

1 **LoRaWAN® Roaming Hub Technical Recommendations (TR10-1.0.0)**

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LoRaWAN[®] Roaming Hub Technical Recommendation (TR10-1.0.0)

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81 **1 Conventions**

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83 The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD",
84 "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be
85 interpreted as described in IETF Best Current Practice 14 (BCP14 [RFC2119] [RFC8174])
86 when, and only when, they appear in all capitals, as shown here.

87

88 The tables in this document are normative. The figures in this document are informative.

89

90 Document titles are written as *LoRaWAN Link Layer Specification*.

91

92 Commands/messages are written ***PRStartReq*** and fields are written `DevAddr`.

93

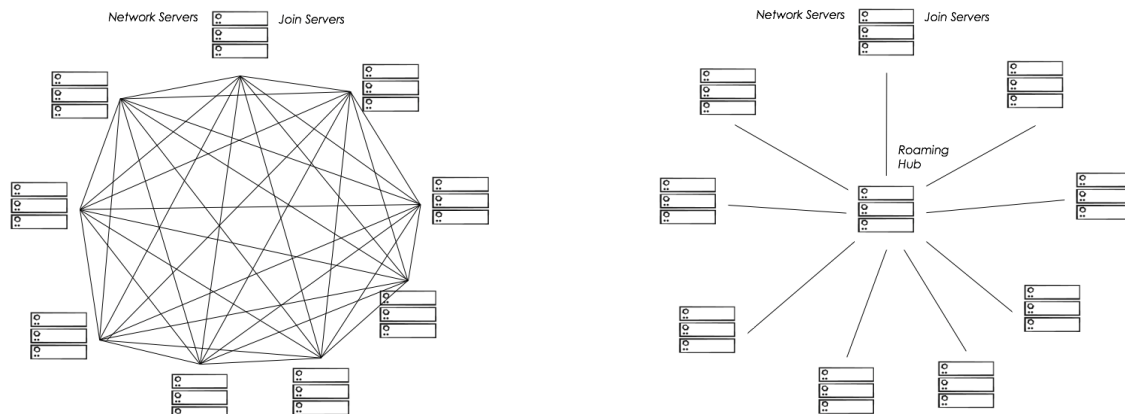
94 **2 Introduction**

95
 96 The LoRaWAN roaming feature, as defined in the *LoRaWAN Backend Interfaces Specification*
 97 [LWBE], requires Network Servers (NSs) and Join Servers (JSs) to be configured to process
 98 incoming messages from their peers and route those messages to their respective
 99 destinations, based on roaming agreements. Configuration parameters include Uniform
 100 Resource Identifiers (URIs) or IP addresses corresponding to JoinEUIs (IDs identifying a Join
 101 server) and NetIDs, firewall rules (e.g., allowing incoming TCP connections from given IP
 102 addresses), HTTP authentication credentials, LoRaWAN roaming policies (e.g., allowing
 103 passive roaming, incoming roaming devices, etc.), and definition of Usage Data Records
 104 (UDRs).

105
 106 As the number of NS and JS nodes involved in roaming increases, managing the exponentially
 107 increasing number of peer-to-peer configurations, along with the associated record
 108 keeping/reporting, has become difficult to set up and maintain.

109
 110 This is traditionally where a Roaming Hub (RH) comes into play. An RH helps transform the
 111 interconnection among several NSs/JSs from a mesh topology to a star topology by inserting
 112 itself between any two nodes, as depicted in Figure 1. Such a change in topology helps reduce
 113 the complexity of roaming management from $O(n^2)$ to $O(n)$.

114
 115



116
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Figure 1: Transforming a mesh topology into a star topology with the help of an RH

118
 119 This document describes various aspects related to the implementation and operation of
 120 RHs, in the form of a LoRa Alliance technical recommendation. There are no new RH-
 121 related backend message types or message fields introduced in this document. All
 122 messages discussed in this document are defined in the the *LoRaWAN Backend Interfaces*
 123 *Specification* [LWBE].

124

3 Functionality

There are two primary functionalities of a roaming hub:

1. Forward messages among peers based on the roaming agreements – The RH forwards an incoming message to its ultimate destination only if there is an associated agreement that allows it to do so. Otherwise, the RH rejects the incoming message, just like the intended destination would do.
2. Keep track of and report the usage, in the form of UDRs – The amount of traffic passed among the nodes served by the RH is recorded in a peer-to-peer fashion and is reported to each node at the end of a configured period.

One or more roaming hubs gets inserted between NSs and JSs, acting as a transparent stateless proxy for the nodes it is serving, as depicted in Figure 2. This example illustrates a single roaming hub.

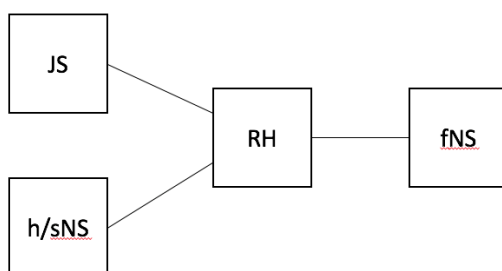


Figure 2: Single roaming hub insertion

When a node needs to deliver a message to its peer, it sends the message to the RH instead of directly sending to the peer. For example, the Forwarding Network Server (fNS) sends a **HomeNSReq** message (to query the home network server of a particular device) that is ultimately destined to the JS towards the RH, so the RH can deliver that message to the JS. Similarly, the Home Network Server (hNS) sends a **XmitDataReq** message that is ultimately destined to the fNS towards the RH, so the RH can deliver that message to the fNS.

The RH appears as a JS when receiving messages from the fNS for the JS. And, the JS treats the RH as an fNS when sending messages to the RH, to be ultimately delivered to the fNS. Therefore, the interface between the JS and the RH, and the interface between the RH and the fNS, is the JS-vNS interface defined in the the [LWBE].

Similarly, the interface between the Serving Network Server (sNS) and the RH, and between the RH and the fNS, is the sNS-fNS interface defined in the [LWBE].

Consequently, the [LWBE] specification is sufficient to implement an RH that is interoperable with the NSs and JSs that are compliant with that specification.

Figure 3 depicts two roaming hubs between the nodes:

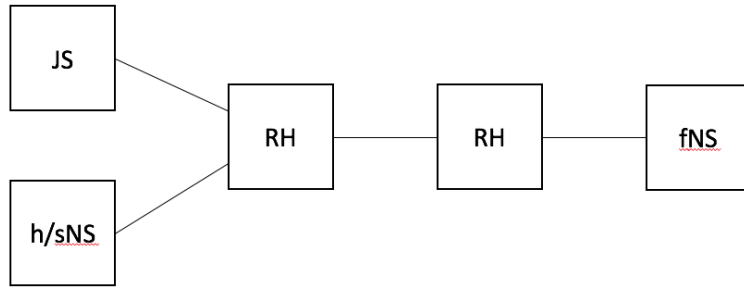


Figure 3: Multiple roaming hub insertion

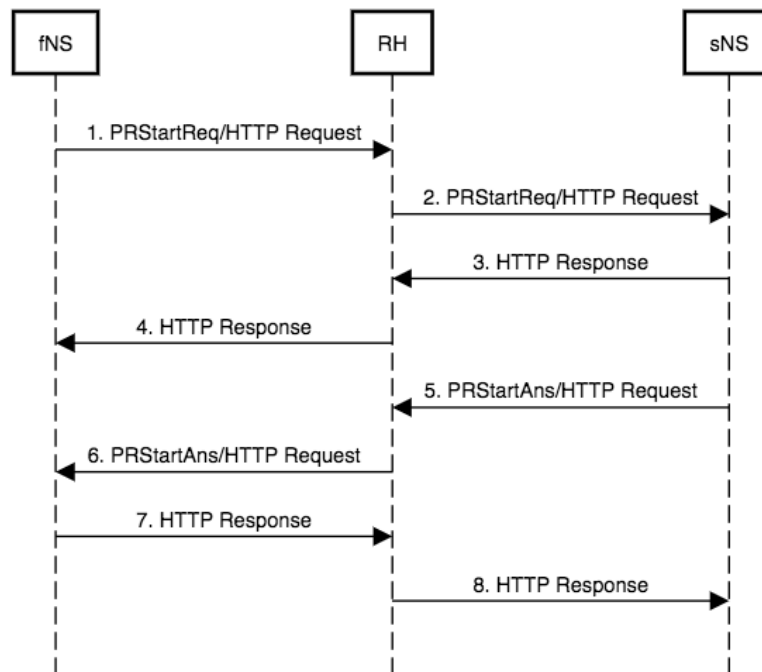
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168 4 Message Flows

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Figure 4 depicts the call flow that SHOULD be used for the RH forwarding *PRStartReq* and *PRStartAns* messages between the fNS and the sNS.



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175

Figure 4: Message forwarding via the RH

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The steps in this call flow are described below:

179

Step 1:

180 Upon receiving an uplink frame, the fNS generates a passive roaming start request
181 *PRStartReq* message. The fNS inspects the end-device address (*DevAddr*), and
182 identifies the NetID of the intended sNS. The fNS identifies the RH as the next hop for
183 delivering backend messages to the sNS. Therefore, the fNS sends the *PRStartReq*
184 message to the RH.

185

186 Step 2:

187 The RH inspects the *SenderID* and *ReceiverID* of the incoming *PRStartReq*
188 message. The RH forwards the message to the sNS, assuming the RH is configured with
189 a roaming agreement for the NetID pair of fNS-sNS. The sNS processes the incoming
190 *PRStartReq* message as if it directly came from the fNS.

191

192 Step 3:

193 The HTTP server on the sNS sends the HTTP response message to the RH in response
194 to the incoming HTTP request from Step 2.

195

196 Step 4:

197 The RH accepts the incoming HTTP response for its pending HTTP request and
198 generates the HTTP response for the incoming HTTP request at Step 1.

199

200 Steps 1-4 complete successful delivery of the **PRStartReq** message sent from the fNS to
 201 the SNS via the RH.

202
 203 The **PRStartAns** message follows the same path in reverse in a similar way.

204
 205 Step 5:
 206 The SNS generates a **PRStartAns** message. The SNS identifies the RH as the next hop
 207 for delivering backend messages to the fNS. Therefore, the SNS sends the **PRStartAns**
 208 message to the RH.

209
 210 Step 6:
 211 The RH inspects the `SenderID` and `ReceiverID` of the incoming **PRStartAns**
 212 message. The RH forwards the message to the fNS, assuming the RH is configured with
 213 a roaming agreement for the fNS-SNS pair. The fNS processes the incoming
 214 **PRStartAns** message as if it directly came from the SNS.

215
 216 Step 7:
 217 The HTTP server on the fNS sends the HTTP response message to the RH in response
 218 to the incoming HTTP request from Step 6.

219
 220 Step 8:
 221 The RH accepts the incoming HTTP response for its pending HTTP request, and
 222 generates the HTTP response for the incoming HTTP request from Step 5.

223
 224 Figure 5 depicts the call flow that SHOULD be used when the RH rejects the **PRStartReq**
 225 message sent by the fNS due to lack of a roaming agreement between the fNS and the
 226 intended SNS.

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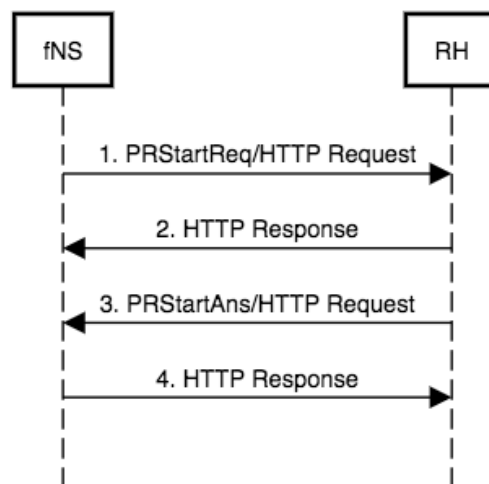


Figure 5: Message rejected by the RH

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231
 232 The steps for rejection are described below:

233
 234 Step 1:
 235 The fNS sends the **PRStartReq** message to the RH.

236
 237

238 Step 2:
239 The RH inspects the `SenderID` and `ReceiverID` of the incoming ***PRStartReq***
240 message. The RH decides to reject the message due to lack of a roaming agreement
241 between the fNS-sNS pair and the HTTP server on the RH sends the HTTP response
242 message to the fNS in response to the incoming HTTP request from Step 1.
243
244 Step 3:
245 The sNS sends the ***PRStartAns*** message with `Result=NoRoamingAgreement` to
246 the fNS.
247
248 Step 4:
249 The HTTP server on the fNS sends the HTTP response message to the RH in response
250 to the incoming HTTP request from Step 3.
251

252 5 Configuration

253

254 Configuration for network servers using an RH SHOULD include the following:

- 255 • The firewall must be set to allow HTTP/TCP/IP communication between the NS and
- 256 the RH.
- 257 • There must be an HTTP credential setting to enable secure HTTP communication
- 258 between the NS and the RH.
- 259 • For each roaming partner of the NS that is reachable via the RH, the URL of the RH
- 260 must be used as the next hop for reaching that roaming partner (as opposed to the
- 261 roaming partner's actual URL).
- 262

263

Configuration for each RH SHOULD include the following:

- 264 • The firewall must be set to allow HTTP/TCP/IP communication between any served
- 265 NS and the RH.
- 266 • There must be an HTTP credential setting to enable secure HTTP communication
- 267 between any served NS and the RH.
- 268 • For each served NS, the RH needs to know:
 - 269 ○ Pair-wise roaming information. This includes NetIDs of the pairs and whether
 - 270 or not passive roaming activation is enabled.
 - 271

272

Note: The roaming relationship is directional. For example, NS1's end-devices may be allowed to roam into NS2's network, but NS2's end-devices may not be allowed to roam into NS1's network.

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- Forwarding information, for when the RH needs to send a message to the NS. This includes the URLs used to forward messages destined to the NetID of the NS and whether or not the NS is directly connected to the RH or is reachable via another RH.

281 **6 Usage Data Records**

282

283 The RH SHOULD keep track of the hub usage in terms of number of uplink and downlink
284 frames forwarded from one NS to another and SHOULD report that information to each
285 associated party at regular intervals (e.g., monthly).

286

287 Glossary

288		
289	fNS	Forwarding Network Server
290	hNS	Home Network Server
291	HTTP	HyperText Transfer Protocol
292	hNS	Home Network Server
293	IP	Internet Protocol
294	JS	Join Server
295	LoRaWAN®	Long Range network protocol
296	NS	Network Server
297	RH	Roaming Hub
298	sNS	Serving Network Server
299	UDR	Usage Data Record
300	URI	Uniform Resource Identifier

301 **Bibliography**

302 **References**

303
304 [LWBE] TS2-1.1.0 LoRaWAN Backend Interfaces Specification (version 1.1), LoRa Alliance,
305 November 2020.