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LoRaWAN[®] Device Identification QR Codes for Automated Onboarding Technical Recommendation (TR005)

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96 1 Conventions

97

98 The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD",
99 "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be
100 interpreted as described in RFC 2119.
101

102 2 Introduction

103

104 This document recommends a standard tagging scheme for LoRaWAN® devices to simplify
105 the device onboarding steps onto a LoRaWAN® network.

106

107 It provides a low-cost and practical method for a variety of LoRaWAN® devices to be
108 securely onboarded by the device owner. By utilizing industry-accepted norms for
109 information processing, this recommendation enables the LoRaWAN® members to
110 implement a quick, easy, secure, and interoperable method for onboarding a device through
111 optical reading or manual entry.

112

113 3 Background

114

115 LoRaWAN devices are generally manufactured in bulk and personalized with their unique
116 DevEUI, JoinEUI, security key(s) and DevAddr (in the case of ABP devices), at the time of
117 manufacturing.

118

119 In order for devices to be accepted by the network, relevant device information must be
120 shared with each network element prior to device activation. This process is called
121 provisioning.

122

123 The process of associating an owner and verifying permission to use a network is called
124 onboarding. During the onboarding process a generic provisioned device is associated with
125 its owner and, optionally, meta-data that eases the management or use of the device. These
126 devices may be offboarded when a user no longer desires to be responsible for the device.

127

128 Device attributes directly or indirectly identified by the QR code SHALL be valid when the
129 device is put to use for the first time. Please note that they MAY change throughout the
130 lifecycle of the device, e.g., by changing the JoinEUI over-the-air or using FUOTA to
131 upgrade the firmware and the Device Profile. Addressing issues that may arise from such a
132 change is outside the scope of this document.

133

134 4 Onboarding Tag Content

135 4.1 Character Set

136
 137 Only the ALPHA and DIGIT characters as defined in IETF RFC 5234 [RFC5234], “.”, and “:”
 138 SHALL be utilized. ALPHA characters SHALL be upper case.

139 4.2 Tag Information

140
 141 Data is organized similarly to URN. A specific sequence of values and optional values are
 142 delimited by a “:”.

144 **Note:** This document has been written to enable the option to adopt
 145 this identifier within a standard URN as managed by IETF in the future.
 146 Specifically, this document would allow the identifier as described to be
 147 prefaced by "URN:DEV:LW:" if and when IANA allocates this URN to
 148 the LoRa Alliance.

149
 150
 151 The preface of the identifier SHALL only consist of “LW:”.

152
 153 The identifier SHALL be, at the minimum, composed of the following mandatory values, and
 154 always in this order: SchemaID, JoinEUI, DevEUI, ProfileID.

155
 156 The mandatory values MAY be followed by one or more optional extensions. The optional
 157 extensions are CheckSum, OwnerToken, SerNum, and Proprietary extension and are pre-
 158 fixed by a parameter key:

Parameters	Key	Description
CheckSum	C	QR Checksum
OwnerToken	O	Owner Token
SerNum	S	Device Serial Number
Proprietary	P	Proprietary Extension

160 **Table 1 – LoRaWAN[®] parameters keys**

161 The maximum size of the full tag information shall be 128 characters, 48 characters are
 162 consumed by the mandatory information which leaves 80 characters for the optional
 163 extensions.

164 4.2.1 SchemaID

165
 166 The SchemaID is used to indicate the schema that should be applied to the remaining data
 167 of the identifier. The SchemaID consists of two characters and is currently defined in the
 168 following table.

169
 170
 171
 172

Schema ID	Description
D0	Device Schema Version 0 – the schema described in this document

173

174

Table 2 – Schema IDs

175

176 4.2.2 JoinEUI

177

178 JoinEUI is the initial JoinEUI value used by the device after shipment (in case the device
179 uses multiple JoinEUIs) that identifies the JS uniquely in the LoRaWAN® Backend
180 Interfaces 1.0 Specification.

181

182 The JoinEUI, formerly AppEUI, value uses a hexadecimal representation resulting in 16
183 characters.

184 4.2.3 DevEUI

185

186 IEEE allocates an Organization Unique Identifier and identifier range to the manufacturer of
187 the subsystem running the LoRaWAN® stack (please refer to **IEEE Registration
188 Authority**).

189 DevEUI consist of 8 bytes and is described in the LoRaWAN® Link-layer Specification [LW].

190

191 The DevEUI value uses a hexadecimal representation resulting in 16 characters.

192 4.2.4 ProfileID

193

194 The profile identifier encodes a Vendor Identifier and a Vendor Profile Identifier as a
195 hexadecimal representation resulting in 8 characters.

196

ProfileID	VendorID	VendorProfileID
Size (Bytes)	2	2

197

198

Table 3 – Product ID

199

200 VendorID is assigned by the LoRa Alliance [VID]. The VendorID, 0xFFFF, is to be utilized
201 prior to commercial production of a device.

202

203 VendorProfileID is assigned by the device manufacturer for commercial products. Because
204 the ProfileID may be used as an index on a Device Profile database or payload decoding
205 database, the manufacturer SHALL use a distinct VendorProfileID for devices with different
206 Device Profiles [BE] or payload encodings.

207 4.2.5 Optional Extensions

208 4.2.5.1 Checksum

209

210 The Checksum is used to validate the data integrity. Even though QR codes have their own
211 built-in integrity checks, this explicit checksum is useful when the content of the QR code is
212 presented as plain text. Checksum is generated using the CRC-16-MODBUS [CRC] of the
213 full QR content except the Checksum field itself, and presented in hexadecimal format
214 without the leading "0x".

215 **4.2.5.2 OwnerToken**

216 The OwnerToken is used to prove the ownership of the end-device (as identified by its
217 DevEUI) to a system that allows the device owner to create and modify settings associated
218 with the end-device. For example: Registering the end-device on the home NS and setting
219 the home NS of the end-device on the JS.

220 It is RECOMMENDED that OwnerToken is not used for retrieving any confidential
221 information related to the end-device. Using it for such purposes requires the OwnerToken
222 to be protected at the same level as the AppKey/NwkKey.

223 The OwnerToken SHALL be protected against unauthorized access on the end-device until
224 it is used by the legitimate owner of the device (e.g., not accessible until the end-device is
225 unpacked).

226 How the OwnerToken is generated, delivered to the systems verifying its value, and whether
227 it is a one-time-use value are outside the scope of this document. See Appendix A for an
228 example.

229 **4.2.5.3 SerNum**

230
231 The SerNum, serial number, is a unique identifier assigned during the product manufacturing
232 process. The SerNum does not need to be strictly a number and may contain any
233 characters, with the exception of the ":" from the available alphabet indicated in Section 5.1
234 of this document.

235 **4.2.5.4 Proprietary**

236
237 Tag content can be extended using proprietary schemes, using any characters, with the
238 exception of the ":" from the available alphabet indicated in Section 5.1 of this document.
239

240 The ProfileID field may be used to determine the interpretation of the proprietary extensions
241 and SerNum field.
242

243

244 **4.3 Example QR Codes**

245

246 Given:

247

248 SchemaID of D0

249 JoinEUI of 11-22-33-44-55-66-77-88

250 DevEUI of AA-BB-CC-DD-EE-FF-00-11

251 ProfileID of AABB-1122

252 OwnerToken of AABBCCDDEEFF

253 SerNum of YYWWNNNNNN

254 Proprietary of FOOBAR

255 CheckSum of AF2C

256

257 This requires size 4 and can only have ECC=Medium.

258

259

260 Here are the 88 bytes of data:

261

262 LW:D0:1122334455667788:AABBCCDDEEFF0011:AABB1122:OAABBCCDDEEFF:

263 SYYWWNNNNNN:PFOOBAR:CAF2C

264

265

266 And the QR code:



Figure 1 QR code example (full)

267

268

269

270

271

272

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284

Example of minimal mandatory:
This requires size 4 and can have ECC=High.

Here are the 48 bytes of data:

LW:D0:1122334455667788:AABBCCDDEEFF0011:AABB1122

And the QR code:



Figure 2 QR code example (basic)

285
286
287

288 **5 QR Code Physical Recommendations**

289
290
291

The exact physical tag is not specified but MUST comply to the following requirements.

292

Note:

293

- Most QR codes default to Medium level of error correction.

294

- Version 4 QR code with level medium correction can contain up to 62 Binary or 90 Alphanumeric characters.

295

296

297

298 **5.1 Requirement 1**

299

300

The QR code format SHALL be correctly readable with standard readers, even when parts of the QR code are dirty or damaged.

301

302 **5.2 Requirement 2**

303

304

The format SHALL allow a QR code with only mandatory parameters to be printed and scanned on as little as a 7x7mm surface and still comply with the interoperability and robustness requirement. Rationale: Some devices have tight space constraints on where to print the QR-code and thus need a very small QR-code size.

305

306

307

308 **5.3 Requirement 3**

309

310

The QR code format SHALL be feasible to be added to the devices in mass production in a cost-efficient manner.

311

312

313 **Appendix A. Example Generation and Use of OwnerToken**

314

315 This is an example of how OwnerToken may be generated and used. There are possibly
316 other ways of managing the OwnerToken. They are all valid as long as they are compliant
317 with the specification in Section 4.2.5.2.

318

319 - At the time of device provisioning on the JS, the JS generates a random OwnerToken and
320 assigns it to the DevEUI of the device. Both the DevEUI and the OwnerToken (along with
321 some other attributes, such as AppKey) are stored on the JS. The JS marks the device as
322 “unclaimed” at that point.

323

324 - The OwnerToken is provided to the manufacturer to generate the QR code to be printed
325 and placed on the end-device. There are other information elements needed for the QR that
326 are not mentioned here for the sake of brevity.

327

328 - Device with the QR code is placed inside a box and made available to the final owner
329 through a chain of events. The QR code cannot be readily seen from outside the box during
330 this journey.

331

332 - The owner unboxes the device. The owner uses the mobile app provided by her LoRaWAN
333 operator in order to provision the newly-acquired device with her own account.

334

335 - Mobile app reads the QR code on the device and sends that to a user account
336 management server in the operator domain.

337

338 - The server contacts the JS as identified by the JoinEUI which is encoded on the QR to
339 attempt to claim the device as identified by the DevEUI in order to set its home NS while
340 presenting the OwnerToken as the proof of ownership. The interface allowing this interaction
341 is currently outside the scope of LoRa Alliance.

342

343 - The JS verifies the device identified by the DevEUI is not claimed and the received
344 OwnerToken matches the stored value. If this is the case, the JS marks the device as
345 “claimed”, and sets the home NS to the value received in the request.

346

347 In this example, one-time claim is illustrated. Subsequent unclaim/claim procedures can be
348 implemented by the JS generating and providing a new OwnerToken back to the current
349 owner to be shared with the future owner of the device.

350

351

352 Glossary

353

354 AS Application Server

355 JS Join Server

356 Hex Hexadecimal

357 NS Network Server

358 QR code A machine-readable optical label that contains information about the item to
359 which it is attached

360 6 Bibliography**361 6.1 References**

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