

**Hochschule Anhalt** 

Anhalt University of Applied Sciences



#### **Energy-saving Intelligent Street Lighting System**

#### **Problem Statement**

- Goal of public lighting systems
  - Keeping public space of settlements safe at dark times of day
    - Street lighting
    - Lighting of parking lots
    - Lighted highways
  - Problem of the "conventional" street lighting:
    - High financial burden to the public administrations
    - At the edges of the city and in settlements almost off use
    - Unnecessary light pollution of the environment





### **Possible Solutions**

#### 1) Switching off lights after 24:00

- Eliminates the main goal of public lighting systems keeping a pedestrian in a "safe" lighting zone
- 2) Switching off each second lamp
  - Also reduces the security and convenience factor significantly
- 3) Equip each lamp with a motion sensor and switch it on/off upon detected motion
  - Limited range of detection
  - Inertia of the lamps effect of switching on behind the pedestrians



Very limited area of illumination



# More intelligent way - communication among the lamps



Motion sensor in each street
lamp

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- Pedestrian movement estimation
- Control lamps' operation:
  - brightness
  - timing

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# More intelligent way - communication among the lamps



- Spanning of illuminated area along pedestrians' paths, e.g.:
  - 250 m ahead / behind
  - Hold-on time 5 min



#### **Operation example (1)**



Step 0. Idle, all lamps are off. Motion detection is on



#### **Operation example (2)**



Step 1. Person detected at the edge lamp. 3 lamps span an illuminated area



#### **Operation example (3)**



Step 2. Person detected at the second lamp. Illuminated area is now ahead and behind the person



#### **Operation example (4)**



Step 3. At a crossing, each possible path must be illuminated



#### **Operation example (5)**



Step 4. After passing the crossroad the left part can be switched off



### System concept



- Linux SoC-based system for communication and management
- Switching on/off, dimming the lamps
- Message exchange with neighboring lamps
- Communication with the central management system





# **SmartLighting - the communication concept**

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- Mesh network over all lamps
  - Using IPv6

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- Auto-configuration of the network
  - IPv6 addresses as position index
- Application-specific IP routing protocol for message delivery
- GPS-based auto-recognition of street topology
- Diversity of network technologies
  - 2.4 GHz (IEEE 802.11x, 802.15.4)
  - PLC
  - UHF technology (868 MHz)

**RREP** {D,6,5,5}

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# **SmartLighting - the communication concept**

- Linux OS on a SoC platform
  - Re-use of open source stacks, libraries and drivers
  - Easy to extend
    - Just extend the software application with new features
      - e.g. dimming instead of simple on/off
  - Easy to maintain
    - Remote access via VPN
    - Integration into a central (communal) lighting management system possible
- A lighting point becomes a powerful network node
  - Advanced applications possible
    - WiFi access point
    - Public security announcements
    - Route information

## **Development status (1)**

- 2-nd generation of lamp prototypes
  - ~ 50 lamps in total
  - Field tests are possible
- Mesh routing protocol for seamless IP-based connectivity
- SmartLighting API for central system monitoring / management purposes





# **Development status (2)**

- Work on object detection
  - PIR sensor
  - Ultrasonic sensor
  - X-band detector
- Other options of object recognition and motion detection
  - IR-camera
  - Hybrid sensors











### **Development status (3)**

- First field test with real lamps on a street with 20 lamps under development
  - Integration of SmartLighting circuitry into the lamps of an Austrian manufacturer is ongoing
- Patent on routing means for SmartLighting granted by the Gerrman Patent Office (DPMA) granted 2014
- Additional patent applications in preparation



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(54) Bezeichnung: Verfahren zur Beleuchtung von Straßen, Wegen, Plätzen oder Räumen sowie Kommunikationseinheit zur Verwendung bei dem Verfahren

(12)



#### **Power savings impact**

- Usage plans
  - Energy saving:
    - Expected savings of 80-90% energy within dark period
- Evaluation of energy savings:
  - Using measurements of real pedestrians' traffic profile







#### **Power savings impact**

		Input Data					Auxiliary da	ta			
	price,	price, kWh, €					minutes per hour		60		
	hold	hold on Time, min			360		days per month		30		
	powe	r of lamp, W	150				days per anno		365		
	dark	time, night, h	9				W/kW		1000		
	number of events per night	duration of on-time, h	energy consumption per night, kWh	costs per night	con per n	energy osumption nonth, kWh	costs per energy month, € consumptic per year		energy sumption er year	costs per year, €	
SmartLighting	6	1	0,1	0,0225		2,7	0,68		32,85	8,21	
Conventional		20	1,35	0,3375		40,5	10	4	192,75	123,19	total savings
Cost saving		19	1,3	0,3		37,8	9		459,9	115,0	9 <b>3,</b> 3%



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