ALICE O2:

BY CULICOV ALEXANDRU

COMPUTATIONAL ARCHITECTURE OF ALICE

- **Distributed Computational Architecture**
  - ALICE O2 is based on a distributed architecture that incorporates 250 FLPs for direct data reading from detectors, each providing a speed of 2 GB/s.
  - This architecture is supported by 400 EPNs that process these data, executing complex computational tasks including event reconstruction and analysis.
- **Functionality and Performance**
  - These EPNs collectively handle the processing of full Time Frames generated every 30 seconds, ensuring effective data distribution and analysis throughout the experiment.

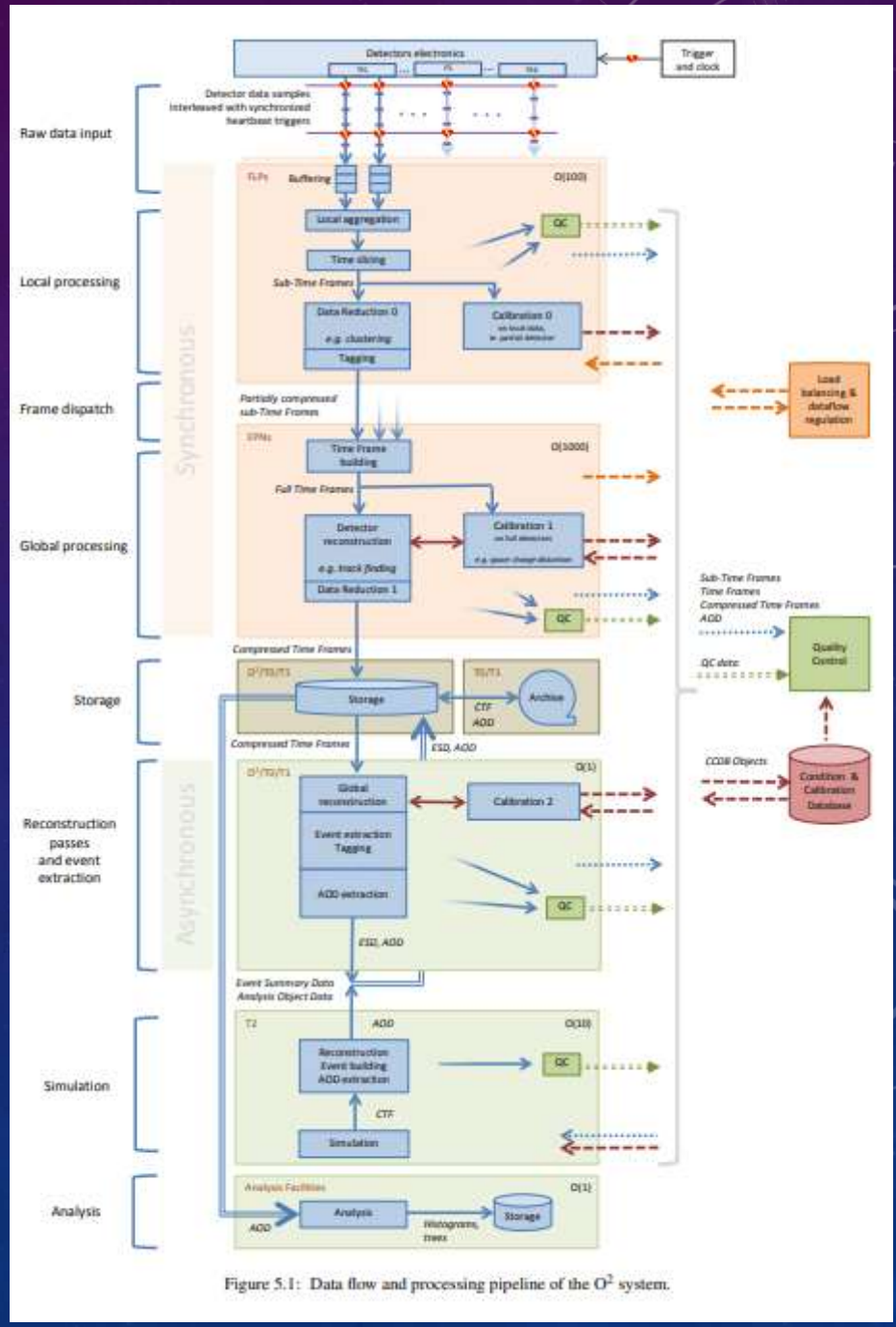


Figure 5.1: Data flow and processing pipeline of the O^2 system.

CONFIGURATION AND PERFORMANCE OF THE NETWORK SYSTEM

- **Network Infrastructure**
- 400 EPNs are connected through a high-speed network with a bandwidth of 10 Gb/s per node, optimizing data transmission and ensuring high resource availability.
- The network architecture is designed to minimize latencies and maximize data processing efficiency, which is crucial for timely processing of Time Frames.

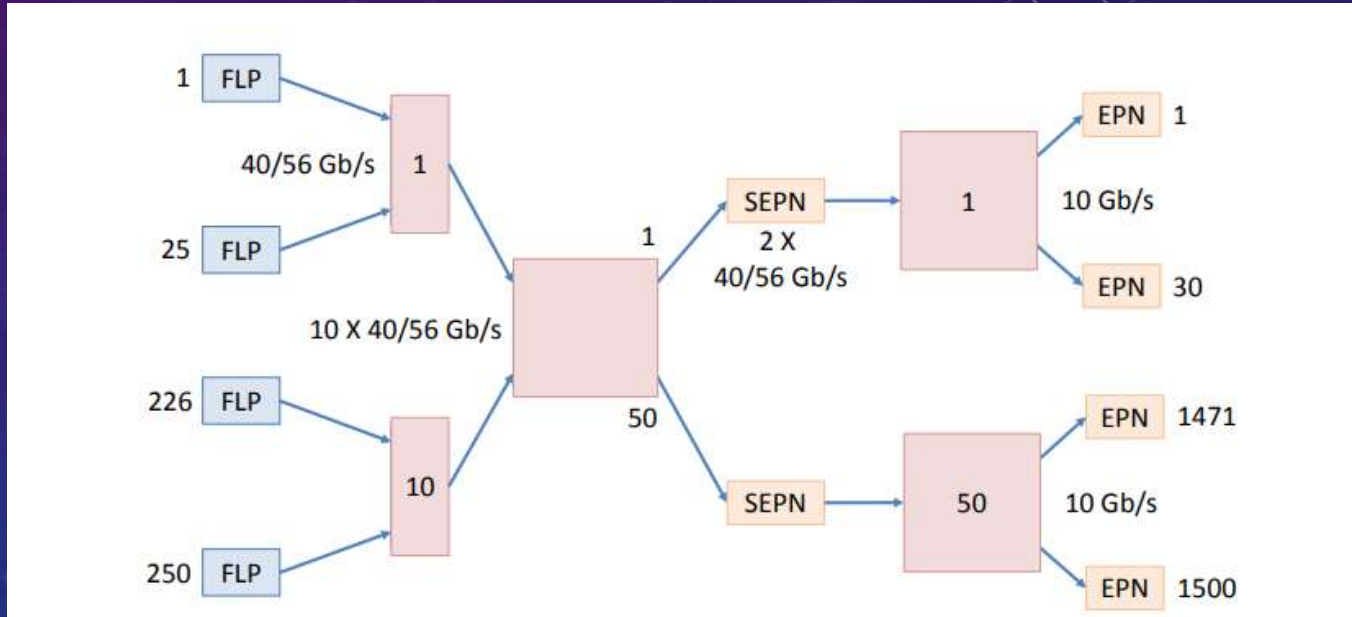
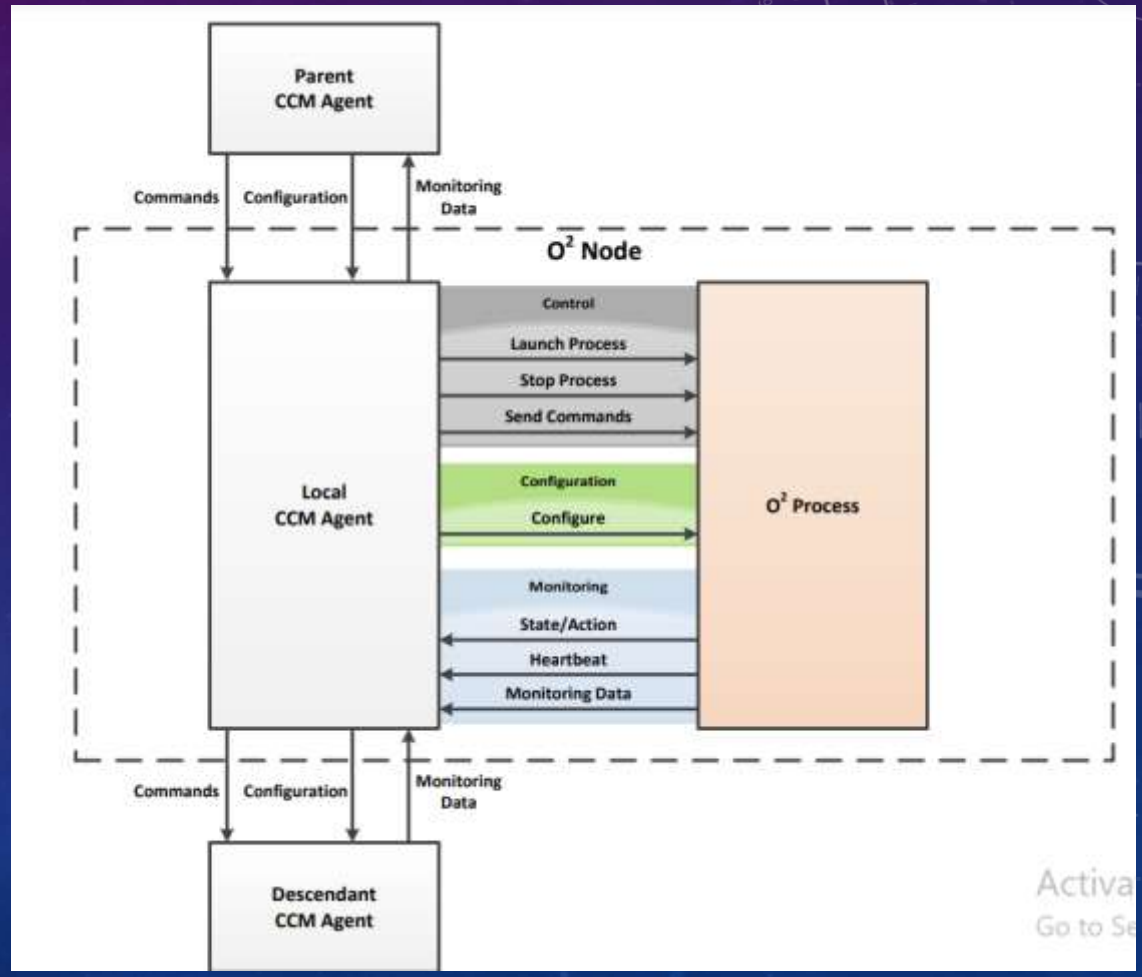


Figure 5.5: FLP-EPN network layout with SEPNs in charge of assembling and distributing the TFs to the EPNs.

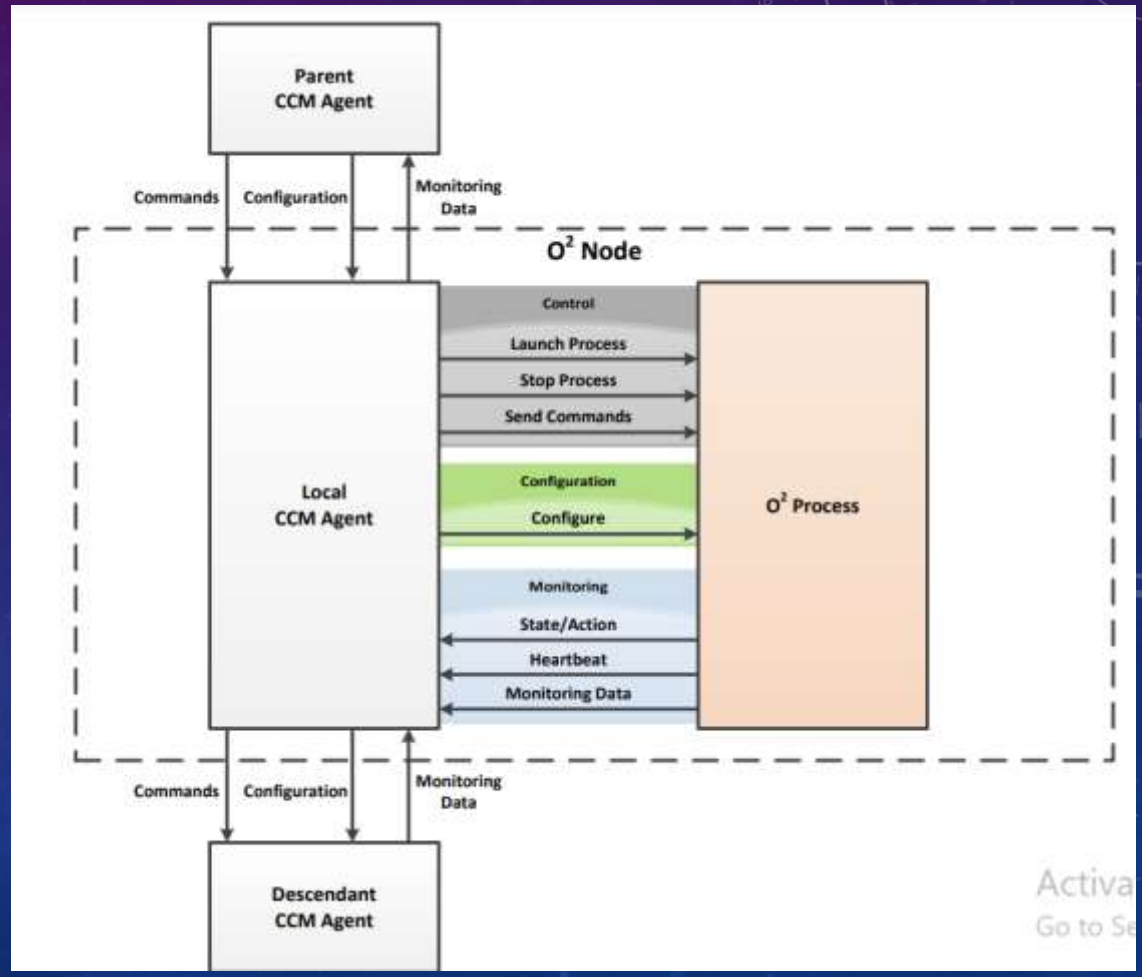
SYSTEM MONITORING AND MANAGEMENT

- **System Monitoring**
  - The O2 monitoring system allows real-time tracking of all components' performance, gathering metrics such as CPU load, memory usage, and network bandwidth.
  - The system employs over 1000 sensors to collect data on the status of hardware and software components.
- **Resource Management**
  - Resource management is conducted through a centralized system that automates task distribution among EPNs and optimizes their load for maximum efficiency.
  - The system supports dynamic scaling, enabling the addition or removal of computational nodes based on the current computational power requirements.



DATA SECURITY AND RELIABILITY

- **Security Measures**
  - ALICE O2 implements a multi-layered security strategy to protect data and infrastructure, including data encryption, user authentication, and regular security audits.
  - An incident detection and response system provides continuous monitoring of network traffic and user activities to prevent unauthorized access.
- **Ensuring Reliability**
  - To guarantee high availability and reliability, the O2 system utilizes redundant data storage and automatic failover to backup nodes in case of failures.
  - Regular backup and data recovery procedures minimize information loss and ensure data integrity under all circumstances.



MEMORY AND COMPUTATIONAL RESOURCE REQUIREMENTS

- **Computational Capabilities**
- To adequately process data and compress events, each of the 1500 EPNs is equipped with approximately 100 GB of RAM, providing the necessary performance for computational tasks.
- Considering the presence of dual-processor systems with 32 cores each, ALICE O2 can effectively distribute and process data streams in real time.

Table 10.2: Nodes of the O^2 facility with their minimal characteristics.

Node Type	Number of nodes	Number of cores	Number and type of accelerators	Memory (GB)	Network bandwidth (Gb/s)	I/O slots PCIe Gen3
FLP TPC	162	2 x 6	FPGA/CRU	32	18	2
FLP ITS	23	2 x 24		32	12	1
FLP other detectors	65	2 x 6		32	12	1 or 2
EPN	1500	2 x 32	2 x GPU cards	100	10	0

DATA STORAGE SYSTEM

- **Volume and Speed** The system processes output data at a maximum rate of 500 GB/s from the ALICE detectors, requiring a robust infrastructure for data storage and processing.
- Each EPN manages 10 GB of data per Time Frame, necessitating advanced solutions for storage and rapid data access.

Table 10.3: Network ports, throughput and bandwidth.

Node type	Network ports and bandwidth (Gb/s)	Data traffic type
FLP (out)	1 x 40GbE or 56 GbIB or 4 x 10GbE	Mostly outgoing traffic, continuous @ 10-20Gb/s
EPN (in)	1 x 40GbE or 56 GbIB or 1 x 10GbE	Input traffic in bursts (full speed during the burst and idle the rest of the time)