

MIMs Plus: Living-in.EU Technical Specifications

Context

This document contains the technical specifications of the [Living-in.EU](https://www.living-in.eu) (LI.EU) upscaling declaration¹ initiative, and is based on existing minimal interoperability mechanisms (MIMs) plus some additional fundamental building blocks – hence the name: MIMs Plus. It is one of three deliverables from the LI.EU Technical sub-group, the others being a *concept paper*², describing the scope and time plan for the work, and an *operational guide*, with practical guidance on how the technical specifications can be used in practice.

Overall, the LI.EU declaration has six guiding principles, of which number five and six are especially relevant from a technical perspective:

THE SIGNATORIES AGREE ON THE FOLLOWING PRINCIPLES⁶:

- a citizen-centric approach;
- a city-led approach at EU level;
- the city as a citizen-driven and open innovation ecosystem;
- ethical and socially responsible access, use, sharing and management of data;
- technologies as key enablers;
- interoperable digital platforms based on open standards and technical specifications, Application Programming Interfaces (APIs) and shared data models.

In addition to the principles above, there are five commitments made by the LI.EU signatories³ and supporting parties⁴: Legal, Financing, Skills, Monitoring & Measuring, and Technical. The technical commitment has the following aims:

1. Use common standards and technical specifications,
2. Make key enablers (including data, infrastructure and services) available to all,
3. Establish a common market.

The first aim is covered by this MIMs Plus specification document, whereas the second and third aims are of a more operational nature, which are addressed in the Operational Guide.

¹ <https://www.living-in.eu/declaration>

² <https://www.living-in.eu/tech/concept-paper>

³ <https://www.living-in.eu/we-signed>

⁴ <https://www.living-in.eu/we-support>

Introduction, content, reading guide

This document is based on and complements the input paper of the LI.EU declaration, states the current state of the art and gives recommendations for technical specifications. It aims to build capacity on top of standards, mechanisms, services, guidelines and tools that enable interoperability of data platforms for cities and communities, to mainstream the delivery of services with a strong positive local impact, while at the same time addressing overall European goals.

The document describes the following topics: An overall Architecture Framework Model, Data Information Models, Context Information Management, Marketplace Enablers, Personal Data Management and Fair AI.

Each topic is described in following perspectives:

- **Goals:** Identifies what the topic aims to achieve and what the main purpose is.
- **Capabilities:** Focuses on how the goals are achieved and what the necessary requirements are.
- **Recommended specifications:** Specs and standards proven to attain the goals.
- **Means of verification:** How conformance is tested and by whom it can be certified.

The governance of this specifications document is outlined in the concept paper. It is quite straight-forward: The MIMs Plus document is proposed by the LI.EU-Tech in evolving versions to be adopted by the LI.EU Steering Group. Each of the specific elements (like SAREF, OASC MIMs, INSPIRE, EIRA, OneM2M etc.) are governed by their respective governance fora.

Version history

Version	Date	Main changes
1.0	October 20, 2019	Initial draft consolidated report on technical specifications for the Digital Europe Programme and Living-in.EU (LI.EU)
2.0	December 6, 2019	Major update in advance of the pre-launch of LI.EU in Oulu, Finland, December 10, 2019
2.1	March 9, 2020	Update with input from European Commission services – DIGIT, GROW perspectives
2.2	April 29, 2020	Update before first meeting in the LI.EU Tech sub-group (May 12, 2020) – further fine-tuning of perspectives from the group
2.3	June 23, 2020	Update before third meeting in the LI.EU Tech sub-group (June 24, 2020) – focus on Personal Data Management and Fair AI, plus adjustments from the group
2.4	July 24, 2020	Adjustments of Personal Data Management and Fair AI
2.5	Sept 25, 2020	Update on the Personal data and Fair Ai
3.0	Dec 18, 2020	Version release of Personal data and Fair AI

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Architecture Framework

Goals

The goals of an architecture framework model for a digital ecosystem for cities and communities is to ensure that the capabilities of such platforms consider functional and non-functional requirements to implement the minimal interoperability that cities and communities need to deliver a prosperous, sustainable and inclusive future for their citizens.

The fundamental perspective is that of technical capabilities for minimal data interoperability. This focus backgrounds many implementation aspects, e.g. related to specific software and hardware stacks, and it allows great flexibility when it comes to adapting concrete deployment and integration to a local context. It is also based on a realisation from current experiences that establishing data spaces on a minimal but enough common ground can be a catalyst to deliver mainstream trusted services for cities and communities in a connected world.

The requirements for such data platforms should lead to specifications that ensure that the platforms are reliable, durable, future proof and performant so that the city can build on the platforms and foster further innovations and evolution. These specifications also ensure that the platforms can extend to a 'system of systems' with all relevant digital means of a community, scale to the needs of the cities and communities and guarantee privacy and security by design, making the platforms trustworthy.

Open source development and involvement of communities are powerful methods in order to guarantee transparency and consequently trust in the platforms for public operators. This particular aspect will be particularly relevant when injecting algorithms based on AI mechanisms into the platforms.

The implementation of minimal interoperability provides a common technical ground that cities and communities need to enable choice, flexibility, value for money and independence avoiding vendor lock-in. The platforms should support formal, de-facto and emerging standards, making sure they are future-proof and stable.

The trustworthiness and the interoperability of the platforms addresses the triple baseline of social, environmental and economic benefits, and supports strategic aims such as the United Nations sustainable development goals.

The platform architectures proposed in the recommended specifications and frameworks are validated in large scale pilots by a large variety of companies in close and direct partnerships with the cities and communities as well as networks of cities.

The group has recognised the Minimal Interoperability Mechanisms adopted by the Open & Agile Smart Cities Council of Cities⁵ as a relevant way to organise the architectural framework and to strike a balance of precision in the technical specifications, neither over- nor under-specifying. The current report covers MIMs 1-3 (Context Information Management, Data models and Ecosystem Transaction Management), which are already adopted, and two more, MIMs 4 and 5 (Personal Data Management and Fair AI), which have been proposed.

⁵ <https://oascities.org/wp-content/uploads/2019/06/OASC-MIMs.pdf>

Complementary sources of potential interoperability requirements are the European Interoperability Framework⁶ and the European Interoperability Reference Architecture⁷.

Capabilities

The frameworks provide a description and guidelines of a common architecture/framework, including a layered overview positioning of all the components and interfaces, as well as the associated requirements and specifications.

They include a description of reference implementations, including conformance testing and/or feedback from market use validation.

To go more into detail, we consider the following topics as common architectural design principles:

- A layered and capability-based approach to follow a common architectural model in different cities/domains.
- Based on open international standards (where available): we do not want to reinvent the wheel ensuring stable and widely used technological approaches.
- Compliant with existing technical solutions (e.g. already present in the cities with many legacy systems) focusing on interoperable interfaces rather than component implementation.
- Modular and scalable solutions for small and big cities: e.g. support different deployment scenarios and performance requirements.
- Security and privacy by design.
- Availability of reference implementations to foster and simplify the adoption in the cities.
- The architecture modularity assures the possibility to implement any component with different/proprietary technologies.
- Based on global, standard-based open APIs to enable both southbound/northbound interoperability.
- Data harmonisation and global standard based semantic interoperability through the adoption of common, linked data models.

In an upcoming version, it would be helpful to establish a more elaborated and robust ontology.

A framework for such an architecture is shown below (Figure 1). In this document the following (orange) parts are further discussed:

- Data information models and Context information management: Context information management realizes the Northbound open APIs and the Southbound APIs as a high-level open API. The Data information models provide the harmonized models.
- Marketplace: discusses the different marketplace API and transaction management (commercial as well as non-commercial).

⁶ https://ec.europa.eu/isa2/sites/isa/files/eif_brochure_final.pdf

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https://joinup.ec.europa.eu/sites/default/files/distribution/access_url/2019-03/76cb237b-0de8-464c-84ca-1327945eac3e/EIRA_v3_0_0_Overview.pdf

High level architecture

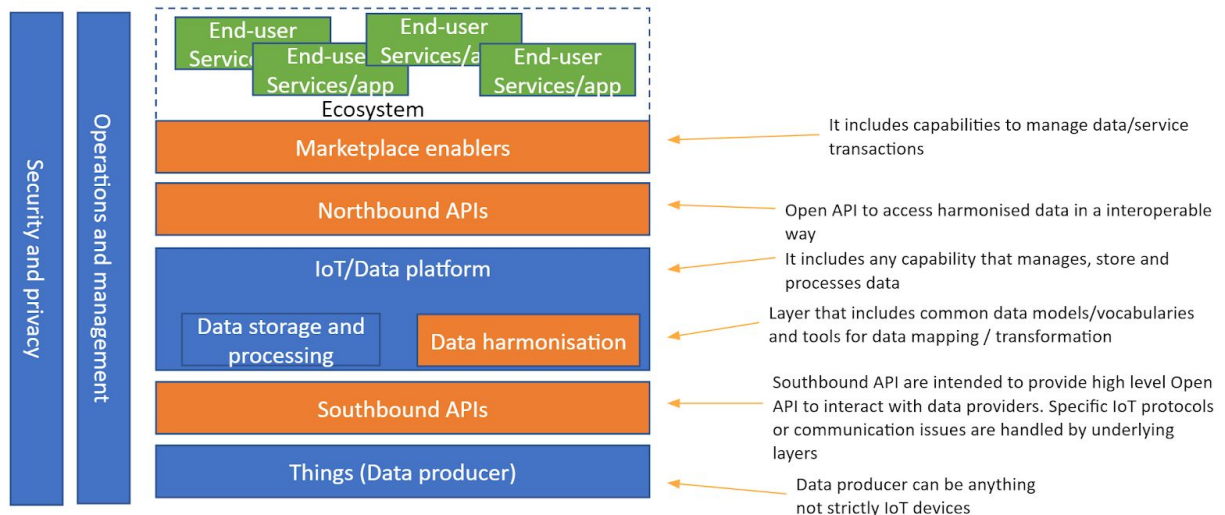


Figure 1. High-level architecture framework model.

Recommended specifications and frameworks

Below a list of specifications that are recommended:

- EIP SCC Reference architecture on Open Urban Platform (DIN SPEC 91357:2017-12) - Reference Architecture Model Open Urban Platform (OUP) <https://www.beuth.de/en/technical-rule/din-spec-91357/281077528>
- Guidelines for SynchroniCity Architecture https://synchronicity-iot.eu/wp-content/uploads/2018/05/synchronicity_d1_3_guidelines_for_synchronicity_architecture.pdf
- Synchronicity Reference Architecture for IoT Enabled Smart Cities, Update https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.10.pdf
- oneM2M Release 2 and release 3 set of specifications. oneM2M Release 2 has been formally approved as ITU-T recommendation under Y.4500 series. oneM2M is a partnership project (where EU is represented by ETSI) that specifies a common service layer for IoT. OneM2M is applicable to many verticals including Smart Cities. oneM2M specifications cover requirements, architecture, APIs, security, interworking and data models. Although not chartered to produce open source, there are several open source implementations supporting oneM2M, those include Eclipse OM2M and S. Korea OCEAN.
- The EIRA Library of Interoperability Specifications, ELIS is a repository of technical specifications based in open standards for the EIRA ABBs
- The CAMSS assessment Library is a repository of ICT open standards assessed using CAMSS

Means of verification

To guarantee the reliability and security of these platforms, certification tests by independent bodies may be applied to them in order to provide the necessary guarantees to public operators.

References

- ITU-T (06/2012) Series Y: Global information infrastructure, internet protocol aspects and next-generation networks-frameworks and functional architecture models <https://www.itu.int/rec/T-REC-Y.2060-201206-I>
- ISO/IEC JTC1 Study Group on Smart Cities, "Resolutions 3, ISO/IEC JTC 1 N 11894, 201311-12," 2012
- "ESPRESSO Project," [Online]. Available: <http://espresso-project.eu/>.
- "The European Innovation Partnership on Smart Cities and Communities EIP-SCC," [Online]. Available: <https://eu-smartcities.eu/about>
- ETSI GS CIM 009 V1.1.1 (2019-01) - Context Information Management (CIM); NGSI-LD API
- European Commission 2019 European Interoperability Reference Architecture, EIRA©
<https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/about>
- European Commission 2020 Core Public Service Vocabulary Application Profile <https://joinup.ec.europa.eu/solution/core-public-service-vocabulary-application-profile>
- European Commission 2020 Core Vocabularies <https://joinup.ec.europa.eu/solution/e-government-core-vocabularies/release/20>
- European Commission 2017. Communication on The European Interoperability Framework- Implementation Strategy COM (2017) 134Annex 2 . Retrieved from: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52017DC0134>
- The API4Gov initiative of the European Commission

Data Information Models and Context Information Management

Goals

The data information models guarantee that we can disseminate and scale out a common data lingua franca based on shared data models.

The context information management ensures a holistic and integrated data access, use, sharing and management of data.

Capabilities

The information that cities, regions and communities possess or gather is available and easily accessible to applications across different domains. To make the information usable the context information is key.

Applications are able to discover the information relevant to them. For example by specifying what is needed and retrieve or subscribe to this requested information. To share and re-use this information an agreement is in place on the concepts, this can be provided by data information models.

Discovery and querying of information, both current and historical, is possible, also in a geospatial way.

Applications can subscribe to changes of information, so that they are always aware of the current status.

The implementation across (and even within) the city, or any application ecosystem, can be very diverse and heterogeneous. An agreement on the interfaces is necessary to be able to access the information. This is enabled by the context management API and the data information models.

The common data and data models are available in a catalogue and guidelines are available so that different verticals are integrated in a holistic/integrated city data lake to enable interoperability for applications and systems among different cities.

The catalogue supports structural interoperability, behavioural interoperability (representation, data mappings) and governance interoperability,

Recommended specifications

- NGSI-LD, as specified by the ETSI Industry Specification Group on Context Information Management (ETSI ISG CIM), provides an API for managing and requesting context information and an underlying meta model based on entities - the core information elements, often the digital counterparts of real-world object - and their properties and relationships to other entities.
- NGSI-LD compliant data models for aspects of the smart city have been defined by organizations and projects, including OASC, FIWARE, GSMA and the SynchroniCity

project and there is an ongoing joint activity of TM Forum and FIWARE to specify more.

- Existing data models and ontologies, e.g. the SAREF (Smart Applications REFERENCE ontology) standard by ETSI/oneM2M, can be mapped for use with NGSI-LD by identifying what are entities, properties and relationships, which can be managed and requested by the NGSI-LD API.
- Even though the NGSI-LD specification has been published relatively recently, there are already three Open Source implementations (Scorpio, djane and Orion-LD). Orion-LD is the NGSI-LD version of the Connecting Europe Facility (CEF) building block Context Broker.
- oneM2M base ontology (that is compatible with SAREF). Additionally, oneM2M provides the means to instantiate ontologies to provide semantic descriptions of the data exchanged (through the use of metadata)
- SAREF: Smart Appliances REFERENCE (SAREF) ontology specified by ETSI OneM2M committee with the extension of SAREF4Cities provides an ontology focused on smart cities
- Core vocabularies of ISA like Core Public Service Vocabulary Application Profile used as the basis for the Single Digital Gateway Regulation that touches local governments, Core Person, Core Organization etc

Sidenote:

Following specifications are in place and are getting more attention related to urban city platforms:

- INSPIRE: Infrastructure for spatial information in Europe is having the requirement to foresee WFS3 by OGC: <https://gdal.org/drivers/vector/oapif.html>

Means of verification

To be included

References

- European Commission 2019 European Interoperability Reference Architecture, EIRA©
<https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/about>
- European Commission 2020 Core Public Service Vocabulary Application Profile
<https://joinup.ec.europa.eu/solution/core-public-service-vocabulary-application-profile>
- European Commission 2020 Core Vocabularies
<https://joinup.ec.europa.eu/solution/e-government-core-vocabularies/release/20>
- European Commission 2017. Communication on The European Interoperability Framework- Implementation Strategy COM (2017) 134Annex 2 . Retrieved from: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52017DC0134>
- Nan Zhang, Xuejiao Zhao, and Xiaope He 2020 Understanding the relationships between information architectures and business models: An empirical study on the

success configurations of smart communities Government Information Quarterly v37 (2), <https://doi.org/10.1016/j.giq.2019.101439>

- [OASC wiki pages regarding Context Information Management](https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/3178508/MIM+1+Context+Information+Management)
<https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/3178508/MIM+1+Context+Information+Management>
- [OASC wiki pages regarding common dta models](https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/7897089/MIM+2+OASC+Data+Models)
<https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/7897089/MIM+2+OASC+Data+Models>
- The Berlin declaration on digital society and value based digital government. (German version)
<https://www.bmi.bund.de/SharedDocs/downloads/EN/eu-presidency/berlin-declaration-digital-society>

Marketplace Enablers

Goals

Scaling of IoT- and AI-enabled services across many cities requires easy and risk-free access to suitable urban data sources that are already deployed in cities and communities today. A Digital Single Market within Europe – and extending to other areas with free-trading agreements such as Japan – allows for easy and risk-free access to relevant and available urban data, solutions and other resources so that services and solutions already deployed in other cities can easily be scaled and reach mainstream deployment. The use and re-use leads to new revenue streams incentivising the infrastructure owners to share data, analytics, services and/or solutions in infrastructure partnerships based on key technology enablers.

With a set of marketplaces established within the European Digital Single Market, and even beyond, all parties can co-create applications, solutions, services and guidelines on top of the common data models and standardised APIs. Facilitating this ecosystem of providers and consumers leads to sustainable business models and fair mechanisms for sharing and compensating, and it reduces the risk for investments.

Capabilities

The marketplace realizes standardized exposure of data and data sets guaranteeing security and privacy by design. The marketplace also realizes access to services that build on this data and transfer it to knowledge, intelligence and information for the consumers.

The marketplace provides catalogue management, ordering management, revenue (sharing) management, SLA management, quality management and data license management.

A crucial aspect of a market place is ecosystem transaction management. These functionalities enable effective matchmaking of urban IoT data sources from providers with respective data consumers, facilitate trusted exploitation of such data based on enforceable data usage agreements and secure value flow between these stakeholders.

There are various ways in realising such Ecosystem Transaction Management. A standardised way of doing so is provided by the TM Forum, who has created an API suite of specifications for digital marketplaces, named the Business API Ecosystem.

Recommended specifications

- Connected Smart Cities and Communities Catalogue: <http://catalogue.city>
- Basic Data Marketplace Enablers
https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.4.pdf
- Guidelines for the integration of IoT devices in OASC compliant platforms
https://synchronicity-iot.eu/wp-content/uploads/2018/09/SynchroniCity_D2.6.pdf
- TM Forum Open APIs and component suites provide service and technology neutral suite of APIs that provide the minimum building blocks for interoperability across all operational management areas. Each API and component suite provide the specification, reference implementations and in most cases conformance test kits.

Reference Implementations are available under the Apache2.0 license. These APIs have gained global adoption in the Telecommunications industry and are proven to maximize reuse. They are designed to be extendable as required for specific services. The respective data models have been harmonized with FIWARE and GSMA data models. <https://projects.tmfforum.org/wiki/display/API/Open+API+Table>

Means of verification

To be included

References

- OASC wiki pages regarding Ecosystem Transaction Management
<https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/86638751/MIM+3+Ecosystem+Transaction+Management>

Personal Data Management

Goals

Provide a clear and easy usable means for citizens and/or other (vulnerable) users to take control of their personal data and control which companies, applications can access and use their data sets/attributes:

- the right to have insight what personal data is available, stored, shared, etc. by the providers of the applications and/or services in use
- the right to change and/or delete part or all personal data available, stored, shared, etc. by the provider of the applications and/or services in use
- a 'permission arrangement' indicating in which circumstances what personal data is 'free' to use for which parties
- a consent from the providers of the applications and/or services, be it governmental or businesses, that attribute based, decentralized storage and 'revealing' of personal data attributes provides full service and access to these applications and/or services
- The right to choose which operator stores personal data and be able to move from operator to operator.

Capabilities

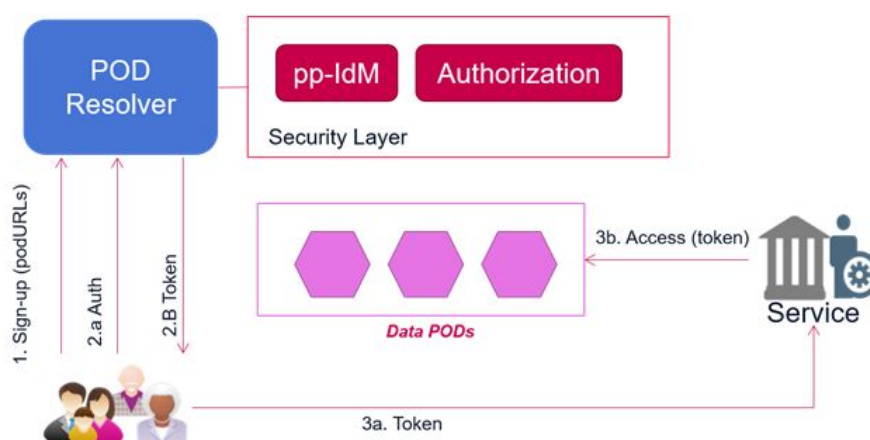
Personal Data Management needs to have an open API in line with MIM1 to broker data and standard data models MIM2. The PDM needs to be fully compatible with the GDPR and needs to enable users to handle consent, allow and revoke access, and have full transparency on their personal data.

The PDM needs to allow users to choose the operator of their data and have a completely free choice to move their data to the operator of their choosing.

It should allow the users to access their data regardless of the channel. So, there should be no wrong door to access the data.

We want to move the management of personal data to the following manner, where decentralised management of data is enabled.

The personal data is stored in so called data pods the way users will have access to their pods is depicted below. The Personal Data Management will also use the CEF component pp-IDM.



Recommended Specifications

- The MyData.org initiative that allows users to select the data operator for their data
<https://mydata.org/wp-content/uploads/sites/5/2020/08/mydata-white-paper-english-2020.pdf>
- IHAN as testbed for fair Data economy, introduction:
<https://www.sitra.fi/en/projects/testbed-for-fair-data-economy-ihanfi/>
- SOLID
- IRMA

Means of verification

To be included

References

- MyData Declaration and Whitepapers:
<https://mydata.org/declaration/> + <https://mydata.org/papers/>
- MyData architecture and technical specifications:
<https://hiit.github.io/mydata-stack/>
- MyData as MIM4 by Kimmo Karhu:
https://mcusercontent.com/33bd4cf643957961c82a89a02/files/981c3b9f-b632-42c5-bfb3-997e5316606d/OASC_Personal_Data_Management_MIM4_Helsinki_v3_1_.pdf
- IHAN as testbed for fair Data economy, introduction:
<https://www.sitra.fi/en/projects/testbed-for-fair-data-economy-ihanfi/>
- IHAN blueprint 2.5:
<https://www.sitra.fi/en/articles/ihan-blueprint/>
- SOLID “Streamlining governmental processes by putting citizens in control of their personal data”:
https://ruben.verborgh.org/publications/buyle_egose_2019/
 - “Inrupt, supporting the Solid ecosystem that gives you back control and choice—online and offline”:
<https://inrupt.com/solid>
 - Solid project and apps:
<https://solidproject.org/Solid>
- Digital Trust Infrastructure
 - On policy level (in Dutch), part of the essay Proper data use in the public space:
“Conduct research into a generic trust infrastructure in the public domain. In addition to making an inventory and evaluating the digital basic infrastructure in the public space, investigating possibilities for the realisation of a national, impenetrable and open digital trust infrastructure for identification, authentication and authorisation of personal data, including the related governance.”
https://www.digitaleoverheid.nl/wp-content/uploads/sites/8/2019/11/behoo_rlijk-datagebruik-in-de-openbare-ruimte.pdf

- Working on project start architecture and use case, reuse IRMA (I Reveal My Attributes architecture and apps, from the (Dutch) Privacy by Design Foundation
<https://irma.app/?lang=en> + <https://privacybydesign.foundation/irma-start/>
- OASC wiki pages regarding Personal Data Management
<https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/30179329/MIM+4+Personal+Data+Management>

Fair AI

Goals

Provide a clear and easy usable means for citizens and/or other (vulnerable) users of data, 'intelligence', applications and/or services to make well-informed decisions if the models, algorithms, machine learning methods, Used in the 'translation' from 'raw' data, via intelligence to knowledge and wisdom are personally or socially acceptable. This includes:

- the description for citizens of used techniques in the process from raw data to suggested actions/advice/decisions
- The proof that the used techniques always gives the same output with the same inputs
- The proof that the techniques are unbiased towards user ethnicity, social background,...

Capabilities

- List of used algorithms and make this fully transparency
- Respond with a list of AI capabilities that the system has, including automated decision making, referring to a finite list of know capabilities (using MIMs 1 and 2)
- Respond with a list of optimisation goals and machine learning algorithms
- Respond with a list of organisations authorising the system's AI capabilities
- Offer a list of test datasets, for external evaluation of algorithms
- Offer a list of test algorithms, for external evaluation of training data
- Indicate on the Digital Single Market, if a data set, an application and/or service require some sort of AI if and how Fair AI models, algorithms etc. is covered/arranged, part of APIs in MIM3?

Recommended Specifications

- Danish Standards PAS DS/PAS 2500-1: 2020, Artificial Intelligence – Part 1: Transparency; DS/PAS 2500-2: 2020, Artificial Intelligence – Part 2: Decision-support usage in public administration

Means of verification

To be included

References

- Presentation democratic control over algorithms
<https://www.slideshare.net/OASC/fair-ai-democratic-control-over-algorithms>
- <https://www.codefor.nl/ai-met-impact/> (Dutch!)
- JRC: AI WATCH, specifically Task 6 (AI in Public sector)
<https://ec.europa.eu/jrc/en/publication/ai-watch-artificial-intelligence-public-sector>

- OASC wiki pages regarding Fair AI and Algoritmes
<https://oasc.atlassian.net/wiki/spaces/OASCMIM/pages/91521069/MIM+5+Fair+Artificial+Intelligence+and+Algoritmes>