

MINISTER'S INNOVATION AWARD



Civil Aviation Authority of Singapore

MERIT AWARD

INFORMATION EXPERIMENTATION PLATFORM (iEP)



PROJECT TEAM



Civil Aviation Authority of Singapore

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OVERVIEW

IMPETUS

INNOVATION

IMPACT

POTENTIAL

MINISTER'S INNOVATION AWARD



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IMPETUS FOR PROJECT

CAAS continually enhances its Air Traffic Management (ATM) capabilities by experimenting and trialling new ATM concepts of operations (ConOps) and key technology enablers for these ConOps. This is to maintain safe and efficient operations within a particularly complex and increasingly crowded airspace, as well as Singapore's position as a leader in ATM and a leading Air Navigation Service provider (ANSP). Without its own platform, CAAS typically relied on external vendors' platforms for these experimentation and trialling of ConOps and data analytics, limiting the amount of autonomy and creativity that CAAS can exercise in its research and development (R&D) as collaborations are separately housed. In particular, CAAS faced the following challenges:

1. Slow and manual experimentation setup, often requiring massive engineering involvement per experimentation related project
2. Excessive and disproportionate amount of time spent on collating and cleaning data prior to conducting data analytics as there was no single repository for data for experimentation;
3. Inability to independently conduct extensive data analytics studies and analyses, especially for problem statements which are sensitive, strategic, and/or require CAAS' internal data; and
4. Heavy reliance on vendors to test, customise or make modifications to new ConOps in order to meet CAAS' needs, driving up costs and limiting speed and flexibility, especially for experimentation that requires frequent iterations.

Statement of Need:

CAAS typically relied on external vendors' platforms for data analytics and for experimentation and trialling of new ConOps. The heavy reliance on vendors limited the amount of autonomy and creativity that CAAS could exercise in its R&D work and strategic and/or sensitive studies, and caused excessive and disproportionate time to be spent on collating and cleaning data prior to conducting data analytics. The Information Experimentation Platform (iEP) aimed to enable a culture of fast, reliable and scalable experimentation and data studies, empowering users to make data-driven decisions, and perform validation and verification on R&D with confidence.

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INFORMATION EXPERIMENTATION PLATFORM (iEP)

EXTENT OF INNOVATIVENESS

To tackle the challenges above, CAAS envisaged a solution that allows:

1. Experimentation setup to be agile and scalable for multiple use-cases without affecting operations;
2. Data to be cleaned and structured in a manner that allows quick access and re-usability, reducing the time from problem conception to insights generation, and for testing and development of new ATM ConOps using empirical data;
3. Experimentation and data analytics to be vendor and/or user-agnostic on a common platform so that there is oversight of work done on problem statements which are sensitive, strategic, and/or require CAAS' internal data; and
4. More flexibility in adapting ConOps to meet CAAS' needs, and to build technical capabilities of CAAS engineers and data scientists.

With this in mind, CAAS developed the concept of the iEP.

As such, the vision of the iEP is to enable a culture of fast, reliable and scalable experimentation and data studies, empowering users to make data-driven decisions, and perform validation and verification on R&D with confidence.

The iEP aims to allow CAAS to trial and develop new ATM ConOps, perform data analytics and experiment on new functionalities and technology enablers to avoid the limitations on experimentation and costs associated with repeated system modifications when hosted by external vendors by reliance on separate systems from our partners and vendors for various projects. The iEP's approach of combining multiple capabilities into one harmonised platform allows better data flow for big data analytics and more comprehensive experimentation. Bringing together diverse groups (ATCOs, data scientists, engineers, researchers, industry partners) on a single platform enables real-time collaboration and innovation. Gathering aviation data and strategic operations in the iEP positions CAAS to leverage on our various stakeholders for innovation and new ConOps, and build independent research and development capabilities. The iEP is also hosted on the Government Commercial Cloud (GCC) to benefit from cloud technologies, scalability and ease of maintenance.

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Civil Aviation Authority of Singapore

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INFORMATION EXPERIMENTATION PLATFORM (iEP)

EXTENT OF INNOVATIVENESS

Besides the GCC, the iEP also leverages on other secure Whole-of-Government (WOG) central services. To our knowledge, the iEP's system design is unique among aviation agencies.

Innovation Highlights:

The iEP creates cutting-edge capabilities, supporting Singapore's role as a global aviation hub and fostering partnerships with both local and international players for developments in aviation.

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IMPACT AND VALUE-CREATION

Impact/Outcome

Data Processing & Analytics:

- centralising data for experimentation means one subscription can be used to support multiple projects by various parties such as industry partners and RIs.

Experimentation:

- Considering pay-per-use cloud products, costs are also significantly lower than using traditional on-premises set up for such a platform which would require products designed for maximum use (i.e. not easily scalable). Different products are also reused to support various use-cases in the iEP.

Data Extraction & Ingestion:

- By consolidating all the data ingests into one platform, the need to re-implement with different tech stacks across different platforms decreases significantly, further driving the cost down.

Development of new capabilities and competencies

The iEP supports CAAS in developing Singapore as a centre of excellence for ATM to enable a vibrant ecosystem in Singapore by gathering users from CAAS, research institutes, industry players, international ATM entities and other aviation stakeholders to develop, test and validate ATM technologies and solutions for ConOps. Besides providing a test environment for development, integration, testing and trial of various ConOps also contribute to the development of new capabilities for safe and efficient air traffic flows with innovations in air traffic flow management and predictive weather.

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IMPACT AND VALUE-CREATION

By using the iEP to experiment on ATM ConOps, CAAS can test and implement these ConOps as an early adopter, and spearhead the direction of such developments. This common and secure environment for R&D makes the various projects under different institutions easy to track and manage, leading to acting as the sector lead in aviation innovation and allowing development of the next generation of aviation professionals.

Value-creation/Human-centricity

The team recognised that a centralised data repository and a scalable and partner-agnostic infrastructure are key elements required to realise the iEP due to the nature of the various types of projects it was to house. As such, the team developed a scalable platform architecture that leverages on cloud to allow flexibility to bring in new technology as and when required, and focused on advancing the following 3 initial development thrusts:

1. Enabling the development and trial of a system for testing to achieve CAAS' future ATM ConOps;
2. Onboarding a data science platform with a data fusion and processing engine to build advanced data science capabilities for ATM; and
3. Providing a dedicated testing environment for testing as well as quick experimentation of new functionalities before implementing full solutions for operations

The team adopted an agile methodology approach and delivered a minimum viable product (MVP) to allow for rapid iteration and continuous improvement based on user feedback.

The planning for the cloud system's architecture based on the 3 thrusts lay the foundation to better support additional CAAS use-cases planned in the next project phases.

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IMPACT AND VALUE-CREATION

Outcome:

The iEP's optimal blend of its modern collaborative platform with various user groups, digital tools and rich data sources strengthens ATM planning and operations as a strategic capability for Singapore by building up local capability and capacity for data analytics, experimentation, and transitioning developments to operations. Additionally, this enables CAAS to contribute to ATM technologies roadmaps at International Civil Aviation Organization (ICAO) to advance seamless transboundary ATM ConOps.

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INFORMATION EXPERIMENTATION PLATFORM (iEP)

FEASIBILITY AND SCALABILITY

Feasibility

The project is realistically achievable with current and near-future technology and resources. The cloud platform and its tech stack are using existing technology and leverages WOG tools. The team also explores new technologies such as data governance tools and integration between the various data processing tools to further bolster the iEP and its use-cases.

Scalability

Within the organisation, as the iEP leverages on the above data and technology, it supports use-cases across divisions currently, and is planned to expand to more divisions in phases for other use-cases.

The iEP also currently supports use-cases involving the aviation ecosystem partners. In summary, the iEP is one common platform used for:

1. Data Processing & Analytics: Data-driven studies that enhances ATM operations
2. Experimentation: To gain knowledge and demonstrate the usefulness of at new services per year that would be beneficial to CAAS' future ConOps
3. Trial development of ATM ConOps: To support local or regional trials without affecting operational systems
4. Human Capital Development: To provide an environment conducive to the build up of in-house expertise to contribute to the development of software modules/ prototypes for use in future ATM concepts.

Potential of Project:

The iEP symbolises the integration of man machine to create a new way of working. The iEP was designed to expand to support use-cases that were not part of the three development thrusts with a highly scalable and secure architecture. The scalability of the iEP supports and fosters collaborations within CAAS and among ecosystem partners such as airport, industry, research institutes, local partners, etc and other ANSPs. Local and regional trials, experimentation projects, and data analytics study to enhance ATM operations are supported through the iEP.