HAPS

High Altitude Platform Station

The Presenters

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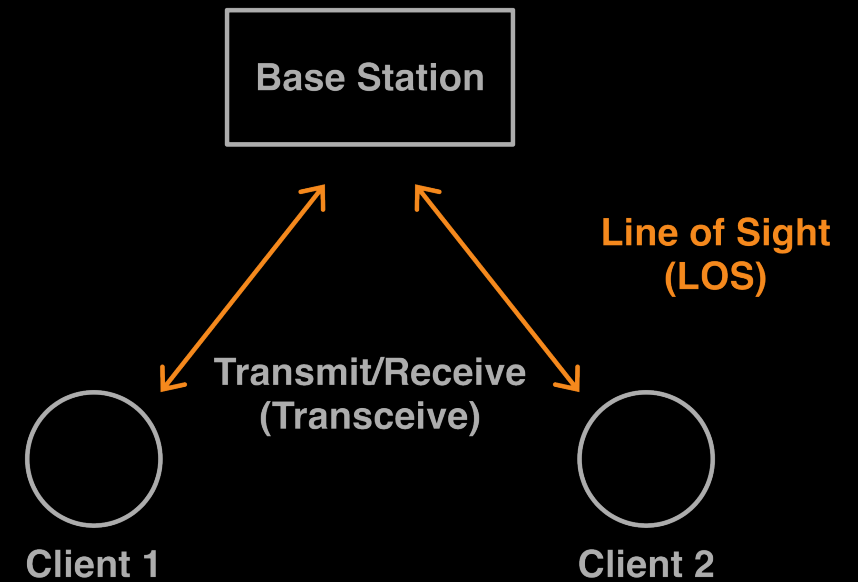**Email**   sornsiri.h@ku.th

Outline

1. Terminologies

2. Classifying Networks by Their Altitude

3. HAPS

4. HAPS Architectures

5. Use Cases

6. Conclusion

7. Our Thoughts on HAPS

Terminologies

- Base Station

- Drones

- Platform

Terms: Base Station

- Fixed transceiver – transmitter/receiver

- Main communication point for one
  or more wireless mobile client devices

Base Station

Line of Sight (LOS)

Transmit/Receive (Transceive)

Client 1

Client 2

Wright, G. (2021). base station. WhatIs.com. Retrieved from https://www.techtarget.com/whatis/definition/base-station

Terms: Drones (Unmanned Aerial Vehicles)

Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems.

Common Drones   HAPS UAV
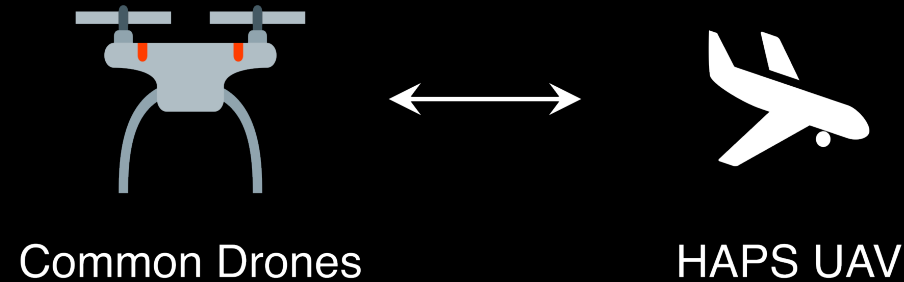
Lutkevich, B., & Earls, A. R. (2021). drone (UAV). IoT Agenda. Retrieved from https://www.techtarget.com/iotagenda/definition/drone

Terms: Platform

Set of installed hardware and software on a computing device required for specific software to run

Platform. (2020, April 30). Retrieved from https://www.computerhope.com/jargon/p/platform.htm

Classes of Communication Networks

Classified by *altitude* – distance above sea level

- **Terrestrial Networks (TN)**
  Installed/deployed the ground

- **Non-terrestrial Networks (NTN)**
 Installed/deployed above sea level,
  typically found in the space
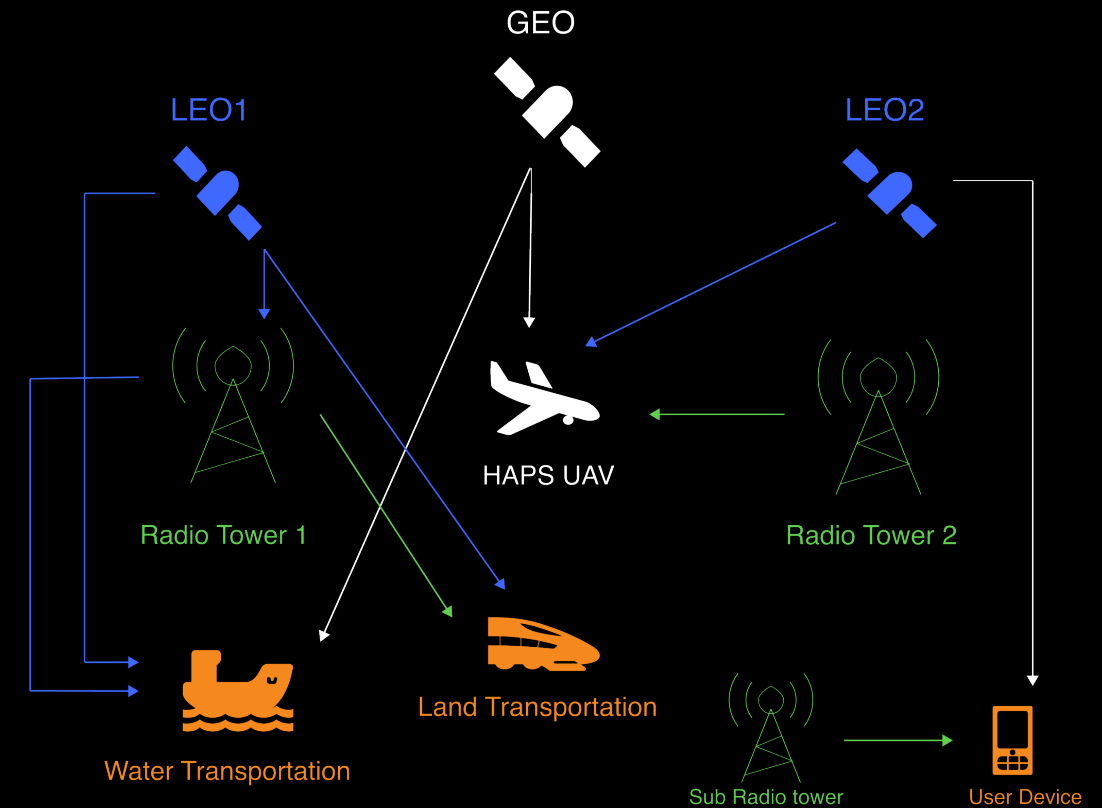
Nguyen, V. (2022). Non-terrestrial networks could be the next frontier for 5G. 5G Americas.
Retrieved from https://www.5gamericas.org/non-terrestrial-networks-could-be-the-next-frontier-for-5g/

Non-terrestrial Network Orbits

TYPE	ALTITUDE (Km)
Geostationary Earth Orbit (GEO)	≥ 35,786
Medium Earth Orbit (MEO)	2,001–35,785
Low Earth Orbit (LEO)	500–2,000
…	

3rd Generation Partnership Project (3GPP). (2019, October). Study on New Radio (NR) to support non-terrestrial networks (TR 38.811 V15.2.0 (2019-09)). 3GPP. Retrieved from https://www.3gpp.org/ftp//Specs/archive/38_series/38.811/38811-f20.zip

Repetitive Flight Pattern (Station Keeping)
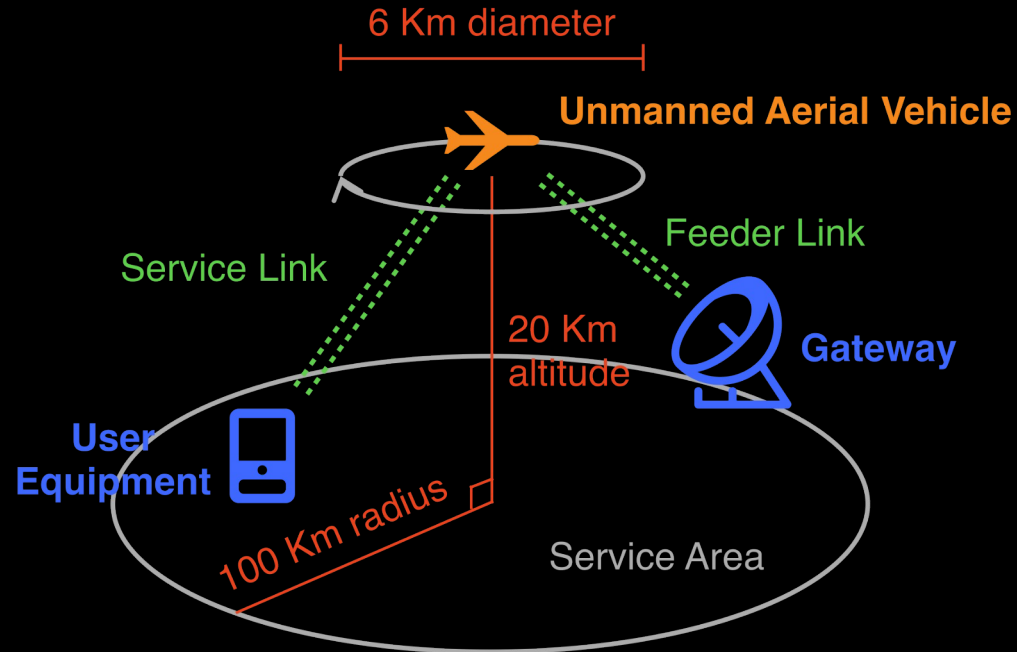
Hsieh, F., Jardel, F., Visotsky, E., Vook, F., Ghosh, A., & Picha, B. (2020, December 1).
UAV-based Multi-cell HAPS Communication: System Design and Performance Evaluation.
IEEE Xplore. https://doi.org/10.1109/GLOBECOM42002.2020.9322476

HAPS

H igh

A ltitude

1 18–24 km above the ground – stratosphere

P latform

2 Set of installed hardware and software on a computing device required for specific software to run

S tation

3 *Base Station*: A fixed transceiver that is the main communication point for one or more wireless mobile client devices

- Platform. (2020, April 30). Retrieved from https://www.computerhope.com/jargon/p/platform.htm

- UAV-based Multi-cell Haps Communication: System Design and Performance Evaluation. GLOBECOM 2020 - 2020 IEEE Global Communications Conference. doi:10.1109/globecom42002.2020.9322476

- Wright, G. (2021). base station. WhatIs.com. Retrieved from https://www.techtarget.com/whatis/definition/base-station

What Does HAPS Improve?

- Have shorter delay (1–2 ms) than LEO

- Small change in frequency in Doppler shift

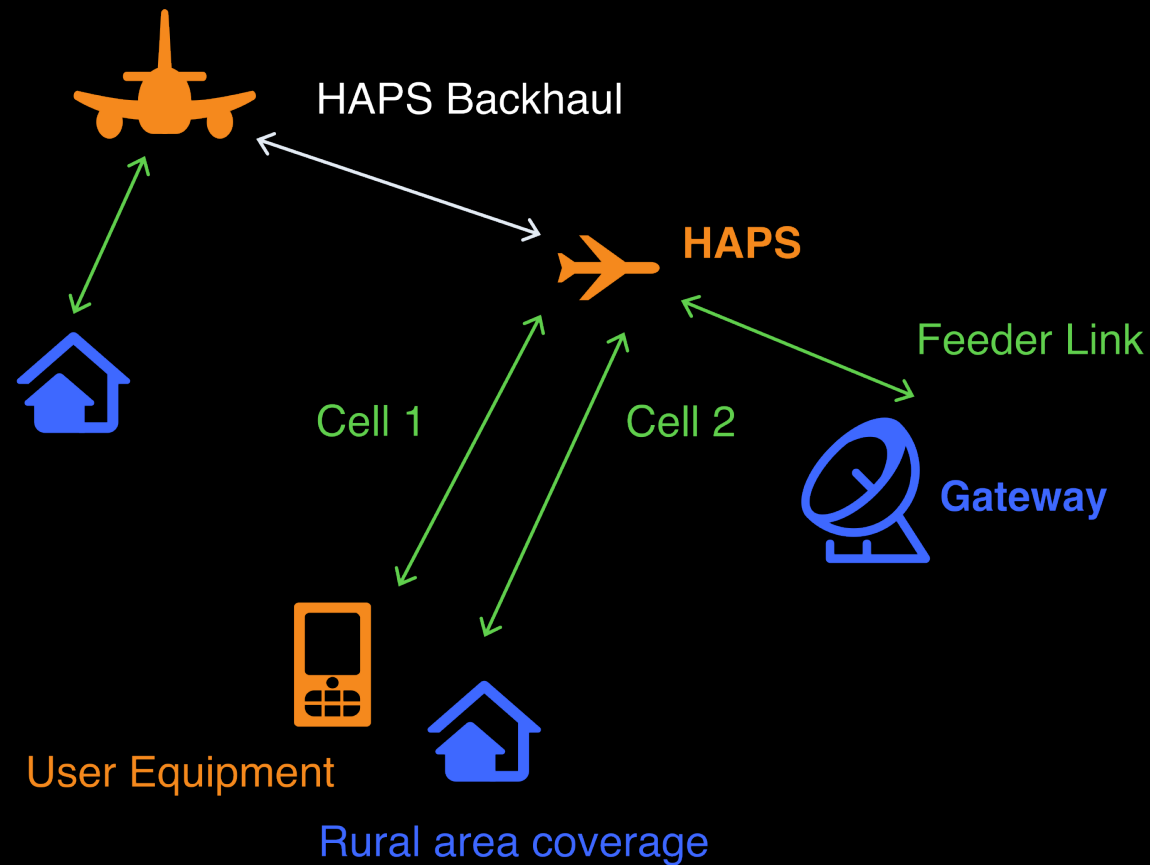- Lower maintenance cost than LEO and the rest of non-terrestrial networks

3rd Generation Partnership Project (3GPP). (2020, September). Technical Specification Group Radio Access Network; Study on New Radio (NR) to support non-terrestrial networks (Release 15) (TR 38.811 V15.4.0 (2020-09)). 3GPP. Retrieved from https://www.3gpp.org/ftp//Specs/archive/38_series/38.811/38811-f40.zip

Bent-pipe Architecture (BP)

- HAPS as a repeater

- Requires lower weight and power consumption than Regenerative Architecture (RG)

- Requires access link (AL) and feeder link (FL) together

Hsieh, F., Jardel, F., Visotsky, E., Vook, F., Ghosh, A., & Picha, B. (2020, December 1).
UAV-based Multi-cell HAPS Communication: System Design and Performance Evaluation.
IEEE Xplore. https://doi.org/10.1109/GLOBECOM42002.2020.9322476

Bent-pipe Architecture (BP)

HAPS Backhaul

HAPS

Feeder Link

Cell 1

Cell 2
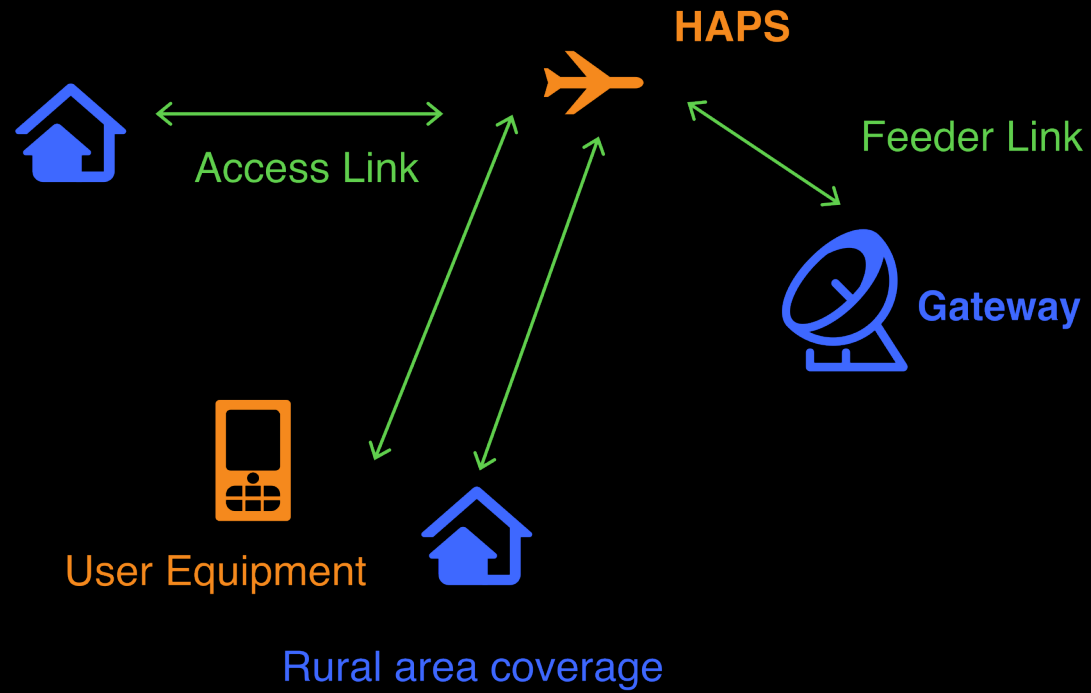
Gateway

User Equipment

Rural area coverage

Bent-pipe HAPS architecture: HAPS as a repeater

Regenerative Architecture (RG)

- HAPS works as base station

- Access link and feeder link can be used independently

- Consume more power and require more weight than Bent-pipe

Regenerative Architecture (RG)

Re-generative HAPS architecture: HAPS as a base station

Use Cases

- Expanding telecom coverage into rural and challenging terrains
  HAPS can act as floating cell towers

- Provides emergency coverage in times of outages and disasters
  HAPS operate above the weather and can be moved at will

High Altitude, Higher Ambitions. (2020, May 1). Retrieved from https://hapsalliance.org/wp-content/uploads/formidable/12/Stratosphere_Whitepaper_May1-1.pdf

Conclusion

- HAPS is a technology that involves deploying unmanned aircraft in the stratosphere to serve as communication platforms

- Classifying networks by altitude
  - Terrestrial Networks (TN)
  - Non-terrestrial Networks (NTN)

- HAPS is NTN, at the height of 18–24 Km – stratosphere

- HAPS uses unmanned aerial vehicles (UAV) as platform for base station

- HAPS can act as a repeater or a base station, depending on architectures

References

- Xing, Y., Hsieh, F., Ghosh, A., & Rappaport, T. S. (2021). High Altitude Platform Stations (HAPS): Architecture and System Performance. IEEE 93rd Vehicular Technology Conference (VTC-Spring). https://doi.org/10.1109/vtc2021-spring51267.2021.9448899

- Hsieh, F., Jardel, F., Visotsky, E., Vook, F., Ghosh, A., & Picha, B. (2020, December 1). UAV-based Multi-cell HAPS Communication: System Design and Performance Evaluation. IEEE Xplore. https://doi.org/10.1109/GLOBECOM42002.2020.9322476

Our Thoughts

"HAPS will resolve some network problems, but it still can't solve at all ."

HAPS makes Internet more accessible.

Q&A