Use of TENA for Distributing Telemetry Data within and between Test Ranges

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ABSTRACT

Systems of Systems are becoming more the norm in technology applied to tactical military systems. Because of this it is necessary to greatly simplify the way telemetry data is formatted and shared with other systems that depend on near real-time information. This is becoming necessary for developmental testing, operational testing and tactical training in realistic battlefield environments. Interoperable data is necessary to fuse Live, Virtual, and Constructive (LVC) participants to create realistic actual and synthetic environments for both testing and training. This need for simplified data communications is important for testing and training to link participants at different ranges, as well as to link distributed instrumentation capabilities within a single range.

Live systems are either deployed tactical systems or developmental systems being evaluated for deployment. Virtual systems consist of actual tactical hardware and software operated in a laboratory environment rather than installed on operating tactical platforms (e.g. aircraft, ships or vehicles) in order to provide realistic data feeds without the expense of operating tactical platforms. Constructive participants consist of models or simulations to provide realistic effects (e.g. weather, electromagnetic threats, adjacent tactical elements, etc.) that are not available, affordable, or practical to use real assets.

This Paper will describe the on-going efforts, including successes and lessons learned to-date at White Sands Missile Range, New Mexico.
KEY WORDS

Telemetry, TENA, JMETC, WSMR, LVC, Interoperability, Standardization

INTRODUCTION

JMETC has done a great job of providing the infrastructure necessary to facilitate the interconnection of ranges for the conduct of distributed testing including the ability to link Live, Virtual, and Constructive participants. However the effectiveness of this data distribution has been impacted by the inability of many ranges to provide robust and timely data formatted in the latest version of TENA. White Sands is also actively working toward implementing TENA for intra- and inter-range range data distribution which will greatly simplify and improve the benefits that can be achieved through full implementation of TENA for efficient data distribution and interoperability services. Through the use of “Publish and Subscribe” TENA will be able to achieve data distribution efficiencies that will greatly enhance the distributed test capabilities of the DoD.

EXISTING TELEMETRY ENVIRONMENT AT WSMR

WSMR collects and processes telemetry to provide the best health and status information of a test vehicle in real-time to WSMR Flight Safety officers and Range Users through a myriad of data products.

Flight Safety:
Although telemetry serves many useful purposes, WSMR’s primary use of Telemetry (TM) is to ensure a safe test for the Range User. Flight Safety uses TM to get accurate real-time position, health and status of a test vehicle in flight.

Range Users:
WSMR supports Range User requirements by ensuring complete coverage of a test vehicle, through various fixed and mobile sites, throughout the test and by providing high quality real-time and post-test data products.

WSMR Field TM can receive, record, and relay S- and L-band Tier 0 and Tier 1 modulation schemed signals. WSMR has three 24-foot fixed trackers and one 8-foot fixed tracker used for on-range support. WSMR also has four 8-foot Mobile Tracking Systems (MTS), two semi-fixed antenna Transportable Tracking Systems (TTS), and three fixed horn antenna Launch Area vans used for both on- and off-range support. Field TM has two Remote Data Acquisition Systems (RDAS) that aid in capturing TM data starting at initial launch, or T-0. All of this data is transferred over microwave and fiber links to the Telemetry Data Center.

The Telemetry Data Center (TDC) records, processes, and distributes telemetry to satisfy Flight Safety and range user requirements. The TDC receives TM data from Field TM and formulates a composite best source of the incoming signals using a NetAcquire Advanced Correlating Source
Selector (ACSS). When three or more TM sites are tracking a signal the ACSS correlates the inputs in time, scores each input at the frame level based on data/signal quality, and outputs a composite signal. This composite is then processed and distributed to Flight Safety and the range user. This method provides a best source, i.e. time consistent data with a 3 dB reduction in noise, for real-time evaluation.

The TDC records all inputs and formulated best sources to ensure test reproducibility and accountability. The main recorded format used is Chapter 10 recorded on Wideband Systems Data Recorders. Other recorded formats have been and can be supported by the TDC.

As computers have increased in processing capability, the cost of software-based TM processing applications has decreased in recent years. The TDC employs WSMR developed C- and Java-based software decommutation applications to process the best source for Flight Safety and Range Users. These applications have reduced cost to the Range User by reducing labor hours and equipment purchases in developing new capability to meet requirements.

The TDC can also provide Range Users with continuing support off range. Two such capabilities are TRACS and stand-alone software systems. TRACS serves as a mobile facility with Range Control, Flight Safety, and TDC capabilities. The TDC has designed, developed, tested, and deployed real-time and post-test software-based systems in support of continuing requirements for programs such as THAAD, ATACMS, ARAV, and HiFire.

Data Products - WSMR TM provides real-time and post-test data products. Real-time products include data displays, 3D vehicle attitude displays, and strip charts. Post-test products include (but are not limited to) ASCII data reduction files, binary data reduction files, Chapter 10 recordings, strip charts, display video files, and display screen captures. Various media formats are supported.

**EXISTING TENA AT WSMR**

Before this effort was initiated WSMR only used TENA for data transfer within their Optic instrumentation capability. All data transferred between instrumentation capabilities and the centralized Range Real Time Data System was using over 30 different data formats (Figure 1). Several instrumentation capabilities could not transfer data electronically at all. The Inter-Range Control Center (IRCC) had a JMETC node and was able to connect using TENA 5.2 but none of the range capabilities were able to connect without specialized interface routines being written.
Figure 1. This describes the state of WSMR network prior to establishment of the TENA Cell.

Over the last two years White Sands has been working to make all Instrumentation capabilities able to send and receive data using TENA. Figure 2 shows where that effort is today.

Figure 2. This describes a pictorial of the activities that we currently have underway

Within the last year the Optic instrumentation has been successfully updated to the latest version of TENA, 6.0.3, and they in the process of installing it on all Optics platforms and conducting
exhaustive testing of its performance. Many years ago an effort was initiated to use TENA for distributing radar data and, in fact, TENA version 5.0 was installed in the NetAcquire data converters that convert the FPS-16 raw data to IP protocol in order to distribute position and track information. However the data that was actually distributed never implemented TENA but used a WSMR unique format (nTSPI). Recently to get ready for the new radars being procured through the Range Radar Replacement Program (RRRP) a project was initiated that will update the NetAcquire version of TENA to 6.0.3 and integrate it with the existing radars. It should be functional by the end of the calendar year. Since the new radars are specified to output data using the latest TENA format, this will allow the new radars to be quickly connected to the WSMR data network.

The TDC at WSMR presently has no TENA data communication capability. The output of TDC’s software decom process is now being evaluated for translation to TENA for that data that is needed by other WSMR instrumentation as well as for distribution to other ranges.

WSMR’s Real-Time Data Processing System (RTDPS) is currently being replaced by the Modular Real-Time Enterprise (MRTE) to modernize the analysis routines and modularize the processing components. As a part of this modernization a TENA interface is being developed to receive and send data from any TENA capable instrumentation. The capability has already been completed for Optics. Implementation for Radar and TM is underway.

Meteorology instrumentation is being updated by developing draft object models for each of the three types of meteorology instrumentation and establishing unclassified data link to PMRF for sharing Met data to support ongoing mission needs.

TENA is also being tested for use in distributing airborne and ground GPS information, surveillance radar information, and frequency monitoring. There is also some interest in integrating Network Test capabilities that are being used to support Network Integration Environment testing in support of the System of Systems Integration (SOSI) office.

**WSMR INTRA-RANGE USE OF TENA – PLAN**

As more and more new instrumentation capabilities come on line using TENA 6.0.3 the historical data protocol and networking environment needs to change. Previously all instrumentation communicated directly with the RTDPS where their own unique data format was translated and processed. This converted data was then sent out in a very few custom instances to other users who had a need for information like the Position Acquisition System (PAS) pointing information. With the implementation of the latest TENA publish and subscribe features and with the use of the mesh networking capabilities available with the extensive fiber based Test Support Network (TSN) individual sensors will be able to subscribe directly to the precise data needed without getting inundated with superfluous information or having to rely on custom translation and distribution, and the inherent latency of a central collection/conversion center.
Figure 3. This describes the on-going or planned system upgrades to the WSMR range instrumentation which will be delivered with appropriate version of TENA.

**Purpose:** Since TENA is DoD’s standard protocol for data transmission and interoperability services, WSMR is converting all data formats between sensors/instrumentation, Range Control Center (RCC) and their Inter-Range Control Center (IRCC) with the latest version of TENA (version 6.0.3). For the most part, data between sensors and the RCC is limited to TSPI and Pointing Angles. However, with this TENA conversion, this will allow all range data producers to publish any data they can in any format they wish and allow range data users to subscribe to only the needed data in the needed format and the TENA middleware will do what is necessary to make it happen.

**Plan:** The WSMR TENA conversion will provide information to the fiber TSN in such a way that every sensor, instrumentation package, or control console can access the data by subscribing to it. This network arrangement is referred to as the TENA Cloud (Figure 3). The current WSMR TENA TM plan is to design, develop and implement a TM TENA Gateway. This requires a concerted effort between Field TM trackers, TDC, Range Operations Real-Time Branch, MRTE, and IRCC. The goal is to provide the TENA Cloud information originated from the test vehicle (position, health, status, events, etc.) to interested entities (MRTE, Optics, Radar, and TM trackers, IRCC). A proposed method is to have the TDC publish the decommutated and processed Program Office approved data and have interested entities subscribe to it. The TENA Software Development Activity is currently developing a Java-based interface to facilitate integration with the TDC’s software decommutation applications. The same will be true for Radar, Meteorology, and GPS data. Optics actually uses TENA natively and will not need a gateway.
Concerns: As with any planning, the earlier that concerns are identified, the lower the overall cost.

• Telemetry
  o Since TM packages are designed by the Program Office, test ranges have to accommodate practically any TM package design. Although efforts have been made by the Range Commanders Council (RCC) to standardize a TM signal/package, advances in modern technology have provided contractors the flexibility to design increasingly complex packages. This allows Programs to have a significantly larger set of instrumented data on the test vehicle. This brings data access and flexibility issues to the forefront.
  o The first concern is publishing approval. Ranges are only allowed to publish data if approval is given them by the Program Office. Unlike Radar and GPS, whose data is independent of the test vehicle, TM data is owned by the Program Office. The Program Office must define what subset of the TM package can be published via TENA.
  o The second concern pertains to the flexibility of the current TM Object Model and its publication. As an example the Interceptor Program Office defines a subset of their TM data for publication by producing a mapping of parameters to measurand names. Similarly the Target Program Office produces such a mapping of their data. Technically both Programs used the same TM Object Model but defined the contents differently. Is a process defined for a range to publish both data sets and for potential subscribers to identify each data set and the parameters within?

• Optics, Radar, Meteorology, and GPS
  o These platforms/sensors/instrumentation packages do not vary from mission to mission, usually remaining somewhat stable for years and often decades of use. Therefore the TENA solutions for them are easier to achieve and the result can be better integrated.

SUCCESES, LESSONS LEARNED, & EXPECTATIONS

Information about successes, lessons learned and performance realized changes almost every day as this modernization/integration effort continues. To date Optics is the farthest along, has demonstrated very stable operations and performance, and has met or exceeded all requirements and expectations. Optics presently can only communicate with the Real-Time Data Processing System (RTDPS) and its evolving replacement, the Modular Real Time Enterprise (MRTE). As soon as a second instrumentation/sensor capability becomes able to communicate with the latest version of TENA (currently v6.0.3), many more observations about successes and performance achieved will be documented. As capabilities become available at other ranges or as mission requirements cause ranges to interconnect and share data, those Inter-Range successes with TENA will also be included. Test plans of interoperability performance between range instrumentation are currently underway. These plans currently include WSMR and PMRF; however, we are awaiting and urging the range community to participate.