INET SYSTEM MANAGER

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ABSTRACT

Network-based telemetry systems have unprecedented amounts of flexibility due to the ability to monitor, control, configure, coordinate, and visualize the operations of the flight test system. As a result of this flexibility, multiple tests can be conducted in a single flight; all it takes is reconfiguration of portions of the system. However, management of such a dynamic system is a complex task. As such, the integrated Network Enhanced Telemetry (iNET) Program is currently developing a System Manager application to provide a model for coordinated management of networked telemetry. The System Manager provides a user application for monitoring, controlling, configuring, coordinating, and visualizing the operations of the Telemetry Network System (TmNS) network. This paper describes the key requirements, capabilities, and development approach of the System Manager.

KEYWORDS

Telemetry Network System (TmNS), System Management, iNET

INTRODUCTION

Over the last decade, network-based data acquisition systems have gained popularity in the deployment of telemetry systems. Due to the ubiquitous nature of communication networks, Internet Protocol (IP) networks in particular, there are several standardized networking protocols and technologies that can be leveraged by a network-based system. By utilizing these proven technologies, standard networking tools can be used, making network-based telemetry systems all the more attractive for deployment. The integrated Network Enhanced Telemetry (iNET) project seeks to enhance classical telemetry systems by utilizing a network-based instrumentation system and introducing a two-way radio link that allows bi-directional communication between the network-based instrumentation on the Test Article (TA) vehicle and the network-based workstations on the ground within the Mission Control Room (MCR). This capability has opened the door for new concepts of operations for telemetry systems.

To support all this advancement, highly specialized applications are needed to fully manage a TmNS. These applications (i.e., managers) are central in maintaining the system working seamlessly, reliably, and effectively. One example of such application is the System Manager, which is being developed as part of the iNET program. The System Manager is a software application that provides both visibility and control capability over an entire TmNS. The System Manager is the user application for monitoring, controlling, configuring, coordinating, and visualizing the operations of the TmNS network. Using the System Manager, users will be able to obtain system, subsystem, and device-level status, including status of onboard instrumentation and information about local and system-wide network performance (expected versus actual). It is an all-encompassing tool for managing and maintaining a functional and reliable TmNS. This paper highlights the key requirements and capabilities of the System Manager, the multiple roles the System Manager will play, and the approach for developing the System Manager.

KEY REQUIREMENTS AND CAPABILITIES OF THE INET SYSTEM MANAGER

The System Manager utilizes various logical interfaces required for system configuration and management. The interfaces provide the functional hooks that enable the higher-level capabilities such as system configuration, control and status of onboard instrumentation, and automated or manual radio handoffs. The key interfaces that enable these capabilities are as follows.

The iNET program developed several standards for TmNS components. These standards are meant to provide a uniform approach to communicating and managing various types of TmNS components from multiple vendors. The iNET program's Metadata Standard defines the Metadata Description Language (MDL), the standard language created by the iNET program for capturing metadata that describes network-based telemetry systems. MDL Instance Documents are files that contain metadata that adheres to the MDL syntax and semantics. MDL Instance Documents are used to configure TmNSs as well as the network-enabled devices attached to them.

MDL is eXtensible Markup Language (XML)-based and follows a syntax that is defined and constrained by an XML schema. The schema defines a vocabulary (names of elements and attributes), a content model (structure and relationships), and a type system. The language syntax represented by the schema is not a complete specification of the language, as it does not provide the semantics of the language. The semantics of a language relate to the meaning of the elements and sentences written in the language. The semantics of MDL correspond to the meaning of the individual elements and attributes and their combination in an MDL Instance Document. The MDL semantics are embodied by a set of use cases and the transformations that will be applied to the metadata to support those uses.

MDL is expressive enough to describe a wide variety of systems: large and small, simple and complex, from the low-level transducer-to-measurement association for an acquisition card on a Data Acquisition Unit (DAU) up to network topology of multiple test mission networks.

The iNET program has also standardized the management interfaces of the TmNS components. The System Management Standard (SMS) contains a set of standard networking protocols to be implemented by all components in order to allow for standard networking tools to be utilized for managing and monitoring various devices from multiple vendors. The SMS has identified Simple Network Management Protocol (SNMP) as the core management technology, and it has defined a private Management Information Base (MIB), the TMNS-MIB, for standard management of all TmNS components. Because of the two-way telemetry link in iNET, a System Manager inside the MCR is able to communicate directly with the instrumentation onboard the airborne instrumentation vehicle. This capability allows for remote control and on-demand status updates of the instrumentation. Other standard network and management technologies include File Transfer Protocol (FTP), Hypertext Transfer Protocol (HTTP), and Internet Control Message Protocol (ICMP), just to name a few. The System Manager will utilize the available standard management interfaces to discover, monitor, and control the onboard TA network components.

The System Manager connected to the range network is also able to discover, monitor, and control the iNET radios as well as other TmNS components on the ground. The System Manager is able to maintain a top level operational view of several concurrent tests by monitoring the health and status of all TmNS assets deployed across a particular range. It is able to manage Link Managers, the entities responsible for issuing the dynamic transmission schedule to all ground and airborne radios. Since the Link Manager is maintaining health, status, and statistics of the radios, the System Manager can retrieve the radio information by indirect management through the Link Manager.

With all the capabilities of the System Manager to gather health, status, and statistics as well as configuring and controlling of all TmNS airborne instrumentation and ground assets, the System Manager is required to present the data to the end user in a Graphical User Interface (GUI) that provides key information into the overall health of the TmNSs on the range. Based on the system information retrieved and displayed by the System Manager, an authorized user may manually issue commands to certain components in order to facilitate necessary system level changes.

With the interfaces of the TmNS components clearly identified through the System Management and Metadata Standards, the basic hooks are set for how to manage each type of TmNS component. From the System Manager application’s perspective, a corresponding interface is required for managing the TmNS components. In other words, in order to be able to manage a TmNS component via the standard-defined SNMP interface, the System Manager shall implement the functionality of an SNMP manager in order to issue SNMP commands and queries to the SNMP agent of the TmNS component.

The System Manager also maintains a complete understanding of the MDL, as it is the software tool that provides the user's window into the system configuration. MDL files that describe entire test missions, from network topology to device settings, even down to measurement packaging information within a message will be created using the System Manager through a combination of user input and negotiation with devices or proxies which can apply constraints of their implementations to describe the resulting measurement and message characteristics. As such, it is a logical requirement that the System Manager provide MDL-authoring and editing capability, allowing a user to create and edit test configurations.

Since the System Manager is an interactive user tool, it is required to provide a GUI. This is the primary means of providing information to the user. With such a complex system with volumes of detailed information available, the GUI must find the right balance of providing the most useful information without overloading the display with too much information. Further, the information that is displayed by the System Manager is dependent upon the role of the user using the System Manager. For instance, one user may have permission to monitor the status of instrumentation on the TA, but he may not be able to control the instrumentation or alter its state or configuration. A more privileged user may have different screens and options available that allow him to issue certain commands and alter the operational state of the instrumentation. The System Manager's GUI is also the primary indicator of any fault conditions detected within the TmNS.

Under certain scenarios the System Manager is required to communicate with another instance of a System Manager operating on a different test range. The System Manager applications communicate configuration, status, and control parameters with each other in order to coordinate inter-range operations such as range-to-range handoff events where a TA leaves the management space of one range and moves into the management space of another.

One other special feature of the System Manager is that it is context-sensitive and dependent upon the user permissions and its host platform's location on the network to determine the GUI screens available to the user. This is discussed in more detail in the following section.

ROLES OF THE INET SYSTEM MANAGER

The System Manager is an all-encompassing management tool, and it incorporates all management capabilities required for managing several TmNSs. While there is a lot of capability wrapped up within the System Manager, not all of those capabilities need to be presented to every user all the time. Using a user-permission and context-sensitive approach, the System Manager only presents the user with information and capabilities that the user is authorized to view. The physical location of the host platform may also affect the available functionality of the System Manager. These roles will be described in more detail below.

The first usage role of the System Manager is that of creating projects which can be used to generate MDL files which ultimately are used to configure all devices within a TmNS. This mode of operation of the System Manager may be completely independent of actually operating the System Manager in a device management mode. There are some scenarios where the System Manager is connected directly to an instrumentation network in order to retrieve the as-built, device-specific configuration to be imported into the active System Manager project. This may be done in a lab environment. The authoring capability of the System Manager may not be available for some users that utilize the System Manager during actual flight test operations.

There are multiple operational views within the System Manager. In one view, the System Manager operates within the MCR. The scope of its management reach includes the MCR as well as the instrumentation on the TA network. Using the defined management interfaces, the System Manager is able to discover the TmNS devices within its scope. It is capable of pushing new configurations to the devices. It is able to command and control the instrumentation, including the starting and stopping of recording activities of the TA-based and MCR-based recorders as well as enabling and disabling the transmit function of the DAUs. The user of the System Manager may retrieve health and status information as well as statistics from any managed TmNS device. If any fault conditions are detected on a managed component, the System Manager can retrieve additional fault information from the device on demand.

A second operational view is when the System Manager operates within the ROC. From this vantage point, the System Manager manages the range network components. These components include both ground-based and airborne radios, Link Managers , and other TmNS components found on the range network. A Link Manager provides the dynamic transmission schedule for the radios whose links it is managing. The System Manager is able to provide system-wide monitoring across the range network that may include multiple concurrent tests. By monitoring a Link Manager, the System Manager is able to retrieve the radio statistics that are being collected by the Link Manager. The System Manager can use this information to provide the user with the ability to command certain types of radio handoff events. A handoff consists of changing from one tracking antenna to another tracking antenna as a TA moves out of the range of one into the range of the other. Because a single ground radio is associated with a single ground antenna, a change in the radio transmission scheduling needs to occur in order to stop transmissions from one radio and begin transmissions for the TA with the other. The System Manager will have the ability to command the Link Manager to perform the radio handoff. It will also be able to push rules to the Link Manager so that the Link Manager can perform a handoff without user interaction on the System Manager.

Figure 1 shows the System Manager operating in both the MCR and the ROC. In this scenario the System Manager operating in the MCR manages devices in the TA network, while the System Manager operating in the ROC manages the range network components.

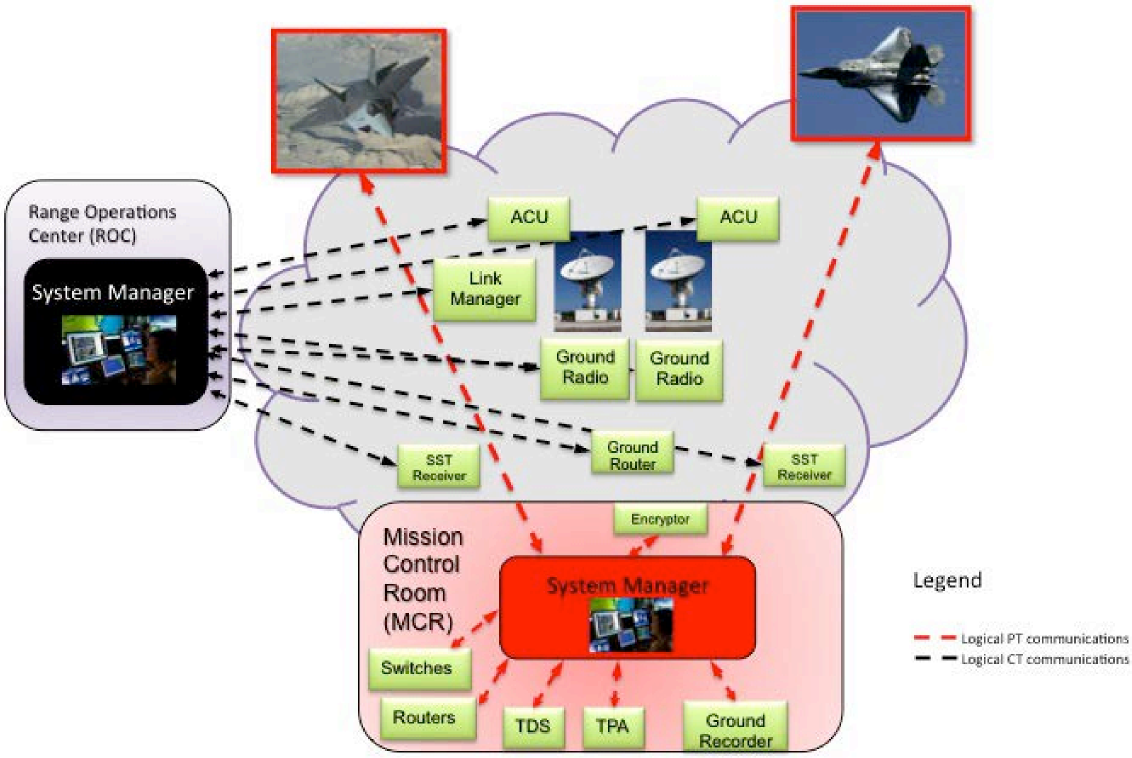

Figure 1. System Manager Roles

Under both operational views, the System Manager is able to view network performance but only as it pertains to the respective networks being managed by each System Manager. For instance, the System Manager operating within the MCR can monitor the network performance of the TA network, but it cannot monitor the performance of the RF network segment or the range network. Network performance management includes an analysis of throughput, latency, data drops and packet loss, and other general network statistics. There is a visualization component provided in the GUI for monitoring the network performance. Based on the MDL descriptions of a particular test, the data rates across the network can be estimated. As part of the network performance monitoring, the System Manager will be able to analyze in real time the expected performance versus the actual performance and notify the user of any discrepancies.

DEVELOPMENT APPROACH OF INET SYSTEM MANAGER

The key to the System Manager's success will be in how well it can handle the various management complexities that come with the new operational concepts while providing a simple but complete user interface for operating the System Manager. It is being designed in such a way so as to handle the system complexities behind the scenes, sheltering the user from all the low-level details. After all, the user should only have to focus on the test mission itself rather than the specific details of SNMP packets, MDL system configuration file elements, or any other mechanism or protocol used for overall management of the system [1].

The System Manager is a sophisticated and complex tool. Indeed, it must be complex given the list of requirements and capabilities that it must perform. However, not all data being maintained by the System Manager should be displayed to every user all the time. Some views of the System Manager involve describing a test network, from network topologies to measurement assignment and packaging rules for sensor data of DAUs. Other views provide live health and status information of discovered network devices and may allow for command and control of those managed devices. The System Manager is being designed with these usage concepts in mind.

The System Manager is being designed around a database. The database will contain descriptions of physical network components within the local range inventory, including network topology information. If the System Manager is operating in a live monitoring mode, then the System Manager will also store information in the database concerning each managed device. The System Manager can perform comparisons between the expected configuration and status of a device and the actual configuration and status of the device. The user would only need to be notified when there is a critical difference between the expected status verses the actual status. The database will also contain settings for context-sensitive capabilities based on the permissions associated with the user roles.

Once the general design phase has been completed, development will begin. Throughout the development stage, the System Manager will be integrated into the iNET System Integration Lab (iSIL) at Southwest Research Institute in San Antonio, Texas. This will allow for testing and interface validation as the development effort progresses.

CONCLUSION

The System Manager is the software application being developed for the iNET project that will be used to describe, configure, command, control, monitor, and visualize the various network components that comprise a TmNS. It is an all-encompassing tool for management of the TmNS. However, due to the complex nature of the TmNS, not all functionality will be made available to every user of the tool. Instead, the System Manager will have a different look and feel based on the permissions of the user and the contextual role of the application. By using this context-sensitive approach, the functionality made available to and seen by a user will vary to match that user’s role, therefore allowing the user to focus on their specific responsibilities.

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