OpenLCB Standard	
Firmware Upgrade	
Apr 25, 2021	**Adopted**

1 Introduction (Informative)

This Standard defines a method for using OpenLCB protocols for upgrading the firmware of an OpenLCB node. This Standard is agnostic to the physical layer.

2 Intended Use (Informative)

5   This method is expected to be implemented in common Configuration Tool (CT) software packages. Any hardware device that is able to follow the interactions defined here and thereby receive a firmware upgrade through this method will be able to be updated using commonly available CT software. This reduces the burden of the manufacturers in that they don't need to develop and provide tools and user interface for firmware upgrade capability, as well as

10   increases user satisfaction, because the user does not have to acquire and learn to use a new tool for each hardware manufacturer, but can use a tool they are already familiar with to update all conforming hardware nodes.

This Standard does not define new protocols, but identifies a specific subset of the OpenLCB protocol stack that is necessary for the firmware upgrade to function, and defines the exact

15   sequence of operations that are expected to happen during a firmware upgrade.

The intended use of this subset is to allow manufacturers to supply their hardware with dual firmware, consisting of a "firmware upgrade" component with the minimum required support for firmware update, as well as a replaceable "production" firmware for full node operation.

3 References and Context (Normative)

20   For more information on format and presentation, see:

- OpenLCB Common Information Technical Note

For information on OpenLCB message transport and OpenLCB communications, see:

- OpenLCB Message Network Standard. That Standard also defines the Uninitialized state and the Node Initialization Complete message, as well as the Protocol Support protocol

25   messages.

Firmware upgrade relies on commands and messages defined in the following standards:

- OpenLCB Memory Configuration Standard, which defines, among others, the commands "Freeze", "Unfreeze", "Write" and "Stream Write".

- • OpenLCB Stream Transport Draft Standard, which defined how streams are opened, data
30   transferred, aborted with error, and completed.

4 Message Formats (Normative)

This Standard does not define any messages.

States (Normative)

A powered-on hardware node may be in one of the following two states:

35 • Firmware Upgrade state. In this state the node supports a writable Memory Space under the number of the Firmware Space to receive the firmware upgrade data, as defined in the firmware upgrade interaction. The hardware is not expected to perform any of its regular operations. The OpenLCB node shall still be standards compliant.

  • Operating state. In this state the node performs its desired function. The node in Operating state
40 must not export a writable Memory Space under the number of the Firmware Space.

5 Interactions (Normative)

5.1 Definitions

There are two nodes involved in the firmware upgrade process:

The **Configuration Tool** (CT) is the node with a user interface that is in possession of the new
45 manufacturer-supplied firmware data file.

The **Target Node** is the node whose firmware is being updated.

5.2 State transitions

A node may not transition between Firmware Upgrade state and Operating state without returning to Uninitialized state, as defined by the OpenLCB Message Network standard.

50 At power-up a hardware node shall start up in Operating state by default, unless one of the following conditions hold:

  • Regular operation is impossible due to the lack of a working firmware. In this case the Target Node may, but is not required to, emit a Producer-Consumer Event Report (PCER) message with the Well-Known Event ID "Firmware Corrupted" after reaching Initialized state.

55 • The user has requested firmware upgrade mode using a hardware switch, if one is available. In this case, the Target Node may, but is not required to, emit a PCER message with the Well-Known Event ID "Firmware Upgrade Requested by Hardware Switch" after reaching Initialized state.

To request a Target Node to transition from Firmware Upgrade state to Operating state, the
60 Configuration Tool shall send a Memory Configuration protocol "Unfreeze" command for the memory

space designated as Firmware Space. The Target Node shall acknowledge the completion of the state transition by sending a Node Initialization Complete message.

To request a Target Node to transition to Firmware Upgrade state (from either Firmware Upgrade or Operating state), a Configuration Tool shall send a Memory Configuration protocol "Freeze" command
65　for the memory space designated as Firmware space. The node shall acknowledge the completion of the state transition by sending a Node Initialization Complete message.

5.3 State identification

A Target Node that supports the Firmware Upgrade Standard shall set the following bit(s) in the Protocol Support Reply message depending on its state:

State	Protocol bit (Normative)	Bit value (Informative)
Operating state	Firmware Upgrade Protocol	0x00 00 20
Firmware Upgrade state	Firmware Upgrade Active	0x00 00 10

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5.4 Data Transfer

5.4.1 Streaming transfer
If the Target Node, while in Firmware Upgrade state, sets the "Stream Protocol" bit in the Protocol Support Reply packet, then the Configuration Tool shall transfer the manufacturer-supplied firmware
75　data by performing a Memory Configuration protocol Stream Write to the memory space of Firmware Space, with a starting offset of zero (0). The stream data bytes are the unmodified, uninterpreted, exact sequence of the manufacturer-supplied firmware upgrade file.

The Target Node being upgraded may, but is not required to, throttle the incoming data on the stream by means allowed by the Stream protocol.

80　After transferring all the bytes in the manufacturer-supplied firmware data file, the CT shall wait until it would be allowed to send more data according to the Stream protocol. Then the CT shall close the stream as defined in the Stream protocol. Afterwards the CT shall initiate a transition of the Target Node to Operating state by sending the Unfreeze command.

5.4.2 Datagram transfer
85　If the Target Node, while in Firmware Upgrade state, does not set the "Stream Protocol" bit in the Protocol Support Reply packet, the Configuration Tool shall transfer the manufacturer-supplied firmware data by performing a sequence of Memory Configuration protocol Write commands, starting at offset 0, with exactly 64 bytes of payload in each datagram except the last, and the datagrams' offsets increasing by 64 bytes after each. The concatenated payloads of the Write messages sent shall be are
90　the unmodified, uninterpreted, exact sequence of the manufacturer-supplied firmware upgrade file.

The Target Node being upgraded may, but is not required to, throttle the incoming data on the stream by means allowed by the Datagram protocol and Memory Configuration Protocol.

95 After transferring all the bytes in the manufacturer-supplied firmware data file, the CT shall wait until the last datagram is responded to as the Memory Configuration Protocol requires. Afterwards the CT shall initiate a transition of the Target Node to Operating state.

5.4.3 Aborting and Re-trying the transfer

If the node being upgraded encounters an error, it may abort the data transfer by aborting the stream with an error code when using the Stream protocol, or, respectively, returning a Datagram Reject with an error code or a Write Response Failed Memory Configuration datagram. If the transfer is aborted,
100 the node is required to stay in Firmware Upgrade state. If the CT re-tries the transfer, it shall do so from offset zero again. If the Target Node aborted the transfer, it is not required to be able to return to Operating state until the transfer is re-tried and successfully completed; however, it is required to be able to boot after a power cycle and return to Firmware Upgrade state, able to accept a new firmware upgrade attempt.

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5.5 Full sequence of firmware upgrade

For a more detailed description of the messages transferred, please see the Firmware Upgrade Technical Note.

1. The CT sends a Memory Configuration datagram command "Freeze" with an argument of
110 Firmware Space. Note that a Datagram Received OK reply message is not always returned to this request.

2. The CT waits for a Node Initialization Complete message from the Target Node.

3. The CT sends a Protocol Support Inquiry to the Target Node to check whether it supports Stream protocol.

115 4. The CT performs the Data Transfer.

5. The CT resets the Target Node using a Memory Configuration datagram command "Unfreeze" with an argument of Firmware Space.

6 Allocations (Normative)

This section describes the numerical values that were referenced in earlier sections and are not defined
120 in their respective standards.

6.1 Memory Space numbers

0xEF	Firmware Space

6.2 Error Codes

The Target Nodes may, but are not required to, use the following error codes to denote specific
125 conditions relating to the firmware upgrade process.

0x2088	Temporary error, Transfer error. The firmware written has failed checksum.
0x1088	Permanent error, invalid arguments. The firmware data is incompatible with this hardware node.
0x1089	Permanent error, invalid arguments. The firmware data is invalid or corrupted.

6.3 Well-Known Event IDs

01.01.00.00.00.00.06.01   Firmware Corrupted

01.01.00.00.00.00.06.02   Firmware Upgrade Requested by Hardware Switch

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