Testing of Application:

Firmware Updates Over The Air (FUOTA)

Application Note

RWC5020A/B and PC Application Software

RAN1990001

Background

The ability to update devices remotely is critical for the IoT, where many sensors are in remote or difficult locations to reach but may require updating. Making FUOTA part of the specification contributes towards future-proofing LoRaWAN and ensuring that LoRaWAN devices will continue to operate over long lifetimes.

Together, the new specifications enable FUOTA, however, three separate specifications (message fragmentation, multicast, and clock synchronization) have been issued because each can be used independently. For example, remote multicast setup protocol can be used standalone to send messages to a group of end-devices; fragmentation can be used on its own to send a large file to a single end-device (unicast); and time synchronization also can be used as a standalone capability.

The FUOTA architecture is shown in Fig 1, where the interfaces with dotted lines are outside the scope of the LoRa Alliance and the interfaces with straight lines are handled by the LoRa Alliance specifications.

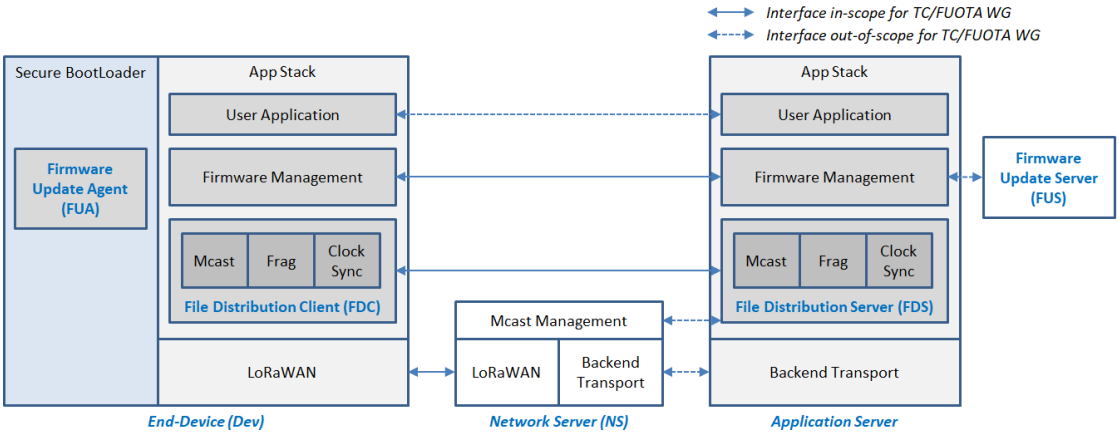

Fig 1. FUOTA Architecture

Message Fragmentation

Normally, the size of firmware binary data (X KBytes) is larger than what can be transmitted in LoRaWAN Packets. Therefore, fragmentation should be used for FUOTA.

LoRaWAN Alliance proposes a simple Forward Error Correction (FEC) code to be used for fragmented transport of large binary files over LoRaWAN. As all radio link, a LoRaWAN link exhibit a certain ratio of lost frames. Adding FEC in the file fragmentation process allows an end-device to autonomously recover the full file even in the presence of lost frames without having to systematically request the missing fragments. The transmitter of the fragmented binary file can select to add an arbitrary redundancy to the transmission content through this FEC. For example a 10% redundancy added by the fragmentation transmitter allows the receiver performing the defragmentation to loose roughly 10% of the incoming frames and still be able to reconstruct the binary file.

Unicast / Multicast

LoRaWAN networks connect thousands of devices deployed in the field supporting customer applications. LoRaWAN's data rate is relatively slow, so upgrading many DUTs one by one (Unicast) is very inefficient and takes too much time. To overcome this issue, a multicast method with Class B or C session is proposed to upgrade many DUTs at the same time.

Multicast function performs the following operations on a fleet of end-devices

- Program a multicast distribution window into a group of end-devices
- Having all end-devices of the group switch to Class B or Class C temporarily at the beginning of the slot
- Close the distribution window and revert to normal operation (e.g. return to Class A, or change to a different periodicity in Class B)

All end-devices should be switched to Class B or Class C session at the same time, Clock Synchronization should be performed first.

Clock Synchronization

It allows to synchronize the real-time clock of an end-device to the network's GPS clock with second accuracy. Synchronizing the end-device(s) clock is very useful of many applications like:

- Get all end-devices of a multicast group switching to class C temporarily and synchronously at the beginning of the slot
- Get many sensors to synchronously perform a measurement (get water meter reading of all meters at midnight every day for example)
- Enabling end-devices to transmit time-stamped events (the door was opened this morning at 8:00AM) with a unified clock

FUOTA test using RWC5020A/B with PC application program

RedwoodComm provides two kinds of FUOTA test function. The first one is Unicast Method which just uses data fragmentation to send user's firmware file. The other one is Multicast Method which uses Clock synchronization, Multicast, and Data fragmentation. The System block diagram is as follows.

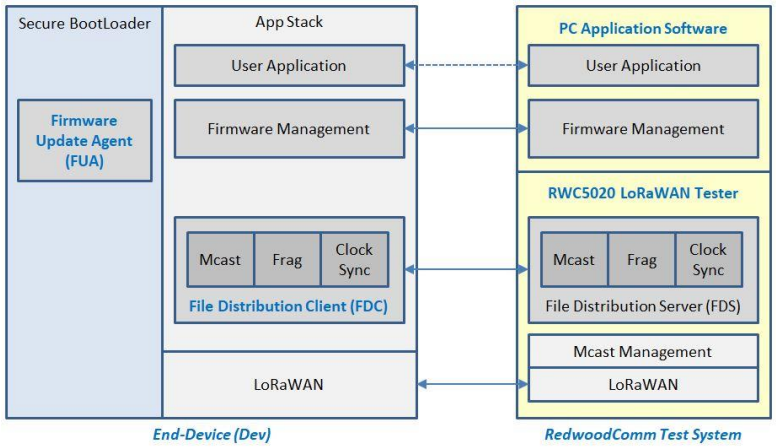

Fig 2. RedwoodComm Test System for FUOTA Test

PC Application

FUOTA can be tested using the PC application program. The GUI of PC application program is as follows.

User can load the firmware binary file for FUOTA test. Fragmentation parameters as well as Multicast parameters are editable using this GUI. As mentioned above, Multicast function is optional. The clock Synchronization function will be performed automatically when Multicast function is selected.

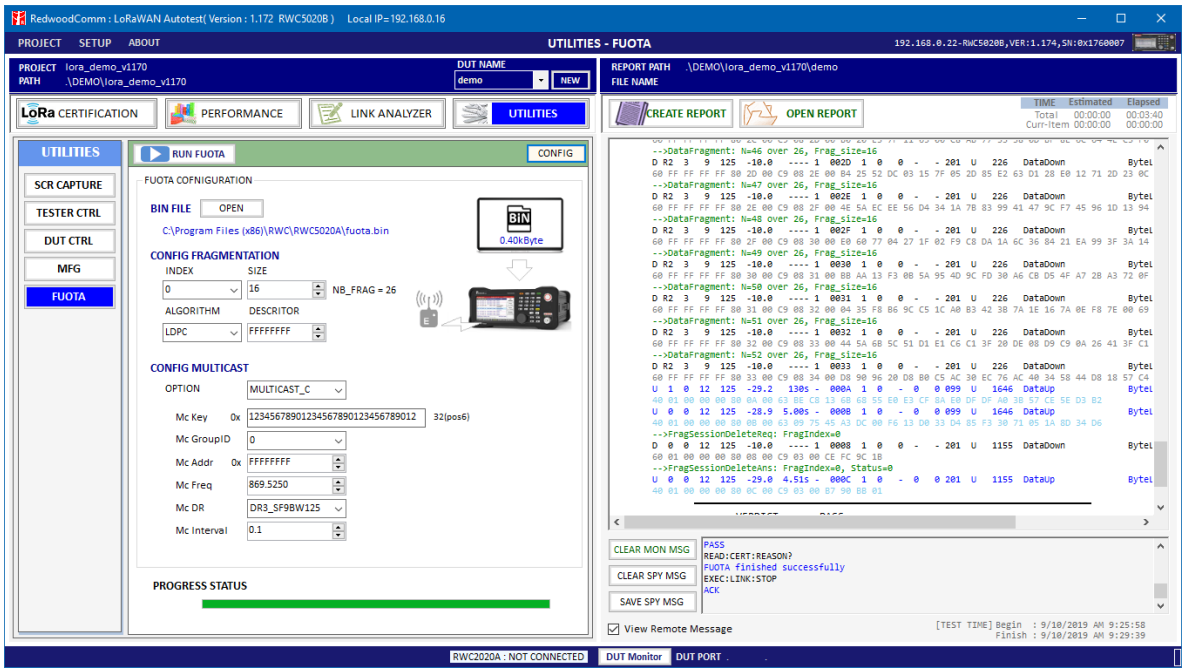

Fig 3. FUOTA Test Screen

Parameter setup

There are two sorts of parameters; common ones for all tests and dedicated ones for each test.

FRAGMENTATION parameters

INDEX
This value identifies one of the 4 fragmentation sessions possible simultaneously. RWC supports only one fragmentation at a time.

SIZE
This value is the size in byte of each fragment. The number of fragments will be calculated and displayed automatically.

ALGORITHM
The LoRa Alliance proposes LDPC as a simple Forward Error Correction (FEC) code to be used for fragmented transport of large binary files over LoRaWAN.

DESCRIPTOR
This value is a freely allocated 4 byte field describing the file that is going to be transported through the fragmentation session.

MULTICAST parameters

OPTION
Select Unicast or Multicast method for FUOTA test.

Mc Key
Multicast Key value which will be distributed into the group of end-devices. The McAppSKey and McNetSKey are derived from the group's McKey.

Mc GroupID
An end-device may support being part of several multicast group simultaneously. Therefore, all multicast related command must always contain McGroupID of the multicast group being affected. RWC supports only one Multicast at a time.

Mc Addr
This value is the multicast group network address.

Mc Freq
This value is the frequency used for multicast.

Mc Addr

This value is the data rate used for multicast.

Mc Interval

This value is the interval between consecutive downlink messages within the multicast session to transmit user binary data.

Test Procedures

The message sequence charts are shown below for Multicast Test and Unicast Test respectively.

Multicast Test

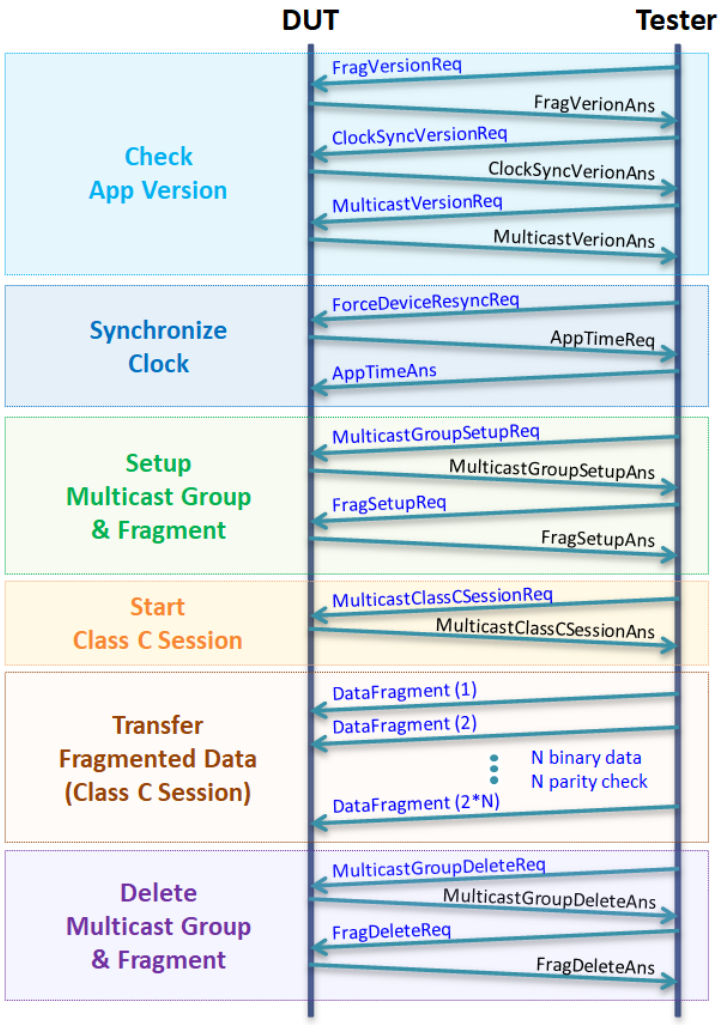

Fig 4. Multicast Test Procedure

Unicast Test

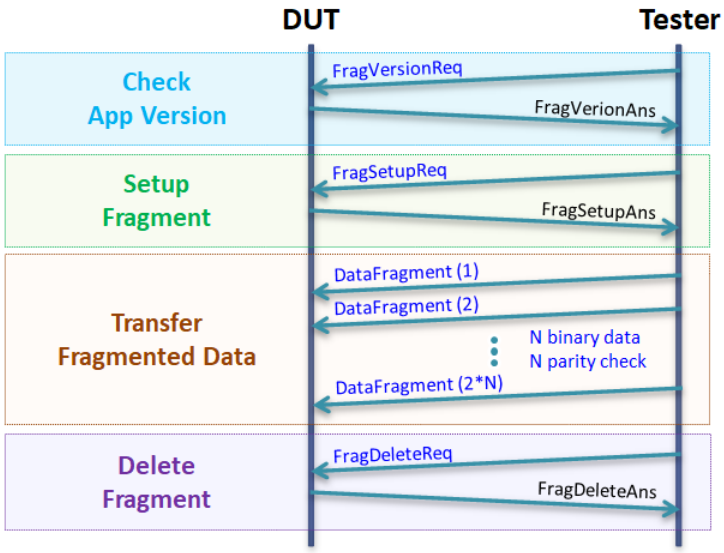

Fig 5. Unicast Test Procedure

References

[1] LoRa Alliance® Resources, *FUOTA Process Summary Technical Recommendation TR002 v1.0.0*

[2] LoRa Alliance® Resources, *LoRaWAN® Application Layer Clock Synchronization Specification v1.0.0*

[3] LoRa Alliance® Resources, *LoRaWAN® Remote Multicast Setup Specification v1.0.0*

[4] LoRa Alliance® Resources, *LoRaWAN® Fragmented Data Block Transport Specification v1.0.0*