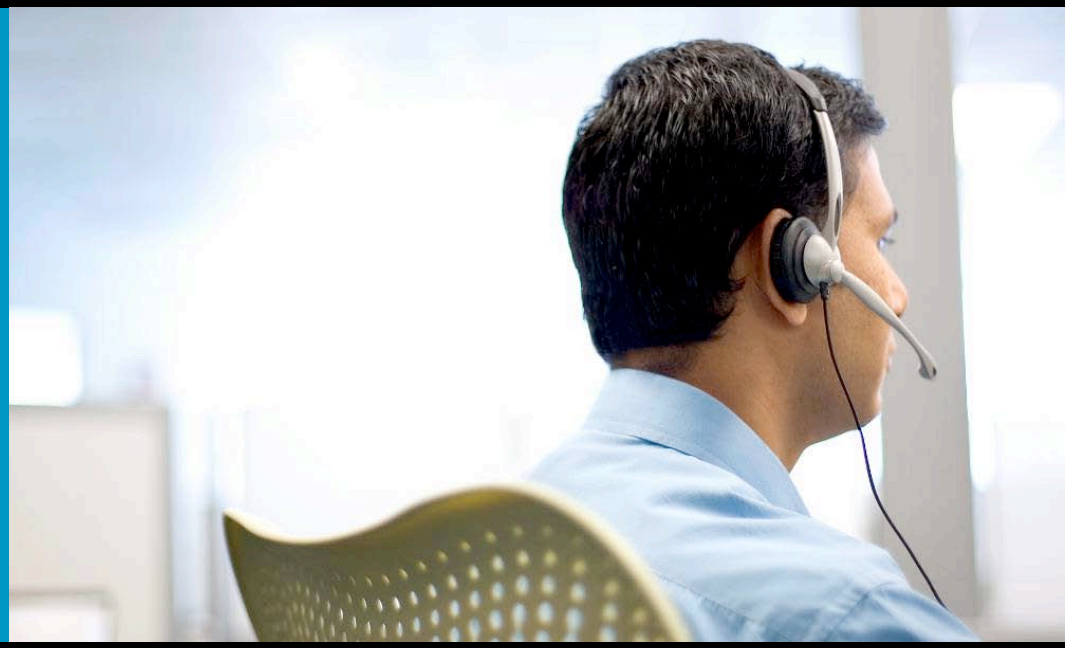
Cisco's Application eXtension Platform (AXP) Technical Overview



Access Routing Technology Group

View This Presentation in “Slide Show” Mode

Agenda

- ISR Overview
- Branch Architectures
- Application eXtension Platform Overview
- AXP Software Services
- AXP Network and Hardware Services
- AXP Use Cases
- Summary

ISR Overview

Core Platform

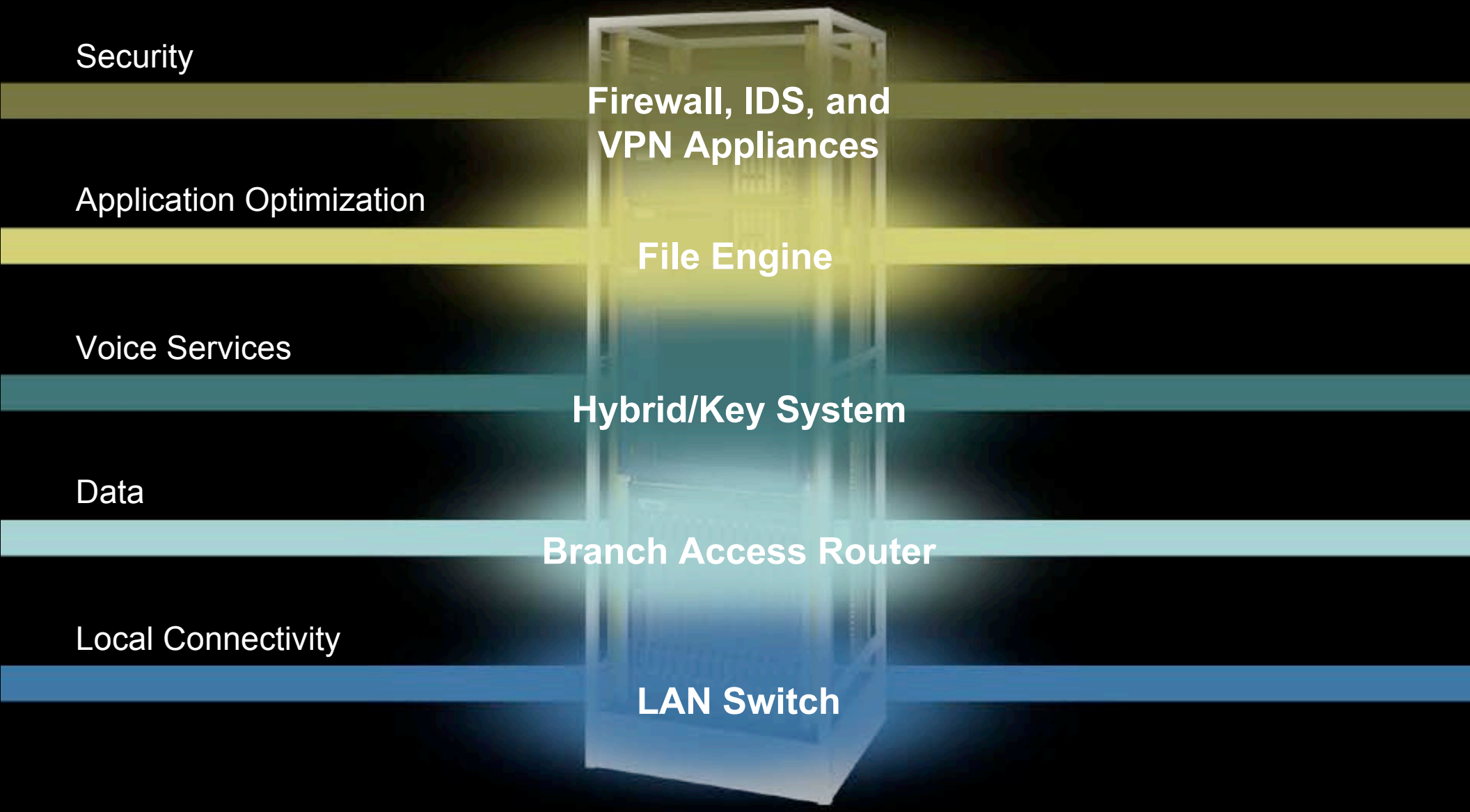
What Do We Do

We Build
"Integrated Services Routers"
Providing…

Connectivity, Security, IP Telephony,
Wireless and Application Solutions

For Enterprise Branch Offices, SP Edges,
and Small and Medium Businesses

Traditional Business Solution
Separate Applications and Appliances



Integrated Solution for Advanced Services

Integrated Services Router

Embedded Security

Voice Ready

Application Optimization

L2 Switching

Network Analysis

A Long Cisco History of Innovation…

1985

Pure Data Delivery

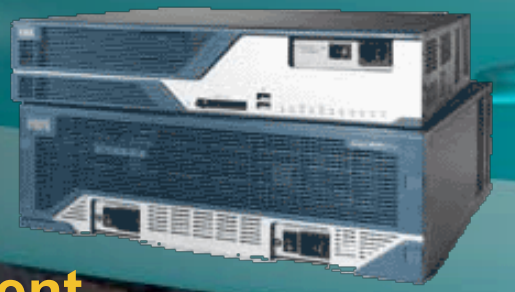
Cisco Access Routers

Early Service Convergence
Security,
Firewall, VPN

Integrated
Data, Security,
IP Telephony, and Intelligent
Application Services

2006

Integrated Services Routers



Secure, Concurrent Services at Wire Speed

Integrated Services Routers Portfolio

Performance and Services Density

Feature Breadth and Scale at Highest Performance

3800 Series

High Density and Performance for Concurrent Services

2800 Series

Embedded, Advanced Voice, Video, Data, and Security Services

1800 Series

800 Series

Embedded Wireless, Security, and Data

SP/Edge Head Office

Branch Office

Small Branch

SMB

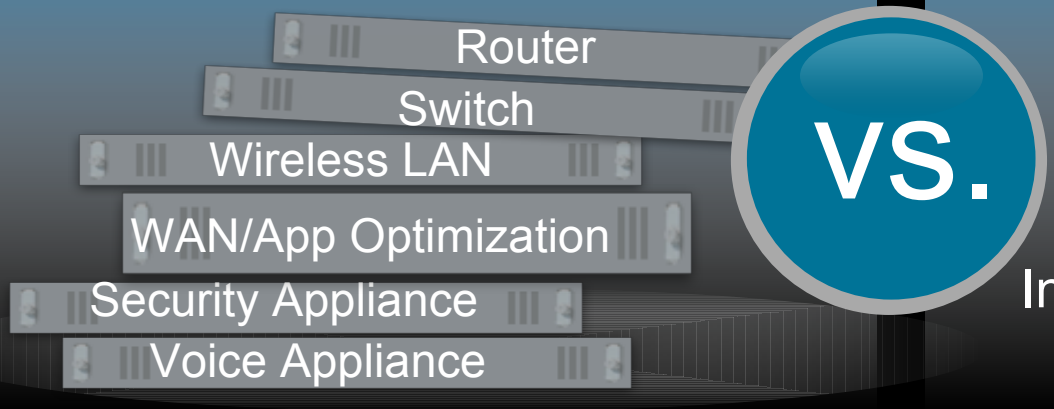
Small Office, Teleworker, and Mobile

ISR: Empowered Branch Services

Application Intelligence	Mobility	IP Communications	Integrated Security	Foundation Technologies
				
Improve Effectiveness of Branch Applications	Wireline and Wireless Equivalence—Ubiquitous Secure Connectivity	More Effective Communication and Collaboration Through Application and Infrastructure Integration	Trusted and Protected Business Applications, Legislative Compliance	Integrated, Intelligent Systems
▪ WAAS module ▪ Network analysis module ▪ Application-oriented NW module ▪ Cisco IOS®-NBAR	▪ Wireless LAN controller module	▪ Cisco Unity® Express module (voicemail, IVR) ▪ Cisco IOS: Cisco CallManager Express ▪ Cisco IOS: survivable remote site telephony	▪ Intrusion detection module ▪ Cisco IOS-VPN ▪ Cisco IOS-firewall	▪ LAN/WAN connectivity modules Serial, async, DSL, cable, HWICs EtherSwitch® modules Wireless ATM, OC3

Our Strategy Is Integration and Convergence

Overlay Appliances



VS.

Integrated Services Router

Cisco ISR 3845 with Integrated Voice, Wireless, Video, WAN Optimization, and Switch

Service Interoperability

- Consistency
- Interoperability
- Tested
- High availability

System Support

- Vendor accountability: network partner
- Fewer maintenance contracts

Operational Efficiency

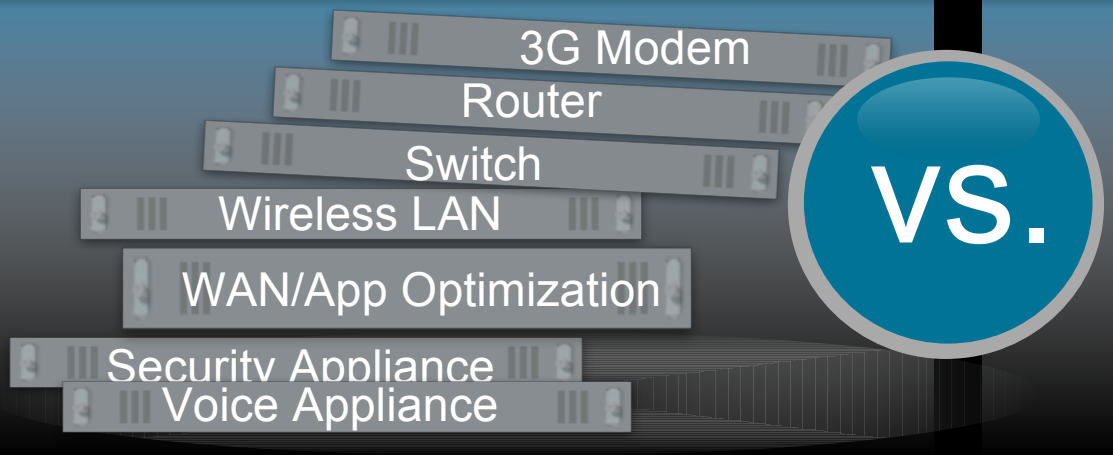
- Fewer devices, management systems, user interfaces
- Simplified troubleshooting

Investment Protection

- Flexibility to evolve through system modularity

Market Acceptance of Integrated Services

Overlay Appliances



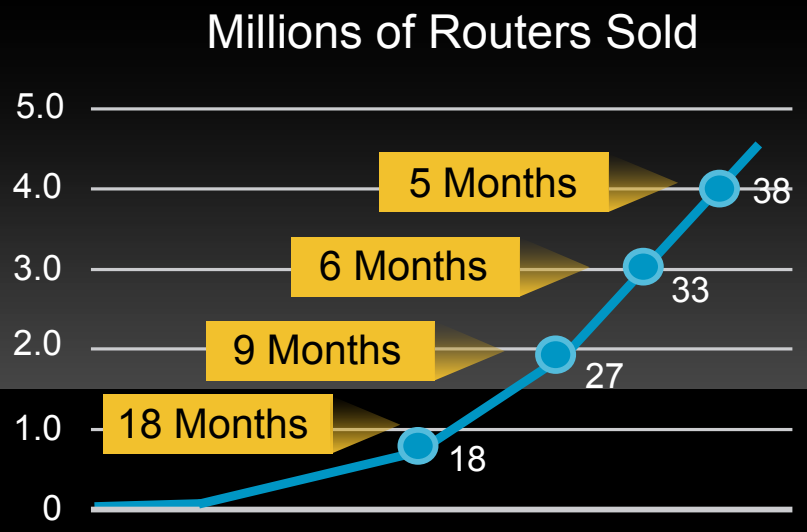
VS.

Integrated Services Router

Cisco ISR 3845

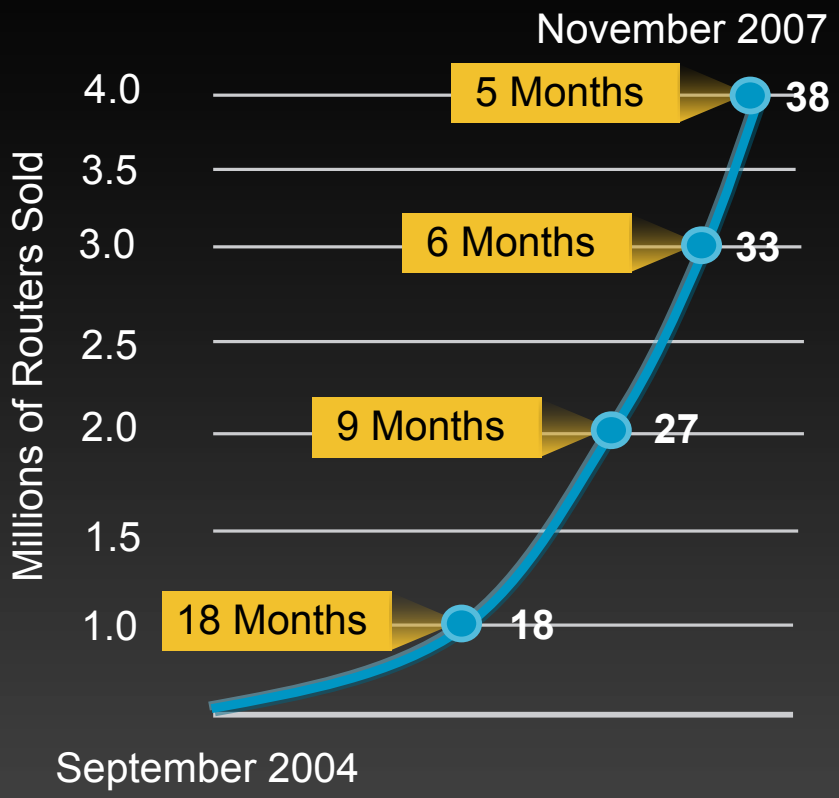
With Voice, Wireless, Video, WAN Optimization, Switch

- Operational efficiency (70% lower OpEx)
- Services consistency (branch ↔ HQ)
- Guaranteed interoperability
- Investment protection

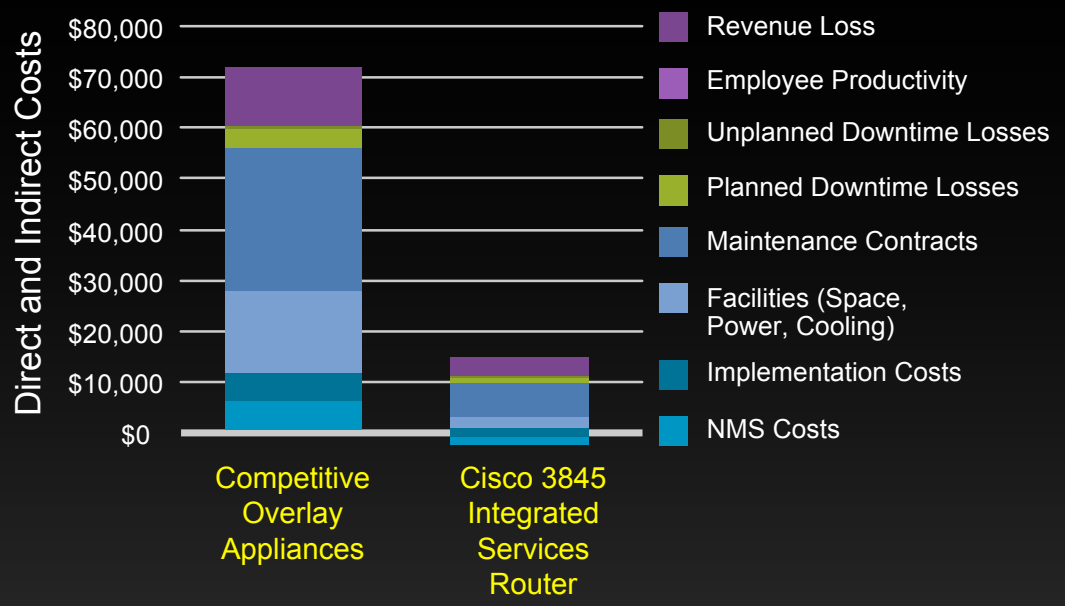


Market Acceptance for Integrated Services

Four Million Routers Sold



Total Cost of Ownership



Cisco ISR Service Integration: Up to 70% OpEx Reduction

Service Interoperability
Operational Efficiency
Systems Support
Investment Protection

Branch Architectures

Why, When, Where, and How?

Addressing the New Business Realities of Distributed IT

Interactive Business

Collaboration Tools

Branches Consume 70% of IT Resources*

Number of Branches Is Growing 10% per Year**

WAN Costs Are > 30% of Operational Expenses

Video on Demand

Web 2.0

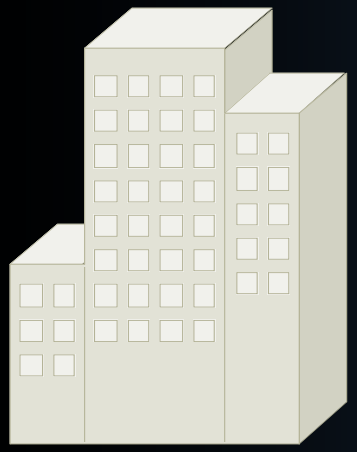
Wireless Mobility

Source: *Internet Research Group, 2005; ** Nemerts Research Virtual Workplace: Branch Office Strategies

Centralized

Decentralized

Data Center



Pros

- Simplified administration
- Operational efficiency
- Lower cost

Cons

- Performance
- WAN dependence
- Productivity
- Decision making

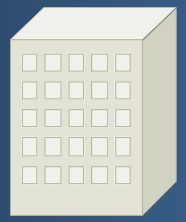
Pros

- Branch performance
- Branch productivity
- Localized decision making

Cons

- Multiple appliances
- Operational inefficiency
- Cost with branch scale
- Administration

Branch



Centralized

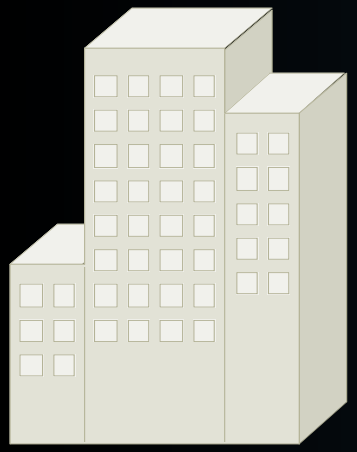
- Core Business Logic
- Heavy Lifting Computes
- Global Services

ISR

Decentralized

- Local Business Logic
- Distributed Computes
- Survivable Services

Data Center



Pros

- Operational efficiency
- Branch performance
- Service consistency

Cons

- Simplified administration
- Multiple appliances
- Single vendor support

Pros

- Branch performance
- Branch productivity
- Localized decision making

Cons

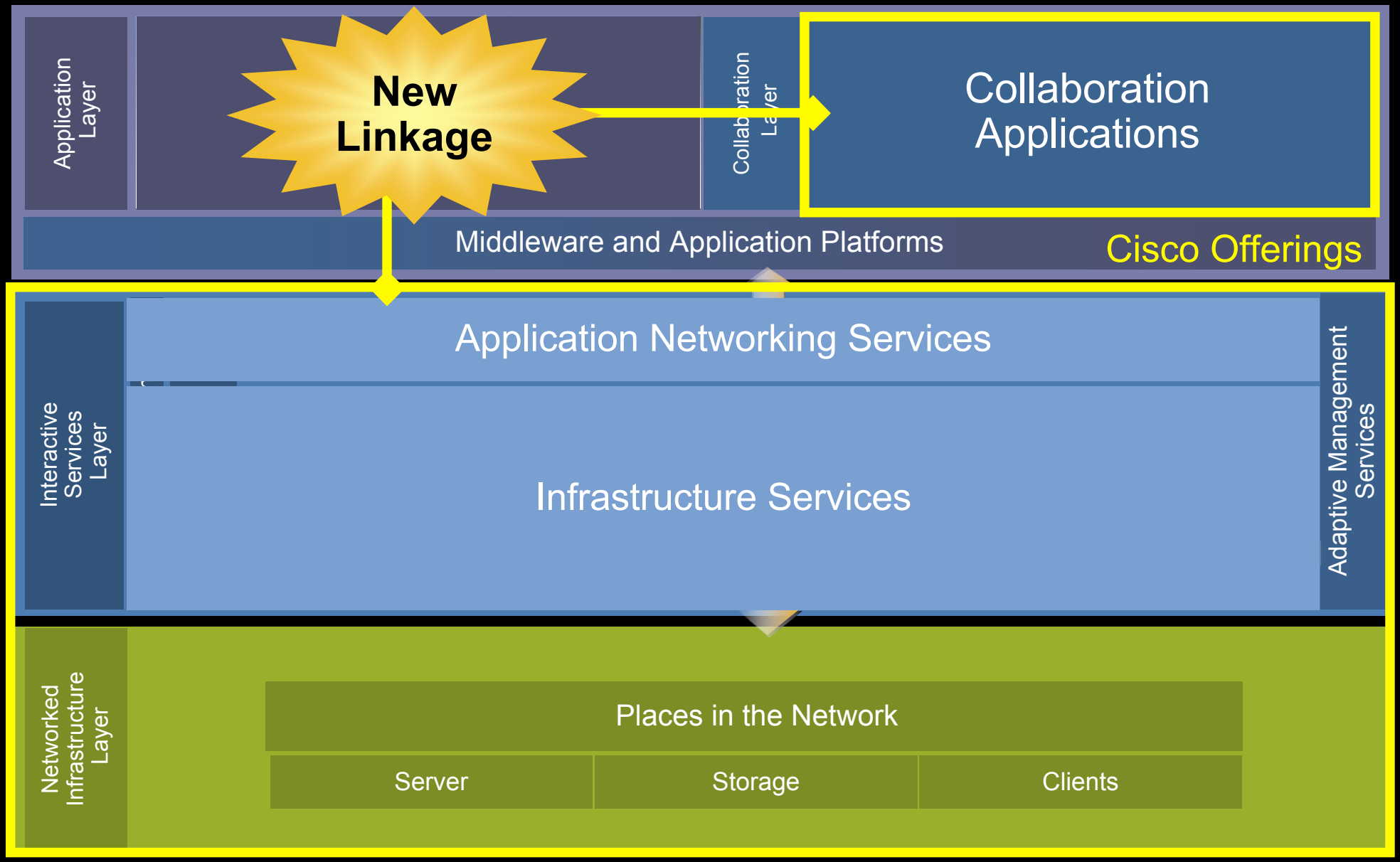
- Operational inefficiency
- Scales hybrid approach
- Cost with branch scale

Cons

- Administration
- Integrated versus “pure play”

Integrated Branch

Service-Oriented Network Architecture (SONA) Framework

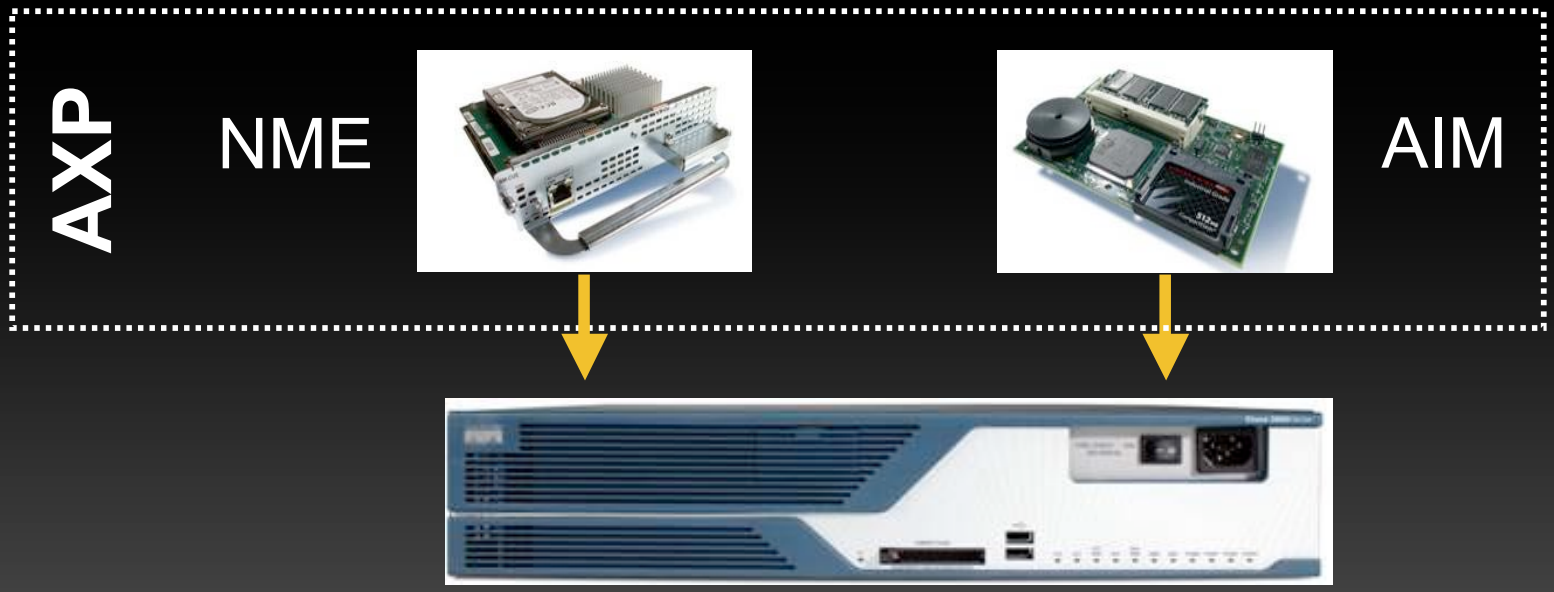


AXP Overview

The Architecture Behind Cisco's New Application Extension Platform

Cisco's Application eXtension Platform

Host Application Services on Cisco's ISR



Application Services on Integrated Services Modules

- Network Module (NME): 1.0/1.4 GHz Intel Pentium M; 512 MB to 2 GB RAM; 80 to 160 GB hard disk
- Advanced Integration Module (AIM): Intel Celeron 300 MHz; 256 MB RAM; 1 GB MB Flash

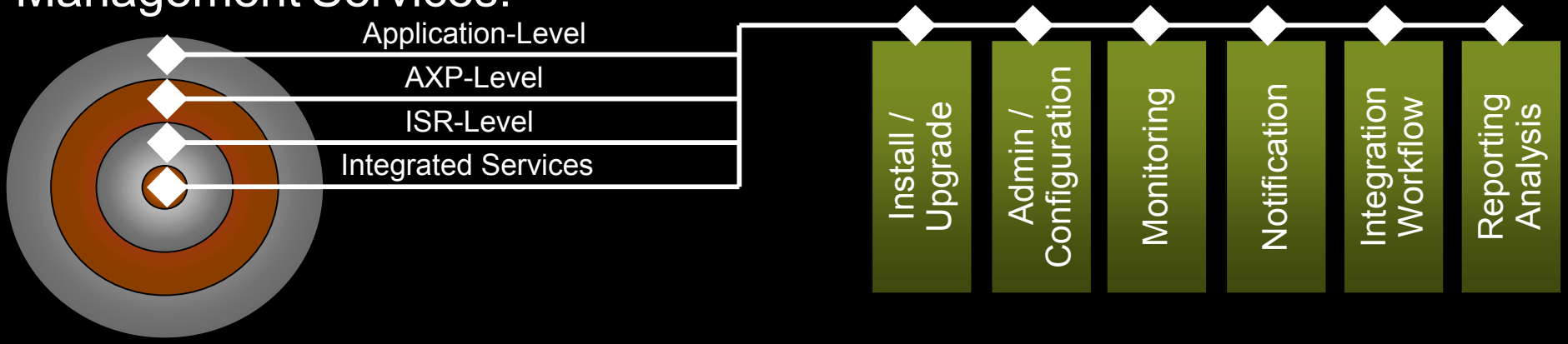
Supported Hardware

- AIM 102
  - CPU: 300 Mhz
  - Memory: 256 MB
  - Compact Flash: 1 GB
- NME 302
  - CPU: 1.0 Ghz
  - Memory: 512 MB
  - Disk: 80 GB
- NME 522
  - CPU: 1.4 Ghz
  - Memory: 2 GB
  - Disk: 160 GB

	AIM 102	NME 302	NME 522
Cisco ISR 1841	Y		
Cisco ISR 2801	Y		
Cisco ISR 2811	Y	Y	
Cisco ISR 2821	Y	Y	
Cisco ISR 2851	Y	Y	
Cisco ISR 3825	Y	Y	Y
Cisco ISR 3845	Y	Y	Y

AXP Services Model

Management Services:



Security Services:

Cisco AXP:
Application
e**X**tension
Platform

Software:
- Virtualized hosting environment
- Cisco Linux OS
- Monitor/Configuration API's

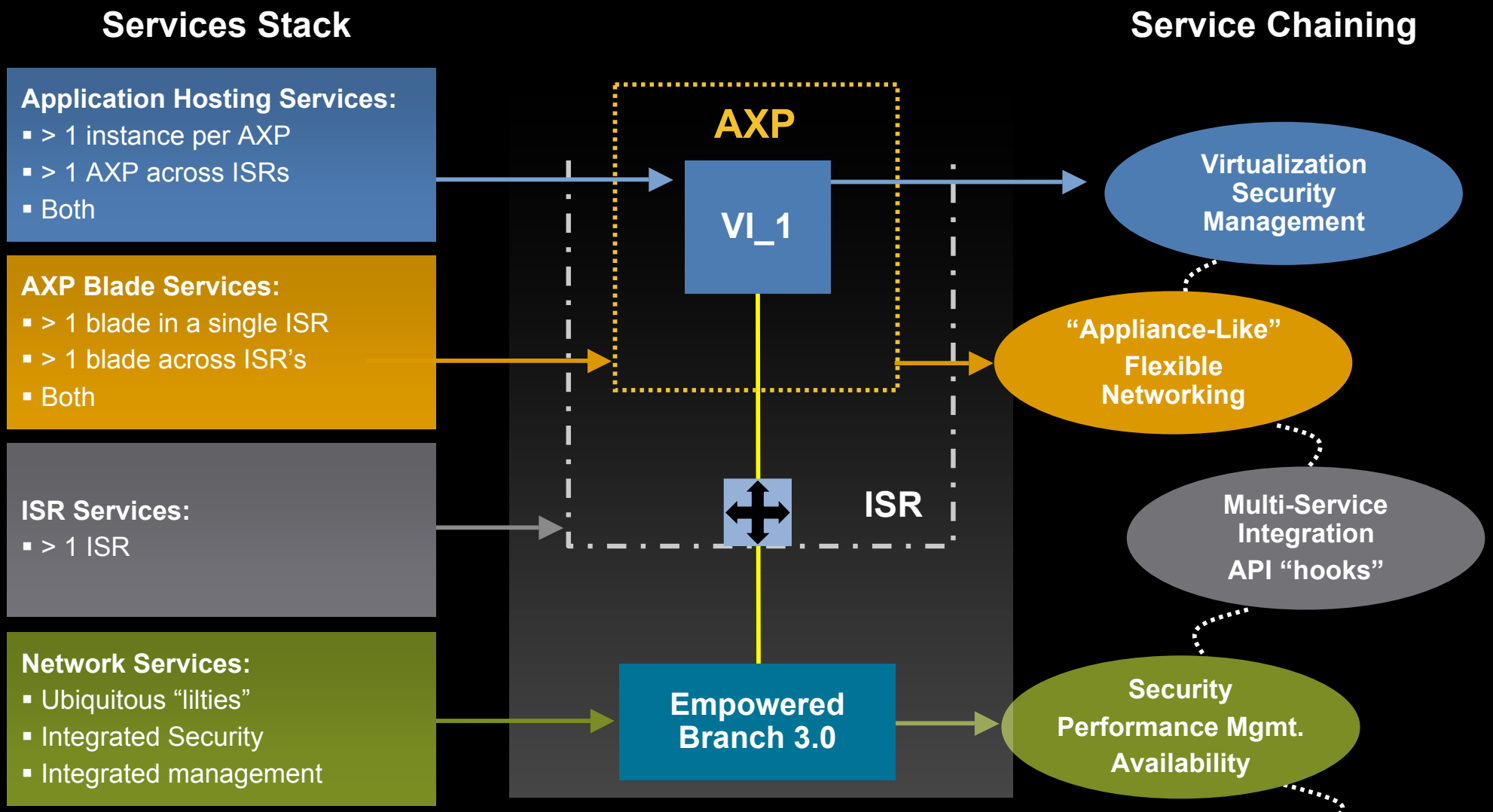
Hardware:
- Standalone CPU, HD, Memory
- NM, AIM service-modules
- ISR 3800, 2800, 1800 support

Linux:
SW Trust Chain
Hardened Linux OS
Rogue SW Protection

Cisco IOS:
ACLs
Stateful FW
IPS

Network Security:
Self-Defending NW

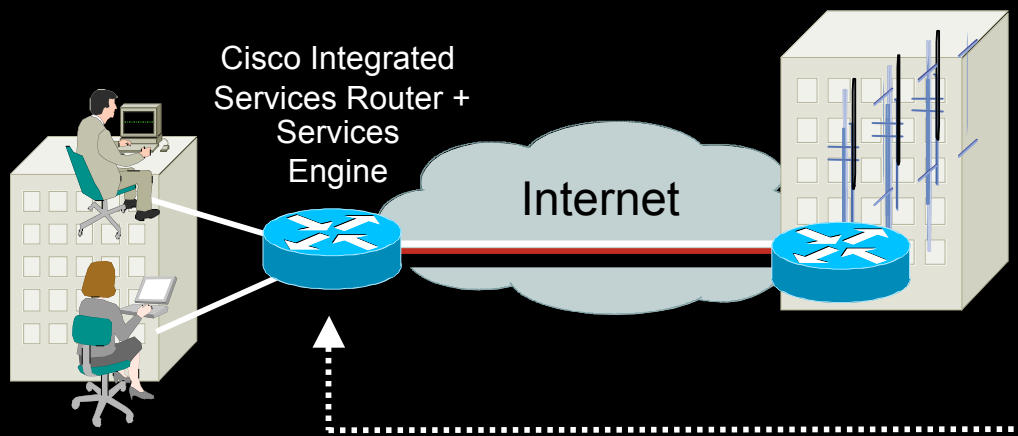
Redundancy Drives HA

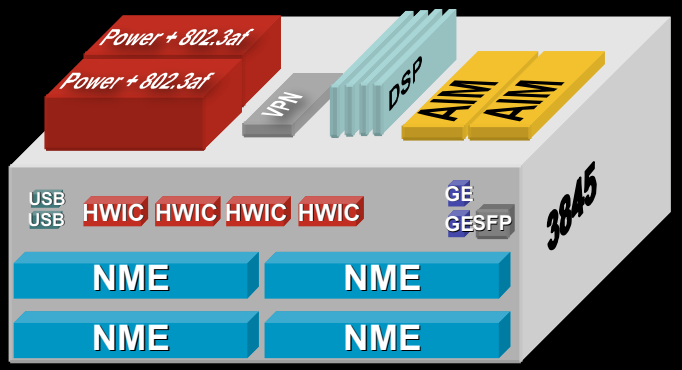


Each Layer Affords Service to the Overall Solution, Where Service "Chaining" Comprises Overall Composite Service to Applications

Services Engine Overview

Service Engines Enable **Services Integration** at the Branch While Preserving Router CPU/Memory for Critical Connectivity and Cisco IOS





- Router integration
  - Blade control protocol between Cisco IOS and service module
- Hardware efficiencies
  - Eliminates separate appliance and preserves rack space
  - Offloads processing/memory to application-specific platform
- Lower total cost of ownership
  - Simplifies deployment/maintenance/management

Service Engine Hardware Offerings

- AIM: integrated into base routers (1841, 28xx, 38xx)
- NM: slot-based module (28xx, 38xx)

AXP Technical Overview

Dedicated Application Resources

- Dedicated CPU, memory and Disk
- Application separated from core router functionality
- Full networking

Standards-Based Hosting Infrastructure

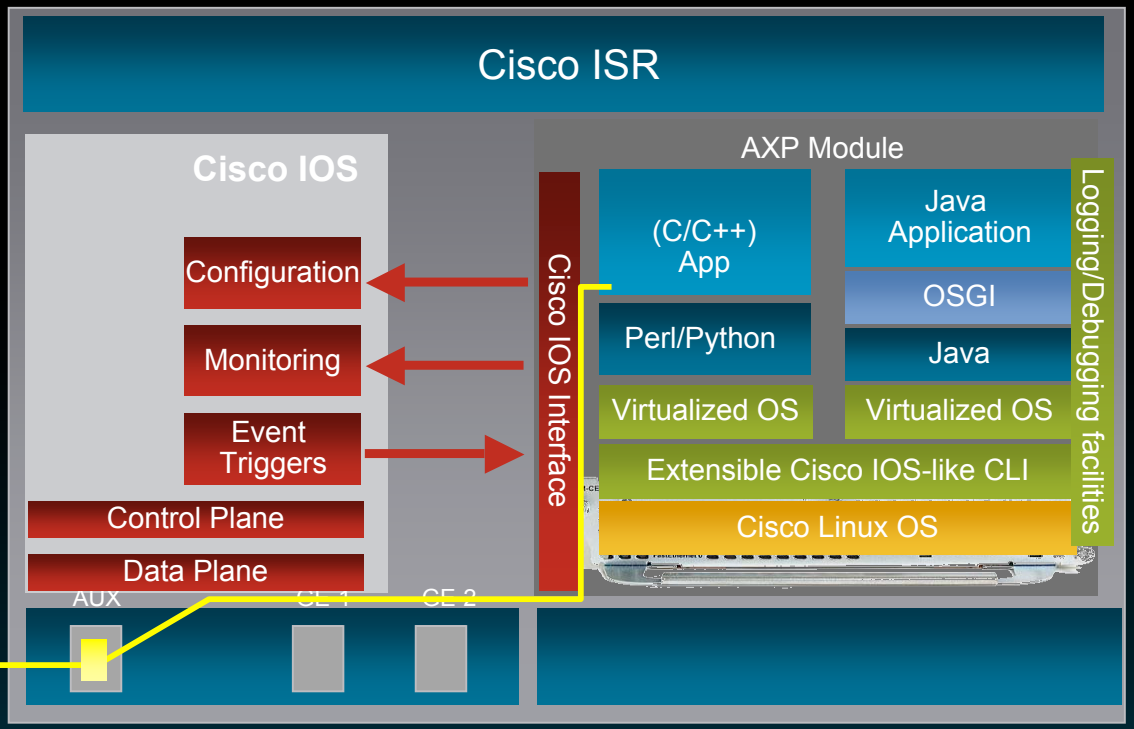
- Hardened Cisco Linux OS with virtualization
- Complete install/upgrade packaging utilities
- Logging and debugging infrastructure

Programming Support

- Support for Native x86 C/C++
- Java support w/ optional OSGI and Tomcat
- Scripting Support (bash, perl, python)

Value-Added Features

- Serial tunneling providing application access to external devices
- Syslog server to store logs from router and other local devices
- Netflow collector to persist and analyze flows locally



Cisco IOS APIs Integrate the Application into the Network

- Programmatically configure and monitor Cisco IOS
- React to changes in network conditions
- Programmatically Influence Routing, QoS and IP-SLA
- Monitor packets flowing through network

AXP Software Services

Core Software Aspects of the System

Cisco Linux OS Overview

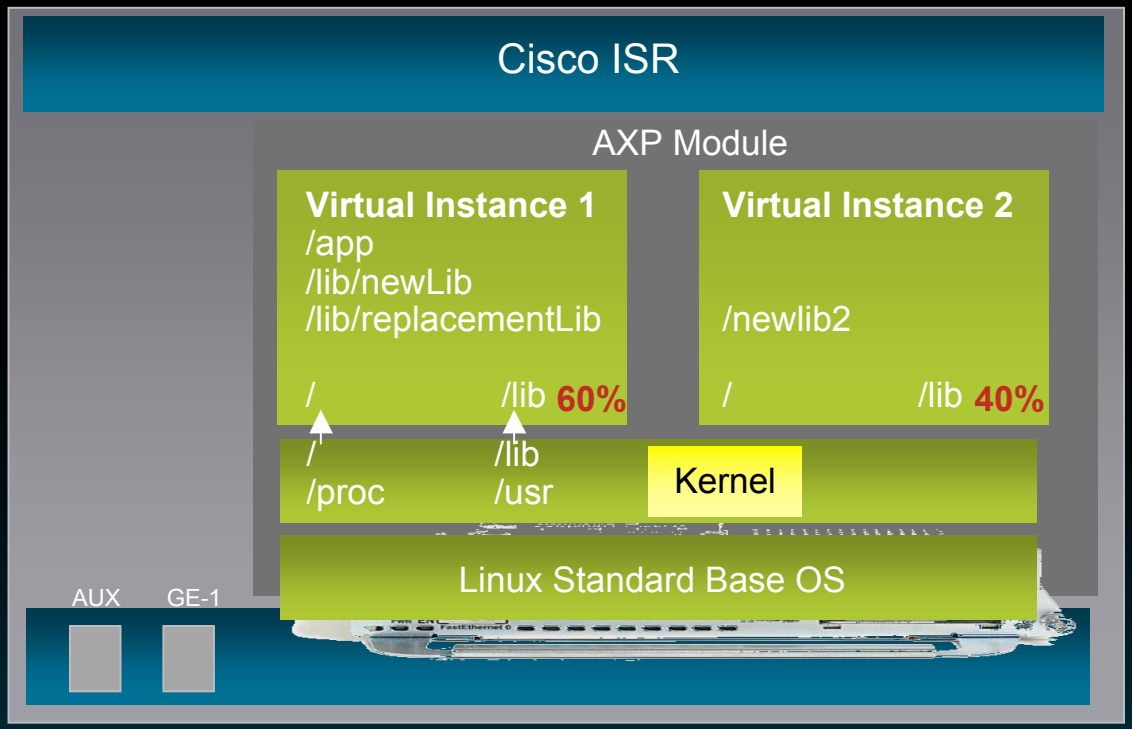
LSB (Linux Standard Base)

- http://www.linux-foundation.org/en/LSB:
  "currently all major distributions comply with LSB"
- Provides a single target for ISVs writing or porting to the Linux platform

  Asianux 2.0, Debian 4.0,Mandriva Corporate 4.0
  Red Hat Enterprise Linux 4 and 5
  SUSE Linux Enterprise 9 and 10
  Ubuntu 6.06 LTS ("dapper")

Linux V-Server

- Creates Virtual instances. Each virtual instance provides a full Linux OS.
- Integrated with AXP Packaging System
- LSB Components of host "Linked" into Guest



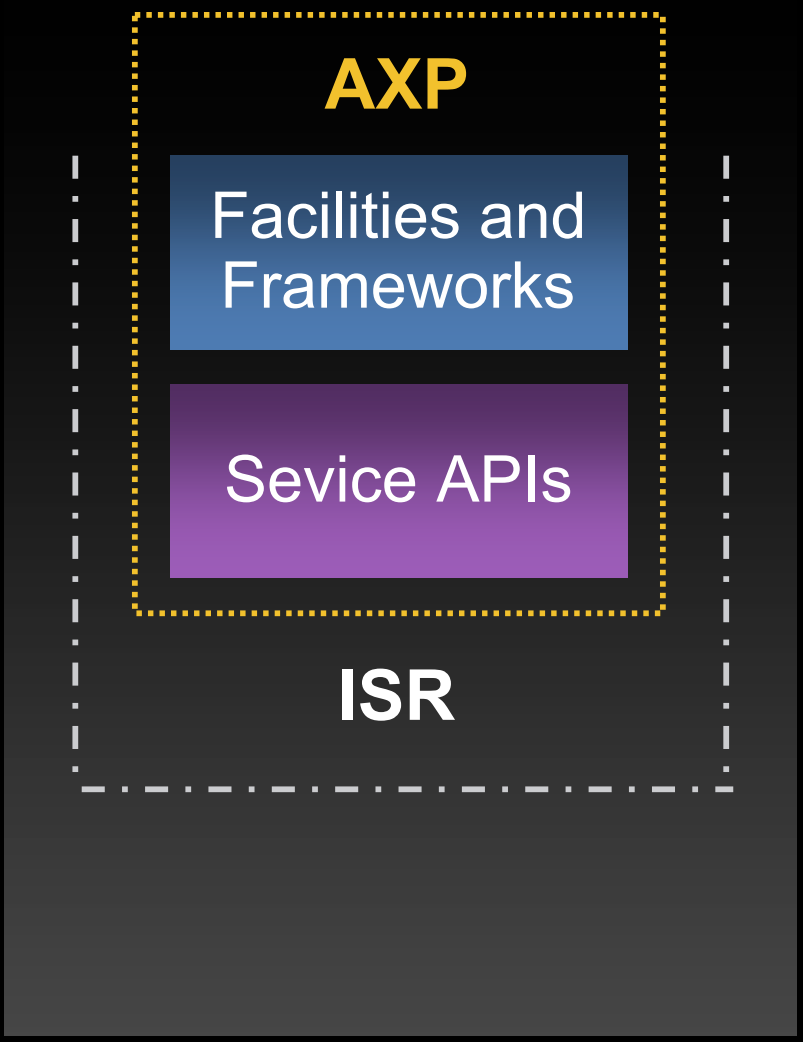
Not Limited to LSB Components

- LSB Components are installed by default.
- Missing Linux components can be packaged as part of the application.
- Application versions prioritized over LSB components during package install

Benefits of Environment

- Consolidation and Separation
- Resource Guarantees
- Independence

AXP Cornerstones and Tenets



- Predictable and constant set of resources to third-party applications
- Discrete execution environment
- Extensible and flexible
- Integrated configuration, monitoring, and debugging environment
- Robust debugging and troubleshooting facilities
- Security against unauthorized software being loaded

AXP Environment

- Third-party applications hosted on ISR blade
- Third-party applications have access to Cisco IOS → advanced applications
  - Modify Cisco IOS configuration
  - Receive notification of events from Cisco IOS
  - Access serial peripherals attached to the ISR

AXP OS
Software Hosting Environment

- Linux-VServer built on top of Cisco's Linux OS
- Prevents third-party software from interfering with host OS
- Creates virtual instances for application separation
- Managed through host OS via CLI
- Reduced troubleshooting times
- OSGI framework enables remote secure lifecycle management of Java applications

AXP OS
Packaging, Code Signing, and Upgrade

- Packaging mechanism
  - Ensures only approved Cisco and third-party applications installable
  - Ensures application integrity prior to install
- Installation framework provides third-party upgrades

AXP OS
Native and Interpreted Applications Support

- Embedded Linux environment supports multiple programming languages
  - Java
  - C (native)
  - Perl (interpreted)
  - Python (interpreted)
  - Bash (interpreted)
- Availability to extend existing support via third-party–supplied libraries and interpreters

Virtualization

Using Open Source VServer for Application Sandboxing

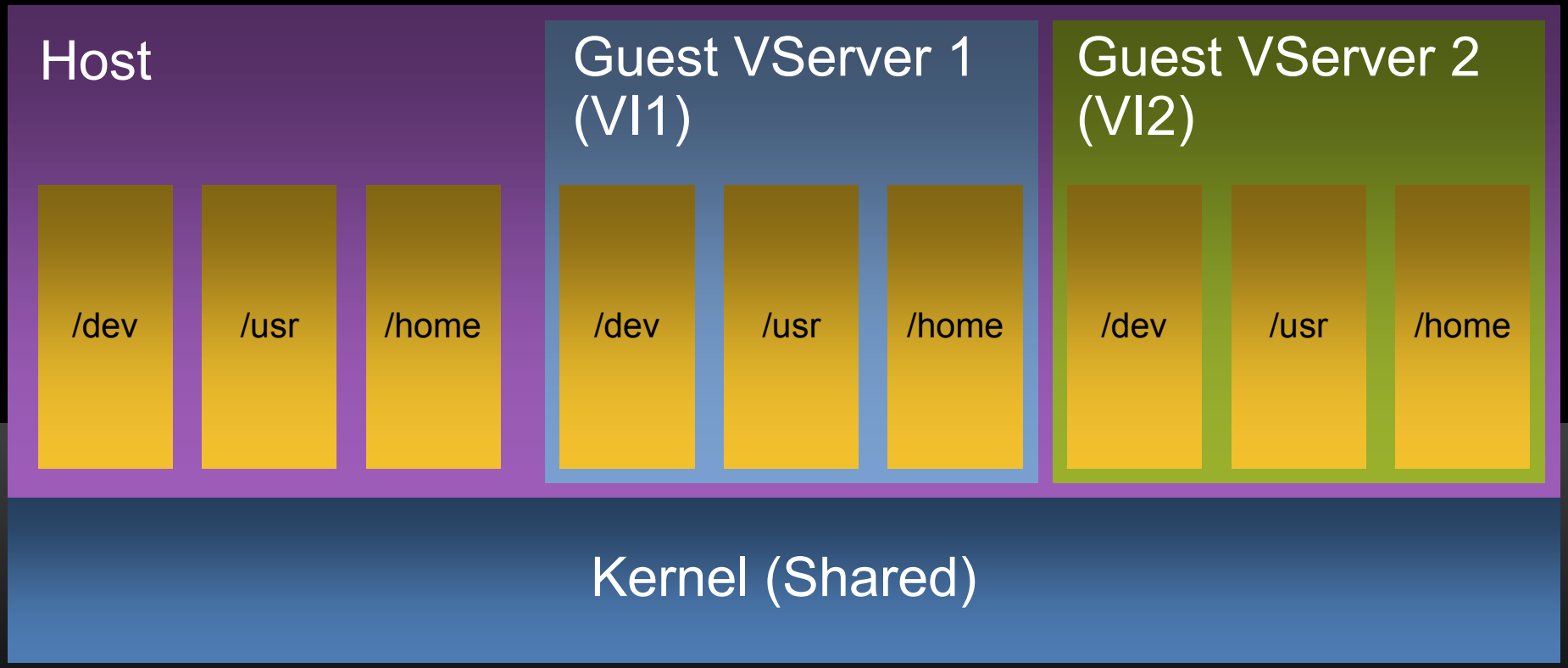
AXP
Virtualization

- Multiple third-party applications running simultaneously on a single AXP blade
- Start/stop/control management plane for individual applications
- Complete isolation ensures discrete health state
- Each application runs its own virtual instance
- Security and fault isolation is at the application/process level, not the kernel/OS level

AXP
Linux-VServer

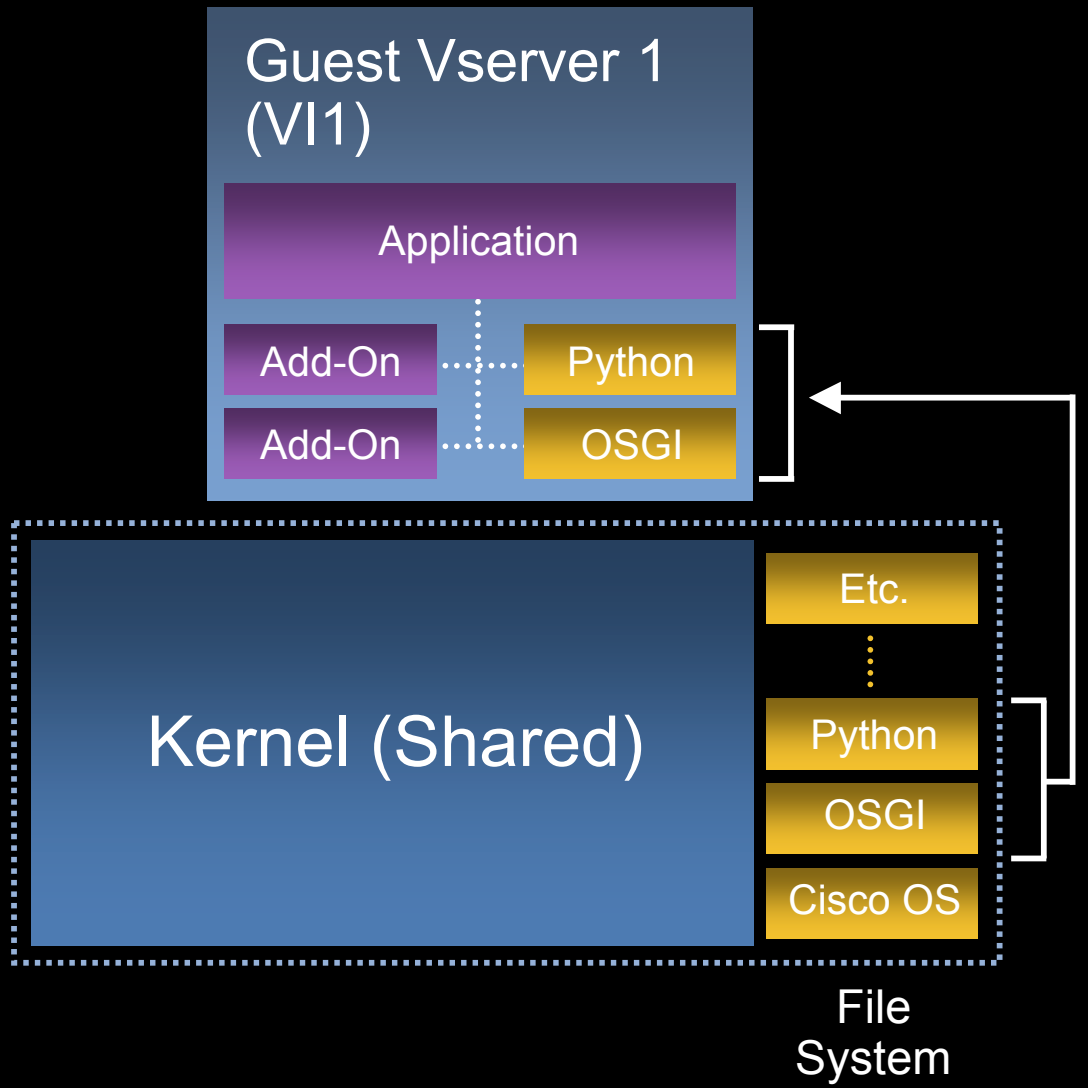
- Container-based virtualization
- Broad-based CPU support, good resource usage, single Linux kernel support (x86 support for AXP—future releases to support additional platforms)
- Efficient use of resources (kernel-level isolation)
  - Process-level security
  - Processes utilize shared resources (no hard partitioning)

AXP
Linux-VServer



AXP
Add-On Packages

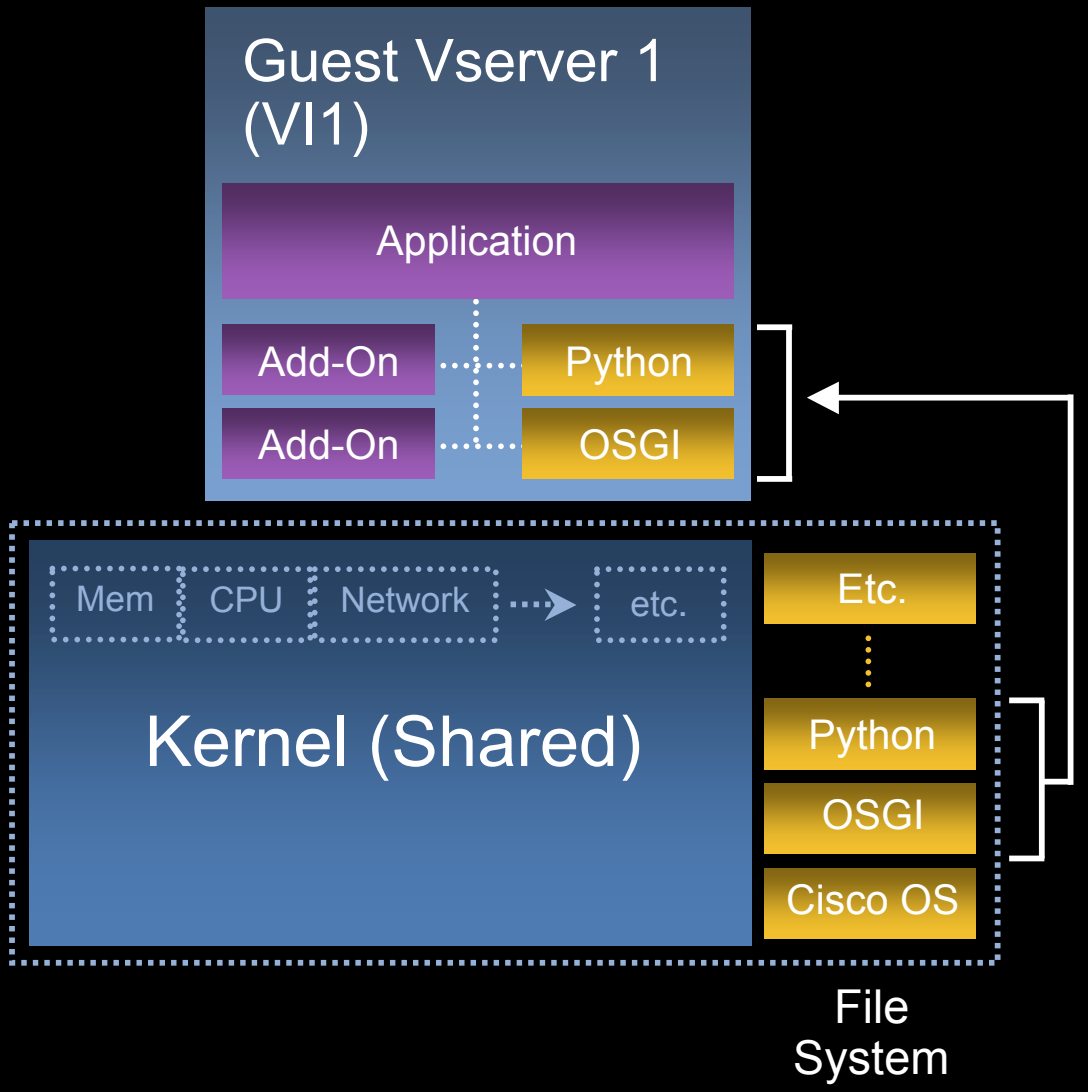
- AXP ships preloaded with Cisco OS that supports virtual Instances
- One copy of infrastructure add-ons will be kept in file system (created and signed by Cisco)
- Infrastructure add-ons are instantiated in VI during runtime startup (shared files)
- Third-party add-ons are loaded by third-party vendor



Shared Files Results in Increased Efficiency in System Resource Utilization

AXP
Installation Process

- Determine dependencies based on third-party application's AXP manifest file
- Create VI and register third-party application in AXP CLI
- Implement shared files by creating hard links
- Install third-party application in VI (may overwrite hard links from Step 3)
- Execute post-install configuration script (resource allocation, network configuration, etc.)



CLI Capabilities

Command Line Interface

AXP CLI Structure
CLI Extensions (Third-Party CLI Integration)

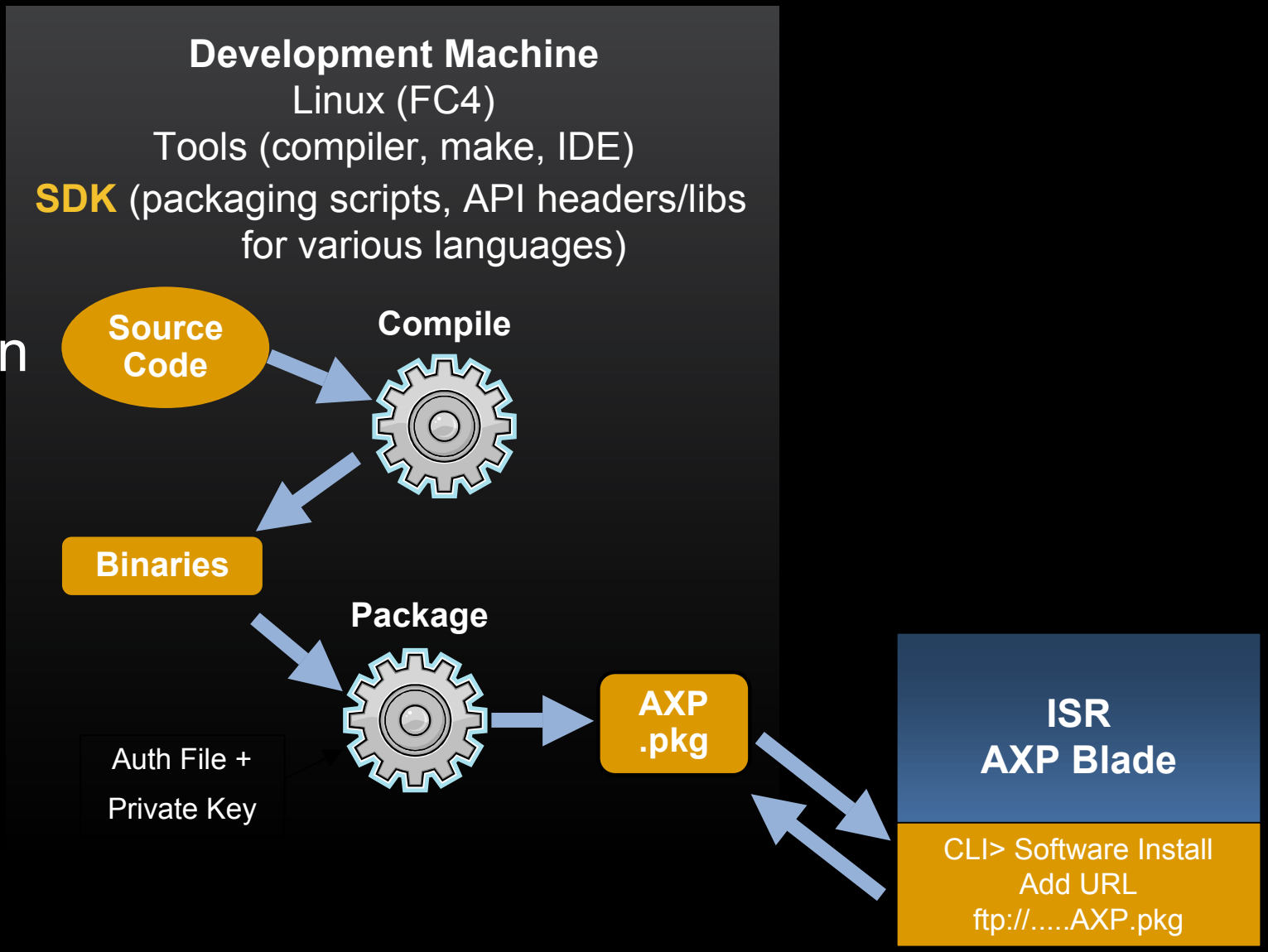
- Custom CLI service
  - CLI server plug-in tools
    - Tools used at third-party development time to validate, process and package the custom CLIs
  - CLI distribution service
    - Interface between AXP CLI server and third-party applications; handles distribution of custom CLIs from AXP CLI server to third-party application that CLIs belong to
- Custom CLI definitions
  - Cisco-defined syntax
- Custom CLI actions
  - Java, C, Shell script implemented via Cisco-defined signatures

Packaging Applications in AXP

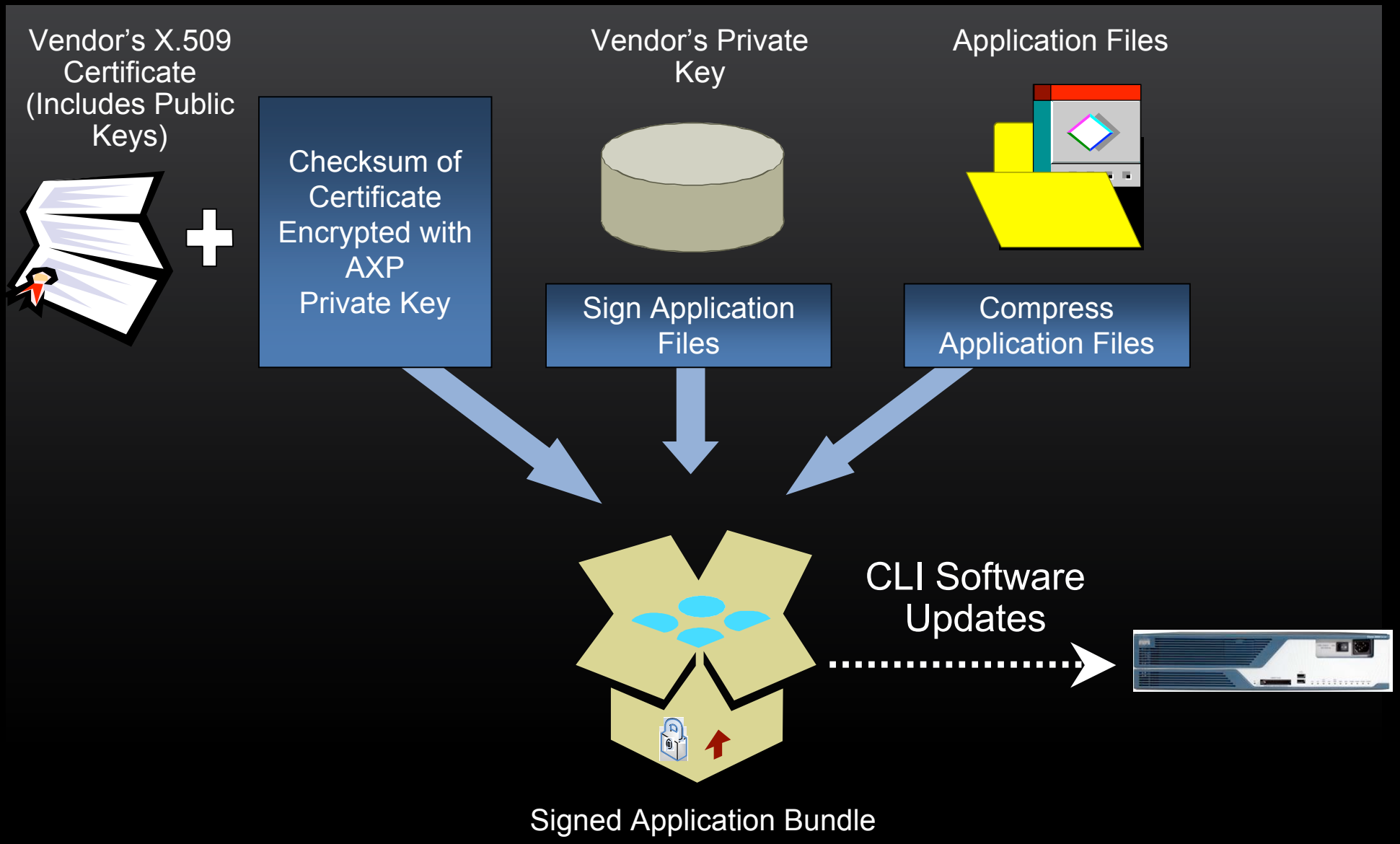
Packaging Is a Core Element of AXP's Value Proposition

Development Process—Production

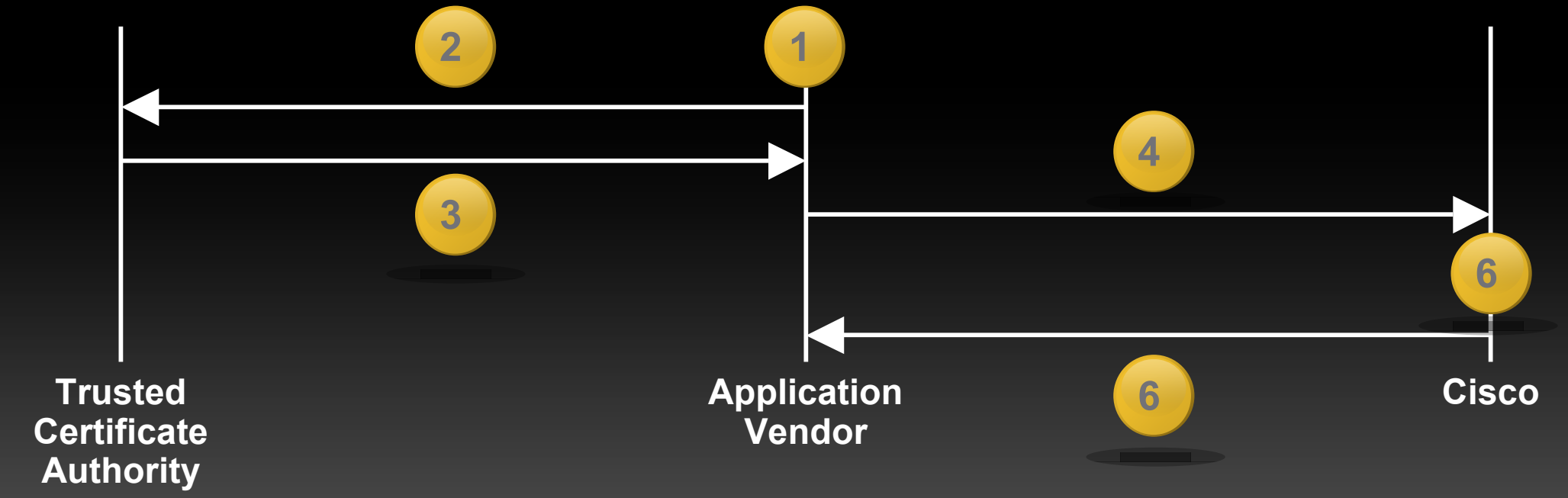
- SDK
- Develop
- Package
- Installation



Application Packaging



Packaging and Bundling Applications
Issuing Application Development Authorization



- Generate certificate request (private/public keys)
- Request certificate signing
- Respond with signed X.509 certificate
- Request software development authorization (include signed certificate)
- Verify certificate authority
- Respond with software development authorization

Application Monitoring, Logging, and Tracing

Monitoring, Logging, and Tracing of Applications in VIs

Application Status
Monitoring State and Health

Application	State (VI)	Health (App)	Meaning
App_A	Online	Initializing	VI Is Running; App Is Starting
App_B	Online	Alive	VI Is Running; App Is Starting
App_B	Online	Down	VI Is Running; App Is Down
App_C	Online	Down	VI Is Down

AXP provides an API call for an application to report its health

Note: AXP will not actively monitor application health values; the application has to report its health to the AXP host

Application Logging
Logging Levels

Syslog Level	Meaning	CLI Access?
LOG_EMERG	System Is Unavailable	No
LOG_ALERT	Action Must Be Taken Immediately	No
LOG_CRIT	Critical Conditions	No
LOG_ERR	Error Conditions	Yes
LOG_WARNING	Warning Conditions	Yes
LOG_NOTICE	Normal, but Significant, Condition	Yes
LOG_INFO	Informational Message	Yes
LOG_DEBUG	Debug-Level Message	No

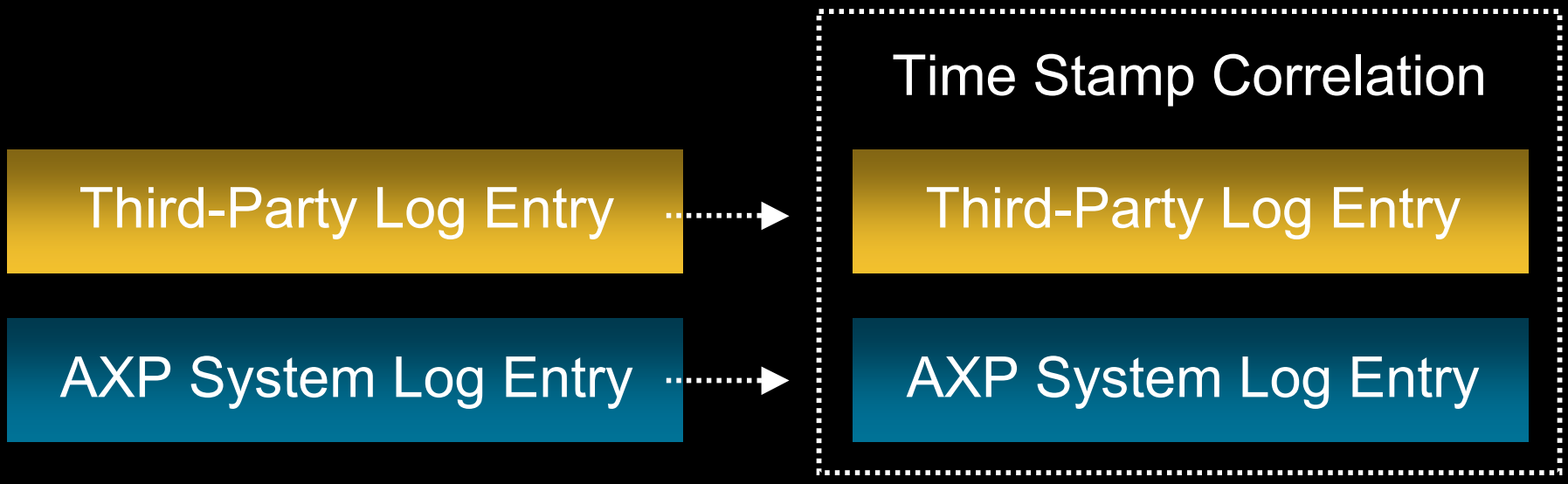
All log levels are available to the application, however, CLI will reduce configuration to four log levels shown above

Application Tracing

- Support for both system level and application level tracing support
  - Third-party software can output internal trace information
  - Both third-party app and OS level logging will be logged to syslog
- Tracing most useful for debugging system-level defects
- Application level tracing within the virtual application environment can be merged with logging (syslog) with no loss of its functionality

Application Logging
Logging Correlation Between AXP and Applications

- Log messages are correlated with each other between third-party applications and AXP components



AXP
Syslog Server

- Optional enabling of a syslog server on AXP OS
  - Allows AXP device to collect log messages from other physical and virtual devices (e.g., virtual instances)
  - Syslog server will accept messages from any source on the network, no authentication support will be considered
  - Maximum size of log file configurable by customers
- Disk requirements
  - Syslog feature consumes available storage space (shared with virtual instances), within limits set by administrator
  - Proper planning required
- Log files available for download
  - Via CLI command
  - Linked to virtual instances (/var/log directories)

Resource Controls

Controlling Consumption of System Resources in Application Hosting Environments

AXP
Application Resource Utilization Control

Goal

Create a Predictable Application Hosting Environment That Does Not Require Complex Configuration

- Resource limits defined by application developer in resource file in package
  - Reside in application's manifest file (e.g., Mem = xMB, Disk = yMB)
- Resource limits based on platform capacities
  - Example: platform CPU index = 10000
  - Example: setting application CPU usage index to 6000 means 60% of CPU resources will be utilized (maximum)

Resource Management

- AXP automatically manages resource utilization globally, across VServer instances
- Example: “show resource limits”

Application	CPU (Index)	Memory (MB)	Disk (MB)	Log (MB)
App_#1	1500	160	150	5
App_#2	5000	256	15,000	5
System Total Allocated	6800	496	15,330	–
Resources Available	3200	4	60,985	–

AXP
Enforcing Resource Constraints

- During application install the following checks will be performed:
  - Application resource profile is compared to available resources to determine if resources available
  - Installer will update global resource tracking database when new applications are installed

AXP SDK

Third-Party Development Environment

AXP SDK

- Cisco will provide 3d-party vendors with an SDK for the Linux environment; the SDK will include:
  - The standard infrastructure add-on packages
  - Information about recommended GCC compiler
  - AXP Guest OS libraries and header files
  - AXP server libraries and any associated header files
  - Tool to simplify manifest creation, including specification of dependencies
  - Toolkit for developing custom application CLI
  - Application packaging and signing tool

Debugging Applications

Third-Party Development Debugging Capabilities

Debugging

- Remote debugging capable
  - Remote debuggers written in C/C++ only
  - Remote Java debugging requires application developer to include remote debugger (eg. Jdb) or compile remote debug stubs into their application
  - Debugging packages removed for production
- SSL Tunneling
  - OpenSSH
  - Enables debugging more easily through firewalls
- SSL Tunnel Authentication
  - Public key or;
  - Password authentication based
- Disabled in production blade by default

Network and Hardware Services

Programmatic Interface to Integrate with Network Services

AXP Network Support

Internal Interface Connects Blade to the Router

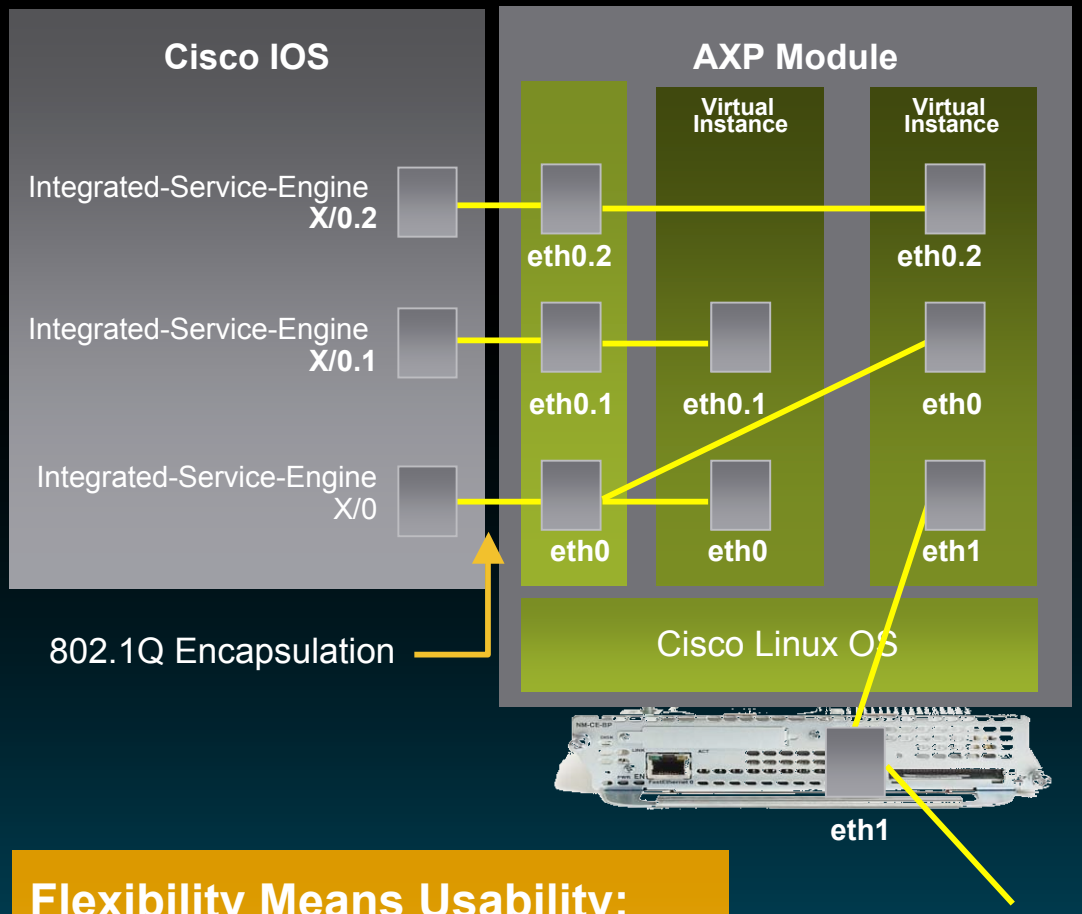
- Integrated-Service-Engine X/0 is the interface on Cisco IOS
- Eth0 is the interface on the Linux side

Virtual Interfaces "Bind" to Interface

- Flexible use of available interfaces
- Sub-interface support
- 802.1Q (VLAN) Encapsulation support
- VRF support

External (NME only) Interface

- Exposed to Linux as *Eth1*
- Virtual instances optionally bind to interface
- Externally routable interface
- Configurable as default route



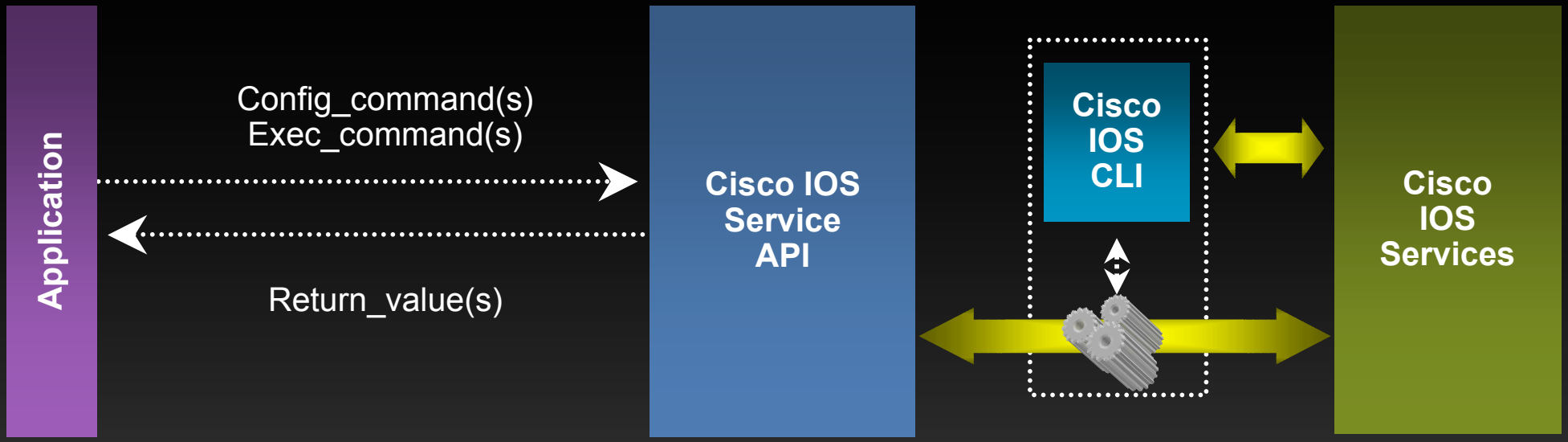
Flexibility Means Usability:

- Migrating existing applications from servers to AXP made easy
- Multiple applications benefit from single or multiple subnets
- Security provisions at blade-level or application-level

AXP
Cisco IOS APIs

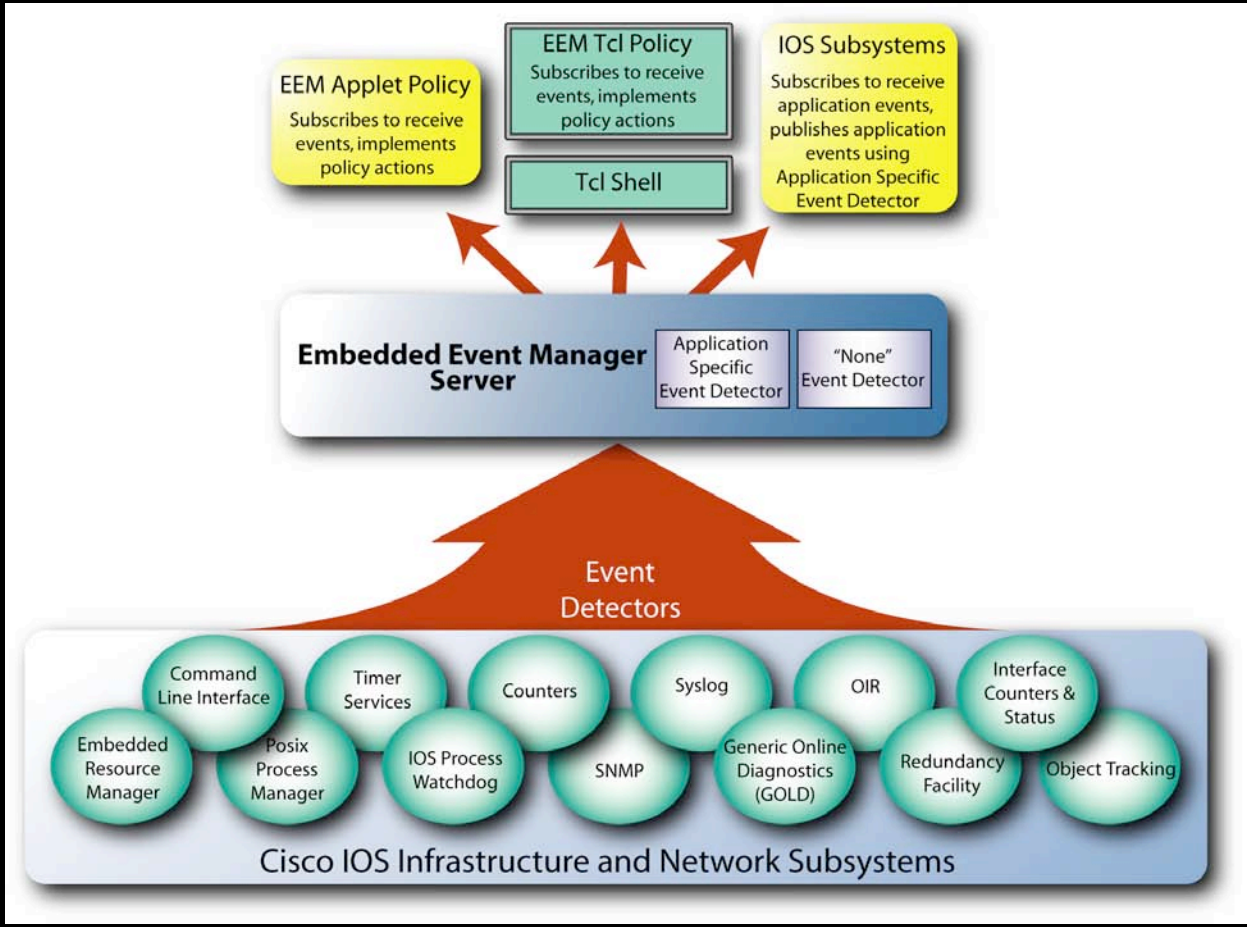
- Cisco IOS Configuration API
  - Allows the application to programmatically change the configuration of the router
  - Utilized for real-time changes “on the fly”
- Cisco IOS Information API
  - Provides query capabilities into Cisco IOS; data contained in show commands, SNMP and exec commands can be retrieved through this API
- Cisco IOS Trigger API
  - Facilities to send notifications to the application based on events in Cisco IOS; allows the application to react to network conditions, changes to Cisco IOS configuration and other Cisco IOS events
- Packet API
  - Mechanisms to send packets to third-party application for analysis or processing

AXP
Cisco IOS APIs



AXP EEM API

- Event Detectors
  - "Watch for events of interest"
- EEM Server
  - The "brains" of the system
- Policies (scripts)
  - Applets
  - TCI-based

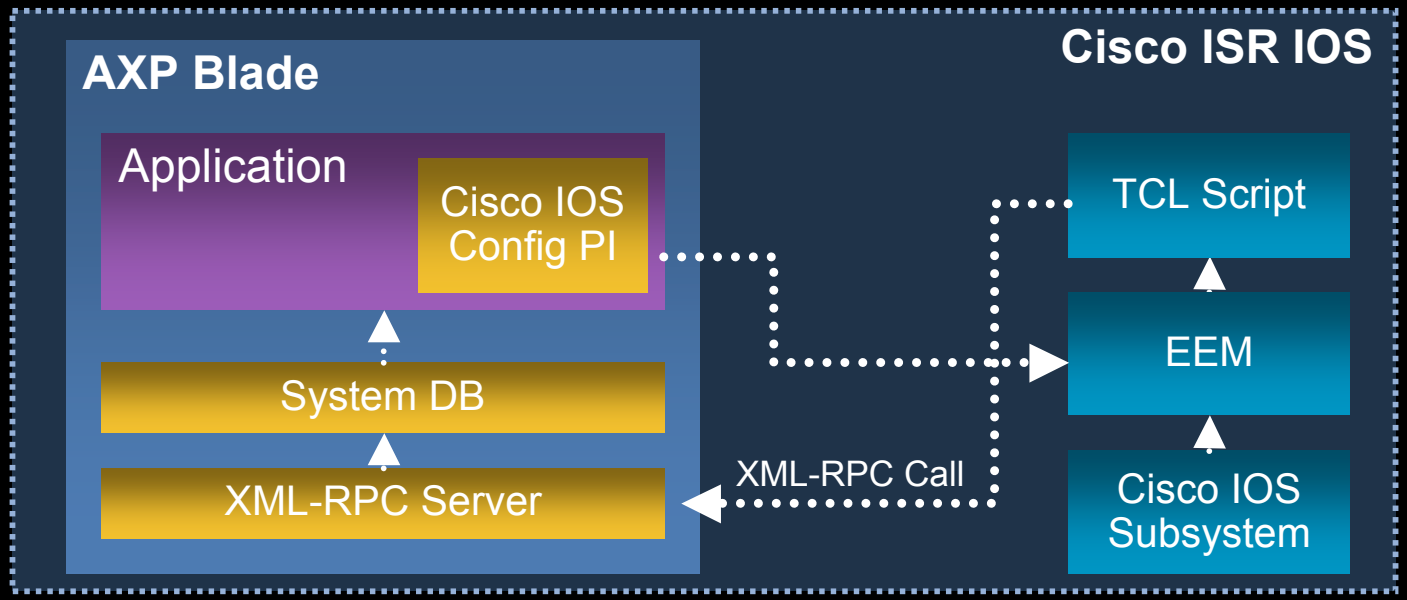


*** All within Cisco IOS**

AXP
Cisco IOS Event Notification

EEM—Embedded Event Manager

- Embedded Cisco IOS events trigger an XML-RPC call to an application (eg: config change, interface state change)
- Applications use API's to listen for events that they are interested in hearing about
- Configured via the CLI



AXP
L2/L3 Networking Considerations

- Individual Virtual Instances
  - Networking configurations decoupled from virtual instances
  - Virtual instance may bind to more than one network interface at a time
- Interface support
  - Physical Ethernet sub-interfaces
  - VRF support
  - VLAN interfaces (802.1Q)
  - SSH
- ISR configurations
  - Standard ISR IP routing configuration commands used
  - ISR IP configuration context separate from AXP IP configuration context

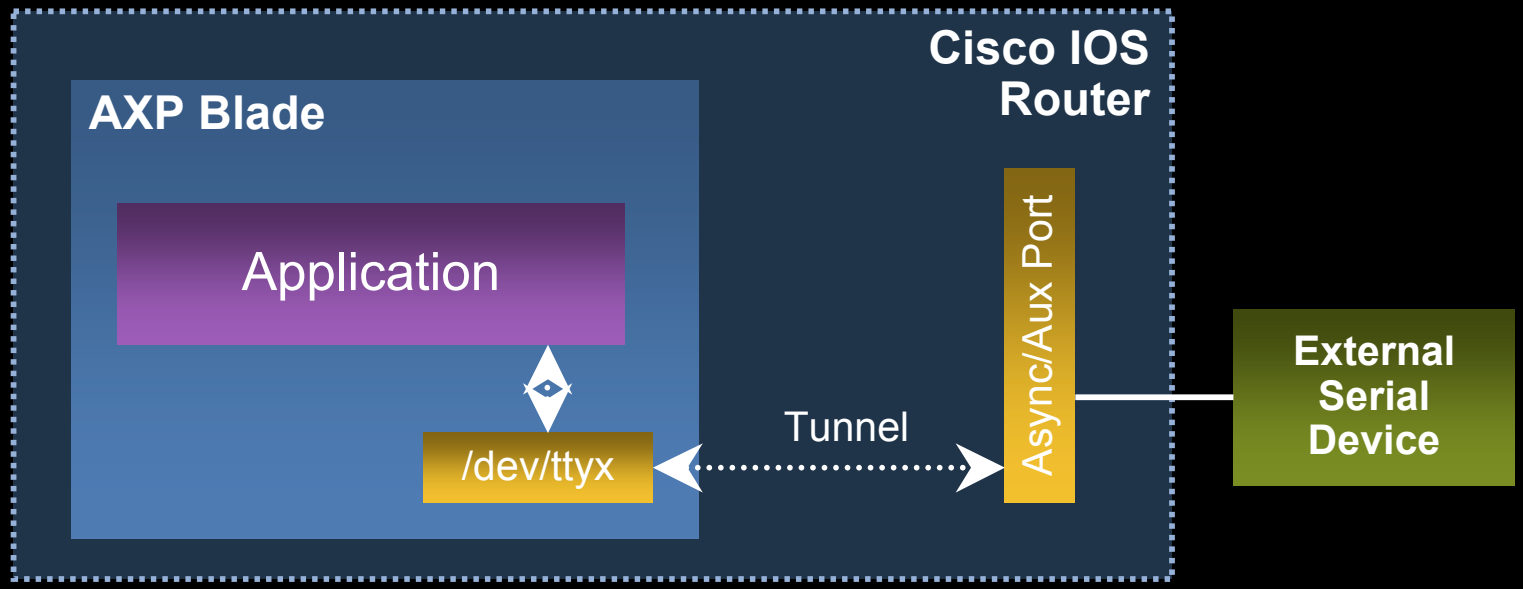
External Device Support

Applications Have the Ability to Connect to Devices External to the Blade

External Devices
Virtual TTY Devices

Cisco IOS Host Serial Port

- Local AXP host TTY device interacts with the external Cisco IOS serial device
- Device name: /dev/router.aux
- Reverse Telnet session established
- Serial port settings (e.g. baud rate) configured through Cisco IOS

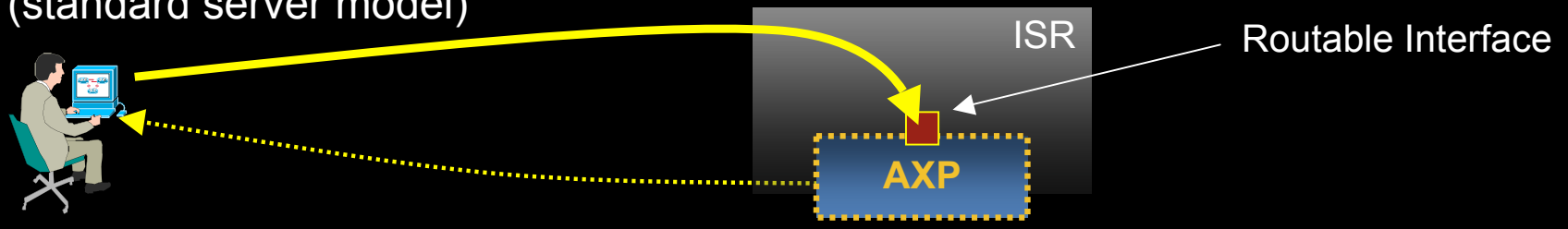


Packet Services

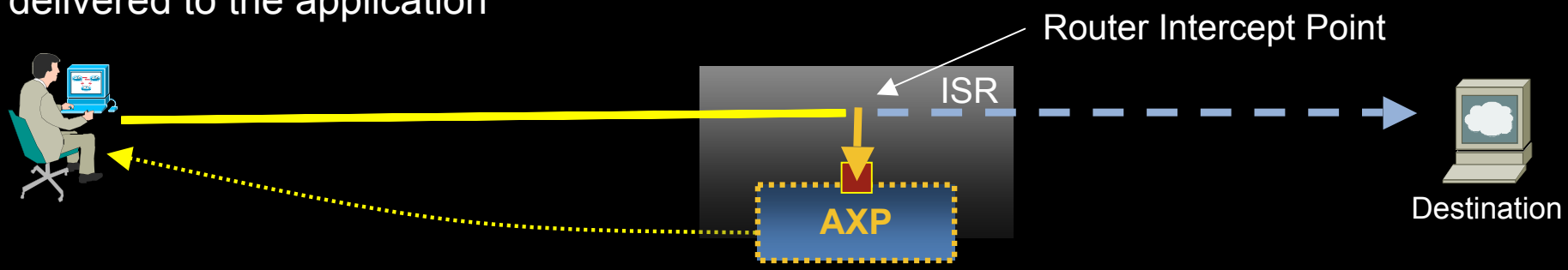
Using Cisco IOS Packet Services to Forward Packets to the AXP Service Module

Application Access Modes

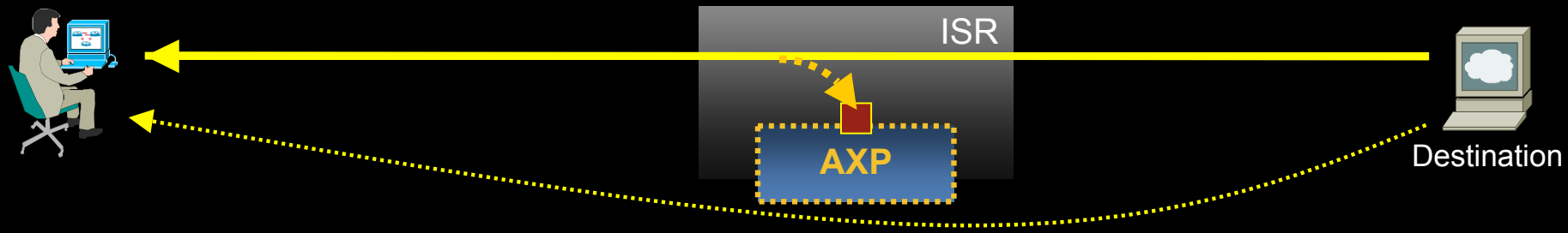
Direct Access—Client sends traffic directly to application IP address (standard server model)



Intercept—Traffic is sent to a remote host and is intercepted by the router and delivered to the application



Promiscuous—A copy of each packet is sent to the module for monitoring/analysis. Flow of packet is unaffected

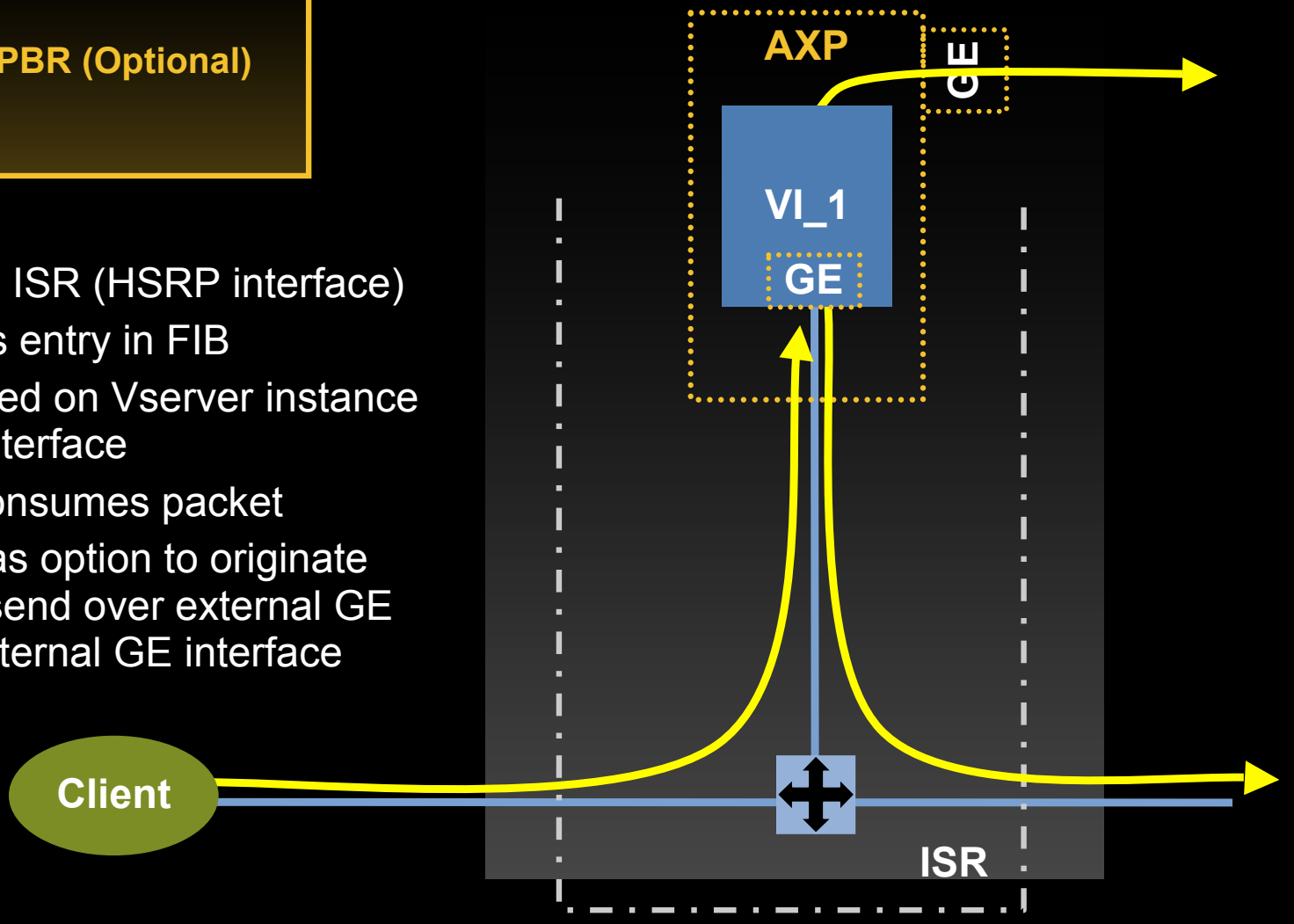


AXP—Direct Access/Intercept Mode

Enablers:

- **IP Routing and PBR (Optional)**
- **HSRP**

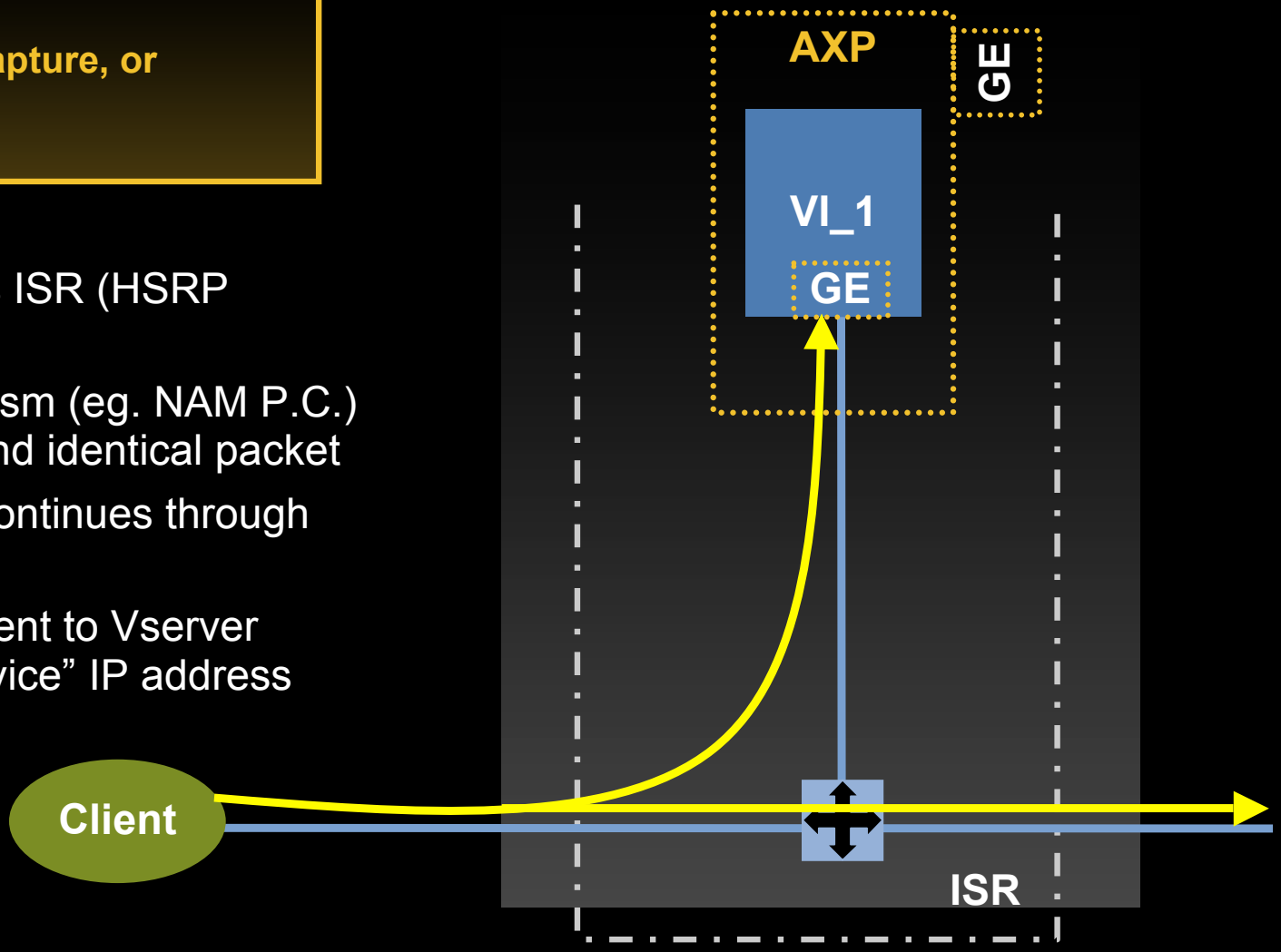
1) Packet enters ISR (HSRP interface)
2) AXP subnet is entry in FIB
3) Packet received on Vserver instance "service" IP interface
4) Application consumes packet
5) Application has option to originate packets and send over external GE interface or internal GE interface (ISR)



AXP—Promiscuous Mode
Sniffer Type Functionality (Like SPAN)

Enablers:
- **NAM, Packet Capture, or**
- **RITE**

1. Packet enters ISR (HSRP interface)
2. CEF mechanism (eg. NAM P.C.) spawns second identical packet
3. One packet continues through CEF stack
4. One packet sent to Vserver instance “service” IP address



HA Problem Statement

Fundamental Challenges in Achieving High Availability in General

Redundancy Drives HA

Redundancy Stack

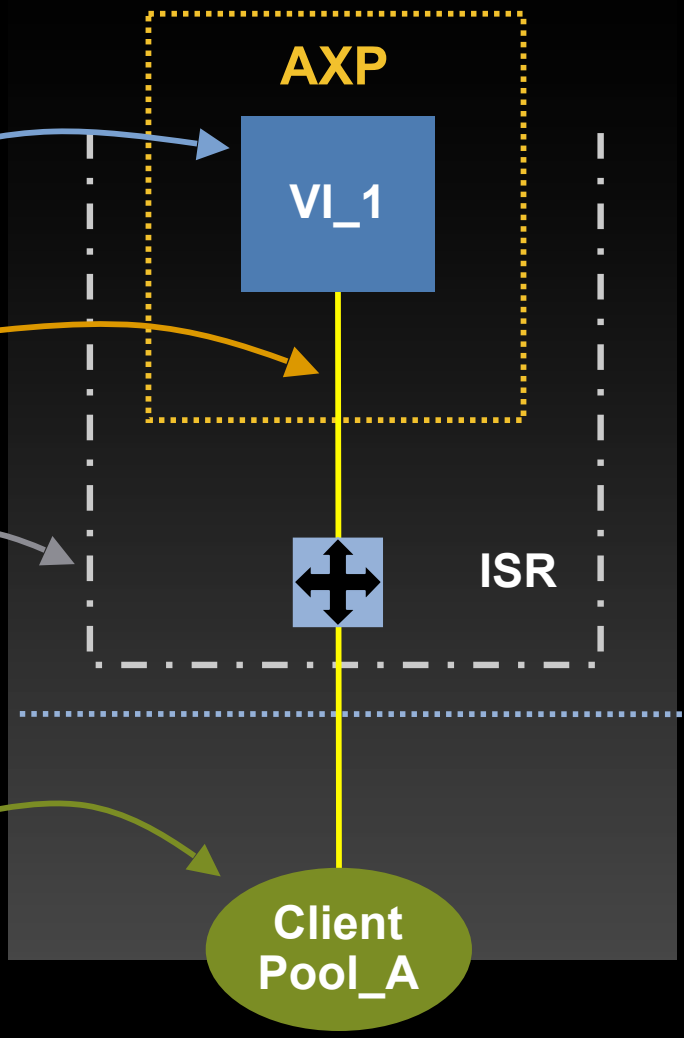
Application Redundancy:
- > 1 instance in ISR
- > 1 instance across ISRs
- Both

AXP Blade Redundancy:
- > 1 blade in a single ISR
- > 1 blade across ISR's
- Both

ISR Redundancy:
- > 1 ISR

Clients Redundancy:
- Dual-homed or -interfaced (optional)

Dynamic Bypass



Each Layer Needs to Be Considered Against the Following Criteria:

1. Active-Active
   - Load-Sharing
   - Load-Balancing
2. Active-Standby

It Is Critical to Impose System-Wide HA Mechanisms

Application Redundancy

Single Application, Single Blade, Single or Redundant ISRs

Redundancy Stack

Application Redundancy:
- PBR-based on "next-hop" config in Cisco IOS
- Dynamic bypass if VI failure

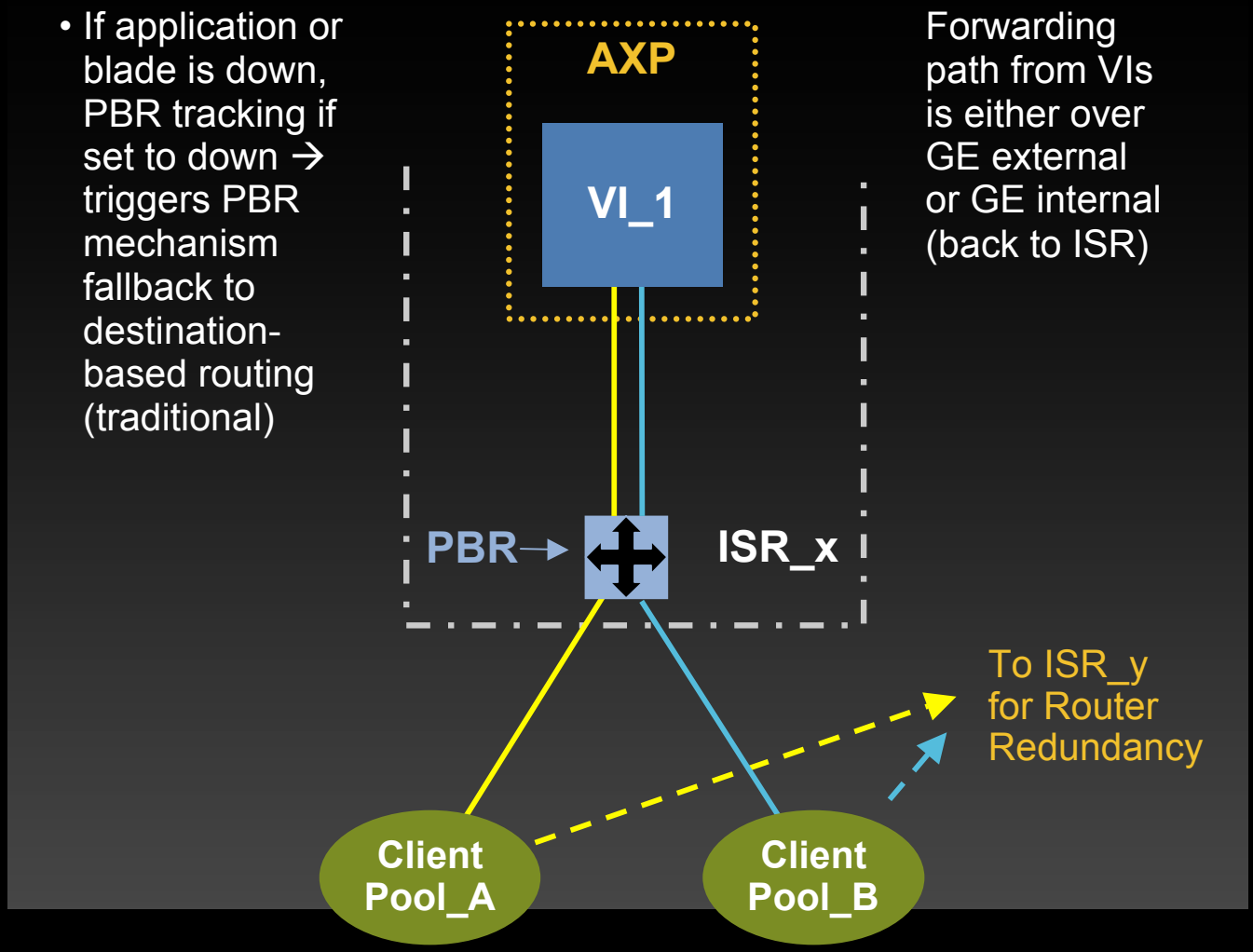
AXP Blade Redundancy:
- N/A (see multiple blade example)

ISR Redundancy:
- Multiple IP sub-interfaces (optional)
- Master HSRP (if 2nd ISR)

Clients:
- Dual-homed or -interfaced (optional)
- DG = HSRP VIP on ISR

Dynamic Bypass

- If application or blade is down, PBR tracking if set to down → triggers PBR mechanism fallback to destination-based routing (traditional)



Forwarding path from VIs is either over GE external or GE internal (back to ISR)

Application Redundancy

Single Application, Multiple Blade, Redundant ISRs

Redundancy Stack

Application Redundancy:
- PBR-based on "next-hop" config in Cisco IOS
- "Load-sharing" via inversion

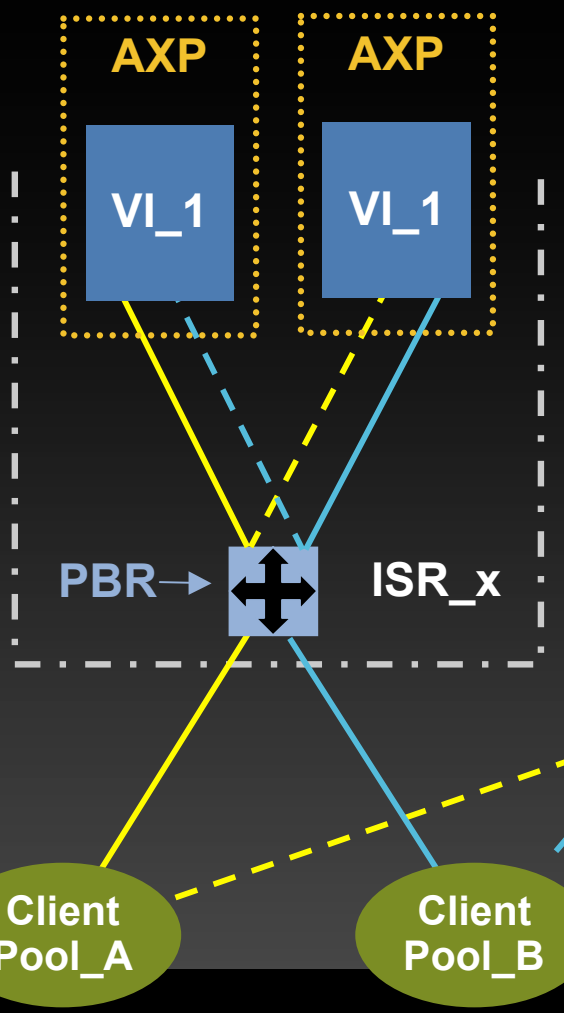
AXP Blade Redundancy:
- Physical + host
- If blade fails, then PBR keepalive to VI triggers flip

ISR Redundancy:
- Multiple IP sub-interfaces (optional)
- Master HSRP (if 2nd ISR)

Clients:
- Dual-homed or -interfaced (optional)
- DG = HSRP VIP on ISR

Load-Sharing VIs

- If application or blade is down, PBR tracking if set to down → triggers PBR mechanism fallback to destination-based routing (traditional) for that instance only
- Surviving application must be able to handle all traffic when failover occurs



Forwarding path from VIs is either over GE external or GE internal (back to ISR)

Application Redundancy

Multiple Application, Multiple Blade, Redundant ISRs

Redundancy Stack

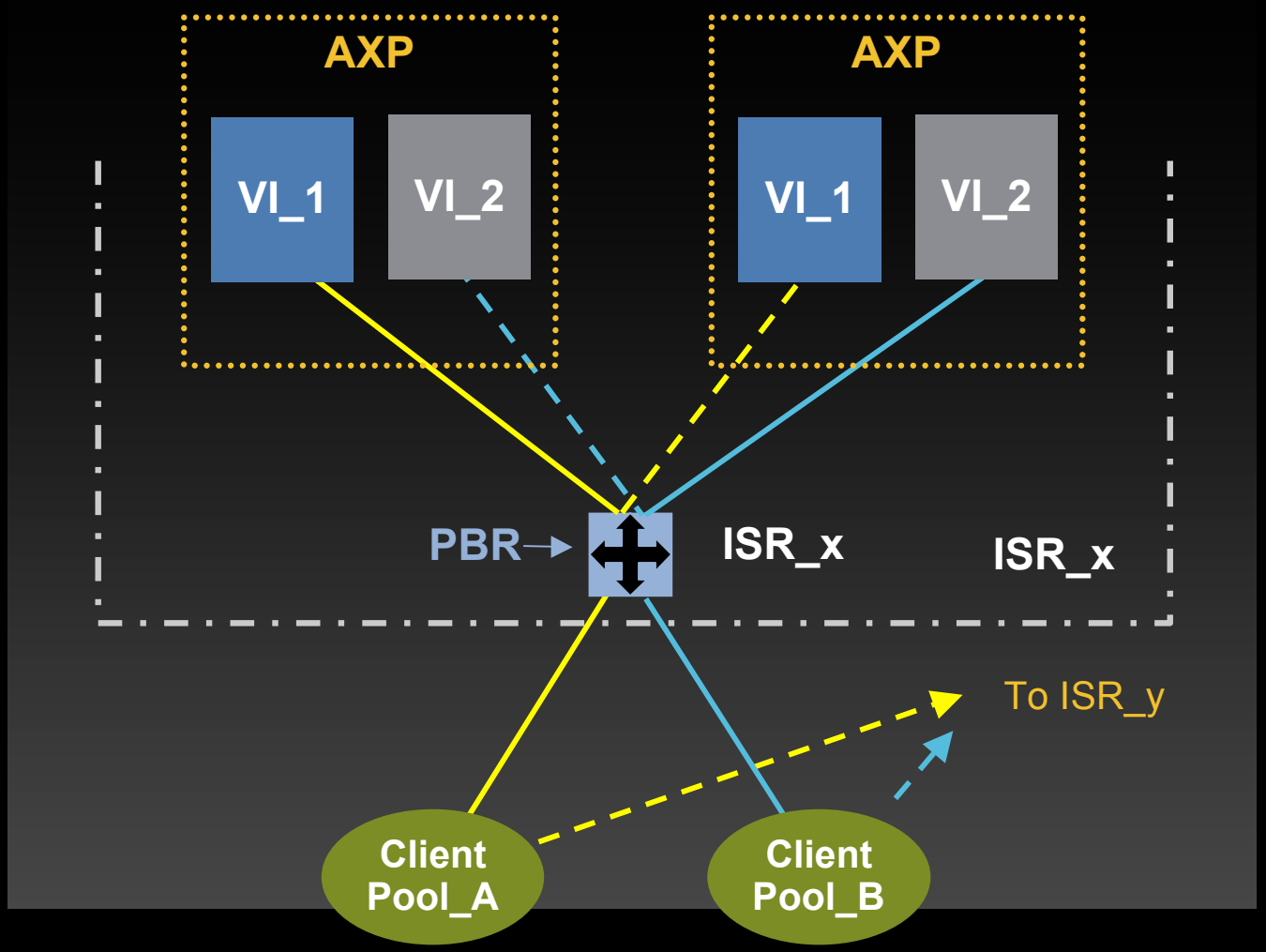
Application Redundancy:
- PBR-based on “next-hop”
- “Load-sharing” via inversion

AXP Blade Redundancy:
- Physical + host
- If blade fails, then PBR keepalive to VI triggers flip

ISR Redundancy:
- Multiple IP sub-interfaces
- Master and Standby HSRP

Clients:
- Dual-homed or -interfaced
- DG = HSRP VIP

Load-Sharing



Application Redundancy

Multiple Application, Single Blade, Redundant ISRs

Redundancy Stack

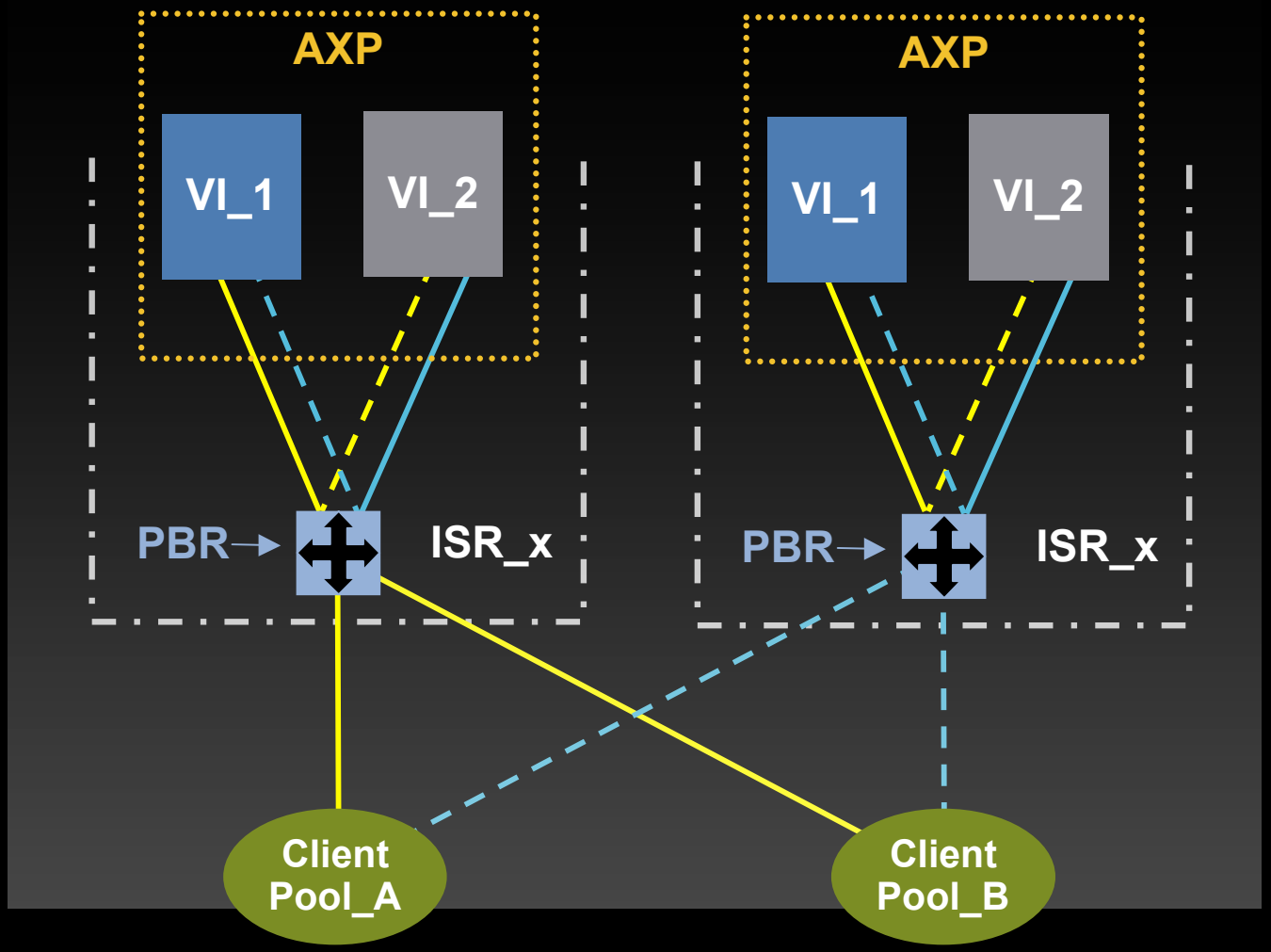
Application Redundancy:
- PBR-based on “next-hop”
- “Load-sharing” via inversion

AXP Blade Redundancy:
- N/A (see multiple blade config to extrapolate to this scenario)

ISR Redundancy:
- Multiple IP sub-interfaces
- Master and Standby HSRP

Clients:
- Dual-homed or -interfaced
- DG = HSRP VIP

Load-Sharing VIs/Active-Standby ISRs



Application Redundancy

Multiple Application, Single Blade, Redundant ISRs

Redundancy Stack

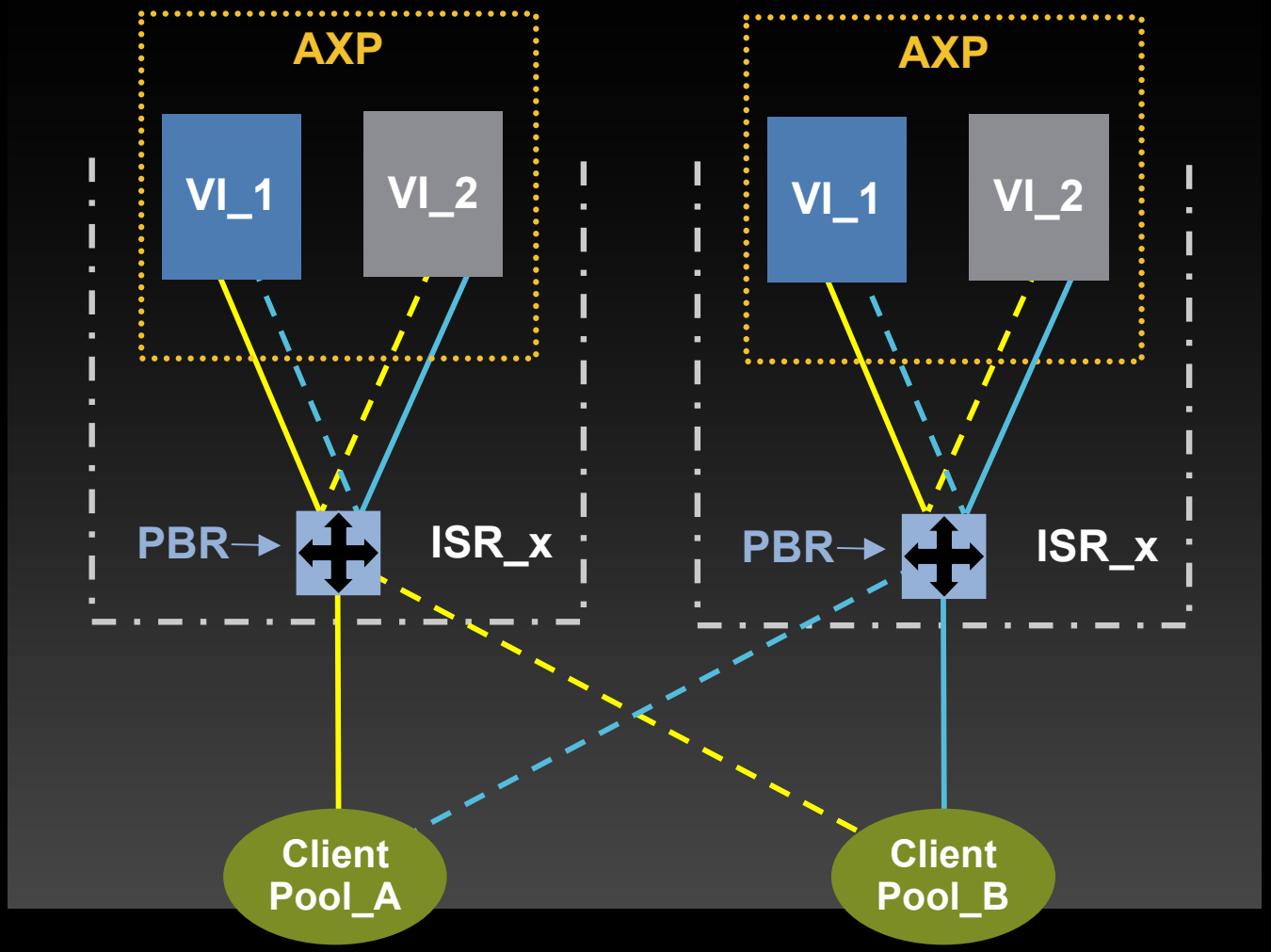
Application Redundancy:
- PBR-based on “next-hop”
- “Load-sharing” via inversion

AXP Blade Redundancy:
- N/A (see multiple blade config to extrapolate to this scenario)

ISR Redundancy:
- Multiple IP sub-interfaces
- Master and standby HSRP

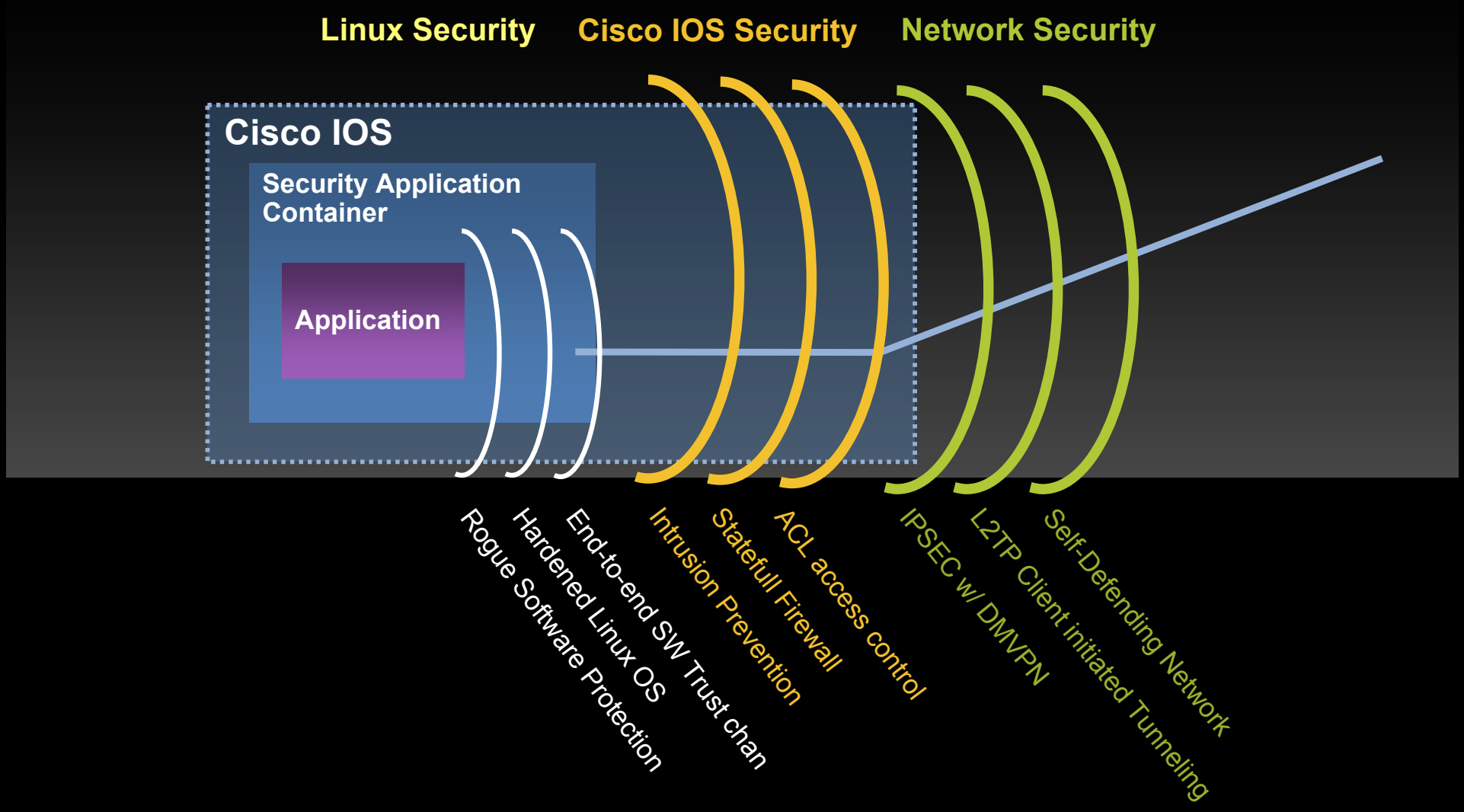
Clients:
Dual-homed or -interfaced
- DG = HSRP VIP (Pool masters on different ISRs)

Load-Sharing VIs/Active-Standby ISRs



AXP Security

Layers of Protection



Packaging and Bundling Applications
Trust Chain Mechanism for Application Vendors

- Unauthorized software will not be allowed to be loaded into operating system
  - Enforced through cryptographic signatures
  - Verify packages have been signed by Cisco
- Application vendors will not have access to private Cisco keys for package signing
  - Need to manage their own public/private key pairs
- Managing permissions
  - Cisco responsible for managing permissions to install software into AXP environment
  - Cisco will provide third-party vendors a checksum of their X.509 certificate encrypted with AXP OS private key → key becomes authorization

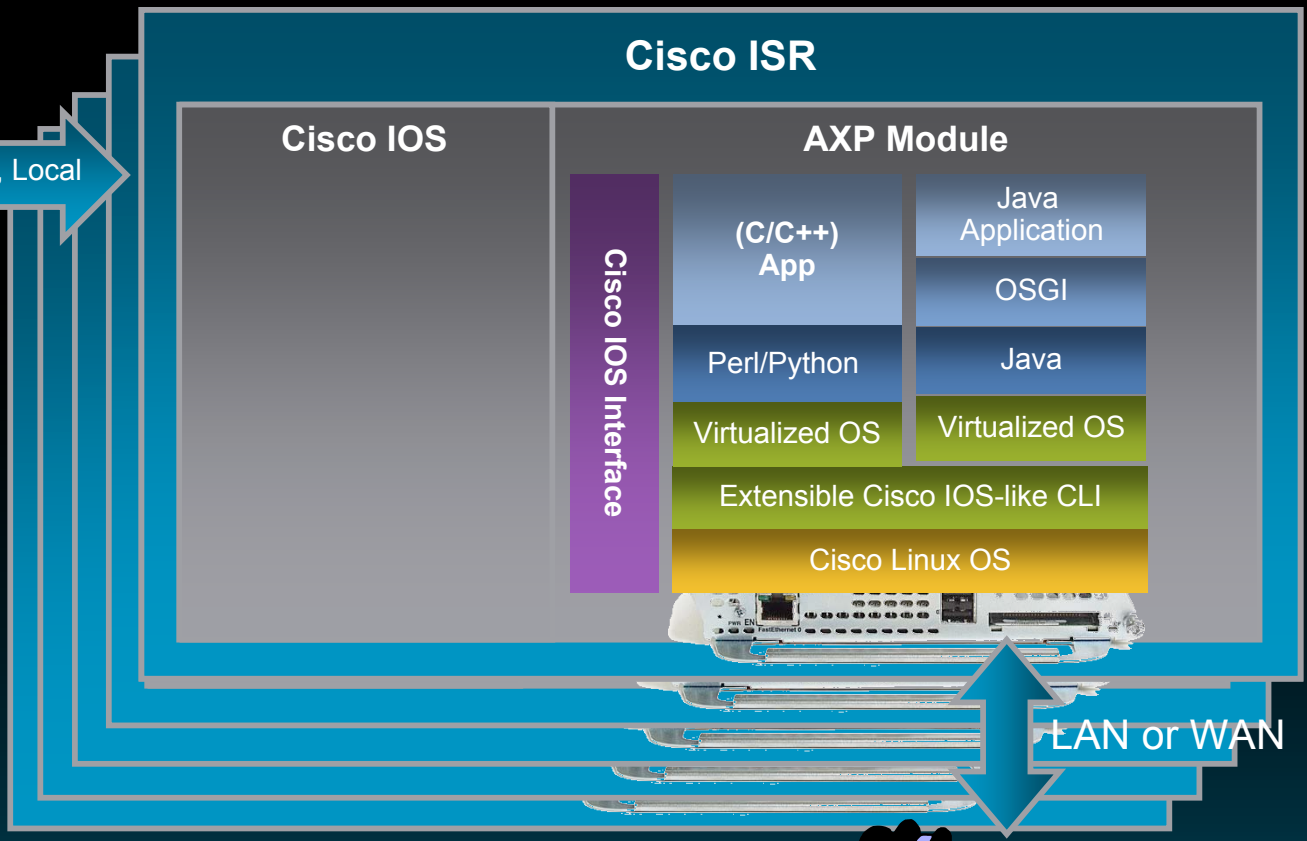
AXP Management

Use Case #1: Install/Update

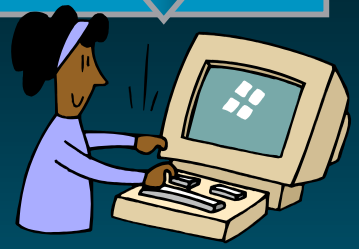
Network Administrator
(IT Operations)

1. Open Change Request Ticket
2. Install ISR + Services Modules including AXP Module
3. Close Change Request Ticket

Repeat x 1000



1. Open Change Request Ticket
2. Install Application
3. Close Change Request Ticket



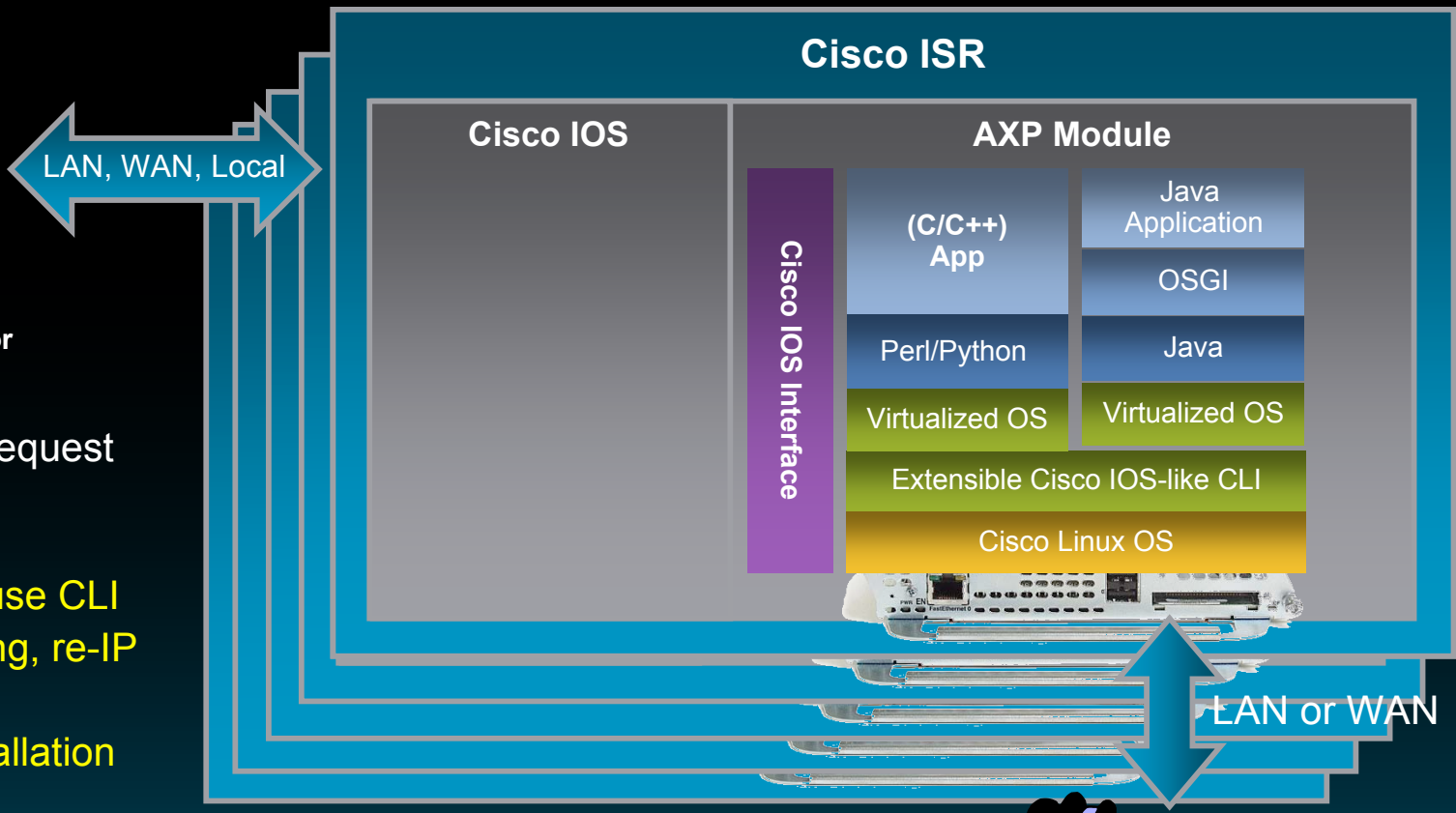
Application Administrator
(IT Operations)

Use Case #2: Administer/Configure

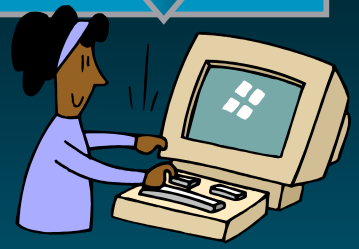
Network Administrator
(IT Operations)

1. Open Change Request Ticket
2. Administer
   - SSH to ISR, use CLI
   - Change routing, re-IP
   - Run sniffer
   - Run bulk-installation script
3. Close Change Request Ticket

Repeat x 1000



1. Open Change Request Ticket
2. Administer
   - Patch application
   - Install open-source utilities
   - Collect app log files
   - Start/stop application
   - Issue OS commands
   - Run bulk-admin script
   - Troubleshoot
3. Close Change Request Ticket



Application Administrator
(IT Operations)

Use Case #3: Monitor/Notify

Network Administrator
(IT Operations)

LAN, WAN, Local

Cisco ISR

Cisco IOS

Cisco IOS Interface

AXP Module

Perl/Python

Java Applica

OSGI

Virtualized OS

Virtualized OS

Exte

S-like

OS

LAN or WAN

SNMP / SMTP
Alert

Enterprise Systems/
Network Mgmt Tool
- IBM Tivoli
- HP Openview
- CA Unicenter

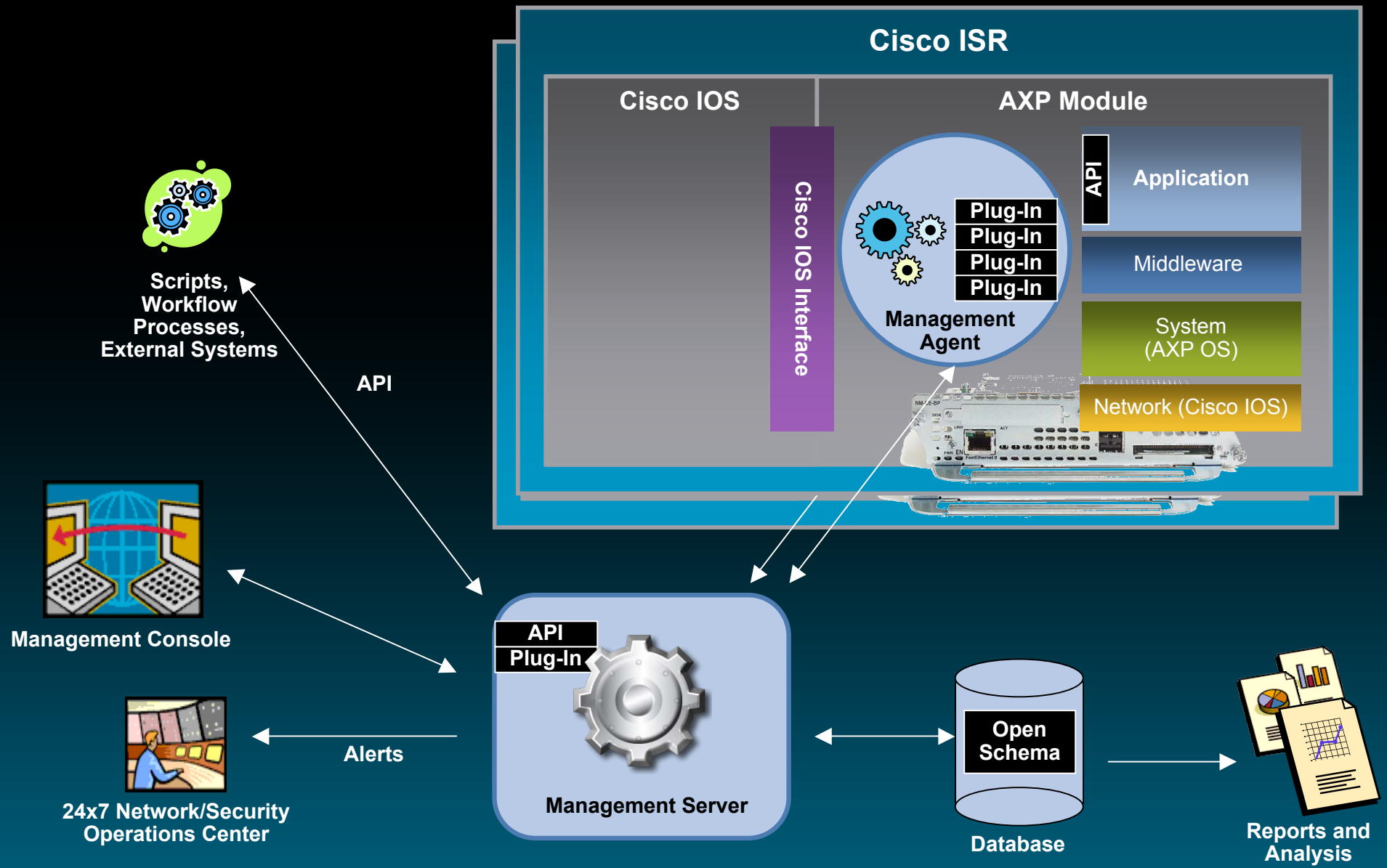
Monitoring Tools
- BMC Patrol
- NetIQ Security Manager
- Microsoft Operations Manager
- Micromuse NetCool

24x7 Network/Security Operations Center
(IT Operations)

1. Log, Open Ticket
2. Assess
3. Notify/Escalate

Application Administrator
(IT Operations)

High-Level Architecture



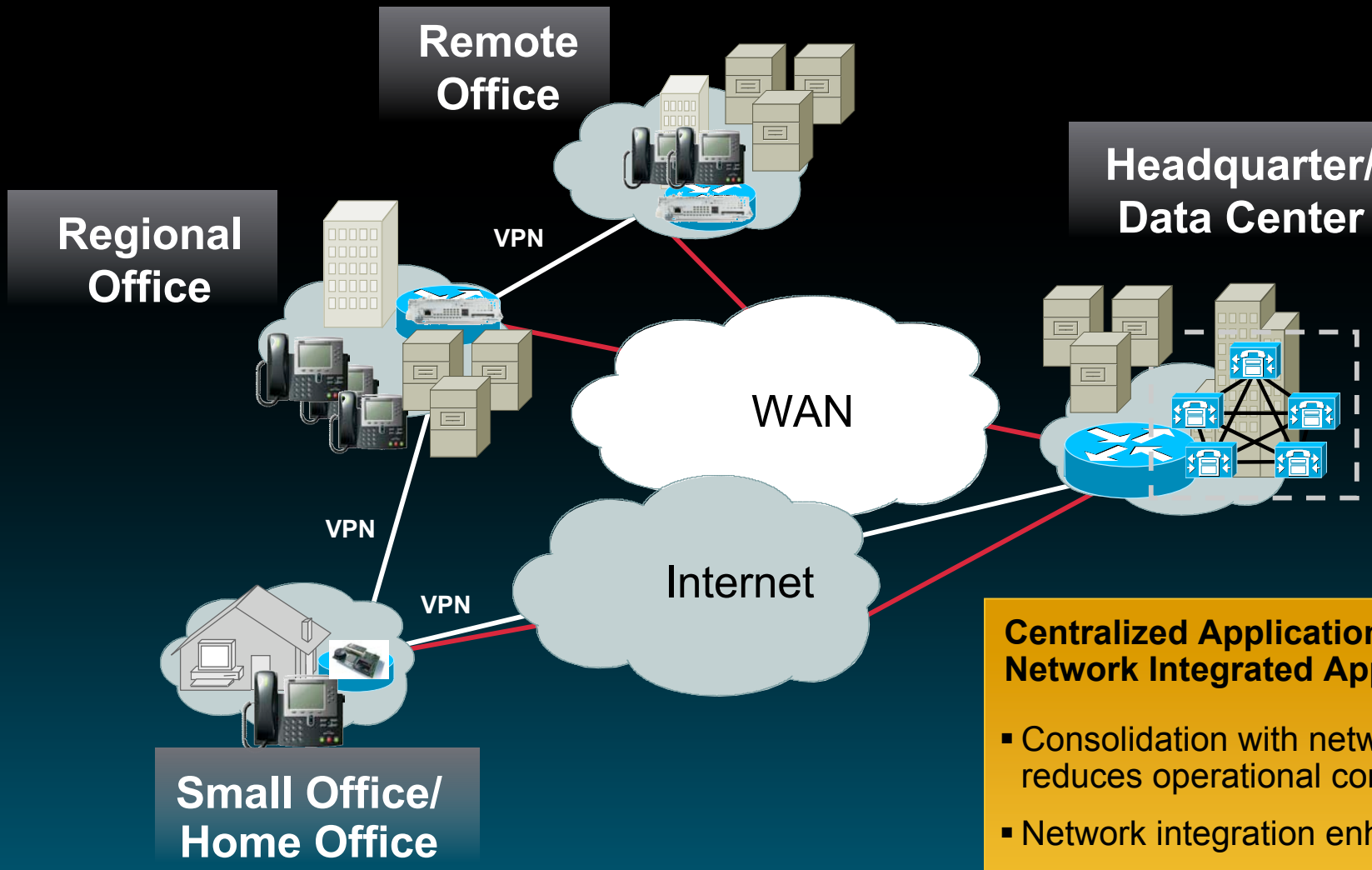
AXP Management Value Proposition

Feature	Benefit
Centralized, Proactive Monitoring ▪ Forwarding of AXP application and ISR alerts to central NOC/SOC management tool	▪ Integration with existing, standard IT processes ▪ Implement high application SLAs
Centralized, Automated Administration ▪ Bulk administration of both AXP applications and ISR ▪ API and automation support	▪ Quicker, less error-prone administration of large number of applications and ISRs ▪ Lower TCO/operating costs ▪ Service provider competitive advantage => increased uptime/reliability and quicker, more reliable rollout of new services
Out-of-Box, Integrated Stack Management ▪ Network (network traffic, routing, SNMP) ▪ OS / System (CPU, RAM, Disk, syslog) ▪ Middleware (web/app server, database) ▪ Application logfiles, process up/down, process control	▪ More complete information about application and dependencies ▪ Better decisions with regards to service outages ▪ Partner/Customer focuses on core business i.e. application development, not management (shorter time-to-market / development cycle) ▪ Consolidated, centralized, holistic view of business application/service ▪ Decreased problem identification/resolution resulting in increased application uptime
Easy-to-use Application Management APIs ▪ Custom application management and monitoring	▪ Quickly implement rich application management functionality ▪ Monitor business application health and events ▪ Implement/improve business application SLAs
Seamless Integration in Common Interfaces ▪ GUI / CLI / API	▪ Minimize training costs with consistent administration interface ▪ Maintain native / legacy tool interfaces

AXP Use Cases

Design/Configuration of Common Deployment Models

Distributed Application Deployments
Benefit from Network + Application Integration



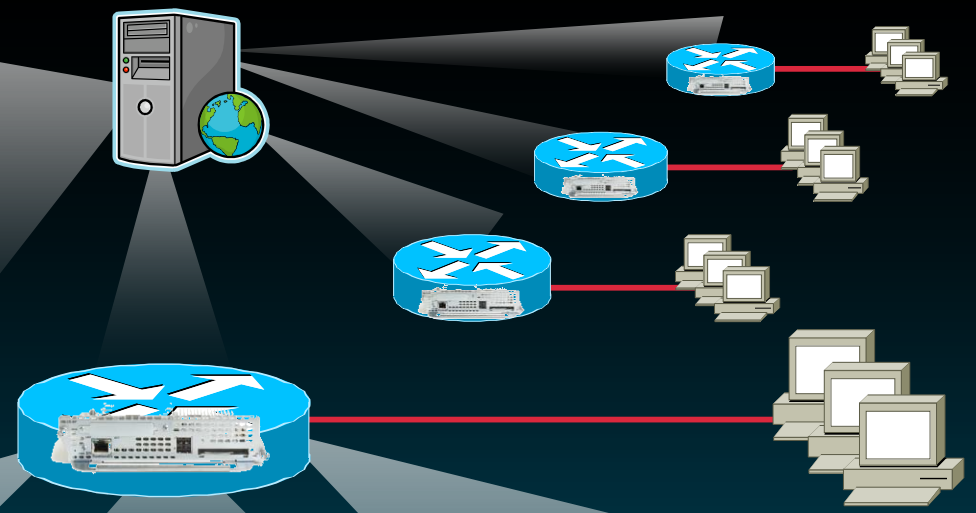
Centralized Application in DC with Network Integrated App in Branch

- Consolidation with network devices reduces operational complexity
- Network integration enhances security
- Intelligent management for WAN outage
- Enhanced user experience

AXP Use Cases—in a Nutshell

- Augments the functionality of the router with value-add Cisco supported services, open source components, third-party applications and homegrown utilities

AXP Central Management
- Software Management (install, upgrade, patches)
- Application/platform Configuration + monitoring
- Extensible architecture to manage custom apps



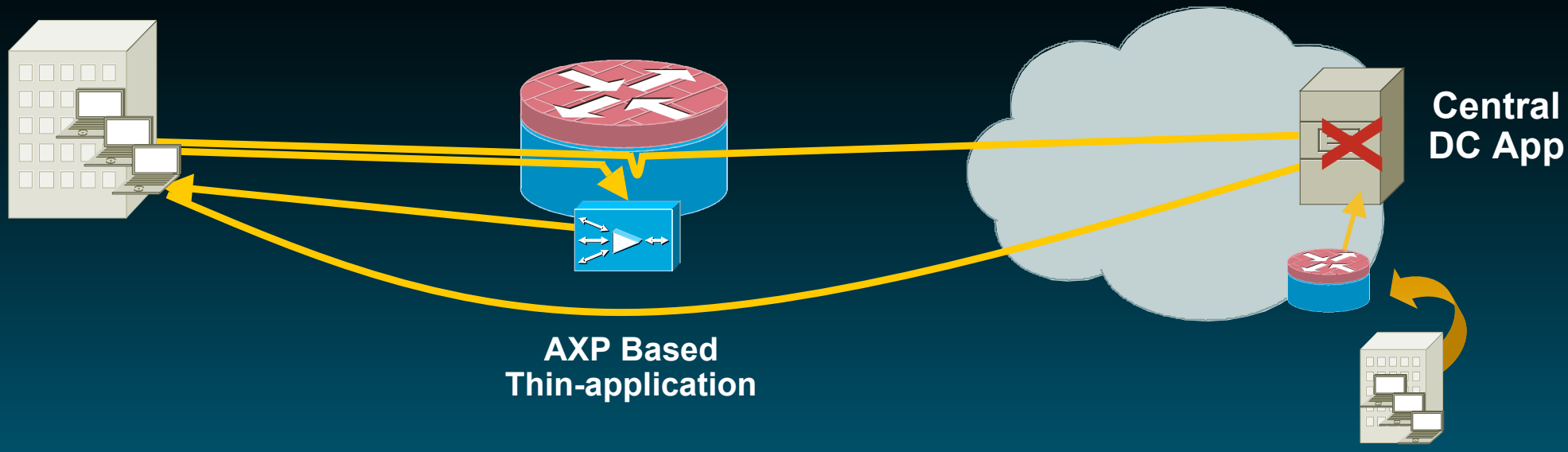
Network Services
- AAA Server
- DNS Server
- NTP Services
- File Services
- Syslog Server

Home-Grown Utilities
- Management Agents
- Monitoring tools
- Custom scripts
- Netflow Analysis

Applications
- Business Apps
- Vertical Apps
- Telephony apps
- Software Mgmt Systems

Network-enabled Thin Branch Applications

- Edge clients utilizes centralized application in the DC
- If the central instance is not available, the router intercepts and forwards the request to local AXP-based thin version of application for survivability
  - Application listens to WAN or central application failure and switches over
- Application resumes normal operation when central version is up
  - Syncs up information with AXP application



Utilizes Network Awareness for Application Survivability

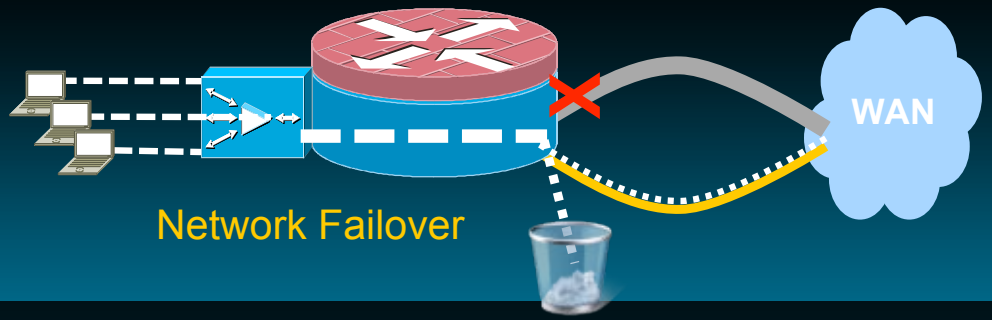
Network-Aware Applications

Use Case:	Router configured with high-bandwidth link for primary, low-bandwidth link for failover Application utilizes high-bandwidth link to provide services to local clients

Normal Operation

Network Failover with Typical Application

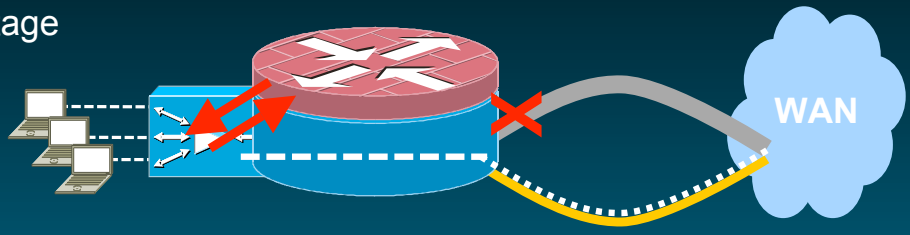
- Router fails over to low-bandwidth link
- Application is not aware of the drop in capacity
- Continues with normal operation
- Loss of service and unpredictable behavior occurs.



Network Failover

AXP Network-Aware Application

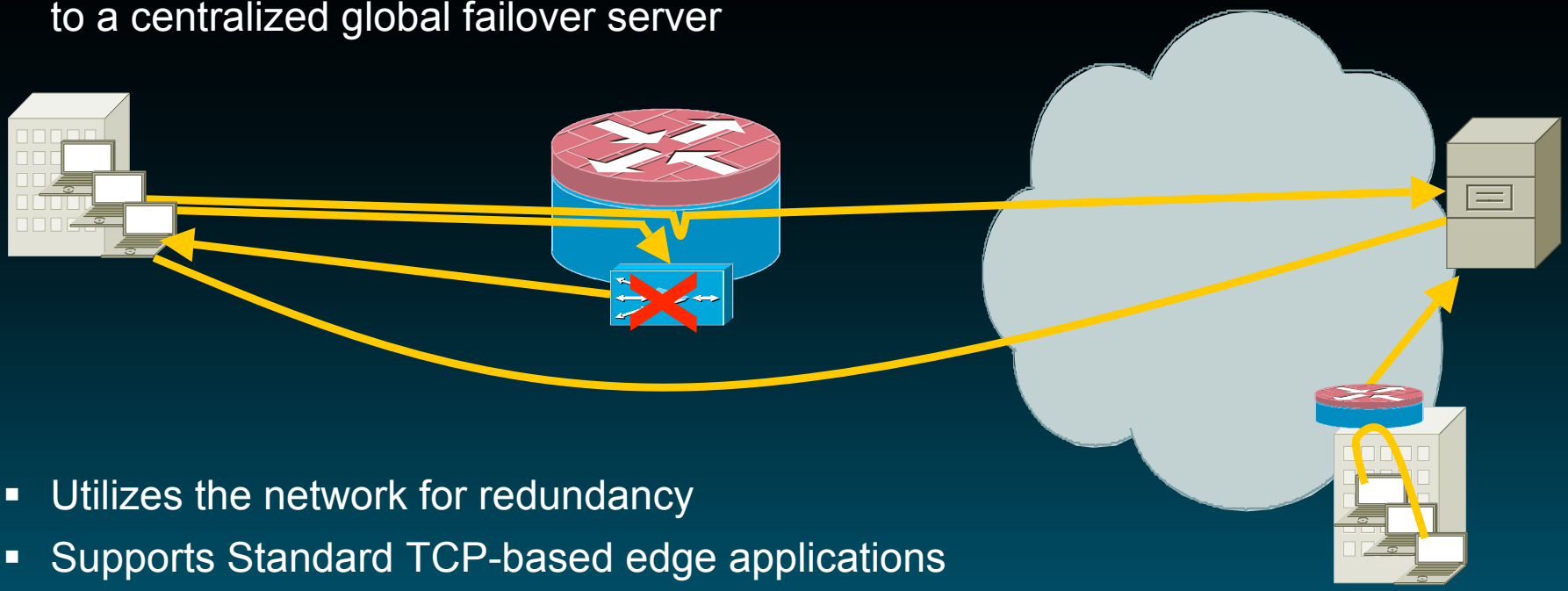
- Router notifies application of bandwidth change
- Application queries router to determine the current state of the outage
  - Dynamically alters router settings based on business rules.
    - Settings based on business situation (time of day)…
- Application alters behavior based on new information
  - Requests low-bandwidth version of data
  - Limits requests to high priority items only



Network Failover w/ AXP App

High Availability
Network-Based Failover for Edge Applications

- Edge clients utilize a local AXP based embedded application
  - Client initiates a request
  - Router intercepts request and delivers to the AXP based application
  - AXP application responds to client
- If the local instance fails, the router bypasses the intercept and forwards the request to a centralized global failover server



- Utilizes the network for redundancy
- Supports Standard TCP-based edge applications
- Saves on Costly HA infrastructure in the edge

Use Case: Custom Network Services

Problem

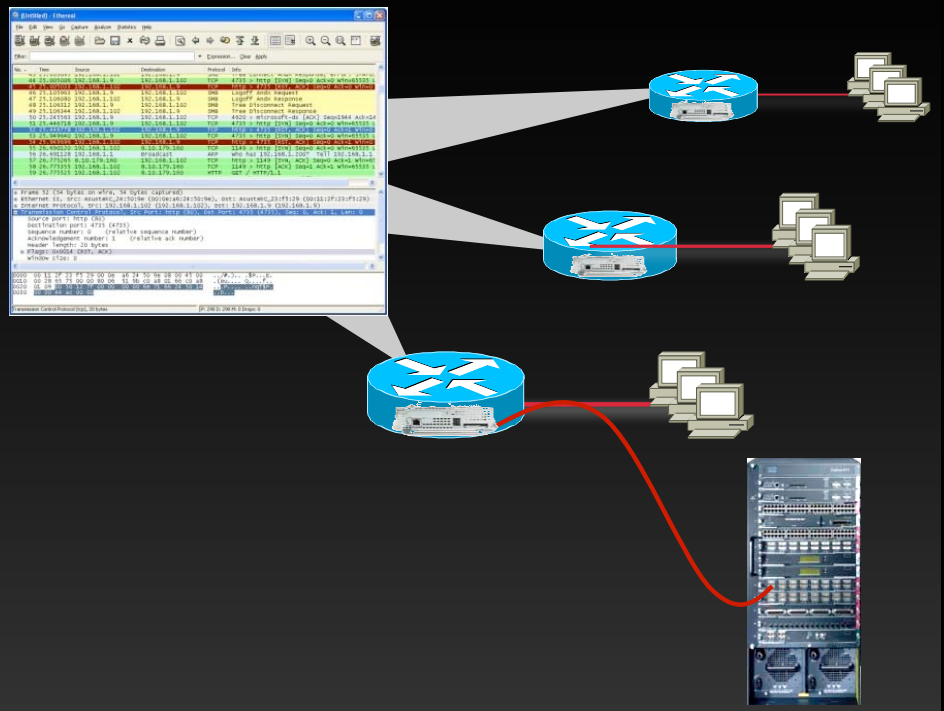
- IT policy prevents deployment of additional physical servers in the branch
- Difficult to perform basic network management or troubleshooting

Solution

- Custom network utilities to monitor and troubleshoot the network
- X-Windows access allows admin to view packets and utility results in real-time
- Custom SLA utilities to measure performance
- Augmented with Cisco-supported network utilities

Benefits

- Platform to enable service providers to enable their own tools and monitoring utilities
- Management of customer networks—new services
- Local survivability of business services



Use Case: Packaged Network Utilities

Problem

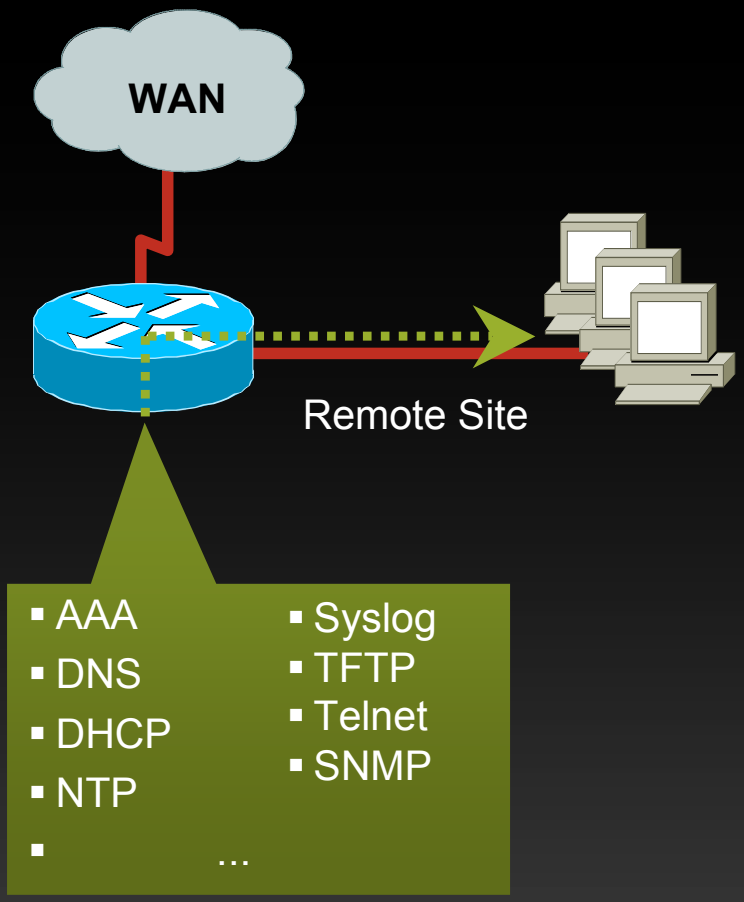
- Various core network-based services such as DNS, DHCP, and AAA need to be resident in each remote site but centrally managed

Solution

- ISR with AXP hosting multiple common network utilities (DNS, DHCP, TFTP, AAA)

Benefits

- Better service to end-customer (performance, availability)
- Integrated solution with lower TCO than other solutions
- No additional appliances; conservation of physical space
- Centrally managed



Local Network-Based Utilities For LAN-Side Clients, WAN Outage Survivability, etc.

Use Case: UC Apps

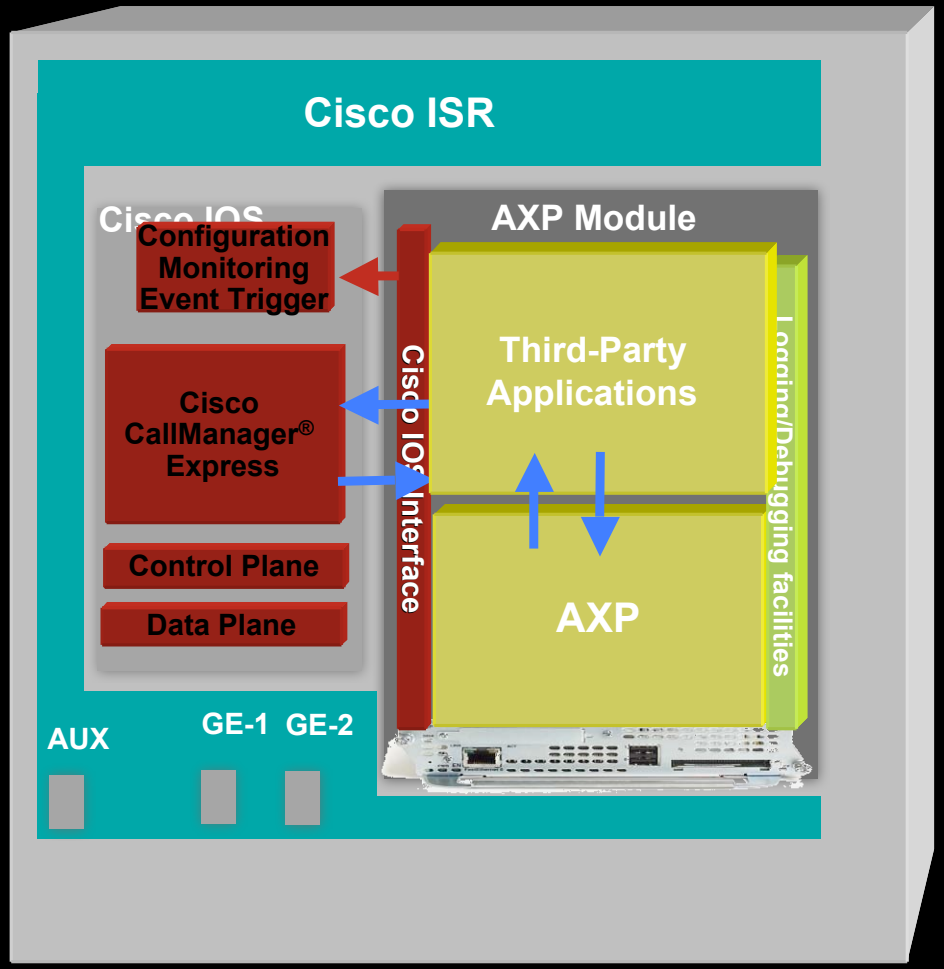
Examples:

- Speech capabilities at enterprise branches

  Speech capability on ISR blade can be leveraged by multiple applications: IVR, Cisco Unity Express, Contact Center Express

- Branch voice recording

  Light weighted recording/ retrieval modules on ISR to support ad-hoc recording, to minimize WAN bandwidth and support recording survivability



- UC apps. Ported on AXP
- UC apps inter-work with CME
- AXP offers hosting environment & Cisco IOS integration

Case Studies

Customer Examples of Application Hosting Environments

Use Case: Lean and Rich Retail Store

Problem

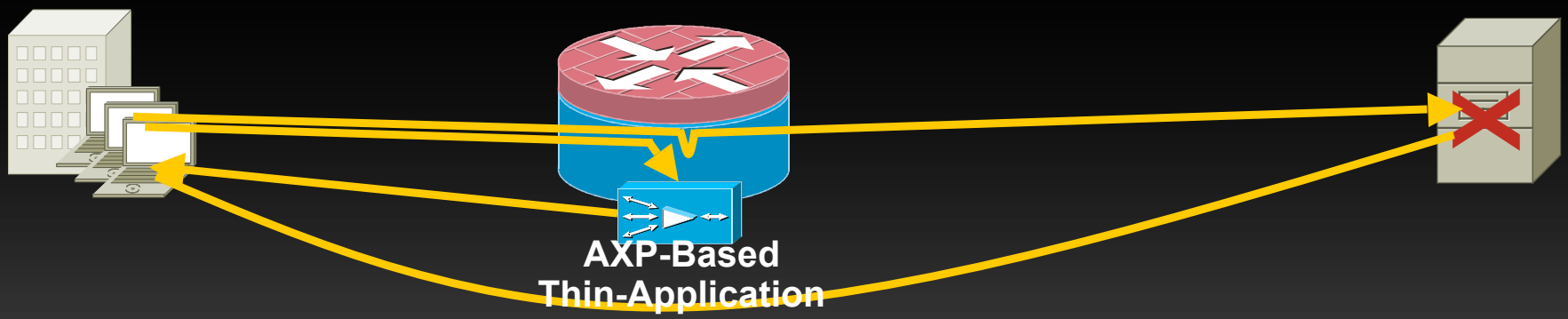
- Retailers want to centralize applications for smaller stores in the DC
- Business continuity is a challenge when WAN does down or becomes slow

Solution

- Thin version of POS & other retail applications on AXP blade on ISR talking to centralized mothership
- Applications interacts with AXP network APIs to go in survivable mode when WAN deteriorates

Benefits

- Lowers infrastructure costs while maintaining business continuity



Use Case: Time Tracking/Workflow

Workforce Management (Employee Scheduling and Optimization); Front-End Is Employee Clock-In/Clock-Out

Problem

- Capturing and consolidating time clock punches critical for the bottom-line in low-margin business
- Need way to address other unique services without high cost/overhead to retail store

Current Solution

- Clock-in/clock-out via dedicated hardware punch clock
- Store-side clock-server app runs on in-store server and synchronizes up with central app

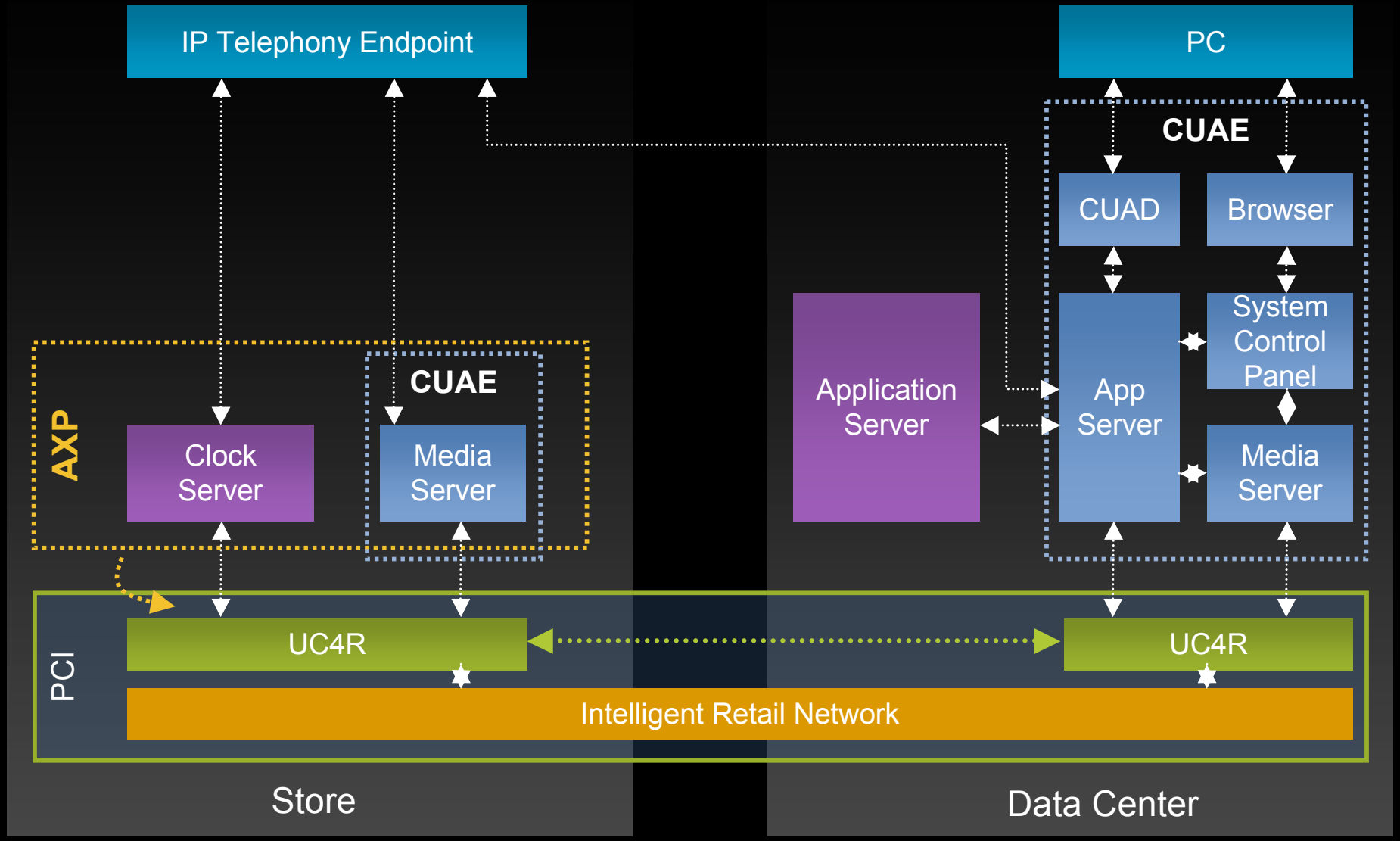
New Solution

- Clock-in/clock-out via Cisco IP phones with other value added services

Benefits

- Reduced infrastructure with store-side clock-server app running on AXP
- Intelligent buffering and sync of data when WAN degrades

Ex: Integrated Environment (Logical)



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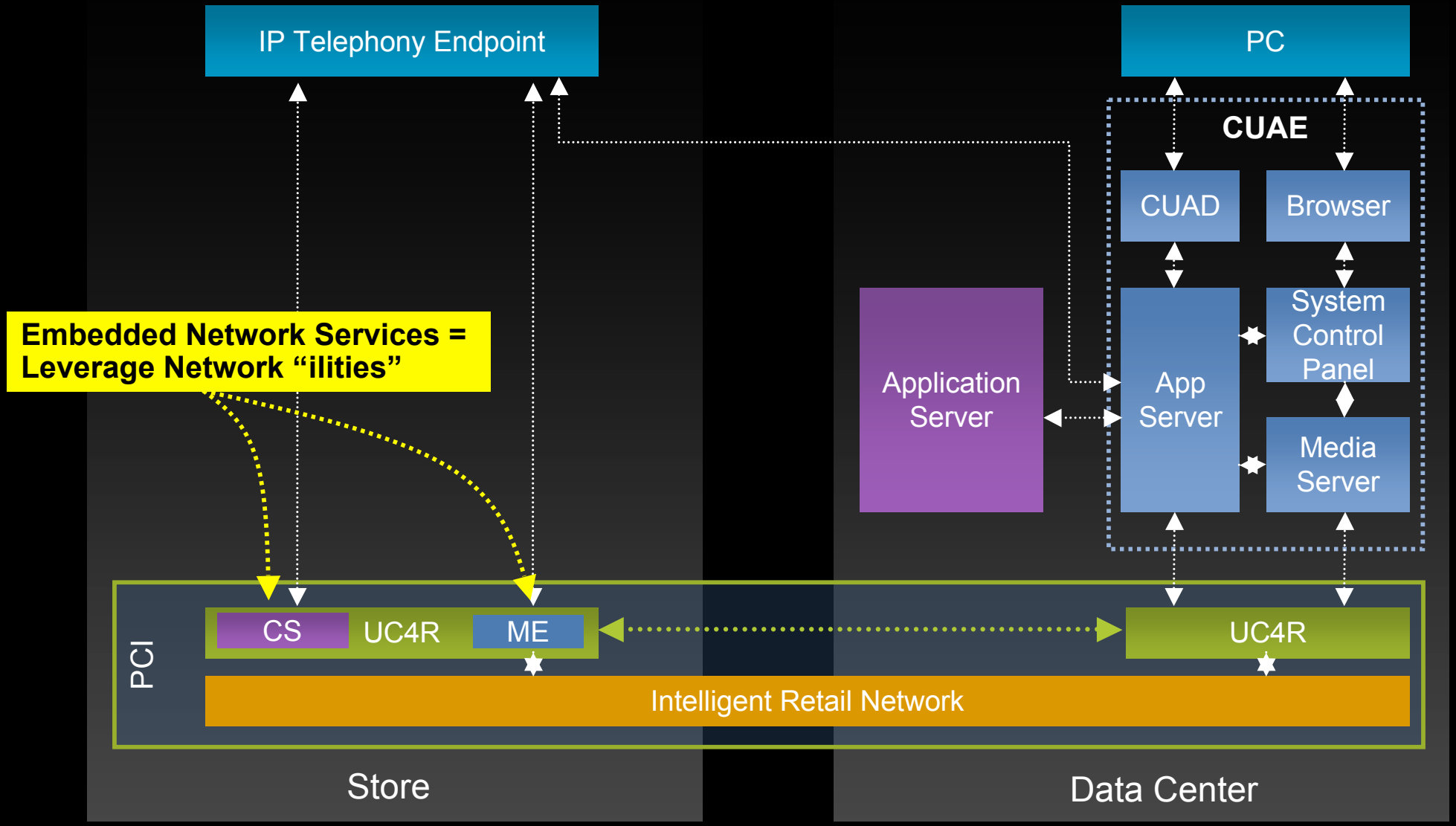
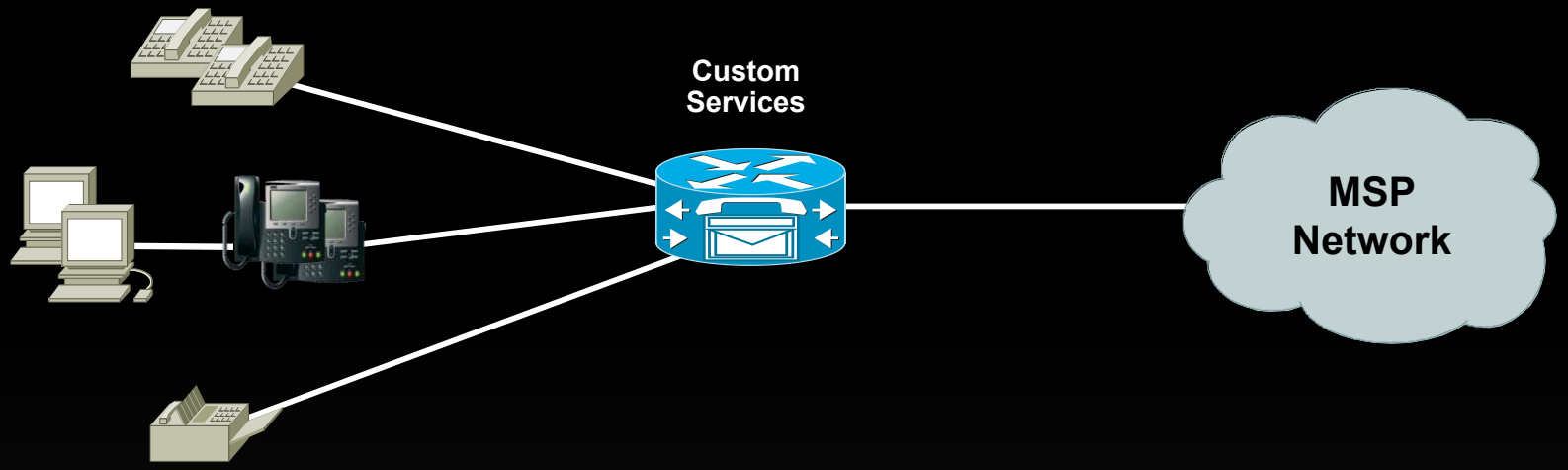


Managed Service Providers
Use Case #2



MSP #1 w/Custom Developed CPE Device

- Access router built with Open Source Technologies
- Integrated value-added proprietary services
  - Custom Remote management and monitoring services
  - Dynamic IP-SLA/QoS services
  - Niche Security services
  - CDN, News feed support, Credit Card support …
- AXP enables MSP to utilize Cisco routers to solve their business needs
- 10,000 non-Cisco end points

Managed Service Provider #2

- Looking for a way to differentiate themselves from competition and add additional revenue
- Remote management, monitoring of customer networks.
- Time of the day routing
- Distributed control domains
- Security Services
- Proprietary services

Use Case: Dynamic Networking Services

Problem

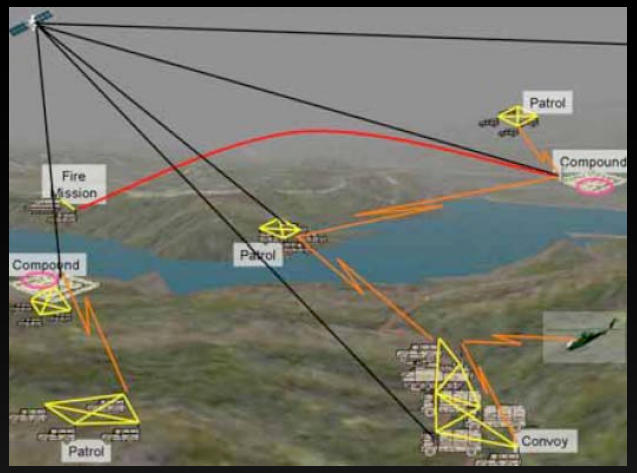
- Wartime mobile command centers require reliable and adaptive communications network
- Need a responsive network to dynamically change routing, servers used for messaging/alerting, upstream points of contact, encryption keys
- Hardware/software footprint must be reliable, simple, and integrated

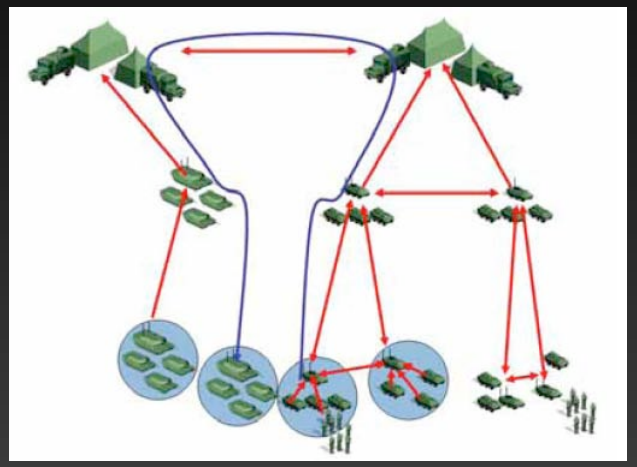
Solution

- ISR with AXP blade
- Routing and policy decisions based on location and situation
- Dynamic, fine-grained control of router
- Direct connectivity to proprietary serial devices (e.g. mobile radio units) using ISR serial port

Benefits

- Integrated interfaces to configure and monitor Cisco IOS
- Cisco IOS event triggers allow application to dynamically react to changes in the network
- No extra server to support at the edge
- Central, integrated device management





Use Case: Connected Healthcare

Problem

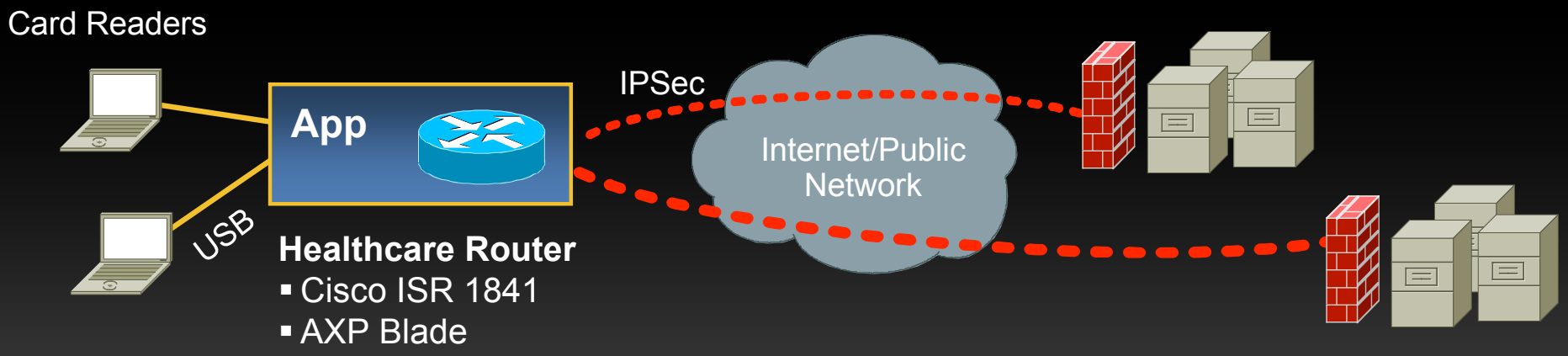
- Doctors struggle to care for patients without knowledge of past treatments / illnesses
- Dangerous medical mistakes, wrong prescriptions

Solution

- Healthcare Connector Application
- Cisco ISR 1841 w/ integrated AXP AIM blade
- USB support for card readers other devices
- Programmatic control of VPN by application

Benefits

- Meets stringent privacy and encryption standards for health record transmission
- Fully-integrated solution (HW/SW platform) with utilization of ISR USB ports for integration of smart card readers
- Easily managed for physician's office and health clinics
- Low-cost



Summary

AXP Technology Value Proposition

- Opex reduction with physical consolidation
  - One-box solution
  - Consolidated maintenance
- Manageability and operations
  - Centralized deployment and upgrades
  - Monitoring
- Hardened “appliance” like characteristics
  - Network device like reliability
  - Easy on-boarding
- Security
  - Secured through router
  - Locked down OS
- Future proofing
  - Flexible SW upgrades to add new applications
- New application capabilities enabled through network integration
  - Intelligent HA/failover
  - Network aware application behavior