IMAGINE THE POSSIBILITIES...
An Overview Of Optical Architectures Necessary To Achieve 5G’s Key Performance Indicators

Kevin Bourg
Director, Commercial Technology – 5G Wireless
Corning Optical Communications
New use cases for 5G are made possible by 5G KPI’s

- The 5G standard expands use cases for wireless communication beyond today’s broadband experience
- The 5G KPI’s are grouped into categories guiding architectural considerations
- New spectrum options such as mm Wave will be deployed driving cell ISD in some cases to 500 feet
- Optical fiber transport will be a key enabler to addressing the 5G KPIs and respective categories
**Architecture: Point-to-point**

- A point-to-point (P2P) architecture dedicates two fibers (1 x transmit, 1 x receive) from the HE to the end device (Active Antenna Unit (AAU))
- Network infrastructure such as fiber and connectivity scales 2:1 with each end point
- Dedicated P2P: An independent P2P network is deployed to support mobile communications
- Shared P2P: The mobile network shares feeder and possibly distribution optical cables lowering infrastructure costs
- Advantages: Capacity, transceiver costs
- Disadvantages: Upfront infrastructure costs, HE fiber management
**Architecture: Point-to-point utilizing WDM**

- **A point-to-point (P2P) utilizing WDM architecture** dedicates a wavelength pair from the HE to AAU.

- **Network infrastructure scales based on WDM technology utilized; however, at a minimum one fiber required per AAU.**

- **BiDi technology:** Integrates a WDM device within optical transceiver allowing for duplex communication on a single fiber.

- **C/DWDM technology:** Leverages multiplexer technology to combine multiple logical duplex communication streams on a single fiber.

- **Advantages:** Lower optical fiber demand, BiDi offers best symmetrical propagation time between transmit and receive paths.

- **Disadvantages:** Higher cost optics, wavelength matching.
Architecture: Passive Optical Network (PON)

- A passive optical network (PON) architecture leverages a single feeder and distribution fiber from the HE which is passively split near the AAU.

- Network infrastructure scales based on passive split ratio in the field. Split ratio can be dictated based on capacity/oversubscription metrics or distance or other.

- A PON network may easily be integrated with a common residential ODN leveraging a different PON standard.

- Standards defined today support speeds up to 50 Gbps with views towards higher speeds.

- Advantages: Low OSP construction costs, optical convergence with residential services.

- Disadvantages: Shared bandwidth (50 Gbps), latency is greater than P2P architectures.
### Mapping of architectures to 5G categories

#### Use Cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Peak Rate</th>
<th>Average Rate</th>
<th>Latency at RAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>eMBB</td>
<td>20/10 Gb/s (DL/UL) (Target)</td>
<td>100/50 Mb/s per user (UR/GU)</td>
<td>10 msec</td>
</tr>
<tr>
<td>URLLC</td>
<td>N x Mb/s</td>
<td>n x Mb/s</td>
<td>1-2.5 msec</td>
</tr>
<tr>
<td>mMTC (IoT)</td>
<td>N x Mb/s</td>
<td>n x kb/s - Mb/s</td>
<td>1-50 msec</td>
</tr>
</tbody>
</table>

#### Architectures

- **N > 1**: BiDi, WDM
- **N = 1**: HE
- **N < 1**: TDM PON
## Architectural considerations for 5G networks

<table>
<thead>
<tr>
<th></th>
<th>Dedicated PT-PT</th>
<th>BiDi PT-PT</th>
<th>Shared PT-PT</th>
<th>xWDM</th>
<th>PON</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>Transport</td>
<td>Transport</td>
<td>Transport &amp; FTTH convergence</td>
<td>Transport &amp; FTTH convergence</td>
<td>Transport &amp; FTTH convergence</td>
</tr>
<tr>
<td><strong>Fiber count</strong></td>
<td>Highest</td>
<td>High</td>
<td>Highest</td>
<td>Lowest</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Adoption</strong></td>
<td>Standard</td>
<td>Emerging</td>
<td>Common</td>
<td>Standard</td>
<td>Under Evaluation</td>
</tr>
<tr>
<td><strong>Complexity</strong></td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Complex</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Path Redundancy</strong></td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Capable</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Construction cost</strong></td>
<td>Highest</td>
<td>Higher</td>
<td>Lower</td>
<td>Lowest</td>
<td>Lower</td>
</tr>
</tbody>
</table>
Summary

• Capacity demand on the mobile network is predicted to increase at a rate of 32% per year

• This demand has caused operators to begin deploying broad 5G coverage to enable new spectrum and spectral efficiency

• New use cases enabled by the 5G KPIs will encourage operators to look to new spectrum options driving a more dense wireless network and multi-gigabit transport per AAU

• Network operators have various network architecture options to consider when planning to support 5G services
  • Identify the use case categories to participate
  • Understand the network requirements necessary to meet the use case KPIs
  • Look to converged service model to lower infrastructure costs and provide long-term capacity needs
Thank You!

Kevin Bourg
Director, Commercial Technology – 5G Wireless
Corning Optical Communications
kevin.bourg@corning.com