TOSHIBA

Leading Innovation

2015 International Technical Exhibition seminar

USB3 Vision, its potential・・・

Date & time：15:30~16:20, (Thu) Dec. 3rd 2015

Venue：Seminar room in exhibition hall, Pacifico Yokohama

Sales & Marketing Div.

TOSHIBA TELI CORPORATION

Doc. No. 4300-0267

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Company overview

Name	**TOSHIBA TELI CORPORATION**
Established	**Feb 17th 1950 (from Toshiba Co.)**
HQ Location	**4-7-1, Asahigaoka, Hino, Tokyo, Japan**
Capital	**JPY 260 mill.**
Shareholder	**72.8% by Toshiba Co.**
Employees	**352 persons (as of Apr. 1st 2015)**
Business	**Design, manufacturing and sales of Industrial camera, medical camera, purveyance camera, RF power unit, remote controller etc.**
Facilities	**Head Quarter & works, Chubu branch, Kansai branch, Shanghai office**

Agenda

- **Advanced feature of USB3.0**
- **Introduction of USB3 Vision**
- **Advantage of our USB3 Vision camera BU/DU series**
- **Challenge to high reliability & quality**
- **Advanced function of BU/DU series camera**
- **TeliCamSDK**
- **Application example**
- **Standard product range**
- **New proposal by Toshiba Teli**

Advanced features of USB3.0

USB3.0 interface spec. (Overview)

1

■ Bit rate : max. 5Gbps (Super Speed)

- Uncompressed HDTV (1920x1080) image can be transferred in 60fps

2

■ Cable length : ~5m

7m, 8m depend on system

- Longer cable with complementary devices are getting available by venders
- Over 20m transfer by active optical cable (AOC)

3

■ Signal lines : 9 lines

- 4 lines: for ordinary USB2.0
- 4 lines: for expanded Super Speed
- 1 line :GND

4

■ Communication mode: Full duplex

- More effective communication than USB2.0 in semi duplex

5

■ BUS power: max. 900mA

- Up to 4.5W with 5V supply

Image transfer of our USB3.0 camera is supported by USB3.0 standard

6

■ Lower compatible

- USB3.0 device can be connected to USB2.0 port (works as USB2.0)
- USB2.0 device can be connected to USB3.0 port

USB3 Vision

What's USB3 Vision ?

- **Machine vision standard**

  (IEEE1394 by IIDC, Gig-E by Gig-E Vision)
- **High band width of 5Gbps (440 MByte/s)**
- **Easy connection with Plug & Play**
- **5m cable length (passive cable)**

  (Longer in case of active optical cable)
- **Standardized software interface with GenICam™**
- **Much improved robust than USB2.0**

Major members of USB3 Vision standard

※ Names and Logo might be trade mark or registered trade mark.

High band width transfer

HIGH
Bandwidth

- Full use of high speed image sensor's feature … USB3.0
- High band width transfer by burst … USB3.0

Sensor : Sony IMX174
Resolution : 1920 x 1200 (2.3MP)

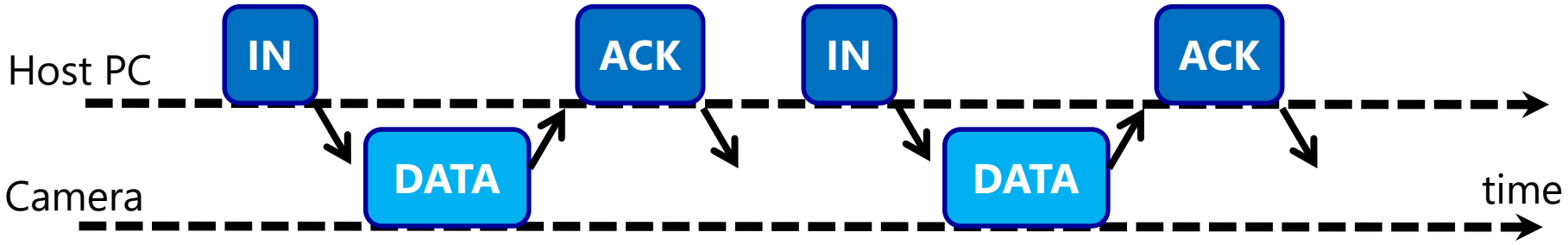
Gig-E Vision Camera	USB3 Vision Camera
Max. frame rate: 50fps	Max. frame rate: 165fps
Data rate: 115MB/s	Data rate: 380MB/s

Sensor : CMOSIS CMV4000
Resolution : 2048 x 2048 (4.2MP)

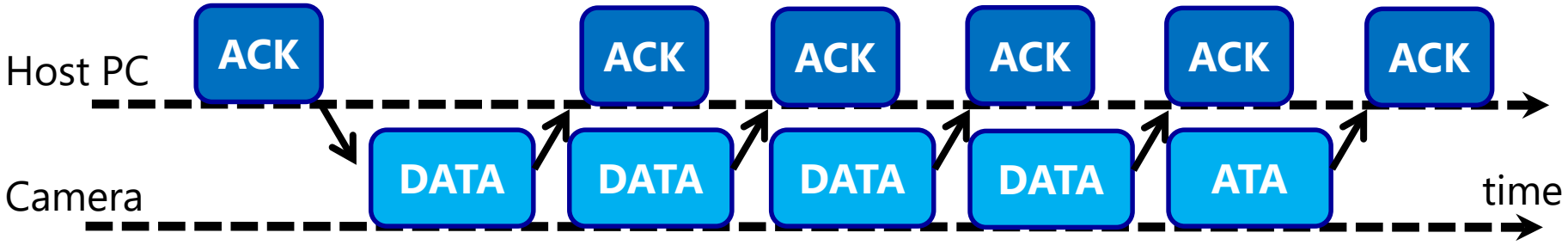
Gig-E Vision Camera	USB3 Vision Camera
Max. frame rate: 25fps	Max. frame rate: 90fps
Data rate: 105MB/s	Data rate: 377MB/s

For burst transfer

■USB2.0 : Not for burst transfer

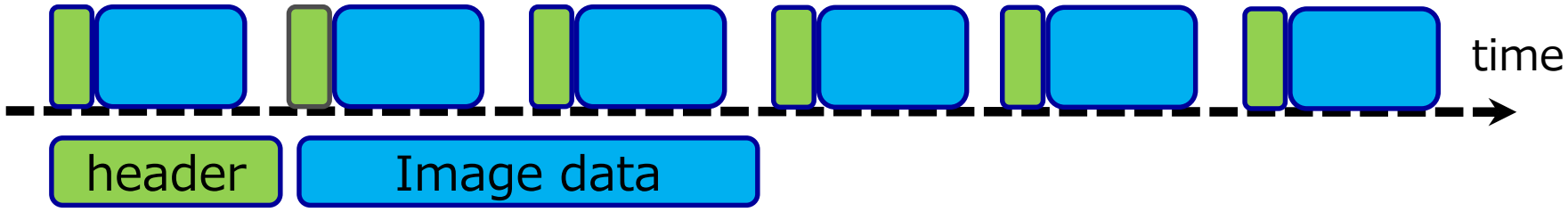


■USB3.0 : for burst transfer

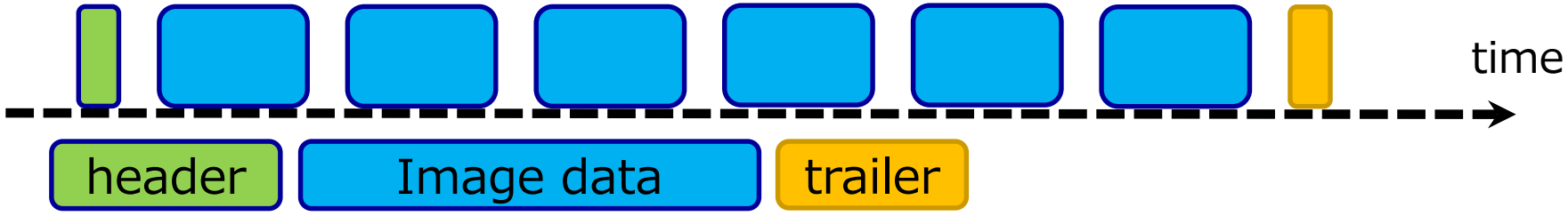


Packet format of USB3 Vision

■ UVC (USB Video Class) packet format



■ USB3 Vision packet format



System cost comparison

LOW COST

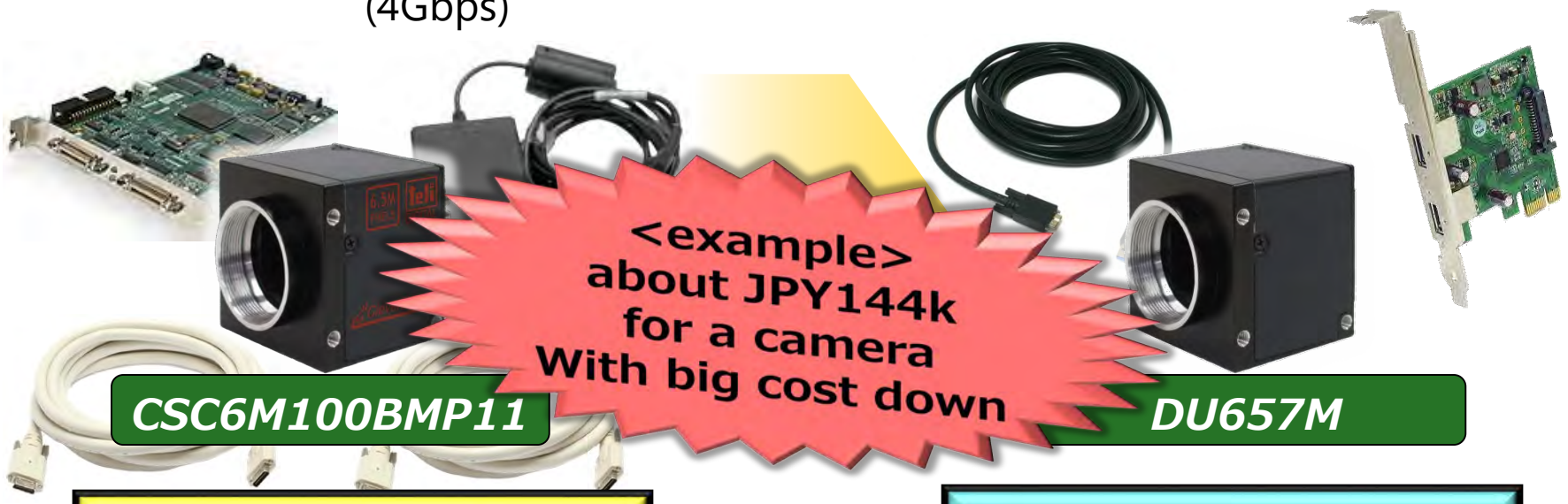
- Low cost accessories …USB3.0
- No power supply is needed …USB3.0

	USB3.0	Gig-E	1394.b	Camera Link
Frame graber	Low	Low	Mid.	High
Cable	Low	Low	Mid.	High
Power supply	Bus	External/ PoE	Bus	External/ PoCL
Camera	Low	Mid.	Mid.	Low
System cost of 4 cameras	**Low**	**Mid.**	**Mid.**	**High**

Applicable range of USB3.0

CameraLink
Medium Configuration
(4Gbps)

USB3.0
(4Gbps)



A camera (CL-FullConfig)
About JPY420k

camera (6.5M)	: JPY280k
board	: JPY100k
cable	: JPY30k
(power)	: JPY10k

A camera (USB3 Vision)
About JPY276k

camera (6.5M)	: JPY260k
board	: JPY8k
cable	: JPY8k

Big cost down by replacing Camera Link system with USB3.0 system!

High reliability

HIGH
Reliability

- Reliable data transfer is ensured ···USB3.0
- Packet format, Appropriate for DMA transfer ···USB3 Vision

Protocol Layer
data check by CRC
packet retransmission in protocol layer level

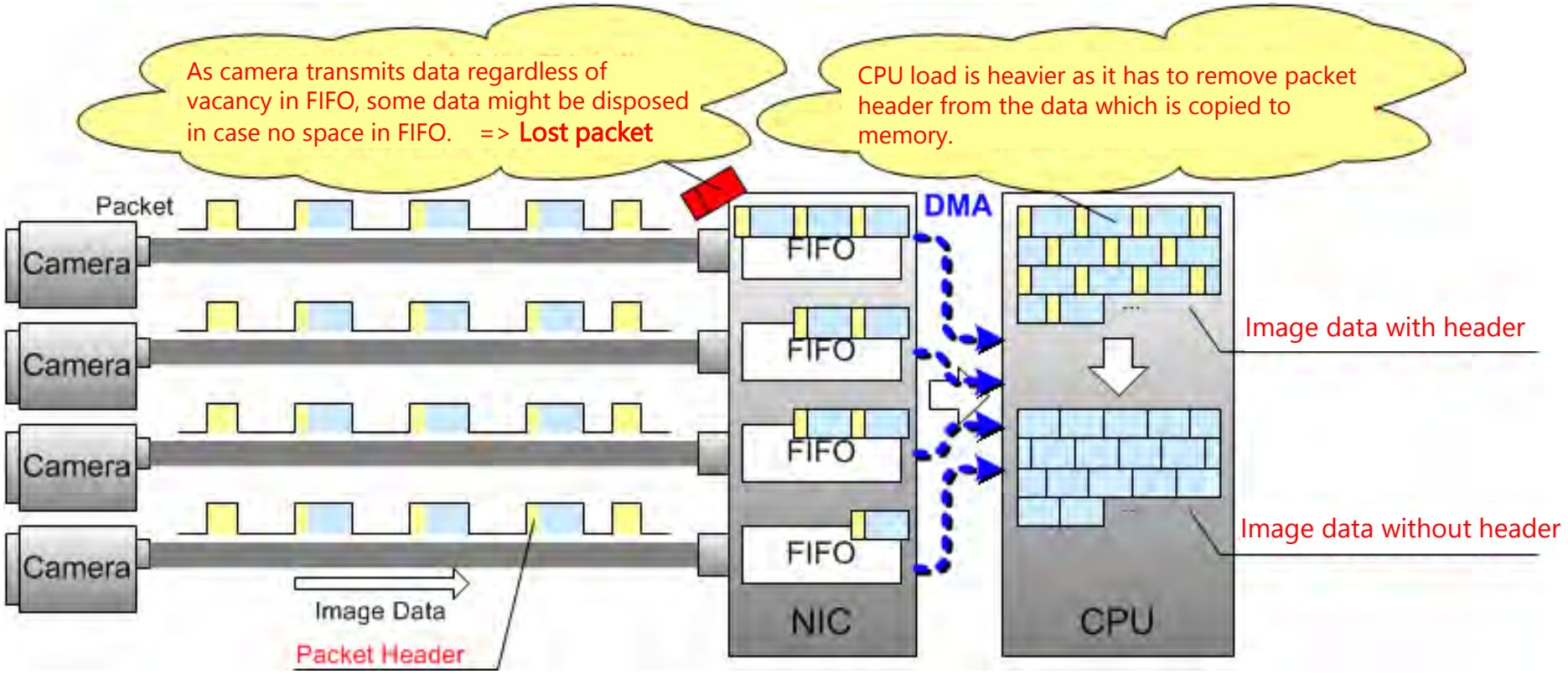
Link Layer
data check by CRC
packet retransmission in protocol layer level

Error protection of USB3.0 is much improved from USB2.0

Physical Layer
bit error ratio in physical layer level is less than $1x10^{-12}$bits

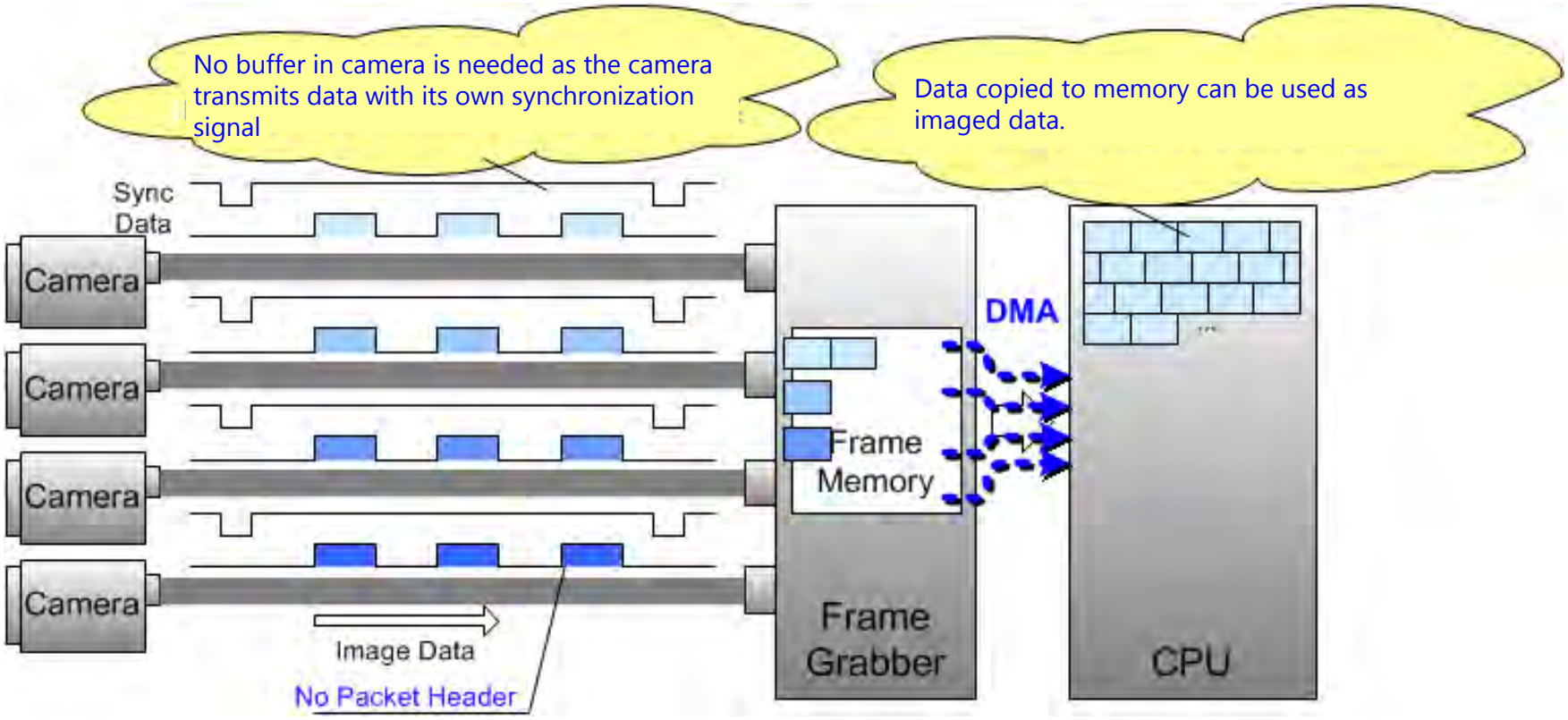
Data transfer reliability in CPU load aspect

- Gig-E Vision



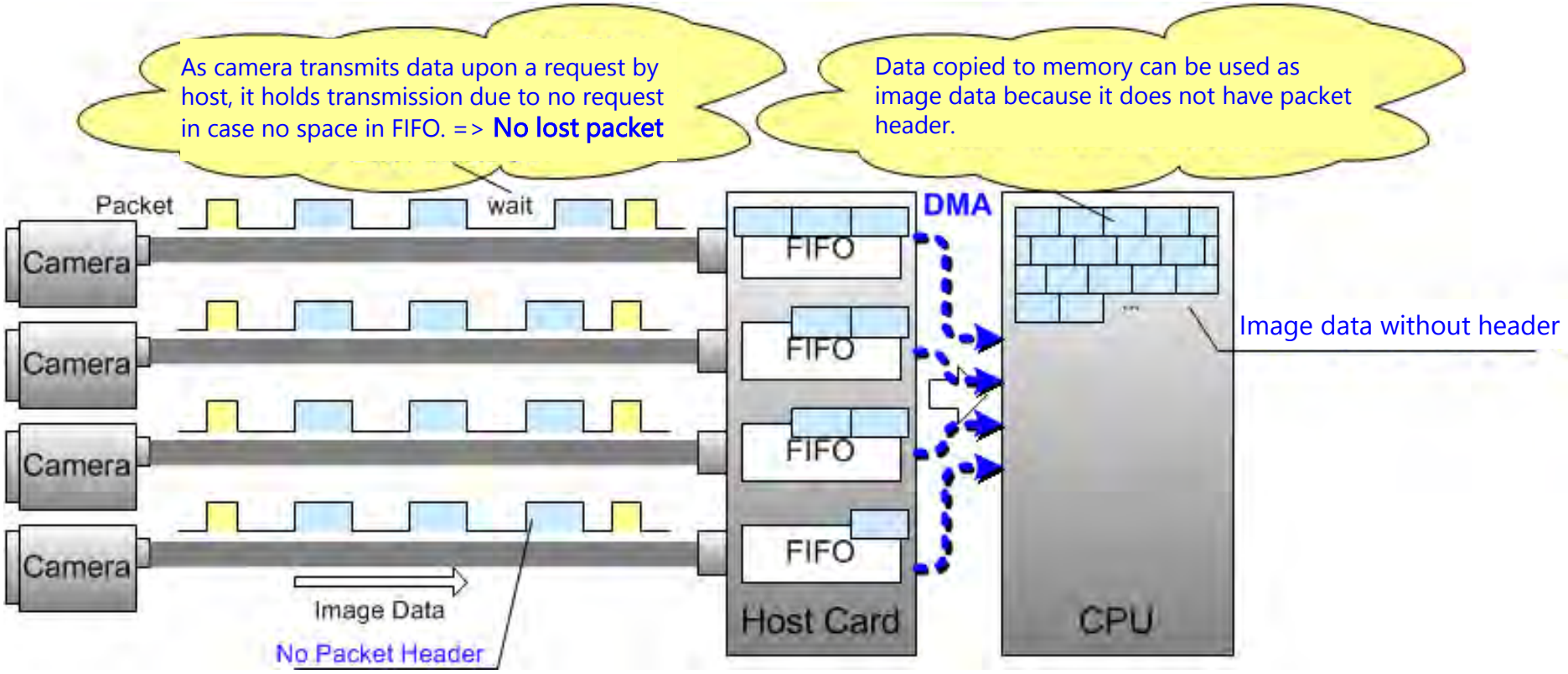
Data transfer reliability in CPU load aspect

- Camera Link



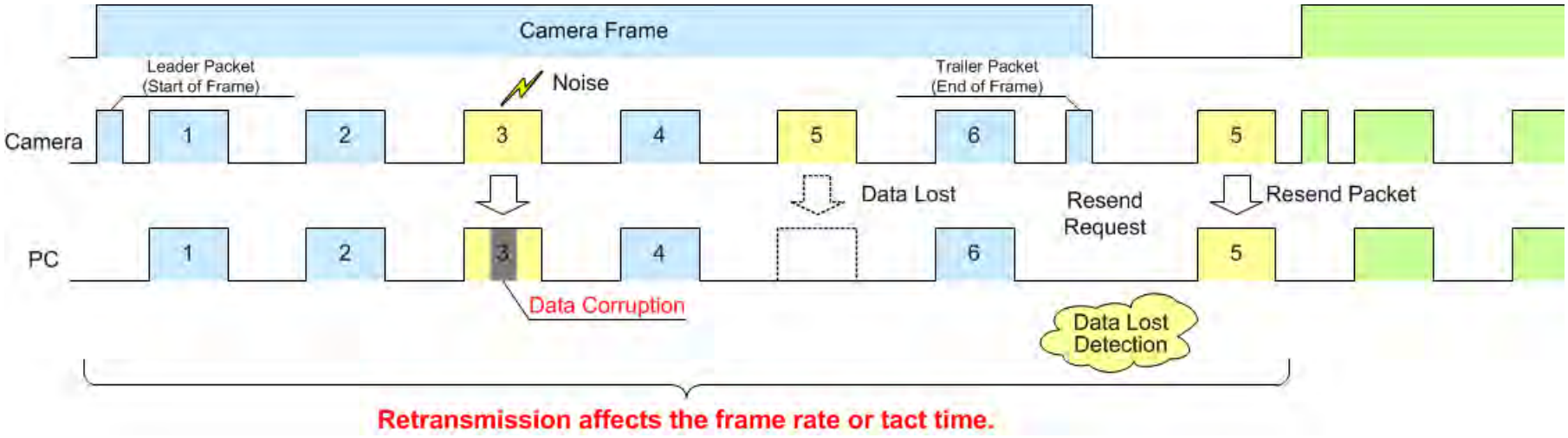
Data transfer reliability in CPU load aspect

- USB3 Vision



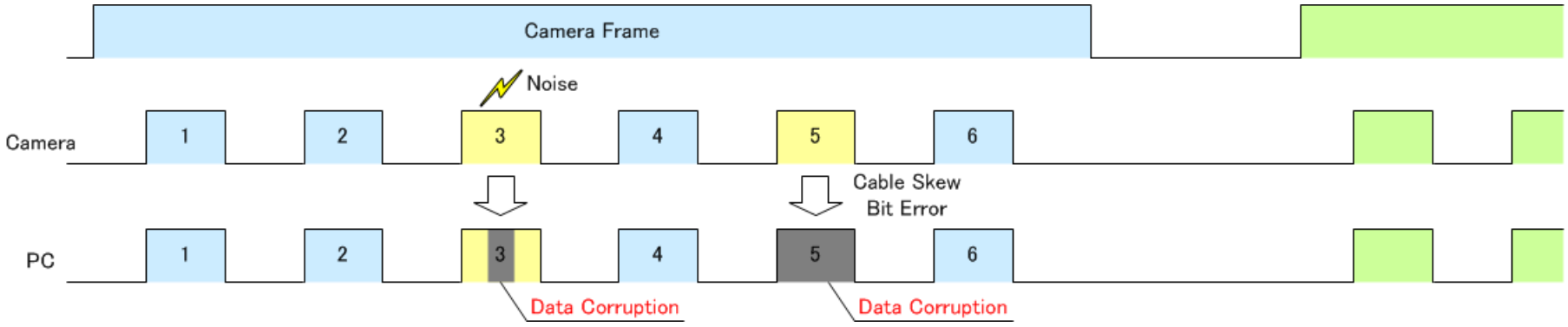
Comparison of error detection and packet retransmission

- Gig-E Vision



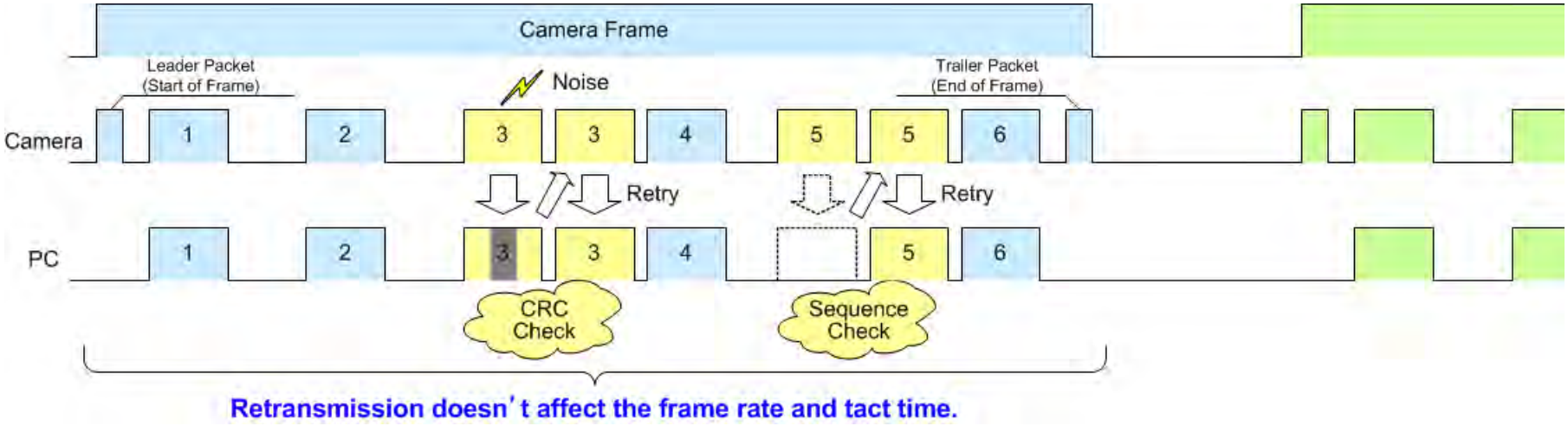
Comparison of error detection and packet retransmission

- Camera Link



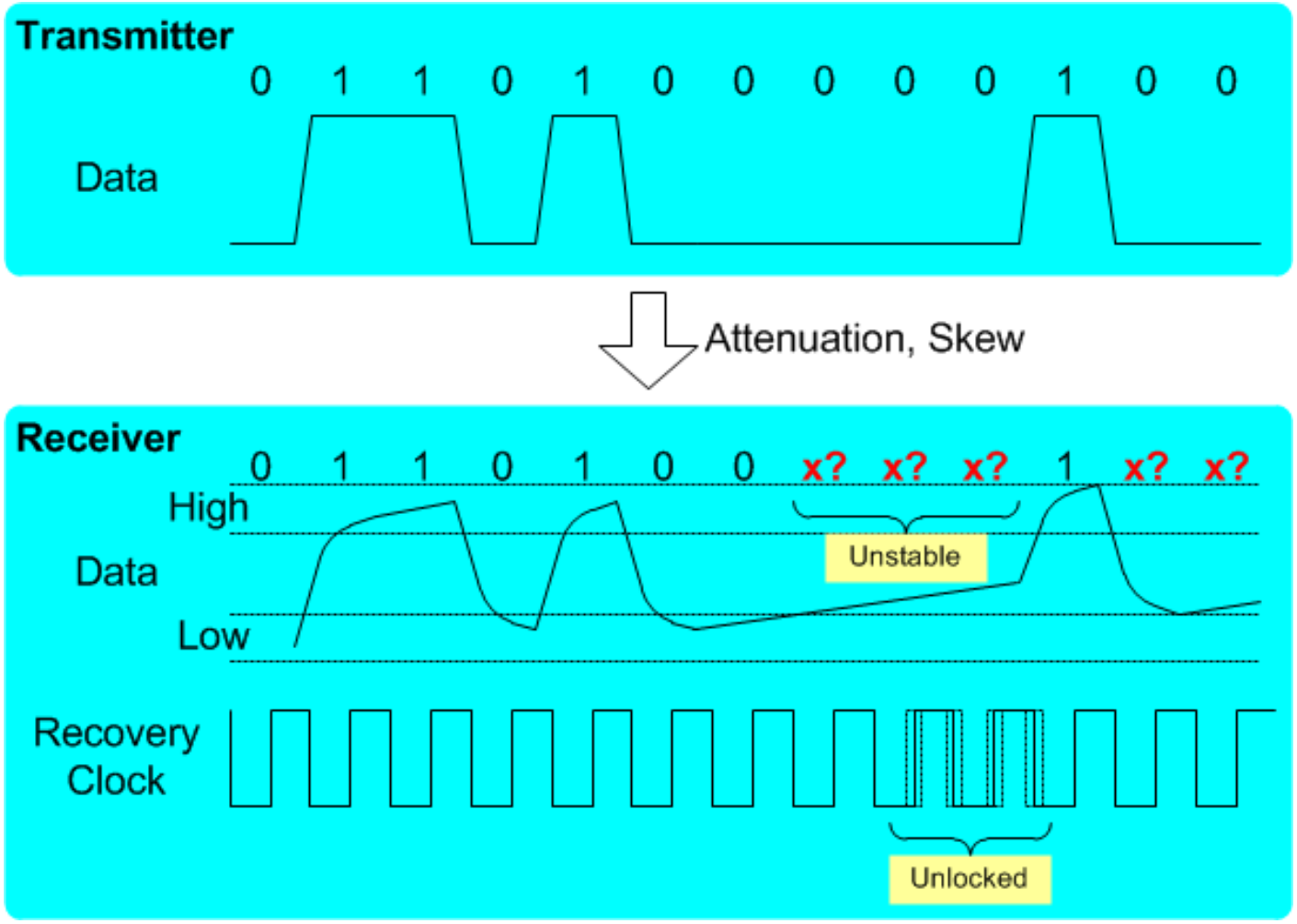
Comparison of error detection and packet retransmission

- USB3 Vision



Expanded data reliability by USB3.0 (Physical Layer)

- DC balance in physical layer



Expanded data reliability by USB3.0 (Physical Layer)

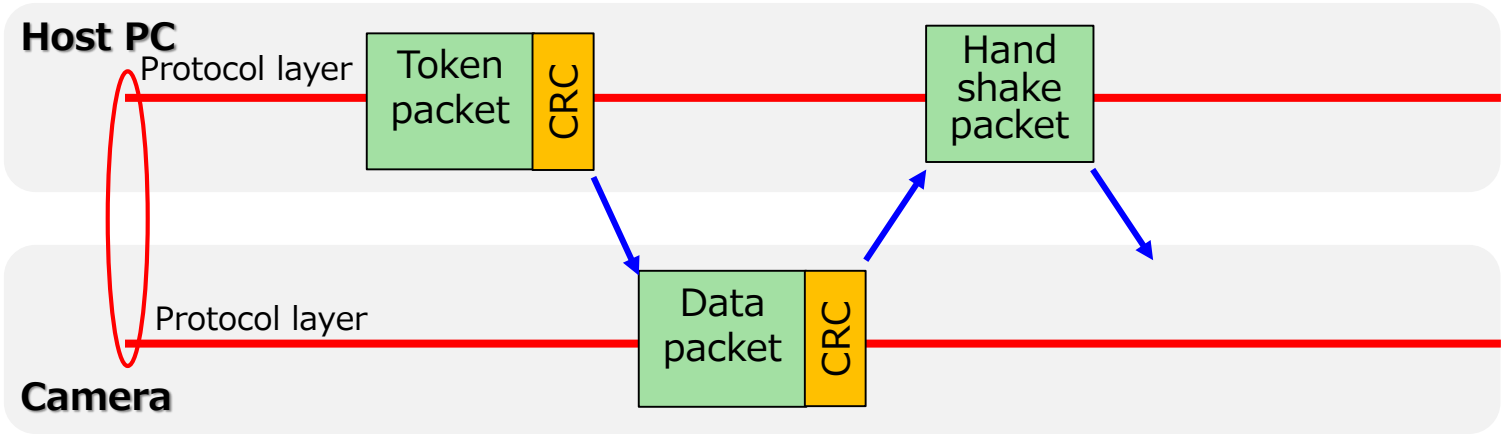
- 8b/10b encode is used in USB3.0

	Encode method	DC balance
CameraLink	none	Bad
IEEE1394.b	8b/10b	**Excellent**
Gig-E(1000Base-T)	PAM5	**Excellent**
USB2.0	NRZI	Good
USB3.0	**8b/10b**	**Excellent**

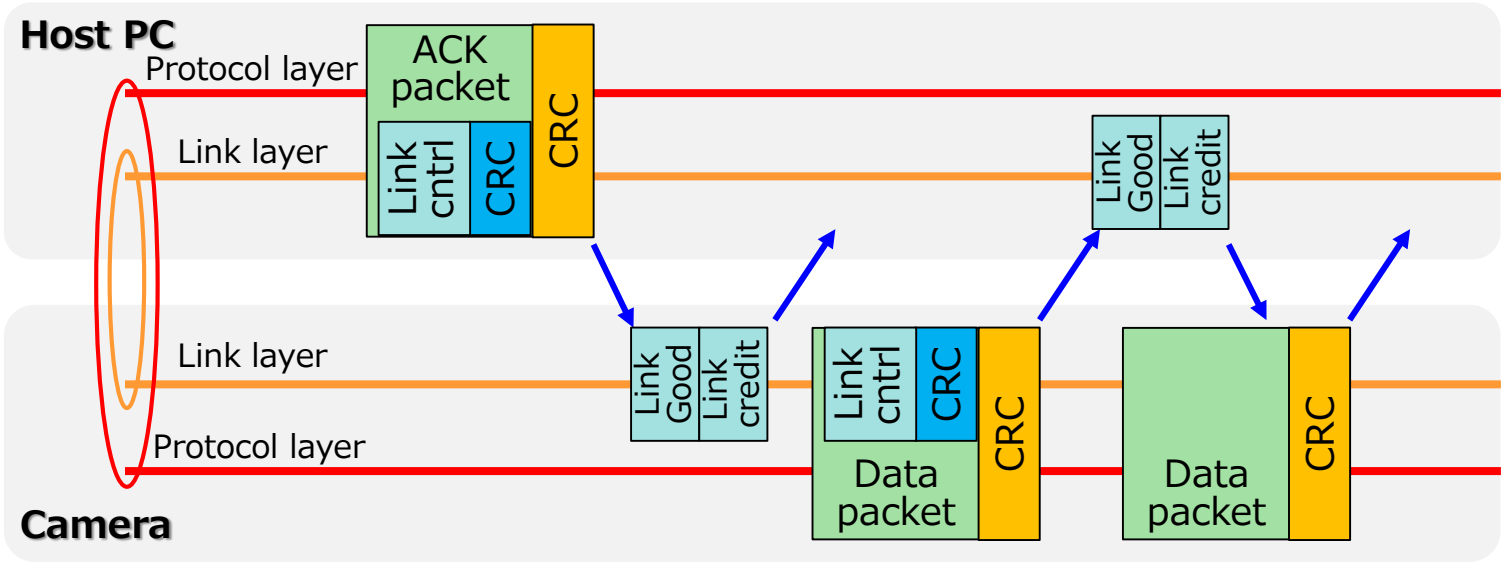
Expanded data reliability by USB3.0 (Link/Protocol Layer)

- Error handling in link layer/protocol layer

USB2.0



USB3.0

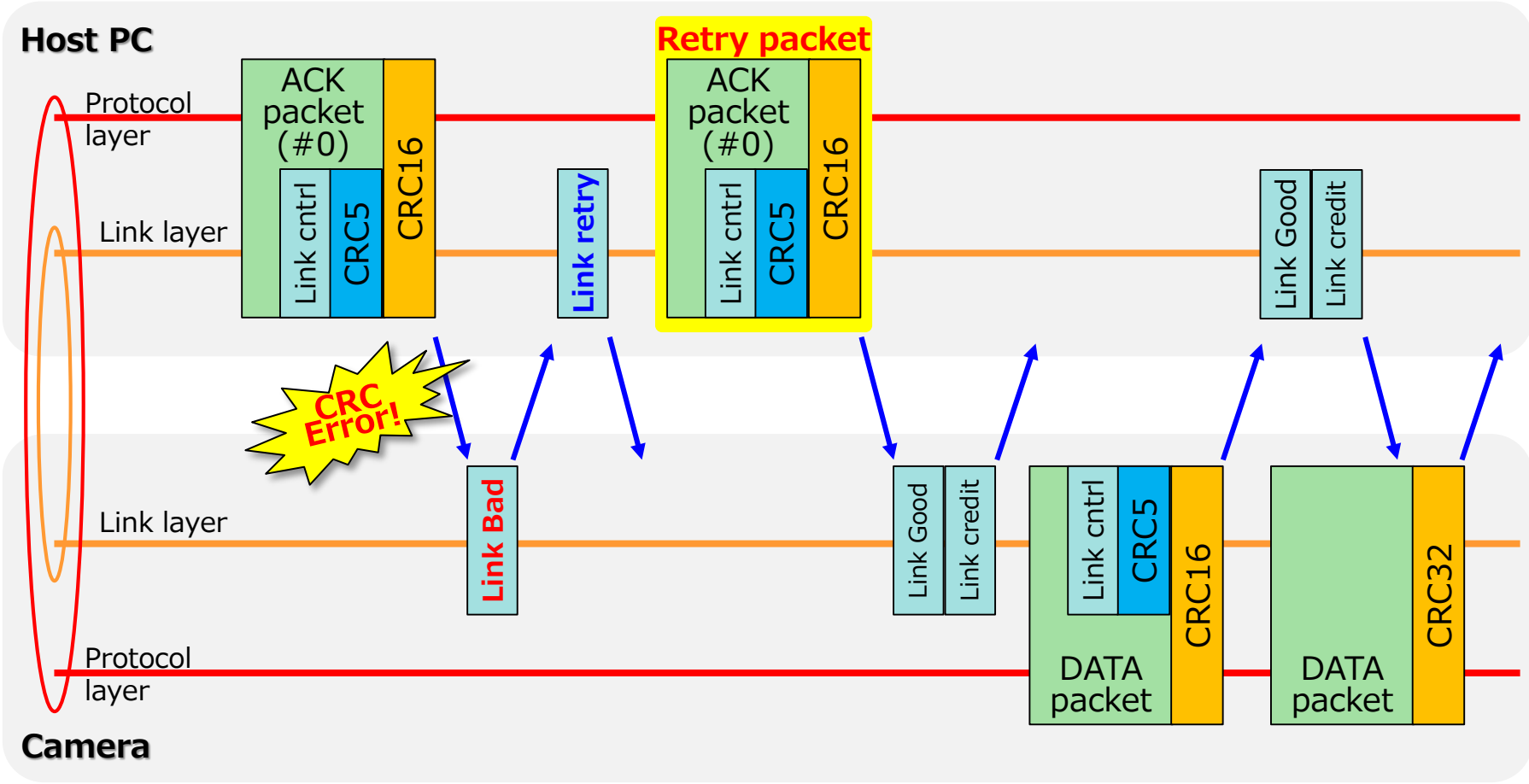


Expanded data reliability by USB3.0 (Link Layer)

Mechanism of USB3.0 re-try

USB3.0

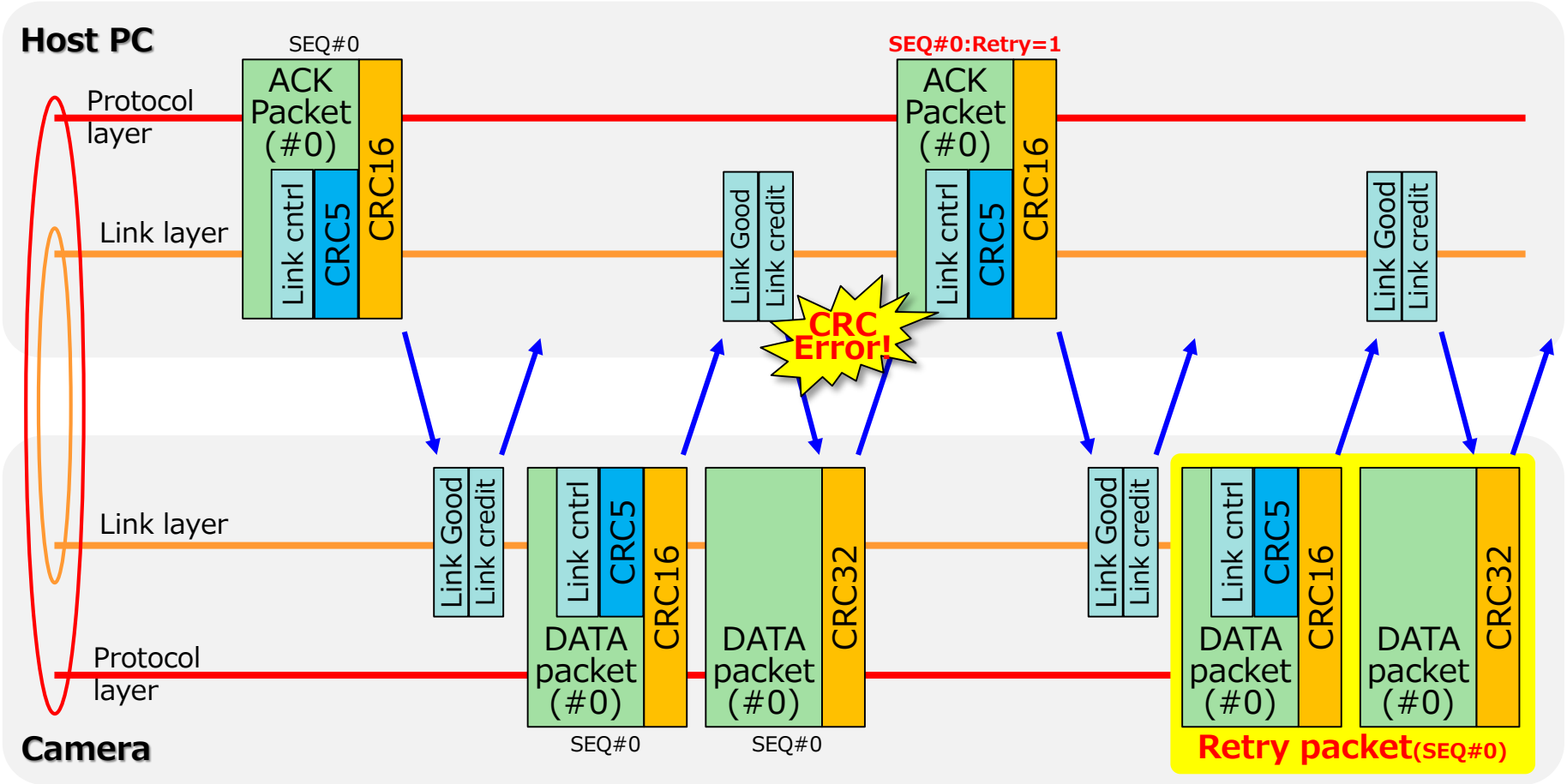
(example of retransmission in link layer level)



Expanded data reliability by USB3.0 (Protocol Layer)

- Retry mechanism of USB3.0 (example in protocol layer)

USB3.0



Expanded reliability by USB3.0

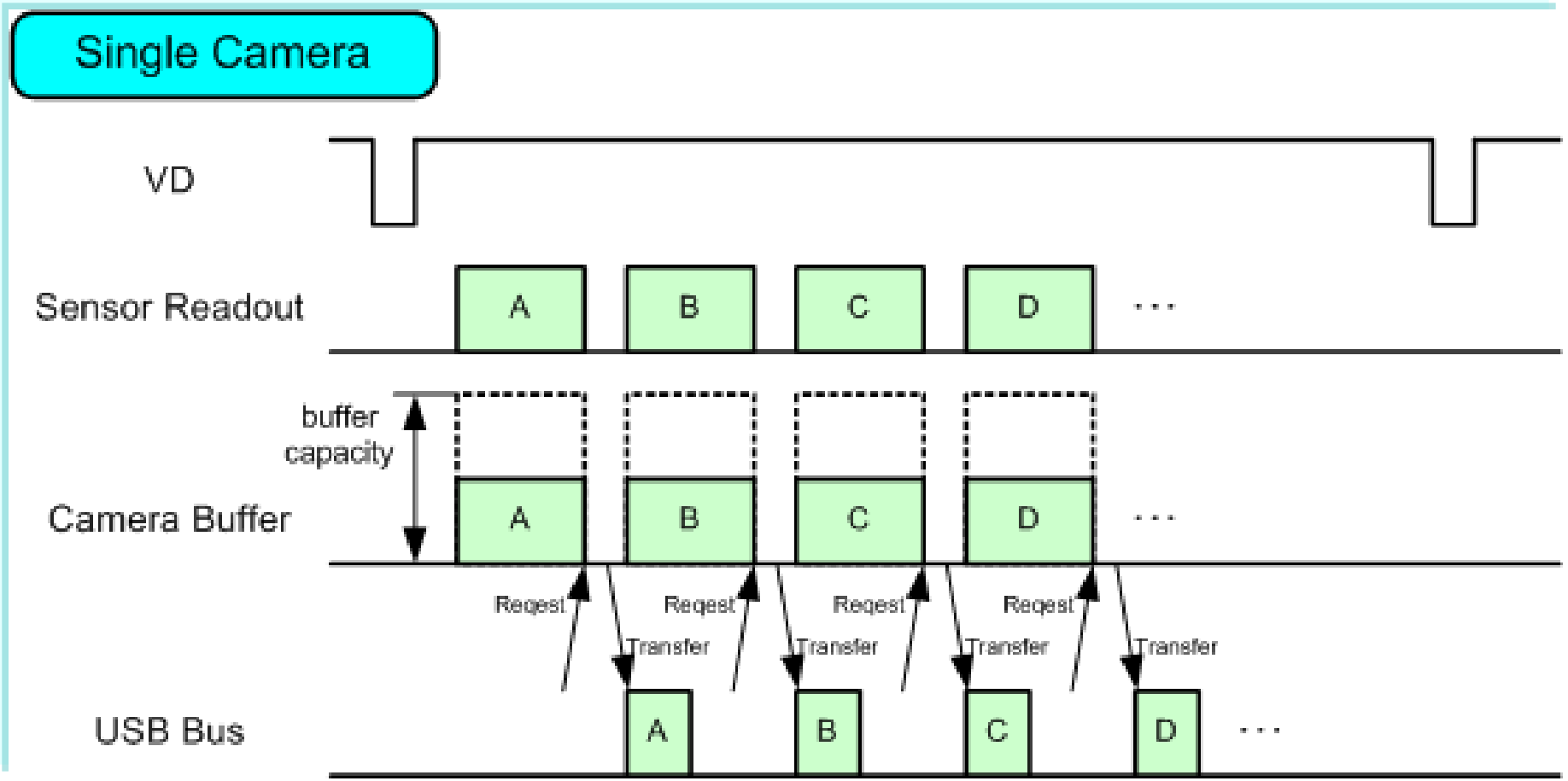
- Support for packet retransmission

	Retry layer	Remarks
CameraLink	None	-
IEEE1394.b	None	Isochronous
Gig-E(1000Base-T)	Application	Gig-E Vision
USB2.0	Protocol	Bulk
USB3.0	**Link/Protocol**	Bulk

Advantage of our USB3 Vision camera BU/DU series

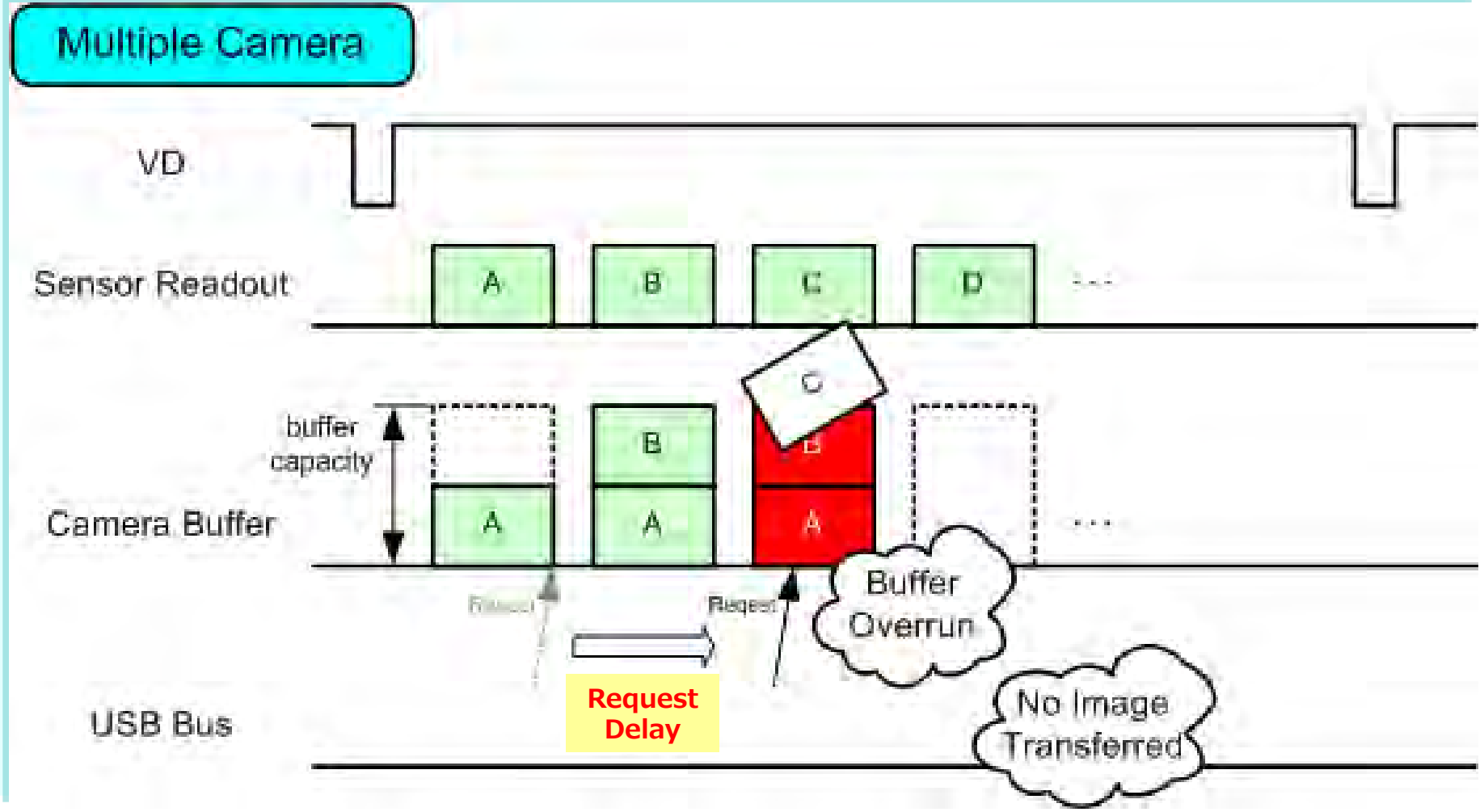
Flow control of image data

- Getting image from a camera :



Flow control of image data

- Example of delayed transmission request from PC with multiple cameras :



Flow control of image data

- Buffer over run protection on our USB3 Vision camera CCD model :

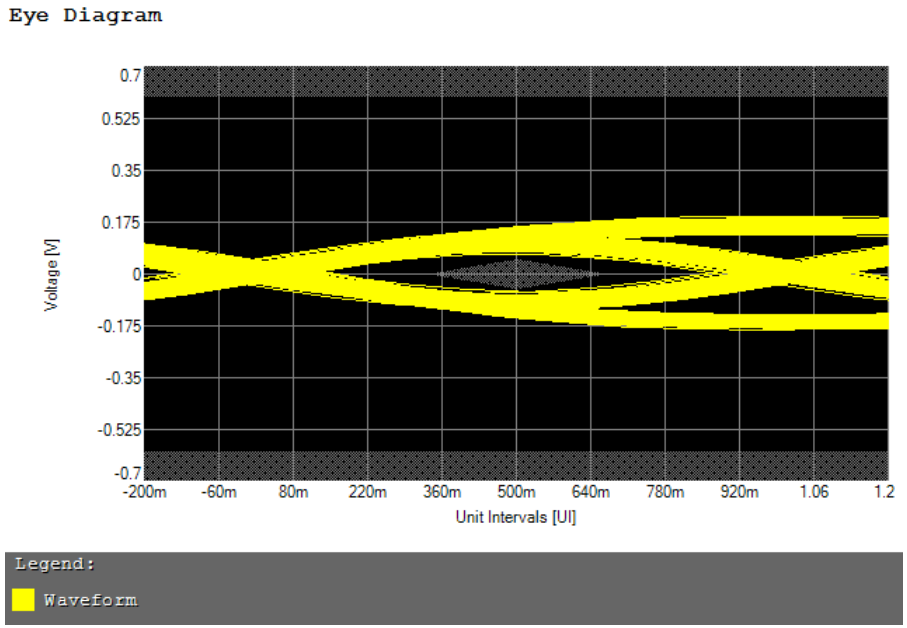
- Solution :

Buffer over run protection realizes a unique control by our design.

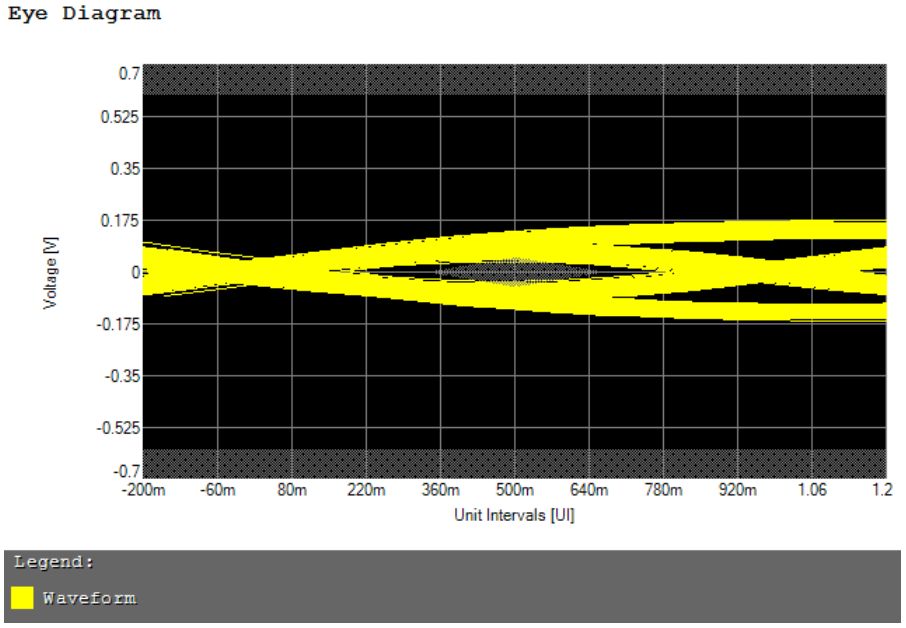
Error recovery

- Cause of communication instability

Good quality cable: eyes are opened

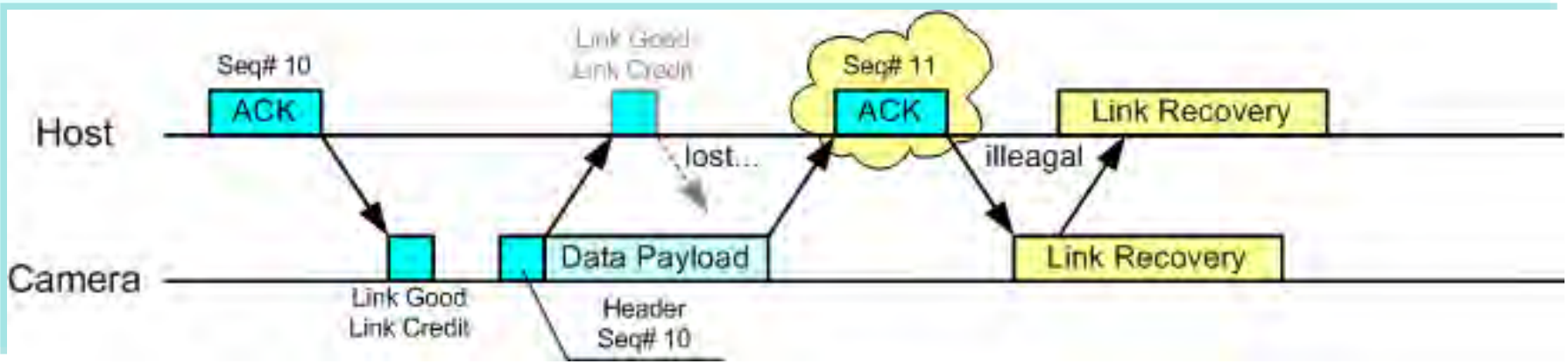


Poor quality cable: eyes are closed



Error recovery

- Case 1: Lost of packet from host

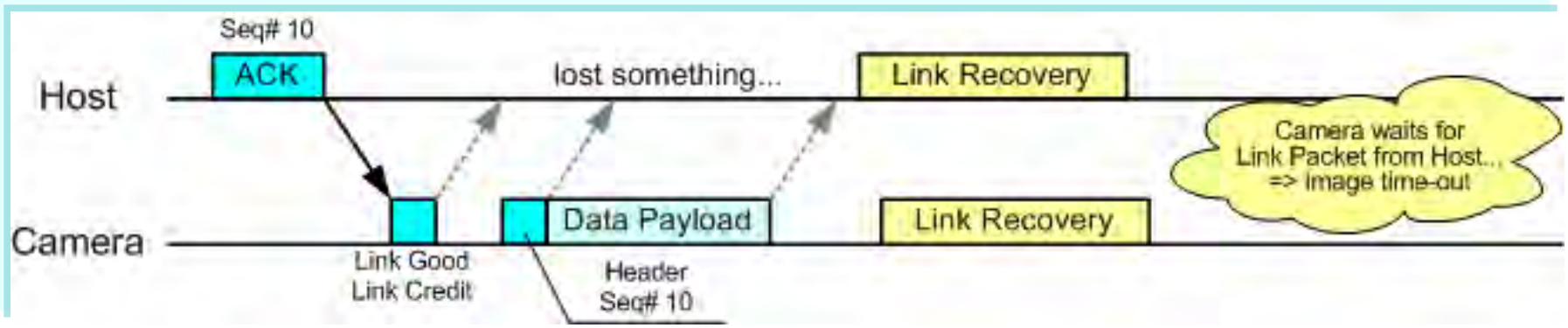


- Solution :

BU/DU camera realizes a unique error recoveries by our USB IP.

Error recovery

- Case 2: Lost of packet from camera



- Solution:

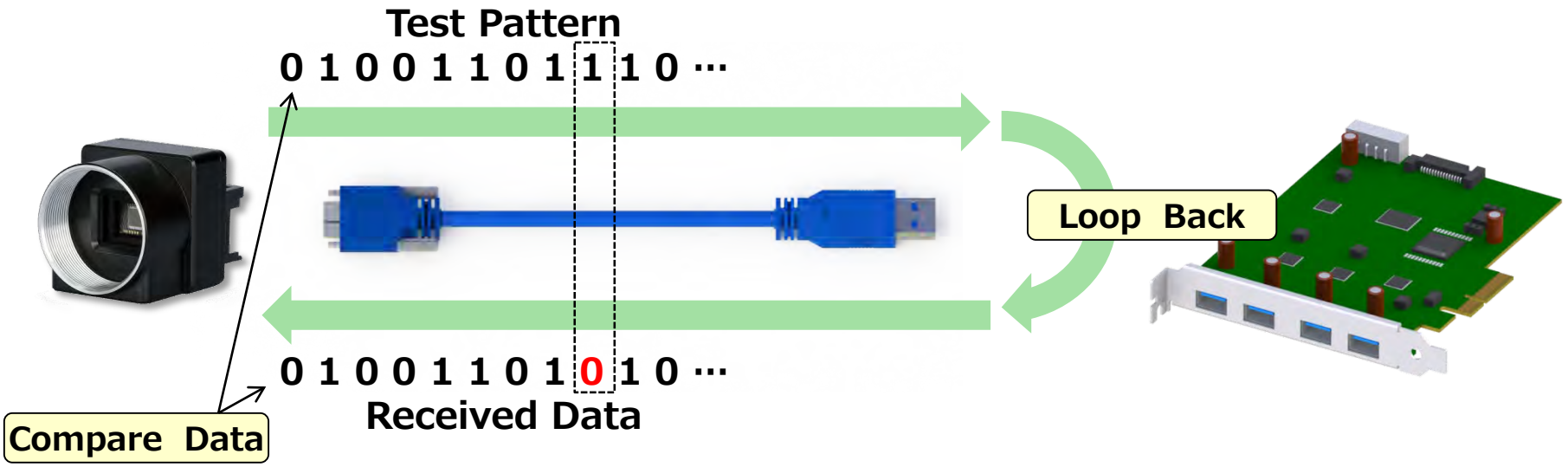
BU/DU camera realizes a unique error recoveries by our USB IP.

Reset function

- Camera reset
- Host controller reset

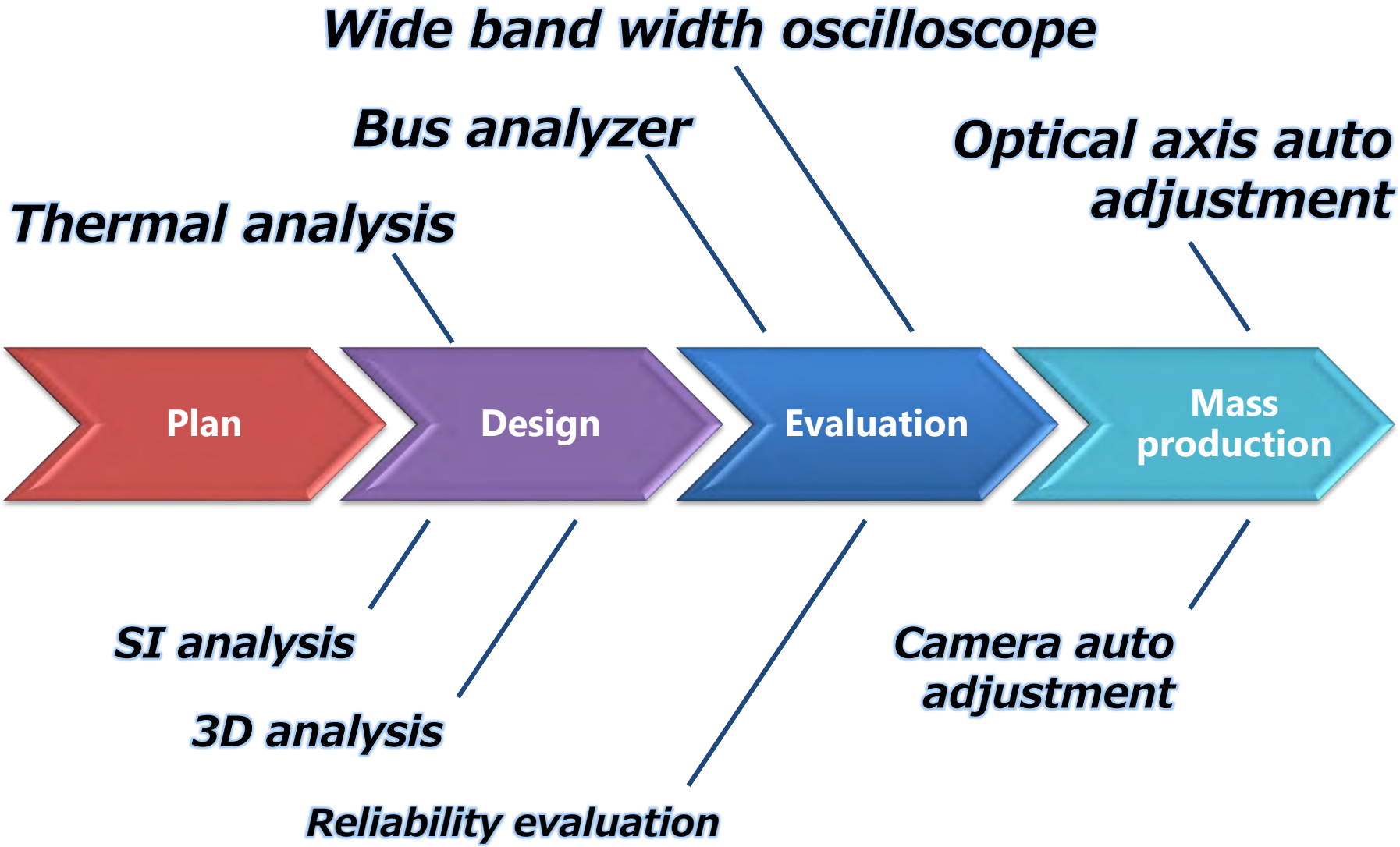
BERT function

- BERT (Bit Error Rate Test) = CMOS model



Challenge to reliability and quality

Challenge to each development status



SI analysis

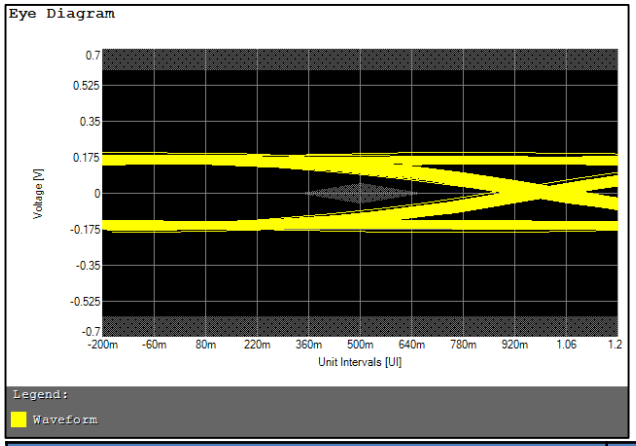
Ensure signal quality on the board by SI analysis

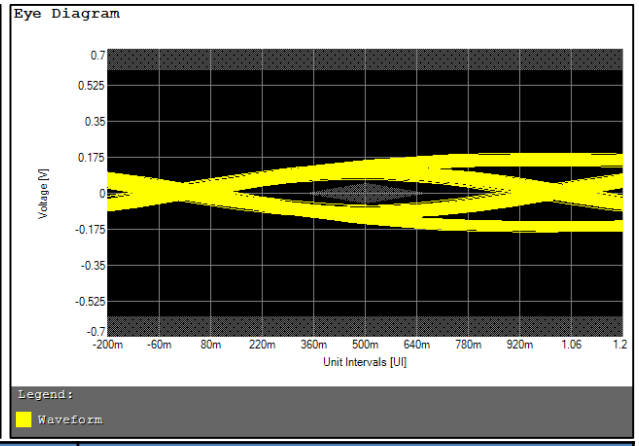
3D analysis

Ideal pattern layout by prior board pattern simulation of impedance, attenuation, delay etc.

Demonstrated signal quality

- Clearing standard by actual measuring verification based on USB compliance test.





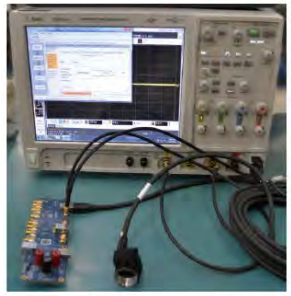
Test Name	Pass	Spec Range
LFPS Peak-Peak Differential Output Voltage	✓	800.0 mV <= VALUE <= 1.2000 V
LFPS Period (tPeriod)	✓	20.0000 ns <= VALUE <= 100.0000 ns
LFPS Burst Width (tBurst)	✓	600.0 ns <= VALUE <= 1.4000 µs
LFPS Repeat Time Interval (tRepeat)	✓	6.0000 µs <= VALUE <= 14.0000 µs
LFPS Rise Time	✓	VALUE <= 4.0000 ns
LFPS Fall Time	✓	VALUE <= 4.0000 ns
LFPS Duty cycle	✓	40.0000 % <= VALUE <= 60.0000 %
LFPS AC Common Mode Voltage	✓	VALUE <= 100.0 mV
TSSC-Freq-Dev-Min	✓	TSSCMin ppm <= VALUE <= TSSCMax ppm
TSSC-Freq-Dev-Max	✓	-300.000 ppm <= VALUE <= 300.000 ppm
SSC Modulation Rate	✓	30.000000 kHz <= VALUE <= 33.000000 kHz
SSC Slew Rate	✓	VALUE <= 10.000 ms
Far End Random Jitter (CTLE ON)	✓	VALUE <= 230 mUI
Far End Maximum Deterministic Jitter (CTLE ON)	✓	VALUE <= 430 mUI
Far End Total Jitter at BER-12 (CTLE ON)	✓	VALUE <= 660 mUI
Far End Template Test (CTLE ON)	✓	VALUE = 0.000
Far End Differential Output Voltage (CTLE ON)	✓	100.0 mV <= VALUE <= 1.2000 V

Cable quality

Normal cable

Robot cable

Active optical cable (AOC)



Reliability test
on USB3 cable

Combinational evaluation result of USB3 Vision board and cables

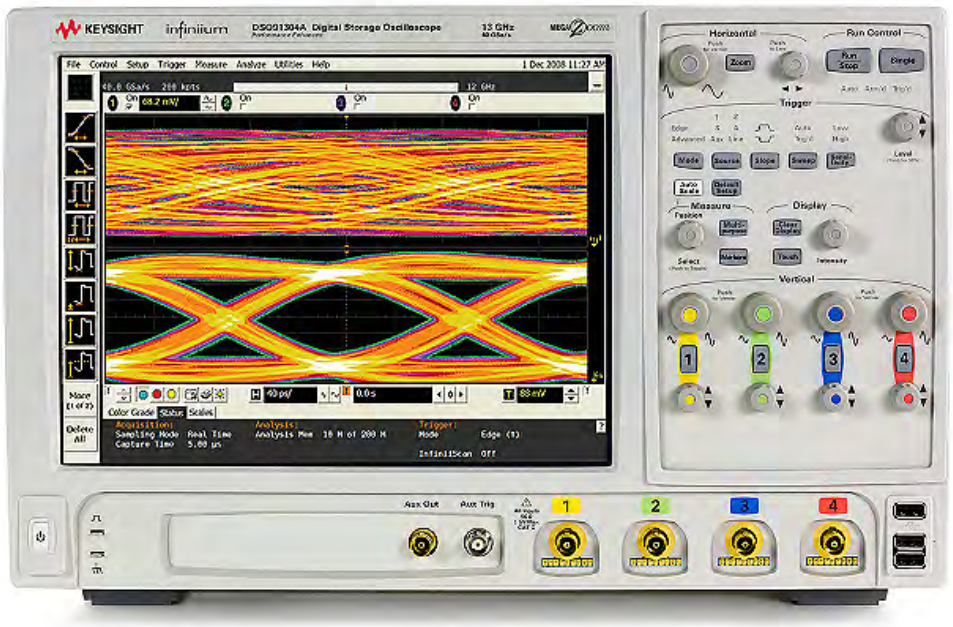
			Board							
			Company X		Company Y				company Z	
			4port		4port		2port		2port	
Cable			BERT	Continuous Test	BERT	Continuous Test	BERT	Continuous Test	BERT	Continuous Test
Company A	Norm	8m	OK	OK	OK	OK	OK	-	NG	NG
	Norm	9m	NG	OK	OK	OK	OK	-	NG	-
	Robot	5m	OK	OK	OK	OK	-	-	OK	OK
	Robot	8m	OK	OK	OK	OK	OK	-	NG	NG
Company B	Norm	5m	OK	OK	OK	OK	-	-	-	-
	Norm	6m	OK	OK	OK	OK	OK	-	OK	-
	Norm	7m	OK	OK	OK	OK	OK	-	OK	OK
Company C	Norm	3m	OK	-	OK	OK	-	-	OK	-
Company D	Norm	5m	OK	OK	OK	-	-	-	-	-
	Active	5m	NG	NG	OK	-	OK	-	OK	OK
	Active	10m	NG	NG	OK	OK	OK	-	OK	OK
Company E	AOC	20m	OK	OK	OK	OK	OK	-	OK	OK

◆BERT : Evaluation result of BERT
◆Continuous Test : Evaluation result of 72 hour continuous operation
◆ "-" : Unadministered test

Evaluation facilities

KEYSIGHT TECHNOLOGIES

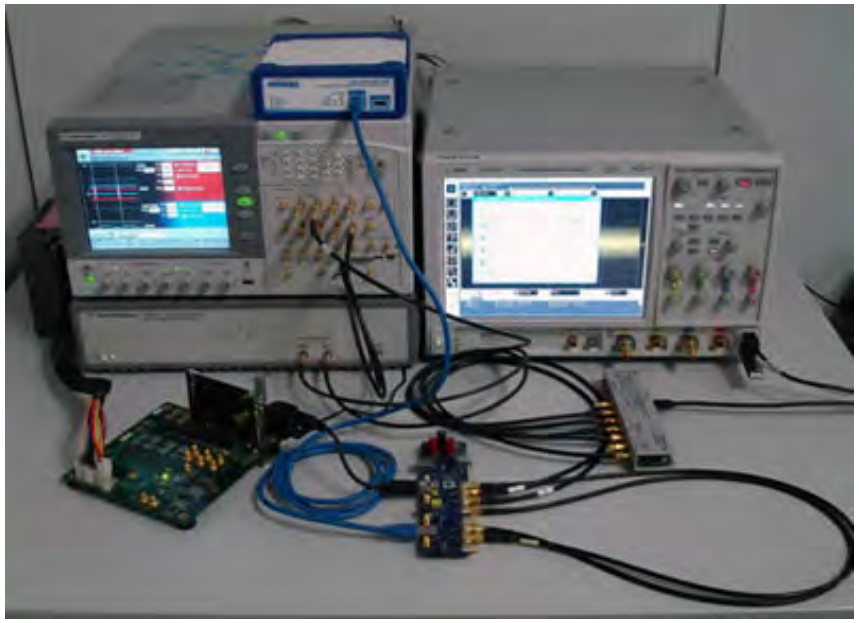
- **Compliance test**
- **Bus analyzer**



Keysight Technologies
DSO91304A Infiniium High Performance Oscilloscope

Wide band range oscilloscope

USB bus analyzer



Advanced features of BU/DU series camera

Advanced features

■ Sequential shutter mode

Bulk trigger setting:
3 shots (example)

Trigger input
(3 times)

Data output
(3 frames)

1st shot

Gain: 0.5dB
Exposure time: 0.7msec

2nd shot

Gain: 3dB
Exposure time: 0.7msec

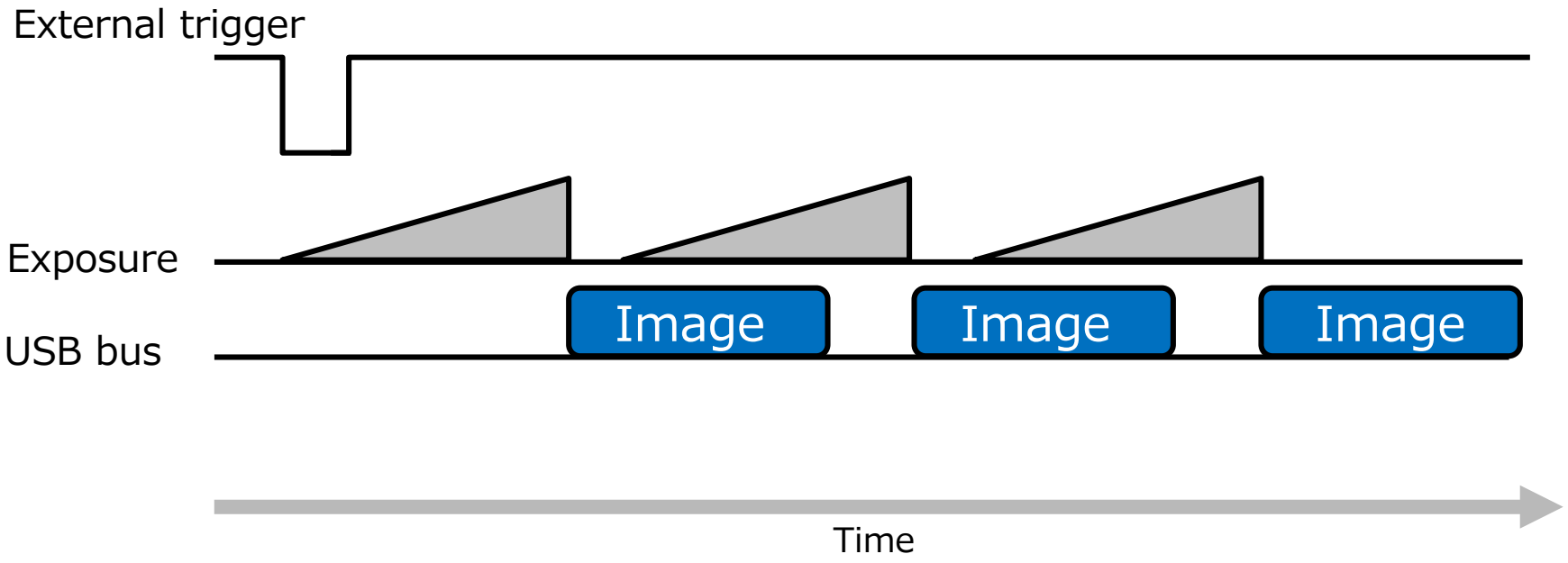
3rd shot

Gain: 8dB
Exposure time: 0.3msec

➢ Toshiba Teli is the patent holder of Sequential Shutter.

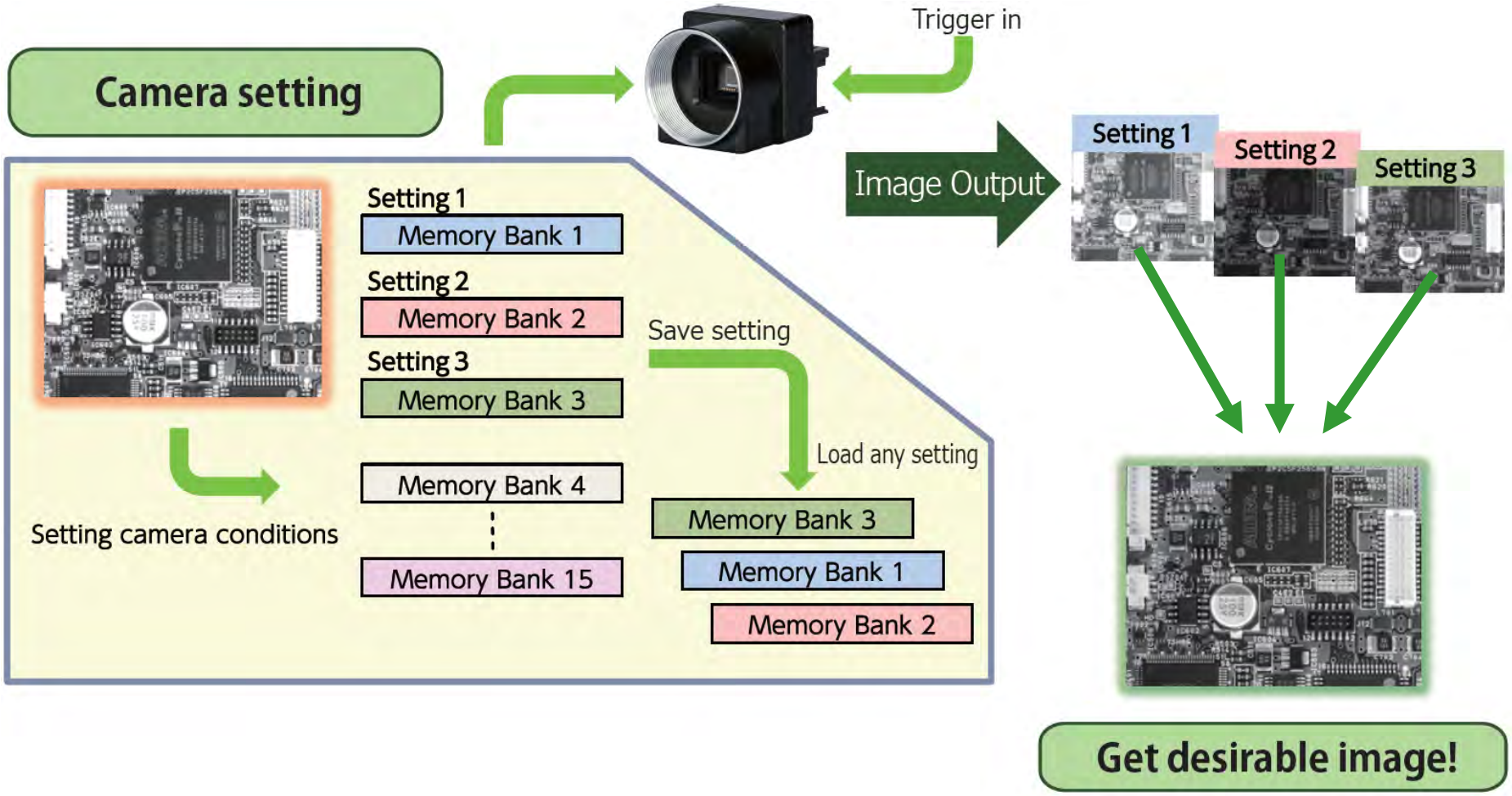
Advanced features

■ Bulk trigger mode



Advanced features

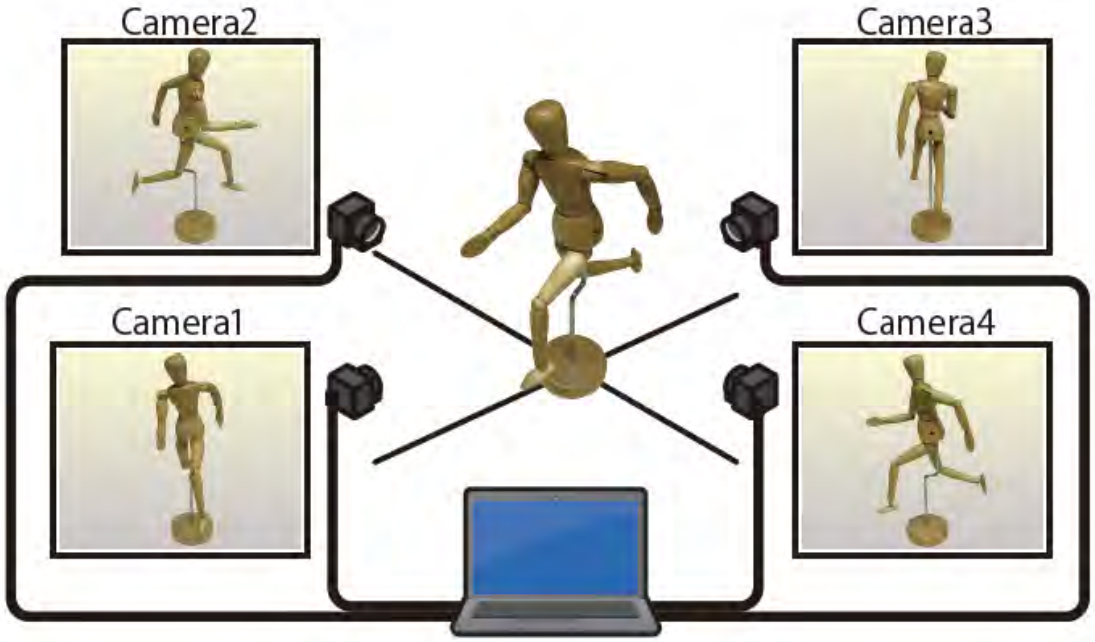
■ Sequential shutter＋Bulk trigger mode

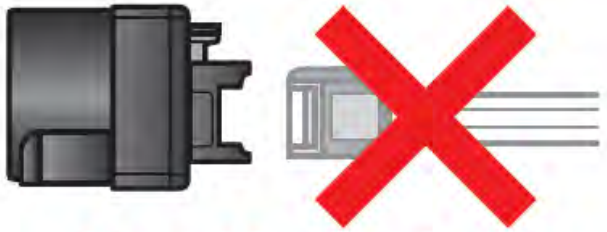


➢ Toshiba Teli is the patent holder of Sequential Shutter.

Advanced features

■ Bus synchronization





No cable needed for 'Trigger in' !

Applications:
Stereo camera
Motion capture

➢ Toshiba Teli is the patent holder of Bus Synchronization.

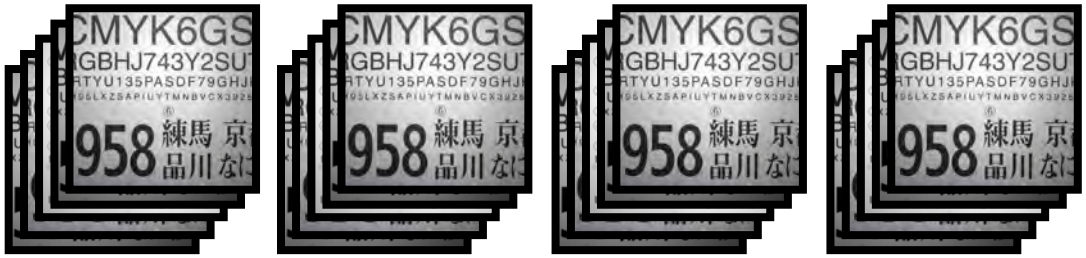
Advanced features

■ Event notification

1	FrameTrigger	: Reception of Frame Start Trigger
2	FrameTriggerError	: Rejection of Frame Start Trigger
3	FrameTriggerWait	: Start of waiting for Frame Start Trigger
4	FrameTransferStart	: Start of transferring Streaming Data
5	FrameTransferEnd	: End of transferring Streaming Data
6	ExposureStart	: Start of Exposure
7	ExposureEnd	: End of Exposure
8	Timer0Start	: Start of Timer ”0”
9	Timer0End	: End of Timer “0”

Advanced features

■ Image buffer

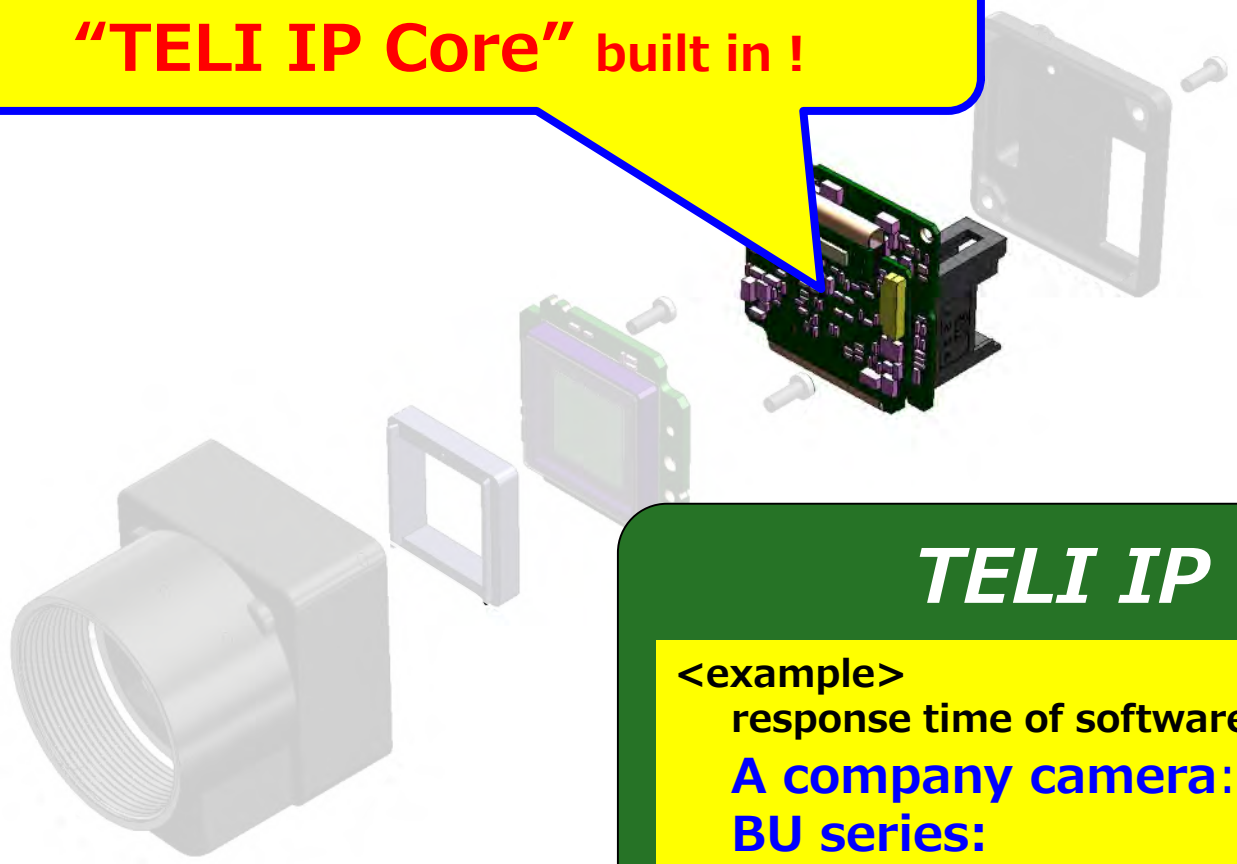


Multiple frames can be read and recorded

IP core of BU/DU series

■ Extremely quick response by original IP core

Newly developed TELI original IP core
"TELI IP Core" built in !

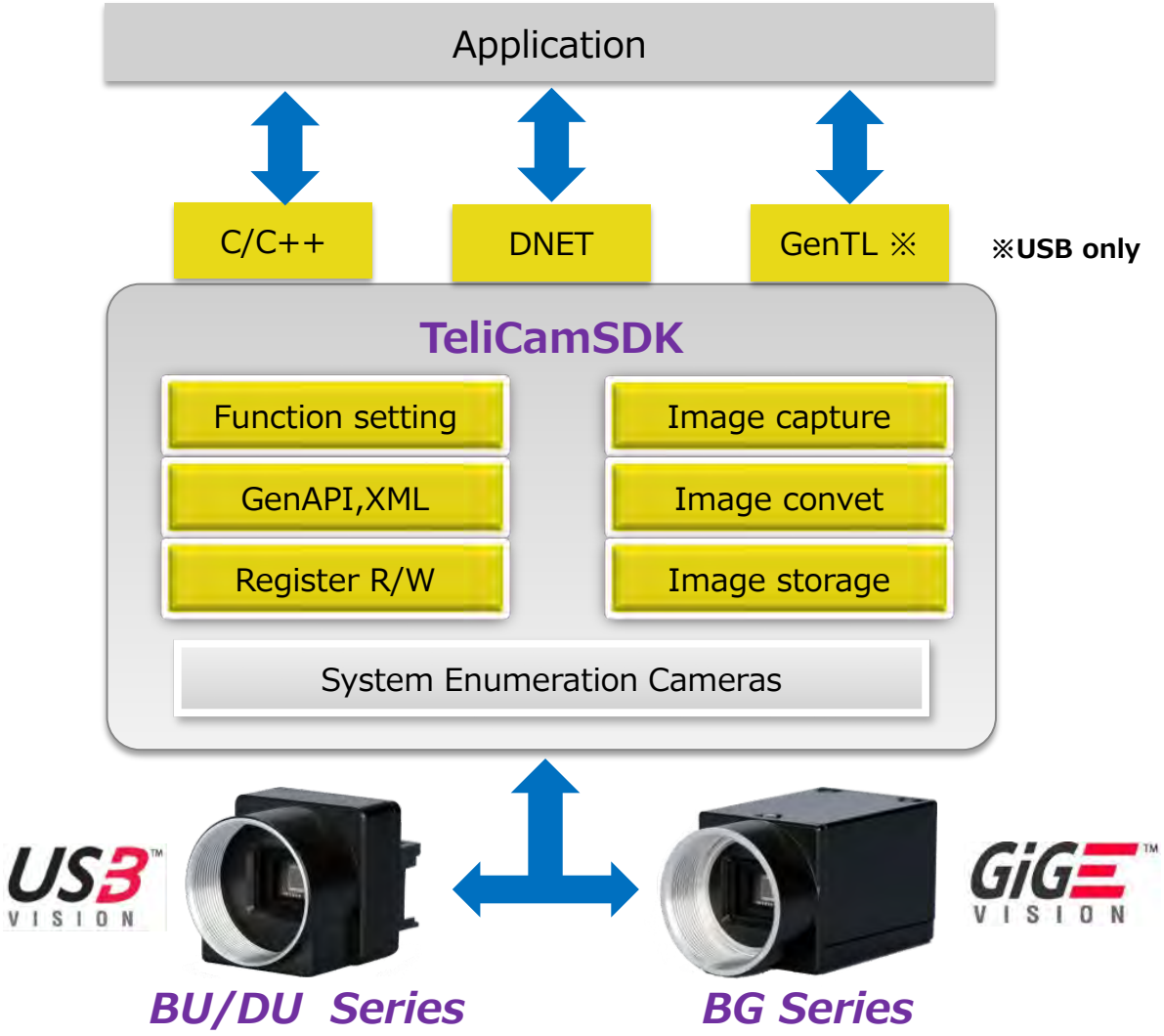


TELI IP Core

<example>
response time of software trigger
A company camera: 4msec
BU series: ***5µsec*** (average)

TeliCamSDK

TeliCamSDK, integration of USB3.0 and Gig-E



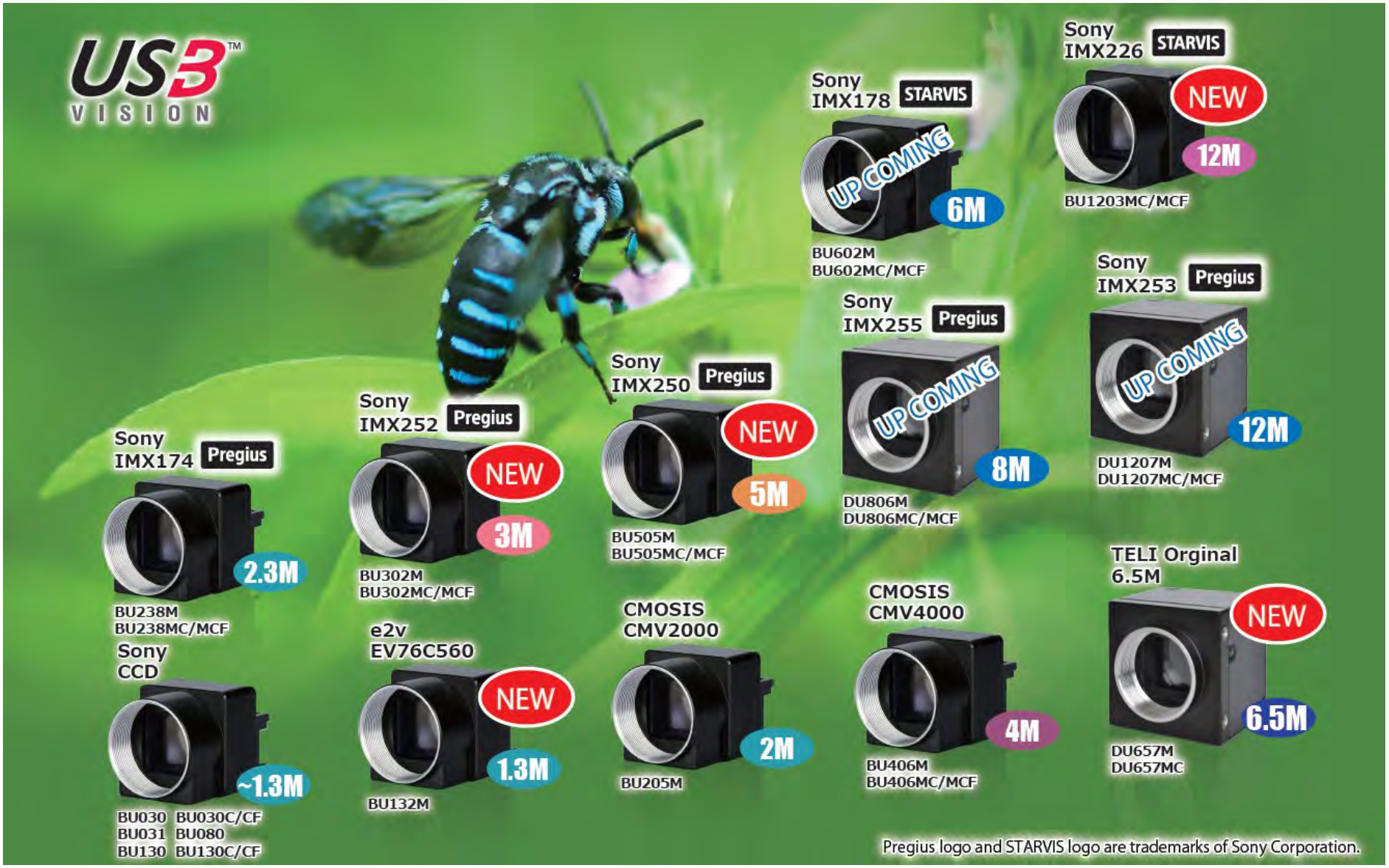
Application case

Application case

Market	AOI、SPI	Making panel	Fruit sorting	Medical
Use	・soldering check, ・solder paste inspection	・Alignment 	・scratch, shape, ripe degree(color)	・Image diagnosis
First camera	・Gig-E camera ・CL camera	・Gig-E camera	・Gig-E camera	・Analogue camera
Customer's challenge	 ・FGB, cable cost down	・Cost down ・reliability improvement	・Speed up ・Cost down ・Image quality improvement ・Color reproducibility 	・Replace CCD camera with CMOS camera ・Higher sensitivity with less lighting ・60fps recording
Point of adoption	・TELI original sensor  ・Quick response (TELI original IP core) ・High image quality ・Advantage of own equipment with new camera	・Quick response (TELI original IP core) ・Resolution ・Cost benefits ・Software support ・Most compact overall dimensions in the industry	・Quick response (TELI original IP core) ・System cost benefits ・High image quality ・High frame rate ・Most compact in the industry 	・High sensitivity ・High S/N ・High speed CMOS sensor
Choice of camera	・DU657MC ・BU238MCF ・BU406MC	・BU1203MC	・BU238MCF	・BU238M 
Needs/ann.	2,000~3,000 sets	1,000~1,500 sets	300~500 sets	100 sets

Standard product range

Toshiba Teli USB3 Vision camera BU/DU series



New proposal from Toshiba Teli

USB3.0 Board Level Camera (concept model)

◆Concept

- ➢ **Flexible camera for use in various fields**
- ➢ **Smaller size than USB3 Vision camera "BU series"**

BU series

◆Advanced feature

➢ Easy operation

- Open frame structure in ultra-thin, compact and light weight
- Flexible optical system
- VGA~12M

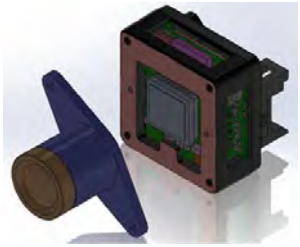
CCD type : 29×29×13mm
(without connector)

CMOS type : 29×29×16mm
(without connector)

➢ Various features

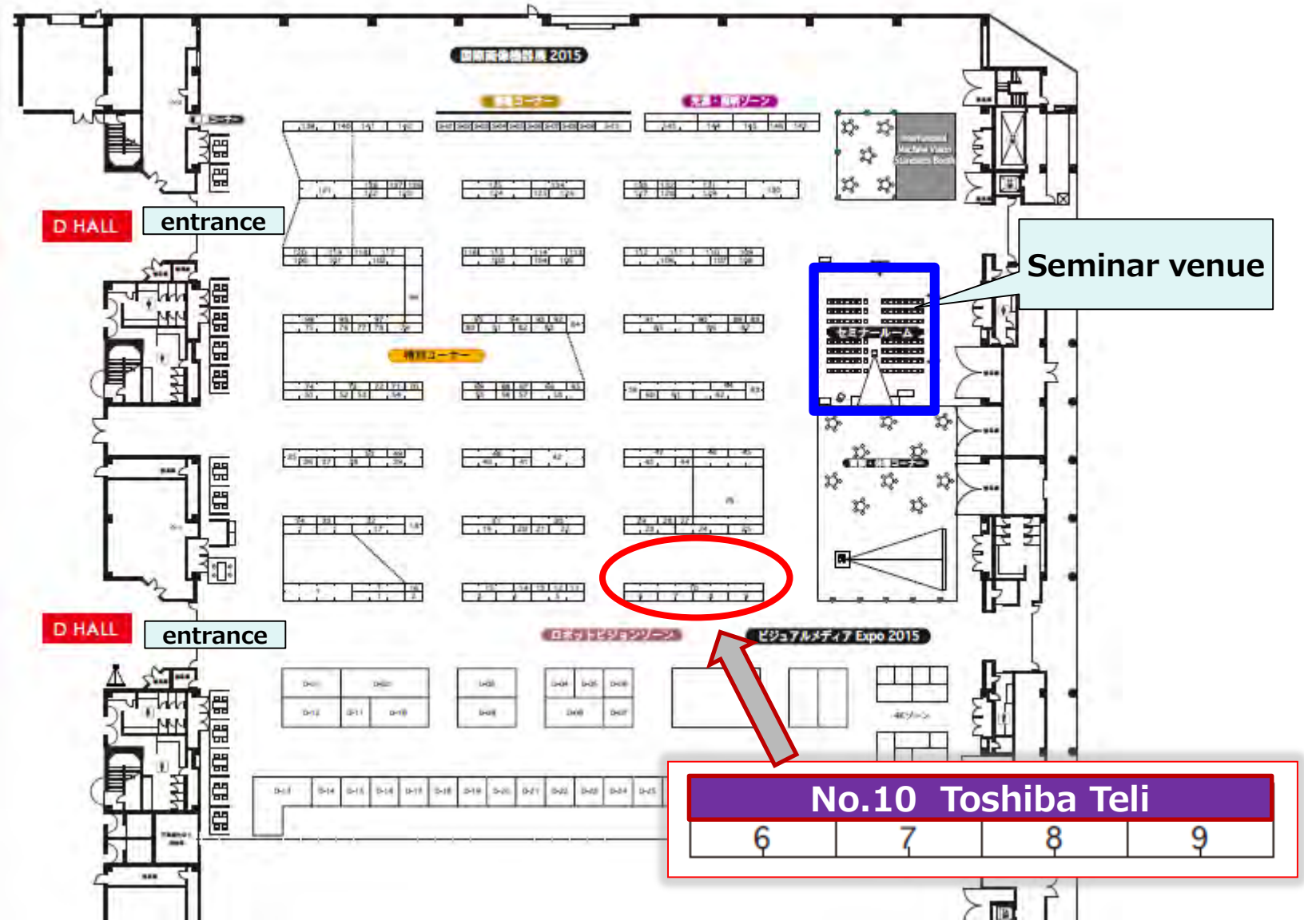
- Super quick response by new IP core
- Event notification
- Bus synchronizing mode
- Bulk trigger *1
- Sequential shutter *2
- Image buffer *3
- Scalable mode & binning mode *4
- BERT function *5

note : ＊1~5 are available in CMOS type only



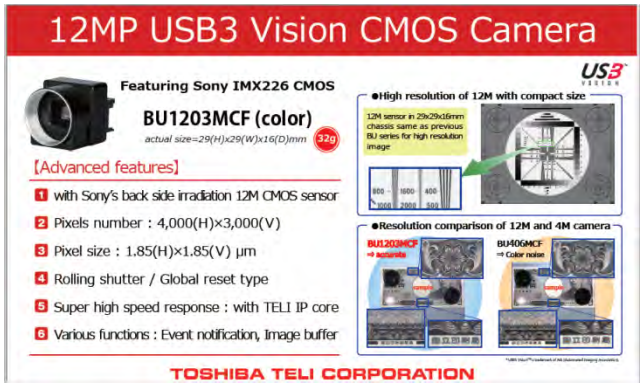
S mount lens
(example)

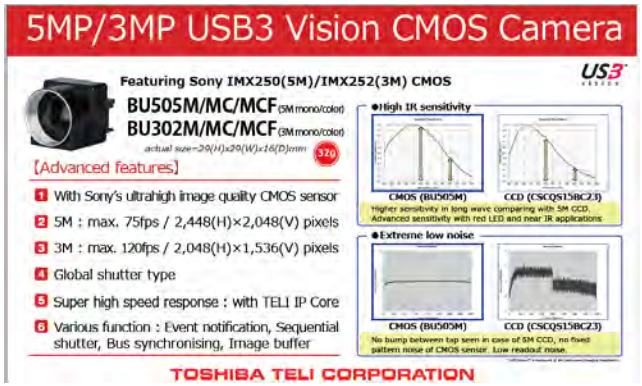
Toshiba Teli booth

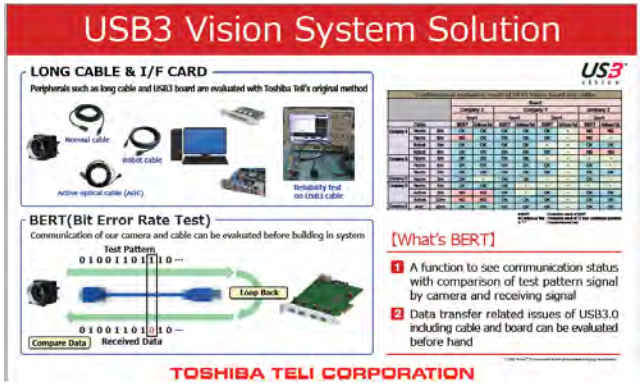


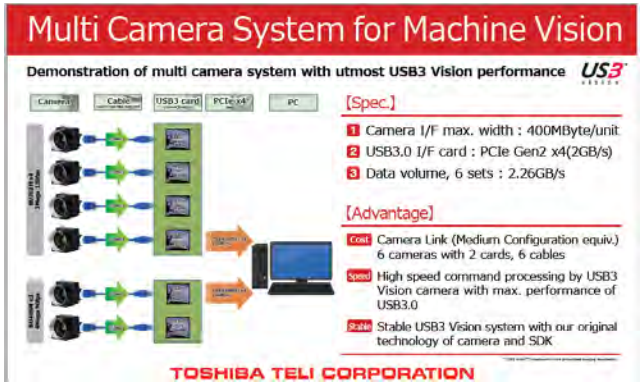
Contents of exhibition

■ New products



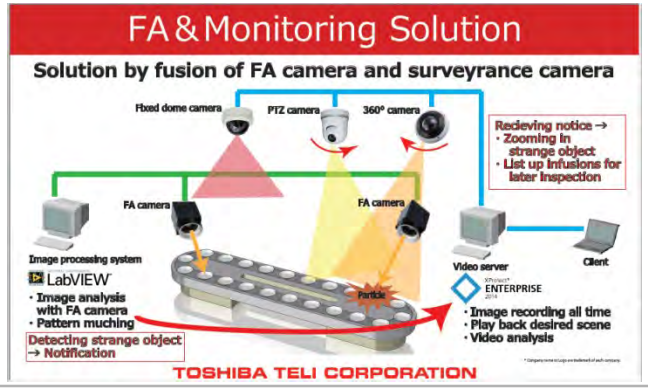


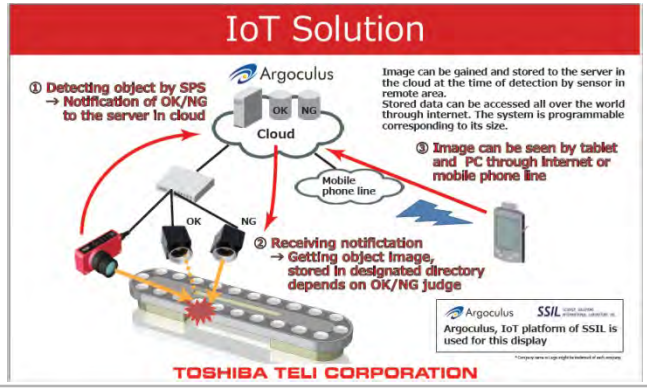




■ Robustness

■ Integration of FA & Monitoring solution





Thank you very much for your attention to the last.
USB3.0 cameras are displayed in our booth.
Please don’t miss.

TOSHIBA TELI CORPORATION


TOSHIBA
Leading Innovation