Camera Serial Interface
CSI-2 and CSI-3

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Camera WG Chair

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INTRODUCTION

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The importance of cameras in smartphones

WORLDWIDE 2 BILLION PEOPLE

smartphone users in 2014*.

Smartphone Usage**

Taking photos	92%
Text Messaging	92%
Internet Browsing	84%
Sending photos	80%
E-mailing	76%
App downloads	69%
Gaming	64%

* Global Smartphone User Penetration Forecast by 88 Countries, 2014, Strategy Analytics
** Internet & American Life Project, 2011, The Pew Research Center

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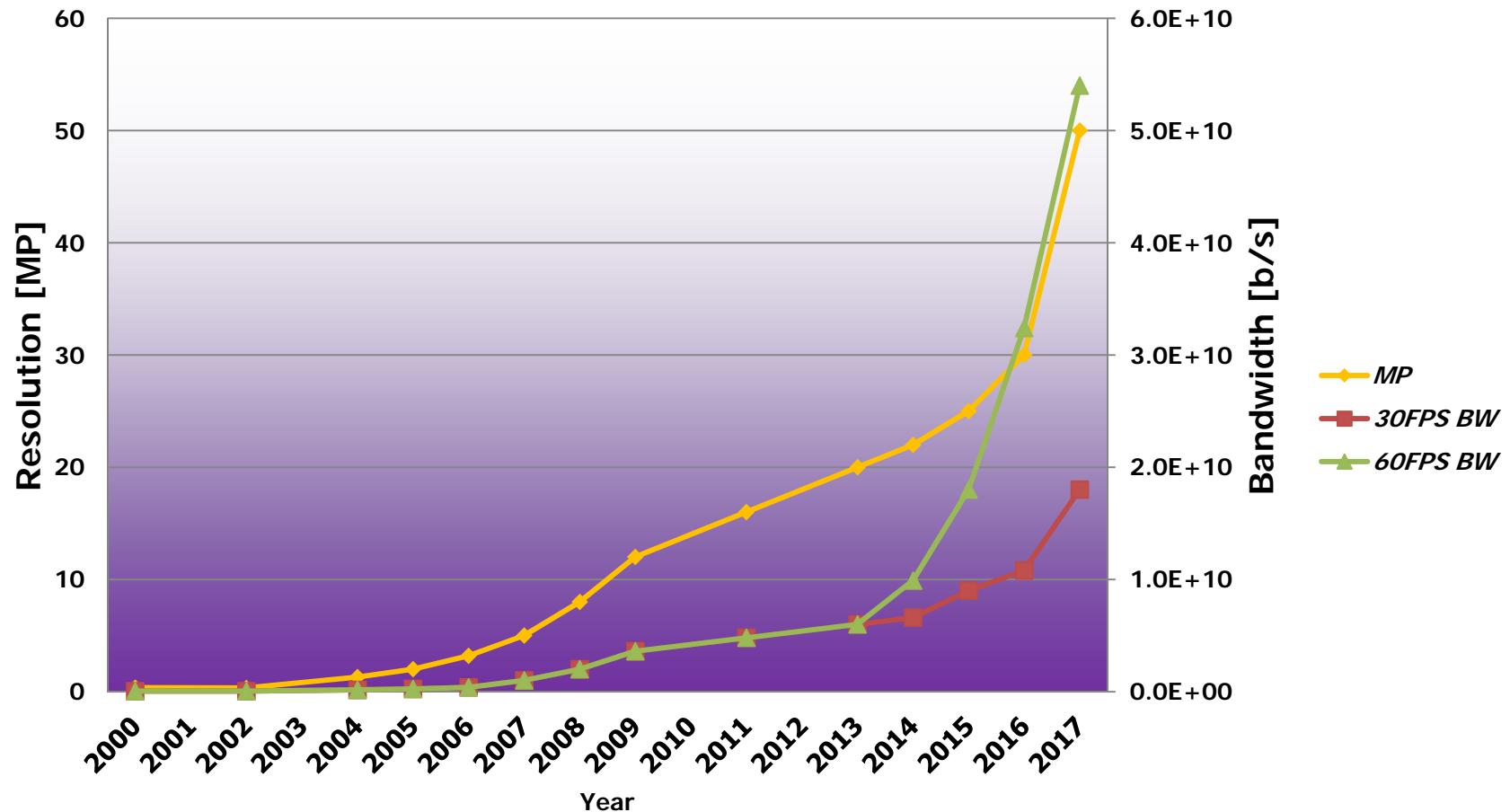
Camera Serial Interface 2 and 3

OVERVIEW

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Why Evolving Standards?

Mobile Phone Camera Resolution and Bandwidth

Designed for Performance

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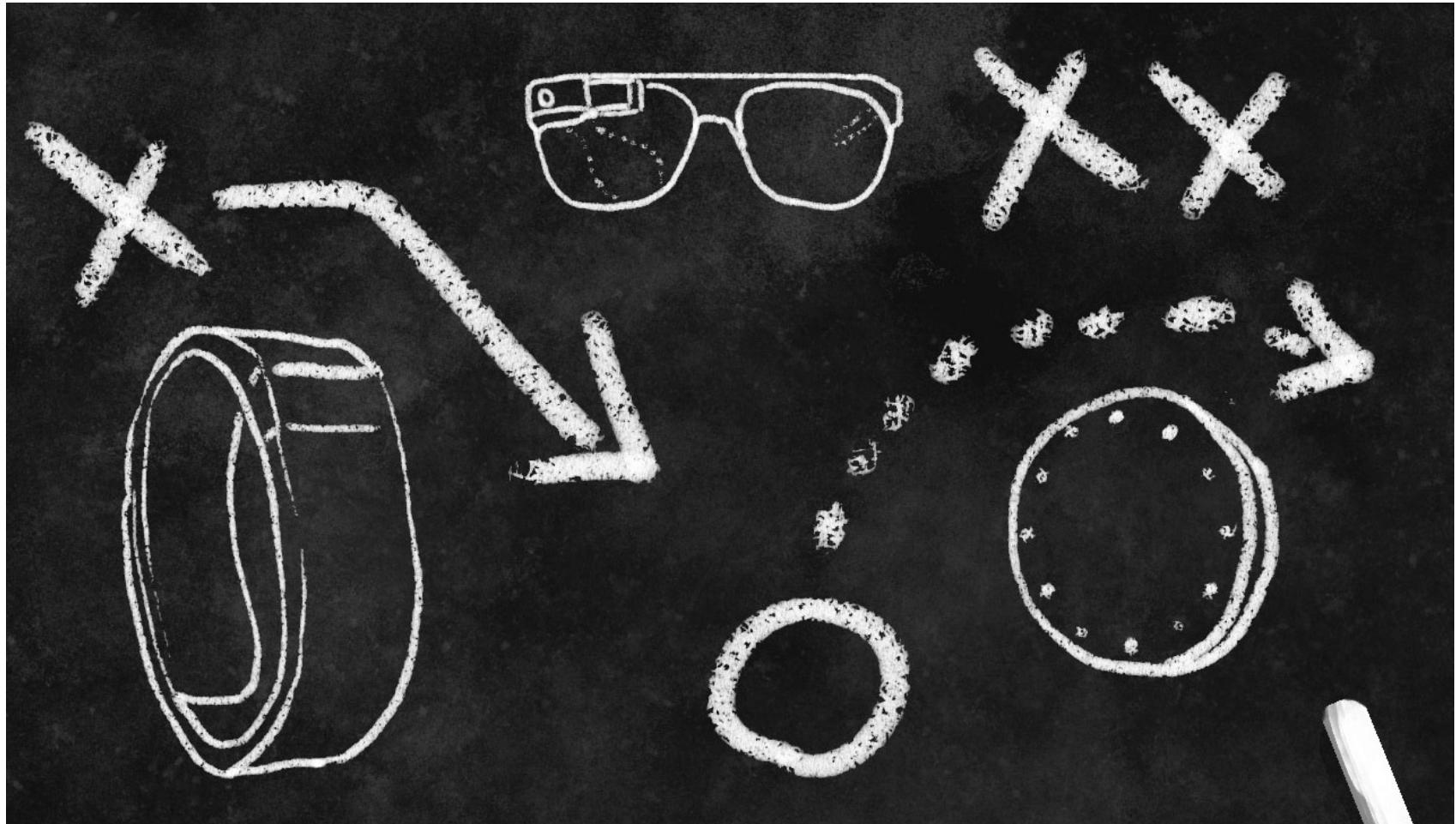
Power is Key

Going beyond mobile

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MIPI's Standards Today

CSI-2 1.3

- D-PHY 1.2, C-PHY 1.0 or "combo PHY" is possible
- 4 Virtual Channels
- I2C based control interface
- Line based transmission
  - Easy implementation
  - Low gate count
  - Matched data rates for sensor and link
- In-band interrupts
- RGB, YUV, RAW, JPEG
- Embedded Data
- CRC/ECC for payload and header protection

CSI-3 1.1

- M-PHY 3.0
- 32 Virtual Channels
- In-band control
- Packet based transmission
  - Line-buffer-less architectures
  - Interleaving on message basis
  - Integration in network architectures
- In-band interrupts
- RGB, YUV, RAW, JPEG
- Embedded Data
- Notification channels for metadata, audio, etc.
- CCI bridging
- Guaranteed delivery of data
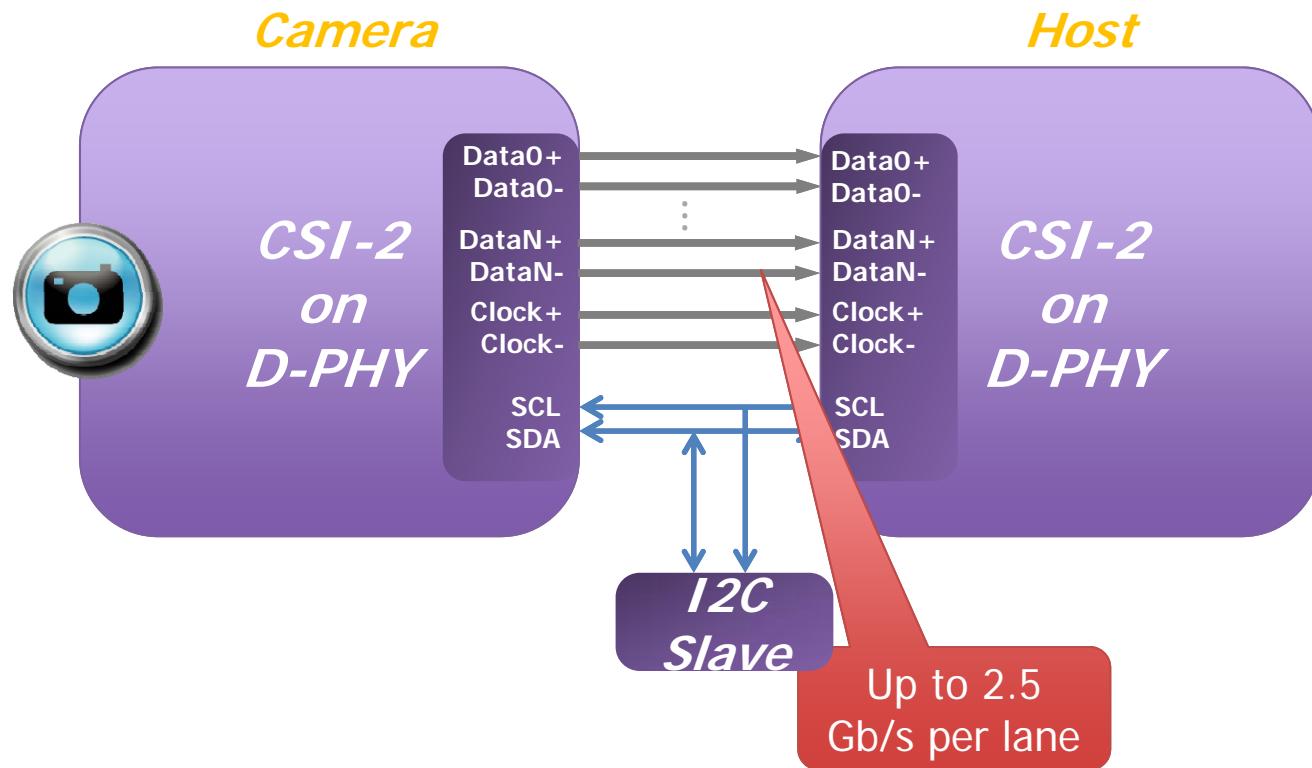
An established and evolving standard

THE CSI-2 SPECIFICATION

CSI-2 on D-PHY

Camera

Host

**CSI-2
on
D-PHY**

Data0+
Data0-

DataN+
DataN-

Clock+
Clock-

SCL
SDA

Data0+
Data0-

DataN+
DataN-

Clock+
Clock-

SCL
SDA

**CSI-2
on
D-PHY**

**I2C
Slave**

Up to 2.5
Gb/s per lane

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CSI-2 on C-PHY

Camera

Host

Up to 5.7 Gb/s per trio

CSI-2 on C-PHY

Data0_A
Data0_B
Data0_C

DataN_A
DataN_B
DataN_C

SCL
SDA

CSI-2 on C-PHY

Data0_A
Data0_B
Data0_C

DataN_A
DataN_B
DataN_C

SCL
SDA

I2C Slave

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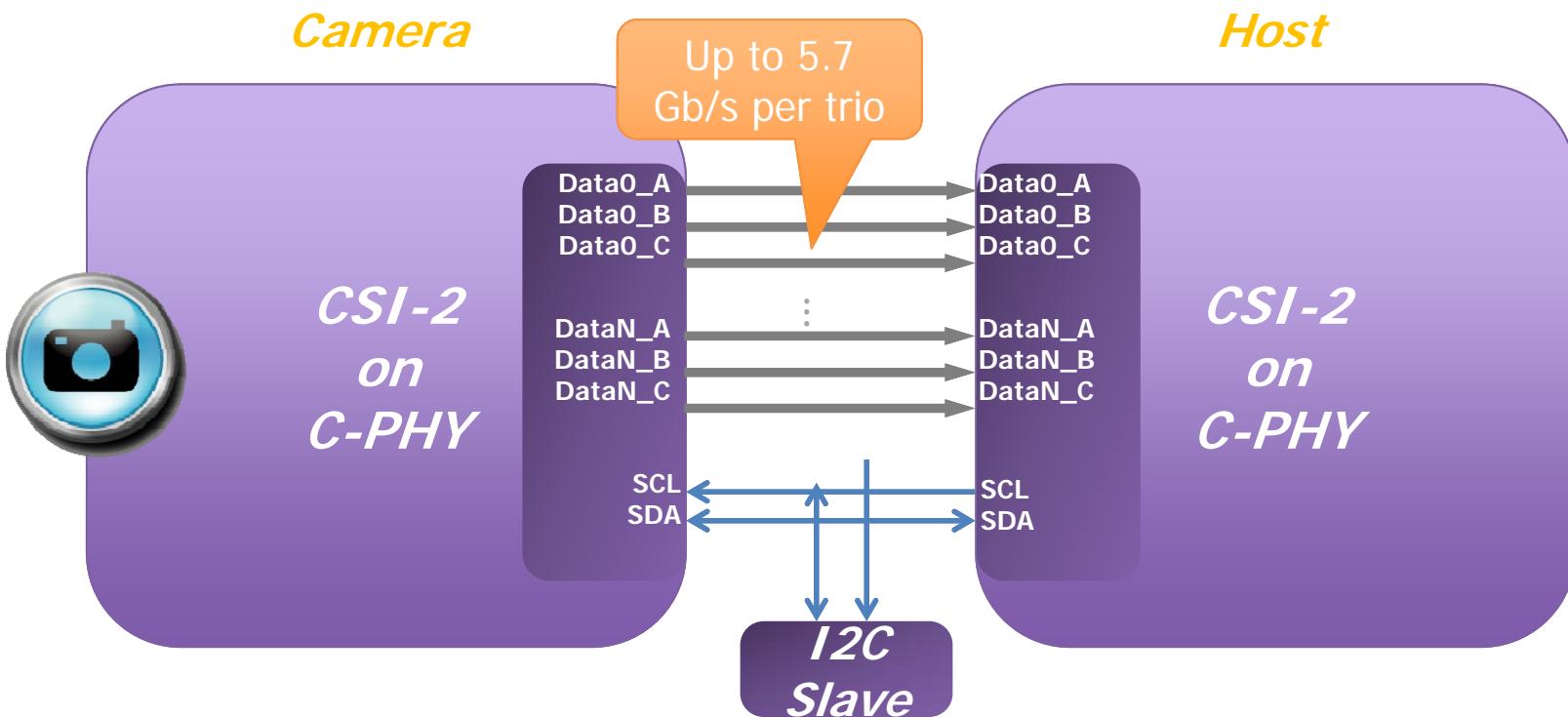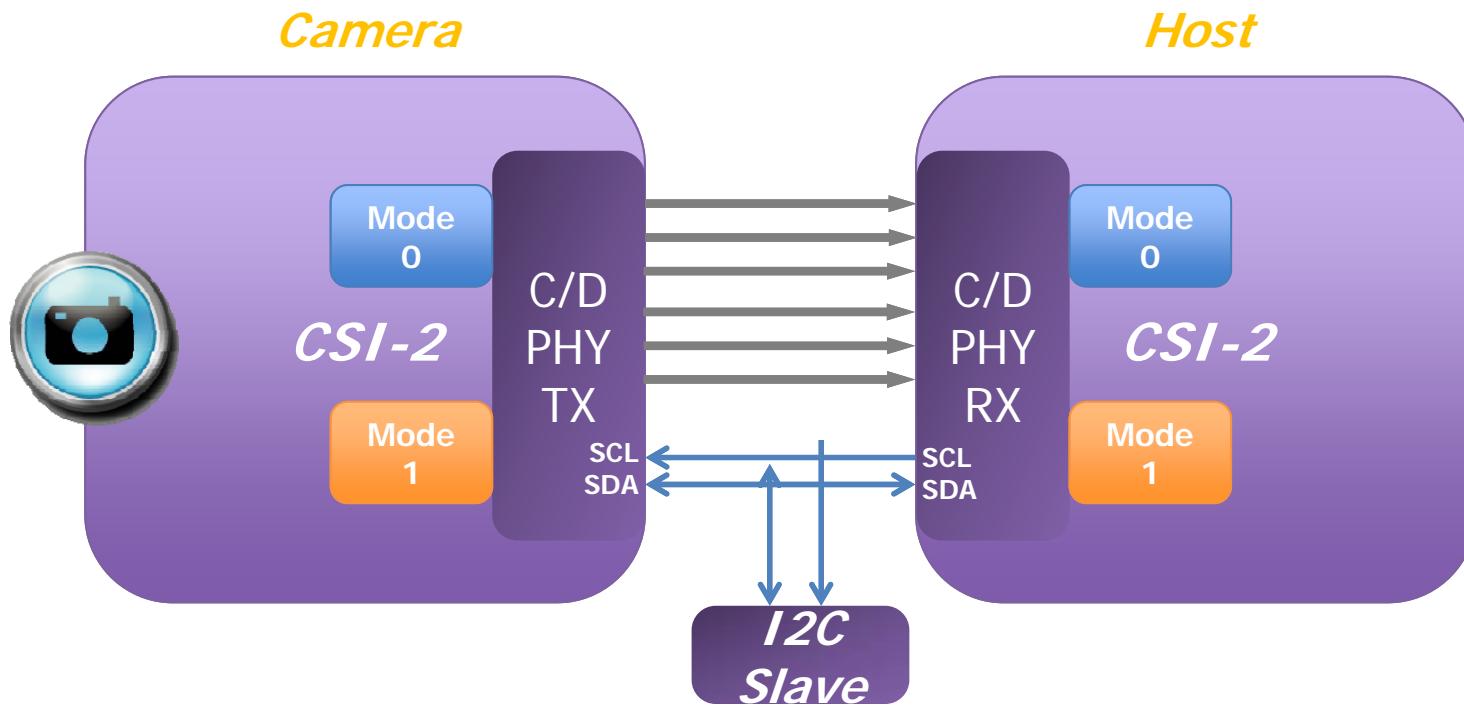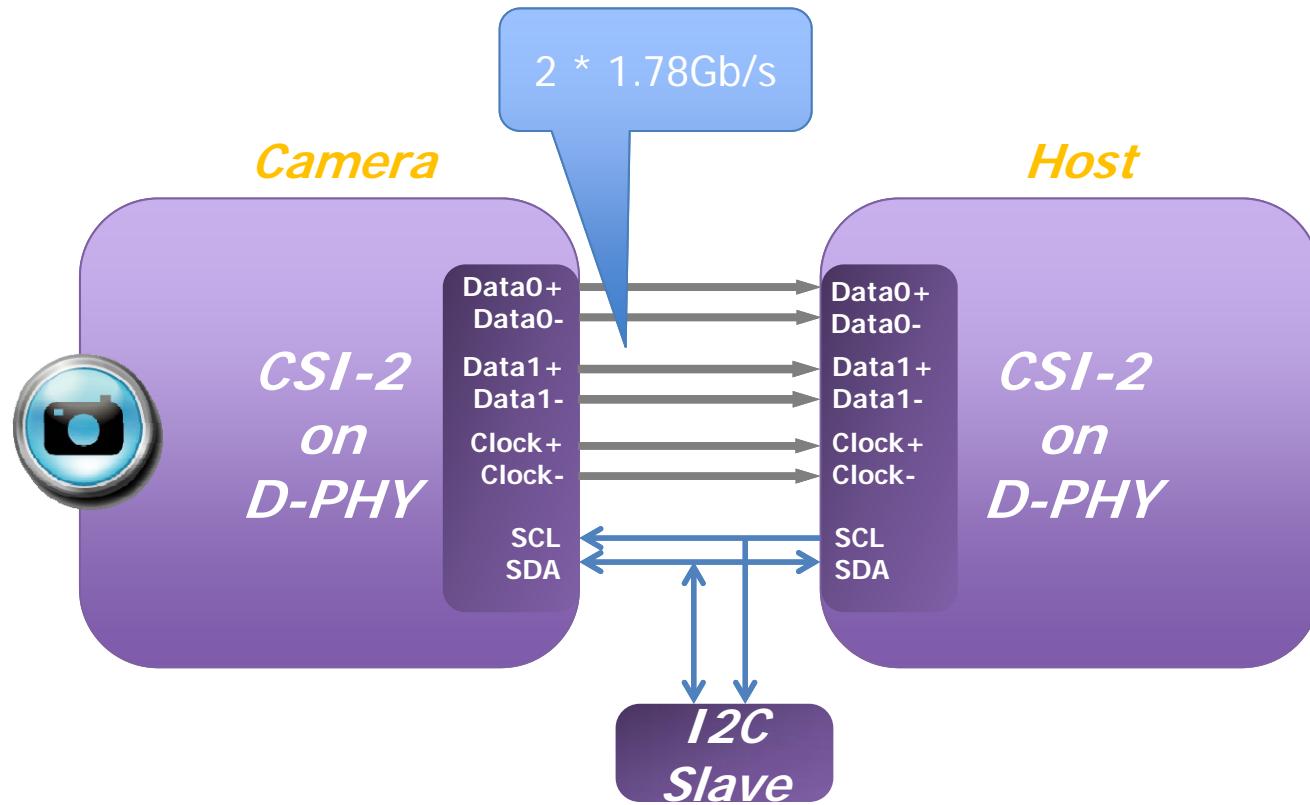
CSI-2 with "combo" PHY
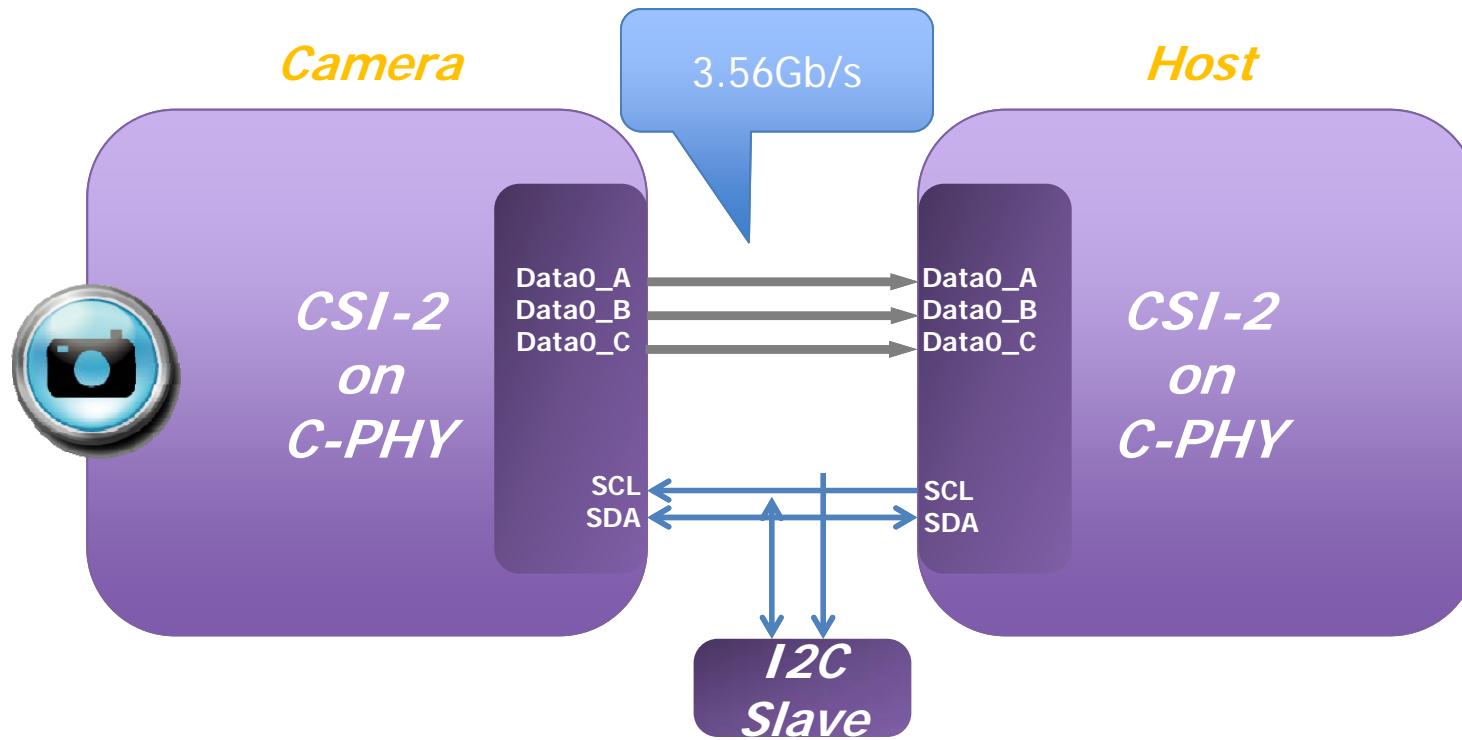
CSI-2 on D-PHY: 4K video 30FPS 12 BPP

2 * 1.78Gb/s

Camera

Host

CSI-2
on
D-PHY

CSI-2
on
D-PHY

Data0+
Data0-
Data1+
Data1-
Clock+
Clock-
SCL
SDA

Data0+
Data0-
Data1+
Data1-
Clock+
Clock-
SCL
SDA

I2C
Slave

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CSI-2 on C-PHY: 4K Video 30 FPS 12BPP

Camera

3.56Gb/s

Host

CSI-2 on C-PHY

Data0_A
Data0_B
Data0_C

Data0_A
Data0_B
Data0_C

SCL
SDA

SCL
SDA

CSI-2 on C-PHY

I2C Slave
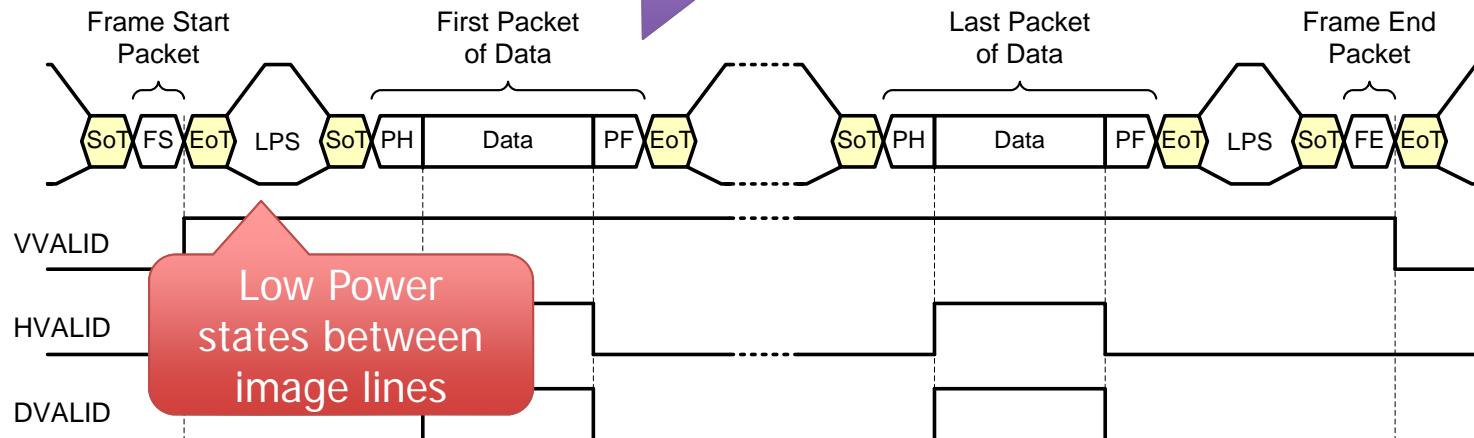
The CSI-2 Packets

Short Packets used for frame synchronization

Image data

Short Packets used for frame synchronization

Frame Start Packet

First Packet of Data

Last Packet of Data

Frame End Packet

| SoT | FS | EoT | LPS | SoT | PH | Data | PF | EoT | | SoT | PH | Data | PF | EoT | LPS | SoT | FE | EoT |

VVALID

Low Power states between image lines

HVALID

DVALID

KEY:
SoT – Start of Transmission   EoT – End of Transmission   LPS – Low Power State
PH – Packet Header   PF – Packet Footer + Filler (if applicable)
FS – Frame Start   FE – Frame End
LS – Line Start   LE – Line End

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Virtual Channels

Virtual Channel 0 – Line 0
Virtual Channel 0 – Line 1
Virtual Channel 0 – Line 2
Virtual Channel 0 – Line 3
Virtual Channel 0 – Line 4
Virtual Channel 0 – Line N

Virtual Channel 1 – Line 0
Virtual Channel 1 – Line 1
Virtual Channel 1 – Line 2
Virtual Channel 1 – Line 3
Virtual Channel 1 – Line 4
Virtual Channel 1 – Line M

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The Road Ahead

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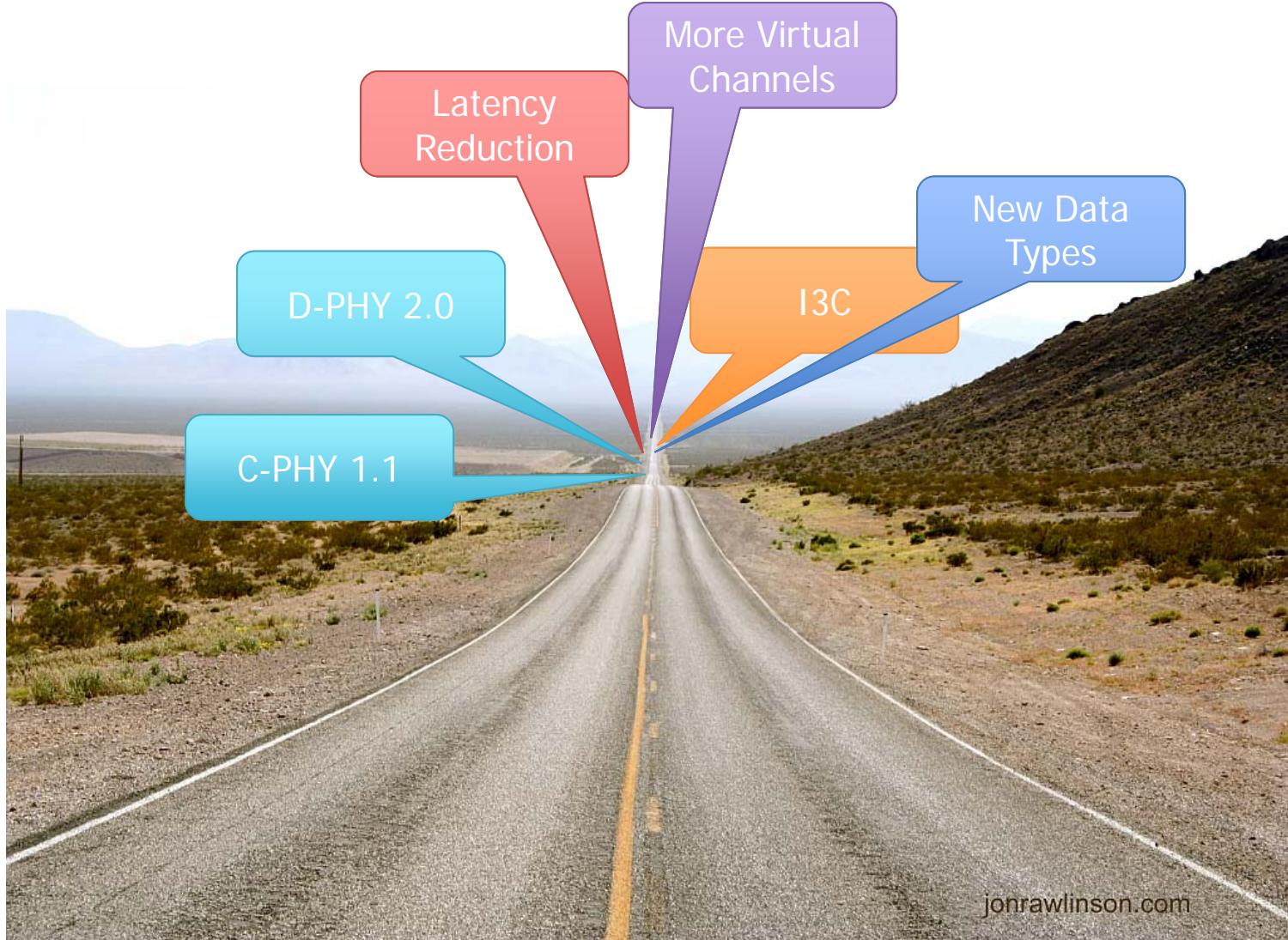
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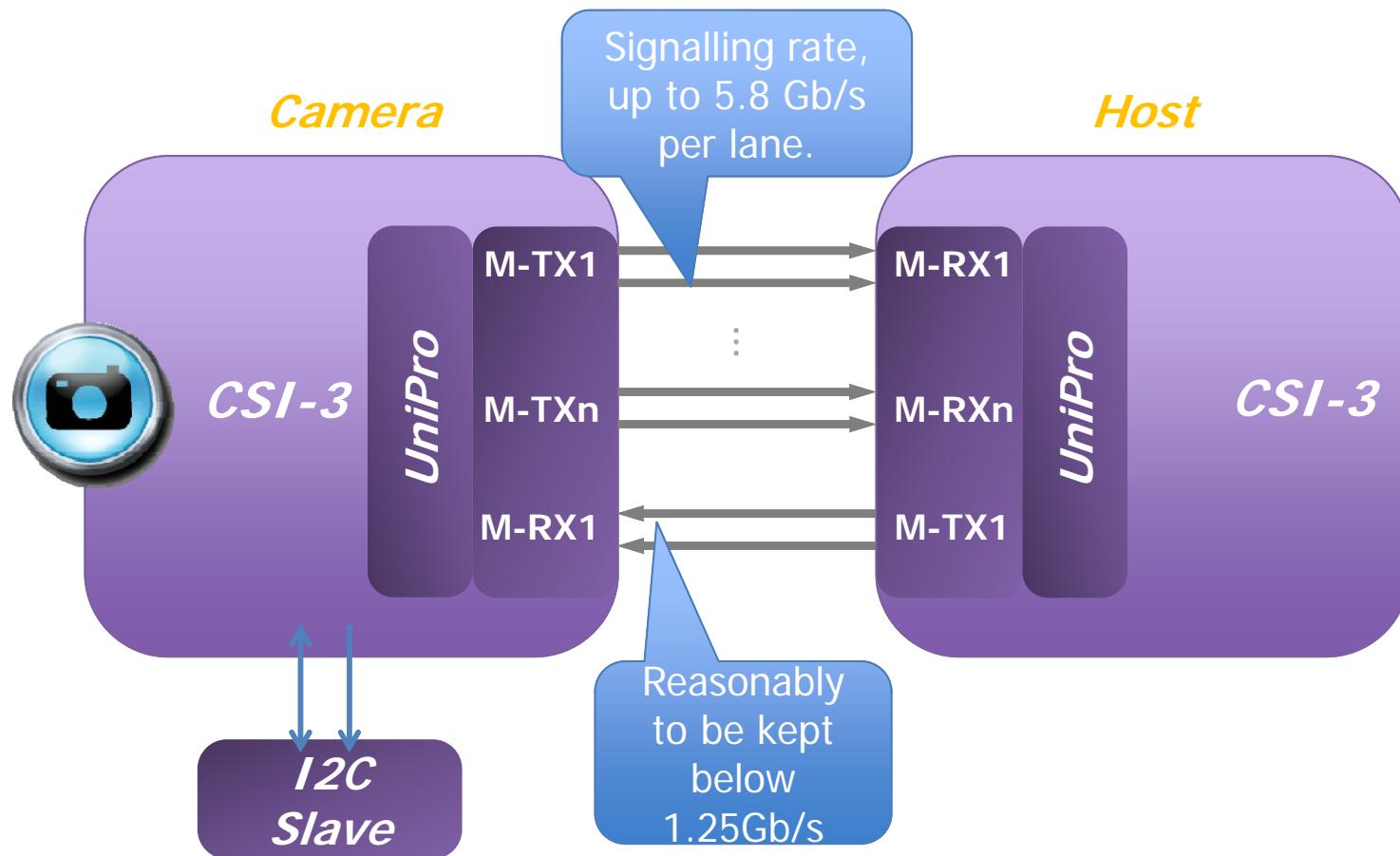
A new generation standard

THE CSI-3 PROTOCOL

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CSI-3 System

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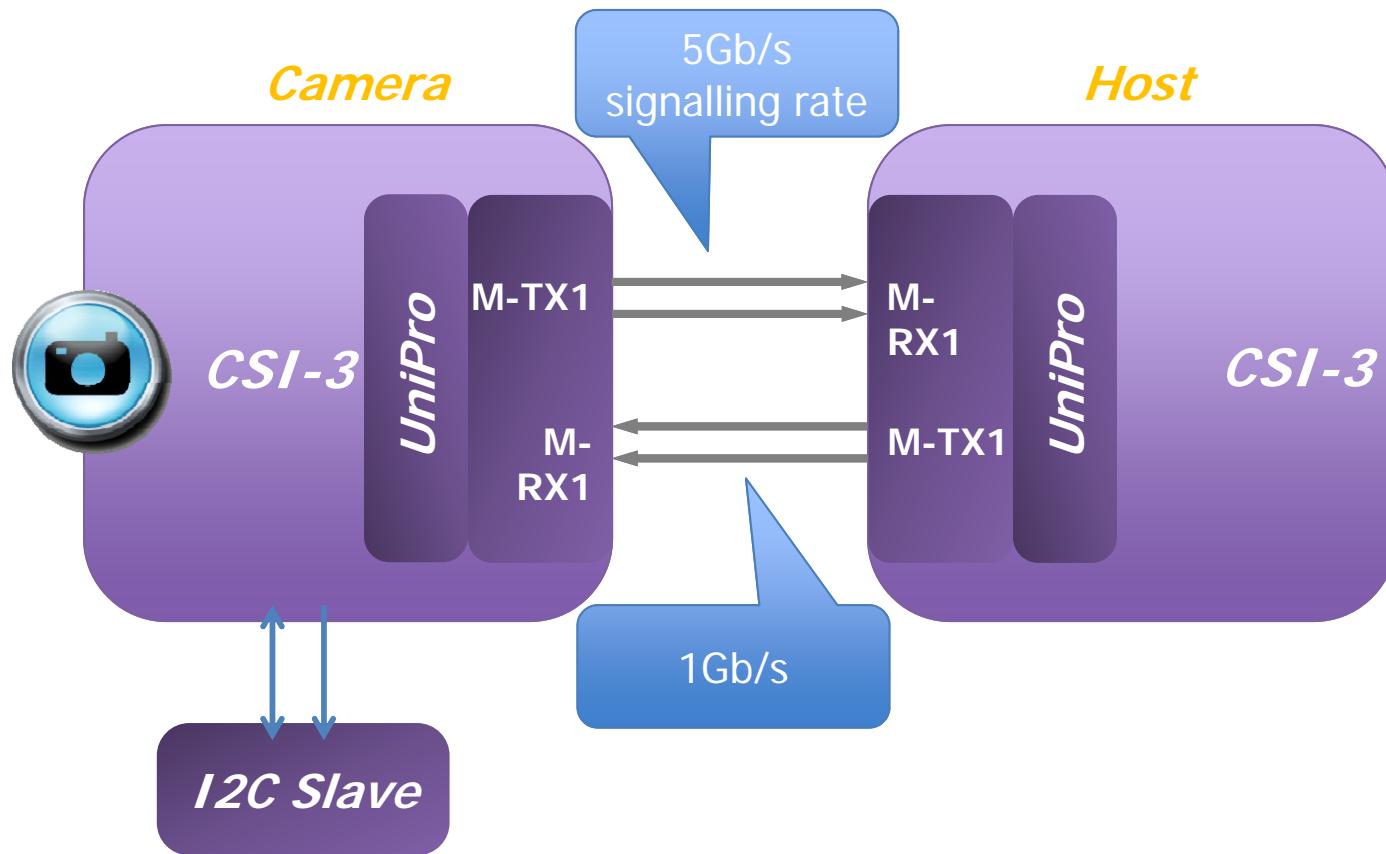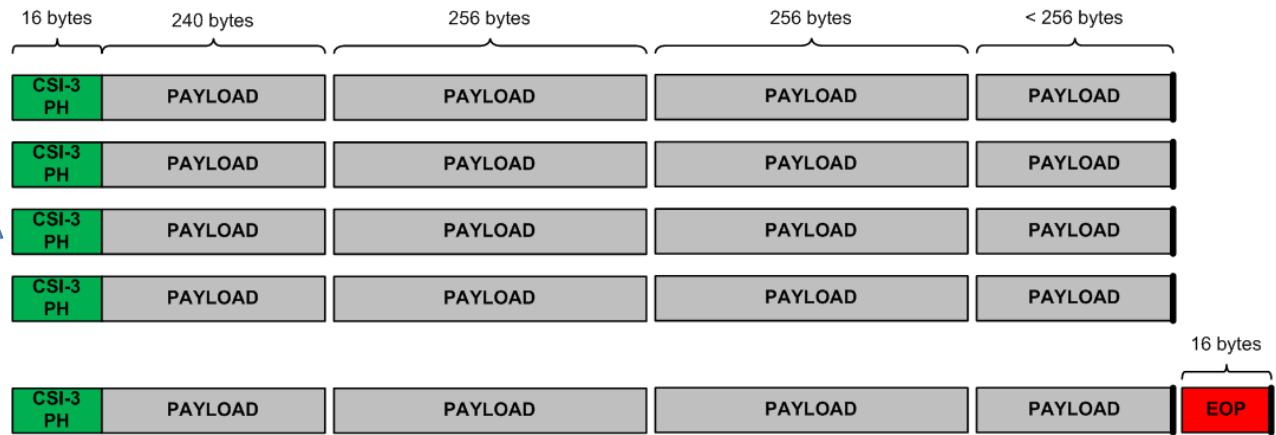
CSI-3 System: 4K Video 30FPS 12BPP

Camera

Host

5Gb/s signalling rate

CSI-3

UniPro

M-TX1

M-RX1

M-RX1

M-TX1

UniPro

CSI-3

1Gb/s

I2C Slave

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The CSI-3 Protocol
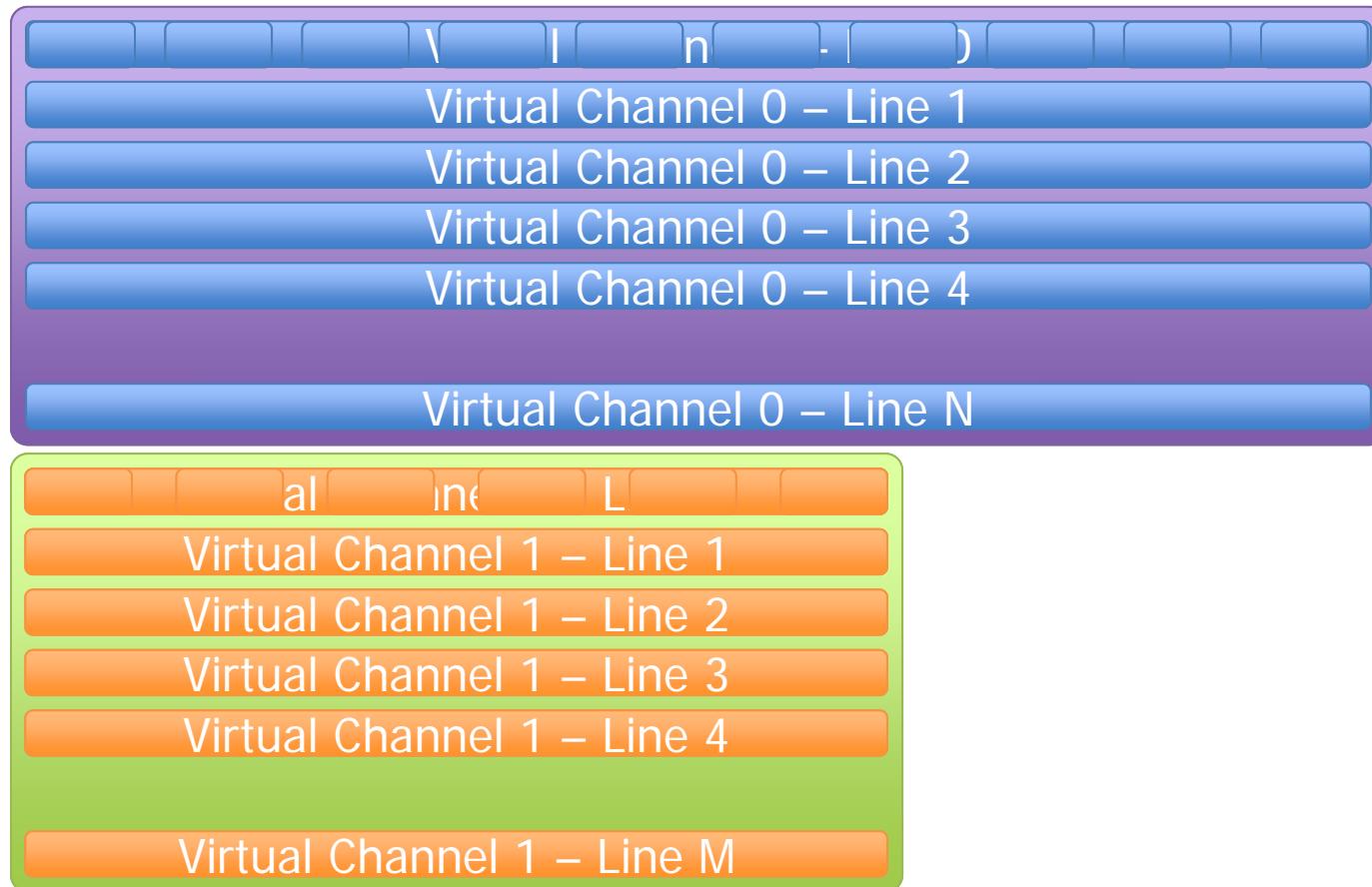
Packet based transmission offers high flexibility and makes the protocol ideal for network applications

16 bytes	240 bytes	256 bytes	256 bytes	< 256 bytes
CSI-3 PH	PAYLOAD	PAYLOAD	PAYLOAD	PAYLOAD
CSI-3 PH	PAYLOAD	PAYLOAD	PAYLOAD	PAYLOAD
CSI-3 PH	PAYLOAD	PAYLOAD	PAYLOAD	PAYLOAD
CSI-3 PH	PAYLOAD	PAYLOAD	PAYLOAD	PAYLOAD

16 bytes

CSI-3 PH	PAYLOAD	PAYLOAD	PAYLOAD	PAYLOAD	EOP

Guaranteed deliver of data by use of CRC checks and retransmission in case of bit errors.

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Packet Transmission

Virtual Channel 0 – Line 0

Virtual Channel 0 – Line 1

Virtual Channel 0 – Line 2

Virtual Channel 0 – Line 3

Virtual Channel 0 – Line 4

Virtual Channel 0 – Line N

Virtual Channel 1 – Line 0

Virtual Channel 1 – Line 1

Virtual Channel 1 – Line 2

Virtual Channel 1 – Line 3

Virtual Channel 1 – Line 4

Virtual Channel 1 – Line M

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Network Example

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The Road Ahead

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QUESTIONS?

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