Joint Radio Manager Enhances Service Interoperability

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Abstract. With the maturity of tactical networking waveforms comes the need to consolidate the planning and management of these waveforms into a joint management system. This consolidated system is called the Joint Enterprise Network Manager (JENM). Soldiers can operate JENM's software application to plan and manage the next generation of lower and mid-tier radio waveforms, which include: the Soldier Radio Waveform (SRW), Wideband Networking Waveform (WNW), and the Mobile User Objective System (MUOS) on Software Defined Radios, as well as the Single Channel Ground and Airborne Radio System (SINCGARS) and Satellite Communications (SATCOM) Legacy Waveforms.

Introduction

An innovative, agile development process has given JENM the capabilities to provide multifold benefits for the warfighter. Foremost, rather than operating a unique manager for each waveform and radio type, a single network manager with a common user interface significantly reduces the equipment needed to manage a tactical network. JENMs manage the Wideband Networking Waveform (WNW), Soldier Radio Waveform (SRW), Mobile User Objective System (MUOS), as well as SINCGARS and SATCOM Legacy Waveforms on lower and mid-Tier Tactical Software Defined Radios (SDRs). JENM improves interoperability since the single type of manager provides a consistent configuration of the many parameters needed among multiple interconnected sub-networks. With an advanced Service Oriented Architecture (SOA), JENM is able to present a common user interface for management of the diverse networking waveforms and be far more user friendly than multiple managers. The Department of Defense (DoD) will save substantial costs in the development and logistics of future systems. This article explains JENM's capabilities and how it works in the hands of the warfighter, its role in advancing interoperability, the methodology for its agile software development, and current product status.

JENM System Overview

Wired and wireless networks require a network management system to configure, monitor and re-configure network devices in order for data packets to properly transit the network and respond to interruptions. A network management system configures devices, such as switches, routers, and security devices. Modern SDRs that host military networking waveforms contain routers and switches and other networking devices that must be similarly configured to a mission's specific communication requirements. Additionally, SDRs and military waveforms are configured for over the air management aspects such as time slot allocation, timing, and information assurance aspects. A wireless radio network for a military system should be able to operate without fixed infrastructure, and also have the capability to connect and interoperate with a wired network.

JENM's management capabilities are able to:

1. Design a Network
2. Load Radios and/or Load Devices
3. Monitor the Networks
4. Manage the Networks

How JENM Works

JENM's concept allows the user to develop a network design based on mission communication requirements. For each radio node in the network or sub-network, JENM develops radio/waveform configuration files including parameters that are unique to individual nodes, parameters that are common to all nodes in the network, and parameters dealing with radio services. Configuration parameters enable the radio and waveform to tune variable aspects of their operation that are changed based on mission communication requirements and operating environment.

JENM develops the configuration parameters based on user inputs and planning rules. The user provides basic network communication characteristics of a mission and JENM then uses planning rules, associated logic, and waveform configuration data to develop the plans. The network plans are translated into radio configuration files for each radio node in the networks or sub-networks. As part of the planning process, JENM interfaces with feeder data sources to obtain information such as Internet Protocol (IP) address ranges and spectrum allocations from the unit's higher level planning tools. This information is optimized into a tactical network configuration for the mission.

After developing the network plans, JENM uses them to develop the radio/waveform configuration files. The files are loaded directly to the radios or via military load devices. While there is overlap, each waveform and radio is configured differently. JENM abstracts the planning details involving complex functionality of multiple waveforms from the User, with a common user interface. This abstraction and the single JENM application results in significant planning time savings as compared to using different tools with different interfaces to plan for each waveform. Recent versions of JENM have reduced planning times by a factor of ten.

Once a network design is put into operation based on the mission's requirements, JENM has the capability to monitor and manage its networks in the field. The network manager can monitor aspects like: topology, performance and faults in the configured radios and waveforms, utilized bandwidths, and input/output data rates. As JENM monitors configured tactical networks, the user can act upon monitoring information or respond to mis-

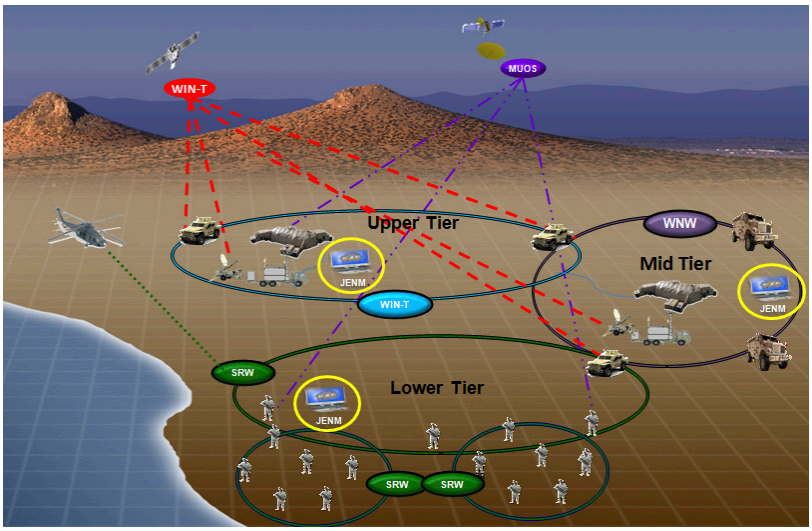

Figure 1: Typical Placement of JENMs in Army Tactical Network

sion changes using over-the-air management to reconfigure the networks. JENM will issue commands, which are sent to radios over the air to change the network configuration or information assurance aspects of network operation. This capability is known as Enterprise Over-The-Air Management (EOTAM).

JENM Improves Interoperability

There are many configuration parameters which need to be set for advanced networking waveforms. These parameters deal with waveform configuration settings at their equivalent three layers: Layers 1, 2, and 3 of the Open Systems Interconnect (OSI) Model. At Layer 1, settings involve configuration of bandwidths, modulation types, data rates and other parameters necessary for RF operation. Layer 2 settings involve wireless slot allocation, timing, and distribution. Layer 3 settings involve wireless and wired routing and packet distribution settings.

After a warfighter using JENM designs a network and sets the parameters, JENM configures the complex network of radios, consistently for all nodes in the network, sub-networks and for interface with connected upper tier backbone networks. It is essential the parameter settings for all nodes are consistent in order for there to be interoperability amongst radio nodes, as well as waveforms. JENM's User Interface properly configures the multitude of settings for all nodes while abstracting the details from the user operating in the field. JENM can do this for single service or joint scenarios enabling interoperability among networks and with higher level networks connecting to the Department of Defense Information Network (DoDIN).

Figure 1 depicts JENM's placement within an Army Tactical Network. The JENM's are strategically positioned at tactical communication control points to manage networks based on the mission and resulting network requirements. JENMs continuously communicate with each other to maintain the consistent network plans, provisioning and configuration for all nodes in all sub-networks throughout the lower and mid-tier tactical network with nodes running on multiple hardware types. Consistent network formation of different echelons and between services include a full awareness of inter-network, gateway and border requirements. The networks shown connect to high bandwidth backbones such as WIN-T resources.

JENM Architecture

JENM uses a SOA to manage the different radios with different interfaces. JENM's SOA leverages the inheritance aspects of object oriented programming to enable plug-ins that facilitate interface with a variety of radios.

Figure 2 illustrates the JENM SOA Multi-Layer Architecture. Items in blue are part of the Consumer Layer that includes user and application specific external interface software to radio equipment. Items in pink are the Service Layer which includes entry points into business logic functions and SOA standard interfaces including Representational State Transfer (REST) and external interfaces. Items in pink also comprise the Component Layer involving the plugin design patterns specific to the service and implementation of business logic. Items in green are part of the persistent Data Layer.

Designing a network is performed within the Designer and Network Development Service within the JENM application. The Designer includes an external interface, with which the warfighter inputs network formation data, and JENM then checks and validates the data. This information is used to design the network or networks and produces a network plan. JENM then develops the Network Plan and displays it to the user. The Network Provisioning Service consumes the plan, produces configuration files for the radios in the network, and loads them directly or via load devices. Each of the network services may interface with other devices in the network to request and obtain feeder data and provide configuration files.

Figure 3 is an illustration of the JENM's plugin approach. Since JENM manages multiple waveforms and radios a flexible architecture approach is needed which can be easily extensible to additional waveforms and radios. The figure shows that there is a plugin for each radio type which adds derived characteristics to the basic packager characteristics. The figure also includes a Target Packager Plugin. There is a similar plugin architecture for waveforms. In the past JENM has responded to the unique interface needs of each radio type. Going forward, JENM is working with the tactical networking radio developers to establish a set of common interfaces which are based on commercially accepted specifications such as Extensible Markup Language and Ethernet to further reduce costs for JENM and the radio programs.

JENM Agile Software Development Process

An agile software development methodology has become a critical component for the success of the JENM program. Agile development methodology rapidly responds to many customers among all services with different interfaces and radio network requirements, without the cumbersome overhead of the traditional waterfall software development processes. The JENM

program office acting as the product owner works closely with the lead developer to establish development priorities. The program office and the lead developer work together to plan development efforts into Sprints, or the creation and prioritization of Product Backlog Items (PBIs) that are responsive to the customer's needs in meeting all components of performance, schedule and cost. PBIs are planned into monthly Sprints to provide incremental capability additions. The lead developer acts as the software architect and leader of the Scrum of Scrums.

Before embracing the Agile Development Process, the JENM product office would let out large development contracts with fixed deliverables to contractors, who would, in turn, develop a system. The product office had limited ability to respond to the changing requirements of the customer base during the long contract development cycle. When the government-led Software Support Activity took over as lead developer, the product office was able to respond more quickly to customer needs without the delays inherent in large contracts.

Figure 4 illustrates JENM's Agile Software Development Process. The process begins with the establishment of the JENM Punch List. The punch list is the list of capabilities or product features needed broken down into small manageable pieces that can be accomplished within individual sprints through a list of PBIs. The punch list also includes a prioritized set of issues reported by users, integrators, and testers.

The punch list is reviewed and approved by the JENM Configuration Control Board (CCB) consisting of representatives from the JENM Program, its Software Support Activity (SSA), customer offices, and the user community. Once the monthly list of prioritized PBIs is established and approved by the CCB, a subsequent monthly planning meeting prioritizes future Sprint PBIs. The monthly list of PBIs is then executed by the government-led SSA. The SSA conducts daily scrums. The CCB approves incremental software releases with customer programmatic needs in mind. The JENM Program monitors its performance using the velocity of planned, in-progress and completed PBIs, requirements burn down, and issues burn down.

JENM Organization and Product Status

The JENM Product Management Office (PdM JENM) is responsible for development of the JENM Product. PdM JENM is a product office within the Project Manager Warfighter Information Network - Tactical (PM WIN-T) in the Army's Program Executive Office for Command Control Communications (PEO C3T). The JENM product office is collocated with the Joint Tactical Networking Center of PEO C3T in San Diego, CA, and it also has a subset of staff at PEO C3T at Aberdeen Proving Ground, Md. The lead developer for the JENM is the Network Management Reference Implementation Laboratory (NMRIL) Software Support Activity located at SPAWAR Systems Center Pacific, San Diego, CA. Contractor support to the NMRIL government staff in the development of JENM includes Booz Allen Hamilton, G2 Software Systems, Harris (formerly Exelis), Northrup Grumman Corporation, Tactical Engineering and Analysis, and additional subcontractors. Government activities

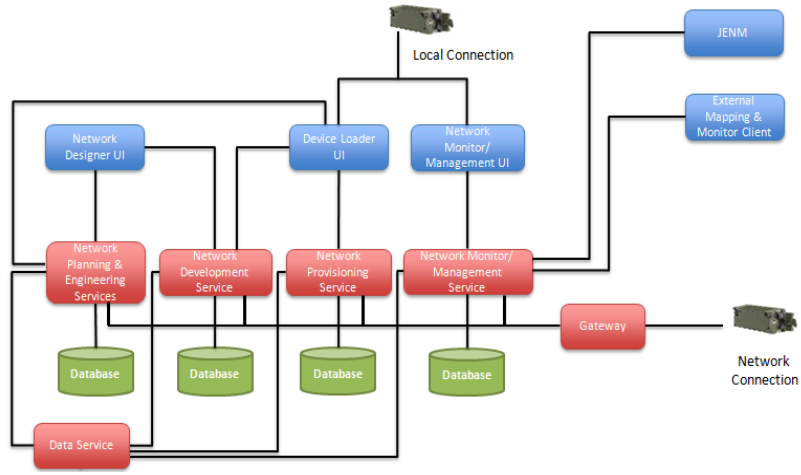

Figure 2 JENM SOA Multi-Layer Architecture

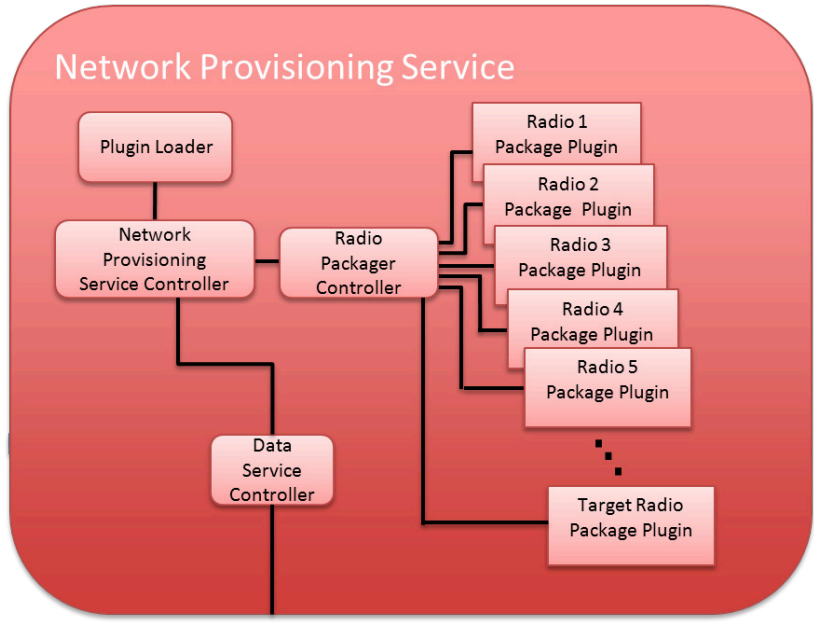

Figure 3 Example of Plugin Architecture

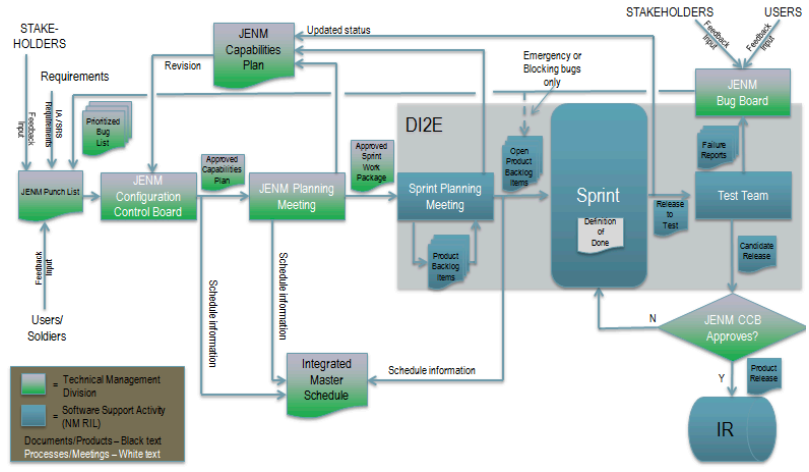

Figure 4 JENM's Agile Software Development Process

also supporting the NMRIL include the Army's Communications - Electronics Research, Development and Engineering Center, the Navy's SPAWAR Systems Center Atlantic, and others in support of radio program offices.

Version 3.3 of the JENM Software Application was released in December 2015. The application manages the WNW, SRW, MUOS, SINCGARS, and SATCOM waveforms on Joint Service SDR Programs of Record including Handheld, Manpack and Small Form Fit (HMS) Program Rifleman Radios, and Mid-Tier Networking Vehicular Radios (MNVR), and AN/PRC-117G for MUOS. A key addition in the JENM v3.3 is the ability to perform over-the-air management of the MNVR Radios. The JENM v3.3 also has many user interface enhancements which significantly reduces reliance on field service representatives. JENM has received positive user feedback based on Army Network Integration Evaluation (NIE) test events, as well as from program specific test events such as the MUOS Operational test event.

"We have developed JENM to provide a user friendly capability to configure and manage lower and mid-tier networking waveforms in a single software application," said Lt. Col. Matthew Jury, former JENM product manager within the Army's WIN-T project office. "With JENM, our warfighters are better equipped to configure networking waveforms to operate seamlessly within and across tactical networks. Working closely with networking and radio program product managers within the Army and with other services, we continue to add features to accommodate management of networking waveforms in a joint force."

Looking forward in the near term, the JENM will continue to develop new versions of software to support the evolving joint service program of record networking radios with capabilities added in step with their procurements. As the tactical networks evolve, the JENM role will be expanded to include configuration and management of selected network control, information assurance, and routing devices. Also the JENM interfaces will be expanded to interoperate with higher level managers and additional mission command devices with roles in configuring networks.

ABOUT THE AUTHORS

Dean Nathans is a Senior Engineer working for G2 Software Systems assigned to support the Joint Enterprise Network Manager (JENM) Technical Management Division in the JENM Product Management Office, within the Project Manager Warfighter Information Network -Tactical Project Office. Mr. Nathans performs systems engineering, network engineering, and interface development for the JENM Product. Mr. Nathans has over thirty years of experience with military communications and navigation systems in industry and government including positions of Senior Engineer, Chief Engineer, and Deputy Program Manager with major acquisition programs. Mr. Nathans has a Master's Degree in Electronics Engineering and a Bachelor's Degree in Electrical Engineering. He has received many awards for his service, including the Superior Service Award and Meritorious Civilian Service Award.

Dan Preissman is the Product Lead for the Joint Enterprise Network Manager (JENM) within the Project Manager Warfighter Information Network - Tactical Project Office. Mr. Preissman has served in this position since 2007 when the JENM was early in its development, and has led the JENM through to its current version 3.3 product release. Prior experience has included management and technical leadership positions involving military aircraft standards, aircraft electrical systems, and automated electrical/electronic test systems. Mr. Preissman has a Master's Degree in Engineering Management, and a Bachelor's Degree in Electrical Engineering. He also holds a Master's Of Arts Degree in National Security and Strategic Studies. Mr. Preissman has received many awards for his service including the Superior Civilian Service Award, and Bronze Order of Mercury Medal.

Alan Gebele is a Senior Software Engineering Manager working for Leidos assigned to support the Joint Enterprise Network Manager (JENM) Technical Management Division in the JENM Product Management Office, within the Project Manager Warfighter Information Network -Tactical Project Office. Mr. Gebele acts as the Deputy Team Leader for a group of software, systems engineers and project managers who manage the JENM requirements and priorities for the JENM Product in support of the JENM Product Owner. Mr. Gebele has over 30 years of telecommunications and military communications experience including the network monitoring development lead for the Joint Network Management Systems developed to plan and manage Joint Task Force level networks in support of Combatant Commanders mission requirements. Prior assignments include the software development and systems engineering roles software products developed for commercial telecommunications providers in the USA, European and African for the full life-cycle of operations. Mr. Gebele has a Master's Degree in Computer Science from Brown University, and a Bachelor's Degree in Computer Science from Purdue University.