Building Aviation Connectivity in Indonesia

Research and Development Activities in Aerospace Design, Air Transport Engineering and Operations

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Aula Barat ITB, 12 November 2015

"…to better serve you design a solution for your operation and maintenance"

Presentation Outline

1. A Brief Introduction to Department of Aeronautics and Astronautics, Institute Teknologi Bandung
2. Building Aviation Connectivity in Indonesia
3. AE Research and Development Activities

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A Brief Introduction to

DEPT. OF AERONAUTICS AND ASTRONAUTICS, INSTITUT TEKNOLOGI BANDUNG

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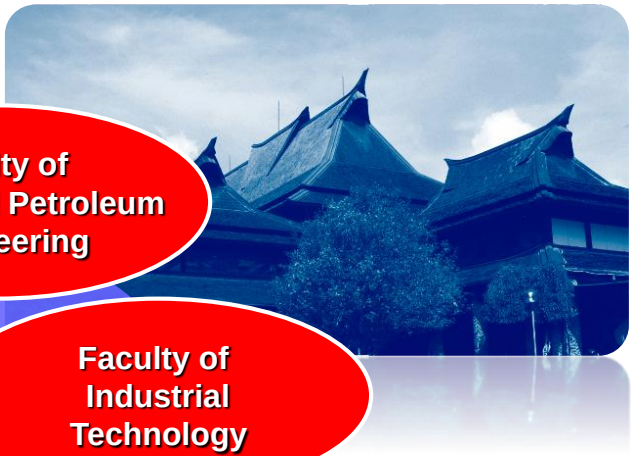
Institut Teknologi Bandung



Faculties and Schools

- Faculty of Civil and Environmental Engineering
- Faculty of Mining and Petroleum Engineering
- Faculty of Industrial Technology
- Faculty of Math and Natural Sciences
- School of Life Sciences and Technology
- School of Pharmacy
- School of Business and Management
- Faculty of Art and Design
- School of Architecture, Planning And policy Development
- Faculty of Earth Sciences and Technology
- School of Electrical Engineering and Informatics
- Faculty of Mechanical and Aerospace Engineering

Faculty of Mechanical and Aerospace Engineering

Number of Faculty	
Total	84
Professors	12
Assoc. Professors	18
Assist. Professors	54
Research Divisions	
Mechanical Design	12
Energy Conversion	21
Mechanical Manufacturing Engineering	9
Material Science and Engineering	13
Flight Physics	**12**
Light-weight Structures and Materials	**9**
Aircraft Design, Operations and Maintenance	**8**

Department of Aeronautics and Astronautics

Established in 1962

2 Main Streams in Study Programs:
- ✓ Aeronautical Product Design
- ✓ Aviation Engineering (Operations and Maintenance)

❑ Degree Programs
- ➢ Bachelor in Engineering
- ➢ Master in Engineering
- ➢ Doctoral Degree

❑ Non Degree Programs
- ➢ Credit Earning Activity (Polman, LAPAN)
- ➢ Training in Airport System (BPSDM)

❑ Research Collaborations
- ➢ Agency for the Assessment and Application of Technology (BPPT)
- ➢ National Aeronautics and Space Institute (LAPAN)
- ➢ Research and Development Institute, Ministry of Defense
- ➢ Research and Development Institute, Ministry of Transportation
- ➢ PT. Regio Aviasi Industri (RAI)

Some Notes on

BUILDING AVIATION CONNECTIVITY IN INDONESIA

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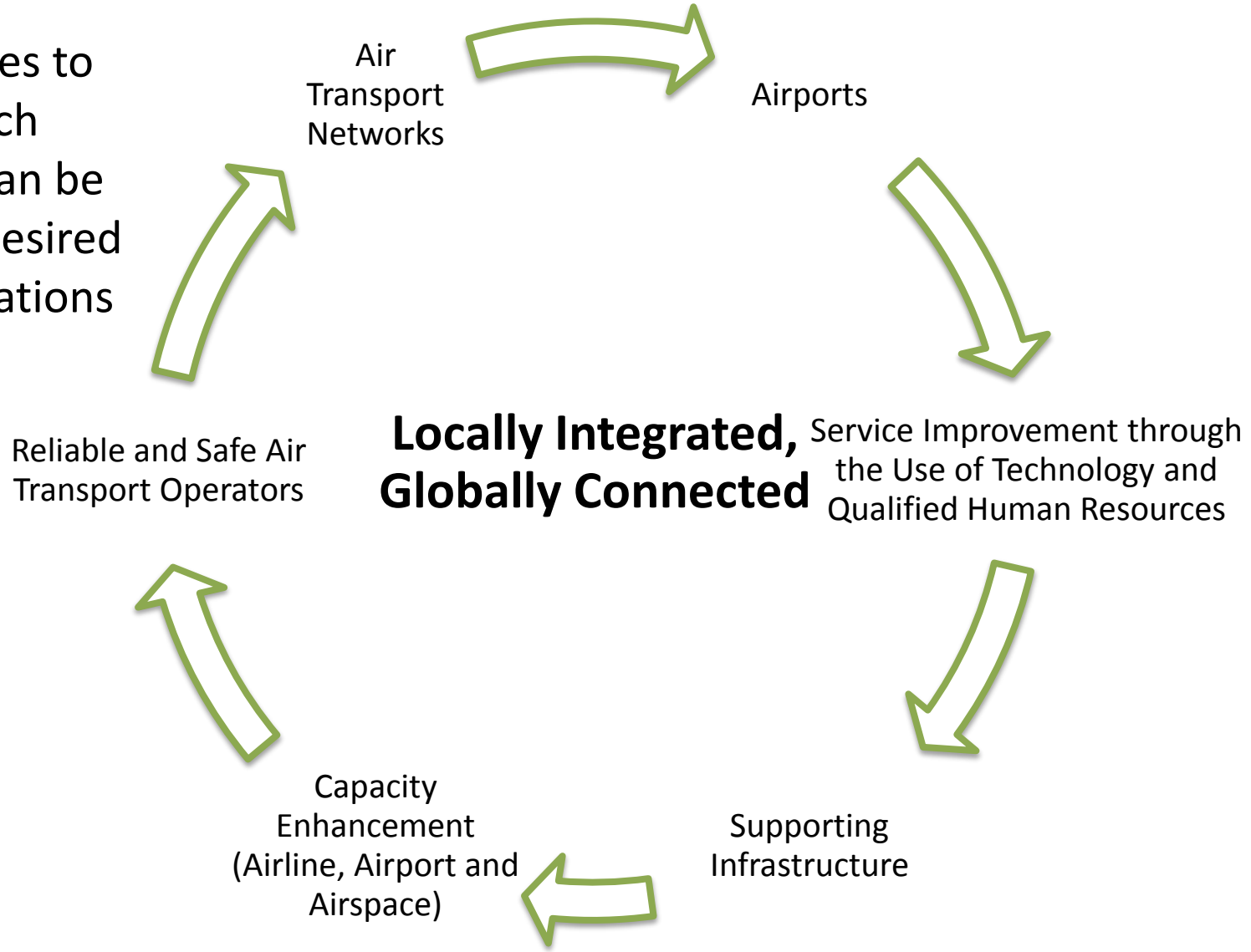
Building Aviation Connectivity in Indonesia

Connectivity relates to the ease with which people or goods can be moved between desired origins and destinations



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Service Improvement through the Use of Technology

Research Activities in

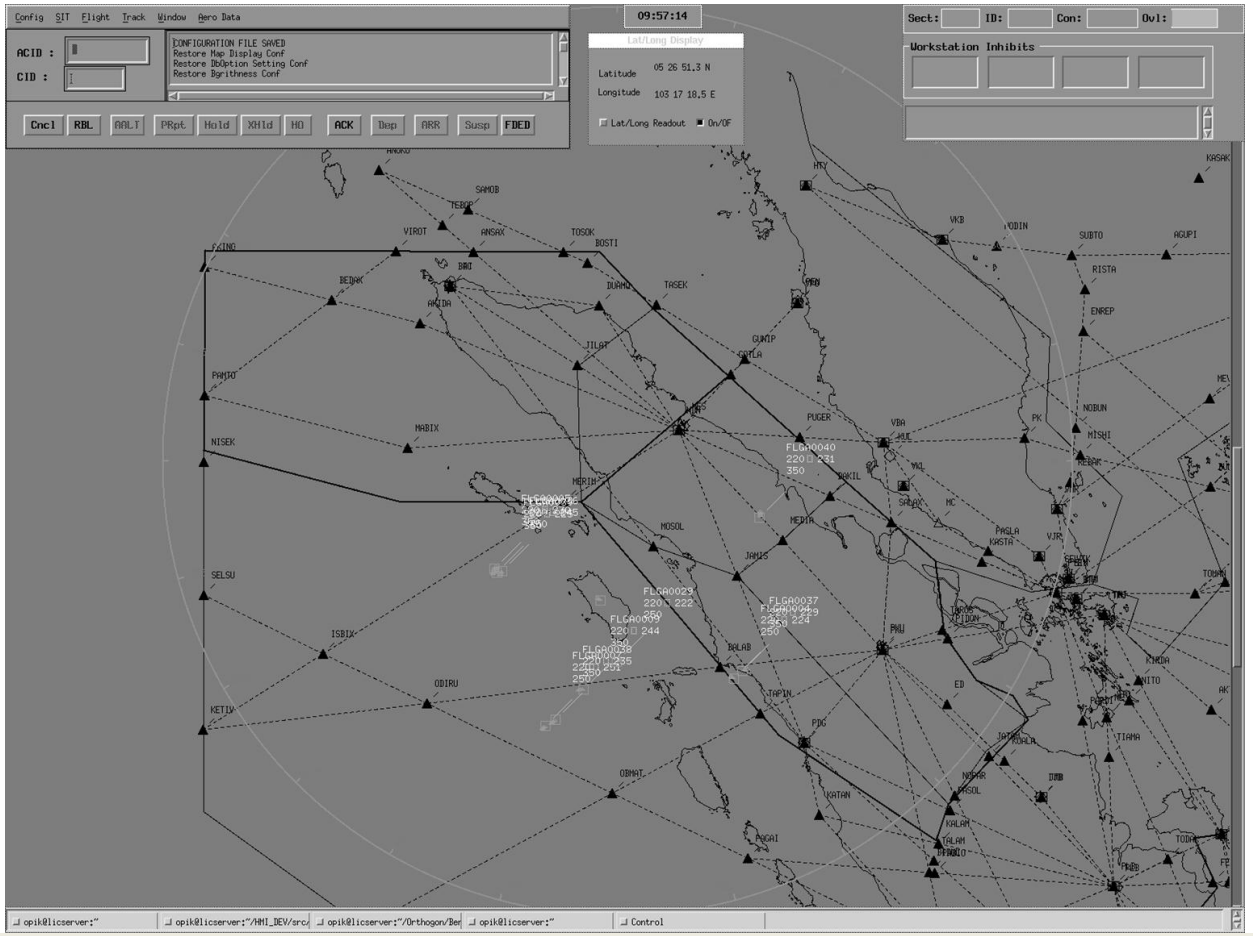
AIR TRANSPORT ENGINEERING AND OPERATIONS

Design, Build and Installation of a Radar Data Processing and Display System (RDPS) at Medan Polonia Airport

Customer: PT. (Persero) Angkasa Pura II

- RDPS is a computer-based tool for assisting air traffic controllers to monitor, control and guide air traffic in an airspace sector.
- It tracks, processes, and displays traffic situation in a window-based control station.
- It helps to provide safe traffic separation, thereby improving traffic flow and increasing airspace capacity.

Medan ACC (Area Control Center)
Air Traffic Situation Display



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Design, Build and Installation of a Radar Data Processing and Display System (RDPS) at Medan Polonia Airport

RDPS Functionalities

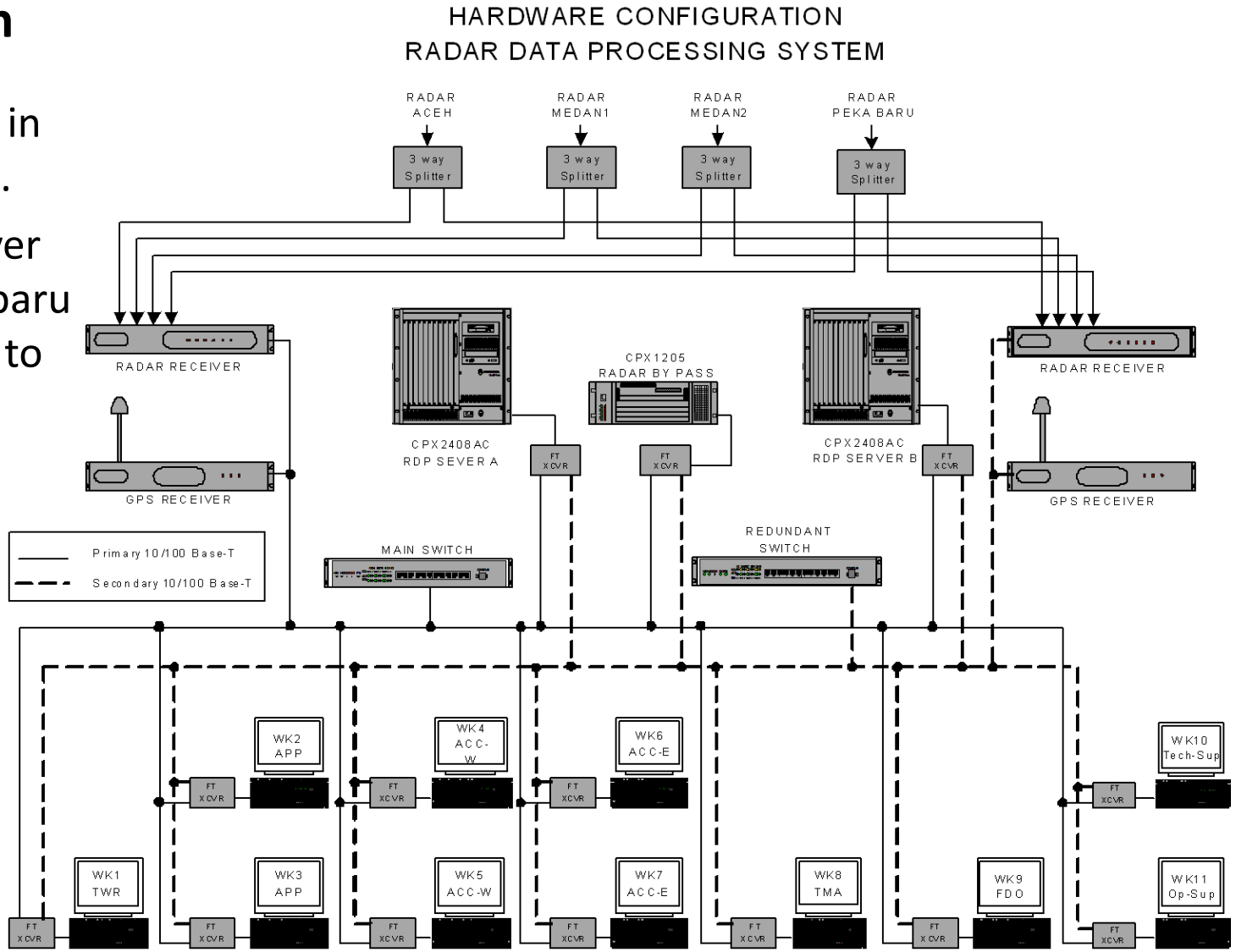
The Radar Data Processing and Display System (RDPS) performs the following functions:

a. Accept primary and secondary radar data from up to 16 radars;
b. Process and format the data combined from all sensors for viewing on up to 20 consoles in the Area Control Centre and remote sites; and viewing at an optional positions in the Control Tower;
c. Display the data at each user position (console);
d. Accept flight plan data and combine with radar data;
e. Provide Minimum Safe Altitude Warning (MSAW) and Short Term Conflict Alert (STCA), and Danger Area Intrusion Alarm functions;
f. Process user requests for data and control;
g. Provide on-line validity checking and alarm;
h. Provide on-line malfunction detection and alarm; and
i. Provide fail-safe degraded mode operation and back-up.
j. In addition to these functions each console (as an option) is capable of receiving radar data directly from all radars. This is referred to as the bypass function.

Design, Build and Installation of a Radar Data Processing and Display System (RDPS) at Medan Polonia Airport

System Configuration

- The system has been in operation since 2007.
- It provides control over airspace from Pekanbaru to Aceh, from Batam to Indian Ocean.



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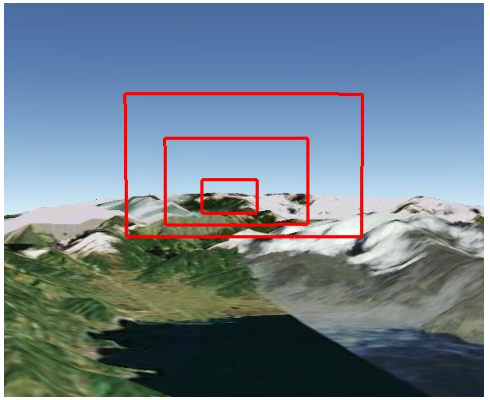
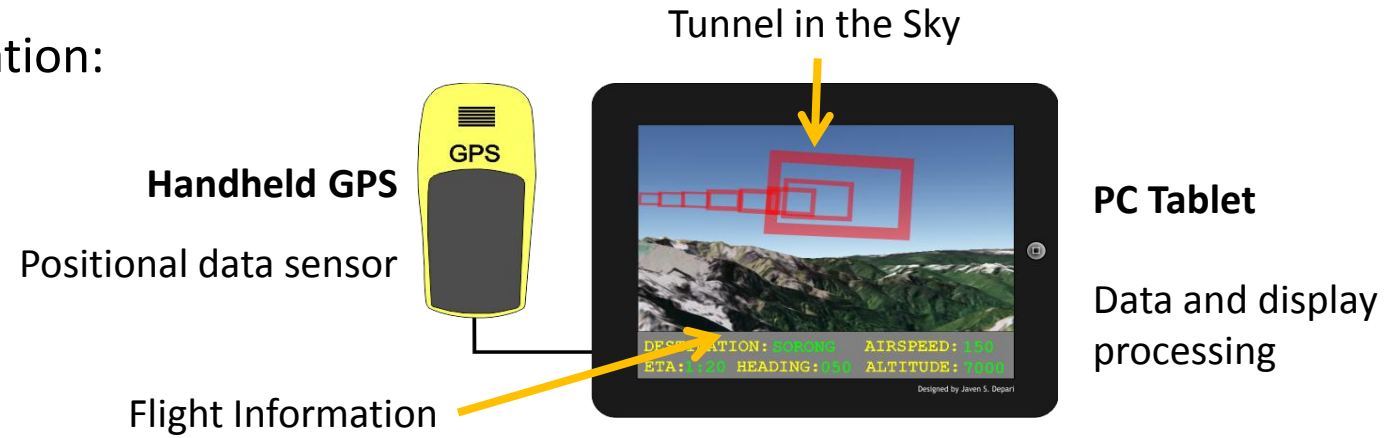
Development of Tunnel in the Sky for Flight Navigation in Indonesian Airspace

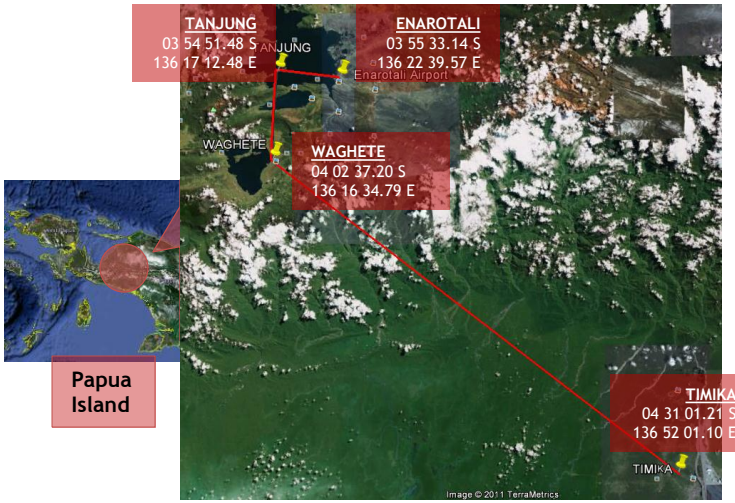
- The objective is **to provide pilots with information of where the aircraft is** relative to the desired flight path and **what action needs to be taken to stay on course.**
- **High quality situational awareness** is required for **low flying through mountainous landscape.**
- **The advent of light computer tablets** with high quality 3-D display processing capability **can provide low cost solution.**
- The system configuration:

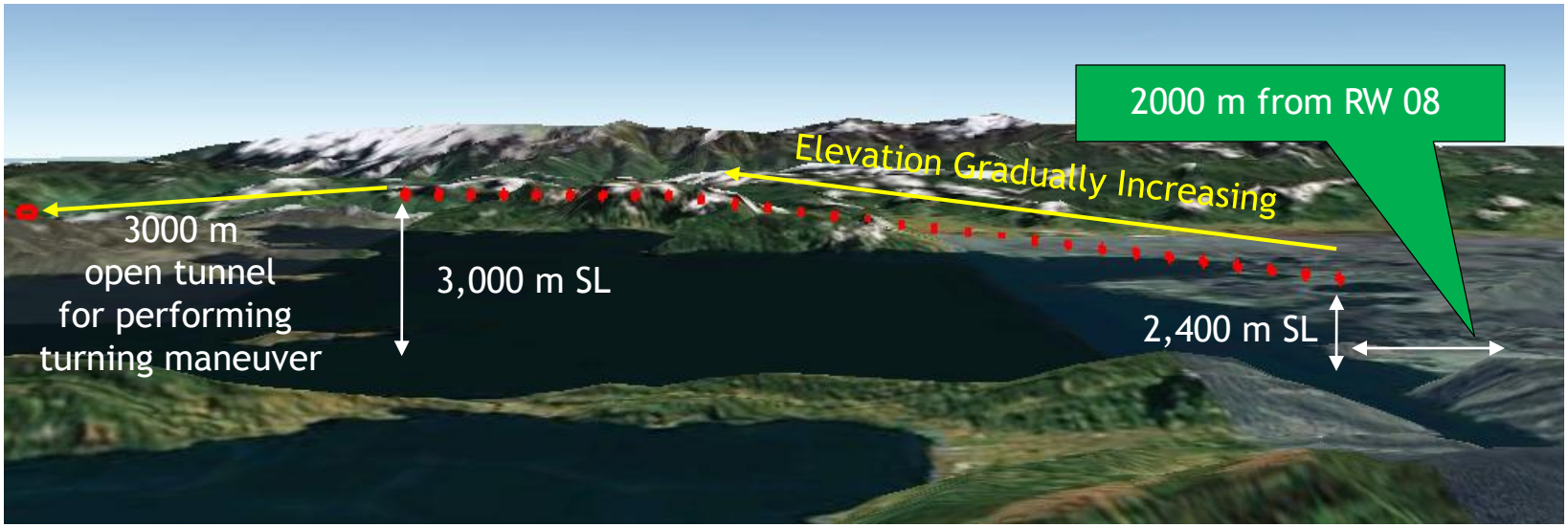




Development of Tunnel in the Sky for Flight Navigation in Indonesian Airspace

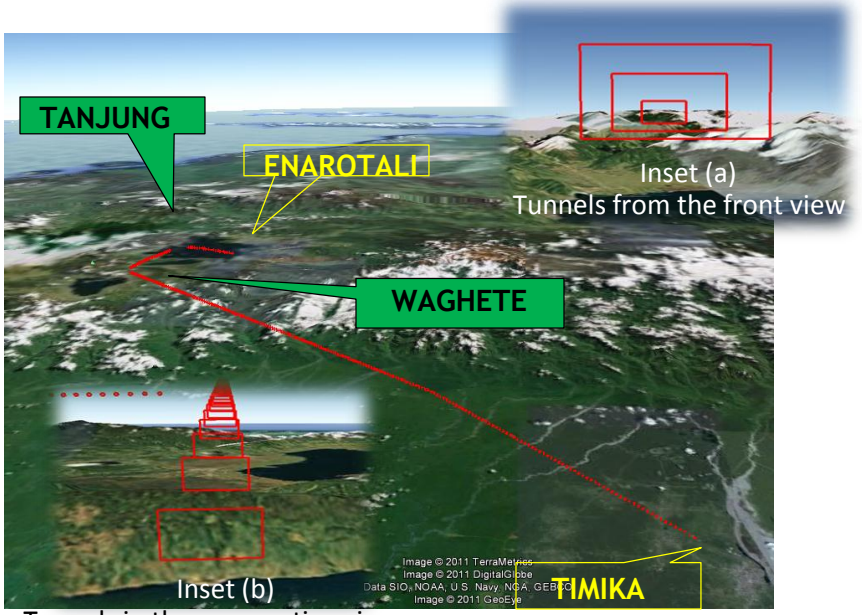
- The Enarotali-Timika route is used for system verification and validation.
- The tunnel size is designed based on the largest type, Twin Otter aircraft.
- The tunnels are positioned at 300 m. interval along the routes, totaling 280 square sections.



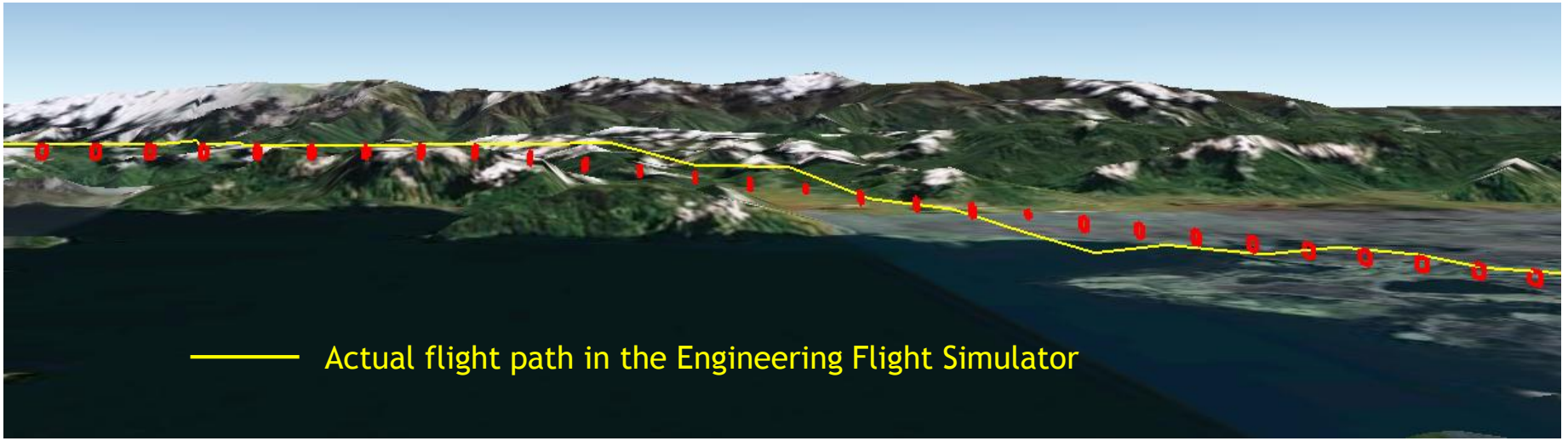


Development of Tunnel in the Sky for Flight Navigation in Indonesian Airspace

- The tunnel design is verified through flight testing in the Engineering Flight Simulator.
- The route is flown by a single engine Cessna 172P Skyhawk.
- To reflect real situations, a bad weather condition is used for the flight testing, in which fog covers the area resulting in much reduced pilot visibility.



Tunnels in the perspective view



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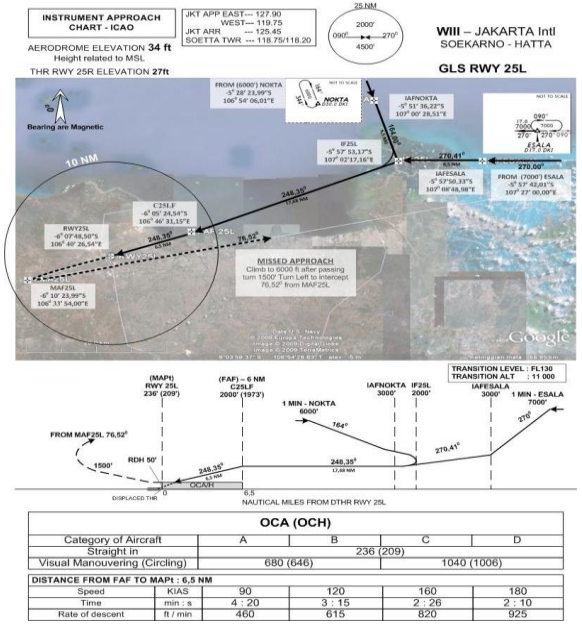
Capacity Enhancement (Airline, Airport and Airspace)

Research Activities in

AIR TRANSPORT ENGINEERING AND OPERATIONS

Design and Analysis of a GNSS-Landing System (GLS) Approach Procedure at Jakarta Soekarno-Hatta International Airport

Instrument Approach RNAV (GNSS) RWY 25L

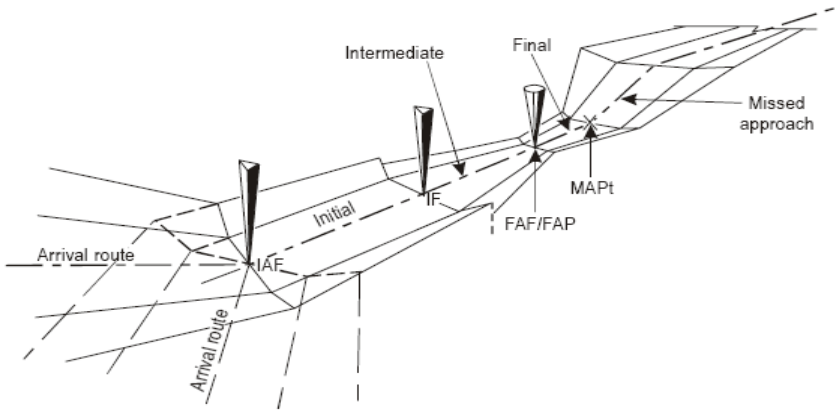


OCA (OCH)				
Category of Aircraft	A	B	C	D
Straight in	236 (209)			
Visual Manouvering (Circling)	680 (646)		1040 (1006)	

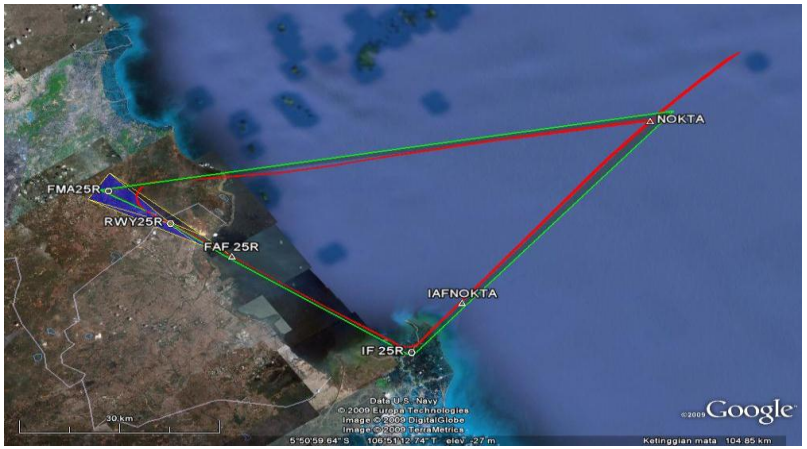
DISTANCE FROM FAF TO MAPt : 6,5 NM					
Speed	KIAS	90	120	160	180
Time	min : s	4 : 20	3 : 15	2 : 26	2 : 10
Rate of descent	ft / min	460	615	820	925

- The objective is to analyze the effectiveness of a GBAS (Ground Based Augmentation System) -based *precision approach procedure* at Jakarta Soekarno-Hatta International Airport.
- The design of the *precision approach* procedure follows the ICAO PANS-OPS Doc 8168 Vo. II Part III Section 6.

OAS (Obstacle Assessment Surface) *Template for* Runway 25R Aircraft Category C/D



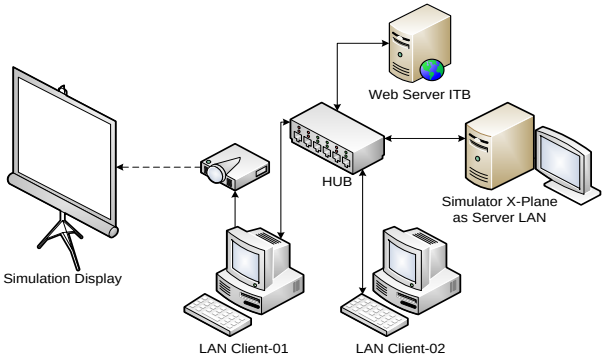
Segment of the *Approach* Procedure



Simulated Flight Trajectory of an RNAV/GPS Approach to Runway 25R

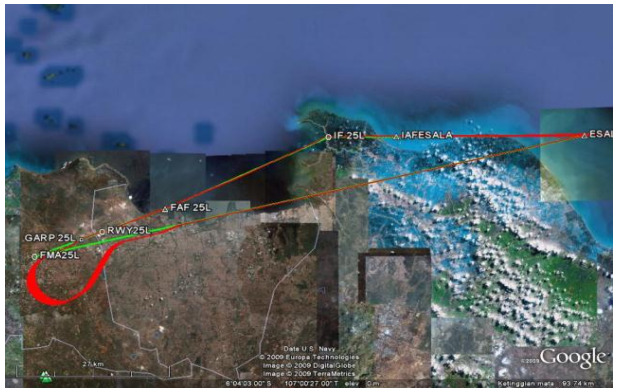
Design and Analysis of a GNSS-Landing System (GLS) Approach Procedure at Jakarta Soekarno-Hatta International Airport

- Flight simulation for verification and validation was performed using the X-Plane, Google Earth5 and MatLab/Simulink based Engineering Flight Simulator at the Aircraft Design, Operations and Maintenance Research Group, ITB

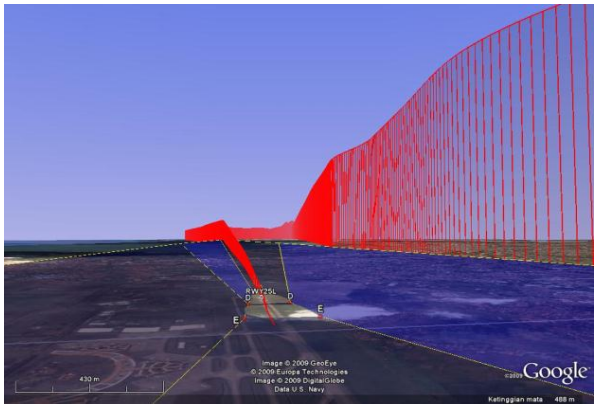


Simulator Client-Server Network

Approach Trajectory to Runway 25L

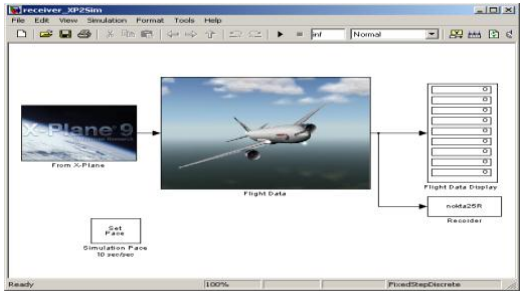


Desired track Simulation track

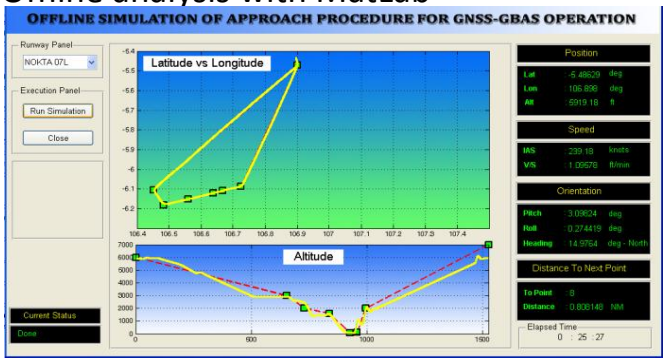


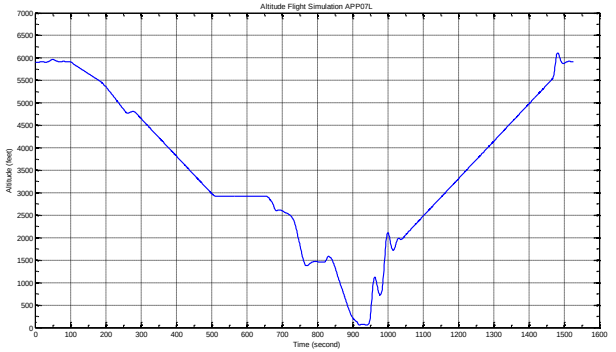
- Simulation was performed using Boeing 777-200 aircraft

- Flight Parameters were recorded for analysis.



Offline analysis with MatLab





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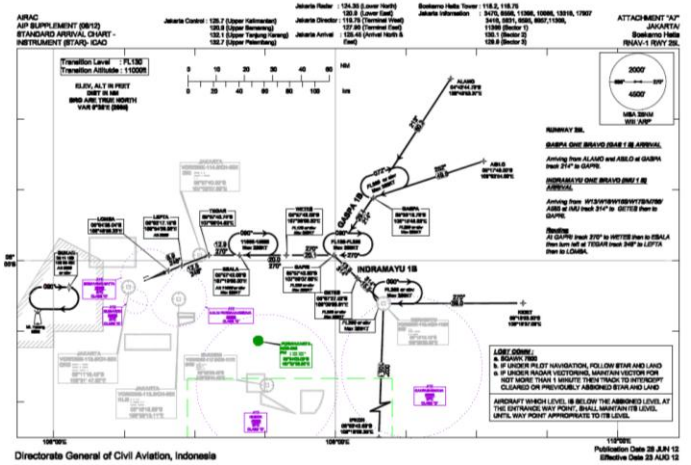
Development of Air Traffic Model at Jakarta Soekarno-Hatta International Airport

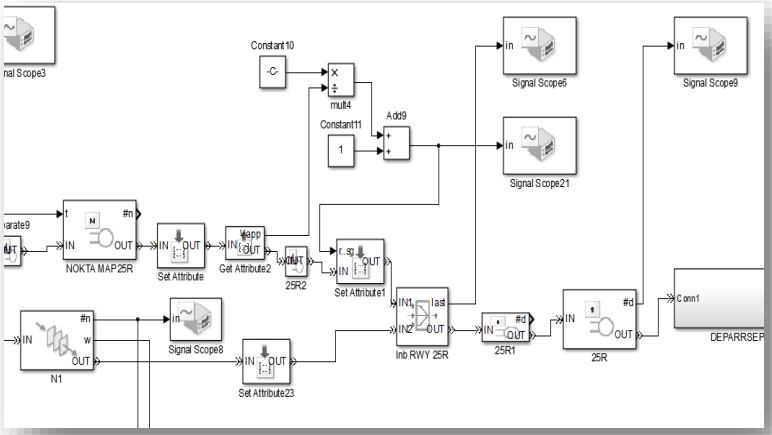
Background

- There is a significant difference in capacity at SHIA as compared to other airports of similar layout.
- Capacity constraint leads to air traffic congestion, thereby increasing operational costs and reducing safety and service levels.



Objectives

- To develop a realistic air traffic model at SHIA that can be used to establish scenarios for increasing capacity



- The model is developed based on MatLab SimEvents taking into account:
  1. Airside configuration of the airport (runways, taxiways, aprons, etc.)
  2. Air traffic procedure into and out of SHIA
  3. Traffic demand rate
  4. Safety standards in terms of aircraft separations between various aircraft categories

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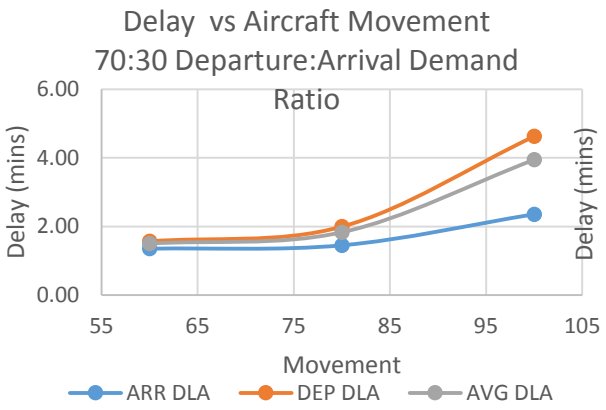
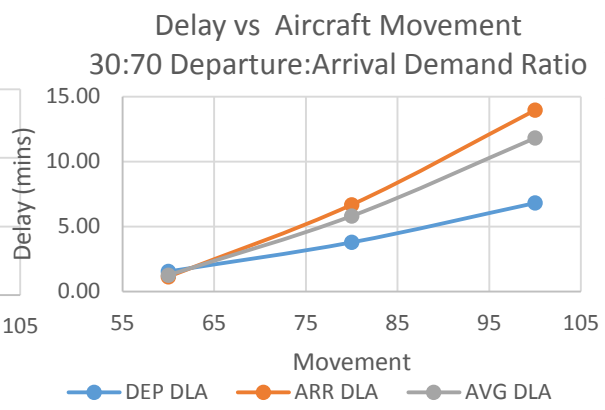
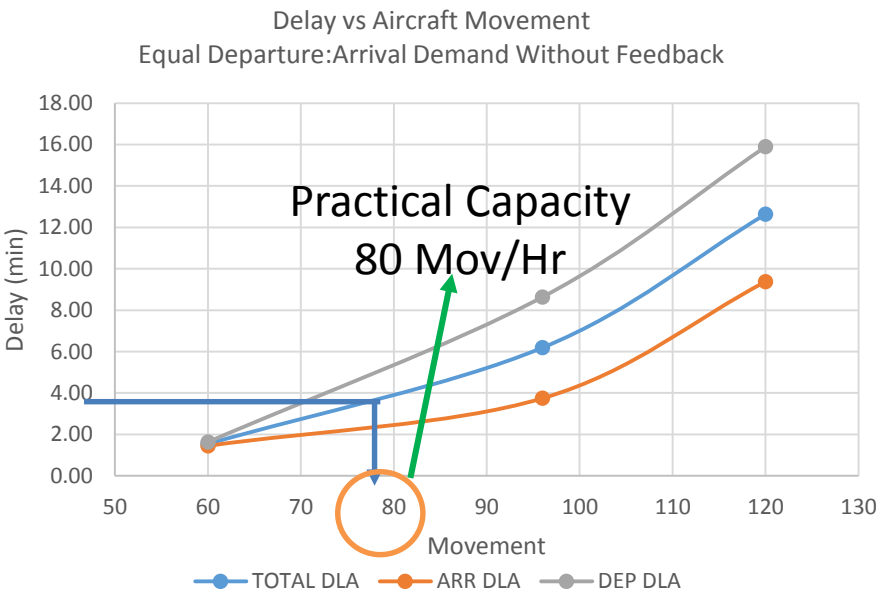
Development of Air Traffic Model at Jakarta Soekarno-Hatta International Airport

Results

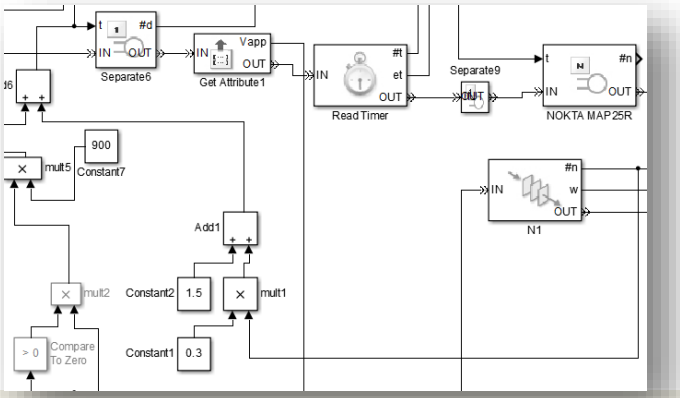
- Different traffic scenarios can be analyzed to establish a procedure that can anticipate real changes in demand pattern







- Different feedback scenarios can be analyzed to establish a procedure that can anticipate real changes in demand pattern
  - Increasing inter-arrival separation to ease departure congestion
  - Rerouting traffic to other waypoints in case of side imbalance



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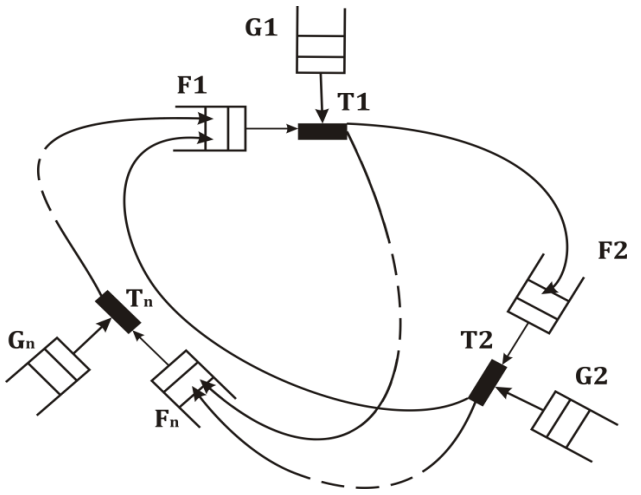
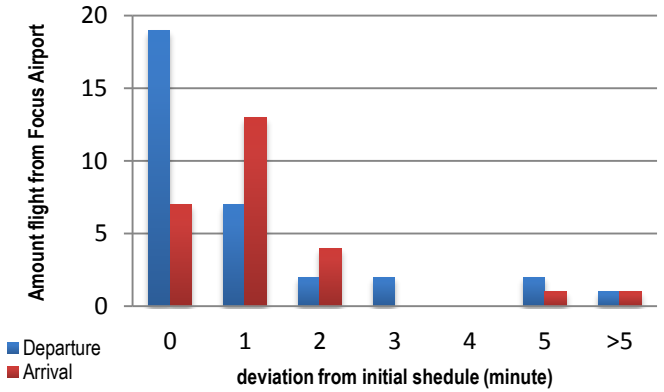
Development of a Multi-Airport Simulation Model for Airport Slot and Traffic Disruption Management

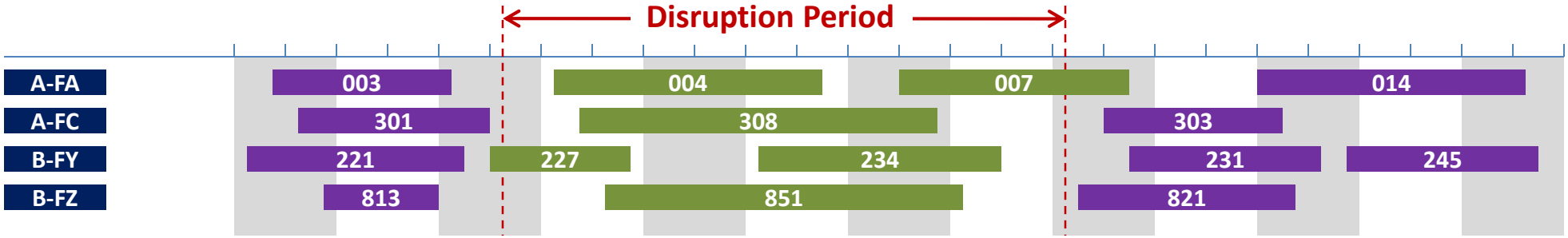
- Flight scheduling can be arranged to reduce traffic congestion at busy major airports.
- Rearranging flight schedules to and from busy airports can reduce delays not only at the airports but also at the other corresponding airports.
- The study utilizes a multi-airport simulation model by taking into account the corresponding airport capacities, flight separation criteria, aircraft rotation and expected flight delays.
- The study performed at 6 busiest major airports in Indonesia indicates that *airborne delays* can be *significantly* reduced by slightly rearranging flight schedules.
- The model can be used to analyze the impact of airline's additional flight requests to the traffic pattern.



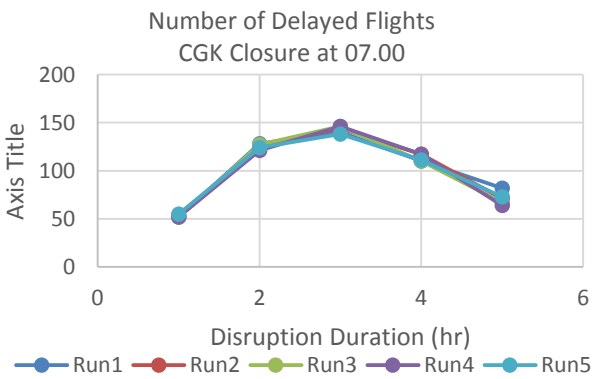


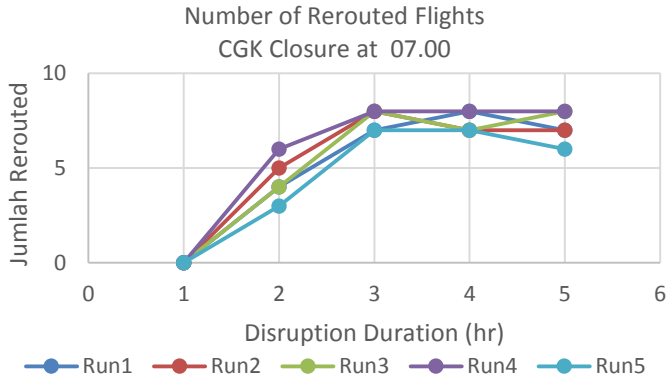
Development of a Multi-Airport Simulation Model for Airport Slot and Traffic Disruption Management

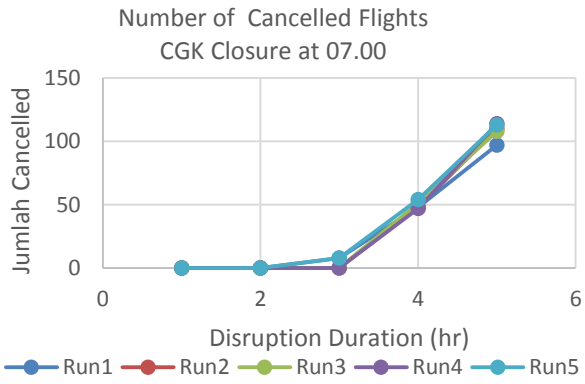
- The model is expanded for traffic disruption management in case of one airport is suddenly unavailable for service.
- The solution can be either rearranging flight schedules to and from the disrupted airports or deviating ongoing flights to the alternate airports.



Disruption effected flight events







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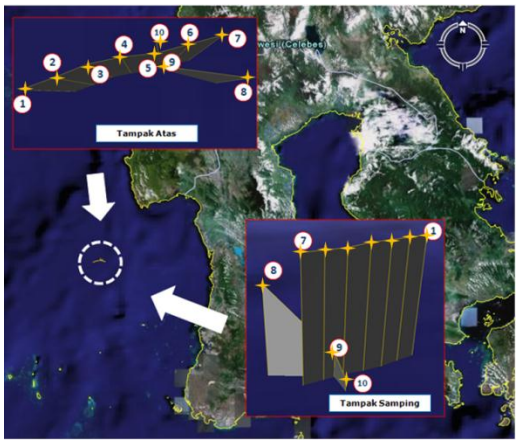
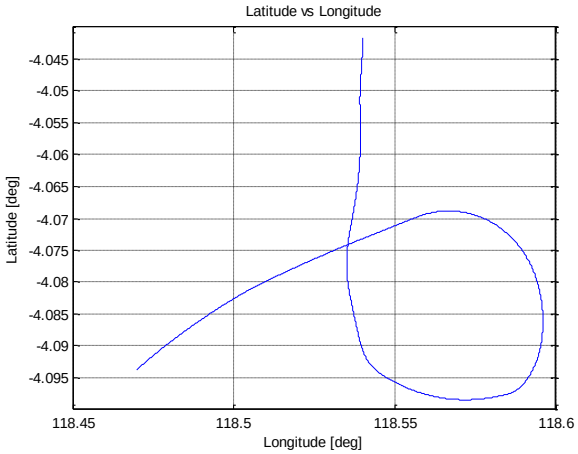
Aircraft Flight Trajectory Reconstruction for Aviation Safety Analysis

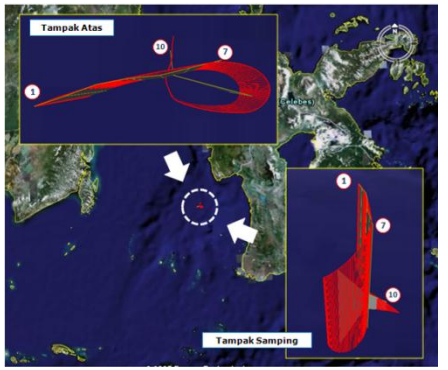
- Aircraft accident analysis has been heavily relied on data recorder in the *Flight Data Recorder* and *Cockpit Voice Recorder* (the so called *black box*) for establishing accurate analysis of the probable causes of accident.
- In the rare event in which the data in *black box* cannot be recovered, available data from other sources can be used to reconstruct the flight to provide clues as to what happen leading to the accident.
- The objective is to identify probable cause by establishing the most probable flight scenarios.
- Flight reconstruction is carried out in the Engineering Flight Simulator by using data obtained from various sources (radar track recording, ATC communication, etc.)

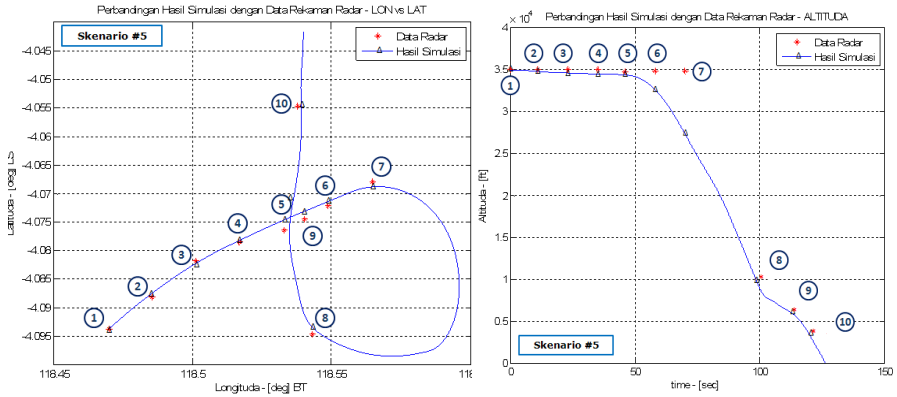


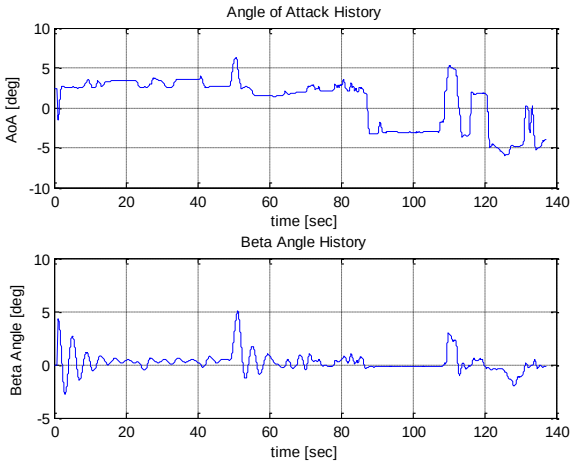


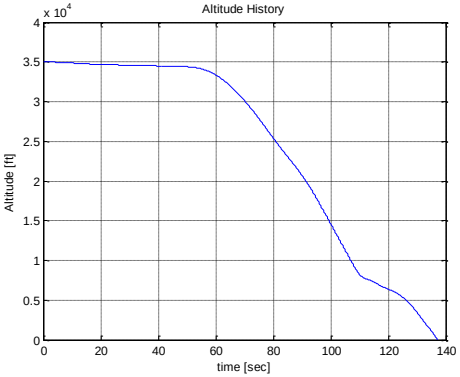
Aircraft Flight Trajectory Reconstruction for Aviation Safety Analysis

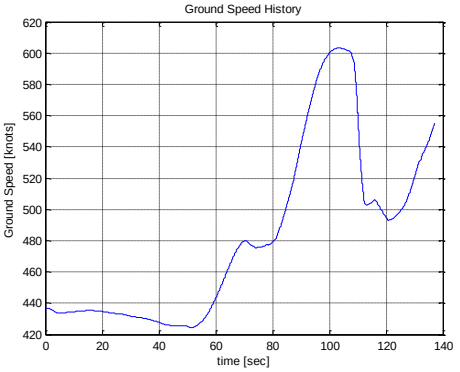
- Several event and flight scenarios are established based on the analysis of the available data.
- The flight can then be reconstructed to closely follow the trajectory.
- Flight parameters are continuously recorded for off-line analysis.











- Based on flight data analysis for the most probable scenario, the probable causes of the accident can be identified.

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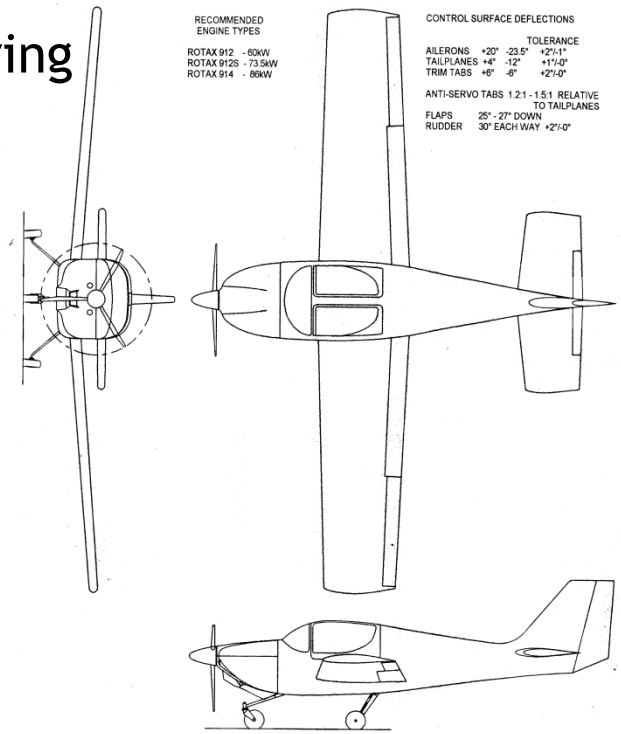
Service Improvement through the Use of Qualified Human Resources

Research and Development Activities in

AEROSPACE VEHICLE DESIGN AND ENGINEERING SIMULATIONS

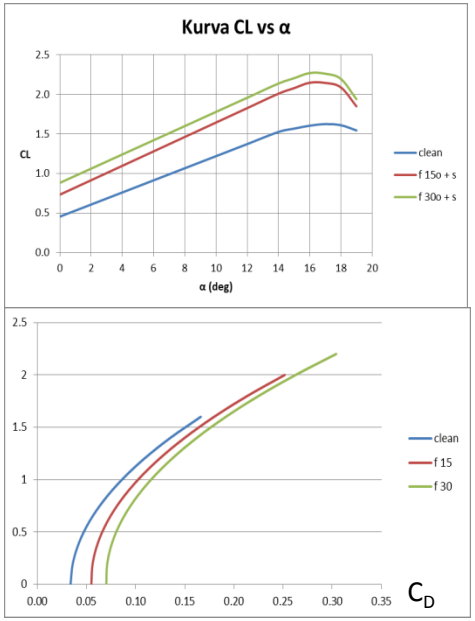
Design of Trainer Aircraft

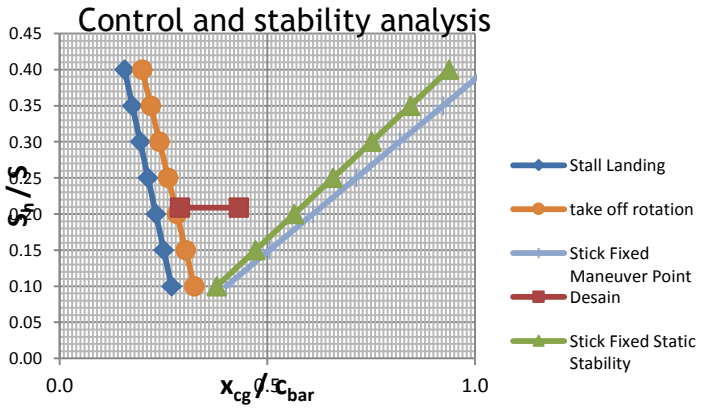
- The project is sponsored by the Institute for Research and Development , Ministry of Transportation, Indonesia, for 3 (three) years (2013-2015).
- The objective is to design and build a two-seat trainer aircraft prototype for flight training.
- 2013: Conceptual design
- 2014: Preliminary design and manufacturing engineering
- 2015: Detail design and manufacture
  - MTOW = 650 kg.
  - Empty weight = 380 kg.
  - Wing area: 9.4 m^2.
  - Engine: Avco Lycoming IO-320B 140 hp

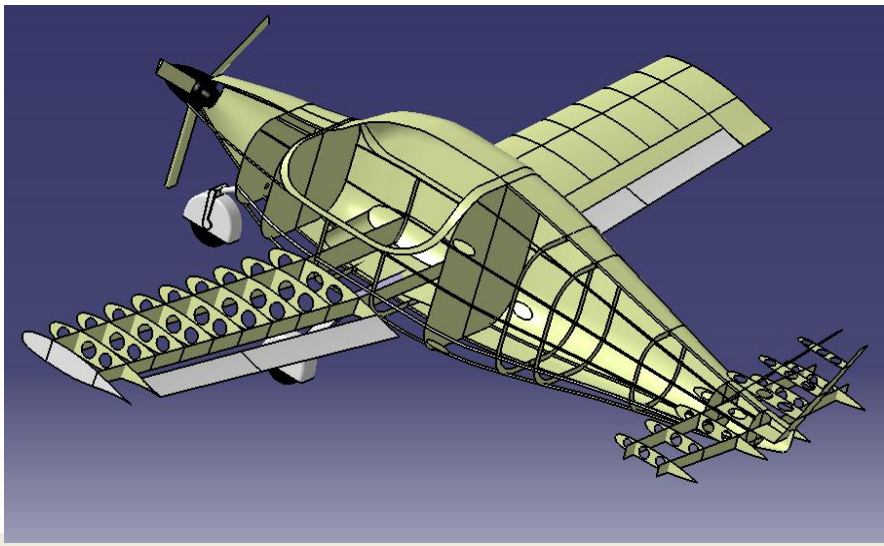


Design of Trainer Aircraft

- At present the activities include:
  - ✓ Preliminary sizing
  - ✓ Aerodynamic design and analysis
  - ✓ Flight performance, stability and control analysis
  - ✓ Preliminary definition of structural layout
  - ✓ Preliminary systems design
  - ✓ Budget and cost estimate







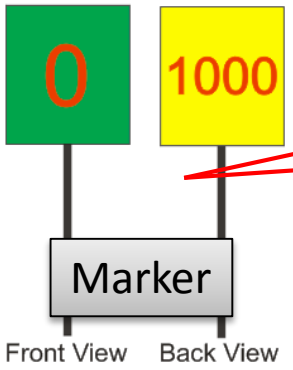
Research and Development in Engineering Simulators

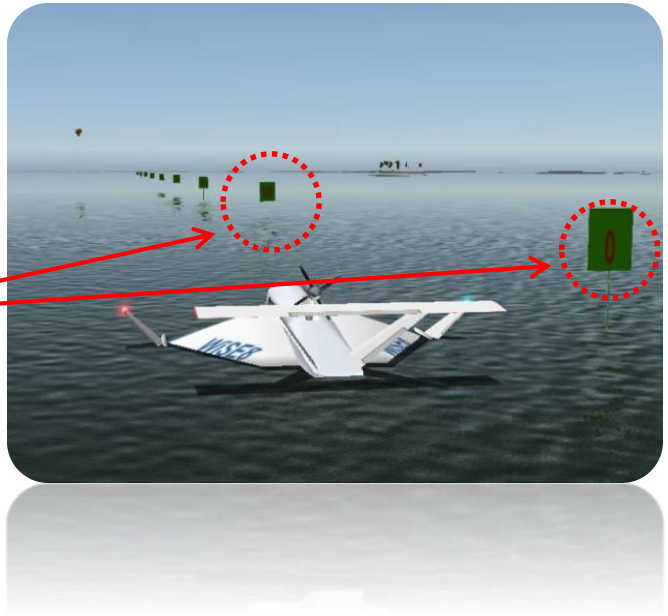
❑ Development of WiSE Craft Engineering Flight Simulator

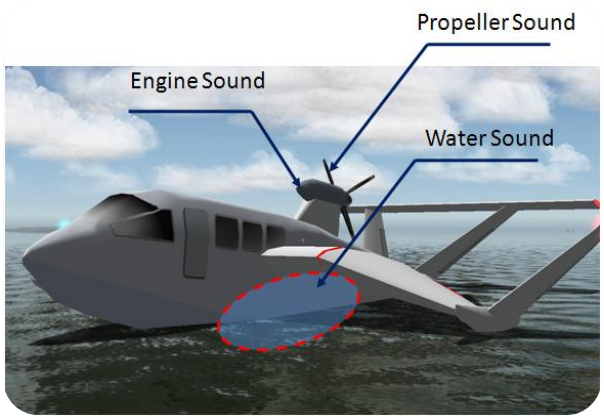
❑ The objective is to use the simulator for cockpit familiarization and operational training for pilots.

1. Development of out-of-window view :

- Day and night out-of-window view
- Test Area out-of-window view







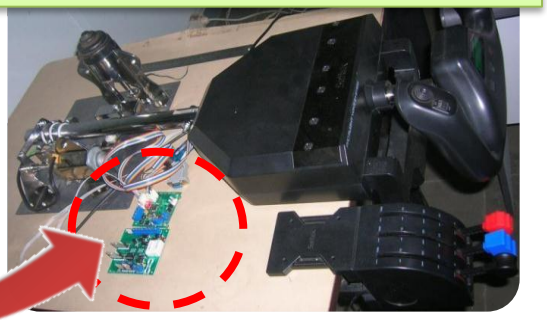
2. Development of audio system

Research and Development in Engineering Simulators

3. Development of simulated instruments

5. Development of Q-feel System

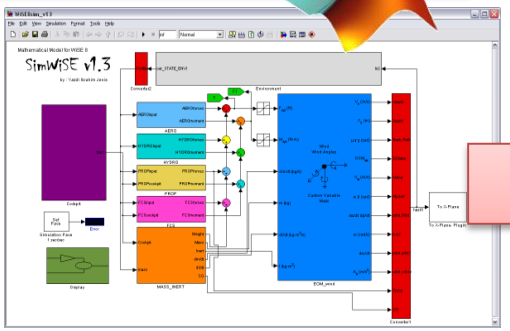
Sofware Functional Test on Hardware System



Microcontroller on the board

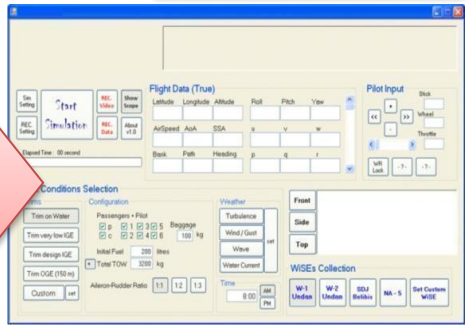
4. Development of Simulation Software

WiSE EFS Cockpit Q-feel



Simulator Software on Matlab/Simulink

SIMplifly.EXE



Executable Simulator Software

6. Integration

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Research and Development in Engineering Simulators

- The WiSE EFS is extensively used for pilot familiarization and training.
- The EFS has been further developed to include other aircraft dynamics and can be used for many purposes:
  - ✓ Fighter air combat simulation and analysis
  - ✓ Aircraft accident analysis
  - ✓ Flight verification and validation of a GNSS-based landing approach procedure.

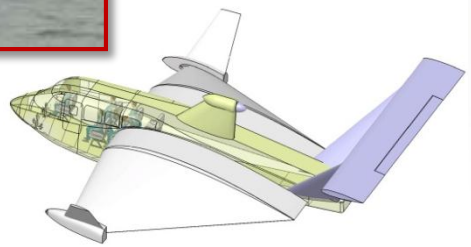
Reliable and Safe Air Transport Operators

Research and Development Activities in

AEROSPACE VEHICLE DESIGN

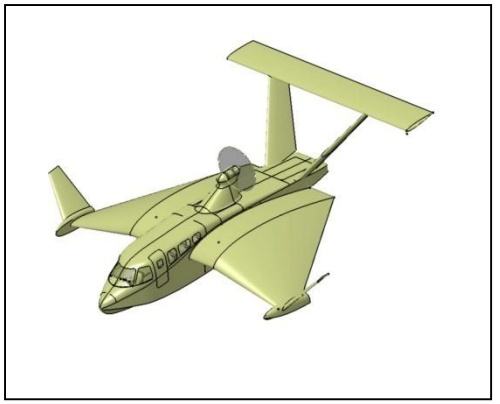
Research and Development in Wing-in-Surface Effect Technology

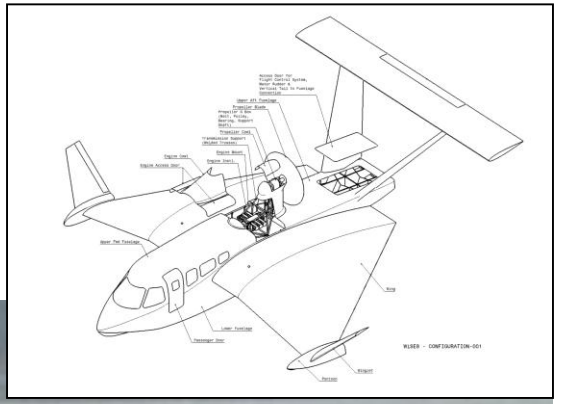
- A collaborative research and development activity between the **Aircraft Design, Operations and Maintenance Research Division** and the **Flight Physics Research Division** of the Faculty of Mechanical and Aerospace Engineering.
- Fully funded by the **Agency for the Assessment and Application of Technology** of Indonesia.
- The aim is to provide a *safe, fuel –efficient, high-speed* transportation mode between islands of Indonesia.

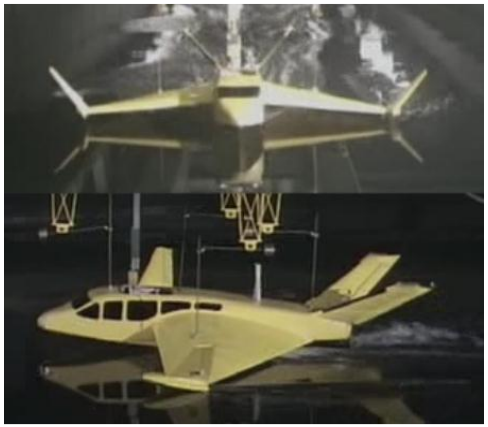


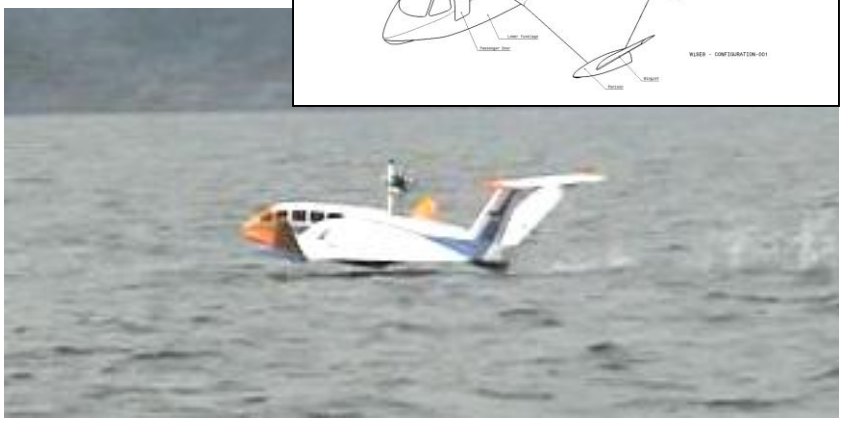
Research and Development in Wing-in-Surface Effect Technology

- Wing in Surface Effect (WiSE) craft, or popularly known as Wing in Ground Effect (WiG) craft is an air vehicle which operates at very low-altitude to gain improved lift-drag ratio by mean of a phenomenon known as ground effect.
- This phenomenon leads to fuel efficiency and finally reducing the flight cost
- The research and development activities cover configuration studies, design, analysis, and manufacturing of sub-scaled and full-scaled models.



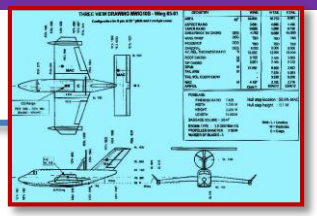






Research and Development in Wing-in-Surface Effect Technology

WORKS ON WISE TECHNOLOGY IN INDONESIA



1. Studies on configuration designs, structures, performances, stabilities, controls, etc

2. Experiments and data gathering

3. Flight Testing of Remote Controlled (RC) models

4. Prototyping of 2-seater and 8-seater configurations

5. Flight Simulator Development

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Research and Development in Wing-in-Surface Effect Technology

- Concept validation is performed through design, build and flight test of remotely piloted sub-scaled models of different configurations.

Rectangular Wing Configuration

Simple Reversed Delta Wing Configuration

Shouldered Reversed Delta Wing Configuration

Research and Development in Wing-in-Surface Effect Technology

- The research concludes at design, analysis and manufacturing of a full-scaled 8-seater WiGE craft