2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS
CONNECTING POINTS OF OPPORTUNITY

SDN Trends

Milan Todorović, Manager of Network Engineering, N-Com

N-com

Association of Communication Engineers
ACE

SDN – Not the best of names

- All networking is defined by software
- Any programmatic solution introduced into the network can be considered SDN
- How software for networking written
  - Tightly vs. Loosely coupled to the hardware
  - Closed vs. Open to interacting with other software
  - Individualized vs. centralized in control

A lot of confusion in the industry comes from the ambiguity of the term SDN

Origins of SDN

- Network devices: computationally constrained, individualized, unaware of the larger network topology
- Protocols: simple, computationally friendly, focused on a single node
- Networks were static, topologies fixed, traffic flow predictable
- Rise in computational power and development of computation power slicing
- Data centers
  - Constantly changing number of server hosts
  - Changing bandwidth requirements
  - Changing topology
  - Fixed, static networks are not sufficient
- Data Centers and Telecom service have different constraints

SDN defining principles

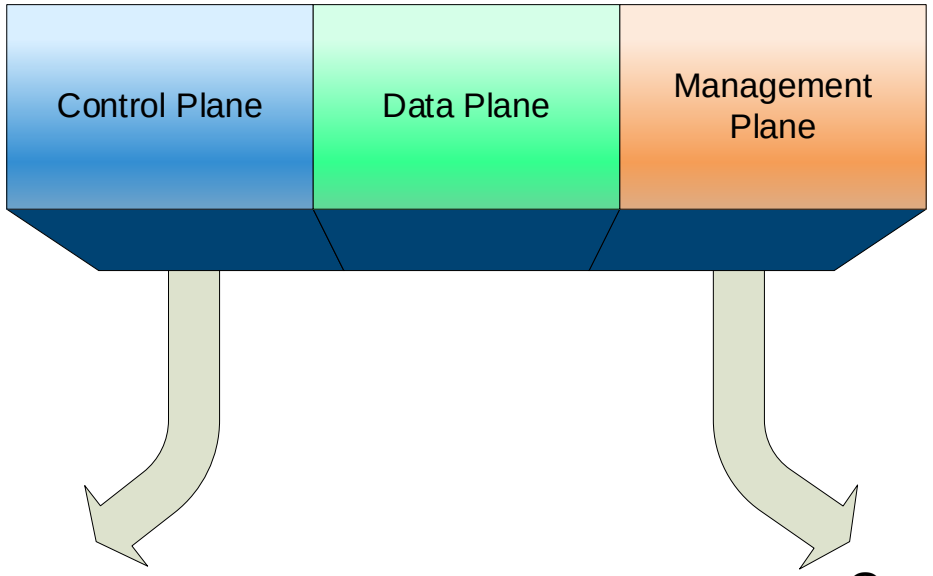
- Separation of functionalities
  - Data Plane – Packet forwarding
    - Hardware/silicon
    - Standardized and commoditized (COTS, barebones)
  - Control Plane – Route processing
    - Software
    - Centralized
  - Management Plane – Provisioning and monitoring
- Depends on the use of well defined APIs and data models
- Works together with or replaces traditional protocols
- Introduces an SDN Controller (Orchestrator)
  - Performs traffic control and/or management functionality

This is where SDN and NFV overlap

The promise of SDN

- Simplify operation
  - Central network provisioning tool
  - Cross-platform provisioning
  - True end-to-end circuit provisioning
  - Zero touch provisioning
- Improve network performance
  - Improve on limitation of current protocols
  - Make decisions that are best for the network at large
- Lower the cost
  - Replace the expensive router port with more cost efficient switch port
- Offer new services
  - Enable flexible networks and support new on-demand services

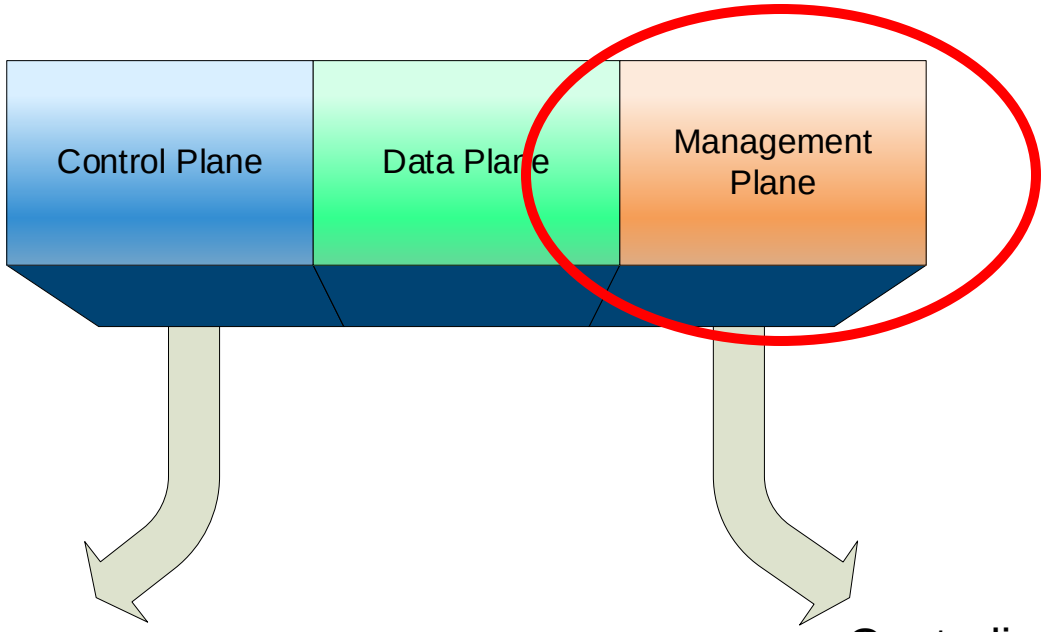
Directions of SDN development



New traffic control paradigms
Flow-based switching
Support of new services

Centralized provisioning
Automation
Custom management tools
Simplified integration with OSS/BSS

Directions of SDN development



New traffic control paradigms
Flow-based switching
Support of new services

Centralized provisioning
Automation
Custom management tools
Simplified integration with OSS/BSS

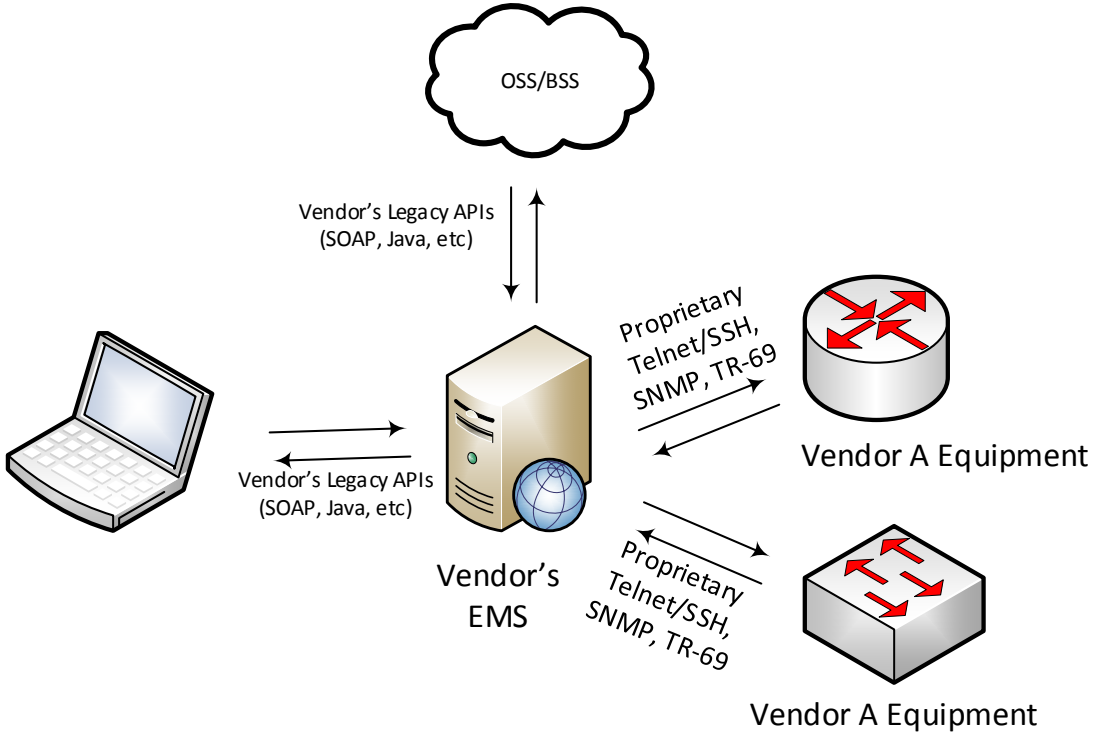
Development in the Management Plane

- Most of the current telecom SDN solutions are focused on management
- Centralize and automate network provisioning and maintenance
- Current methods are not conducive to software-based network control
  - CLI (Serial/Telnet/SSH), SNMP, TR-069
  - Proprietary and vendor specific
  - User focused
  - Limited data that can be obtained
- Defining clear set of protocols, data models and APIs for software access to the equipment
- Standardizing the way all equipment is managed (on the back-end)

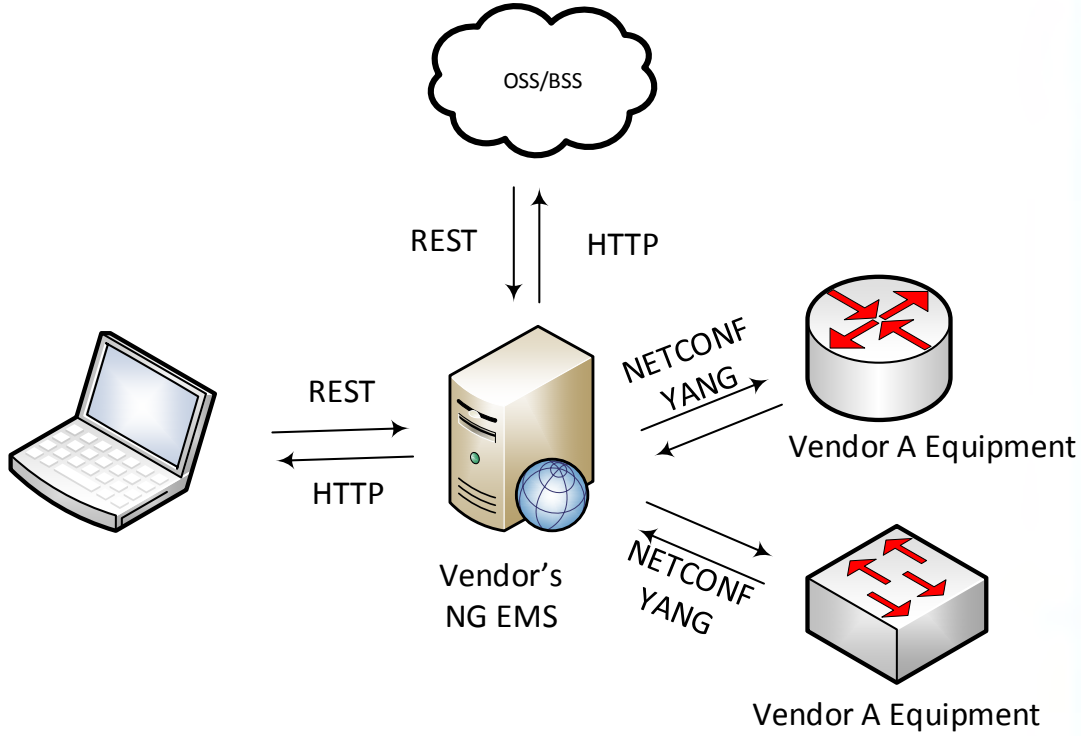
Building blocks of new management

- NETCONF – network management protocol
  - Uses XML based information
  - YANG – data modeling language
    - Uses XML to define network element properties and events
    - IETF defined models, vendor-specific models
  - RPC (remote procedure call) based
- REST API
  - Common way to programmatically request or change information
  - HTTP-based
  - Uses JSON
- Translating REST API into NETCONF/YANG
  - Vendor specific tools
  - SDN Controller
- RESTCONF

Evolution of Network Management



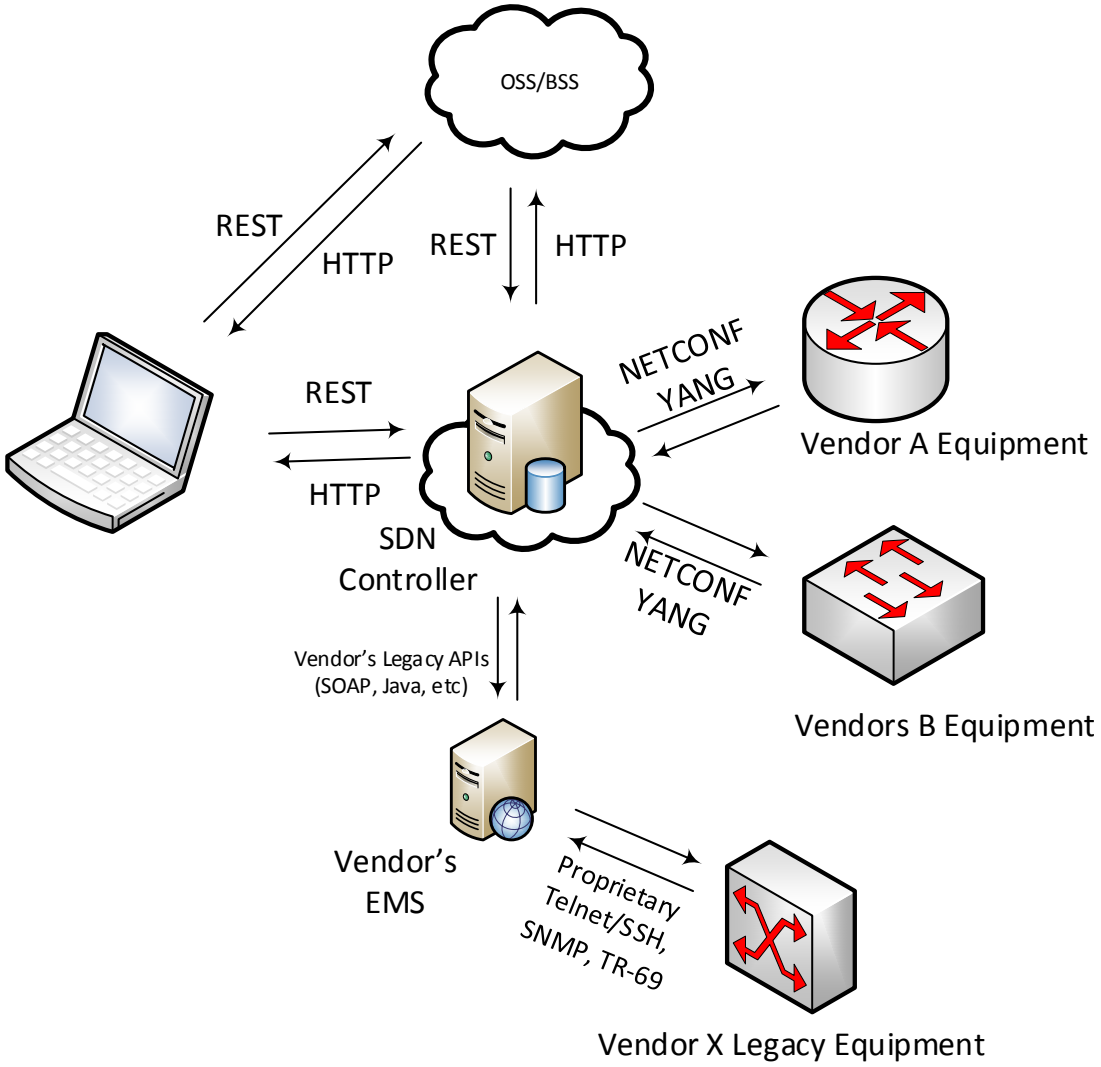
Legacy Network Management



Next-Gen Network Management

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

Final Step of SDN Management



- Single management interface for all equipment
- Single point of interface to OSS/BSS
- Flow-through provisioning
- Allows for automation/error reduction
- Allows for development of custom management tools

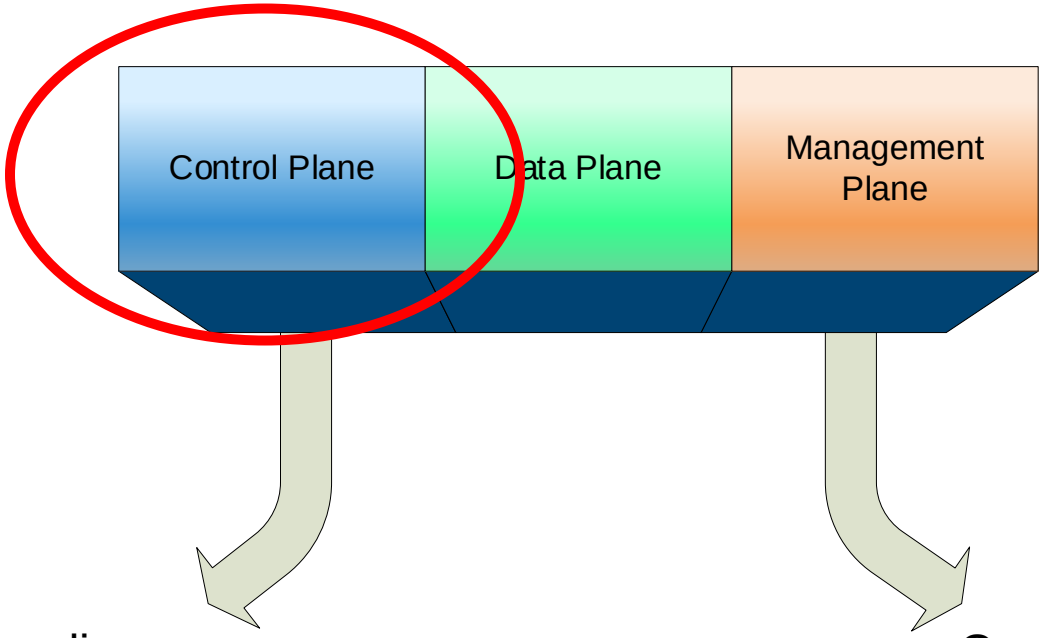
Obstacles to Management Plane Development

- Standards are still changing
- Cost
  - New equipment supports new management protocols and APIs
- Monolithic software/firmware is not conducive to SDN
  - Re-write code to be modular
  - Re-write code to access HAL (Hardware Abstraction Layer) instead of tightly coupled to hardware
- Integrating legacy software and legacy systems is not profitable
- Market pressures – open is not always open, vendors don't always play nice
- Development of controllers

Vendors operating in this space

- SD-Access
  - Adtran
    - Mosaic OS
    - Mosaic Cloud
  - Calix
    - AXOS/EXOS
    - SMx
- SDN Controller & Manager
  - Ciena – Blue Planet
- Other players: Juniper, Cisco, Metaswitch

Directions of SDN development



New traffic control paradigms
Flow-based switching
Support of new services

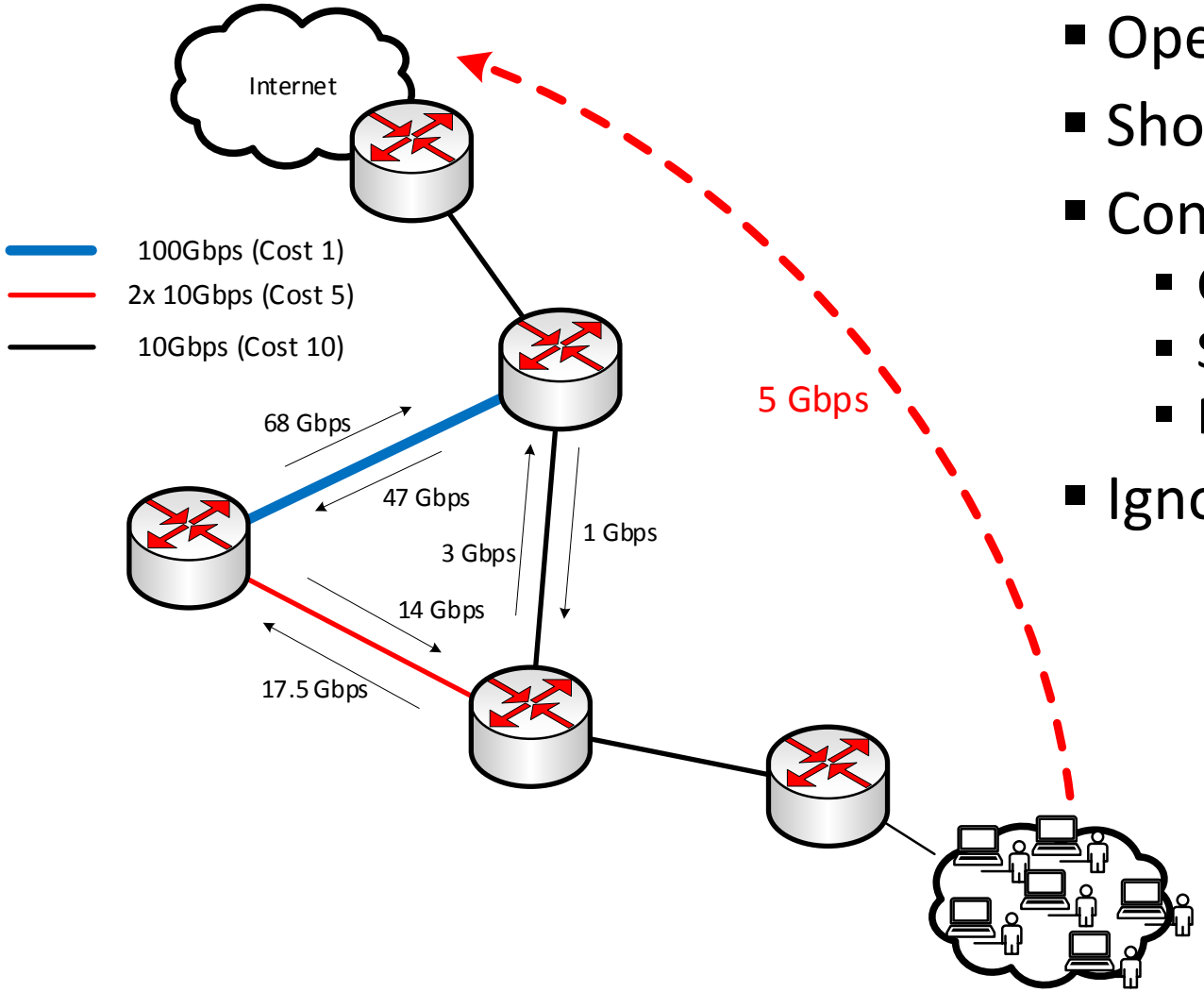
Centralized provisioning
Automation
Custom management tools
Simplified integration with OSS/BSS

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

Development of the Control Plane

- Separating control plane into a separate device(s) – moved to Cloud
- SDN Controller
  - Traffic routing decisions made with the knowledge of the whole network
  - Not constrained by traditional protocols
  - Computationally capable
  - Open Daylight, ONOS, BigSwitch, Metaswitch
  - Supports traditional protocol switches, vSwitches and flow-based switches
- Flow-based switching
  - OpenFlow 1.3
- SDN Holy Grail: SDN Controller + low-cost flow-based switching – obsoleting expensive routers

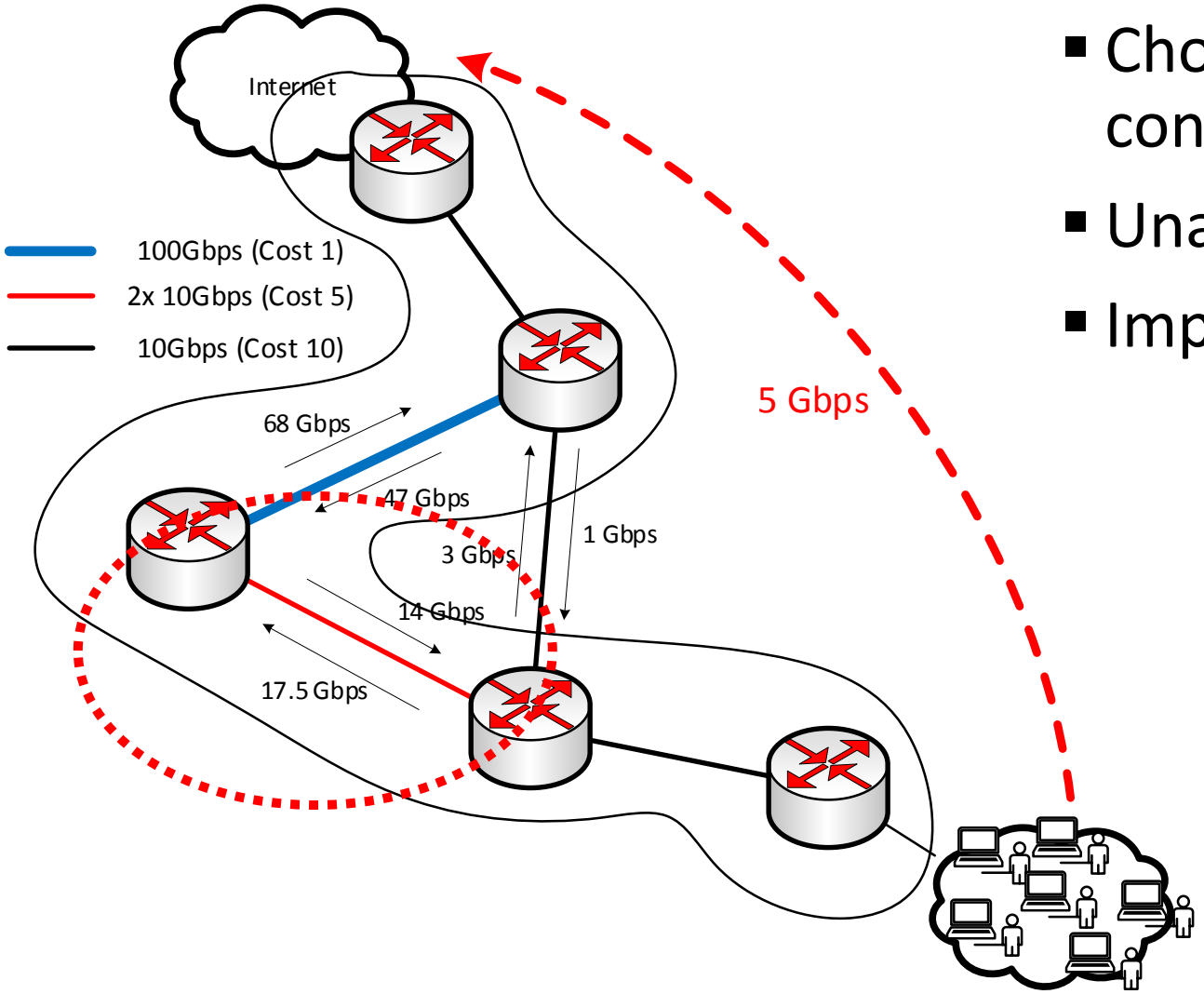
Case 1 - OSPF



- Open Shortest Path
- Shortest Path = Lowest Cost Path
- Considers:
  - Connection state
  - Size of the connection
  - Number of links
- Ignores: congestion, latency, jitter

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

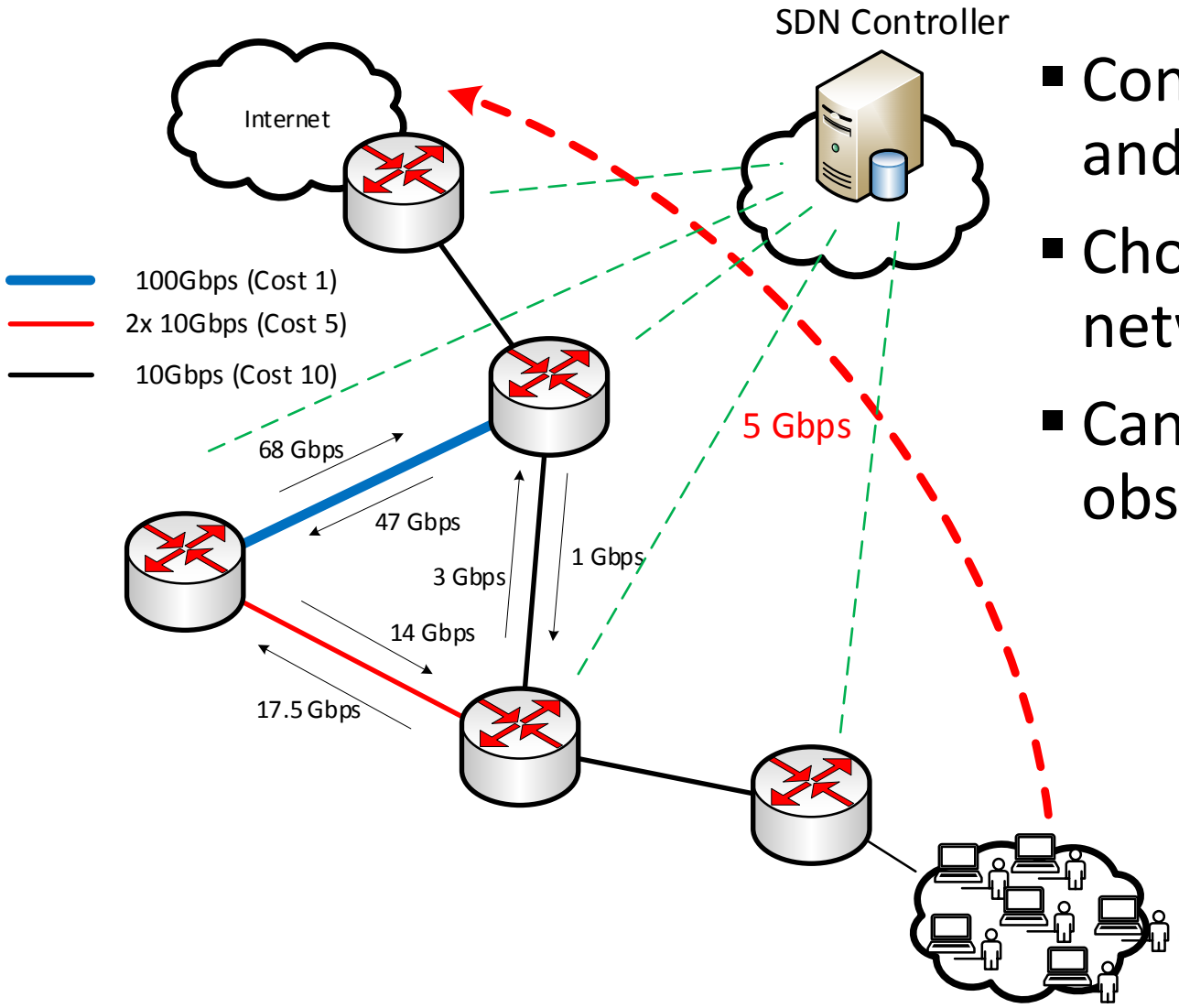
Case 1 - OSPF



- Chooses path containing congested link
- Unaware of congestion
- Impacts performance

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

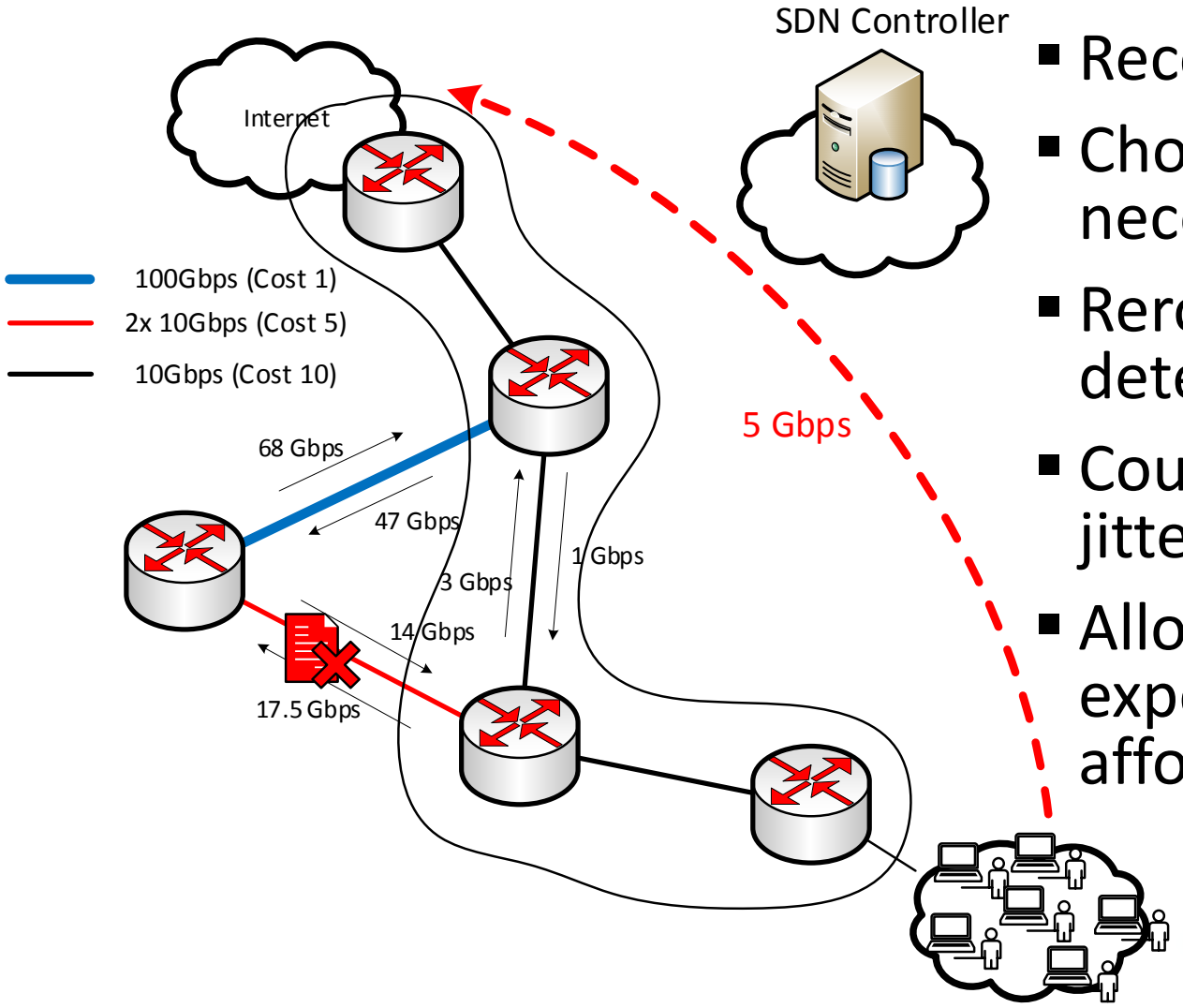
Case 1 - OSPF



- Controller is aware of all routers and all links
- Choose the path based on the network state
- Can override OSPF *or* can obsolete OSPF

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

Case 1 - OSPF



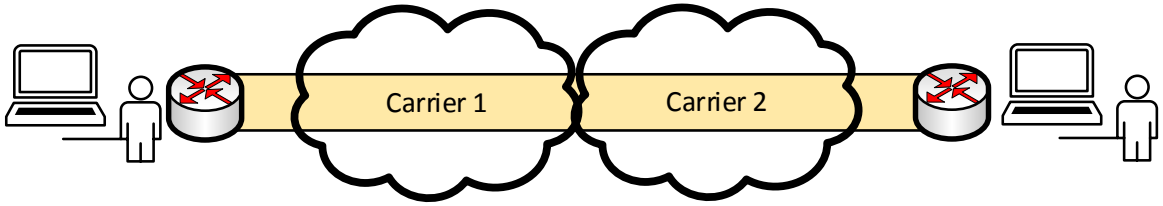
- Recognizes the congested link
- Chooses the best path not necessarily lowest cost
- Reroutes when congestion is detected
- Could be used for latency and jitter sensitive routing
- Allows for replacement of expensive routers with more affordable switches

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS ATLANTA
CONNECTING POINTS OF OPPORTUNITY
Association of Communication Engineers
ACE

Case 2 – SD-WAN

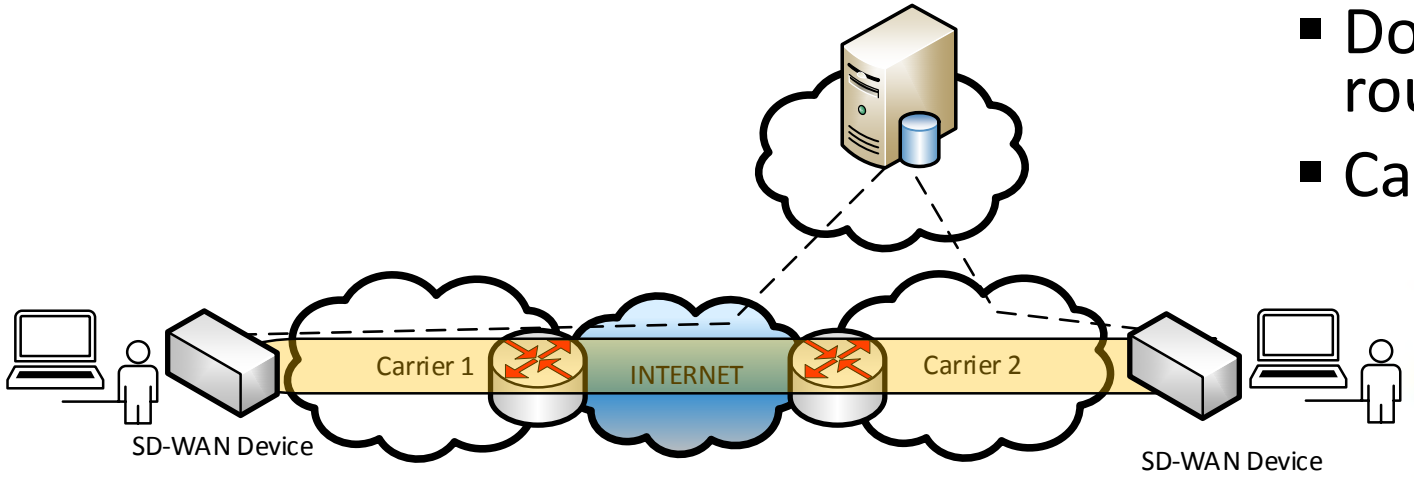
- A way to replace dedicated Ethernet circuit/MPLS service with a service of same functionality over the Internet
- More than VPN - provides security, prioritization, failover, load balancing
- Support connections through multiple technologies (FTTP, DSL, Coax, LTE)
- Controller provisions both endpoints and tunnel between them
- Controller manages the traffic and changing network conditions
- Why should you care about SD-WAN
  - Much more cost effective for the customer
  - Carriers can provide SD-WAN to the customer they do not physically serve
  - NaaS model - recurring revenue

Case 2 – SD-WAN



MPLS Service

SD-WAN Service



- Utilizes any and all Internet connections
- SD-WAN makes failover simple with secondary or tertiary connections
- Doesn't require any circuit specific inter-carrier connections – not always easy with Tier 1s
- Doesn't require expensive MPLS routers
- Can be deployed with NFV

Obstacles to Control Plane Development

- Telecom services and traffic still do not require the flexibility - YET
- A lot of work has to be done on the SDN Controllers
- A lot of work has to be done on the SDN traffic control apps
- OpenFlow switches and hybrid switches still not cost effective in telco industry – economies of scale
- Cost saving may occur only in large networks
- For smaller providers it may be more cost effective to add bandwidth
- Steep knowledge curve

Future of SDN in Telecommunications

- It's coming – Tier 1 are pushing it; they scale, so they benefit
- Customers will start demanding new services
- For small carrier, SDN adoption is going to be slow and granular
  - 1-3 years: adoption of new management methods, deployment of SD-WAN
  - 5-7 years: limited use of vendor specific/inter-oped SDN controllers for highly specific purpose
  - 10-15 years: common use of flow-based switches/hybrid switches
  - 20+ years: wider use of SDN controlled network traffic
- Smaller carriers will depend on vendor packaged software and apps
- Few carriers will write their own apps (or need to) in the foreseeable future.

SDN DYI Primer – For the Enthusiasts

- SDN Controller: ONOS or Open Daylight (ODL) free to download
- Mininet – OpenFlow network simulator
- GNS3 – Network simulator
- Software deployment:
  - Python and CURL
  - Postman – API development and testing tool
  - YANG Brower
- Raspberry Pi + USB Ethernet dongle + vSwitch = cheap OpenFlow switch
- VMware ESXi – free for personal use

2018 ACE SCHOOL & RUS SYMPOSIUM
TERMINUS
CONNECTING POINTS OF OPPORTUNITY

Thank you!

Milan Todorović

milan@ncom.com

N-com

Association of Communication Engineers
ACE