



Instrumentation
Technologies

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Fast orbit stabilization system

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Libera **WORKSHOP**
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FOSS objectives

Suppression of beam disturbances

- aperiodic, stochastic: human activity
- periodic: power supply (50Hz)

BW ultimately limited by corrector magnets (<500Hz)

Basic building blocks

- Libera Brilliance and other sources, e.g Libera Photon
- Fast, low latency communication system
- Computational engines
- Interfaces to PS and corrector magnets

Libera Brilliance

FA data stream:

- 10 kHz sampling rate, \sim 2kHz bandwidth
- Optimized DSP for minimized (group) delays
- Data available:
 - Amplitudes: V_A, V_B, V_C, V_D
 - Positions: $X, Y(Z)$
 - Other: Σ, Q
 - Status
 - Packet time-stamping
 - Libera status: Interlock, ADC overflow, ...
 - Libera id.

Transmitted: Sum, position X, Y and status

Communication system

Fast

- 100 Liberas * 40 bytes * 10 kHz = 40 MB/s
 - Not including protocol overhead
- Multiple MISO systems: serialized position data

Low latency

- 1Gb/s: 40 μ s on one cable
 - No collisions, no duplicates

Routing!

Computational engines

DSP processing for control algorithms

- CPU clusters/SMP/multiple cores
 - Intra CPU communication
 - Real - time
- DSP
 - Boards available with fast network links
 - Fixed architecture
- FPGA
 - Programmable hardware

Versatility, flexibility vs. ease of programming

Control algorithms: PID, ...

PS interfaces and magnets

Myriad of interfaces

- Optics
- Analogue
- RS485
- Network attached PS??
 - Converters (Gb-ethernet 2 xy)

LP filters

- Latency, group delay

Non homogeneous structure (APS)

Libera based FOSSes

Centralized

Fully distributed

Hybrid approach



FOSS: Fully distributed

Libera is used as:

- FA data source
- Router
- Computational engine
- PS driver

Communication network & protocol - proprietary

User specific FPGA modules in Libera

- Communication controller
- PID controller
- PS interface

Example: Soleil

FOSS: Centralized

Libera

- FA data
- Gigabit ethernet data stream: standard UDP/IP

Communication network based

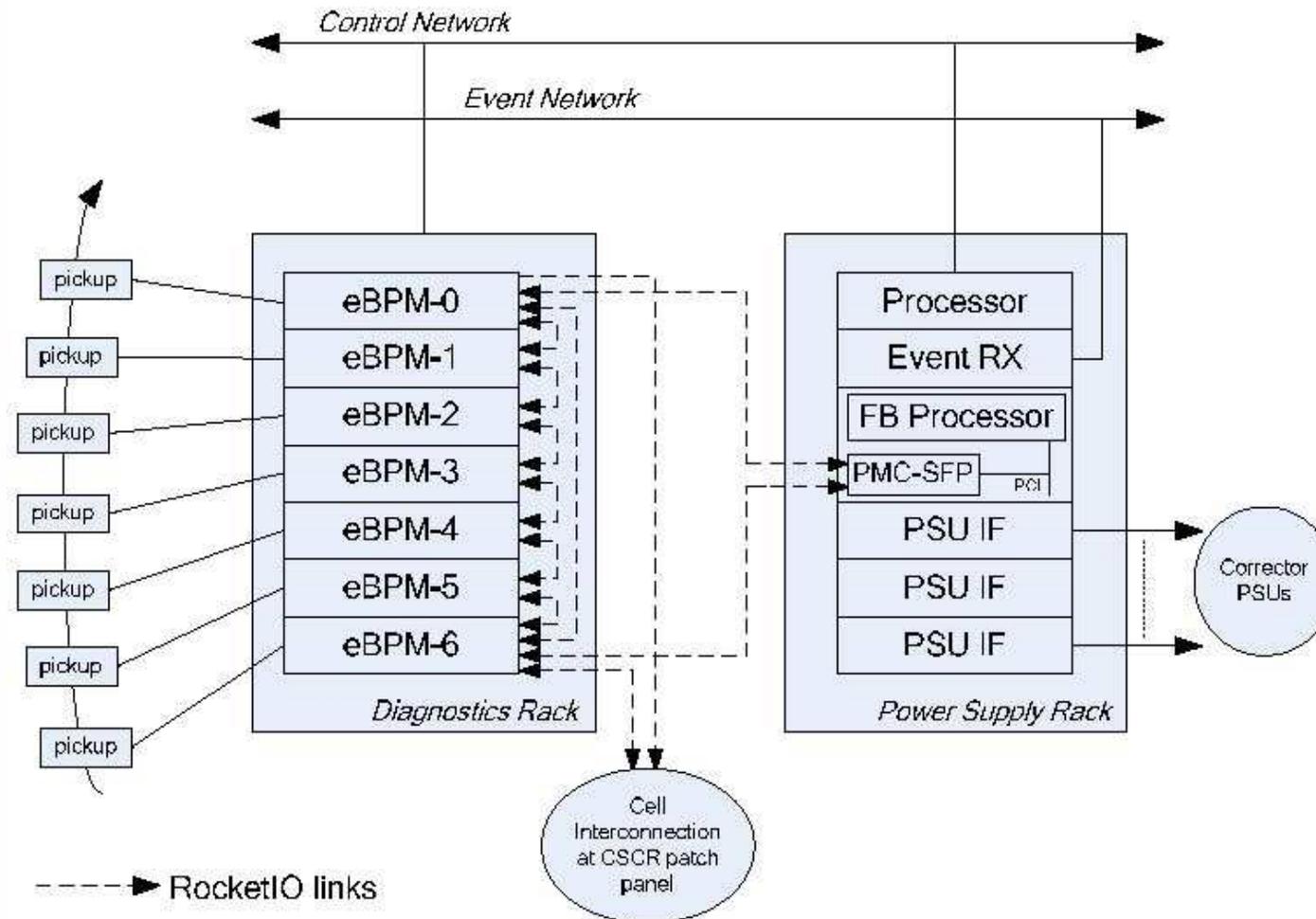
- Standard Gigabit ethernet for all (COTS infrastructure)

Specific FPGA modules residing in Libera

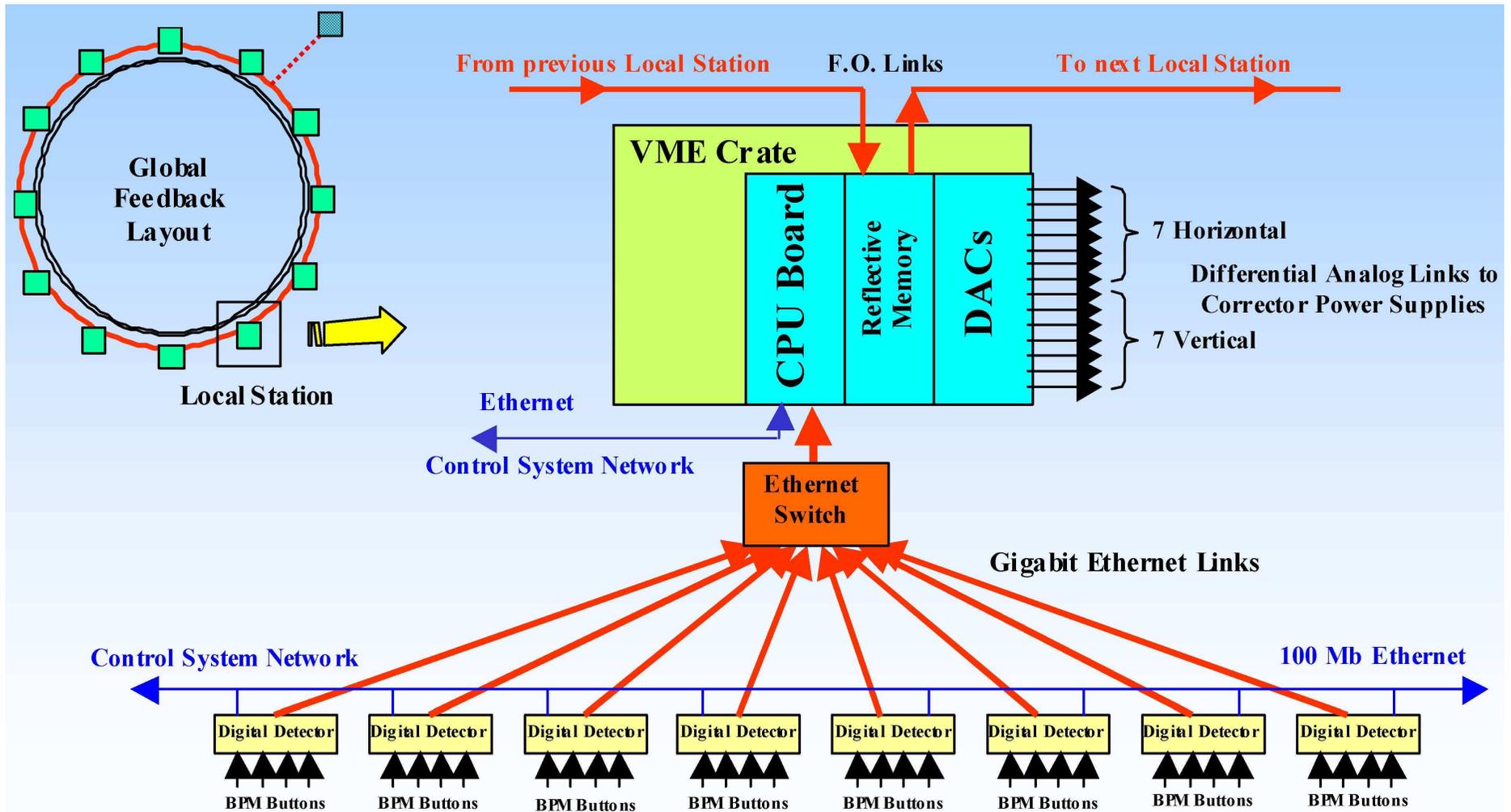
- Gigabit ethernet communication controller

For smaller machines, testing, ...

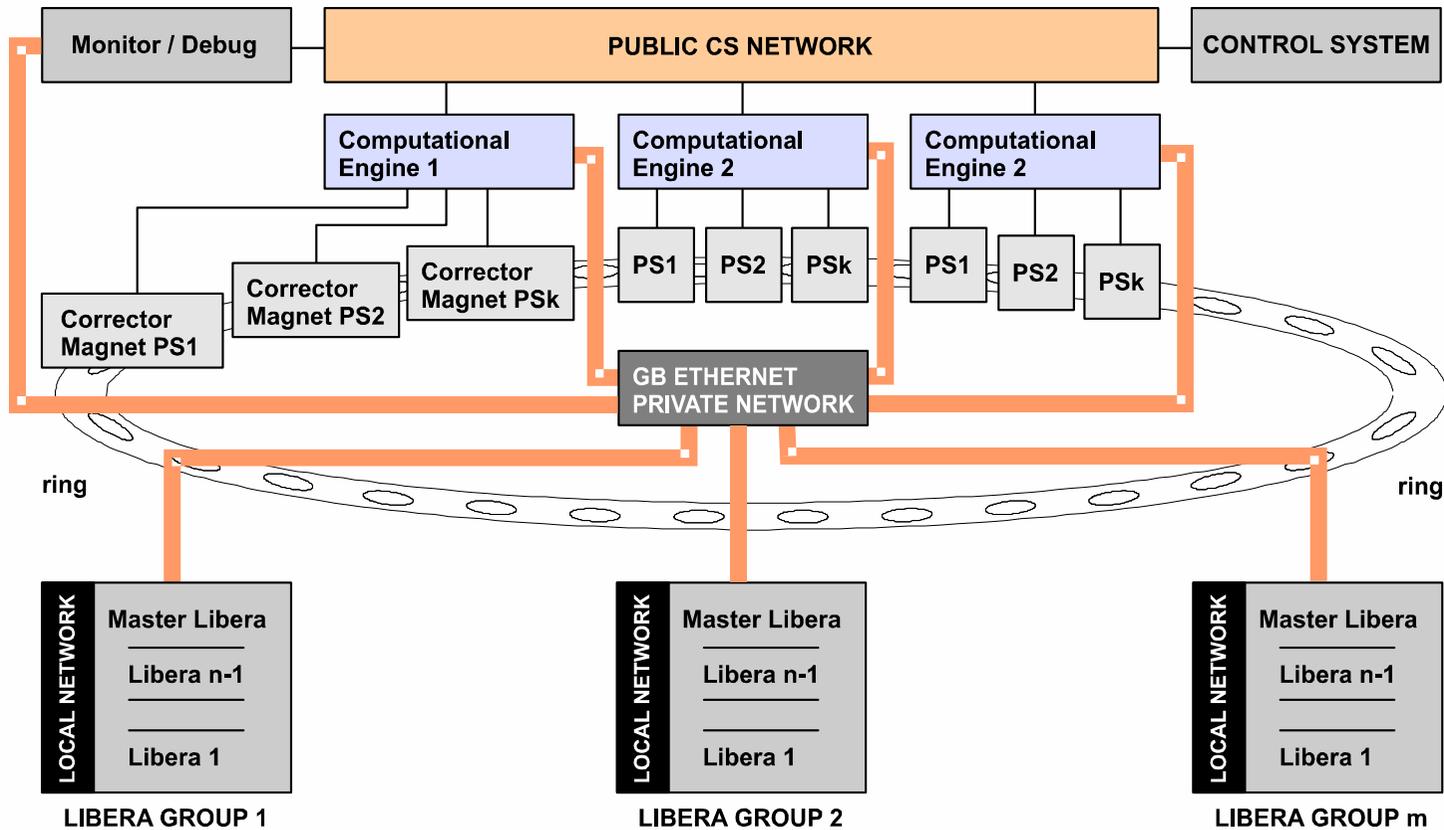
Hybrid example: Diamond



Hybrid example: Elettra

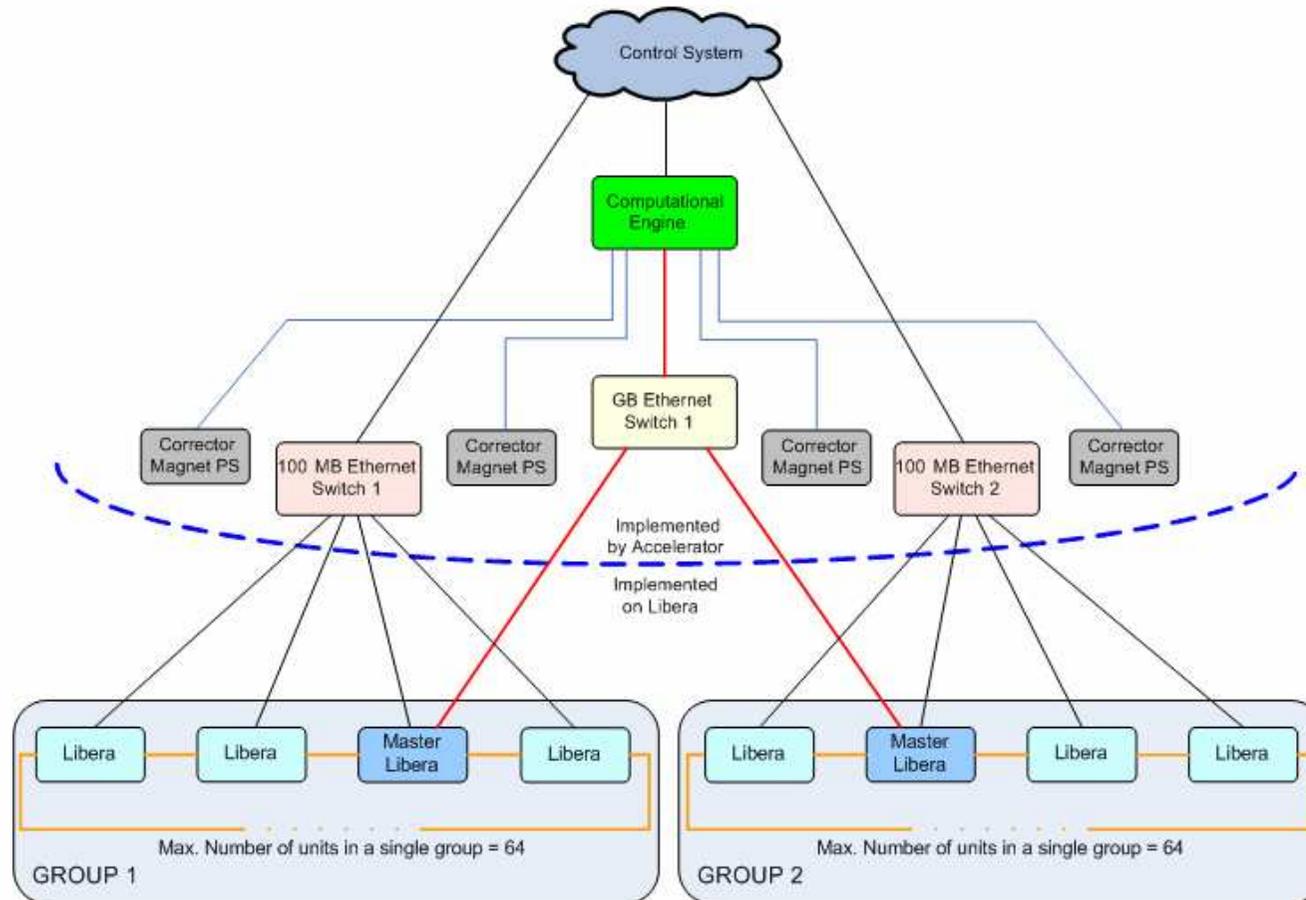


FOSS setup



— GB Ethernet
 — 100MB Ethernet

FOSS schematic, 1

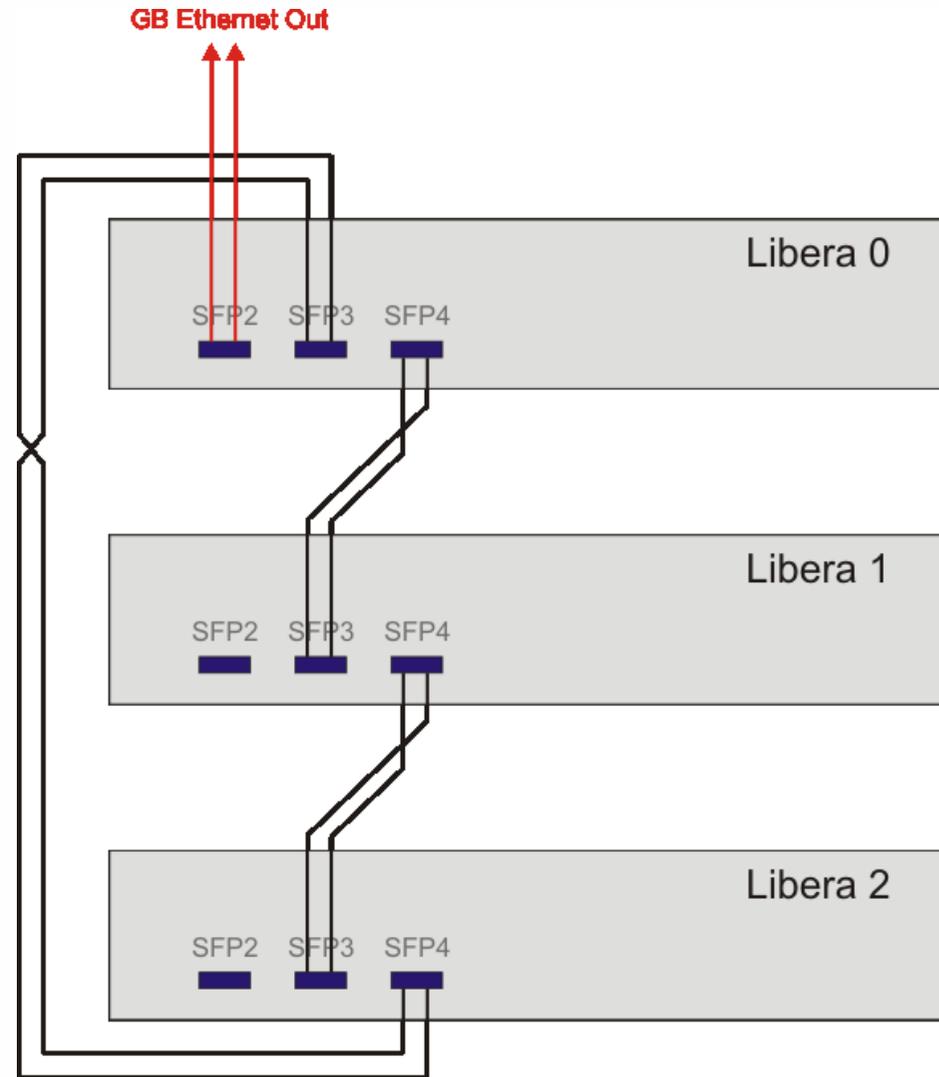


Connections: — GB Ethernet — 100 MB Ethernet — Bidirectional mox

FOSS schematic, 2

Cabling:

- **Copper**
- **Optics**
- **Both GbE, Local**



Libera GbEthernet Interface and Libera Grouping demo, 1

- **Setting up Libera**

```
[root@xcep /]# cat /etc/default/fai_header  
00:0d:9d:9c:9c:77  
00:00:00:00:00:01  
1  
10.0.3.33  
10.0.1.249  
2048  
2048  
0  
[root@xcep /]#
```

Libera GbEthernet Interface and Libera Grouping demo, 2

- **Libera Grouping FA data contents**

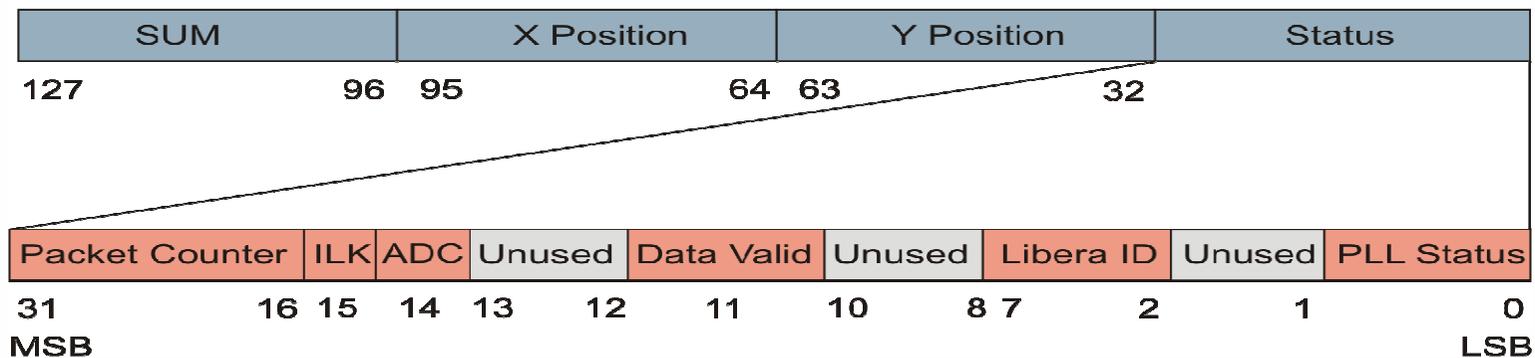
LIBERA
ID=0

LIBERA
ID=1

LIBERA
ID=2

UDP | SUM, X, Y,... | SUM, X, Y,... | SUM, X, Y,... ...

128 Bit Data Structure



Libera GbEthernet Interface and Libera Grouping demo, 3

- **Timing system**
 - Each Libera maintains its internal timing system that is locked to TbT clock (MC input)
 - Used for data time-stamping and syncing
 - Visible easily in DD data (Turn-by-Turn)
- **Time syncing – Set time**
- **Libera Group FA data**
- **Fault tolerance**

FOSS Grouping Efficiency

No grouping

UDP/IP	Payload	Total	UDP/IP overhead
42 bytes	9*4 bytes	78 bytes	54 %
42 bytes	4*4 bytes	58 bytes	72 %

Grouping: 64 Liberas

UDP/IP	Payload	Total	UDP/IP overhead
42 bytes	64*4*4 bytes	1066 bytes	4 %

Latency: 5-20 us, depends on group size

FOSS, summary

- Standard COTS components
- Standard protocol – routing, monitor/debug
- Scalability
- Comp. engine independent architecture
- Redundancy if required
- Friendly to tweaking, maintenance

- In use at Taiwan Light Source

Libera Feedback options

1. GbEthernet + Grouping

- Turn-key, included in Libera Brilliance
- Available in Libera Photon (XBPM), too

2. Diamond Communication Controller

- Turn-key, included in Libera Brilliance (soon)
- On request

3. User developed

- FPGA development kit available
- Tech. support optional