SysML for Telescope System Modeling

by the

INCOSE MBSE Challenge Team SE^2

Agenda

- What is SE^2
- What is ESO?
- What is the Challenge project about?
- The deliverables
- What have we achieved?
- Is there a future?
- What is next?
- Live demo of the model

About SE^2

- Collaboration between the European Southern Observatory (ESO) and the German Chapter of INCOSE (GfSE)
- Access to a high-tech project, the Active Phasing Experiment (APE).
- The team members are:
  - Robert Karban (ESO)
  - Tim Weilkiens (oose GmbH)
  - Rudolf Hauber (HOOD Group)
  - Rainer Diekmann
  - Andreas Peukert (TU Munich)

ESO

Non-profit Intergovernmental European Organisation for Astronomical Research in the Southern Hemisphere

http://www.eso.org

Headquarters in Munich, Germany, 3 Observatories in Chile

Mission statement

Build and operate world class ground based astronomical facilities

ESO major projects

Very Large Telescope (VLT)

Started 1988, in operation since 1999

Atacama Large Millimeter Array (ALMA)

Europe-US-Japan

Started 1998, installation starting now

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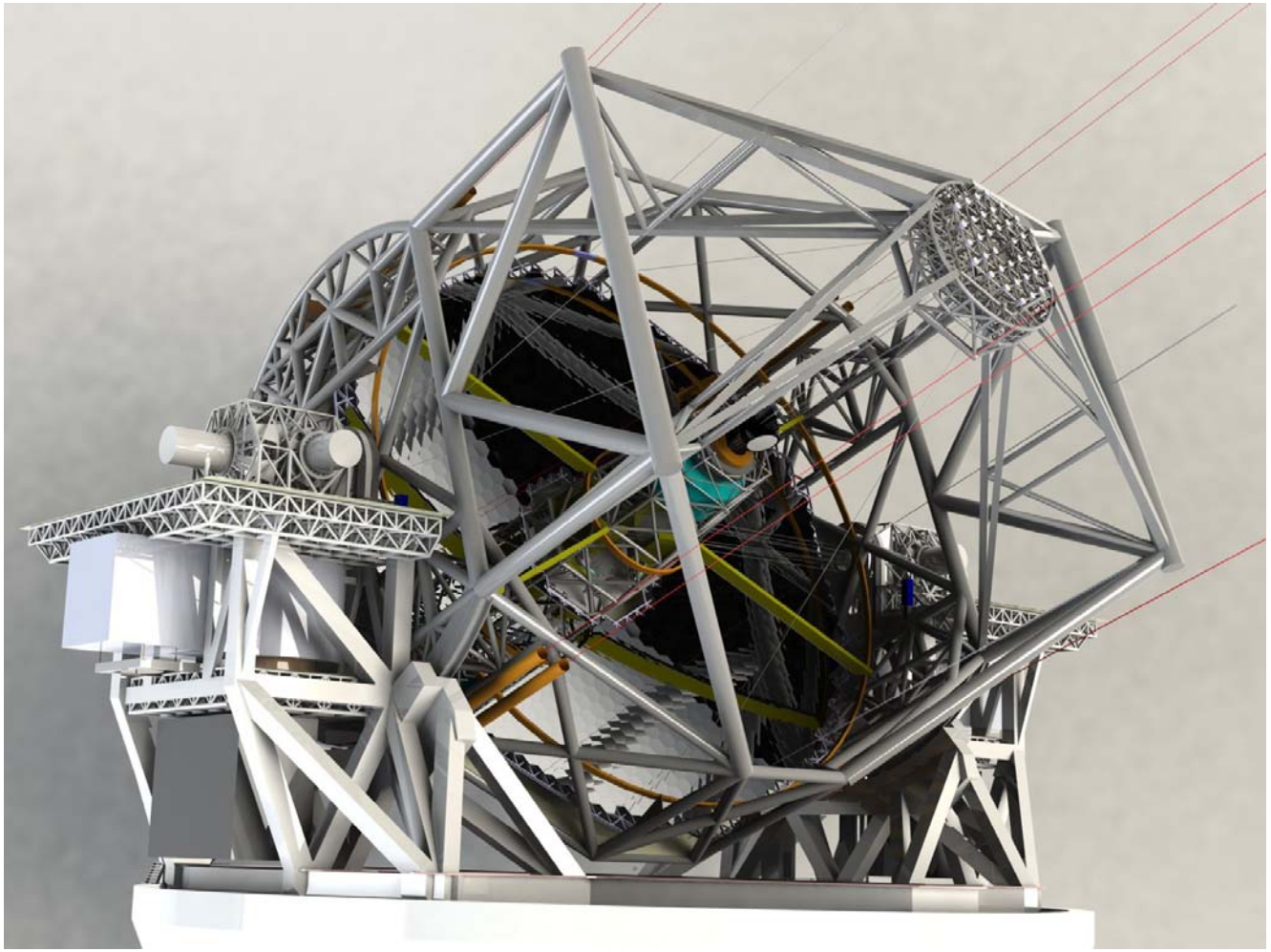
E-ELT



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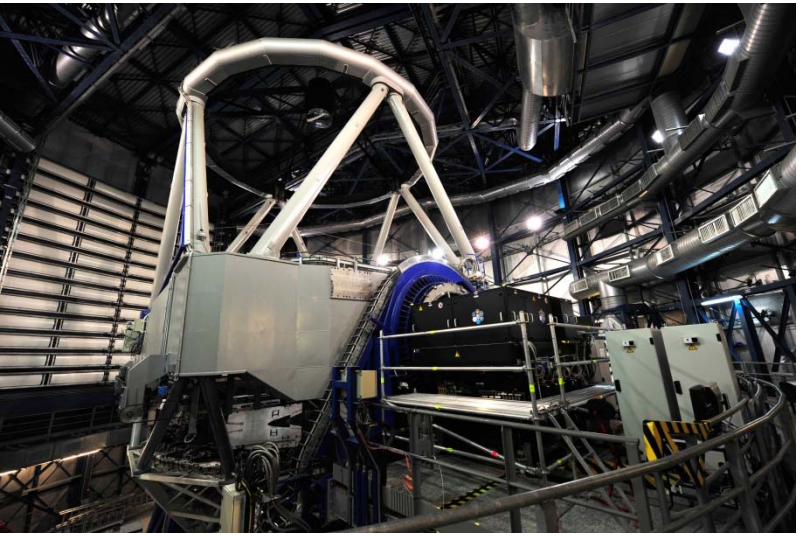
What is it about?

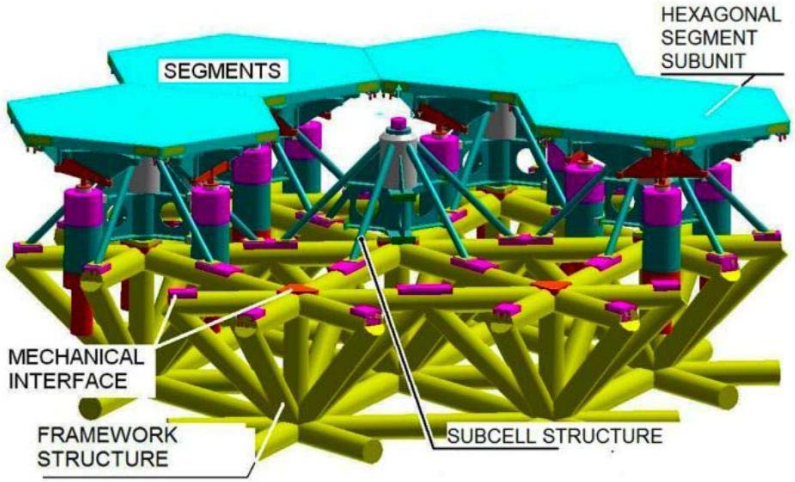


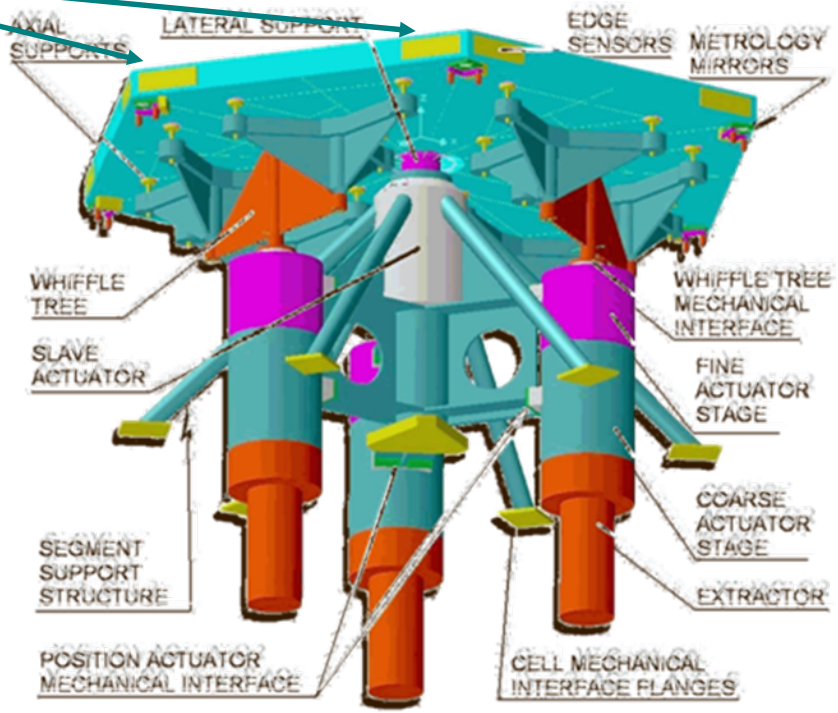
- System case study (since 2007)
  - The APE technology demonstrator for the future Extremely Large Telescope (ELT)
  - High-Tech interdisciplinary opto-mechatronical system in operation at the Paranal observatory

Goals

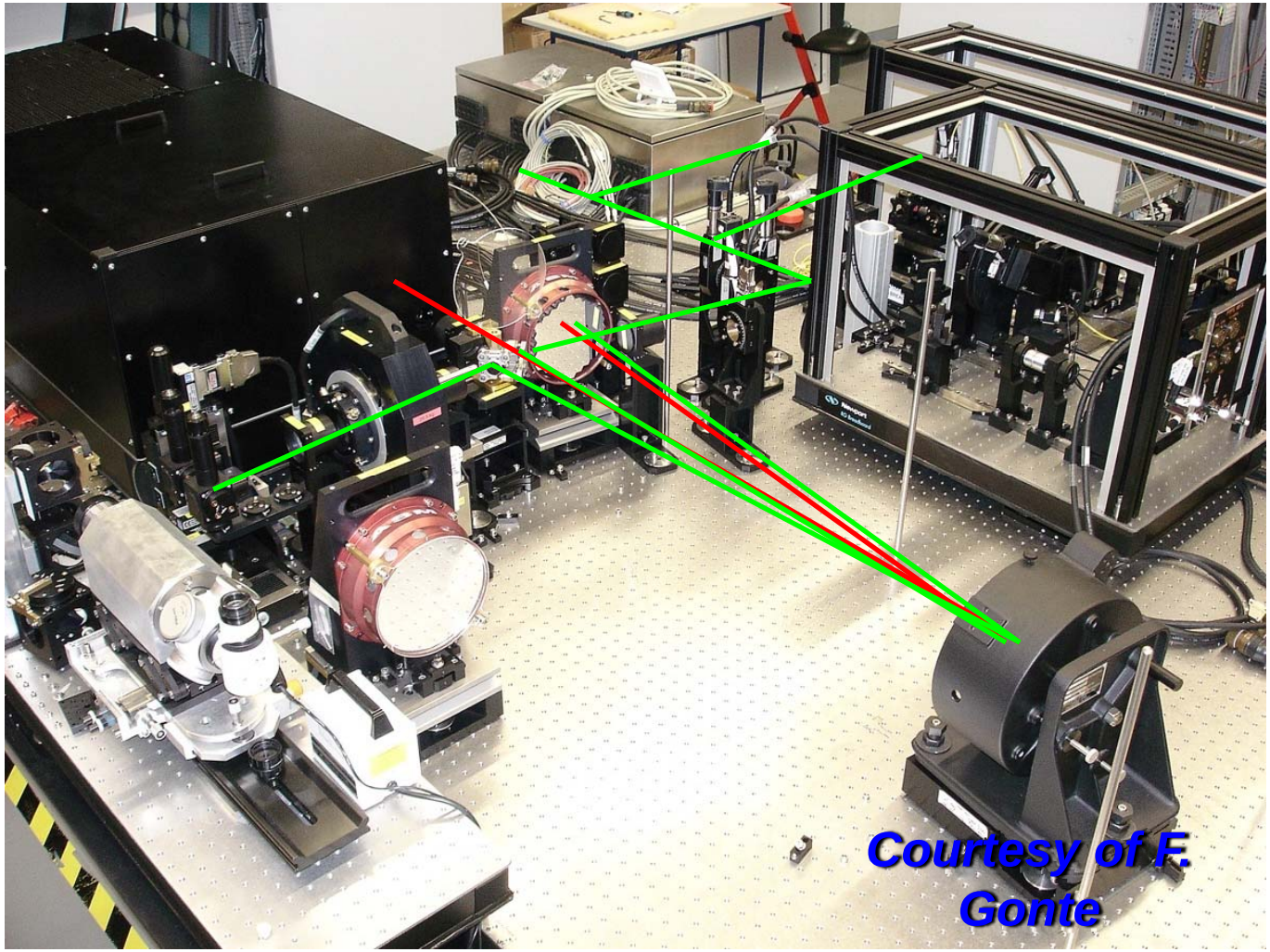
- Create modeling guidelines and conventions for all system aspects, hierarchy levels, and views
- Create a fully fledged SysML model
- **Documented at http://mbse.gfse.de**

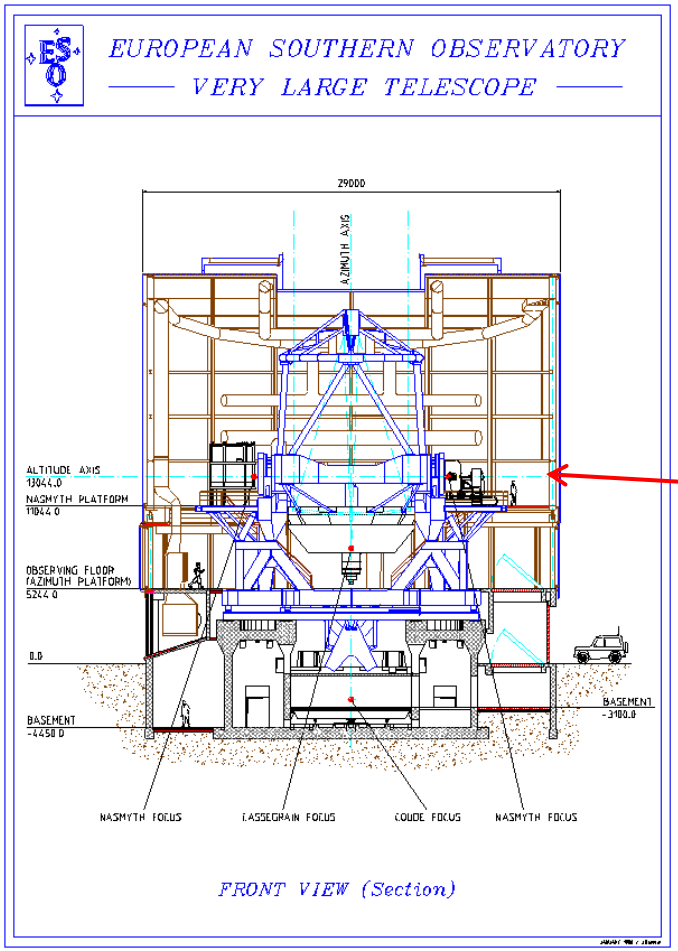
Edge Sensors

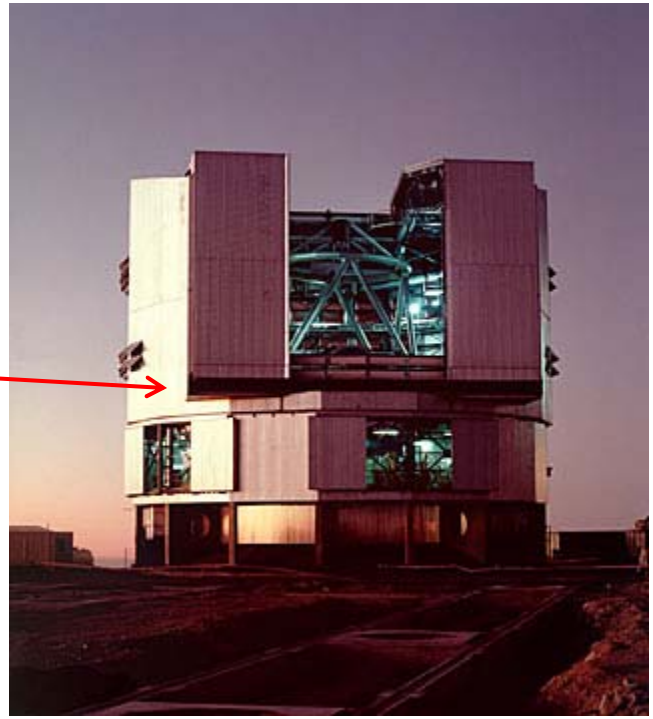




Detect nanometers of phasing error in micrometers of turbulence with Phasing Wave Front Sensors (~20 nm RMS)







APE was installed at the telescope in the Atacama desert, Chile.

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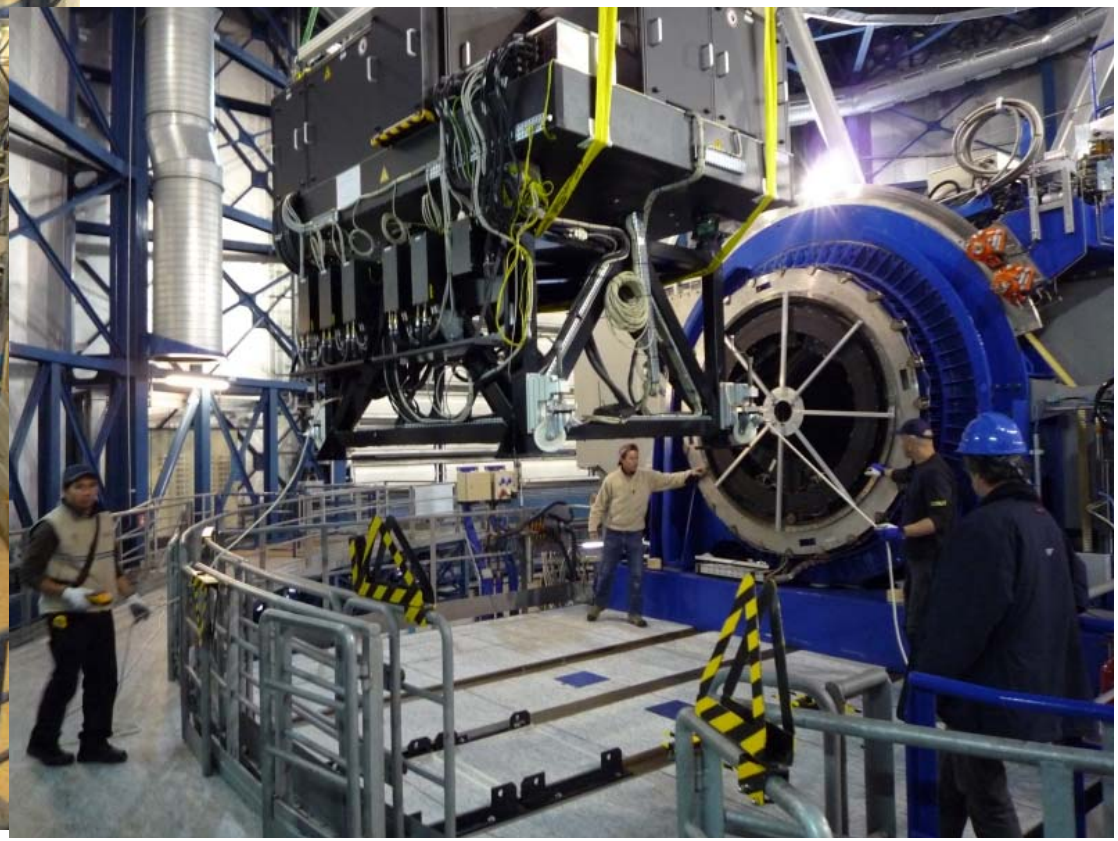
Installation on the platform of the telescope



Deliverables (1/2): Generic SysML modelling FAQ

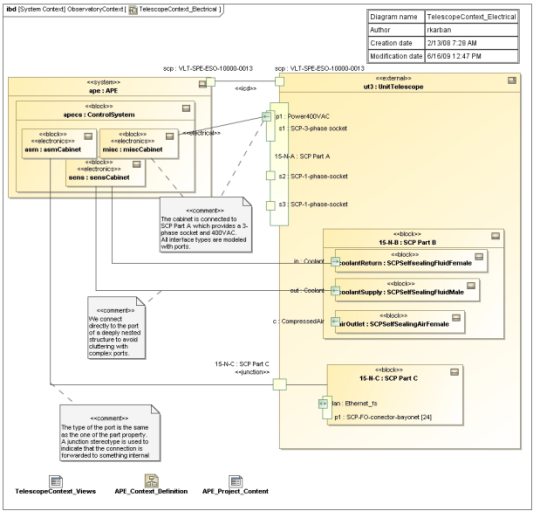
- General modeling guidelines
- Guidelines for necessary system models and aspects
- Guidelines for modeling the system requirements
- Guidelines for modeling the system structure

Deliverables (2/2): SysML model for the APE project

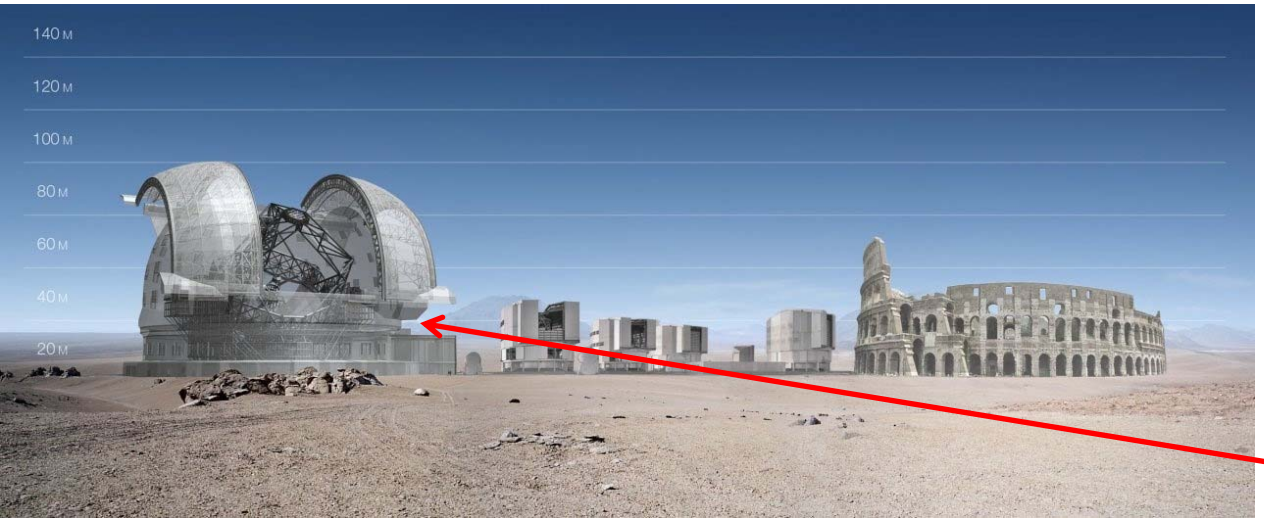
- Three major model parts:
  - Actual system model: APE (with all mentioned system aspects)
  - Catalogue model: standard parts, library of block prototypes
  - Modelling profile: additional stereotypes
- Main characteristics:
  - Scalable model structure and organisation
  - Includes model annotations, external references
  - Various examples of ports and flows to model interfaces
- Abstraction levels
  - Functional, Structural, Deployment

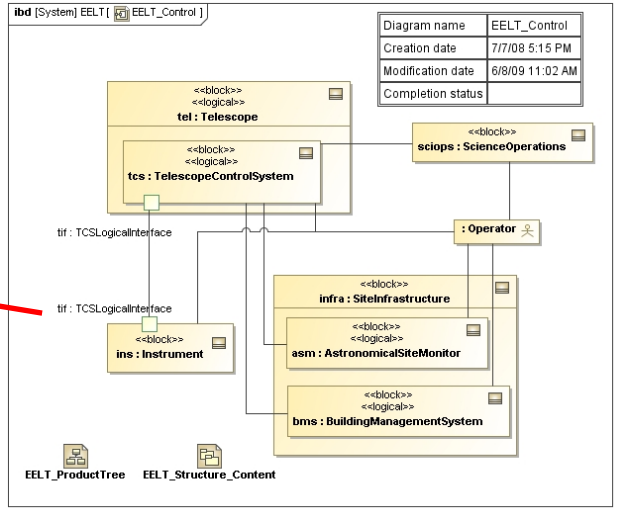
What have we achieved?

- APE model, guidelines, and best practices
  - Model structure and overview
  - Objectives and Requirements
  - Context, System Structure
  - Behavior. Data
  - Verification
  - Model library and SE Profile
- Modeling challenges
  - Identified, solved, and presented (RTF input)
  - Notation (e.g. Connection of nested blocks)
  - Model (e.g. Grouping of interfaces)
  - Tool (e.g. Configuration and Quality Control)
  - Methodology (e.g. multi-layer allocation)
- Plug-in for modeling tool



Is there a future?





- 10000 tons of steel and glass
- 20000 actuators, 8000 mirrors
- 60000 I/O points, 700Gflops/s, 17Gbyte/s
- Many distributed control loops, excessive control strategy
- Use SysML to model the control system since 2008

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What is next?

- Update guidelines and FAQ
- Create a “Solving SysML problems in a nutshell” booklet
- Elaborate APE reference model
- Practical variant modelling
- Application of parametrics

Live demo of the E-ELT model

- Please standby - setting up the system…