Test and Evaluation/Science and Technology Program

Live Virtual Constructive Technologies for Test (LVCT)

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Problem Statement

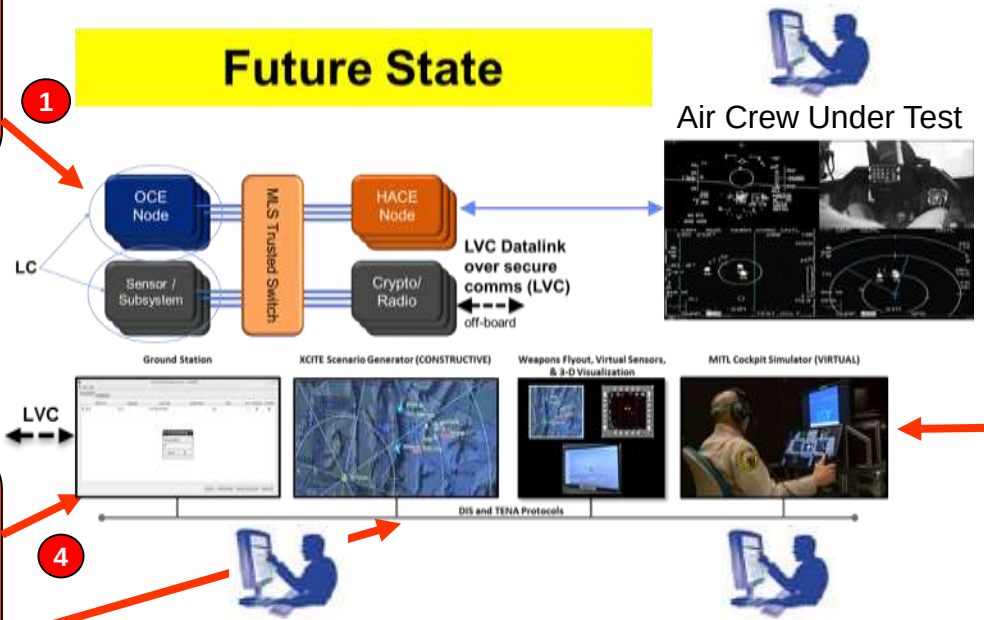
- **T&E Need**
  - Testing 4th and 5th Generation Aircraft Against 5th Generation Threats – Few Range Systems Replicate 5th Generation Threats (Simulation Can Address the Gap)
  - Air to Ground Interoperability within LVC Environment – Need for a Rich Data Set and Integration with Mission Systems and Sensors (Wireless)
- **S&T Challenge**
  - Direct Message Injection – Creating Software Patterns that Support Mission System & Sensor Awareness of Simulated Data
  - Mission Context QOS – Create a scalable and reliable wireless data link through QOS algorithms that support message prioritization and channelization thus conserving bandwidth
  - Dynamic T&E Network – Merging Mission Requirements with the Communications Infrastructure (Waveforms, Spectrum Utilization)

Project Description

- LVCT is Developing Software & Communications Technologies to Permit LVC Operational Test for 4th and 5th Generation Aircraft.
  - Enable Mission System and Sensor Integration to Inject Threats/Targets and Listen to the Aircraft Buses for Real Time Monitoring & Management
- LVCT Provide Guidance on the Application of Waveform & Spectrum Use.
  - Identify Waveform Candidates and Methods for LVC Network Configuration/Control

Open Mission Systems Integration OMS/FACE Bridge

"Leverage S&T Activities to Accelerate!"



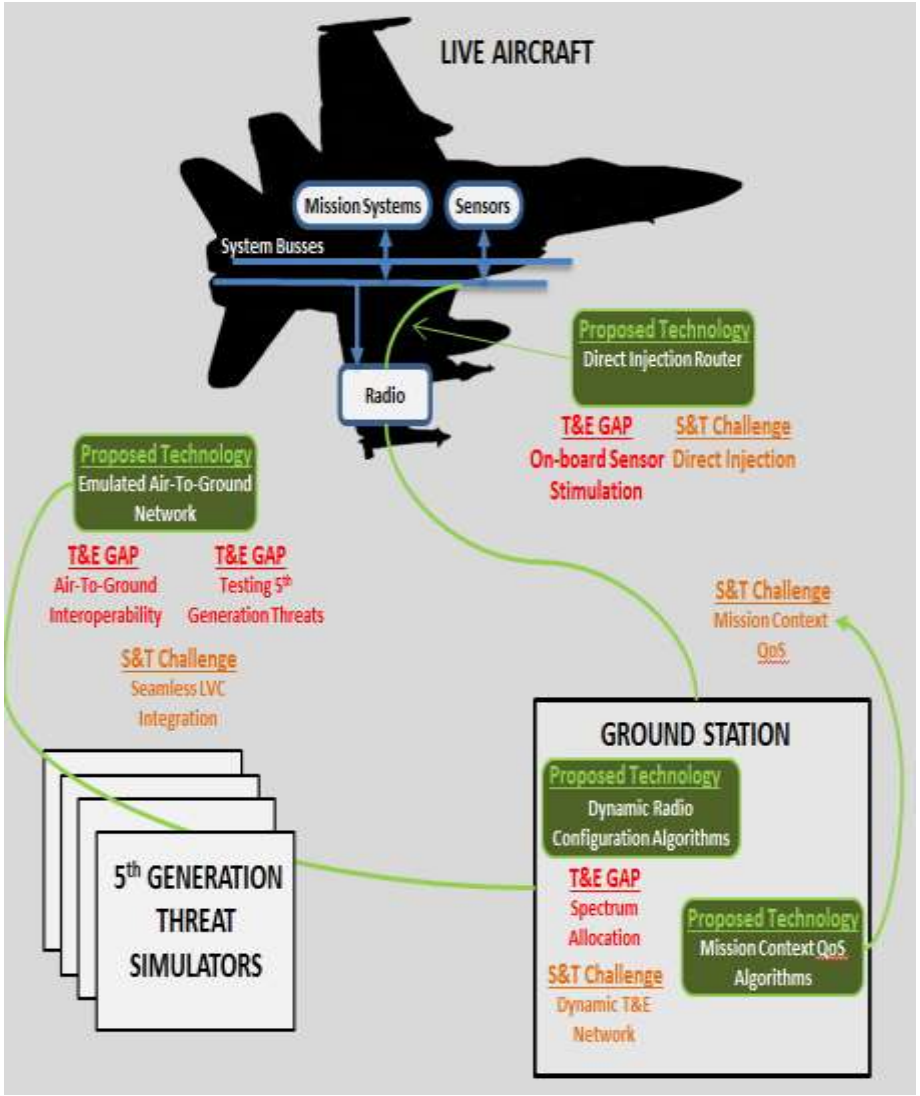
Live Real Time Sensor View & Engagement

Execute Operational Test Events with Virtual & Constructive Supplementing Live

Provide Network Control Wire/Wireless Data Link

S&T Background

- **Secure, Optimized Wireless Distributed Connectivity**
- **Open Standards for cost efficiencies**
- **Mission System and Sensor Integration**
- **Quality of Service for realistic scenario representation**
- **Spectrum Management for Scalability of Full Mission Test**

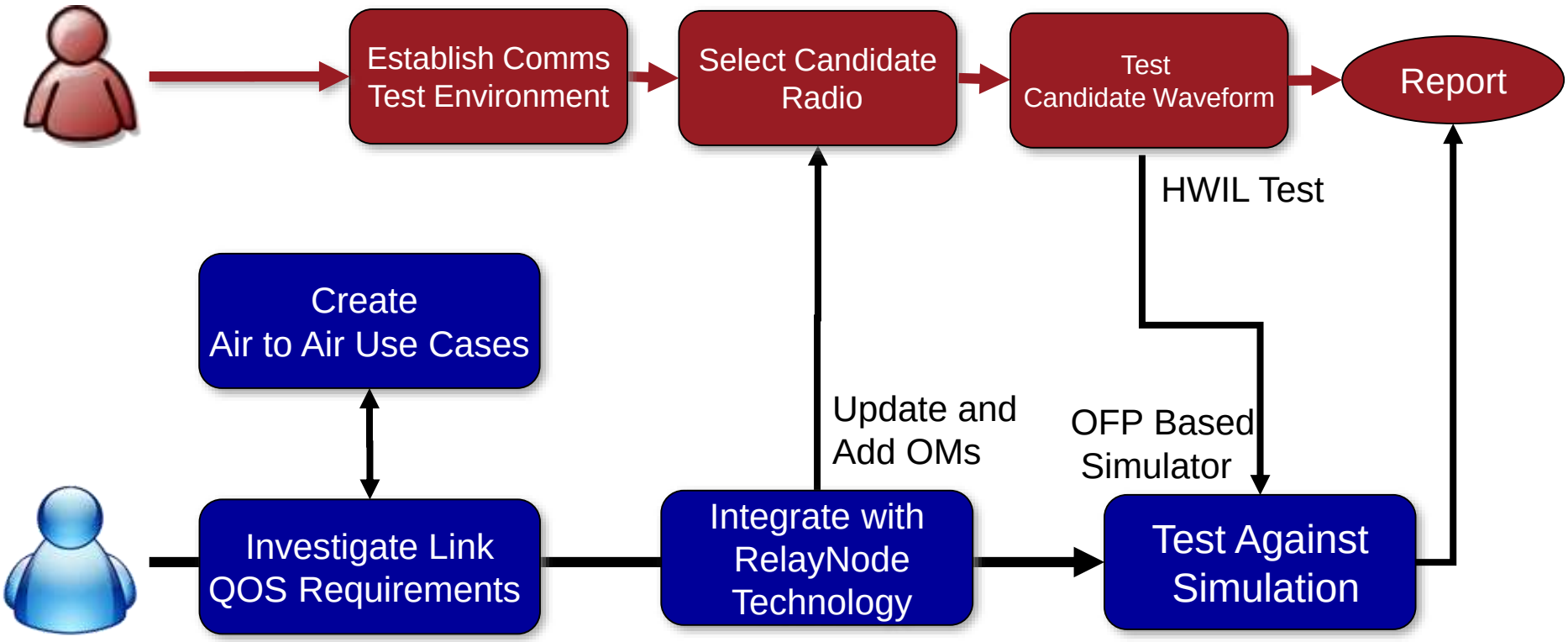


Project Specifications

	Specifications			
Parameter	**Current Performance Level**	**Current Target**	**Ultimate Goal**	**Achieved**
Range	Nautical Miles	100 NM	> 150 NM	40 NM
Number of Live Platforms	Quantity/Units	4	> 30	1
Latency	500mS Each way	< 250mS	< 100mS	~ 500mS
OT Environment Setup	Days to Weeks	Hours/Days	Minutes/Hours	Not Assessed
Integration into Platform	Months to Years	Months	Weeks to Months	> 1 Year

NOTE: Project in Early Stages – Current and Ultimate are Subject to Further Test

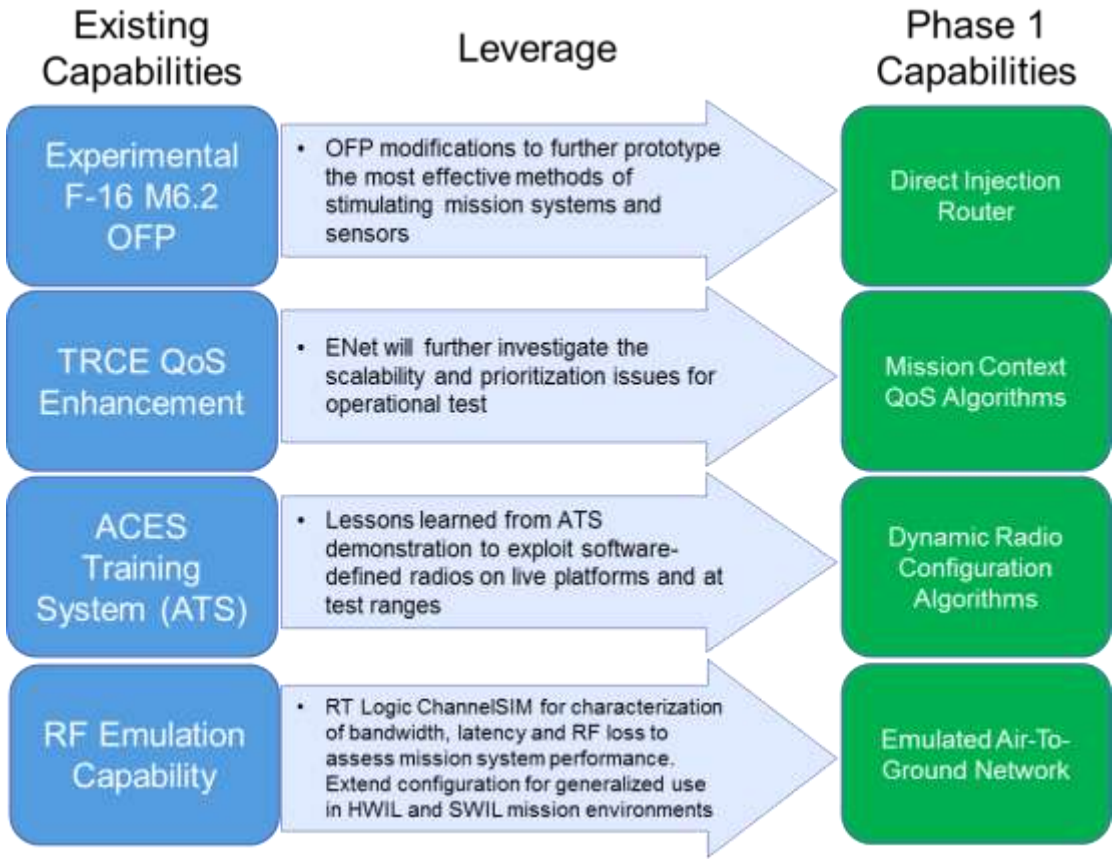
Current Phase Efforts



Select Candidate Radio and Waveform for Test with the Data Link (LVC Link Manager) to assess Performance, develop OMs to Support the Test Environment and Test Against the Target Platform OFP (F-16) Through Mission Bus Injection.

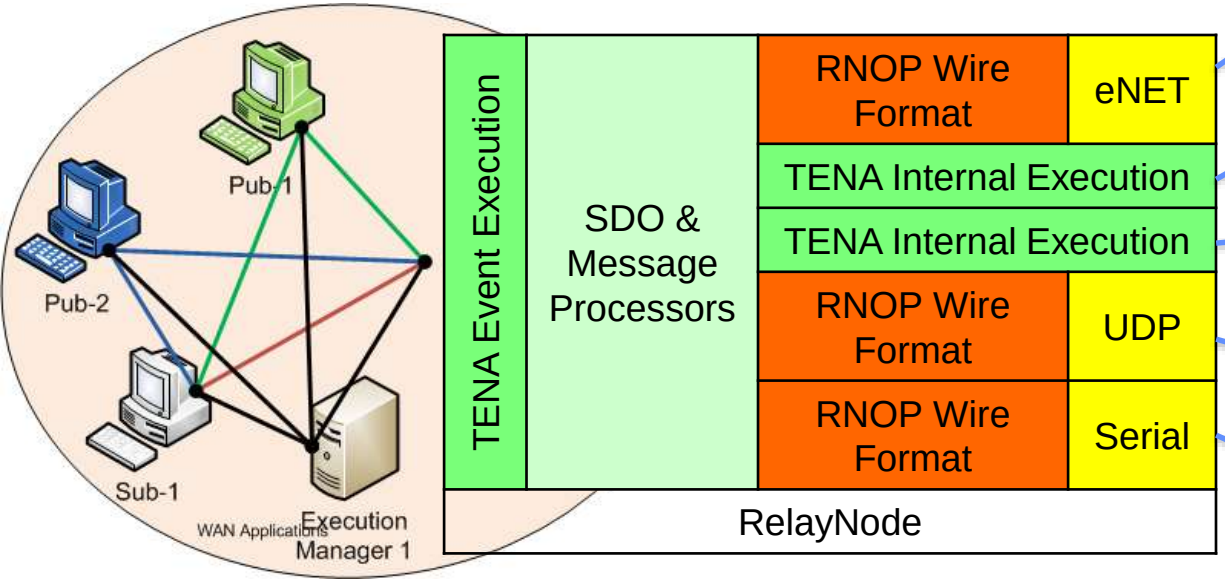
Current Phase 1 Results

- ✓ Leveraging Earlier Efforts and S&T Tech (TRCE RelayNode) to Design LVC Link Manager Prototype
- ✓ Conducting Investigations on QoS and Transport Technologies while Establishing Lab Test Environment
- ✓ Selected WIN-T Local Access Waveform (LAW) Gausian Minimum Shift Keying (GMSK) as the 1st Candidate Waveform, Aeronix as the Radio Provider
- ✓ Considering Stretch Goal to Include CRIIS

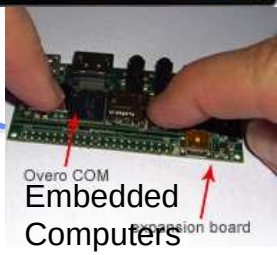


TRCE RelayNode Prototype

- Leverage Prototype from TENA in Resource Constrained Environments (TRCE) Project



Tablets & Smartphones



Embedded Computers

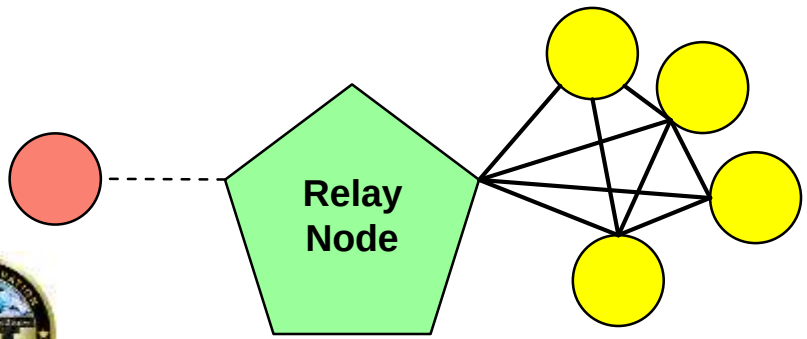
- Auto-generated application that supports a wide range of object models
- Can be deployed at strategic points geographically on the LAN/WAN
- Supports each device connection in separate thread
- Replicates TENA API as closely as possible
- RelayNode Optimized Protocol (RNOP) minimizes Platform update size

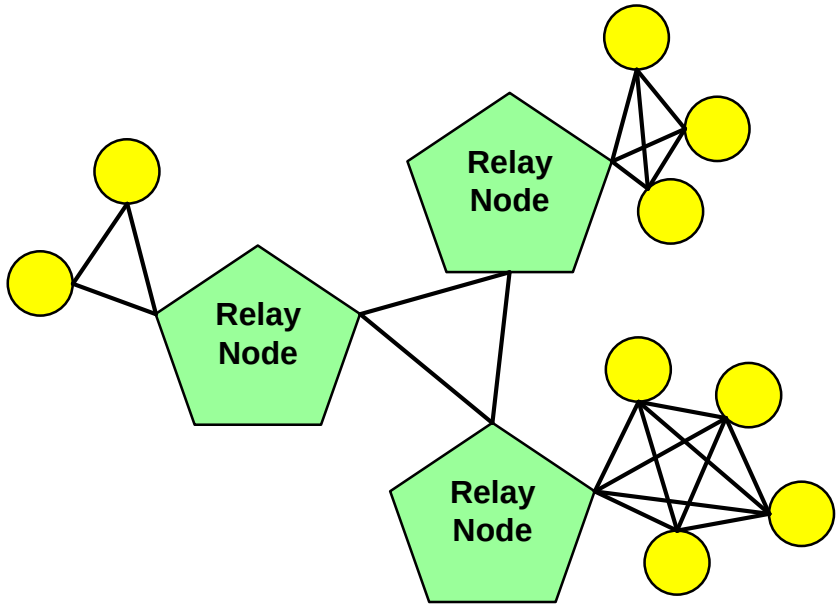
Acoustic Modem

TENA 1.0.0 RelayNode

Leverage Technologies for Netcentric Test Interoperability (TNTI) Project S&T Efforts

- **Single Application Mode**
  - Used for individual communication links that have constrained or unreliable links
  - RelayNode can tolerate some transient communication faults
- **Multiple Execution Mode**
  - Used to connect separate site executions with a common WAN execution
  - Allows sites to operate independently, but exchange certain data with other sites

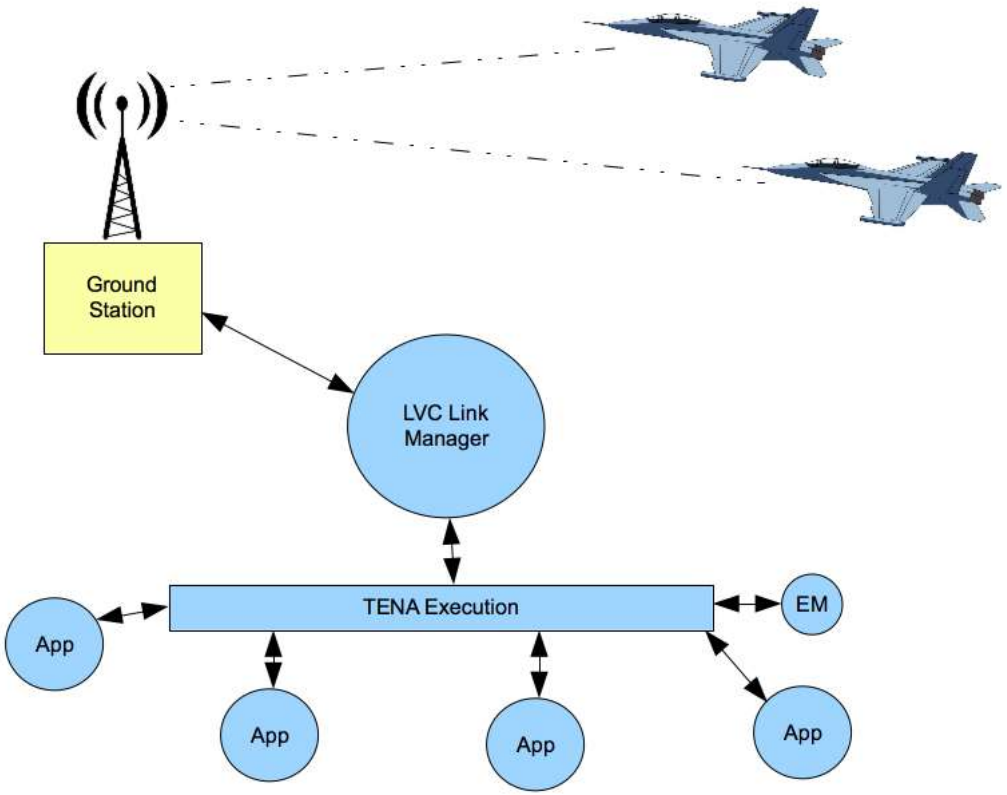




LVC Link Manager

Leveraging source code from TRCE RelayNode prototype and TENA RelayNode 1.0.0 to build LVC Link Manager Prototype using TENA Middleware 6.0.5 (new release)

- Evaluate multiple transport layers
  - Data Distribution Service (DDS)
  - ZeroMQ
  - RabbitMQ
  - eNET
  - Session Description Protocol (SDP)
- Evaluate QoS Approaches
  - Partial Dynamic Updates
  - Geospatial Filtering
  - Reliable/Best Effort Channelization by Message Type / Instance
  - TENA Tag Filtering



RF Link Laboratory Testing

- RT Logic T400 RF Channel Simulator

Transmit Equipment → *IF/RF Cable* →  → *IF/RF Cable* → **Receive Equipment**

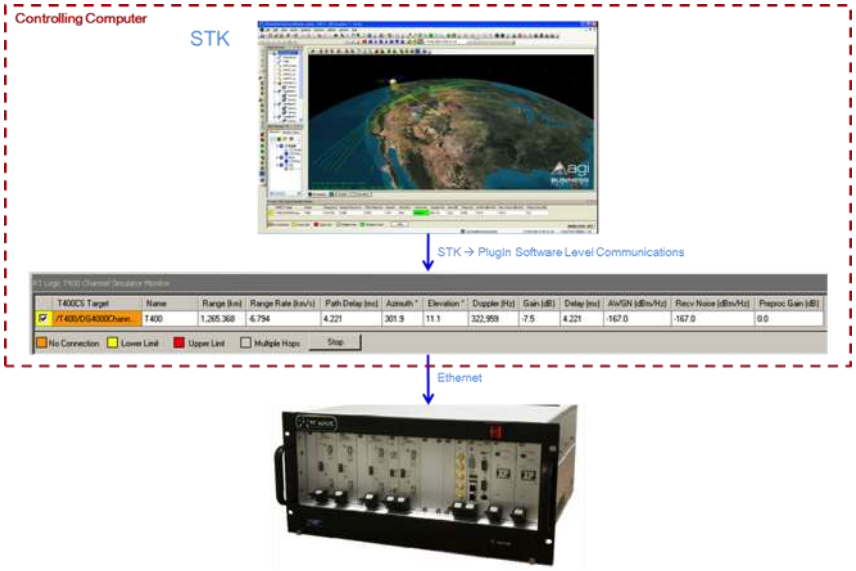
- **Modems**
- **Radios**
- **Transmitters**
- **Firmware**
- **Software**

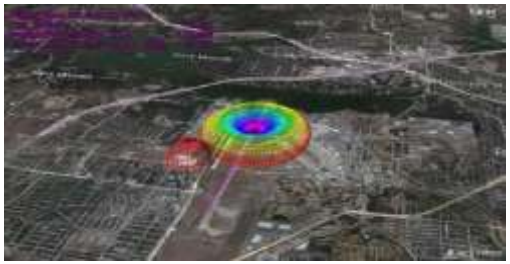
Doppler Shift
Path Loss
Multipath Fading
Delay
Noise
Phase Offset
Interference

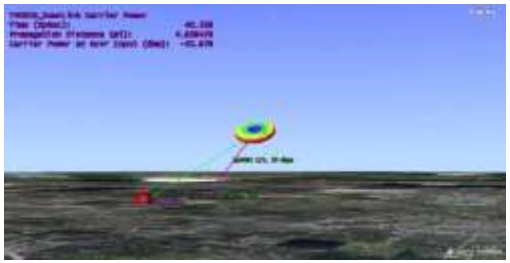
- **Modems**
- **Radios**
- **Receivers**
- **Firmware**
- **Software**

Visualization and Control

- Analytic Graphics System Tool Kit (AGI STK)
  - Provides equations to calculate the RF environment
  - Provides control of the T400CS hardware
  - Provides antenna selection, modification and characteristics
  - Provides visualization of flight paths
  - Allows Physics Complaint testing and analysis of RF systems

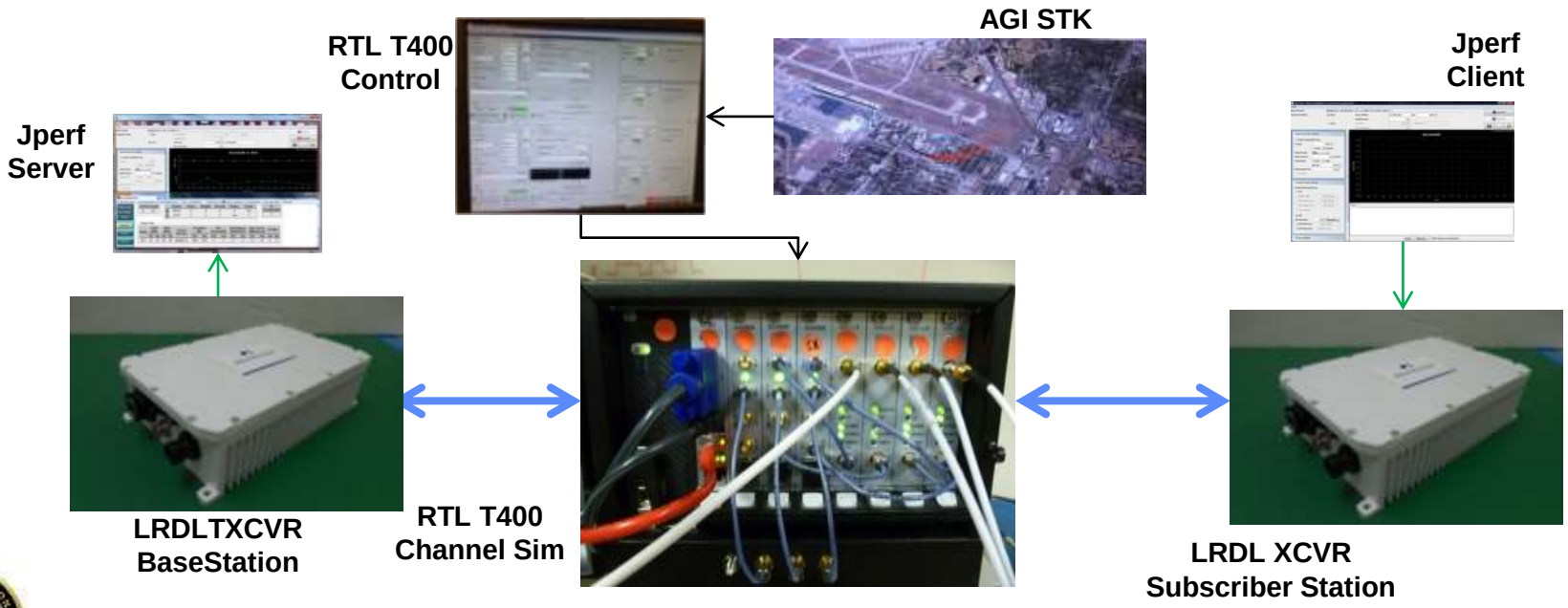




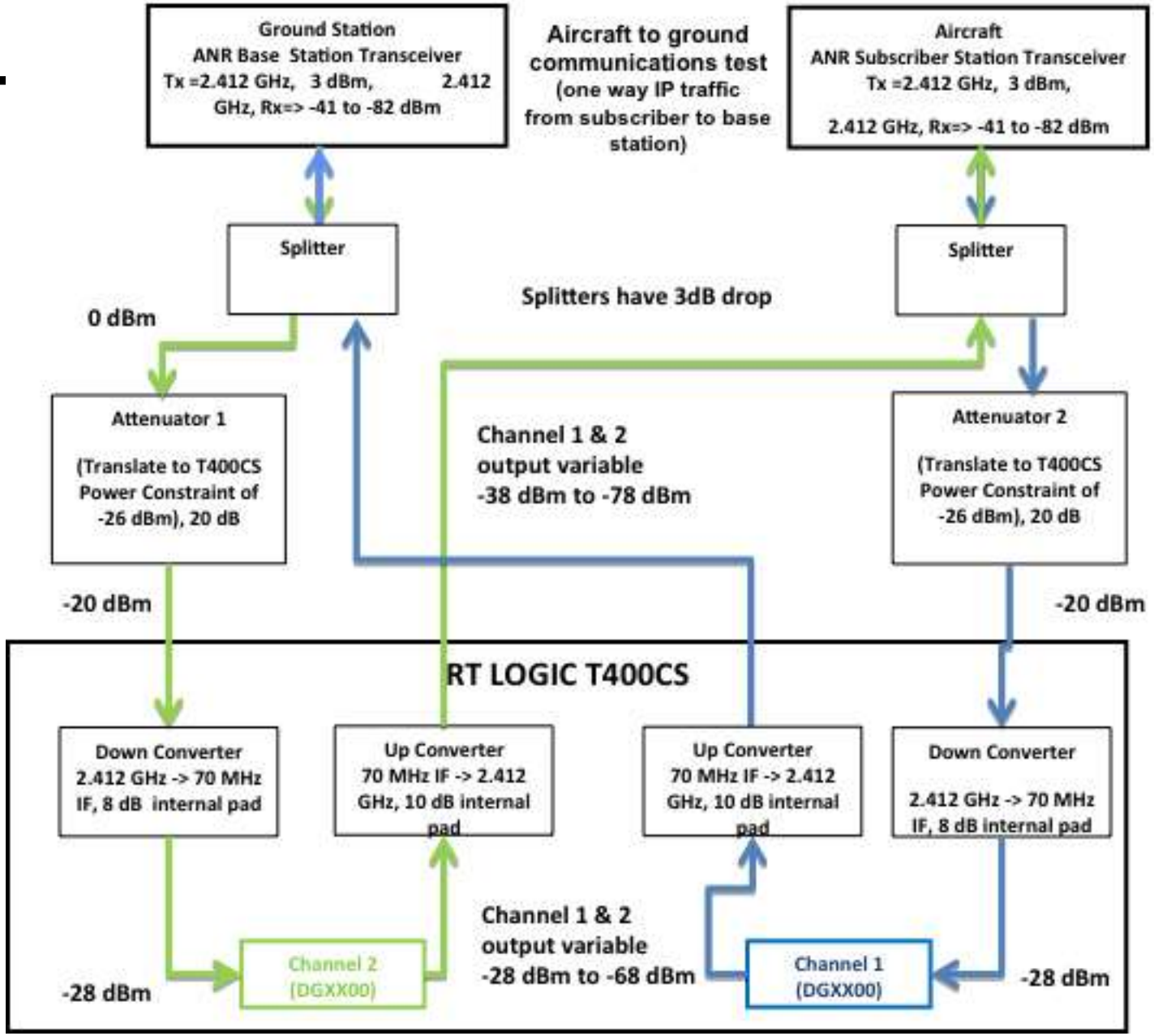


RF Link Test System Setup

- Several components were used to develop an RF Link Test System
  - RF Channel Characteristics generation – RT Logic T400 Channel Simulator
  - Command and Control Interface – Analytic Graphics System Tool Kit
  - Visualization – Analytic Graphics System Tool Kit
  - Candidate Transceiver – Aeronix Advanced Network Radio Transceiver
  - UDP Data Test Generator – Iperf / Jperf

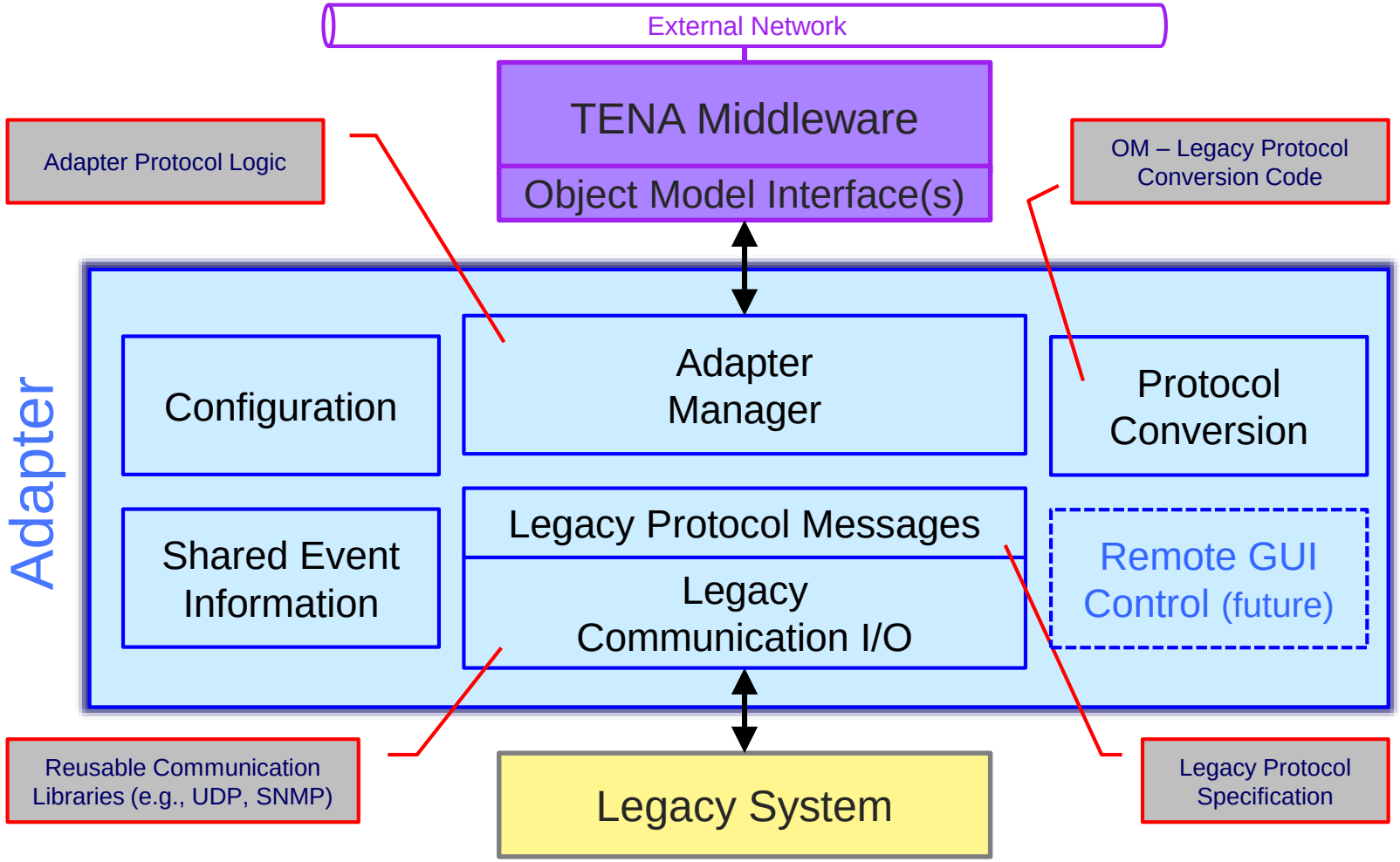


Half Duplex Modem, T400CS Channel Simulator Test Setup



TENA Adapter Framework for Dynamic Control of Ground Station Radios

Leverage Technologies for Netcentric Test Interoperability (TNTI) Project S&T Efforts



Architecture/framework attempts to separate adapter specific code into the four areas shown

Next Phase Outline

- **Technology**
  - Further Develop Relay Node & OMs
  - Create Radio Configuration Software – Test Operator Station (TOS)

- **Development**
  - Test Against Other Waveforms
  - Test in Relevant Environment

- **Prototype for demonstration testing**
  - Scenario Creation - LVC
  - Use Case Test Development

- **Documentation**
  - Requirements and Test Results

Project Transition Plan

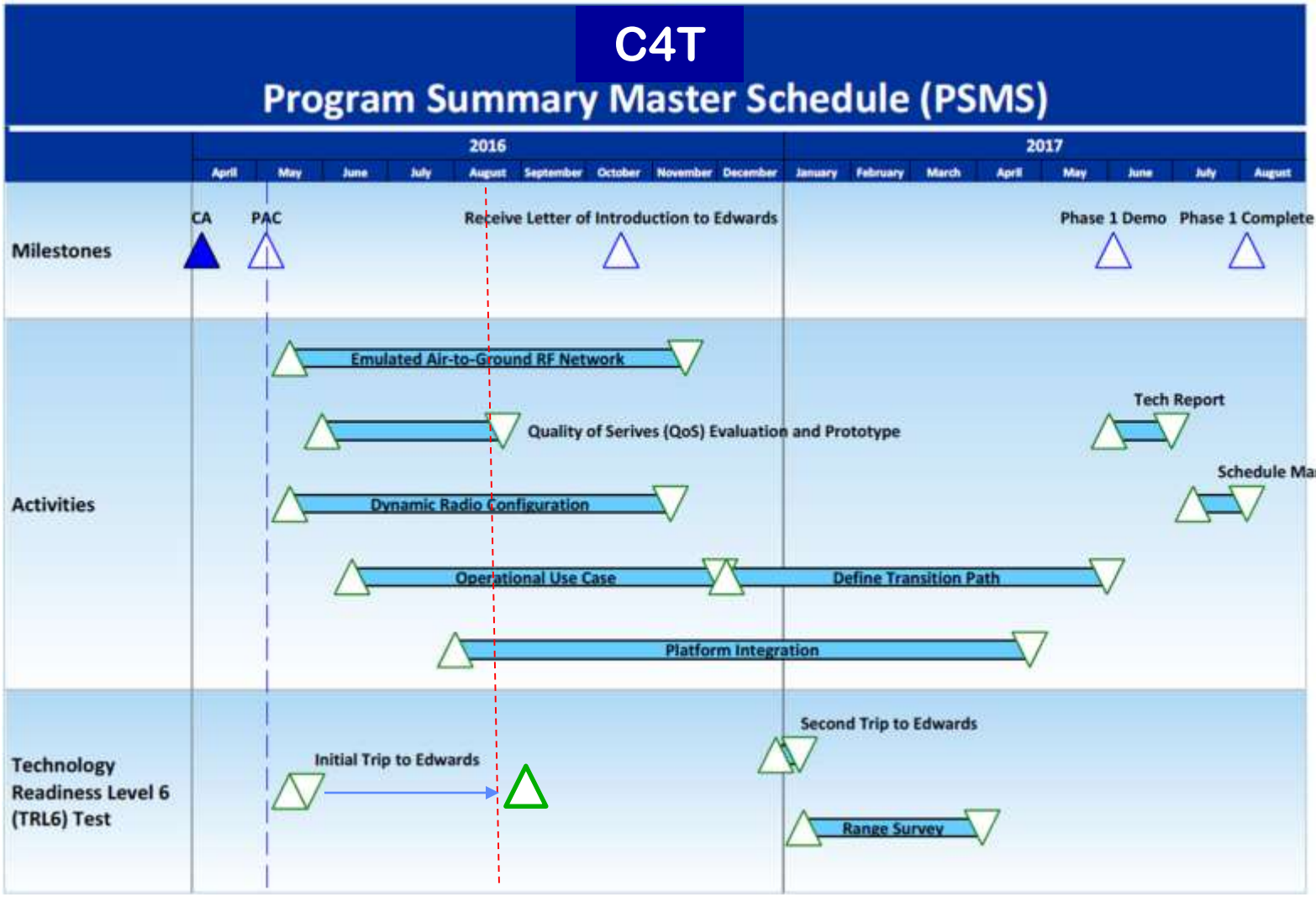
Test Activity (e.g. AFRL (KHILS/GWEF) or CTEIP Activity (e.g. DETEC)	Need Quarter/FY	Level of Coordination	Intent to Use
AFRL Secure LVC Advanced Technology Environment (SLATE)	Q4 2018	Coordination with the Technical Lead Dr. Winston Bennett 711 HPE	Backup to LVC Waveform & Compressed DIS Data Link
TENA Software Development Activity (SDA)	Q4 2018	Coordination with Mr. Ryan Norman (TENA-SDA)	LVC Link Manager to compliment TENA Relay Node for Wireless LVC connectivity

- **Benefit to Warfighting**
  - Provides the Ability to conduct complex Operational Tests in Complex Environments with 4th and 5th Generation Assets – Compatible with Existing Range Infrastructure
  - Provides requirements that will Transition LVC fro Vague to Specific for Mission Systems and Sensors (Reduce Overall Modification Cost Early)

Partnerships and Roles

- **Government Executing Agent:**
  - Mr. Gil Torres
- **Principal Investigator:**
  - Mr. Mark Phillips
- **Subcontractors:**
  - Leidos
- **Potential Collaborators**
  - CRIIS Program
  - International Partners
  - Aeronix
  - Rockwell Collins
  - 412 Test SQN
  - USAF Test Pilot School
  - AFRL
  - TENA-SDA
  - NAVAIR Atlantic Test Range (ATR)

FY16/17 Schedule



We Are Here

Wrap Up

- **LVCT (LVC for Operational Test)** provides a framework and software components that will push the operational test of Live platforms in highly contested environments forward – the intent is to mix realities and advance capabilities in the operational test domain.

- **Technology innovation**
  - Advanced scalable Data Link that can perform under different spectral bands and across waveforms
  - Software patterns for open mission system integration to reduce cost to platforms and programs
  - A path to integration of 5th generation (fused information systems)

- **LVCT** through leveraging of other S&T projects as well as its own investigations will bring the network to Net-Centric Operational Test
  - Range Compatible Data and Waveform Integration
  - Open Systems Approaches to Integration
  - Mission Focused Systems Architecture

Acknowledgement

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