Cloud & Virtualization

Unleash the Power of Cloud Computing for CMTS

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Serverless CMTS

Agenda

- Virtualized CMTS Overview
- CMTS Cloudification Objectives and Options
- Cloud Service Platform Characteristics
- CMTS workload placement
- CMTS-as-a-Service
- Conclusions

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Virtualized CMTS (vCMTS) Overview

vCMTS Architecture Today

- On-premises, dedicated physical servers
- Cloud-native software platform
- Multiple service domains with distinctive timing requirements

**MP** = Management Plane (> 1 sec)

**NRTC** = Non-Real Time (>1 sec) controller & applications

**nRTC** = Near-Real Time (10msec - 1 sec) controller & applications

**RTC** = Real time (< 10ms) control services

**UPF** = User plane function (<10ms), also known as the data plane (name comes from mobile)
Public Cloud Infrastructure

Example – AWS Global Infrastructure

AWS US regional and edge locations

Global coverage with easy access options

AWS Global Infrastructure
• 25 geographic Regions
• 81 Availability Zones

Multiple Edge Infrastructure Solutions
• On-premises solution (AWS Outposts)
• Metro area solution (AWS Local Zones)
• 5G Edge solution (AWS Wavelength)
Drivers for hosting vCMTS in cloud

- Unlimited capacity w/o upfront capex
- Consumption based cost model
- Flexibility and agility
- Built-in resiliency and security
- Managed infrastructure/platform
- Global coverage

Select the cloud platforms to best suite the business needs

- Region proximity, edge availability
- Reliability and performance
- Tooling compatibilities
- Cost
vCMTS Cloudification Architecture Choices

#1 On-Prem
- Current system with no cloud
- Applies to RPHY Core on prem
- This also applies to FMA where CMTS SW is in the node

#2 MP in Cloud
- CMTS MP
- CMTS NRTC, nRTC
- CMTS RTC, UPF
- RPD
- Applies to RPHY Core on prem
- This also applies to FMA where CMTS SW is in the node

#3 MP/CP in Cloud
- CMTS MP
- CMTS NRTC, nRTC
- CMTS RTC, UPF
- RPD
- On Prem UPF and RTC
- All workload placement run from cloud.
- Requires control and user plane separation.

#4 Full Cloud
- CMTS MP
- CMTS NRTC, nRTC
- CMTS RTC, UPF
- RPD
- UPC and RTC run in Edge.
- Full cloud for testing and development, and alternative IP transit services.
vCMTS Host Platform Comparison

**Dedicated Physical Servers**
- User managed servers
- Servers are owned by users
- Fixed capacity once installed
- Over or under provision risk
- On-site redundancy for HA

**Resource Aware**
- User configured CPU, memory and storage
- Pay by instances
- Provisioned scaling, coarse-grained
- Support geo-redundancy

**Serverless**
- Cloud configured CPU, memory and storage
- Pay by transaction
- Elastic scaling, fine-grained
- Support geo-redundancy
CMTS Workload Placement Considerations

Matching Platform w/ Workload

UPF & RTC:
- On-prem/Edge
- In-box resource sharing

nRTC:
- Edge or In-Region
- Resource Aware

NRTC & MP:
- In-Region
- Serverless
Full Cloud CMTS Deployment Model

Example – Full Cloud CMTS on AWS

Full Cloud across Edge and Region

- CCAP Core fully operates in Cloud (Edge + Region)
- Edge connects to Region via cloud direct connect service / SP core network
- BGP distributes routes for the distributed CMTS service endpoints.
- DOCSIS punt/injection interfaces separate UPF and CP.
- REST API and telemetry streaming interfaces used for MP
• CMTS needs to maintain states for the cable network elements, including service groups (SGs), cable modems (CMs), and service flows (SFs).

• Serverless compute is stateless, as the compute resource may only last for one invocation.

• Two ways to handle states on a serverless platform:
  o Use serverless data store outside the microservices/functions
  o Use workflow to orchestrate stateless tasks
Manage States as Events

- Externalize states as events
- Decouple a stateful logic into stateless event handlers
- Preserve event sources
  - Stream events to propagate states
  - Log events for AI/ML analytics,
  - Replay events for debugging/fault recovery
- Route events to functions
  - Sort events to database tables
  - Trigger the handlers watching the table
  - Persist the state change across triggers
Serverless Profile Management on AWS

- **AWS Step Functions workflow**
  - Start
  - Select a CM to test
  - Request profile test
  - Analyze test result
  - Update CM profile
  - DBC CM to new profile
  - Notify success
  - Notify no-change
  - Notify test failure
  - DBC failed
  - No Change needed
  - Profile test failed
  - Notify test failure
  - End

- **Hold States in Workflows**
  - A workflow holds application states and actions to transition from one state to another.
  - Each action is a stateless event handler, unaware of its location in the execution sequence.
  - Knowledge of the execution order helps prepare the resource needed by the event handlers.
  - The workflow itself is a serverless cloud service with built-in elasticity and resiliency.
Cloudification Proof of Concept

Objective:
• Experiment all CMTS workload in Cloud
• Study impact on service placement

Strategy:
• Jump start with lift-and-shift
• Test driven development, targeted optimizations

PoC Setup:
• Cisco vCMTS runs on Amazon EC2 instances in the AWS Region
• AWS Region connects to CIN at Cisco lab via AWS Direct Connect
CMTS–as-a-Service

- CMTS is hosted by cloud and delivered to users over the internet/direct connections.
- CMTS-as-a-Service requires multi-tenancy to be successful and sustainable
  - Share common CI/CD pipeline to speedup development/upgrade, save time/cost
  - Share compute and storage resource cost and maintenance overhead

![Diagram showing Continuous Integration and Continuous Delivery pipelines for N Tenants]

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Multi-Tenant CMTS Resource Sharing & Isolation

MT CMTS Code
- ST CMTS Account
- ST CMTS VPCs
- ST Compute
- ST Database

#1 Share s/w

MT CMTS Code
- ST CMTS Account
- ST CMTS VPCs
- ST Compute
- ST Database

#2 Share account

MT CMTS Code
- MT CMTS Account
- MT CMTS VPCs

#3 Selectively share compute and data storage

MT CMTS Code
- MT Compute (Resource Aware)
  - ST nRTC Containers
- MT Database (Resource Aware)
  - ST nRTC Tables

ST Compute (On-prem) UPF & RTC

MT Compute (Serverless)
- NRTC, MP Function

ST Database (On-prem) UPF & RTC

MT Database (Serverless)
- NRTC, MP Tables

ST MP & RTC Containers

MT = Multi-Tenant
ST = Single Tenant
Conclusions

Cloudification unleashes the power of cloud computing for CMTS

- Cloudification allows the CMTS to take advantage of the highly scalable Cloud infrastructure/platform
- In cloud, you pay for what you use, spend less time managing the infrastructure, more time innovating CMTS
- Two types of cloud resources to consider for placing CMTS services today:
  - **Resource-aware**, in Region and Edge, offers similar development and operation environment as the server based vCMTS today.
  - **Serverless**, in Region only, offers built-in auto scaling and hides all underlying resource provisioning complexities.
- Cloudification can start out with a test-driven development approach to iteratively optimize CMTS operation in cloud.
- Ultimately offering CMTS-as-a-Service with multi-tenancy + cleaner CI/CD model.
Thank You!

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