X-Haul Wireless Modem IP

Enables Telecom OEMs to deliver high capacity low-latency products for 5G front-haul and back-haul

HCL offers Telecom OEMs a complete modem IP suite for millimeter-wave and microwave radios supporting high-capacity, low-latency products for 5G front-haul and back-haul. Also, we provide a comprehensive suite of consulting services to integrate our IP into designs and flexible licensing models to develop cost-effective X-Haul radio solutions.

**X-Haul Product Overview**

A scalable and configurable set of modem IP for 5G wireless front-haul and back-haul applications.

- **The product family includes:**
  - Multi-Band modem, 1x uW + 1x E-band carrier
  - E-band dual carrier modem with full XPIC capabilities and 4x4MIMO support
  - MicroWave single and dual carrier modem, with full XPIC capabilities

- **The modem IPs are designed to be technology-independent**
  - The demonstrator system is optimized for Xilinx RF-SoC FPGAs
  - The IPs are portable to Intel FPGAs or other technologies using external DAC/ADC converters
  - Select the target technology as per your choice

**Illustration of Radio link product configuration**

- **MultiBand**
  - Traffic Unit
  - MPU
  - MW carrier
  - DAC/ADC
- **Dual carrier E-band**
  - Traffic Unit
  - MPU
  - E-band carrier
  - DAC/ADC
- **Dual carrier MW**
  - Traffic Unit
  - uP
  - MW carrier
  - DAC/ADC

- **MPU:** Handles the radio link configuration & monitoring and some specific PHY layer control loops
- **MW Carrier:** Includes all the modulation and demodulation functions for the microwave RF carrier
- **E-band Carrier:** Includes all the modulation and demodulation functions for the millimeter wave RF carrier
- **Traffic Unit:** Implements the Ethernet L1 traffic handling
- **DAC:** Implements the final up-sampling of the signal and the conversion to analog domain
- **ADC:** Implements the analog signal conversion to digital domain and first down-sampling
5G X-haul

Higher Capacity
5G requires wireless transport solutions with significant higher capacity.

Lower Latency
5G requires wireless transport solutions with much lower latency.

Telecom OEMs

Product Differentiation
Telco OEMs specific functions can be integrated with HCL modem IPs to deliver a custom product solution.

Radio Architecture Optimization
HCL modem IPs can be tailored to match the target radio architecture.

Business Benefits
- Increase product differentiation
- Reduce time to market for new features
- Reduce total solution cost with optimized design
- Remove dependence on a single silicon supplier

Key Features
- Dual Carrier E-Band modem with up to 25Gbps bandwidth and < 50µs latency
- Dual band hybrid (E-band & uW) modem for high reliability and high throughput
- MicroWave modem with best-in-class spectral efficiency - supporting up to 16K QAM
- mmWave Modem front-haul ready supporting up to 50 Gbps with 4x4 MIMO configuration
- Flexible solution for wireless communication & mobile X-haul based on RF SoC technology
- Select the right technology depending on the stage of your product in the lifecycle
  - Initial deployment with FPGA based baseband modem processing
  - Flexible choice of target FPGA technology – multiple vendors support
  - Structured ASIC or standard-cell ASIC option for high volume production

Deliverable Set
- Modem IP optimized for the target technology
- Demonstrator system based on Xilinx RF-SoC evaluation board
- Complete SW package to configure and operate the modem IP set including:
  - API libraries delivered as linkable object code
- Reference modem application delivered as source code
- Configuration and Monitoring GUI delivered as source code
- Full driver set for demonstrator board peripherals
- Specific drivers for the modem IP functions
### Microwave Modem specific features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td>Channel spacings</td>
<td>7, 14, 28, 40, 56, 112, 224 MHz (ETSI)  5, 10, 20, 40, 50, 80 MHz (ANSI)</td>
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<tr>
<td>Net radio throughput</td>
<td>&gt;1.25 Gb/s payload traffic per carrier at 112MHz CS</td>
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<tr>
<td>QAM constellations</td>
<td>4, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384 symbols</td>
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<tr>
<td>Non Linearities compensation</td>
<td>5th order polynomial, for AM/AM and AM/PM compensation RX over the hop detector</td>
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<td>RF Interface support</td>
<td>IF or I/Q baseband, depending on customer application</td>
</tr>
<tr>
<td>XPIC / MIMO</td>
<td>full XPIC / 2x2 line-of-sight MIMO / 4x4 MIMO (dual polarization)</td>
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### Millimeter Wave E/D band modem specific features

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<tbody>
<tr>
<td>Channel spacings</td>
<td>62.5 125, 250, 500, 750, 1000, 1250, 1500, 1750, 2000 MHz (ETSI) with XPIC support</td>
</tr>
<tr>
<td>Net radio throughput</td>
<td>&gt; 5 Gb/s at 1GHz CS, &gt;10 Gb/s at 2 GHz per carrier  25/50 Gbps dual carrier / four carrier full XPIC and MIMO configurations</td>
</tr>
<tr>
<td>QAM constellations</td>
<td>4, 16, 32, 64, 128, 256, 512, 1024 symbols</td>
</tr>
<tr>
<td>Non Linearities compensation</td>
<td>3rd order for AM/AM and AM/PM compensation RX over the hop detector</td>
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<tr>
<td>RF Interface support</td>
<td>I/Q baseband with full unbalance compensation support</td>
</tr>
<tr>
<td>XPIC / MIMO</td>
<td>Full XPIC/4x4 MIMO</td>
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### Modem common feature

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| Channel Coding                 | MLC – L1: LDPC - L2: Reed-Solomon or uncoded LDPC  
code Rates: ½, 3/4 and 7/8 mother codes  
block length 4k,8k, 12k and 16kb  
Reed-Solomon: GF(256), t = 2, 4, 8 with shortening support |
| Automatic Link Adaptation      | Hitless Adaptive Coding, Modulation and Bandwidth                      |
| Radio Framing & Signalling     | Frame Alignment for fast link recovery / acquisition  
Pilots management  
In band control channels for PHY layer over-the-hop loops management |
| SyncE – 1588                   | frequency and phase synchronization with clock protection support      |
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