Silicon and Modules for Critical Communications

Leveraging a Scaled Ecosystem

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Critical Communications
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Workflows
Economics & Country Risk
Product Design
Supply Chain

IHS Markit: 360-degree view
140+
Serving customers in over 140 countries
Silicon and Modules

- The RF Chain
- Mission-critical LTE: Silicon status
- What to expect with 5G
- Module support
The RF Chain

Turning this ...

... into information
RF Chain: The Bridge to Connectivity
RF Chain: The Bridge to Connectivity

- Power amplifier
- Band specific filters
RF Chain: The Bridge to Connectivity

- The “Radio”
RF Chain: The Bridge to Connectivity

• The “Modem”
RF Chain: The Bridge to Connectivity

• The “Application Processor”
RF Chain: The Bridge to Connectivity

A deeper look at the modem

• Manage multiple streams of RF signal
  > Multiple-in Multiple-out antenna ports
  > Varying encodings
• Convert RF signal to digital information
• Deliver digital information to application processors

The heart of the mobile device
RF Chain: The Bridge to Connectivity

The Central Role of the Modem

Layer 3
- Non Access Stratum (NAS)
- Internet Protocol (IP)
- Radio Resource Control (RRC)
  - PDCP Control

Layer 2
- Radio Link Control (RLC)
  - RLC Control
  - Radio Link Control (RLC)
    - RLC PDUs
  - Medium Access Control (MAC)
    - MAC Control
    - MAC PDUs

Layer 1
- Uplink: SC-OFDM
- Downlink: OFDM

Control Traffic
- User Traffic
  - RRC PDUs
  - Packet Data Convergence Control (PDCP)
  - RRC PDUs

Radio Bearers
- Logical Channels
  - Radio Link Control (RLC)
  - RLC PDUs
  - Transport Channels
  - MAC PDUs

Physical Channels
Example Modem: Snapdragon X24 LTE Modem Features

Capabilities
> Multi SIM: LTE Dual SIM Dual Standby (DSDS)+LAA, Dual SIM Dual VoLTE (DSDV)
> Next-generation Calling Services: VoLTE with SRVCC to 3G and 2G, HD and Ultra HD Voice (EVS), CSFB to 3G and 2G

LTE Category
> Uplink/Downlink LTE Category: LTE Category 20

LTE Downlink Features
> Downlink LTE Streams: Maximum 20 spatial streams
> Downlink Carrier Aggregation: 7x20 MHz carrier aggregation
> Downlink LTE MIMO: Up to 4x4 MIMO on five carriers, Full-Dimension MIMO (FD-MIMO)
> Downlink QAM: Up to 256-QAM

LTE Uplink Features
> Uplink Technology: Qualcomm® Snapdragon™ Upload+, Uplink Data Compression (UDC)
> Uplink Carrier Aggregation: 3x20 MHz carrier aggregation
> Uplink LTE Streams: Up to 2x 106Mbps LTE streams
> Uplink QAM: Up to 256-QAM

LTE Speed
> LTE Peak Download Speed: 2 Gbps
> LTE Peak Upload Speed: 316 Mbps

Cellular Technology
> Cellular Technology: WCDMA (DB-DC-HSDPA, DC-HSUPA), TD-SCDMA, CDMA 1x, EV-DO, GSM/EDGE
> LTE Technology: LTE FDD, LTE TDD including CBRS support, LAA, LTE Broadcast
A modem is only one part of the solution

Modems are general purpose devices … supporting:

- many bands
- many modulations
- multiple radio air interfaces

GSM    LTE
UMTS   5G

Filters and antennas are matched to specific bands
Mission-critical LTE: Silicon status

3GPP Release 12

- Proximity-based Services Specification (ProSe)  
  **Significant modem impact**
- Group Communication System Enablers for LTE (GCSE_LTE)
- Public Safety Broadband High Power User Equipment for Band 14 for Region 2

3GPP Release 13

- Group communications between group members via the network
- Group communications between group members via the network and a ProSe UE-to-network relay
- QoS Class Identifiers added for MC-PTT and MC-Video  
  **Moderate modem impact**
- Support for evolved Multimedia Broadcast Multimedia Service (eMBMS) single cell broadcast areas  
  **Moderate modem impact**
- Isolated E-UTRAN operation for Public Safety (IOPS)

3GPP Release 14

- Mission-critical video
Mission-critical LTE: Silicon status

Public safety operations require direct mode support
• Back-to-back for out-of-network operations
• Relay capabilities for person-to-vehicle-to-network

LTE substitution requires Proximity-based Services (ProSe)
• Modem suppliers reluctant to implement
• ProSe may not be adequate . . . other elements of RF chain may be poorly positioned for back-to-back coverage
> Power Amplifiers limited to 125 mW
> Use of internal antennas

Niche market for mission-critical means essential features may not be implemented in modems
What to expect with 5G

Fixed broadband
Pervasive video
Cloud services

Broadband access in dense areas

High-speed transport

Higher speed mobility

High-speed transport, taken to the next level

Fixed and mobile broadband, taken to the next level

The “Why” of 5G

Tactile internet
Autonomous transport

Extreme real-time communications

Medical

Ultra-reliable communications

Public safety

Factory automation

Massive IoT

Wearables

Sensors

Connecting “Things”

5G vehicle-to-vehicle shares characteristics with TETRA direct-mode
Module support

Many LTE modules on market . . . but support for MC-LTE is still in early days

- A modem may support 3GPP Release 12 and 13 QCIs for mission-critical push-to-talk, but the modules may not implement the capability
- Most modules on the market are aimed at general-purpose IoT applications . . . not mission-critical functionality

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<thead>
<tr>
<th>A</th>
<th>B</th>
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<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Model</td>
<td>Photo</td>
<td>Benefits of Module or Other Features/Comments From Manufacturer</td>
<td>Wireless Protocol</td>
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<tr>
<td>31</td>
<td>KYOCERA</td>
<td>Auto</td>
<td>1. Automotive-grade LGA module 2. LTE cat 4 up to 150Mbps DL 3. Digital audio interface</td>
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<tr>
<td>32</td>
<td>153 modules listed in AT&amp;T list of approved modules – but only one vendor listed as “FirstNet Ready”</td>
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<tr>
<td>33</td>
<td>NVIDIA</td>
<td>NB196-N</td>
<td>1. Standard PCIe M.2 form factor 2. SAR proximity sensors supported 3. SIM hot-plug supported 4. AGPS SUPL 1&amp;2 and eC-ID supported with GPS chip on the final system</td>
<td>GPRS/EDGE/HSPA/LTE</td>
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Twitter/@MCFRSPIO Montgomery County Fire Rescue Service
Qualcomm dominates AT&T FirstNet “FRC” modules today

<table>
<thead>
<tr>
<th>SDX20</th>
<th>MDM9207</th>
<th>MDM9250</th>
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<tbody>
<tr>
<td><strong>Foxconn</strong></td>
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<tr>
<td>Foxconn T77W968 (Qualcomm SDX20)</td>
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<td><strong>Quectel</strong></td>
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<td>Quectel EG25-G (Qualcomm MDM9207)</td>
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<td>Sierra Wireless WP7610 (Qualcomm MDM9207)</td>
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<td><strong>TELIT</strong></td>
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<td>TELIT LE910C4-NF (Qualcomm MDM9207)</td>
<td>TELIT LM960 (Qualcomm SDX20)</td>
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Will future be different?

2019 Chipset Approvals

- Qualcomm SC8180X
- MediaTek MT8768
- Qualcomm SM6125
- MediaTek MT2625
- MediaTek MT8766
- MediaTek MT6768
- MediaTek MT6767
- Qualcomm QM215
- Qualcomm SM7150
- Qualcomm SM6150
- Samsung Exynos 9820
- Samsung Exynos 9610
- Samsung Exynos 9110
Conclusions

• Modem support is but one element of MC-LTE support, availability for your region / needs depends on other radio front-end components

• Support for ProSe is missing today, but may show up soon in response to UK Home Office requirements

• Support for ProSe may not be sufficient for full-fledged direct mode operations due to limited power output and internal antennas

• Modules are aimed at broader market and support for mission-critical may remain limited to a small subset