ANS Architecture Design - Key to Flexibility and Interoperability

2 June 2025

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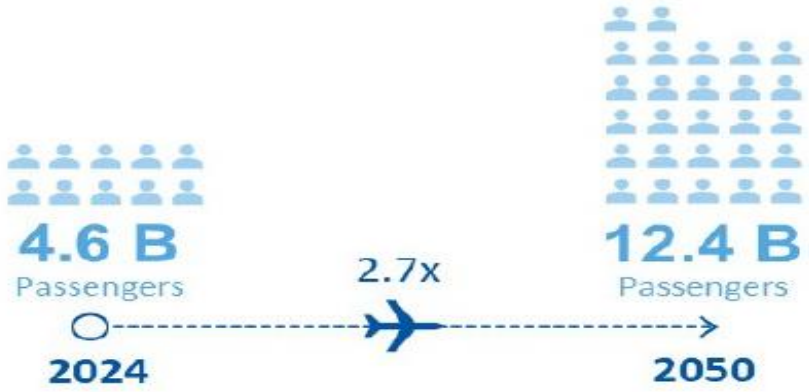
Outline

- Introduction
- Challenges and lessons from Monolithic / Closed System Architecture
- Architecture Design Principles
- Singapore’s Next Generation ANS Systems
- Conclusion

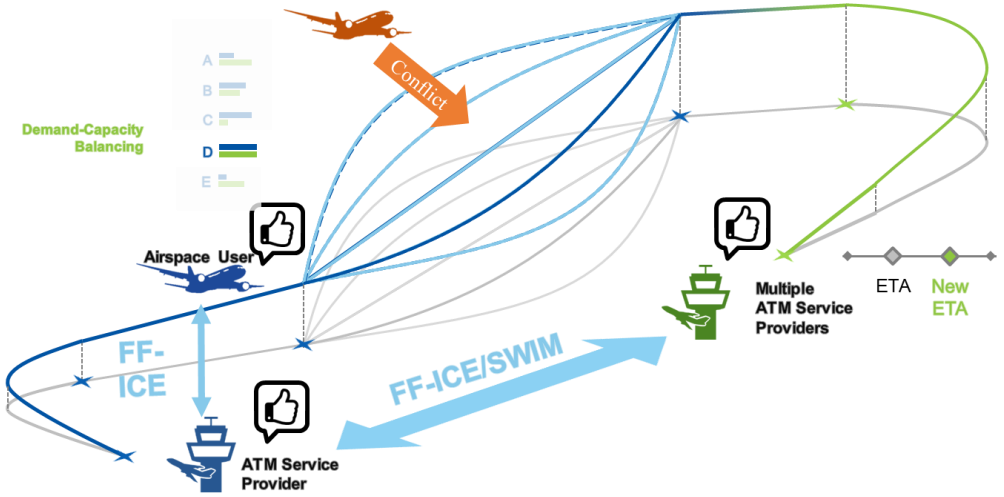
Introduction

- This presentation shares on Architecture Design Principles – a key consideration to support ANSPs in implementing future-ready systems
- The aviation industry is experiencing rapid transformation, driven by increasing air traffic, technological advancements, and evolving operational requirements.
- Given the long planning / implementation cycle and high cost, systems planners face various challenges while planning for the next generation of ANS systems

Challenges faced by Systems Planners



*Taken from ICAO Long Term Strategic Plan for 2026 – 2050.
Actual growth may differ between regions / sub-regions / States



- Growth in air traffic volume: ICAO projects it will double by 2050*
- Advent of new ConOps and new operational requirements
  - Need for system interoperability - FF-ICE and eFPL, Digital NOTAM, and others
  - New approaches to airspace design, route optimisation, free-route airspace and dynamic airspace management

Challenges faced by Systems Planners

- Increase in airspace / operational complexities
  - Proliferation of eVTOLs, Remote-Piloted Aerial Vehicles, High Altitude Vehicles
  - Expected rise in frequency / severity of disruptions due to climate change
- Technological Advancements
  - Fast obsolescence
  - Leveraging on Big Data, Artificial Intelligence, Cloud Technology
- Rise in cybersecurity threats

Lessons from Monolithic / Closed System Architecture

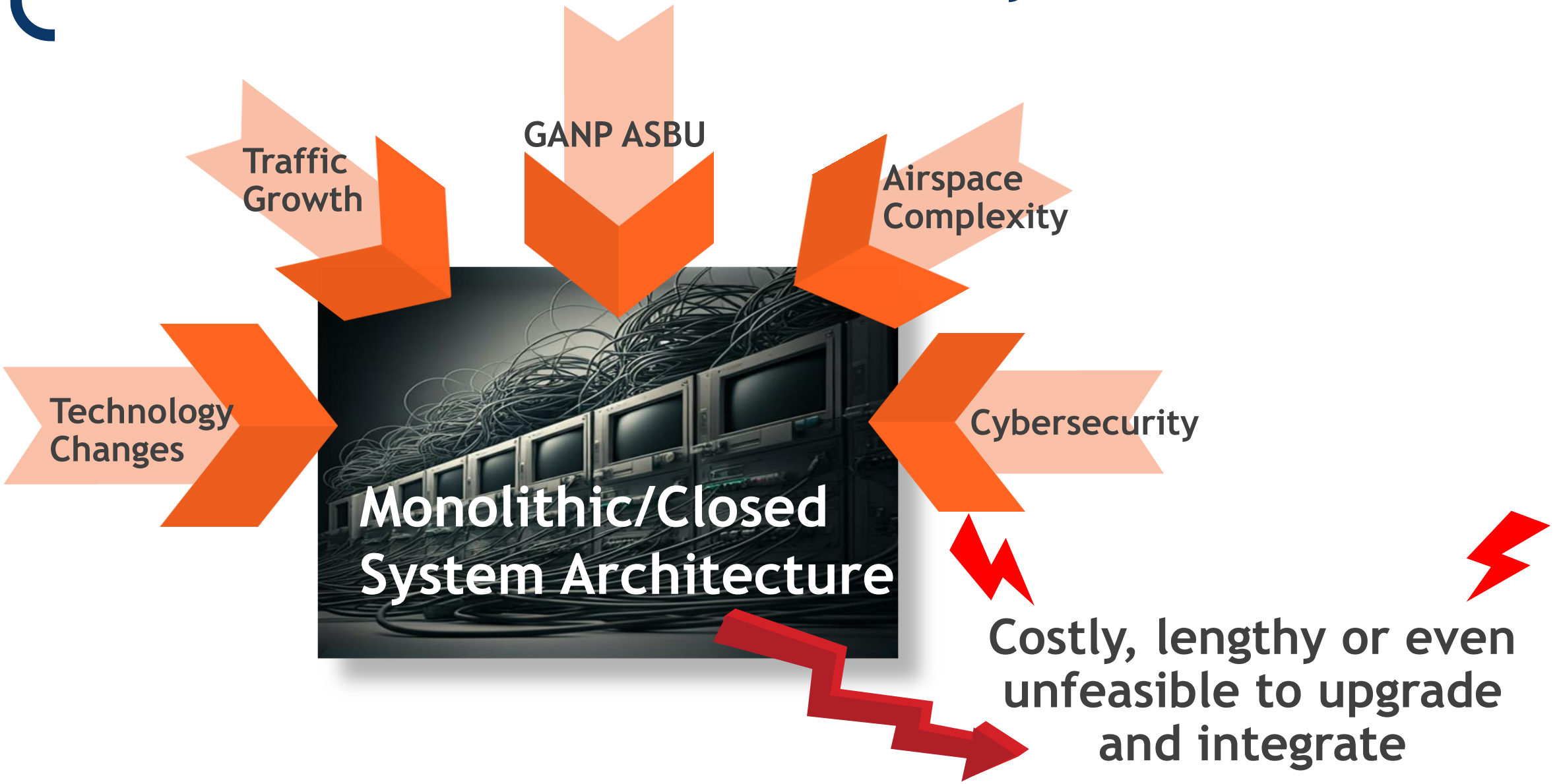


*Image generated by Gemini AI

Requirements for Future ANS Systems

Flexible

Continual improvements including to onboard new capabilities

Amenable

Upgrading to tackle obsolescence and ever-evolving cyberthreats in cost-effective way

Interoperable

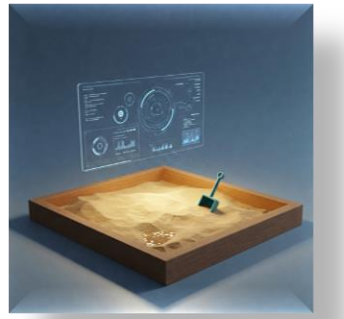
Interoperability between systems to enable seamless ANS ConOps

Four Architecture Design Principles

Modularity

Open Interfaces & Common Data Exchange Standards

Security-by-Design



Continuous Innovation

*Images generated by Gemini AI

Architecture Design Principle 1 - Modularity

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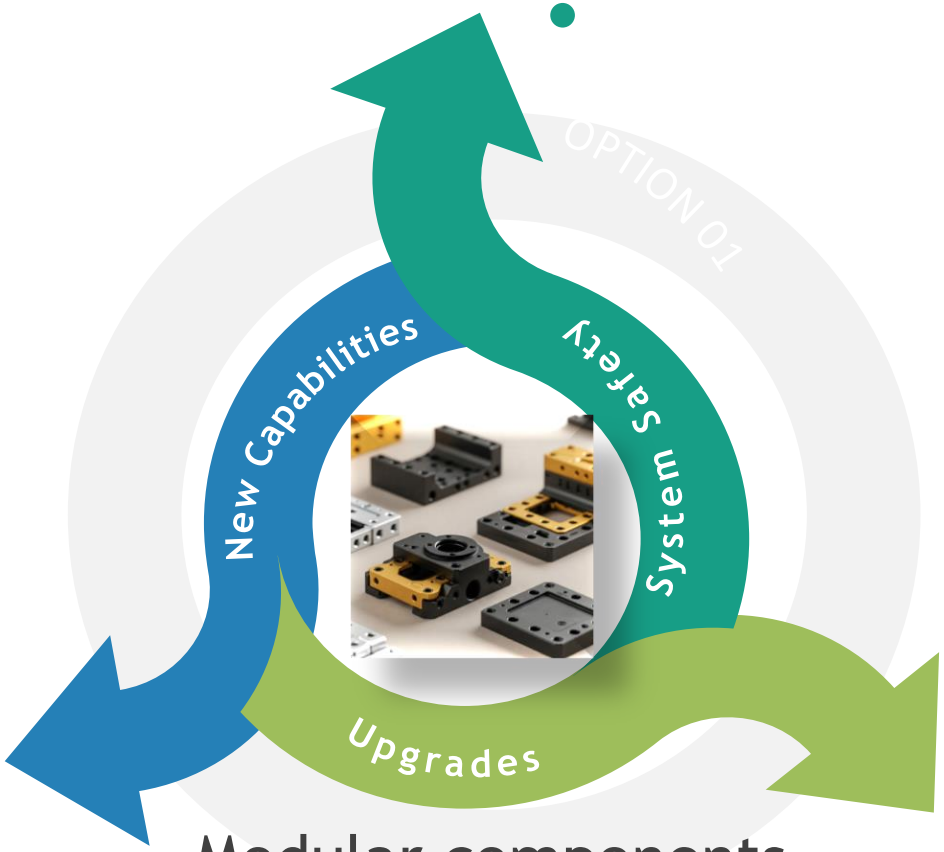
Integrate New Capabilities

Incorporate new technologies and capabilities independently



Increase System Safety

Clear distinction between safety-critical and non-safety critical ANS systems

Ease of Upgrades

Enable updates or fixes without affecting other systems

Modular components that are independent with specific function (low coupling)

Architecture Design Principle 2 - Open Interfaces and Common Data Exchange Standards

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- Use proven solutions and mechanisms for information exchanges
- Enable the integration of diverse technologies
- Reduce integration effort through standardization

Common Data Exchange Standards & Protocols such as AIXM, FIXM, iWXXM, AMQP, REST

Architecture Design Principle 3 – Security-by-Design

Standardized security framework across ANS systems

Ensure consistent policies and procedures at every point of the system's lifecycle, from design to implementation

Establish robust network security perimeter

Reduce the risk of attack propagation via data exchanges

Establish robust network security perimeter

Ready for evolving landscape of cybersecurity threats and increased connectivity

Architecture Design Principle 4 – Continuous Innovation

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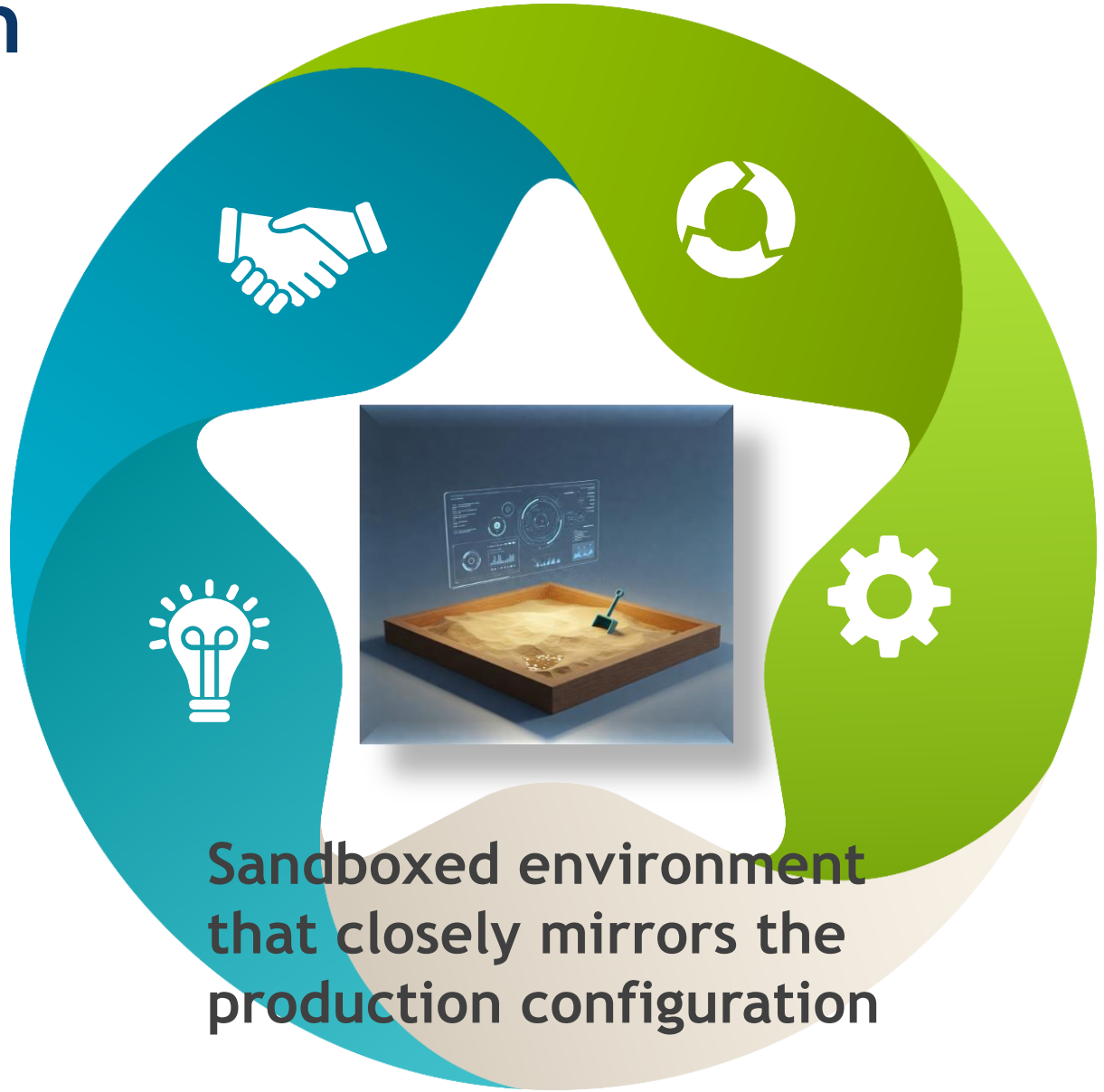
Controlled setting

Flexibility for experimentation that does not impact live operations



Reduce transition risks

Realistic Validation and Verification of systems including integration testing

Data driven approach

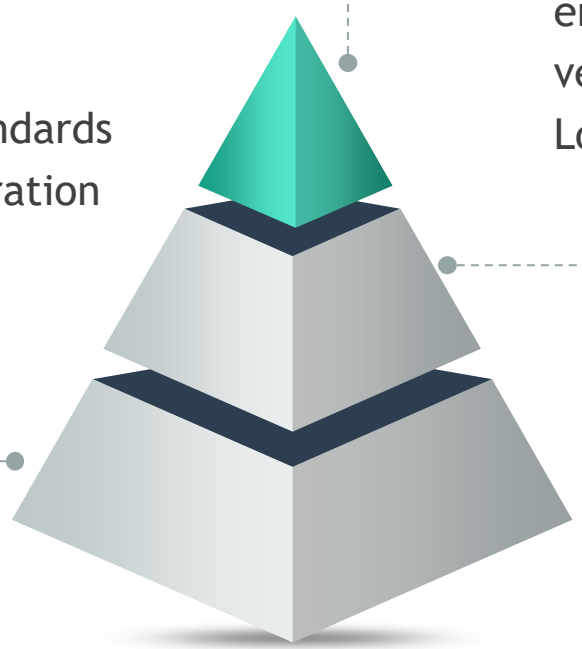
Use data for What-if to drive development of new Conops

Singapore's Next Generation ANS Systems

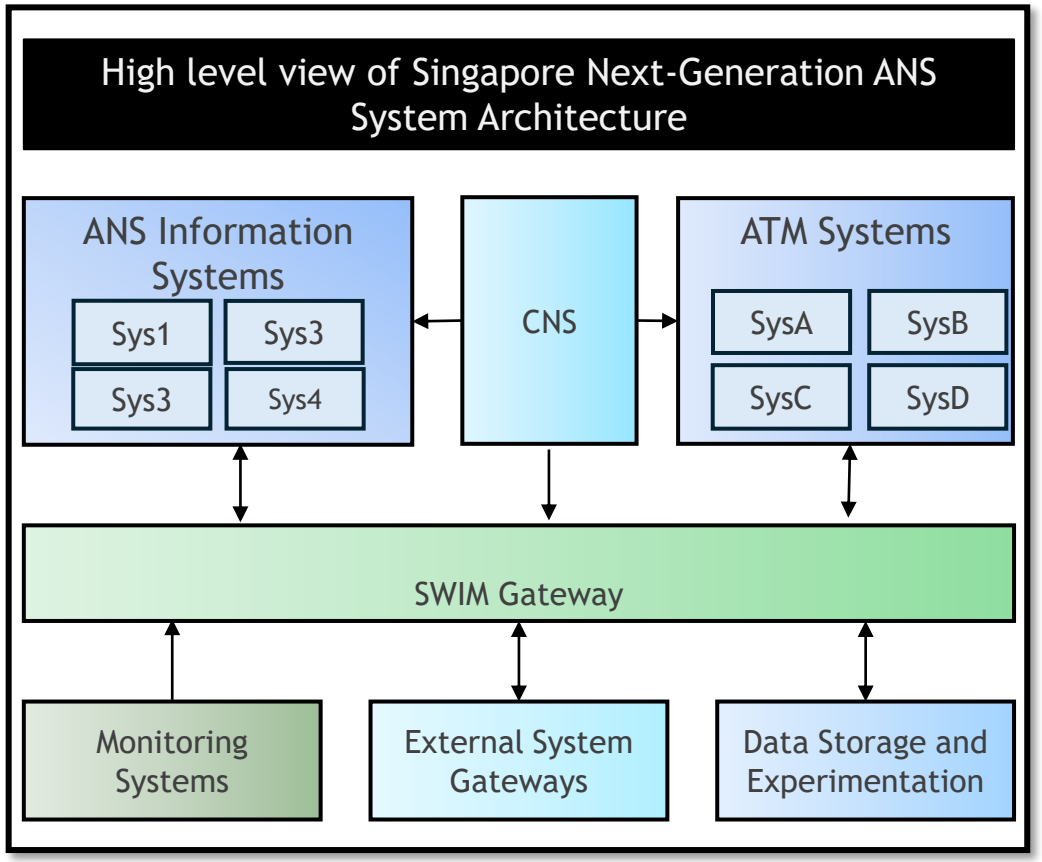
Modularity and interoperability as Open Architecture requirements

Opportunity to engage best-in-class vendors/No Vendor Lock-in

Common data exchange standards to ease integration effort



Flexibility to accommodate add-on modules to address operational needs in a timely manner

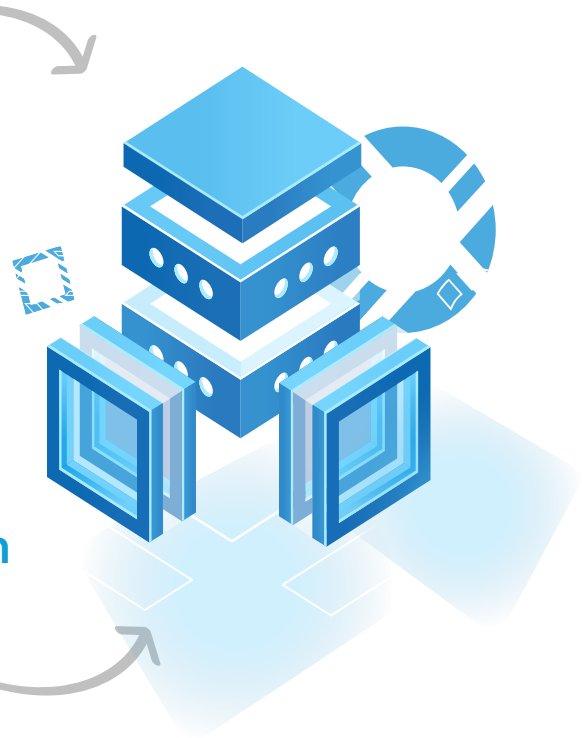


Singapore's Next Generation ANS Systems

Adoption of Security-by-Design and Continuous Innovation Principles

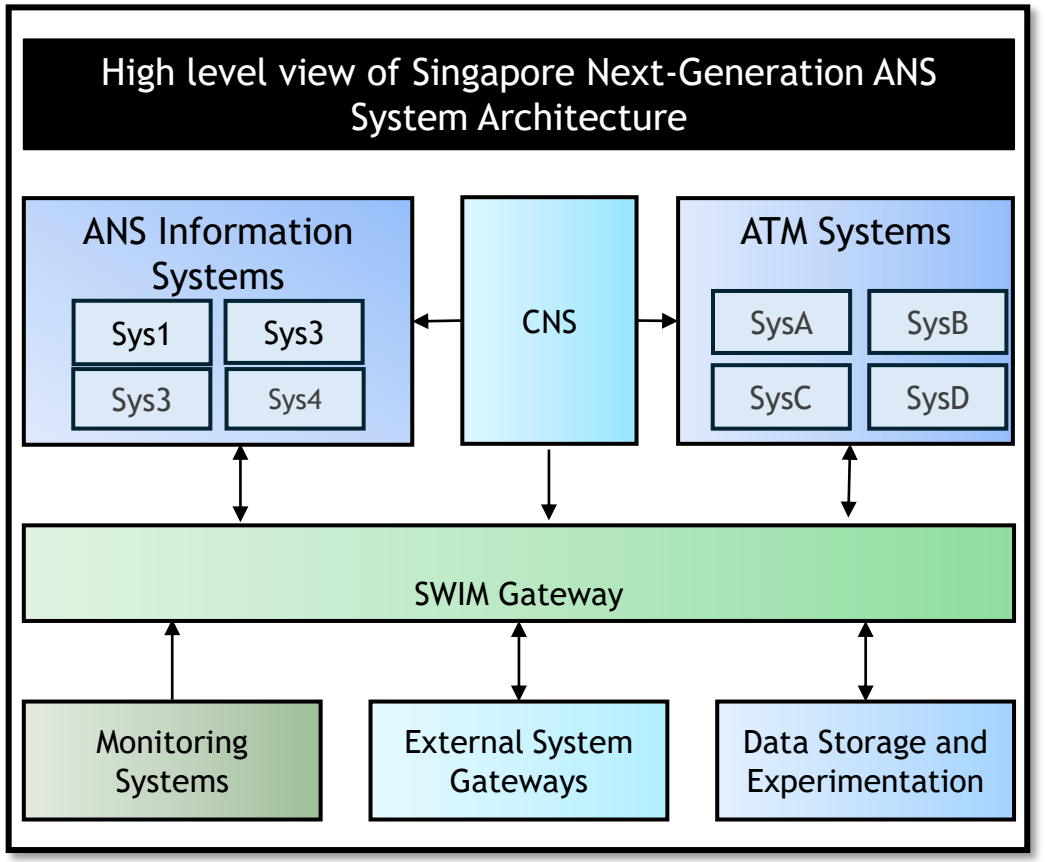
Security-by-Design

Security-in-Depth including integrated monitoring systems



Continuous Innovation

Experimentation platform built on Cloud technology



Journey so far

- Developing coherent architecture to enhance interoperability and resiliency of systems
  - Through better understanding of end-to-end operational processes and data needs
- Improving end-to-end system integration and cybersecurity capability
- Building experimentation capabilities

Many Benefits of Architecture Design Principles

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Long Term
Cost Savings

A robust foundation of
flexible and interoperable
and resilient ANS systems

Ease system integration from different vendors

Minimise vendor lock-in

Ease Upgrading

Facilitate adding new capabilities

Support New Conops

Tackle Obsolescence

Increase Cybersecurity Posture

Support Innovation

Be Future Ready

Conclusion

- Digital transformation is happening
- Consider adopting architecture design principles
- Encourage ANSPs and Industry to share thoughts and plans

Thank you