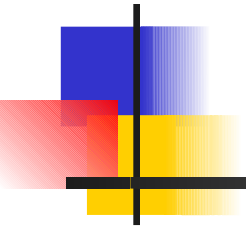
Openet: *Open Networking through Programmability*



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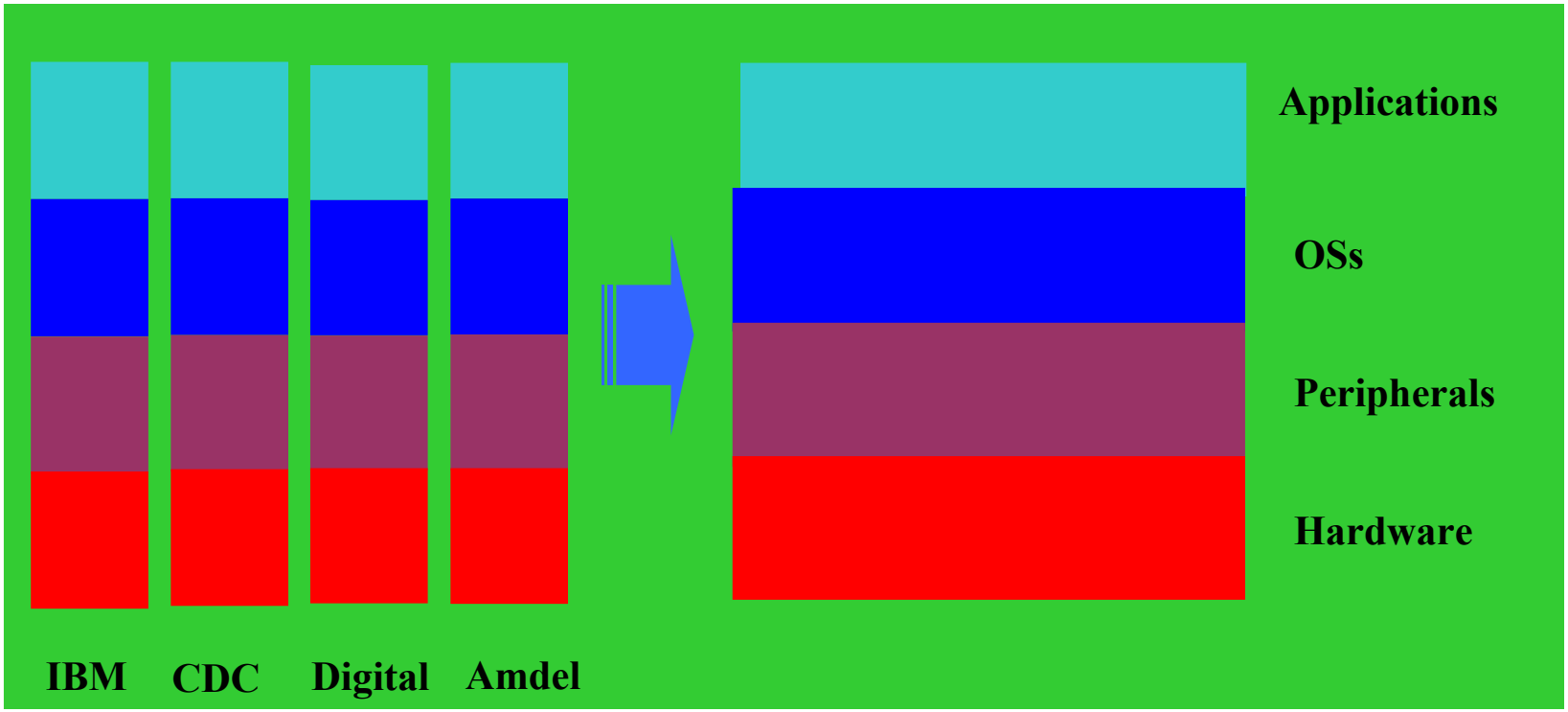
Nortel Network, Advanced Technology Lab

Agenda

- Two Evolutions: computer vs network
- Openet: open networking
- ORE and Openet Compositions
- Typical Applications
- Related Projects
- Summary

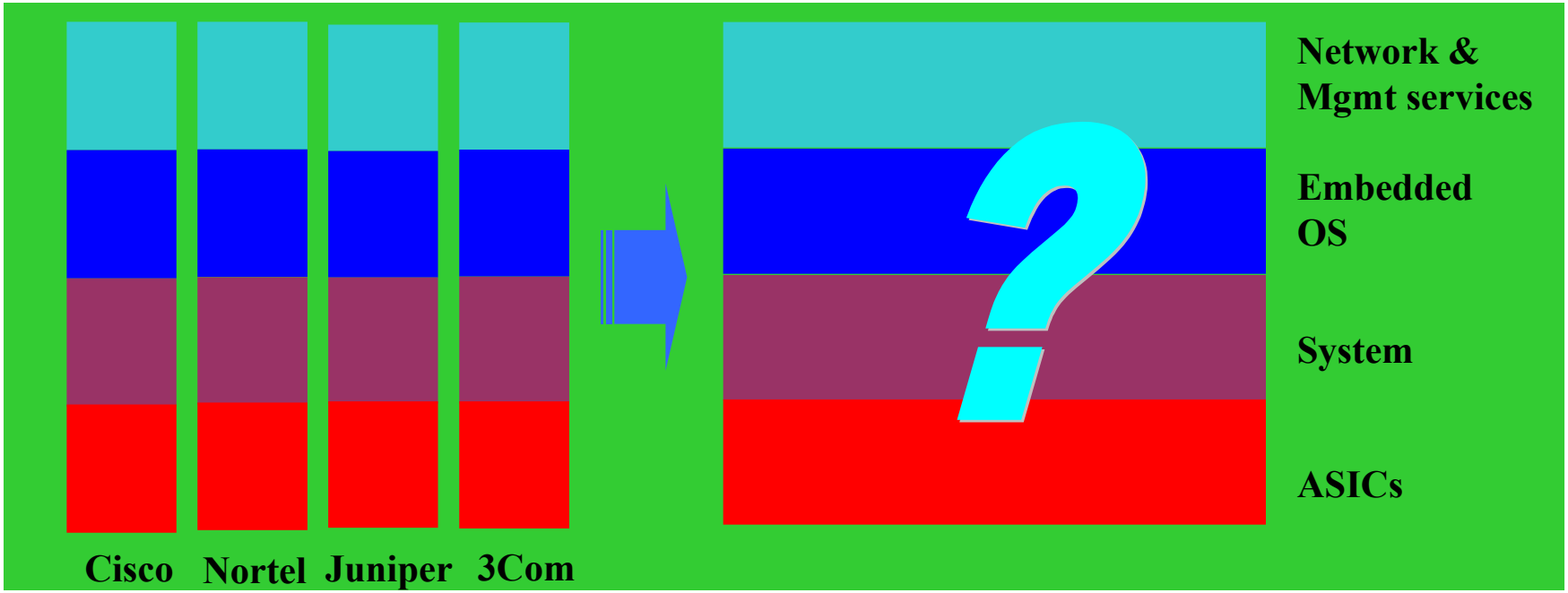
Think of computer evolution …



1980s - Vertical Industry

2000s - Horizontal Industry

What's network evolution?



"00 Vertical Network Industry

Horizontal Network Industry

The inflection point is quickly approaching …

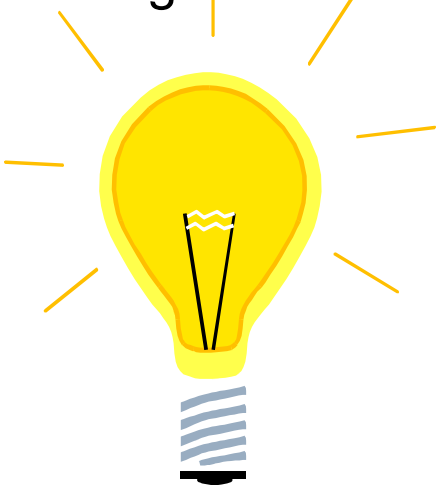
Why Open Networking?

- Open network boxes to public
  - Current network devices are close systems
- Intelligence to network nodes because
  - Internet infrastructure evolves slow
  - Customers can not add new services
- Better use of network resources
  - Abundant bandwidth
  - Diversified clients' needs

Move Turing Machine onto Device

Add local intelligence to network devices

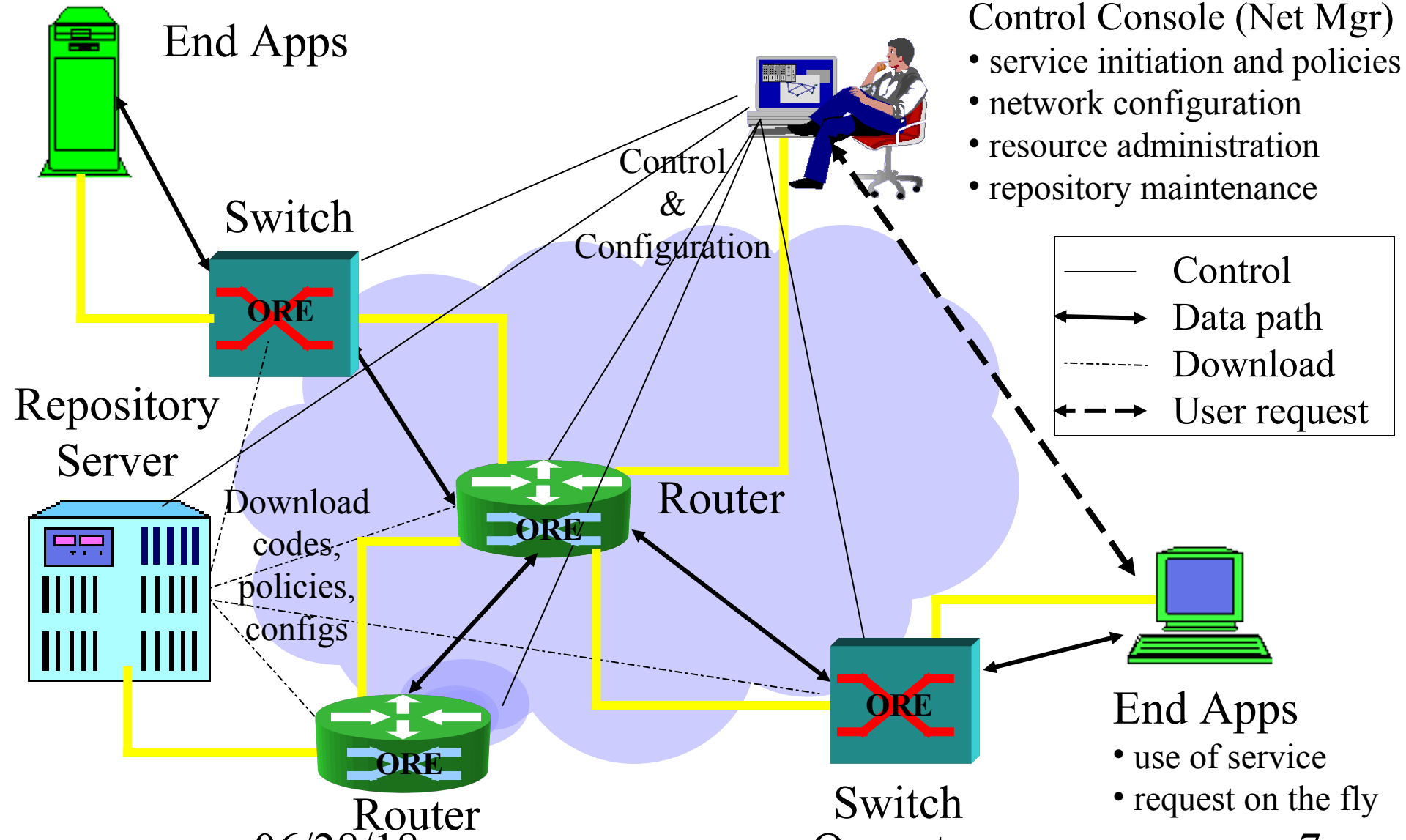
```
while (true)

doLocalProcessingOnDevice
();
```



The Openet Approach

- Open networking through programming
  - A Service-enabled networking platform
  - Intelligence to commercial network devices
    - Network control and management
    - Packet forwarding and processing
  - Not impeding network performance and reliability
    - Forwarding
    - Security
- Enabling service creation and deployment
  - Value-added services across network elements
  - Dynamic and downloadable
- Standards and Partners
  - IEEE, IETF, Active Networks and FAIN
  - Columbia U., UC Berkeley and UPenn
  - MITRE, TASC, NetFuel and CSIRO

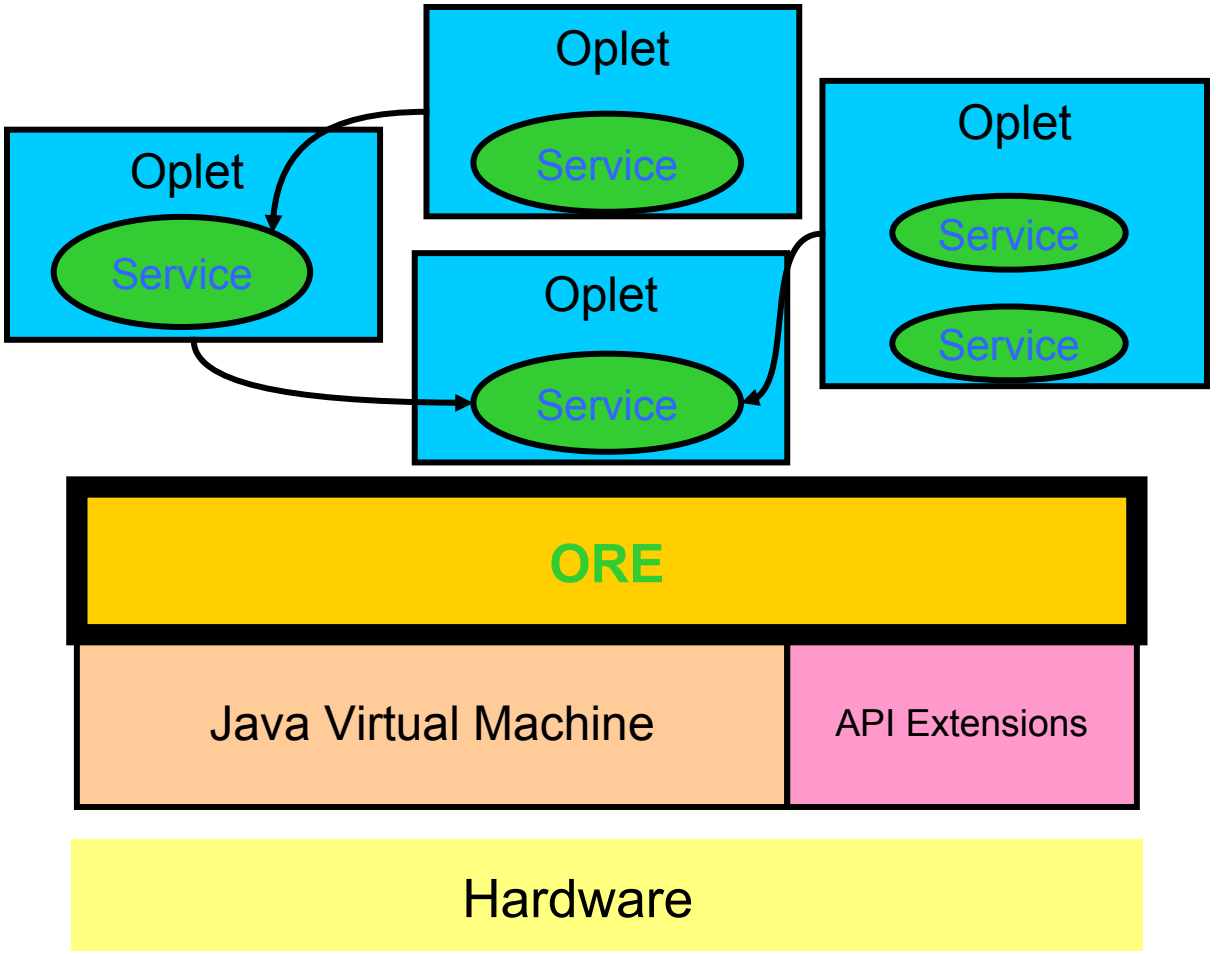
Openet Architecture



Openet Compositions

- ORE
  - Service creation and deployment
  - Service lifecycle management
- Services
  - Every network function is a service
  - Every service provides object APIs
- ODK
  - Service development and encapsulation
- Management
  - Service mgmt: initiation, policy and configuration
  - Manager on console and Agents on nodes

Openet: a node's view



Oplet is a program unit wrapping services

ORE: the Openet Core

- ORE
  - Object-oriented Runtime Environment
  - Run customized software on network nodes
  - Neutral to heterogeneous hardware
  - Secure downloading, installation, and safe execution inside JVM
  - Fully implemented using Java

System Services: JFWD

- Java Forwarding
  - IP forwarding and routing
    - Diffserv marking
    - Filtering and diverting
    - Forwarding priority
    - Routing
- Platform-independent APIs
  - Implemented on Passport/Accelar and Linux

Function Services

- Common use utility
- Public neutral APIs
- Examples
  - HTTP: HTTP service
  - Shell: ORE interactive shell
  - Packet: packet handling (IP, TCP, UDP)
  - Logger: service runtime printout
  - OreServlet: Java servlet

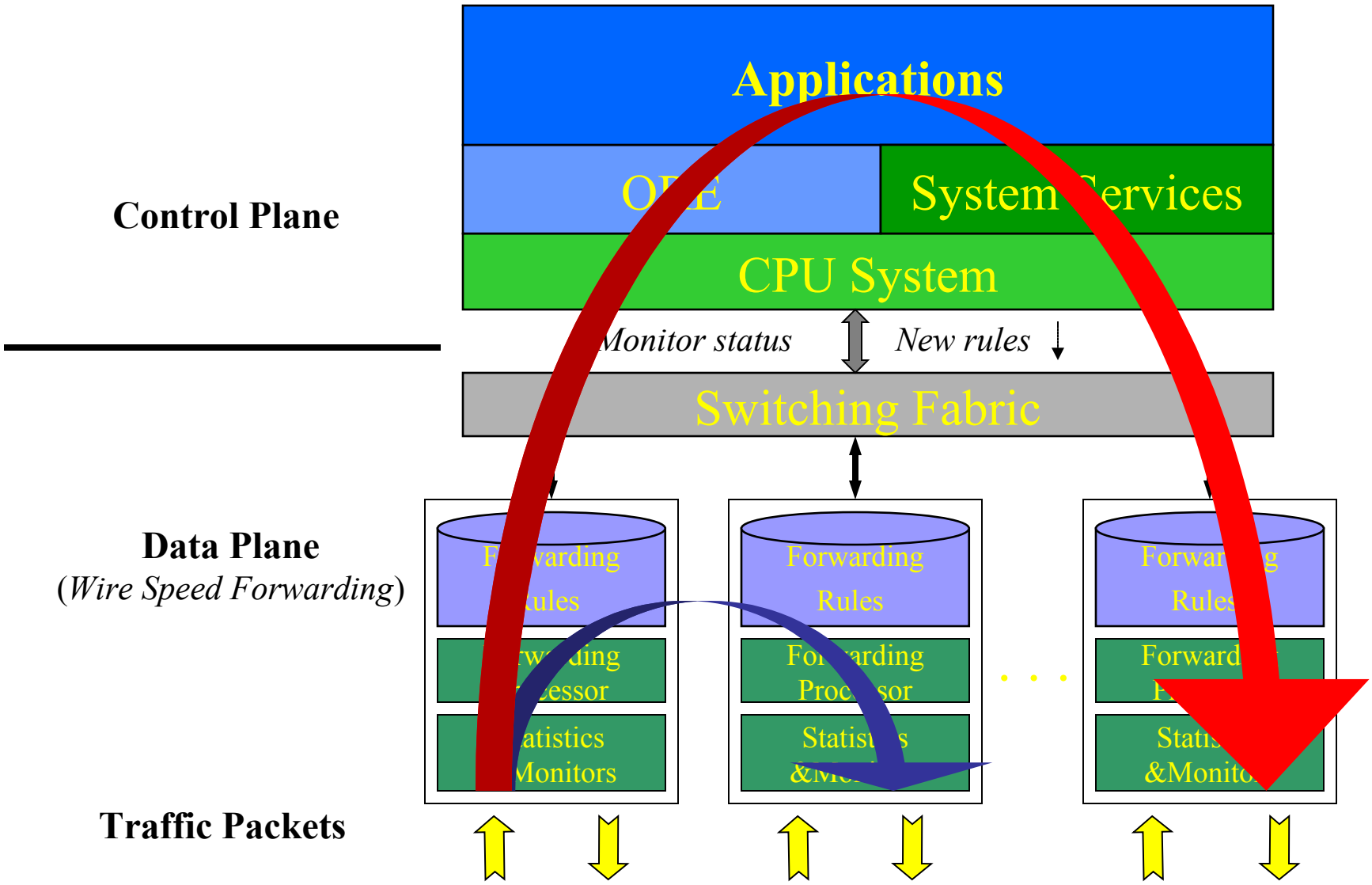
Typical Applications

- JDiffserv
  - Diffserv forwarding and DSCP marking on Passport 8600
- OpeCfg
  - Dynamic configuration of optical port interfaces
- IP filtering
  - Dynamic priority changes on Passport 1100
- JSNMP and JMIB
  - SNMP/MIB access
  - Passport 1100 and 8600
- Regatta: Fault recovery

Challenges and Solution

- Active Networks requires
  - Open boxes to users
  - Networking programmability
- Commercial network devices have
  - Ever more use of hardware acceleration
    - Static and well-defined protocols and services
  - Little flexibility to introduce users' intelligence
    - Allowing configuration rather than value addition
- Our solution
  - Openet
    - A programmable networking platform across devices
  - Active Services through Openet

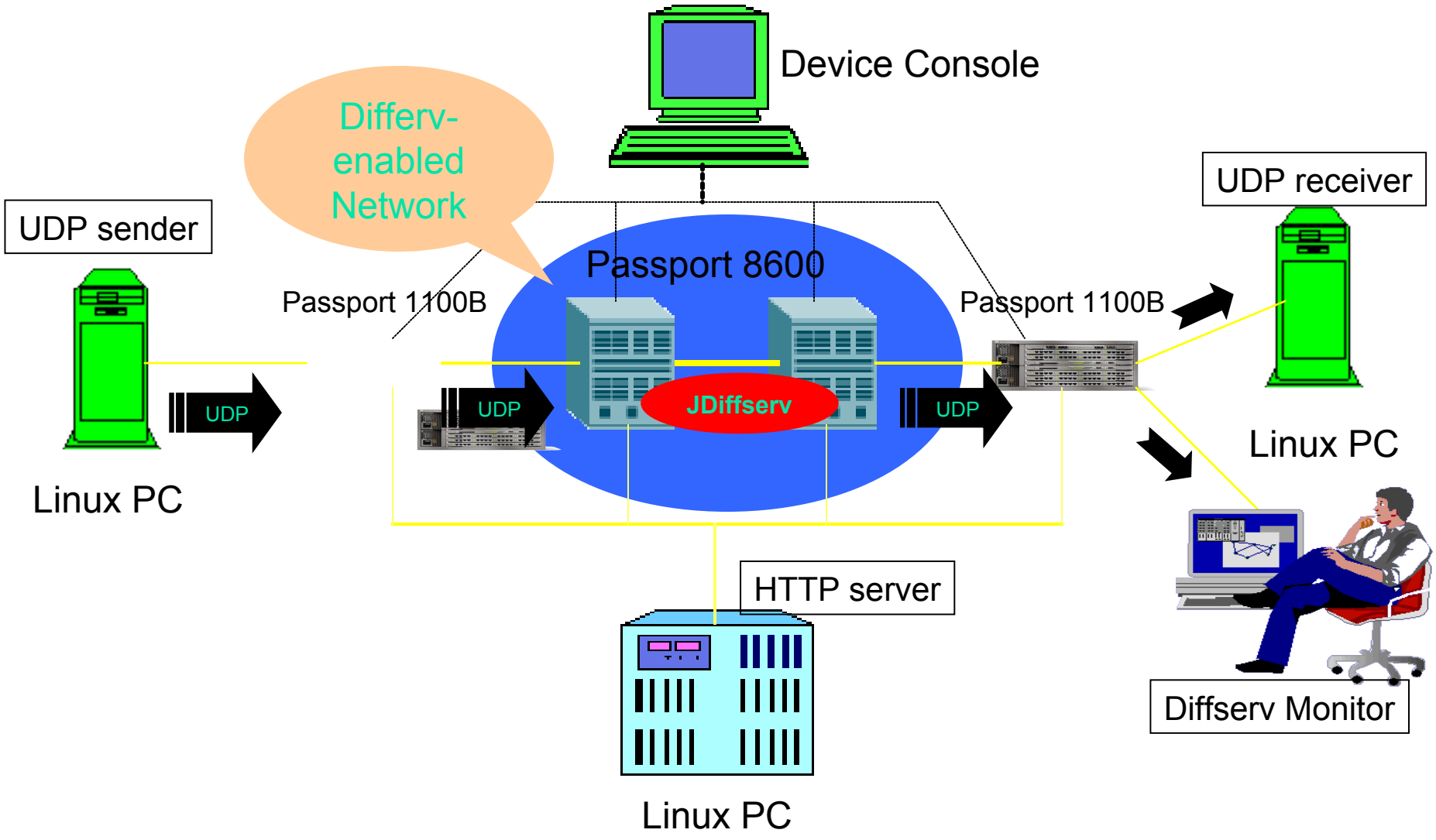
Openet Architecture



JDiffserv

- Goals
  - DSCP marking and re-marking
  - Priority forwarding or dropping
  - Filtering
- Passport
  - Model: 8600
  - Java 2
- ORE
  - version 0.4.1
  - JFWD/JDiffserv service
  - URL: “http://www.openetlab.org/downloads/”

JDiffserv on Passport



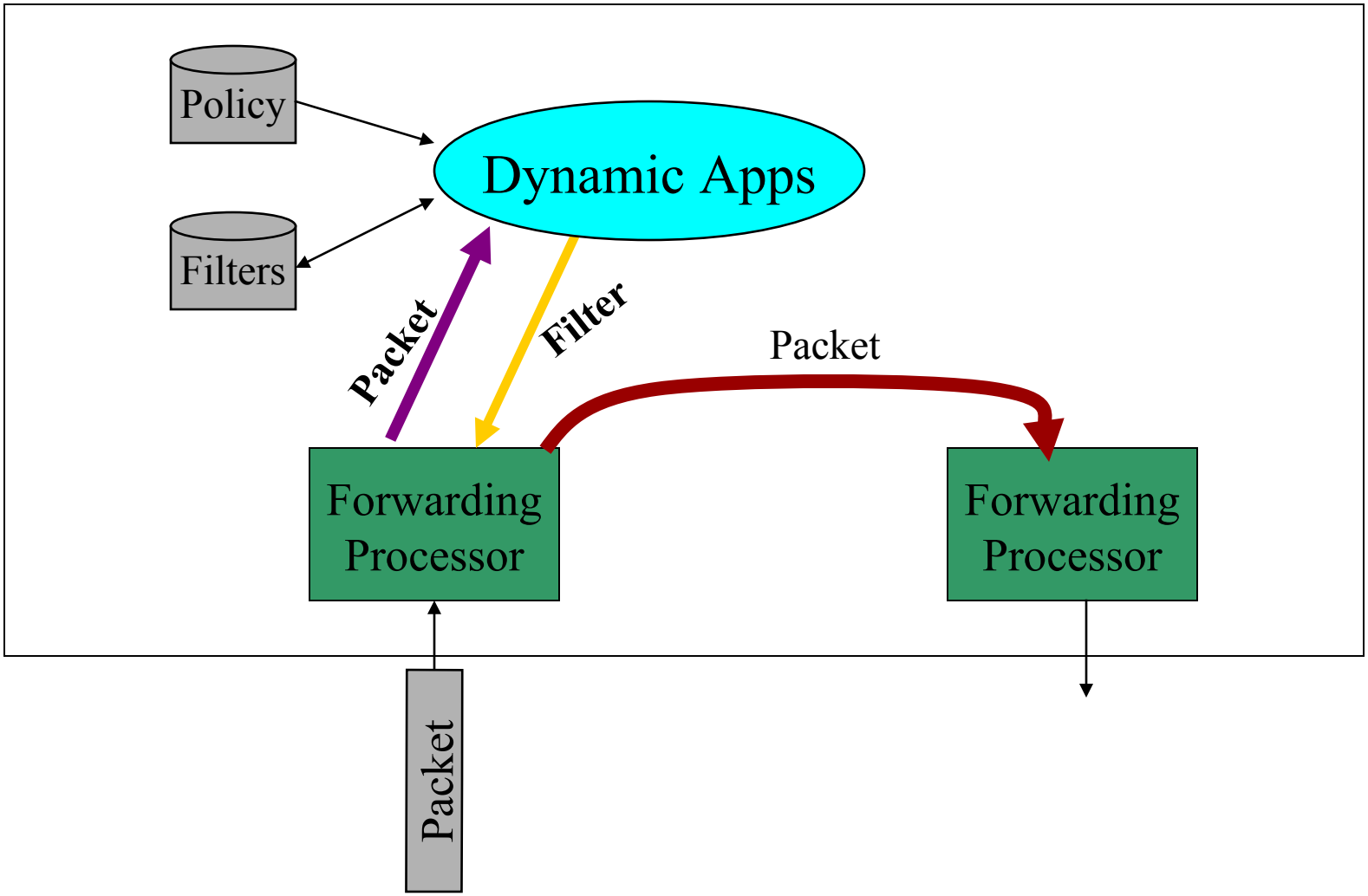
JDiffserv Features

- Marking Types
  - Admission marking
  - condition marking (a.k.a., remarking)
- Filters
  - IP headers: 5-tuple
    - Source address and port, destination address and port
    - Protocol type
  - DSField: DSCP
  - Interface ports
- Traffic profile
  - Average rate and bucket size
  - Peak rate and bucket size
- Action
  - Marking then forwarding
    - 3-color marker: R/Y/G,RFC 2697
    - new DSCP
  - Dropping

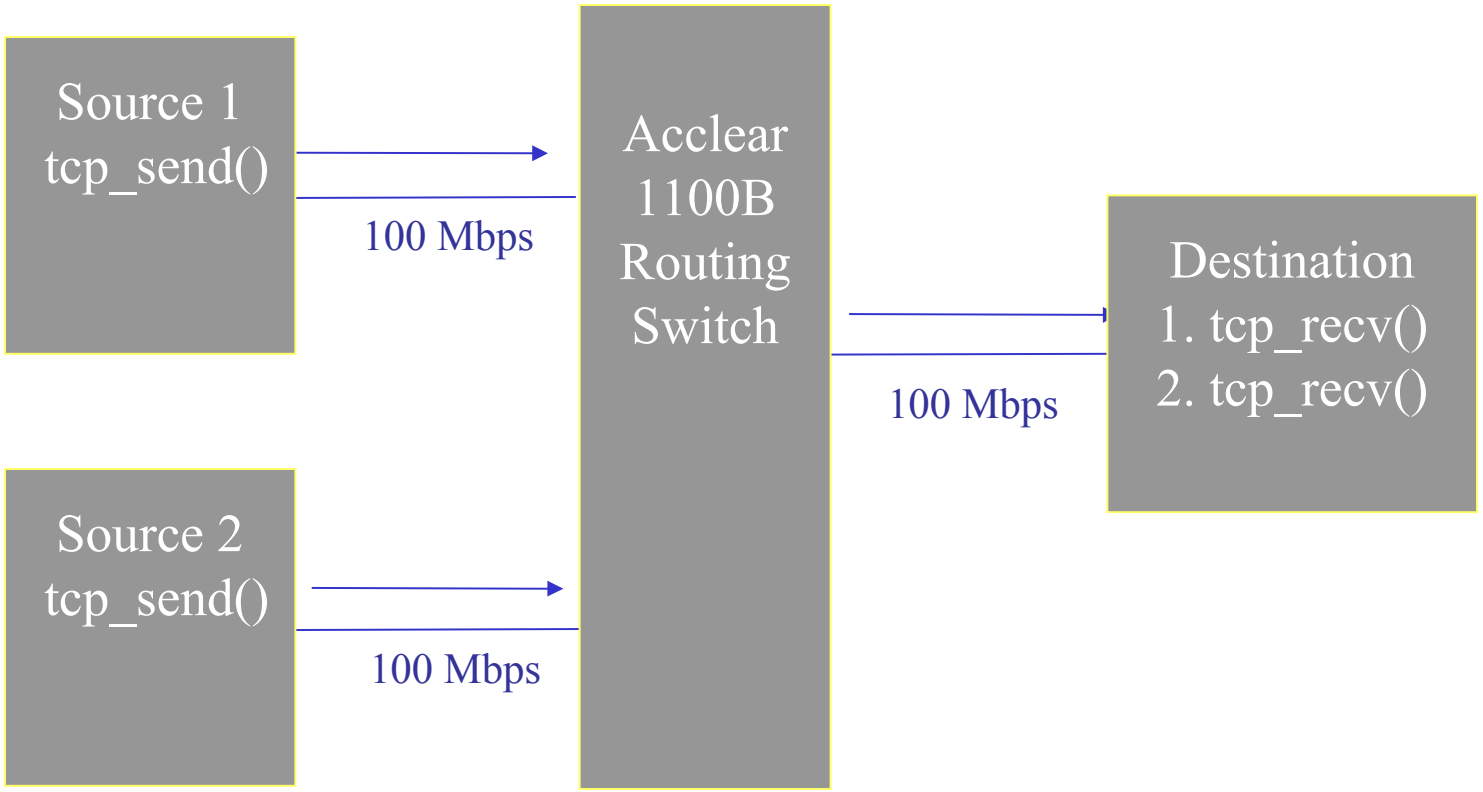
Dynamic Classification

- **Objectives**
  - **Implement flow performance enhancement mechanisms**
  - without **introducing software into data forwarding path**
  - **Service defined packet processing in a silicon-based forwarding engine**
  - **packet classifier**

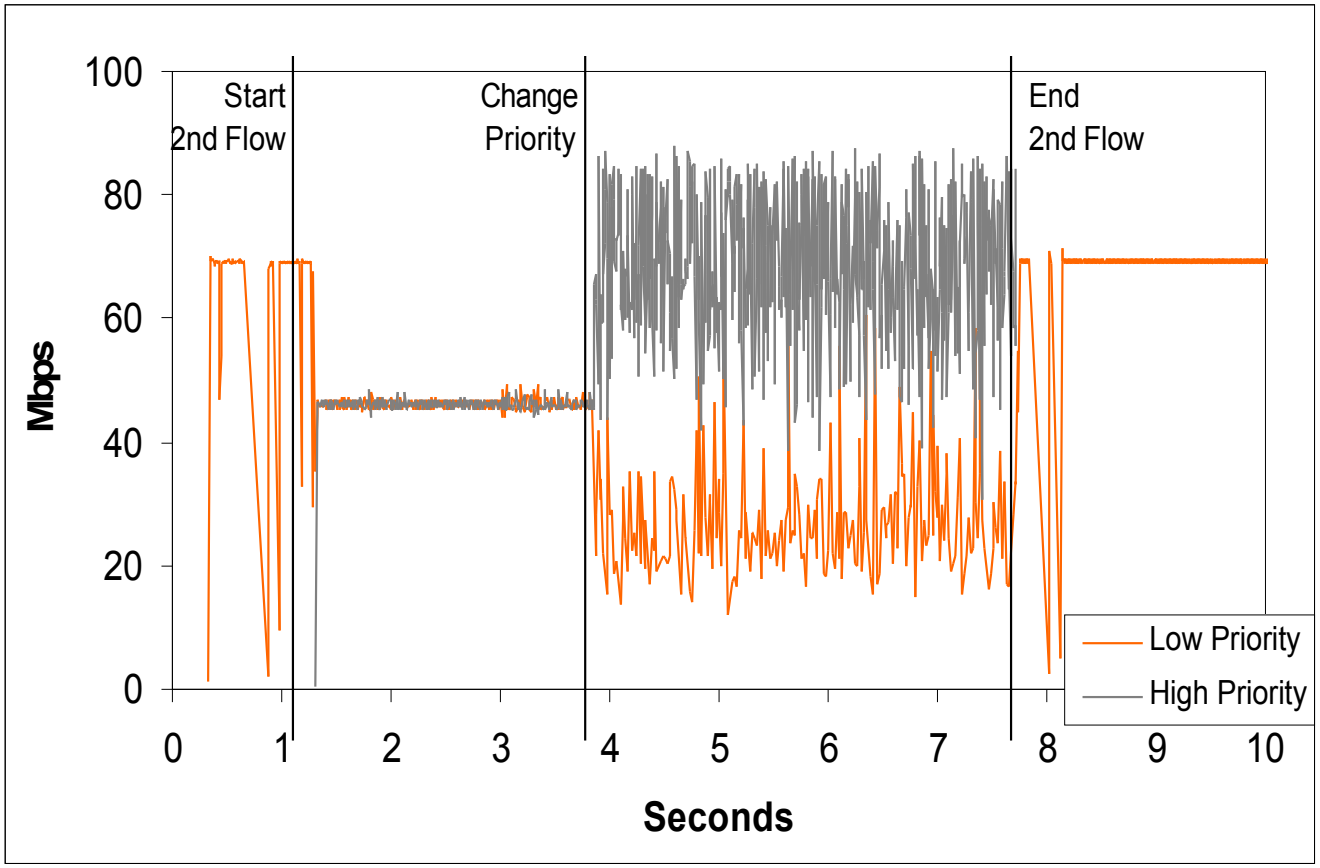
On-the-fly configuration



Experimental Setup

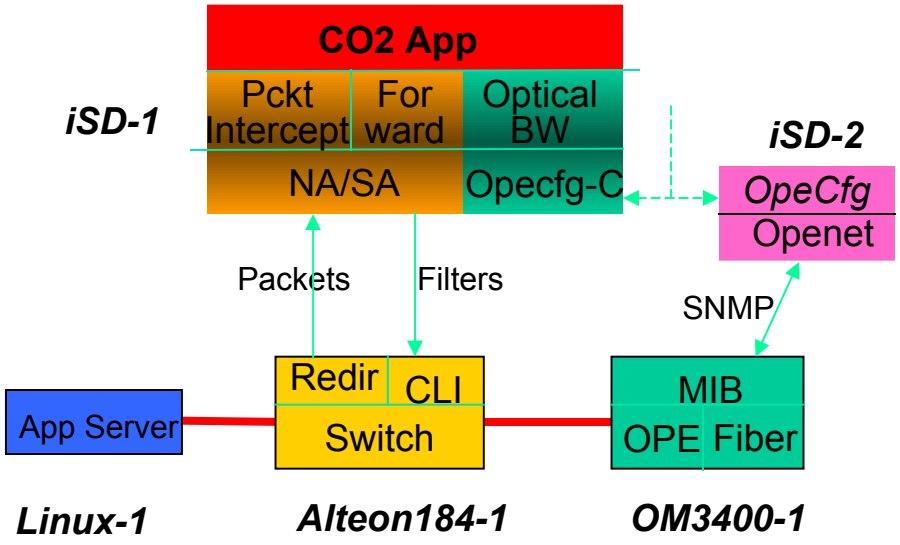


Throughput Results



OpeCfg: Optical Control

- Goals
  - Content-aware bandwidth allocation
- Features
  - Content flow interception
  - Dynamic optical control
- 2 Alteon switches, 3 iSD boxes and 2 OM3400



DARPA-Funded Project

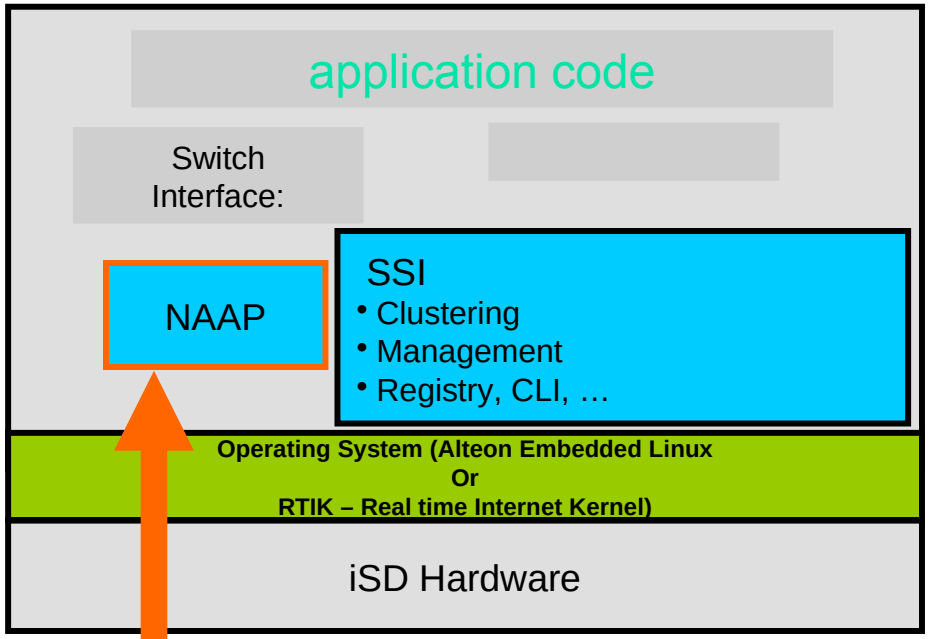
Active Nets Technology Transfer through High-Performance Network Devices

- Exploring new commercial network hardware
  - L2-L7 filtering
  - Fast content filtering and redirection
  - Strong and extensible CPU capability
  - Secure partitioning hardware and software
  - Supporting heterogeneous EEs
- Research platform
- Server and network collapse

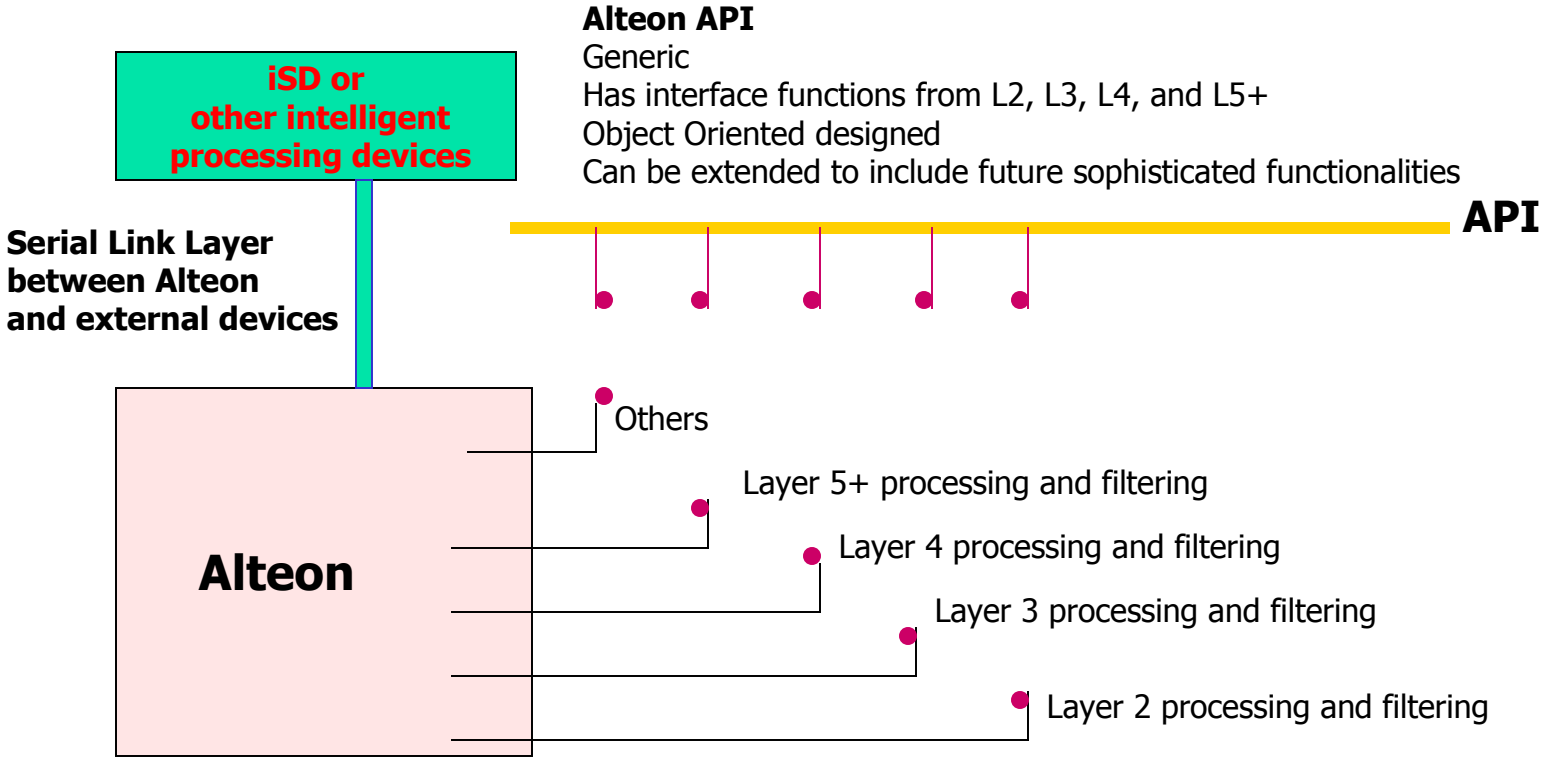
iSD Architecture

iSD

Web Switch

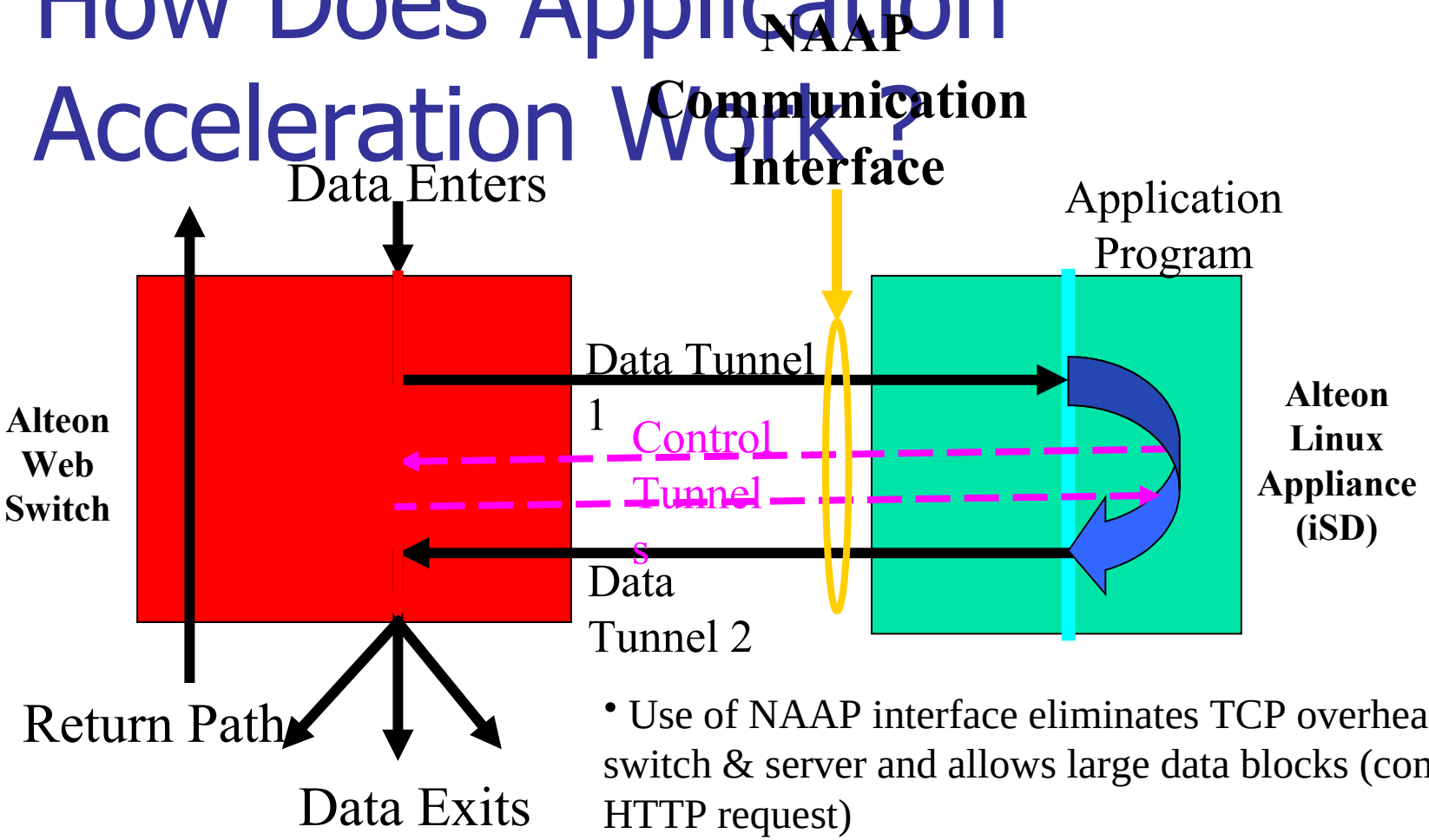


Alteon API – differentiates itself from other boxes



This slide and other previous slides sent to you illustrate my point.
You can also see it more clearly if you ask the question "Why don't I just use a powerful iSD without the Alteon?"

How Does Application Acceleration Work?



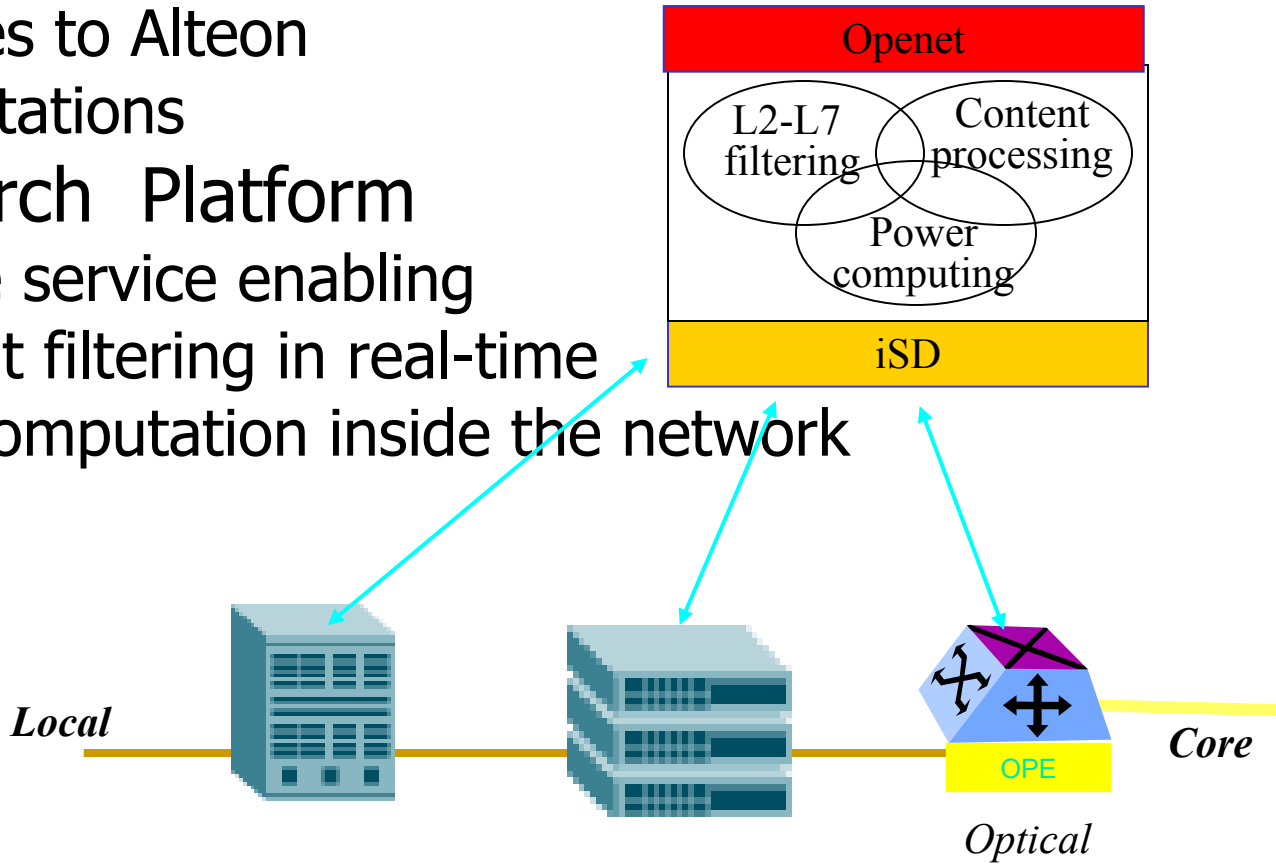
- Use of NAAP interface eliminates TCP overhead between switch & server and allows large data blocks (complete HTTP request)
- Server is removed from return data path
- Switching functions are removed from Linux application code and transferred to switch hardware
- See notes section below for further detail

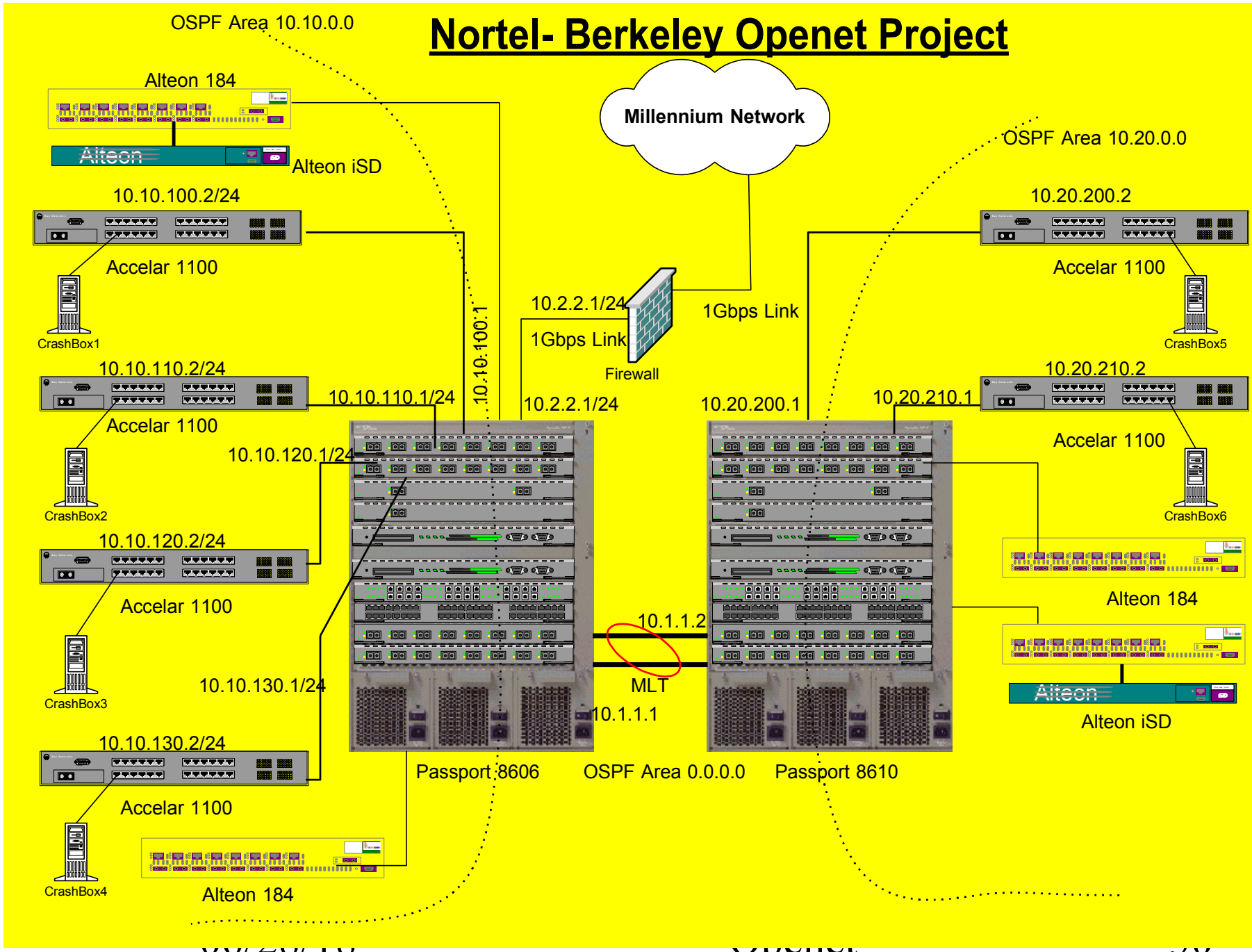
T1: Programmable content switch

- Openet on Alteon
  - L2-L7 filtering
  - Fast content filtering and redirection to active services
  - Enhanced closely with Alteon features
- Alteon: new generation of content switch
  - Multiple processors and ASICs
  - Programmable microcode
  - L2-L4 and application filtering and processing

T2: Research Platform

- iSD: powerful and extensible computational plane
  - Partitioning hardware and software resources
  - Close interfaces to Alteon
  - Cluster computations
- Network Research Platform
  - Openet: active service enabling
  - Alteon: content filtering in real-time
  - iSD: integral computation inside the network




Nortel- Berkeley Openet Project
OSPF Area 10.10.0.0
Alteon 184
Alteon iSD
Millennium Network
OSPF Area 10.20.0.0
10.10.100.2/24
Accelar 1100
CrashBox1
10.10.100.1
10.2.2.1/24
1Gbps Link
1Gbps Link
Firewall
10.20.200.2
Accelar 1100
CrashBox5
10.10.110.2/24
Accelar 1100
CrashBox2
10.10.110.1/24
10.2.2.1/24
10.20.200.1
10.20.210.1
10.20.210.2
Accelar 1100
CrashBox6
10.10.120.1/24
10.10.120.2/24
Accelar 1100
CrashBox3
10.10.130.1/24
10.1.1.2
MLT
10.1.1.1
Alteon 184
Alteon iSD
10.10.130.2/24
Accelar 1100
CrashBox4
Alteon 184
Passport 8606
OSPF Area 0.0.0.0
Passport 8610

Any interest?

Looking for grant?

- Interested in summer internship?
  - Talk with me latter

How Can we Collaborate?

- Corry is not far from Soda
  - Are we EE+CS or EECS?
  - How can we bridge CS and EE projects?
  - Can we create a virtual lab? How?
- Openet and SmartNet are supported by DARPA

Summary

- Industry supports open networking
  - Network evolutions
  - Programmable network devices
- Openet is a programmable networking platform
  - Java 1.1 and Java 2
  - Devices: Alteon/iSD, Passport 1100 and 8600
  - OS: VxWorks, Linux, Unix and Windows

Q & A

Visit us at
HTTP://www.openetlab.org

Thank You !

Backup

What's an Oplet?

- Oplet***: a self-contained downloadable unit***
  - Encapsulates one or more service objects
  - Contains service attributes, e.g., names
  - Eases secure downloading and service installation
  - Use other service oplets
  - Examples
    - Active Networks services: EE
    - Java Forwarding services: JFWD
    - Base services: ODK

How a service is deployed?

- Service design and coding
  - Regular Java programming
- Service package
  - Oplets by ODK
  - JAR files
  - Uploading to downloading servers
- ORE start at Passport
- Service activation by ORE
  - Downloading, start and stop
    - Startup service
    - Shell service
- Service execution