



# Department of Defense INSTRUCTION

NUMBER 4630.09  
November 3, 2008

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ASD(NII)/DoD CIO

SUBJECT: Wireless Communications Waveform Development and Management

References: See Enclosure 1

1. PURPOSE. This Instruction establishes policy, assigns responsibilities, and provides procedures for the development and/or modification of wireless communications waveforms to improve network interoperability in accordance with the guidance in DoD Instruction 5025.01 (Reference (a)) and the authority in DoD Directives 5144.1 and 4630.05 (References (b) and (c)).
  
2. APPLICABILITY. This Instruction:
  - a. Applies to OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as the "DoD Components").
  
  - b. Applies to all Acquisition Category I-IV programs as well as procurements that use wireless communications waveforms.
  
  - c. Does not apply to programs and procurements that use any other wireless waveforms whose primary function is to support highly specialized missions, such as Defense Intelligence and Counterintelligence, aircraft and weapons system integration, air traffic control, and collision and avoidance control. Such waveforms include but are not limited to:
    - (1) Flight control links, weapons control links, maintenance and/or logistics links, training data links, test and evaluation telemetry and data links, identification friend or foe, safety of flight, sensors, optical, or acoustic.
  
    - (2) Science and technology (S&T) efforts for research purposes and pre-system acquisition phase only.

(3) Standards-based commercial-off-the-shelf (COTS) waveforms, unless a standards-based COTS waveform is being modified for use in the Department of Defense.

3. DEFINITIONS. See Glossary.

4. POLICY. It is DoD policy that:

a. The number of communications waveforms and modifications to existing waveforms will be reduced in order to decrease the complexity of the wireless integrated network. This will be accomplished without imposing undue burden on the acquisition system or hindering technology advancement.

b. Communications waveform development or modification, and the associated network, will implement Internet Protocol (IP) capability to the extent possible to enable net-centric interoperability.

c. Communications waveform development or modification shall be subject to review and assessment by the Assistant Secretary of Defense for Networks and Information Integration/DoD Chief Information Officer (ASD(NII)/DoD CIO) in accordance with the procedures specified in this Instruction.

d. A DoD waveform portal will be established to facilitate the application and evaluation process, provide a current DoD Communications Waveforms list, a database of DoD communications waveforms parameters, evaluation criteria, and a list of waveform standards and/or technical documentation.

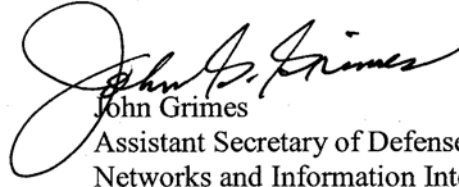
5. RESPONSIBILITIES. See Enclosure 2.

6. PROCEDURES. See Enclosure 3.

7. INFORMATION REQUIREMENTS. The information requirements in this Instruction are exempt from licensing in accordance with paragraphs C4.4.2. and C4.4.4. of DoD 8910.1-M (Reference (b)).

8. RELEASABILITY. UNLIMITED. This Instruction is approved for public release. Copies may be obtained through the Internet from the DoD Issuances Web Site at <http://www.dtic.mil/whs/directives>.

9. EFFECTIVE DATE. This Instruction is effective immediately.



John Grimes  
Assistant Secretary of Defense for  
Networks and Information Integration /  
DoD Chief Information Officer

Enclosures

1. References
  2. Responsibilities
  3. Procedures
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ENCLOSURE 1

REFERENCES

- (a) DoD Instruction 5025.01, "DoD Directives Program," October 28, 2007
- (b) DoD Directive 5144.1, "Assistant Secretary of Defense for Networks and Information Integration/DoD Chief Information Officer (ASD(NII)/DOD CIO)," May 2, 2005
- (c) DoD Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," May 5, 2004
- (d) DoD 8910.1-M, "Department of Defense Procedures for Management of Information Requirements," June 30, 1998
- (e) Chairman of the Joint Chiefs of Staff Instruction 3170.01F, "Joint Capabilities Integration and Development System," May 1, 2007
- (f) DoD Instruction 4630.8, "Procedures for Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," June 30, 2004
- (g) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003
- (h) DoD Directive 4650.1, "Policy for Management and Use of the Electromagnetic Spectrum," June 8, 2004

ENCLOSURE 2

RESPONSIBILITIES

1. ASD(NII)/DoD CIO. The ASD(NII)/DoD CIO shall:
  - a. Provide oversight for implementation of this Instruction.
  - b. Establish and provide oversight for the DoD communications waveform portal established by this Instruction.
  - c. Establish and maintain a current list of DoD Communications Waveforms at the communications waveform portal. The initial lists are provided at Enclosure 5.
  - d. Establish and maintain a current DoD communications waveform parameters database and the list of waveform standards and/or technical documentation at the portal site.
  - e. In coordination with the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)), review and update procedures for evaluating the communications waveform applications as required.
  
2. DIRECTOR, DEFENSE INFORMATION SYSTEMS AGENCY (DISA). The Director, DISA, under the authority, direction, and control of the ASD(NII)/DoD CIO, shall provide subject matter expert support to the evaluation process of individual communications waveform applications.
  
3. USD(AT&L). The USD(AT&L) shall:
  - a. As the Defense Acquisition Executive, ensure the policies outlined in section 4 of the front matter of this Instruction are adhered to and addressed during systems acquisitions, as appropriate.
  - b. Provide subject matter expert support to the evaluation process of individual communications waveform applications.
  
4. HEADS OF THE DoD COMPONENTS. The Heads of the DoD Components shall:
  - a. Ensure the requirements of this Instruction are implemented during the systems acquisition process or for communications waveform modifications as appropriate.
  - b. Provide subject matter expert support to the evaluation process of individual communications waveform applications.

c. Ensure new waveforms meet requirements specified in a validated capabilities document(s) in accordance with Chairman of the Joint Chiefs of Staff Instruction 3170.01F (Reference (e)).

5. CHAIRMAN OF THE JOINT CHIEFS OF STAFF. The Chairman of the Joint Chiefs of Staff shall provide subject matter expert support to the evaluation process of individual communications waveform applications.

ENCLOSURE 3

PROCEDURES

1. WAVEFORM REVIEW. The waveform sponsor shall determine whether a review or an update is required for a new waveform or waveform modification. The initial DoD communications waveform list is provided at Enclosure 5. The list will be updated as required and posted at the initial DoD waveform portal at: <http://www.us.army.mil> (keyword search: DoD CIO Waveform). The DoD waveform review process is outlined in paragraphs 1.a. through 1.c. of this enclosure.

a. Waveform sponsors will submit applications for review and assessment by the ASD(NII)/DoD CIO prior to:

(1) The inclusion of any new or modified communications waveform in a program of record as part of that program's Milestone B approval process.

(2) The incorporation of changes proposed to any new or modified waveform in a program of record since that program's Milestone B approval, as part of that program's Milestone C approval process.

(3) The modification of a communications waveform into an existing, post Milestone C (Sustainment) program of record through technology improvement or addition of new functionality.

(4) A procurement that utilizes non-standards-based waveforms.

(5) The incorporation of existing non IP-capable waveforms, as listed in Table 4 of Enclosure 5, into a new acquisition program.

b. No review is required to incorporate existing net-centric, IP-capable waveforms, as listed in Table 3 of Enclosure 5, into a new or existing acquisition program.

c. An update of the current waveform data posted in the DoD waveform portal repository is required for modification of a waveform that does not affect all modes of interoperability but does change parameters listed in the waveform application.

2. WAVEFORM APPLICATION

a. Waveform sponsors shall submit the application using the format provided in Enclosure 4. The application can be downloaded from the DoD waveform portal. Sponsors will electronically submit new and modification applications in pdf format, with electronic signature, to the ASD(NII)/DoD CIO point of contact (POC).



b. Waveform sponsors shall provide the current version of the following program acquisition-related documents to ASD(NII)/DoD CIO, along with the waveform application. These additional documents provide a comprehensive understanding of the waveform and minimize burden to the sponsor.

(1) Information support plan (ISP) with information exchange requirements (IERs), in accordance with DoD Instruction 4630.8 (Reference (f));

(2) Analysis of alternatives (AoA), in accordance with DoD Instruction 5000.2 (Reference (g));

(3) Application for DD Form 1494, "Application for Equipment Frequency Allocation," in accordance with Reference (h);

(4) Capabilities document for the new waveform validated in accordance with Reference (e).

c. Applications should be prepared in accordance with governing classified document directives and submitted via appropriate methods. The ASD(NII)/DoD CIO POC is to be notified in advance of applications or updates in order to make the appropriate preparations.

### 3. WAVEFORM EVALUATION

a. ASD(NII)/DoD CIO will conduct an initial review of the waveform application for completeness and clarity within 10 working days. An application lacking the appropriate information will be returned to the waveform sponsor for additional information or clarification as appropriate.

b. Upon completion of the initial review, ASD(NII)/DoD CIO will forward the waveform application for technical review, assessment, and coordination to the Director for Command, Control, Communications and Computers (C4) Systems Directorate (J-6), Joint Staff; USD(AT&L); Joint Program Executive Officer (JPEO) Joint Tactical Radio System (JTRS); Military Satellite Communications (MILSATCOM) Systems Wing (MCSW); Net-Centric Capability Portfolio Management; Common Data Link (CDL) Executive Agent; and others as appropriate. The application technical review, assessment, and coordination will be completed within 30 working days.

c. ASD(NII)/DoD CIO will conduct a final review and assessment with the waveform sponsor and other appropriate stakeholders and recommend a disposition to the appropriate DoD Components within 10 working days.

d. The detailed waveform evaluation criteria are provided at Table 2 of Enclosure 4.

4. DISPOSITION. Based on the results of the waveform review and assessment, the ASD(NII)/DoD CIO will provide the recommendation to the appropriate Milestone Decision Authority or the acquisition authority during sustainment. For ACATs below I/IA, the recommendation will be provided through the DoD Component waveform sponsor. The recommendation will be attached, in memorandum form, as an appendix to the initial ISP or as an appendix to ISP updates, as appropriate.

ENCLOSURE 4WAVEFORM APPLICATION AND EVALUATION CRITERIA

1. WAVEFORM APPLICATION. Waveform applications must be completed using the format defined in Table 1 which is also available on the DoD Waveform Portal, located at <http://www.us.army.mil> (keyword search: DoD CIO Waveform). Waveform sponsors shall address all waveform parameters in a narrative format, as illustrated in Table 1. Depending on the acquisition stage of the waveform, some parameters may be target values, theoretical interim values obtained from design models, and/or empirical data collected from fielded waveforms. These values must be updated as the waveform progresses through the acquisition phases to fielding.

Table 1. List of Parameters

<b>General Information</b>	
<b>Parameter</b>	<b>Description</b>
Sponsor Information	Identify waveform sponsor and provide contact information.
Program Management Office (PMO)	Identify the PMO and other Service and/or Agency PMO support for the waveform development and hosting into a radio and/or host system.
Waveform Identification	Identify the name or proposed name of the waveform and the standard or draft standard that applies to the waveform.
Operating Network	Identify the network in which it will operate.
Purpose	Identify the activity requiring the new or modified waveform.
Existing Approved Waveforms Inadequate	Substantiate the need for new or modified waveforms by describing operational scenarios in which the existing DoD-approved waveforms are deemed technologically inadequate or obsolete.
<b>Operating Environment</b>	
<b>Parameter</b>	<b>Description</b>
Joint Mission(s) Supported	Identify joint mission thread(s) that the waveform will support (e.g., close air support, combat search and rescue, suppression of enemy air defenses, time-sensitive targeting/time-critical targeting (TST/TCT)).
Threat Addressed	Identify threats mitigated with the proposed waveform design (e.g., as stated in the System Threat Assessment Report).
Domain	Identify the operational domains in which the waveform shall be deployed (air, ground, maritime (surface or sub-surface), space), (fixed, mobile (land or surface, sub-sonic, supersonic, hypersonic)).

Table 1. List of Parameters (continued)

Architecture Hierarchy	Describe the operational architecture of the systems that will employ the waveform (e.g., peer-to-peer, client-server, backbone node, node-to-node, access, node-to-peer).
Network Size (Units)	Describe the number of nodes envisioned for the network domain in which the waveform will operate (e.g., 800 nodes point-to-point mode; 16 nodes local/80 nodes extended; 25 multifunction advanced data link (MADL) nodes per network; classified).
<b>Operating Requirements</b>	
<b>Parameter</b>	<b>Description</b>
Mode of Operation	Identify all waveform operating modes (e.g., gateway, asymmetric, receive-only, low probability of interception (LPI)/ low probability of detection (LPD), low latency, point-to-point).
Information Rates	Provide the waveform data transmission rate capabilities for each operating mode (kilobit per second (Kbps), megabit per second (Mbps), gigabit per second (Gbps)).
Network Throughput	Provide the total network data transmission capacity (Kbps, Mbps, Gbps).
Operating Range	Describe the radio frequency (RF) operating range of the waveform for each operational application with and without relays as appropriate (e.g., 200 nautical mile (nm) air to air; 200 nm air to ground; 5 nm ship to ship; 200 nm anti-jam (AJ); 25 nm LPI/LPD).
Reliability	Provide reliability metrics that the waveform will support (e.g., packet error rate <1%; message delivery probability 99.9-95% depending on message category).
Anti Jamming Characteristics	Describe the waveform AJ characteristics, if any (e.g., direct sequence spread spectrum, time frequency filtering).
Low Observable (LO) Features (LPI/LPD/ Low Probability of Exploitation (LPE))	Describe waveform LO features, if any (e.g. signal masking; ability to avoid detection by radiometric 2 <sup>nd</sup> and 4 <sup>th</sup> order cyclostationary detectors within 1 kilometer (km); reduced emission capability).
Latency	Identify the latency requirements that the waveform can support (e.g., 10-100 millisecond (ms); <5ms; 250+ ms; line-of-sight (LOS) 100 nm, 20 ms).
RF Noise Environment	Provide specific details on capability to operate in tactical RF propagation noise environments (e.g., radio interference, RF noise suppression, antenna sharing, jamming, fading parameters).
Commercial Interoperability (as Applicable)	List any capabilities to interface with external networks running commercial IP (e.g., Institute of Electrical and Electronics Engineers (IEEE) 802.3 Open Shortest Path First(OSPF); Border Gateway Protocol version 4 (BGPv4); Internet group management protocol (IGMP)).
<b>Networking Requirements for Waveform Supported Network</b>	

Table 1. List of Parameters (continued)

<b>Parameter</b>	<b>Description</b>
Timing and Synchronization	Describe the network timing requirements (e.g., global positioning system (GPS), but capable of operating if GPS timing is not available).
Formation	Describe the formation characteristics of scalable networks that the waveform supports (e.g., initialize 150 nodes < 15 minutes (min); add 1 node < 1 min; add 8 nodes < 2 min; network entry time < 5 seconds (sec)).
Topology	Provide the configuration characteristics of waveform connections between network nodes (e.g., mesh, star, fully-connected, bus) and capability to support ad hoc changes to the network topology (e.g., add/delete 4 nodes in < 4 sec; 5 - 20 nodes < 300 sec).
Mobility	Describe waveform capability to support connectivity to and between air, ground, or surface mobile platforms moving at speeds relative to other platforms while maintaining network connectivity and traffic transmission integrity (e.g., maximum relative velocity between nodes = 400 knots; maximum relative velocity = 217 kilometers per hour (UAVs)).
QoS	Describe the mechanisms used to support differential handling of traffic classes and priorities, including probability of a packet success in passing between two points in the network within its desired latency period (e.g., differentiated services, IP precedence, best effort). Identify the maximum number of hops the waveform is capable of achieving before packet loss becomes unmanageable.
Data Precedence	List all data precedence level capabilities that support preferential treatment of user traffic (e.g., Flash, Flash Override, Immediate, Priority, Routine).
Multimedia	List the information content formats and information processing capabilities that are supported (e.g., voice, video, text, graphics, animation, interactivity).
Multimedia Performance	List multimedia performance specification values that the waveform will support for each priority level, message type, or message category (e.g., Priority 1 Tactical Voice - 75ms maximum delay, 0.5% packet loss; Flash Data Message - < 2 sec minimum delay, 95% reliability; Tactical Imagery/Video/ Voice/Maps - single hop latency 75-100 ms, 95% delivery probability).
<b>Link Layer Performance</b>	
<b>Parameter</b>	<b>Description</b>
Message Support	Identify the information (e.g., packets, datagrams, messages) delivery methods that the waveform is capable of supporting (broadcast, multicast, unicast).
Channel Access	Describe the methodology or protocols employed to manage access to the physical layer (e.g., asynchronous transfer mode (ATM), fiber

Table 1. List of Parameters (continued)

	distributed data interface (FDDI), Ethernet, Recommended Standard-232 (RS-232), Electronic Industries Alliance-530 (EIA-530), high speed serial interface (HSSI), token ring).
Link Layer Addressing	Describe how physical addressing (media access control (MAC) addressing) is accomplished for network devices within LOS with respect to one another (e.g., fixed; logical, configurable by user, dynamic spectrum access protocol (DSAP), simple spectrum access protocol (SSAP)).
Packet Delivery	Describe the packet delivery techniques that support assured and best effort message delivery (e.g., error notification alerts, flow control).
<b>Network Layer Performance</b>	
<b>Parameter</b>	<b>Description</b>
Information Flow	Describe Internetworking capabilities and how packets are routed between end systems (e.g., supports exchange of IP packets between like Soldier Radio Waveform (SRW) networks, external IP-capable networks, and other SRW network domains).
Addressing	Describe the IP addressing formats that the waveform can support (e.g., IP subnet addressing, unique host addressing, group multicast addressing) and specifically its ability to support IP version6 IPv6 addressing and tunneling through IP version 4 (IPv4) networks.
Routing	Identify the capabilities of the routing protocols supported (e.g., ad hoc network topology changes, ad hoc changes to network parameters, local and transit traffic).
Fragmentation	Describe capability to prevent fragmentation of the network due to distance or terrain, and/or measures to recover from network fragmentation events (e.g., hierarchical, multi-tier network formation algorithms).
Link Management	Provide expected network topology adjustment rates for varying connectivity due to network node mobility (e.g., network change due to add/delete 1-4 nodes $\leq$ 30 sec; 5-20 nodes $\leq$ 300 sec).
<b>Network Management Requirements</b>	
<b>Parameter</b>	<b>Description</b>
Planning	Describe the network capability to generate configuration files; disseminate planning information to associated network management sites; import text and graphics files to produce network plans and configuration files; and capability for on-line, real-time chat capability to support fault isolation. Discuss the network management bandwidth requirement.
Configuration	Describe the network capability to dynamically manage itself, permitting nodes to join and leave the network without manual intervention; autonomously execute network security features; permit a network manager to plan, monitor, and manage the network or to

Table 1. List of Parameters (continued)

	manually intervene for disaster recovery; and exercise operational control for over-the-air rekey (OTAR) of crypto keys.
Fault Monitoring	Address the fault management capability at the network manager's terminal, including capability to store fault history and corrective action inputs.
<b>Information Assurance (IA)</b>	
<b>Parameter</b>	<b>Description</b>
Confidentiality	Describe the National Security Agency (NSA) cryptographic product or algorithm the system will use to protect classified and sensitive information transmitted over the wireless networks (e.g., NSA Type 1, National Institute of Standards and Technology (NIST) Type III) as well as the mode of algorithm (e.g., Cypher Text Auto Key (CTAK), long cycle, counter, message indicator).
Availability	Provide details on system capability to recover from loss of cryptographic synchronization (communications security (COMSEC), transmission security (TRANSEC)), denial of service, jamming, interference, unauthorized use, and spoofing.
Integrity	Describe the electronic counter-countermeasures (ECCM) capabilities, if any, used for initiating and validating the wireless link (e.g., anti-spoofing protocols). Identify data error detection and correction protocols to the description.
Identification and Authentication	Describe the methods to limit device use of specific users. Identify protocols used to convey the sender's identification and authentication to the receiver. Address the planned security policy for accessing the NSA cryptographic module (e.g., password, biometric data), and the strength of the authentication mechanism.
Transmission Security (TRANSEC)	Discuss TRANSEC design features with respect to: throughput requirements, LPI/LPD levels, AJ capability, frequency band(s) of operation, synchronization requirements and adaptability to accommodate environmental degradation. Identify the specific algorithm used for the TRANSEC design.
Key Management	Describe the methods by which the system can be rekeyed (e.g., over-the-air, local fill).
Algorithm Management	Address how users of crypto algorithms employed in the system will be tracked so that in the event an algorithm is replaced under a mandatory modification, the modification can reach all users.
Cryptography	Describe the new or modified waveform's compliance and/or compatibility with High Assurance Internet Protocol Interoperability Specification (HAIPIS) and/or High Assurance Internet Protocol Encryptor (HAIPE). Identify the crypto throughput requirements for the waveform.
Specifics of IA Accreditation Plan	Provide the waveform IA status.

Table 1. List of Parameters (continued)

<b>Proposed Waveform Host</b>	
<b>Parameter</b>	<b>Description</b>
Existing Software Radio - Rationale, Integration Approach, and Impact to Joint Capabilities	Identify any new Software Defined Radio (SDR), wireless communications equipment, and/or system planned for development in which the waveform is to be ported.
New Software Radio - Rationale, Integration Approach, and Impact to Joint Capabilities	Identify any new SDR or Software Communications Architecture (SCA) radio, wireless communications equipment, and/or system planned for development in which the waveform is to be instantiated. Also, address the counter-electromagnetic pulse (EMP) properties or envisioned properties of the host.
<b>Compliance with National, DoD, and Service Spectrum Policy</b>	
<b>Parameter</b>	<b>Description</b>
Compliance with DoD and Joint Staff Spectrum Policy	Comply with DoD Directive 4650.1 (Reference (h)). Provide the status of the system or network RF spectrum allocation (e.g. spectrum supportability, DD Form 1494, and host-nation coordination) with respect to satisfying the technical, operational, and regulatory requirements for worldwide operation.
Emission Bandwidth	Identify the RF spectrum over which the waveform will operate, including identification of waveform features that may be adjusted to provide a variable bandwidth (e.g., data rate, coding rate, direct sequence spread spectrum, ultra-wideband (UWB), transmit duty cycle for burst waveforms, and selectable hop sets for frequency hopping waveforms).
Spectrum Access	Discuss the waveforms ability to accommodate flexible and dynamic spectrum access situations that often may involve the use of frequency bands not normally available to military equipment (e.g., operations in locally unused civilian bands; at isolated military test ranges; in overseas areas that have different frequency bands allocations).
Spectrum Reuse	Describe any design features that facilitate a high rate of reuse, such that unique subnets can occupy the same frequency channels without large geographic separation (e.g., time division multiple access TDMA, code division multiple access (CDMA), adaptive power management, smart antenna technology,).
<b>Design Parameters</b>	
<b>Parameter</b>	<b>Description</b>
Processing Requirements	Describe the new or modified waveform's processing requirements (e.g., throughput, memory).
Software Lines of Code (SLOC)	Describe the estimated or actual SLOC and explain SLOC terminology.
Description of Internal and External	State GPS requirements and explain timing and synchronization requirement if GPS is denied.



Table 1. List of Parameters (continued)

Timing and Synchronization	
Spectrum Sharing	List the waveform design adaptive features that enhance the potential for spectrum sharing (e.g., orthogonal frequency division multiplexing (OFDM), frequency division multiplexing (FDM), TDMA, dynamic spectrum access techniques).
Vocoder Algorithm	Describe the new/modified waveform's vocoder algorithm (e.g., mixed-excitation linear predictive (MELP), continuously variable slope delta (CVSD)).
Modulation	Describe the modulation techniques used in generation of the signal (e.g., differential quadrature phase shift keying (DQPSK), m-ary cyclic correlation shift keying (MCCSK), 8-ary, 2 Raised-Cosine Continuous Phase Modulation (8-ary 2RC CPM)).
Coding	Identify waveform coding techniques employed (e.g., pulse code modulation (PCM), non-return to zero (NRZ), conditioned diphas interface (CDI)).
Information Rate	Provide the user throughput rate, excluding protocol and network overhead for each operating mode (e.g., Adaptable, 2-5 Mbps; combat communications mode - 2Mbps, Electronic Warfare (EW) mode - 200Kbps; LPI/LPD - 100Kbps).
Frequency Tuning Range	Provide all of the radio frequency operating ranges of the waveform (e.g., 225-400 mega hertz (MHz), 1350-1390 MHz, 1755-1850 MHz) in accordance with Reference (h).
Allocated Signal Bandwidth	Provide each of the bandwidth requirements for each type of RF signal (e.g., wideband 150 KHz - 2 GHz; LPI 10 - 30 MHz; AJ 600 KHz - 30 MHz) and the necessary bandwidths and type of data that can be carried on the signal (emission designator) where applicable in accordance with Reference (f).
Signal Description	Identify all emission designators for each type of RF signal the waveform will operate on (e.g., wideband 150KG1D, 300KG1D, 600KG1D, 1M20G1D).
Doppler Limitations	Identify the maximum Doppler effect that the waveform supports (e.g., 900-knot airborne platform; 600-ms closing speeds for non line-of-sight launch system (NLOS-LS); ground unit velocities for dismounted soldier (DS)).
Line of Sight Operating Range	Provide the range of operation between nodes within line of sight of each other (e.g., Command & Control < 1000 nm; Situational Awareness < ~1000 nm; air-to-air <200 nm; air-to-ground <200 nm; ground-to-ground <5.4 nm; Low Latency -LOS <300 nm).
Media Access and Controls	Identify the data link layer channel access control mechanisms that manage access to the physical medium (e.g., orthogonal domain multiple access (ODMA), carrier sense multiple access (CSMA), FDMA, TDMA).
Channel Coding	Identify the channel coding used (e.g., Reed Solomon, Convolution,

Table 1. List of Parameters (continued)

	Turbo, cyclic redundancy check (CRC)).
Waveform Spectral Efficiency	Provide the achieved spectral efficiency of the link in which the waveform is used (e.g., bit/s/Hz) in accordance with Reference (f).
Error Rates Expected Under Normal and Threat Conditions	Provide the expected reliability of the waveform (e.g., <0.1% packet error rate with packet sizes 64, 576, and 1500 bytes; delivery probability 99.9%).
SWAP	Identify all relevant size, weight, and power limitations for the systems that will employ the waveform to include operational battery life objective for battery powered real time systems.
Roadmap to Joint Interoperability with Other Waveforms	Describe how the waveform will integrate in the electromagnetic environment and how the waveform will be integrated with the existing mission waveforms to increase joint effectiveness. Broadband Satellite Communications (SATCOM) (i.e., Transformational SATCOM Extended Data Rate (TSAT XDR+)); narrowband SATCOM the Mobile User Objective System (MUOS); ground terrestrial backbone with the Wideband Networking Waveform (WNW); the Air Tier with the Joint Airborne Networking –Tactical Edge (JAN-TE); the small footprint (weight, volume, and power) and DS applications with SRW; the Joint Intelligence, Surveillance and Reconnaissance (ISR) Common Data Link (CDL); and the waveforms supporting the Joint Family of Message Standards.
GIG Interface and Interoperability	Describe the waveform capability to support IP (e.g., inherently IPv6; supports IP routing).

2. WAVEFORM EVALUATION CRITERIA. A waveform will be evaluated against the criteria listed in Table 2.

Table 2. Evaluation Criteria

<b>Element</b>	<b>Criteria</b>
Baseline Comparison	<ul style="list-style-type: none"> <li>• Degree of duplicity of any baseline waveform for user intended application.</li> <li>• Reference to DoD Baseline Waveforms that were considered for use.</li> <li>• Specific general and technical parameters from Table 1 of the baseline waveform that cannot be met (operating environment, operating requirements, networking requirements, link and network layer performance requirements, etc.).</li> </ul>
Interoperability	<ul style="list-style-type: none"> <li>• Degree of Joint Service interoperability with mission waveforms on the baseline list at both networking and information layers to include IPv6 protocol, GIG interface, and coalition.</li> <li>• Degree of interoperability to future DoD net-centric capability.</li> </ul>
Open Architecture Compliance	<ul style="list-style-type: none"> <li>• Compliance with the SCA for SDRs under the JTRS policy.</li> <li>• Compliance with commercial, international, and military standards.</li> </ul>
Total Life-Cycle Cost	<ul style="list-style-type: none"> <li>• Estimation of total life-cycle development and support costs:</li> <li>• Research and Development, acquisition, standardization (including configuration management), integration (porting, testing, and certification) and operation and support costs.</li> <li>• Standardization costs.</li> </ul>
Operational Value (Value added to existing waveform baseline)	<ul style="list-style-type: none"> <li>• New or increased threat mitigation capability,</li> <li>• Significant improvements to baseline waveform capabilities for LPD, LPI, LPE, AJ, spectrum efficiency, spectrum access flexibility, spectrum sharing, or throughput.</li> <li>• Retirement of baseline or existing waveforms.</li> <li>• Architecture and scalability for networking waveforms.</li> <li>• Hardware and software technology infusion within life cycle without disruption of interoperability.</li> </ul>
Security	<ul style="list-style-type: none"> <li>• Initial accreditation.</li> <li>• Sustainment over life cycle.</li> <li>• Conformance with the NSA Cryptographic Modernization Program Initiatives.</li> <li>• Conformance with NSA Requirements for the Development of Information Assurance Products.</li> </ul>

ENCLOSURE 5COMMUNICATIONS WAVEFORMS

1. DoD COMMUNICATIONS WAVEFORMS. Tables 3 and 4 will be updated semi-annually by ASD(NII)/DoD CIO, and maintained in a database located at the DoD Waveform Portal.

Table 3. Net-Centric, IP-Capable Waveforms

<b>Waveform</b>	<b>Waveform</b>
Advanced Common Data Link (A-CDL)	Mobile User Objective System Common Air Interface (MUOS CAI)
Bandwidth Efficient Common Data Link (BE-CDL)	Network Centric Waveform (NCW)
Discovery Common Data Link	Network Common Data Link (N-CDL)
Highband Networking Waveform (HNW)	Soldier Radio Waveform (SRW)
Military Standard (MIL-STD) 188/165B (MD-1366)	Standard Common Data Link (STD-CDL)
Digital Video Broadcasting - Second Generation / Return Channel via Satellite (DVB-S2/RCS) (Joint IP Modem (JIPM))	Transformational SATCOM Ka Waveform (TSAT Ka)
Wideband Networking Waveform (WNW)	Transformational SATCOM Extended Data Rate (TSAT XDR+)
	MIL-STD 188-110A/B (High Frequency (HF) Modem)

Table 4. Non IP-Capable and Non-DoD Waveforms

<b>Non IP-Capable Waveforms</b>	
<b>Waveform</b>	<b>Waveform</b>
Advanced EHF Extended Data Rate (AEHF XDR)	Link 11
Cooperative Engagement Capability (CEC)	Link 11B <sup>1</sup>
EHF Low Data Rate (EHF LDR)	Link 16 <sup>1</sup>
EHF Medium Data Rate (EHF MDR)	Link 22 <sup>1</sup>
Enhanced Position Location Reporting System (EPLRS)	Multifunction Advanced Data Link (MADL)
HAVEQUICK I/II (HQ I/II)	SATCOM/Integrated Waveform (IW)
HAVEQUICK IIA/Second-generation AJ Tactical Ultra High Frequency (UHF) Radio for NATO (SATURN)	SHF SATCOM
High Frequency (HF)	Single Channel Ground and Airborne Radio System (SINCGARS)
Integrated Broadcast Service Common Interactive Broadcast (IBS CIB)	UHF Demand Assigned Multiple Access (DAMA) SATCOM
Internet Controller (INC)	UHF LOS
Intraflight Data Link (IFDL)	UHF SATCOM
Link 4A <sup>1</sup>	Very High Frequency (VHF) LOS
Collection of Broadcasts From Remote Assets (COBRA)	Guard Monitor 243.0Mhz
<b>Non-DoD Waveforms</b>	
<b>Waveform</b>	<b>Waveform</b>
Association of Public Safety Communications Officials Project 25 VHF and UHF FM Public Service Subscriber Waveform (APCO P25)	Space System for the Search of Vessels in Distress - Search and Rescue Satellite Aided Tracking (COSPAS-SARSAT)
BOWMAN VHF Waveform	VHF AM Air Traffic Control (ATC)
Commercial SATCOM IP MODEM	VHF AM Voice
HF ATC Data Link	VHF ATC Data Link Mode 2
IEEE 802 Waveforms	VHF ATC Data Link Mode 3
INMARSAT	Digital Video Broadcast –Satellite (DVB-S) (GBS Block II)
Standardization Agreement (STANAG) 5066 (HF Modem)	
Note 1: The listed name is synonymous with the formal waveform title (e.g., Link 16 – Joint Tactical Information Distribution System (JTIDS)).	

2. DOCUMENTATION. The DoD Waveform Portal will contain a listing of current waveform standards and/or technical documentation. For proprietary documentation, the portal will also provide either a direct hyperlink or instructions to users as to the location of the waveform parameters and the commercial, international, or military standard(s) or waveform technical documentation for that waveform. For classified documentation, the portal will provide instructions to users for obtaining that document. This list will be updated by the DoD CIO as necessary.

GLOSSARY

PART I. ABBREVIATIONS AND ACRONYMS

8-ary 2RC CPM	8-ary, 2 Raised-Cosine Continuous Phase Modulation
A-CDL	advanced common data link
AEHF XDR	Advanced EHF Extended Data Rate
AJ	anti-jam
AoA	analysis of alternatives
APCO P25	Association of Public Safety Communications Officials Project 25 VHF and UHF FM Public Service Subscriber Waveform
ASD(NII)/DoD CIO	Assistant Secretary of Defense for Networks and Information Integration/DoD Chief Information Officer
ATC	air traffic control
ATM	asynchronous transfer mode
BE-CDL	Bandwidth Efficient Common Data Link
BGPv4	Border Gateway Protocol version 4
C4	command, control, communications, and computers
CAI	Common Air Interface
CDI	conditioned diphas interface
CDL	Common Data Link
CDMA	code division multiple access
CEC	cooperative engagement capability
CJCSI	Chairman of the Joint Chiefs of Staff Instruction
COBRA	Collection of Broadcasts From Remote Assets
COMSEC	communications security
COSPAS-SARSAT	Space System for the Search of Vessels in Distress – Search and Rescue Satellite Aided Tracking
COTS	commercial-off-the-shelf
CRC	cyclic redundancy check
CSMA	carrier sense multiple access
CTAK	Cipher Text Auto Key
CVSD	continuously variable slope delta
DAMA	demand assigned multiple access
DISA	Defense Information Systems Agency
DoD CIO	Department of Defense, Chief information Officer
DQPSK	differential quadrature phase shift keying
DSAP	dynamic spectrum access protocol
DS	dismounted soldier
DVB	Digital Video Broadcast
DVB-S	Digital Video Broadcast – Satellite

DVB-S2 / RCS	Digital Video Broadcasting - Second Generation/Return Channel via Satellite
ECCM	electronic counter-countermeasures
EHF LDR	EHF Low Data Rate
EHF MDR	EHF Medium Data Rate
EIA-530	Electronic Industries Alliance-530
EMP	electromagnetic pulse
EPLRS	Enhanced Position Location Reporting System
EW	Electronic Warfare
FDDI	fiber distributed data interface
FDM	frequency division multiplexing
FDMA	frequency division multiple access
GBS	Global Broadcast Service
GIG	Global Information Grid
Gbps	gigabit per second
GPS	global positioning system
HAIPE	High Assurance Internet Protocol Encryptor
HAIPIS	High Assurance Internet Protocol Interoperability Specification
HF	High Frequency
HNW	Highband Networking Waveform
HQ	HAVEQUICK
HQ I/II	HAVEQUICK I/II
HSSI	high speed serial interface
IA	information assurance
IBS CIB	Integrated Broadcast Service Common Interactive Broadcast
IEEE	Institute of Electrical and Electronics Engineers
IER	information exchange requirement
IGMP	Internet group management protocol
IFDL	Intraflight Data Link
INC	internet controller
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISP	information support plan
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
IW	integrated waveform
J-6	Communications system directorate of a joint staff command, control, communications, and computer systems staff section
JAN-TE	Joint Airborne Networking-Tactical Edge



JIPM	Joint IP Modem
JTIDS	Joint Tactical Information Distribution System
JTRS	Joint Tactical Radio System
JPEO	Joint Program Executive Office
Kbps	kilobit per second
km	kilometer
LO	Low observable
LOS	line-of-sight
LPD	low probability of detection
LPE	low probability of exploitation
LPI	low probability of interception
MAC	media access control
MADL	multifunction advanced data link
Mbps	megabit per second
MCCSK	m-ary cyclic correlation shift keying
MCSW	Military Satellite Communications Systems Wing
MELP	mixed-excitation linear predictive
MHz	mega hertz
MILSATCOM	military satellite communications
ms	millisecond
MIL-STD	Military Standard
MUOS	Mobile User Objective System
N-CDL	Network Common Data Link
NCW	Network Centric Waveform
NIST	National Institute of Standards and Technology
NLOS-LS	non line-of-sight launch system
nm	nautical mile
NRZ	non-return to zero
NSA	National Security Agency
NSS	National Security Systems
ODMA	orthogonal domain multiple access
OFDM	orthogonal frequency division multiplexing
OSI	open systems interconnection
OSPF	Open Shortest Path First
OTAR	over-the-air re-key
PCM	pulse code modulation
PMO	Program Management Office
POC	point of contact
QOS	Quality of Service

RF	Radio Frequency
RS-232	Recommended Standard-232 (Serial interface)
S&T	Science and Technology
SATCOM	Satellite Communications
SATURN	Second-generation AJ Tactical UHF Radio for NATO
SCA	Software Communications Architecture
SDR	Software Defined Radio
SINGARS	Single Channel Ground and Airborne Radio System
SLOC	software lines of code
SRW	Soldier Radio Waveform
SSAP	simple spectrum access protocol
STANAG	Standardization Agreement
STD-CDL	Standard Common Data Link
SWAP	Size, Weight, and Power
TDMA	time division multiple access
TRANSEC	transmission security
TSAT Ka	Transformation SATCOM Ka Waveform
TSAT XDR+	Transformation SATCOM Extended Data Rate
TST/TCT	time-sensitive targeting/time-critical targeting
UAV	unmanned aerial vehicle
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
UHF	Ultra High Frequency
UWB	ultra-wideband
VHF	Very High Frequency
WNW	Wideband Networking Waveform

## PART II. DEFINITIONS

These terms and their definitions are for the purposes of this Instruction.

IP-Capable. The ability of a system or product to receive, process, and forward IP packets and/or interface with other systems so that IP packets flow across networks and the GIG.

Net-Centric Waveform. A waveform that enables the seamless transmission of information in an end-to-end communication system within the GIG.

Open Systems Interconnection (OSI) Layer 1 (physical layer). Defines all the electrical and physical specifications for devices. In particular, it defines the relationship between a device and a physical medium.

OSI Layer 2 (data link layer). Provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors that may occur in the physical layer.

OSI Layer 3 (network layer). Provides the functional and procedural means of transferring variable length data sequences from a source to a destination via one or more networks, while maintaining the quality of service requested by the transport layer. The network layer performs network routing functions, and might also perform fragmentation and reassembly, and report delivery errors.

OSI Layer 4 (transport layer). Provides transparent transfer of data between end users, providing reliable data transfer services to the upper layers.

OSI Layer 5 (session layer). Controls the dialogues and connections (sessions) between computers. It establishes, manages, and terminates the connections between the local and remote application.

OSI Layer 6 (presentation layer). Establishes a context between application layer entities, in which the higher-layer entities can use different syntax and semantics.

OSI Layer 7 (application layer). Interface directly performs application services for the application processes.

signal-in-space. The propagation of electromagnetic energy carrying information (e.g., voice, video, data) over the air.

waveform. A representation of signal-in-space, typically defined by OSI Layers 1 through 3 along with the controls and processes for a desired function or application, but does not include the message content or format.

waveform modification. Any change made to an existing (in use) waveform that affects its interoperability with the existing waveform either forward or backward.

waveform sponsor. The DoD Component responsible for all program documentation, periodic reporting, and funding actions required to support the capabilities development and acquisition process for a specific capability proposal.