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JAUS Transport Considerations

RATIONALE

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1. SCOPE

This SAE Aerospace Information Report (AIR) discusses characteristics of data communications for the Joint Architecture for Unmanned Systems (JAUS). This document provides guidance on the aspects of transport media, unmanned systems and the characteristics of JAUS itself that are relevant to the definition of a JAUS transport specification.

1.1 Purpose

The purpose of this document is to facilitate interoperation of unmanned vehicle systems, subsystems, and payloads by indicating relevant characteristics of transport media, unmanned systems and of JAUS itself, so that new transport standards may conform to expected performance.

1.2 JAUS Document Organization

The Joint Architecture for Unmanned Systems (JAUS) defines a suite of standards for use in the research, development, design, acquisition and deployment of Unmanned Systems. The JAUS Standards are divided into four essential scopes: the Domain Model, the Reference Architecture, the Transport Specification, and the Compliance Specification. Each scope is individually documented.

1.2.1 Domain Model

The Domain Model [JAUS-DM] is an abstract model of operational requirements that must be supported by a given unmanned system. This model is a tool to be used by a developer of an unmanned system to better understand the requirements of the acquirer of that unmanned system. The Domain Model is written in language understandable by both the developer and the acquirer. This line of documents is also known as the Architecture Framework for Unmanned Systems, or AFUS.

1.2.2 Reference Architecture

The Reference Architecture [JAUS-RA] is the technical specification used to implement unmanned systems in compliance with the JAUS standards and to assess technical compliance with the Standard. The most recent version of the Reference Architecture [JAUS-RA] is itself divided into three major sections: the Architecture Framework, the Message Definition, and the Message Set.

1.2.2.1 Architecture Framework

The Architecture Framework volume of the Reference Architecture provides a description of the structure of systems based on the Reference Architecture. This document serves as the primary mapping of Domain Model requirements to the JAUS message set.

1.2.2.2 Message Definition

The Message Definition volume of the Reference Architecture specifies the current JAUS message header and the types of messages employed. This document focuses on the rules of messaging as opposed to the domain-specific semantics contained in the message set.

The JAUS message header defined by this document is an application-layer header, and is specified without reference to any particular transport medium. JAUS Transport Standards note how implementations may make use of certain fields within this header to provide more efficient communications. However, transport implementations are not required to do so in order to maintain correctness or interoperability.

1.2.2.3 Message Set

The Message Set volume of the Reference Architecture specifies the domain-specific messages and their exact content.

1.2.3 Transport

JAUS Transport defines communication services for JAUS messages. These services are the means by which messages are conveyed from one JAUS entity to another.

There are currently two documents relevant to the discussion of JAUS message transport: the JAUS Transport Considerations Report (this document) and the JAUS Transport Specification [JAUS-TS].

1.2.3.1 JAUS Transport Considerations Report

The JAUS Transport Considerations report (this document) discusses aspects of transport media, unmanned systems and widely used transport protocols, as well as characteristics of JAUS itself. This document then identifies characteristics of concern in the implementation of a compliant and efficient JAUS Transport standard. In this respect, this document serves as a meta-specification – in effect specifying the standards for a JAUS Transport standard.

This document may also be viewed as a summary of “lessons learned” by individuals involved in communications in unmanned systems. As the use of unmanned systems increases, this report will be updated and revised, as the experience of deploying more numerous, more autonomous unmanned systems increases.

1.2.3.2 JAUS Transport Specification

The JAUS Transport Specification [JAUS-TS] defines a family of transports for conveying JAUS messages between different JAUS entities via different link-layer implementation technologies. These transports are designed to incorporate the concerns outlined in the JAUS Transport Considerations Report.

1.2.4 Compliance Specification

The Compliance Specification [JAUS-CMP] defines compliance with JAUS. Since JAUS is a message-based architecture, compliance with JAUS is assessed by verifying that the message traffic between JAUS entities satisfies the definitions and requirements of the JAUS standards.

1.3 Field of Application

The Field of Application for the Transport Considerations report is data communications between nodes on a computer network.

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2.3 Acronyms

ACK	Acknowledgment (positive) Generally, a byte or message sent to acknowledge successful receipt of a packet or message. Specifically, the ASCII control character octet of value 0x06.
ADCCP	Advanced Data Communication Control Procedures ADCCP is an ANSI standard derived from IBM's SDLC (Synchronous Data Link Control). As such, ADCCP is a bit-oriented synchronous data-link layer protocol, and is very similar to the ISO HDLC (High-level data link control) standard, which also derives from SDLC.
ANSI	American National Standards Institute ANSI is a non-governmental, non-profit standards organization, overseeing the development and administration of technical standards in the United States. ANSI is the official U.S. representative to the ISO.
ARQ	Automatic Repeat reQuest A transport protocol is said to be an ARQ protocol if it uses positive and negative acknowledgements and sender timeouts, and further employs packet replacement on request to overcome packet loss or corruption over noisy or unreliable channels.
ASCII	American Standard Code for Information Interchange ASCII is a character encoding for digital representation of the English alphabet, for representation of text in computers and digital communications.
CRC	Cyclic Redundancy Check An error check algorithm based on polynomial division over a binary field.
CRC-CCITT	A specific CRC, defined by its polynomial, initial conditions for accumulation, and terminal conditions, as defined by ITU Recommendation X.25 (which was once CCITT recommendation X.25).
CPPP	Compressed Point-to-Point Protocol A variant of PPP (point-to-point protocol) incorporating a form of TCP header compression (Van Jacobsen header compression).
CSLIP	Compressed Serial Line Internet Protocol A variant of SLIP (serial line internet protocol) incorporating a form of TCP header compression (Van Jacobsen header compression).
DHCP	Dynamic Host Configuration Protocol DHCP is a protocol (set of rules) used by network clients to obtain an IP address and other networking parameters (such as the subnet mask and the IP addresses of DNS servers and default gateway) from a server providing network management services.
DLE	Data Link Escape An ASCII control character, an octet of value 0x10, this character is used in the implementation of data transparent protocols such as those consistent with [X3.28].
DNS	Domain Name System A fundamental element of internet infrastructure, the Domain Name System translates human-readable hostnames to IP addresses.
EMI	Electromagnetic Interference Interference by electromagnetic signals that can cause reduced data integrity and increased error rates on communication channels.

FIFO	First-In, First-Out This term describes a simple queuing technique in which requests, data, or processes are handled in order of arrival; the term also is used as a noun, describing an instance or implementation of a queuing mechanism with that handling behavior.
HMI	Human-Machine Interface See “OCU – Operator Control Unit”
IANA	Internet Assigned Numbers Authority The IANA is responsible for assignment of IP addresses, top level domains and Internet protocol code point allocations (such as port assignments). The IANA assignment data is maintained on the IANA website, http://www.iana.org.
IETF	Internet Engineering Task Force The engineering body responsible for technical specifications, definitions and direction for the continued development of internet technologies.
IP	Internet Protocol The internet layer of the TCP/IP protocol suite stack defining the packet format for message packets to be sent across an internet, and the protocol for delivering those packets to their intended destination. The protocol is Internet Protocol (IP); the packet defined is the IP datagram. See [RFC791].
IPS	Internet Protocol Suite The protocol suite defines network communications using the TCP/IP family of protocols.
ISO	International Organization for Standardization A non-governmental organization that leverages the activities of the national standards organizations of 146 countries, ISO is the largest developer of technical standards in the world.
JAUS	Joint Architecture for Unmanned Systems A suite of standards used in the research, development, design, acquisition and deployment of Unmanned Systems.
JPEG	Joint Photographic Experts Group This committee created a standard of the same name, defining means of encoding and compressing image data into a stream of bytes, and of decompressing that stream into an image; both lossy and lossless compression techniques are defined. The standard also defines the file formats for storing the stream of bytes.
MSN	Message Sequence Number A unique identifying “serial number” assigned to packets as transmitted; the MSN is typically used in the detection of missed messages, in providing assurance of correct sequence of delivery, and in the requesting of retries when multiple outstanding messages are supported.
MTU	Maximum Transfer Unit The Maximum Transfer Unit (MTU) is a term for the size of the largest datagram that can be passed by a layer of a communications protocol.
NAK	Acknowledgement (negative) Generally, a byte or message sent to indicate unsuccessful receipt or non-receipt of a packet or message. Specifically, the ASCII control character octet of value 0x15.
OCU	Operator Control Unit A device by means of which a human operator may control an Unmanned System.

OSI	Open Systems Interconnect A data communications model developed by ISO to assure communications interoperability across disparate systems.
PDU	Protocol Data Unit An application message (for the purposes of this specification, this will be assumed to be a JAUS message) being propagated down the protocol stack on the sender side, or up the protocol stack on the receiver side.
PPP	Point-to-Point Protocol An encapsulation protocol for sending IP datagrams across serial communications links, PPP also incorporates strong blockchecks, control protocols and a high degree of configurability. [RFC1661]
RF	Radio Frequency Electromagnetic energy or signaling based thereon whose frequency is normally associated with radio wave propagation.
SLIP	Serial Line Internet Protocol An encapsulation protocol for sending IP datagrams across serial communications links. [RFC1055]
TCP	Transmission Control Protocol A reliable, connection-oriented message delivery protocol defined by [RFC793] and related IETF documents.
UAV	An unmanned aerial vehicle; may be teleoperated or autonomous.
UGV	An unmanned ground vehicle; may be teleoperated or autonomous.
USV	An unmanned surface-of-water vehicle; may be teleoperated or autonomous.
UUV	An unmanned undersea vehicle; may be teleoperated or autonomous.
UDP	User Datagram Protocol An unreliable best-effort connectionless message delivery protocol defined by [RFC768] and related IETF documents.
XML	Extensible Markup Language A general purpose markup language providing users the ability to define their own tags. XML is a simplified subset of an earlier markup language, SGML (Standard Generalized Markup Language).