TALQ White Paper

The Smart City Protocol

TALQ Specification Version 2.0

August 2018

About TALQ

The TALQ Consortium has developed a global standard protocol to enable Central Management Software to configure, control, command and monitor multiple Outdoor Device Networks from various suppliers through an easy-to-integrate RESTful/JSON protocol. TALQ is open to industry members to join and participate in the evolution of the TALQ Protocol.

TALQ also provides a Partner Program for cities, municipalities, utilities and consultants to contribute to the future of Smart City. To learn more about us, our members and partners, please visit www.talq-consortium.org

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About this document

This white paper helps companies understand the concepts of the TALQ specification. For any further explanation of the contents of this document, or in case of any perceived inconsistency or ambiguity of interpretation, please contact the TALQ Consortium:

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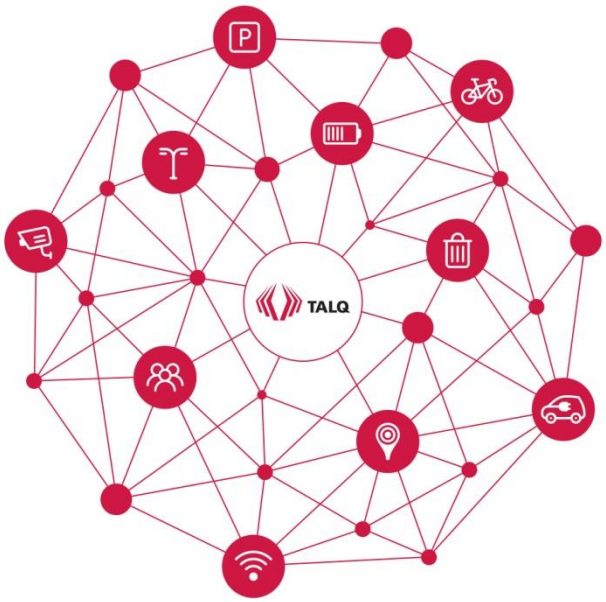
1. THE CHALLENGE

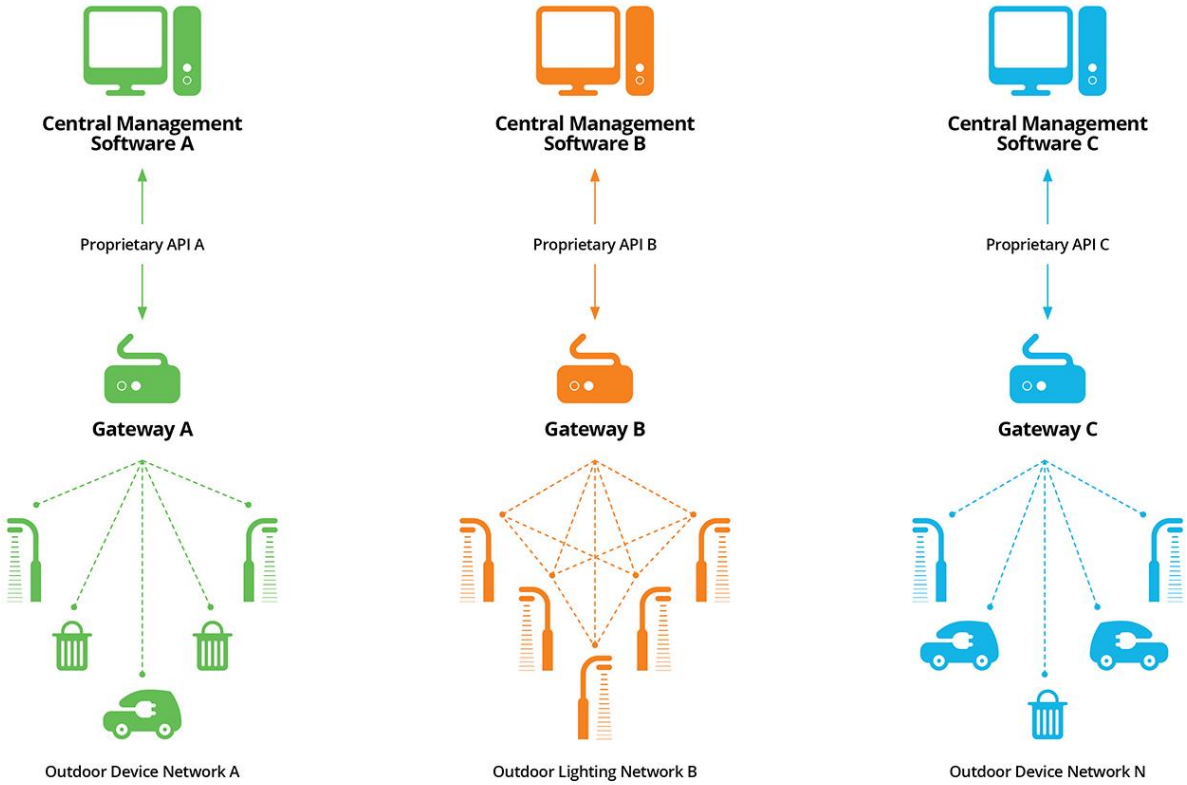
Every day a new Smart City project is announced: streetlights are being connected to save energy and increase the quality of lighting services in the streets, waste containers are being monitored to reduce truck traffic whilst helping cities to get cleaner, free parking spaces are detected and advertised to drivers both to reduce pollution and to allow variable pricing depending on their availability, and more.

Most of the available solutions, however, are proprietary, locking cities into single vendor solutions. Thanks to the TALQ Smart City Protocol, cities can now adopt control solutions from multiple vendors and control them all through a single Central Management Software.



The TALQ Smart City Protocol is an application interface to exchange data, commands and programs between one or more Central Management Software (CMS) and Outdoor Device Networks (ODNs) from different vendors to enable configuration, control, command and monitoring of connected devices in the city.

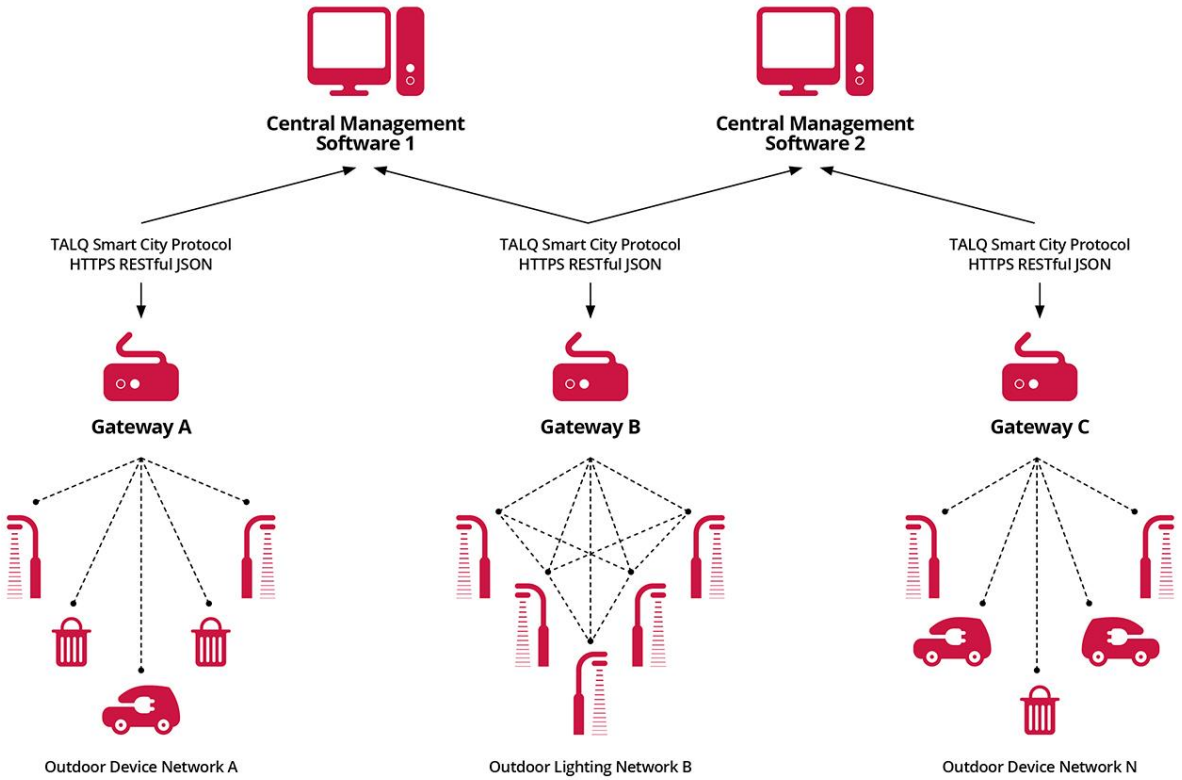
Today's challenge is the complexity associated with multiple proprietary systems and interfaces. The lack of standards makes controlling different connected devices and smooth deployment of various systems for different applications across a region or city very difficult.



Centrally Managed Smart City System without TALQ

2. TALQ, THE SMART CITY PROTOCOL

The TALQ Consortium develops and manages the TALQ Smart City Protocol. The TALQ Smart City Protocol defines the message types, data format, parameters and behaviour of CMS and Gateways, to configure, control, command and monitor different types of connected devices on various ODNs. As illustrated in the drawing below, TALQ does not constrain the protocols and network implementation of the ODN itself but provides a common interface between an interface to an ODN, called the Gateway, and a CMS.



Centrally Managed Smart City System with TALQ

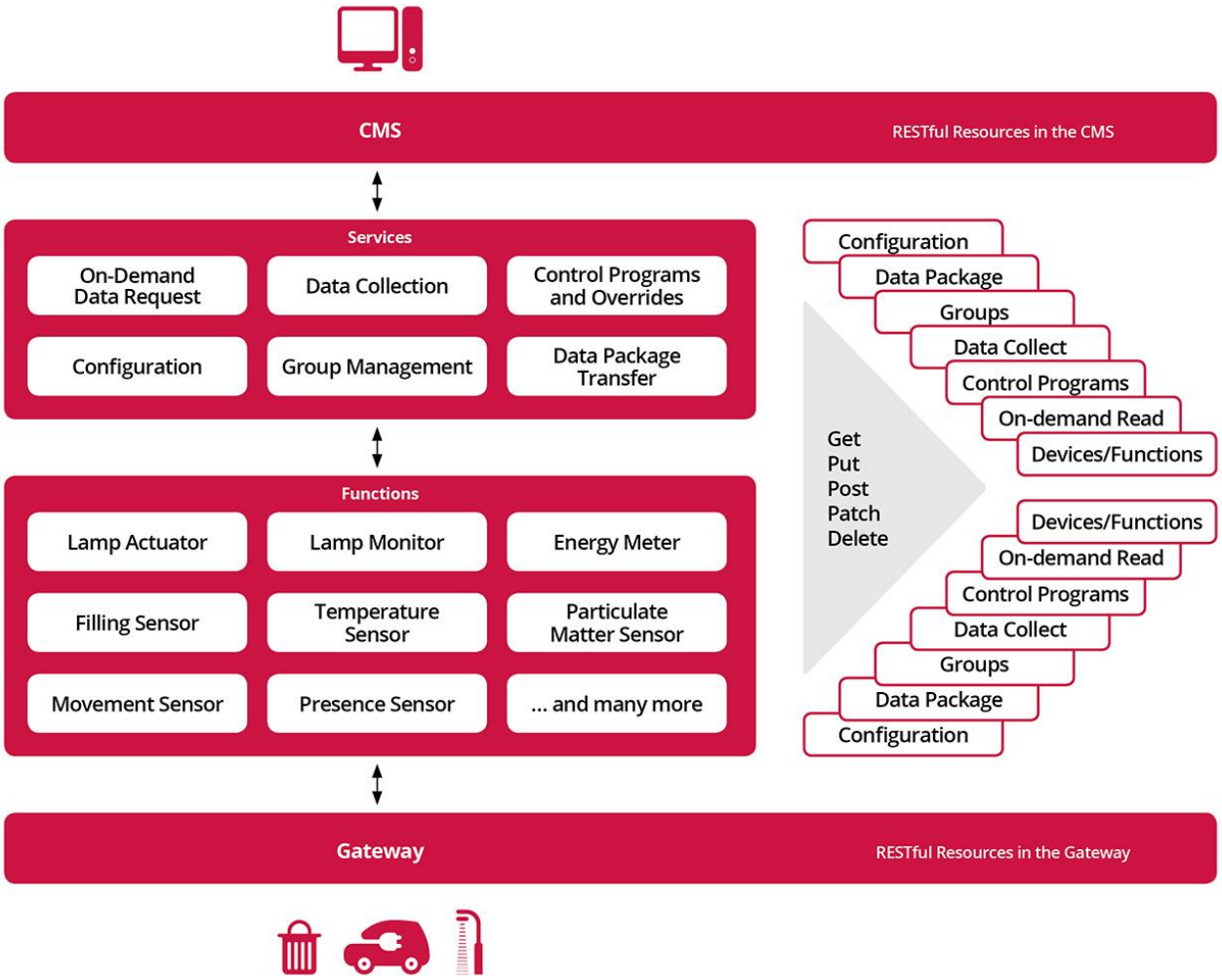
The TALQ Smart City Protocol offers the following key benefits:

- **TALQ offers a flexible data model** that is applicable to a wide range of sectors and use cases, such as outdoor lighting control, waste collection, parking space detection, environmental data collection, energy management and more. With TALQ, vendors are free to describe their devices using TALQ functions that include a set of agreed configuration, operational and metering attributes and events, which can be configured, controlled, commanded and monitored using TALQ services.
- **TALQ covers a broad set of services**, not only data collection but also configuration services, dynamic control programs and manual overrides, an on-demand data read service, group management and firmware updates.
- **TALQ is based on well-known standards to be easy to implement**. The standard RESTful approach adopted by TALQ makes it easy to integrate in both existing CMS and Gateways. To enable configuration, control, command and monitoring from a CMS, the TALQ Smart City Protocol provides secured HTTP REST GET, PUT, POST, PATCH and DELETE requests and associated JSON data payloads to describe the devices, their functions and attributes.
- **TALQ provides a comprehensive certification program** and associated test tools which are valuable both for vendors during their implementation process and for end-customers to make sure products are fully interoperable.

3. TALQ, A FLEXIBLE SMART CITY DEVICE DATA MODEL

To support many Smart City use cases, including, but not limited to, outdoor lighting control, waste collection, parking space detection, environmental data collect and energy management, the TALQ model:

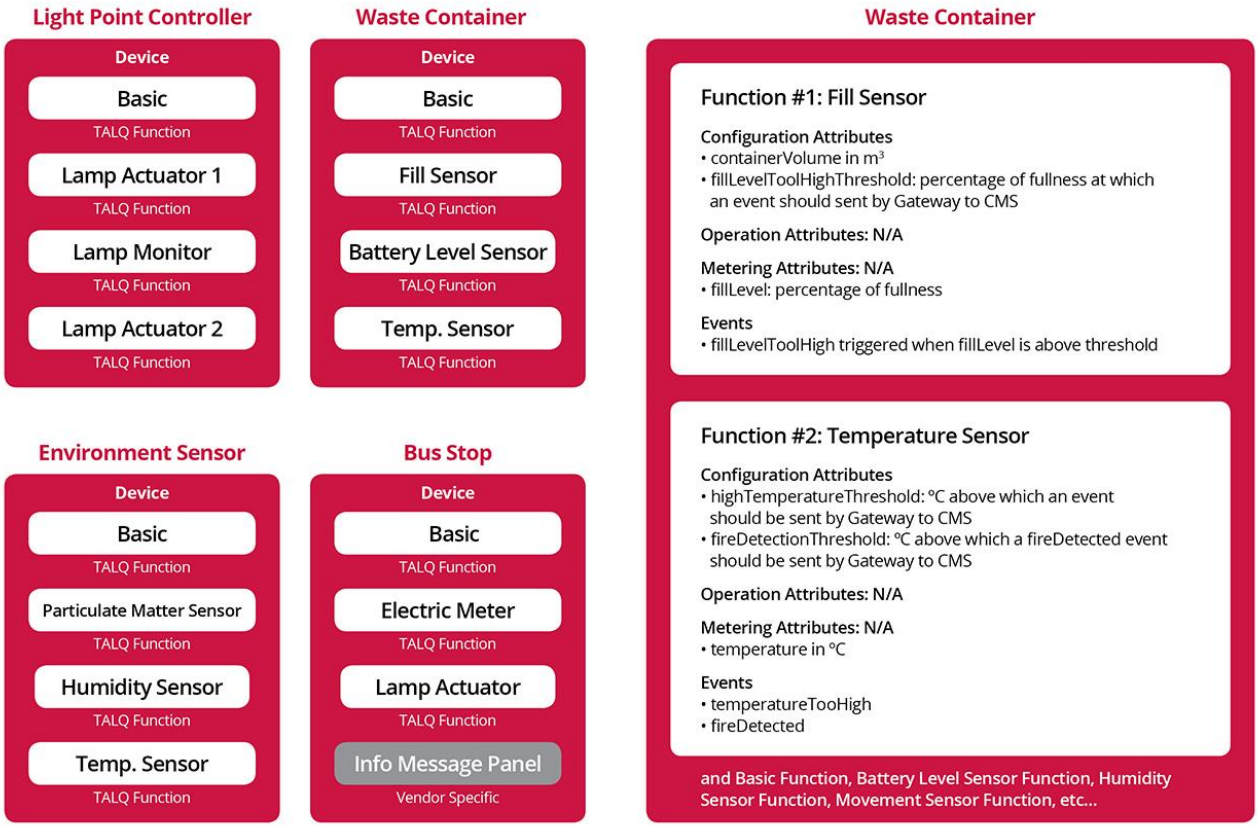
- provides a whole range of services, not limited to data collection but also including remote control, device configuration, schedulers and calendars, firmware update and more, and
- enables vendors to describe any type of device using functions, attributes and events, in a way which is easy to understand for Central Management Software.



TALQ Device Data Model

A TALQ device is made of a set of functions which represents the capabilities of a physical device. Vendors are free to model their physical devices using the existing TALQ functions and their attributes and events. They can also use the TALQ generic functions or can design their own functions, attributes and events based on existing ones.

The following diagram shows four example devices that are built as a composite of functions. Each function has four types of attributes: configuration, operational (i.e. commands), metering and status (corresponding to events).



Exemplary devices with its set of TALQ functions

3.1. TALQ services

The TALQ services define the message exchanges and application behaviour needed to manipulate function attributes in order to implement a certain set of features. The following services are supported in TALQ.

Configuration service

The configuration service enables the Gateway to announce device and service capabilities (i.e. supported services and a list of supported device classes including their functions and attributes) as well as to announce connected devices to the CMS. It also enables the CMS to create devices in the Gateway and to configure their configuration attributes.

On-demand read service

The on-demand read service enables the CMS to read any metering attribute from any function of any device. This service is actually supported by a standard RESTful GET API on the device/function/attribute resource.

Control service

The control service describes the mechanisms to operate commands in order to enable both schedule-based and override control.

The override control mode enables the CMS to actuate any command or groups of commands as needed, e.g. open/close a valve to start/stop water irrigation, switch a lamp in real time, send a message to an information panel.

The schedule-based control, also called control program, enables the CMS to pre-configure the behaviour of one or more commands based on one or more factors, such as time and sensor inputs (e.g. open/close water irrigation valve when humidity is below a threshold, increase light level when a pedestrian is detected, switch ON a light at sunset). Control programs enable use cases such as:

- Dynamic outdoor lighting: automatically adjusting light levels of groups of streetlights when vehicles and/or pedestrians are detected or depending on vehicle count or speed.
- Water irrigation: irrigating plants only when humidity is low and depending on sun and temperature.
- Dynamic city information panel: displaying automatic messages on city information panels depending on traffic and/or pollution measurements.

Group management service

The group management service provides the mechanisms to define and manage groups. Groups can be used across TALQ services whenever there is a need to address a set of devices and/or functions together. For instance, an override control command may be sent to a group of devices. The same control program may be distributed to a group of lamp actuators. A group may also include other groups as members. Groups can also be used in the configuration of the data collection features.

Data collection service

The data collection service enables the CMS to configure how ODN should report metering attribute values, status information and events, and when or under what conditions the logged data is transferred to the CMS. This service enables adaptation of the data collection and transporting behaviour to the needs of the specific CMS and ODN implementations.

Data package transfer service

The data package transfer service provides a mechanism to transfer data packages containing ODN vendor specific information, such as firmware updates, from the CMS to the Gateway.

3.2. TALQ functions

The complete and detailed description of these TALQ functions, their attributes and events is available in the member area of the TALQ web site and will be enriched with new functions over time. The list below is given as a set of examples:

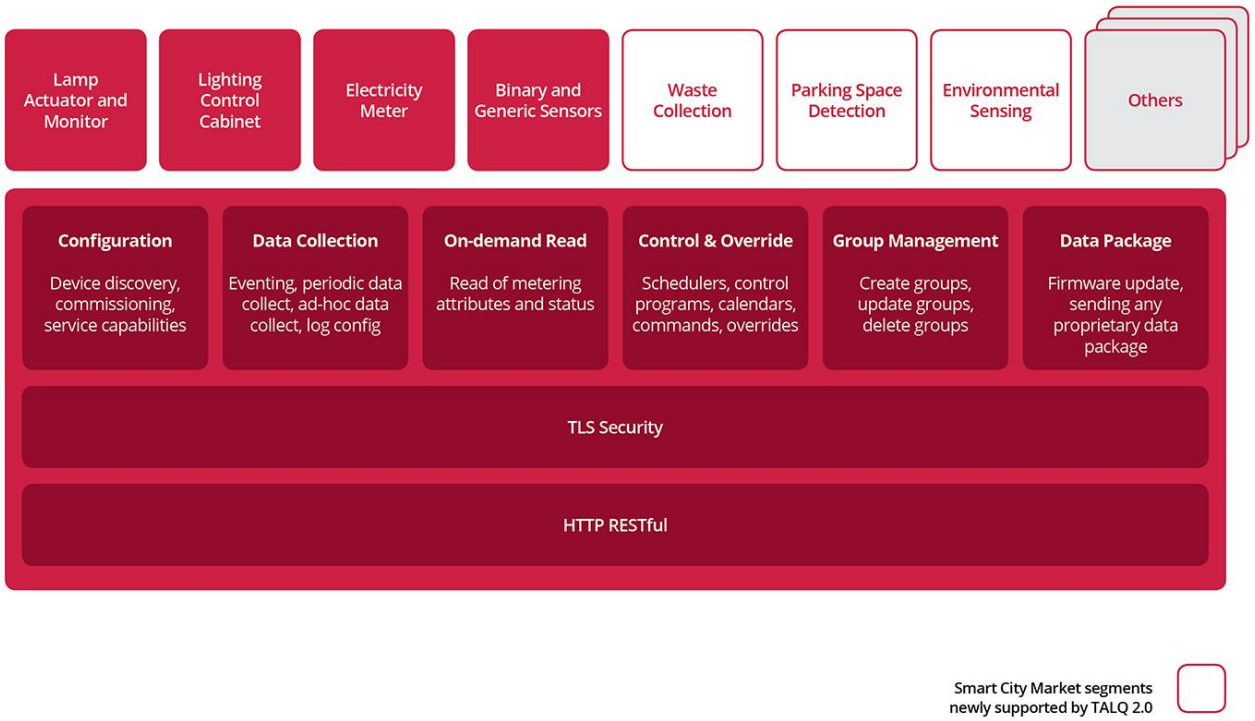
Function	Description
Basic	The Basic function describes the configuration attributes of the physical device, such as its identifier, its longitude/latitude and more. This function also provides attributes such as time zone and local time.
Gateway	The Gateway function includes the attributes to enable the communication between the CMS and the Gateway according to the TALQ Smart City Protocol.
Communication	The Communication function hosts configuration and metering attributes (e.g. signal strength) related to the communication within the ODN, i.e. between ODN devices and the Gateway, and events such as communication failure or weak communication signal.
Lamp actuator	The Lamp Actuator function includes operational attributes related to switching and dimming one or more lamps with one single actuator.
Lamp monitor	The Lamp Monitor function includes configuration and metering attributes such as lamp types, energy consumption, current, voltage, active power, power factor, temperature and more. It also gathers events such as lamp failure, low/high current, etc.
Electrical meter	The electrical meter function supports metering attributes such as voltage, current, power, energy, and power factor on single or three phases and events related to these attributes.

Light sensor	The Light Sensor function provides the output of a light sensor and allows Gateways to send events in case the value is above/below configurable thresholds.
Temperature sensor	The Temperature Sensor function gathers configuration and metering attributes to monitor temperature and detect high temperature and fire alarms.
Humidity sensor	The Humidity Sensor function gathers configuration and metering attributes to monitor humidity and detect alarms. It may be used in water irrigation use cases.
Particulate Matter sensor	The Particulate Matter Sensor function gathers configuration and metering attributes to monitor PM10, PM2.5 and PM1 and detect alarms.
Presence sensor	The Presence Sensor function may be used in Parking Place detectors as well as in dynamic outdoor lighting scenario.
Movement sensor	The Movement Sensor function allows to detect movement. This function may be used in Waste Container sensor to detect that container gets emptied or is not in the proper position, as well as in asset tracking applications.
Filling level sensor	The Filling Level Sensor function gathers configuration and metering attributes to monitor how full a container is and to send events in case the value is above/below configurable thresholds.
Battery level sensor	The Battery Level Sensor function gathers configuration and metering attributes to monitor battery. It may be used in parking sensors, waste container sensors and many other battery-powered devices..
Generic actuator	The Generic Actuator function enables to control an actuator, for instance in an electrical cabinet or an irrigation valve.
Generic sensor	A Generic Sensor function can used to model any sensor that provides an analog output and send events in case the value is above/below configurable thresholds.
Binary sensor	A Binary Sensor function can be used to model any sensor that provides a digital output. It may be used in many use cases to detect the ON/OFF status of any actuator.

Experts in new smart city vertical segments are increasingly working with experts from the TALQ consortium to understand how their use cases and devices can map onto the TALQ device data model. In most cases this simply requires new functions with associated attributes and events. The set of services available in TALQ is comprehensive and designed in a flexible way to support many different use cases.

New functions can remain vendor-specific or can be submitted for publication and wider use as the scope of use of the TALQ specification grows.

Thanks to its flexible device data model, TALQ can already be used to provide interoperability between Central Management Software and suppliers' Outdoor Device Networks in many smart city vertical markets, allowing them to cover multiple smart city applications within a single platform.

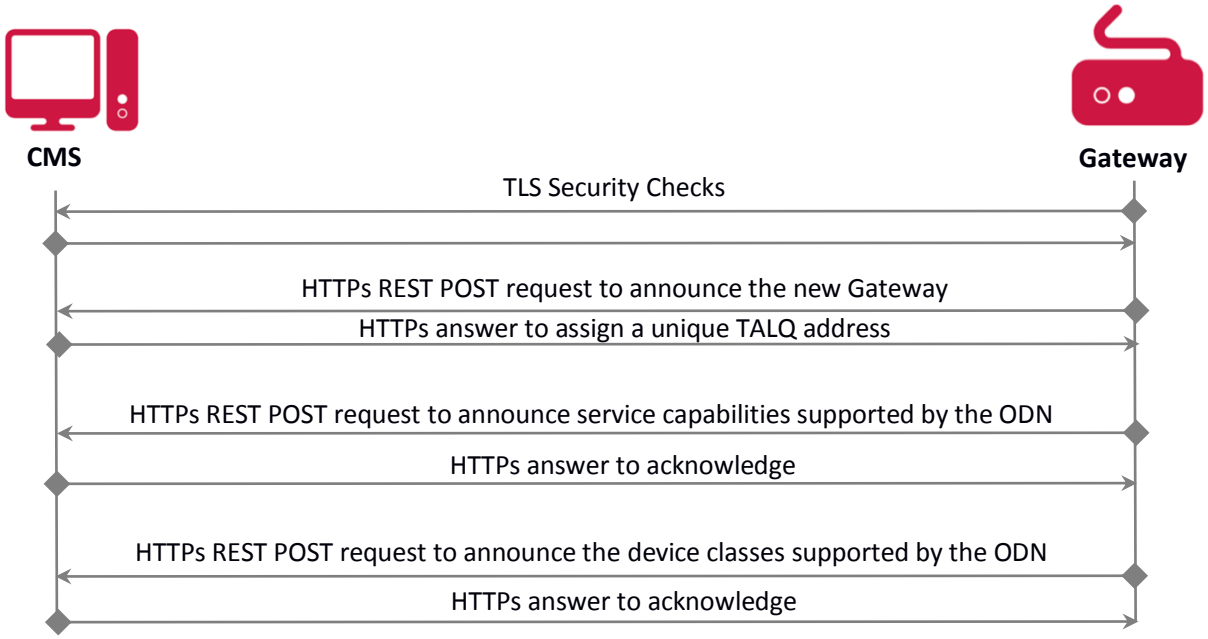


4. TALQ, A RESTFUL AND JSON ARCHITECTURE

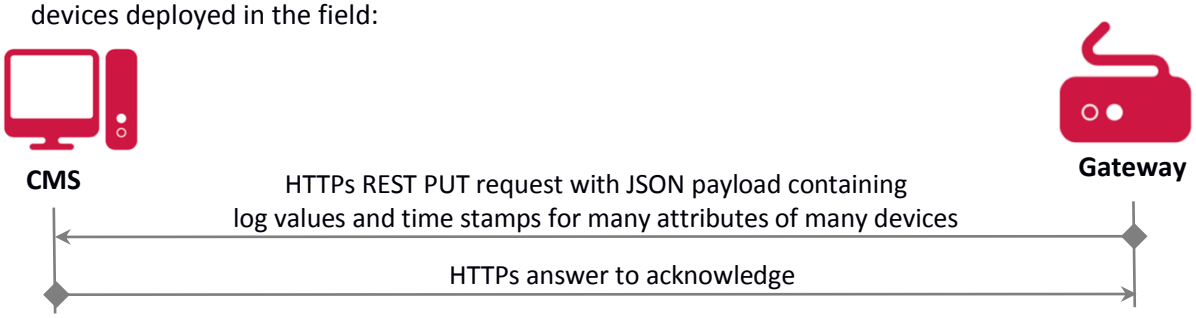
The TALQ 2.0 Smart City Protocol is based on a RESTful architecture and a JSON data model representation, because of their widespread use and inherent simplicity of implementation. The protocol is released as a Technical Specification document, two Open API v3 (OAS 3) files and one JSON Schema file, which describe both the CMS and Gateway APIs and the data model in JSON, so that software developers can easily generate their source code using Open API tools (e.g. Swagger) and support TALQ in their CMS or Gateway.

The figure below illustrates some typical exchanges between CMS and Gateway:

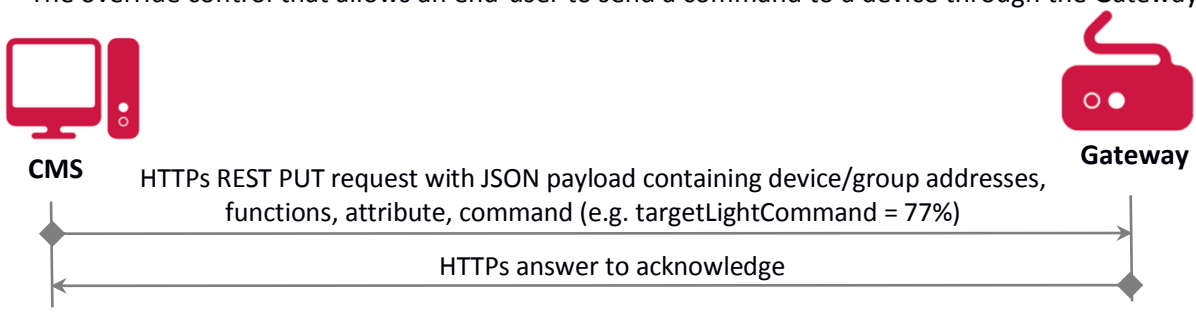
- The Bootstrap & Discovery process that enables a new Gateway to be connected to a CMS



- The Data Collect Service that allows log data to be sent to the CMS from one or more or a group of devices deployed in the field:



- The override control that allows an end-user to send a command to a device through the Gateway.

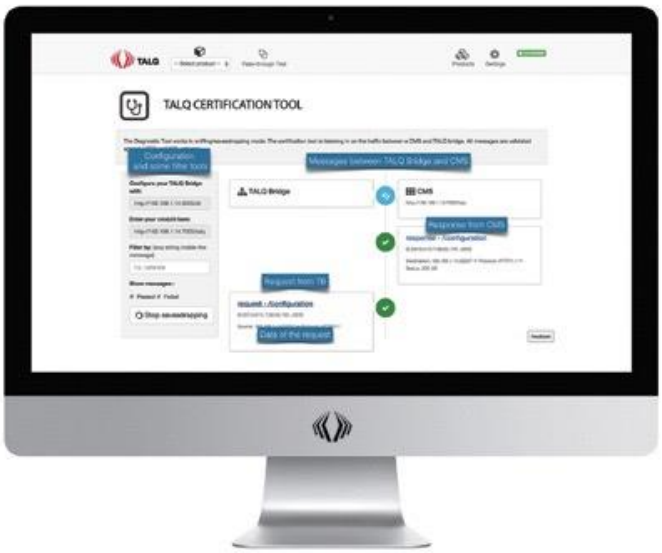


Here are some other examples of the TALQ REST requests to get, create, update and delete resources by the Gateway on the CMS or by the CMS on the Gateway:

Objective	RESTful API (URL)
Get the list of all the devices that exist in the Gateway, their functions and attributes	HTTP GET https://<gatewayUri>/devices?clientAddress=<cmsAddress> The answer shall be a HTTP Response Code 200 with a JSON payload providing the list of devices, functions, attributes.
Get the list of functions and attributes for one particular device in the Gateway	HTTP GET https://<gatewayUri>/devices/<deviceAddress>?clientAddress=<cmsAddress> The answer shall be a HTTP Response Code 200 with a JSON payload providing the list of functions and attributes from this device.
Set the value of a list of configuration attributes of a device on a Gateway	HTTP PATCH https://<gatewayUri>/devices/<deviceAddress>?clientAddress=<cmsAddress> associated with a JSON payload to list the values to set. The answer shall be a HTTP Response Code 202. Note: in the case of a function array, each array element passed in will be used to update any existing element with the same function id. If there is no existing element with the same function id, one will be added.
Report a list of log values from one device by a Gateway to the CMS	HTTP POST https://<cmsUri>/log-report?clientAddress=<gatewayAddress> associated with a JSON payload to list the log values to report. The answer shall be a HTTP Response Code 201. or HTTP POST https://<cmsUri>/devices?clientAddress=<gatewayAddress> associated with a JSON payload to list the log values if they relate only to devices' attributes and events. The answer shall be a HTTP Response Code 201.
Read a particular metering attribute (supplyVoltage) on one device by the CMS	HTTP GET https://<gatewayUri>/devices/<deviceAddress>/<lampMonitorAddress>/supplyVoltage?clientAddress=<cmsAddress> The answer shall be a HTTP Response Code 200 with a JSON payload providing the attribute value.
Set the value of one particular attribute of a device in the Gateway	HTTP PUT https://<gatewayUri>/devices/<deviceAddress>/<lampActuatorAddress>/lampTypeId?clientAddress=<cmsAddress> associated with a JSON payload to set the new value of lampTypeId attribute. The answer shall be a HTTP Response Code 201. Note: PUT may be used to remove functions from a function array.
Create a list of devices in the CMS	HTTP POST https://<cmsUri>/devices?clientAddress=<gatewayAddress> associated with a JSON payload to provide the device list and their functions/attributes. The answer shall be a HTTP Response Code 201.
Delete a device in the CMS	HTTP DELETE https://<cmsUri>/devices/<deviceAddress>?clientAddress=<gatewayAddress> The answer shall be a HTTP Response Code 200.
Add a list of new calendars in a Gateway	HTTP POST https://<gatewayUri>/calendars?clientAddress=<cmsAddress> associated with a JSON payload to list the content of the calendars. The answer shall be a HTTP Response Code 201.

5. THE TALQ CERTIFICATION PROGRAM

The TALQ Consortium operates a Certification Program with transparent procedures and a TALQ Test Tool to provide confidence in full interoperability between a TALQ-compatible CMS and a TALQ-compatible Gateway. TALQ Members can challenge their own CMS or Gateway with the TALQ Test Tool until their implementation of the TALQ Smart City Protocol is verified. Additional TALQ plug fest sessions allow members to test their solution in collaboration with solutions from other vendors.



Official certification of TALQ compliance is awarded by the TALQ Certification Workgroup shortly after companies submit all the files and declarations necessary for certification.

Certified TALQ compliant products are identified by the TALQ symbol and listed on the TALQ website.

6. WHY JOIN TALQ?

Here are the main reasons why companies consider joining the TALQ Consortium:

- Cities need open and interoperable systems. TALQ answers this market need and allows them to control various vendor solutions from one single Central Management Software or Smart City Platform. Cities such as Paris, Miami and Copenhagen are using TALQ-compatible systems. More and more tenders require systems to be TALQ compatible.
- TALQ is based on leading technical standards which makes it easy and fast to implement. TALQ is an application protocol which considerably reduces the complexity of integrating systems with each other, while offering a wide range of features to build Smart City Platforms.
- TALQ supports many smart city vertical applications including outdoor lighting control, waste collection, parking space detection, energy metering, environmental sensing and more.
- TALQ's architecture is highly scalable and supports projects with millions of devices and transactions.
- TALQ is supported by large companies and market leaders as well as dynamic startups.
- TALQ is designed to evolve thanks to a flexible device and service data model.
- TALQ offers a robust certification program.

7. HOW TO JOIN TALQ

You may want to join TALQ as a Regular Member, an Associate Member or as a Partner. Regular Members contribute to update, manage and promote the TALQ Smart City Protocol and can implement the protocol in their products. Regular Members participate in all Workgroups including Technical and Certification Workgroup.

Associate Members participate to the Promotion and Requirements Workgroup and can implement the protocol in their products.

Partners are end-customers and consultants. They can't implement the protocol but can contribute to its promotion.

All benefits of the different membership types are described in detail on the TALQ website. To join the TALQ consortium, go to www.talq-consortium.org and request a membership form. The TALQ Consortium will contact you soon.

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