MBSE

used in developing a

Telescope Manager

Objective

Report on our experience of MBSE

- Introduction and Background
- Our MBSE strategy
- Outcomes
- The future

Introduction and Background

Introduction and Background
What is MBSE?

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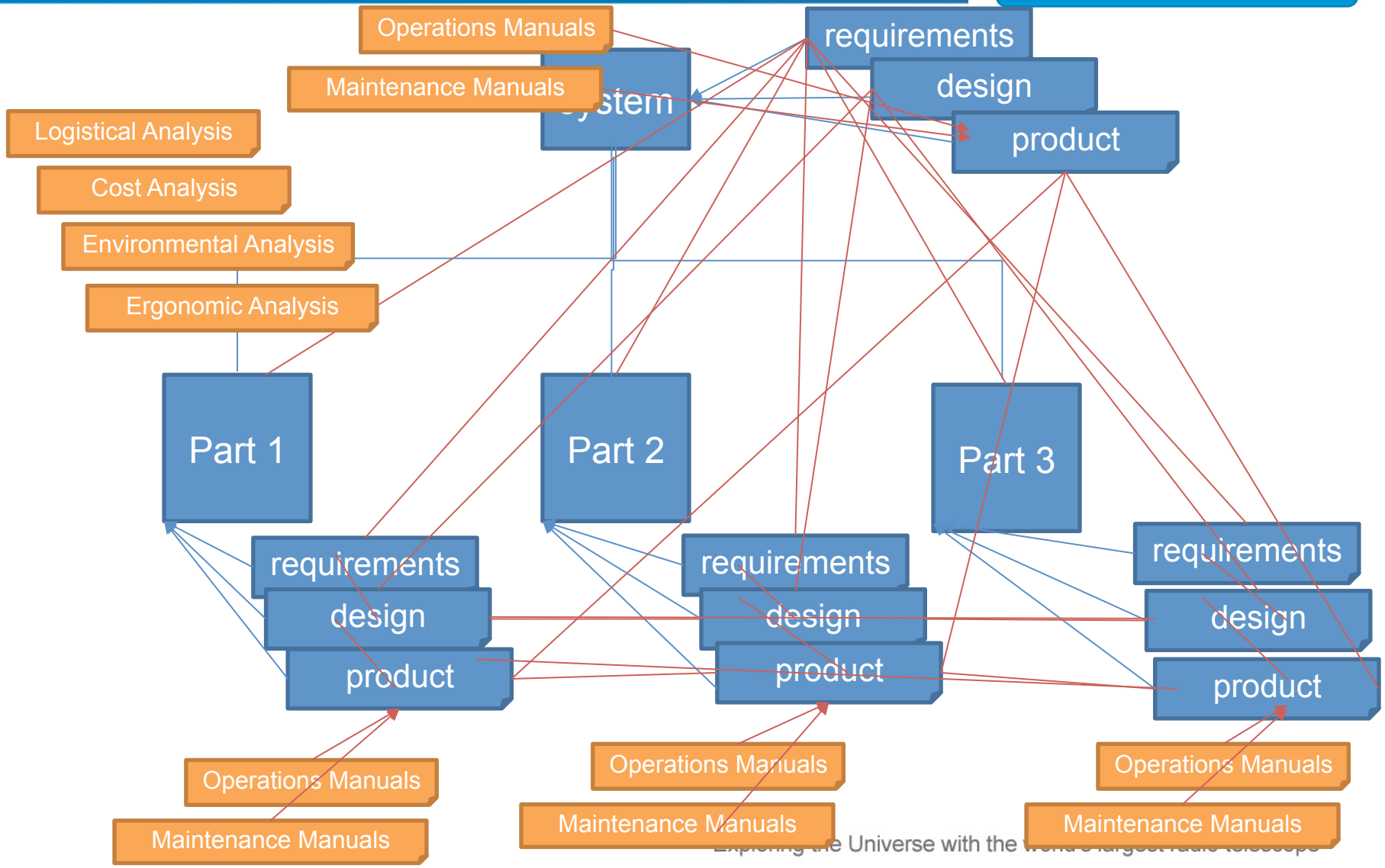
Systems engineering but…

> *"the primary artefact of those activities is an integrated, coherent, and consistent system model, created by using dedicated systems modeling tools"* (Delligatti, 2014, p. 3)

- **Integrated model vs. Collection of documents**
- **Formal language (SysML, UML etc.)**
- **Complex Tool**

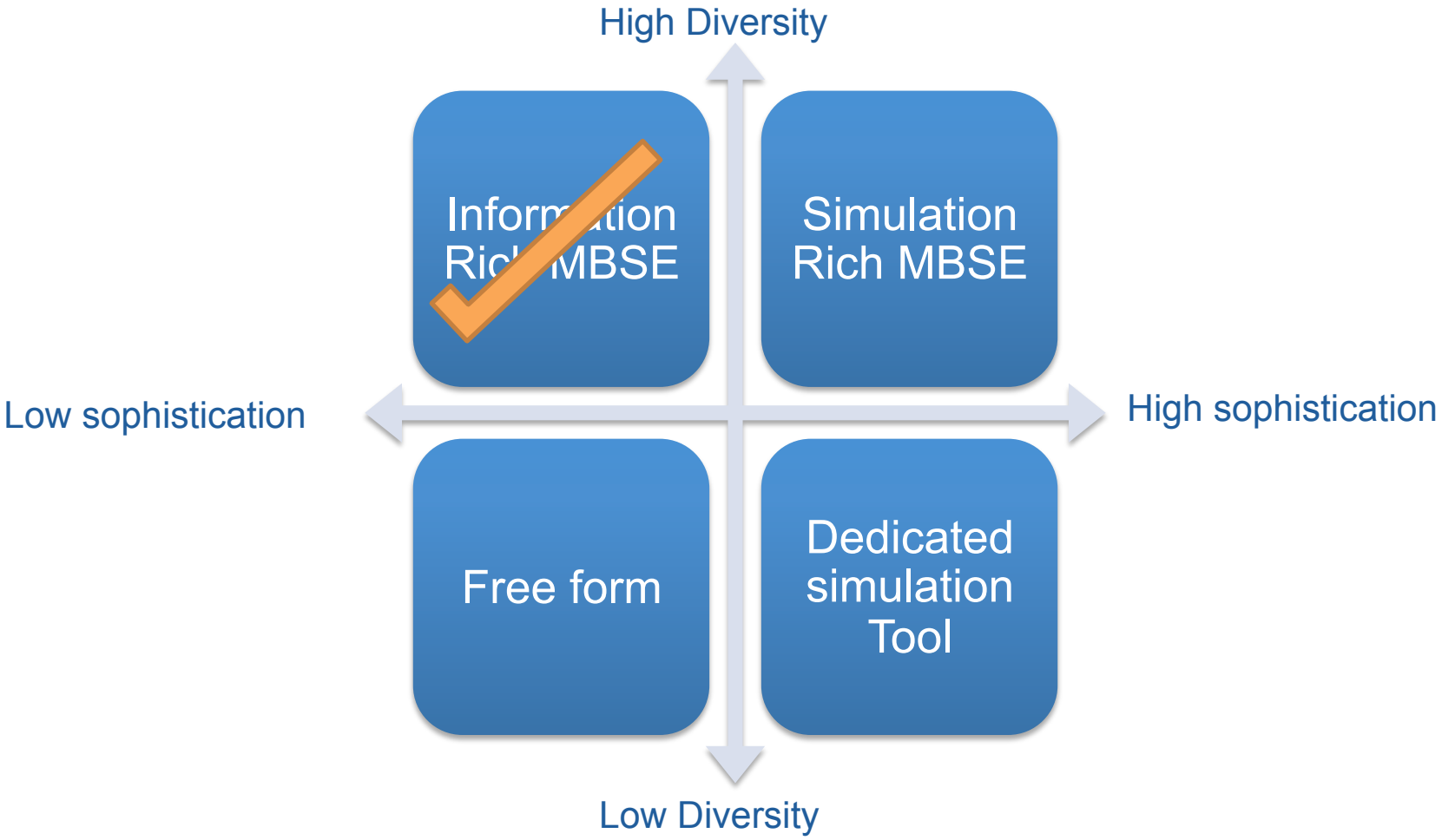
Introduction and Background

What is MBSE? Personal experience



Introduction and Background

What is MBSE?



Introduction and Background
What is TM?

Telescope Manager System

- Conduct observations (mission) execution
  - 16 concurrently
  - Various types (pulsars, imaging, spectrometry)
- Maintain operational state (monitor)
  - Detect & Manage Failures and Alarms
  - Protect Assets
  - Observation integrity
- Planning observations
- Manage proposals for observations

Mid Telescope Domain Model

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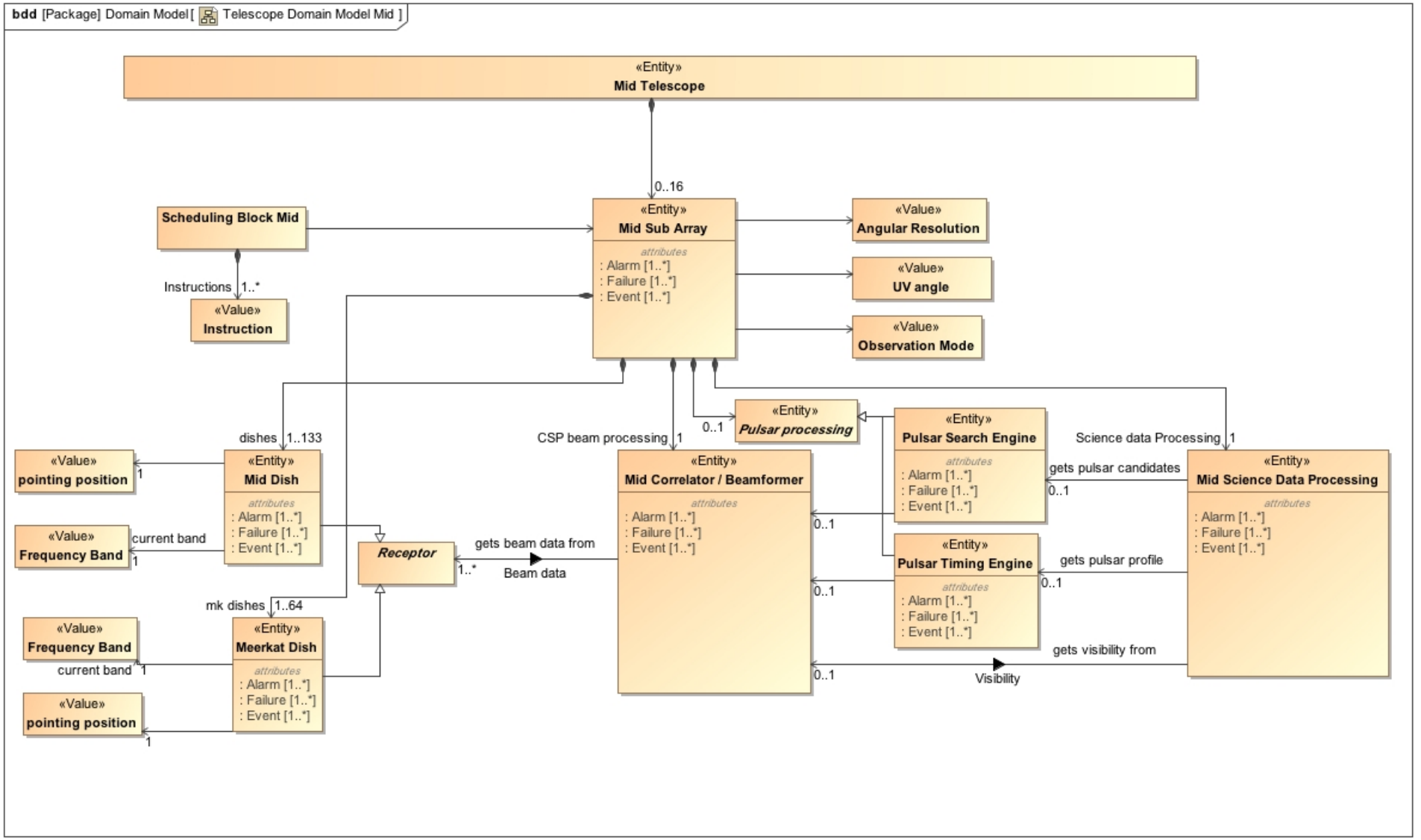
Mid Telescope Domain Model



Introduction and Background

TM Project and Consortium

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SCISYS

PERSISTENT

NCRA • TIFR

TATA

- 56 members (12 phd's)
- 12 research institutions and commercial partners
- 8 countries
- 6 work packages

INAF ISTITUTO NAZIONALE DI ASTROFISICA

SKA AFRICA
SQUARE KILOMETRE ARRAY

instituto de telecomunicações

CRITICAL SOFTWARE

CSIRO

gtd

CARC·NRC Canada

scope

Introduction and Background

Locations of members

Introduction and Background

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In summary

- Information generated - will be huge
- Consistency - big challenge
- Conceptual modeling of software needed

Model Based Systems Engineering

Our MBSE strategy

MSBE Strategy
Language as an integrator of diversity

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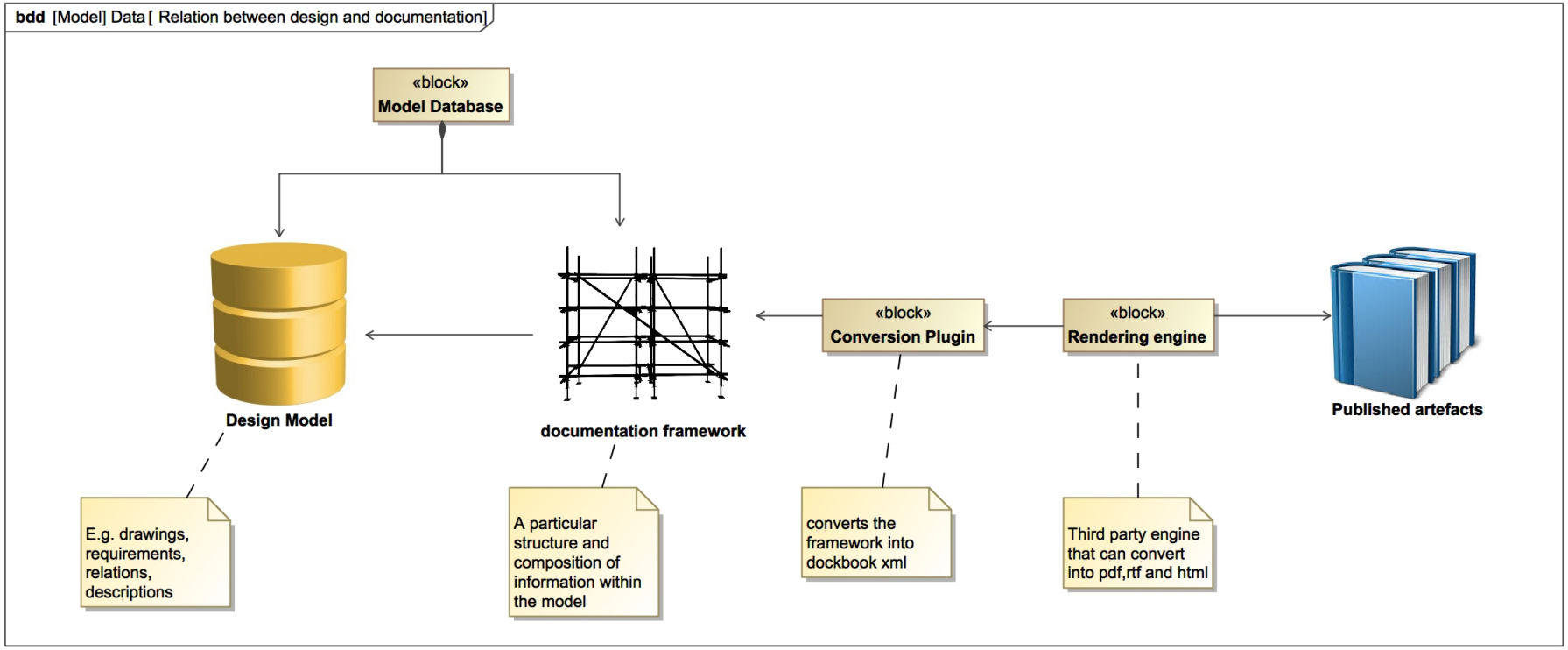
- Model Language - SySML (UML)
  - Training of members
    - (relatively straight forward)
  - Tailoring language to our own Context
  - (e.g. modeling interfaces)
    - Requires strong knowledge of principles
  - Meta model – derive a dialect of SySML to reflect idiosyncrasies of project
  - Considerable effort spent in adapting language to our own domain

OMG SYSTEMS MODELING LANGUAGE SysML™

MSBE Strategy
Information consumption versus production

- Not just a matter of creating information
- Need to find a way to distribute and present design outputs to dispersed stakeholders
- Need to manage reviews, changes and comments across different teams
- Preliminary used Google docs with surprising success: (ease of concurrent and collaborative use)
- However: interdependency across documents – need to model underlying structure (MBSE)
  - Challenges in exporting data into model
  - Challenges in presenting data as documents

MSBE Strategy
Information consumption



MSBE Strategy
How to handle documents

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tmreport.pilar.co.za/mainbody.html

Next

TM Design update

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Figure 1.1. TM Generic PBS

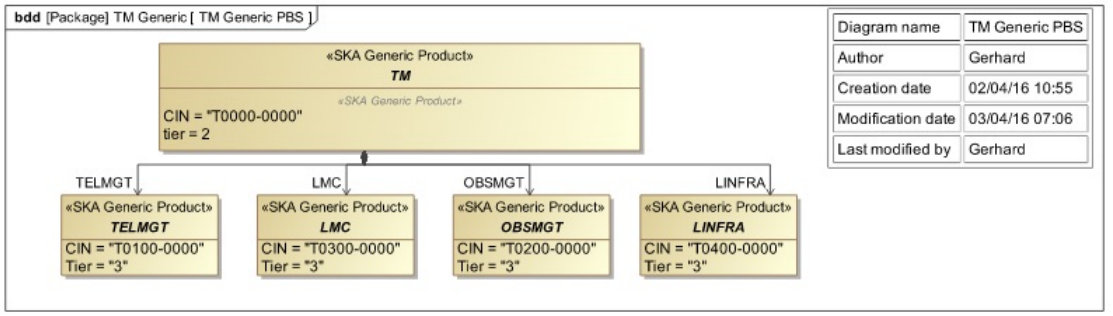


Figure 1.2. TM Mid PBS

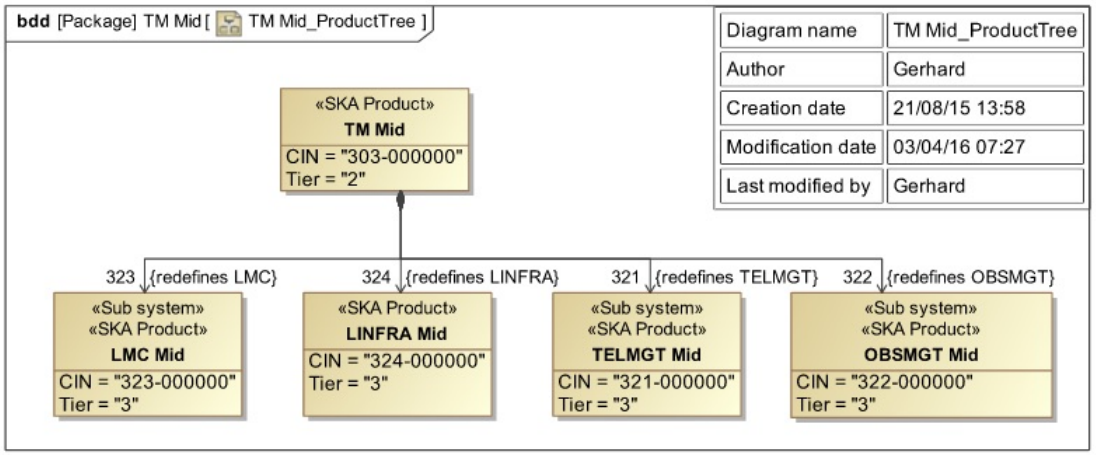
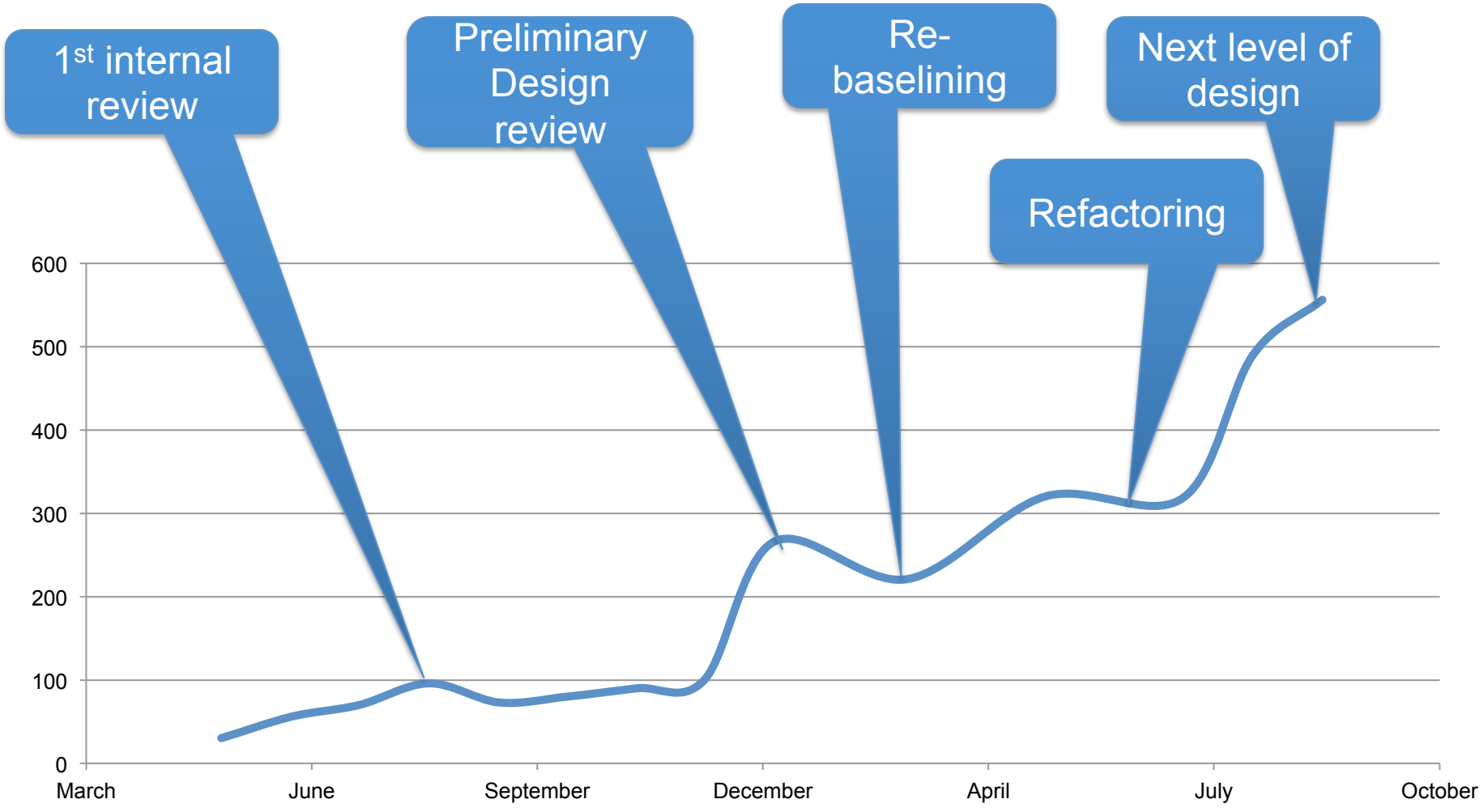


Figure 1.3. TM Low PBS

MSBE Strategy

#drawings generated over time



MSBE Strategy
Life Cycle of information

MSBE Strategy
Life Cycle of information

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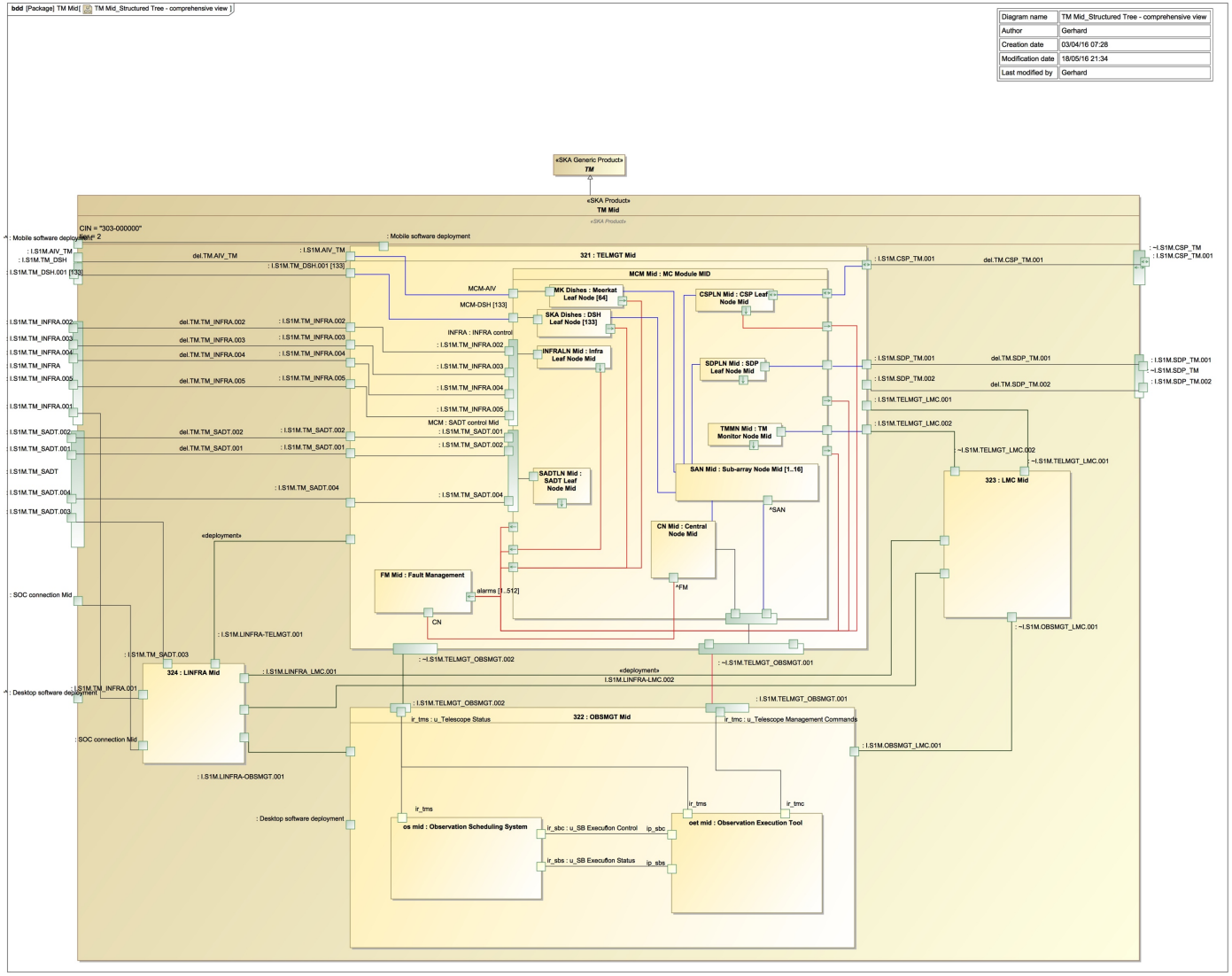
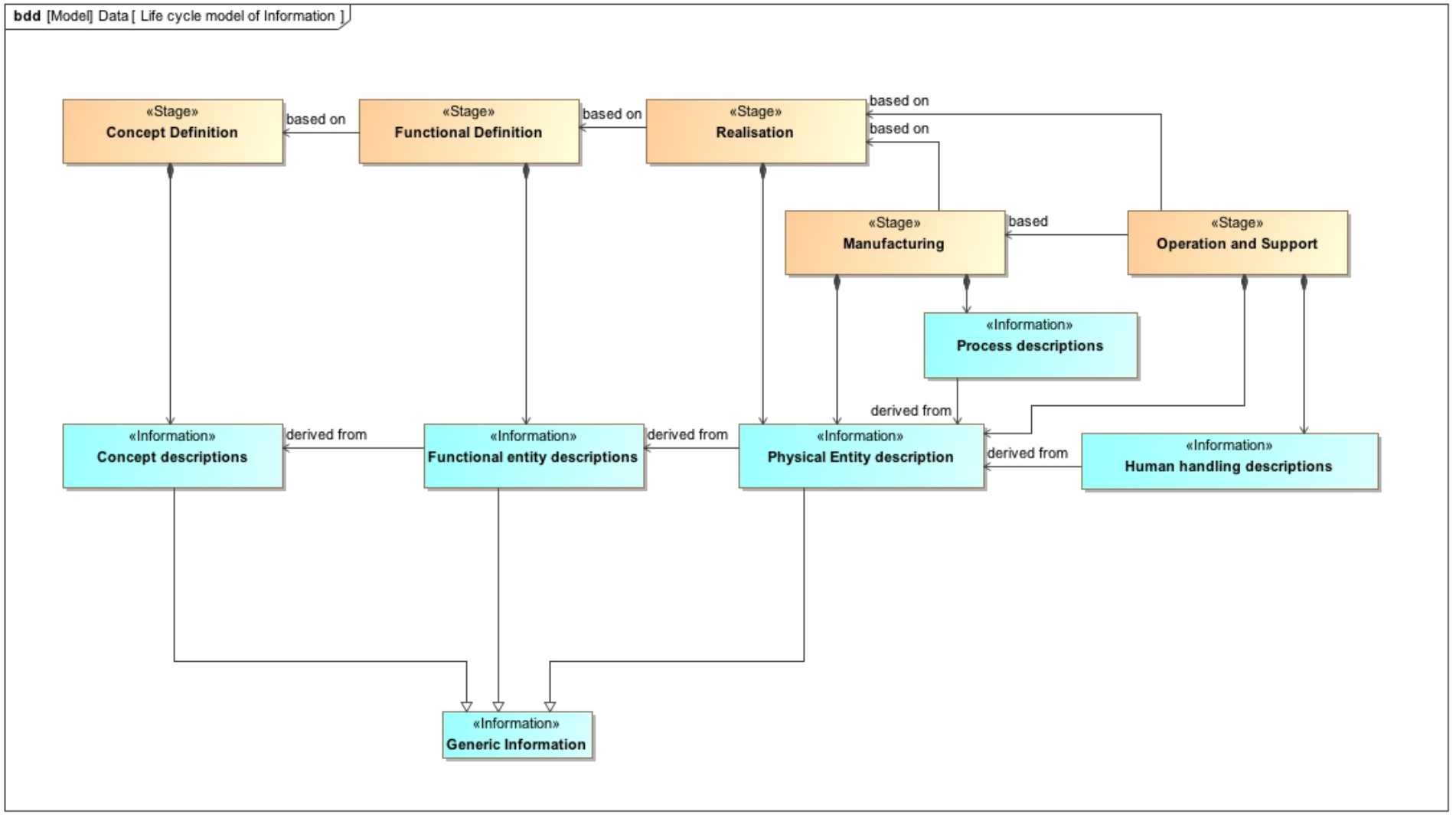
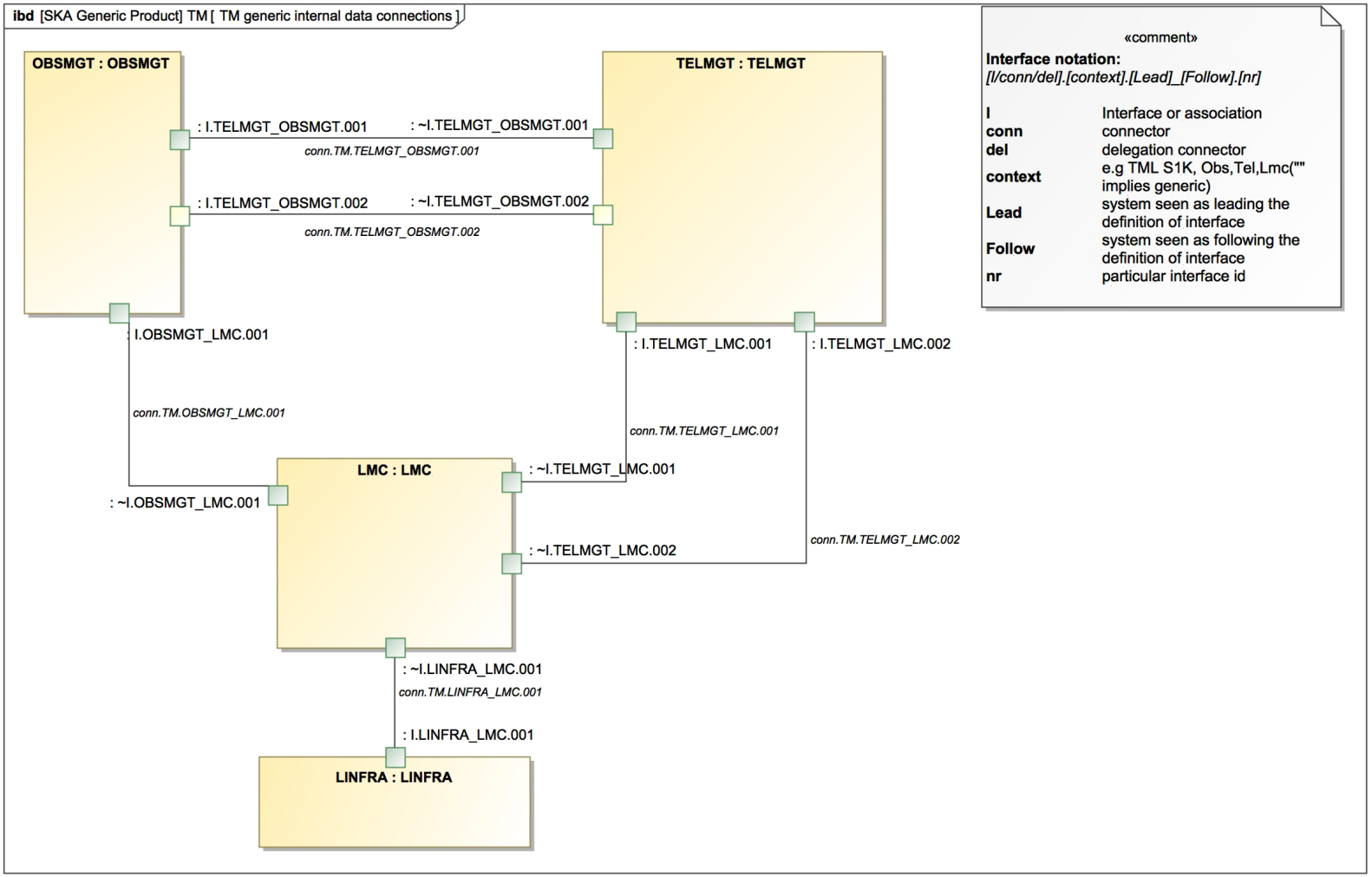


's largest radio telescope

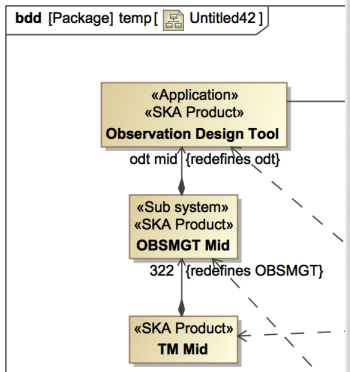
MSBE Strategy
Life Cycle of information



MSBE Strategy
Life Cycle of information



MSBE Strategy
Requirements integrated into model



TM_REQ_85

Create Observing Project from Proposal

The TM shall allow science operations users to create an Observing Project from an approved/accepted Proposal.

Work Packaged: TM

Status: Approved

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*Refined Function: Create Project (implemented by **Observation Design Tool**)*

*Allocation: **TM Mid***

Assigned to: OBSMGT (direct allocation DAL2.85)

Derived from:

***SKA1-SYS_REQ-2723** – There shall be a tool to facilitate the assessment, review and ranking of proposals, guided by official SKA Policies.*

Derived to:

***OBSMGT_00167** – The ODT will provide summarised details of the scheduling information, together with the results of simulated execution in a form that allows observatory staff and projects to verify that the project as defined should meet the scientific and technical aims defined in the original proposal. (decomposed as OBSMGT_00167, OBSMGT_00168)*

Verified by:

***TM_VREQ_71** – Using the TM GUI, demonstrate creation of an Observing Project by an Operator. (Use events VE1, VE2, VE3 and VE5)*

MSBE Strategy

Requirements integrated into model

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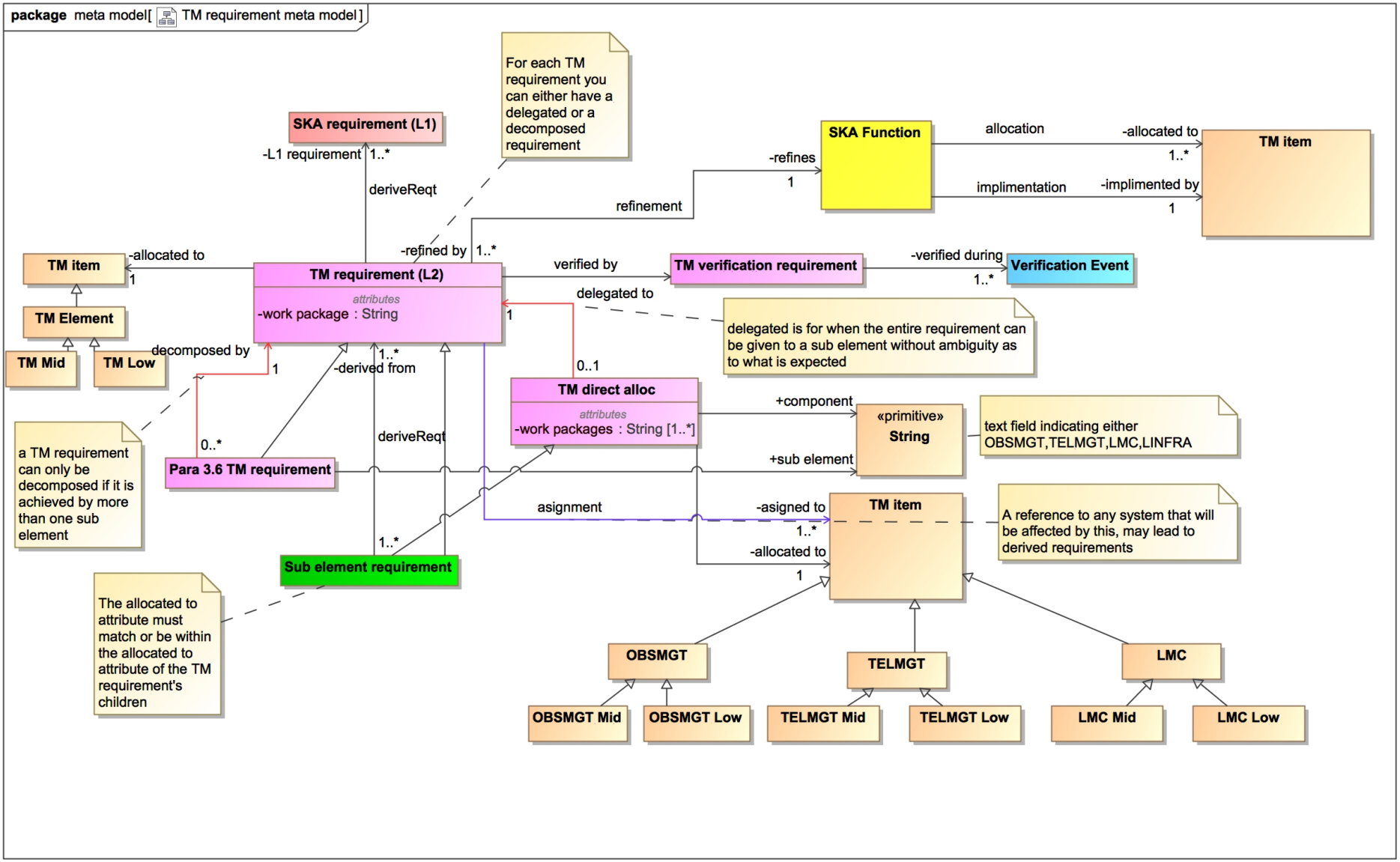


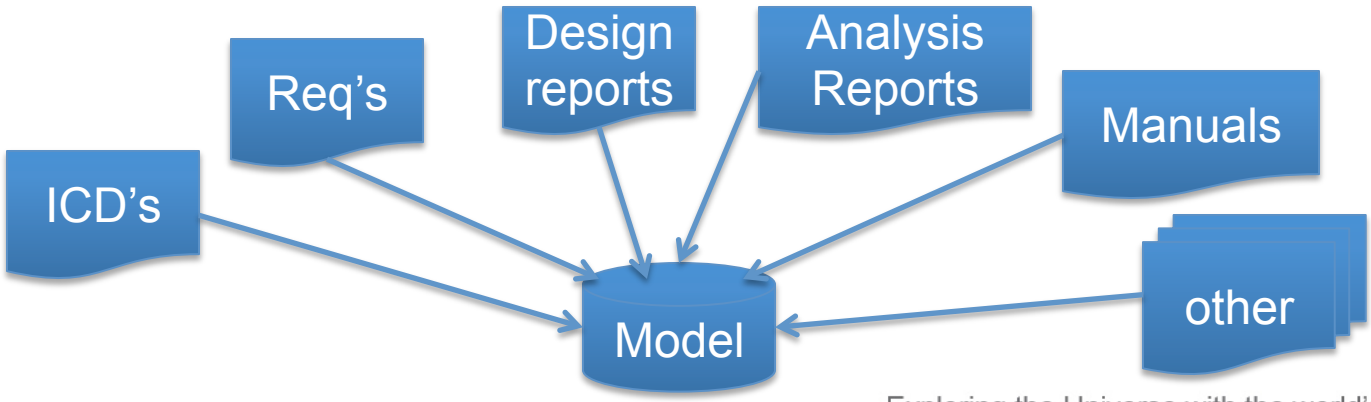
MSBE Strategy
The ubiquitous document

- Despite the promises of lean SE, agile and MBSE – quantity of documents are still huge
- However this may be due to an underlying need:
  - client needing information as intermediate deliverables of work effort
  - separate teams requiring input information to complete tasks and
  - To manage and assess changes during development

Event	Nr Docs
Submission for External preliminary review	84
Intermediate update after External review	86
Submision for conclusion of Prelimary Baseline	118

MSBE Strategy
How to handle documents

- What is a document really?
  - Presentation of information
  - Consistent and self standing
  - Whole (complete) - not partially
  - **But** as a "view" only of some underlying model according to some presentation logic
- Model View Controller (MVC)



Outcomes

Outcomes
Productivity

- Tools are memory hoarders:
  - Diagramming create unnecessary data
  - Sometimes difficult to separate noise from information
  - Mostly alleviated by following a life cycle approach
- Tool are complex applications with steep learning curves
- Importing and exporting information:
  - Difficult to tailor into own project specific context
  - Requires investment in scripting and plugins

Outcomes
Productivity

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- **However there are significant Positive aspects:**
  - explanatory power: present the problem or design in a language that conveys meaning
  - structuring the design: Force the design work into architectural concerns (structural definition)
  - Spend more time working on design than on “boiler plating”

Conclusions

Conclusions
What to look for in a Tool

- Key features of a MBSE tool:
  1. Requirements + Model
  2. Generate information for consumption into different formats (word documents, pdf's, websites etc.) that is **customisable**
  3. Assist information to be modeled according to separate life cycle stages.

Conclusions
What will the future look like?

- Interesting Trends:
  - Decoupling of persistence technologies from application technologies.
  - Open source cloud based computing (e.g. slack, JIRA, confluence, alfresco)
  - Network speed result in web sites becoming web applications
- From this we may “speculate” that tools become separated:
  1. Front ends may move more towards the web (especially for collaboration purposes – production and consumption)
  2. Back ends may allow for rendering different products (pdf’s, web pages, word docs, excel)

Conclusion
Is there value in MBSE?

- YES
  - Reduces inconsistencies, redundancies and waste
  - Ease change management
  - Ease communication (explanatory power)
- BUT
  - Requires investment (not an off the shelf solution):
    - Learning and adapting to own context
    - Importing/Exporting data
    - Steep learning curves

Thank you

Questions