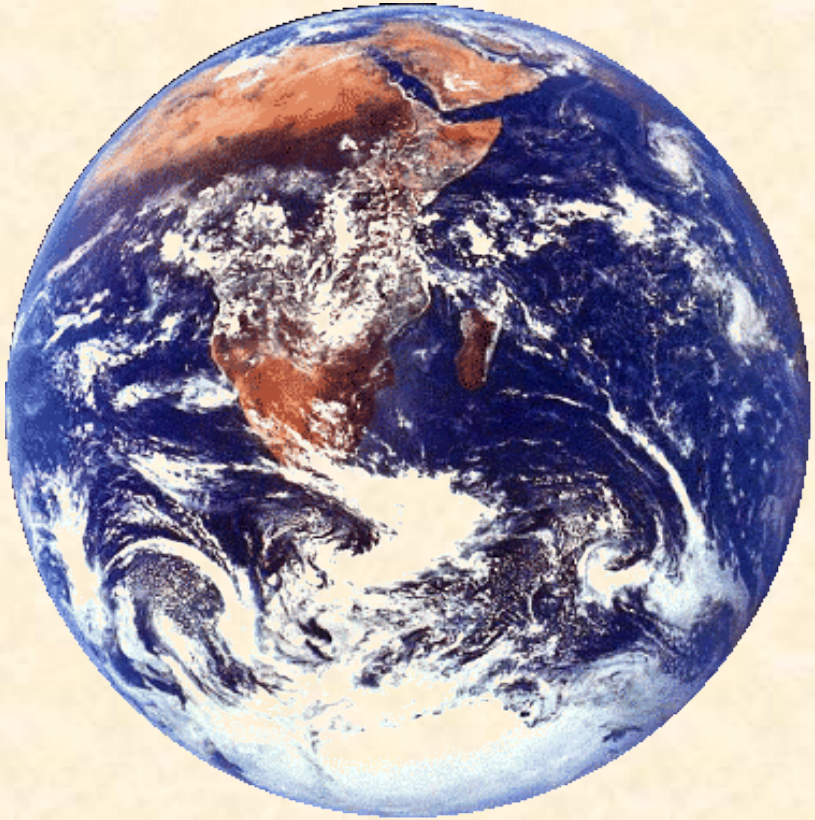
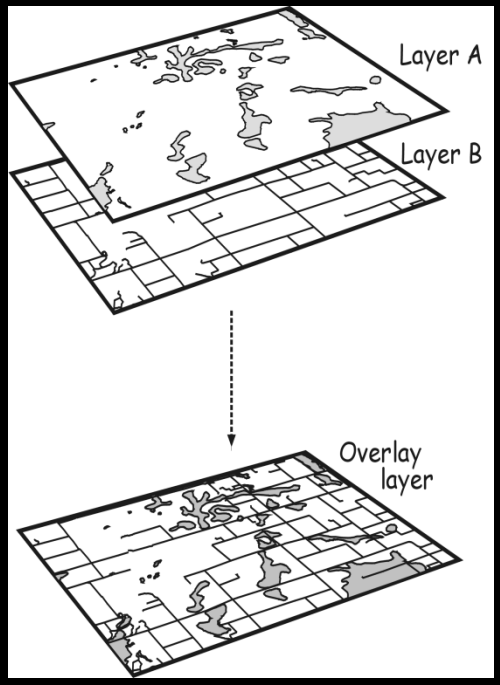
# Global Positioning System Use by the Military



EV478

# New Enabling Technologies




- GPS
- UAVs

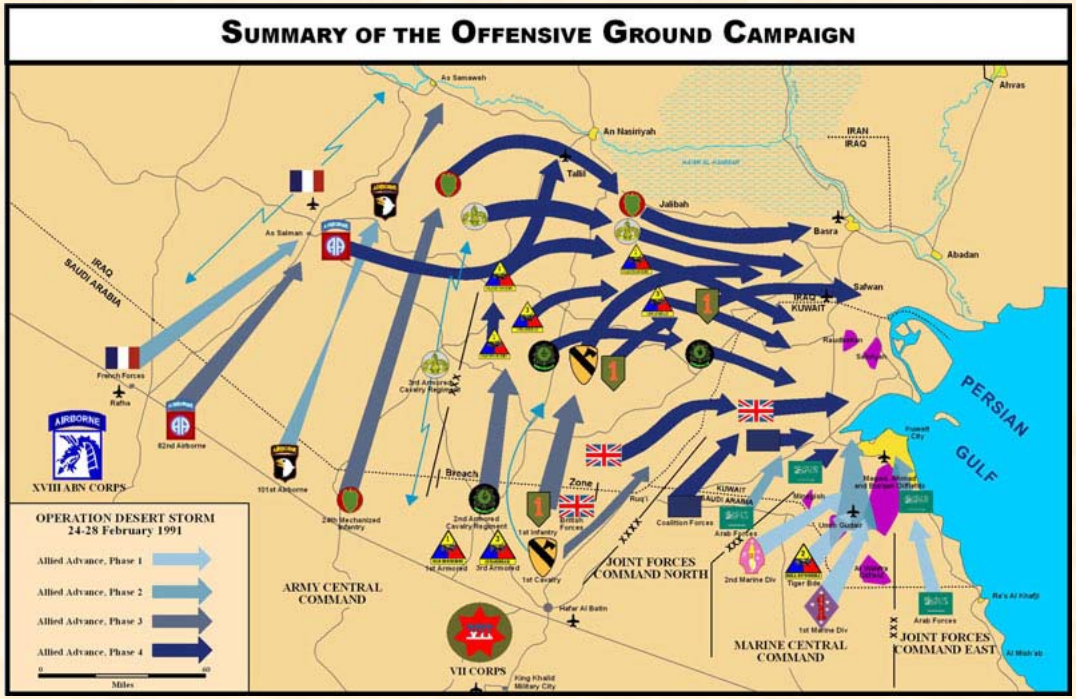
- High Res Satellites
- GIS

# AGENDA

- ✓Why GPS Anyway?
- ✓Current US/Allied Military GPS Applications
- ✓Why Change GPS Anyway ?
- ✓GPS Modernization
- ✓Future US/Allied Military GPS Applications
- ✓Take Aways

# Why GPS Anyway?

# Why GPS Anyway ?
# That's Why !!




US/Allied victory in Desert Storm

(January 16th through March 3rd 1991)

# *Desert Shield*
# "Setting the Conditions for Success During Desert Storm"

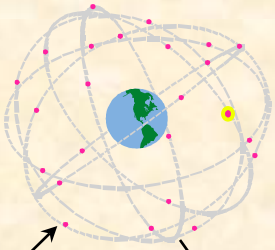
One of the *MOST* Critical Conditions
-- Creating the GPS Application Structure –

- ✓ **Device Placement**
- ✓ **Maps**
- ✓ **Training**
- ✓ **Integration**

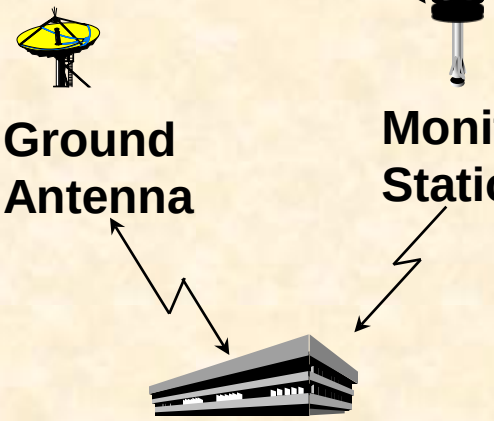
**All done in ~ six months time**

# GLOBAL POSITIONING SYSTEM (GPS)

**24-satellite (nominal) constellation**



**Time and Orbit Position**

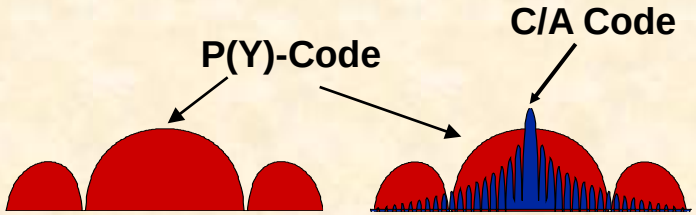


**Ground Antenna**

**Monitor Station**

**Master Control Station (Schriever AFB)**

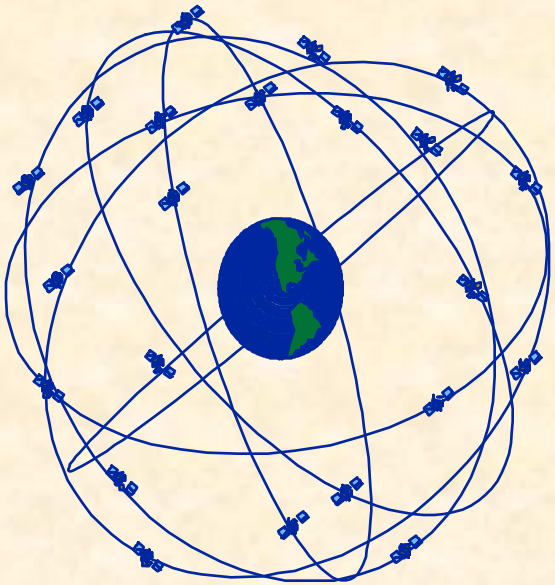
**Receiver Calculates 3-D Location and Time**

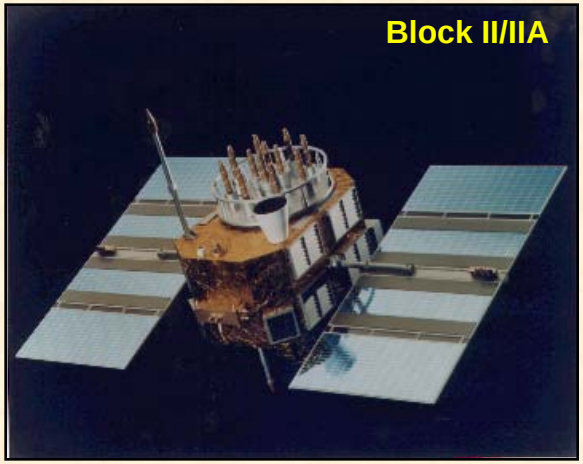



**L2**
**1227.6 MHz**

**L1**
**1575.42 MHz**

# GPS SPACE SYSTEMS

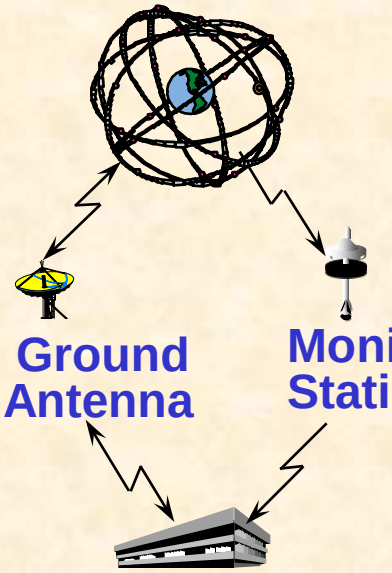






- 24-satellite (nominal) constellation
- Six orbital planes, four satellites per plane
- Semi-synchronous, circular orbits (~11,000 mi)
- Current List

# GPS OPERATIONAL CONTROL SYSTEM (OCS)

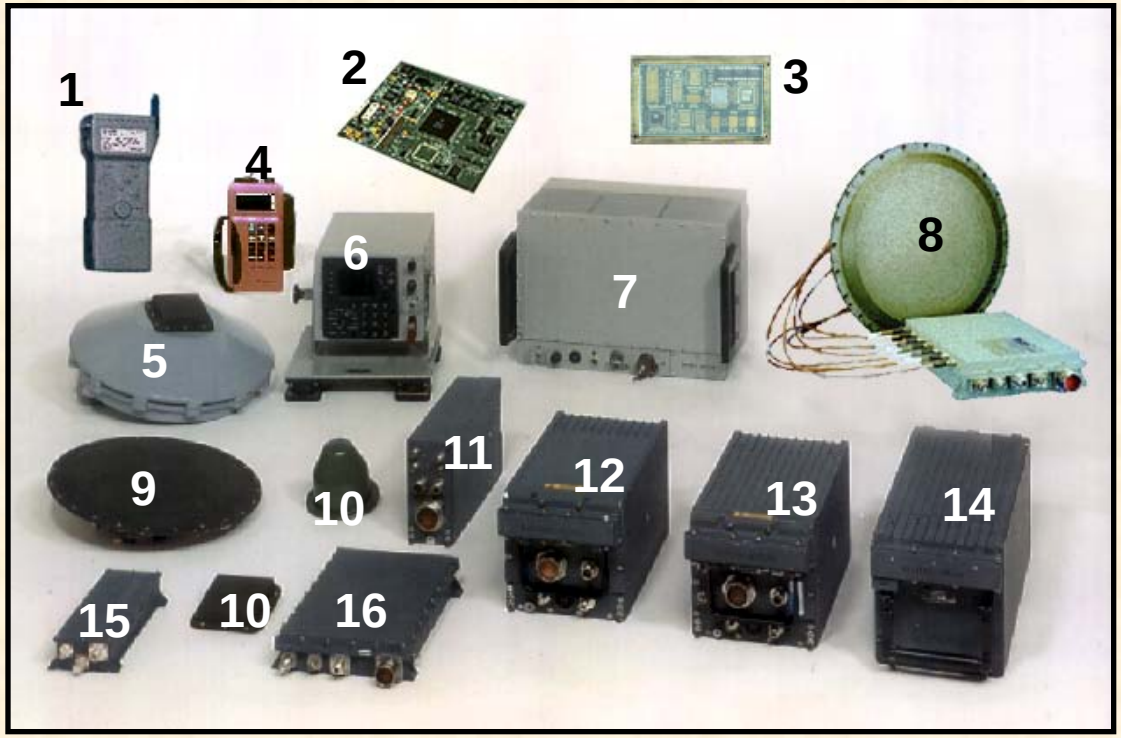




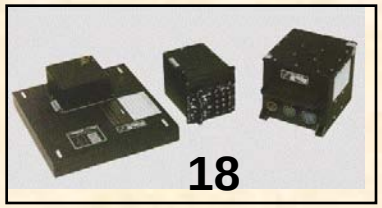


- *Master Control Station (MCS):* Satellite control, System operations
- *Alternate Master Control Station:* Training, Back-up
- *Monitor Station (MS):* L-band; Collect range data, Monitor navigation signal
- *Ground Antenna (GA):* S-band; Transmit data/commands, Collect telemetry

# The Tools – GPS User Equipment

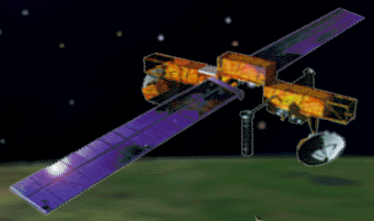







1. Combat Survivor/Evader Locator (CSEL)
2. GPS Receiver Applications Module (GRAM) with SAASM
3. Selective Availability Anti-Spoofing Module (SAASM)
4. Precision Lightweight GPS Receiver (PLGR)
5. FRPA Ground Plane (FRPA-GP)
6. Standard Control Display Unit (CDU)
7. Receiver 3S
8. GPS Antenna System (GAS) -1
9. Controlled Radiation Pattern Antenna (CRPA)
10. Fixed Radiation Pattern Antenna (FRPA)
11. Miniature Airborne GPS Receiver (MAGR)
12. Receiver OH (MIL-STD-1553)
13. Receiver UH (ARINC 429)
14. Receiver 3A
15. Antenna Electronics AE-4
16. Antenna Electronics AE-1/AE-1A
17. Embedded GPS / INS (EGI)
18. Doppler-GPS Navigation System (DGNS)

# Military Applications



Satellite positioning

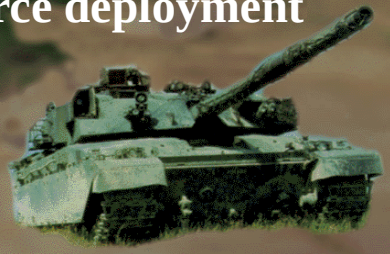
Navigation

Imagery

Weapon guidance

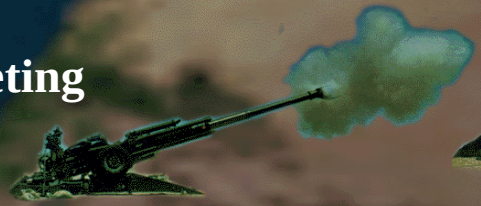
Force location

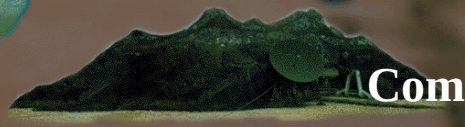
Force deployment



Coordinate mensuration

Targeting





Communication network timing

97-0018

# Demonstrated and Documented Force Enhancement Qualities of GPS

| Improved Position Accuracy | Accurate Weapon Placement |
|---|---|
| Mine Countermeasures | Saved Ordnance |
| Search and Rescue | Improved "Kill Ratios" |
| Special and Night Operations | Increased Efficiency |
| Intelligence Assessments | Demoralized Enemy |
| Logistics Support & Tanker Ops | Reduced Exposure to Hostile Fires |
| **Enhanced Systems Performance** | **Provided Time Synchronization** |
| Standoff Land Attack Missile | Command and Control |
| Patriot | Secure Communications |
| Artillery and Armored Vehicles | Coordinated Operations |
| Sensors | Joint Operations |
| EC-130/F-16/B-52/RC-135 | Special Operations |

# Current Applications

- Navigation
- Satellite Positioning
- Weapon Guidance
- Targeting/Fire Control
- Intelligence/Imagery
- Attack Coordination/Coordinate Mensuration
- Search and Rescue
- Force Location
- Communication Network Timing
- Force Deployment/Logistics

# Navigation and Positioning Applications

- Marine Navigation
- Aircraft Navigation
- Land Navigation
- Satellite Positioning

# Navigation and Positioning Applications

## Land Navigation

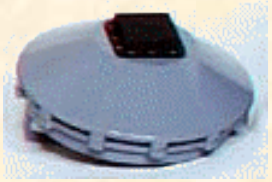
**PLGR**

**DAGR**

**Receiver 3S**

**CDU**

**FRPA Antenna**



**SWAGR**

## Marine Navigation

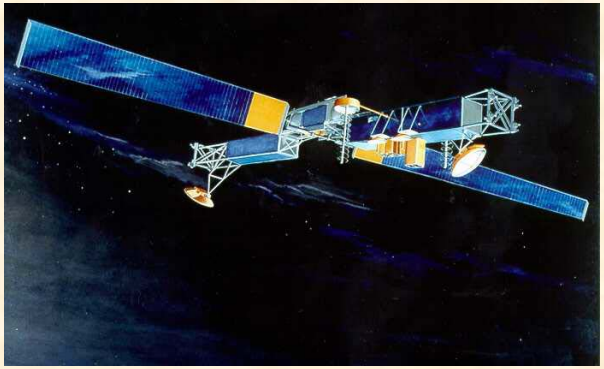
# Navigation and Positioning Applications

Aircraft Navigation

Receiver 3A

MAGR


CUGR



Satellite Positioning

CRPA Antenna

# Navigation and Positioning Applications

Land and Air Navigation Integration

# Guidance and Fire Control Applications

- Ballistic Missile Guidance
- Cruise Missile Guidance
- Artillery Spotting and Correction
- Bombing from Aircraft
- Air Defense

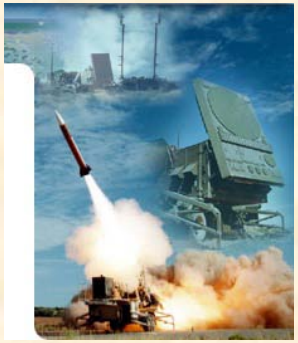
# Guidance and Fire Control Applications

Ballistic Missiles


Cruise Missiles

SAASM

Bombs



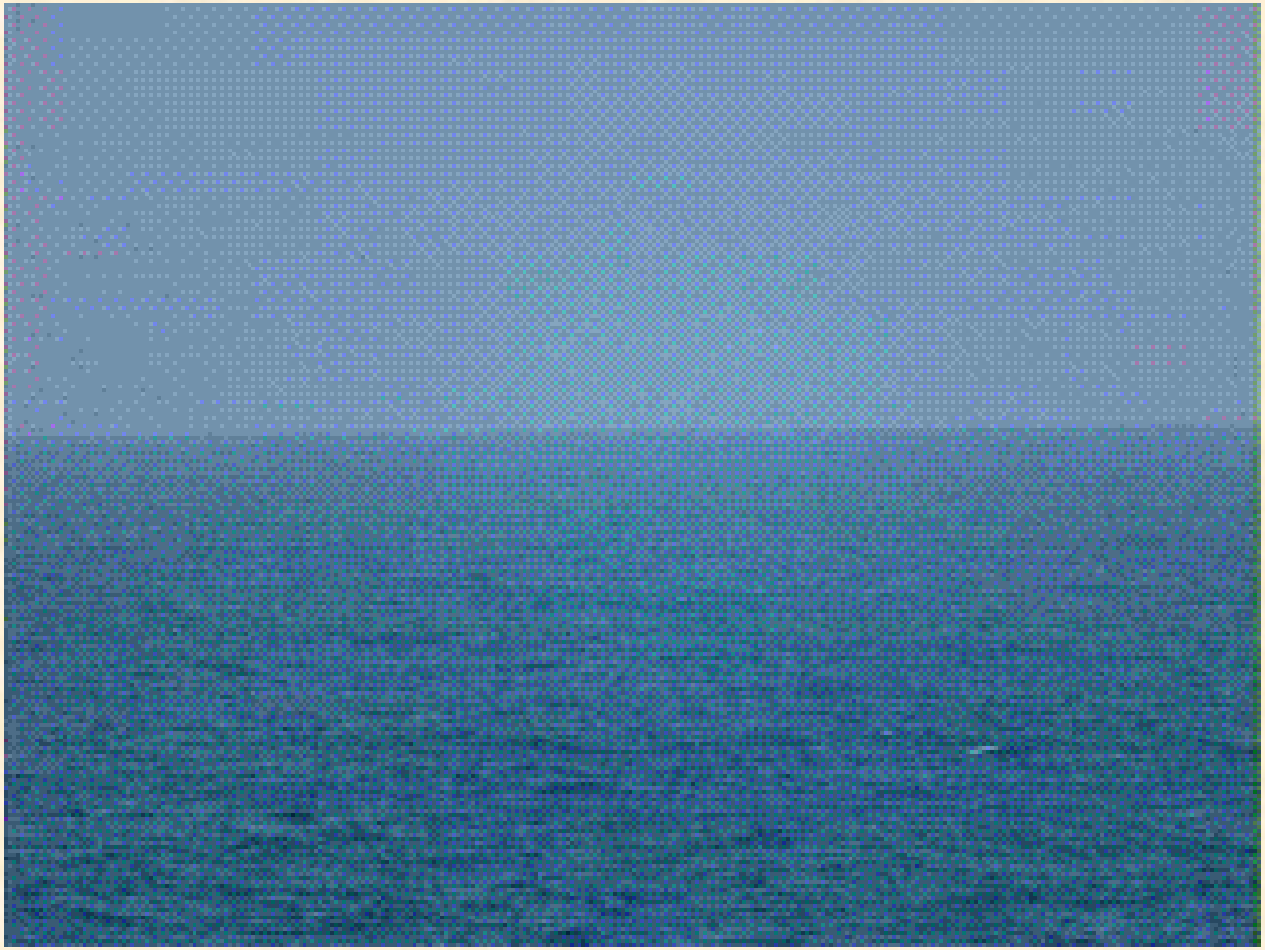
Air Defense Systems

# Guidance and Fire Control
# Fleet Ballistic Missile Guidance

**Primary Function:**
Strategic Nuclear Deterrence

**Unit Cost:** $30.9 million
**Length:** 44 feet (13.41 meters)
**Weight:** 130,000 pounds (58,500 kg)
**Diameter:** 83 inches (2.11 meters)
**Range:** Greater than 4,000 nautical miles (4,600 statute miles, or 7,360 km)
**Guidance System:** Inertial and GPS
**Warheads:** Nuclear MIRV (Multiple Independently Targetable Re-entry Vehicle)

# Guidance and Fire Control
# Ballistic Missile Guidance



# Guidance and Fire Control
# Cruise Missile Guidance


**AGM-86/130**

**Type:** Air launch cruise missile
**Range:** 1550 miles
**Speed:** 550 mph
**Guidance:** Flies at low altitude and relies on global positioning system
**Launch:** Launches from B-52H and B-1B


**TOMAHAWK**

**Type:** Land attack cruise missile
**Range:** 1,000 miles (approx.)
**Guidance:** Uses global positioning system to reach targets
**Launch:** Launches from ships or submarine torpedo tubes

# Guidance and Fire Control
# Bombing from Aircraft


**JSOW (Joint Standoff Weapon)**

**Type:** Air-to-ground smart bomb
**Range:** 30 miles (approx.)
**Guidance:** Can use global positioning system to seek targets
**Use:** Used to attack targets from outside enemy air defenses

**JDAM (Joint Direct Attack Munition)**

- Global positioning system guidance kit
- Converts existing free falling bombs into "smart" weapons

# Guidance and Fire Control
# Air Defense


**Patriot Air Defense System**

**Type:**Ground-to-air missile
**Range:** 37 nautical miles (approx.)
**Guidance:** Use GPS to assist in target acquisition, radar-based fire control
**Use:** Used to attack all types of aerial targets

# Intelligence/Imagery Applications

- Intelligence
  - Special Forces (SOF)
  - Enemy Radar Locations
  - Signals Intelligence (SIGINT)
  - Submarine Tracking
  - Mine Location
- Imagery
  - DOD Image Correction and Rectification

# Other Applications

- Attack Coordination
- Search & Rescue
- Force Location
- Force Deployment/Logistics
- Communication Network Timing

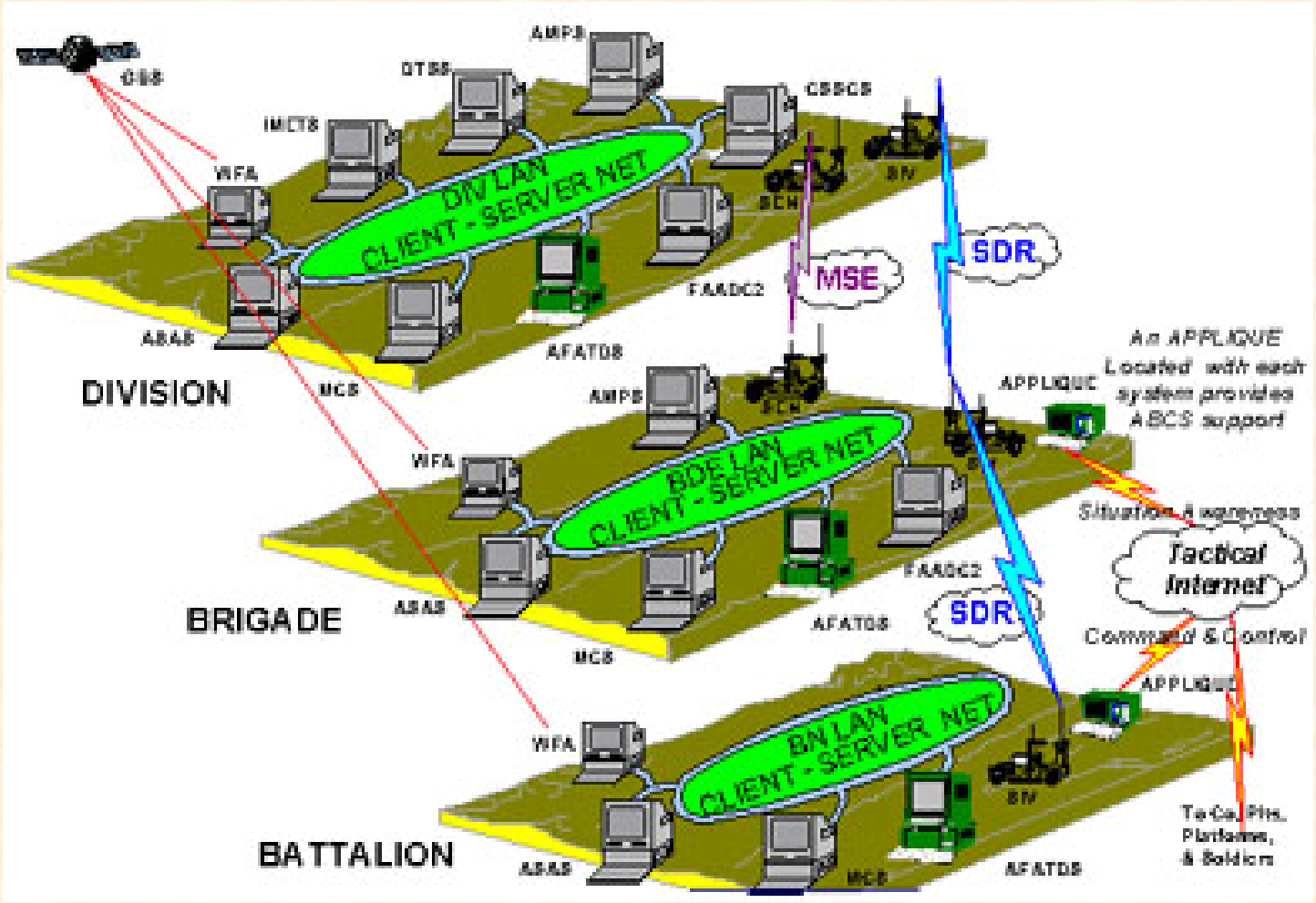
CSEL

Combat Survivor/Evader Locator

# Other Applications

Attack Coordination and Communication Network Timing

(e.g., FBCB2 thru strategic assets [Predator])



# MAJ[P] Brian Bailey
# FA24 Telecommunications Systems Engineer

# Why Change GPS Anyway
# "If It's Not Broke…Why Fix It ?"

***… Maybe It is Broken !!!***

1. Not Accessible Enough

2. Too Vulnerable

# PRESIDENTIAL DIRECTION
## "Not accessible Enough"

- ✓ Free to *peaceful* use worldwide
- ✓ Dual civil/military system
- ✓ Military / civil Interagency GPS Executive Board (IGEB) managing GPS
- ✓ Military must:
  - ✓ Protect friendly use
  - ✓ Prevent adversary use
  - ✓ Preserve civil use outside area of operations
- ✓ Turn-off Selective Availability (SA) by 2006

*GPS is the world's standard*

# POSSIBLE MISUSE OF GPS "Too Vulnerable"

- Terrorist Use

- Misuse by Other Governments

  Use by unfriendly governments against the United States or it's allies.
  Use by friendly governments in ways unintended by the United States.
  Use by non-aligned countries against other non-aligned countries.

FACTS for the Warfighter

# MODERNIZING GPS OVERVIEW

- ✓ Better support the warfighter in the evolving threat environment
  - ✓ More signal power = more anti-jam
  - ✓ More secure new military code structure
  - ✓ More User Equipment anti-jam capability = more protection
  - ✓ Better able to deny an enemy use of GPS

- ✓ Better support to civil GPS customers
  - ✓ New civil signals for improved accuracy, integrity and continuity of service = robustness
  - ✓ Compatibility with civil aviation systems

# Defense Advanced GPS Receiver (DAGR)

- Improved hand-held GPS Receiver
- Authorized DoD, Federal Civilian, and FMS users of GPS PPS User Equipment
- Unit price ≤ $2,000
- Interoperable with current Precision Lightweight GPS GPS Receiver (PLGR)
- Five year warranty with a five year priced option
- Focus on ease-of-use and diverse functionality
  - One-handed operations
  - Graphical User Interface (GUI)
- Two-phase acquisition approach
  - Four PRDA development efforts - a "family" of receivers
  - Commercial production contract - up to 217,000 production units - deliveries starting in Jul 03

# HAND-HELD RECEIVER COMPARISON

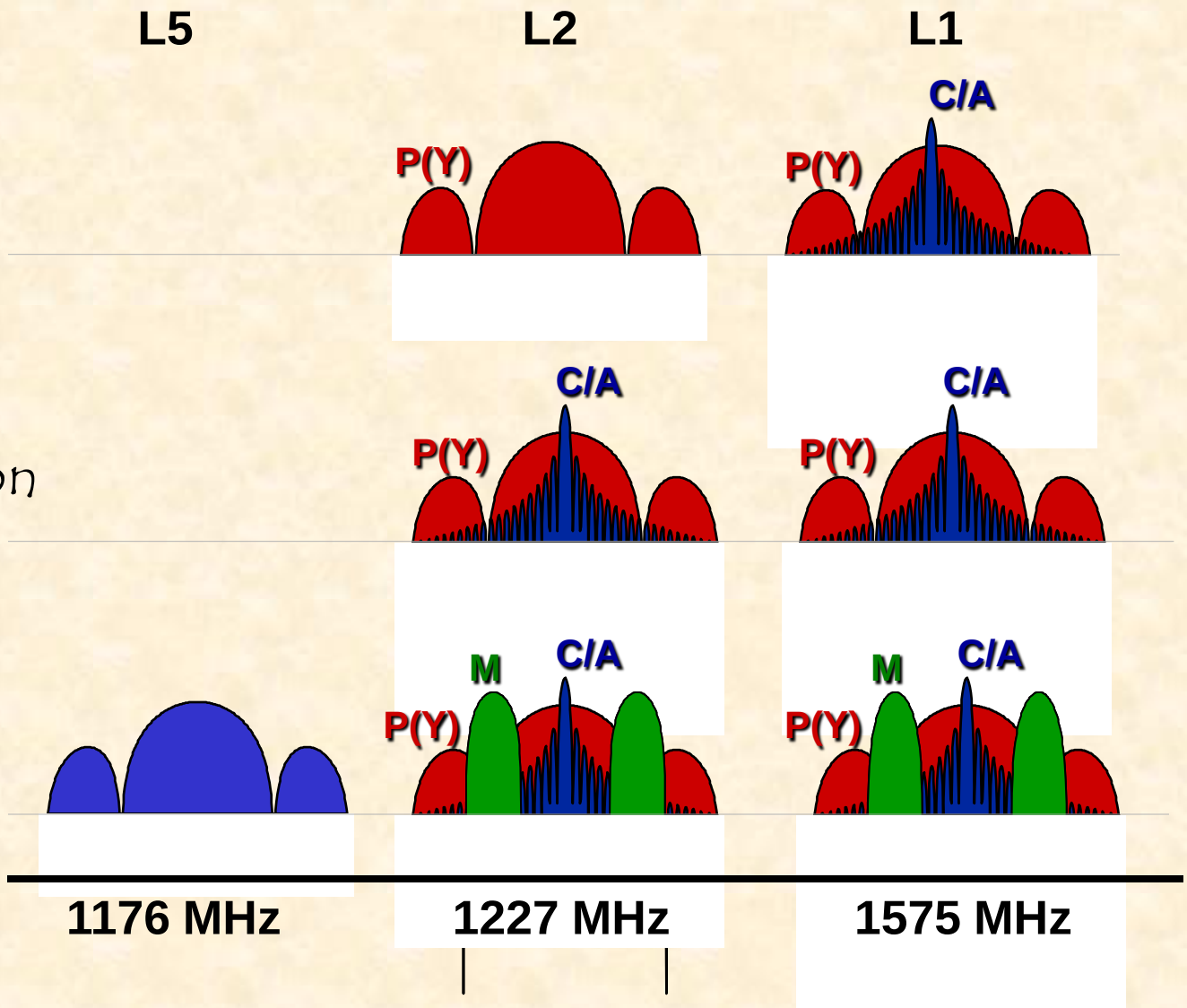
| PLGR | | DAGR |
|---|---|---|
| ✓ Single (L1 only) | *Frequency* | ✓ Dual (L1/L2) |
| ✓ PPS-SM | *Security* | ✓ SAASM |
| ✓ Text only | *Display* | ✓ Graphical |
| ✓ 5 Maximum | *Satellites* | ✓ All-in-View |
| ✓ 24 dB | *Anti-Jam* | ✓ 34 - 42 dB |
| ✓ 6 minutes | *TTFF* | ✓ 1 minute |
| ✓ 2.75 lbs | *Weight* | ✓ ≤ 1.9 lbs |
| ✓ ≤ 120 cu. in. | *Volume* | ✓ ≤ 38 cu. in. |

**PPS-SM = Precise Positioning Service - Security Module**

**SAASM = Selective Availability Anit-Spoof Module**

**TTFF = Time to First Fix**

# MODERNIZED SIGNAL EVOLUTION



# FOREIGN MILITARY SALES (FMS)

- Sales to 27 authorized countries
  - 4 New countries orders pending: Czech Republic, Hungary, Poland, Thailand
- $8.4M in FY98 sales, $9.4M in FY99 sales
- Over $58.55M pending sales

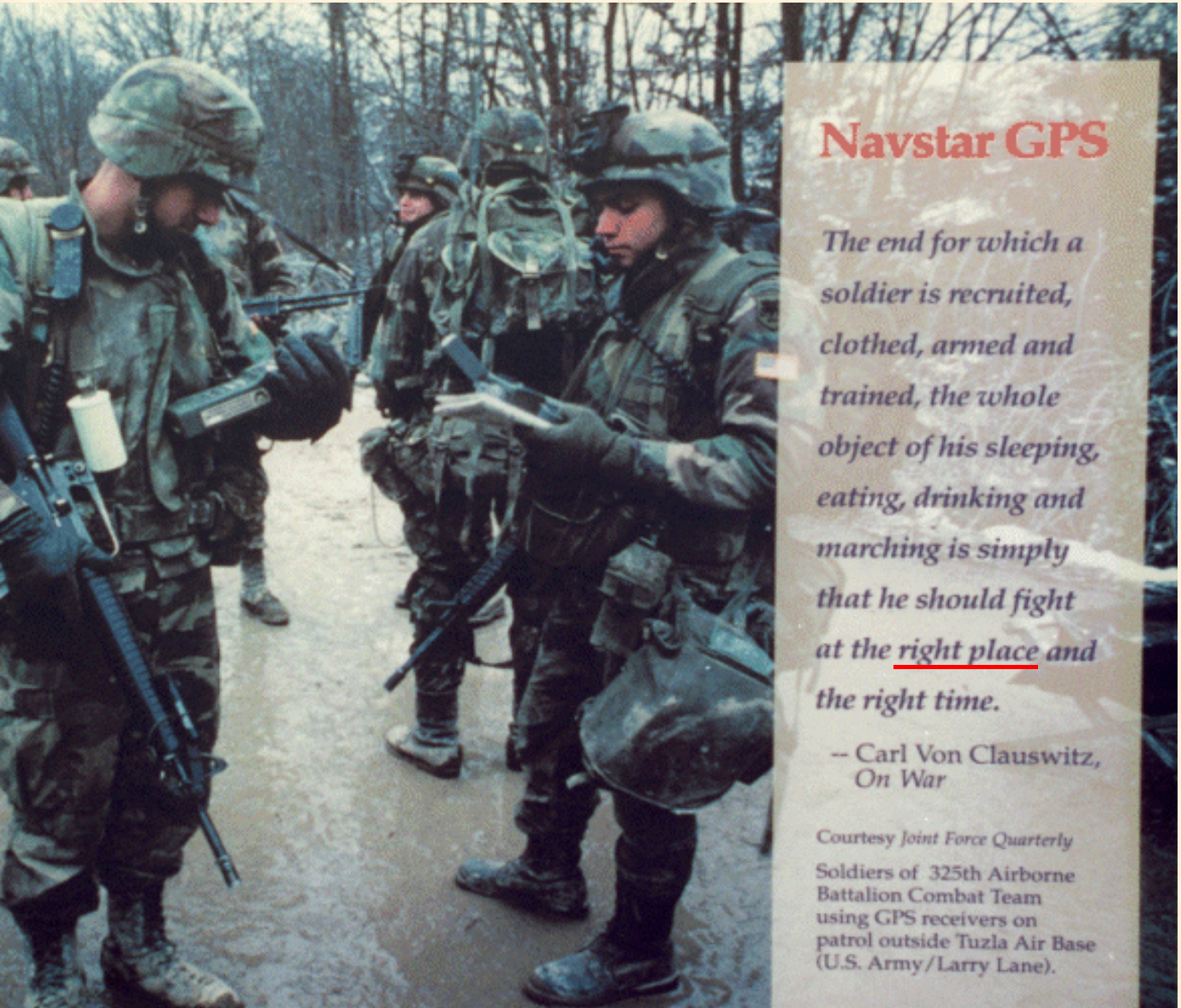
## PRODUCTS

- Receivers
- Antenna Systems
- Security Devices
- Accessories

# TAKE AWAYS
# -- THREE KEY POINTS --

- ✓ Initially, GPS changed the way U.S. and Allied Forces fight.
- ✓ Additionally, GPS fulfilled many civil and commercial uses.
- ✓ Accordingly, GPS must change to meet the needs of the future.

# But, at the end of the day…….




……. a valid desire to know place and a sure need to know place must remain separable.