GSAW 2021 Tutorial A:

Mission Ops and Ground Systems 101: Why and How Your Ground System is Driven by Your Space Mission

Overview:

- Overview of satellite mission types:
  - Earth Observation
  - Navigation (PNT)
  - Science
  - Planetary
  - Communications
- Overview of the Earth-orbiting Orbital Regimes, including a discussion of Field of View and Swath concepts, and why a particular mission type would choose one orbit over another
  - LEO: characteristics of Low Earth Orbits, including discussion of sun synchronous orbits, flying in formation, and a brief mention of launch and de-orbiting
  - MEO: characteristics of Medium Earth Orbits and their challenges with a particular discussion of the Van Allen Radiation Belts and their impacts on space missions, and semi-synchronous orbits
  - GEO (Geostationary/Geosynchronous Earth Orbit): characteristics of GEO, a discussion of the GEO slots and how they are allocated, collocation in GEO slots and what impacts this has on ground systems, and how constantly being over the same location on the Earth impacts ground systems.
- An overview of the most common Mission Operations Drivers and how space missions have historically managed these drivers to attempt to minimize risk
  - What does it mean to keep the spacecraft safe and healthy? How do we optimize anomaly detection and recovery?
  - What does it mean to maximize a space mission?
  - What is mission criticality and how does this impact mission requirements?
  - What impacts does orbit have on ground contacts, commanding, planning & scheduling, mission data dumpts and anomaly detection and recovery?
  - How to get the data where it's got to go
  - What does minimizing cost mean? What are some common cost trade-offs which impact ground systems?
  - How do standards play into ground systems?
  - What role does heritage play in ground system design for better and for worse?
- An overview of ground system design
- An overview of a classic, generic design of a Mission Operations Center, including a brief discussion of interfaces, standards, and pub/sub mechanics. This also includes a discussion of the cost of maintenance and sustainment as compared to development of ground systems, and how to think about vendor lock-in and other heritage problems which often affect ground systems.

Instructor: Theresa Beech, NASA Goddard Space Flight Center Goddard Space Flight Center

Biography:

Theresa Beech

Almost 25 years experience in satellite ground systems, space mission design, and space communications network design for space operators around the world. She has extensive experience in satellite ground system design and development, space-to-ground interfaces, satellite flight dynamics, precise orbit determination, software development, and technical team leadership.

Has worked on a wide variety of types of satellite missions including: communications, imagery, PNT, and scientific missions for US Government space agencies (NASA, NOAA, USGS, DoD), commercial

telecommunications operators (Intelsat, Star One of Brazil, Measat of Malaysia, Azerspace of Azerbaijan), and joint agency missions. Specific mission experience includes: GOES-R, TDRSS, Landsat-8, the Lunar
Reconnaissance Orbiter, the US Air Force Satellite Control Network (AFSCN), and multiple commercial telecommunications systems. Led technical teams responsible for developing new ground systems from a green field, as well as teams doing complex, multi-satellite, multi-site ground system migrations.

Before joining NASA Goddard Space Flight Center, founded and ran MetiSpace Technologies Inc., a small engineering business dedicated to satellite ground systems engineering. Currently the Goddard Mission Services Evolution Center (GMSEC) Product Development Lead and Deputy Project Manager, leading a technical team of 20+ engineers who design and develop ground systems SW for NASA and other US Government Space Agencies.

Description of Intended Students and Prerequisites:
Personnel responsible for the staffing, management, acquisition, development, and/or maintenance of ground systems. No specific ground system expertise is required. Material contains references to commercial, civil, DoD space and a variety of different missions types (Earth observation, communications, science, weather, navigation). Good overall introduction to what drives ground system design from a satellite mission perspective, providing a broader perspective of how ground systems fit into the overall space mission.

What can Attendees Expect to Learn:
Attendees will gain an understanding of what types of Earth orbiting satellite missions there are, what orbits they are in, what drives the choice of these orbits, and what these orbits drive to in terms of mission operations concepts and, ultimately, ground system design. They will gain an understanding of the differences between certain mission types and what impact this has on ground systems from the perspective of a wide variety of satellite mission types (communications, navigation, earth observation, weather, science) in different customer spaces (commercial space, DoD space, civil space). Attendees will be exposed to a typical mission operations drivers, typical mitigation strategies, typical mission constraints and what this leads to in terms of a typical ground system and mission operations architecture. The purpose of this tutorial is to give attendees a broader picture of how mission operations and ground systems fit into the overall space mission enterprise.