MIPI RFFE Open Day Outline

• Market Dynamics
• MIPI RFFE Application
  – Features enabled by RFFE
• Driving Force Behind the Development of RFFE
  – Reasons for the need of RFFE
• Key Factors for RFFE’s Success
  – Secret to RFFE’s success
• Key features of RFFE
  – v1.x features
  – v2.0 features
  – v2.1? potential features
• Q & A
Connect Everything

28B Devices by 2020
Number of Connected Devices Are Exploding

IoT Emerging as the Next Big Mega-trend

Y-axis is on a logarithmic scale

Source: IDC, Ericsson, Goldman Sachs Global Investment Research
Global Mobile Data is Exploding

Exabytes Per Month

61% CAGR 2013–2018

Source: Cisco VNI Mobile, 2014
## Increasing Front End Requirements

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2014</th>
<th>2016E</th>
<th>2020E</th>
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<td>LTE Rel</td>
<td>LTE Rel-11</td>
<td>LTE Rel-12</td>
<td>LTE Rel-X</td>
<td>5G</td>
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<td># CA Bands</td>
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<td>3</td>
<td>3</td>
<td>5</td>
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<td>8x8</td>
<td>64x8</td>
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<td>Proposed New Bands</td>
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<td>50</td>
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<td>CA Band Combos</td>
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<td>75+</td>
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<td>300</td>
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<td>3Gbps</td>
<td>6Gbps</td>
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Increasing Front End Complexity
What is RFFE?

**RFFE Introduction**

- RFFE WG is the RF Front-End Control Working Group within the MIPI Alliance
  - MIPI System Diagram
- RFFE WG has specified a two-wire control bus to be used (but not limited to) in controlling various RF Front-End devices (e.g. PAs, Filters, Switches, Antennas etc.)
- Work started Sep 2008 and was developed on an accelerated schedule.
RFFE in the RF Front-End

The RF is essential in conveying the communication over radio waves

- The RF performance and functionality increases the devices versatility by
  - better coverage
  - higher throughput
  - better call connectivity
  - providing international roaming
  - dual or multi SIM configurations
  - providing improved battery life

- Complex RF solutions incorporate a multitude of customized components in the RF Front-End

- Standardized solutions required for control

- RFFE is broadly adopted by the industry being the excellent solution for controlling the RF Front-End
Driving Force Behind RFFE Development

• During the initial development of RFFE in 2008 a real need was identified for a standard control interface.
  – Traditional GPIO could no longer meet the requirements
    • Too many pins required
    • Amount of control required was quickly escalating
  – Many serial interfaces were being introduced
    • Proprietary Buses
    • Competing standards
    • Different buses complicated system and device design
Key Factors for RFFE’s Success

• RFFE is highly adopted
  – Key players in the RF Front-End were part of the initial development
  – Specification saw a high rate of adoption even before the specification was officially released.
  – Billions of devices in the market that use RFFE interface
  – RFFE owns the RF Front End Control Interface – No competing interfaces

• RFFE continues to meet the needs of the control interface
  – Very flexible interface
  – Many optional features that meet the wide variety of system requirements
RFFE v1.x Overview

• **Electrical & Digital Details**
  – Up to a 26 MHz bus speed.
  – Supports up to an address space of 16 bits.
  – Contains parity bits for error checking
  – Common voltage reference defined for the interface.

• **Flexible Bus Configuration**
  – One master system, which eliminates arbitration for the bus.
  – Slave devices are very configurable.
  – Slaves support an optional programmable Unique Slave ID.
  – Supports user defined group IDs for write commands.

• **Multiple Message types**
  – Single byte and multi-byte read and write commands are supported
  – Supports broadcast messages over the bus to multiple slave devices.
  – An optional trigger feature to solve potential timing issues.
  – Supports a command initiated soft reset.
What’s New in MIPI RFFE v2.0?

Key New and Improved Features

- **Electrical & Digital Details**
  - Extended Frequencies – increased command sequence bandwidth capabilities
  - Synchronous Read introduction – Allows for a wider range of bus loading by allowing more time for data propagation on the bus by Slaves, and also enables Extended Frequencies

- **Flexible Bus Configuration**
  - Multi-Master - supporting Carrier Aggregation (CA) system architectures

- **Multiple Message types**
  - Interrupt-Capable Slave functionality – quicker response opportunities for Slave Devices to report to Master(s)
  - New Reserved Registers and functions – Common function register locations easing hardware and software development
MIPI RFFE v2.1: Future Enhancements

What comes after RFFE v2.0?

- The Working Group has begun to gather ideas for the next release and some of these ideas are outlined below.

- **Electrical & Digital Details**
  - Longer Trace Lengths
  - RFFE over M.2 Connector/Socket

- **Flexible Bus Configuration**
  - Potential Extension of the Manufacturer ID Bit Field

- **Multiple Message types**
  - Optional extensions to the Master Write (& Read?) CS(s)
  - Software Considerations

- The WG welcomes additional members and contributions!
MIPI RFFE: Documents

RFFE Specification and Supporting Documents (available to all MIPI Members)

- https://members.mipi.org/wg/All-Members/home/approved-specs#RFFE

MIPI® Specification for RF Front-End Control Interface (RFFE℠) v1.10:
- Specification: Version 1.10 – November 2011
- Application Note: Version 1.10 – November 2011
  - Usage examples (Triggers, Group Slave IDs, Resolving USID Conflicts, etc.)
  - FAQs
- PICS: Version 1.10 – October 2011
  - Protocol Implementation Conformance Statement, Checklist for vendors

MIPI® Specification for RF Front-End Control Interface (RFFE℠) v2.0:
- Application Note: Version 2.0 – February 2015
- FAQ: Version 2.0 – February 2015
- Conformance Test Specification (CTS): Version 2.0 – (estimated release: 3Q15)
**MIPI / RFFE Website**

- **Questions to the WG?** Contact PM: rob.anhofer@mipi.org
- **Questions from Press/other?** Contact Marketing: jennifer.mcaleer@mipi.org
- Public website – RFFE WG: http://mipi.org/working-groups/rf-front-end
- MIPI Contributor and Board Members are welcome to join the WG:
  - Member website (request a member login): https://members.mipi.org/site/login
  - Access to WG mail reflector and discussions, file repository, calendar, meeting agendas and minutes, schedules and access to Bugzilla change request system
  - Weekly WG meetings: Wednesday’s @ 8:30am PST / 11:30am EST / 17:30 CET (2hr)
  - RFFE WG calendar: https://members.mipi.org/wg/RF-FE/calendar
  - RFFE WG dashboard: https://members.mipi.org/wg/RF-FE/workgroup
  - RFFE v2.0 Press Release was released March 12, 2015