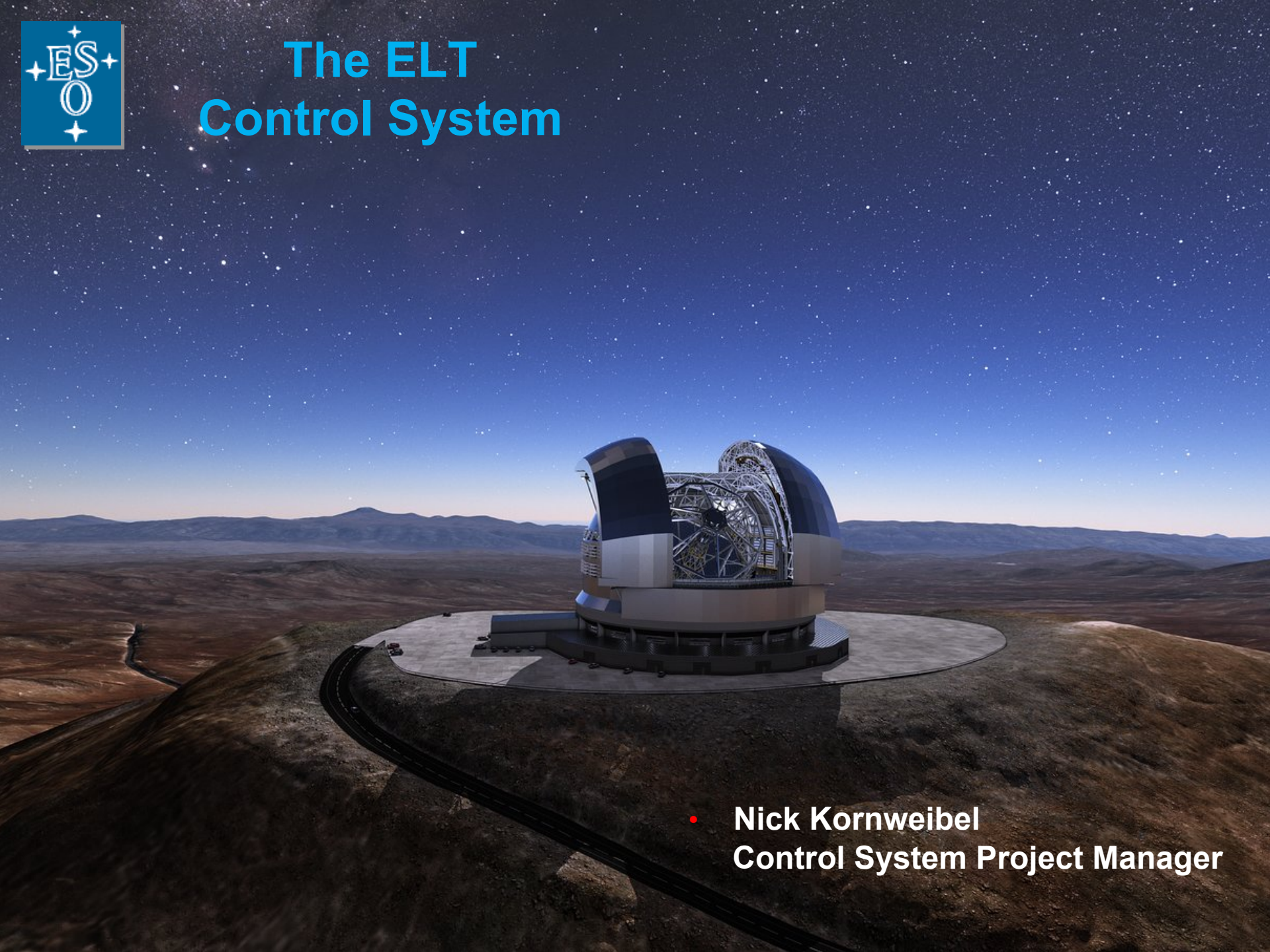
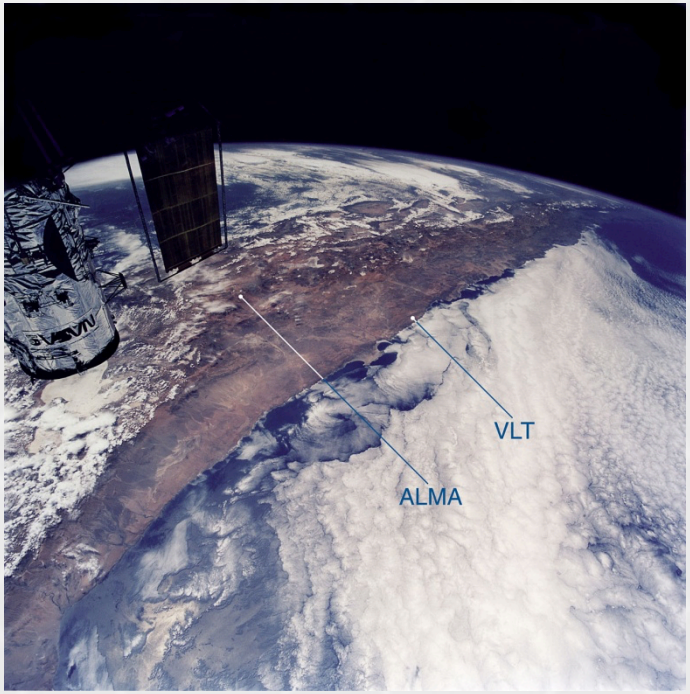
The ELT Control System



- Nick Kornweibel
  Control System Project Manager

Site

- Armazones Peak 3050 m. high. & 25 km from Paranal

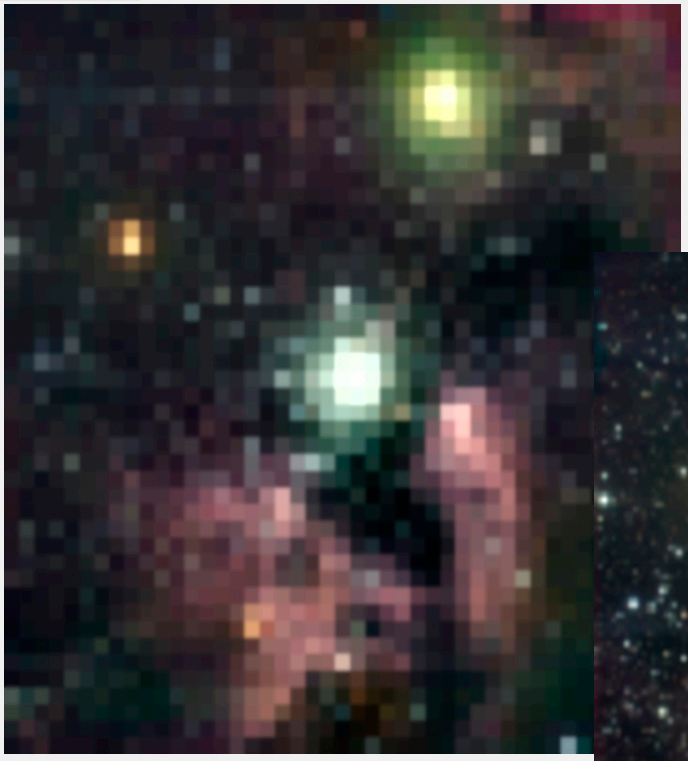


Selection criteria: impact on science, outstanding atmosphere, construction and operations logistics.

Project

- Top priority of European ground-based astronomy (on Astronet and ESFRI lists).
- Cerro Armazones selected as the E-ELT site in April 2010.
- Detailed Design Phase completed in 2011.
- Construction Proposal published in Dec 2011.
- Project fully approved in Dec 2012.
- Construction started in 2014 with road and platform blasting.
- Start of operations approx 2024.
- Construction cost: approx 1000 M€.

Spectacular Resolution



HST

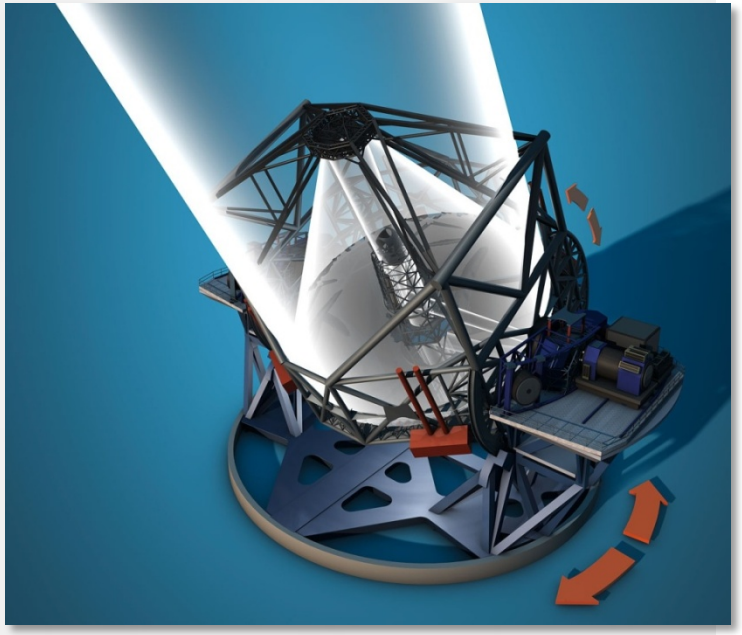
VLT+AO

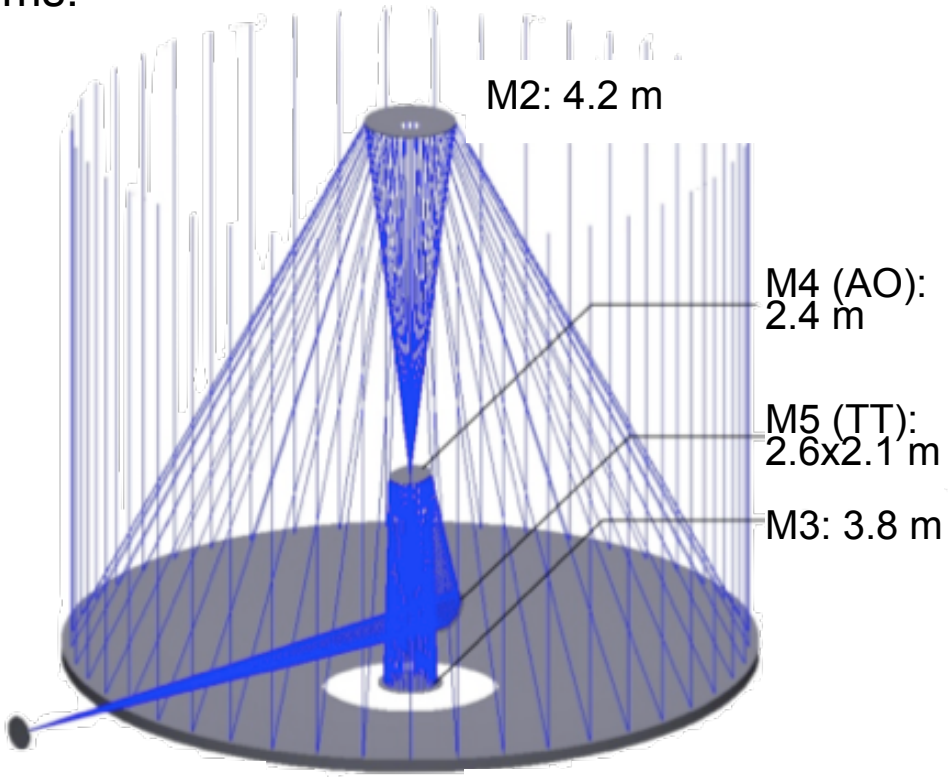
ELT

Telescope

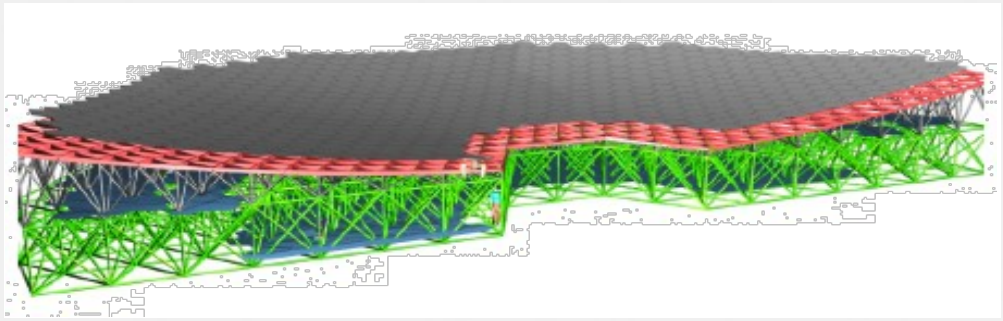
E-ELT is an adaptive telescope,

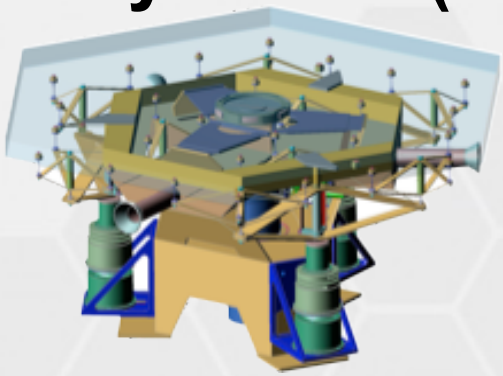
- control system far more complex than previous generations of telescopes.
- substantial increase of I/O points,
- higher computational and communication demands
- stronger coupling among subsystems.





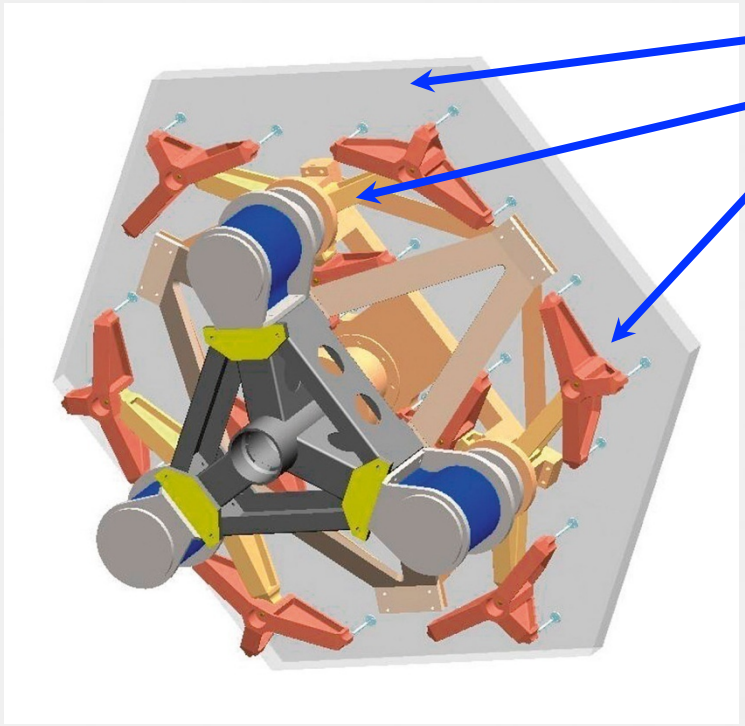
The Primary Mirror (M1)

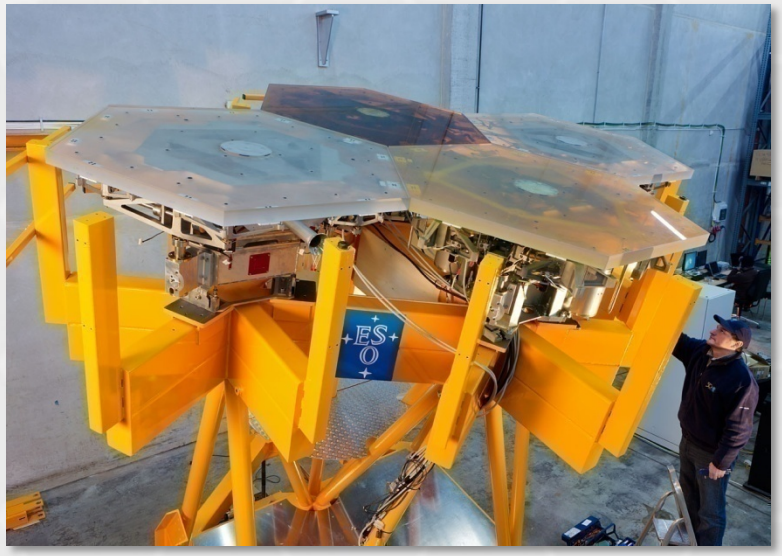




Segment Active Control

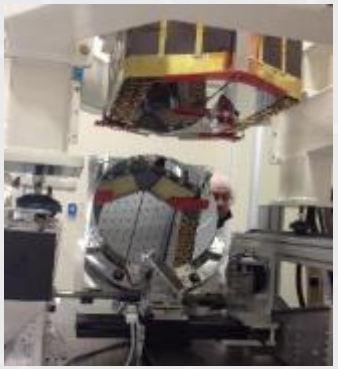
- 6 Edge Sensors (Piston/Shear/Gap)
- 3 Actuators (Piston/Tip/Tilt)
- 1 Surface Deformation harness

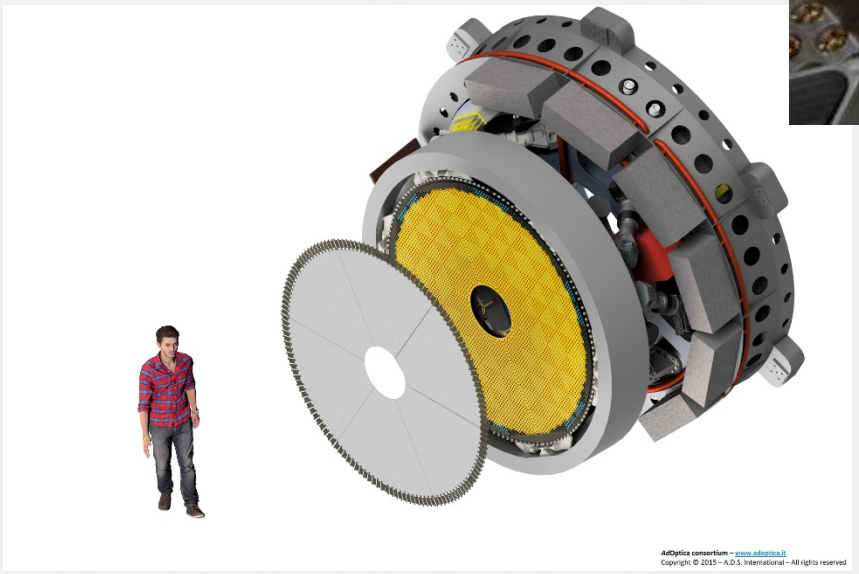


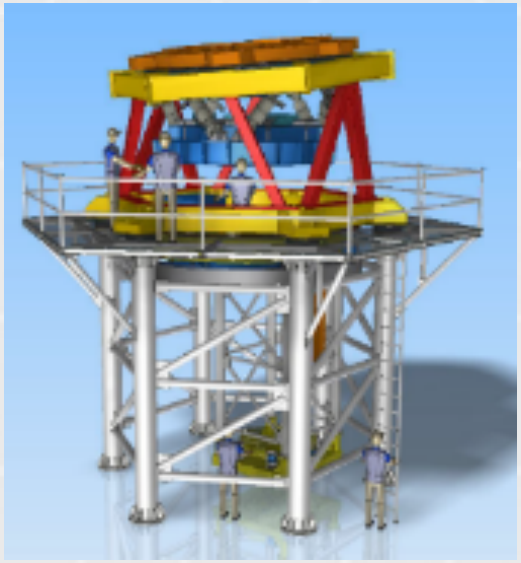


M4 Mirror - Deformable

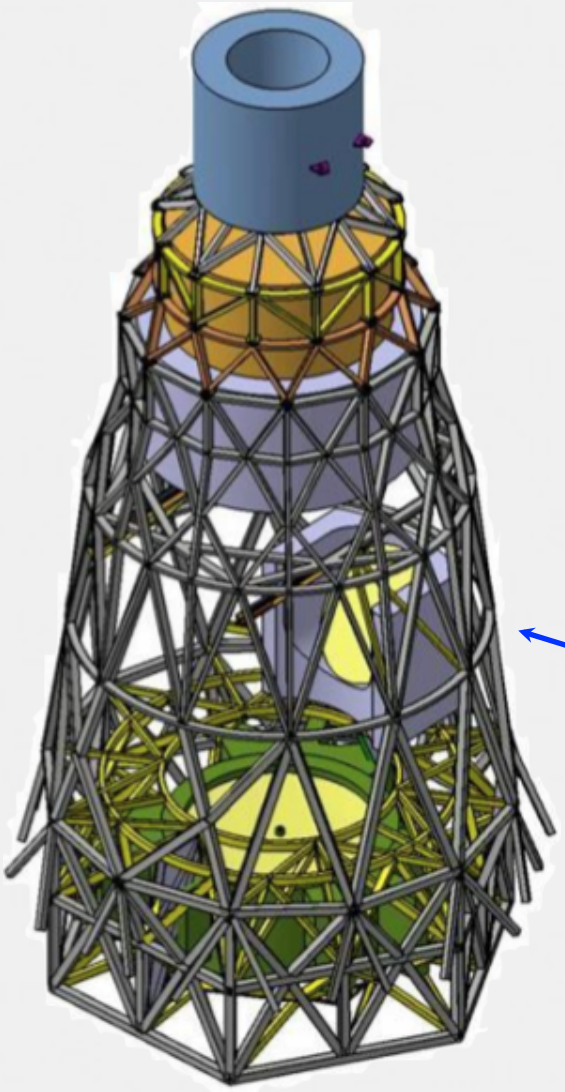
- 2.4-m flat adaptive mirror – 6 thin-shell petals only 1.95mm thick!
- ~5300 contactless actuators driving the mirror shape at 1 kHz
- Contracts for Final Design and Manufacturing is running

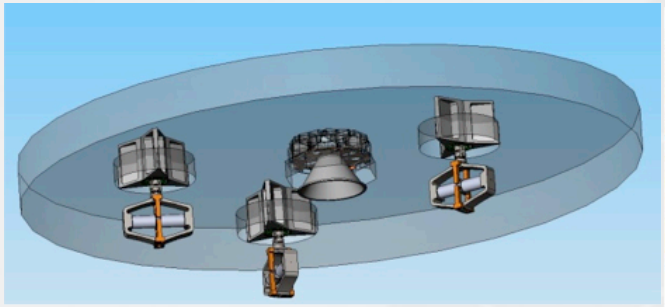


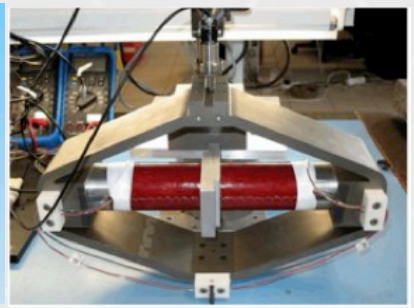


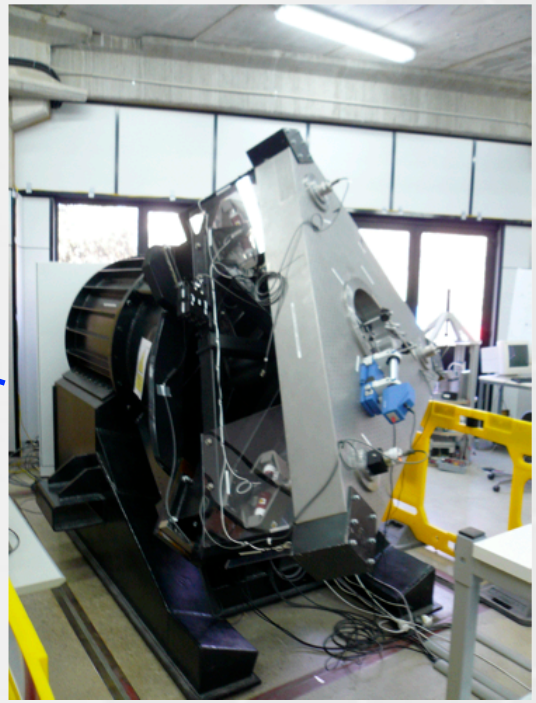


M5 Mirror – Fast Tip-Tilt







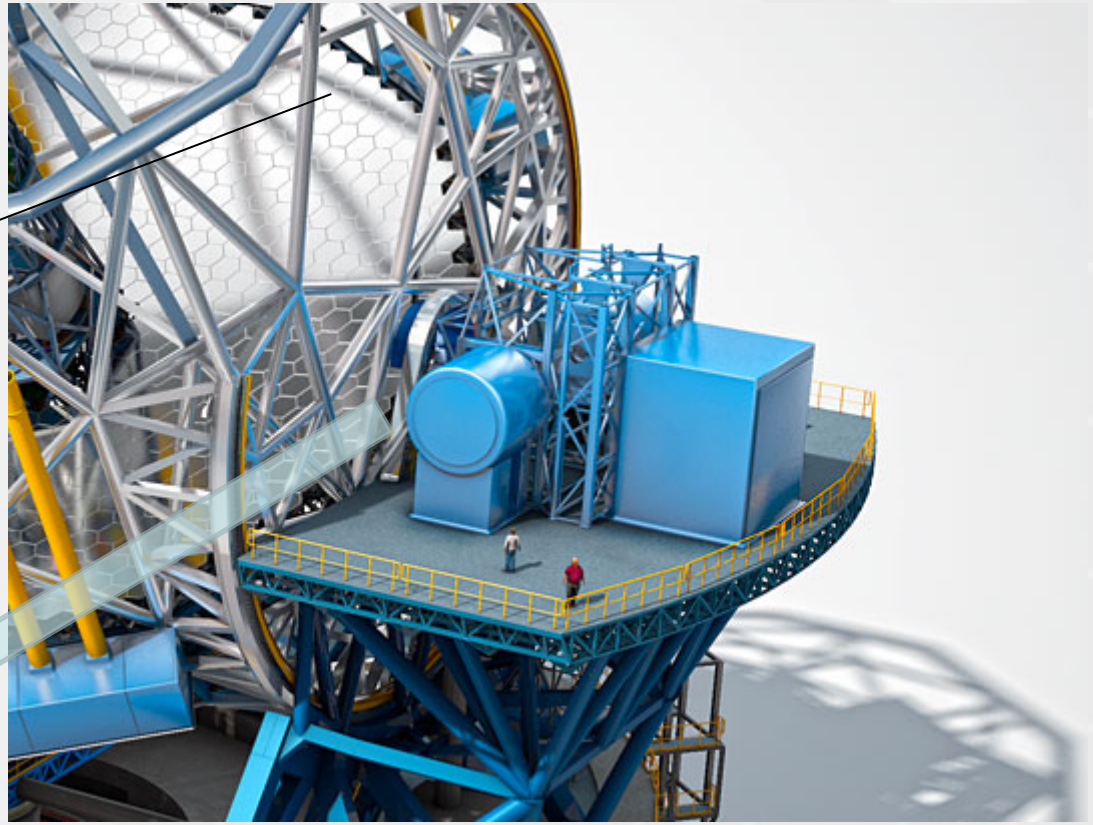


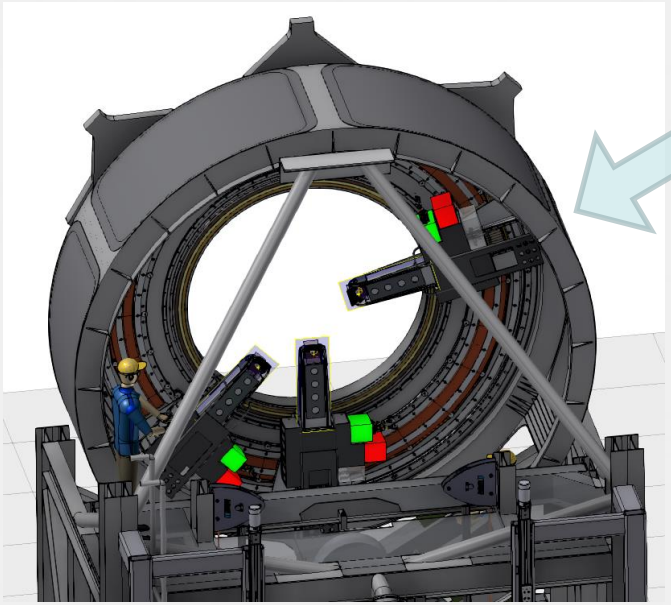
Prefocal Station Overview

Optical sensing unit on the Nasmyth platform

Performs optical sensing to support wavefront control of telescope.

Two PFS in total: one per Nasmyth platform



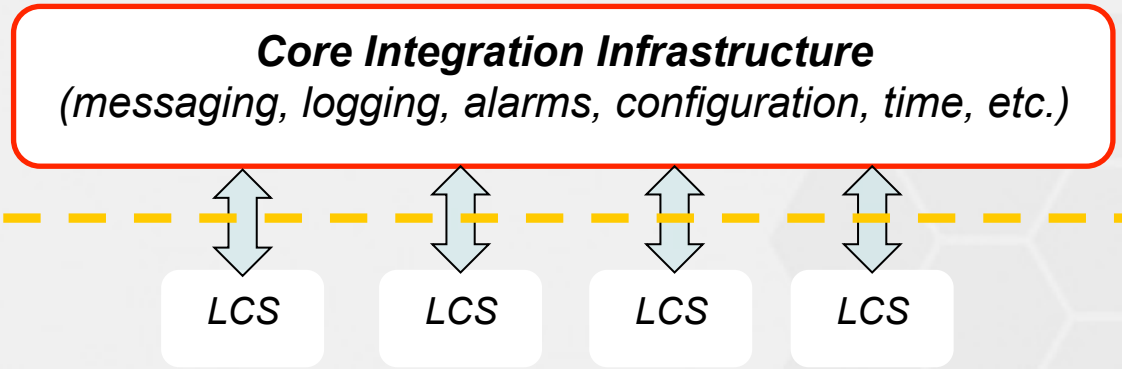


Control System Architecture

- System of Systems:
  - *Local Control System(s)* fully responsible for subsytem function and safety.
  - *Central Control System:* integrated control and telescope level safety.

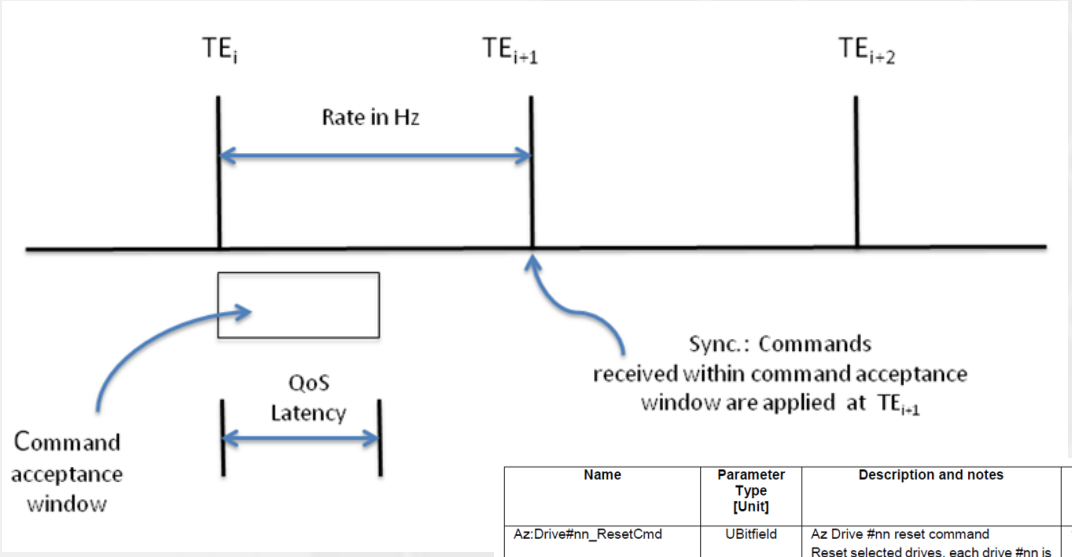
- Principals:
  - Separation of control and safety functions
  - Physical separation between computing units and field devices.
  - Usage of mainstream industrial standards.
  - Usage of mainstream COTS components.

Interface Definitions



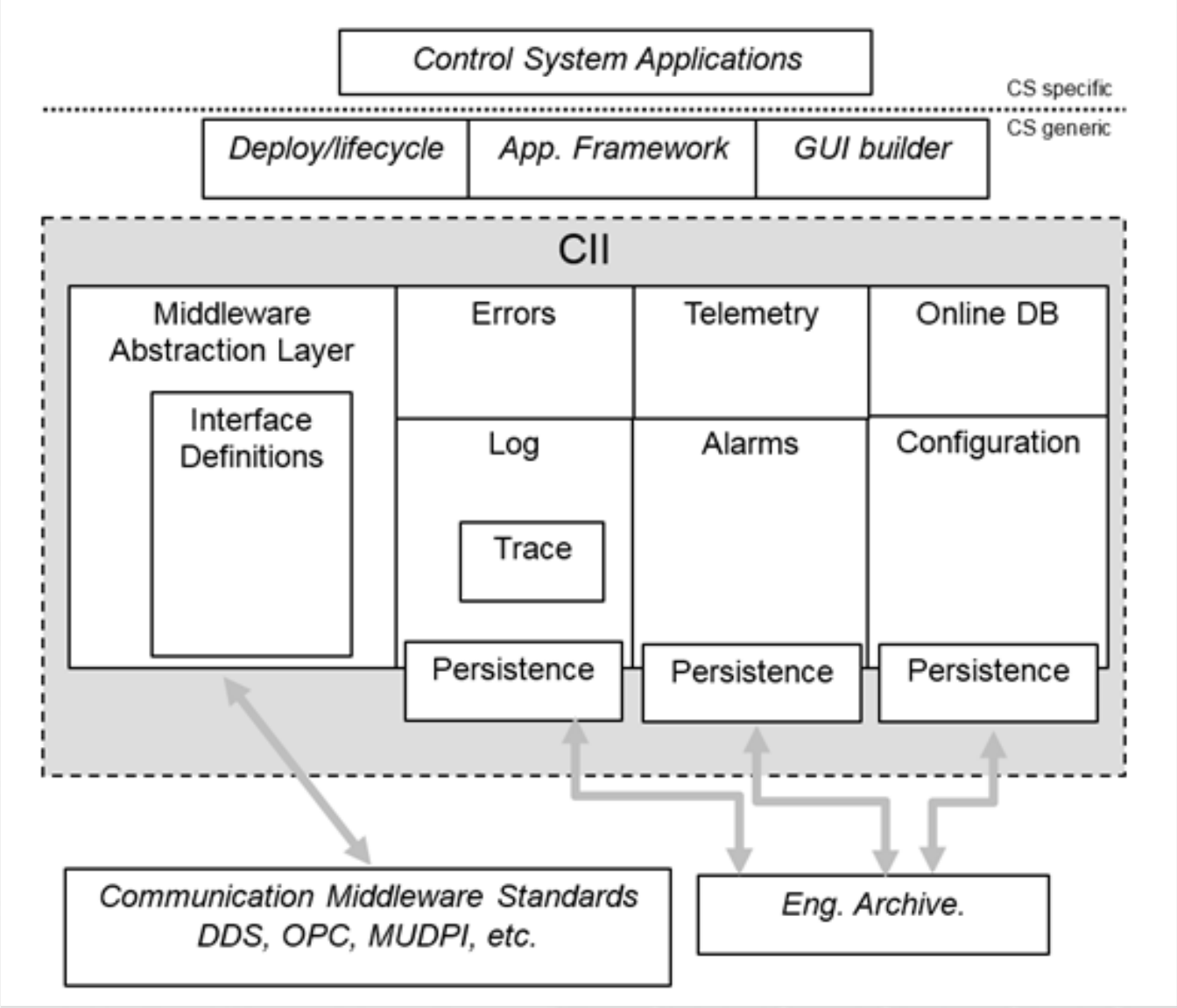
2 Patterns:
- Pub/Sub
- Cmd/Reply

4 Standards:
- DDS
- OPC/UA
- ZMQ/ProtoBuf
- MUDPI

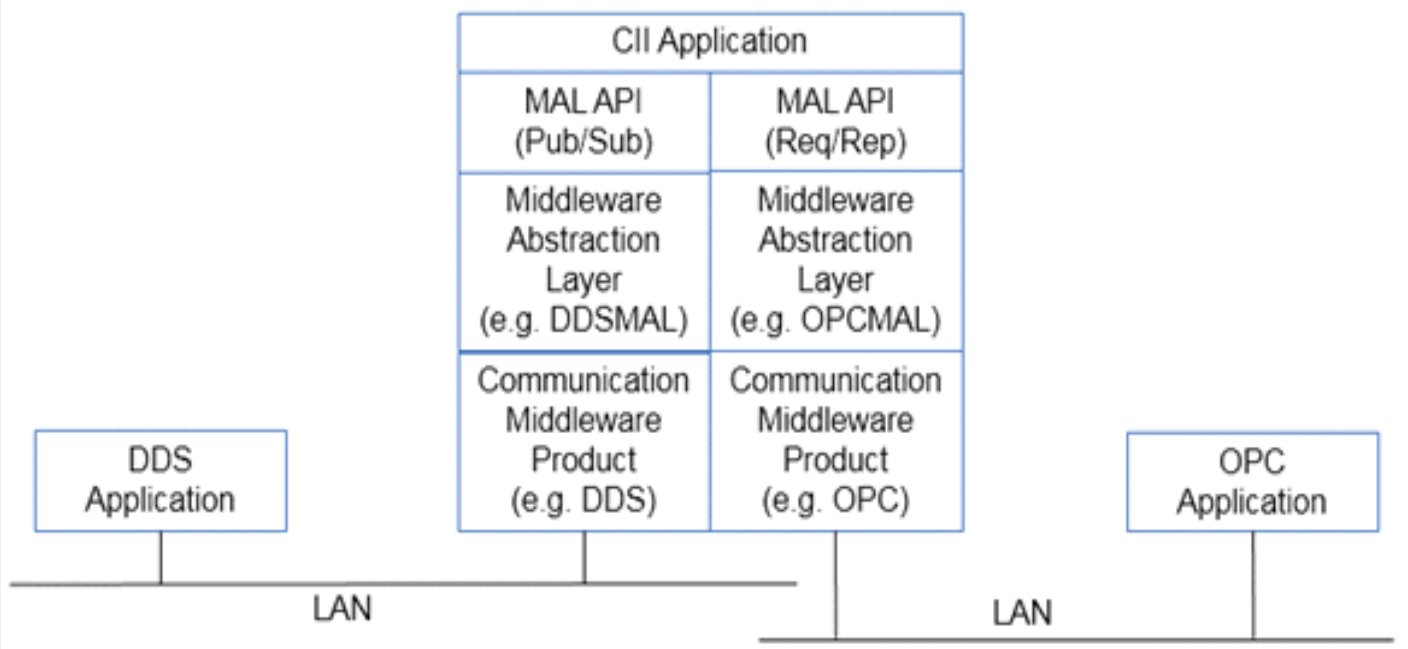


Name	Parameter Type [Unit]	Description and notes	Rate	Sync. /Async.	QoS Latency
Az:Drive#nn_ResetCmd	UBitfield	Az Drive #nn reset command Reset selected drives, each drive #nn is represented by one bit of the bitfiled, 1= drive reset, 0 = no action.	1Hz	Async.	1000ms
Az:Drive#nn_EnablCmd	UBitfield	Az Drive #nn enable command Enable selected drives, each drive #nn is represented by one bit of the bitfiled, 1= drive reset, 0 = no action.	1Hz	Async.	1000ms
Az:Drive#nn_DisablCmd	UBitfield	Az Drive #nn disable command Disable selected drives, each drive #nn is represented by one bit of the bitfiled, 1= drive reset, 0 = no action.	1Hz	Async.	1000ms

Core Integration Infrastructure

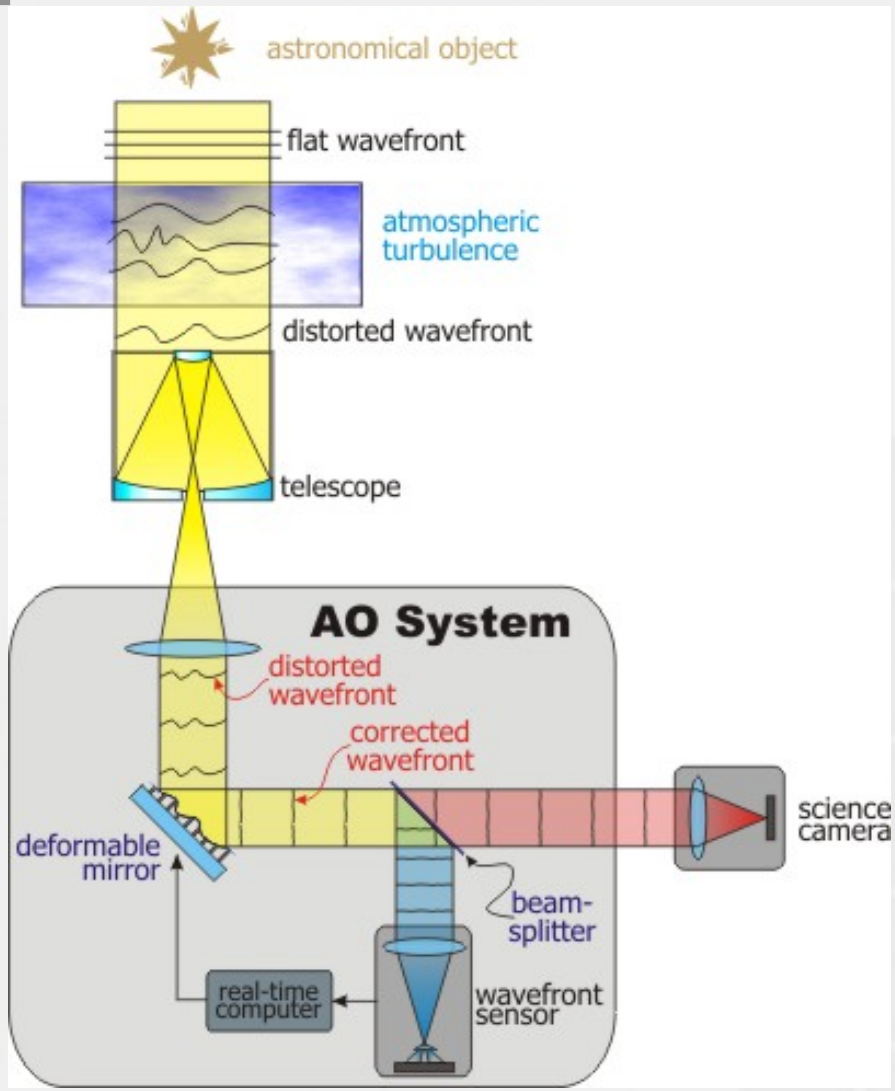


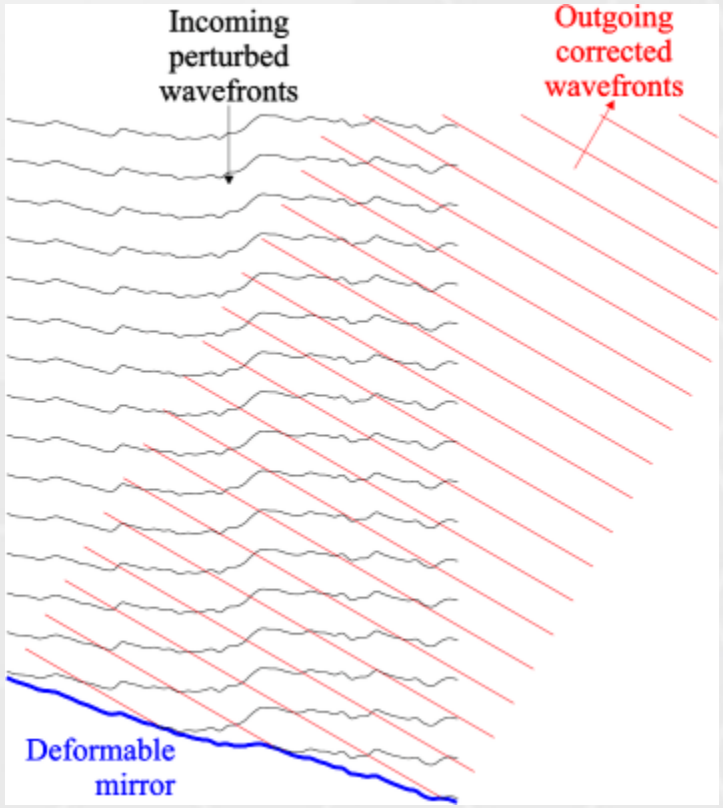
Middleware Abstraction Layer



	Publish/Subscribe	Request/Reply
OPC/UA Data Access		✔
OPC/UA History		✔
OPC/UA Methods		✔
OPC/UA Events	✔	
DDS	✔	✔
ZMQ/Protobuf	✔	✔
MUDPI	✔	

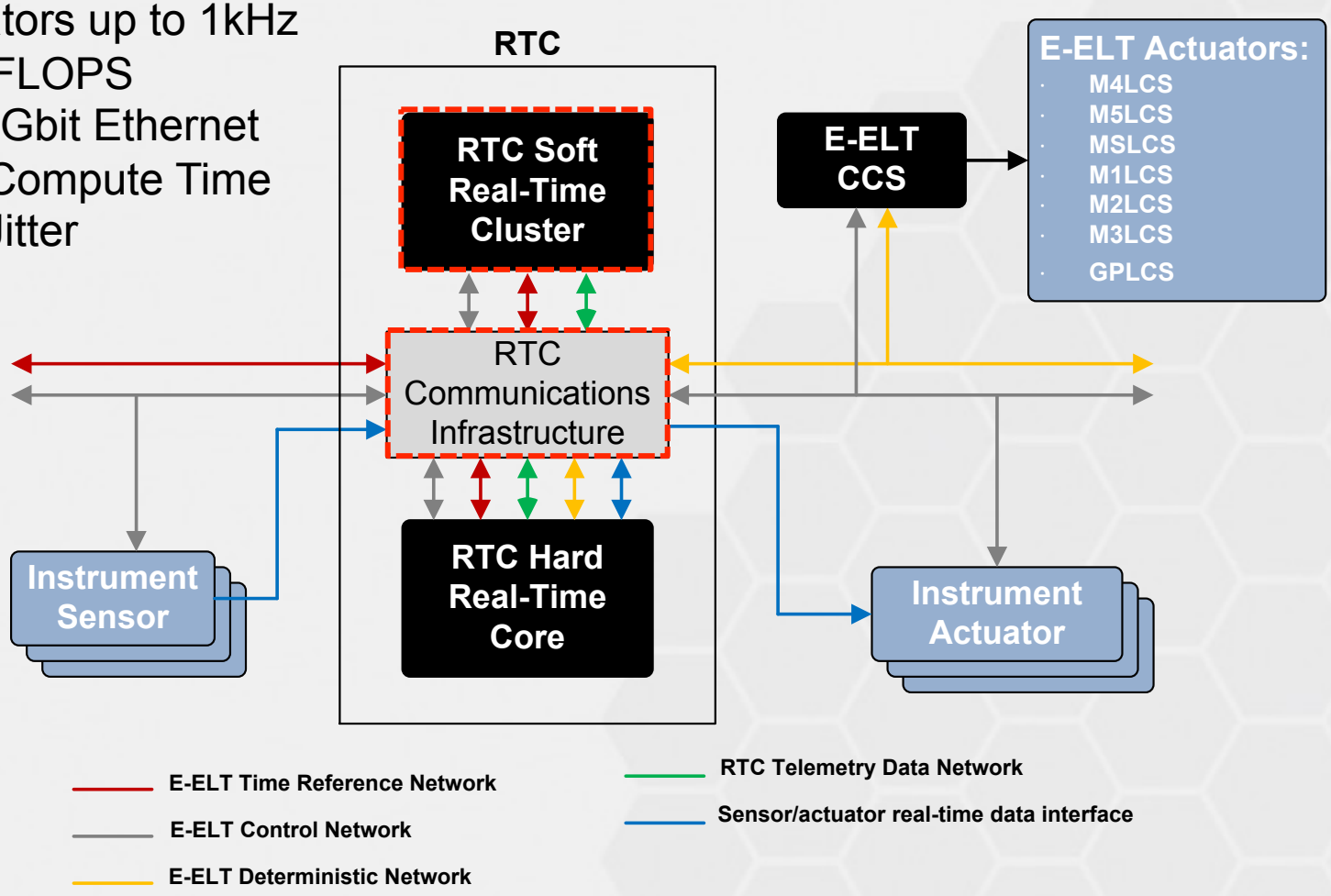
Adaptive Optics principle





Adaptive Optics Real-Time Computer

- Sensors up to1kHz
- Actuators up to 1kHz
- 1.4 TFLOPS
- 10/40Gbit Ethernet
- 1ms Compute Time
- Low Jitter



Putting it all together…