

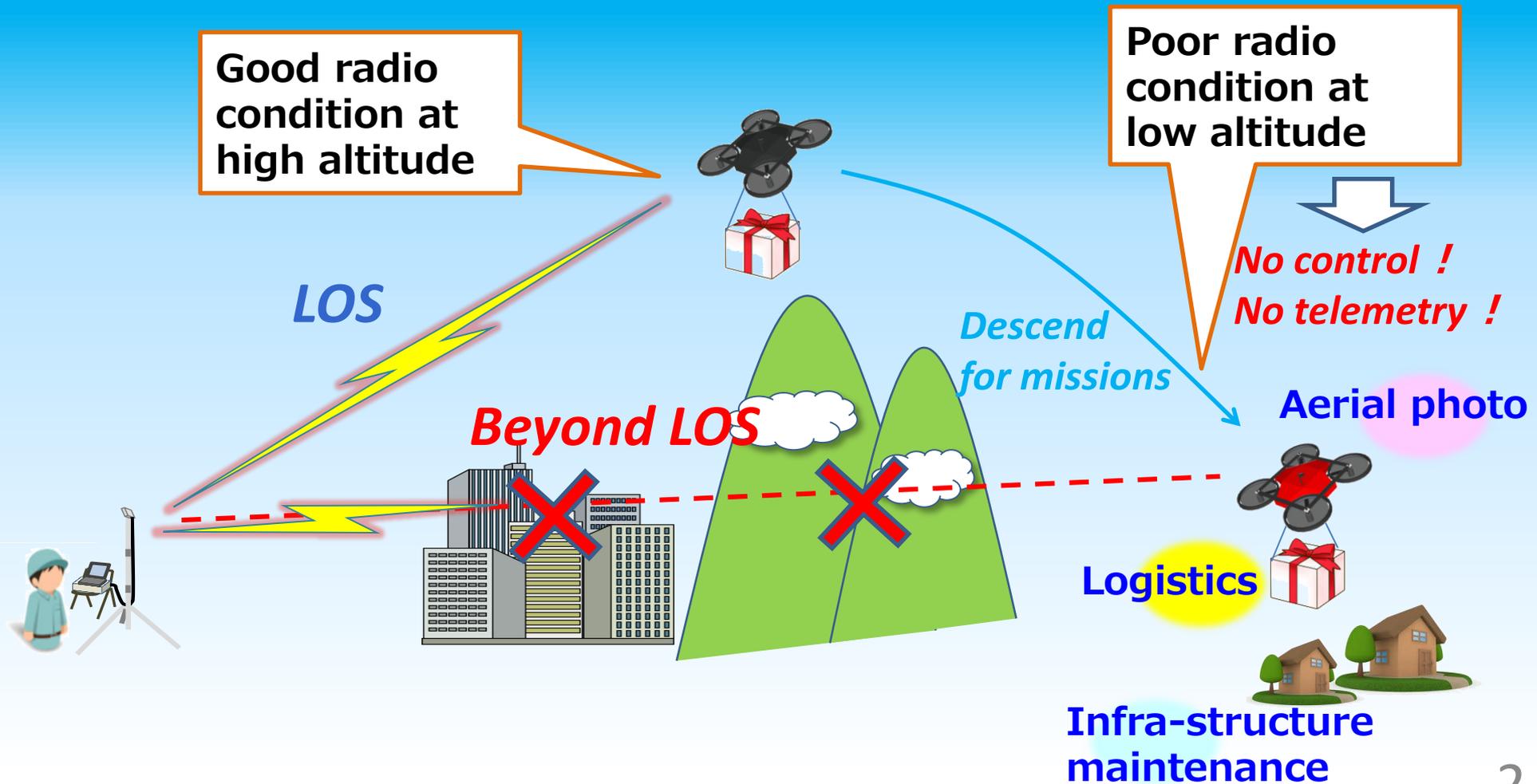
# Wireless Communication Technologies For Drones

~Application to Safety Operations of Drones  
Beyond Line-Of-Sight~



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# Beyond LOS (Line-of-Sight) Operations in Mountain or Urban Areas



# (1) Multi-hop Remote Control Communication "Command Hopper"

## Research target

To remotely control beyond-LOS drones or robots by cooperation with nearby robots with continuity even with disasters(\*)

(\*) Cell phone networks would be disabled due to the power outage or physical damages

Buildings, walls, trees, or mountains

Obstacles to attenuate or block radios

Operator (GCS)

Relay robot (drone)

Target robot (ground)

Target robot (drone)

Relay robot (ground)

## Specifications

	Normal Mode	Backup Mode
Freq. band	920MHz	169MHz
Transmitting Power	< 20mW	Air.<10mW Ground<1W
Data rate	~50 kbps	~20kbps
Latency	~60msec	~2.6 sec
Size	96 x 93 x 31.7 mm (w/o antenna, battery)	
Weight	~340g (w/o antenna, battery)	

※ This research is supported by the project "Tough Robotics Challenge" in the ImPACT Program of the Cabinet Office.

# Field Test 1

(Nov. 2016)

Ultra-high speed relay route switching  
 from 1 hop to 3 hops  
 (switching latency ~ 50-60 msec)



1 hop (Direct)

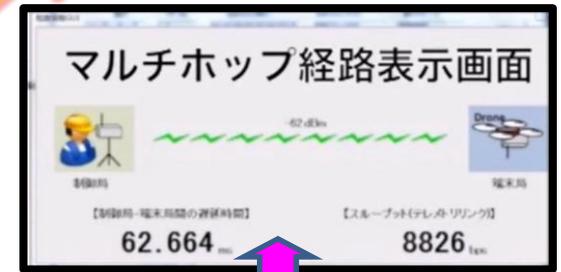
2 hop

3 hop

GCS (fixed on pole)

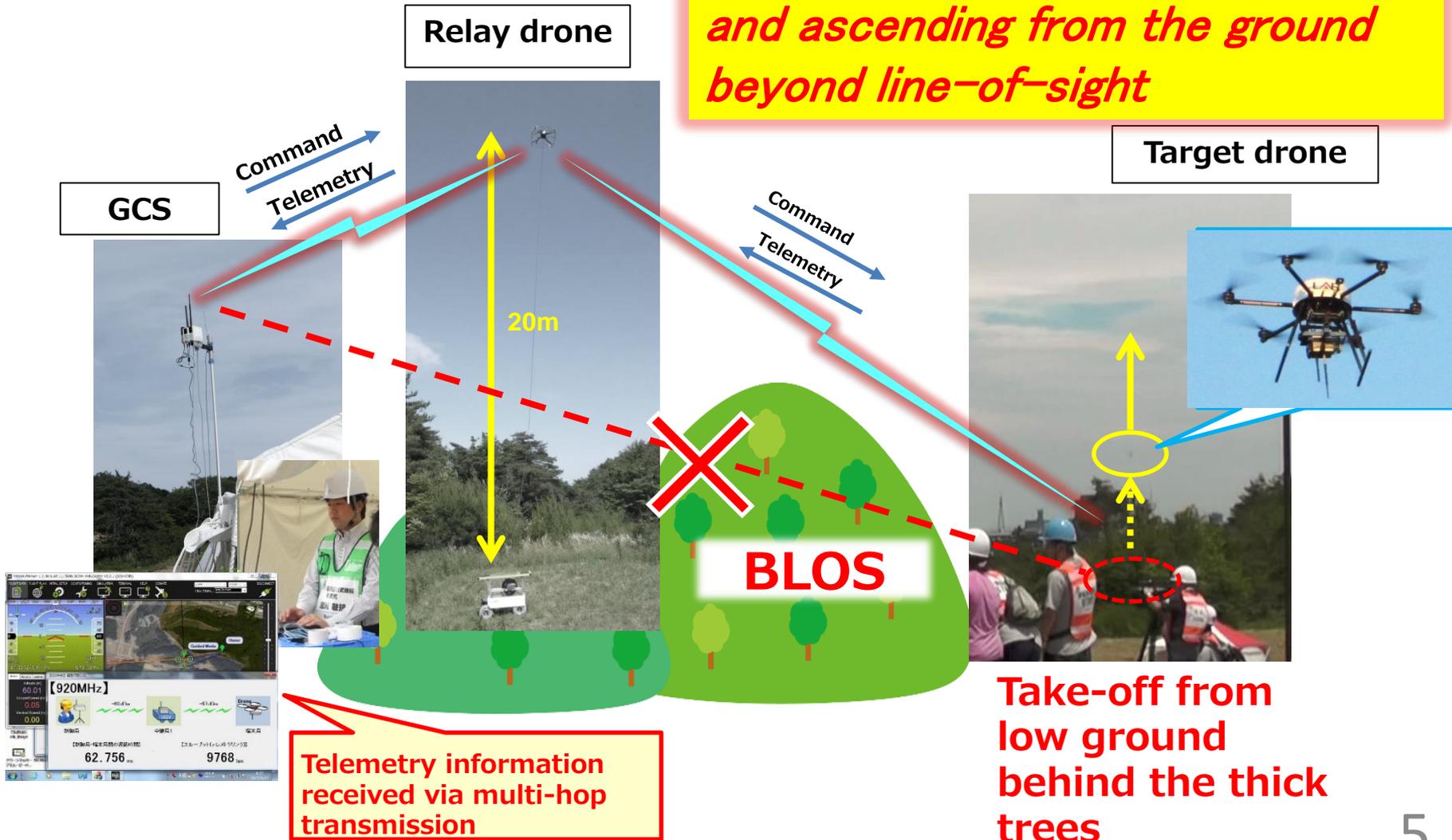
Relay stn. 1  
(fixed on pole)

Relay stn. 2  
(onboard UGV)



# Field Test 2 (Jun. 2017)

*Successfully achieved take-off and ascending from the ground beyond line-of-sight*



# Field Test of Multi-hop Drone Control (Nov. 2016@Aobayama Campus, Tohoku Univ.)



A drone flying away via  
3-hop C2 link



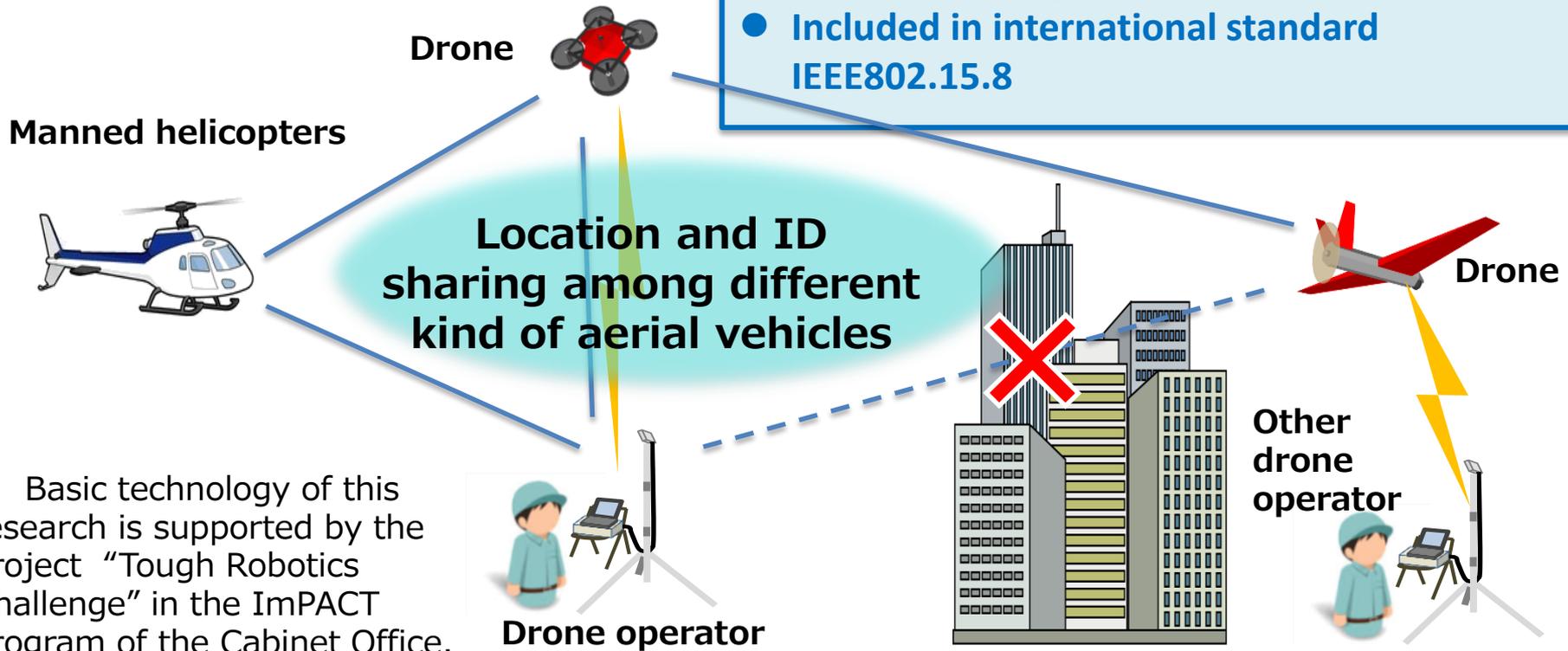
# (2) Location Information Distribution Network for Aerial Vehicles "Drone Mapper"

## Research target

To share the location and ID information among nearby drones and manned helicopters within the area of 1~2km.

## Features

- Base on Infra-less decentralized D2D network
- Simplified broadcast access control protocol
- Covering beyond LOS by 2-hop relay
- Using 920MHz band and no license needed (RF device complies with ARIB STD T108)
- Included in international standard IEEE802.15.8



※ Basic technology of this research is supported by the project "Tough Robotics Challenge" in the ImPACT Program of the Cabinet Office.

# Drone Mapper: Field Test

Drone A



Drone B



Monitor Display on the Android Tablet PC  
(Location, altitude, heading, etc. for near drones)



Other drone  
(on the ground)



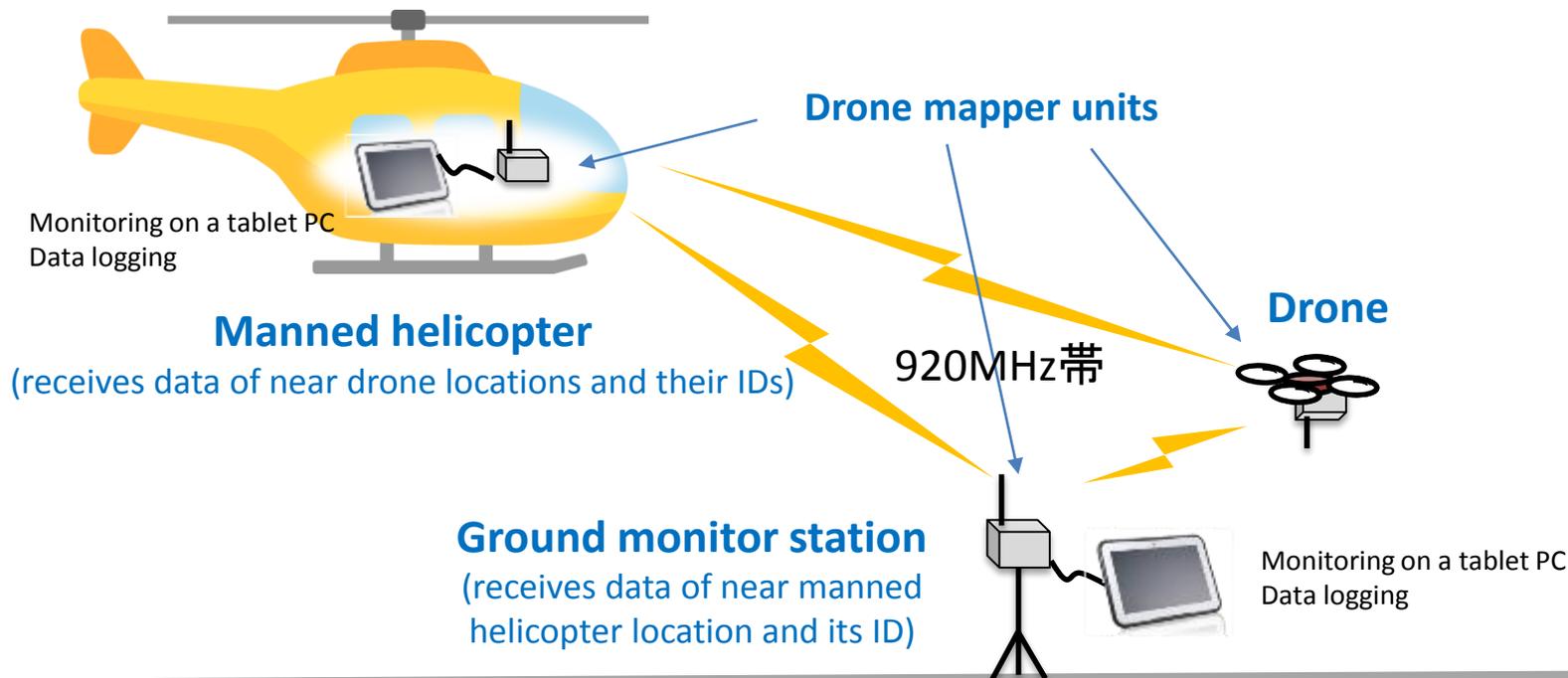
GCS

Data of each of the drones



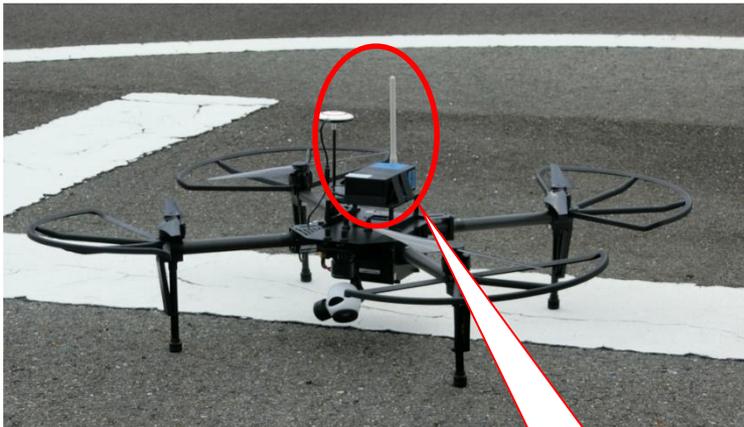
	Single-hop/Multi-hop mode
Frequency	920MHz
TX power	20mW or lower
Data rate	20 kbps
Size	90 x 75 x 45 mm (w/ battery, w/o antenna and case)
Weight	310g (w/ antenna and battery, w/o case)

# V2V Communication Field Test for Location Info. Sharing Between Drones and Manned Helicopters



Date: March 2, 2018  
 Venue: Kiso river, Aich pref.  
 Promotor: NEDO、Sky Perfect JSAT、NICT  
 Support: Aisai City, Terra Drone, Nakanihon Air Service

# Implementation



On a drone



Carried into the helicopter  
as a hand baggage



Dronemapper unit  
(920MHz-20mW、LoRa)



# Tablet PC Display of the Ground Monitor Station (showing the location of a helicopter around 9 km away)

**ドローンマッパー**

自機詳細情報 ID :43  
 種別 :Station  
 時刻 :10:53:28  
 距離 :0.000m  
 緯度 :35.227253  
 経度 :136.684814  
 高度 :13.0m  
 速度 :0.1km/h  
 方位 :0.0度  
 RSSI : -000dBm  
 受信数 :68回  
 補足 :  
 001100000

周辺機詳細情報 ID :46  
 種別 :Drone  
 時刻 :10:53:26  
 距離 :8.432m  
 緯度 :35.227329  
 経度 :136.684814  
 高度 :23.0m  
 速度 :5.6km/h  
 方位 :0.0度  
 RSSI : -66dBm  
 受信数 :34回  
 補足 :  
 000000000

周辺機詳細情報 ID :31  
 種別 :Helicopter  
 時刻 :10:53:27  
 距離 :9273.394m  
 緯度 :35.301716  
 経度 :136.731110  
 高度 :174.0m  
 速度 :133.3km/h  
 方位 :30.5度  
 RSSI : -103dBm  
 受信数 :32回  
 補足 :  
 000000000

**Helicopter**

**Drone (own)**

**~9km**

**Helicopter ID**

**Range**

**Altitude**

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# Summary



- **Wireless technology is one of the key issues for safety operations of drones, particularly for Beyond LOS operations.**
- **Our research works focus on the improvement of reliability and availability of wireless technologies for drone operation including over urban areas.**