Cisco 7000 Family Hardware Configuration and Performance Optimization
Session 2805
Hardware Configuration

• System Architecture
• Components and Options
• Configuration Guidelines
  - Cisco 7200 PCI Bus Loading and Balancing
  - Cisco 7500 CyBus Loading
  - Cisco 7500 VIP2 and Port Adapters

Software Configuration

• Basic Configuration Tasks
• Boot Sequence
• Switching Modes
• Performance Parameters
• Packet Buffers and Queues
• Interfaces and IDBs
Hardware Configuration
Cisco 7200, 7100, and 7500

Cisco 7200
Cisco 7200 Hardware Architecture

Cisco 7200 Bus Architecture
Cisco 7200 (NPE200/150/100) Data Path

Inbound Data to DRAM

Outbound Data from SRAM
Cisco 7200VXR (NPE300) Data Path

Outbound Data
(Same data path for NPE225/175)

Network Services Engine NSE-1

• Embedded PXF Processor for service acceleration:
  CEF, NetFlow, ACL, WFQ, WRED, NAT at FCS;
  more to follow
• Same port adapter configuration guideline as NPE300
• Multiple on-chip processors using pipelining and parallelism to maximize utilization of external data memories
7200VXR Multiservice Interchange

- Built-in TDM buses and switching capabilities integrated into the midplane
- Each PA slot has two full-duplex 8.192-Mbps TDM streams, and each stream has 128 DS0 channels (128 x 64 Kbps = 8.192 Mbps)
- Switching among all 12 streams at DS0 level done by Multiservice Interchange (MIX) on the midplane, no NPE processing involved
- TDM capabilities available with all NPE/NSE models

Multiservice Interchange

- Multiservice Interchange (MIX) integrated into 7200 VXR
  Switches DS0 time slots between up to 12 MIX interconnects
  Based on time division multiplexing (TDM) technology
- Two bi-directional 8.192 Mbps MIX interconnects to each port adapter slot (128 DS0 channels per stream)
Cisco 7200 Components

- Chassis
- Power supply
- NPE/NSE
- Memory
- Software
- I/O controller
- Port adapters

Cisco 7200 Chassis

- Cisco 7206 and 7206 VXR—six slots
- Cisco 7204 and 7204 VXR—four slots
- Each slot takes a port adapter
- Same port adapters are used on all Cisco 7xxx routers (a few PAs are not supported on all models)
Cisco 7200 Power Supply

- Single AC
- Single DC
- Dual AC (load-shared redundant)
- Dual DC (load-shared redundant)
- Not AC and DC on same chassis

Cisco 7200 NPE/NSE

<table>
<thead>
<tr>
<th>Model</th>
<th>Processor</th>
<th>CPU Clock Rate</th>
<th>Fast Packet Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPE100</td>
<td>RISC 4700</td>
<td>150 MHz</td>
<td>None</td>
</tr>
<tr>
<td>NPE150</td>
<td>RISC 4700</td>
<td>150 MHz</td>
<td>1 MB SRAM</td>
</tr>
<tr>
<td>NPE200</td>
<td>RISC 5000</td>
<td>200 MHz</td>
<td>4 MB SRAM</td>
</tr>
<tr>
<td>NPE175</td>
<td>RISC 5270</td>
<td>200 MHz</td>
<td>32+ MB SDRAM</td>
</tr>
<tr>
<td>NPE225</td>
<td>RISC 5271</td>
<td>262.5 MHz</td>
<td>32+ MB SDRAM</td>
</tr>
<tr>
<td>NPE300</td>
<td>RISC 7000</td>
<td>262.5 MHz</td>
<td>32+ MB SDRAM</td>
</tr>
<tr>
<td>NSE-1</td>
<td>RISC 7000 PXF (4x4)</td>
<td>262.5 MHz (100 MHz (x16))</td>
<td>128+ MB SDRAM</td>
</tr>
</tbody>
</table>
7200 Chassis and NPE/NSE

<table>
<thead>
<tr>
<th>Model</th>
<th>NPE Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco 7206VXR</td>
<td>NPE 300/225/175/200/150/100, NSE-1</td>
</tr>
<tr>
<td>Cisco 7204VXR</td>
<td>NPE 300/225/175/200/150/100, NSE-1</td>
</tr>
<tr>
<td>Cisco 7206</td>
<td>NPE 225/175/200/150/100</td>
</tr>
<tr>
<td>Cisco 7204</td>
<td>NPE 225/175/200/150/100</td>
</tr>
</tbody>
</table>

Cisco 7200 Memory

- NPE DRAM options: 32, 64, 128 MB (256 MB SDRAM option for NPE300)
- NSE-1 SDRAM options: 128, 256 MB
- Flash SIMM: 4 MB
- Flash memory card: 8, 16, 20 MB
- Flash disk: 40, 110 MB
- Two PCMCIA slots
Cisco 7200 Software Feature Sets

- Enterprise
- Enterprise with APPN
- Desktop and IBM
- IP routing (11.2+)
- Encryption options to above (IPSec DES, 3DES)
- Firewall option to above

Cisco 7200 Software Feature Licenses

- WAN Packet Protocols/NetFlow
  ATM, FR, SMDS, X.25, NetFlow
- Interdomain Routing/Tag Switching
  BGP, EGP, Tag Switching
Cisco 7200 I/O Controller

- Standard
  - Console port
  - Aux port
  - Two PCMCIA slots
- Optional
  - Embedded Fast Ethernet interface with both RJ45 and MII connector, full duplex

Cisco 7200 Port Adapters

LAN
- 1p Fast Ethernet (TX/FX)
- 2p Fast Ethernet (TX/FX)
- 4p and 8p Ethernet (10BaseT)
- 5p Ethernet (10BaseFL)
- 4p Token Ring (HDX/FDX)
- 1p FDDI (HDX and FDX)
- 1p 100VG
- 1p Gigabit Ethernet
- EtherSwitch (12E/2FE)

WAN
- 4p and 8p Serial
- 4p E1 G.703
- 1p and 2p HSSI
- 1p and 2p T3/E3
- 4p and 8p BRI
- 1p ATM-CES
- 1p ATM T3/E3/OC-3
- 8p T1/E1 ATM with IMA
- 1p SRP OC-12

Voice
- 2 T1/E1 Voice (2 versions)

L3 Services
- Encryption
- Compression
- Encr + Comp
Cisco 7200 Port Adapters

LAN

• One-port Fast Ethernet 100Base (TX, FX, VG)
• Two-port Fast Ethernet 100Base (TX, FX)
• Four- and eight-port Ethernet 10BaseT
• Five-port Ethernet 10BaseFL
• Fourteen-port (12E/2FE) EtherSwitch (Cisco 7200 only)
• One-port Gigabit Ethernet (SX, LX, LH) (Cisco 7200 only)
• Four-port Token Ring (HDX, FDX)
• One-port FDDI (HDX, FDX; SM, MM)
• One-port ATM (OC3; SM, MM)

Cisco 7200 Port Adapters

WAN

• Four- and eight-port serial
• Two-port serial (JT2) (Cisco 7200 only)
• One- and two-port HS serial (T3, E3)
• One- and two-port HSSI
• One-port Packet-Over-SONET
• One-port DPT (OC12) (Cisco 7200 only)
• Eight-port BRI (S/T) (Cisco 7200 only)
• Four-port BRI (U) (Cisco 7200 only)
WAN (Cont.)

- Two-port channelized/PRI (T1, E1)
- One-port channelized (T3 + 4 DSX1 breakouts)
- Four- and eight-port multichannel (T1, E1, DSX1)
- One-port multichannel (T3, E3)

WAN (Cont.)

- One-port ATM CES (OC-3, DS3) (Cisco 7200 only)
- One-port enhanced ATM (OC-3, DS3, E3; SM, MM)
- Eight-port ATM with IMA (T1, E1)
- One-port Channel (ESCON, parallel) (Cisco 7200 only)
- Two-port T1/E1 Digital Voice
## Channelized vs. Multichannel

<table>
<thead>
<tr>
<th>Model</th>
<th>DS1 Channels</th>
<th>DS0 Channels</th>
<th>PRI Support</th>
<th>Full DS0</th>
<th>Interf Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>C T1/E1</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>DSX1</td>
</tr>
<tr>
<td>MC-T1/E1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>T1/E1</td>
</tr>
<tr>
<td>CT3</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>T3</td>
</tr>
<tr>
<td>MC-T3/E3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>T3/E3</td>
</tr>
</tbody>
</table>

## Cisco 7200 Service Adapters

- Compression (CSA)
- Encryption (ESA)
- Integrated (ISA)
Cisco 7200 VXR and Port Adapters

- Following port adapters are **not** supported in Cisco 7200VXR (regardless of NPE/NSE model):
  - PA-F-xx, PA-F/FD-xx, PA-4R, PA-4R-FDX, PA-CT3/4T1, PA-2CT1/PRI, PA-2CE1/PRI, SA-COMP, PA-A1 (*NSE-1 only*)

- Following port adapters require specific minimum hardware revision levels when used in 7200VXR:


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Cisco 7200 PA Slot Numbering

<table>
<thead>
<tr>
<th>Slot 5</th>
<th>Slot 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slot 3</td>
<td>Slot 4</td>
</tr>
<tr>
<td>Slot 1</td>
<td>Slot 2</td>
</tr>
<tr>
<td>Slot 0 (I/O FE)</td>
<td></td>
</tr>
</tbody>
</table>
**Cisco 7200 PA Classification**

- **Low-BW PAs:**
  All T1’s, all E1’s, PRI, BRI, CSA, 1-port parallel channel

- **Medium-BW PAs:**
  All 10Base Ethernets, Token Ring (HDX), ESA

- **High-BW PAs:**
  Those not listed above

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**Cisco 7200 PA Configuration Guidelines**

- **For NPE150, NPE200, NPE175, and NPE225**
  Three or fewer high BW PAs
  Five or fewer high and medium BW PAs

- **For NPE100:**
  Two or fewer high BW PAs
  Four or fewer high and medium BW PAs
Cisco 7200 PA Configuration Guidelines

• I/O FE counted as one high BW PA
• All PAs counted regardless of configuration status
• Only one ATM CES PA supported per chassis (this is a double-wide PA and it uses PCI Bus 2)
• EtherSwitch PA is double-wide and automatically picks the less loaded (BW) PCI Bus at boot time

NPE300 and NSE-1 Port Adapter Configurations

• Use BW points (~aggregate interface BW) for each PA:
  400: PA-GE
  300: PA-xx-OC-3, PA-12E/2FE, PA-2FEISL, PA-SRP-OC-12
  200: PA-FE, PA-2H
  180: PA-2T3, PA-2E3
  120: PA-4R-FDX/DTR
  100: PA-1H, PA-1C-E4
  90: All single-DS3/E3 PA’s (serial, MC, ATM)
  80: PA-8E
  60: PA-4R, CSA, ESA
  50: PA-5E
  40: PA-4E
  0: All low-BW PA’s

• Each PCI bus can support 600 BW points
• Don’t forget I/O FE on bus 1
Cisco 7200 Bus Balancing

- PA load should be balanced between two PCI buses to optimize performance
- Configure PAs as follows
  - Sort PAs in descending order of bandwidth
  - Fill in slot 2, slot 1, slot 4, slot 3, slot 6, slot 5
  - Adjust for better balancing as appropriate
- I/O FE uses Bus 1

Cisco 7200 NPE200/150 Configuration Examples

<table>
<thead>
<tr>
<th>Slot 0 (I/O FE)</th>
<th>Serial</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSSI</td>
<td>Ethernet</td>
</tr>
<tr>
<td>Serial</td>
<td>Serial</td>
</tr>
<tr>
<td>Ethernet</td>
<td>ATM (OC-3)</td>
</tr>
</tbody>
</table>
### Cisco 7200 NPE200/150 Configuration Examples (Cont.)

<table>
<thead>
<tr>
<th>Ethernet</th>
<th>Serial</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDDI</td>
<td>Serial</td>
</tr>
<tr>
<td>ATM CES</td>
<td></td>
</tr>
<tr>
<td>Slot 0 (No I/O FE)</td>
<td></td>
</tr>
</tbody>
</table>

### Cisco 7200 NPE 300 Configuration Examples

<table>
<thead>
<tr>
<th>8E</th>
<th>MC-8T</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC-T3</td>
<td>FE</td>
</tr>
<tr>
<td>2T3</td>
<td>A3-OC-3</td>
</tr>
<tr>
<td>I/O FE</td>
<td></td>
</tr>
</tbody>
</table>

Bus1 = 200 + 180 + 90 + 80 = 550
Bus2 = 300 + 200 + 0 = 500
### Cisco 7200 NPE300 Configuration Examples (Cont.)

#### Configuration 1

<table>
<thead>
<tr>
<th>FE</th>
<th>2H</th>
</tr>
</thead>
<tbody>
<tr>
<td>POS</td>
<td>A3-OC-3</td>
</tr>
</tbody>
</table>

**A2-T3**

**No I/O FE**

Bus1 = 300 + 200 = 500  
Bus2 = 90 + 300 + 200 = 590

---

#### Configuration 2

<table>
<thead>
<tr>
<th>FE</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>POS</td>
<td>FE</td>
</tr>
</tbody>
</table>

**EtherSwitch**

**No I/O FE**

Bus1 = 300 + 200 = 500  
Bus2 = 300 + 200 + 90 = 590
Cisco 7100

Cisco 7100 Internal Architecture

CPU
Cache SRAM
System Controller
SDRAM (64 MB)
System Controller
SDRAM (64-256 MB)
Con/Aux
NVRAM
Flash
ROM
I/O Bus

PCI 0
PS1
PS2
SW1
PB1
WAN1
PCI 1
PS3
PS4
PB3
WAN2
(Cisco 7120 Only)
(Cisco 7140 Only)

(10/100 TX)

FE1
FE2
PCMCIA-1
PCMCIA-2

(Cisco 7140 Only)

WAN-1
WAN-2
(Cisco 7140 Only)
Cisco 7100 Factory Options

<table>
<thead>
<tr>
<th>Model</th>
<th>Power Supply</th>
<th>Fixed WAN Interface Options</th>
<th>Fixed LAN</th>
<th>PA Slot</th>
<th>SM Slot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco 7120</td>
<td>Single AC</td>
<td>1-Port ATM-OC-3 (SMI) 1-Port ATM T3 or E3 1-Port T3 or E3 4-Port Serial (T1/E1)</td>
<td>Dual 10/100 FE</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cisco 7140</td>
<td>Dual AC</td>
<td>2-Port ATM-OC-3 (MM) 2-Port ATM T3 or E3 2-Port T3 or E3 8-Port Serial (T1/E1) No WAN (2 FE only)</td>
<td>Dual 10/100 FE</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

PA slot supports one port adapter
SM slot supports one service module (ISM)

Cisco 7100 Memory

- SDRAM options: 64, 128, 192, 256 MB
- Flash SIMM: 8 MB
- Flash memory card: 8, 16, 20 MB
- Flash disk: 40, 110 MB
- Two PCMCIA slots
- Default SDRAM is 64 MB
Cisco 7100 PA Support

- All Cisco 7200 VXR PA’s except:
  - Channelized/Multichannel PA’s
  - Packet-Over SONET and DPT PA’s
  - IBM Channel PA
  - Dual-wide PA’s (PA-A2 and PA-12E/2FE)
  - CSA, ESA, PA-100VG
- PA-GE and voice PA’s will be supported

Cisco 7100 Software Feature Sets

- Enterprise
- IP
- Encryption options to above (IPSec DES, 3DES)
- Firewall option to above
In Cisco 7140, use WAN-1 as primary

Cisco 7500

- Architecture
- Components and options
- Distributed switching
- System bus bandwidth
- VIP2 and port adapters
Cisco 7500 System Architecture

Route Switch Processors

Common Port Adapters

Network Processing Engine
Cisco 7500 Components

- Chassis and power supply
- CPU
- Memory
- Software
- VIP2
- Port adapters
- Interface processors

Cisco 7500 Chassis

<table>
<thead>
<tr>
<th>Model</th>
<th>RSP</th>
<th>CyBus</th>
<th>Power Supply</th>
<th>No. of xIP Slots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco 7505</td>
<td>Single</td>
<td>Single</td>
<td>Single</td>
<td>4</td>
</tr>
<tr>
<td>Cisco 7507</td>
<td>Single/Dual</td>
<td>Dual</td>
<td>Single/Dual</td>
<td>5</td>
</tr>
<tr>
<td>Cisco 7513</td>
<td>Single/Dual</td>
<td>Dual</td>
<td>Single/Dual</td>
<td>11</td>
</tr>
<tr>
<td>Cisco 7576</td>
<td>Single(x2)</td>
<td>Dual (x2)</td>
<td>Single/Dual</td>
<td>11</td>
</tr>
</tbody>
</table>
Cisco 7576 Chassis Slots

Cisco 7500 CPU

- RSP1—for Cisco 7505 only
- RSP2—for Cisco 7507 and 7513
- RSP4—for Cisco 7505, 7507, 7513, and 7576
- RSP8—for Cisco 7505, 7507, 7513, and 7576
Cisco 7500 Memory (Per RSP)

- DRAM options: 32, 64, 128 MB, 256 MB (RSP4 and RSP8 only)
- Flash SIMM: 8 MB (16 MB for RSP8)
- Flash memory card: 8, 16, 20 MB
- Flash disk: 40, 110 MB
- Two PCMCIA slots
- Default DRAM is 32 MB (64 MB for RSP8)

Cisco 7500 Software Feature Sets

- Enterprise
- Enterprise with APPN
- Desktop and IBM
- IP routing
- Encryption options to above (IPSec DES, 3DES)
Cisco 7500 Software Feature Licenses

- WAN Packet Protocols/NetFlow
  ATM, FR, SMDS, X.25, NetFlow
- Interdomain Routing/Tag Switching
  BGP, EGP, Tag Switching

Cisco 7500 Versatile Interface Processor

Diagram showing the versatile interface processor with various components such as route switch processors, switch processor, port adapter, packet memory, and interface adapters.
VIP2 Options

<table>
<thead>
<tr>
<th>Product</th>
<th>SRAM</th>
<th>DRAM</th>
<th>Dist Sw</th>
<th>Dist Svcs</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIP2-15</td>
<td>1 MB</td>
<td>8 MB</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>VIP2-40</td>
<td>2 MB</td>
<td>32 MB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VIP2-50</td>
<td>4/8 MB</td>
<td>32–128 MB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VIP4-50</td>
<td>64 MB</td>
<td>64–256 MB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VIP4-80</td>
<td>64 MB</td>
<td>64–256 MB</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Distributed Services

Basic Switching
- Cisco Express Forwarding
- IP Fragmentation
- Fast EtherChannel

VPN
- Access Lists—Extended and Turbo
- Cisco Encryption
- GRE Tunnels
- IP Security
- L2TP Tunnels

QoS
- NBAR
- Traffic Shaping
- Policing (CAR)
- Congestion Avoidance
- Guaranteed Minimum Bandwidth
- Policy Propagation
- Policy Routing

Accounting
- Output Accounting
- Flow Export
- Precedence and MAC Accounting

Load Balancing
- CEF Load Balancing
- Multilink PPP

Multiservice
- Low Latency Queuing
- FRF.11 and FRF.12
- RTP Header Compression

Caching
- WCCP v1

Compression
- L2 SW and HW Compression
Cisco 7500 Port Adapters

- Fast Ethernet, Ethernet
- FDDI, Token Ring
- POS, ATM
- Serial
- Channelized, multichannel
- PRI
- CSA, ESA, ISA

Cisco 7500 Interface Processors

- Early IPs:
  EIP, TRIP, FIP, HIP, FSIP, AIP, MIP, CIP2, FEIP
- New IPs (VIP2-based, fixed-configuration):
  POSIP, CT3IP, FEIP2, GE
VIP2 Distributed Switching

Cisco 7500 System Bus Bandwidth

- **Cisco 7507, Cisco 7513, and “half-7576”**
  - Dual CyBus
    - 1066 Mbps each, total 2 Gbps
- **Cisco 7505**
  - Single CyBus at 1066 Mbps
- **RSP7000 (and Cisco 7000/7010)**
  - Single CxBus at 533 Mbps
Cisco 7500 IP/VIP Classification

- **Cy mode**
  All VIPs and VIP-based IPs, CIP, FEIP
  Use CyBus at 1066 Mbps

- **Cx mode**
  All other IPs
  Use CyBus at 533 Mbps

Cy Mode and Cx Mode on CyBus

**Cx Mode**

One bit per clock cycle, bus bandwidth is 533 Mbps

**Cy Mode**

Two bits per clock cycle, same basic clock rate as Cx, total bus bandwidth becomes 1066 Mbps (Two “Cy clock cycles” = One “Cx clock cycle”)
Cy Mode and Cx Mode
Bandwidth Consumption

- CyBus bandwidth is 1066 Mbps in Cy mode
- Cx mode uses two “Cy clock cycles” per bit
- Cx card takes up twice as much CyBus capacity as Cy card

Cisco 7500 Bus Bandwidth

- Each VIP/IP requires bandwidth from the bus
- Aggregate bandwidth requirement should not exceed bus capacity
  - Over-subscription
  - Bus overhead
  - Interface utilization
- Two CyBuses are independent
- Balance between the two buses
Cisco 7500 Bus Bandwidth Calculation

\[ \sum (\text{IP BW} \times \%\text{IP Util}) \leq \text{Bus BW} \times \%\text{Bus Util} \]

gives

\[ \sum \left( \frac{\text{IP BW} \times \%\text{IP Util}}{\%\text{Bus Util}} \right) \leq \text{Bus BW} \]

- Define the fraction term as:
  Interface Bus Bandwidth Factor (IBBF)
- Pre-calculate IBBF for each interface

Cisco 7500 IBBF Assumptions

- 75% utilization for all channelized interfaces (CT3, MC-T3/E3, CT1/E1, MC-T1/E1, MIP, CIP)
- 75% utilization for all ATM interfaces
- 100% utilization for all other interfaces
- 80% utilization on system buses
- These are very conservative assumptions
Cisco 7500 IBBF Examples

- **EIP6**

  Total IP BW = 60 Mbps, %IP_Util = 100%
  
  \[ \text{IBBF-Cx} = \frac{60 \times 100}{80} = 75 \]
  
  Since EIP is Cx, IBBF-Cy = 150

- **CT3IP**

  Total IP BW = 45 x 2 = 90 Mbps, %IP_Util = 75%
  
  \[ \text{IBBF-Cx} = \frac{90 \times 75}{80} = 84 \]
  
  Since CT3IP is Cy, IBBF-Cy = 84

IBBF Table—Part 1

<table>
<thead>
<tr>
<th>IP</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIP-2</td>
<td>Cx</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>EIP-4</td>
<td>Cx</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>EIP-6</td>
<td>Cx</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>TRIP-2</td>
<td>Cx</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>TRIP-4</td>
<td>Cx</td>
<td>80</td>
<td>160</td>
</tr>
<tr>
<td>FIP</td>
<td>Cx</td>
<td>125</td>
<td>250</td>
</tr>
</tbody>
</table>
### IBBF Table—Part 2

<table>
<thead>
<tr>
<th>IP</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIP</td>
<td>Cx</td>
<td>113</td>
<td>226</td>
</tr>
<tr>
<td>FSIP-4</td>
<td>Cx</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>FSIP-8</td>
<td>Cx</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>AIP-DS3</td>
<td>Cx</td>
<td>84</td>
<td>168</td>
</tr>
<tr>
<td>AIP-TAXI</td>
<td>Cx</td>
<td>188</td>
<td>376</td>
</tr>
<tr>
<td>AIP-OC3</td>
<td>Cx</td>
<td>291</td>
<td>582</td>
</tr>
<tr>
<td>MIP-1</td>
<td>Cx</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>MIP-2</td>
<td>Cx</td>
<td>8</td>
<td>16</td>
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### IBBF Table—Part 3

<table>
<thead>
<tr>
<th>IP</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEIP-1</td>
<td>Cy</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>FEIP-2</td>
<td>Cy</td>
<td>291</td>
<td>291</td>
</tr>
<tr>
<td>CIP-1</td>
<td>Cy</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>CIP-2</td>
<td>Cy</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>
### IBBF Table—Part 4

<table>
<thead>
<tr>
<th>IP</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSIP</td>
<td>Cy</td>
<td>388</td>
<td>388</td>
</tr>
<tr>
<td>CT3IP</td>
<td>Cy</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>FEIP2</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>FEIP</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
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</table>

### IBBF Table—Part 5

<table>
<thead>
<tr>
<th>PA</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA-FE (FDX)</td>
<td>Cy</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>PA-FE (HDX)</td>
<td>Cy</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>PA-100VG</td>
<td>Cy</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>PA-FDDI</td>
<td>Cy</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>PA-FDDI/FD</td>
<td>Cy</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>PA-ATM (OC3)</td>
<td>Cy</td>
<td>291</td>
<td>291</td>
</tr>
<tr>
<td>PA-ATM (DS3)</td>
<td>Cy</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>VIP2-Limit</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>VIP4-Limit</td>
<td>Cy</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: VIP2 (VIP4) card bandwidth cap at 400 (800), which gives IBBF cap at 500 (1000)
### IBBF Table—Part 6

<table>
<thead>
<tr>
<th>PA</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA-8E</td>
<td>Cy</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>PA-4E</td>
<td>Cy</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>PA-5EFL</td>
<td>Cy</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>PA-4R</td>
<td>Cy</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>PA-4R/FD</td>
<td>Cy</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>VIP2-Limit</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>VIP4-Limit</td>
<td>Cy</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: VIP2 (VIP4) card bandwidth cap at 400 (800), which gives IBBF cap at 500 (1000)

### IBBF Table—Part 7

<table>
<thead>
<tr>
<th>PA</th>
<th>Cx or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA-2H, 2T3</td>
<td>Cy</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>PA-H, T3</td>
<td>Cy</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>PA-2E3</td>
<td>Cy</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>PA-E3</td>
<td>Cy</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>PA-MC-T3</td>
<td>Cy</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>PA-MC-E3</td>
<td>Cy</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>PA-2JT2</td>
<td>Cy</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>VIP2-Limit</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>VIP4-Limit</td>
<td>Cy</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: VIP2 (VIP4) card bandwidth cap at 400 (800), which gives IBBF cap at 500 (1000)
### IBBF Table—Part 8

<table>
<thead>
<tr>
<th>PA</th>
<th>Cy or Cy</th>
<th>IBBF-Cx</th>
<th>IBBF-Cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA-8T</td>
<td>Cy</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>PA-4T</td>
<td>Cy</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>PA-MC-8T1</td>
<td>Cy</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>PA-MC-4T1</td>
<td>Cy</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>PA-MC-8DSX1</td>
<td>Cy</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>PA-MC-8E1</td>
<td>Cy</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>PA-2CT1</td>
<td>Cy</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>PA-2CE1</td>
<td>Cy</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>CSA</td>
<td>Cy</td>
<td>IBBF x 2</td>
<td>IBBF x 2</td>
</tr>
<tr>
<td>VIP2-Limit</td>
<td>Cy</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>VIP4-Limit</td>
<td>Cy</td>
<td>1000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Note: VIP2 (VIP4) card bandwidth cap at 400 (800), which gives IBBF cap at 500 (1000)

### How to Use IBBF

- Use IBBF-Cy values for CyBus systems (75xx), and IBBF-Cx values for CxBus systems (RSP 7000 and 70x0)
- To verify a given configuration, sum up corresponding IBBFs for each bus, and check that it is within limit (1066 for CyBus and 533 for CxBus) plus oversubscription allowance
- Balance between two buses where appropriate
Cisco 7500 IBBF and Bus Over-Subscription

- Conservative assumptions (i.e., worst-case scenarios) are used as a start
- Real-world networks are not 100% utilized (queuing delay)
- Bi-directional links are usually asymmetrically loaded
- Some links may be used as backup only
- Full-duplex/half-duplex
- Over-subscription is possible
  But no fixed rules

Cisco 7500 VIP2 Block Diagram

VIP2 Capacity Areas:
- Kpps
- SRAM
- Bandwidth

CyBus
- CyBus Interface
- CPU and DRAM

Packet Bus
- Pkt Memory Controller
- SRAM

Primary PCI Bus
- PCI Bridge
- Port Adapter

Secondary PCI Buses
- Port Adapter
VIP2 Configuration

SRAM Capacity Consideration

- Particles and descriptors allocated out of SRAM for each PA
- Number of particles varies with PA
- Particle size depends on PA-pair and VIP2 model (amount of SRAM)
- Does not affect VIP2-40 and above

VIP2 Configuration

PCI Bandwidth Consideration

- Electrical bandwidth is 800 Mbps, but data throughput is about 400 Mbps
- Overhead due to bus arbitration and non-data traffic, varies by PA
- Effective data throughput on PCI bus determines PA-pairing support
VIP2 Configuration

Switching Capacity Consideration

- VIP2-40 (VIP2-50) distributed switching at 65 Kpps (100 Kpps)
- VIP2 forwarding to RSP at 135 Kpps
- Forwarding puts load on RSP
- Estimate Kpps load from each PA

VIP2 Configuration

Current Guidelines

- ATM OC-3 PA requires a dedicated VIP2 (except PA-A3-OC-3 on VIP2-50)
- PA-A3, PA-MC-T3/E3/T1/E1, PA-2JT2, CSA, and ESA require VIP2-40 or above
- 4R paired with 8T require VIP2-40 or VIP2-50
VIP2 Configuration

Current Guidelines (Cont.)

- VIP2-50 supports all existing PAs except 100VG and TR
- Balance PA’s across VIP’s to optimize VIP resource utilization on router

Cisco 7500 VIP4 Block Diagram

CyBus

CPU

VIP4 Controller

SDRAM

Port Adapter

Port Adapter
VIP4 Configuration

• Distributed switching capacity:
  150 to 210 Kpps for VIP4-80
  100 to 135 Kpps for VIP4-50
• Aggregate bandwidth capacity 750+ Mbps
• VIP4 does not support PA-A1, PA-2JT2, PA-4E1G, PA-4R, CSA, and ESA
• Supports VIP4 and VIP2 on same chassis
Software Configurations

- Basic configuration tasks
- Boot sequence
- Switching modes
- Performance parameters
- Packet buffers and queues
- Interfaces and IDBs

Basic Configuration Tasks

- Enable routed protocols
- Configure interface addresses and parameters
- Select switching mode(s)
- Activate routing protocol(s)
- Add packet services
- Set up network management, etc.
Boot Sequence

- **ROM monitor**
  - Wakes up the CPU
  - Finds and loads "boot loader"
- **Boot loader**
  - Brings up all hardware components
  - Finds and loads or net boots system image
  - No routing
- **System image**

Basic Boot Configurations

```
boot bootldr bootflash:rsp-boot-mz.121-2
boot system flash slot0:rsp-pv-mz.121-2
```

- Boot loader image should be current with respect to hardware components
- Good practice: use the same release of boot loader image as system image
Cisco 7200 Switching Modes

- Process switching
  Packets copied to system memory
  Handled at process level
- All other switching
  Packets switched in fast packet memory
  Handled at interrupt level

Cisco 7200 Switching Modes

- Process switching—Process level
- Fast switching—Uses fast switching cache
- Optimum switching—Improved search algorithm and data caching
- NetFlow switching—NetFlow cache identifies data flows and maintains flow statistics
Cisco 7200 Switching Modes

- Cisco Express Forwarding (CEF)—Forwarding information based on routing table instead of route cache built from demand
- Tag Switching—Based on tags and Tag Distribution Protocol
- Not all switching modes are available in all releases

Cisco 7500 Switching Modes

- RSP-based switching—Process, fast, optimum, NetFlow, CEF, Tag
- VIP distributed switching—Optimum, NetFlow, CEF, Tag
- Not all switching modes are available in all releases
Switching Configuration Commands—Fast/Opt/Flow

- `ip route-cache`
- `ip route-cache [optimum | flow]`
- `ip route-cache distributed`
- These are interface config commands

Switching Configuration Commands—CEF

- CEF switching is configured with global configuration commands
  - `ip cef switching`
  - `ip cef distributed switching` (Cisco 7500 only)
- CEF global command will enable CEF on all supported interfaces
Switching Configuration Commands—Tag

- Tag Switching requires CEF
- Tag Switching global configuration command
  tag-switching advertise-tags
- Tag Switching interface configuration command
  tag-switching ip

Which Switching Mode Is in Effect?

- Inbound packets entering the same interface can be switched by different modes
- Switching mode of a packet is determined by switching config at both its input and its output interface
Switching Configuration Matrix

<table>
<thead>
<tr>
<th>Input Interface</th>
<th>Output Interface</th>
<th>Sw Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>ip route-cache cef</td>
<td>- any -</td>
<td>cef</td>
</tr>
<tr>
<td>- any except CEF -</td>
<td>no ip route-cache</td>
<td>process</td>
</tr>
<tr>
<td>no ip route-cache</td>
<td>ip route-cache</td>
<td>fast</td>
</tr>
<tr>
<td>no ip route-cache</td>
<td>ip route-cache opt/flow/cef</td>
<td>fast</td>
</tr>
<tr>
<td>ip route-cache</td>
<td>ip route-cache</td>
<td>fast</td>
</tr>
<tr>
<td>ip route-cache</td>
<td>ip route-cache opt/flow/cef</td>
<td>fast</td>
</tr>
<tr>
<td>ip route-cache opt/flow</td>
<td>ip route-cache</td>
<td>opt/flow</td>
</tr>
<tr>
<td>ip route-cache opt/flow</td>
<td>ip route-cache opt/flow/cef</td>
<td>opt/flow</td>
</tr>
</tbody>
</table>

Understanding Kpps

- Measure of switching rate or capacity
- Smallest packets are used in testing, typically 64 bytes, to avoid saturating bandwidth before hitting switching capacity limit
- Lab traffic is deterministic
- Real world traffic is random and not all 64 bytes
How Important Is “Line Rate”?  

<table>
<thead>
<tr>
<th>Traffic Mix</th>
<th>Line Rate for a Given Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>64-Byte Packets</td>
<td>X Kpps</td>
</tr>
<tr>
<td>256-Byte Packets</td>
<td></td>
</tr>
<tr>
<td>1518-Byte Packets</td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>90%</td>
<td>77% of X Kpps</td>
</tr>
<tr>
<td>60%</td>
<td>24% of X Kpps</td>
</tr>
<tr>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

End-to-end network delay components

- Propagation Delay: approx. 1000 usec per 100 miles
  - Example coast-to-coast: ~30,000 usec or 30 msec
- Insertion Delay (a.k.a. Serialization Delay)
  - Example with 250-byte packet: 1000 usec on 2-Mbps link
    - 200 usec on 10-Mbps link
    - 20 usec on 100-Mbps link
- Queuing Delay = queue depth x insertion delay
- Router Latency: less than 100 usec for Cisco 7500
  - (64-byte packets over FDDIs, varies with packet sizes)
Packet Buffers and Queues

- A packet buffer is a group of memory cells where a packet is stored.
- A queue is a data structure to keep track of the ordering of packets stored in memory.
- A queue is typically implemented as a linked list of pointers pointing to the packet buffers.
- Queue manipulations are just linked list operations, the packet stays in the same buffer.
- Copying of packets is needed only when moving between different memory areas (e.g. from VIP2 SRAM to RSP MemD).

Packet Buffers in Cisco 7500

<table>
<thead>
<tr>
<th>Int’f Tx Queues</th>
<th>Raw Queue</th>
<th>I/O Buffers</th>
<th>VIP2 (SRAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MemD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSP</td>
<td>System Queues</td>
<td>System Buffers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DRAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distributed Int’f Output Queues</td>
<td>Buffers</td>
<td>RxRings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rx Rings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tx Rings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rx FIFO</td>
</tr>
</tbody>
</table>

Cisco.com
Interfaces and IDB

- Interface descriptor block (IDB)
  - Software data structure
  - Stores configuration and status of all interfaces
- Software IDB
- Hardware IDB

IDB Allocation

- Non-channelized cards
  - One hardware IDB and one software IDB per physical port
- Channelized cards
  - One hardware IDB and one software IDB per channel
- Subinterfaces
  - One software IDB per subinterface
- Example: FR interface with 10 subinterfaces $\Rightarrow$ 11 IDBs
Interface Scalability in Cisco 7xxx

- Aggregation scalability has been significantly enhanced in 12.0:
  - 750+ interfaces
  - 1200+ subinterfaces (FR)
- 300 software IDBs per chassis supported in 11.1 and 11.2
- All physical interfaces take up IDBs, regardless of configuration and status

Subinterfaces and IDB

- Subinterfaces take up IDBs
- Subinterfaces add routing overhead
- For ATM and FR:
  - An interface or subinterface can terminate multiple PVCs
  - Usually there is no need to configure a subinterface for each PVC
  - A PVC does not necessarily use up an IDB
Summary—Hardware Configuration

- Cisco 7100
  “Fixed” configuration and PA support
- Cisco 7200
  Number of high-BW and medium-BW PAs
  PCI bus loading and balancing
- Cisco 7500
  System bus loading
  CyBus balancing in dual-bus systems
  PA configuration (pairing) on VIP2 cards

Summary—Software Configuration

- Commands and features specific to Cisco 7xxx platform operations
- Understanding performance
- Networkers sessions available on topics such as EIGRP, OSPF, BGP, security, VPN, QoS, and others
- Network design clinics
Cisco 7000 Family Hardware Configuration and Performance Optimization

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