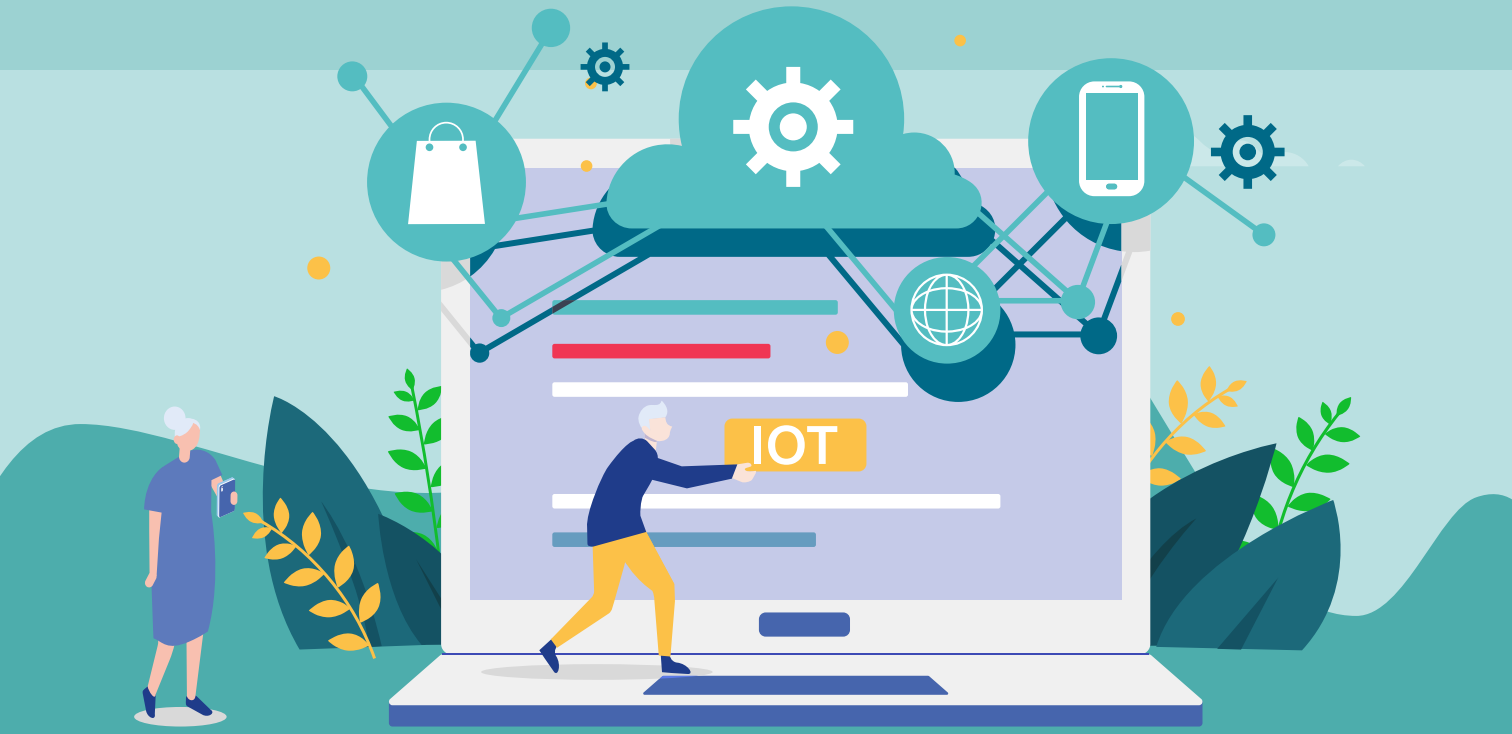
ACTIVAGE PROJECT

ACTIVAGE IoT Ecosystem

FOR SMART LIVING ENVIRONMENTS



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ACTIVAGE PROJECT

Background

- ACTIVAGE is a **European Multi Centric Large Scale Pilot on Smart Living Environments.** The main objective is to build the first European IoT ecosystem across 9 pilot sites called Deployment Sites (DS)[1], in seven European countries, reusing and scaling up underlying open and proprietary IoT platforms, technologies and standards, and integrating new interfaces needed to provide interoperability across these heterogeneous platforms, that will enable the deployment and operation at large scale of **Active & Healthy Ageing IoT based solutions and services, supporting and extending the independent living of older adults in their living environments,** and responding to real needs of caregivers, service providers and public authorities.

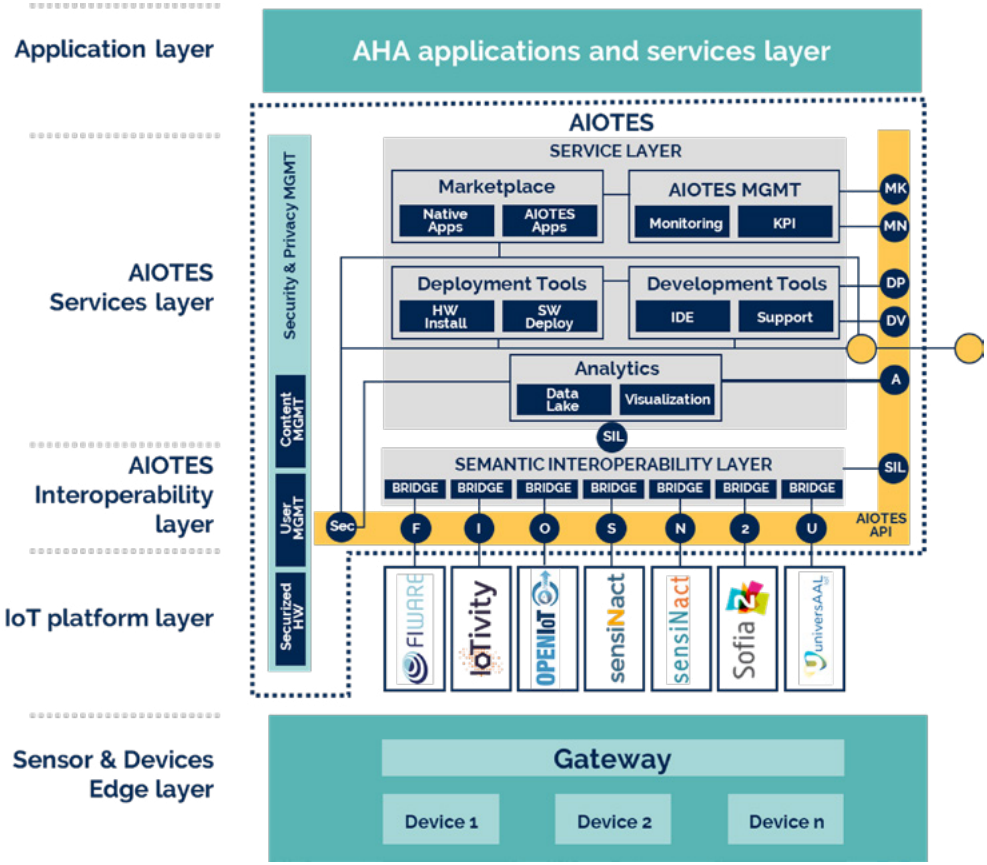
[1] Deployment Site: geographical region where Smart Living Environment based on IoT technologies are deployed that support and sustain active and healthy ageing ICT services for senior citizen.

- DSs deploy Reference Use Cases (UC) that address specific end-user needs, to improve their quality of life and autonomy, reaching 7.000 users. **A single common interoperable ACTIVAGE IoT Ecosystem Suite (AIOTES)** was designed and developed that provides every DS with the capacity to build standard and interoperable IoT ecosystems on top of legacy IoT platforms, or communication and data management infrastructures.

  More information on ACTIVAGE project, UCs, KPIs and pilots experiences are available at project web site **www.activage-project.eu**

ACTIVAGE IoT
Ecosystem architecture

- This generic functional architecture proposed by ACTIVAGE follows the **IoT Reference Architecture (HLA)** functional model described by the AIOTI-WG3 [4] which is compliant with ITU-T Y.2060 IoT Reference Model, OneM2M reference architecture and IIC's Industrial Internet Reference Architecture (IIRA), and it considers specificities of the AHA domain.



ACTIVAGE has implemented the full reference architecture, in particular layers 4, 5 and 6 which consist in the core of the interoperability framework of ACTIVAGE, i.e. the **AIOTES framework**. In this way ACTIVAGE provides the total decoupling between the applications: i.e. AHA applications providing services to senior people and caregivers, from the backend IoT platform complexities and variability in design, and standards used.

ACTIVAGE has defined a reference architecture for IoT Platforms Interoperability. **This architecture aims to build general approaches to face the interoperability in a universal way with the objective of serving as common framework to build interoperable smart ACTIVE AGEING solutions** that can be deployed, extended and replicated at Deployment Sites across Europe.

The IoT Platform Layer in ACTIVAGE architecture

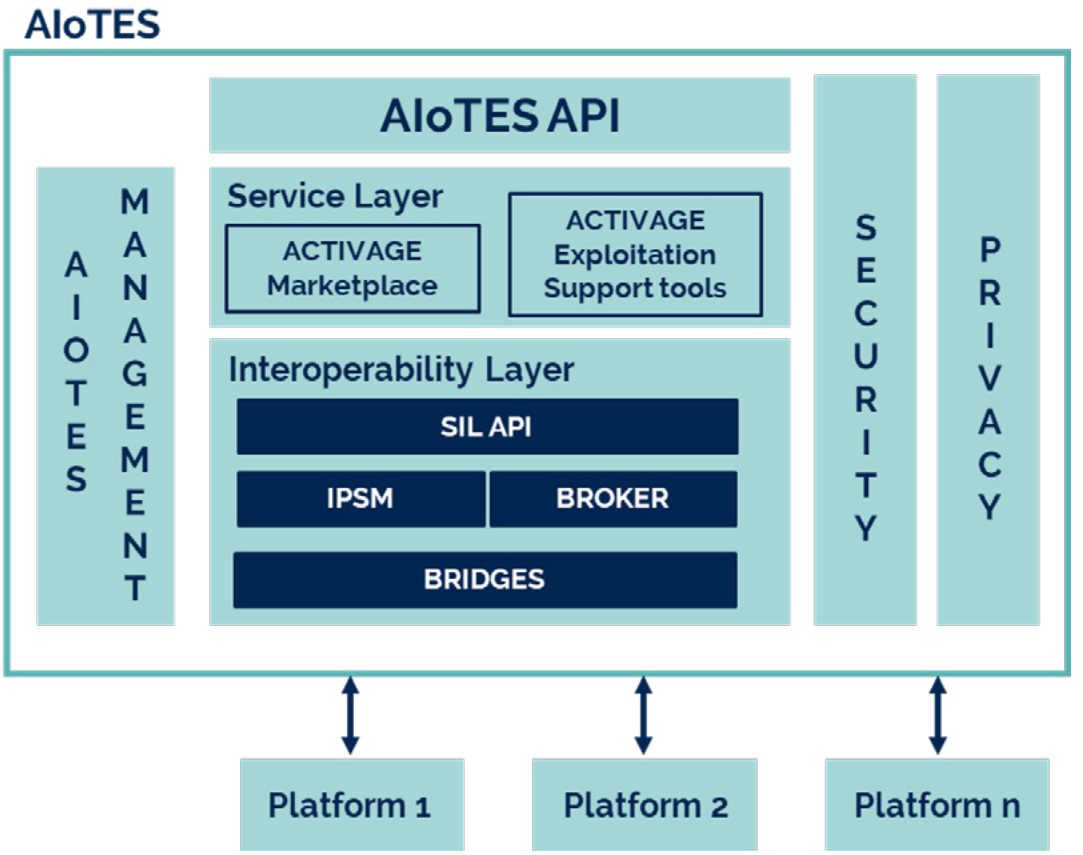
- The IoT Platform enables the connection of sensors and devices, i.e. the "things", ensuring seamless integration with the communication networks and provide resources and mechanisms for the management of these connected things and data.. An IoT platform is also often referred to as **IoT middleware,** which underlines its functional role as that of a mediator between the hardware and application layers.

  IoT platforms are very fragmented; the majority of existing and emerging IoT platforms access to their data and devices in a very heterogeneous way. The Platform Layer in ACTIVAGE contains the platforms that are part of the ACTIVAGE Project, namely, **FIWARE, SOFIA2, universAAL, OpenIoT, IoTivity and others.** The motivation that gives rise to the grouping of platforms in a layer is the objective of **interconnect various platforms to achieve an interoperable IoT for LSE ecosystem across the 9 DS.**

  This layer serve as a bridge between the platforms, working as an abstraction layer and allowing the connection between the devices (at the bottom of the architecture) and the application (on top of the architecture). Thus, **one service will be able to be replicated in any deployment site across Europe.** Several interoperability scenarios were tested in ACTIVAGE.

ACTIVAGE IoT
Ecosystem Suite (AIoTES) Framework

- Consists of a set of software techniques, tools and methodologies for Semantic Interoperability, privacy and data protection, and security between heterogeneous IoT Platforms and Active and Healthy Ageing applications, services and solutions. The schema below summarizes the **main different software components of AIoTES:**



Semantic Interoperability Layer

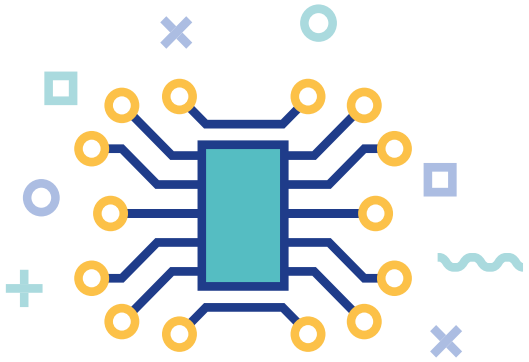
- The **Semantic Interoperability Layer** is the element that provides interoperability among platforms and allows other elements of ACTIVAGE to communicate with any platform through a common API. The Interoperability layer has been proposed as a **solution to overcome the lack of interoperability among the existing IoT platforms.**

  This layer can be divided into three main blocks, namely, 1) the **Broker** that is the component responsible for the communication and flow control, 2) the **IPSM** that provides semantic interoperability; and c) the **Bridges** to the different IoT platforms

  The information exchange is facilitated thanks to the use of **Platform Bridges**. These bridges manage the communication with the subjacent IoT platforms by translating its requests and answers. Different bridges might need to use HTTP, REST, sockets or other technologies to talk to the platforms, but these will be translated northwards into messages.

  The **IoT Platform Semantic Mediator (IPSM)** block manages the ontologies and provides semantic interoperability through the translation among the different platform ontologies and the ACTIVAGE ontology. This translation is performed by means of ontology alignment.

Communications are managed by a **Message Broker** which participates in every communication in IoT Semantic Interoperability Layer. A general API is used to access the broker that exposes basic common operations (message pub/sub, topic creation, basic resources management...), enabling interchangeability of the actual implementation of the broker. . On the one hand, one of the benefits is the isolation of the communication responsibility in a single element, which in turn makes profiling, scaling and adaptation to enterprise infrastructures easier. On the other hand, it allows complete decoupling between components. The broker can be divided, from a functional point of view, into four blocks, namely, API Requester Manager, Platform Request Manager, Data Flow Manager and Message Queue.



ACTIVAGE SERVICE LAYER

- This is a set ot productivity tools and the marketplace that facilitate the use and exploitation of the many ACTIVAGE features.

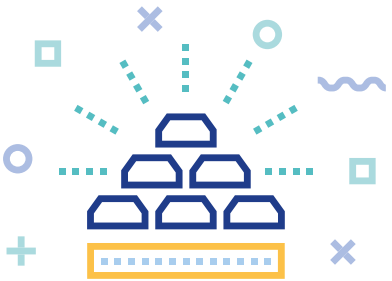
AIoTES Development Tool Kit

The purpose is to offer the appropriate development infrastructure which facilitates the creation of **new IoT applications by technical developers, through the (re-)use of existing IoT applications already registered at the ACTIVAGE application ecosystem.**

The development tools offer means for facilitating the use of existing applications by other developers, such as making use of available source code samples, browsing documentation, viewing available tutorials, testing sample code and using public or mocked data. The development tools also offer a link to the **ACTIVAGE data analytics API**, in order to include data analytics services in new applications, through easy-to-use tools.

The development tools are divided in the following categories:

- **Support:** Tools for providing documentation and instructions about using the AIOTES development tools.
- **Integrated Development Environment (IDE):** Tools for facilitating the creation of new applications.
- **Data / visual analytics tools:** Tools for facilitating the introduction of data analytics and visual analytics in an application.
- **Data Lake tools:** Tools for facilitating access to the data available through the Data Lake.
- **Semantic Interoperability Layer tools:** Tools for facilitating access to the Semantic Interoperability Layer ontologies.



AIToES – Deployment Tools

The **AIoTES Deployment Tools** allow IoT site administrators and application developers to register IoT components and applications to the overall IoT ecosystem and allow deployers to discover already existing ones, thus facilitating the actual deployment of IoT applications in the Deployment Sites. All functionalities are offered through a cloud-based platform.

Components that can be registered and deployed are divided into three categories:

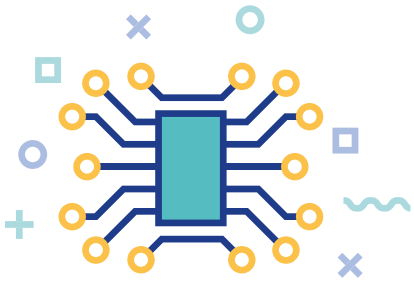
- **Devices** (sensors, actuators, etc.)
- **Infrastructure** (gateways, servers, etc.)
- **Applications** (software that runs on top of the infrastructure, using information from the devices)

AIoTES – Data analysis tools

Data analysis tools provide a bridge between the massive amounts of raw data collected from the IoT sensors and devices of multiple IoT platforms, as unified through the ACTIVAGE interoperability layer, and the human researcher and clinician, who is in charge of extracting useful information from this bulk of data and taking decisions.

There are three main components as shown in the figure:

- **Data Lake,** a collection of components responsible for the crawling, indexing, pre-processing and storage of the collected data, in formats that are suitable for further analysis.
- **Data analytics tool,** which contains components for the analysis of the data contained in the Data Lake, and the extraction of information that is meaningful for the human operator, such as summarizations of data and patterns **detected in them.**
- **Information visualization tool,** which contains components capable of presenting the results of the analyses in intuitive and comprehensive ways.



ACTIVAGE MARKETPLACE

- The **ACTIVAGE Marketplace is a deployment tool,** one very close to the users as it is intended for any online user, deployment site or general healthcare professional, third party adopter, existing and potential developer, individual or business entity to **develop, provide and obtain applications build for AIOTES.** The ACTIVAGE Marketplace functionalities include basic services for registering users, publishing and retrieving offerings and demands, search and discover offerings according to specific user requirements as well as lateral functions like review, rating and recommendation.

The ACTIVAGE Marketplace follows a standard **web application technology stack, using recent frameworks and tools validated and well-established in the industry.** The Front-end provides user interfacing and experience for Application Users and Developers as well as Marketplace Administrators. The back-end implements logic and operations such as interfacing with external APIs which, in turn, include various 3rd party APIs but also the AIOTES components required.

SECURITY AND PRIVACY CROSS-LAYER

- AIOTES Security and Privacy Module is under development at this moment, and it will be available for AIOTES V3.0 in the Q4 2019.

  A main requirement in the specifications of the architecture of the **Security and Privacy layer (S&P module) has been to provide a simple and transparent way to secure the interoperability layer with the minimum modification or not impact on the SIL module.**

  Security and privacy are key features in the ACTIVAGE architecture and its implementation and integration with other services should not be perceived as a delaying nor a hardship process for final users or SIL developers. For this reason, the solution proposed should provide security and privacy for user and service management as a completely independent layer.

  Access control and security administration will be implemented taking advantage of a well-defined authorization architecture according to oneM2M standard and the RFC2753 and RFC3858 recommendations.

SECURITY AND PRIVACY CROSS-LAYER

- The figure below shows the architecture of the Security and Privacy layer and its interface with the SIL and the other services. The functional blocks constituting the S&P layer are the following:

  - **Policy Administration Point (PAP).** This block is in charge of creating, updating, deleting and managing the policies.
  - **Policy Decision Point (PDP),** This block will evaluate and issue authorization decisions based on the policies in the Policy Database and from the user or services requesting any action.
  - **Policy Enforcement Point (PEP).** This block will be in charge of intercept users' access request to a resource and enforces PDP's decision.
  - **Policy Information Point (PIP).** This block will provide external information to a PDP, such as LDAP attribute information.

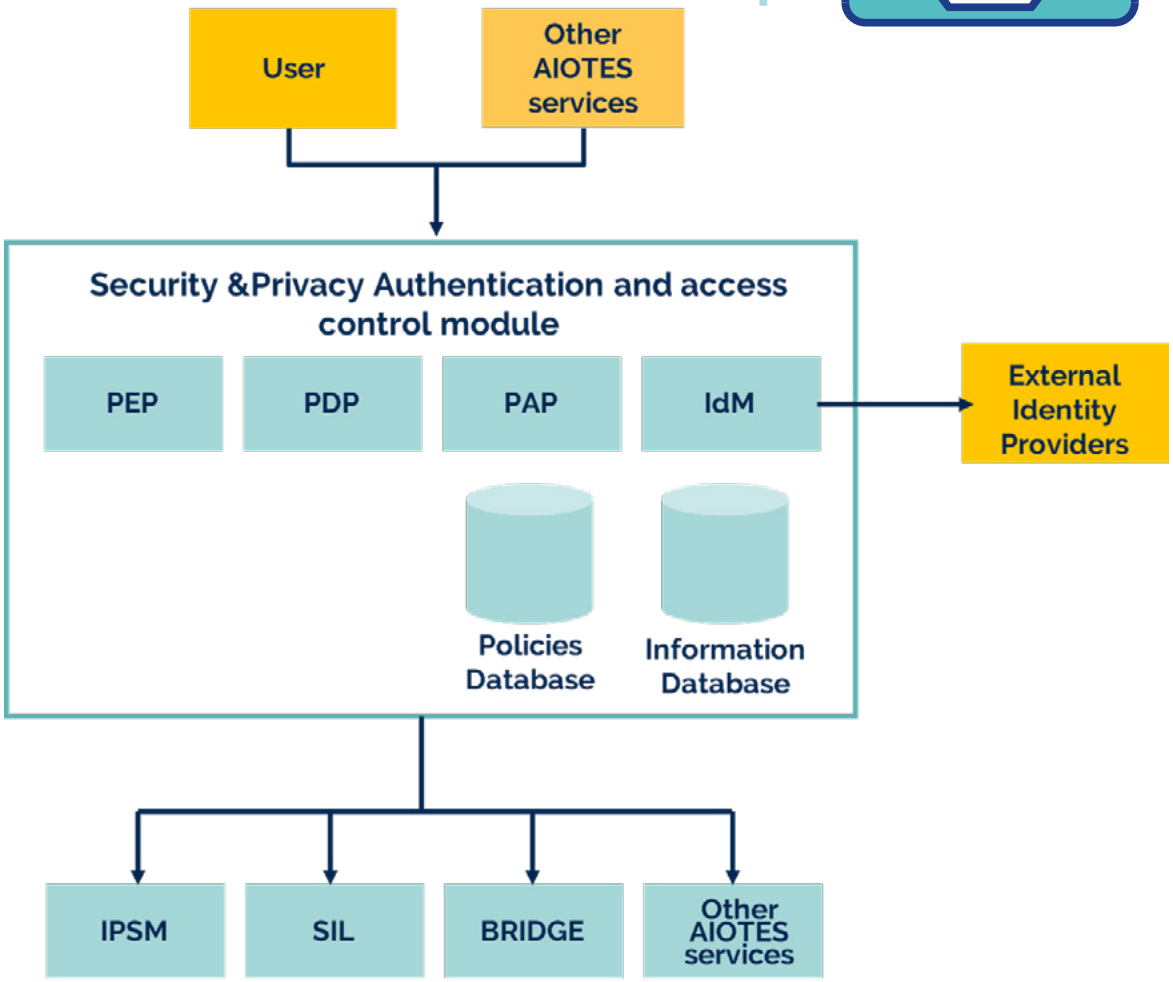
  The S&P architecture is complemented with an **Identity Manager** playing the role of Identity provider for users, services, and information point (PIP) for the PDP.

  The module will be delivered as a centralized tool where all the blocks functionalities will be implemented. At the same time, a completely isolated tool with PEP functionality will be presented. This PEP will serve for other than a centralized deployment.

  Using this approach, the main deployment integration flow will be:

  - The services in the interoperability layer must be registered in the Security and Privacy module, receiving an identifier and a secret.
  - For these services, roles and groups will be defined in order to allow or deny the use of their APIs to the registered users.

  Obviously, this flow simplifies the actual exchanges. The actual flow will be based in OpenID Connect for identification and authentication, JSON Web Token, and a set of access control mechanisms (ABAC, RBAC, RuleBAC).


User
Other AIOTES services
Security &Privacy Authentication and access control module
PEP
PDP
PAP
IdM
External Identity Providers
Policies Database
Information Database
IPSM
SIL
BRIDGE
Other AIOTES services

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