Introduction

- This is a presentation of the work in IEEE 802.1
- How IEEE 802.1Q supports SDN
  - Split architecture by design
  - External control, e.g. SDN Controller
  - The feature rich L2 data plane
- A network reference model for IEEE 802
  - Logical/functional model representation
  - Providing an SDN abstraction
  - Showing commonality of 802 protocols

IEEE STANDARDS ASSOCIATION IEEE

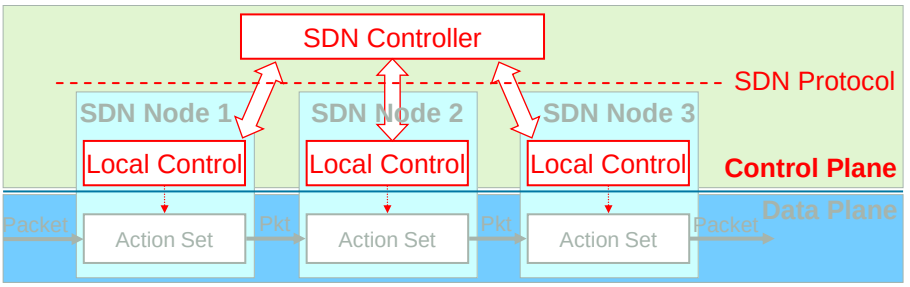
Network Requirements

- SDN and/or distributed controlled networks have to meet various requirements e.g.:
  - Providing L2 and L3 connectivity services
  - Network virtualization
  - Supporting several customers or tenants
  - Scalability
  - Decoupling logical and physical configuration
  - Address separation
  - Traffic isolation
  - Supporting station mobility, e.g. virtual machine (VM) mobility
  - Quality of Service (QoS) assurance
  - Auto-provisioning and service discovery
  - Operations, Administration and Maintenance (OAM)
- Good news: a lot is already provided → good basis for SDN

Software Defined Networking

- Software Defined Networking (SDN) relies on directly programming the packet handling mechanisms of the network nodes by a network controller
- SDN allows defining the networking behavior via software tools that are easy to modify as opposed to behavior hard-coded in the equipment by design
- SDN provides flexibility along these characteristic features:
  - Programmability of the network
  - Separation of the control plane from the data plane
  - A Controller that has a view of the entire network and can control the network devices
- SDN approaches: ForCES, OpenFlow, OpenStack, OpenDayLight
- SDN can also use NETCONF or SNMP

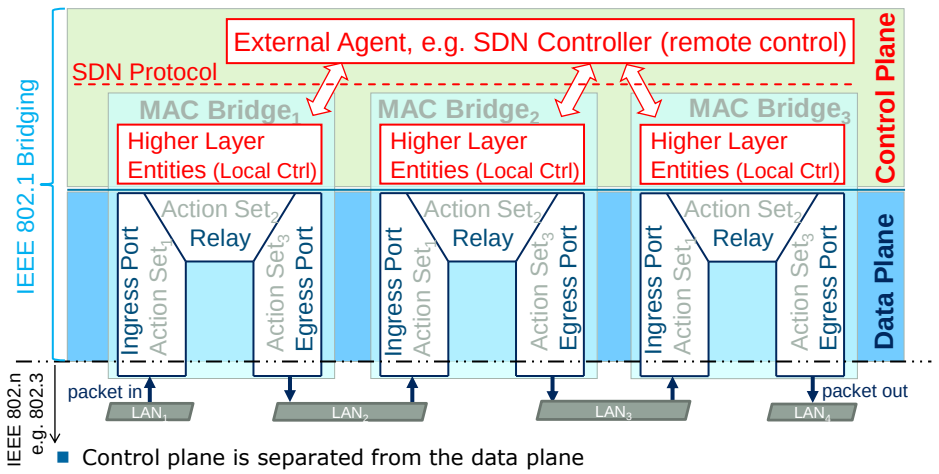
SDN Architecture



- Control plane is separated from the data plane
- Control plane:
  - SDN Controller: all computation tasks, figuring out data plane actions
  - SDN Protocol: control channel between the Controller and Local Control
  - Local Control: programs the node as instructed by the Controller
- Data plane invokes the Action(s) out of the Action Set supported by the device, as programmed by the Controller

IEEE STANDARDS ASSOCIATION IEEE

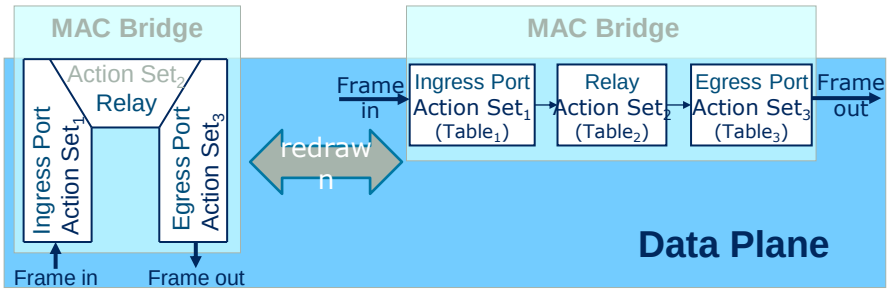
IEEE 802.1Q Bridge Architecture



- Control plane is separated from the data plane
- External Agent can control, i.e. program the data plane; then
- Data plane invokes the Actions as programmed

IEEE STANDARDS ASSOCIATION IEEE

Data Plane Actions

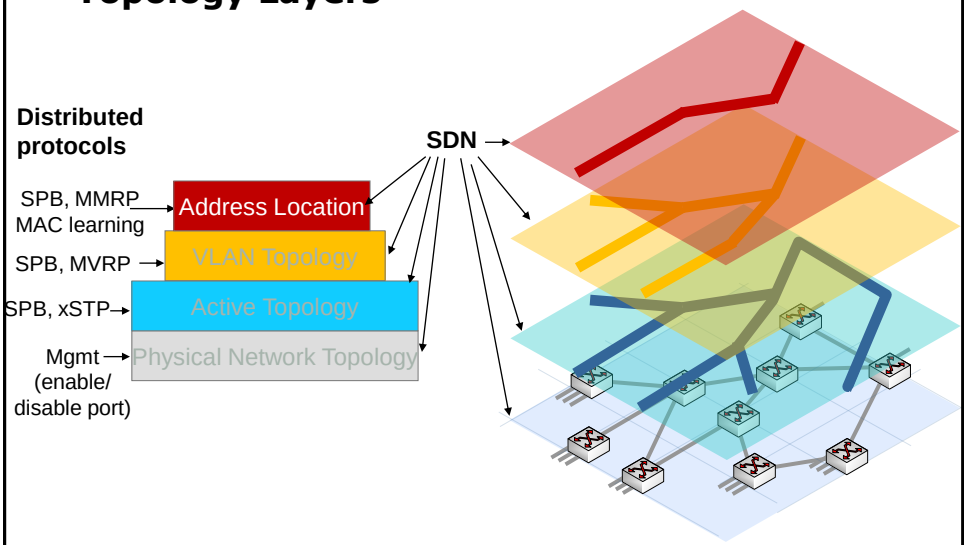


- Ingress Port: Action Set$_1$
  - Filtering (drop), (un)tagging, VID translation, de/en-capsulation, metering
- Relay: Action Set$_2$
  - Forwarding, filtering
- Egress Port: Action Set$_3$
  - Filtering, (un)tagging, VID translation, de/en-capsulation, queuing, transmission selection

Data Plane Programmability and SDN Protocol

- The SDN Controller can program the bridges based on the standard [802.1Q]:
  - Information Model (Managed Objects, Clause 12)
    - Structured text description, evolving to structured tabular summary
  - Data Model (MIBs, Clause 17)
    - IETF style preamble (structure, security, relationships)
- Current SDN Protocol supported by the standard is SNMP
- IS-IS can be the SDN Protocol for explicit trees: P802.1Qca ongoing
- Note: there is room for further options / future work here
  - Other SDN Protocols can be used if e.g.:
  - the Local Control performs translation between the SDN Protocol and the models specified by the standard
  - each standard compliant chip provides access to program the data plane

Further Knobs for Programming: Topology Layers



SDN Features Presented

- Separation of the control plane from the data plane
  - The bridge architecture separates the control plane from the data plane
  - The External Agent is geographically separated
- Separate topologies per VLAN
  - Any given VLAN can be assigned to MSTP, SPB, External Agent, or any other standard- or user-defined control methodology
- Centralized controller having a view of the network
  - The External Agent can be a centralized SDN Controller
  - IS-IS can be used for topology discovery, whether any VLANs are assigned to control by SPB or not
  - Link Layer Discovery Protocol (LLDP) [802.1AB] can be used for topology retrieval by the SDN Controller
- Programmability of the network
  - Well defined objects and functionality for programming the bridges

IEEE 802.1CF OmniRAN

Scope

- Network Reference Model and Functional Description of IEEE 802 Access Network
  - Based on the family of IEEE 802 Standards
  - Including entities and reference points along with behavioral and functional descriptions of communications among those entities (e.g. Stage-2)

Use cases considered

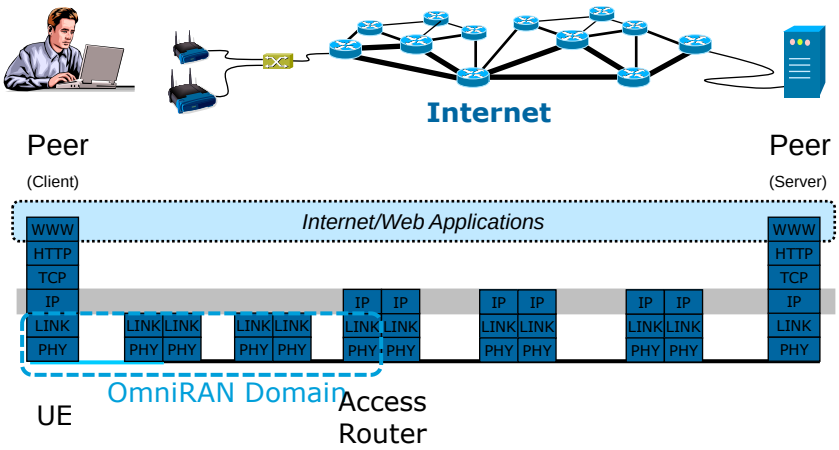
- SDN-based Model
- Smart Grid
- 3GPP WLAN EPC Access, etc

Commonalities of IEEE 802 Access Networks

- More (huge) networks are coming up by everything gets connected
  - e.g. SmartGrid, ITS, IoT, …
- New markets for IEEE 802 access technologies
  - e.g. factory automation, in-car communication, home automation, …
- IEEE 802 access is becoming more heterogeneous
  - multiple network interfaces
    - e.g. IEEE 802.3, IEEE 802.11, IEEE 802.15…
  - multiple access network topologies
    - e.g. IEEE802.11 in residential, corporate and public

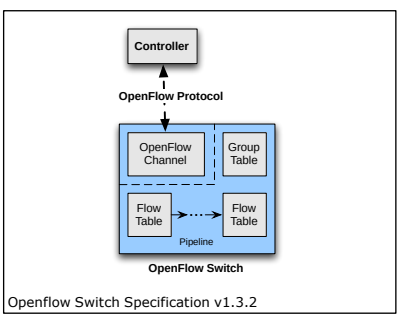
  - multiple network subscriptions
    - e.g. multiple subscriptions for same interface
- New emerging techniques, like SDN and virtualization

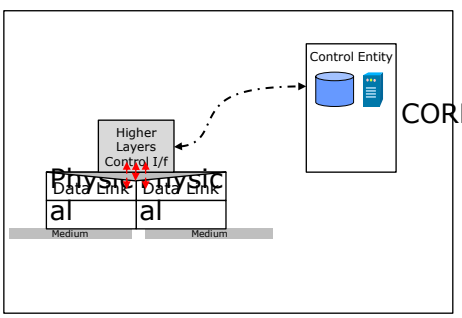
OmniRAN in the big picture of the Internet



OmniRAN provides a generic model of an access network based on IEEE 802 technologies.

SDN is part of OmniRAN P802.1CF





- Common understanding of SDN is aligned to the same architectural model as used by OmniRAN.
- Access networks have always been a kind of 'software defined' network.

Summary

- Basic design principles of Ethernet bridging (802.1Q) are in-line with SDN and today's network requirements
- Existing data plane features can be leveraged, even complex ones such as OAM or protection switching
- SDN co-existence with distributed control is beneficial
- OmniRAN (802.1CF) will document an SDN abstraction for all 802 technologies

IEEE STANDARDS ASSOCIATION IEEE

Further Reading

- "Software Defined Networking Supported by IEEE 802.1Q" http://www.ieee802.org/1/files/public/docs2014/Q-farkas-SDN-support-0314-v01.pdf
- IEEE 802.1Q-2011, "IEEE standard for local and metropolitan area networks: Media access control (MAC) bridges and virtual bridged local area networks," August 2011. http://standards.ieee.org/getieee802/download/802.1Q-2011.pdf
- IEEE 802.1aq-2012, "IEEE standard for local and metropolitan area networks: Media access control (MAC) bridges and virtual bridged local area networks – Amendment 20: Shortest path bridging," June 2012. http://standards.ieee.org/getieee802/download/802.1aq-2012.pdf
- IEEE 802.1AB-2009, "IEEE standard for local and metropolitan area networks: Station and media access control connectivity discovery," September 2009. http://standards.ieee.org/getieee802/download/802.1AB-2009.pdf
- P802.1Qca, "Draft standard for local and metropolitan area networks: Media access control (MAC) bridges and virtual bridged local area networks – Amendment: Path control and reservation," http://www.ieee802.org/1/pages/802.1ca.html
- Deterministic Ethernet – IEEE 802.1 standards for real-time process control, industrial automation, and vehicular networks, http://www.ieee802.org/802_tutorials/2012-11/8021-tutorial-final-v4.pdf
- IEEE 802.1Q: Media Access Control Bridges and Virtual Bridged Local Area Networks http://www.ieee802.org/802_tutorials/2013-03/8021-IETF-tutorial-final.pdf
- P802.1CF, "Network Reference Model and Functional Description of IEEE 802 Access Network," http://www.ieee802.org/1/pages/802.1cf.html

IEEE STANDARDS ASSOCIATION IEEE