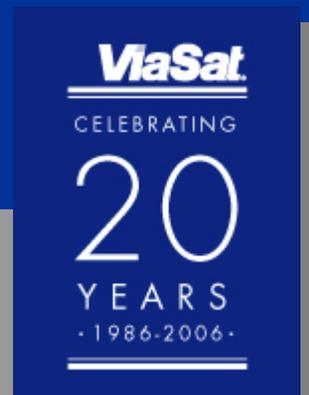




Test for Success: Next Generation Aircraft Identification System RF Simulation

Manuel L. Garcia
John M. Hoffman
Jeffry L. Rowley
Daniel L. Stone



- **IFF Historical Perspective**
- **SIF Modes**
- **Next Generation IFF Systems**
 - ◆ Mode S
 - ◆ Mode 5
 - ◆ ADS-B
 - ◆ Blue Force Tracking
- **RF Simulation Architecture**
- **RF Simulation Challenges**
- **Summary**

■ IFF Systems Evolved Along with Radar

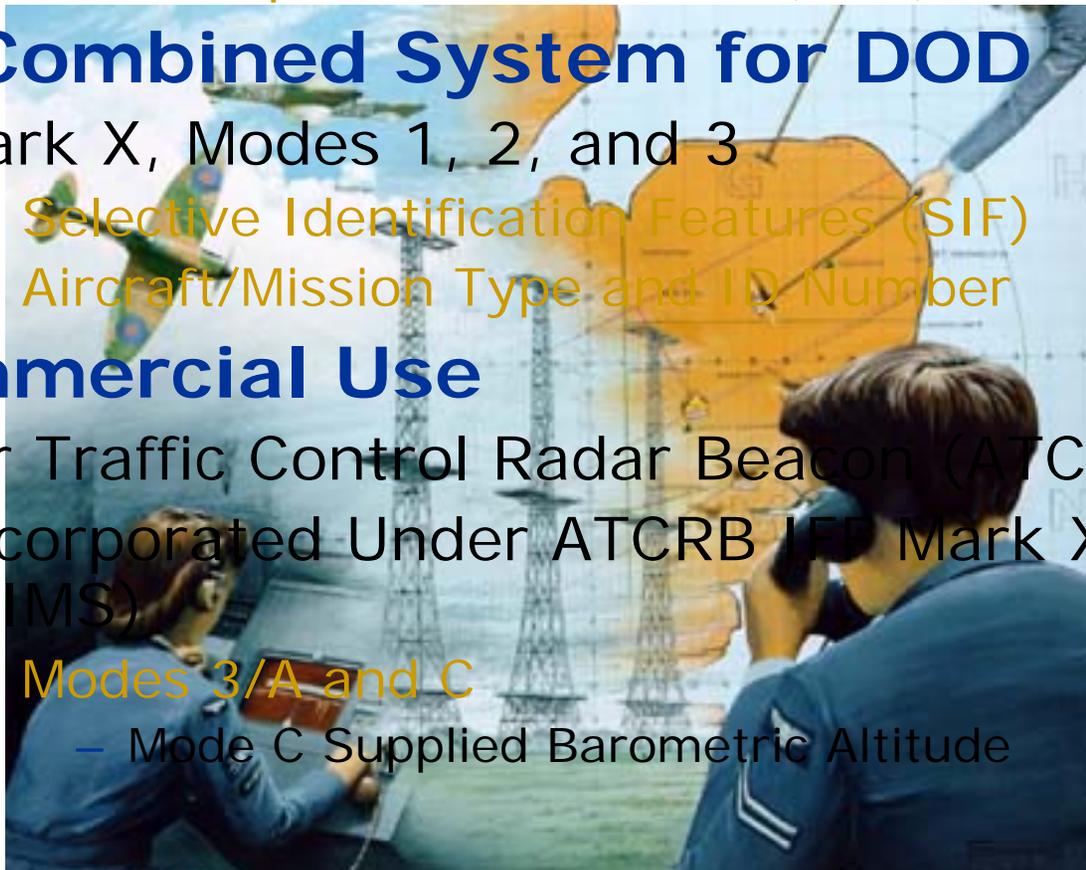
- ◆ British, US, and German Systems in WWII
- ◆ Pulses in Same RF Band as Radars
 - Pulse Amplitude Modulation (PAM)

■ US Combined System for DOD

- ◆ Mark X, Modes 1, 2, and 3
 - Selective Identification Features (SIF)
 - Aircraft/Mission Type and ID Number

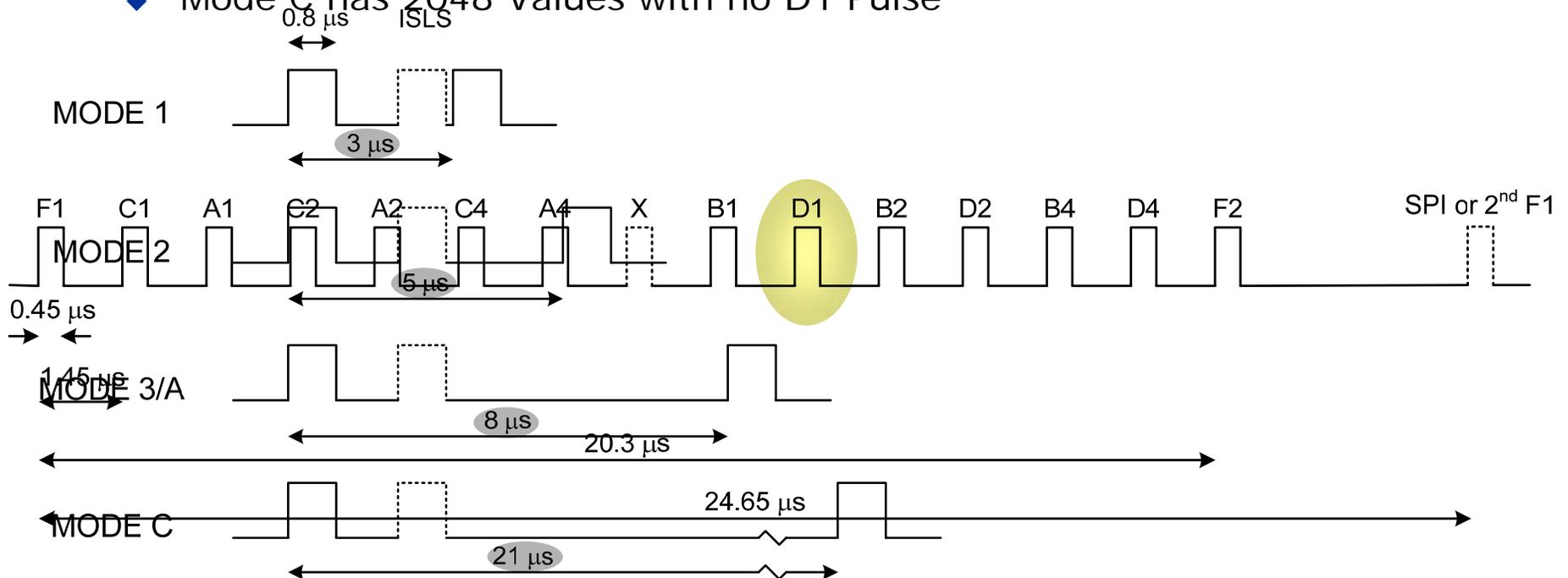
■ Commercial Use

- ◆ Air Traffic Control Radar Beacon (ATCRB)
- ◆ Incorporated Under ATCRB IFF Mark XII System (AIMS)
 - Modes 3/A and C
 - Mode C Supplied Barometric Altitude



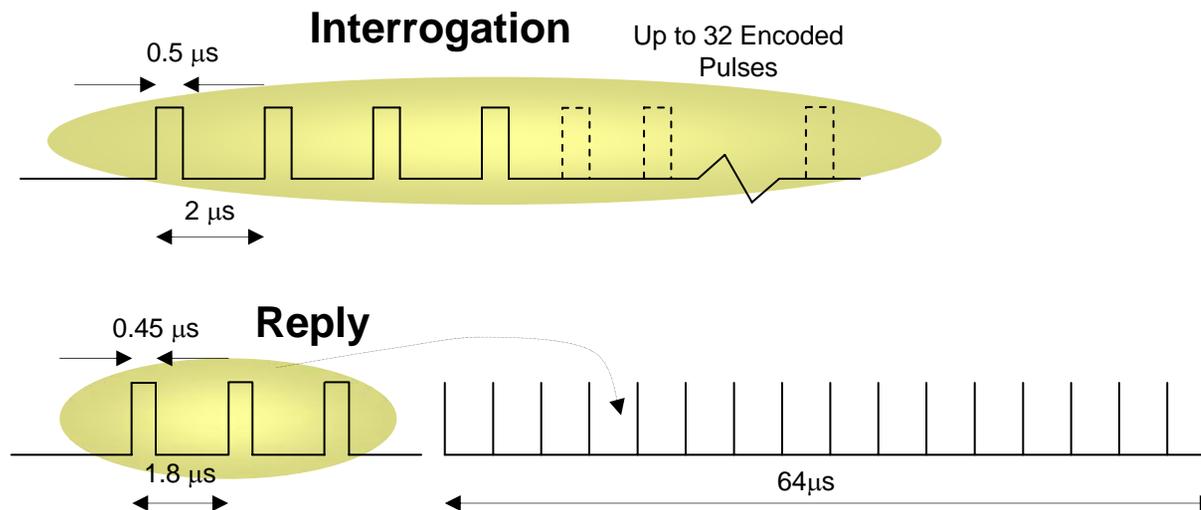
SIF Modes

- **Two Frequency Channels**
 - ◆ Interrogations at 1030 MHz
 - ◆ Transponder Replies at 1090 MHz
- **PAM for Interrogations and Replies**
- **Interrogations Use Pulse Separation Time for Mode Distinction**
 - ◆ Interrogation Side Lobe Suppression (ISLS)
 - Pulse Amplitude Comparison to Avoid Replies through Antenna Side Lobes
- **Reply Pulses Allow up to 4096 Values**
 - ◆ Mode C has 2048 Values with no D1 Pulse



■ Encrypted IFF for DOD Use

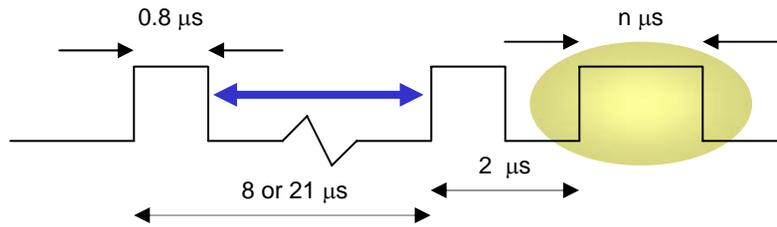
- ◆ Interrogations Use Up to 32 Encoded Pulses
- ◆ Replies Use Triplet Pulses
 - Delayed into 1 of 16 Time Slots
 - Delay Based on Decoded Interrogation



- **Enables Aircraft Specific Interrogation**
 - ◆ Reduces false replies uncorrelated in time (FRUIT)
 - Aircraft Replying to Multiple Interrogating Platforms
 - ◆ Reduces probability of garbling
 - Aircraft Replying Nearly Simultaneously
- **Waveform Improvements on Interrogations and Replies**
 - ◆ Differential Phase Shift Keying (DPSK)
 - Improves Interrogation Performance in Interference
 - ◆ Pulse Position Modulation (PPM) on Replies
 - ◆ Up to 112 Data Bits with Interrogations and Replies
- **Compatible with Legacy SIF Modes**
 - ◆ Directed Interrogations Spoof Legacy Systems with ISLS-Like Timing and Pulse Amplitude
 - ◆ All-Call Interrogations

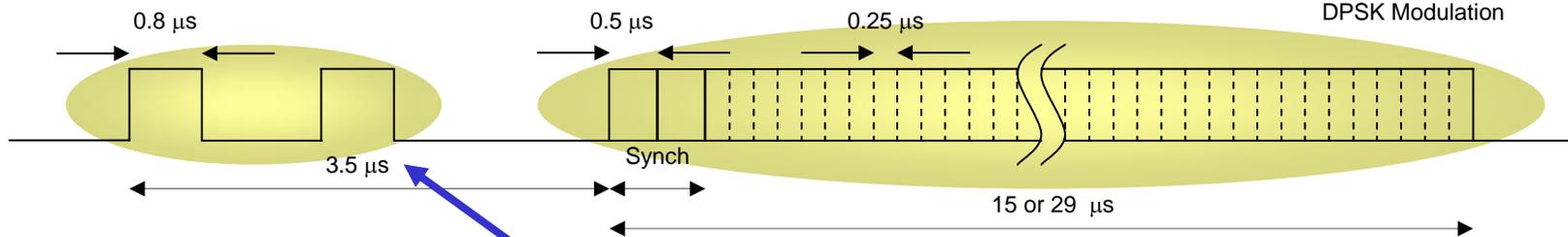
Mode S Waveforms

All-Call Interrogation



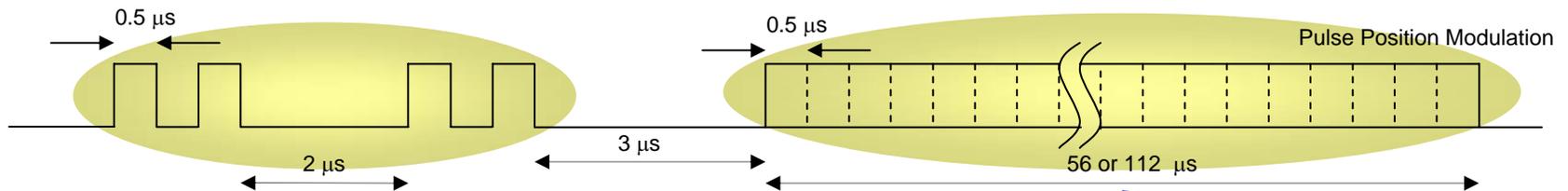
Legacy Systems Reply with Mode 3/A or C

Directed Interrogation



Legacy Systems See ISLS and Do Not Reply

Reply



Either 56 or 112 Data Bits

Cutting Edge Secure DOD IFF

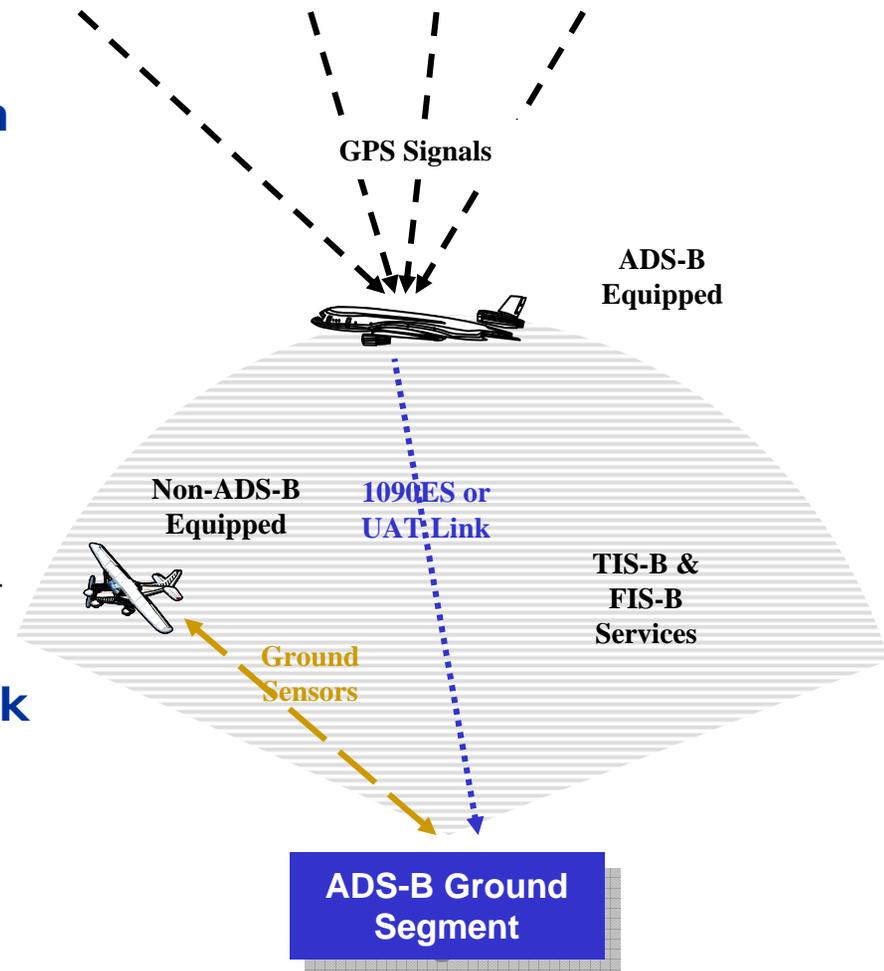
- **Interrogation Messages in Multiple Formats**
 - ◆ Support Legacy Mode 1, 2, 3, and C Data
 - ◆ Expanded Formats for ID, National Origin, Mission Code, Latitude, Longitude, and Altitude
- **Complex Encrypted Pulse Stream**
 - ◆ Greater Reliability and Security
 - Error Correction and Transmission Security (TRANSEC)
- **Similar Processing on Interrogation and Transpond Response Messages**
 - ◆ Transpond Responses in Reply or Report Formats
- **Fully Defined by AIMS 03-1000A**

Automatic Dependent Surveillance – Broadcast (ADS-B)

ViaSat

Situational Awareness for National Air Space (NAS)

- Corner Stone of Next Generation Air Transportation System (NGATS)
- GPS Receivers on Aircraft
- Data Linked to Other Equipped Aircraft and Ground Segment
 - ◆ 1090 Extended Squitter (Mode S) for Commercial Aircraft – 112 Data Bits
 - ◆ Universal Access Transceiver (UAT) for General Aviation
- Ground Sensors Detect and Track Non-ADS-B Equipped Aircraft
- Ground Segment Broadcast
 - ◆ Flight and Traffic Information Services (FIS-B and TIS-B)
 - Ground Sensor Aircraft
 - Cross Link Aircraft
 - UAT -> 1090 ES
 - 1090 ES -> UAT

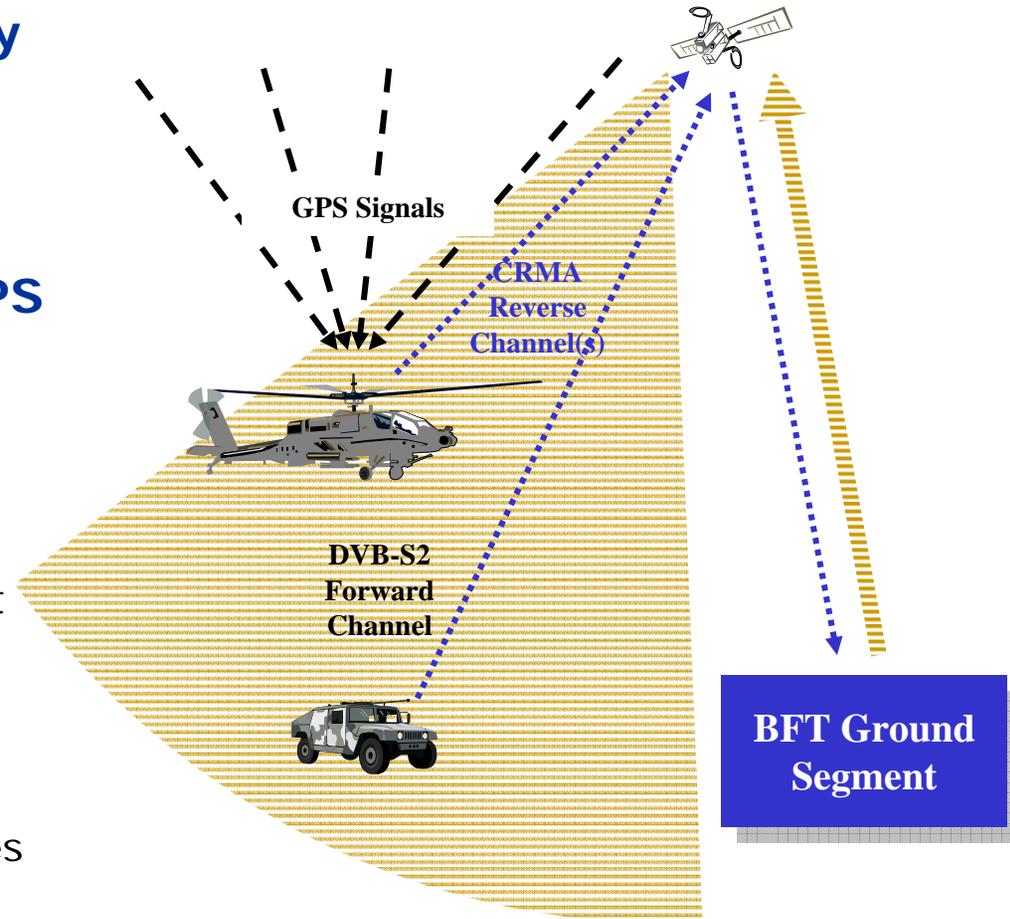


Blue Force Tracking

ViaSat

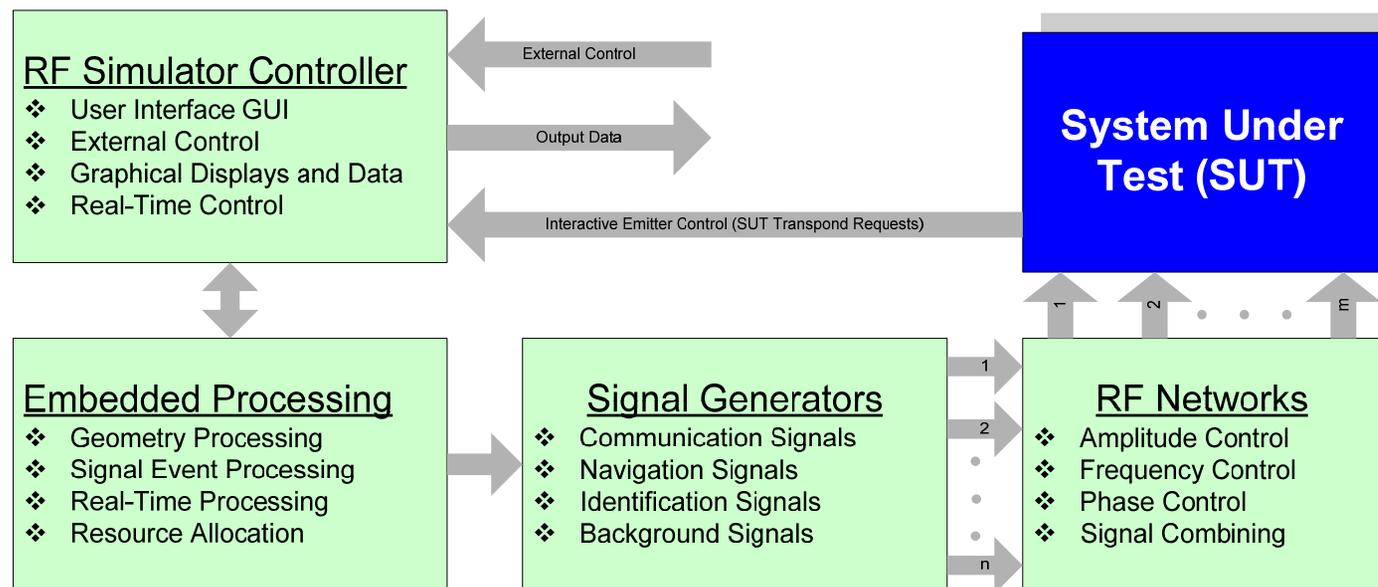
Secure System for the US Army

- Tracking of Ground and Airborne Platforms
- L-band Satellite Segment
- Platforms Equipped with GPS Receivers
- Modified BFT Waveforms Enable Greater Network Capacity and Scalability
 - ◆ Secure Reverse Channels Report Platform State Vector
 - Code Re-use Multiple Access Technique in a Spread Spectrum Waveform
 - ◆ Secure Forward Channel Provides Blue Force Position
 - Direct Video Broadcast Broadband Waveform
 - Enables Low Cost Receivers on BFT Platforms



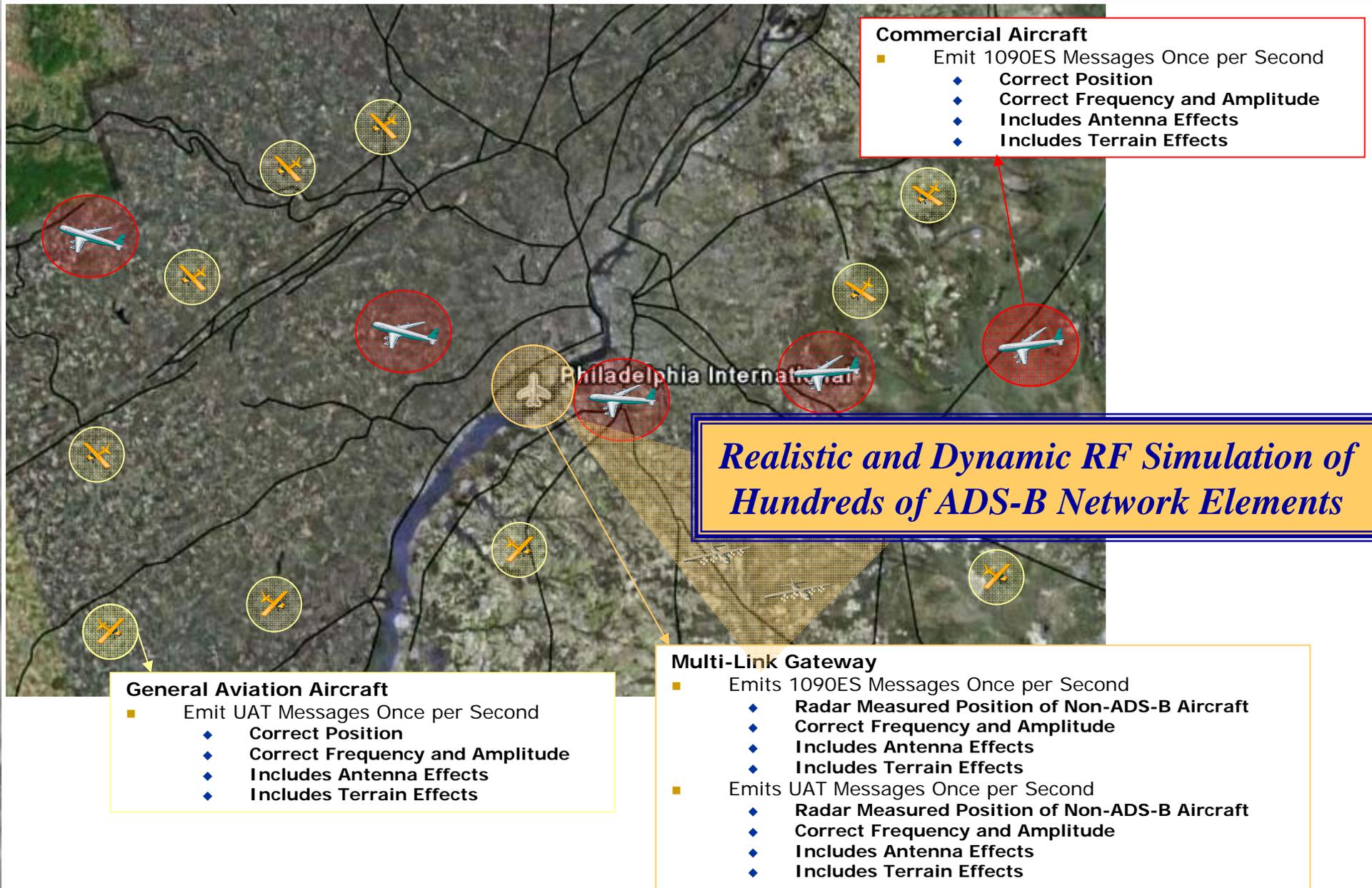
RF Stimulator Architecture

- **Generates the RF Signals to the SUT**
 - ◆ Data content, amplitude, frequency, Doppler, phase
 - ◆ Deterministic, for run-to-run consistency
- **Flexible User Interface for Scenario Definition**
- **Arbitrary Waveform Generator**
 - ◆ Capable of Generating Virtually Any RF Signal
 - ◆ Large Library of Existing Communication, Navigation, and IFF Signals



- **Mode S**
 - ◆ New Waveforms, But Easy to Implement
 - **DPSK and PPM Models**
- **Mode 5**
 - ◆ More Complex Waveforms and Signal Processing
 - ◆ New Crypto Interface for Interrogations and Transponds
 - ◆ Multiple Interrogation and Response Messages
- **ADS-B**
 - ◆ UAT Waveforms and Message Formats
 - ◆ TIS-B Information Uplink
- **BFT**
 - ◆ CRMA Waveform on Reverse Channels
 - ◆ Unique Crypto Interface
 - ◆ Satellite L-band Channel Simulator Integration
 - ◆ DVB-S2 Information Uplink

ADS-B Stimulator Example



- **RF Simulation Supports Legacy IFF**
 - ◆ Modes 1, 2, 3/A, C, and 4
- **Mode 5 IFF in Development**
- **Mode S IFF Proposed to Customer**
- **ADS-B and BFT**
 - ◆ Capabilities Briefings Provided to Government Agencies and Primes

The Floor is Open for Questions