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**MPAI Technical Specification**

**Compression and Understanding of Industrial Data**

**MPAI-CUI**

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| **WD 0.4** |

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**Compression and Understanding of Industrial Data**

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# Introduction

Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI) is an [international Standards Developing Organisation](http://mpai.community/) with the mission to develop *AI-enabled data coding standards*. Research has shown that data coding with AI-based technologies is generally *more efficient* than with existing technologies. Compression and feature-based description are notable examples of coding.

*Compression and understanding of industrial data* (MPAI-CUI) is an MPAI Standard, comprising the “AI-based Company Performance Prediction (CPP)” Use Case. CPP uses AI to extract the most relevant information from indus­trial data, with the aim of assessing the performance of a company and predicting the risk of bankruptcy long before it may happen.

The current version of MPAI-CUI has been developed by the MPAI Compression and Understan­ding of Industrial Data Development Committee (CUI-DC). Future versions of the standard may extend the scope of the Use Case and/or add new Use Cases in the scope of Compression and Understanding of Industrial Data.

In the following Terms beginning with a capital letter are defined in *Table 1* if they are specific to this MPAI-CUI Standard and to *Table 10* if they are common to all MPAI Standards.

The AI Framework (AIF) execution environment (MPA-AIF) [2] depicted in *Figure 1* enables Interoperable AI applications and services.



*Figure 1 –Architecture and Components of the AI Framework (AIF)*

MPAI-CUI normatively specifies the technologies required to support the AI-based Company Performance Prediction Use Case (CPP). *Figure 2* is the instantiation of the general AIF Architec­ture to the CPP Use Case. Note: the Internal Storage and Access of *Figure 1* are not represented.



*Figure 2 – AI-based Company Performance Prediction Reference Model*

The rectangle including green boxes in *Figure 2* is called AI Workflow (AIW). The AIW is charac­terised by the following normative elements:

1. The format and semantics of the input data, i.e., “Prediction Horizon”, “Governance”, “Finan­cial Statement” and “Risk Assessment”.
2. The function of the AIW, i.e., “Compute company performance indicators in a given prediction horizon”.
3. The format and semantics of the output data, i.e., “Adequacy index of organisational data”, “Default probab­ility” and “Business continuity probability”.
4. The Connections of the green boxes – called AI Modules (AIM).

Each AIM, like the one depicted in *Figure 3* called Governance Assessment,



*Figure 3 – An example of AI Module (AIM)*

is characterised by the following normative elements:

1. The format and semantics of the input data, i.e., “Governance” and “Financial Statement”.
2. The function, i.e., “Compute the Governance Features”.
3. The format and semantics of the output data, i.e., “Governance Features”.

AIMs are defined by their functions and interfaces, not by their internal architectures, which may need not be known and may be based on AI or data processing, and implemented in software, hardware or hybrid software and hardware technologies.

MPAI defines Interoperability as the ability to replace an AIM in an AIW with another AIM having the same normative elements and Interoperability Level and obtain a functionally equivalent AIM.

An Implementation may have 3 different Interoperability Levels:

|  |  |
| --- | --- |
| Level 1 | An AIF Implementation running an AIW composed of AIMs performing any propri­etary function and exposing any proprietary interface but exposing the interfaces requ­ired to be executed in the AIF. |
| Level 2 | An AIF Implementation running an AIW composed of AIMs whose functions and interfaces are specified by an MPAI Application Standard. |
| Level 3 | An Implementation running an AIW composed of AIMs certified to possess the attributes of Reliability, Robustness, Replicability and Fair­ness – collectively called Performance. |

# Scope of the MPAI-CUI standard

The AI-based Company Performance Prediction Use Case of the Compression and Understanding of Industrial Data (MPAI-CUI) Standard

1. Predicts the performance of a Company, from its Governance, Financial and Risk data (see subsections 6.2.2, 6.2.3 and 6.2.4). The time of prediction is given as Prediction Horizon see 6.2.1).
2. Measures the Performance of the Company with Default Probability, Adequ­acy Index of Organis­ational Model, and Business Continuity Index (see 6.2.8, 6.2.9 and 6.2.10).

Company Performance Prediction normatively defines the AIW and the connections of the AIMs, the AIMs and the Formats of the input and output data of the AIW and the AIMs.

The word *normatively* implies that an Implementation claiming Conformance to:

1. An *AIW*, shall have:
	1. The function specified in Section 5.1.1.
	2. The input and output data specified in Subsection 5.1.2
	3. The AIM Topology specified Subsection 5.1.3.
	4. The AIMs with the functions specified in Subsection 5.1.4.
2. An *AIM*, shall have:
	1. Perform the AIM function specified by the appropriate section of Section 6.1.
	2. Receive as input and produce as output data in the formats specified in Section 6.2.
3. A *Data Format*, the data shall have a format specified in Section 6.2.

Users of this Technical Specification should note that:

1. This Technical Specification defines the possible levels of conformance of an Implementation but does not mandate any.
2. Implementers decide the Interoperability Level their Implementation satisfies.
3. Implementers can use the Reference Software to develop their Implementations [4].
4. Implementers can use the Conformance Testing specification to test the Conformance of an Implementation with this Technical Specification [5].
5. Performance Assessors assess the Grade of Performance of an Implementation based on the results of Performance Assessment [6].
6. The Governance of the MPAI Ecosystem is outlined in Annex 3 and specified in [1].

# Terms and definitions

The Terms used in this Technical Specification specific of MPAI-CUI and whose first letter is capital have the meaning defin­ed in *Table 1*. The general MPAI Terms are defin­ed in *Table 10*.

*Table 1 – MPAI-CUI terms*

|  |  |
| --- | --- |
| **Term** | **Definition** |
| Financial features | A set of indexes and ratios computed using financial statement data. |
| Financial statement  | Data produced based on a set of accounting principles driving maintenance and reporting of company accounts so that financial statem­ents can be consistent, transparent, and comparable across companies. |
| Governance features | A set of indexes/parameters that are used to assess the adequacy of the organizational model. |
| Risk assessment | Attributes that indicate the internal assessment that the company performs to identify and measure potential or existing vertical risks, and their impact on business continuity. |
| Risk matrix | Table composed of two rows for the risks (cyber and seismic) and four columns for the characteristics (occurrence, business impact, gravity and risk retention) as evaluated by the company. |

# Normative references

The following documents are normatively referenced by MPAI-CUI.

1. MPAI Document: Governance of the MPAI Ecosystem V.1
2. MPAI Technical Specification: AI Framework (MPAI-AIF) – under development
3. MPAI Technical Specification: Compression and Understanding of Industrial Data (MPAI-CUI) V.1
4. MPAI Reference Software: Compression and Understanding of Industrial Data (MPAI-CUI) V.1
5. MPAI Conformance Testing: Compression and Understanding of Industrial Data (MPAI-CUI) V.1
6. MPAI Performance Assessment: Compression and Understanding of Industrial Data (MPAI-CUI) V.1
7. International Financial Reporting Standard. List of IFRS Standards. Available online: <https://www.ifrs.org/issued-standards/list-of-standards/>
8. International Organization for Standardization. ISO 31000 – Risk Management. Available online: <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100426.pdf>
9. International Organization for Standardization. ISO 27005 Information technology -- Security techniques -- Information security risk management
10. International Organization for Standardization. ISO/IEC 27032 -- Information technology — Security techniques — Guidelines for cybersecurity.
11. Federal Emergency Management Agency (FEMA). Earthquake-Resistant Design Concepts. An Introduction to the NEHRP Recommended Seismic Provisions for New Buildings and Other Structures. FEMA P-749/December 2010.

# Use Case Architecture

## AI-based Company Performance Prediction

### Function

The AI-based Company Performance Prediction Use Case) Standard

1. Predicts the performance of a Company, from its Governance, Financial and Risk data (see subsections 6.2.2, 6.2.3 and 6.2.4). The time of prediction is given as Prediction Horizon see 6.2.1).
2. Measures the Performance with Default Probability, Adequ­acy Index of Organis­ational Model, and Business Continuity Index (see subsections 6.2.8, 6.2.9 and 6.2.10).

### Input/output data

|  |  |
| --- | --- |
| **Input** | **Comments** |
| Prediction Horizon | Number of months of prediction. |
| Governance | Governance data. |
| Financial Statement | Full financial statement. |
| Risk Assessment | The company assessment of the impact of vertical risks: cyber and seismic assessed according to ISO 31000 Risk Management [8], and ISO 27005 Infor­mation security risk management [9], specific for cyber risk management. |
| **Output** | **Comments** |
| Default probability | the probability of the company default in the specified prediction horizon.  |
| Adequacy index of organisational model | the adequacy of the organisational model expressed as a linear score in the 0 to 1 range in the specified prediction horizon. |
| Business continuity probability | the probability of an interruption of the operations of the company for less than 2% of the specified prediction horizon. |

### Implementation Architecture

*Figure 2* (repeated below for convenience) gives the normative Architecture of the AI-based Company Performance Prediction Use Case.



This is how AI-based Company Performance Prediction operates:

1. User defines a Prediction Horizon and feeds Governance, Financial Statement and Risk Assessment data.
2. Governance Assessment produces Governance Features by processing Governance and Finan­cial data.
3. Financial Assessment produces Adequacy of Financial Features by processing Financial Stat­ement data.
4. Risk Matrix Generation produces the Risk Matrix by processing Risk Assessment data.
5. Prediction produces Adequacy Index of Organisational Model and Default Probability by processing Governance Features and Financial Features.
6. Perturbation produces Business Continuity Probability by processing Default Probability and Risk Matrix.

### AI Modules

The AI Modules in *Figure 2* perform the functions described in *Table 2*.

*Table 2 – AIMs of AI-based Company Performance Prediction*

|  |  |
| --- | --- |
| **AIM** | **Function** |
| **Financial Assessment**  | Computes the financial features defined in (see 6.2.5). |
| **Governance Assessment** | Computes the governance features defined in (see 6.2.6)\_. |
| **Risk Matrix Generation** | Builds the risk matrix defined in (see 6.2.7). |
| **Prediction** | Computes 1. The Default Probability (see 6.2.8) in a prediction horizon
2. The Adequacy Index of Organizational Model (see 6.2.9).
 |
| **Perturbation** | Perturbs the Governance Features and Financial Features to compute the Business Continuity Probability (see 6.2.10). |

### AIW Metadata

Specified in Annex 4 Section 2.

# AI modules

## MPAI-CUI AIMs and their data

### AI-based Performance Prediction

*Table 3* gives the I/O data of AI-based Company Performance Prediction.

*Table 3 – I/O data of the AI-based Company Performance Prediction AIW*

|  |  |  |
| --- | --- | --- |
| **AIM** | **Input Data** | **Output Data** |
| **Financial Assessment**  | Financial Statement Data | Financial Features |
| **Governance Assessment** | Governance Data | Governance Features |
| **Risk Matrix Generation**  | Risk Assessment  | Risk Matrix |
| **Prediction** | Financial FeaturesGovernance FeaturesPrediction horizon | Default probabilityAdequacy Index of Organizational Model |
| **Perturbation** | Default probabilityRisk Matrix | Business Continuity probability |

The AIM Metadata are specified in Annex 4 Section 3.

## Data Formats

*Table 4* gives the links (column 2) to the Subsections where the Data Formats (column 1) are defined. Column 3 gives the Use Cases that uses the Data Formats.

*Table 4 – Data formats*

|  |  |  |
| --- | --- | --- |
| **Name of Data Format** | **Subsection** | **Use Case** |
| Prediction horizon | 6.2.1 | CUI |
| Financial statement | 6.2.2 | CUI |
| Governance | 6.2.3 | CUI |
| Risk assessment | 6.2.4 | CUI |
| Financial features | 6.2.5 | CUI |
| Governance features | 6.2.6 | CUI |
| Risk matrix | 6.2.7 | CUI |
| Default probability | 6.2.8 | CUI |
| Adequacy index of organisational model | 6.2.9 | CUI |
| Business continuity probability | 6.2.10 | CUI |

### Prediction Horizon

The number of months into the future that represents how far ahead Prediction computes the Default Probability.

### Financial Statement

The financial statement provided by the Company in JSON format. The JSON data are accessible from https://mpai.community/standards/mpai-cui/data/FinancialStatementData-JSON/*.*

### Governance

The governance data provided by the Company in JSON format. The JSON data are accessible from https://mpai.community/standards/mpai-cui/data/GovernanceData-JSON/.

### Risk assessment

The risk assessment data provided by the Company in JSON format *RiskMatrixData-JSON*. The JSON data are accessible from https://mpai.community/standards/mpai-cui/data/.

### Financial features

The Financial features, computed directly from the financial statement data, are given in *Table 5*.

*Table 5 – Financial features*

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Name** | **Feature type** | **Feature value** |
| **1** | Revenues | Revenue/Profit | Absolute value |
| **2** | EBITDA margin | Revenue/Profit | Percentage (%) |
| **3** | EBITDA | Revenue/Profit | Absolute value |
| **4** | Quick ratio | Revenue/Profit | Absolute value |
| **5** | Current ratio | Revenue/Profit | Percentage (%) |
| **6** | Net working capital | Revenue/Profit | Absolute value |
| **7** | Net Financial Position | Cost/Debt | Absolute value |
| **8** | Net short-term assets | Cost/Debt | Absolute value |
| **9** | Shareholder funds-Fixed assets | Cost/Debt | Absolute value |
| **10** | Long-term liability ratio | Cost/Debt | Percentage (%) |
| **11** | Coverage of fixed assets | Cost/Debt | Absolute value |
| **12** | Amortization rate | Cost/Debt | Percentage (%) |
| **13** | Debt on sales (%) | Cost/Debt | Absolute value |
| **14** | Interest coverage ratio | Cost/Debt | Percentage (%) |
| **15** | Average stock turnover | Production | Absolute value |
| **16**  | Stock coverage days | Production | Absolute value |
| **14** | Return on Investments (ROI) | Revenue/Profit | Percentage (%) |
| **15** | Return on asset (ROA) | Revenue/Profit | Percentage (%) |
| **16** | Return on sales (ROS) | Revenue/Profit | Percentage (%) |
| **17** | Return on equity (ROE) | Revenue/Profit | Percentage (%) |
| **18** | Cash flow | Production | Absolute value |
| **19** | Interest on sales | Cost/Debt | Percentage (%) |
| **20**  | Type of financial statement  | Financial statement type  | Enumeration |

Feature n. 20: enumeration elements: Abbreviated, Micro, Detailed.

*Table 6* specifies how the features of *Table 5* (column 2) are normatively computed according to International Financial Reporting Standard (column 4) [1]. The definitions of column 3 are informative.

*Table 6 – Financial features specifics*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Feature** | **Name** | **Definition** | **Formula** | **Data type** |
| **1** | Revenues | The total amount of revenues | Directly provided in the financial statement | String of real numbers |
| **2** | EBITDA margin | A measure of a company’s profitability by comparing its gross revenues with its earnings | EBITDA/Revenues | Percentage |
| **3** | EBITDA | A measure of a company’s profitability | Operating margin + (Depreciation + Amortization + Writedowns) | String of real numbers |
| **4** | Quick ratio | The company’s ability to meets the short-term obligations with its only liquid assets | (Current assets - inventory)/Current liabilities | String of real numbers |
| **5** | Current ratio | The company’s ability to meets the short-term obligations with its current assets (e.g., cash, inventories, etc.) | (Current assets)/Current liabilities | String of real numbers |
| **6** | Net working capital | A measure of a company’s liquidity and its ability to meet short-term obligations, as well as fund operations of the business | Current assets - Current liabilities | String of real numbers |
| **7** | Net Financial Position | A financial ratio that expresses the overall financial position of the company by including all liabilities of financial nature | Due to banks + Due to lenders – Total liquid funds | String of real numbers |
| **8** | Net short-term assets | A margin that expresses the company's ability to meet current short-term liabilities through the use of cash and cash equivalents and short-term receivables | Trade and other accounts + Total liquids funds – Short term liabilities | String of real numbers |
| **9** | Shareholder funds-Fixed assets | The company’s financial solidity, thus its ability to finance itself from shareholders’ equity | Shareholders’ funds – Fixed assets | String of real numbers |
| **10** | Long-term liability ratio | The incidence of long-term debts on the total liabilities | Long- and medium-term liabilities /Total assets | String of real numbers |
| **11** | Coverage of fixed assets | An asset self-coverage ratio, which expresses the ratio of equity to tangible assets | Tangible fixed assets/Shareholders funds | String of real numbers |
| **12** | Amortization rate | The portion of capital invested in tangible fixed assets that has already been recovered | Amortization funds/ Tangible assets | String of real numbers |
| **13** | Debt on sales (%) | The company’s ability to cover its debts with the revenues from sales | Total debts /Revenues  | Percentage |
| **14** | Interest coverage ratio | The degree to which the operating profit is able to cover the cost of financial interests. | Operating margin + Depreciation, Amortization and Writedowns/ Interests | String of real numbers |
| **15** | Average stock turnover | The measure that expresses how often the warehouse is renewed | (Stocks-Advances)/Turnover \*365 | String of real numbers |
| **16**  | Stock coverage days | The average length of time during which the stocks are in warehouses | Stocks/ Cost goods sold \*365 | String of real numbers |
| **14** | Return on Investments (ROI) | The profitability of an investment, measuring the amount of return of that particular investment, relative to its cost | Operating margin / (Shareholder’s funds + Bonds + Due to banks + Due to shareholders for loans + Due to other lenders)  | Percentage |
| **15** | Return on asset (ROA) | The profitability of a company in relation to its total assets | Operating margin / Total assets  | Percentage |
| **16** | Return on sales (ROS) | Efficiency of a company in turning sales into profits | Operating margin / Total revenues  | Percentage |
| **17** | Return on equity (ROE) | The company’s annual result divided by the value of its total shareholders’ equity | Result (profit or loss)/Shareholder’s funds  | Percentage |
| **18** | Cash flow | The money coming in and going out of the company during a specific accounting period | Result (profit or loss) + (Depreciation + Amortization + Writedowns) | String of real numbers |
| **19** | Interest on sales | A measure of the incidence of interest expenses on turnover created by the company and absorbed at the service of the third-party capital employed | Interest/Revenues  | Percentage |
| **20**  | Type of financial statement  | The type of financial statement that the company prepares according to accounting regulations | Given by the reference jurisdiction  | Enumeration |

Feature n. 20: enumeration elements: Abbreviated, Micro, Detailed.

### Governance features

The Governance features, computed directly from the governance data, are given in *Table 7*.

*Table 7 – Governance features*

|  |  |  |
| --- | --- | --- |
| **Feature** | **Name** | **Feature value** |
| **1** | Number of stakeholder individuals  | Integer |
| **2** | Number of stakeholder companies  | Integer |
| **3** | Shareholder share | Percentage (%) |
| **4** | Shareholders gender | Enumeration |
| **5** | Decision-makers gender | Enumeration |
| **6** | Number of decision-makers | Integer |
| **7** | Members of the Revision and Advisory Board | Integer |
| **8** | Presence of the advisory company  | Binary |
| **9** | Number of decision-makers by the same family | Integer |
| **10** | Company phase | Enumeration |

Features n. 4 and n. 5: enumeration elements: Female, Male.

Feature n. 10: enumeration elements: Startup, Mature, Historical.

*Table 8* specifies how the features of *Table 7* (column 2) are normatively computed. The definitions of column 3 are informative.

*Table 8 – Governance features specifics*

|  |  |  |  |
| --- | --- | --- | --- |
| **Feature** | **Name** | **Definition** | **Data type** |
| **1** | Number of stakeholder individuals  | The total numbers of stakeholder individuals in the company  | Integer |
| **2** | Number of stakeholder companies  | The total numbers of stakeholder companies in the company  | Integer |
| **3** | Shareholder share | The share owned by each shareholder in the company  | Percentage |
| **4** | Shareholders gender | The gender of shareholders | Enumeration |
| **5** | Decision-makers gender | The gender of decision-makers | Enumeration |
| **6** | Number of decision-makers | The total numbers of decision-makers, members of the board of directors and representatives | Integer |
| **7** | Members of the Revision and Advisory Board | The total numbers of auditors and advisors | Integer |
| **8** | Presence of an advisory company  | The presence of a company specialized in the corporate advisory | Binary |
| **9** | Number of decision-makers by the same family | The number of decision-makers that have the same family name | Integer |
| **10** | Company phase | The company phase according to its age | Enumeration  |

Features n. 4 and n. 5: enumeration elements: Female, Male.

Feature n. 10: enumeration elements: Startup, Mature, Historical.

### Risk matrix

*Table 9* gives the four characteristics, defined by ISO 31000 [8], for the vertical risks considered:

1. *Cyber risk* defined as the preservation of confidentiality, integrity and availability of information [10].
2. *Seismic risk* defined as the measure of the possible losses associated with the behavior of a building or structure in likely earthquakes [11].

Each risk has four characteristics as indicated in *Table 9*:

*Table 9 – Risk characteristics*

|  |  |  |
| --- | --- | --- |
| **N.** | **Characteristic** | **Data type** |
| **1** | Occurrence | Real |
| **2** | Business impact | Real |
| **3** | Gravity | Real |
| **4** | Risk retention | Percentage (%) |

1. **Occurrence**: likelihood of the risk happening [8]. It can have three possible outcomes:

|  |  |  |
| --- | --- | --- |
| Low Probability  | 1 | the risk may occur only in exceptional circumstances or is unlikely to occur. |
| Medium Probability  | 2 | the risk may occur at some time. |
| High Probability  | 3 | the risk is expected to occur. |

1. **Business Impact**: consequences of a risk event [8]. It can take three values:

|  |  |  |
| --- | --- | --- |
| Minor  | 1 | Relatively minor changes in the company processes and/or products and services. |
| Moderate  | 2 | Some minor changes in the company processes and/or products and services. |
| Major  | 3 | Company processes and/or products and services are altered significantly. |

1. **Gravity**: impact on the ability of the company to deliver compliant products to the customer; to the internal efficiency; to damage to people, the environment, or property measured in terms of the estimated time needed to restore normal business activities. It can take five values:

|  |  |  |
| --- | --- | --- |
| Irrelevant  | 1 | The risk has no impact on the ability to deliver compliant products to the customer; no loss of internal efficiency; no damage to people, environment, or property. The estimated recovery time is from 1 to 8 hours.  |
| Not very relevant  | 2 | The risk has minor impacts on the ability to deliver compliant products to the customer; marginal loss of internal efficiency; no damage to people, environment, or property. The estimated recovery time is from 2 to 5 days. |
| Relevant  | 3 | May result in significant sensitive consequences on product conformity or on-time delivery; may lead to a substantial loss of internal efficiency (massive rework or 100% selections); no damage to people and the environment but possible major damage to property. The estimated recovery time is from 3 to 10 days. |
| Very relevant  | 4 | Can have very important consequences on the conformity of the products or the impossibility of their delivery; no damage to persons, any marginal damage to the environment or major property damage. The estimated recovery time is from 4 to 14 days. |
| Serious  | 5 | The occurrence of the risk has very important consequences on the conformity of products or the impossibility of delivery; involves damage to people, the environment or damage important damage to property. The estimated recovery time is greater than 15 days. |

1. **Risk Retention** portion of the risk that the Company decides to retain (percentage) [8].

The risk matrix is a table composed of two rows for the risks and four columns for the charac­teristics.

### Default probability

It is a score in the 0 to 1 range that represents the probability of the company default in a specified number of future months dependent on financial features. It is computed by Prediction using the financial features.

### Adequacy index of organisational model

It is a score in the 0 to 1 range that linearly represents the adequacy of the organisational model. Its value can be used to identify potential critical points or conflicts of interest that can lead to an increase in the risk of default. It is computed by Prediction using the governance and financial features.

### Business continuity probability

It represents the probability of an interruption of the operations of the company for a period of time less than 2% of the prediction horizon. It is computed by Perturbation using Default probability and Risk Matrix.

# Annex 1 – MPAI-wide terms and definitions (Normative)

The Terms used in this standard whose first letter is capital and are not already included in *Table 1* are defined in *Table 10.*

*Table 10 – MPAI-wide Terms*

|  |  |
| --- | --- |
| **Term** | **Definition** |
| Access | Static or slowly changing data that are required by an application such as domain knowledge data, data models, etc. |
| AI Framework (AIF) | The environment where AIWs are executed. |
| AI Workflow (AIW) | An organised aggregation of AIMs implementing a Use Case receiving AIM-specific Inputs and producing AIM-specific Outputs according to its Function. |
| AI Module (AIM) | A processing element receiving AIM-specific Inputs and producing AIM-specific Outputs according to its Function. |
| Application | A usage domain target of an Application Standard |
| Channel | A connection between an output port of an AIM and an input port of an AIM. The term “connection” is also used as synonymous. |
| Communication | The infrastructure that implements message passing between AIMs |
| Component | One of the 7 AIF elements: Access, Communication, Controller, Internal Storage, Global Storage, MPAI Store, and User Agent |
| Conformance | The attribute of an Implementation of being a correct technical Implem­entation of a Technical Specification. |
| Conformance Tester | An entity authorised by MPAI to Test the Conformance of an Implem­entation. |
| Conformance Testing | The normative document specifying the Means to Test the Conformance of an Implem­entation. |
| Conformance Testing Means | Procedures, tools, data sets and/or data set characteristics to Test the Conformance of an Implem­en­tation. |
| Connection | A channel connecting an output port of an AIM and an input port of an AIM. |
| Controller | A Component that manages and controls the AIMs in the AIF, so that they execute in the correct order and at the time when they are needed |
| Data format | The standard digital representation of data and their semantics. |
| Ecosystem | The ensemble of the following actors: MPAI, MPAI Store, Implementers, Conformance Testers, Performance Testers and Users of MPAI-AIF Im­plem­en­tations as needed to enable an Interoperability Level. |
| Explainability | The ability to trace the output of an Implementation back to the inputs that have produced it. |
| Fairness | The attribute of an Implementation whose extent of applicability can be assessed by making the training set and/or network open to testing for bias and unanticipated results. |
| Function | The operations effected by an AIW or an AIM on input data. |
| Global Storage | A Component to store data shared by AIMs. |
| Internal Storage | A Component to store data of the individual AIMs. |
| Identifier | A name that uniquely identifies an Implementation. |
| Implementation | 1. An embodiment of the MPAI-AIF Technical Specification, or
2. An AIW or AIM of a particular Level (1-2-3) conforming with a Use Case of an MPAI Applic­ation Standard.
 |
| Interoperability | The ability to functionally replace an AIM with another AIM having the same Interoperability Level |
| Interoperability Level | The attribute of an AIW and its AIMs to be executable in an AIF Implem­en­tati­on and to be proprietary (Level 1) or to pass the Conformance Tes­ting (Level 2) or the Perform­ance Testing (Level 3) of an MPAI Applic­ation Standard. |
| Knowledge Base | Structured and/or unstructured information made accessible to AIMs via MPAI-specified interfaces |
| Message | A sequence of Records transported by Communication through Channels. |
| Normativity | The set of attributes of a technology or a set of technologies specified by the applicable parts of an MPAI standard. |
| Performance | The attribute of an Implementation of being Reliable, Robust, Fair and Replicable. |
| Performance Assessment | The normative document specifying the procedures, the tools, the data sets and/or the data set characteristics to Assess the Grade of Performance of an Implementation. |
| Performance Assessment Means | Procedures, tools, data sets and/or data set characteristics to Assess the Performance of an Implem­en­tation. |
| Performance Assessor | An entity authorised by MPAI to Assess the Performance of an Implementation in a given Application domain |
| Profile | A particular subset of the technologies used in MPAI-AIF or an AIW of an Application Standard and, where applicable, the classes, other subsets, options and parameters relevant to that subset. |
| Record | A data structure with a specified structure |
| Reference Software | A technically correct software implementation of a Technical Specific­ation containing source code, or source and compiled code.  |
| Reliability | The attribute of an Implementation that performs as specified by the Application Standard, profile and version the Implementation refers to, e.g., within the application scope, stated limitations, and for the period of time specified by the Implementer. |
| Replicability | The attribute of an Implementation whose Performance, as Assessed by a Performamce Assessor, can be replicated, within an agreed level, by another Performamce Assessor. |
| Robustness | The attribute of an Implementation that copes with data outside of the stated application scope with an estimated degree of confidence. |
| Service Provider | An entrepreneur who offers an Implementation as a service (e.g., a recommendation service) to Users. |
| Standard | The ensemble of Technical Specification, Reference Software, Confor­man­ce Testing and Performance Assessment of an MPAI application Standard.  |
| Technical Specification | (Framework) the normative specification of the AI Framework.(Application) the normative specification of the set of Use Cases belonging to an Application Domain along with the AIMs required to Implement the Use Cases. the collection of Use Cases relevant to the Applic­ation Domain that include:1. The formats of the Input/Output data of the AIWs implementing the Use Cases.
2. The Topology of the AIMs of the AIWs.
3. The formats of the Input/Output data of the AIMs belonging the AIW.
 |
| Time Base | The protocol specifying how Components can access timing information |
| Topology | The set of AIM Connections of an AIW. |
| Use Case | A particular instance of the Application domain target of an Application Standard. |
| User | A user of an Implementation. |
| User Agent | The Component interfacing the user with an AIF through the Controller |
| Version | A revision or extension of a Standard or of one of its elements. |
| Zero Trust |  |

# Annex 2 - Notices and Disclaimers Concerning MPAI Standards (Informative)

The notices and legal disclaimers given below shall be borne in mind when downloading and using approved MPAI Standards downloaded from https://www.mpai.community/resources/.

In the following, “Standard” means the collection of four documents: “Technical Specification”, “Reference Software” and “Conformance Testing” and, where applicable, “Performance Testing” approved and published by MPAI at https://www.mpai.community/resources/.

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MPAI Standards are developed in accordance with the [MPAI Statutes](https://mpai.community/statutes/). An MPAI Standard may only be developed when a Framework Licence has been adopted. MPAI Standards are developed by especially established MPAI Development Committees who operate on the basis of consensus, as specified in Annex 1 of the [MPAI Statutes](https://mpai.community/statutes/). While the MPAI General Assembly and the Board of Directors administer the process of the said Annex 1, MPAI does not independently evaluate, test, or verify the accuracy of any of the information or the suitability of any of the technology choices made in its Standards.

MPAI Standards may be modified at any time by corrigenda or new editions. A new edition, however, may not necessarily replace an existing MPAI standard. Visit the [web page](https://mpai.community/resources/) to determine the status of any given published MPAI Standard.

Comments on MPAI Standards are welcome from any interested parties, whether MPAI members or not. Comments shall mandatorily include the name and the version of the MPAI Standard and, if applicable, the specific page or line the comment applies to. Comments should be sent to the MPAI Secretariat. Comments will be reviewed by the appropriate committee for their technical relevance. However, MPAI does not provide interpre­tation, consulting information, or advice on MPAI Standards. Interested parties are invited to join MPAI so that they can attend the relevant Development Committees.

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# Annex 3 – The Governance of the MPAI Ecosystem (Informative)

**Level 1 Interoperability**

With reference to *Figure 1*, MPAI issues and maintains a standard – called MPAI-AIF – composed of the following:

1. An environment called AI Framework (AIF) running AI Workflows (AIW) made where aggregations of interconnected AI Modules (AIM).
2. AIWs are implementations of Use Cases.
3. AIMs expose standard interfaces (e.g., access to Controller API).
4. A distribution system of AIFs, AIWs and AIMs called MPAI Store from which an AIF Implementation can download AIWs and AIMs.

|  |  |
| --- | --- |
| Implementers’ benefits | Upload to the MPAI Store and have globally distributed Implementations of* AIFs conforming to MPAI-AIF.
* AIWs and AIMs performing prop­rietary functions executable in AIF.
 |
| Users’ benefits | Rely on implementations that have been tested for security. |
| MPAI Store | * Tests Implementations for conformance to MPAI-AIF.
* Verifies Implementations’ security, e.g., absence of malware.
* Indicates unambiguously that Implementations are Level 2.
 |

**Level 2 Interoperability**

In a Level 1 AIW Implementation, an Implementer can use proprietary AOWs and AIMs within the constraints of the MPAI-AIF Standard. In a Level 2 implem­entation, however, the AIW must be an Implementation of an MPAI Use Case and the AIMs must con­form with an MPAI Applicati­on Standard.

|  |  |
| --- | --- |
| Implementers’ benefits | Upload to the MPAI Store and have globally distributed Implementations of* AIFs conforming to MPAI-AIF.
* AIWs and AIMs conforming to MPAI Application Standards.
 |
| Users’ benefits | * Rely on Implementations of AIWs and AIMs with functions and interfaces reviewed during standardisation.
* Achieve a level of explainability of the AIW operation because the AIM func­tions and interfaces are known.
 |
| Market’s benefits | * Open AIW and AIM markets foster competition leading to better products.
* Competition of AIW and AIM Implementations fosters AI innovation.
 |
| MPAI Store’s role | * Tests Conformance of Implementations with the relevant MPAI Applic­ation Standard.
* Verifies Implementations’ security.
* Indicates unambiguously that Implementations are Level 2.
 |

**Level 3 Interoperability**

MPAI does not generally set standards on how and with what data an AIM should be trained. This is an important differentiator that promotes competition leading to better solutions. However, the performance of an AIM is typically higher if the data used for training are in greater quantity and more in tune with the scope. Training data that have large variety and cover the spec­trum of all cases of interest in breadth and depth typically lead to higher “quality” Implementations

For Level 3, MPAI normatively specifies the process, the tools and the data or the characteristics of the data to be used to Assess the Grade of Performance of an AIM or an AIW.

|  |  |
| --- | --- |
| Implementers’ benefits | May claim their Implementations have passed Performance Assessment. |
| Users’ benefits | Get assurance the Implementation being used performs correctly, e.g., it has been properly trained. |
| Market’s benefits | Implementations’ Performance Grades stimulate the development of more Performing AIM and AIW Implementations. |
| MPAI Store’s role | * Verifies the Implementations’ security
* Indicates unambiguously that Implementations are Level 3.
 |

**The MPAI ecosystem**

*Figure 4* is a high-level description of the MPAI ecosystem operation applicable to fully conforming MPAI implementations:

1. MPAI establishes and controls the not-for-profit MPAI Store (step 1).
2. MPAI appoints Performance Assessors (step 2).
3. MPAI publishes standards (step 3).
4. Implementers submit Implementations to Performance Assessors (step 4).
5. If the Implementation Performance is acceptable, Performance Assessors inform Implementers (step 5a) and MPAI Store (step 5b).
6. Implementers submit Implementations to the MPAI Store (step 6); The Store Tests the Implementation Confor­mance and security.
7. Users download Implementations (step 7).



*Figure 4 – The MPAI ecosystem operation*

The Ecosystem operation allows for AIW and AIF Implementations

1. To be proprietary: security is verified and Conformance to MPAI-AIF Tested (Level 1).
2. To be conforming to an MPAI Application Standard: security is verified and Confor­mance to the relevant MPAI Application Standard Tested (Level 2).
3. To be Level 2 and have additionally their Reliability, Robustness, Fairness and Replicability Assessed (Level 3).

The MPAI Store shall duly display the Interoperability Level of Implementations.

MPAI offers Users access to the promised benefits of AI with a guarantee of increased trans­parency, trust and reliability as the Interoperability Level moves from 1 to 3.

# Annex 4 – AIW and AIM Metadata

# ID linearisation

Note: Fields that are used to generate automatic IDs may not contain “:” characters.

When one needs to reference them from other contexts, automatic unique IDs for AIWs/AIMs can be generated with the following formula:

AIM->Implementer\_ID:(**S**:AIM->Standard->Name:AIM->Standard->Version:AIM->Standard->Use\_Case:AIM->Standard->Name|**U**:AIM->User\_Defined->Name):AIM->Version

Examples:

* 00089:(S:(MMC:CWE:2:\_MAIN\_)):123 // A workflow
* 00089:(S:(MMC:CWE:2:GovernanceAssessment)):345 // A sub-module of a workflow
* 00089:(U:PCA\_based\_analysis):75

In the following, 00089 will be used as Implementer Identifier.

# AIW metadata

|  |
| --- |
| "AIM": { "Implementer\_ID": ###, // Number provided by MPAI store, e.g., 00089 "Standard": { // Defined by MPAI, selected by implementer "Name": "CUI", "Use\_Case": "CPP", "Version": "1", "Name": "\_MAIN\_" // Always \_MAIN\_ for workflows } | "User\_Defined": { // Provided by implementer "Name": "MyCUIPCC" }, "Version": "\*", // Provided by implementer "Profile": "Main" // Defined by MPAI, selected by implementer "Description": "This AIW implements MPAI-CUI Company Performance Prediction (PCC) Use Case", "Ports": [ { "Name": "PredictionHorizon", "Direction": "InputOutput", "Record\_Type": "{int8 PredictionHorizon} PredictionHorizon\_t", "Type": "Software", "Protocol": "" }, { "Name": "Governance", "Direction": "InputOutput", "Record\_Type": "float32 [] Governance\_t", "Type": "Software", "Protocol": "" }, { "Name": "FinancialStatement", "Direction": "InputOutput", "Record\_Type": "float32[] FinancialStatement\_t", "Type": "Software", "Protocol": "" }, { "Name": "RiskAssessment", "Direction": "InputOutput", "Record\_Type": "float32[] RiskAssessment\_t", "Type": "Software", "Protocol": "" }, { "Name": "AdequacyIndex", "Direction": "OutputInput", "Record\_Type": "{float32 AdequacyIndex} AdequacyIndex\_t", "Type": "Software", "Protocol": "" }, { "Name": "DefaultProbability", "Direction": "OutputInput", "Record\_Type": "{float32 DefaultProbability} DefaultProbability\_t", "Type": "Software", "Protocol": "" }, { "Name": "BusinessContinuityProbability", "Direction": "OutputInput", "Record\_Type": "{float32 BusinessContinuityProbability} BusinessContinuityProbability\_t", "Type": "Software", "Protocol": "" }, ] "AIMs": [ // Automatic ID for module 1 "GovernanceAssessment": "@\*:(S:(CUI:CPP:1:GovernanceAssessment)):\*"  // Automatic ID for module 2 "FinancialAssessment": "@\*:(S:(CUI:CPP:1:FinancialAssessment)):\*", // Automatic ID for module 3 "RiskMatrixGeneration": "@\*:(S:(CUI:CPP:1:RiskMatrixGeneration)):\*", // Automatic ID for module 4 "Prediction": "@\*:(S:(CUI:CPP:1:Prediction)):\*", // Automatic ID for module 5 "Perturbation": "@\*:(S:(CUI:CPP:1:Perturbation)):\*" ], "Topology": [ "PredictionHorizon": { "Output": { "Module": "", "Port”: "PredictionHorizon" }, "Input": { "Module": "Prediction", "Port": "PredictionHorizon" } }, "Governance": { "Output": { "Module": "", "Port”: "Governance" }, "Input": { "Module": "GovernanceAssessment", "Port": "Governance" } }, "FinancialStatement\_1": { "Output": { "Module": "", "Port”: "FinancialStatement" }, "Input": { "Module": "GovernanceAssessment", "Port": "FinancialStatement" } }, "FinancialStatement\_2": { "Output": { "Module": "", "Port”: "FinancialStatement" }, "Input": { "Module": "FinancialAssessment", "Port": "FinancialStatement" } }, "RiskAssessment": { "Output": { "Module": "", "Port”: "RiskAssessment" }, "Input": { "Module": "RiskMatrixGeneration", "Port": "RiskAssessment" } }, "GovernanceFeatures": { "Output": { "Module": "GovernanceAssessment", "Port”: "GovernanceFeatures" }, "Input": { "Module": "Prediction", "Port": "GovernanceFeatures" } }, "FinancialFeatures": { "Output": { "Module": "FinancialAssessment", "Port”: "FinancialFeatures" }, "Input": { "Module": "Prediction", "Port": "FinancialFeatures" } }, "RiskMatrix": { "Output": { "Module": "RiskMatrixGeneration", "Port”: "RiskMatrix" }, "Input": { "Module": "Perturbation", "Port": "RiskMatrix" } }, "AdequacyIndex": { "Output": { "Module": "Prediction", "Port”: "AdequacyIndex" }, "Input": { "Module": "", "Port": "AdequacyIndex" } }, "DefaultProbability\_1": { "Output": { "Module": "Prediction", "Port”: "DefaultProbability" }, "Input": { "Module": "", "Port": "DefaultProbability" } }, "DefaultProbability\_2": { "Output": { "Module": "Prediction", "Port”: "DefaultProbability" }, "Input": { "Module": "Perturbation", "Port": "DefaultProbability" } }, "BusinessContinuityProbability": { "Output": { "Module": "Perturbation", "Port”: "BusinessContinuityProbability" }, "Input": { "Module": "", "Port": "BusinessContinuityProbability" } } ], "Authentication": "ENC.V.?", "TimeBase": "PROT.V.?", "ResourcePolicies": [ "CPU": ? ], "UserAPIProfile": "Low.V", "ControllerAPIProfile": { Version: "27", Level: "High" }, "Implementations": [ { "Type": "Source", "Function\_Name": "CompanyPerformancePrediction\_Implementer\_Name", "Language": "C", "Architecture": "", "OS": "", "OS\_Version": "", "ID": "" } ], "Documentation": [ { "Type": "tutorial", "URI": <https://mpai.community/standards/mpai-cui/>  } ]} |

# AIM metadata

## GovernanceAssessment

|  |
| --- |
| "AIM": { "Implementer\_ID": ###, // Number provided by MPAI store "Standard": { // Defined by MPAI, selected by implementer "Name": "CUI", "Use\_Case": "CPP", "Version": "2", "Name": "GovernanceAssessment" } | "User\_Defined": { // Provided by implementer "Name": "MYGA" }, "Version": "\*", // Provided by implementer "Profile": "Main", // Defined by MPAI, selected by implementer "Description": "This AIM implements ...", "Ports": [ { "Name": "Governance", "Direction": "InputOutput", "Record\_Type": "float32 [] Governance\_t", "Type": "Software", "Protocol": "" }, { "Name": "FinancialStatement", "Direction": "InputOutput", "Record\_Type": "float32[] FinancialStatement\_t", "Type": "Software", "Protocol": "" }, { "Name": "GovernanceFeatures", "Direction": "OutputInput", "Record\_Type": "float32[] GovernanceFeatures\_t", "Type": "Software", "Protocol": "" } ], "AIMs": [ ], // Does not depend on other AIMs "Topology": [ ], // Does not depend on other AIMs "Authentication": "ENC.V.?", "TimeBase": "PROT.V.?", "ResourcePolicies": [ "CPU": ? ], "UserAPIProfile": "Low.V", "ControllerAPIProfile": { Version: "27", Level: "High" }, "Implementations": [ { "Type": "Source", "Function\_Name": "GovernanceAssessment\_Implementer\_Name", "Language": "C", "Architecture": "", "OS": "", "OS\_Version": "", "ID": "" } ], "Documentation": [ { "Type": "tutorial", "URI": <https://mpai.community/standards/mpai-cui/> } ]} |

## Financial Assessment

|  |
| --- |
| "AIM": { "Implementer\_ID": ###, // Number provided by MPAI store "Standard": { // Defined by MPAI, selected by implementer "Name": "CUI", "Use\_Case": "CWE", "Version": "2", "Name": "FinancialAssessment" } | "User\_Defined": { // Provided by implementer "Name": "MYFA" }, "Version": "345", // Provided by implementer "Profile": "Main", // Defined by MPAI, selected by implementer "Description": "This AIM implements ...", "Ports": [ { "Name": "FinancialStatement", "Direction": "InputOutput", "Record\_Type": "float32[] FinancialStatement\_t", "Type": "Software", "Protocol": "" }, { "Name": "FinancialFeatures", "Direction": "OutputInput", "Record\_Type": "float32[] FinancialFeatures\_t", "Type": "Software", "Protocol": "" } ], "AIMs": [ ], // Does not depend on other AIMs "Topology": [ ], // Does not depend on other AIMs "Authentication": "ENC.V.?", "TimeBase": "PROT.V.?", "ResourcePolicies": [ "CPU": ? ], "UserAPIProfile": "Low.V", "ControllerAPIProfile": { Version: "27", Level: "High" }, "Implementations": [ { "Type": "Source", "Function\_Name": "FinancialAssessment\_Implementation\_Name", "Language": "C", "Architecture": "", "OS": "", "OS\_Version": "", "ID": "" } ], "Documentation": [ { "Type": "tutorial", "URI": <https://mpai.community/standards/mpai-cui/> } ]} |

## Risk Matrix Generation

|  |
| --- |
| "AIM": { "Implementer\_ID": ###, // Number provided by MPAI store "Standard": { // Defined by MPAI, selected by implementer "Name": "CUI", "Use\_Case": "CPP", "Version": "2", "Name": "RiskMatrixGeneration" } | "User\_Defined": { // Provided by implementer "Name": "MYRMG" }, "Version": "345", // Provided by implementer "Profile": "Main", // Defined by MPAI, selected by implementer "Description": "This AIM implements ...", "Ports": [ { "Name": "RiskAssessment", "Direction": "InputOutput", "Record\_Type": "float32 [] RiskAssessment\_t", "Type": "Software", "Protocol": "" }, { "Name": "RiskMatrix", "Direction": "OutputInput", "Record\_Type": "float32 [] RiskMatrix\_t", "Type": "Software", "Protocol": "" } ], "AIMs": [ ], // Does not depend on other AIMs "Topology": [ ], // Does not depend on other AIMs "Authentication": "ENC.V.?", "TimeBase": "PROT.V.?", "ResourcePolicies": [ "CPU": ? ], "UserAPIProfile": "Low.V", "ControllerAPIProfile": { Version: "27", Level: "High" }, "Implementations": [ { "Type": "Source", "Function\_Name": "RiskMatrixGeneration\_Implementer\_Name", "Language": "C", "Architecture": "", "OS": "", "OS\_Version": "", "ID": "" } ], "Documentation": [ { "Type": "tutorial", "URI": <https://mpai.community/standards/mpai-cui/> } ]} |

## Prediction

|  |
| --- |
| "AIM": { "Implementer\_ID": ###, // Number provided by MPAI store "Standard": { // Defined by MPAI, selected by implementer "Name": "CUI", "Use\_Case": "CPP", "Version": "2", "Name": "Prediction" } | "User\_Defined": { // Provided by implementer "Name": "MYP" }, "Version": "345", // Provided by implementer "Profile": "Main", // Defined by MPAI, selected by implementer "Description": "This AIM implements ...", "Ports": [ { "Name": "GovernanceFeatures", "Direction": "InputOutput", "Record\_Type": "float32 [] GovernanceFeatures\_t", "Type": "Software", "Protocol": "" }, { "Name": "FinancialFeatures", "Direction": "InputOutput", "Record\_Type": "float32 [] FinancialFeatures\_t", "Type": "Software", "Protocol": "" }, { "Name": "AdequacyIndex", "Direction": "OutputInput", "Record\_Type": "{float32 AdequacyIndex} AdequacyIndex\_t", "Type": "Software", "Protocol": "" } { "Name": "DefaultProbability", "Direction": "OutputInput", "Record\_Type": "{float32 DefaultProbability} DefaultProbability\_t", "Type": "Software", "Protocol": "" } ], "AIMs": [ ], // Does not depend on other AIMs "Topology": [ ], // Does not depend on other AIMs "Authentication": "ENC.V.?", "TimeBase": "PROT.V.?", "ResourcePolicies": [ "CPU": ? ], "UserAPIProfile": "Low.V", "ControllerAPIProfile": { Version: "27", Level: "High" }, "Implementations": [ { "Type": "Source", "Function\_Name": "Prediction\_Implementer\_Name ", "Language": "C", "Architecture": "", "OS": "", "OS\_Version": "", "ID": "" } ], "Documentation": [ { "Type": "tutorial", "URI": <https://mpai.community/standards/mpai-cui/> } ]} |

## Perturbation

|  |
| --- |
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