



| NMRA Standard | |
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| Layout Command Control™ (LCC) Event Transport | |
| Apr 25, 2021 | 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 | | 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” |
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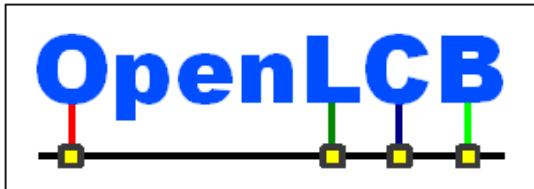
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| OpenLCB Standard | |
| Event Transport | |
| Apr 25, 2021 | Adopted |

1 Introduction (Informative)

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

2 Intended Use (Informative)

- 5 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
- 10 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. This document defines that interaction between producers and consumers in terms of OpenLCB messages.

- 15 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)

- 20 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.
 - 25 • 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)

- 30 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.

35 “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
40 range “R”, compute:

$$\text{inRange} = ((E \text{ AND NOT mask}) \text{ EQUALS } (R \text{ AND NOT mask}))$$

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 |

45 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 |

50 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

- 55 • 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 |

- 60 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 |

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

- 70 • 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 |

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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 |

80

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”.

85 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:

- 90 • 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.

95 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.

100 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. 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.

- 140 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.
- 145 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.
- 150 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.
- 155 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)

- 160 There are no specific provisions for CAN transport. The messages are formatted on CAN transport as defined for generic addressed messages in the OpenLCB Message Network Standard.

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