Flight Path: Exploring a Career in Aerospace Engineering

Sheldon Clark
Raytheon

Agenda

- Today's Activities:
  - Overview of Aerospace Engineering
  - What is a satellite?
  - Introduction to our mission
  - Satellite Subsystem overview
  - Final design preparation
  - Pre-launch checklist
  - Payload Launch!

Introduction

- Presenter – Sheldon Clark
  - Systems Engineer for Raytheon
  - Grew up in central Florida
  - B.S. and M.S. Aerospace Engineering from University of Florida
  - Previous work at NASA and Raytheon Missile Systems

What is Engineering?

- Who and what are engineers? What do they do?
- Engineers are problem solvers
  - We think creatively to find solutions
  - New, better, more efficient, quicker, and less expensive
- Engineers are translators
  - We speak the language of math, science, and physics and translate into concepts of the world around us
  - We bridge the gap between theory and reality
- Engineers come from all walks of life
  - Male, female, from all cultures and all nationalities

What is Engineering?

- Engineers are team players
  - Engineers are most successful when their teams are successful
  - Can adapt to new problems, situations, and environments
- Engineers help shape the future
  - New products and new technologies
- Engineers are everywhere
  - Almost everyone can relate to breaking down and solving problems

Dive Deeper – What is Aerospace Engineering?

- Space vs Planes – Which is it?
  - Modern term of aerospace engineer is a combination of the traditional Aeronautics and Astronautics disciplines

- With obvious differences, both have their similarities
  - Both share the same origins
  - Both are heavily dependent on math and science
  - Both are rooted in the same culture and industry
  - Both serve a vast majority of the population in some way

Aeronautics

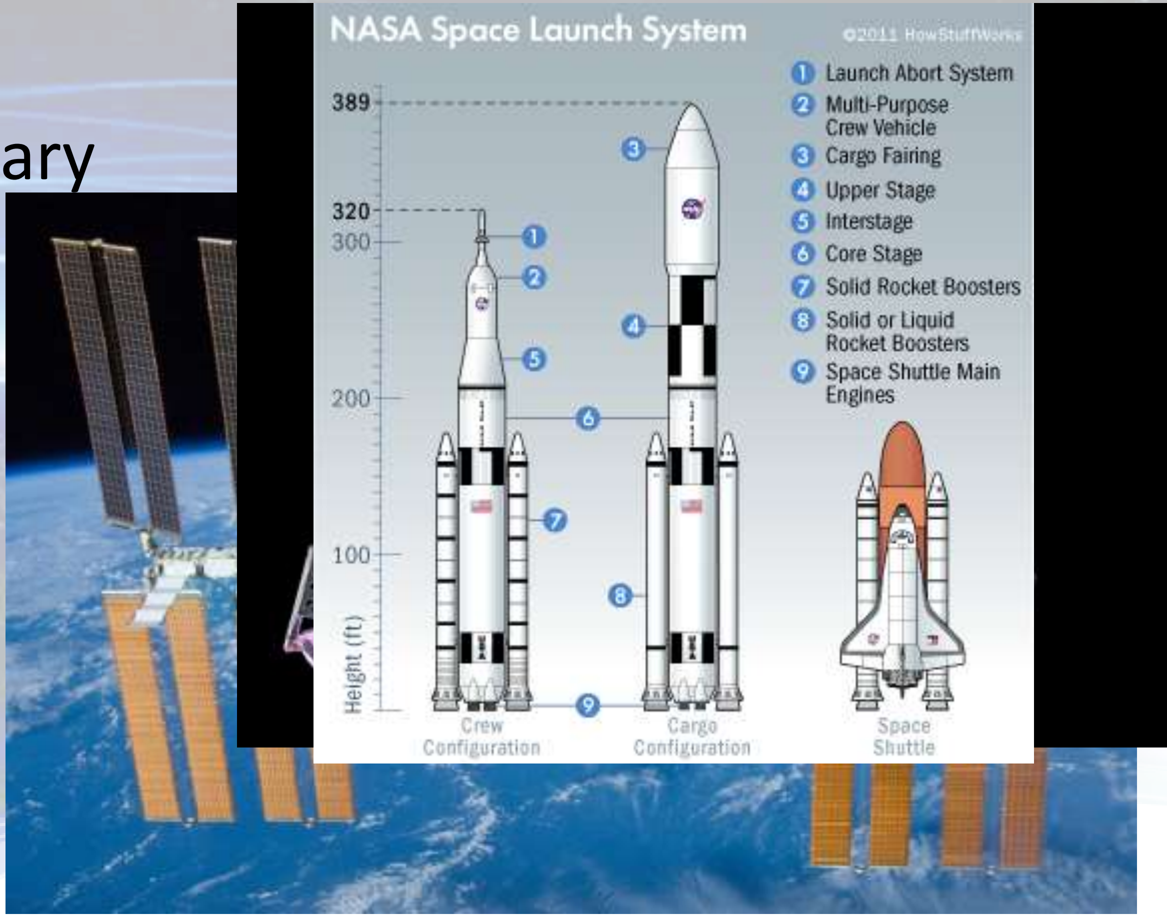
- Typically focuses on air breathing vehicles
  - Propeller vs jet aircraft
  - Commercial vs. Military aircraft
- Includes most anything that flies
  - Planes, balloons, missiles, etc
- Major projects:
  - F35 Joint Strike Fighter
  - NextGen Commercial Aircraft
    - Boeing 787 and Airbus A380

Aeronautics

- What might an Aeronautical Engineer do?
  - Apply principles of science and technology to create aircraft, components and support equipment
  - Using computer-aided design (CAD) software to create designs and plans
  - Participating in flight test programs to measure take-off distances, rate of climb, stall speeds, maneuverability and landing capacities
  - maintaining aircraft for full operation including making regular inspections, maintenance and servicing
  - investigating aircraft accidents

Astronautics

- Typically focuses on vehicles operating out of Earth's atmosphere
  - Manned vs. Unmanned
  - Commercial vs. Government vs. Military
- Major projects:
  - Space Station
  - GPS-III
  - James Webb Telescope
  - Space Launch System

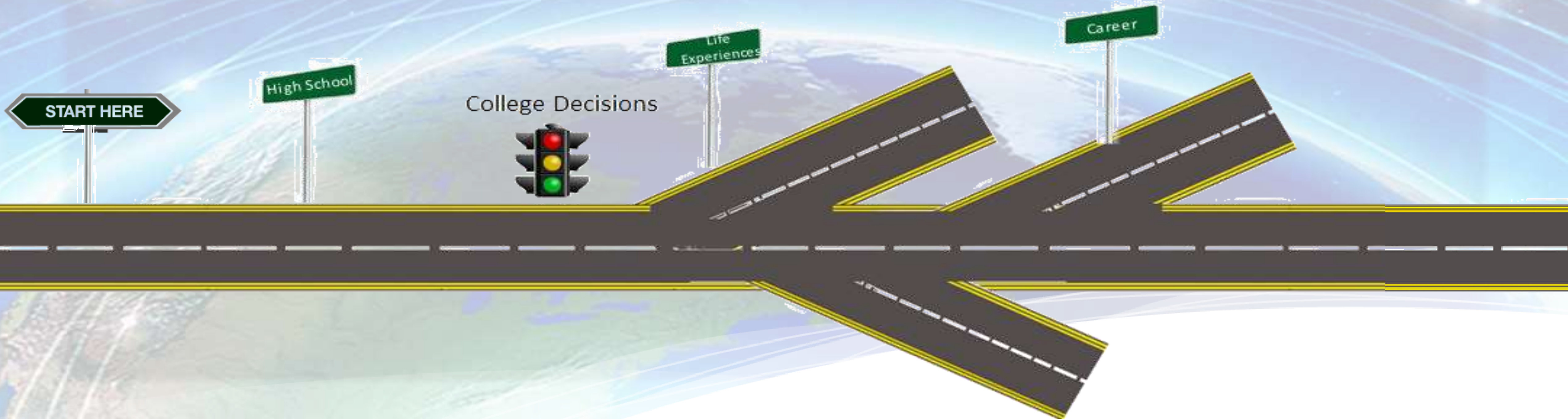


Multidisciplinary field

- Aerospace engineering is a conglomerate of a huge number of studies and disciplines:
  - Fluid dynamics
  - Thermodynamics
  - Astronomy
  - Orbital and Celestial mechanics
  - Aerodynamics
  - Electrical engineering
  - Computer hardware engineering
  - Computer software engineering
  - Computer sciences
  - Manufacturing sciences
  - Robotics
  - Propulsion
  - Material Science
  - Nuclear physics and engineering
  - Systems engineering
  - Sales engineering
  - Structural sciences
  - Mechanical engineering

Aerospace Engineering Road Map

- HS to College to Career
- What can you do while still in High School?
- How do you take full advantage of post-high school opportunities?



My Personal Road Map

Road Map – High School

- Keep up your grades
  - Build strong study habits and academic discipline
  - Take as many math and sciences courses as possible!
- Apply to college
  - Apply to multiple institutions and apply early!
- Remain as active as possible
  - Get heavily involved in a wide variety of extra curriculars
  - Seek out leadership positions. Be more than just a “member”
- Write a resume
  - One of the more important documents you’ll need over the next several years
- Seek out differentiating experiences
  - High School Internships, space camps, precollegiate camps

Road Map - College

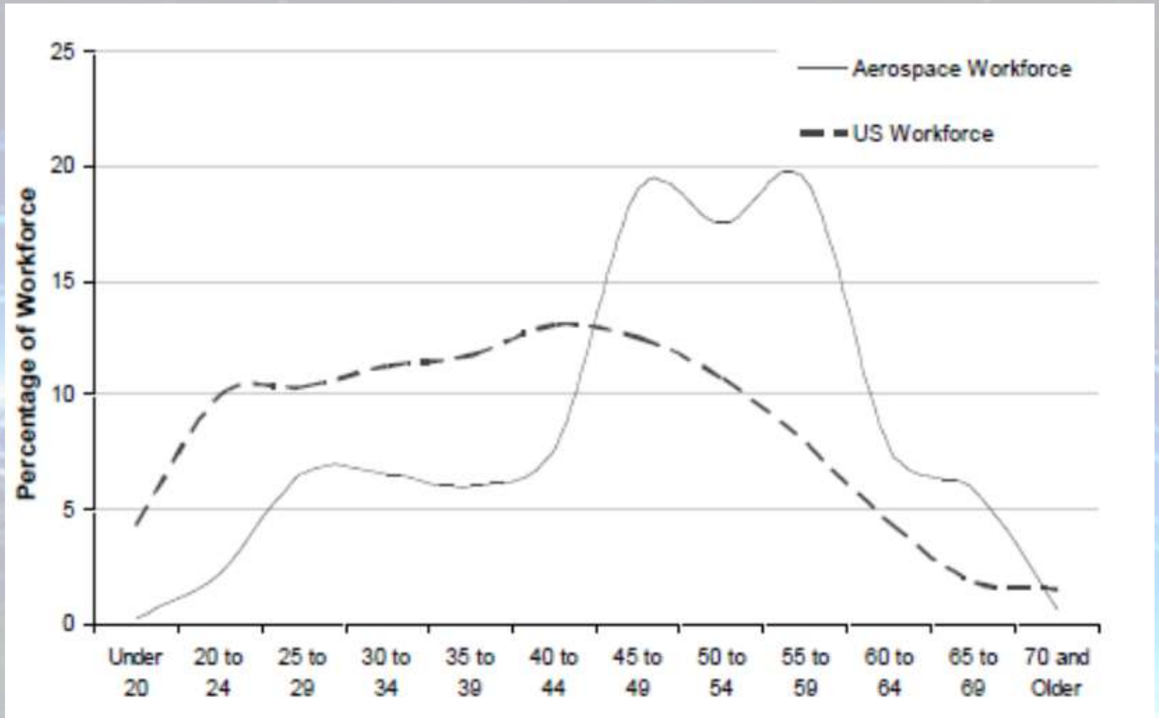
- Build a strong academic profile
  - Grades are still the most important ! (but not the only) aspect of your college career
- Find an opportunity to take a leadership role
  - Learn and practice your personal leadership style
  - The earlier the better – it's never too soon!
- Seek out diversity - broaden your horizons
  - Build yourself into a well rounded individual
  - Engineering is a global profession, so be ready to interact and communicate with many different cultures and personalities
- Find a design team or project and get hands-on
  - Future employers like to see initiative and practical engineering skills

Road Map - College

- Actively search out professional experience early
  - Professional experiences are available, even for freshman
  - Internships, lab assistant, research assistant all great choices
- Join professional societies
  - Offer great support and opportunities to learn and get involved
- Study abroad
  - Don’t listen to rumor – Yes there are opportunities for engineers to study abroad, and yes, it is worth it!
- Never stop seeking opportunities
  - Experiences are one of the best

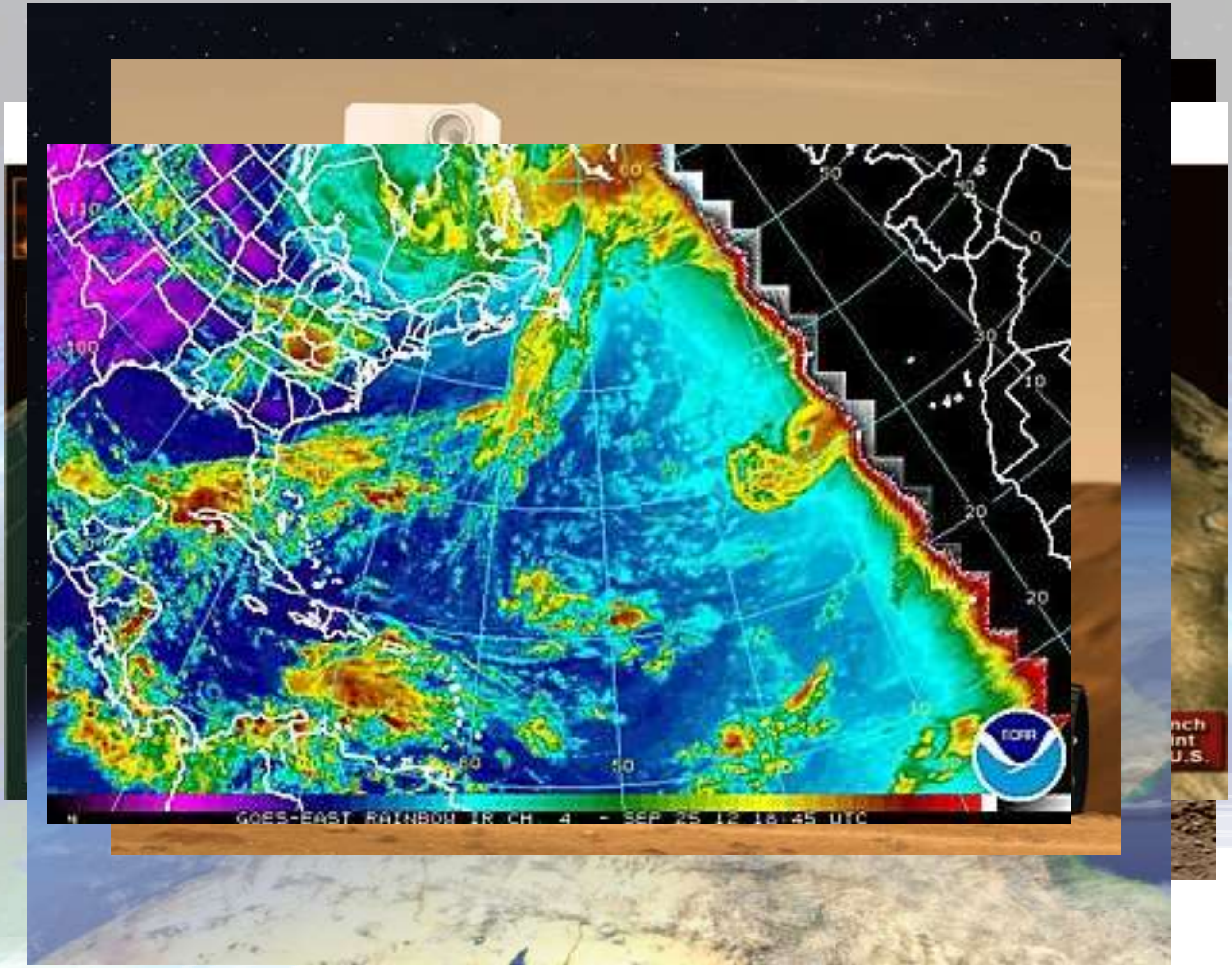
The Boomer Bubble

- Career

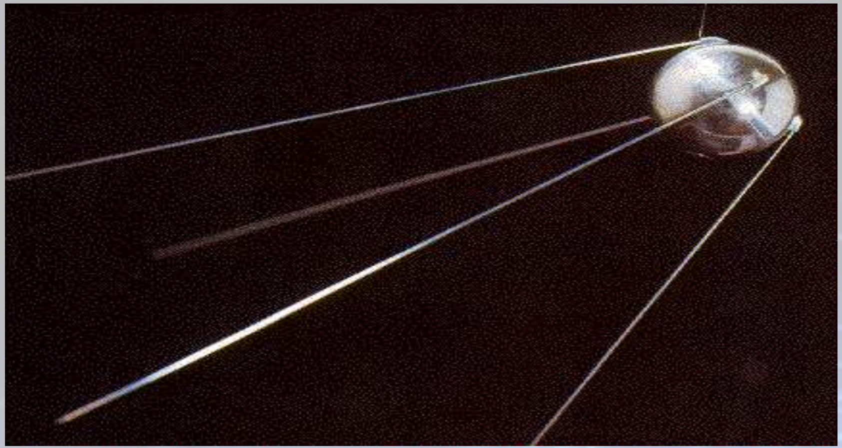


Why space?

- Exploration
- Technology advancement
- Weather monitoring
- Defense



Where have we been?



Where are we going?

Where are we going?

- Space is Expanding
  - Privatization of many areas of the space network
  - Planned missions to Moon, Mars, and Asteroids
  - Replacing and improving older generations of satellites
  - Commercialization and expansion of space tourism
  - Miniaturization of satellite technology

Introduction to Satellites

- Introduction
- Satellite System
- Engineering Procedure
- Cases Study

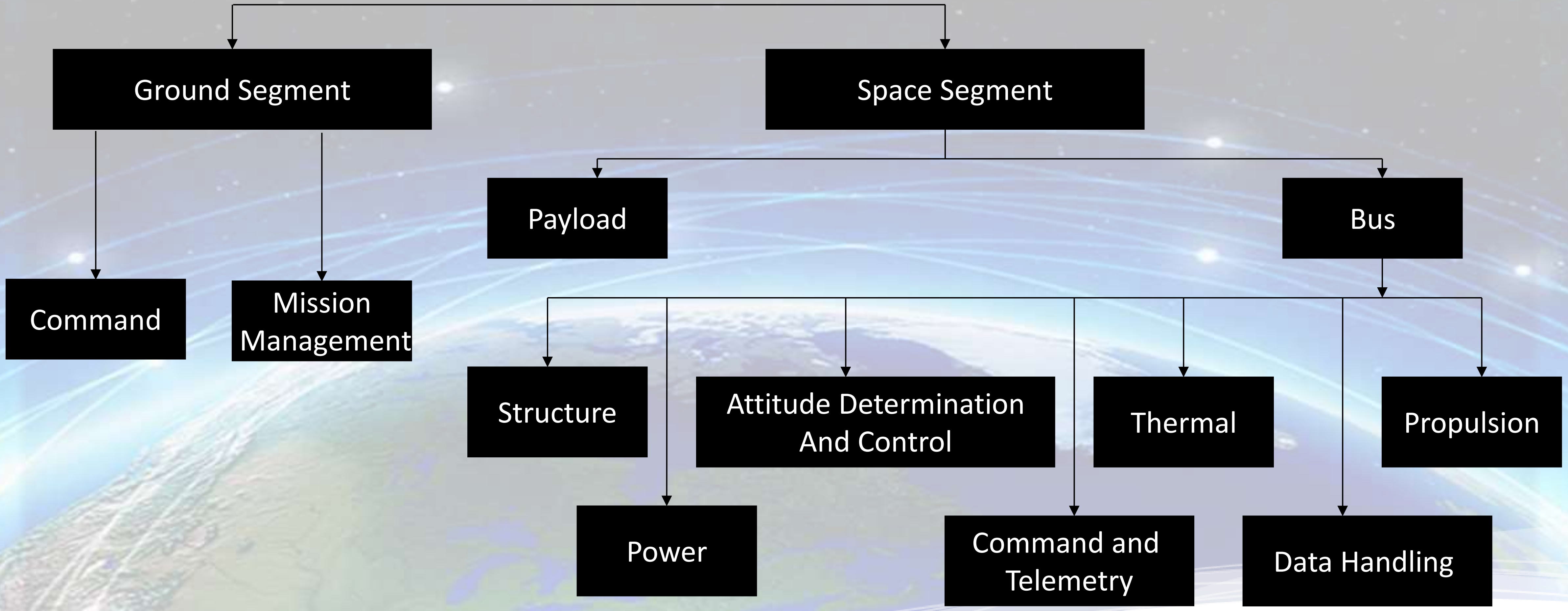
Introduction to Satellites

- MISSION AND PAYLOAD
  - Space mission: the purpose of placing in equipment (payload) and/or personnel to carry out activities that cannot be performed on earth
  - Payload: design of the equipment is strongly influenced by the specific mission, anticipated lifetime, launch vehicle selected, and the environments of launch and space.

What do Satellites do?

- Possible missions
  - Communications
  - Earth Resources
  - Weather
  - Navigation
  - Astronomy
  - Space Physics
  - Space Stations
  - Military
  - Technology Proving

How does it all fit together?



Satellite System

- A satellite system is composed of the spacecraft (bus) and payload(s)
- A spacecraft consists of the following subsystems
  - Propulsion and Launch Systems
  - Attitude Determination and Control
  - Power Systems
  - Thermal Systems
  - Configuration and Structure Systems
  - Communications
  - Command and Telemetry
  - Data Handling and Processing

SATELLITE SYSTEM (cont'd)

- Propulsion and Launch Systems
  - Launch vehicle: used to put a spacecraft into space.
  - Once the weight and volume of the spacecraft have been estimated, a launch vehicle can be selected from a variety of the manufacturers.
  - If it is necessary to deviate from the trajectory provided by the launch vehicle or correct for the errors in the initial condition, additional force generation or propulsion is necessary
  - On-board propulsion systems generally require a means to determine the position and attitude of the spacecraft so that the required trust vectors can be precisely determined and applied.

SATELLITE SYSTEM

- Attitude Determination and Control System (ADCS)
  - ADCS are required to point the spacecraft or a component, such as solar array, antenna, propulsion thrust axis, and instrument sensor, in a specific direction.
  - Attitude determination can be accomplished by determining the orientation w.r.t. the star, earth, inertial space, geomagnetic field and the sun.
  - Attitude control can be either passive or active or combination.

SATELLITE SYSTEM

- Power Systems
  - Spacecraft power can be obtained from the sun through solar cell arrays and thermal electrical generators and from on-board devices such as chemical batteries, fuel cell, and nuclear theem-electronic and therm-ionic converters.
  - Most satellites use a combination of solar cell array and chemical batteries.

SATELLITE SYSTEM

- Thermal Control Systems
  - The function of the thermal control system is to maintain temperatures to within specified limit throughout the mission to allow the onboard systems to function properly and have a long life
  - Thermal balance can be controlled by using heaters, passive or active radiators, and thermal blankets of various emissivities on the exterior.

SATELLITE SYSTEM

- Configuration and Structure Systems
  - The configuration of a spacecraft is constrained by the payload capability and the shape of the fairing of expendable launch vehicle.
  - Large structures, such as solar arrays and antenna are erected in the space through deployable components.
  - Explosive devices, activated by timing devices or command, are used to separate the spacecraft from the launch vehicles, release and deploy mechanisms, and cut cables.

SATELLITE SYSTEM

- Command and Telemetry
  - The Command and Telemetry system provide information to and from the S/C respectively.
  - Commands are used to provide information to change the state of the subsystems of the S/C and to se the clock.
  - The Telemetry subsystem collects and processes a variety of data and modulates the signal to be transmitted from the S/C.

SATELLITE SYSTEM

- Data Handling and Processing
  - Data processing is important to help control and reconfigure the spacecraft to optimize the overall system performance and to process data for transmission.
  - Consists of processor(s), RAM, ROM, Data Storage, and implemented by machine, assembly or high level language.
  - Low mass, volume, and power requirements, insensitivity to radiation, and exceptional reliability are important characteristics of processor.

SATELLITE SYSTEM

- Communications
  - Radio frequency communication is used to transmit information between the S/C and terrestrial sites and perhaps other S/Cs.
  - Information transmitted from the S/C include the state and health of the subsystems in addition to data from the primary instruments.
  - Information transmitted to the S/C generally consists of data to be stored by on-board processors and commands to change the state of the on-board system either in real-time or through electronic logic that execute them as a function of time or as required.

Engineering Procedures

- Space Systems Engineering
  - System Definition
    - System, Subsystem, Components, and Parts
    - A large collection of subsystems is called a segment.
    - In a space mission, the spacecraft, the launch vehicle, the tracking stations, the mission control center, etc., may each be considered a system or segment by their principle developers but are subsystems of the overall system.
  - Value of a System
    - System's ability to satisfy criteria generally called system level requirements or standards for judgment.

Engineering Procedures

- Engineering a Satellite
  - Mission Needs
  - Conceptualization and system requirements
  - Planning and Marketing
  - Research and Technology Development
  - Engineering and Design
  - Fabrication and Assembly
  - Integration and Test
  - Deployment, operation and phase-out

Engineering Procedures (Cont'd)

What is a CanSat?

- Why do we build cansats?
- What can they do?
- How are we going to build one?

Hands on Overview

- What is Arduino?
- What is the subsystems?
- How do we emulate them?
- How do we launch?

Mission

- Your Mission
  - NASA is building the next generation manned rocket and is looking to update their Pressure and Temperature models for the upper atmosphere. They contract you to develop, build, and launch a cost effective payload to take accurate measurements of the upper atmosphere.

CanSat - Comms

- Intro to comms systems
- Comms on Cansats
- Why are they important?
- Completing a link budget
- What is our comm system?
- Roadmap
- Disciplines

CanSat – C&DH

- What is a C&DH?
- What is Arduino?
- Intro to coding
- Walk through a program section by section
  - Determine some fill in the blank items that explains code/logic
- Disciplines
- Road Map

Launch Services

- What is a launch service?
- What does it mean to enter “operatons”?
- What is the role of the GS?
- Intro to balloons and high alt launches

Launching the Balloon/Payload

- Intro to lift/buoyance
- Trajectory
- Recovery
- Getting Data

Conclusions/Review

- What to emphasize?
- Closing remarks?
- What is the takeaway?