 140G fabric

Varied Applications
- **MSC140**: High Speed Edge apps
- **FP140**: Core, Peering apps
Unmatched Scale
Interface Modules (PLIMs)

1x100GBE
- Line-rate performance (100Gbps)
- CFP optics (LR4)

14X10GBE-WL-XFP
- Line-rate performance (140Gbps)
- Configurable LAN/WAN PHY

20X10GBE-WL-XFP
- Oversubscribed (140Gbps)
- Configurable LAN/WAN PHY

Each PLIM requires MSC140 or FP140 Service Card
Each PLIM occupies 1 slot (front side)
Unmatched Scale
Service Cards

**CRS-FP140**
- Core, Peering apps
- 8 queues per port
- Wire-rate COS, TE, Multicast

**CRS-MSC-140G**
- High speed edge apps
- 64000 queues, 12000 interfaces
- Wire-rate H-QoS

Each Service Card supported on all CRS models
Each occupies 1 slot (back side)
The 100GE Interface

- Single Flow 100GE Throughput

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Transmit and Receive Wavelength</th>
<th>Transmit Power</th>
<th>Receive Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Max per lane</td>
<td>Min per lane</td>
</tr>
<tr>
<td>CFP-100G-LR4</td>
<td>40GBASE-KR4</td>
<td>4 lanes: 1295.6nm, 1300.1nm, 1304.6nm, 1309.1nm</td>
<td>4.5 per lane</td>
<td>-4.3 per lane</td>
</tr>
</tbody>
</table>

- CFP-100G-LR4
Unmatched Interface Scale
Range of Options: Low to High

Industry’s Highest 10GE port density per rack

Capacity (Gbps)
- 40G/slot
- 140G/slot

10GE Interface Density
- 40G/slot
- 140G/slot
Savings
1x CRS Family
Investments Protected for Decades

- **Lower Cost of Ownership**
  - Significantly higher capacity in existing footprint
  - **Reuse** existing components (chassis, power, OIM, fans, fiber interconnects)
  - **Compatible** with existing components (line-cards, route processors)
  - **Integrated** functionality with higher performance

- **Green Mode Operations**
  - Around 10% savings for idle/non use of ports
  - POP Consolidation with Secure Domain Routing (SDR) & IPoDWDM eliminates extra equipment reducing power, cooling, rack space
1x CRS Family
Investments Protected for Decades

Excellent Return on Investment
1x CRS Family
Investments Protected for Decades

![Diagram of CRS-1 and CRS-3 with 40G Cards, Route Processor, Fabric, Chassis, Fan, and Power]

New Option:
Modular Power System (AC, DC)
‘Pay as you grow’

Investments Protected for Decades
1x CRS Family
Reduced Resources per Bit

CRS Form Factor

Watts

Power @ 40G/slot
Power @ 140G/slot
Total Power
W/Gbps @ 40G/slot
W/Gbps @ 140G/slot

>60% reduction
1x CRS Family
Unprecedented Savings

Watts/Gig

10
9
8
7
6
5
4
3
2
1
0

Vendor A  Vendor B  Vendor C  Vendor D  Cisco CRS-3 (16-slot)  Cisco CRS-3 (8-slot)

4.4  5.00  7.06  4.4  2.73  2.75

CRS-3 Power Reduction Per Gbps

60%

Even More with New: Modular Power System

Significant Drop in Power and Cooling

Source: Current Published Documentation

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Cisco CRS-3
Validated by AT&T