



TEKTELIC
c o m m u n i c a t i o n s

— IoT for life —

Store and Forward Application

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Version	1.0
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Store and Forward – Device details

Configuration:

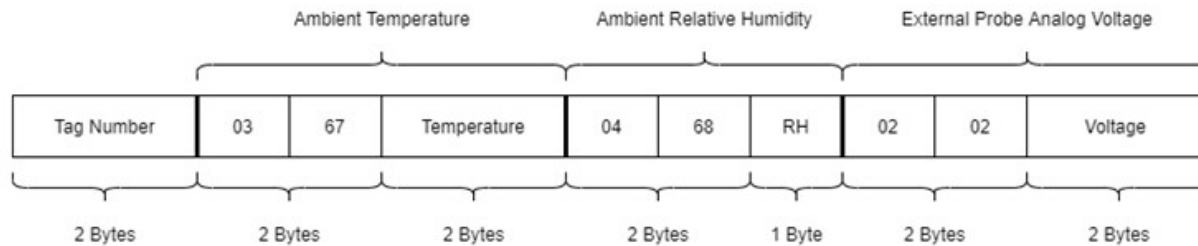
- Default configuration has Temperature, Humidity, and probe voltage enabled in S&F uplinks every hour
 - This can be configured as needed, for example to 15 minutes
- S&F uplinks are tagged with an integer ranging from 1 to 3000, after 3000 it will wrap
- Port 32 is used for these ULs
- Application is expected to observe tags and request (via downlinks on ports 112 - 122) missing tagged data
- Retransmitted data is sent using ports 33 and 34
 - There is a detail/complication regarding fragmenting large payload packets that will be needed
 - One example is DR0 in the US915 region (max. payload = 11 bytes) compared to DR1 (53 bytes)

- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4

Store and Forward – Device details

Tagged uplinks:

- Port 32 (0x20) is used to communicate the tagged uplinks
- Big endian format (MSB first) is always followed
- Each reading (T, H, or V) can be enabled or disabled via configuration



- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 2.4

Store and Forward – Device details

Frame Payload Retransmission

- Retransmitted tagged data is sent on port 33 (0x21)
- Same endianness as original tagged data
- Format allows consecutive tags to be retrieved together

In Figure 2-3, missing tag m and its $q - 1$ subsequent missing tags are being addressed. **LoRaWAN port 33 (0x21)** is used for unfragmented data forwarding.

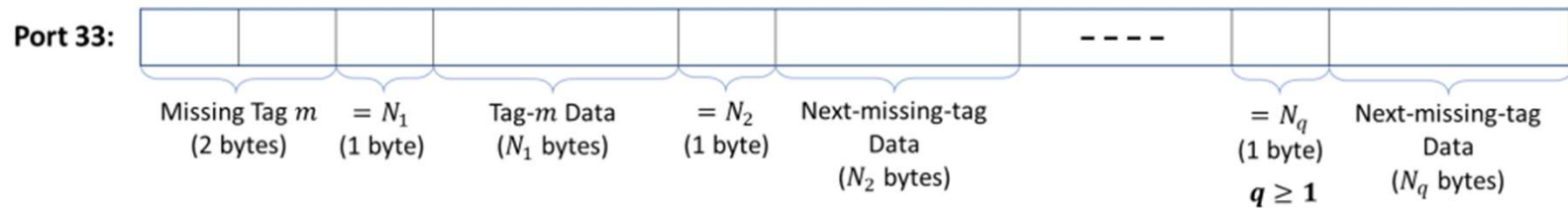


Figure 2-3: The Unfragmented Data Forwarding Payload Format

- This message may exceed the maximum payload size so may need to be fragmented.
- The order of the tagged data is as requested via DL – the application needs to remember what it asked for
- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 2.5

Store and Forward – Device details

Fragmented Data Forwarding

- Cloud based application needs to handle this case
- The missing tag value m (2 bytes) will be the same for all fragmented messages
- The value N is only in 1st fragment on port 33
- N communicates the total number of bytes
- Sensor will send next fragments on port 34 until N bytes in total are transmitted
 N does not include missing tag bytes

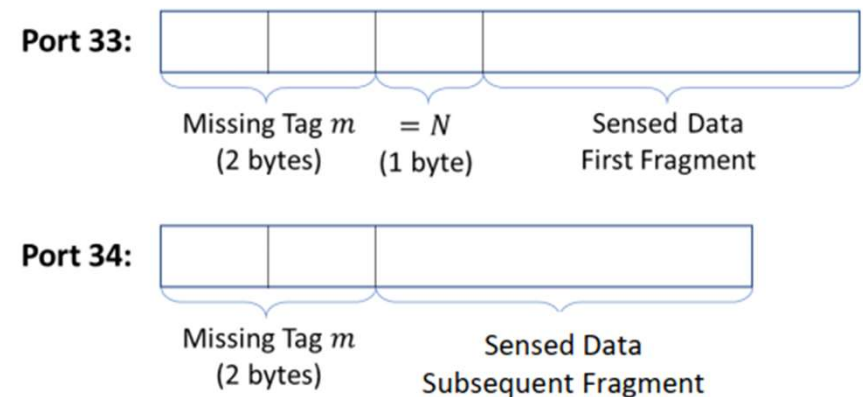


Figure 2-4: The Fragmented Data Forwarding Payload Format

- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 2.5

Store and Forward – Device details

Downlink Messages

- Configuration is performed on Port 100 (allow selection of what to tag and send, etc.)
- This is common for all TEKTELIC sensors so not explained in detail here, other resources are available

- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 3

Store and Forward – Device details

Downlink Messages

- Request for missing tagged data
- Single tagged entry request using port 112 (0x70), payload is simply the tag number
- Multiple tagged entries request using port 112 (0x70), payload is minimum tag number plus bit mask

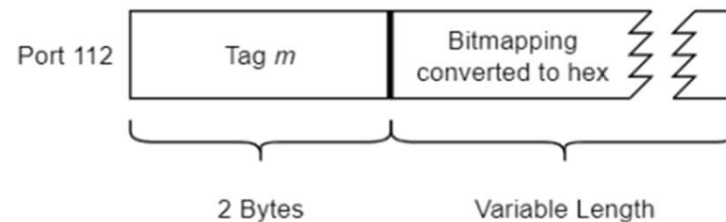


Figure 3-3: Bitmapping DL Format to Request Multiple Tagged Entries

- Simple application start point: use only port 112 (single or small set of missed packets covering a gap of up to $8 \times N$), where N is the number of bytes used for bitmapping
- Run Length Encoding, RLE, can be used to efficiently request large sets of missed tags
 - Ports 113 to 122 are used to signal various run lengths
- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 3.3

Store and Forward – Device details

Errors:

- If tagged entries do not exist these tag numbers are returned on port 14 (0x0E)

- Details: Tundra Sensor Technical Reference Manual, T0006940_TS_TM version 1.4
 - Section 2.3

Store and Forward – Use Cases

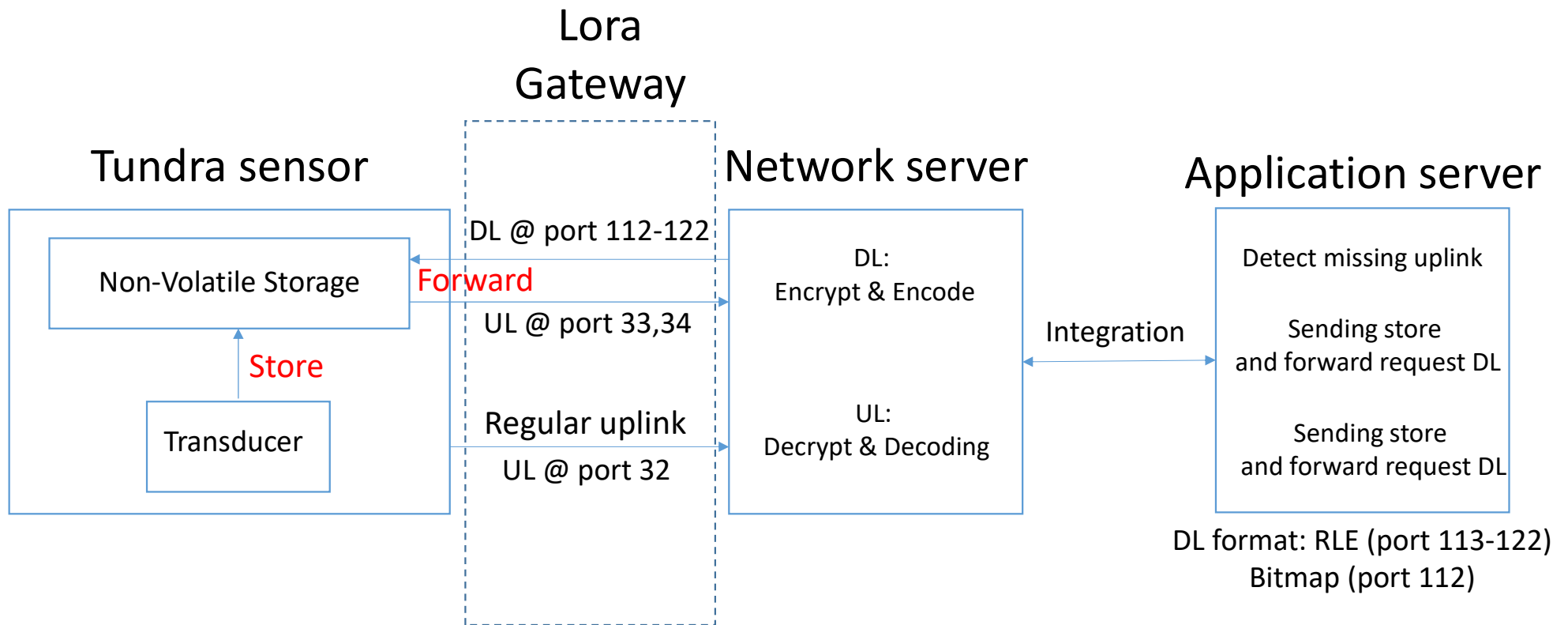
- Mobile device, a moving device may leave LoRaWAN network coverage and then re-enter (for example, delivery from a factory to a retail location)
 - both the factory and the retail location have LoRaWAN coverage
 - The Tundra sensor is reporting temperature every hour and the delivery takes 4 hours
 - About 4 hours = 4 uplinks are expected to be lost at their original measurement time but available for retrieval once the tundra enters LoRaWAN coverage at the retail location
 - In this way the quality of the delivery can be measured – the product temperature was or was not within the proper temperature range during delivery
- Network Outage
 - A location is equipped with several Tundra devices reporting every 15 minutes
 - There is a site wide outage (network or power) that results in gateways not being operational for 1 hour
 - About 1 hour = 4 uplinks are expected to be lost at their original measurement time but available for retrieval once the gateways recover
 - In this way the product temperature can be reviewed to determine if the outage impacted its quality
- Occasional missed LoRaWAN packet (due to RF reasons)
 - The application can request a re-transmission of any missed tag that is observed
 - This case can also be solved by more frequent periodic reporting

Store and Forward – Application hints

Cloud based Application

- S&F uplink packet communication takes place on port 32 for initial packets; ports 33 and 34 for retransmitted packets, errors are reported on port 14
- Tag values should be observed of port 32 communications and missing tags noted
 - Action is required when missing tag(s) are observed.
 - Create and queue a downlink to request missing tags, this will be delivered to Tundra after next UL
- Missing tags will be sent as uplinks on ports 33 and 34
 - Note: these ports cannot be reassembled by data converters and must be done by application
 - full packet is recreated by combining initial port 33 UL with following port 34 ULs with the same missing tag id until N bytes are received, Care should be taken to not create overlapping/conflicting requests
 - If this recreation is not successful (i.e., a retransmitted packet is lost) the DL request needs to be repeated. Note: this error detection can be helped by observing LoRaWAN UL FCnt values.
 - Raw format of the set of missed tags can then be created (in the original port 32 format)
 - <tag, telemetry payload>, <tag, telemetry payload>, for each tag requested
 - When periodic ULs are used, the time of measurement for each missed tag is known by its tag number
- Error messages related to bad tag requests are transmitted on port 14
 - This is only expected to happen if a "empty/not yet used" tag is requested
 - Recommend to create log messages/alerts when this happens
 - Probably only expected to happen during debugging

S&F – High Level View



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