



# AM4INFRA

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- 4 - FEHRL – FORUM DES LABORATOIRES NATIONAUX EUROPEENS DE RECHERCHE ROUTIERE – FR
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# Acronyms

Table 0-1 List of Acronyms

Acronym	Definition
ADD	Asset Data Dictionary
AIMCS	Asset Information Management Core System
ASP	Active Server Pages
BBP	Business Blueprint
CDE	Common Data Environment
CGI	Common Gateway Interface
CSV	Comma-separated values
ETL	Extract, Transform, Load
FTP	File Transfer Protocol
HTML	HyperText Markup Language
IRI	International Roughness Index
IT	Information Technology
KML	Keyhole Markup Language
KPI	Key Performance Indicator
NIA	National Infrastructure Agency
ODS	OpenDocument Spreadsheet
ODT	OpenDocument Text
OWL	Web Ontology Language
RDF	Resource Description Framework
PAS	Publically Available Specification
PDF	Portable Document Format
PHP	Hypertext Pre processor
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
SSO	Single sign-on
TEN-T	Trans-European Networks - Transport
UC	Use Case
UDDI	Universal Description Discovery and Integration
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
WP	Work Package

## Executive Summary

Data coming from the several corporate systems related to asset management need to be integrated, combined and refined to provide consistent information to decision making processes.

Within Work Package 3 “Information and Data Management”, task 3.1 “**Asset Data Dictionary Design**” has represented the **first pillar** to build a common approach for asset data management among NIAs. The drawing up of a **Business Blue Print (BBP)** related to an Asset Information Management Core System (AIMCS) has been identified as **second pillar** for the development of a common approach for asset information management.

**BBP** is a detailed document about the scope, the specifications and the completeness of an IT solution (details, components, processes, users, functions, programs, enhancements, and so on) in order to obtain desired outcomes and benefits.

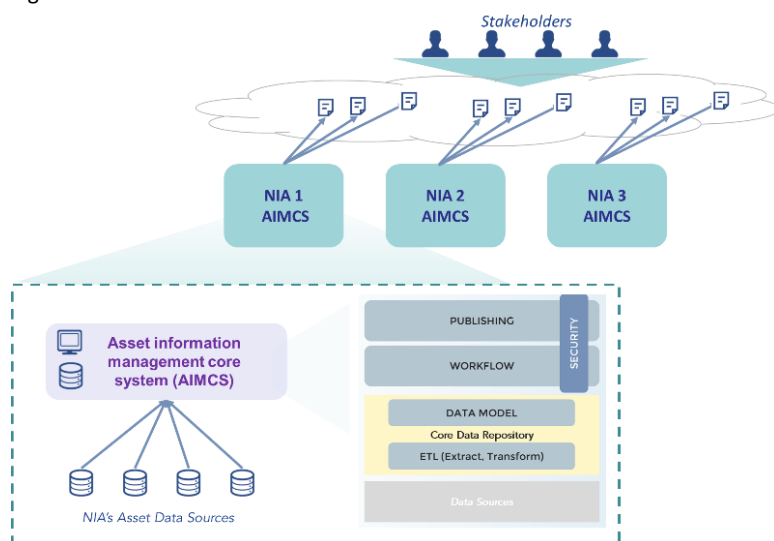
Within BBP, the following goals for an Asset Information Management Core System (**AIMCS**) has been identified:

- to integrate in **one single repository** the core data related to each NIA’s assets;
- to improve asset data governance and **control** asset information publishing process;
- to standardize the **dissemination of asset information** towards stakeholders or across NIAs;

AIMCS has the following inputs/outputs:

- **Inputs for AIMCS:** data sources are NIA’s IT system databases (Maintenance System, Asset Inventory System, Financial System, etc.), where asset data are usually scattered;
- **Outputs of AIMCS:** information (e.g. KPIs, reports, etc.), derived from loaded data, published to stakeholders;

Figure 0-1. AIMCS scheme



AIMCS main functionalities are summarized as follows:

- to **extract asset data** present in several IT systems (data sources);
- to **aggregate and transform** them according to a standard data model (derived from the ADD scheme) and to be compliant to publishing rules;
- to assure data **reliability, integrity and uniqueness**;
- to manage **verification and approval** processes through a **web interface**;
- to **publish information** that could be shared within various asset stakeholders;
- to keep stored in a repository **all past approved and published data**;
- to allow profiling and accessibility to the **front-end application**.

The identification of **AIMCS architecture components** have been identified taking into account the following drivers:

- Centralization, integration and standardization of data coming from heterogeneous sources;
- Metadata management of acquisition, transformation, and loading Processes;
- Decoupling<sup>1</sup> between acquisition and publishing processes, allowing having different technologies of source systems/target publishing systems.

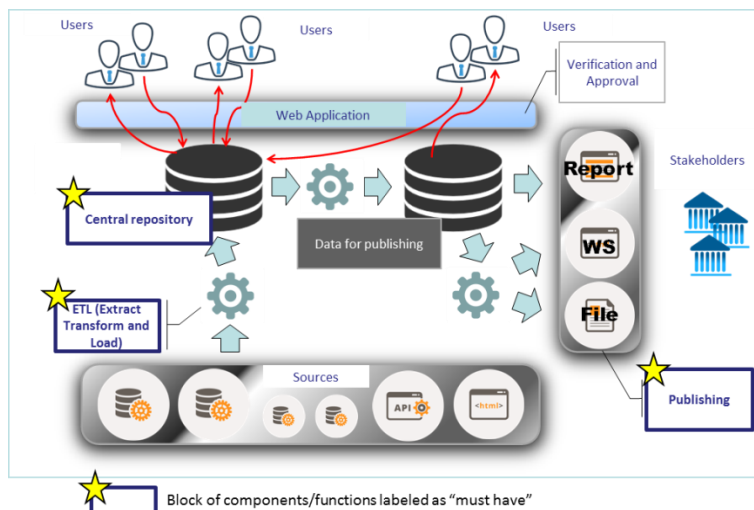


Figure 0-2. AIMCS Architectural scheme

For AIMCS implementation, each NIA can identify its development path according to own maturity level of IT technologies. However, for the design of AIMCS, the possible differences across NIAs have been taken in consideration; for this reason, the development of AIMCS can be faced with a **modular approach**, starting from a **core block of components/functions** and then **adding modules** with an **"agile" approach**.

The core block of **components/functions** labeled as *"must have"* are the following:

- **Central repository:** this is the AIMCS foundation and the starting point to build the system;
- **ETL (Extract Transform and Load):** in order to be able to get data from source systems (or from file) and produce the outputs;
- **Publishing:** ability to provide at least files containing the information for the stakeholders.

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<sup>1</sup> Decoupling allows each component to perform its tasks independently of the others

# 1 Purpose of the document

## 1.1 DOCUMENT STRUCTURE

Document structure is the following:

- An overview on Asset Information Management Core System;
- A presentation of Information model representing the basis for the Asset Information Management Core System;
- A detailed description of the designed solution and the system architecture components
- A set of guidelines to support system implementation within NIAs

## 1.2 DEVIATIONS FROM ORIGINAL DESCRIPTION IN THE GRANT AGREEMENT ANNEX 1 PART A

### 1.2.1 DESCRIPTION OF WORK RELATED TO DELIVERABLE IN GA ANNEX 1 – PART A

The task objectives are:

- To build a common approach for NIAs about data collection and delivery of information to assets stakeholders
- To identify a functional solution for an information asset management system able to gather and share data from multiple sources
- To write a Business Blueprint document containing a system landscape configuration
- To propose a set of guidelines aiming at development and roll out of asset information management system across European countries
- To make it available the common core mode on the living lab, having collected input from the dissemination of the results of Task 3,1, above

The purpose of task is to propose a functional description of an asset information management system in terms of:

- System Requirements: a brief explanation of the general needs or requirements and a context for the system.
- System Overview: the characteristics of IT landscape and how its components fit together;
- Communication Components: how the different layers of IT landscape can communicate;
- Guidelines for implementation: a set of guidelines in order to develop the designed asset management information system within other national road authorities.

The approach for defining the guidelines will consider the possible different maturity levels within each organization, regarding the deployment of asset management systems, allowing their implementation in different contexts

### 1.2.2 TIME DEVIATIONS FROM ORIGINAL PLANNING IN GA ANNEX 1 – PART A

No time deviations have occurred during the task.

### 1.2.3 CONTENT DEVIATIONS FROM ORIGINAL PLANNING IN GA ANNEX 1 – PART A

No content deviations have occurred during the task.



## 2 Introduction

Data coming from the several corporate systems related to asset management need to be integrated, combined and elaborated to provide consistent information to decision making processes.

Within Work Package 3 “Information and Data Management”, task 3.1 “**Asset Data Dictionary Design**” has represented the **first pillar** to build a common approach for asset data management among NIAs. The drawing up of a **Business Blue Print (BBP)** related to an Asset Information Management Core System (AIMCS) has been identified as **second pillar** for the development of a common approach for asset information management.

**BBP** is a detailed document about the scope, the specifications and the completeness of an IT solution (details, components, processes, users, functions, programs, enhancements, and so on) in order to obtain desired outcomes and benefits.

In AM4INFRA context, the outcomes foreseen by the design and adoption of an AIMCS are:

- generation of comparable information among NIAs on assets;
- improvement of asset information sharing;
- identification of a set of common IT components allowing further data integration;

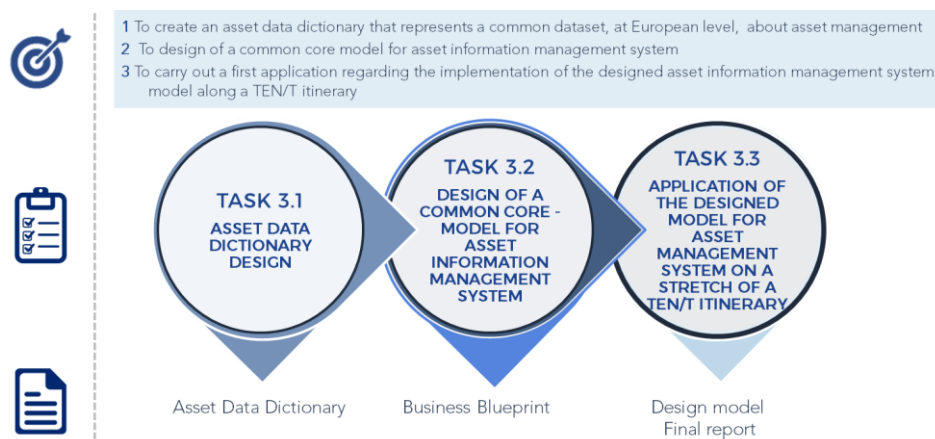


Figure 2-1. Asset Common Data Management Approach

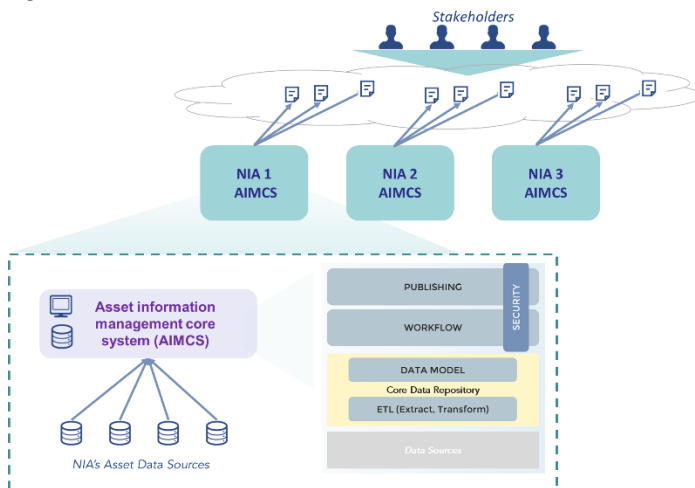
The concept of an AIMCS has been inspired by the definition of **Common Data Environment (CDE)** by PAS 1192-3, as “the single source of information used to collect, manage and disseminate documentation; creating this single source of information facilitates collaboration between project team members and helps avoid duplication and mistakes”. AIMCS therefore aims at generating within NIA context a virtuous use of asset data in order to obtain information to be disseminated to external stakeholders. This goal, as detailed within the report, can be obtained with **an IT solution able to collect data from several sources, create an unique repository of asset data, and then publish information according to a controlled process.**

## 3 AIMCS Overview

Asset Information Management Core System (**AIMCS**) has the following goals:

- to integrate in **one single repository** the core data related to each NIA's assets;
- to improve asset data governance and **control** asset information publishing process;
- to standardize the **dissemination of asset information** towards stakeholders or across NIAs;

Figure 3-1. AIMCS scheme



Each NIA develops and manages its own AIMCS that has the following inputs/outputs:

- **Inputs for AIMCS:** data sources are NIA's IT system databases (Maintenance System, Asset Inventory System, Financial System, etc.), where asset data are usually stored;
- **Outputs of AIMCS:** information (e.g. KPIs, reports, etc.), derived from loaded data, published to stakeholders;

Outputs produced by AIMCS will be published in an open data portal, where stakeholders can easily access. Therefore, the users of AIMCS will be within each **NIA organization**, and, according to a **workflow** for authorization and publishing of outputs, there will be the **following roles**:

- **Reviewer:** user who can browse the repository and perform checks on asset data; within each NIA there will be several reviewers;
- **Approver:** user who periodically has the responsibility to approve the information/KPIs derived by core asset data, before they will be published;
- **Publisher:** user who performs the publishing and dissemination of information.

AIMCS main functionalities are summarized as follows:

- to **extract asset data** present in several IT systems (data sources);
- to **aggregate and transform** them according to a standard data model (derived from the ADD scheme) and to be compliant to publishing rules;
- to assure data **reliability, integrity and univocity**;
- to manage **verification and approval** processes through a **web interface**;
- to **publish information** that could be shared within various asset stakeholders;
- to keep stored in a repository **all past approved and published data**;

- to allow profiling and accessibility to the **front-end application**.

AIMCS will support the publishing and sharing of **Information (e.g. KPIs, reports)**, calculated from the data loaded into the system, related to a transportation network toward stakeholders.

This process will be based on an authorization workflow based on **3 levels**:

- verification;
- approval;
- publishing.

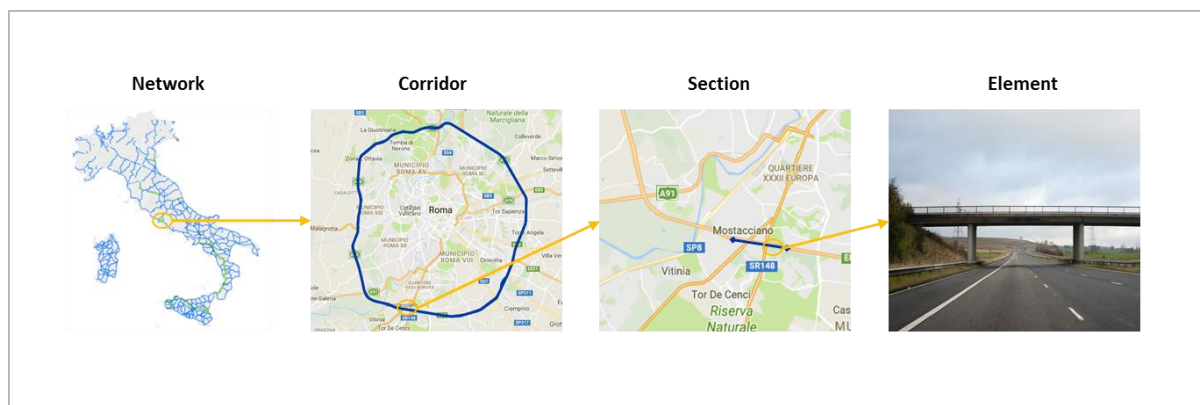
**System users** will manage data according to specific authorization levels and roles; the AIMCS users can be identified in:

- **Service Providers (Asset Operators/ /Contractors)**: they can act on the system as **reviewers** visualizing and checking only a subset of asset data;
- **Asset Managers**: having the responsibility on a transportation network or section of it, they will be able to access to KPIs and full data, acting as **approvers**;
- **NIA's Network Manager/Head of Institutional Relations**: user acting as **publisher**, having the responsibility to authorize the publishing of data/KPI/reports to external stakeholders (e.g. **asset owners**, local authorities, government, etc.)

The system will present the data according to the following hierarchy:

1. Network – Transportation Network
2. Corridor - Road/Railway/Waterway (e.g. A90 Motorway);
3. Section - (e.g. A90 Motorway section 5 km 20÷25);
4. Element - Asset (Asset ID).

Figure 3-2 Example of Data Hierarchy



## 4 Information Model

An **information model** is a representation of concepts and the relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. Typically it specifies relations between kinds of things, but may also include relations with individual things. It provides sharable, stable, and organized structure of information requirements or knowledge for the domain context.

For AM4INFRA context, to represent the AIMCS information model, **an ontology map** has been drawn based on standards defined by World Wide Web Consortium (W3C) as the Web Ontology Language (OWL) and Resource Description Framework (RDF).

The ontology map allows to:

- Represent the knowledge in a graphical mode, easily understood and shared with all involved actors, in order to identify common concepts, relations, attributes, etc. within a domain of knowledge;
- Ease the passage from a logical model to a physical one during the implementation phase;

Figure 4-1. AIMCS Ontology map

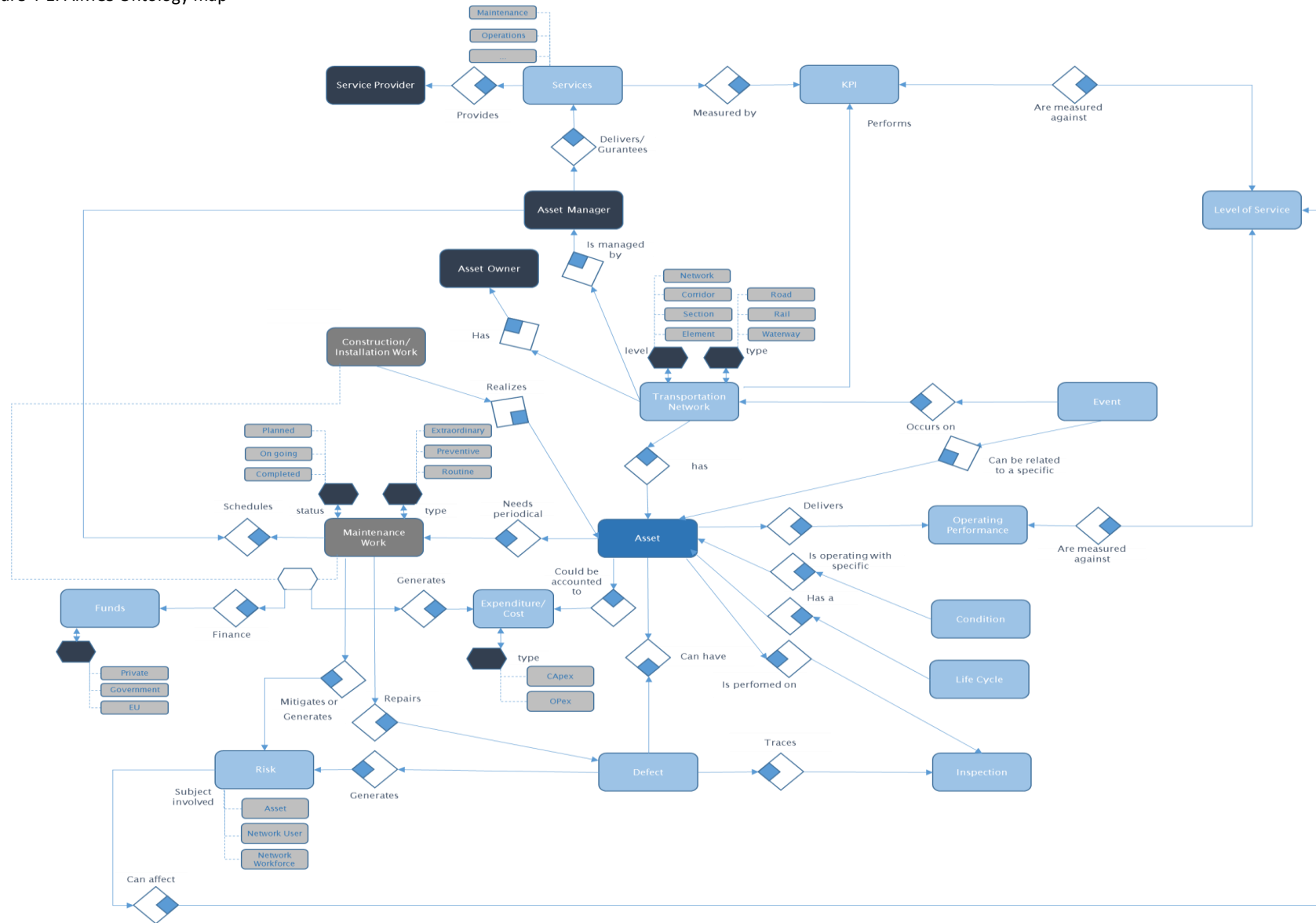
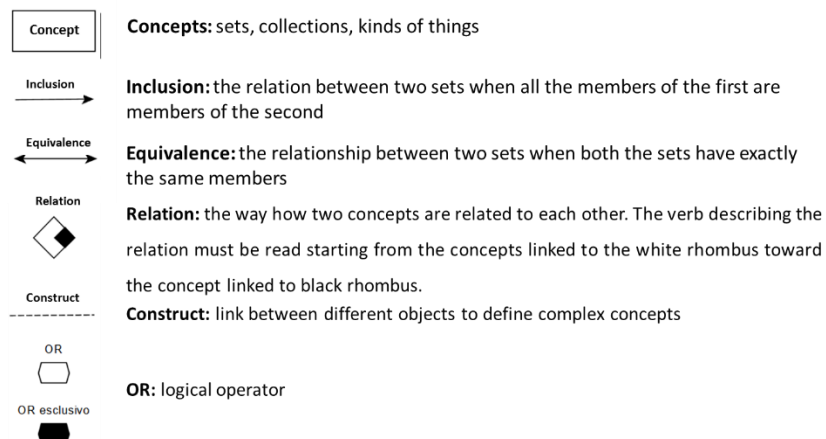


Figure 4-2. Legend for the Ontology map



Concept	Attributes (ref. 3.1 ADD Datasets)	Primary Key	Foreign Key
Asset	<i>Asset Inventory</i>	▪ Asset ID	-
Construction /Installation Work	<i>Asset Construction/Installation</i>	▪ Work ID	▪ Asset ID
Maintenance Work	<i>Maintenance Work</i>	▪ Work ID	▪ Asset ID
Funds	<i>Asset Fund</i>	▪ Fund ID	▪ Work ID ▪ Asset ID
Risk	<i>Asset Risk</i>	▪ Risk ID	▪ Asset ID ▪ Work ID
Defect	<i>Asset Defect</i>	▪ Defect ID	▪ Asset ID ▪ Inspection ID
Inspection	<i>Asset Inspection</i>	▪ Inspection ID	▪ Asset ID
Expenditures	<i>Asset Expenditures</i>	▪ Expenditure ID	▪ Asset ID
Lifecycle	<i>Asset Lifecycle</i>	▪ Asset ID	-
Condition	<i>Asset Condition</i>	▪ Asset ID	-
Operating Performance	<i>Asset Performance</i>	▪ Asset ID	-
Event	<i>Asset Event</i>	▪ Event ID	▪ Asset ID ▪ Corridor ID
Transportation Network	<ul style="list-style-type: none"> <li>▪ Network</li> <li>▪ Corridor</li> <li>▪ Node</li> <li>▪ Link</li> </ul>	<ul style="list-style-type: none"> <li>▪ Network ID</li> <li>▪ Corridor ID</li> <li>▪ Node ID</li> <li>▪ Link ID</li> </ul>	

## 5 AIMCS Functional Solution

As **first step**, AIMCS needs to **collect asset data** from data sources (e.g. other IT systems in use within the organization like Pavement Systems, Maintenance systems, Financial Systems, Accounting and Cost control Systems, etc.).

In order to perform this step, the solution design is to develop/use specific **data extractors** that, in an asynchronous way (e.g. during nighttime), collect and store data on the **system core repository**.

This **database** represents therefore the **unique repository** for the data that will be disseminated during the publishing process to stakeholders; data coming from the several data sources needs therefore to be normalized to erase any redundancy and to guarantee univocity.

In case of **data redundancy** (e.g. same data duplicated on different IT systems), the master data need to be identified in order to extract them. The normalization of the data will bring to identify the “master” system, which will be the unique system source for the specific data.

Subsequently through the ETL procedure (Extract Transform and Load ref. 6.2.2) of **AIMCS**, data are extracted, transformed and loaded on the repository ready to be viewed by the approval owner, via a web application, that allows to navigate and visualize data.

Approved data will be again transformed by AIMCS in order to be ready for publishing.

Approved and published data are then archived into database in order to allow a data recovery when needed.

AIMCS will support the publishing and sharing of **Information (e.g. KPIs, reports)**, calculated from the data loaded into the system, related to a transportation network toward stakeholders.

This process will be based on an authorization workflow based on **3 levels** (verification, approval, publishing)

For each Asset, the related data are organized and shown to the user in separated form (e.g. maintenance form, construction form, expenditure form, condition form, etc.); it is possible therefore to navigate through the data related to each asset, according a specific topic. “Data Verification Process” and “Data Approval Process” sections presents a detailed description of these contents (ref. 5.4 and 5.5).

Regarding the data presentation layer, level of details changes depending both on the level of hierarchy (asset -> network), and on coherence with authorization level.

- **Reviewer** can navigate through a specific set of assets and related data; reviewer can optionally perform a formal check on the data;
- **Approver** will approve KPIs’ values derived from asset data loaded into the system and before any publication event;
- **Approver** has the possibility to navigate within assets data in case a more detailed view is necessary before performing the approval;

Users cannot modify the data visualized in the system in order to guarantee coherence with data stored in source systems; in case of missing data from source systems, it will be possible to insert them manually. This choice will allow a NIA to integrate metrics if current IT systems do not support the entire range of data needed to calculate some KPIs.

The authorization workflow for the data will be the following:

- The data loaded from system sources will assume the status “**To be verified**”;
- Each reviewer can navigate through its data; before “freeze period”, in case of missing data or data to be updated, he can modify data on source systems that then will be uploaded in AIMCS repository; asset data at the end of “freeze period” will assume the status “**Verified**”;

- **“Verified” data** will enter into the perimeter of approval owner, who will have the responsibility to check data through the visualization of specific **performance indicators** that will be related to a single asset, a portion of transportation network or the entire network; once the approval owner has approved data then they, together with performance indicators, will assume the status **“To be published”**;
- The publisher, giving the ok and performing the publication, will move data to **“Published”** status.

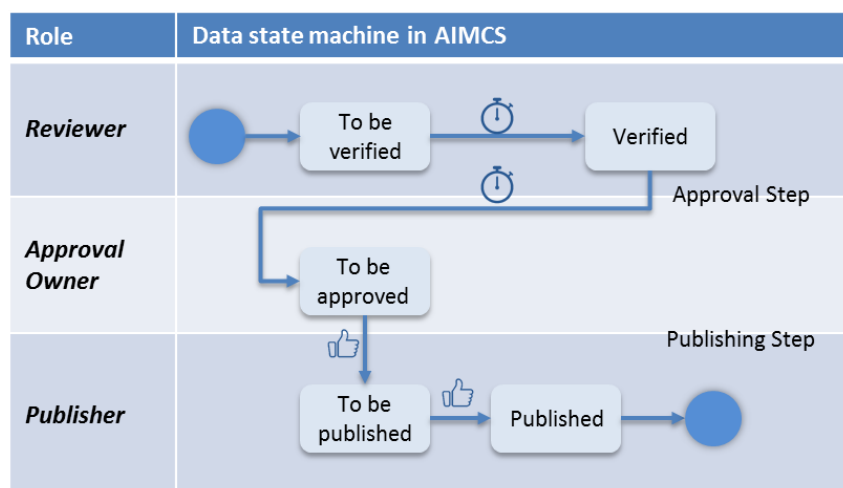
AIMCS repository will trace and store any status assumed by data during workflow, allowing recovering and viewing at any time the changes occurred on data status during a period.

For **AIMCS workflow** an incremental approach for the implementation could be performed:

- The **publishing step** is compulsory, in order to have a formal action before data dissemination;
- The **verification and approval steps** can be added subsequently, in presence of constraints (economical, technical, IT level of maturity) within a NIA organization.

The following picture represents the data machine state for the AIMCS:

Figure 5-1. Data state machine



**User activity**

**Automatic activity**

## 5.1 WORKFLOW TIMING

Reviewer and approval owners can always access to AICMS. Every change occurring on system sources will be loaded into AIMCS through asynchronous interfaces working during night time; the day after, the changes will be visualized into AIMCS and then users can consequently verify or approve these changes. Data changes on system sources will affect all the information stored in AIMCS related to the changes (e.g. if a data change consequently a KPI on the AIMCS will change).

The activities to be performed on the system by the users should be scheduled according to a specific calendar in order to standardize the publishing process. AIMCS will include the possibility to configure within the system a calendar to schedule on a periodical basis the activities of approval and publishing.

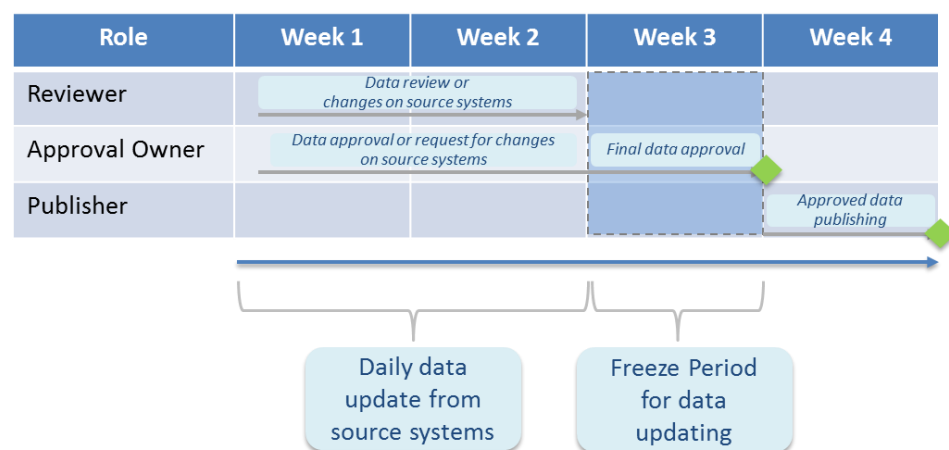
In order to give a more clear representation of the workflow timing and for illustrative purpose only, the following picture represent how AIMCS would work considering a month timeframe; the possible milestones would be the following:

- During **Week 1 and Week 2** – AIMCS will be updated with data changes occurring on system sources; reviewers and approval owners can in the meantime verify loaded data or approve them, if no changes are foreseen.



- During **Week 3** – AIMCS will not upload any new data from source systems (*“Freeze period”*), in order to allow the approval owner performing the final check on data
- During **Week 4** – At the end of “freeze period”, approved data will be ready for publishing; in this moment AIMCS will consolidate the outputs ready for publishing. The publisher will then release the publication to target outputs.

Figure 5-2. Workflow timing



## 5.2 DATA ACQUISITION PROCESS

### 5.3 DATA FLOWS AND LOADING RULES

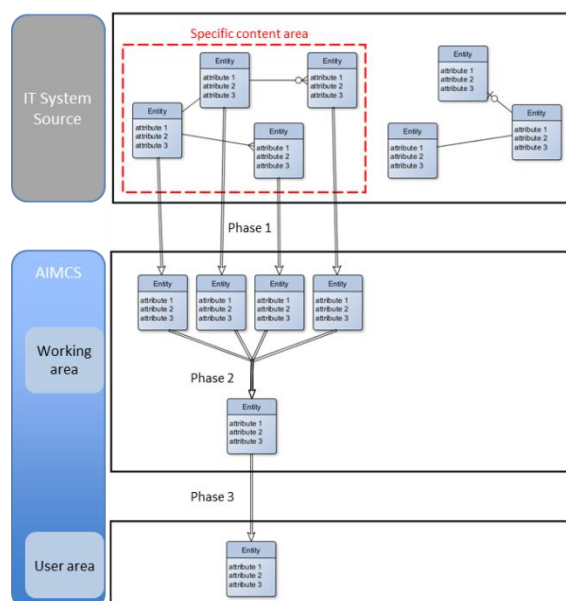
In the AIMCS, data flows are mapped in a relation 1:1 with each IT source System, or in case of complex IT systems data flows can be more than one and be dedicated to specific content area within same IT system.

In order to achieve a data loading process with high quality and consistency, each data flow will be loaded according to a phased process; each phase can start only if the previous one has positively concluded.

This approach considers **three phases** to load a data flow into AIMCS:

- Phase 1:** data extraction from source systems and writing in a working area of AIMCS;
- Phase 2:** during this phase, the transformations to integrate data sources into AIMCS data target model are performed; automatic procedures in the AIMCS implement:
  - Data standardization:** data domain standardization, data format conversion (e.g. from thousand € to million €, from centimeter to meter, etc.);
  - Integrity control:** verification of coherence rules among data (e.g. presence of inconsistent values in specific fields, presence of a starting data value greater than the finishing one, etc.), verification of referential constraints (e.g. data can't be loaded if the ones from which they depend are missing);
  - Calculation:** calculation of single attributes based on specific algorithms or construction of entire set of aggregated data to be stored separate from single data.
- Phase 3:** during this phase, AIMCS will identify the data changes occurred since last data loading process in terms of new data not present in the database or existing data that have been modified since last upload.

Figure 5-3. Data flows and loading rules



### 5.3.1 LOADING FREQUENCY

The data loading procedures will be scheduled daily during a timeframe when users don't usually operate on IT systems that are AIMCS data sources (e.g. during night time)

### 5.3.2 INTERFACING OTHER SOURCE SYSTEMS

The data acquisition from source systems can be performed in several ways: through files, services, views or tables of databases stored in systems themselves.

In order to ease the maintenance and reliability of data extraction rules it is recommended to use an additional layer that allows uncoupling the data structures in source systems with the ones present in AIMCS.

This choice brings two major benefits:

- to have a better awareness on the impacts to AIMCS, in case of changes on source systems
- to succeed in keeping the alignment between AIMCS and source systems only adjusting the interfaces

### 5.3.3 FULL OR PARTIAL DATA LOADING

The rules to be implemented for storing data, allows identifying, before of the loading into the system repository, data already acquired, new data or data modified.

According to the adopted strategy, the choice to extract from source systems the entire amount of data or only the delta since last acquisition does not influence the result but only execution time.

This design choice allows implementing mixed solutions considering that each source system can or cannot have the possibility to assess which data have been updated.

### 5.3.4 ERROR MANAGEMENT

During the loading data procedure, AIMCS will manage errors that could occurs in two ways:

- **Predictable errors:** this kind of errors will be considered as “waste”, and it will not stop the data loading process; typical predictable errors occur when a referential constraint is violated; in each loading cycle, ETL procedure will verify the presence of this kind of errors or the correction of previous inconsistency.

- **Unpredictable errors:** this kind of errors will be managed through the data loading workflow (ref. 5.1) and they will cause its interruption. The design choice to subdivide the data loading in 3 phases reduces the possibility to have a partial data loading as only phase 3 has effect on the actual system repository

## 5.4 DATA VERIFICATION PROCESS

The following paragraph aims at describing the detailed solution related to **Verification process** representing the first step for AIMCS workflow.

The goal is to identify a solution aiming at easing **data review** by the users, minimizing the effort and the impact on daily activities. The users involved in the verification process could be for example a Service Provider, an Asset operator or an Asset contractor.

The users at this stage will perform the following activity:

- Reviewing group of homogenous data related to asset.

### 5.4.1 DATA ORGANIZATION

The data related to an asset will be grouped as follows:

- **Header:** header form will present general data related to the asset (e.g. ID, name, position, etc.) and will be always visible to the users
- **Sections:** each section contains one or more forms where data related to a specific topic will be grouped and shown to the users (e.g. asset condition section, asset defects section, etc.);

Asset XYZ				
+	Header	Header Form		
		Field 1	Field 2	Field 3
		Field 1	Field 2	Field 3
+	Section 1	Form 1		
		Field 1	Field 2	Field 3
		Field 1	Field 2	Field 3
+	Section 2	Form 2		
		Field 1	Field 2	Field 3
		Field 1	Field 2	Field 3
+	Section n	Form n		
		Field 1	Field 2	Field 3
		Field 1	Field 2	Field 3

Figure 5-4. Asset Sections Scheme

The data related to an asset will be grouped in the sections presented in the following table.

Table 5-1 Section name and related contents

Section Name	Description of form contents
Condition	State of an asset at a particular instance in time
Performance	Asset technical levels of service
Lifecycle	Life history of the asset
Risk	Risks occurring on the asset like risk likelihood, impact, action to be implemented
Defect	Defects occurring on the asset, and their updates during time (e.g detection date of the defect, defect closing date, asset defect rate, etc.)
Expenditure	Monitoring of asset expenditures
Fund	Funding model for asset management
Valuation	Data referred to asset valuation process
Maintenance	Data to record both the future intervention works and the history of what has been done to an asset
Inspection	Activity related to asset condition monitoring
Event	Data to describe any relevant event occurring during network operations

#### 5.4.2 REVIEW PROCESS DESCRIPTION

After logged into the system, the reviewer has the possibility to search the assets and browse their data. AIMCS will show a list of the assets matching searching criteria that reviewer has inserted as inputs; these could be the asset type, the location (e.g. a specific corridor) or a specific asset ID.

The screenshot shows the AIMCS Reviewer Home Page. At the top is a dark blue header with the AIMCS logo, a user icon, a Home button, and a Log out button. Below the header is a search section with a 'Search' button and a magnifying glass icon. The search criteria are as follows:

Search Criteria	Operator	Value
Transportation Network	AND	Road
Corridor	OR	Corridor xy
Asset Type	OR	Bridge
Asset ID	-	

Below the search section, it shows '3 Results (Page 1 of 1)'. The results are displayed in a table:

	Asset ID	Asset Type	Corridor	Transportation Network
	Asset 1	Bridge	Corridor xy	Road
	Asset 2	Bridge	Corridor xy	Road
	Asset 3	Bridge	Corridor xy	Road

Figure 5-5. Reviewer Home Page

Clicking on a specific asset, AIMCS will show the detailed data retrieved from source systems and organized in sections and forms as shown in the following picture:

Figure 5-6. Asset Data Page

The screenshot shows the AIMCS web application interface. At the top, there's a navigation bar with 'AIMCS', a user icon, 'Home', and 'Log out'. Below this, a breadcrumb trail shows 'Bridge A001 – Corridor XY - Roadway'. On the left is a sidebar menu with items: Condition, Performance, Lifecycle, Risk, Defect (highlighted in yellow), Expenditure, Fund, Valuation, Maintenance, Inspection, and Event. A red dotted line connects the 'Defect' menu item to the 'DEFECT' form. The form has tabs for 'Defect 1', 'Defect 2', and 'Defect 3'. The 'Defect 1' tab is active, showing a table of defect details. At the bottom right of the form is a blue 'Verify' button with a hand cursor icon over it. A circular arrow icon is also present at the bottom right.

The verification by users will be performed at **section/form level** and not to single data field; the **forms** linked to a section will assume the following status:

- **Reviewed:** if the user has marked on the system the form as reviewed; the form will assume a green color;
- **To be reviewed:** if a data contained in the form has been updated, but the review owner has not reviewed the form yet; the form will assume a yellow color;

Consequently the **section** can assume the following status:

- **Reviewed:** if all the forms contained into a section have been reviewed in referral period; the section will assume a green color;
- **To be reviewed:** when at least one section form, that contains updated data, has not been reviewed; the section will assume a yellow color;

**Asset** will be then:

- **Reviewed:** if the review of all sections has been completed; the object will assume a green color;
- **To be reviewed:** when at least one section has not been reviewed; the object will assume a yellow color;

### 5.4.3 USE CASES

Table 5-2 Use cases for Review Process

ID	USE CASE NAME	USER	USE CASE DESCRIPTION	FUNCTION
UC- 1	User Log-in	Reviewer	<ul style="list-style-type: none"> <li>▪ User logs into the system typing user name and password</li> </ul>	<ul style="list-style-type: none"> <li>▪ FUN-1 Log-in</li> </ul>
UC- 2	Asset Data Search	Reviewer	<ul style="list-style-type: none"> <li>▪ User selects data to be reviewed, through a search engine that allows to: <ul style="list-style-type: none"> <li>▪ Select a specific transportation network <u>and/or</u></li> <li>▪ Select a specific corridor <u>and/or</u></li> <li>▪ Select of an asset type (e.g. bridge, tunnel, etc.) <u>and/or</u></li> <li>▪ Select of a specific Asset through its Asset ID <u>and/or</u></li> <li>▪ Select the assets still to be reviewed</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ FUN-2 Asset search</li> </ul>

			<ul style="list-style-type: none"> <li>AIMCS will show the list of asset that match search criteria</li> </ul>	
UC- 3	<b>Asset Data Verification</b>	Reviewer	<ul style="list-style-type: none"> <li>From the list, user selects the asset that wants to review;</li> <li>User browses asset data sections;</li> <li>User performs verification;</li> </ul>	<ul style="list-style-type: none"> <li>FUN-3 Section data browsing</li> <li>FUN-4 Section data verification</li> </ul>
UC- 4	<b>Manual fill in of data not present in source systems</b>	Reviewer	<ul style="list-style-type: none"> <li>User manually fills in the asset data which are not present on source systems</li> </ul>	<ul style="list-style-type: none"> <li>FUN-5 Manual fill in of missing data</li> </ul>

#### 5.4.3.1 FUNCTIONS

Table 5-3 Log-in Function

<b>Function</b>	FUN-1 Log-in
<b>Description</b>	The function allows user to access to AIMCS through username and password
<b>User</b>	<ul style="list-style-type: none"> <li>Reviewer</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>User is already configured on AIMCS</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>User is logged to AIMCS</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li><u>User</u>: clicks on the link to AIMCS;</li> <li><u>AIMCS</u>: displays the log-in form;</li> <li><u>User</u>: types username and password;</li> <li><u>User</u>: clicks on “Sign-in” button;</li> <li><u>AIMCS</u>: verifies credential and authorizes log-in.</li> </ol>
<b>Detailed requirements</b>	-

Table 5-4 Asset Search Function

<b>Function</b>	FUN-2 Asset search
<b>Description</b>	The function allows searching a set of assets or a specific one.
<b>User</b>	<ul style="list-style-type: none"> <li>Reviewer</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>Asset data loaded on AIMCS.</li> <li>User logged in AIMCS</li> </ul>
<b>Post-condition</b>	Asset list displayed according to search parameters.
<b>Path</b>	<ol style="list-style-type: none"> <li><u>User</u>: fills in the searching forms;</li> <li><u>AIMCS</u>: displays the list of assets, that match the search criteria</li> </ol>
<b>Detailed requirements</b>	<p>RD_ 1 User can search only the assets whose he is responsible.</p> <p>RD_ 2 AIMCS will display a warning in case there is not any asset matching the searching criteria.</p> <p>RD_ 3 User can clear all the inputs in the search forms with a specific button.</p>

Table 5-5 Section data browsing

<b>Function</b>	FUN-3 Section data browsing
-----------------	-----------------------------

<b>Description</b>	The function allows to browse asset data present in the sections forms
<b>User</b>	<ul style="list-style-type: none"> <li>Reviewer</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>At least one asset should be present in the list.</li> </ul>
<b>Post-condition</b>	Asset data displayed according to search parameters.
<b>Path</b>	<ol style="list-style-type: none"> <li><u>1. User</u>: clicks on an asset present on the list;</li> <li><u>2. AIMCS</u>: displays the asset data present in header section, and the menu with the different sections that user can browse.</li> <li><u>3. User</u>: clicks on a section title;</li> <li><u>4. AIMCS</u>: displays the section first form;</li> <li><u>5. User</u>: clicks on the other forms' title present for a section;</li> <li><u>6. AIMCS</u>: displays the selected form and related data.</li> </ol>
<b>Detailed requirements</b>	<p>RD_ 4 Header section will be always visible by the user</p> <p>RD_ 5 If a section has more than one form, these ones will be separated and organized as different tabs</p> <p>RD_ 6 User can switch between sections by clicking on section names</p>

Table 5-6 Section data verification

<b>Function</b>	FUN-4 Section Data Verification
<b>Description</b>	The function allows to perform formal verification on asset data
<b>User</b>	<ul style="list-style-type: none"> <li>Reviewer</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>At least one asset should be present in the list.</li> <li>At least one asset section filled with data.</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>Asset data section verified</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li><u>1. User</u>: clicks on an asset data section;</li> <li><u>2. AIMCS</u>: displays data present in the section form;</li> <li><u>3. User</u>: clicks on “verify” button;</li> <li><u>4. AIMCS</u>: shows the section as reviewed.</li> </ol>
<b>Detailed requirements</b>	<p>RD_ 7 For the review, system will show a pop up to confirm the operation</p> <p>RD_ 8 User should be able to select more sections at time and perform verification for all the selected sections.</p>

Table 5-7 Manual fill in of missing data

<b>Function</b>	FUN-5 Manual Fill in of missing data
<b>Description</b>	The function allows to integrate asset data not present in a AIMCS source system, but needed for the publishing process
<b>User</b>	<ul style="list-style-type: none"> <li>Reviewer</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>Missing data are present in sections</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>Data correctly saved into the system</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li><u>1. User</u>: clicks on an asset data section;</li> <li><u>2. User</u>: identifies the data form, where information are missing</li> <li><u>3. User</u>: clicks on “integrate” button, insert the information and save.</li> <li><u>4. AIMCS</u>: saves the information into the repository</li> </ol>
<b>Detailed requirements</b>	RD_ 9 When user saves, AIMCS will perform formal controls on some type of inserted data (e.g. data format) and in presence of error it will display a message.

## 5.5 DATA APPROVAL PROCESS

The following paragraph aims at describing the detailed solution related to **Approval process** representing the second step for AIMCS workflow.

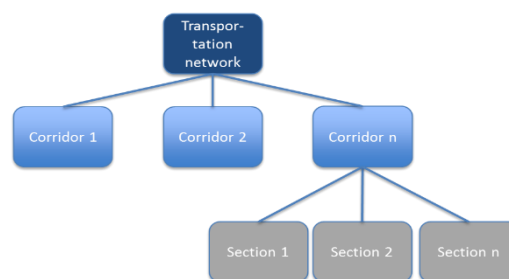
The goal is to identify a solution aiming at easing **data approval** by the users, presenting a **set of key performance indicators**, calculated from aggregated data.

Performance Indicators will be classified in the following **three categories**:

- **Strategic KPIs:** to track performance metrics against high-level objectives; as a result, these KPIs tend to summarize performance over the past month, quarter, or year; target audience for this kind of KPIs can be Asset owners, Asset Managers and other external stakeholders;
- **Tactical KPIs:** to monitor the processes that support the organization's strategic initiatives. Tactical KPIs help the decision-making process; target audience of this KPIs is Asset Managers;
- **Operational KPIs:** to monitor and analyzing NIA's processes related to core activities; target audience of this KPIs can be both Service Providers and Asset Managers;

**Key Performance indicators** will be related to the following **objects** hierarchically linked together:

- **Transportation Network:** entire transportation system managed by NIA;
- **Corridor:** key parts composing the transportation network;
- **Section:** network segments composing each corridor;



AIMCS will allow the user to view and approve key performance indicators both at section level and at transportation network level.

The approval of the higher level will propagate the status to the bottom ones; for example if a user approves a key performance indicator for a corridor, AIMCS will consider its sections also approved.

Each user configured as “approver” will visualize only key performance indicators calculated on the objects for which he has the authorizations. Within a NIA organization, it is possible to identify the following user category:

- **Asset Manager:** users who will have a visibility according to the extension of transportation network managed (e.g. an entire corridor, a section, etc.)

The users at this stage will perform the following activities:

- Browsing key performance indicators related to a transportation network;
- Approving performance indicators.

### 5.5.1 KPI

Performance indicators should be linked directly to the expectations of the transportation system. An objective performance indicator is one whose definition and measurement all stakeholders can agree upon.

Cost, performance, service delivery and safety are key elements in most transportation decision-making.

For AIMCS the following table shows a preliminary set of KPIs identified as representative for Strategic, Tactical and Operational areas. The KPIs could correspond partially or entirely to the NIA's contractual obligations toward stake/shareholders.

Table 5-8 Strategic, Tactical and Operational KPIs



Area	Feature	KPI	Units	Breakdown
Strategic	<i>Service quality (Comfort)</i>	<ul style="list-style-type: none"> <li>Ride &amp; Surface quality</li> </ul>	<ul style="list-style-type: none"> <li>% good, fair, poor linked to threshold for technical KPIs (e.g. IRI &lt; 1,5 = good, Rut depth etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Corridor, Section</li> </ul>
Strategic	<i>Service quality (Mobility and Speed)</i>	<ul style="list-style-type: none"> <li>Average Travel Speed</li> </ul>	<ul style="list-style-type: none"> <li>Km/h</li> </ul>	<ul style="list-style-type: none"> <li>Corridor, Section</li> </ul>
Strategic	<i>Economic return</i>	<ul style="list-style-type: none"> <li>Asset Value /Replacement Cost</li> </ul>	<ul style="list-style-type: none"> <li>€ or %</li> </ul>	<ul style="list-style-type: none"> <li>Corridor, Section, Asset</li> </ul>
Strategic	<i>Utilization</i>	<ul style="list-style-type: none"> <li>Travel</li> </ul>	<ul style="list-style-type: none"> <li>Vehicle – km/year travelled</li> </ul>	<ul style="list-style-type: none"> <li>Network, Corridor, Section</li> </ul>
Strategic	<i>Expenditure</i>	<ul style="list-style-type: none"> <li>Expenditures for maintenance</li> </ul>	<ul style="list-style-type: none"> <li>€/km</li> </ul>	<ul style="list-style-type: none"> <li>Network, Corridor, Section, Asset</li> </ul>
Tactical	<i>Maintenance Works</i>	<ul style="list-style-type: none"> <li>Number, progress status, economic value</li> </ul>		<ul style="list-style-type: none"> <li>Network, Corridor, Section, Asset</li> </ul>
Tactical	<i>Safety</i>	<ul style="list-style-type: none"> <li>Number of accidents, fatalities and injuries</li> </ul>	<ul style="list-style-type: none"> <li>Total number or rate (Number/veh-km)</li> </ul>	<ul style="list-style-type: none"> <li>Network, Corridor, Section</li> </ul>
Tactical	<i>Utilization &amp; Traffic</i>	<ul style="list-style-type: none"> <li>Network availability (Closures)</li> </ul>	<ul style="list-style-type: none"> <li>Hours</li> </ul>	<ul style="list-style-type: none"> <li>Network, Corridor, Section</li> </ul>
Operational	<i>Operational Effectiveness</i>	<ul style="list-style-type: none"> <li>Incident Response Time</li> </ul>	<ul style="list-style-type: none"> <li>Minutes</li> </ul>	<ul style="list-style-type: none"> <li>Network, Corridor, Section</li> </ul>
Operational	<i>Pavement</i>	<ul style="list-style-type: none"> <li>Pavement condition</li> </ul>	<ul style="list-style-type: none"> <li>IRI, Rut Depth, etc.</li> </ul>	<ul style="list-style-type: none"> <li>Corridor, Section, Asset</li> </ul>
Operational	<i>Bridge</i>	<ul style="list-style-type: none"> <li>Bridge condition (Visual inspection)</li> </ul>	<ul style="list-style-type: none"> <li>% (good, fair, poor)</li> </ul>	<ul style="list-style-type: none"> <li>Asset</li> </ul>

### 5.5.2 BROWSING KEY PERFORMANCE INDICATORS

The **home page** of the approver will show a resume of objects' number for which key performance indicators have been calculated in the referring period.

The synthesis reports the total number referred to the objects for which KPIs have been calculated:

- Number of transportation networks;
- Number of corridors composing the transportation network;
- Number of sections composing the transportation network;

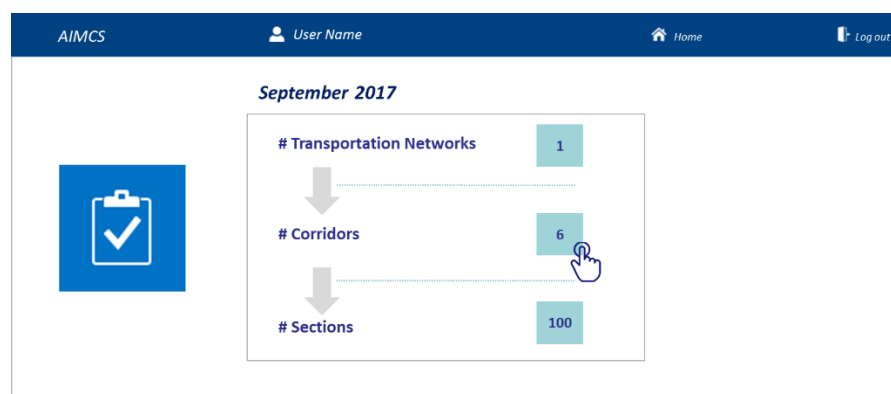


Figure 5-7. Approval Home page

Selecting the object category (Network, Corridor or Section), user will access to a dashboard related the approval process; for each item, AIMCS will display **the status of the indicators** (approved or to be approved) and will allow to browse the specific indicators related to the three identified categories for indicators (strategical, tactical and operational).



Figure 5-8. KPIs' Dashboard per Object

Subsequently, user can access to the page displaying KPIs' values, as shown in the following picture.

The page will display for each performance indicator **the current value** related to the referring publishing period and calculated on updated data, and the **last approved value**. In case of no change occurred on a KPI value, this one will appear as approved.

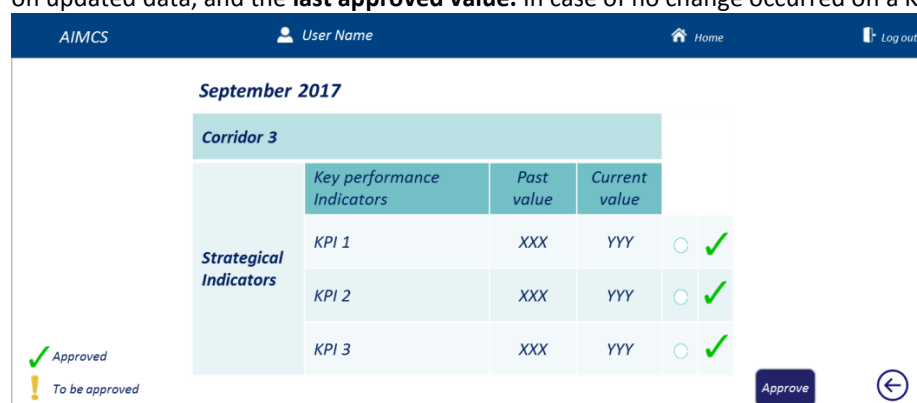


Figure 5-9. KPIs' values per Object

### 5.5.3 KEY PERFORMANCE INDICATORS APPROVAL

Once the user has checked KPIs' values, it would be possible to perform the approval with the following processes:

- In the **"KPIs' Dashboard Page"**, without accessing to the values page, selecting in single, multiple or massive way the objects to be approved;

September 2017		Indicators		
Corridor Name		Strategical	Tactical	Operational
Corridor 1	<input type="radio"/>	✓	✓	✓
Corridor 2	<input type="radio"/>	✓	!	✓
Corridor 3	<input checked="" type="radio"/>	!	✓	✓
Corridor 4	<input checked="" type="radio"/>	✓	✓	!
Corridor 5	<input type="radio"/>	✓	✓	✓
Corridor 6	<input type="radio"/>	✓	✓	✓

✓ Approved  
 ! To be approved

Approve

Figure 5-10. KPIs' approval per object

- In the "KPIs' Values", approving in a single or multiple way, the KPIs;

September 2017					
Corridor 3					
	Key performance Indicators	Past value	Current value		
Strategical Indicators	KPI 1	XXX	YYY	<input type="radio"/>	✓
	KPI 2	XXX	YYY	<input checked="" type="radio"/>	!
	KPI 3	XXX	YYY	<input type="radio"/>	✓

✓ Approved  
 ! To be approved

Approve

Figure 5-11. KPIs' approval

Pushing the "Approve" button, AIMCS will show a confirmation pop up, that will ask a confirm of the approval. Once approved, KPI will change its status.

#### 5.5.4 USE CASES

Table 5-9 Use cases for Approval Process

ID	USE CASE NAME	USER	USE CASE DESCRIPTION	FUNCTION
UC- 5	User Log-in	Approver	<ul style="list-style-type: none"> <li>User logs into the system typing user name and password</li> </ul>	<ul style="list-style-type: none"> <li>FUN-3 Log-in</li> </ul>
UC- 6	KPIs' Approval	Approver	<ul style="list-style-type: none"> <li>User selects the object category for which intends to view KPIs;</li> <li>AIMCS will display the list of objects;</li> <li>User selects one specific object;</li> <li>AIMCS will show the KPIs values related to the object;</li> <li>User selects one or more object/KPIs and perform approval</li> <li>AIMCS will change status of the KPI</li> </ul>	<ul style="list-style-type: none"> <li>FUN-6 KPI's Browsing</li> <li>FUN-7 KPIs' Approval</li> </ul>

#### 5.5.4.1 FUNCTIONS

Table 5-10 KPIs' Browsing

<b>Function</b>	FUN-6 KPIs' Browsing
<b>Description</b>	The function allows viewing KPIs' values related to the transportation network and its components.
<b>User</b>	<ul style="list-style-type: none"> <li>Approver</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>At least one KPI should be present into the system</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>KPI value displayed.</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li><u>User</u>: clicks on an object type;</li> <li><u>AIMCS</u>: displays the list of the objects;</li> <li><u>User</u>: clicks on a KPI category for a specific object;</li> <li><u>AIMCS</u>: shows the KPIs page for the selected category.</li> </ol>
<b>Detailed requirements</b>	-

Table 5-11 KPIs' approval

<b>Function</b>	FUN-7 KPIs' approval
<b>Description</b>	The function allows to approve one or more KPIs
<b>User</b>	<ul style="list-style-type: none"> <li>Approver</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>At least one KPI should be</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>KPI value displayed.</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li><u>User</u>: selects one or more KPIs;</li> <li><u>User</u>: clicks on "approve" button;</li> <li><u>AIMCS</u>: shows the confirmation pop up;</li> <li><u>User</u>: clicks on confirm;</li> <li><u>AIMCS</u>: change KPI status;</li> </ol>
<b>Detailed requirements</b>	-

## 5.6 INFORMATION PUBLISHING PROCESS

The publishing process represents last step of the workflow, before disseminating information to the stakeholder.

Considering that data have been already reviewed and approved, the process doesn't provide any other check on data but AIMCS supports the publisher in scheduling activities and control of publishing achievement.

The recipients of the information generated by AIMCS will be:

- Open data portals
- NIA's portals
- Stakeholders emails

AIMCS will perform publishing toward recipients in two ways:

- Automatic:** if an automatic interface is present (e.g. a web service), AIMCS will the deliver the information to the targets;
- Manual:** in case a manual upload is needed by the publisher; AIMCS will produce a file, but the publisher will be in charge for the process completion;

### 5.6.1 PRE-PUBLISHING MANAGEMENT

Considering a periodical publishing of information related to asset, AIMCS will implement a calendar management for the publishing event.

On the system, the publisher will have a complete view of the tasks in terms of current publishing activities, planned (defining “to do list”) and the ones occurred in the past (helping to have a history of past published information).

Table 5-12 Publisher Homepage

For each publishing cycle associated to a specific set of information (e.g. strategical KPIs), AIMCS will show a status that identifies if the publisher has performed the needed activities to accomplish the publication:

- The publisher have correctly published the information (*green flag*);
- The information are ready for publishing (approval cycle ended) but the publisher has not yet performed the publishing (*yellow flag*);
- The publisher didn't have published the information according to deadline (*red flag*)
- The publisher has published the information, but some errors have been found (this event occurs in case of a full automatic publishing procedure via web services) (*black flag*)

From the home page, selecting the current publishing cycle and the target stakeholder, the publisher can access to the information to be published.

Table 5-13 Publisher Activities

The publisher will be able to:

- **View** data to be published or already published;
- **Publish** approved data (automatically or manually);

- **Download** final output (e.g. xml file, csv file, pdf file, etc.) to be sent or already sent (past publishing);

### 5.6.2 INFORMATION PUBLISHING

In case of **automatic publishing** via Web Services or other transfer protocols (e.g. FTP), AIMCS will manage the control and monitoring transmission results:

- **Checks on transmission outcomes between AIMCS and recipients** – in this case AIMCS will manage “status checks” deriving from Web Service calls or communication attempts through FTP;
- **Checks on information contents** – this is the case where a recipient performs checks on information contents and provides feedbacks; AIMCS will be configured in order to be able to receive log inputs that publisher can then analyze.

For **manual publishing**, AIMCS will perform the file production but it cannot assure that publisher will then transmit/publish the information to the recipients.

### 5.6.3 USE CASES

Table 5-14 Use cases for Approval Process

ID	USE CASE NAME	USER	USE CASE DESCRIPTION	FUNCTION
UC- 7	User Log-in	Publisher	<ul style="list-style-type: none"> <li>▪ User logs into the system typing user name and password</li> </ul>	▪ FUN-4 Log-in
UC- 8	Publishing Calendar Display	Publisher	<ul style="list-style-type: none"> <li>▪ User accesses to the publishing calendar</li> <li>▪ User selects, according to current publishing cycle, a specific set of information to be published</li> </ul>	▪ FUN-7 View of publishing calendar
UC- 9	Information Visualization	Publisher	<ul style="list-style-type: none"> <li>▪ User selects the “View” function;</li> <li>▪ AIMCS displays the information to be published/already published in a table form or with a specific report</li> </ul>	▪ FUN-8 Publishing preview
UC- 10	Information Publishing	Publisher	<ul style="list-style-type: none"> <li>▪ User selects “Publish” function, allowing AIMCS to generate the file for publishing (e.g. xml, pdf, etc);</li> <li>▪ Then AIMCS will send via Web Service/FTP (if an automatic interface is present) the file to target destination to complete the publishing process.</li> <li>▪ At the end, AIMC will store sent files.</li> </ul>	▪ FUN-9 Information publishing
UC- 11	Information Download	Publisher	<ul style="list-style-type: none"> <li>▪ Following the publishing, user can download to a local folder the file containing the information;</li> </ul>	▪ FUN-10 Download

#### 5.6.3.1 FUNCTIONS

Table 5-15 View of publishing calendar

<b>Function</b>	FUN-7 View of publishing calendar
<b>Description</b>	<ul style="list-style-type: none"> <li>▪ The function allows to view the publishing calendar for target recipients;</li> </ul>
<b>User</b>	<ul style="list-style-type: none"> <li>▪ Publisher</li> </ul>
<b>Pre-condition</b>	<ul style="list-style-type: none"> <li>▪ User logged-in</li> </ul>
<b>Post-condition</b>	<ul style="list-style-type: none"> <li>▪ AIMCS shows all target recipients and the publishing current status.</li> </ul>
<b>Path</b>	<ol style="list-style-type: none"> <li>1. <u>User</u>: performs the log-in</li> <li>2. <u>AIMCS</u>: displays for the user, the publishing calendar</li> </ol>

<b>Detailed requirements</b>	RD_ 10 Control and verification of publishing status for target recipient and related information; AIMCS will check the publishing status, displaying it through a flag (green, red, yellow or black).
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Table 5-16 Information Publishing

<b>Function</b>	FUN-9 Information publishing
<b>Description</b>	The function allows to: <ul style="list-style-type: none"> <li>■ Create the file with the information to be published;</li> <li>■ Historicize file into AIMCS;</li> <li>■ Send automatically file to recipients;</li> <li>■ Manage the log regarding the transmission outcomes.</li> </ul>
<b>User</b>	■ Publisher
<b>Pre-condition</b>	■ No publishing already performed.
<b>Post-condition</b>	■ Information published and stored in AIMCS
<b>Path</b>	<ol style="list-style-type: none"> <li>1. <u>User</u>: clicks on “Publish” function;</li> <li>2. <u>AIMCS</u>: loads data to be published and generate the file for publishing;</li> <li>3. <u>AIMCS</u>: stores the file;</li> <li>4. <u>AIMCS</u>: establishes a communication channel with target recipient and send the file;</li> <li>5. <u>Target recipients</u>: receives correctly the file;</li> <li>6. <u>AIMCS</u>: receives the log file.</li> </ol>
<b>Detailed requirements</b>	

Table 5-17 Publishing preview

<b>Function</b>	FUN-9 Publishing preview
<b>Description</b>	■ The function allows to view in table/report form the information that are going to be published.
<b>User</b>	■ Publisher
<b>Pre-condition</b>	■ In the current publishing cycle, information have been approved.
<b>Post-condition</b>	■ AIMCS displays the tables/reports containing the information to be published
<b>Path</b>	<ol style="list-style-type: none"> <li>1. <u>User</u>: clicks on “View” function;</li> <li>2. <u>AIMCS</u>: loads the data and organize them according specific table templates</li> <li>3. <u>Users</u>: views the tables/reports</li> </ol>
<b>Detailed requirements</b>	-

Table 5-18 Download

<b>Function</b>	FUN-9 Download
<b>Description</b>	■ The function allows to download files sent for a publishing cycle
<b>User</b>	■ Publisher
<b>Pre-condition</b>	■ User has already sent the information to be published.

<b>Post-condition</b>	■ File correctly downloaded by the user
<b>Path</b>	<u>1. User</u> : clicks on “Download” function; <u>2. AIMCS</u> : recovers the published file for the selected cycle; <u>3. User</u> : view or save to a local folder the file;
<b>Detailed requirements</b>	-



## 6 AIMCS Architectural Components

The identification of **AIMCS architecture components** have been identified taking into account the following drivers:

- Centralization, integration and standardization of data coming from heterogeneous sources;
- Metadata management of acquisition, transformation, and loading Processes;
- Decoupling<sup>2</sup> between acquisition and publishing processes, allowing having different technologies of source systems/target publishing systems.

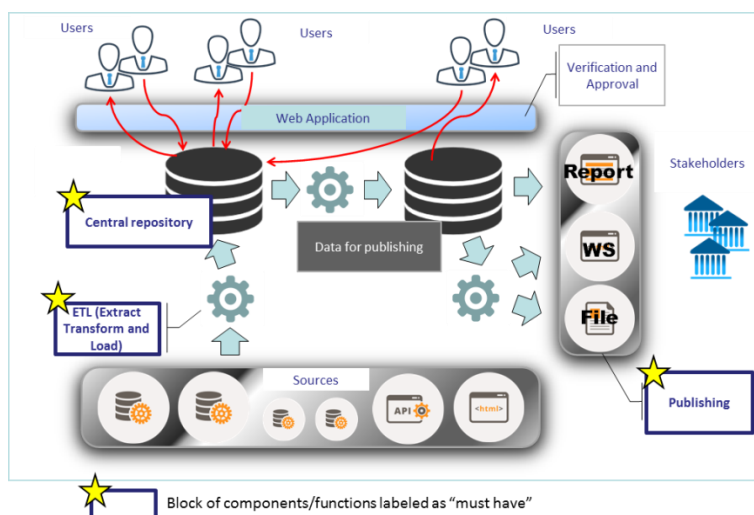


Figure 6-1. AIMCS Architectural scheme

### 6.1 SOURCE SYSTEMS

Source systems are NIAs applications on which asset data are generated, through specific procedures or management processes. Data are usually already reviewed on source systems by controls performed by the applications.

The integration between sources systems and AIMCS can be performed in various ways like:

- **Connectors to Relational Database:** a relational database is a collection of data items organized as a set of formally-described tables from which data can be accessed or reassembled in many different ways without having to reorganize the database tables. The standard user and application program interface to a relational database is the structured query language (SQL). SQL statements are used both for interactive queries for information from a relational database and for gathering data for reports.
- **Web services:** are XML-based information exchange systems that use the Internet for direct application-to-application interaction. These systems can include programs, objects, messages, or documents. In other terms a Web service is a standardized way of integrating Web-based applications using the XML, SOAP, WSDL and UDDI open standards over an Internet protocol backbone.
- **File transfer:** transmission of a file through a communication channel from one system to another; typically, file transfer is mediated by a communications protocol.
- **XML Documents Extensible Markup Language (XML)** is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable. The W3C's XML 1.0 Specification and

<sup>2</sup> Decoupling allows each component to perform its tasks independently of the others

several other related specifications, all of them free open standards, define XML. The design goals of XML emphasize simplicity, generality, and usability across the Internet.

## 6.2 CENTRAL REPOSITORY

The **central repository** is the core AIMCS element containing all the information needed for its functioning.

### 6.2.1 DATA MODEL

It represents the **physical database** where data are stored and all the information useful for verification, approving publishing are available. It's within the database that consistency and congruence between the items is guaranteed.

### 6.2.2 ETL (EXTRACT TRANSFORM AND LOAD)

An **ETL tool** is used to acquire a temporary subset of data for reports or other purposes, or a more permanent data set may be acquired for other purposes such as: the population of a data mart or data warehouse; conversion from one database type to another; and the migration of data from one database or platform to another.

For **AIMCS purposes**, ETL is the **application layer** where procedures for data acquisition from source systems and transformation for publishing are performed.

## 6.3 WEB APPLICATION

The web application represents **AIMCS front-end** where users can perform verification and approval processes.

A **web application** is a client–server software application in which the client (or user interface) runs in a web browser. Web applications use web documents written in a standard format such as HTML and JavaScript, which are supported by a variety of web browsers. During the session, the web browser interprets and displays the pages, and acts as the universal client for any web application.

Web applications are usually broken into logical chunks called "**tiers**", where every tier is assigned a role.

For AIMCS context, the web application should be a **three-tiered application**. In its most common form, the three tiers are called **presentation, application and storage**, in this order:

- The **web browser** is the **first tier (presentation)**;
- The engine using some **dynamic Web content technology** (such as ASP, CGI, ColdFusion, Dart, JSP/Java, Node.js, PHP, Python or Ruby on Rails) is the **middle tier (application logic)**;
- The database is the **third tier (storage)**, represented by the **AIMCS central repository**.

## 6.4 PUBLISHING

It represents the layer for the fruition of information by third parties (e.g. stakeholders); this could happen through **delivery of files** or **web services** for information exchange.

In order to let the information available for publishing, AIMCS will have a specific component for reporting, allowing adherence with major standards associated with publishing:

- **The 8 Principles of Open Government Data**: set of fundamental principles for open government data, that describe how correctly manage an open data repository;
- **5-star deployment scheme**: system of rating that begins at one star and data gets stars when proprietary formats are removed and links are added;
- **W3C-Data on the Web Best Practices**: document that provides Best Practices related to the publication and usage of data on the Web designed to help support a self-sustaining ecosystem.

Open data is the notion that certain types of data should be freely available for everyone to use and share without restrictions such as copyrights, patents or other control mechanisms. The only requirement - at most - is that those who use and share the data attribute it to its source.

Table 6-1 The 8 Principles of Open Government Data

#	Principle	Description
1.	<b>Complete</b>	All public data is made available. Public data is data that is not subject to valid privacy, security or privilege limitations.
2.	<b>Primary</b>	Data is as collected at the source, with the highest possible level of granularity, not in aggregate or modified forms.
3.	<b>Timely</b>	Data is made available as quickly as necessary to preserve the value of the data.
4.	<b>Accessible</b>	Data is available to the widest range of users for the widest range of purposes.
5.	<b>Machine processable</b>	Data is reasonably structured to allow automated processing
6.	<b>Non-discriminatory</b>	Data is available to anyone, with no requirement of registration.
7.	<b>Non-proprietary</b>	Data is available in a format over which no entity has exclusive control
8.	<b>License-free</b>	Data is not subject to any copyright, patent, trademark or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed.

Source: [opengovdata.org](http://opengovdata.org)

Table 6-2 Example of file formats for open data document

File Format	Utilization
XML	■ data definition
CSV	■ data in tabular form
ODT	■ textual documents
Shapefile and KML	■ geographical data
PDF	■ document representation
ODS	■ spreadsheet

Table 6-3 Examples for each level of 5-star deployment scheme for Open Data

Star Rating	Example
★	Data is available on the Web, in whatever format
★★	Available as machine-readable structured data, (i.e., not a scanned image)
★★★	Available in a non-proprietary format, (i.e, CSV, not Microsoft Excel)
★★★★	Published using open standards from the W3C (RDF and SPARQL)
★★★★★	All of the above and links to other Linked Open Data

Source: W3C - 5 Star Linked Data ([https://www.w3.org/2011/gld/wiki/5\\_Star\\_Linked\\_Data](https://www.w3.org/2011/gld/wiki/5_Star_Linked_Data))

## 6.5 SECURITY

Security represents the AIMCS component that allows managing users profiling and authorizations for front-end application.

According to security best practices, AIMCS should allow **Single sign-on** (SSO); SSO is a property of access control of multiple related, yet independent, software systems. With this property, a user logs in with a single ID and password to gain access to a connected system or systems without using different usernames or passwords, or in some configurations seamlessly sign on at each system.

## 7 Guidelines for AIMCS implementation

For AIMCS implementation, each NIA can identify its development path according to own maturity level of IT technologies. However, for the design of AIMCS, the possible differences across NIAs have been taken in consideration; for this reason, the development of AIMCS can be faced with a **modular approach**, starting from a **core block of components/functions** and then **adding modules** with an **“agile” approach**.

The core block **of components/functions** labeled as *“must have”* are the following:

- **Central repository:** this is the AIMCS foundation and the starting point to build the system;
- **ETL:** in order to be able to get data from source systems (or from file) and produce the outputs;
- **Publishing:** ability to provide at least files containing the information for the stakeholders;

From this basic landscape, it would be then possible to add *“nice to have”* features that improve the system architecture, through an incremental approach.

AIMCS component/feature	“Must have”	“Nice to have” or incremental upgrades
<b>ETL</b>	<ul style="list-style-type: none"> <li>▪ Availability to upload asset data via file</li> <li>▪ Capability to perform basic checks on data consistency</li> </ul>	<ul style="list-style-type: none"> <li>▪ External connectors to source systems</li> <li>▪ Web services integration</li> <li>▪ Advanced checks on data consistency</li> <li>▪ Data loading realized in three phases allowing uncoupling the data structures in source systems with the ones present in AIMCS (ref. 5.3)</li> </ul>
<b>Central Repository</b>	<ul style="list-style-type: none"> <li>▪ Database with the capability to store current and past asset data</li> </ul>	
<b>Web application (Front End)</b>	<ul style="list-style-type: none"> <li>▪ 3 tier web application</li> <li>▪ Basic user functions (e.g. asset data search, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Compliant to W3C standards</li> <li>▪ Function for browsing on asset data</li> <li>▪ Graphic Charts for KPIs visualization</li> </ul>
<b>Workflow</b>	<ul style="list-style-type: none"> <li>▪ 1 Level Workflow (Publishing)</li> </ul>	<ul style="list-style-type: none"> <li>▪ 2 more levels of workflow (Approval and Reviewer)</li> </ul>
<b>Publishing</b>	<ul style="list-style-type: none"> <li>▪ Creation of <b>output files</b> to be disseminated</li> <li>▪ Delivery of files in <b>open format</b></li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Automatic publishing</b> interfaces (e.g. Web services)</li> <li>▪ Calendar Management Functions (ref.5.6.1)</li> <li>▪ Full open data standard adoption</li> </ul>
<b>Security</b>	<ul style="list-style-type: none"> <li>▪ Basic user profiling and authorization (<i>Username &amp; password</i>)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Adoption of <b>Single Sign On</b> (ref. 0)</li> </ul>

If necessary, each NIA can look for the required components constituting AIMCS solution on the market of Software Vendors. In this scenario, it is strategic to perform an effective Sw selection for the “off the shelf” products (e.g. data management solutions, master data management, etc.) that can support the realization of an asset information management system.

For this goal, a valid support can come from available public research and benchmark, as for example “Forrester Wave” or “Gartner Magic Quadrant” research methodologies. Gartner research provides a graphical competitive positioning of four types of technology providers in fast-growing markets: Leaders, Visionaries, Niche Players and Challengers. As companion research, Gartner Critical Capabilities notes provide deeper insight into the capability and suitability of providers' IT products and services based on specific or customized use cases.

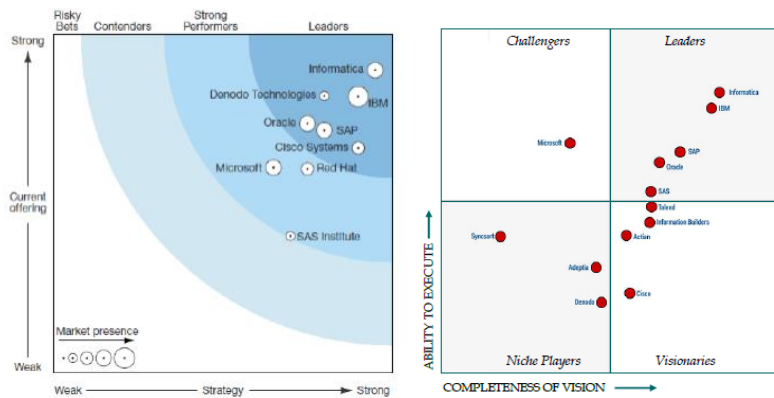


Figure 7-1. Example of Sw Selection methodologies

## 8 Conclusion

The **design of an Asset Information Core System** represents the **second pillar** to build a common approach for asset data management among NIAs.

The solution described in this report demonstrates that asset information and data management can be improved with a system that allows achieving:

- An **improved control on asset data**, through an integration of different data sources, enabling also a better knowledge and monitoring of NIA's core activities.
- A **managed process to disseminate information**, through different authorization roles;
- A **common approach on information contents** for the key players of asset management (service providers, asset managers and asset owners) through a set of KPIs shared among NIAs ;
- An **improved publishing process**, based on a controlled process both on raw and elaborated data, and focused on adopting open data standards;

AIMCS architecture reflects these goals as each component (ETL, Web application, Publishing, etc.) has been designed to perform specific tasks.

Goal of next **task 3.3 “Application of the designed model for asset management system on a stretch of a TEN-T Itinerary”** will be to verify how the models and solutions identified in D3.1 and in D3.2 would fit in a real case.

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