IMPARO

Impact of anomalies and non-conformances on future requirement formulations

esa

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INNOVATING SOLUTIONS

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Introduction

The main objective is to summarize the main features and considerations of the project executed to provide a solution to the Tender: **"Impact of anomalies and non-conformities on future requirement formulations"**.

- <u>Contractor</u>: **Big Data & Artificial Intelligence Division** from **GMV Secure e-Solutions** (**GMV-SES**).
- <u>Customer</u>: **European Space Research and Technology Centre, Software Technology Section** (ESTEC/TEC-SWT) from **ESA**.

THE MAIN DATES OF THE PROJECT WERE AS FOLLOWS:

03/02/2020 Kick Off

21/09/2020 AnR

24/03/2021 AR

ESA needs & objectives

The main objective is to summarize the main features and considerations of the project executed to provide a solution to the Tender: **"Impact of anomalies and non-conformities on future requirement formulations"**.

OBJECTIVES:

- **Exploit lesson learn to improve future Space Mission ESA development**.
- **Conceptualize & formalize** in a structured and well-defined ontology the space mission domain.
- **Transform project data into knowledge**.
- **Bring benefit from Artificial Intelligence** to Space Mission ESA development.

CHALLENGES:

- **Information overload**: outdated information, excessive number of documents & redundancy/duplicity.
- **Complex & unconnected** data: large volumes of data & unstructured.
- **Lack of information standardization**: heterogeneous sources & representation, ambiguity & difficulty to share info.

HOW:

- Building a **Knowledge Graphs based on a defined ontology**.
- Applying **AI & programmatic rules to gather information from unstructured data**.

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ESA needs & objectives

User story

- **A possible user story/example is the following:**

As CDF Mission/System Engineer during Pre Phase A, I want to get Lessons Learned/Anomalies/Alerts concerning my mission/system concept (e.g. "Design of Entry Descent and Landing of a Probe in the atmosphere of a planet").
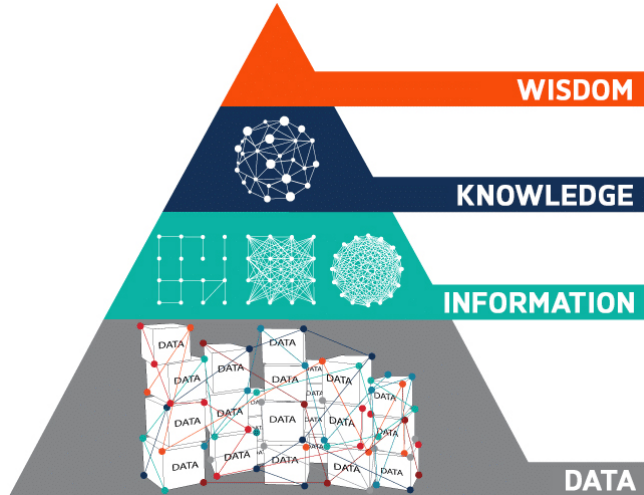
DIKW Pyramid.
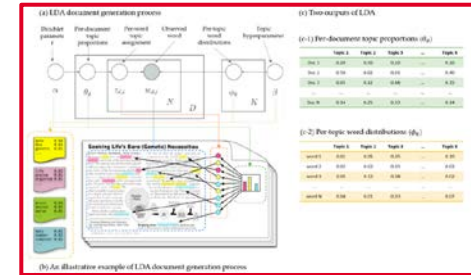Source: https://www.ontotext.com/knowledgehub/fundamentals/dikw-pyramid/
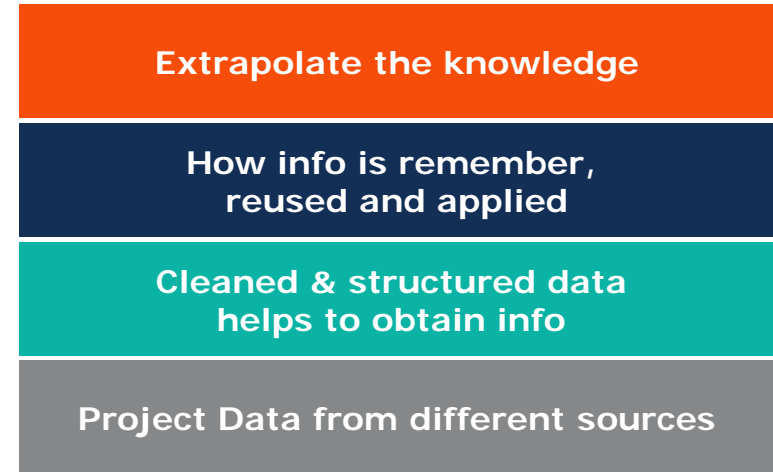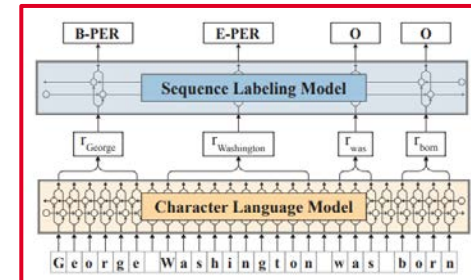
How AI can help?

Figure: Adapted from *Knowledge Graphs: The Third Era of Computing* by Dan MCreary

Machine Learning

Latent Dirichlet Allocation to discover topics from documents.

Named Entity Recognition to identify entities within a context.
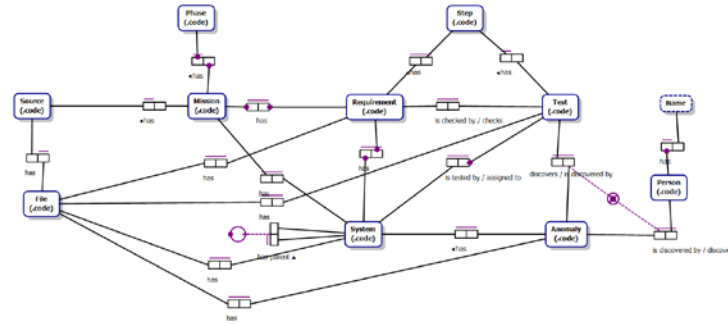
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Sources: Knowledge graph inputs

- **Management Documents** (Documentation Control List, SW Release Notes, Glossary)

- ✓ **Issues and RIDs** (Jira, Redmine, ARTS)

- **Configuration and Installation Guides**

- ✓ **Software Requirements** (SR)

- **Software User Manuals** (SUM)

- **Technical Notes** (TN)

- ✓ **Test Documents** (SVTD, STP)

- ✓ **Software Design Documents** (ADD, DDD)

- ✓ **Interface Control Documents** (ICD)

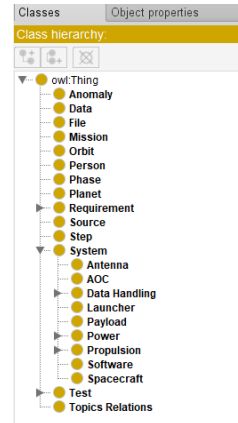- ✓ **Concurrent Design Facility** (CDF)

✓ **RELEVANT DOCUMENTS**

EUD4S2K

BEPIMCS

S2K

CHEOPS SCC-MOC

CHEOPS IFSW

Anomalies

Tests

Requirements

Systems

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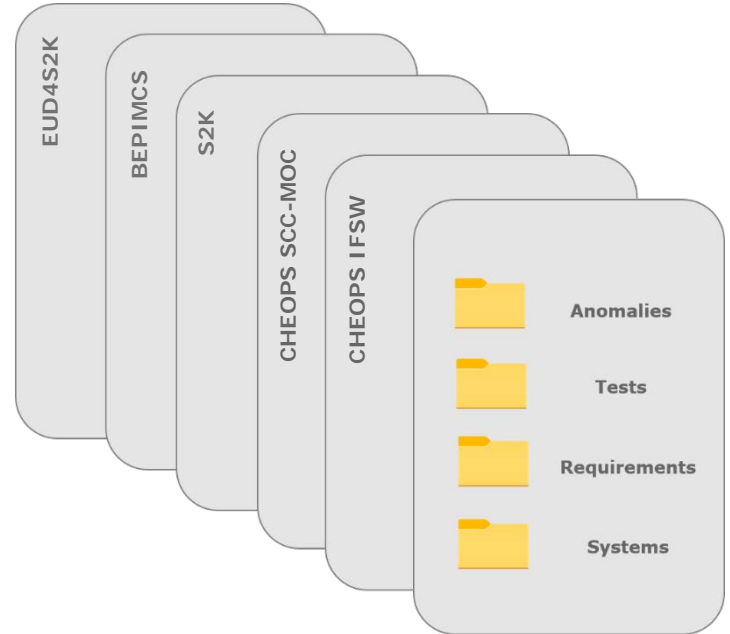
Strategy to extract information

GLOBAL DATA MODEL

ONTOLOGY

Ontology metrics	
Axiom	849
Class	35
Object property	67
Data property	53

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Strategy to extract information
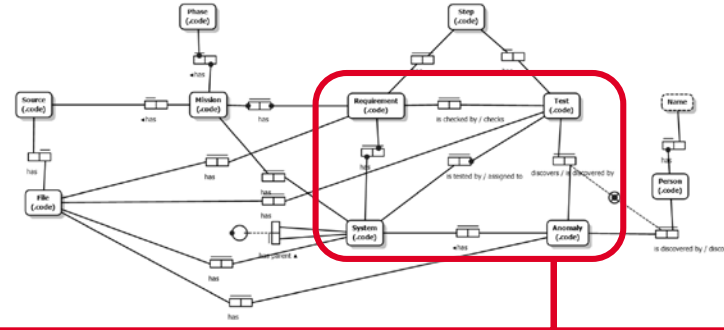
Entity	Technical Approach
Anomaly	Table extraction
Requirement	Table extraction Rules / Regex
Test	Table extraction Rules / Regex
System	DL models
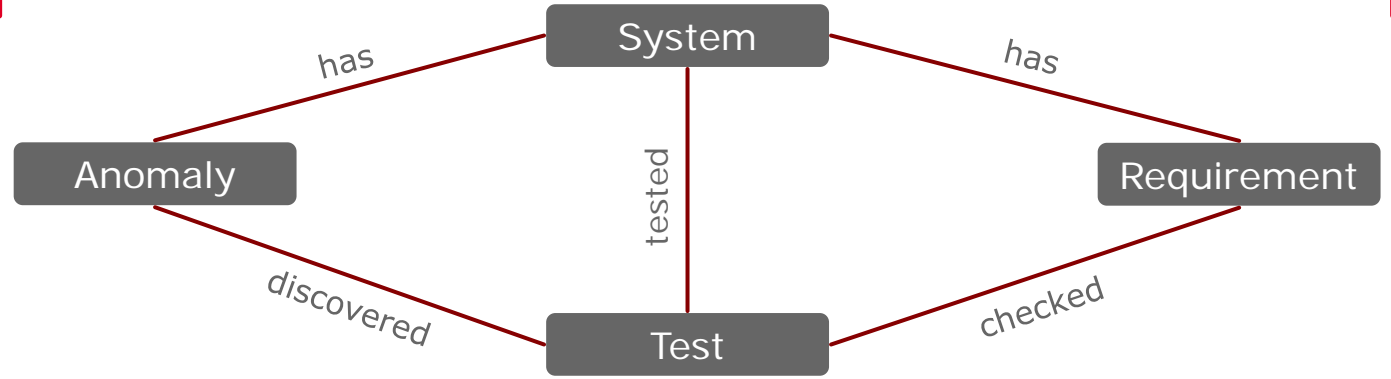
Workflow

Population of the Knowledge Graph

Developed services

Third party services
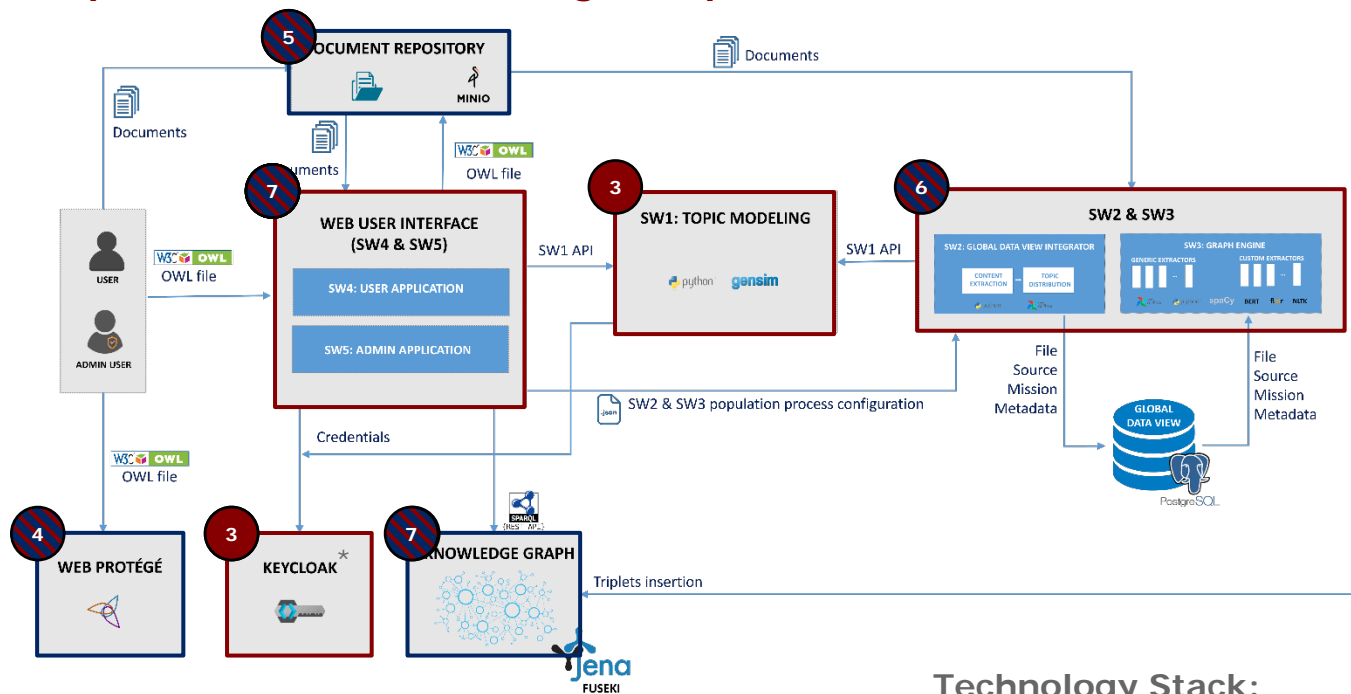
Figure: Global System Design

Workflow

1	Upload raw data to MinIO
2	Login
3	Train LDA Model
4	Upload the ontology
5	Config. Data sources
6	Trigger the population
7	Request info from KG

Technology Stack:

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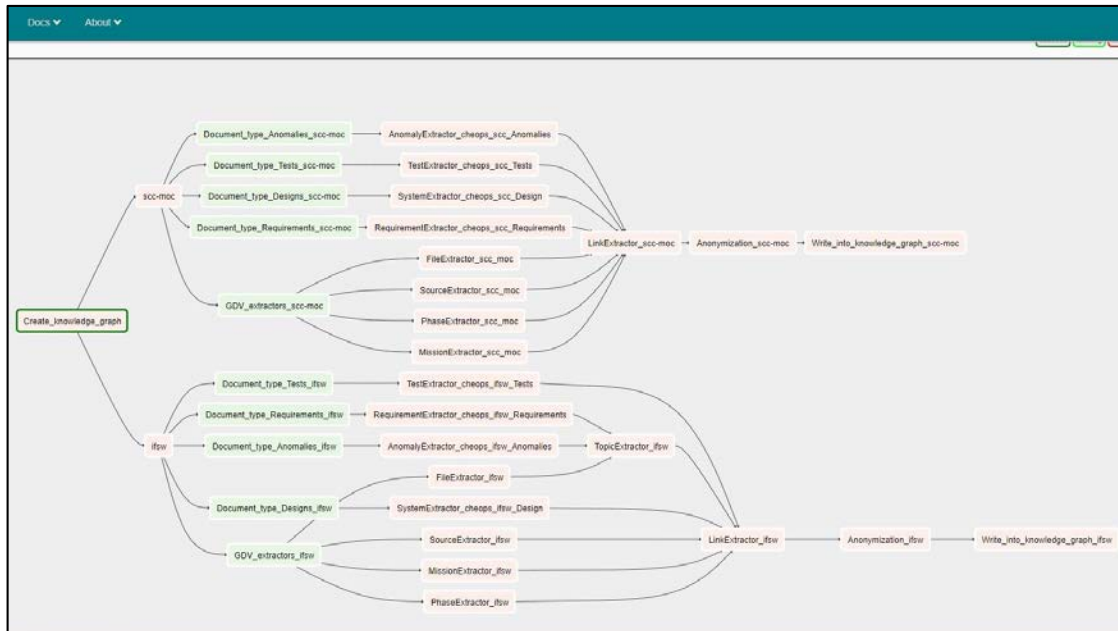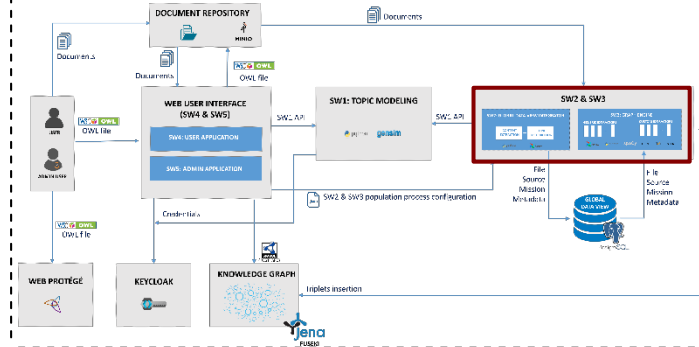# Implemented solution

Developed Services

Figure: Dynamic Computational Graph for the orchestration of the tasks
(standardization, semantic extraction, topic modelling, etc.)

IMPARO Demo

From a CDF Mission / System Engineer

As CDF Mission / System Engineer I want to compare a new mission to be launched with previous ones in order to prevent anomalies and improve the specification in a particular system.

*I am interested in the **IASW** system, namely:*

- *What requirements were applied ?*
- *What anomalies were detected?*
- *What tests were used to detect the anomalies?*

From a Administrator User

- *Model management*
- *Anonymization*
- *Knowledge Graph Population*

IMPARO Demo

IMPARO

Impact of Anomalies and non-conformances on future Requirement formulations

Figure: IMPARO Web Interface

System extension proposal

- Automatic method to **measure** the **performance** of the **LDA** model trained.

- **Management** of the **False Positives** and **False Negatives** in the Knowledge Graph.

- Incorporating the ability to **read other** types of **table** (embedded in the text documents) **formats**.

- Take advantage of **section structure** in the documents to extract the relevant information.

- Add a **reasoner** to the system to infer new instances and relationships.

- **Add sources** to the Knowledge Graph in an **incremental mode**.

- Use the glossary of terms as a thesaurus and **unify instances**.

- **Improve web application** usability and functionalities.

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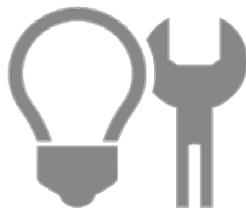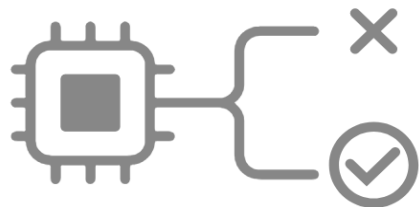
Management considerations

Project executed under Agile Culture following the SCRUM Framework:

- Team **Dailies**.

- **Sprint Reviews** every three weeks showing the progress, Deliverables state, the Roadmap for the rest of the project, the goal for the next Sprint and others considerations to discuss.

- **Sprint Planning** defining next steps and the **main goal** to the next Sprint.

- **Backlog refinement** and priorities review with ESA.

- **Retrospectives** to improve teamwork.
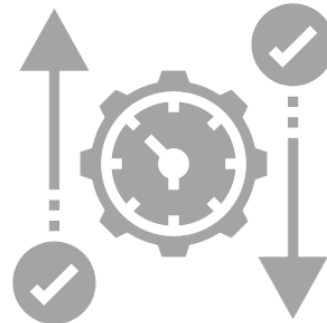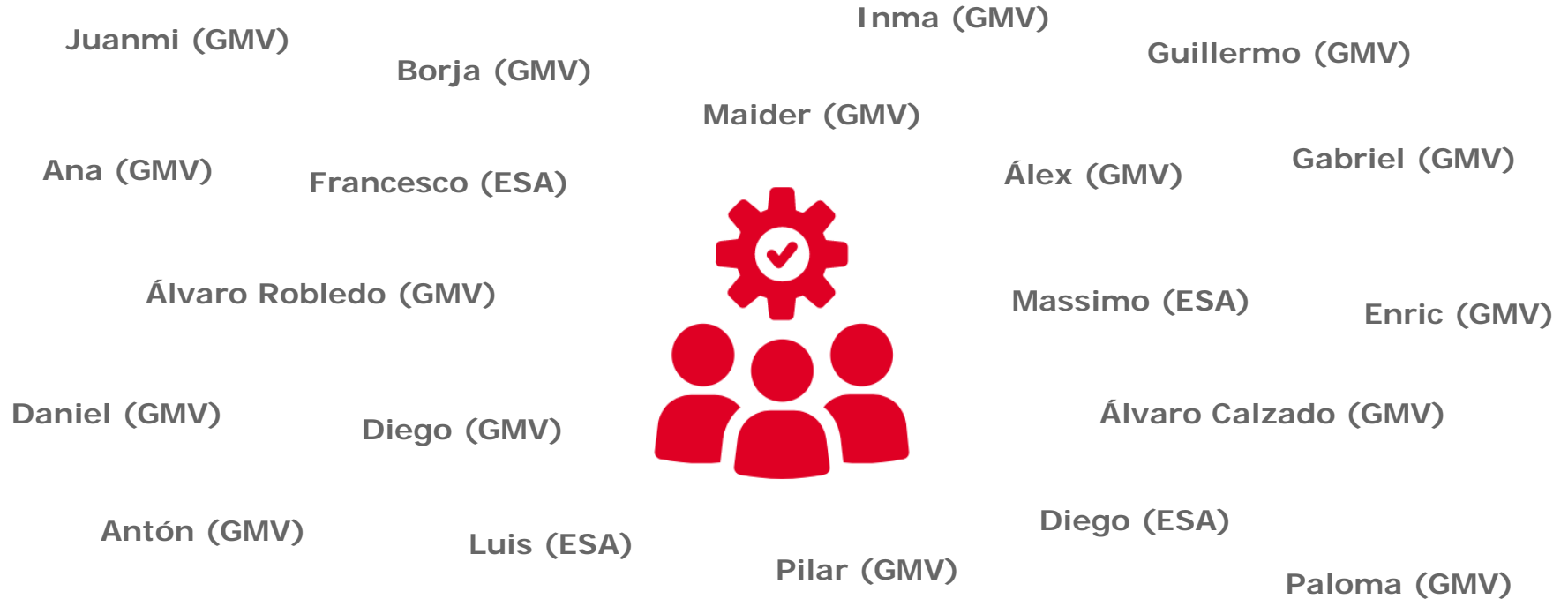
Management considerations

The main aspects that have helped us to work successfully are the following:

- Excellent **Teamwork**. ESA and GMV very good **communication and collaboration**.

- Frequent reviews of ESA **expectations**.

- Continuous **Risks** Management.

- **Easy interaction** through Redmine to handle RIDs and defects.

- Statement of Work vs Requirements **traceability**.

- Improved **development** of different software components **in parallel**, allowing ESA to **evaluate the complete system** as soon as possible.
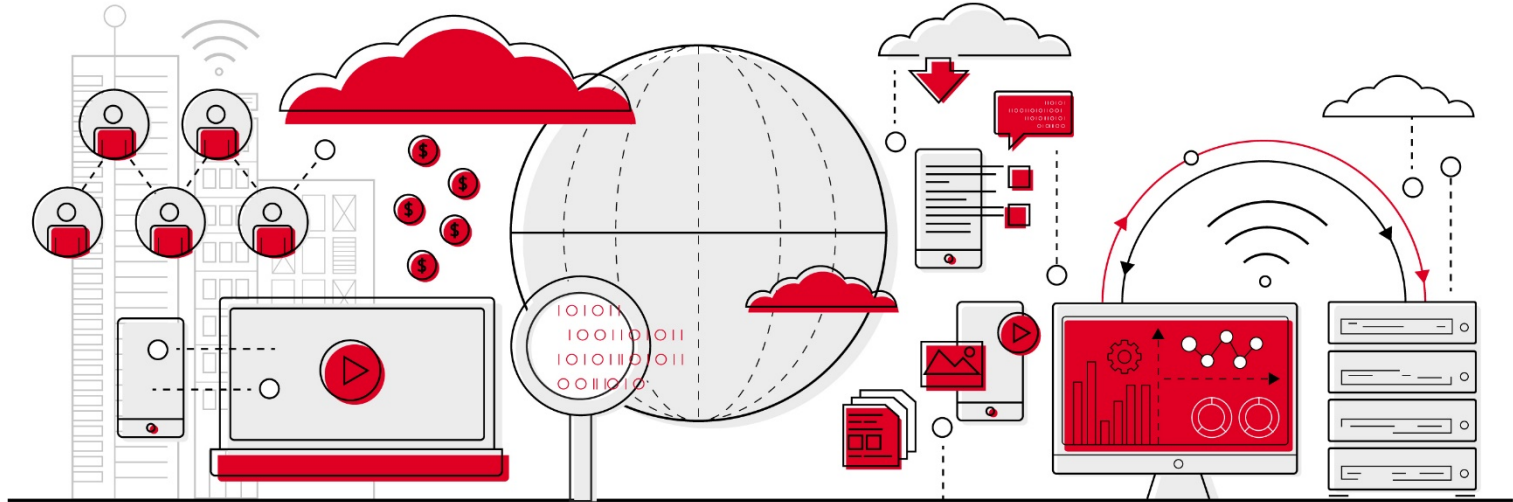
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Management considerations

THANK each and every one of the people who have participated in the project.

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Final questions and comments

Thank you

GMV BDA