



OpenLCB Standard

Memory Configuration

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Adopted

1 Introduction (Informative)

This Standard defines a protocol for configuring OpenLCB nodes by directly accessing their configuration memory.

2 Intended Use (Informative)

- 5 Intended to be used to configure self-contained nodes over their OpenLCB links.

3 References and Context (Normative)

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

- OpenLCB Configuration Description Information (CDI), which defines fixed information to allow a Configuration Tool (CT) to configure a node.
- 10 • OpenLCB Datagram Transport Protocol, which defines the protocol for transporting 0-72 byte datagrams from node to node.
- OpenLCB Message Network, which defines message interchange for OpenLCB, specifically how this protocol appears in the Protocol Support Reply message and Error Codes.
- 15 • The OpenLCB Stream Transport Standard, which defines the protocol for transporting data from node to node.

4 Message Formats (Normative)

- The tables below show available configuration message formats. All other formats are reserved. Note that Byte 6 is sometimes specified as optional. When Byte 6 is specified as optional, and
20 not used, it is not present in the message, and the remaining bytes directly follow Byte 5 with no Byte 6 padding in between.

4.1 Address Space Size

- Configuration memory addresses are 32 bits. The addressable quantity is the byte. There are 256 unique address spaces, which are specified using an address space selectors. Address spaces may
25 be wholly designated as read-only or write-only by the implementing node. An address space may not be partially designated as read-only or write-only

4.2 Address Space Selection

Of the 256 unique address spaces, those that follow are required to be implemented by any node that implements this Standard (these may or may not have content on a particular node); the following address space numbers can only be used for the specified purpose, and if the corresponding information is available, it must be accessible by these address space selectors (in addition to any others the designer might provide):

- (space=0xFF, control bits=0b0000011) Configuration definition – A read-only space containing the Configuration Description Information for this node, if any.
- 35 • (space=0xFE, control bits=0b00000010) All memory – This special space provides access to all memory in the device, where “all” is defined by the designer.
- (space=0xFD, control bits=0b00000001) Configuration – A writable basic configuration space, with the structure of the 32-bit space defined by the designer.

These three spaces, inclusive, can (but do not have to) be addressed without an extra byte in the datagram using control bits in the flag byte (byte 1). All others must be specified as a byte value in byte 6 of the datagram payload (see Section 4.3).

4.3 Generic Error Handling

An unknown command in byte 1 shall return a datagram rejected reply with an error-code as defined in the OpenLCB Message Network Standard.

- 45 Additionally, the following protocol specific enumerated error code extensions (logically or'd into bits 0-3 of the error code as defined in the OpenLCB Message Network Standard) are defined for use with commands that are supported and known to the node:
- 0x0001 – Out of bounds, the address space is valid, however the address within the space is not implemented.
 - 50 • 0x0002 – Write access to a read-only address space.
 - 0x0003 – Read access to a write-only address space.

4.4 Read Command

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Byte 7/6
0x20	0x40 Space in byte 6 0x41 Space 0xFD 0x42 Space 0xFE 0x43 Space 0xFF	Starting Address	Address Space	Read Count (1 – 64 bytes) Upper bit reserved, must be ignored

55 In reply to the datagram containing a Read command, the receiving node shall set the Reply Pending bit in the Datagram Received OK message. The receiving node may, but is not required to, include a specific timeout interval in the Datagram Received OK message.

If the interval is provided and has elapsed without a Read Reply message being returned, the node requesting the Read operation may, but is not required to, repeat the request.

- 60 Attempts to read from an invalid location, either outside the available address range in a valid address space, or from an invalid address space, still require a returning a Read Reply datagram with a data length of zero.

4.5 Read Reply

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remaining Bytes (in network order, top to bottom)
0x20	OK status: 0x50 Space in byte 6 0x51 Space 0xFD 0x52 Space 0xFE 0x53 Space 0xFF	Starting Address	Address Space	Data (1 – 64 bytes)
	Failure status: 0x58 Space in byte 6 0x59 Space 0xFD 0x5A Space 0xFE 0x5B Space 0xFF			<ul style="list-style-type: none"> Error Code (two bytes) optional zero-terminated message string (0 – 63 bytes)

- 65 In general, a read reply may provide less than the requested data, but always at least one byte if it's a valid read. The maximum read request is 64 bytes when reading via datagrams. When reading via streams, any length up to 0xFF,FF,FF,FF (4GB-1) can be requested; a length of 0x0 means “read forever” or until the end of the address space.

Reading at least one byte, but less than the requested amount, due to the length of the address space is not considered an error.

- 70 If the full number of bytes cannot be read for any reason other than the size of the address space, or if no bytes can be read, the Read Reply shall have the Fail bit set and include an error code instead of the requested data.

4.6 Read Stream Command

Byte 0	Byte 1	Bytes 2-5	Byte 6 (optional)	Remaining Bytes (in network order, top to bottom)
0x20	0x60 Space in byte 6 0x61 Space 0xFD 0x62 Space 0xFE 0x63 Space 0xFF	Starting Address	Address Space	<ul style="list-style-type: none"> Read Count (4 bytes) Destination Stream ID (1 byte)

- 75 Very similar to a Read Command, except that a stream is created to carry the read information back to the requesting node. The stream must be established before the Read Reply datagram is sent, so that error codes can be returned via the Read Reply in the stream initialization fails.

The Destination Stream ID provided must be used as the suggested Destination Stream ID in the subsequent OpenLCB Stream Transport protocol Stream Initiate Request.

80 **4.7 Read Stream Reply**

Byte 0	Byte 1	Bytes 2-5	Byte 6 (optional)	Remaining Bytes (in network order, top to bottom)
0x20	OK status: 0x70 Space in byte 6 0x71 Space 0xFD 0x72 Space 0xFE 0x73 Space 0xFF	Starting Address	Address Space	<ul style="list-style-type: none"> Read Count (4 bytes) Destination Stream ID (1 byte) Source Stream ID (1 byte)
	Failure status: 0x78 Space in byte 6 0x79 Space 0xFD 0x7A Space 0xFE 0x7B Space 0xFF			<ul style="list-style-type: none"> Error Code (2 bytes) optional zero-terminated message string (0 – 63 bytes)

85 The Destination Stream ID must match the Destination Stream ID used in both the Read Stream Command and the subsequent stream that was created as a result of the Read Stream Command. The Source Stream ID must match the Source Stream ID used in the the subsequent stream that was a result of the Read Stream Command. The Read Stream Reply shall be sent after the stream has been established, but before any data has been sent using the stream. When the stream successfully closes, after having read 1 or more bytes, the transaction is considered complete. If the stream closes with an error, this transaction is considered to be in error.

90 Should an error occur prior to or during the establishment of the stream, the Read Stream Reply shall indicate a failure with the error code set appropriately.

4.8 Write Command

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remaining Bytes
0x20	0x00 Space in byte 6 0x01 Space 0xFD 0x02 Space 0xFE 0x03 Space 0xFF	Starting Address	Address Space	Data (1 – 64 bytes)

95 If the write operation can be done immediately and succeeds, only the Datagram Received OK message reply to the Write Command datagram is returned. The Reply Pending bit is not set in the Datagram Received OK reply.

If the write operation takes time, or fails immediately, the Datagram Received OK message reply to the Write Command datagram shall carry the Reply Pending bit set. The receiving node may, but is not required to, include a specific timeout interval in the Datagram Received OK message. This is followed

100 later by the receiving node sending a Write Reply datagram with either OK or Fail set. If Fail is set, the error code shall be included. The optional message string may be, but is not required to be, included.

If a timeout interval was provided and has elapsed without a Write Reply message being returned, the node requesting the Write operation may, but is not required to, repeat the request.

4.9 Write Reply

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remaining Bytes (in network order, top to bottom)
0x20	OK status: 0x10 Space in byte 6 0x11 Space 0xFD 0x12 Space 0xFE 0x13 Space 0xFF	Starting Address	Address Space	(None)
	Failure status: 0x18 Space in byte 6 0x19 Space 0xFD 0x1A Space 0xFE 0x1B Space 0xFF			<ul style="list-style-type: none"> Error Code (two bytes) optional zero-terminated message string (0 – 63 bytes)

105 This message is sent in only if the Reply Pending bit in the Datagram OK message reply to a previous Write Command is set. If the write fails, a Failure Status reply is sent with the Error Code set appropriately.

4.10 Write Under Mask Command

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remainder
0x20	0x08 Space in byte 6 0x09 Space 0xFD 0x0A Space 0xFE 0x0B Space 0xFF	Starting Address	Address Space	Data pairs (2-64 bytes)

110 The data pairs are (Mask, Data) where each of Mask and Data are single bytes. Bits in Data where the corresponding bit in Mask is a 1 will be written to the memory location. Bits in memory where the corresponding bit in Mask is a 0 will be left unchanged. The first data pair refers to memory at the Starting Address. Each following data pair refers to a successive byte in memory.

115 The Write Under Mask Command requires a response consistent with that of a standard Write Command whereby the Reply Pending bit in the Datagram OK reply determines if a subsequent Write Reply will occur.

4.11 Write Stream Command

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remainder (in network order, top to bottom)
0x20	0x20 Space in byte 6 0x21 Space 0xFD 0x22 Space 0xFE 0x23 Space 0xFF	Starting Address	Address Space	<ul style="list-style-type: none"> send as 0xFF, ignore on receipt (1 byte) Source Stream ID (1 byte)

- After sending this command, and receiving Datagram OK, an OpenLCB Stream Transport protocol Stream Initiate Request will be sent. The destination node is not required to accept the subsequent stream, however, once the Write Stream Command has received a Datagram OK reply, the destination node has committed itself to sending a Write Stream Reply with the appropriate success or failure with error code. If the Datagram OK reply has the Reply Pending bit set, it may use any timeout value (if provided) to wait for the Write Stream Reply. Any timeout shall be from the time of the last stream shutdown message and is provided for the receiving node to commit data to memory.
- The destination node may reject the operation immediately with a Datagram Rejected response and the error code set appropriately. In this case, no stream will be established, and a Write Stream Reply is not required or expected.

4.12 Write Stream Reply

Byte 0	Byte 1	Byte 2-5	Byte 6 (optional)	Remaining Bytes (in network order, top to bottom)
0x20	OK status: 0x30 Space in byte 6 0x31 Space 0xFD 0x32 Space 0xFE 0x33 Space 0xFF	Starting Address	Address Space	<ul style="list-style-type: none"> Destination Stream ID (1 byte) Source Stream ID (1 byte)
	Failure status: 0x38 Space in byte 6 0x39 Space 0xFD 0x3A Space 0xFE 0x3B Space 0xFF			<ul style="list-style-type: none"> Error Code (two bytes) optional zero-terminated message string (0 – 63 bytes)

- The Destination Stream ID must match the Destination Stream ID used in both the Read Stream Command and the subsequent stream that was created as a result of the Read Stream Command. The Source Stream ID must match the Source Stream ID used in the the subsequent stream that was a result of the Read Stream Command. The Read Stream Reply shall be sent after the stream has been established, but before any data has been sent using the stream. When the stream successfully closes, after having read 1 or more bytes, the transaction is considered complete. If the stream closes with an error, this transaction is considered to be in error.

Should an error occur prior to or during the establishment of the stream, the Read Stream Reply shall indicate a failure with the error code set appropriately.

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