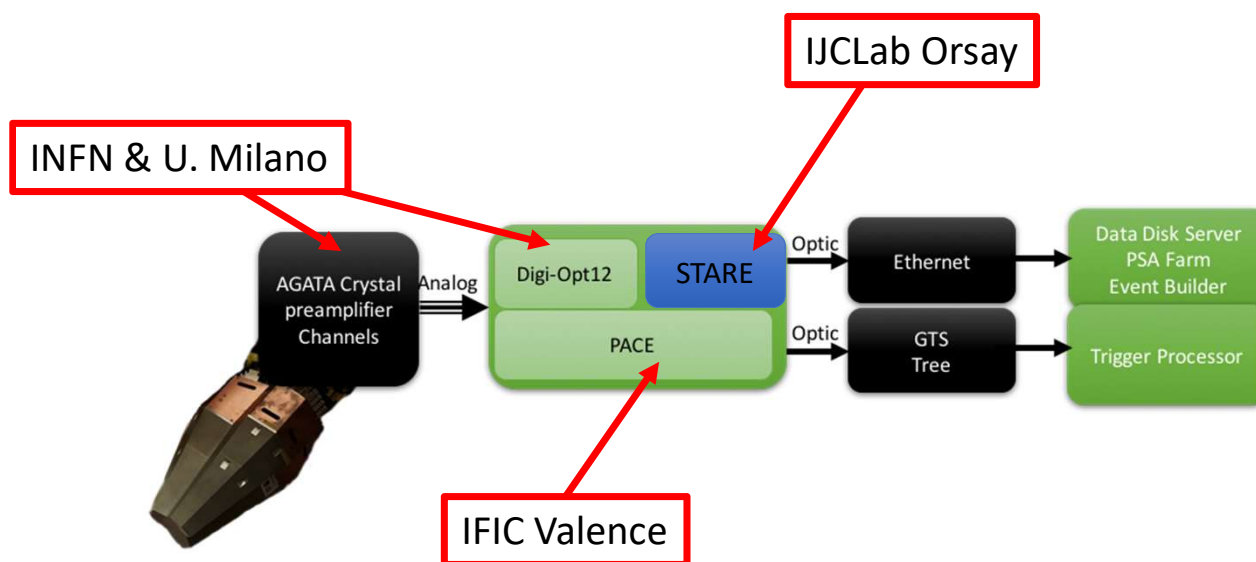


AGATA Project

STARE

(Serial Transfer And Readout over Ethernet)

- ✓ STARE : why, where, how ?
- ✓ STARE Firmware
- ✓ Tests production
- ✓ STARE Production Status



FMC Vita57.1 connector (standard : power supply, clocks, high speed link)

Input data rate from pre-processing (FMC) : 4 x 10 Gbps serial (AURORA)

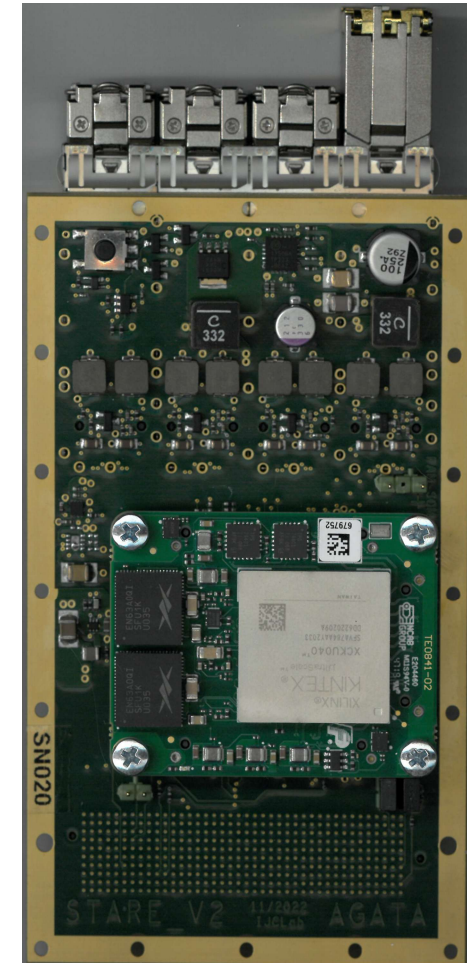
Network Bandwidth up to 4 x 10 Gbps in parallel.

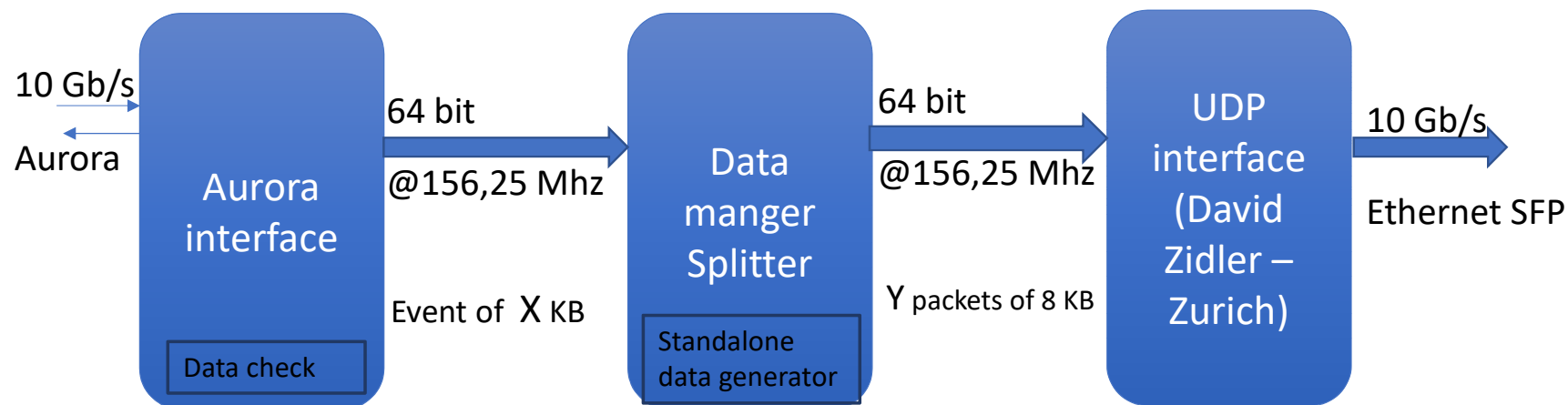
Spare LVDS I/O on FMC for future use (SPI)

Full clock management inside the SOM and the FMC carrier.

1 Gbps IPBus for slow control.

2 Gbyte DDR4 memory



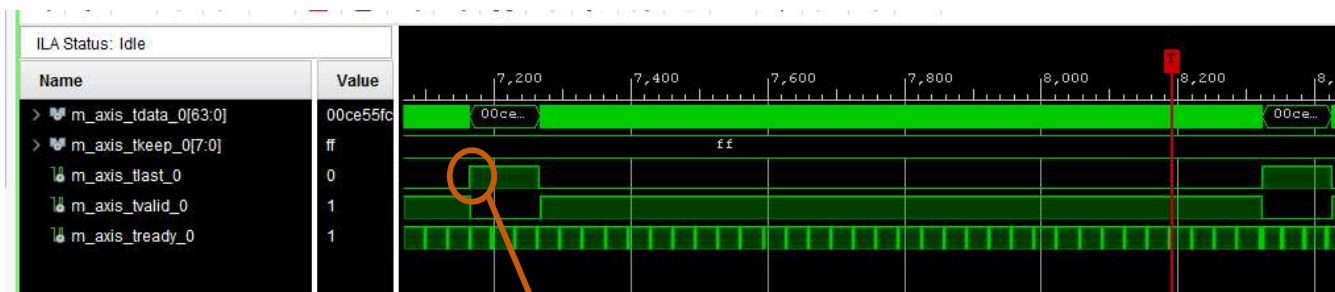


- _ Slow control
- _ EEPROM (ID)
- _ Clock manager
- _ Spare LVDS link

Generators available (compute by IpbuS, independant, rate ajustable) :

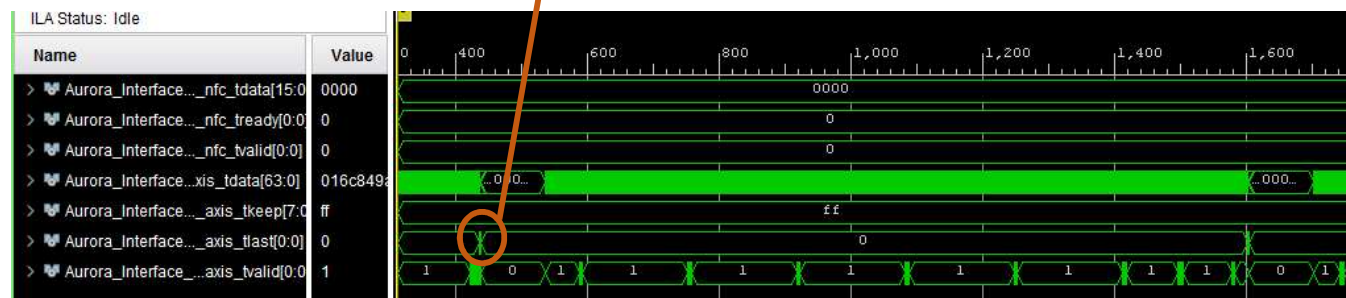
- _ byteANDpackage_counter : data can be checked by SQM ; size of event 8 Bytes -> 256 MBytes
- _ 2 Rams of 8KB : can be fill by IpbuS ; TS and EV is managed by firmware
- _ adf_DTH : particular format asked by Olivier S.

Transmitter



End of event => receiver deduces the size

Receiver



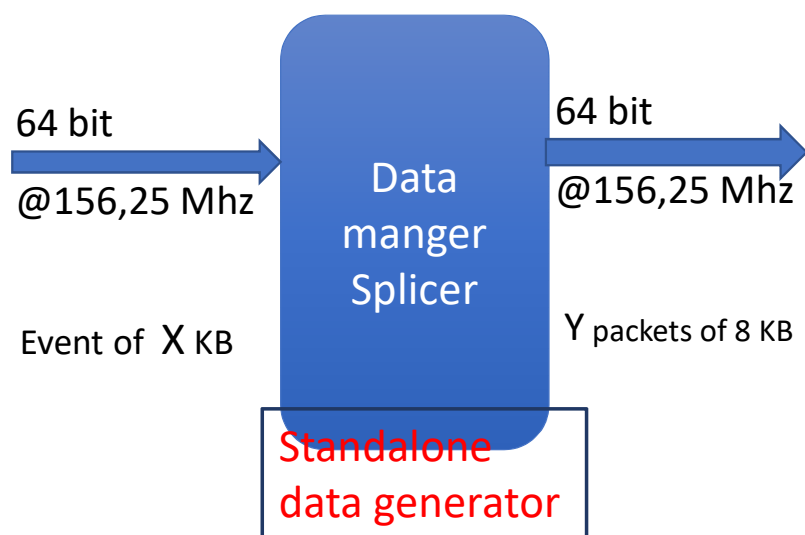
Serial link

Tlast signal = End of event

Tested on 4 lines @10Gb/s

Evaluation board

20 hours => No error



Splits X KB event on packets of 8 KB
Add header
Sent packets to UDP transmitter IP

UDP_packet_id (48 bits) + last_packet of event(1bit) + packet_id(15 bits)

00000000ADDA	0	0
DEADBEEF 00000000		
DEADBEEF 00000001		
DEADBEEF 00000002		
DEADBEEF 00000003		
DEADBEEF 00000004		
DEADBEEF 00000005		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF 000003FF		
00000000ADDB	0	1
DEADBEEF 00000400		
DEADBEEF 00000401		
DEADBEEF 00000402		
DEADBEEF 00000403		
DEADBEEF 00000404		
DEADBEEF 00000405		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF 000007FF		
00000000ADDC	0	2
DEADBEEF 00000800		

00000000ADDF	0	5
DEADBEEF ...		
00000000ADE0	0	6
DEADBEEF 00001800		
DEADBEEF 00001801		
DEADBEEF 00001802		
DEADBEEF 00001803		
DEADBEEF 00001804		
DEADBEEF 00001805		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF 000018FF		
00000000ADE1	1	7
DEADBEEF 00001C00		
DEADBEEF 00001C01		
DEADBEEF 00001C02		
DEADBEEF 00001C03		
DEADBEEF 00001C04		
DEADBEEF 00001C05		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF ...		
DEADBEEF 00001FFFF		

64 KB ->
8192 words of
64 bits

8 KB

8 KB

8KB

8 KB

last KB

8 KB

byteANDpackage_counter :

64B < Event size < 256 MB

Event_ID(32bits -> 8 octets)	byte_counter(32bits -> 8 octets)	
DEADBEEF	00000000	8 KB -> 1024 words of 64 bits
DEADBEEF	00000001	
DEADBEEF	00000002	
DEADBEEF	...	
DEADBEEF	000003FE	
DEADBEEF	000003FF	
DEADBEF0	00000000	8 KB -> 1024 words of 64 bits
DEADBEF0	00000001	
DEADBEF0	00000002	
DEADBEF0	...	
DEADBEF0	000003FE	
DEADBEF0	000003FF	
DEADBEF1	00000000	8 KB -> 1024 words of 64 bits
DEADBEF1	00000001	
DEADBEF1	00000002	
DEADBEF1	...	
DEADBEF1	000003FE	
DEADBEF1	000003FF	

Available on PACE ; checkable on STARE

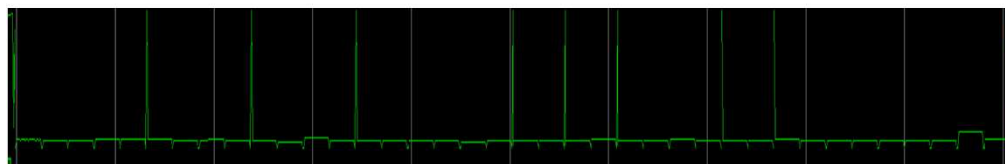
2 Rams of 8KB : can be modify by IPbus

ADF

```
fa01010100001f98
c81ff69500000000
da01000a00000135
0000000000000064
1042104afffffffd
105d105510591052
10621064105f105b
1069106f10671065
1050105a10631067
1058105310551055
105e105610581056
.....
```

counter

```
0003000200010000
0007000600050004
000B000A00090008
000F000E000D000C
0013001200110010
0017001600150014
.....
0FEBOFEA0FE90FE8
0FEF0FEE0FED0FEC
0FF30FF20FF10FF0
0FF70FF60FF50FF4
0FFB0FFA0FF90FF8
0FFF0FFE0FFD0FFC
```



Trigger : regular or random ; frequency managable

_XML module
description
_Python scripts
_uHAL



network



STARE

Ipbus interface
1G Ethernet

Ipbus fabric

IP Bus Protocol

Adress
Data

Slave
EEPROM

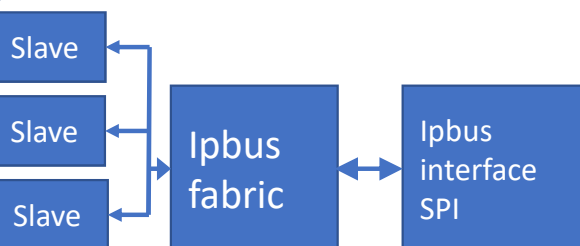
Slave
Splicer

Slave
Prog_bitstream (new)

Slave
PACE_SPI_bridge

SPI protocol

PACE



3 * 9.6 Gbps from one PACE (byteANDpackage_counter stand alone generator), STARE, switch, 3 DAQ server
C6400 : 13 days

```

SSH: dcod@c6400-10
server = c6400-10
interface = eth0
port = 5001
framesize = 8200
eventsize = 8192
cpu = 20
nbframeinbuffer = 65536
windowsize = 200
pnhnbuffer = 10
pnhnbufferSize = 536870912
pnhnbuffername = "green_buffer"
nbstabilization = 20000
rudpflag = 0
runnumber = 12
nodcod = 1
datacheck = 1
nbloops = 0
nbpacketinfo = 10000
saveinfile = 0
pattern invalid frame in file : /home/dcod/Stare_Queue_Manager_back_pressure/Config/default_frame.tpl
10 nbbuffer, 65536 frameInBuffer, 8200 frameSize, 3 frameFormat, 8192 eventSize
Listening for frames at udp://10.10.3.10:5001
Acquisition in standalone , checking consistency of paquets

Ctrl-C to quit the program or wait end of nbLoops!

Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-06-13 18:43:34
[Receive 166091620000 frames rate 1227.32Mo/s Lost: 0 + 169 empty(missing) = 169 and corrupted:0

SSH: dcod@c6400-11
server = c6400-11
interface = eth0
port = 5001
framesize = 8200
eventsize = 8192
cpu = 20
nbframeinbuffer = 65536
windowsize = 200
pnhnbuffer = 10
pnhnbufferSize = 536870912
pnhnbuffername = "green_buffer"
nbstabilization = 20000
rudpflag = 0
runnumber = 14
nodcod = 1
datacheck = 1
nbloops = 0
nbpacketinfo = 10000
saveinfile = 0
pattern invalid frame in file : /home/dcod/Stare_Queue_Manager_back_pressure/Config/default_frame.tpl
10 nbbuffer, 65536 frameInBuffer, 8200 frameSize, 3 frameFormat, 8192 eventSize
Listening for frames at udp://10.10.3.11:5001
Acquisition in standalone , checking consistency of paquets

Ctrl-C to quit the program or wait end of nbLoops!

Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-06-13 18:43:52
[Receive 166088930000 frames rate 1227.23Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0

SSH: dcod@c6400-12
empty(missing) = 635 Receive 60131550000 frames rate 1227.64Mo/s Lost: 0 + 635 empty(missing) = 635 Rec
ive 60131560000 frames rate 1226.9Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131570000 frames
ate 1227.4Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131580000 frames rate 1227.45Mo/s Lost: 0
635 empty(missing) = 635 Receive 60131590000 frames rate 1227.54Mo/s Lost: 0 + 635 empty(missing) = 6
Receive 60131600000 frames rate 1227.01Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131610000 fr
es rate 1227.98Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131620000 frames rate 1227.62Mo/s Los
: 0 + 635 empty(missing) = 635 Receive 60131630000 frames rate 1227.38Mo/s Lost: 0 + 635 empty(missing)
= 635 Receive 60131640000 frames rate 1227.12Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 6013165000
frames rate 1227.49Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131660000 frames rate 1227.47Mo
Lost: 0 + 635 empty(missing) = 635 Receive 60131670000 frames rate 1227.31Mo/s Lost: 0 + 635 empty(mis
sing) = 635 Receive 60131680000 frames rate 1227.51Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 6013
90000 frames rate 1227.05Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131700000 frames rate 1227
.6Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131710000 frames rate 1227.56Mo/s Lost: 0 + 635 empt
(missing) = 635 Receive 60131720000 frames rate 1227.09Mo/s Lost: 0 + 635 empty(missing) = 635 Receive
0131730000 frames rate 1227.78Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131740000 frames rate
1227.25Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131750000 frames rate 1227.43Mo/s Lost: 0 + 635
empty(missing) = 635 Receive 60131760000 frames rate 1227.14Mo/s Lost: 0 + 635 empty(missing) = 635 Rec
ive 60131770000 frames rate 1227.16Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131780000 frames
ate 1227.75Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131790000 frames rate 1227.25Mo/s Lost: 0
635 empty(missing) = 635 Receive 60131800000 frames rate 1227.31Mo/s Lost: 0 + 635 empty(missing) = 63
Receive 60131810000 frames rate 1227.38Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131820000 fr
es rate 1227.18Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131830000 frames rate 1227.42Mo/s Los
: 0 + 635 empty(missing) = 635 Receive 60131840000 frames rate 1227.69Mo/s Lost: 0 + 635 empty(missing)
= 635 Receive 60131850000 frames rate 1227.23Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 6013186000
frames rate 1227.18Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131870000 frames rate 1227.66Mo
Lost: 0 + 635 empty(missing) = 635 Receive 60131880000 frames rate 1227.53Mo/s Lost: 0 + 635 empty(mis
ing) = 635 Receive 60131890000 frames rate 1226.98Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 6013
00000 frames rate 1227.78Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131910000 frames rate 1227
.4Mo/s Lost: 0 + 635 empty(missing) = 635 Receive 60131920000 frames rate 1227.32Mo/s Lost: 0 + 635 empt
(missing) = 635 Receive 60131930000 frames rate 1227.18Mo/s Lost: 0 + 635 empty(missing) = 635 Receive
0131940000 frames rate 1227.56Mo/s Lost: 0 + 635 empty(missin Receive 65996590000 frames rate 1227.07
e 88020040000 frames rat Receive 88045 Receive 133463930000 Receive 133497860000 frames rate 1227.07
[Receive 166089600000 frames rate 1227.43Mo/s Lost: 0 + 1855 empty(missing) = 1855 and corrupted:0

```

More than 166 billions event per channel received = 498 billions events
169 + 1855 event loss => 4×10^{-9}

2 * 3.2 Gbps, STARE(stand alone generator random trigger @ 50KHz), switch, 1 DAQ server C6400 (2 links) : 13 days

```

CSSH: dcod@c6400-09
server = c6400-09
interface = eth1
port = 5001
framesize = 8200
eventsize = 8192
cpu = 26
nbframeinbuffer = 65536
windowsize = 200
pmhnbbuffer = 10
pmhnbuffersize = 536870912
pmhnbuffersname = "green_buffer"
nbstabilization = 20000
rudpflag = 0
runnumber = 12
nodcod = 1
datacheck = 1
nbloops = 0
nbpacketinfo = 10000
saveinfile = 0
pattern invalid frame in file : /home/dcod/Stare_Queue_Manager_back_pressure/Config/default_frame.tpl
10 nbbuffer, 65536 frameInBuffer, 8200 frameSize, 3 frameFormat, 8192 eventSize
Listening for frames at udp://10.10.7.9:5001
Acquisition in standalone , checking consistency of paquets

Ctrl-C to quit the program or wait end of nbLoops!

Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-06-16 16:32:31
[Receive 42239850000 frames rate 407.488Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0

CSSH: dcod@c6400-09
stare = emulator
server = c6400-09
interface = eth0
port = 5001
framesize = 8200
eventsize = 8192
cpu = 20
nbframeinbuffer = 65536
windowsize = 200
pmhnbbuffer = 10
pmhnbuffersize = 536870912
pmhnbuffersname = "green_buffer"
nbstabilization = 20000
rudpflag = 0
runnumber = 11
nodcod = 1
datacheck = 1
nbloops = 0
nbpacketinfo = 10000
saveinfile = 0
pattern invalid frame in file : /home/dcod/Stare_Queue_Manager_back_pressure/Config/default_frame.tpl
10 nbbuffer, 65536 frameInBuffer, 8200 frameSize, 3 frameFormat, 8192 eventSize
Listening for frames at udp://10.10.3.9:5001
Acquisition in standalone , checking consistency of paquets

Ctrl-C to quit the program or wait end of nbLoops!

Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-06-16 16:32:33
[Receive 42239750000 frames rate 407.352Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0
  
```

No error if dedicated server's processor are not use for other application

Stare boards generate 8*10Gbps

Acquisition on C6400 is OK for 1*10 Gbps per server ->

40 Gbps acquisition OK

```
CSSH: dcod@localhost
Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-03-13 15:10:24
Receive 259540000 frames rate 1237.75Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0
```

```
CSSH: dcod@c6400-10
Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-03-13 15:10:24
Receive 259540000 frames rate 1237.29Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0
```

```
CSSH: dcod@c6400-11
Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-03-13 15:10:24
Receive 259540000 frames rate 1237.11Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0
```

```
CSSH: dcod@c6400-12
Ready, waiting datas
Found frame size of 8200 octets
wait for 20000 frame for stabilization

STARTING acquisition at 2025-03-13 15:10:24
Receive 259540000 frames rate 1237.29Mo/s Lost: 0 + 0 empty(missing) = 0 and corrupted:0
```

More than 10 Gbps on one server is usually not possible, but some times it can works (???)

Acquisition test between building and more switches : is RUDP mandatory ?

Acquisition with a 25 Gbps network board on server

Validation from pulser, digitizer, PACE, STARE to PSA.

10 prototypes delivery (march 2021)

Pre production (2023) :

New I/O SOM Power supply designed, PCB modified & ready to manufacture.

Difficulties in purchasing Components: All components in stock.

Ready to produce Pre-production (10 STARE V2): Delivery : March 2023.

Production (July 2024) :

No modification on STARE PCB

New batch for SOM (oscillator and PLL) <= fixed by firmware

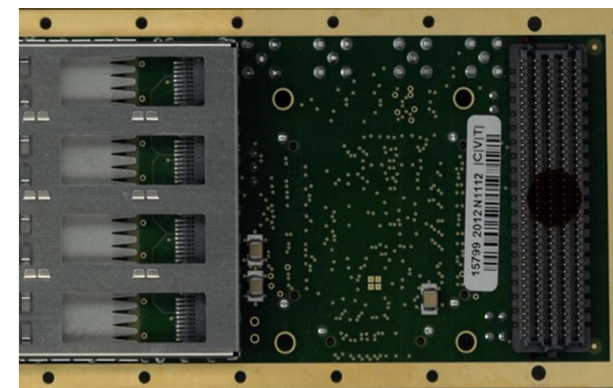
Third batch of SOM <= tested on 2 borads : OK

65 card validated, 13 ongoing, last SOM for end 2025

Top side



Bottom side



Manufacturer : STAE

134 Stare produced (+10 Pre-production)

65 SOM (3 different batches) mounted (+10 Pre-production) :
=> 74 OK, 1 failed (3,3 -> 1,8 converter)

_ 13 SOM and all SFP modules transfered to STAE

_ 64 SOMs ordered (delevery expected begin of december)



MERCI