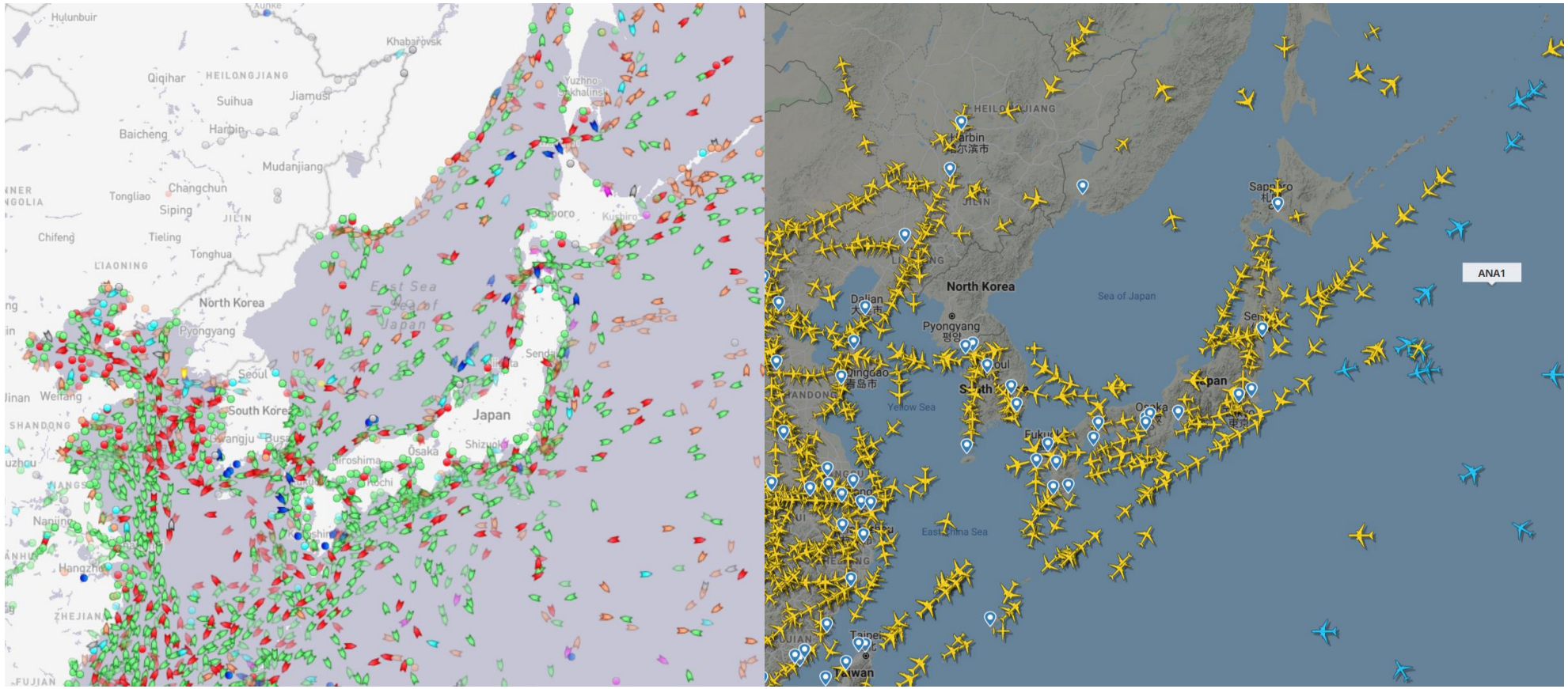
航空宇宙通信
Aerospace Communication

航空無線、船舶用無線 Network
Ship Traffic / Air Traffic



Mobile Ad-Hoc Network Based Relaying Data System for Oceanic Flight Routes in Aeronautical Communications

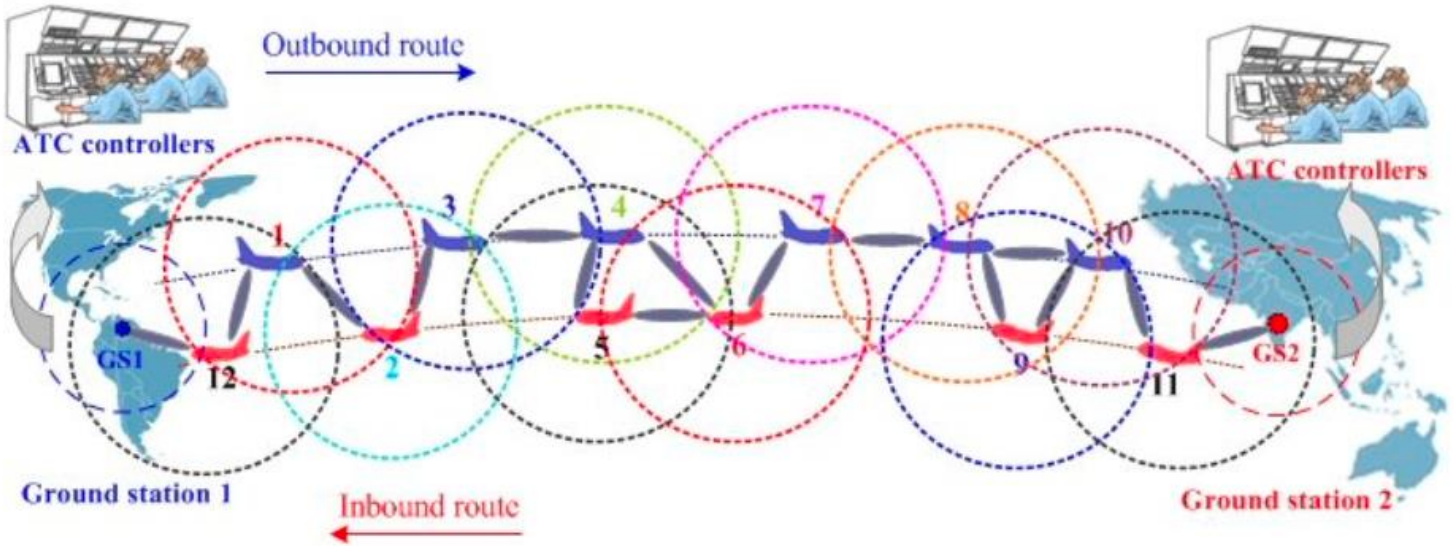
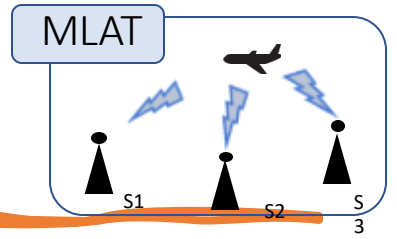


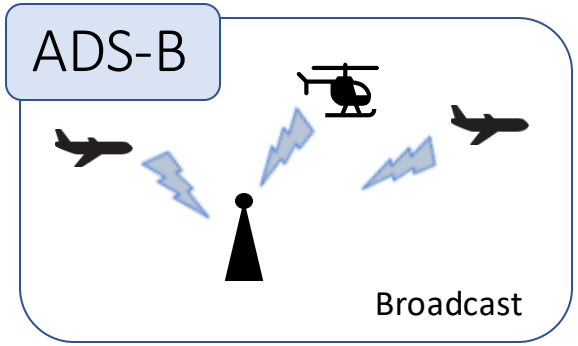
Fig. 6. Model for oceanic flights route employing mobile Ad-hoc network

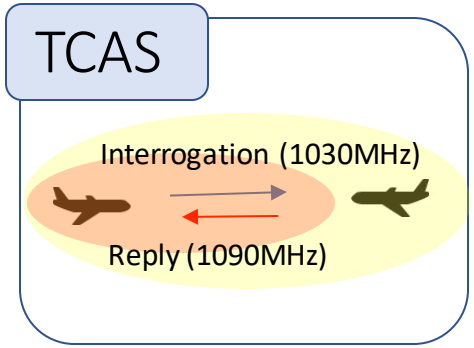
About 1090MHz Band

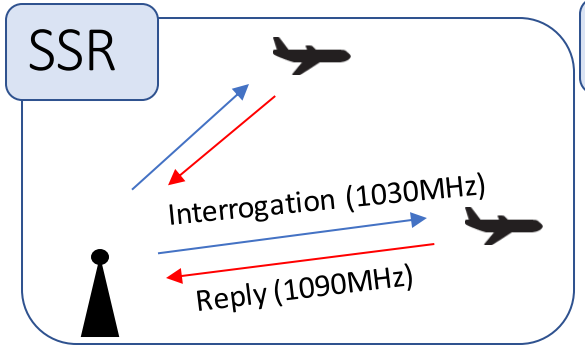
Increase in aircrafts causes saturation!

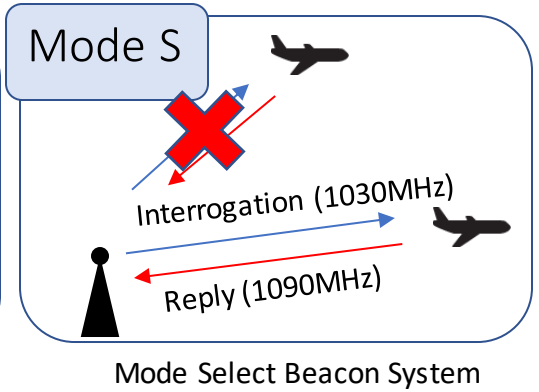


- Currently Used in
  - ADS-B (Automatic Dependent Surveillance Broadcast)
    - From 2020, became mandatory (Number of users increasing drastically)
  - SSR (Secondary Surveillance Radar)
    - Interrogation signal 1030MHz
    - Reply signal (squawk) 1090MHz
  - TCAS (Traffic Collision Avoidance System)
    - To avoid collision, creates two types of alerts depending on distance
      - TA (Traffic Advisory) Caution Area
      - RA (Resolution Advisory) Warning Area
  - MLAT (Multilateration System)
    - WAM (Wide Area Multilateration)
    - Determine position with TOA (time of arrival)



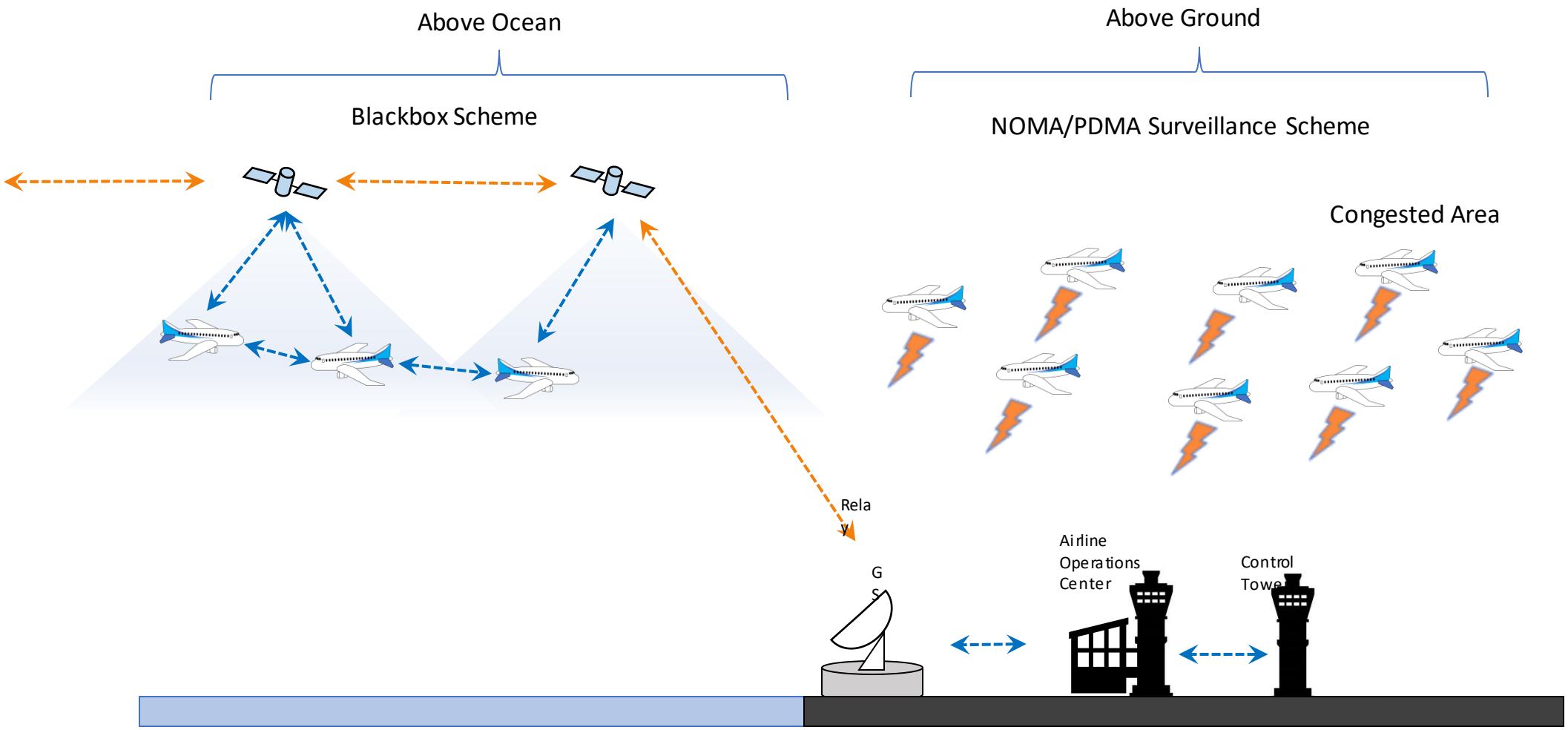






Mode Select Beacon System

Master's Research Overview



Master's Research Overview

Above Ocean

Satellite Blackbox Scheme

Where:
Primarily above ocean where ground links cannot be made

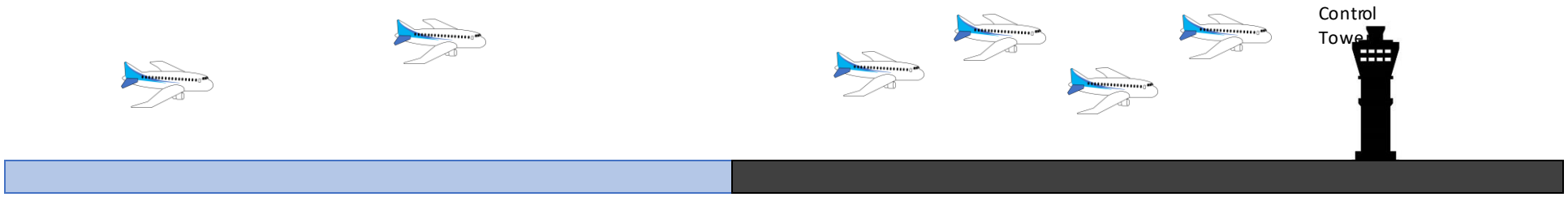
Purpose:
Unicast/Broadcast Blackbox data for redundancy. Reduce the need to recover a physical blackbox

Above Ground

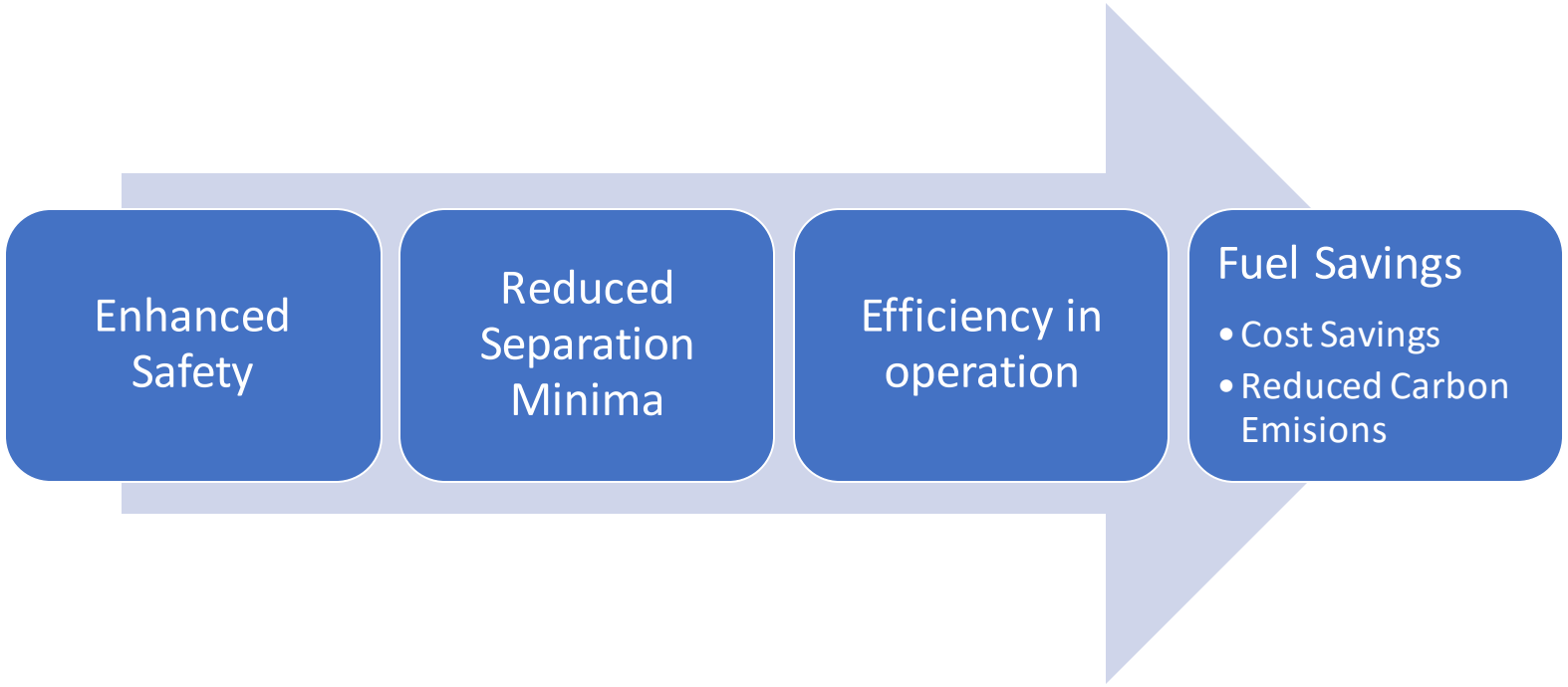
NOMA/PDMA Surveillance Scheme

Where:
Primarily above ground in congested air space

Purpose:
Enhance above ground surveilance technology in order to achieve spectral efficiency for growing air traffic and increasing data rates

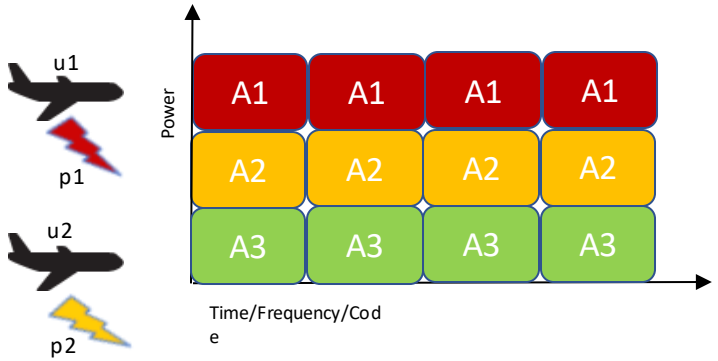


Outcome

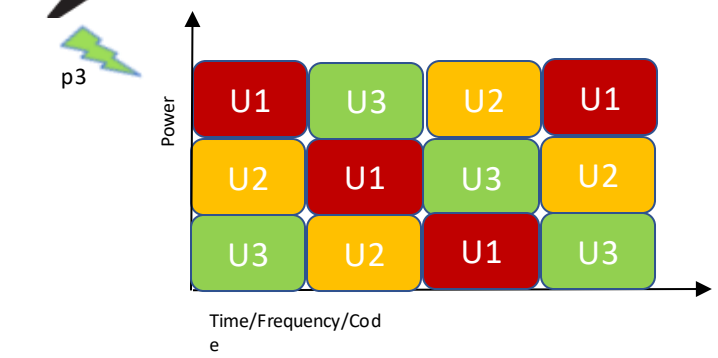

Enhanced Safety
Reduced Separation Minima
Efficiency in operation
Fuel Savings
• Cost Savings
• Reduced Carbon Emisions

Above Ground Proposal Considerations

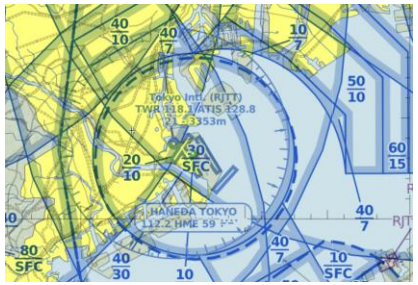
NOMA According to Area



PDMA with Different Aircrafts

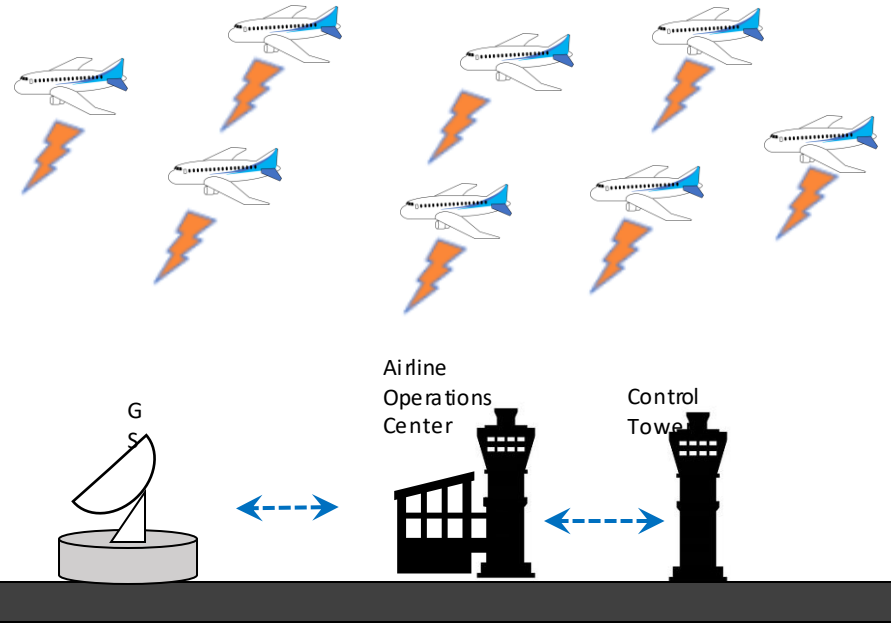


Congested Airspace such as Haneda

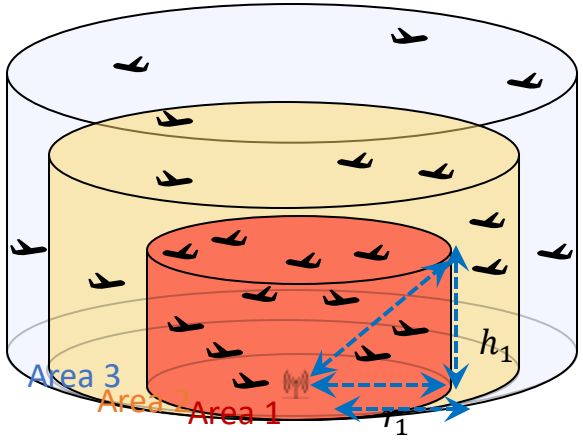


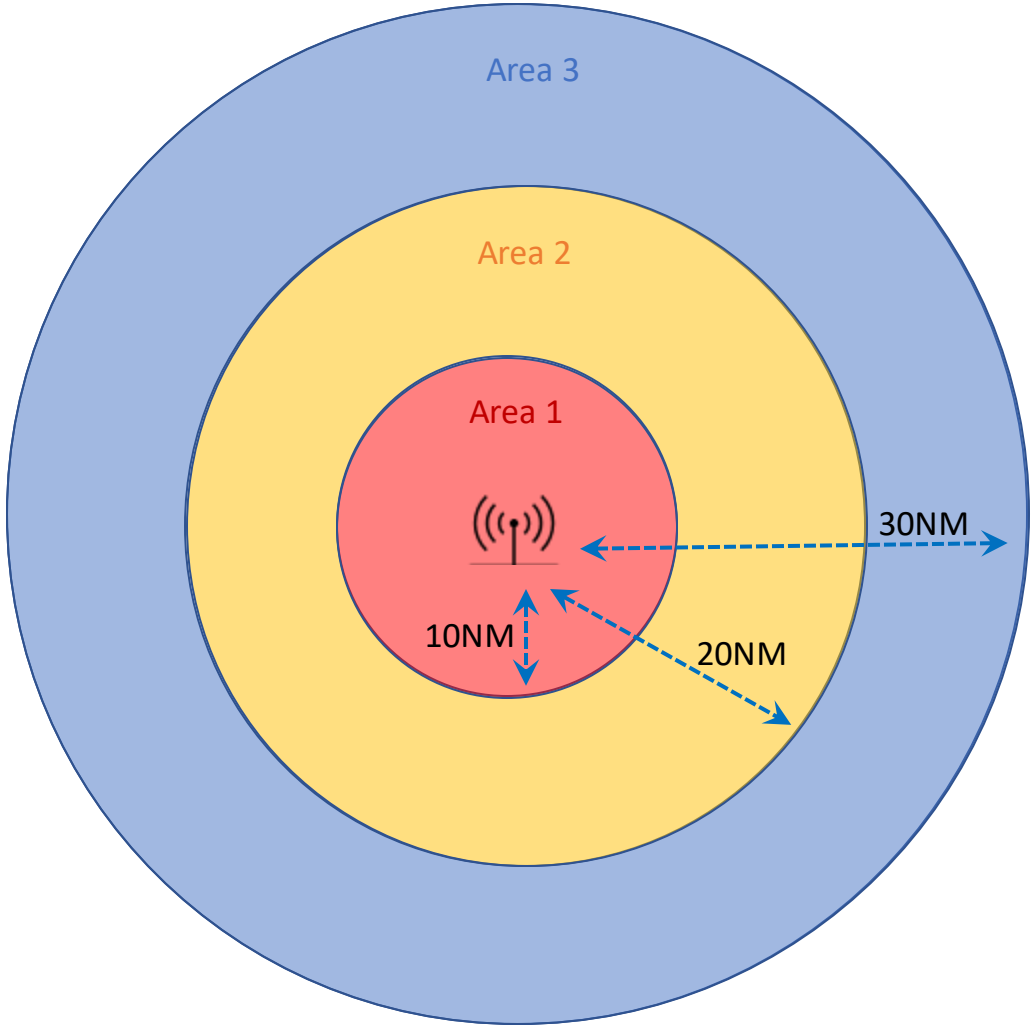
Above Ground

Congested Area




30NM

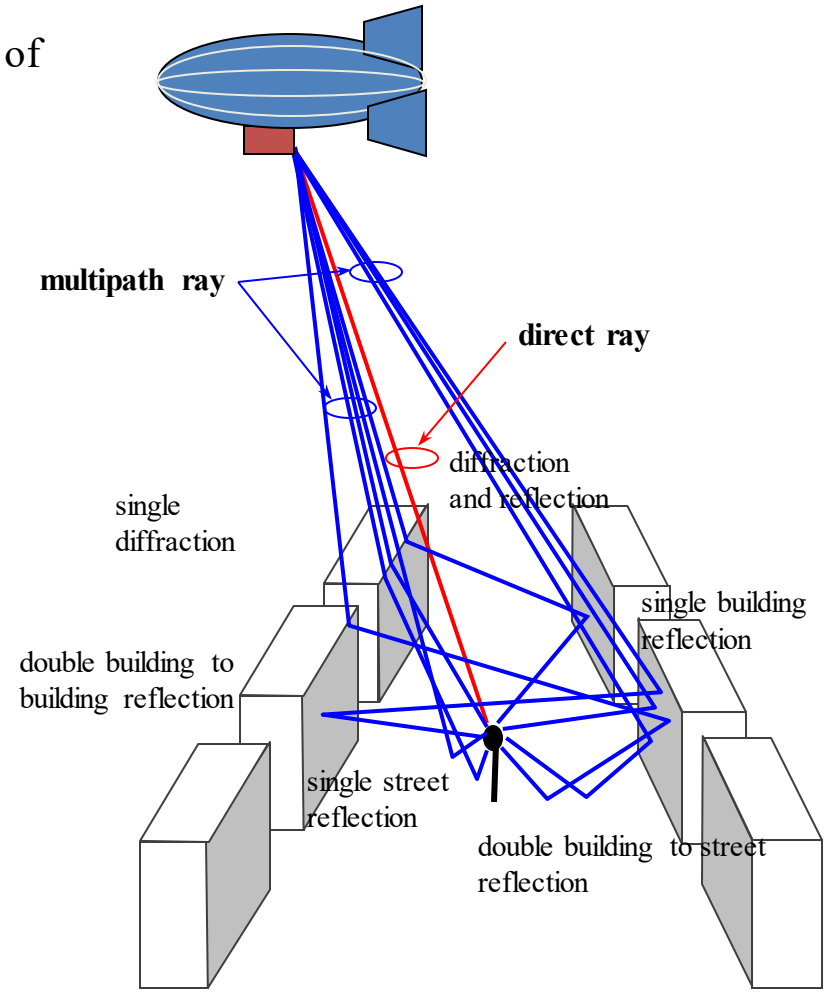

Area 3
Area 2
Area 1
h_1
r_1


Area 3
Area 2
Area 1
30NM
10NM
20NM

Ray Tracing Method

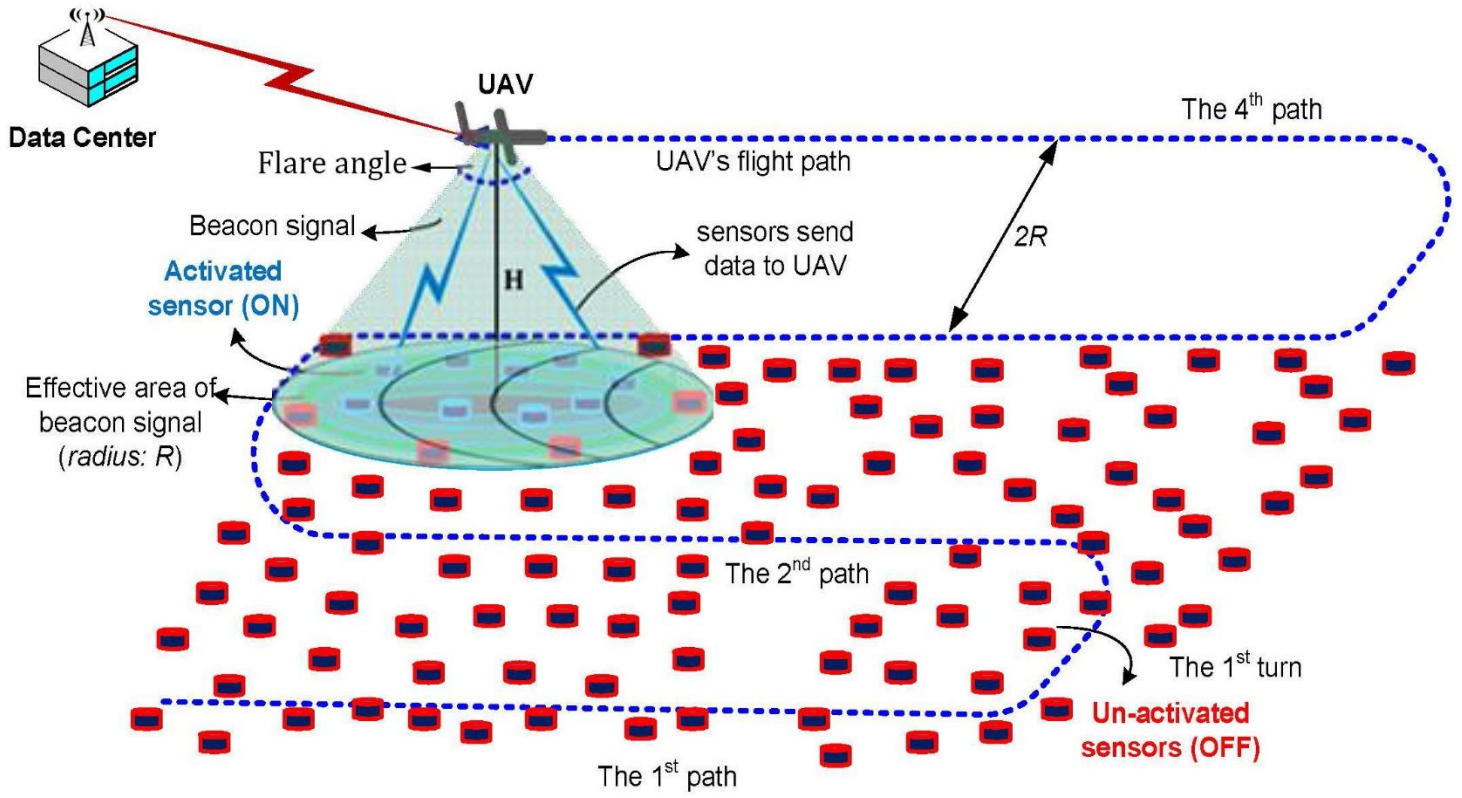
- Basic concept
  - Geometrical optic (GO) and uniform theory of diffraction (UTD)
- Rays categories
  - 9 ray categories involved in the simulation
    - direct ray
    - single reflection from building
    - single reflection from street
    - double reflection from building to street
    - double reflection from building to building
    - diffraction from building rooftop
    - diffraction from rooftop and single reflection from building
    - diffraction from rooftop and single reflection from street
    - diffraction from rooftop and double reflection from building to street
- Electrical parameters

	ε_r	$\sigma\,[\Omega^{-1}m^{-1}]$
Building	3	0.005
Street	15	7

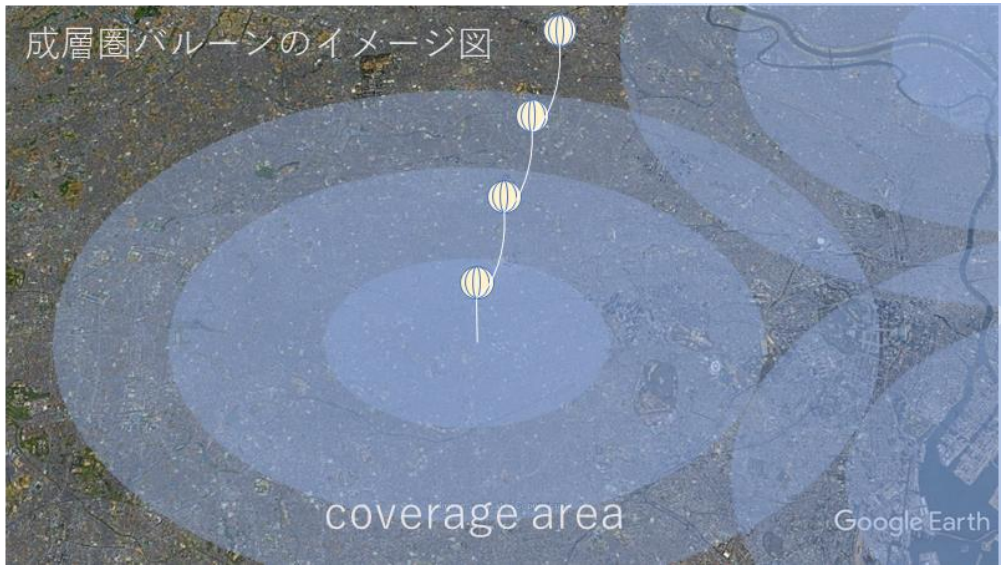


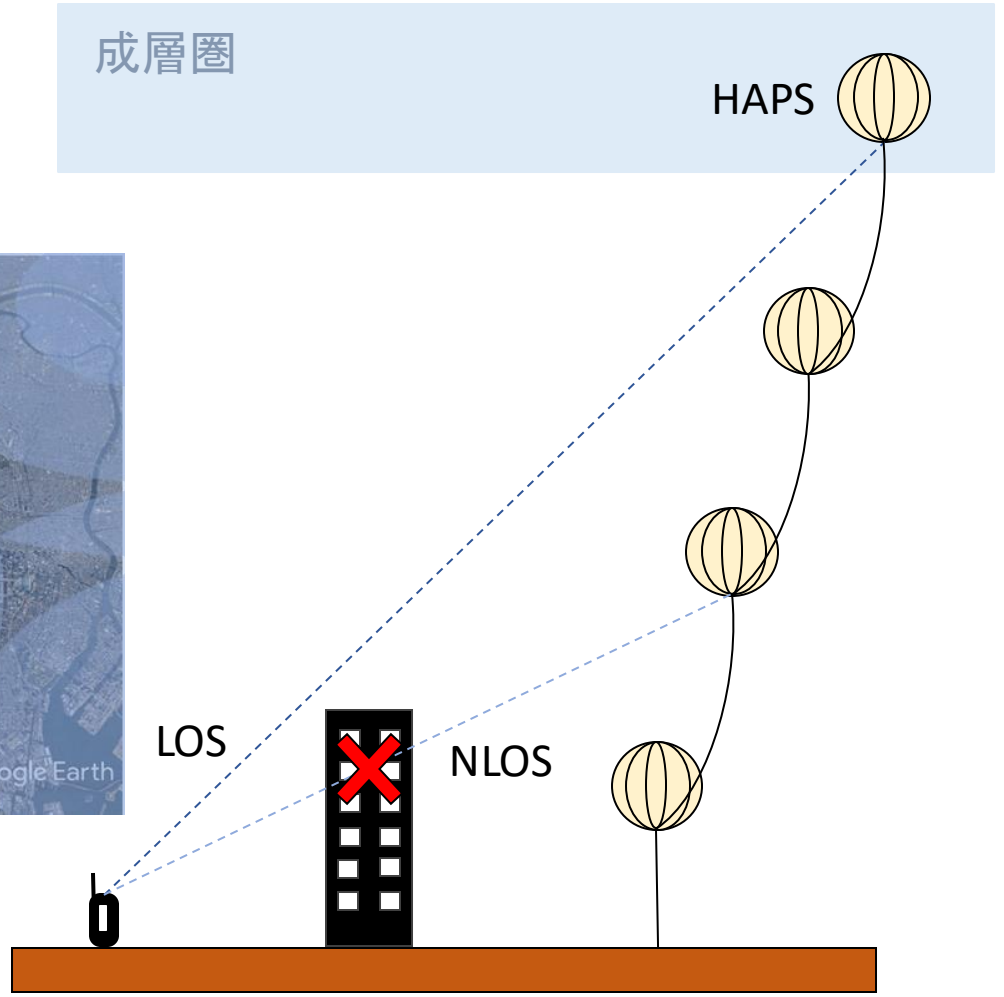
Priority-based Data Gathering

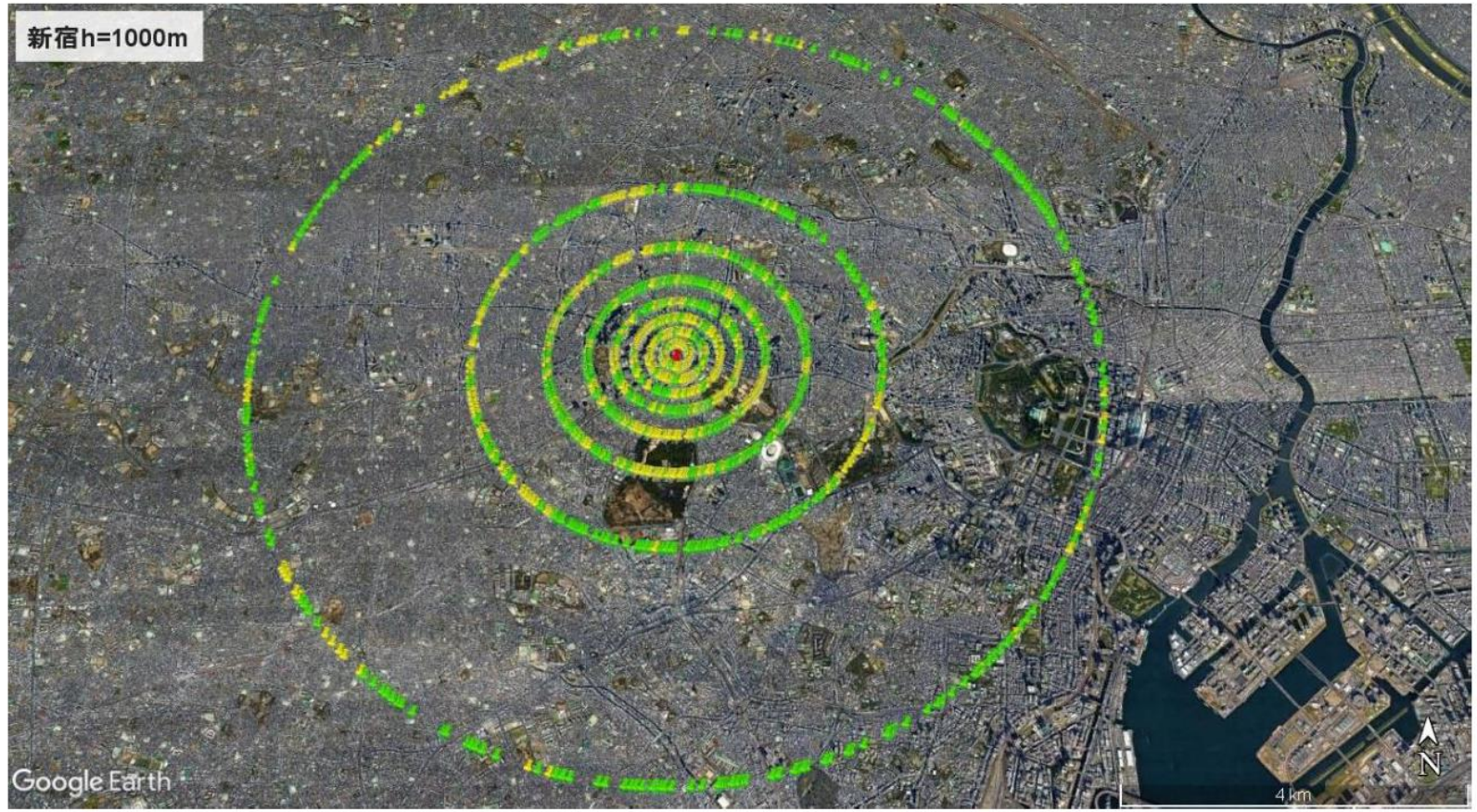
- Network model (UAV-based sensor networks)



HAPS based on Tethered Balloons






新宿h=1000m
Google Earth
4 km
N

Multiple Access Schemes in Non-terrestrial Integrated Optical Networks （LEO, MEO, GEO, HAPS）

Background

- The amount of traffic on the ground continues to increase, and the amount of traffic varies greatly depending on location and time. There is a need for a network that enables flexible network control while coping with enormous traffic.
- The quality of communication requirements (latency, capacity, and accuracy) for each traffic also varies greatly from service to service, requiring QoS control tailored to the characteristics.

Objectives

- Proposal of Multiple Access Scheme for QoS Control and Maximization of Communication Capacity in Non-terrestrial Integrated Networks
- Use of optical and millimeter waves depending on weather conditions
- Adaptive control and power allocation according to traffic characteristics

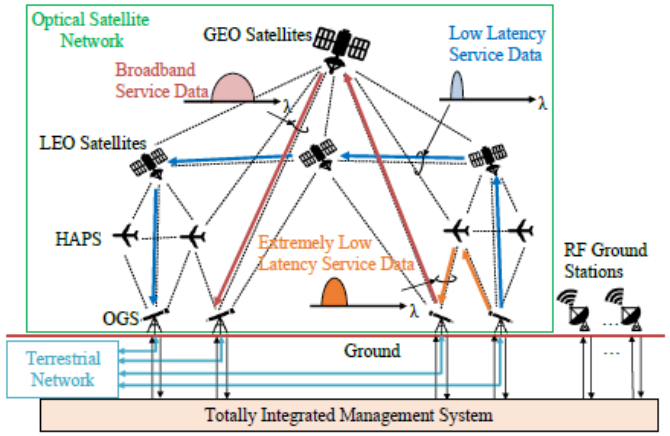
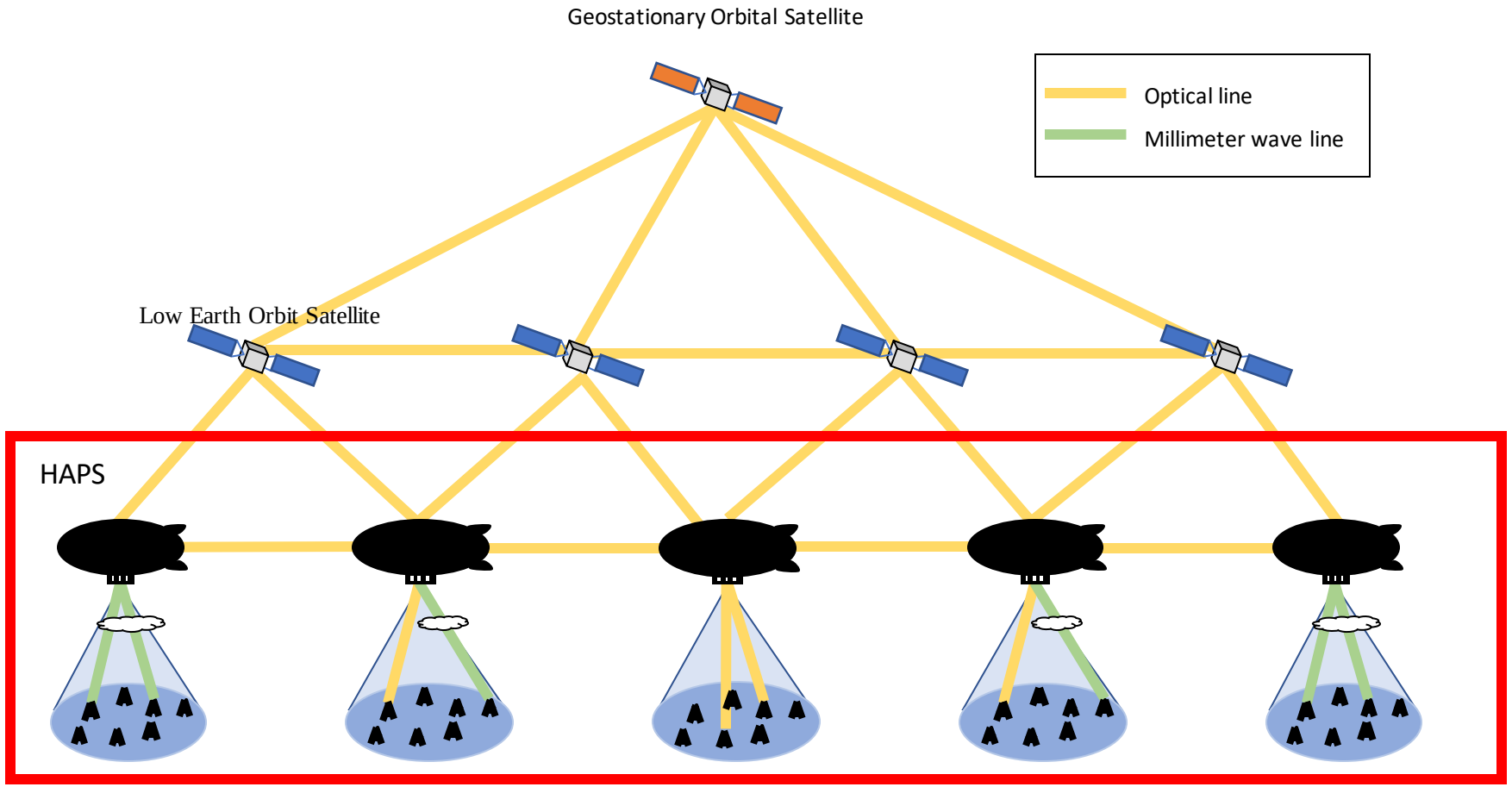
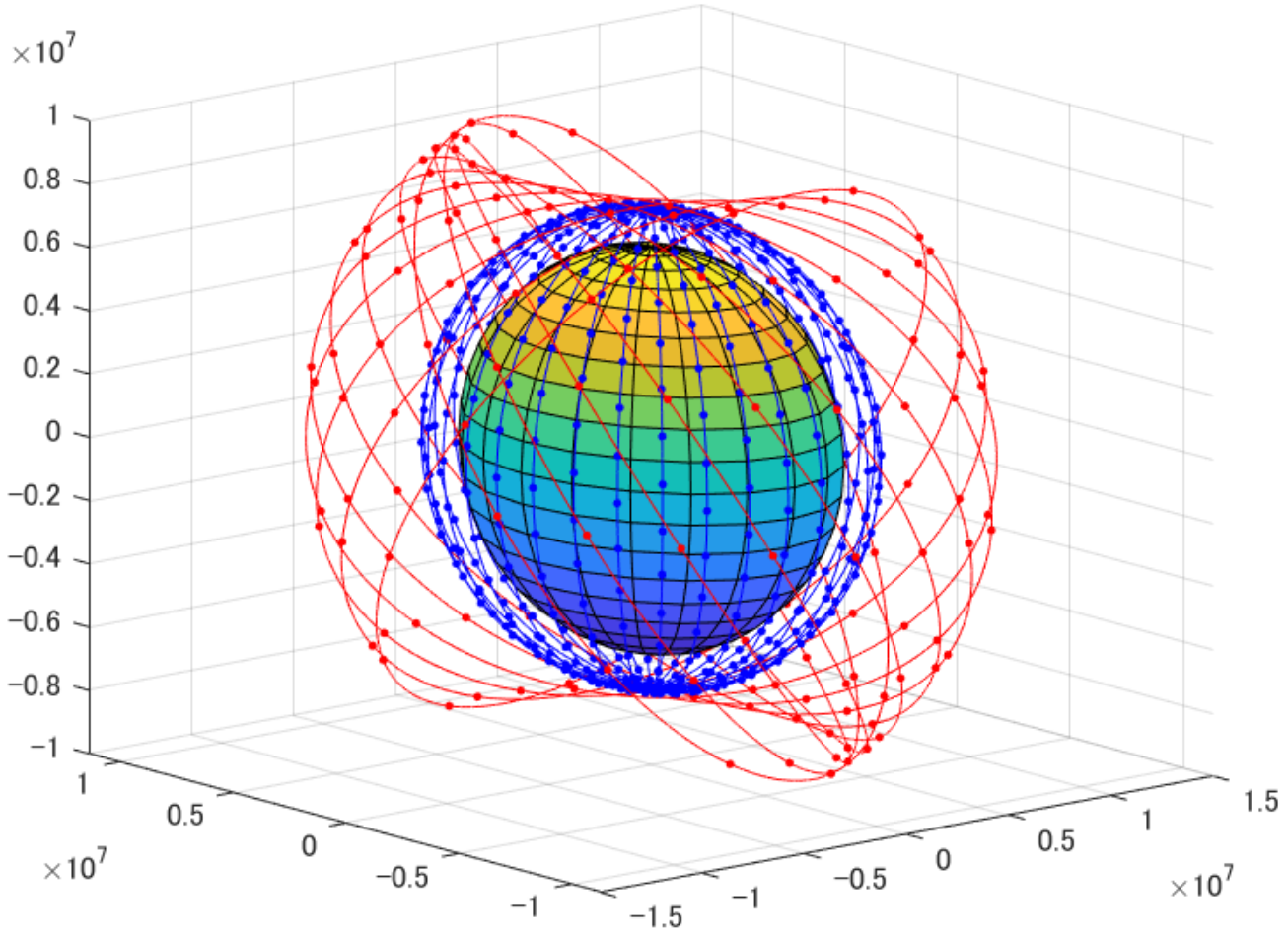


Fig. 2. System configurations of our proposed AOSN.

System Model

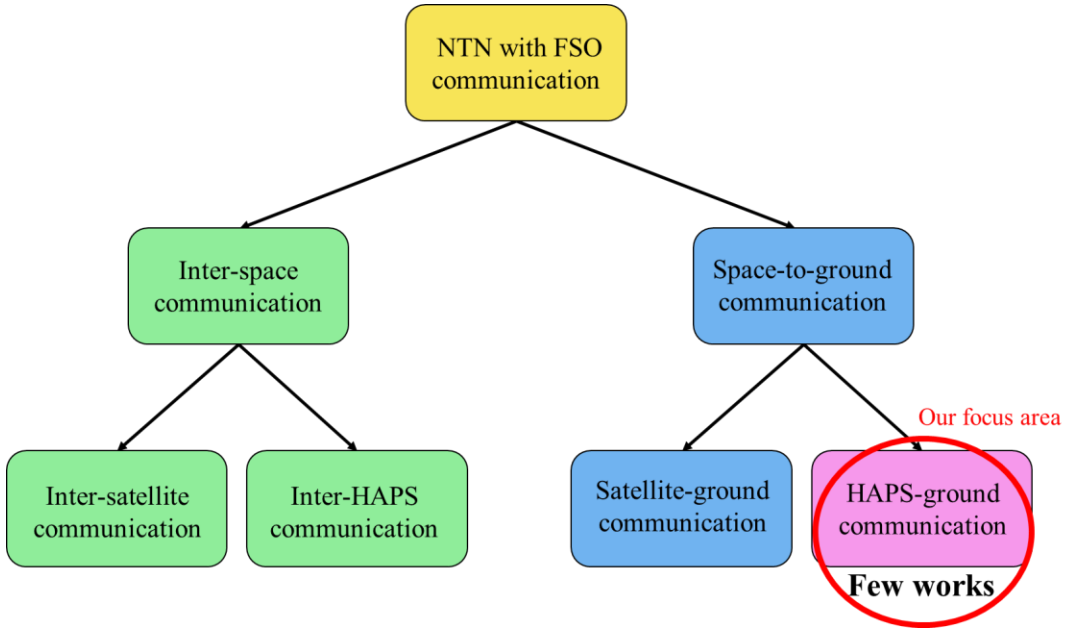


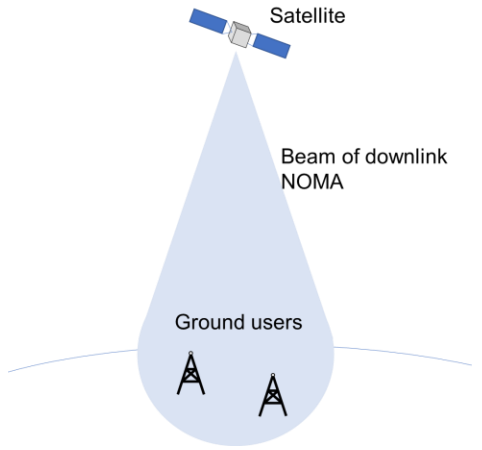
Combining low and mid orbit satellite to configure global network



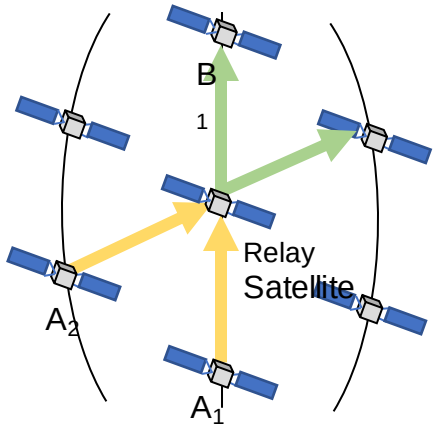
Related research

Related research for NOMA in NTN



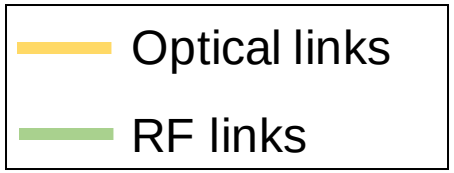


Application of NOMA for satellite-to-ground links



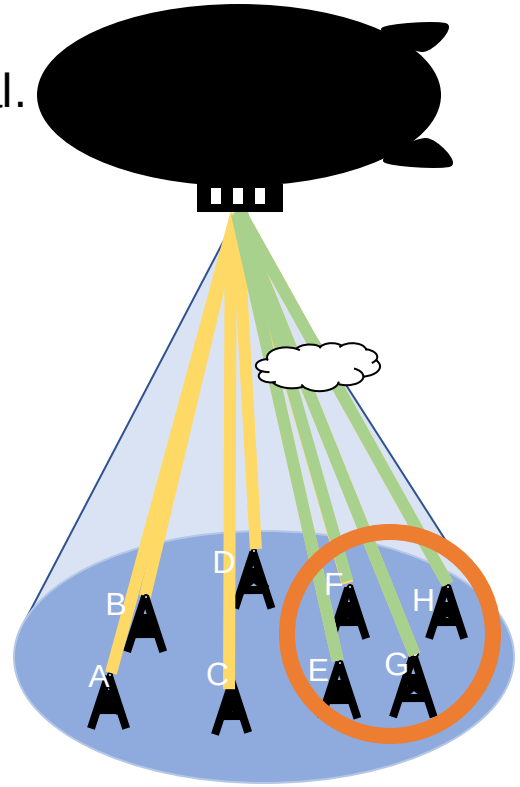
Application of NOMA for inter-satellite links

System model 1/2



1. Each ground user sends a reference optical signal to HAPS for channel state measurement at regular interval.
2. At HAPS, the received power of reference signals and estimate the channel coefficient for each user.
3. For each domain of optical and RF, the assignment and transmission power for PDMA are determined.
4. HAPS notifies the ground users of the assignment, and they start to transmit.

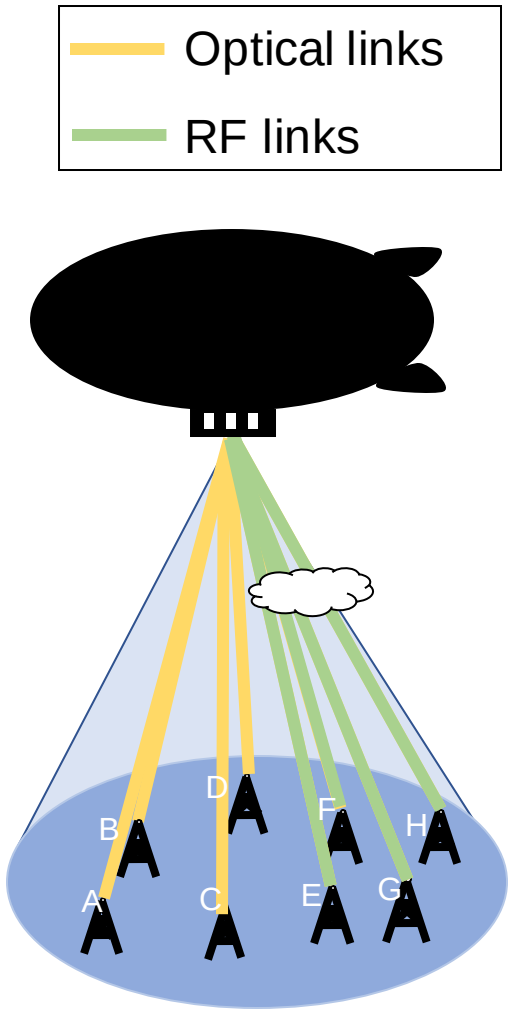
		Timeslot 1		Timeslot 2		Timeslot 3	
		optical	mm	optical	mm	optical	mm
Power level	1	A	E	D	H	C	G
	2	B	F	A	E	D	H
	3	C	G	B	F	A	E
	4	D	H	C	G	B	F



System model 2/2

Characteristics of our model

- Hybrid operation of optical and RF
- Application of PDMA
- Original power control algorithm according to channel states



Hybrid operation of optical and RF