

Airport Take-off and Landing Operations for Advanced Air Mobility

Dependent and Independent Operations of AAM Flights Relative to IFR Flights

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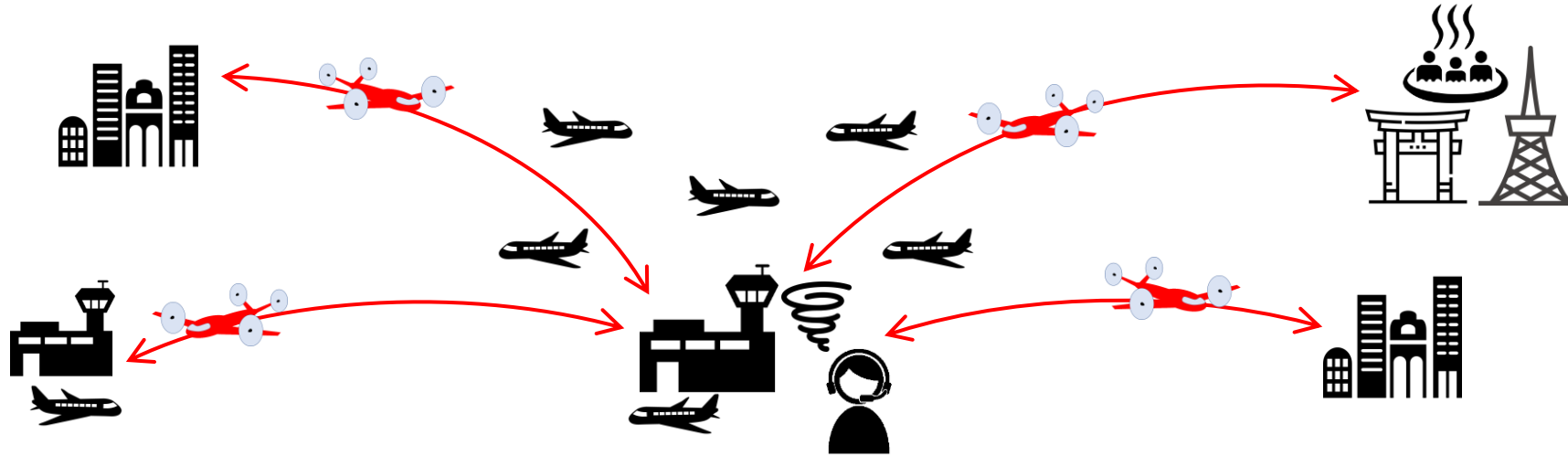
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1. Introduction



AAM use case

- AAM is a new air transport system that features advanced technologies such as high automation, electrification, and VTOL.
- One of the most promising use cases is an airport shuttle service.
- AAM aircraft must be able to take off and land near hub airports.
- However, the increase in AAM takeoffs and landings at airports raises concerns about airport capacity saturation and the increased workload of air traffic controllers.



AAM: Advanced Air Mobility

VTOL: Vertical Take-Off and Landing

1. Introduction



Target of this study

- To increase the number of AAM takeoffs and landings at airports, additional requirements for AAM aircraft are expected to be necessary.
- Stakeholders must balance potential benefits and additional costs.

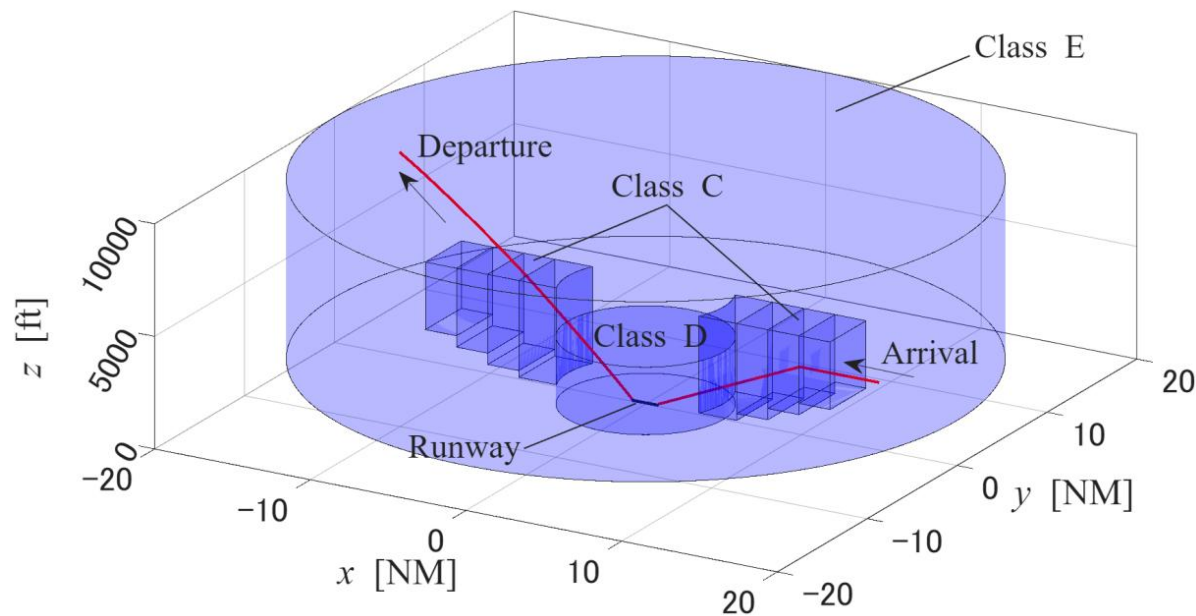


- The simulation results and discussions are expected to inform stakeholder decisions about the implementation of AAM airport shuttle services.

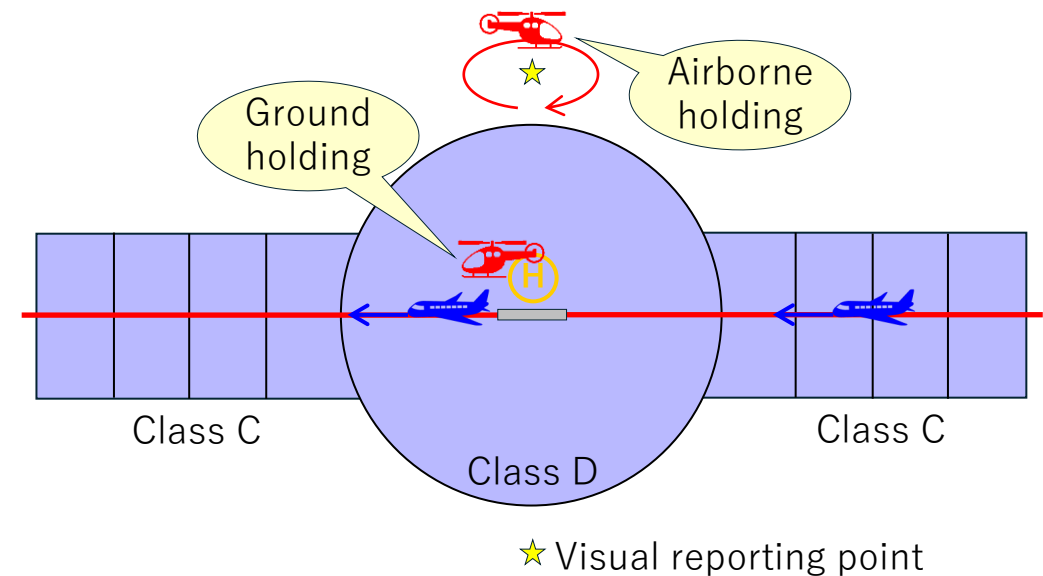
2. Airport Takeoffs and Landings Operations



Current VFR Operations around Hub Airports in Japan



Airspace around hub airports in Japan



Helicopter operations around hub airports

IFR: Instrument Flight Rules

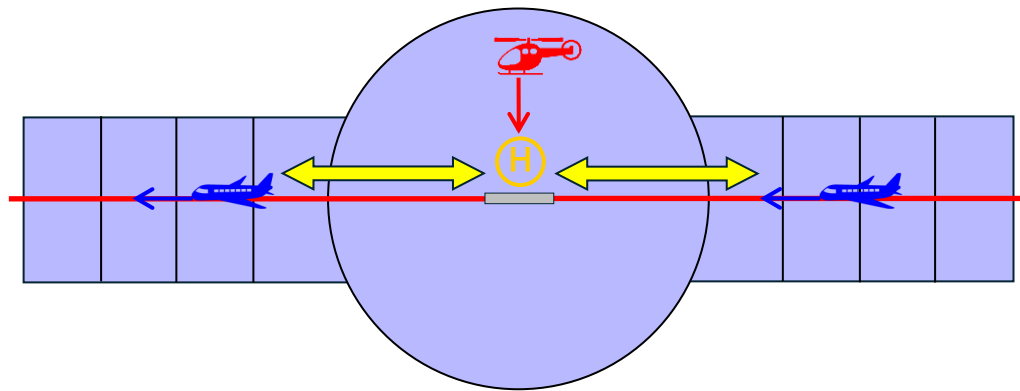
VFR: Visual Flight Rules

2. Airport Takeoffs and Landings Operations



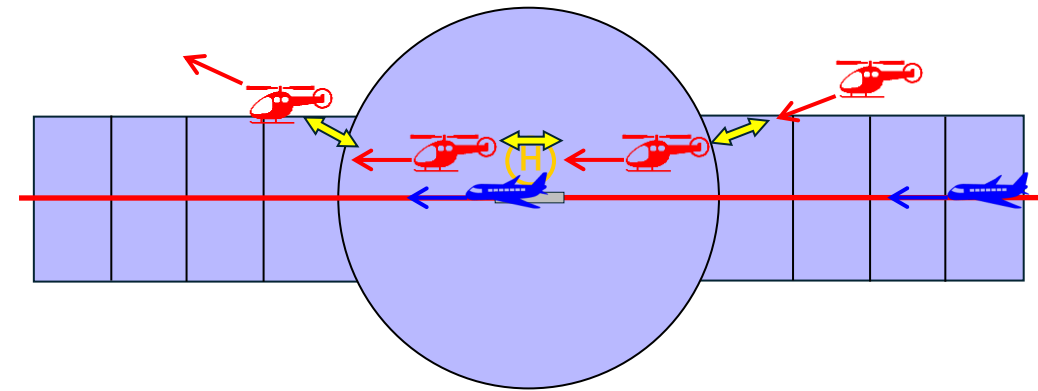
Dependent and Independent Operations

- Initial AAM operations are expected to be conducted under VFR, but VFR flights are dependent on IFR flights around airports.
- To increase the number of AAM taking off and landing, it is necessary to allow AAM flights to operate independently of IFR flights.



Dependent operations

Separation: IFR vs. IFR, AAM vs. AAM, **IFR vs. AAM**



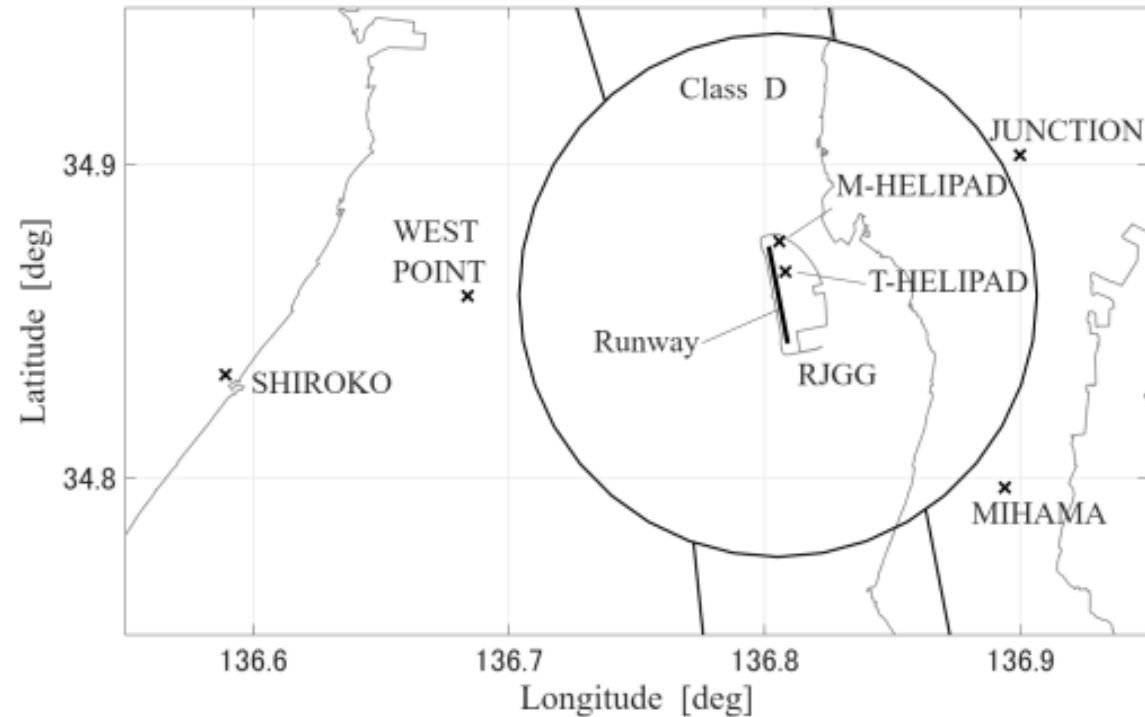
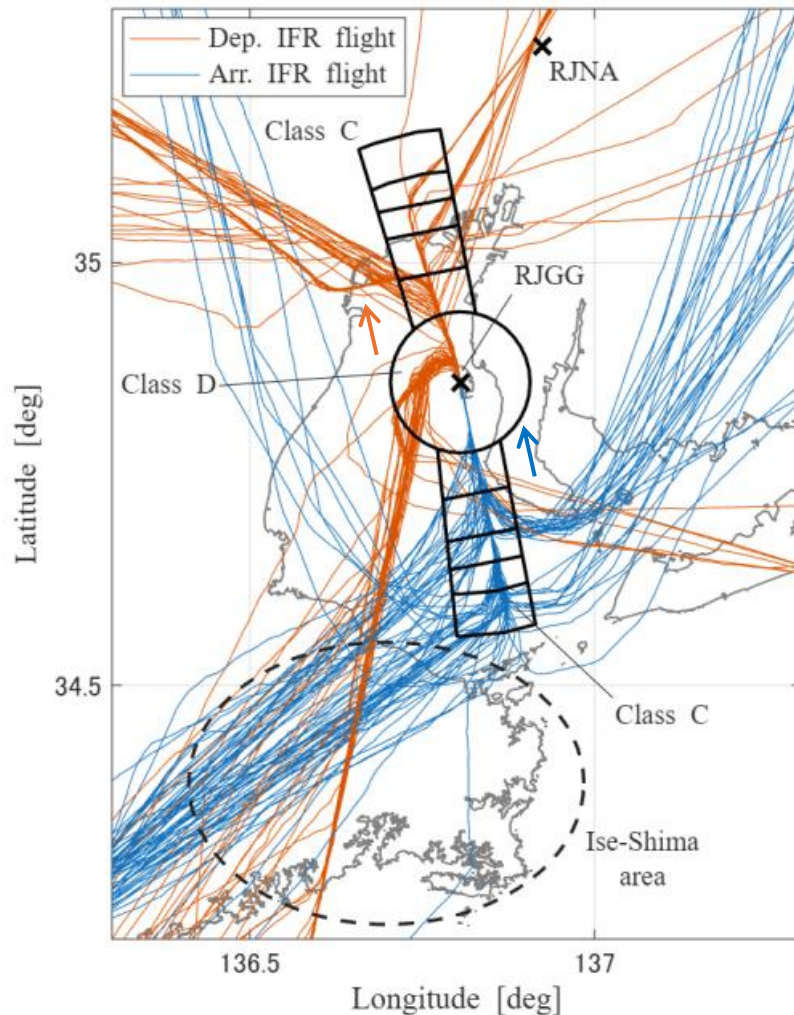
Independent operations

Separation: IFR vs. IFR, AAM vs. AAM

3. Take-off and Landing Scheduling Simulations



Target airport: Chubu Centrair International Airport (RJGG)



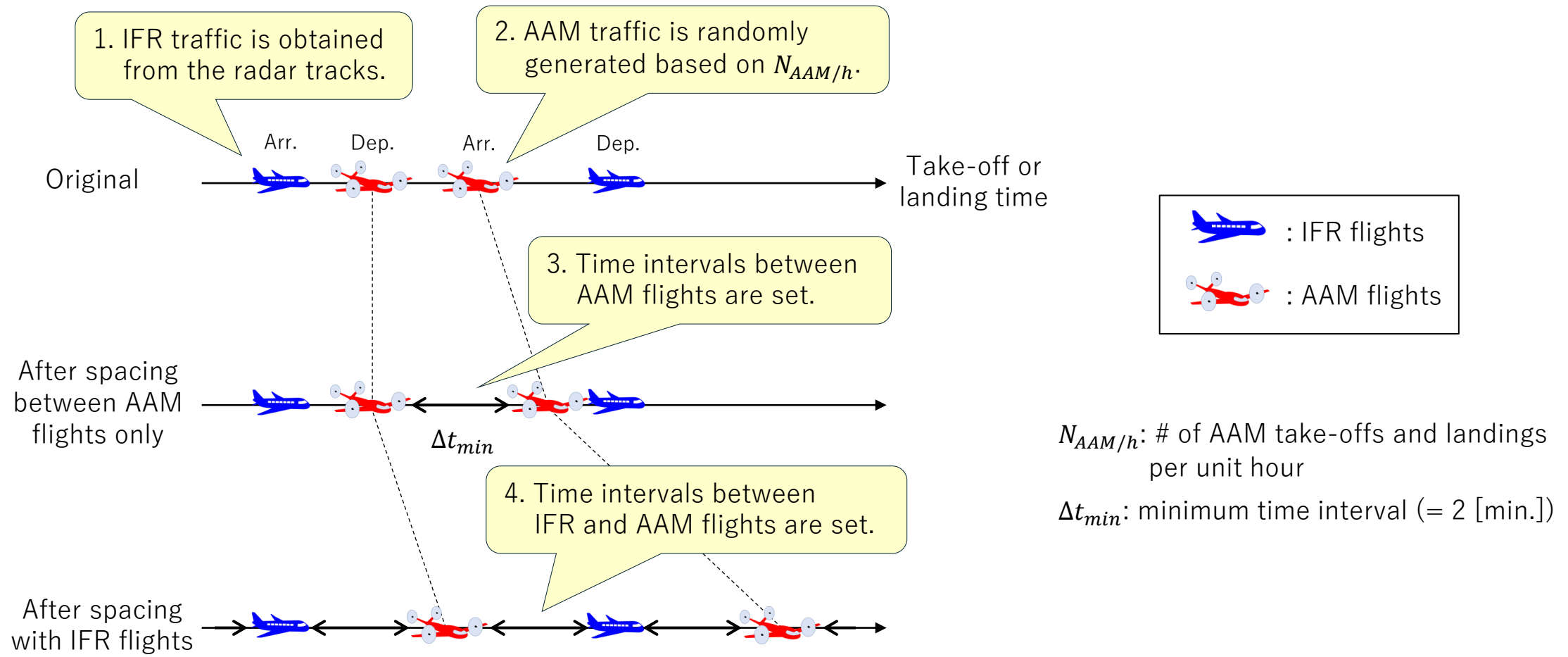
Airspace around RJGG and the radar tracks
(April 16, 2023)

RJNA: Nagoya Airfield

3. Take-off and Landing Scheduling Simulations



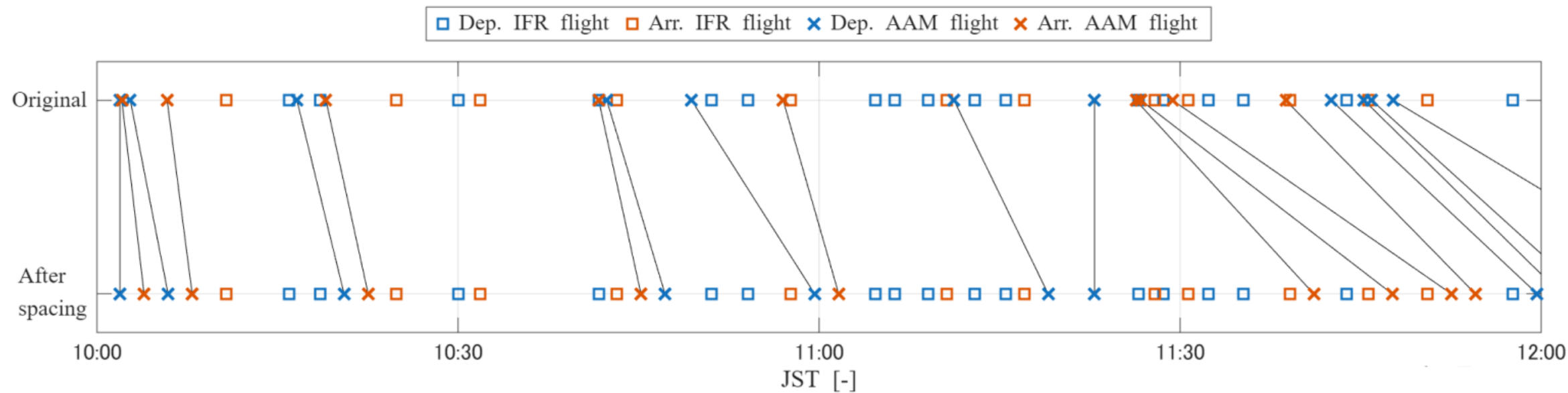
Simulation method



3. Take-off and Landing Scheduling Simulations



Simulation example ($N_{AAM/h} = 10$)



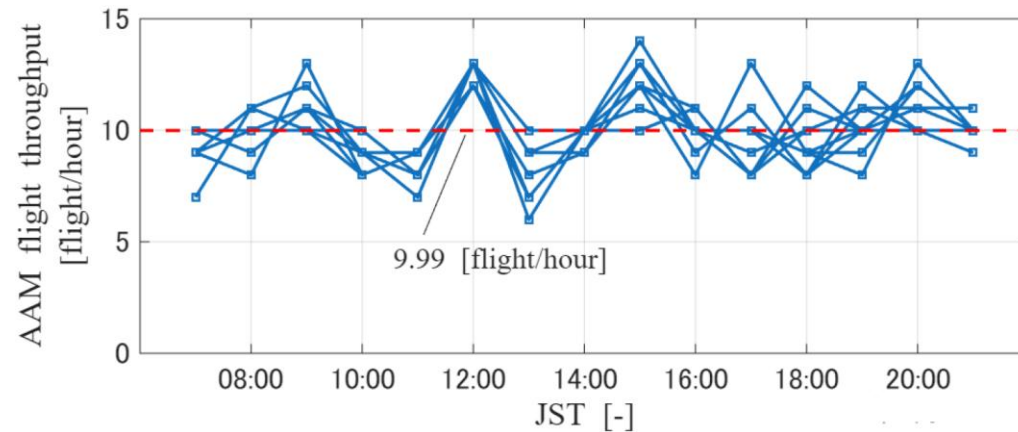
Average holding time

Dependent operations	7.49 [min./flight]
Independent operations	0.47 [min./flight]

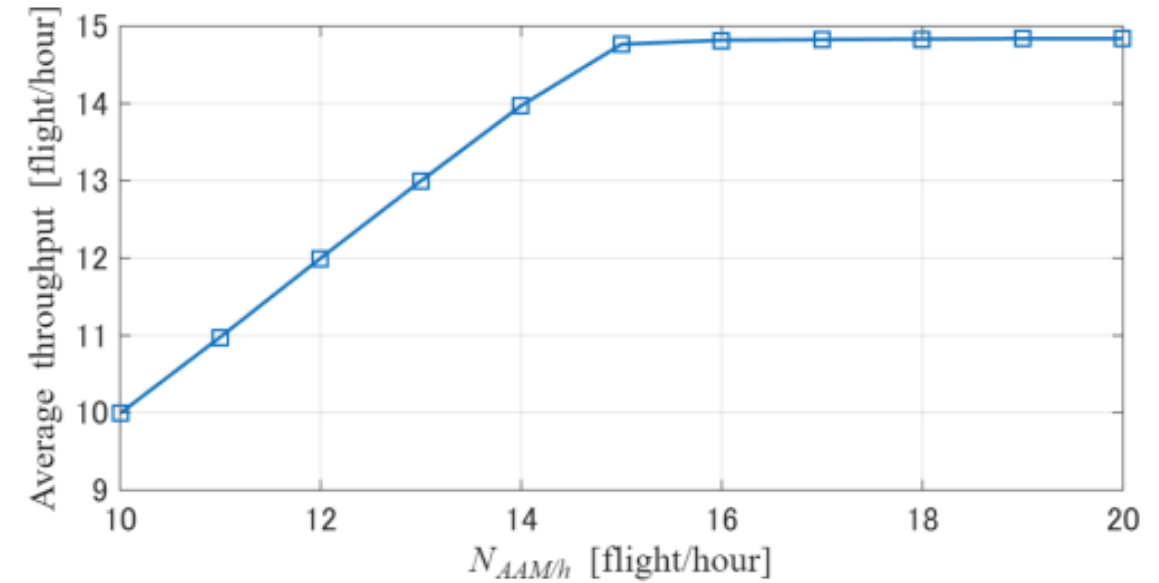
3. Take-off and Landing Scheduling Simulations



Simulation results: Throughput of AAM flights



Case with $N_{AAM/h} = 10$



$N_{AAM/h}$ vs. AAM throughput

Max. potential throughput of AAM flights

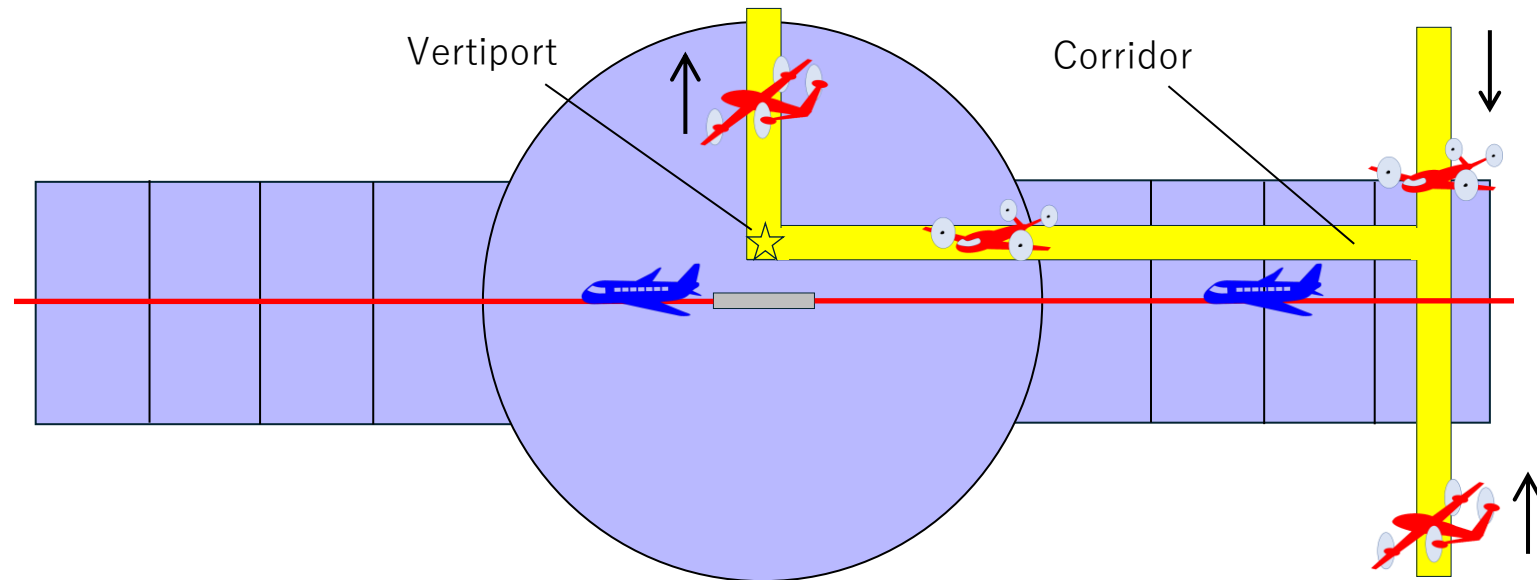
Dependent operations	14.8 [flight/hour]
Independent operations	30.0 [flight/hour]

4. Discussion



Concept of independent operations

- Assumptions:
 - ✓ ADS-B in/out
 - ✓ Onboard or remotely piloted
 - ✓ Cruising around 1,000 ft

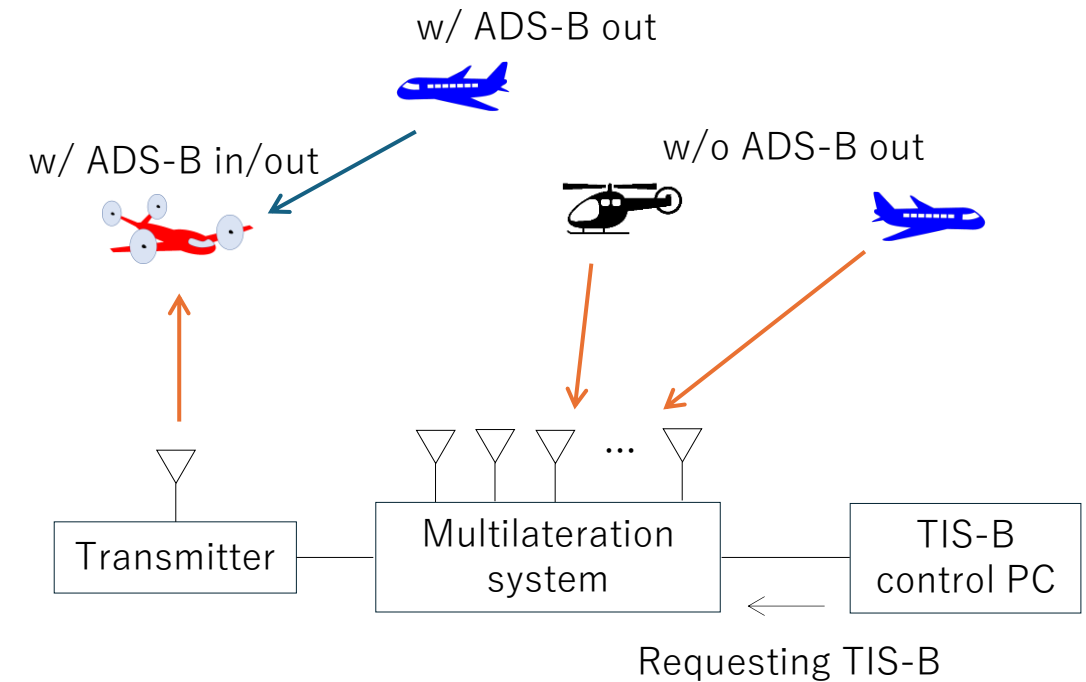
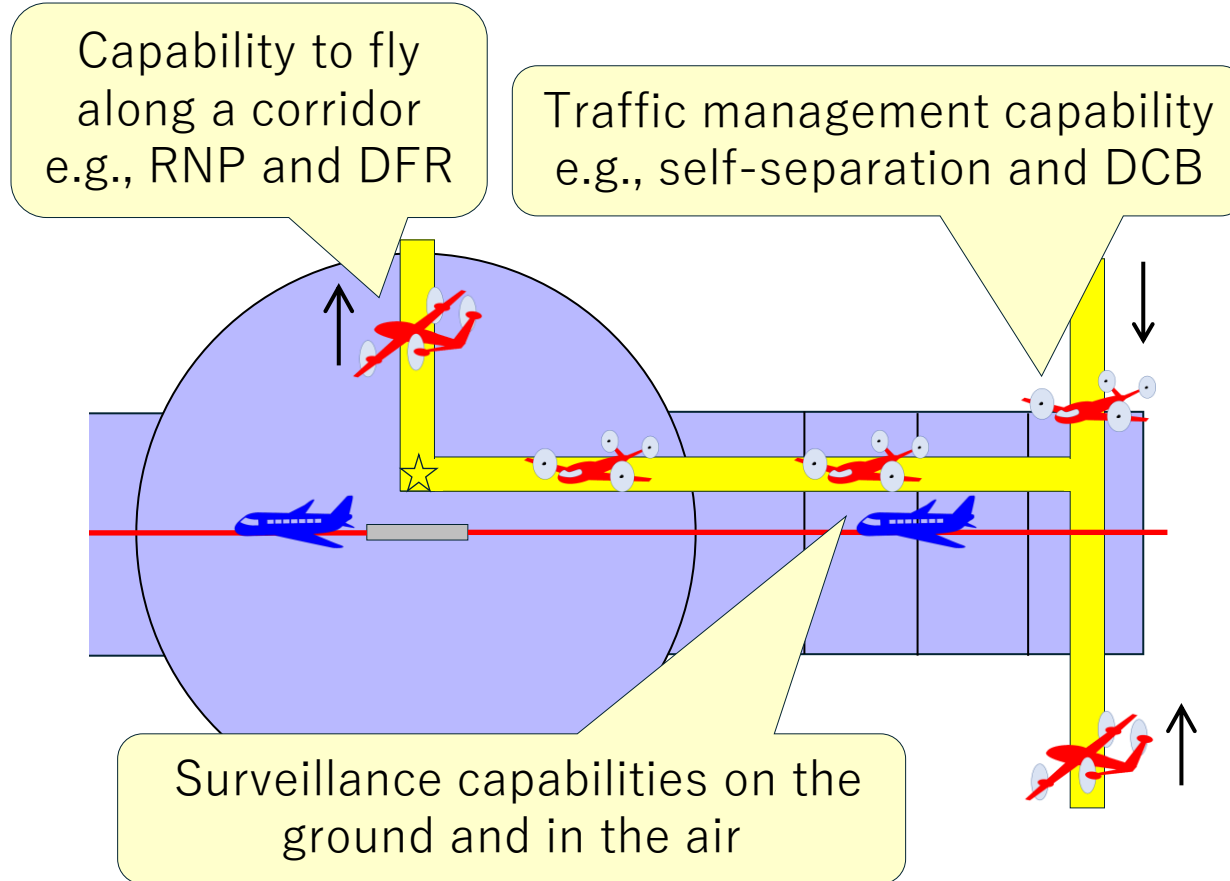


ADS-B: Automatic Dependent Surveillance – Broadcast

4. Discussion



Additional requirements for independent operations



Overview of TIS-B

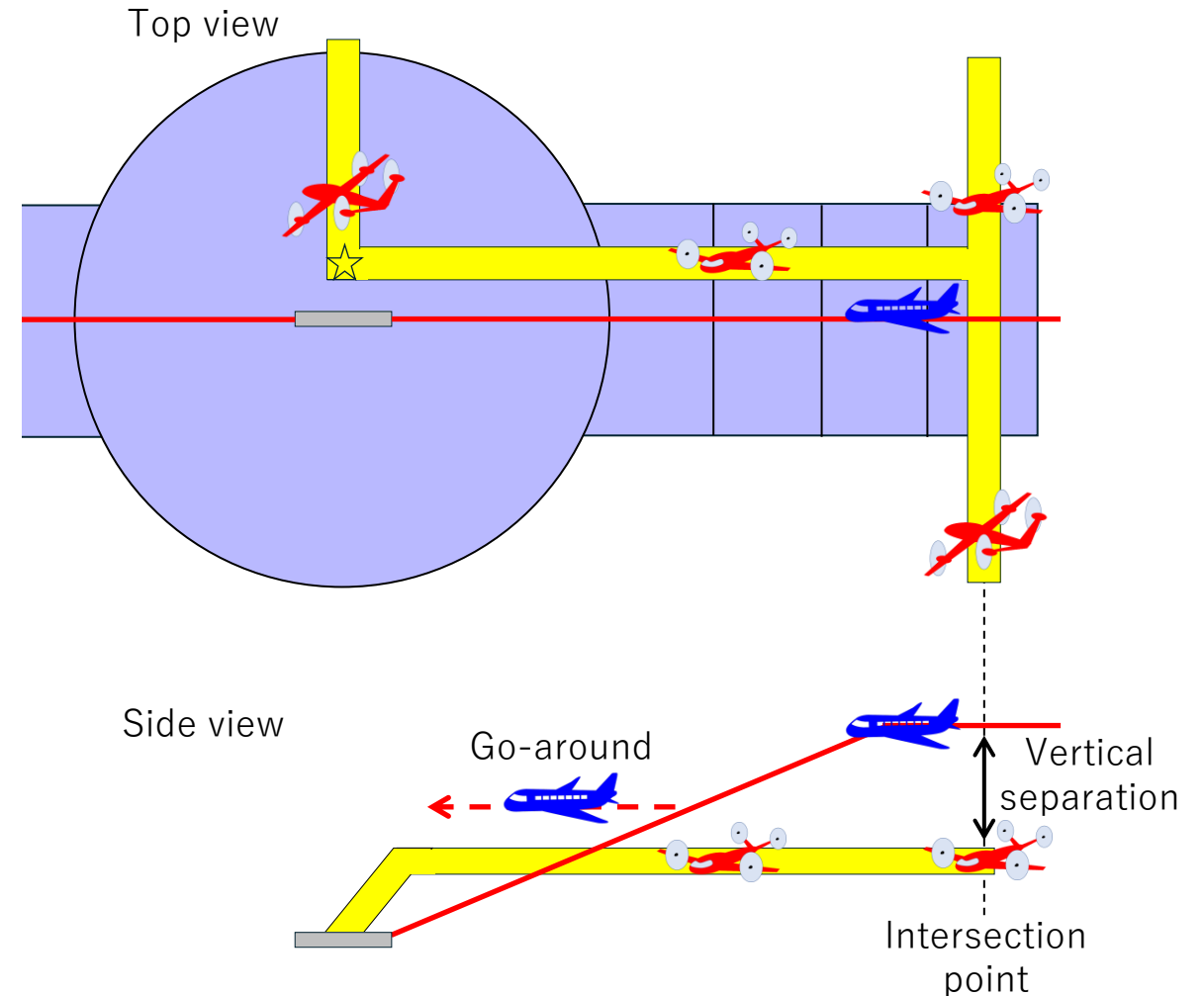
RNP: Required Navigation Performance DFR: Digital Flight Rule
DCB: Demand Capacity Balancing TIS-B: Traffic Information Service – Broadcast

4. Discussion



Design methods for corridors

- The corridor design also requires further discussion.
 - ✓ The vertical separation is set to ensure an appropriate separation between the IFR flight route and the corridor.
 - ✓ The corridor must be designed taking into account safety during off-nominal situations.
 - ✓ Corridors must be designed based on the actual configurations of the airport, such as runways, vertiports, and flight routes.



5. Conclusion



- This study discussed independent and dependent operations for airport take-offs and landings of AAM flights.
- The take-off and landing scheduling simulations demonstrated that the implementation of independent operations could potentially double AAM flight throughput compared to dependent operations.
- The realization of independent operations was found to require additional capabilities.
- Future work will conduct a further examination of each additional requirement to achieve independent operation and address airports with multiple runways.