Service Provider Summit at Cisco Live!
Your Time Is Now
Building the Mobile Network Foundation for the 5G era

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Tom Fisher, Managing Director, IoT Cloud, ANZ  <tomfish@cisco.com>

Thursday 9th March
Abstract

Mobile networks continue to evolve, driven by the need for increased performance, agility and lower cost per bit to open new revenue streams like IoT. At this pace the traditional 4G architecture is fast becoming obsolete. Leveraging the key foundational technologies of SDN, NFV and Cloud, we can start to re-architect the network to enable concepts like Network Slicing, Control and User Plane Separation (CUPS), Mobile Edge Computing (MEC) and Hybrid-Cloud Services. We show a phased transformation from 4G Mobile Core to 5G Service Core, supported by business case drivers and realistic timelines.
Future Network Platform

Service Creation
 SERVICE Design | SERVICE Assurance | Cloud Optimization

Cloud-based Services
 Consumer | Business | IoT | Video | Mobility

Network Abstraction
 Orchestration | Automation

Infrastructure
 Physical | Virtual | Data Center

Self Healing Network
Cisco Mobility Solution
HetNet SP Wi-Fi, SON Automation, MVMT Service Core, Cloud Services

Ultra Service Platform (SDN/NFV)

Policy Suite
- OCS
- PCRF (ES, ANDSF, DRA)
- SPR

Mobile Packet Core
- PGW
- GGSN
- SGW
- MME
- SGSN
- HxNBGW
- SaMOG ePDG
- CSGN eSCEF
- Ultra IoT

New Features:
- Multi-Vendor Multi-Technology (MVMT)
- Ultra Service Platform
- Policy Suite
- Mobile Packet Core
- New Technologies: NB-IoT, VolTE, LTE, 3G, 2G, VoWiFi, VoLTE

Cisco Mobility Solution for HetNet SP Wi-Fi, SON Automation, MVMT Service Core, Cloud Services.
Agenda

• Introduction: The Next Decade of Mobility
• Business Opportunities → Challenges
• Network Requirements → Technology Enablers
  • Introducing Mobile Network Virtualisation
  • Hybrid-Cloud Services: Jasper IoT Platform Case Study
  • The role of Wi-Fi in 5G networks
• Key Takeaways
• Discussion
Introduction: The Evolution of Mobile Technology

1980
- 1G – TACS. AMPS

1990
- 2G – GSM/GPRS/EDGE. DAMPS/CDMA

2000
- 3G WCDMA/HSPA. CDMA1x/DO

2010
- 4G – WiMAX. LTE/LTE Advanced

2020+ 5G Era
- 5G – ...

Service Evolution
- Voice
- Digital
- Data
- IP
- IoT
Introduction: Technology Convergence

Based on: Gartner’s Hype Cycle for Emerging Technologies, 2016

- NFV/SDN – “Plateau of Productivity”
- IoT – “Slope of Enlightenment”
- 5G – Emerges from “Trough of Disillusionment”

2021 only ~1% of traffic on 5G. Cisco VNI LTE, NB-IoT, WiFi carry the load in 2020+ era
# APAC Mobile 5G Era Forecast

## Diverse Growth Drivers across Region

<table>
<thead>
<tr>
<th>Region</th>
<th>2021 Mobile Users (inc M2M)</th>
<th>Connections (inc M2M)</th>
<th>Avg Speed</th>
<th>Traffic/Device per Month</th>
<th>Total Mobile Data Traffic per Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>APAC</td>
<td>3,000 M (3% YoY)</td>
<td>5,700 M (7% YoY)</td>
<td>22 Mbps</td>
<td>4.3 GB (40% YoY)</td>
<td>22,850 PB (50% YoY)</td>
</tr>
<tr>
<td>China</td>
<td>1,100 M (2% YoY)</td>
<td>2,000 M (7% YoY)</td>
<td>33 Mbps</td>
<td>4.8 GB (48% YoY)</td>
<td>9,100 PB (56% YoY)</td>
</tr>
<tr>
<td>India</td>
<td>890 M (6% YoY)</td>
<td>1,350 M (6% YoY)</td>
<td>9 Mbps</td>
<td>1.5 GB (42% YoY)</td>
<td>1,970 PB (50% YoY)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>211 M (2% YoY)</td>
<td>435 M (4% YoY)</td>
<td>13 Mbps</td>
<td>3.5 GB (47% YoY)</td>
<td>1,500 PB (53% YoY)</td>
</tr>
<tr>
<td>Rest of APAC</td>
<td>570 M (3% YoY)</td>
<td>1,180 M (5% YoY)</td>
<td>12 Mbps</td>
<td>5.6 GB (45% YoY)</td>
<td>6,500 PB (51% YoY)</td>
</tr>
<tr>
<td>Australia</td>
<td>23 M (2% YoY)</td>
<td>80 M (14% YoY)</td>
<td>39 Mbps</td>
<td>4.6 GB (25% YoY)</td>
<td>340 PB (39% YoY)</td>
</tr>
<tr>
<td>Japan</td>
<td>113 M (0% YoY)</td>
<td>360 M (13% YoY)</td>
<td>39 Mbps</td>
<td>8.1 GB (23% YoY)</td>
<td>2,200 PB (33% YoY)</td>
</tr>
<tr>
<td>Korea</td>
<td>45 M (1% YoY)</td>
<td>180 M (16% YoY)</td>
<td>45 Mbps</td>
<td>7.5 GB (23% YoY)</td>
<td>1,140 PB (37% YoY)</td>
</tr>
</tbody>
</table>

### Emerging Asia:
- More Users
- Smartphone Adoption
- Wireless Local Loop

### ANZ:
- More BW and richer services

### Developed Asia:
- More connections with IoT

---

**Network Challenge:**
- Increase in Traffic: 50%+ YoY (>7x in 5 years, >50x over 10 years)
- Increase in connections: 15%+ YoY (>5x in 5 years, >24x over 10 years)

---

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2016–2021

Note: The numbers above pertain to 2021, and the CAGR’s are for 2016–2021 period
Revenue vs Yield

APAC Mobile Revenues
Source: Ovum, 2017

APAC Mobile Data Growth & Yield
Source: Cisco VNI, 2017

Network Challenge: Reduce “Cost to Serve” at > 25% YoY to maintain/recover margin

Traffic (GB/mth) Yield ($/GB)

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New Services and New Business Models

Access **Requirements** of potential 5G use cases

Source: GSMA Intelligence

<table>
<thead>
<tr>
<th>Use Case</th>
<th>ARPC per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected Car</td>
<td>$0.6</td>
</tr>
<tr>
<td>Connected Industry</td>
<td>$0.6</td>
</tr>
<tr>
<td>eHealth</td>
<td>$0.4</td>
</tr>
<tr>
<td>Smart Meter</td>
<td>$0.2</td>
</tr>
<tr>
<td>Smart City</td>
<td>$3.4</td>
</tr>
<tr>
<td>Mobile Broadband</td>
<td>$10.0</td>
</tr>
</tbody>
</table>

Average **Revenue** per Connection 2020 forecast

Source: Machina, GSMA

Network Challenge:

Support 10x more diverse services, differentiate QoE
Enable new B2B business models for enterprise and IoT

IoT is >10 factor lower revenue per connections
## Network Requirements & Enablers

<table>
<thead>
<tr>
<th>MNO 5-Year Requirement</th>
<th>Strategy</th>
<th>Technology Enablers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Growth &gt; 50% YoY</strong></td>
<td>• Scale User Plane separate from Control Plane</td>
<td>• NFV Control and User Plane Separation</td>
</tr>
<tr>
<td></td>
<td>• Distribute Network: Break-out and resiliency</td>
<td>• NFV based Edge Services (MEC)</td>
</tr>
<tr>
<td></td>
<td>• HetNet (inc WiFi) offload</td>
<td>• Access Policy/Roaming</td>
</tr>
<tr>
<td><strong>Cost to Serve reduction &gt; 20% YoY</strong></td>
<td>• Distribute Network: Backhaul &amp; real-estate savings</td>
<td>• NFV network slices, Cloud workloads</td>
</tr>
<tr>
<td></td>
<td>• Service over WiFi</td>
<td>• VoWiFi convergence</td>
</tr>
<tr>
<td></td>
<td>• Refarm 2G/3G for 4G. Add LPWA (NB-IoT, LoRA)</td>
<td>• SON and VoWiFi. C-IoT Core.</td>
</tr>
<tr>
<td><strong>Service Time to Market 10x faster</strong></td>
<td>• Network “Sand-pit” for Agile Development</td>
<td>• Virtual Network Model &amp; Service APIs</td>
</tr>
<tr>
<td></td>
<td>• Auto-scaling</td>
<td>• SON and NFV</td>
</tr>
<tr>
<td></td>
<td>• Cloud Hosting</td>
<td>• Cloud Services like Jasper IoT</td>
</tr>
<tr>
<td><strong>Improved Customer QoE</strong></td>
<td>• Auto-scaling, Auto-healing</td>
<td>• SON and NFV-O</td>
</tr>
<tr>
<td><strong>New Services (lower latency, higher BW)</strong></td>
<td>• Optimisation and Automation</td>
<td>• SON and GiLAN Service Chaining</td>
</tr>
<tr>
<td></td>
<td>• Local Service Hosting (Video, IoT, Enterprise)</td>
<td>• MEC</td>
</tr>
<tr>
<td></td>
<td>• Security</td>
<td>• Expand security visibility and control</td>
</tr>
<tr>
<td><strong>New Revenue &amp; Business Models</strong></td>
<td>• Service Hosting for B2B (IoT, Video, Enterprise)</td>
<td>• Hybrid cloud: edge, central &amp; global services</td>
</tr>
<tr>
<td></td>
<td>• Service Exposure for B2B2C</td>
<td>• Service APIs, Analytics and Security</td>
</tr>
<tr>
<td></td>
<td>• Be ready for 5G “killer use cases”</td>
<td>• Access agnostic Service Platform</td>
</tr>
</tbody>
</table>
Introducing Mobile Network Virtualisation
Enabling Technologies

Automation, provisioning, and interworking of physical and virtual resources

Service Orchestration

SDN

NFV

Connectivity “fabric”

Software Network functions running on COTS HW

Enabling Architectures

Control/User Plane Separation (CUPS)

Mobile Edge Computing (MEC)

Network Slicing

Decomposition of RAN
Evolving from 2 Tier Functional Hierarchy
Evolving to 3 Tier Functional Hierarchy

Management Plane
- Lifecycle Automation
- Service Orchestration / SON
- Service Exposure (APIs)

Control Plane
- Central/Cloud: Policy, Charging, Authentication, LI

User Plane
- Offload Optimise
- Mobile Edge Services

Continuum of Compute
NFV Introduction & Evolution

VNF Led
- Service driven approach
- Service Agility
- Business outcome desired

Orchestration Led
- Service Elasticity
- Ease of Provisioning; Time to market

Infrastructure Led
- Cloudify & Automate DC Infra
- Leverage OpenSource
- Virtualize, Programmable & Provisionable

Operational Transition

VNF (Vertical) to NFVi (Horizontal) Transition
Considerations for Virtualization – 5G (2020 era Mobility)

Current Scope for Virtualisation
- Macrocell Radio Business CPE
- Small cell Radio Home CPE
- OSS/BSS, IMS & Policy control
- Mobility Management (MME)
- Appliances, GiLAN (L4-L7)
- Small GWs

Scope for 5G Virtualisation
- (Service Chaining, Control/User Plane Separation, Network Slicing)

Scope for 5G Virtualisation
- RAN decomposition, MEC

CPU Reqs
- Low
- High

Wire-line GWs

Distributed: CPUs + Lots of NPUs

Packet Forwarders
Bare metal

Centralized: CPU + NPU

Distributed: CPUs + Lots of NPUs

Service Provider Summit - ciscoLive!
Phased Architectural Transformation

**BUSINESS BENEFIT**

**Software Defined Functions**
- 2G/3G/4G, WiFi, SCell converged
- Virtualised SW (StarOS) on dedicated HW (ASR5500)

**Architecture:**
- Centralised CP & UP Nodes

**Why:**
- Single service control point (Gx)
- Simplified internalised interfaces
- Common lifecycle mgmt
- Pooling of capacity

**Virtual Functions**
- VNF on standard NFV-I

**Architecture:**
- Horizontal: Virtual CP & repurpose HW for UP
- Static NW slices: VoX, IoT PGW
- Vertical: Small remote PoP, MVNE

**Why:**
- Elastic scaling for resiliency & TCO
- Service optimise (VoX, IoT, MVNO)
- GiLAN lifecycle simplification

**Phase 1**

**Orchestration of VNF & PNFs**

**Architecture:**
- Introduce Orchestration (PNF & VNF)
- Distribute UP for Edge services (enterprise, video optimise, MEC)
- Dynamic service chaining

**Why:**
- Service customisation for enterprises, MVNOs, private, IoT
- Automated, agile lifecycle mgmt
- GiLAN TTM

**Phase 2**

**Dynamic Service Orchestration**

**SDN-enabled Ultra Service Platform**

**Architecture:**
- Policy based dynamic NW slicing
- Telco cloud workload optimisation
- Micro-services MEC / CUPS
- 5G ready (access agnostic scaling)

**Why:**
- New NaaS business models
- Service differentiation
- Improve data centre economics

**Phase 3**

**5G Service Core**

**CP = Control Plane**
**UP = User Plane**
**VNF = Virtual Network Function**
**PNF = Physical Network Function**
**TCO = Total Cost of Ownership**
**TTM = Time To Market**
**CUPS = Control User Plane Separation**
**MEC = Mobile Edge Compute**

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## Evolving Mobile Core NFV Use Cases

<table>
<thead>
<tr>
<th>Year</th>
<th>Service Provider</th>
<th>Country</th>
<th>NFVI</th>
<th>Cisco VNFs</th>
<th>Use Case</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>AT&amp;T</td>
<td>Various</td>
<td>HP</td>
<td>vPC</td>
<td>Connected Car</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Naka Mobile</td>
<td>Switzerland</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>MVNO/MVNE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Legos</td>
<td>France</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>MVNO</td>
<td></td>
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<tr>
<td></td>
<td>MVNO</td>
<td>Hong Kong</td>
<td>Cisco UCS</td>
<td>vPC, vPCRF</td>
<td>MVNO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aspider</td>
<td>Netherlands</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>M2M MVNE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tier-1 MSP</td>
<td>USA</td>
<td>HP/Dell</td>
<td>vPC, vPCRF</td>
<td>Enterprise</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>STC</td>
<td>Saudi Arabia</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>Corporate, M2M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>XL Axiata</td>
<td>Indonesia</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>Consumer</td>
<td>&gt; 100 Gbps</td>
</tr>
<tr>
<td></td>
<td>AT&amp;T</td>
<td>USA</td>
<td>HP</td>
<td>vPC, vPCRF</td>
<td>Consumer</td>
<td>&gt; 100 Gbps</td>
</tr>
<tr>
<td></td>
<td>Vodacom</td>
<td>South Africa</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>Consumer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tier-1 MSP</td>
<td>South Korea</td>
<td>HP</td>
<td>vPC</td>
<td>Consumer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tier-1 MSP</td>
<td>Russia</td>
<td>Cisco UCS</td>
<td>vPC</td>
<td>Consumer, Corporate</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>Tier-1 MSP</td>
<td>Belarus</td>
<td>Cisco UCS</td>
<td>vPC, vPCRF</td>
<td>Consumer</td>
<td></td>
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<tr>
<td></td>
<td>Tier-1 MSP</td>
<td>USA</td>
<td>Cisco UCS</td>
<td>vPC, vPCRF</td>
<td>VoLTE, Consumer, MEC</td>
<td>&gt; 1,000 Gbps</td>
</tr>
</tbody>
</table>

- Partial list of reference customers
Hybrid Cloud Services for IoT
IoT Services Are Fundamentally Different
Existing platforms ill-suited for very low ARPU, highly variable services

- Consistent lifecycle
- Limited usage models
- Local customers
- Predictable needs

Traditional Mobile Phone Business

- Variable lifecycles
- Custom usage models
- Local & global customers
- Unpredictable needs

IoT Services Business
IoT Service Lifecycles Vary
Enterprise device deployment models are unique and complex
Usage Models Are Customized

Enterprises demand usage models unique to their business
Customers Are Local and Global

Enterprises want standard platforms across networks
Control Center - Service Provider Improvements

- **4x growth**
  - Device growth: **Accelerated**
  - Month-to-month devices grew 4 times faster

- **1/3 less ARPU erosion**
  - ARPU decline: **Curbed**
  - ARPU decline slowed to a third

- **1/2 churn**
  - Customer churn: **Minimized**
  - Annual churn reduced from 4% to 2%

- **1/5 support**
  - Support cost: **Reduced**
  - Monthly cases reduced from >20 to 5 per 100K devices
  - Provisioning tasks and costs reduced by 80%

- **1/7 less cost**
  - IT operations: **Streamlined**
  - Reduction in opex and capex due to IT consolidation

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Radio Data Communications supply industry-leading security panels. Permaconn is the company’s flagship solution

- Grew at 800 devices per year before Jasper, and 20,000 per year since using Control Centre
- APIs allowed production improvements from 150 devices/worker/month to 900
- Control Centre facilitates growing at scale without additional overhead

“Since using Control Center, we haven’t raised a single support ticket to our Service Providers on an individual SIM card.”

— Paul Behr
Managing Director
Transport for New South Wales manages buses in Sydney with GPS devices to optimize journey times

- On-demand activation/de-activation of connected smart buses
- Single view of bus fleet for troubleshooting and diagnostics
- Management of pooled network usage policies

Transport for NSW uses Control Center to manage the connected service lifecycle for its fleet of connected buses that feed GPS tracking info to their route planning and traffic prioritization system to speed up journey times
One of Australia's largest energy delivery service – serving more than 1.3M homes and businesses

- Real-time status of smart meter activity
- Optimized network usage and costs
- Operational insights to reduce truck rolls

Control Center provides operational insights into over 500 thousand devices that generate millions of events per day. AusNet Services uses this information in their centralized and mobile applications to help their field workers be more efficient.
Hybrid Cloud is opening up new possibilities for Service Providers

- **Enterprise MBB**
  - Improve customer experiences at low cost to serve

- **Enterprise Mobility**
  - Customer Self Serve creates higher UX & win-rates

- **Site Failover**
  - Auto-provisioned, cost-effective connectivity at all times

- **Connected Cars**
  - New experiences & Business Models (eg 3PP content)

- **Create New Businesses**
  - Launch quickly on hybrid cloud
The Role of Wi-Fi in 5G Networks
**Parallel Radio 5G Evolution**  
Standardised up to 2018, Commercialised ~2020

<table>
<thead>
<tr>
<th>Objective</th>
<th>3GPP 5G Innovations</th>
<th>IEEE Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet of Things</td>
<td>Cellular IoT</td>
<td>802.11ah (HaLow)</td>
</tr>
<tr>
<td></td>
<td>- Narrow band, extended range</td>
<td>- sub-1 GHz license-exempt bands, extended range</td>
</tr>
<tr>
<td></td>
<td>- Energy efficient</td>
<td>- lower energy consumption</td>
</tr>
<tr>
<td></td>
<td>- Signally optimised</td>
<td>- Optimised signalling for large groups of sensors</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve Spectral Efficiency</td>
<td>New Waveforms for &lt;6GHz bands</td>
<td>802.11ax 10Gbps in 5GHz band</td>
</tr>
<tr>
<td></td>
<td>- Advanced Multi-carrier &amp; Non-orthogonal Tx</td>
<td>- Enhanced OFDMA to improve spectral efficiency</td>
</tr>
<tr>
<td></td>
<td>- Spectral efficiency, less signalling, spectrum sharing</td>
<td>- Higher order 1024 QAM modulation higher rates</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher Data Rates</td>
<td>Massive MIMO</td>
<td>802.11ax/ay</td>
</tr>
<tr>
<td></td>
<td>- Many antenna elements (&gt;16) in active array.</td>
<td>- Enhanced MIMO to 8x8 spatial streams</td>
</tr>
<tr>
<td></td>
<td>- Interference management and cancellation</td>
<td>- Beamforming enhancements</td>
</tr>
<tr>
<td></td>
<td>- Spectral efficiency, higher data rates (for low mobility)</td>
<td>- MU-MIMO enhancements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilise New Spectrum</td>
<td>Millimeter-Wave (mmW)</td>
<td>802.11ay 20-40 Gbps in 60GHz band</td>
</tr>
<tr>
<td></td>
<td>- 30-60 GHz bands for short range access</td>
<td>- Enhanced 802.11ad, channel bonding and MU-MIMO</td>
</tr>
<tr>
<td></td>
<td>- More capacity, higher data rates</td>
<td>- extended transmission distance of 300–500m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhance Location Services</td>
<td></td>
<td>802.11az Next Generation Positioning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- improve location accuracy (~3m) and scalability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- new usages such as directionality and ranging</td>
</tr>
</tbody>
</table>
HetNet: A matter of Economics and QoE!

<table>
<thead>
<tr>
<th>Layer</th>
<th>Cost to Serve</th>
<th>Voice (US$/min)</th>
<th>Data (US$/GB)</th>
<th>Relative (Data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3G Macro</td>
<td></td>
<td>0.04</td>
<td>1.3</td>
<td>100%</td>
</tr>
<tr>
<td>3G Macro</td>
<td></td>
<td>0.06</td>
<td>0.3</td>
<td>20%</td>
</tr>
<tr>
<td>Small Cell</td>
<td></td>
<td>0.04</td>
<td>0.7</td>
<td>54%</td>
</tr>
<tr>
<td>SP WiFi Indoor</td>
<td></td>
<td>0.003</td>
<td>0.09</td>
<td>7%</td>
</tr>
<tr>
<td>SP WiFi Outdoor</td>
<td></td>
<td>0.001</td>
<td>0.04</td>
<td>3%</td>
</tr>
<tr>
<td>WiFi Home</td>
<td></td>
<td>0.0004</td>
<td>0.015</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Cisco Study, 2017
- Developing APAC Market
- TCO with 5-Year Amortisation
Key Takeaways

1. The 5th era of Mobility is a business & technology convergence for 2020+
2. Traditional and new network requirements drive evolution from today
3. Network “Cloudification” with NFV/SDN/Orchestration is an architectural and operational change over time
4. Hybrid-Cloud Services (NaaS) are essential for new services like IoT
5. 5G era Access must be Heterogeneous (4G,5G,IoT,SP WiFi, WiFi)
   - 4G LTE and WiFi continue to carry lion’s share of traffic
Discussion
Service Provider Summit at Cisco Live!