RangeDB in support of MBSE

Flexible Infrastructure enabling incremental application of MBSE

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With contributions of …

Chris Blade, Florence Mattler, Alain Martinez, Andre Labouche, Jacques Seronie-Vivien, Michael Scheuble, Anne-Laure Tournoud, Oliver Zanon, Guillaume Pelouas, Ambros Morscher, Nico Kalmbach, Tobias Steinle, Robert Birn, Françoise Carre
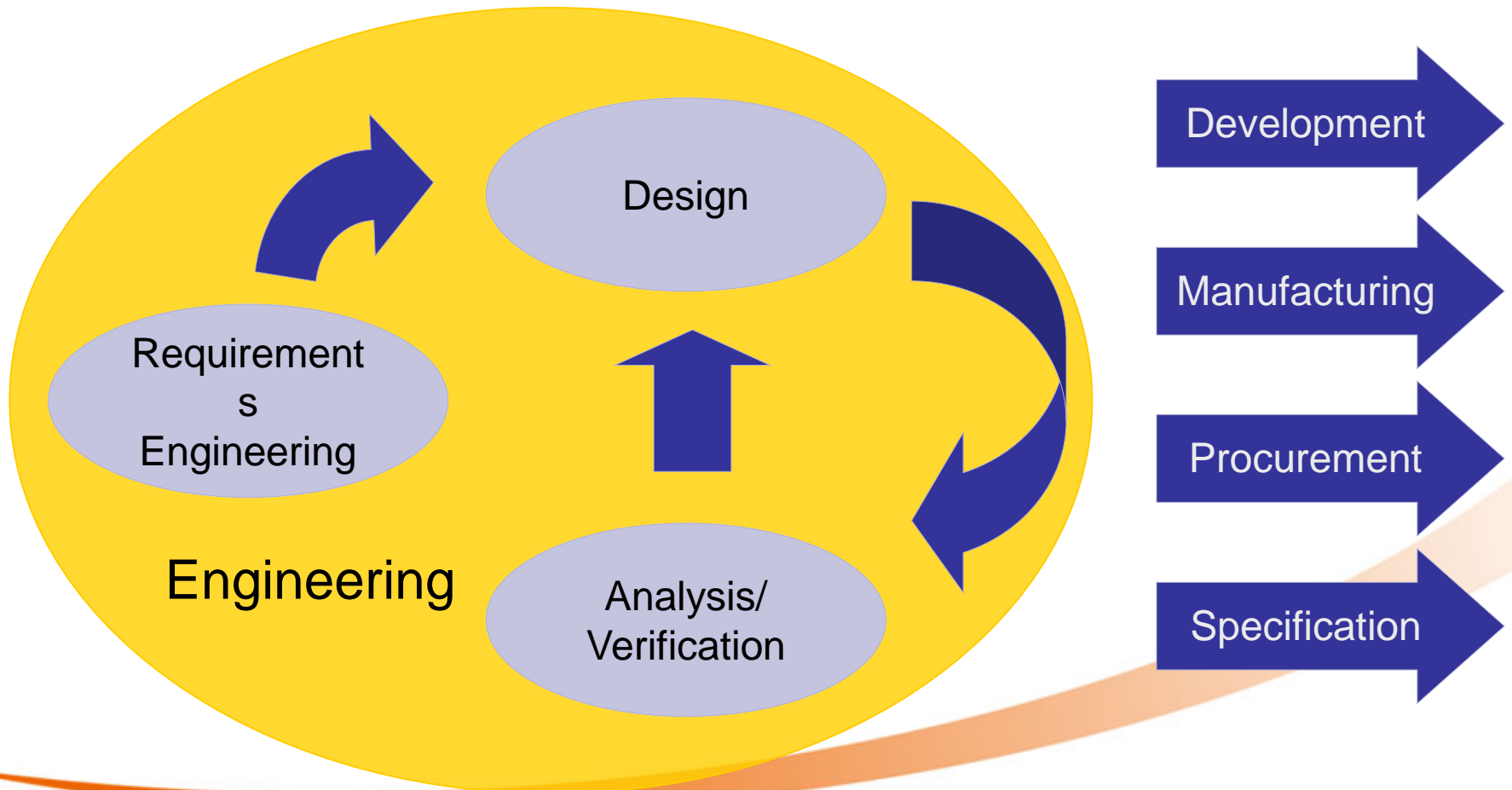
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Application of MBSE requires a continuous evolution and integration of tools

- Model-driven engineering is an overall trend for all engineering disciplines

- Evolving systems engineering into model-based systems engineering turned out much more complex

- Application of MBSE requires a flexible infrastructure, allowing the incremental increase of supported use cases
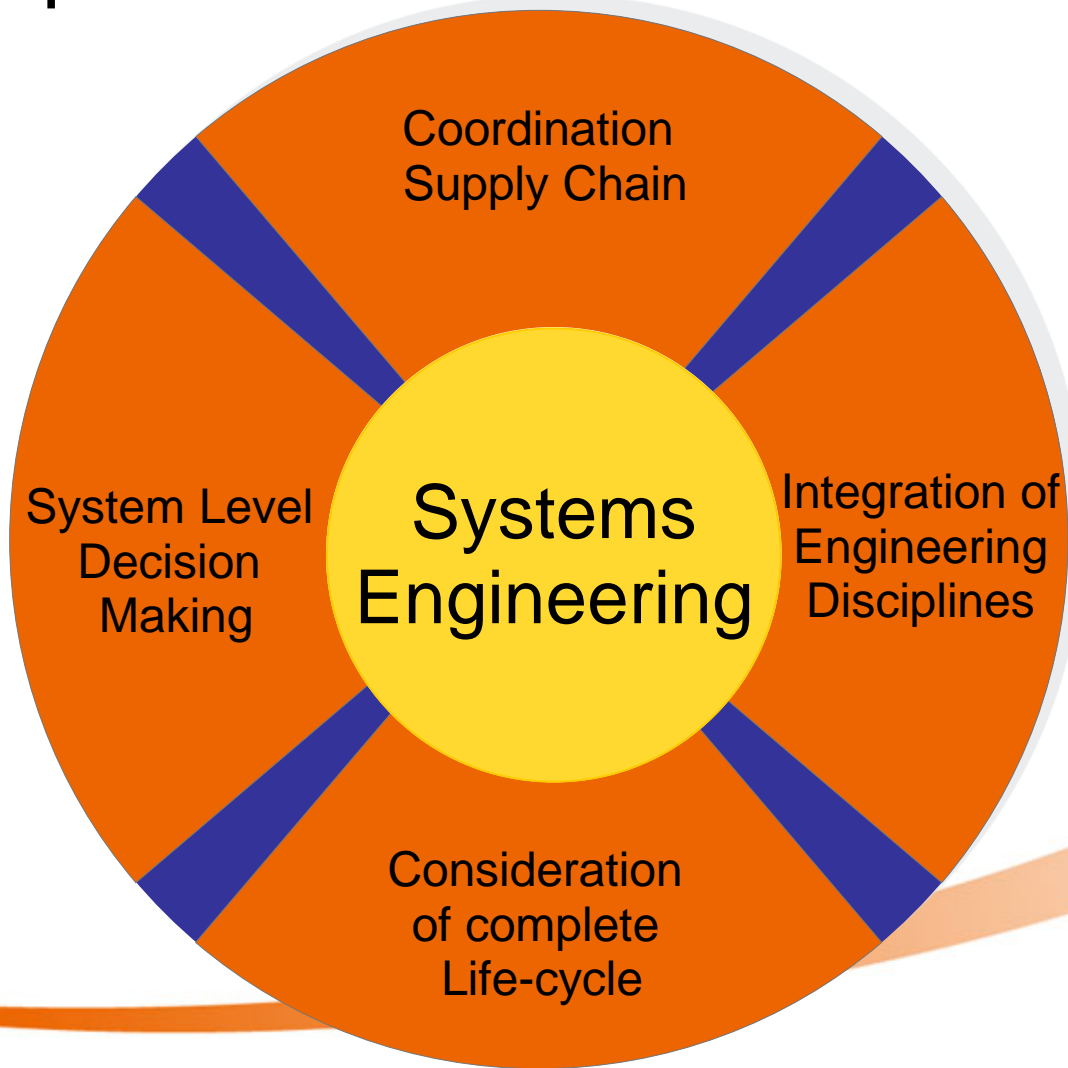
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Systems Engineering follows basic Engineering principles

Engineering

- Requirements Engineering
- Design
- Analysis/Verification

Development

Manufacturing

Procurement

Specification

In addition, systems engineering has some specific characteristics

Coordination Supply Chain

System Level Decision Making

Systems Engineering

Integration of Engineering Disciplines

Consideration of complete Life-cycle

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Relying on computer-based models is an overall trend, however MBSE is more tricky

- Various computer models are in use supporting the specific steps of engineering

- Realizing model-based engineering for systems engineering is much more complex - due to complex nature of SE

- An efficient tool support for MBSE is currently not given (i.e. SysML ≠ MBSE), thus tailored solutions are required

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Trend of model-driven engineering (MDE) cares for end-2-end model integration

Systems
Engineering
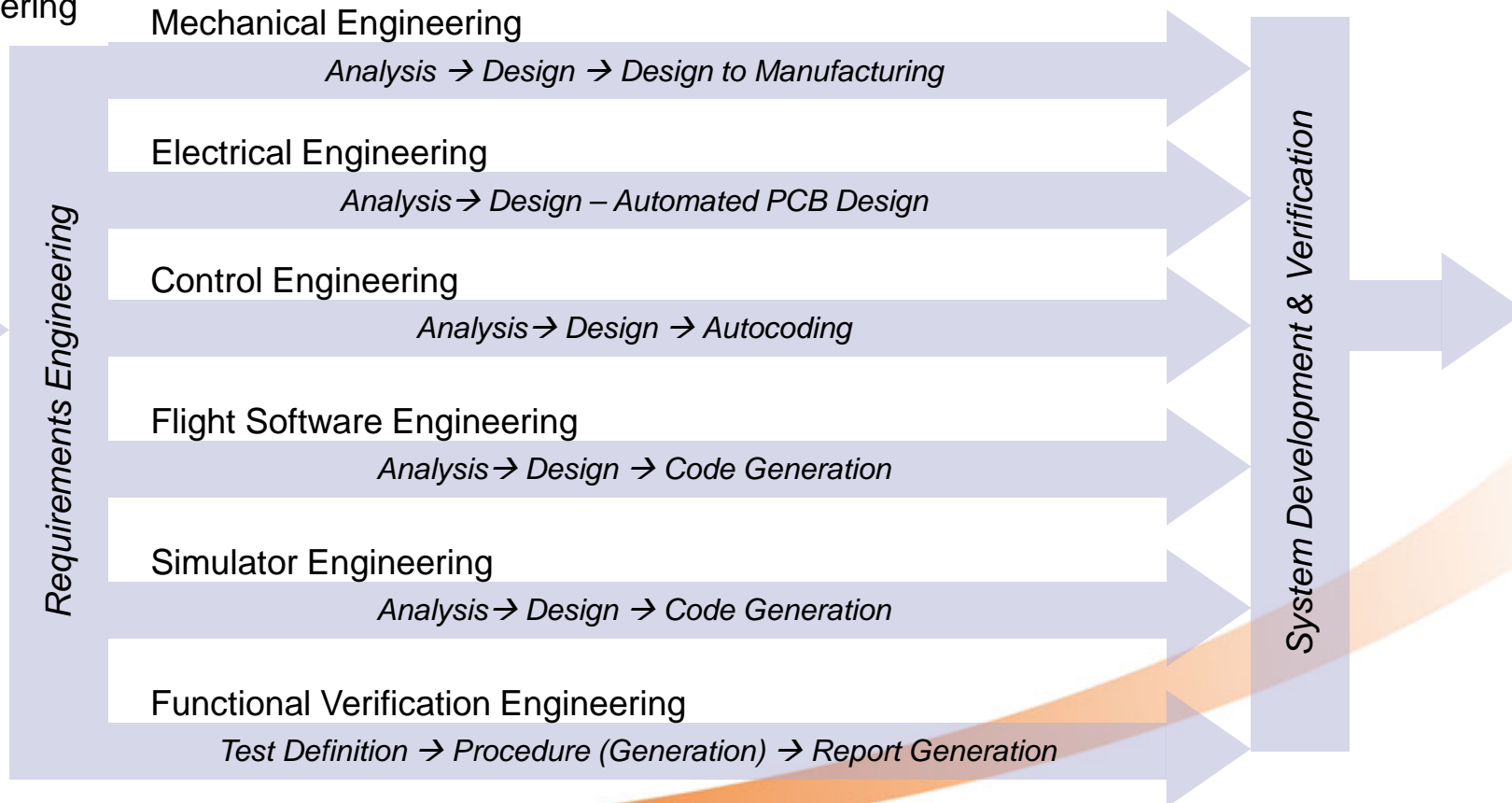
Requirements Engineering

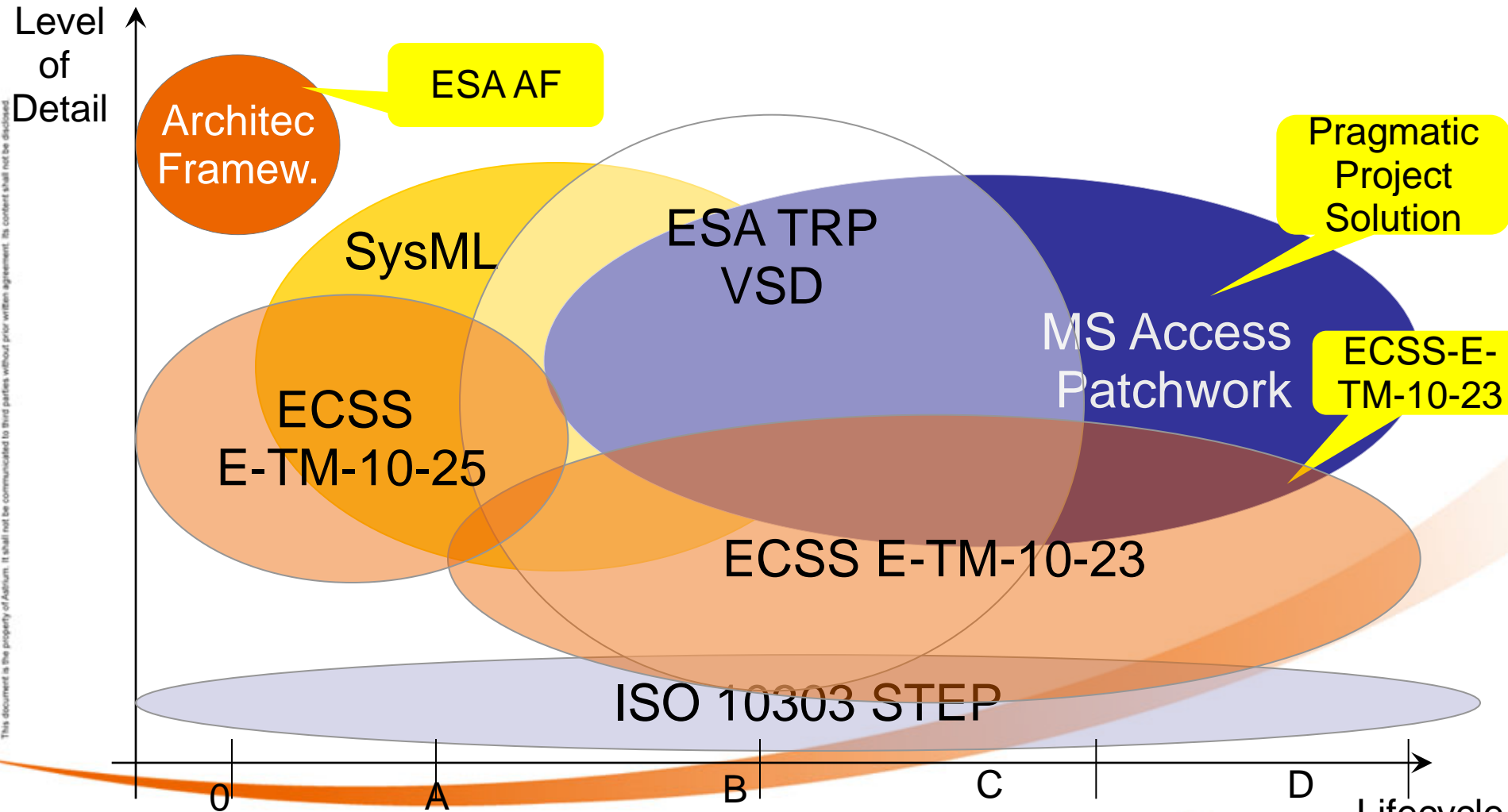*System Development & Verification*

Mechanical Engineering

Analysis → Design → Design to Manufacturing

Electrical Engineering

Analysis→ Design – Automated PCB Design

Control Engineering

Analysis→ Design → Autocoding

Flight Software Engineering

Analysis→ Design → Code Generation

Simulator Engineering

Analysis→ Design → Code Generation

Functional Verification Engineering

Test Definition → Procedure (Generation) → Report Generation

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MBSE suffers lack of integrated – shared – system model representation
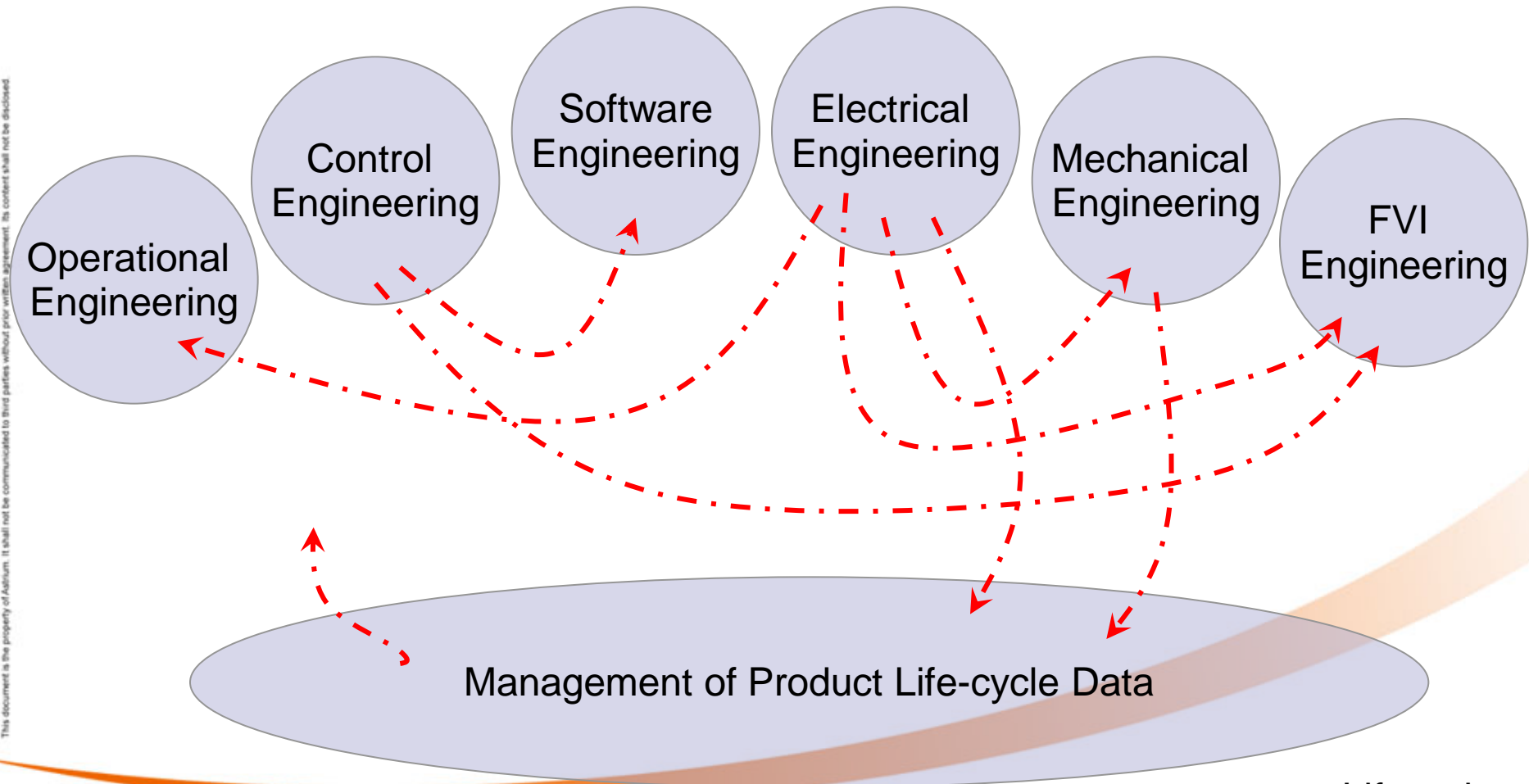
Operational Engineering

Control Engineering

Software Engineering

Electrical Engineering

Mechanical Engineering

FVI Engineering

Management of Product Life-cycle Data

Lifecycle

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No coherent technological standardization and technology to close gaps between models

RangeDB supports the emerging MBSE application, starting with SRDB use case
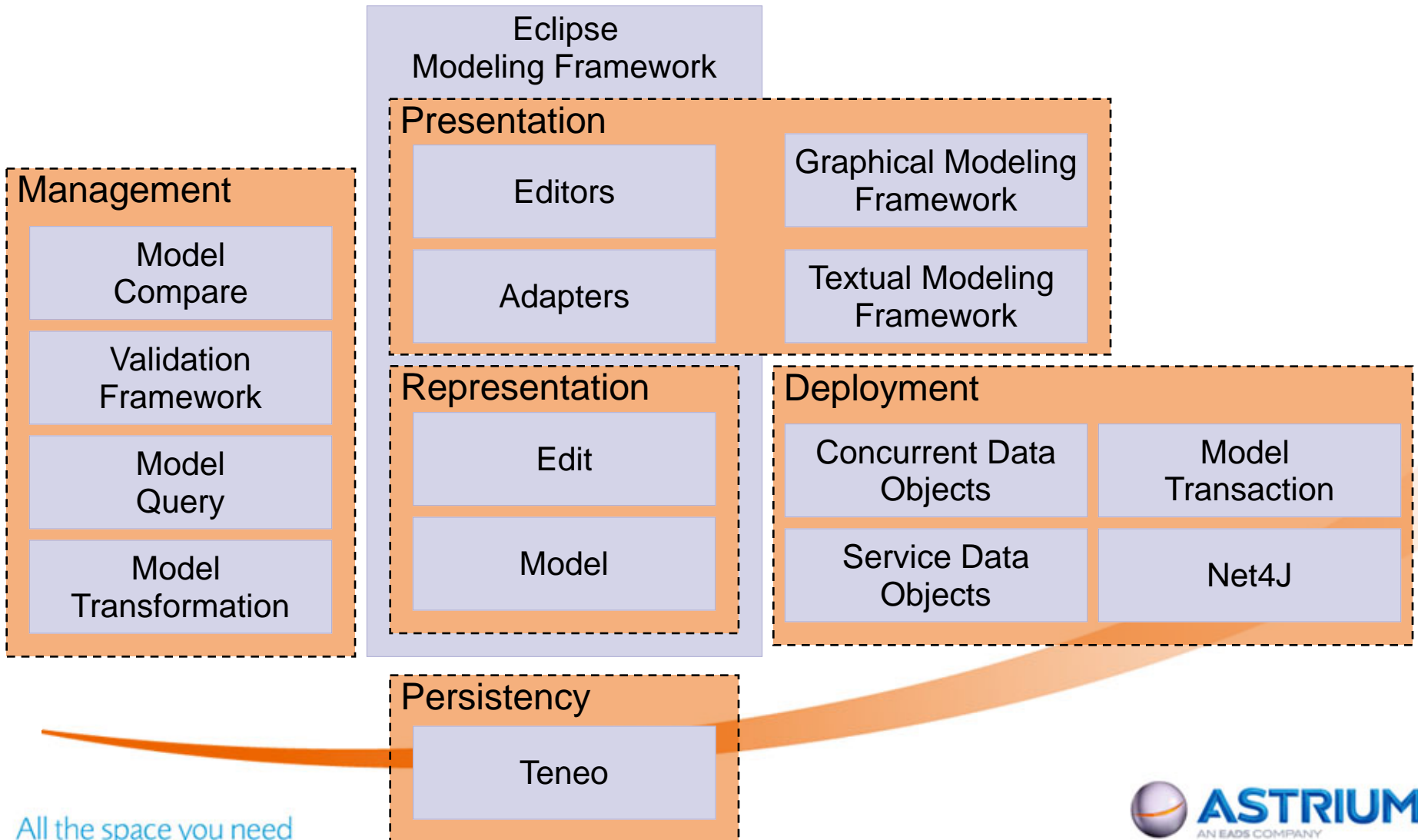
- **Evolvable infrastructure as basis**
    - Formalized conceptual data model
    - Infrastructure with little dependencies on the data model

- **Various deployment architecture allowing to tailor solution according to project needs**

- **Flexible organization of data according to engineering process constraints**

- **Powerful data management functions enabling the user to full master the process**

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Modular conceptual data model allowing the evolving support of MBSE use cases
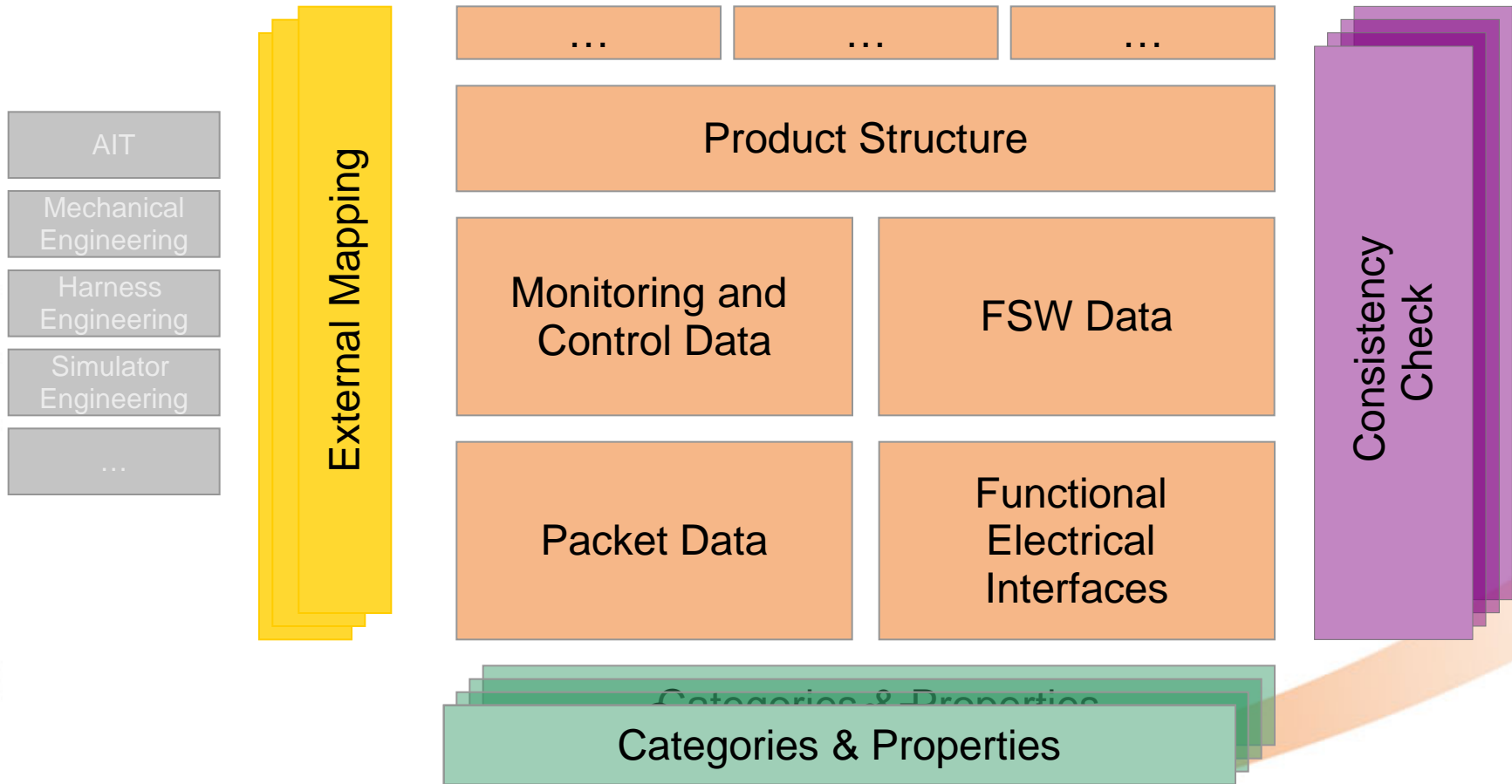
AIT
Mechanical Engineering
Harness Engineering
Simulator Engineering
...

External Mapping

...	...	...

Product Structure

Monitoring and Control Data

FSW Data

Packet Data

Functional Electrical Interfaces

Categories & Properties

Categories & Properties

Consistency Check

→ Model is derived from ECSS E-TM-10-23 and QUDV and coordinated through EGS-CC

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Eclipse offers a rich framework to build solutions for model-based/driven processes

Eclipse Modeling Framework

Presentation
- Editors
- Adapters
- Graphical Modeling Framework
- Textual Modeling Framework

Management
- Model Compare
- Validation Framework
- Model Query
- Model Transformation

Representation
- Edit
- Model

Deployment
- Concurrent Data Objects
- Model Transaction
- Service Data Objects
- Net4J

Persistency
- Teneo

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Different frameworks tie into each other, for flexible configuration of application
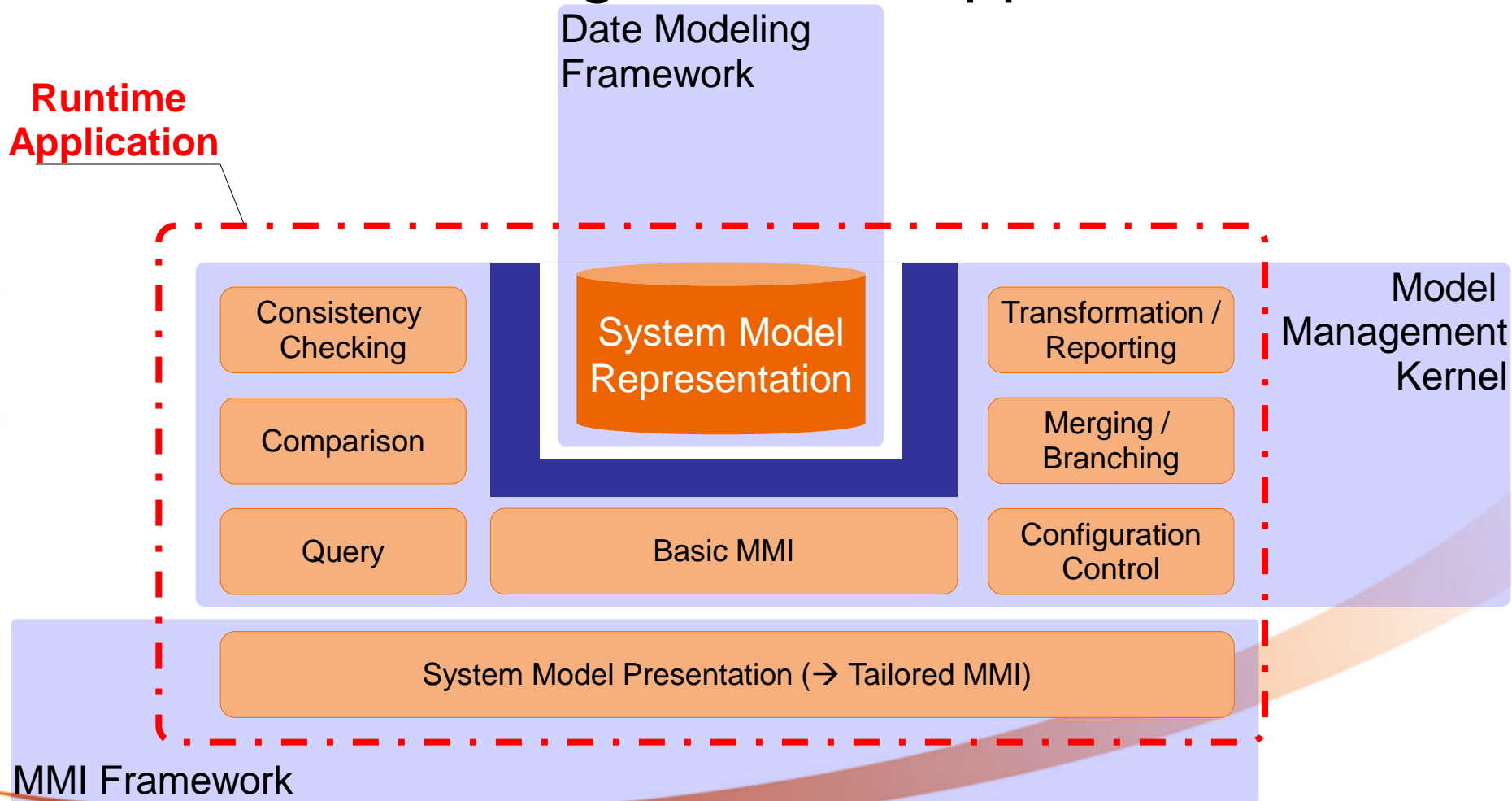
Date Modeling Framework

Runtime Application

Model Management Kernel

Consistency Checking

System Model Representation

Transformation / Reporting

Comparison

Merging / Branching

Query

Basic MMI

Configuration Control

System Model Presentation (→ Tailored MMI)

MMI Framework

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Flexible organization of data according to engineering process constraints

product tree
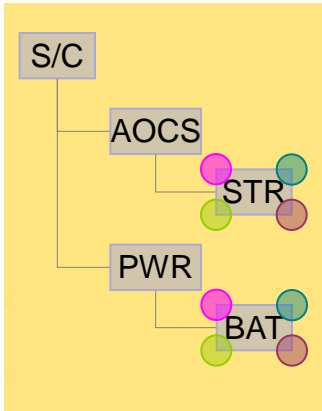
configuration

configuration control

dependencies

branching
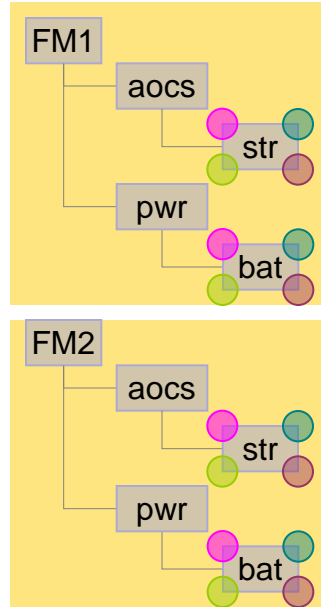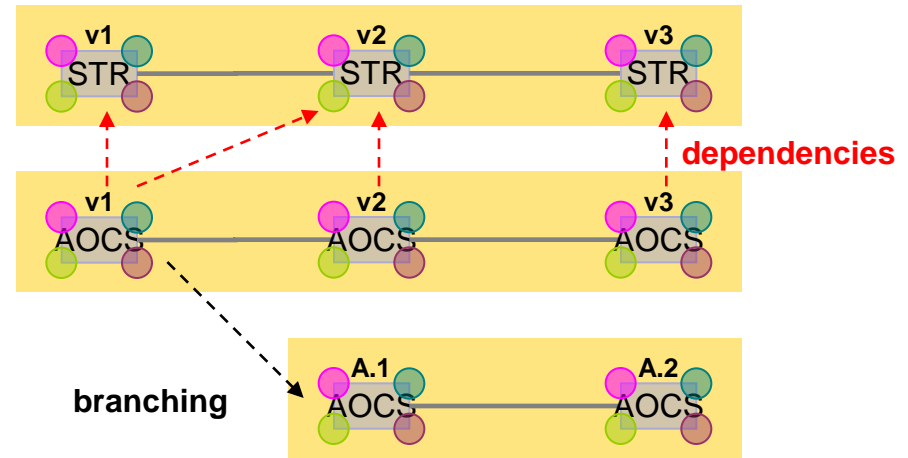
implicit definition

str-a

auto-derived

str-b
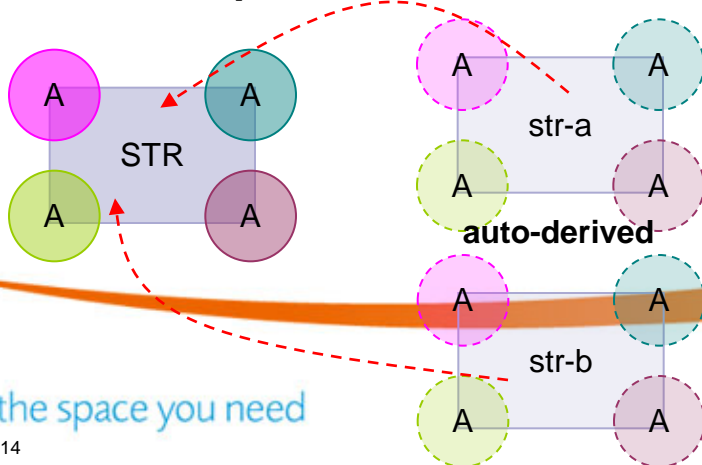
aspect group management
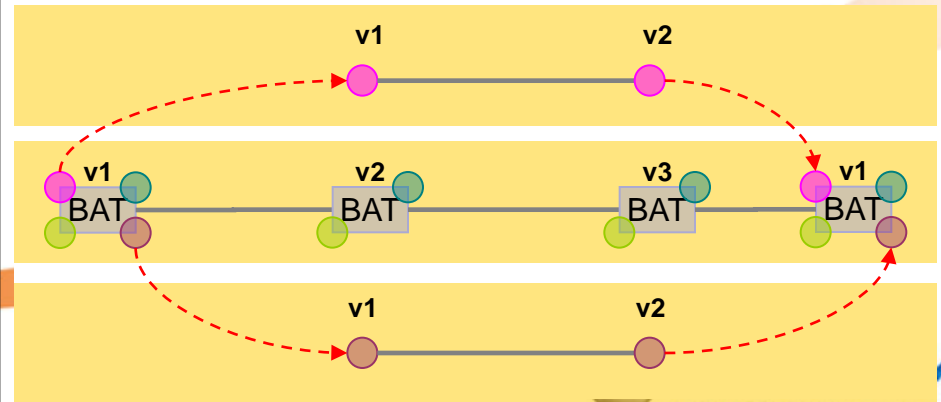
Various deployment architecture allowing to tailor solution according to project needs

RCP
- CC
- MCF
- ...

online-mode

RCP

RCP

offline-mode

Range DB Server

Repository

Web Server

RAP
- CC
- MCF
- ...

SVN

Browser

Browser

Browser

■ ■ ■

■ ■ ■

cascading

RDB Server
Rep. | WS

RDB Server
Rep. | WS

RDB Server
Rep. | WS

RDB Server
Rep. | WS

RDB Server
Rep. | WS

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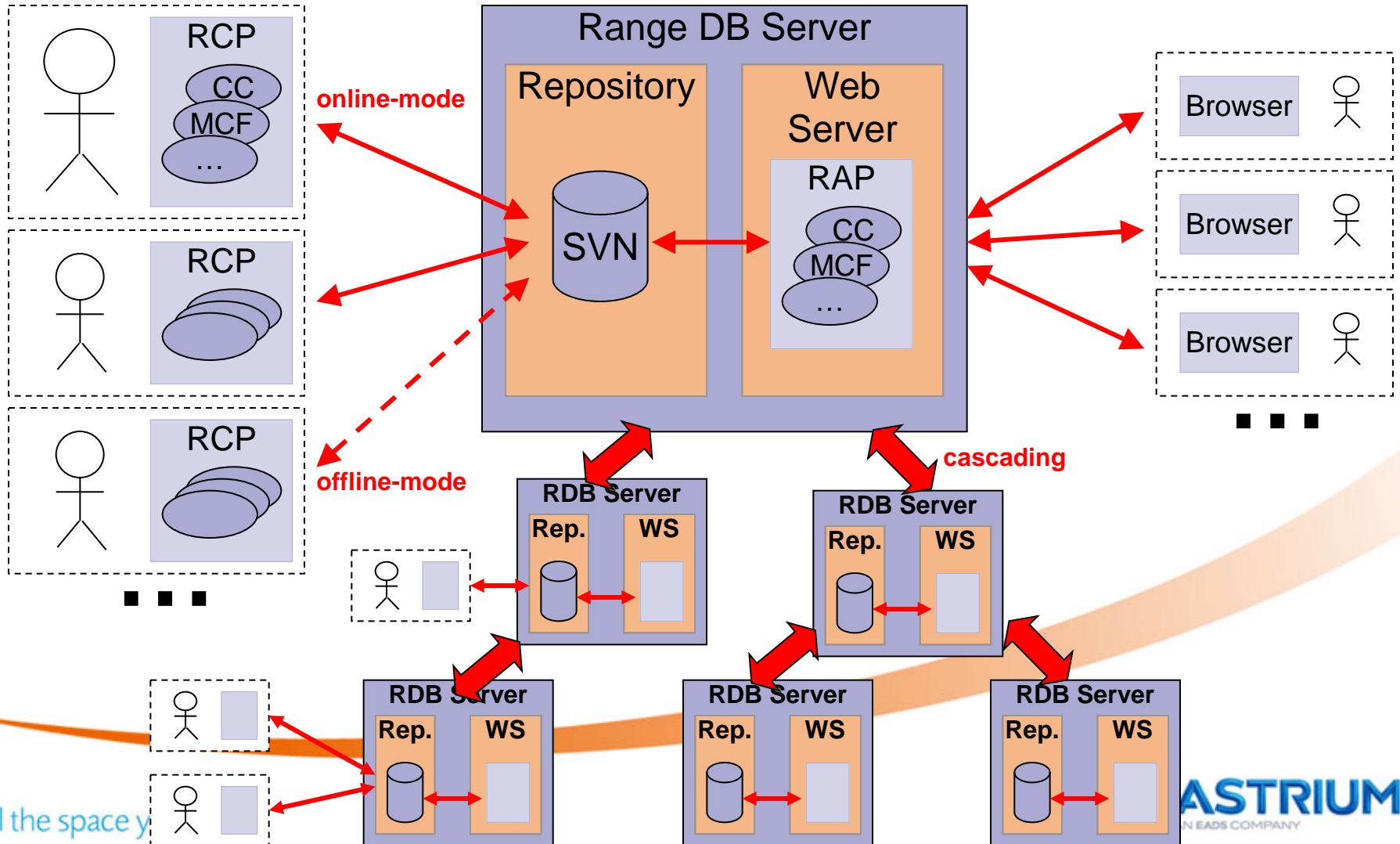
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RangeDB will be an essential part of the overall model management architecture
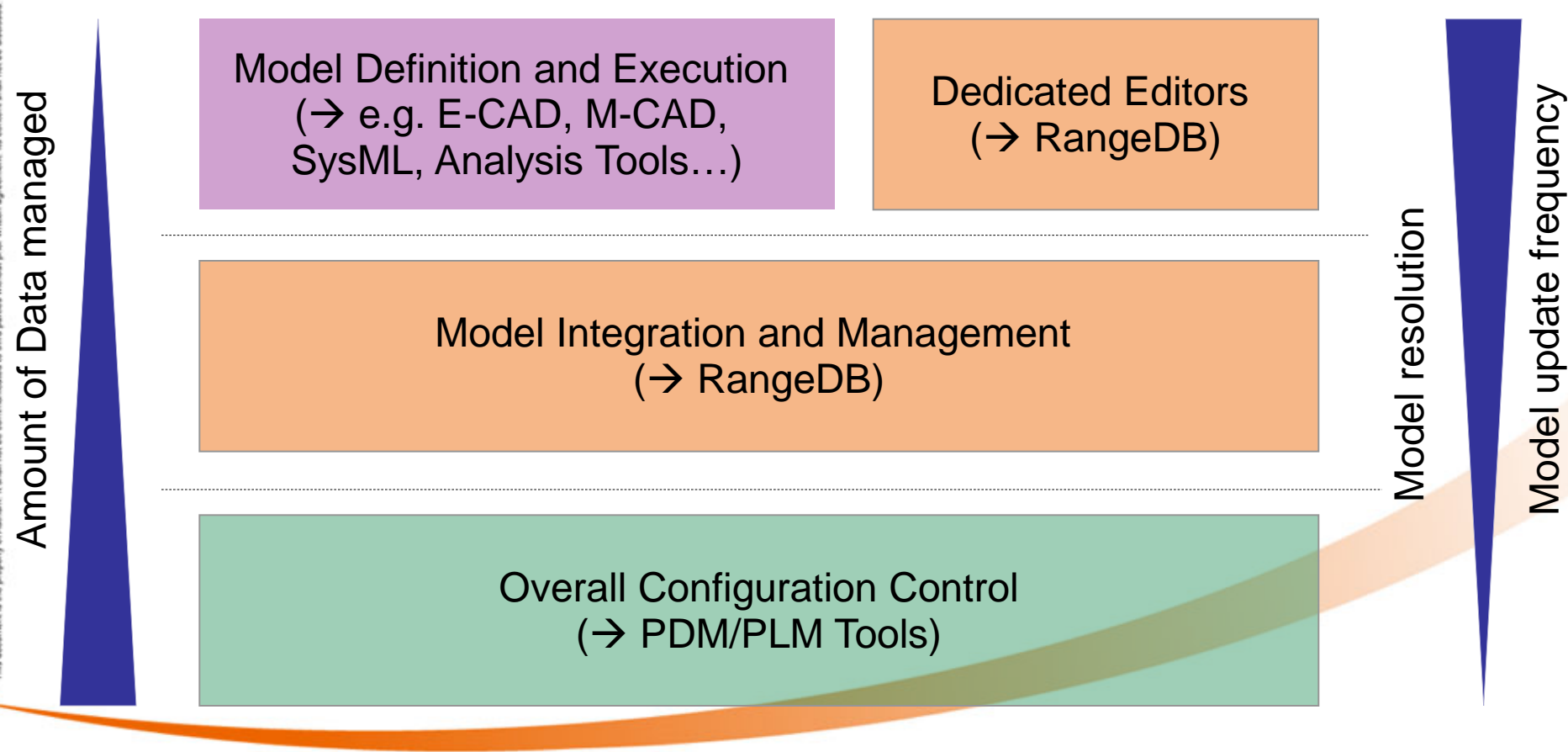
Amount of Data managed

Model Definition and Execution
(→ e.g. E-CAD, M-CAD, SysML, Analysis Tools…)

Dedicated Editors
(→ RangeDB)

Model Integration and Management
(→ RangeDB)

Overall Configuration Control
(→ PDM/PLM Tools)

Model resolution

Model update frequency

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RangeDB offers powerful features to manage the models and data

- MMI tailored for the use cases, evolved in co-engineering with the users

- Highly configurable query and reporting of data

- Fine-grained tracing of history, changes and resolution of conflicts

- On-demand application and resolving of consistency checks

- Run-time configuration of properties managed through customized application of QUDV

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Overview Slide on MMI required

RangeDB Data Model

Specifies MMI for

Layout = Chart
X = point.x
Y = point.y

MMI Model

edits

Developer/User

RangeDB Application

Reads at runtime

UI-Engine

Creates UI at runtime

Graphical exploration of model content and dependencies

- Allows graphical queries to the model
  - Based on data model associations
  - Results can be filtered all – selected

- Results are graphically displayed
  - Layout is done automatically
  - Different placing algorithms

- "Perspectives" can be persisted
  - Storage of queries, filters
  - Perspective follows model content

- Full integration with editor given

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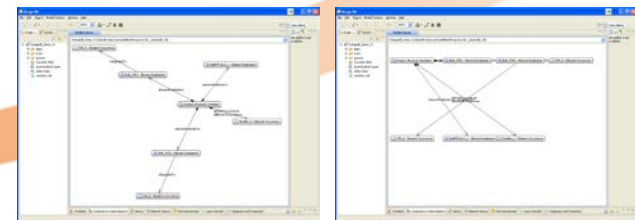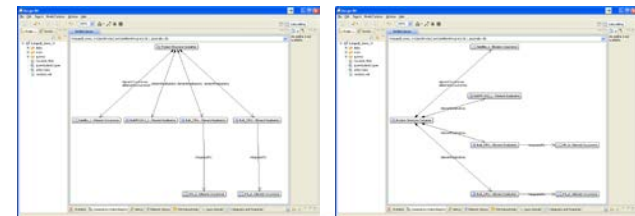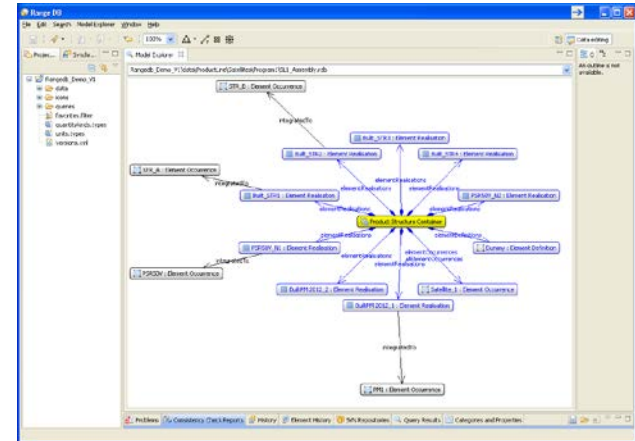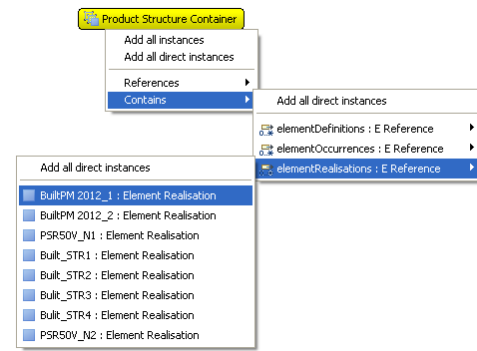
EMF provide SQL-like query mechanisms

- State of the art editing of queries
  - Syntax highlighting, auto-completion, …

- Pre-definition, sharing and versioning

  from *<Type(Table)>* **as** *<alias>* **select** *<alias>*
  where *<alias>.<attribute> = <alias or alias attribute>*
  and\or *<alias or alias attribute>*
  in *(<nested-query>)*

- Flexible query execution:
  - Batch mode, or "live" directly from editor


```
new_queries.query    pcf.query

import "http:///rangedb_cdm/monitoringdata/monitoringparameterscalibration.ecore"
import "http:///rangedb_cdm/monitoringdata/monitoringparameters.ecore"

GetAllPcf:
from PCF as pcf select pcf

GetCategory1Pcf:
from PCF as pcf select pcf.PCF_NAME, pcf.PCF_DESCR where pcf.PCF_CATEG like "CAT_1" or pcf.PCF_NAME like "*P*"
```

Problems   Query Results

Search

caf.CAF_NUMBR (ecore::EString)	caf.CAF_DESCR (ecore::EString)	caf.CAF_ENGFMT (ecore::EString)	caf.CAF_NCURVE (ecore::EInt)
CASP3301TM	ES Pitch Angle	R	33333
CASP3302TM	ES Roll Angle	R	3
CSBP1009TM	ICDU Int TH (18k41 at 20degC)	R	176

Powerful tracking of changes and resolution of conflicts

- Changes (local, remote) can be tracked and visualized

- Conflicting modifications can be identified and resolved

- Merge of concurrent branches
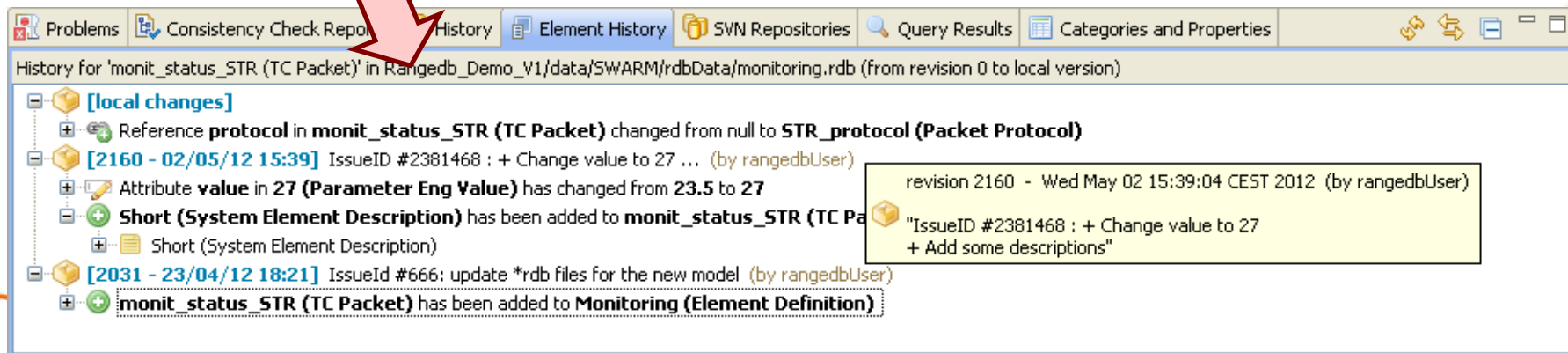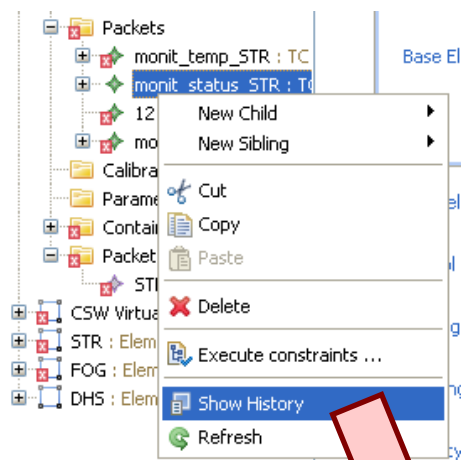
- Support for online, offline activities

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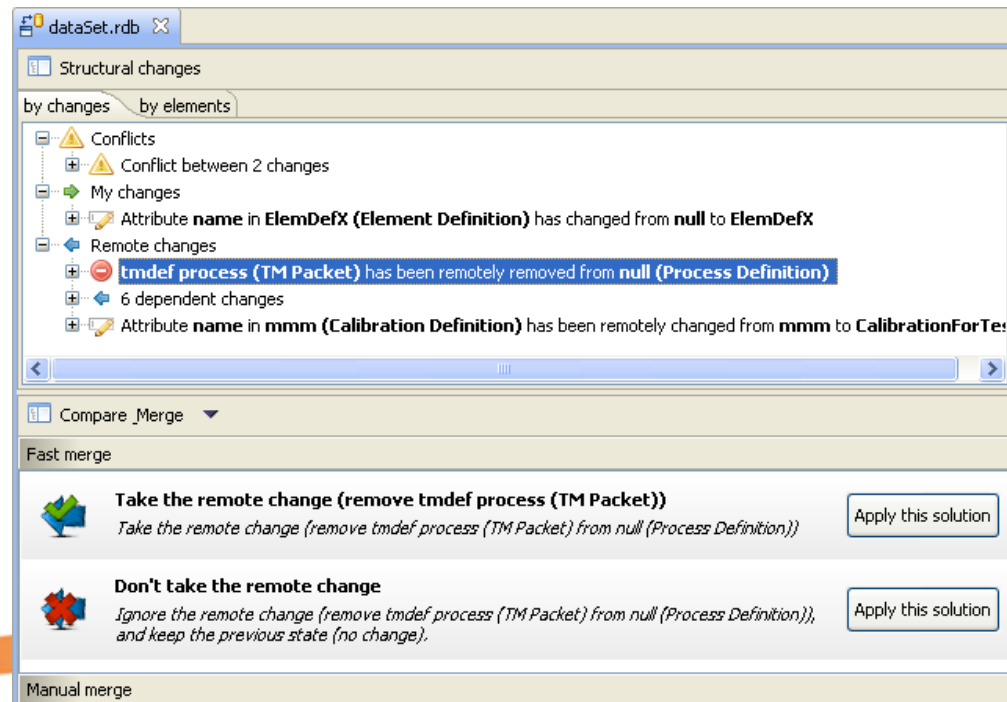
History of data items can be traced

=> Following the user need to have object-centric history

- **View the detailed history for a selected object(s)**

  - History for the object and its content
  - Sorted by revisions (= "commit" / "check in")
  - Information available:
    - Revision number
    - Author
    - Date
    - Comment
    - State of the data after each change
  - Show also local changes

History for 'monit_status_STR (TC Packet)' in Rangedb_Demo_V1/data/SWARM/rdbData/monitoring.rdb (from revision 0 to local version)

- **[local changes]**
  - Reference **protocol** in **monit_status_STR (TC Packet)** changed from null to **STR_protocol (Packet Protocol)**
- **[2160 - 02/05/12 15:39]** IssueID #2381468 : + Change value to 27 ... (by rangedbUser)
  - Attribute **value** in **27 (Parameter Eng Value)** has changed from **23.5** to **27**
  - **Short (System Element Description)** has been added to **monit_status_STR (TC Pa...**
    - Short (System Element Description)
- **[2031 - 23/04/12 18:21]** IssueId #666: update *rdb files for the new model (by rangedbUser)
  - **monit_status_STR (TC Packet)** has been added to **Monitoring (Element Definition)**

revision 2160 - Wed May 02 15:39:04 CEST 2012 (by rangedbUser)

"IssueID #2381468 : + Change value to 27
+ Add some descriptions"

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Applicationo of Consistency Checks

- Constraint definition
  - OCL editing on data model
  - User defined in application

- Execution
  - Automatic during build
  - User driven on demand
  - Customize/Store execution

- Integration in UI
  - Problems View
  - Consistency check view
  - UI navigation

- Results

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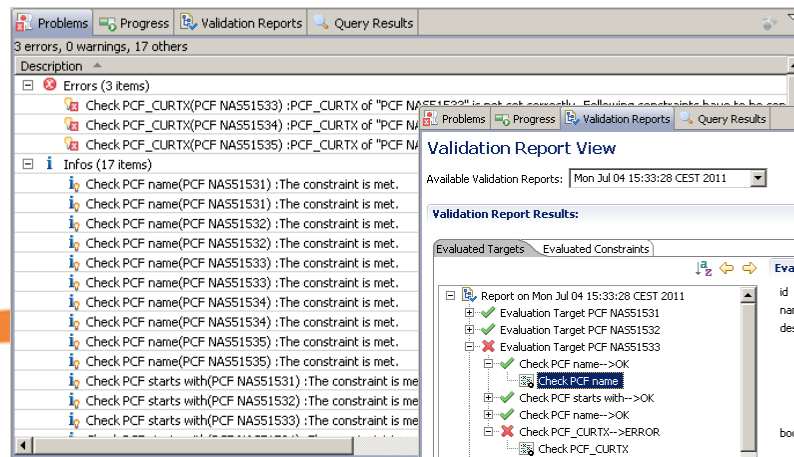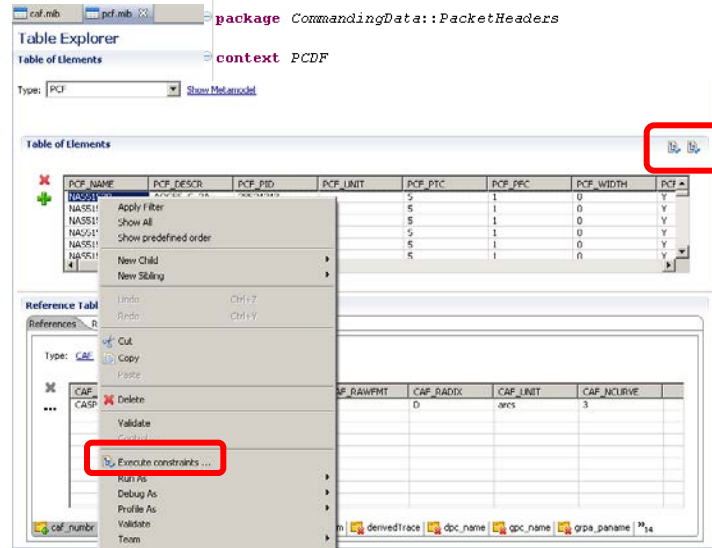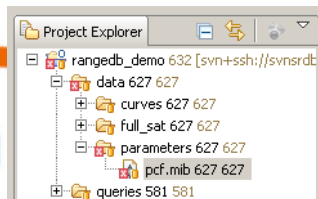
Dealing with Engineering Properties

- Consistent application of categories
    - Consistency checking
        - Errors in Categories and Properties View
        - Errors in Problem view
        - Problem markers on Files
    - Problem resolving
        - Action on editor
        - Dialog with detail information
        - Quick-fix in problems view

- Pre-defined categories delivered with application (Project independent)
    - Physical
    - Equipment
    - System Element
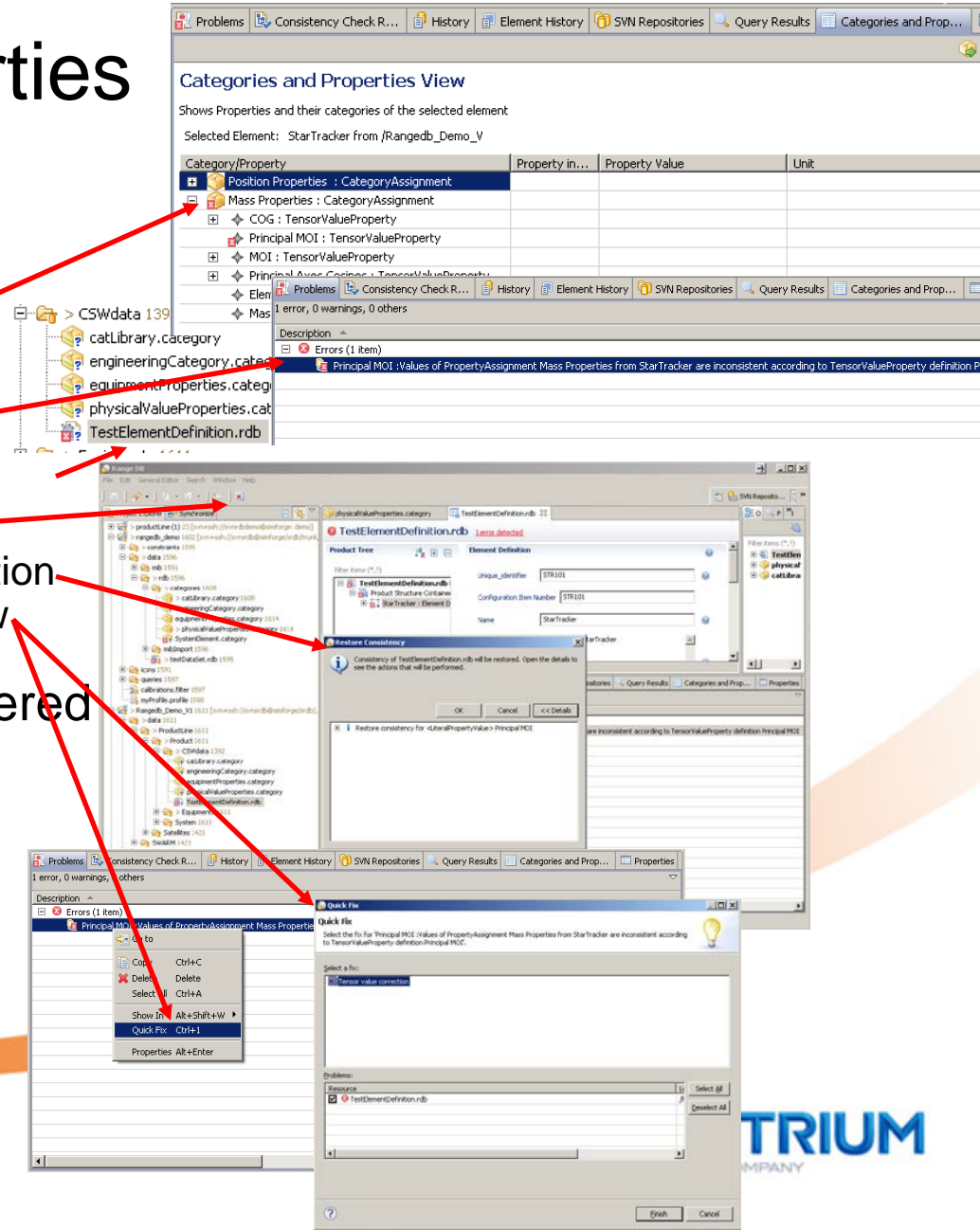
RangeDB is a key element for the incremental adoption of MBSE

- **RangeDB initially supports the classic SRDB use case - as starting point, for MBSE support**

- **Flexible infrastructure enables the future enhancement of data managed, I/F supported**
  - Explicit – fully managed – specification of data
  - Infrastructure with little dependencies on data model
  - Tailored, use case driven MMI
  - Incremental development and close collaboration and co-engineering with users

- **Collaboration with ESA and industrial partners**
  - Key driver for selection and validation of technologies
  - Collaboration is continued (EGS-CC, ECSS-E-TM-23/5, Data Modeling Technologies)

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