OpenLCB Standard

Function Description Information

Jul 1, 2024 | Draft

1 Introduction (Informative)

This document defines a standard for the storage of static information that describes the user interface options for controlling available functions on an OpenLCB Train Node, called “Function Description Information (FDI)”.

The format is XML-based in order to allow reasonable extensibility, while enabling programmatic generation and parsing of the structured information. This XML document is specific to the particular Train, and is exposed at the Memory Space 0xFA. Throttle Nodes retrieve this data from the Train Node using the Memory Configuration Protocol.

2 Intended Use (Informative)

The Throttle Node downloads the FDI content from the Train Node using the Memory Configuration Protocol after the user selected the given train. The XML is exposed at a fixed Memory Space number (0xFA). The throttle parses the XML and uses the information therein to configure the function buttons’ behavior and/or the display items shown to the user.

The information presented is the list of available function numbers, the type of the function button (toggle, momentary or analog function), optional name and description strings, and for analog functions the available range of values that are valid.

If the throttle has fixed marked buttons (e.g. a button labeled Horn/Whistle), it will assign a varying function number to these buttons, by finding which function number belongs to the given behavior.

OpenLCB-connected native Train Nodes built into specific models may ship a fixed constant FDI XML, as it will describe the behavior of the functions as implemented by the hardware and software. Flexible / configurable OpenLCB decoders may provide a mechanism to update the FDI XML if their function numbers can be reconfigured. DCC Command Stations that provide Virtual Train Nodes for OpenLCB throttles may either provide a generic fixed FDI (e.g. listing Headlight, Bell, Horn, F3..F28), or may have a Roster configuration storage, where the user can store a per-DCC-address mapping of functions to behaviors. In this case the Command Station generates the FDI XML on-the-fly based on the DCC address that is being controlled from the throttle. For an MFX/M4 decoder, or a DCC decoder supporting DCC-A, RailComPlus, or the appropriate standardized RailCom data pages, the function mapping can be read out from the locomotive directly using the track protocol, and this information can be used to generate the FDI XML on-the-fly.

The FDI provides a read-only interaction to retrieve the function metadata. There is no provision in this Standard on how to modify the function metadata. For modification, the regular configuration standards and protocols are recommended.

3 References and Context (Normative)

For more information on format and presentation, see:

- OpenLCB Common Information Technical Note

For information on how to fetch the FDI information from a node, see:

- OpenLCB Memory Configuration Protocol Standard

For information on how to control the functions, see

- OpenLCB Train Control Protocol Standard

For information on XML encoding and XML Schema, see:

- World Wide Web Consortium (W3C) “Extensible Markup Language (XML)”[1]
- World Wide Web Consortium (W3C) “XML Schema”[2]

4 Content (normative)

The FDI information shall be constant. A node may not change the FDI information after any part of it has been retrieved and before the next transition of the node away from the Initialized state.

5 Format (normative)

The FDI is provided as a zero-terminated string of bytes. The bytes encode UTF-8 characters. There is no byte-order mark (BOM) at the start of the string. Lines in the string are delimited with 0x0A Newline (NL) characters.

The content defines the configuration description information in XML 1.0 format using a specific XML vocabulary defined by an XML 1.0 Schema. No extensions to XML 1.0 are permitted.

The version number of an OpenLCB FDI schema contains two numbers: The major version first, and the minor version second. This version of this Standard specifies version 1.0 of the schema. That version of the schema is defined at https://openlcb.org/schema/fdi/1/0/fdi.xsd and in Appendix A of this document. The FDI content shall pass validation against its referenced schema. Nodes are not required to do the validation.

The first line of the FDI is:

```
<?xml version="1.0"?>
```

to define the XML version of the content.

[1] http://www.w3.org/XML/

[2] http://www.w3.org/XML/Schema

The root element of the FDI XML is required to be:

```
<fdi xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xsi:noNamespaceSchemaLocation="https://openlcb.org/schema/fdi/1/0/fdi.xsd">
```

to define the OpenLCB FDI version of the content.

The schema contents are normative.

Numerical values in attributes and element text shall be specified as decimal numbers. OpenLCB nodes are not required to parse any other numeric format.

5.1 XML Elements

5.1.1 <fdi> Element

A single <fdi> element is the root of the XML information. The <fdi> element must contain exactly one <segment> element.

5.1.2 <segment> Element

A <segment> element shall contain an optional user-readable name and optional description, and a sequence of zero or more <group> and/or <function> elements. The user-readable name and description are intended as hints for optional UI display by throttles.

A <segment> element may provide a “space” attribute with the fixed value of “249”. Alternative memory spaces beyond the Function Space (249, 0xF9) are not currently defined for use with Functions.

5.1.3 <group> Element

The <group> element allows logical grouping of functions, providing common documentation for them.

A <group> element shall contain an optional user-readable name and optional description tags, and a sequence of zero or more <group> and/or <function> elements. The user-readable name and description are intended as hints for optional UI display by throttles.

5.1.4 <function> Element

The <function> element describes the metadata of one function.

The ‘size’ attribute is currently reserved, and if specified, shall carry a value of 1.

The ‘kind’ attribute specifies the behavior of the function button, with the following allowed values:

- ‘binary’ (default) defines an on-off function with a toggle button behavior
- ‘momentary’ defines an on-off function with a momentary button behavior
- ‘analog’ defines an analog function with integer values accepted between the optional <min> and <max> sub-elements (inclusive).

The <function> element may contain a <name> element. The string contents of that element is meant to be used by a Throttle to convey information about this function to the user.

The <function> element shall contain a <number> element with a decimal integer as contents, which specifies the function number defined. The number must be greater than or equal to zero.

Appendix A: The 1.0 Version of the XML Schema for FDI

```
<?xml version="1.0" encoding="utf-8"?>
<?xml-stylesheet href="schema2xhtml.xsl" type="text/xsl"?>
<!-- XML Schema for OpenLCB Function Description Information (FDI)     -->
<xs:schema version="FDI 1.0" xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <xs:simpleType name="NonNegativeInteger">
    <xs:restriction base="xs:int">
      <xs:totalDigits value="5"/>
      <xs:fractionDigits value="2"/>
      <xs:minInclusive value="0"/>
    </xs:restriction>
  </xs:simpleType>

  <xs:complexType name="groupType">
    <xs:sequence>
      <xs:element name="name" minOccurs="0" maxOccurs="1" />
      <xs:element name="description" minOccurs="0" maxOccurs="1" />
      <xs:choice minOccurs="0" maxOccurs="unbounded">
        <xs:annotation>
          <xs:documentation>
            Allows any sequence of the contained element types
          </xs:documentation>
        </xs:annotation>
        <xs:element name="group" type="groupType" minOccurs="0" maxOccurs="1" />
        <xs:element name="function" type="functionType" minOccurs="0" maxOccurs="1"
/>
      </xs:choice>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name="functionType">
    <xs:sequence>
      <xs:element name="name" minOccurs="0" maxOccurs="1" />
      <xs:element name="number" type="NonNegativeInteger" minOccurs="1"
maxOccurs="1" />
      <xs:element name="min" type="xs:int" minOccurs="0" maxOccurs="1" >
        <xs:annotation>
          <xs:documentation>
            Smallest valid value for this function.
            Only used when type is "analog".
          </xs:documentation>
        </xs:annotation>
      </xs:element>
      <xs:element name="max" type="xs:int" minOccurs="0" maxOccurs="1" >
        <xs:annotation>
          <xs:documentation>
            Largest valid value for this function.
            Only used when type is "analog".
          </xs:documentation>
        </xs:annotation>
      </xs:element>
    </xs:sequence>
    <xs:attribute name="kind" default="binary">
      <xs:annotation>
        <xs:documentation>
          Type of function being described
        </xs:documentation>
      </xs:annotation>
      <xs:simpleType>
        <xs:restriction base="xs:token">
          <xs:enumeration value="binary"/>
          <xs:enumeration value="momentary"/>
          <xs:enumeration value="analog"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="size" default="1">
      <xs:annotation>
        <xs:documentation>
          Storage size of this variable in bytes.
          Reserved, ignore upon receipt.
        </xs:documentation>
      </xs:annotation>
      <xs:simpleType>
        <xs:restriction base="xs:token">
          <xs:enumeration value="1"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>

  <xs:element name="fdi">
    <xs:annotation>
      <xs:documentation>
        This is the schema for Function
        Description Information (fdi)
      </xs:documentation>
    </xs:annotation>
    <xs:complexType>
      <xs:sequence>
        <xs:element name="segment" minOccurs="1" maxOccurs="1">
          <xs:annotation>
            <xs:documentation>
              Define the contents of the function memory space
            </xs:documentation>
          </xs:annotation>
          <xs:complexType>
            <xs:sequence>
              <xs:element name="name" minOccurs="0" maxOccurs="1" />
              <xs:element name="description" minOccurs="0" maxOccurs="1" />
              <xs:choice minOccurs="0" maxOccurs="unbounded">
                <xs:annotation>
                  <xs:documentation>
                    Allows any sequence of the contained element types
                  </xs:documentation>
                </xs:annotation>
                <xs:element name="group" type="groupType" minOccurs="0"
maxOccurs="1">
                  <xs:annotation>
```

```
                    <xs:documentation>
                      Allows grouping and replication of multiple locations.
                    </xs:documentation>
                  </xs:annotation>
                </xs:element>
                <xs:element name="function" type="functionType" minOccurs="0" 
maxOccurs="1">
                  <xs:annotation>
                    <xs:documentation>
                      Describes one function.
                    </xs:documentation>
                  </xs:annotation>
                </xs:element>

<!--
                XML Schema 1.1 construct expressing extensibility promise
                <xs:any minOccurs="0" maxOccurs="1" processContents="lax">
                <xs:assert test="every $x in * satisfies
                                    (exists($x/@size) and $x/@size castable to 
xs:integer)"/>
                <xs:assert test="every $x in * satisfies
                                    (exists($x/@offset) and $x/@offset castable to 
xs:integer)"/>
                  <xs:annotation>
                    <xs:documentation>
                      Extension point for future schema
                    </xs:documentation>
                  </xs:annotation>
                </xs:any>
 -->

              </xs:choice>
            </xs:sequence>
            <xs:attribute name="space" default="249">
              <xs:annotation>
                <xs:documentation>
                  The decimal number of the address space where the information is 
found.
                  Reserved, ignore upon receipt.
                </xs:documentation>
              </xs:annotation>
              <xs:simpleType>
                <xs:restriction base="xs:token">
                  <xs:enumeration value="249"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="origin" default="0">
              <xs:annotation>
                <xs:documentation>
                  Starting address of the segment's contents
                  within the memory space.
                  Reserved, ignore upon receipt.
                </xs:documentation>
              </xs:annotation>
              <xs:simpleType>
                <xs:restriction base="xs:token">
```

```
                  <xs:enumeration value="0"/>
                </xs:restriction>
              </xs:simpleType>
            </xs:attribute>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

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