OPEN SOURCE NETWORK DAYS
BAY AREA – FALL 2018

PERFECT STORM FOR SOFTWARE RELIABILITY

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Vice President, SDN Platform & Systems Development, AT&T
Software Defined Everything & Revolution

A World Is Colliding & Converging

Chips, Sensors, Quantum Computing, Fiber, Spectrum, Towers, Small cells, 4G/5G Technology Advancements

Explosive Network Traffic, Video (4K/8K), VR/AR Apps

Software Super Powered by Cloud, Open Source, SDN/VNF, AI/ML & Deep Learning

Business & Operation Automation

New Use Cases and Ideas about Consumer and Enterprise
No signs of slowing

360,000%

Data traffic growth on AT&T’s mobile network since 2007
SOFTWARE-DRIVEN WIRELESS TECHNOLOGY EVOLUTION

THE FUTURE IS SOFTWARE-DRIVEN RADIO

TODAY

- Carrier Aggregation
- 4X4 MIMO
- 256 QAM
- C-RAN
- SDN
- UHF Spectrum

FUTURE

- Millimeter Wave
- SDR-based Cells
- Neural Networks
- Massive MIMO
- Network Slicing
- Full Duplex
- Beamforming/Beam Steering

THE FUTURE IS SOFTWARE-DRIVEN RADIO
Emerging Technologies are demanding lower latency and accelerated processing at the edge

<table>
<thead>
<tr>
<th>NFV Edge Infrastructure</th>
<th>Wireless (vRAN, vEPC..)</th>
<th>Wireline (PON, ..)</th>
<th>uCPE (SD-WAN..)</th>
<th>IP Enterprise services</th>
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</thead>
<tbody>
<tr>
<td>Autonomous Devices</td>
<td>Drones</td>
<td>Autonomous vehicles</td>
<td>Industry Robots</td>
<td>Medical</td>
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<tr>
<td>Immersive Experiences</td>
<td>Virtual Reality</td>
<td>Augmented Reality</td>
<td>360 Video</td>
<td>Wearable Cognitive Assistance</td>
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<tr>
<td>IOT &amp; Analytics</td>
<td>Industrial Sensors</td>
<td>Home Devices</td>
<td>Retail</td>
<td>Healthcare</td>
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Emerging Technology Enablers:
- On-demand NFV
- Hardware Acceleration
- A.I.
- Microservices
- 5G
Operator’s owned Network Edge are optimal zone for edge placement

<table>
<thead>
<tr>
<th>Millions</th>
<th>Thousands</th>
<th>Tens</th>
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<tbody>
<tr>
<td>Customer Devices</td>
<td>Customer Premises</td>
<td>Access Methods</td>
</tr>
<tr>
<td>Mobile</td>
<td>Home</td>
<td>5G</td>
</tr>
<tr>
<td>AR/VR</td>
<td>Smart Cities</td>
<td>LTE</td>
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</tbody>
</table>
| end user | Small Enterprises | WiFi | Other Telco real estates (wire centers…)
| drones | Stadiums | Wireline | |
| Autonomous Vehicles | Enterprises | |
| Enterprises | Public buildings | |

Device* ~2 ms
Last mile network* <5 ms
Access* 1-3 ms
Edge computing ~5-20 ms
Backbone ~2-100
Non-accelerated processing ~5-50 ms

Edge Placement
Burst Capacity
Optimal Edge Zone
Not Optimal

Telco Operated

* Estimates
### Perfect Storm for Software Reliability

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<td>Application of Agile Methodology</td>
<td>Self resiliency and self traceability/diagnosis</td>
<td>Model Driven Design &amp; Ecosystem Data Quality</td>
<td>VNF/PNF Integration &amp; ETE Automation</td>
<td>Stream Analytics (Latency)</td>
<td>5G Revolution</td>
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*PERFECT STORM FOR SOFTWARE RELIABILITY CHALLENGES & OPPORTUNITIES*