NMRA Standard	
Layout Command Control™ (LCC) Event Transport	
July 22, 2024	**S-9.7.3.1**

Adopted as a NMRA Standard

The OpenLCB Standard document appended to this cover sheet has been formally adopted as a NMRA Standard by the NMRA Board of Directors on the date shown in the *Adopted* column in the *Version History* table below.

Version History

Date	Adopted	Summary of Changes
Feb 17, 2015		Initial version submitted for public comment
Feb 6, 2016	Feb 20, 2016	Minor grammatical corrections and readability improvements
Apr 25, 2021	**July 2, 2021**	Changed LCC logo to include the ® symbol Changed "Layout Command Control" to have the ™ symbol Added the NMRA Legal Disclaimer fine-print Changed the OpenLCB license to "Creative Commons Attribution-ShareAlike 4.0 International"
July 22, 2024		Add Events with Payload

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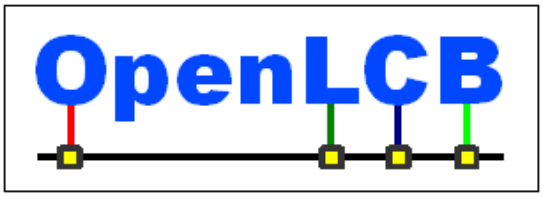

OpenLCB Standard	
Event Transport	
July 22, 2024	Adopted

1 Introduction (Informative)

This OpenLCB Standard defines the protocol for transporting OpenLCB events across the OpenLCB network.

2 Intended Use (Informative)

Transporting events provides general and flexible messaging between nodes, following the principles of the Producer-Consumer model. The information is carried by an Event Identifier (Event ID), a number which in of itself does not have any explicit information. Instead the Event ID is assigned by the user to one specific concept, such as a specific lighting configuration, or a more abstract concept, such as the "start of the day" or "global stop". That concept can then be implemented and shared by cooperative action between nodes that "produce" the event by sending messages, and nodes that "consume" the event by receiving messages and acting upon them. In addition, the Event ID can be accompanied by one or more bytes of payload whose content is defined by other OpenLCB documents. This document defines the interaction between producers and consumers in terms of OpenLCB messages.

This document describes the required message formats for event transport. Section 4 gives an overview of the message types with an abstract numeric description intended as a normative guide to the construction of concrete message types over specific physical transport media. Section 7 describes in concrete detail the implementation of the event transport message formats for the specific physical transport media that have been adopted as normative standards.

3 References and Context (Normative)

This standard is in the context of the following OpenLCB Standards:

- The OpenLCB Message Network Standard, which defines the basic messages and how they interact. Higher-level protocols are based on this message network, but are defined elsewhere. The Message Network Standard defines the Initialized node state which is referenced here.
- The OpenLCB Event Identifiers Standard, which defines the format and content of Event IDs including the class of Well-Known Event IDs and Automatically-Routed Event IDs.
- The OpenLCB CAN Frame Transport Standard, which defines the formats for transporting OpenLCB messages over CAN networks.

4 Message Formats (Normative)

In the following, the “Common MTI” column specifies the MTI value to be used when communicating in OpenLCB common format. The Common MTI is an abstract numeric description intended as a normative guide to the construction of concrete message formats over specific physical transport media.

“Event ID Range” in the Data Content field refers to a range of Event ID values specified through a compare-under-mask operation. The low bit of the field defines the sign of the mask: a '1' least-significant bit indicates the mask is represented by 1-bits, and similarly for a 0 LSB. The mask is made up of the adjacent identical bits: if the lowest bit is a '0', then all low order contiguous '0' bits will form a mask, while if the lowest bit is a '1', then the low order contiguous '1' bits will form the mask. The remaining upper bits determine the range prefix. To determine whether an Event ID “E” lies within the range “R”, compute:

inRange = ((E AND NOT mask) EQUALS (R AND NOT mask))

4.1 Producer/Consumer Event Report (PCER)

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Producer/Consumer Event Report	Y	N	Y	0x05B4	Event ID
Producer/Consumer Event Report With Payload	Y	N	Y	0x0F14	Event ID, followed by 1 to 256 additional payload bytes

The MTIs of 0x0F14, 0x0F15 and 0x0F16 are permanently reserved for the CAN implementation of this protocol and shall not be used in any future version of this or any other OpenLCB Standards for any other purpose.

4.2 Identify Consumer

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Identify Consumer	Y	N	Y	0x08F4	Event ID

4.3 Consumer Identified

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Consumer Identified	N	N	Y	0x04C4 – Valid 0x04C5 – Invalid 0x04C7 – Unknown	Event ID

This message has three sub-forms, which carry the status of the identified consumer. They are, respectively:

- Currently valid – the internal state of the consumer & associated devices is known to be the same as if this was the last event consumed
- Currently invalid – the internal state of the consumer & associated devices is known to not be the same as if this was the last event consumed
- Currently unknown – the consumer cannot determine whether either of the previous conditions is true

4.4 Consumer Range Identified

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Consumer Range Identified	N	N	Y	0x04A4	Event ID Range

Nodes shall not emit Consumer Range Identified messages where more than 50% of the Event IDs included in the range are not consumed by the node, except when specified by another OpenLCB Standard.

4.5 Identify Producer

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Identify Producer	Y	N	Y	0x0914	Event ID

4.6 Producer Identified

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Producer Identified	N	N	Y	0x0544 – Valid 0x0545 – Invalid 0x0547-- Unknown	Event ID

This message has three sub-forms, which carry the status of the identified producer. They are, respectively:

- Currently valid – the internal state of the producer & associated devices is known to be that which would cause them to produce the event
- Currently invalid – the internal state of the producer & associated devices is known to not be the same as that which would cause them to produce the event
- Currently unknown – the producer cannot determine whether either of the previous conditions is true

4.7 Producer Range Identified

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Producer Identified Range	N	N	Y	0x0524	Event ID Range

Nodes shall not emit Producer Range Identified messages where more than 50% of the Event IDs included in the range are not produced by the node, except when specified by another OpenLCB Standard.

4.8 Identify Events

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Identify Events	Y	N	N	0x0970	
	N	Y	N	0x0968	Destination Node ID

4.9 Learn Event

Name	Simple Node	Dest ID	Event ID	Common MTI	Data Content
Learn Event	Y	N	Y	0x0594	Event ID

5 States (Normative)

Each consumer and producer of each event has two possible states: "Unadvertised" and "Advertised".

When the node hosting the producer or consumer is not in Initialized state, the consumer or producer shall be in and remain in Unadvertised state.

A producer or consumer of a specific event moves to Advertised state when any of the following happens:

- The producer or consumer sends a Producer Identified or Consumer Identified, respectively, message containing the Event ID.
- The producer or consumer sends a Producer Range Identified or Consumer Range Identified, respectively, message where the indicated range contains the Event ID.
- Producers and consumers of Event IDs in the Automatically-Routed range are in the Advertised state once the node is in the Initialized state.

The messages defined by this Standard shall only be sent when the sending node is in Initialized state.

Producer/Consumer Event Report messages may only be sent when the associated producer is in the Advertised state. OpenLCB equipment may, but is not required to, omit forwarding PCER messages to a consumer of a particular Event ID when that consumer is in Unadvertised state.

Consumers and Producers may, but are not required to, have additional state associated with the use of the Learn Event message.

6 Interactions (Normative)

After each transition to Initialized State and before sending a Producer/Consumer Event Report (PCER) message producing a specific Event ID outside the automatically-routed Event ID range, a node shall transition to Advertised state for that Event ID by emitting a Producer Identified or Producer Range Identified message identifying that Event ID.

To ensure receipt of PCER messages, a node consuming a specific Event ID outside the automatically-routed Event ID shall transition to Advertised state for that Event ID by emitting a Consumer Identified or Consumer Range Identified message identifying that Event ID.

6.1 Event Transfer

To produce an event, the node containing the producer shall emit a PCER message containing the specific Event ID with or without additional payload. The OpenLCB message network shall transport that message to all attached nodes, except as described in the next paragraph. Nodes containing consumers shall check for a match between the message Event ID and their consumers. If a match is found, the consumer shall perform any local operations configured into it. If a match is not found, the consumer shall not perform any local operations.

Equipment that transports PCER messages shall transport them to all connected nodes from which the equipment has received a Consumer Identified or Consumer Range Identified for the reported Event ID. Equipment that transports PCER messages shall transport all PCER messages containing Event IDs

in the automatically-routed range to all connected nodes. Equipment that transports PCER messages may, but is not required to, omit transporting PCER messages with Event ID outside the automatically-routed range to nodes from which the equipment has not received a Consumer Identified or Consumer Range Identified for the reported Event ID.

6.2 Event Inquiry

Upon receipt of either an unaddressed (global) Identify Events message or an addressed Identify Events message addressed to the node, that node shall reply with Producer Identified and/or Producer Range Identified messages covering all non-automatically-routed Event IDs produced by the node, and Consumer Identified and/or Consumer Range Identified messages covering all non-automatically-routed Event IDs consumed by the node.

In response to an unaddressed (global) Identify Events message or an addressed Identify Events message address to the node, that node may but is not required to include Producer Identified and/or Producer Range Identified messages covering automatically-routed Event IDs produced by the node, and Consumer Identified and/or Consumer Range Identified messages covering automatically-routed Event IDs consumed by the node.

6.3 Producer Inquiry

Any node receiving an Identify Producer message that includes a non-automatically-routed Event ID produced by the node shall reply with one or more Producer Identified messages containing that Event ID.

Any node receiving an Identify Producer message that includes an automatically-routed Event ID produced by the node may, but is not required to, reply with one or more Producer Identified messages containing that Event ID.

6.4 Consumer Inquiry

Any node receiving an Identify Consumer message that includes a non-automatically-routed Event ID consumed by the node shall reply with one or more Consumer Identified messages containing that Event ID.

Any node receiving an Identify Consumer message that includes an automatically-routed Event ID consumed by the node may, but is not required to, reply with one or more Consumer Identified messages containing that Event ID.

6.5 Teach/Learn Configuration

A node may, but is not required to, send a Teach Event message containing an Event ID.

A node receiving a Teach Event message may, but is not required to, configure the contained Event ID into some or all of the producers and consumers it contains.

6.6 Resetting to Default

Nodes shall ensure that every producer and consumer within the node contains a valid and unique Event ID after the node is reset to defaults. For this purpose, the producers and consumers may contain either well-known Event IDs or Event IDs defined based on this node's unique ID.

If a producer or consumer within the node contains an Event ID based on the node's unique ID, and if that Event ID could have been copied from the node, resetting the node to default shall reconfigure that producer or consumer with a newly-defined Event ID that has not been used before.

7 CAN Adaptation (Normative)

There are no specific provisions for CAN transport other than the Producer/Consumer Event Report message. The other messages are formatted on CAN transport as defined for generic addressed messages in the OpenLCB Message Network Standard.

When the Producer/Consumer Event Report message has only the Event ID and no additional payload, it is sent as a single frame with the 0x05B4 MTI documented above.

When a Producer/Consumer Event Report message contains an additional payload, it is sent as multiple frames:

- The Event ID is sent in a CAN frame formatted with the Variable field containing 0x0F16
- If there are more than eight bytes of payload, one or more CAN frames carrying eight sequential bytes of the payload are sent with the Variable field containing 0x0F15. Note that these must carry exactly eight bytes of payload.
- The final one to eight bytes are sent in a CAN frame with the Variable field containing 0x0F14.

The CAN frames making up a single Producer/Consumer Event Report message with payload shall be sent together, with no inter-frame delays or intervening frames of other messages at the same or lower priority. This includes a Producer/Consumer Event Report message without payload (MTI 0x5b4). A Gateway translating the above CAN frame sequence to a different Data Link layer shall ensure that for this sequence of frames, only one message is sent out with an MTI of 0x0F14.

Nodes that consume Producer/Consumer Event Report messages with payload shall be prepared to receive and process at least two Producer/Consumer Event Report messages that have overlapped.

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