

ARTIFICIAL INTELLIGENCE AND NATURAL LANGUAGE PROCESSING TO SUPPORT SPACE SYSTEMS ENGINEERING

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AGENDA

/// AI and NLP usages for engineering

/// Implemented use-cases

/// An operational deployment need :

- Data
- Architecture
- IT infrastructure

/// Way forward

AI & NLP USAGES FOR ENGINEERING

Engineering data
continuity

- / Discover links, align concepts, smart merging
- / Reconciliation

Technical debt

- / Verify rules on textual assets (requirements, Capella descriptions, ...)
- / Verify model conformity rules (coverage, allocations, ...)

Engineering digital
assistant

- / Smart and ubiquitous searching
- / Content recommendation (for review, requirement writing, reuse, ...)
- / Questions/answers and knowledge extraction

Tedious tasks automation

- / Automated traceability, ...
- / Inconsistency detection, ...

Out of scope of this presentation : others usages of AI like simulation, digital twin, ...

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OSIP STUDY USE-CASES

/// Smart search

- Across all the artefacts, including :
 - Textual content
 - Model elements
- Taking into account business knowledge :
 - Acronyms, taxonomy, ...
- Semantic search
 - Concept closeness instead of key word matching

/// Recommendation

- Propose related artefacts to the reviewer

/// Traceability assistant

- Between two specification, a function and implemented requirements, test and requirements, ...
- Propose artefacts to be traced to the user
 - The user has always the final decision

The image displays three overlapping screenshots of the OSIP system interface. The top screenshot shows a search results page with a list of requirements and a detailed view of a requirement (GYR-URD-REQ-0002) with its text and a traceability graph. The middle screenshot shows a recommendation interface with a list of related requirements (e.g., MLA-GEN-PF-TRD-REQ-151, 145, 170, 171, 006, 0072) and their scores. The bottom screenshot shows a search results page with a list of requirements and a detailed view of a requirement (GYR-URD-REQ-0002) with its text and a traceability graph. A blue callout box points to a requirement in the middle screenshot with the text: "Similar requirement in another specification (we are in gyro spec and it proposes the star tracker spec)".

AI NEED... DATA

/// AI algorithm training need (potentially large) data-set of good quality

/ Aggregation of data of several projects on a long period

Need a lot of
data

/// Need large data scope : requirements + architecture + IVV + planning + ...

/ Maximum potential is achieved on end-to-end data

/ Aggregation of data coming from different tools with very different interfaces

With large
scope

/// Need strong and consistent semantic and highly connected data

/ Ontology structuring a knowledge graph as primary source of data

With strong
semantic

/// NLP is the beginning, graph neural networks are promising

/ Not only textual data but complete graph

Not limited to
textual data

AI NEED... REFERENCE ARCHITECTURE

/// Fast pace :

- ! algorithms or models of today are deprecated tomorrow
- ! authoring tools of today are also deprecated tomorrow

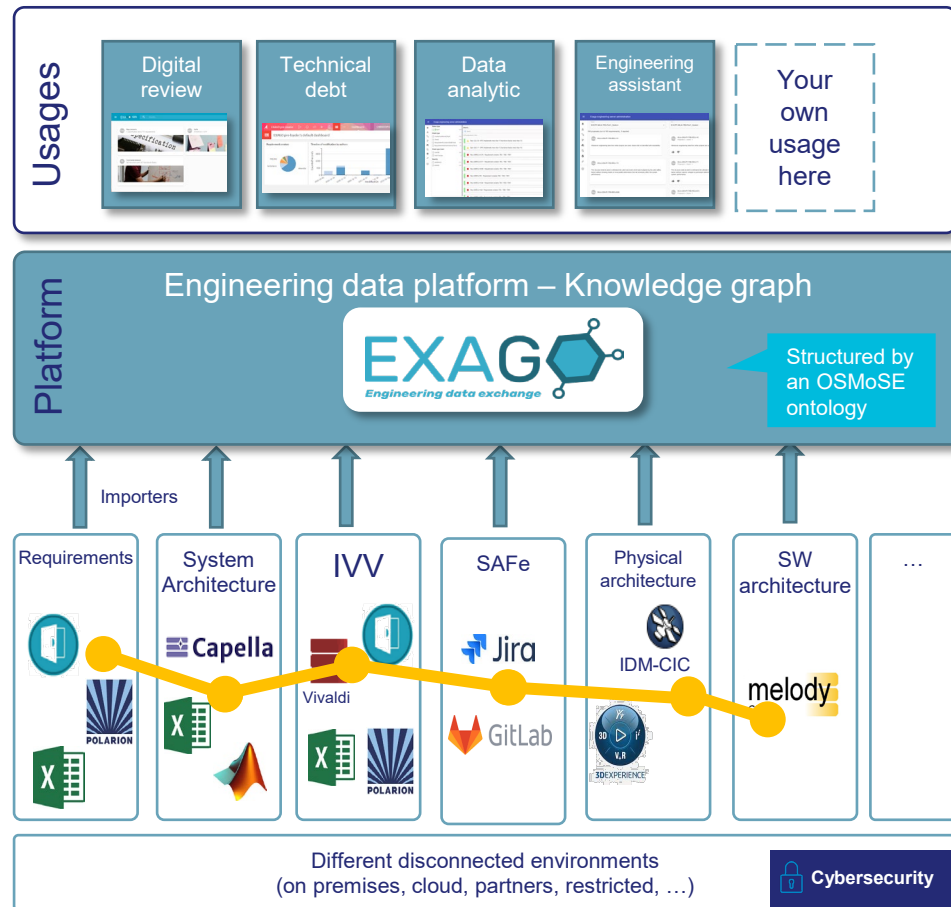
/// Optimisation of developments and integration costs

- ! Do not develop specific connectors each new applications and each authoring tools upgrade

/// Unification of user experience

- ! Not one interface per AI usage
- ! Centralised detection of problems

/// Easy integration of innovation (internal or external)



IT INFRASTRUCTURE CHALLENGES

/// Usages range from near real-time interaction to long batch processing

/// Store (big) knowledge graphs efficiently

- ! 10s of projects each >500k nodes and >500k edges + history
- ! Performance is required on read (incl. graph traversal), less critical for write
- ! Need dedicated databases

/// Many type of queries : graph traversal, k-nearest neighbours, faceted search, inference, ...

- ! No one size fit all solution
- ! Knowledge graph has to be indexed in highly specialised databases (add complexity to the solution)

/// Continuous delivery of improvements

- ! Switch to a release of the solution every 6 months to several releases per day

/// Will being cyber-secure

- ! End-to-end authentication and roles, network connectivity, SecOps...

Graph
databases

Complex
infrastructure

CI/CD,
Kubernetes, ...

CONCLUSION

/// AI for engineering is a key enabler for future engineering environment

/// Continue R&D on this topics : search for better algorithms,
new use-cases implementations, ...

/// Deploy operationally AI use-cases :

- / Integrate in the rest of the ecosystem
- / Work on operational deployment constraints
- / Demonstrate value with real users

AIDA ESA study
(with Rhea and Univ. of
Strathclyde)

**AI use-cases are a
brick in a larger
environment**