2

Logic Architecture, Components, and Functions

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Abstract

This chapter provides an overview of iURBAN ICT, describing the overall architecture, main functionalities of each component and interfaces.

Keywords: ICT, Architecture, Functionality, Interfaces.

As shown in Figure 2.1, the principle idea behind the iURBAN platform and its architecture is to provide a set of outputs based on the inputs received by the smart metering infrastructure in Plovdiv and Rijeka pilots.

The architecture of iURBAN platform is mainly composed by three main blocks, as Figure 2.2 shows: the local decision support system (LDSS), centralized decision support system (CDSS), and the SMART urban decision support system (smartDSS). The three blocks communicate between them in order to provide a set of outputs; on one hand, the CDSS output is target to energy companies, municipalities, and other public authorities, while the LDSS is target to public and private customers. The smartDSS consists of a set of components that are used for both the LDSS and CDSS. Apart from that, the LDSS and CDSS have also its own components.

A global logic view of the architecture is depicted in Figure 2.3. The main components of iURBAN platform are the *Smart City Database* (SCDB), a set of open *interfaces/application program interfaces (APIs)* to connect third-party tools and services, and to provide support to internal modules of iURBAN. Within the *Orchestrator* is located the *smartDSS* and its business unit (BU), the LDSS, and CDSS. All of them under the security and privacy framework.

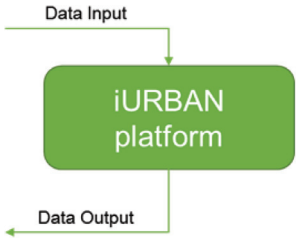

Figure 2.1 Data input–output iURBAN platform.

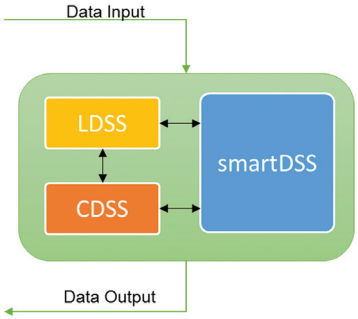

Figure 2.2 High-level logical architecture of the iURBAN platform.

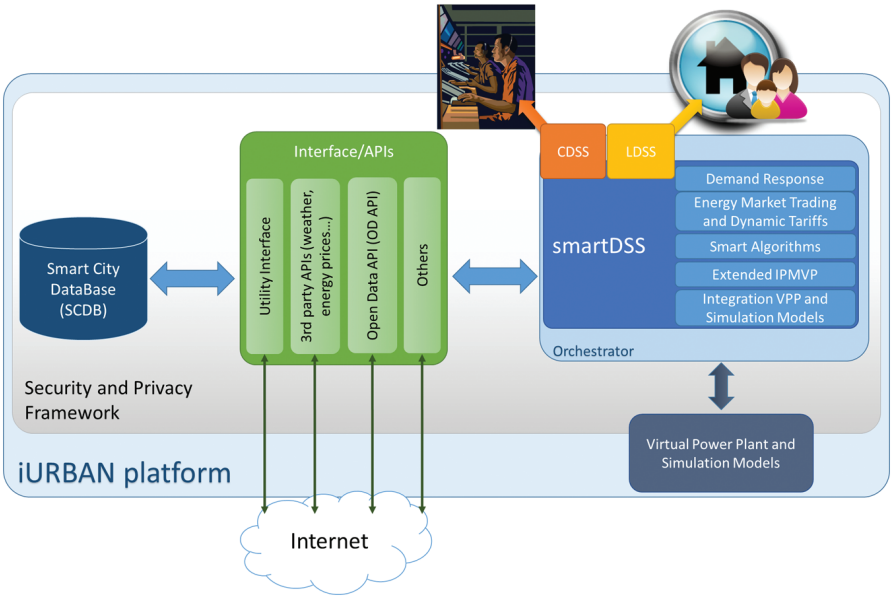

Figure 2.3 Logical architecture envisioned.

Energy consumed and produced and any related information with energy is provided by either internal or external services to iURBAN. All data is stored in the SCDB.

The four main services are as follows:

- **Utilities**: Service to receive energy consumption and production data from utilities' smart metering system.
- **Smart Home**: Smart Home provides contextual information such as internal temperature, humidity, CO_2 levels, and luminosity. The energy consumption can be obtained by smart plugs and sub-meters to obtain more detailed home consumption. Furthermore, it provides automation and security functionalities.
- **Energy Prices**: Service to receive energy prices, so the users can be up to date on bill expenditure.
- **Weather Provider**: Service to receive historical, current, and future weather information.

Figure 2.4 shows schematically all different function modules of iURBAN; furthermore, it relates each function to a main component (see figure's legend). Notice for instance that the *Information and Motivation* function module only affects the LDSS; thus, all components affecting this package are fully developed and integrated in the LDSS. Similarly, the *Technical Loses* function module only affects the CDSS; therefore, all components are inside CDSS package. Furthermore, the demand response (DR) function module affects LDSS and CDSS; then, a component to automatically identify potential DR actions is created within smartDSS components; in this particular case, additional components are also created in the LDSS (historical DR, notification, and advise) and CDSS (generation and validation) to support the use case.

2.1 Logic View

2.1.1 Local Decision Support System

The LDSS component of iURBAN is responsible to deliver a set of functions to households. It is composed by a back end and front end (Web- and mobile phone-based graphical user interface (GUI)) build on top of nAssist© IoT service from Sensing and Control (further information can be found in Section 2.2.1.4) (Figure 2.5).

LDSS main goal is to engage consumers and prosumers by capturing near real-time data related to their energy consumption, as well as energy production from their installed distributed energy resources (DER). The engagement

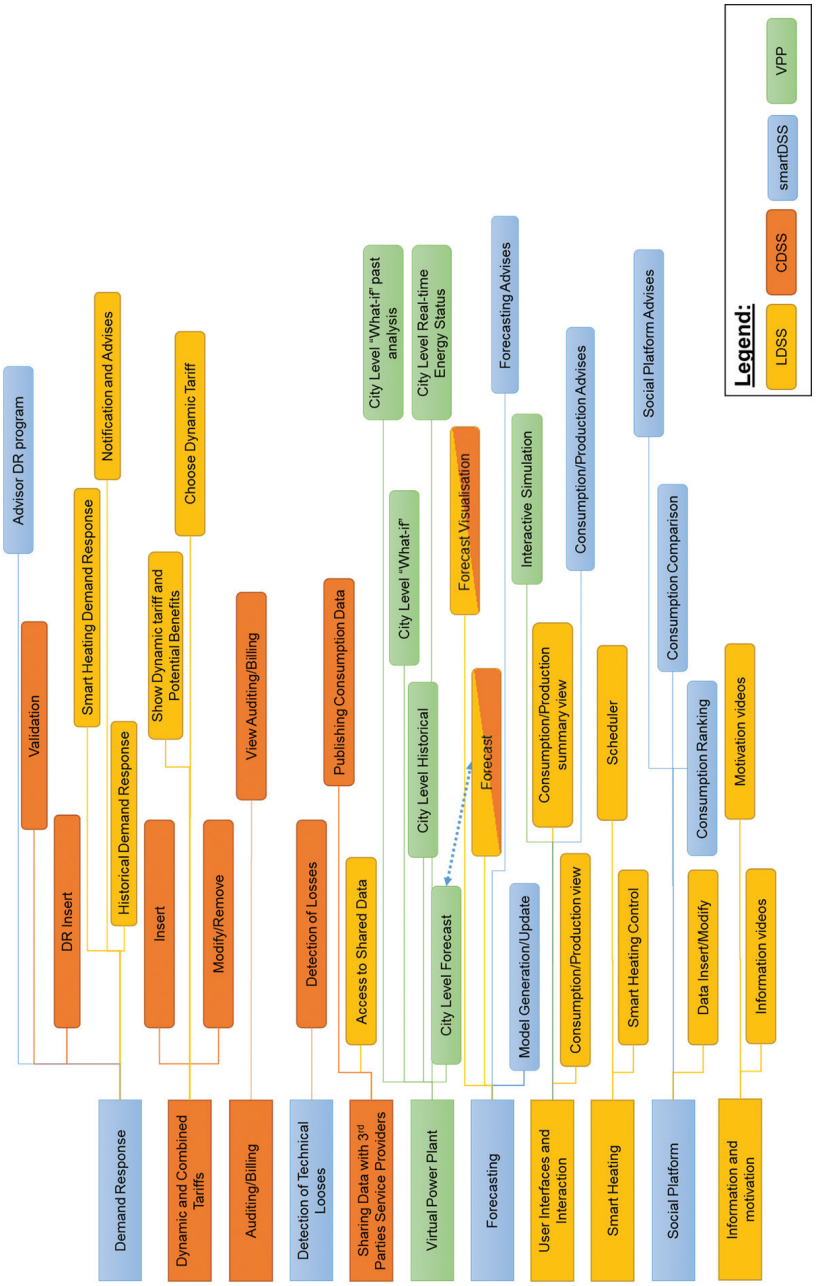

Figure 2.4 Business models UCs, user interaction UCs, and their impact with LDSS, CDSS, smartDSS, and VPP.

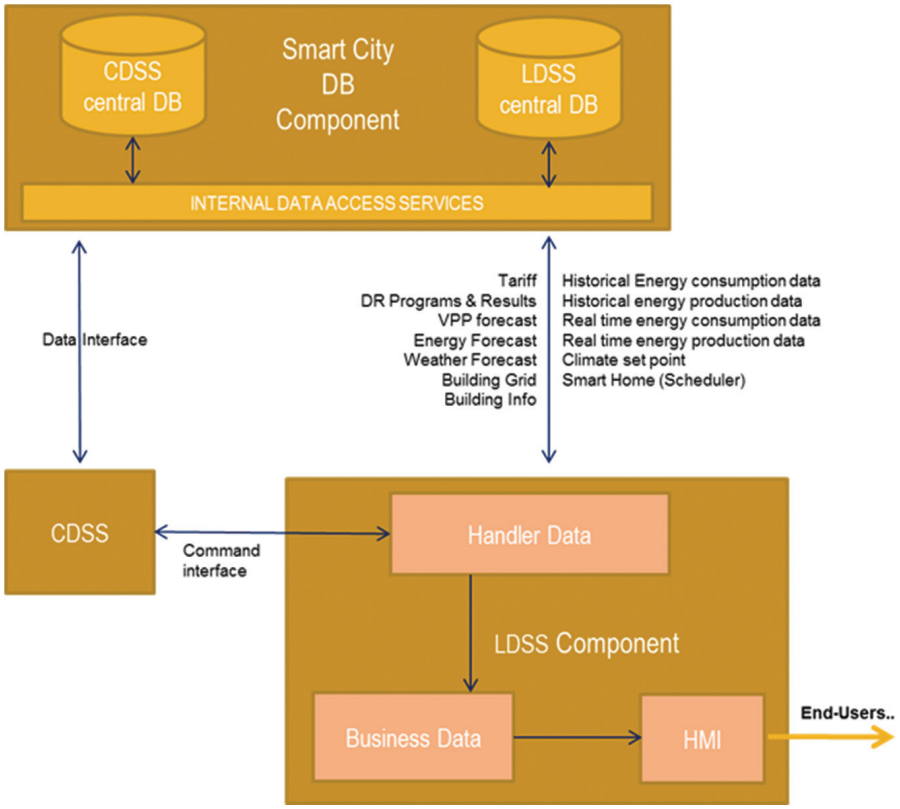

Figure 2.5 LDSS component and its relations.

is target throughout a user-friendly interface via smart phones, tablets, PCs, etc. Furthermore, it provides support for decision making; for instance, it advises how to achieve a DR actions, which dynamic tariff is more convenient, deviations compared to similar days/months/weeks and simulations to understand how different parameters affects to the user consumption and comfort. At this aim, the LDSS communicates directly with the CDSS in order to exchange information for the decision making process.

2.1.1.1 Handler data

The handler data is a sub-component of the LDSS component. It manages the interface from different components of iURBAN platform. This sub-component interfaces the LDSS component with the SCDB; it exposes two different interfaces: one for the CDSS central database and other for the LDSS local database to collect data to be sent to the business sub-component.

The handler data also manages command interface with CDSS component to send command in order to notify end user the availability of new DR program and the result of a given DR program ID executed.

2.1.1.2 Business data

The different sub-modules are depicted in Figure 2.6 and its functionalities are shown in Table 2.1.

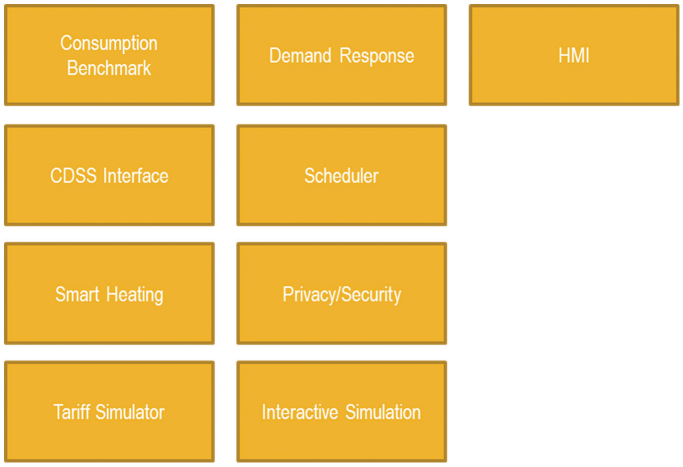

Figure 2.6 LDSS component.

Table 2.1 LDSS modules

Component	Description
Consumption benchmark	This module benchmarks your consumption and/or production against other peers.
Smart heating	This module implements the smart heating control of the home/business, plus the possibility to be controlled (target temperature) by the utility.
Tariff simulator	This module visualizes the different dynamic tariffs available and calculates the potential benefits of a time period taking into account its consumption profile (heating, gas, and electricity). It allows also to choose among the different available tariffs.
Demand response	This module implements DR programs, including notifications, historical DR actions, and smart heating DR.
Scheduler	This module implements the scheduler of DR program and smart thermostat control.
Interactive simulation	This module allows the users to see and simulate their consumption/ production profiles in terms of kWh, CO_2 emissions, and EUR.
CDSS interface	This module provides a service interface for the communication between LDSS and CDSS.

2.1.1.3 Local decision support system user interface

This module provides the user interfaces of LDSS. The interfaces are developed on top of the current nAssist©, either modifying current ones or adding them to actual product. The new interfaces are tailored to increase user's satisfaction on iURBAN, and more concretely to support the user engagement activities and DR programs within the project.

Figure 2.7 shows the sub-modules of the HMI one, while further describes them. The default client and user interface platform is a Web browser.

The client implements those functions as visual components consuming data from LDSS RESTful API (using HTTPS connection) (Table 2.2).

Figure 2.7 LDSS HMI interfaces.

Table 2.2 LDSS HMI sub-interfaces

Component	Description
Energy consumption and production	This interface provides to the end user a historical and almost real-time view of their consumptions and productions, provides both kWh and monetary cost. It differentiates between the different energy sources; electricity, water, and heating. The view is split in daily, weekly, and monthly information insights.
Home parameterization	This interface allows the user to insert home-related information that is used for the generation of personalized advice and the benchmark computation for energy consumption comparison. This information is additionally used for the user engagement.
Scheduler	This interface provides the scheduler for the smart heating use case. It allows to set a temperature in a concrete day of the week and hour (24×7 calendar).

(*Continued*)

Table 2.2 Continued

Component	Description
Demand response	This interface provides notifications about DR actions sent by the utilities and historical DR actions.
Advise	It provides advice for users with the aim to reduce their energy consumptions.
Notifications	This interface notifies the user about any communication with the CDSS.
Tariff simulation	This interface shows the available dynamic tariffs for the user, and it simulates its performance against the average consumption curve of this user. Moreover, it notifies when a more optimal tariff for the user is detected.
Energy forecast	This interface provides the (hourly, daily, 24/48/72 hours) energy consumption and production forecast. It shows an additional bar on plots with the real consumption and production.
Privacy policy	This interface provides to user means to decide the privacy policy configuration for his/her own data (energy and user information).
Interactive simulation	This interface provides a simulation of the energy building consumption performance. It allows to choose a set of parameters and verify how it affects to the consumption curve.
Home comparison	This interface provides the comparison between the user and its neighborhood.
Information and motivation videos	This interface provides a video or a link to a video with helpful hints, tips, and short easy videos on how to save energy. It also provides stories about peers telling why they use iURBAN platform and why is good, and what helped them save energy and money.

2.1.1.4 nAssist©

The core IoT platform of the LDSS architecture is the nAssist© IoT middleware platform, a commercial property of Sensing and Control S.L. It is provided to the iURBAN and adapted to accommodate city energy management, energy engagement functionalities, and advance energy service of the LDSS. The modular architecture of this platform allows it to be adapted very easily to other areas of application. The nAssist© platform has been developed following service-oriented architecture paradigm and therefore constituted by several tiers of processing. The module-based logic view is depicted in Figure 2.8. As shown, the software is divided into four main modules:

- Hardware/Software Interface: This module takes care of communication with field devices and external software services. The communication may be bidirectional depending on the type of devices connected and function to be used. Information transferred from remote sources is parsed, cleaned, formatted, and finally sent to upper software layer.

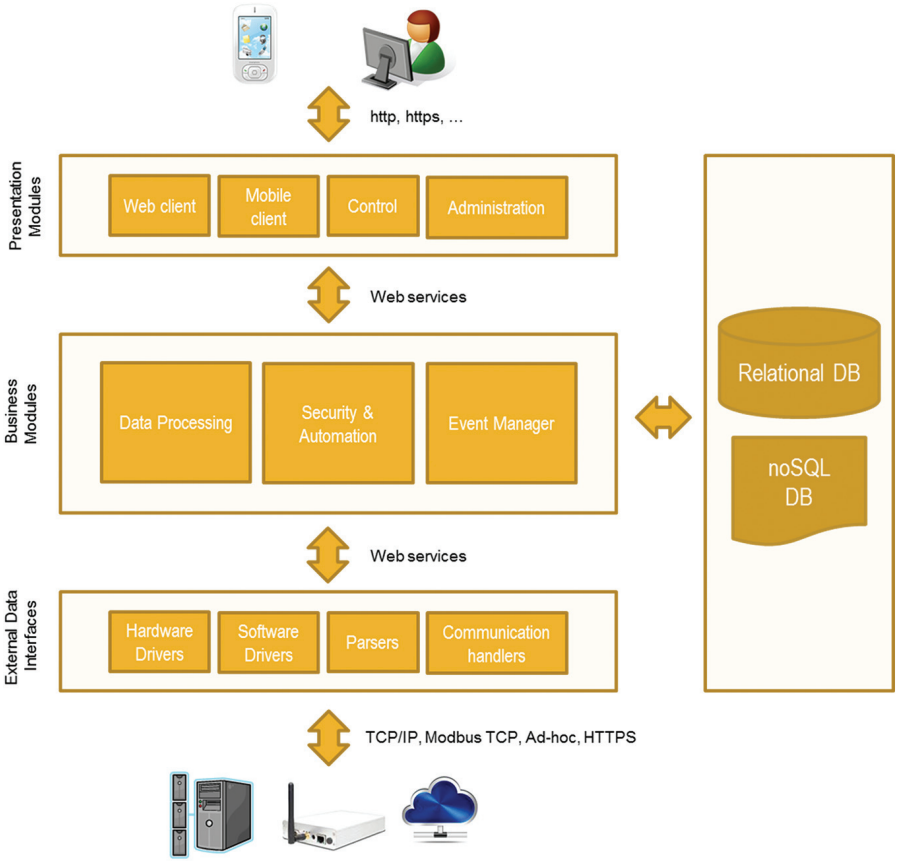

Figure 2.8 nAssist© logic architecture.

- Business Modules: The central module handles all the processing/ intelligence of the software. It has a built-in event manager that handles communication between hardware interfaces and user interfaces, automation routines, and alarm/events handling and auto-generation based on rules. It handles database access.
- User Interfaces: The upper module of the software is the user interface, which works within standard Web clients and smart phones.
- Database: The core of the nAssist© platform provides a data warehouse and business intelligence components to analyze, manage, and comprehend data from devices and meter measurements. It has a relational database and a noSQL database.

nAssist© is built around special logic module called "framework foundations," which provides a common interface to access the low-level functions implemented by the middleware. This logic module works on two layers:

- Service layer: This includes business domains (user and application authentication, user and application registration, scheduling, etc.). Everything is accessible to both local and remote clients.
- Client layer: Clients are connected to service layer over the wire, meaning that those can work with server infrastructure if they have LAN or Internet connection. A client may be a Web site—Web-based products—or just a hardware sensor. Both end up using a RESTful Web service API.

2.1.2 Centralized Decision Support System

The CDSS component of iURBAN is responsible to aggregate and manage data at city level. That component delivers a set of functions to end users such as authorities, energy service company (ESCO), and municipalities, collecting data that come from other components of the system. The scope of CDSS is to integrate measurements data, with business models and energy production and consumption simulations.

The CDSS allows its users to perform the following activities:

- Get a continuous snapshot of city energy consumption and production.
- Manage energy consumption and production.
- Forecast energy consumption.
- Plan new energy "producers" for the future needs of the city.
- Visualize, analyze, and take decisions of all the end points that are consuming or producing energy in a city level, permitting them to forecast and planning renewable power generation available in the city, a real-time optimization and being perfectly scalable (meaning its ability to be enlarged to accommodate growth of data).

It composed by a back end and front end (Web- and mobile phone-based GUI). In this task, the GUI for CDSS is developed with a novel framework employing Web technologies (HTML5, CSS3, JScript, Websocket) to provide a Web 3.0 user interface experience. The different modules and sub-modules are depicted in Figure 2.9 and its functionalities are shown in Table 2.3.

The CDSS sub-components into the logical view are as follows (Figure 2.10 and Table 2.4):

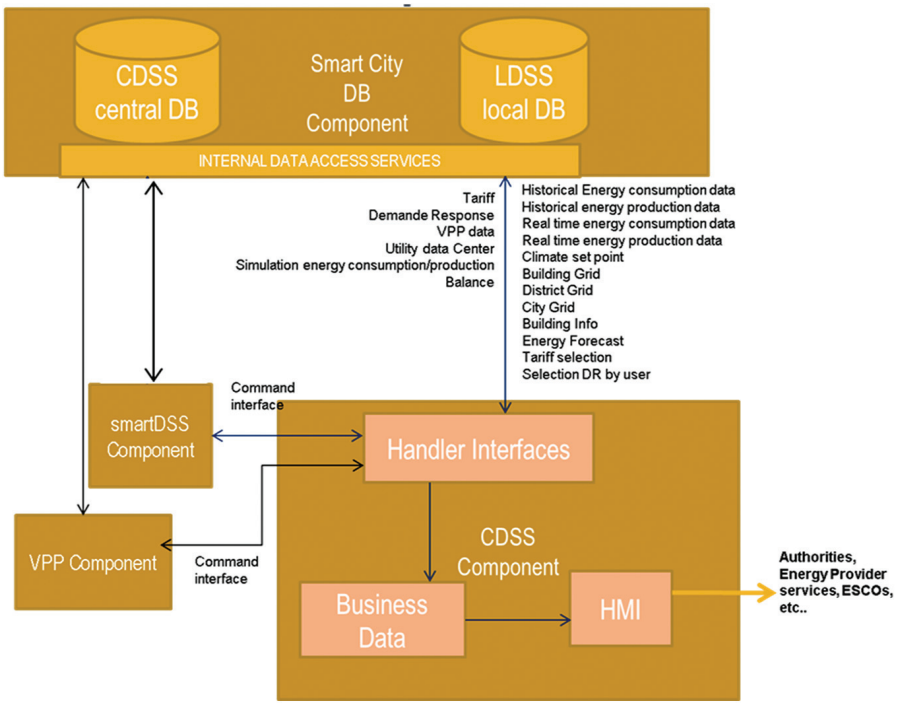

Figure 2.9 CDSS components.

Table 2.3 CDSS component

Component	Description
CDSS central database	It is the data warehouse database that also collects all the data at the city level. This database is used as data storage for business intelligent system.
Internal data access services	It is a sub-component that exposes services in order to communicate with other components internal to the platform as the CDSS, LDSS, VPP, and smartDSS.
Handler interfaces	It is a sub-component that has interfaces in order to • invoke VPP and smartDSS functionalities • invoke functionalities of internal data access services • invoke functionalities related to business data component
Business data	It is a sub-component that contains functionalities related to business intelligent system in order to perform historical data analysis.
HMI	This sub-component contains the CDSS graphical user interfaces for the end users.

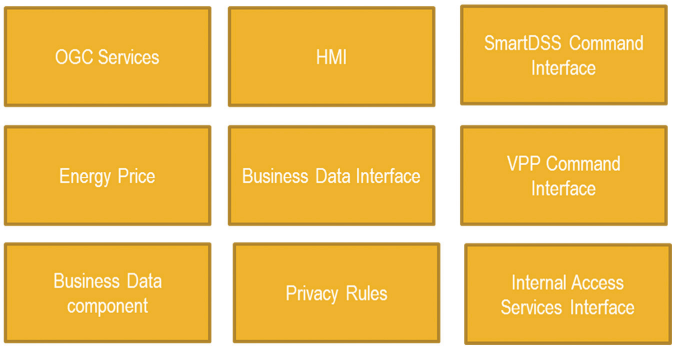

Figure 2.10 CDSS sub-components.

Table 2.4 CDSS sub-components

Component	Description
OGC services	It provides services in order to manage geographical information.
HMI	It is a sub-component to visualize data and information to the end user of the iURBAN platform side CDSS.
Energy price	It is a sub-component to manage tariffs information from utility provider price
Business data interface	This sub-component contains the interfaces to invoke functionalities related to business data component
smartDSS command interface	This sub-component contains the interfaces to invoke functionalities related to smartDSS component
Internal access service interface	This sub-component contains the interfaces to invoke functionalities related to internal access service sub-component
Privacy rules	This interface provides user means to decide the privacy policy configuration for his own data (energy and user information)
VPP command interface	This sub-component contains the interfaces to invoke functionalities related to VPP component

2.1.2.1 Centralized decision support system central database

The CDSS central database is a data warehouse database used for business intelligent system of iURBAN platform. This database is composed of two sub-components:

- Staging Area: It is a suitable database area that collects all the facts related to business intelligent system such as
  - Consumption (kWh)
  - Consumption (m^3)

- Production (kWh)
- Production (m^3).

These above data are read from LDSS database and stored to the staging area.

- Star Schema: It is a suitable database schema composed by fact tables and dimensional tables. Fact tables contain measurements related to consumption and productions and suitable foreign keys to dimensional tables. Dimensional tables contain information regarding data of
  - geographical
  - date–time
  - tariffs.

The goal of CDSS central database (that is a data warehouse database) is to have a storage that is used by suitable analysis functions in order to have historical data analysis.

This historical data analysis allows the user to aggregate facts (measurements) by dimension like:

- particular geographical zones;
- date–time intervals;
- tariffs intervals.

The tariffs are stored (to correspondent dimensional table of tariffs) from the energy utilities that provide energy prices. The tariffs are heterogeneous because each type of service operates on its own scheme; additionally, most measurements differ by nature (gas, heat, electricity). The smartDSS invokes functionalities of internal data access services in order to perform suitable data queries (from CDSS database) to obtain predictions regarding measurements (consumption or production).

The simulations data, coming from virtual power plant (VPP) component, are stored to LDSS database as described above. All the measurement data (simulated or not) are stored to staging area (of data warehouse) on the LDSS database. Figure 2.11 describes a logical view of CDSS component:

2.1.2.2 Handler interfaces

The handler interfaces is a sub-component into the CDSS component. It has suitable interfaces in order to invoke functionalities of different internal components of iURBAN platform. These interfaces invoke functionalities of components:

- VPP
- Business data

- smartDSS
- Internal data access services.

The handler interface also manages command interfaces. It sends commands to the following:

- VPP component in order to activate a processing of simulation to know how nonexisting "virtual" units can affect the consumption or saving CO_2.
- smartDSS component in order to perform prediction analysis of consumption and production (Figure 2.12 and Table 2.5).

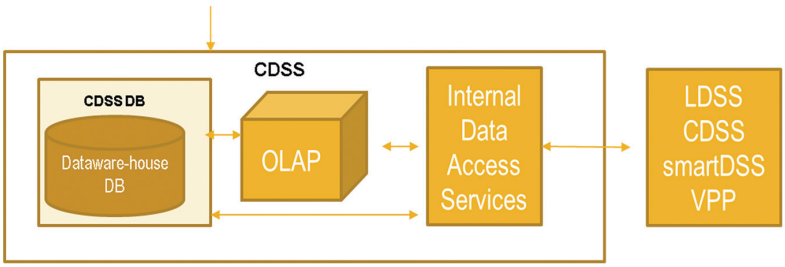

Figure 2.11 CDSS description.

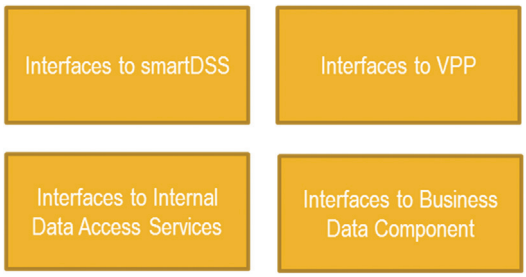

Figure 2.12 CDSS handler interfaces sub-component.

Table 2.5 Handler interfaces sub-components

Component	Description
Interfaces to smartDSS	It is able to invoke functionalities of smartDSS component
Interfaces to VPP	It is able to invoke functionalities of VPP component
Interfaces to internal data access services	It is able to invoke functionalities of internal data access services component
Interfaces to business data component	It is able to invoke functionalities of business data component

2.1.2.3 Business data

This is a sub-component that contains functionalities related to data analysis. In particular, these functionalities allow the user to

- Aggregate measurements of consumption/production following dimensions like
  - Date–time interval;
  - Geographical zones; and
  - Tariffs intervals.
- Detect technical losses: functionalities to calculate the differences between produced and consumed (by user) energy.
- Billing calculation (from consumed energy).
- Insert and validate actions related to DR.
- Dynamic and combined tariffs: manage the dynamic tariffs, update, and insert new dynamic tariff into SCDB (Figure 2.13 and Table 2.6).

2.1.2.4 Centralized decision support system HMI

The CDSS links and shows the data (including citywide energy production and consumption forecasts) generated from iURBAN with the end users via CDSS HMI.

The CDSS HMI component manages the interface with the authorities, the municipalities, the ESCOs, the utility provider services, iURBAN decision maker, etc., in order to display information as DR, dynamic tariffs, simulation VPP data, detection of technical losses, etc.

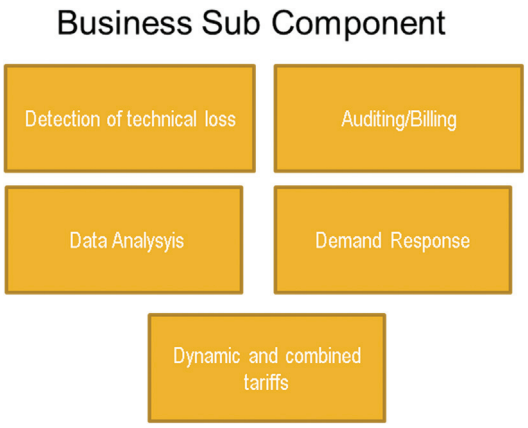

Figure 2.13 CDSS business component.

Table 2.6 CDSS business component

Component	Description
Detection of technical loss	To calculate the differences between produced and consumed (by user) energy.
Auditing/billing	Billing calculation
Data analysis	To aggregate measurements of consumption/production following dimensions like • Date–time interval; • Geographical zones; and • Tariffs intervals.
Demand response	To insert and validate demand response action and smart heating demand response
Dynamic and combined tariffs	To manage the different dynamic tariffs available. Inserts and updates or removes the dynamic tariffs from the system

The GUI allows monitoring the global loads of the grid, supporting the end user to plan suitable activities aimed at improving energy efficiency.

It also provides tools for visualizing and supporting the end user decisions concerning the best business models to apply. In case of existing building energy management systems (BEMS), the necessary adaptations for the correct functioning with the smartDSS should be developed in order to interface it to get data and be able to manage and control (Figure 2.14 and Table 2.7).

Manage communication channel is a sub-component to manage different devices and channels (mobile, portal, etc.) in order to communicate with end users (third parties, authorities, etc.).

iURBAN platform displays an overview of the grid status (electricity, heat and district hot water) for the level selected by the end user.

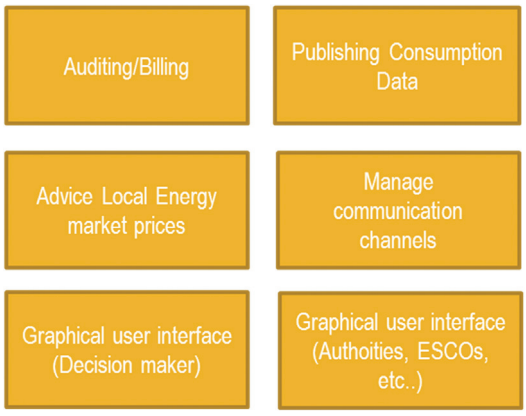

Figure 2.14 CDSS HMI sub-component.

Table 2.7 CDSS HMI sub-component

Component	Description
Auditing/billing	It is a sub-component to show auditing and/or billing information to the CDSS end user (third party, authorities, etc.)
Publishing consumption data	It is a sub-component to show publishing consumption data to the CDSS end user (third parties, authorities, etc.).
Advice local energy market prices	It is a sub-component to show results of predictor component in order to advice and help the CDSS end user (third party, authorities, etc.) taking the best solution about aspects of the market.
Manage communication channels	It is a sub-component to manage different devices and channels (mobile, portal, etc.) in order to communicate with end users (third parties, authorities, decision maker position).
GUI (decision maker)	It is a sub-component to provide an operative position for the decision maker. The info displayed is as follows: • Dynamic tariffs • Demand response • Detection of the technical losses • VPP
GUI (authorities, ESCOs, etc.)	It is a sub-component to provide a monitoring position for the authorities, ESCOs, and municipalities.

2.1.3 Smart Decision Support System

The smartDSS component of iURBAN is responsible to deliver a set of functions to be used by the LDSS and CDSS. It is composed by a back end with different business units (Figure 2.15).

smartDSS's main goal is to generate a set of insights on consumed and produced energy, based on the data stored in the SCDB. The principle idea behind the smartDSS is to generate valuable information and actions that cannot be taken by the LDSS and CDSS alone. There are common functions comparing LDSS, CDSS, and VPP; therefore, there is a need to have a common component capable to provide such output to the rest of components. For instance, the smart city prediction algorithms generate a set of outputs that are used by several packages or the DR actions that affects both the CDSS and LDSS. smartDSS is envisioned to group these components.

The different sub-components are depicted in Figure 2.16 and its functionalities are shown in Table 2.8.

2.1.4 Virtual Power Plant

The VPP component is responsible to deliver outputs stored on the SCDB, which in turn feeds as inputs into the CDSS. The relationship between the VPP and CDSS is as follows. The VPP is to act as the background calculation

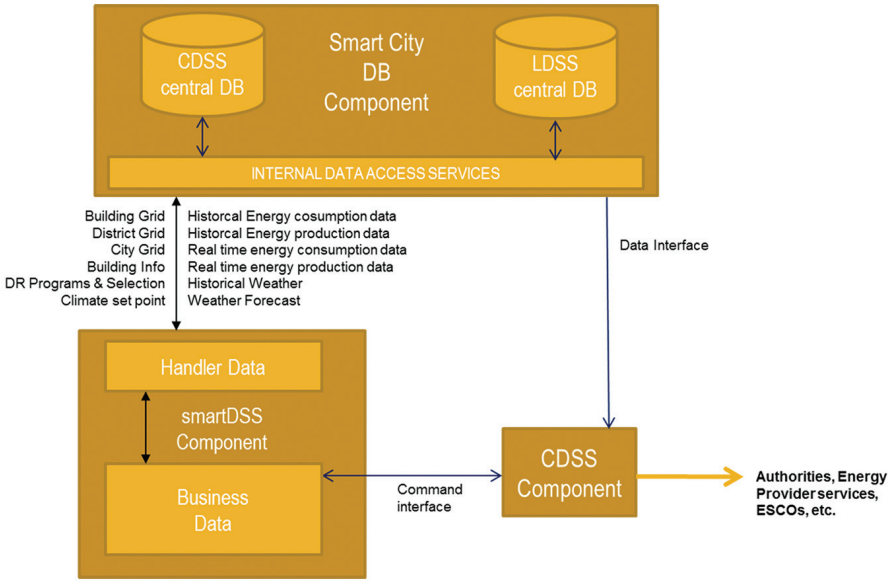

Figure 2.15 smartDSS components.

Figure 2.16 smartDSS sub-components.

engine to the CDSS, where the CDSS is to act as an interface to the VPP initiating user commands to the VPP. The different sub-modules are depicted in Figure 2.17 and its functionalities are shown in Table 2.9.

Table 2.8 smartDSS sub-components' description

Component	Description
Prediction algorithms	This module is responsible for the forecast models generation of the energy consumption and/or production for a given installation
Detection of technical looses	This module detects when there is a significant deviation from the smart meter data at building level and the sum of smart meters data at apartment level, belonging to this building
Consumption and production ranking	This module computes the different consumption and production rankings for each of the possible clusters.
Advisor DR program	This module advises to the CDSS about demand response actions that potentially could benefit to decrease load peaks and shift the load consumption curve. It generates also the optimal reward assigned to the demand response action.
Consumption/production advises	This module generates advises for the LDSS based on the historical and current energy consumption and production with the aim to reduce peak consumptions, CO_2 emissions, etc.
Social platform advises	This module generates advises for the LDSS to improve the energy ranking and contest.
Forecasting advises	This module generates advises for the LDSS based on the forecasted data with the aim to reduce peak consumptions, CO_2 emissions, etc.

Figure 2.17 VPP component.

2.1.5 Smart City Database

The SCDB is depicted in Figure 2.18. It contains the database of iURBAN and provides components to import data from external sources, as depicted in Figure 2.19, and additionally provides interfaces for accessing

Table 2.9 VPP modules

Component	Description
Energy metered data (building level)	VPP to access energy demand and generation metered per building/apartment from SCDB.
Smart algorithms (building level)	VPP to access smart algorithm data (demand, renewable, tariff) per building/apartment from SCDB.
Energy load aggregation (district level)	CDSS to send user commands to the VPP based on user defined and selected levels of interest in the model ranging from high-level city planning to the selection of individual buildings. VPP to carry out load aggregation of near real-time metered energy demand and generation data at building/apartment levels and data derived from smart algorithms, based on grouping schemes discussed above. VPP outputs to be stored on the SCDB for access by the CDSS and visually represented in the CDSS interface.
What-if simulation (building level)	CDSS to send user commands to the VPP defining what-if simulations to be carried out by the VPP calculation engine. What-if simulations are defined as simulation of additional distributed energy resources (DER), electricity storage, electric vehicles, etc., at user-defined building and/or city/district level. VPP outputs at building level to be stored on the SCDB.
Energy load aggregation (district level)	Same as above, except the focus here being on aggregation of near real-time metered energy demand and generation data at building/apartment levels, data derived from smart algorithms, and data from what-if simulations, based on grouping schemes discussed above. VPP outputs to be stored on the SCDB for access by the CDSS and visually represented in the CDSS interface.
Copy and paste metered data (building level)	User to identify lack of information in the CDSS city model (e.g., metered data only available for a small percentage of all buildings in the district/city). CDSS user option to copy and paste metered data at building level to buildings with insufficient metering within the city model.
Energy load aggregation (district level)	Same as above.
HMI	This module is led by CDSS, as the CDSS GUIs for the end users. VPP uses HMI as a user interface.

energy-related data collected from the main modules of iURBAN (LDSS, CDSS, smartDSS, and VPP). There is a special module, which allows access to data externally following the privacy and security policy of iURBAN (explained in Chapter 3).

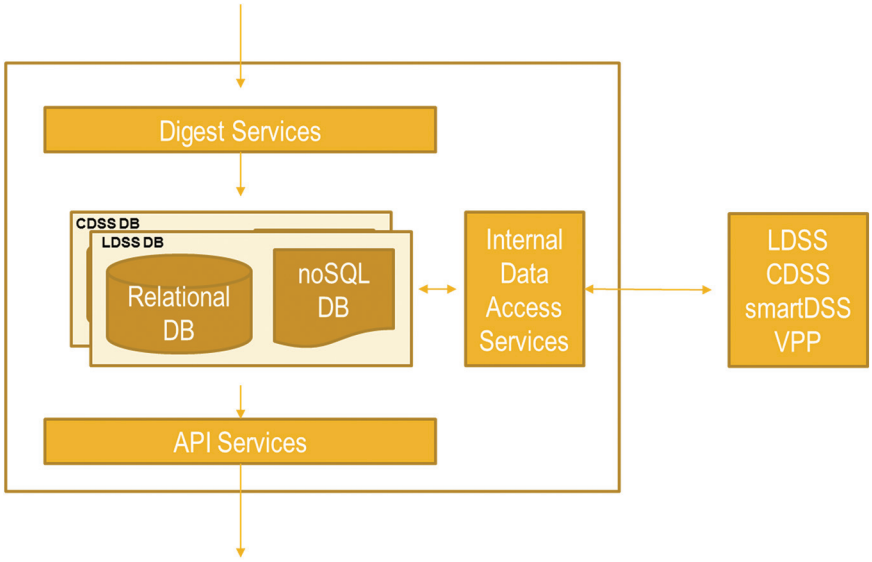

Figure 2.18 SCDB.

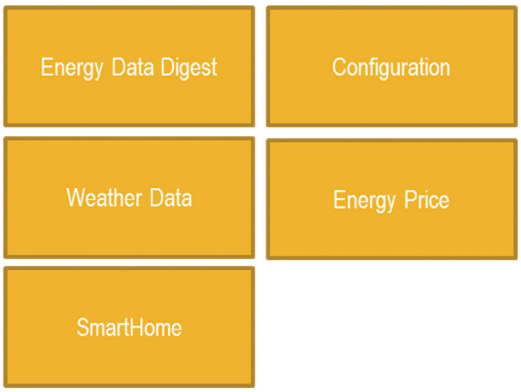

Figure 2.19 Digest component.

The database is divided into two main blocks, which matches the functionalities target for the LDSS and CDSS. Basically, all energy-related information from meter up to building level is stored in the LDSS database, while all energy-related information above building level is stored in the CDSS database; this include aggregated meter at city-level (district wise

and city wise) data and VPP data. Both LDSS and CDSS incorporate a relational database, where the relation of the meters is defined: apartment/home/business, building, district, and city level, and a noSQL database to store massive energy information. Next sub-sections provide information about the different sub-components.

2.1.5.1 Digest component

The digest component of the SCDB is the responsible to acquire data from external sources necessary for business units to execute its function in correct way. It provides six different functions, as shown in Figure 2.19, which are further explained in Table 2.10.

2.1.5.2 Open data API services

The API service component is responsible for granting access to the energy information collected and computed within iURBAN following the iURBAN security and privacy policy. It provides an open API that allows third parties to offer external services to the users of iURBAN. This component provides a set of different as shown in Figure 2.20, which are further explained in Table 2.11.

2.1.5.3 Centralized decision support system database

CDSS database is a data warehouse database used by business intelligent system of iURBAN platform (Figure 2.21).

Table 2.10 Digest modules

Component	Description
Energy data digest	It provides Web services for the acquisition of meter data from the utilities. This component is responsible for storing meter data in the smart city database.
Configuration	It provides Web services for the setup of the smart city database relational content in relation with the utility meters.
Weather data	This module is responsible for fetching current and forecast weather data from external service.
Energy price	It provides Web services for the input of energy price.
Smart home	This module extends the current capabilities of nAssist© smart home interface providing new communication features in order to fulfill new smart home functions related to iURBAN user engagement and DR programs.

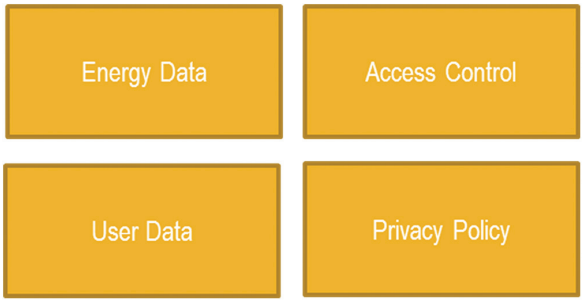

Figure 2.20 OPEN API module.

Table 2.11 OPEN API sub-modules

Component	Description
Energy data	This component exposes the energy data stored in iURBAN database. It provides access to current and historical data, from meter level up to city level.
User data	This component provides information from users following the privacy policy
Access control	This module controls which information can be access through the open API based on the request and the type of external service accessing the data. It logs all the request and all data access from external services.
Privacy policy	This module is used to set privacy policies for data access (explained in this chapter).

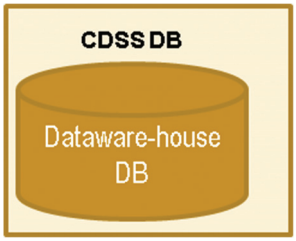

Figure 2.21 CDSS DB (data warehouse).

The data types stored to database are as follows:

- Consumption (KWh)
- Consumption (m^3)
- Production (KWh)
- Production (m^3).

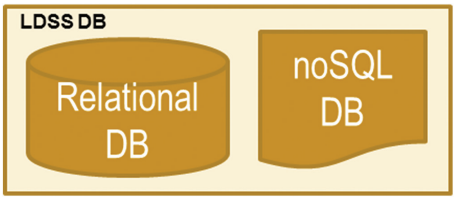

Figure 2.22 SQL/noSQL LDSS database.

2.1.5.4 LDSS database

The LDSS database (logic diagram in Figure 2.22) is built by adding new tables, relations, and storage on top of the nAssist©'s database.

The database is running in the cloud and it is only accessible through dedicated Web API provided by nAssist© enabled service.

Meter data is stored in the actual infrastructure of the nAssist© database. To support LDSS functionalities, the LDSS database stores additional information and relation as follows:

1. Grid infrastructure at building level.
    a. Electrical grid
    b. Heating grid
2. Tariffs
3. Demand response programs
    a. Historic events
4. Forecast calculations
    a. Hour basis
    b. Day basis
    c. 24/48/72-hour basis
5. Benchmark statistics at city level

2.2 Deployment View

The diagram below represents the typical production deployment of the iURBAN platform and can be viewed as a high-end configuration. Each sub-component of the platform is represented (Figure 2.23).

Almost all components of iURBAN platform are located online on the cloud in particular the LDSS sub-system. The cloud computing approach assures to the platform the following advantages:

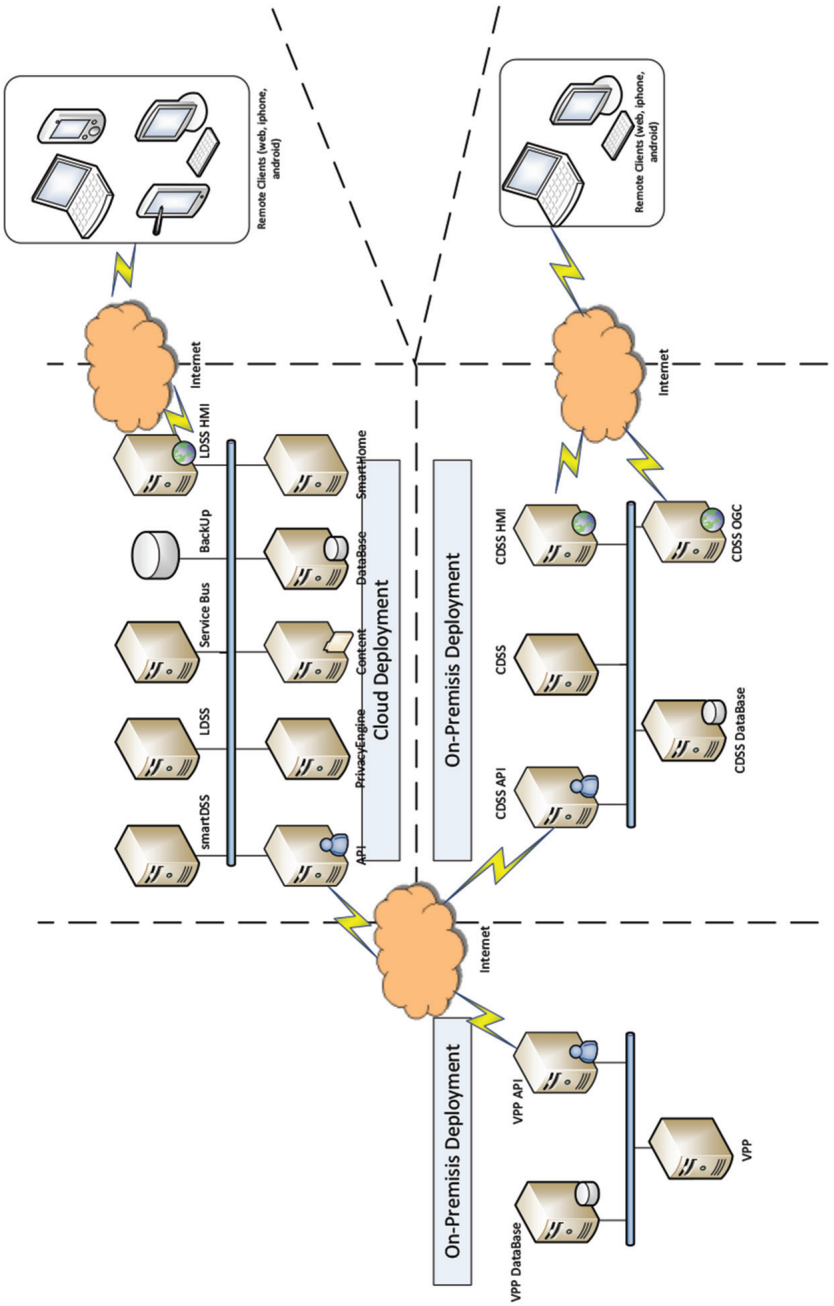

Figure 2.23 iURBAN deployment diagram.

- **Reduced Cost**: Cloud technology is paid incrementally, saving iURBAN consortium money.
- **Increased Storage**: The platform can store more data than on private computer systems.
- **Highly Automated**: No personnel need to worry about keeping software up to date.
- **Flexibility**: Cloud computing offers much more flexibility than other computing methods.
- **More Mobility**: Users can access information wherever they are, rather than having to remain at their desks.
- **Easy Deployment**: Centralized deployment.

However, in order to provide a high degree of data security and confidentiality, iURBAN platform is based on a "**Hybrid Mode**" deployment, which foresees to have critical components deployed on premises.

2.3 Conclusion

This chapter provides an overview about the main three ICT components of iURBAN tool and their relations. For each component, a sub-component explanation has been given, so the reader is able to have a wide overview of the functions and how those ones are mapped into its respective components and sub-components.

We have use hybrid architecture for deployment. Cloud infrastructure has been selected in order to account for main database, interfaces/API and intensive computation algorithms, and artificial intelligence models (predictions). This allows the reassign ICT and computational resources as smart grid meters grows over the time, which is expected to happen in parallel with number of residential users (LDSS users). CDSS and VPP have been designed to be deployed on premises, the ICT-demanded resources are lower, and it makes more manageable for local deployment.