

# DAYTECH

## ENVISION INDUSTRIAL IOT PLATFORM TRAINING AND EDUCATION WORKBOOK

USER LEVEL EDUCATION ON DAYTECH'S IIOT PLATFORM, 4G IIOT-SMARTPOWER GATEWAY, SMARTPOWER BATTERIES, SMARTNODE, SCOUTNODES, INDUSTRIAL IOT ARCHITECTURE, WITH THE FLOW PROGRAMMING TOOL AND DT-LOGIC IEC61131 PROGRAMMING IDE.



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STUDENT INTRODUCTORY TRAINING AND EDUCATION WORKBOOK - REV A

**PREPARED FOR** | Authorised Students, Engineers and Technicians

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## **1. DEFINITIONS**

Definitions of Industrial IoT, Mesh Networks and other relevant names and acronyms.

### **1.1 IIoT**

Industrial Internet of Things. The Industrial version of IoT.

The Internet of Things (IoT) describes the network of physical objects - "things"- that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

### **1.2 WSN**

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on.

### **1.3 Mesh Network**

A mesh network is a local network topology in which the infrastructure nodes connect directly, dynamically and non-hierarchically to as many other nodes as possible and cooperate with one another to efficiently route data from/to clients.

### **1.4 DT-MESH**

Daytech's hardened Zigbee Mesh Network protocol, designed with advanced command-response API's. DT-MESH has higher throughput, is faster and has lower packet loss than typical Zigbee.

### **1.5 IIoT-SMARTNODE**

Daytech's multifunctional Wireless Industrial IoT node. The IIoT-SmartNode can not only power and receive data from sensors, it can intelligently control equipment as well.

### **1.6 IIoT-SCOUTNODE**

Daytech's rugged plug and play 316SS Wireless Industrial IoT node. The IIoT-ScoutNode can not only power and receive data from sensors, it can intelligently control equipment as well.

### **1.7 IIoT-SMARTPOWER GATEWAY**

Daytech's multifunctional Wireless Industrial IoT Gateway. The IIoT-SmartPower Gateway can not only power itself and receive data from remote wireless SmartNodes and ScoutNodes, it can intelligently control entire process with multiple equipment, as well as provide user interfaces with

onboard webserver based graphical UIs and protocol interfacing to SCADA/Server/Cloud and much more.

## **1.8 IIoT-SMARTPOWER BATTERY**

Daytech's multifunctional Wireless Industrial IoT Smart Battery. The IIoT-SmartPower Battery, contains a SmartNode and can not only power itself and instructions from the gateway, it can intelligently power and control equipment directly.

## **1.9 DT-LOGIC**

Daytech's hardened process control software building IDE for development and runtime for execution, designed with IEC61131 standardised programming languages including Ladder Logic, Sequential Function Chart, Function Block and Structured Text.

## **1.10 OSI Model**

The OSI Model (Open Systems Interconnection Model) is a conceptual framework used to describe the functions of a networking system. The OSI model characterizes computing functions into a universal set of rules and requirements in order to support interoperability between different products and software.

## **1.11 IO**

Inputs and Outputs. Used to read information from physical systems as inputs and output from devices to interface with the external world.

## **1.12 API**

Application Programming Interface. A set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.

## **1.13 LOS**

Line of Sight. Line-of-sight propagation is a characteristic of electromagnetic radiation or acoustic wave propagation which means waves travel in a direct path from the source to the receiver. Electromagnetic transmission includes light emissions traveling in a straight line. LOS does not mean the node will have this amount of range in the real world application as there are many variables to consider.

## 2. WORKBOOK OVERVIEW AND INTRODUCTION

This workbook goes hand in hand with the introductory training package from DAYTECH. This course is aimed at engineers and technicians, with previous industry experience and training.

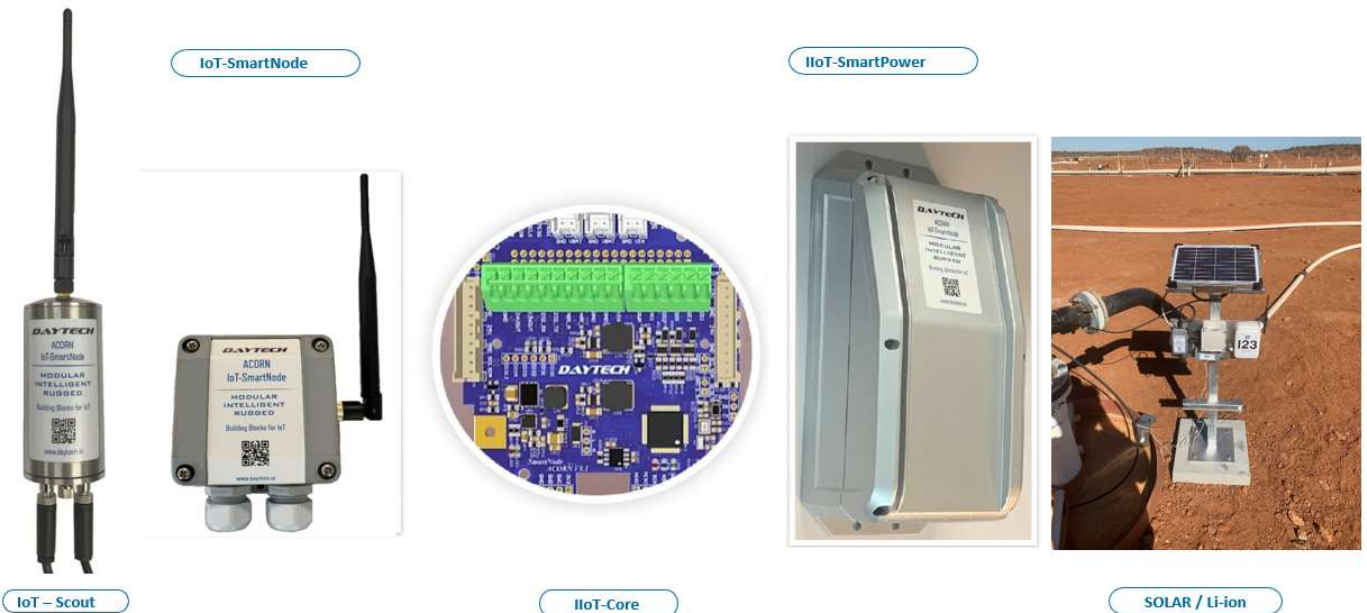
The workbook provides an introductory level education on Daytech's IIoT Platform, 3G/4G/WiFi IIoT-SmartPower Gateway, SmartPower Batteries, SmartNode, ScoutNodes, Industrial IoT Architecture, with the Flow Programming tool and DT-LOGIC IEC61131 programming IDE.

Daytech, a leader in IIoT, develop and manufacture state of the art and high quality Wireless IoT equipment in Adelaide, Australia and have commercialised an advanced range of products, from wireless IO nodes to advanced scalable gateways. Our mission with this workbook is to upskill you, our valuable student, in the technical art of Wireless Mesh Networks and Industrial IoT using Daytech's Platform, so that you can be empowered to create the future of industry yourself.

An overview of the key IIoT technologies you will learn about, is shown below.



### THE SOLUTION



### 2.1 The IIoT-Core / IIoT-SmartNode Solution

Daytech's range of modular all-in-one hardware and software technology, products offer robust, precise, sophisticated real-time monitoring and automatic wireless mesh network control. These innovative Industrial IoT solutions are suitable for a wide range of process and environmental applications, including mission critical applications.



The IIoT-SmartNode Core forms the central hardware building blocks of the platform, where many different modular options can be built upon this.

## 2.2 The IIoT-SmartPower, IIoT-SmartNode and IIoT ScoutNode Hardware Systems

The IIoT-SmartPower, IIoT-SmartNode and IIoT-ScoutNode, together form the ENVISION Platform, which provides a complete wireless process control and automation solution. Using intelligent industrial grade, high speed, real-time IIoT wireless mesh network hardware and software, this platform represents the next wave in Industrial Automation and Process Control, namely Industry 4.0 for digital transformation.

Flexible and expandable remote battery/solar powering or mains power, allows many applications to be fully wireless and off-grid. This system is used for process control, automation, monitoring, remote power and control, as well as concentrating data from local IO and remote wireless devices in the Mining, Industrial and Energy sectors, to SCADA, cloud or server based systems, or as a complete all-in-one standalone system, using the onboard GUI webserver.

***The IIoT-SmartNode and IIoT-ScoutNode Series – A highly modular, rugged, flexible and agile solution for Industrial IoT!***



## 2.3 The IIoT-SmartNode and IIoT-SmartPower IO and Connectivity Options

The IIoT-SmartNode-IO Expansion, together with IIoT-SmartPower Gateway PRO version, connects to almost any type of sensors and peripheral, with various connectivity options including:

- Analogue and Digital IO;
  - Analogue Input 4-20mA / 0-10VDC / 0-5VDC;
  - Analogue Output 4-20mA / 0-10VDC / 0-5VDC;
  - Digital Input 5-32VDC range;
  - Digital Pulse Input;
  - Digital Output (optional 5VDC/12VDC/24VDC) up to 250mA – requires interface relay for larger loads.
  - Varying options depending upon the model of SmartNode selected.
- TCP/IP Ethernet, HTTP, MQTT, COAP, WEBSERVER, CLOUD, REMOTE SERVER
- Multichannel RS485 MODBUS, Multichannel RS232
- Up to 144 local expansion IO, and up to 30 remote IIoT mesh network nodes (or 100s more with more gateways).

## 2.4 The IIoT-SmartNode and IIoT-SmartPower – Flexibility and Configurability

The platform is flexible and configurable. Deployments of a systems consists of firmware, software, single or dual redundant 4G network communications, single or dual redundant CPU and Webserver platform in the SmartPower Gateway PRO, with application specific software development and integration. Each Gateway includes redundant backup UPS battery power. This means the system will be highly reliable and with builtin redundancy, if a CPU fails, the system can be setup to continue to run on the backup CPU, whilst sending out an automatic notification. The redundant battery UPS on board, will continue to power the system, even in the even of a power failure, with a notification being sent out.

Multiple and flexible hardware and software options for configuration of the ENVISION Platform with IIoT-SmartNodes, IIoT-ScoutNodes, SmartPower Batteries and Gateways are available to suit the needs of many application.

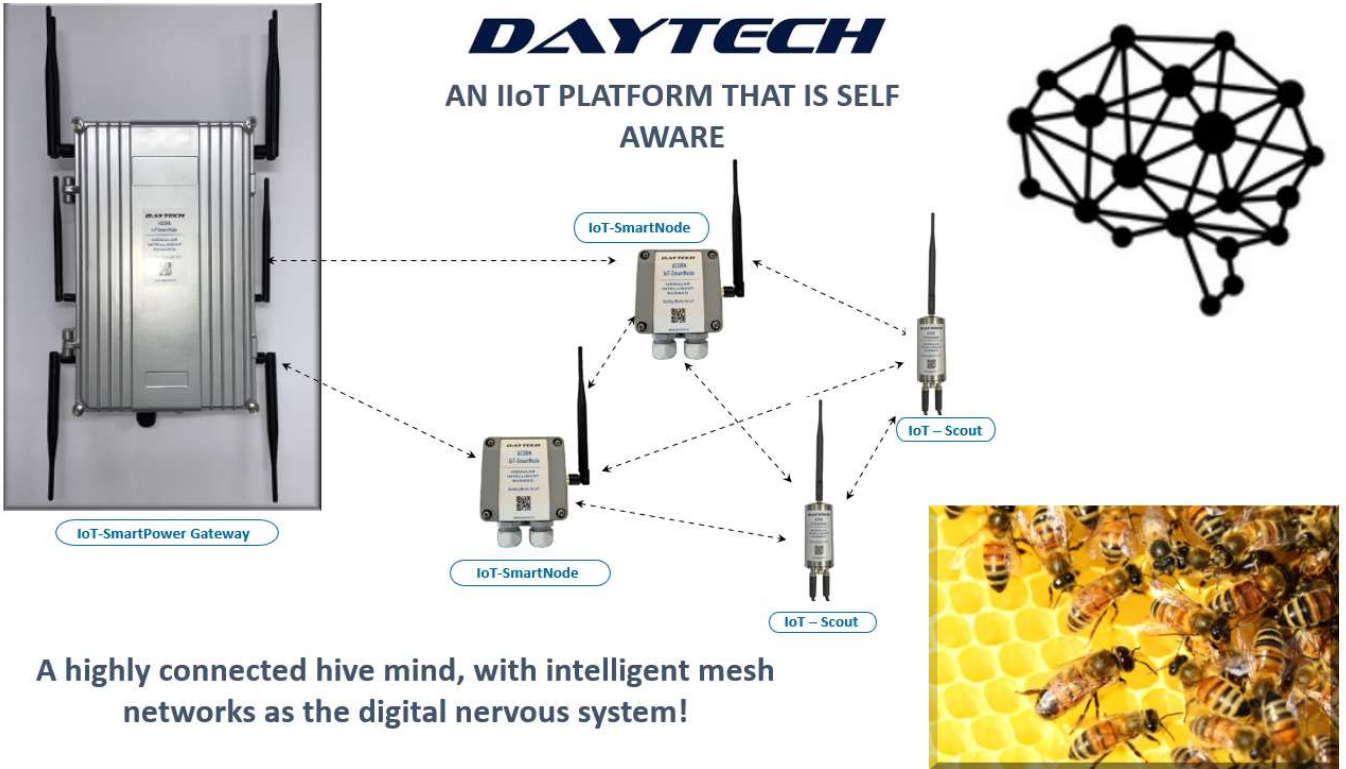
Over time, as processes change and expand, the platform can be upgraded, as the site requirements rearrange and grow. The platform, whilst highly scalable and upgradable, does have

some inherent limitations, which are important to understand before adding nodes and features to your platform.

Recent Examples of the IoT-SmartPower PRO Gateway and IoT-SmartNodes during FAT bench testing:



## 2.5 The IIoT-SmartNode Wireless Mesh Network System



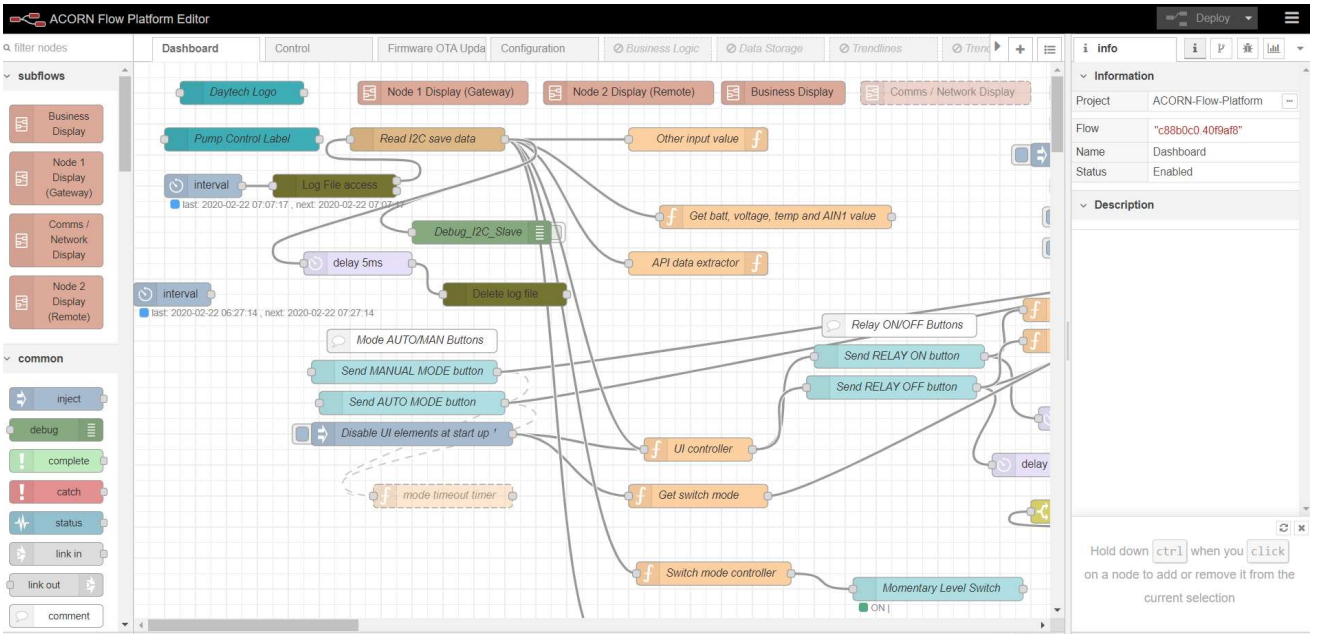
## 2.6 Eliminate PLCs, Marshalling Cabinets, Cabling and Cabling Systems

**GOOD THINGS COME IN SMALL PACKAGES!**

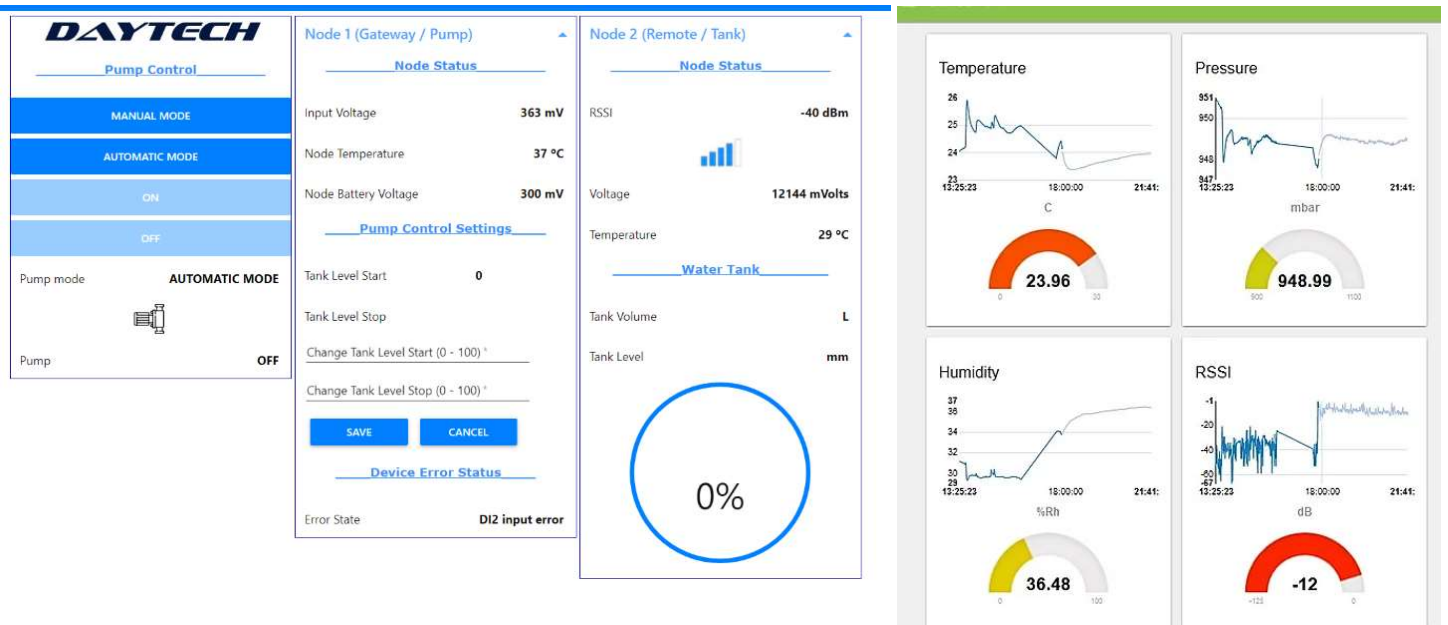


**WIRING IS FOR THE 20<sup>th</sup> CENTURY!**

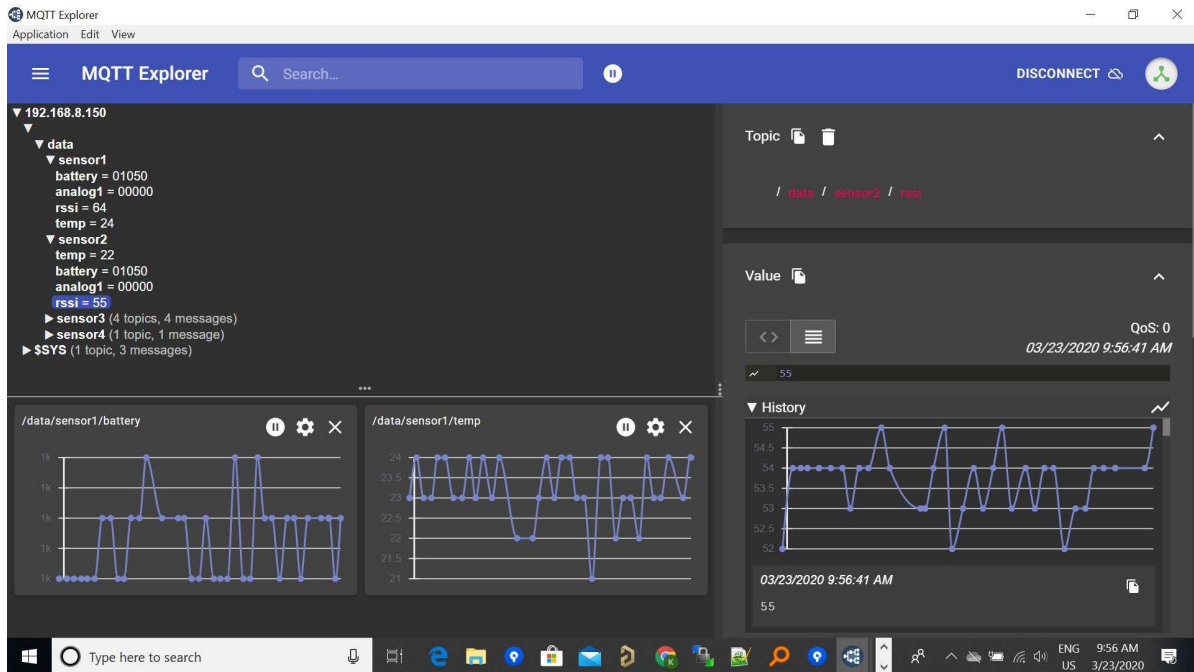
## Flow Programming Tool and DT-LOGIC IEC61131 Software IDE and Runtime Solution



Example of user customisable dashboards:



Example Software development platform and customisable communications and integrations:



### 3. ADVANTAGES OF THE IIoT-SMARTNODE PLATFORM

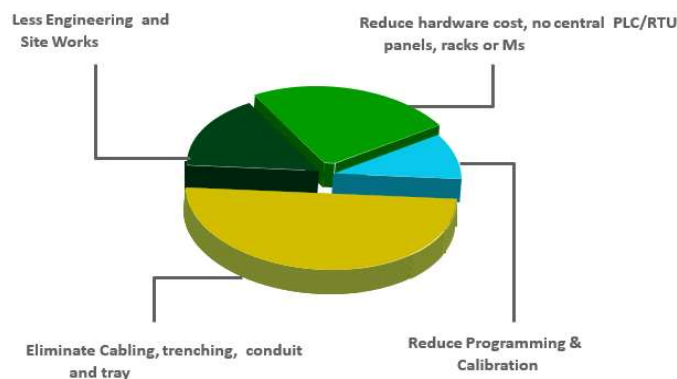
Some Key advantages of the ACORN IoT-SmartNode platform with SmartPower Gateway PRO system:

- Modular hardware and software - a fast, time saving, building blocks approach to IoT;
- Agile platform, that can evolve with you, the platform adapts to your needs as they arise. Future proof technology, enabling flexible and easy upgrades;
- Designed from the ground up as a wireless IoT remote access and control system;
- Rugged and reliable industrial hardware design and protocols;
- Higher Speed Polling for wireless mesh networks;
- Higher QOS and uptime, automatic communication acknowledgments and retries occur on networks including 4G, wireless mesh network and local comms;
- Dual redundant CPU and 4G modems, providing maximum uptime and reliability;
- Advanced Mesh Network Gateway - high speed, low power, long range performance, with multihopping range of up to 105km radius distance;
- Scalable number of gateways, routers and end-nodes and scalable local IO of up to 144 Expansion IO on SmartNode modules and 1000 remote IO;
- OTA (Over the Air) updates, configuration, maintenance and application development;
- Remote support and programming from within the site's secure network and safely via external VPN if permitted;
- User friendly and user customisable software - we provide you with application specific source code and can train your team to develop on the Flow Platform tool;
- Hardened Real-Time Operating System and Daytech's API's, developed for deterministic process control over wireless mesh networks;
- Wifi or 4G backhaul with 2.4GHz or 5GHz in the PRO Gateway, as well as Ethernet for both wired and wireless redundancy;
- Australian designed, Australian made and Australian backed warranty and support;
- No lock in contract fees - you own your SmartNode system.

#### Efficiency and ROI



**Save up to 70% in control systems capex & opex with the Wireless IoT-SmartNode**



**Substantially increase total control systems project ROI**

## 4. APPLICATIONS FOR THE IIoT-SMARTNODE/SCOUTNODE PLATFORM

- Remote Real-Time IIoT enabled Control and Automation, Remote Monitoring and Control
- Remote Machine, Process and Equipment Monitoring and control,
- Remote PLC, RTU, SCADA, control system and communication equipment integration
- Remote pressure, temperature, flow and other sensor measurement and control
- Remote analytical and environmental measurement and control
- Remote Flow Control of Valves, Pumps and Pipelines
- Can be factory programmed for many applications
- Can be user programmed via the flow programming tool and DT-LOGIC for process control and automation as well as highly interoperable IIoT integration
- Process and Mining Industries,
- Water and Wastewater treatment, Irrigation,
- Smart Heavy Industry, Chemical and Process
- Smart Food and Beverage Manufacturing
- Smart Agriculture and Farming
- Scientific and Environmental
- OEM – machine builders and equipment manufacturers – embedded IIoT Solutions.



## 4.1 APPLICATIONS – MINING AND RESOURCES



### **MINING & RESOURCES - DIGITAL REMOTE OPERATIONS**

Remote Wireless Control, Engineered IIoT, Smart Battery solutions and environmental monitoring/control for the resource industries.

### **IIoT FOR MINING PROCESS CONTROL & OPERATIONS**

- Remote operational control and telemetry
- Crusher, ball mill and hammer mill remote monitoring
- Tank and pumping monitoring and control
- Dust suppression and monitoring
- Pipeline, valve and flow - remote control, automation and monitoring
- Tailings dam monitoring and control
- Cooling tower control systems
- Industrial Wastewater Automation
- RO / Permeate Systems Control
- Chemical dosing / Batch control
- Inhibitor / Boiler control
- Oil/lube pressure monitoring
- Predictive maintenance and optimisation
- Robotic Systems Integration
- EEHA - Hazardous Areas

## 4.2 APPLICATIONS – PROCESS CONTROL AND SMART ENERGY MANAGEMENT



### PROCESS CONTROL & SMART ENERGY MANAGEMENT

Intelligent Engineered IIoT and Smart Battery technologies for the process and manufacturing industries, upgrading to Industry 4.0.

#### IIoT FOR SMART PROCESS CONTROL & POWER SAVINGS

- Power analysis and load control
- Renewable energy, wind and solar power farm monitoring and control
- Generator and turbine remote monitoring, optimisation and predictive maintenance
- Tank monitoring and control
- Pumping system control
- Pipeline, valve and flow - remote control, automation and monitoring
- Cooling tower control systems
- Industrial Wastewater Automation
- RO / Permeate Systems Control
- Chemical dosing / Batch control
- Inhibitor / Boiler control
- Oil/lube pressure monitoring
- Predictive maintenance and optimisation
- Robotic Systems Integration
- Pumping system remote control
- EEHA - Hazardous Areas

## 4.3 APPLICATIONS – PROCESS CONTROL AND SMART ENERGY MANAGEMENT



### **FOOD & BEVERAGE MANUFACTURING & PROCESS**

Advanced Engineered IIoT and Smart Battery technologies for the food, beverage and wine industries, upgrading to Industry 4.0.

#### **IIoT FOR FOOD & BEVERAGE PROCESS CONTROL**

- Silo and bulk solids monitoring and control
- Batch remote control and automation
- Tank monitoring and control
- Pumping system control
- Pipeline, valve and flow - remote control, automation and monitoring
- Temperature control and monitoring
- Cooling tower control systems
- Water treatment
- Solid Waste plants
- Chemical dosing
- CIP systems
- Batching systems
- Wash down bays
- Remote Process Control and Monitoring
- Predictive maintenance and optimisation
- Robotic Control and Automation
- Automated Solids and Liquids Handling
- Air temperature and humidity monitoring

## 4.4 APPLICATIONS – SMART WATER AND FARMING

### **SMART WATER & FARMING**

Remote Wireless Control, Engineered IIoT and Smart Battery solutions.



### **SMART AGRICULTURE, WATER & WASTE WATER**

Advanced IIoT and Smart Battery technologies for Precision Agricultural, Smart Water and Wastewater industries.

- Automatic Remote IIoT controlled Irrigation Systems
- Soil moisture monitoring and integration
- Fertilisation and fertigation automation, monitoring and control
- Filtration, washing and sterilisation System Automation, integration and monitoring
- Pipeline, valve and flow - remote control, automation and monitoring
- Sewage Treatment \ Potable Water Treatment \ Industrial Wastewater
- RO / Permeate Systems Control
- Chemical dosing: Chlorine / Ozone / Fluoride / Coagulation and Polymer Dosing Systems / hydroponic nutrient dosing.
- Tank monitoring and control
- Pumping system control
- Greenhouse monitoring and control
- Solar Powered offgrid systems

## 4.5 APPLICATIONS – SCIENTIFIC AND ENVIRONMENT

### SCIENTIFIC & ENVIRONMENT

Remote Wireless Control, engineered IIoT and Battery solutions for remote environmental monitoring and scientific applications.

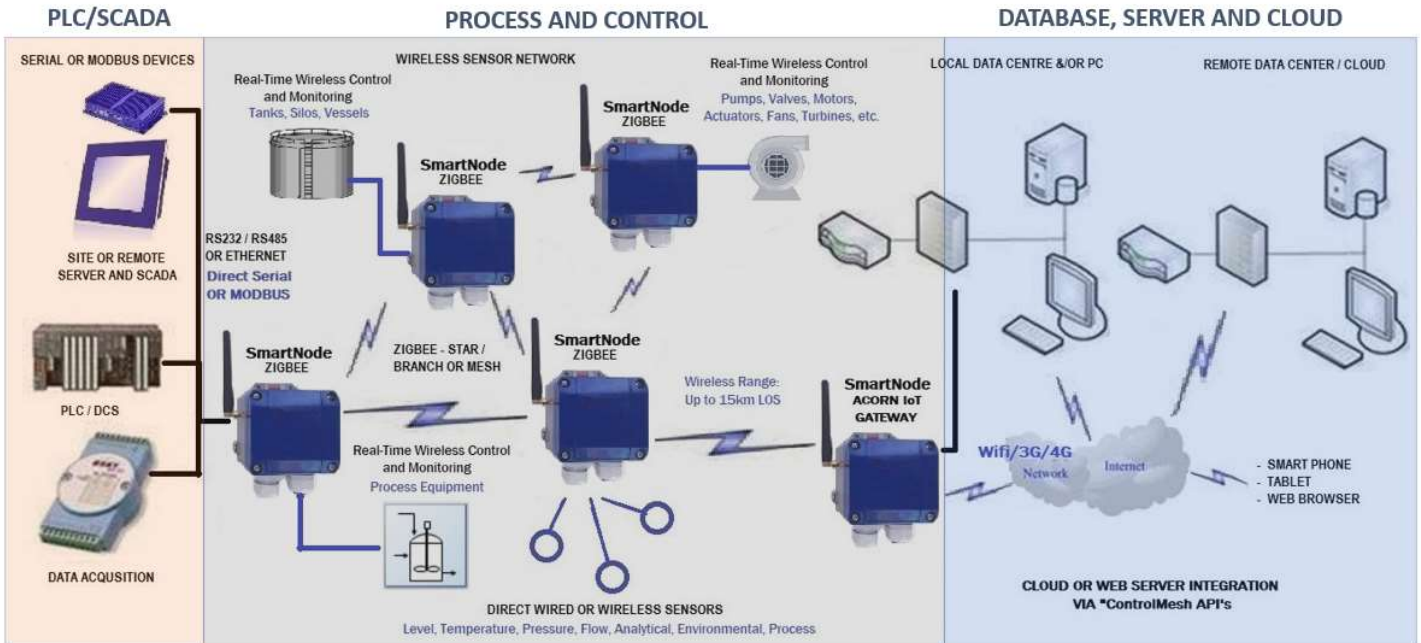


### IIoT FOR SCIENTIFIC AND ENVIRONMENTAL APPLICATIONS

- Remote monitoring, control and telemetry
- Scientific studies and data collection
- Surface water monitoring and control
- Air pollution monitoring and control
- Water pollution monitoring and control
- Soil pollution monitoring and control
- Tank monitoring and control
- Environmental monitoring, ground water monitoring and EPA compliance
- Dust suppression and monitoring
- Tailings dam monitoring and control
- Local and State Government environmental monitoring and rehabilitation programs
- Pumping system control
- Ecological studies
- Geological applications
- Civil and structural sensing and monitoring

## 5. TECHNICAL OVERVIEW – PLATFORM TOPOLOGY

### 5.1 SITE LEVEL NETWORK TOPOLOGY

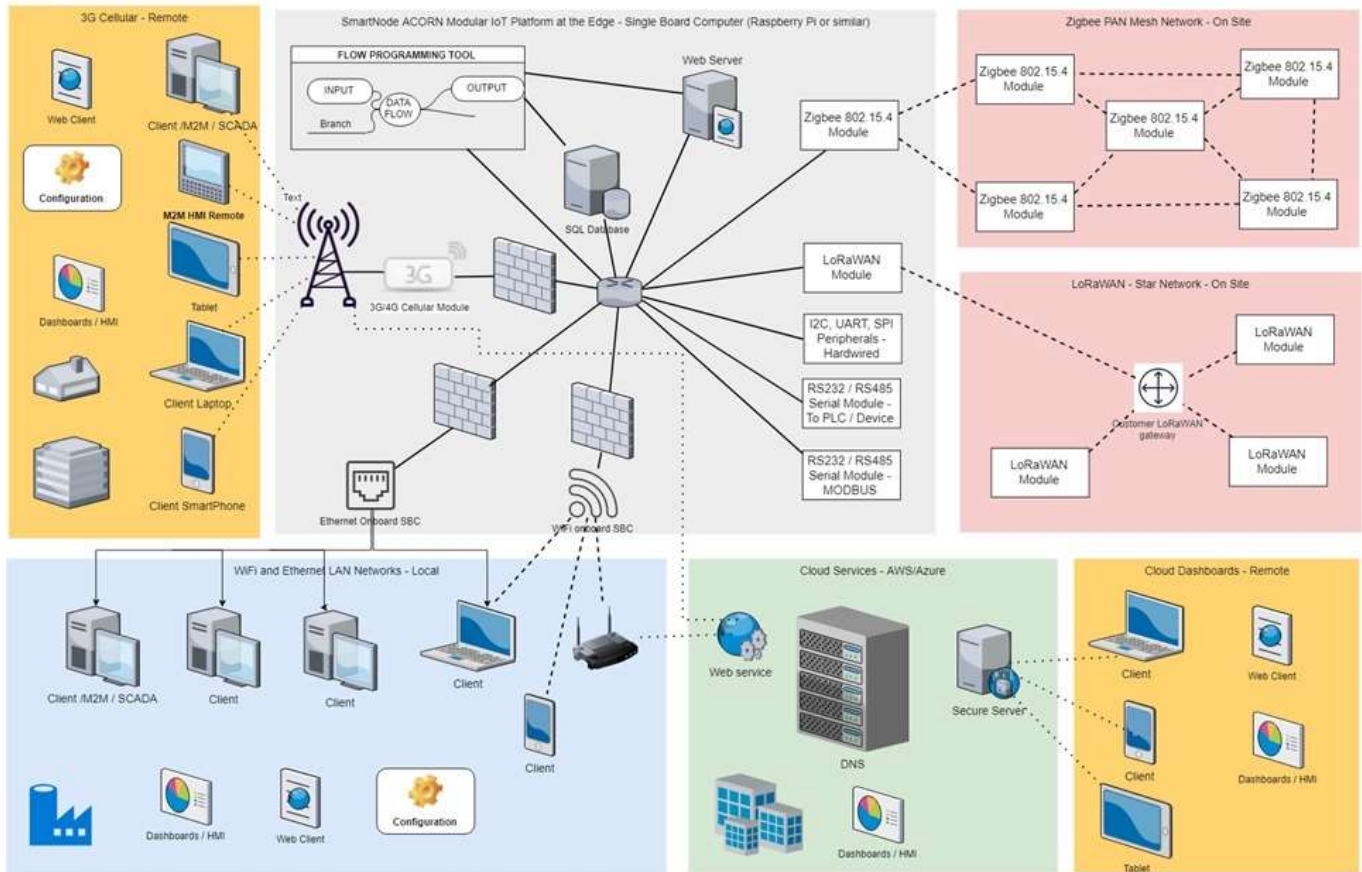


That connects humans, machines and infrastructure together and automates all processes, seamlessly and in real time.



## 5.2 IIOT-SMARTNODE ACORN GATEWAY - GENERAL SYSTEM TOPOLOGY

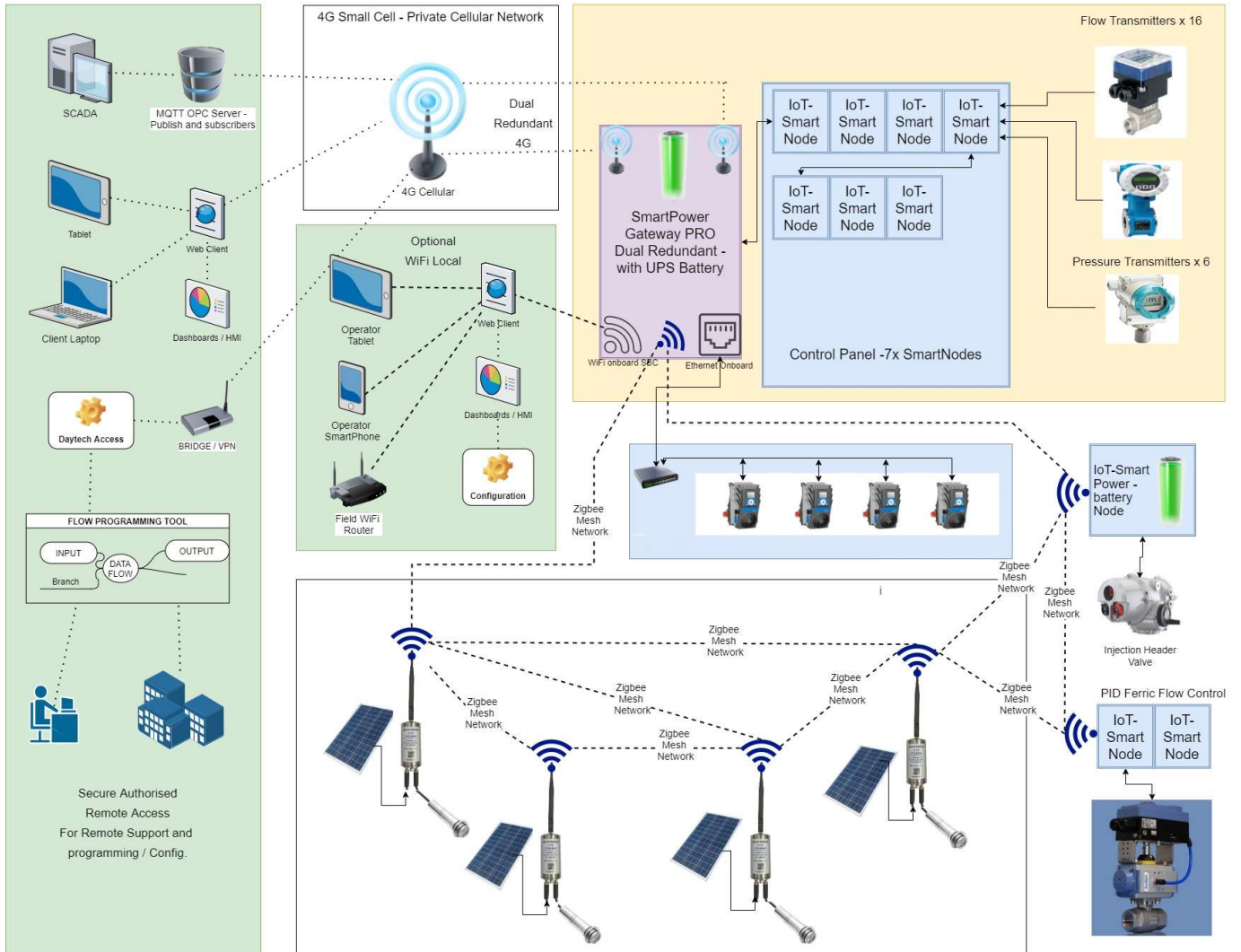
DAYTECH - SMARTNODE ACORN AND CONTROLMESH - NETWORK TOPOLOGY



### 5.1 IIOT-SMARTPOWER GATEWAY PRO GENERAL TOPOLOGY



DAYTECH - ACORN IoT SmartNode - NETWORK TOPOLOGY





## 6. TECHNICAL OVERVIEW – WIRELESS RANGE CONSIDERATION

### 6.1 SMARTNODE RANGE

20mW Transceivers on the gateway = approximately 3-5km LOS

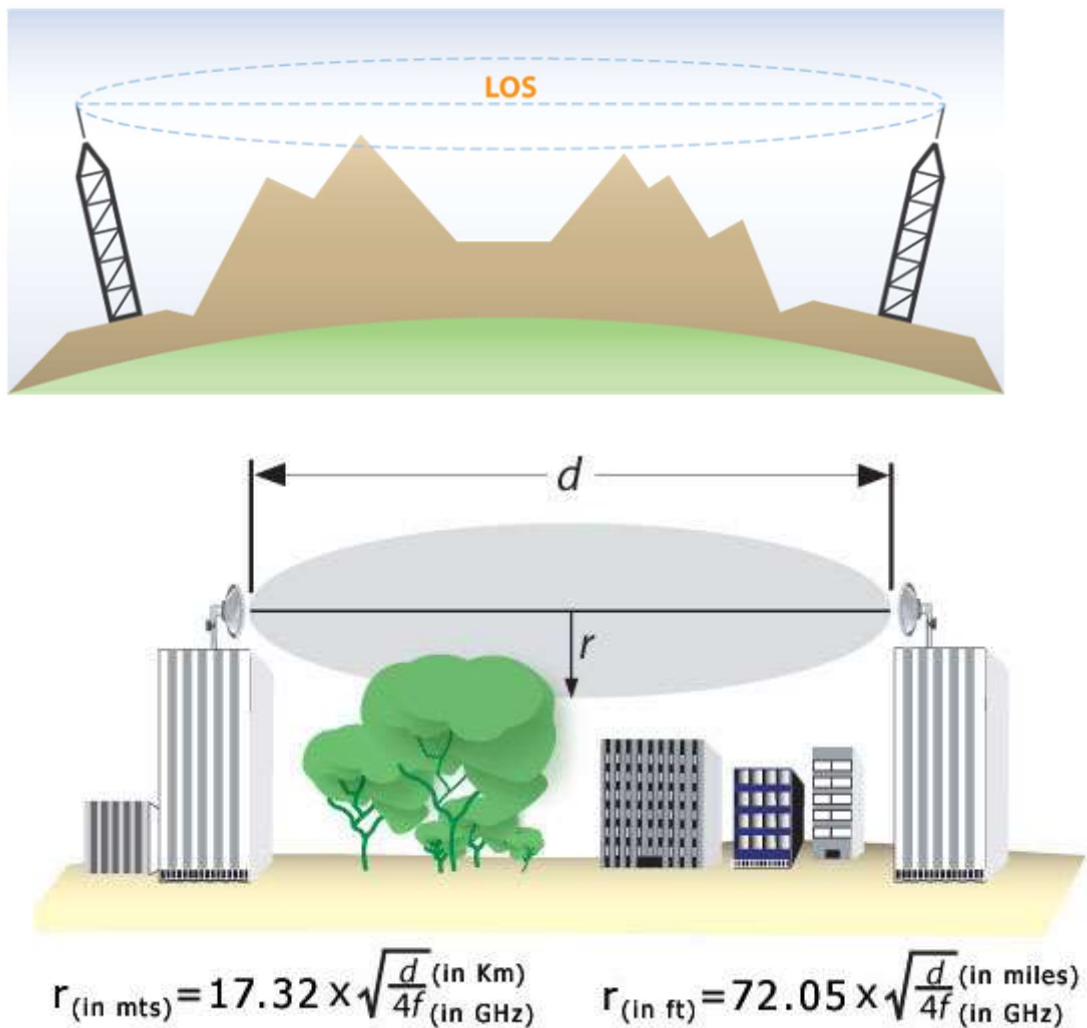
1W Transceivers on the gateway = approximately 5-10km LOS

Options for higher power transceivers in the SmartNode are available.

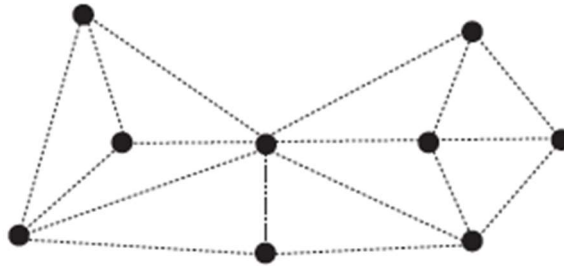
Options for high gain and directional antennas are available.

Daytech can perform a formal wireless range survey, providing a complete site report as required.

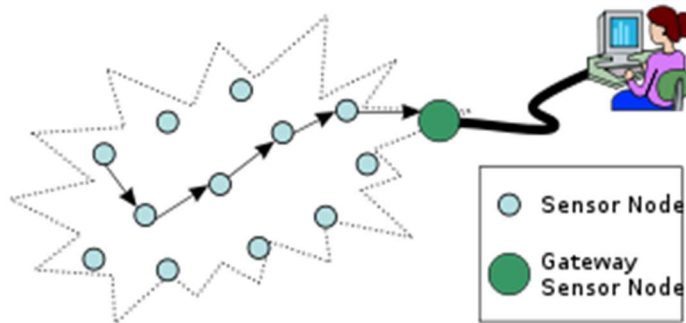
### 6.2 LOS AND THE FRESNEL ZONE



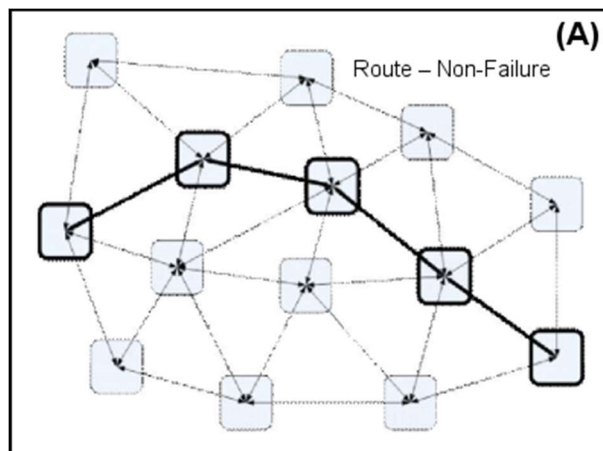
### 6.3 SMARTNODE RANGE – MULTIHOPPING



SmartNodes and ScoutNodes on Daytech's DT-Mesh Zigbee network, can multihop up to 7 times, extending the range significantly.



Each node is automatically a repeater at the protocol level, with no additional programming or configuration required. DT-Mesh is a self-healing mesh network, with automatic re-routing.



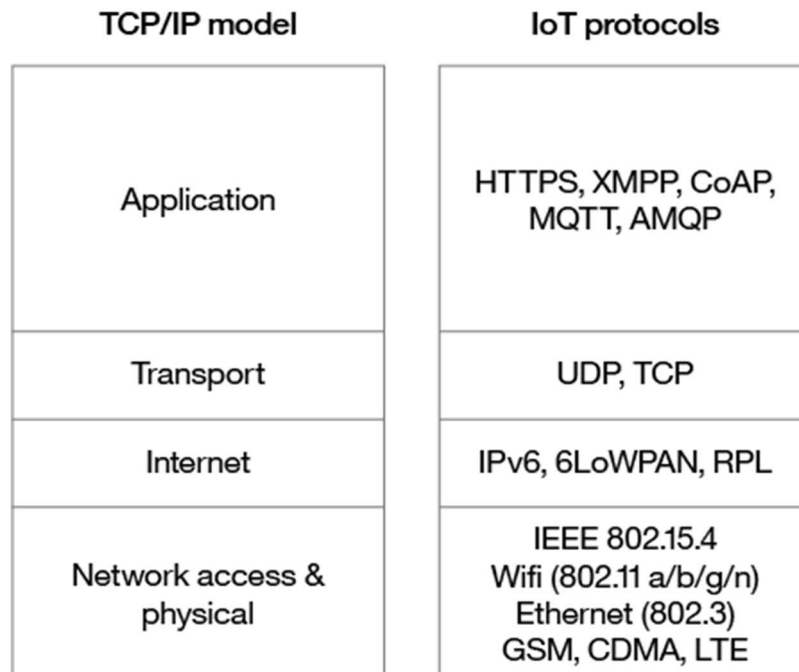
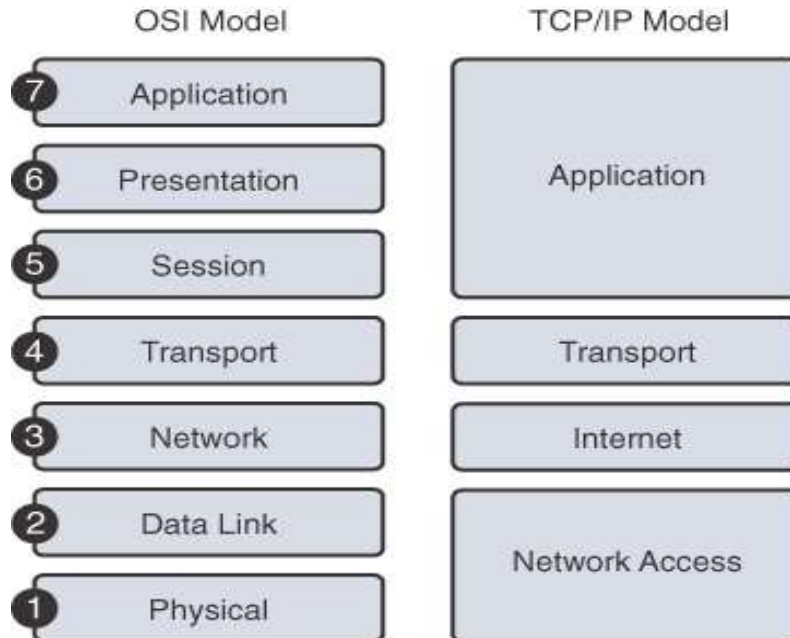
Care must be taken with multihopping in automation applications, as message and network latency can increase, slowing the polling down. System performance testing is required to ensure network speed is suitable for the application, otherwise speak with Daytech to discuss your application.

## 7. TECHNICAL OVERVIEW – COMMUNICATION PROTOCOLS

### 7.1 OSI MODEL

|   |                    |  |
|---|--------------------|--|
| 7 | Application Layer  | Human-computer interaction layer, where applications can access the network services |
| 6 | Presentation Layer | Ensures that data is in a usable format and is where data encryption occurs          |
| 5 | Session Layer      | Maintains connections and is responsible for controlling ports and sessions          |
| 4 | Transport Layer    | Transmits data using transmission protocols including TCP and UDP                    |
| 3 | Network Layer      | Decides which physical path the data will take                                       |
| 2 | Data Link Layer    | Defines the format of data on the network  |
| 1 | Physical Layer     | Transmits raw bit stream over the physical medium                                    |

## 7.2 IOT PROTOCOLS ON THE STACK



### 7.3 COMPARISON OF ZIGBEE TO WIFI

This Table explains why we use DT-MESH (Zigbee) for battery powered Nodes and why we use WiFi or 4G for Gateways.

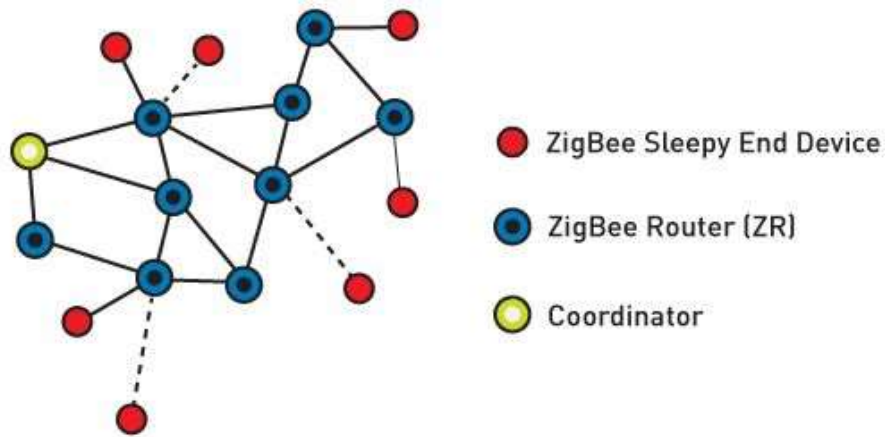
Notice that Zigbee is much lower power but also lower bandwidth.

| TABLE 1: Physical Layer Comparison |   |  |  |
|------------------------------------|---|--|--|
|                                    | Bluetooth 4.2 LE  | 802.15.4   | 802.11   |
| Frequency Bands                    | 2.4 GHz   | 900 MHz and 2.4 GHz  | 2.4 and 5 GHz  |
| Channel Bandwidth                  | 2 MHz   | 2 and 5 MHz  | 20, 40, and 80 MHz   |
| Modulation type                    | FHSS (frequency hopped spread spectrum) with GFSK (Gaussian Frequency Shift Keying) | DSSS (Direct Sequence Spread Spectrum) with BPSK/QPSK (Binary/Quadrature phase shift keying) | QAM-OFDM (Quadrature Amplitude Modulation-Orthogonal Frequency Division Multiplexing) with MIMO (Multiple Input Multiple Output) |
| PHY data rate                      | 1 Mbps  | Up to 250 Kbps   | Up to 867 Mbps (2 antennas, 80 MHz); 72.2 Mbps for 1 antenna, 20 MHz channel   |
| Packet length                      | 10-265 bytes  | 127 bytes  | Up to 1,048,575 bytes  |
| Power consumption                  | < 10 mW   | < 10 mW  | > 100 mW   |

## 7.4 DT-MESH – ZIGBEE

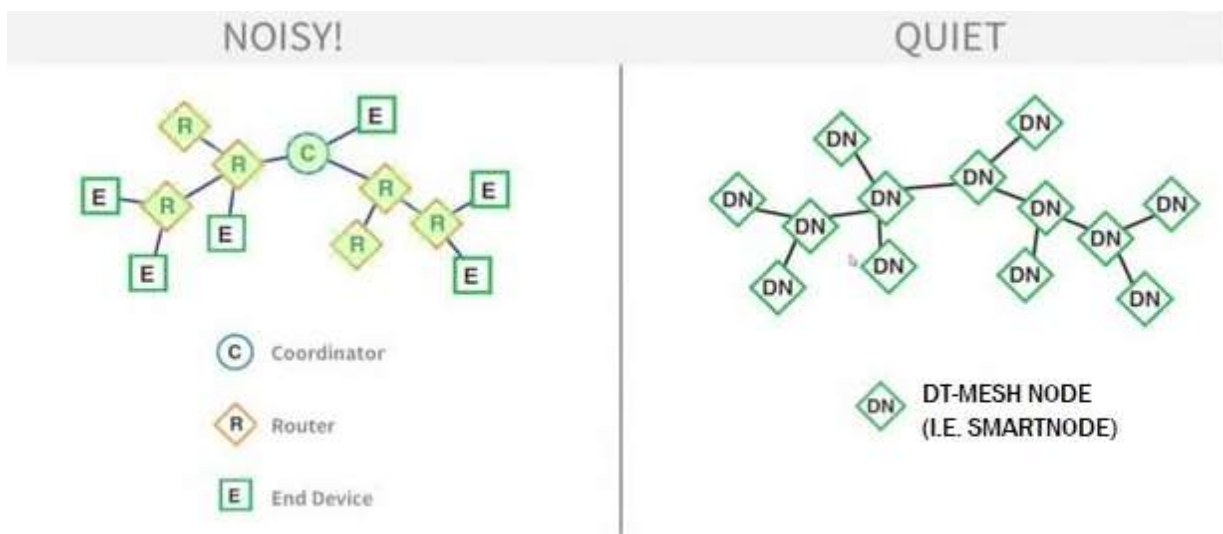


### 7.4.1 ZIGBEE – STANDARD TOPOLOGY - IEEE 802.15.4



### 7.4.2 ZIGBEE – DT-MESH TOPOLOGY

Normal Zigbee is very chatty, whereas DT-MESH is quiet. This means the network is higher speed and far more reliable! Optionally, SmartNodes and ScoutNodes contain a DT-MESH transceiver.



## 7.5 WIFI

**Wi-Fi** uses multiple parts of the IEEE 802 protocol family and is designed to interwork seamlessly with its wired sibling Ethernet. Compatible devices can network through wireless access points to each other as well as to wired devices and the Internet.



The SmartNode system uses WiFi on the Gateways, to allow network connectivity to a WLAN and optionally to the internet via an Access Point, so that the Gateway can access the internet and therefore act as a backhaul device in the same way as 3G/4G works. Daytech's gateways can optionally be configured to create their own wireless access point, independent of any other device, allowing the users to directly connect to the gateway from tablets, smartphones and PCs.

## 7.6 3G/4G LTE CELLULAR

Like 3G, **4G** networks are IP-based (Internet **protocol**), meaning that it uses a standard communications **protocol** to send and receive data in packets. Unlike 3G, however, **4G** uses IP even for voice data. It is an all-IP standard. The 3G and 4G networks use cellular towers for communication and require SIM cards for operation.



In Australia, the current LTE networks mostly use the 700MHz 1800MHz, 2100MHz and 2300MHz spectrums. That said, the networks are constantly testing, trialling and expanding their networks on other frequencies. **Vodafone** has 850MHz spectrum running LTE, while Telstra and **Optus** have both tested 2600MHz.

The IIoT-SmartNode and SmartPower Gateways come with optional 3G/4G modems for connecting to various cellular networks, requiring a SIM card and configuration.

## 7.7 SERIAL RS232/RS485 (Onboard IIoT-SmartNode)

The IIoT-SmartNode COMMS model has an onboard RS232 and RS485 serial chip, with spring terminals for connecting to serial devices. These communication protocols are configurable via the UI and with APIs. The RS485 port can be used as either direct serial or configured with onboard drivers for MODBUS RTU protocol.

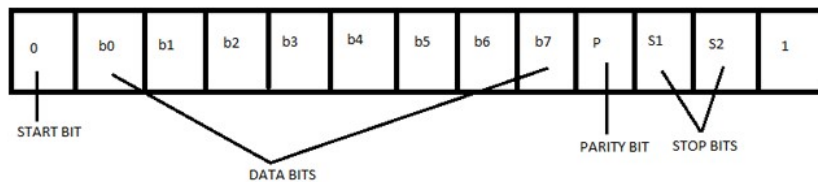
## 7.8 SERIAL RS232

RS232 is a standard hardware layer interface used for serial communication, it is used for connecting a computer or microcontroller to peripheral devices to allow serial data exchange between them. RS232 is point to point only, with a DTE and DCE device and TX/RX connections.

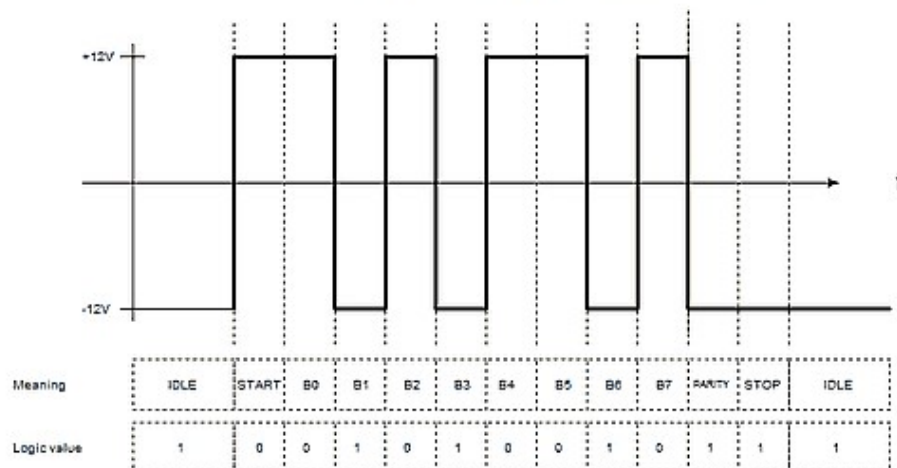
### Architecture of RS-232

- ✓ Architecturally RS-232 is a bi-directional point to point link.
- ✓ Two independent channels are established for two-way (full duplex) communications.
- ✓ RS-232 can also carry additional signals used for flow control (RTS, CTS) and modem control (DCD, DTR, DSR, RI).

### 7.8.1 SERIAL RS232 DATA TRANSMISSION STRUCTURE



RS232 Transmission of the letter 'J' - 0x4A





## 7.9 SERIAL RS485

RS485 is a standard hardware layer interface used for serial communication, it is used for connecting a computer or microcontroller, such as the IIoT-SmartNode or PLC to peripheral devices on a multidrop bus network to allow serial data exchange between them.

RS-485 signals are used in a wide range of computer and automation systems.

### 7.9.1 SERIAL RS485 TERMINATING RESISTOR

Ideally, the two ends of the cable will have a termination resistor connected across the two wires. Without termination resistors, signal reflections off the unterminated end of the cable can cause data corruption. Termination resistors also reduce electrical noise sensitivity due to the lower impedance

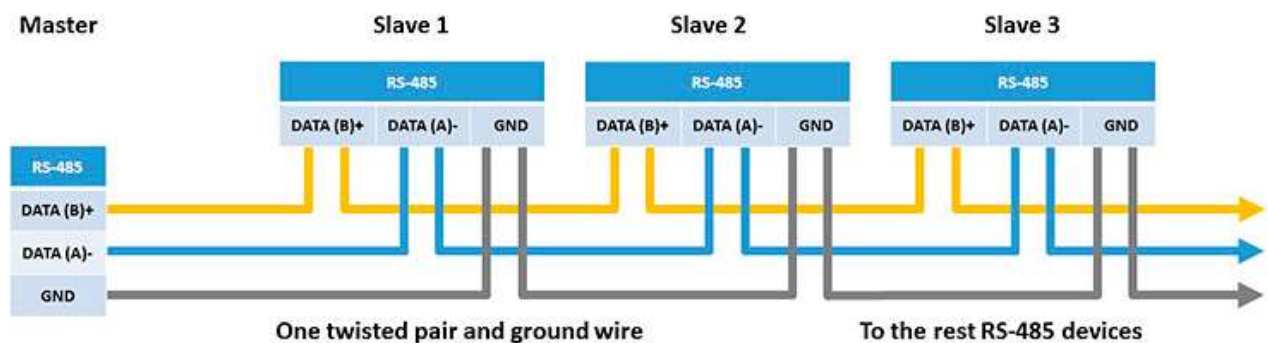
### 7.9.2 SERIAL RS485 SIGNAL STATES

| Signal | Mark (logic 1) | Space (logic 0) |
|--------|----------------|-----------------|
| A      | Low            | High            |
| B      | High           | Low             |

The RS-485 differential line consists of two signals:

- **A**, which is low for logic 1 and high for logic 0 and,
- **B**, which is high for logic 1 and low for logic 0.

### 7.9.3 SERIAL RS485 BUS NETWORK



## 7.10 DIFFERENCES BETWEEN RS232 AND RS485

RS485 vs RS232 – What are their differences?

Let us compare their characteristics:

|                            | <b>RS232</b>               | <b>RS485</b>               |
|----------------------------|----------------------------|----------------------------|
| Line Configuration         | Single-Ended               | Differential               |
| Max Number of Drivers      | 1                          | 32                         |
| Max Number of Nodes        | 1                          | 32                         |
| Wiring Arrangement         | half duplex<br>full duplex | half duplex<br>full duplex |
| Network                    | Point to Point             | Multipoint                 |
| Max Communication Distance | 15m                        | 1200m                      |
| Max Communication Speed    | 20 KBit/s                  | 10MBit/s                   |
| Typical Logic Levels       | ±5 to ±15 V                | ±1.5 to 6 V                |
| Max Slew Rate              | 30 V                       | –                          |
| Receiver Input Resistance  | 3 to 7 kΩ                  | 12 kΩ                      |
| Receiver Sensitivity       | ±3 V                       | ±200mV                     |

## 7.11 MODBUS OVERVIEW

The IIoT-SmartPower Gateway has MODBUS TCP over ethernet, with drivers and interfaces. The IIoT-SmartNode COMMS module has MODBUS RTU onboard with RS485, drivers and interfaces.

Modbus is a data communications protocol originally published by Modicon in 1979 for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices.

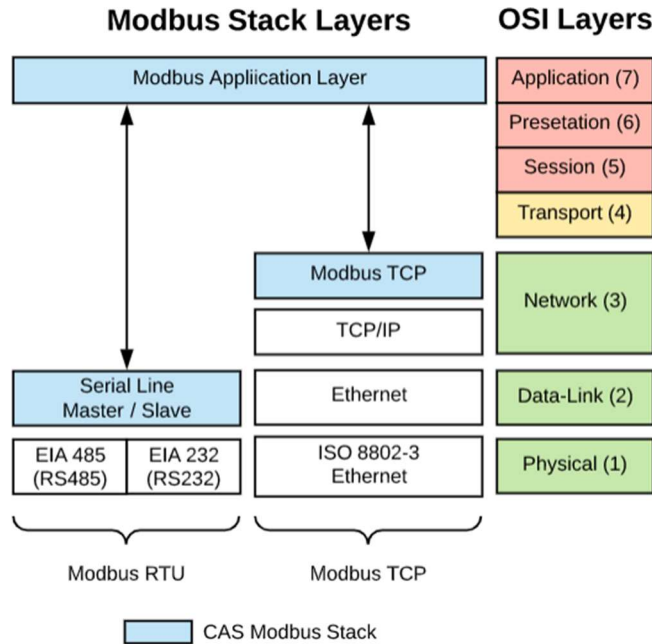


### 7.11.1 MODBUS OBJECT TYPES

The following is a table of object types provided by a Modbus slave device to a Modbus master device:

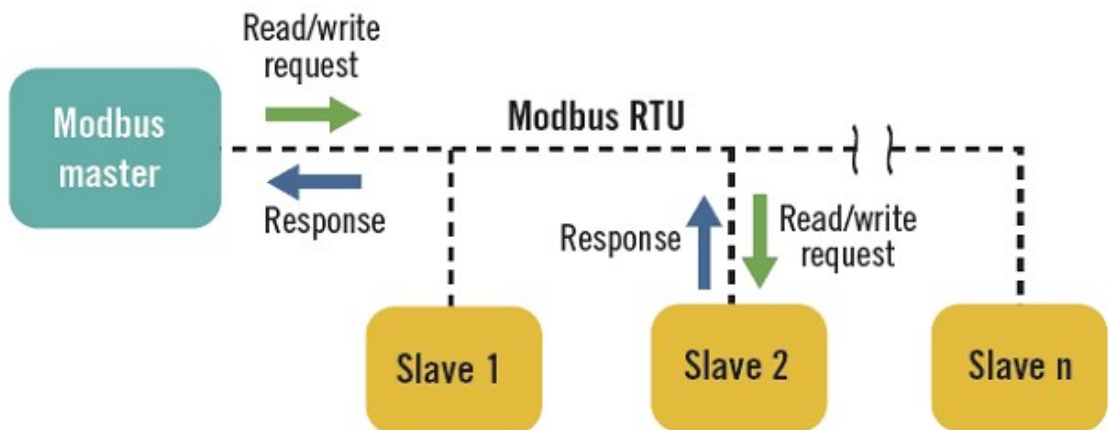
| Object type      | Access     | Size    | Address Space |
|------------------|------------|---------|---------------|
| Coil             | Read-write | 1 bit   | 00001 - 09999 |
| Discrete input   | Read-only  | 1 bit   | 10001 - 19999 |
| Input register   | Read-only  | 16 bits | 30001 - 39999 |
| Holding register | Read-write | 16 bits | 40001 - 49999 |

### 7.11.2 MODBUS STACK LAYERS



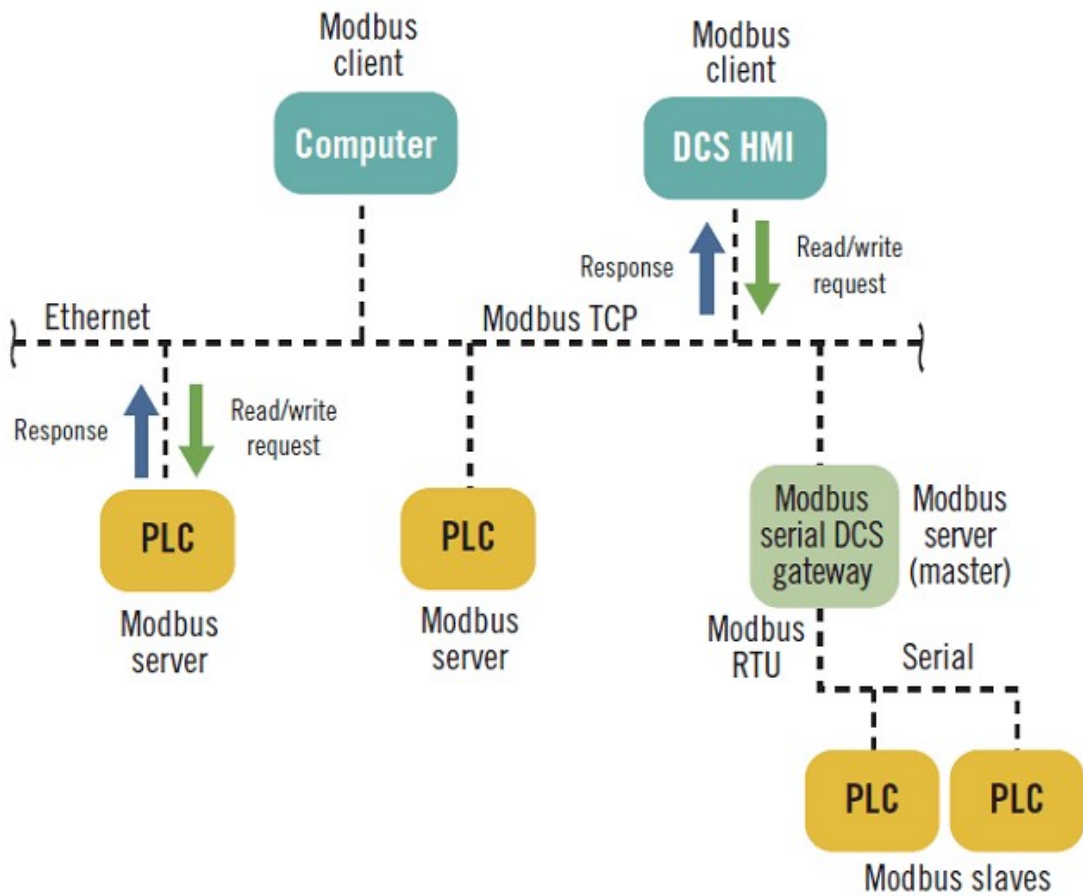
### 7.11.3 SERIAL RS232/RS485 MODBUS RTU

Modbus RTU — This is used in serial communication and makes use of a compact, binary representation of the data for protocol communication. The RTU format follows the commands/data with a cyclic redundancy check checksum as an error check mechanism to ensure the reliability of data. Modbus RTU is the most common implementation available for Modbus. A Modbus RTU message must be transmitted continuously without inter-character hesitations. Modbus messages are framed (separated) by idle (silent) periods.

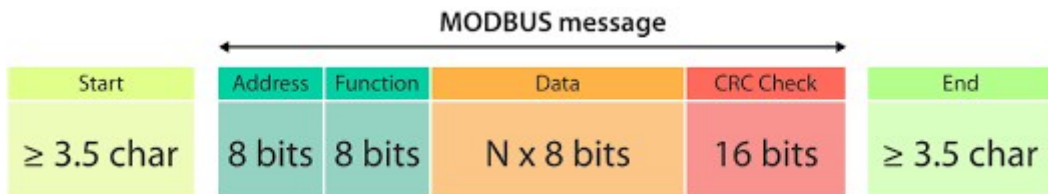


### 7.11.4 MODBUS TCP

Modbus TCP/IP or Modbus TCP — This is a Modbus variant used for communications over TCP/IP networks, connecting over port 502. It does not require a checksum calculation, as lower layers already provide checksum protection.



### 7.11.5 MODBUS MESSAGE STRUCTURE



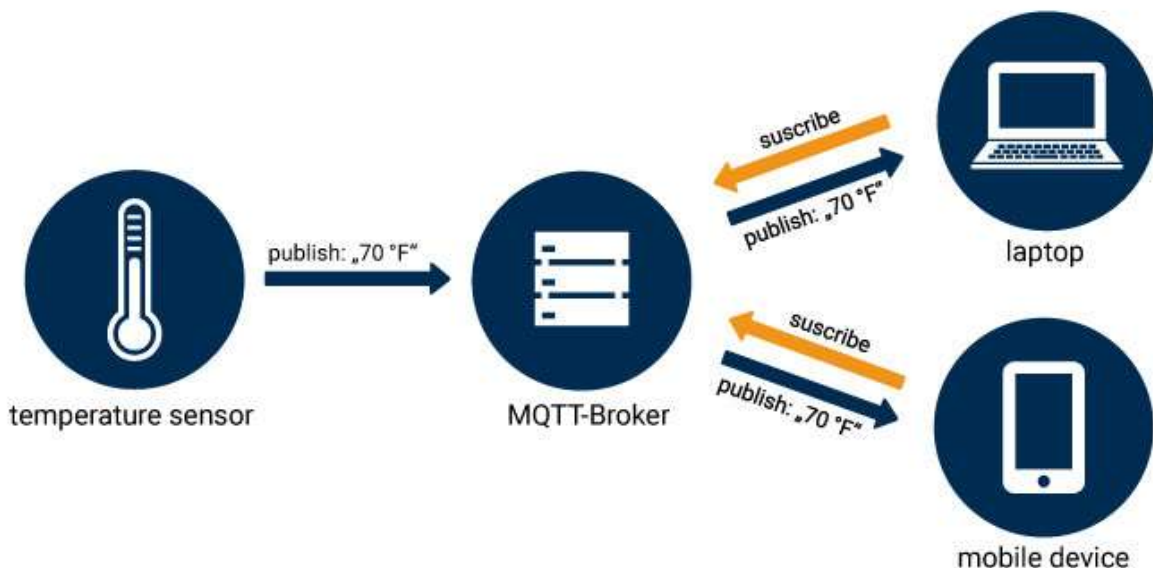
## 7.12 MQTT

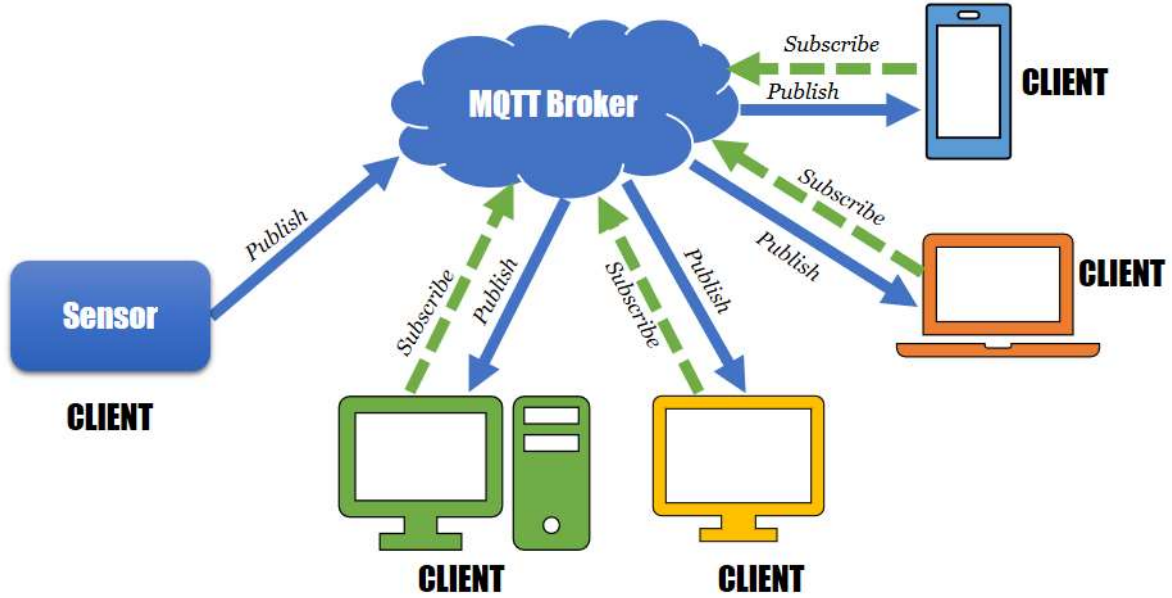
MQTT is an OASIS and ISO standard messaging protocol for the Internet of Things (IoT). It is designed as an extremely lightweight publish/subscribe messaging transport that is ideal for connecting remote devices with a small code footprint and minimal network bandwidth. MQTT today is used in a wide variety of industries, such as automotive, manufacturing, telecommunications, oil and gas, etc.

MQTT's publish-subscribe network protocol transports messages between devices. The protocol usually runs over TCP/IP; however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT

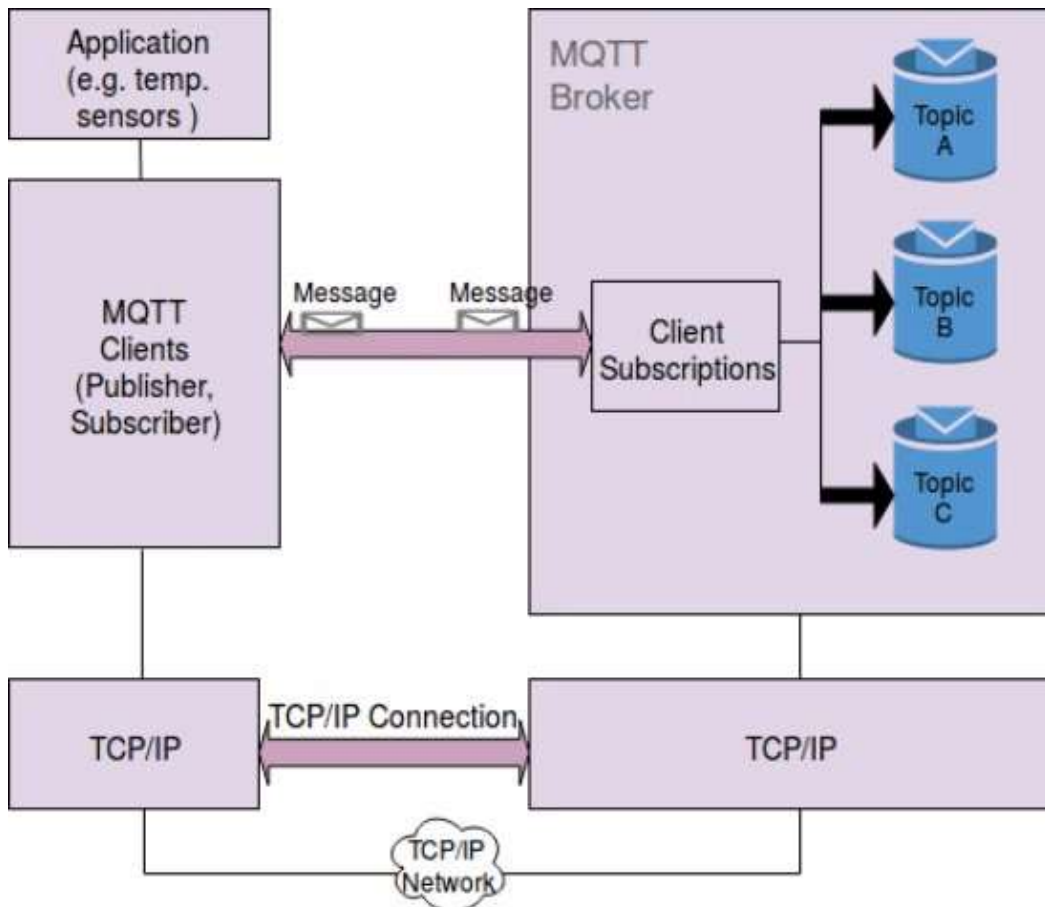


### 7.12.1 PUBLISH SUBSRIBE ARCHITECTURE

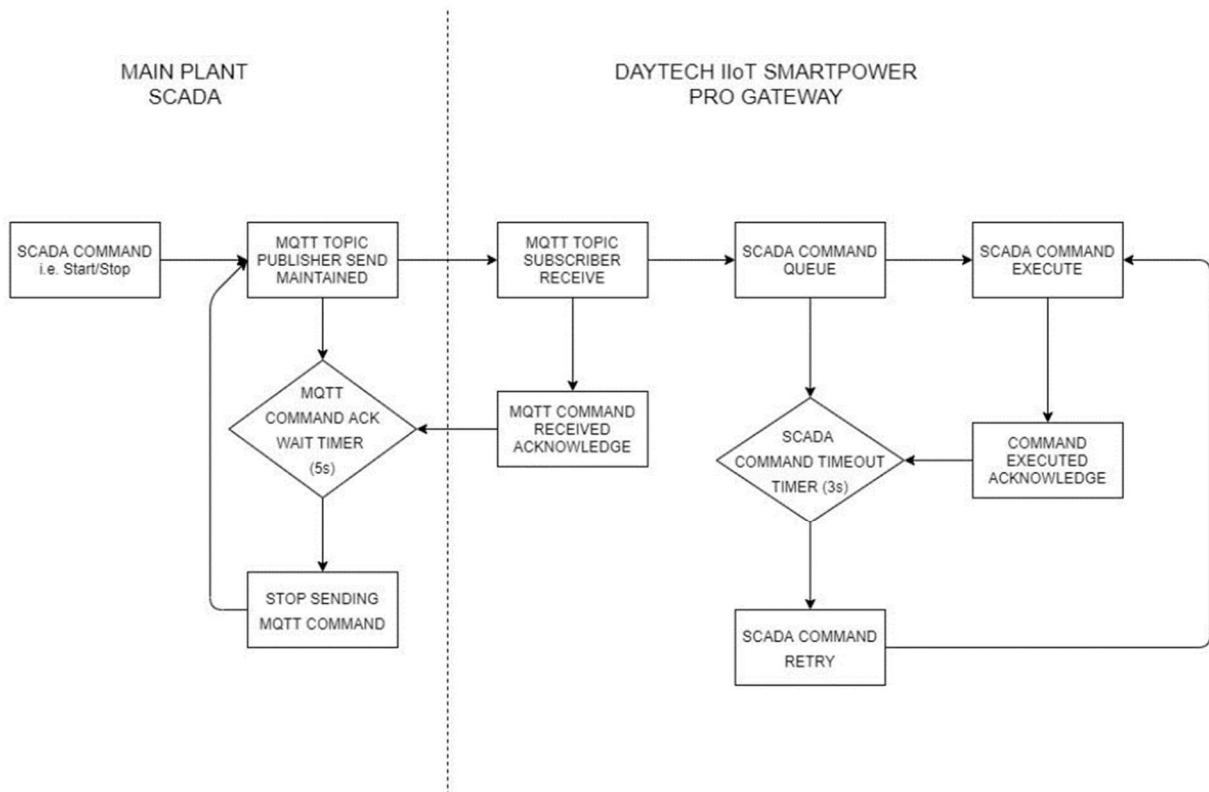




**7.12.2 TOPICS AND MESSAGES ARCHITECTURE**



### 7.12.3 EXAMPLE APPLICATION ARCHITECTURE (GATEWAY ← → SCADA)





## 8. TECHNICAL OVERVIEW – HARDWARE

### 8.1 The IIoT-SmartNode Core

#### IIoT-SmartNode-Gateway – Core Components



#### "THE MUSCLE" - HARDENED REAL TIME OPERATING SYSTEM (RTOS) MCU

The **ACORN IoT SmartNode** range of wireless sensor network, edge computing and gateway nodes, forms a highly inter-operable and modular platform, powered by an advanced ARM Cortex M4 IoT-Core MCU, with hardened RTOS for industrial control, with plugin modules for LoRa, LoRaWAN, Zigbee 2.4GHz, Zigbee 900MHz, 3G/4G, WiFi, Bluetooth and soon onto the market - NBloT. The ACORN comes with 6 industrial IO onboard (2 x DI, 2 x DO, AI with 0-5V / 0-10V / 4-20mA, high speed pulse input) and has expansion modules, covering almost any type of IO, allowing up to 36 IO in one unit and 1000s of distributed wireless IO nodes, meaning you can replace an RTU or DCS/PLC systems with state of the art IoT hardware.



#### "THE BRAIN" - POWERFUL & INTEGRATED SINGLE BOARD COMPUTER / GATEWAY

The **ACORN IoT SmartNode** has a plug-in slot for a single board computer, that fits within the weatherproof housing, allowing you to program sophisticated control applications, gateway to cloud and remote servers, run sophisticated AI/ML and Neural Network algorithms for control or edge processing and many more features. You can run DAYTECH's drag and drop "flow programming" tool for GUI, dashboard and automation app development! This also allows you to access, program, configure and control your applications locally via WiFi/Bluetooth with the GUI from your PC/Smartphone/Tablet, or remotely via WiFi, or 3G/4G (plug-in required) with VPN or cloud integrated solutions.



#### "THE COMMUNICATION SKILLS" - RS232/485, CAN BUS, MODBUS, UART, I2C, SPI

The **ACORN IoT SmartNode** can not only walk the walk, it can talk the talk! For fully inter-operable IIoT solutions, you need the flexibility to communicate with a myriad of devices and other platforms. We've packed the ACORN full of communications ability, not only wireless protocols such as WiFi/Bluetooth/Zigbee/LoRa, Cellular 3G/4G but also comes standard with RS232/485, CAN Bus, UART, I2C and SPI. We can factory configure GPS, SDI-12, MODBUS-RTU, MODBUS-TCP or a plethora of other protocols, set us a challenge!



#### "THE POWER" - MAINS 230VAC, 12VDC, 24VDC, EXPANDABLE BATTERIES, SOLAR

The **ACORN IoT SmartNode** can be powered from 230VAC with a plugpack, or directly to DC with a wide range 12-28VDC input range. It has an onboard solar battery charging IC for sophisticated and safe solar power charging or up to 2 x Lithium Ion 3Ah battery packs per node, for seriously long life remote operation. The node features 12VDC outputs and 24VDC optional output to power, control and monitor sensors and actuators, wireless and from battery/solar power. Intelligent sleep modes allow you to expand battery life and shut down individual modular units of the node and externally powered sensors/actuators as required.



## 8.2 The IIoT-SmartNode Gateway

### Description

The DAYTECH IoT-SmartNode-Gateway Series modular and expandable Industrial IoT gateways are designed for reliable, sophisticated and robust, all-in-one remote monitoring and automation performance. The gateway can be installed as a stand-alone monitoring and control unit, it can be integrated with existing control systems such as PLC/SCADA and also forms the backbone of your IoT wireless mesh networks in the field.

The IoT-SmartNode-Gateways have many advanced features; however, we have designed the software platform to be simple to setup and operate, using function block flow programming. With its intuitive app building user interface, your remote Industrial IoT application will be reliably up and running in no time.

### Key Features

*The ACORN IoT-SmartNode-Gateway is the backbone of your Industrial IoT system, providing a highly modular, flexible and scalable hardware and software platform, for an all-in-one remote control and monitoring solution.*

- Easy to use and flexible “Wire and Play” easy to wire design;
- Build your own dashboards and apps with “Drag and Drop” tools;
- Expandable system, with a power and comms bus, powering up to 8A per rail, for 4 modules and many external sensors and controls;
- ARM Cortex M4 MCU - "The Muscle" - Coordinates Mesh Networks, RS232/485 and the IO with low level RTOS (Real Time Operating System) control.
- Embedded SBC 1GHz, Single-core CPU, 512MB RAM Computer - "The Brain" - Handles IoT Gateway functions, GUI graphics and user interface with higher order control, AI/ML and 'drag & drop' flow programming with DAYTECH's Node-Red.
- DAYTECH's ControlMesh Wireless Mesh Network Protocol and API's for ease of setup and control
- Embedded Computer, "The BRAIN" handles gateway functionality, WiFi, 3G/4G cellular and TCP/IP services, user defined control and automation, huge memory with 8GB-128GB of datalogging, MQTT/COAP/HTTP, remote access and OTA firmware updates, GUI and dashboards.
- Intelligently handles 6 onboard IO, expandable up to 36 local IO and 100s of remote IO, with Mesh Networks, Zigbee wireless and CAN, MODBUS, RS232 and RS485 Communications.
- Sleep modes handled via the industrial grade MCU with hardened RTOS (Real Time Operating System);
- Designed for high reliability industrial control applications
- IP65 housing for outdoor use, or alternatively DIN rail mounted;
- 12VDC OR 24VDC regulated output from the node for supplying power to external industrial controls OR sensors.
- Solar/battery, DC or mains powered, with Intelligent charging.
- Acts as a Wireless Mesh Network Zigbee Co-Ordinator and concentrator, with LOS range of up to 15km to remote SmartNodes and multihopping up to 7 times. Connect 100s of remote IO.



### 8.3 The IIoT-SmartNode

#### Description

The DAYTECH IoT-SmartNode Series modular and expandable Industrial IoT nodes are designed for reliable, sophisticated and robust, all-in-one remote monitoring and automation performance. The SmartNode can be installed as a stand-alone monitoring and control unit when connected to a gateway, or it can be integrated with existing control systems such as PLC/SCADA as intelligent remote IO.

The IoT-SmartNodes have many advanced features; however we have designed the software platform to be simple to setup and operate, using function block flow programming over the gateway, or use simple AT/API commands, when integrating with a third-party system.

#### Key Features

*The ACORN IoT-SmartNode is the foot soldier of your Industrial IoT system, providing a highly modular, flexible and scalable hardware and software node, for a gateway or PLC/SCADA connected remote control and monitoring solution.*

- Easy to use and flexible “Wire and Play” easy to wire design;
- Connect to the IoT-SmartNode-Gateway and build your own dashboards and apps with “Drag and Drop” tools;
- Expandable system, with a power and comms bus, powering up to 8A per rail, for 4 modules and many external sensors and controls;
- ARM Cortex M4 MCU - "The Muscle" - Coordinates Mesh Networks, digital and analogue IO and optional RS232/485 with low level RTOS (Real Time Operating System) control.
- DAYTECH's *ControlMesh* Wireless Mesh Network Protocol and API's for ease of setup and control
- Intelligently handles 6 onboard IO, expandable up to 36 local IO and 100s of remote IO, with Mesh Networks, Zigbee wireless and Optional CAN, MODBUS, RS232 and RS485 Communications.
- Sleep modes handled via the industrial grade MCU with hardened RTOS (Real Time Operating System);
- Designed for high reliability industrial control applications
- IP65 housing for outdoor use, or alternatively DIN rail mounted;
- 12VDC OR 24VDC regulated output from the node for supplying power to external industrial controls OR sensors.
- Solar/battery, DC or mains powered, with Intelligent charging.
- Acts as a Wireless Mesh Network Zigbee End-Node, Router or Co-Ordinator and concentrator, with LOS range of up to 15km to remote SmartNodes and multihopping up to 7 times. Connect 100s of remote IO.



## Environmental and Installation Consideration – Rugged Industrial Design

- Designed for high reliability industrial control applications:
- Power supply and all IO has ESD to 15KV, overvoltage, undervoltage, reverse polarity, and overcurrent protection; plus designed for EMC compliance;
- Protection on all IO and wiring interfaces to prevent user damage.
- Designed to allow for noisy EMI (industrial environments);
- Robust and allow for industrial levels of vibration and high levels of environmental moisture;
- Designed for easy wiring into the spring connections, with positioning for easy installation.
- Rugged and robust for industrial and outdoor conditions
- Installation outdoors with no enclosure required and integral antenna, or DIN rail mounted inside an enclosure, with external antenna via coaxial extension cable with the SMA connector.
- High temperature range (Operating: -10 to 70degC),
- High temperature range (Ambient: -10 to 50degC),
- Vibration (can be mounted on vehicles and industrial machines);
- Impact resistance tested;
- High Humidity, up to 90%;
- Over current and overvoltage protection.
- Intelligent signal processing.
- RCM and CE Certification



## IO Features

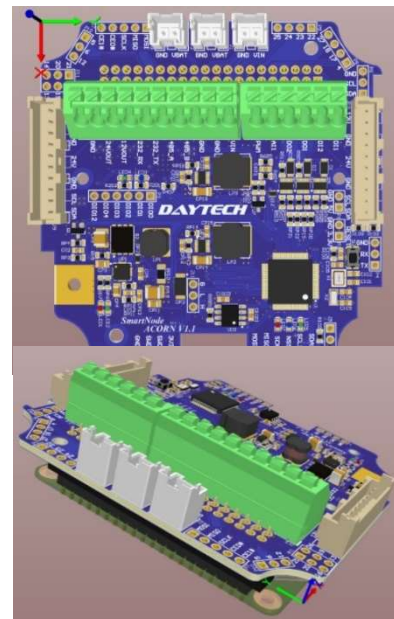
The ACORN IoT-SmartNode system is flexible and expandable. Connect up to 4 modules together, with up to 36 local IO. The locally plugged in expansion units are conveniently connected via ribbon cable, forming one device with a common power and communications bus. The same SmartNode unit can communicate locally or remotely over the wireless mesh network. Wirelessly connect 100s of remote mesh networked IO SmartNodes to the one gateway or PLC/SCADA system.

### ON Board the ACORN IoT-COMBO Gateway:

- 2 x DI (5-35VDC – opto-isolated and protected), takes 12VDC and 24VDC inputs;
- 2 x DO (5VDC / 12VDC / 24VDC configurable), 24VDC only when factory configured (easy to do, speak to the team at DAYTECH for more info);
- 1 x AI (4-20mA/0-5V/0-10V configurable), connected to high resolution and high speed ADC (12 Bit);
- 1 x High Speed PWN counting inputs (Pulse Input);

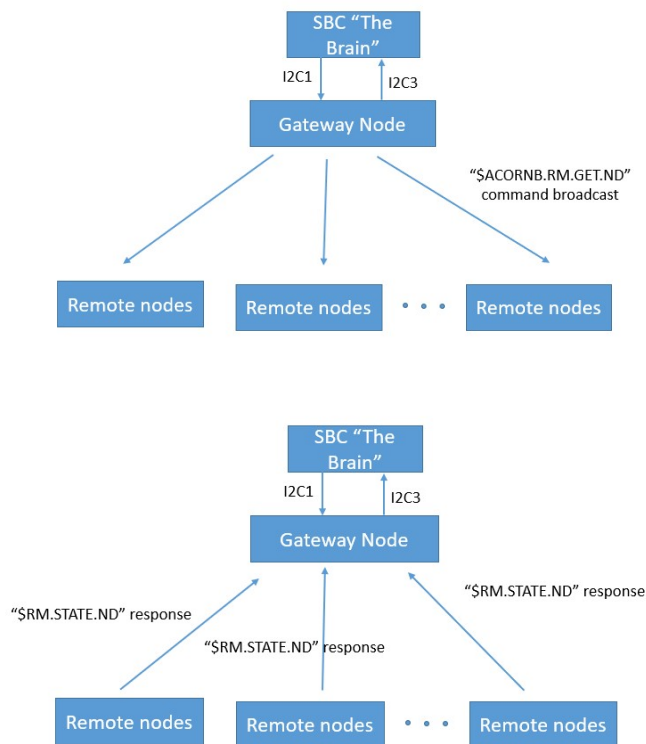
### IO PINOUT:

|                |                |            |            |                        |           |
|----------------|----------------|------------|------------|------------------------|-----------|
| 5-36V DC input | 5-36V DC input | 12V DC Out | 12V DC Out | 4-20 mA / 0-10V / 0-5V | PWM Input |
| DI 1           | DI 2           | DO 1       | DO 1       | AI 1                   | PWM In    |



## 9. TECHNICAL OVERVIEW – HARDWARE & SOFTWARE ARCHITECTURE

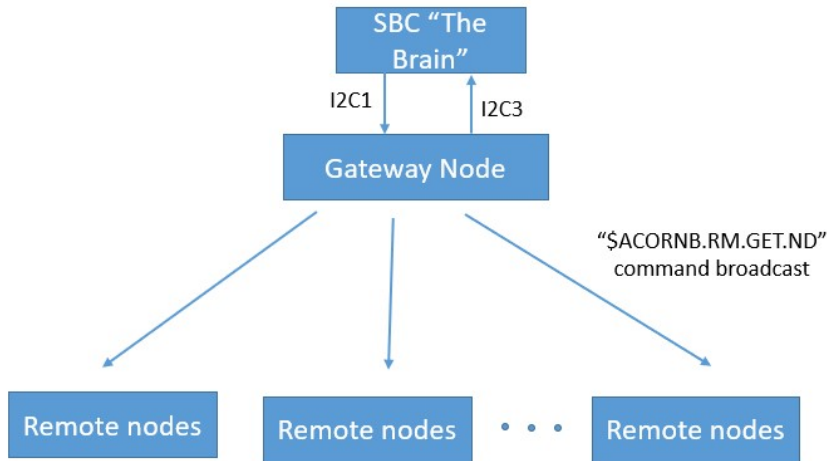
### 9.1 API'S COMMAND RESPONSE ARCHITECTURE



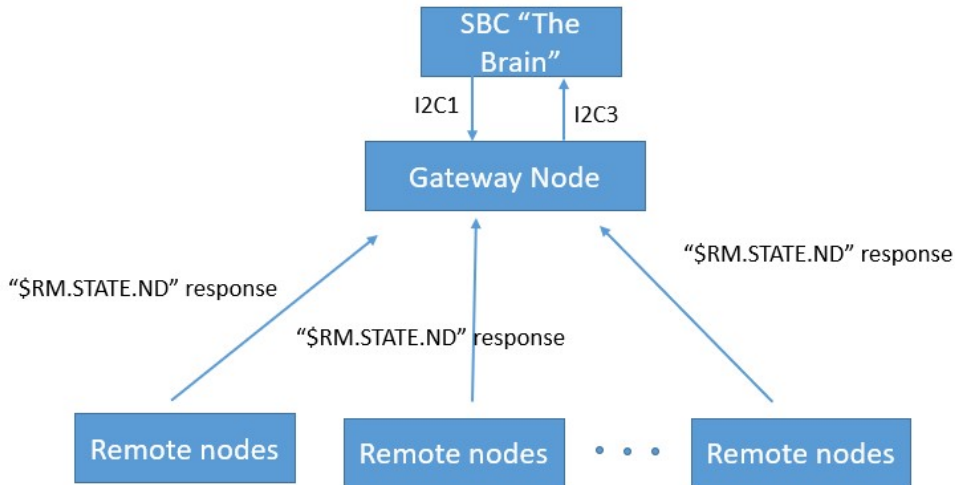
The remote nodes received "\$ACORNB.RM.GET.ND" command from Gateway node responses to Gateway the packet "\$RM.STATE.ND".

## 9.2 API'S REMOTE SMARTNODE DISCOVERY ARCHITECTURE

### 9.2.1 Stage 1 : Send first discovery command to remote nodes

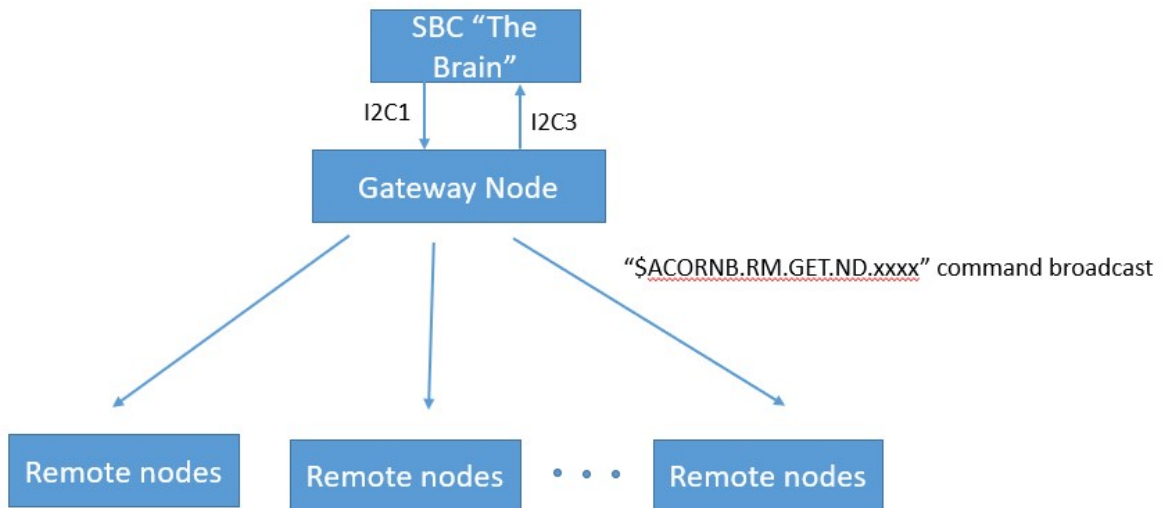


### 9.2.2 Stage 2 : Response to Gateway node from remote nodes



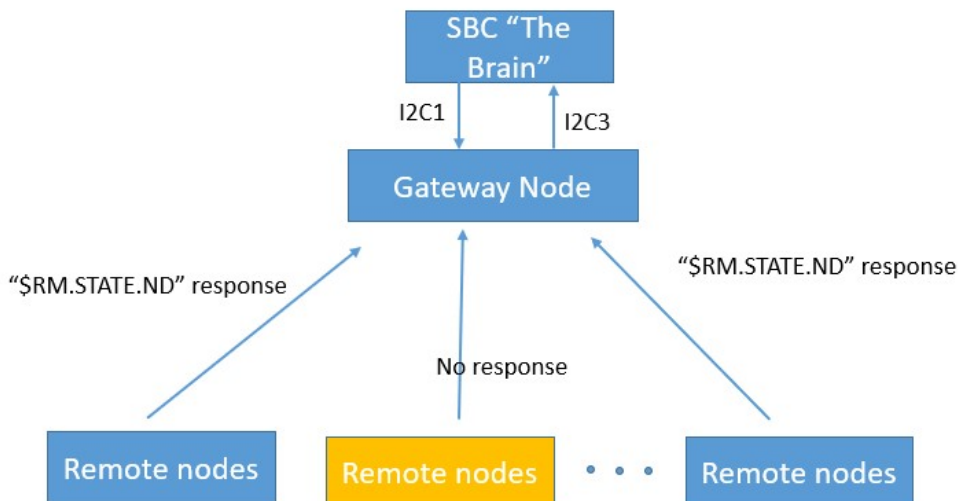
The remote nodes received "\$ACORNB.RM.GET.ND" command from Gateway node responses to Gateway the packet "\$RM.STATE.ND".

**9.2.3 Stage 3 : Broadcast the discovery command with received remote node’s addresses to remote nodes**



Gateway receives the packets from remote nodes, reads node’s MAC address. Then it broadcasts the packet to remote nodes "\$ACORNB.RM.GET.ND" command with the received MAC addresses again.

**9.2.4 Stage 4 : Each remote nodes determines the response to Gateway based on reading the packet from Gateway.**



Once remote node received "\$ACORNB.RM.GET.ND" packet with node addresses, it checks if one of the addresses on packet is same as own MAC address.

Once node’s address is existed in packet, it means Gateway detected that node already.

In this case remote node doesn’t response to Gateway to make the number of packets to broadcast decrease.

## 10. TECHNICAL OVERVIEW - SOFTWARE

- All-in-One and Easy to Program Platform for Real-Time Wireless Monitoring, Remote Control and Automation.
- Intelligent Edge Processing - with a Drag and Drop Flow Programming Editor.
- Easy and fast application development, inter-operability and cloud integration.
- Develop your own GUI's, notifications and automation functions.
- Securely access, update and support your IIoT system from anywhere in the world!
- Perform process control and automation using our fully integrated IEC61131 (Ladder Logic, SFC, FBD, Structured Text) programming tool, called DT-LOGIC.

### 10.1 DAYTECH's ENVISION IIoT Gateway Software Platform Architecture

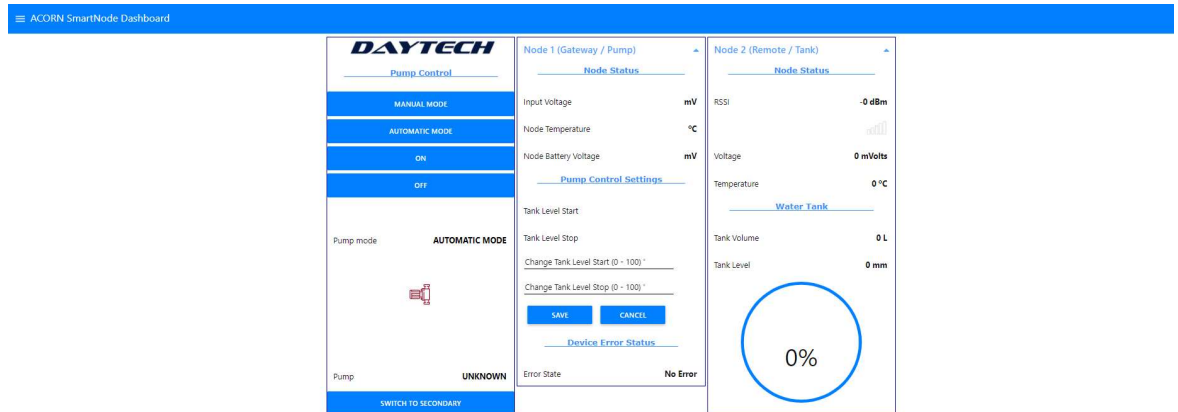
Luke will draw up the overall architecture on the whiteboard. Please copy the architecture block diagram here within the box.

**Draw DAYTECH's ENVISION IIoT Platform software architecture here:**



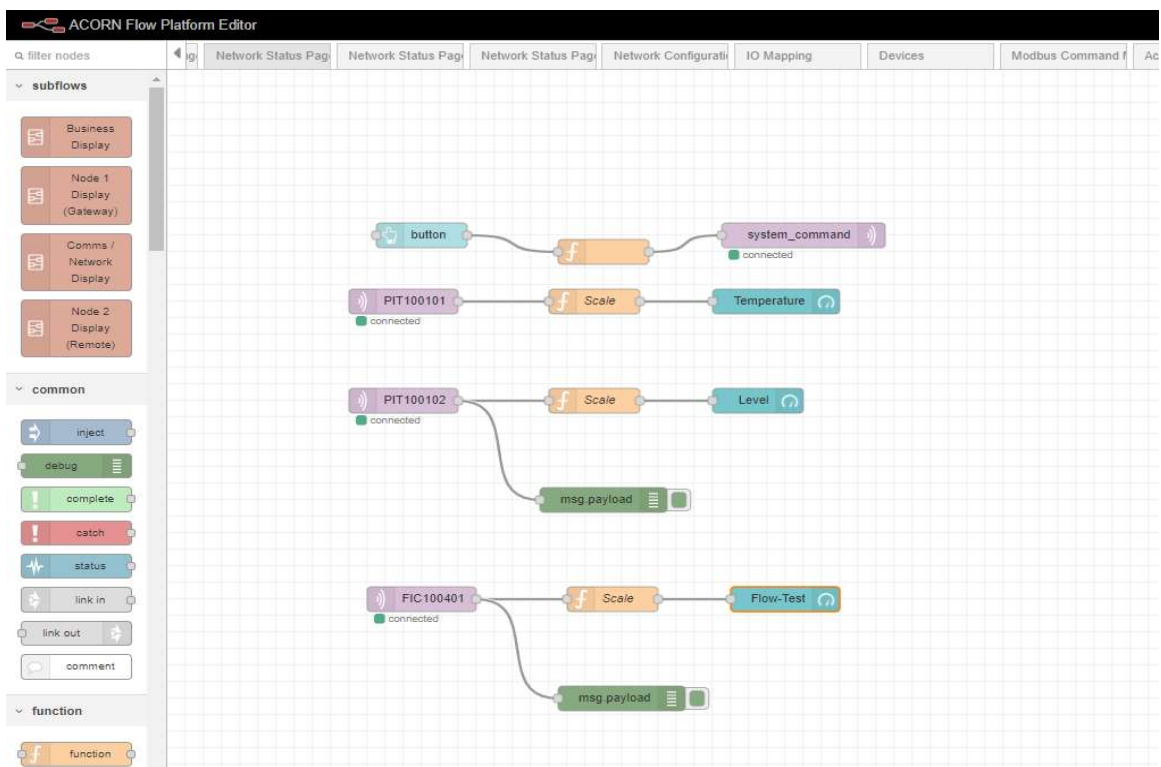
## 10.2 DAYTECH's Envision Platform Webserver GUI

A graphical user interface, which displays setup, configuration, status, and process data. This GUI also allows the users to control and monitor the platform via a webserver system that is cross platform and can run on Smartphones, tablets and PCs.



## 10.3 Drag and Drop Flow Programming Editor

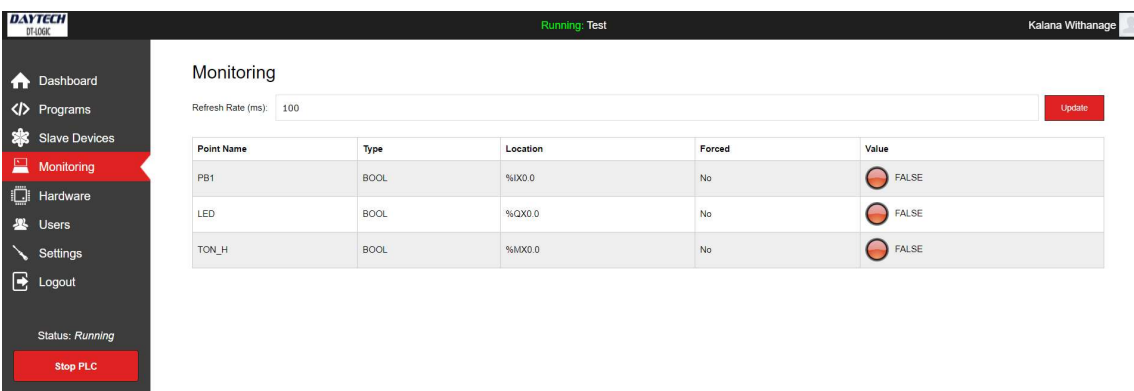
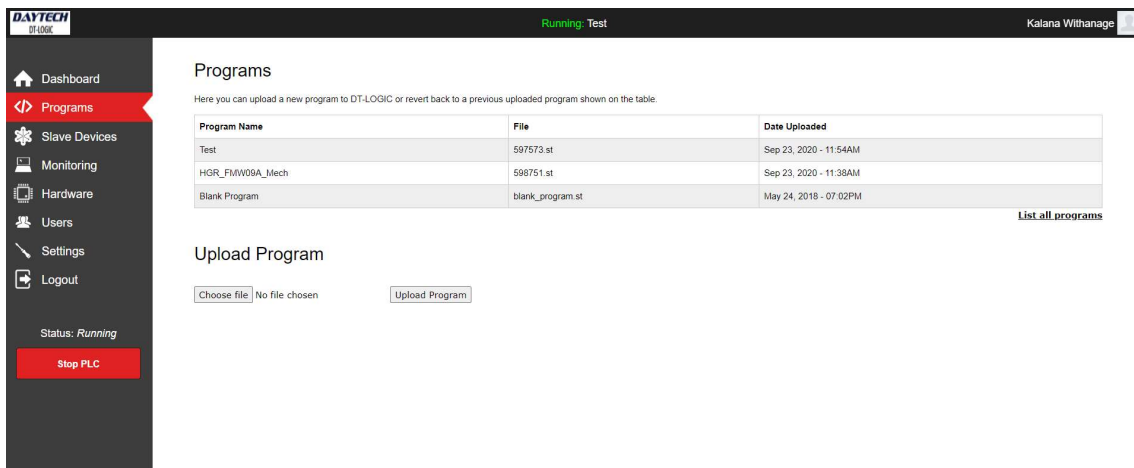
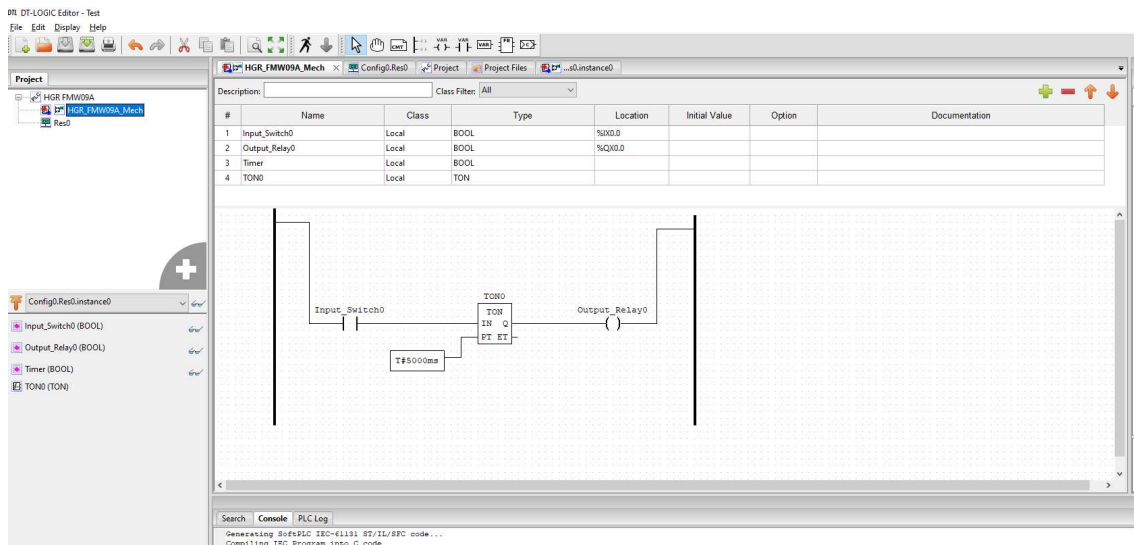
The webserver based tool that allows developers to program the GUI and a wide range of advanced interfaces. This tool allows complete Internet of Things connectivity to many devices and software platforms.



## 10.4 DT-LOGIC – IEC61131 IDE and RUNTIME

Daytech’s process control logic IDE and webserver controlled access, with hardened embedded runtime on the gateways. To access the runtime monitoring tool, goto:

`http://<ip-address>:8080.`



## 11. TECHNICAL TUTORIAL 1 – INITIAL COMMUNICATIONS SETUP

In this tutorial, you will use the built-in UI, with a IIoT-SmartPower Gateway, to set up the IP address, 3G/4G modem, MQTT and MODBUS.

|  |  |  |
|--|--|--|
| <p><b>4G Setting</b></p> <p>APN _____</p> <p>Phone _____</p> <p>Username _____</p> <p>Password _____</p> <p><b>SAVE</b>   <b>GET</b></p> | <p><b>Ethernet Setting</b></p> <p>Node IP _____</p> <p>Subnet mask _____</p> <p>Gateway IP _____</p> <p><b>SAVE</b>   <b>GET</b></p> | <p><b>Wifi Setting</b></p> <p>SSID _____</p> <p>Password _____</p> <p>Node IP _____</p> <p>Subnet mask _____</p> <p>Gateway IP _____</p> <p>Name servers _____</p> <p><b>SAVE</b>   <b>GET</b></p> |
|--|--|--|

|   |  |   |   |
|---|--|---|---|
| <p><b>RS232 Setting</b></p> <p>Baud rate <u>Select option</u> ▼</p> <p>Parity <u>No</u> ▼</p> <p>Data Bits <u>Select option</u> ▼</p> <p>Stop Bits <u>1</u> ▼</p> <p><b>SAVE</b>   <b>GET</b></p> | <p><b>RS485 Setting</b></p> <p>Baud rate <u>9600</u> ▼</p> <p>Parity <u>No</u> ▼</p> <p>Data Bits <u>Select option</u> ▼</p> <p>Stop Bits <u>1</u> ▼</p> <p><b>SAVE</b>   <b>GET</b></p> | <p><b>Zigbee Setting</b></p> <p>Baud rate <u>Select option</u> ▼</p> <p>Parity <u>No</u> ▼</p> <p>Stop Bits <u>1,5</u> ▼</p> <p>Tx Power Level <u>Select option</u> ▼</p> <p><b>SAVE</b>   <b>GET</b></p> | <p><b>System</b></p> <p><b>GET IP ADDRESS</b></p> <p>Internal IPv4 IP Address</p> <p>Public IPv4 IP Address</p> <p>4G IP interface</p> <p><b>REBOOT</b></p> |
|---|--|---|---|

## 12. TECHNICAL TUTORIAL 2 – REMOTE NODE ASSOCIATION

In this tutorial, you will use the built-in UI, with a SmartNode and ScoutNode, to Associate the nodes to the Gateway and configure the poll rates.

| Remote Node 1 Configuration     | Remote Node 2 Configuration     | Remote Node 3 Configuration      |
|---------------------------------|---------------------------------|----------------------------------|
| PWM input setting: COUNTER      | PWM input setting: COUNTER      | PWM input setting: GPIO          |
| Voltage/Current: Voltage        | Voltage/Current: Voltage        | Voltage/Current: Voltage         |
| Pump control setting: Momentary | Pump control setting: Momentary | Pump control setting: Maintained |
| Power Supply Setting: 5V        | Power Supply Setting: 5V        | Power Supply Setting: 5V         |
| DOWNLOAD GET                    | DOWNLOAD GET                    | DOWNLOAD GET                     |
| IO Poll Rate: 0s                | IO Poll Rate: 0s                | IO Poll Rate: 0s                 |
| Input PollRate(3 - 100) *       | Input PollRate(3 - 100) *       | Input PollRate(3 - 100) *        |
| SAVE CANCEL                     | SAVE CANCEL                     | SAVE CANCEL                      |

| Network Configuration                | Remote Node1 Status                   |
|--------------------------------------|---------------------------------------|
| Connected Node Number: 0             | Status: <b>Not Connected!</b>         |
| Search Node Number: 0                | Mac Address:                          |
| Discovery Timeout: 30s               | RSSI: -0 dBm                          |
| Input Node Number(1 - 100) *         |                                       |
| SAVE CANCEL                          | Response Time: 0ms                    |
| Discovery Status: <b>Not started</b> | DI 1 Status: <input type="checkbox"/> |
| START NETWORK DISCOVERY              | DI 2 Status: <input type="checkbox"/> |
| GET NODE INFORMATION                 | DI 3 Status: <input type="checkbox"/> |
| SAVE CURRENT INFORMATION             | DO 1 Status: <input type="checkbox"/> |
| FACTORY RESET                        | DO 2 Status: <input type="checkbox"/> |
|                                      | Input Voltage: 0mV                    |
|                                      | Battery Voltage: 0mV                  |
|                                      | AI 2 Input: mV(mA)                    |
|                                      | AI 3 Input: mV(mA)                    |
|                                      | AI 1 Input: mV(mA)                    |
|                                      | Temperature: 0°C                      |
|                                      | PWM Input: CLEAR PWM COUNTER          |

## 13. TECHNICAL TUTORIAL 3 – FLOW PROGRAMMING EDITOR

### 13.1 Tutorial Overview

This tutorial introduces the Node-RED editor (known in Daytech's environment as the Flow Programming Editor) and creates a flow that demonstrates the Inject, Debug and Function nodes.

### 13.2 Access the editor

With Daytech's Flow Programming Editor running, open the editor in a web browser.

If you are using a browser on the same computer that is running Daytech's Flow Programming Editor, you can access it with the url: <http://localhost:1880>.

If you are using a browser on another computer, you will need to use the ip address of the computer running Daytech's Flow Programming Editor

```
http://<ip-address>:1880.
```

### 13.3 Add an Inject node

The Inject node allows you to inject messages into a flow, either by clicking the button on the node, or setting a time interval between injects.

Drag one onto the workspace from the palette.

Select the newly added Inject node to see information about its properties and a description of what it does in the Information sidebar pane.

### 13.4 Add a Debug node

The Debug node causes any message to be displayed in the Debug sidebar. By default, it just displays the payload of the message, but it is possible to display the entire message object.

### 13.5 Wire the two together

Connect the Inject and Debug nodes together by dragging between the output port of one to the input port of the other.

### 13.6 Deploy

At this point, the nodes only exist in the editor and must be deployed to the server.

Click the Deploy button.

With the Debug sidebar tab selected, click the Inject button. You should see numbers appear in the sidebar. By default, the Inject node uses the number of milliseconds since January 1st, 1970 as its payload.

## 13.7 Add a Function node

The Function node allows you to pass each message through a JavaScript function.

Delete the existing wire (select it and press delete on the keyboard).

Wire a Function node in between the Inject and Debug nodes.

Double-click on the Function node to bring up the edit dialog. Copy the following code into the function field:

```
// Create a Date object from the payload
var date = new Date(msg.payload);
// Change the payload to be a formatted Date string
msg.payload = date.toString();
// Return the message so it can be sent on
return msg;
```

Click Done to close the edit dialog and then click the deploy button.

Now when you click the Inject button, the messages in the sidebar will now be formatted as readable timestamps.

---

## 13.8 Summary

This flow demonstrates the basic concept of creating a flow. It shows how the Inject node can be used to manually trigger a flow, and how the Debug node displays messages in the sidebar. It also shows how the Function node can be used to write custom JavaScript to run against messages.

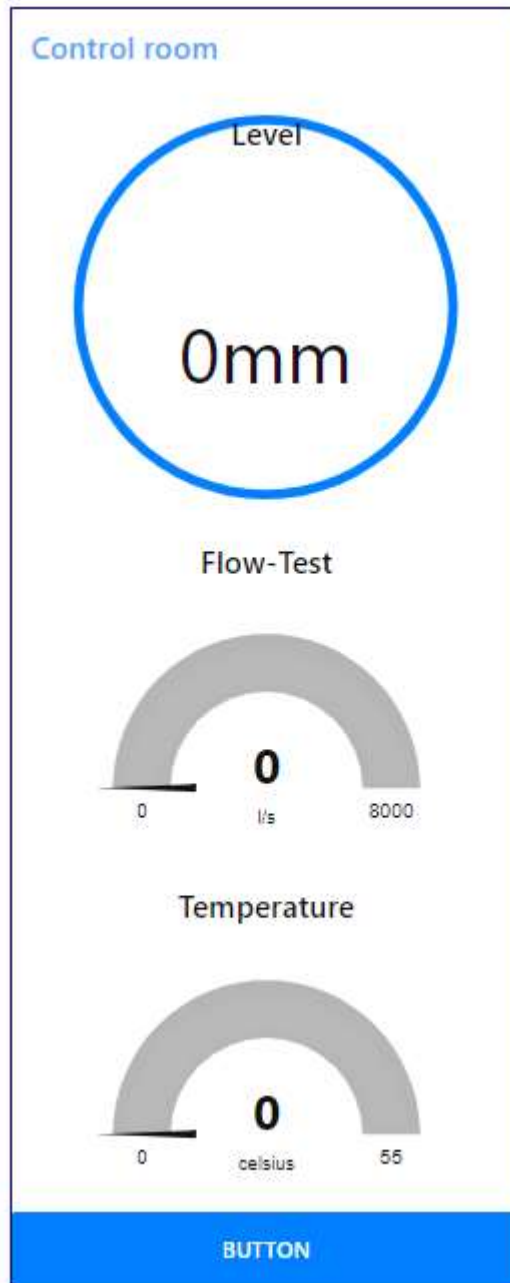
## 13.9 Source

The flow created in this tutorial is represented by the following json. To import it into the editor, copy it to your clipboard and then paste it into the Import dialog.

```
[{"id":"58ffae9d.a7005","type":"debug","name":"","active":true,"complete":false,"x":640,"y":200,"wires":[]}, {"id":"17626462.e89d9c","type":"inject","name":"","topic":"","payload":"","repeat":"","once":false,"x":240,"y":200,"wires":[["2921667d.d6de9a"]]}, {"id":"2921667d.d6de9a","type":"function","name":"Format timestamp","func":"// Create a Date object from the payload\nvar date = new Date(msg.payload);\n// Change the payload to be a formatted Date string\nmsg.payload = date.toString();\n// Return the message so it can be sent on\nreturn msg;","outputs":1,"x":440,"y":200,"wires":[["58ffae9d.a7005"]]}]
```

## 14. TECHNICAL TUTORIAL 4 – FLOW PROGRAMMING EDITOR

In this tutorial, you will use the Flow Programming Editor, with a SmartNode and ScoutNode, to measure and display sensor data on your own UI.



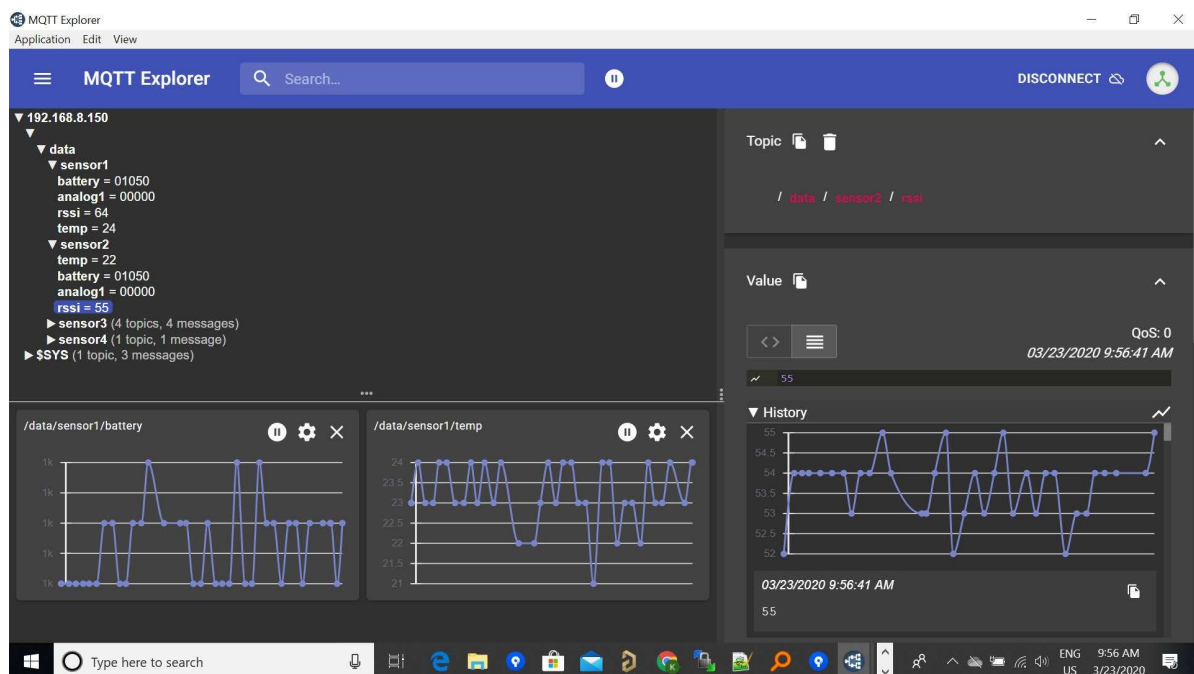
## 15. TECHNICAL TUTORIAL 5 – MQTT MAPPING

In this tutorial, you will use the Flow Programming Editor and the UI, to map data to the MQTT publisher and subscriber.

IO map configuration

Select Node REFRESH SAVE

| Index | Global channel | Local channel | Scale | Offset | MQTT topic | Sampling rate |
|-------|----------------|---------------|-------|--------|------------|---------------|
| 1     | DI.0           | Node0.DI.0    | 1.0   | 0.0    | PAHH100141 | 1.0           |
| 2     | DI.1           | Node0.DI.1    | 1.0   | 0.0    | ZA100911   | 1.0           |
| 3     | DI.2           | Node0.DI.2    | 1.0   | 0.0    | LAL100021  | 1.0           |
| 4     | DI.3           | Node0.DI.3    | 1.0   | 0.0    | LAL1000xx  | 1.0           |
| 5     | DI.4           | Node1.DI.0    | 1.0   | 0.0    | SPINP01    | 1.0           |
| 6     | DI.5           | Node1.DI.1    | 1.0   | 0.0    | SPINP02    | 1.0           |
| 7     | DI.6           | Node1.DI.2    | 1.0   | 0.0    | SPINP03    | 1.0           |
| 8     | DI.7           | Node1.DI.3    | 1.0   | 0.0    | SPINP04    | 1.0           |





## 16. TECHNICAL TUTORIAL 5 – MODBUS MAPPING

In this tutorial, you will use the Flow Programming Editor and the UI, to map data to/from the MODBUS publisher and subscriber.

**Device Mapping**

Select Node REFRESH

Save

| Device ID | Name            | Type        | IP address   | Port | Slave ID | I2C Ad |
|-----------|-----------------|-------------|--------------|------|----------|--------|
| 0         | VSD_Controller1 | MODBUS      | 192.168.1.40 | 502  | 1        |        |
| 1         | VSD_Controller2 | MODBUS      | 192.168.1.41 | 502  | 1        |        |
| 2         | VSD_Controller3 | MODBUS      | 192.168.1.42 | 502  | 1        |        |
| 3         | VSD_Controller4 | MODBUS      | 192.168.1.43 | 502  | 1        |        |
| 4         | CP_01           | COMBO_INPUT |              |      |          | 40     |

**Modbus Commands Mapping**

Select Node REFRESH SAVE

All

Save

| Device ID | Command Type | MQTT Topic      | MQTT Value | Address | No. of words | Data v |
|-----------|--------------|-----------------|------------|---------|--------------|--------|
| 0         | SW           | /VSD1_CONTROL   | ON         | 2000    | 2            | 1#0    |
| 0         | SW           | /VSD1_CONTROL   | OFF        | 2000    | 2            | 0#0    |
| 0         | SW           | /VSD1_SET_FREQ  | <>         | 2002    | 1            | <>     |
| 0         | RR           | /VSD1_STATUS    | <>         | 2101    | 1            | <>     |
| 0         | ST           | /VSD1_LAST_RESP | <>         |         |              |        |

## 17. TECHNICAL TUTORIAL 6 – DT-LOGIC

In this tutorial, you will use DT-LOGIC (IEC61131 IDE), with a SmartNode and ScoutNode, to program a small ladder logic program.

The screenshot displays the DT-LOGIC IDE interface. On the left, a project tree shows the configuration for 'HGR\_FM09A' and 'Res0'. The main workspace shows a ladder logic program with the following components:

- Input\_Switch0**: A normally open contact.
- TON0**: A timer block with a preset time of **T#5000ms**.
- Output\_Relay0**: A coil.

The compilation log at the bottom shows the following output:

```

Generating SFCto IEC-dt11: dt/IL/SFC code...
Compiling IEC Program into C code...
Extracting Located Variables...
c code generated successfully.
PLC :
[CC] plc_main.c -> plc_main.o
[CC] plc_debugger.c -> plc_debugger.o
py_ext :
[CC] py_ext.o -> py_ext.o
PLC :
[CC] Config.o -> Config.o
[CC] Res0.c -> Res0.o
Linking :
[CC] plc_main.o plc_debugger.o py_ext.o Config.o Res0.o -> Beathgate RM09 Project.dll
Successfully built.
DT-LOGIC program generated successfully
Build directory already clean
    
```

## **18. SYSTEM INSTALLATION**

To be demonstrated and discussed during presentation.

## **19. SYSTEM SETUP AND COMMISSIONING**

To be demonstrated and discussed during presentation.

## **20. SYSTEM OPERATING AND MAINTENANCE**

To be demonstrated and discussed during presentation.

## **21. SYSTEM TROUBLESHOOTING**

To be demonstrated and discussed during presentation.