



National Aeronautics and  
Space Administration



# Emerging Commercial Satellite Communications

## Telemedicine Takeaways

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# Outline

- Telemedicine Needs and Limitations
- Communication System Fundamentals
- Basics of Satellite Communications
- Advancements in SatCom & 5G
- Looking Forward Toward the Future

# Telemedicine Communication Needs

## Ubiquitous Coverage

- **Rural and Remote Patients have limited access to broadband communications**

## High Data Rates

- **Few wireless solutions offer cost effective options for large amounts of data**

## Secure

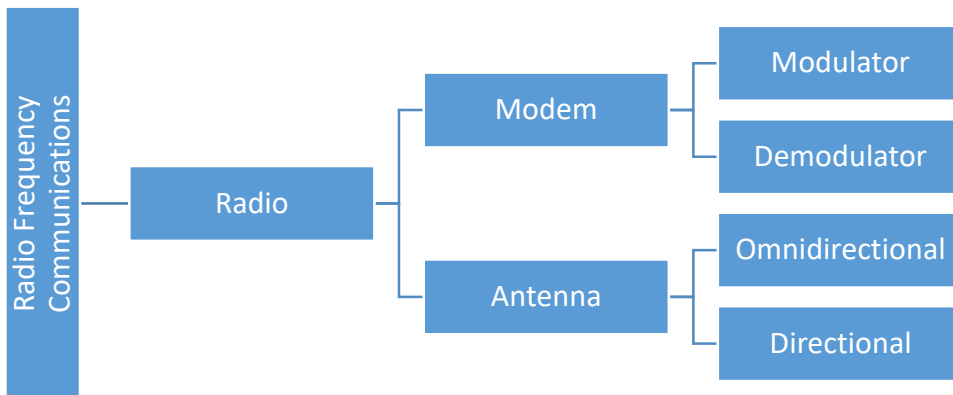
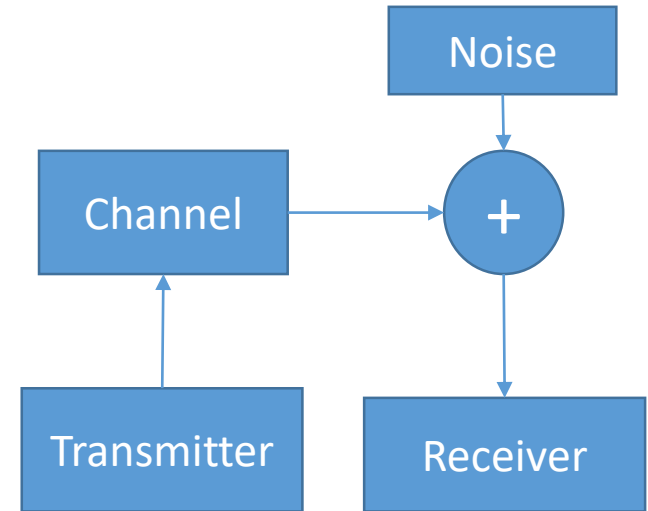
- **Healthcare information is private and protected**

SATCOM has long standing history supporting telemedicine

# What is a Communication System

Communication systems in general:

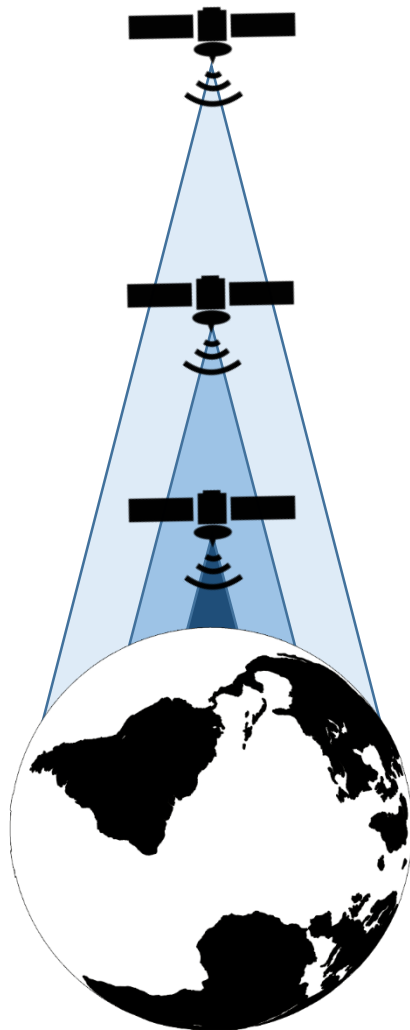
- Transmitter/Receiver: Devices that send and receive a communication signal
- Channel: the physical medium to transmit the signal (cable, EM wave, air, water)
- Noise: Something that interferes with the communication signal



Design Considerations

- Data Rates
- Power Needs
- Antenna Pointing
- RF Propagation
- Interference

# Satellite Communication Basics



## Geosynchronous/Geostationary Orbit (GEO)

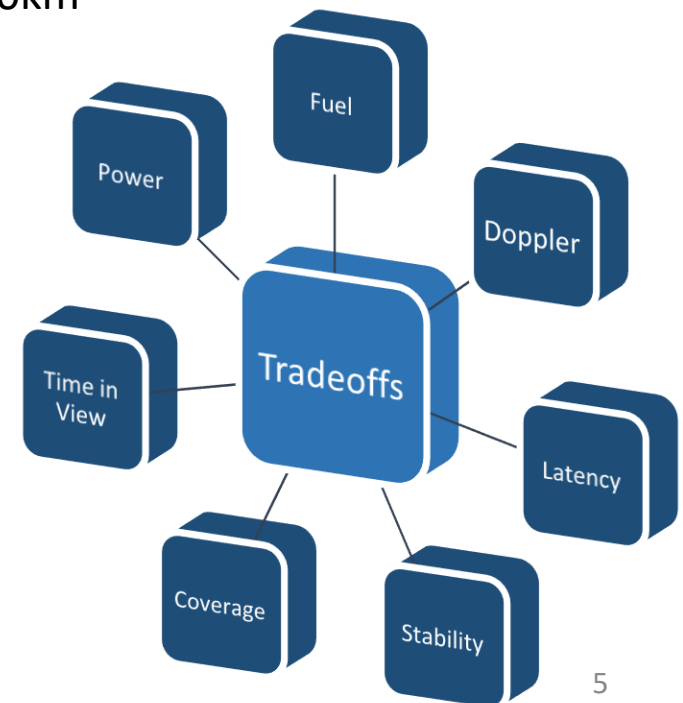
- Altitude: 35,786 km
- Orbit Period: 24 hours
- Examples: Weather and Data Relay Satellites

## Medium Earth Orbit (MEO)

- Altitude: 2,000km – 35,000km
- Orbit Period: 2-24hrs
- Examples: GPS

## Low Earth Orbit (LEO)

- Altitude: <2,000km
- Orbit Period: <2hrs
- Examples: ISS, CubeSats



# Commercial Service Providers



eutelsat



INTELSAT.



ASTRANIS



# Commercial SatCom - GEO



eutelsat



INTELSAT.



ASTRANIS



# Commercial SatCom - MEO



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HUGHES

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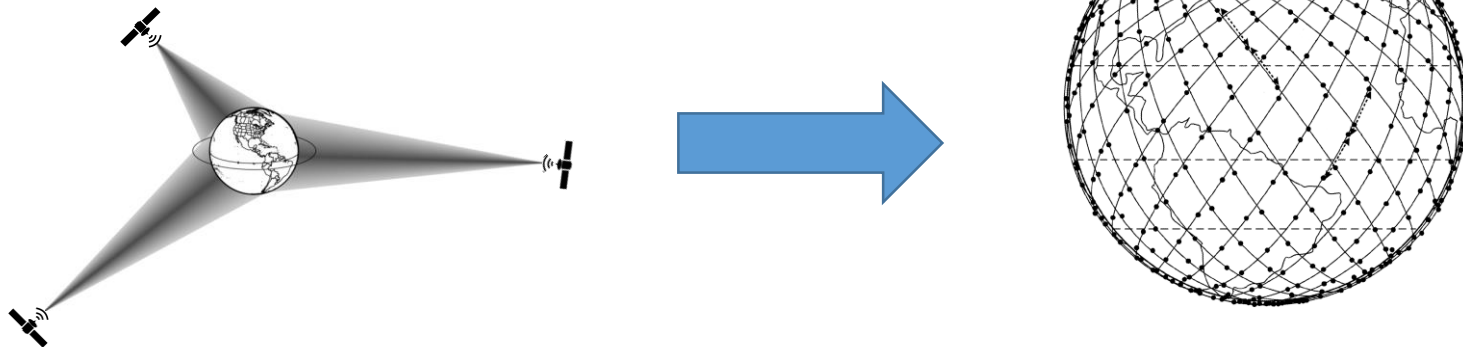


# Commercial SatCom - LEO



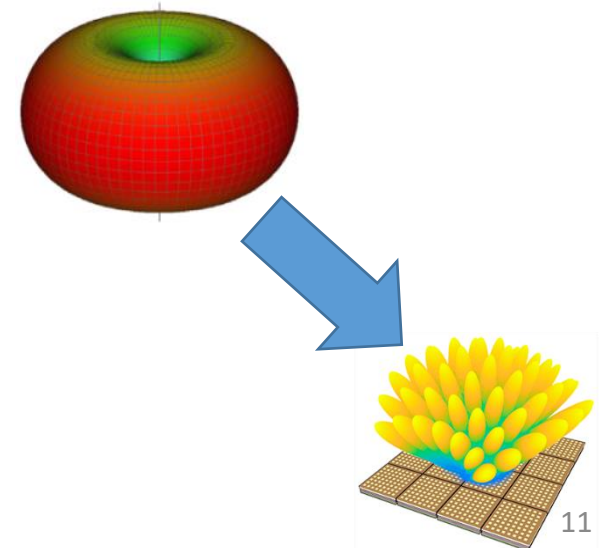
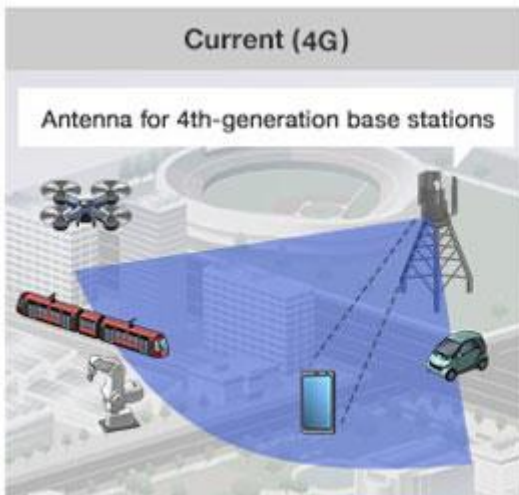
# LEO Commercial Challenges

- Require larger constellations
  - 1000s of satellite needed for full earth coverage
  - Smaller, Less expensive satellites
- Constant Satellite Refreshes
  - Satellites deorbit due to atmospheric drag
- Complex inter-satellite networking
  - Short Orbit Requires constant handoffs
  - Significant Doppler Effects to compensate
- Small size limits transmit power



# LEO Constellation Drivers

- Building and launching satellites is getting cheaper
  - Most gains seen with SmallSats in LEO
  - >\$500M → <\$5M and decreasing
- Leverage 5G investment in silicon based phased arrays
  - High frequency signals offer high data rates over short distances
  - Arrays change basic communication model
  - Ka-Band propagation means multiple beams needed for each user



# Looking Forward

## Goals

- Roam across WiFi, 5G, Satellites Seamlessly
  - Connectivity anywhere
  - Easy to off load capacity to alternative networks
- Flexibility and robustness to support variety of users
- Constant High Data Rates
  - Dramatic increases in IoT

## Challenges

- Early Days of dramatic changes to Terrestrial and Satellite Networks
  - Standards still being established
  - Too many companies
- Significant increase in complexity
  - Actual capability not well understood
  - High Frequencies are good for data and bad for propagation
- Lots of vertical integration
  - Interoperability very challenging



Questions?

