



THE JOINT ARCHITECTURE FOR UNMANNED SYSTEMS

Events and Service Connections

Version 1.9

October 26, 2005

Draft v 1.9

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10-26-05

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Proposal for Events and Service Connections

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1. Introduction

Last year Kathy Wienhold spent a great deal of effort creating a workable solution to Service Connections. This draft builds on that work, expanding it to encompass both service connections and events. To this end, command service connections are history, and service connections (and non-periodic events) are created using a Query message.

First we must look at how information flows in a typical unmanned (or any command and control) system. Setting aside commands and initial handshaking, there are several ways to ask for and receive data.

1. On-demand – I want this information, and I want it right now. This is handled in JAUS by a Query/Report message pair. The entity that needs the data sends a Query to the entity that can provide it, who then responds with the corresponding Report message. This document does not cover on-demand Q/R messages, as they are already handled and extensively used.
2. On change – I only want to know when something happens. This is what most people would define a JAUS event to be. The entity that needs the data sends an event setup Query to the entity providing the service, who in turn responds with a Report message when the trigger conditions are met.
3. Periodic – I want this information on a regular basis. JAUS currently defines this type of data flow to be Service Connections. The entity that needs the data sends a service connection Query to the entity providing the service, along with a requested rate. The provider then sends the data at a set rate (not necessarily the requested rate) in a non-queuing manner.

This message set combines “On Change” and “Periodic” exchanges into the general category of Events. This allows any query/report pair to be used for events. It also requires that any new events be structured as query/report pairs. This message set goes through normal communication channels for Event Management. The subsequent generation of events should follow established protocol – Periodic Events have a fundamental set of rules that must still be followed (see Reference Architecture Volume II, Part 2, Version 3.2 section 3.6 for these rules). Note that ACK/NAK should be permitted for Event Management messages.

Code F0A1h: Create Event

This message is used to set up an event. Required fields are 1, 2, 3, and 12¹. Field 1

¹This ordering breaks previously established rule that all required fields be first (RA section 3.7.6); if memory serves, this rule was deemed unnecessary and slated for removal during the August 2004 JAUS working group meeting in Pittsburgh.

provides a mapping of which optional fields are included. Field 2 contains the JAUS Command Code of the included Query message, so the recipient knows how to interpret the message. Field 3 is the Event Type, which allows the requester to specify the type of event – Periodic specifies that the event is a service connection request and should not be queued, in which case field 11 (Requested periodic rate) must be included. Event type of Every Change specifies that the corresponding Report message should be sent every time the data associated with that message changes, subject to the optional boundary conditions. Event type of First Change specifies that the Report message should be sent only the first time the data associated with that message changes, subject to the optional boundary conditions. Event type of First Change In and Out of Boundary specifies that the Report message should be sent the first time the data associated with that messages changes, subject to the boundary conditions, and again when the boundary conditions are no longer satisfied (as an exit report). Event type of Periodic without Replacement specifies that the report should be generated at the given periodic rate, but should be treated as a regular message and not subject to existing service connection replacement rules.

Fields 4 through 9 are semantically linked. If none of these fields are specified and the Event Type is Every Change, then any and all changes to that message should trigger the event. If Field 4 is included, Fields 5 and 6, as well as either Field 7 and/or Field 8, or Field 9 should also be included.

Field 4 allows the requester to specify triggering conditions for events. An event could be triggered when a condition is:

- Exactly met, most likely used for discrete fields, such as Status or waypoint number;

 - value = trigger condition

- Not met, often used for discrete fields like Status

 - value != trigger condition

- Between two values (such as a payload arm position)

 - trigger low <= value <= trigger high

 - trigger low < value < trigger high

- Outside of two values (such as a temperature reading being too high or too low),

 - value <= trigger low OR value >= trigger high

 - value < trigger low OR value > trigger high

- Above a given value (a temperature is too high, speed is too fast, notification when a robot has come up to speed)

 - value > trigger condition

 - value >= trigger condition

- Below a given value (low fuel or battery).

 - value < trigger condition

 - value <= trigger condition

Used in conjunction with “Periodic” event type, a service connection is activated when the trigger condition is met and suspended when it is not met. Used in conjunction with the event type “Every Change” an event will be triggered when that triggering condition is met, and every value that meets that triggering criteria should cause an event

notification to occur. Used with “First Change” event type, an event would be triggered once per trigger event – that is, if the watched value crosses the trigger boundary, it triggers an event, then does not trigger another event until the value goes back outside the triggering boundary and back in.²

Field 6 specifies the field number of the field in the report message that corresponds to the boundary condition and Field 5 specifies its data type. It should be included if and only if a boundary condition is specified (field 4). Field 7 should be used to specify the lower boundary value for Inside, Outside, and Low Boundary Types. Field 8 should be used to specify the upper boundary value for Inside, Outside, and High Boundary Types. Field 9 should be used if and only if the Event Boundary type is Equal.

Field 10 is used for throttling updates in periodic messages. If a Service Connection is created for position, and the vehicle is sitting still, it allows the requester to tell the provider to throttle-back the flow during that time. If the Requested Update Rate (field 11) is 5 and the Requested Minimum Update Rate (field 10) is 1, the events will be generated at a rate of 5 HZ if it is changing, but only 1 HZ when the content of the message (i.e., position) is not changing. Field 11, as specified earlier, is the requested rate for service connections.

Field 12 contains the Query message that is to specify the contents of the Report. **This is intended to be the full Query message, including the JAUS header.**

²This assumes that if the requester wants to know when the trigger condition ceases, a separate “first change” event will be issued with the opposite trigger. Could add a field for exit from trigger condition if the need is there.

Table 1 CreateEvent

Field #	Name	Type	Units	Interpretation
1	Presence Vector	byte	N/A	See mapping table below
2	Message Code	Unsigned short integer	N/A	Message code of the Query message that the receiving component will use to generate a responding Report for this message stream.
3	Event Type	byte	N/A	Type of event, enumeration: 0: Periodic (SC) 1: Every Change 2: First Change 3: First change in and out of boundary 4: Periodic w/o replacement
4	Event Boundary	byte	N/A	Boundary condition on event trigger, enumeration: 0: Equal 1: Not Equal 2: Inside Inclusive 3: Inside Exclusive 4: Outside Inclusive 5: Outside Exclusive 6: Greater than or Equal 7: Strictly Greater than 8: Less than or Equal 9: Strictly Less than
5	Limit Data Field Type	byte	N/A	Enumeration 0: byte 1: Short Integer 2: Integer 3: Long Integer 4: Unsigned Short Integer 5: Unsigned Integer 6: Unsigned Long Integer 7: Float 8: Long Float 9: RGB (3 Bytes) 10 – 255: Reserved
6	Limit Data Field	byte	N/A	Field from Report message to base trigger limit on

Field #	Name	Type	Units	Interpretation
7	Lower Limit	varies (see field 5)	varies	Lower limit for trigger condition, used for Inside, Outside, and Low Event Boundary Types
8	Upper Limit	varies (see field 5)	varies	Upper limit for trigger condition, used for Inside, Outside, and High Event Boundary Types
9	State	varies (see field 5)	varies	Trigger value used for Equal Event Boundary Type. Typically used for discrete-type events.
10	Requested Minimum Periodic Rate	Unsigned short Integer	Hertz	For Periodic events, used to throttle messages if the value is not changing. Desired update rate: Scaled Integer Lower Limit: 0 Upper Limit: 1092
11	Requested Periodic Update Rate	Unsigned Short Integer	Hertz	Desired update rate: Scaled Integer Lower Limit: 0 Upper Limit: 1092
12	Query Message	J AUS Message	N/A	The JAUS Query message to be used by the receiving component to generate the Report message(s).

Vector to Data Field Mapping for Above Command								
Vector Bit	7	6	5	4	3	2	1	0
Data Field	11	10	9	8	7	6	5	4

“R” indicates that the bit is reserved.

Code F009h: Confirm Event

Confirm Service Connection -> Confirm Event. Add 1 byte presence vector for rate since some events will not have rates.

Table 2ConfirmEvent

Field #	Name	Type	Units	Interpretation
1	Presence Vector	byte	N/A	See mapping table below
2	Command Code	unsigned short	N/A	Command code of the message to be sent in this event
3	Event ID	byte	N/A	The specific event
4	Confirmed Periodic Update Rate	unsigned short	Hertz	Scaled Integer: Lower Limit = 0 Upper Limit = 1092
5	Response Code	byte	N/A	Enumeration: 0 = successful 1 = Periodic events not supported 2 = Change-based events not supported 4 = Connection Refused 5 = Invalid event setup 6 = Message not supported

Vector to Data Field Mapping for Above Command								
Vector Bit	7	6	5	4	3	2	1	0
Data Field	R	R	R	R	R	R	R	4

Code F0A2h: Update Event

Update Event – This would allow the requester to request a rate or threshold change. The format would be the same as the Create Event, only with the addition of Event ID (formerly Instance ID) field to specify the given event. To preserve the message format and presence vector, the EventID is proposed to be added at the end of the message.

Field #	Name	Type	Units	Interpretation
1	Presence Vector	byte	N/A	See mapping table below
2	Message Code	Unsigned short integer	N/A	Message code of the Query message that the receiving component will use to generate a responding Report for this message stream.
3	Event Type	byte	N/A	Type of event, enumeration: 0: Periodic (SC) 1: Every Change 2: First Change 3: First change in and out of boundary 4: Periodic w/o replacement
4	Event Boundary	byte	N/A	Boundary condition on event trigger, enumeration: 0: Equal 1: Not Equal 2: Inside Inclusive 3: Inside Exclusive 4: Outside Inclusive 5: Outside Exclusive 6: Greater than or Equal 7: Strictly Greater than 8: Less than or Equal 9: Strictly Less than
5	Limit Data Field Type	byte	N/A	Enumeration 0: byte 1: Short Integer 2: Integer 3: Long Integer 4: Unsigned Short Integer 5: Unsigned Integer 6: Unsigned Long Integer 7: Float 8: Long Float 9: RGB (3 Bytes) 10 – 255: Reserved
6	Limit Data Field	byte	N/A	Field from Report message to base trigger limit on

Field #	Name	Type	Units	Interpretation
7	Lower Limit	varies (see field 5)	varies	Lower limit for trigger condition, used for Inside, Outside, and Low Event Boundary Types
8	Upper Limit	varies (see field 5)	varies	Upper limit for trigger condition, used for Inside, Outside, and High Event Boundary Types
9	State	varies (see field 5)	varies	Trigger value used for Equal Event Boundary Type. Typically used for discrete-type events.
10	Requested Minimum Periodic Rate	Unsigned short Integer	Hertz	For Periodic events, used to throttle messages if the value is not changing. Desired update rate: Scaled Integer Lower Limit: 0 Upper Limit: 1092
11	Requested Periodic Update Rate	Unsigned Short Integer	Hertz	Desired update rate: Scaled Integer Lower Limit: 0 Upper Limit: 1092
12	Event ID	byte	N/A	Unique Identifier to of existing event to update
13	Query Message	J AUS Message (bytes)	N/A	The JAUS Query message to be used by the receiving component to generate the Report message(s).

Vector to Data Field Mapping for Above Command								
Vector Bit	7	6	5	4	3	2	1	0
Data Field	11	10	9	8	7	6	5	4

Code F00Bh: Cancel Event

Cancel Event – This message allows the requester to cancel/request deletion of the specified event.

Table 3 Cancel Event

Field #	Name	Type	Units	Interpretation
1	Command Code	unsigned short	N/A	Command code of the message to be stopped
2	Event ID	byte	N/A	Unique ID of the event to be removed

Code F2A1h: Query Event

Query Events – Used to request detail on all/given events:

Field 2 indicates the message code in question. If left out, all message codes should be returned. Field 3 indicates the event type to report on. If left out, all event types should be considered. Field 4 Indicates a specific event ID. If left out, all event Ids should be considered.

Table 4 Query Event

Field #	Name	Type	Units	Interpretation
1	Presence Vector	byte	N/A	See mapping table below
2	Message Code	Unsigned short integer	N/A	Message code of the Query message that the receiving component is inquiring about
3	Event Type	byte	N/A	Type of event, enumeration: 0: Periodic 1: Every Change 2: First Change
4	Event ID	byte	N/A	Event ID returned by Confirm Event for details on specific event.

Vector to Data Field Mapping for Above Command								
Vector Bit	7	6	5	4	3	2	1	0
Data Field	R	R	R	R	R	4	3	2

“R” indicates that the bit is reserved.

Code F4A1h: Report Event

Report Events

Same format as Update Event, used to reply to Query Events message to give the detail on which events are currently in use by the provider (as defined by the query message).

Other issues

Replace all references to “Service Connections” with “Periodic Events.”

Suspend Event – stop sending but do not remove. Do we want this?

Service Connection infrastructure

SC bit in header -> move to Event Bit, add periodic bit (for OPC, use existing SC bit)

