Application of TENA in Real-Time Wireless Flight Test Engineering with Tablet Support

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ABSTRACT:

Flight line checkout of aircraft and Unmanned Aerial Systems (UAS) is a necessary part of Test Range operations. Checkout systems have been designed to support the Flight Test Engineer (FTE) and aircraft technicians to validate the operations of the aircraft instrumentation systems and to help in troubleshooting problems. Current systems in use by the FTE include using range assets, such as range Telemetry Receiving system, and even home built systems. One system used at Edwards Flight Test Center is called the Instrumentation Ground Support Units (IGSU) or "Taco Carts", a system that contains the basic elements of a telemetry ground system that also has the additional capability to connect directly to the aircraft. This presentation shows advancement prototypes that enable the FTE access to modern technologies that will provide efficiencies using wireless networks, tablets and the Test and Training Enabling Architecture (TENA) TENA through activities developed as part of the TENA in Resource Constrained Environments (TRCE) project.

I. INTRODUCTION

DoD ranges were initially developed with “stovepipe” telemetry (TM) receiving systems. These systems were built with different antennas, receivers and the associated components. Mostly these systems were manually operated and employed people who were very familiar with all aspects of the TM receiving system. In the flight test engineering realm, TM instrumentation was either connected directly to the aircraft telemetry and instrumentation busses (ports), or data is received over the air using an antenna. This required the FTE to be close to the receiving system or have someone who would “call-out” the status of the system being investigated. With advancements in communications technology, it is now possible to decouple the TM receiving system from the aircraft and even from the test engineer.

II. TENA TRCE

The Test and Training Enabling Architecture (TENA) is the DoD corporate approach for interoperability. TENA provides real-time software system interoperability by interfacing to existing TM hardware and TM processing systems. TENA provides the middleware software component and can be used on any Internet Protocol Based network.

The OSD Test Resource Management Center (TRMC) Test and Evaluation (T&E) / Science and Technology (S&T) Program sponsors the TENA in Resource Constrained Environments (TRCE) project. TRCE improves the TENA Middleware's operation and performance in resource-constrained environments by developing prototype technologies that support a broad range of variable quality networks, including wireless networks, and provide native TENA support for handheld & embedded computing platforms. TRCE technologies will enhance the TENA Middleware to support these types of networks and platforms to provide common, robust interoperability architecture.

The TRCE project has focused on developing capabilities to extend the use of the TENA Middleware to telemetry systems. Two key aspects of the program related to developing reliable communication with performance constrained links (related to variable quality and low data rate networks) and operation on constrained hardware devices (related to low power, reduced CPU and reduced memory). Examples of constrained link types may be wireless, cellular, low power & small form factor computers, embedded instrumentation, and mobile internet devices (MID) such as computers on module, smartphones, and tablet computers. TRCE technologies are being developed in order improve the reliability and robustness of the TENA middleware in these types of environments.

III Prototype Demonstration

Recent TRCE Phase 5 transition activities were centered on transition demonstrations at the Edwards Air Force Flight Test Center where technical personnel use Instrumentation Ground Support Units (IGSU) to monitor and test on-aircraft instrumentation systems and data in support of flight test activities. The IGSUs contain electronic equipment such as telemetry receivers, decryptors, radios, oscilloscopes, spectrum analyzers and computers. The IGSUs are parked at a distance from the aircraft and the engineers and technicians must spend time walking from the plane to the IGSU to accomplish mission objectives.

For the Edwards demonstration, the main use cases were:

- FIPS 140-2 interface for Taco Cart interface to iPads via wifi to support Test Engineer.
- TRCE FIPS 140-2 Enabled Tablets for Test Support

The set of requirements for the different demonstration systems was described including the OMs defined, ILIAD TENA Publisher Interface, the wireless Encryption and User Authentication required as well as the streaming media needed to support the use cases. One of the fallouts of the work was the interface to the oscilloscope and spectrum analyzer Digital Bridge that could lead to a more general OM for interfacing to these types of devices.

The TRCE transition demonstration focused on getting information from the oscilloscope, spectrum analyzer, video and ILLIAD TM measurand information to the FTE over an existing wireless network. By providing the ability to select parameter sets from a tablet or handheld device, this would allow the FTE an uncoupled connection to the IGSU, allowing the FTE to view selected parameters collected into the ILLIAD TM database. This provided the ability to create several different displays on the tablet, such as stripcharts, EU converted parameters and raw data.

The demonstration allowed personnel to use wireless Android and iPad tablet devices to view and monitor the IGSU information in real-time while working at the aircraft location. The demonstration leveraged a new TENA interface to the Instrumentation Loading, Integration, Analysis, and Decommutation (ILIAD) software used on the IGSUs and a TRCE developed prototype TENA Webserver application to provide the real-time updates to the tablet displays.

Information provided to the user interface on tablet displays included real-time access to post decommutation telemetry measurand data sets in standard TENA object models, strip chart representation of measurand values, oscilloscope and spectrum analyzer displays, and telemetered video streams, all over a FIPS 140-2 compliant wireless communication network. A representation of the transition demonstration is shown in Figure 1 and a picture of the real-time spectrum analyzer display on an iPad is shown in Figure 2.

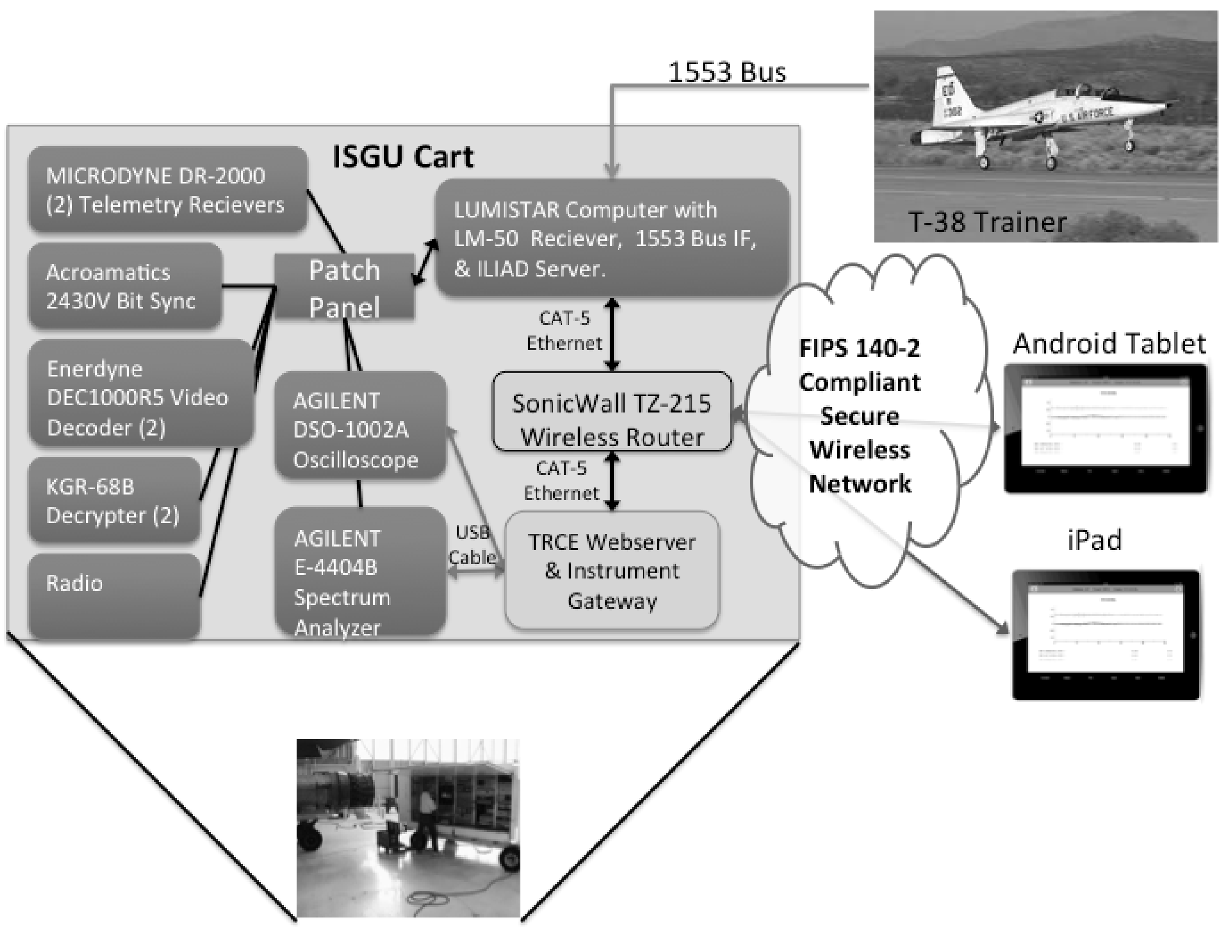
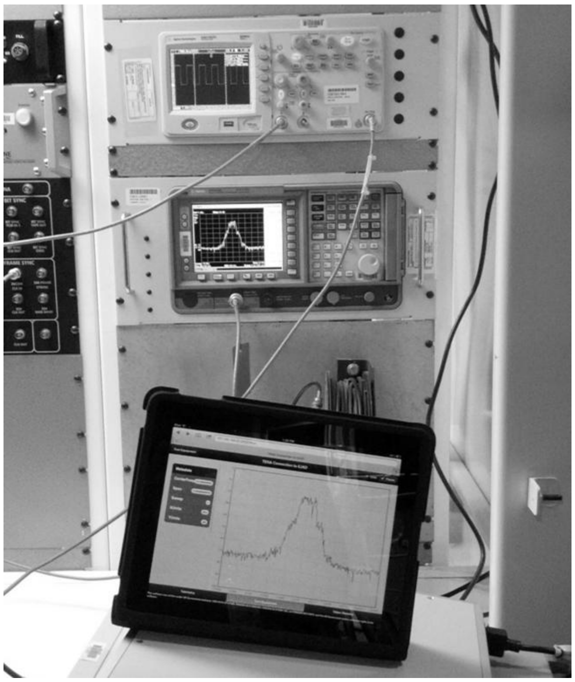


Figure 1. TRCE ISGU Transition Demonstration

The development used several different protocols to collect information from the instrumentation. The oscilloscope and spectrum analyzer used USB or GPIB protocols to collect the display information, and republished in TENA using the prototype Instrumentation Gateway. The prototype TENA Web Server subscribed to this instrumentation data over Ethernet and served the data to the tablet displays. The tablet displays were then able to display the instrumentation as well as the published ILIAD TM data in near real-time with latency <100ms.

Embedded video in the TM stream was also re-transmitted from ILIAD using the open source VLC application and displayed on the tablets, which provided the FTE with a handheld interface to all key systems on the ISGU while working on the aircraft.

The TENA Webserver Prototype was specific to the OMs used for this demonstrations/use case. We used a polling based mechanism from the tablets so the latency is based on that polling frequency and not the standard TENA pushing mechanism. Future implementations will rely on use of the TENA Web Binding Beta 2 version to provide this connectivity to tablet devices.



Development activities involved in wireless and embedded instrumentation applications included TENA Middleware on HW Constrained devices, RelayNode Prototype and TENA Webserver Prototype, including products like GumStix devices, iPad and Android. The conclusion of these efforts lead to transition of these prototype technologies to the TENA Software Development Activity (SDA) team for long term transition and support for mobile devices.

We focused these prototypes on the Edwards AFB and their Instrumentation Ground Support Unit (IGSU), also known as the "Taco" Cart, and the EMC3 ILIAD System that interfaces to the instrumentation on the aircraft. We developed use cases and benefits for integrating the handheld devices with the Taco Cart to allow the test Engineer to be able to interface with the Taco Cart without being tethered to that cart.

IV Summary

This project focused on developing TENA support for things such as Low Data Rate Networks, Secure Wireless Networks, Hardware Constraints, etc., the types of environments that were considered during this transition demonstration. The devices that were used during the project were the Overo Gumstix, Embedded Instrumentation Systems Architecture (EISA), iPad, Andriod devices and iPhones.

The efforts during the TRCE Phase 5 of the project were:

- FIPS 140-2 Compliant Wireless Link Support
- Android Port to TENA 6.0.3
- **Transition Demonstration of tablet Prototype interface for Edwards AFB Flight Test Center**
- Prototype Policy-Based User Authentications/Authorization for TENA

The Instrumentation Loading, Integration, Analysis and Decommuntation (ILIAD) System is GOTS product supported by EMC^2 for configuring and acquiring and analyzing test instrumentation data. It is a suite of software that support the preflight configuration and checkout of flight line instrumentation, the processing of real-time data streaming from the instrumentation, and post-test decommutation of the Chapter 10 data recordings.

The publishing of instrumentation data on the wireless network, displaying that data on the handheld devices, along with the video and instrumentation data from a test aircraft was processed through the TENA-enabled ILIAD system and published out the TRCE Webserver. Control and display of test equipment (oscilloscopes, etc.) was also demonstrated on the handheld devices and running on the FIPS 140-2 wireless network.

The TRCE prototype technologies discussed in this paper are for demonstration purposes only. There are potential benefits demonstrated by the use these technologies, and broader requirements and utility need to be determined to verify if they will benefit the FTE and overall range TM operations. Maturation of the technologies, features, and interfaces needs to be accomplished in order to fully support the fault tolerance required in an operational flight line environment.

These technologies also provide the potential for a different approach for data to be transmitted to the Taco Cart without the need of TM RF transmission by using a FIPS 140-2 certified secure wireless network at the flight line instead of requiring the allocation of L/S/C band. We also can provide aircraft TM settings to the range to verify range tracking system configuration and potentially provide auto-configuration of range systems, in certain circumstances.

Future implementations of this prototype system will rely on use of the formal TENA Web Binding activities (currently in Beta 2 version) to provide connectivity to tablet devices. Future extensions of the prototype may include the development of a formal TENA Instrumentation Bridge that would provide support for families of instrumentation in a vendor agnostic manner where the common functions and display characteristics can be standardized upon in a TENA Object Model. This approach will allow for common user and system interfaces to be developed for instrumentation systems with out requiring the “specifics” of different manufacturers. Such a capability will help realize an enterprise approach for instrumentation and reduce developmental and training requirements when new manufacturer products are brought online.

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Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Test Resource Management Center (TRMC) Test and Evaluation/Science & Technology (T&E/S&T) Program and/or the U.S. Army Program Executive Office for Simulation, Training & Instrumentation (PEO STRI)