Skywire® BeagleBone Cape Lite User Manual

NimbeLink Corp

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1. Introduction

1.1 Overview

This document is the System Reference Manual for the Skywire® BeagleBone Cape Lite. Throughout the document Skywire BeagleBone Cape Lite will often be referred to as 'the cape,' although it may be referred to by its full name.

The NimbeLink Skywire modem is available with bundled data plans from leading cellular carriers.

The Skywire cellular modem and antennas are sold separately.

Make sure you check NimbeLink's Skywire BeagleBone Cape Lite product page for the most up to date information.

1.2 Product Description

The Skywire BeagleBone Cape Light is a cape that allows easy access to the Internet of Things (IoT) via cellular connection. BeagleBone Black and BeagleBone Green are low-cost, community-supported development platforms that allows quick, easy application development. They accepts plug-in boards called “capes” that allow a wide variety of expanded capabilities. The Skywire BeagleBone Cape Light supports any of NimbeLink’s end-device certified Skywire plug-in cellular modems with optional bundled, no-contract cellular plans and in addition to cellular connectivity offers:

- Wide power supply input 5V-15V (12V recommended)
- Compatible with the BeagleBone Black, BeagleBone Black Wireless, and the BeagleBone Green.
- BeagleBone Green Wireless can be used with additional standoffs
- Two user populatable Grove sensor interfaces for easy sensor interfacing
- Fast, easy prototyping made possible by the Skywire BeagleBone Cape Light.

1.3 Orderable Parts

Number	Description	Manufacturer	Carrier	Network Type
NL-AB-BBCL	Skywire BeagleBone Cape Lite Development Kit	NimbeLink		
NL-SW-LTE-SVZM20	Skywire, 4G LTE CAT M1, Verizon, Engineering Sample	NimbeLink	Verizon	4G LTE
NL-SW-LTE-GELS3-C	Skywire, 4G LTE CAT 1, Verizon	NimbeLink	Verizon	4G LTE
NL-SW-LTE-WM14	Skywire, 4G LTE CAT 1, AT&T, T-Mobile	NimbeLink	AT&T, T-Mobile	4G LTE
NL-SW-LTE-TSVG	Skywire, 4G LTE CAT 3, w/ GNSS, Verizon	NimbeLink	Verizon	4G LTE
NL-SW-LTE-TNAG-B	Skywire, 4G LTE CAT 3, w/ GNSS, AT&T, T-Mobile	NimbeLink	AT&T, T-Mobile	4G LTE
NL-SW-LTE-S7588-T	Skywire, 4G LTE CAT 4, AT&T, T-Mobile	NimbeLink	Verizon	4G LTE
NL-SW-LTE-S7588-V	Skywire, 4G LTE CAT 4, Verizon	NimbeLink	AT&T, T-Mobile	4G LTE
TG.08.0113	Monopole Cellular Antenna	Taoglas		
TG.30.8113	Dipole Cellular Antenna	Taoglas		

1.4 Compatible BeagleBones

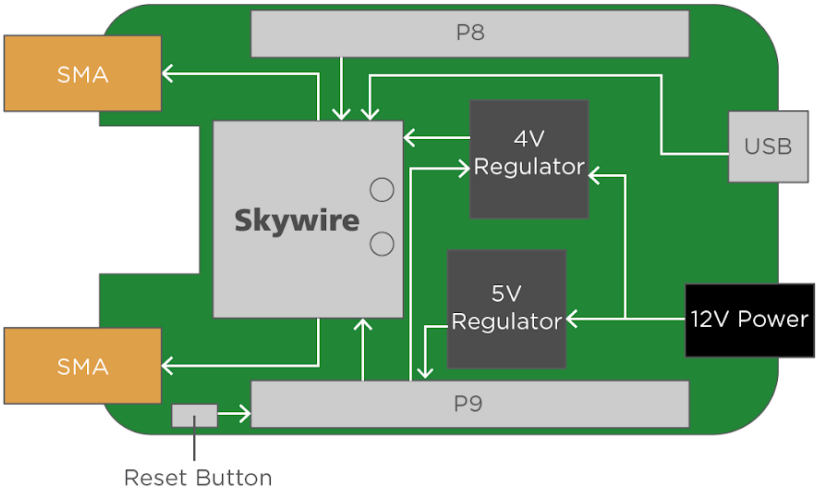
Number	Notes
BeagleBone Black	
BeagleBone Black Wireless	
BeagleBone Black Industrial	
BeagleBone Green	
BeagleBone Green Wireless	Users must use additional header standoffs. Recommended part: Adafruit 706

1.5 Additional Resources

- NimbeLink's Skywire BeagleBone Cape Lite Product Page
- NimbeLink's Skywire BeagleBone Cape Lite Device Tree Overlay
- NimbeLink's Skywire BeagleBone Cape Lite Schematic
- NimbeLink's Skywire BeagleBone Cape Lite Design Files

2. Technical Specifications

2.1. Block Diagram



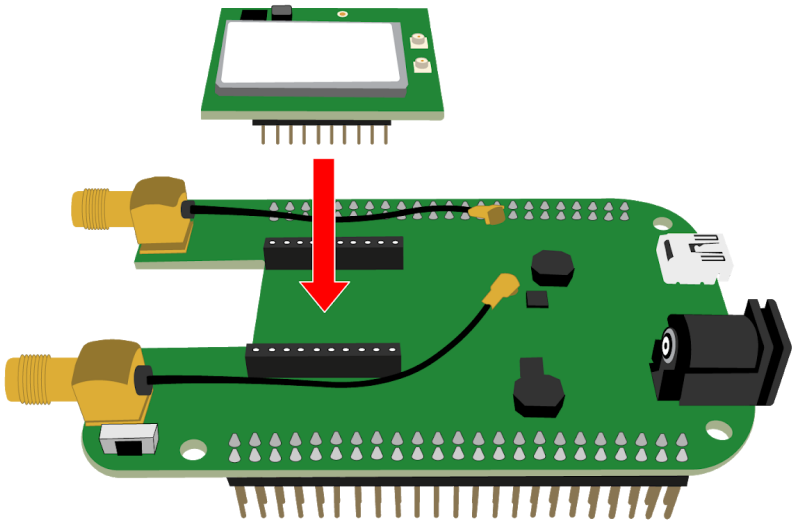
2.2. Pinout

PIN Name	Direction	GPIO Name	Connection	Notes
P9-11	Output	UART4_RXD	Skywire DOUT	
P9-13	Input	UART4_TXD	Skywire DIN	
P8-33	Input	UART4_RTS	Skywire RTS	
P8-35	Output	UART4_CTS	Skywire CTS	
P9-12	Input	GPIO1_28	Skywire DTR	
P9-15	Input	GPIO1_16	Skywire Reset	
P9-27	Input	GPIO3_19	Skywire ON-OFF	
P9-23	I/O	GPIO1_17	Skywire ADC	Not configured by DTO, not connected
P9-22	I/O	UART1_RXD	Skywire DIO2	Not configured by DTO, not connected
P9-24	I/O	UART1_TXD	Skywire DIO3	Not configured by DTO, not connected
P8-17	Input	GPIO_0_27	4V Regulator Enable	
P8-26	Output	GPIO1_29	4V Regulator PG	
P8-38	Output	UART5_RXD	Grove UART5 RX	Not configured by DTO
P8-37	Input	UART5_TXD	Grove UART5 TX	Not configured by DTO
P9-17	Input	I2C1_SCL	Grove I2C1 SDA	Not configured by DTO
P9-18	I/O	I2C1_SDA	Grove I2C1 SCL	Not configured by DTO
P9-19	Input	I2C2_SCL	I2C2 SCL	
P9-20	I/O	I2C2_SDA	I2C2 SDA	
P9-25	Input	GPIO3_21	EEPROM WP	Pulled High via external pullup
J8	Input		12V Input	12V recommended. 6V-15V Accepted.

3. Getting Started

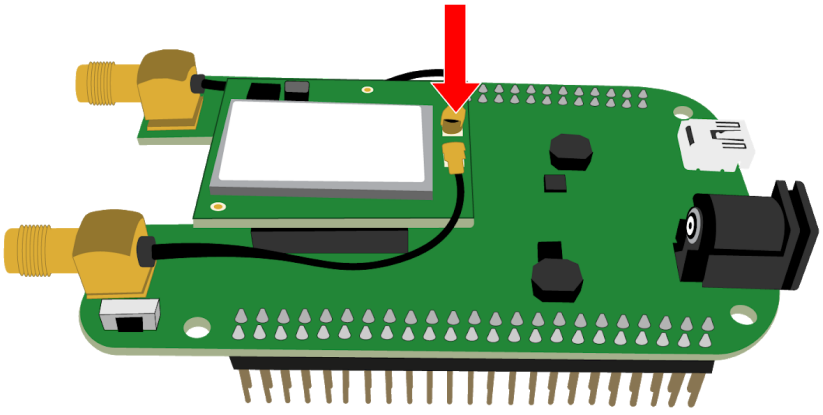
3.1. Skywire Placement

Mount the Skywire on the cape with the Skywire's UFL connectors towards the middle of the board.



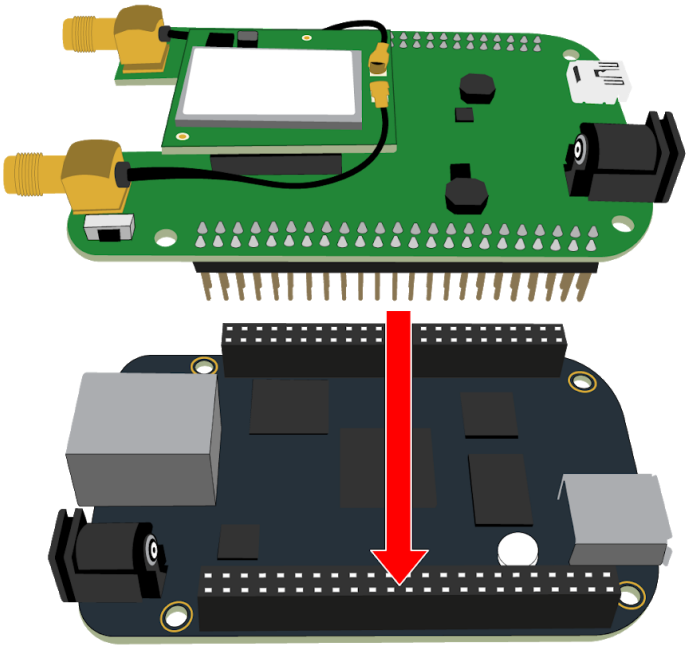
3.2. Connect the UFL Antenna Cables

Attach the UFL antenna cables to the Skywire.



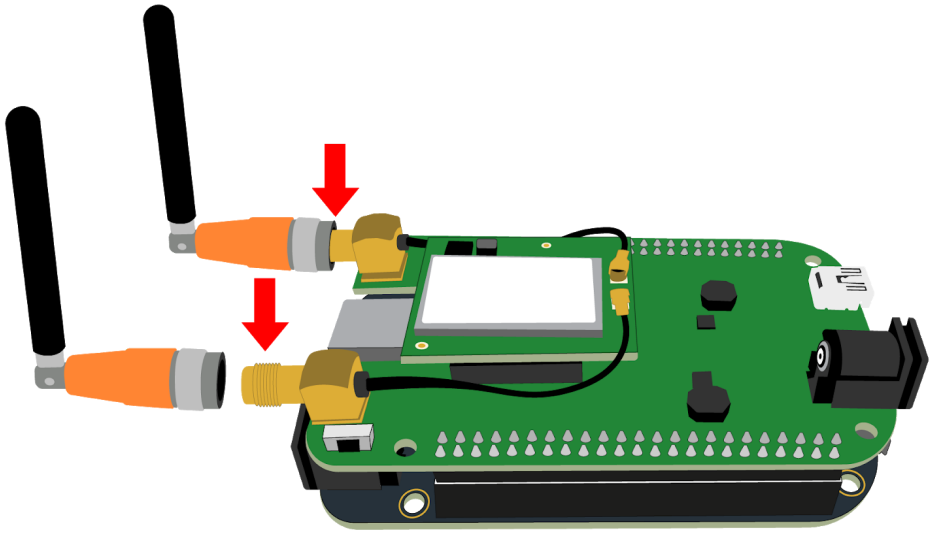
3.3. Cape Placement

Align the capes P8/P9 headers with the BeagleBone's headers and gently press the two boards together to connect them.



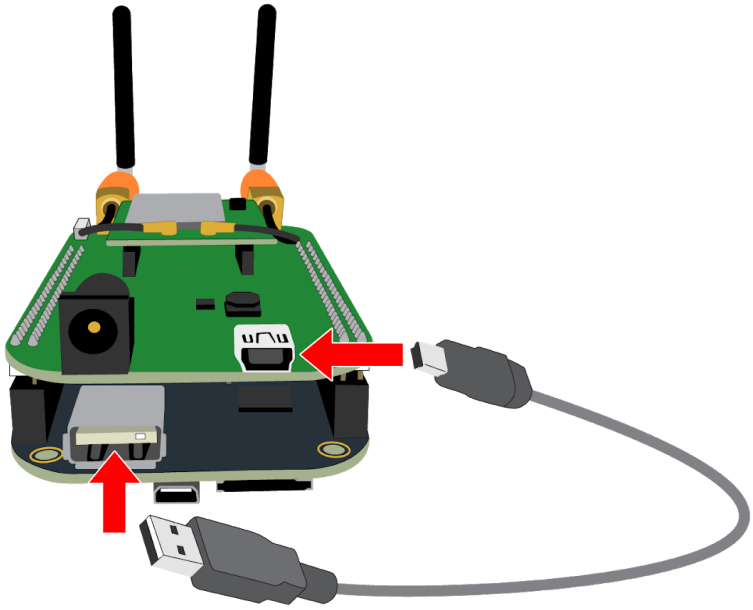
3.4. Attach Antennas

Connect the cellular antennas to the cape.



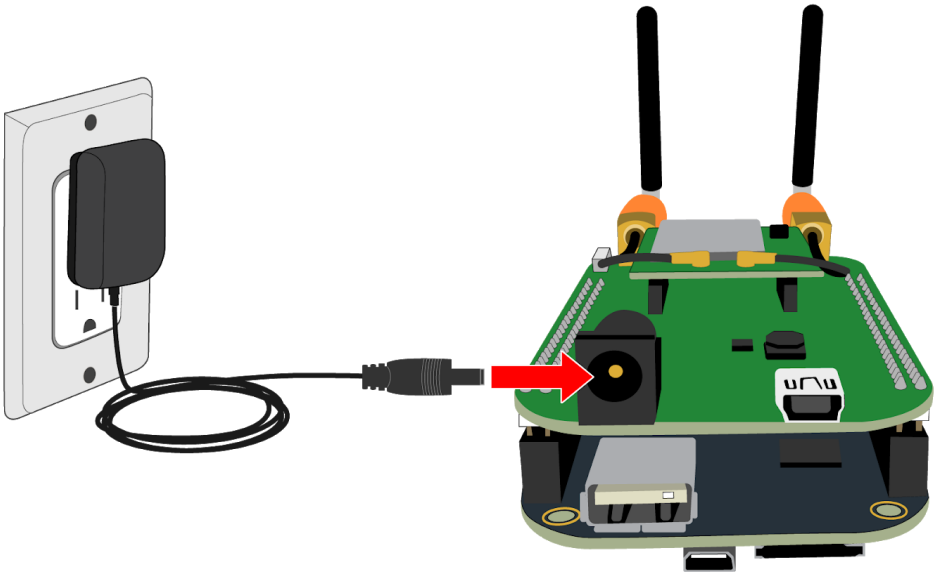
3.5. Connect USB

Connect the Skywire's USB interface to the capes.



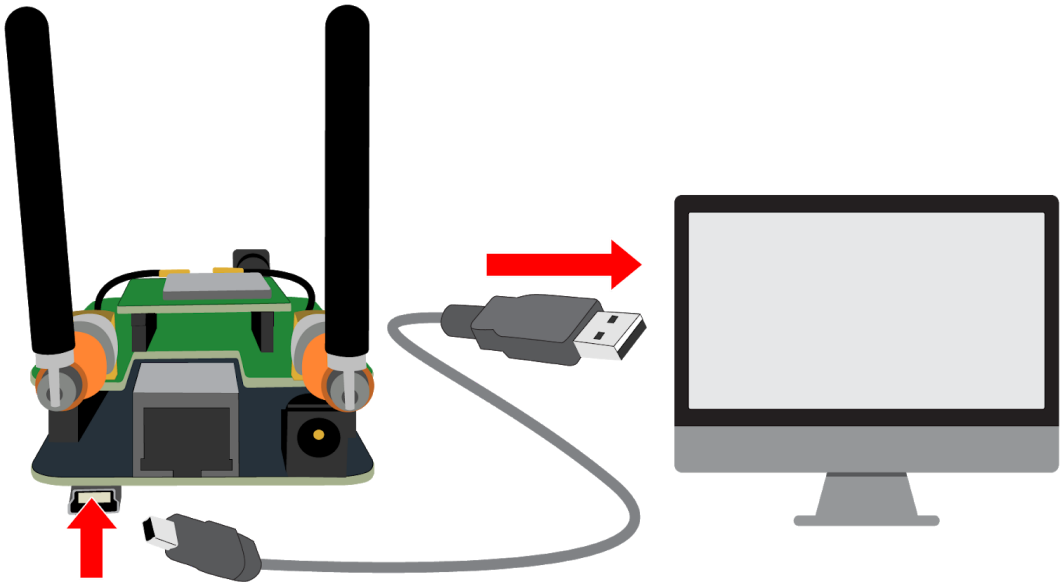
3.6. Apply Power

Apply 12V power to the cape. The capes onboard 12V to 5V regulator will supply 5V to the BeagleBone.



3.7. Connect

Connect your BeagleBone to your computer through the BeagleBone's USB interface (via SSH or COM port).



3.8. Device Tree Overlay

The cape's GPIO pins are automatically configured by the cape's Device Tree Overlay (DTO). The DTO is integrated into Debian releases after 2017-04-25. You can check the system log to see if the DTO was loaded for the cape by issuing:

```
# dmesg | grep NL-AB-BBCL
```

This command will query the system log for anything to do with the cape. If the cape did not load you will see a message similar to this:

[2.435969] bone_capemgr bone_capemgr: slot #2: 'NL-AB-BBCL,00B0,NimbeLink,NL-AB-BBCL'

[3.490471] bone_capemgr bone_capemgr: loader: failed to load slot-2 NL-AB-BBCL:00B0 (prio 0)

If the cape did successfully load you will see the following when you query the system log:

```
# dmesg | grep NL-AB-BBCL
```

[2.463957] bone_capemgr bone_capemgr: slot #2: 'NL-AB-BBCL,00B0,NimbeLink,NL-AB-BBCL'

[2.531693] bone_capemgr bone_capemgr: slot #2: dtbo 'NL-AB-BBCL-00B0.dtbo' loaded; overlay id #0

If your release does not have the capes DTO please follow these steps to install the most recent device tree from bb.org:

1. On your systems terminal enter the following commands:

```
# sudo apt update
# sudo apt install bb-cape-overlays
```

2. Once the bb-cape-overlays has installed restart your system.
3. Check your system log to verify the DTO has been loaded for the cape:

```
# dmesg | grep NL-AB-BBCL
```

3.9. Activate Modem (one-time step)

Your Skywire cellular modem does not ship with an active cellular plan. NimbeLink provides reduced rate M2M data plans for Skywire products. To activate a data plan, please visit go.nimbelink.com to set up a data plan account.

3.10. UART Configuration

The capes DTO will automatically configure the Beaglebones UART4 for communication, with flow control (RTS/CTS), with the Skywire. To test the communication launch a terminal interface from the BeagleBone to the modem. In this example we'll use picocom to interface to the modem.

On the beaglebones command line enter the following command:

```
# picocom -b 115200 /dev/ttyS4
```

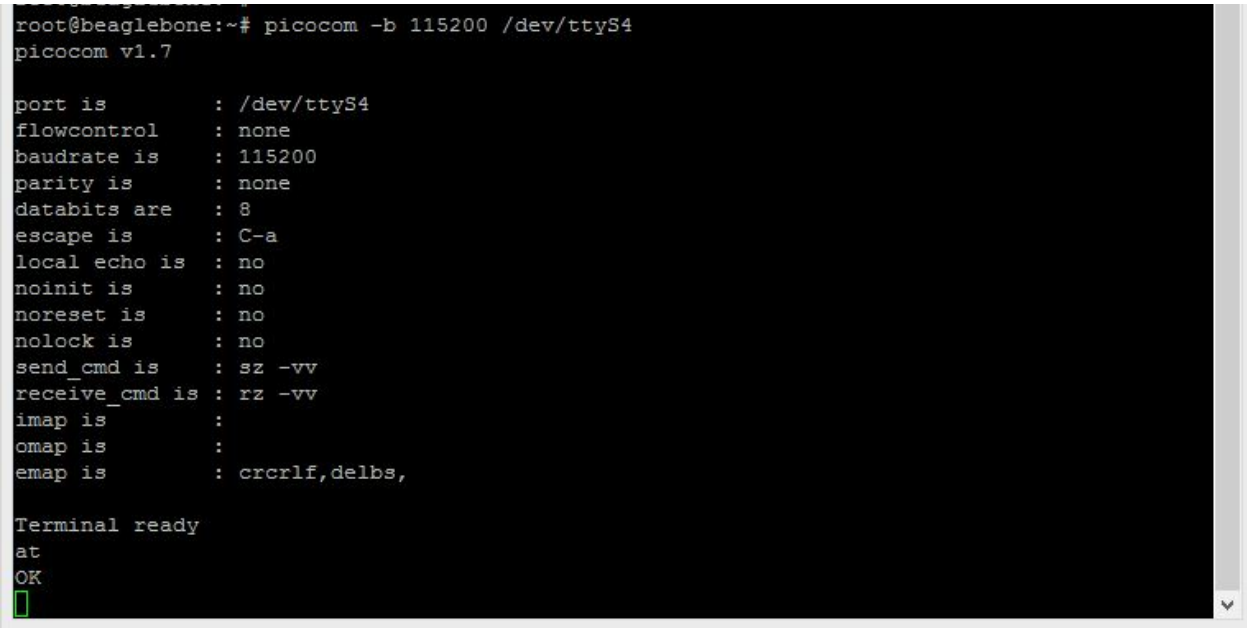
followed by the enter key, this will launch picocom with a serial terminal connection to the modems UART port.

Once picocom (or the terminal program of your choosing) has launched, issue the following command to the modem to test the UART connection:

```
AT
```

Followed by the enter key. The modem should respond with:

```
OK
```



3.11. USB Configuration

Connector J5 on the cape allows users to connect their BeagleBone directly to the Skywire's USB interface using a mini-B USB Cable. Each skywire has a unique USB interface and users should consult data sheet for the specific Skywiremodem they're using for more details on interfacing to the modem over USB. In general users can interface with the Skywire's USB interface in the same manner as the UART when using the cape.

Users can set up the modems to provide a seamless network interface to their BeagleBone. Depending on the modem a different protocol, such as PPP, CDC-ETH, CDC-NCM, or QMI, will be required. To set up the network connection for your modem please refer to the guide listed below for your modem. Please note that this list is not exhaustive of the reference materials for the Skywire modems and additional application notes may be available under your modem's product page in the Application Notes section.

- NL-SW-LTE-GELS3-C: Sending and Receiving Data with CDC-ECM
- NL-SW-LTE-GELS3-C: Sending and Receiving data with PPPd
- NL-SW-LTE-WM14: Sending and Receiving data with CDC-ETHER
- NL-SW-LTE-TSVG: Sending and Receiving data with PPPd
- NL-SW-LTE-TSVG: Sending and Receiving data with QMI
- NL-SW-LTE-TNAG: Sending and Receiving data with PPPd
- NL-SW-LTE-TNAG: Sending and Receiving data with QMI
- NL-SW-LTE-S7588-T: Sending and Receiving Data with CDC-NCM
- NL-SW-LTE-S7588-T: Sending and Receiving data with PPPd
- NL-SW-LTE-S7588-V: Sending and Receiving Data with CDC-NCM
- NL-SW-LTE-S7588-V: Sending and Receiving data with PPPd

3.12. Grove Connections

The cape has two user populatable Grove connectors that allow users to attach grove sensors. The J15 connector is wired into UART5 and the J16 connector connects to I2C1. Both of connectors can also be configured as GPIO's by the user if needed. It should be noted that the device tree overlay for the cape does not configure any of the pins attached to the connectors.

The footprint on the PCB is designed to fit JST S4B-PH-K-S(LF)(SN) connectors.

4. Additional Resources

- Skywire Cellular Modems Product Page
- Sending and Receiving files with FTP
- Sending and Receiving data with Socket Dials
- Sending and Receiving SMS messages
- Sending GPS data using Python
- Defining PDP Contexts MSCs
- Streaming Video over LTE on BBC
- Starting PPP at Boot
- Starting PPP with SSH over Ethernet