Carrier Ethernet 2.0 services in mobile backhaul networks utilizing OpenDaylight and OpenFlow

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- Introduction
- CE services in Mobile backhaul networks based on SDN
- Cloud, CE, and SDN
- Five-nines availability using OF
- NMS and SDN
- Use case scenario based on OF
- Conclusion

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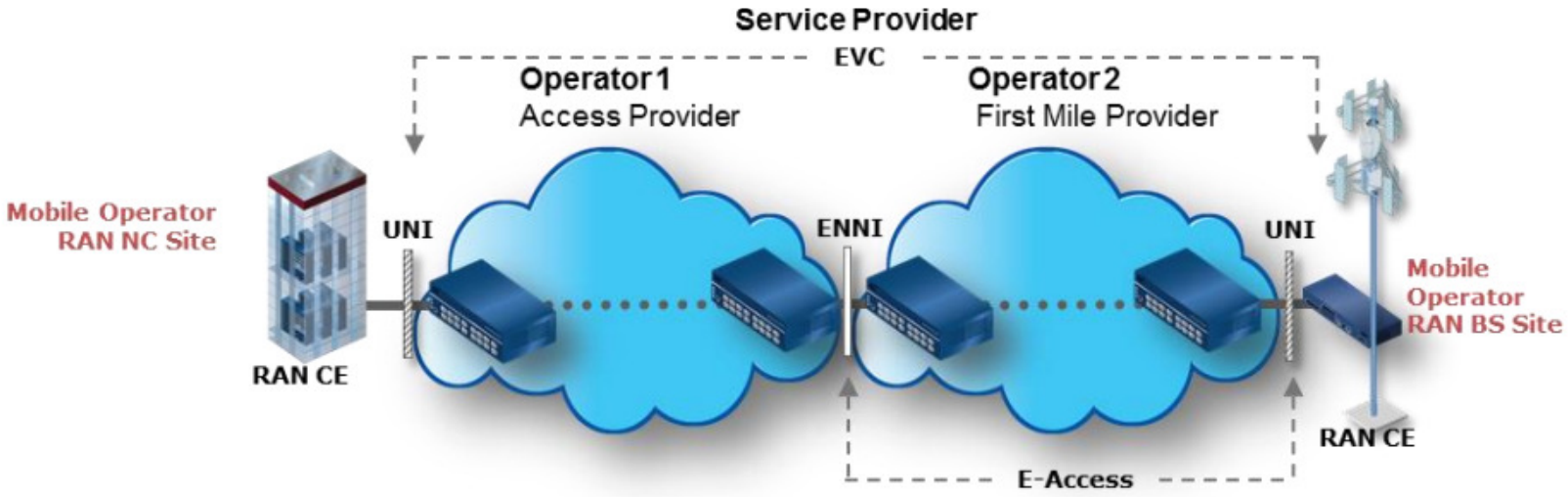
Introduction

- The term Mobile Backhaul includes a collection of networks and network technologies, including the transport between parts of the Radio Access Network (RAN) and Core Networks
- Next generation mobile equipment and networks with Ethernet service layer (ETH) functions can support MEF Carrier Ethernet (CE) Services
- CE services will provide the connectivity in the Mobile Backhaul network (simple to deploy and maintain, effective and inexpensive technology)



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Challenges

- Backhaul is a constrained environment [Bercovich, 2014]
  - Impossible to find infinite interconnect capacity in real backhaul networks
  - Spectrum for transport applications is costly (linearly increased with usage)
  - Wireless radio links have a statistical behavior due to weather conditions
- Service providers are looking for automation, service agility, end-to-end network control, and fulfillment of the growing demand for bandwidth [Metro, 2014b]
- End-users are looking for more control of their services including the ability to dynamically modify their service on-demand [Metro, 2014b]

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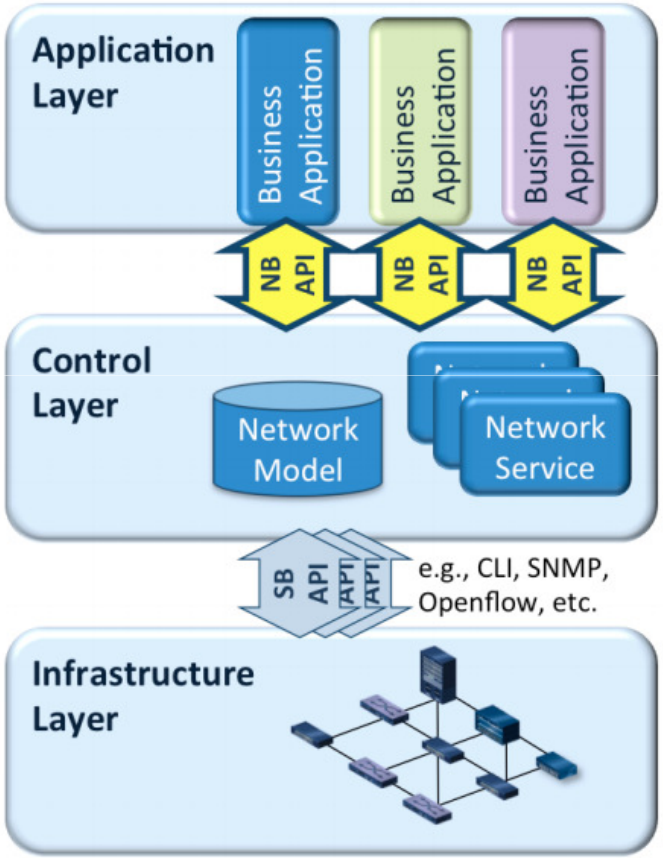
SDN Driver

- Carrier Networks must migrate to a dynamic and responsive CE service enabled by the implementation of software defined networking (SDN) and Network Functions Virtualization (NFV)
- SDN makes CE more dynamic and agile due to the separation of data-plane forwarding from control and management functions
- Networks are simplified by centralizing control and providing an end-to-end perspective on services
- Service automation is supported
- The most commonly used implementation vehicle of SDN is OpenFlow (OF) southbound API (ONF approach of adapting SDN to carrier networks [Bercovich, 2014])



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SDN-based CE services in mobile backhaul networks (1/2)

- Open and standardized interfaces (OF, OF-Config, Netconf, etc.) can make wireless transport elements programmable – vendor agnostic
  - Normal elements can be replaced by simpler and cheaper off-the-shelf devices
  - Flow shaping, rerouting, traffic aware power management, network-level traffic optimization, and dynamic spectrum management become feasible
- The CE intelligence is centralized
- OpenDaylight (ODL), an industry-supported and collaborative open source SDN controller supports a variety of SDN features, and a Zero touch-based approach

SDN-based CE services in mobile backhaul networks (2/2)

- Distributed traffic forwarders can be added as demand dictates, reducing costly oversubscription of network bandwidth.
- Customer VLAN-id mappings and transformations required by CE virtual services can be easily supported
- CE services without long-term contracts (turn up and down easily)
- Simplified control - More robust Network Management System (NMS) integration and lower operational costs.

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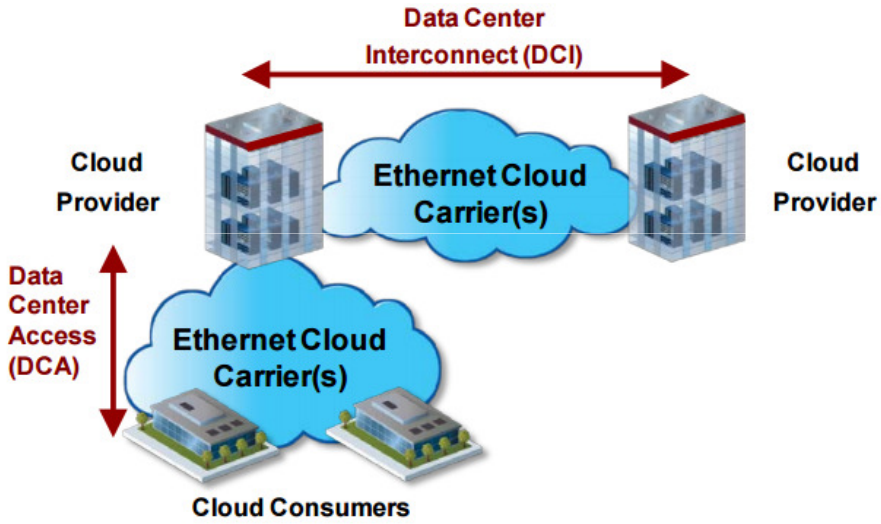
Cloud, and CE - Challenges

- Enterprises/Mobile operators are migrating their applications and infrastructure into the cloud (for example the Evolved Packet Core (EPC)) [Metro, 2014a]
- Need for reliable and elastic connectivity
- CE Services provide a high quality interconnection enabling strict control of access and conforming to a service level specification (SLS) [Metro, 2014a] .



Cloud, and CE – SDN Driver

- The next stage of CE services growth will come from cloud services and interconnections, combined with virtualized network services.
- SDN enables an orchestrator to establish, modify elastic CE service attributes on demand
- Dynamic and on-demand bandwidth allocations can be supported by coordinating the functionality of heterogeneous network elements (OF protocol is required) in the backhaul

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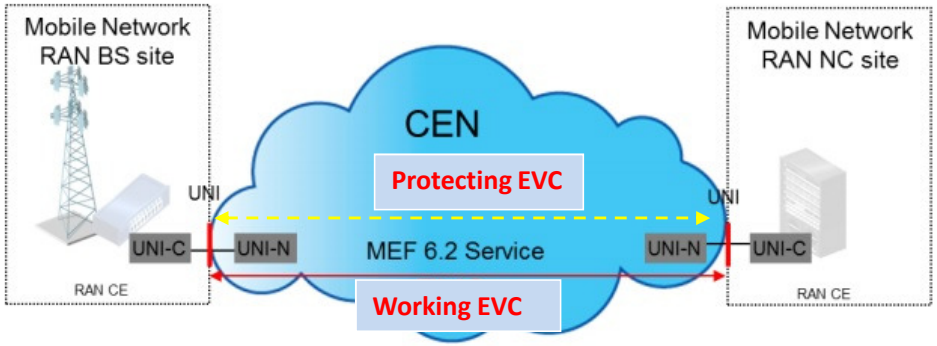
Five-nines availability

- High-level survivability against failures for specific CoS names
- When failures do occur, they are not supposed to be noticed by the subscriber
- Fast recovery is achieved in less than 50ms (being debated)
- In OF context, it is achieved by using Fast Failover (FF) group types (only 1:1 protection switching is supported as OF is a stateless protocol)



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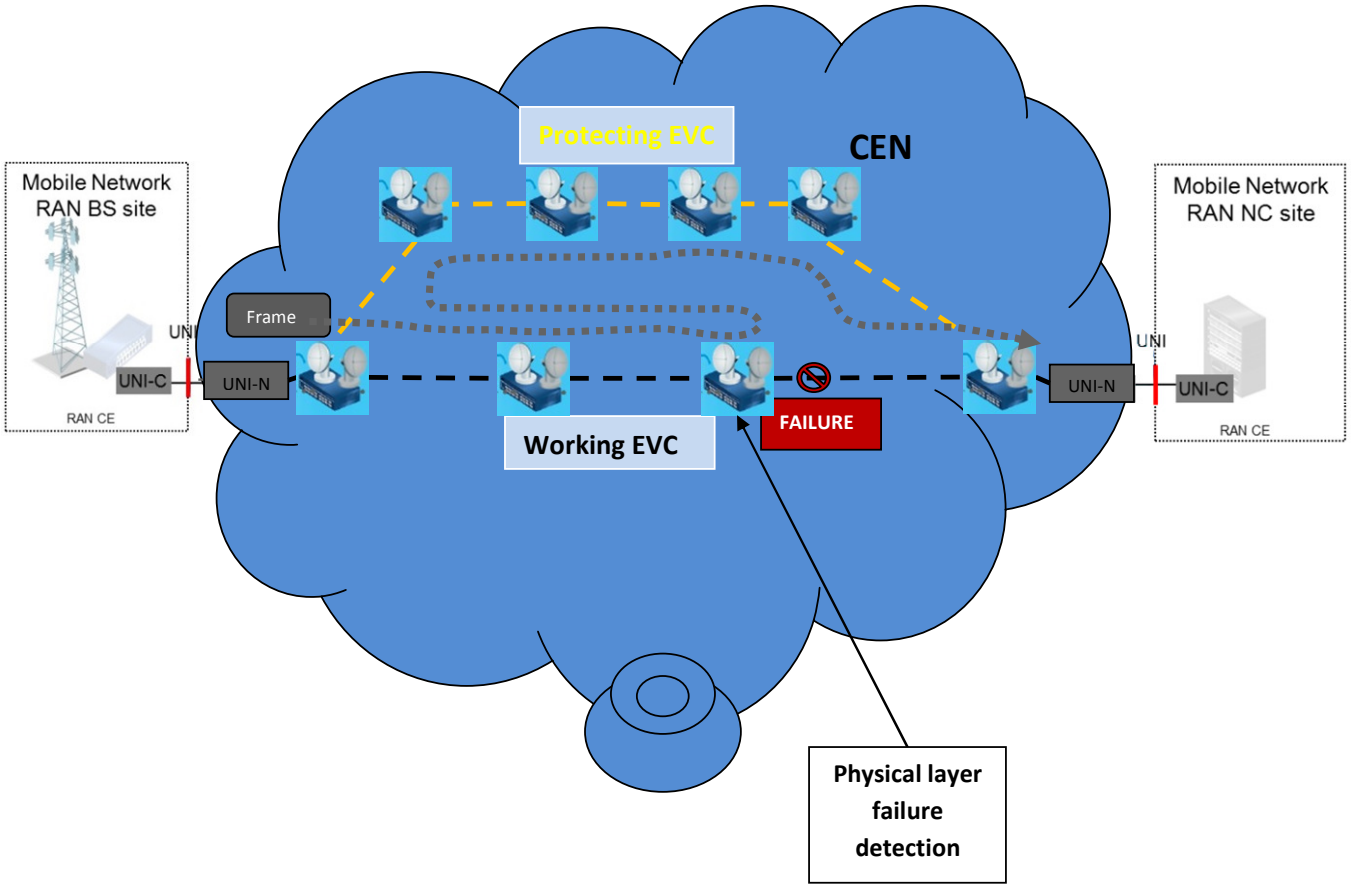
OF FF – Physical layer mode

- Requires local link failure detection by the switches (for example Layer 1 failure detection, Tx-Rx blinking, etc)
- Most of the switches support such failure detections (cheap ones)
- Switches take local action to quickly reroute traffic
- Preinstalled alternative flows exist on the switches
- Traffic must reach the switch that the failure occurred. Then, it is rerouted. Loops can be handled by using OF
- Recovery time is hardware dependent (typically less than 50 ms)

OF FF – Physical layer mode - *Example*

- Switches watch a specific physical port status to determine which bucket is live
- Customer frames must reach the point of failure
- Then, the FF is triggered



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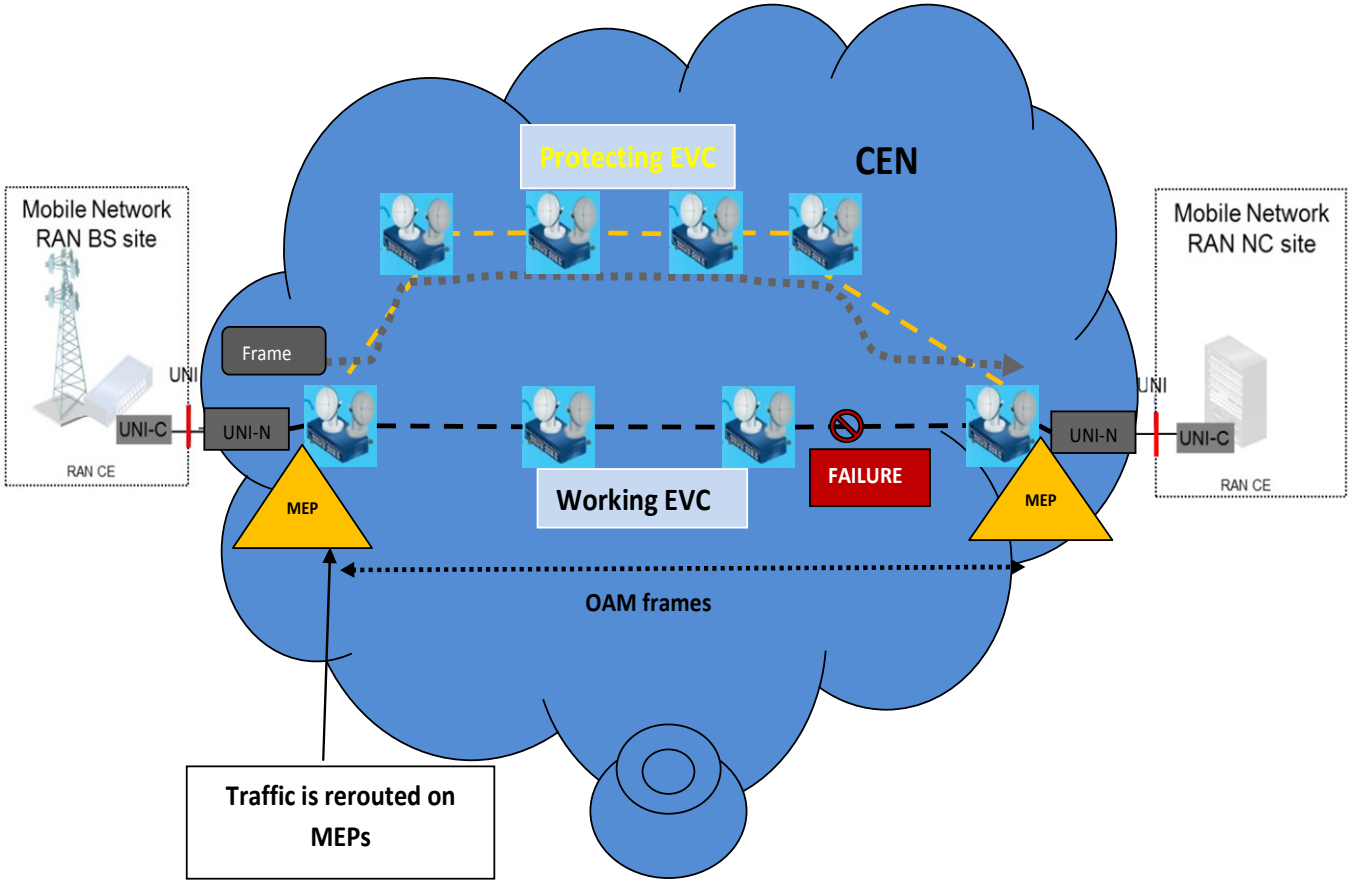
OF FF – Data link layer mode

- End-to-end connectivity monitoring of an EVC is required
- It can be accomplished by using an OAM protocol such as Connectivity Fault Management (CFM)
- Switches take local action to quickly reroute traffic
- Preinstalled alternative flows may exist on the switches
- Traffic can be rerouted before it reaches the failure point
- Recovery time is varying

OF FF - Data link layer mode - *Example*

- Switches watch a specific logical port (for OAM purposes) status to determine which bucket is live
- Customer frames are rerouted from the maintenance endpoints (MEPs) of a service
- The FF is triggered by the MEPs



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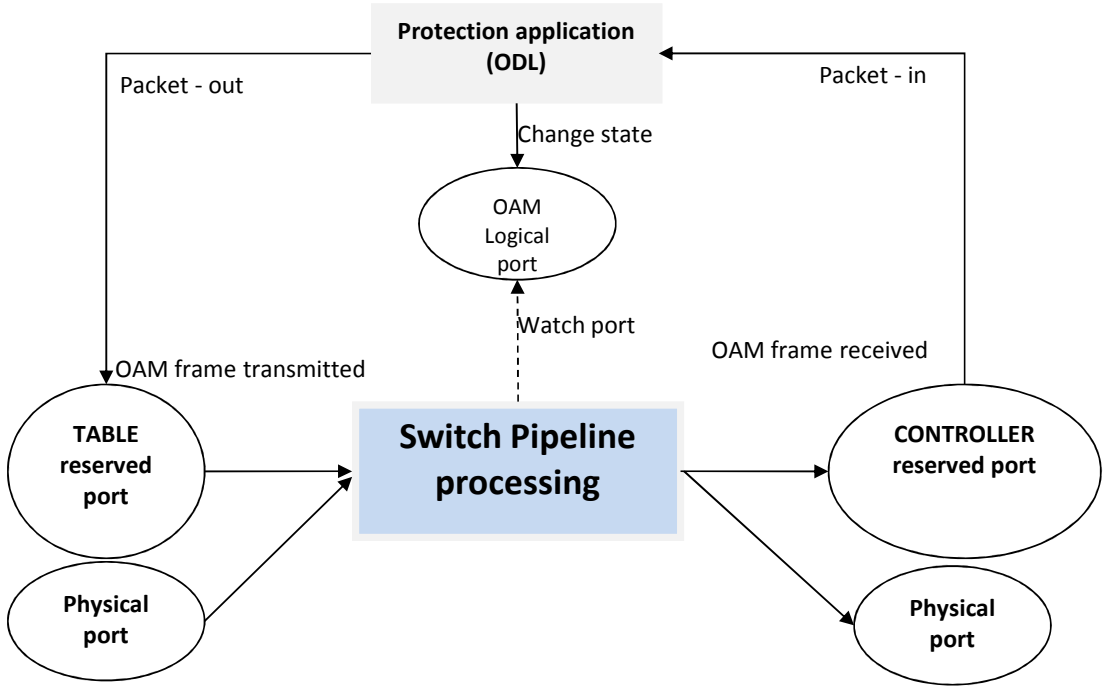
OF - FF - Data link layer mode
First approach

- Protection application runs on ODL
- It generates OAM frames and sends them to the switches
- It implements all the OAM state machines
- Flows on switches direct appropriate OAM frames to the ODL
- If time expires, ODL changes the status of a logical port, or deletes and adds flows on the switches



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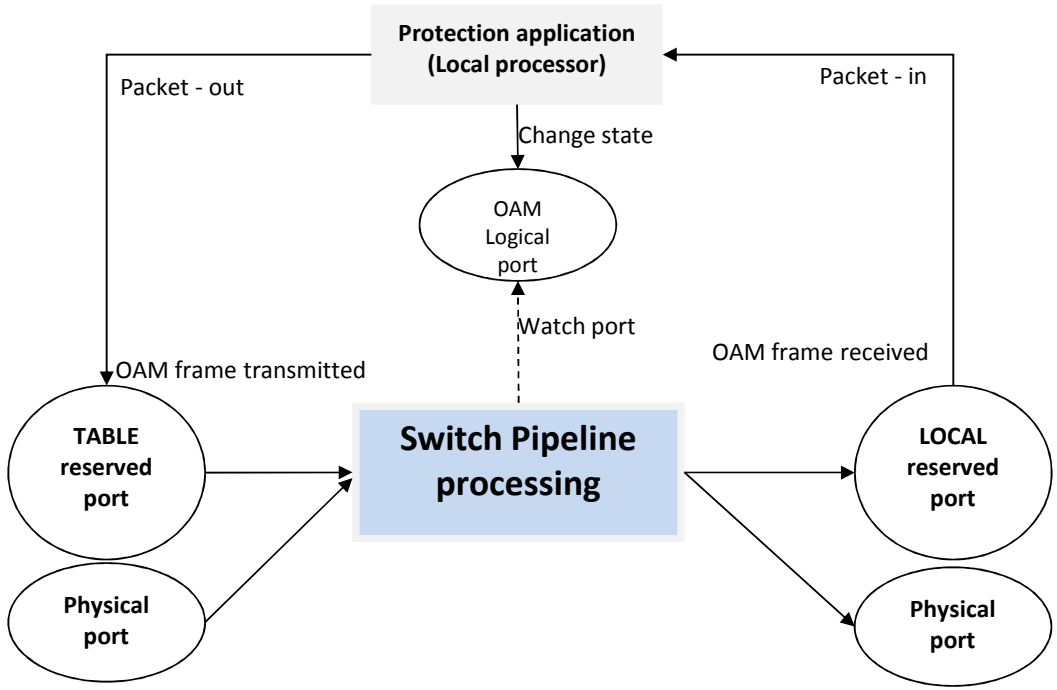
OF - FF - Data link layer mode
Second approach

- A local protection application must be supported by each switch
- This application generates OAM frames
- It implements all the OAM state machines
- Flows direct appropriate OAM frames to the local application
- If time expires, the status of a logical port is changed by the application and the traffic is automatically rerouted



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Comparison of the OF FF mechanisms

Feature / Approach	Usage of ONF standardized features	Applicable to any OF-enabled switch	Usage of Experimenter matching fields and instructions	Only OF is required	Fulfillment of five-nines availability requirements	Service monitoring	High switch cost
Physical layer mode	Yes	Yes	No	Yes	Implementation dependent (High possibility)	No	No
Data link layer mode-*First approach*	Yes	Yes	No	Yes	No (Low possibility)	Yes	No
Data link layer mode-*Second approach*	No	No	Yes	No (switch internal protocol stack is required)	Implementation dependent (High possibility)	Yes	Possible

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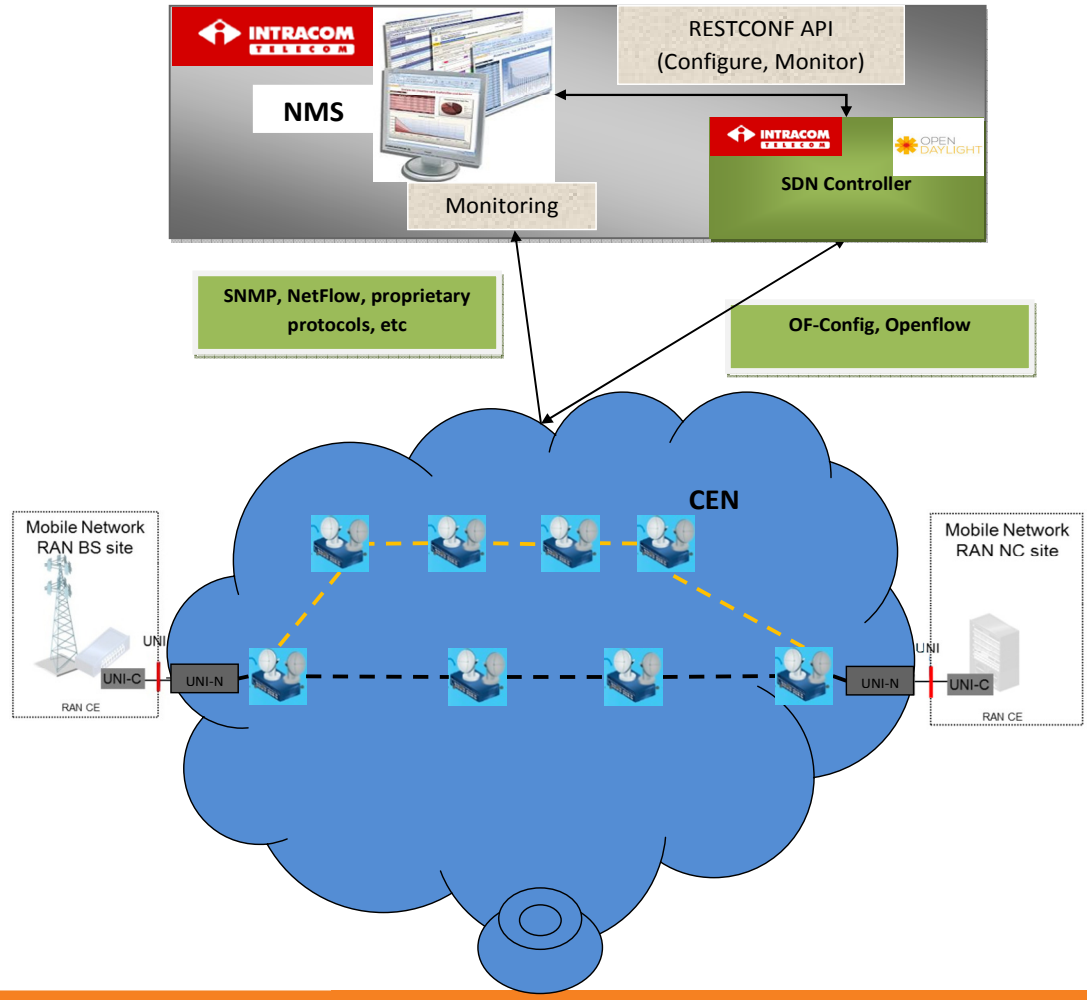
NMS and SDN (1/2)

- Traditional NMS requests for configuration and performance information
  - This includes a lot of different backend proprietary protocols
- In a traditional CE configuration, all the parameters must be defined for each CE enabled network device in the EVC [Metro, 2014c]
- In a traditional environment, the service provider must configure all the MEPs, MIPs, and SOAM test parameters for each UNI-pair within the service [Metro, 2014c]
- New mechanisms are needed that allow the configuration of SDN-based networks.

NMS and SDN (2/2)

- The CE configuration in SDN context is delegated to the ODL
  - Open APIs and a consistent level of network abstraction
  - Network resources virtualization is supported
  - A service can be turned up or torn down quickly – Service deployment is automated
- The NMS and the SDN world can profit from each other by having access to additional information
- The ODL can maintain state knowledge of each UNI-pair and the precise format for instructing the network elements to begin connectivity testing



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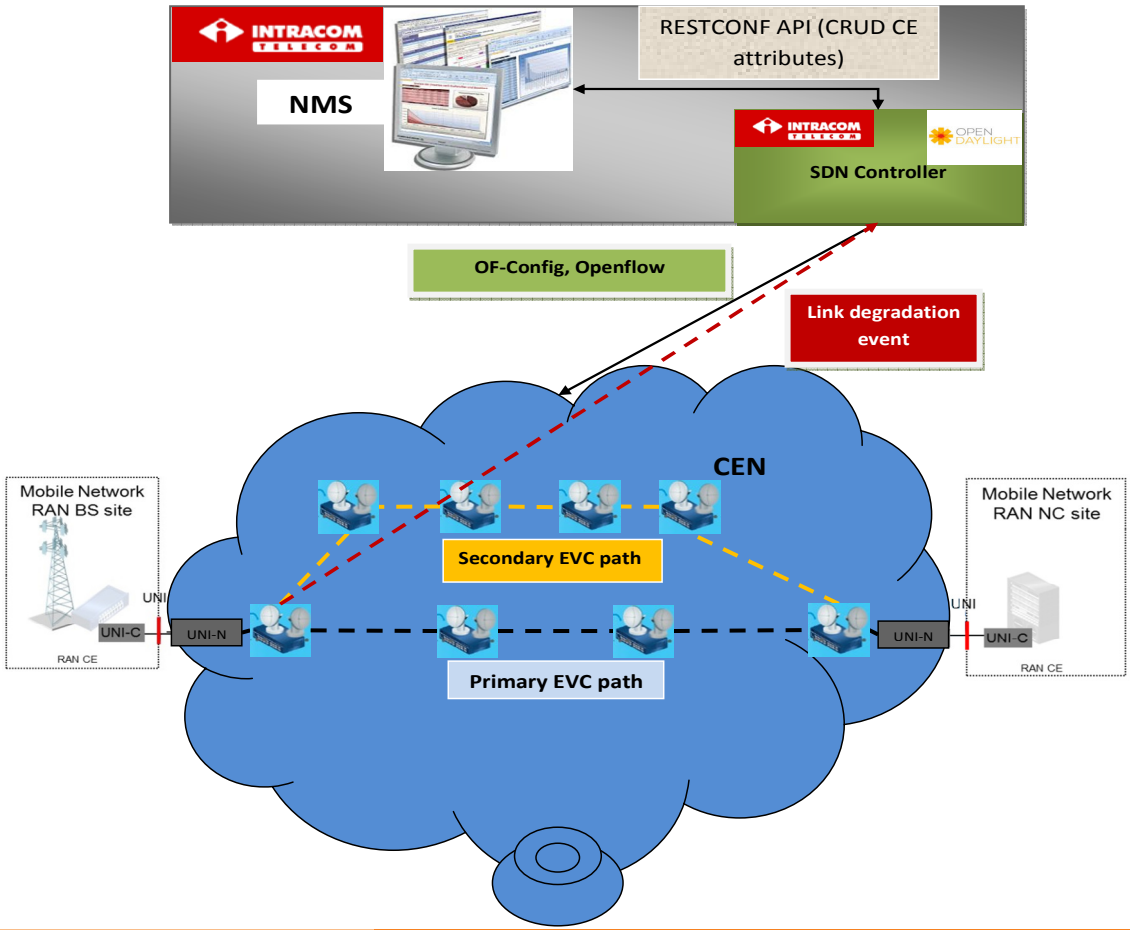
Dynamic traffic rerouting

- Setup
  - Provider bridging (Q-in-Q) is used as the transport technology (instead of MPLS-TP) – Reduced devices cost
  - Intracom-Telecom MEF CE feature is integrated into the ODL
  - OF and OF-Config are used as southbound APIs
- Dynamic change of attributes (new SLA) can be supported (OF redirects traffic)
- In cases of link degradations, the ODL is informed and traffic is redirected automatically again using OF



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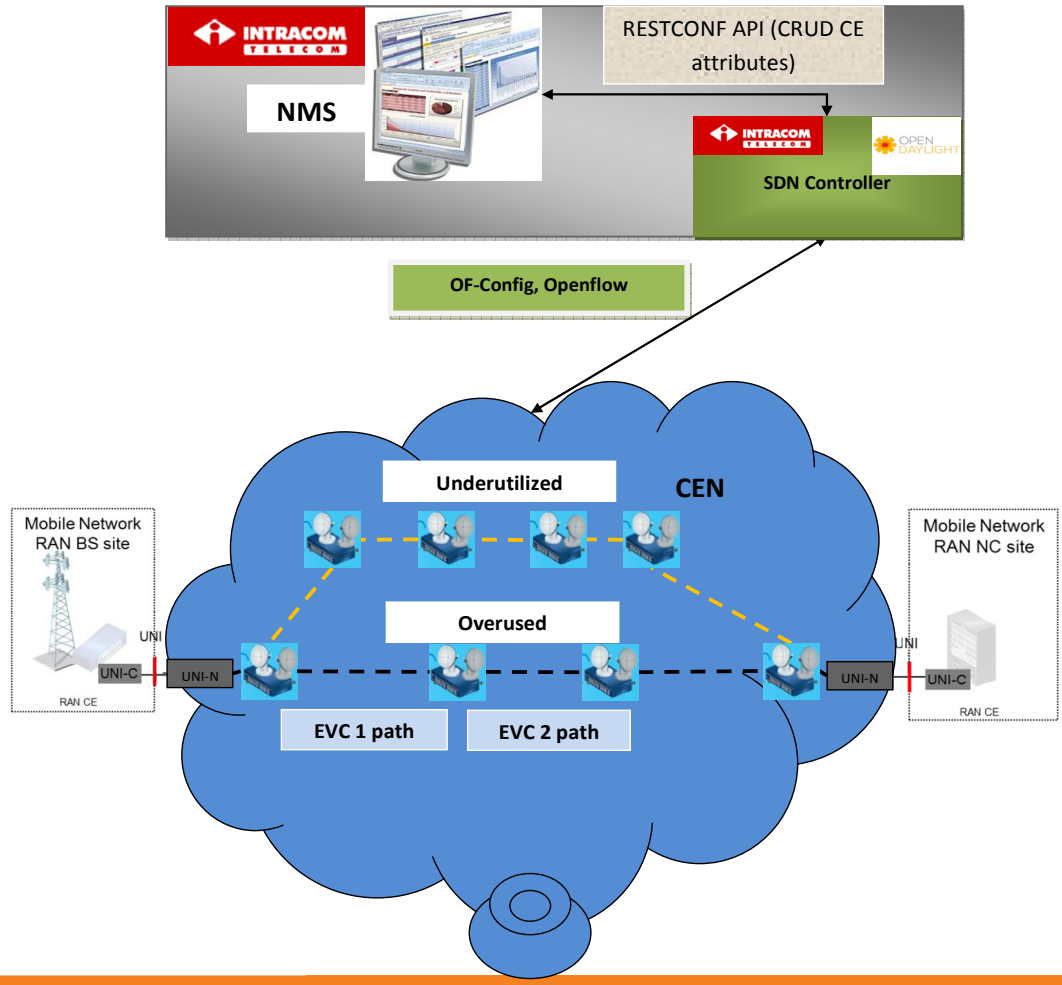
Traffic engineering – Fine tune and optimize traffic flows (1/2)

- Some links may be overused while others remain underutilized
  - Shortest-path routing protocols send traffic without considering other network parameters
- ODL creates a complete catalogue of the utilization of all the nodes and EVCs in the Carrier Ethernet Network (CEN)



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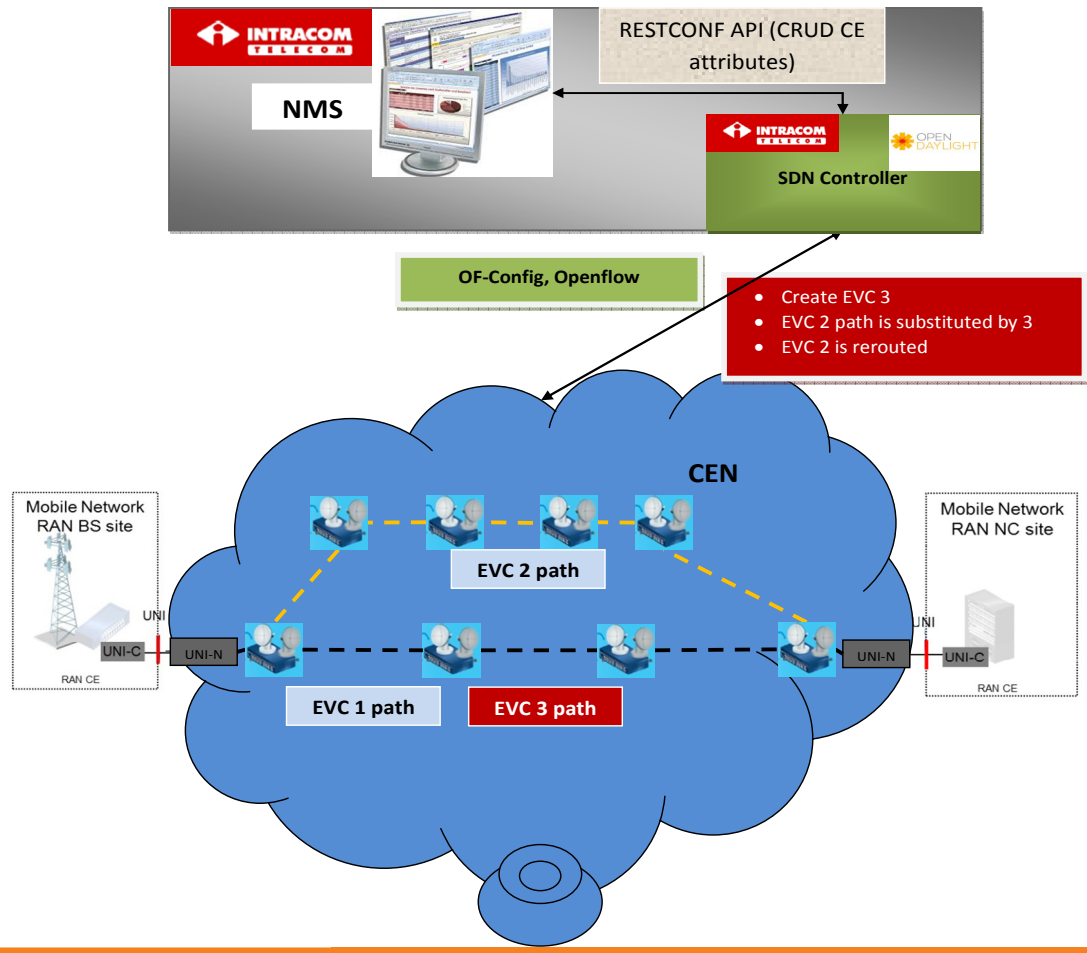
Traffic engineering – Fine tune and optimize traffic flows (2/2)

- When a new EVC is requested, Intracom-Telecom traffic engineering application can re-program network elements' forwarding planes using OF
  - Network operators can redistribute packet flows to attain more uniform distribution across all links.
  - Full and efficient utilization of existing network capacity



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Conclusion

- CE services in mobile backhaul networks should become SDN-based
  - Resource-constrained characteristics can be dealt with accordingly
  - Optimization of resource utilization can be supported
  - Customer experience is improved by optimizing and automating service development
- Traffic engineering can be supported with a relative ease
- Five-nines availability between heterogeneous devices becomes a reality
- ODL is a remarkable choice for the SDN controller
  - Many SDN-based features and protocols are supported
- Traditional NMS must change
  - SDN Controller should be a part of it

References

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