The Outlook for Open and Disaggregated Packet and Optical Networks

January 26, 2021

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Today’s Agenda

10 Min Introduction and Project Highlights
   • Sterling Perrin, Senior Principal Analyst, Heavy Reading

10 Min Operator Keynote: Transport Strategy: Transport and IP Disaggregation
   • Rafael Canto Palancar, Transport & IP Network Manager, Telefonica

10 Min Operator Keynote: Towards Open and Disaggregated Transport Networks
   • Lloyd Mphahlele, General Manager, Group Technology MTN

45 Min Moderated Panel Discussion
   • Tim Doiron, Senior Director, Solution Marketing, Infinera
   • Hugh Kelly, Vice President, Marketing, Volta
   • Diego Mari Moretón, Connectivity Technologies & Ecosystems Manager, Facebook
   • Shaji Nathan, Chief Product Officer, IP Infusion

15 Min Audience Q&A
About the Market Leader Project

Focus: open and disaggregated transport networks roughly mapping to TIP OOPT scope of work

Global operator survey conducted December 2020
- 82 respondents

90-minute symposium webinar

Survey results white paper: to be published soon

Two analyst blogs
Survey Demographics

By Region

North America 56%
EMEA 21%
Asia/Pacific 11%
CALA 12%

By Revenue

More than $5 billion 44%
$1 billion to $5 billion 13%
$500 million to $999 million 15%
$200 million to $499 million 4%
Less than $50 million 13%
$50 million to $199 million 11%

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Survey Demographics (continued)

By Operator Type

- Converged operator (fixed and mobile assets): 44%
- Mobile operator: 27%
- Fixed-line telecom operator: 13%
- Cable operator: 9%
- OTT service provider: 5%
- MVNO, MVNE with infrastructure: 2%

By Job Function

- Network planning: 38%
- Engineering: 32%
- Corporate management: 9%
- Operations/services: 9%
- Sales & marketing: 4%
- Other: 4%
- Consulting: 2%
- Operations/transmission: 2%
- Customer support: 1%

100% involved in network planning and/or purchasing

N=82

Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Disaggregated Networks Deployments Phase

Q3. Which statement best describes your organization’s current phase of deploying disaggregated networking solutions?

- Not surprisingly, operators are fairly early in the process:
  - 55% currently in early stages of pre-PoC and PoC
  - 45% in more advanced stages of trial and deployment
- North American phases far more advanced vs. ROW
- Survey self-selection suggests respondents skew more aggressive than greater population of operators

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Operator Deployment Timelines

What is your organization’s expected timeline for deployment disaggregation in the following segments?

- Plans most aggressive for data center networks, core routers, CPE
- North American timelines far more advanced vs. ROW countries
- Interest in DCSG is high, but deployment timeline lags other segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>2020/Already deployed</th>
<th>2021</th>
<th>2022</th>
<th>2023+</th>
<th>Unknown/No plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data center networks</td>
<td>34%</td>
<td>27%</td>
<td>17%</td>
<td>13%</td>
<td>9%</td>
</tr>
<tr>
<td>Core routers</td>
<td>32%</td>
<td>27%</td>
<td>9%</td>
<td>18%</td>
<td>15%</td>
</tr>
<tr>
<td>CPE</td>
<td>29%</td>
<td>28%</td>
<td>18%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Provider edge routers</td>
<td>24%</td>
<td>29%</td>
<td>15%</td>
<td>21%</td>
<td>11%</td>
</tr>
<tr>
<td>Optical line systems</td>
<td>23%</td>
<td>21%</td>
<td>18%</td>
<td>17%</td>
<td>21%</td>
</tr>
<tr>
<td>PON/FTTX</td>
<td>23%</td>
<td>24%</td>
<td>23%</td>
<td>13%</td>
<td>16%</td>
</tr>
<tr>
<td>Optical transponders/muxponders</td>
<td>21%</td>
<td>17%</td>
<td>32%</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>Disaggregated cell site gateway</td>
<td>20%</td>
<td>26%</td>
<td>20%</td>
<td>20%</td>
<td>16%</td>
</tr>
</tbody>
</table>

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
What Is Driving Disaggregation?

What are the top factors motivating your organization to adopt disaggregated networking solutions?

- Innovation and flexibility top driving factors
- New services/revenue and lowering capex form second tier of important drivers

- Faster innovation/flexibility in adopting latest technology (51%)
- Launch new services/increase revenue (39%)
- Reduce capex (38%)
- Break single vendor lock-in/Apility to choose from best-in-class suppliers/elements (32%)
- Increase network capacity (30%)
- Increase network reliability (30%)
- Add network programmability/automation (28%)
- Reduce opex (27%)
- Protect network infrastructure (24%)

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
What Challenges Stand in the Way?

What are the biggest challenges to adopting/deploying open disaggregated networking technologies in your organization?

• Dual challenges consistently rise to the top:
  – Technology maturity and feature parity with traditional elements
  – Operational challenges of dealing with disaggregated networks

• Encouragingly, costs are not standing in the way

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>The technology maturity level and available features</td>
<td>61%</td>
</tr>
<tr>
<td>Internal processes and lack of operational models to deal with this type of solutions (e.g. procuring components from different suppliers)</td>
<td>50%</td>
</tr>
<tr>
<td>Security concerns</td>
<td>46%</td>
</tr>
<tr>
<td>Problem resolution and root cause analysis when several providers are involved (no single “throat to choke”)</td>
<td>40%</td>
</tr>
<tr>
<td>Quality and reliability concerns</td>
<td>37%</td>
</tr>
<tr>
<td>Total cost is too high/not compelling (including capex and opex)</td>
<td>29%</td>
</tr>
</tbody>
</table>

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Transport Strategy
IP & Optical Disaggregation

Rafael Cantó Palancar
Telefonica CTIO Office

The Outlook for Open and Disaggregated Packet and Optical Networks
26.01.2021
Telefónica Transport Network Strategy

SDN brings intelligence to IP and Optical network. Traffic Engineering is simplified. Basic for automation, disaggregation and slicing.

TECHNOLOGY EVOLUTION

2019: Transformation of IP and optical networks completed with a multiservice multilayer flattened network approach, providing support for 5G & FTTH.

First trials and deployments of both IP and optical disaggregation.

Open Transport
Open Transport

Software Defined Networking

Disaggregation
Why are we deploying SDN?

- Consolidate OSS integration with a **single northbound interface per technology**.
- **Decouple** technology **evolution** in OSS and Network.
- Enable **traffic engineering** and **automatic service provisioning**.
- Facilitate **migrations** and **operational** processes.
- SDN enables adopting **new suppliers** as the device have the same interface.
- Generation of **free demand** in RFQs.
- Control mechanisms to allocate the required **network resources per slice** and assure performance and quality.
How can we achieve SDN deployment?

- Functional Architecture
  - Standard agreed NBI and SBI

- Use Case Oriented

- Reference Model

- Standards Based

- Network Abstraction Model

- Step by step
  - Provide value

- E2E network view
  - Minimize entrance barriers

- Industrial alliances
  - Follow mature standards

- Network Operators
  - Suppliers
  - Collaboration Fora
Open Transport

Software Defined Networking

Disaggregation
Why moving to disaggregated solutions?

Efficiency

Differentiation

Innovation

Stronger ecosystem
Open Fusion: Disaggregating transport networks

**IP NETWORK**

- Merchant-silicon vs ASICS. Ex. Cisco over Broadcom
  - Core backbone (International Network)
  - Cache aggregation (Latam)
  - Service platforms...

**PARTIAL OPTICAL DISAGGREGATION**

Within TIP and ONF, Telefonica is collaborating in operator-led initiatives to create **open disaggregated optical equipment**, open and common standards, and open-source software.

**Open White-box**

- Network OS
- Bare-Metal

Mature industrial solutions may cover **Cell Site Router** (HL5) demand. First commercial deployments. High volume

Focus on Partial optical disaggregation (**transponder-OLS**), currently applied in our procurement processes, and covers certain share of the demand. This option leverages on SDN capabilities for scale.
Open FUSION is transforming Telefonica’s IP networks

Complexity and Volume considerations

HL1: Interconnection Routers ~10 nodes

HL2: P Routers ~20 nodes

HL3: Caches connec. ~100 nodes
PE Platforms ~200 nodes

HL4: IP Edge (BPE, BRAS) ~1K nodes

HL5: Cell Site Gateway ~10K nodes

Short term focus
Our journey to disaggregation

- Certification of grey-boxes: 2017
- Advanced Switching RFI: Mid 2017
- Deployment of grey-boxes: H2 2017
- Telefonica joins TIP OOPT: Mid 2018
- First RFx with white-boxes: End 2018 Beg. 2019
- Production deployments: 2019
- Other OPEN projects
- OpenBNG HL-4 initiative
- Tests and more RFx
- Contrib. back to TIP DCSG
- Germany HL5
Telefónica collaboration in disaggregated initiatives

Leveraging when possible shared work with other Operators to build momentum

**Disaggregated Cell Site Router**
- **Launch Oct 2018.** Telefónica, Vodafone and TIM Brasil led the spec definition.
- **Production.** Telefónica deployed DCSG in 2020 in Ecuador, Peru and Germany.

**Open BNG**
- Coordinated Open Community started by BT, DT, Telefónica, and Vodafone
- High Level **Specs released Oct 2020** in TIP

**Cassini**
- **Launch 2017.** Project launched within TIP.
- **Field trial.** Telefónica tested Cassini in 2019 in Peru.

**Phoenix**
- **Launch March 2020.** Telefónica, Telia, NTT, MTN, DT and Vodafone led the spec definition.
- **Testing.** Products are ready validation will start in Q1 2021.
Wrap Up
Wrap Up

- Telefónica already using disaggregation both in optical and IP
  - IP Disaggregation initial focus in low hierarchy routers (HL 5 - DCSG) to be extended to HL4 – OpenBNG in 2022
  - Optical (partial) Disaggregation through the use third party transponders (e.g. Phoenix). More complex disaggregation models under evaluation
- SDN as key enabler of transport automation and disaggregation
  - Use case progressive approach is demonstrating to be the right approach. MUST initiative in TIP extends this methodology to the Industry
- Collaborative, agreed, common requirements will be key to build attractive and healthy ecosystems around open disaggregated networks in the long term
Towards Open and Disaggregated Transport Networks

Lloyd Mphahlele,
General Manager, Group Technology, MTN
Open Disaggregated Technology At MTN

LEARNSINGS
- Multivendor RAN interoperability
- 5G RAN ready
- Remove Vendor lock-in
- Interoperability with other leading IP Core Providers
- Roadmap to Network Automation

BENEFITS
- Increased technology options to meet MTN network of the future needs
- Meets MTN network agility needs as a connectivity provider in the region
- Align to MTN strategic objectives

CHALLENGES
- Operator management systems readiness for open API’s

“First African operator to demonstrate 5G RAN vendor interoperability on open, disaggregated technology (DCSG)”
The Transport CASSI Framework to Drive Value

ENABLING GROWTH

CONVERGED & CONGESTION Free to enable growth

ALWAYS On to protect revenues

TCO EFFICIENCY

SCALABLE to drive TCO Efficiency

SIMPLIFIED to drive TCO Efficiency

INTELLIGENT to enable automation
The Transport CASSI Framework To Drive Value

**THE CASSI FRAMEWORK**

- **C**: Converged & Congestion Free
- **A**: Always On
- **S**: Scalable
- **S**: Simplified
- **I**: Intelligent

**VALUE ALIGNMENT**

- Open IP-Optical convergence to increase MTN network capacity
- Open API’s seamlessly stitch and converge transport network domains
- Convergence of web scale technology to meet increase in service needs
- High-capacity capability enabling network agility

- Always on provides strong resilience and high network availability
- Innovation to realize true open network automation
- Evolving legacy transport domains into software define and controlled architectures

- Realizing scale through best of breed technology vendor ecosystem, increased competition, driving lower cost
- Operator led design of purpose fit transport network solutions

- Open and disaggregated network architectures to ease integration and lower network OpEx cost
- Future proof network investments

- Software defined automation, reducing services lead times
- Visualization & forecast with SDN
MTN Collaboration in Disaggregated Initiatives

Disaggregated Cell Site Gateways (DCSG)
Open and disaggregated vendor neutral cell site gateway with high capacity chipsets to future proof capital investment and standard based API to ease network integration and optimize operational expenditure

Phoenix
An open neutral L0/L1 transponder that MTN can deploy on top/together with their existing line systems to increase the capacity of their optical networks. It is based on disaggregated components (HW and SW) with 200/400G line interfaces

Disaggregated Open Routers (DOR)
To build open and disaggregated core routers that MTN can deploy in their current IP/MPLS networks to future proof 5G investments

Wireless Backhaul
A wireless backhaul transport solution, adopting the principles of an open and disaggregated architecture to optimize network efficiencies, speed up service deployment and ease integration

<table>
<thead>
<tr>
<th>TODAY</th>
<th>NEXT</th>
</tr>
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<tbody>
<tr>
<td>Lab Trial Complete</td>
<td>Scale Field trial (Q1 2021)</td>
</tr>
<tr>
<td>Operator Specification Released</td>
<td>Prototyping (Q1 2021)</td>
</tr>
<tr>
<td>Requirements published</td>
<td>RFI/Prototyping (Q1 2021)</td>
</tr>
<tr>
<td>Prototyping</td>
<td>Lab trial (Q2 2021)</td>
</tr>
</tbody>
</table>
What's Next

• Open and disaggregation Cell site gateway deployment at scale
• 5G acceleration with open and disaggregation technologies
• Finalize MUST use cases for adoption
• Expand and incubate ecosystem for DOR and Phoenix
• Roadmap to Network Automation
Together We Build

We are good together
Panelists

Tim Doiron
Senior Director, Solution Marketing, Infinera

Hugh Kelly
Vice President, Marketing, Volta

Diego Mari Moretón
Connectivity Technologies & Ecosystems Manager, Facebook

Shaji Nathan
Chief Product Officer, IP Infusion
Motivations

• How specifically will open and disaggregated networks:
  – Drive faster innovation?
  – Deliver new revenue streams for operators?

• Examples?
Inhibitors

• Survey shows dual challenges stand in the way of progress on disaggregation:
  – Technology maturity and feature parity with traditional elements
  – Operator ability to operationalize disparate vendors and technologies

• How does the industry address these two challenges?

• Examples?
## Disaggregated Networking: Customer Deployments

<table>
<thead>
<tr>
<th>CSR Customer in Taiwan</th>
<th>Disaggregated Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nation-wide operator with close to 2M subscribers for 3G/4G and 5G</td>
<td>• OcNOS software, Ufispace S9500-30XS (QAX), support services for access and aggregation</td>
</tr>
<tr>
<td>• Close to 3000 network devices in upgrade/expansion plan</td>
<td>• MPLS, L2,L3VPN, 1588v2, SyncE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CSR Customer in Brazil</th>
<th>Disaggregated Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Subsidiary of Direct TV</td>
<td>• OcNOS software, Dell Qumran 4248-FBL</td>
</tr>
<tr>
<td>• Connecting 11x different sites with more than 40 nodes in deployment</td>
<td>• Metro ring for fixed and mobile wireless</td>
</tr>
<tr>
<td></td>
<td>• MPLS FRR, VPWS, CFM, Y.1731</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Packet Optical Customer in Chile</th>
<th>Disaggregated Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Multi-city ISP (internet, voice, IPTV)</td>
<td>• OcNOS software, Cassini OOPT Edgecore</td>
</tr>
<tr>
<td>• Close to 50 Cassini systems, plus another 50 AS5912-54x (Qumran MX)</td>
<td>• Cassini for spine and inter-connect</td>
</tr>
<tr>
<td></td>
<td>• VXLAN, Multicast</td>
</tr>
</tbody>
</table>
Industry Collaboration and Ecosystems

• What is the role of TIP in building open and disaggregated networks?
• What other groups are most significant for packet and optical networks?
Value of TIP: A Service Provider Perspective

Q: What do you see as the most important help/benefits that TIP can bring to service providers interested in open and disaggregated networks?

“accelerate the development and deployment of open, disaggregated, solutions”

“Interoperability and flexibility in the context of a multivendor, open ecosystem”

“A new approach to building and deploying telecom network infrastructure”

“Scalability and improved delivery timelines”

“Shared Knowledge”

Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Disaggregated Cell Site Gateway

• Disaggregated cell site gateway is gaining traction with operators:
  – What is the value proposition of disaggregating this element?

• What are the critical features for DCSG?
Open Optical Networks

• What is the winning disaggregated architecture for optical networks?
  – Horizontal disaggregation?
  – Vertical disaggregation?

• Are pluggable modules set to supplant embedded optics at 400G?
Benefits of Open Optical Networks

What are the biggest benefits of deploying a multi-vendor open optical networking solution?

- Eliminate vendor lock-in: 65%
- Lower capex: 61%
- Faster innovation cycle with independent transponder/optical-engine evolution: 54%
- Lower opex: 41%
- Lower the barrier to entry to for “specialty” entrants: 21%

Cost plays rate highly for open optics

N=82
Source: Heavy Reading Open and Disaggregated Networks Survey, 2020
Key Attributes for Open Optical Networking Solutions

**TRADITIONAL CLOSED SOLUTIONS**

**SINGLE-VENDOR NETWORKING SOLUTIONS**

XPONDERS

OPTICAL LAYER

(ROADMs, Amplifiers, Filters)

**PROPRIETARY PLATFORMS & INTERFACES**

OTN

PACKET OPTICAL

OLS

**OPEN OPTICAL SOLUTIONS**

**SEPARATION OF TRANSPONDER & OPTICAL LAYER**

1. FUNCTIONALLY ENABLE MULTI-VENDOR NETWORKS

XPONDERS

OPTICAL LAYER

(ROADMs, Amplifiers, Filters)

**STANDARD OPEN APIs & STANDARD DATA MODELS**

2. OPERATIONALLY ENABLE MULTI-VENDOR NETWORKS

NETCONF, RESTCONF, Streaming Telemetry

YANG BASED

(OpenConfig, Open ROADM)

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Questions and Answers