A.T.2.1

DESIGN AND DEVELOPMENT OF TOOLS SUPPORTING PARKING REGULATION SCHEMES SELECTION AND IMPLEMENTATION

Deliverable D.T 2.1.3 –*Smart Parking supporting tool developed*

Final Version 05/2018

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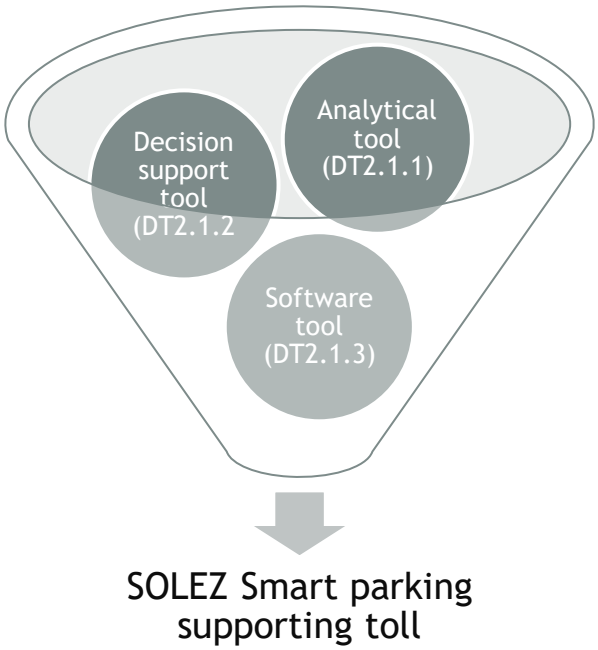


Table of abbreviations

API	Application Programming Interface
AWS	Amazon web services
SW	Software

Introduction

This report represents the last delivery of the SOLEZ work package WPT2.1 (DT2.1.3), whose subject is an overall description of the smart parking supporting tool for implementation and operation (Task T2.1.3). The previous reports, DT2.1.1 and DT2.1.2, were dealing with reviewing and user analysis of user requirements for the smart parking (Task T2.1.1 analytical tool), design of a proper regulation scheme and the related Data Management (Task T2.1.2 decision support tool).

This report is aimed at guiding Public Administrations and transport operators in the following implementation of the software tool (SOLEZ smart parking software platform). In this respect, a detailed description of the basic parking process and the cloud solution are defined along with characteristic of a general architecture.

This report is based on a joint work with the project partners involved in the pilot implementation of the parking tool within the SOLEZ project and takes into account remarks arisen from the Torino project meeting and, subsequently, on the basis of later conjoint discussions with partners via skype.

The report therefore considers the fact that the developed software tool will be tested in the framework of the pilot test, so it is necessary to describe in detail to the partners how to install the software, how the principle of using a shared computing works, and what the project partners can expect from the pilot test. Due to the nature of the software application, based on the pilot, it is possible to modify the software and improve its use.

The goal is also to show the possibility of using of a shared computing, the possibility of using a less costly way of software applications. Before, for example, ordering a costly solution for own local server infrastructure, it is advisable to gain experience just through the pilot testing.

1. Technical descriptions

1.1. Organisation structure

This section describes the organisational structure of the developed SOLEZ Smart Parking supporting tool.

The Smart Parking supporting tool is designed as modular, it consists of individual tools that are connected to each other but can also be used separately.

This means that if the system user (customer) does need the system, the built-in parking control scheme (DT2.1.2) can be used and one of the proposed solutions can be chosen based on the input attributes. The DT2.1.2 decision making model completed can then be used to select the appropriate detection technology for the given area and, last but not least, the completed software tool for collecting and evaluating of the data from the detection technology can be used.

Part 3 of this document describes the software tool (SOLEZ parking software platform) that is being developed and how to install and run the software tool. The software tool *(as central element)* is implemented on a cloud infrastructure. The software tool will always be owned by the cloud infrastructure lessor, ie by the operator (a municipality, a region) of it.

The following diagram shows the interconnection of the parts of developed smart parking tool.

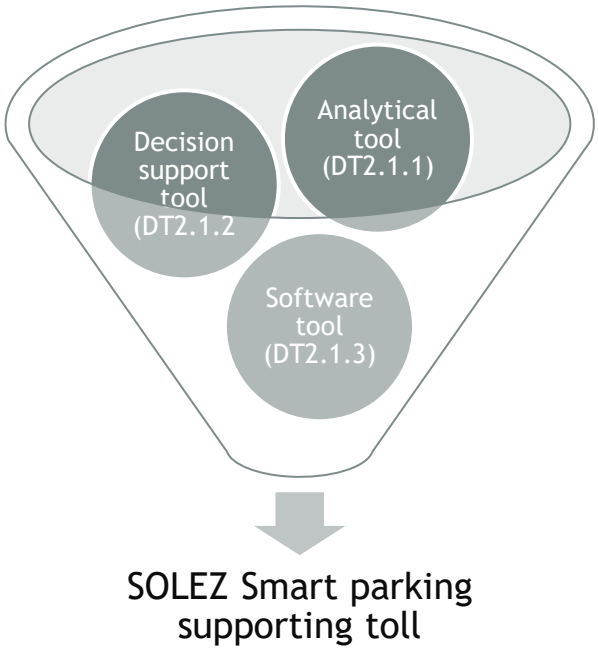


Figure 1: an overview of SOLEZ parking toll

1.2. Description of software tool (SOLEZ parking software platform)

We build on the assumption that the policy of restricted entry into functional areas is the most efficient way of reduction of environmental burden caused by traffic. To support this policy, we created decision support tool (variants of the smart parking regulatory schemes) within the previous deliverable (DT2.1.2). The regulatory schemes are based on requirements for improving conditions in FUAs of the participating partners´. All proposed regulatory schemes are based on centralized concept which enables organizational and economical savings during the parking system implementation and, at the same time, meets the requirements for standardized interconnection of individual parts.

It is thus the process of system integration of various components (detection technologies), the subsystems into a single functioning complex. However, it is a very complicated process, as the systems are developed in different environments, new ones evolve and old ones disappear, it is therefore necessary to arrange sustainable development of the system as a whole.

The software tool for the system integration (SOLEZ parking software platform) on data and user levels, described in this report, enables:

1) Interconnection of data from implemented detection technologies selected within the regulatory scheme. This smart parking SW tool is designed in general terms to enable use also in other cases than in pilot testing within the project.
2) Customization for individual pilot locations based on various attributes of a chosen location and deployment.

This process concerns the requirements of technical interoperability, i.e. the ability of different systems to communicate with each other, the requirements for semantic interoperability, the ability to comprehend data content and quality.

1.3. Functional attributes of the SOLEZ parking software platform

The chapter describes the functional attributes that the SOLEZ smart parking software platform completes.

This means that if the user needs it, the system can be used to find the following information:

- **Technology operating status monitoring** – basic information on current operation status of the technologies. This function enables common surveillance of remote systems in real time, in an integrated manner – e.g. from a single workplace, through a single system for sending alerts to operators or traffic dispatchers.
- **Technologies and operating data -** providing data on current status of a device/system in real time. This operating data is instantly utilizable by other control systems. The platform is designed to enable definition and subsequent implementation of a system function according to end user requirements.
- **Analytical function of the system** – Technologies operator can evaluate efficiency of the system, changes of traffic behavior and other trends, in a long term. These data can also be used by professional public and the institutions participating in the infrastructure development planning and traffic control optimization.
- **Current information for public** – Provision of data for user services´ operators such as traffic and navigation information. The application enables set-up and configuration of an open interface which allows provision of the data to third parties, for the purpose of end applications´ development.

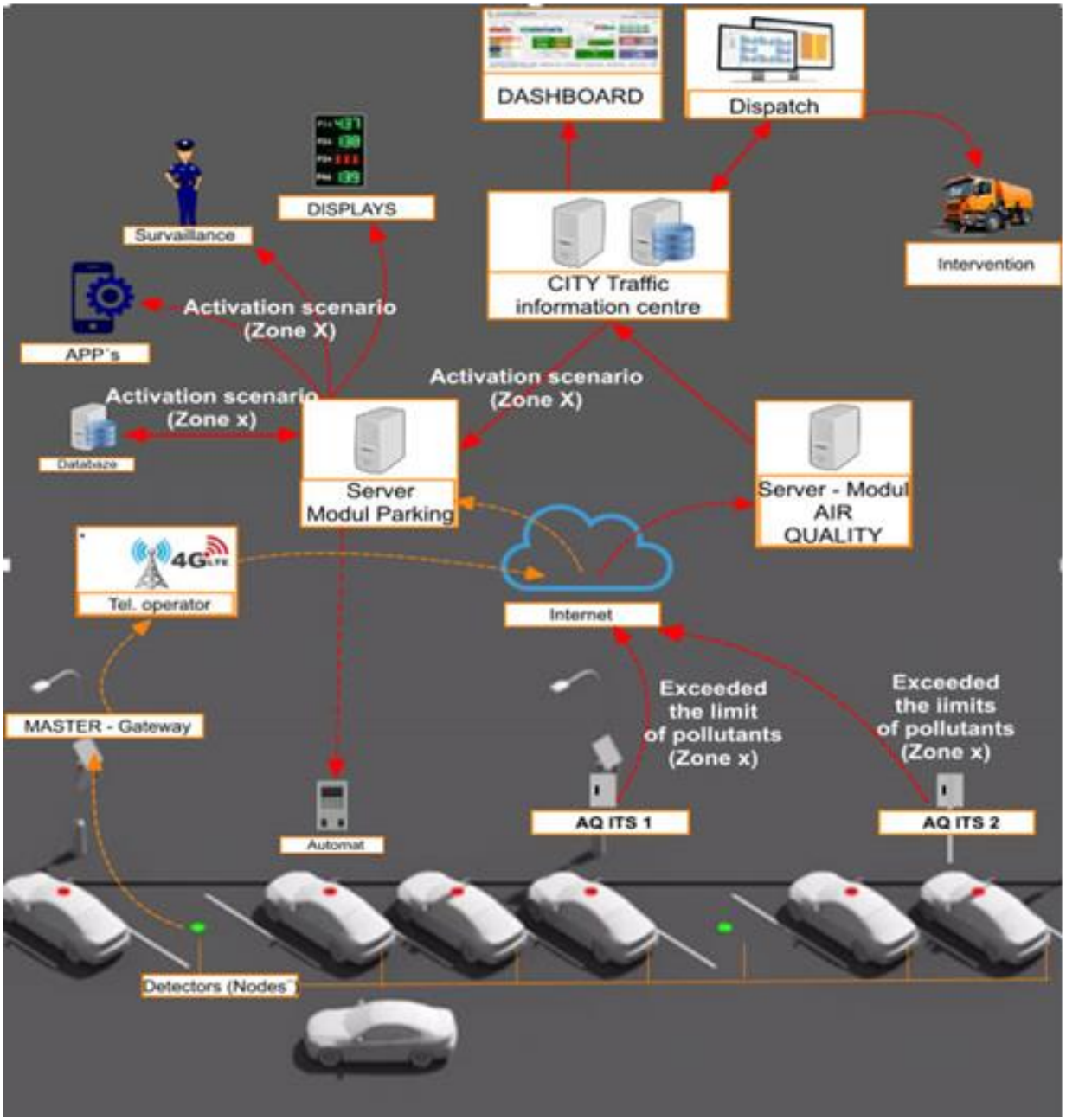


Figure 2: Functional deployment of the Central parking element

1.4. General architecture of the software tool (SOLEZ parking software platform)

It is important to describe the architecture of the platform for a general idea of how the system works.

The architecture is composed of three key elements described in the Figure 2 below:

- Interface for linking to data collection executed by detection technologies
- Database – data processing and storage
- Interpretation – connection of the database to analytical and visualization tools

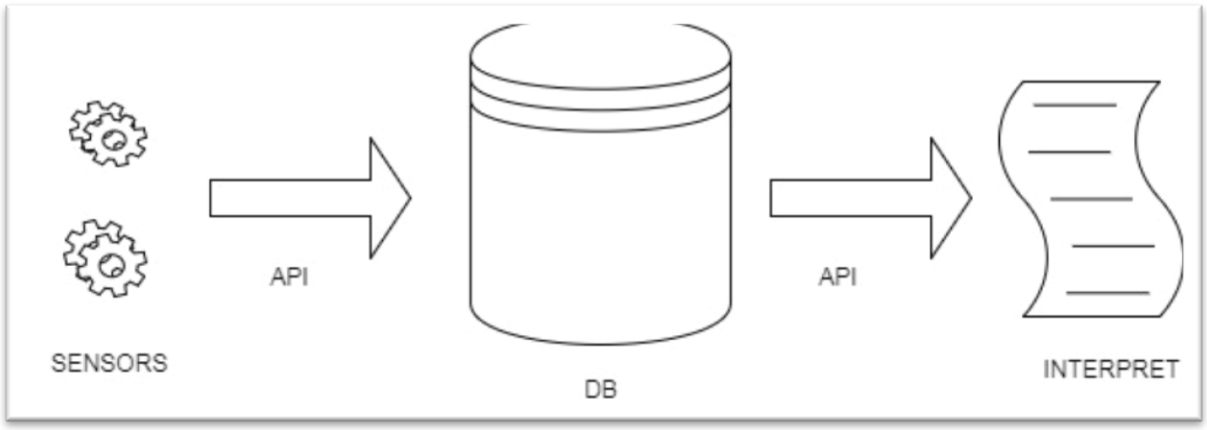


Figure 3: General architecture of the SOLEZ parking software platform elements

This general architecture can be implemented when using various tools.

It can be implemented to one's own server infrastructure or to cloud infrastructure.

During development, it is necessary to always ask the key question: whether the software to be implemented must be fully under control (as on one's own local server infrastructure) or whether it is desirable to hire it as a service, i.e. SaaS (Software as a Service on cloud infrastructure).

Based on the SOLEZ project partners´ input requirements analysis, it was decided to deploy the Central element software at a cloud infrastructure which will be always owned by the cloud infrastructure's lessor, i.e. Central parking system operator (a municipality, a region).

Fundamental aspects for deployment to a cloud infrastructure are as follows:

- Cost efficiency and expansion rate of the deployment
- Definition of user requirements

1.4.1. Cost efficiency and expansion rate of the deployment

To raise awareness of cloud computing, its basic characteristics are described in the following chapter.

There are huge expectations for the cloud computing. The software development is faster and less expensive when using services and complex tools offered by various providers.

Implementation of systems and applications into company processes is usually easy and quick, both upwards and downwards scalability is smooth as required. Only the used sources (computing performance, storage) are charged for. There is even a potential for savings if we include all the costs, so not only of hardware, infrastructure and software but also of operation, maintenance and technical staff.

To get an idea, the costs of the cloud solution are zero in the first year (in case of the chosen Amazon Web Service platform) and in the following years, the costs of the Central element operation on cloud infrastructure can reach hundreds of Czech Crowns (CZK) per month (1 EUR/about 25 CZK). The price depends on number of used services and extent of elements connected to the system. The price is estimated for the case of FUA in Blansko at Brno (CZ).

1.5. Definition of user requirements

The SOLEZ project partners who will execute the pilot implementation of the regulatory scheme selected, on the basis of decision support tool provided by them, have unique and specific requirements for the Central element software (2.6.1). It is thus assumed that within the DT3.1.2 activity, general settings of the software tool will be modified according to the requirements resulting from the needs of their pilot installation selected.

It is also assumed that the system operators (with respect to novelty of the Central element software) do not know yet exactly what to expect from similar software and how to define all their requirements. Before they order a costly solution on their own local server infrastructure, it is appropriate to gain experience by working with and using the very Central element software tool created within the SOLEZ project. This will enable them to define/describe what they expect from such software and to identify requirements for the hardware infrastructure.

In this respect, it is worth noting that the software is ready to integrate outputs from various types of detection technologies (ANPR, magnetic detectors tors) and also the output part of the system can be modified

1.6. General description of AMAZON WEB SEVICES (AWS)

As previously stated, the SOLEZ software tool is developed in the environment of Amazon web services (AWS).

For completeness of information and its easy understanding, we provide a brief description of how this development environment works and what the service offers.

AWS is composed of many services that can be hired independently by customers.

Customers pay only for the used services, e.g. for computer time, transferred data, disk capacity, transactions, processed items etc. This solution has the advantage that customer can order only what he really needs, e.g. large disk space with relatively low computing capacity for file storage service or on the contrary massive computing power and minimal disk capacity for computing-heavy applications.

Another huge advantage is that it is necessary to know demand of an application exactly in advance – another virtual server can be added or capacity can be increased flexibly at any time. That way, the situations with oversized and unused server or on the contrary service failures caused by insufficient power are avoided.

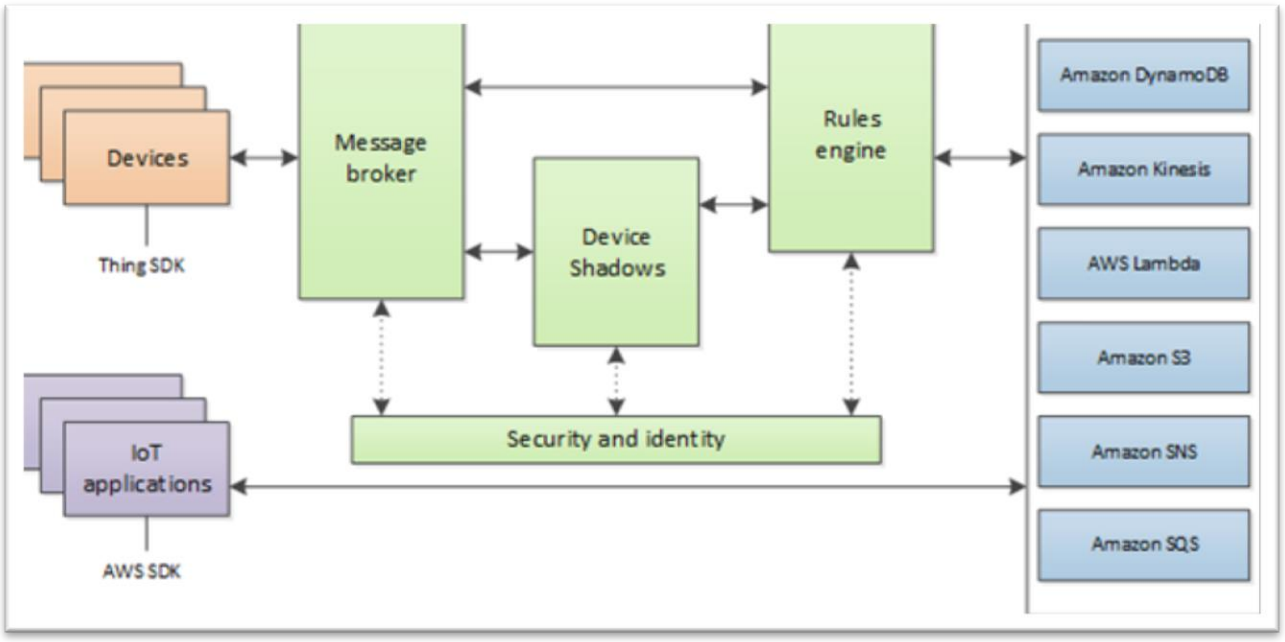


Figure 4: The AWS architecture

List of offered AWS services is long and covers perhaps all needs for creation of big, robust and affordable web application. The services are mutually independent to a certain extent, some can thus be used without the need for using others. Simple control by means of web environment but also via application program interface (API) is common for all services. Individual requests can thus be sent directly via client's application in an automated way. Let's sum up fundamental features of the SW platform designed within the Cloud solution:

- API actions that allow you to programmatically create and manage things, certificates, rules, and policies.
- Augment or filter data received from a device.
- Process messages from a large number of devices.
- Write data received from a device to a database.
- Save a file to server.
- Send a push notification to all registered users.
- Publish data to a queue to be retrieved by applications.
- Invoke function to extract data.
- Use machine learning models.

1.6.1. Fundamental services (of modules) within the Central element architecture

Fundamental services used within the SOLEZ Central element architecture are listed below:

- S3 (Simple Storage Service)

The service offers storage space. We can imagine S3 as simple web server where files are stored. Files stored in S3 can be available online, both through web (via a classic HTTP address) and through torrent services that are especially important, if we want to provide large volumes of data (Big data) to end users – by means of installation discs etc. The files can be also accessed via the API.

- DynamoDB and InfluxDB

  At web applications, the ability to store data so that we can process it further is often much more important instead of trying to fit it into a fixed data structure.

- DynamoDB enables to store, locate and re-read the data, based on a specified key. DynamoDB is a NoSQL database and is not compatible with some visualization tools. That's why we dockerize InfluxDB, the MySQL database, to the Central element besides the AWS services.

- SNS (Simple Notification Service)

  It is a notification delivery service. The messages send (Push) notifications to registered recipients. They thus do not have to check the queue continuously if they do no wait for new requests. Specific users can be entered into the system, who will always be informed on a specific event immediately upon its emergence.

1.7. Connections of software tool with other ICT systems

Simple and undemanding MQTT protocol (formerly Message Queuing Telemetry Transport, presently MQ Telemetry Transport) is used for message exchange among individual detection technologies and the central point. Due to its undemanding and simple character, it is easy to implement it even to devices with „small"processors and it becomes popular rather rapidly, in the field of telemetry.

The Central element is, as already mentioned, tool of system integration on data and user levels - Data Web Service – primarily, it organizes the collected data and enables the data storage, connection to the third-party software and services, access to these data and the option of sending informative and warning messages.

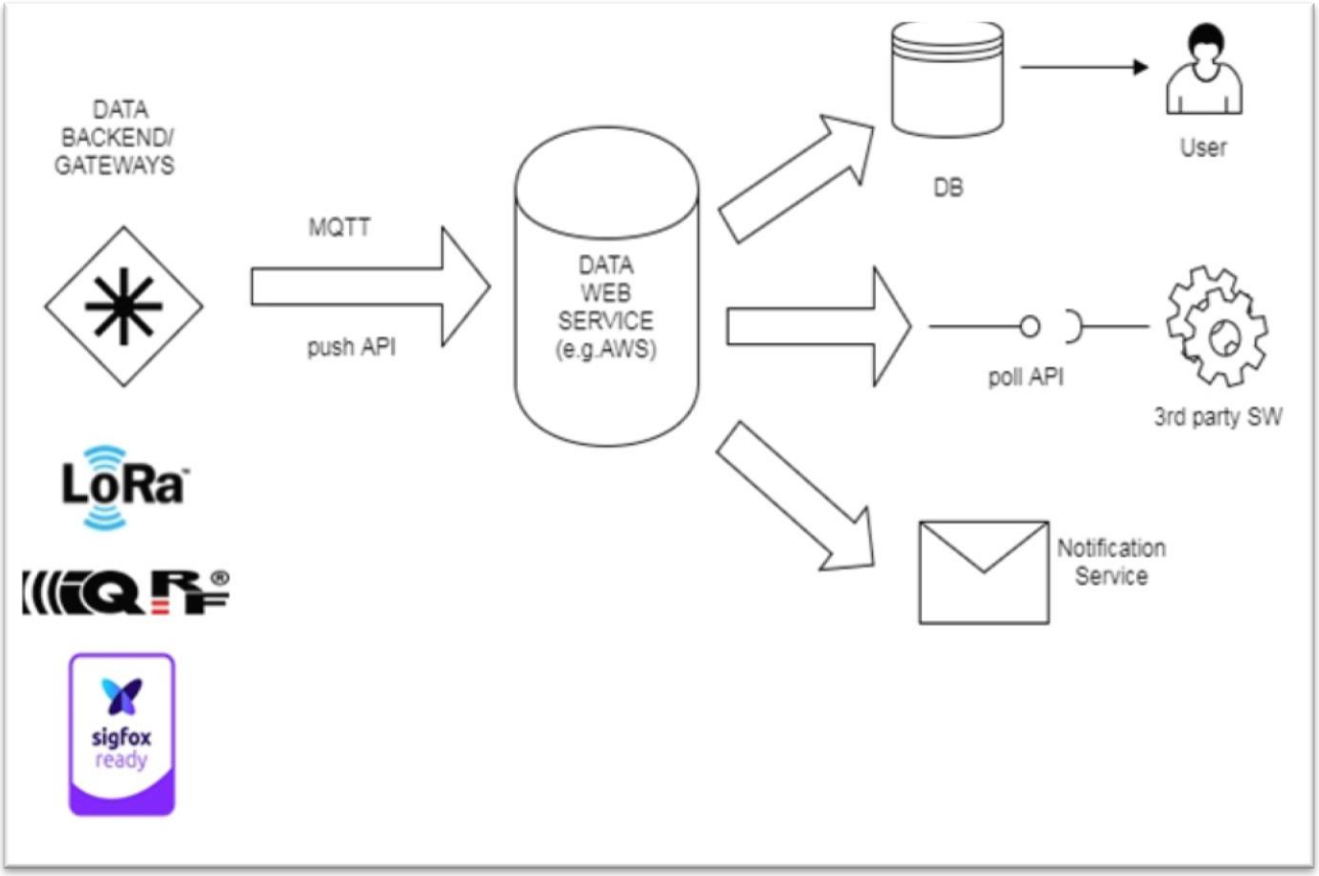


Figure 5: Central element – the tool of system integration

2. How to instal the software tool

2.1. Overview

The aim of this part of the document is to show step by step how to simply put the configuration file titled “configSOLEZ” into operation in the Amazon Web Service cloud system.

As already mentioned, this system, after being put into real-life operation, will gather data from installed detection systems and enable users to evaluate it subsequently.

In order to make the system usable and to verify its features and functions, it will be made accessible to its future users and verified during pilot operation by the SOLEZ project partners (DT3.1.2 -3).

Based on this pilot testing, the system will be modified and adapted to various uses, as the project partner’s pilot-verify various regulatory schemes.

Besides testing of the system operation itself which will focus on monitoring of user behaviour, the flaws that can occur during real-life operation will be also monitored. The pilot testing aims to improve the system reliability and to show users that the created software platform is easy to use. Also that it will enable better mobility planning due to availability of traffic data from monitored areas.

Thanks to this system, user can e.g. decide what requirements shall be expressed for design of the robust system, what requirements could be expected for organisation and operation of the system, e.g. for its maintenance.

2.2. How do I get started

Here is an overview of the process

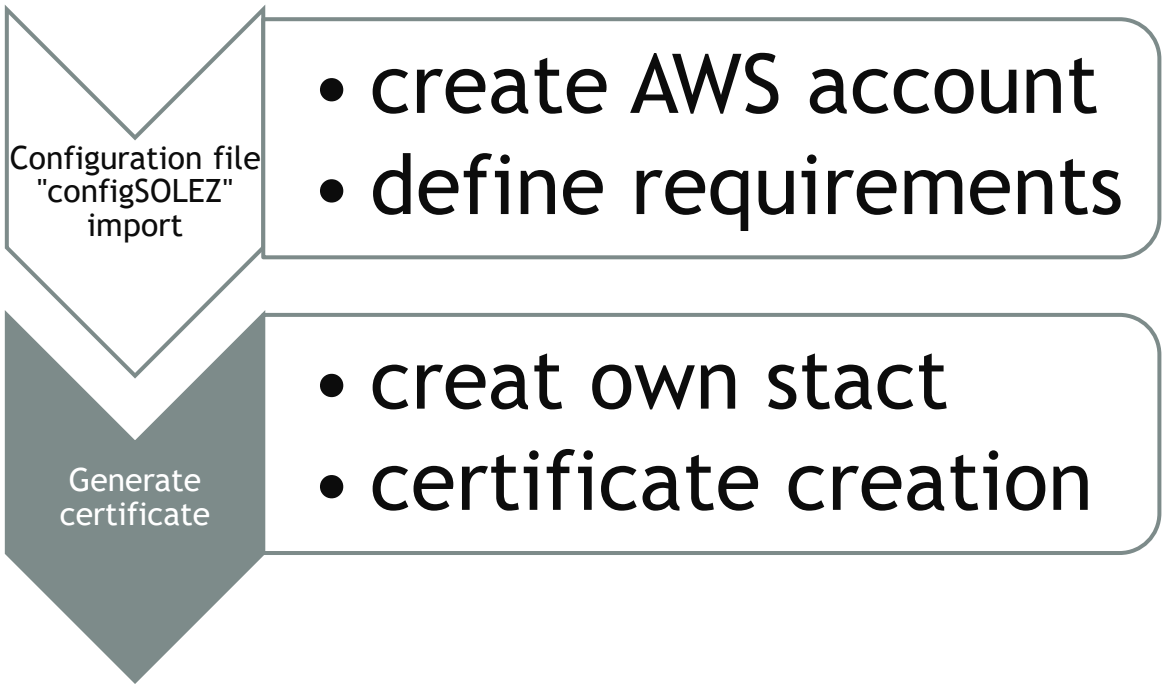


Table 1: An overview of process

Objective of the configuration file import is to open ready-made environment for the users where they can define requirements for software tool (central parking software platform) which will evaluate data from detection sensors.

Another objective is to transfer generate certificate to detection technology operator in order to inform him where to store data. This means that the detection sensors need to know the address for sending data and that access to create storage space must be enabled so that the detection sensors´ data is stored to prepared platform.

Following steps describe the procedures how to define requirements and how to generate certificate to be transferred to detection technology operator.

2.2.1. Configuration file “configSolez” import

Here is an overview of the process

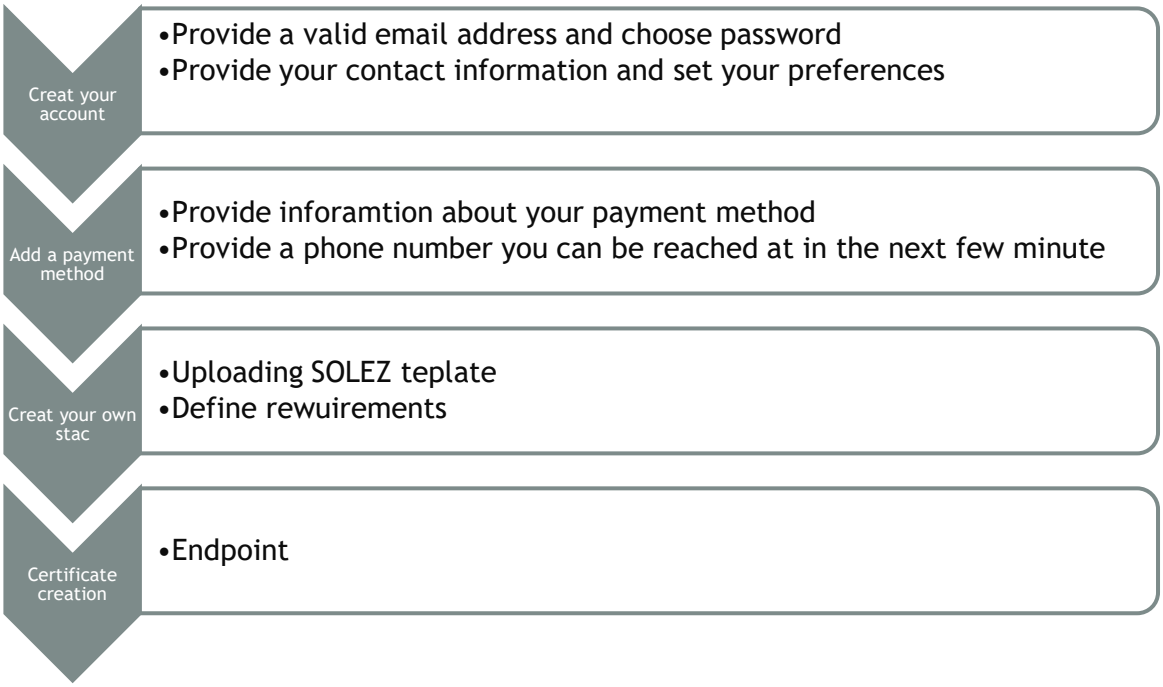


Table 2: An overview of the process

2.2.1.1. Create your account

1) Go to the Amazon Web Services home page.
2) Choose Sign Up.

Note: If you've signed in to AWS recently, it might say Sign In to the Console.

3) Type the requested account information, and then choose Continue.

Note: If Create a new AWS account isn't visible, first choose Sign in to a different account, and then choose **Create a new AWS account**. When creating a new account, be sure that you enter your account information correctly, especially your email address. If you enter your email address incorrectly, you might not be able to access your account or change your password in the future.

4) Choose Personal or Professional.

Note: These two account types are identical in functionality.

5) Type the requested company or personal information.

6) Read the AWS Customer Agreement, and then check the box.
7) Choose Create Account and Continue.

2.2.1.2. Add a payment method

The registration is cost free.

These free tier offers are only available to new AWS customers for first 12 months following the AWS sign-up date. When the 12 month free usage term expires or if the application use exceeds the tiers, simply pay accordingly with a standard pay-as-you-go service rates (see https://aws.amazon.com/free/ each service page for full pricing details). Restrictions apply; see offer terms for more details

On the Payment Information page, type the requested information associated with your payment method. If the address for your payment method is the same as the address you provided for your account, choose Secure Submit.

Otherwise, choose Use a new address, type the billing address for your payment method, and then choose Secure Submit.

2.2.1.3. Choose an AWS Support plan

On the Select a Support Plan page, choose one of the available Support plans. For a description of the available Support plans and their benefits, see AWS Support - Features.

After you choose a Support plan, a confirmation page indicates that your account is being activated. Accounts are usually activated within a few minutes, but the process might take up to 24 hours.

Note: You can sign in to your AWS account during this time. The AWS home page might continue to display a button that shows "Complete Sign Up" during this time, even if you've completed all the steps in the sign-up process.

When your account is fully activated, you'll receive a confirmation email. After you receive this email, you have full access to all AWS services.

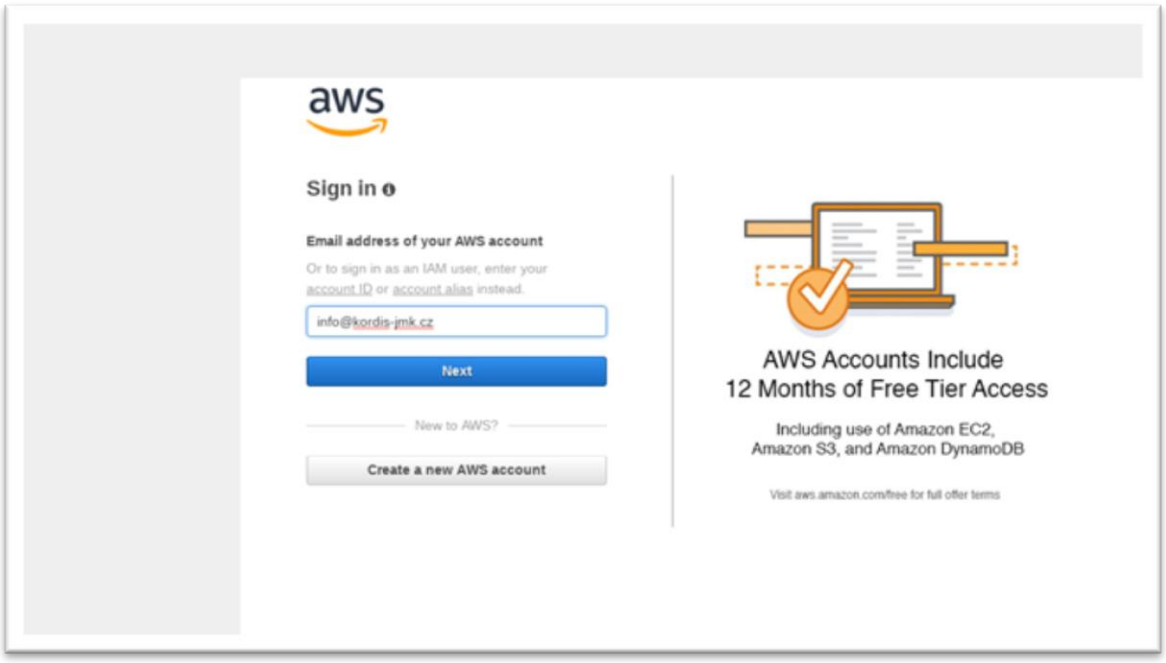


Figure 6:An overview of home page

2.2.1.4. Create your own stack

After you create member account you have to create your own stack. How do I do it?

Short Description: All the resources in a STACK are defined by the stack's AWS CloudFormation template. A STACK, can include all the resources required to run a database, and networking rules

1. Open AWS services, and then choose CloudFormation

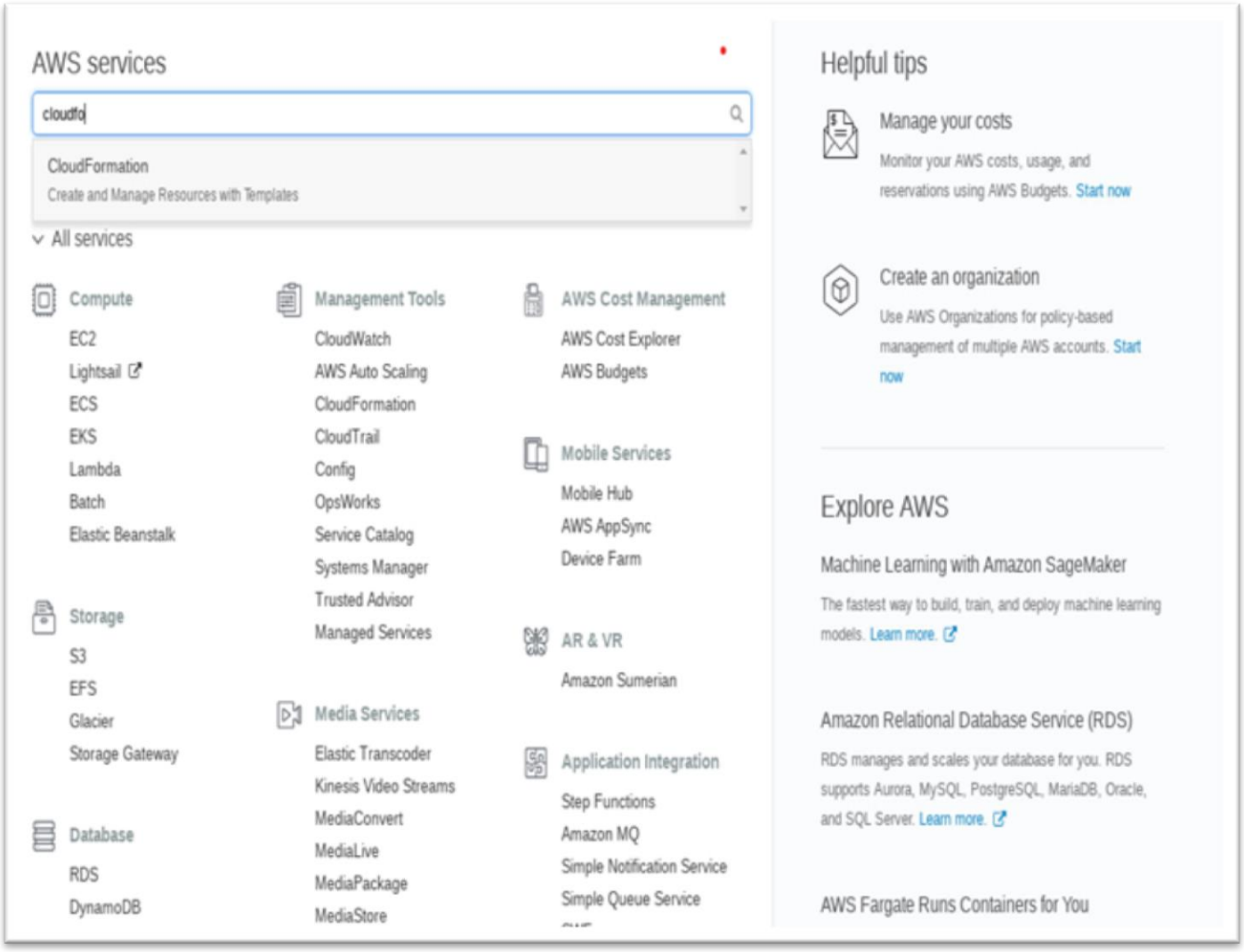
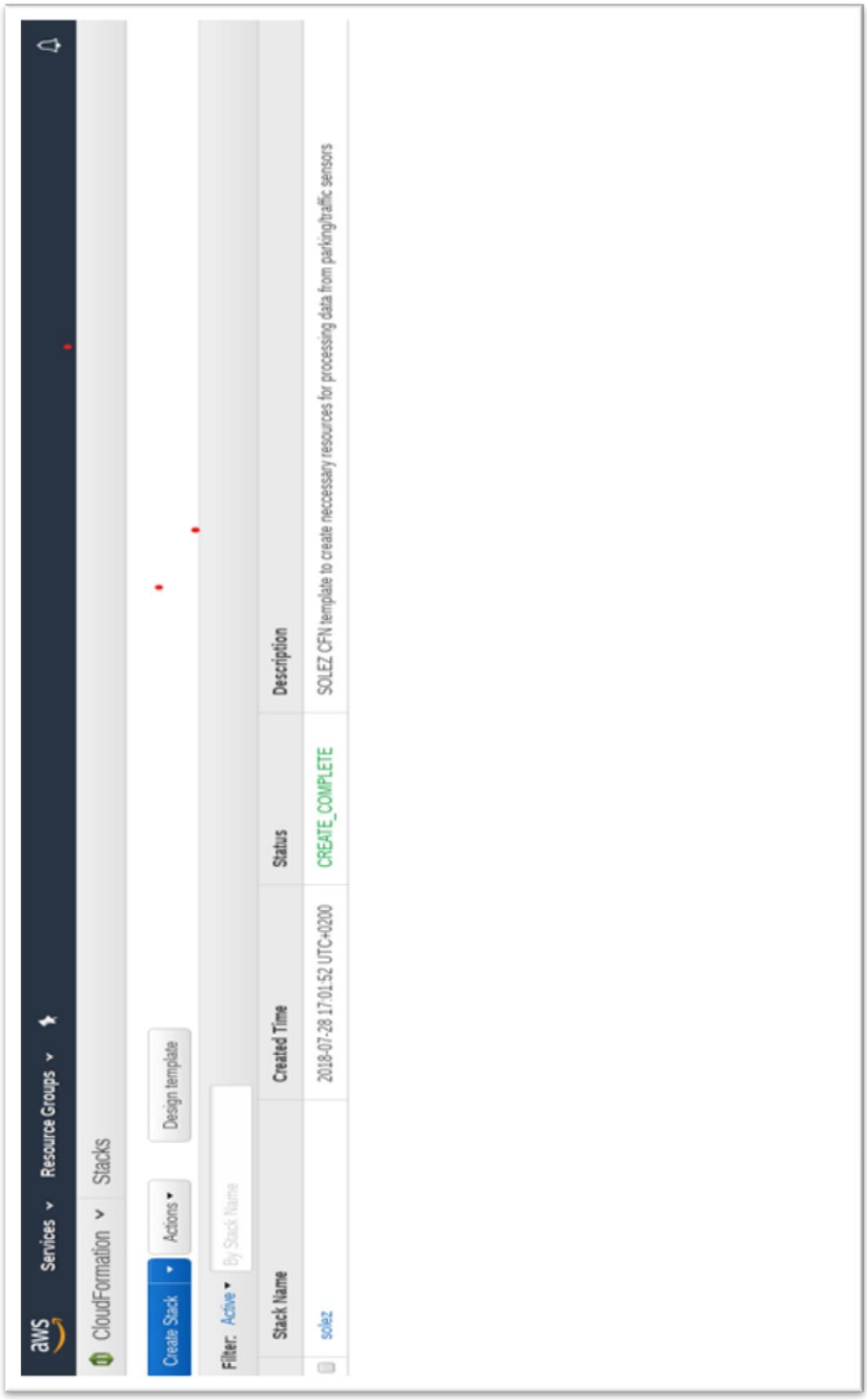


Figure 7:An overview of the CloudFormation

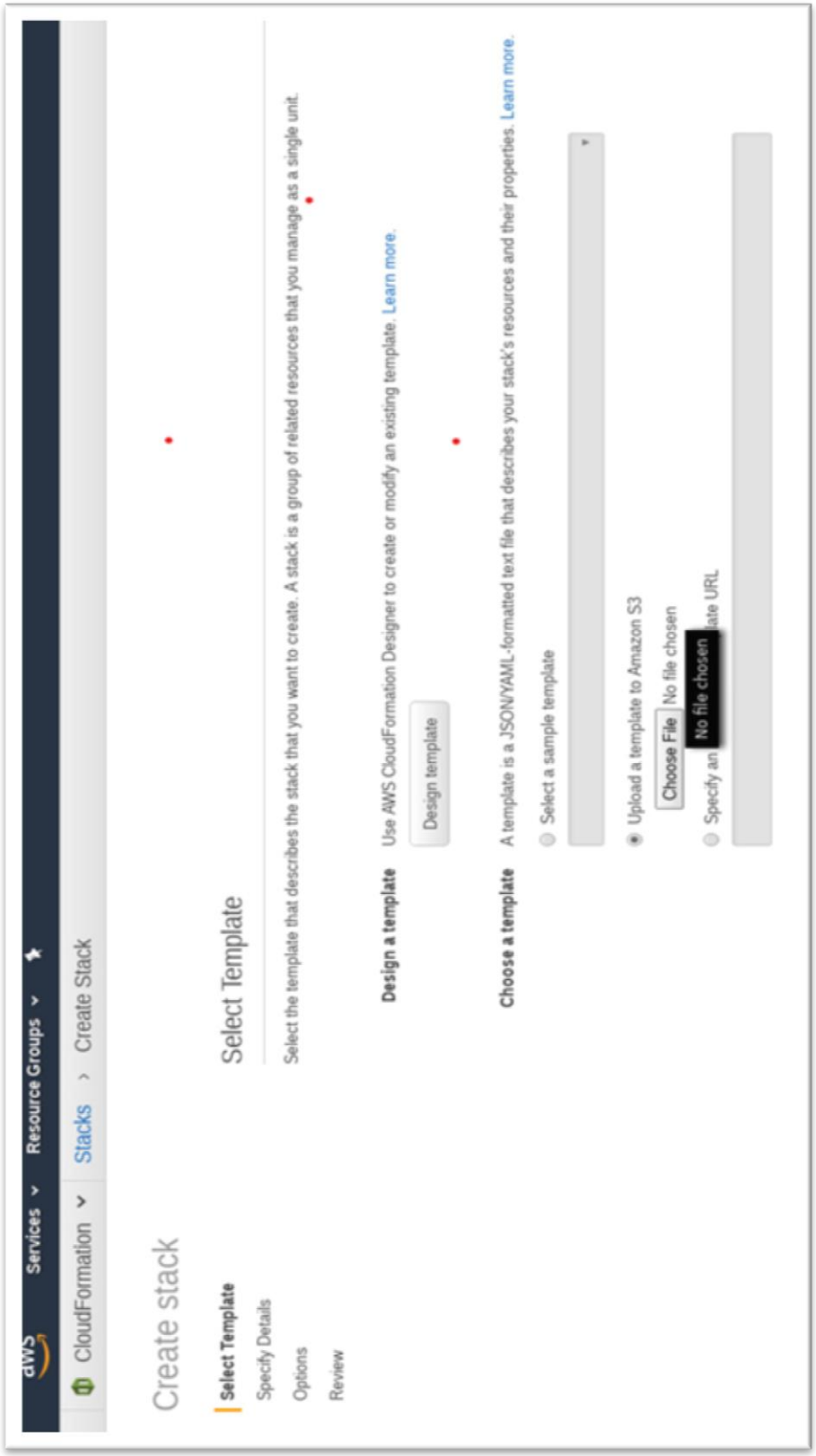
2. Choose **Create Stack**

Figure 8: An overview of the CloudFormation



3. Choose Upload a template to Amazon S3

Figure 9: An overview of Create stack, Select Template



4. Upload the template **Solez.yaml.**

Descriptions:

Solez yaml you can find and download from SOLEZ Web site

Figure 10: An overview of Create stack, Select Template Upload a template, Choose File solez.yaml

5.Choose **specify detail**

Descriptions:

to define individual components / locations with their specific features within each pilot site need and to gain better orientation in the data registers for the future use.

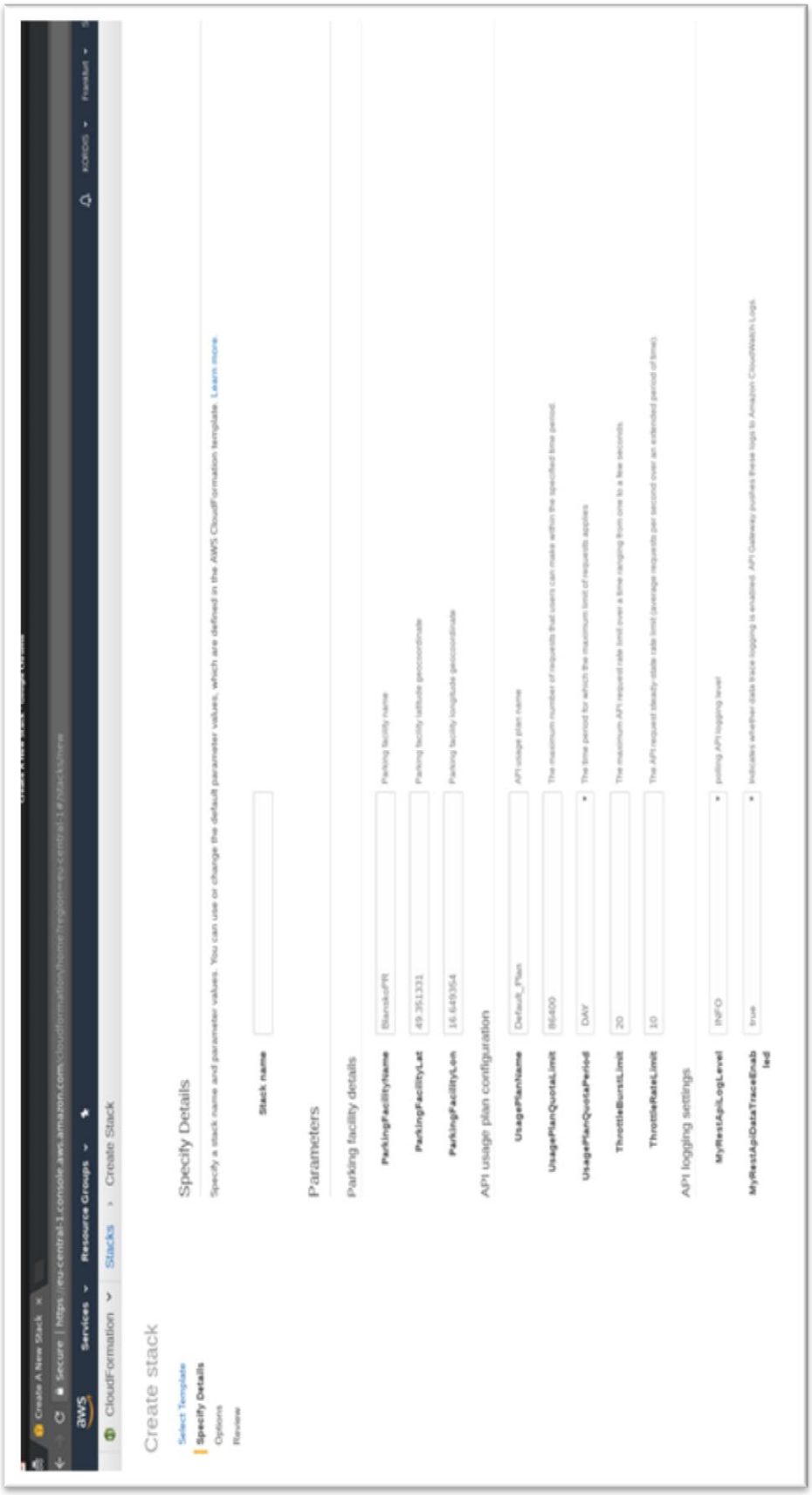


Figure 11: An overview of Specification of details

6. Choose **parameters**

The description and configuration information, specific for given location, can be add to **Parameters**

Descriptions:

This makes management of “things“(detectors, sensors, systems) easier and defines their attributes: serial number, manufacturer and capacity. Max capacity is 50 attributes of specific end devices.

There is no limit for the amount of types of “things“(detectors, sensors systems). Systems of any size can be created this way.

Figure 12: An overview of Specification of details

7. Choose **option and then choose Permissions**

Description

You can choose IAM role" I acknowledge that AWS CloudFormatin might create IAM resources"

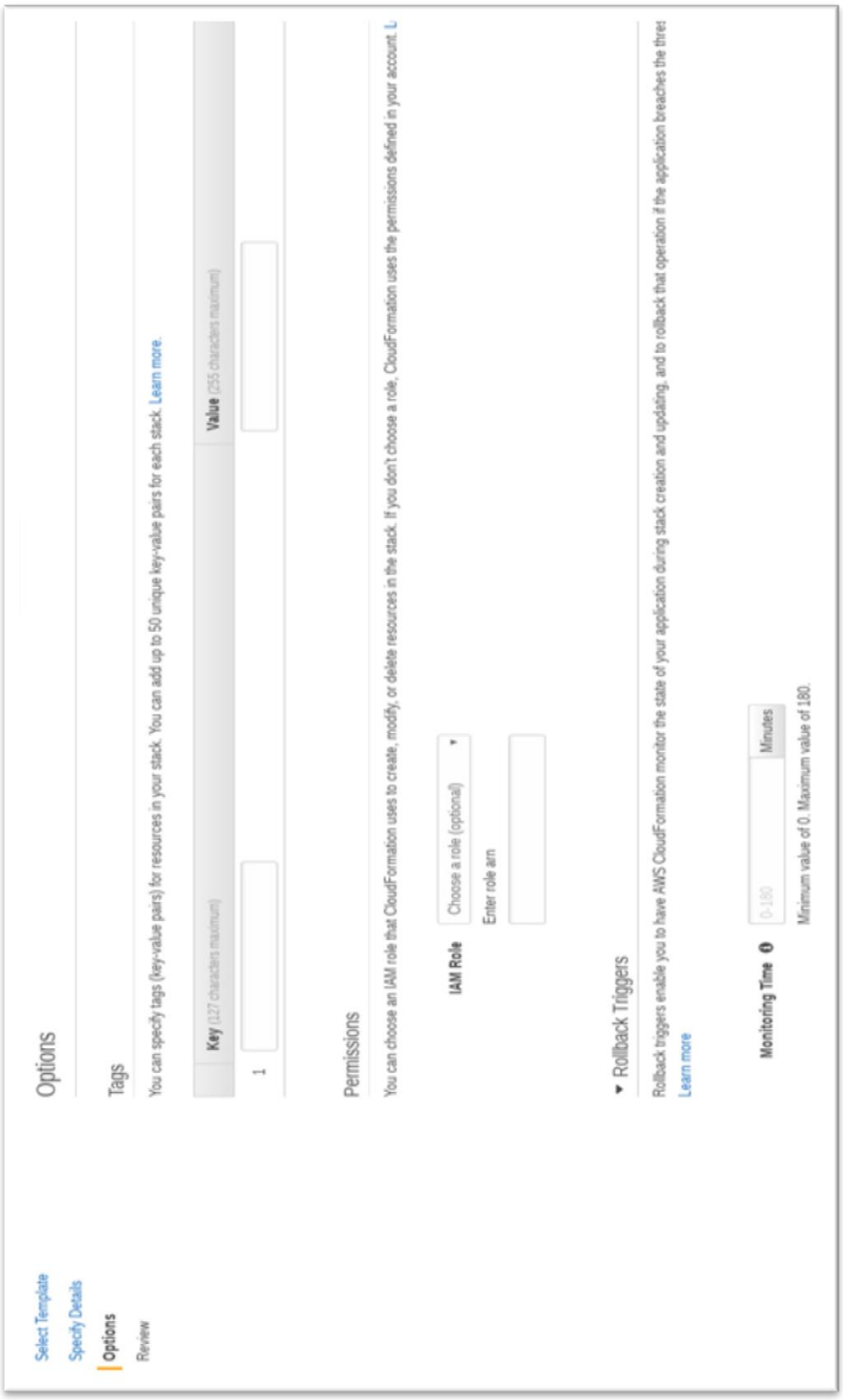


Figure 13: An overview of Options

8. Choose **Review**

Description:

You can see details of created Stack

Figure 14: An overview of Review

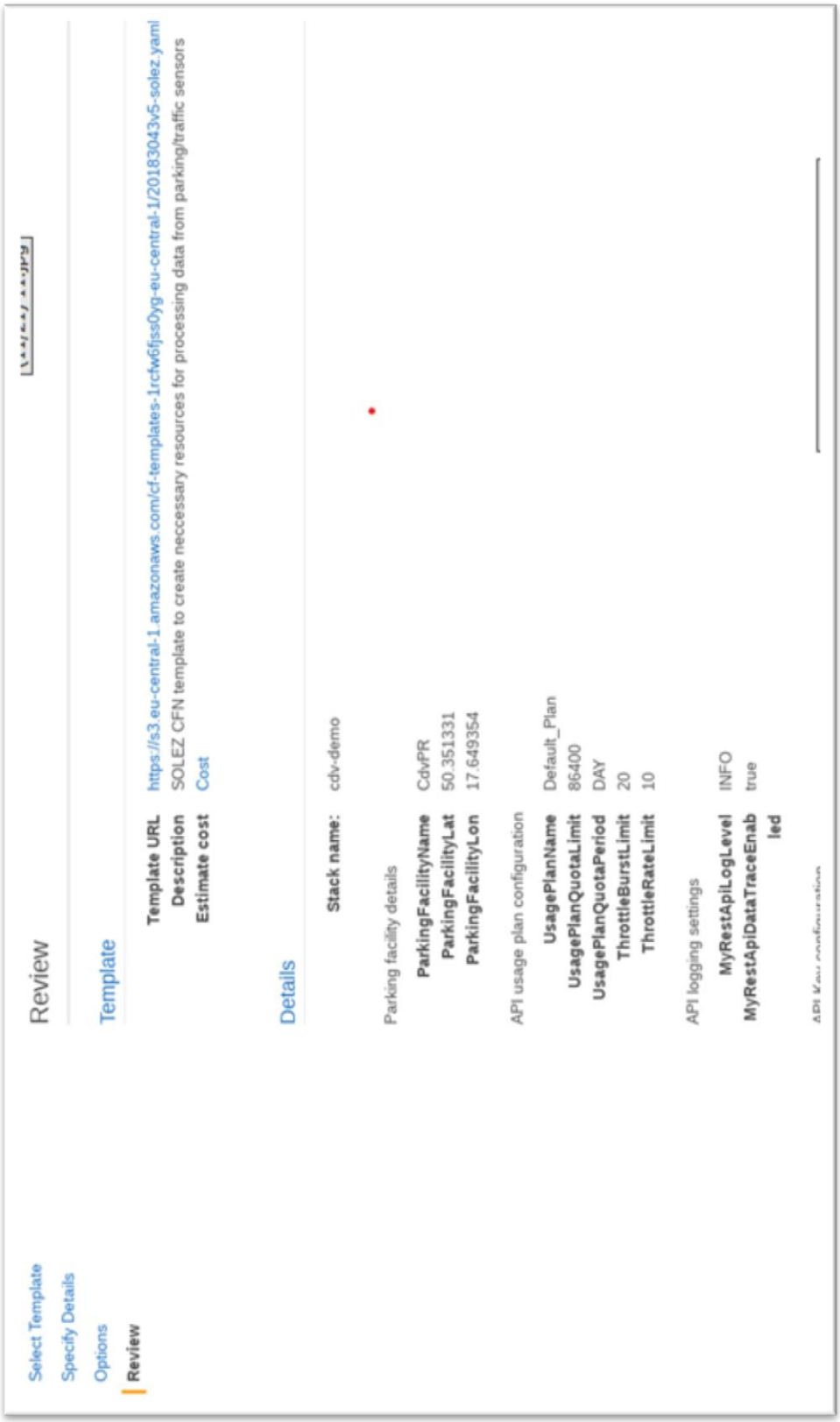
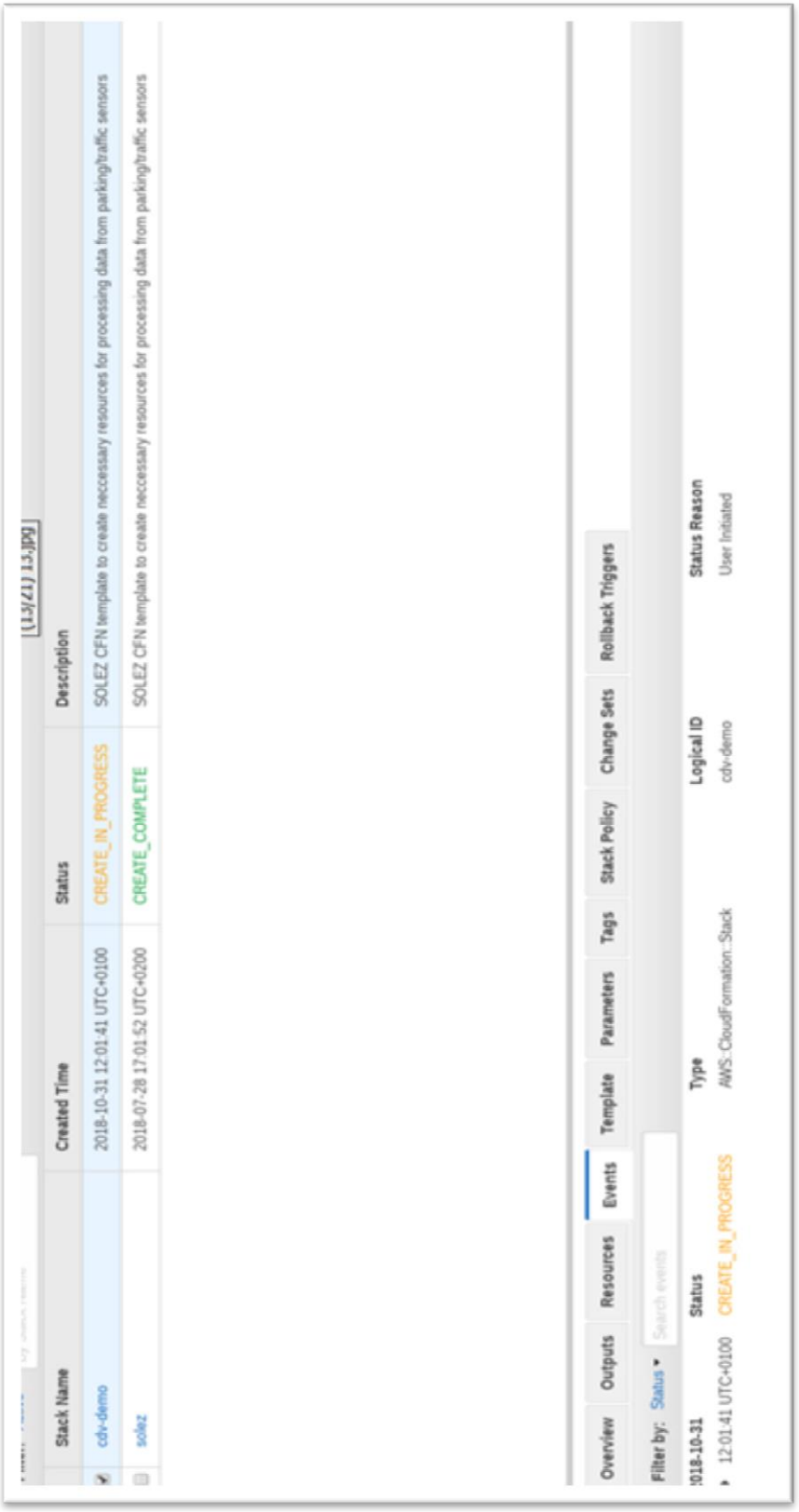


Figure 15: An overview of Status created complete



9. Choose **Iot core**

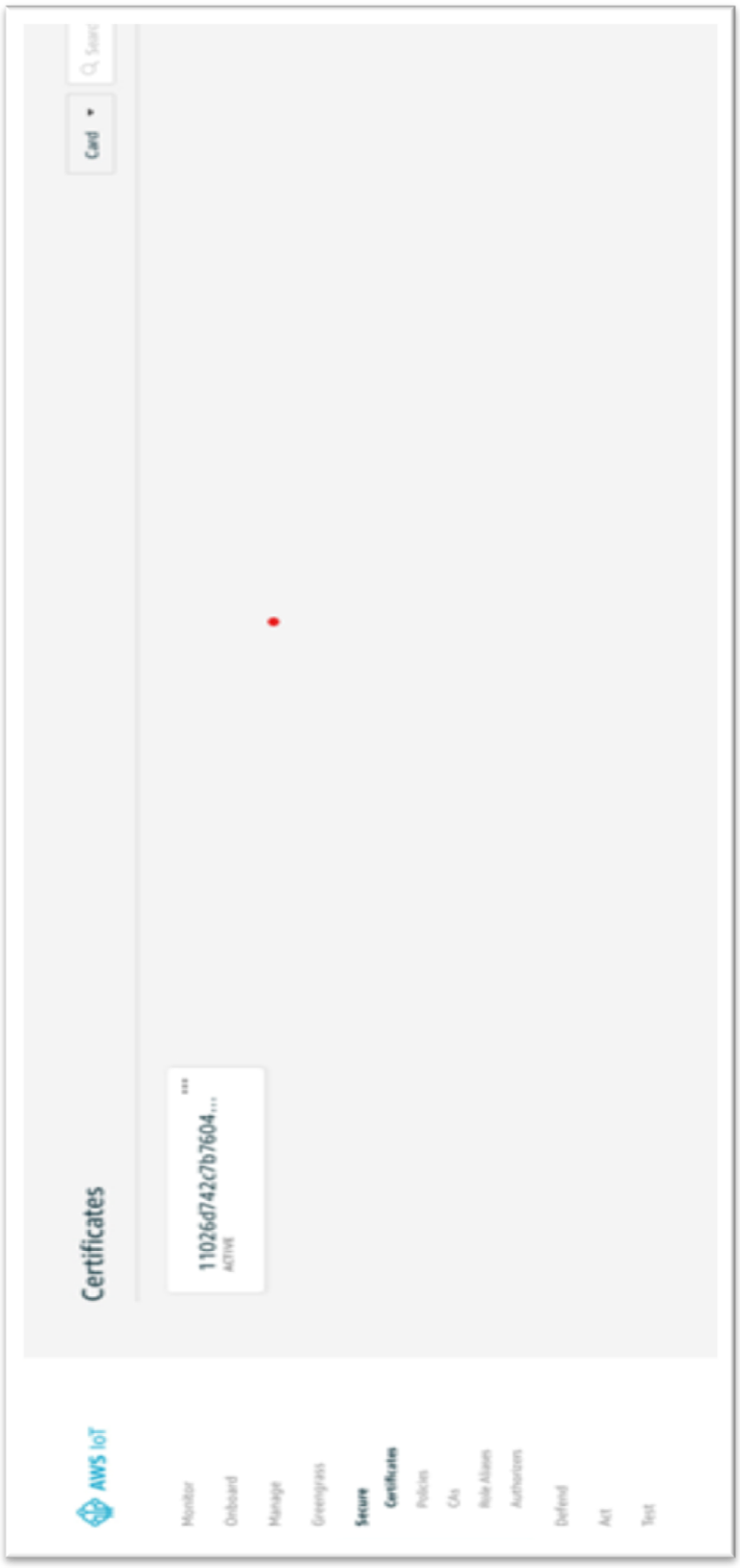
Description:

The STACK is created and now is important to authorise the certificate for Connect Devices to the Cloud. The certificate will be sent to provider of parking detectors, parking cameras and etc.

Figure 16: An overview of Connected devices to the cloud

10. Choose **secure certificates**

Figure 17: An overview of the certificate´s creation



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11. Choose **Create certificate**

Description:

This step will generate a certificate using AWS Iot´s certificate authority

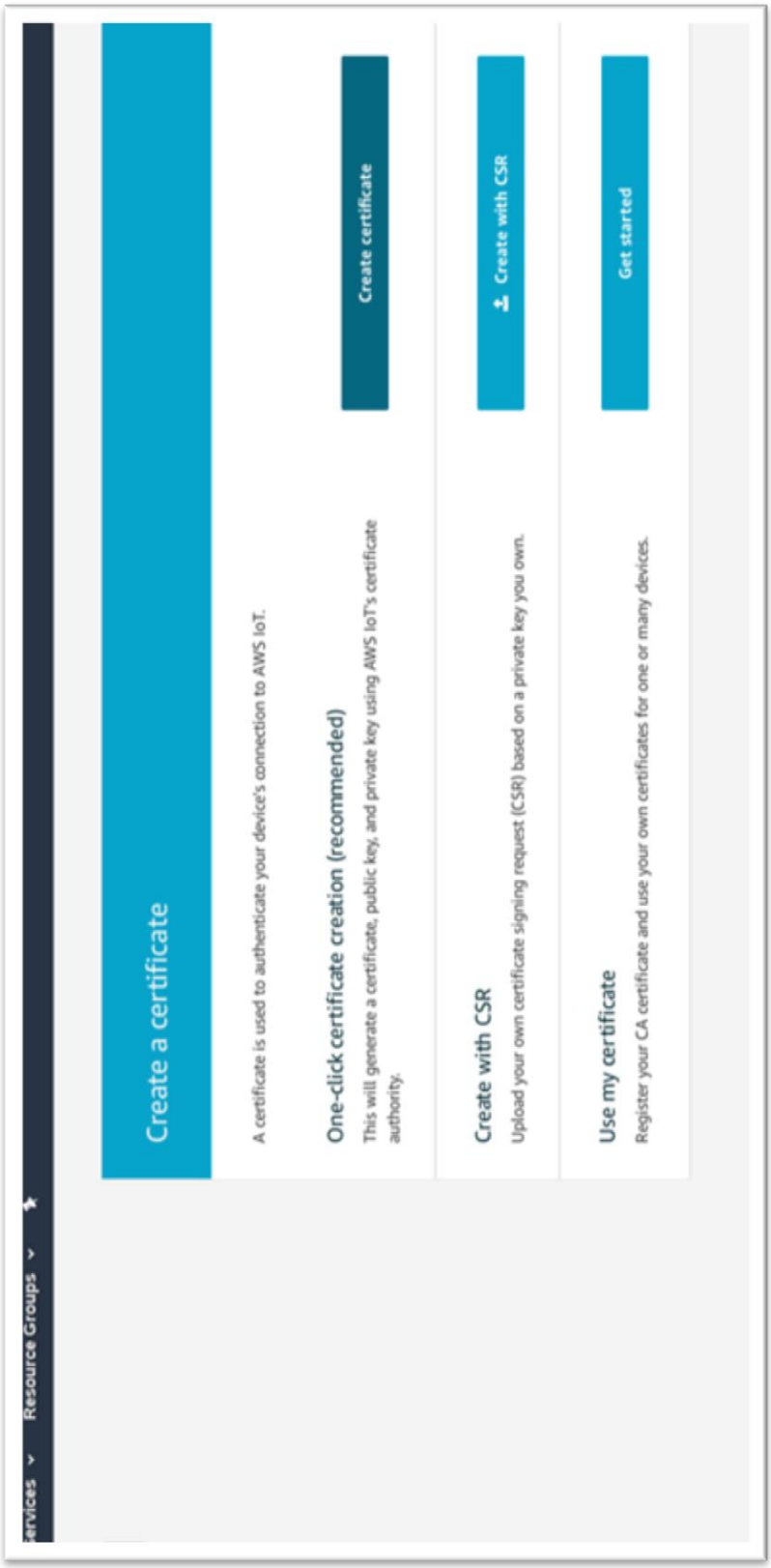


Figure 18: An overview of creat a certificate

12. Choose **Certificate created**

Description:

Obtaining certificates and endpoints – spots for receiving and transmitting the data; more precisely, it is the address which defines where the service runs, i.e. where shall the third parties (detector, service provider etc.) send data and messages. Each third party must naturally receive authorization for transmitting this data to this address. The generated key / certificate is used for this purpose. The system security is considered. The data security and protection is currently one of key features of solutions based on large volumes of data.

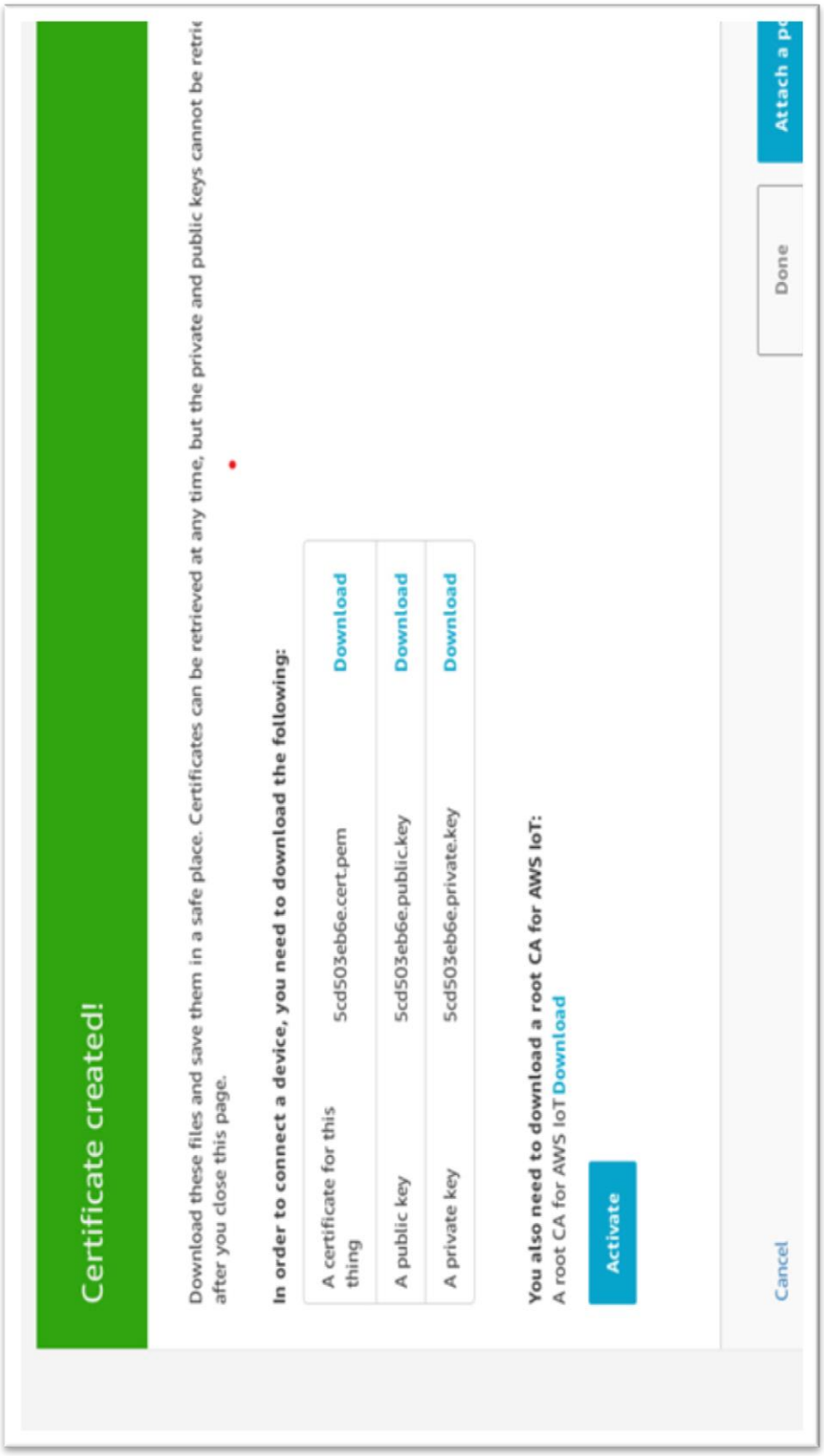


Figure 19: An overview of Certificate created

13. Choose Add authorization to certificate

Description:

A predefined policy must be selected, this policy is general and can be selected by anyone.

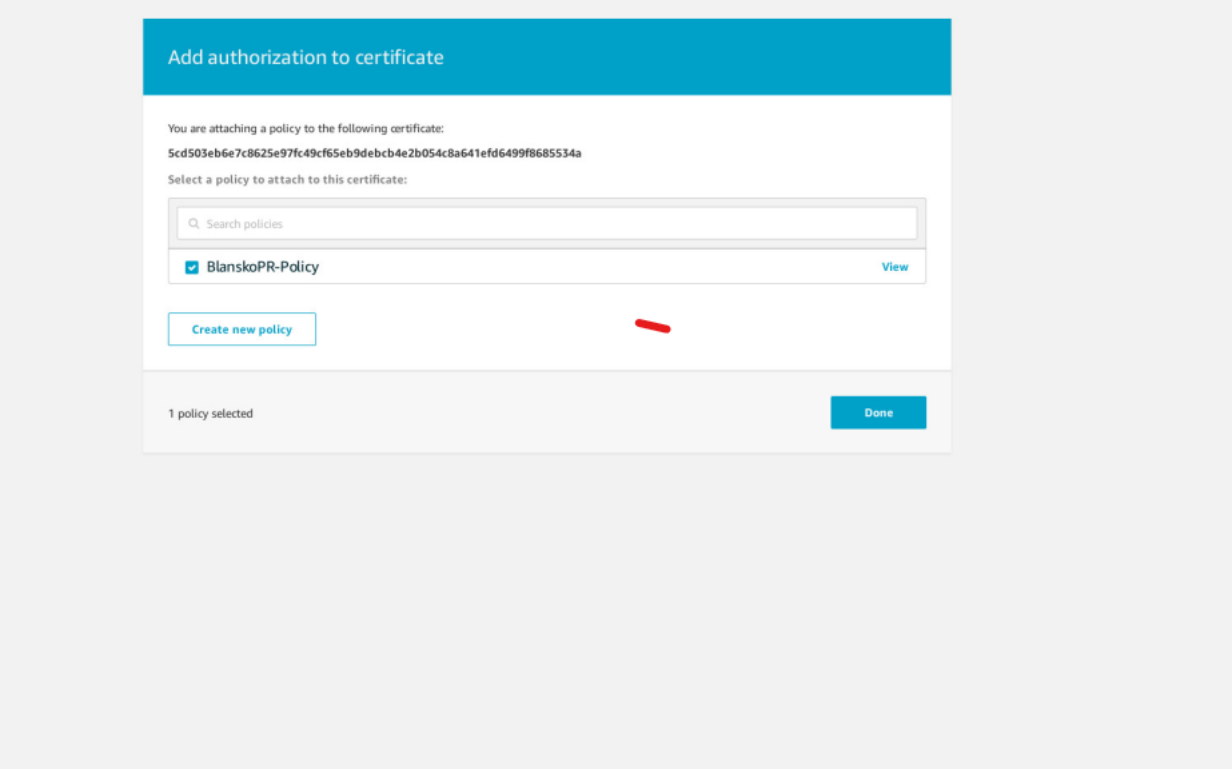


Figure 20: An overview of Add authorization“ (detectors, sensors)

14. Choose **Secure**

Description:

The certificate has been created (white box). After click on two point on the right up site I can choose, the certificate activating or deactivating, or the download of the file with certificate. The certificate is standardized (MQTT protocol)

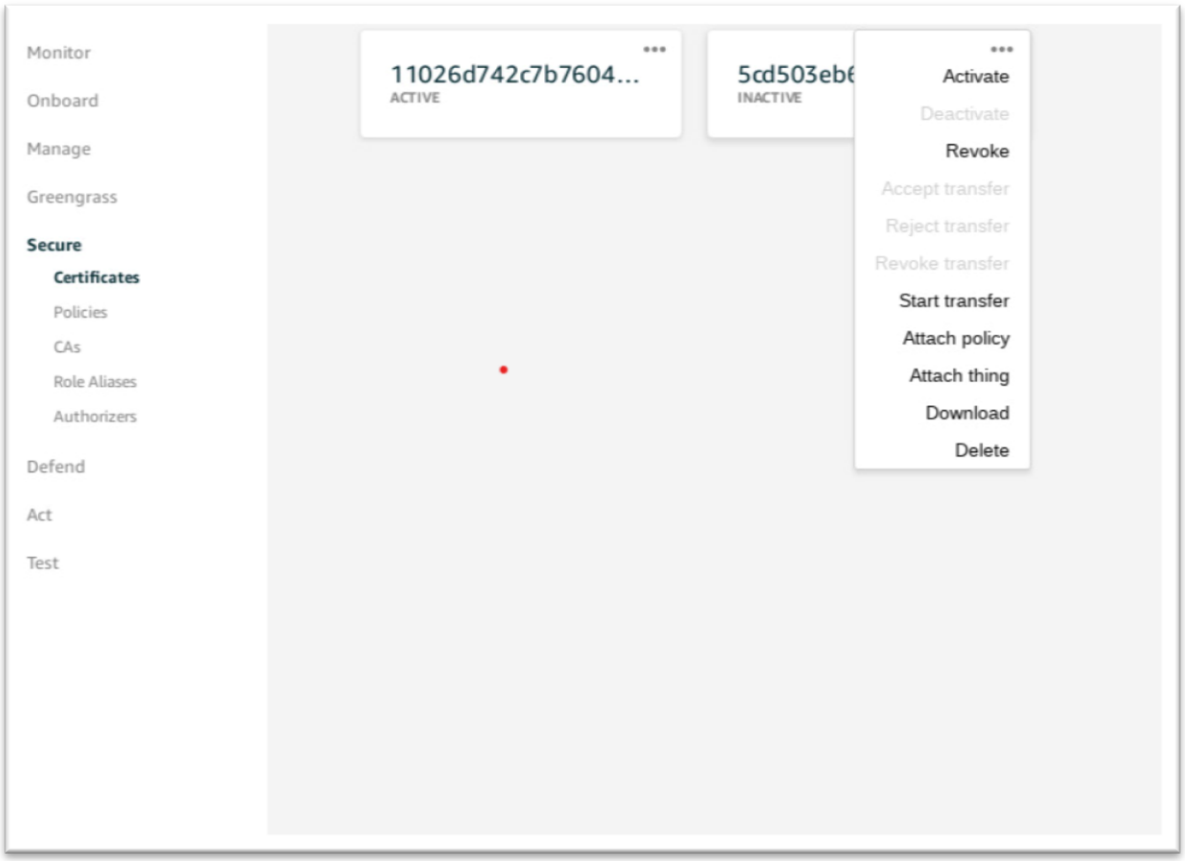


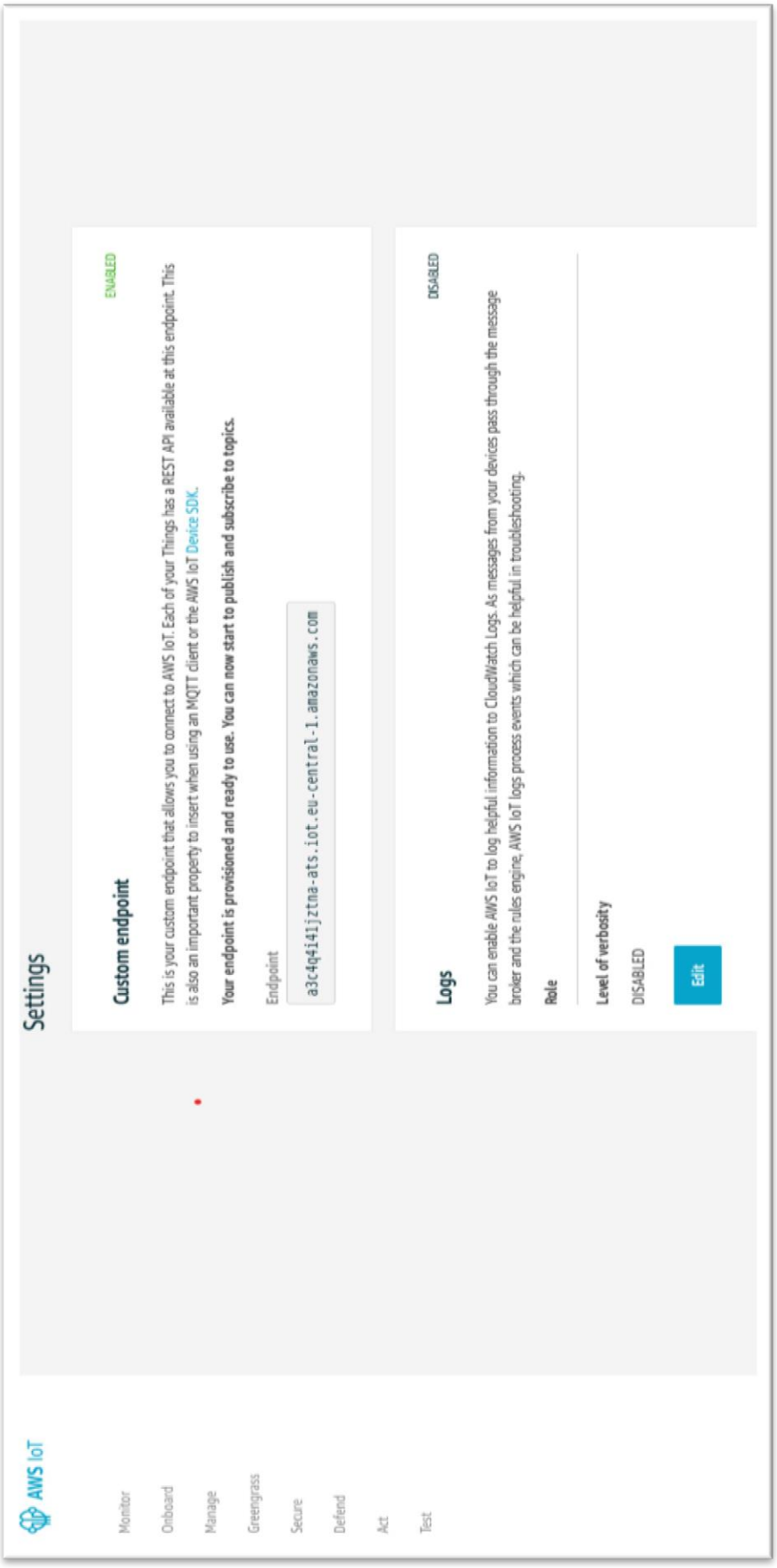
Figure 21: An overview of Secure: certificates

15. Choose Custom endpoint

Description:

Next important information for provider is “endpoint” This is custom endpoint that allows you to connect to AWS IoT. This is address for sending data.

Figure 22: An overview of endpoint



3. Conclusion

As already mentioned, the smart parking concept is based on continuous monitoring of parking spaces´ occupancy. It aims to support city parking policy by means of technology and to introduce complex and unified parking system, integrating ideally all devices in functional areas to a single whole in order to affect the traffic based on environmental conditions, to monitor development of traffic conditions after introducing a measure and to motivate drivers to facilitate change.

However, several steps must be met before achieving this goal. Before starting the process of regulatory scheme and detection technology selection, we must know traffic conditions in a given location. We must therefore have necessary input data available to detect both current and long-term traffic load in order to enable preparation of decision-making basis for competent policy-makers. It must be stated that as of present moment, none of the SOLEZ project partners has introduced unified parking policy enabling mutual compatibility (barrier systems, parking meters, street parking zones). Improvement of public sector´s professional capacity thus becomes benefit of this decision support tool. Monitoring of current status can be approached in several ways; choice of one affects several factors at once.

Procedures for monitoring this state and for correct monitoring area selection are listed in the deliverable (DT2.1.2 decision support tool). User can thus define what he wants to achieve by means of monitoring and what requirements he imposes on the system. Decision-support model recommends user which detection technology to deploy and what results to expect. This enables subsequent decision on which regulatory scheme is to be optimal to use in the future.

To implement use of sensoric networks, the SOLEZ platform has been established which enables sharing of data provided by selected detection technology by means of a certain type of devices. Within the SOLEZ project, general technical requirements for opening a tender for detection technologies were also compiled as Annex

These devices are supplied by the users on the basis of tender results. Supplier of these devices – can be cameras or various types of sensors – needs to know the storage space to which the devices are supposed to send data.

Basic steps for meeting the objective of using smart parking technology to support low-emission zones in FUA can be characterized as follows:

1. Definition of political vision – each action plan shall describe desired future situation which is to be achieved by means of regulation. It is the consequence of implementing the regulation. The regulation is clear and factual; it enables execution of the vision (improvement of the air quality in FUA, increased number of parked cars outside of zone). To adjust the regulation, it is necessary to analyse where the problem of interaction between standing and moving traffic in the long term and to define these areas. The policy-makers can be familiar with these facts already thanks to received complaints or they can commence to analyse current status by means of detection technologies. The tool part 1 (DT2.1.1) has been created for this purpose. It contains list of example solutions of regulations along with set of policies for partial domains such as availability of smart parking technologies. Thanks to the tool part 1, the users become aware what technologies are currently possible to demand and what the examples of regulation are.

2. Analysis of current state – the action plan shall be based on available data. This allows later assessment of whether the improved state was achieved by means of implementation of the selected regulation. The result (DT2.1.2) proposes procedure for compiling the analysis and its expected results. It also mentions how to proceed upon identification of problematic locations suitable for sensor deployment.

3. Sensoric network architecture – in order to implement smart parking system, it is necessary to know how to choose suitable sensors and what mode of communication is the most appropriate for this purpose. The choice shall be backed by sufficient extent of analyses and market research. For this purpose, the result has been created which contains summary information as well as decision-making model to be described in

greater detail in the result (DT2.1.2). To support decision-making while selecting the most suitable technology, the application has been created which is available at the SOLEZ project website.

4. Purchase of devices – system user must define technical specifications of the devices he wants to implement and operate. For these purposes, general technical specifications were defined within the project for its partners. These technical specifications are transferable for further use and can serve as a basis for definition of technical conditions.

5. Connecting into information and control systems – user of the SOLEZ tool can access created central software platform for storing and sharing of the detection technology data. This platform is operated at the Amazon Web Services cloud storage. Upon installation of the SOLEZconfig configuration file, he is entitled to use this platform as well as related services such as data visualisation, data presentation and its subsequent evaluation. Installation procedure of the SOLEZconfig configuration file.