LoPy LoRaWAN IoT Workshop

University of Edinburgh

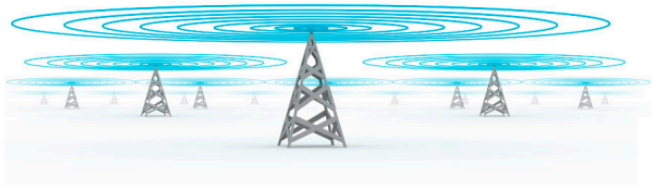
Pycom

October 2016

The Plan for Today

- Two hour workshop
  - we are working in pairs, each pair needs a laptop.
- We'll give a bit of background on LoRaWAN
- The we'll get stuck into Pycom LoPy programming
  - Getting set up
  - Simple LoRaWAN communication
  - Hooking up a Light Sensor
- At 4pm presentation by Fred de Haro CEO of Pycom
- All done by 5pm

LoRaWAN for Low Power Wide Area Networking



Long Range

- Greater than cellular
- Deep indoor coverage
- Star topology

Max Lifetime

- Low power optimized
- 10-20yr lifetime
- >10x vs cellular M2M

Multi-Usage

- High capacity
- Multi-tenant
- Public network

Low Cost

- Minimal infrastructure
- Low cost end node
- Open SW

LoRaWAN Specification Europe

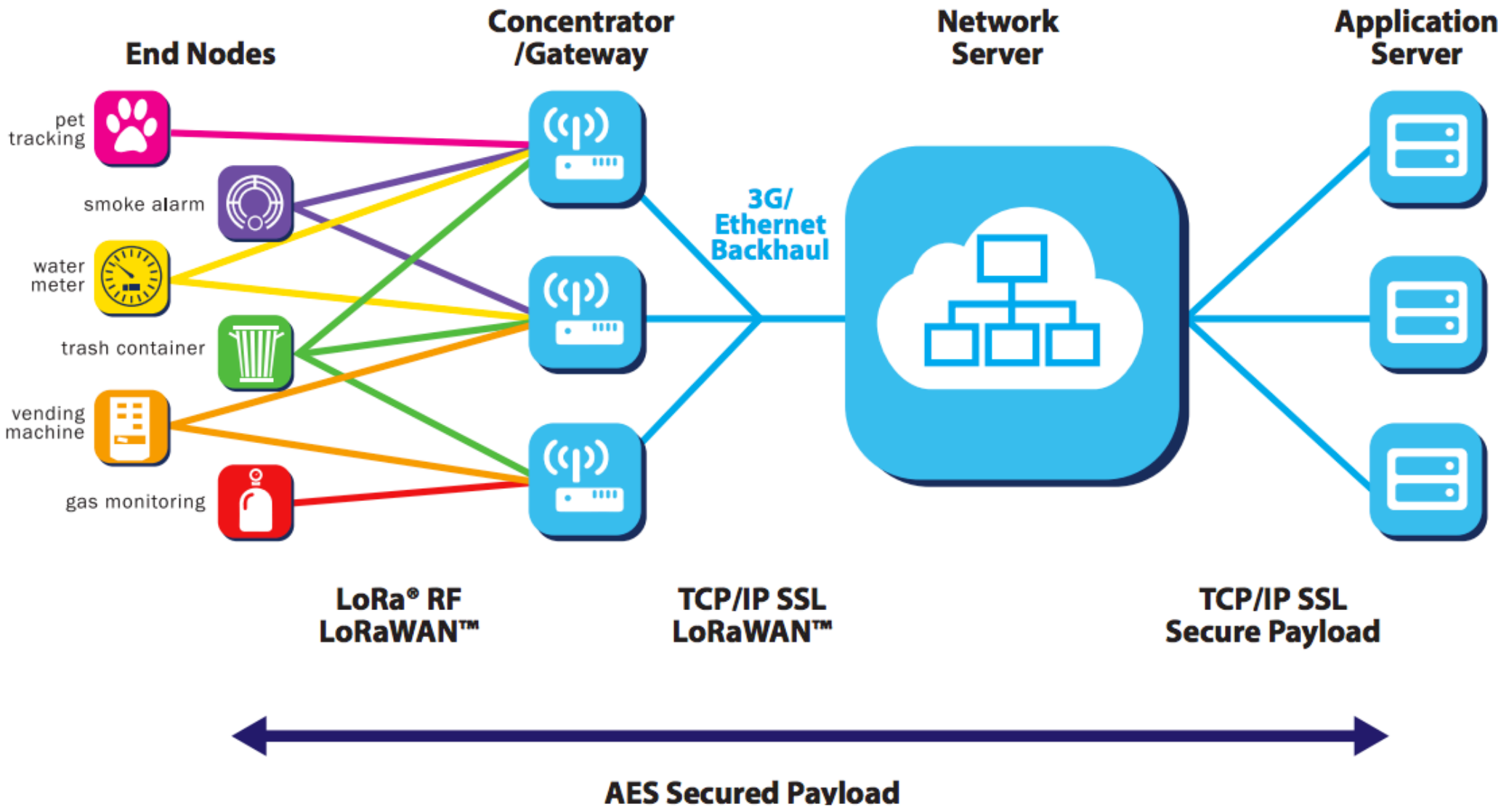
LoRaWAN™ for Europe

LoRaWAN defines ten channels, eight of which are multi data rate from 250bps to 5.5 kbps, a single high data rate LoRa® channel at 11kbps, and a single FSK channel at 50kbps. The maximum output power allowed by ETSI in Europe is +14dBM, with the exception of the G3 band which allows +27dBm. There are duty cycle restrictions under ETSI but no max transmission or channel dwell time limitations.

	Europe
Frequency band	867-869MHz
Channels	10
Channel BW Up	125/250kHz
Channel BW Dn	125kHz
TX Power Up	+14dBm
TX Power Dn	+14dBm
SF Up	7-12
Data rate	250bps- 50kbps
Link Budget Up	155dB
Link Budget Dn	155dB

Feature	LoRaWAN
Modulation	SS Chirp
Rx bandwidth	500 - 125 KHz
Data Rate	290bps - 50Kbps
Max. # Msgs/day	Unlimited
Max Output Power	20 dBm
Link Budget	154 dB
Batery lifetime - 2000mAh	105 months
Power Efficiency	Very High
Interference immunity	Very high
Coexistence	Yes
Security	Yes
Mobility / localization	Yes

LoRaWAN Architecture

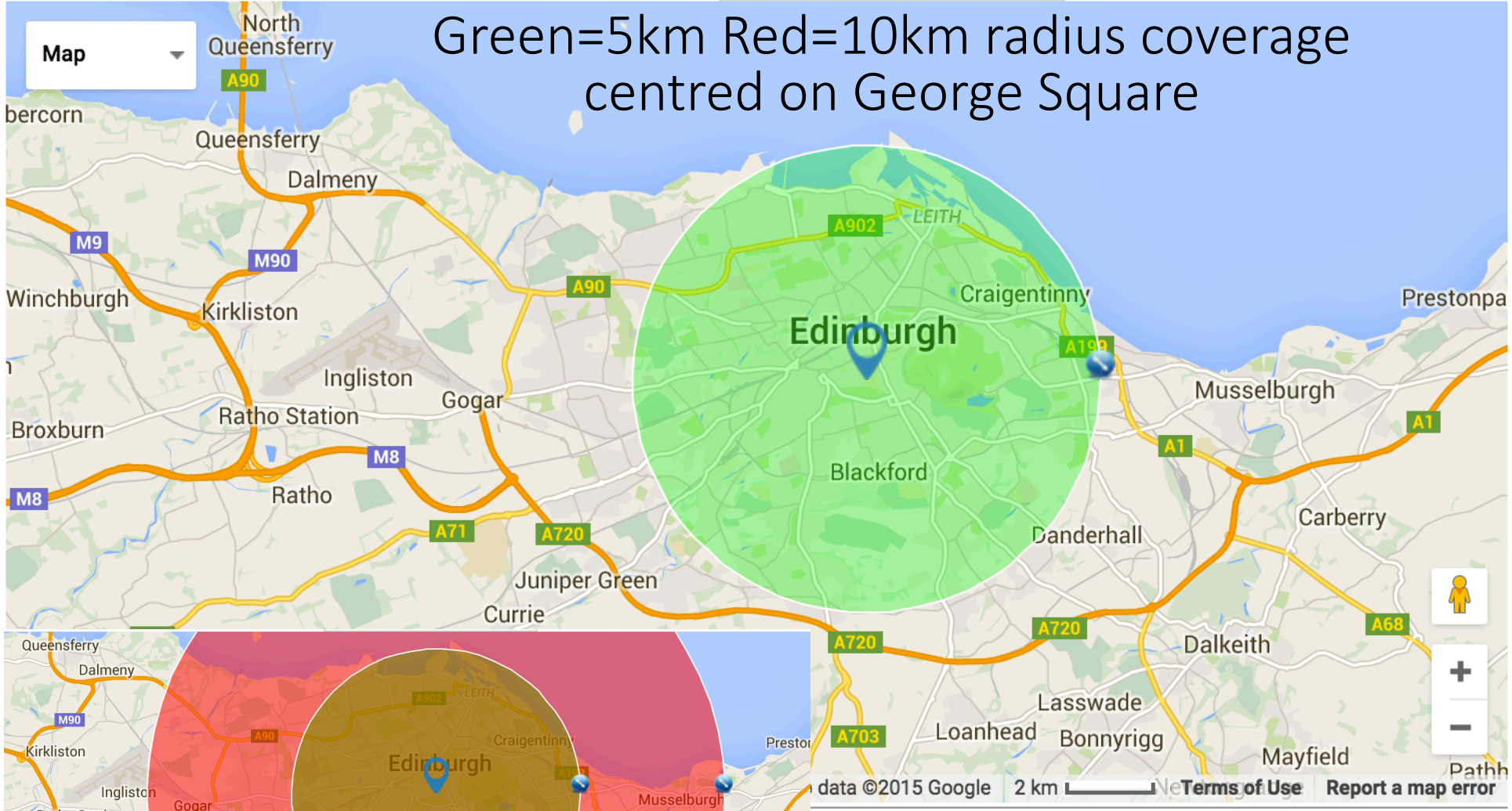


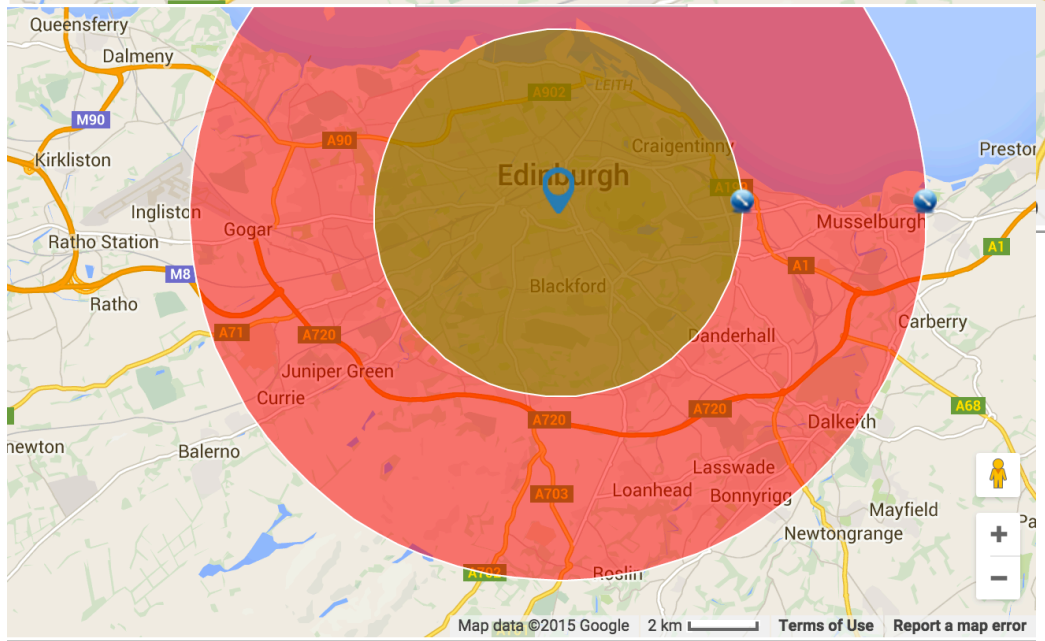
LoRaWAN performance characteristics

Spreading factor (at 125 kHz)	Bitrate	Range (indicative value, depending on propagation conditions)	Time on Air (ms) For 10 Bytes app payload
SF7	5470 bps	2 km	56 ms
SF8	3125 bps	4 km	100 ms
SF9	1760 bps	6 km	200 ms
SF10	980 bps	8 km	370 ms
SF11	440 bps	11 km	740 ms
SF12	290 bps	14 km	1400 ms

(with coding rate 4/5 ; bandwidth 125Khz ; Packet Error Rate (PER): 1%)

Green=5km Red=10km radius coverage centred on George Square





University of Edinburgh is putting in place 5 Kerlink gateways.

Multiple gateways also enable triangulation of position of sensors (LoRaWAN 2.0).

LoRaWAN Device Classes

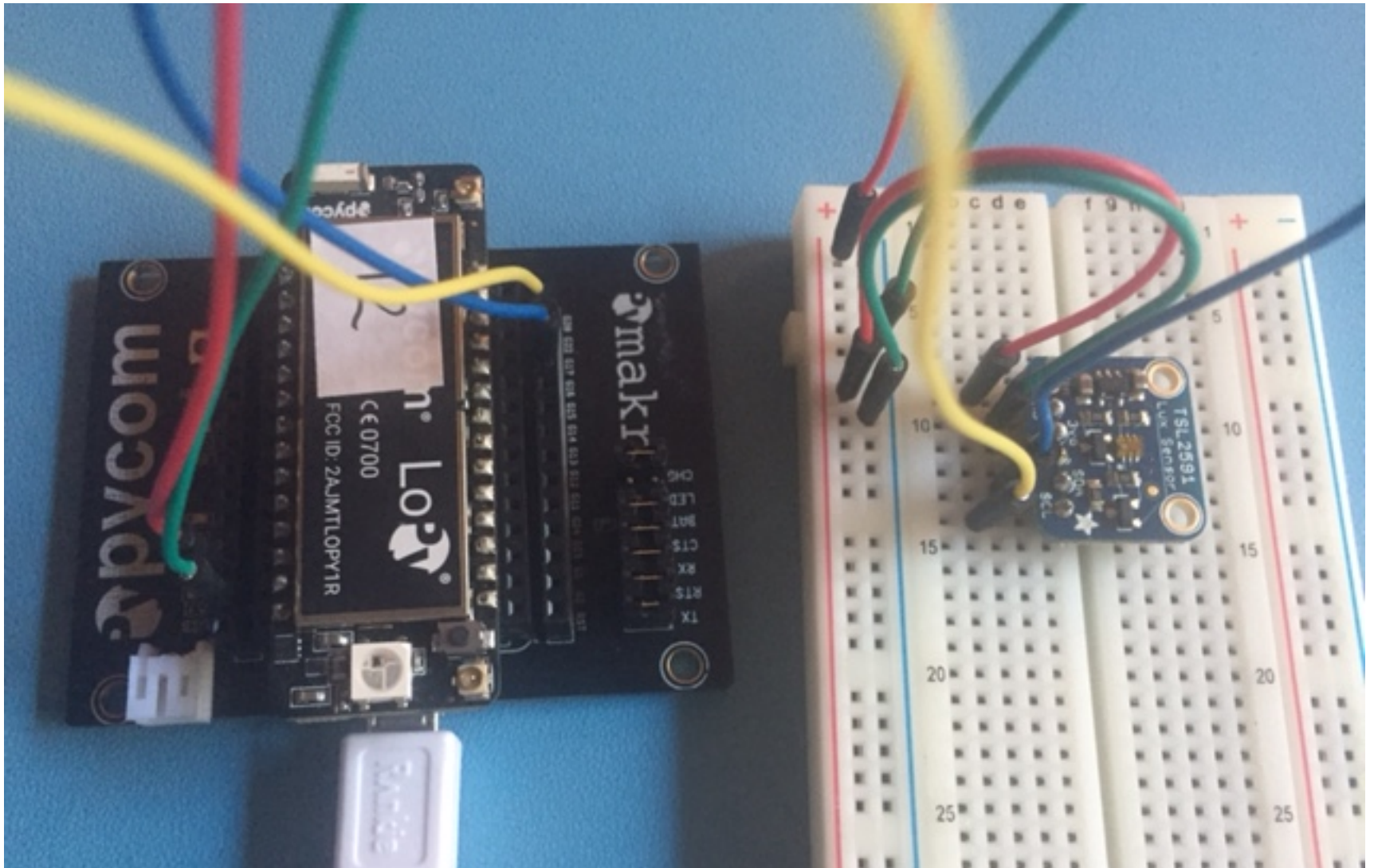
Class name	Intended usage
A (« all ») “Aloha”	**Battery powered sensors**, or actuators with no latency constraint Most energy efficient communication class. Must be supported by all devices
B (« beacon »)	**Battery powered actuators** Energy efficient communication class for latency controlled downlink. Based on slotted communication synchronized with a network beacon.
C (« continuous »)	**Mains powered actuators** Devices which can afford to listen continuously. No latency for downlink communication.

Key LoRaWAN Networking Concepts

- Data is encrypted at the network layer (metadata) and separately at the application layer (payload).
- Application
  - An Application is identified by a unique 64-bit Application EUI.
  - Devices must be registered with a specific Application.
- Device
  - A device has a unique 64-bit Device EUI assigned by the manufacturer.
  - The network will refer to the device by assigning it a 32-bit Device Address.
- *Activation By Personalisation (ABP)* [insecure]
  - Requires you know your assigned 32-bit Device Address, and 128-bit Application Session Key and 128-bit Network Session Key – a static configuration.
- *Over The Air Activation (OTAA)* [secure]
  - Requires you know your Application's Key (which is assigned when the Application is created), Application EUI and Device EUI.
  - Session keys are assigned dynamically by the network as part of the join procedure.
- Frame counts are maintained by the network and device for uplink (device to gateway) and downlink (gateway to device). The network will reject new frames received that have an earlier frame count.

We will only be using ABP today.

What we are aiming to build today

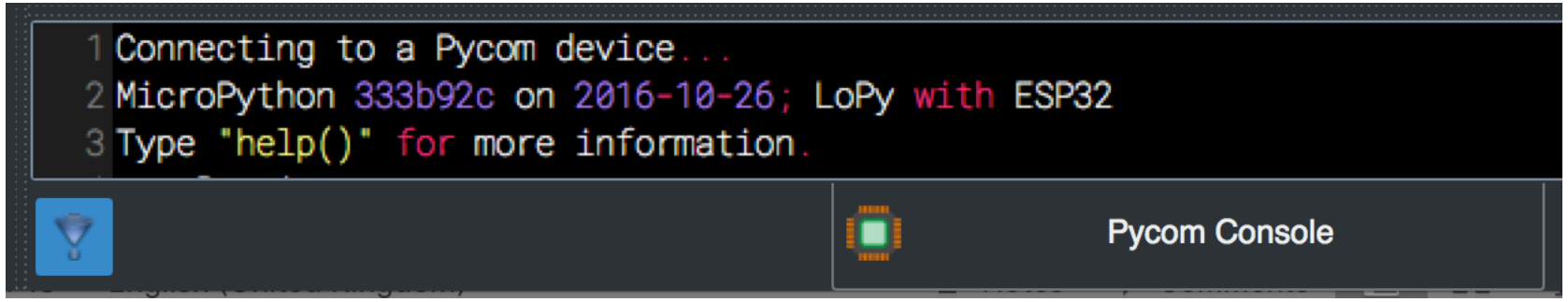


This is our first time!
Please be patient…

This is really new technology and you have the very latest firmware release in your hands before anyone else(!), and there will be lots for all of us to learn today ☺

Initial set up

- Download and install the Pymakr IDE
- Plug your LoPy in via the USB cable to your laptop
  - If working, you should see a periodic flashing blue light
- Run Pymakr IDE
  - The LoPy will be connected to via USB serial port



  - If not try exiting and restarting Pymakr…

Turn off the flashing blue LED

At the Micro-Python prompt type:

```
import pycom
pycom.heartbeat(False)
```

Let’s send a message via LoRaWAN

- Open a new source code file in Pymakr to save your code in.
- You can simply run the contents of this file (green play button) on the LoPy.
- You will need to set the various auth keys to those for your LoPy.

```
from network import LoRa
import time
import socket
lora = LoRa(mode=LoRa.LORAWAN)
# ABP auth tuple (NwkSKey, AppSKey, DevAddr)
auth = (bytes([0x7B, 0x38, 0x8D, 0xD4, 0xC4,
0x91, 0x6E, 0xB7, 0xFC, 0xA8, 0x60, 0x65, 0x11,
0x10, 0xF0, 0x42]), bytes([0xA8, 0xFD, 0xC5, 0x6B,
0x82, 0x40, 0x07, 0x18, 0x69, 0xBA, 0xAB, 0x74,
0x10, 0x63, 0xCA, 0x74]), 0x01000304)
lora.join(activation=LoRa.ABP, auth=auth)
while not lora.has_joined():
  time.sleep(2.5)
s = socket.socket(socket.AF_LORA, socket.SOCK_RAW)
s.setblocking(False)
s.send(“hello-X”) # X = your group number
```

And now for the Light Sensor

- LightSensor driver code will be distributed via email / USB stick.
- Please take care wiring up the board, and use the anti static wrist strap provided.
- The rest is up to you!

- The goal is to transfer the lux light reading once every 30 seconds to the UoE LoRaWAN backend.

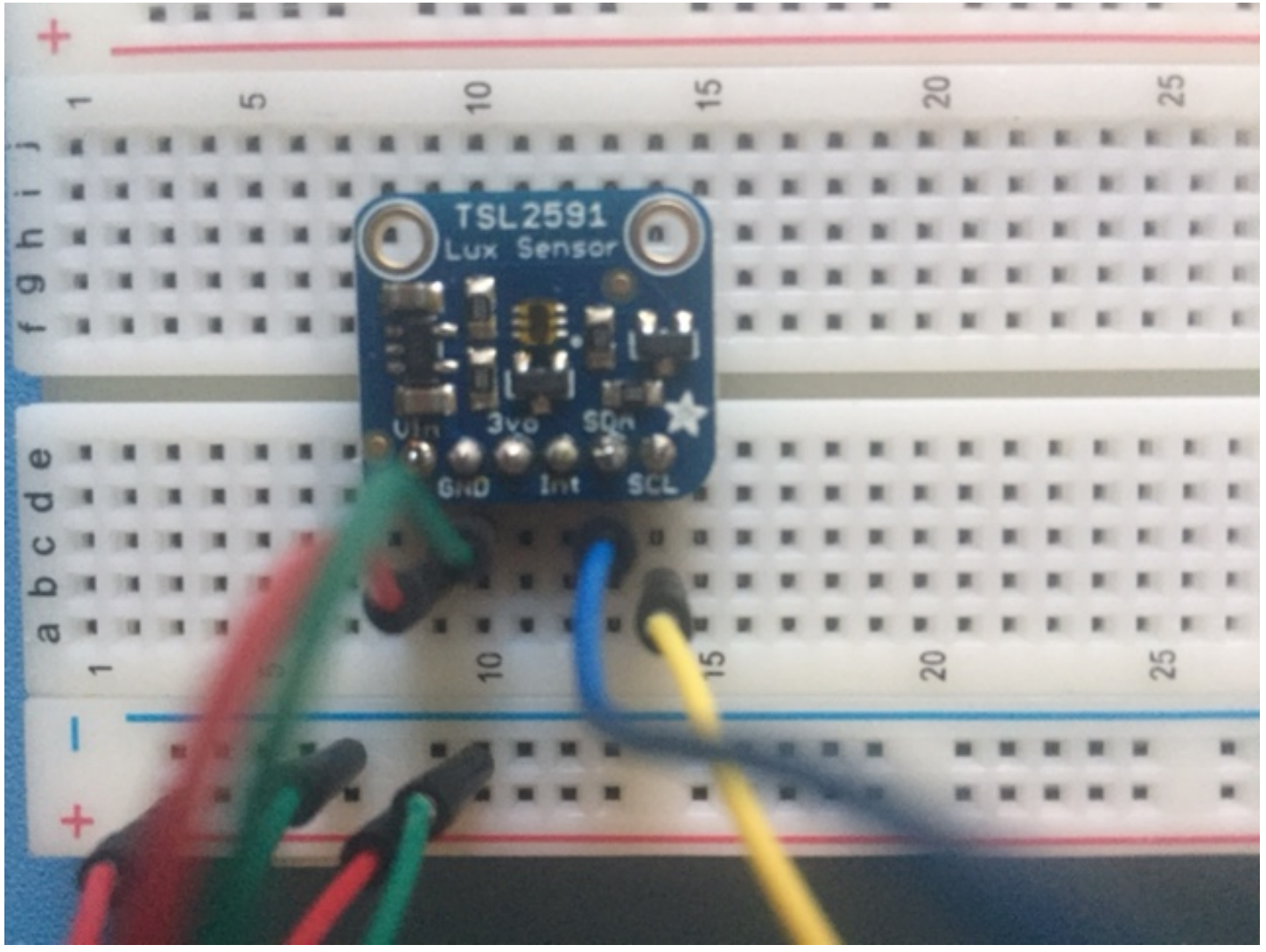
Wiring up the Light Sensor board

- Please note on the expansion board pinout:

  G16 = SDA

  G17 = SCL

- We will connect 3V3 on the expansion board to VIN on the sensor, and GND to GND as you would expect.



That’s all folks!

Thanks so much for your participation and please send us your feedback by email, good/bad it all helps improve the tech and our workshop delivery, and please do also tell us what would you like a future workshop to cover with the LoPy?