Basics of mobile communications technologies and standards

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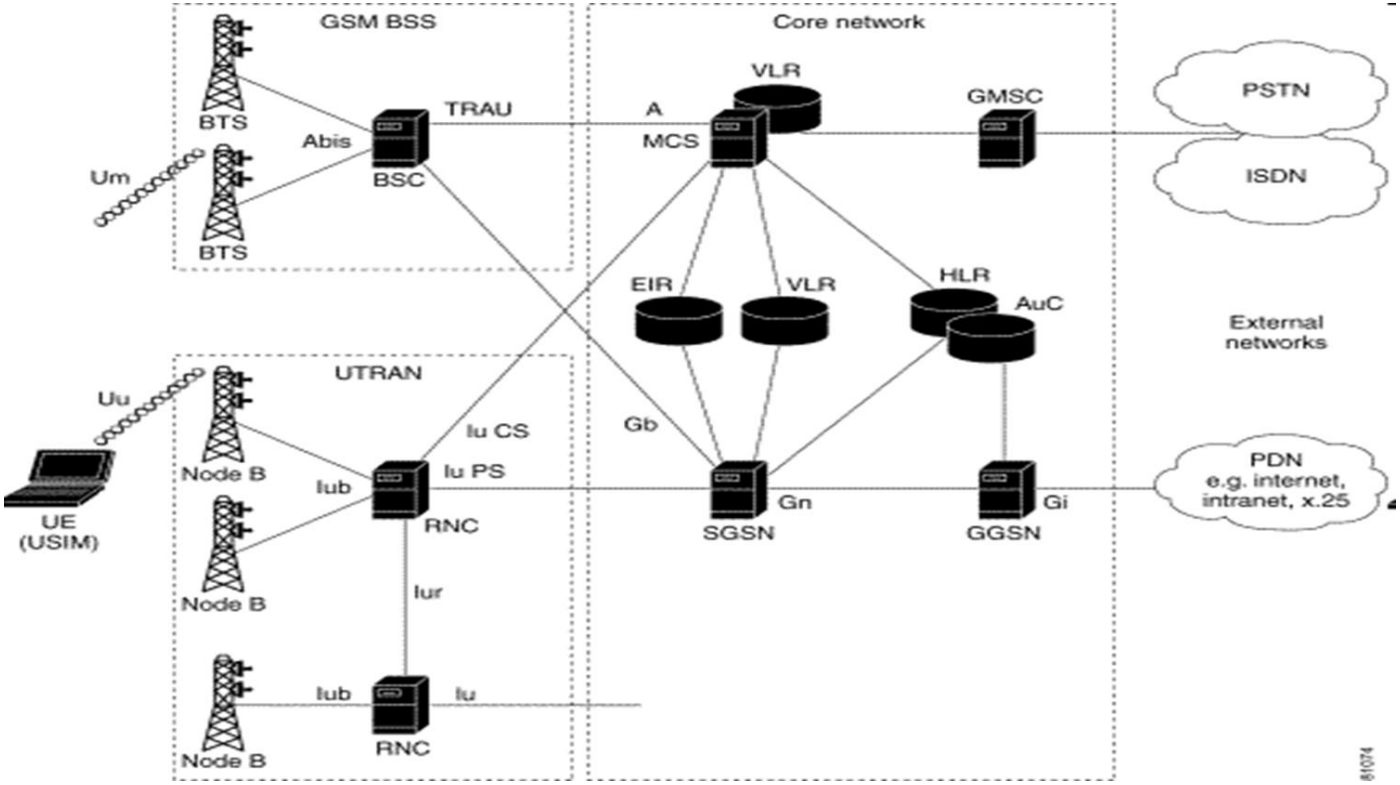
Agenda

- Basics of mobile communications technologies and standards
- Networking
- Radio Access Networks
- Transmission Networks
- Core Networks
- Services Architecture, devices evolution to smartphones, VAS platforms
- Virtualization Infrastructure(SDN/NFV/Orchestration)

Basics of mobile communications technologies and standards

- Definition of “Mobile communications”
  - A communication network which doesn't depend on any physical connection between two communication entities and have flexibility to be mobile during communication
- Definition of standards
  - A definition or format that has been approved by a recognized standards organization or is accepted as a de facto standard by the industry. Standards exist for programming languages, operating systems, data formats, communications protocols, and electrical interfaces.
    - ITU-T - International Telecommunications Union
    - IETF - Internet Engineering Task Force
    - European Interoperability Framework
    - ETSI
- High Level Architectures
  - Represents a general purpose architecture for a distributed system
  - Collection of: Architectures, Models, Design, Analysis

High Level Architecture



Mobile Communications Evolution

- Old Mobile Communication Technologies
  - 1980’s there were few mobile communication (1G) technologies
  - Each country had deployed their own set of standards for communications
  - Operating system hardware was no compatible to the OS of other communication technologies form other countries
  - Very expensive, there were no concepts of International roaming do the limitations of the systems, no international calls were possible using these technologies
  - Telephonic systems were analog

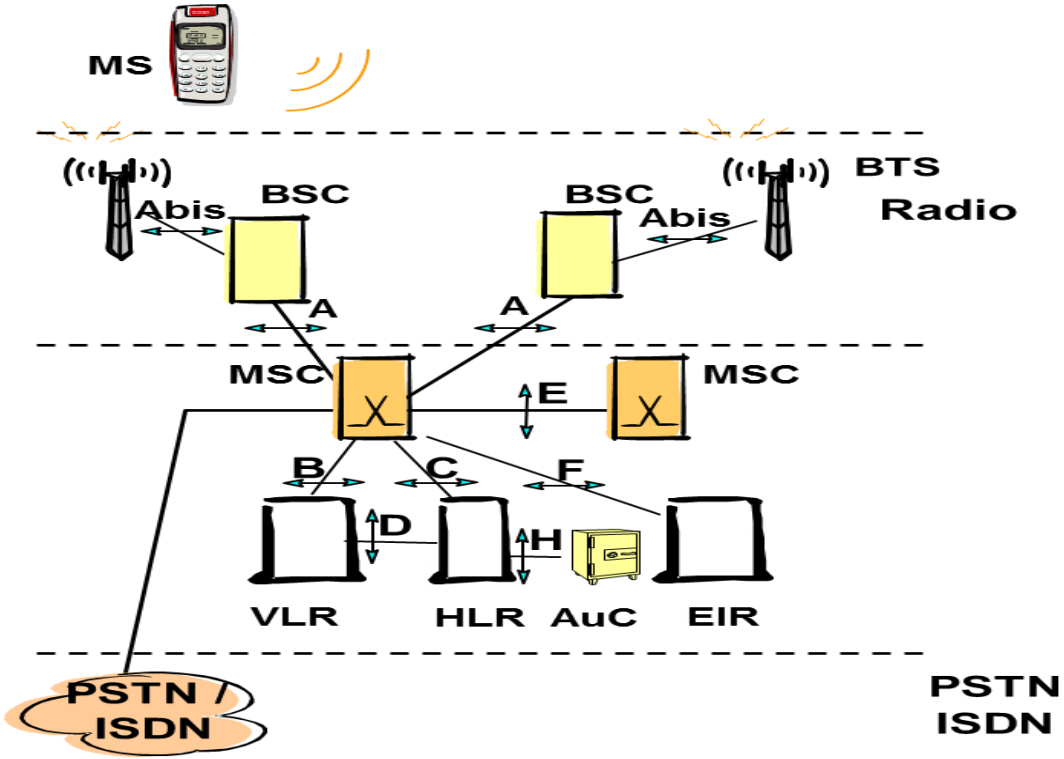
- Challenge
  - Evolution in this industry and need for digital technology was realized
  - The first-generation cellular networks were made obsolete by the appearance of an entirely digital second generation – 2G

RAN

GSM Networks (Global System for Mobile communications)

- Concepts
  - The 2nd generation of mobile networks : the first generation of cellular telephones by switching from analogue to digital
  - Standard uses the 900 MHz and 1800 MHz frequency bands in Europe (dual-band)
  - Standard uses the 1900 MHz frequency bands in USA
  - Multiple Access Techniques:
    - **TDMA** (**T**ime **D**ivision **M**ultiple **A**ccess), using a technique of time division of communication channels
      - Orange, Vodafone
      - **CDMA** (**C**ode **D**ivision **M**ultiple **A**ccess), using a spread spectrum technique that allows a radio signal to be broadcast over a large frequency range
- New Services :
  - Text Messages – SMS (**S**hort **M**essage **S**ervice)
  - Multimedia Messages – MMS (**M**ultimedia **M**essage **S**ervice)
  - Data Rate: 9.6kbps
  - GPRS (General Packet Radio System) service
  - EDGE (Enhanced Data Rates for Global Evolution)

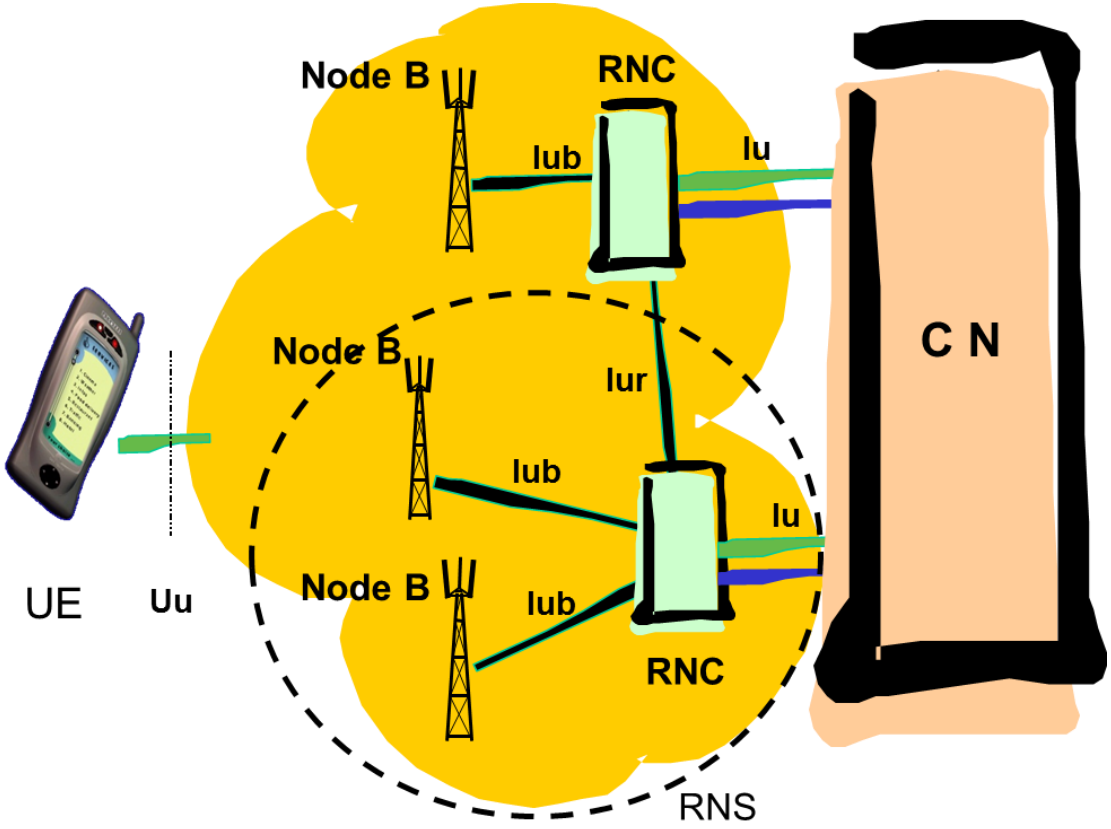
GSM Functional Architecture



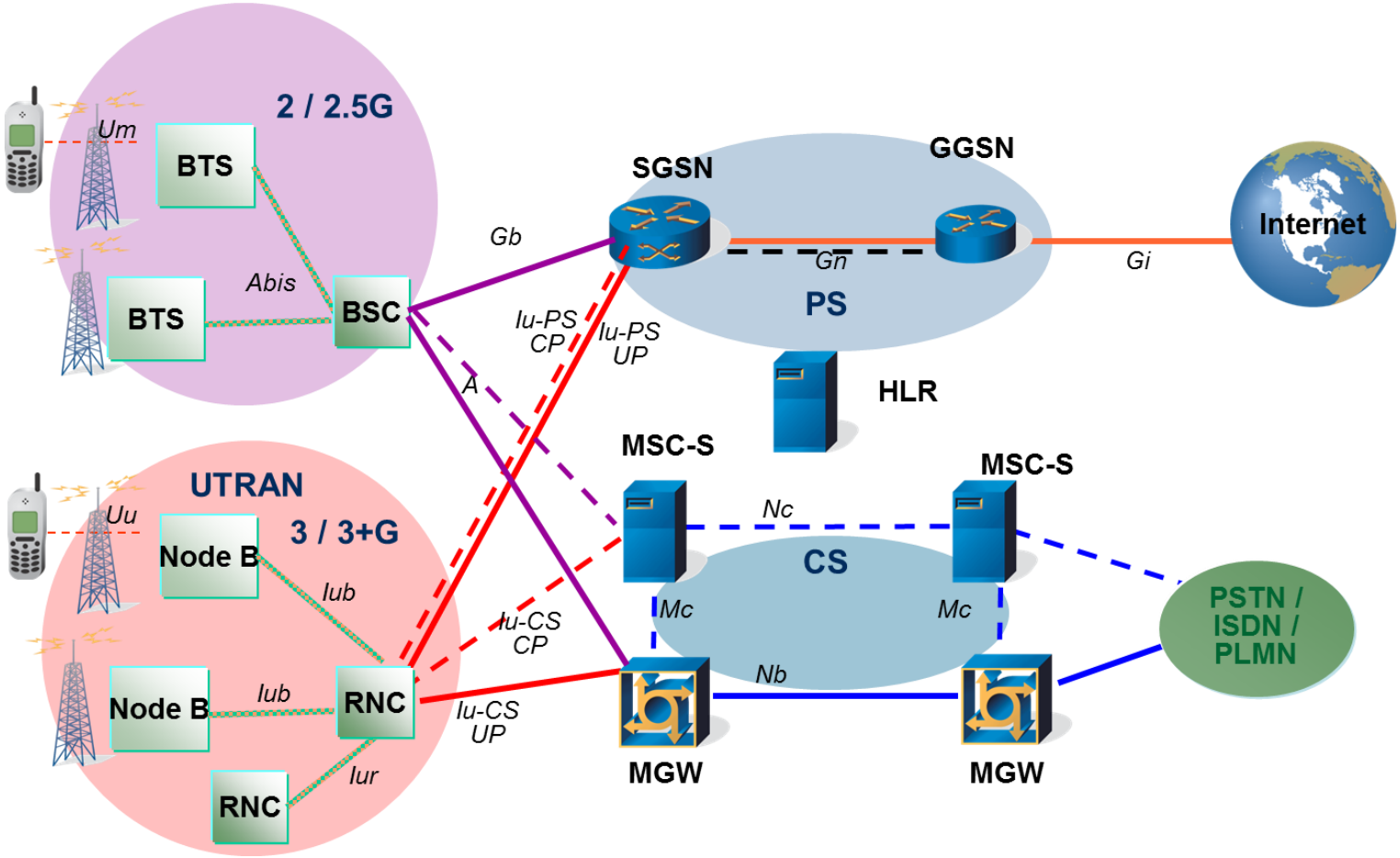
3rd generation of mobile communications 3G

- 3GPP – 3rd Generation Partnership Project
  - collaboration between groups of telecommunications associations
  - globally applicable 3G mobile phone system specification based on evolved GSM specifications within the scope of the International Mobile Telecommunications-2000
  - 3GPP standardization encompasses Radio, Core Network and Service architecture
- Key Concepts
  - High transmission data rate up to 2Mbps
  - World compatibility
  - Compatibility of 3rd generation mobile services with second generation networks
  - Opening the door to multimedia uses such as video transmission, video-conferencing or high-speed internet access.
- HSDPA (High-Speed Downlink Packet Access)
  - third generation mobile telephony protocol, dubbed "3.5G“
    - data rates on the order of 8 to 10 Mbps
  - HSDPA + up to 42Mbps – dual carrier access
  - Starting 2005
  - Allows simultaneous transfer of voice and high-speed digital data

3G Functional Architecture

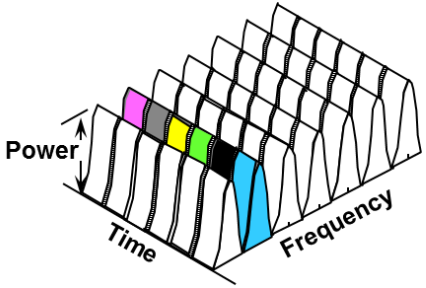


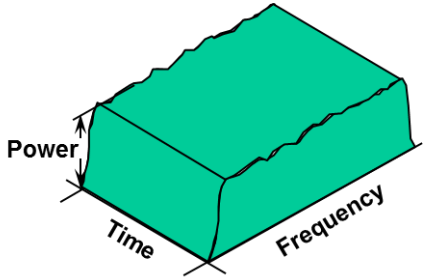
2G & 3G Functional Architecture

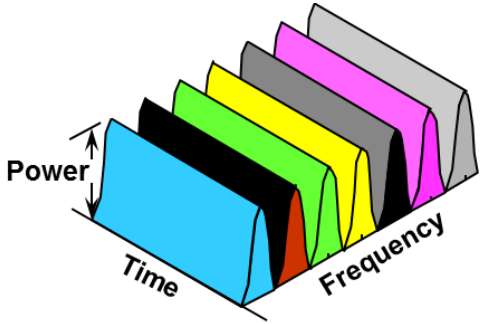


2G & 3G Multiple Access

- Time division multiple access (TDMA)
  - Time division multiple access (TDMA) is a channel access method for shared medium networks
  - Users share the same frequency channel by dividing the signal into different time slots
  - Used in 2G
- W-CDMA (Wideband Code Division Multiple Access)
  - Radio channels are 5 MHz wide.
  - Supported mode of duplex: frequency division (FDD), Time Division (TDD)
  - Used in 3G
- FDMA (Frequency Division Multiple Access)
  - FDMA gives users an individual allocation of one or several frequency bands, or channels
  - share the time simultaneously but each user transmits at single frequency
  - allows multiple users simultaneous access to a transmission system
  - Satellite communication







LTE Fundamentals

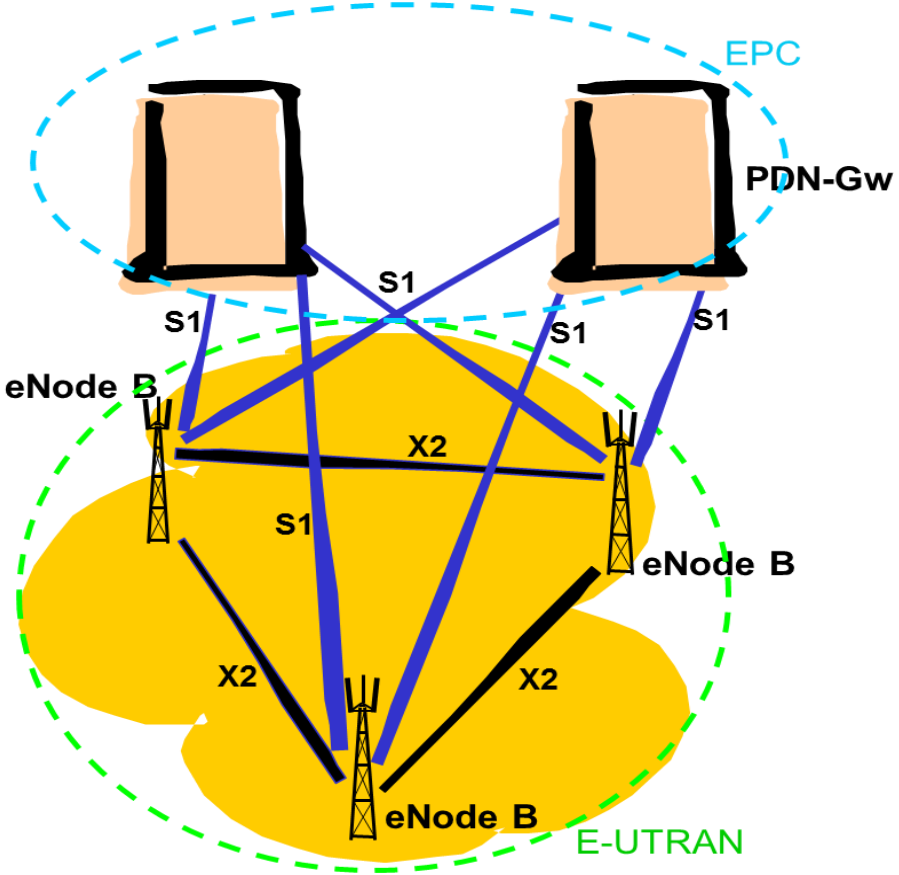
Key Concepts

- Increase in the use of data carried by cellular services, and this increase will only become larger in what has been termed the "data explosion".
- Increased demands for increased data transmission speeds and lower latency, further development of cellular technology have been required.
- The UMTS cellular technology upgrade has been dubbed LTE - Long Term Evolution
- LTE enables much higher speeds to be achieved along with much lower packet latency
  - Reduced cost per bit
  - Increased service provisioning – more services at lower cost with better user experience
  - Flexibility of use of existing and new frequency bands
  - Simplified architecture, Open interfaces
  - Allow for reasonable terminal power consumption

LTE Fundamentals

- LTE technologies
  - OFDM technology - incorporated into LTE because it enables high data bandwidths to be transmitted efficiently while still providing a high degree of resilience to reflections and interference
  - MIMO (Multiple Input Multiple Output)
    - multiple signals arising from the many reflections that are encountered
    - using MIMO, these additional signal paths can be used to advantage and are able to be used to increase the throughput
  - System Architecture Evolution
    - necessary to evolve the system architecture to enable the improved performance to be achieved
    - LTE include download rates of 100Mbps, and upload rates of 50Mbps
    - LTE must be able to support at least 200 active users in every 5MHz cell. (i.e. 200 active phone calls)
    - Small latency

LTE Architecture

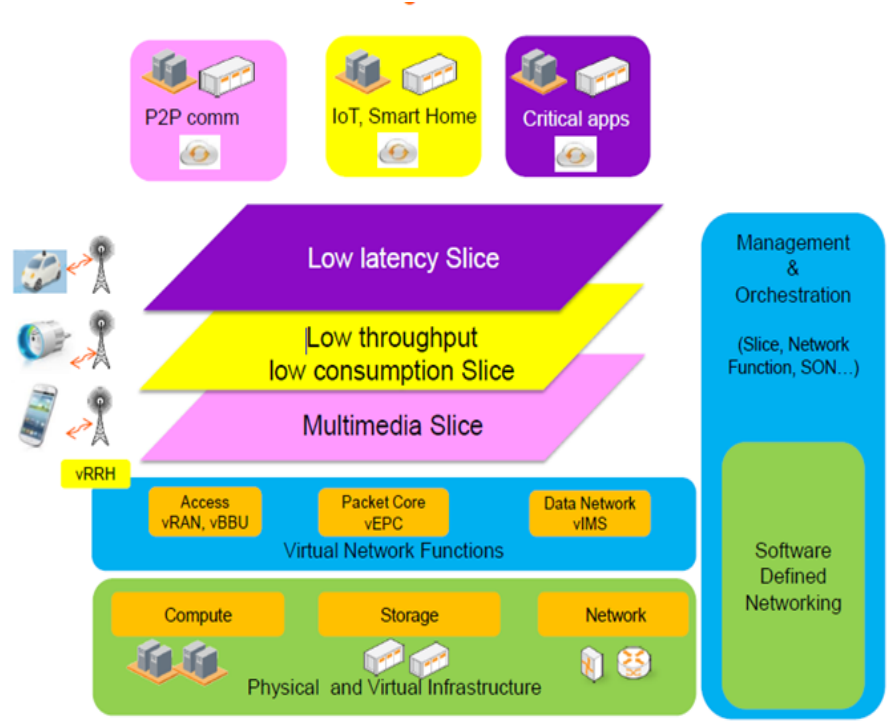


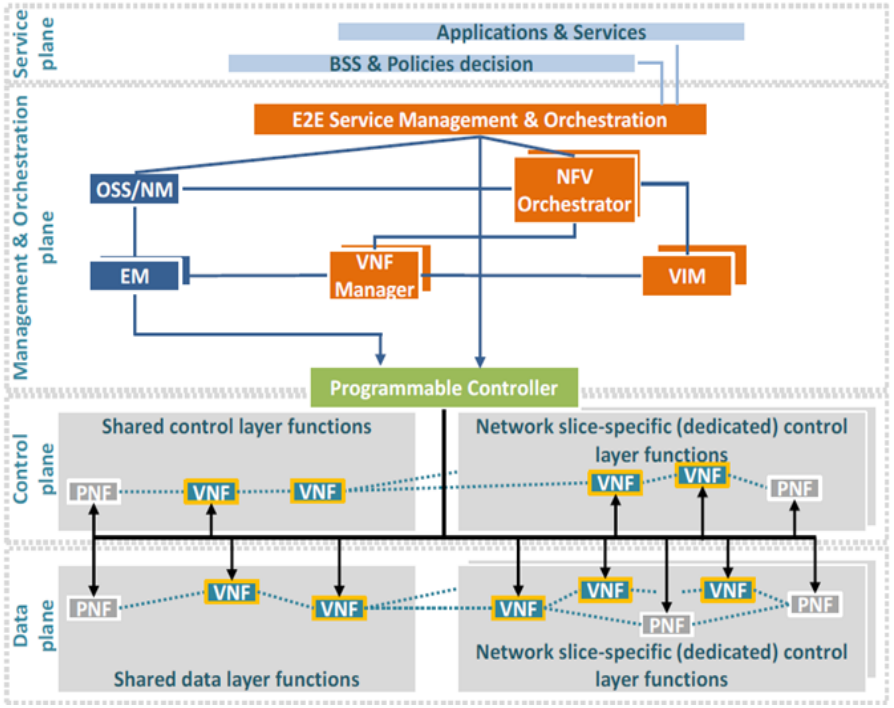
- LTE contains only one Node, named eNodeB
- eNodeB supports all the features
- X2 Interfaces support data traffic and signaling
- S1 Interface – communication between eNodeB and Network Gateway
- EPC – Evolved Packet Core corresponding to Core Architecture in UMTS
- PDN-GW Packet Data Network Gateway – Interconnection to others networks
- All IP Network

5G Concepts

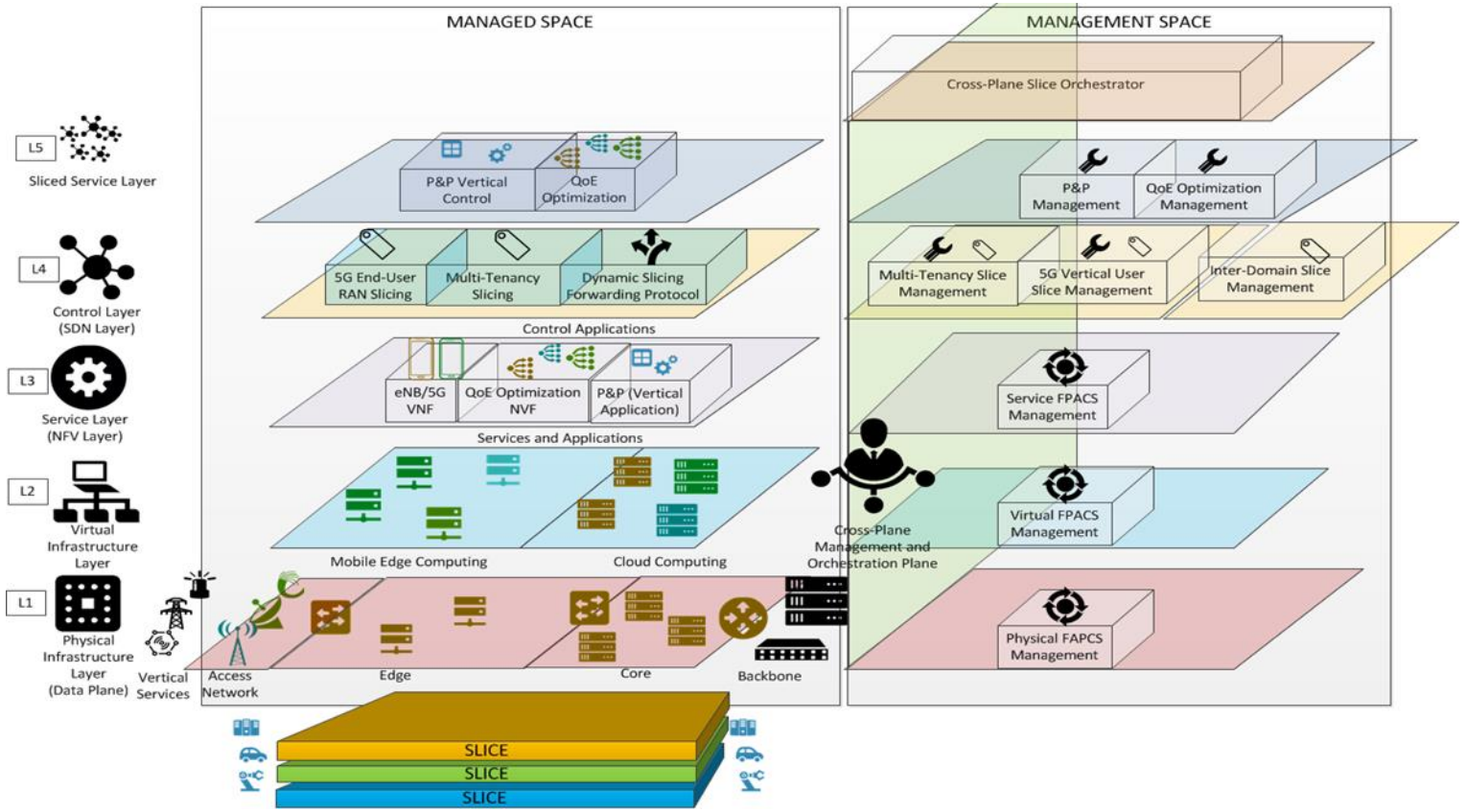
5G is intended to deliver solutions, architectures and technologies for the next coming decades with huge potential of creating new markets, business models and innovation opportunities and actions in areas such as Smart Cities, e-Health, Intelligent Transport, Education, Agriculture, Media and Entertainment.

5G Architecture





5G SLICE Simplified Architecture



*** SLICENET H2020 project**

5G Evolution Knowledge

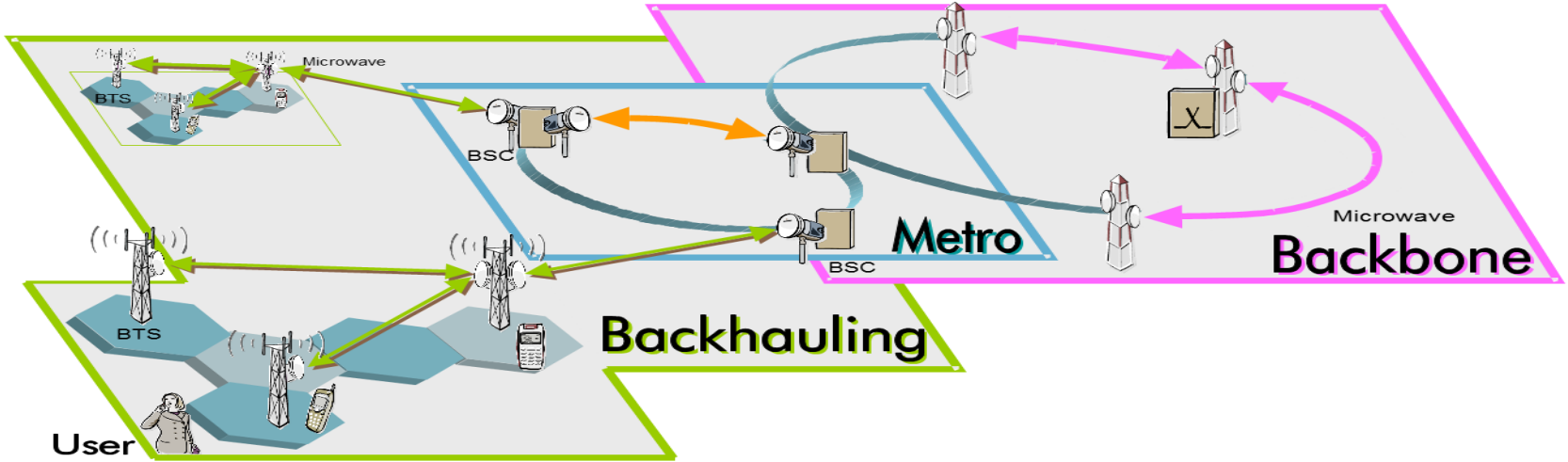
- 4G & 5G Architecture
- ETSI NVF/VNF
- Virtualization, Dockers & Container
- Scripting, Automation
- Security & Cybersecurity
- Open stack, VMware
- SDN concepts
- API Interfaces

Transmission

Transmission Networks

- Data Transmission Network - telecommunications network is a collection of terminals, links and nodes which connect together to enable telecommunication between users of the terminals

- Transmission Networks (Capabilities)
  - Plesiochronous Digital Hierarchy (PDH)
  - Synchronous Digital Hierarchy (SDH)
  - Micro-Waves Ethernet
  - Wavelength-Division Multiplexing (WDM)
  - Multi-Protocol Label Switching (MPLS)



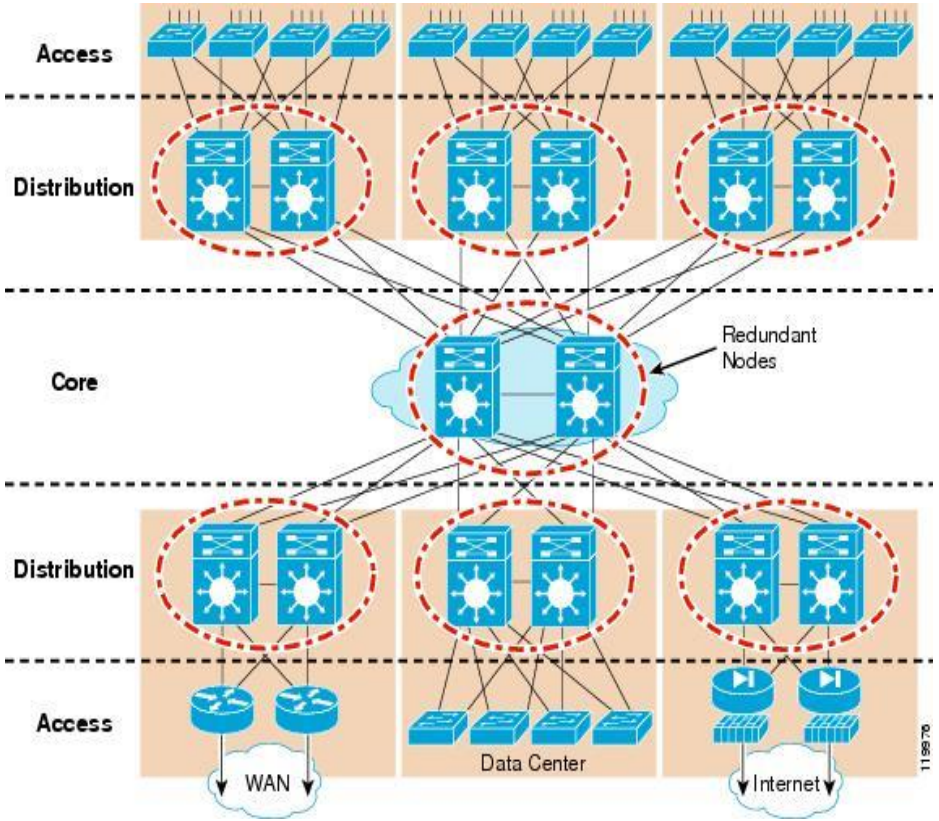
Networking

Networking

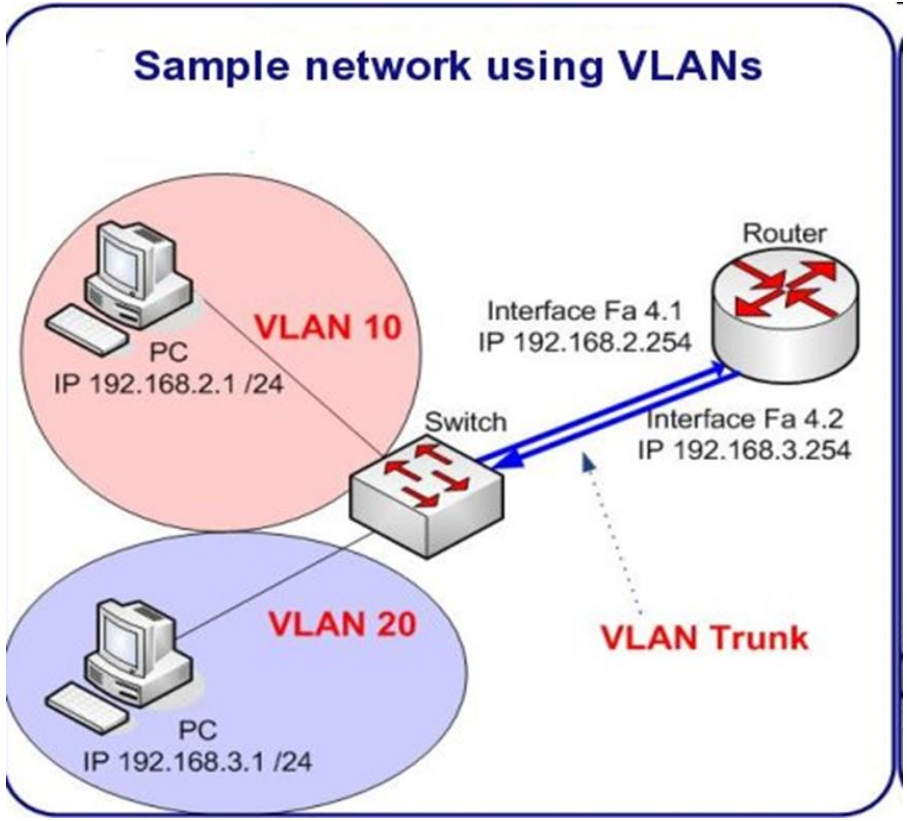
- What represents a Network?
  - In information technology, a network is a series of points or nodes interconnected by communication paths
- Networking
  - Routing
  - Switching
  - QoS
  - Applications in Service Providers Networks
  - Resiliency & Redundancy (FRR, TE)
- When Appeared ?
  - ATM & Frame Relay Networks
  - Ethernet & IP

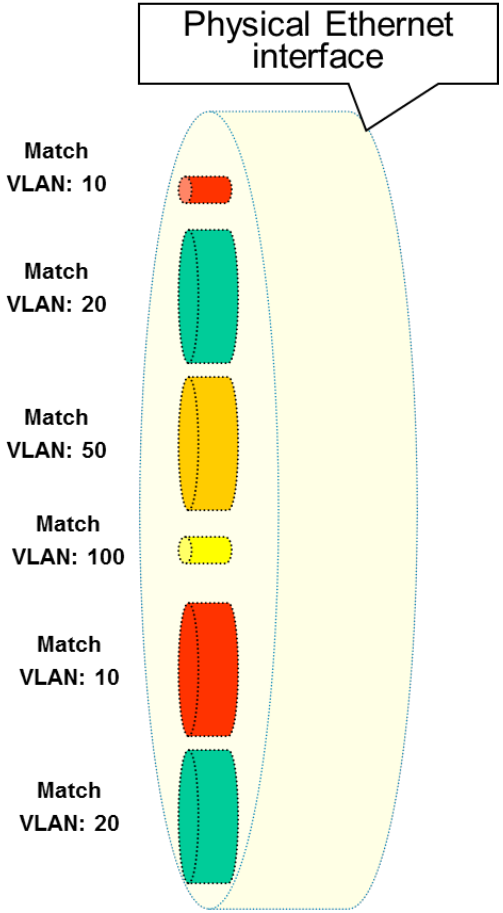
Networking

- Considering the spatial distance, networks can be as follows:
  - Local Area Networks – LANs
  - Metropolitan Area Networks – MANs
  - Wide Area Networks – WANs
- Hierarchical Model
  - Access
  - Distribution
  - Core (Backbone)



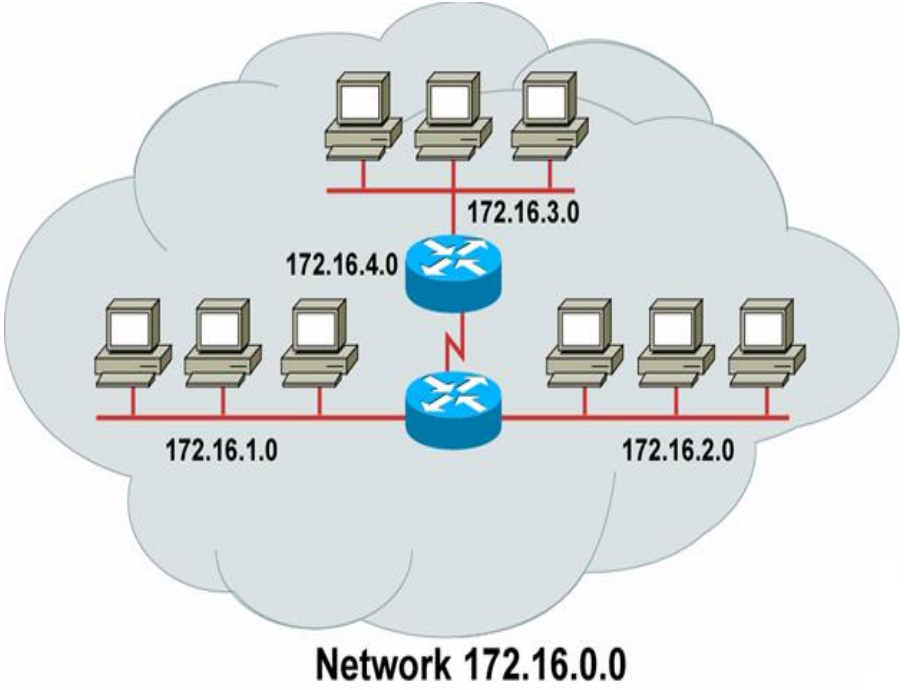
Networking Example





Networking Example

- Today IP Protocol version 4 and version 6
- IPv4 defines an IP address using 32 bits
- IPv6 defines an IP address using 128 bits
- Discover possible routes
- Select the best route
- Maintain and verify routing information
- Route Learning
  - Static
  - Dynamic
  - RIP, EIGRP
  - OSPF
  - IS-IS, BGP
  - Connected



MPLS - Multi-Protocol Label Switching

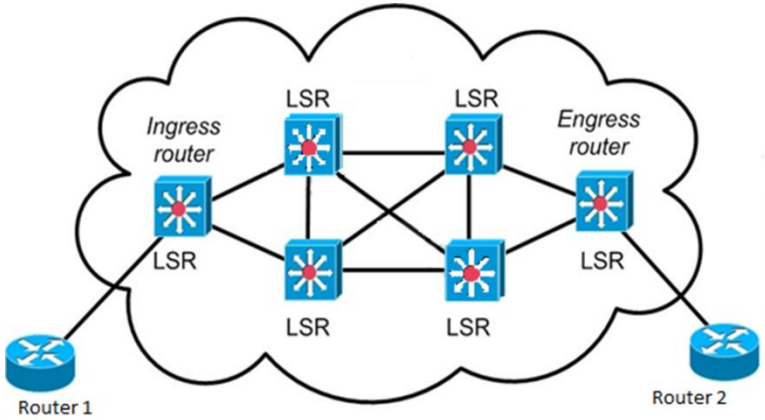
- What is MPLS ?
  - A way of improving the forwarding speed of routers
- MPLS is the generation of a short fixed-length label that acts as a shorthand representation of an IP packet's header
- MPLS is:
  - As a code for an address: house, street, city …
  - IP packets have an DA address to which packet to be routed
  - Traditional Routing is made Hop by Hop
  - When MPLS enabled, the forwarding decision is made using labels
  - A forwarding scheme designed to speed up IP packet forwarding (RFC 3031)

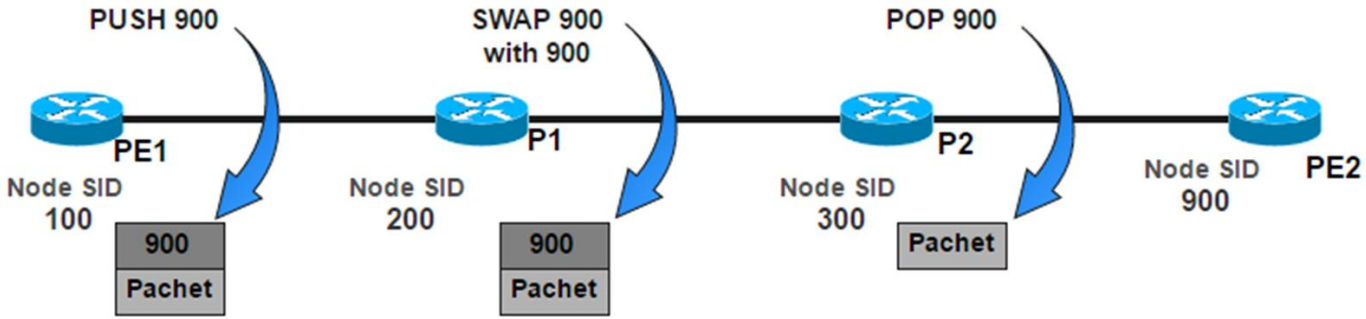
MPLS - Multi-Protocol Label Switching

- Idea: use a fixed length label in the packet header to decide packet forwarding
- Label carried in an MPLS header between the link layer header and network layer header
- Support any network layer protocol and link layer protocol
- Used in ISP networks
- MPLS is based on another protocols to learn and distribute labels:
  - IGP
  - TDL (Tag Switching)
  - LDP – Label Distribution Protocol

MPLS - Multi-Protocol Label Switching

- MPLS Traffic Engineering:
  - RSVP-TE Introduction
    - Basic Function Definition
  - Label Distribution Model





MPLS – Segment Routing Concept

- Cisco:” Segment Routing (SR) is a flexible, scalable way of doing source routing. The source chooses a path and. encodes it in the packet header as an ordered list of segments. Segments are identifier for any type of instruction”

- Routing based on segments:
  - Simple
  - Scalable
  - Seamless deployment
  - Traffic Engineering
  - Failure protection (TI-LFA)
  - Network Programming
  - SDN Capabilities
  - Inter-domain policies (DC, Metro,WAN)

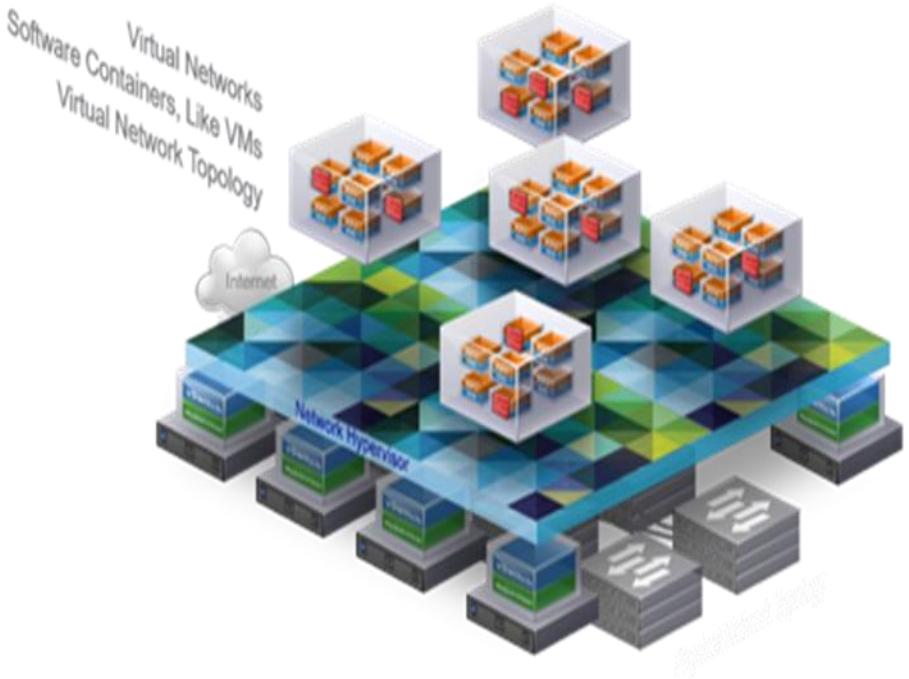
Data Center

Data Center Architecture

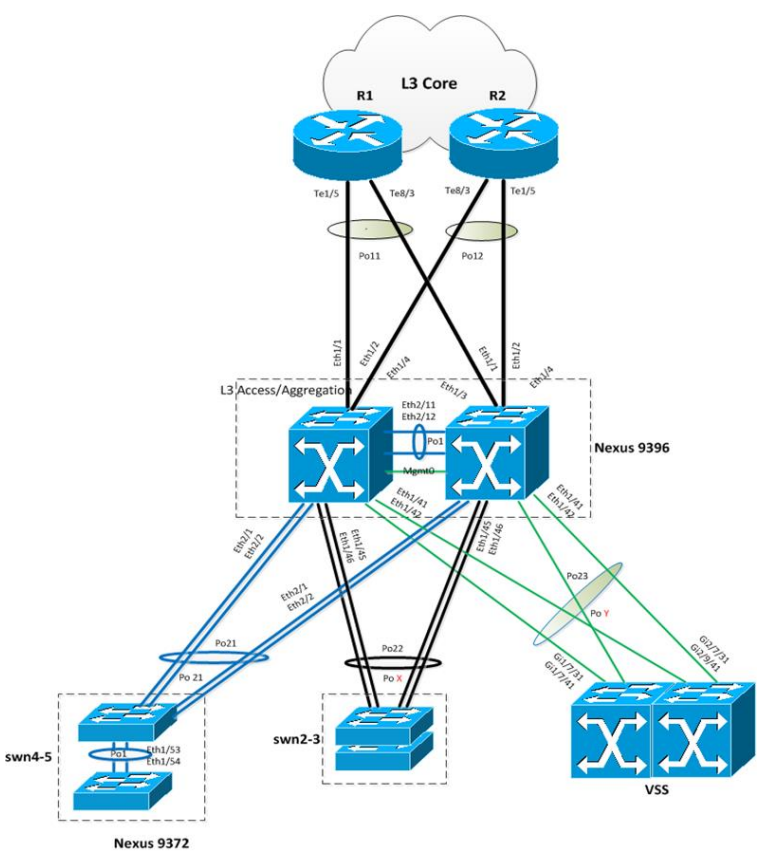
- What is a Data Center ?
  - Sum of server and/or application running on virtual or physical machines and network elements
  - Physical Servers: HP/IBM/Huawei
  - Virtual Servers running on top of physical servers
    - VmWare Application
- Request: full resiliency due to critical application
- OSS/Subscribers Database/WEB Application/Hosting/Services
- Networks Elements (Firewalls, Routers, PCRF, Management Servers) are moved in “cloud”, as virtualized machines

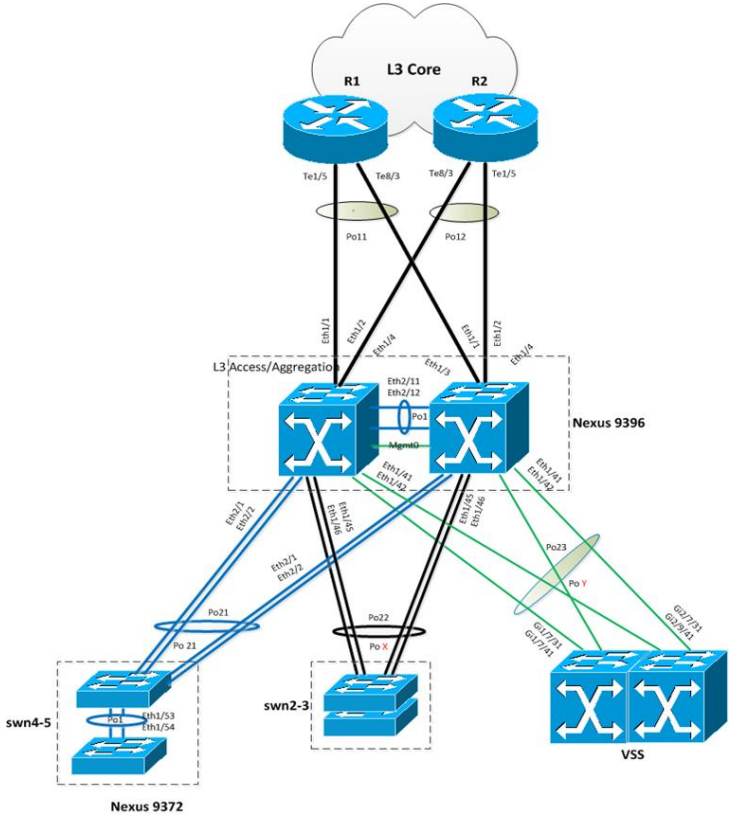
Data Center Architecture

- Advantage: Huge processing – cost effective
- Complexity of architecture
- New topology deployed -> introduction of virtualization in networking domain
  - Virtualization of equipment's/links
  - Introduction of new concepts: VxLAN and their application, Ethernet-BGP, L2 encapsulated in L3, Multicast signaling
- L2/L3 Diagram/Topology



Data Center Architecture



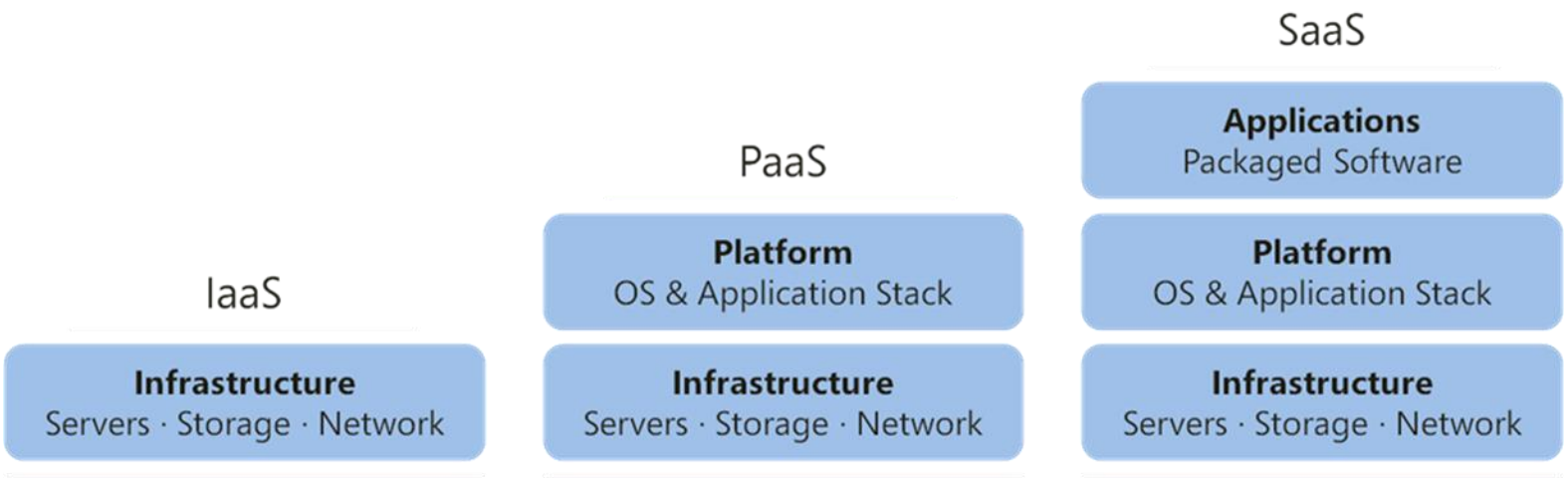


- Geographical Distributed Architecture

Data Center – Cloud

- “Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”
  - Get the compute resources when you need
  - Able to deliver quality results faster, cheaper
  - Reduce projects time-to-market cost significantly
  - SCALE-UP / SCALE-DOWN
  - Mobility, Security

Service Models



Service Models

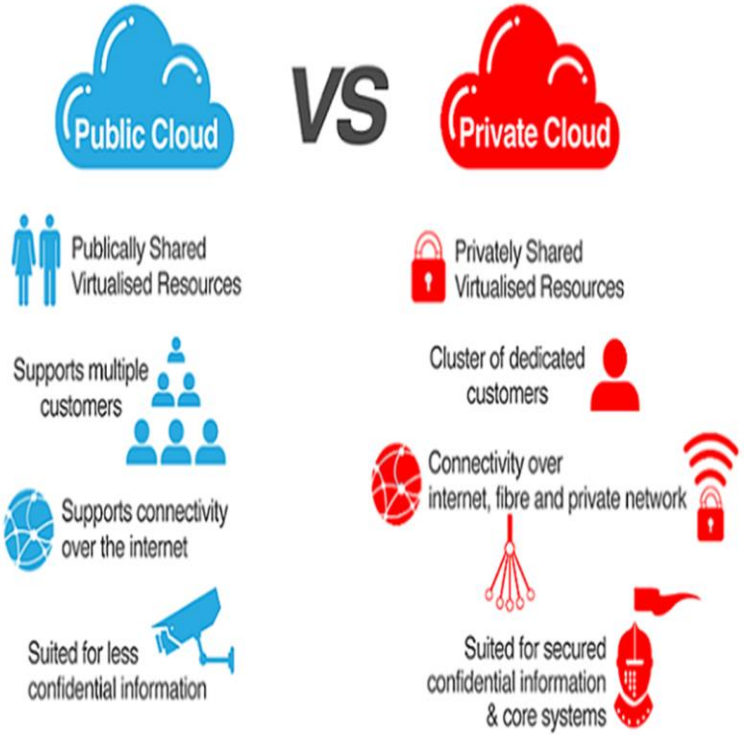
- Software as a Service (SaaS)
  - use the provider's applications running on a cloud infrastructure able to deliver quality results faster, cheaper (web email)

- Platform as a Service (PaaS)
  - deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider

- Infrastructure as a Service (IaaS)
  - provision processing, storage, networks and other computing resources

Cloud Types

- Private cloud - exclusive use by a single organization comprising multiple use the provider's applications running on a cloud infrastructure able to deliver quality results faster, cheaper (web email)
- Community cloud - exclusive use by a specific community of consumers from organizations that have shared concerns (mission, security requirements, policy, and compliance considerations).
- Public cloud - provisioned for open use by the general public
- Hybrid cloud - composition of two or more distinct cloud infrastructures (private, community, or public)



QoS

Quality of Services

- Key Concepts
  - Allow the transport of traffic with special requirements
  - Defined by the ITU in 1994
  - Starting from Telephony needs
- An ISP Network must assure :
  - Throughput
  - Dropped packets
  - Latency, Delay
  - Jitter
  - Out-of-Order Delivery

Quality of Services

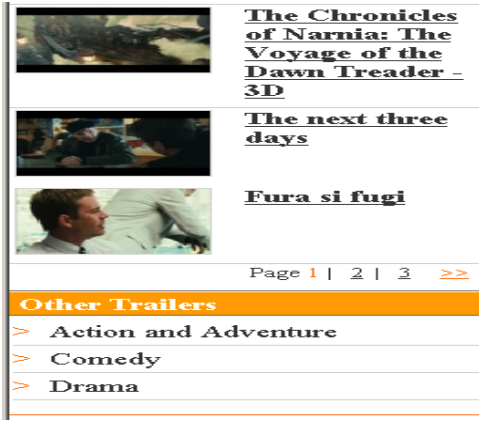
- Assuring Qos:
  - Best Effort
  - Efficient sharing of bandwidth
  - Relative importance depends on traffic type (audio/video, file transfer, interactive)
  - Challenge: Provide adequate performance
- Qos Mapping to Service Providers Needs, including Voice and Data for mobile networks
- How to prioritizing the traffic:
  - Voice
  - Signaling
  - Video
  - Data
- Do not affect the traffic profile
- Definition of Congestion
  - Links congestion
  - Hardware/ports/interfaces congestion

Quality of Services

- Congestion Avoidance models
- Congestion Management models
- End to End QoS for each traffic profile in a Service Provider Network
  - Including mobile networks, based on Architecture
- Traffic increase management, more than 100% increase year by year for mobile data traffic

Service Architecture

Services Architecture, devices evolution to smart-phones, VAS platforms



Core Network

Core Network

- Key Concepts
  - Central part of a telecom network that provides various services to customers
  - Provides path to exchange Information
  - High capacity communication facilities
  - Defined as providing communication any-to-any according the network requirements
- Main Parts:
  - Circuit Switching – CS
  - Packet Switching – PS
  - IMS
- Functions:
  - Transport
  - Signaling

Thank you