2026 International Conference on Green Aviation

The Operational Digital Twin Technology for Advanced Air Mobility

Prof. and Director

Jae-Woo Lee



KADA
Konkuk Aerospace Design Airworthiness Institute

- KADA Established 2013.05.02
- KLA-100 Development & Maiden Flight 2017.07.20
- MOE University Research Institute Program Selection 2020.06.01
- KU President-Designated Research Institute 2021.03.01
- Korea's First UAM ConOps Published 2021.06.10
- Phase 1 Evaluation Rated "Excellent" 2023.03.10
- KU-Designated Specialized Research Institute Only in Science & Eng. 2025.07.01



Institute Director

Prof. Jae-Woo Lee

6 Faculty Members
Aerospace, ICT and AI

10 Full-Time Researchers
(including 6 doctoral-level)

59 Master's and Doctoral Student Researchers

Career Highlights

- 1996–Present: Professor, Aerospace & Mobility Engineering, Konkuk University
- 2013–Present: Director, KADA, Konkuk University
- 2022–2024: Dean, Graduate School, Konkuk University
- 1992–1996: Senior Researcher / Systems Integration Team Lead, Agency for Defense Development

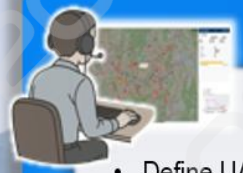
Professional Activities and Service

- Present: Founding President, Korean Society of Space Security
- Present: Chair, Defense AAM Research Group
- Present: AAM Advisor, Korea Aerospace Industries Association
- Present: Steering Committee Member, K-UAM Team Korea, Ministry of Land, Infrastructure and Transport
- 2023–2025: Space Affairs Advisor, Ministry of Foreign Affairs
- 2020: 33rd President, Korean Society for Aeronautical and Space Sciences
- 2020–2022: Policy Advisor, Republic of Korea Air Force
- 2012–2014: Expert Member, Defense Acquisition Program Promotion Committee, Ministry of National Defense

Major Awards

- Ministerial Commendation, Ministry of Land, Transport and Maritime Affairs (2009)
- KSAS Academic Award (2024)
- Konkuk University Research Awards (2001, 2009, 2014, 2015)

Digital Twin and AI Applications Research



UAM Operation

- Define UAM ConOps and operating procedures
- Integrated airspace, route and infrastructure simulation
- Assess UATM, noise and emissions impacts

AI-based Autonomy



- AI autonomy, path planning and collision avoidance
- Automated UAM decisions and scheduling
- Reinforcement learning for crewed–uncrewed teaming and mission planning



Flight Simulation and Control

- Flight simulation for fixed-wing, multirotor and eVTOL aircraft
- Multimode UAM scenarios and control logic validation
- Data-driven modeling for optimal and robust flight control

AAM Operational Digital Twin



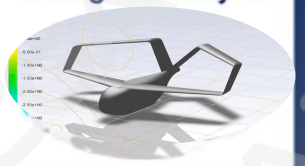
- Digital twin environments for AAM operations
- Integrated flight, ground and ATC procedures: performance and safety verification
- AI flight autonomy and operator decision support
- Predictive monitoring and risk response

Aerospace Design and Analysis

Aerospace Design



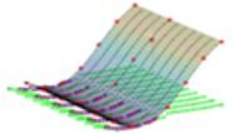
Design & Analysis



Design Optimization



Surrogate Modeling and Data Fusion



Advanced Air Mobility Ecosystem



Airspace & Environment

Airspace and routes
Weather conditions
Terrain and obstacles

Flight Operations

Traffic coordination
Fleet operations
Flight planning

Ground Infrastructure

Vertiports
Charging facilities
Ground transport access

AAM Aircraft

Airframe and propulsion
Energy systems
Sensors and flight control

Digital Twin Concept

A digital twin is a virtual representation of a physical system, updated using data from its physical counterpart. It supports monitoring, simulation, and predictive analysis



Multi-Scale Digital Twin Framework

Our framework spans four modeling scales
: individual components, vehicle systems, complete aircraft, and AAM operations



AAM Digital Twin Development and Applications

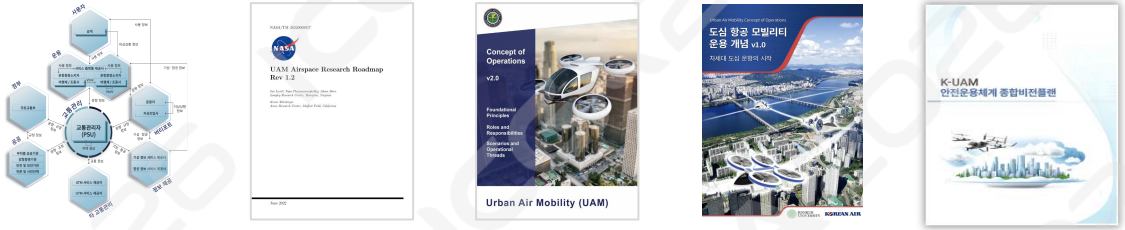
Our approach combines operational analysis, engineering modeling, digital implementation, and physical–digital twinning to support AI-based situation awareness, prediction, and planning



Step 01	Step 02	Step 03	Step 04	Step 05
Operational Concept Analysis	Engineering Modeling	Digital Implementation	Physical–Digital Twinning	AI Applications
Define operational scenarios and requirements	Model physical behavior and system interactions	Implement engineering models in a digital environment	Connect physical and digital systems through P2D and D2P	Support situation awareness, prediction, and planning

[1] Operational Concept Analysis

ConOps and Requirements Analysis



Operational Concept Documents and Prior Studies

- Mission Objectives
- Stakeholders and Roles
- Normal Operating Procedures
- Off-Nominal Scenarios

Digital Twin Scope and Requirements

Digital Twin Information Requirements



Modeling Aspect	What to Model
Entities & Roles	Aircraft, operators, vertiports, infrastructure, and their roles
States & Properties	Position, velocity, attitude, energy, environmental conditions, and resource availability
Operational Procedures	Mission phases, action sequences, transition conditions, and off-nominal responses
System Interactions	Requests, approvals, status reports, and information exchanges
Rules & Constraints	Airspace restrictions, resource limits, operating priorities, and timing constraints

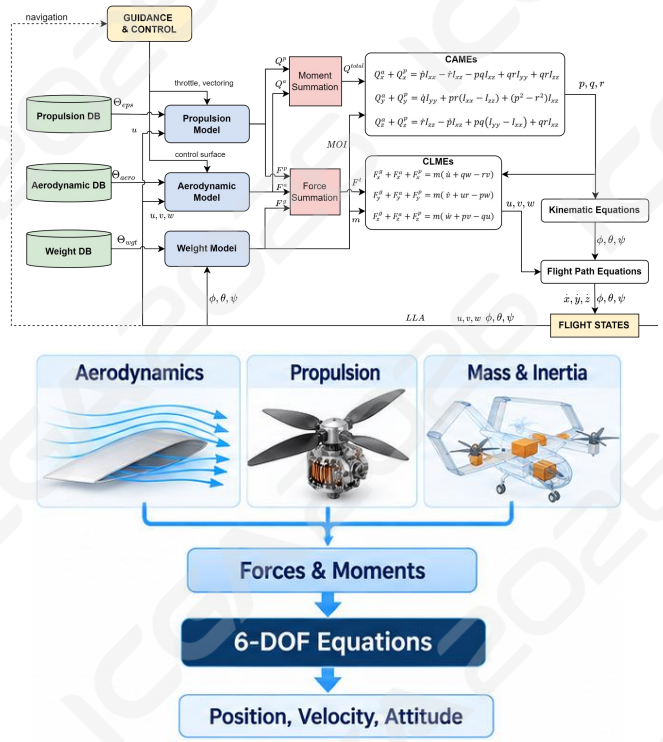


[2] Engineering Modeling

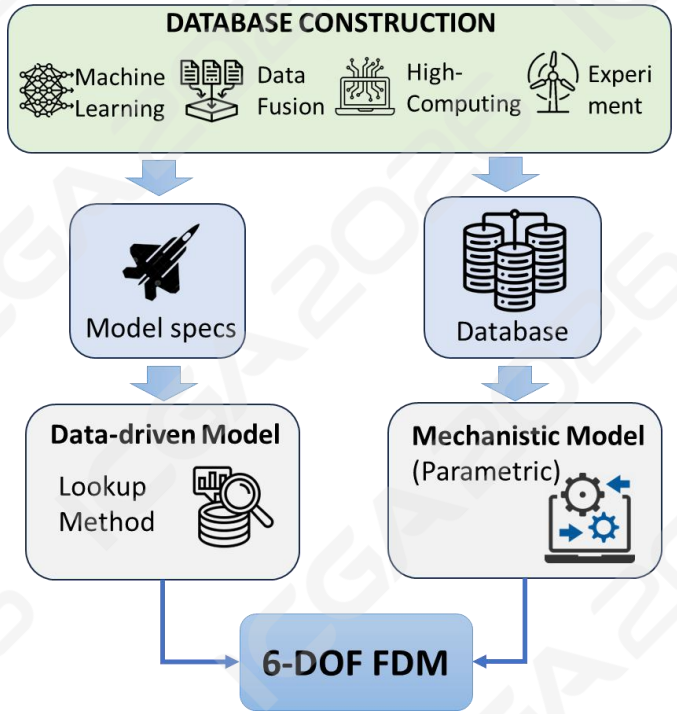
Engineering modeling represents system behavior and interactions using mathematical and logical models

Example: High-Fidelity Aircraft Modeling — *Konkuk Flight Dynamic Simulation*

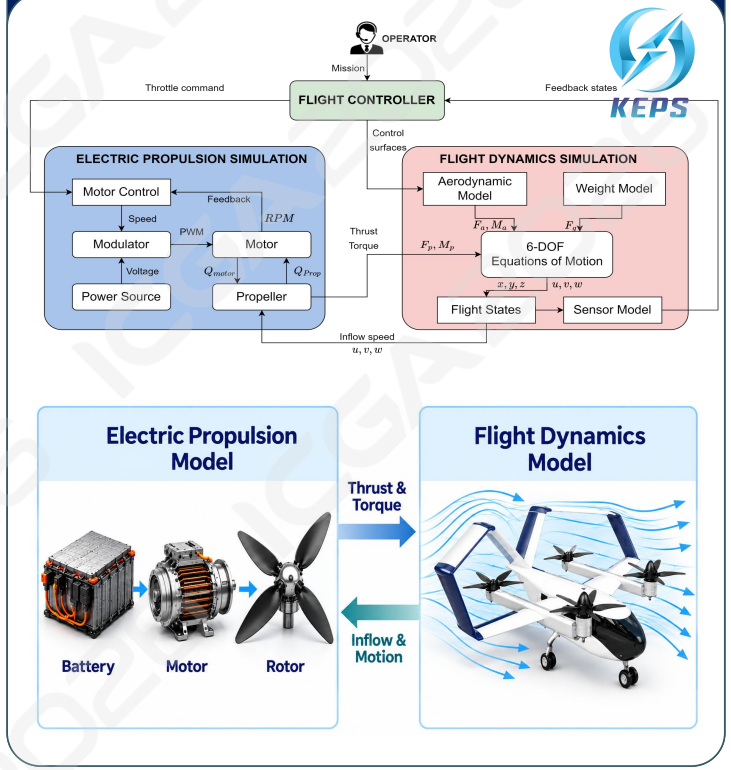
6-DOF Flight Dynamics



Hybrid Modeling

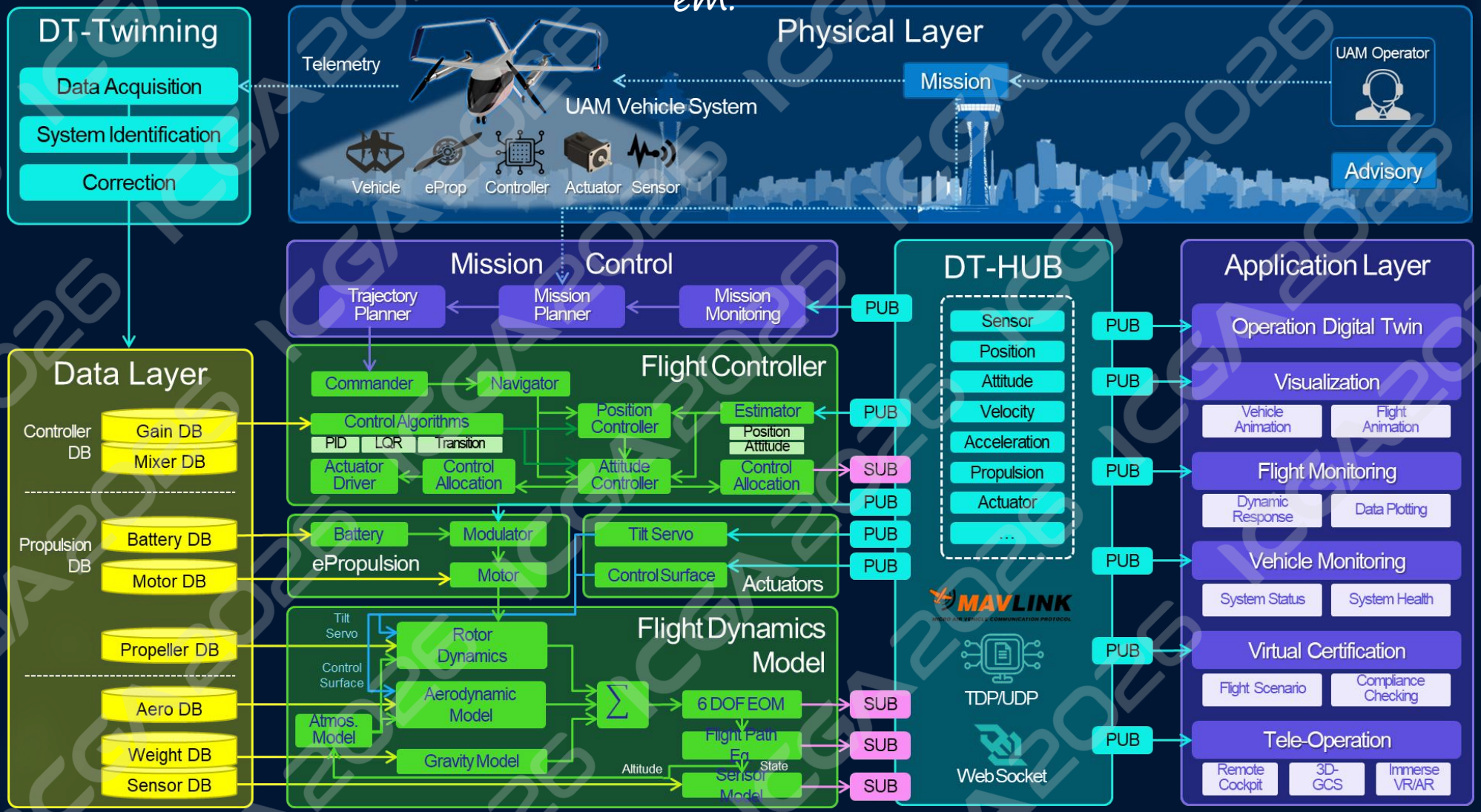


Multi-physics Co-sim



[3] Model Implementation & Integration

Implement engineering models as software and integrate them into an executable simulation system.



[4] Physical–Digital Twinning

Physical measurements synchronize digital states and improve model fidelity.
Reviewed decisions return to physical operations.

Physical Layer



KP-2C flight-test platform

Physical to Digital

P2D

Measured states and system data

Digital to Physical

D2P

Reviewed commands and plans

Digital Layer



KP-2A high-fidelity digital model

State Synchronization

Align time and reference frames
Update the current digital state

Model Updating

Compare measured and model responses
Calibrate model parameters

Digital Model Environment

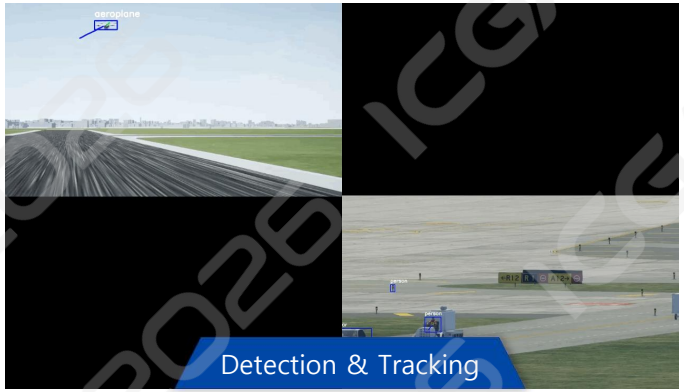
KFDS KEPS VIAERO DTHUB

Aircraft physics, visualization and data

[5] AI Applications for AAM Operations

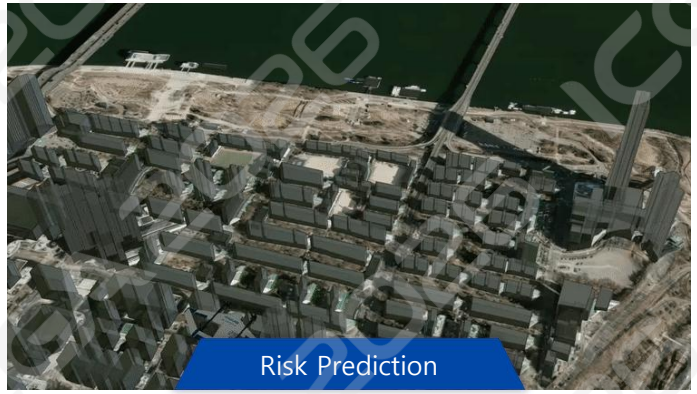
AI supports situation awareness during twinning, predicts future states, and replans operations as conditions change.

Situation Awareness





Prediction





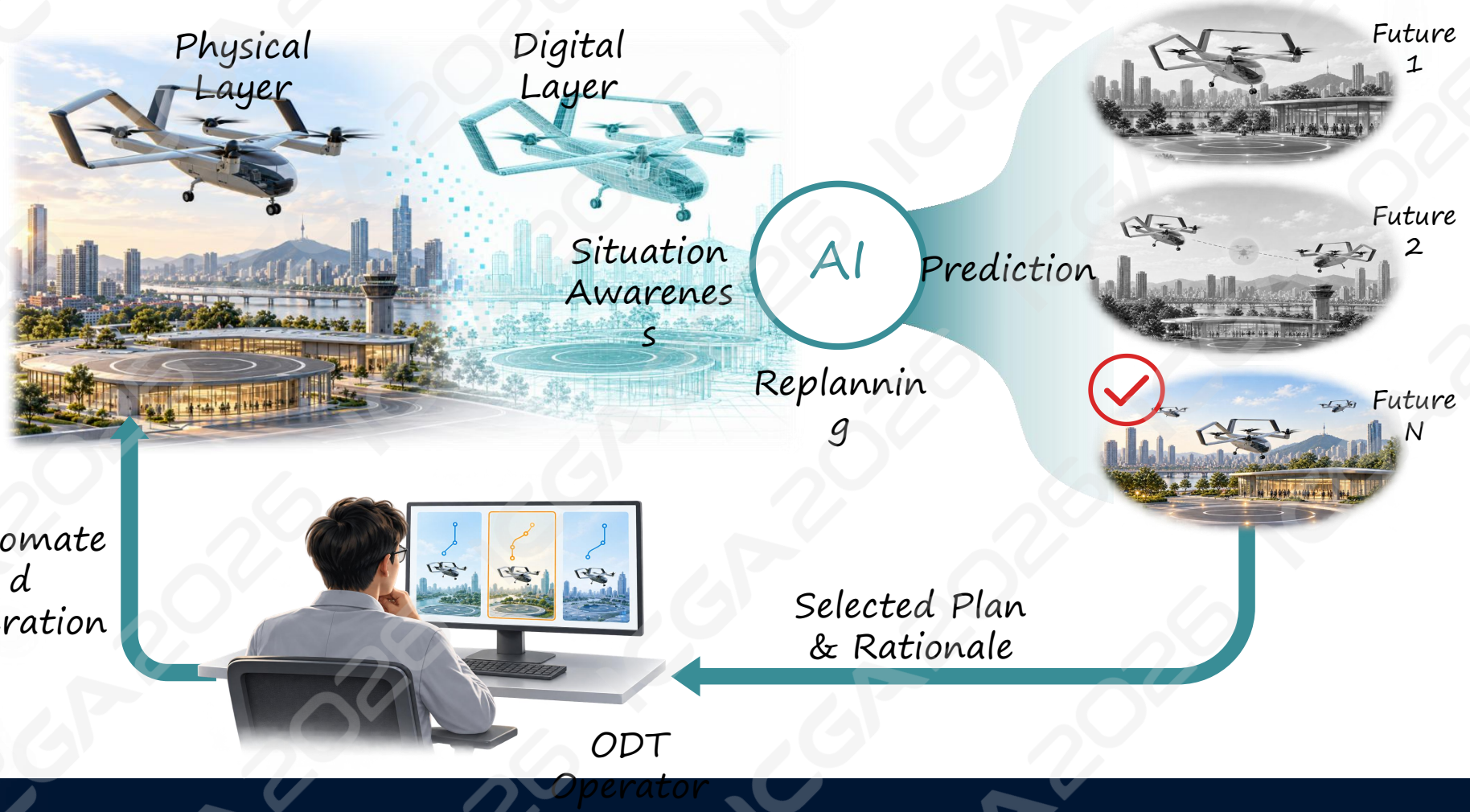
Planning/Replanning





ODT-Enabled Closed-Loop AAM Operations

The operational digital twin connects physical–digital synchronization, situation awareness, prediction and replanning, with operator-reviewed plans fed back into physical operations



Why an Operational Digital Twin?

Continuous synchronization connects system-wide understanding with coordinated action

Standalone Simulation



Tests scenarios and alternatives
No required live operational link

Fragmented Operations



Separate data and local decisions
Limited cross-system context

Operational Digital Twin

Aircraft, infrastructure, airspace and stakeholders



AI and Simulation

Situation awareness → Prediction → Planning / Replanning

Shared data and compute for timely decisions

Demo – 1 : High Fidelity Vehicle Digital Twin

AAM DIGITAL TWIN

From Aircraft Physics to Virtual Validation



ICGA2026

Demo - 2

Automated Operation — Collision Avoidance



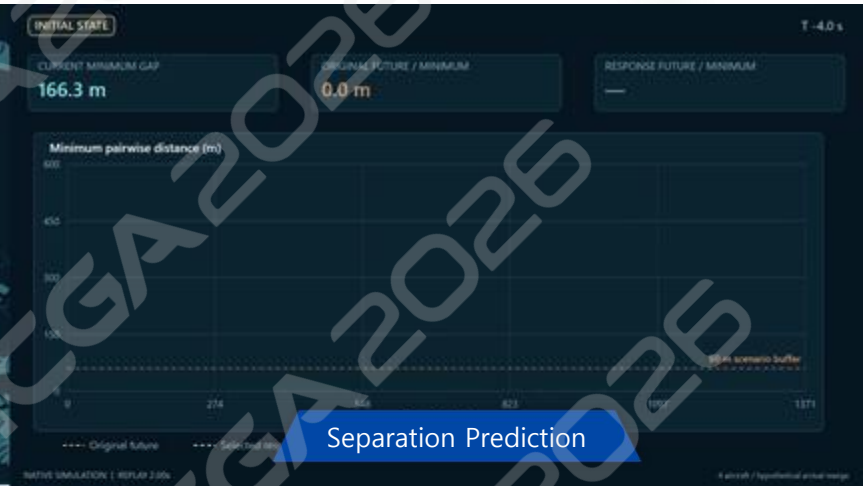


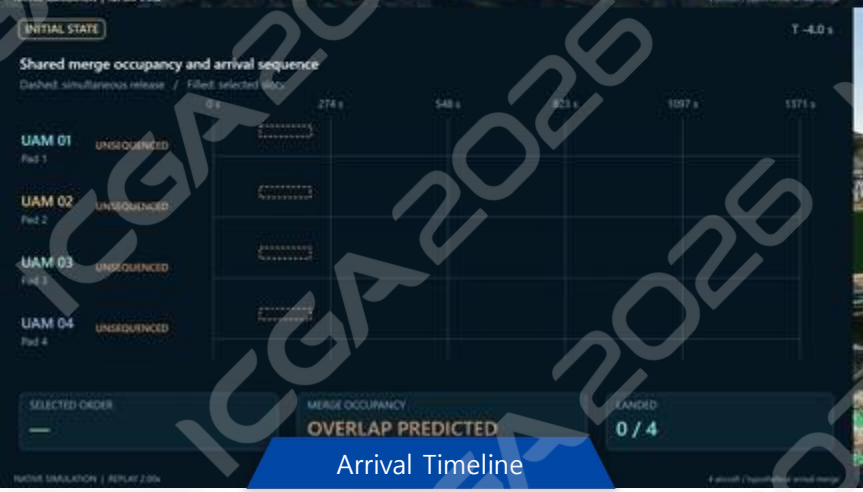
Demo - 3

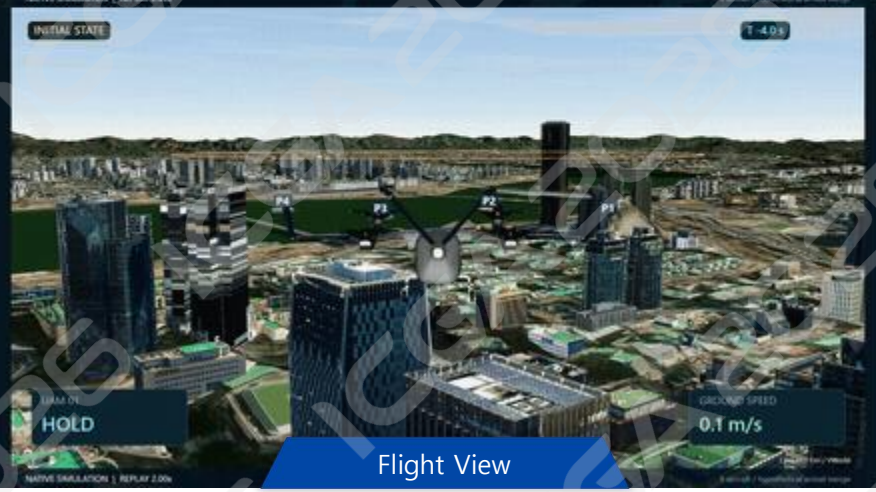
Automated Operation — Traffic Coordination





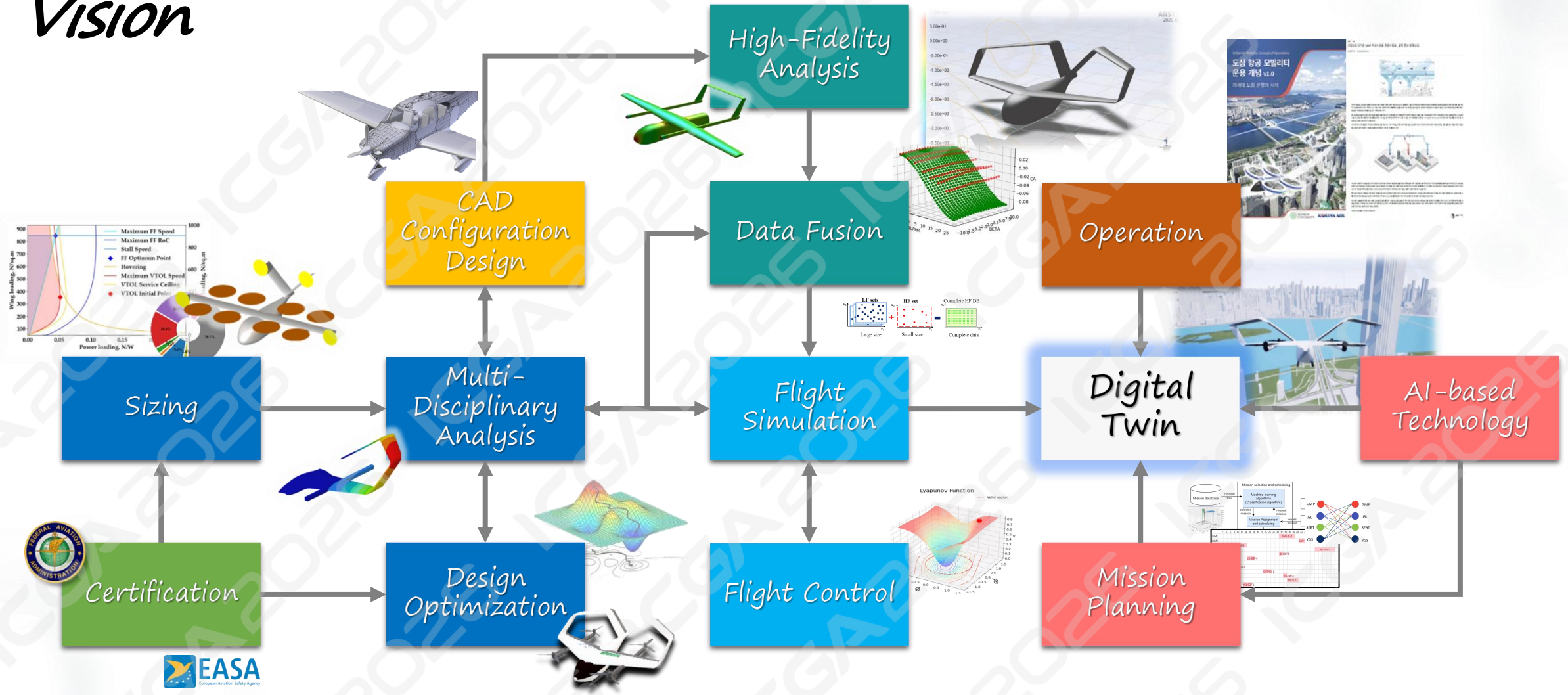








Vision



Toward Safe, Efficient and Automated AAM Operations


감 사 합 니 다
Thank You
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