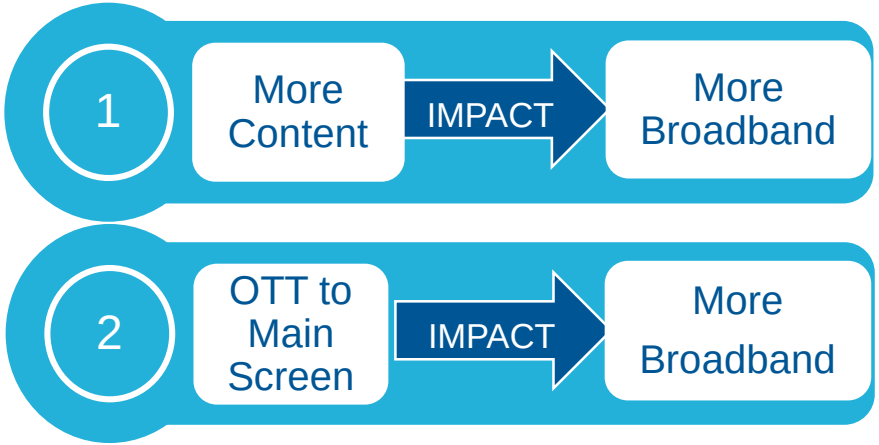
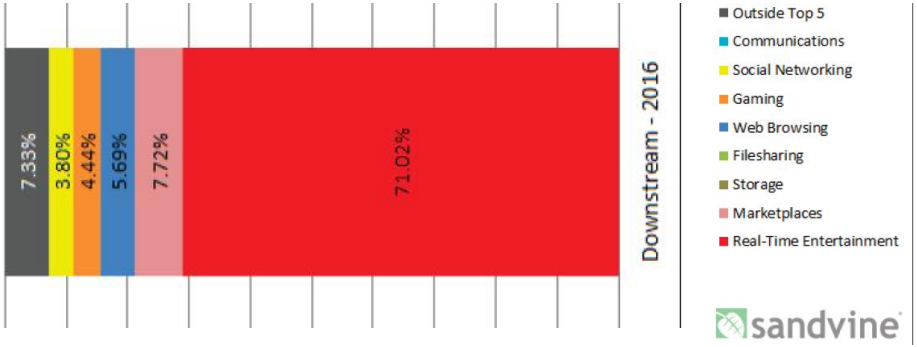
Architectural Options for ‘Gigabit’ and beyond…

Dutch Guild

David Whitehead

Video Trends Impact the Cable Industry



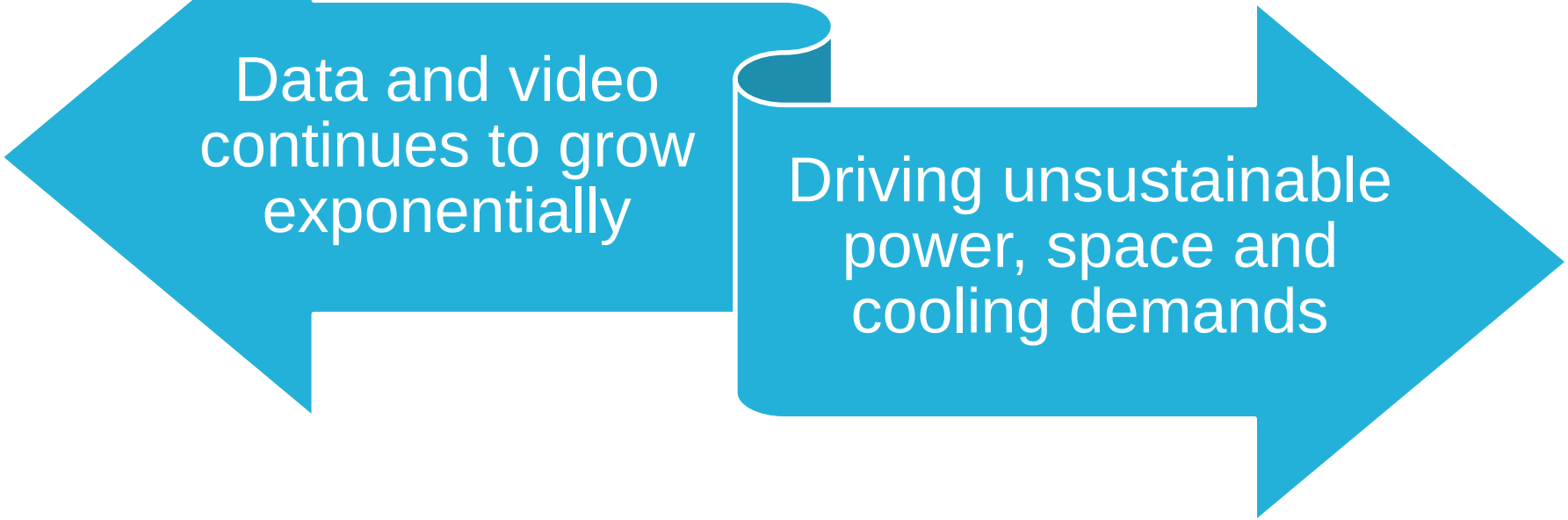


- Real-Time Entertainment is responsible for over 70% of downstream bytes during peak period
- North America will be the first region to surpass the 80% of downstream traffic streaming threshold, which should occur by the end of 2020
- Key drivers
  - Continued expansion of streaming audio and video adoption
  - Increased adoption of emerging video technologies such as 4K, High-dynamic-range (HDR) video, and virtual reality

Source: Sandvine, 2016 Global Internet Phenomena, Latin America & North America

Traditional Deployment Challenges continue…

Traditional CMTS/HFC equipment does not sustainably address growing demands in bandwidth or services



Historical Cable Access Architectures

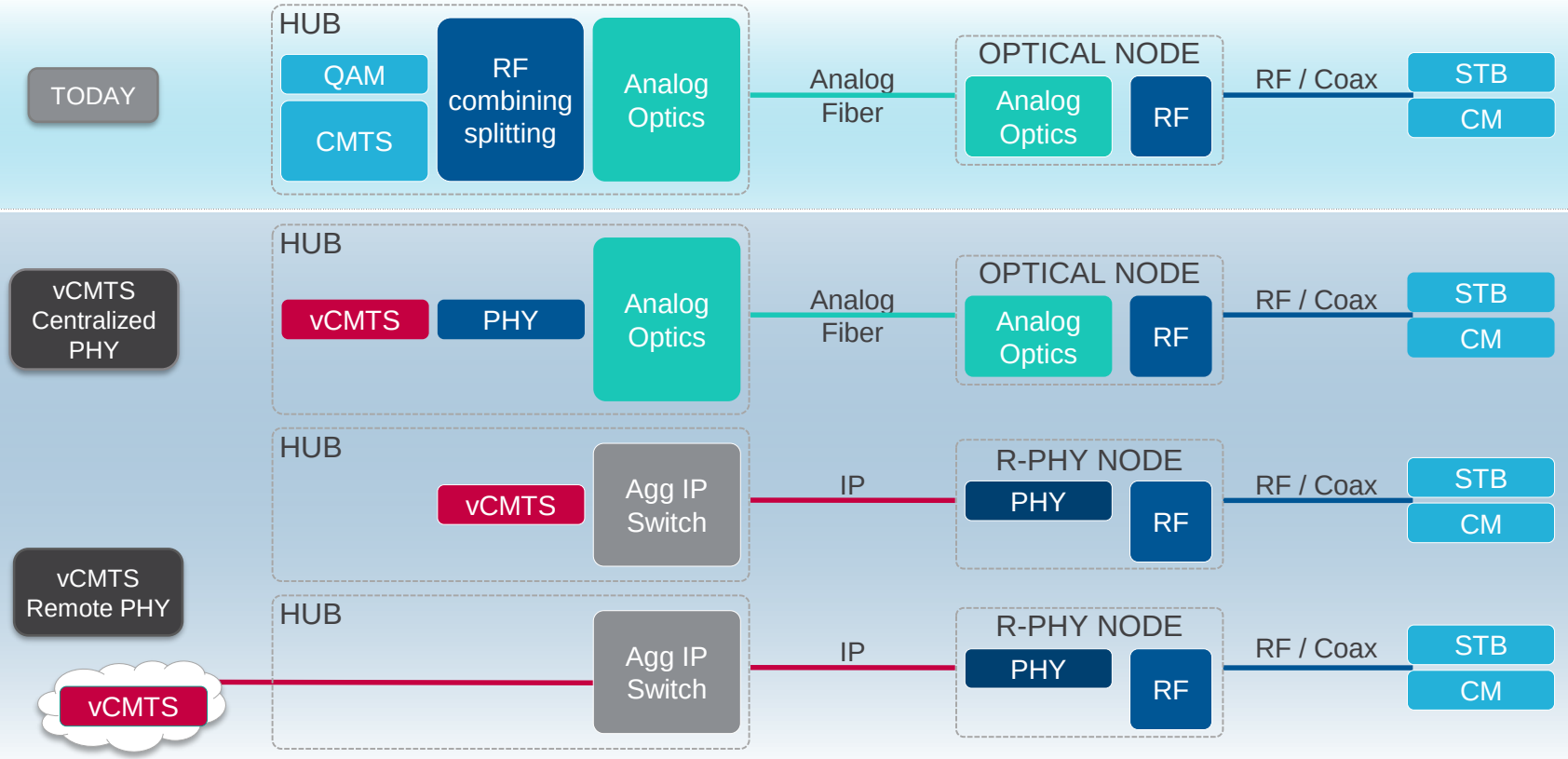
- Centralised ‘Big Iron’ CMTS/EdgeQAM Hardware
  - Hardware Upgrade Cycles to add Capacity/Density/Functionality
  - Chassis typically stays, all else changes
- Analog Fibre Optical Distribution Network
- Cost of Capacity expansions becoming prohibitive
  - Increased Capacity requires additional Hardware
  - Significant Infrastructure Investment required
    - Traditional Fibre Node Splits are costly and take time
    - More CCAP Infrastructure to provide additional Capacity

The Promise of Virtualization

- Virtualization separates software from hardware
  - Quickness and agility to increase business efficiencies and productivity
  - Scalability
  - Elastic deployment
  - Sustainable capacity management

Enable change at a pace which exceeds demand in the most effective manner

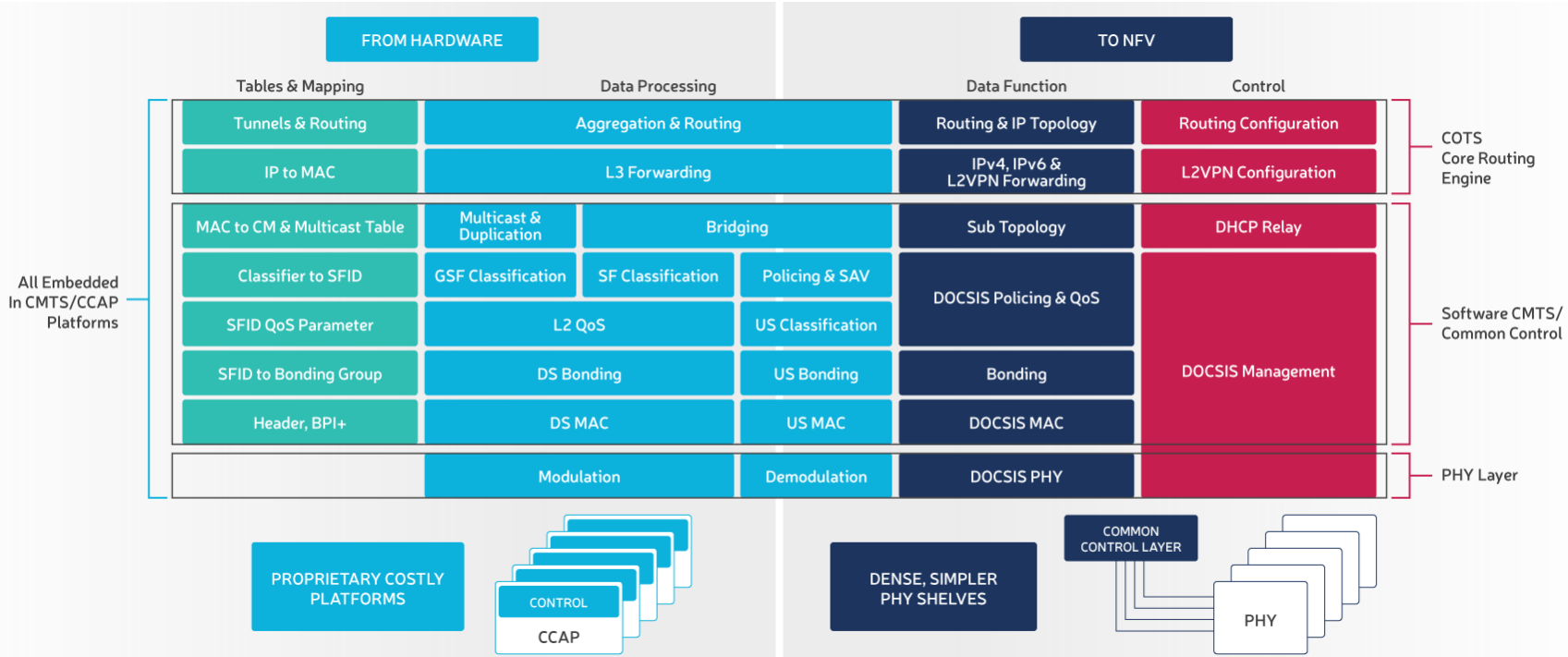
Traditional CMTS/HFC vs. vCMTS



vCMTS Enablers

Full spectrum DOCSIS 3.1	Remote PHY Node (hardware) has a long lifespan
	CMTS Core (software) increases performance and functionality over time
CableLabs Remote PHY Standard	Separating the PHY from the CMTS Core
	Standards-based approach
Commercial-Off-The-Shelf (COTS) Intel x86 Servers	Today's performance is great
	Consistent, regular performance increases

CMTS Stack



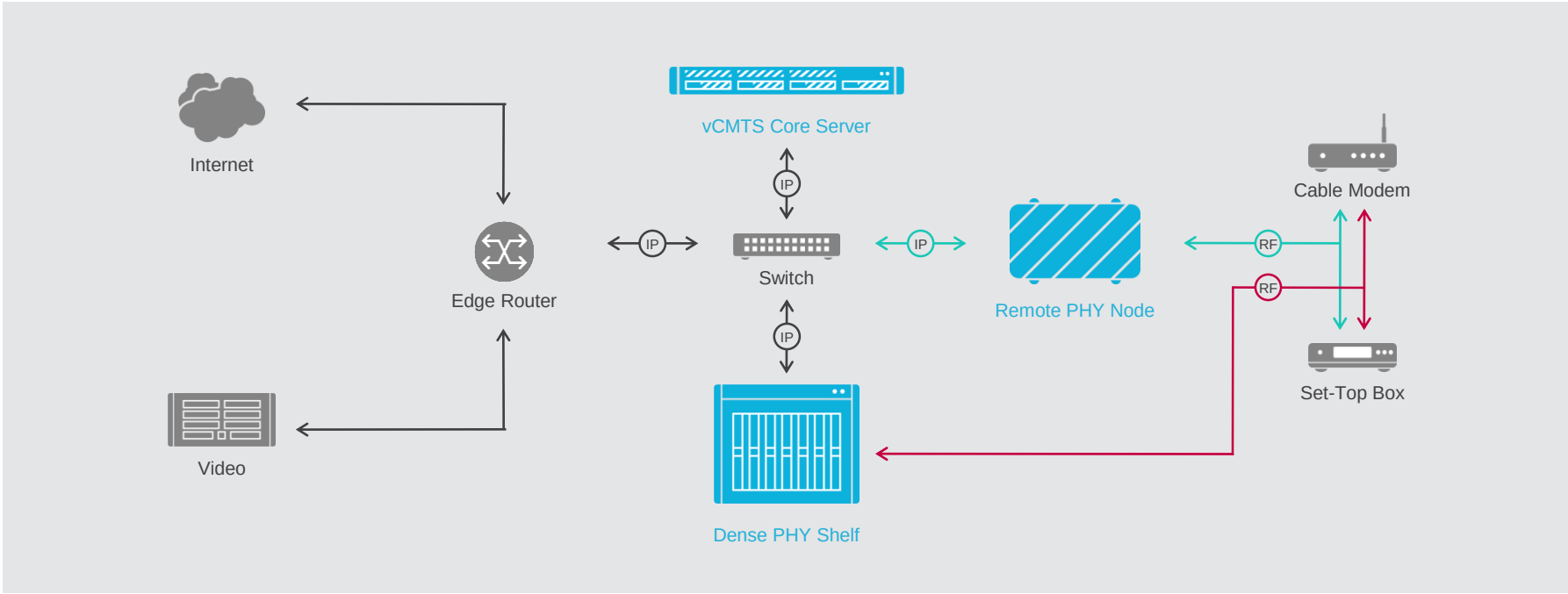
What is virtualized in a vCMTS?

vCMTS

Physical Layer

Tunnels & Routing	Aggregation & Routing		Routing & IP Topology	Routing Configuration
IP to MAC	L3 Forwarding		IPv4, IPv6 & L2VPN Forwarding	L2VPN Configuration
MAC to CM & Multicast Table	Multicast & Duplication	Bridging	Sub Topology	DHCP Relay
	GSF Classification	SF Classification	Policing & SAV	DOCSIS Policing & QoS	DOCSIS Management
SFID QoS Parameter	L2 QoS		US Classification		
SFID to Bonding Group	DS Bonding		US Bonding	Bonding	
Header, BPI+	DS MAC		US MAC	DOCSIS MAC	
	Modulation		Demodulation	DOCSIS PHY	

vCMTS for Centralized and Distributed Architectures



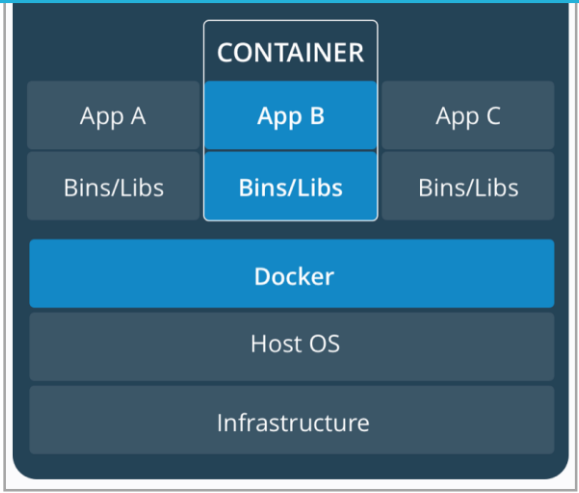
Virtualization Building Blocks

Terminology

- **Containerization**: "**applications can be broken up into manageable, functional components, packaged individually with all of their dependencies**, and deployed on irregular architecture easily."
- **Docker**: **a set of tools to package and deploy containers, which can specify container constraints and access permissions.** Additionally, Docker sets up and deploys the container in Linux.
- **Cloud native**: "cloud native computing uses … software … to be **containerized, dynamically orchestrated, and microservices oriented**."
- **Kubernetes**: "**an open-source system for automating deployment, scaling, and management of containerized applications**."
- **Microservice**: "refers to an architectural approach that independent teams use to prioritize the **continuous delivery of single-purpose services**. The microservices model is the **opposite of traditional monolithic software** which consists of tightly integrated modules that ship infrequently and have to scale as a single unit."

Containers and Docker

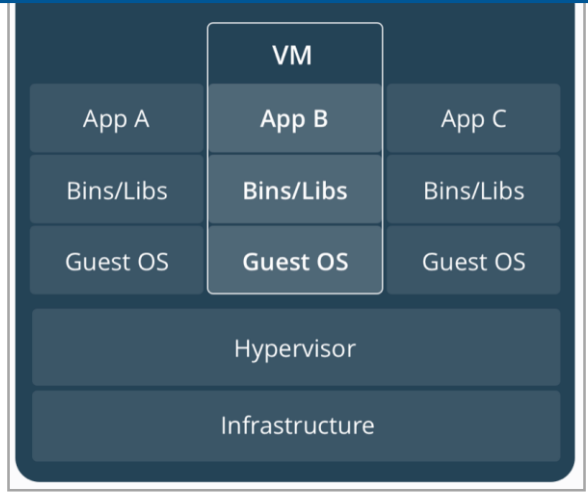
Containers



- Packages code and dependencies together
- Multiple containers can run on the same machine
- Share the OS kernel with other containers
- Docker is a set of tools to package and deploy containers, which can specify container constraints and access permissions

Source: https://www.docker.com/what-container

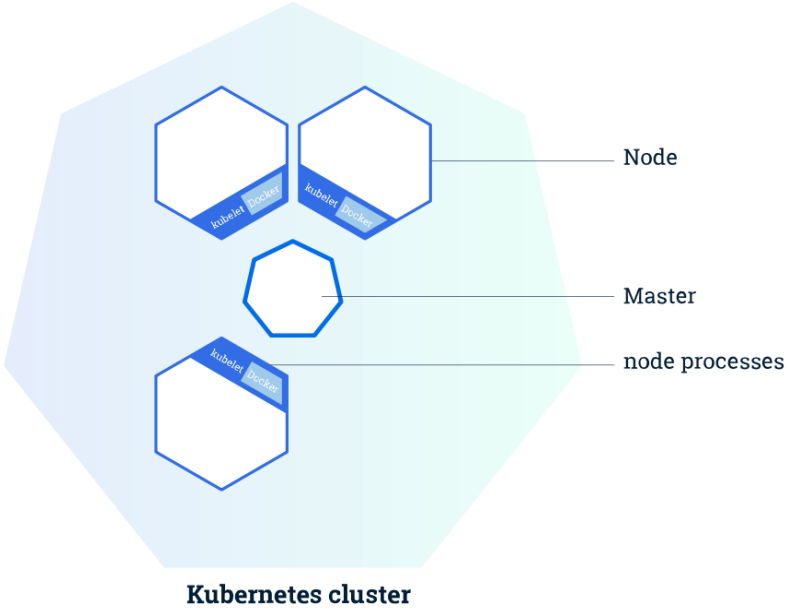
Virtual Machines



- Abstraction of physical hardware turning one server into many servers.
- Each VM includes a full copy of an operating system
- Hypervisor allows multiple VMs to run on a single machine.
- ‘Bare metal’ options also possible

Kubernetes

- Kubernetes automates the distribution and scheduling of application containers across a cluster in a more efficient way
- A Kubernetes cluster consists of two types of resources
  - The Master coordinates the cluster
  - Nodes are the workers that run applications
- A Kubernetes cluster can scale to dozens of servers handling thousands of service groups — perfect for handling new RPD-based deployments. Elastic scalability allows sizing of cluster based on each deployment's needs



Source: https://kubernetes.io/docs/tutorials/kubernetes-basics/cluster-intro/

Bare Metal Architectures

Bare metal scale up

All software (bare metal or virtualized)

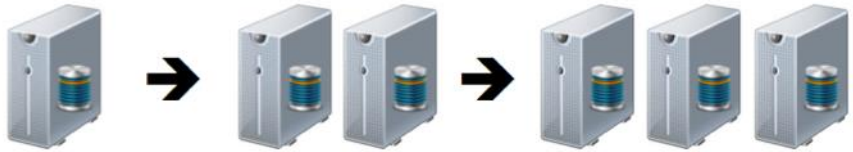
Bandwidth and subs scales with:

- Intel CPU (cores, GHz), NIC (10G, 40G, 100G)
- Load balanced architectures for Redundancy

Optimized for performance and price

Failure domain = single unit or multi serving group domain

Containerized Architecture with SG per Workload



Scale out (horizontal scaling)

All software (***containerized***)

Bandwidth, subs scales with additional containers on same or additional servers

Easier to develop/test smaller units (nodes)

Test out SW Upgrades before mass deployment

Smaller failure domain

Full redundancy

Lends itself to on demand infrastructure deployment on a per SG basis

Comparing Hardware-Based and Virtualization Approaches

Old Way	New Way
Application runs on custom hardware	Application runs on COTS hardware
Application is implemented partially or fully on hardware components (e.g. ASIC, FPGA)	Application is implemented in software
Replaced every three to five years	Long lifespan RF Hardware
Application is upgraded infrequently	Application is upgraded regularly
Equipment location is limited	Equipment location is varied
Services turned on are labor intensive	Services are turned on automatically with orchestration
Service monitoring is labor intensive	Service monitoring (telemetry) is performed by software analytics
Service events are limited to local hardware storage	Service events are stored in the cloud

Migration to vCMTS

- vCMTS may co-exist with existing hardware-based systems
  - Deliver immediate power and space savings
  - Capacity headroom for many years to come
- vCMTS architectures support legacy services
  - MPEG video delivery (Video Core)
  - Out-of-band (OOB) signaling systems for MPEG video delivery (OOB Core)
- vCMTS feeds all data, voice and video services over IP, as legacy services diminish

vCMTS Benefits

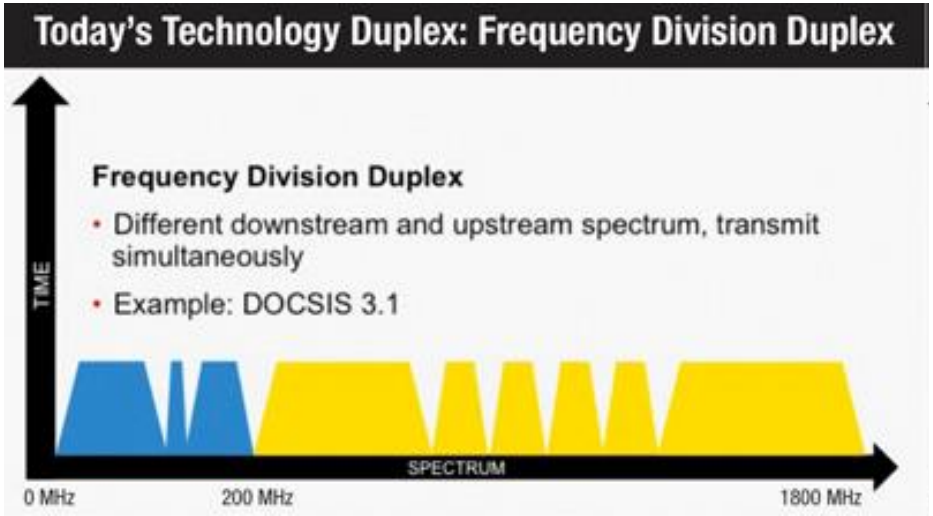
Sustainably grow capacity

Adapt quickly to customer demands

Dynamically augment and shift resources to the most in-demand applications

What is next – Full Duplex DOCSIS

- Upstream Throughput currently limited by available Spectrum
- Need to expand spectrum available for Upstream Traffic



Full Duplex DOCSIS - considerations

- New RPD Hardware absolutely Required
- CCAP Core *MAY* be SW upgradeable
- FDD is a Node+0 Technology
  - No Active devices after the node
  - Requires Fibre pushed deeper, or 10 Gbps pushed deeper into Network
- More complex Silicon for RPD – potentially higher Power, larger device

Summary

- Capacity Growth continues to be required
- Virtualization enables manageable expansion of Infrastructure with continual requirement for more RF Capacity
- Virtualization options can offer increased deployment flexibility
- Full Duplex DOCSIS offers future potential for Symmetrical 10 Gigabit services, but with additional Architectural considerations.

Thank You