Project Outline Annex

INSIST

Integrated service delivery for citizens’ safety and comfort

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Date: 03 October 2018

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# Project key data

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# Project one-page description

The urban spaces are full of stand-alone sensor based installations of different services designed according to their own purpose and requirements. For example the municipalities provide several services to the citizens: public lighting, safety and security services of citizens in the streets, traffic management, etc. These services rely mostly on street-implemented infrastructure, such as lighting poles, cameras, induction loops. In addition local businesses have their own illumination systems, advertising infrastructure including neon signs, public displays etc. They also monitor customer behaviour using various sensor systems. The INSIST project proposes an integration of these sensor based systems into a wider perspective. The INSIST project aims to develop a smart connected ecosystem for public spaces, where the sensor data provided by the different INSIST sensor systems:

smart lighting

surveillance

traffic management

advertising and atmosphere

business intelligence and building management

This can be efficiently used for not only the proprietary infrastructure services, but also to offer value added services based on data fusion from multiple sensor systems. The cross-over between light management, monitoring and surveillance is expected to increase public comfort, safety and security while improving energy efficiency through intelligent light control strategies and lowering emissions from city traffic. In the INSIST ecosystem the expensive sensor installations essential for e.g. lighting and surveillance services are used to create new business potential for digital service providers focusing on data fusion, analysis and knowledge management aiming at new intelligent services e.g. for business intelligence or intelligent advertising and atmosphere creation..

Public lighting is fundamental for the safety and comfort of citizens. However numerous case studies show that simply increasing light levels or maintaining high lighting levels does not necessarily promote or maintain enhanced safety or security. Besides, lighting already accounts for 19% of global energy consumption, of which 8% goes for outdoor lighting. Solid-state light sources offer potential energy savings approaching 50%. Another 20% can be saved when solid-state lighting technology is combined with intelligent light management systems that regulate light output according to ambient lighting conditions or people’s presence and activities. The ledification of outdoor illumination is already taking place on a large scale, while smart light management systems responsive to environmental conditions or presence and activities of persons are deployed only on a very small scale. Larger-scale deployments are difficult due to high system complexity and installation costs. Moreover, the current sensing information provides limited insight of the environmental conditions and activity in the observed scene, while the robustness of the sensory systems is in fact restricting their applicability.

Video surveillance solutions are widely deployed in city agglomerations to secure public safety and targeted to ease the work of public security officers. The contextual information provided by advanced video analytics could be used to detect the first signs of undesired behaviour. Proper illumination is crucial for the proper functioning of surveillance systems. Besides, the manipulation of outdoor illumination could prevent violent or criminal activities from occurring or further escalation without physical presence of security officers. Despite the interaction between surveillance and lighting system being so critical, currently there is no solution available that enables intimate interaction between light management and surveillance infrastructures.

Management of transportation flow using intelligent systems has major impact on the life of people. It helps to enhance public safety, to reduce traffic congestion and it allows improving access to transit information. On the other hand the quantity and quality of transport infrastructure as well as the traffic management affect significantly the spatial and economic development of cities and regions (e.g. saving costs due to optimization of transport of goods, transport of people to work, to shopping sites, to touristic sites etc.). By combining traffic management with the previously mentioned services, e.g. lighting can be adjusted depending on traffic conditions such as traffic density or car accidents or the intelligent advertisement can adapt to people behaviour based on traffic information.

Advertising systems in urban spaces are currently often stand-alone digital signage installations or part of limited networked systems. The latest digital signage advertisements often include interactive elements, which have limited capability to react to the people behaviour or changes in the surrounding local environment. The atmosphere adaptation can currently be done for example with large projections or illumination. However also these cannot adapt to changes in the space in real-time and the stand-alone installations are expensive. By combining the intelligent advertising with smart lighting systems and sensor-based business intelligence services we can offer new opportunities to automatically adapt the advertising content and interaction to match the current status in each position. The INSIST ecosystem will also make possible new type of ambient and atmosphere creation by smart lighting control.

Other challenges to consider when designing public space lighting, surveillance, traffic management, building infrastructures, intelligent advertising and atmosphere creation are the psychological aspects of comfort and security from user perspective. Especially in combination with intelligent outdoor lighting, there is limited research activity on human perception in this area. The illumination levels should be such that people will feel secure while minimize the risks of accidents and criminal activities. Also, there is limited knowledge of the effects of dynamic light control strategies on street users and residents.

The goal of the INSIST project is to increase comfort and safety of public spaces by integrating sensor based INSIST services and technology into a smart connected ecosystem to overcome current limitations of these systems and services. In order to increase knowledge and create proof points in the unexplored area of comfort and security perception of public systems and services, the project will investigate how smart light controls are perceived by users through pilot studies. Finally, the collection of data from INSIST systems into a connected ecosystem with intelligent data analysis and knowledge management features will allow to investigate new digital services beyond lighting delivery, surveillance and traffic management. The INSIST project will address:

* An architecture supporting real-time video-based presence sensing, an open database accessible by INSIST services to exchange information and events, and supporting big data analysis (e.g. city planning). The analysis of large amount of historic data will also allow identifying trends and automating several aspects of system configuration, thus allowing lower installation costs. INSIST will apply a distributed, extensible, flexible architecture with network interfaces for the exchange of information. Such a loosely coupled architecture will safeguard the integrity of the system components such as the light management and surveillance system.
* Advanced video analytics mapped to embedded sensing solutions to enable reliable real-time responses of the smart lighting infrastructure. INSIST is expected to significantly extend sensing functionalities from simple presence detection to more intelligent interpretation (through single or multi-camera video or depth data processing techniques) and thus enabling more intelligent service control strategies. Also, the project will deliver sensing functionalities requiring limited computational resources to enable the application of cost-efficient embedded vision solutions. Third, the project will be addressing challenges related to distributed sensing and light control. Furthermore, it will enable a significant decrease of deployment costs through self-configuration and self-management of multi camera systems and by requiring the installation of a reduced number of sensors that can provide more advanced features (e.g. object classification, speed detection, trajectory analysis).
* A more intimate integration of data analytics and statistical data mining into the embedded hardware platform to collect and summarize the most salient sensor data information, so that it can be transmitted and stored efficiently across the INSIST ecosystem.
* The integration of smart lighting infrastructure, surveillance and traffic systems, business intelligence, building information management, intelligent advertising and atmosphere creation to allow the different systems to leverage each other’s sensing and actuation capabilities in order to improve functionalities and reduce installation cost to promote a wider applicability of various systems. The integration with other systems and sources of information (e.g. online information such as weather data, special events information, traffic etc.) is also foreseen to explore new public service offerings and opportunities to improve the different systems while reducing deployment costs. The wide integration of sensor based services will also create new business opportunities for digital service providers specialized in knowledge intensive services benefiting of data acquired from different sensor systems.
* Security and comfort perception studies for users of public spaces with dynamic outdoor illumination. There is some controversy over whether lighting improves security, although there is little doubt that individuals feel more secure when walking, cycling or driving in a well-lighted area. However, empirical studies on the effect of dynamic light control and its perception in terms of comfort and security are few and far between. In the INSIST project we will investigate the lighting preferences and needs of different road users in different situations, as well as their perception of dynamic, smart public lighting with one or if possible several pilot studies in public spaces. The outcome of the study will be very valuable to improve current control strategies.

# Project added value



## Rationale of the project



### Business vision and value chain

**Business vision**

Global population growth and urbanization are increasing the demand for intelligent systems to improve the quality of life in our cities, from illumination to traffic management, surveillance, intelligent advertising and atmosphere adaptation. In the current challenging economic situation, municipalities will have to make their existing infrastructure smarter, reducing expenses while enhancing the comfort and security of citizens. For these reasons, and driven also by the decreasing cost of sensors, connectivity and storage, as well as by the maturity of analytics and data mining technologies, the markets of a number of smart connected applications are rapidly growing.

**Lighting** - Solid-state light sources offer potential energy savings approaching 50% which can get to 70% when they are combined with intelligent light management systems that regulate light output according to ambient lighting conditions or people’s presence and activities [1][2]. Studies forecast that by 2020, LED lamps for street lights will generate more than EUR 2 billion in annual revenue [3]. The demand for intelligent lighting systems, combined with the greater controllability of LED-generated light, will also result in an expected EUR 7 billion in revenues in lighting systems control components in 2020 [4]. Combined LED and smart street lighting markets are expected to reach a cumulative EUR 3.6 billion in the US alone by 2025 [5].

**Surveillance** - Smart video analysis is a key part of integrated city surveillance offers. Global Intelligent Video Surveillance (IVS) & Video Analytics (VA) industry revenues totalled $13.5 billion in 2012, and are estimated to reach $39 billion in 2020 [6].

The rapid market growth is driven by the following dynamics:

* Increased use of video surveillance.
* Migration from analog to digital cameras and to IP based cameras.
* Technology maturity. Video analytics algorithms, processors, applications and products underwent a decade of technological evolution to intelligent video processing, based on advancements in image processing, enabling automatic detection of signatures detection and identification.
* Cost reduction of video analytic systems driven by the falling prices of image processing DSPs and communication systems.
* Cost-performance of new edge-based video analytics DSP technologies (e.g., Intel, Texas Instruments DSPs).

Human operators entail high cost & high rate of overlooked events. Real time analysis of video images and recorded footage is a need that can hardly be answered effectively by human operators, and manpower cost. Furthermore, human operators fatigue and boredom cause a high rate of overlooked events.

**Traffic management** – During construction of a modern mass public transit system, instrumented, interconnected and intelligent technologies shall form the basis of a smarter transportation system. Smart and networked traffic lights help to ease the flow of traffic through the city. Cameras and social media technologies could help monitor the road network and provide intelligence to decision makers. By using Big Data technologies to analyse mobile phone data, city officials could gain a clearer view of how people move around within the city and how the existing transportation systems could be enhanced. There are many aspects to improve transport safety, security and network efficiency whilst taking into account measures to reduce environmental impact. The traffic management system shall work towards zero accidents, zero delays and fully informed people, where services are affordable and seamless, the environment is protected, privacy is respected and security is provided.

**Advertising and atmosphere** – Advertising spending is growing steadily even if the global economy is in crisis. In 2012 the global ad spending grew 3.2%, where the growth focused to digital advertising channels (TV, radio, internet, cinema and outdoor advertising [7]). The industry is in transition as the traditional printed media is losing its share of ad spending and for example the digital signage market is becoming a mainstream advertising medium [8]. Worldwide business intelligence (BI) software revenue will reach $13.8 billion in 2013, a 7 percent increase from 2012, according to Gartner, Inc. The market is forecast to reach $17.1 billion by 2016. The combination of real-time business intelligence and customer behaviour monitoring with adaptive intelligent advertising and atmosphere creation services will offer a major competitive edge, when competing of the advertising spending.

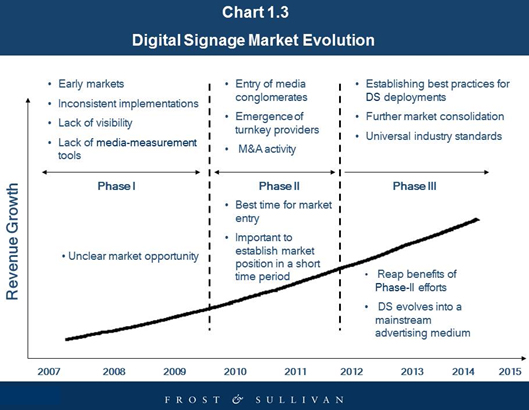


Figure 1: Digital Signage Market Evolution [8]

The INSIST project aims to develop a smart connected ecosystem for public urban spaces focusing on enhancing the functionality, energy-efficiency and interoperability of existing outdoor light management, traffic management surveillance, building infrastructure and digital signage systems. In addition the INSIST smart connected ecosystem will enable the creation of new services benefiting from the sensor information acquired from the urban sensor-based services.

**Value chain**

The urban spaces are full of stand-alone sensor based installations of different services designed according to their own purpose and requirements: public lighting, safety and security of citizens in the streets, traffic management, etc. These services are designed according to their own purpose and aspect. The aim of the INSIST project is to improve services for citizens’ safety and comfort by developing new solutions for the different components of each system and by integrating relevant information from adjacent systems to provide breakthrough innovations while leveraging on existing infrastructure.

The **value chain** of integrated smart services for citizens’ safety and comfort consists of lighting management system, surveillance system, traffic management system, business intelligence and building information management system, advertising and atmosphere system, system integration and information exchange; finally, the last and possibly most important link of the chain is the user of the service.

* Lighting management system includes dimmable luminaires that are connected to a network and controllable remotely or through dedicated sensors. INSIST will consider smart, energy-efficient lighting systems (**Philips Research** in the Netherlands, **Helvar,** **Valopaa** and **C2SmartLight** in Finland). The project will investigate new sensing solution for lighting activation, will develop algorithms for presence detection and activity recognition based on such solutions, and will investigate innovative network sensing and control strategies (**Philips Research** and **TU Delft** in the Netherlands, **Kone, Helvar**, **Valopaa** and **VTT** in Finland).
* Surveillance system comprises camera networks and analysis systems for event detection, activity analysis and recognition. INSIST will consider modern (both standard and high resolution) camera network infrastructures (**Prodrive** in the Netherlands, **TEB** and **Thales** in France, **Scati** in Spain), and will develop new solutions for advanced people and crowd detection and tracking, activity recognition and event detection (**TU Eindhoven VCA** and **ViNotion** in the Netherlands, **CEA LETI**, **UniLille** and **Thales** in France, **Scati** in Spain).
* Traffic management system involves sensor systems to monitor traffic, algorithms to detect traffic flows and analysis algorithms for traffic management applications such as flow prediction, route optimization etc. INSIST will consider camera networks, cellular networks data and magnetic sensors solutions for traffic monitoring and analysis (**Prodrive** in the Netherlands, **TEB** and **Citilog** in France, **Verisun**, **Ericsson** and **Kocsistem, Argevas** in Turkey, **Telvent** in Spain). The project will also develop new integrated applications for traffic management and optimization, as well as information visualization for drivers and traffic managers (**TU Eindhoven VCA** and **ViNotion** in the Netherlands, **Citilog** and **Thales** in France, **Ericsson**, **Argedor** and **Provus** in Turkey, **Telvent** in Spain).
* Advertising and atmosphere system includes actuators such as interactive displays and luminaires, sensor networks for monitoring the environment, and algorithms for sensor interpretation and data analytics for business intelligence. INSIST will investigate interactive advertising systems (**VTT**, **Pro Piknik Festivals** and **MyPose** in Finland) and atmosphere creation (**VTT** and **Valopaa** in Finland), as well as business intelligence and data visualization services (**Innorange** and **Offcode** in Finland).
* System integration represents a crucial aspect in the INSIST project. The project aims at investigating how different systems can use information made available through a common platform by other systems. INSIST will rely on the connected platform provided by **Philips Corporate IT** to exchange information between the different systems and provide services integrating lighting, surveillance, traffic management, signage and advertising. **All partners** will contribute to the system integration to develop new integrated applications for the security and comfort of citizens.
* Users: the INSIST project will look beyond the technological solutions alone, and will investigate user experience with new smart services. For the smart lighting domain, lighting preferences and needs will be investigated for different types of road users and situations. At the same time, the project will scrutinize the efficacy of smart lighting solutions in eliciting the desired effects on human functioning and security at night. This work will be conducted by **Philips Research** and **TU Eindhoven HTI** in the Netherlands, and by **Siveco** and **ECRO** in Romania.

### The concept

Global population growth and urbanization poses several challenges for maintaining the livability and efficiency of a city. This concerns aspects such as safety and the efficiency of road infrastructure while contributing to energy saving. Below we elaborate on a few examples.

* With the increase of demand for lighting and the current budgetary pressure, municipalities will have to reduce their expenses for lighting, while preserving or enhancing the comfort and security of citizens.
* Increasing population, large crowds during events and high-density traffic increases safety issues, crime and the risk for terroristic activities. Therefore, efficient monitoring of the flows is highly desirable. In case of incidents, panic or other safety issues, the public lighting system and traffic control systems such as digital signage and traffic light can help to mitigate the safety issue and send help services.
* As the population is growing and the capacity of city infrastructure is limited, optimization of transportation of people and vehicle traffic is essential. As the flow of vehicles is improved, the emission of pollution is reduced.

The INSIST project aims to develop a smart connected ecosystem for public urban spaces focusing on enhancing the functionality, energy-efficiency and interoperability of existing outdoor light management, traffic management and surveillance systems. In addition the INSIST smart connected ecosystem will enable the creation of new services benefiting from the sensor information acquired from the urban sensor-based services (including smart lighting, traffic management, surveillance). By refining and fusing the data provided by the sensors, we will be able to offer information on people’s behaviour, and make inferences about their mental states, thus allowing tailored services for various application domains. The smart lighting system can automatically adapt to people’s personal or situational needs; providing optimal lighting needed for general functioning at night, providing personal route information, or guiding groups of people in crowded situation. The real-estate managers can get real-time and long-term information on how the buildings are being populated and the spaces in them used. Crowd and audience data can be utilized to create interactive spaces, atmosphere or target marketing.

Smart lighting systems will increase energy savings while preserving the safety and comfort of the people in public spaces. The roadblocks that prevent high market penetration of smart lighting like the installation cost and complexity of the additional sensory systems will be taken away by providing cost-effective and easy to install sensory systems. Richer and more robust information enable intelligent light control strategies and (semi-)automatic configuration, operation and maintenance of lighting systems. Besides light control, it is also expected that large-scale sensor information can be exploited for services beyond lighting management (e.g. monitoring of environmental and weather conditions, traffic density).

Video surveillance solutions are widely deployed in city agglomerations to secure public safety and targeted to ease the work of public security officers. The contextual information provided by advanced video analytics could be used to detect the first signs of undesired behavior of people, groups, crowds and vehicle traffic. Proper illumination is crucial for the proper functioning of surveillance systems. Moreover, the manipulation of outdoor illumination could prevent violent or criminal activities from occurring or further escalation without physical presence of security officers. Even though the interaction between surveillance and lighting system is proven to be effective, currently there is no solution available that enables intimate interaction between light management and surveillance infrastructures.

We expect that the research and development in real-time computer vision technologies will enable automatic analysis of human behaviour and traffic intelligence, so that the tedious work of a security officer is considerably reduced and directed at the preselected important events. We aim at automatic surveillance of large events, where crowds of people are moving on the streets, at all times, including the periods of poor lighting conditions such as night hours. Intelligent video analysis algorithms will be created and deployed for detecting abnormal or suspicious behaviour of groups of people, for tracking a person or a group in crowded environment. Not only content but also the context of the scene plays a role in analysing it. Safety and security of the people in a urban environment can only be achieved when the traffic is controlled. Intelligent traffic analysis will lead to detecting the accidents in real time. It will also provide and record the information on traffic participants so that the stored information can serve for data mining later. This information includes vehicle classification, speed estimation, trajectory analysis. For example, if an ambulance car is detected, the traffic can be managed in the way that favours the fastest movement of this car. Or in case of an accident, the behaviour of a car or of a group of cars can be tracked and analysed. Combined with smart lighting, these technologies bring a significant improvement in the safety and security of the urban citizens.

Traffic management is already accepted as a multi-national issue by Europe and ERTICO (Intelligent Transport Systems and Services for Europe) has been established to create an efficient traffic system in Europe. To decrease the resources used for transport, eco-driving is also supported by cooperative systems include vehicle to vehicle infrastructure communications providing real-time interactive information from the road environment such as traffic lights. As an example; the interactive information systems will guide the driver in a perfect flow of green lights. The sensors on the road and the traffic lights shall check the traffic load on the road and inform the drivers with the estimated arrival time and based on the profile and or the preferences of the driver.

Other challenges in public space lighting and surveillance are the psychological aspects of security from user perspective. Especially in combination with intelligent outdoor lighting, there is limited research activity on human perception in this area. This is unfortunate as the tailoring of light to the needs of a specific individual or situation by means of information from integrated urban sensors poses several challenges. The main challenge is to formulate the lighting requirements for different road users and situations. In meeting this challenge, one has to face novel lighting parameters. Parameters that were irrelevant for conventional static street lighting, but that are crucial to maximizing the trade-off between energy savings and human functioning and security in intelligent systems. The question, for example, is no longer just how much lighting a type of road user needs, but also where on the street this lighting should be offered. For urban services, including public lighting and surveillance, to benefit optimally from integrating information obtained from various connected sensors, user perception studies are much needed. Conversely, the proposed intelligent sensing system may aid such user perception research by offering new opportunities for evaluation and user testing. By integrating information from different sensors detailed analysis of human behavior and emotions becomes possible, offering an unobtrusive means to measure whether a specific urban service (e.g., a lighting design) indeed has the desired effects. Moreover it enables experimentation with services in the public domain as it becomes possible to correlate, e.g., lighting manipulations with changes in sensor data.

Our vision is to provide a truly intelligent sensing system connected to the urban infrastructure with traffic control and lighting that can provide for example light only when and where needed through smart interpretation of events and environment, to achieve sizable energy savings while providing a secure, comfortable, pleasant environment. The INSIST systems are interconnected through a common data management platform to leverage on each other’s hardware and software infrastructures in order to improve functionalities and reduce installation cost to promote wider applicability. In order to increase knowledge and create proof points in the unexplored area of comfort and security perception of public smart lighting systems, the project will investigate how smart light controls are perceived by users through pilot studies. Finally, the collection of data from interconnected INSIST systems into a connected ecosystem will allow to investigate new services beyond lighting delivery, surveillance and traffic. This wide integration of sensor based services will create new business opportunities for digital service providers specialized in knowledge intensive services benefiting of data acquired from different sensor systems. Figure 2 illustrates the INSIST ecosystem for public service delivery, with several smart systems connected through the data management system.

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|  |
| Figure 2: Connected platform for public service delivery. |

### The challenges addressed by INSIST

**Societal challenges**

* Global population growth and urbanization are increasing the demand for citizens’ services in the urban environment, such as lighting, surveillance, building infrastructure and traffic management.
* Resource scarcity and climate change are of increasing concern, and governments are responding to these concerns with stricter regulation towards energy efficiency.
* The demand for improved services to citizens while reducing energy consumption and costs for the municipalities leads to a growing need for intelligent integrated systems that deliver services when and where needed, providing safety and comfort to citizens while reducing pollution and energy consumption.
* The INSIST ecosystem will enable the interaction between smart systems in urban environments to provide services for the comfort and safety of citizens, while reducing costs and energy consumption.

**Economic challenges**

* Increasing energy costs and high financial pressure on municipalities.
* Integrated platform will enable improved services while leveraging on common infrastructure, thus reducing hardware and installation costs.
* Improved, smarter systems will provide better decision making, thus allowing greater energy savings and pollution reduction, e.g. for lighting control, traffic management, surveillance.
* Integration of information from multiple smart systems will enable both municipalities and companies to develop new business models based on data intelligence, such as intelligent advertising and interactive adaptive spaces.

**Technical challenges**

* Embedded detection, classification and counting algorithms for improved light control to provide safer, more comfortable, more energy-efficient lighting systems.
* Integration across multiple systems (lighting, surveillance, traffic management, building infrastructure, advertising) for increased intelligence at a reduced cost thanks to systems integration.
* Distributed, heterogeneous data integration for different systems and applications to allow for interoperability, smarter behaviour and reduced cost exploiting systems’ integration.
* Data analytics for system maintenance and automatic configuration to allow wider applicability, ease of installation, reduction of installation and maintenance costs.

### The technological value chain

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|  |
| Figure 3: Technology value chain of connected platform for public service delivery. |

### The project proposal solutions & objectives

The **aim** of the INSIST project is to provide a truly integrated lighting, traffic surveillance, advertisement and atmosphere management system connected to the urban infrastructure. The integration across systems will allow leveraging the different systems’ hardware and software infrastructures, making the resulting solutions more affordable and more intelligent.

**Objectives and solutions**

* An **architecture** supporting real-time video-based presence sensing, an open database accessible by light management, traffic management, advertising and surveillance systems to collect and share information and events. The analysis of large amount of historic data will also allow identifying trends and automating several aspects of system configuration, thus allowing lower installation and maintenance costs. INSIST will apply a distributed, extensible, flexible architecture with network interfaces for the exchange of information. Such a loosely coupled architecture will safeguard the integrity of the system components.
* **Advanced, cost-effective sensing solutions** to enable reliable real-time responses at a cost that allows its wide applicability. INSIST is expected to significantly extend sensing functionalities from simple presence detection to more intelligent interpretation (through single or multi-camera video processing techniques, sensor network processing etc.) and thus enabling more intelligent light control strategies, advanced monitoring functionalities and cross-domain service solutions. The project will deliver sensing functionalities requiring limited computational resources to enable the application of cost-efficient embedded vision solutions. Third, sensing solutions alternative to conventional cameras that promise to be interesting for lighting control (e.g. HDR sensors with special faceted lenses, microphones for audio event classification) will be explored and evaluated.
* The project will be addressing challenges related to **distributed sensor networks**, investigating methods to cope with the installation of a reduced number of sensors that can still provide advanced features through sensor network analysis (e.g. object classification, speed detection, trajectory analysis).
* A more intimate integration of **data analytics and statistical data mining** into the embedded hardware platform to collect and summarize the most salient sensor data information, so that it can be transmitted and stored efficiently across the connected platform.
* The integration of smart lighting infrastructure, traffic management, advertising and surveillance systems to explore **new cross-domain public service offerings**. Integration across systems will allow the different components to leverage each other’s sensing and signaling capabilities in order to improve functionalities and reduce installation cost to promote a wider applicability of smart systems. The integration with other sources of information (e.g. online information such as weather data, special events information etc.) is also foreseen to investigate opportunities to improve the various systems while reducing deployment costs.
* **Perception studies for users** of smart services developed in the project. Experiments and user studies will be conducted to elucidate the differential lighting preferences and needs of different types of road users and situations, thereby explicating the user requirements of smart lighting solutions. Furthermore, the INSIST project will put these integrated smart public lighting solutions to empirically scrutiny; evaluating their efficacy in eliciting the desired effect on human functioning and security at night by means of laboratory experiments, and several pilot studies in (semi-) public spaces. The outcome of these evaluations will be valuable in improving control strategies and energy saving policies.

**Final demonstrators**

**Finland**

The intelligent advertising results will be demonstrated in the city of Oulu. The demonstration will include adaptive digital signage information and adjustable atmosphere lighting elements based on sensor data from people presence and behaviour sensors. The goal is to increase the comfort and effectiveness of advertising by controlling the atmosphere of the environment. The demonstration consists of:

* multisensor environment monitoring network
* illumination control logic
* people behaviour monitoring, flow maps
* intelligent advertising systems
* data fusion and decision making from multiple data sources

**France**

Achieved results for surveillance and traffic management shall be demonstrated in the city of Strasbourg including multiple cameras tracking of individuals and vehicles for security, traffic management and soft transportation solutions optimization (e.g. tramway, busses, bicycles traffic)

**Romania**

Achieved results of the city lighting quality system will be tested in a relevant area in Sibiu in term of light excess consumption. Later feedbacks from the population and municipality will bring answers regarding the fact that the measures were or not in the right direction in terms of technical/economic efficiency.

**Spain**

The results of the project will be demonstrated in the city of Sevilla integrating traffic and surveillance management and including advanced features. Links with smart lighting will also be explored through this deployment for targeting optimized cross domain service solutions.

**The Netherlands**

Achieved results will be demonstrated in an installation at High Tech Campus Eindhoven including controllable, connected LED luminaires, a connected network of dedicated sensors for light control and connected surveillance cameras with algorithms. The inclusion of additional systems (traffic management, advertising, etc.) will also be considered. In this intelligent outdoor lighting architecture will be used to demonstrate:

* Improved sensing functionalities of the dedicated lighting sensor network and associated lighting control strategies.
* New distributed detection, tracking, classification algorithms for hybrid sensor networks including both dedicated lighting sensors and surveillance cameras.
* The use of the lighting system for signaling in surveillance/security applications.
* Data analytics methods for automatic configuration and maintenance of the lighting control system.
* Measurement of pedestrian and vehicle flows to optimize traffic and the use of the road infrastructure, while exploiting the light optimization.

**Turkey**

Efficient traffic management is a subject handled by governmental level in Turkey recently. The major autobahns of Turkey will be managed by Koç Holding and KoçSistem ıs the system ıntegrator of the Group. Therefore, the results of the research project may be tested in Turkish national autobahns. Ericsson works on M2M data traffic management globally, so the results of the project may be carried even out of Europe. Meanwhile, Verisun is the company that has implemented the official mobile application for the traffic in Istanbul. As the back office provider of HGS (Toll Collection System in Turkish motorways and Istanbul bridges), Provus will provide its Business Intelligence and Data Processing expertise in the demonstrator scenario. Argedor has experience and expertise in big data analytics, data mining and recommender systems. The company will contribute to big data storage and development of platform services and personalized services to drivers and traffic managers. The company is planning to detect social media profile and traffic behavioural analysis and recommend related services to the users. Argedor will also work on efficient routes to the drivers.

## Technology



### State-of-the-Art (SotA) and “roadblocks”

#### Application areas

**Outdoor light management**

In conventional outdoor lighting systems luminaires are switched by a controller that provides mains power to a segment containing multiple luminaires. Additionally, luminaires could be equipped with an ambient light level sensor. In case the measured ambient illumination is lower than a certain threshold the luminaire will turn on. More advanced luminaires support timer-based dimming schedules that allow light level to be configured for specific periods. For example, in evening and morning when much traffic is expected the light level will be set at 100%, while in the nightly period of low activity the light level can be dimmed down to 20% to realize energy savings. There is a trend to connect luminaires to a light management system by wireless or power line communication. The light management system is designed for configuration, operation and maintenance of the lighting network. The system is able configure luminaire behavior on an individual level by setting parameters like time-schedules and light levels, but also can directly control individual or segments of luminaires for example in case of emergencies. The Global Positioning System (GPS) provides the location of luminaires which is used by the light management system. Also, it provides time information necessary for timer-based control. Luminaires containing sensors for presence-based light control are entering the market. The conventional motion detectors are based on passive infra-red (PIR), radar, ultrasonic sensing or camera-technology and only provide very basic presence information (binary signal). Richer sensor information like position, speed, type, density of traffic or weather conditions will enable more intelligent light control strategies. More robust sensing solutions will extend the applicability and could open up city services beyond lighting management. The Romanian consortium will develop new algorithms to maintain real-time, up-to-date dynamic comfort factors, as inputs for multi-criteria dynamic lighting, including in relation with energy sources, energy prices and energy availability in each time frame.

**City surveillance**

The area of city surveillance has grown continuously over the years, of which visual surveillance is clearly the dominant factor. The application areas are split into people and crowd monitoring, people counting and flow measurement for safety management, parking lot surveillance, and monitoring of critical infrastructure. A growth area that strongly emerges is shop and retail surveillance both for people safety and or shopping behaviour.

1. **People and crowd monitoring** is certainly one of the most important applications in urban areas. This is particularly important for the happenings or events in cities, like big sports events, trade fairs, city festivals and further. The surveillance is deployed with an existing – usually fixed mounted - infrastructure of surveillance cameras, which are connected to a network (CCTV or fibre, or similar). The information is typically video compressed and gathered in a local control room, operated by city government and/or police or security companies. The analysis is strongly based on the detection of individual persons and the tracking thereof. The control room contains many video displays arranged in a matrix and requires personnel to actively observe the live video images and then signal situations to local police and other services. Experiments in the R&D area also report besides the detection of persons, the behaviour of persons by analysing their profile and motion actions over time, also the behaviour analysis of groups of people.
2. **People counting and flow measurement** is closely connected to the previous area of monitoring. For large festivals or city events, the counting of people in certain areas is crucial for safety reasons and organizational guidance. Conventional surveillance cameras are not always good enough for accurate measurements, so that regularly a temporal and/or removable system is deployed with a specialized camera. The advantage of such a system is that the sensor is optimized for the purpose, such as a high sensitivity for low or fluctuating light conditions. The corresponding video analysis is a highly tuned person detector and classifier that optimal for specific mounting positions of the camera. The use of stereo cameras and range finding sensors has been reported in literature for such experiments. Also, tracking algorithms for persons are available, based on various principles, such as mean shift, motion analysis, various filtering techniques like particle filtering. New sensors can be optimized even for measuring heart beat and so on, but this is not yet broadly used and infrared sensors may be used for night-time surveillance.
3. **Monitoring of critical infrastructure** (incl. parking lots). This is a field where typically more sensing principles are jointly used, because of the value of the construction. For example, in a harbour, radar is often used for ship guidance, and this may be extended with visual sensors. For vehicles, magnetic coils or inductive loops are used for detection and supplemented with visual sensing. For entrance control, applications of face detection and recognition are deployed and can be enhanced with eye detection or iris scanning, or biometric features like fingerprint processing and recognition. With respect to analysis, the world is diverse in that area. Human face recognition exists, but the size of the database may become critical at larger scale and for fast identification. The detection of vehicles and other objects with different sensors is may be enhanced with different information such as identity tags, and is typically shown in large control rooms or on a table or screen. In urban areas, object detectors and classifiers exist for cars and persons and initial algorithms are there for following an object through the infrastructure from one camera view to the other. Tunnels in a city have typically a similar infrastructure for surveillance.
4. **Shop and retail surveillance.** This is an emerging area that is initially starting from safety but now increasingly is used for shopping behaviour as well, so that the investment for the retail becomes more interesting. The typical mode is visual surveillance and this is regularly extended with RFID tags and magnetic / inductive loops for good flow and detection. The analysis involves high-quality person detectors and pose and posture descriptors and trackers for recording the walking paths of customers in a shop. It is obvious that the people’s presence and the type of goods may be well combined with specific light types and colours of light to stimulate customer behaviour.

**Traffic management**

We distinguish two types of systems for intelligent traffic management as state-of-the-art: Intrusive sensors and non-intrusive sensors. The first ones include devices such as pneumatic road tubes and inductive loop detectors. These systems are installed directly on the pavement surface of a road via saw-cuts, holes, or by anchoring directly to the pavement surface as is the case with pneumatic road. In general the advantage of using intrusive sensors is related to the maturity, well understood and cheap to implement technology. On the other side, the drawback is related the costs due to disruption of traffic installations and roads every time such systems are deployed.

In location where road pavement work and interruption of traffic should be minimized non-intrusive sensors can be used. These sensors can be mounted aboveground, above the lane of traffic they are monitoring or on the side of a roadway where they can view multiple lanes of traffic at angles perpendicular to or at an oblique angle to the flow direction. The non-intrusive technologies include Global positioning systems (GPS), PIR sensors and video content analysis based camera sensors. Like intrusive sensors, the non-intrusive sensors measure vehicle count, presence, and passage. However, sensors like video content analysis based cameras deliver more broad information such as multiple-lane, multiple-detection zone coverage, vehicle speed and vehicle classification,

In the following subsection we describe the principle of functioning, the use, the advantages and disadvantages of each intrusive and non-intrusive sensor:

1. **Pneumatic road tubes** consist of a rubber tube with air that signals a vehicle when pressured. This method is cheap and easy to install. However measurement accuracy is not very high due to high temperature sensitivity of the air switch and the unknown relation between the number of wheels and the vehicle. Moreover, it cannot classify the traffic, does not work for pedestrian and bicycles and is sensitive for vandalism and wear produced by truck tires.
2. **Inductive loop** detectors are devices composed by a coil of wire embedded in the road and a detector. Such systems are used to assess vehicle passage, presence, count, and occupancy. The main advantage of such technology is the low costs involved purchasing the sensors, however the drawbacks include disruption of traffic for installation and repair and failures associated with installations in poor road surfaces. Also inductive loops are not suitable for pedestrians and bicycles.
3. **Passive Infrared (PIR) sensors** are made of thermoelectric materials and usually contain lenses or mirrors in order to focus the infrared light for maximum reception in its field of view. PIR sensors are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall. Infrared sensors are used for estimation of object speed, as well as detecting pedestrians in crosswalks. A PIR sensor can provide accurate measurement of object position and speed although it cannot distinct different traffic participant and is not able to classify the type of participant. Consequently, if the traffic situation is at some points a bit dense, the sensors fail.
4. **Cameras and video content analysis.** A smart camera usually consists of several components like the image sensor device and an image processing unit. An example of usage of video content analysis techniques to assess presence of absence of pedestrians and vehicles in an urban area to control the light intensity of lighting poles has been investigated in the Intelligent Street Lighting for Energy Saving & Safety (ISLES) project. In literature, extraction of moving objects from a static camera is typically carried out by calculating a background model of the scene. Usually foreground objects are detected by evaluating the difference between the current image and the background image. However, the maintenance of a background model is difficult, because of issues related to lighting change, moving background (e.g., waving leaves and flowing water and cast shadows). In order to solve these problems, in this project we propose to use a technology based on object recognition carried out employing knowledge of object shape and texture properties. Such approach is independent of motion, illumination changes and a background model. Such methodology has already been proven by ViNotion who has developed a people counting system that is specifically suited for counting in a passageway (such as street), based on the localization of individual people. The employment of video content analysis systems covers multiple applications. Such systems provide detection and classification of vehicles, bikes, motorcycles, pedestrian in multiple lanes, vehicle/pedestrian counting, assessment of speed, assessment of density and forecast of travel time. Other advantages with respect to the other methods are that video content analysis techniques are general and can serve other purposes such as intelligent video surveillance. For instance a camera network on a street and the video content methods could be used by public authorities such as the police to monitor a certain area. Because a video camera solution is non-intrusive for the road infrastructure and can serve multiple more city services such surveillance and lighting control, the solution is more cost efficient.

Regarding video detection for road traffic application the challenges of a deep integration with traffic lighting will be:

* 1. the capacity to work under changing lighting condition (as of today road traffic detection relies on the fact that illumination changes over a scene are slow)
  2. installation constraints allowing easy deployment compatible with public lighting deployment constraints. Especially the constraints for road traffic video detection will be: the capacity to work on camera with wide angle focal length (panoramic focals), automatic calibration, video sensors positioning
  3. the possibility to integrate a video sensor within a lamp pole:
  4. with enough processing capacities to be able to detect the situations of interest without the need to send back the images to other location to be analyzed
  5. with low power consumption
  6. at low cost to allow large scale diffusion

The Turkish consortia will develop an integrated and an interactive traffic management system to create a perfect flow of green lights. This will be handled with sensors and cameras to detect the traffic flow and also to manage vehicle-vehicle communication and vehicle-traffic environment communication. The mobile application to be developed shall define arrival estimation and define alternative routes based on the driver’s profile and preferences.

**Data Management Systems**

The Connected Products Platform (CPP) is a high available, secure and reliable platform that provides global connection services to devices and mobile apps, enabling them to access online services. The platform is composed of generic components using industry standards. Devices and/or applications require a client software component with a small footprint that supports the connectivity, authentication and authorization with the platform. Additional services that can be configured and managed centrally are:

* Notification
* Firmware download
* Data collection
* Remote diagnostics
* Device control
* Registration
* Key provisioning
* Device Pairing

By using the CPP as the connectivity platform will take away the connectivity burden and its related functionality. Applications can be designed and built with focus on the required functionality and leverage the CPP services as input. The CPP is providing device and connectivity information to underlying application(s) and/or systems. The platform is generic, it does not contain specific application logic but acts as the interface between devices and their respective application(s). Therefore any data analysis logic or business Intelligence must be handled by a separate component outside the CPP.

**Business intelligence and building information**

Business intelligence based on sensor data can provide new innovative service opportunities, lead to intelligent design of spaces by understanding the people movement and behaviour better. It will also lead to more profitable business and cost-efficient system design and savings by intelligently controlling the needs of the building and the space utilisation in various domains out and indoors.

One important factor in the sensing is to understand how people move around in space. Understanding people presence and occupancy is valuable information for many services. People presence can be detected for example via WLAN or Bluetooth, and now a days there exists accurate positioning systems based on these technologies, but it always requires an active device. People segmentation and tracking can be also done with camera and depth sensor based technologies. People segmentation and tracking is a widely researched subject which has been started in context of security and surveillance. As the camera based algorithm research and development has been going on for long time there are quite extensive surveys available in [9]. Recent advance in depth sensing technologies has enhanced the algorithm development on that field as well. With depth sensors the people tracking [10],[11],[12]benefits from the understanding of 3D scene, handing occlusions and ability resist changing lighting conditions.

There are also several intelligent technologies and systems available for smart building automation containing a huge number of different standards, devices and subsystems. In current state of the art building already has sensors for HVAC (heating, ventilation and air-conditioning) systems, Lighting systems, Fire protection Systems, but they are often individual systems and not used for cross domain or even new intelligence. The possibility to utilise the existing sensoring across domains is huge. Smart environment relies on sensory data from the real world. Table 1 lists some of the properties of the environment that need to be captured and how they can be measured. The basic sensor types utilized currently include pressure, temperature, flow, motion, light, and camera sensors.

|  |  |
| --- | --- |
| Properties | Measurand |
| Physical properties | Pressure, temperature, humidity, flow |
| Motion properties | Position, velocity, angular velocity, acceleration |
| Contact properties | Strain, force, torque, slip, vibration |
| Presence | Tactile/contact, proximity, distance/range, motion |
| Biochemical | Biochemical agents |
| Identification | Personal features, personal ID |

Table 1: Sensors for smart environments [13]

**Advertising & Atmosphere**

The adaptive advertising has traditionally referred to personalized advertising content based on profile information acquired for example automatically from the user or user group behaviour in a webshop or based on demographic user information (e.g. paper ads of toys mailed to parents of small children). Public screens and digital signage systems in retail and advertising as well as digital installations are getting very common these days. Currently most of these systems are passive, but some of them hold already different interaction methods. The user can either interact by gestures of their body with the content or the systems can be interactive with personal devices using for example smartphones with NFC (Near Field Communication) technologies. As the future systems will contain more and more sensorial information from surroundings and interaction different methods to understand behaviour of the people are required. Depth sensing technologies can provide valuable tool for natural interaction and people behaviour monitoring even for people intention and emotion analysis based on their actions. It will support the new type of advertising where the original people can be part of it via interactive digital solutions in city view as well as through social media.

The audience funnel models describe the audience behaviour in front of public displays. At the first stage the user is only passing the display, but in second stage they start to react to it by glancing, smiling or approaching towards it [14]. Detecting this implicit behaviour of the user will enable developing more emphatic interactive screens. In this stage the interactive system should encourage the user for further interaction to engage the user. This will require understanding the actions and movements of users in space as well as users emotional state.

The future systems will have larger and larger displays and by their illumination properties they can act as luminaires and have direct effect on the atmosphere of the space they are present in. This can be already seen in how 3D projections to facades, architectural lighting or interactive outdoor illuminations, which currently are created more or less as installations, can change the visual view of the whole space. The projection technologies are a powerful tool for changing the how the environment looks and feels. Microsoft’s IllumiRoom proof of concept of an augmented reality projection already shows what the technology including depth sensing, 3D modelling and projectors can create.

**Distributed sensing networks for outdoor**

New ambient light sensing technologies will be investigated in the INSIST project, where we envision to take advantage of the combination of two emerging technologies: High Dynamic Range (HDR) imaging and 3D printed micro-lens arrays. HDR imaging is an image capturing techniques that makes it possible to capture the whole range of radiances of a scene using either several exposures of that scene either special image sensors. HDR imaging is used for artistic purposes but also machine vision and surveillance applications. It also becomes a more and more popular tool for light measurements [15],[16],[17]. Combined with systems capable of non-destructive pixel readout [18], these techniques make it possible to embed light measurement at pixel level directly into a smart camera.

The other key technology to be used in INSIST for ambient light measurement is micro-lens arrays. Such optics replace a traditional lens and provide many entry points for light instead of one. These entry points (the lenses) can be oriented so that they capture light coming from a known direction in space. Progress in 3D printing technology enable now to print objects with controlled optical properties [19],[20].

Installing, operating and maintaining a large network is currently time-consuming and costly, because standard solutions (protocols and the like) typically use an engineering approach where individual nodes are linked –possibly hard wired– to a central control authority. Within the INSIST project we will try to overcome this inherent bottleneck, by introducing direct communication between nodes. This will allow for exchanging more data between nodes, hence, more advanced algorithms can be used to control the coordinated lighting of street segments based on observed human activity. To minimize operational costs we will explore routing-free communication protocols, such that costly and error-prone configuration found in standard solutions is no longer necessary. In particular, we like to explore the use of gossip-based protocols as our initial experience with such scale-free solutions for controlling large networks of embedded devices is very positive [22].

**User studies**

Although informative to the design of smart lighting services, current norms and guidelines for static lighting do not cover fully the more complex design space of intelligent dynamic lighting. Moreover, user perception studies on smart lighting remain few and far between (for an exception, see [23]). At the same time, the effects of public lighting on crime and security remain a topic of debate, and although there is a general consensus that improved street lighting can reduce crime and increase a sense of security [24], the field lacks a thorough understanding of the underlying mechanisms (i.e., through enhancing visibility and surveillance, through strengthening a sense of community, or through improving the atmosphere of the environment; e.g. [25]. For example, there is conflicting, mostly anecdotal, evidence regarding motion detection home security lights having a psychological benefit over static lighting in chasing away burglars by installing in them a feeling of being detected. Taken together it remains difficult to predict whether a specific dynamic lighting setting will have the desired effect, for example, on perceived safety, deterring crime, or preventing aggressive situations to escalate. The required empirical investigations are challenging especially because they require specialized test sites with fully controllable LED luminaires and sensor technology. In situ pilot studies with smart lighting are still rare, and past en present evaluations, by relying on single sensor presence detection, have not addressed the psychological issues that arise when lighting is tailored to a specific type of road user or situation.

#### Status of current R&D work

Table below summarizes preceding and present projects and their relations to the INSIST proposal.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Project Name | Cooperative Programme | Time period (approx.) | Technical Focus | Relation to, and difference with, this project proposal |
| ViCoMo | ITEA | 2010-2012 | Modelling of visual context to improve video analysis | ViCoMo did not study crowds and high-density traffic. Video analysis in INSIST is typically optimized for dense people and traffic flow for safety and light control reasons. |
| ISLES 2014 | Point One | 2011-2013 | Investigating intelligent dynamic residential lighting using PIR-based presence detection to reduce energy consumption and maximize feelings of safety | ISLES 2014 project focusses on lighting services only. It does not focus on integrating sensors from multiple urban services, and thus does not focus on tailoring the light to different types of road users and situations. |
| 3D-TestBench | (ITEA2-06043) | 2007-2010 | Has contributed in developing modelling and simulation techniques to meet the chal­lenges of the growing com­plexity of software systems by im­proving the design and validation phases for a wide variety of new engineering products. | Will extend the control and execution of modelling and simulation to support decision making capabilities to achieve smart lighting management and surveillance systems. |
| LASCOT | (ITEA-02027) | 2003-2005 | Web services technologies - XML as extensible mark-up language for data, using the Simple Object Access Protocol (SOAP), and Universal Description, Discovery and Integration (UDDI) as a directory of Web services. | Brings in focus new generation of Semantic Web technologies for both surveillance and lighting systems to achieve the adequate situational-awareness through visualization. |
| SERKET | (ITEA-04005) | 2006-2007 | An open software platform for preventive security in public crowded places and for large events. | Will support open-source initiatives, and contribute to the standardization through PSIA, OGC and OASIS as well accepted standards. |
| ESNA | (ITEA-05023) | 2006-2009 | Open-source architecture supports off-theshelf sensor network nodes, including applications, software development kits and middleware services, based on documented interoperability specifications. | The lighting monitoring and surveillance system will have a wired or wireless communication interface that sends and receives messages to and from other external systems, where the ESNA results might be reused. |
| Empathic Products | ITEA2 | 2012-2015 | Enabling intention and emotion aware products | Developing technologies that support detecting people intentions and emotions for multiple application fields e.g. video communication, health, advertising |
| Smarcos | Artemis | 2010-2013 | Smart composite human-user interface techniques | Smarcos focused on user interface techniques, intelligent backed server analysis, and fusion of context, task, UI modalities and target/source device properties to enable interusability across user interfaces used in smart environment. |
| SmartProducts | FP7 | 2009-2012 | Contextual knowledge management & interactive data visualization with focus on processes/ workflow, cases automotive, industrial and smart kitchen | Public domain is not addresses in SmartProducts. Moreover INSIST will focus more on event-action/service activation rather than workflow management. |
| SOFIA | Artemis | 2009-2012 | Semantic cross-domain interoperability on data level | SOFIA’s knowledge management technology can be considered by INSIST, more domain specific knowledge models need to be developed |
| EnLight | ENIAC JU | 2011-2014 | Energy efficient and intelligent lighting systems | Intelligent lighting system development, energy evaluation, advanced sensoring and control capability with mobile devices. |
| SparkSpace | Tekes | 2011-2013 | Adaptive lighting control with multi-channel ambient sensing | Intelligent lighting system development, wireless control, advanced sensoring. |
| AthLEDics | Tekes | 2010-2013 | Advanced technologies for energy efficient LED lighting applications to satisfy user needs | Intelligent LED luminaire and lighting system development. The results validated with technical performance as well as with user acceptance studies. |
| D-SenS | FP7 (Research for benefit of SMEs) | 2012-2014 | The D-SenS depth sensing framework will enable the development of new innovative applications in different application areas to yield state-of-the art performance and beyond. | In D-SenS the main focus is in indoor application domain for people safety. INSIST has a wider technology scope and new challenges for computer vision technology deriving from outdoor environment. |

### Innovation



#### Technology

**Technology for light management**

The next generation of light management systems will go beyond state-of-the-art sensors used nowadays in outdoor lighting applications. The INTENSE project is expected to significantly extend sensing functionalities from simple presence detection to more intelligent interpretation through single or distributed sensors such as vision and sound. Advanced distributed sensing tasks such as detection, classification and tracking of objects and behavior monitoring will enable more intelligent light control strategies. Also, the project will deliver sensing functionalities requiring limited computational resources to enable the application of cost-efficient embedded solutions. Third, the project will be addressing challenges related to distributed sensing and light control with constrained communication bandwidth. Furthermore, it will enable a significant decrease of deployment costs through self-configuration and self-management of multi-sensor systems. In addition to goals related to cost-efficiency and energy savings the INSIST ecosystem will be used to evaluate the possibilities to create new experiences to the citizens by adjusting the atmosphere in urban spaces by combining smart lighting control systems with the people behaviour data.

The distributed dynamic comfort level, with many possible factors influencing locally the lighting behaviour, is expected to give answers to both decision regarding general lighting level/policy in cities but also to cover most of the “special” cases to cover an improved technical/economic lighting efficiency.

The proposed lighting system is not only more efficient and controllable, but it has an adaptive behaviour due to the following factors:

* The “comfort” factor is a dynamically measured criterion, based on real-time actions from street-passing citizens. Well adapted “avatars” running on smartphones will allow dynamic factoring of traditional lighting level, based on on-the-fly inputs at any time-moment either:
  + at will (walking people give a recommendation for satisfaction of lighting at that place and moment, will of increase or decrease lighting level) or
  + automatic - smartphone may automatically exchange information with distributed intelligence of the lighting system, giving a default preference (children, women may want always a higher momentary lighting for increasing their security feeling, while some man may accept a lower illumination as they are not so much afraid of dark);
  + the lighting level may be changed suddenly, superposing the other rules, due to special situations (temporary feeling of un-security, temporary need for more light for reading the map, the street name or other info displayed on the building).
* The dynamic “comfort” factor will be amended also by energy availability, energy price in that time frame, energy availability with renewables.

**Technology for city surveillance**

The next generation of surveillance algorithms for city surveillance will have to focus much more in the direction of increased level of intelligence to enable autonomous decision making of simple cases and alerting for complex cases and scenarios. Secondly, a higher robustness is needed for large-crowd scenarios as in festivals and sports events. The typical individual person object detector is then of limited use and the focus has to be on group detection and behaviour. In groups, the individual persons cannot be detected anymore in a reliable way, so that other models have to be deployed. An example is the deep analysis of motion behaviour on the basis of particles instead of persons that share a common behaviour and/or trajectory. An example of this is shown in Figure 4 for density estimation.

The higher robustness of city surveillance should come from new sensor technology where sensors make use of different spectral properties and from improved and intelligent lighting conditions, since so many visual sensors are used in a city. In video surveillance, the new generation of cameras will largely benefit from the use of larger sensor surfaces for high light sensitivity, higher resolution and more integration efficiency. The vast majority now involves CMOS sensors which have rapidly decayed in cost. This is paving the way for infrared sensors to gradually go down in cost as well. The resulting improved picture quality due to higher resolution and sensitivity allows reliable detection of person groups and group behaviour for city management and light control, to a level that was previously not possible. This type of video analysis is innovative for the surveillance industry and it also innovates the current surveillance systems and overall systems control offered by the industry, which is currently still based on person-based interpretation and decision making.

**Technology for crowd and traffic management**

The technology developed in the INSIST project is general and is beneficial for different applications. For example, the intelligent multi-camera systems installed in the city could be used to automatically observe and to recognize abnormal events (e.g. people fighting, crime scenes etc.), as well as vehicle and people to measure flow and to count them. That is possible, since the basics of the algorithms involved in such different applications follow a common principle. A machine learning algorithm is trained using a dataset of objects of interest (e.g. people, bikes, cars etc.), described with certain features invariant with respect to intensity and contrast, and robust with respect to scale and view point. One the objects of interest are learned, they can be detected and classified. Hence, objects of interest present in the video images are recognized and then tracked (see Figure 4)[26],[27]. The detected objects allow creating quantitative measures about the presence and the movements of pedestrians/bikes/vehicles (single or group) in a considered area of interest (e.g. number of pedestrians/bikes/vehicles entering and exiting the area under observation; origin to destination matrixes). In Figure 5, the people counting system developed by ViNotion is used to measure the density of pedestrians walking on a large area.

According to the quantitative measures, the system will be able to propose actions to be carried out on the field by operators such as: limiting access to an area, to prevent excessive congestions or densities, facilitate or stimulate the egress from an area, for similar reasons, proposing information to operators on the field but also to simple pedestrians in an area (for instance by means of informative signage).

|  |
| --- |
| C:\Users\ejaspers\Desktop\2012-12-03 ViNotion using Ampleye\roermond.jpg |
| Figure 4: Detected people (left image), detected cars (right image). |

|  |
| --- |
| PeopleDensity.png |
| Figure 5: People density estimation. |

Innovation regarding traffic management will rely on the deep integration of video detection sensor to the public lights lamp. As of today the public lighting is only based on a time of the day switch. The availability of new lighting technology with capacity to dynamically adjust the luminosity level and deeper integration of road traffic sensors will open the possibility to have intelligent lighting depending on the current traffic situations. Public lighting will have the possibility to adapt themselves based on information provided by traffic sensors. As an example, the lighting level may be adjusted based on the current volume of traffic in order to save power when the volume of traffic is low.

The project will also investigate the possibility to use the lamp on poles to inform road user of certain hazardous situations and thus reinforce road safety. Thanks to a deep integration the light can be used as a variable message sign to notify for the presence of a pedestrian on cross-walk, an incident ahead on the road, or a stopped vehicle on the road or on the emergency lanes. The video traffic sensors will provides the accurate detection.

This can also be used to improve the mobility of PRM (Person with Reduced Mobility). As an example specific path may be illuminated when a vehicle is detected on a PRM parking.

Last but not least, deep integration of traffic sensors with public lighting is a way to accelerate for the diffusion of ITS (Intelligent Transportation Solutions) over the world in order to the global road mobility and safety challenges.

To create efficient traffic information for drivers, Verisun and Ericsson will co-operate to gather the information from traffic environment. Kocsistem will focus on the big data on urban areas, Ericsson will be focusing on the data traffic between the sensors and the framework. Argedor will analyse big data received from data sources such as information services and social media services. The company will work on processing and storing big data. Argedor will also contribute to developing personalized services for drivers and traffic managers. Verisun will create a mobile application that interacts and provides an efficient route based on the big data gathered. Provus will develop an a profiling database of drivers based on the big data gathers. This profiling information will be used by traffic systems and mobile applications. Argevas will develop an algorithm to define an energy consumption level of a route. As the backoffice provider of HGS (Toll Collection System in Turkish motorways and Istanbul bridges), Provus will provide its Business Intelligence and Data Processing expertise in the demonstrator scenario.

**Technology for business intelligence, intelligent advertising and atmosphere**

The business intelligence services will combine information acquired from different sensor systems providing real-time information in a cost-effective way. The combination of different types of sensors from visual sensors to more simple presence sensors will enable coverage of large areas and at the same time detailed information from specific hotspots. This will mean advanced sensing possibilities via multi-modal detection using different sensor types for elaborated person presence and activity detection, and context analysis. The INSIST solution will extend the system re-configurability, and optimise the system performance via the sensor fusion. The solution breaks the barriers between the different sub-systems of urban automation – e.g. Lighting, Heating/Cooling, Surveillance, Intelligent Advertising and Safety -, thus facilitating the synergies in the sensing and control. Efficient co-design of lighting and information systems (e.g. people behaviour information and statistical business intelligence data) will lead to added comfort and more effective advertising. In the long-run the ecosystem can be improved by adding intelligent visual sensors capable of interpreting semantic events.

**Technology for data management systems**

The platform security is based on a smart combination of existing standards like SHA, AES, and TLS allowing for authentication and communication security for (embedded) devices with different levels of processing capabilities. Communication content is based on HTTP and JSON standards. The platform itself is open to accept different kinds of data upload formats, among which those based on the Continua or HL7 (home) health standards. Inter-server components make use of well-defined industry standards such as WSDL and SOAP (WS-I basic profile).

The proposed solution is to use the CPP as the interface between the different devices and the application(s). All devices will use the CPP client software to connect to the CPP infrastructure. Depending on the device type additional services will be configured like data collection, firmware download, notification services, etc.

**Technology for distributed sensing networks**

For this project we are specifically interested in cameras with low pixel counts. Together with specially designed optics, it is possible to achieve an efficient ambient light estimation by exploiting the properties of multiple lenses optics. Such optics, similar to the faceted eyes of insects, allows each pixel (or group of) to receive light from a predefined direction in space only. Moreover, changes in light intensity over the facets provide an essential clue for changes in the scene. Practically, faceted optics, together with HDR cameras appear to be the perfect tool for ambient light monitoring: they make it possible to measure the amount of light from a wide range of known directions in space with a single or few (very) low resolution sensor(s). Enhanced with communication capabilities, a network of such cameras will be able to share information and computing resources to build a global illumination map of, for instance, a street where light poles are equipped with such systems.

Concerning video surveillance, one of the most innovative aspects of the envisaged technologies is the tight coupling between video analytics and light management in an integrated system. Depending of the current situation from the security point of view, light may be adapted, for instance increased, if an abnormal behaviour is detected, or reduce to save energy if nothing happens. Vision based algorithms should be robust to lighting changes, especially in outdoor environments. On the other hand, co-locating cameras and sources of light is an optimal configuration for a good scene illumination. In addition, the knowledge of light status may be taken into account in video analytics to better model illumination. The relevance of surveillance related functionalities, as well as the accuracy of situational awareness assessment will benefit from controlled adaptation of light sources.

In the INSIST project, surveillance and traffic management applications will be addressed in a common framework and share common generic video analysis algorithms such as people/groups of people, vehicle detection and tracking, and event recognition.

Gossip-based communication, in which nodes in a large-scale network interact with random (neighbouring) nodes, has the advantage of being very robust to the network topology. In contrast to standard (ad-hoc) routing protocols there is no need to build up and maintain state (routing tables) about the (local) network topology. Spreading of information in a gossip-based network, however, still requires some care as the default behaviour of flooding entails high overheads in large-scale networks. Either the information range can be limited by introducing a time-to-live counter, or the information can be processed (fused, aggregated) at each node allowing for the creation of information landscapes [21] that capture network-wide knowledge about the monitored process. For example, by periodically exchanging/fusing information with direct neighbours only, gradients to a human walking on the street segment of interest can be formed to track and estimate its path for lighting purposes.

#### Advances over SOA

**Advances in city surveillance, crowd and traffic management**

Although object recognition of different type of objects is discussed in scientific literature, it is not applied for real-time traffic management and in particular to classification all different traffic participants. In combination with object tracking this is essential to apply the technology for different type of city services. Hence, in the project we will adopt models for different type of traffic participant and use them for recognition with machine learning techniques.

The recognition and tracking technology enables analysis of traffic density, flow and behaviour in the city including pedestrians. The higher quality of sensing now enables to exploit group detection and tracking and automated analysis of group behaviour. Both these improve robustness and the level of intelligence of video analysis to a city management function to which light control can be coupled. Nowadays, information on vehicle traffic is available, but only national roads while the information is only used to warn the drivers about traffic jams. However, typically the transportation speed within city centres is worse. The INSIST project will reveal this information within the city centre and can be used for control of traffic lights, digital signage, navigation information and public lighting.

If city centres become more crowded due to traffic or pedestrians that visit large events, the safety and security becomes an issue. If these situations are not notified, the capacity of police officers is too low while ambulances, fire engines and police vehicles get stuck. By measuring all traffic within and at the borders of the city, preventive actions can be taken and incidents can be circumvented.

The platform architecture of INSIST will allow us to collect information for many different sensors and sources. Not only the traffic participants, but also real-time people behaviour information, weather forecasts, event agenda's, shopping hours, public holidays, road constructions, etc. are available in a single system. This type of information is already being used for city services, but the decision making from large amounts of different information is cumbersome to interpret by human operators that need to make instant decisions for security and traffic management. By doing the automatically, the efficiency is increased considerably.

Argevas will develop an algorithm to define an efficiency parameter to be used by traffic systems per route. This parameter will provide a value for the driver to choose the route to take and to be aware of the energy consumption of the car on the defined route. The individual preferences define the crowd profile and that will provide valuable information for the authorities also.

Argedor will use clustering and classification algorithms for analysing big data coming from data sources such as information services and social media services. The company will contribute to big data storage. We will develop platform services and personalized services for drivers and traffic managers.

The information gathered from the sensor will be used by the mobile application of Verisun for the consumer to advice either public transportation or the personal transportation or their combination. Public transportation and vehicle 2 vehicle communication will be mobile application data resources.

Kocsistem will focus on the big data on urban areas. The main contribution areas of KocSistem will be on requirements specification of the global management of big data sets; developing use cases to check the feasibility and accuracy of data formats; testing the functionality of the tools developed; and contributing in development of algorithms to improve the efficiency of the data processing, analysis and exchange.

Ericsson, a key player in M2M area, strives to improve the ability to understand the big data that is being creating constantly by billions of sensors all around the world.  M2M, as known communication of the machines will be heterogeneous that means the data providers can change. Data can mean the level of the light, an alarm, temperature or movement of the objects. Combing these data with each other and understanding possible situations from different sources is a very difficult and challenging opportunity. It is also a closer step to “Internet of things” world. We as Ericsson Turkey R&D want to develop an algorithm supported with software to handle this problem with an optimized solution.

As the backoffice provider of HGS (Toll Collection System in Turkish motorways and Istanbul bridges), Provus will provide its Business Intelligence and Data Processing expertise in the project work packages. Provus has also expertise in End-User Profiling and technological background for extracting these informations from different resources such as ATMs, POS, Mobile Applications, HGS and other kind of terminals.

**Advances in Data Management Systems**

By using the CPP as interface between devices and underlying application(s) the advantage is that all connected devices and applications will make use of a generic platform with industry standard protocols. Scaling, reliability and security are fully embedded in the platform and proven technology. The other additional services will be of immediate added value and help to speed up implementation and integration of the different components of the project.

**Advances in business intelligence, intelligent advertising and atmosphere**

With the intelligent advertising and atmosphere creation INSIST will aim at offering new experience to the users/customers as well as novel advertising possibilities by providing both new interaction methods in adaptive urban spaces and real-time information on people behaviour. When we understand better the people behaviour and movement in space we can tailor the content and presentation in digital services providing intelligent, more alluring ads. The service design can be based on the knowledge how people move in the space or the advertising can be intelligently distributed and displayed.

In INSIST there is a need for more flexible and light information integration and data fusion means e.g. to put together the measurements obtained from different sensor systems in-situ with information coming from human actors and social web as well as efficient scaling techniques for knowledge representation assets. Considering in particular applications where human actor is involved in data exploitation process (e.g. maintenance domain), challenges exist with respect to information filtering, and information presentation. An important aspect to address will be to investigate the means to personalise and contextualise data in order to create data representation and data analysis views tailored to particular actors involved in the data exploitation process and the situation at hand.

**Advances in distributed sensing networks**

For this project we will develop a new modality for ambient light sensing based on low resolution HDR sensors and multi-lens optics. This technology will enable smart lightning systems to gather the information they need in order to adapt their behaviour to the circumstances (LT). The necessary steps to achieve this result will lead to advances in HDR image processing and (auto) calibration procedures for effective measurement. This will enable a whole range of application where HDR will be suitable for light measurement (ST). Finally progress in 3D printing will be achieved in order to increase the optical properties to the printed material and the spatial resolution of the printing (MT).

Intelligent video surveillance and light management have not been addressed jointly so far. Over the last years, a lot of effort was spent to improve the robustness of video analytics to lighting conditions, especially in outdoor environments. Existing video analytics technologies can exhibit good performances in controlled environments (indoor or outdoor with stable or smoothly varying light conditions) but lack robustness when illumination changes rapidly. Moreover, information about artificial sources of light is not exploited, but could be used could increase video analytics performances, by adapting parameters or type of processing.

Gossip-based algorithms hold the promise for achieving scale-free networking. The INSIST project will provide the unique opportunity to explore the theoretical results obtained so far in a concrete use-case scenario and a real-world practical setting. In addition, the INSIST project will challenge us to develop new aggregation/fusion algorithms; one of the issues that need to be addressed is how to track pedestrians when only limited information is available (i.e. due to cost considerations the cameras do not cover the entire street leaving “black holes”) inducing the need for prediction.

**Advances in user studies**

The promise of integrating multiple sensors is urban services that are better tailored to the different type of users of a public space or to the situation they are in. For a selected set of use cases from the lighting and security domain, the INSIST project will thoroughly investigate the lighting preferences and needs of specific user groups, and situations of use, in order to set requirements for the desired smart lighting solutions. Where needed, gaps in our understanding of the effects of lighting on, for example, human functioning and the sense of security at night will be resolved. To do so, we aim to overcome one difficulty inherent to user perception research on smart lighting solutions: the need for specialized, fully interactive outdoor lighting test sites. We will explore and develop means of employing immersive virtual environments (IVEs) as a methodological tool for research on lighting and security. The benefits of IVEs are plentiful: They offer more control over experimental (e.g., lighting settings) and contextual variables (e.g., weather, height of lampposts, street characteristics) than is possible with most outdoor lab facilities, while at the same time allowing for more natural and ecological valid experimental circumstances than classical laboratory research (pre-testing, for example, a lighting solution in a virtual environment that mimics closely the real environment in which the smart lighting system is intended to be used. IVEs also offer the possibility to radically break with current experimental paradigms in which the effects of lighting on the sense of security are investigated under circumstances of relative low anxiety. Due to its immersive qualities, a participants’ sense of anxiety may be more easily manipulated in an IVE than in a classical laboratory situation. Possible triggers may be visible (e.g., by adding signs of incivilities) or occurring even outside a participant’s awareness (e.g., by subliminal levels of a burning smell). Of course actual field trials are inevitably, not in the least because of the yet to be proven validity of using night time virtual environments for lighting and safety research. A lot is to be learned from in situ pilot studies, but we believe that these evaluations may become even more informative when we exploit the possibilities offered by the integrated sensor system in providing real-time measurements of human behaviour and mental states. By integrating information from different sensors detailed analysis of human behavior and emotions becomes possible, offering an unobtrusive means to measure whether a specific urban service (e.g., a lighting design) indeed has the desired effects. Moreover it enables experimentation with services in the public domain as it becomes possible to correlate changes in, for example, lighting settings with changes in sensor data.

## Market & business

### Current market trends and competition

As the Smart Lighting technology evolves from first generations of “smartness” – e.g. systems capable of reacting to occupancy and daylight – to more sophisticated intelligent systems aiming at energy savings and positive effect on people health and mood the smart lighting market revenues are expected to grow rapidly to over 11 billion $ by 2020 (Figure 6). The main application fields of smart lighting are Commercial and Industrial, Outdoor Lighting and Transportation, which all will be in the focus of INSIST project.

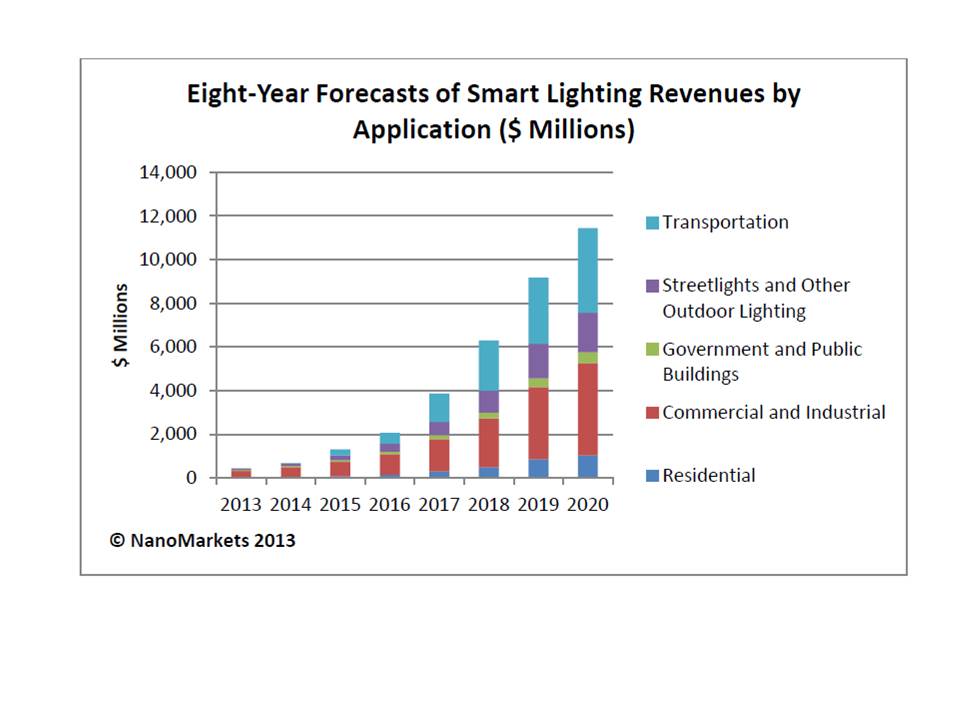


Figure 6: Smart Lighting Revenues by Application - forecast 2013-2020 [28]



Figure 7: Market estimation of video surveillance [29]

Frost and Sullivan have estimated a strong worldwide growth rate for video surveillance market revenues at the upcoming years as seen in Figure 7. They also estimate video content analysis (in security) market to reach $623.6 million in 2014 with a CAGR (Compound Annual Growth Rate) of 27.7% from 2007 to 2014. Similarly independent market research agencies as IMS Research forecast the video surveillance market to grow from a value of 2.1 billion dollars (1.5 billion euro) in 2009 to 3.3 billion dollars (2.4 billion euro) in 2015 with a CAGR (compound annual growth rate) of 10%.

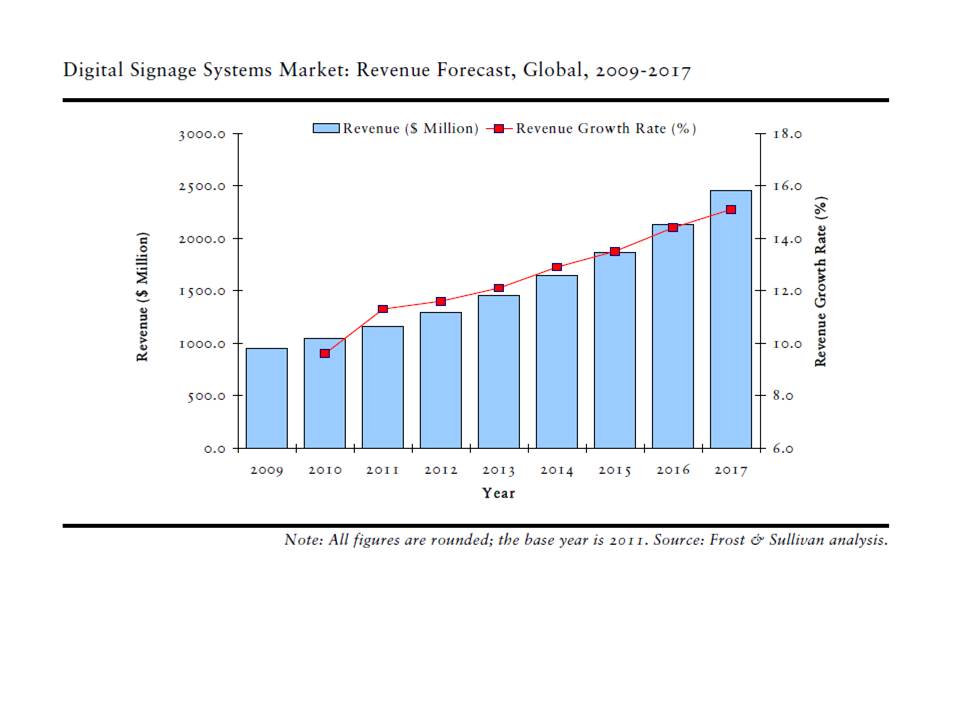


Figure 8: Digital Signage Systems Market: Global Revenue Forecast, 2009-2017 [30]

Advertising spending is growing steadily even if the global economy is in crisis. In 2012 the global ad spending grew 3.2%, where the growth focused to digital advertising channels (TV, radio, internet, cinema and outdoor advertising). The revenue for the global digital signage displays market is expected to increase from $384.8 million in 2011 to $821.8 million in 2017, at a CAGR of 13.5 percent, while the overall digital signage systems market is expected to increase to $2.5 billion by 2017 [30].

Internationally 54 % of the capital is on real estates. Only, in Finland the market potential in total results from the number of 3 million real estate property in total. Giving an example of the estimations of the impact of ICT is used the energy usage in smart housing and intelligent transport. Currently, final energy consumption in the EU is dominated by households 37 % (including also services) and transport 28 %. The digitalization of services will turn into energy saving and cost-effective housing and transportation. The potential of energy efficiency of the digital ecosystem of housing and mobility is proven to be very high by several studies. As an expert guess, we can speak of the multitude of 10 to 20 per cent enabled by ICT.

ICT has considered the key enable in many paths of life and new legal frameworks have launched as for example for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport (Directive 2010/40/EU) across Europe. Several policy and action papers urge to use ICT when applicable, not to mention the Innovation Union and Digital Agenda.

Regarding the citizen involvement, INSIST project has also an important impact. A “Green World” vision is not possible to achieve without empowering people with systems that enhance their capabilities, also from a ICT systems’ design perspective. The market impact is remarkable since each and every of the contributions we will provide the project with, are innovative and are being heavily requested by an ever-growing critical mass of practitioners who need them.

### Market opportunities: expected business

The increasing capacity and capability of technology resulting from INSIST ecosystem allows rapid emergence of new and improved digital services. This will clearly be the major growth area for different organisations across the INSIST value network over the next decade as consumers, public bodies and businesses recognize the benefits of networked and highly intelligent services. The challenge of crafting new connected sensor systems occurs in both consumer oriented and B2B markets. The impact of this project will therefore be not limited to a specific market segment but rather the results will be applicable to a large number of ICT solution providers across different sectors and application domains benefiting from an interconnected sensor-based information ecosystem.

The project will create a “paradigm” for crafting intelligent and flexible sensor-based systems and services for urban spaces. The consortium expects that the potential economic benefits of the results of this project will greatly outweigh its research and development cost. Indeed, European smart sensor-based system builders will benefit from the results of INSIST, as these will enable firms to strengthen their competitive position in an ever more demanding market and ever changing business environment, by differentiating from their competitors on the basis of solutions built by INSIST-project.

The INSIST project increases the market opportunities of the partners on the following main business domains (See details from the Market opportunity Table in the section 3.3.3):

* Indoor and outdoor lighting business and intelligent lighting management
* Flexible surveillance systems and their management services
* Traffic management of people, goods and machines
* Intelligent advertising and atmosphere service business
  + The partners operating on lighting business are seeking to increase their markets by developing more energy efficient high quality products, control systems and novel intelligent, efficient and scalable lighting management services as well as create new markets by integrating physical products with intelligent cloud services. The partners include: Philips, Citilog, Valopaa, MyPose, Offcode, KONE, Helvar, C2SmartLight, Digital Living, Nemein, SIVECO, ECRO, VUB-ETRO.
  + The partners operating on surveillance business aim at extending the market of video surveillance for outdoor public areas for surveillance, focusing on automatic real-time behaviour interpretation and analysis of pedestrians and vehicles, traffic and crowd management and megapixel camera technologies for that field. The partners include: ViNotion, Prodrive, Thales, CEA-LETI, TEB, KONE, Nemein, Digital Living, Scati, Catec, VUB-ETRO
  + The partners operating on traffic management believe that their business will increase on by developing a framework supporting mobile applications and cloud based services for example to define routes and personalized services in smart traffic utilising big data storage, solutions for advanced Intelligent traffic control, integrated city mobility management as well as implementing SW for utilising M2M data. The partners include: ViNotion, Prodrive, Thales, Nemein, Argevas, KoçSistem, Ericsson, Argedor, Provus, Verisun, Telvent, Catec, VUB-ETRO.
  + The partners operating on intelligent advertising and atmosphere are expecting to increase their market share in the field of business intelligent platforms, interactive marketing/advertising solutions and crowd and audience management for retail. The partners include: MyPose, Offcode, Innorange, Pro Piknik Festivals, Digital Living, Nemein.

### Exploitation plans

The results of INSIST project will be exploitable both in short- and long-term timeframe. The technology innovations focused on development of specific sensor systems (e.g. smart lighting or surveillance) will create new business opportunities and competitive advantage in relatively short time after the end of the project. On the other hand the commercialization of the new innovative services resulting from data fusion from different sensor systems or the cross-usage of the sensor data between various systems will aim at beyond the immediate end of INSIST project.

The INSIST partners have different roles in the value chain leading to diverse exploitation processes, plans and prospective. For example:

**Philips Research** is an organization that helps Philips introduces meaningful innovations that improve people’s lives. We provide technology options for innovations in the area of lighting, targeted at both developed and emerging markets. Positioned at the front-end of the innovation process, we work on everything from spotting trends and ideation to proof of concept and – where needed – first-of-a-kind product development.

**ViNotion** foresees the following steps concerning the exploitation plan:

* Find system integrators as strategic partners for marketing and sales
* Align the development with these potential system integrators (customers)
* Together with the system integrators involve end users for validation in R&D pilots
* Jointly start marketing campaign to find further details customer requirement and feedback of potential customers
* Perform pilots and disseminate the results to further promote the new technology
* After the project further invest to develop products based on the INSIST project demonstrators
* Start marketing of the products and start sales activities

After the project and once the INSIST technology is mature for market introduction, we expect the business of ViNotion on security and traffic management product to grow considerably. In partnership with internationally-oriented system integrators we will offer our solution to all cities in Europe.

**Thales labs** politics consists in fostering the emergence of software-based systems that fulfil the needs of the business divisions of Thales. The commercial strategy is to delegate industrialization and marketing of its results to third parties, internal or external Thales.

In the following table we list the specific exploitation plans for each partner.

|  |  |  |  |
| --- | --- | --- | --- |
| **Industrial partner** | **Country** | **Software/ system to be developed** | **Market opportunity** |
| Philips | NL | Intelligent light control algorithms and architecture | More efficient light management improves energy efficiency and reduces total cost of ownership |
| ViNotion | NL | Camera-based intelligent sensing applications:  - Smart video surveillance  - Traffic management  - Crowd management  The intelligent sensing will be based on video content analysis methodologies. | With the INSIST technology, ViNotion will be able to address an extended market of video surveillance for outdoor public areas deploying systems for real-time behaviour interpretation of pedestrians and vehicles for surveillance, traffic and crowd management.  Since this is a new market, the potential is huge. |
| TU-Delft | NL | Image processing software and gossip networks for very low resolution HDR image sensors and intelligent lampposts networks. | IP development for industrial partners |
| TU/e-VCA | NL | New Image/Video Analysis algorithms and technology is developed with intensive cooperation in the local high-tech industry. Object perceptual evaluation of light usage provides independent know-how to the industry. | IP is regularly offered or used by the industrial partners in exchange of research budget for further innovation of systems and products. Besides this, TU/e group research lead to new SME spin-off companies, e.g. the TU/e VCA group research resulted in 3 spin-offs companies in the last 6 years. The research in image analysis is also exploited in new education courses on 3D and analysis. |
| TUE-HTI | NL | Optimizing interactions between users, lighting systems, and public spaces in order to optimize both energy saving and security | TU/e HTI benefits through scientific publications, and the involvement of educational programs: Psychology & Technology BSc, Human-Technology Interaction MSc, and the Engineering Intelligent Lighting certificate program. Insights will find their way into readers and lectures, and student projects will be formulated around the INSIST research. |
| Argevas | TR | An algorithm to define efficient route for energy consumption | There is no traffic application that has an efficiency parameter |
| Argedor | TR | Big data storage,  Platform services and personalized services for smart traffic. | Argedor will utilise the outcomes of INSIST to enhance its existing business solutions and to develop new solutions in data mining and recommender systems. |
| Ericsson | TR | We want to produce software that can analyse data created by M2M devices. Ericsson estimates that by 2020, there will be 50 billion devices connected on planet earth. So understanding and giving meaning to it will be a very important issue and a problem to be solved. So we plan to develop this software to understand M2M environment in a better view. | The market is ready for this kind of solutions. The only missing part is that the solutions provided are not stable and reliable.  Ericsson with a high knowledge of productization we believe we can enter the market easily with the power of brand all around the world. When we complete this product we will have chance to market it all around the world via our Ericsson global network. |
| KoçSistem | TR | KocSistem is interested in adding value to framework development and mobile application and cloud based services development. | By the end of the project, KocSistem would like to make exploitation of the common workspace KocSistem will develop, public transportation mobile applications services. |
| Provus | TR | A profiling database based on the behaviour of drivers’ on the traffic database | Traffic data is a new data source for profiling, personalized services could be provided to end users |
| Verisun | TR | A mobile application to design a new approach to define routes including public transportation | Public transportation is a new option on mobile applications for route definition. |
| Fada-Catec | ES | Infrastructure software for surveillance and traffic management solutions | Fada-Catec is a technology centre and as such it will exploit project results through the collaboration with the industry |
| Scati | ES | Security and surveillance | Scati develops powerful set of video analysis and applications such as recording, utilization, local and/or remote management, control and monitoring combined with megapixel cameras. The project will allow extending current market domains. |
| Telvent | ES | Traffic management | Telvent develops advanced Intelligent traffic control solutions as well as integrated city mobility management. The project will provide the opportunity to evolve in interoperability and to explore optimised multiservice solutions. |
| SIVECO Romania SA | RO | Web platform development for end-users | SIVECO will develop specific web platform for citizens in their relation with authorities and energy providers |
| ECRO SRL | RO | End-user involvement | ECRO will develop new algorithms to maintain real-time, up-to-date dynamic comfort factors, as inputs for multi-criteria dynamic lighting, including in relation with energy sources, energy prices and energy availability in each time frame |
| Citilog | FR | Video detection sensor OEM for smart public lighting and Traffic Management | New distribution mode (OEM / ODM) relying on public lighting distribution  New market opportunity: road traffic data for smart public lighting |
| Thales | FR | Architecture for large scale security and traffic management | Improvement and refinement of large cities security and traffic management systems |
| C2SmartLight | FI | Advanced features to Intelligent outdoor lighting control system,  Wireless sensor technology to intelligent outdoor lighting control system,  Interfaces and interoperability of intelligent outdoor lighting control system and smart urban environment | Results to be achieved in project are expected to strengthen company’s competitiveness in export sales. |
| Digital Living | FI | A web 3.0 cloud based services for the Internet of Things (IoT) | The company core is in the IoT ecosystem building on its sophisticated software, which has globally a huge market potential as any IoT system and applicable in several businesses and paths of life. The first spear head application of Digital Living Finland Oy is Housebook for real estate business and building. |
| Innorange | FI | Innorange is a leading retail business intelligence provider for brinck-and-mortar retail what comes to customer behaviour. Innorange Business Intelligence platform currently fuses information from radio, camera, WiFi authentication and 3rd party databases such as cashier data. | Currently Actions resulting from Innorange’s Business Intelligence platform are typically based on a measurement period of one or more weeks. With INSIST project Innorange aims to add real time Actions to its service portfolio. |
| Helvar | FI | Intelligent  LED lighting control system | Major energy saving potential, simplicity in commissioning and usage |
| KONE | FI | End-user interface solutions for KONE People Flow intelligence (lighting & UI). KONE develops a signalization series which is integrated to new software platform. | Integrated People Flow system, smart lighting and user interface solutions enables efficient flow of people and energy. New modular signalization solution enables novel people flow experience, flexible solutions and new maintenance benefits. |
| Offcode | FI | Seamless connectivity between dummy and intelligent devices and system | The results of INSIST project can be utilized in multiple business sectors providing essential added value to Offcode toolchain. |
| MyPose | FI | MyPose will develop interactive marketing solutions concentrating on personal marketing and advertising solutions where the users can provide content for social media and include information of sensor data to it as well as control lighting at the moment of content creation for creating suitable atmosphere. | MyPose creates interactive marketing solutions for retail – connecting offline and online. Our area of expertise is software. We create applications for interactive displays, especially touch-screen, but also for other methods of interaction. We develop software to the client and server side, creating full solutions for retail marketing. The INSIST ecosystem will provide added value to our services in form of sensor data applicable both to interactive marketing content adaptation and interaction. |
| Pro Piknik Festivals | FI | Crowd and audience management solutions Marketing/advertising solutions | The ideas tested in project will be taken to production provided they add the value of the whole process and business model, an evolutionary choosing method of relevant ideas. Without exploring new things the business cannot evolve. |
| Valopaa | FI | LED luminaire and control systems development, Wireless control system HW and SW development, Sensor HW and SW development, System integration | Valopaa has developed LED lighting control systems. Several systems have been installed. Due to increasing demand for energy savings, demand for LED luminaires and controls system is expected to increase. Current lighting control system functionality can be enhanced by providing new features and/or interfaces to other systems. |

## Standardisation & Dissemination

### Standardisation strategy

The project has a strong ambition to distribute, transfer and exploit the knowledge, experience and relevant project results to the European community and world-wide.

The project members intend to contribute to the evolution of relevant standards, through direct membership and following the standardization in the relevant bodies. The standards that the project will follow and contribute if possible are for example:

Technology standards such as:

* DALI    Digital Addressable Lighting Interface
* KNX    KNX is a standardized (EN 50090, ISO/IEC 14543), OSI-based network communications protocol for intelligent buildings.

Energy saving/lighting quality standards such as

* EN 15193   Energy performance of buildings, energy requirements for lighting
* EN 12464-1 Light and lighting, lighting of work places, part 1: indoor work places

The main actors of this project are already involved in the standardization groups. Also the project will receive the feedback of the work being developed in these standardization bodies from the partners involved in them. The relevant standardisation bodies will wary according to the application domains defined in INSIST project.

Also some partners of INSIST will investigate the possibility to contribute to open source software (OSS), while making sure that the participants’ commercial endeavours are not endangered.

The best practices should also be codified in open source libraries that the project will either seek, or if needed, build. This includes activities like:

* Contributing new libraries into the open source space
* Ensuring continuity and good governance of the tools contributed by the project
* Activating relevant developers and open source communities to adopt these libraries and standards
* Promoting the standards and libraries in technical conferences
* Organizing workshops for interested developer communities aiming for standards and tool adoption
* Working with relevant standards bodies to document the best practices
* Contributing to related open source efforts

### Dissemination

Not needed in PO phase

# Consortium



## Consortium overview: key players

Auto-generated section, input only to be provided in the Community website

## Partners’ positioning along the described value chain

The **INSIST consortium** consists of 29 partners in the Netherlands, France, Finland, Romania, Turkey, Spain and Belgium: 7 large enterprises (Philips, Prodrive, Thales, KoçSistem, Provus, Ericsson, Telvent), 16 SMEs (ViNotion, TEB, Citilog, Valopaa, MyPose, Offcode, Innorange, Pro Piknik Festivals, SIVECO, ECRO, Argevas, Argedor, Provus, Verisun, Scati, Noesis) and 6 research institutes (TU Eindhoven, TU Delft, CEA-LETI, Lille University, VTT, Vrije Universiteit Brussel). The current partners are complementary and represent the separate parts of the relevant **value chain**, as shown in the table below**.**

| **Country** | **Partner** | **Lighting management** | | | **Surveillance** | | | **Traffic management** | | | **Advertising and atmosphere** | | | **System integration** | **User experience** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Sensing | Analysis | Service | Sensing | Analysis | Service | Sensing | Analysis | Service | Sensing | Analysis | Service |  |  |
| **NL** | Philips | x | x | x |  |  |  |  |  |  |  |  |  | x | x |
| **NL** | TUe-HTI |  |  | x |  |  |  |  |  |  |  |  |  |  | x |
| **NL** | TUe-VCA |  |  |  |  | x | x |  | x | x |  |  |  | x |  |
| **NL** | TUD-BR | x | x |  |  |  |  |  |  |  |  |  |  | x |  |
| **NL** | TUD-ES |  | x | x |  |  |  |  |  |  |  |  |  | x |  |
| **NL** | ViNotion |  |  |  |  | x | x |  | x | x |  |  |  | x |  |
| **NL** | Prodrive |  |  |  | x |  | x | x |  | x |  |  |  | x |  |
| **FR** | Thales |  |  |  | x | x | x |  |  | x |  |  |  | x |  |
| **FR** | CEA-LETI |  |  |  |  | x |  |  |  |  |  |  |  | x |  |
| **FR** | UniLille |  |  |  |  | x |  |  |  |  |  |  |  | x |  |
| **FR** | TEB |  |  |  | x |  |  |  |  |  |  |  |  | x |  |
| **FR** | Citilog | x | x |  |  |  |  | x | x | x |  |  |  | x |  |
| **FI** | VTT | x | x |  |  |  |  |  |  |  | x | x | x | x |  |
| **FI** | Valopaa |  | x | x |  |  |  |  |  |  |  |  |  | x |  |
| **FI** | MyPose |  |  |  |  |  |  |  |  |  | x | x | x | x | x |
| **FI** | Offcode |  | x |  |  |  |  |  |  |  |  | x | x | x |  |
| **FI** | Innorange |  |  |  |  |  |  |  |  |  | x | x | x | x |  |
| **FI** | Pro Piknik Festivals |  |  |  |  |  |  |  |  |  |  |  | x | x | x |
| **FI** | KONE | x | x | x | x | x |  |  |  |  |  |  |  | x |  |
| **FI** | Helvar | x | x | x |  |  |  |  |  |  |  |  |  | x |  |
| **FI** | C2SmartLight | x | x | x |  |  |  |  |  |  |  |  |  | x |  |
| **FI** | Digital Living |  | x |  |  | x |  |  |  |  |  | x |  | x |  |
| **FI** | Nemein |  |  | x |  |  | x |  |  | x |  |  | x | x |  |
| **RO** | SIVECO |  |  | x |  |  |  |  |  |  |  |  |  | x | x |
| **RO** | ECRO |  |  | x |  |  |  |  |  |  |  |  |  | x | x |
| **TR** | Argevas |  |  |  |  |  |  |  |  | x |  |  |  | x |  |
| **TR** | KoçSistem |  |  |  |  |  |  |  |  | x |  |  |  | x |  |
| **TR** | Ericsson |  |  |  |  |  |  | x | x | x |  |  |  | x |  |
| **TR** | Argedor |  |  |  |  |  |  |  | x | x |  |  |  | x | x |
| **TR** | Provus |  |  |  |  |  |  |  | x | x |  |  |  | x | x |
| **TR** | Verisun |  |  |  |  |  |  | x | x |  |  |  |  | x |  |
| **SP** | Telvent |  |  |  |  |  |  | x | x | x |  |  |  | x |  |
| **SP** | Scati |  |  |  | x | x | x |  |  |  |  |  |  | x |  |
| **SP** | Catec |  |  |  | x | x |  | x | x |  |  |  |  | x |  |
| **BE** | VUB-ETRO |  | x |  |  | x |  |  | x |  |  |  |  | x |  |
| **BE** | Noesis |  |  |  |  |  |  |  |  |  |  |  |  | x |  |

## Cooperation added value

### Technology level

**Horizontal and vertical technology innovation/cooperation contained in the consortium**

The INSIST project proposal wants to establish innovations by bridging several technological fields: the lighting field and surveillance field (with traffic management), and advertisement where the combination of these fields will nurture not only ideas and exchange of technology within the fields, but the combination/bridge between the two areas will enable unprecedented innovation at the high system layer in information-controlled lighting and strongly improved safety and security vice versa from the lighting in the surroundings. Especially at this bridge/combined level, scenario’s and solutions can be developed that would never occur by a project in one individual field. The consortium has been positioned and constructed in this way. The current practice is that within each individual field, such intelligent scenario-based applications would never be implemented at large scale, since projects are typically not positioned for this. INSIST will enable such scenarios and their evaluation.

Looking to the individual fields of lighting and surveillance/traffic management, the consortium is well balanced in the sense that a few large industrial partners per area will lead the areas and offer the reception platform for high-tech innovations coming from the SMEs in the respective areas. In the lighting area, the Philips Company is a world leader in lighting systems, Prodrive offers embedded platforms for integrated computing and their own production technology, whereas Ericsson can aid with networking between lighting devices (M2M) and connected systems technology. For the surveillance area, a similar situation occurs, where the company Thales, KocSistem and Telvent are in large surveillance and traffic management systems development.

For the several fields a number of high-tech SMEs are enclosed in the consortium, offering multiple specific and niche solutions in terms of algorithms and techniques, which are interesting for integration of innovative solutions into the larger systems of the large industrial partners. Examples of this are ViNotion and Scati with crowd and object detection and recognition (video analysis), a group of SMEs like MyPose, Innorange, Propiknik Festivals in the advertisement area, Argevas, Argedor, Provis, etc. for traffic management. Besides these SMEs, innovations will come and defined by a number of Universities and research institutes, such as TU-Delft for embedded solutions for lighting, Lille University, CEA-LETI and TU/e with video analysis for traffic and surveillance, VTT for advertisement and people behaviour. The number of SMEs and Universities/institutes is just broad enough to create substantial innovation power in conjunction with the larger partners.

While the individual clusters in lighting, traffic, surveillance and advertisement are powerful for their application area, the bridging between the areas will enable very interesting innovative scenarios for research and development of new applications. In this sense, the project consortium brings both width in applications and depth in systems and technology and innovation providers.

With respect to what the project can bring in terms of the goals of individual partners, we sketch snapshots of the interests of a selection of partners, since the consortium is too large to describe each individual partner’s benefits and goals.

### Business level

**Examples of partner goals and benefits within the project**

**Philips** aims at growing the lighting market with intelligent professional systems that reduce energy consumption. Intelligent embedded systems with integrated algorithms will offer a lower total cost of ownership for cities, infrastructure customes and the like. For the company as a system maker, it essential to learn the breaking point when that cost of ownership is lower than that of conventional situations

**ViNotion** expects serious market potential due to its SW component integration into professional surveillance cameras. They foresee markets for cities throughout Europe. The project offers large system integrators working on an international scale that may adopt their algorithms, whereas they can benefit from the existing and expanding university relations for new algorithm ideas such as from TU/e, Lille University and CEA for video analysis technology.

**Prodrive** can become the electronic platform provider for multiple camera systems in which powerful processing is needed for intelligent video analysis in traffic and surveillance cases. The company can benefit from both small SMEs such that they learn new advanced analysis applications and the requirements for new electronic embedded platforms. Further, the can contact large system companies for their cooperation and they can address international system suppliers from France, Spain and Turkey.

**TU Delft-ES** has been active in the area of Wireless Sensor Networks for more than 10 years and has a solid understanding of networking and data processing on embedded devices with limited capabilities. Participation within the INSIST project will allow them to expand their knowledge base and validate gossip-based algorithms in a real-world setting.

**TU/e** is active in video analysis for coding and intelligent video communication systems for 15 years now and has an excellent track record in industrial cooperation. The INSIST project offers a multitude of partners in new countries like Turkey, while the Dutch, French and Finish countries offer supplementary market areas for learning new applications, and thus expand on the depth and width of its know-how in image analysis and real-time applications.

**Thales** is a large industrial system maker for the defense and surveillance markets. The INSIST project offer them the possibility to enter new market segments and countries and learn from innovative SME technology from various participating SMEs at the levels of algorithms, communication and across new markets (e.g. surveillance and light/signage)

**SIVECO** will utilize its expertise of building software systems (information retrieval, content management, decision making, and application integration), empowered by the knowledge of INSIST related technologies gained during the project, in order to setup a valid strategy for the exploitation of project results. SIVECO's participation in the project is to share relevant information in order to develop competences for the beneficiaries of the project in the project's targeted domain and to raise awareness of the research work carried out within the project.

**VTT** can further expand its R&D and relationships fro advertisement and signage technology. The cooperation with and amount of SMEs is significant, so that they expand in the discipline of signage applications and underlying technology components.

# Work Description



The INSIST project is divided into 6 technical work packages, main activities are described below.

## Work Breakdown Structure and technical overview

**WP1 Requirements and system definition**

* Develop requirements (operational and functional) for smart lighting, security, traffic monitoring, advertising systems (ALL)
* Develop requirements (operational and functional) for systems of systems integrating lighting, security, traffic monitoring, advertising (ALL)
* Develop propositions for cross-system integrated services for citizens’ safety and comfort (ALL)
* Define scenarios and integration options (ALL)

**WP2 Sensing and feature extraction algorithms**

* Sensors and algorithms for detection and classification for lighting system control (Philips Research, TUDelft-BR, TUDelft-ES, VTT, C2SmartLight, Citilog)
* Sensors and algorithms for video people detection and tracking, data analytics, event recognition (Prodrive, TUe-VCA, ViNotion, Thales, CEA LIST, Kone, UniLille, TEB, Scati, Catec)
* Sensors and algorithms for detection and tracking, data analytics, event recognition for traffic monitoring (Prodrive, TUe-VCA, ViNotion, Citilog, TEB, Ericsson, Verisun, Telvent, Catec)
* Sensors and algorithms for intelligent advertising and atmosphere creation (VTT, MyPose)

**WP3 Integrated connected systems for citizens’ safety and comfort**

* Information format requirements for integration with other systems (Philips Research, ViNotion, Thales, Citilog, VTT, Offcode, Helvar, Kone, Digital Living, , SIVECO, ECRO, KoçSistem, Ericsson, Argedor, Provus, Telvent, Scati, Catec)
* Feature extraction and analysis algorithms for integration with other systems (ALL ABOVE)
* Algorithms for people, vehicle, activity, event detection in distributed, hybrid sensor networks (ALL ABOVE)
* Data analytics for system maintenance, fault detection, automatic configuration, business intelligence, visualization (ALL ABOVE)

**WP4 Infrastructure and data representation**

* Infrastructure requirements (Philips Corporate IT, Philips Research, ViNotion, Thales, Citilog, VTT, Valopaa, Offcode, Helvar, Kone, ProPiknik, Digital Living, , SIVECO, ECRO, KoçSistem, Ericsson, Argedor, Provus, Telvent, Scati, Catec)
* Data management infrastructure (communication, storage…) and data formats (ALL ABOVE)

**WP5 User studies for integrated services for citizens’ safety and comfort**

* Study definition, identification of relevant parameters (Philips Research, TUe-HTI, ECRO, SIVECO)
* Proposition and evaluation light control strategies for security and energy savings (Philips Research, TUe-HTI, ECRO, SIVECO, Kone)

**WP6 Applications and field tests**

* Infrastructure set-up (ALL)
* Collection of representative datasets for development purposes (ALL)
* Smart lighting, surveillance, traffic monitoring, signage integrated services demonstrators (ALL)

### Project and Work Package Leaders information

Auto-generated section, input only to be provided in the Community website

### Effort breakdown

Auto-generated section, input only to be provided in the Community website

## Work Packages description

|  |
| --- |
| Figure 9 shows the work packages of the INSIST project, which are summarized below, indicating intended WP leaders in bold. |
| Figure 9: Work package structure of the INSIST project |

### WP 1 - Requirements and system definition

*WP leader:* ***Philips Research***

The role of WP1 is to gather the requirements on the smart systems targeted by the INSIST project, and their development flow. WP1 will capture and organize the functional requirements of the smart lighting, surveillance, traffic monitoring and advertising systems. These will include sensing requirements, functionalities requirements (detection, recognition, tracking, etc.), and system responsiveness. The operational requirements will be also defined and prioritized: system cost, electrical consumption, networking, installation complexity etc. In WP1 operational and functional requirements for the integration and compatibility of the lighting, surveillance, traffic monitoring and advertising systems will be developed and organized. Based on these requirements, propositions for cross-system integrated services for citizens’ safety and comfort will be elaborated and documented, and demonstration scenarios and integration options formulated.

### WP 2 - Sensing and feature extraction algorithms

*WP leader:* ***TU Eindhoven***

The goal of WP2 is to develop a set of tools and algorithms to capture and analyse data from sensors monitoring the environment where smart lighting, surveillance, traffic monitoring and advertising systems are installed. The aim is to extract and describe the salient information of the observed scenes, so that data can be effectively used by the considered application and/or it can be shared with the other systems for further processing and aggregation to develop integrated hybrid applications. WP2 will develop new sensor network infrastructures and algorithms for detection and classification for lighting system control, algorithms for people detection and tracking, data analytics, event recognition in surveillance camera networks, algorithms for vehicle and pedestrian detection and tracking, traffic density and lane density estimation for traffic monitoring, and algorithms for smart signage interaction. This work package receives input from WP1 in the form of requirements and use case definitions, and will provide input for WP3 and WP4, where integration tasks between different systems will be carried out.

### WP 3 - Integrated connected systems for citizens’ safety and comfort

*WP leader:* ***Thales***

WP3 defines data requirements for information exchange between systems. The goal is to identify which information can be provided by each system that can be useful for other connected systems. Beside data type, requirements will cover operational aspects such as data size and capturing frequency, such that data is made usable and manageable for other applications. In this work package feature extraction and data aggregation algorithms will be specifically developed to facilitate the integration with other systems, in accordance with the developed requirements. WP3 will also develop algorithms for people, vehicle, activity, event detection in distributed, hybrid sensor networks, as well as data mining algorithms working on the share big data set for systems configuration, fault detection, business intelligence, visualization. This work package is central to the project: it receives input from WP1 and WP2 and it is executed in tight cooperation with WP4 where the data infrastructure is defined. WP3 develops the tools to enable the applications that are tested and demonstrated in WP5 and WP6.

### WP 4 - Infrastructure and data representation

*WP leader:* ***Argevas***

The goal of WP4 is to define and implement the requirements for the communication infrastructure between the different systems. Several diverse, complex, broad systems need to be able to exchange information is a secure, reliable way. In this work package we will define the hardware and software infrastructure requirements, as well as the data formats and interfaces to enable data sharing and logging across systems.

### WP 5 - User studies for integrated services for citizens’ safety and comfort

*WP leader:* ***Telvent***

User studies on how integrated services for safety and security are perceived will be carried out in this work package. The goal of WP5 is to define the boundaries and conditions of the tests and identify relevant parameters that need to be evaluated in the studies. The use of simulation tools such as immersive virtual reality environments and ‘wizard of Oz’ approaches are foreseen in the preparation phase. In this work package, new light control strategies and user interaction approaches for improved users’ comfort and energy savings in smart lighting systems will be proposed and tested with users. This work package will receive input from WP1, WP2 and WP3 and will provide useful insights for future applications of smart integrated systems. This work package will be executed in tight collaboration with WP6, where field tests and final applications will be executed.

### WP 6 - Applications and field tests

*WP leader:* ***VTT***

The role of WP6 is to realize applications and field tests to validate the INSIST platform. Field tests are envisioned within four main different application domains: outdoor lighting management, surveillance, traffic management and intelligent advertising and atmosphere creation. Integrated value-added services combining several of the above mentioned systems will also be considered. Applications will be implemented using the platform developed in WP2, WP3 and WP4, and will demonstrate how well the INSIST solution answers the stakeholder’s requirements on different domains. The use cases and field tests will be performed based on the specifications developed in WP1 and refined in this work package. Additionally, the infrastructures developed in this work package will be used during the project execution phase to capture representative datasets for development purposes.

### WP 7 - Project Management, exploitation and dissemination, standardisation

*WP leader:* ***Philips Research***

* **WP7 Exploitation and dissemination, Project Management**

This WP monitors and controls the overall project progress and ensures that deliverables and milestones are achieved on time. Risks will be carefully identified at the beginning and midterm milestone of the project while mitigation plans are defined. It is also the responsibility of this WP to organize regular meetings, to report progress and to ensure good communication between the partners. Therefore, a project start up workshop will be organized at the beginning of the project with all participants involved in this project. Project goals, planning, rules and way of working will be explained and set during this meeting. This work package will also manage the communication between the project partners and with the ITEA2 organization. Finally, an IT infrastructure (e-mailing lists and document system) will be made available to all partners.

The management and internal communication of the project will be carried out in WP7. The main objective is to support the technical, financial and contribution aspects of the other work packages. Project reporting and monitoring will follow strictly all ITEA2 guidelines and requirements. The dissemination, exploitation and demo activities will also take place within this work package.

# Main milestones and deliverables

In this PO phase of the proposal, the following major milestones are defined. In FPP phase the technical work packages will be defined in very detail, and also the corresponding deliverables.

|  |  |
| --- | --- |
| Month | Milestone or Deliverable title[[1]](#footnote-1) |
| M9 | Social context and system requirements defined |
| M12 | Definition of demonstration scenarios accepted |
| M15 | Final version system architecture and component technologies accepted |
| M18 | First demonstration of component technologies ready |
| M24 | First version of demonstrators ready |
| M35 | Final version of demonstrators ready for validation |
| M36 | Project end: all deliverables and documents |

# Rationale for public funding

The aim of INSIST project consortium is to take a leading role on European level in the development of innovative sensor-based systems for smart lighting, surveillance, traffic management, intelligent advertising and atmosphere creation, business intelligence and building information management. These systems can be exploited separately for various application fields or providing a single solution for public bodies providing services to citizens in urban spaces. The coordinated effort in INSIST can bring major benefits in the global competition to the European companies. The success of such a development relies heavily on easy adoption of state-of-the-art computer vision and sensor technology offering major benefits compared to the solutions available on the market currently and totally new business opportunities.

**INSIST importance** – The advent of cost-effective sensor installations serving multiple application fields is a major breakthrough. As a result the previously expensive technology can be adopted on novel application fields to provide services and solutions, which could not be realized before due to technology or cost limitations. However efficient adoption of new technology on many application domains necessities development of an interconnected ecosystem with advanced data fusion and analysis services as well as well-defined interfaces between various systems keeping in mind the most important security aspect of services for citizens in urban spaces.

Developing interconnected sensor systems with well-defined interfaces is a challenging task, thus synergies created in this project need to be exploited efficiently. INSIST consortium consists of efficient mix of different partners that support each other for performing the project goals. The consortium includes experienced research and company participants focused on specific INSIST application domains as well as technology developers and providers specialized in specific technology topics. The software developer companies will support the realization of the ecosystem that will allow easy integration of new sensor systems and value-added services by use of specific APIs for building the next generation services for urban spaces. The project allows more generic design of the technology provided by participants, thus new value chains can be formed and participants may increase their market potential in new application domains.

In INSIST we will demonstrate the ecosystem functionality by developing national application demonstrators. The combination of these INSIST application domains will ensure the functionality of the ecosystem on a wide range of services from smart lighting and traffic management to business intelligence.

**Rationale for funding** – The effort to reach the INSIST project goals is notable, because we need to address the sensor technology and system development from many aspects and build the interconnected INSIST ecosystem to support the creation of services. INSIST is built on a well-balanced group of actors from all needed domains including large industry, researchers and SMEs. This will seriously increase the chances of success of the consortium in the ambition to obtain a true European adoption of the resulting sensor and service technology. The integration of smart traffic, surveillance and lighting could lead to major benefit in the development of transversal optimized solutions that will help in sustainability, as well as in security and in quality of life. This type of innovation for bringing different service sectors together, deploying results to support the validation, can only be achieved through public funding support.

**European co-operation added value** – The INSIST partners present a wide selection of European companies and research institutes providing expertise on related technology, application fields and user expectations. Many of the INSIST partners have also already experience from European co-operation projects and collaborate with both INSIST partners and other European projects and companies. The newcomers on the other hand will provide new insights and specialized knowledge for INSIST. By joining the different expertise and background in INSIST consortium into a common coordinated effort, Europe is clearly preparing a significant leap into the future of sensor-based systems and services with new means for the industry and SME partners to create cost-effective and highly innovative products for their customers.

# Contacts with Public Authorities

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The Country coordinators in the above mentioned table are responsible for the negotiation with the local funding authorities; they have discussed the current consortium mentioned in this PO. Final consortium, his effort and total costs will be defined in FPP phase.

# How the FPP takes into account the recommendations of the PO evaluations

Not needed in PO phase

# Appendices



## Partner Overview

Auto-generated section, input only to be provided in the Community website

## Efforts per Partner

Auto-generated section, input only to be provided in the Community website

## Costs per Partner

Auto-generated section, input only to be provided in the Community website

## Efforts per Country

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## Costs per Country

Auto-generated section, input only to be provided in the Community website

## Efforts per Work Package

Auto-generated section, input only to be provided in the Community website

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1. Titles should be self-explanatory. [↑](#footnote-ref-1)