Beyond Sensors: What’s New in MIPI I3C® v1.1

Ken Foust, Principal Engineer, Intel
MIPI I3C WG Chair
12 February 2020
Outline

An Introduction to MIPI Alliance
  – Peter Lefkin, Managing Director

Beyond Sensors: What’s New in MIPI I3C® v1.1

  • Introduction to MIPI I3C
  • Current status
  • Industries beyond mobile and usages beyond sensing
  • I3C evolution – v1.0 vs. v1.1
  • Why adopt I3C v1.1?
    – Deeper dives into Multi-lane for Speed, HDR-BT and Slave Reset
  • What’s next?
  • Additional resources
About MIPI Alliance

Peter Lefkin
Managing Director, MIPI Alliance
2003

MIPI ALLIANCE FORMED TO STANDARDIZE CAMERA AND DISPLAY INTERFACES
MIPI Alliance Member Ecosystem

- Automotive OEMs/ Tier 1 suppliers
- Application Processor Developers
- Semiconductor Companies
- Test Equipment Companies
- Test Labs
- IP and VIP Providers
- Consumer Electronics (Cameras, Tablets, PCs/Laptops, Peripherals, Wearables)
- Software Providers
- Device OEMs

As of 31 December 2019, 339 members

Number of countries 27
MIPI Specifications Leveraged Beyond Mobile

Fundamentally, usage rights are granted to members royalty free for implementation of MIPI specifications from all MIPI members.
Beyond Sensors: What’s New in MIPI I3C® v1.1

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What is MIPI I3C®?

• Innovative new 2-wire interface for sensing and beyond
• Key features address historical pain points
  – In-band Interrupt, Dynamic Addressing, Multi-Master, Standardized Commands, Time Control, Hot-Join, Error Detection and Recovery
  – Plus…

I3C Compatibility

Low Power

High Data Rates
MIPI I3C® for Ubiquitous Low Speed Interfacing

- Anywhere sensors are used, MIPI I3C belongs
- Aimed toward historical I²C, SPI and UART applications in...
MIPI I3C® Vision

Too Many I/Os! Fragmented Interfaces!

I²C Compatibility
In-band Interrupt
Common Command Codes
Reduced Signal Count
Reduced Interface Power

Host

Accelerometer
Magnetometer

Accelerometer
Gyro

ALS/Proximity

Altimeter (barometric pressure)

Compass

Grip Sensor (ULPP)

Near Field Comm

Fingerprint

ADC

Touchscreen

Accelerometer

Magnetometer

Accelerometer
Gyro

ALS/Proximity

Altimeter (barometric pressure)

Compass

Grip Sensor (ULPP)

Near Field Comm

Fingerprint

ADC

Touchscreen
Current Status

- MIPI I3C v1.1 specification is now released!
- MIPI I3C v1.0 maturing
  - Interoperability confirmed via multiple MIPI sponsored plugfests
  - Master and Slave IP available from all major providers
  - Test/Analysis equipment available
- Standardized Host Controller Interface (MIPI I3C HCI\textsuperscript{SM} v1.0)
  - MIPI I3C HCI\textsuperscript{SM} v1.1 in development
- Linux Kernel support for I3C subsystem
- 5G Ready
- MIPI I3C v1.1 interoperability workshop(s) in planning
Capabilities Beyond the Mobile Industry

• Internet of Things (IoT)
  – An efficient way to connect sensors to SoCs
• High Performance Compute / Servers
  – MIPI driving industry liaisons to ensure adoption while shunting fragmentation
• Automotive
  – Let’s discuss these new challenges on next slide...
MIPI I3C® for Automotive

• Opportunities
  1. Control/manageability
  2. Sensor data transport

• Challenges
  – Functional Safety (FuSa)
  – Reliability
  – Security
  – EMI/EMC
  – Long reach

Source: MIPI Whitepaper – Driving the wires of Automotive
http://resources.mipi.org/mipi-automotive-white-paper
Usages Beyond Sensing

• As part of its charter, the I3C WG carries the responsibility to ensure MIPI I3C “maintains a relevant feature set and scope”
• The following notable usages, among others, have been instrumental in evolving I3C forward:
  – MIPI Camera Control Interface (CCISM)
  – MIPI Touch over I3C
  – MIPI Debug for I3C$^{SM}$
  – System Manageability
• MIPI CCI<sup>SM</sup> (Camera Control Interface) over I3C offers faster, lower latency and more efficient camera control with future abilities to support grouped data write and AON imaging

• Touch screen controller interfaces are fragmented
• For many touch screens, MIPI Touch over I3C presents a converged interface option for processed and raw touch data, leveraging IBI and HDR modes

• MIPI Debug for I3C<sup>SM</sup> offers a more complete closed chassis, scalable and power aware platform debug capability with minimum boundary pin count
Usages Beyond Sensing – System Manageability

- MIPI I3C can be used to manage complex systems when a common Management Transport Protocol is adopted (e.g. MCTP)

- A simple binding can allow a common Transport Protocol over the MIPI I3C interface
MIPI I3C® Evolution at a Glance

- MIPI Leadership and Contributors continue to drive MIPI I3C forward!
  - Support and ecosystem engagement
  - Mobile-influenced features
  - Industry liaisons

2013
- MIPI Sensor WG formation and MIPI I3C v1.0 development
  Mobile sensor interface that evolves for new usages

2017
- Ongoing development of collateral and support
  FAQ, CTS, System Integrator App Note, Interop Sessions, DevCon
- MIPI I3C v1.1 development and release
  New features for Mobile and Mobile-influenced usages
- Establish Industry liaisons
  JEDEC, DMTF, VESA

Today
- MIPI I3C Basic™ v1.0
  Reduced features, SSO alignment and RAND-Z
## MIPI I3C® v1.0 vs. I3C v1.1

<table>
<thead>
<tr>
<th>Feature</th>
<th>I3C v1.0</th>
<th>I3C v1.1</th>
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<tr>
<td>12.5 MHz SDR (Legacy I²C Slave Compatibility)</td>
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<td>1.2V-3.3V Operation for 50pf $C_{load}$</td>
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<td>In-band Interrupt (w/MDB)</td>
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<td>Common Command Codes</td>
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<td>Secondary Master</td>
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<td>Timing Control (Synchronous and Asynchronous)</td>
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<td>HDR-DDR</td>
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<td>HDR-TSL/TSP</td>
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<td>HDR-BT (Bulk-Transport)</td>
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<td>Slave Reset</td>
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<td>Set Static Address as Dynamic Address CCC (SETAASA)</td>
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<td>Grouped Addressing</td>
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<td>Device to Device(s) Tunneling</td>
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<td>Multi-lane for Speed (Dual/Quad for all modes)</td>
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<td>Monitoring Device Early Termination</td>
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Why Adopt MIPI I3C® v1.1?

- More clearly written document
- Higher speeds through Multi-lane and new HDR mode (HDR-BT)

- Configurable, pattern-based Slave Reset

- Grouped Addressing, Device to Device(s) Tunneling, Comprehensive Multi-Mastership...
Higher Speeds

• Multiple lanes specified for all modes (SDR, DDR, TSP, BT)
  – Employs additional physical Data (SDA[1-3]) wires for faster payload transfer
    • Single Clock (SCL) used
  – Coexistent with normal 2-wire operation
    • Frame formats, sequencing and timing consistent with I3C
  – Standardized configuration and link test
• New HDR Mode: Bulk Transport (HDR-BT)
  – Gives highest throughput using Clock-and-Data, DDR transmission model
  – Supports Single/Dual/Quad lanes
  – Built upon I3C’s standardized HDR (High Data Rate) modality
  – Feature rich: CRC16/32, Slave Clock drive on Read, Command/Control decoupled from Data, Wide data block model (32-bytes)
Slave Reset

• In-band, pattern-based Slave Reset
• Allows different levels of Reset of one or more selected Slaves, while avoiding Reset of others
• Enhances error escalation and recovery mechanism
• Standardized configuration (RSTACT CCC)
  – Set different levels of Reset (from I3C Peripheral to whole Device)
• Each I3C Slave reacts to the Slave Reset Pattern as configured
  – Coexistent with all I3C modes
What's Next for MIPI I3C®?

• Sensor WG ramping up discussion on the next evolution of MIPI I3C
• Considering multiple capabilities / improvements
  – Long reach
  – Specification development improvements
  – Automotive requirements
  – Speed increases
  – New multi-lane uses
  – New PHY approaches
  – Standardized connectors
  – Feature refinements
• Reaching out to industry partners and forming liaisons
• Join us now to ensure that MIPI I3C evolves to meet the needs of new industries and usages!
Additional Resources

• MIPI I3C WG (formerly Sensor WG)
  – https://www.mipi.org/groups/sensor

• MIPI I3C Specification
  – https://www.mipi.org/specifications/i3c-sensor-specification

• Whitepaper: Introduction to the MIPI I3C Standardized Sensor Interface
  – http://resources.mipi.org/i3c-sensor-specification-whitepaper-from-mipi-alliance

• MIPI I3C Frequently Asked Questions
  – https://www.mipi.org/resources/I3C-frequently-asked-questions

• MIPI I3C System Integrator’s Application Note

• MIPI Automotive Whitepaper: Driving the Wires of Automotive
  – http://resources.mipi.org/mipi-automotive-white-paper
Any Questions?