Prepare for the 5G Era with 5G Ready Data Centers

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Agenda

• Impact of 5G on Telco DC
• 5G ready DC solution with ACI
• 5G ready DC solution with Nexus 9000
• Monitoring and Compliance for Telco DC
• Network Insights for Telco DC
Customer Experience is Taking Centre Stage

Mobile ARPU, Multiple Countries

<table>
<thead>
<tr>
<th>Year</th>
<th>ARPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>50</td>
</tr>
<tr>
<td>2016</td>
<td>45</td>
</tr>
<tr>
<td>2017</td>
<td>40</td>
</tr>
<tr>
<td>2018</td>
<td>35</td>
</tr>
<tr>
<td>2019</td>
<td>30</td>
</tr>
<tr>
<td>2020</td>
<td>25</td>
</tr>
</tbody>
</table>

Consumer ARPU is Declining or Flat

B2B or B2B2x Market Has Future Growth

Low Latency for better QOE and to Enable New Applications, Customer Experience Transformation

Source: EU Commission

Operator business mostly focused on the saturated consumer market

Vertically targeted services will accelerate operator business growth
Service Edge Transformation

The Service delivery architecture is evolving as the Service Edge functions are undergoing the following transformations:

Virtualization

Decomposition

Placement

Centralized, Appliance Based Mobile Gateway

Distributed, Virtualized, Decomposed Mobile Gateway
Use Cases for Edge

- Operator Branded or Business to Business (B2B)
- (Open) Virtualized RAN
- Decomposed Mobile Core (CUPS)
- Edge CDN for (Mobile) Video
- Interactive/VR Gaming
- Connected Autonomous Vehicle (Big Data)

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**Decomposed Mobile Core (CUPS)**

- RAN
- Control Plane
- Edge Services
- Core

**Edge CDN for (Mobile) Video**

- Mobile Network
- Mid-Tier Cache

**Interactive/VR Gaming**

- Gaming Node
- APIs
- GW + Gi
- Virtualization Platform

**Connected Autonomous Vehicle (Big Data)**

- RU
- DU
- CU
- ML / AI
- URF + Gi
5G Architecture Evolution

- Virtual Packet Core is the #1 workload for NFVi today
- Distribution of the User Plane the only way to meet 5G low latency requirements
Slicing and 5G Services
### Impact of 5G on Telco Datacenter Fabric

| Multi-Site | - Multiple locations with lesser footprint (1 / 2 pairs in edge DC)  
|            | - Multiple Central/Regional DC with ACI fabrics.                     |
| Automation | - 5G Slice calls for end to end automation, need SDN to integrated with MANO as well as virtualization domains like K8, Openstack. |
| Service Chaining | - As U-Plane goes out, services will move along and we would need to chain different APN’s to different services. |
| Analytics | - 5G calls for end to end slicing with slice management, we need DC to stream real time telemetry data outside. |
| Virtualization | - Platform to host distributed workloads (VM, Containers) |

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## Distributed Telco DC challenges

<table>
<thead>
<tr>
<th>Lifecycle Management</th>
<th>Scaling 100s-1,000s sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Chaining</td>
<td>Complex operations, requires granular visibility</td>
</tr>
<tr>
<td>Automation</td>
<td>Seamless inter-working w/ Transport SDN</td>
</tr>
<tr>
<td>Availability</td>
<td>No central point of failure</td>
</tr>
</tbody>
</table>
ACI Architecture For Distributed Telco Cloud

Distributed Edge DC Fabric

- Multi site SDN Controller
- Network as a Fabric
- Scale to MEC sites with Remote leaf
- Consistent Policy Model across fabric

Network and Security Policy enforcement

~ ACI Remote Leaf
~ 10s VMs + Mini POD

Analytics and Assurance

- Streaming Telemetry and Analytics: Visibility and Performance
- Network Service Assurance: Simulation and validation

SDN Fabric Management

- Driven by virtualization
- Fabric Automation
- Ops tools for lifecycle management
- Policy driven with Service Chaining
- SDN-ACI & SR-MPLS Integration for NaaS

Cloud Management

- Workload Management across clouds
  - Openstack
  - Kubernetes
- Virtual Network Connectivity across clouds

CRAN/Pre-Agg 1000s
CO/Edge DC Few 100s
Regional DC >100s
Central DC Few 10s
sGi LAN
Internet Peering

Transport with SR-MPLS/SRv6

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MSO- Multisite Orchestrator
NSO- Network Service Orchestrator
Architecture Overview

Remote Location contains Nexus 9300 connected to IP Network and fully managed by APIC cluster of Main DC

APIC and Spine Nodes remain at Main DC

ACI Main DC

Local Traffic forwarding between endpoints
ACI Multi-Pod

Single Telco DC Campus with multiple server halls

- Managed by a single APIC Cluster
- Single Management and Policy Domain
- End-to-end policy enforcement
- Control plane fault isolation

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ACI Multi-Site Overview

- Separate ACI Fabrics with independent APIC clusters
- No latency limitation between Fabrics
- End-to-end policy definition and enforcement
- MP-BGP EVPN control plane between sites
- Data Plane VXLAN encapsulation across sites
ACI Extensions To Multi-Cloud

ACI Multi-Site Appliance

Site A
Site B
ACI – On Premise
Google Cloud Platform

Site C
Microsoft Azure

Site D

Consistent Network and Policy across clouds
Seamless Workload Migration
Single Point of Orchestration
Secure Automated Connectivity

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Service aware Interworking between DC and Transport Domain

- End-to-end service provisioning
  - Service aware provisioning of transport and DC domain
  - Using technologies like SR-MPLS and EVPN for seamless integration between Datacenter and Transport
  - End to end service provisioning with NSO

Better Customer Experience: End to End Differential Service
Rakuten End-to-End Architecture Foundation

Service chaining with ACI
## Challenges of Service chaining

<table>
<thead>
<tr>
<th>Multiple devices In service chain</th>
<th>Telco DC needs to support multiple type of devices such as TCP optimizers, Deep Packet inspection, CG-NAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex Configuration</td>
<td>Traditionally configuration is done device by device using complex routing and PBR configuration, it needs to be simplified</td>
</tr>
<tr>
<td>Load balancing</td>
<td>Devices such as TCP optimizers needs fabric to provide load-balancing capabilities</td>
</tr>
<tr>
<td>Scale out configuration</td>
<td>Traditional PBR based configuration is static, it needs to be dynamic and fabric should provide capability to add capacity on demand</td>
</tr>
</tbody>
</table>
| Different type of devices in service chain | Services devices could be L1, L2 or L3  
|                                   | Services devices could be VM, containers or Bare-Metal |

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Multi-Node Service chaining in Telco DC

Service chaining for any type of workload – L1, L2, L3 or VM, bare-metal of containers
Logical ACI Construct for service chaining

- **UPF EPG**: Classified based on subscriber Pool
  - 10.0.0.0/8
  - 2000::/8

- **Contract**

- **Service Graph Template**
  - Group of TCP Optimizers
  - DPI
  - CG-NAT

- **Internet EPG**: Classified based on Internet prefixes
Simplified Configuration

L4-L7 Service Graph Template - service-chaining

TCP_OPT_Group Information
Route Redirect: true

CG-NAT Information
Route Redirect: true

DPI-Multi-Node Information
Route Redirect: true
Integration with TCP Optimizer
TCP Optimizer Integration with ACI

Automatic Load-balancing and Symmetry of traffic flow

- Symmetric PBR ensure return traffic choses same TCP optimize
- Automatic load-balancing of traffic across different TCP optimizers based on forwarding table hash (Source IP, Destination IP, Source Port, Destination Port)
TCP Optimizer Integration with ACI

Simplified Configuration

UPF EPG
Classified based on subscriber Pool

Contract (PBR)
TCP = Any or UDP = 443

Internet EPG
Classified based on Internet Prefixes

Subscriber Pool

TCP OPT 1
TCP OPT 2
TCP OPT 3
TCP OPT N

N-TCP Optimizers in a group

Internet
TCP Optimizer Integration with ACI

Tracking TCP Optimizer Liveliness

- N-TCP Optimizers in a group
- Internet
- Inside 1.1.1.1
- Outside 2.2.2.1
- TCP OPT 1
- TCP OPT 2
- TCP OPT 3
- TCP OPT N

ICMP & TCP Tracking of Inside & Outside Interface

Automatic Load-Balancing to remaining TCP Optimizers after failure

Removes whole TCP Optimizer if either Inside or Outside interface goes down

Subscriber Pool
TCP Optimizer Integration with ACI

Simplified expansion

New TCP optimizers can be added anywhere in fabric
Large SP customer

Subscriber
150Mn→400Mn

Data Capacity
1.5EB → 6.5EB per Month

Services Offered
• Unlimited voice calls
• Low data prices
• Unlimited home grown multimedia content
• Many more home grown application planned

Challenges
• Extremely aggressive timelines
• Brownfield environment
Large Telco DC deployment with ACI

Policy Intent at Scale
20+ ACI fabrics deployed for vEPC
2000+ ACI nodes
400Tbps data capacity trending to 1.2Pbps

Time to value
Earlier 1 DC Fabric in 3 Weeks; Now 3 DC Fabric in 1 week with ACI
40+ New Telco DC deployed in less than 3 months

Agility
High performance resilient SDN fabric for NFVi project
ACI Service Chain for their Gi-LAN services

Visibility & Control
Operations benefit from hardware telemetry and visibility
Software upgrade now completed in couple of days without impact to services
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N9K NX-OS Solution for SP DC

- N9K VXLAN fabric solution
- VXLAN SR-MPLS handoff
- DCNM for automation and management

vPC/VXLAN

CRAN/Pre-Agg (1000’s)
- Centralized RAN
- Cloud RAN*
- BBU Hotel

CO/Edgc DC (Few 100’s)
- vCU-Radio Element
- User Plane*
- Gi-Services*
- OTT Caching*
- CDN*

Regional DC (10-60 DC’s)
- User Plane
- Gi-Services
- OTT Caching
- CDN

Central DC (2-6DC’s)
- IMS
- vEPC Control Plan
- CP
- Gi-Services
- OTT Caching
- CDN

Transport with SR-MPLS/SRv6
VXLAN Multi-Site

Site A

Core Data Centers

Site B

VXLAN Fabric

IP WAN

VXLAN Fabric

IP WAN

VXLAN Fabric

Fault Isolation

Pervasive Mobility

Elastically Scalable
DCNM—Automation and Life Cycle Management

- DCNM zero touch provisioning
- DCNM manage remote switches
- DCNM scale
- DCNM Multi-Site Manager
N9K VXLAN to SR-MPLS Handoff

Seamless integration between DC and WAN

Simplifying Integration between Datacenter and WAN
N9K Elastic Service Redirection

- Granular Traffic Filtering, Redirection and Distribution
- Simplify Service Node (FW/LB/IPS, etc.) insertion/deletion
- Automatic handling of service node-failures
- Service automation, traffic flow statistics and health monitoring

Cost Savings
Simplify Operations
Scalability
KT 5G telco DC Powered by ACI

- Nexus 9000 running in ACI mode power KT 5G telco cloud
- Nexus 9000 running in NX-OS as core switch connects telco cloud to other parts of DC and WAN
- Cisco mobile packet core with CUPS
- Cisco core routing with SR-MPLS
- Press release
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TAP/SPAN for monitoring/compliance

Solution for both ACI and Standalone

SPAN/ERSPAN from ACI towards Nexus Data Broker (NDB) switches

Filter traffic based on 5-tuples (source IP, destination IP, protocol, source port, destination port) filter in ACI

- Advance ingress packet filtering and modification
- Load-balancing in egress

Analytics and Monitoring Tools

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Network Insights Resources

Network Insights Advisor

App Hosting Framework
App Store

DCNM

Data collection
and ingestion

Data correlation
and analysis

Data visualization
and action

Visibility
Learn from your network and recognize anomalies

Insights
See problems before your end users do

Proactive Troubleshooting
Find root cause faster with granular details

DCNM APIC

App Hosting Framework
App Store

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Network Insights Resource App

Shorten Time to Remediation for Troubleshooting

Long & Slow Troubleshooting → Remediate

Shorter & Faster Troubleshooting

Packet drops | Latency | Reachability | Routing | Micro Bursts

Network Insights: Resource Analysis
Network Insights Resource App

Increase Speed and Agility for Capacity Planning

Long & Slow Capacity Planning

Remediate

Shorter & Faster Capacity Planning

Automated with statistical models

Network Insights: Resource Analysis

Bandwidth

Ports

TCAM

Scale limits
Network Insights-Advisor

- Advisories
  - Software/Hardware Recommendations
  - Workarounds

- Notices
  - EOL/EOS Field Notices
  - SMUs

- Anomalies
  - Known Issues/PSIRTs
  - Unknown runtime
  - Config anomalies

- Compliance
  - Version Scale
  - Limits/Hardening
  - Check Configuration

- Diagnostic
  - Forwarding State Check
  - Loops Detection
  - Cable Checkers

- Avoid multiple TAC calls
- Keep Network up to date
- Adhere to Cisco policies
- Recommendations

- Remove Complexity
- Avoid Outages
- Faster Deployment times

- Significant CAPEX
- And OPEX Savings

- Prevent traffic black holing
- Avoid downtimes
Conclusion
Conclusion

- 5G deployments will create multiple highly distributed DC’s
- Automation, Lifecycle Management, and Analytics will be key aspects
- ACI and DCNM with N9K provides solution to these challenges