Expected Performance Benefits from Cloud RAN

Fronthaul & CRAN 2014
October 29, 2014
Aggregating baseband improves implementation of CoMP that enhances network performance
Baseband Virtualization

- Migration to new technology
- Base station consolidation
- Applications at the edge

Decouple software from hardware
Benefits of Cloud RAN

**Pros**
- Reduced cost
  - Operations & management
  - Energy savings (primarily HVAC)
  - Leasehold expenses
- Improved performance
  - Higher utilization of baseband resources
  - Lower interference
  - Higher capacity
- Simplified maintenance & upgradeability processes

**Cons**
- Fiber availability & cost
Cloud RAN Deployment Scenarios

Scenario 1
Homogeneous network with intra-site CoMP

Scenario 2
Homogeneous network with inter-site CoMP

Scenario 3
Heterogeneous network with low power RRHs within the macrocell coverage
Coordinated Multipoint (CoMP)

- Communication between mobile device and multiple geographically distributed base station antennas

- Benefits
  - Improves cell edge performance
  - Improves average cell performance
  - Complementary to MIMO
    - Network MIMO

- Requirements
  - Fast connectivity between base stations (X2): low latency & jitter

Joint transmission: DL/UL cooperative MIMO; Joint processing of received signals

Coordinated Multiple Point Transmission and Reception (CoMP)
### DL CoMP Performance in Macro Cells (FDD)

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1 (1 cell cluster)</th>
<th>Scenario 2 (9 cell cluster)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X-Pol</td>
<td>ULA</td>
</tr>
<tr>
<td><strong>Downlink</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CS/CB, SU MIMO</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2x2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Average</td>
<td>3.67%</td>
<td>5.15%</td>
</tr>
<tr>
<td>Cell Edge</td>
<td>9.63%</td>
<td>11.64%</td>
</tr>
<tr>
<td><strong>Downlink</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>JT, MU MIMO 2x2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cell Average</td>
<td>2.68%</td>
<td>12.68%</td>
</tr>
<tr>
<td>Cell Edge</td>
<td>26.13%</td>
<td>36.68%</td>
</tr>
<tr>
<td><strong>Uplink</strong></td>
<td></td>
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<tr>
<td><strong>JR, SU MIMO 1x2</strong></td>
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</tr>
<tr>
<td>Cell Average</td>
<td>22.25%</td>
<td>12.15%</td>
</tr>
<tr>
<td>Cell Edge</td>
<td>41.19%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Note: Results are averages of simulations
ULA: Uniform linear array
X-Pol: Cross polarized antenna
For more data, see 3GPP TR 36.819
## DL CoMP Performance (FDD) – HetNets (Scenario 3)

<table>
<thead>
<tr>
<th></th>
<th>CS/CB with eICIC</th>
<th>JP with eICIC</th>
<th>CS/CB without eICIC</th>
<th>JP without eICIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Downlink</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro cell area average</td>
<td>2.70%</td>
<td>3.30%</td>
<td>5.1%</td>
<td>3.0%</td>
</tr>
<tr>
<td>5% Worst user</td>
<td>19.70%</td>
<td>52.80%</td>
<td>24.8%</td>
<td>24.1%</td>
</tr>
<tr>
<td><strong>Uplink</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JR, SU MIMO 1x2</td>
<td>Macro cell area average</td>
<td>13.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5% Worst user</td>
<td>39.70%</td>
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</tbody>
</table>

Note: Results are averages of simulations
For more data, see 3GPP TR 36.819
CoMP Takeaways

- Greater benefits in HetNet scenario than macro cell deployment
- Higher gain for cell edge user in comparison to cell-center users
- Easier to implement in uplink than downlink
- Higher gain possible in TDD than FDD networks
  - More sophisticated processing techniques possible in TDD

Performance improvement in CRAN will depend on network topology and operating mode
Case Study: Business Case for Asian Operator

› Macro cell deployment
   – 3 sectored cell sites

› Dark fiber is available to cell sites
   – PTP star topology from fiber center; 50 sites per center

› TDD LTE (Config 1); 20 MHz channel; 4:1 DL/UL traffic ratio
   – 104 Mbps peak capacity; 27 Mbps average capacity

› CoMP gain: 16% DL; 20% UL average cell area gain

› Pooled & virtualized base station resources in data center
8-Year Total Cost of Ownership

-26% Opex
-28% Capex

27% Reduction in TCO
Capex Analysis

Additional spend on fronthaul offset by reduction in site buildout and RAN equipment cost
Opex Analysis

Reduction in energy, site rental and O&M costs
Statistical & Sensitivity Analysis

› Monte Carlo Analysis
  – 2% std. deviation

› Cost reduction drivers
  – Site rental expense
  – Site buildout
  – Operation & maintenance
  – Power consumption
Cost of Capacity ($/Mbps)

36% Reduction in $/Mbps
A Word About Xona Partners

A Boutique Advisory Specialized in Technology Businesses

Incubation

- Multi-layer technology expertise
  - Infrastructure, OS, application ecosystem business verticals
  - Telco, Cloud Migration/Data Center, Data Sciences focus

- Services offering
  - New business incubation & growth strategies
  - Due diligence & lifecycle management

- Published C-RAN market report in collaboration with Mobile Experts (Jan 2014)
  - Update to be released in Jan 2015
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