From virtualization, thru’ multi-vendor sharing to 5G RAN modularization

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Radio Network Evolution

Hyper Dense Outdoor Network
- Coverage and capacity for enhanced mobile broadband
- Higher frequencies, larger bandwidths
- Smaller cell sites (100s per km²)
- Integrated fronthaul transport

Sliced, Virtualized, Orchestrated and Automated

Digitized Enterprise
- Supporting enterprise vertical value chains
- Edge compute with API based value exposure
- Multi-operator/Neutral host
- As-a-service consumption
Indoor and Densification Challenges – the rise in Network Sharing

- Widespread network sharing (both passive and active) - 40%
- Each operator owns and operates its own network - 40%
- Hybrid network models (e.g., public funding for rural) - 11%
- Single/Dual wholesale shared networks per country - 3%
- Single shared network per city region - 3%
- Others - 3%

Source: GSMA Survey of 750 Operator CEOs (2017)
Question on 5G Industry Structure and Infrastructure Ownership
How Best to Share the RAN?
If the RAN splits, then we need to be able to share the PNF
Neutral Host – driving architectural convergence and Multi-Vendor support

- CARRIER #1 MANAGEMENT PLATFORM
- NEUTRAL HOST MANAGEMENT PLATFORM
- CARRIER #2 MANAGEMENT PLATFORM
- CARRIER #2 ACCESS FUNCTIONS
- CARRIER #1 ACCESS FUNCTIONS
- NEUTRAL HOST ACCESS TECHNOLOGY

- 5G/3GPP gNB-DU-to-OAM
- LTE/SCF P9 PNF OAM
- Multi-Vendor
- 5G/3GPP F1
- LTE/SCF nFAPI
nFAPI Multi-Vendor Specifications: SCF082 & SCF167 available from scf.io

- SCF082: “nFAPI” open and extensible interface between VNF and PNF for multi-vendor interoperability and multi-operator use cases

- SCF167: An open and extensible TR-069 based PNF management, enabling a neutral host to manage the PNF and partition/slice resources between multiple operators
### Splits, CoMP and Transport Latency

<table>
<thead>
<tr>
<th>Advanced RF Combining Capability</th>
<th>PDCP/RLC</th>
<th>Split MAC</th>
<th>MAC/PHY</th>
<th>Split PHY</th>
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</thead>
<tbody>
<tr>
<td>1 Carrier Aggregation</td>
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<tr>
<td>2 Cross Carrier Scheduling</td>
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<td>3 High Order MIMO</td>
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<td>4 Down Link Joint Processing – Joint Transmission (JT)</td>
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<tr>
<td>5 Up Link Joint Reception (JR) independent PHY decoding</td>
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<td>6 Up Link Joint Reception (JR) joint equalization PHY decoding</td>
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<tr>
<td>7 Join Processing – Dynamic Point Selection (DPS)</td>
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<tr>
<td>8 Coordinated Scheduling/Beamforming (CS/CB) UL and DL</td>
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Source: Small Cell Forum SCF106

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Thinking differently about multi-vendor RANs: How can open source complement standardization to improve market adoption?

nFAPI encode/decode libraries and Wireshark dissectors compliant to the latest SCF082 specification
Apache-2.0 License
nFAPI Timeline

- **JUN 2014**: SCF Operators Initiate Virtualization Study
- **AUG 2015**: nFAPI definition program commences
- **FEB 2017**: Open-nFAPI public repository
- **JUN 2015**: Virtualization Study Complete
- **NOV 2016**: SCF Virtualization Release, including nFAPI SPoC
- **NOV 2017**: Initial integration of Open-nFAPI into OAI
Moving from open source libraries to Multi-Vendor Implementation
Summary

• 5G needs to focus on lowering the barriers for deploying active sharing in order to support multi-operator deployments
• Issue of multi-vendor interoperability of internal RAN interfaces needs to be addressed
• Open source complements the standardization of RAN splits to enable improved multi-vendor interoperability
• Lessons learned with LTE/nFAPI can then be applied to 5G/F1 and other multi-vendor splits
A KEY Virtualization Question: How best to Split? A real engineering compromise!

- SCF concluded that MAC/PHY split delivers key benefits of centralization, enables 75% of possible CoMP techniques to be re-used, without any requirements to increase transport bandwidths.

- Autonomous Hybrid ARQ processing needed to increase the fronthaul latency budget up to 6ms, BUT there are consequential impacts on the peak single UE throughput.

- The MAC/PHY split is based on the established and successful multi-vendor FAPI platform decomposition.