# GPS Overview

Last updated 3/7/24

# GPS Overview

- Global Positioning System - Origins
  - US Department of Defense
  - Cold War technology to allow submarines to know their position accurately
    - Allow precise targeting of Inter Continental Ballistic Missiles (ICBMs)
    - Most Soviet ICBMs were land based – leading to an advantage for the US if they could target from the sea
  - Widespread benefits outside military applications

# GPS Overview

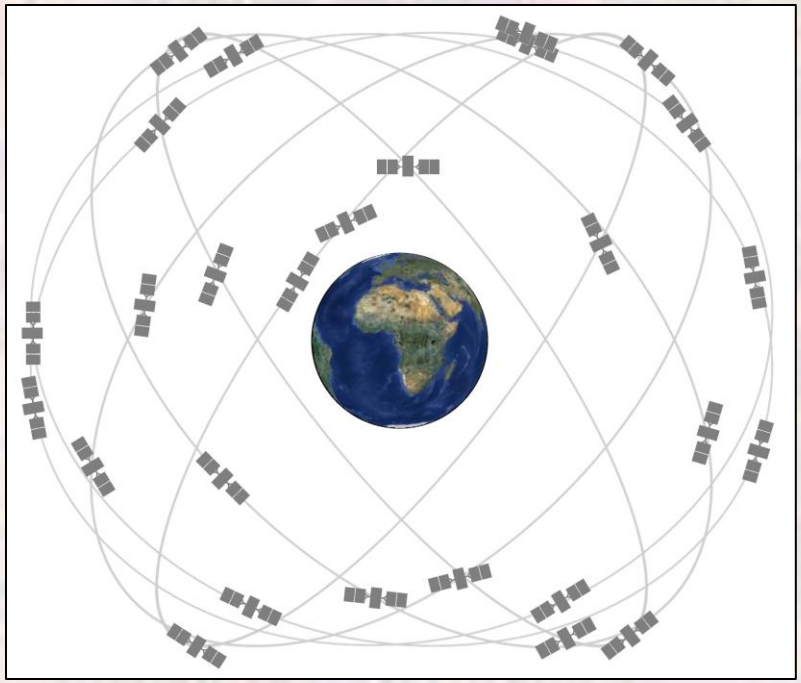
- Basic Configuration
  - Constellation of satellites
  - Associated ground stations
  - Mobile Receivers

  - Nominal position resolution of a few meters

  - Advanced systems capable of cm resolution

# GPS Overview

- Constellation of Satellites
  - Medium earth orbit
    - 12,550mi (20,200Km)
    - Non-stationary
      - 2 complete orbits / day
  - 27 active + 4 spares
  - 6 equally spaced planes
    - 3 with 4 slots / plane
    - 3 with 5 slots / plane



→ 4 satellites visible at all locations, at all times
  - Exceptions for topography

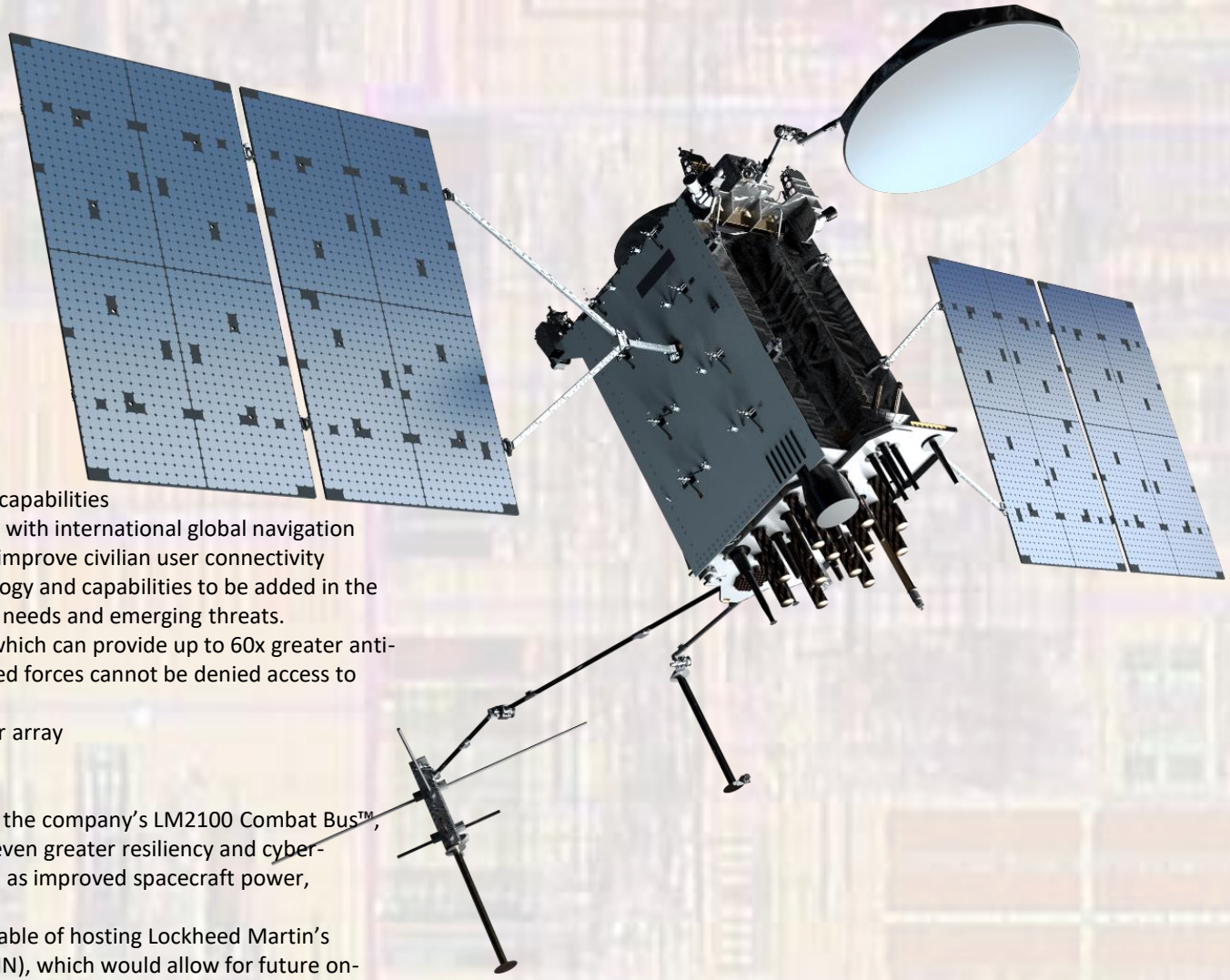
# GPS Overview

- Satellites


- Name: NAVSTAR
- Manufacturer: Rockwell International
- Altitude: 12,550 nautical miles
- Weight: 1900 lbs (in orbit)
- Size: 17 ft with solar panels extended
- Orbital Period: 12 hours
- Orbital Plane: 55 degrees to equatorial plane
- Planned Lifespan: 7.5 years
- Constellation: 24 Block II production satellites
- Visibility: 5-8 visible at any time

# GPS Overview

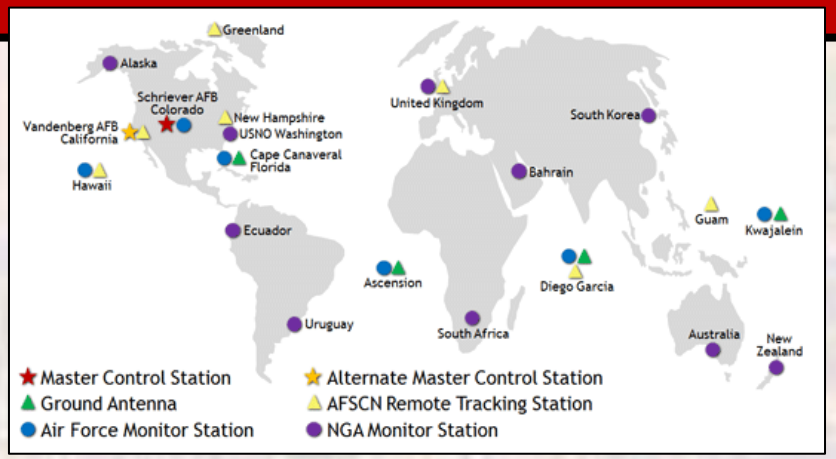
- Satellites
  - GPS IIIF



- Three times better accuracy
- Up to eight times improved anti-jamming capabilities
- A new L1C civil signal, which is compatible with international global navigation satellite systems, like Europe's Galileo, to improve civilian user connectivity
- A modular design that allows new technology and capabilities to be added in the future to better address changing mission needs and emerging threats.
- A Regional Military Protection Capability which can provide up to 60x greater anti-jamming in theater to ensure U.S. and allied forces cannot be denied access to GPS in hostile environments
- An accuracy-enhancing laser retroreflector array
- A new search and rescue payload
- A fully digital navigation payload
- GPS IIIF SV13 and beyond will incorporate the company's LM2100 Combat Bus™, an enhanced space vehicle that provides even greater resiliency and cyber-hardening against growing threats, as well as improved spacecraft power, propulsion and electronics
- LM2100 Combat Bus vehicles are also capable of hosting Lockheed Martin's Augmentation System Port Interface (ASPIN), which would allow for future on-orbit servicing and upgrade opportunities.

# GPS Overview

- Ground Stations
  - Called Control Segment
  - Monitor the GPS satellites
    - Check their operational health
    - Check their exact position in space
    - Update the Satellites with their position
    - Update the Satellites with time offsets
  - Stations
    - Master control station
      - Alternate master control station
    - 11 command and control antennas
    - 16 monitoring sites




# GPS Overview

- Ground Stations
  - Master Control Station
    - Provides command and control of the GPS constellation
    - Uses global monitor station data to compute the precise locations of the satellites
    - Generates navigation messages for upload to the satellites
    - Monitors satellite broadcasts and system integrity to ensure constellation health and accuracy
    - Performs satellite maintenance and anomaly resolution, including repositioning satellites to maintain optimal constellation
    - Currently uses separate systems (AEP & LADO) to control operational and non-operational satellites
    - Backed up by a fully operational alternate master control station

# GPS Overview

- Ground Stations
  - Command and Control Ground Antennas
    - Send commands, navigation data uploads, and processor program loads to the satellites
    - Collect telemetry
    - Communicate via S-band and perform S-band ranging to provide anomaly resolution and early orbit support
    - Consist of 4 dedicated GPS ground antennas plus 7 Air Force Satellite Control Network (AFSCN) remote tracking stations
  - Monitor Stations
    - Track GPS satellites as they pass overhead
    - Collect navigation signals, range/carrier measurements, and atmospheric data
    - Feed observations to the master control station
    - Utilize sophisticated GPS receivers
    - Provide global coverage via 16 sites:
      - 6 from the Air Force plus 10 from NGA

# GPS Overview

- Fixed and Mobile Receivers
  - Handheld / mounted

  - Integrated


# GPS Overview

- Applications
  - Ubiquitous
    - watches
    - phones
    - cars, boats, planes,
    - construction equipment,
    - farm machinery
    - …
  - Applications
    - location
    - directions
    - common interests
    - …