

D3.2.3

Smart Lighting System Draft Prototype

Project number:	257243
Project acronym:	TClouds
Project title:	Trustworthy Clouds - Privacy and Resilience for Internet-scale Critical Infrastructure
Start date of the project:	1 st October, 2010
Duration:	36 months
Programme:	FP7 IP

Deliverable type:	Prototype
Deliverable reference number:	ICT-257243 / D3.2.3 PU / 1.0
Activity and Work package contributing to the deliverable:	Activity 3 / WP 3.2
Due date:	September 2012 – M24
Actual submission date:	28 th September, 2012

Responsible organisation:	EFACEC ENG
Editor:	Paulo Santos
Dissemination level:	Public
Revision:	1.0

Abstract:	This document describes what has been accomplished during the development of the Smart Lighting System Draft Prototype, hosted on a commodity cloud.
Keywords:	Smart, Grid, Public, Lighting

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Disclaimer

This work was partially supported by the European Commission through the FP7-ICT program under project TClouds, number 257243.

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Executive Summary

This document describes the concrete implementation of the Smart Lighting Web application with its supporting modules, the Command Centre Bridge and the Smart Lighting gateway.

We start by referring to some design change decisions and then we turn our focus to the software architecture, how it was implemented and how all the software systems collaborate to the same goal.

Chapter 3 then addresses a few considerations over moving an otherwise in-house hosted solution to a cloud environment, and what the expectations for adopting TClouds security solutions are.

Finally there is a detailed explanation on how to use the Smart Lighting Web application.

All software systems were developed guaranteeing that all system frontiers were independent of each other, that way we could completely develop the Smart Lighting solution without having an actual implementation of the State Machine Replication (SMR) [9]. Doing this we can easily replace the current persistence implementation by the final implementation of the SMR without impact to the other systems.

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Chapter 1

Introduction

1.1 TClouds — Trustworthy Clouds

TClouds aims to develop trustworthy Internet-scale cloud services, providing computing, network, and storage resources over the Internet. Existing cloud computing services today are generally not trusted for running critical infrastructure, which may range from business-critical tasks of large companies to mission-critical tasks for the society as a whole. The latter includes water, electricity, fuel, and food supply chains. TClouds focuses on power grids, and electricity management and patient-centric health-care systems as main applications.

The TClouds project identifies and addresses legal implications and business opportunities of using infrastructure clouds, assesses security, privacy, and resilience aspects of cloud computing and contributes to building a regulatory framework enabling resilient and privacy-enhanced cloud infrastructure.

The main body of work in TClouds defines an architecture and prototype systems for securing infrastructure clouds, by providing security enhancements that can be deployed on top of commodity infrastructure clouds (as a cloud-of-clouds) and by assessing the resilience, privacy, and security extensions of existing clouds.

Furthermore, TClouds provides resilient middleware for adaptive security using a cloud-of-clouds, which is not dependent on any single cloud provider. This feature of the TClouds platform will provide tolerance and adaptability to mitigate security incidents and unstable operating conditions for a range of applications running on a cloud-of-clouds.

1.2 Activity 3 — Benchmark Applications & User-centric Evaluation

Activity 3 focuses on the applications and the evaluation of the TClouds platform. The activity's objective is to define and validate cloud applications' architecture and specifications (the medical and the smart grid use case). For this purpose, Activity 3 will specify cloud and application functionalities and requirements, define application prototypes to be implemented on the cloud platform, and validate the application prototypes and the TClouds platform. For this purpose, the requirements defined in Activity 1 will serve as a generic guideline, which will be refined and consolidated in Activity 3. Finally, there is a continuous and close interaction between Activity 3 and Activity 2 in order to make sure that the platform and applications match the specifications and that the TClouds project achieves its overall objectives.

1.3 Workpackage 3.2 — Cloud-middleware and Applications for the Smart Grid Benchmark Scenario

The objective of WP3.2 is to define a sample Smart Grid application architecture and validate it by means of a prototype. We plan to develop a Public Lighting Management System (Smart Lighting) as our sample application that is migrated to the TClouds platform while providing scalable computing and enhancing its resilience and integrity assurance. WP3.2 also investigates how information gathering and response times could be achieved in a cloud-computing environment while achieving real-time timing guarantees. In close relation with WP2.4, WP3.2 also evaluates, through a prototype in a real world environment, both

scalability and availabilities while their resilience and intrusion tolerance increases. This architecture is linked and integrated in general with A2.

1.4 Deliverable 3.2.3 — Smart Lighting System Draft Prototype

1.4.1 Overview

This document serves as an addition to the Smart Lighting System Draft Prototype, which is indeed the D3.2.3 deliverable. Besides instructions on how the prototype may be used, it also gives insight into the implementation decisions and considerations on cloud environments.

1.4.2 Structure

In Chapter 2, we give details on the implementation of the Smart Lighting System Draft Prototype, and on design changes and decisions.

Chapter 3 addresses a few considerations of moving an otherwise in-house hosted solution to a cloud environment, and the expectations for adopting TClouds security solutions.

Lastly Chapter 4 provides a user manual on the Smart Lighting Application.

1.4.3 Deviation from Workplan

The implementation of this prototype is fully compliant to the defined workplan.

1.4.4 Target Audience

This deliverable aims at TClouds Activity 2 partners wishing to evaluate and identify security deficiencies which TClouds security solutions may further tackle in the third year of the TClouds project. It also serves as a demonstration application of all requirements [12] and architectural design [5], defined during the first year of the TClouds project. And finally it defines a base point for WP3.3 to apply its validation and evaluation procedures on.

The deliverable requires background in software engineering, and SCADA systems in order to be fully understood.

1.4.5 Relation to Other Deliverables

D3.2.3 is required to execute WP3.3 validation protocol (D3.3.3 – Validation Protocol and Schedule for the Smart Power Grid and Home Health Care Use Cases), and to supply the evaluation results on D3.3.4 – Final Report on Evaluation Activities, as seen in Figure 1.

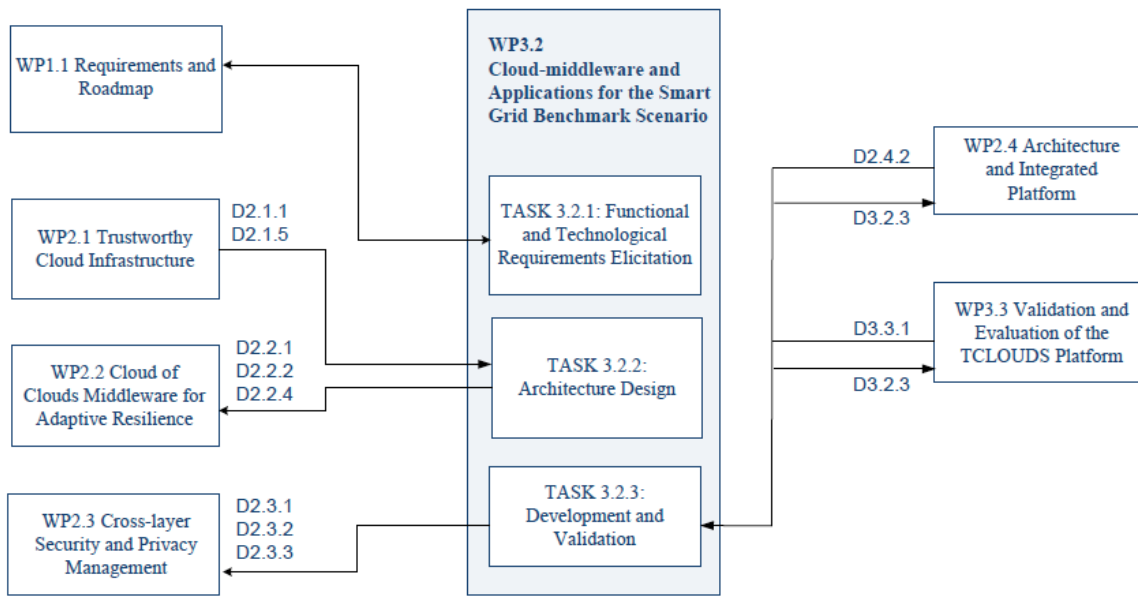


Figure 1: WP3.2 interdependencies

Chapter 2

Smart Lighting System implementation

Within this chapter we give insights into the implemented Smart Lighting Draft Prototype.

2.1 Design changes

While implementing the Smart Lighting System we realized that some minor changes had to be made to the initial design [5]. These changes are:

- The DTC Management [5] sub-system was made part of the web application, as a library instead of a separate process, since no other process in the cloud makes changes to the DTC (Distribution Transformer Controller) configuration. The advantage of this approach is that we won't have several instances of the DTC Management (one for every node in the cloud), possibly competing for the same data and consuming server resources. This way each instance of the web application only sends the changes made in its instance. To avoid blocking the user interface when many changes need to be sent, a separate thread is used for sending the changes across the wire. If this thread is unable to completely send all changes, due to a database error, a network error, or other unforeseen error, it is possible to resubmit all pending changes. Figure 2 and Figure 3 depict this redesign.
- The web session is now stored in the web server memory, thus rendering the Smart Lighting web application stateful. A web session is a memory buffer kept in the server side that is destroyed every time a user stops interacting with the web application. Due to this volatile nature and the tremendous impact in performance (for every request the web application would have to get its session from the SMR [5] and upon completion would have to store it again) there is no interest in storing this state in the SMR. For this, the web application access point (load balancer, across cloud-of-clouds) has to implement sticky sessions. The designation of sticky sessions refers to the ability of a load balancer to deliver all requests in a user session to the same server node. It is expected that the cloud load balancer implement this out of the box with no need for extra development. But if a server node crashes, all session's data in this server will be lost. Since only the user experience is affected and no business data is lost, the consequences are small. In the future if the need arises, other solutions can be applied transparently to the application, such as session replication.
- We exchanged XML-RPC with Hessian binary web service protocol [1], a much more efficient protocol [2] for the use case in hand.

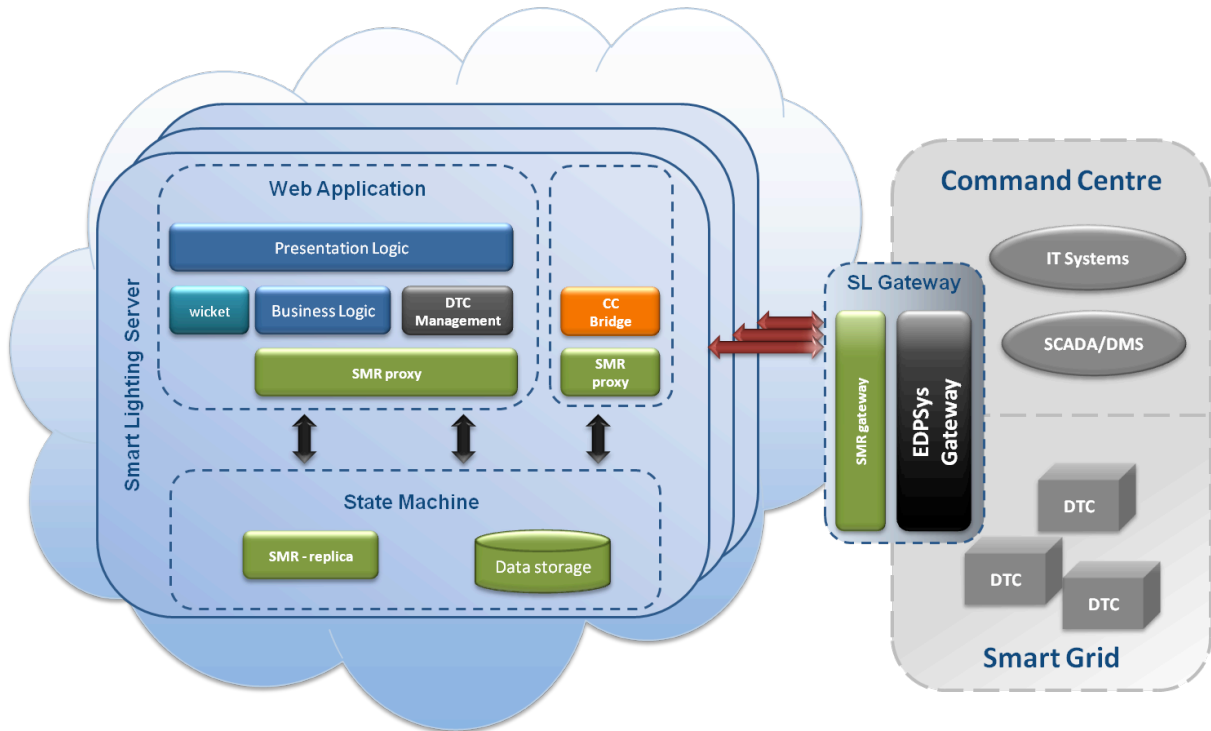


Figure 2: Smart Lighting System components

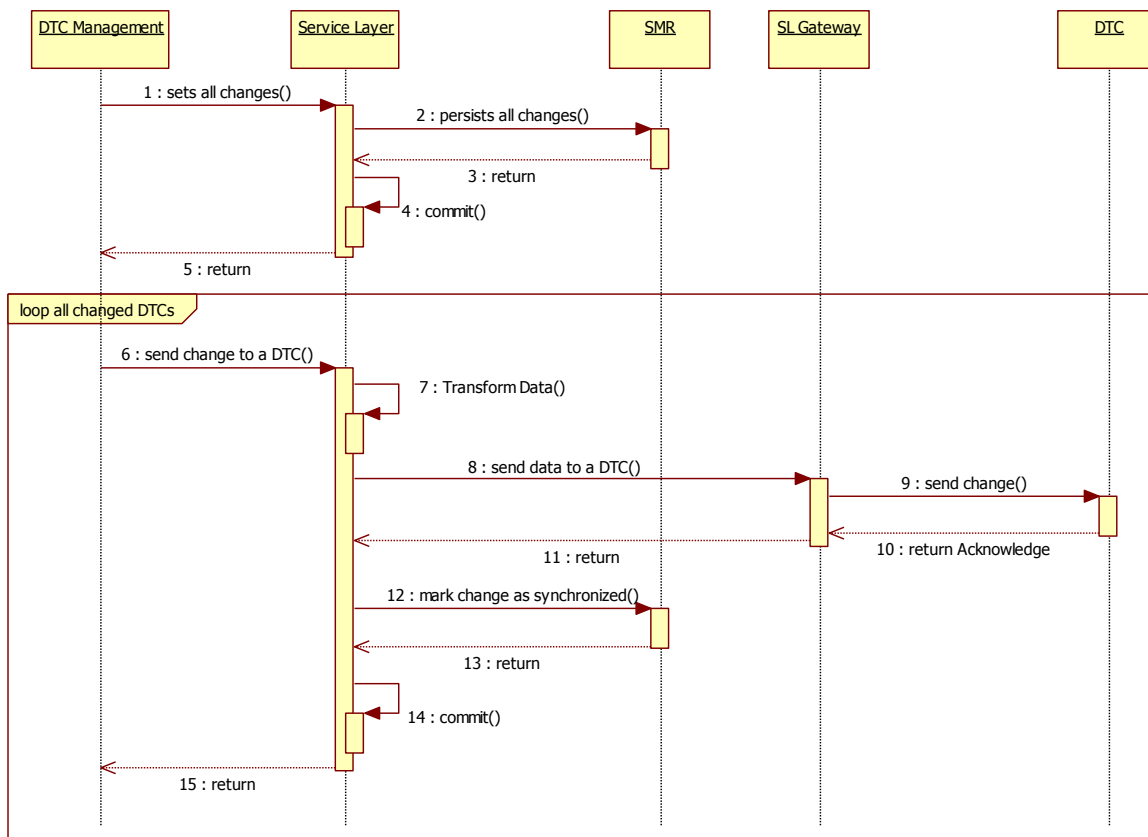


Figure 3: DTC synchronization sequence diagram

2.2 Modules

In this chapter we briefly describe the modules that support the web part of the Smart Lighting Solution and the interaction between them.

2.2.1 Smart Lighting Web Application

The main goal of this application is to provide users a web interface for the remote configuration of the DTC's public lighting services. All submitted configurations are processed, validated, and persisted to the SMR by a separated business logic layer.

This is not a public web application therefore access to this application is only possible with a username and password. Users have different access levels according to the assigned role.

2.2.2 Command Centre Bridge

The Command Centre Bridge [5] is a java lightweight process, built using the jetty [4] Web Server, that listens and processes events (state, mode, and asset changes) delivered by the Smart Lighting Gateway [5]. The Command Centre Bridge may run in several nodes of the cloud independently of the Smart Lighting Web Application nodes. As seen for the web application, the business logic also resides in the Business Layer.

2.2.3 Smart Lighting Gateway

Similar to the Command Centre Bridge, the Smart Lighting Gateway is also built using the jetty Web Server, and is listening to events from the Smart Lighting System and delivering them to the EDP Systems [5] and the other way around. This process will work outside of the cloud, as this sub-system is the gateway between the EDP Systems and the outside world.

2.2.4 Module Interaction

Every time there is a creation/change on a DTC the EDP Command Centre [5] broadcasts an event with the information of the DTC. When the Smart Lighting Gateway receives an event, it will propagate the information to the Command Centre Bridge and store the timestamp if it is successful in propagating the information.

If the Smart Lighting Gateway is unable to successfully communicate with the Command Centre Bridge, it will keep trying until it gets a response. After getting a response the Smart Lighting Gateway broadcasts an event to the EDP Command Centre asking for DTC's updates since the last stored timestamp.

2.3 Architecture

In this chapter we address the major architectural decisions used through out all the Smart Lighting System.

2.3.1 Loose coupling

Every sub-system [5] is loosely coupled, meaning each sub-system is independent of the definitions of other separate sub-systems. Any sub-system can be replaced by a different implementation, either local or remote, and the system as a whole will still work, as long as the interfaces between them are ensured.

With this approach different developers can work on different sub-systems without interfering with each other.

This loose coupling is also very useful in testing. If we want to test a specific sub-system we do not need the whole system up and running. The supporting sub-systems can be local dummy implementations, saving the developer from the startup time of each sub-system and saving the developer from questions such as “is the remote process running” or “is the remote connection established”.

2.3.2 SOA

For designing and developing the Smart Lighting System we use a Service Oriented Architecture (SOA) [7]. Within this architecture (Figure 4), business functionalities are built as software components providing functionalities as services. Therefore, specific business logic is located in one place, and can be called from different clients who want to use these functionalities.

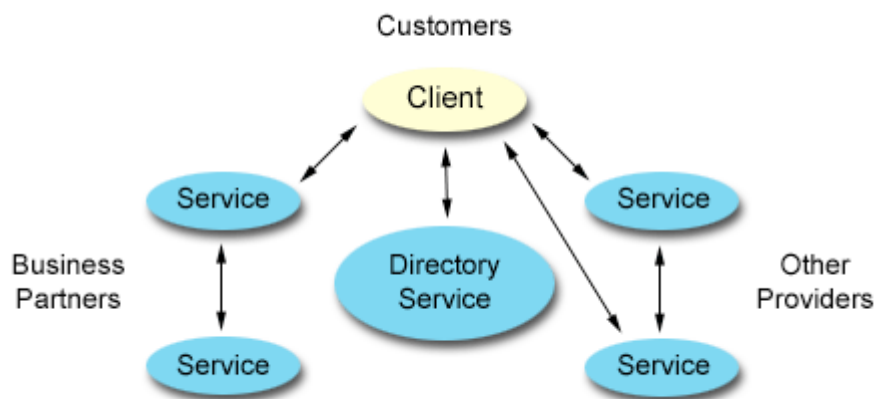


Figure 4: SOA diagram from [7]

Usually these services are connected through an enterprise service bus (ESB), but since our use case is simple, there is no need to use one.

2.3.3 Multi-Tier in the web application

As many java enterprise applications, the Smart Lighting web application is built using a multi-tier architecture [8] (Figure 5). In this architecture each tier has a unique responsibility, is logically separated, loosely coupled from the others, and may be distributed across distinct nodes.

A multi-tier architecture forces a separation of concerns among presentation logic, business logic and database logic. This separation makes it easy to maintain, to manage and to scale.

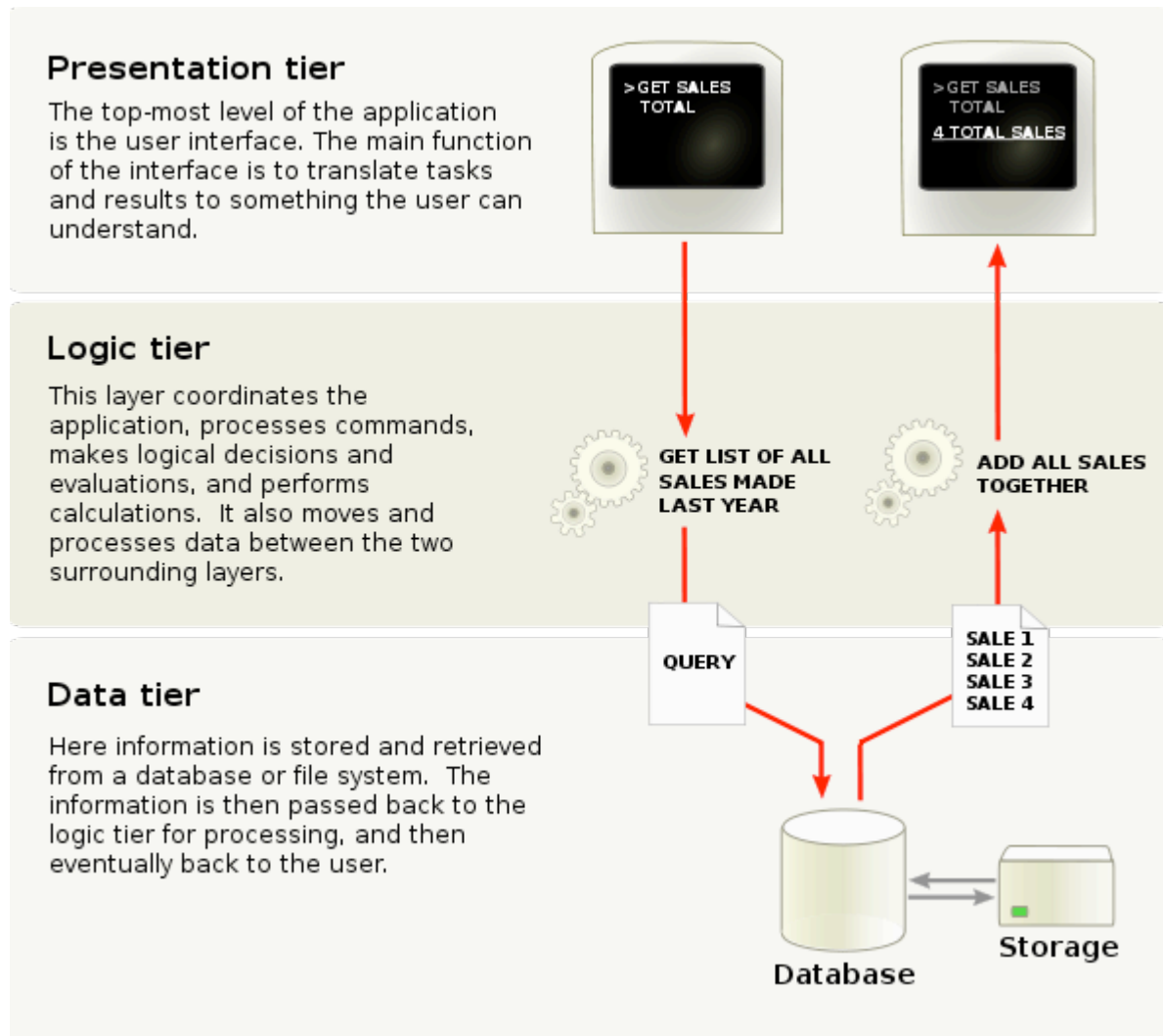


Figure 5: Multitier diagram from [8]

In the next sub sections we describe the tiers used in our implementation.

2.3.3.1 Client Tier

In our implementation this tier is represented by a web browser or a web service client.

2.3.3.2 Presentation Tier

This tier controls the rendering of a page in response to a client request and manages logins and sessions. This tier can also access the business services if needed in the request cycle.

2.3.3.3 Logic Tier

This tier centralizes the business logic and the domain data. The Data tier is accessed through this tier.

2.3.3.4 Data Tier

This tier contains the storage system, such as databases

2.4 Software abstractions

In this chapter we address the major software implementation decisions used through out the development of the Smart Lighting System.

2.4.1 Dependency injection

In order to implement the loose coupling between software layers and sub-systems we use the Dependency Injection (DI) design pattern. In this approach the dependencies between modules are not programmatically defined but through configuration of the container responsible of injecting in each component with its declared dependencies.

2.4.2 Presentation Layer

This layer contains the user interface and follows the Model-view-controller (MVC) pattern. Using this pattern there is a clear separation of concerns between domain logic and user interface, enabling developers and designers to work independently.

The View part of MVC is HTML. Every view has a corresponding controller. One controller has the presentation logic, and has access to services with the business logic that were injected by the web container with the help of the Spring Framework [3].

2.4.3 Business Layer

This layer exposes services that implement the business logic of our application. Whenever a service is called, a transaction is initiated and closed upon service completion. If a service calls another service, the transaction is propagated from one service to the other. If an error occurs, the transaction rollbacks; otherwise, it commits. Transaction demarcation is provided by the Spring Framework [3] in a transparent way to the developer.

In a way similar to the controller, the business services have access to the data layer through Data Access Objects (DAOs) that are injected by the container.

2.4.4 Data Layer

This layer is responsible for persisting and retrieving data, exposing its implementation through DAOs. This is where the persistence technology resides. The persistence engine is of the responsibility of the SMR.

Using an independent layer for accessing the data, we completely isolated the business layer from the implementation of the data access, enabling us to change, if needed, the underlying technology without impacting the business logic. As an example, instead of using JPA [6] to access SQL Databases, we could use a more native syntax, specific to a NoSQL Database and not a single line of business code would change. Of course, one would have to re-implement all the data access logic in the light of the new technology.

2.4.5 Session

The Wicket Framework [10] provides easy access to the web container session and a way of supplying our own implementation. We extended the wicket session object for easy access to the authenticated user.

With the exception of the login page all pages in the Smart Lighting web application are stateful.

2.4.6 Security

Only logged users will be able to access pages from the web application. In addition to authentication, some pages are accessible only to authorized users. To accomplish this, we provide an authorization strategy for Wicket to check each component (including pages) if instantiation and rendering is allowed.

For more information please refer to [11].

2.4.7 Audit

Whenever a login, logout or session timeout occurs, it is written in the audit table. There is no way a user can bypass this behaviour as this belongs to the core of the web application, thus not accessible to any user. In the future, other auditing information will be also registered. For example: new schedule created, removed or modified, etc.

Chapter 3

Cloud environment

Traditionally a software solution such as the Smart Lighting system, would be hosted in the Utility (public service provider for electricity, gas, water, or sewage) datacentre, due to:

- Sensitive functional context
- Required integration with the Utility internal systems
- Tight operational and maintenance control over services
- Most of the required (operational) resources are already in place, except for the hosting server

With these facts in mind, a move to a cloud environment is less a technical decision, but rather an economical, legal and ultimately a political decision (as long it's technically feasible). Within TClouds though, a cloud environment is indeed a technical decision, with the purpose to highlight all trade-offs involved first on a commodity cloud, and at the end to identify the full benefits of adopting TClouds security options.

Moving from an in-house hosted solution to a cloud hosted one, has undoubtedly several benefits.

- Lower deployment investment. No longer required to invest a few K€ to startup, on hardware equipment
- Lower implicit operational and maintenance costs. Though on a regular Utility, there is already at least one large datacenter with required personnel and logistics, their operating and maintenance costs will not explicitly decrease, due to this new service being hosted on the cloud
- Higher scalability. The computational resources may be dynamically leveraged, without any downtime, as the need arises
- Higher reliability. The risk of hardware failures is no longer a concern

But also, some drawbacks.

- Higher security risks. By being hosted in the cloud, it is exposed to all sources of cyber-attacks
- Higher legal concerns. Besides legal restrictions that may or may not apply to host Utility data and services outside the company, or even cross-border, a specific service agreement may also be more difficult to leverage with the provider, given the amount of standard agreements the provider usually employ with the majority of their customers
- Lock-in to cloud provider. Ending the service agreement with the cloud provider, and transfer the service elsewhere, may pose unexpected operational difficulties
- Potentially higher operational costs in the long run. As with any other rental service, and depending on the expected service duration, there is a point in time the accumulated rental cost will eventually get higher than the investment on an in-house solution

TClouds security solutions will expectedly increase cloud environment benefits by mitigating some of their drawbacks.

- Higher security. Through data encryption, and restrictions applied to the provider management actions
- Higher resilience, and availability, besides no lock-in to cloud provider. The solution may be hosted dispersedly across different cloud providers, with TClouds cloud-of-clouds solution

Still, some shortcomings may also be found.

- Lack of data modeling flexibility. TClouds SMR [9], restricts the ability to define relational constraints, normalize data, specify joins between data sources, and ultimately apply business intelligence functions directly to the relational engine
- Potentially higher operational costs. Increased benefits may have its own costs, since several service agreements would have to be conducted with different cloud providers
- Potentially higher maintenance complexity. There is always some degree of maintenance that relies on the customer, therefore dealing with several different cloud providers, in order to sustain a single solution, will undoubtedly entail more maintenance (and even legal) difficulties, than dealing with a single provider
- Unknown performance levels. At this stage, it is an uncertainty about performance levels, when TClouds security solutions are adopted

Chapter 4

User manual

In this chapter we describe the main functionalities of the Smart Lighting application from a user perspective.

The main goal of this application is the remote configuration of the DTC's public lighting services.

First is given a general description of the application and next is presented the graphical interface.

4.1 General Description

To define the behaviour of public lighting services, configuration schedules are created. These schedules are a set of periods. Periods are pairs of turn on and turn off points in time, applied to a range of days. A public lighting service under a period configuration will turn on and turn off every day at the time defined by the period.

For bulk configuration of DTC's, the application allows the creation of configuration profiles for a set of DTC's. These profiles have a base schedule and a set of DTC's. We can also specify the services these profiles apply to.

Schedules can be of three types: Base, Specific and Special.

A Base schedule is a schedule that is associated to a Profile or DTC. The schedule defined for a particular service is called Specific schedule and it has precedence over the Base scheduler. It is possible to define behaviour exceptions for some services in certain days. These exceptions are called Special Days and the resulting schedules are called Special schedules and they prevail over the other two. Special schedules can also be defined at the DTC level.

For the Base and Special schedules there is a configuration hierarchy. When one of these schedules is applied to a Profile, all of the associated DTC's will inherit the applied schedule, if they do not have one already.

It is possible to retrieve or update some configurations of the physical DTC, namely:

- Turn on or off a Service;
- Change the Service mode;
- Retrieve a Schedule;
- Retrieve the DTC physical location in a map, through its GPS coordinates;
- IP address;

Changes to the configuration of the Service mode and state are updated synchronously. All remainder configurations are updated in a background process. The progress of this operation can be observed accessing the menu option "reports > synchronization". If the process does not complete, it can be restarted by clicking the "synchronize DTCs" button, in the previous menu option.

Application users can have one of three access levels: Administrator, Operator or Client. The options available to a user depend on his type.

4.2 Graphical Interface

4.2.1 Login

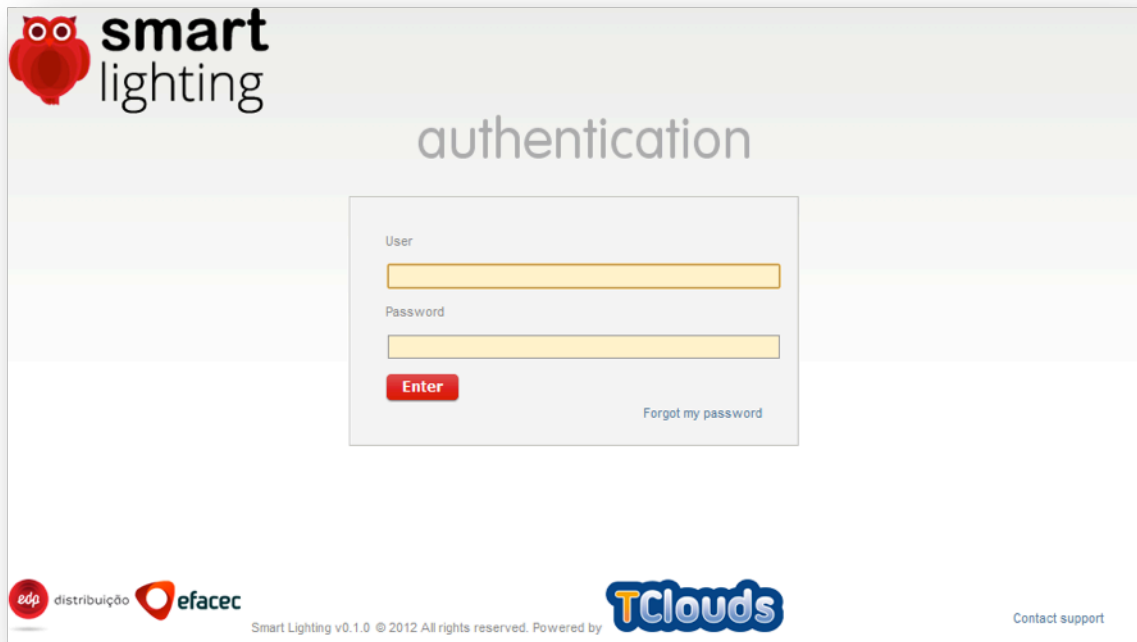


Figure 6: Login

Figure 6 shows the login screen where the user puts its credentials to access the application.

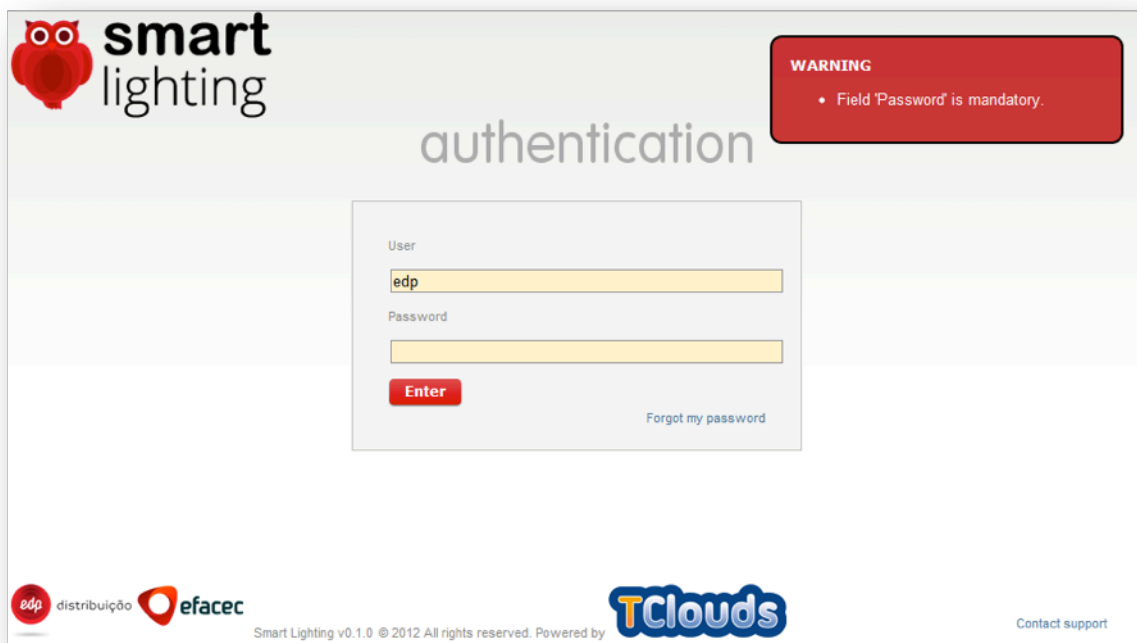


Figure 7: Access Denied

Figure 7 demonstrates what happens when a user uses invalid credentials.

There is a limit for consecutive failed attempts to login. If a user exceeds that limit, it will be locked, and only an administrator user can unlock it, through the menu option “administration > users”.

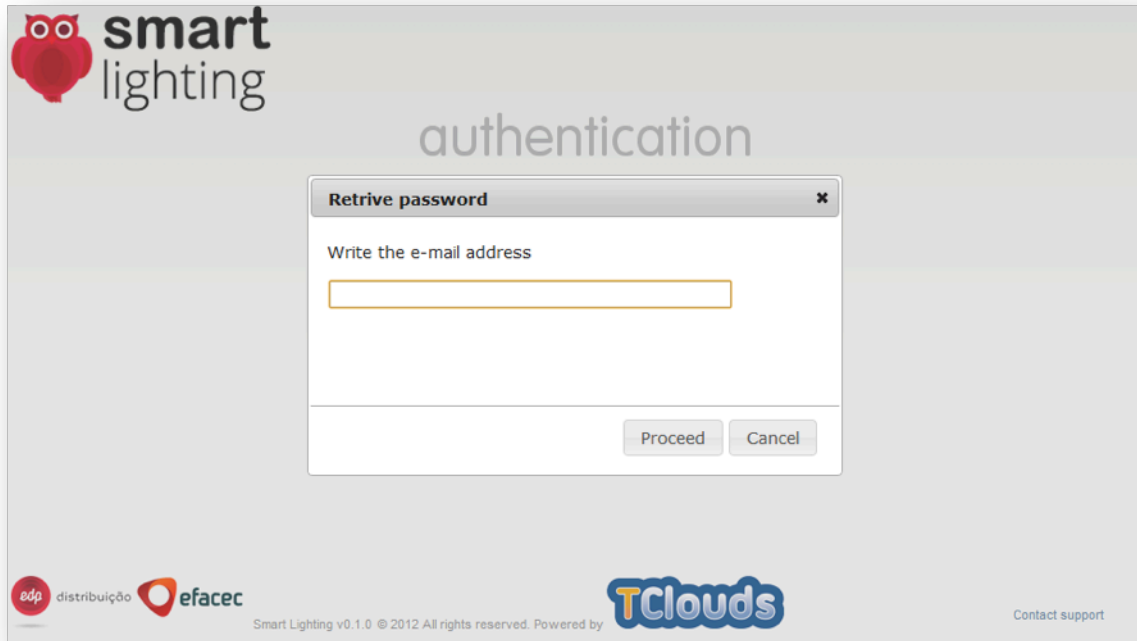


Figure 8: Password Retrieval

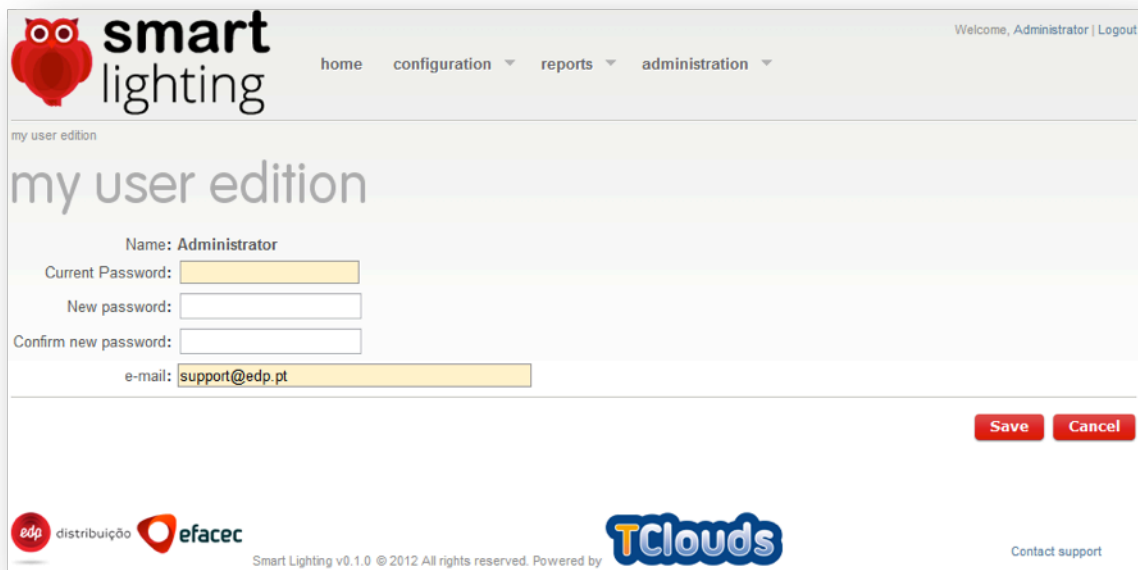
If a user forgets its password a new one can be requested by clicking in the link “Forgot my password” at the lower right corner of the login form. A window, like the one in Figure 8, will popup asking for an e-mail address and if it is a recognized address by the application, a new password will be sent to the supplied e-mail.

When an administrator user enters the application, it has access to the following menus:

- home
- configuration
- reports
- administration

The user can end its session by clicking in the link “logout” in the upper right corner.

The user can change its password and e-mail by clicking in the link with its name, also in the upper right corner. The user will navigate to a page demonstrated by Figure 9.



smart lighting

Welcome, Administrator | Logout

home configuration reports administration

my user edition

my user edition

Name: Administrator

Current Password:

New password:

Confirm new password:

e-mail: support@edp.pt

Save Cancel

edp distribuição efacec

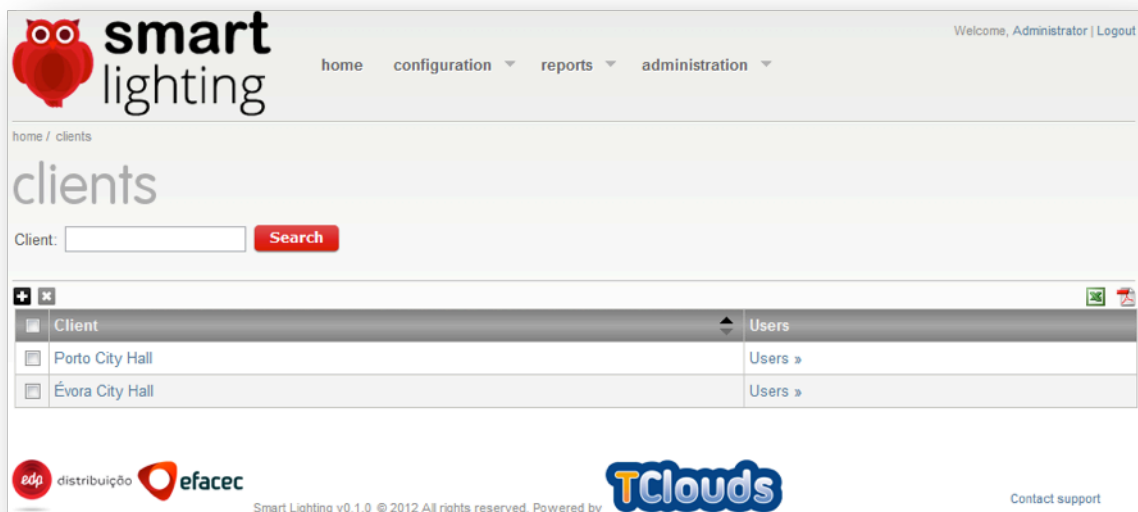
Smart Lighting v0.1.0 © 2012 All rights reserved. Powered by TClouds

Contact support

Figure 9: Application User

4.2.2 Home

When an administrator user logs in, the first screen presented to him, is a listing of all the Clients registered in the application. If the user is not an administrator, he will see a list of profiles that he has access to, as demonstrated by Figure 10.



smart lighting

Welcome, Administrator | Logout

home configuration reports administration

home / clients

clients

Client: Search


Client	Users
Porto City Hall	Users »
Évora City Hall	Users »

edp distribuição efacec

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Contact support

Figure 10: Clients

The administrator can add a new Client by clicking in the  icon. A dialog, demonstrated by Figure 11, will popup asking for a name of the new Client as seen in the next figure.

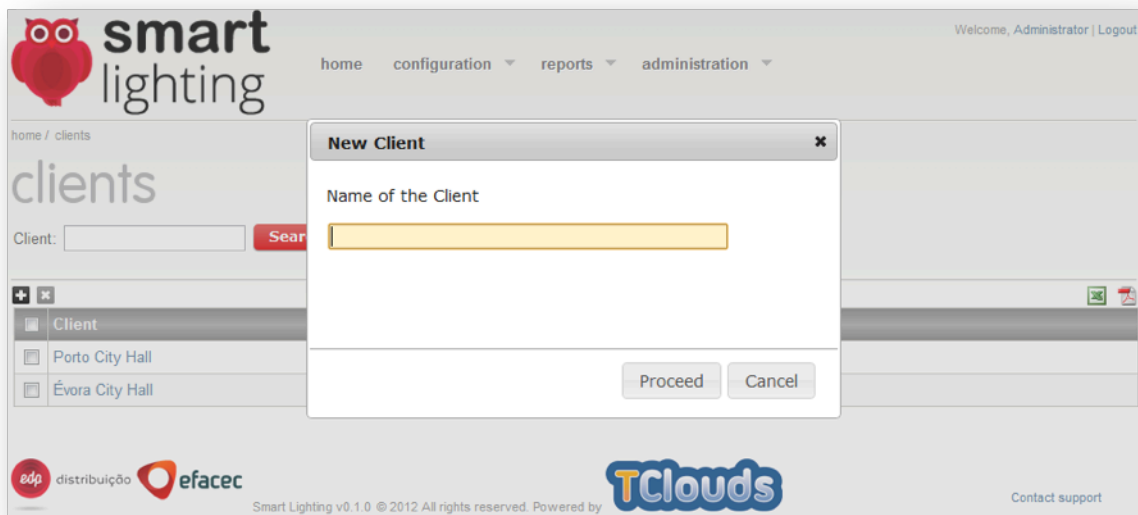



Figure 11: New Client

To remove a client, the administrator checks the desired client or clients, and click on the  icon. A confirmation dialog, like the one in Figure 12, will show up.

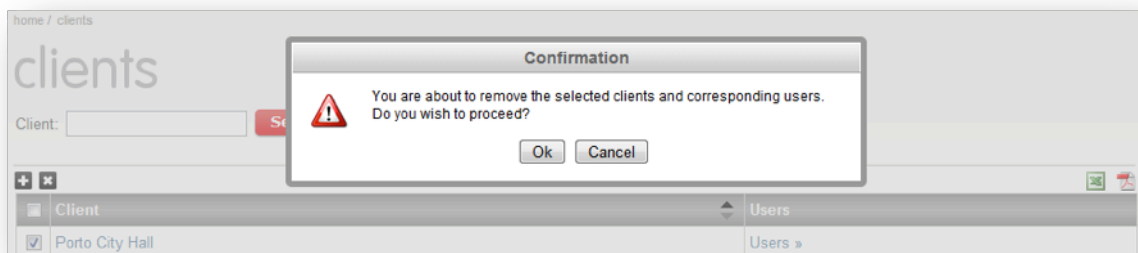


Figure 12: Remove Client

The administrator can change the name of a previously created Client. For that he has to click in the link with the name of the Client. The detail of the Client will show along with the list of associated DTC's, as demonstrated by Figure 13..

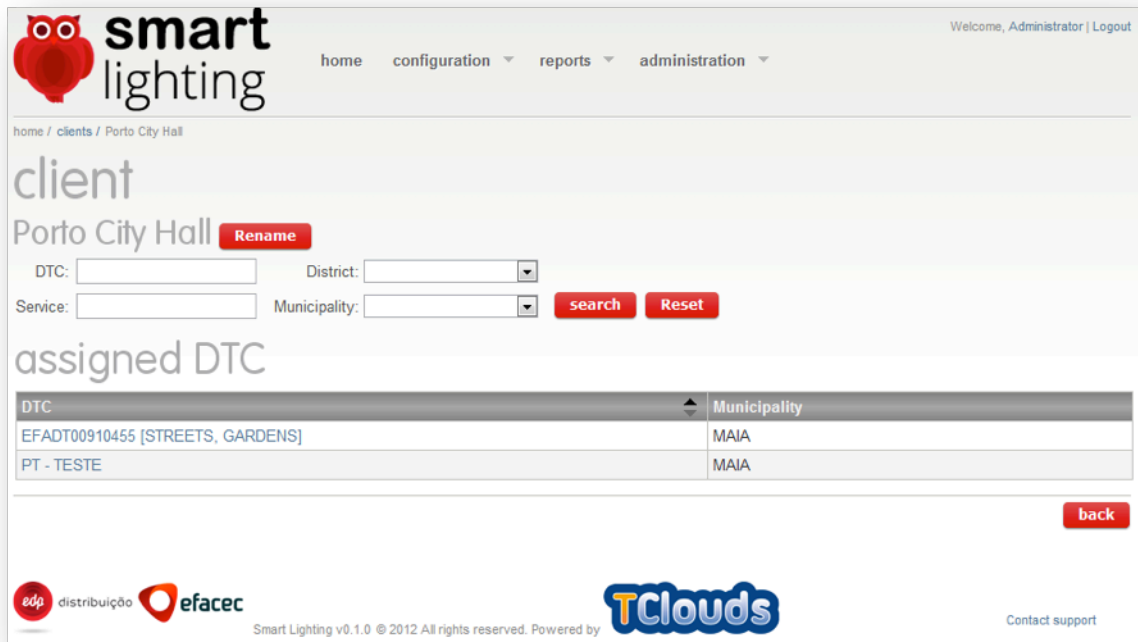


Figure 13: Client Detail

Clicking the button “Rename” a dialog will show up, enabling the user to change the name of the Client as seen in the next figure.

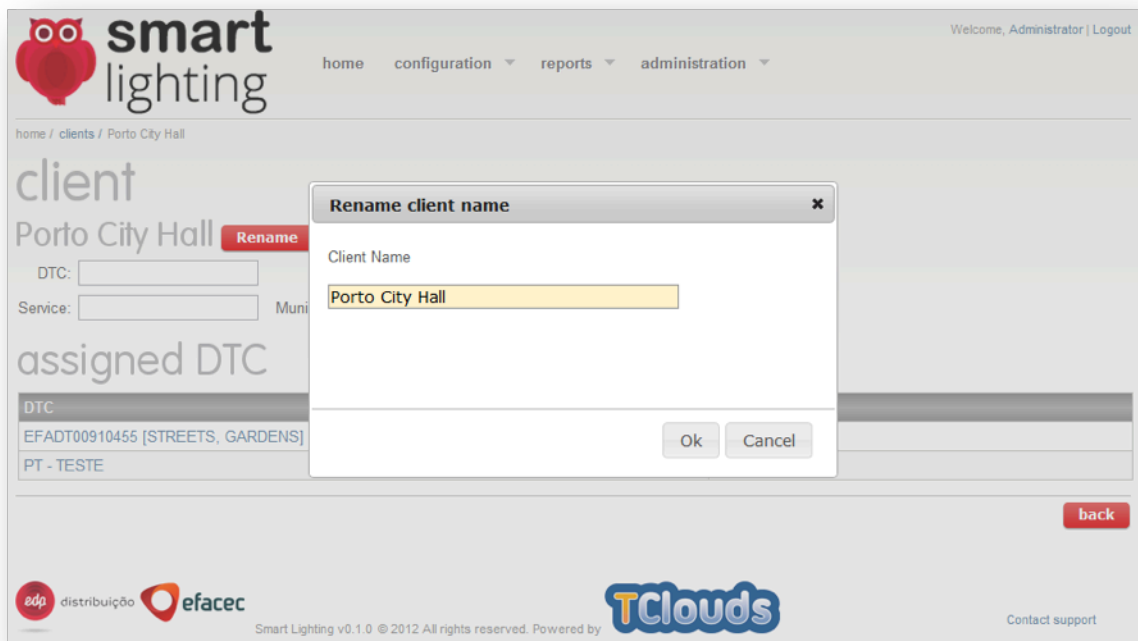


Figure 14: Rename Client

Clicking the link “Users »” of page Clients (Figure 10) the user is redirected to a page listing all the users of that Client, as shown in Figure 15.

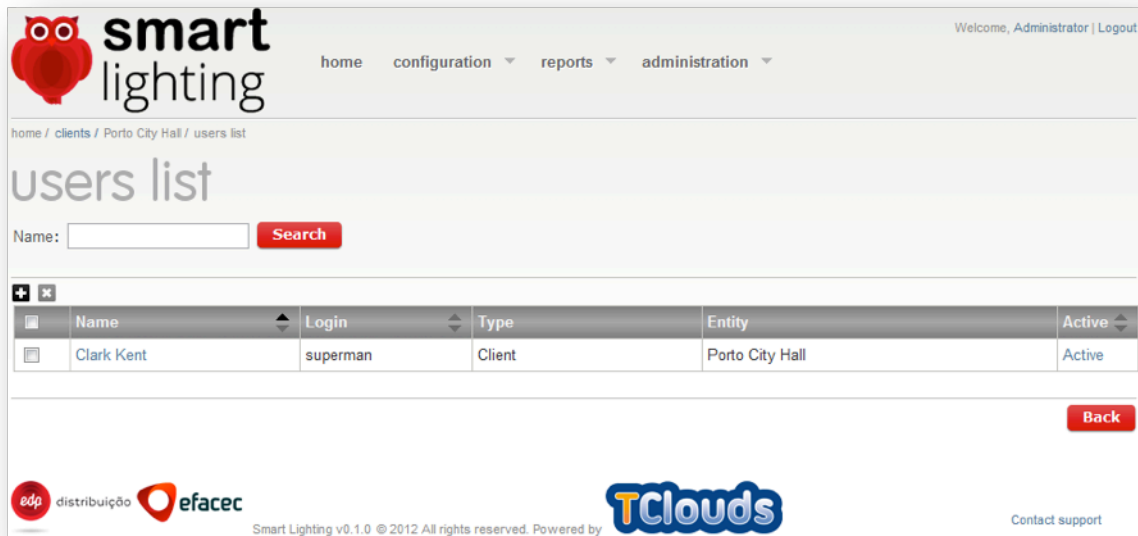


Figure 15: User List

In this page the administrator can add a new user (+), remove a selected user (x), block or activate a user or navigate to the user detail page (Figure 16) by clicking the link with the user name.

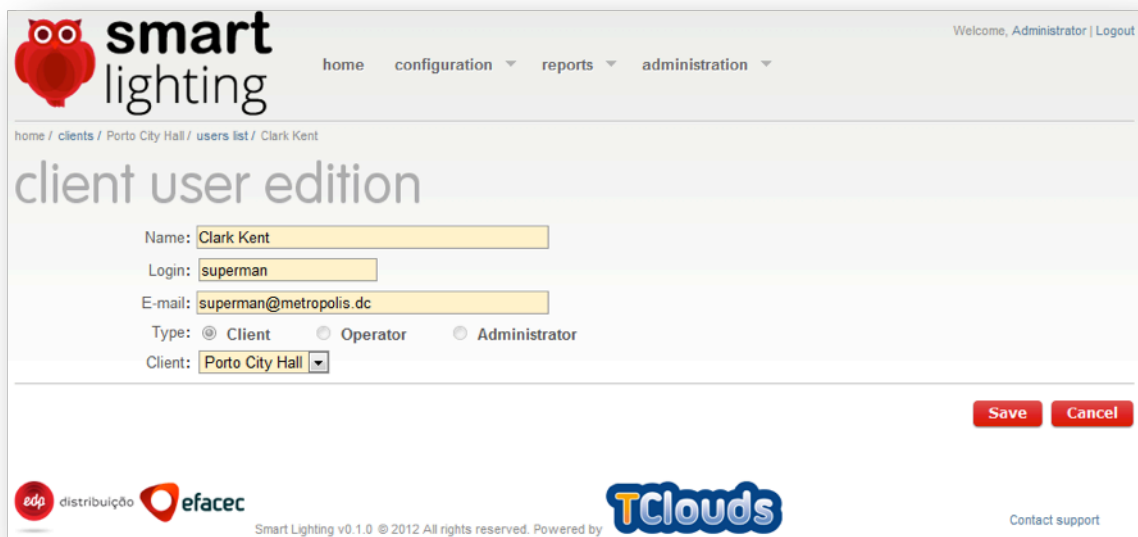


Figure 16: User Detail

4.2.3 Configuration

In the configuration menu (Figure 17), the user has access to several options, all related to the public lighting configuration:

- Profiles – a list of profiles according to the user’s access level

- Schedules – a list of schedules
- Special days – a list of special days
- Clients – managing DTC's of a client

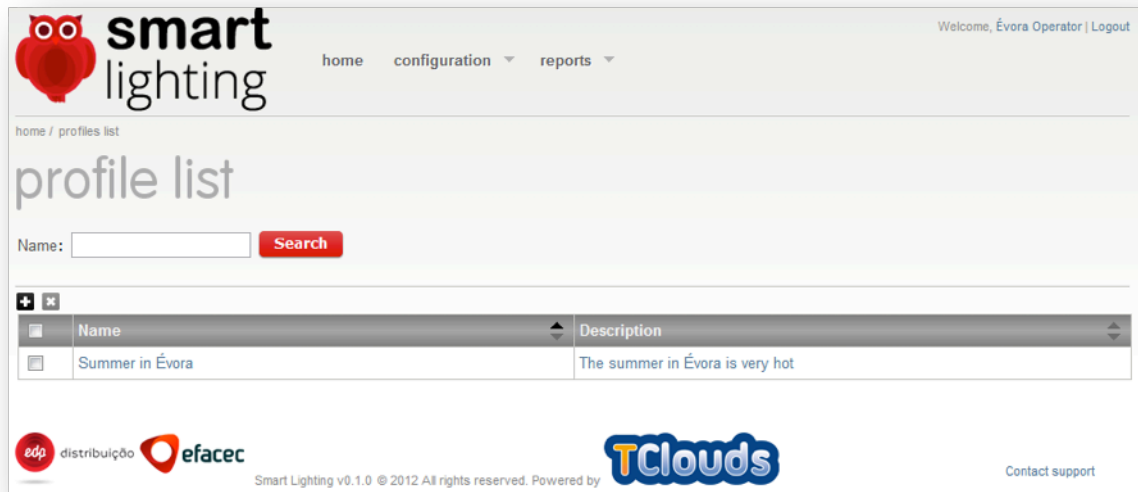
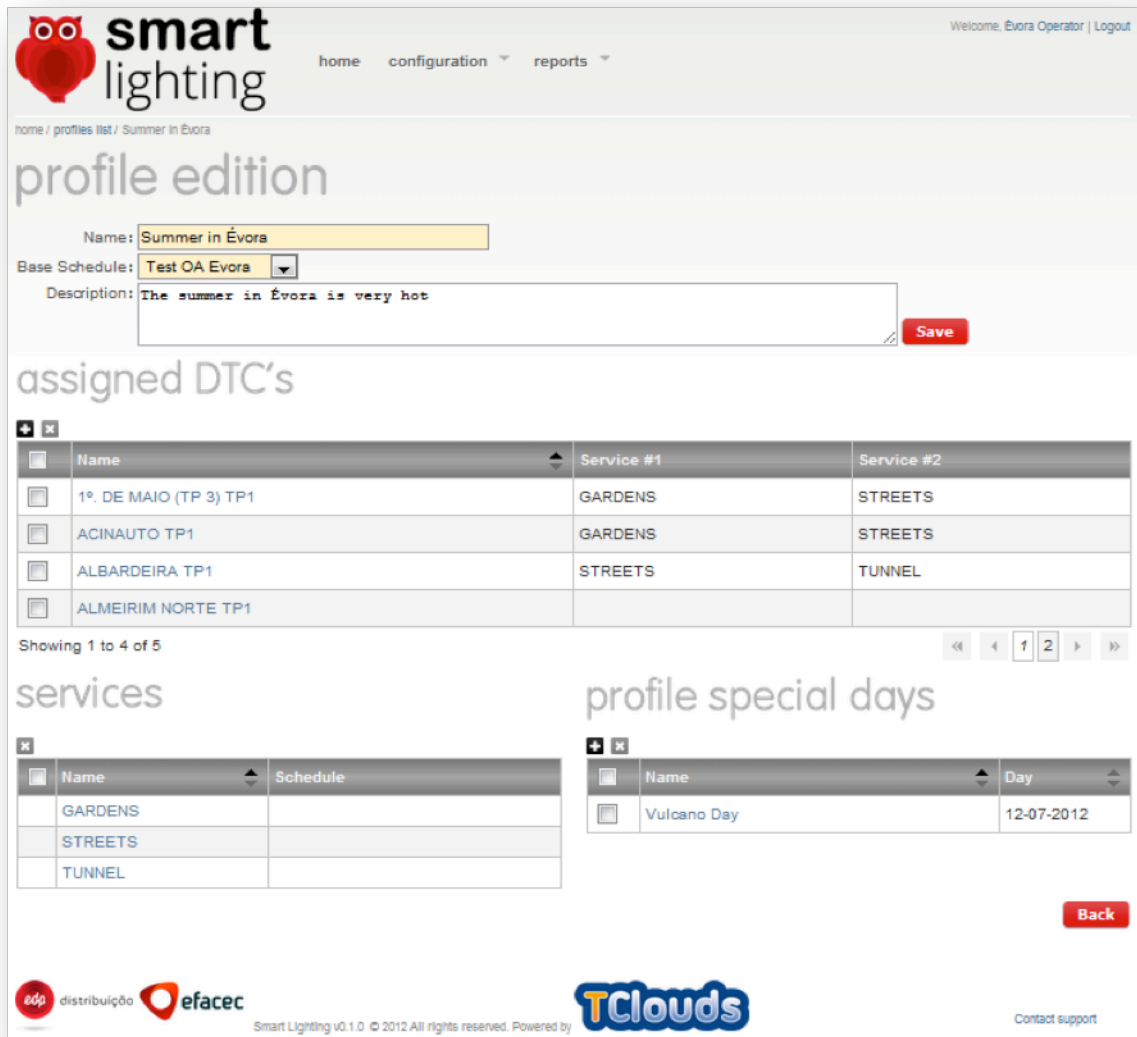


Figure 17: Configuration Menu

4.2.3.1 Profiles

By clicking the link with the name of the profile we navigate to the detail page of the profile (Figure 18). This page is the same for the creation of a profile, with the exception that all fields would be empty.

In this page we see the full configuration of the profile, including assigned DTC's, Services and special days, which we can add or remove from the profile, if we are logged in as an Operator user.



smart lighting

Welcome, Évora Operator | Logout

home configuration reports

home / profiles list / Summer in Évora

profile edition

Name: Summer in Évora

Base Schedule: Test OA Évora

Description: The summer in Évora is very hot

Save

assigned DTC's

Name	Service #1	Service #2
1º. DE MAIO (TP 3) TP1	GARDENS	STREETS
ACINAUTO TP1	GARDENS	STREETS
ALBARDEIRA TP1	STREETS	TUNNEL
ALMEIRIM NORTE TP1		

Showing 1 to 4 of 5

services

Name	Schedule
GARDENS	
STREETS	
TUNNEL	

profile special days

Name	Day
Vulcano Day	12-07-2012



Back



edp distribuição efacec

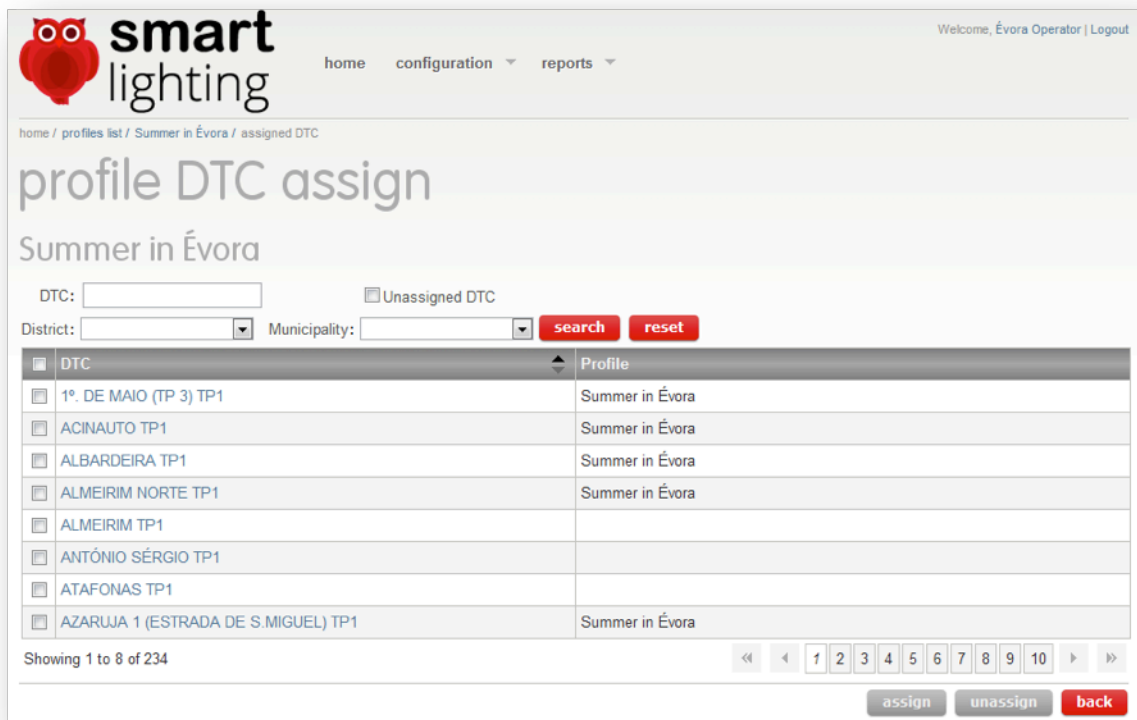
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Contact support

Figure 18: Profile Detail

By clicking the  or the  icon the user can remove or delete an item from the corresponding list.

By clicking the  icon in the assigned DTC's list the user can unassign, after confirmation, the selected DTC's from the Profile. By clicking the  icon the user navigates to the DTC's assignment page as shown in the next Figure.



The screenshot shows the 'smart lighting' web interface. The header includes the logo, navigation links (home, configuration, reports), and a user greeting 'Welcome, Évora Operator | Logout'. The main content area is titled 'profile DTC assign' and 'Summer in Évora'. It features a search form with fields for 'DTC:', 'District:', and 'Municipality:', along with 'search' and 'reset' buttons. Below the form is a table with two columns: 'DTC' and 'Profile'. The table lists several DTC services, with the first one, '1º. DE MAIO (TP 3) TP1', assigned to the 'Summer in Évora' profile. At the bottom, there are 'assign', 'unassign', and 'back' buttons.

DTC	Profile
<input type="checkbox"/> 1º. DE MAIO (TP 3) TP1	Summer in Évora
<input type="checkbox"/> ACINAUTO TP1	Summer in Évora
<input type="checkbox"/> ALBARDEIRA TP1	Summer in Évora
<input type="checkbox"/> ALMEIRIM NORTE TP1	Summer in Évora
<input type="checkbox"/> ALMEIRIM TP1	
<input type="checkbox"/> ANTÓNIO SÉRGIO TP1	
<input type="checkbox"/> ATAFONAS TP1	
<input type="checkbox"/> AZARUJA 1 (ESTRADA DE S.MIGUEL) TP1	Summer in Évora

Figure 19: DTC assign

4.2.3.1.1 DTC

In Figure 19 the user can access the DTC detail page, by clicking the link with the DTC name. Since the list of DTC services is generated with information from the physical DTC in real-time, and to avoid the page to hang while communicating with the DTC, this list is loaded asynchronously as seen in the next Figure 20.

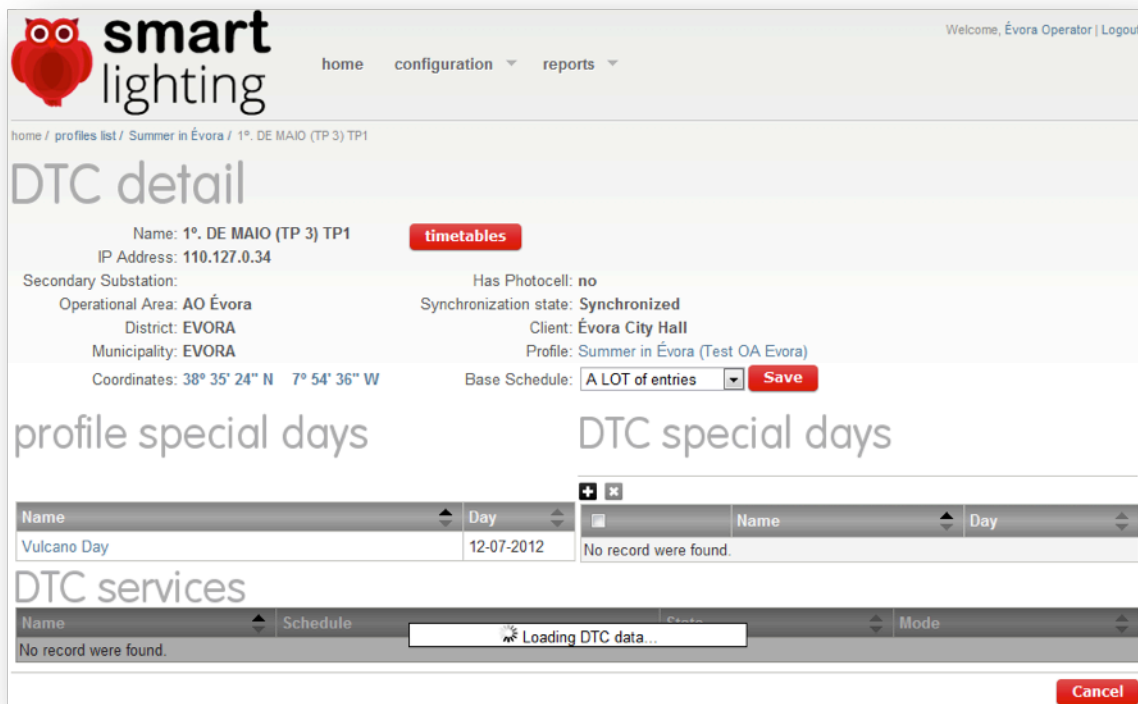


Figure 20: DTC detail loading service information

When the list is loaded, it will show as seen in Figure 21:

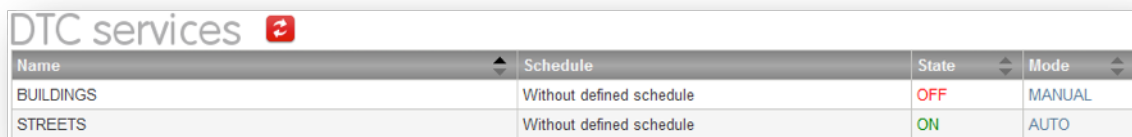


Figure 21: DTC detail with service information loaded

Here the user can add (+) or remove (x) DTC special days, in the same way that is done for the profile.

The user can change the state and the mode of the Services with immediate effect in the physical DTC. It can also change the Base Schedule of this DTC.

The user can see the location of the DTC in the Google Maps web application using the link with GPS coordinates.

When the user clicks in the button “timetables”, the application asks the physical DTC for its schedules and displays the aggregated information as shown in the next Figure.

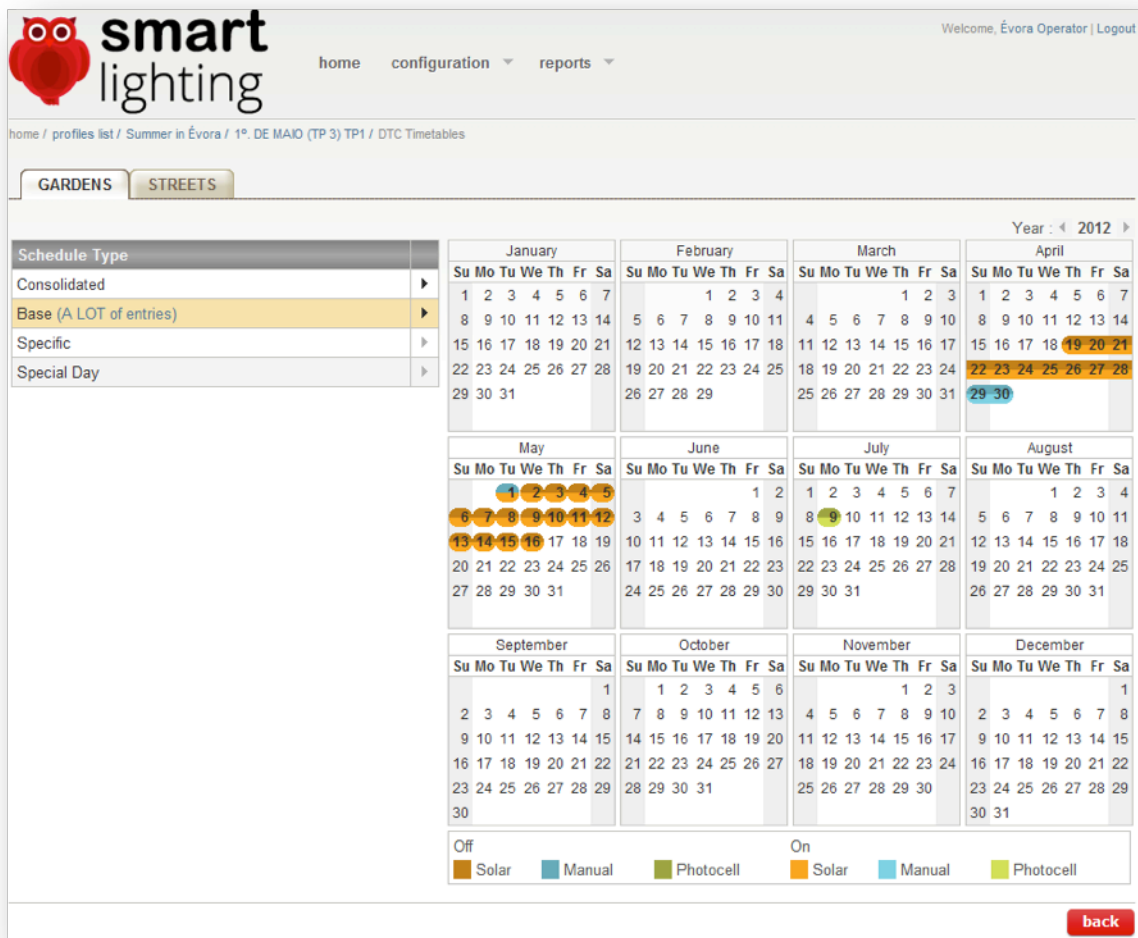


Figure 22: DTC public lighting parameters

This page displays the parameters defined in the DTC for each Service. The annual calendar shows the actual definitions of the DTC for the selected timetable on the left. If there is a schedule configuration associated with the listed DTC timetables, that schedule is presented next to the timetable between parentheses, allowing the user to navigate to the detail of that configuration.

4.2.3.1.2 Services

Clicking in the name of a Service in the Profile detail the user navigates to a page where he can configure the schedule to be used with that Service as shown in the next Figure.

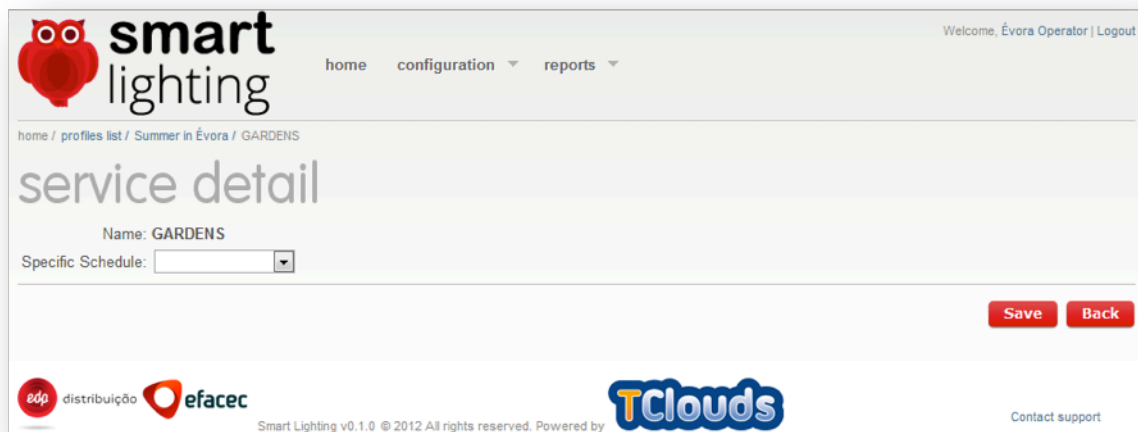


Figure 23: Service detail

4.2.3.2 Schedules

When the user selects the menu option Schedules a list is presented with all the schedules that the user has permissions to access, as shown in Figure 24.

The user can create (+), copy (📄), remove (✖) and edit when in this page. Clicking the icon ▶ the detail of the schedule is presented in the annual calendar. When selecting a Schedule the copy icon 📄 or the remove icon ✖ becomes active depending on the type of selected Schedules.

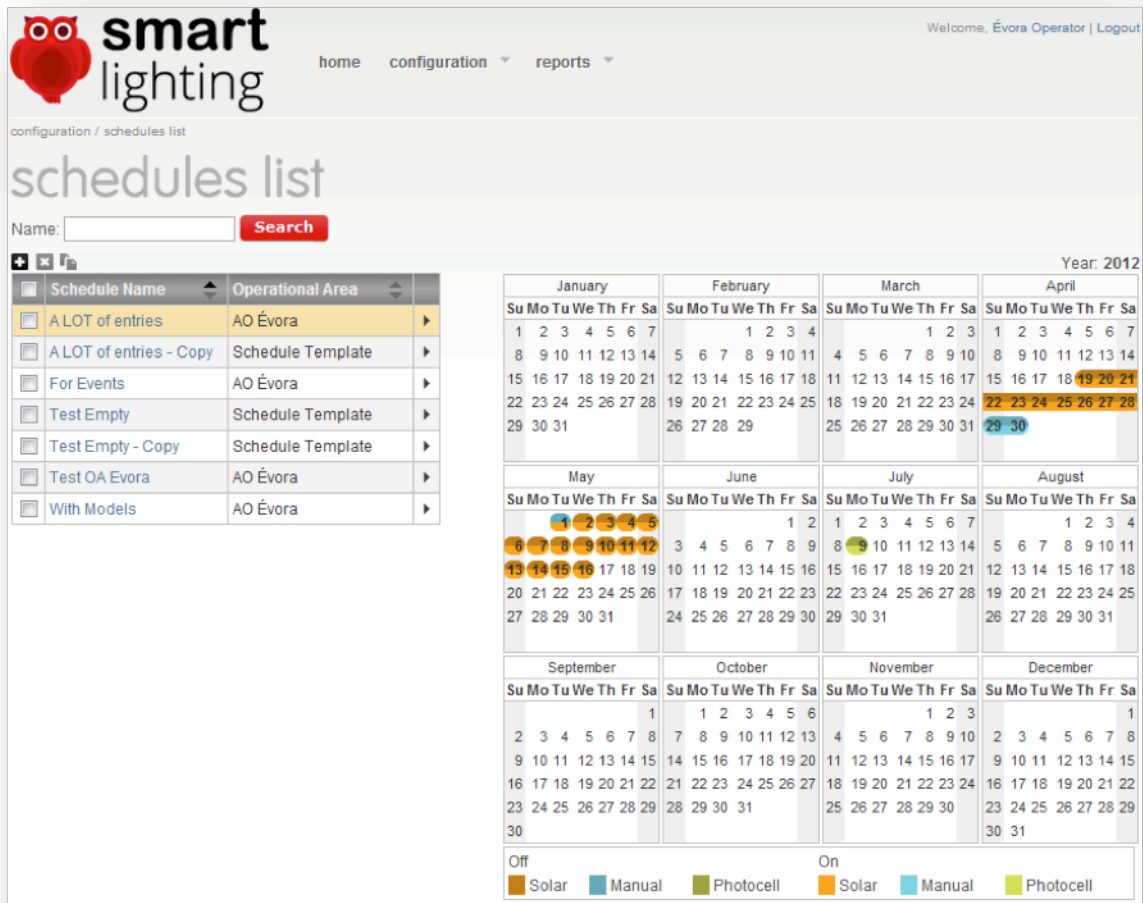


Figure 24: Schedule list

If a user tries to remove one or more schedules a confirmation dialog will show up, as shown in Figure 25.

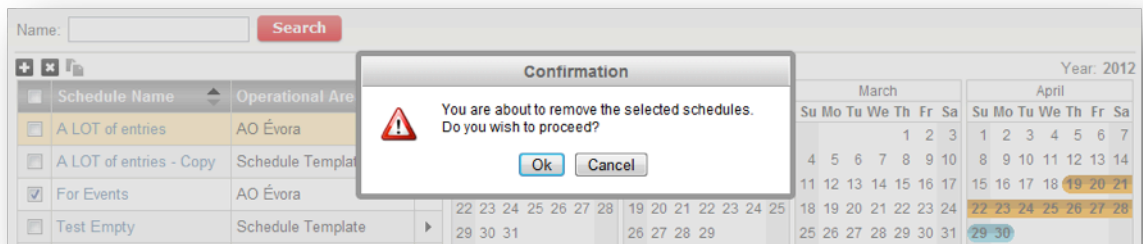



Figure 25: Confirmation dialog

Administrator users can only remove template schedules and operator users can only remove schedules belonging to its operational area. Schedules created by an administrator user are templates, and the ones created by an operator user are Operational Area schedules.

If the operator user selects one template schedule (and only one) the copy icon will activate. When clicked, a copy of the selected schedule will be created and the page with the schedule detail is presented, as seen in the next Figure. The default name for the new schedule is the name of the template appended with “ - Copy”. The user can change the name of the new schedule.

The same page, Figure 26, is presented when adding a new Schedule, by clicking the icon , or when editing an existing one, by clicking the link with the schedule name.

Start	End	Controls
19-04-2012		Solar / Solar
24-04-2012	28-04-2012	Cell / Cell

Figure 26: Schedule detail

The table on the left shows all the periods for this schedule. Each period has a start date and an end date. The turn on and turn off configurations are applied to each day between this two dates (that can be equal when referring to one day).

There are three configuration modes for the turn on and turn off:

- Solar – the DTC computes its turn on and turn off time, based on the date and its GPS coordinate. It is possible to add an offset time between -60 and 60 minutes.

- Manual – the user inputs the exact time for turn on and turn off
- Photocell – the DTC uses its photovoltaic cells to control the turn of and turn off.

Clicking in the link with the start date of a period a popup dialog will show up with the details of the selected period, enabling the user to edit the period, as seen in the next Figure.

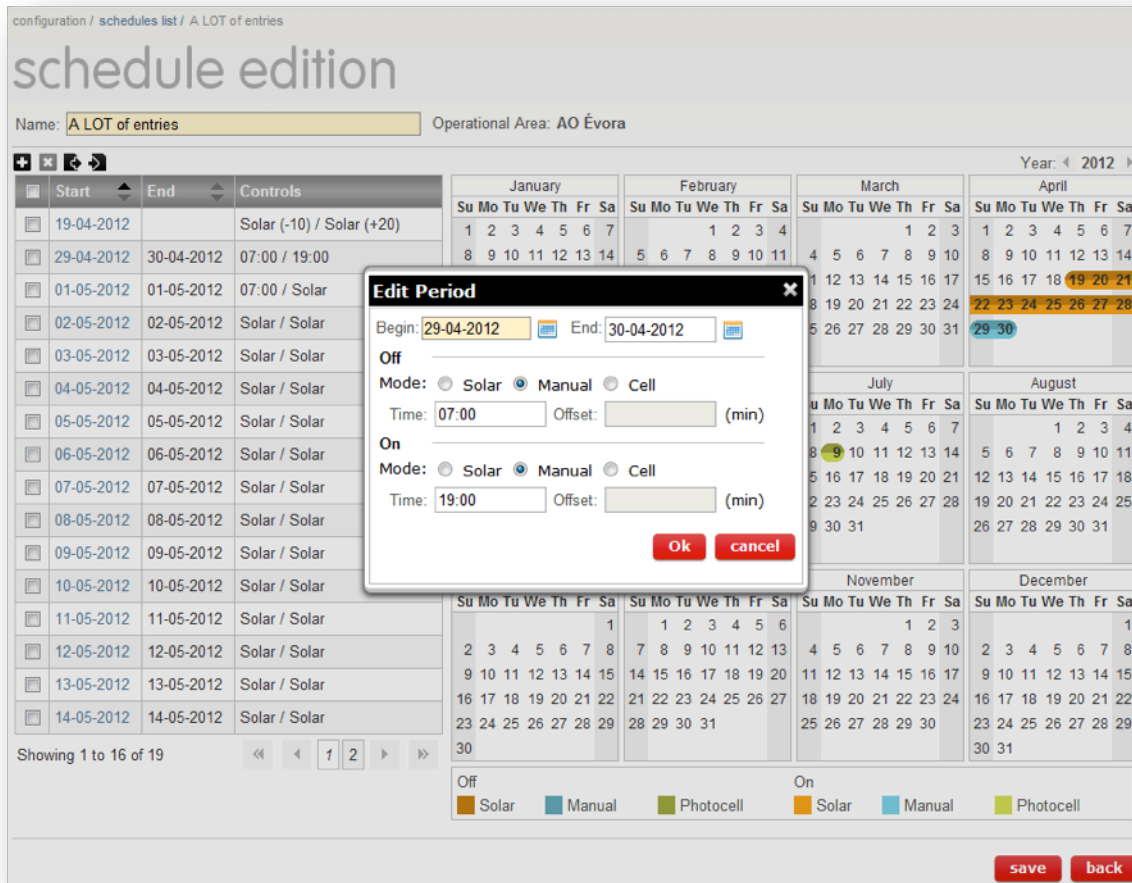


Figure 27: Period edit

Clicking the icon the user can add a new period to the schedule. A similar dialog popup as the one shown for editing the periods, will appear.

There is also the possibility to export () or import () periods to or from a csv file. The file format is included as comments in a exported file.

4.2.3.3 Special Days

A special day enables an exceptional configuration for one day. For one special day, it is possible to configure one or more services, with distinct configurations.

Choosing the menu option “configuration > special days” the user navigates to the list of special days, as seen in the next Figure. In this listing it is only possible to remove special days. To add special days the user has to access the editing pages for Profiles or DTCs.

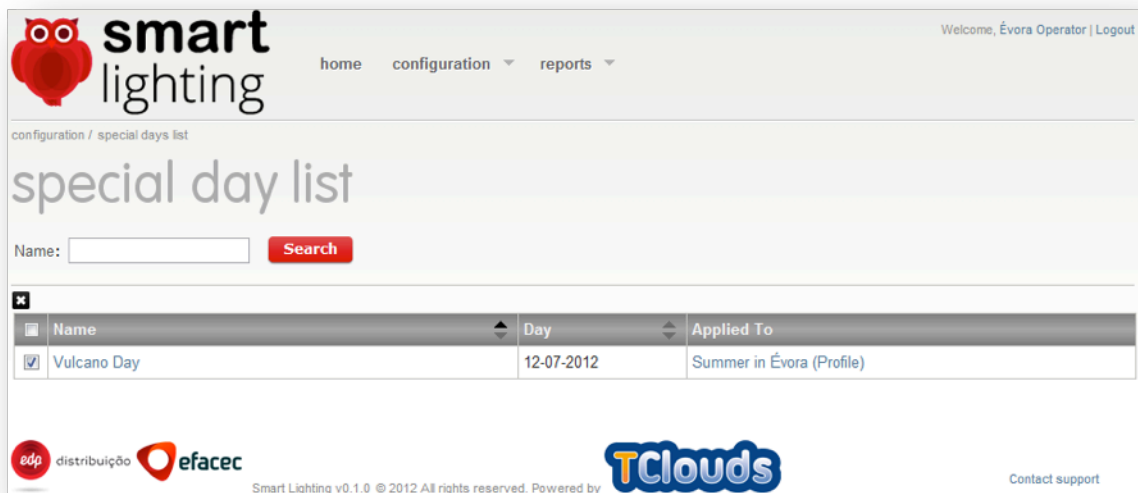


Figure 28: Special days list

Clicking the link with the name of the special day the user navigates to the page with the special day detail (Figure 29).

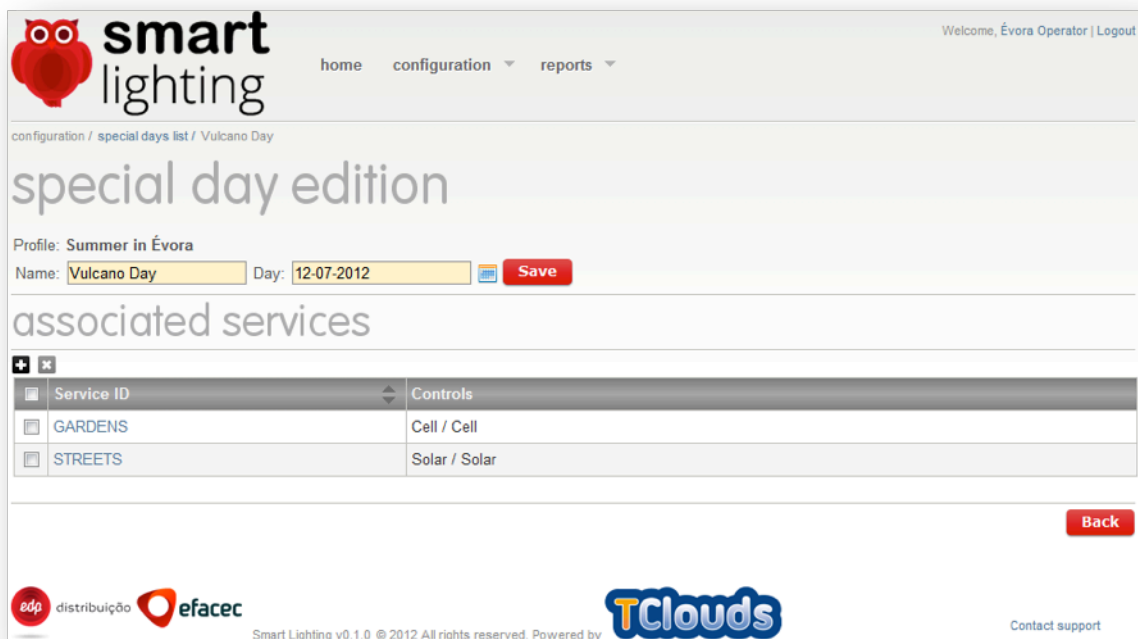



Figure 29: Special day detail

When creating a new special day, it's only possible to add associated services after saving. To associate a service to the special day, the user has to click the icon . A dialog will show up (as seen in the next Figure) enabling the user to select the service and the turn on and turn off configuration.

In this context, only one configuration per service is possible, so if a previous configuration for a service exists, it will be overwritten.

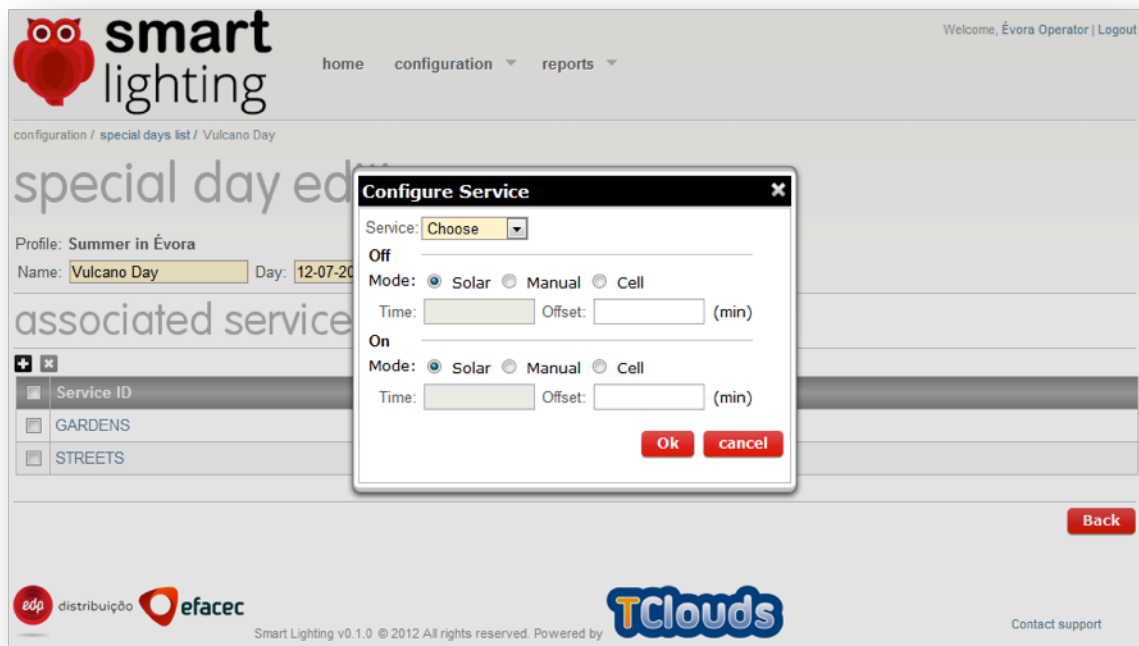


Figure 30: Special day service configuration

4.2.3.4 Clients

Choosing the menu option “configuration > clients” the user navigates to the list of clients, as seen in the next Figure.

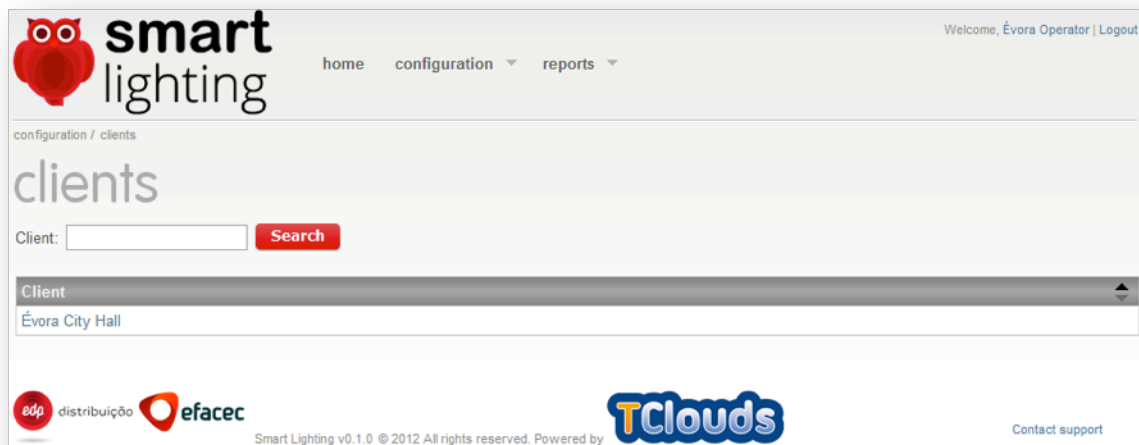


Figure 31: Special day service configuration

Clicking the link with the client name the user navigates to the page shown in Figure 13.

4.2.4 Reports


The Smart Lighting application has a set of listings that enables us to get a general overview of the state of public lighting, and generate Excel or PDF reports from them.

Each listing has a set of filters to narrow the search results.

The input text filters, like DTC or Service, enables the search for case insensitive text over the corresponding column. In those fields the “%” wildcard can be used for matching zero or more characters.

The Municipality filter has a dependency on the District filter. The shown values for the Municipality depend on the selected District.

The other filters are straightforward.

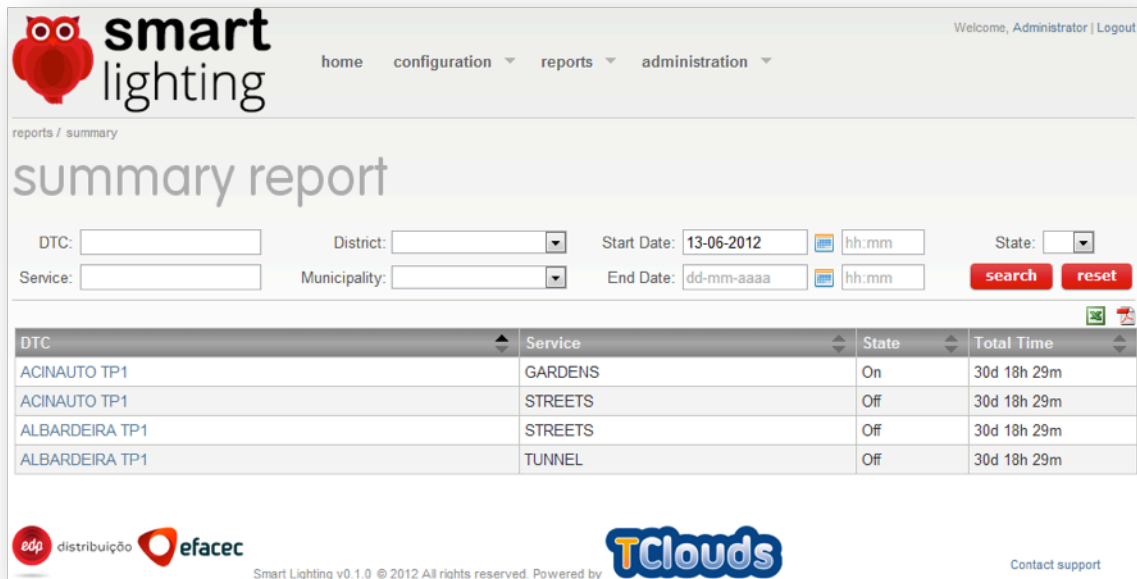
The search results can be ordered by clicking the columns that have the icon .

The search result values under the DTC column are links that allows us to navigate to the detail page of the corresponding DTC.

4.2.4.1 Summary report

This report, demonstrated by Figure 32, shows the amount of time that each service from each DTC was in a state (on/off).

A start date is mandatory and the end date when left blank, the current date is assumed.



The screenshot shows the 'summary report' page in the Smart Lighting application. The page has a header with the 'smart lighting' logo and navigation links: home, configuration, reports, and administration. Below the header, there are search filters for DTC, Service, District, Municipality, Start Date (13-06-2012), End Date (dd-mm-aaaa), and State. There are 'search' and 'reset' buttons. The main content is a table with the following data:

DTC	Service	State	Total Time
ACINAUTO TP1	GARDENS	On	30d 18h 29m
ACINAUTO TP1	STREETS	Off	30d 18h 29m
ALBARDEIRA TP1	STREETS	Off	30d 18h 29m
ALBARDEIRA TP1	TUNNEL	Off	30d 18h 29m

The footer of the page includes logos for 'edp distribuição' and 'efacec', the text 'Smart Lighting v0.1.0 © 2012 All rights reserved. Powered by TClouds', and a 'Contact support' link.

Figure 32: Summary report

4.2.4.2 State report

This report, demonstrated by Figure 33, shows the current state and the date of the last change of the public lighting for each service of each DTC.

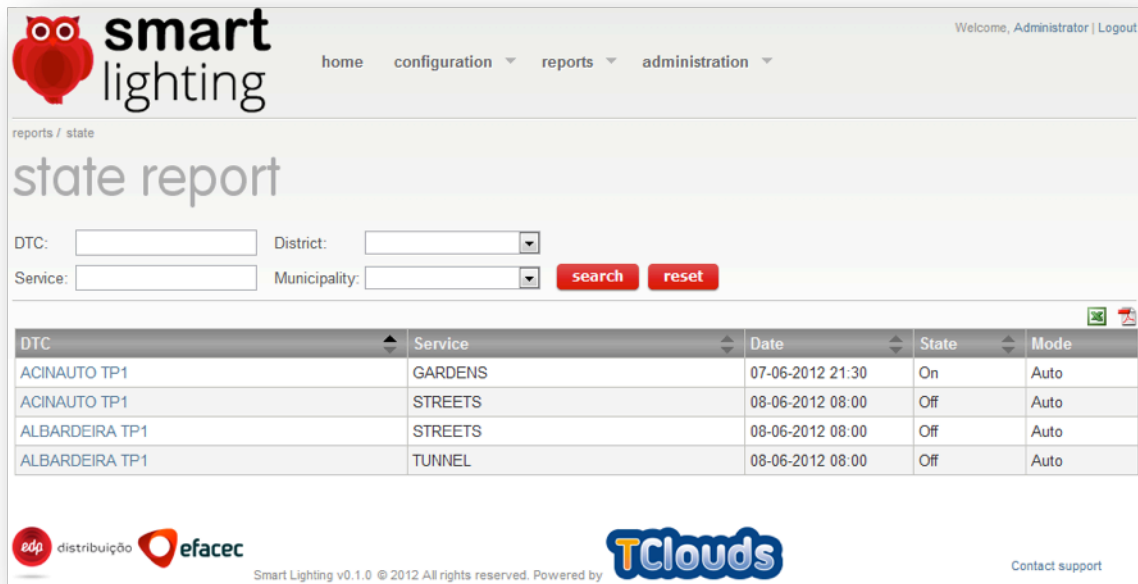


Figure 33: State report

4.2.4.3 Transitions report

This report, demonstrated by Figure 34, shows the date and actual value of each state transition for each Client, DTC, Service and Profile.

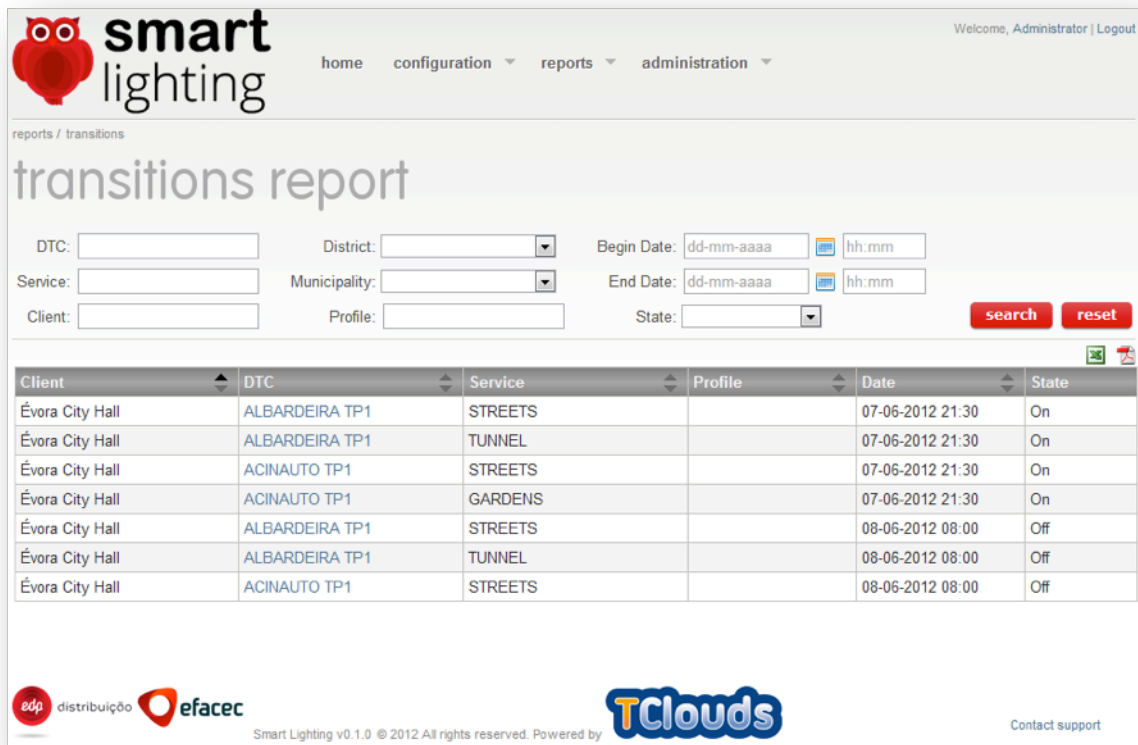
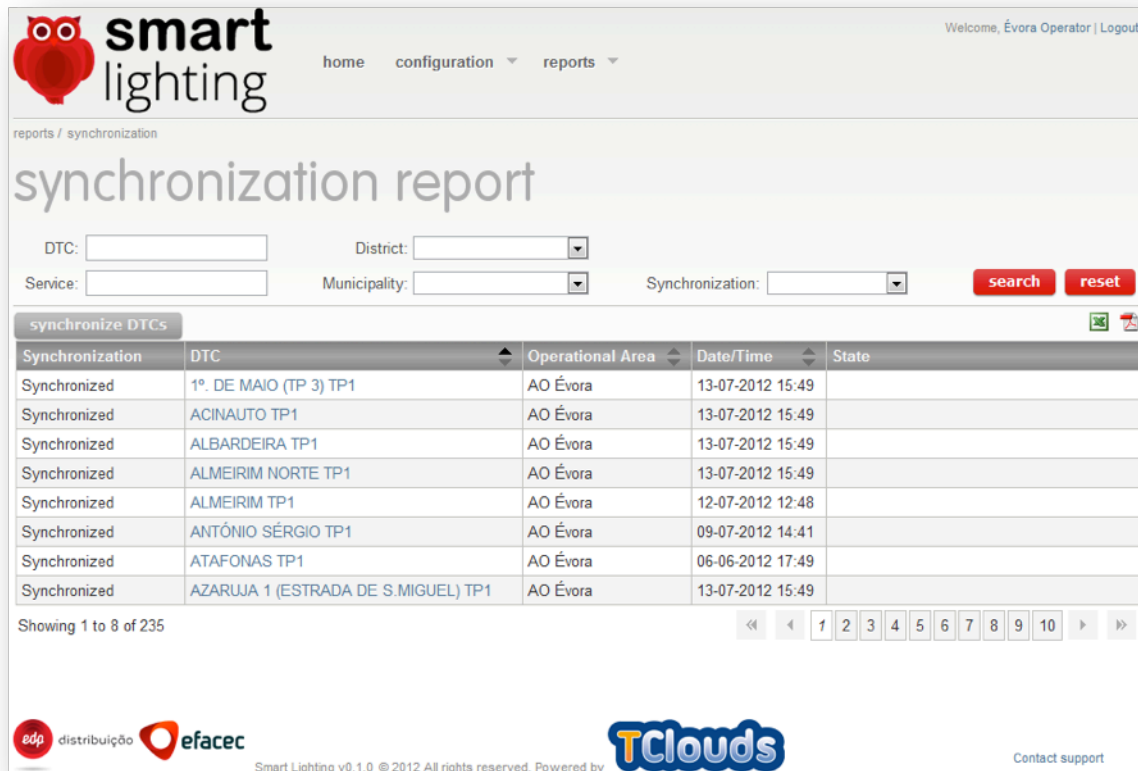


Figure 34: Transitions report

4.2.4.4 Synchronization report

This report, demonstrated by Figure 35, shows the synchronization state of the physical DTC with the application. If the user is an Operator, it is also possible to launch a synchronization process, after a search that included the Synchronization parameter with the value “Unsynchronized”.



smart lighting

Welcome, Évora Operator | Logout

home configuration reports

reports / synchronization

synchronization report

DTC: District:

Service: Municipality: Synchronization:

synchronize DTCs

Synchronization	DTC	Operational Area	Date/Time	State
Synchronized	1º. DE MAIO (TP 3) TP1	AO Évora	13-07-2012 15:49	
Synchronized	ACINAUTO TP1	AO Évora	13-07-2012 15:49	
Synchronized	ALBARDEIRA TP1	AO Évora	13-07-2012 15:49	
Synchronized	ALMEIRIM NORTE TP1	AO Évora	13-07-2012 15:49	
Synchronized	ALMEIRIM TP1	AO Évora	12-07-2012 12:48	
Synchronized	ANTÓNIO SÉRGIO TP1	AO Évora	09-07-2012 14:41	
Synchronized	ATAFONAS TP1	AO Évora	06-06-2012 17:49	
Synchronized	AZARUJA 1 (ESTRADA DE S.MIGUEL) TP1	AO Évora	13-07-2012 15:49	

Showing 1 to 8 of 235

edp distribuição efacec TClouds

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Figure 35: Synchronization report

4.2.4.5 Problems report

This report, demonstrated by Figure 36, lists all problems that have occurred with the application.

The Criticality search field refers to the severity of the problem and can have the values Error, Fatal and Warning.

The Type search field refers to the nature of the problem and it can have the values of Communications, Sync Offsets and Sync Timetables.

Communications type refers to problems with general communications, for example with the Business Layer, not contemplating Offsets and Timetables synchronization communication since they have a type of their own.

Sync Offsets refers to problems occurred when sending or retrieving information regarding the offsets of a DTC.

Sync Timetables refers to problems occurred when sending or retrieving information regarding the Timetables of a DTC.

All the others search fields are self explanatory.

smart lighting

Welcome, Administrator | Logout

home configuration reports administration

reports / problems

problems report

DTC: District: Start Date: hh:mm

Service: Municipality: End Date: hh:mm

Description: Criticality: Type:

Criticality	Type	Description	DTC	Service	Date
Error	Communications	Unable to determine the mode for the service STREETS of AUTO	1º. DE MAIO (TP 3) TP1	STREETS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpMode	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpMode	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpState	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpMode	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpState	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpState	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00
Error	Communications	You need to be authenticated to access the service getIpState	1º. DE MAIO (TP 3) TP1	GARDENS	29-03-2012 00:00

Showing 1 to 8 of 26

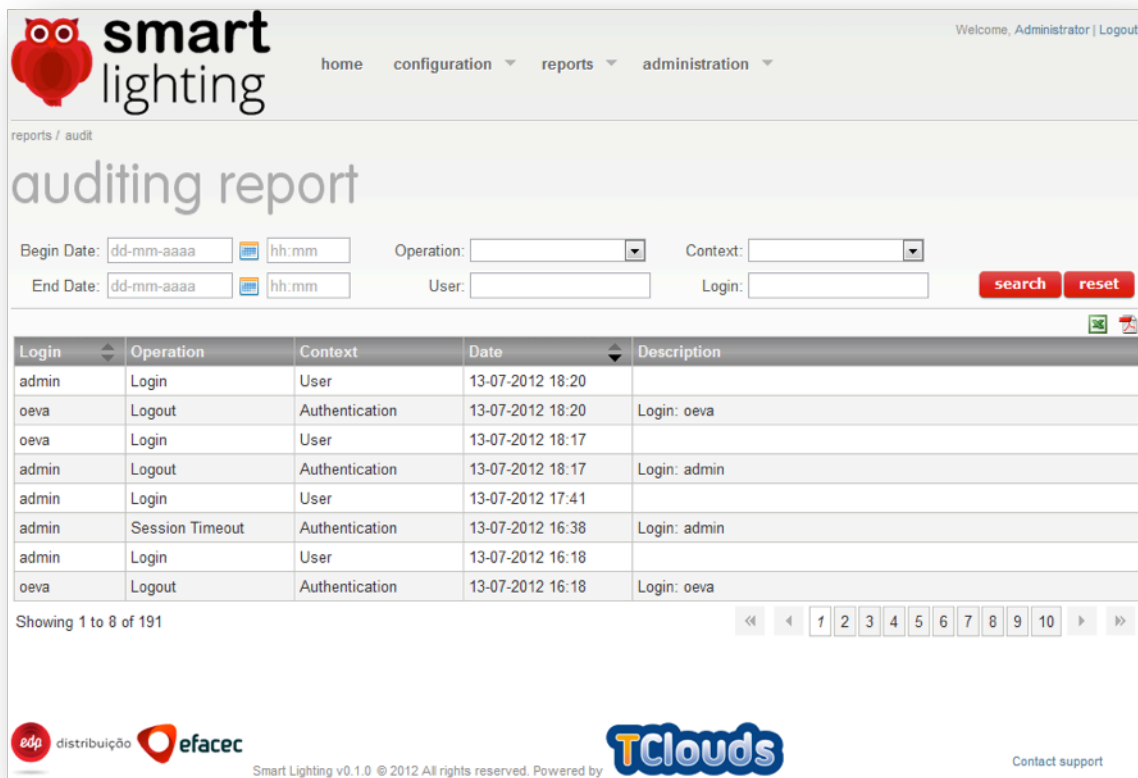
Figure 36: Problems report

4.2.4.6 Auditing report

This report, demonstrated by Figure 37, lists all the Operations executed by a user inserted in a Context. Operations are actions like Add, Assign, Modify, etc while Context identifies the target of the action, like DTC, Services, Users, etc.

All the search fields are self explanatory.

This report is only available to administrators.



smart lighting

Welcome, Administrator | Logout

home configuration reports administration

reports / audit

auditing report

Begin Date: Operation: Context:

End Date: User: Login:

Login	Operation	Context	Date	Description
admin	Login	User	13-07-2012 18:20	
oeva	Logout	Authentication	13-07-2012 18:20	Login: oeva
oeva	Login	User	13-07-2012 18:17	
admin	Logout	Authentication	13-07-2012 18:17	Login: admin
admin	Login	User	13-07-2012 17:41	
admin	Session Timeout	Authentication	13-07-2012 16:38	Login: admin
admin	Login	User	13-07-2012 16:18	
oeva	Logout	Authentication	13-07-2012 16:18	Login: oeva

Showing 1 to 8 of 191

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Contact support

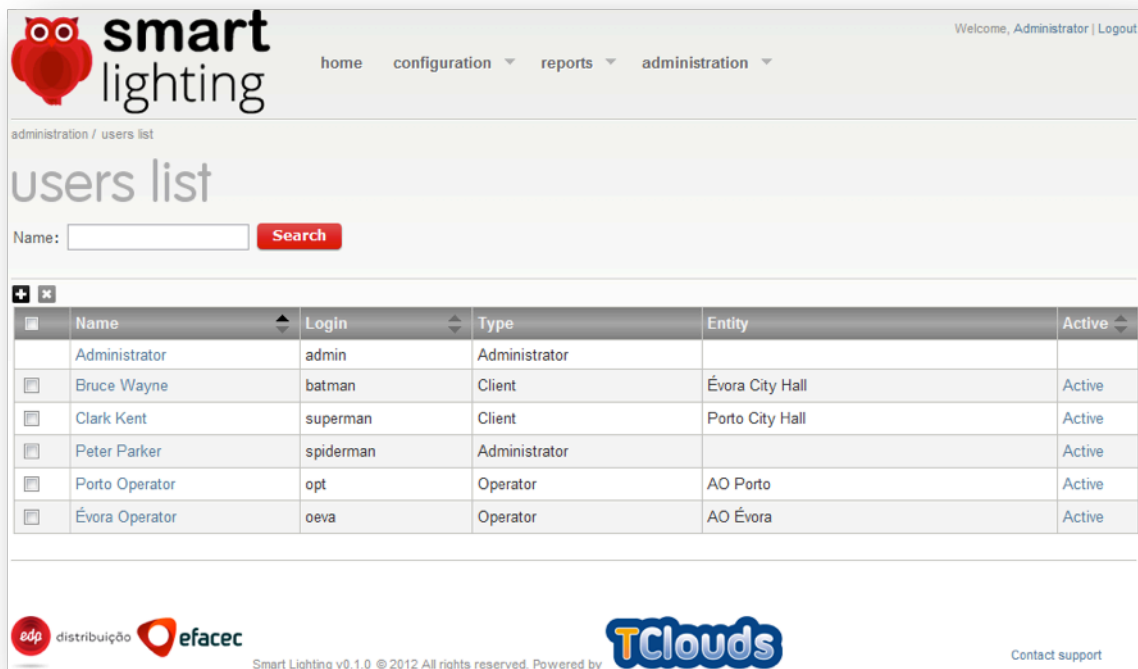
Figure 37: Auditing report

4.2.5 Administration

In the menu administration, only available to administrator users, it's possible to manage the application users and configuration.

4.2.5.1 Users

Choosing the option "users", it is presented the page depicted in the following figure:



smart lighting

Welcome, Administrator | Logout

home configuration reports administration

administration / users list

users list

Name:


Name	Login	Type	Entity	Active
Administrator	admin	Administrator		
Bruce Wayne	batman	Client	Évora City Hall	Active
Clark Kent	superman	Client	Porto City Hall	Active
Peter Parker	spiderman	Administrator		Active
Porto Operator	opt	Operator	AO Porto	Active
Évora Operator	oeva	Operator	AO Évora	Active

edp distribuição efacec

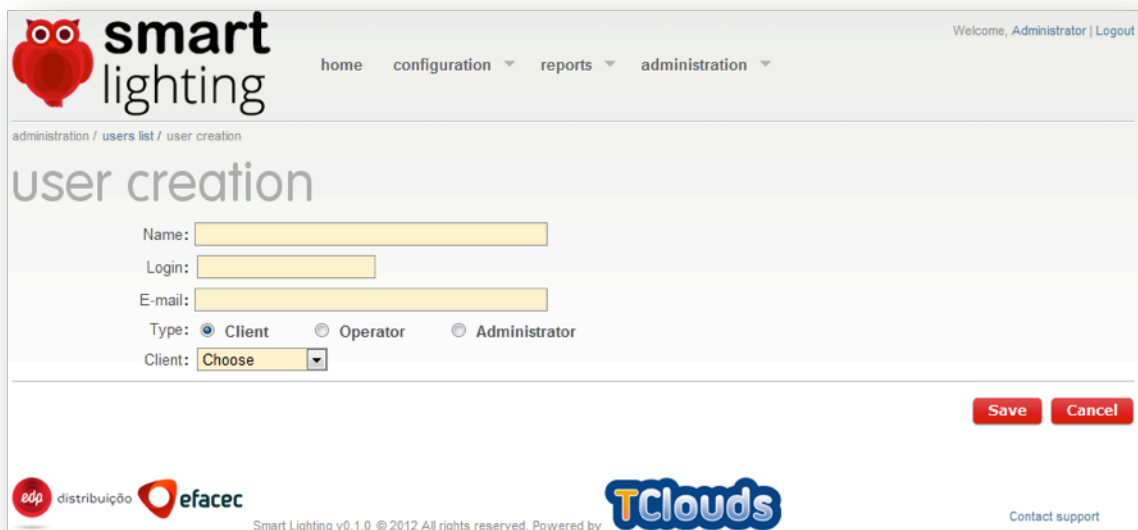
Smart Lighting v0.1.0 © 2012 All rights reserved. Powered by TClouds

Contact support

Figure 38: User list

From here it is possible to edit a user, by clicking the link with the username, or add a new user, by clicking the icon .

Both actions results in the navigation to the page represented in the next figure (the title and the data presented depends on the previous selected option):



smart lighting

Welcome, Administrator | Logout

home configuration reports administration

administration / users list / user creation

user creation

Name:

Login:

E-mail:

Type: Client Operator Administrator

Client:

edp distribuição efacec

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Contact support

Figure 39: New user

The user can be one of three types:

- Client – can only view the state of its client public lighting
- Operator – can view and edit the state of the public lighting for the operational area that he belongs
- Administrator – can view, but not edit, the entire state of the public lighting.

4.2.5.2 Application

Choosing the option “application” in the menu “administration”, the page depicted by the following figure is shown:



Figure 40: Application configuration

In this page it is possible to configure the e-mail address for the application support, used when a user clicks in the link “Contact support”, located at the lower right corner.

4.3 Installation instructions

All the supplied software can run in any Windows/Linux server as long as they meet the minimum requirements described in each chapter.

The installation procedure of the modules will refer to a `{WORKING_FOLDER}` as the folder where the installation package was unpacked.

For this demonstration purposes two self-signed digital certificates are provided. One is for the CC Bridge and Smart Lighting Web application and another is for the Smart Lighting Gateway application. For a production environment the certificates must be purchased from a well-known Certificate Authority such as VeriSign or Thawte.

When using these certificates for securing communications with the Smart Lighting Gateway and the CC Bridge, it is assumed that the CC Bridge is located in the server “tclouds” and the Smart Lighting Gateway is located in the server “slgateway”. A quick solution for this demonstration is to edit the `hosts` file and add the “tclouds” and “slgateway” entries where it makes sense.

A Linux operating system is assumed.

4.3.1 H2 database

This chapter describes the installation and configuration of the H2 database [15]. This persistence engine will be used until the availability of an implementation of the SMR.

4.3.1.1 Minimum Requirements

- 100MB of available RAM
- 100MB of free disk space (for demonstration purposes)
- Java™ 1.7 Runtime [13] or higher

4.3.1.2 Installation

Copy the `{WORKING_FOLDER}/db` folder to the machine that will be used as a database server. This folder contains the database engine and the datafiles of the Smart Lighting.

4.3.1.3 Running

Open a command line shell positioned inside the previously copied folder and execute the following command:

- `./H2start.sh`

4.3.2 CC Bridge

This chapter describes the installation and configuration of the CC Bridge.

4.3.2.1 Minimum Requirements

- 100MB of available RAM

- 1MB of free disk space
- Java™ 1.7 Runtime [13] or higher

4.3.2.2 Installation

Copy the `{WORKING_FOLDER}/bridge` and the `{WORKING_FOLDER}/config` folders to the machine that will be used as the CC Bridge server.

Open the file `{BRIDGE_SERVER}/config/application.properties` and change the properties according to the installation environment. These properties define the access to the database. The properties are self explanatory.

4.3.3 Running

Open a command line shell positioned at `{BRIDGE_SERVER}/bridge` and execute the following command:

- `./bridge.sh`

4.3.4 Smart Lighting Gateway

This chapter describes the installation and configuration of the Smart Lighting Gateway.

4.3.4.1 Minimum Requirements

- 100MB of available RAM
- 1MB of free disk space
- Java™ 1.7 Runtime [13] or higher

4.3.4.2 Installation

Copy the `{WORKING_FOLDER}/gateway` and `{WORKING_FOLDER}/store` folders to the machine that will be used as the Smart Lighting Gateway server.

Open the file `{GATEWAY_SERVER}/gateway/gateway-context.xml` and locate and change the value of `STORE_PATH` to the location of `{GATEWAY_SERVER}/store`. Do the same to `{GATEWAY_SERVER}/gateway/gateway.sh` file. In the file `{GATEWAY_SERVER}/gateway/gateway-context.xml` there is also the property `offlineRetryInterval` that defines the interval, in seconds, between unsuccessful connections to the Smart Lighting Web application.

4.3.4.3 Running

Open a command line shell positioned at `{GATEWAY_SERVER}/gateway` and execute the following command:

- `./gateway.sh`

4.3.5 Smart Lighting Web application

This chapter describes the installation and configuration of the Smart Lighting Web application.

4.3.5.1 Minimum Requirements

- 512MB of available RAM
- 100MB of free disk space
- Java™ 1.7 Runtime [13]
- Apache Tomcat 7.0 [14]

4.3.5.2 Installation

Copy the `{WORKING_FOLDER}/config` folder to the machine that will be used as the Smart Lighting Web application server.

Open the file `{WEB_SERVER}/config/application.properties` and change the properties according to the installation environment. These properties define the access to the database and the URL to the gateway. The properties are self explanatory.

Copy the file `smartlighting.war` from the working folder to `{TOMCAT_DIR}/webapps`.

Open the file `{TOMCAT_DIR}/conf/server.xml`, uncomment the connector with the port 8443 and add the attributes `keystoreFile="{WEB_SERVER}/config/tclouds.jks"` `keystorePass="efacec"` to the connector.

4.3.5.3 Running

Open a command line shell positioned at `{TOMCAT_DIR}/bin` and execute the following commands:

- `export CATALINA_OPTS =-Dsmartlighting.folder=<CONFIG_DIR>\config`
- `./startup.sh`

Chapter 5

List of Abbreviations

BFT	Byzantine Fault Tolerance
DB	Database
DTC	Distribution Transformer Controller
JPA	Java Persistence API
POJO	Plain Old Java Object
RMI	Remote Method Invocation
SCADA/DMS	Supervisory Control and Data Acquisition / Distribution Management System
SL	Smart Lighting
SMR	State Machine Replication

Table 1: List of Abbreviations

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