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Revision History

Version	Date	Status	Editor	Comments
1.0	Nov 29, 2019	Released	A.Narayanan	Updated name Pico to Micro Lite, added details about format new configuration files
1.1	Feb 07, 2020	Released	A. Naryanan	Fixed formatting issue that caused some pages to be blank

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1 Introduction

This guide provides step by step instructions on how to reconfigure the Micro lite gateway (formerly known as Kona Pico) to connect to a server of your choice. Additionally it provides firmware upgrade procedure and troubleshooting tips.

If you are setting up the Micro lite gateway for the very first time, please refer to Kona Micro Lite User Guide [1] before you proceed with reconfiguring the gateway.

1.1 Product description

Kona Micro Lite gateway is a compact and cost effective LoRa base station for IoT applications. The product is designed to operate in the Industrial, Scientific and Medical (ISM) Band. The gateway supports two configuration options for backhaul connection, namely Ethernet only and Ethernet/Wi-Fi (optional).

LoRaWAN™ is a Low Power Wide Area Network (LPWAN) specification intended for wireless battery operated things in regional, national or global network. LoRaWAN target key requirements of internet of things such as secure bi-directional communication, mobility and localization services.

Gateway is designed for indoor use to provide good coverage within and around the building. It can simultaneously receive on eight 125-kHz channels and one 500-kHz uplink channel. Gateway supports a maximum transmit RF conducted power of +27 dBm.

Table 1: Kona Micro Lite Gateway Models

Product Code	Description	RF Region
T0004471	LORA GATEWAY MODULE, KONA PICO, NA, EXTERNAL ANTENNA	NA
T0004599	LORA GATEWAY MODULE, KONA PICO, EU, EXTERNAL ANTENNA	EU

2 Gateway setup

Follow the below diagram to setup the gateway. Make sure that the Ethernet cable and LoRa antenna are connected to their respective ports on the gateway.
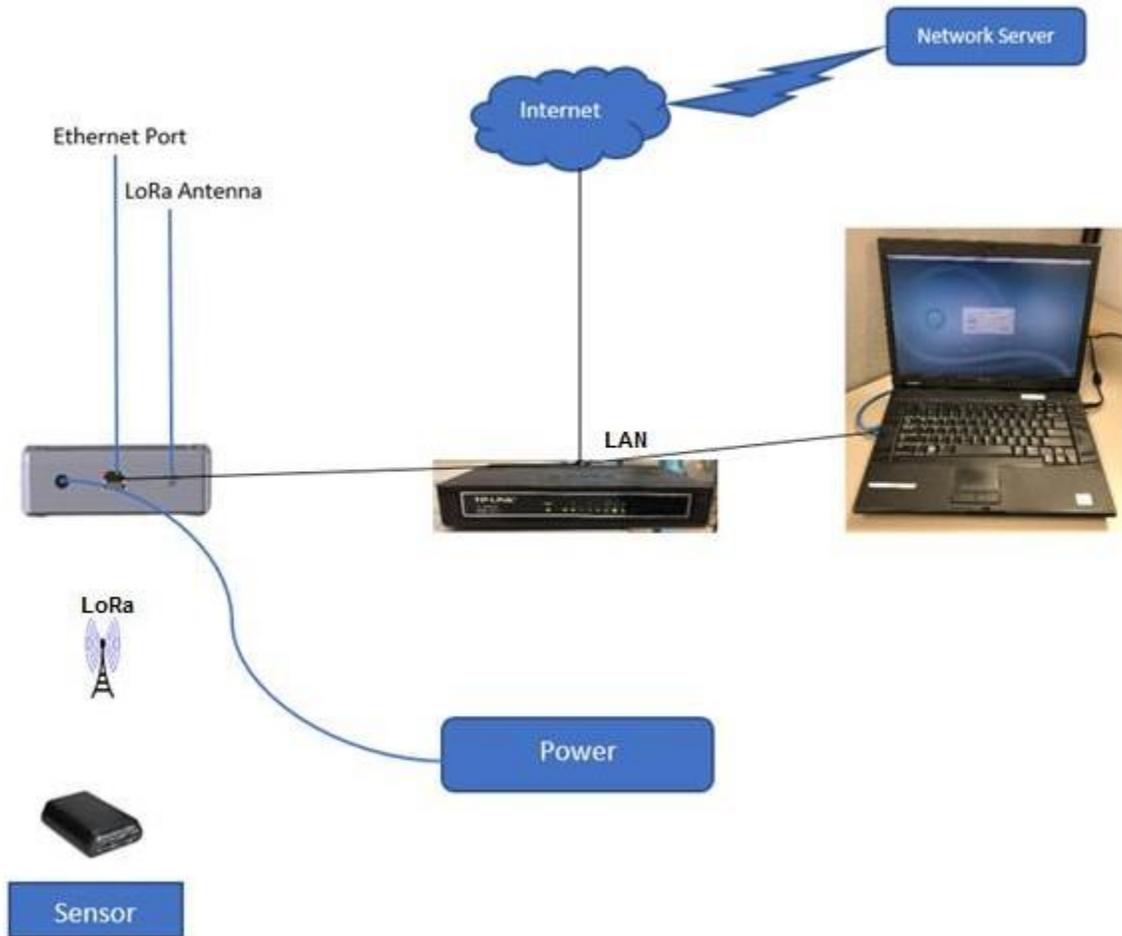
Figure 2: Gateway Setup

2.1 Finding Gateway IP

1. Connect the gateway to the local network using Cat 5E cable.

2. Power ON the gateway and ensure that it gets an IP from the DHCP sever (Power led blinks few times and then stays ON when IP has been acquired).

3. Install KonaFT software on Windows PC using the installer available on the Tektelic support portal.

4. Obtain the IP address assigned to the gateway using KonaFT

   a) You can scan your network for gateways using the 'Find My Gateway' feature of KonaFT tool. Access it from the top menu Tools -> Find My gateway.

   b) It provides a list of IPs of all Tektelic GWs and corresponding MAC address connected to your network.

   c) MAC address of your GW is shown on the label on the bottom side of the gateway.
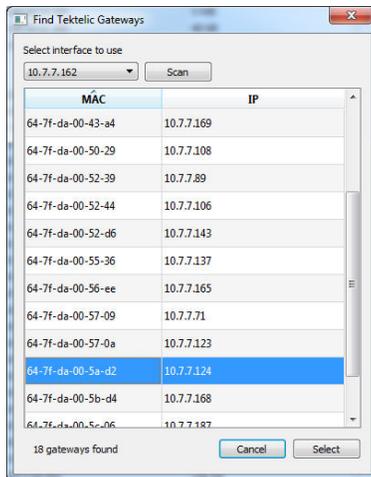
Figure 2: Find My Gateway

NOTE: Gateway management features of KonaFT are <u>not supported</u> by Micro Lite gateway. Firmware upgrade and re-configuration of the gateway is performed using a TFTP client as detailed later in this document.

3   Upgrading the Gateway firmware

Micro Lite Gateway is shipped with latest the firmware (semtech-vx.xx.bin) that includes the UDP packet forwarder that supports Semtech protocol version 2.0.

1. Obtain the IP address of your gateway as described in section 2.1.

2. Use any TFTP client to PUT the Gateway.bin (or semtech-vx.xx.bin) file to the gateway as shown in Figure 1

   Eg: http://tftpd32.jounin.net/

3. Gateway reboots after a successful firmware upgrade, otherwise a TFTP error is reported and gateway continuous to operate with the old firmware.
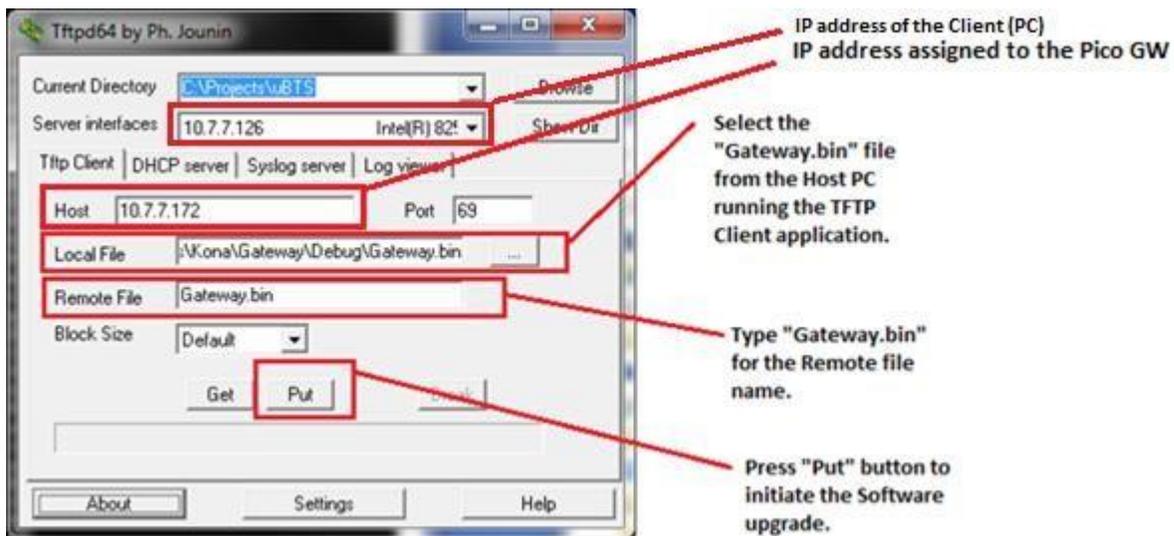
Figure 1 TFTP client settings

5. See section 5.6.1.1 for TFTP troubleshooting tips.

   Note: The version of firmware currently installed on the gateway can be read back by using TFTP GET of Status.json. See section 0 for instructions on reading configuration files from the gateway.

4 Network servers

This section describes the steps required to connect your gateway to various network servers. Micro Lite gateway is configured by default to connect to Tektelic network server unless the gateway is custom ordered with specific configuration. Micro lite can be reconfigured to work with various network servers using the default Semtech packet forwarder (UDP) installed on the gateway as shown in Table 2. More details on the configuration of the gateway is given in section 5

Micro Lite gateway can also support other custom packet forwarder formats required by network servers (Tektelic (mqtt), Actility, Orbiwise and TTN (mqtt)) using custom firmware. Custom firmware and instruction for configuring the firmware can be obtained through a support ticket.

Table 2: Network servers supported by the UDP forwarder

Network Server	Customer.json

TEKTELIC	```{```
	    ```"network": "semtech",```
	    ```"semtech": {```
	        ```"host": "lorawan-ns-na.tektelic.com",```
	        ```"up_port": 1700,```
	        ```"down_port": 1700```
	    ```}```
	```}```

LORIOT	```{```
	    ```"network": "semtech",```
	    ```"semtech": {```
	        ```"host": "us1.loriot.io",```
	        ```"up_port": 1780,```
	        ```"down_port": 1780```
	    ```}```
	```}```

TTN	```{```
	    ```"network": "semtech",```
	    ```"semtech": {```
	        ```"host": "router.us.thethings.network",```
	        ```"up_port": 1700,```
	        ```"down_port": 1700```
	    ```}```
	```}```

ChirpStack (open source LoRaWAN network-server)	```{```
	    ```"network": "semtech",```
	    ```"semtech": {```
	        ```"host": "192.168.1.5",```
	        ```"up_port": 1700,```
	        ```"down_port": 1700```
	    ```}```
	```}```

4.1   TEKTELIC Network Server

Gateways are configured to automatically connect to Tektelic network server unless specifically requested by the customer to pre-configure the gateways to a different network server. See Tektelic LoRaWAN Network Server Guide [2] for details on how to view/ add gateways and LoRa devices on the network server.

If the gateway has been to be reconfigured to work with a different server and needs to be switched back to Tektelic network server, use the following steps:

1. Update the Gateway firmware to semtech-vx.xx.bin

2. Update Customer.json file with the correct server address and port to match your server instance. See Table 2 for a sample configuration.

3. Upload the updated Customer.json to the gateway

4. Power cycle the Gateway for the new configuration to take effect.

4.2   LORIOT Network Server

The details on how to register a gateway on the LORIOT server can be found in the network server documentation [3]. The steps to configure a Pico Gateway to connect to LORIOT server are described here:

1. Update the Gateway firmware to semtech-vx.xx.bin

2. Update Customer.json file with the correct server address and port to match your server instance. See Table 2 for a sample configuration.

3. Upload the updated Customer.json to the gateway

4. Power cycle the Gateway for the new configuration to take effect.

4.3   The Things Network

This section will guide you through registration of a gateway and node (LoRa device) on The Things Network.

1. You need a TTN account, register it here:

https://account.thethingsnetwork.org/

2. Register the gateway using link:

Register the GW at https://console.thethingsnetwork.org/gateways

It is important to select the "I'm using the legacy packet forwarder" option. The EUI is the GW ID printed on the gateway label. It is of the format "64 7F DA FF FE XX XX XX".

3. Pick right TTN router host from documentation page:

Pick the router from https://www.thethingsnetwork.org/wiki/Backend/Connect/Gateway

Choice depends on the band. E.g., for NA band, you need: router.us.thethings.network.

4. Create Customer.json with following format:

For example:

```
{
        "network": "semtech",
        "semtech": {
                "host": "router.us.thethings.network ",
                "up_port": 1700,
                "down_port": 1700
        }
}
```

5. Upload Customer.json using tftp.

See section 0 for detailed instructions on how to upload Customer.json.

6. Upload LoRaWAN.json using tftp

Depending on the region, the things network expects the Gateway to listen on different channel plans. Identify the channel plan required from TTN documentation and modify the LoRaWAN.json. See section 0 for detailed instructions on how to modify and update LoRaWAN.json.

Note: TTN networks uses the second set of 8 channels (903.9MHz-905.3MHz), but Pico Gateway uses the first 8 channels by default. So LoRaWAN.json needs to be updated as shown below

```
{
        "radio":
                        [
                                {
                                "enable":true,
                                "freq":904300000
                                },
                                {"enable":true,
                                "freq":905000000
                                }
                        ]
}
```

7. **Go to the TTN website and check gateway status:**

Under https://console.thethingsnetwork.org/gateways/ select your gateway and check `Last Seen` field. It should display something like `Last Seen 26 seconds ago`.

Now, if the gateway is successfully seen in the TTN, it is time to add some LoRa devices:

8. **Create application in the TTN as described in the documentation:**

    https://www.thethingsnetwork.org/docs/applications/add.html

9. **Get AppEUI, DevEUI, AppKey for device you want to connect.**

The EUIs and Keys should be obtained from the device vendor.

10. **Modify AppEUI on the server to match the device.**

Modify AppEUI using Settings tab under the application page, using values, obtained on step 11. Use this page to modify AppEUI:

https://console.thethingsnetwork.org/applications/%application_id%/settings/euis

where %application_id% is the application ID, chosen on step 10.

11. **Add devices to the application, using Devices tab under application page.**

On the device page, click Settings tab and modify AppKey and DevEUI using values obtained on step 11. By default, the device is configured for OTAA (over-the-air activation) not APB (activation-by-personalization).

12. **Turn ON the LoRa device.**

You should be able to see device communicating with TTN on the Data tab.

4.4   ChirpStack (open source LoRaWAN network-server)

The steps to configure a gateway to the ChirpStack server are described here:

1. Update the Gateway firmware to semtech-vx.xx.bin

2. Update Customer.json file with the correct server address and port to match your server instance. See Table 2 for a sample configuration.

3. Upload the updated Customer.json to the gateway

4. Power cycle the Gateway for the new configuration to take effect.

Note: Before you try to connect the gateway , ensure that your instance of ChirpStack server (including the ChirpStack Gateway Bridge) is installed on a network accessible to the gateway. Network server documentation can be found on the website [4]

5 Reconfiguring the gateway

This section goes into details of various configuration files supported and steps for updating the configuration. See details of the configuration files in section 5.1.

5.1 Configuration files

Proper operation of the gateway requires that it be configured correctly. Such configuration includes the parameters and data required for the gateway to function as a packet forwarder within a customer's LoRa WAN network.

Each gateway maintains a permanent (non-volatile) copy of its configuration in flash. At start-up (system boot), the gateway software loads the permanent copy of the configuration to its internal (SRAM) memory for use at run-time. When configuration files are updated, the gateway should be restarted to ensure that the new configuration is in effect.

Configuration files from the gateway can be read back using TFTP GET. See section 0 for instructions to read back configuration files. In general, it is recommended that the default configuration file be read from the gateway (as a backup) before any change is made to the gateway.

A summary of configuration files supported by the gateway is shown in Table 3 . A complete list of configuration files is documented in the Tektelic Support Portal.

Table 3: Configuration files supported by the gateway

New Remote file name	Legacy file name Not supported from semtech-v1.7.bin	Access	Description
Customer.json	Customer_conf.json	Read/Write	The customer (network) configuration, which specifies the environment in which the gateway is expected to operate. E.g., the DNS name of the network server(s) to/from which LoRa WAN packets must be forwarded appears as part of the customer (network) configuration.
LoRaWAN.json	lorawan_conf.json	Read/Write	The LoRa WAN (radio) configuration, which describes how to configure the 8-channel gateway concentrator (SX1308) when such configuration is not provided by the network server.
Basic.json	basic_conf.json	Read	The basic (board) configuration, which identifies and describes the Gateway hardware. E.g., the serial number of the Gateway appears as part of the basic (board) configuration.
CaRootCertificate.pem	gateway_ca_root_cert.pem	Write	The CA root certificate(s) to be used in authenticating the network (and other) server(s), as needed/supported.
Certificate.pem	gateway_cert.pem	Write	The (gateway) certificate to be used in authenticating the gateway itself to the network (and other) server(s), as needed/supported.
PrivateKey.pem	gateway_key.pem	Write	The (gateway) private key to be used in securing communications with the network (and other) server(s), as needed/supported.
Site.json	-	Read/Write	Stored site (GW location specific) configuration- SNTP Server url, GPS location, Ethernet link retry timeout
Status.json	-	Read	Reports version of currently installed gateway firmware. Only supported on firmware version semtech-v1.7.bin and above

Note 1: Read access through TFTP GET is only available when new Remote file name is used.

Note 2: If the firmware programmed on the Pico Gateway and the configuration used don't match the system LED will blink at a slow rate while the gateway is waiting for a valid configuration file. See Table 2 for valid configuration file and firmware combinations.

Note 3: There are small differences in the format of old and new configuration files. Semtech-v1.7.bin does support old config files that are stored in the gateway, so reconfiguration of old gateways is not required when upgrading firmware to Semtech-v1.7.bin.

5.2 Reading back configuration files

Configuration file shown in Table 3 that have read access can be downloaded to a PC from the gateway using TFTP GET. Note that the remote file name should use the new file names as shown in Table 3.

For e.g: to download Customer.json (old name: Customer.json), the remote file should be set to *Customer.json.* See Figure 2 for the settings required on the TFTP client tab to perform a TFTP GET.
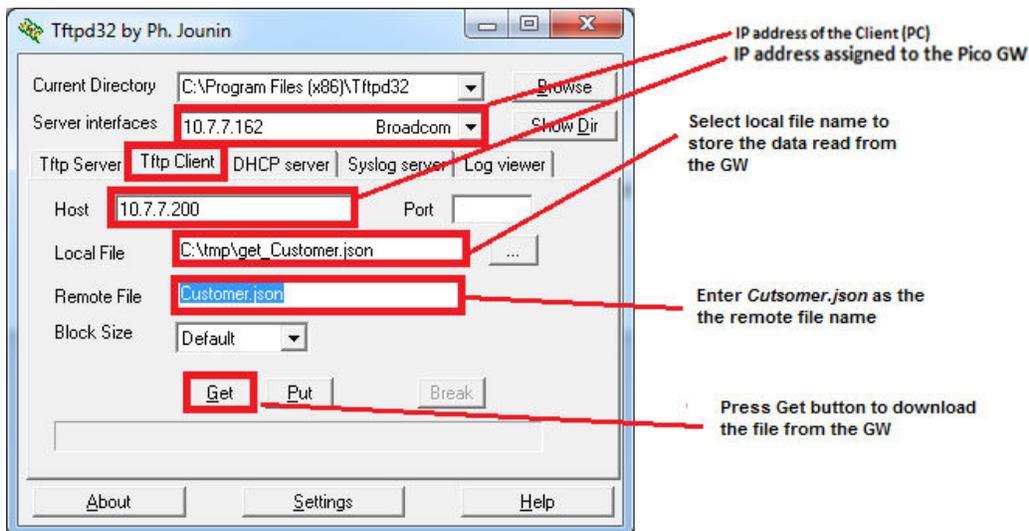
Figure 2 tftp client settings for downloading Customer.json

5.3 Converting old configuration files to the new format

There are small differences in the format of old and new configuration files listed in Table 3. Although Semtech-v1.7.bin supports old config files that are stored in the gateway, some new features may require one to use the new format. Configuration file formats are documented in the readme-config-vx.xx [5]

The easiest way to update the format of you custom configuration file is to read back the config file using TFTP GET from your gateway as described in the previous section.

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5.4 Updating Customer.json

Customer.json file needs to be updated when the gateway needs to connect to a new network server. A list of sample Customer.json is shown in Table 2

1. The instructions are similar to steps in section 3. See Figure 3 for the settings required on the TFTP client tab to upgrade the Customer.json.
2. After upgrading the Customer.json, power cycle the board for the settings to take effect.
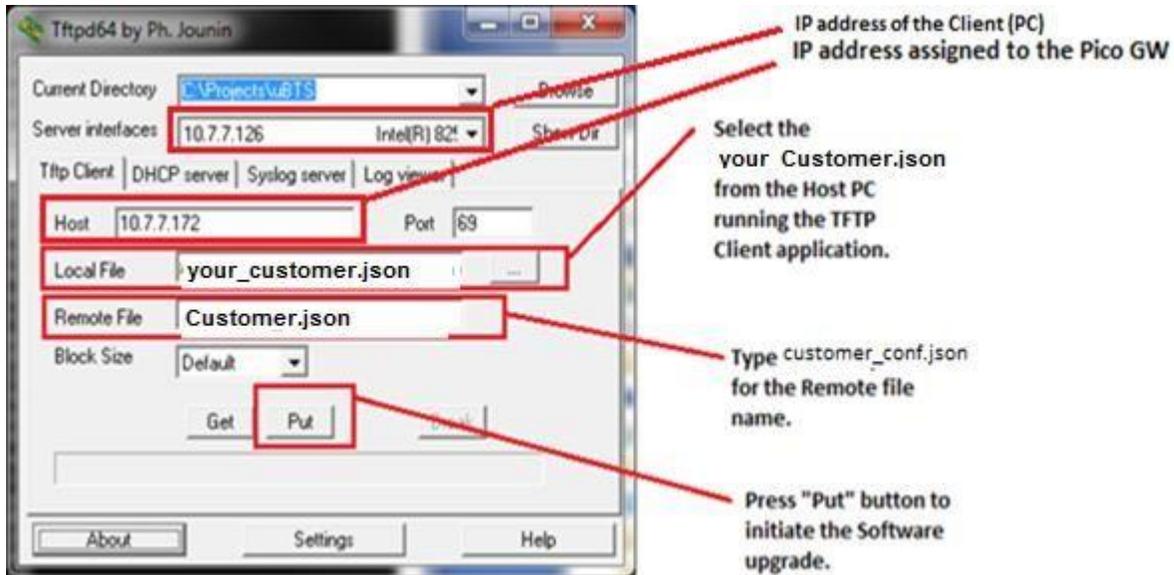
Figure 3 Tftp client settings for updating Customer.json

Once the Customer.json has been updated the Gateway needs to be power cycled for the settings to take effect. At this point the GW is ready to connect to the network server, however, depending on the network server the GW ID/ MAC address needs to be registered on the server to authenticate the GW. The procedure for registering/authenticating a gateway is specific to the networker server and usually requires login credentials to access the documentation [3] [6] [7] [2]

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5.5   Updating LoRaWAN.json

The default to receive channels to which Pico Gateway is configured is shown in Table 4 . The Gateway can be configured to listen to different channels by changing the *LoRaWAN.json* file. The LoRa WAN (radio) configuration is delivered by means of a JSON string having the following format (see the inline comments and notes below for description of the JSON string). LoRaWAN.json file has no effect when using Orbiwise server as the frequency plan is set by the server during GW initialization.

The instructions for updating LoRaWAN.json would be same as the steps described in section 3, one exception being the remote file name which needs to be set to *LoRaWAN.json* in the TFTP client.

Table 4: Default channel plan configured on the gateway

Frequency Variant	Default Channel Plan
NA[1]	125KHz Rx channels (MHz): 902.3, 902.5, 902.7, 902.9, 903.1, 903.3, 903.5,903.7 500KHz Rx channels (MHz): 903.0 SF8 only
EU	125KHz Rx channels (MHz): 867.1, 867.3, 867.5, 867.7, 867.9, 868.1, 868.3, 868.5 250KHz Rx channels (MHz): 868.3 SF7 only

Note: Comments are only shown for clarity. Comments are not supported in the *LoRaWAN.json*

```
{
      "public":true,
      "radio":     /* an array of up to two (2) entries */
          [
                  {
                  "enable":true/false,
                  "freq":n,              /* in Hz */
                  }
                  /* etc. */
          ],

          "lora_multi":          /* an array of up to eight (8) entries */

          [
                  {
                  "enable":true/false,
                  "radio":0-1,
```

---

[1] Default NA channel plan doesn't work with TTN network. See section 1.1 for the correct lorwan_conf settings.

```
                    "offset":+/-n,
                    /* an empty string denotes the default bandwidth */
                    "bandwidth":""/"125kHz",
                "sf7":true/false,"sf8":true/false,"sf9":true/false,"sf10":true/false,"sf11":true/false,"sf12":true/false,
                    },

                    /* etc. */
            ],

     "lora_std":
            {
                "enable":true/false,
                "radio":0-1,
                "offset":+/-n,
                /* an empty string denotes the default bandwidth */
                "bandwidth":""/"125kHz"/"250kHz"/"500kHz",
                /* an empty string denotes the default spread factor */
                "spread_factor":""/"SF7"/"SF8"/"SF9"/"SF10"/"SF11"/"SF12",
            },

     "fsk":
            {
                "enable":true/false,
                "radio":0-1,
                "offset":+/-n,
                /* an empty string denotes the default bandwidth */
                "bandwidth":""/"7.8kHz"/"15.6kHz"/"31.2kHz"/"62.5kHz"/"125kHz"/"250kHz"/"500kHz",
                "datarate":0/500-250000
            }
    }
```

JSON 1 LoRaWAN.json

Notes:

1. The shape of the JSON string was designed to prevent errors. That said, the values are validated only when the configuration is applied to the 8-channel gateway concentrator (SX1308) using the HAL. As a result, it is possible in some cases to specify a value that the HAL will reject (e.g., an FSK data rate of 250).
2. The shape of the JSON string does not permit the configuration of some of the parameters supported by the HAL. Such parameters are a function of the hardware. E.g., radio A (radio 0) is the clock source on the Pico Gateway, but radio B (radio 1) serves this purpose on the Semtech evaluation board.
3. **Disabling all of the spread factors (sf7-sf12) for a LoRa multi-SF (spread factor) channel (IF) results in the HAL using the default set of spread factors, which (paradoxically) corresponds to enabling all of the spread factors.**

A sample *LoRaWAN.json* file that configures the Gateway to first 8 channels of Lora US band is shown below

```
{
"public":true,
"radio":
                [
                                {
                                "enable":true,
                                "freq":902700000
                                },
                                {"enable":true,
                                "freq":903400000
                                }
                ],
"lora_multi":
                [
                                {
                                "enable":true,
                                "radio":0,
                                "offset":-400000,
                                "bandwidth":"",
                                "sf7":false,
                                "sf8":false,
                                "sf9":false,
                                "sf10":false,
                                "sf11":false,
                                "sf12":false
                                },
                                {
                                "enable":true,
                                "radio":0,
                                "offset":-200000,
                                "bandwidth":"",
                                "sf7":false,
                                "sf8":false,
                                "sf9":false,
                                "sf10":false,
                                "sf11":false,
                                "sf12":false
                                },
                                {
                                "enable":true,
                                "radio":0,
                                "offset":0,
                                "bandwidth":"",
                                "sf7":false,
                                "sf8":false,
                                "sf9":false,
                                "sf10":false,
                                "sf11":false,
                                "sf12":false
                                },
                                {
                                "enable":true,
                                "radio":0,
```

```
"offset":200000,
"bandwidth":"",
"sf7":false,
"sf8":false,
"sf9":false,
"sf10":false,
"sf11":false,
"sf12":false
},
{
"enable":true,
"radio":1,
"offset":-300000,
"bandwidth":"",
"sf7":false,
"sf8":false,
"sf9":false,
"sf10":false,
"sf11":false,
"sf12":false
},
{
"enable":true,
"radio":1,
"offset":-100000,
"bandwidth":"",
"sf7":false,
"sf8":false,
"sf9":false,
"sf10":false,
"sf11":false,
"sf12":false
},
{
"enable":true,
"radio":1,
"offset":100000,
"bandwidth":"",
"sf7":false,
"sf8":false,
"sf9":false,
"sf10":false,
"sf11":false,
"sf12":false
},
{
"enable":true,
"radio":1,
"offset":300000,
"bandwidth":"",
"sf7":false,
"sf8":false,
"sf9":false,
"sf10":false,
"sf11":false,
"sf12":false
}
```

```
                    ],
"lora_std":
                    {
                    "enable":true,
                    "radio":0,
                    "offset":300000,
                    "bandwidth":"500kHz",
                    "spread_factor":"SF8"
                    },"fsk":
                    {
                    "enable":false,
                    "radio":0,
                    "offset":300000,
                    "bandwidth":"250kHz",
                    "datarate":100000
                    }
}
```

5.6 Troubleshooting configuration issues

5.6.1.1 TFTP error codes

When the configuration files are successfully transferred via TFTP a confirmation message similar to one shown below is returned by the TFTP client
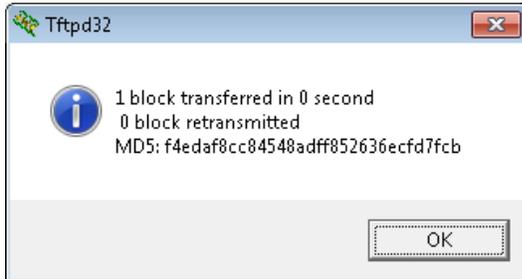

Figure 4 Successful TFTP transfer

Otherwise, if an error message like the one shown below is reported or the TFTP client hangs without completing the transfer then the following steps can be used to troubleshoot the issue.
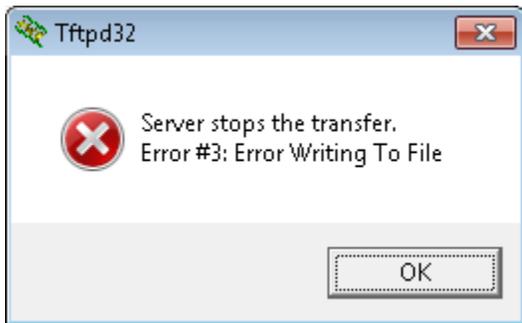

Figure 5 Unsuccessful TFTP transfer

1. Ensure that the IP address of the gateway is correctly entered

2. Ensure that "remote file" name is specified correctly. For e.g. in the case of firmware the remote file name is always Gateway.bin,

   a. *tftp -i 192.168.1.15 put Semtech-vxx.bin **Gateway.bin***

3. Ensure that the JSON string in the configuration file has no missing/extra braces or comas. Also check for any incorrect name/value pairs

   Note: During the TFTP transfer, the gateway also checks for valid JSON string and valid names before writing it to the non-volatile memory

4. Check the details of the error code returned by the TFTP client in

NOTE: the error code values are byte swapped and then displayed as decimal by some TFTP clients (observed by Mac users). Byte swapped value of the error codes are shown in parenthesis.

Table 5: TFTP error codes

Error Code	Error message	Error description
0	Not defined, see error message (if any)	"No TFTP Connections Available", i.e., transfer already in progress (max. 1 transfer at a time)
1 (256)	File not found	Remote file name doesn't match any of the valid files supported by the GW firmware
2 (512)	Access violation	TFTP PUT to file that only supports TFTP GET, vice-versa
3 (768)	Error writing to File	a. The transfer was invalid (e.g., Invalid JSON string, invalid configuration, invalid firmware binary). b. The transfer was too large (e.g., >0.5 MiB in case of software update, or >4KiB in case of configuration update).
4 (1024)	Illegal TFTP operation	Client is not following the protocol. E.g., Gateway received a message other than an ACK (or DATA) from the client when expecting an ACK (or DATA).

6 Frequency Ask Questions

Question	Solution
Gateway's System LED is flashing continuously, what does this mean?	Note that the slowly flashing system LED indicates that (outside) corrective action is needed - Slowly flashing system LED could indicate that gateway has not been able to successfully get an IP address or connect to the Network server. - The LED flashes at a high rate (roughly 5 Hz) while the gateway is obtaining an IP address via DHCP -The LED flashes during the TFTP transfer (i.e., while the software image is being transferred to the gateway). 1. Please check your DHCP logs to see if Pico Gateway has been issued an IP and try to ping the IP from a computer. 2. Ensure that the connection to network server is not blocked by your firewall. 3. Ensure that the firmware version used and the Customer.json match the network server you are using. See Table 2 for details.
How to find the MAC Address of the GW	The sticker at the bottom of the gateway shows the MAC ID. Typically it is formatted as 647FDAFFFE0000
What is the basic configuration that Pico GW comes with?	The Gateway is configured with the Semtech packet forwarder to talk to the Tektelic network Server, if you require a re-configuration to other network server, please see section 2
How to use Kona Field (KonaFT) management tool on Pico gateway	Kona Field management tool is not yet supported on Kona Pico Gateway, although you can still use it find the IP address of your Pico GW
Why is the TFTP transfer unsuccessful	See section 5.6.1.1 for details
Why is the sensor not joining the network or packets not showing up on the server although the Gateway's System LED is solid?	1. Ensure that the Sensor and Network sensor are set to same frequency plan as the gateway as shown in Table 4. a. LoRa LED will blink when gateway receives or transmits a packet. 2. Ensure that the sensor credentials have been correctly entered on the network server.

7 Bibliography

[1] "Kona Micro Lite User Guide," Tektelic, 2019.

[2] Tektelic, "LoRaWAN Network Server Guide," Tektelic, 2017.

[3] "loriot.io," [Online]. Available: https://loriot.io/.

[4] "chirpstack.io," chirpstack.io, [Online]. Available: https://www.chirpstack.io/.

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