CAPELLA DAYS 2021 WARM-UP session

Introduction to CAPELLA/ARCADIA and NASA Systems Engineering handbook: Modeling overview with the HUBBLE Space Telescope

DROUIN Remy

Capella
Open Source MBSE Solution

ARCADIA

Speaker introduction

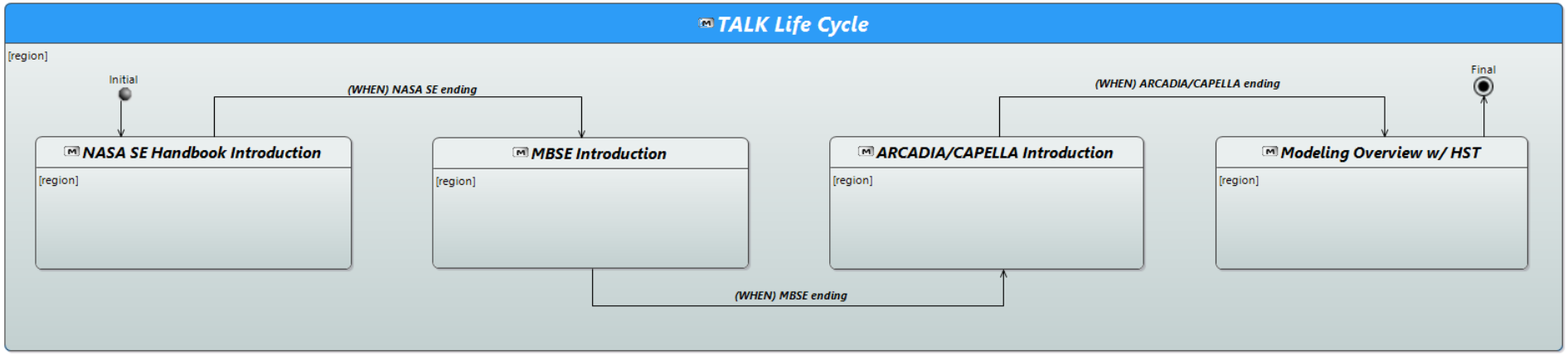
Speaker: DROUIN Remy

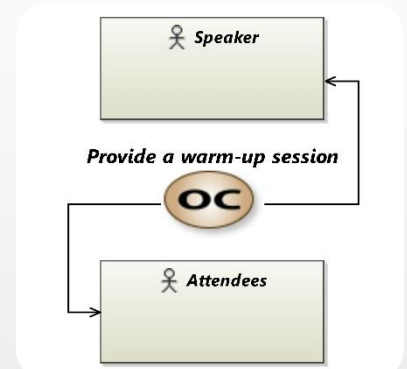
- ***Avionic systems engineer in the French Air Force***
- ***Team Leader in automotive industry designing connected solutions***
- ***Program Manager in elevator industry designing connected solutions***
- ***Head of system department in defense industry designing High Energy Laser Systems***
- ***Lecturer for French universities introducing Systems Engineering and Model-Based Systems Engineering***

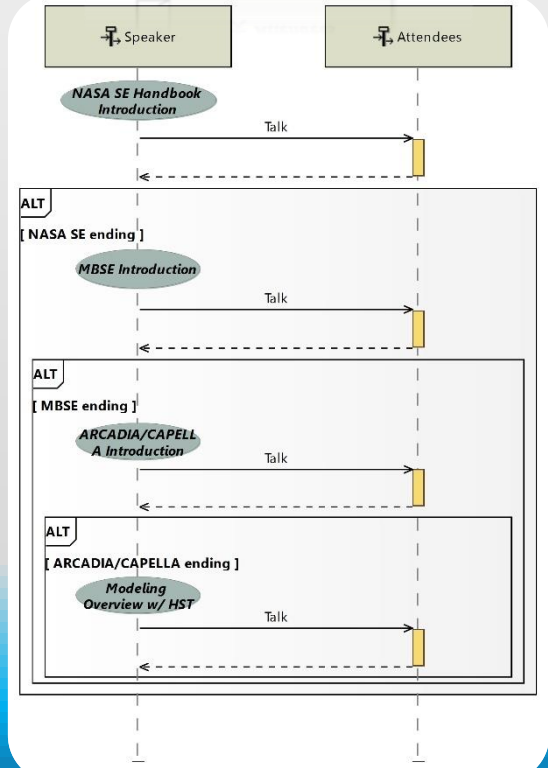
"The NASA System Engineering (SE) handbook aims to provide general guidance and information on systems engineering, as it should be applied throughout NASA. The handbook introduces 3 common technical processes. One of these, is the System Design Process, describing the stakeholders expectations, requirements definition, logical decomposition and design solution definition. The 4 activities can be supported by a Model-Based Systems Engineering (MBSE) approach. To do so, an appropriate method and tool is necessary as the one provided by the ARChitecture Analysis & Design Integrated Approach. ARCADIA, with its modeler CAPELLA, is a MBSE solution supporting system modeling activities. Based on 4 architectural layers, which are Operational Analysis, System Analysis, Logical and Physical Architecture, it is a structured architecture engineering method for defining and validating multi-domain systems. This talk will present an educational overview of the ARCADIA methodology and System Design Process from the NASA SE, by introducing MBSE artefacts for space system.
The HUBBLE Space Telescope (HST) is a Cassegrain reflector telescope. Orbiting above the earth, HST elaborates a clear view of the universe free from the blurring and absorbing effects of the atmosphere. In order to illustrate the journey throughout CAPELLA, the HST will be introduced, as example, based on public information available."

Speaker: DROUIN Remy

- NASA Systems Engineering Handbook
- MBSE
- CAPELLA/ARCADIA
- Modeling overview with HUBBLE Space Telescope





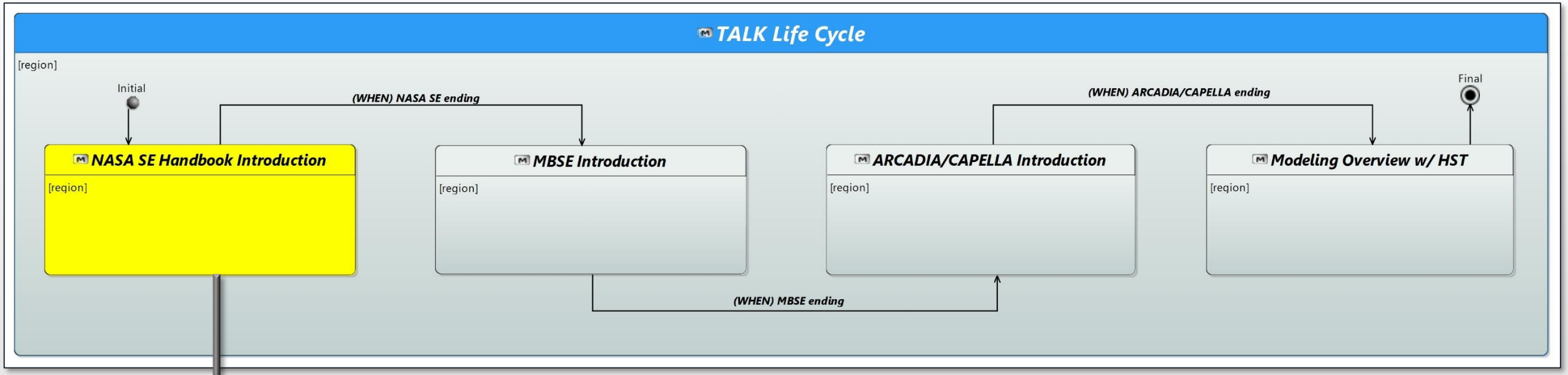


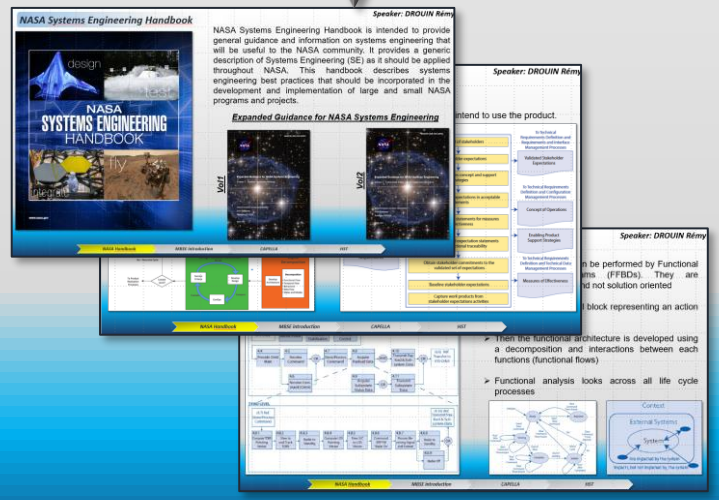
« All models are wrong, but some are useful »

George E.P.Box (British statistician)

TALK Life Cycle

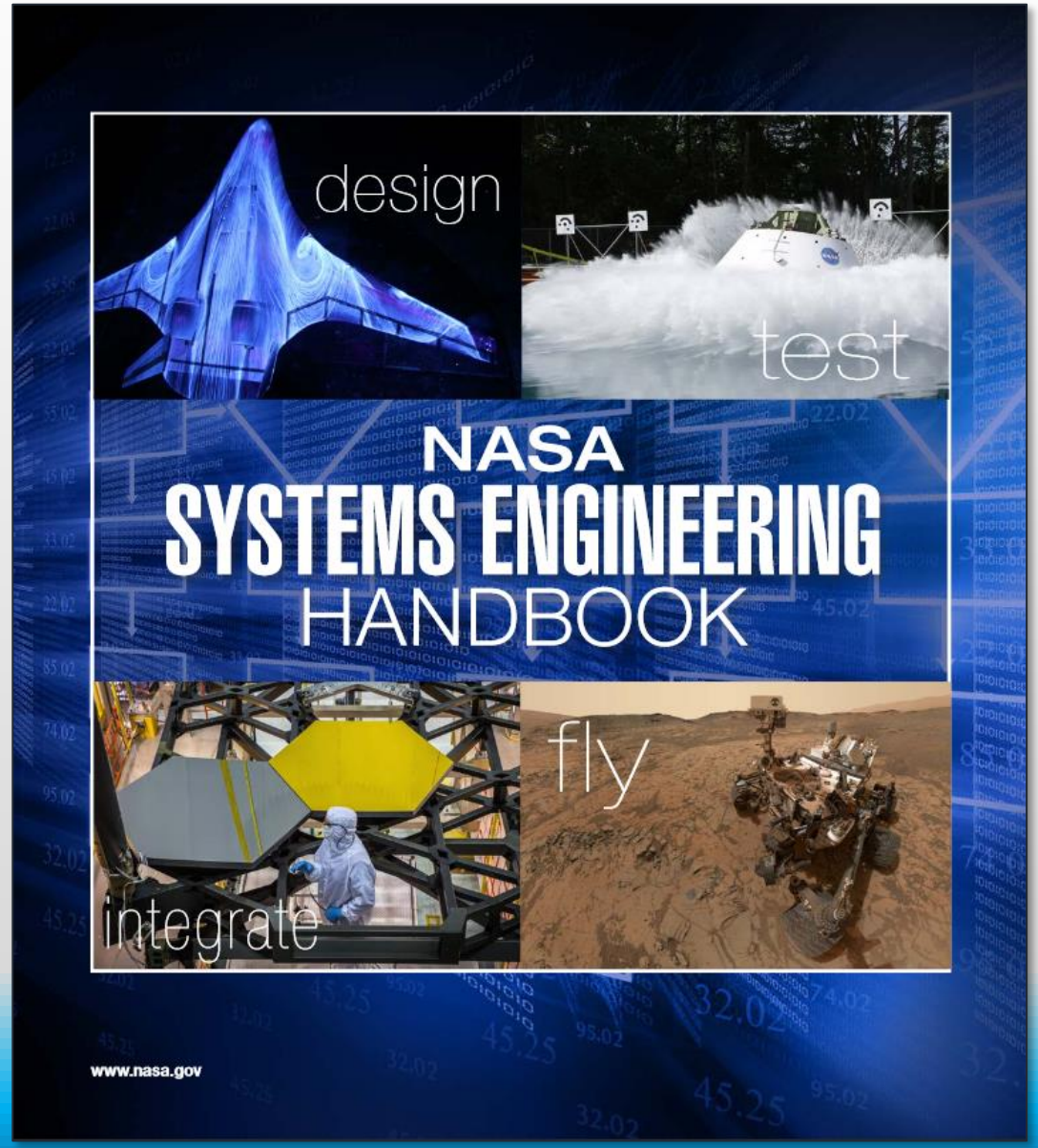
Speaker: DROUIN Remy





NASA Systems Engineering Handbook

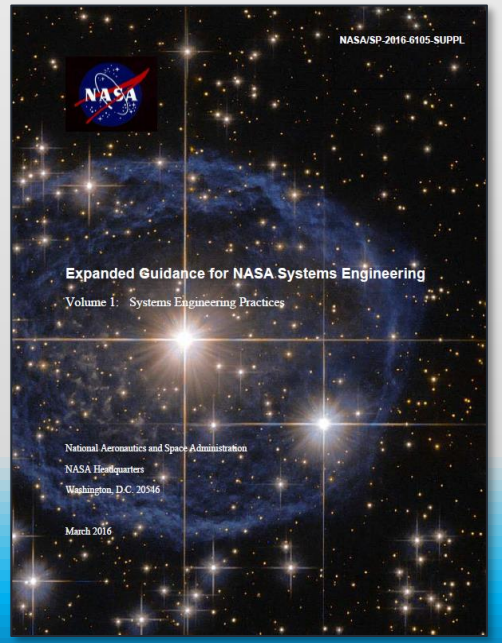
Speaker: DROUIN Remy



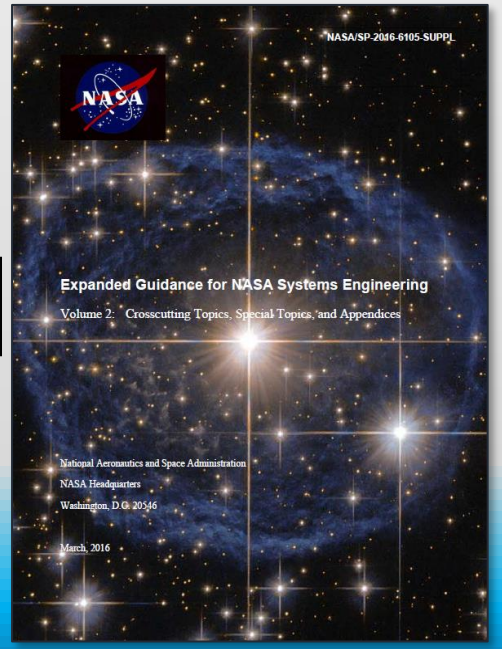
NASA Systems Engineering Handbook is intended to provide general guidance and information on systems engineering that will be useful to the NASA community. It provides a generic description of Systems Engineering (SE) as it should be applied throughout NASA. This handbook describes systems engineering best practices that should be incorporated in the development and implementation of large and small NASA programs and projects.

Expanded Guidance for NASA Systems Engineering

Vol1



Vol2



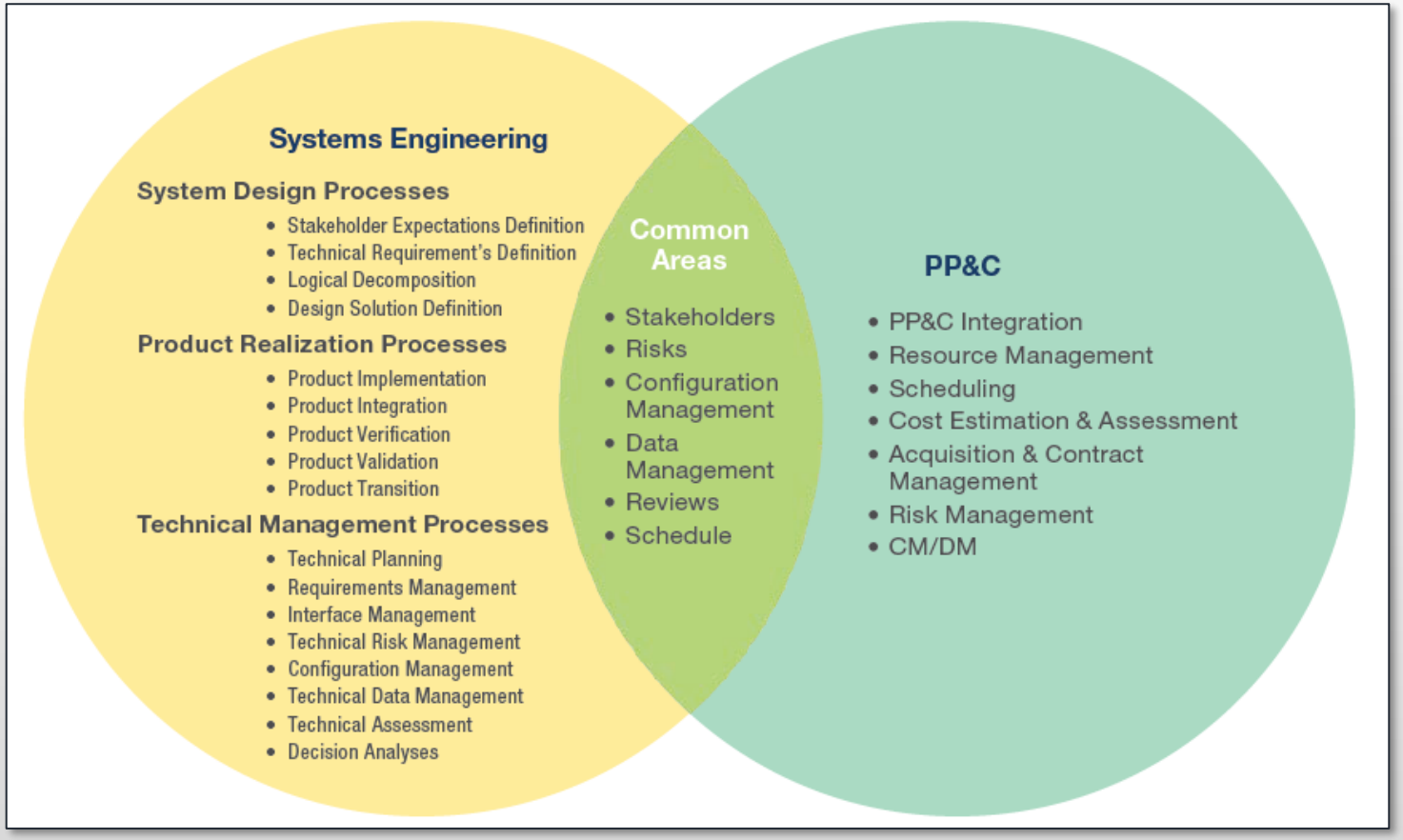
NASA SE Handbook – Systems Engineering

Speaker: DROUIN Remy

"Systems engineering" is defined as a methodical, multi-disciplinary approach for the design, realization, technical management, operations, and retirement of a system.

The systems engineer usually plays the key role in leading:

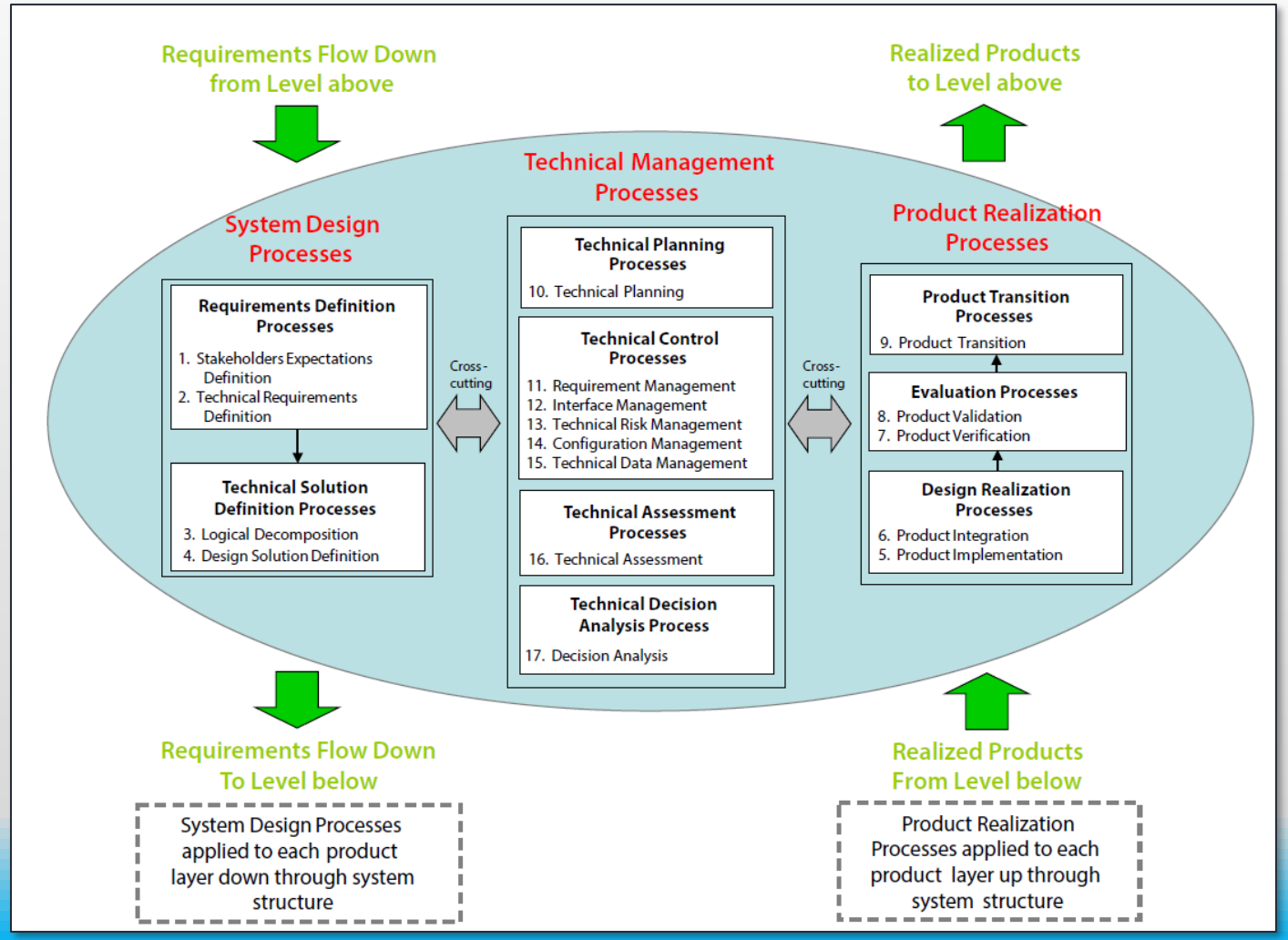
- the development of the concept of operations and resulting system architecture
- defining boundaries
- defining and allocating requirements
- evaluating design tradeoffs
- balancing technical risk between systems
- defining and assessing interfaces, providing oversight of verification and validation activities

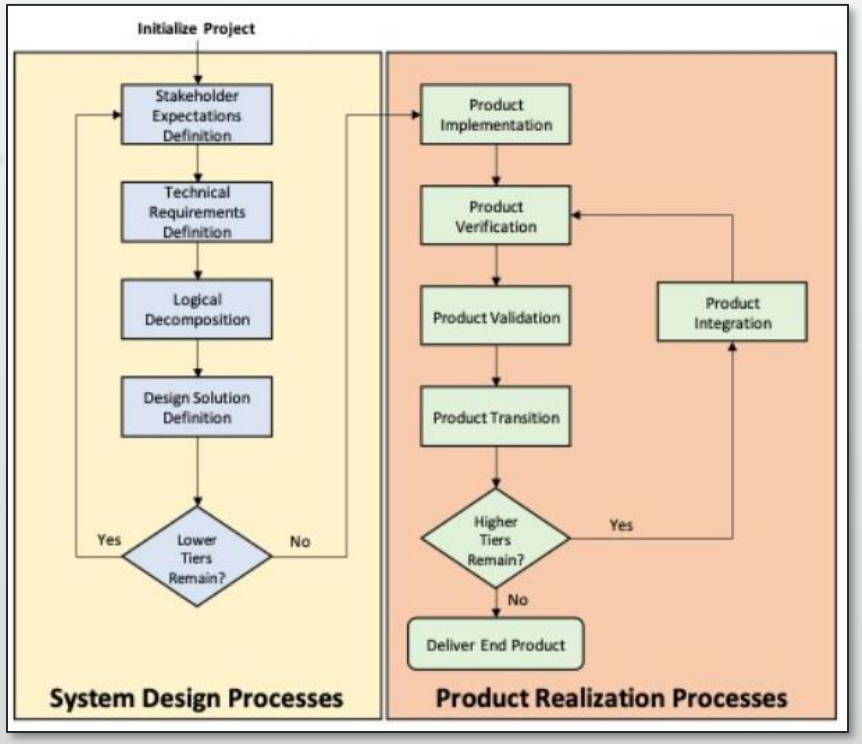


NASA SE Handbook - Processes

Speaker: DROUIN Remy

There are 3 sets of common technical processes: system design, product realization, and technical management.

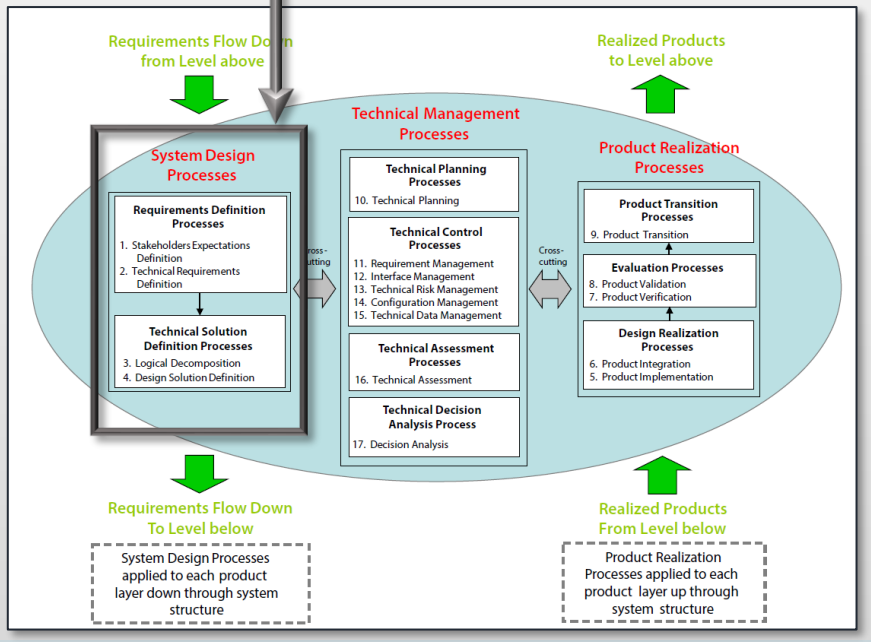


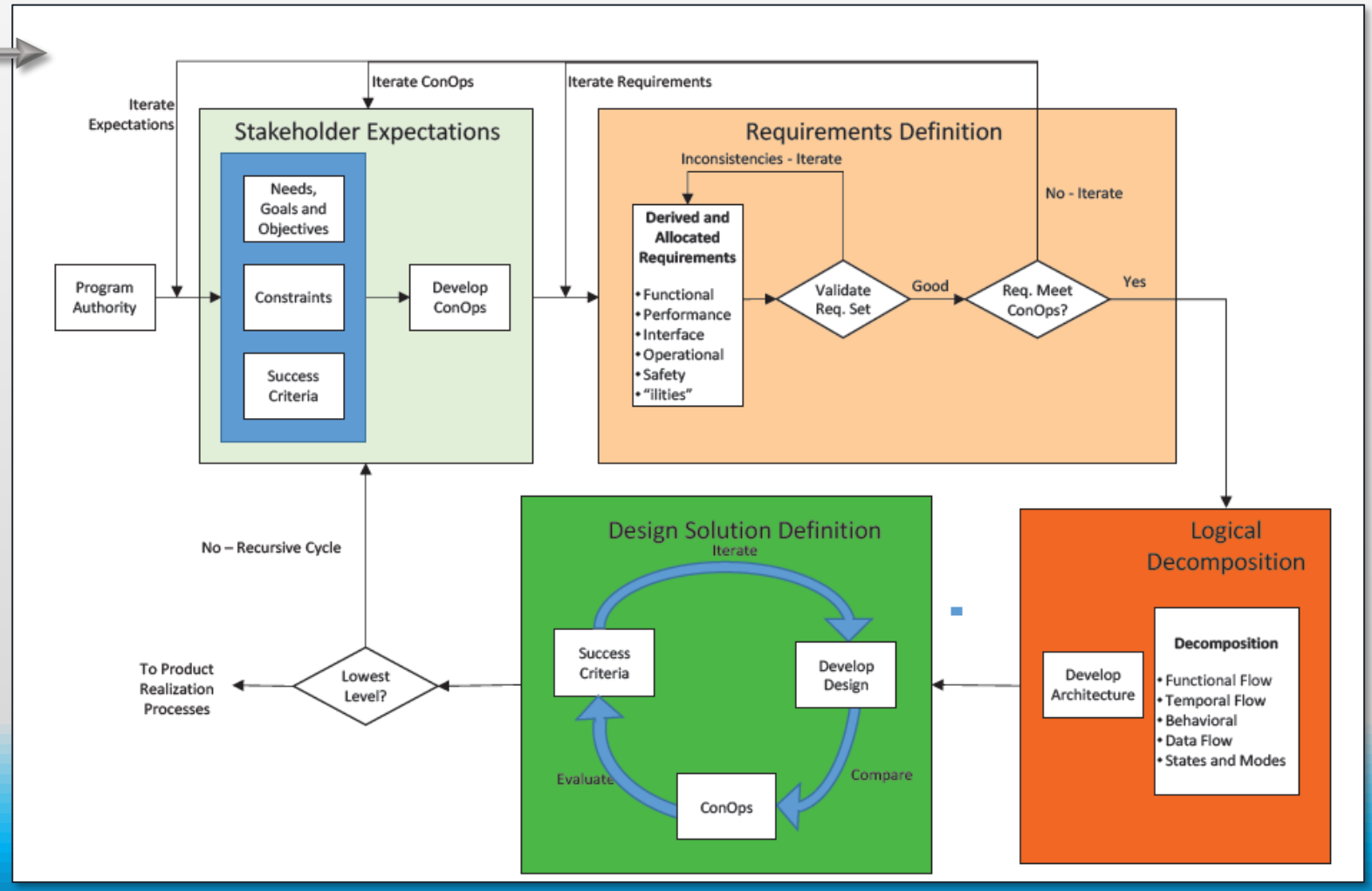


NASA SE Handbook – System Design Process

Speaker: DROUIN Remy

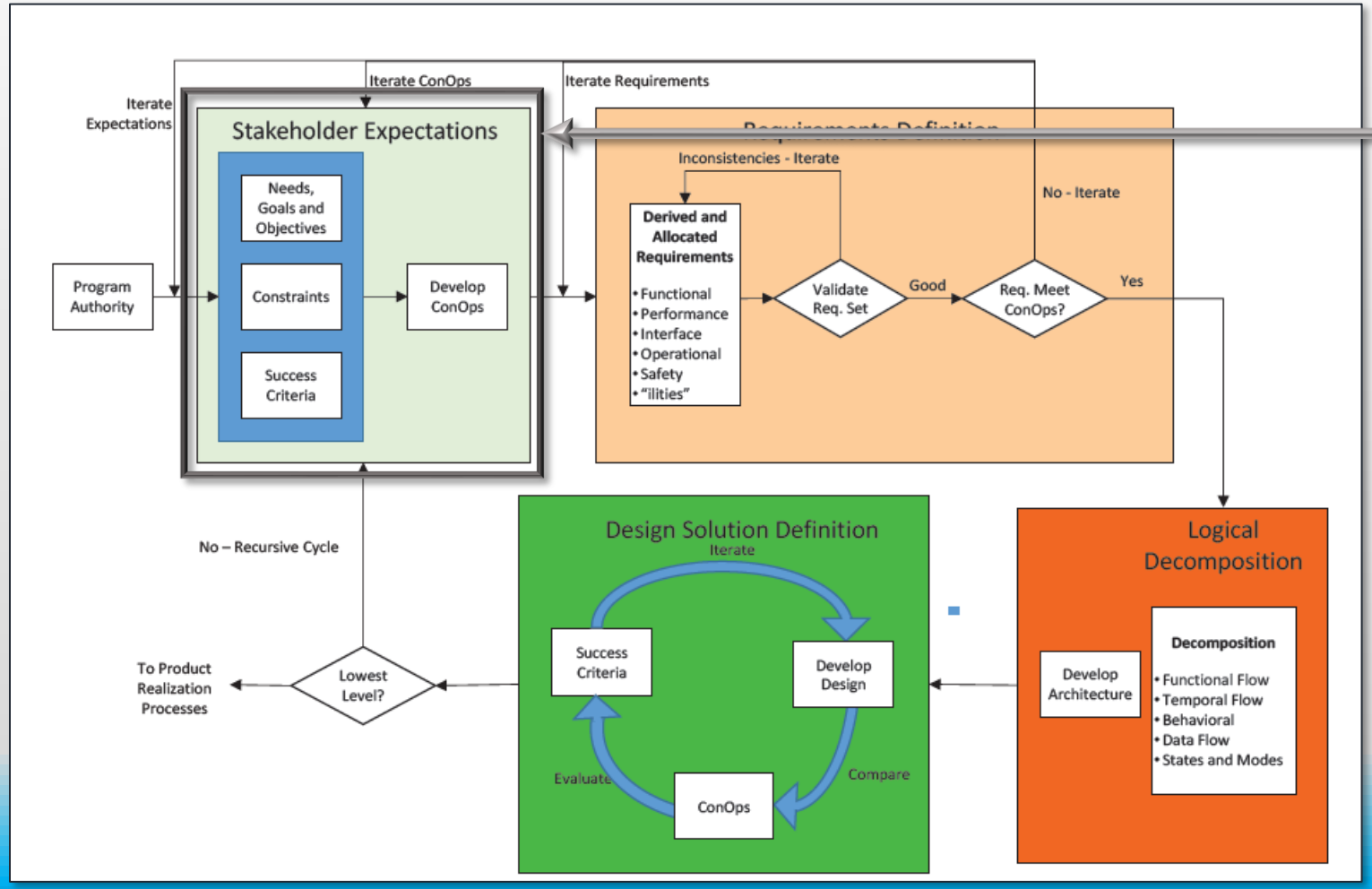
The four system design processes are used to define and baseline stakeholder expectations, generate and baseline technical requirements, decompose the requirements into logical and behavioral models, and convert the technical requirements into a design solution that will satisfy the baselined stakeholder expectations.

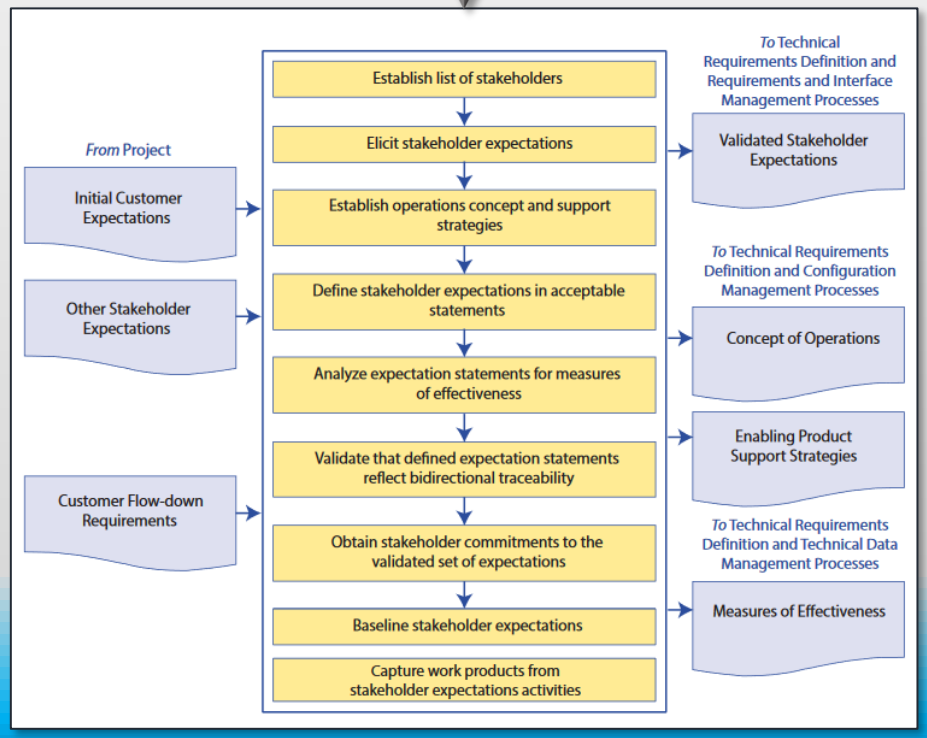




Stakeholder expectations

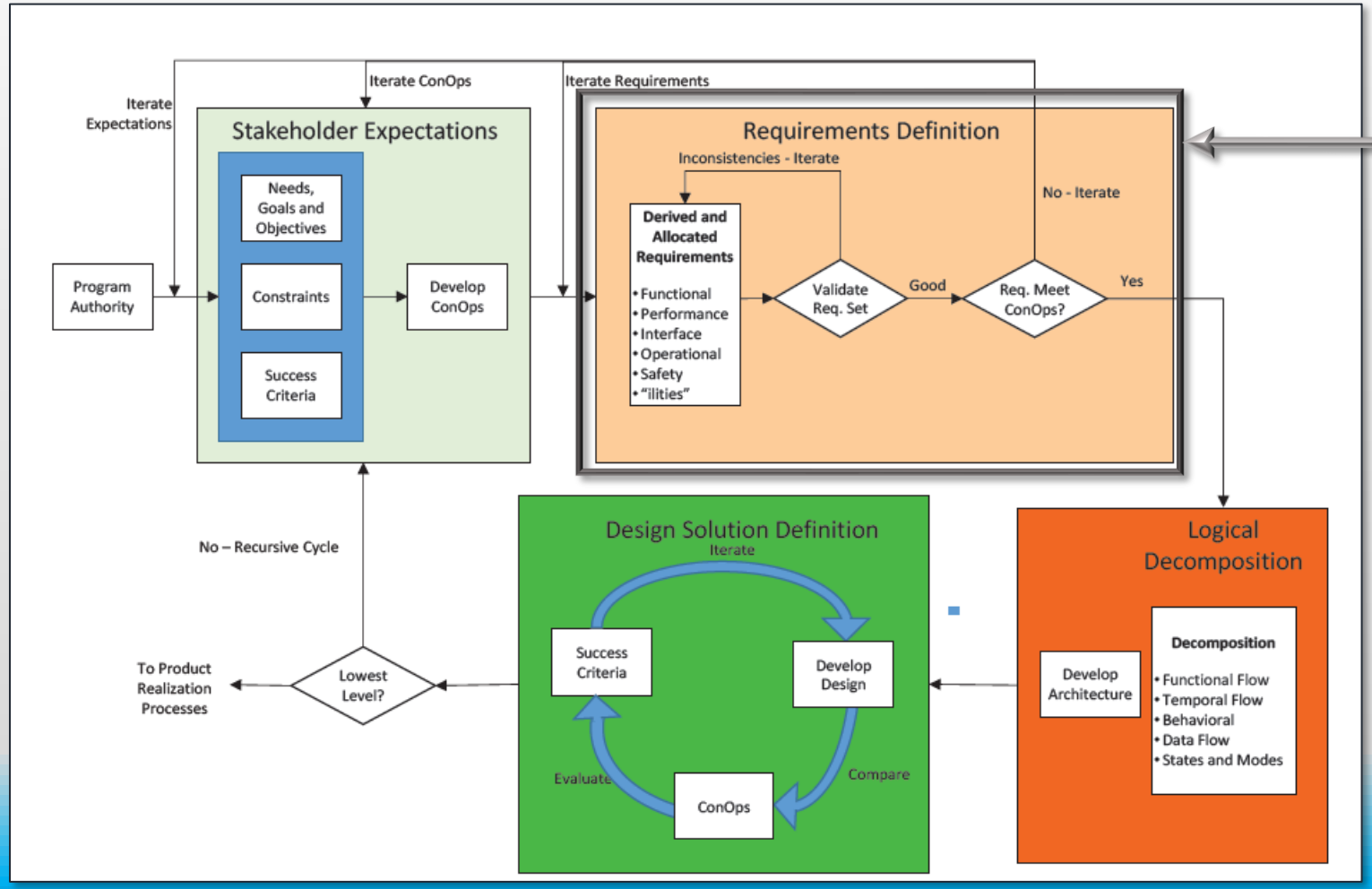
The main purpose of this process is to identify who the stakeholders are and how they intend to use the product.

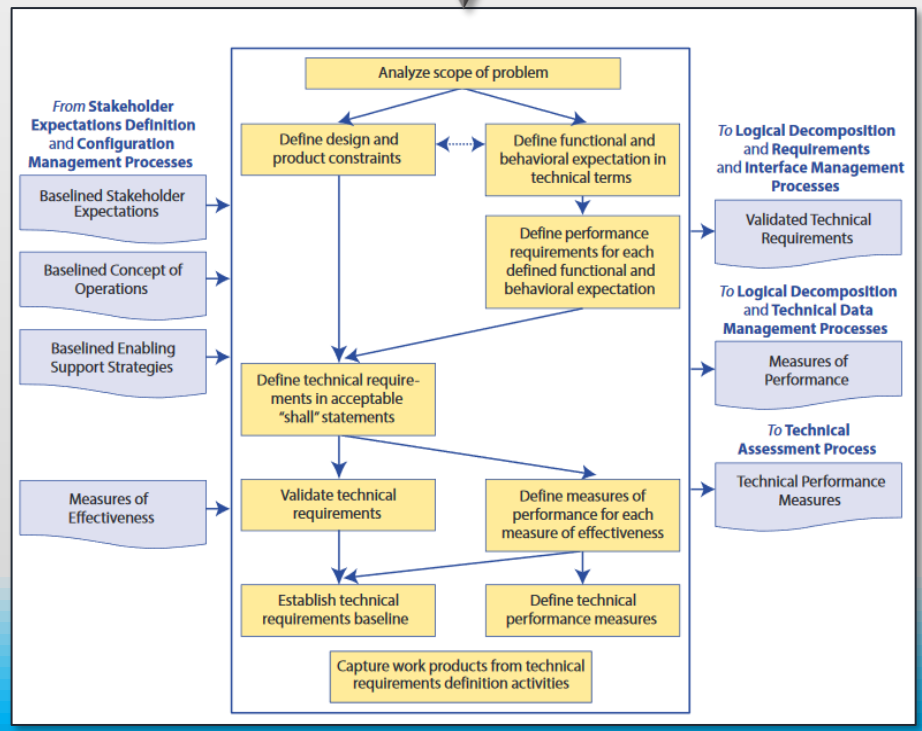




Requirements definition

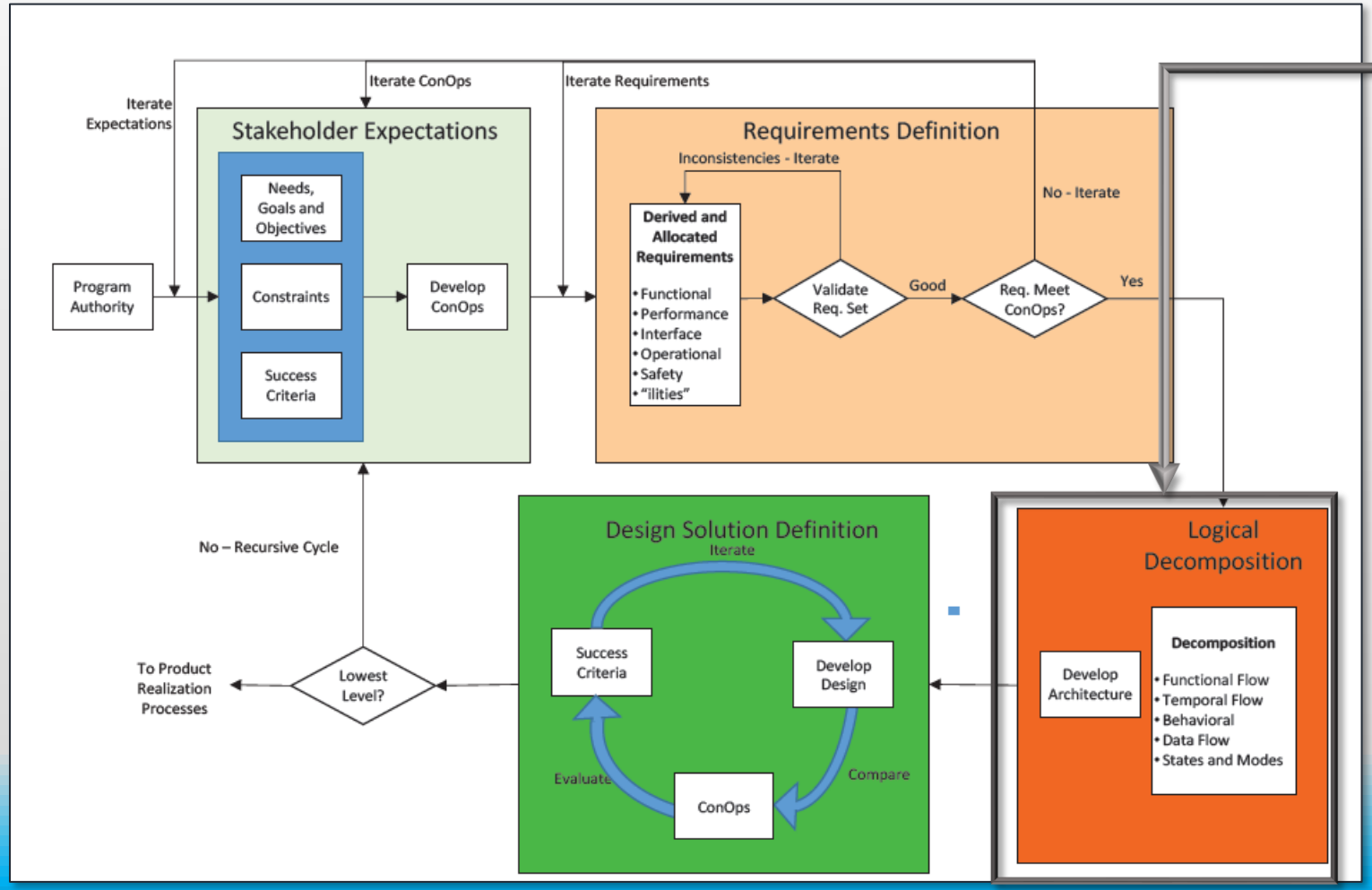
The Requirements Definition process transforms the stakeholder expectations into a definition of the problem.

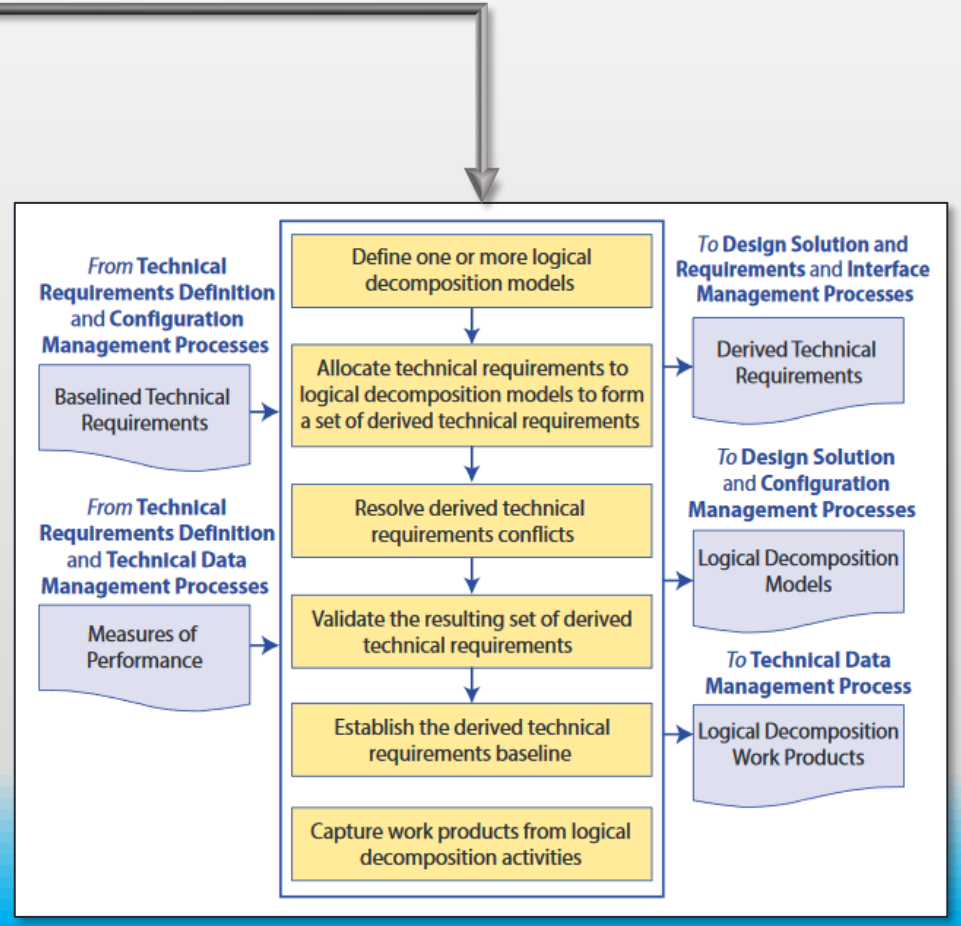




Logical decomposition

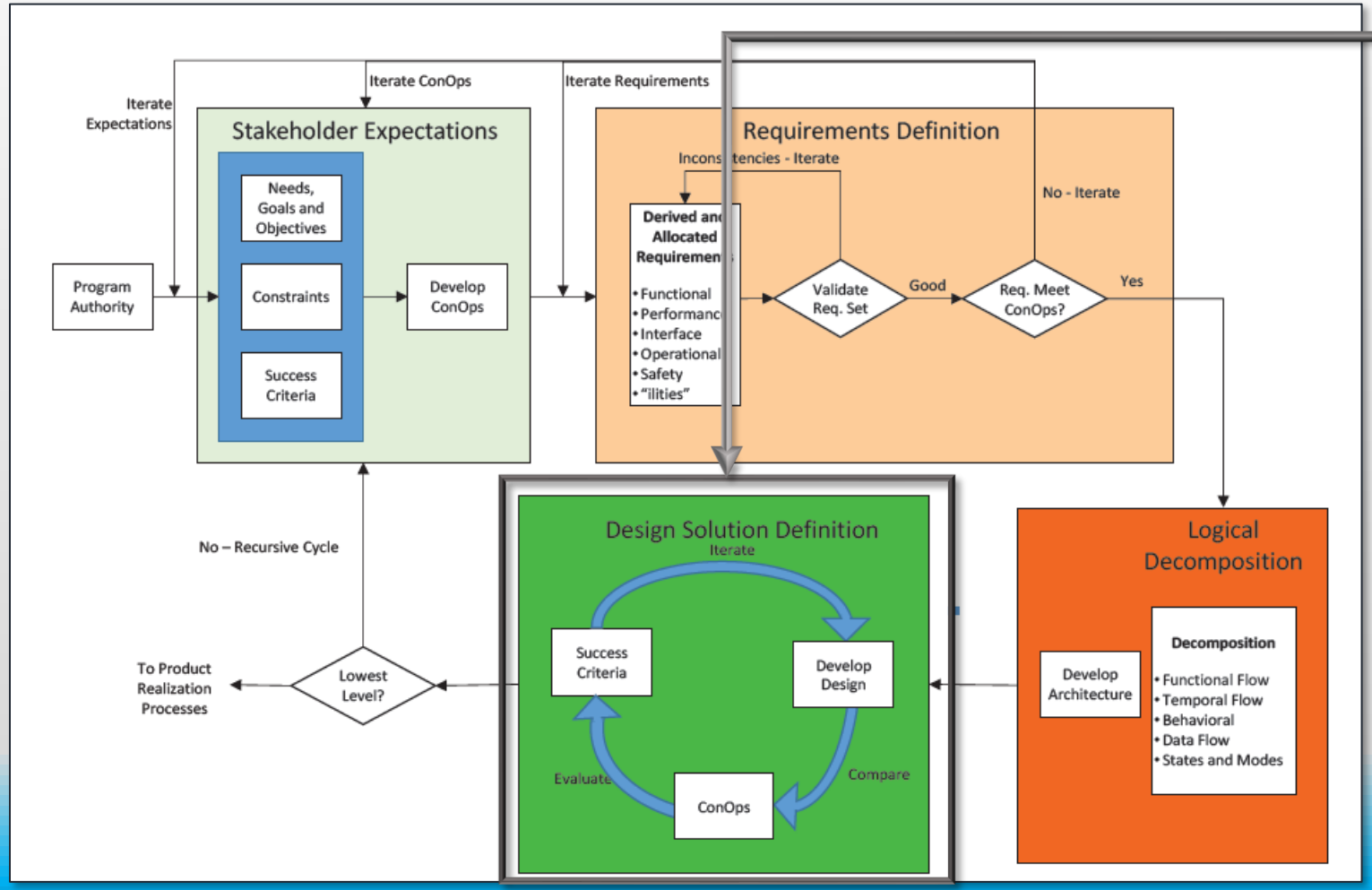
Logical decomposition utilizes functional analysis to create a system architecture and to decompose top-level requirements and allocate them down to the lowest desired levels.

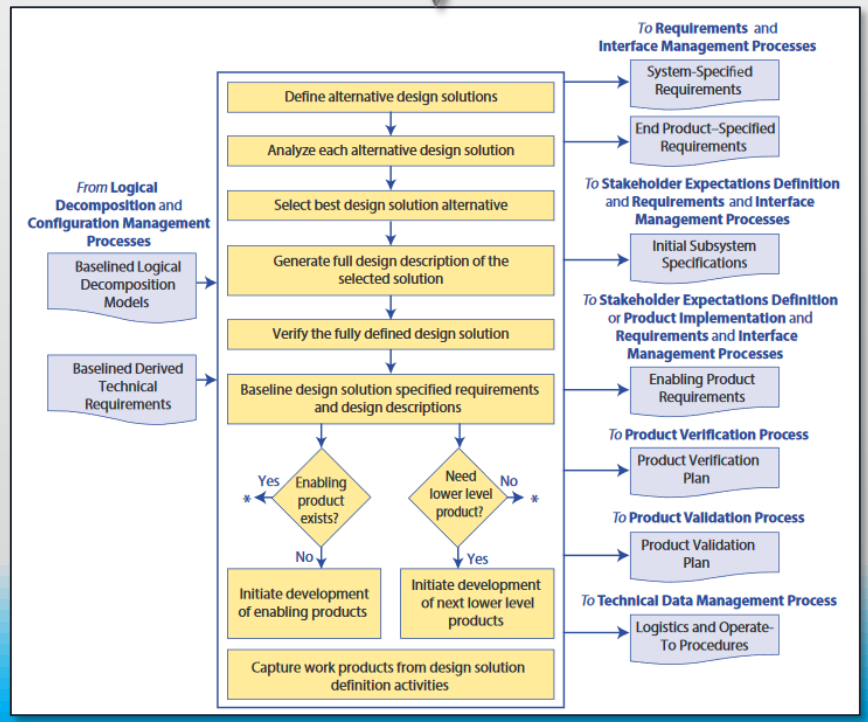




Design solution definition

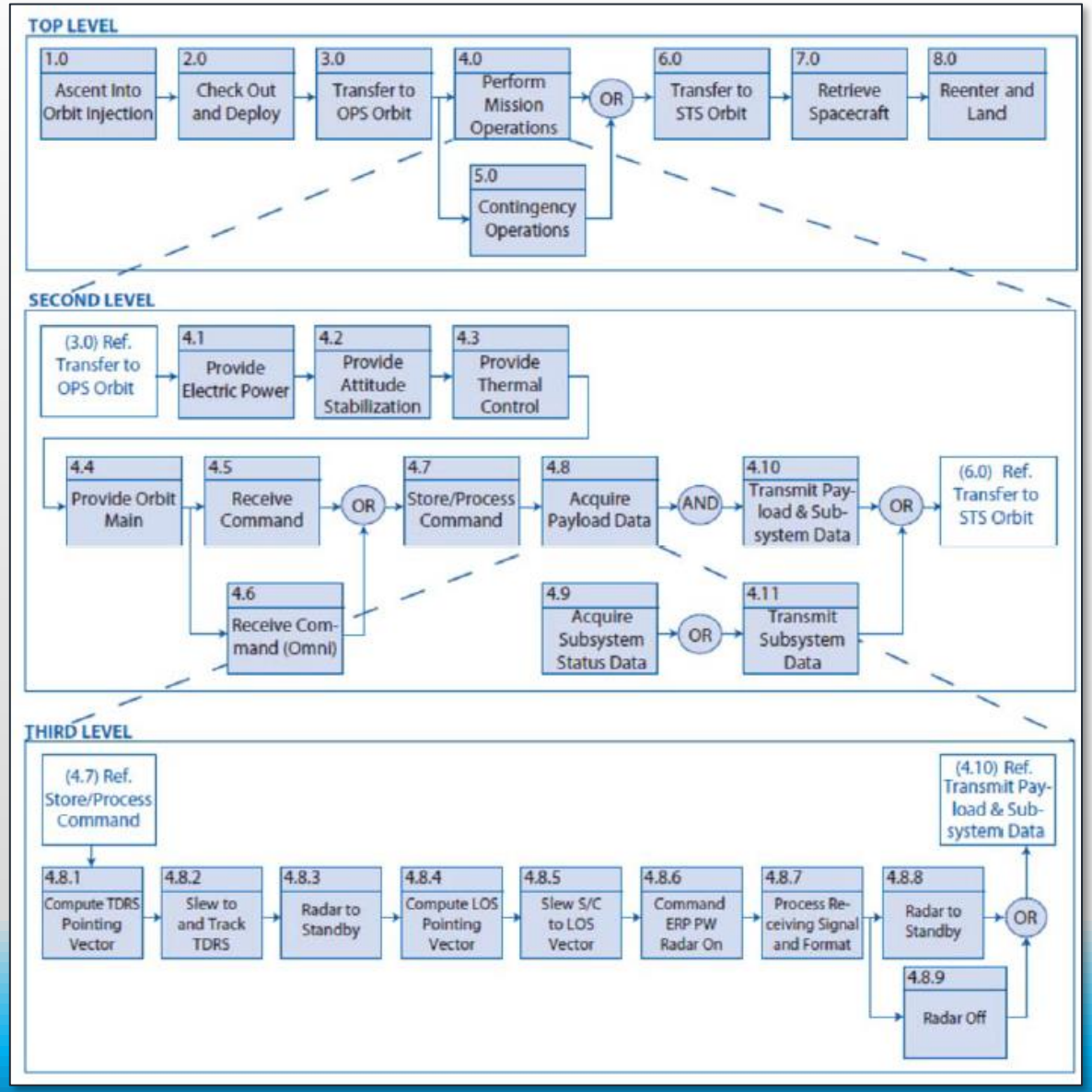
The Design Solution Definition process is used to translate the requirements derived from the stakeholder expectations and the outputs of the Logical Decomposition process into a design solution.



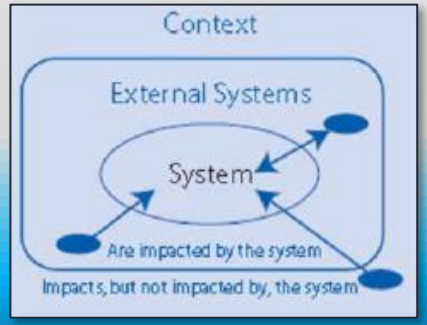


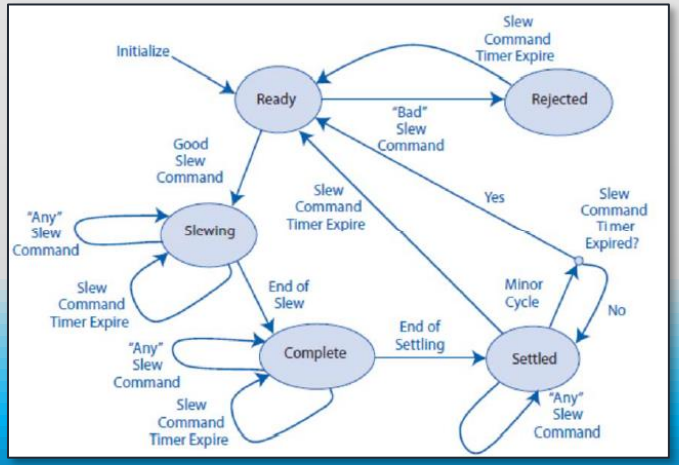
NASA SE Handbook – Functional Analysis

Speaker: DROUIN Remy



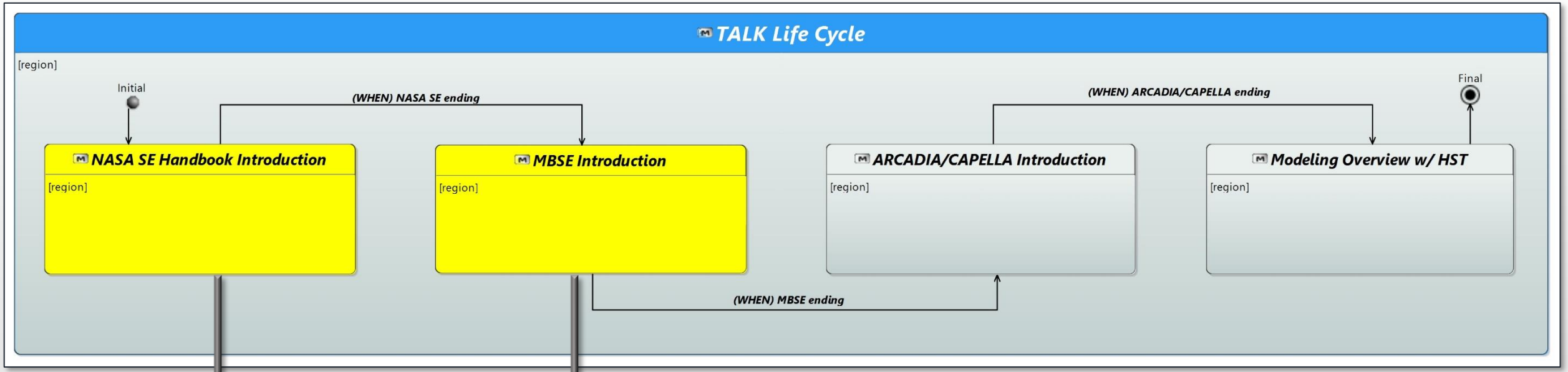
- Functional analysis can be performed by Functional Flow Block Diagrams (FFBDs). They are functionally oriented and not solution oriented
- It is made of functional block representing an action to be accomplished
- The functional architecture is developed using a decomposition and interactions between each functions (functional flows)
- Functional analysis looks across all life cycle processes

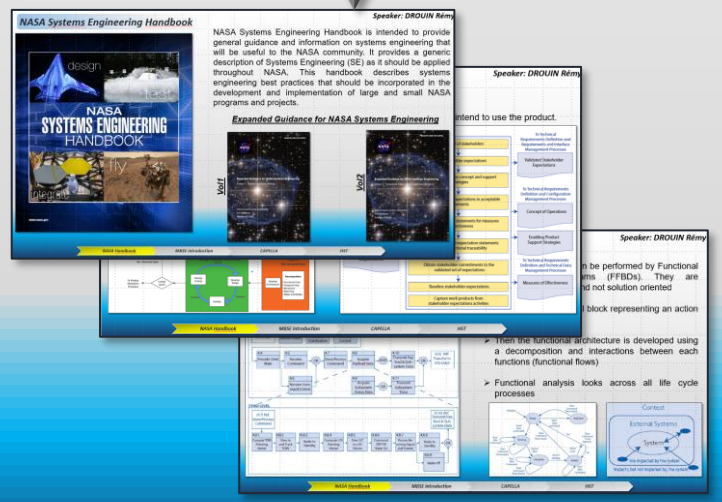


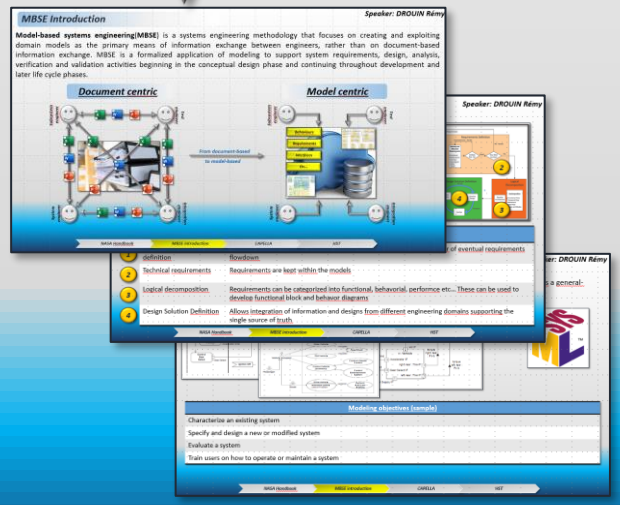


TALK Life Cycle

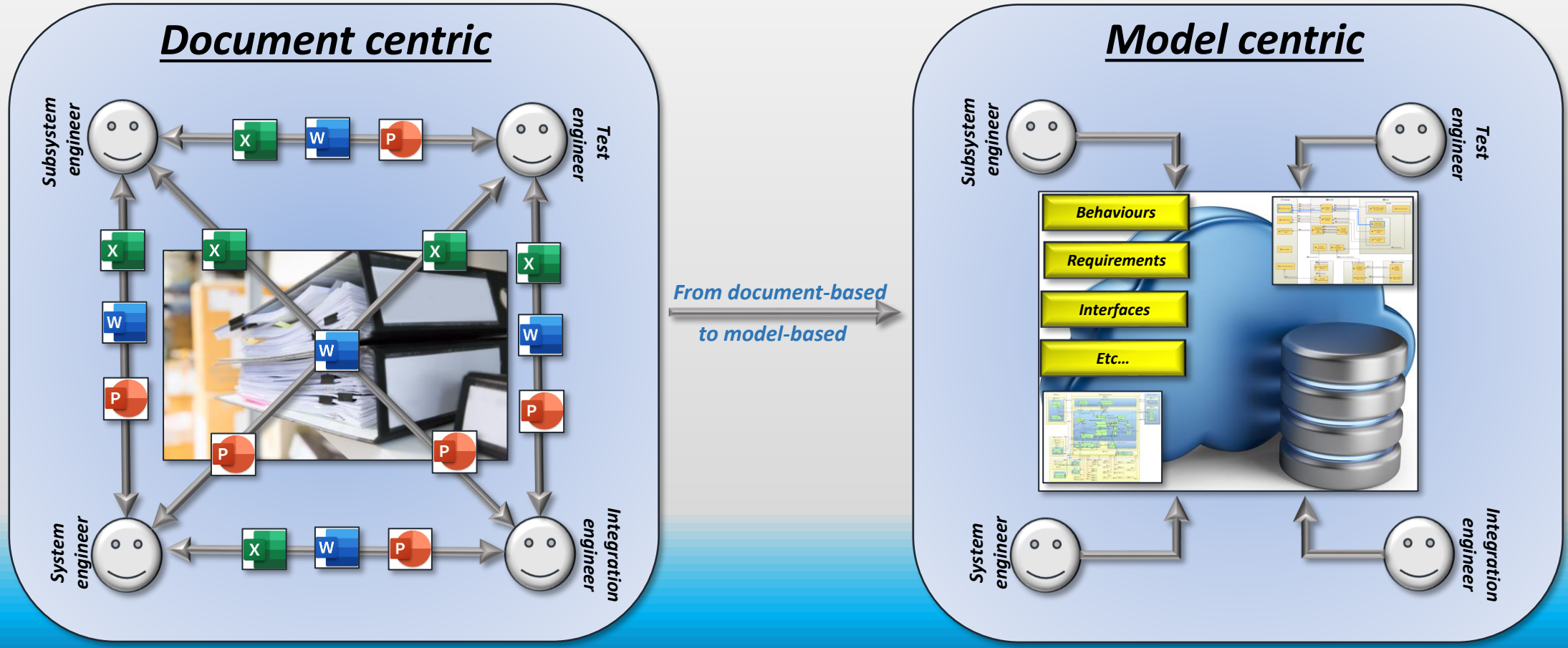
Speaker: DROUIN Remy





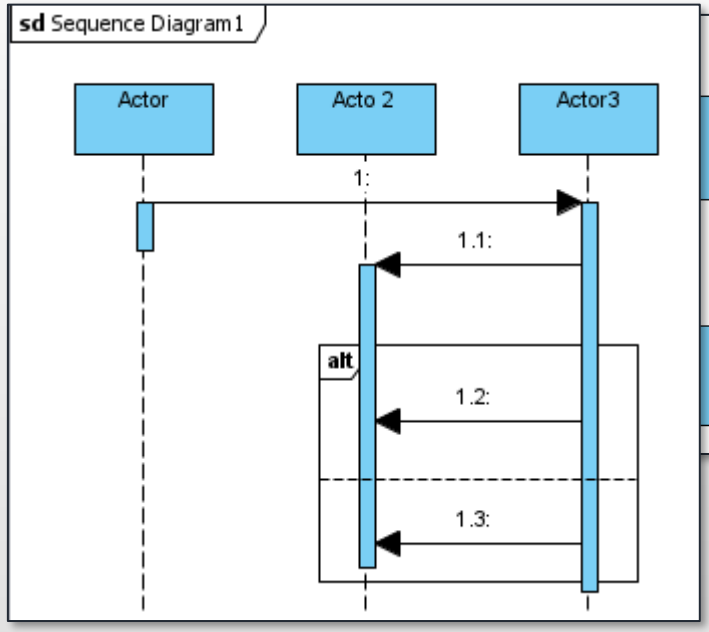


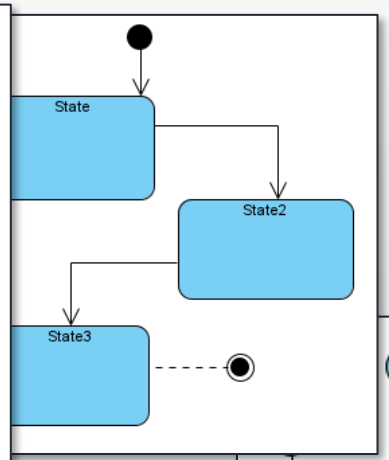
Model-based systems engineering(MBSE) is a systems engineering methodology that focuses on creating and exploiting domain models as the primary means of information exchange between engineers, rather than on document-based information exchange. MBSE is a formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.

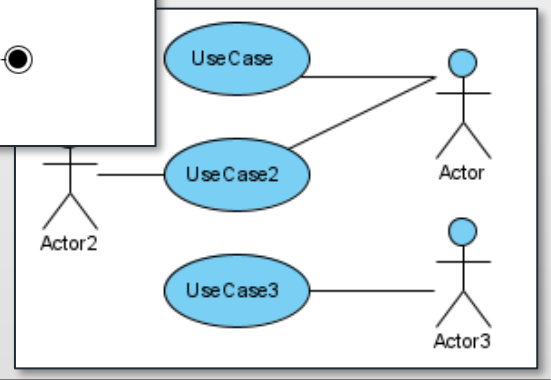


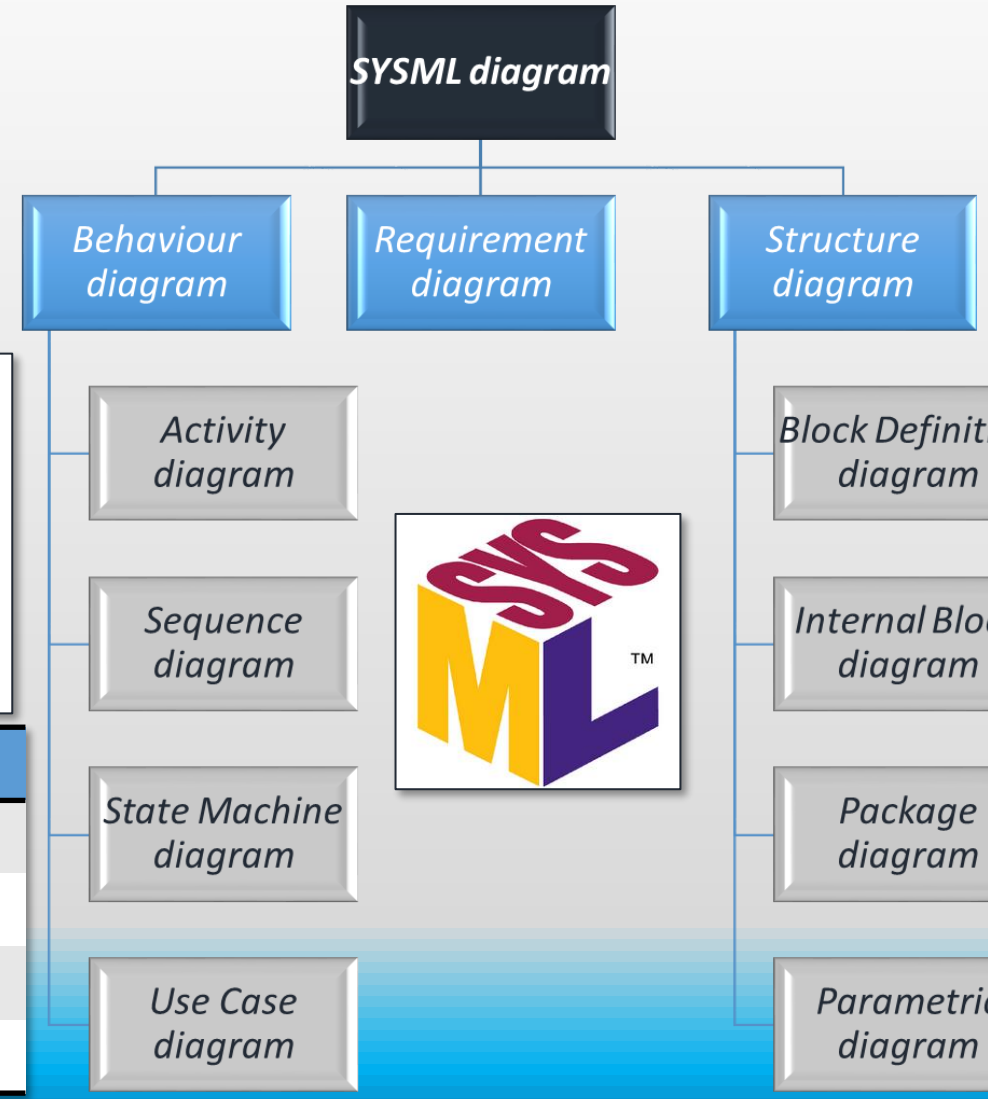
Speaker: DROUIN Remy

A model consists of elements that represent requirements , design element, and their relationships. SYSML is a graphical modeling language that supports modeling activities.





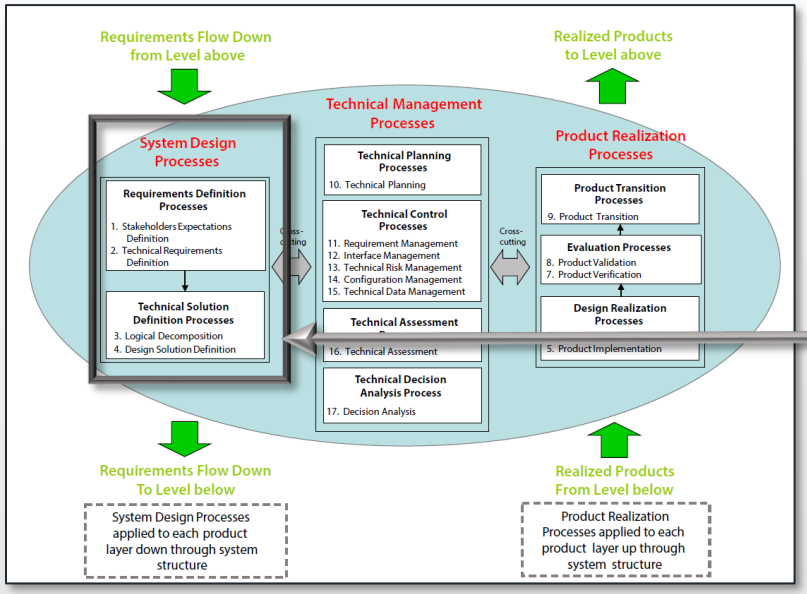


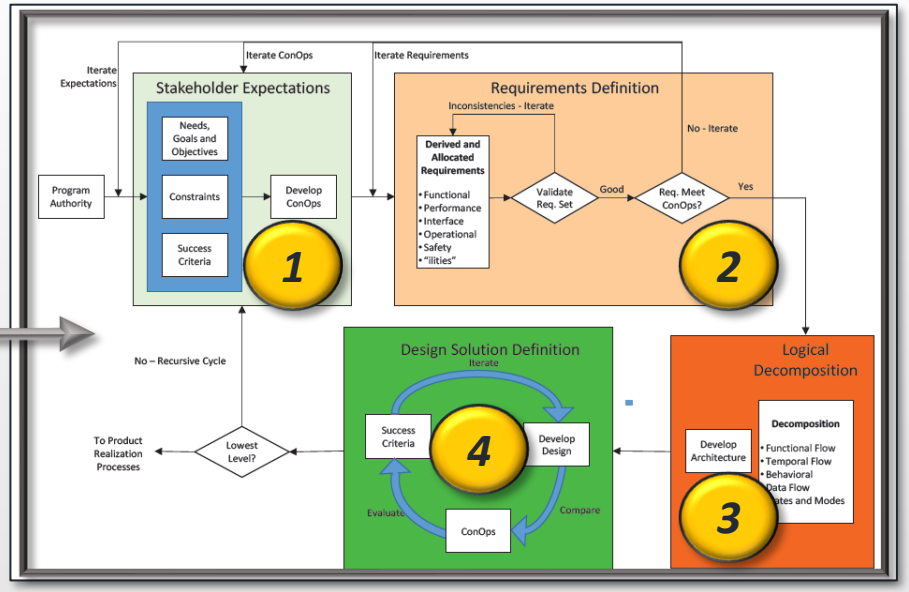


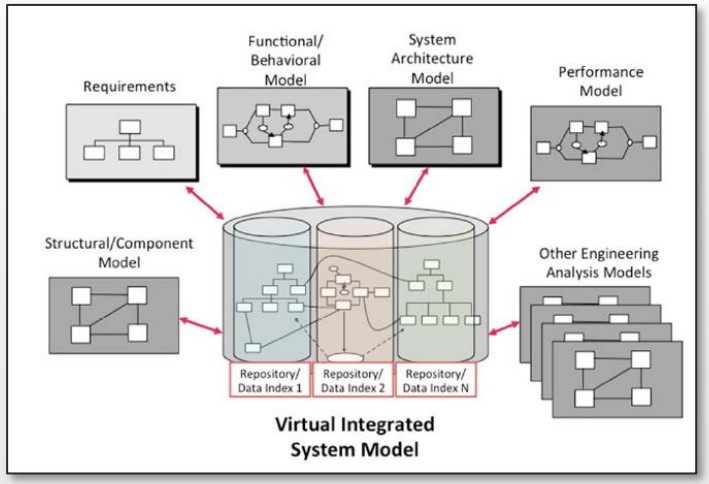
Modeling objectives (sample)
Characterize an existing system
Specify and design a new or modified system
Evaluate a system
Train users on how to operate or maintain a system

MBSE across SE engine (NASA SE)

Speaker: DROUIN Remy







	System Design Processes	MBSE Contributions (NASA)
1	Stakeholders expectations definition	Need, goals and objectives are kept within the model and form the top tier of eventual requirements flowdown
2	Technical requirements	Requirements are kept within the models
3	Logical decomposition	Requirements can be categorized into functional, behavioral, performance etc… These can be used to develop functional block and behavior diagrams
4	Design Solution Definition	Allows integration of information and designs from different engineering domains supporting the single source of truth

MBSE Benefits

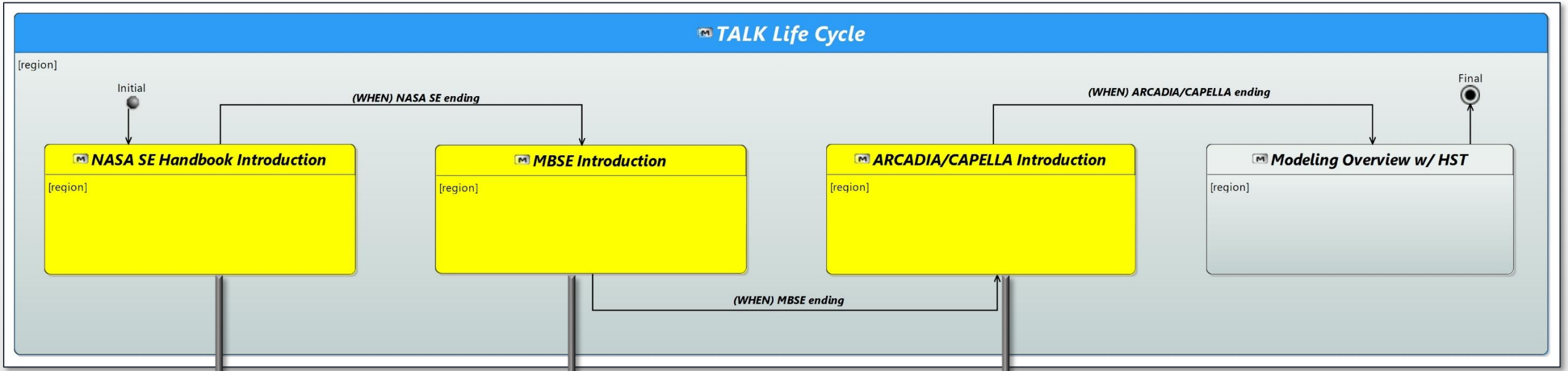
Speaker: DROUIN Remy

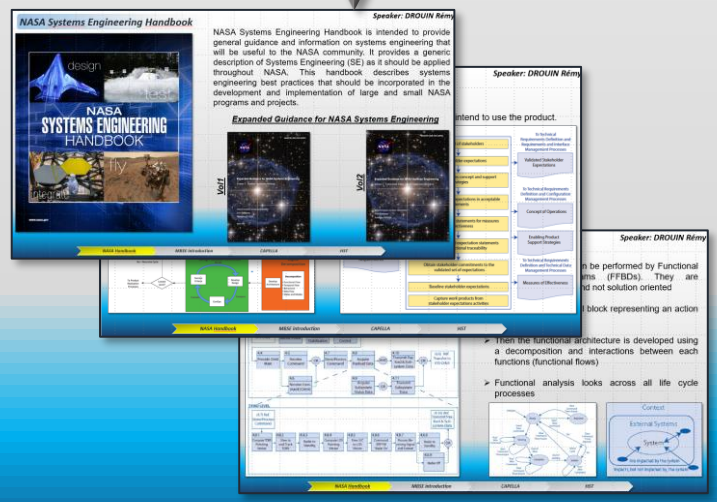
Model-based systems engineering does not affect process but will enable the opportunity for overall better quality, lower cost, and lower risk.

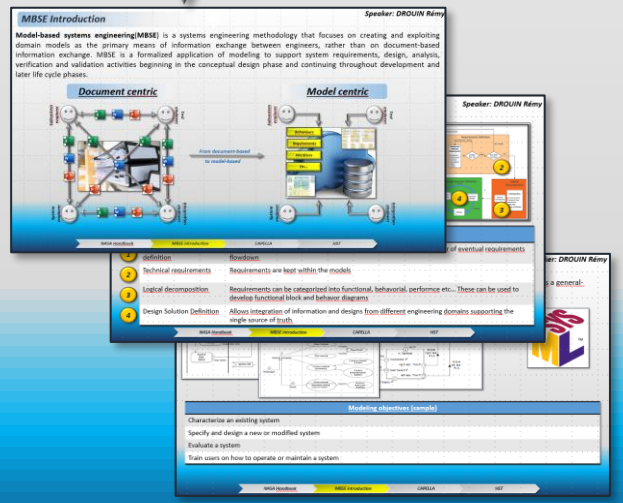
Overall MBSE benefits (sample):	NASA MBSE benefits (sample)
Enhance communication	Greater consistency of all products because any single piece of design information can be expressed authoritatively in a single place that can later be referred to by others for decisions, derivations, or formation of artifacts
Reduce development risk	Better visibility into the salient characteristics of a system because multiple views can be created that succinctly address specific stakeholder concerns
Encourage collaboration	Model-based artifacts can be generated automatically, lowering the effort to keep them up to date with the result that artifacts can always match the best available information
Manage complexity	Navigation, traceability, and interrogation of information are facilitated in the model-based approach
Automatic document generation	Can be less investment lost in erroneous design because sometimes the model reveals a flaw as soon as it is created, enabling correction before downstream work is done, work that would be invalid if the upstream mistake were not corrected immediately
Reuse of existing models in several projects	
Better requirements traceability	
More stakeholder involvement	
Digitalization	
Single source of truth	

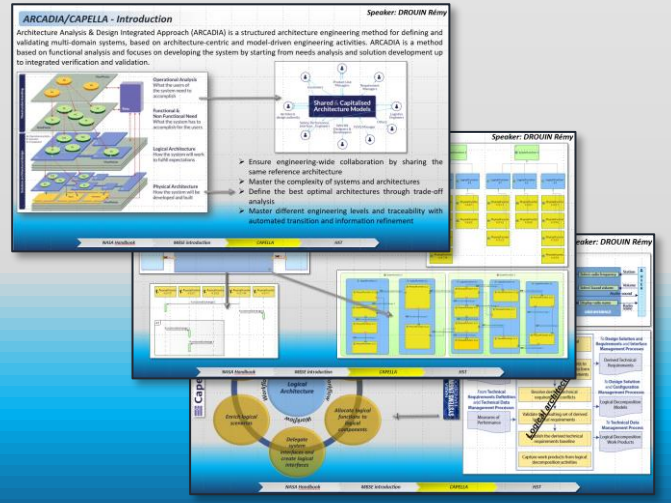
TALK Life Cycle

Speaker: DROUIN Remy





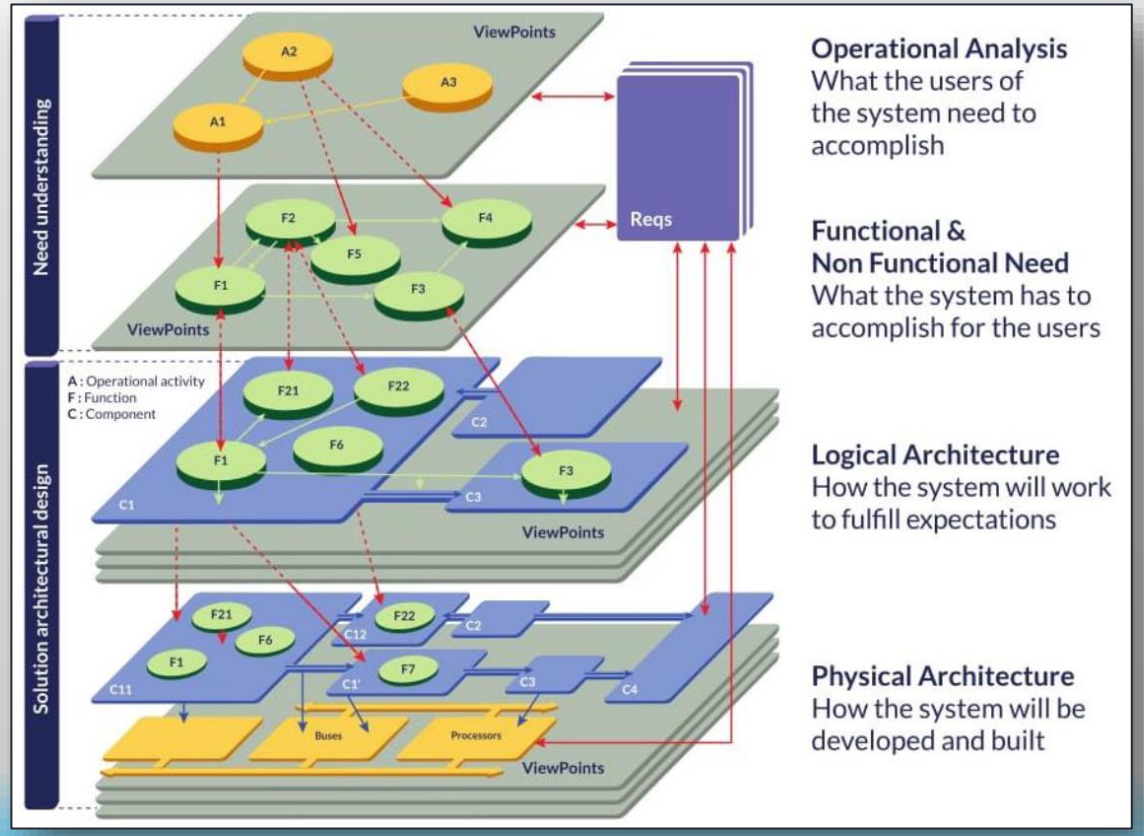


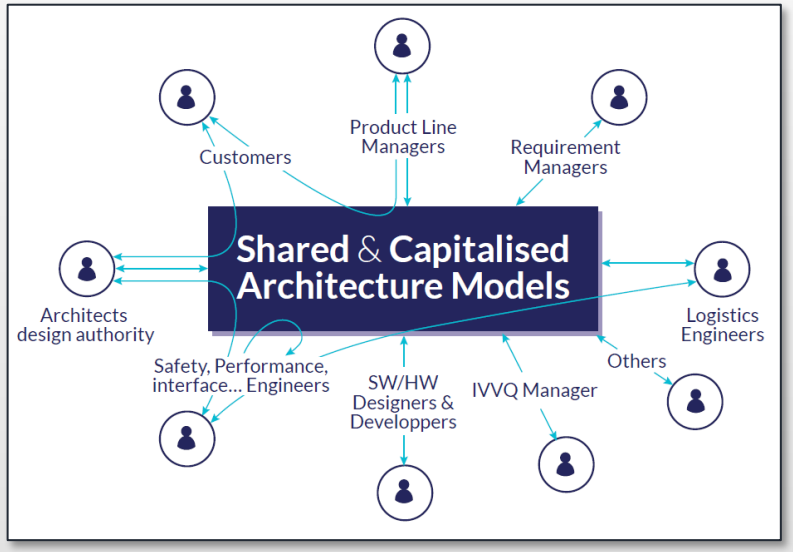


ARCADIA/CAPELLA - Introduction

Speaker: DROUIN Remy

Architecture Analysis & Design Integrated Approach (ARCADIA) is a structured architecture engineering method for defining and validating multi-domain systems, based on architecture-centric and model-driven engineering activities. ARCADIA is a method based on functional analysis and focuses on developing the system by starting from needs analysis and solution development up to integrated verification and validation.





- Ensure engineering-wide collaboration by sharing the same reference architecture
- Master the complexity of systems and architectures
- Define the best optimal architectures through trade-off analysis
- Master different engineering levels and traceability with automated transition and information refinement

ARCADIA/CAPELLA - Introduction

Speaker: DROUIN Remy

Designing complex and critical systems, and more generally architectures that are subject to multiple functional and non-functional constraints, is an activity which requires a level of rigor that can only be provided by formalized and tooled modeling approaches like the ones based on Arcadia/Capella and SysML tools.

Method

The Arcadia method enforces an approach structured on different engineering perspectives establishing a clear separation between system context and need modeling (operational need analysis and system need analysis) and solution modeling (logical and physical architectures).

Language

The Arcadia concepts are mostly similar to the UML/SysML standard and the NATO Architecture Framework (NAF) standard. Because of the focus on architectural design, some of the SysML concepts have been simplified or specialized in order to better match the concepts system engineering practitioners already use in their engineering documents and assets.

Diagrams

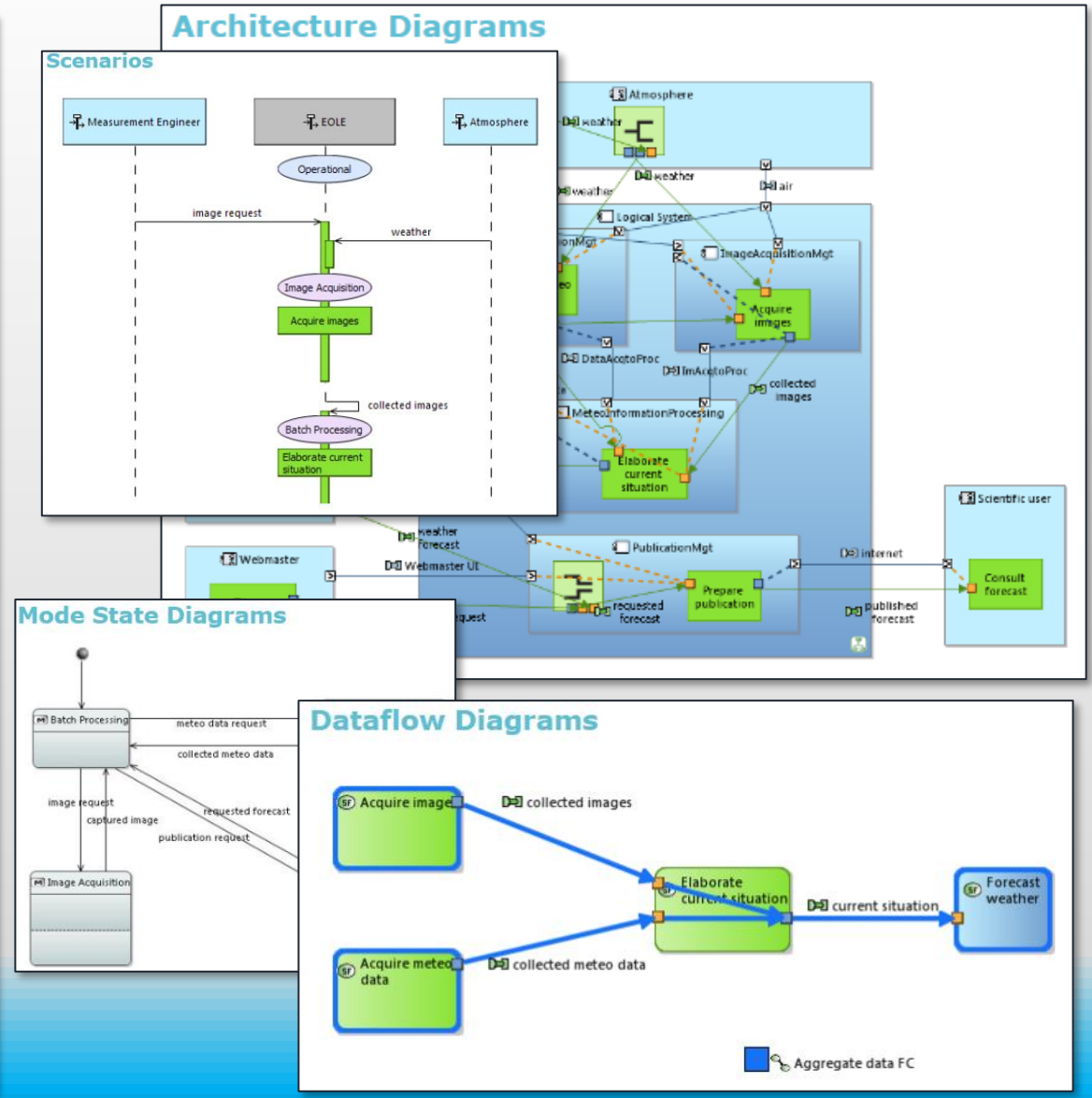
Arcadia method is supported by various kinds of diagrams largely inspired by UML and SysML:

- Architecture diagrams;
- Dataflows diagrams;
- Functional chains diagrams;
- Sequence diagrams;
- Tree diagrams;
- Mode and States diagrams;
- Classes and Interfaces diagrams.

ARCADIA/CAPELLA - Diagram description

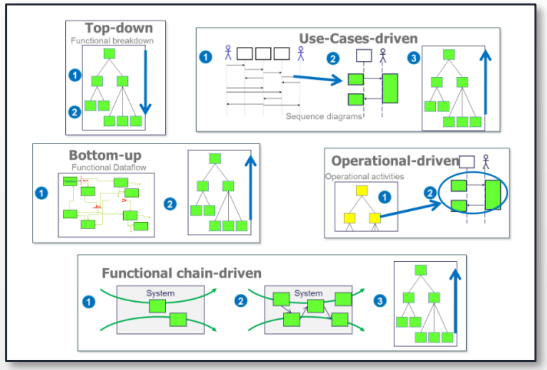
Speaker: DROUIN Remy

Diagram	Description
Breakdown diagram	Stakeholders/Functions/Components decomposition through graphical tree
Capability diagram	Equivalent to a use-case diagram, used to organize the functional analysis
Dataflow diagram	Provide informations exchanged between functions
Architecture diagram	Described the assembly of components or functions and interfaces
Scenario	Provdes dynamic behavior between functions
Mode&State	Provide the working type of function or actor or system.
Class diagram	Often, data-class diagram compress of exchange items or data parameters utilized in a system

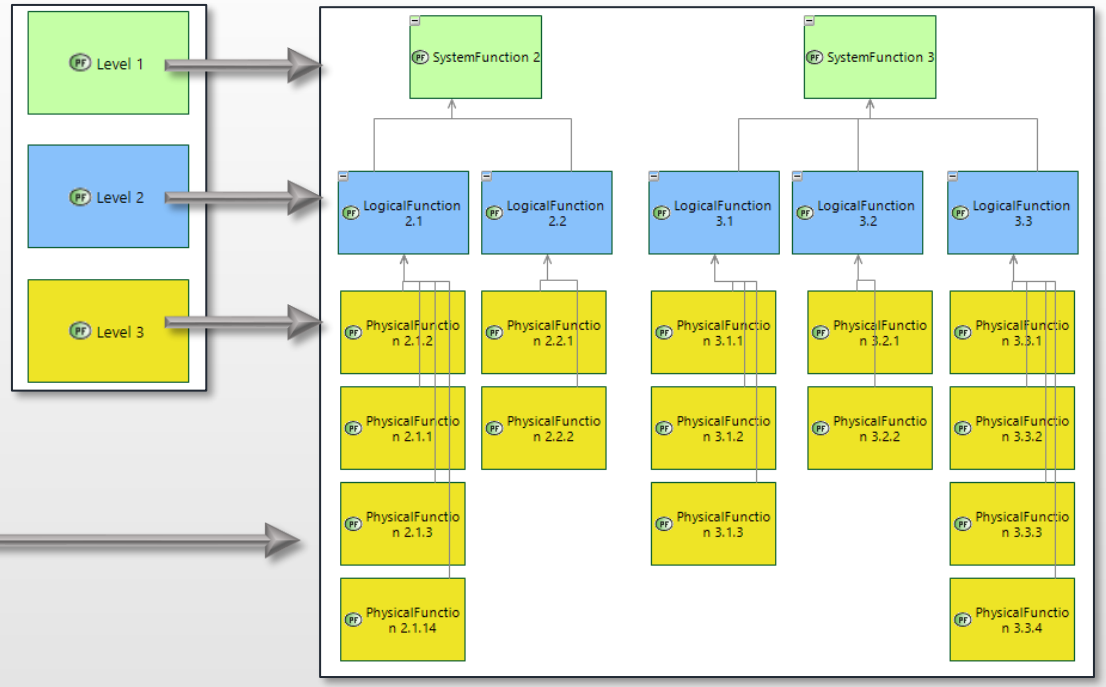


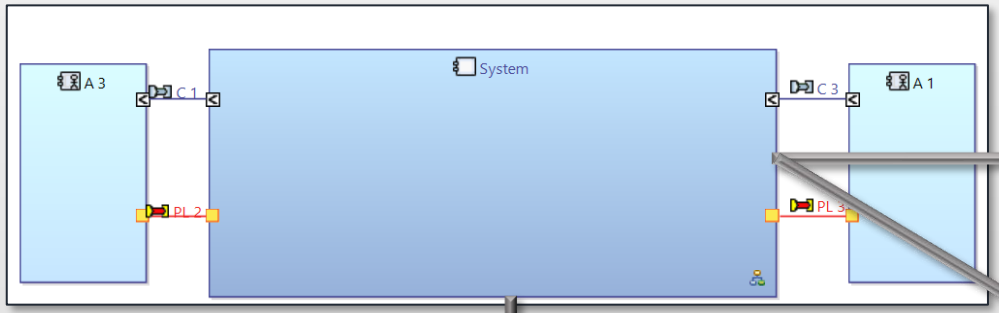
ARCADIA/CAPELLA – Functional analysis

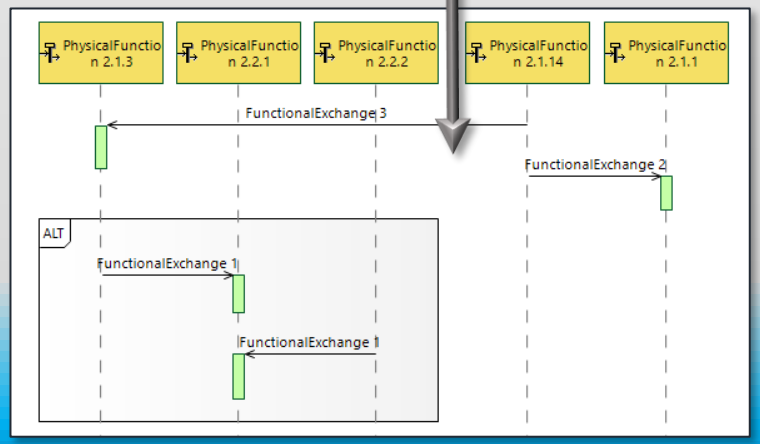
Speaker: DROUIN Rémy

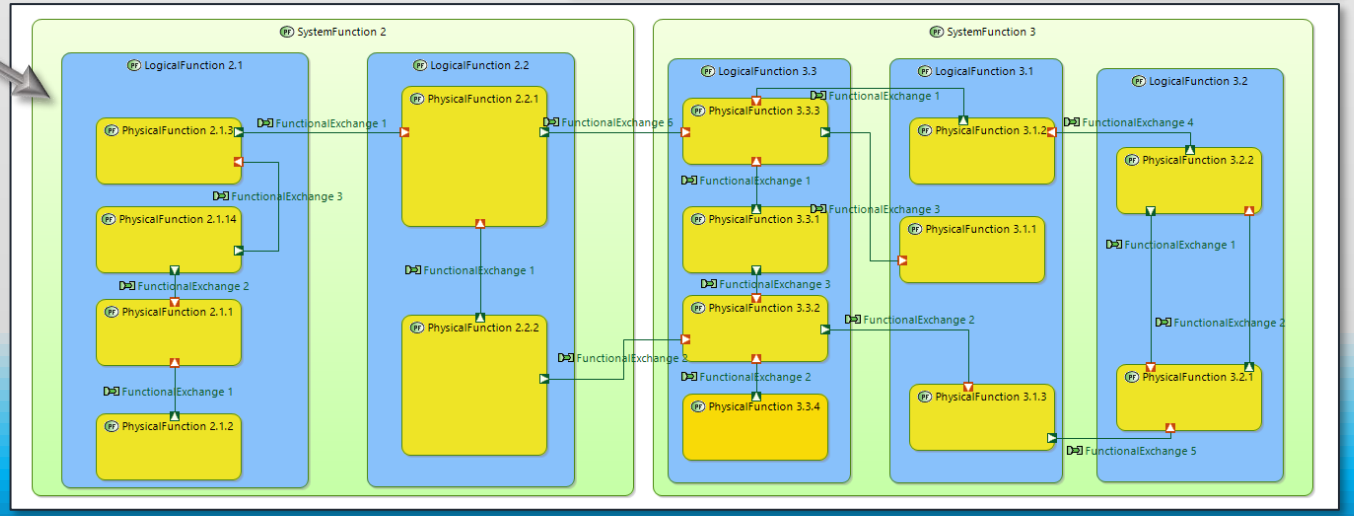


- Define the system
- Define the functions
- Define the tree diagram
- Define the functional dependencies







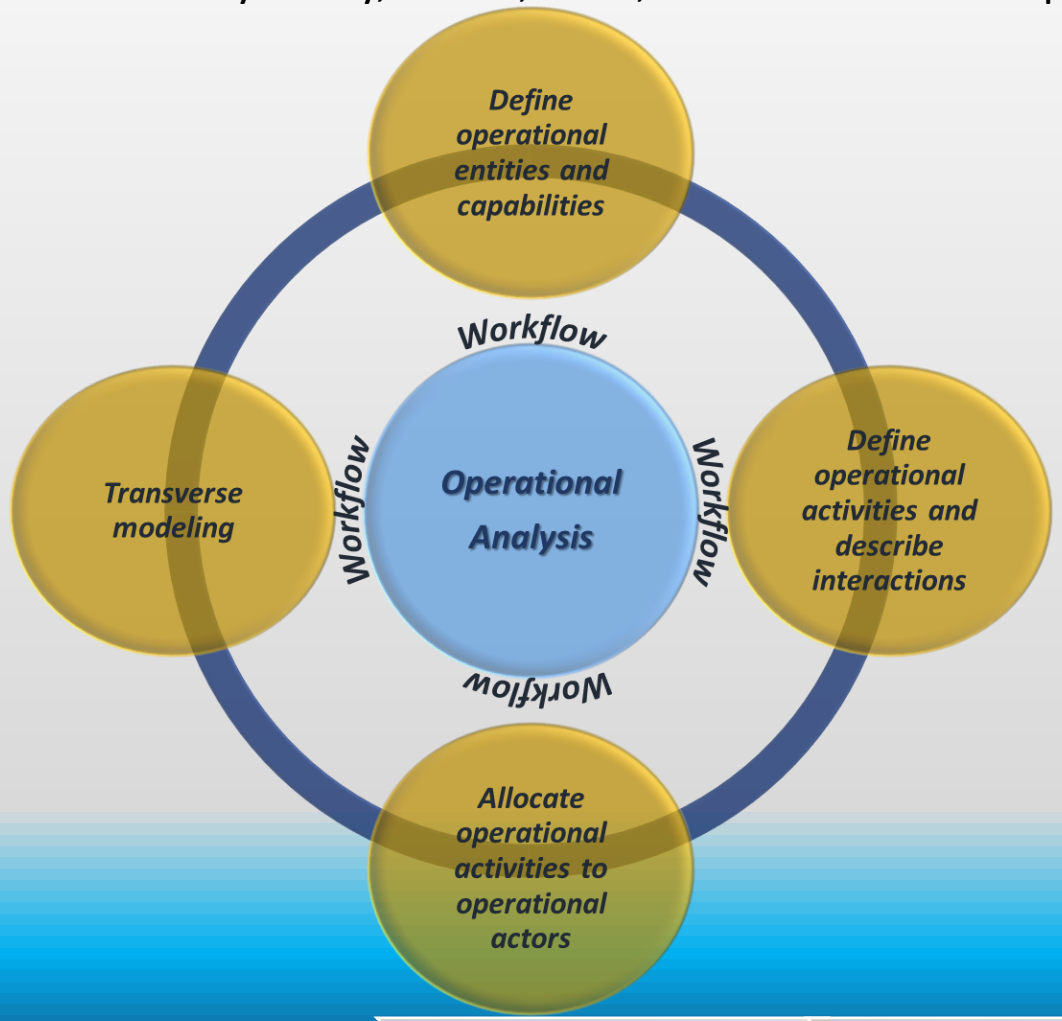


ARCADIA/CAPELLA - Operational Analysis

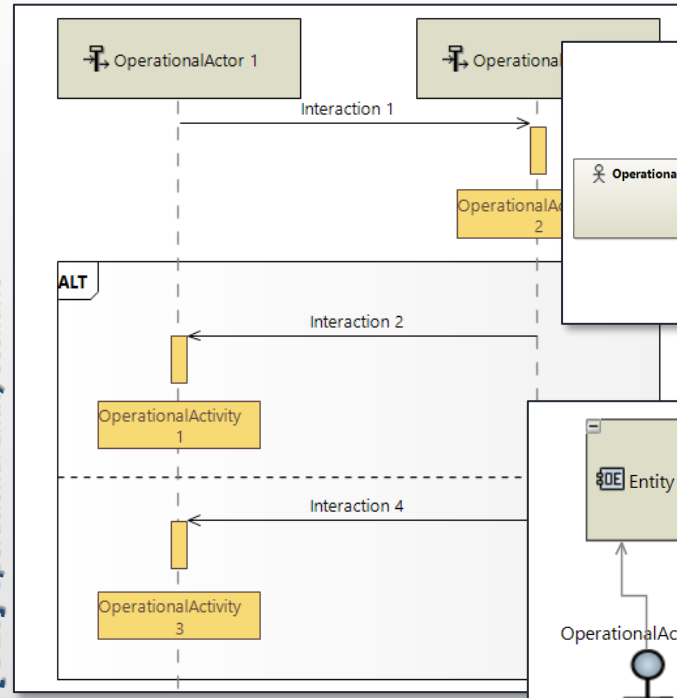
Speaker: DROUIN Remy

Define Stakeholder needs and environment

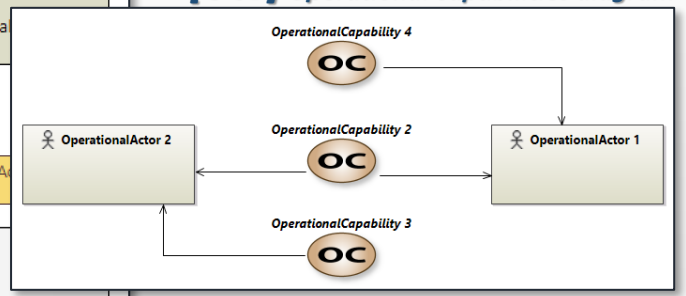
- Capture and consolidate operational needs from stakeholders
- Define what the users have to accomplish
- Identify entity, actors, roles, activities and concepts



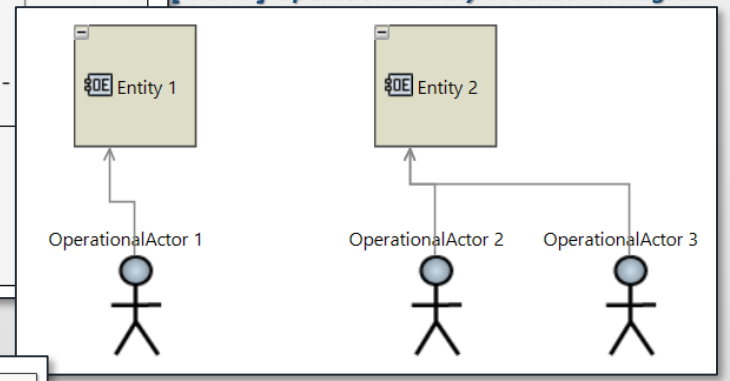
[OES] Operational Entity Scenario



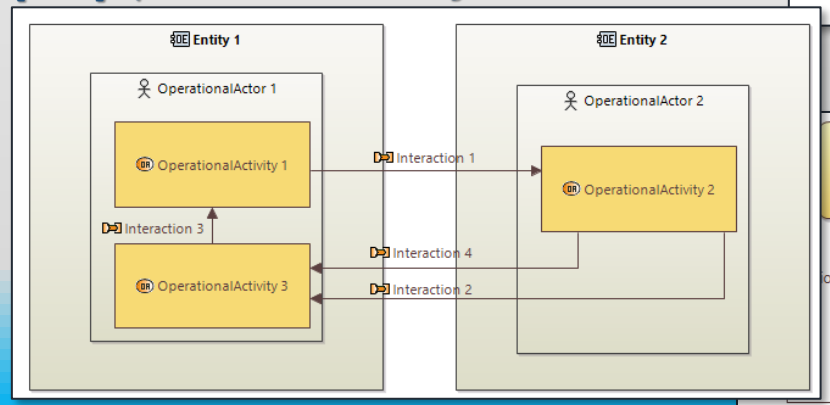
[OCB] Operational Capabilities diagram



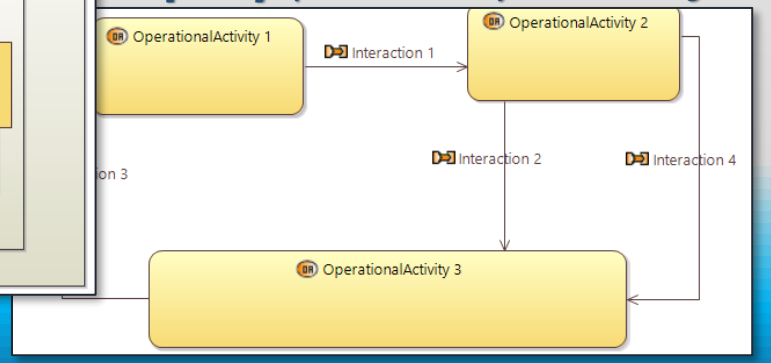
[OEBD] Operational Entity Breakdown diagram



[OAB] Operational Architecture diagram



[OAIB] Operational Activity Interaction diagram

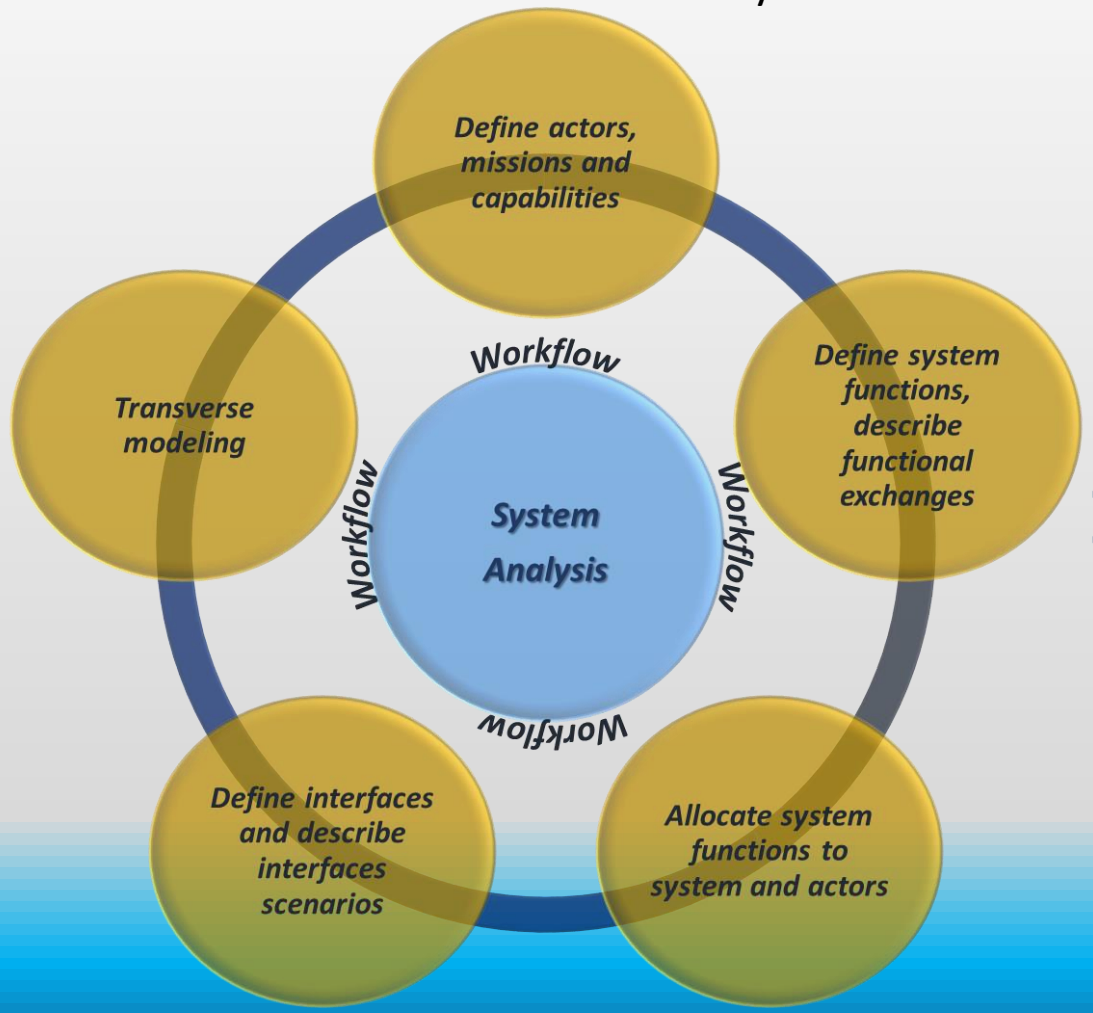


ARCADIA/CAPELLA - System Analysis

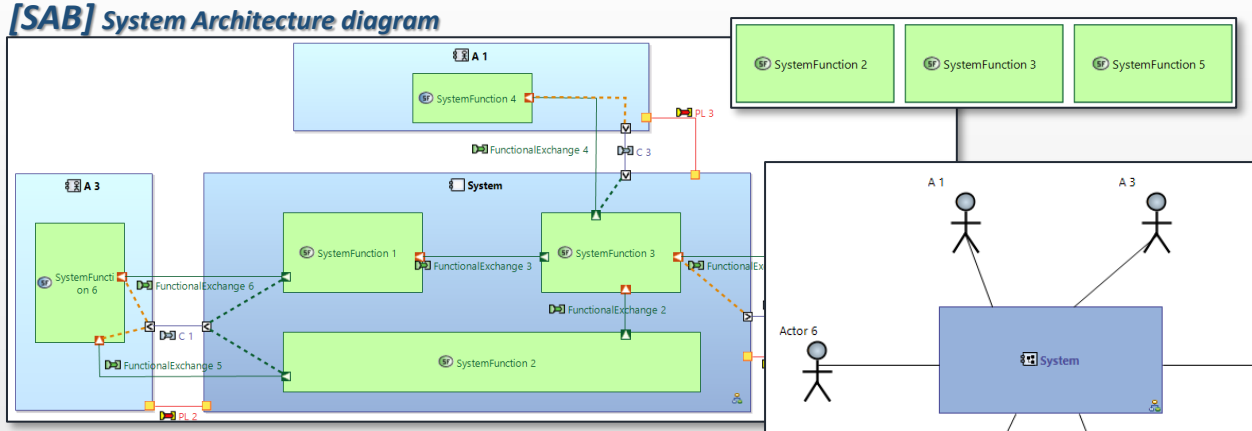
Speaker: DROUIN Remy

Formalize system requirements

- Identify the boundary of the system
- Define what the system has to accomplish for the users
- Model functional dataflows and dynamic behaviour

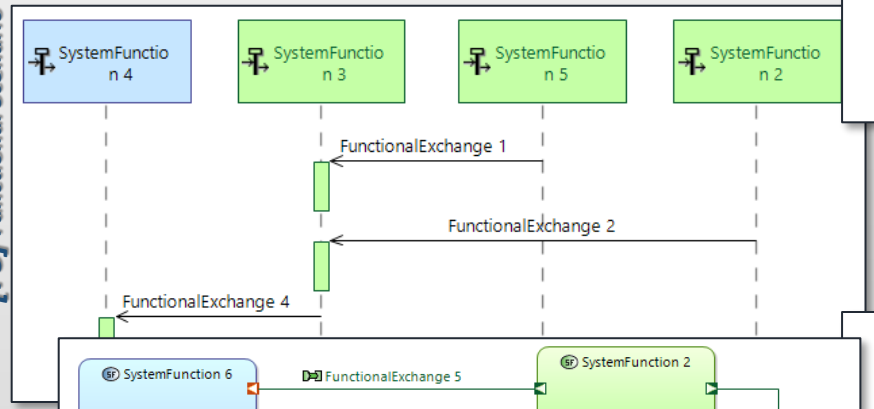


[SAB] System Architecture diagram

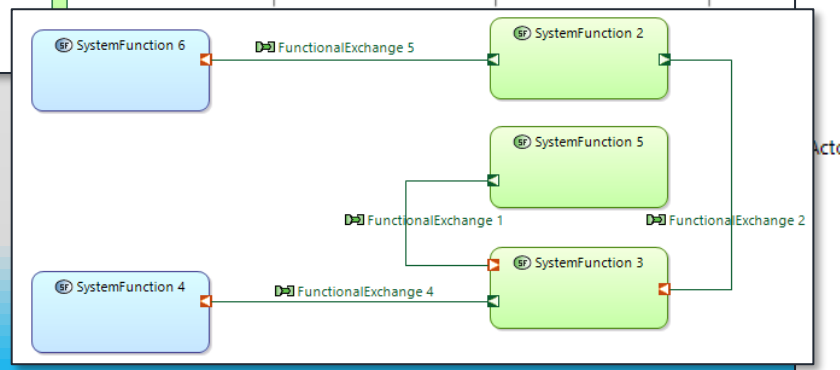


[CSA] Contextual System Actors diagram

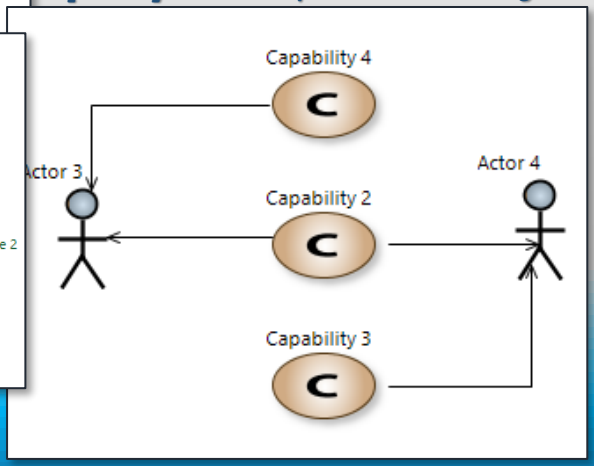
[FS] Functional Scenario



[SDFB] Functional Dataflow Blank diagram



[MCB] Mission Capabilities Blank diagram

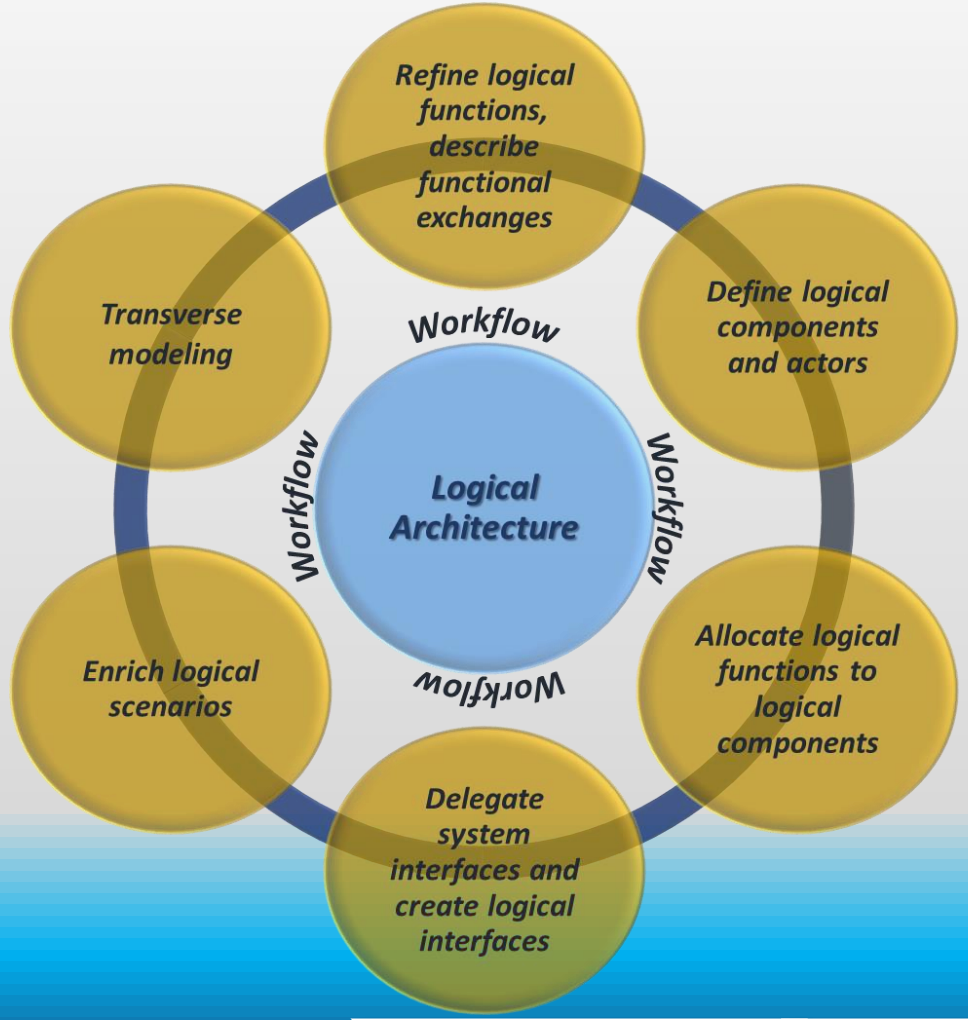


ARCADIA/CAPELLA - Logical Architecture

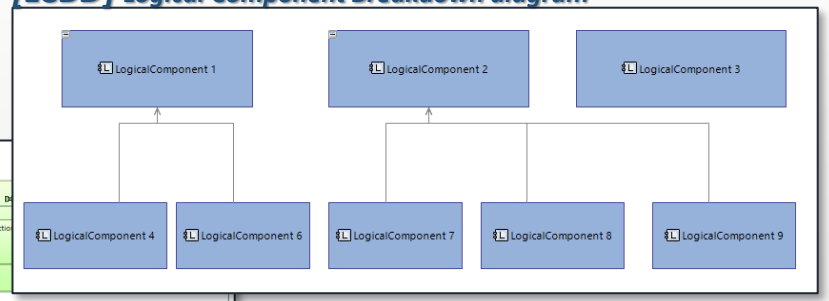
Speaker: DROUIN Remy

Developp system logical architecture

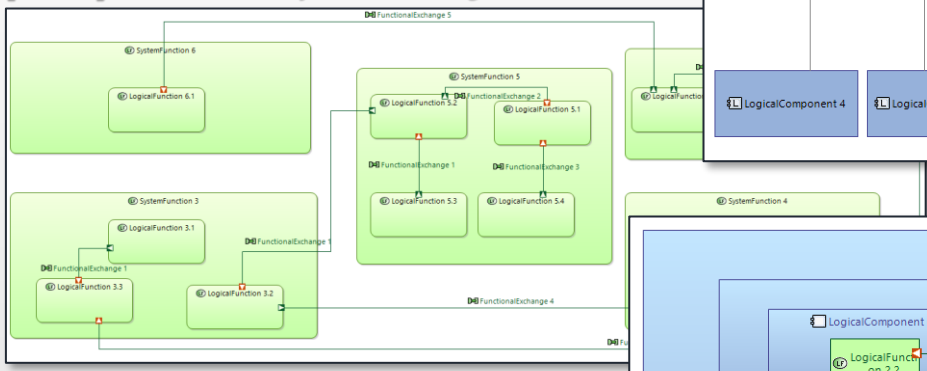
- See the system as a white box define how the system will work so as to fulfill expectations
- Perform a trade-off analysis



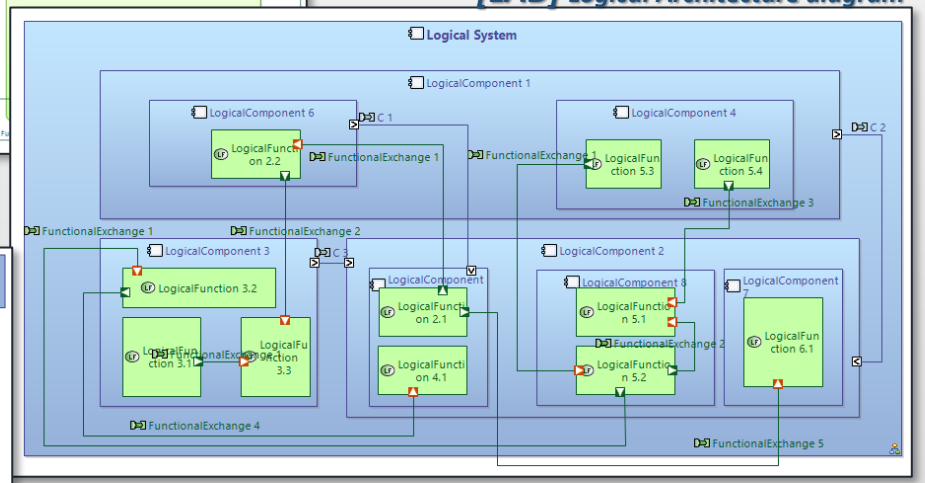
[LCBD] Logical Component Breakdown diagram



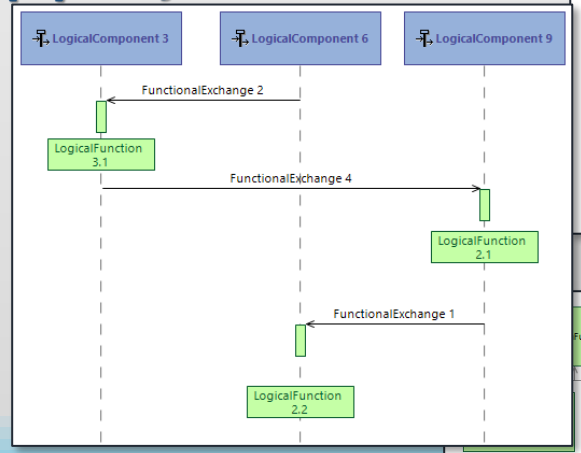
[LDFB] Functional Dataflow Blank diagram



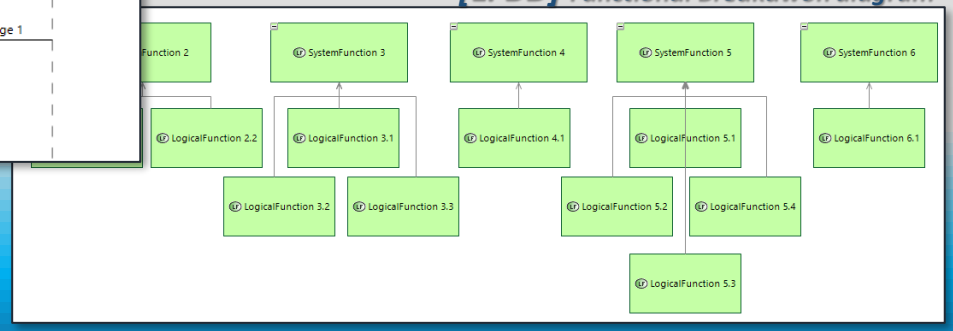
[LAB] Logical Architecture diagram



[ES] Exchange Scenario



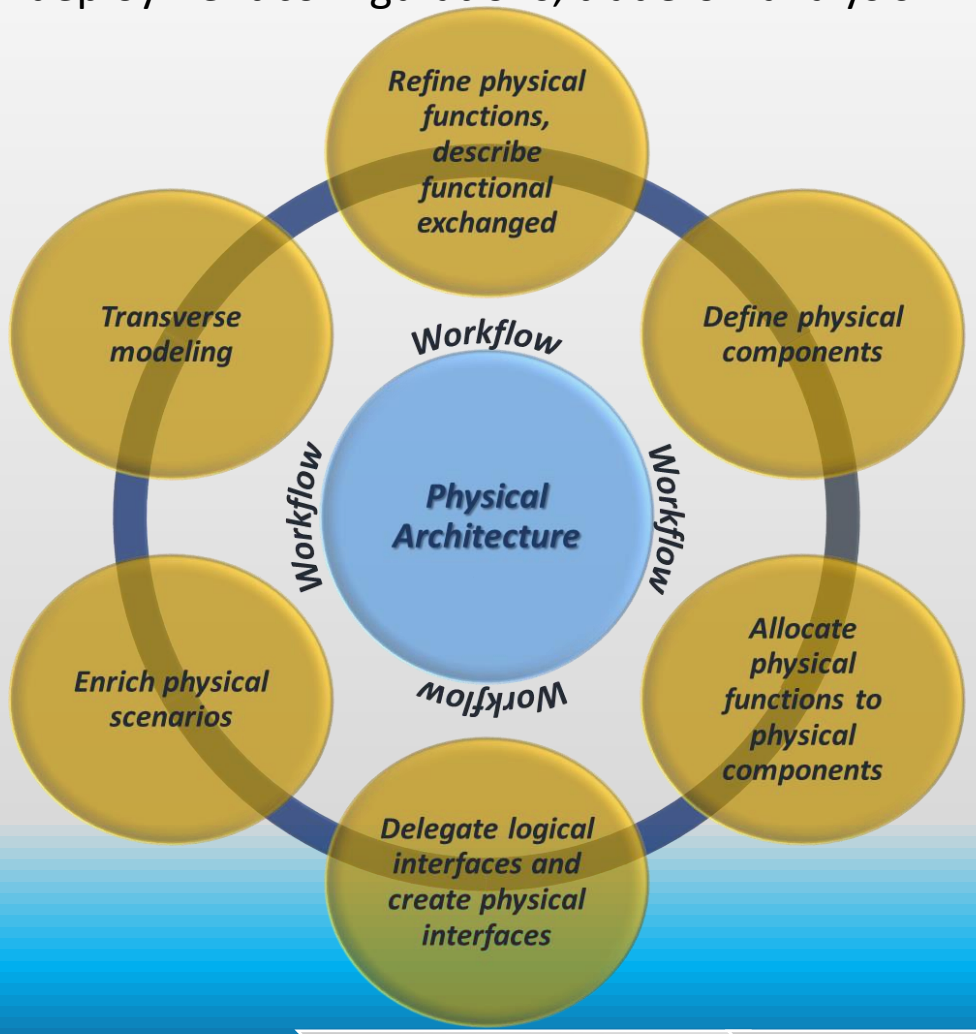
[LFBD] Functional Breakdwon diagram



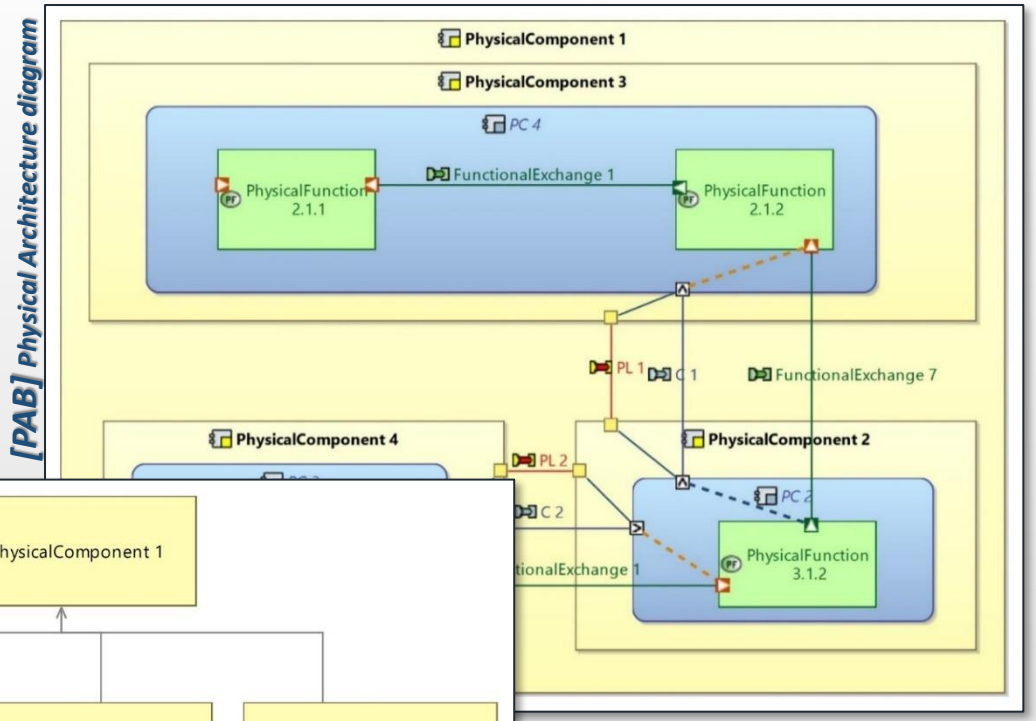
Speaker: DROUIN Remy

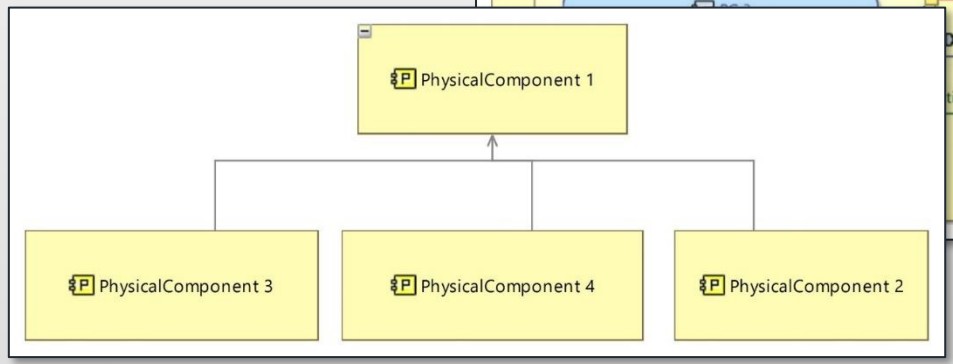
Develop system Physical architecture

- How the system will be developed and built
- Software vs. hardware allocation, specification of interfaces,
- deployment configurations, trade-off analysis



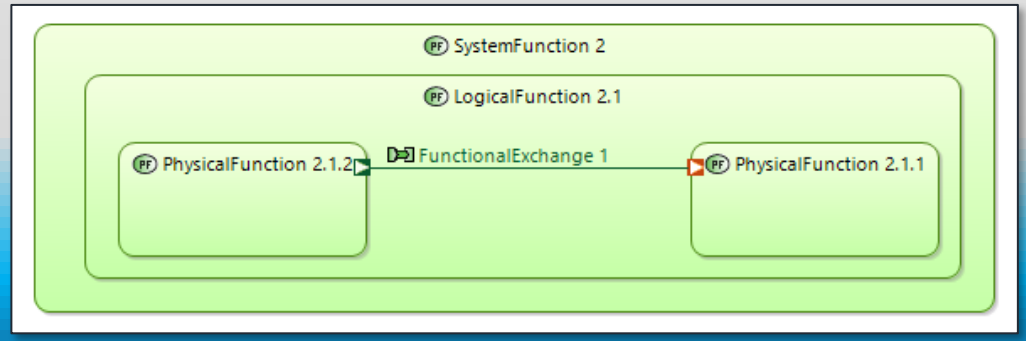
[PAB] Physical Architecture diagram





[PCBD] Physical Component Breakdown diagram

[PDFB] Physical Dataflow Blank diagram



ARCADIA/CAPELLA - Add ons sample

Speaker: DROUIN Remy

Several add ons are availables in order to unleash the power of MBSE workbench

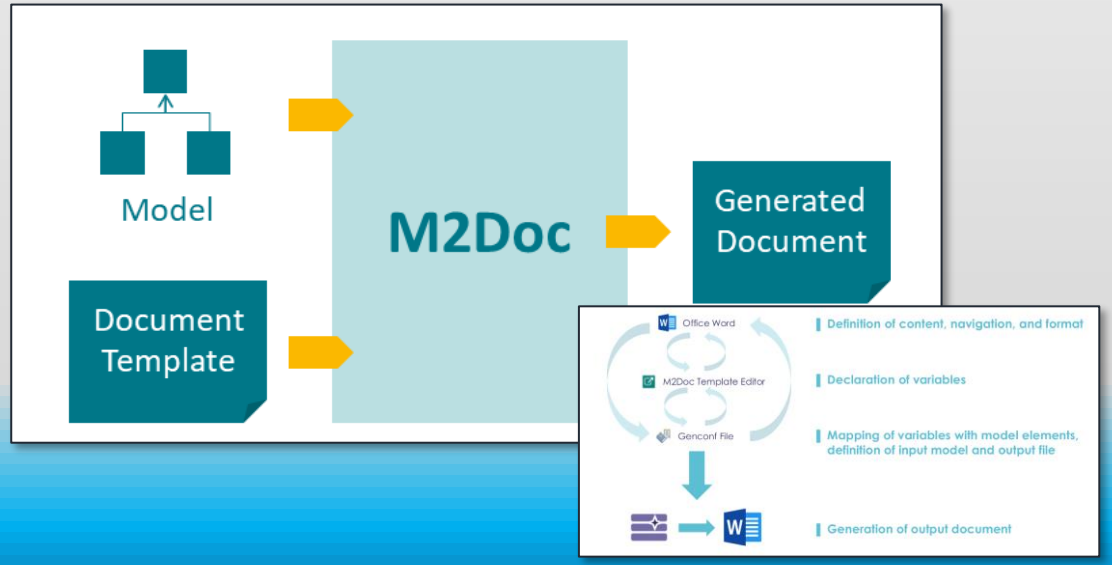
Open-Source Add ons

Capella	Subsystem-Transition	Requirements	Filtering	Basic-Viewpoints	xhtml-docgen	M2Doc
5.0.x						
1.4.x						
1.3.x	(releases)	(releases)	(releases)	(releases)	(releases)	(releases)
1.2.x						
1.1.x						
1.0.x						
0.8.x						

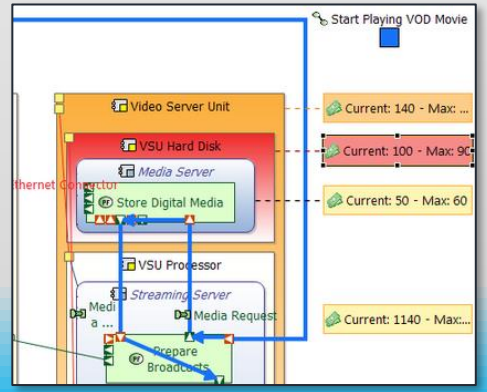
The ***Mass viewpoint*** enables to simply describe the non-functional aspect of mass in Capella.
The ***Price viewpoint*** enables to simply describe the non-functional aspect of price in Capella.
The ***Performance viewpoint*** enables to simply describe the non-functional aspect of performance in Capella.

Xhtml docgen addon enables the end-user to generate an HTML website from a Capella project.
Sharing models with all stakeholders is essential in model-based systems engineering. Publishing and sharing HTML versions of models helps make models The reference of all engineering activities.

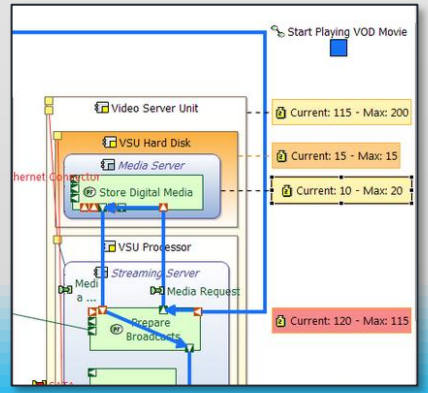
M2Doc generates MS-Word documents from Capella models. M2Doc uses customable Word templates to extract data and diagrams from your models and display them in a docx file.



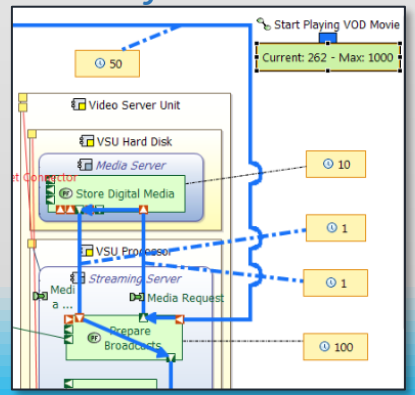
Price



Mass



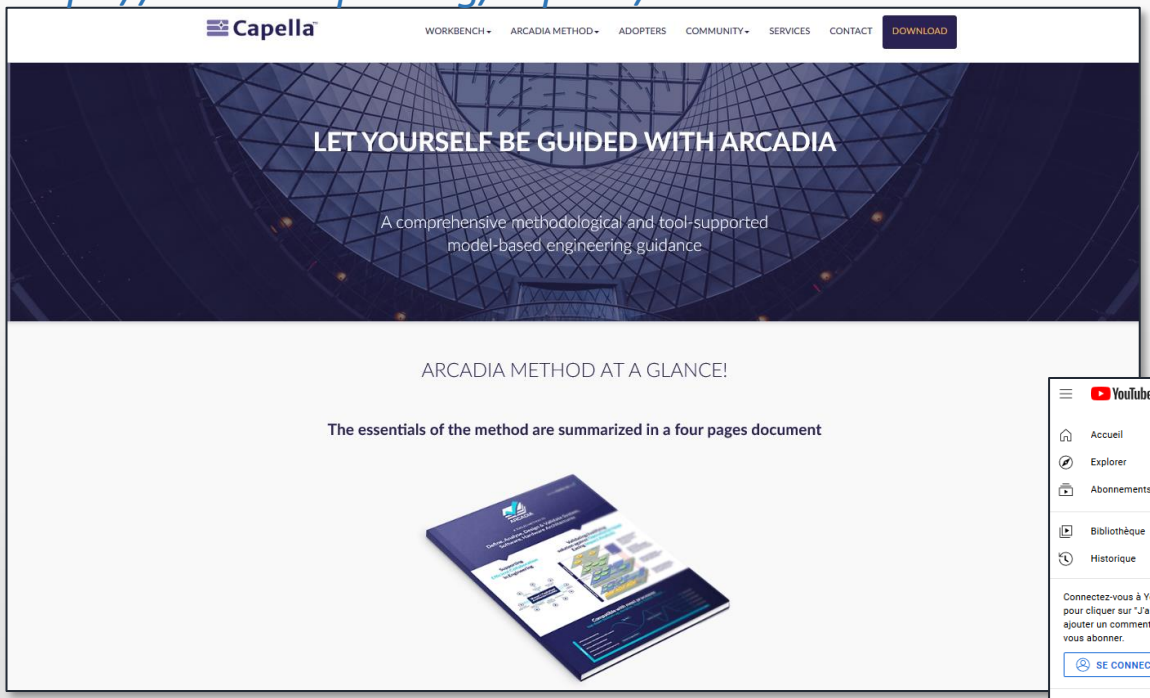
Performance

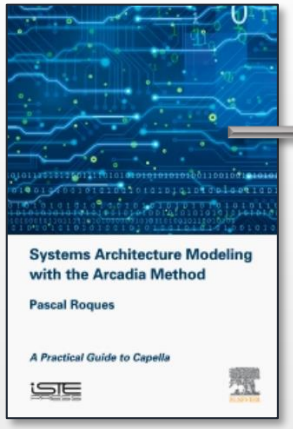


ARCADIA/CAPELLA - WEBSITE

Speaker: DROUIN Remy

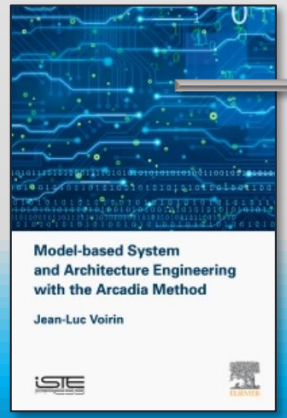
https://www.eclipse.org/capella/arcadia.html



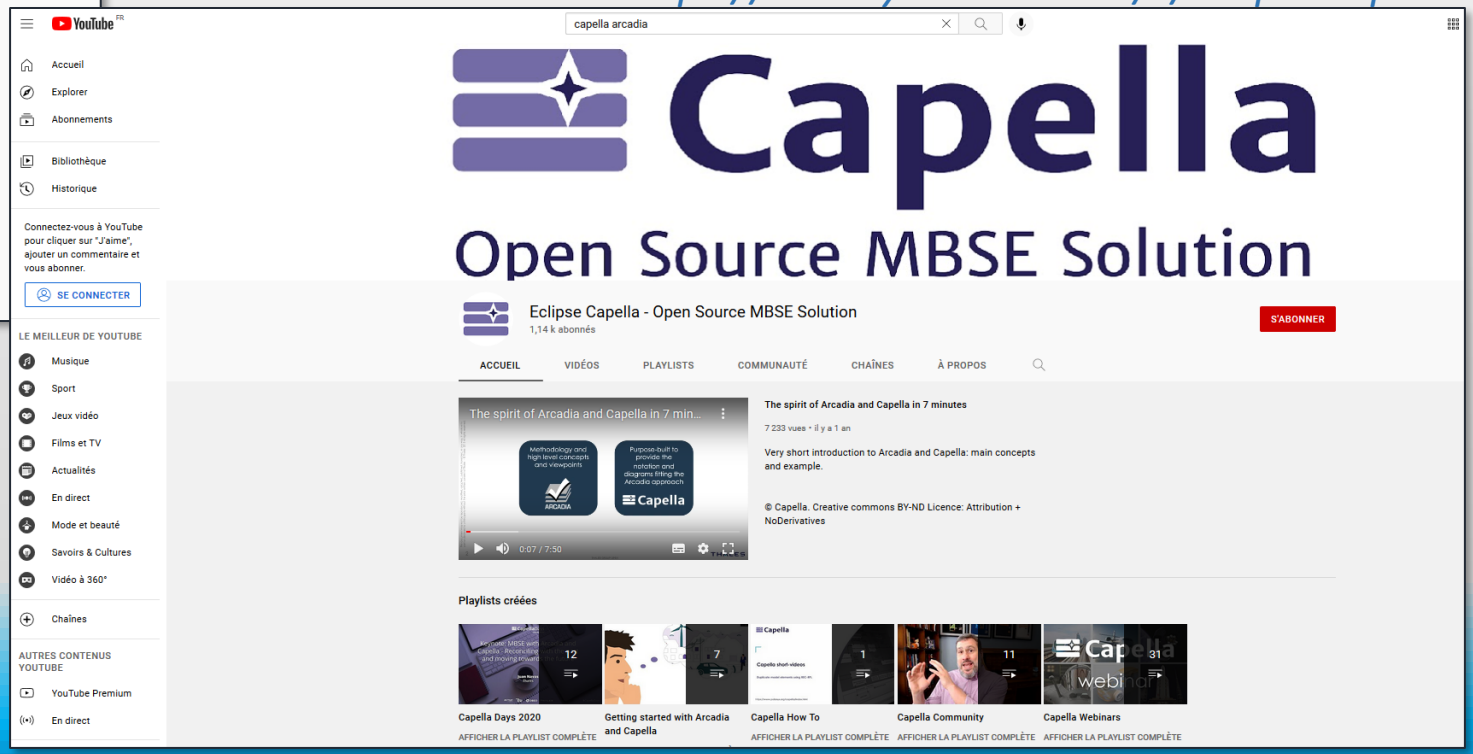


"Systems Architecture Modeling with the ARCADIA Method"
@Pascal Roques

https://www.youtube.com/c/EclipseCapella



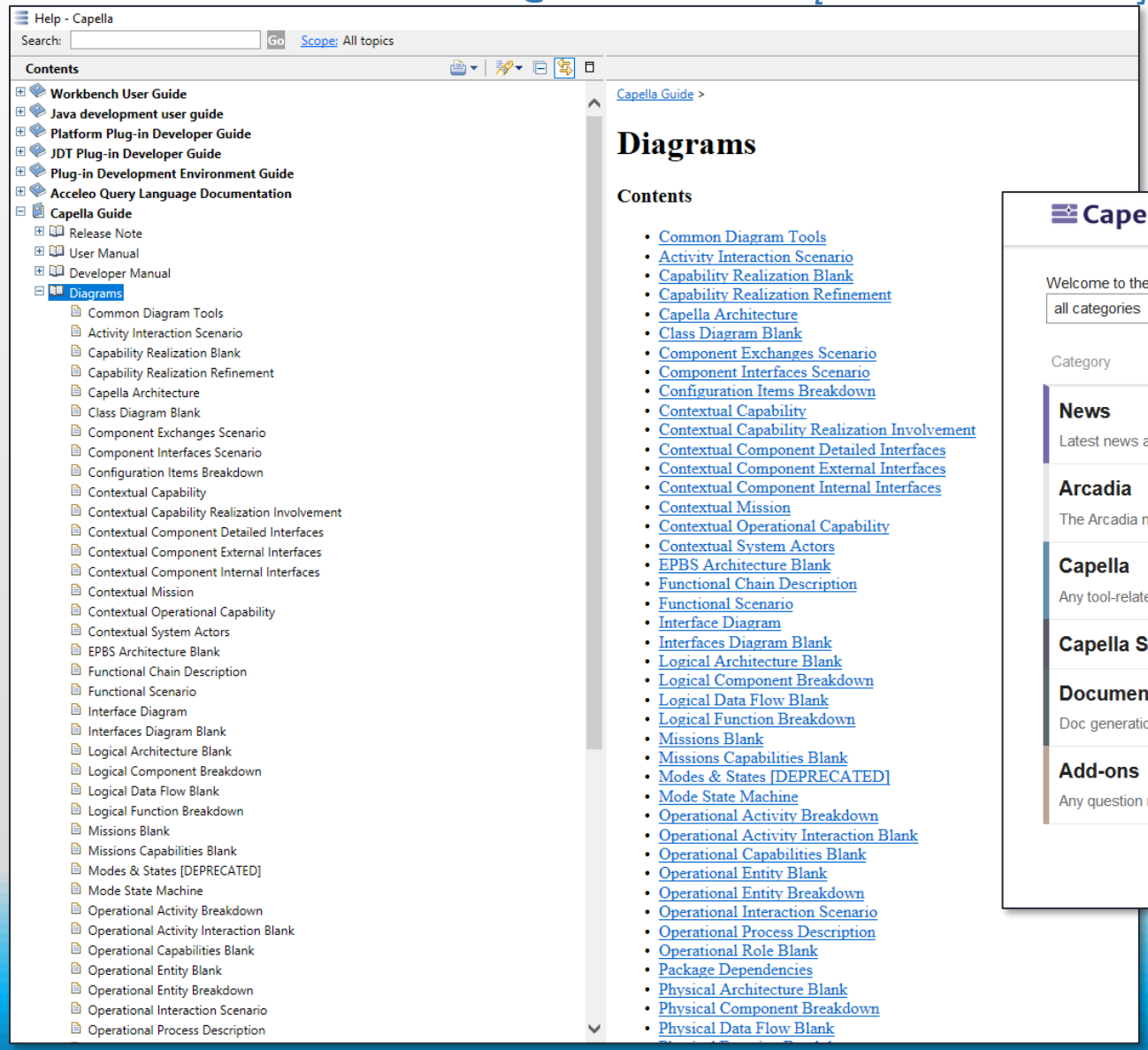
"Model-Based Systems and Architecture Engineering with the ARCADIA Method
@Jean Luc Voirin



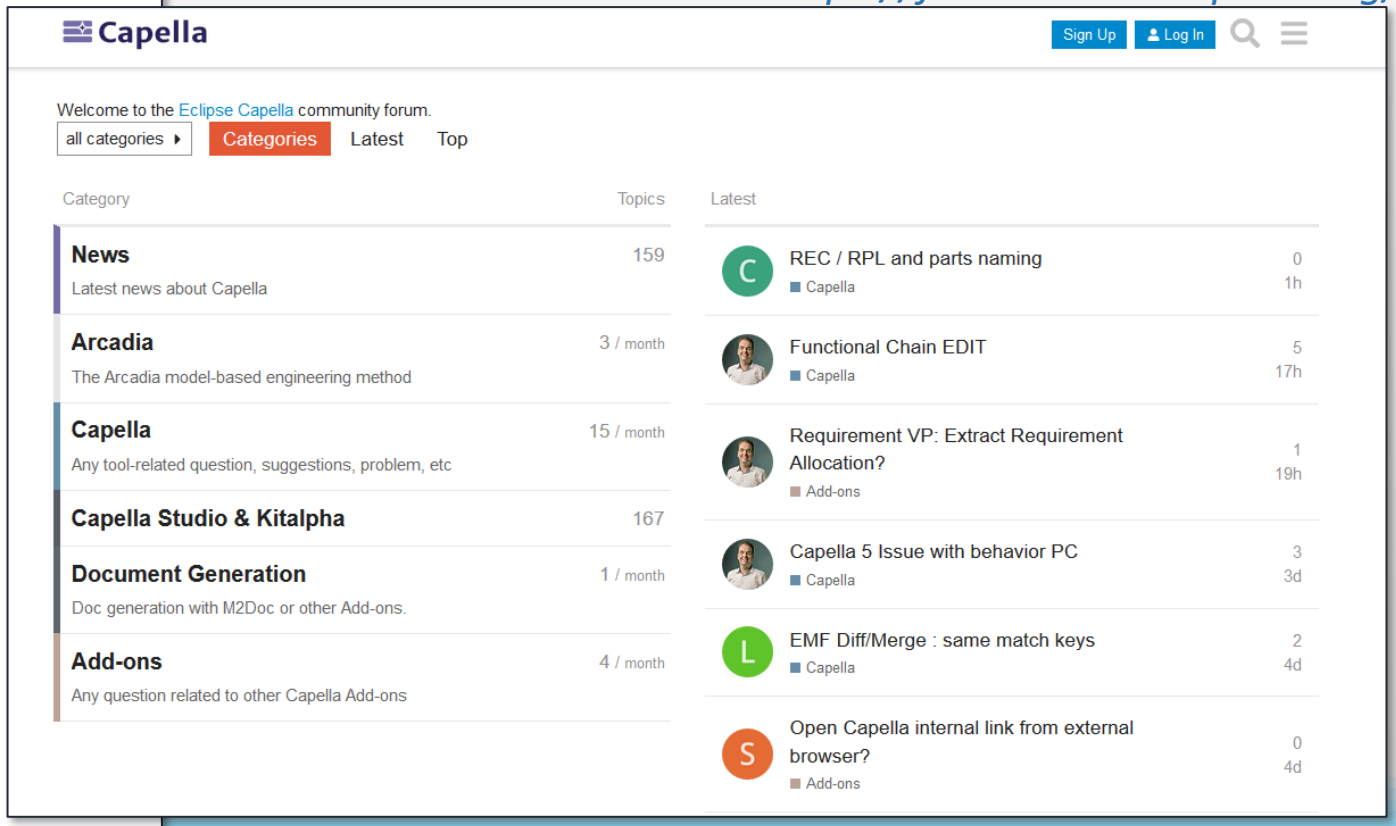
ARCADIA/CAPELLA - HELP

Speaker: DROUIN Remy

@HELP Contents [CAPELLA modeler]



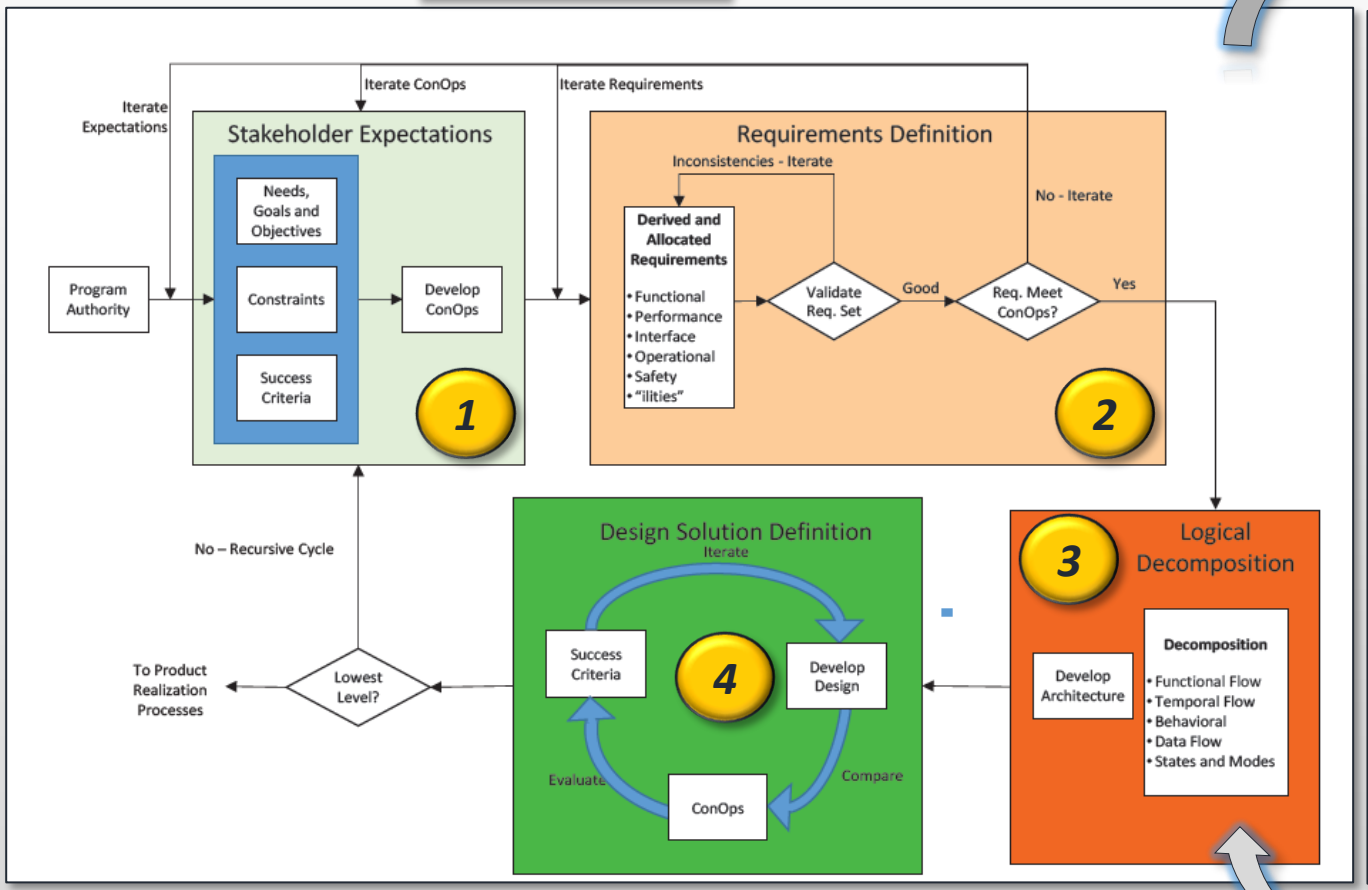
https://forum.mbse-capella.org/



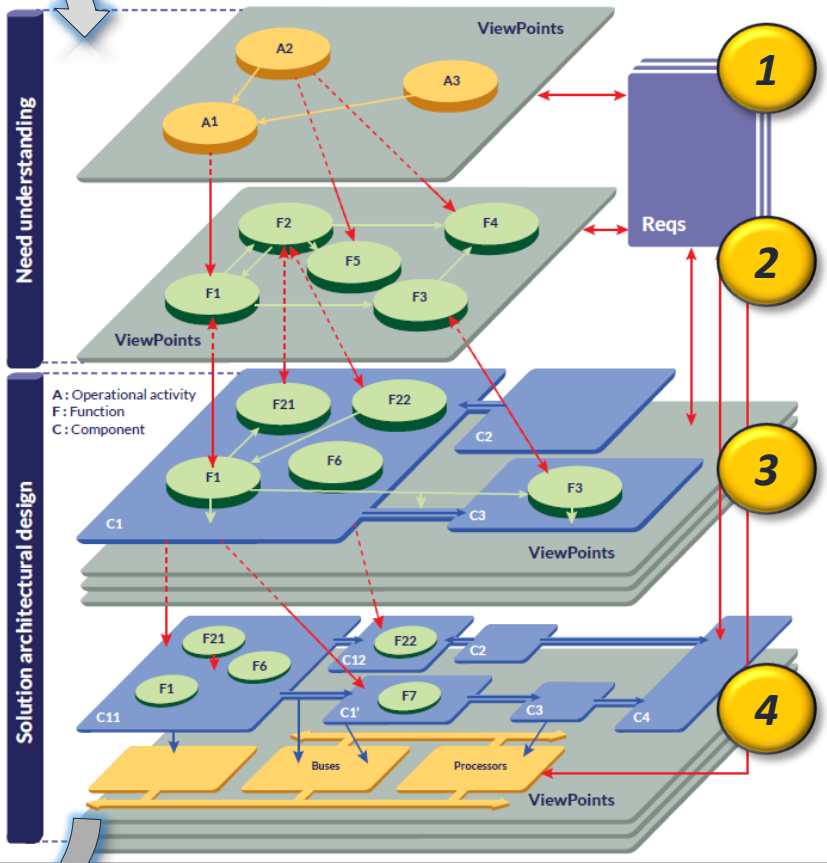
ARCADIA Versus NASA System Engineering Handbook

Speaker: DROUIN Remy

NASA SYSTEMS ENGINEERING HANDBOOK



Capella™



1 **Operational Analysis**
What the users of the system need to accomplish

2 **Functional & Non Functional Need**
What the system has to accomplish for the users

3 **Logical Architecture**
How the system will work to fulfill expectations

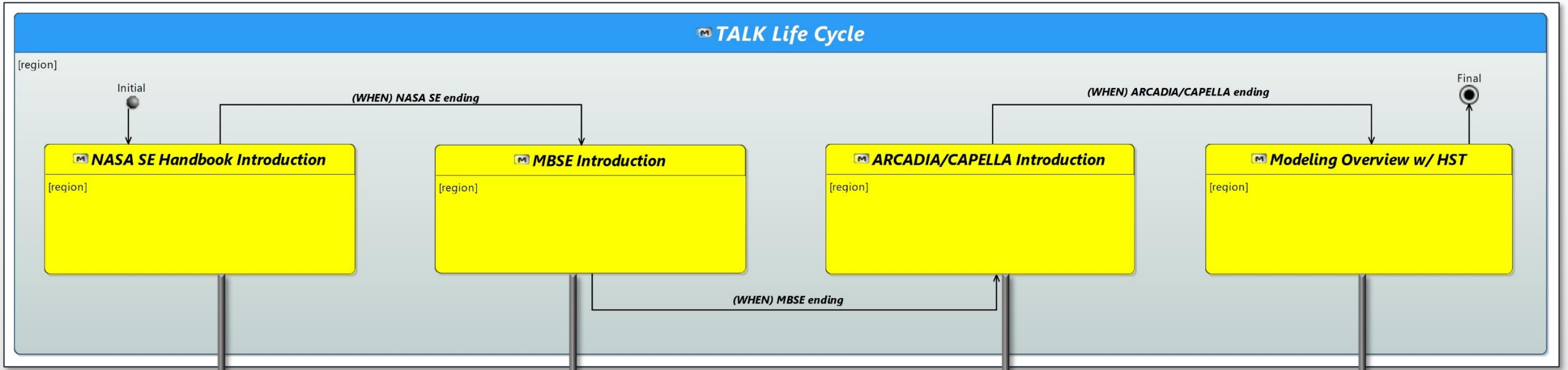
4 **Physical Architecture**
How the system will be developed and built

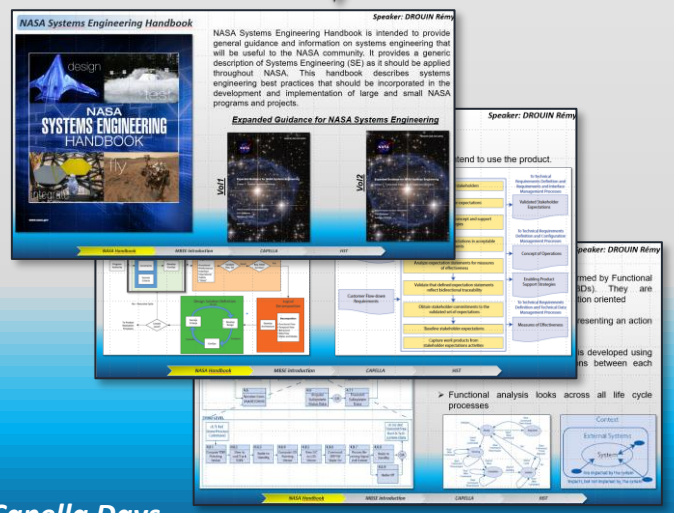
Requirements definition process
Technical solution definition process

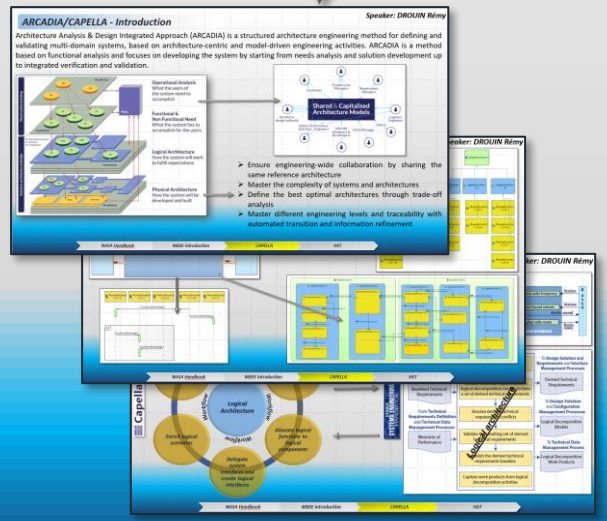
Need understanding
Solution architectural design

TALK Life Cycle

Speaker: DROUIN Remy







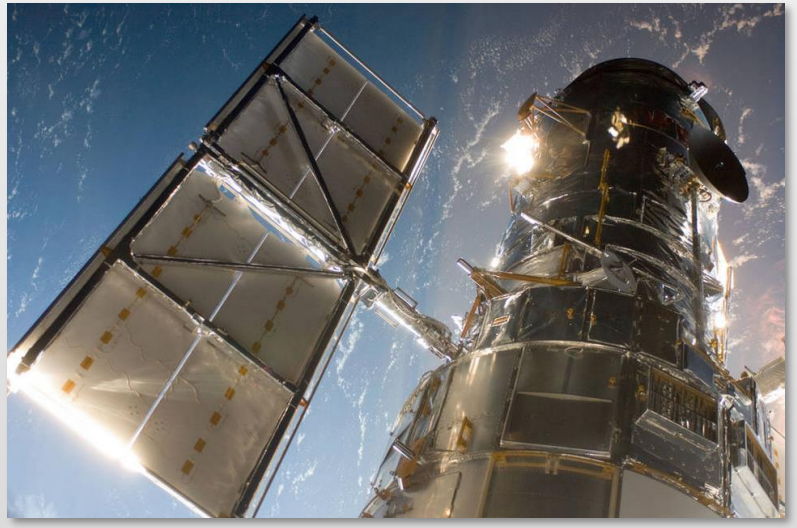
HUBBLE Space Telescope - Introduction

Speaker: DROUIN Remy

The goal is not to apply the MBSE approach to the entire system, but just to apply few diagrams showing the application of ARCADIA/CAPELLA

« All models are wrong, but some are useful » George E.P.Box (British statistician)

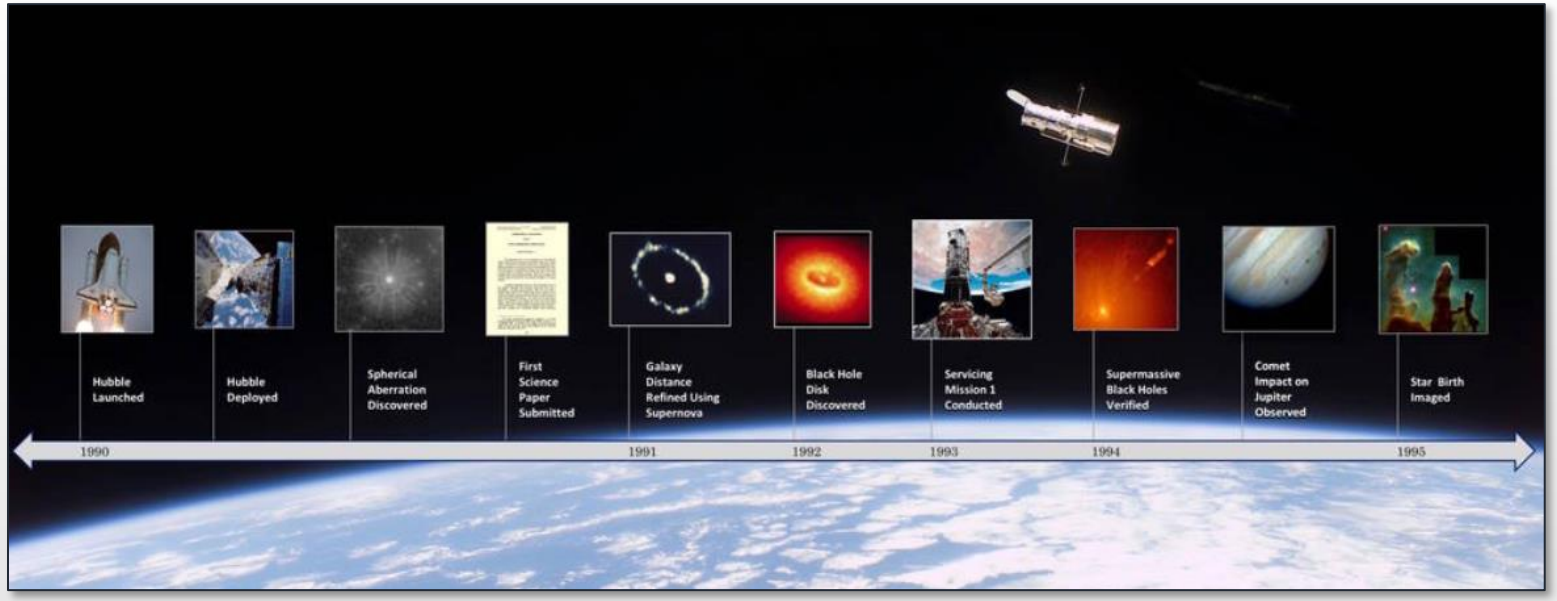
Hubble is a Cassegrain reflector telescope. Light from celestial objects travels down a tube, is collected by a bowl-like, inwardly curved primary mirror and reflected toward a smaller, dome-shaped, outwardly curved secondary mirror. The secondary mirror bounces the light back to the primary mirror and through a hole in its center. The light is focused on a small area called the focal plane, where it is picked up by its various science instruments.

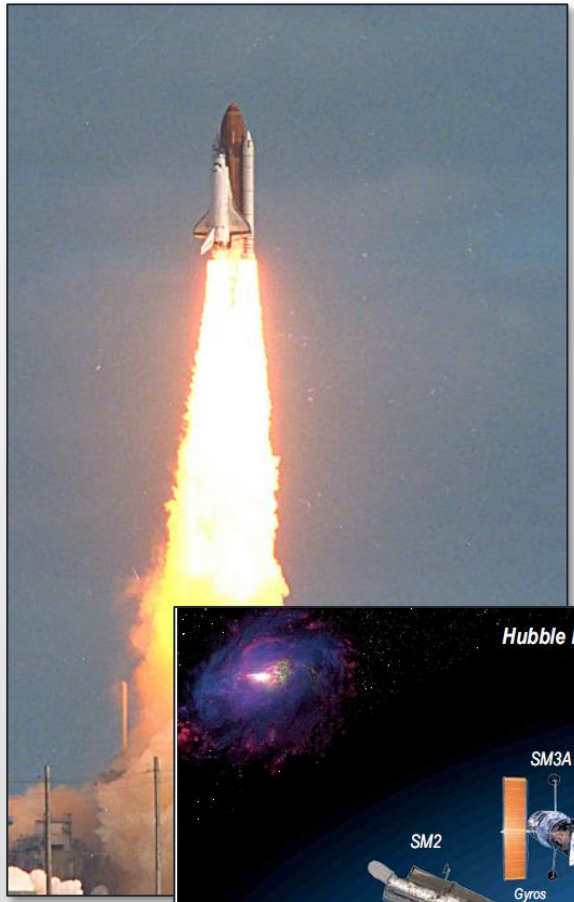


Orbiting high above the Earth, the Hubble Space Telescope has a clear view of the universe free from the blurring and absorbing effects of the atmosphere. In addition to observing visible and near-infrared light, Hubble detects ultraviolet light, which is absorbed by the atmosphere and visible only from space. The telescope has beamed hundreds of thousands of celestial images back to Earth during its time in space.

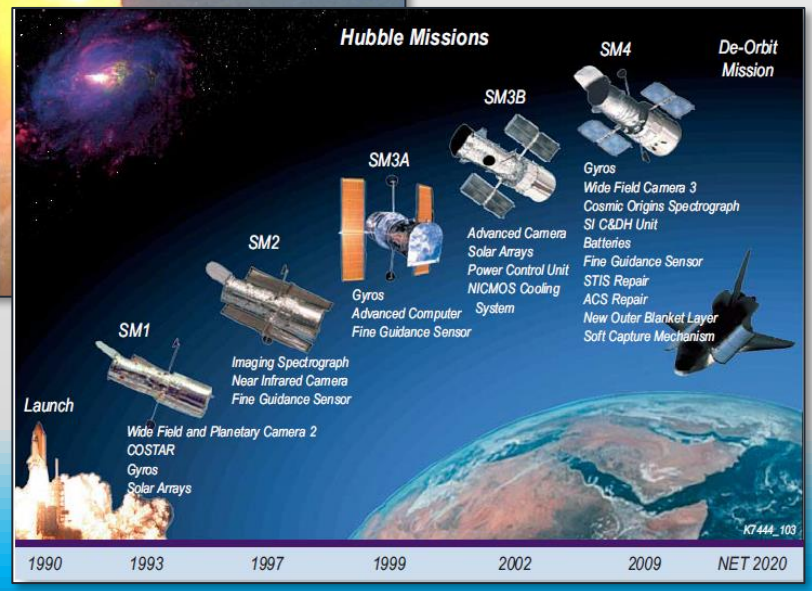
HUBBLE Space Telescope facts

Speaker: DROUIN Remy





- ***Launched:*** April 24, 1990
- ***Deployed:*** April 25, 1990. First Image – May 20, 1990
- ***Servicing missions:*** 4 (SM1 – SM4)
- ***Launch vehicle:*** Space Shuttle Discovery (STS-31)
- ***Launch site:*** Kennedy Space Center, Florida
- ***Location:*** Orbiting 340 miles (540 kilometers) above the Earth
- ***Orbital Period:*** Approximately 95 minutes to complete one orbit around Earth
- ***Speed:*** About 17,000 mph (27,300 kph)
- ***Wavelength coverage:*** Sensitivity to light: Ultraviolet through Infrared (115-1700nm)

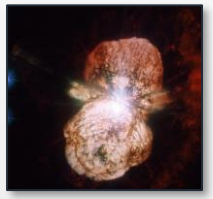


HUBBLE Space Telescope science

Speaker: DROUIN Remy

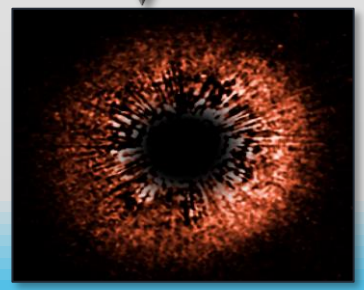
Answer some of the most compelling astronomical questions of our time, and uncovered mysteries we never knew existed

SCIENCE

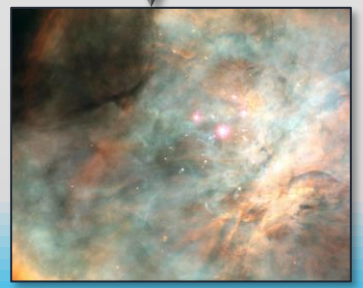


Solar System

Exoplanets

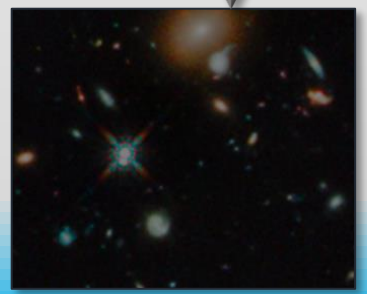


Stars&Nebulas



Galaxies

Universe

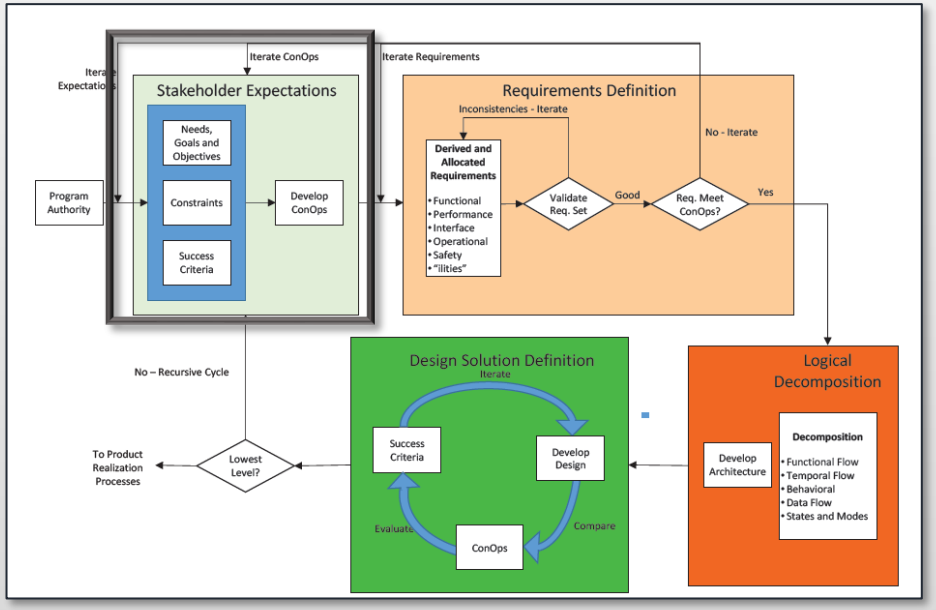


Cosmic Wonders

Operational Analysis

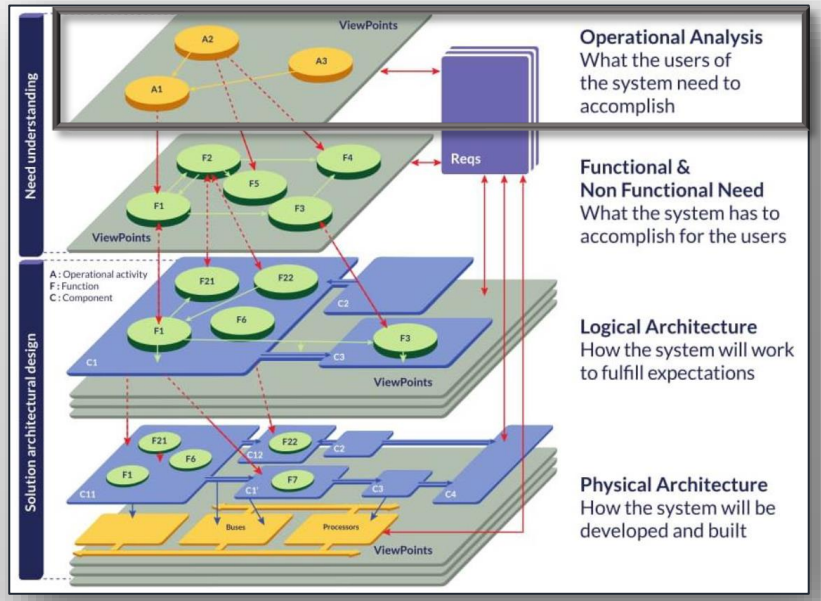
Requirements definition process

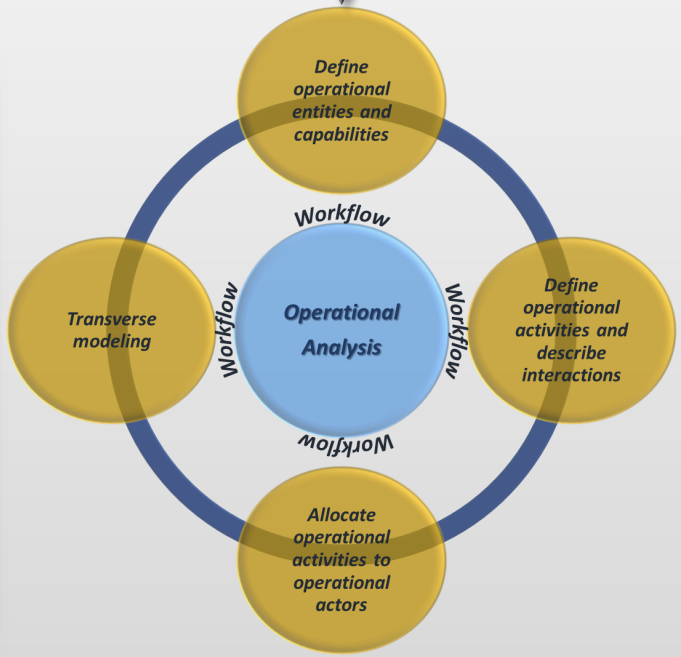
Technical solution definition process



Need understanding

Solution architectural design

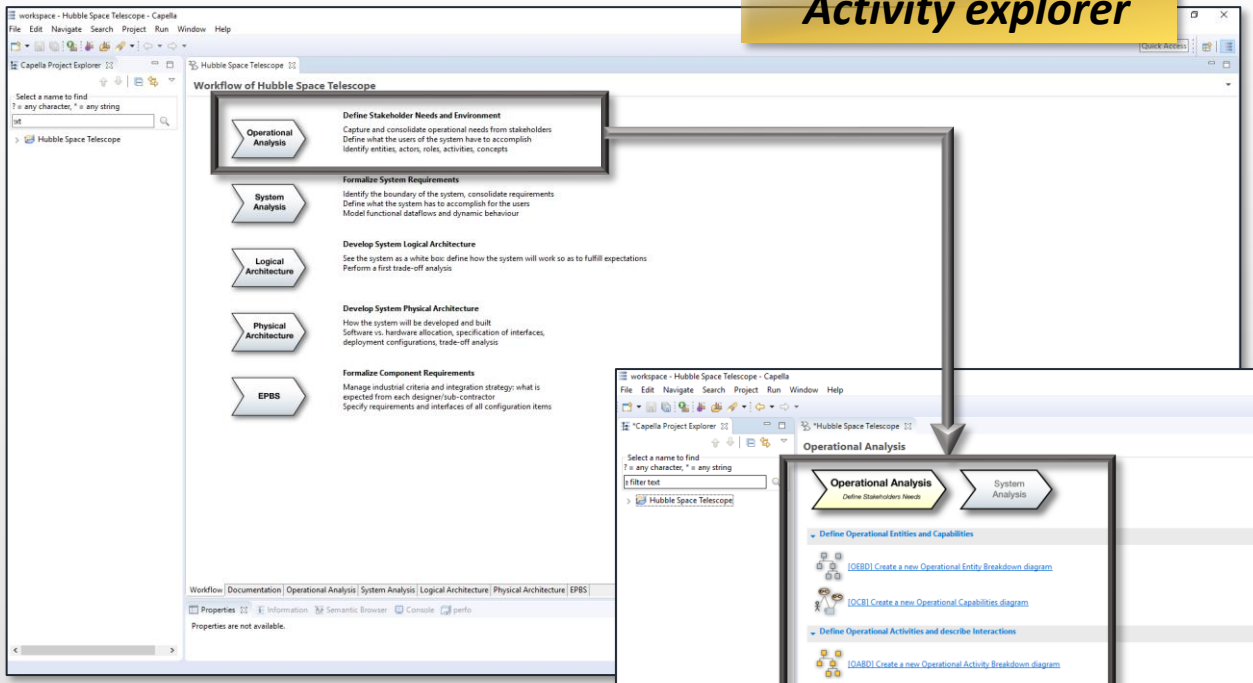




Operational Analysis

Speaker: DROUIN Remy

Activity explorer



Activity explorer

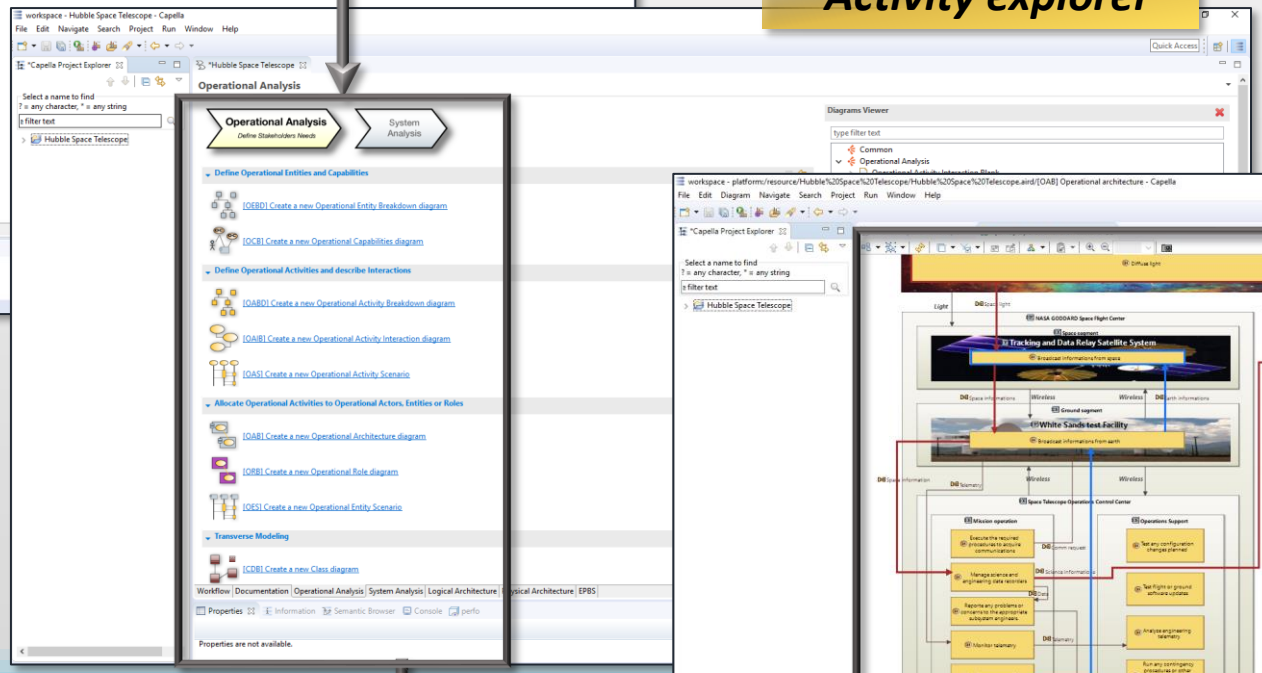
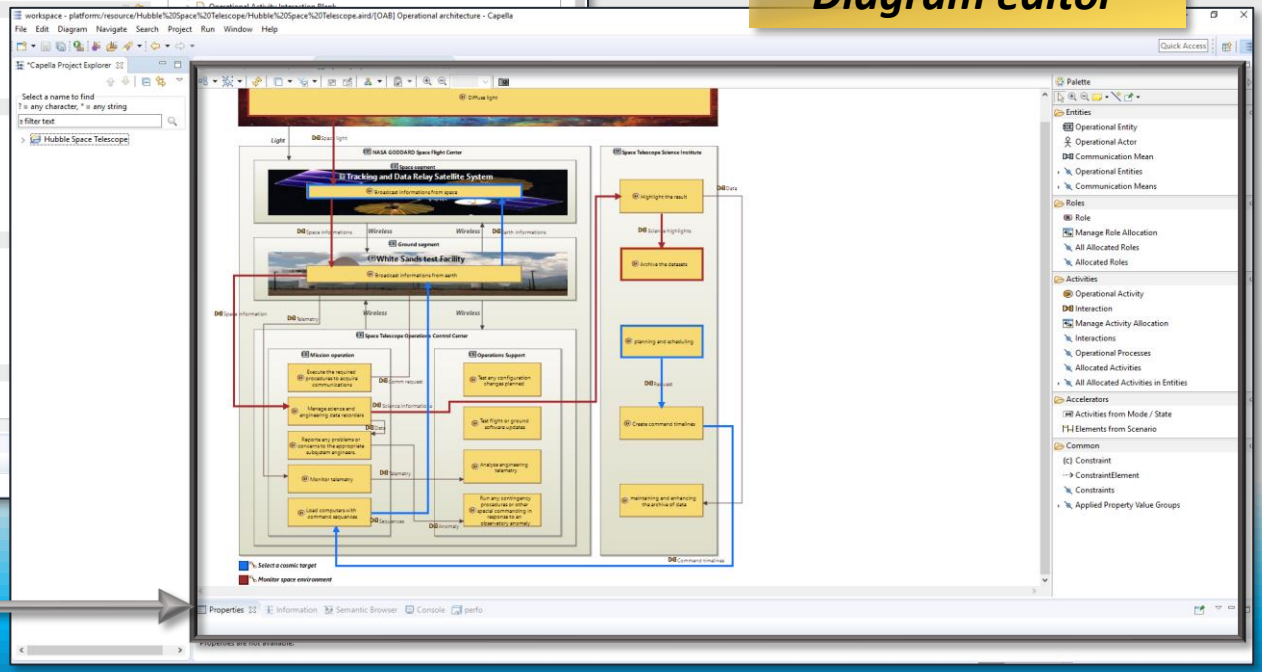


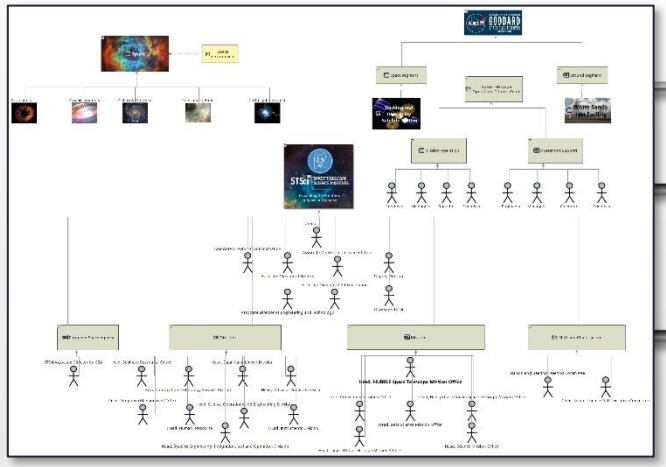
Diagram editor

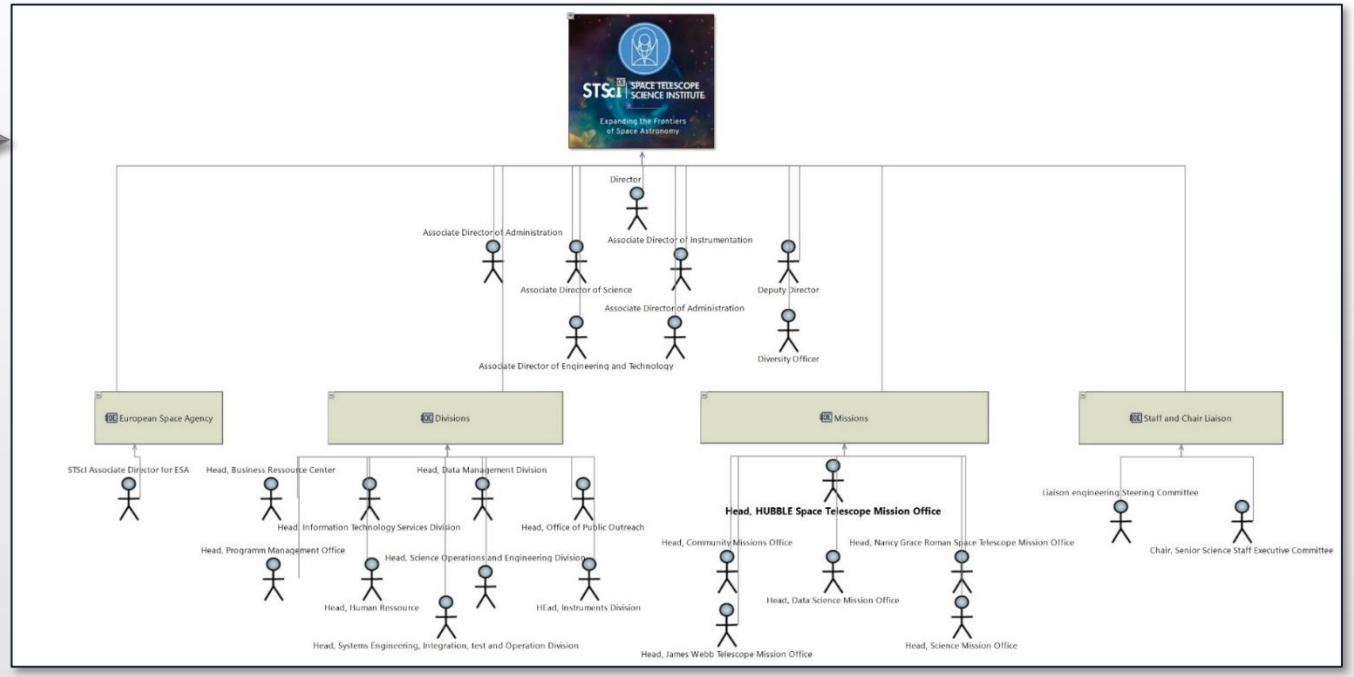


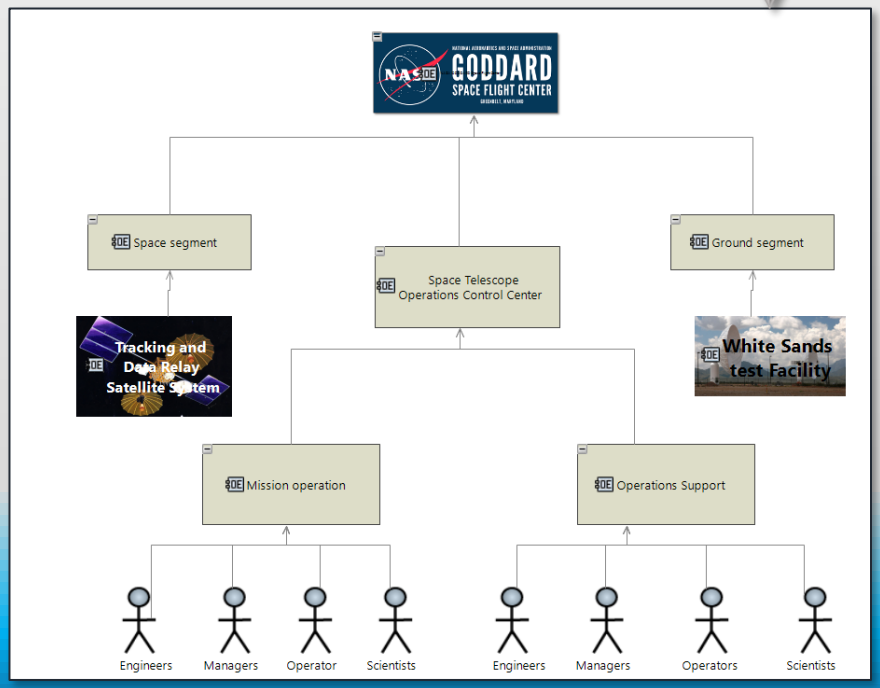
Operational Analysis

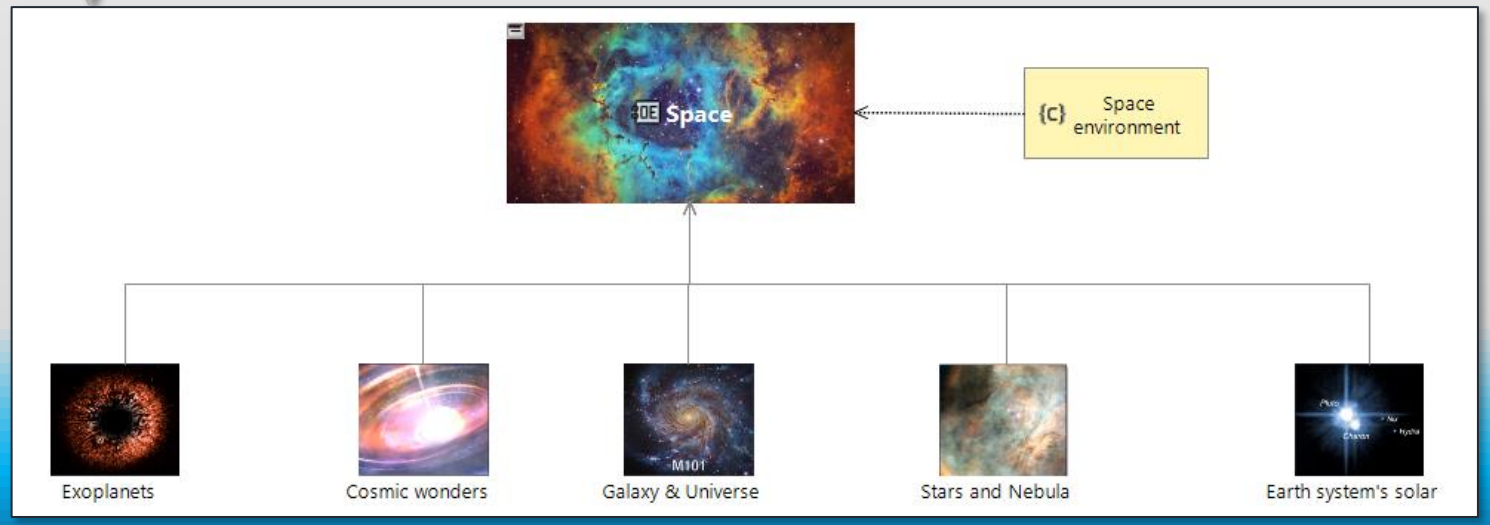
Speaker: DROUIN Remy

[OEBD] Operational Entity Breakdown diagram





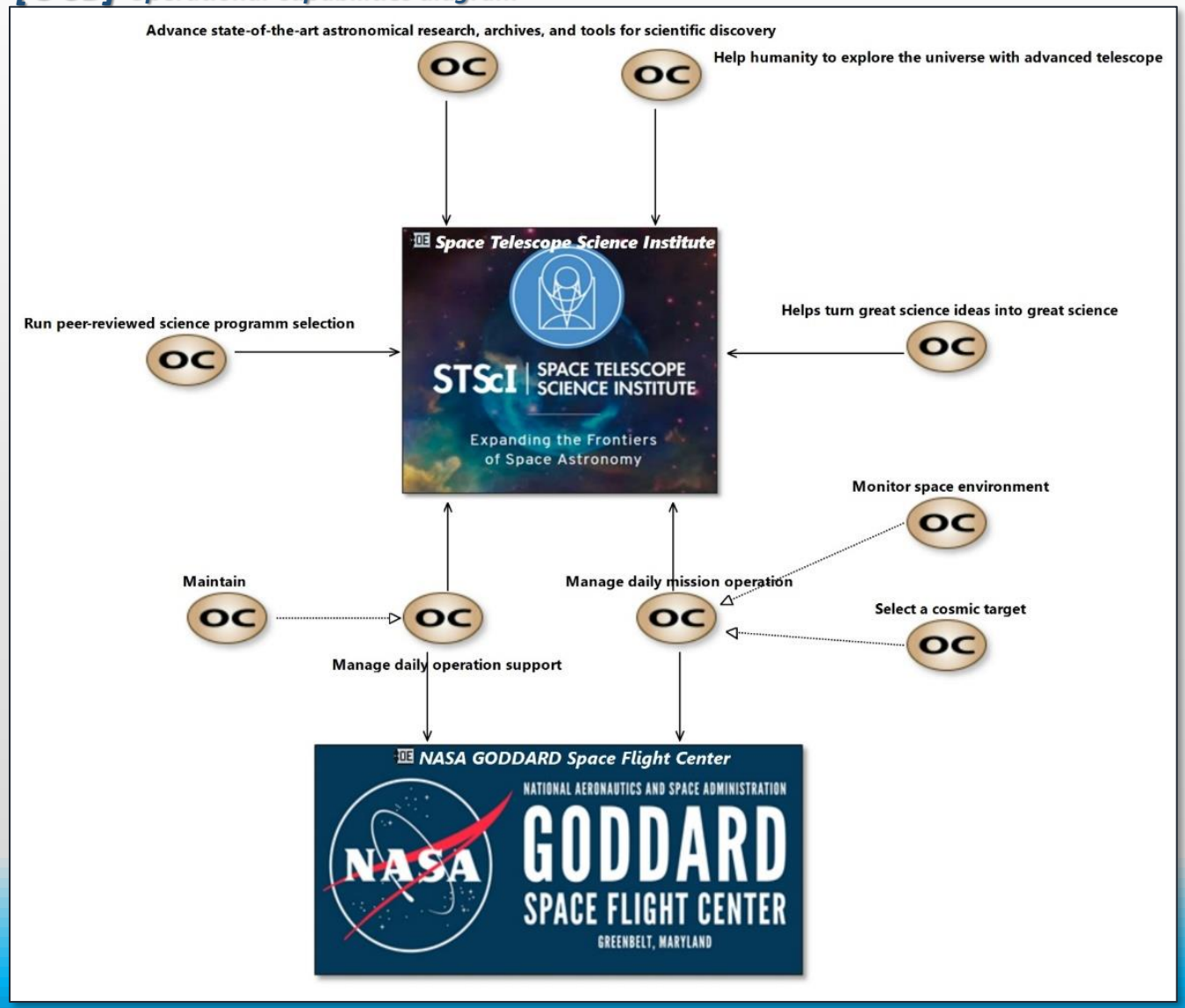




Operational Analysis

Speaker: DROUIN Remy

[OCB] Operational Capabilities diagram



Behind Hubble's captivating images and groundbreaking science is a team of people who control the telescope, ensure its health and safety, and innovate ways to keep it at top performance more than three decades after its launch. This group of engineers, scientists, and operators at NASA's Goddard Space Flight Center work together to monitor Hubble as it travels around Earth, point the telescope at cosmic targets, and solve any problems that arise. They perform their work in specialized facilities that provide the tools and equipment needed to operate this great observatory and continue its legacy of success.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD
SPACE FLIGHT CENTER
GREENBELT, MARYLAND

HUBBLE SPACE TELESCOPE (HST)

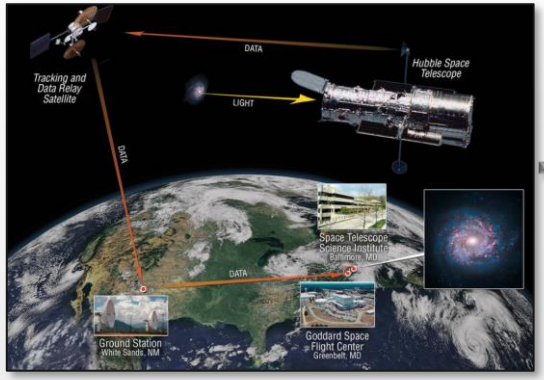
LAUNCHED APRIL 24, 1990

We are the science operations center for the Hubble Space Telescope. Our
the lifecycle of a scientific proposal for Hubble observations, which we hav
since its launch in 1990. We help turn great science ideas into great science, highlight the results, and distribute the data acquired for others to use. Our work includes running the peer-reviewed science program selection, planning and scheduling of the telescope, characterizing the performance of the instruments, maintaining and enhancing the archive of data, and making the data freely available to the world.

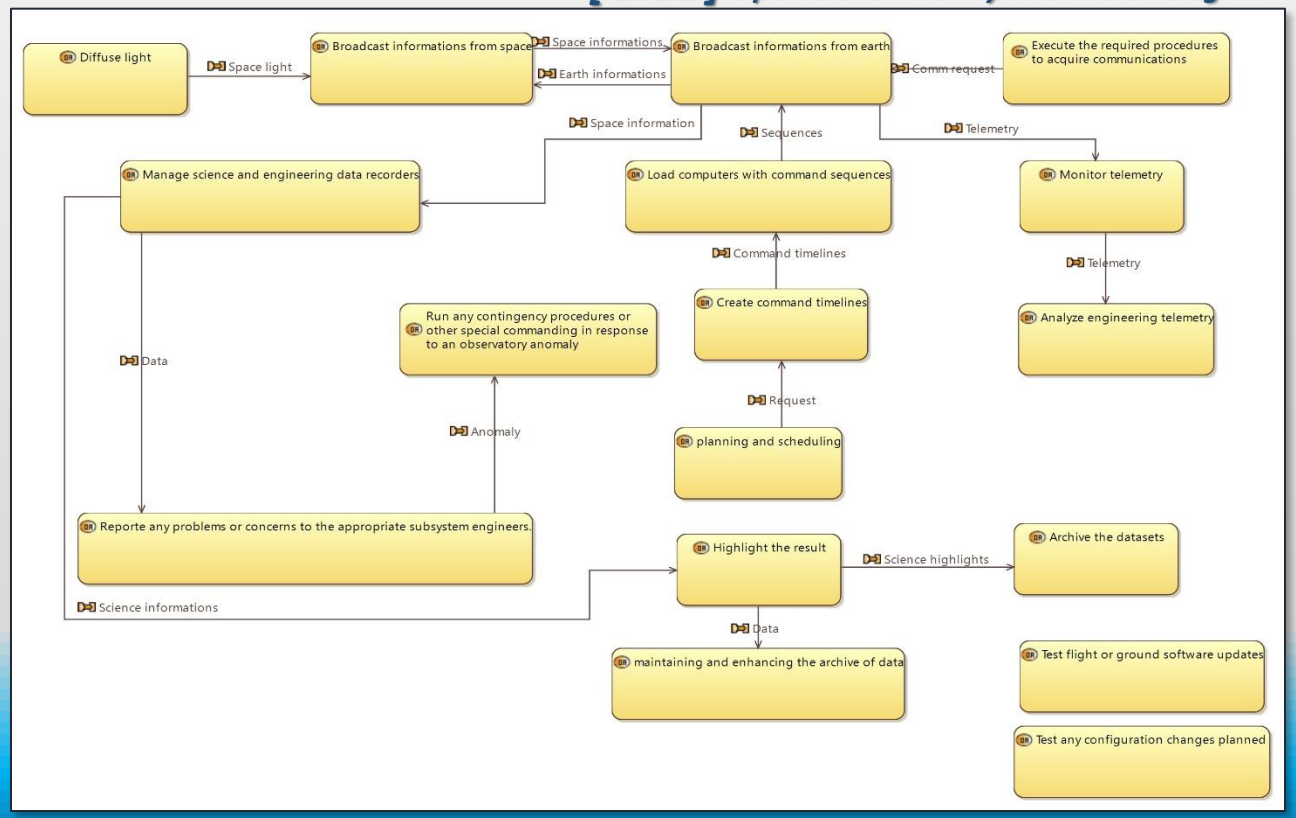
STScI | SPACE TELESCOPE SCIENCE INSTITUTE
Expanding the Frontiers of Space Astronomy

Operational Analysis

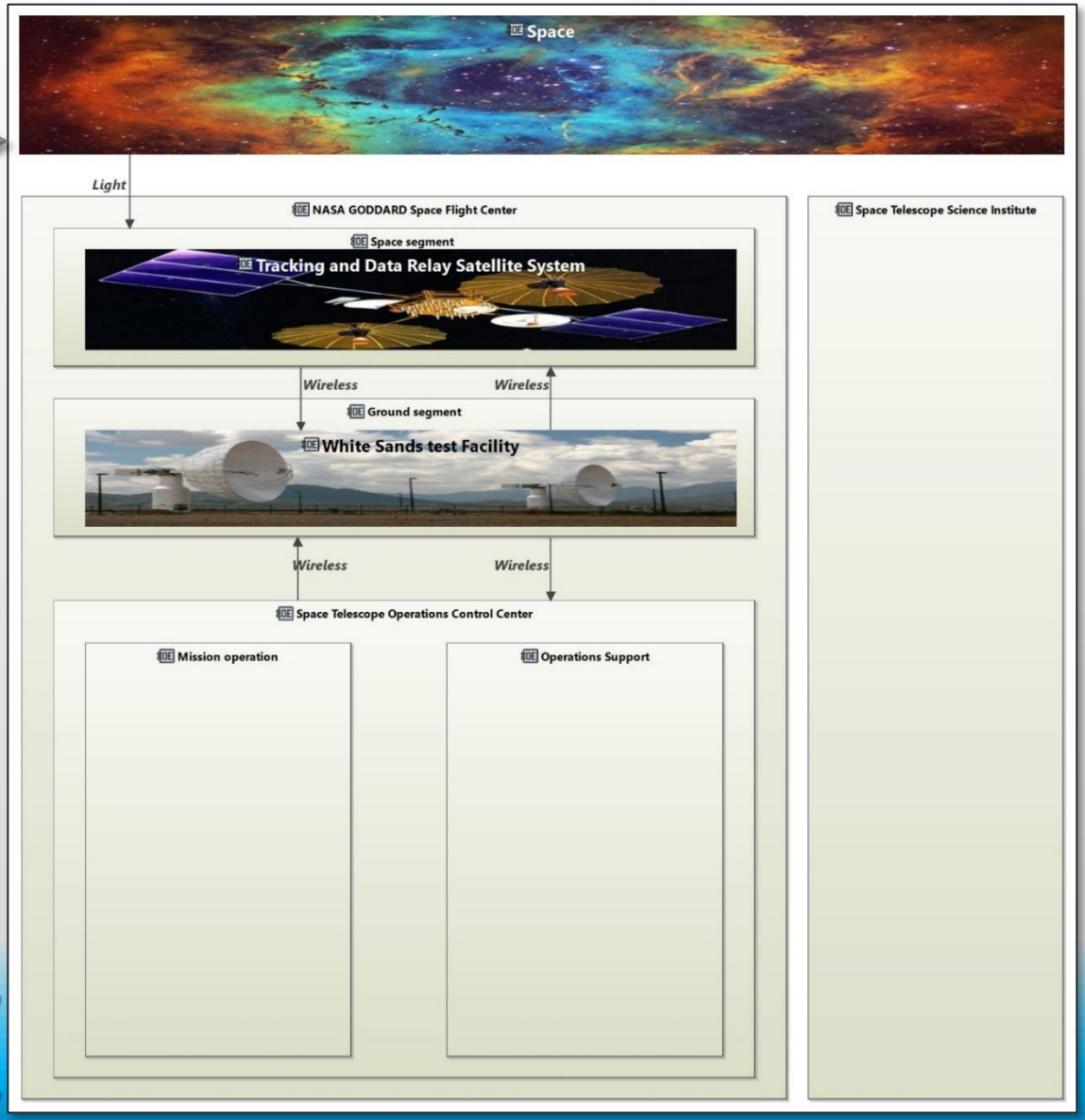
Speaker: DROUIN Remy



[OAIB] Operational Activity Interaction diagram



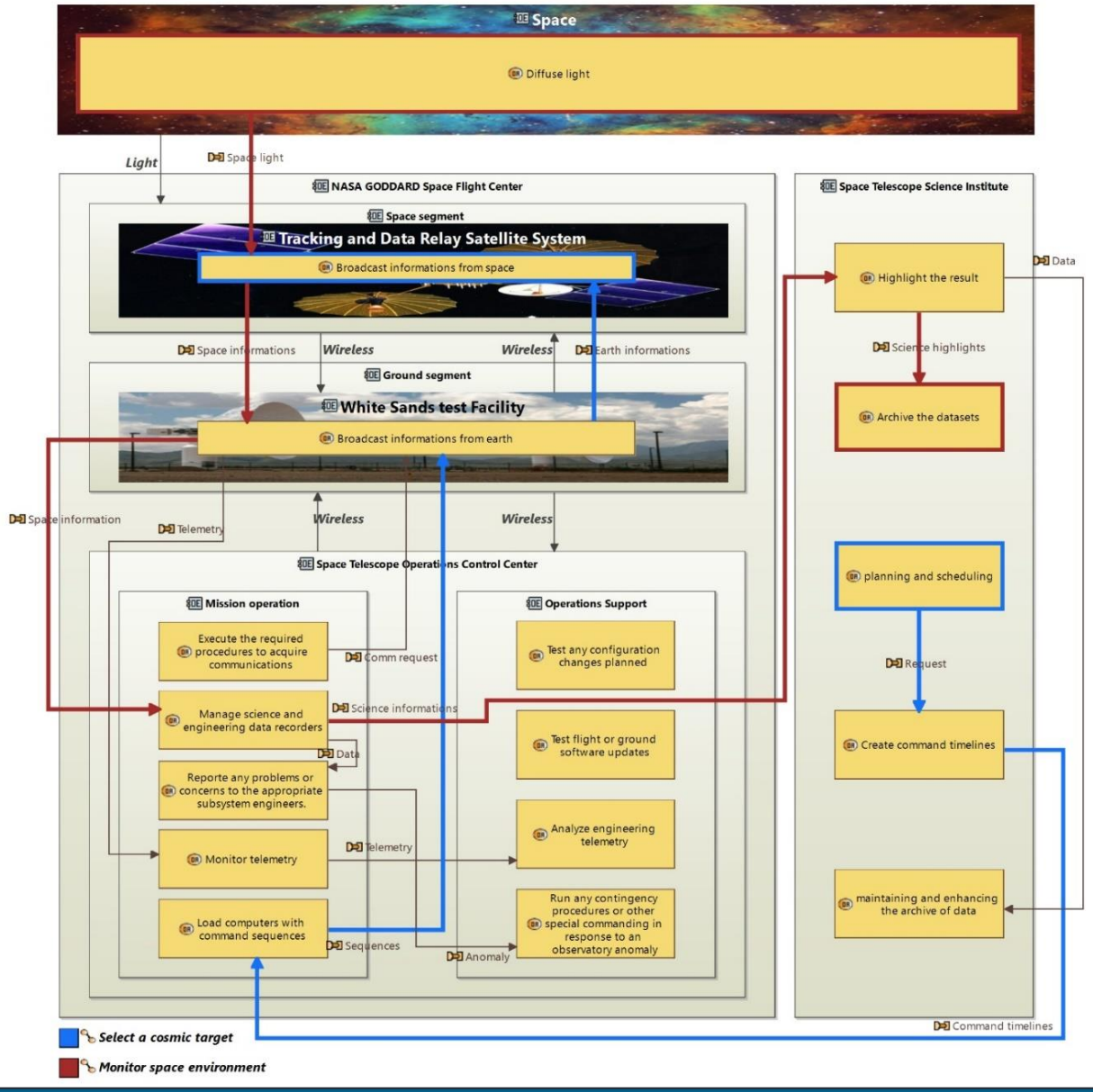
[OAB] Operational Architecture diagram



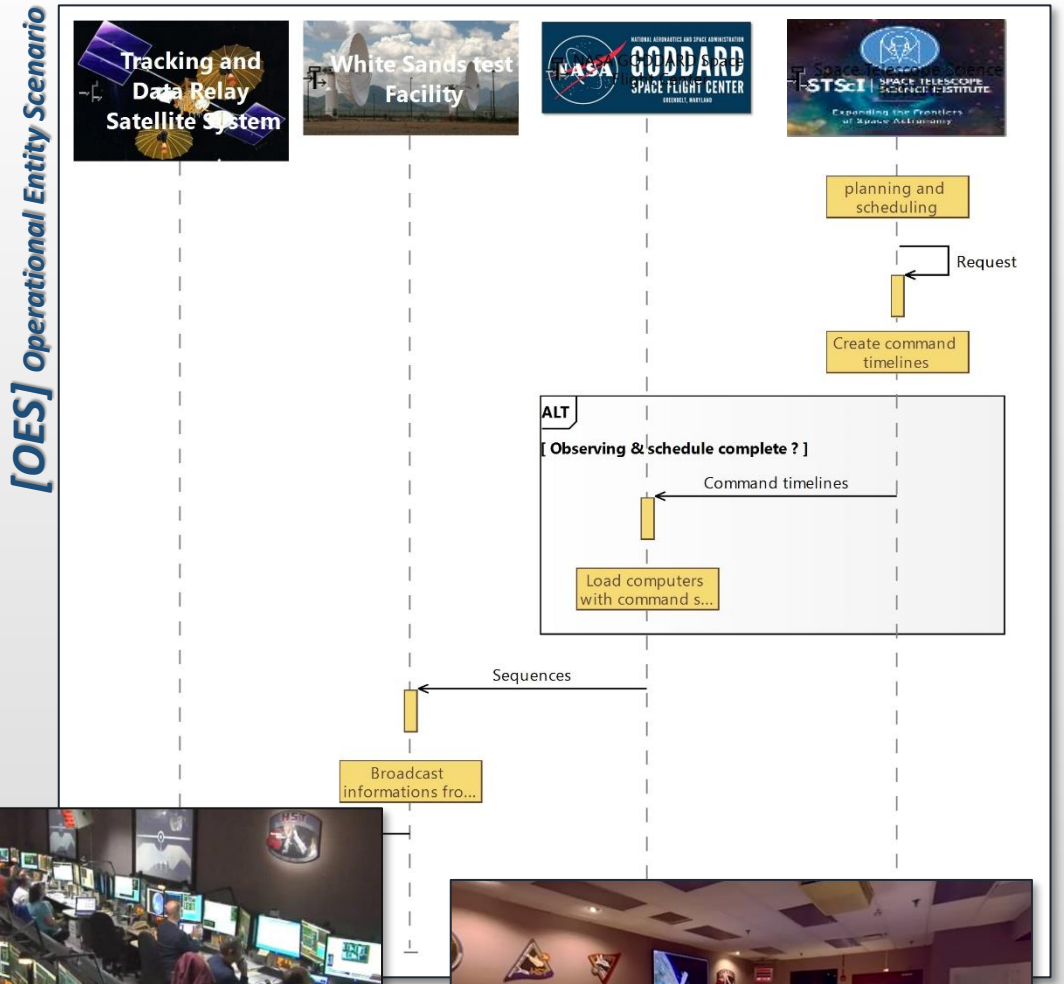
Operational Analysis

Speaker: DROUIN Remy

[OAB] Operational Architecture diagram



[OES] Operational Entity Scenario



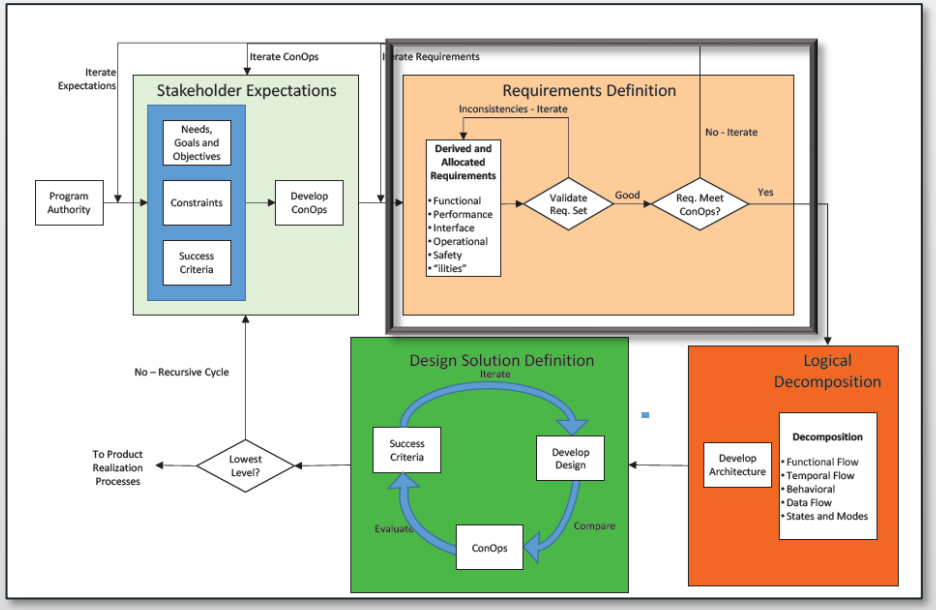
Mission Operations Room

Operations Support Room

System Analysis

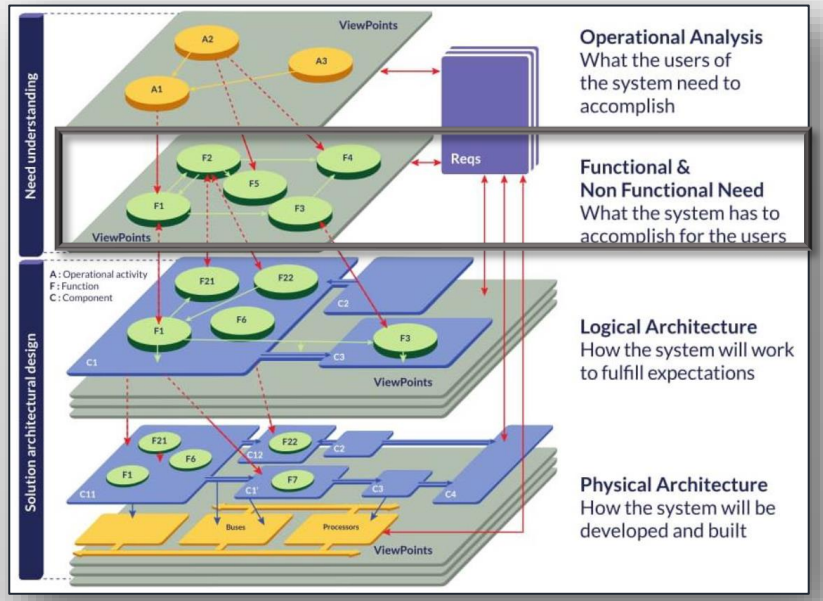
Requirements definition process

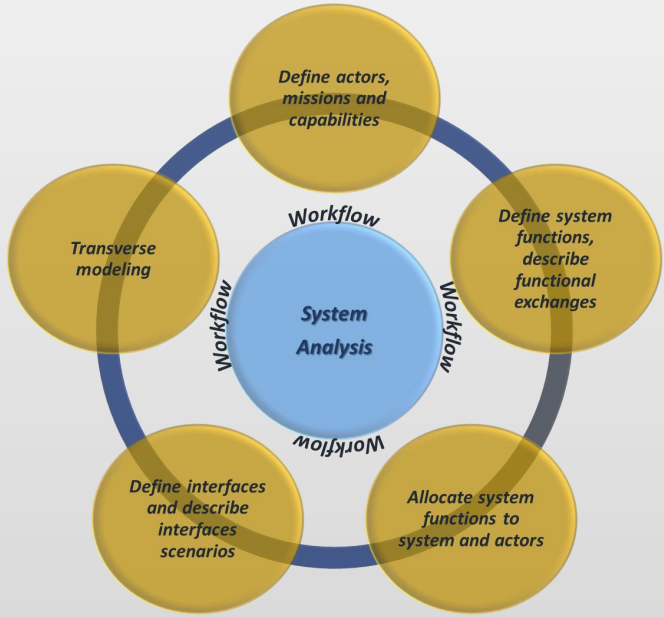
Technical solution definition process



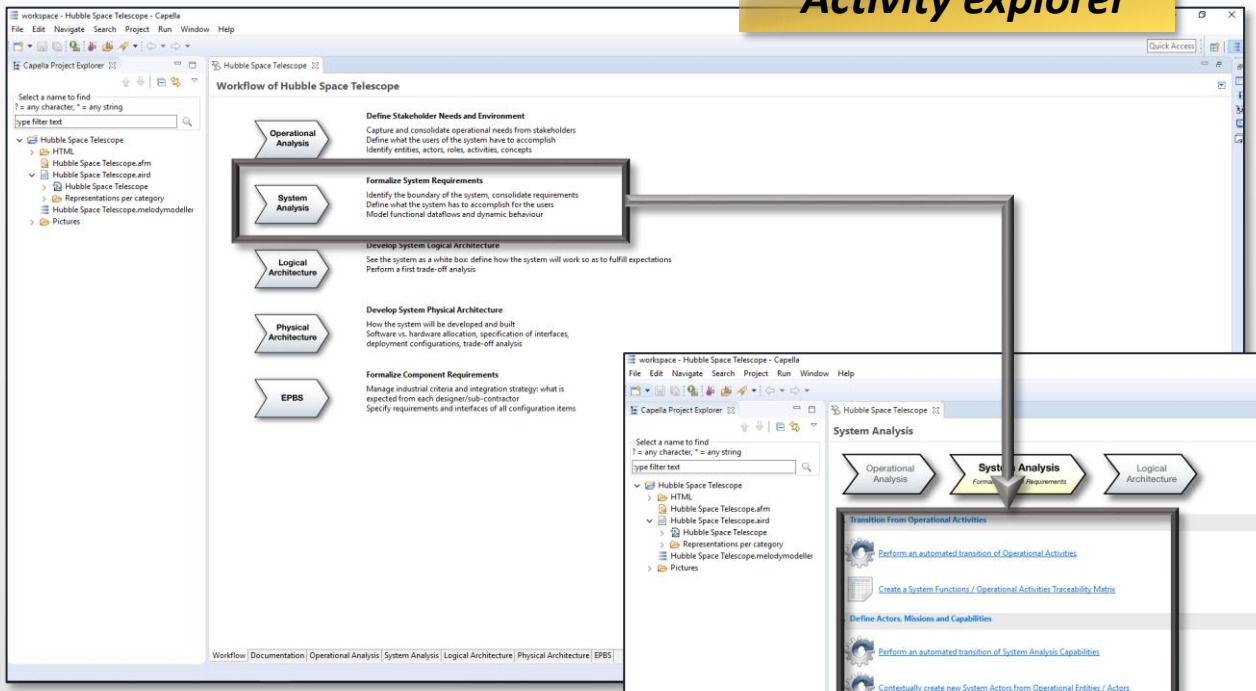
Need understanding

Solution architectural design





Activity explorer



Activity explorer

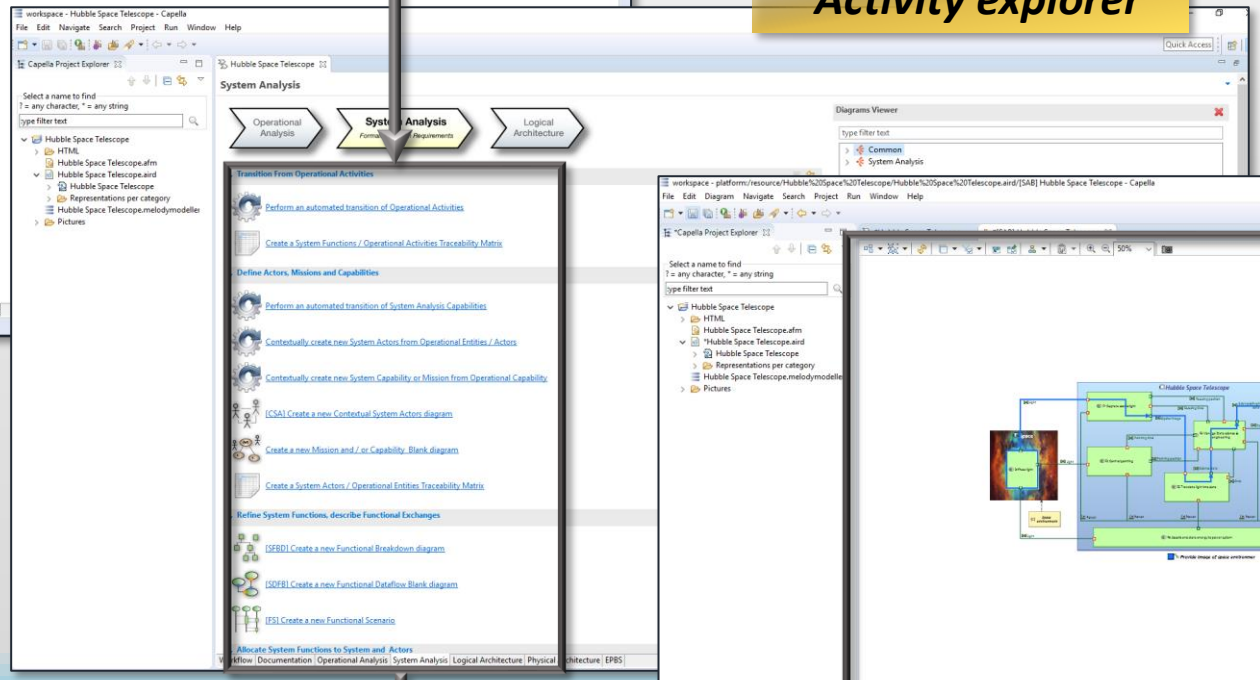
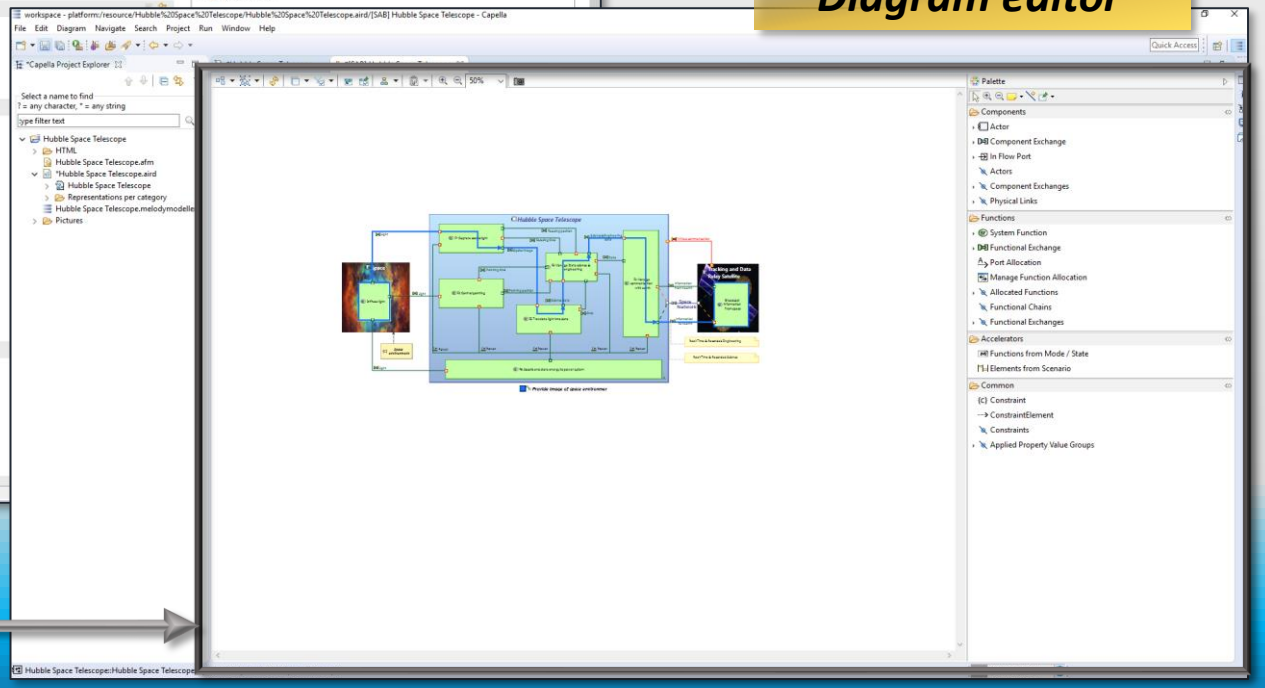
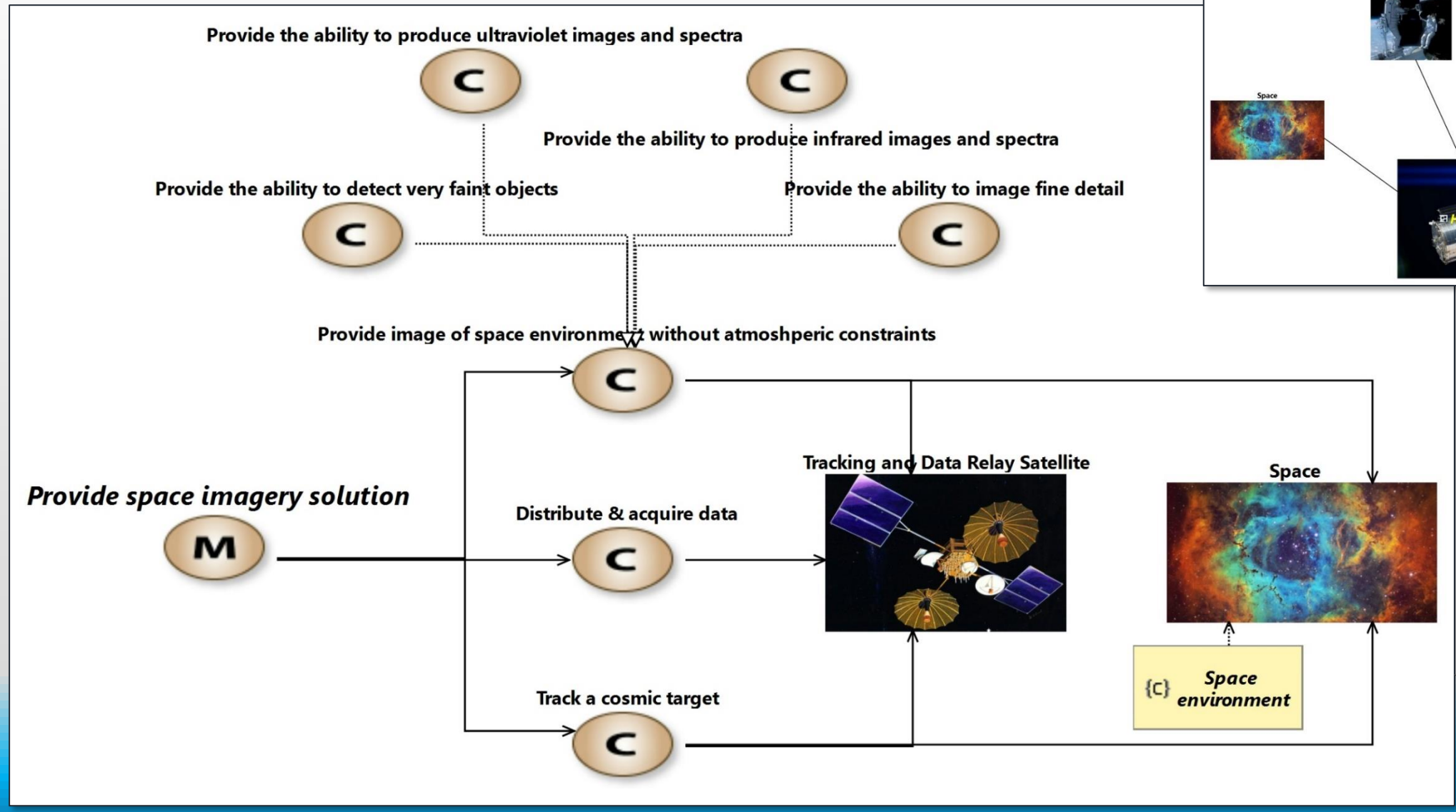


Diagram editor

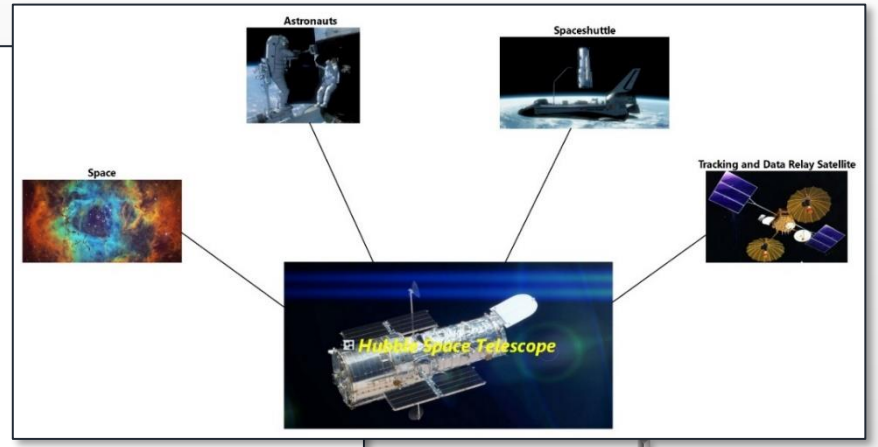


Speaker: DROUIN Remy

[MCB] Mission Capability Blank diagram



[CSA] Contextual System Actors diagram

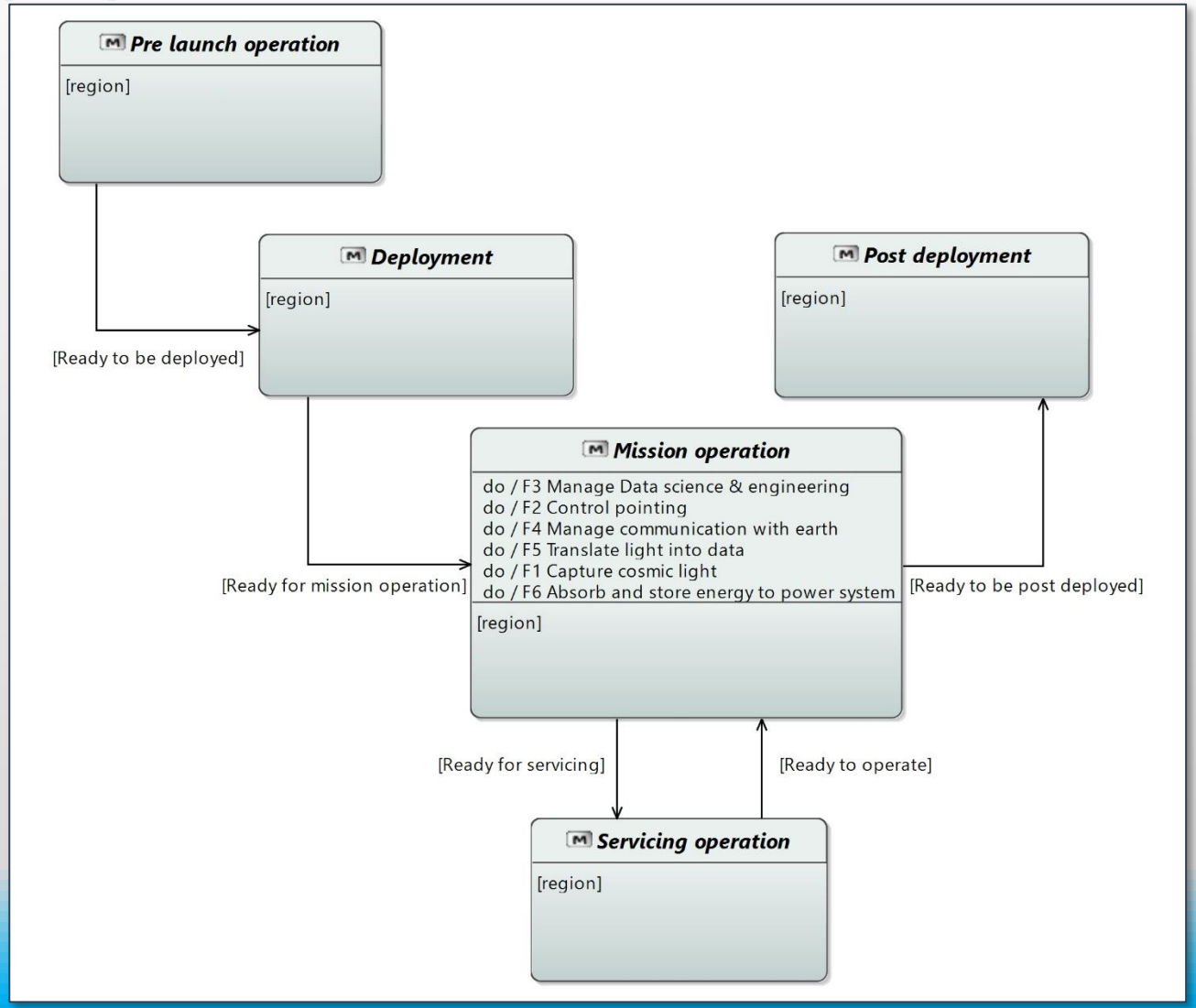


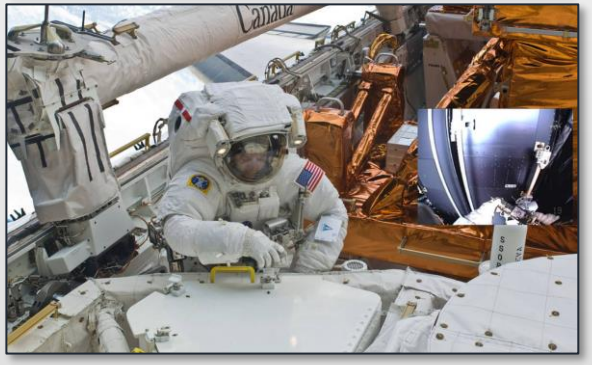
Speaker: DROUIN Remy

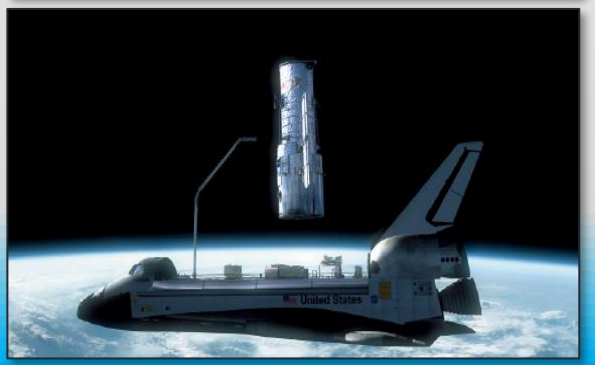
[SFBD] Functional Breakdown diagram

- F1 Capture cosmic light
- F2 Control pointing
- F5 Translate light into data
- F4 Manage communication with earth
- F6 Absorb and store energy to power system

[M&S] Mode&State diagram

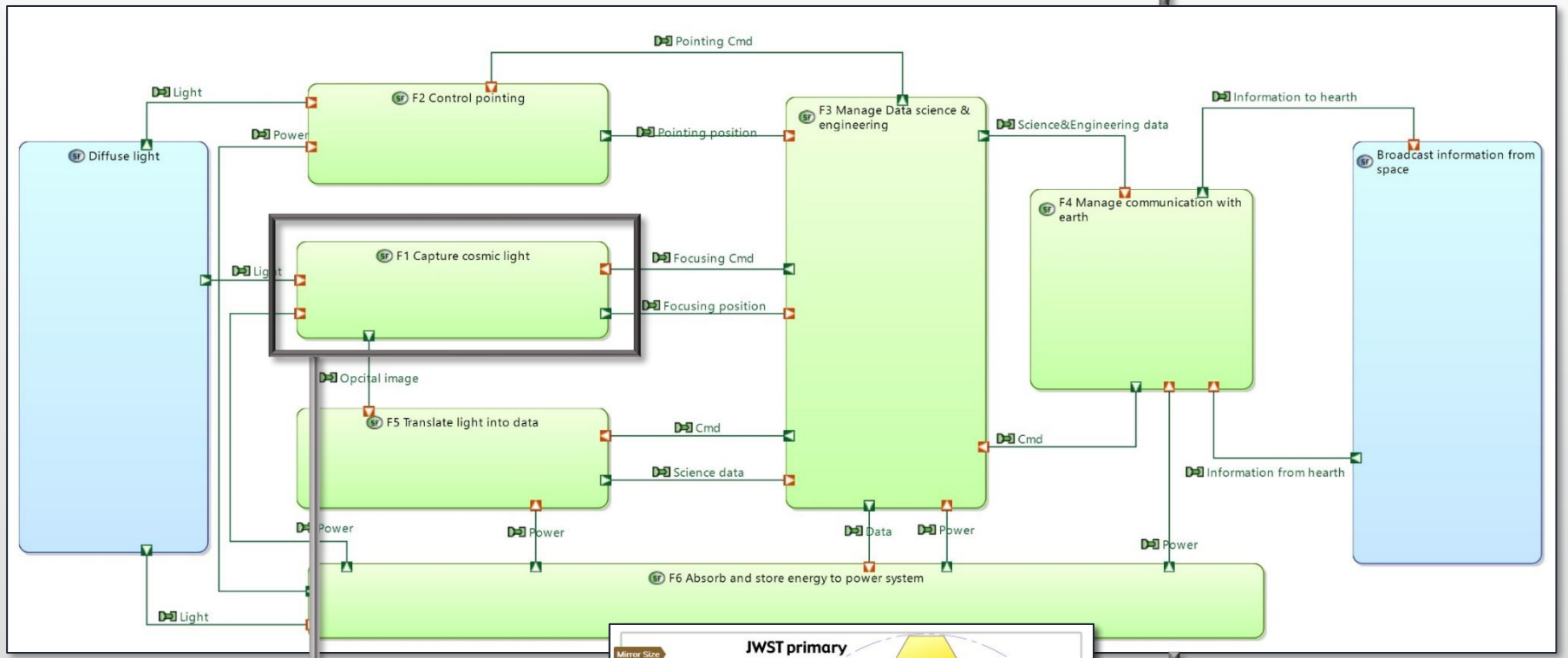




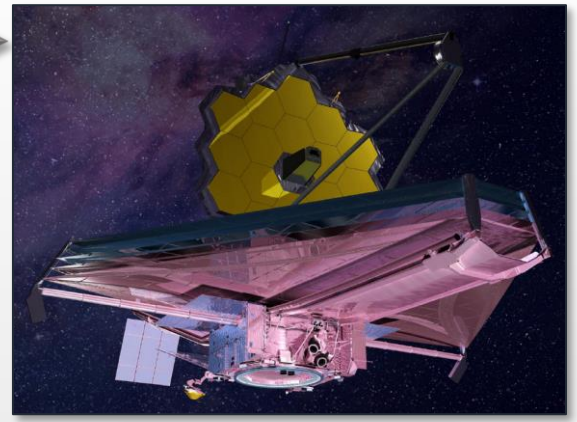


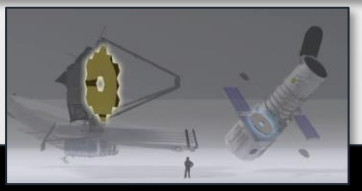
Speaker: DROUIN Remy

[SDFB] Functional Dataflow Blank diagram

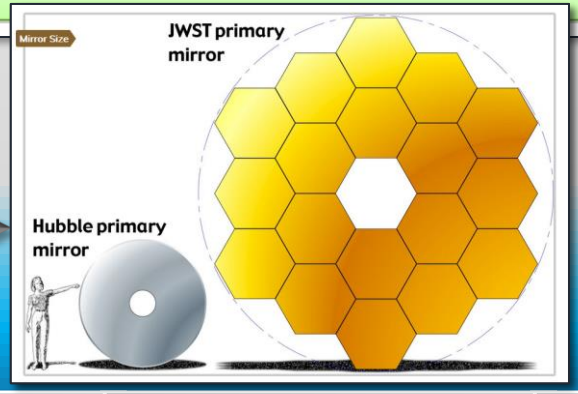


James Webb Telescope



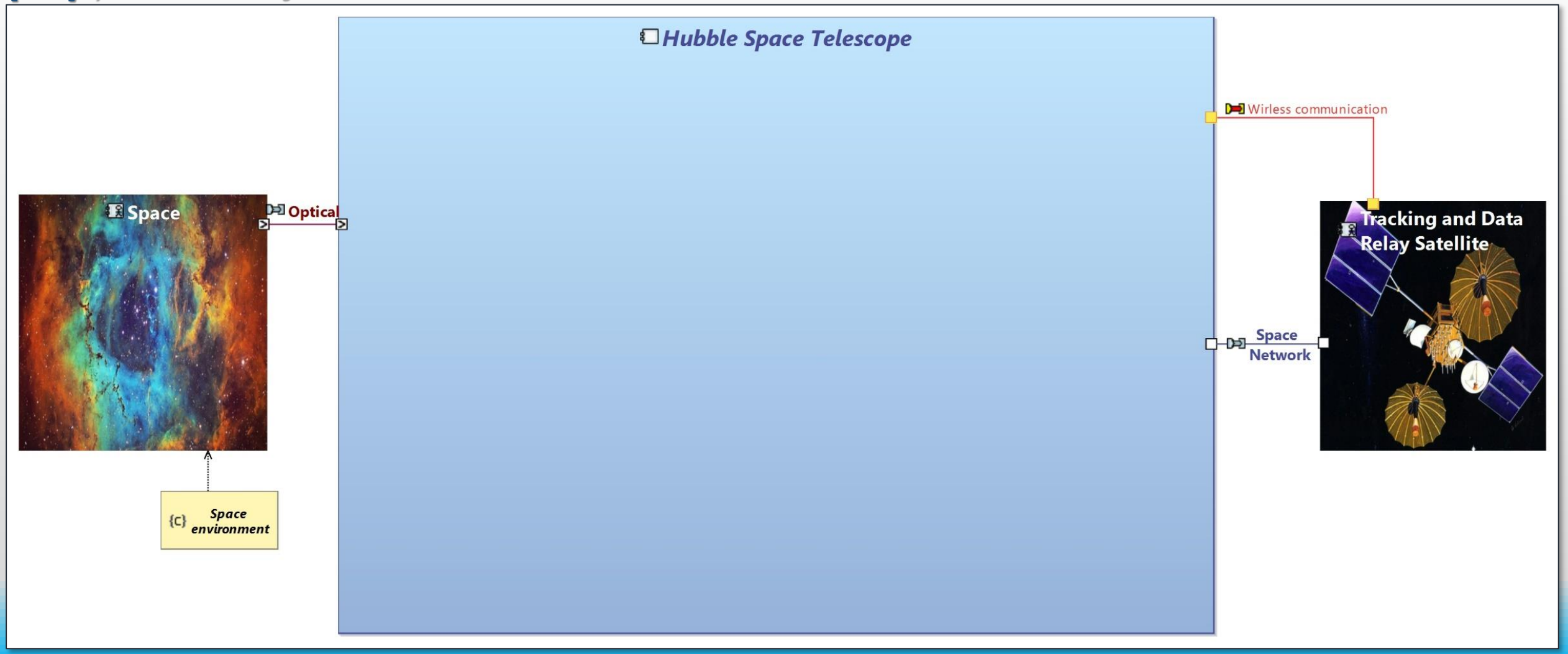


F1 Capture cosmic light

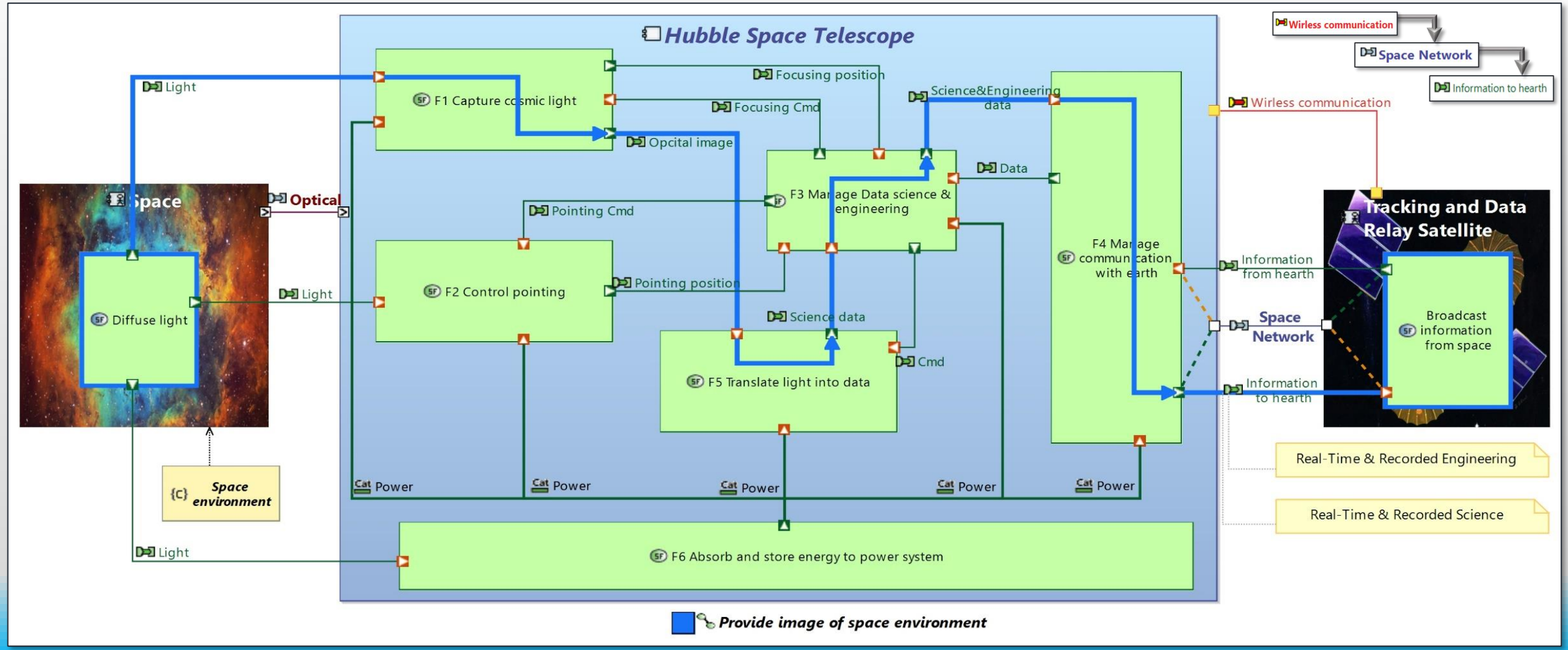


HUBBLE Telescope

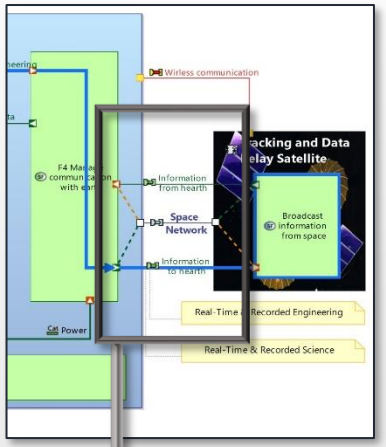
[SAB] System Architecture diagram

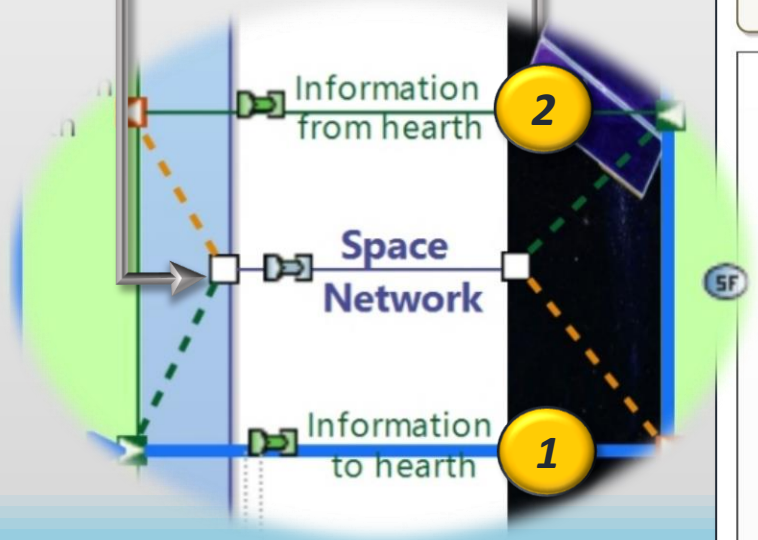


[SAB] System Architecture diagram



[CDB] Class diagram





Information to earth 1

Recorded Data (science)

- Hr : Hour recorded
- Mr : Minute recorded
- Dr : Second recorded
- Science data 1 recorded : Ultra-violet spectrum
- Science data 2 recorded : high-resolution spectra
- Science data 3 recorded : wide-field imagery in visible
- Science data 4 recorded : wide-field imagery in ultraviolet, visible and infrared light

Information from earth 2

Science data selection

- Science data 1 record selection : Ultra-violet spectrum
- Science data 2 record selection : high-resolution spectra
- Science data 3 record selection : wide-field imagery in visible
- Science data 4 record selection : wide-field imagery in ultraviolet, visible and infrared light
- Drs : Day record selection
- Hrs : Hour record selection
- Mrs : Minute record selection
- Srs : Second record selection

DataPkg

Day recorded
- [Min] = 0
- [Max] = 31

Hour recorded
- [min] = 0
- [Max] = 23

Minute recorded
- [Min] = 0
- [Max] = 59

Second recorded
- [Min] = 0
- [Max] = 59

Day record selection
- [Min record selection] = 0
- [Max record selection] = 31

Hour record selection
- [Min record selection] = 0
- [Max record selection] = 23

Minute record selection
- [Min record selection] = 0
- [Max record selection] = 59

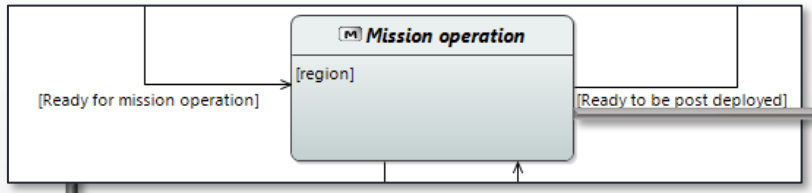
Second record selection
- [Min record selection] = 0
- [Max record selection] = 59

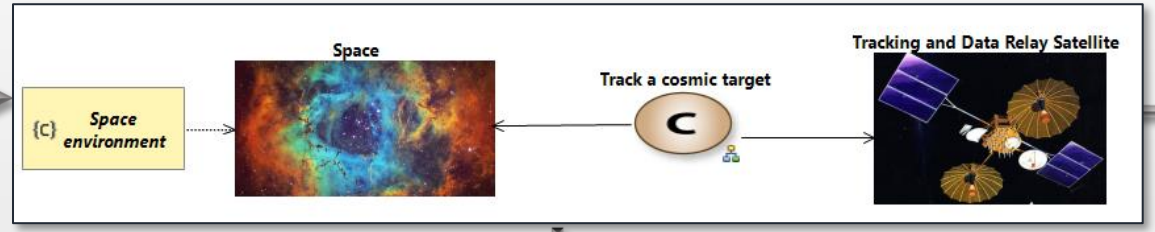
Ultra-violet spectrum
- [Min wavelength] = 175nm
- [Max wavelength] = 300nm

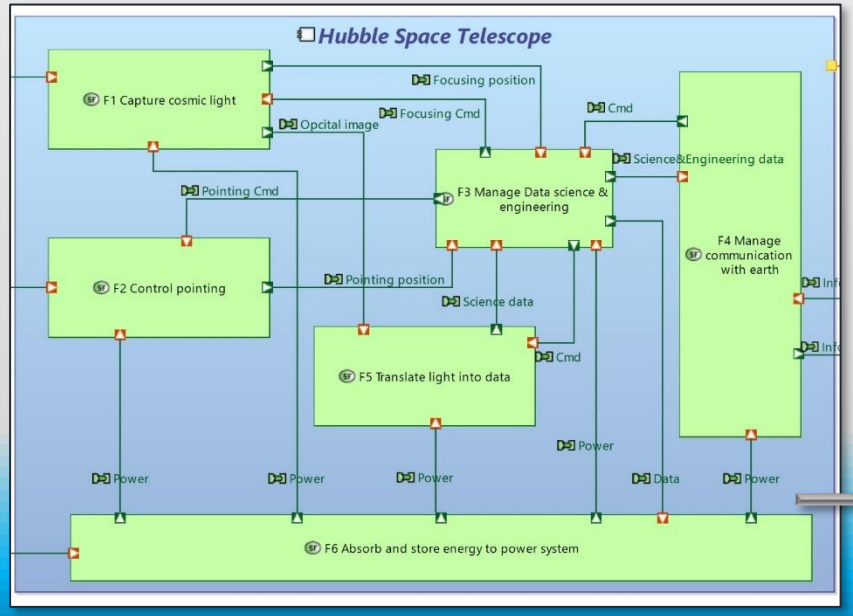
wide-field imagery in visible
- [Min wavelength] = 115nm
- [Max wavelength] = 1050nm

high-resolution spectra
- [Min wavelength] = 115nm
- [Max wavelength] = 1000nm

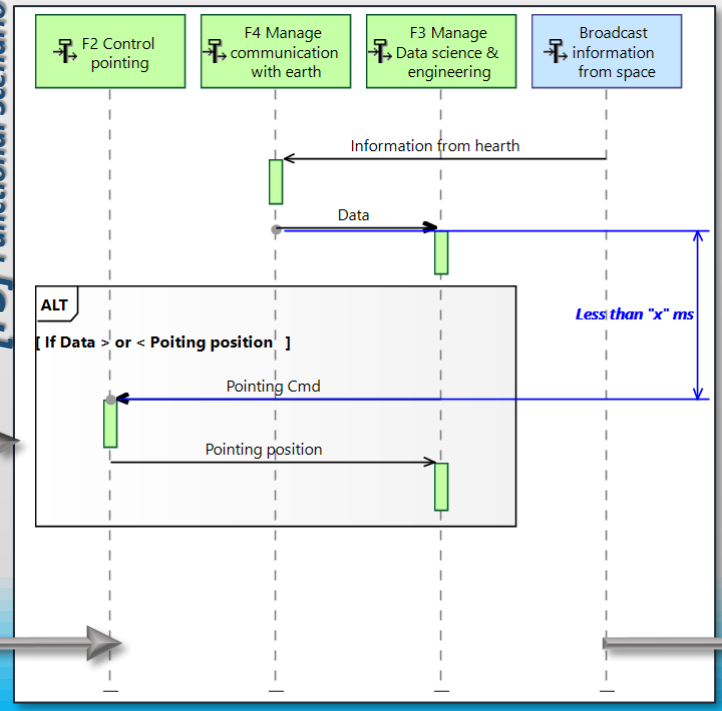
wide-field imagery in ultraviolet, visible and infrared light
- [Min wavelength] = 200nm
- [Max wavelength] = 1700nm



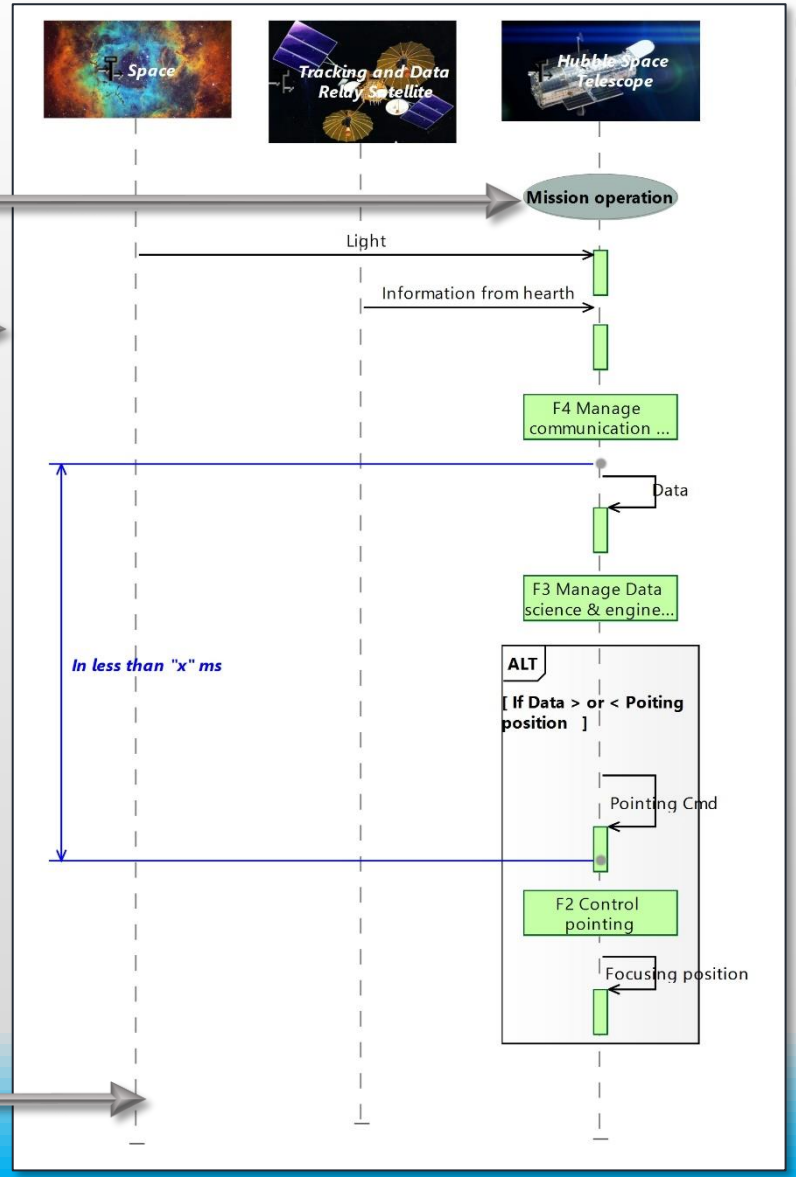




[FS] Functional Scenario



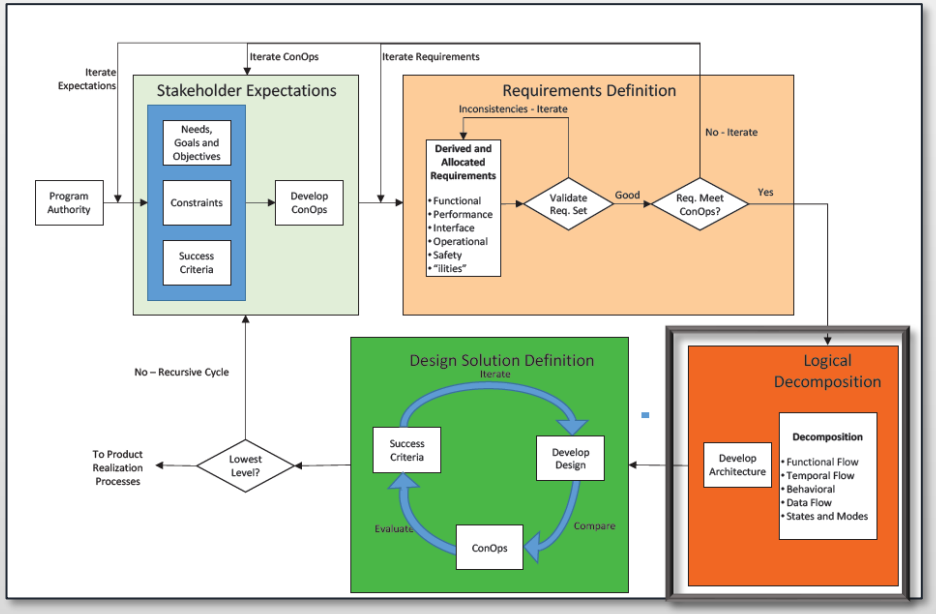
[ES] Exchange Scenario



Logical Architecture

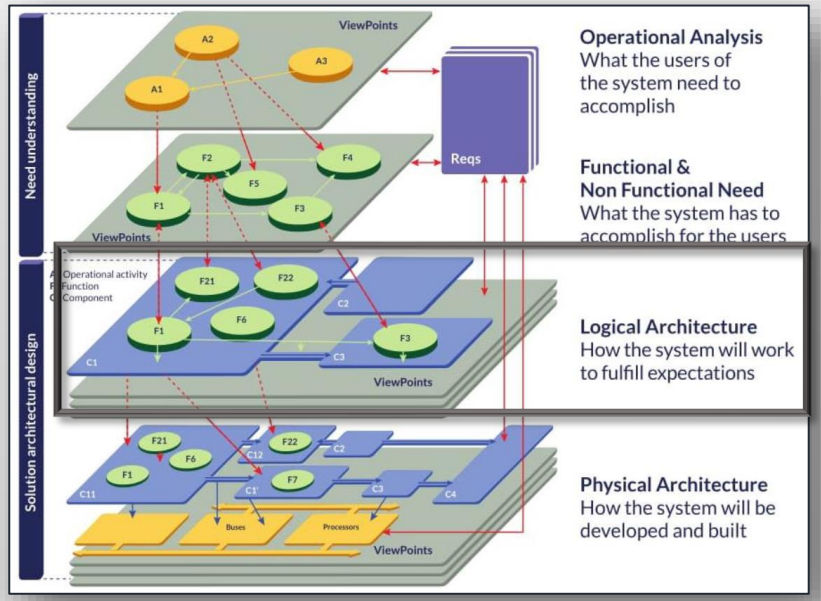
Requirements definition process

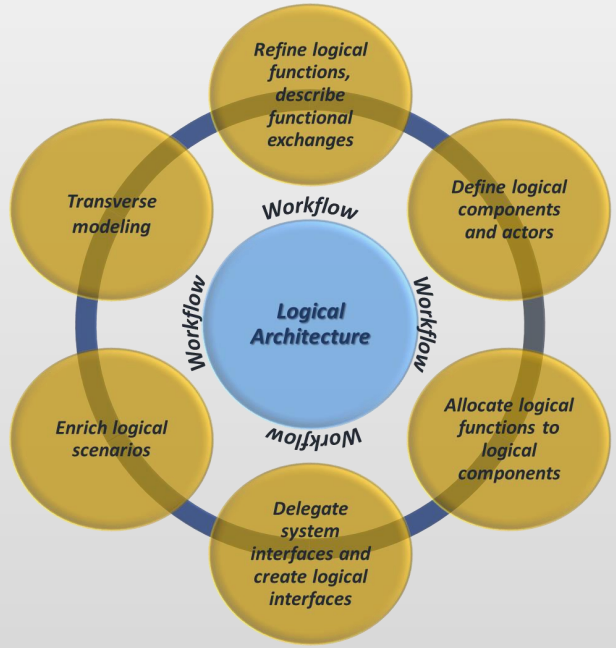
Technical solution definition process



Need understanding

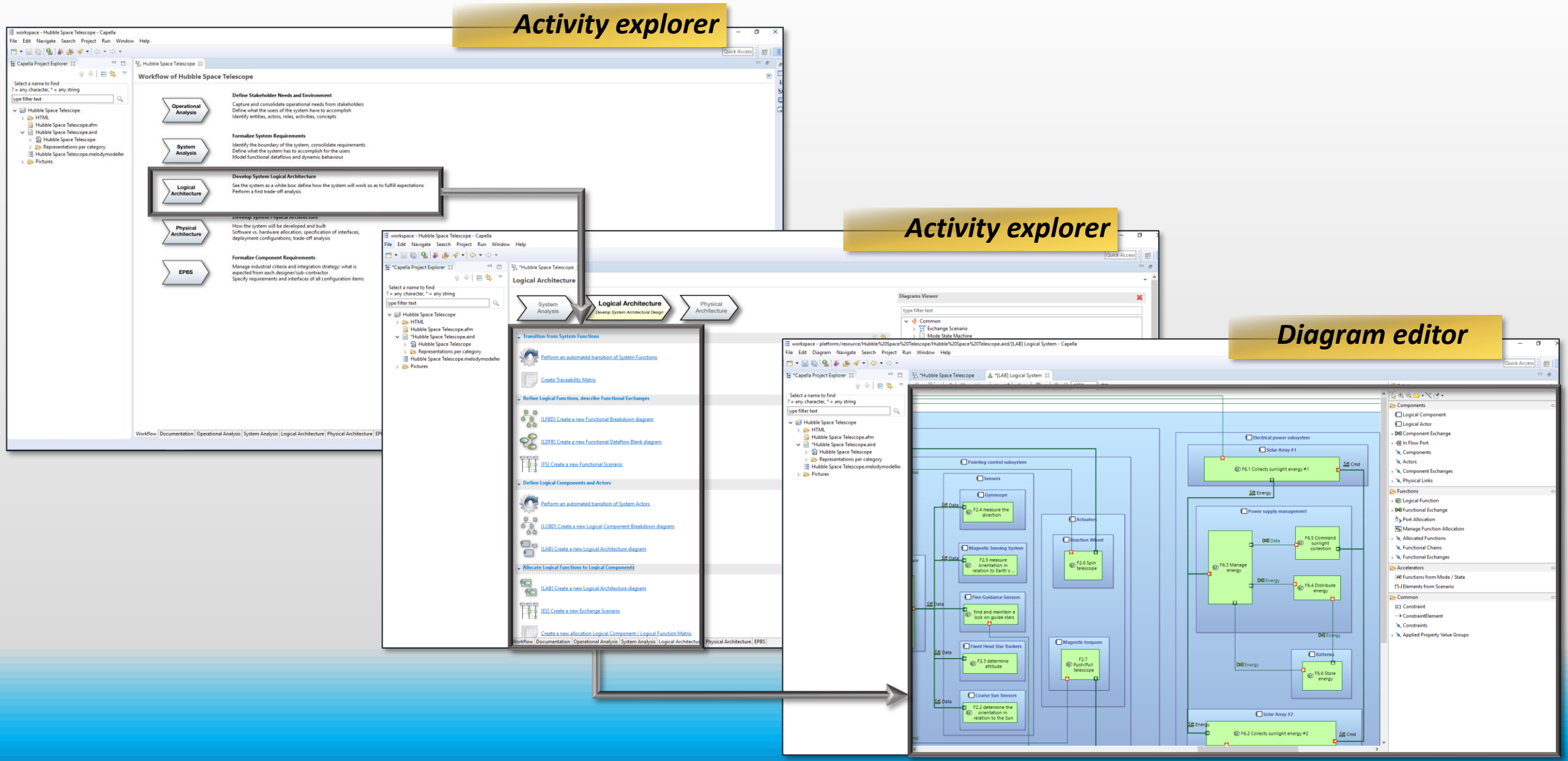
Solution architectural design



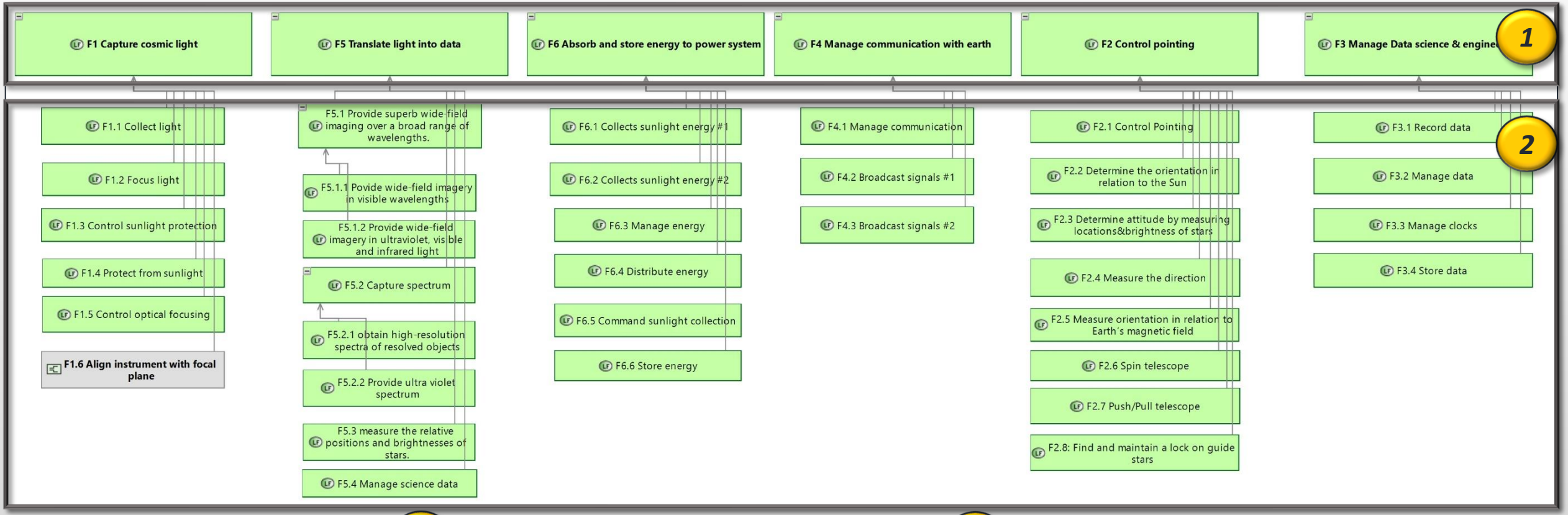


Logical Architecture

Speaker: DROUIN Remy



[LFBD] Functional Breakdown diagram



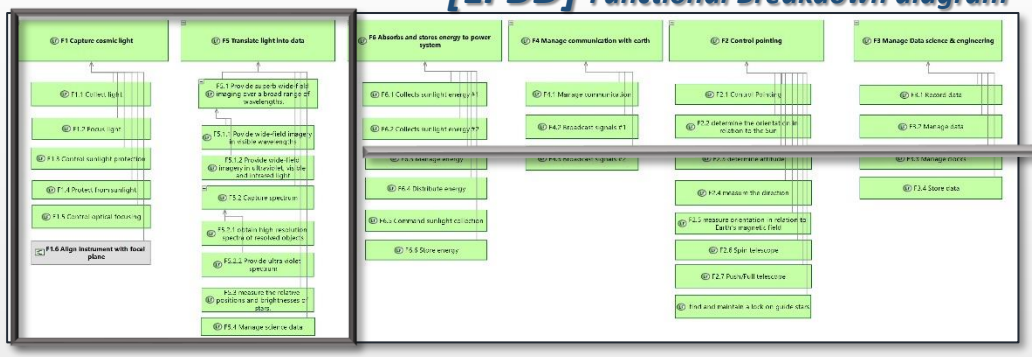
1 From System Analysis

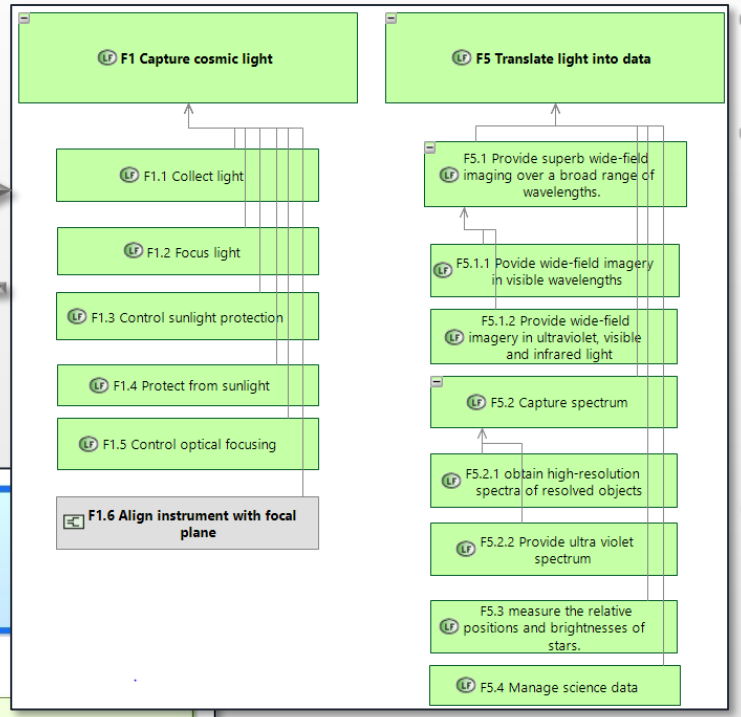
2 From Logical Architecture

Logical Architecture

Speaker: DROUIN Remy

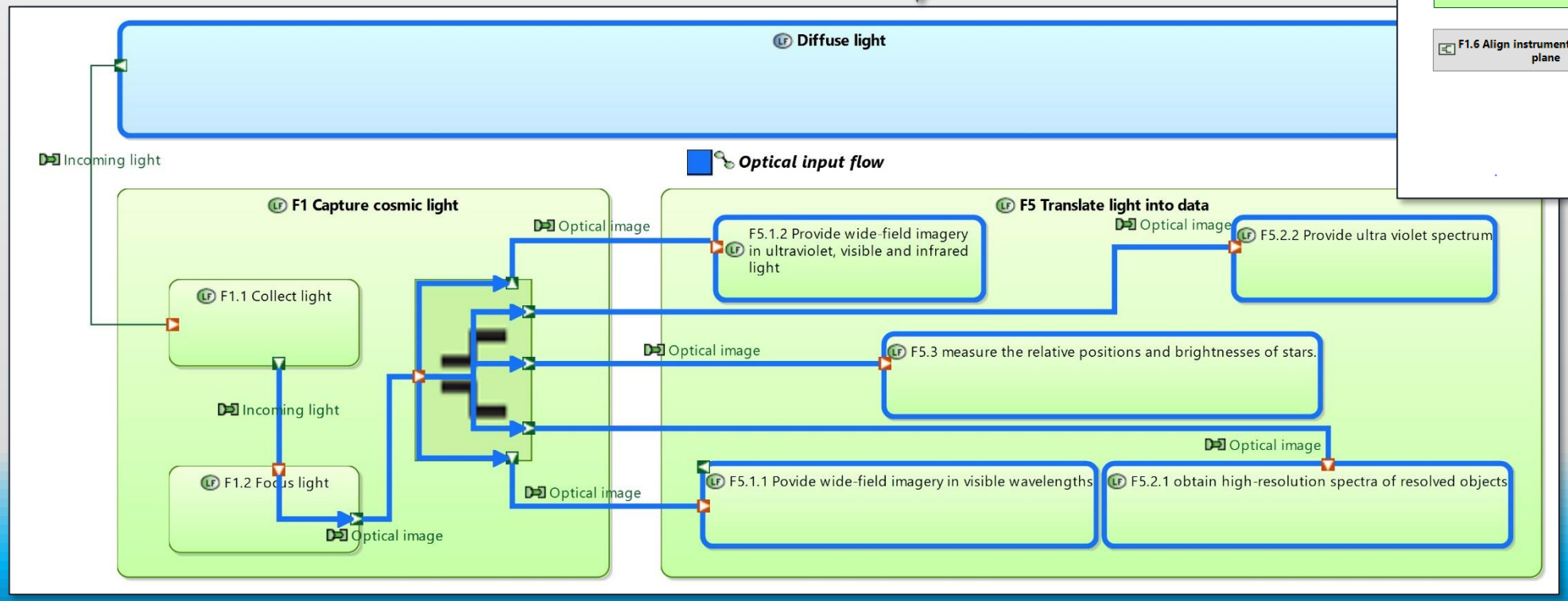
[LFBD] Functional Breakdown diagram





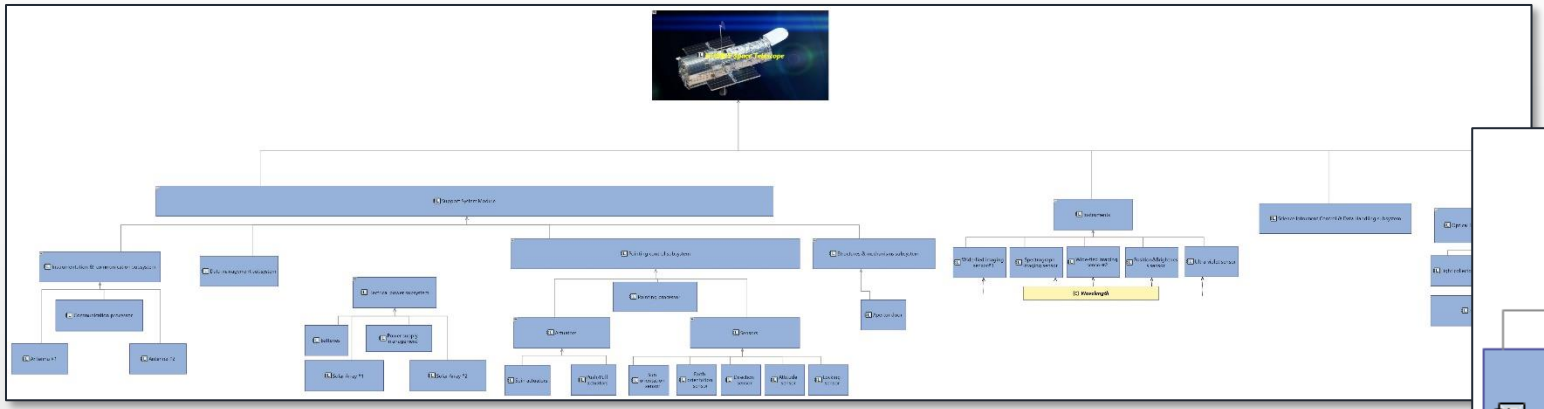
[LFBD] Functional Breakdown diagram

[LDFB] Functional Dataflow Blank diagram

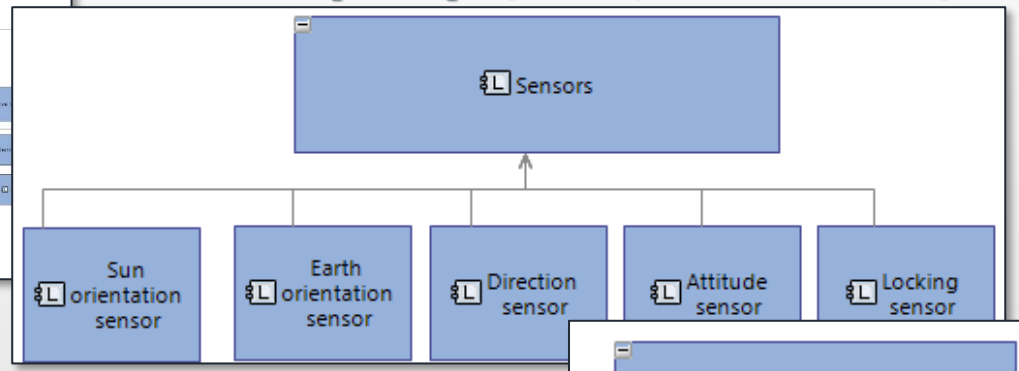


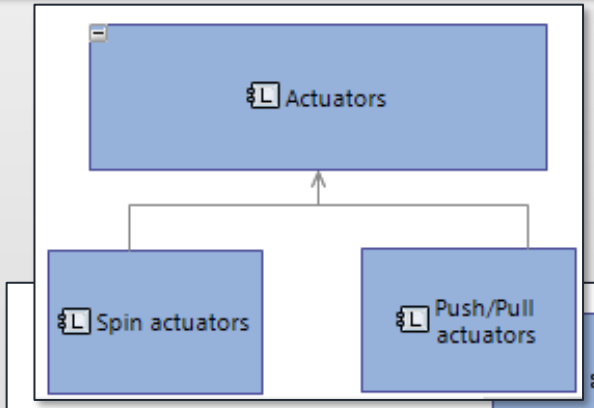
Logical Architecture

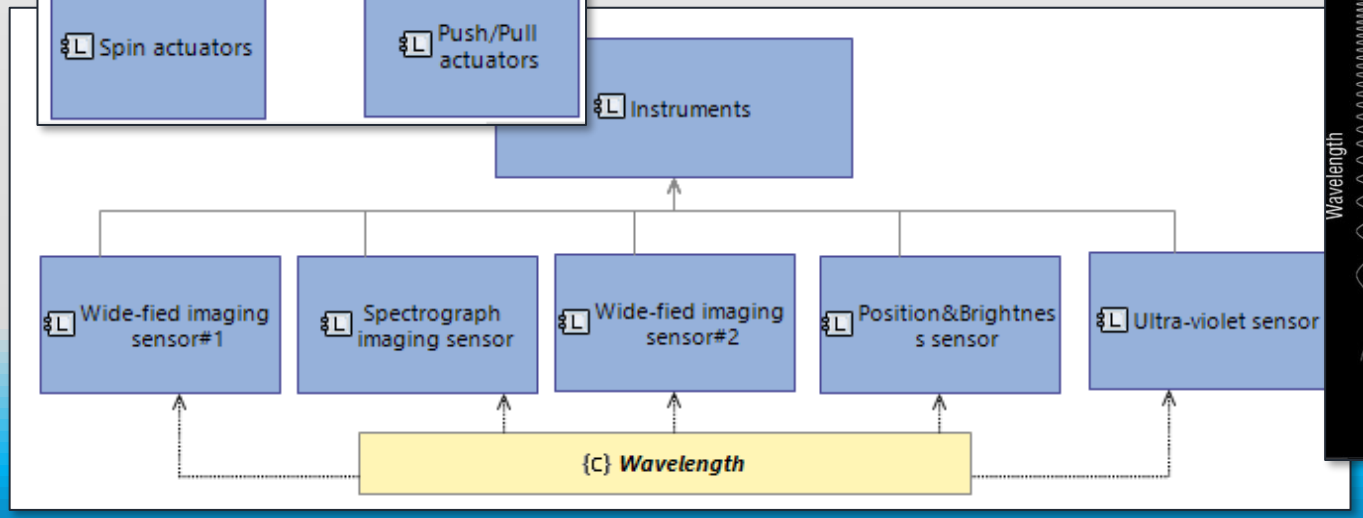
Speaker: DROUIN Remy

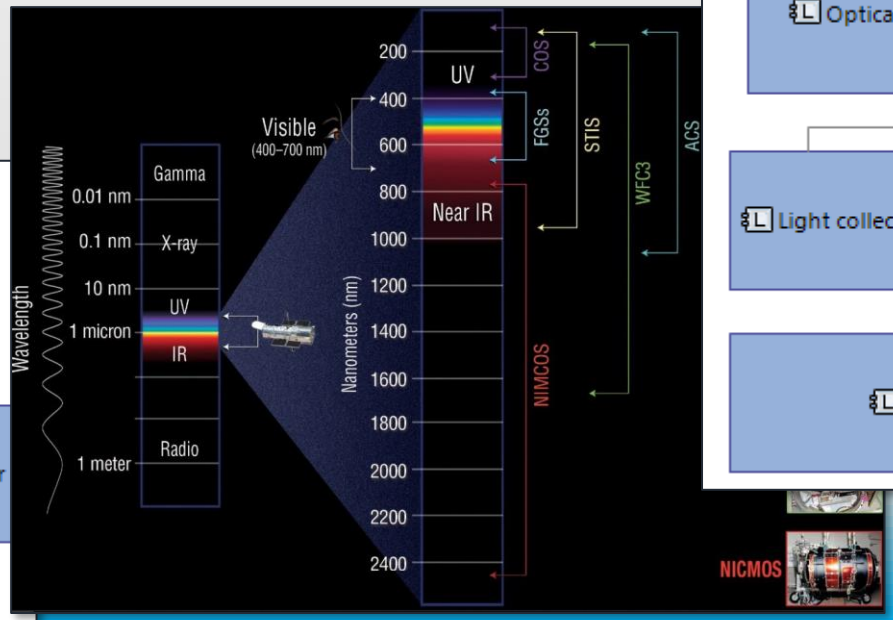


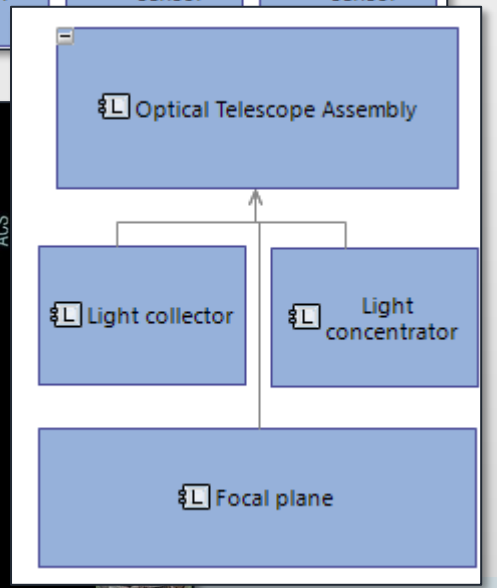
[LCBD] Logical Component Breakdown diagram





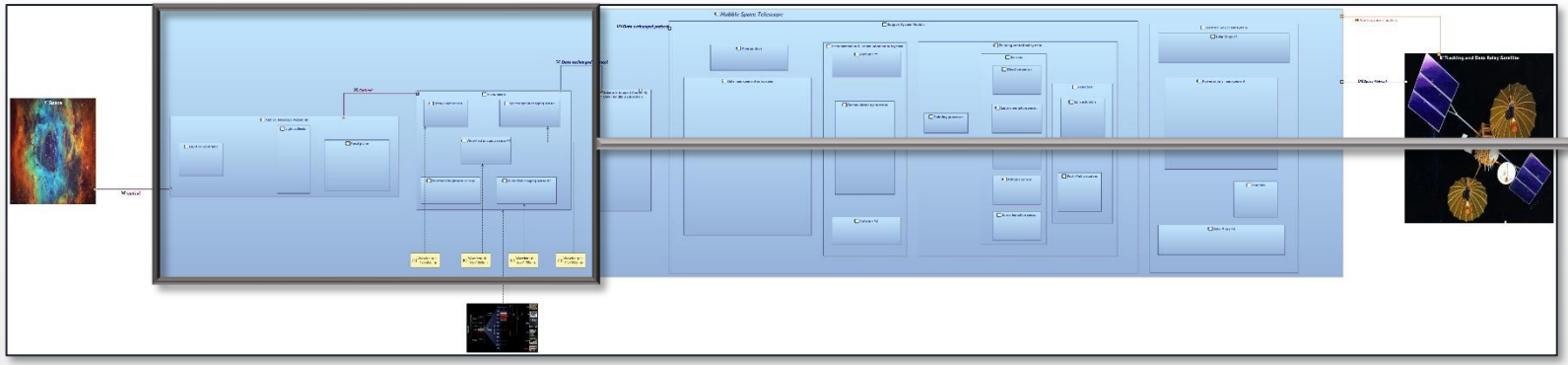


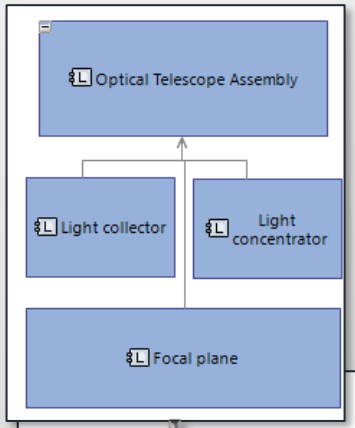




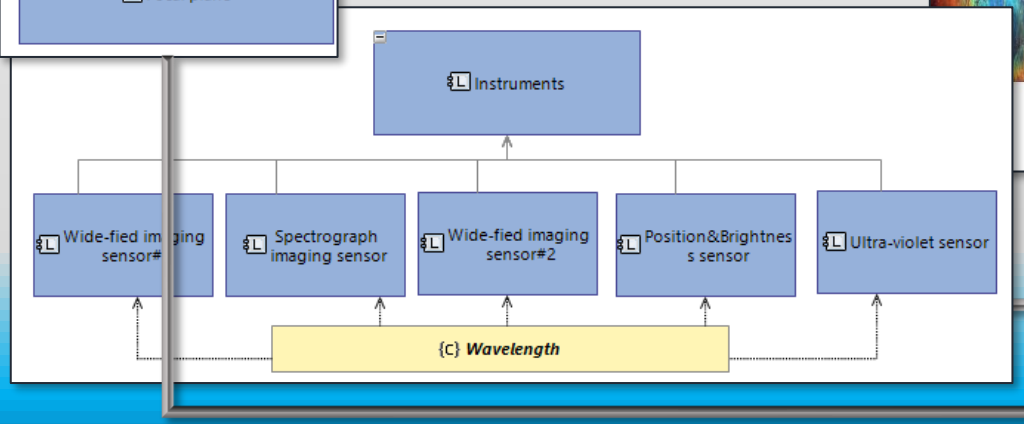
Logical Architecture

Speaker: DROUIN Remy

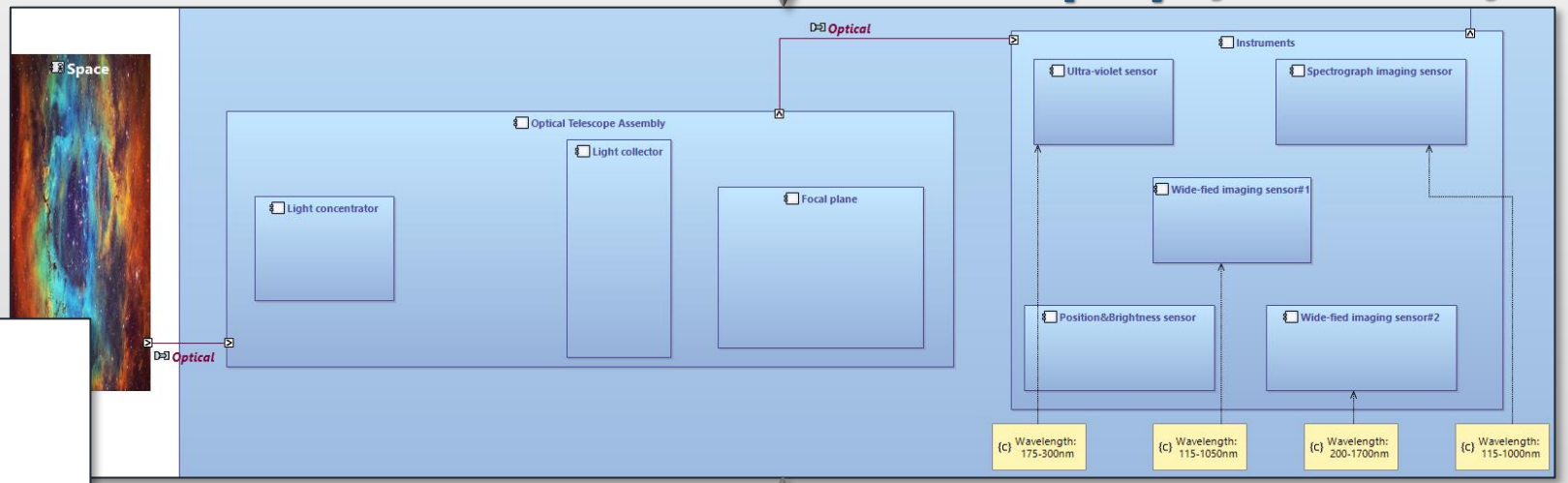




[LCBD]
Logical Component Breakdown diagram

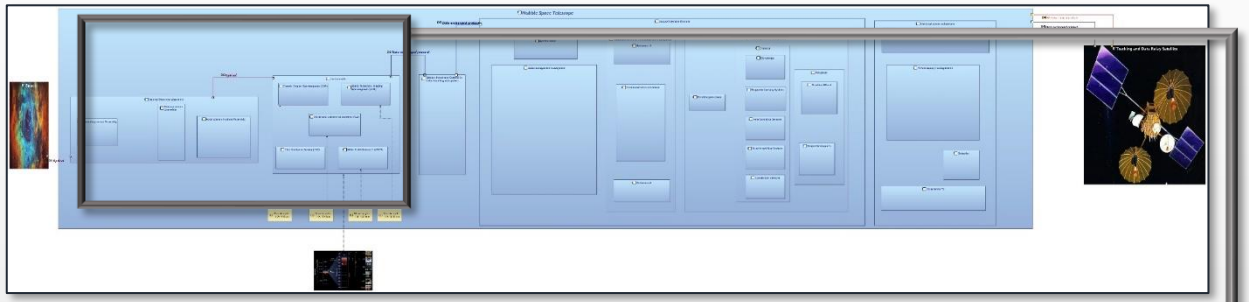


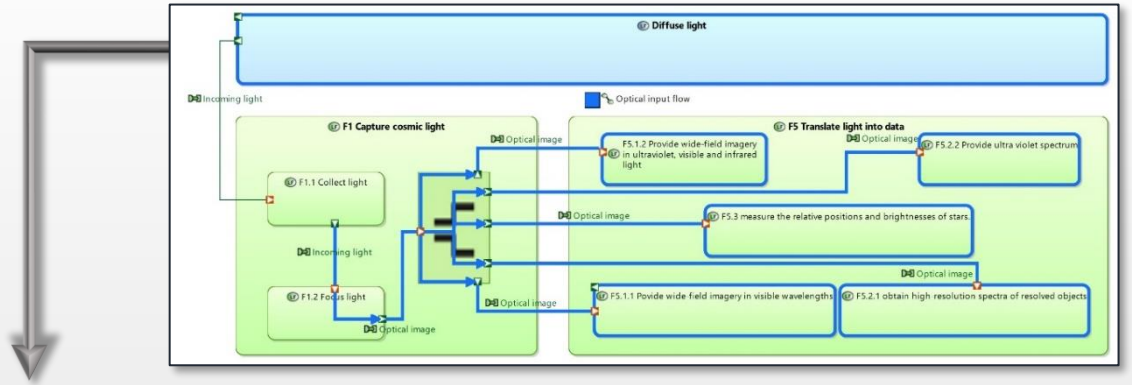
[LAB] Logical Architecture diagram



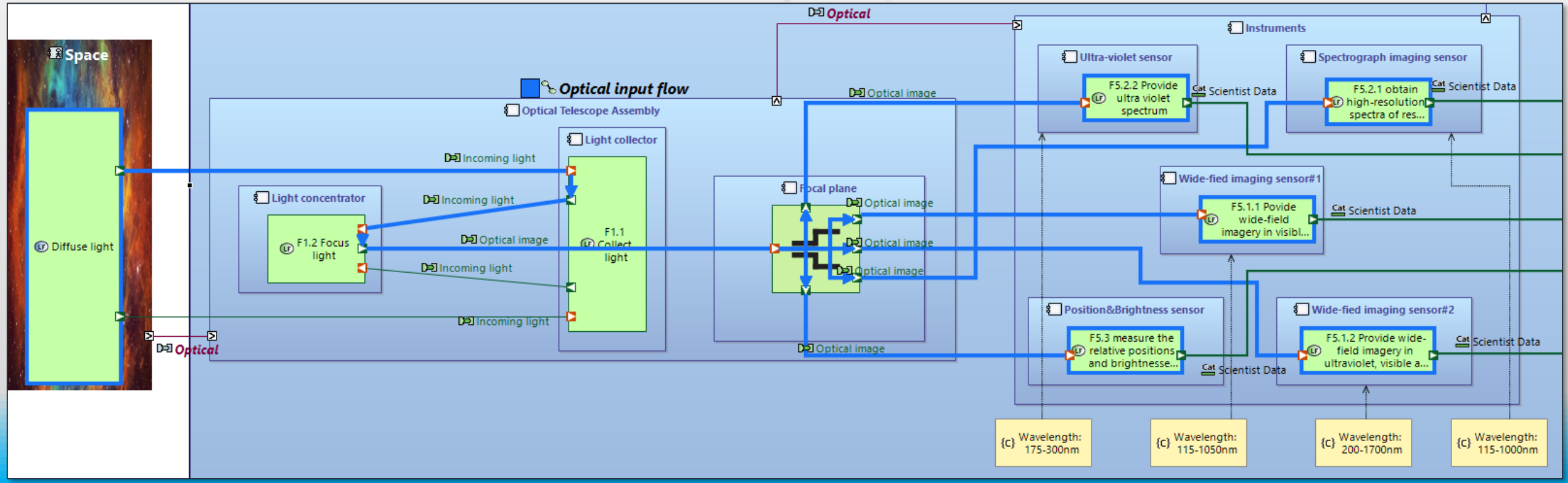
Logical Architecture

Speaker: DROUIN Remy





[LAB] Logical Architecture Diagram

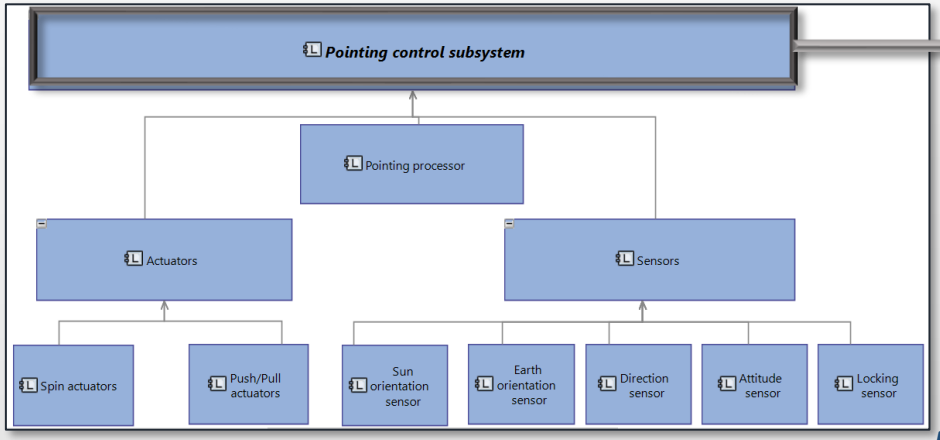


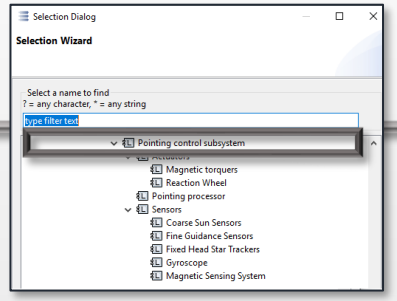
Speaker: DROUIN Remy

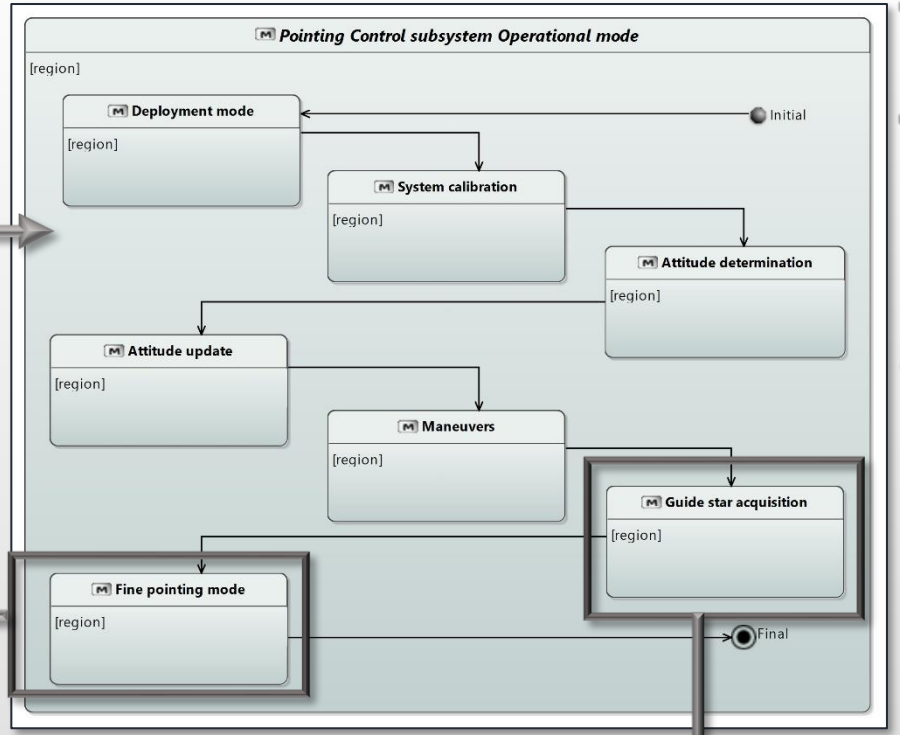
Pointing control subsystem analysis

Breakdown/Mode&State/Sequence diagam

[LCBD] Logical Component Breakdown diagram

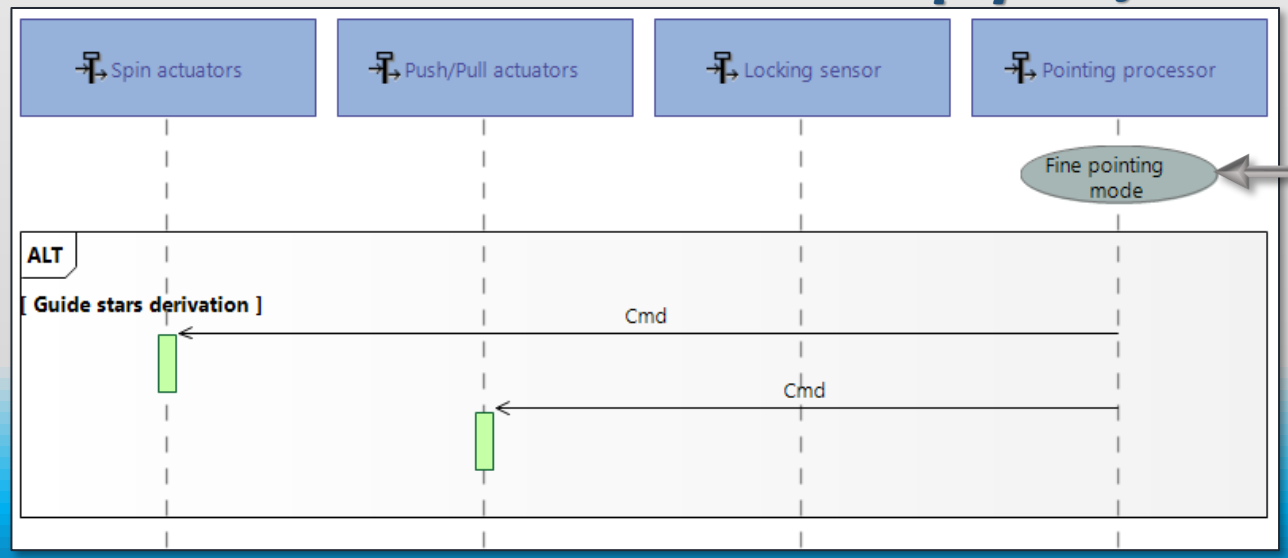




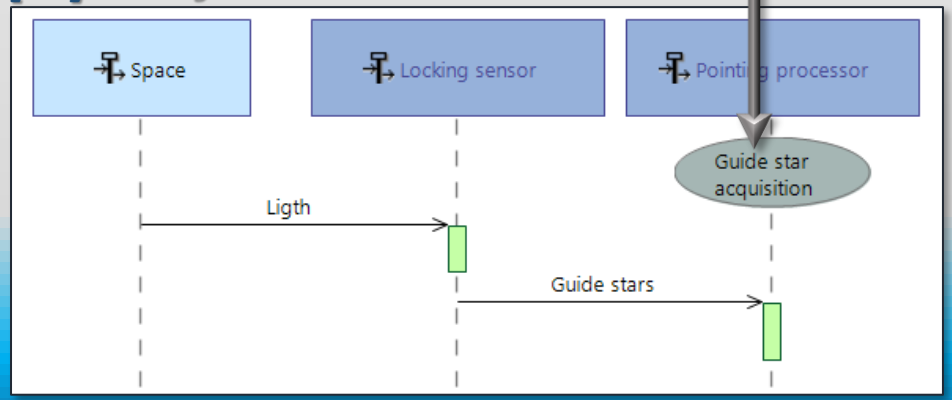


[M&S] Mode&State diagram

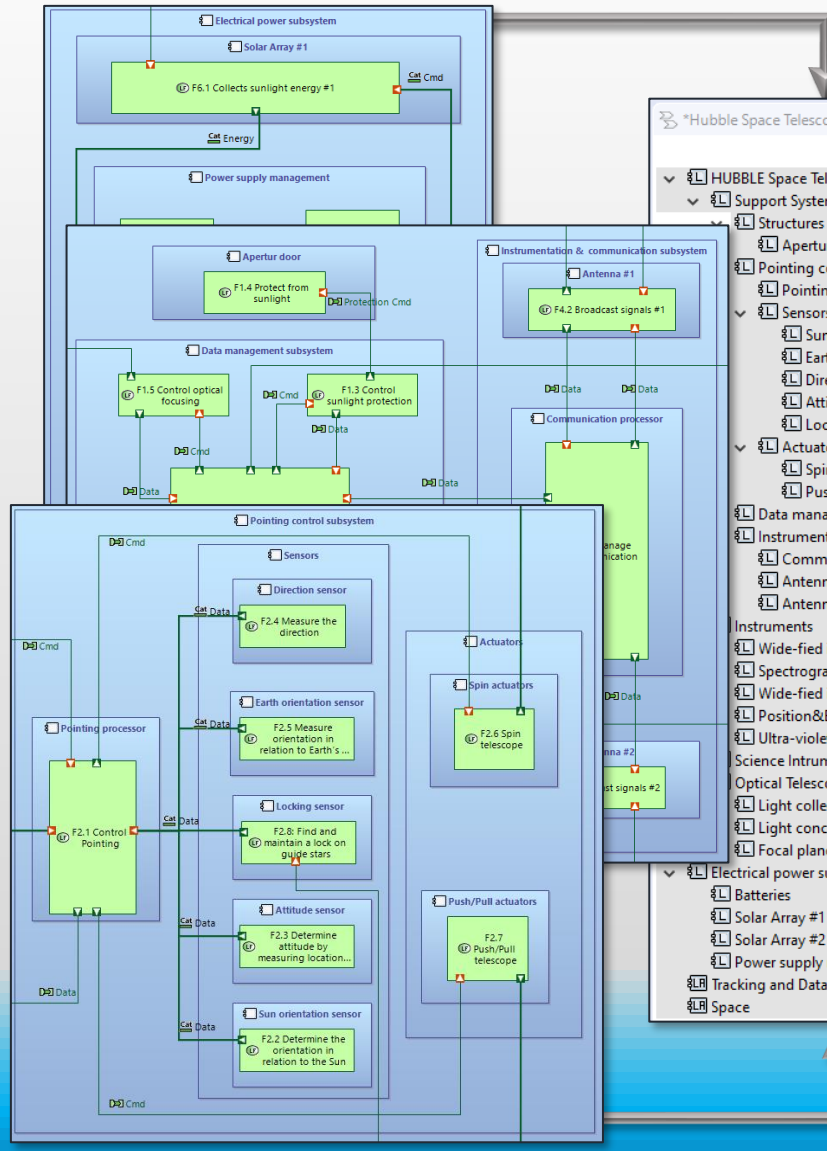
[ES] Exchange Scenario



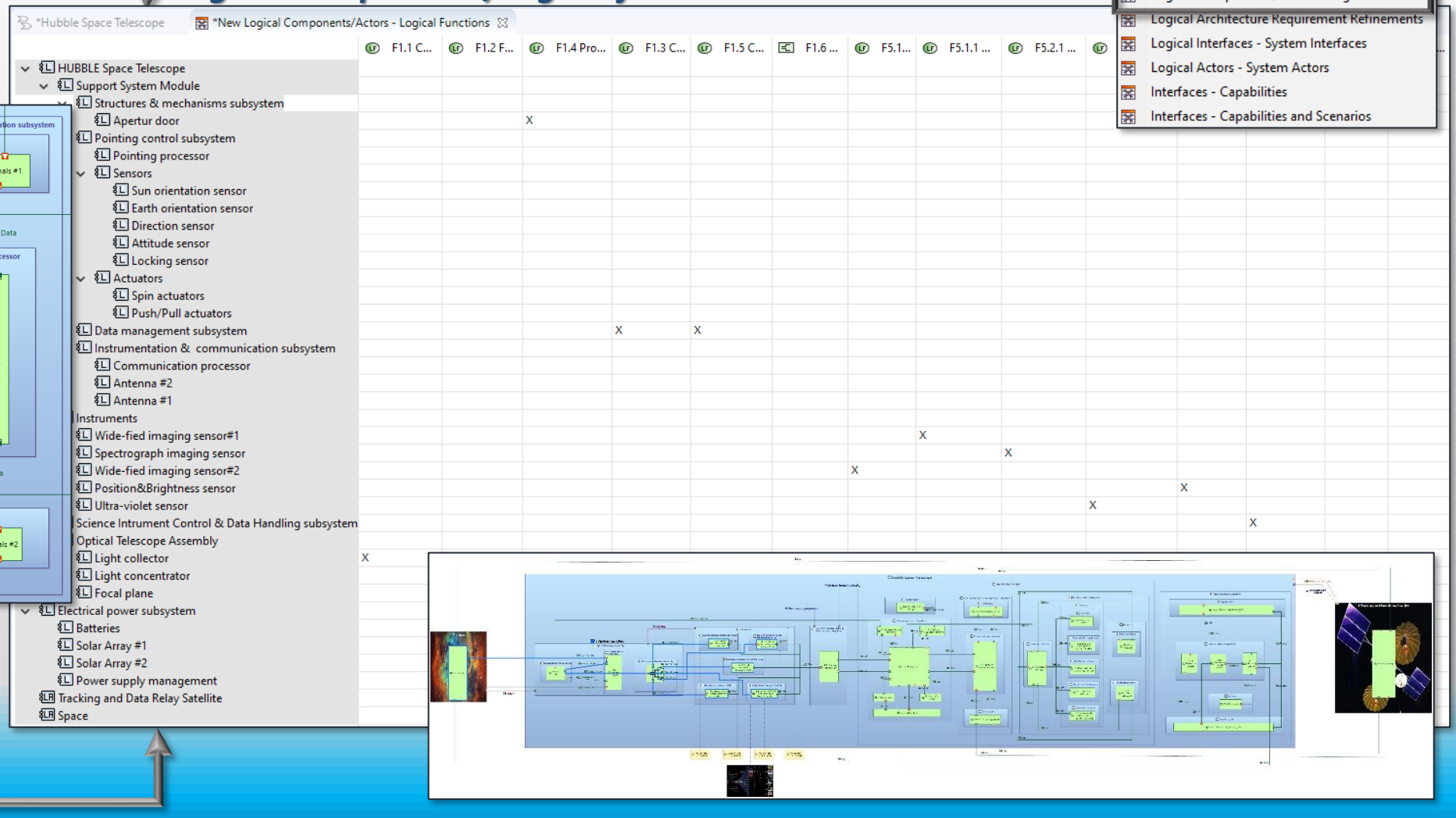
[ES] Exchange Scenario



[LAB] Logical Architecture Diagram



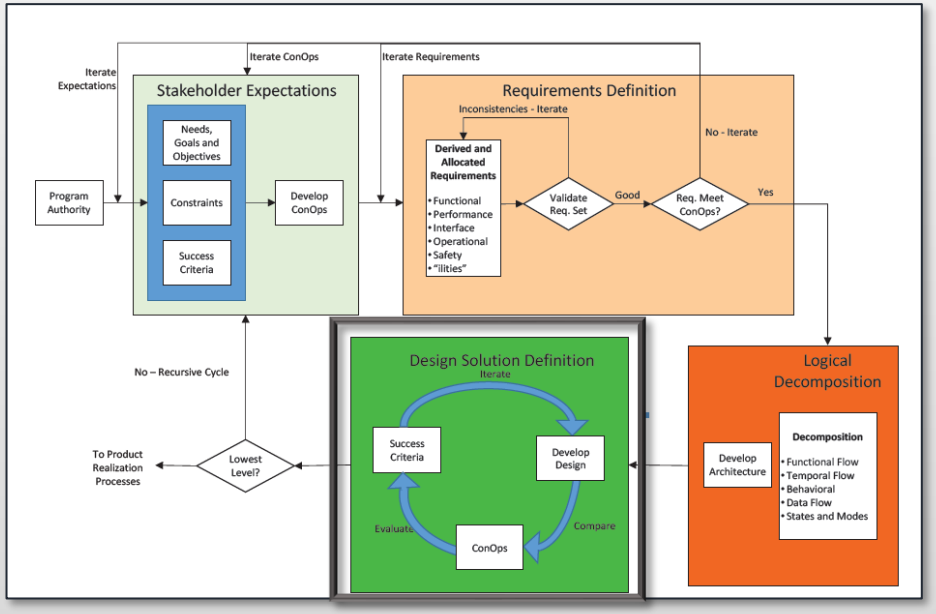
Logical Components/Logical functions allocation matrix



Physical Architecture

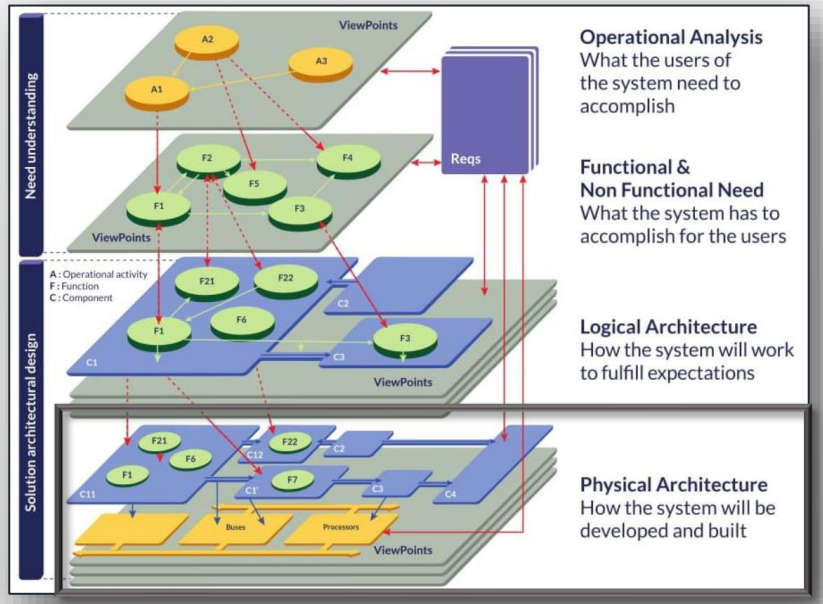
Requirements definition process

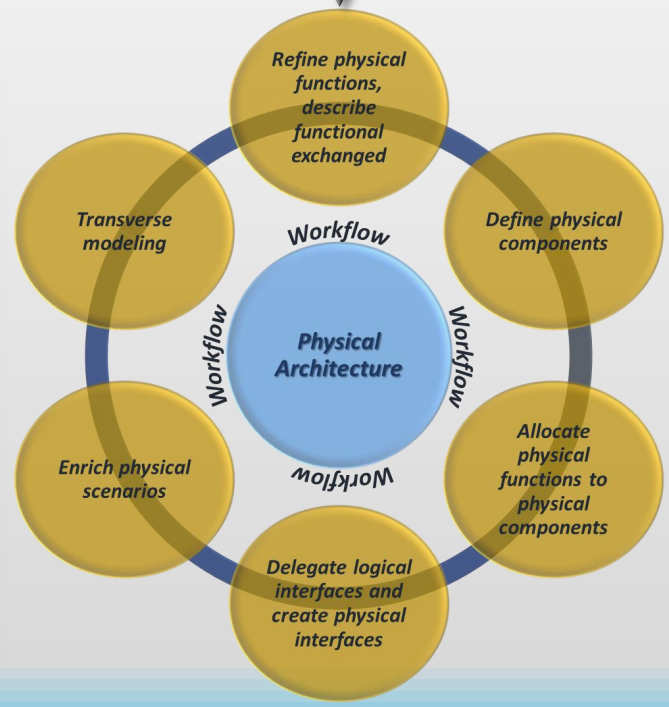
Technical solution definition process



Need understanding

Solution architectural design

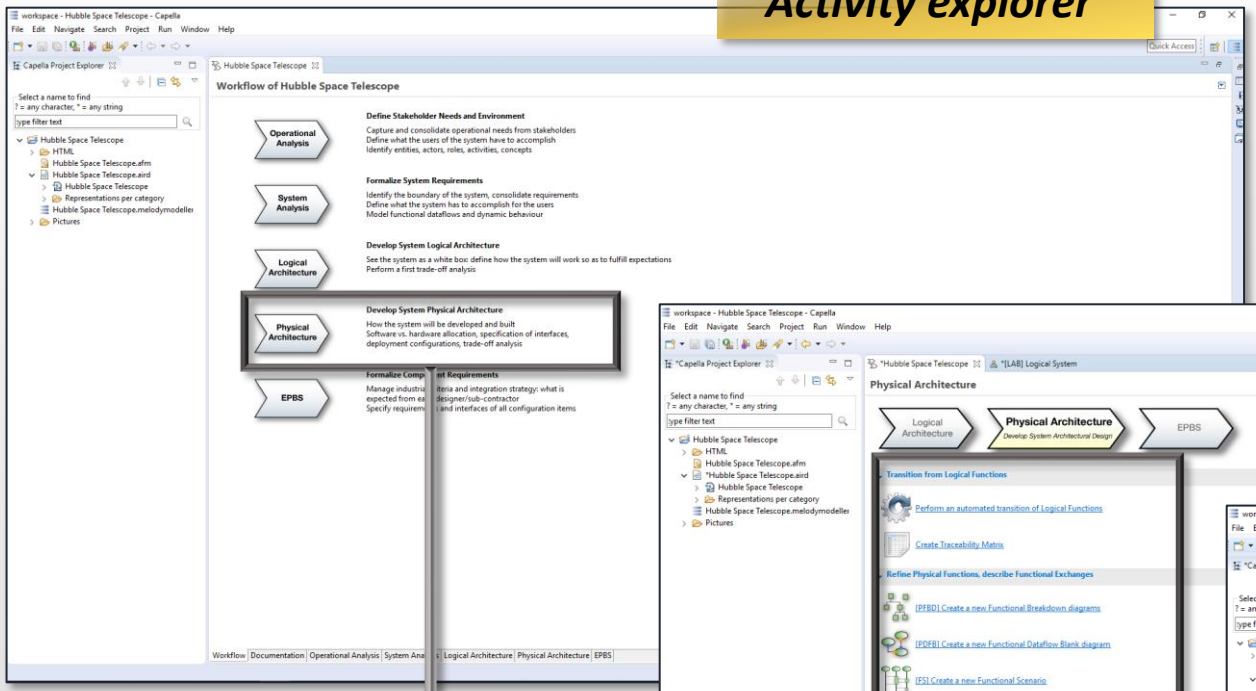




Physical Architecture

Speaker: DROUIN Remy

Activity explorer



Activity explorer

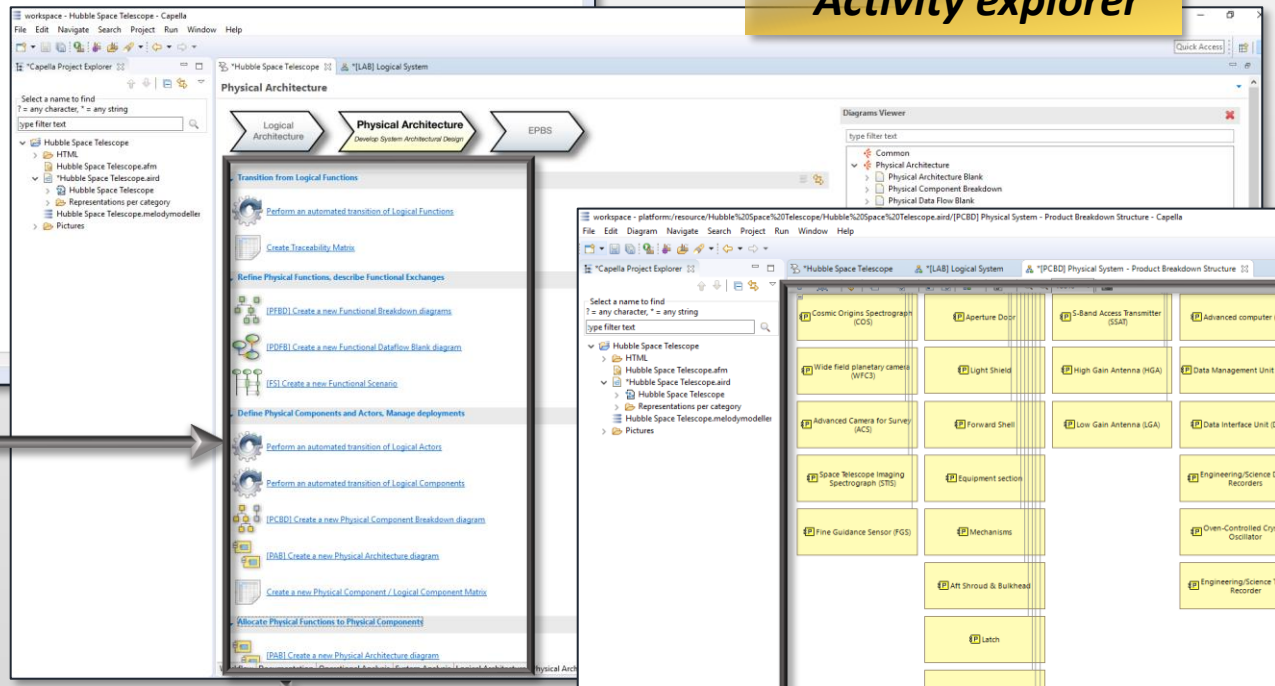
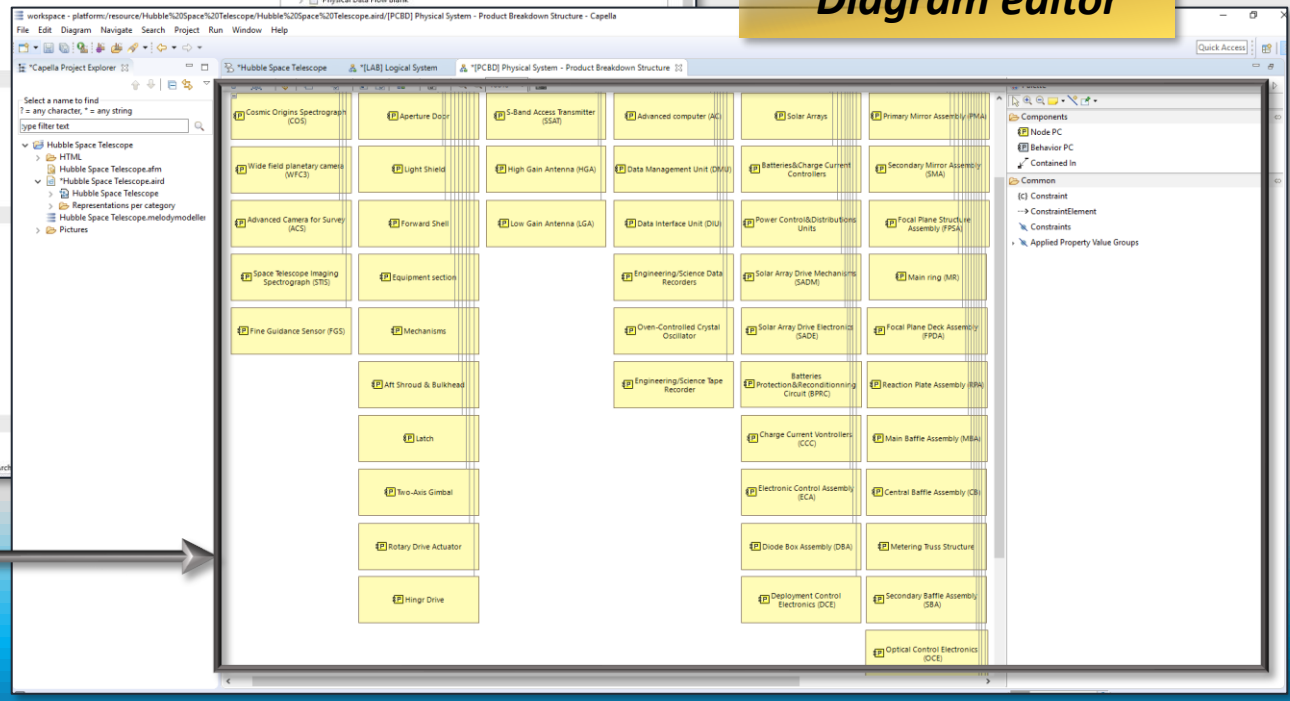
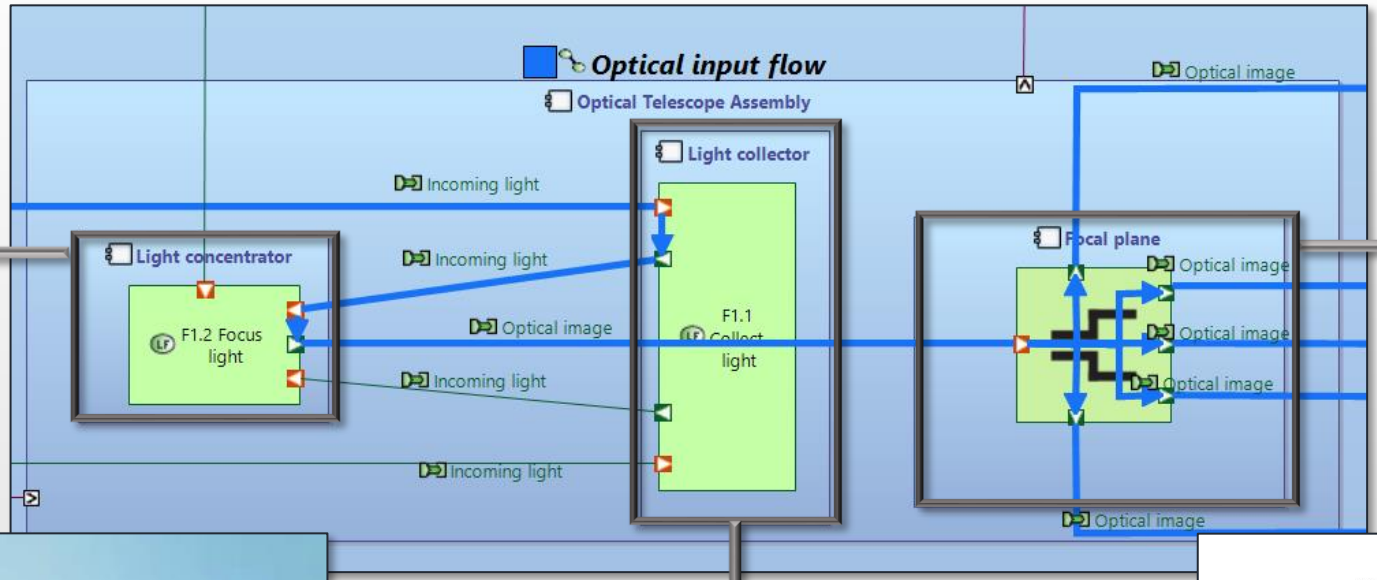


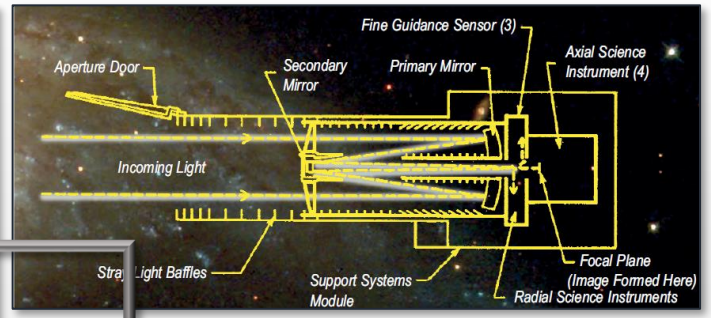
Diagram editor

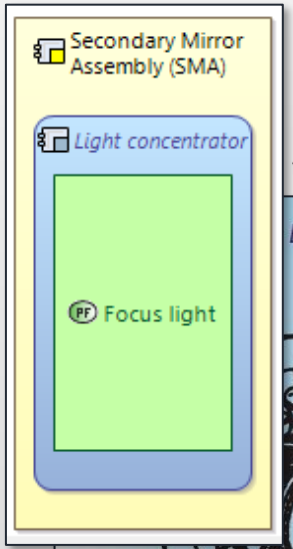


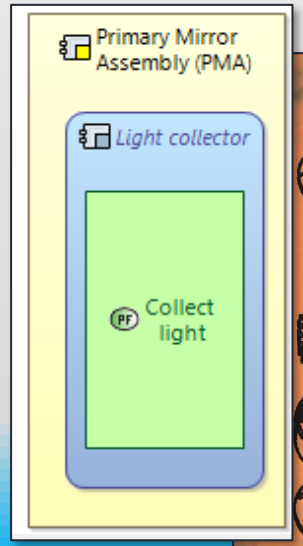
Physical Architecture

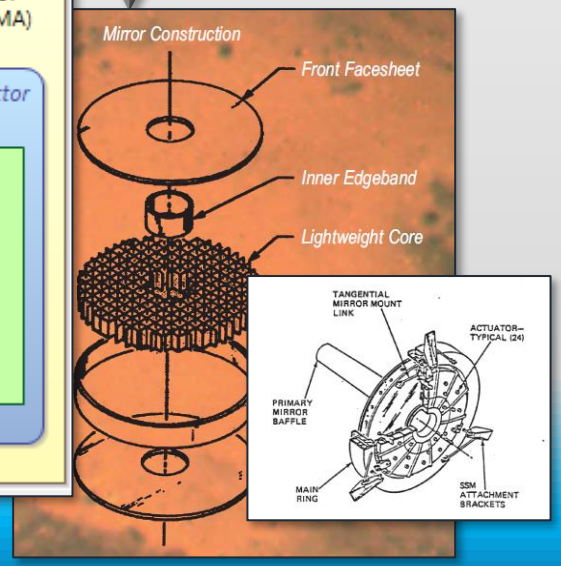
Speaker: DROUIN Remy

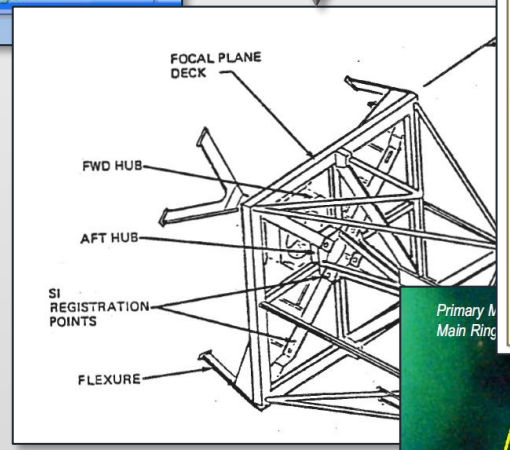


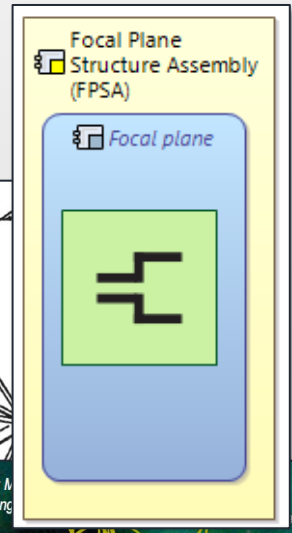


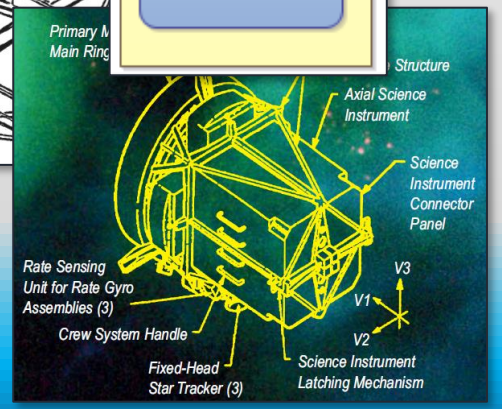








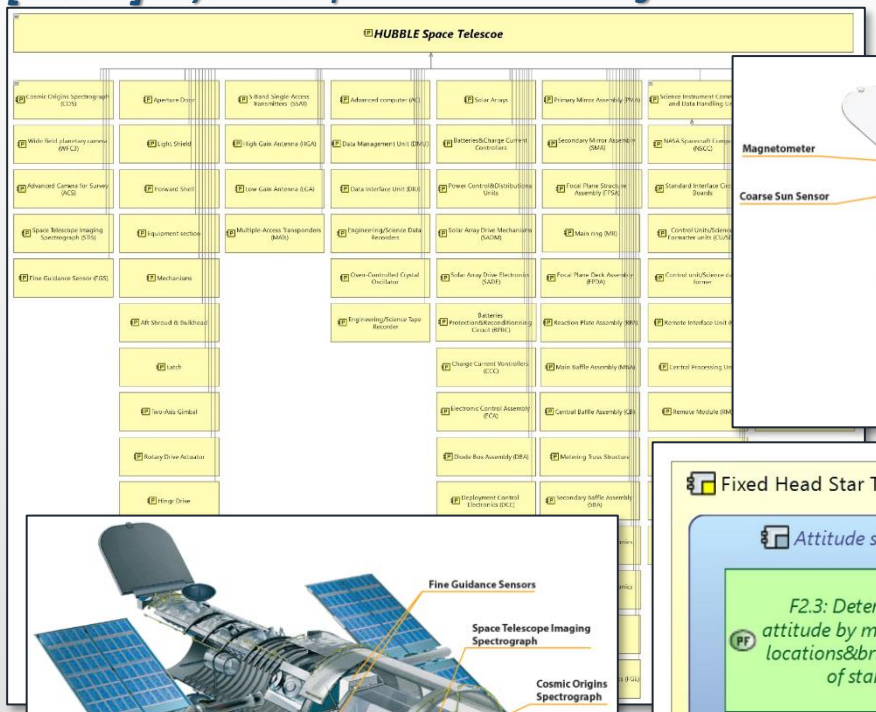


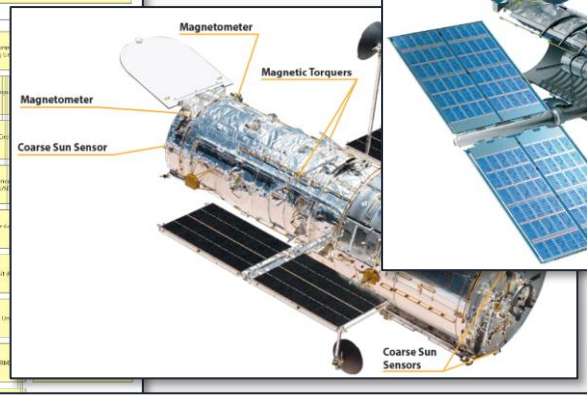


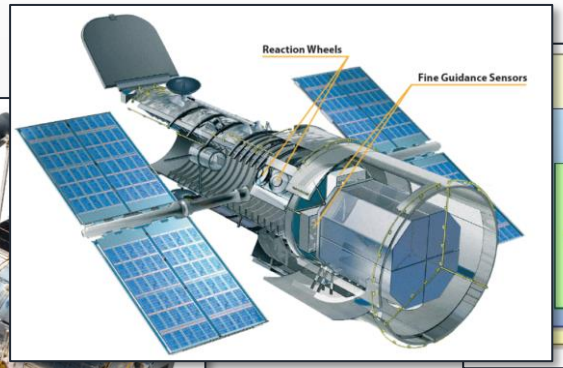
Physical Architecture

Speaker: DROUIN Remy

[PCBD] Physical Component Breakdown diagram







Actuators

- Magnetic troquers
  - Push/Pull actuators
    - PF F2.7: Push/Pull telescope
- Reaction Wheels Assembly (RWA)
  - Spin actuators
    - PF F2.6: Spin telescope

Sensors

- Fixed Head Star Tracker (FHST)
  - Attitude sensor
    - PF F2.3: Determine attitude by measuring locations&brightness of stars
- Fine Guidance Sensor (FGS)
  - Locking sensor
    - PF F2.8: find and maintain a lock on guide stars
- Coarse Sun Sensor (CSS)
  - Sun orientation sensor
    - PF F2.2: Determine the orientation in relation to the Sun
- Magnetic Sensing System (MSS)
  - Earth orientation sensor
    - PF F2.5: Measure orientation in relation to Earth's magnetic field
- Gyroscope
  - Rotation sensor
    - PF F2.4: Measure the rotation

Instruments

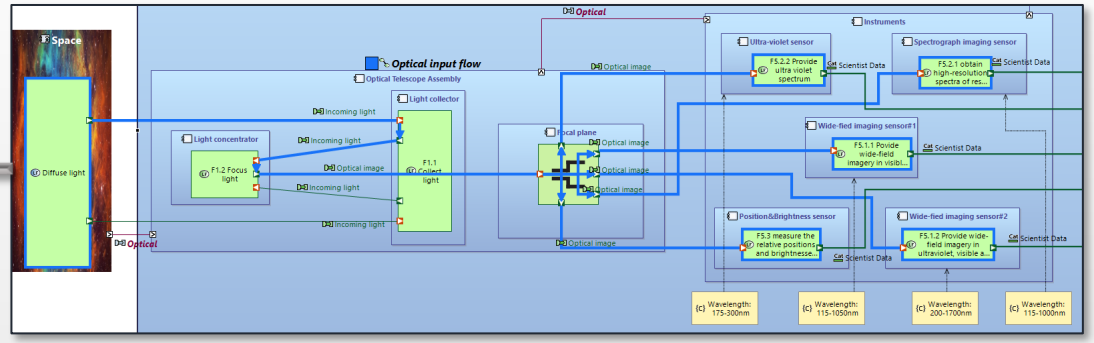
- Space Telescope Imaging Spectrograph (STIS)
  - Spectrograph imaging sensor
    - PF F5.2.1: Obtain high-resolution spectra of resolved objects
- Advanced Camera for Survey (ACS)
  - Wide -field imaging sensor#1
    - PF F5.1.1: Povide wide-field imagery in visible wavelengths
- Wide field planetary camera (WFC3)
  - Wide-field imaging sensr#2
    - PF F5.1.2: Provide wide-field imagery in ultraviolet, visible and infrared light
- Cosmic Origins Spectrograph (COS)
  - Ultra-vioel sensor
    - PF F5.2.2: Provide ultra violet spectrum
- Fine Guidance Sensor (FGS)
  - Position&Brightness sensor
    - PF F5.3: measure the relative positions and brightnesses of stars.

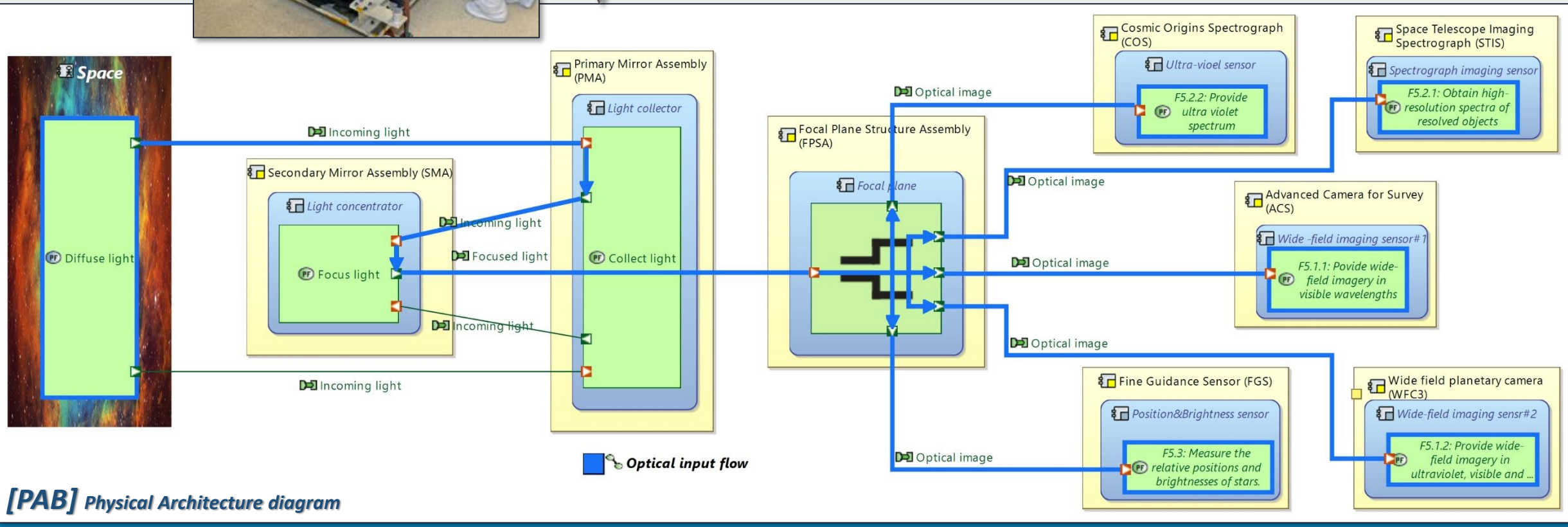
Physical Architecture

Speaker: DROUIN Remy

From [LAB]
To [PAB]

[LAB] Logical Architecture Diagram

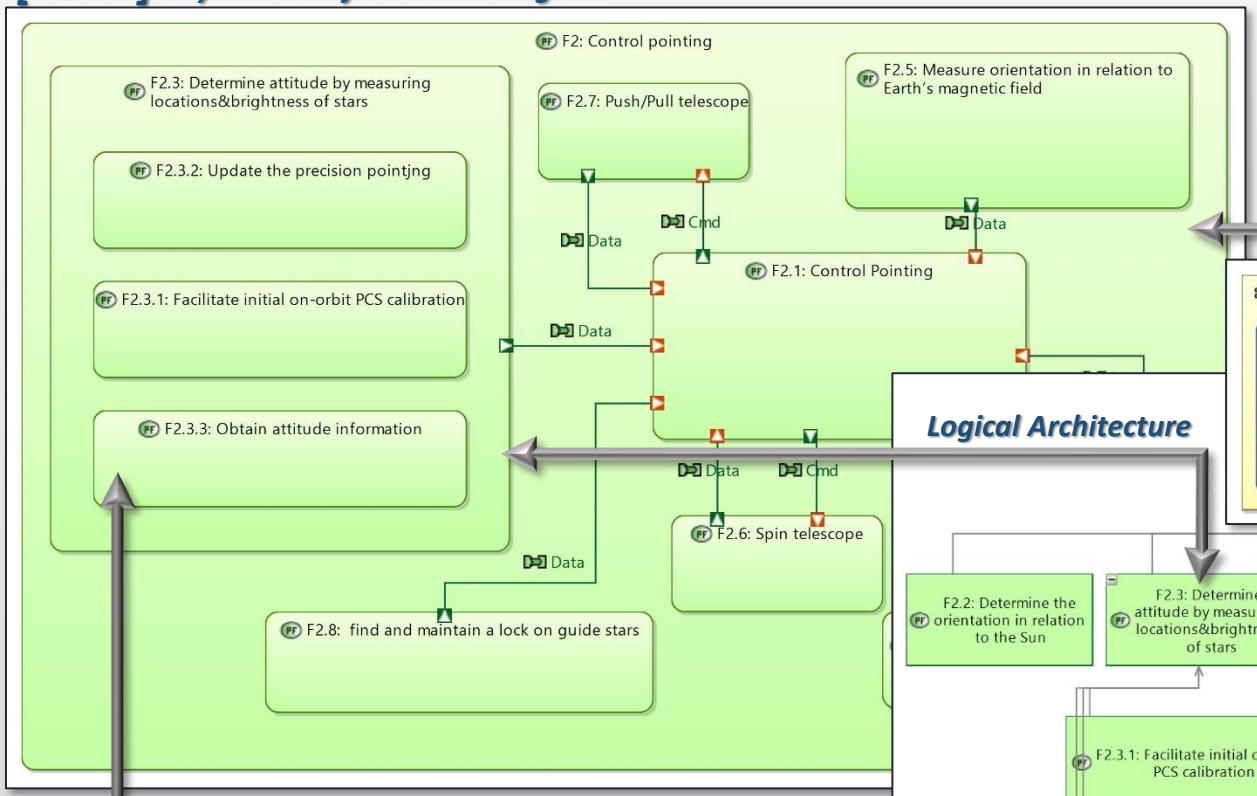




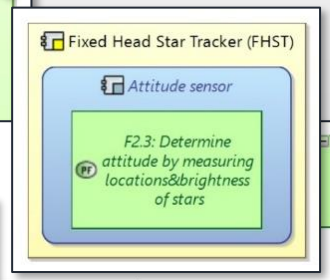
[PAB] Physical Architecture diagram

The Fixed Head Star Tracker ("*Determine attitude by measuring location&brightness of stars*"" function) is a sensitive, electro-optical detector which has the capability of locating and tracking a target star within its Field Of View

[PDFB] Physical Dataflow Blank diagram



System Analysis



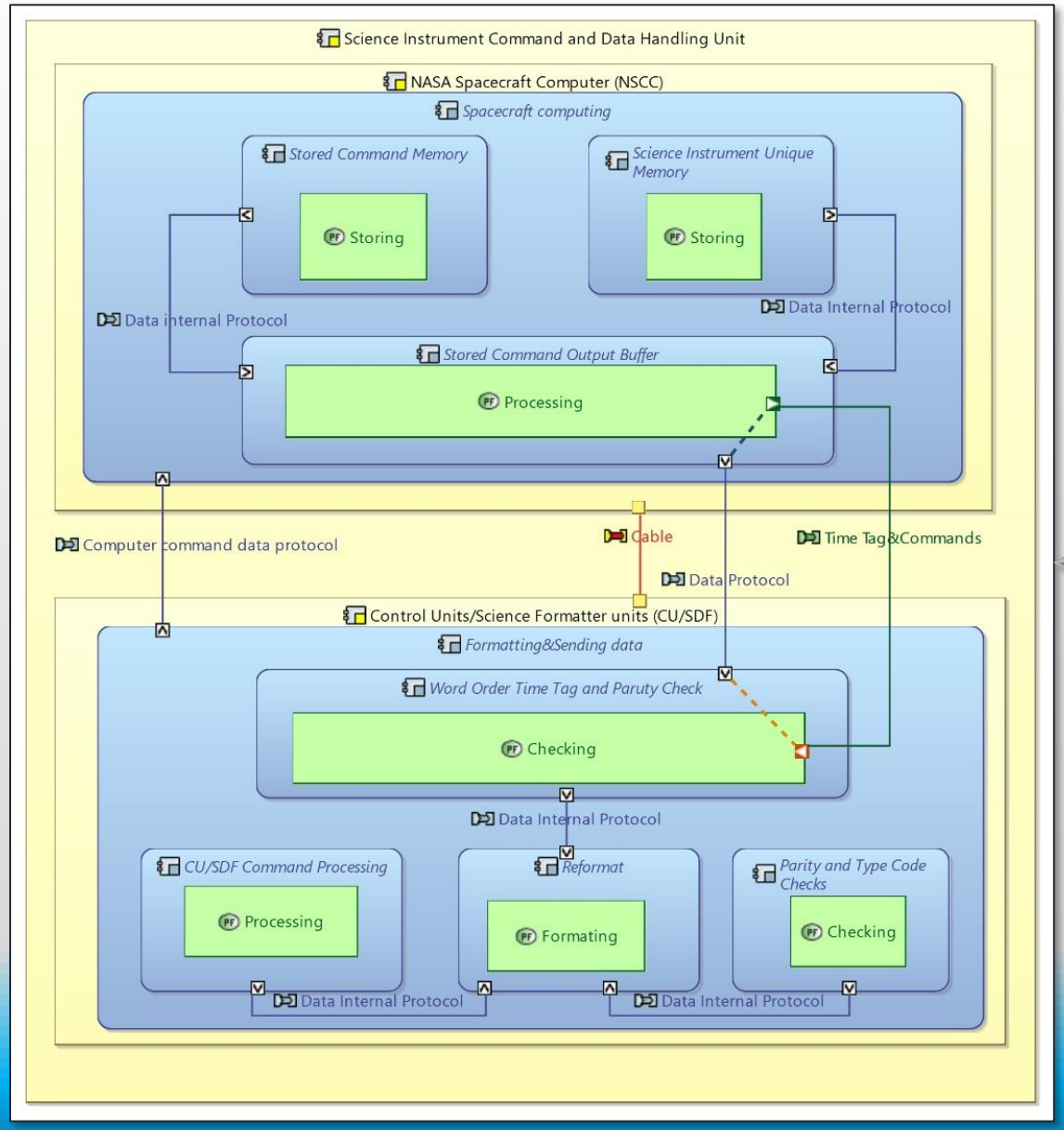
Logical Architecture

[PFBD] Functional Breakdown diagram

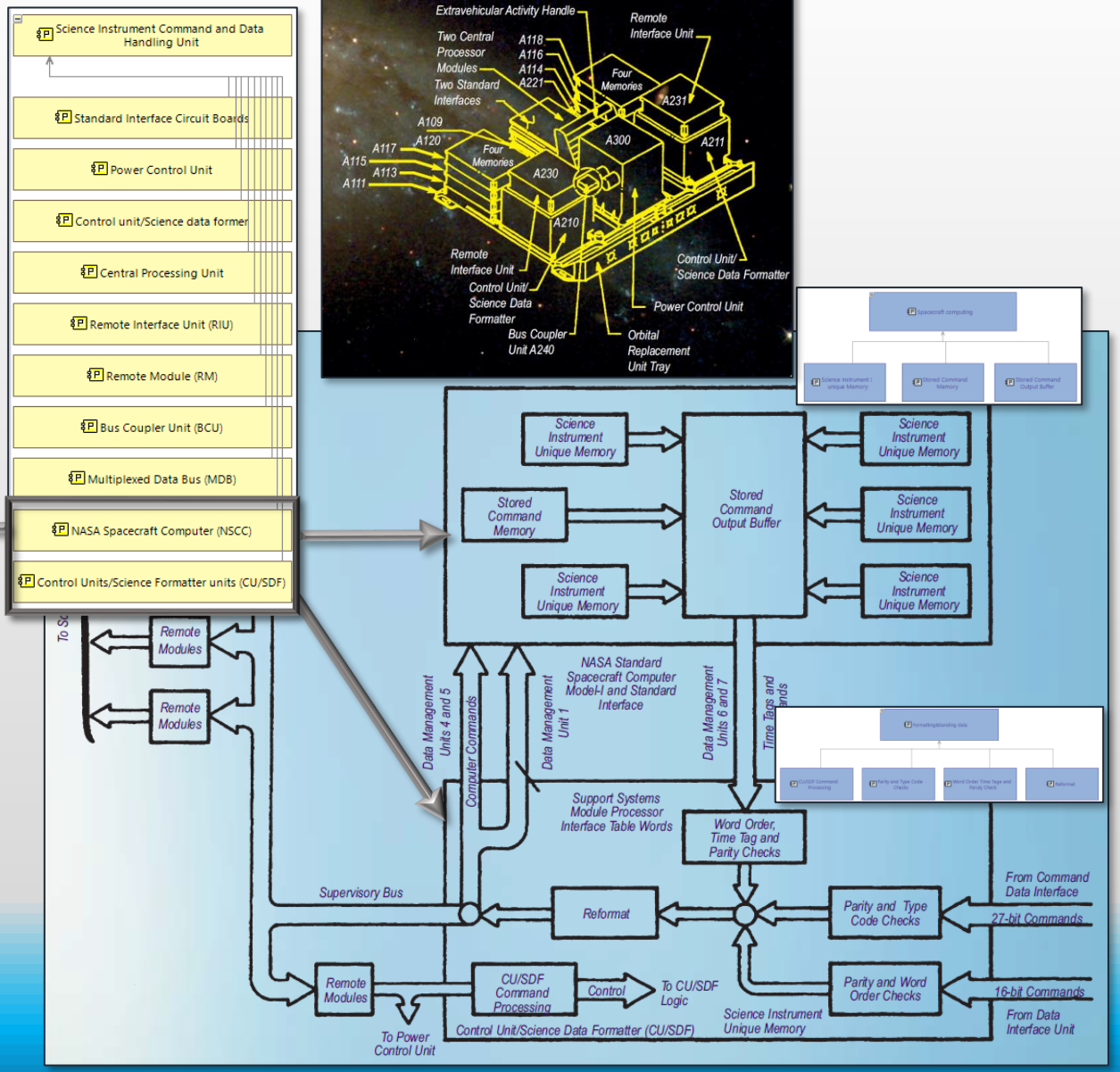
Physical Architecture

Physical Architecture

Speaker: DROUIN Remy



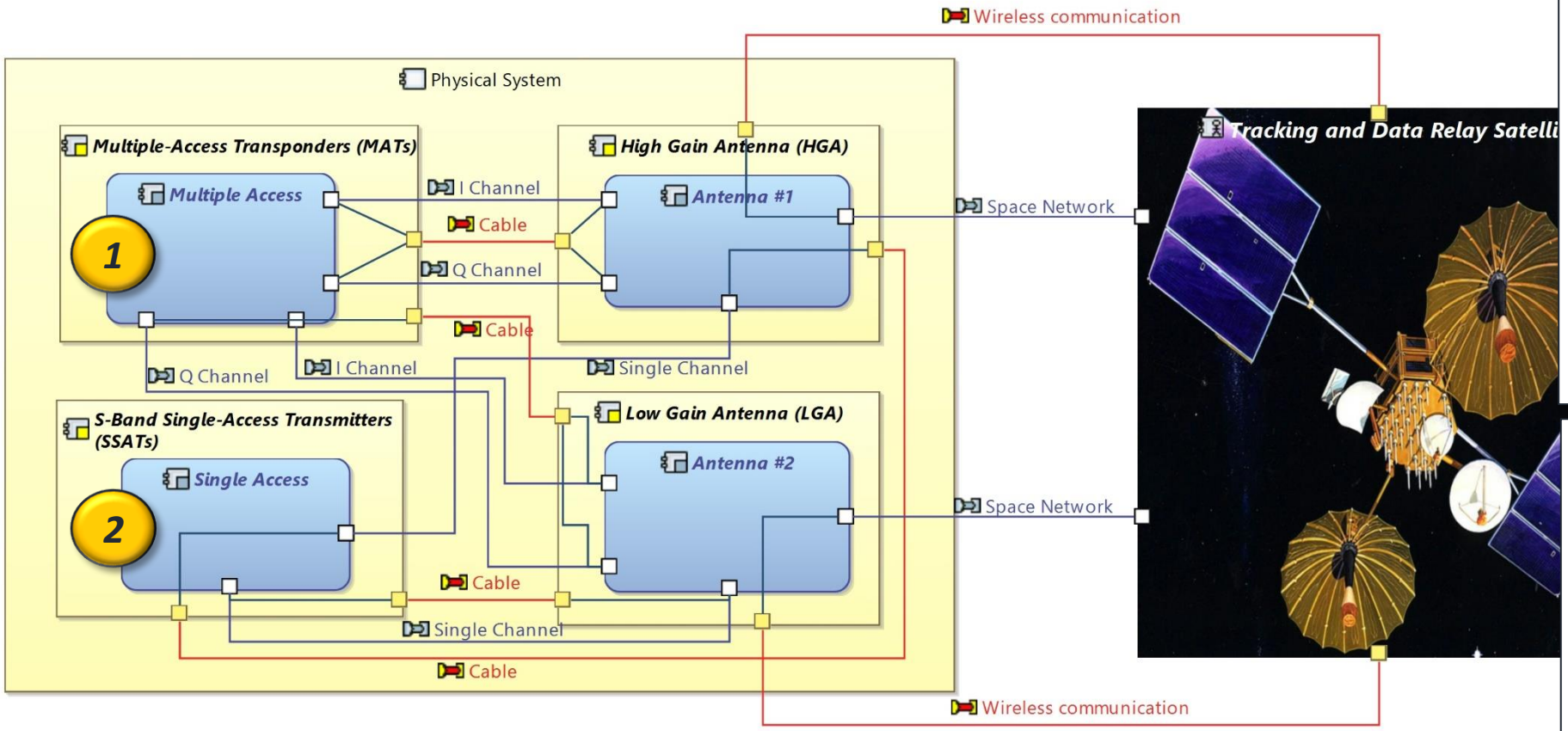
[PAB] Physical Architecture diagram



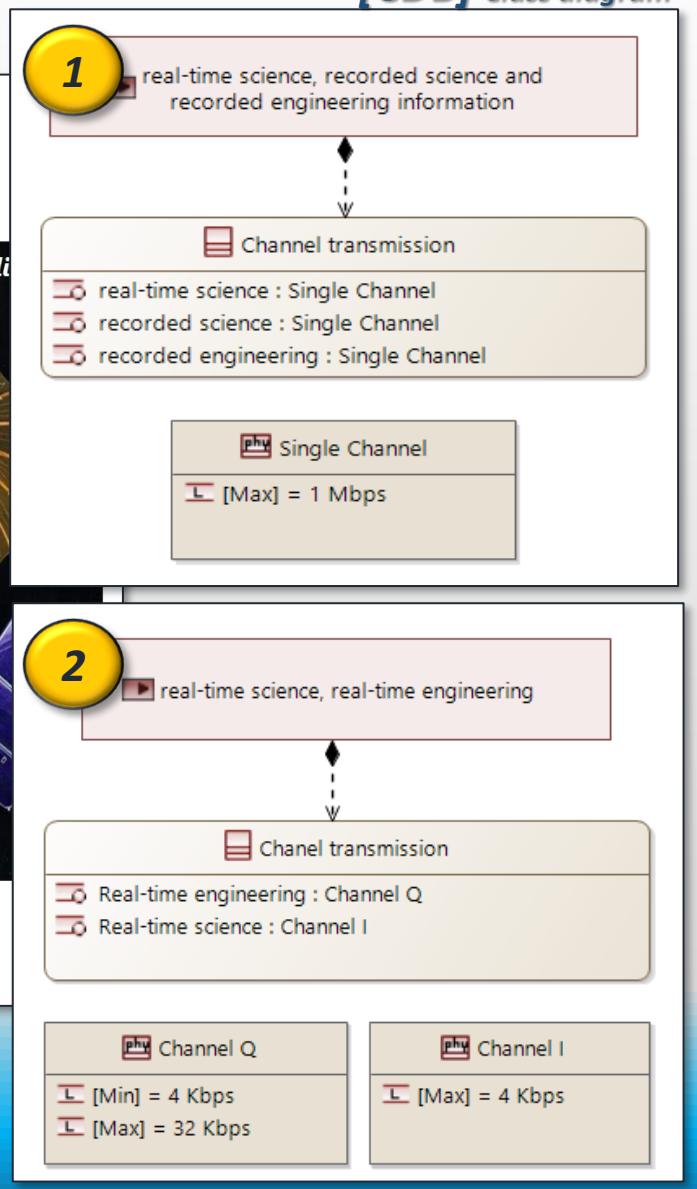
Physical Architecture

Speaker: DROUIN Remy

[PAB] Physical Architecture diagram

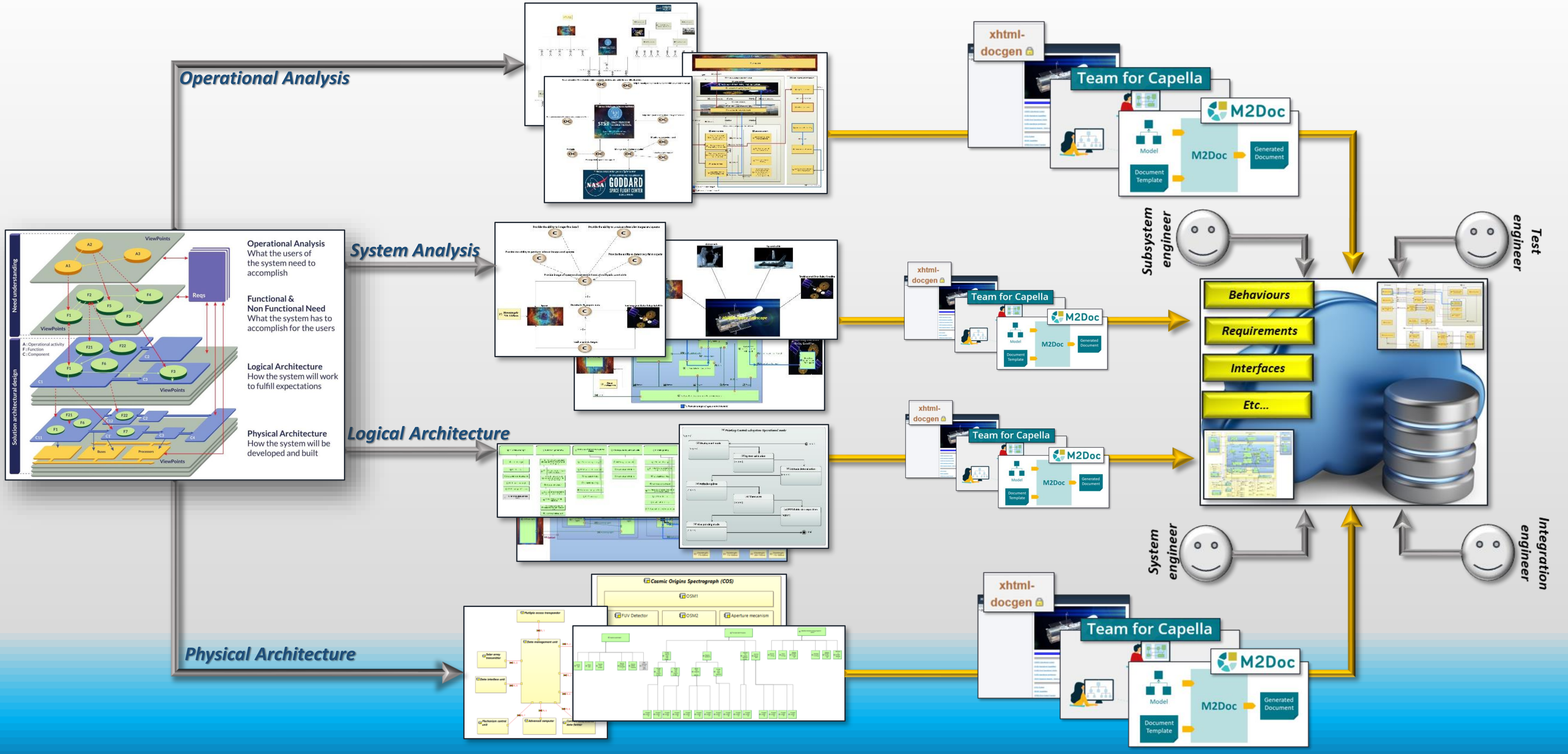


[CDB] Class diagram



Way to share data

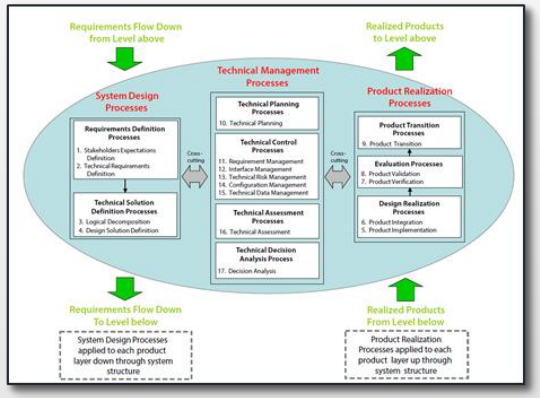
Speaker: DROUIN Remy

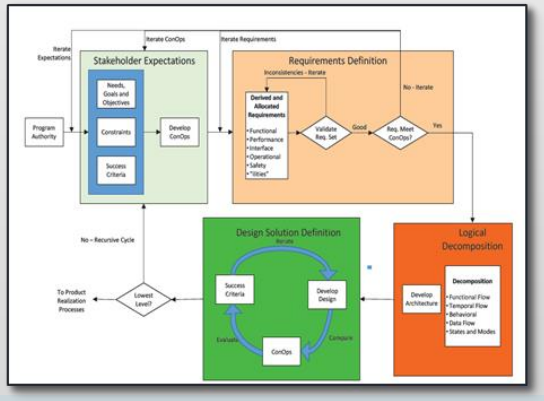


Speaker: DROUIN Remy

NASA Handbook

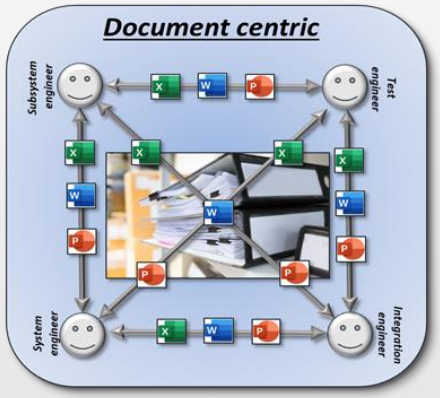
Systems Engineering

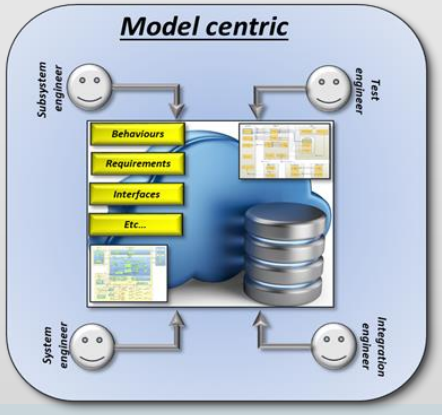




MBSE introduction

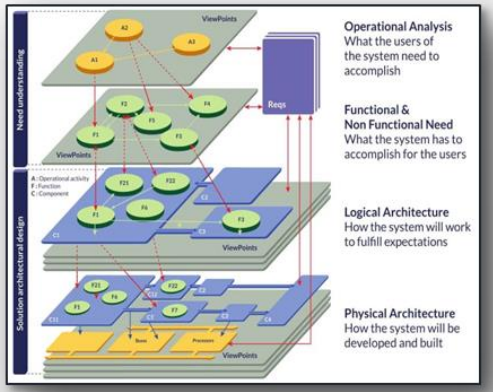
Mode-Based Systems Engineering

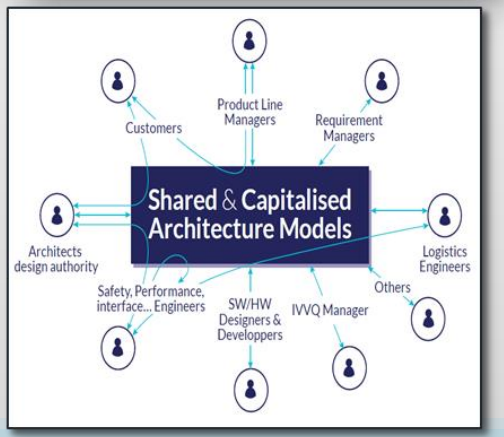




CAPELLA/ARCADIA

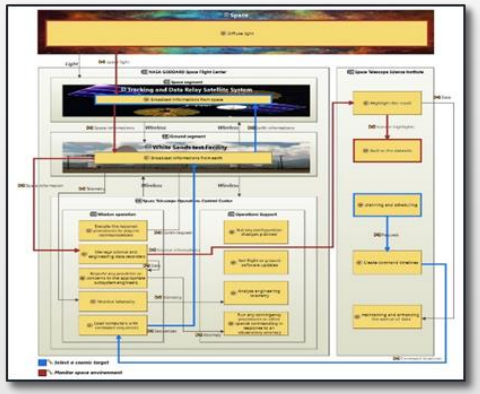
MBSE solution

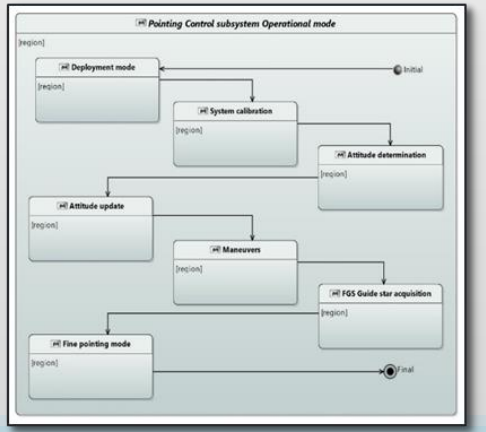




HST

Application





Thank you