Achieving DoD IP Modem Interoperability Utilizing the Joint IP Modem (JIPM)

Christoper Catlin, Dana DeFrancesco
Defense Information Systems Agency (DISA)
Ft. Meade, MD USA

Andrew Lincoln, Ben Davis
ViaSat, Inc.
Carlsbad, CA USA

Bharat Parikh
AASKI Technology, Inc.
Ocean, NJ USA

Andrew Melchior, Ling-Bing Kung
Booz Allen Hamilton
McLean, VA, USA

Abstract— **IP Modem interoperability has been a topic of discussion for the past 7 years with major efforts underway to enhance the use of commercially available standards, incorporating Department of Defense (DoD) unique security capabilities for use by the Warfighter. The Defense Information Systems Agency (DISA), in conjunction with Project Manager, Defense Communications & Army Transmission Systems (PM DCATS), has developed the Joint Internet Protocol Modem (JIPM) Interoperability Standard, which defines extensions to the Digital Video Broadcast – Second Generation (DVB-S2) and Digital Video Broadcast – Return Channel via Satellite (DVB-RCS) standards, and provides a mechanism to incorporate Transmission Security (TRANSEC), incorporate Information Assurance (IA), meet National Institute of Standards and Technology (NIST) requirements, and obtain DoD Information Assurance Certification and Accreditation Process (DIACAP) accreditation. This first-of-its-kind capability has been implemented in the JIPM. The JIPM Standard defines all of the necessary parameters required by equipment manufacturers to implement modes that will allow varying platforms to interoperate in the encrypted and non-encrypted modes. This paper will discuss how next generation Internet Protocol (IP)-based Satellite Communication (SATCOM) Modems can leverage the JIPM Standard to promote interoperability while providing enhanced features needed by today's Warfighters.**

Keywords—Joint IP Modem; JIPM; DVB-RCS; DVB-S2; DVB-RCS2; SATCOM; ETSI; TRANSEC, COTM, Global Broadcast System; GBS; IP; IPv6; IA, DIACAP; NIST

I. INTRODUCTION AND CHALLENGE

The transition from Single Channel Per Carrier (SCPC) serial interface modems to bandwidth-on-demand, Internet Protocol-based SATCOM presents unique opportunities and challenges for today's tactical Warfighter as well as the enterprise gateways and logistics communities which support the Warfighter. The rapid adoption of commercially-based IP modems by today's Warfighter has resulted in unprecedented access to data on the Global Information Grid (GIG). For example, the Global Broadcast System (GBS) program provides the tactical user access to critical information resources (briefings, weather reports, training, etc.) using broadcast over the Digital Video Broadcast – Satellite (DVB-S) waveform, but can benefit from advances inherent in DVB-S2, Transmission Security (TRANSEC), and two-way capability. As another example, IP networks currently support tactical video streaming over multicast IP from small remote terminals to both GIG users and other remote terminals in the networks. One current challenge, since the current force modems are Commercial off the Shelf (COTS), is that adversaries can use the same modem to intercept data communicated and/or attempt to exploit security weaknesses in the current systems due to the lack of National Security Agency (NSA)-approved transmission security and DIACAP certification. Another current challenge is the number of different IP-over-SATCOM modems in use today: the logistics, training, and sustainment costs needed to support fundamentally similar capabilities using different modems are not sustainable in today's budget environment.

This paper will explore the IP Modem Interoperability Standard ("the JIPM Standard") as the basis for over-the-air interoperable IP modems based on commercial DVB-S2 / DVB-RCS standards. The paper will also address the evolution to enhanced capabilities in the context of the DoD's vision of a family of IP-centric modems from multiple sources.

II. BACKGROUND

Current-force IP modem networks support broadcast, hub-spoke, or mesh topologies. Broadcast and hub data injection points are typically installed at Enterprise Gateways (e.g., Teleport and Standardized Tactical Entry Point (STEP)) with access to the GIG. Mesh network control sites are typically installed at larger tactical sites, with emerging demand for mobile/tactical data injection points. The current force ground remote terminals are typically used at the halt, with increasing demand for ground mobile Communications-On-The-Move (COTM) terminals. Current and near-term naval requirements are for receive-only terminals. Current air-to-ground data is typically line-of-sight with rebroadcast over satellite, with a trend toward integrated IP over SATCOM airborne terminals.

The current version JIPM modem version 1 (JIPM V-1) implements the JIPM Standard and is optimized to enhance current force broadcast and hub-spoke network topologies for

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ground-based Communications-On-The-Halt (COTH) and naval receive-only requirements, as shown in Figure 1. Advantages of the JIPM V-1 compared to similar current force modems include:

- Introduction of NSA-approved, NIST-certified TRANSEC to IP SATCOM modems.
- Enhanced broadcast capabilities by use of European Telecommunications Standards Institute's (ETSI's) DVB-S2 standard (vice current DVB-S), including turbo codes, and adaptive/variable coding and modulation.
- Enhanced two-way return capabilities by extending ETSI's DVB-RCS standard to include 8PSK, dynamic link adaptation, and network Quality of Service (QoS), similar to capabilities in the DVB-RCS2/NexGen standard, currently in blue book form (DVB A-155).
- The JIPM V-1 Remote Modem forwards the entire DVB-S2 IP layer capacity to the remote LAN (up to 165 Mbps @ 50 Msym/s), while current force modems are typically processor-limited to a maximum of 50 or 60 Mbps.

Planned, near-term enhancements to the JIPM are focused on the DVB-RCS-based return link, and include support for communications-on-the-move (COTM) such as BPSK and direct sequence spread spectrum (DSSS), mesh networking, and higher return link symbol rates/chip rates. These enhancements will extend JIPM capabilities for ground mobile, Intelligence, Surveillance and Reconnaissance (ISR) contribution, and tactical mesh applications. The JIPM Standard already defines support for higher return channel symbol rates and will be extended to define other enhancements to meet Warfighter needs based on advances in commercial technology, open standards (TIA/ ETSI/ DVB/ SatLabs), and input from defense organizations (DoD/ NATO).

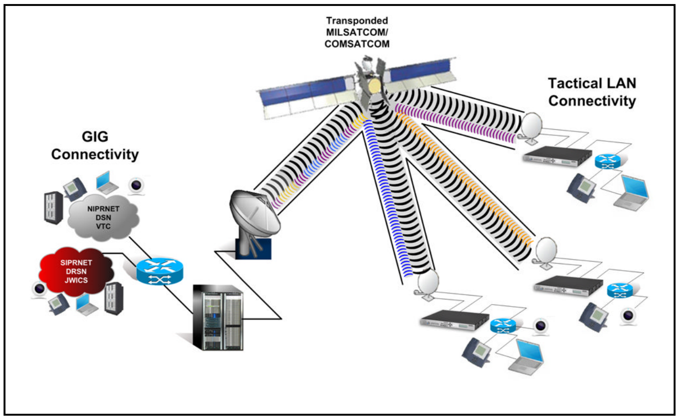

Figure 1. JIPM Operational View

III. Interoperability Objectives

The main purpose of the JIPM program was to create a DoD-wide IP modem capability. The goal was not just to build a modem, but to define a standards-based foundation for achieving interoperability as technology refresh of current force IP modems occurs. By creating a flexible architecture based on readily available standards, publishing augmentations to those standards for use by all equipment manufacturers, and creating a concept centered on a family of modems, a true foundation for interoperability has been laid in the JIPM V-1 baseline and associated Standard. It is anticipated that the Warfighter will reap several benefits from this foundation for interoperability.

First, development of multiple equipment sources in the family of modems will provide enhanced features and tailored functionality to the Warfighter. Currently, each supplier has products with many similar capabilities and some differences compared to other suppliers. Building on top of the family of modems concept is intended to standardize a solid foundation while allowing innovation to focus on the unique needs of different groups in the Warfighter community.

Also, reduced logistics, training, and sustainment costs at each Enterprise Gateway can be anticipated by use of a common platform based on the JIPM Standard. Current force modems are different enough that Enterprise Gateway operators must be skilled in the operation and maintenance of at least four different IP modems. The costs of maintaining a large number of IP modem platforms are considerable: spare equipment components, software release cycles, technical manuals, and user interfaces are all different. Consolidating platforms with similar capabilities reduces overall costs and yields higher value for the Warfighter.

Additionally, enforcement of minimum performance and functionality standards leads to better network operation and availability. The Government has benefited from the adoption and enforcement of performance standards such as Military Satellite Communication (MILSATCOM) and High Assurance Internet Protocol Encryptor (HAIPE), which have ensured that communications meet the needs of the users while protecting critical shared resources (terminals, satellites, networks). Current force IP modems need to evolve to meet more stringent functional and performance standards, especially in the areas of TRANSEC, IPv6 compliance, IA design, DIACAP certification, and MILSATCOM certification. The JIPM V-1 meets all applicable IA requirements, with Authorization to Operate (ATO) expected soon.

Finally, the use of common networks and hardware platforms leads to increased bandwidth efficiency. The Warfighter needs more access to information on the GIG and reliance on transport via SATCOM is increasing. Utilizing an interoperable platform such as JIPM allows commonly requested information and videos to be transmitted once, reducing the need to retransmit based on unique networks. An example of this transition is Global Broadcast System (GBS), which started with its own networks of DVB-S modulators and receive suites, and is evolving to a data service behind the JIPM Network Control Center (NCC) at the Enterprise Gateway. JIPM provides the ability of a V-1 RM user to receive information on two DVB-S2 based networks simultaneously, enhancing their ability to request and obtain mission critical information in addition to commonly requested data.

IV. NSA-APPROVED TRANSEC

The JIPM Standard fully defines the TRANSEC-covered DVB-S2 and DVB-RCS waveforms, as well as all related over-the-air messaging implemented in the JIPM V-1. The intent of the JIPM Standard is to provide all information needed by an industry partner to develop an interoperable TRANSEC capability, certified to NIST Federal Information Processing Standard (FIPS) 140-2 Level 2 requirements. The JIPM standard incorporates IA design requirements recommended by the National Security Agency (NSA) to increase the security robustness of JIPM implementations and waveform. These requirements enhance and support DIACAP certification providing a TRANSEC implementation designed to industry best standards and rigorously evaluated prior to receiving ATO. Final interoperability testing could be conducted against an existing implementation at a Government lab or other facility with a JIPM NCC and Remote Modem (RM) setup. This approach formalizes previous success with the DoD's standard Frequency Division Multiple Access (FDMA)/ SCPC modem, the MD-1366 Enhanced Bandwidth Efficient Modem (EBEM) (evolution of MIL-STD-188-165A expressed in Standardization Agreement (STANAG) 4486 edition 3). As in the EBEM Standard, the JIPM Standard's definition of TRANSEC stipulates the integration of existing algorithms and standards to meet the modem's functional requirements. Recent testing between an MD-1366 EBEM and another supplier's airborne variant demonstrated successful TRANSEC interoperability with minimal support from ViaSat, the developer of the MD-1366 EBEM.

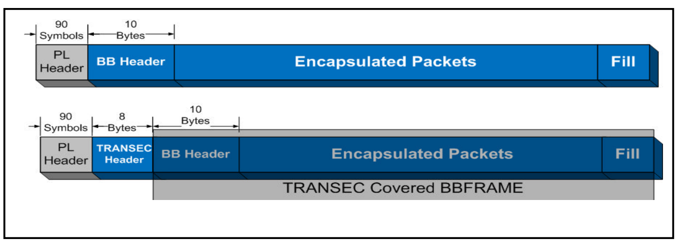

Figure 2. DVB-S2 Forward Links: TRANSEC Bypassed and Covered

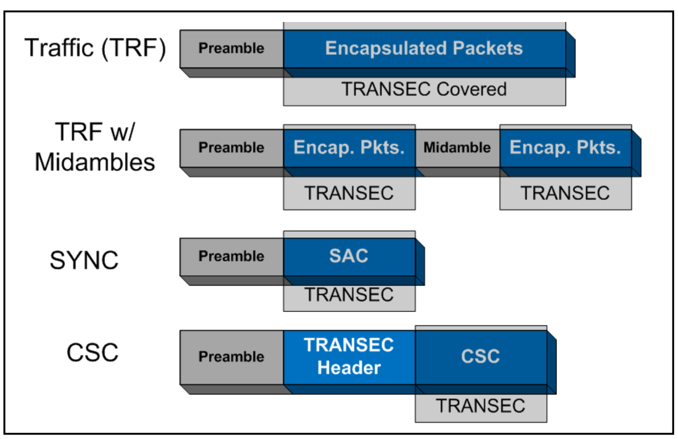

Figure 3. TRANSEC-Covered DVB-RCS Bursts

The JIPM Standard details additions to the DVB-S2 standard waveform for TRANSEC: a small TRANSEC header is added to the start of each baseband frame, as shown in Figure 2. This header provides timing information referenced to a secure time server at the JIPM NCC, with the result that the JIPM supports a mix of two-way and receive-only RMs, entering and leaving the network on an ad-hoc basis, while allowing RMs entering the network to quickly and reliably synchronize their TRANSEC decryptors. The JIPM Standard fully specifies the method used to encrypt bursts on the DVB-RCS return links. The basic approach, illustrated in Figure 3, requires no changes to DVB-RCS synchronization (SYNC) or user traffic (TRF) burst formats, adding only a small TRANSEC header to the slotted aloha login (CSC) bursts. The JIPM Standard approach provides TRANSEC cover for all DVB-S2 baseband frame and all DVB-RCS burst payload information, leaving only the physical layer header and preambles / midambles uncovered to aid demodulation.The JIPM Standard defines how user-entered TRANSEC Seed Keys (TSKs) and passphrases are used to form Traffic Encryption Keys (TEKs), the order and cryptoperiod for each key, and the method used to provide automatic, seamless rollover of TEKs and TSKs/ passphrases. The JIPM Standard leaves user interaction for TRANSEC management (e.g. how / where passphrases are entered) to be defined by lower level product requirements, since they do not impact interoperability. The JIPM Standard allows for a number of near-term usability enhancements suitable for JIPM V-1 by software upgrade or for future variants built by other vendors, such as:

- Utilization of a FIPS-mandated user login/password that would retrieve previously stored passphrases to simplify operations.
- If passphrases were non-volatile, it would be useful to allow the operator of a nomadic RM to pre-load TSKs and passphrases for several JIPM networks prior to insertion in an operational zone. The operator could then select one of these preset keys as part of modem configuration, similar to selecting the symbol rate. This enhancement would provide mission flexibility without needing access to a key loading device.

These and other TRANSEC enhancements must still meet FIPS 140-2 Level 2 compliance to be considered a JIPM and should be coordinated through the JIPM PMO.

The JIPM Standard also defines a notional method to enhance the JIPM V-1's TRANSEC-covered extension of the DVB-RCS waveform. To simplify global operation of the JIPM, the enhancement would provide cryptographic separation between networks operating with the same TSK and passphrase for the DVB-RCS return links. A similar feature was developed, tested, and verified for the JIPM V-1: DVB-S2 forward links belonging to different networks may securely use the same seed key and passphrase because the Counter Value of the Advanced Encryption Standard (AES) 256-bit cryptographic engine includes NCC-operator entered information about the particular JIPM network being encrypted.

The JIPM Standard provides a complete description of the JIPM's TRANSEC waveform, and the waveform is designed for minimal extensions to the current DVB-S2 and DVB-RCS standards. Whenever possible, the goal has been to leverage existing capabilities of DVB-RCS. As an example of this, the JIPM Standard mandates use of the DVB-RCS Free Capacity Assignment (FCA) capability to ensure that return link carriers and timeslots are maximally filled, in order to prevent traffic analysis based on network activity. Use of FCA ensures that RMs will have access to all network capacity at all times to send any available traffic. In contrast, the approach in DVB-RCS2's A-155 bluebook is to create a new "dummy" return link burst, where the contents must be filled with spoofing data and discarded upon receipt. The method in the JIPM Standard is simpler, requires no changes to DVB-RCS, and provides all available capacity to network users.

V. CHANGES TO DVB-S2 v1.1.1 STANDARD

The JIPM V-1 and the JIPM Standard were developed based on DVB-RCS (ETSI EN 302 307 v1.1.1), as augmented to meet the needs of the Warfighter. Some of the key enhancements include:

- The system architecture was simplified, deleting support for multiple input streams, 32 APSK, merger/ slicer function, etc. These DVB-S2 features are not required to meet the JIPM's mission requirements.
- A modified baseband frame (BBFRAME) format is defined for TRANSEC operation. User packet fragmentation across BBFRAMEs is recommended, as well as a concept called MODCOD promotion.
- The use of DVB-S2 Dummy PLFRAMES is deprecated, with preference given to a similar concept: Dummy BBFRAMEs. The difference is that Dummy BBFRAMEs are covered by TRANSEC, offering greater network security.
- DVB-S2 waveform performance requirements are fully specified in the JIPM Standard to ensure interoperability.

VI. CHANGES TO DVB-RCS V1.4.1 STANDARD

The JIPM V-1 and the JIPM Standard were developed based on DVB-RCS (ETSI EN 301 790 v1.4.1), as augmented to meet the needs of the Warfighter. Some of the key enhancements include:

- Support for 8PSK traffic bursts on the return channels.
- Full definition of the control and network provisioning messages sent from the JIPM V-1 NCC to RMs used for centralized network management of IP address, routes, software download, key distribution, remote disable and zeroize, etc.
- Support for Dynamic Link Adaptation (DLA), a powerful closed-loop technique for rain fade mitigation, combining automatic power control, Adaptive Coding and Modulation (ACM), and symbol rate adaptation.
- Support for network-wide Quality of Service on the DVB-S2-based forward link and DVB-RCS-based return links.
- Support for IPv6 in accordance with the DoD IPv6 Standard Profiles for IPv6 Capable Products, as verified by conformance testing defined by the DoD IPv6 Generic Test Plan.
- DVB-RCS waveform performance requirements are fully specified in the JIPM Standard to ensure interoperability.

The JIPM Standard extends DVB-RCS to fully define support for 8PSK return link traffic bursts including the constellation, bit mapping, code rates, burst sizes, and preamble/midamble sequences. Adding support for 8PSK was easily done by extending the DVB-RCS Timeslot Composition Table (TCT) to define the 8PSK modulation type and 8PSK traffic with multiple Motion Picture Experts Group Two – Transport Stream (MPEG2-TS) packets as a burst type. An NCC could support mixed types of RMs in the same network by sending each population of 8PSK-capable RMs a TCT with both QPSK and 8PSK, and each population of QPSK-only RMs a TCT with only QPSK defined. The TCT's extension to 8PSK is a simple modification of the existing DVB-RCS baseline for current DVB-RCS modem manufacturers.

In a similar manner, the JIPM Standard used a simple extension to DVB-RCS in order to provide support for highly inclined satellites while meeting a Government desire of not requiring the NCC operator to maintain satellite ephemeris information. As also recognized by the DVB-RCS2 A-155 bluebook, the current Correction Message Descriptor (CMD) is unable to support large login burst (CSC) guard times typical of highly inclined satellites without ephemeris being conveyed in the Satellite Position Table (SPT). The JIPM Standard approach creates a modified Correction Message Descriptor by changing the Burst_time_correction field from 8 to 32 bits, and mandates that NCCs send the standard descriptor whenever possible, sending the modified descriptor only when needed to convey a larger guard time. This means that JIPM V-1 NCC can support legacy DVB-RCS modems over Wideband Global SATCOM (WGS) or similar low-inclination satellites.

The JIPM Standard addresses a challenge in current DVB-RCS: where interoperability is limited to basic DVB-RCS functionality because advanced features such as IP addressing and route management are not defined in DVB-RCS, but instead left to each manufacturer to address with proprietary signaling. NCCs from one manufacturer may interoperate with RMs from another manufacturer, but those RMs must be locally programmed to match the NCC's configuration database. As network parameters change (e.g. routes are added), the RMs must be reconfigured to follow the changes. This work is tedious, error-prone and typically limits competition for different brands of remote modems in a DVB-RCS network. In contrast, the JIPM Standard provides a full description of the over-the-air control messages used by the JIPM V-1. The messages are defined as tables sent via DVB-RCS Network Layer Information Descriptor (NLID) as Information Elements (IEs). For example, two-way RMs are provisioned with IP addresses, unicast and multicast routes, IP tunnels, QoS flow profiles, RM configuration information, etc. at the JIPM NCC, and the information needed by the RM is pushed to the RM at login and upon any relevant change. This allows the NCC operator to maintain the network from a central location and eliminates the need for manual reconfiguration of the RMs in a JIPM network.

The JIPM Standard also provides a full description of other monitor and control messages used in the JIPM V-1. One set of messages is used to signal network information to receive-only RMs to which DVB-RCS signaling tables do not apply. Another set of messages is used for TRANSEC Over-The-Air Rekey (OTAR) and Zeroize (OTAZ) functions mandated by the JIPM performance specification. A generic multicast file download protocol is also documented to support reliable software download to two-way or receive-only RMs from different RM manufacturers.

The JIPM Standard extends DVB-RCS support for power corrections to provide full-featured, closed-loop return link DLA. The JIPM Standard adds a new "power available" M_and_C_message type to the DVB-RCS SYNC burst periodically transmitted by each RM. DLA protocols and required actions are fully defined in the JIPM Standard. First, the RM reports its power headroom, relative to a defined baseline power, and this allows the NCC to compute the most time-efficient symbol rate and MODCOD that the RM can currently support. Next, the NCC computes link margin for each RM based on burst Es/No measurements, and signals power corrections using DVB-RCS Correction Message Table (CMT). Finally, the NCC signals the code rate and signal rate adaption portion of DLA using DVB-RCS Terminal Burst Time Plan (TBTP) tables. It is anticipated that current DVB-RCS modems can be easily enhanced to support DLA because the SYNC signaling change is modest and the required behavior of the RM is fully specified.

The JIPM Standard enhances DVB-RCS to provide a method for return link QoS, supporting up to five traffic classes. As defined in the Standard, an IP flow is defined based on IP addresses, ports, protocols, DiffServ Code Point (DSCP), etc. and is assigned to one of several traffic classes. There can be many flows assigned to a particular traffic class, and in the JIPM V-1, flows are configured at the NCC and pushed to the RM via NLID IE messages described above. The JIPM Standard fully defines a SYNC burst format that allows each RM to request bandwidth for each traffic class. The Standard also defines how the DVB-RCS Logon Initialize Descriptor's Return_VCI and Return_TRF_PID are used to signal the traffic class of each capacity allocation. The RM then sends return link data segments identified by VCI/PID, providing return link QoS with excellent latency and jitter performance, in accordance with performance requirements defined in the Standard for each component (NCC and RM) and each traffic class.

The JIPM Standard defines the minimum list of IP RFCs (Request For Comments) needed for compliance to the DoD standard profile. Additionally, IPv4 and IPv6 functional and performance requirements are fully defined, along with near-term potential future enhancements. It is anticipated that all JIPM variants will undergo IPv6 conformance testing. Thus, the JIPM Standard provides a clear and consistent roadmap for IP support in the JIPM, reducing interoperability risks for inter-networking of NCCs and RMs from multiple vendors.

VII. SPECIFIED PERFORMANCE REQUIREMENTS

The JIPM V-1 has been designed and tested to performance requirements defined in the JIPM Standard. All requirements in the JIPM Standard are mandatory for interoperability compliance. It is anticipated that the Government will establish a conformance test plan, similar to IPv6 conformance, to provide guidance to Industry in their efforts to build interoperable modems conforming to the JIPM Standard. At the same time, performance requirements in the JIPM Standard are minimum requirements and manufacturers may provide enhanced performance in order to differentiate their products in the marketplace, to provide unique capabilities, etc. For example, the Type 0 RM defined in the JIPM Standard must support DVB-S2 symbol rates of 1-23 Msym/s but particular brands of Type 0 RMs may be designed to support 1-30 Msym/s, in order to better serve the needs of the Warfighter.

In recognition of the challenges of interoperability testing, the following examples are intended to illustrate the importance of conforming to the requirements in the JIPM Standard.

First, the JIPM Standard mandates that a remote modem must be capable of forwarding at least 95% of all IP traffic received over DVB-S2, at a 1300 byte packet size, to a maximum of 300 Mbps. The RM V-1, for example, has demonstrated the ability to forward > 99% capacity up to 330 Mbps. The JIPM V-1 NCC is similarly designed and tested to forward maximum rates to one RM (unicast / multicast) or to a set of RMs (multicast), up to 165 Mbps per network. In contrast, several of the current force modems are processor-limited to a maximum of 50 to 70 Mbps. If interoperable modems are not upgraded to support data egress rates up to its waveform capability (symbol rate and MODCOD), in accordance with the JIPM Standard, then network operators will have to manually work around limitations of these modems in a mixed capability network. Meeting the JIPM Standard's requirements is relatively simple given the current state of the art.

Second, the system must work in challenging network scenarios, such as two-way terminals in high latitudes, on inclined satellites, with commercial Block Upconverters (BUCs) and Low Noise Block Downconverters (LNBs), over Government satellites. As an example, MILSATCOM requirements are for the RM to maintain a 1E-7 frequency accuracy for terminals at any latitude for a 7° inclined satellite, and also to login within 90 seconds at any time of day. While the DVB-S2 and DVB-RCS standards impose modest requirements on frequency accuracy, the JIPM Standard mandates the DVB-S2 symbol timing accuracy and stability to be 1E-7 and 1E-8, respectively. These requirements, which are relatively easy to meet in the DVB-S2 modulator (the JIPM V-1 is better than 1E-9), allows lower cost RM designs to be considered. For example, the JIPM V-1 RM auto-calibrates its internal oscillator used to generate carrier frequency and symbol timing by measuring the DVB-S2 symbol timing error over 24 hours to average out the effects of satellite motion. If the NCC accuracy requirement were not met, RMs would need periodic operator calibration to meet their MILSATCOM-based 1E-7 frequency accuracy requirements. Failure to maintain sufficient accuracy can impair the performance of the

NCC's DVB-RCS demodulator, making it difficult at a system level to ensure that RMs login within the specified time limit.

Within the DoD vision of NCC and RM from different manufacturers, conformance to the requirements in the JIPM Standard reduces the probability and severity of issues that would impact system performance. Non-conformance would create issues where the system operators observe degraded system performance but would have difficulty determining which vendor should take corrective action. This scenario would cause delay in correcting the reduced system performance, and negatively impact the Warfighter.

VIII. Specified Functional Requirements

The JIPM Standard also mandates functional behavior where necessary, while allowing manufacturers latitude (where possible) to provide unique solutions to the market.

For example, the JIPM Standard mandates how RMs fill the M_and_C_message field in the return link SYNC bursts, as this is necessary to ensure performance of the DLA feature. The JIPM Standard defines how RMs should set the transmit power of each return link burst based on MODCOD, burst type, and symbol rate, also to ensure DLA performance. Similarly, the JIPM Standard mandates that compliant receive-only RMs stop forwarding data from their forward link receivers to their data LAN ports unless the RM sees its ID on a "white list" periodically sent by the NCC. This approach is necessary to prevent unauthorized receive-only RMs from eavesdropping on networks, even if they possess the correct TRANSEC keys.

On the other hand, while all of the over-the-air configuration messages for IP addresses, routes, tunnels, etc. are defined in the JIPM Standard, the functional behavior of the RM upon message receipt is not specified. It is evident from context what the RM could do with the messages (e.g. install an IP address, install a route, etc.) but the behavior is not mandatory. Since DVB-RCS did not define these messages at all, the JIPM Standard allows leeway in recognition that current manufacturers have existing solutions, such as local configuration via Simple Network Management Protocol (SNMP). Early interoperable RMs may ignore the messages, may use them to validate local configuration, or may use them to configure the RM. The long term intention is that RMs use the messages to configure themselves, but the JIPM Standard allows for evolution in this regard.

As a practical example of the efficacy of this approach, in a joint laboratory test, the JIPM V-1 NCC is interoperable with the STM Group's SatLink 2000 RCST (RM) when TRANSEC is bypassed. The SatLink 2000 was developed prior to publication of the JIPM Standard, and therefore could not be expected to implement configuration messages first published in the JIPM Standard. The SatLink 2000 is interoperable with a JIPM V-1 NCC in a two-way mode with local configuration, while a JIPM V-1 RM interoperates with the JIPM V-1 NCC using the over-the-air configuration messages defined in the JIPM Standard. Both modems may operate in the same JIPM V-1 network.

IX. Conclusion

The JIPM is the DoD Standard IP Modem providing baseline capabilities for secure IP transmission over DoD-owned or leased satellites. The JIPM Standard described in this paper provides a full and complete description of the extensions needed to the DVB-S2 and DVB-RCS standards to ensure interoperability and system performance for a family of IP Modems.

Based on open standards, JIPM leveraged the high level of investment made by Industry while providing additional capabilities needed by today's Warfighter. The JIPM Standard and the JIPM V-1 provide a baseline capability with excellent performance, while allowing for future evolution to meet emerging and future requirements. As the JIPM V-1 is deployed and Industry responds with interoperable modems, the Warfighter will benefit from increased security, functionality and performance, while also benefiting from reduced logistics, support, and training costs.

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