i4Trust

DTaaS4aero

the CNS (Communications, Navigation
and Surveillance) aeronautical Digital Twin

Aviation, Aeronautical communications

DTaaS4aero: the CNS (Communications, Navigation and Surveillance) aeronautical Digital Twin.

DTaaS4aero is the CNS specific Digital Twin platform that tackles the issue of knowing the real performance of CNS equipment. DTaaS4aero is able to collect, validate and disseminate performance information across the industry, providing simulation and predictive tools as well as a 3D real-like environment for training and testing.

With the contribution of:

ATTICCA REALITIES

LA ISLA INGENIERÍA Y SISTEMAS

WAPPY DREAMS FACTORY

AWR TECHNICS

FAUBOURG NUMERIQUE

AVIATION MANAGEMENT SYSTEMS

OBIZCO

Challenge & Context

Do we really know the real aeronautical communication systems performance?
And, can we really optimise it?

CNS systems (Communication, Navigation and Surveillance), are a pillar of Air Navigation Services infrastructure. CNS performance highly influences air navigation services capacity and safety.

The aeronautical industry faces a growing pressure to increase its efficiency and reduce its overall costs. In particular, aeronautical infrastructures suffer from a low efficiency in their life cycle due to missing feedback and communication between the different parties.

One piece of equipment can be manufactured by a company, then included onto a more complex system by another engineering company, then installed and integrated into the actual infrastructure by another contractor, and then operated and maintained either by the contractor or by the final user or client. All these different parties operate

their business receiving little, if not at all, structured feedback about the performance of their systems and equipment. In most cases, only a verbal feedback between the people involved is the most a company can expect, and only when an actual failure is produced and the guarantee is requested to intervene.

In this way, it is difficult for companies to really improve their services, equipment performance, and engineering processes, as well as foreseeing possible issues based on real performance based on predictive maintenance, rather than preventive or corrective maintenance.

This information fragmentation also prevents the possibility of a wider sharing and valorization of data and knowledge, for instance through other third parties like a specialised consultancy.

DTaaS4aero faces the need to produce, validate and disseminate real operational, contextualised and standardised CNS system performance data to the benefit of the ANS Community (institutions, ANSPs, manufacturers).

Solution

DTaaS4aero is a CNS Digital Twin platform able to collect, validate and disseminate performance information across the industry, providing simulation and predictive tools as well as a 3D real-like environment for training and testing.

During the last 9 months, DTaaS4aero has created an i4Trust-powered digital twin of an Aeronautical voice RADIO equipment JOTRON 910 (AM 25kHz / 8.33 kHz) which not only provides reliable near-real time data about its Integrity, Availability and Continuity but also provides predictive future values for the same Integrity, Availability and Continuity KPI's, delivering an invaluable alert-tool for companies to take advanced actions affecting the whole life cycle of the product and related services.

In the project, 7 partners from 3 different countries have collaborated together in order to achieve the goals and milestones set:

- La Isla Ingeniería y Sistemas, Spain, as leader and communications engineering expert;
- Faubourg Númerique, France, as DIH;
- Attica Realities, Spain, as technical coordinator with digital twins and simulation expertise;
- AWR Technics, Tunisia, as communications and maintenance expert and developer;
- Wappy Dreams Factory, Spain, as software developer expert;
- Obizco, Luxembourg, as aviation consulting expert; and
- Aviation Management Systems, Spain, as equipment supplier and aviation industry expert.

AWR uses equipment from different suppliers like AMS. AWR needs to have an accurate calculation of the life cycle of its installations in order to provide its clients (mostly Air Navigation Service Providers) with the most competitive proposal but also guaranteeing a long lasting and reliable system. The maintenance of the system is also provided by AWR, and so improving service and reducing failures is key to keep costs and risks down. Monitoring actual KPI's is key to their business and for the safety of navigation ecosystems.

LA ISLA is building aggregated data and engineering algorithms to establish the relation between operational data of the equipment and its operational KPI's, establishing the real performance of the equipment, allowing for early actions that will save time and costs compared to traditional reactive actions upon failures.

In complement of the maintenance services, LA ISLA enhances its Digital Twin approach by offering a 3D representation of the equipment with simulation capabilities to facilitate:

● a better supervision of the system,
● a realistic environment to learn about simulated behaviors,
● modern training multiuser environment, leveraging knowledge bases built from real implementations.

AWR delivers the data about the radio equipment that will be consumed by LA ISLA. LA ISLA provides the aggregated data services to all interested parties. In this particular case, AMS consumes data and information about the KPIs of their sold equipment from the data aggregation services provided by LA ISLA through its Digital Twin as a Service concept.

How it works

The following figure depicts the high level architecture associated with the DTaaS4aero use case, where there are 2 core interaction between 3 independent systems:

● Interaction 1: the data related to the RADIO Comms Equipment IoT system, held by AWR delivered in the form of temporal values of the observed parameters; consumed by La Isla System as input dataset for its services (integrated to "Digital Twin as a Service" concept).

● Interaction 2: the aggregated and processed data generated by LA ISLA, delivered in the form of KPIs, consumed by AMR as input of its maintenance management system. Both Obizco and AMS are consuming the aggregated data generated by LA ISLA to improve their respective businesses.
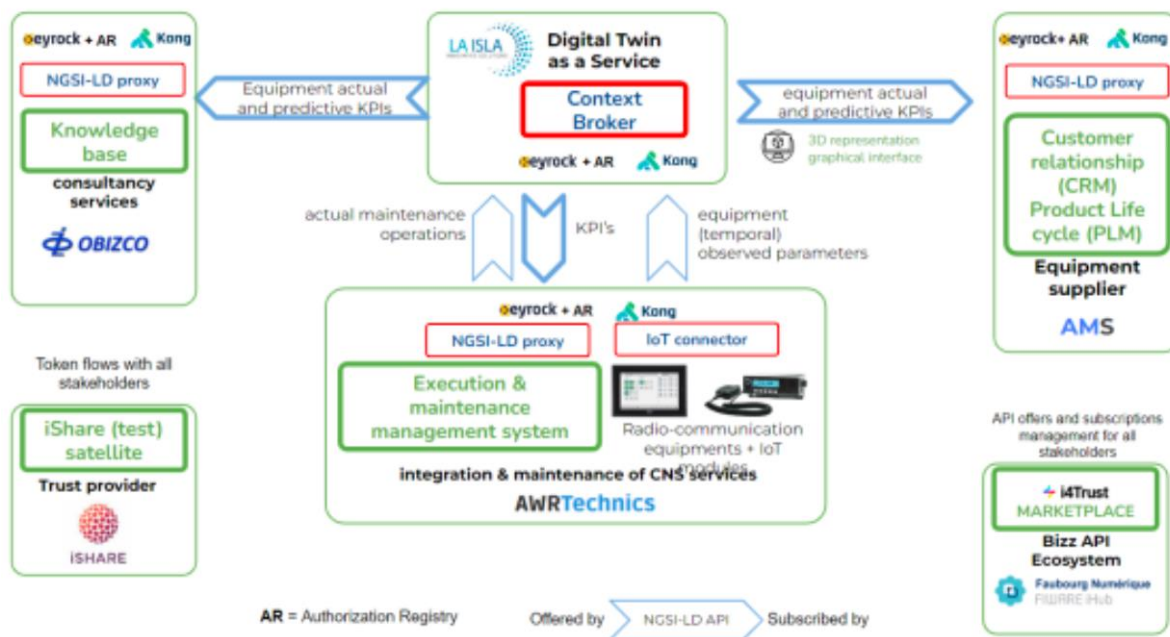
i4Trust-components-based architecture

LA ISLA runs the **Data Space Connector**, which includes an operating instance of the Orion-LD Context Broker. AWR, AMS and OBIZCO connect to the Context Broker via specific instances of NGSI-LD proxy and access control managed through iShare tokens (trusted via iShare TEST satellite), PEP/PDP Kong, IDM Keyrock and its dedicated Authorization Registry. In the case of AWR, an IoT Agent is part of the software installed where IoT-A and Supervisory System are part of the RADIO deployment.

Data collection:

AWR has installed the IoT-A and the IoT supervisory system as part of the RADIO Equipment to be able to collect the RADIO operational parameters. The IoT-SS sends observed data to the IoT Agent. The IoT Agent then translates the received values into NGSI-LD and then updates the values according to the metrics and data model of the RADIO Digital Twin.

The operating RADIO attributes are updated to the Context Broker installed in LA ISLA. The attributes of the RADIO are sent as a notification based on a subscription on any measurement updates to the Context Broker of LA ISLA. The datasets related to the parameters observations (temporal properties) of the Radio Equipment is transferred to the ML-processing services in a data flow managed through a specific combination of Draco - Apache Nifi processors.

Marketplace implementation:

All the data exchanged from one system to another are managed through APIs. The access to the APIs are controlled by PBAC rules and pricing rules (possible frees) are defined on the i4Trust Marketplace.

All industrial partners SMEs hold their iShare (TEST) certificates, and are using the i4Trust

marketplace instance provided by DIH Faubourg Numérique, their own Keyrock instances configured as external IDPs, and own Authorization Registries to manage the related data sharing and exchange and to manage their individual and global Business Models (cost and revenue sharing).

Lessons learnt:

One of the most difficult parts of any data related project is data modelling. Basically, agreeing on something which will be conceptually shared as a "common language", in order to understand and get understood. i4Trust technology is a reflection of that complexity, that once resolved becomes a magic language of efficiency. Thus, designing the right solution with the right models well in advance, becomes one of the most (if not the most) critical parts of achieving an efficient data space.

For addressing this challenge, the DTaaS4aero stakeholders relied on the Smart Data Models global repository as a reference, and on the Data Space participation administration console ouranos-ws to design, visualise and test the possible common data models.

Benefits & Impact

According to LA ISLA's calculations, there are about 180 Air Navigation Service Providers, 50 OEMs, and roughly 68 000 airports around the world, each of them using at least one radio. With the right Go-To-Market strategy and commercial effort, DTaaS4aero has good chances to become a world aeronautical data space success and break data silos in the industry.

We are aware that Equipment Manufacturers (not only of radios but also of other communications systems) and Air Navigation Service Providers (ANSP) are interested in the outcome of this project.

Communication service interruptions hold a series of cascade issues, which are difficult to evaluate. Improving the service of the equipment reverses this vicious-cycle and has the following positive impact on cost, energy consumption and safety:

● Increase aviation Safety.
● Decrease service interruptions.
● Decrease intervention times upon failures.
● Improve the life-cycle management of the equipment.
● Decrease energy consumption levels of each equipment.
● Decrease the number of redundant equipment needed to guarantee the service.
● Decrease the number of corrective maintenance interventions.
● Decrease the number of operational interruptions.

DTaaS4aero is very specific to the aeronautical industry, a niche sector, and so very much apart from any mass consumption type of approach in terms of business market.

Apart from the 3 current users of the digital twin, LA ISLA has recently reached an agreement with a 4th industrial user, a manufacturer of CNS equipment. La Isla is also in advanced conversations with other 4 parties, manufacturers and ANSPs, interested in becoming users.

Having ANSPs (Air Navigation Service Providers), CNS Maintenance Organizations and CNS equipment manufacturers as the key clients of the CNS Digital Twin, the main sources of revenue will be the implementation and subscription to data of CNS systems, expecting at least to have 10 of these major clients in the next 5 years.

Even though providing growth numbers at this stage seems difficult, according to DTaaS4aero sustainability plan, sales could increase around 50% from year 3. Most importantly providing stable flow of cash and sales.

Cross-border approach:

The aeronautical industry is mostly international by essence. Communications equipment is manufactured by a limited number of international companies, which are resold by other local suppliers depending on the geographical region, then integrated and maintained by other international specialised companies, of which the Air Navigation Service Providers (usually public national companies) benefit and operate.

It is expected that DTaaS4aero will help Air Navigation Service Providers and airports from different countries standardise their Safety levels and communications systems KPIs, all by sharing common data spaces and data models.

Added value through i4Trust

- Smart data modelling is a key tool in order to aspire to have a standardisation of CNS systems across the aeronautical industry. This aspect is extremely important in order to draw the attention of international regulation authorities such as the International Civil Aviation Organization (ICAO) and the European Union for Data interoperability, as a key enabler of the emerging data economy. Even though DTaaS4aero implements for the moment generic Smart Data Models, the idea, as shown in the section "Next Steps" is to propose Smart Data Models specific to the industry able to head towardsa real standardisation of the aeronautical industry.
- The integration of the marketplace is an important tool that allows DTaaS4aero to disseminate the data obtained from the digital twin in a much more flexible way.
- i4Trust ecosystem has been able to introduce DtaaS4aero team to a wide number of integrators and users currently working on i4Trust related projects that made for a smoother and wider integration of i4Trust components into the project.

Next steps

DTaaS4aero is currently looking to incorporate interested parties willing to connect their CNS systems into the platform and/or interested in accessing processed data in order to increase its user-base.

After incorporating as much CNS equipment as possible, DTaaS4aero will have to review and come up with general rules for data modelling and categorization of the different types of CNS systems, not only radios but also VCCS, ILS, radars etc. This exercise will allow DTaaS4aero to come up with proposals for Smart Data modelling of CNS equipment that may act as a standardisation proposal of the aeronautical industry. This aspect would be extremely important in order to draw the attention of international regulation authorities such as the International Civil Aviation Organization (ICAO) and the European Union for creating the first Data Space dedicated to the civil aviation sector.

In terms of new functionalities, DTaaS4aero is also planning to use its 3D environment to further develop its training functionalities by populating the environment with all types of CNS equipment.

Another aspect to be considered for the future is to have a Data Space Connector compliant with DSBA recommendations.

DTaaS4aero is ready to start commercialisation of the platform and so it will be actively participating in international events and forums such as ICAO's Air Navigation World in Montreal, August 2023 and SESAR Innovation Days (https://www.sesarju.eu/sesarinnovationdays), Seville 27th to 30Th November 2023. SESAR (Single European Sky ATM Research) is the EU initiative to provide the technological pillar of the Single European Sky.

References

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Categories

User(s):

ANSP (Air Navigation Service Providers), airports, equipment manufacturers, consultants, infrastructure engineers, maintenance engineers, airports, international regulators cush a ICAO and the European Union.

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transportation infrastructure, engineering, communications and control systems, standardisation, cns rationalisation, simulation, performance analysis

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