



E-street Initiative

Work Package 5.2

Topology of administrative systems

On behalf of the E-Street project (www.e-streetlight.com)



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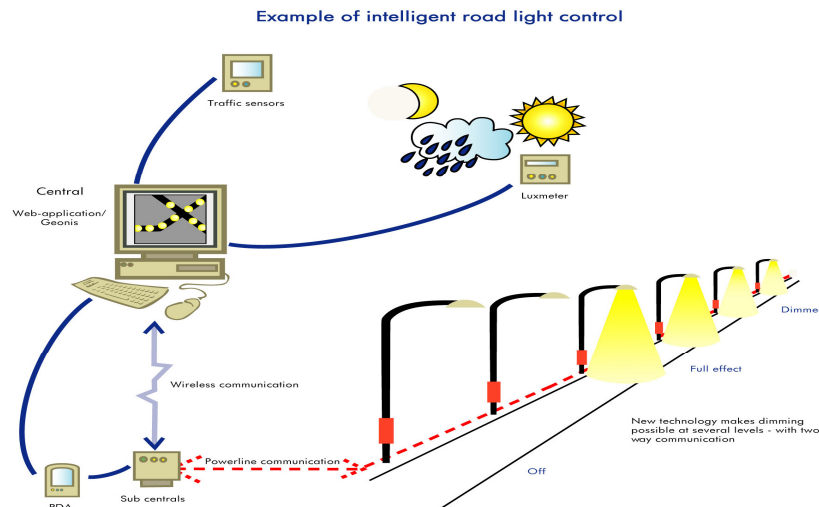
1 INTRODUCTION

With introduction of intelligent street lighting with two-way communication and the possibility for control and energy metering from different suppliers, street owners is dependent of an effective coordination and administration of the streetlights. This new options and efficiency potentials also raises new challenges in utilise the possibilities. This means that streetlight is no longer a stand alone system, rather a highly integrated part of the street owners administrative system for operation, maintenance, energy metering and billing, as well as interfaced with customers services, geographical systems and administration of sub-contractors.

This report gives a short introduction to administrative aspects and challenges regarding streetlighting and new technology, furthermore it gives a description of a administrative system for streetlighting witch gives the streetlight owners a tool to handle all streetlights, including the complexity of intelligent street lighting.

2 TECHNOLOGY ASPECTS

2.1 Topology of streetlighting



A streetlight system without any new technology known as "Intelligent streetlighting" is quite simple when it comes to the equipment used. In short it consist of luminaries, poles, lines/cabels, switchcabinet and for instance a photocell for ignition and switch off the light. In some cases there are one or a few photocell which is centralized, and the signals for ignition and switch off are sendt through signal cables to a contactor in each switch cabinet.

Introducing intelligent streetlighting, the street light system will be a lot more complex with new technology in both luminaries and switch cabinets as well as new datasystems controlling the streetlights.

2.2 Communication

There are several technologies available for communicating with street lighting installations. The three dominant technologies are:

- Radio/telephone
- Fiber
- Powerline

All these technologies are today utilizing digital signalling. Prior radio/telephone systems operated on an analogic basis, in some cases still in use in old systems.

Radio/telephone

Telephone /radio communication is undergoing rapid development and changes. Prior airborne GSM solutions now currently are provided with GPRS, 3G or EDGE. For fixed wire/twisted pair solutions ADSL is more commonly used than the previous ISDN. The different capacity, flexibility and tariffs will define your choice.

Fiber

Fiber-cable is developing in competition with existing telephone and video-cable installations. In many cities fiber is available at reasonable pricing for long distance transfer of data. Fiber is in use for street lighting installations between the switch cabinet and central database.

Powerline

Powerline is a relatively new technology. It utilizes the existing power-cabel for high frequency signalling. Powerline is now available for the private home market in applications for i.e local broadband internet connections. In street lighting installations it is commonly used between switch cabinet and the luniniaries.

2.3 System integrations of databases

The Management software forms the part of the solution where it all comes together. The software consists of a database and various applications around it that together form the management system. The software should give complete control over the Outdoor Lighting System and the data coming from it. It should be your choice to host the management platform on your own server or use an Application Service Provider (ASP) for the management system. The management software provides all the functions needed to keep your solution efficient, well maintained and safe. The software should enable you to:

- collect, organize and store the data coming from the street
- recalculate and rework the data so it becomes useful information
- set the schedules, data loggers and alarm options in your system
- manage the Wide Area Network as well as the control network in the street
- present the data in the way that you like it best, using a normal web browser on a standard PC
- present data to other applications that you already have like billing or maintenance systems using standard web technology and SOAP/XML.

The software has four important functions; a Data Engine, the Expert Engine, the data interface and the Front-end. All software should be developed using best practice and state of the art Open technology like SQL and Flex.

2.3.1 Database and data collection

The heart of the software is formed by a SQL database where the data coming from the different sources, like lamps, feeder pillars and sensors is organized and stored. The data gathering software should be developed with GPRS in mind and is therefore a very “lean” solution that will not transfer one byte too much. After all, over GPRS the data has to be paid by the byte. The database normally stores information in four different sections containing information like:

Streetlight attributes

- Lamp name
- Lamp ID/Location/GPS position
- Power
- Owner
- Type
- Metering ID, if lamp itself is doing metering

Feederpillar attributes

- Feederpillarname
- Area (where it belongs)
- Metering ID if there is a meter installed in the feederpillar

Streetlight data (data coming from the lamps)

- Ballast value
- Burning hours
- State
- Lamp feedback
- Energy count

Feederpillar data (data coming from the feederpillars)

- Energy count
- State and door status

To store the right data in the database in a timely manner a Data Collector gathers the data from the Segment Controllers. The Data Collector pre-processes this and then organizes it in the database. Very important is the scalability so the size of the solution is practically irrelevant. It should be possible to run 35 lamps and one feeder pillar or 55.000 lamps on 800 feeder pillars with similar performance in the management system.

2.3.2 Combining data and experience

To be able to use the data in the right way and combine it with all the expertise available there should be a module that continuously calculates, combines and interprets your data to help answer questions like:

- why do some lamps fail unexpectedly
- present the data in the way that you like it best using a normal webbrowser on a standard PC
- what causes intermittent problems and how can they be solved
- does a group replacement make more sense than a individual lamp change
- how can my schedules be optimized to save even more energy
- are there any power supply issues in my network

2.3.3 Sharing the data

If the information from your street light system needs to be available in other (enterprise) applications, like your maintenance systems, billing system or financial applications a data interface will take care of it. It should be able to present any information available in any standard format you wish to other software packages.

If you need to control items in your system from another application, like a traffic management system, accident detection application or weather feeds from the internet it is also done through this data interface as well. The data interface should be able to cope with all standard ways of exchanging information known today.

2.4 Intelligent streetligting – at what level ?

Streetlighting system is possible to operate in different degree of intelligence depending on the customer´s needs, topology of electrical network, purchase and operating costs and etc. Intelligence of streetlighting systems is, according to the presence of actuators and measuring elements, located in the switch cabinet or in the luminaire or combined.

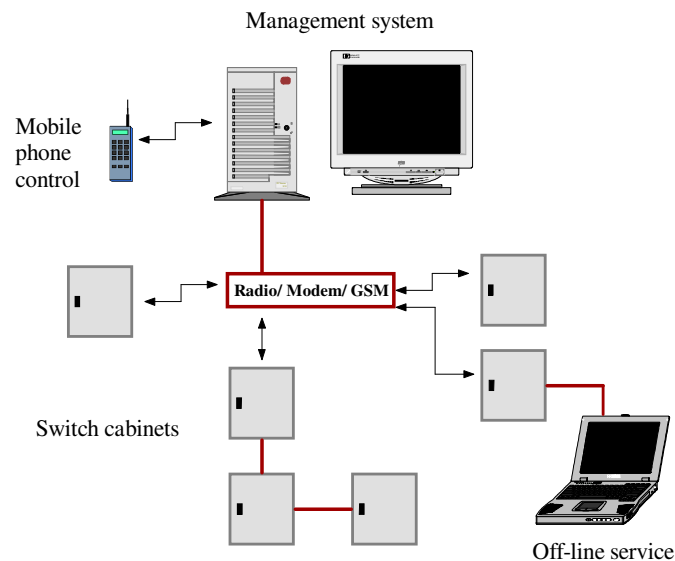
2.4.1 Switch cabinet

Intelligent streetlighting system based on the switch cabinet provides remote control for optimal central switching, dimming of lighting systems and monitoring of operating and faulty states of switch cabinet. Segment controller is ordinarily link to the certified electronic electrometer measuring electrical values with high accuracy such as current (identification of the failure of the group of lamps on outgoing sections), voltage (power failure), power factor (quality of electricity), electric input (illegal power take-offs), consumption of electrical energy (overview of electrical energy payments). Further more the state of main circuit breaker is monitored as well as state of switch cabinet's door (unauthorized entrance).

Segment controller provides also switching via contactors according to the information from astronomical clock or photocell. Dimming is usually provided by central voltage regulator located in or next to the switch cabinet. Segment controller is equipped with GPRS module or any other W-LAN modem for communication to the over all management system.

The main features of the system are less demanding maintainance of intelligence assets, lack of information about the state of lamps, identical dimming regime for the areas with different lighting demands and also nominal power input of central voltage regulator is not usually optimally utilized (power input reserve for additional lighting system).

System is applicable for the lighting system powered from own electrical network. Billing is based on the consumption of electrical energy measured in the switch cabinet. At the moment the system is not appropriate for the lighting system powered from the same electrical network together with house connection and other customers.



2.4.2 Luminaire

Streetlighting system based on intelligent luminaires provides remote control and monitoring of operating and faulty states of each lamp. The basic set-up of intelligent luminaire is a lamp and dimmable ballast in combination with a outdoor luminaire controller for this ballast. The specifications are stated in WP 5.1 - "Working tool for market players – Guide for energy efficient street lighting installation".

The main features of the system are lack of information about the operational state of switch cabinets, more demanding maintainance (installation of the control unit in each luminaire), individual control and monitoring of each luminaire and streetlighting powered from one switch cabinet, constant lighting flux via stabilization in each luminaire. System is applicable for the case

of lighting system powered from the same electrical network together with house connections without metering in the cabinet.

2.4.3 Switch cabinet and Luminaire

Intelligence of the system allows to control and monitor operational status in the switch cabinets as well as in each luminaire. The main feature of the system is complete information of the maintained assets stated in WP 5.1 – "Working tool for market players – Guide for energy efficient street lighting installation".

System is applicable in those areas, where consumed electricity is measured in the switch cabinet whereas it is demanded to utilize all advantages of individual communication with luminaires. Open technology should be used so the complexity can be added step by step.

3 ADMINISTRATIVE ASPECTS AND CHALLENGES

The number of streetlights in a city or within a municipality is often of a great number, it is therefore crucial to have a system to administrate this assets. Introduction of different types of intelligent streetlight systems within the same city or municipality demands a common interface of all the systems for the operator and other users.

The infrastructure can also be suitable for other purposes, such as managing Trafficlights. The system should be expandable and it should have the flexibility to be used for other purposes.

3.1 Operation and maintenance

Operation and maintenance of the street light is a huge challenge because of the large number of components in a street light system. It is therefore required to install a system which take care of all the information concerning the state of each component, including information about ongoing activities and historical information. Hence of this each luminaire/component must have a unique objectnumber in the database.

There are various scenarios on the maintenance strategy you can implement. Of course there is the "run-to-failure" maintenance scenario sometimes called "crisis maintenance" in this form the management is done based on the actual status of the overall system. Most management solutions work this way.

Second it is possible to set up periodic preventive maintenance, or "historical" maintenance. This is where the history of each lamp type is analyzed and periodic replacement is scheduled before the statistically expected problems occur.

Most sophisticated is to set up predictive maintenance, which is based on the determination of the lamps condition while in operation. By using the information from the database some solution make it possible to sense the symptoms by which the lamp warns that it will break down.

The latest innovation in the field of maintenance is called predictive maintenance or so-called pro-active maintenance, which uses a variety of technologies to extend the burning hours of the lamps and to virtually eliminate reactive maintenance. The major part of the pro-active tools is what is called "root cause failure analysis". The fundamental causes of lamp failures like frequent power supply issues can be identified and corrected and using this technique failure causes can be gradually engineered out.

The maintenance part of the software should offer a fully automated work order and workflow management system as well as the possibility for tracking and tracing maintenance task in various ways.

3.2 Energy metering and monitoring

The energy consumption is rarely measured with a meter, but calculated based on run hours and installed effect. This gives an inaccurate metering, thus both the grid company and the streetlight owner wish the streetlight to be measured with an energy meter. The easiest way to do this is by installing a meter in the switch cabinet, but this require that the streetlight is built as an electrical network, and not integrated with other types of energy consumptions.

Intelligent streetlighting gives the possibility to meter the energy consumption in each luminaire, hence the streetlight owner is not dependent on having the meter in the switch cabinet. However there are some challenges that have to be solved with this type of new technology:

- The technology is not yet authorized to use for billing purposes
- The meter has to be certified, and this can be an time consuming and expensive process
- Ownership and maintainance responsibilities of the meter in the luminaire.

3.3 Human/machine interface

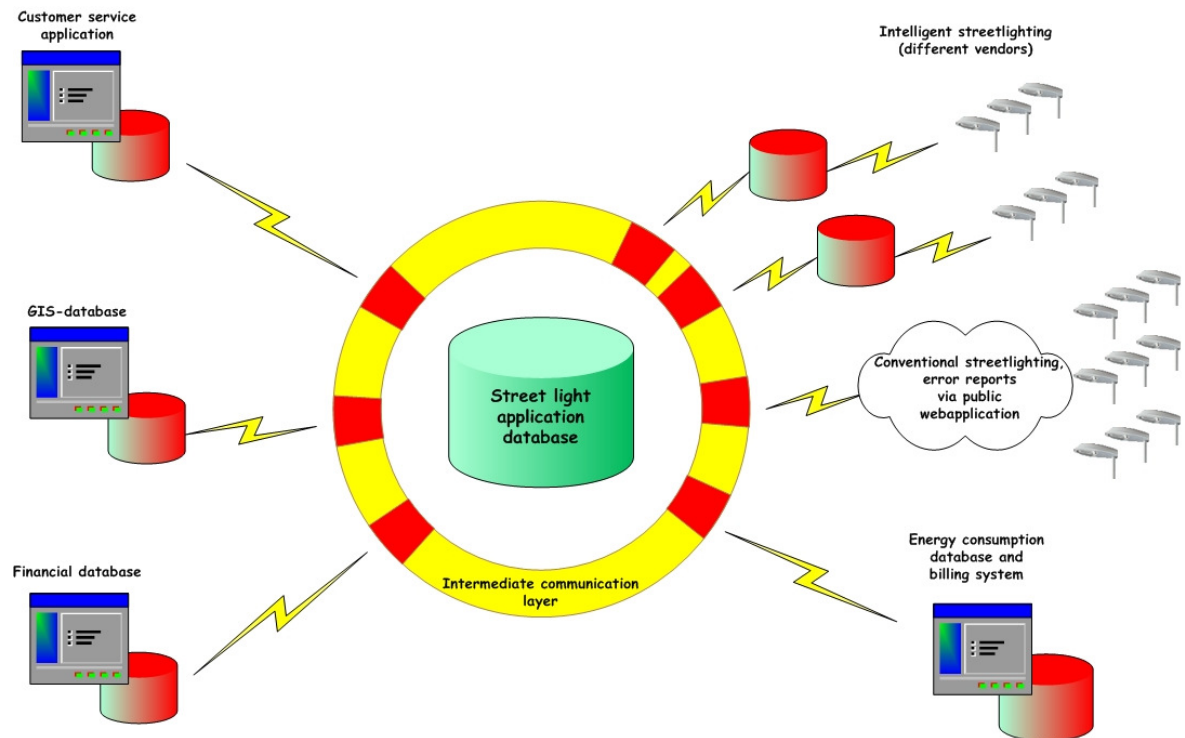
The public and the serviceproviders are both dependent on information about the streetlight from the streetlight operator. The public are interested in a system for fault reporting on the street lighting, and to observe the status on each street light. The serviceproviders are interested in a system for accurate information on the luminaires and reported failures. They are also dependent on a system for reporting the work that has been done regarding failures and other relevant information. The interface for the user should be a GIS system. GIS is very important for maintenance services, it makes it easier to find and identify the failures. The user interface on the web should be simple and easy to handle for everybody.

The front end software allows you to find, manipulate and view the information from your street light system. It will also let you change the settings in your system and monitor the health of your networks.

Normally the front end software is modular and allows for multiple extended functions when needed. In the basis the software should offer a complete Street Light Management System with all basic functionality integrated. It should allow you to look at multiple sites, check and set your schedules, analyze your lamp and equipment behavior as well as your energy usage. It has a simple reporting mechanism that allows for pre-defined reports to be generated and printed. Color coding and letters in one screen should give a first overview and general impression on the segment controller and the lamps. By Clicking on the various items information regarding the object you clicked should be presented to you in lists, tables or graphs.

4 PRINCIPAL DESCRIPTION

Below find a principal system sketch with adjoining system where communication channels are to be established. The communication channels are in the sketch shown in red in a “common” intermediate layer solution.



It is recommended that the communication channels should be a part of the administration system in an implemented solution.

This will be favourable for the customer-center through an effective and accurate feed-back to the public on errors on the street lighting, and an improvement of the economic system due to better control with the different suppliers. The solution requires an automatic administration system for technical and economical reporting.

The system will in most cases be integrated with the existing IT solutions. The main functionality will be:

1. Administration system for street lighting
2. Customer service solution including a communication facilities
3. Active control of street light and integration to the Customer system and energy metering
4. Integration to order system and a fully developed CRM-system.

The customer-service application shall include a web/internet portal adjusted to non-professional user (public) for access and directly reporting of errors etc. Open technology should be used so the complexity can be added step by step.

4.1 Administration system for street lights

The administration system shall consist of an administration database for street lighting, communication channels to surrounding (connected) systems (intermediate layer), an separate user applications with construction record, task list with job orders, plus history and reporting.

The administration database have a data model adjusted to the data delivered from the functional controlled street lighting operation range. Available data from the traditional street lighting is also to be stored in the database. The administration database shall handle construction structure and all the basis data with attributes for both the functional controlled and the conventional street lighting. Data from the user application in the administration system shall also be stored in the database.

It is important that the different communication channels/integrations to the surrounding systems are based on open solutions.

The software should allow for management of two main hierarchies for user Groups: one for access to the Front-end (so users can log in to the web site and view designated sections and pages) and one for the Back-end Administration access.

4.1.1 Task list

The system offers a task list with functionality, such as:

- An order functionality with a task register (a list of job orders).
- A list over customer information for the fixture identities is to be generated.
- Predefined templates for different tasks shall be available.
- The solution is to contain a calendar- function with a display of job orders.
- A given constructor shall be limited only to see his own tasks.
- The job orders are to be given mutual priority.
- The purchaser of tasks shall be able to see the status and the progress for his orders.
- Orders have to be related to individuals or groups in the construction register (i.e. switch cabinet).
- The service supplier must be able to print out finished tasks with the date and the failure cause.
- The service supplier must be able to print out a prioritized list for correction of errors for the fixtures

4.1.2 History

The administration system has to handle reporting of condition reports from the service suppliers, with the following-up of remarks. The remarks are to be categorized depending on the error.

The task registers must report back with a joint history. It shall also be possible to register special history for individual orders in the task register.

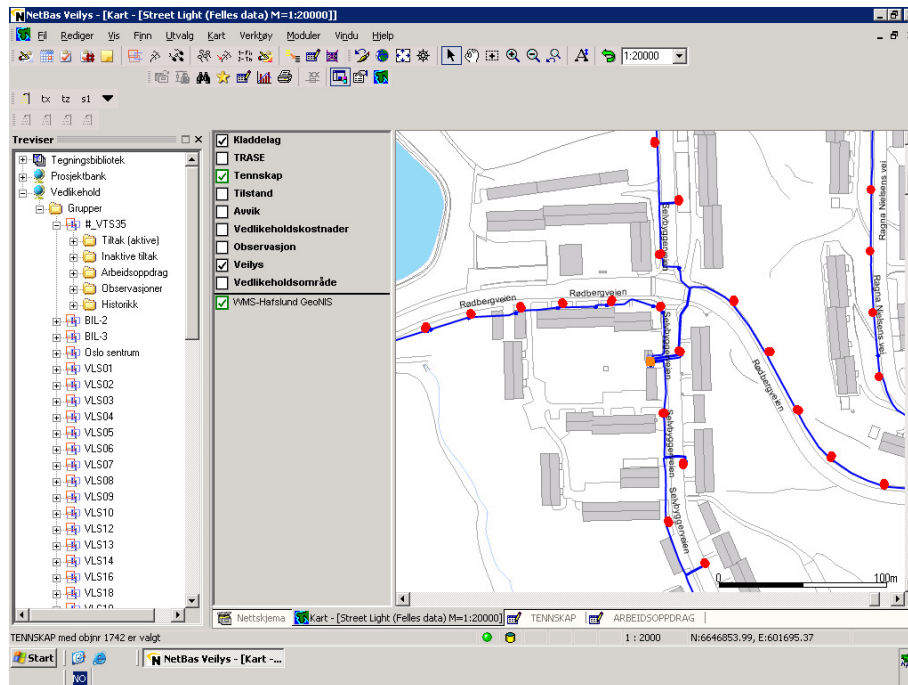
The history from completed job lists is to be related to the fixture identity.
The adm. system shall present the history generated from the functional controlled street lighting.

4.1.3 Reporting

Since reporting is a very import part of the system there should be an extension that allows you to build your own reports. There should be functions to set up the reporting the way your organization and your service providers require it with your fonts, logo's and lay-out. Ideal is a WYSIWYG editor to make your report layouts and allows for different output formats like .pdf or word.

4.1.4 Administration database for streetlight

This application shall be used only by the operator and have a lot of functionality regarding maintenance tasks and reports. In this system all the components (such as luminaires and switch cabinets) are structured in a hierarchy. Such a structure can be based on electrical structure, geographical structure or other.



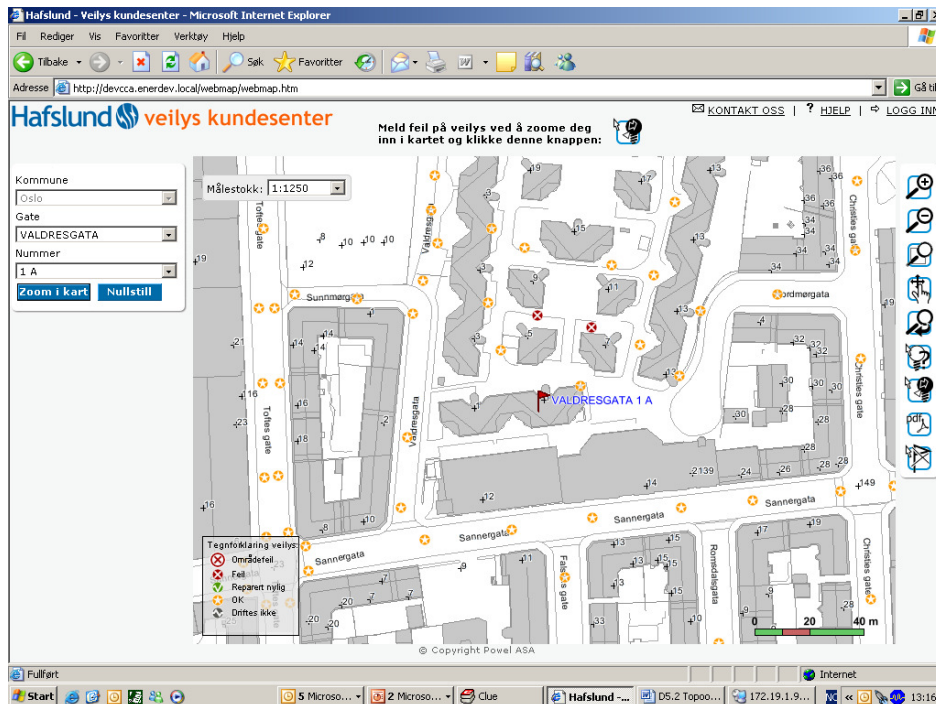
4.2 Customer service application

The Customer service application shall handle reception and following-up of customer messages for street lighting. The application shall be the case handler's tool for reception and following-up of customer inquiries.

The application shall have a web-based map interface for visualization of street lighting with accompanying attribute/quality data (as errors, dimming etc). The solution shall use the standard formats Shape, SOSI and Oracle Spatial as data source for the map presentation.

The application will be related to a "living" map. It means that the map will be updated/changed frequently. Therefore it is necessary that the Customer service application can relate directly to the primary data source without converting to a proprietary format.

The Customer service application shall present data from the administration database for street lighting in a way that supports the operators proceedings. It will be given access to general construction data, status information, overview of ongoing tasks and history etc. from the administration database.



4.3 Data collection from street light

Functional controlled street lighting

The system must handle fixtures from different intelligent streetlight suppliers. Suppliers built their solutions on different types of standards and technologies for instance LNS-database (a database solution from Echelon) for exchange and storage of data. In connection with the introduction of a common administration system, the existing street lighting databases will be used as a data source. In the next phase, the existing system will be omitted, and the administration system will be related directly to each fixture, but still via a concentrator (subcentral).

A common used structure is based on two-way communication of data through the luminaries power supply, so called "power line communication". The information to and from the different luminaries are transferred to a concentrator located in the fixture's electrical supply (switch cabinet). The concentrators then communicate, via telephone (GPRS with MDA Mobil Data Access) with the central database or via fibre optic cables.

Traditional street lighting

The fixtures and the attributes is registered in the cartographic information. It is important that the luminaries have the right type of attributes, for instance x- and y coordinates.

Further, data from some energy meters for traditional street lighting is to be collected. Here, an energy meter which is connected to the same type of concentrator as for the functional controlled light is used. This way the collection of data will be similar, but with limited data size on the concentrator.