



# 衛星通訊的創新應用

## IoT物聯網服務

鐳洋科技

林致宏

# Business Unit

## RF Test Solution

射頻測試方案

**67GHz** Capable  
WiFi6E, Ka, Ku  
Array Solution

**Cal + MP**

## Automation

自動化

Servo Motor  
Controller

**Switch / Relay**

## Advanced RF RD Center (ARRC)

先進射頻研發中心

## Products Design

5G-NR FR1&**FR2** / **LEO**

Satellite

Other Customized Design

## Prophasor

陣列天線設計

4X4 8X8  
16X32 32X32

**Full /Half Duplex**

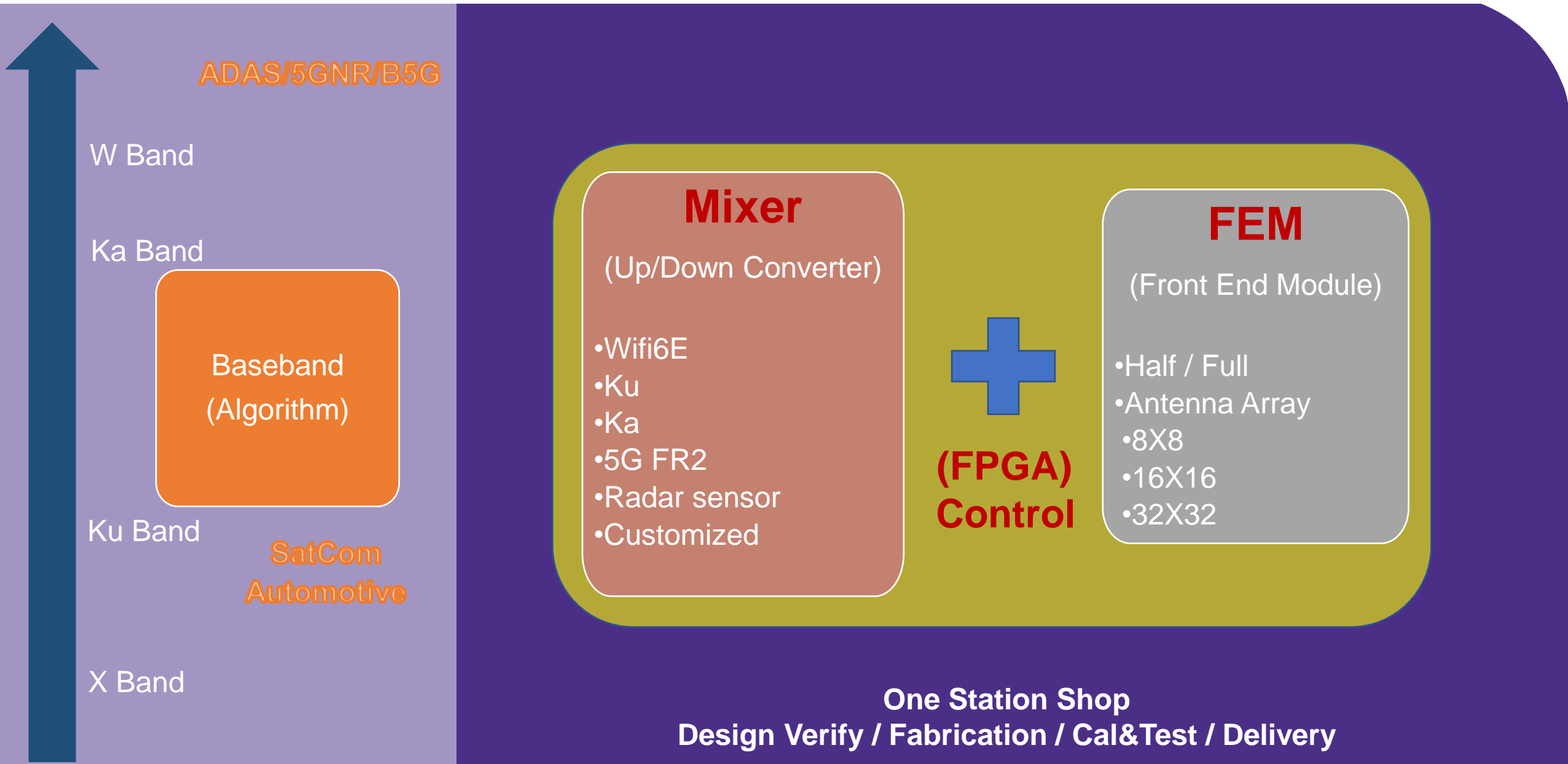
## Space

太空

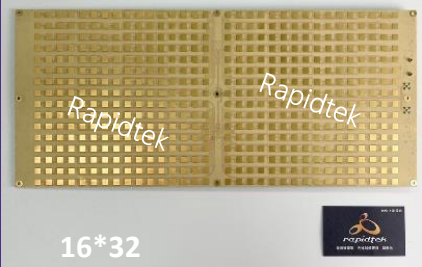
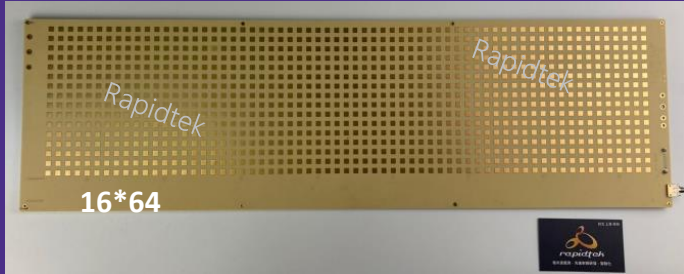

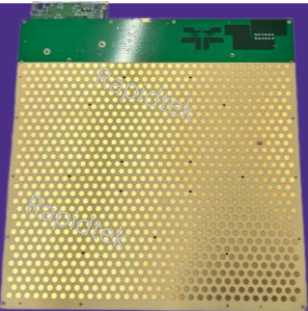

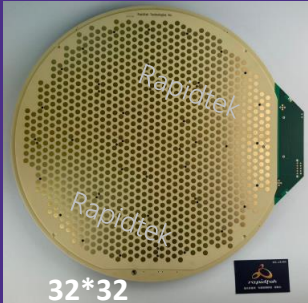
**CUBESAT**

Com Payload  
UHF Transceiver







Application	RX AESA	TX AESA	Rx/Tx Hybrid AESA
Space			NA
Ground			 

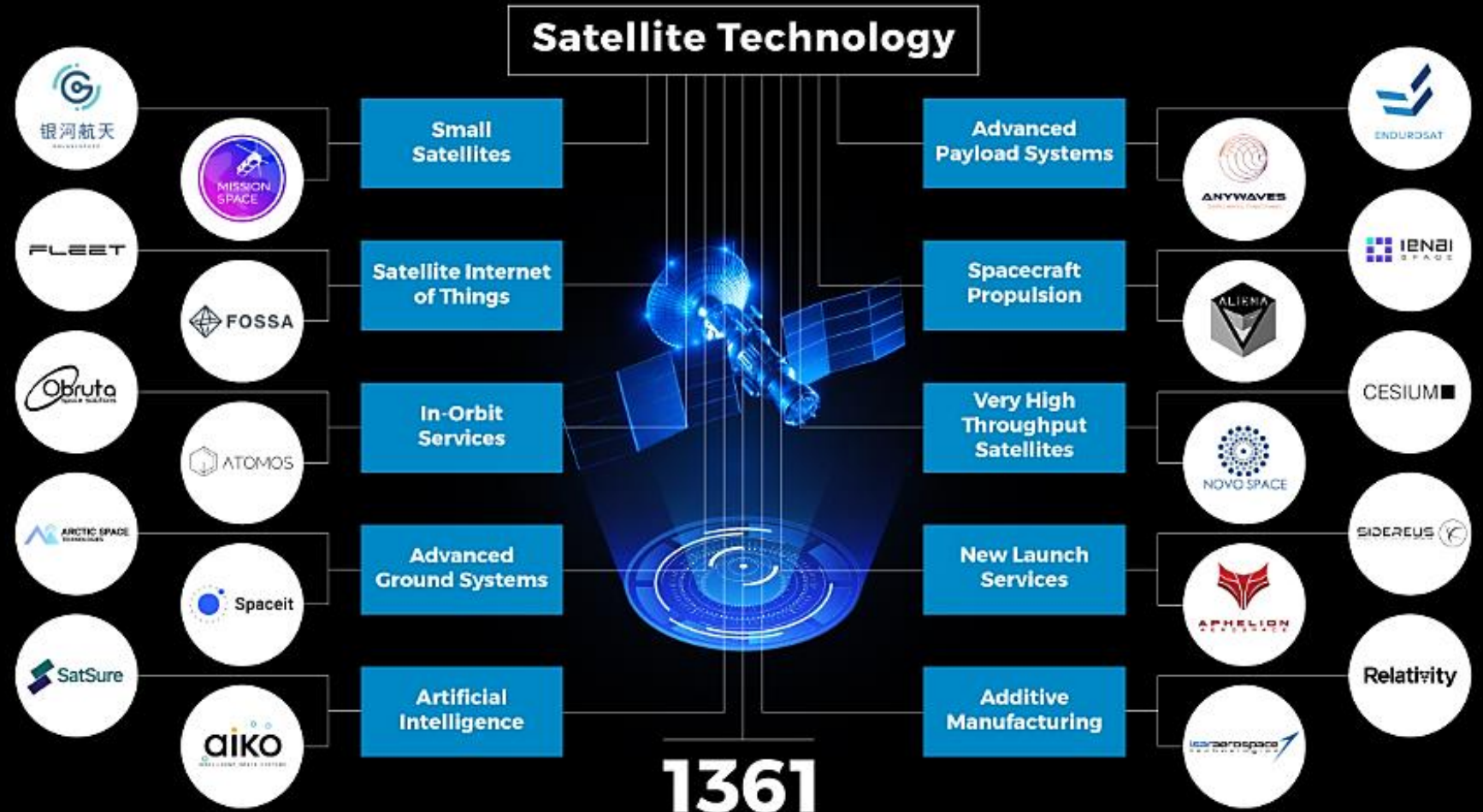
Ku band  
 G/T: 11.5 dB/k  
 Power <100 W  
 Beam scan area: +-60 degree  
 Polarization: V-pol, H-pol, RHCP and LHCP

Ku band  
 EIRP: >45 dBW  
 Power <200 W  
 Beam scan area: +- 60 degree (AZ)  
 Polarization: V-pol, H-pol, RHCP and LHCP

Integrated with Up/Down converter  
 Frequency: Ku band  
 EIRP: >39 dBW  
 G/T: >9 dB/k  
 Beam switching time: <0.5 mS  
 Polarization: RHCP for Rx, LHCP for Tx

# Top 10 Satellite Industry Trends in 2024

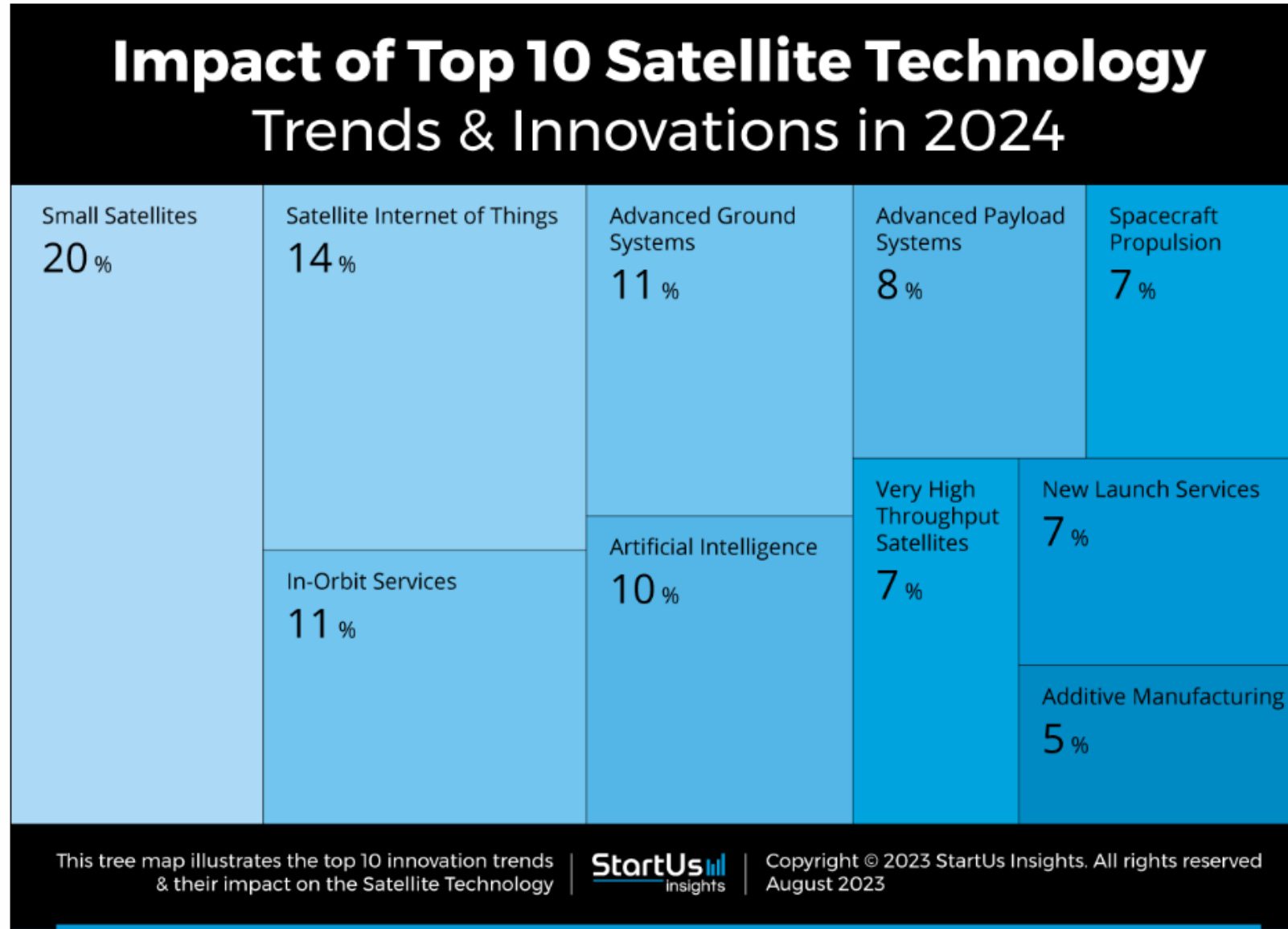
# Top 10 Satellite Technology Trends & Innovations in 2024



**1361**

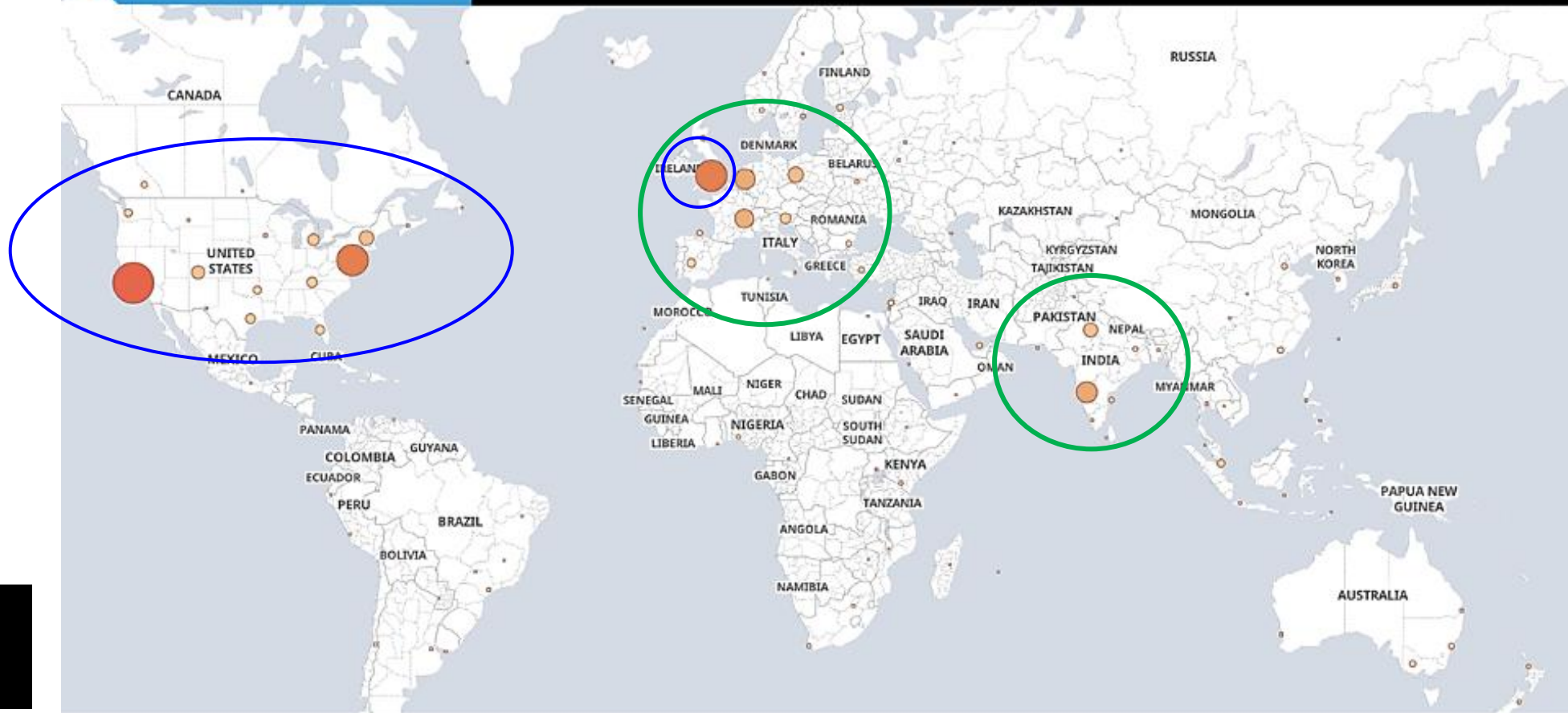
Startups & emerging companies analyzed

# Top 10 Satellite Industry Trends in 2024





# Global Startup Heat Map: Satellite Technology





# 低軌衛星技術現狀 -2 衛星物聯網的應用與發展

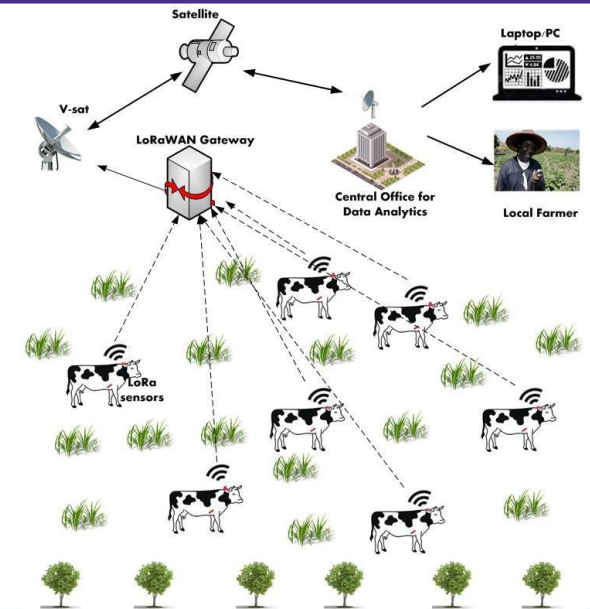
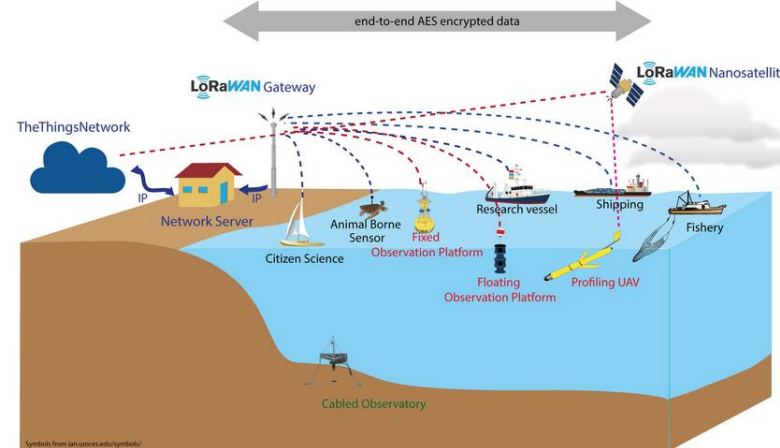
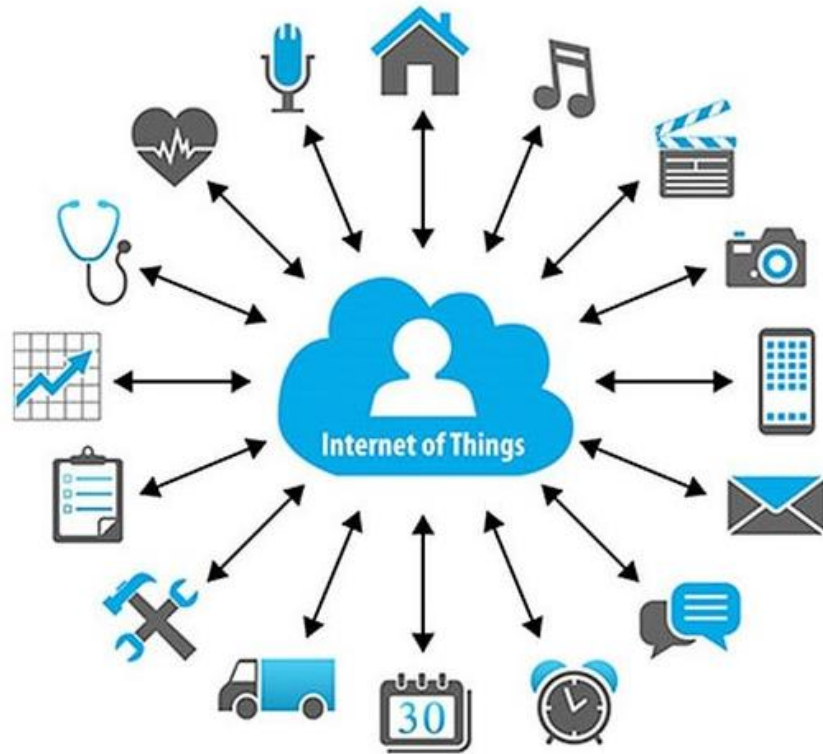


Figure:

<https://medium.com/@bmuha1/what-is-the-iot-introduction-to-the-internet-of-things-57335391cd5f>

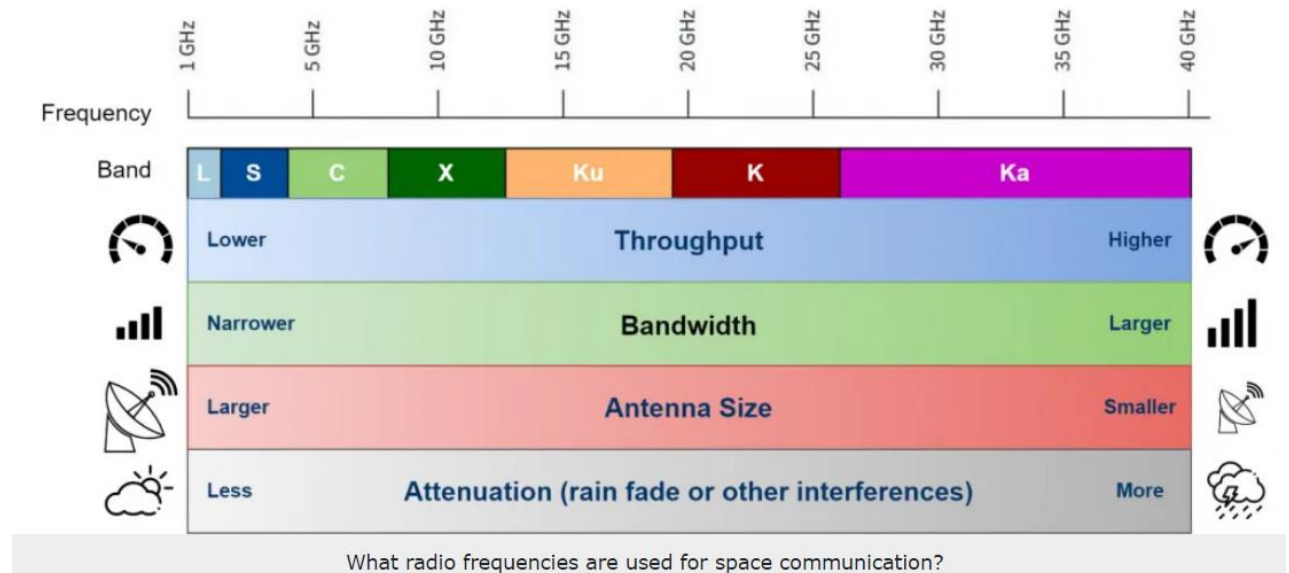
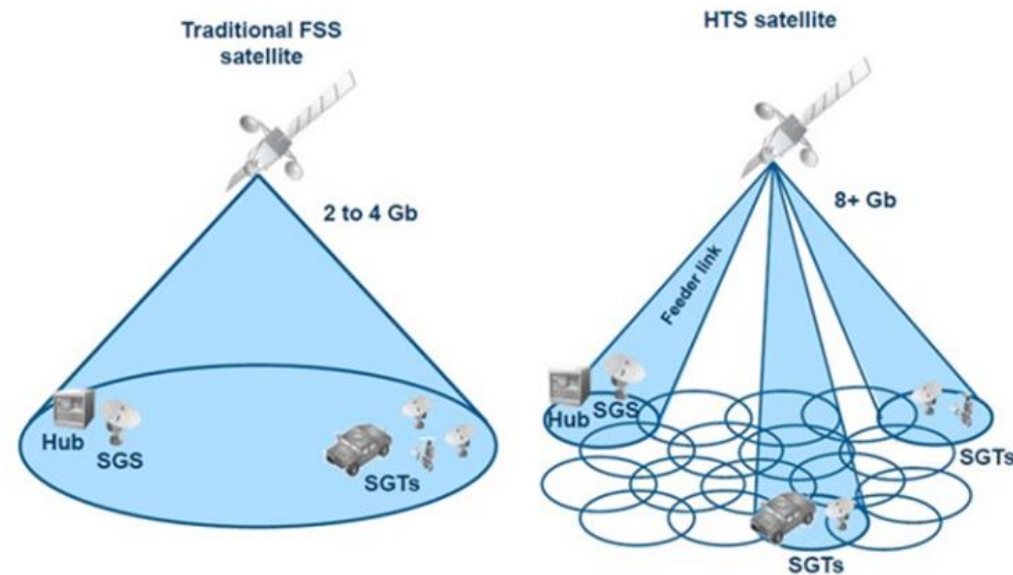
<https://www.deepseadev.com/en/blog/iot-farming-explained/>

[https://www.researchgate.net/publication/340949440\\_EXPLOITING\\_IoT\\_and\\_LoRaWAN\\_TECHNOLOGIES\\_FOR\\_EFFECTIVE\\_LIVESTOCK\\_MONITORING\\_IN\\_NIGERIA/figures?lo=1](https://www.researchgate.net/publication/340949440_EXPLOITING_IoT_and_LoRaWAN_TECHNOLOGIES_FOR_EFFECTIVE_LIVESTOCK_MONITORING_IN_NIGERIA/figures?lo=1)

[https://www.researchgate.net/publication/354030000\\_Collaborative\\_Automation\\_and\\_IoT\\_Technologies\\_for\\_Coastal\\_Ocean\\_Observing\\_Systems/figures?lo=1&utm\\_source=google&utm\\_medium=organic](https://www.researchgate.net/publication/354030000_Collaborative_Automation_and_IoT_Technologies_for_Coastal_Ocean_Observing_Systems/figures?lo=1&utm_source=google&utm_medium=organic)

<https://www.iridium.com/blog/what-is-satellite-iot-and-how-is-it-used/>

# 低軌衛星技術現狀 – 8 超高通量衛星技術與應用



- **Ku-Band:** from 12 to 18 GHz and is widely used for high-powered satellite communication, including television broadcasting and broadband internet. It offers greater bandwidth than lower frequencies bands, enabling the transmission of large amounts of data.
- **Ka-Band:** from 26.5 to 40 GHz, is situated in the upper part of the microwave spectrum. It provides an even larger bandwidth, which is ideal for data-intensive applications like high-speed internet services and high-definition satellite television.

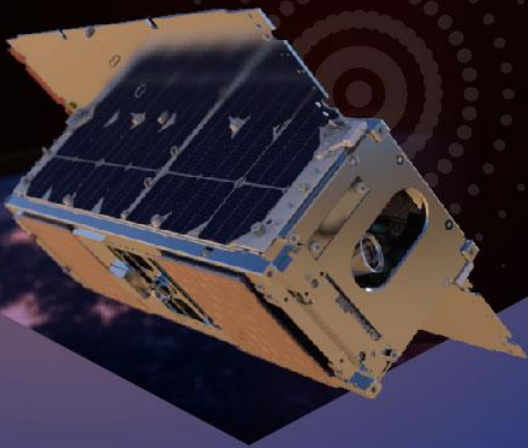
Figure:

[https://www.google.com/imgres?q=Very%20high%20throughput%20satellites&imgurl=https%3A%2F%2Fcdn.satnow.com%2Fcommunity%2F1702959688464\\_638385564896944237.png&imgrefurl=https%3A%2F%2Fwww.satnow.com%2Fcommunity%2Fwhat-are-high-throughput-satellites-hts&docid=viVkcUKJ2n1IWM&tbnid=sUNwS\\_rGXH5msM&vet=12ahUKEwiX65jS-dylAxW\\_dvUHHYrIDQgQM3oECE0QAA..i&w=940&h=588&hcb=2&ved=2ahUKEwiX65jS-dylAxW\\_dvUHHYrIDQgQM3oECE0QAA](https://www.google.com/imgres?q=Very%20high%20throughput%20satellites&imgurl=https%3A%2F%2Fcdn.satnow.com%2Fcommunity%2F1702959688464_638385564896944237.png&imgrefurl=https%3A%2F%2Fwww.satnow.com%2Fcommunity%2Fwhat-are-high-throughput-satellites-hts&docid=viVkcUKJ2n1IWM&tbnid=sUNwS_rGXH5msM&vet=12ahUKEwiX65jS-dylAxW_dvUHHYrIDQgQM3oECE0QAA..i&w=940&h=588&hcb=2&ved=2ahUKEwiX65jS-dylAxW_dvUHHYrIDQgQM3oECE0QAA)  
<https://www.radio2space.com/what-radio-frequencies-are-used-for-space-communication/>

# NIGHTJAR

鐳洋首顆3U立方衛星

夜鷹 Nightjar



研發團隊 鐳洋科技

規 格	3U
任務酬載	Ku頻段高速物聯網服務
軌道高度	590km
任務壽命	12個月
航 班	SpaceX/Transporter-11
發射日期	2024/8
測試目標	連線固定或移動地面站，未來提供大面積衛星物
與願景	聯網服務。

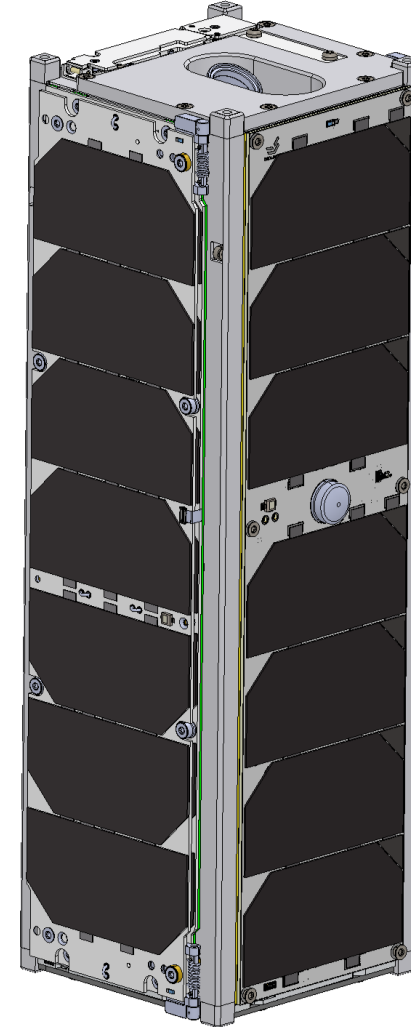
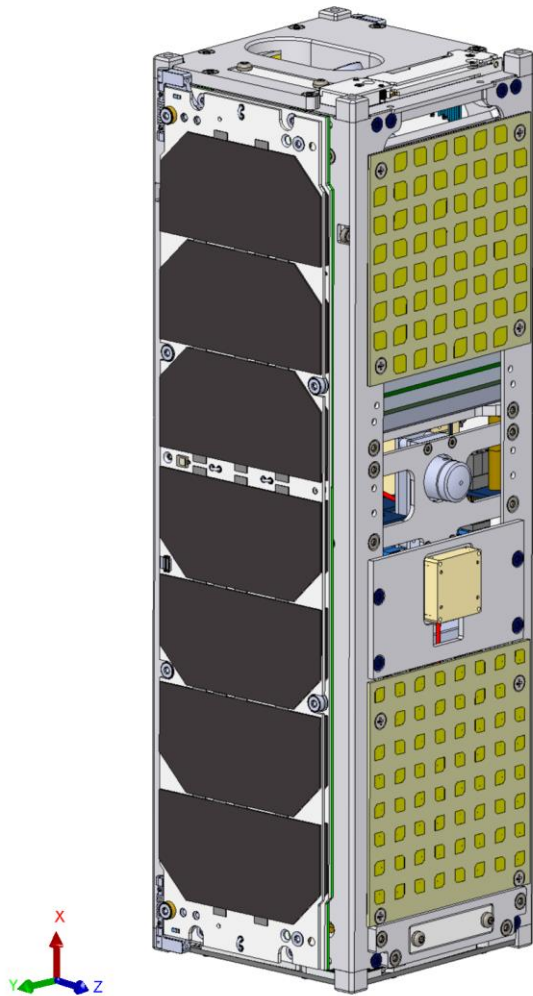
圖片來源：鐳洋科技

# Mission Requirements

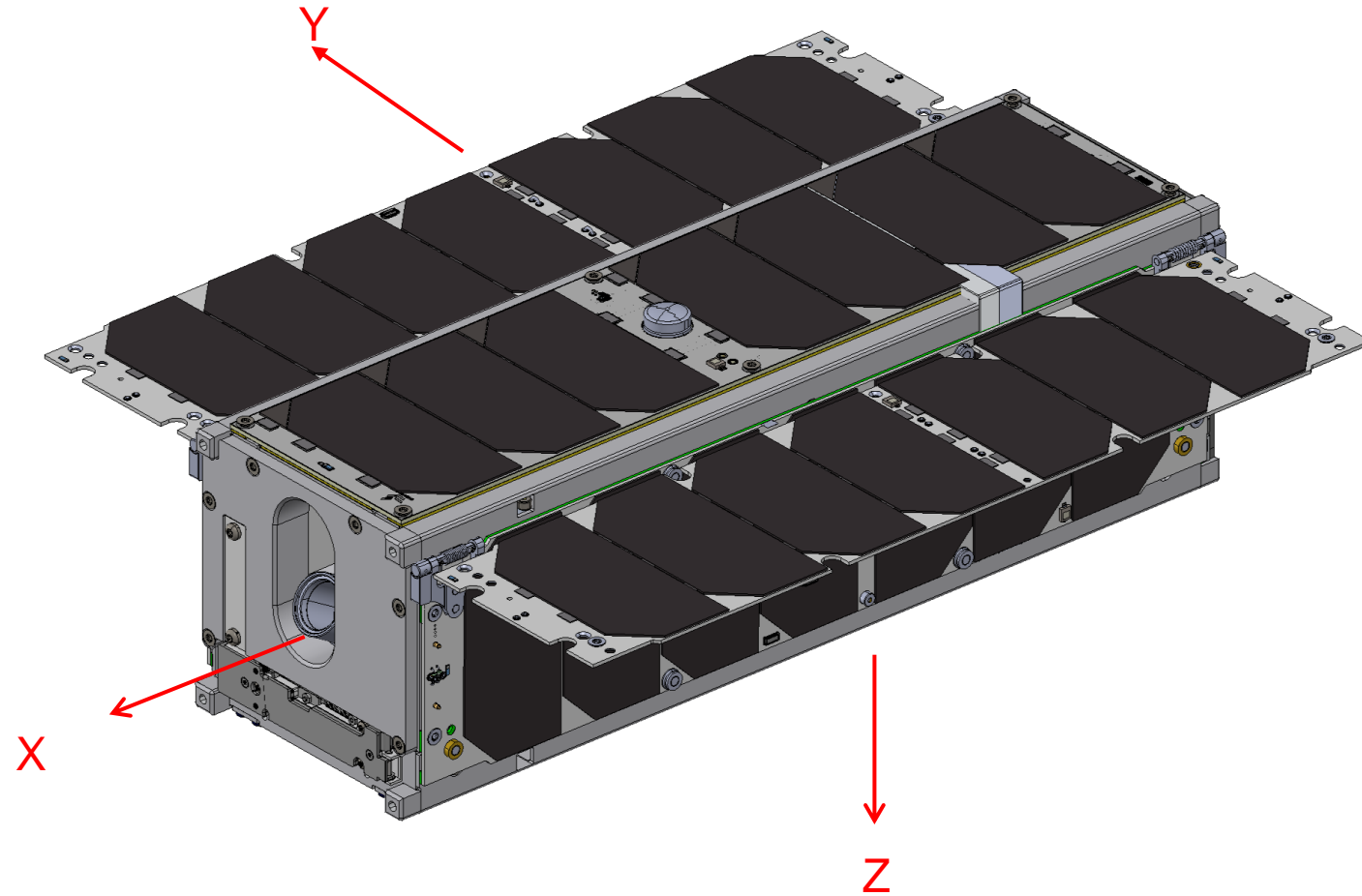
Type	LEO IoT Satellite (first satellite for verifying the payload)
Mass(Weight)	less than 6 kg
Size	3U 100 x 100 x 340 mm <sup>3</sup>
Orbit	Height 590 km, SSO (Sun-synchronous orbit)
Subsystem	OBC, FSW, ADCS, EPS, STR, TCS, KuCPL, UHF
Operation Modes	Hell mode、Safe mode、Detumbling mode、IDLE mode、Payload mode
Attitude Control	Pointing Accuracy: $\pm 1^{\circ}$ ( $3\sigma$ )
Service Range	Within a radius of 50 kilometers
Data Transmitting	>32 Mbps @20 MHz BW
Users	16 users at least
Service life	One year at least



# Bus Configuration (Stowed)

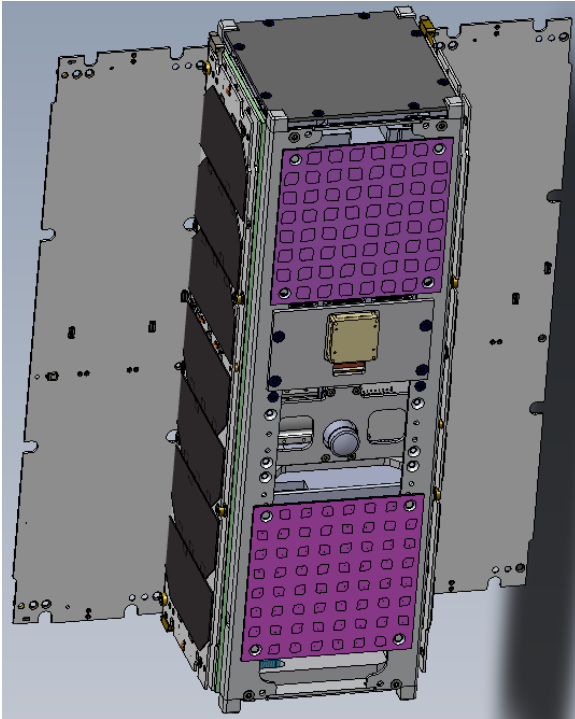


# Bus Configuration (Deployed)

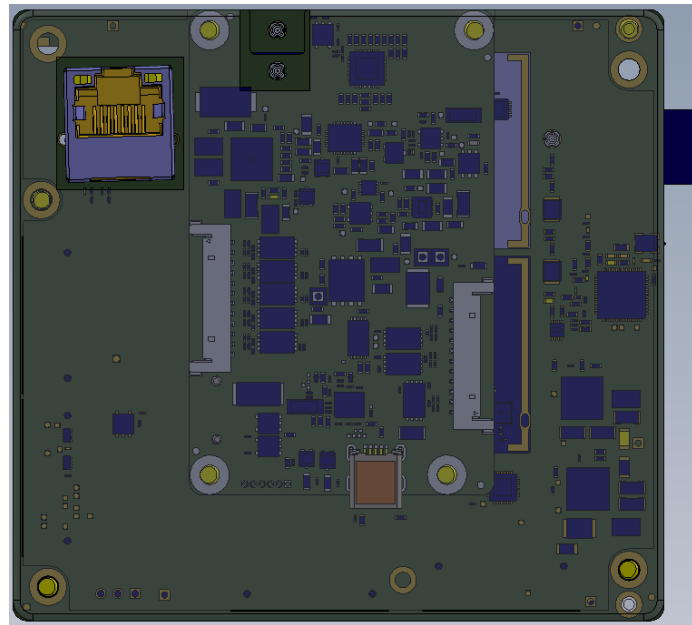


# Payload (KuCPL)

- **Ku-band transmit and receive feature**



Ku-band patch antenna



Ku-band payload

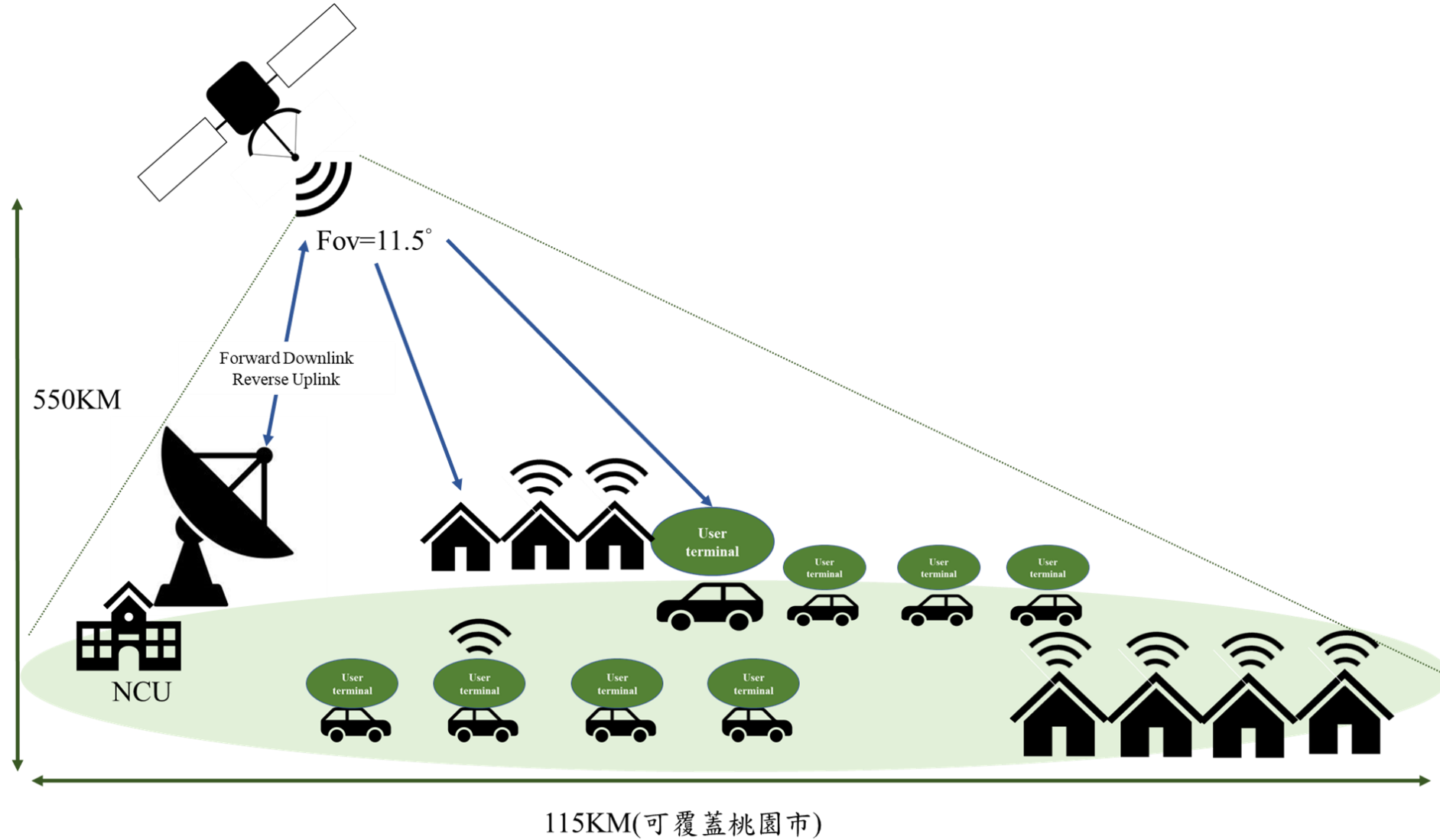
- Satellite Payload: Rapidtek
- Size (height): 43.47mm
- Ku-band IoT payload (KuCPL) includes:
  - Ku-band patch antenna (Receiver)
  - Ku-band patch antenna (Transmitter)
  - FPGA
  - ADDC
  - PA
  - Mass: <0.8 Kg

# Communication time analysis





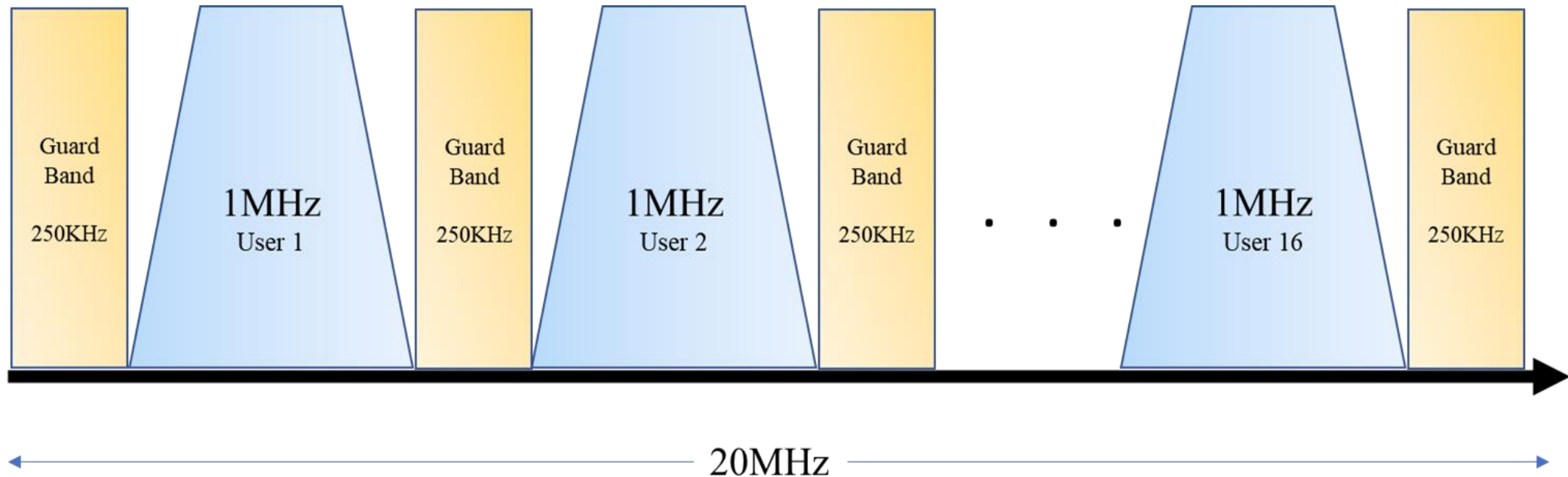
# Satellite Mission



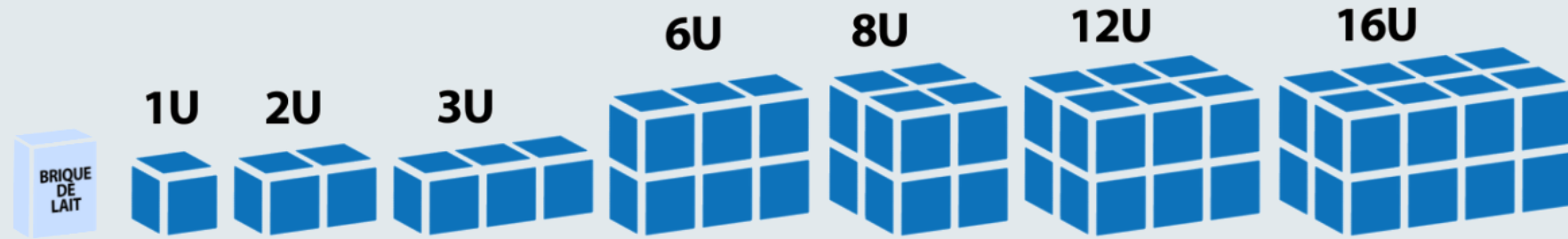
# Ku-band IoT payload

- **Spectrum**

1. The KuCPL is able to support 16 users with a total data rate of 32 Mbps.
2. 1Mbps for each user
3. Maximum Data Rate = Bandwidth \*  $\log_2(1 + \text{SNR})$



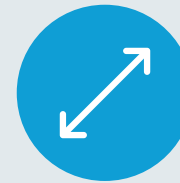
# 8U CubeSat



**Upgrade** the performance for IoT communication.



Add the capability for **inter-satellite link** communication.



Expect **more users**.



Expect **faster transmission**.



Equip **phased array** for beamforming.



Expect **more application scenarios**.



Passed MDR, SDR, and PDR.



Soon to enter the CDR stage, the **final stage of design**.

# Operation Plan (Ku band)

## (Phase I: 1枚衛星連通1地面站)

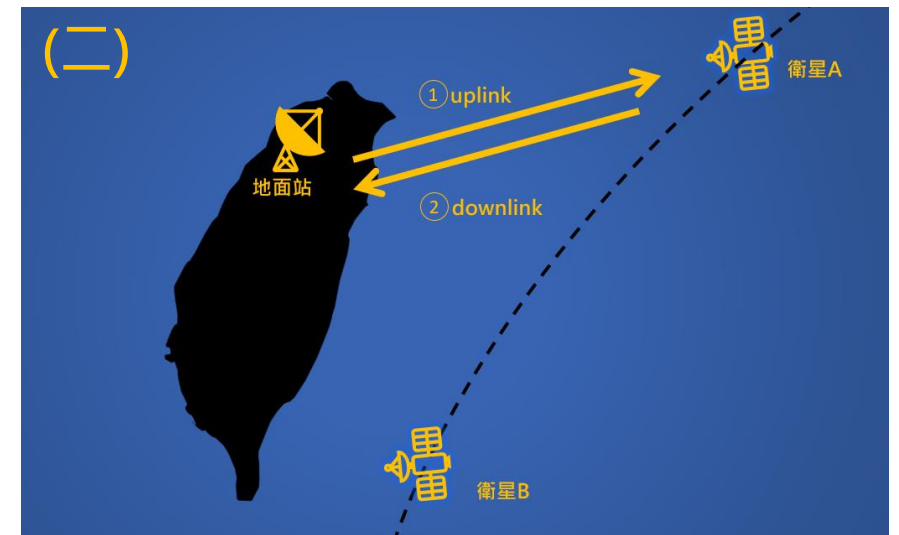
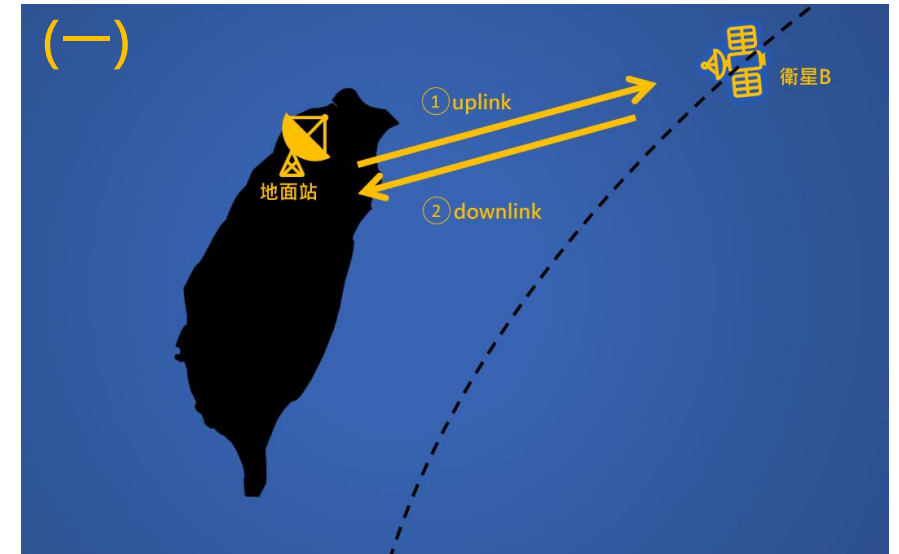
### 基礎通聯驗證

衛星操作需先達成單枚衛星的通訊，如右圖(一)所示，當衛星B先行經過台灣後，將測試衛星B與地面站之通聯測試。

同理如圖右(二)，後續將再次測試衛星A與地面站之通聯測試。

操作時，因為衛星天綫是omnidirectional，姿態定義為Nadir。

預計通聯時間預估：3-5 min/satellite





# Operation Plan (Ku and Ka band)

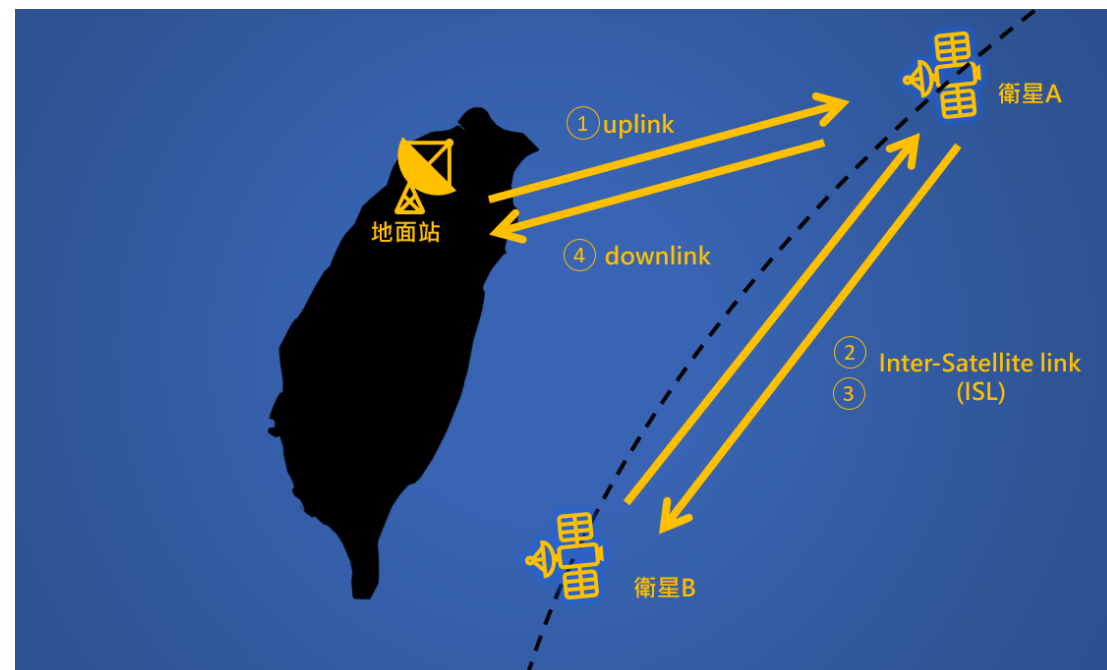
## (Phase II: 2枚衛星與1地面站)

### 星間通訊(ISL)驗證

待衛星A與衛星B完成基礎通聯測試後，後續將啟動衛星A與衛星B之星間通訊酬載(Rx, TBD)，後續，待衛星A經過台灣並與地面站進行上鏈通聯後，由衛星A測試與衛星B之ISL，並由衛星A進行下鏈通聯將接收狀態與接收資料傳遞至地面站。目前任務首要目標先以台灣上空進行通聯。

操作時，利用phased array的優勢，讓衛星姿態控制簡化。姿態也定義為Nadir

通訊時間預估：3 - 5 min for each satellite, ISL is 5 min



# Operation Plan (LoRa application)

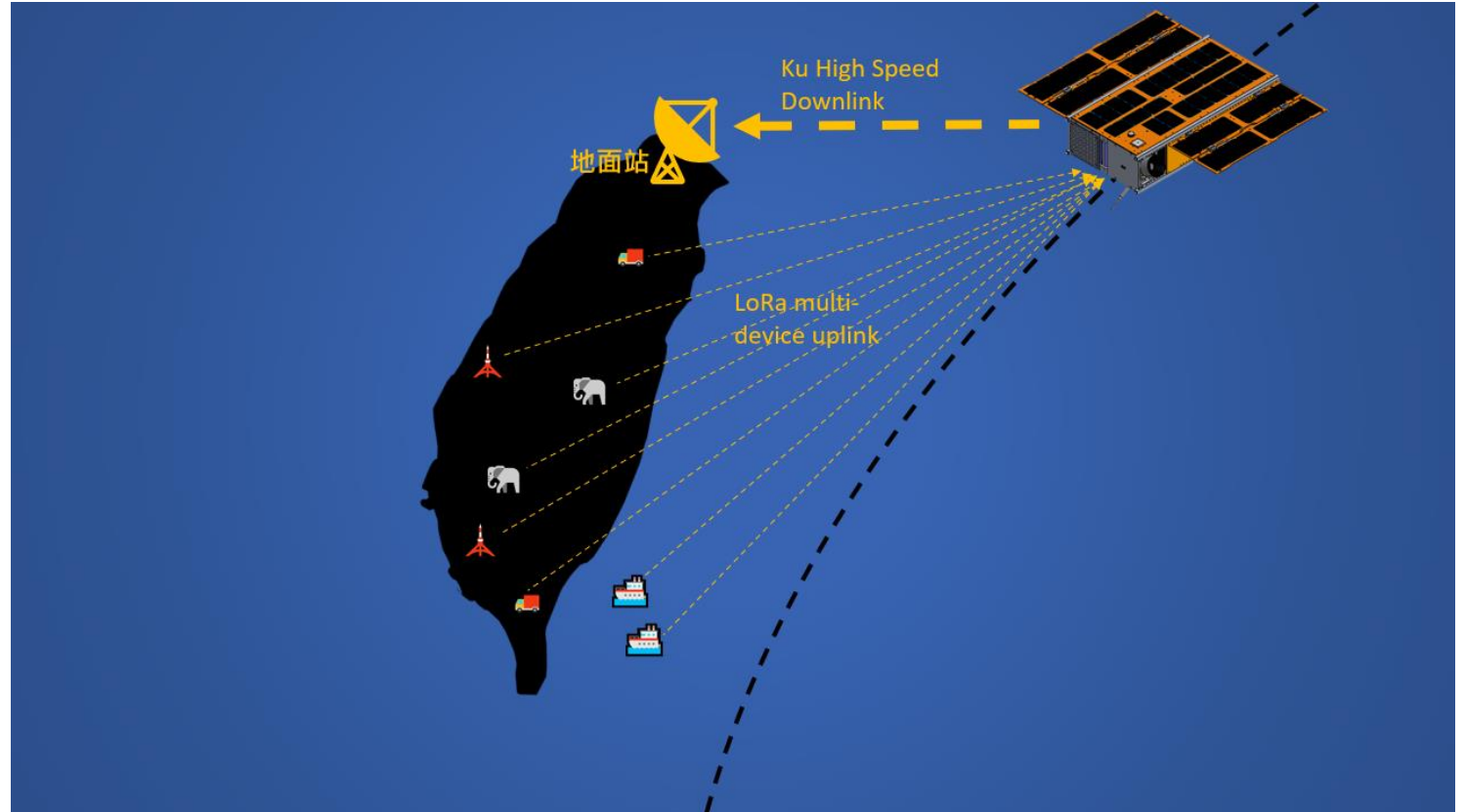
## (Low Speed and High Conductivity Scenario)

### 通訊鏈路說明

此通訊藉由使用現有LoRa技術，  
目的在收集使用者終端資訊。

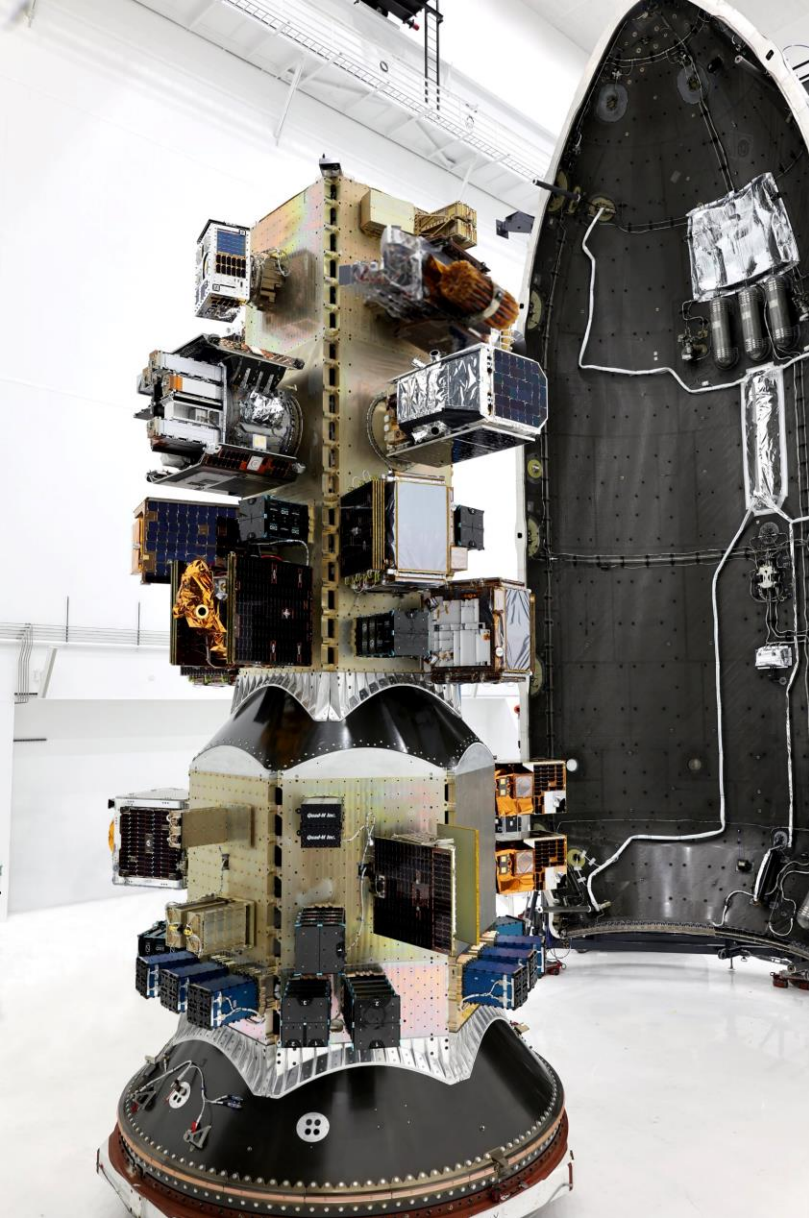
於衛星通過時，由使用者終端發送訊號，由衛星之LoRa天線接收。  
OBC將收集到的資訊藉由Ku-band傳遞至Ku地面站，完成資料收集與監控。

預計通聯時間預估：3-5  
min/satellite



Note. 驗測實驗上會以位於同一個天線波束直徑涵蓋之區域進行。

# Launching





# Nightjar separation confirm!





# Summary

- 透過衛星，IoT應用將可以有不受限地理區域的可能性與應用。
- 首顆衛星將會進行先期實驗驗證，確認通訊環境。
- 實現台灣低傳輸與高傳輸資料IoT的可能性應用
  - 智慧城市、智慧農業、物流與供應鏈管理
  - 森林、牧業、緊急救助的應用可能性
  - 海洋資訊的取得，如風力發電、遠洋漁船、海洋環境等
  - 拓展國際合作與市場，擴大應用的範圍
  - 透過大數據讓資料產生意義，建立物聯網數據平台，提供增值服務

