UNLEASH THE POWER OF LIMITLESS CONNECTIVITY
Converged Networks and Mobility

How vCMTS Paves the Way for 5G over DOCSIS

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A Premise

Everything that *CAN* be implemented in software

*SHOULD* be implemented in software
A Premise

Everything that **CAN** be implemented in software **SHOULD** be implemented in software

<table>
<thead>
<tr>
<th>SHOULD</th>
<th>CAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero hardware NRE or development time</td>
<td>Power is acceptable</td>
</tr>
<tr>
<td>Develop on any server or cloud</td>
<td>Footprint is reasonable</td>
</tr>
<tr>
<td>Use readily available building blocks</td>
<td>Throughput is adequate</td>
</tr>
<tr>
<td>Faster time to market</td>
<td>Latency is sufficiently low</td>
</tr>
<tr>
<td>More easily modified</td>
<td>TCO is comparable (see footprint)</td>
</tr>
<tr>
<td>Scalable and portable</td>
<td></td>
</tr>
</tbody>
</table>
What is vCMTS?

<table>
<thead>
<tr>
<th>vCMTS Application</th>
<th>DPDK or FD.io/VPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPDK</td>
<td>Telemetry: Collectd, Prometheus, Grafana</td>
</tr>
<tr>
<td>Containerd</td>
<td>Kubernetes</td>
</tr>
<tr>
<td>Ubuntu or CentOS</td>
<td>Topology Mgr, CPU Mgr, Multus, CNI (SR-IOV) Plugin, QAT Plugin</td>
</tr>
</tbody>
</table>

- DOCSIS MAC, Control Plane, Scheduler runs on software
- [PHY moves to Node or to shelf]
- Cloud native software stack built on readily available high speed packet processing libraries and components
- Cloud-native automation, scalability, flexibility and observability
How vCMTS Paves the Way for 5G over DOCSIS

What is vRAN?

- RAN baseband processing - upper PHY, MAC, Control Plane, Scheduler runs in software
- Lower PHY runs on FPGA or eASIC
- Forward Error Correction runs on accelerator
- Cloud native software stack built on readily available high speed packet processing libraries and components
- Cloud-native automation, scalability, flexibility and observability
How vCMTS Paves the Way for 5G over DOCSIS

What is 5G [Xhaul] over DOCSIS?

5G RAN Split Options

<table>
<thead>
<tr>
<th>Split 2</th>
<th>Split 7-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer 3</td>
<td>Layer 2</td>
</tr>
<tr>
<td>Layer 2 (PDCP)</td>
<td>Layer 1 PHY (High)</td>
</tr>
<tr>
<td>Midhaul</td>
<td>Fronthaul</td>
</tr>
<tr>
<td>Layer 2</td>
<td>Layer 1 PHY (High and Low)</td>
</tr>
<tr>
<td>Layer 1 PHY (High and Low)</td>
<td>Layer 1 PHY (Low)</td>
</tr>
</tbody>
</table>

- Lower Pooling Benefits
- Lower Bandwidth
- Less Constringent Latency

- Integrated (no split)

- Higher Pooling Benefits
- Higher Bandwidth
- More Constringent Latency
Can DOCSIS Run In Software?...YES!

**Purpose Built CMTS**

14 RU footprint, 9 kW, 100 Gbps

**vCMTS on Standard High-Volume Servers**

2 RU footprint, 2 kW, 200 Gbps

- Realize Space and Power Savings in the HeadEnd
- Dynamically Scale Solution for Network Needs
- Automate with Intelligent Orchestration and Advanced Telemetry

**Numbers are approximate based on an amalgam of data points.**

*Remote PHY Shelf (if used) adds additional rack space and power. Not including redundancy.*

HW = Hardware, RU = Rack Unit, Gbps = Gigabits per second, kW = kilowatt

For workloads and configurations visit [www.Intel.com/PerformanceIndex](http://www.Intel.com/PerformanceIndex). Results may vary. Results have been estimated or simulated.
**Can RAN Run In Software?...YES!**

**Global vRAN Momentum**
- Verizon First Fully Virtualized 5G Data Session
- Rakuten 5G MidBand Rollout begins
- Dish’s 5G buildout of first virtualized ORAN
- Telefónica and STC partner with Rakuten Mobile to deploy open RAN
- DT, VMWare and Intel collaborate on Open and intelligent VRAN

**vRAN Announcements**
- Samsung leading with vRAN, Announces VRAN Portfolio
- Ericsson announces Cloud RAN portfolio for increased network flexibility
- Nokia commercializes next-generation 5G Cloud RAN
- Intel and VMware partner on 5G vRAN, open interfaces, RIC
- Amdocs SmartRAN optimization solution integrated w Intel’s FlexRAN

**vRAN Momentum: By The Numbers**
- 2 Commercial 5G vRAN deployments
- 10+ More commercial launches planned for ‘21
- 25+ Ongoing operator trials
- 107 FlexRAN license holders

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Can DOCSIS Support 5G xHaul?...Not Without Modification!

- **5G Fronthaul ~100 usec**
- **5G Midhaul ~5 msec**
- **5G Backhaul 100+ msec**

Source – Intel rough averages based on various data points

AQM – Active Queue Management
PSG – Predictive Service Grants
LLD – Low Latency DOCSIS
LLX – Low Latency Xhaul
Innovation for 5G xHaul...requires DOCSIS, RAN Updates

vCMTS and vRAN More Easily Updated (vs. purpose built)

<table>
<thead>
<tr>
<th>Item</th>
<th>Innovations</th>
<th>CMTS Mods Needed?</th>
<th>RAN Mods Needed?</th>
</tr>
</thead>
</table>
| Low Latency DOCSIS (LLD) | • Separate ‘queue building’ and ‘non queue building traffic  
                          • Reduce grant/request cycle time  
                          • Introduce proactive grants (PGS) | YES               | NO               |
| Low Latency Xhaul (LLX) | • Bandwidth reporting (BWR)  
                          • Grant sharing | YES               | YES              |
| Future Innovation     | • How meet 5G Fronthaul requirements?  
                          • How reduce wasted grants further with AI? | LIKELY            | LIKELY           |
Where will vCMTS and vRAN Need to Run?...

Doesn’t Matter – Software Can be Scaled Down as Needed
So how **DOES** vCMTS Pave the Way for 5G over DOCSIS?

Current and Future Innovation to address 5G latency requirements as well as RAN and DOCSIS spectral efficiency algorithms easier to implement in software

As 5G deployments scenarios evolve, software based vCMTS [and vRAN] can be scaled and deployed from headend to node to...wherever needed

vCMTS provide benefits of modern telemetry, orchestration and management for enabling AI based optimization models and AI driven services
Thank You!

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