#ONFConnect 2019 Presentation

The Impact of Open Source on Communication Service Provider Capital Spending

Chris DePuy
chris@650group.com
+1 650-600-7105
Addressable Market: What is CORD-related

• CORD = Central Office Re-architected as a Datacenter
  • Leverages SDN, NFV and Cloud
  • Integrates multiple open source projects to build agile datacenters for the network edge
  • The open source projects impact:
    • Broadband Access
    • Metro Ethernet
    • RAN
    • EPC (and other telecom core)
    • Optical Transport
    • SD-WAN
    • VPN
    • SP Router
    • CDN

Source: ONF, 2019
5-Year Revenues = $490B

- RAN is large, complex opportunity
- Broadband easier
- Operators move to open source on a project and technology basis over time
- Opex savings can be significant
- Service agility will be improved

*Excludes services, non-network systems
Addressable Market: Broadband and Core Are Easy Targets

<table>
<thead>
<tr>
<th>Product</th>
<th>Gross Margin</th>
<th>% TAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadband Access</td>
<td>30%</td>
<td>16%</td>
</tr>
<tr>
<td>Metro Ethernet</td>
<td>45%</td>
<td>2%</td>
</tr>
<tr>
<td>RAN</td>
<td>25%</td>
<td>37%</td>
</tr>
<tr>
<td>Telecom Core</td>
<td>60%</td>
<td>15%</td>
</tr>
<tr>
<td>Optical Transport</td>
<td>25%</td>
<td>15%</td>
</tr>
<tr>
<td>SP Router/SD-WAN/VPN/CDN</td>
<td>60%</td>
<td>15%</td>
</tr>
<tr>
<td>Summary</td>
<td>35%</td>
<td>100%</td>
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</tbody>
</table>

- Broadband and Core are large and have abundant merchant technology sources*
- Homogeneous networks save $$$
- In the cloud market, there was a 50% savings from merchant silicon

*non-systems suppliers of DSPs, radios, processors, optics, etc.
Adoption Trends: CSPs Can Leverage Hyperscaler Experience

- Hyperscalers made the transition
- Each has enough scale to make demands
- Common technology stack and 100’s of locations

- CSPs are making the transition
- Only together do CSPs have enough scale
- Billions of endpoints, 100’s K’s edge locations
- Trillions of services revenue
- Society is changing with 5G/IoT, improving lives
Adoption Trends: A 10 Year Journey...

Cloud hyperscalers

- Open source Adoption begin: 2005
- Introduced new suppliers: 2010
- White Box adoption: 2015

NFV (telecom core)

- ETSI MANO Whitepaper Trials: 2013
- Deployments begin: 2018
- “NFV” is at mass adoption: 2023

ONF CORD

- CORD introduced Trials: 2016
- Deployments begin: 2020
- “Open” is at mass adoption: 2025
Adoption Trends: NFV License/Session Shipments

- Industry contributing open source for NICs, security, virtualization, orchestration
- Control plane moves quickly to software/server environment
- Open source is causing a rapid adoption of NFV
Adoption Trends: Survey Results

Operators are confident that organization will mass-adopt open source deployments by 2023 = 85%

% of capex budget focused on open source for top ranked project = 10-15%

% of total capex budget focused on open source = 0-10%

capex project growth focused on open source in edge/access in next 2 years = 15%

*July/August 2019 survey of Tier 1 CSPs associated with ONF
Addressable Market: What’s Impacted by Open Source?

<table>
<thead>
<tr>
<th>Product</th>
<th>In 2023 – Associated with Open Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadband Access</td>
<td>62%</td>
</tr>
<tr>
<td>Metro Ethernet</td>
<td>60%</td>
</tr>
<tr>
<td>RAN</td>
<td>15%</td>
</tr>
<tr>
<td>Telecom Core</td>
<td>46%</td>
</tr>
<tr>
<td>Optical Transport</td>
<td>34%</td>
</tr>
<tr>
<td>SP Router/SD-WAN/VPN/CDN</td>
<td>46-52%</td>
</tr>
</tbody>
</table>

**Summary**

| Year 5 Revenues that are “open” | $36B |

- **2023...**
  37% of vendor revenues to CSPs will be impacted by open source technologies
Addressable Market: In First 5 Years, $73B Will be Impacted

• First mover technologies like Broadband Access will be nearly completed in the journey to open source in five years
• Inflection point of growth in complex systems like RAN will occur a few years later
Market Impact:
Summary

1. Open Source adoption in CSP networks depends on CSPs working together
2. CSPs have introduced new concepts to kickstart the Open Source movement
3. Incumbent vendors will resist and will co-opt these efforts
4. CSPs will experience capex savings... if the opportunity is big enough for new vendors to profit
5. 85% of CSPs are confident of move to open source in 5 years
About 650 Group
We started 650 Group to provide our subscribers and customers with a unique perspective on the industries we research. Our team has decades of experience researching our focus industries and in roles at companies similar to the ones we cover. We research the data center, communications and Information Technology markets.

• Founded in 2017 by Chris DePuy and Alan Weckel
• Headquartered in Silicon Valley
• Trusted source of research for system vendors, component manufacturers, service providers, sell-side, buy-side, and standards bodies
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  • 80 tables of data from cloud to telco to IT that sizes the market and identifies key vendors
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• Market intelligence reports
• Custom projects:
  • Market sizing
  • Product positioning
  • Due diligence
• Webinars
• Expert witness services
• Application Delivery Controller (ADC)
• Broadband Access
  • Fixed Wireless Access, Cable, Optical Access
• Cloud and Colocation Providers
  • Search/Social, Colo, IaaS/PaaS, SaaS, & CAPEX study
• Data Center Interconnect (DCI)
  • Ethernet DCI, Total DCI
• Ethernet Switching
  • Bundle
  • Total Market
  • Data Center, Enterprise, SMB, CE
• IOT
  • Installed Base, Connection Type
• Merchant Silicon in Data Center Switching
  • Switch Fabric ASICs
• NFV
• Optical Networking
  • Long Haul, Metro, DCI

• Mobile RAN
  • Baseband units, macro, small cell, 4G, 5G
  • CBRS
• Routers
• SD-Branch
• SD-WAN (Enterprise and Service Provider)
• Security
  • Appliance, Virtual, Enhanced NAC
• Servers
  • Smart NICs
• Storage
• Telecom Core
  • EPC/5GC, IMS, SBC, OSS, BSS & NFV (MANO)
• Unified Access
  • Cloud Services & Software
  • WLAN + Campus Switching & MultiGig
• WLAN
  • Enterprise, Outdoor, Consumer (incl Mesh)
• WLAN Semiconductors
  • Consumer networks, enterprise networks
Addressable Market: Our methodology

- Have been researching > 20 yrs
- Interview system vendors quarterly
- Interviewed Top CSPs from around the world
- Includes feedback from traditional equipment companies, startups, operators and open source community

Source: ONF, 2019