



OpenLCB Technical Note

OpenLCB Event Transport

Jan 19, 2013

Preliminary

1 Introduction

This explanatory note contains informative discussion and background for the corresponding “OpenLCB CAN Event Transport Specification”. This explanation is not normative in any way.

OpenLCB nodes respond to local inputs and state changes by emitting Producer/Consumer Event Report (PCER) messages. When they do this, they are acting as "Producers". OpenLCB nodes receive these messages, and can act on them locally if desired. If they do so, they are acting as "Consumers".

The P/C Event ID included in a PCER message is a 8-byte unique identifier. The method for assigning these and ensuring their uniqueness is in the Event ID S and TN.

There are many possible ways to use these 64 bits, some of which are discussed as examples below. In particular, OpenLCB does not require or enforce any particular partitioning of the eight bytes. More than one node may emit the same P/C Event ID (note that the NID of the emitting node is available in the message). More than one node may receive and act on a PCER message with a specific P/C Event ID. The only requirement is that the 8-byte quantity be unique to the event.

2 Annotations to the Specification

This section provides background information on corresponding sections of the Specification document. It's expected that two documents will be read together.

2.1 Introduction

More background & references would be good.ⁱ

2.2 Intended Use

A few examples....

2.3 References and Context

For more information on format and presentation, see:

- OpenLCB Common Information Technical Note

2.4 Message Formats

[[[To TN: For example, the event-mask 0xABCD0000 would form the range 0xABCD0000-ABCDFFFF, since the first significant '1' bit is the first low bit of the 'D' hexdigit. Similarly, the event-mask 0xFEDCBFFF would form the range 0xFEDC8000-FEDCBFFF, since 0xB =

- 30 *0b1011, and the lowest significant '0' bit is in the 3rd digit. The smallest ranges are specified by 0xyyyyyyyE, which specifies a range of 0xyyyyyyyE-0xyyyyyyyF, and 0xyyyyyyyD which specifies 0xyyyyyyyC-0xyyyyyyyF. 0X00000001 gives 0x00000000-0x00000001, and 0x00000002 gives 0x00000000-0x00000002, 0x00000003 gives 0x00000000-0x00000003*

Event-Mask	Effective Mask	Bits	#	Resulting Range
0x00000001	0xFFFFFFFFFE	1	2	0x00000000-0x00000001
0x00000002	0xFFFFFFFFFE	1	2	0x00000002-0x00000003
0x00000003	0xFFFFFFFFFC	2	4	0x00000000-0x00000003
0x00000004	0xFFFFFFFFFC	2	4	0x00000004-0x00000007
0x00000005	0xFFFFFFFFFE	2	4	0x00000004-0x00000005
0x00ABCDEF	0xFFFFFFFFF0	4	16	0x00ABCDE0-0x00ABCDEF
0x00ABCDF0	0xFFFFFFFFF0	4	16	0x00ABCDF0-0x00ABCDF7
0x00ABCDE0	0xFFFFFFFFE0	5	32	0x00ABCDE0-0x00ABCDF7
0x0000FFFF	0xFFFFF0000	16	65k	0x00000000-0x0000FFFF
0xABCD0000	0xFFFFF0000	16	65k	0xABCD0000-0xABCDFF
0xFFFFF0000	0xFFFFF0000	16	65k	0xFFFFF0000-0xFFFFFFFF

///

35 **2.4.1 Producer/Consumer Event Report (PCER)**

This message transports an Event-number from a producer node(s) to zero or more unspecified consumer nodes. It's the backbone of the protocol, and forms most of the expected traffic.

2.4.2 Identify Consumer

This message is broadcast and requests every node to report if they consume this event ID.

40 **2.4.3 Consumer Identified**

This message is broadcast, in response to a received Identify Consumer message, from each node that consumes the included event ID. Nodes also send this as part of their startup so that other nodes know they want to consume particular events.

This is one of the messages that allows bridges to do automatic routing of event messages.

- 45 The “valid”, “invalid”, “unknown” subforms are used to attempt to recover the state of the overall system. In general, event transmission via PCER messages conveys state changes. If a node comes in during operation, it might want to determine the correct value of the distributed state. Producers can, but don't always, know that state. For example, consider “On” and “Off” events for a light. There might be two producers attached to toggle switch. In that case, one of them will still see their state as current, and will reply with valid. Alternately, the two produces might be set to produce when two
- 50 separate pushbuttons are pressed. In that case, at some later time neither producer knows whether the distributed state corresponds to its event. They both have to report as unknown. Consumers can also know the state. The lamp controller that consumes the “On” and “Off” probably knows whether it's

55 currently providing power to the lamp, and so can reply with valid for one event and invalid for the other.

2.4.4 Consumer Range Identified

This message broadcasts, in response to a received Identify Consumer message, from each node that consumes event is in the range specified by the included event-ID-with-mask. This is one of the messages that allows bridges to do automatic routing of event messages.

60 The 50% is to allow rounding up to the enclosing bit, but no further.

2.4.5 Identify Producer

This message is broadcast and requests every node to report whether they produce this event ID.

2.4.6 Producer Identified

65 This message is broadcast, in response to a received Identify Producer message, from each node that produces the included event ID. This is one of the messages that allows bridges to do automatic routing of event messages.

2.4.7 Producer Range Identified

The 50% is to allow rounding up to the enclosing bit, but no further.

70 An example would be a fast clock node that sends a range of events to indicate the time. Since there are $24 \times 60 \times 60 = 86,400$ seconds in a day, it needs a range containing 86,400 events. That could be expressed in 17 bits, so if the range was start with an event ID of 0x12.34.56.78.00.00.00.00, the range could be expressed as 0x12.34.56.78.00.01.FF.FF using 1 bits to represent the mask. If the range had to start at 0x12.34.56.78.FF.FE.00.00 for some reason, 1 bits would not properly represent the mask because 0x12.34.56.78.FF.FF.FF.FF is actually a different range. Using a 0 bit for the mask would
75 work, giving 0x12.34.56.78.FF.FE.00.00 as the representation.

This message broadcasts, in response to a received Identify Producer message, from each node that produces events in the range specified by the included event-ID-with-mask. This is one of the messages that allows bridges to do automatic routing of event messages.

2.4.8 Identify Events

80 Two forms of identify events; recommendation on uses for global form

2.5 States

After the IC message is sent, and before any corresponding Producer/Consumer Event Report messages are sent, the node must identify all events produced or consumed on the board via zero or more Identify Consumers, Identify Consumed Range, Identify Producers and Identify Consumed Range messages.

85 These are not required to be in any particular order.

2.6 Interactions

Nothing prevents extra IdentifyX messages. Nothing prevents combining replies to multiple requests. This allows simplified implementations, for example setting a bit to indicate that a reply can be sent when time/priority is available.

90 You can sent identify/identified for automatically routed messages. Well-known messages require response; there's no exemption for those.

You can query a state when you come up with the request-id message. Conflicting states can happen, and have to be addressed.

95 Note that the state machine resets with the Initialiation Complete message, not the lower level link (CAN or other) state machine.

Delay in sending the PI/PRI or CI/CRI messages after IC is OK, but there's no delivery guarantee for this nodes events until those have been sent.

100 When a node changes the events it manages, it still needs to emit the PI/PRI and/or CI/CRI messages. For example, reconfiguration could cause this. It can be handled by sending individual messages, or by resetting and sending them all as part of that.

105 There is no way to indicate that a node is no longer interested in a particular Event ID. (Sending IC again says that all are not interesting though). This could be added, but it's much harder for gateways to decide an Event ID is not interesting than that it is, because they have to keep a list of all the node IDs that are interested and back that off. Better to just let that the set of interesting event IDs grow until the layout or gateway is reset.

To ensure that event messages are properly routed, nodes must announce when they start to produce or consume messages. Specifically, they must do this at two times:

- When the node is first initialized and the "Initialization Complete" message has been sent.
- When a configuration change has added an event ID that can be produced or consumed.

110 To announce new Event IDs being consumed, the node must transmit a Producer Identified message for each P/C Event ID it can produce, and a Consumer Identified message for each P/C Event ID for which it is listening.

2.6.1 Event Transfer

The last sentence is the key to gateway traffic reduction. See below.

115 2.6.2 Event Enquiry

Two forms of identify events; recommendation on uses for global form. This can be a huge load, and should only be used when needed.

120 The two forms of this message are sent to request that the specified nodes report all the events they produce or consume. These reports can be ether Identified messages specifying individual event IDs or ranges of events. One form is an unaddressed message sent globally to all nodes, and the other is an addressed message to a specific node

It is useful to be able to rapidly determine which, if any, P/C Event IDs that a particular node is listening for and that it can emit.

125 This can be used as a configuration diagnostic.

To determine which P/C Event IDs can be send by a particular node, the inquiring node sends an Identify Events message addressed to the target node.

The node must reply with a Producer Identified message for each P/C Event ID it can produce, and a Consumer Identified message for each P/C Event ID for which it is listening.

130 **2.6.3 Producer Enquiry**

It is useful to be able to determine which, if any, nodes are configured to possibly emit a specific P/C Event ID message and their current state.

This can be used as a configuration diagnostic, and as a way of building filtering and routing tables.

135 To determine which nodes can send a particular P/C Event ID, a node sends an Identify Producers message carrying the desired P/C Event ID. This is an unaddressed message addressed to all nodes.

All nodes that are listening for that P/C Event ID reply with a Producer Identified broadcast message.

140 The "valid" bit indicates that the node's internal condition is consistent with sending this P/C Event ID. For example, assume a node sends P/C Event ID 2 when the input goes active and P/C Event ID 4 when the input goes inactive. Then if the input was active and the node was asked about P/C Event ID 2, it would reply "valid"; if asked about P/C Event ID 4, it would reply "not valid". Depending on the node's structure, it might not always be possible to set the "valid" bit with certainty, in which case the "unknown" bit must be set.

145 You can query a state when you come up with the request-id message. Conflicting states can happen, and have to be addressed. You might also want to enquire of the consumers if you don't get a definitive answer from the producers.

valid/invalid/unknown – always possible to send unknown or ignore the three sub-forms, but a lot of capability is lost

2.6.4 Consumer Enquiry

150 It is useful to be able to determine which, if any, nodes are listening for a specific P/C Event ID message.

This can be used as a configuration diagnostic, and as a way of building routing tables.

To determine which nodes are listening for a particular P/C Event ID, a node sends an Identify Consumers message carrying the desired P/C Event ID. This is an unaddressed message processed by all nodes.

155 All nodes that are listening for that P/C Event ID reply with a Consumer Identified broadcast message.

160 The "valid" bit indicates that the node is currently in the state it would be if this message had been received last. For example, assume a node sets its output active for P/C Event ID 2, and inactive for a P/C Event ID 4. Then if the output was active and the node was asked about P/C Event ID 2, it would reply "valid"; if asked about P/C Event ID 4, it would reply "not valid". Depending on the node's structure, it might not always be possible to set the "valid" bit with certainty, in which case the "unknown" bit must be set.

3 Background information

This section is general information of interest to the reader, implementers, etc.

3.1 Gateways

- 165 Gateways can route PCERs only to segments with nodes expressing interest by processing the other event messages.

3.2 Implementation hints

Buffering issues, particularly on CAN.

Ordering & processing

- 170 Performance & loading at node startup, layout startup particularly on CAN. Numbers and simulations.

3.3 Well known events

There are a small number of cases where a globally-allocated and reserved Event ID will simplify operation. These “well-known Event ID numbers” can be used to e.g. advertise that a node can provide a specific capability, or to tell locomotive control hardware to stop all trains instantly, etc.

- 175 For these to be useful, they not only have to be unique (so there are no collisions that accidentally trigger reactions to them), but they must also be well-known. So we have created a central spreadsheet on which uses can be recorded. This will eventually provide a machine-accessible record.

All of these are assigned with a reserved ID in their upper six bytes to ensure uniqueness and simplify recognition.

- 180 Nodes using these must mention them when listing the event IDs they produce and consume. Gateways may filter on these, but are not required to. (For ease of implementation, a gateway may just pass all events with the common top 6 bytes)

3.4 History section:

- 185 For monitoring purposes, it was proposed that a PCER message carry a sequence number which increments each time the associated P/C Event ID is sent. It is not at all clear how to do this across nodes, or even across Producers within a single node, as there may be more than one thing that can cause the same P/C Event ID to be sent by a single board;. We decided this would cause more problems than it solved, and omitted it.

- 190 There's not room in a CAN frame for both a destination NID and a EID. The protocol has therefore been constructed so that any message carrying an EID (and that isn't a datagram) is globally addressed.

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10 iThe Producer/Consumer Model and Control System Design ControlLogix 1999 https://cours.etsmtl.ca/gpa774/Cours/old-24-03-04/Documentations/Rockwell/articles/Producer_Consumer.html