Proposed Development of NASA Glenn Research Center's Aeronautical Network Research Simulator (ANRS)

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Presentation Overview

- CNS Testing Needs
- Current Test Bed System Overviews
  - Virtual Aircraft & Controller (VAC)
  - Joint Communications Simulator (JCS)
- New, Robust and Cost Effective Test Facility
  - ANRS Summary
  - ANRS Architecture
  - Key Features
- Summary
- Questions/Answers

CNS Testing Needs

- Enhancing activities on research & development of CNS technologies that help modernize the NAS
- Studying impact of data link traffic loads on future underlying communications infrastructure within the NAS (currently, NOT well understood)
- Current test bed system is inadequate, no real RF environment and lack of robust features and capabilities
- A need for a new, robust and cost effective test facility to allow:
  - Complex RF signal generation
  - Flexible and large scale testing of numerous CNS/ATM Concepts
  - Modeling CNS communication traffic loads of realistic operational scenarios (flight plan)
  - Performance evaluation of throughput and delay of aeronautical subnetworks under load
  - Supporting repeatable experimental trials
  - Provide an affordable approach to large scale testing
  - Include mobility related RF effects

NASA GRC VAC Overview

- NASA GRC VAC consists of major component applications:
  - Human Interactive Aircraft (HIA)
  - Human Interactive Controller (HIC)
  - Autonomous Aircraft (AA)
  - Autonomous Controller (AC)
  - System Manager
- Software applications interface with ATN routers & provide a virtual aircraft/controller capability that emulates pilot/controller data link exchanges for up to 160 aircraft, using script-driven events
- Support Context Management (CM) & CPDLC messages
- VAC Build C (an upgrade) supports TIS-B, ADS-B and realistic flight-plans

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VAC System Overview

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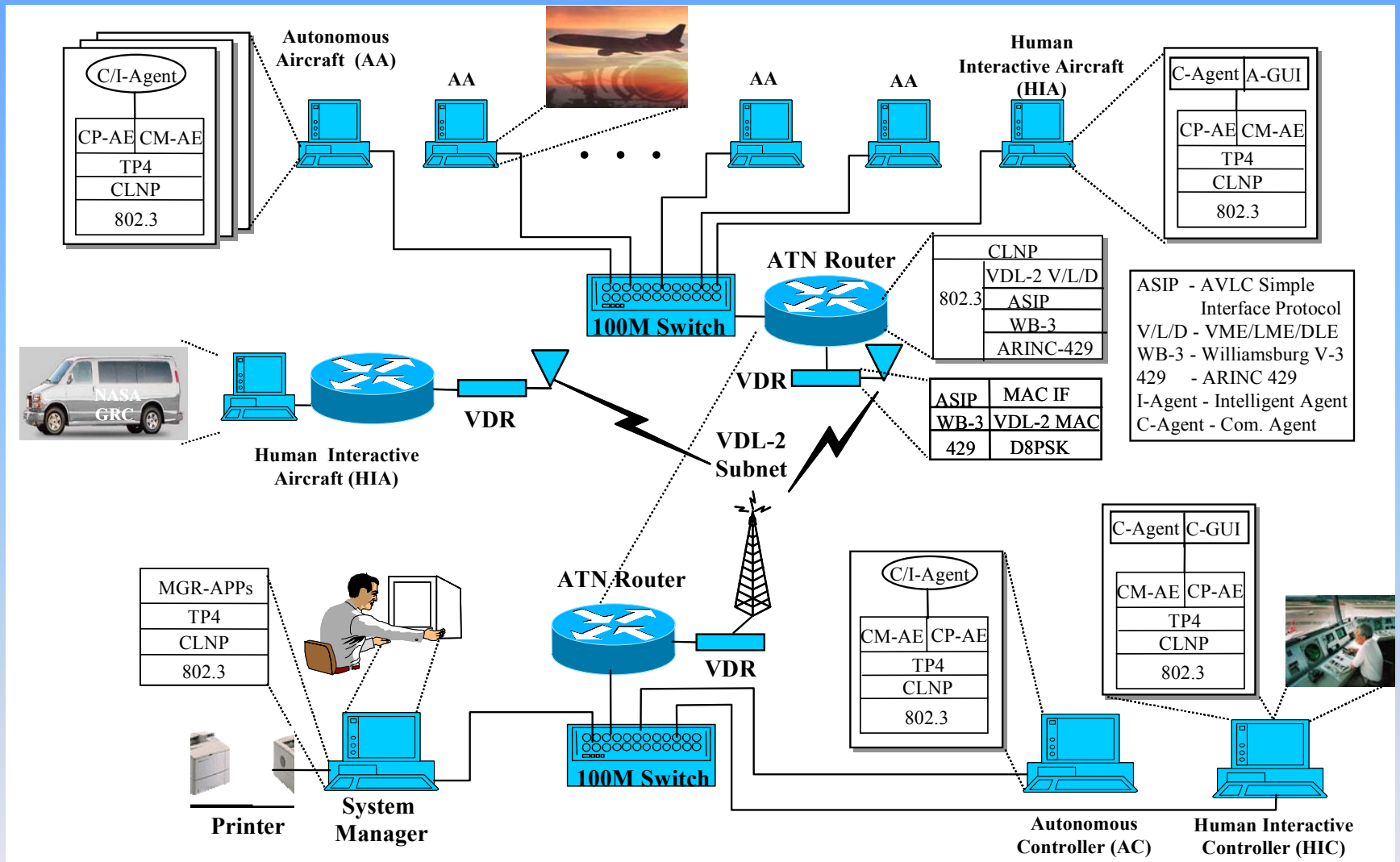

= System Manager Data Channel

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JCS Overview

- JCS was built for the U.S. Air Force & Navy Avionics Test Commands by ViaSat, Inc to provide communications band test & simulation capability for RF spectrum.
- JCS architecture consists of following main components:
  - Control Station
  - Control Station Subsystem
  - Signal Generation Units
  - Non-AoA RF Data System
  - AoA RF Data System

JCS Top Level Architecture

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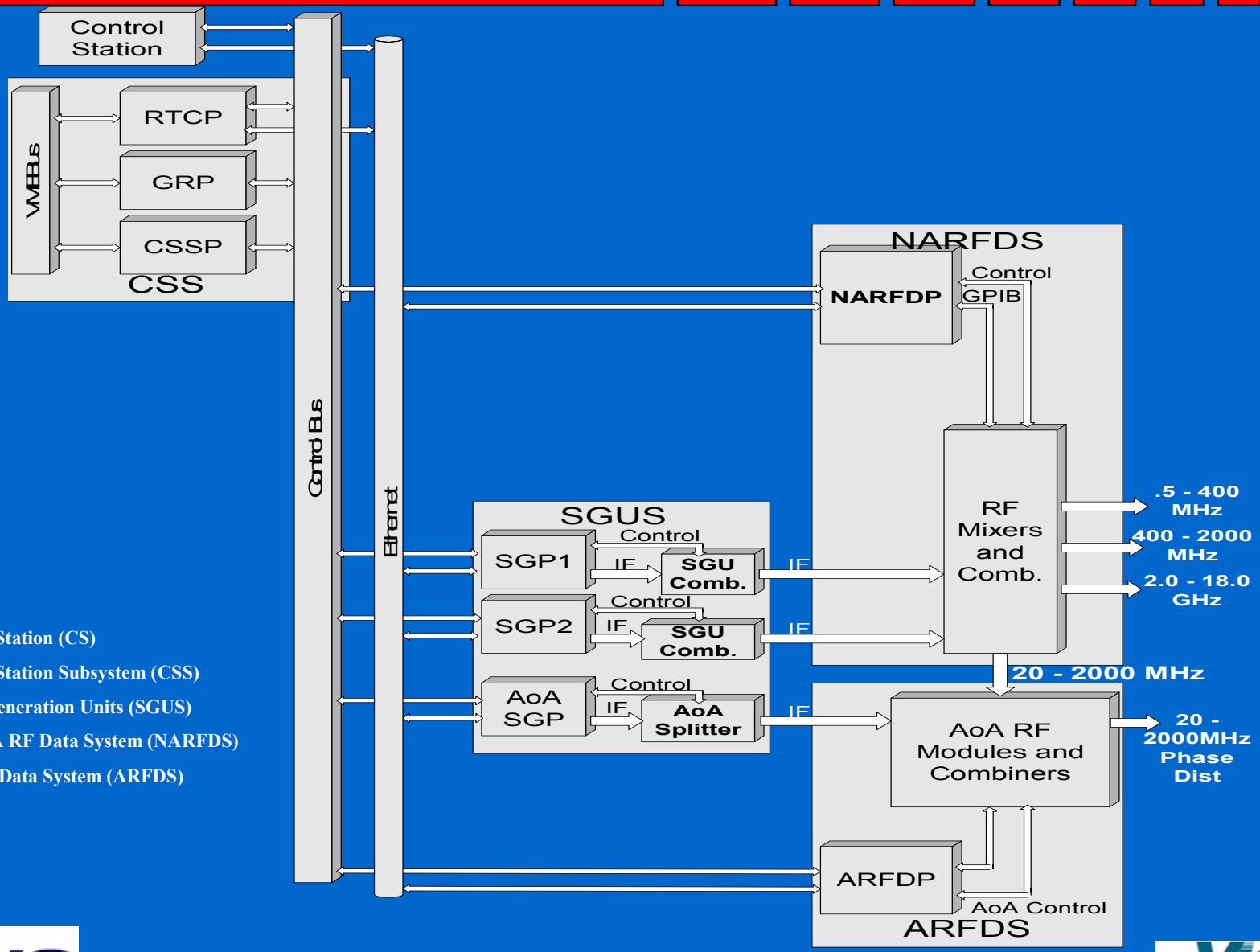

– Control Station (CS)
– Control Station Subsystem (CSS)
– Signal Generation Units (SGUS)
– Non-AoA RF Data System (NARFDS)
– AoA RF Data System (ARFDS)

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Joint Communication Simulator

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Summary of Proposed ANRS

- To develop a new, robust and cost effective Virtual RF Test Bench Environment/Facility requires a modular, scalable approach to allow:
  - New functions and upgrades to be added at minimum risk and cost
  - Leveraging existing architectures, functions and HW/SW capabilities of NASA GRC VAC and U.S. Air Force & Navy Avionics Test Commands JCS Systems
  - Minimize redefinition of software states and modes while maintaining flexibility, thus avoiding large cost through preservation of existing JCS software functional architecture
- Incremental/staged approach to development and implementation to ensure
  - Adequate system capability available at each stage of development
  - And, thus allowing ANRS operating from a Virtual RF environment through hardware-in-the-loop testing
  - Additional HW, SW and system capability to be integrated & demonstrated at each phase providing researchers with additional capability
- Additional waveforms added without significant impact to existing hardware
  - Customize future deliveries based on budget and schedule constraints
- Model Air Traffic communication traffic loads of realistic operational scenarios (flight plan)
- Performance evaluation of throughput and delay of aeronautical sub networks under load
- Support repeatable experimental trials

ANRS Architecture

- **ANRS architecture is a blend of both VAC & JCS**

  Note: VAC was developed as a network simulation capacity tool, while JCS as an RF stimulation & test tool

- **Key elements of ANRS architecture:**
  - **Real time software interface between network management tools & RF assets**
  - **RF simulation capability**
  - **RF stimulation of system under test (SUT)**
  - **Simplified scenario generation & post-test analysis tools**

ANRS Top Level Architecture

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ircraft Control and Management System Simulator

VDL Messages to/from Controller

VDL Messages to/From Aircraft

Network Monitoring

Network Capacity

Stimulation and Operational Environment Simulator

- •RF Signal Generation, Reception and Analysis
- •RF Signal Routing and Conditioning
- •RF Environment and Cosite

Test/Simulation Console

- •Simulation System Scenario Generator
- •Own ship and Target Dynamics
- •Support data fusion
- •Support mix of real and simulated sensors
- •Injected Signals or apertures

UUT: CNI System

Req'd for end-end tests

VDL or Other CNI Equipment

Apertures

CMU

A/C Control Bus

Integration Console(s)

- •Message Editor
- •Scenario Editor
- •Test Control
- •Test Status
- •Data Analysis
- •Graphic Presentation
- •Debugging and trace
- •Post Test File interface
- •Interface to Mission Avionics SW

COTS Test Equipment

- •Spectrum Analyzer
- •GPS Simulation/Stimulation
- •Other Navigation

RS 422

Message Router HW/SW

- •Test Equipment Control
- •Time Sync
- •Time Tagging
- •Test Sequencing
- •Message Parsing
- •Conflict Resolution
- •Data Reception
- •Data Distribution
- •Scenario Stimulation
- •Data Logging

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ANRS Logical Architecture

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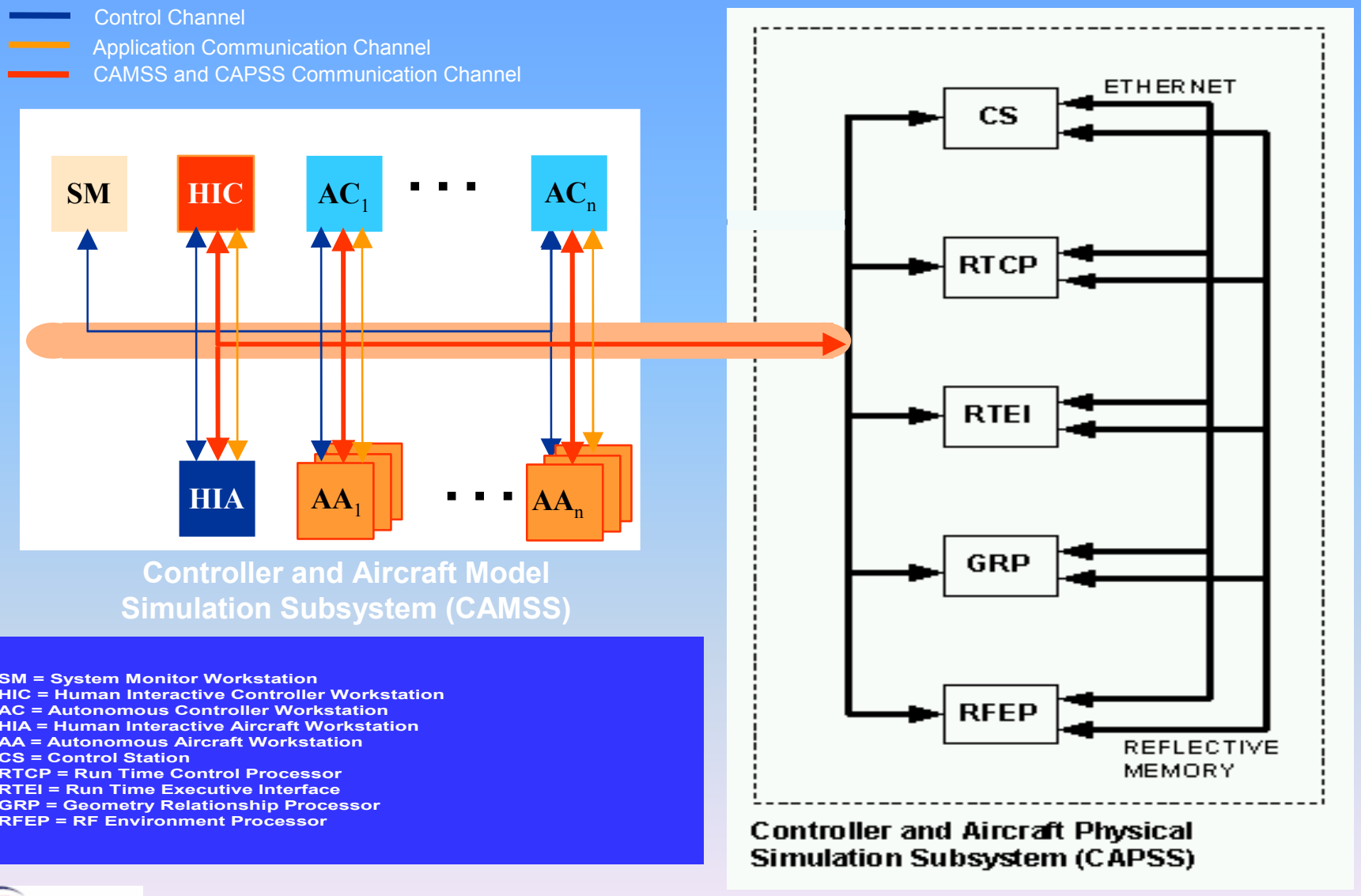

Controller and Aircraft Model Simulation Subsystem (CAMSS)

Controller and Aircraft Physical Simulation Subsystem (CAPSS)

SM = System Monitor Workstation
HIC = Human Interactive Controller Workstation
AC = Autonomous Controller Workstation
HIA = Human Interactive Aircraft Workstation
AA = Autonomous Aircraft Workstation
CS = Control Station
RTCP = Run Time Control Processor
RTEI = Run Time Executive Interface
GRP = Geometry Relationship Processor
RFEP = RF Environment Processor

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ANRS Key Features

Desirable key features:

- **Realistic Mix of Signals**
  - Environment filled with independent RF sources
  - RF sources placed with physical characteristics including frequency, modulation, ERP, antenna patterns and content
  - Terrain characteristics
- **Full Run Time Control**
  - Operator intervention to instantly change environment
  - Enable or disable any individual emitters carrier frequency, ERP or message rate
  - Manually control movement of platforms including dynamic movement
- **Capability to present almost any type of signal simulation**
  - Up to 10 mega symbols per second in combination with any other set of signals
  - Creates realistic operational environment prior to operational status
  - Existing Waveform modifications tested prior to final implementation of change

Summary

- **Proposed ANRS test facility represents a new, robust and cost effective research tool that can leverage on existing systems**
- **Implementation of emerging aeronautical network protocol standards and the associated waveforms under complex conditions**
- **Enhancing R&D activities in CNS technologies**

Thank You!