IT in AEC Industry 4.0
IOT-NIMBUS

n-Blocks & nBlocksStudio
A Modular Low-Power Low-Code
IoT
Platform

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- IoT Hardware development in Nimbus
- n-Blocks Hardware Platform
  - Motivation
  - Concepts
  - Modularity
  - Some use cases
- nBlocksStudio Firmware Development Platform
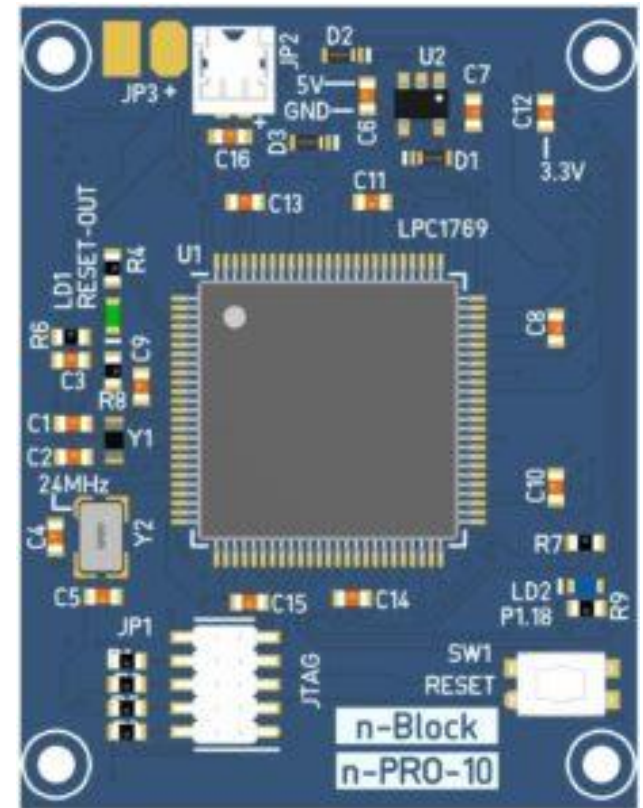 - Concepts
  - Workflow
  - Examples
- Summary

IoT hardware development in Nimbus

Embedded Hardware

PCB schematic and layout for rapid prototyping, proof of concept, pre-production prototypes

Simulation

Assembly, testing and verification.

IoT hardware development in Nimbus

Firmware

Communication protocols

Interface modules (SPI, UART, I2C, Smart GPIO...)

RF, Sensors, Remote Monitoring and Telemetry

Proximity, based on GPS, BLE and Wi-Fi.

Non-Blocking and Real time
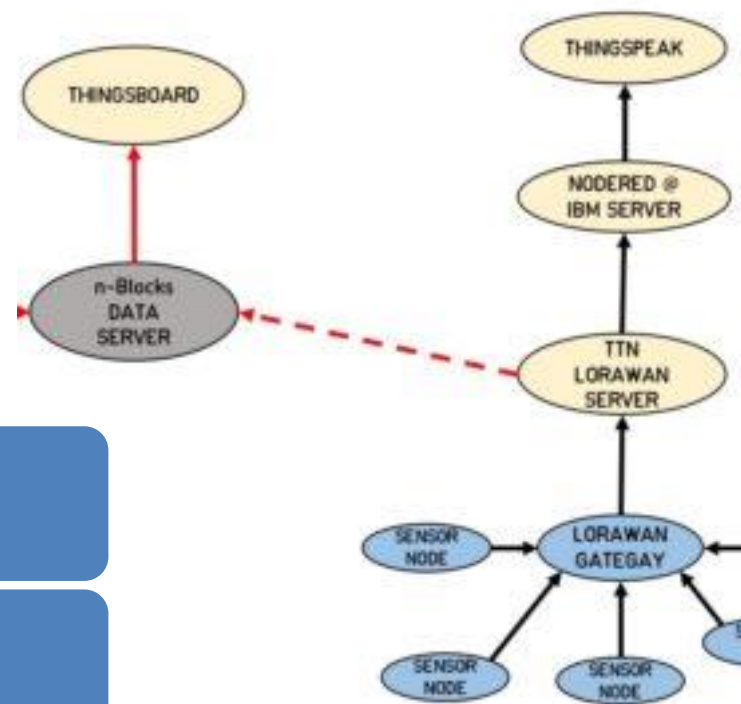
IoT hardware development in Nimbus

System Integration

Interfacing the hardware and software components

System testing strategy

Validation of system-level functions throughout the integration process

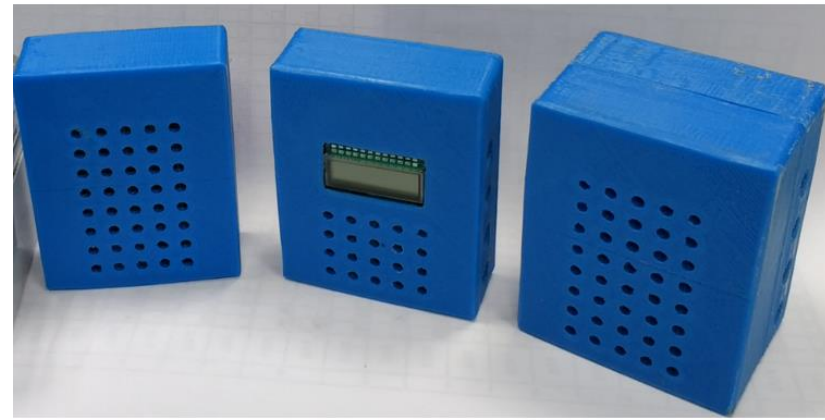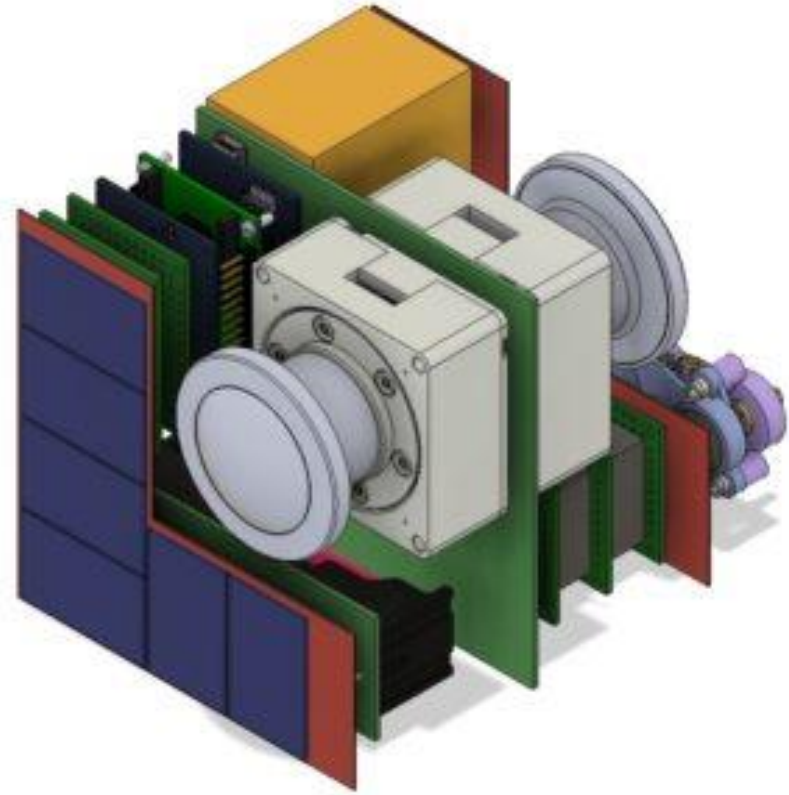Collaboration with Nimbus/CIT Software and Mechanical-design groups

IoT hardware development in Nimbus
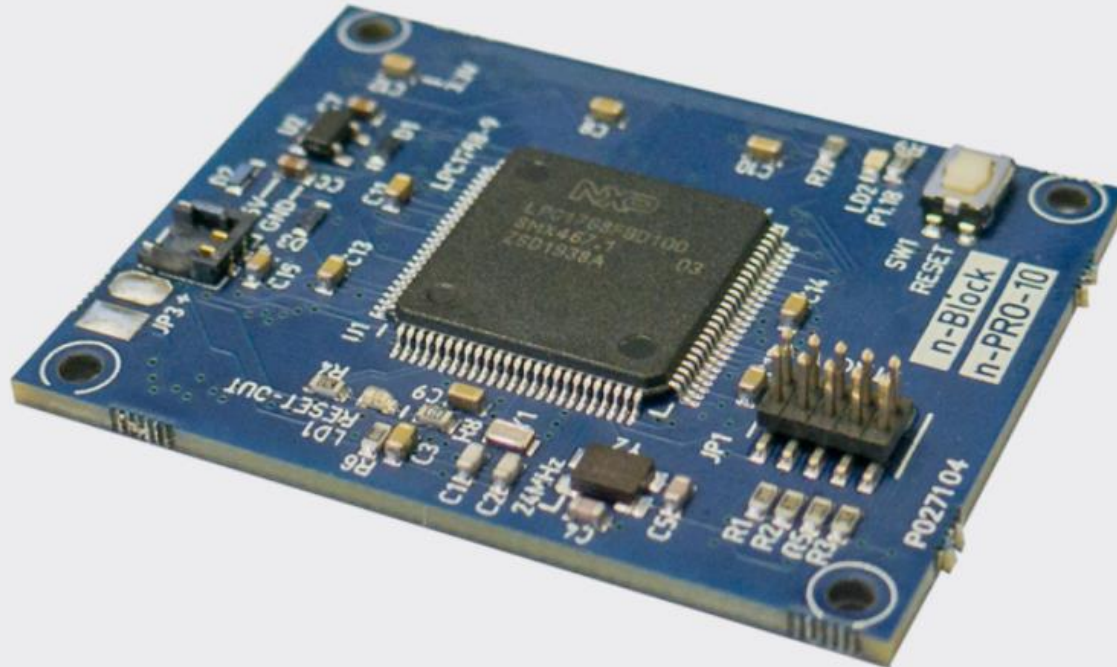
Product Design

Overall system Architecture
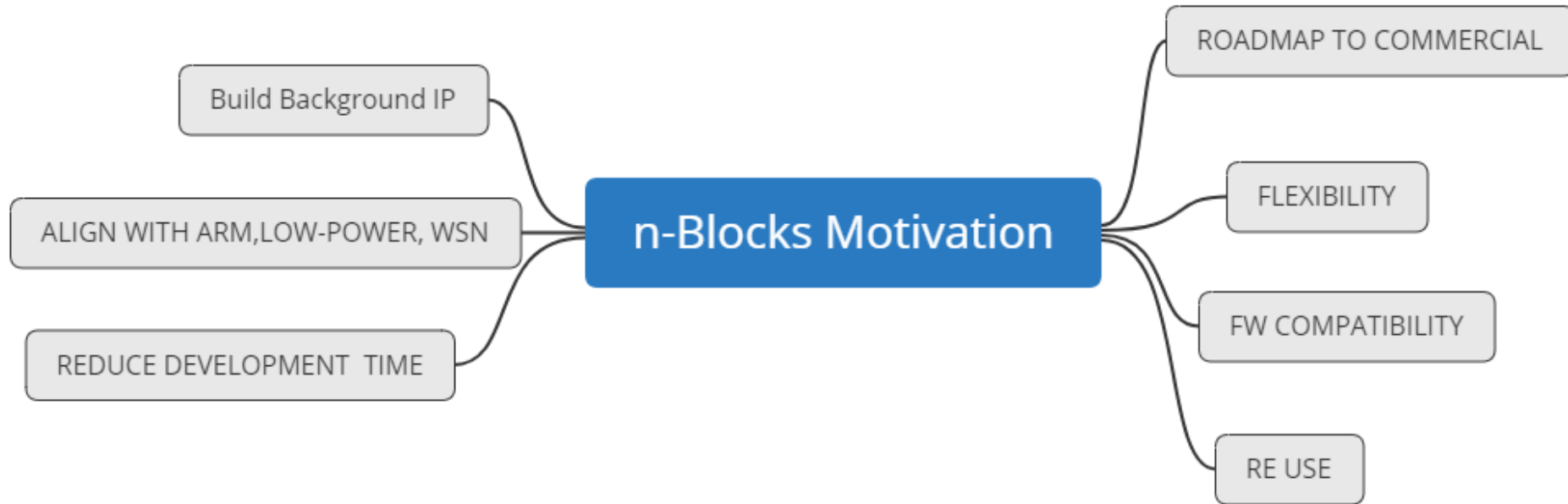
Mechanical enclosure designs

Small form factor designs

www.n-Blocks.net

n-Blocks
Modular Platform for IoT Devices

n-Blocks: Motivation

1. **Provide an IoT proof of concept platform that offers an easy roadmap towards**
    1. **Commercial products**
    2. **Nimbus client's projects**
2. **Provide more flexibility than off-the-shelf technology**
3. **Compatibility with mainstream firmware development platforms**
4. **Re-use hardware/firmware**
5. **Reduce development time**
6. **Align development with ARM Cortex, Low Power & WSN**
7. **Build Background IP on hardware and firmware via standardization.....OR.......**

HOW TO AVOID THE FUTURE DEVELOPERS TO TREAT OUR CURRENT WORK LIKE THIS
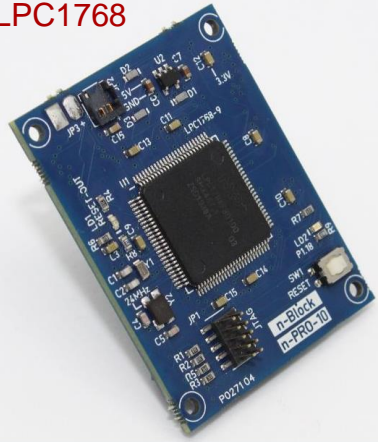# HOW TO TRANSFORM OUR DAILY DEVELOPMENT TO BACKGROUND-IP

n-Blocks: Modular IoT Design Principles
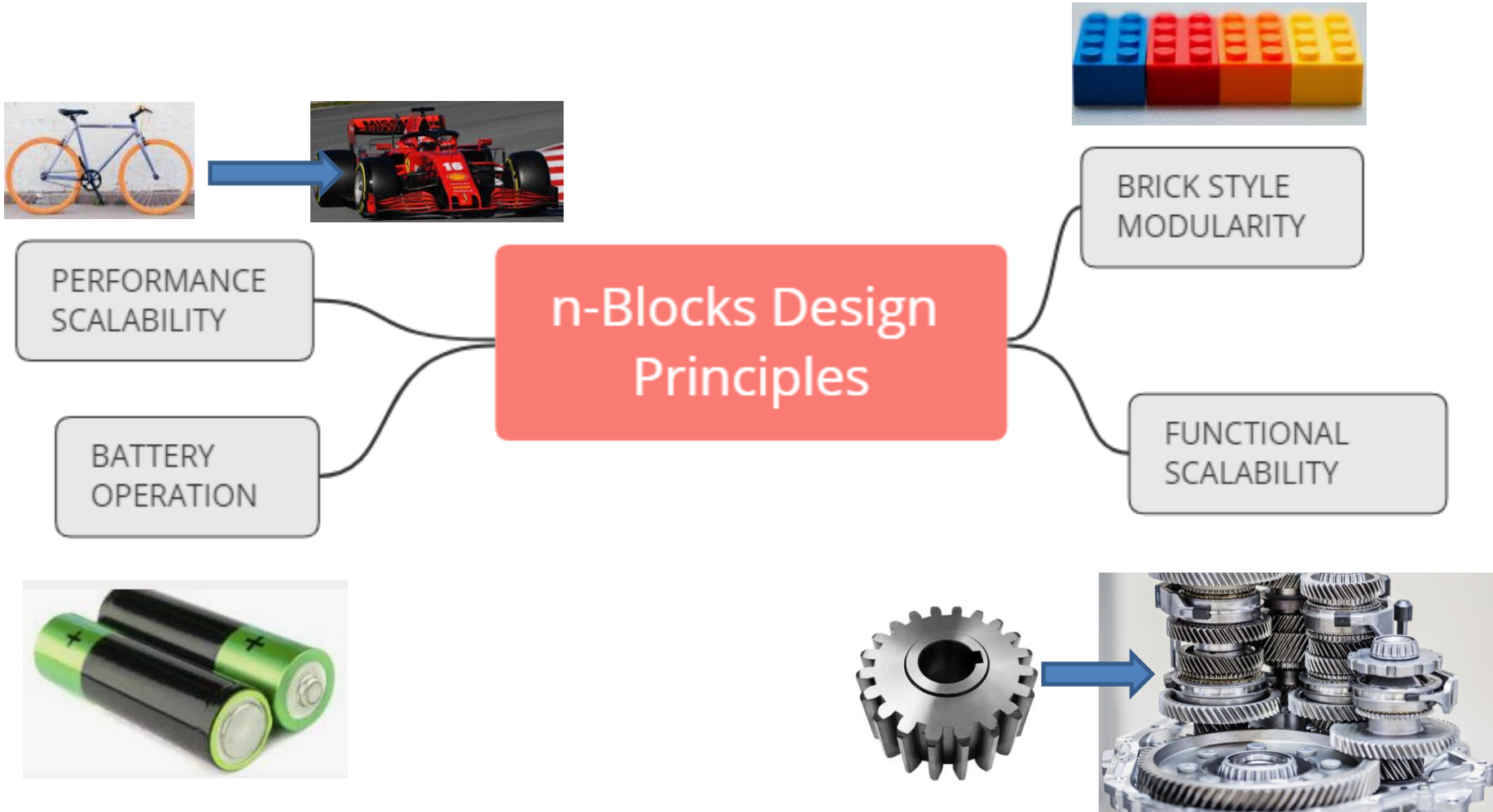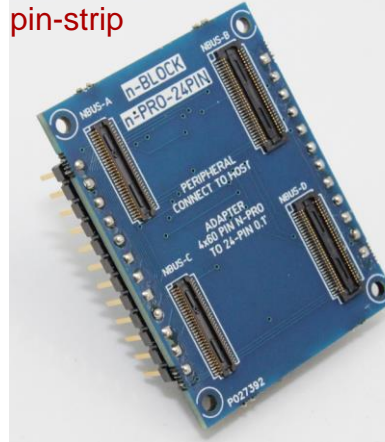
n-Blocks: HW Modularity

NXP Cortex M3
LPC1768

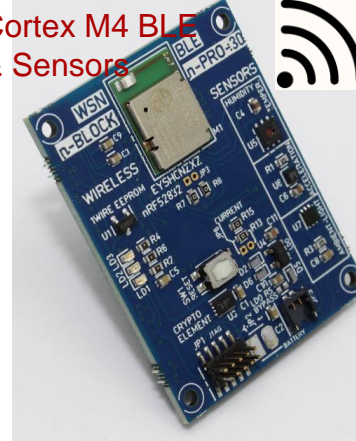TI Cortex A8
OSD3358
Linux

Adapter to
pin-strip

LoRa STM32L072
SX1276 &
Sensors

WIFI/BLT Espressif
WROOM32
& Sensors

BLE Nordic ARM
Cortex M4 BLE
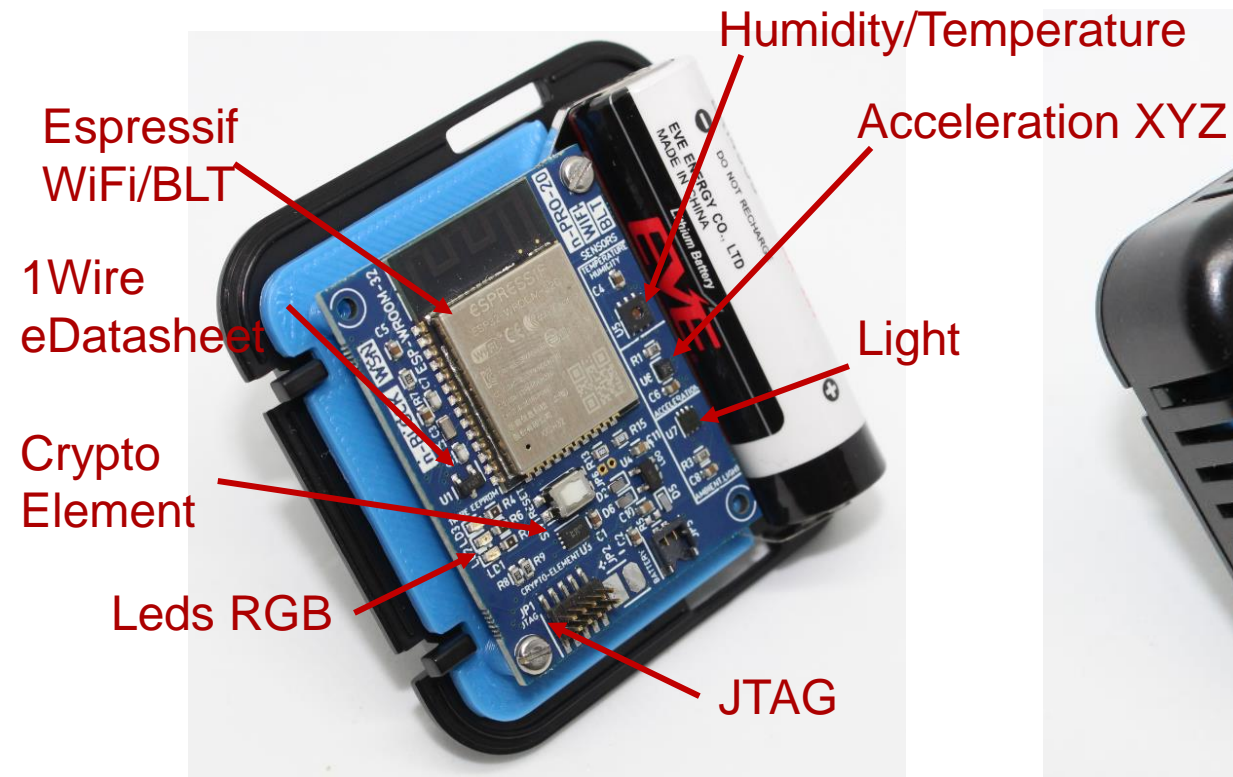& Sensors

Cortex M0, M3, M4
STM32 64 pins

Wide
MCU range

Standalone Host Board : Wireless with sensors

## Example: n-PRO-20 WiFi / Host Sensor board

- Running on a 3 year battery life setup, on a low cost off-the-shelf indoor sensor enclosure

Espressif WiFi/BLT

1Wire eDatasheet

Crypto Element

Leds RGB

JTAG

Humidity/Temperature

Acceleration XYZ

Light

WiFi Sensor

Standalone Host Board: Wireless with Sensors
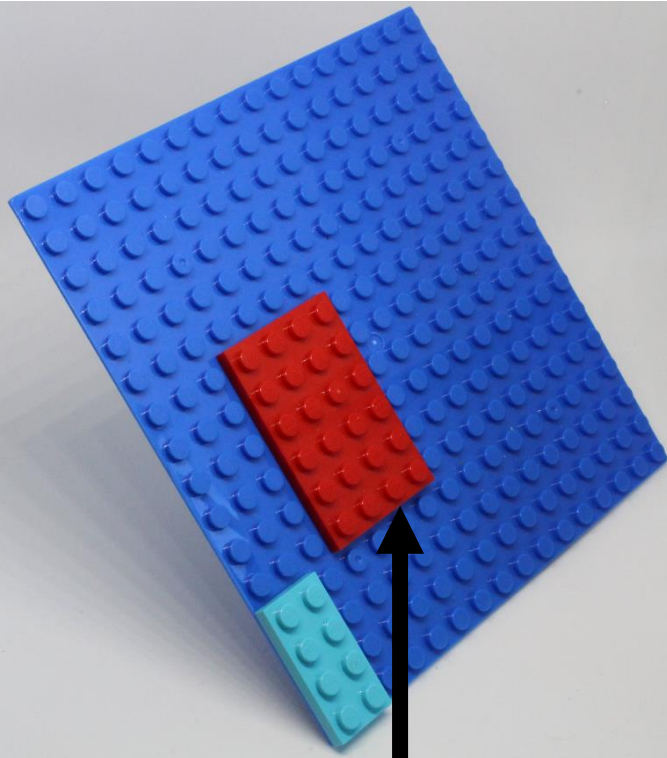
Example: LoRa Sensor

- Running LoRaWAN on a 10 year battery life setup, on a low cost off-the-shelf indoor sensor enclosure
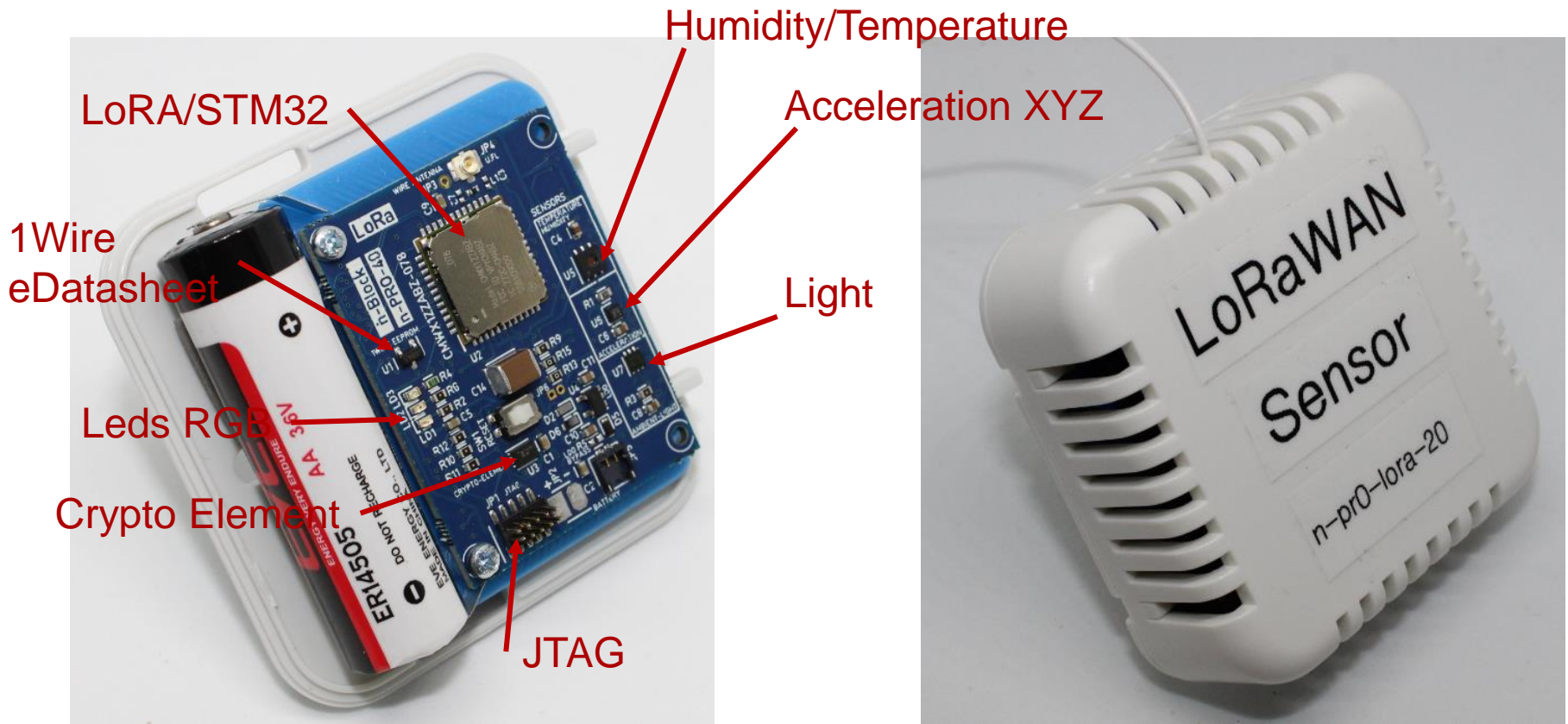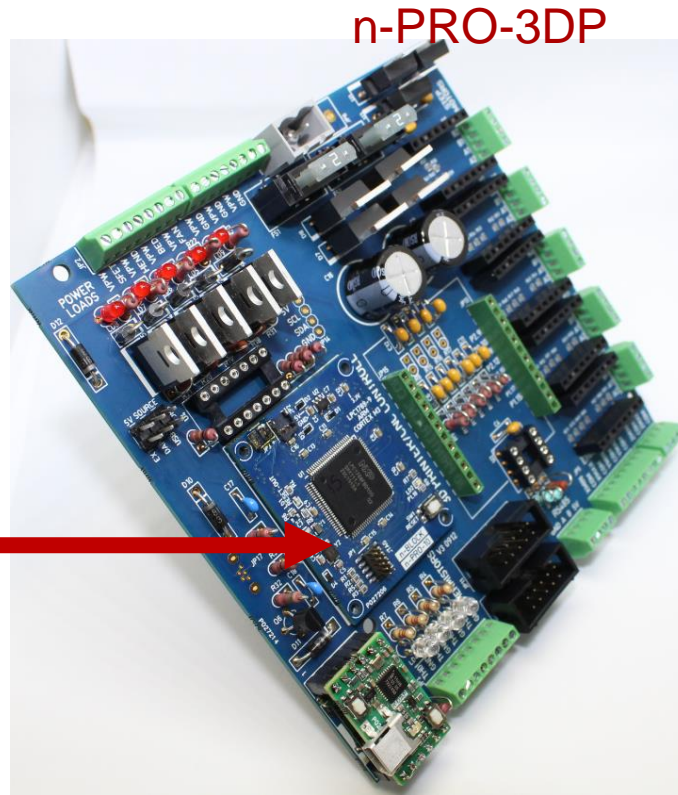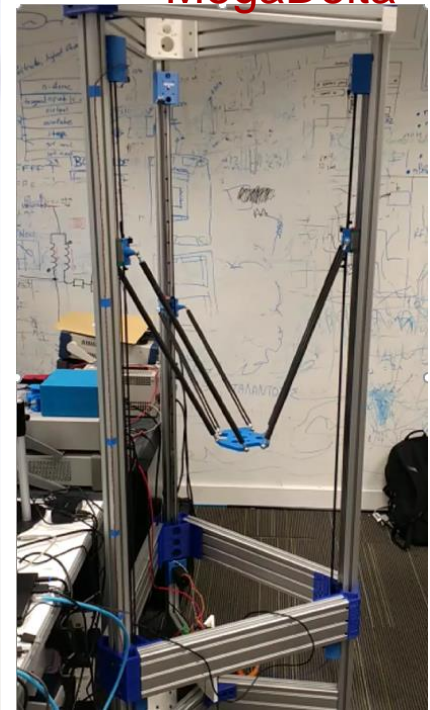
Application Board + Host Board

- Example: 3D printer / CNC / Robot controller
- Application board, with Host MCU board, tested on a MegaDelta Robot

n-PRO-3DP

MegaDelta

n-PRO-10

n-Blocks: Wireless Sensor modularity

- Example: Feature-rich LoRa sensor

  - n-PRO-MBSEN Peripheral board VOC sensing, Magnetic contact, NFC, PIR motion, Sounder, expansion socket (120 pin) and AAA battery holder with low cost wall-mount indoors-sensor enclosure
  - n-PRO-40 LoRaWAN/sensors board
  - n-PRO-SEN1 peripheral board with ultra-low-power-I2C environmental sensors to expand sensing capabilities of a host node
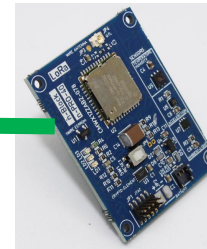
n-PRO-SEN1
Ultra Low Power Sensors
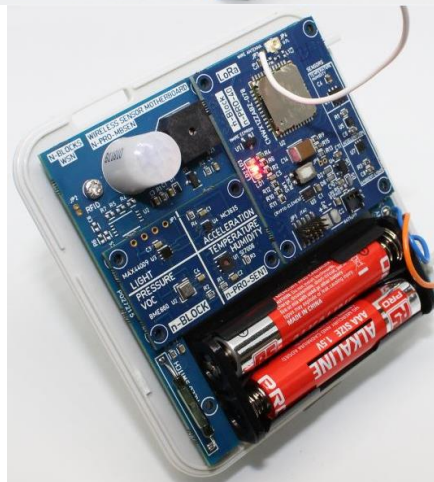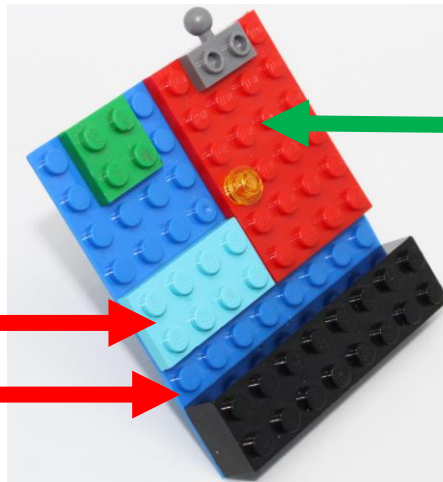- LIGHT
- PRESSURE
- VOC
- HUMIDITY
- ACCELERATION 3D

n-PRO-40
LoRa n-Block
- LoRaWAN
- Crypto element
- 1 wire eeprom
- RGB leds
- JTAG
- On Board sensors

n-PRO-MBSEN
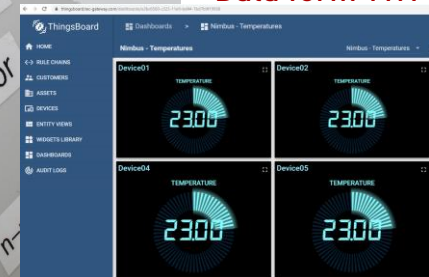**Wireless Sensor Motherboard**
- PIR
- SOUNDER
- MAGNETIC CONTACT
- VOC
- HUMIDITY
- NFC
- SOUNDER

ENCLOSURE
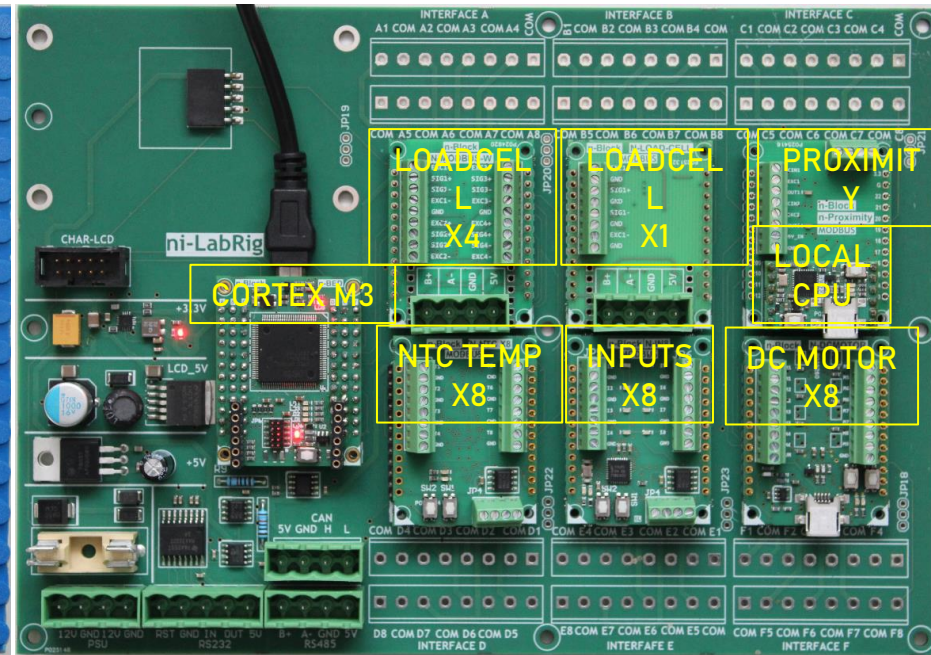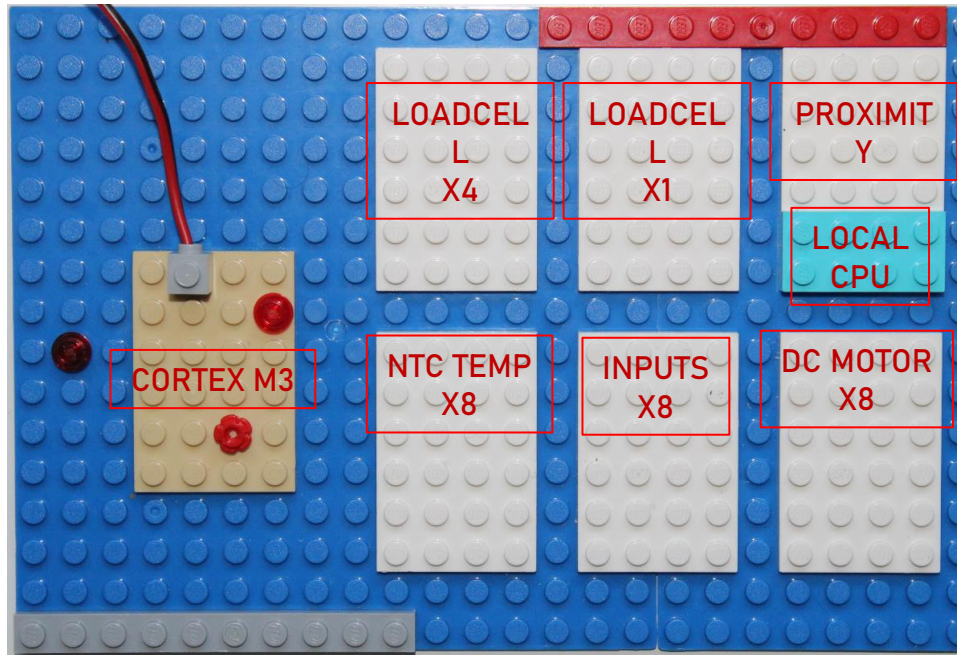**COTS BMS Wall mount Sensor**

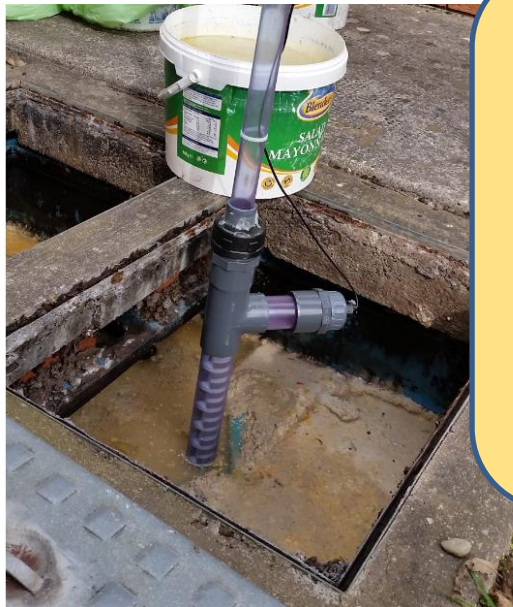**Cloud Dashboard Getting MQTT Data form TTN**

n-Blocks: Modular Lab Rig

Use Case – Fats, Oils and Grease Monitor

- Blockages of waste pipes big problem in urban areas
- Monitoring system can help to detect blockages early
- Preventative maintenance of pipes

Sensors:
Custom Capacitive
IR light,
RGB,
Temperature

Coms:
3G, WiFi, Ethernet

Use Case – Wireless Building Management

- Deployment of wireless sensors in Kalvino library in Torino, Italy

- Prototype development as part of FP7 Tribute project

Sensors:
CO2
VOC
Light
Temperature

Coms:
802.15.4, USB,
Ethernet

Use Case – Environmental Monitoring

- Demonstrate deployment in the wild
  - Multiple sensors, processing, wireless communications with backup
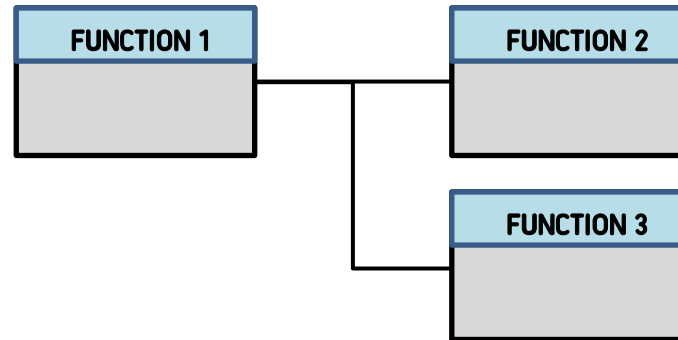 - Energy harvesting

Environmental Monitoring

River Liffey Deployment

Sensors:
Depth
Turbidity Water-Temp
Air Temp
Humidity Tilt
Vibrations Light
Position Flow
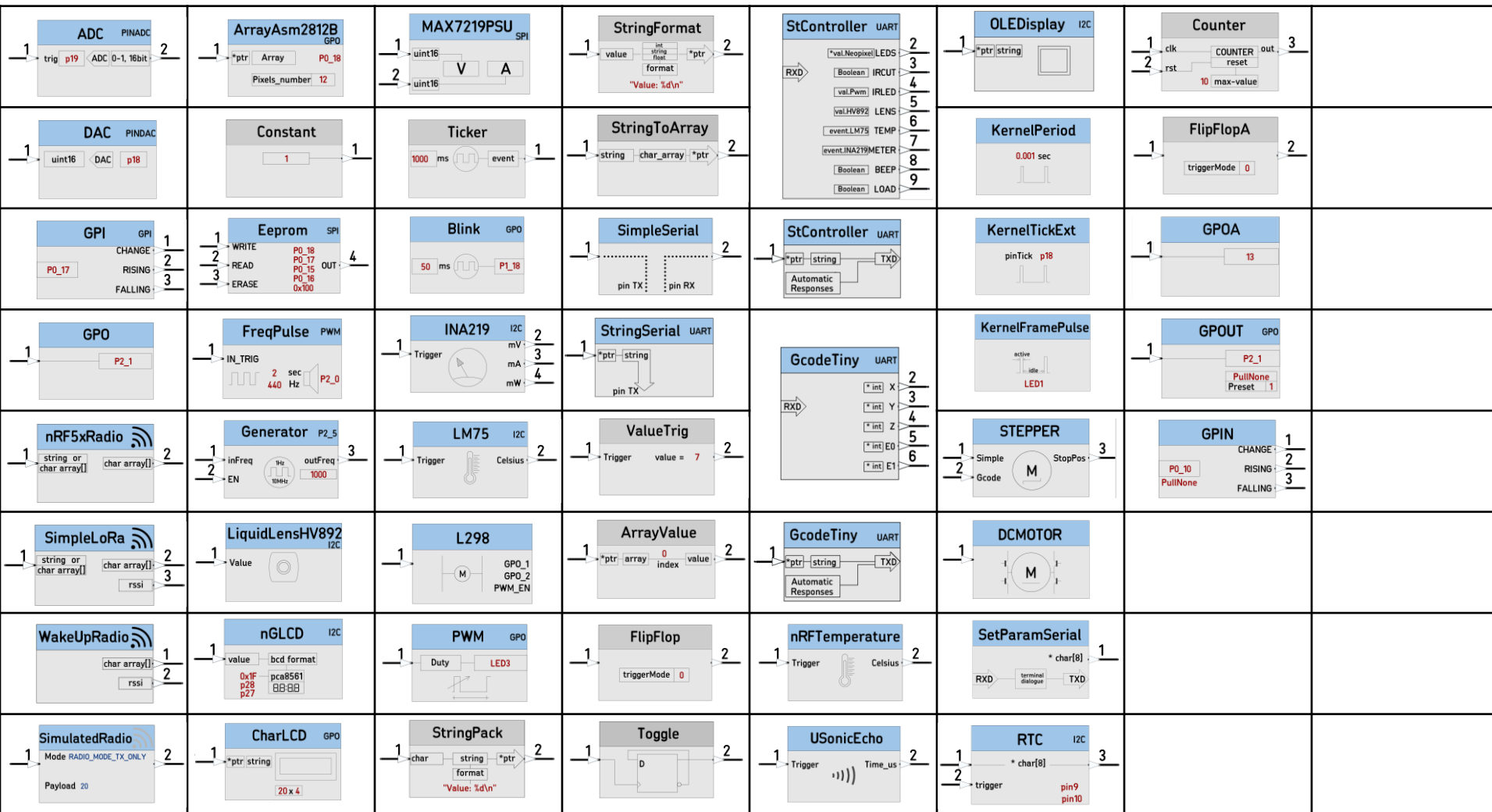Compass

Comms: 3G, LoRa

nBlocksStudio: Introduction

nBlocksStudio
- Graphical-Diagrammatic programming environment
- Aim – allow users to develop applications without writing code
- Uses the Flow Based Design paradigm
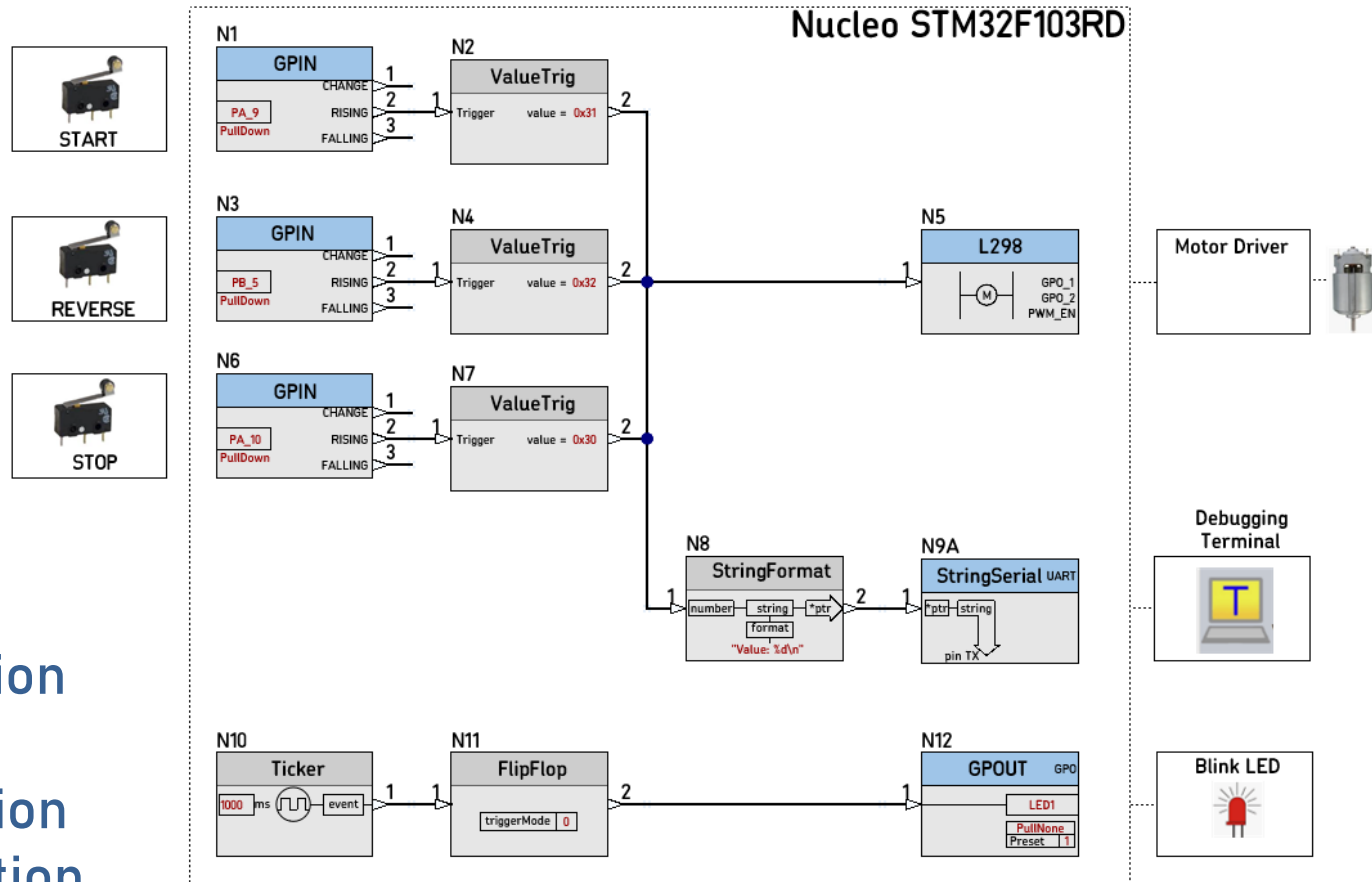- Function-Nodes connected with Wires

Code
- Autogenerated code runs in a soft-real-time system
- Underlying layer: Kernel and Event driven tasks
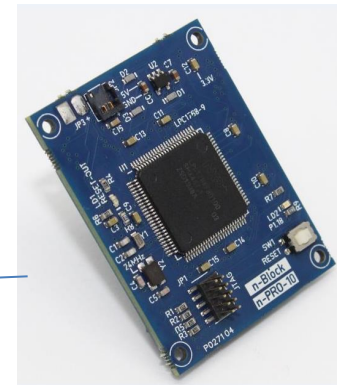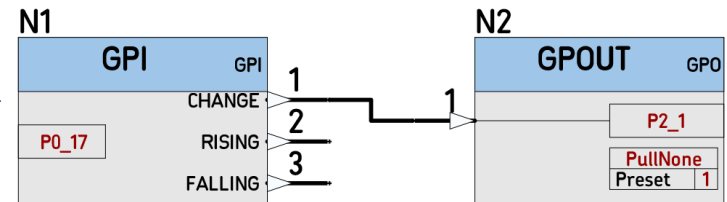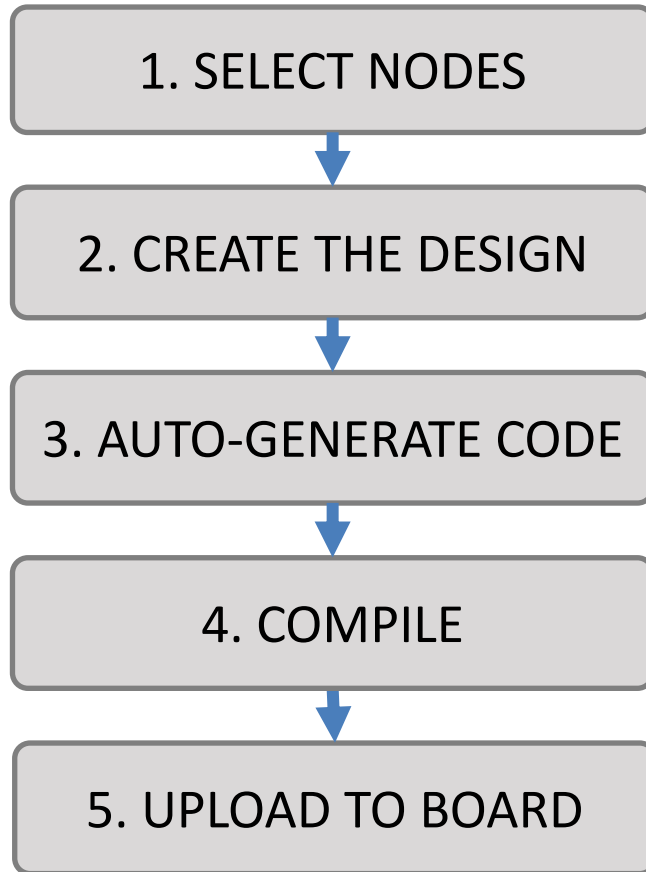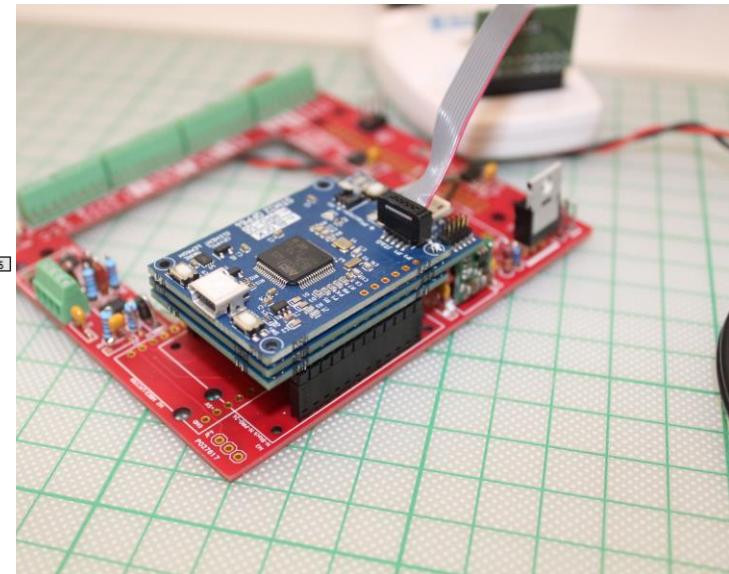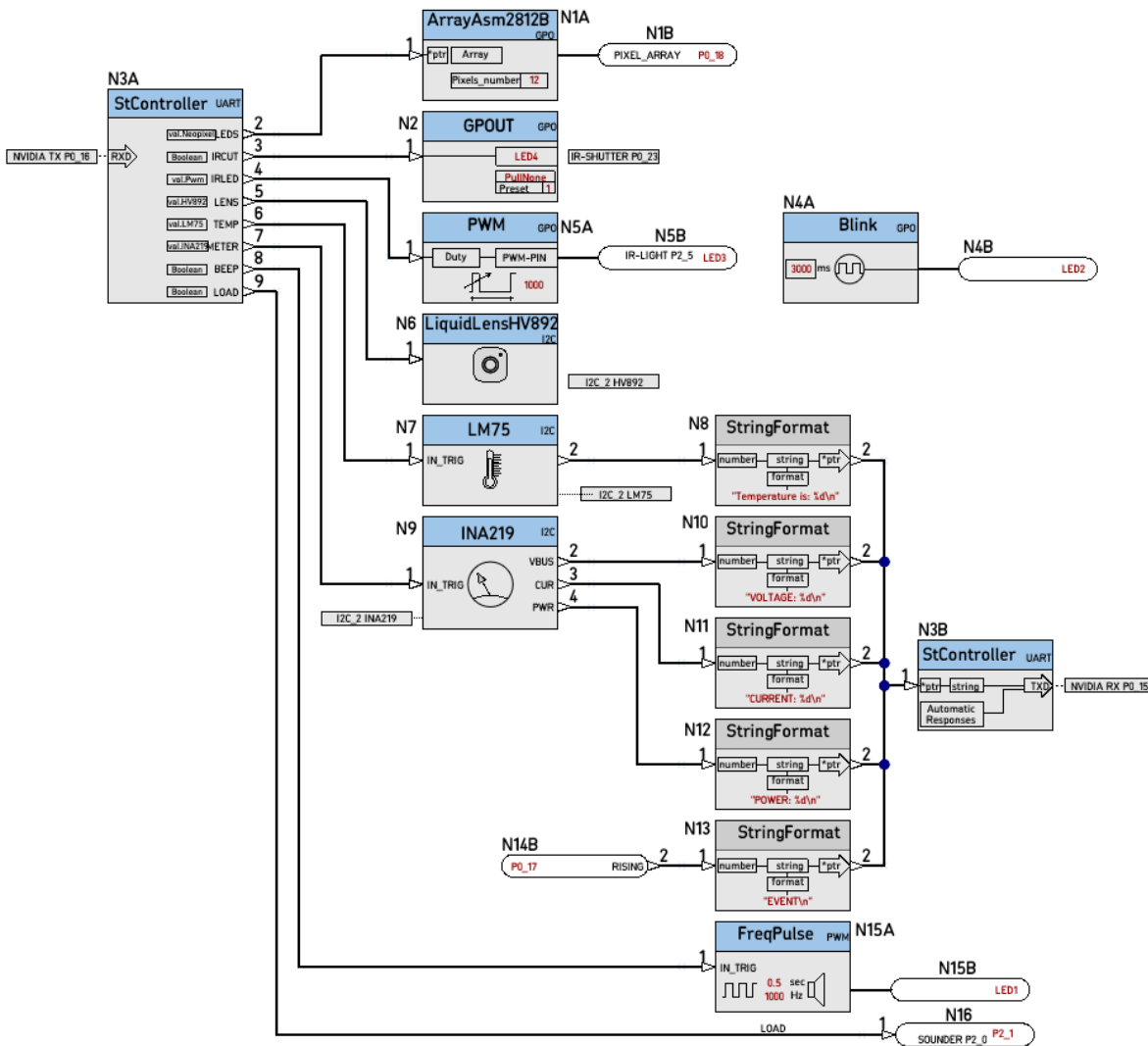- Contribution server

Function Blocks

Concepts

1. Node
2. Flow
3. Connection
4. Design
5. Translation
6. Compilation

Workflow

1. SELECT NODES

↓

2. CREATE THE DESIGN

↓

3. AUTO-GENERATE CODE

↓

4. COMPILE

↓

5. UPLOAD TO BOARD
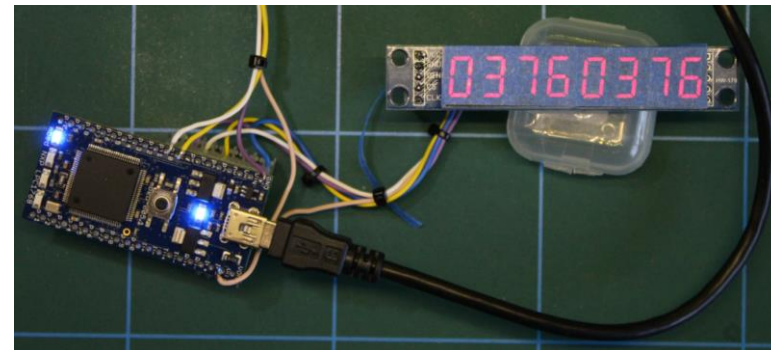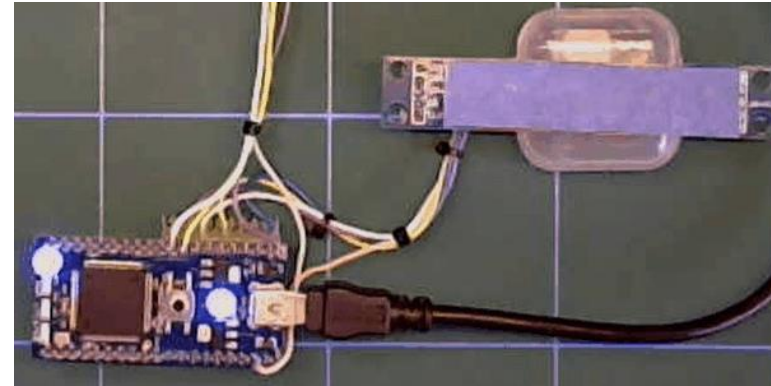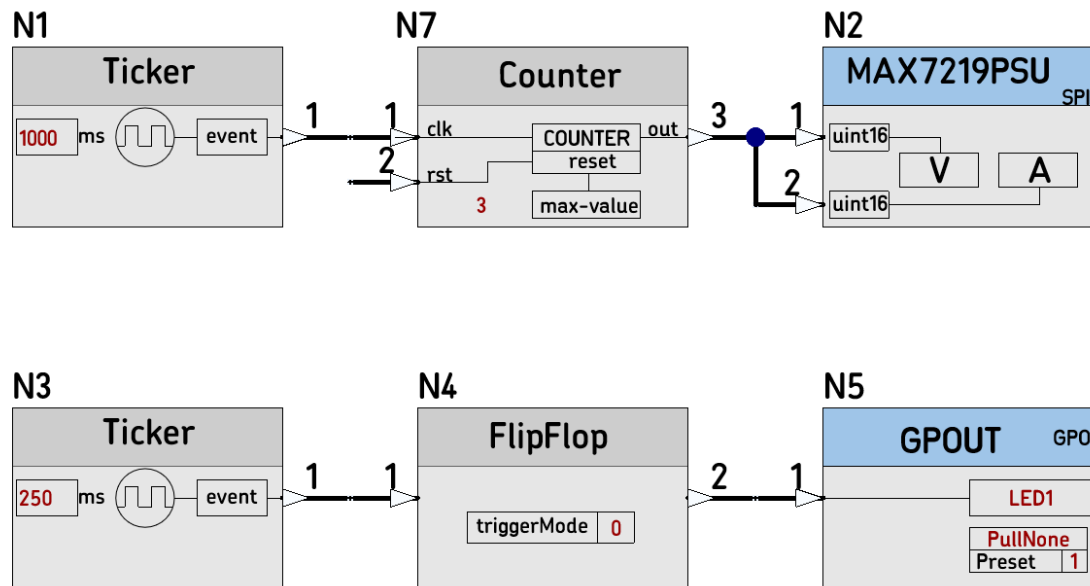
Example: Optical Scanner Controller

Example: seven-segment Display

N1

Ticker

| 1000 | ms | event |

N7

Counter

clk
COUNTER out
rst reset
3
max-value

N2

MAX7219PSU SPI

uint16 V A
uint16

1 → 1 → clk, out 3 → 1 → uint16
2 → rst
2 → uint16

N3

Ticker

| 250 | ms | event |

N4

FlipFlop

triggerMode 0

N5

GPOUT GPO

LED1
PullNone
Preset 1

1 → 1 → 2 → 1

Example: Simple motion automation
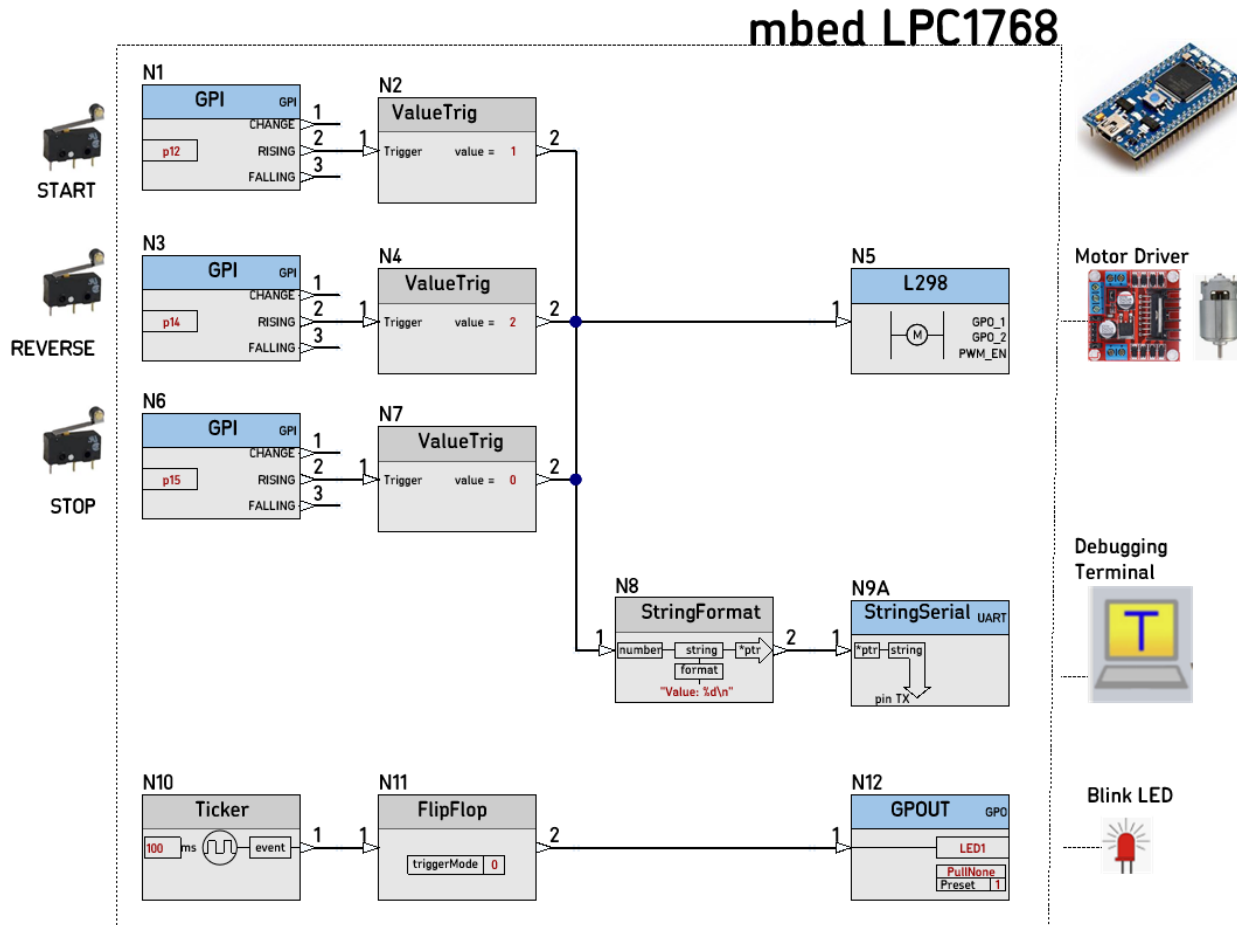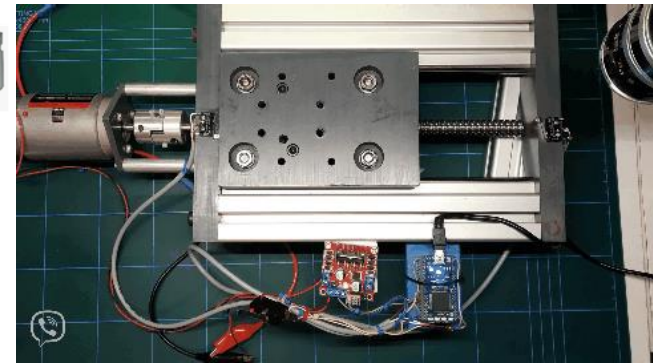
Example: Simple 2.4GHz Link

TRANSMITTER

RECEIVER

Receives every se...
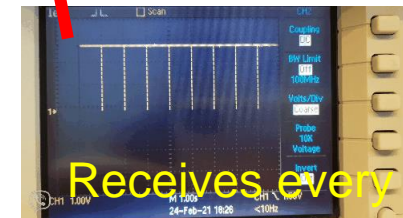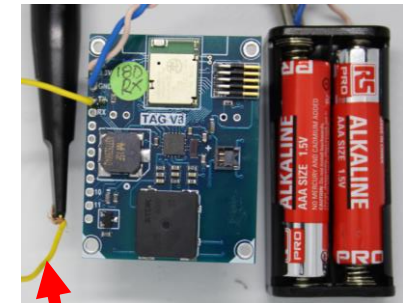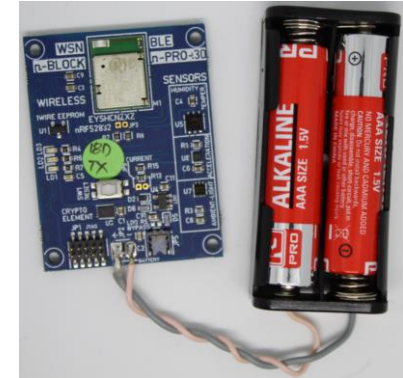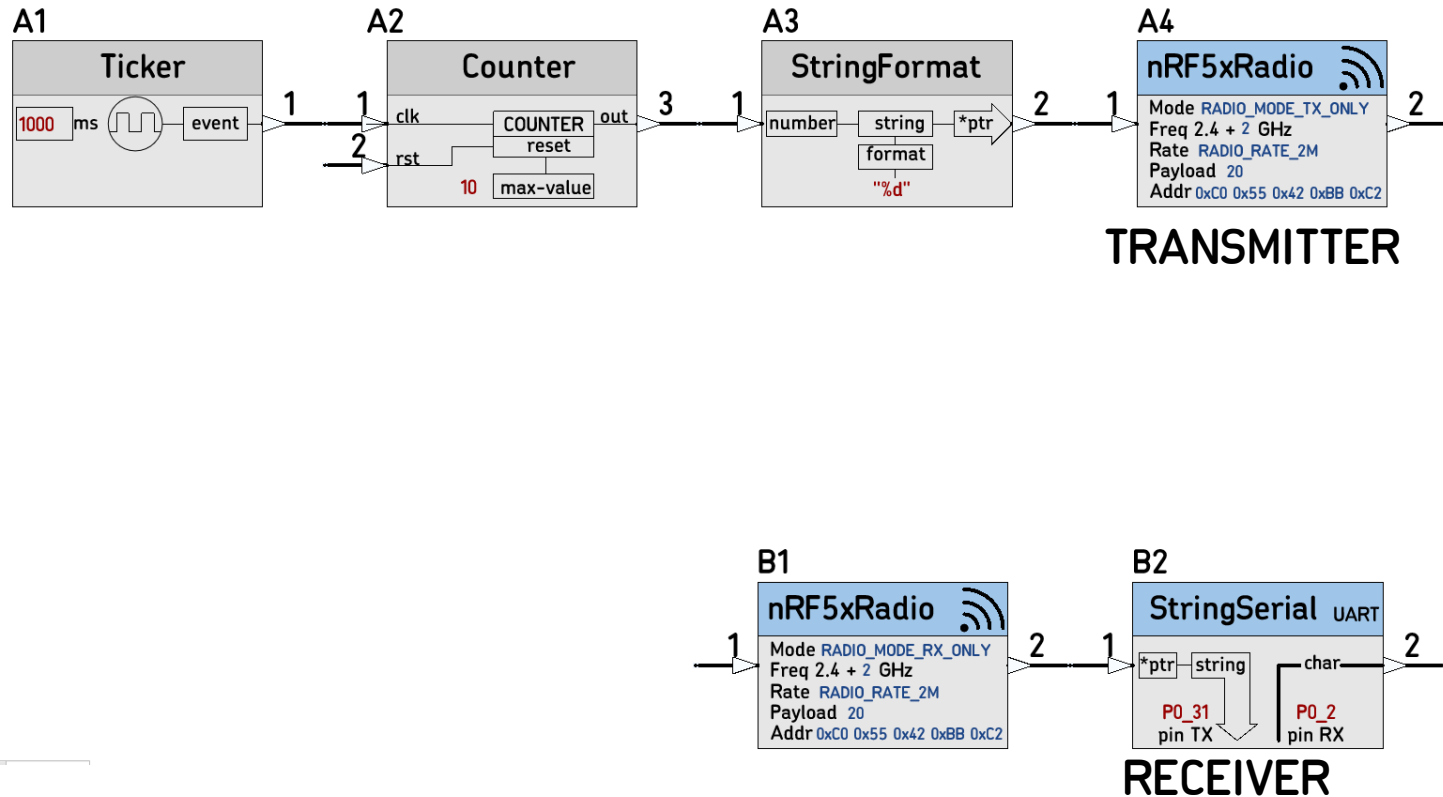
Example: Simple LoRa Link

TRANSMITTER

RECEIVER

TX current

Receiver to terminal
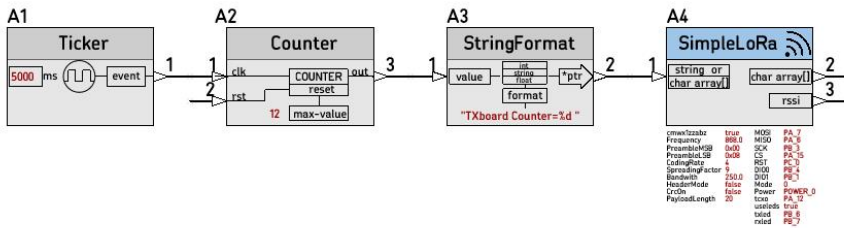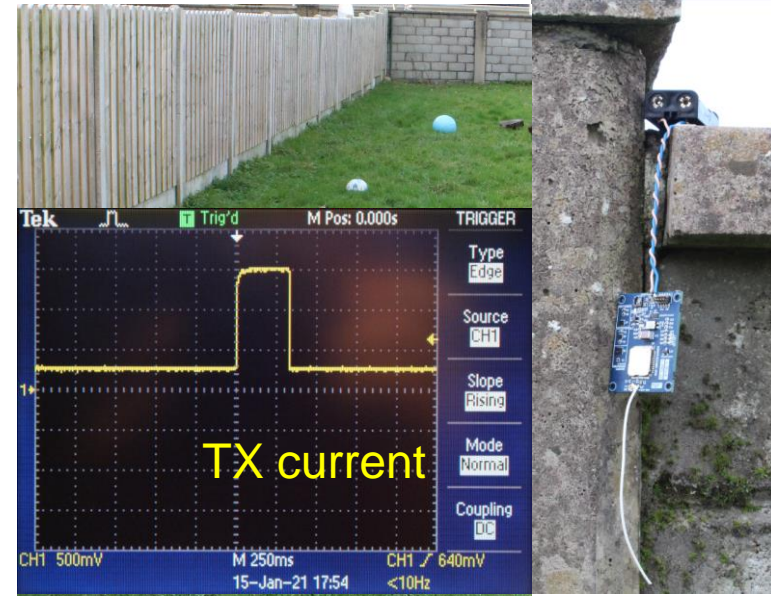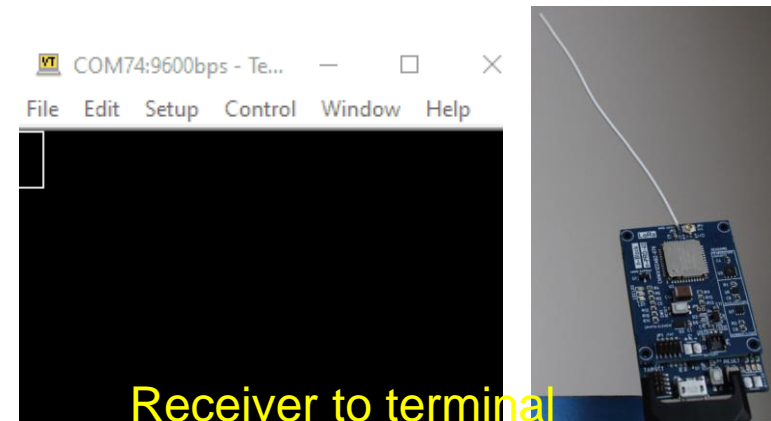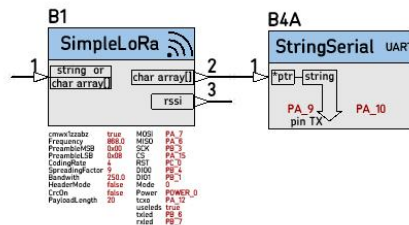
Example: Counter to OLED display
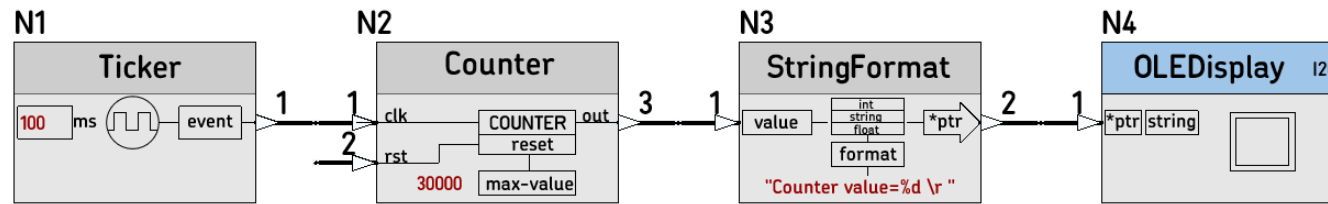
Example: Ultrasonic Range finder
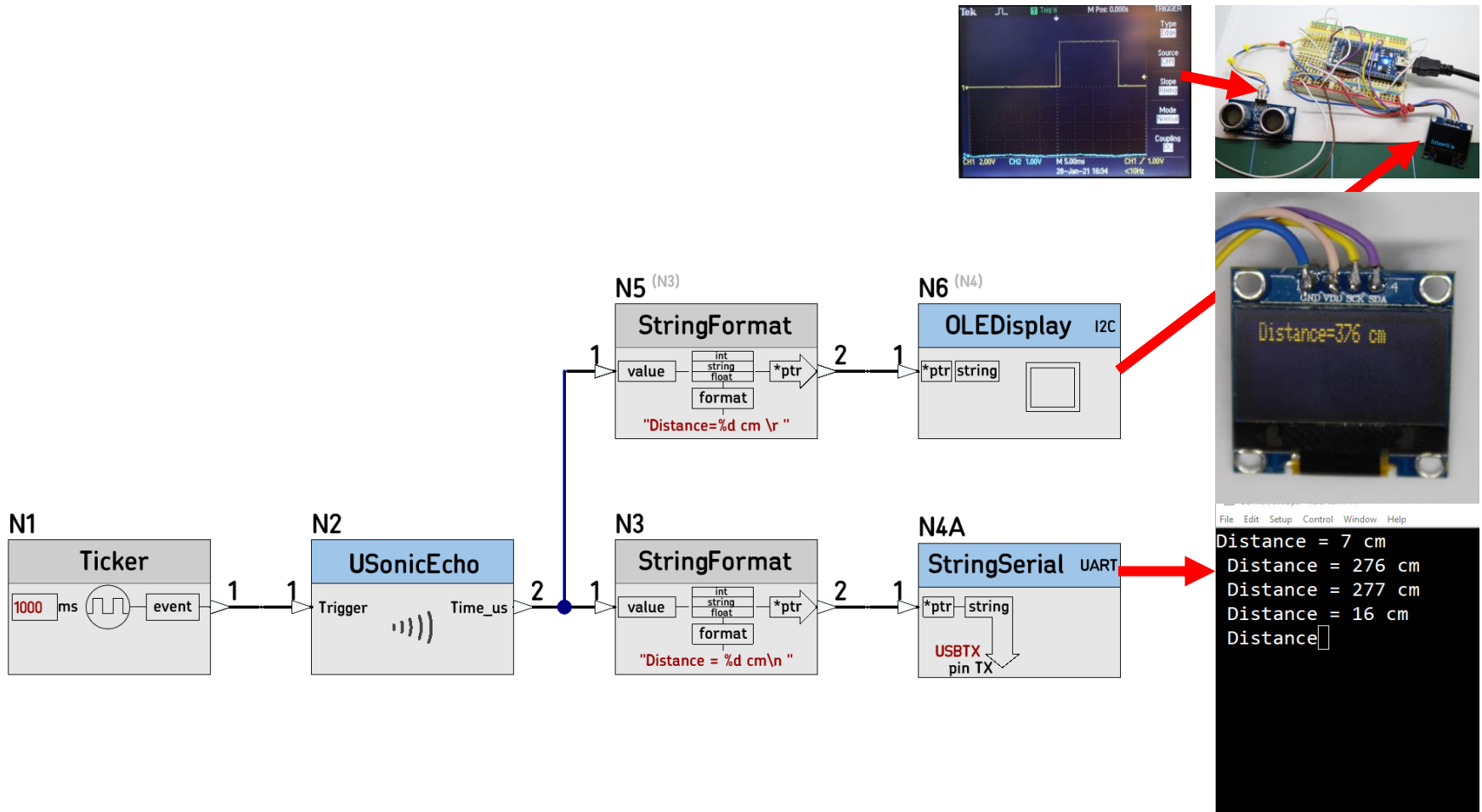
Example: Simple Stepping-Motor

N1

Ticker

| 4000 | ms | event |

N2

Counter

clk
COUNTER out
reset
rst
5 max-value

N3

STEPPER

Simple
M
Gcode
StopPos

MOSI	p11	pinSTEP	p26	speed	0.00004
MISO	p12	pinDIR	p29	accel	10
SCK	p13	pinEN	p30	Axis	1
SS	P0_11	pinSTOP	p25	TMC2130	true
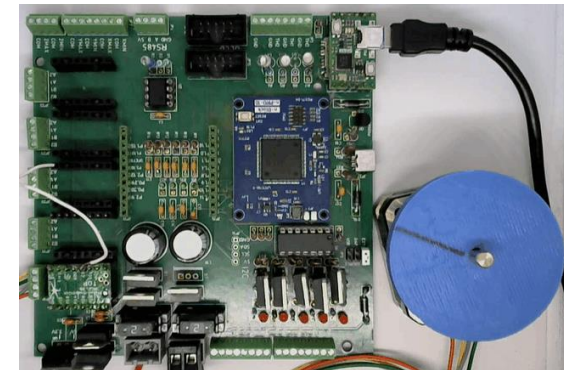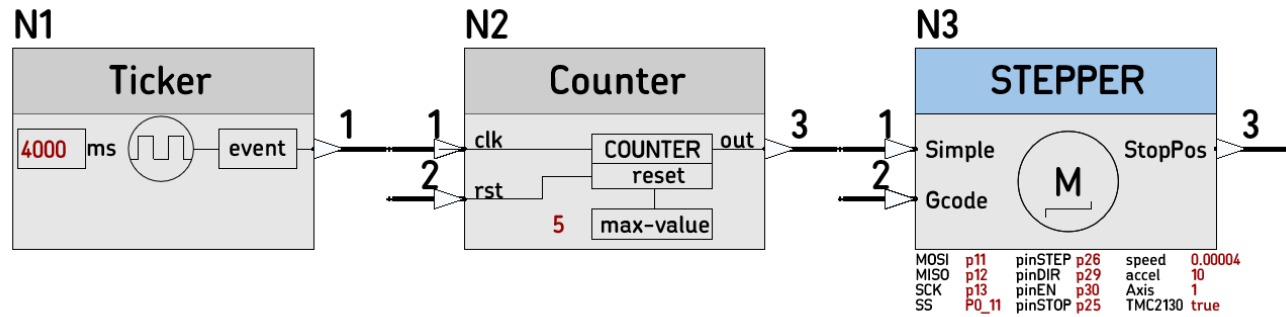
Summary

- n-Blocks: A modular low power IoT Hardware platform

    - Uses Standardized Form-factor, Connectors, Interfaces

    - Sensor focused, Powered by ARM Cortex Microcontrollers

    - Applied to real Projects

    - No Cables: Reduces complexity and time to Higher TRL

- nBlocksStudio: A flow-based / function-blocks programming environment, for microcontrollers.

    - Uses Function Blocks. Controlled by events and messages

    - Design driven, Powered by C++ classes and abstractions

    - Applied to real Projects and reference designs:

    - No Code: Reduces drastically development time