Project acronym: **IoTrust**

Project title: Secure trust bootstrapping and peer-to-peer network connections in

the Internet of Things

Third Party: **XXX**

[Insert LOGO of the Third Party]

Deliverable D1

IoTrust Architecture Design

|  |  |
| --- | --- |
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| **Dissemination level:** | Public / confidential |

Abstract: Please provide a brief description

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**Table of contents**

[1 Introduction 1](#_Toc26358819)

[2 Activities carried out to complete the deliverable 1](#_Toc26358820)

[3 Technical description 1](#_Toc26358821)

[4 Conclusions and next steps 1](#_Toc26358822)

[Appendix 2](#_Toc26358823)

Nb: The deliverable structure below is only provided for guidance and you may adapt in a free form manner the structure to fit your needs.

# Introduction

The deliverable **D.1 IoTtrust Architecture Design** fulfils the objective **O1** which aims to design a human-centric and open IoTrust solution to increase the use trust and application of secure IoT networks in worldwide sectors like Smart Cities, Industry 4.0 etc. The deliverable D.1 is the output of the task **T.1 IoTrust Architecture Design**. The task T.1 was completed in the duration of month M1 to M6. The DW was the leader of the task. The milestone **MS2 Enhanced final version of IoTrust architecture** was achieved by D.1. The milestone MS2 is the advanced version of the MS1.

# Activities carried out to complete the deliverable

The user-centric requirement analysis was performed in the task T.1 to deliver deliverable D.1. It was an iterative process in which requirements of end users and other stockholders such as internet developers were taken in to consideration in designing the IoTrust architecture.

The task T.1 was performed based on Agile SCRUM methodology. Each SCRUM sprint cycle was of 2 weeks. At the start of each sprint cycle requirements were gathered from end users and patterners. These requirements were analysed and an IoTrust architecture draft was designed and developed based on them. At the end of the cycle, this draft was verified and validated against the requirements. This process was performed iteratively throughout the lifecycle of the task T.1.

In a project like this, where a final product is shaped according to the end user and external stakeholders' requirements, some unforeseen issues might arise in the areas such as requirement gathering, changing and unclear requirements, functional requirements verification and validation criterion etc. These problems were identified and solved using the iterative SCRUM cycle before they could occur and hinder the project. The requirement gathering and analysis were continuous process like the designing the architecture.

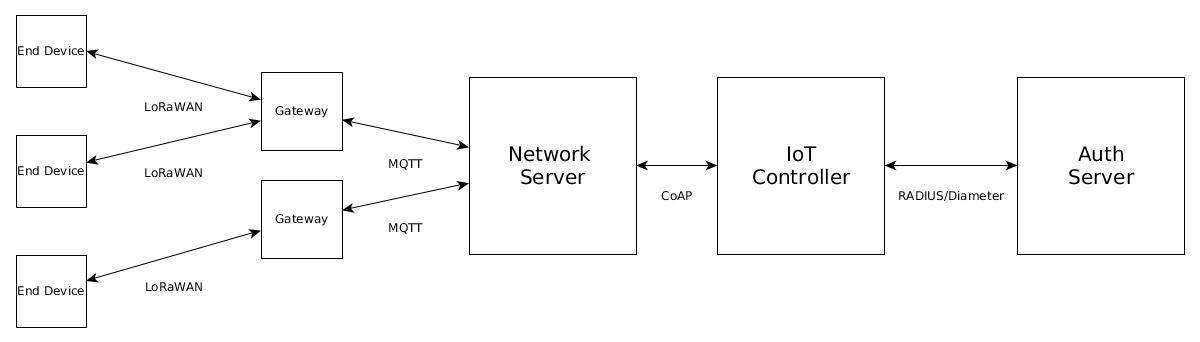
There were some unforeseen technical issues also addressed and fixed in the task T.1. The project is going to employ LoRaWAN[[1]](#endnote-1) protocol to send data packets between a LoRa[[2]](#endnote-2) node and gateway using radio communication in the 868 MHz ISM band. There are a large number of development boards available with different LoRa modems such as SX1276/77/78/79[[3]](#endnote-3) from [Semtech](https://www.semtech.com/), RFM95/96/97[[4]](#endnote-4) from [HopeRF](https://www.hoperf.com/), RN2483[[5]](#endnote-5) from [Microchip](https://www.microchip.com/) etc. We identified early enough that some libraries used for SX127X chips can send a packet of maximum 51 bytes which is not desirable for this project. It would have been a blocker in the project if we had not identified it at the start of the project.

# Technical description

Describe briefly the key technical characteristics of the deliverable and explain how they are related to the final results expected to be achieved by the project.

You can choose to include or annex relevant documents, mock-up, weblinks, screenshots, etc).

The core aim of the deliverable D.1 was to prepare an advanced IoTrust architecture design with an iterative process. There are many aspects to the architecture design. We have analysed and prepared it with the details of hardware, software stack, communication protocols, DevOps, user interface, customer experience, API end points etc. This architecture design will serve as a reference for further deliverables. Although the core attributes of the architecture will be the same, there might be some minor changes as we reach to the next milestones. The Figure 1 illustrates the overall IoTrust architecture.



The architecture components are described as follows.

## End-Device

It is a small form-factor hardware which sits on the edge of an IoT network. It consists of microcontroller, memory, input/output peripherals, communication protocol etc. These end-devices are put in to work for a specialized task. They are more suitable than the conventional computing devices for small, repetitive tasks because of their small form-factor and lower power consumption.

In the IoTrust architecture, an end-device will be used to collect, format and send sensor data to a server. It is paramount to authenticate an end-device before it connects to the server using a critical network. Because if the end-device is compromised than it opens the flood gate to the critical network infrastructure. The authentication, authorization and key management tasks will be performed by a secure bootstrapping protocol, peer to peer and distributed ledger technologies.

The SmartEverything (SME) Lion[[6]](#endnote-6) [[7]](#endnote-7) development board will be employed as an end-device for the IoTrust project. It is designed and developed by [Arrow](https://www.arrow.com/). It is packed with Atmel SAMD21 microcontroller based on the ARM Cortex M0+ architecture, Microchip RN2483 LoRaWAN module, Telit Jupiter SE868-A GPS module, Microchip RN4871 BLE module, Atmel AT24C256C 32Kx8 Bits EEProm and Atmel ATECC508A crypto authentication chip. An end-device will use LoRaWAN protocol for communication. It will send LoRa packets using radio channels.

## Gateway

A gateway is the last component at the end of the LoRaWAN network infrastructure. This base-station serves as an intermediary between an end-device and network server. Basically, a gateway is a multi-channel high performance transceiver module which can receive, process and send several LoRa packets simultaneously using different spreading factors on various channels. An end-device will send data using LoRaWAN protocol. The LoRa packets will be received by all gateways in its proximity. It is often called LoRa gateway. It can handle LoRa packets from thousands of devices in the range of 1 to 10 kms.

The Wirnet iStation[[8]](#endnote-8) [[9]](#endnote-9) [[10]](#endnote-10) will be utilized as a gateway. It is designed and developed by [Kerlink](https://www.kerlink.com/). It comes with 4G connectivity module with 3G/2G fallback and Ethernet module with RJ45 port. It also houses fully integrated internal LoRa antenna with peak gain of 2.6dBi, and ARM Cortex A9 microprocessor. The gateways and end-devices both will operate in the EU868 ISM band

## Network Server

The Network Server is part of the LoRaWAN back-end infrastructure. It represents the central hub of all communications from and to LoRaWAN end-devices. It aims to hide the Physical (PHY) and Medium Access Control (MAC) layer details of the LoRaWAN protocol to the components that need to communicate with end-devices. The network server is in charge of collaborating with the end-devices to keep the overall network health, i.e., optimise the data-rate and overall energy consumption of the deployment site, as well as orchestrate what radio configuration parameters end-devices should employ in order to avoid packet loss or unnecessary retransmissions.

The IoTrust project will employ the ChirpStack.io open source LoRaWAN Network Server Stack [cite chirpstack]. This project is popular a Free Open Source Software (FOSS) implementation of the LoRaWAN network server that provides several operation and administrative facilities in order to deploy a network of end-devices. All the components are licensed under the MIT license, therefore, modifications and improvements can be made commercially available. Its architecture employs several operation and administrative end-points common in the IoT application scenario. These include, a web interface dashboard, standardised protocol event-based broker using MQTT [cite MQTT], and a REST API over secure HTTPS connections. Therefore, its integration with other IoT libraries and networking components is relatively easy.

Overall, the LoRaWAN network server is a unique component — there is only one single instance per deployment — and provides high-level abstraction of end-device communications. This is, applications and users are presented with a high level abstraction end-point to send and receive messages to and from end-devices. These end-points may be a REST API, an MQTT broker o other customizable solutions. The network server will manage all the low-level details in order to guarantee secure and reliable delivery of messages to and from the LoRaWAN infrastructure.

## IoT Controller

The IoT Controller plays the role of authenticator in the Authentication, Authorisation, and Accounting (AAA) architecture (cite AAA). End-devices perform a bootstrapping process when they are deployed for the first time. This process includes an authentication and key agreement stage. The device credentials and ID information needs to be previously configured in an Authentication Server. While the end-device

Typically, end-devices transmitting over non-constrained networks perform the bootstrapping by directly addressing any authentication server connected to an IP network. This exchange usually employs a standardised protocol such as RADIUS or Diameter (cite RADIUS and Diameter) to carry Extended Authentication Protocol (EAP) (cite EAP) messages over regular IP networks. However, RADIUS and Diameter require an exchange of relatively large messages with a large number of transmissions. This only exacerbates the problem of energy consumption and radio bandwidth usage due to header overhead for constrained radio technologies such as LoRaWAN.

Therefore, a lightweight Low-Overhead EAP over CoAP (LO-CoAP-EAP) [cite LO-CoAP-EAP] protocol is chosen instead. LO-CoAP-EAP employs the novel Constrained Application Protocol (CoAP) [cite CoAP] and a set of efficient primitives to significatively reduce the header overhead of transmitting authentication EAP messages over a constrained network. The IoT Controller includes the LO-CoAP-EAP protocol logic that parses the upstream messages transmitted by the end-devices, and forwards its contents to an authentication server that employs typical AAA protocols such as RADIUS or Diameter to carry EAP payloads. Likewise, when the authentication server answers with the new downlink EAP messages, the IoT Controller generates a new LO-CoAP-EAP packet and forwards it to the end-device.

## Authentication Server

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## Data Flow

* Include details about data exchange steps that take place among the different architecture components described above.
* Maybe include a figure.

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# Conclusions and next steps

Outline any conclusions on the results achieved and any lessons learned for the next stage of the project.

Describe briefly the next steps in the project development and how you will build on this deliverable to complete the work.

Appendix

* E.g. mock-ups, screenshots
* References
* Etc.

1. https://lora-alliance.org/sites/default/files/2018-05/2015\_-\_lorawan\_specification\_1r0\_611\_1.pdf [↑](#endnote-ref-1)
2. https://web.archive.org/web/20190718200516/https://www.semtech.com/uploads/documents/an1200.22.pdf [↑](#endnote-ref-2)
3. https://semtech.my.salesforce.com/sfc/p/#E0000000JelG/a/2R0000001Rbr/6EfVZUorrpoKFfvaF\_Fkpgp5kzjiNyiAbqcpqh9qSjE [↑](#endnote-ref-3)
4. https://www.hoperf.com/modules/lora/RFM95.html [↑](#endnote-ref-4)
5. http://ww1.microchip.com/downloads/en/devicedoc/50002346c.pdf [↑](#endnote-ref-5)
6. <https://static6.arrow.com/aropdfconversion/5ff647cd30f423703234cbf85de7f2e794f2b199/smarteverythingasmelionuserguide.pdf> [↑](#endnote-ref-6)
7. https://lorawan-hackathon.readthedocs.io/en/latest/lion.html [↑](#endnote-ref-7)
8. https://lora-alliance.org/sites/default/files/showcase-documents/Commercial\_leaflet\_Wirnet\_iStation\_2019-1.pdf [↑](#endnote-ref-8)
9. https://www.kerlink.com/product/wirnet-istation/ [↑](#endnote-ref-9)
10. https://www.thethingsnetwork.org/docs/gateways/kerlink/istation/ [↑](#endnote-ref-10)