Position Paper
“Smart Living” Data Space

Members of Gaia-X Smart Living Working Group

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Data Space Business Committee – Position Papers

Consolidated Version for Industry Verticals

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1 Mission and Goals of the data space

In the future Smart Living technologies and applications will become an inherent part of our lives. The "Smart Living" ecosystem is developing rapidly (Figure 1). In Europe 250 Mio residential buildings have a massive potential for Smart Home/ Smart Building technologies and cross- domain applications/services. Consequently, the global Smart Living market is expected to raise above 22% (Figure 2). This development's significant driving factor is artificial intelligence (AI) and its potential for highly individualized, context-aware and cross-domain applications and more intelligent systems and devices.

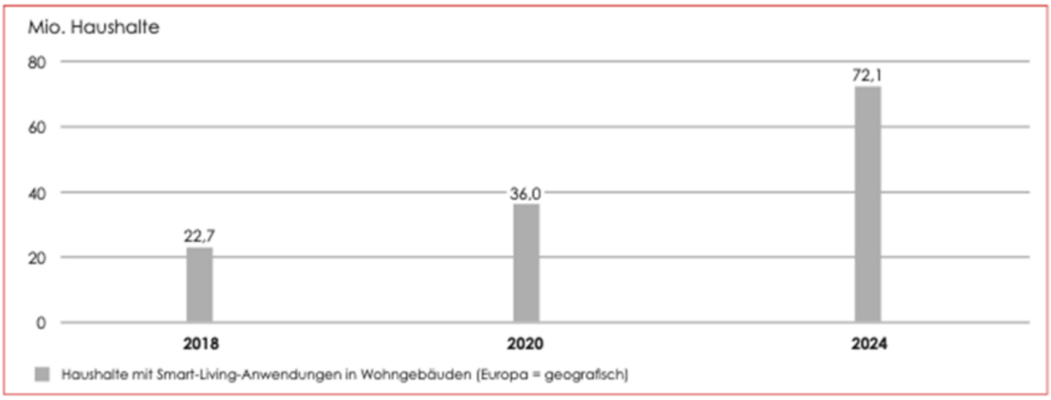

Figure 1 Number of Smart Living applications in residential houses in Europe[1]

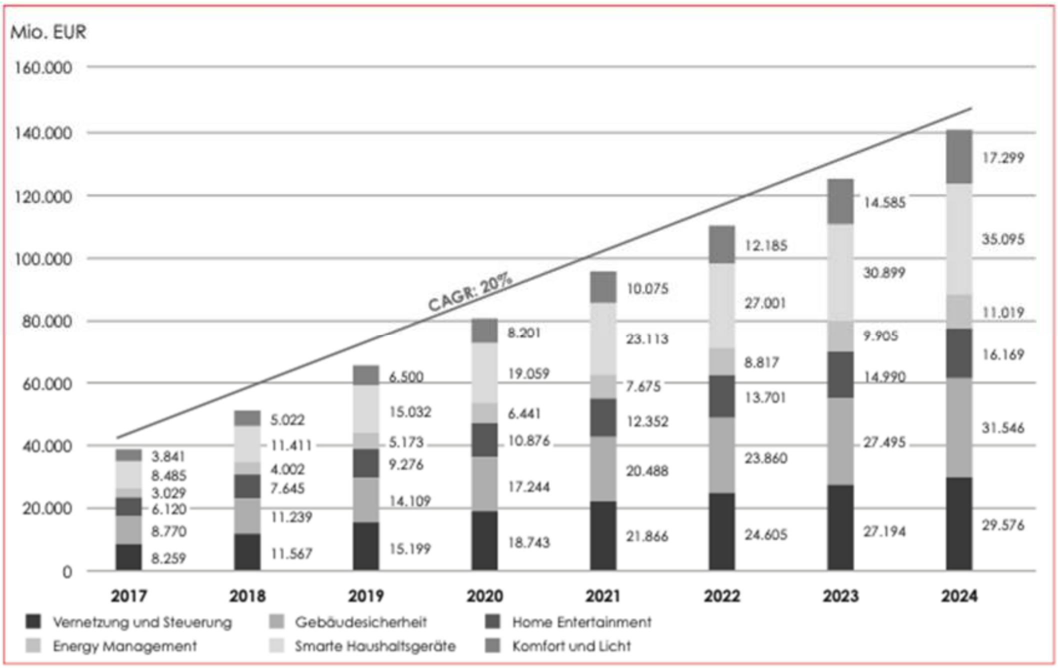

Figure 2 Prediction of global market development of Smart Living and Smart Living applications[2]

Given the fact of intensive connections to adjacent domains, such as smart energy networks, smart city, assistance and AAL, etc. (Figure 3) the overall concept of Smart Living is "Building as an intelligent Service".

[1] Source: SmartLiving2Market 2020, page 15
[2] Source: SmartLiving2Market 2020, page 13

A Smart Home, a Smart Building or a group of Smart Buildings should be able to interact more or less intelligent with smart energy networks, smart city structures, smart mobility offerings and smart assistance services. Information gained from smart buildings are useful and even essential for all these domains. The mission and goal of a GAIA-X Smart Living Shared Data Space is to enable such cross-domain services and applications.

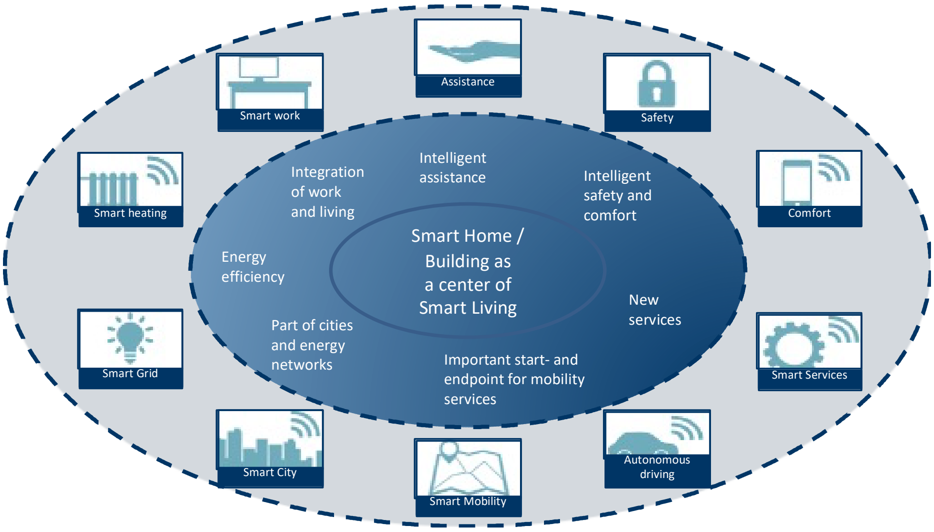

Figure 3 Smart Living and adjacent, connected domains[3]

Service development should be simplified drastically to meet future (and urgent) requirements, such as seamless integration of (smart) buildings in smart energy networks for an improved energy efficiency or to make smart buildings ready for urgently required assistance at home.

The potentially massive Smart Homes and Buildings scalability and federation of distributed clouds and edge devices are considered a vital issue for further development. Reasonable standards to describe clouds, resources, and data provided by specific clouds, useful semantic search functionalities, federated and maybe domain-specific resource catalogues, and an integrated cross-resources access management for improved data sovereignty are key factors for the future Smart Living applications. Consequently, a Smart Living Shared Data Space is a next logical step towards a virtualization of data locations, data access as well as computation, AI and storage resources. Service developers need to concentrate on development of intelligent services and not on handling numerous clouds, searching highly distributed data, implementing numerous interfaces to different clouds and services and access mechanisms.

To realize these goals, GAIA-X offers the Smart Living domain and the housing industry an improved, easy and secure access to a multifunctional cloud environment in the GDPR space. GAIA-X will provide required technologies to connect regional and functionally specialized data centres and thus supports the task-specific scaling of smart-living applications that are dedicated to edge computing due to high latency requirements. GAIA-X facilitates suitable standardization requirements for linking the growing volumes of

[3] ForeSight Community

data and data sources and thus promoting the emergence of further AI-applications, mainly through cooperation between the digital economy, housing industry and electrical industry.

2 Challenges addressed

Number of stakeholders: Before a building gets smart, several stakeholders must work together. Real estate industry plans (Building Information Modelling - BIM), builds, operates, maintains and markets a building, manufactures (electrical industry) develop, configure and market innovative equipment and components and tech industry develops and connects smart services using those installations (Figure 4). Today, Smart Living still comprises completely separate trades that will/must in the future interact in cross-domain applications. These applications require intelligent, situation-adaptive buildings that fit seamlessly into comprehensive structures.

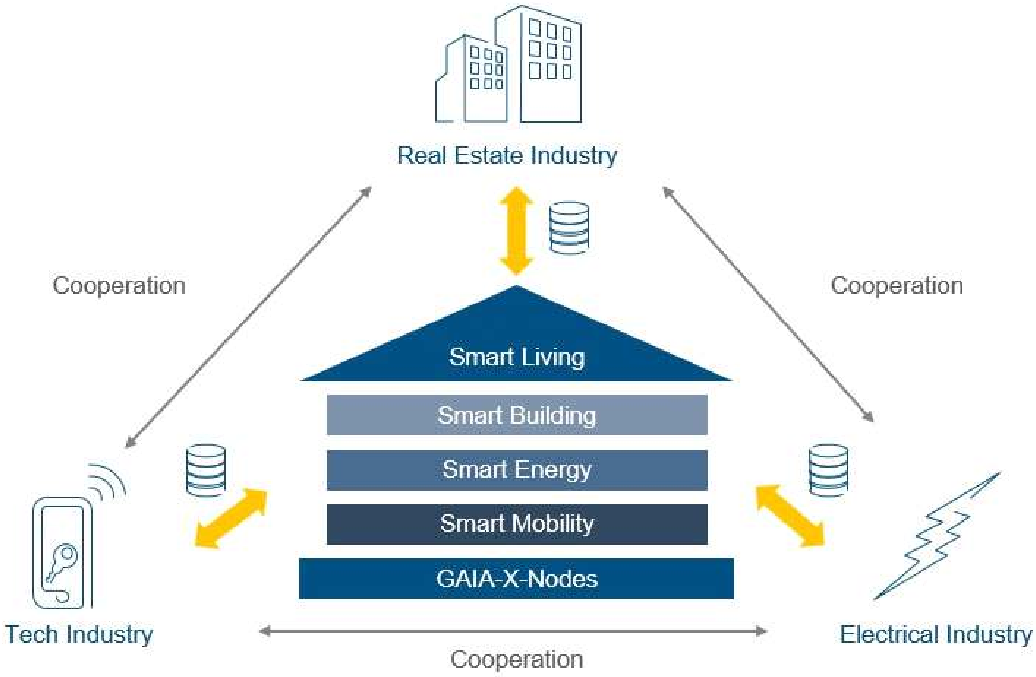

Figure 4 Stakeholders of Smart Living

Heterogenous ecosystem: A prerequisite for such, in many cases AI-based services, is consistent data acquisition, processing and networking. The Smart Living ecosystem consists of numerous (69,000 housing companies with 53,2 billions turnover in Europe) mainly small and medium companies. Within this heterogenous structure service developers are confronted with many different, in most cases incompatible smart home system families and devices, highly individual installations, more and more widely distributed cloud representations of components and devices with incompatible interfaces as well as with many different stakeholders owning data and providing access to required data. Development of useful and intelligent Smart Living applications requires a coordination of numerous domains, integration of separated, incompatible devices, implementation of methods and interfaces for individual data handling, an adoption on different markets, system families and different standards, and of different scales (Figure 5).

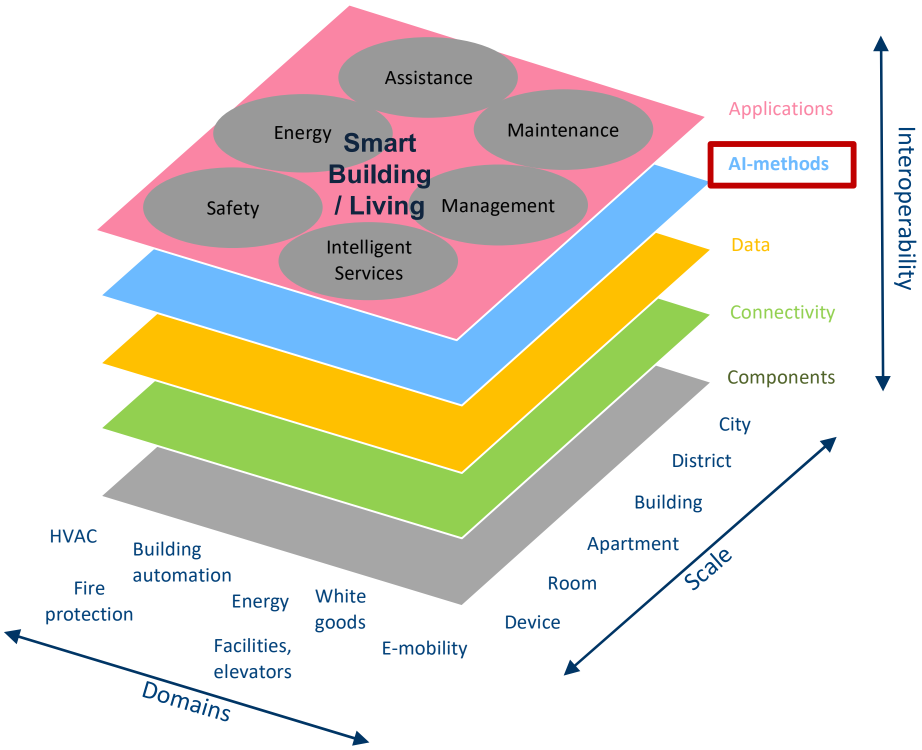

Figure 5 Smart Living data model[4]

Scalability and semantics: Due to heterogeneous structure a consistent semantic description of data and resources as well as more or less publicly available, federated resource catalogues with intelligent search functionalities. There is a need for a secure, scalable and high-performance cloud environment that also includes local edge devices.

Data protection: Smart Living data is often (strictly) personal and sometimes health-related, i.e. highly sensitive, especially because data of third parties like guests is considered as well. This includes, for example, the recognition of activities, patterns of movements, usage habits, presence and emergencies. Other scenarios, such as predictive maintenance for building technology or smart energy management, are less sensitive or not sensitive at all. GAIA-X must offer configuration options for these scenarios.

Transparency: Companies in the housing industry want to offer intelligent services and automation solutions and in return store and process customer data flexibly, transparently and in locally in Europe (DSGVO room). Transparency and easy to use settings where data is located and what can be done with

[4] ForeSight Community

it are required. An increasingly important factor is to clarify of what AI is allowed to do with data – and what is off limits!

Integration of data and functionalities: Smart Living applications have to integrate data and functionalities on several levels (Figure 5). Data from smart homes must be merged with data from the building and its technical installations for numerous applications. Automated buildings should be monitored as efficiently as possible for maintenance requirements and technical problems. The combination of occupant-specific smart home installations, intelligent household appliances, etc. in conjunction with their specific clouds and other manufacturer-specific clouds for building technologies with data from the tenant management demands a sensibly structured, secure and reliably available data management.

Performance: Smart Living applications in a broader sense have very different requirements on performance (some applications need reactions in hard real-time, some others are fine with more extended periods), amount of data, scalability and level of data protection and IT-security. Besides high availability requirements up to 100% up-time for critical smart-living services such as emergency detection and fire protection are required in building services engineering.

Interoperability: As described above Smart Buildings and Smart Homes consist of different system families and smart devices. So called vendor clouds provide users (and developers) complex digital twins of components and devices. Most vendors offer cloud-based, proprietary JSON-interfaces to interact with data and functionalities. For service developers the challenge is that each cloud and digital twin has specific interfaces and for the vendors the challenge is the high effort to transfer a given, complex data space to a different cloud provider, so that a virtualization layer based on GAIA-X might improve interoperability on different levels.

3 Solution: Data space description in a holistic view – detailed view on the endeavour

The use of open standards in the implementation of Smart Living Data Spaces will be a key success factor on the way to a GAIA-X compliant architecture and a wide acceptance. In this way, the ecosystem achieves global interoperability, scalability, and resilience while avoiding vendor lock-ins. These characteristics, in turn, drive innovation and enable users to freely choose services.

Cloud infrastructures: For cloud infrastructures and the service implementations based on them, this applies. The choice of the right provider, the implementation of standard solutions and a community-led strategy are success factors here. Already today, many data centres use a mix of different cloud services from different providers. This makes multi-cloud management necessary, which pursues two main goals: Users from the business departments should be able to obtain the cloud services they need as far as possible independently in self-service, while from the IT point of view, automated billing takes place, among other things. Industrial companies are developing their own cloud and IoT enablement platforms based on the major hyper scalers or are increasingly becoming providers themselves. This is accompanied by a number of cloud management tasks that contribute to a functioning overall system: Infrastructure Management, Application Management, Service Management, Managed Services, Full Managed Services. Interoperable tools for common tasks including deployment, autonomic scaling, and monitoring are extremely helpful. The focus here is on integration, portability, interoperability, and innovation.

Various tools have already been established in the implementation community, some of which have also been used in the use cases described above. In the foreseeable future, containerization will be the tool of choice for scalable and resource-efficient provision of cloud services. The major cloud providers rely on their own platform solutions for setting up and managing the services. However, there are different cloud computing platforms based on open standards for the deployment of public and private clouds, such as OpenStack. For service management, OpenShift is probably one of the most powerful tools on the market at the moment, offering many of the functions described above integrated. For orchestration, Kubernetes is often used, which as an open-source-platform achieves excellent results in the management of workloads and services in the containers. The overall goal must be to simplifying any transfer of existing cloud and data spaces and established cloud-based applications. Finally, event streaming platforms will play a major role in the architecture of data rooms. Here, a growing community has already successfully deployed Kafka Server. The open-source platform is already used by a variety of companies for high-performance data pipelines, streaming analytics, data integration, and mission-critical applications. In the project ForeSight we are establishing Kafka to evaluate its capabilities for the Smart Living domain.

Standards and virtualization: As described above, a Smart Living Shared Data Spaces should be a virtualization layer on top of existing cloud and edge environments. In order to gain a wide acceptance, it should be based on international standards – in the best case W3C and well-accepted industrial standards. A data space should offer data providers and service developers

- standards for semantic description of cloud resources, cloud functionalities (storage, high security, AI, etc.)
- standards for semantic description of resources hosted in a cloud or on an edge device
- standards for semantic descriptions of data, services and things
- a set of basic ontologies for typical smart living and connected domains e.g. iotschema.org, SAREF, SAREF4Ener, GTFS, etc.
- a comprehensive set of tools for the required mapping between different data models, and ontologies
- a comprehensive set of tools to perform automatic semantic uplifting of data and interfaces that are not yet semantically described. Those tools should be predefined for a standard set of data models of the Smart Living domain
- catalogues for those data, services and things with a comprehensive search functionality and a fine-grained access control
- concepts to setup and connect federated catalogues as well as to enable cross catalogue semantic searches and reasoning
- concepts to describe data origin, data quality, quality of service, as well as limitations for an AI based data processing
- easy and cross cloud deployment of containerized services and environments
- easy to use, predefined AI environments for machine learning and rule-based AI
- tools for data analytics beyond AI

Integration of IoT: Smart Living is an umbrella of many sub-domains in the Internet of Things (IoT) and IoT is a collection of advanced technical tools that only fully develop their potential in such complex and heterogeneous scenarios. Consequently, IoT platforms should be made GAIA-X compliant - and GAIA-X should support this. Figure 6 shows in principle how an open IoT platform can be used even more flexibly as a federated IoT platform, e.g., by splitting it among different GAIA-X-compliant clouds or by IoT-as-a-Service offerings described via federated catalogues.

Some IoT platforms already provide semantic descriptions, in this example accessible via a graph API. Other approaches include triple stores and SPARQL instead. These are massive steps to support (symbolic) AI and simplify service developments in the context of high data sets / device volumes. The integration of such IoT platforms into GAIA-X should provide a common set of mappings between different semantics and typical data models for further simplification and thus scalability opportunities.

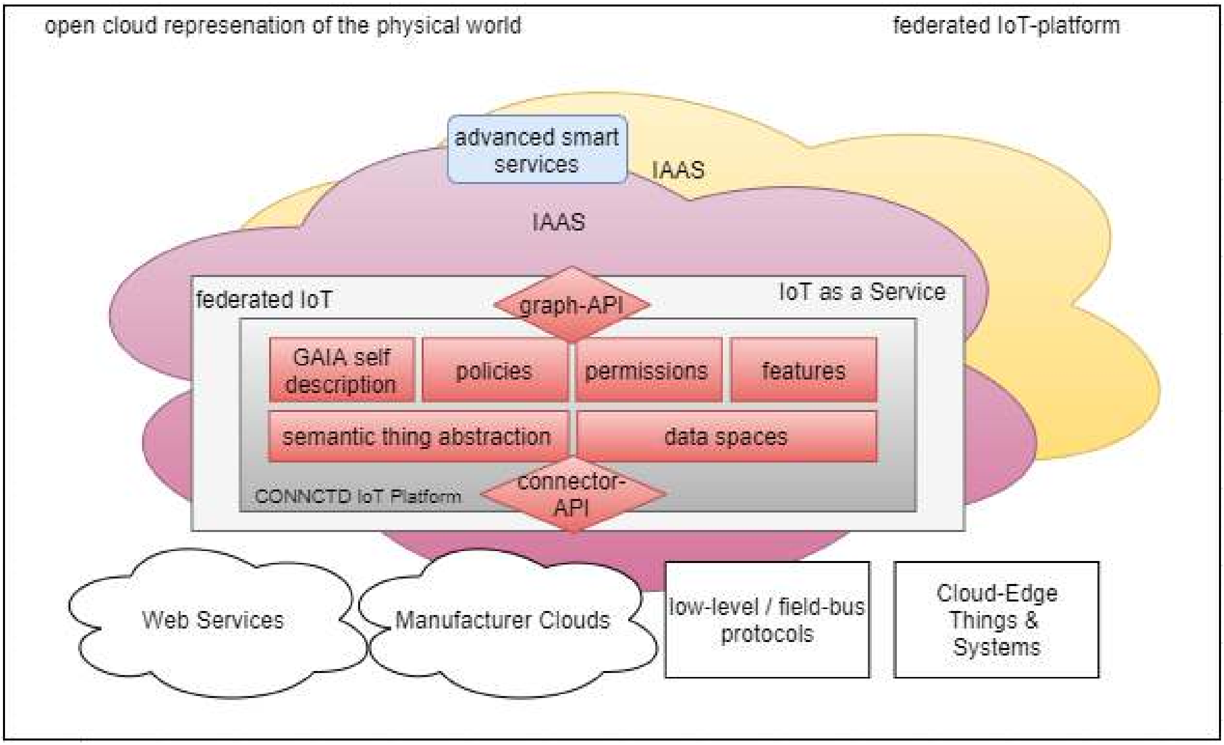

Figure 6 The concept for a federated IoT platform[5]

ForeSight Smart Living Shared AI Data Space, digital twin(s): Figure 7 shows the existing prototype of a (partially) GAIA-X compliant shared data space. The so-called ForeSight AI platform has been developed in the BMWi funded project ForeSight and is a Smart Living **AI** Data Space. It comprises a federated catalogue (registry), semantic things descriptions, digital twins of connected appartements/buildings, a SPARQL end point, a reasoner, a multi-agent system for data collection and dynamic removal and injection of new things and services in the registry, a concept for virtual sensors, a tool set and predefined AI cloud environment for machine learning as well as a set of essential AI services for Smart Living applications. All services are semantically described and stored in the registry. For data resources that are not yet

[5] ©IoT connctd GmbH 2021

semantically described a set of mapping tools/services has been developed to uplift those data and interfaces on a semantic level. ForeSight uses Web of Things to semantically describe “things” on an abstract but machine-readable level. The base IoT ontology of services inside that data space is iotschema.org. This data space can be seen as a first prototype for a Smart Living Shared AI Data Space.

Identity and access management (IAM): All services, as well as all digital twins, are protected with IAM-system “Keycloak” as suggested by the GAIA-X consortium. Keycloak offers various realms, roles and groups, which in our case provide different scopes of rights, for example, to give tenants, guests, patients, doctors and relatives appropriate access options to the data they need. A system such as Keycloak allows extremely fine-grained adjustment of access rights, which protects individual data endpoints based on roles and at the same time on attributes, taking into account other factors such as the time of access and highly secure identification and authentication to address the privacy and security requirements in Europe.

GDPR: GAIA-X-compatible Smart Living systems need to be GDPR compliant and should lead by example when it comes to data acquisition and data management strategies:

- Acquire a minimum of necessary data to fulfil the purpose of the systems service, e. g. make distinctions of necessary location levels (miles for weather related purposes, meters for positioning-tasks)
- Enable a user to set such data access rules easily, i.e. by offering a similar approach like currently in cell phones, which will be extended to address all relevant GAIA-X-specific challenges.
- Forbid unnoticed data combination and offer built-in segmentation strategies to achieve this goal.

Report a maximum of real data access related to user’s data, e. g. offer a dashboard for each user.

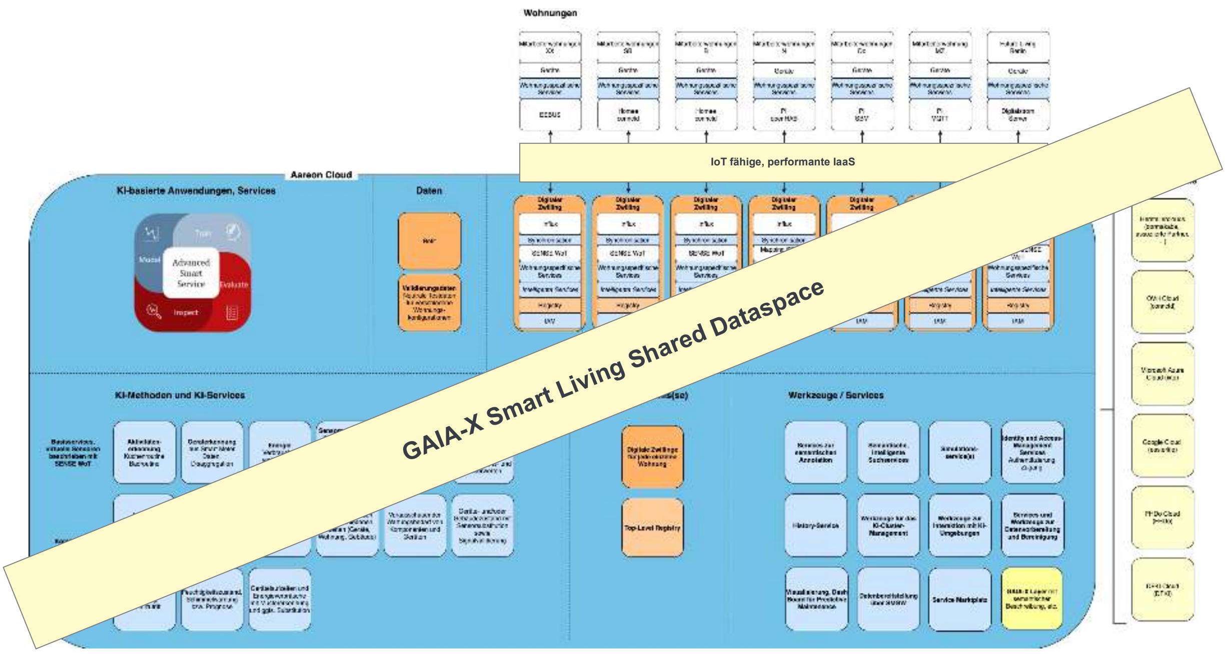

Figure 7 ForeSight Shared Data Space[6]

[6] ForeSight Community

AI: From a user's perspective, there are several points to consider when AI technologies are used. A classical approach that is usually employed nowadays is to transfer data to a cloud system with virtually infinite computing and storage resources. However, this approach has a couple of disadvantages. First, with growing numbers of sensors and increasing sensor capabilities/resolutions, the utilized bandwidth is as well. Second, many people would like to avoid transferring highly sensitive data that is inevitably created in their own homes to cloud systems owned by companies or governments they do not trust, and which are not under their control for privacy and data protection reasons. Another important aspect in the energy domain is that a system should react instantaneously to specific events to provide a high level of safety. This means that AI systems should be able to provide decisions in real time, i.e., in deterministically predictable amount of time.

Edge, Edge AI: One possible approach to increase the confidence of users, minimize amount of data to transfer and storage and provide real-time capable AI functionality is to process the data locally, i.e., where it is generated. In this case, AI methods run on computing devices that are located in or close to the apartment, home or building of the corresponding owner or tenant and transfer only specific data to the external cloud system, e.g., data that describes the occurrence of important events as predicted by the AI methods or significant changes of the state of the environment. This concept is called Edge Computing or Edge AI for the specific case of AI computations.

For Edge AI it is usually preferable to use power efficient and small embedded computing devices. To provide the computing performance required for AI methods, application specific hardware accelerators that are targeted towards AI computations can be used. This has several reasons. First, for many applications it is desired that the computing hardware is "invisible", i.e., deeply embedded into the application and not recognizable as such by a user. Second, from an energy efficiency perspective, the AI methods should need as little energy as necessary, since the number of computing devices used for the Edge-AI concept might be very high and the devices are continuously running.

3.1 Partners of the ecosystem

As described above our ecosystem consists of many different stakeholders or sub ecosystems that are in many cases not or not well connected. Stakeholders are amongst others

- residential companies as owner and/or managers of buildings
- residents
- manufactures/vendors of smart home components, devices, systems
- manufacturers/vendors of intelligent wide goods and kitchenware
- manufactures of smart elevators, heating, cooling, photovoltaic, battery equipment
- manufacturers and / or operators of internal energy management systems
- manufacturers and / or operators of internal access control systems
- manufacturers and / or operators of internal fire protection systems
- operators of charging stations for e-cars
- operator of surrounding energy network
- services providers
- maintenance providers
- care provider
- financial industry

- municipalities
- waste management companies
- utilities (gas, water)

Consequently, the existing ForeSight community comprises currently 70 partners.

3.2 Use-cases (scenarios) within the data space and the current state of development

Smart Living addresses two societal highly relevant topics, namely energy efficiency and the ageing society in many European countries. Additionally, to these comprising and extremely challenging use cases the GAIA-X Smart Living working group currently develops a set of minor use cases tackling single aspects of a Shared Data Space.

An important attraction and extension of the existing Smart Living Shared Data Space is AI. Nearly all use cases that partners describe are somehow related to AI in general. Because all hyper scalers offer at least more or less ready-to-use machine learning environments, partners expect such functionality plus specific AI-based essential services that simplify application development remarkably. Thus, ForeSight aims to develop a valuable set of such basic services for different purposes and to develop an advanced virtualization layer for a dedicated AI-cloud environment.

Studies have shown that in the Smart Living domain the "one and only" Shared Data Space makes no sense. Use Cases, services and applications are too heterogeneous to bring them all together in one Data Space. In fact, applications/use cases require specific Shared Data Spaces that provide precisely the data and resources required. Those project-specific Smart Living Data Spaces need to have reasonable concepts for semantic descriptions of and comprise cross-Data Space search functionalities for resource and data catalogues.

3.3 Use Case Smart Living Assistance/AAL

3.3.1 Solution

The elderly, sick, or care-dependent people are primarily faced with one question: Do I stay home, or do I move to a nursing home? One objective of "Smart Living" is to help the person concerned to maintain their independence and quality of life, despite health limitations. The ability for them to stay in their own home is an essential factor here. In addition, younger people may profit from the monitoring of health and fitness data to prevent e.g. civil illness.

To make this possible, an optimal living environment needs to be created with the affected person, their relatives, the care, medical and emergency services, insurance companies, local authorities, and, if necessary, the housing company. Solutions that assist within everyday life (Ambient Assisted Living (AAL) solutions) can be a great help here. In addition, medical treatments and diagnoses can also be supported with digital technologies. AI based Monitoring and hazard recognition of vital data based on embedded AI systems for example can support online care and event detection by resident doctors e.g. in case of stroke patients. AAL solutions also comprise alarms to monitor and/or signal an emergency, smoke, air quality, indoor climate, water consumption/leakage, and stove use. They also encompass door openers and sensors, sensors to detect absence and monitor getting up as well as activity and inactivity, internet-based communication services and voice assistants. A GAIA-X Shared Data Space is a perfect basis for a confidential data protection compliant and scalable cross trade solution.

3.3.2 Problem solved

Through the use of AI, it is now possible to develop processes that incorporate existing sensor and actuator technology and offer better care and decision-making support by linking information from all data sources together. For example, information on electric power consumption, i.e. from smart meter data, could also be used to obtain important indicators of activity/inactivity or for monitoring residents behaviour.

Besides, there are all kinds of services supporting everyday life up to the affected person's professional care and support. The array of processes concerned must be coordinated between all service providers and systems involved, and, in particular, information from AAL systems is made accessible to all the persons concerned so it can serve as an essential additional source of data.

In the case of pandemics and the associated restrictions on social contact, networked assistance solutions that assist with everyday life are essential for enabling the person affected to maintain their independence and quality of life in their interactions with other people.

3.3.3 Main technology/GAIA-X components

- Protected edge/cloud environment for IoT sensors on humans and smart home IoT devices
- Time-series data bases (e.g. Influx DB)
- Federated catalogue/registry
- Semantic description of all data and resources of things as well as thing locations
- Predefined semantic searches (SPARQL based)
- IDS as a semantic description of related clouds
- iotschema.org as IoT ontology and SENSE WoT for semantic description
- Keycloak as IAM system for all services
- OpenShift for containerization and deployment

3.3.4 Concrete benefits

Solutions that provide assistance with everyday life are used in various domains, each with different requirements depending on the particular protection classes concerned (for example, equipment technology, energy, health, and “human” data) GAIA-X-Governance enables all of these different requirements to be taken account of.

It is vital to ensure all participant’s data sovereignty, provided that GAIA-X methods for data exchange in the AAL area are applied and supported. AAL can thus use all available data sources without violating data protection rights.

Within the GAIA-X framework, it would thus be possible to enable transparent and secure data exchange between the various actors (affected persons, relatives, medical, personal care services, emergency call services, health insurance companies, and corresponding AAL platforms).

3.4 Use Case Smart Living Energy Efficiency of Smart Buildings

3.4.1 Solution

Buildings are important entities in the context of a more flexible balancing of (smart) energy networks. The ratio of the total energy consumption is currently around 40%. If we want to realize the macroeconomic and overarching energy efficiency goals for individual buildings, neighbourhood solutions, quarters and smart cities, we need to create overarching, interoperable networks that cross local boundaries (Figure 8). Smart Buildings / Smart Homes must become an intelligent counterpart to smart and intelligent energy networks and should be enabled to internally manage their energy consumption and production. But only a cloud system with governance rules that provide clear guidelines for data protection will be able to manage the balancing act between data protection, individual user habits, and energy supply security in the long term. If such a solution were available, it would also be relevant for our secure critical energy infrastructure, which is under special regulatory protection. Here, clear distributed approaches under national co-regulation can guarantee availability. GAIA-X offers the opportunity to provide such a cloud infrastructure and protected access for all actors (residents, owners, energy service providers, and contractors) to the usage data needed for energy forecasting, e.g., energy consumption and behaviour-specific information such as arrival and departure times and any absences.

GAIA-X enables a uniform and holistic pool of information to be established on all relevant devices installed in a building. This is vital in order to develop scalable, cross-cutting energy products.

An overarching IAM-system provide secure access (confidential chain of action) to the devices from private and semi-public areas, provided that the customer or the owner has provided their consent. This access system can either be used to benefit the grid (clear guidelines, timetables) or consist of rate-based incentive schemes. After that, the focus will be on the mass market.

By pairing the iMSys infrastructure with the GAIA-X cloud infrastructure, further energy efficiency gains can be made.

Figure 8 Smart Building as entity in an energy network

3.4.2 Problem solved

Today, around 40% of final energy is consumed in our homes. Germany has around 21,7 Mio buildings that consume 870 TWh. As part of the energy efficiency strategy for buildings, Germany's building stock is to be made virtually climate-neutral by 2050. Meeting this goal will only be possible by using smart solutions that increase energy efficiency and cloud-based coupling between the electricity, heat, electric mobility, and buildings sectors. This will involve data-based solutions to network the relevant energy consumers, producers, and storage systems across different buildings. In addition to the devices that are already widely connected today - such as heating and cooling installations and all types of IoT and household appliances - an important role will also be played by power-to-heat (PtH), power-to-gas (PtG), power-to-mobility (PtM) as well as electricity and heat storage devices.

Buildings as well as associated charging infrastructures for e-cars are important factors for the balancing of any energy network. With more and more decentralized regenerative generation of electrical energy and reinforced by the development of private and public charging infrastructure for electromobility, the task arises in the distribution network to carry out suitable intelligent control. At grid nodes (transformer stations), for example, a grid-serving feed-in/load profile of the instantaneous electrical power can be aimed for. This can be done in relation to this point via a suitable intelligent central control system. The sum of the powers must be balanced at any time. In the future grid, it consists of the supply from the upper grid segment, the PV feed-in, the supplied/discharged power of the controllable electrical/thermal storage units, the load from charging stations, heat pumps and households, and the load from the companies in the grid segment. Controllable components can be made available through appropriate switching on and off. The goal can be in this case to carry out a grid-serving balancing aggregation of the supplied and dissipated powers and, if possible, to follow a predefined overall load curve through demand side management. For this purpose, the instantaneous powers of the billing-relevant measuring points in the network segment must be recorded in fine granular form and the loads and storage facilities must be controlled appropriately according to the specifications of the central control system.

In the information technology model, the switching and measuring points within the distributed energy network are data points in the IoT that permanently supply or are supplied with data in encrypted form at specific measuring intervals in accordance with IT security requirements and in accordance with IT service quality (QOS) requirements in terms of sampling rate and packet delay. Endpoints/edge controllers (smart device controllers, SDC) are smart meters and switching devices at smart meter gateways (SMGW) or energy management controllers (EMC) that communicate via IP interfaces with cloud systems and a GAIA-X service environment.

By semantic description of the data points according to the WoT specification supplemented by the geo-position, a digital twin of the grid segment can be built up, which can describe the state of the distribution grid segment to be spatially observed in each measurement interval. This in turn can be used for intelligent dynamic adjustment of the network quality. By intelligent use of resources with a location-based service for intelligent demand side management and prediction of feed-in and consumption in the cloud, the peak power in the grid segment can be reduced. For example, a service in the cloud has the task of minimizing energy needed in the short term to regulate production and consumption by balancing feed-in, consumption, and storage. This saves both CO_2 emissions and power-related costs.

Another service in the cloud is, for example, the operational management of the assets of the network in terms of predictive maintenance. A reduction of possibly required network expansion costs due to the higher energy consumption of electromobility and the conversion of heating systems to heat pump systems and theoretically possibly also regenerative feed-in can be achieved.

The aforementioned services allow integration into energy marketplace systems that bring network aspects of local energy distribution networks into connection with energy trading transactions. This should also be seen in relation to the BDEW traffic light concept considered in Germany.

3.4.3 Main technology/GAIA-X components

- Protected edge/cloud environment for IoT sensors on humans and smart home IoT devices
- Time-series data bases (e.g. Influx DB)
- Federated catalogue/registry
- Semantic description of all data and resources of things as well as thing locations
- Predefined semantic searches (SPARQL based)
- IDS as a semantic description of related clouds
- iotschema.org as IoT ontology and SENSE WoT for semantic description
- Keycloak as IAM system for all services

3.4.4 Concrete benefits

In order to balance generation, storage, and consumption, various processes need to be established around the building, from power management at the grid connection (smart meter gateways), to smart energy management, through to energy trading across all buildings. Smart solutions are required that enable the systems to be designed around the individual needs of the residents.

3.5 Maturity indication of the data space

With the ForeSight Smart Living Shared Data Space, a demonstrator has been built for “Digitalgipfel 2020”. The demonstrator (Figure 9) is wholly based on W3C standards and known technical concepts and artifacts out of the GAIA-X technical working groups. Therefore, we would sort it in in TRL 5. We did not tackle and implement software artefacts for the topic trust. Our federated catalogue is based on RDF-triple-stores and SPARQL. Mapping services have been implemented to translate between different ontologies and data models.

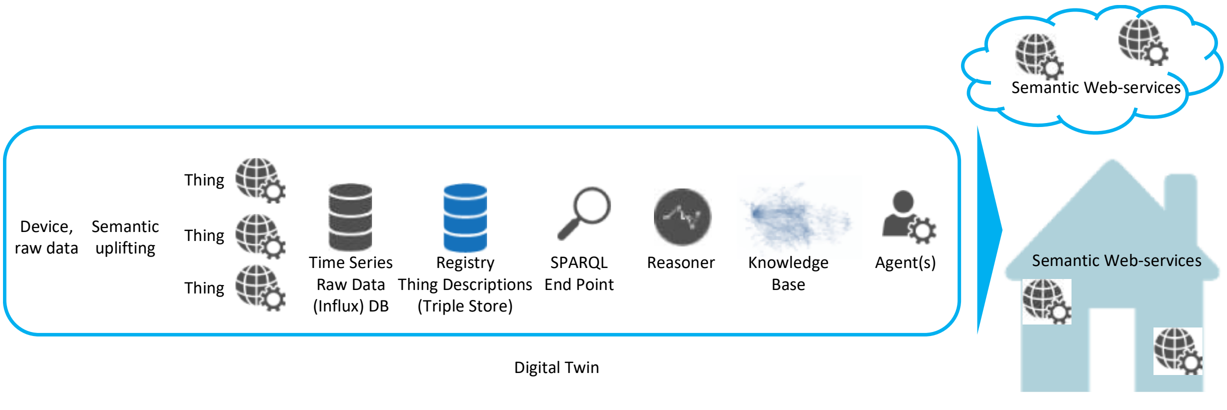

Figure 9 Elements of Smart Living Shared Data Space

One focus of the demonstrator is the concept of a registry / catalogue. This is because, the smart living data ecosystem is characterized by a high degree of heterogeneity and complexity. Use cases in the domain often require that previously isolated products, services, and data sources that are distributed among different actors are integrated into overarching systems. For example, the development of a smart building access management service (‘intelligent doorkeeper’) requires the integration of data from building ERP systems of the housing industry, biometric data of residents and visitors, context data, and the integration of services such as an AI-based facial recognition and a door lock API. In turn, the processing of this sensitive data requires a high degree of transparency and traceability, which is primarily in the hands of the service engineer (i.e., the developer) of the overall service, so that he or she can consider data flows and data storage early in the development process. To achieve this, it is essential to provide the service engineer with tools to evaluate relevant information about products, services, or data in order to help him make the best decisions and thus certify to users the privacy-compliant characteristics of the overall system. For this purpose, the service registry was developed as part of the existing demonstrator. It instantiates the basic idea of a GAIA-X federated catalogue for the Smart Living domain and extends its scope to the service level. The registry allows service engineers to register their services in a central system, store meta-data that facilitates the use of the services by other actors of the ecosystem and search it to make use of existing services. The registry thus represents the central starting point for service development within the Smart Living data ecosystem. On the one hand, it lists services currently registered in the domain (Figure 10), on the other hand, it provides detailed information on individual services (Figure 11). The detailed information includes, for example, information on the provider, the version, dependencies, the costs or the security classification. To ensure compatibility the self-description of each service is based on the W3C Web of Things (WoT)[7] description and extended by domain specific aspects like the Smart Readiness Indicator for Buildings[8] of the European Commission. In addition, the registry also includes GAIA-X specific information, such as the ID and physical location of the executing GAIA-X node. Since the ecosystem's services often process sensitive data, information about the protection classification of the data being processed is crucial for the engineer to ensure appropriate processing that meets the requirements of the data provider. Of particular importance is the data visualization component of the service registry. Its goal is to increase transparency within the data ecosystem by showing data flows between individual services. In this way, data producers who share data with the ecosystem can get an overview of how this data is further processed. On the other hand, the user of a service (e.g., and end user or an intermediary, like the above-mentioned service engineer) can track which services a particular service uses and thus ensure compliant use of his own offer.

Our prototype of the service registry demonstrates the concept for the domain Smart Living following central GAIA-X values: Transparency and interoperability. This is realized by extending domain-specific standards (W3C WoT), allowing access via a web-GUI and a REST API and providing information on dataflows.

[7] https://www.w3.org/TR/wot-architecture/
[8] https://smartreadinessindicator.eu

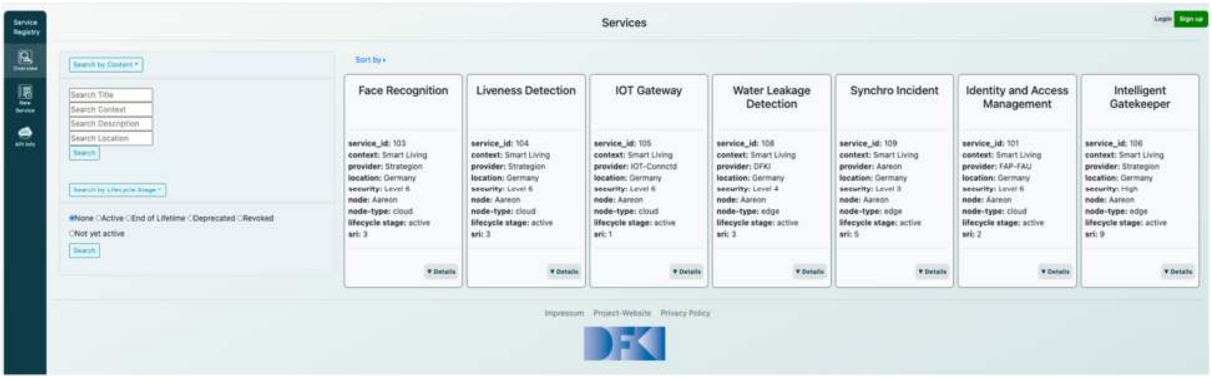

Figure 10 Screenshot of the landing page of the service registry showing all available services

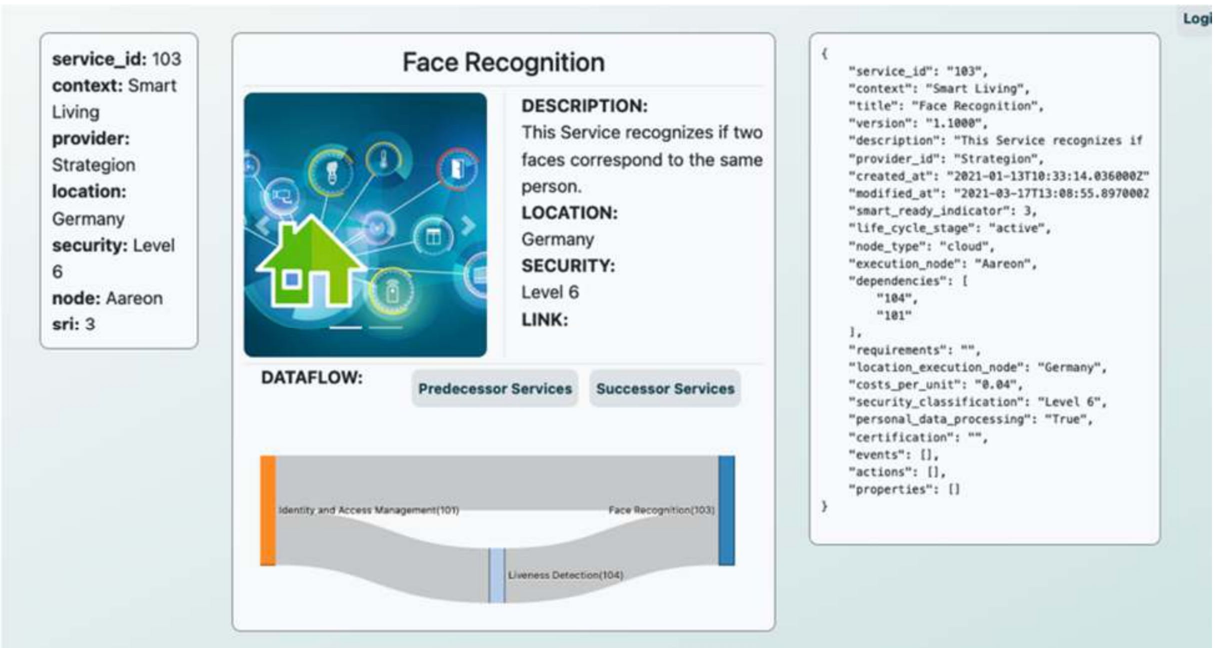

Figure 11 Detailed information regarding a particular service, including the transparent visualization of data flows and the service self-description

3.5.1 Main technology/GAIA-X components

Figure 12 provides an overview on technical components of the Smart Living Shared Data Space that have been partially used for the implementation of the demonstrator described above.

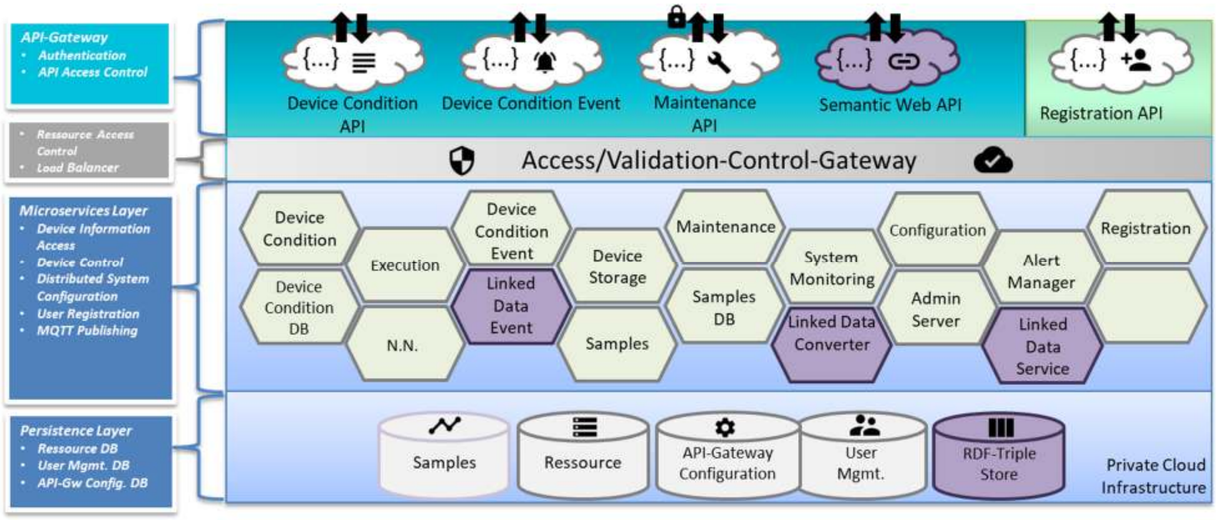

Figure 12 Technical overview

Key components are:

- Protected edge/cloud environment for IoT sensors and actuators
- time series data bases (e.g. Influx DB)
- Federated catalogue/ service registry
- Semantic description of all data and resources of things as well as thing locations
- predefined semantic searches (SPARQL based)
- IDS as semantic description of related clouds
- iotschema.org as IoT ontology and SENSE WoT for semantic description
- Keycloak as IAM system for all services
- OpenShift for containerization and deployment

3.5.2 How is the demand side represented?

Partners of the ForeSight community.

3.5.3 How is the supply side represented?

Partners of the ForeSight community.

3.5.4 Is there an equal representation of demand and supply side to provide a sustainable business model?

Not yet.

3.5.5 Is the story of the data space well documented?

Scientific publications regarding the demonstrator and its components are currently written, a promotion video by the Digitalgipfel 2020 can be accessed here:

https://foresight-plattform.de/newsroom/digitalgipfel-2020/

3.5.6 What is the business model and the business mechanics of the data space after the PoC implementation?

An essential part of Smart Living ecosystems/projects is service engineering. The concept of basic services, predefined AI environments, etc. are made to simplify service engineering and application development. The community comprises numerous service developers of the domains housing industry, IoT, assistance, maintenance and energy management. The partners take over at least parts of ForeSight Smart Living AI Shared Data Space and are currently integrating those concepts in their own business mechanics. The process is still ongoing because ForeSight is running for another 1 ½ year.

3.5.7 Which components will be certified according to the GAIA-X federation services?

Catalogues/registries, cloud descriptions, semantic searches, mapping, semantic databases for IoT Things, AI tools and layer, deployment of services, transfer of services between clouds, integration of edge devices and maybe the concept of digital twins.

3.5.8 What is the potential for adoption of the endeavour and for further scaling?

One smart building might not be a considerable challenge in terms of resources required. However, if we take energy efficiency and societal changes seriously, smart Living should be more or less completely implemented for 21,7 Mio. buildings in Germany and 33 Mio. in France. Around 100 Mio. smart homes are expected in the year 2025 (Figure 13 and Figure 14).

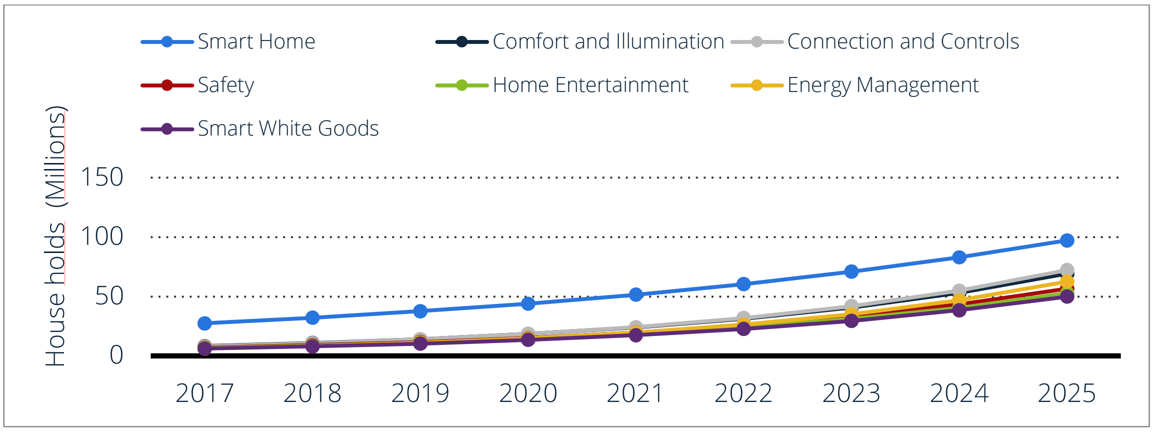

Figure 13 Forecast of the number of smart homes in Europe[9]

[9] Statista ID 801572

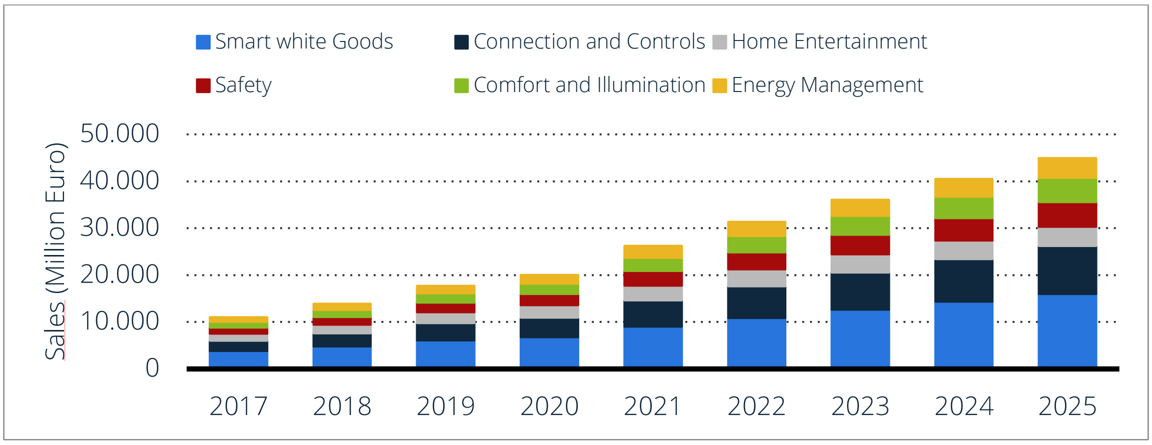

Figure 14 Forecast of sales[10]

3.5.9 How can the commitment of the parties involved be proven?

All partners involved are already partners of the ForeSight community. All partners are actively participating on development of numerous use cases in the field of assistance, energy efficiency, safety and predictive maintenance. Nearly all partners are now members of GAIA-X working group Smart Living.

3.5.10 Are sufficient resources available to realize the endeavour according to its mission?

Yes, due to funding of the BMWi.

[10] Statista ID 801527

4 Evolution of the data space

4.1 Roadmap of the evolution

The roadmap (Figure 15) follows the work plan of ForeSight and possibly a domain-specific GAIA-X project currently in the acquisition.

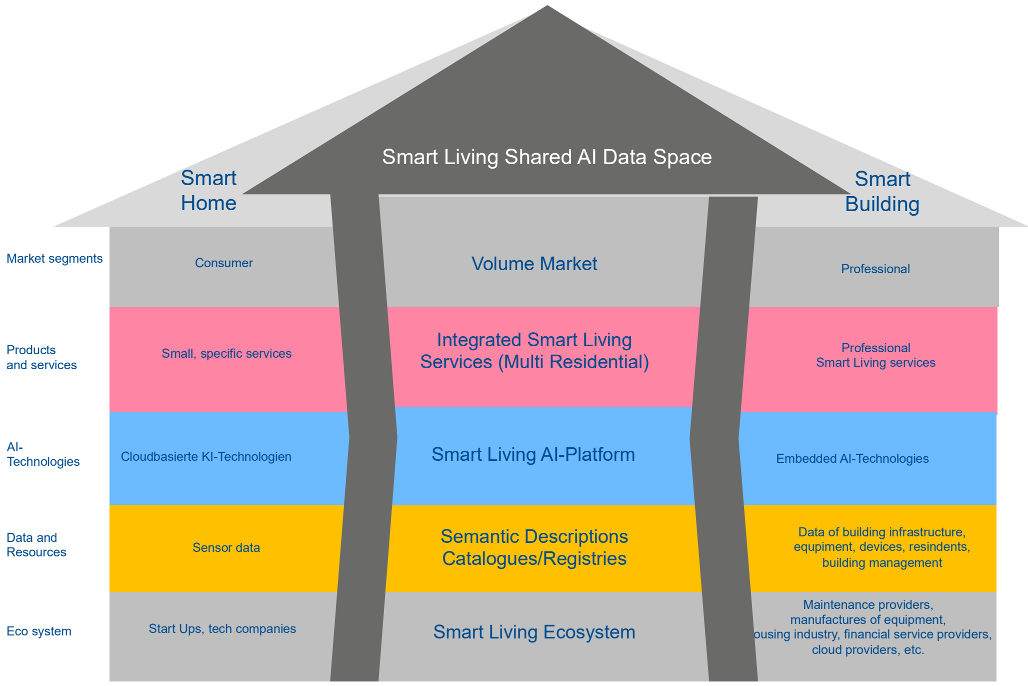

Figure 15 Roadmap towards Smart Living Shared AI Data Space

4.2 Quick-wins (for 2021)

The technology demonstrator is available and ready to be presented. All basic components of our Data Space are ready to run and are used in different use cases and application developments along with the ForeSight workplan. The Data Space is expected to grow during runtime of ForeSight. The concept of associated partners within ForeSight (currently 70 partners) will bring up new service ideas and maybe prototypic implementations for our domain.

4.3 Mid-term benefits (2022-2023) building on already-launched or soon-to-be-launched projects

Following the ongoing development within the context of ForeSight we expect a first integrated prototype of our Smart Living Shared (AI) Data Space at the end of 2022 contain all basic AI-services, digital twins, test data and connections to iot and manufactures clouds, AI-cloud and a data cloud. We expect useful evaluation of the Kafka streaming platform in the context of Smart Living also.

4.4 Long-term benefits requiring significant investments on the 2021-2025 period

The next step is to realize a prototype of a cross-domain data space based on GAIA-X.

5 Actions to be taken and recommendations for industry, politics and society

The Smart Living domain will definitely take advantage of a future GAIA-X infrastructure. Due to the heterogeneous character of our domain many different and up to now separated edge and cloud solutions must work together seamlessly for innovative interoperable (AI-based) applications and services. Existing cloud spaces and interfaces are using W3C standards. We recommend that GAIA-X respects and strengthens these standards and possibly participates actively at W3C. We also recommend developing GAIA-X in a way that enables service developers to more or less easily setup cross domain, maybe AI-based applications that are using many different data sources. We support the driving vision of more data sovereignty.

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