| ID | Title |
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| 0 | *A short title* |
| 1 | Context-aware multimodal real time travel planner |
| 2 | Public parking space availability prediction |
| 3 | Stimulating green behavior |
| 4 | Green urban ecosystem, micro planet |

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| 5 | Urban crowd sourced collective micro agriculture |
| 6 | Energy performance of buildings |
| 7 | Efficient lighting |
| 8 | Operation center of everything |
| 9 | Air pollution countermeasures (Citizen perspective) |
| 10 | Air pollution countermeasures (City authority perspective) |

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| 11 | Hazardous material transport accident |
| 12 | Water utility pipe leak management |
| 13 | Pollution monitoring |
| 14 | The green browser |
| 15 | Is Linköping CO2 neutral now? |
| 16 | Efficiency in delivering the “Pastry & Milk” program |

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| 17 | Parking management through video surveillance |
| 18 | “I need to get to…” |
| 19 | “What is my route?” Mobility management |
| 20 | Efficient public transport |
| 21 | Interconnectivity of GIS systems in the Brasov Municipality |

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| 22 | Improvement of GIS real time information through smartphone apps |
| 23 | Development of new GIS layers |
| 24 | Parking spaces real time management |
| 25 | Real time 3D maps |
| 26 | Made with Aarhus |

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| 27 | Vote a lamppost |
| 28 | The Freemium Smart City |
| 29 | Open Data Toolkit |
| 30 | Managing household waste (City administrators) |

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| 31 | Improving cycling safety (City administrators) |
| 32 | Event and traffic management |
| 33 | Housing guide for new students |

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| 34 | Crime map |
| 35 | Resource index |
| 36 | User satisfaction |

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| 37 | Smart elderly care system |
| 38 | Pay it forward |
| 39 | Smart car parking system |

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| 40 | Smart/green buildings |
| 41 | SmartFit navigation |
| 42 | Route planning for logistic companies |
| 43 | Energy efficient building |
| 44 | Impact of public utilities works |

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| 45 | Reserve parking place for electronic vehicles |
| 46 | Optimizing bus departure, pull bus out into traffic |
| 47 | Shopping tour in Osnabrück |
| 48 | Smart commuting |

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| 49 | Smart shopping platform |
| 50 | e-Neighborhood |
| 51 | Dynamic routing of vehicles in a city |

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| 52 | Save energy with friends |
| 53 | Tourist grouping service |
| 54 | Smart metering data for planning and optimizing the low voltage grid |

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| 55 | Intelligent commuter 1 |
| 56 | Intelligent commuter 2 |
| 57 | Autopilot |
| 58 | Intelligent public transport |
| 59 | Mobile payment |
| 60 | Smart parking |
| 61 | Smart rail network |
| 62 | Home Central Control |

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| 63 | Green you |
| 64 | City Information Model |
| 65 | Commuter information model |
| 66 | Smart irrigation in the city |
| 67 | Smart waste management |
| 68 | Cultural information |

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| 69 | Smart drums |
| 70 | Remote water network monitoring |
| 71 | Smart pallets |
| 72 | Smart events |
| 73 | Smart evacuation and robotic monitoring |
| 74 | Personal emergency response |
| 75 | Social Car Parking |
| 76 | Emergency response corridor |

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| 77 | Chronic disease |
| 78 | Aging population – Alzheimer's disease |
| 79 | Support for depression |
| 80 | Continuous care |
| 81 | Smart sun protection |
| 82 | Aging population – home monitoring |
| 83 | Personal trainer |

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| 84 | Automated social networking |
| 85 | Smart RunningTrack |
| 86 | Smart golf trainer |
| 87 | Mobile fitness application |
| 88 | Intelligent shopping application |
| 89 | Product information |

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| 90 | Smart product management |
| 91 | Smart orchard |
| 92 | Smart herding |
| 93 | Digital DJ |
| 94 | M2M gaming |

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| 95 | Digital museum |
| 96 | Interactive Street Sensing |
| 97 | Pollution monitoring |
| 98 | Sustainable urban planning |
| 99 | Green city |
| 100 | Wind farms |
| 101 | Mobile application for smart meters |

# CityPulse Project 101 Scenarios

| Narrative |
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| *A narrative story line.* |
| A person needs to travel from A to B for whatever purpose (business, work commuting, leisure). Different means of transportation are generally available and include walking, biking (own, shared), moped/scooter (own, shared, electric/petrol), car (own, pooling, ride sharing, taxi/shared taxi), public transportation (bus, metro, commuter train, ferry/boat). Transportation can be optimized on a case-by-case basis according to preferred travel time, convenience (comfort, seating, crowdedness, safety, environmental quality like air, humidity, temperature in the metro), total cost, environmental impacts, scenic route or personal health. Factors that impact the optimization include conditions of the different transport modes (road, weather, maintenance works, traffic intensity, people density, parking availability, charging pole availability, current environmental conditions like pollution, air quality, etc., irregularities in traffic schedules, road tolls, seating availability, accidents, charging level of EV, availability of city bikes, ...). The ideal route and selection of each leg of the journey from A to B can be done based on concurrent as well as projected aggregated conditions, and recalculation of the proposed route(s) can happen if conditions or preferences change and will follow and adapt to any detour of own choice. |
| Finding public parking space is difficult. Cities are increasingly reducing the amount of parking spaces per unit (e.g. apartment) and difficulty of finding a parking space is both annoying and results in environmental impacts (pollution, noise) from “circulating cars” looking for available parking slots. By using multiple input sources of information, a certain degree of probability of finding parking in different locations can be provided, also considering timed “no parking” zones, and can assist citizens in reducing “circulation times”. By knowing the current situation of circulating cars, hot spots can be avoided by controlling circulation routes by rerouting cars towards different paths thus to even out the distribution. People can also actively provide parking availability via smartphones. |
| The city council has an interest in making people aware of their environmental impacts in an attractive way without applying “social engineering” of people. By providing a dashboard, citizens and interested parties can follow the “environmental heartbeat” of the city as well as their own impacts and contributions taking into account various environmental parameters as noise levels, air quality (pollution, pollen), waste index (solid waste, waste water), recycling activities, fresh water quality, sea/lake water quality, ratio of environmental friendly travelling modes etc. Different settings can provide different “filters” in what information can be displayed on the dashboard or towards the individual. The personal behavior and activities can be compared to averages of other groups for benchmarking. Competitions are arranged between individuals to collect “green points”, and competitions are also arranged between residence houses, city blocks or even city districts. Not only the fun of competition is stimulating, but Green Points can be traded for rebates on public transport and other environmentally friendly actions and forms a “green economy” (“green coins”). |
| Optimization of microclimates in urban outdoor areas. Temperature, luminosity, humidity, moisture, controlled shading. Allow for CO2 sinks, green areas to regulate humidity and temperature to avoid artificial means of HVAC solutions outdoors. Increase biodiversity in green areas by providing the right conditions by reusing resources (energy, water, but primarily current weather conditions) and to have configurable control resources like shading etc. |

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| Micro urban agriculture using common infrastructures for optimized growth and micro marketplaces. Agriculture is done on balconies by single apartment tenants, on rooftops and facades by building owners or other actors. This is done on own citizen initiatives or as collective efforts. Buildings are instrumented with the proper infrastructures for this like water/micro irrigation, nutrition, but also appropriate green house climate (temp, humidity, wind, shading) depending on crop. Oxygen generated by plants in larger farms are collected and injected into buildings. Exhaust air from buildings including the heat is reused. Open markets are available based on collective and crowd sourced support, demand/response of herbs/plants etc. so you trade with your neighbors or across the block for whatever plants you need. Composted greenery is reused and monitors, waste water tanks have algae that recycle nutritiants etc. |
| Buildings in Europe stand for 40% of the energy consumption (Horizon 2020). The energy performance of buildings (residences, commercial/offices, industrial) is monitored from a holistic perspective. This is done inside buildings, parts of buildings, influx/out flux of buildings. A holistic view implies considering all energy dependent external factors like wind, luminosity, influx of energy (heating, gas, electricity). Filtering out energy that goes to different subsystems (cooling, heating, food, lights, ...). Internal factors impacting energy sink/source and storage like airflow, people occupancy, activities, fresh water temperature, waste water temperature. Energy storage in walls, floors, etc. All is considered and monitored to get a full picture so that this information can be used to further make a holistic optimization of energy in general in buildings. |
| Maria is jogging regularly, late in the afternoon at Vasaparken when she notices that one of the lamps in the middle of the park is out of order, thus creating a rather bleak spot in her jogging path. Using an app she points towards the lamp, taking a geo tagged picture and submits it to the local authority reporting the incident. Maria can report this by authenticating herself into the system and thus earn points that can be redeemed in the local market or she can report this anonymously.<br>Turning this scenario around, viewed from the local authorities perspective, such maintenance activities can be automated by taking into consideration the lifetime of each lamp. A simple predictive mechanism can use this information as input and prepare a lamp for the preventive maintenance of a lamp grid installation. |
| Max is working in the mayor’s office and he is having trouble coping with all the different authorities that participate in maintaining all the networks that run within a city, i.e. electricity/water/gas/transportation. Essentially each network as such has its own internal network operation center and it is hard for Max to get the big picture. It would be interesting for Max to have a dashboard that would aggregate and visualize all the information originating from different networks, thus providing an overview of the status of the city. |
| Alice has just got in her car to drive from the suburbs to the city where she works. Her GPS connects to the city traffic service and suggests a possible route with the objective of reducing air pollutant concentrations. Alice starts her trip. On the way to the city, the city traffic system suggests to Alice that she should park her car at a metro train station and take the metro instead. The parking fee is free but she needs to pay for the metro ticket. The metro ticket is cheaper than the (dynamic) congestion tax imposed for high traffic areas. |
| City authorities operate an air pollution response center in collaboration with traffic authorities. This operational center is supported by the City Traffic System which collects information from multiple different sources and provides monitoring and action capabilities to the city authorities and monitoring capabilities to the citizens through their GPS devices. The system also connects to the transportation authority services (e.g. retrieving public transportation schedules). When congestion and air pollutants are high in certain areas, traffic lights are instructed to limit the flow of cars in these parts and virtual gates to increase the fee of a car passing through them. Upon a congestion and eminent pollutant high concentration the city authorities react by coordinating with the transport authorities so that drivers can “park & ride” means of public transportation. |

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| “2Fast” is a package delivery company with clients in chemical and biotechnology industries. One sunny day one of the company’s trucks got in an accident with other vehicles falling over and causing fire. The city operation center (OC) received an alarm raised by a surveillance camera located on the street as well as sensors on the truck and assessed the severity. OC requested information about the truck and the goods and performed classification of the fire. Based on the obtained info, the OC notified the right city authorities (police, ambulance, fire fighters) and provided all the gathered information on the incident so that the appropriate rescue facilities could be engaged as well as controlling diversion of traffic, notification to the public and evacuation of people nearby. |
| Construction work on a street caused damage on a water pipe. Deployed pressure sensors detected a pressure drop between valves, thus triggering an alarm at a City Operation Center (OC). The OC located the leak on the pipe city map, calculated optimal valve isolation based on investigation, current and projected water usage and pinpointing conducted in cooperation with field workers. The OC created a proposal for the city councils to work on the leak, divert traffic and bus routes, suspend parking, close roads, supply surrounding schools and hospitals with water and forwarded it for solving the issue. After receiving a reply from the city authorities a team of engineers has been dispatched to fix the pipe. |
| Decentralized control of concentration of pollutants. Types of pollutants: micro-pollutants, chemicals, hormones.<br>Method: Sensors in each house (street) monitors the pollution level, thus helping to build statistics about how families impact pollution levels. In the long run statistics will help to arrange campaigns that will be directed to certain families to encourage them in reducing pollution from their side.<br>Advantages: Cleaner waste water that will require less processing and targeted influence on people to become more eco-friendly. |
| Every morning Dima takes the bus to work. He likes to spend a few minutes to check the live data from his neighborhood.<br>The live data of the neighborhood shows overall electricity and water consumption, CO2 emission rate, waste water pollution, etc. Dima sees that the neighborhood has become more environment friendly compared to the previous month. He’s glad that the connected bus stop makes him aware of his impact on the environment. Dima also sees that his neighborhood is becoming “greener” on the city map displayed on the billboard. |
| This scenario needs to be addressed to the citizens, providing them information they are interested in (e.g. characterizing citizens' profiles and contextual information): Most people are not really motivated or interested in knowing how green they are, but some of them want to know the amount of recyclable material they produce, others might be more interested in transforming this feedback into the amount of saving, or some device being able to answer the questions “how much am I saving?”, “how much more can I save?” or more specific, action-driven questions like “how much am I saving if I do the laundry now?”<br>A solution that is able to present different information to different classes of citizens is the key, and this context and profile aware citizens classification can help break down the specific. |
| Each day, pupils 7 to 15 years old must receive a light meal in school. This is delivered by small local companies. Often, a lot of food is thrown away if one or more students do not attend class in a certain day.<br>Based on the access card records (currently being installed in schools), the caterer knows how many packaged meals must be delivered in each school, thus eliminating waste.<br>The data from the access cards could be aggregated with the quantity of water, electricity, gas used and allow for better projections of consumptions in schools or other public buildings. |

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| Still, the public behavior in mobility in the city of Brasov involves the use of private cars. The issue of parking is one of great concern for the public administration, especially in the city center.<br>The app available to the general public will show the driver where there are free parking slots and also the time needed to get there from the current location. This will make the public parking management in the city center more efficient. The app would be available also to tourists paired with a map of the city so they know how to reach the parking area. |
| George is a student in Brasov. He comes from a town about 150 km away and these days he is completely lost in a new town.<br>The map available on the city hall website allows him to locate streets by name, public buildings as well as various general interest destinations.<br>The data from the interactive map can be designed to fit various types of users (local tourists, foreign tourists, tourists guides, students, youth, the elderly, etc.)<br>The data could be updated in real time through info picked up from various social networks or mobile apps or with data regarding municipal works in progress. |
| Maria needs to get to work in a hurry. She is already a bit late and needs to be efficient when choosing the route from her house to her workplace. For this, Maria would log on to an app that aggregates data from an interactive map available on the city hall's website. The map shows various works that take place in the city as well as other types of data (stray dog present, road works, pedestrian walkways works, tree trimming, traffic signaling works, etc.). When Maria inputs the start and the destination of her journey, as well as her mean of transportation (car, bike, public transport) she gets some alternative routes to follow as well as the estimated time of arrival to work.<br>The interactive map allows for citizens to input various data and allow for real time updating of the situation in the entire city. |
| Every day, congestions affect thousands of citizens who move around the city. In order to ensure mobility efficiency, public transport needs to be a viable alternative to transportation. Moreover, "time lost" in traffic should become "time gained" in public transport.<br>Based on a variety of data and control systems, public transport (PT) services should have the following: (1) Traffic light priority in congestion situation, (2) Easy access to Wi-Fi Internet on the PT vehicles, (3) Useful urban information delivered to the PT users, (4) Increased safety, especially for children, women, the elderly, etc., (5) Increased accessibility. |
| The Brasov municipality has developed its own GIS a few years ago. Since then, the GIS system has been developed and is used in more and more various aspects of urban management. Currently, there are active protocols with various urban enterprises to provide relevant data to the municipality in order to update the GIS system.<br>In the Brasov area, there are two more stakeholders who operate their own GIS system - the gas company and the water and sewage company.<br>A useful application could be to create the necessary mechanism for the 2 private GIS systems to connect to the public GIS servers and update data. The main challenge is represented by the security protocols of the gas and water companies who often do not allow the interconnectivity of these systems. A real time updating of GIS would allow for better real time information used in urban management |

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| Currently, city hall employees go out in the field (urban area) and report various situations (pot holes, water network malfunction, etc.) In order to accurately report the locations, they need adequate GPS devices that allow for the proper identification of the problem area. The data collected with the GPS devices is then uploaded onto the GIS server via USB. When GPS devices are not available, city employees will report based on various fixed points (“2 meters away from lighting pole number xx” or “in front of the number 4 building on the zzz street.” ) This information is not so easy to upload into the GIS.<br>Most smartphones these days have GPS tracking incorporated in the phone itself. A smartphone app available to city employees or the entire general public would allow for the use of smartphones in order to properly report any malfunctions or special situations in the city. This would allow for the information to make its way into the GIS, then into various applications managed by the city that keep track of ongoing repairs and ultimately, the information could reach various urban data streams that can reach interested citizens. |
| Up until now, the GIS system owned by the municipality has been making its way into improving various aspects of city life such as utilities networks, traffic flow, public transport, etc.<br>A new task could be assigned to the GIS system and that is to intervene in more aspects of urban life. For example, the law enforcement agencies could use simple, specially designed software in order to record data such as traffic accidents, traffic violations, burglaries, etc. This geographic data could then be aggregated into a GIS format and correlated with public lighting data, traffic data, various urban situations, in order to determine the patterns that allow for accidents or for public safety violations. This will help various public bodies in the city to share information and to predict problem areas in the city that could be redesigned in order to improve safety and quality of life. |
| Many times, drivers coming into the Brasov city center, especially at rush hour, cannot find parking spaces. Presently, available parking spaces are part of a pay to park system, which includes the possibility of paying cash to an automated machine or paying by SMS.<br>Data regarding available parking spaces or when and where parking spaces will be available in the next few minutes (provided by the automated machines or through the sent SMS) could be included into a real time app that would be available to drivers coming into the city center. The app could then be populated with other real time useful information about various public interest activities in the city center. |
| Now that Aarhus is producing real time data in every corner of the city, and the open data platform facilitates the possibility of tapping into this data, the SME “Real time liberators” has created a broad service for citizens, journalists, the municipality and other SME’s. The service is a real time 3D map of Aarhus, where it‘s possible to tick data sources on and off. This means that you can tick power consumption on, and immediately 3D bars will rise from the ground at specific locations. The bars are dynamically moving up and down according to measurements in the surrounding areas. Furthermore, you can tick on public transportation, and suddenly small busses will move around on the streets between the buildings. All this is accessible through a web browser and can therefore be seen on any device imaginable. This service is the real-life, real time version of SimCity. |
| Now that the city of Aarhus has a full-blown open data portal with all sorts of static and real time data from the city, citizens are developing more applications and services than ever. In helping developers getting their services out, and making sure that the quality is sufficient, the city is now facilitating a branding procedure. This means that a service can be branded with ”Made with Aarhus”. When having this mark, the service meets certain criteria and is quality approved from the municipality. By having this branding procedure, Aarhus gets branded (if the specific service is good enough), and the service itself will have a higher integrity. This entails that citizens might be more willing to try it out and pay more for the service.<br>Furthermore, developers might get exclusive access to specific data, if they consent to the criteria – they might get actual real time access to data for faster reactions and event detection. |

For a long time Karl has had a hard time sleeping at night. This is primarily due to the lamppost outside his bedroom window – it lights up his entire bedroom. Recently the town (Tarm) has been updated with intelligent street lighting, which makes it possible for the inhabitants to influence the lighting lifecycle.
It's Friday 10 PM and Karl is tired after a long day at work. Outside his bedroom window there is a lamppost, and Karl can't sleep when the bedroom is lit up. Therefore he opens his laptop, accesses the lamppost liberation website and logs in. When he is logged in, the system knows his location and gives him access to the lampposts that are nearest him. Karl can now select a specific lamppost and suggest changes. He can choose between turning the lamppost on or off, changing the luminance and when these changes should take effect. This specific evening Karl wants to turn off the lamppost. He selects the lamppost nearest the bedroom and requests turning it off at 10:10 PM. Online and logged in neighbors near the lamppost will get a notification about the request. They can now vote whether they want the suggestion to take effect or not. On the opposite side of the street Arne (who is a family father) gets Karl's notification and votes it down. He has a daughter who is at a party, and she will come home in a couple of hours. Therefore he wants the light to be on, so she can have a safe trip home. While voting the suggestion down, Arne can add a comment on the voting and suggest another solution. In this particular situation, Arne suggests that they could dim the lamppost and immediately creates a new request for dimming at 10:10 PM. Karl sees the comment, removes his request and votes for the suggestion. Minutes later the lamppost dims to half the luminance.

The city has a freemium option. If resources are available in abundance, services are free. E.g. free electricity if the grid has overcapacity.

The Open Data Toolkit challenges the traditional role of citizens, the public sector and the private sector. Among other things, it creates a new way of collaborating and creating public services. It's an alternative way of solving and addressing societal challenges and can be a part to strengthen the digital economy and creating jobs. It's empowering the people.
Robert uses the Open Data Toolkit and open data from the open data platform in Aarhus to develop an app to car drivers in Aarhus.
Using the toolkit he can learn how to use the open data platform, use certain formats/APIs, collaborate with the city, etc.

The Waste Department in The City of Aarhus has difficulties as regards to inform new citizens, mostly students, about the waste procedures in the city. For example they see that the citizens just leave their waste, especially bulky waste, at curbstones around the city. There is an existing bulky waste solution, where citizens can order collection of bulky waste. Citizens just leaving bulky waste around the city are costly for the Waste Department. The waste app can in an easy way tell (young) citizens about the existing waste solutions in the city. Enabling direct feedback from citizens regarding the existing waste solutions would give the Waste Department useful information, which they are actually without at the moment.
A future scenario would be that Peter (new in town) just started at the university. He doesn't know about the waste procedures in the city, as for example how to get rid of bulky waste. He downloads the waste app and in that way gets collection information relevant for his zone at his fingertips. He can set up reminders for regular, holiday and special collections and find locations where he can discard paper and glass.

The City of Aarhus is a cycle city with a high number of cyclists – and it's increasing. That is positive for the environmental accounts, but causes a lot of dangerous situations around in the traffic.
The city has an ambitious strategy for Aarhus as a city for cyclists and reorganizing the cycling infrastructure is being considered.
To make the right decisions the city would like to know where the citizens experience the dangerous situations. The city is considering distributing "Bicycle cards" with RFID chips to a high number of cyclists. That would give them info about the cyclists' behavior in the traffic – also data that is relevant to implement in the app.
A concrete scenario is that Julie is using the bicycle app to plan her routes around the city. For example she would like to avoid the dangerous intersections. She is told where and when there are lots of/few cyclists, where the roads are covered with paving stones and so on. She registers her own routes and what she thinks about it as regards to safety. "Bicycle cards" with RFID chips would make it possible for Julie to see the bicycle traffic in real time and immediately decide what route to take.

The city needs, during 2017 where a lot of events take place, to be able to (re)organize locations and adjust transportation network (busses, roads and so on).
Using direct feedback from users (via social media) and traffic data, the interactive map can show in real time whether some adaptation is needed (e.g. send more officers in a particular area, close certain roads or open others, provide city bikes in crucial areas where there are no bikes left wherever there is such service, or manage parking dynamically).

In August 2013 around 12,000 new students were to start studying in Aarhus and therefore needed a place to live in Aarhus. Every year it's a challenge for the students to find accommodation. Most of the students want to live in the city center and are not aware of the housing possibilities around the city.
Julie is going to study for the next five years in Aarhus. She therefore needs a place to live. She doesn't know anyone in Aarhus and doesn't know the city that well, mostly the city center. And therefore she wants to live there. But it's very expensive and impossible to find an apartment.
In the material from the university there was a link to a housing guide for new students in Aarhus. Julie downloads the app, which gives her different kinds of information about the areas around the city.
For example in Gellerup (Aarhus ghetto) it shows all the cultural events in the area, the shopping possibilities, bus routes, sports activities, housing expenses like house rent, waiting time for an apartment. Most of the data comes from the municipality, but the app also shows user generated data where users have pointed out spots where they think something relevant is in Gellerup.
Julie didn't know that there were so many things (e.g. culture and sport) going on in Gellerup. She therefore decides to call the housing association in Gellerup to talk with them about the housing possibilities in Gellerup.
From the city's view the housing guide could remedy housing challenges and increase integration in e.g. Gellerup.

Aarhus would like an interactive and online crime map. The crime map lets residents view crime data by specific neighborhoods — and in real time as reports occur. If possible the crime map should offer both geographic criminal history and day-by-day data regarding crime in the city.
The map can help residents or new residents to find safe neighborhoods, but also enhance the city administration's and the police's understanding of where felony and violent crime persist and in that way make it possible to focus resources to crime prevention. The map should build on report data from the police and present it visually in neighborhoods across the city. This is to keep the public well-informed about what is going on in their city/neighborhood.
The map could have a feature, which makes it possible for people to report incidents. In that way the map would also show user-generated data. The user-generated/reported data should be sent directly to the police. Static data through some different parameters, such as e.g. neighbor.

Elin is a very eco-conscious mother of two living in Aarhus. She sorts her garbage, cycles to almost everything, but she finds it hard to get an idea of their consumption of electric power, water and heating. The bills she gets from the utility companies are badly arranged and not easy to understand.
Elin therefore likes the new online resource index, which shows in a clear and easily understood way her family's consumption. She's presented with a visual presentation of their expenditure and can choose to see historical data, compare with the same month last year and the like. She is presented to hints on how to reduce their consumption.
It's also possible for her to see the consumption in a certain area in the city or the whole city – what is the CO2 level of the city right now? And to compare different areas in the city.
Elin can also find the city's climate plan in the index and it's possible for her to comment on it and in that actively participate in the city's planning regarding climate and environment.
From the city's view the resource index could help make people more eco-conscious and possibly change behavior. Aarhus has a goal of becoming carbon neutral in 2030.
It could also be possible for the city to see the consumption in all public buildings in the city and in that way be aware of it's own eco-behavior.

The biggest swimming facility in Aarhus has a user satisfaction system, which makes it possible for the visitors to express their satisfaction/dissatisfaction in certain areas around the facility. The system is available for visitors at interactive screens around the facility.
Everyday an employee has the responsibility for the areas that are a part of the user satisfaction system. That is for example the women's changing room. Sophie works at the swimming facility and today she is responsible for the women's changing room.
This means that she is equipped with a wireless device through which she's immediately notified when a user presses dissatisfied and writes a reason at the screen in the women's changing room. With the reason from the user Sophie has the possibility to react immediately – if the reason is too much water on the floor, no soap, dirty toilets or the like she supposed to correct it. And hopefully while the user actually sees it. This shows that the feedbacks from the users are taken seriously.
The data from the user satisfaction system is directly uploaded to Aarhus's open data platform. Screens are set up at 12 different places.

Caroline works for the home care in Aarhus Municipality. Every day she drives the same route to the elderly and provides home care. The municipal Health and Care Department has just implemented a Smart Elderly Care System, which gives them the opportunity to change the routes of the day according to the needs of the elderly.
At each home of the elderly several sensors are installed, for example sensors on light switches and water taps. In that way the Health and Care Department is able to see if for example Mrs. Jensen has been at the toilet several times during the night or if she hasn't turned on any light in 24 hours. Given the first example of data they can assume that Mrs. Jensen has some bladder problems and react on that. Given the last example they can assume that something is very wrong with Mrs. Jensen and therefore change the route so e.g. Caroline drives by Mrs. Jensen immediately.
From the city's point of view the Smart Elderly Care System could help them provide better elderly care and plan better.
From the citizen's point of view the system can provide security and safety – also for the relatives of the elderly.

Jens is waiting for the bus at Park Allé in Aarhus. Through the "pay it forward" app, he knows that it's coming in two minutes and twenty seconds. When the bus comes Jens gets on, registers his transportation type (bus, car, bike, walking, etc.) and selects the specific bus number in the app. Now the phone is registering Jens' movement and feeds GPS data back to the "pay it forward" system. With this information the system can figure out when a bus is coming, if it's late or early, it can predict and announce traffic jams, find alternative routes, etc. All this is done in real time, with actual real time data from within the city. When Jens reaches his end stop, he stops the registration of GPS data, so that his phone doesn't consume as much power and he doesn't want the system to know where his final destination is.
The engine of "pay it forward" is the citizens' willingness to share their data and help fellow inhabitants. This means that "pay it forward" is powered by crowd sourcing, and therefore relies on a constant and large amount of users to be working sufficiently. Fortunately "pay it forward" has now been so popular that 2,000 citizens are using the app on a daily basis in Aarhus. This makes the app a relevant and novel service for citizens in their daily routines. Furthermore, it gives people the opportunity to give something back to society while leveraging from it at the same time.

The city of Dublin is hosting Olympics. The city has built a huge sports complex called Olympics Park, where all the sport events are being held. For public facilitation the sports complex has one big car park for the citizens attending any of the sport events. The car park is facilitated with an automated ticketing system, which displays the number of vehicles parked and the number of vacancies available. These numbers are automatically updated on entrance or exit of any vehicle.
Even though at the main entrance it is shown that vacancies are available, every driver has to drive for a very long time to find a suitable/empty space, resulting in waste of time and money/resources. Citizens also want to park closest to their favorite sports facility. The smart car parking system is equipped with individual sensors at all car parking spaces. User has mobile app for smart car parking system, which integrates real time sensor information of the car parking space, its GPS locations and combines it with the user profiles to find a suitable place while considering the user's sport interest, event starting time, tickets purchased/seat numbers etc.

Company X is a medium scale organization with more than 200 employees. Employees use an internal resource management system to arrange their meetings and book resources that are needed. All the meeting rooms are equipped with sensors to control lights, air conditioning, heating and status (on/off) of all the available devices. Meeting rooms are monitored by an automated temperature control system, which automatically turns on/off the heating/air conditioning before the meeting and similarly after the meeting, and that adapts to the time of the year, to the outside temperature and light and to the need of the presenter in automatic set-up of the appropriate parameters for all resources before the meeting.

Allocation of green areas is a very important part of the health and quality of life in a city. Green areas and parks are also vital for citizens' health and they can promote outdoor activities and exercises like jogging.
Not every city, though, has the opportunity to provide green areas that are wide enough for habitual joggers and runners, and some type of training would require people to exercise going through city traffic, to green areas, to roads with wide sidewalks, back to green areas.
A similar destiny affects people who cycle (both for sport and as a means for transportation).
Larry has a very sedentary job and he really cares about health and fitness for himself and for his family.
Larry jogs three times a week, and he likes to do it outside during the spring and summer months. Given the outline of an exercise plan (e.g. number of calories or distance or time, means – bike vs. walk), Larry's SmartFit Navigation assistant can dynamically suggest him the best path to take, considering the level of CO2, the weather conditions (wind, rain) and his own fitness plan, so that his health and benefits from the exercise are maximized. His biomedical parameters are also taken into account so that if he decides to run faster, a cleaner or less crowded area can be suggested.
On Sundays, Larry likes to go biking with his wife and his young daughter, and he can customize SmartFit Navigation assistant to suggest appropriate paths for cycling that can help safeguard his health and the health of his family.

At the outskirts of the city are located several depots which provide construction materials and equipment to a number of construction sites distributed around a city. Several minivans are used to transport the materials and equipment according to the construction site requirements and the dispatcher approvals. The minivan drivers have to deliver the materials in the shortest time possible, so they have to reconfigure the route if a traffic jam occurs.
All the agents which participate to the traffic transmit their location to a traffic information service provider. This information is used to detect traffic jams and other unpredictable events. The transport company drivers receive notifications when a traffic jam is detected on its route.

In his home John has installed several sensors and actuators as follows: temperature sensors (inside and outside), humidity sensors, HVAC controls, window blinds controls, alarm horns and surveillance cameras. John's smart home application offers the following services: temperature controls of the rooms (it is also connected to the calendars of John's family members); detection of fault conditions (forgot to open window - temperature dropped/increased in the room beyond the accepted margins), fire detection and camera control.

Gas company needs to check and replace some of the pipes located on a street relevant for public service. With such operations, near safety issues need to secure the access to the neighboring school, impact on correlated public networks, public transportation, and provisioning of affected citizens and businesses. Since such work might affect the stakeholders on a different degree and timeline, the plan of the work should be coordinated by the city hall office, insuring lowest impact on affected ones and shortest time to complete. At the same time, all involved ones need to know the status of progress in order to properly plan their activities and fallback plans.

Otto lives in Löhne and is employed at a company in Osnabrück. He has to travel about 50 km from his home to work. As Otto wants to live more eco-sensitive he sold his old car and bought a new electric vehicle.
While Otto is working, there is enough time to recharge the car's battery. The only problem is to find a parking place with a charging station near his workplace. While he is eating breakfast Otto starts a parking application for electric vehicles on his smartphone and reserves a suitable parking place with the possibility to recharge next to his office building. The "system" tries to find a place as near as possible to the workplace of Otto. With an intelligent behavior the system estimates the demand of parking places for electric vehicles and assigns as many recharging spots as possible to drivers of electric vehicles. If no parking place with a charging station can be assigned to Otto, he is informed that recharging will not be possible that day. So for example Otto cannot make a detour on his way back home.
To support further investments in new charging stations a heat map with the degree of capacity utilization will be created. The heat map could be used to get a quick survey about the utilization of charging stations.

Otto works for the municipality of Osnabrück. He is employed as a bus driver. His working place is bus line 1. Line 1 reaches from the central train station in the middle of the city about 10 km to a nearby village in the south of Osnabrück.
Especially in the city part of the route, it is a problem to pull the bus out into traffic after holding at a bus stop. Often the bus wastes some time to get back into traffic in cause of non stopping cars etc. In addition to the simple usage of indicator lights an application is planned that informs nearing cars about the starting bus.
Karl, driving a car behind the stopping bus, gets a notification (acoustical/visual) on his navigation system/smartphone that the bus will leave the bus stop any moment. Karl can react early and reduce the speed of his car giving Otto the opportunity to get back into traffic. Hence, the bus can stay on schedule.

The Meyer family lives in Löhne which is about 50 km away from Osnabrück. The next weekend they plan to do a shopping tour in the city of Osnabrück.
As it is always hard to find a place to park their car, the Meyer family starts a smartphone app and announces that they plan to travel to Osnabrück and want to go shopping in the city. Based on the information about where and when they want to start their tour the "system" calculates an optimal route to the city. In optimal case the Meyer family is directed to a parking deck near their desired starting point. As the traffic situation gets worse and some parking decks are already full with cars the system calculates another route. In this case parking at a car park in the municipal area is advised by the smartphone application. Additionally the fastest way to the city by public transport is searched for. To animate the Meyer family to use the planning application as an alternative the advantage in time compared to the manual searching for a parking place in the inner city is displayed.
From the city's view the planning application could be useful to distribute the traffic flow over the whole city and to avoid traffic jams.

David lives in a remote part of Guildford and commutes to London for work. He drives to Guildford station, parks his car at the station car park and takes the train to go to London. Recently Surrey county council has launched a 'Smart Commuting Platform' where commuters can plan their journey based on traffic, weather forecast and public transport information, as well as reserve parking slots for their cars.
When David plans his journey, he accesses the Smart Commuting Platform using his smartphone and inputs his current location and at what time he should be in London. The platform checks the traffic (including any planned road work and traffic predictions), weather forecasts (e.g. snow, flooding), public transport information (including prediction of any delay/cancellation due to weather conditions) and parking slots and suggests a convenient route to Guildford station, parking availability, train departure time and weatherproof clothing. David reserves a parking slot and starts his journey according to the suggestions made by the platform. The Smart Commuting Platform provides all the information at one place and makes commuting stress-free.

For Peter, shopping at supermarkets has always been a hassle. He forgets to check the stock at home before leaving for shopping, forgets the items to be purchased during shopping, never checks any promotion on regular products, etc.
Miracle, supermarket chain in the UK, recently implemented a 'Smart shopping platform' to assist its customers in their shopping. The platform maintains customers' shopping profiles based on their previous shopping histories and makes shopping suggestions. Moreover, the platform is connected to its each customer's smart storages (equipped with sensors) at home (e.g. smart fridge, smart cabinet, etc.) and is able to check individual customer's stock availability on regular products (e.g. milk, egg, washing powder, etc.) in real time.
When Peter visits one of the Miracle stores, he logs in to the smart shopping platform using his smartphone client application. Once logged in, the smartphone client application shows items he has run out of at home, any promotion on regular and related products, suggestions on weather related products (e.g. sun cream) based on the local weather forecast, stock availability at the store he is visiting, etc. and lets Peter shortlist the items that he plans to buy. The smartphone application also directs Peter to pick up the shortlisted items in a convenient way. With the help of smart shopping platform, Peter finishes his shopping promptly and efficiently.

Chris lives in a remote residential area of Guildford. The residents in his area have been suffering from anti-social behavior of teenagers, such as making noise, breaking post boxes, putting wastes at residents' doors, etc. To manage this kind of neighborhood areas, the Guildford council has launched an e-Neighborhood system where the residents can report local incidents using their smartphones, giving photo, audio and video evidences. The reported incidents will be analyzed by the system immediately and appropriate actions (e.g. informing the police for crime related incidents) will be triggered automatically.
One day, Chris noticed that some teenagers were trying to break a public property nearby. He recorded the incident using his smartphone and reported it onto the e-Neighborhood system using the smartphone client application. As a result, a neighborhood officer was informed about the incident by the system. The officer arrived at the incident place on time, protected the property and issued warnings to the teenagers and their parents. The e-Neighborhood system helps to protect the neighborhood areas easily and efficiently with the support of local residents.

Sabrina usually takes the car for commuting to work. She would like to take public transport but the bus is often late or full at the time when she would need it. Recently the city introduced a smartphone app to better control bus routes and adapt to passengers' needs.
It is Monday morning and Sabrina leaves her apartment for the bus to work. On the way there Sabrina tells the new bus app, that she is now on her way to work. Since she entered the address of her workplace earlier, the phone app now knows when and where she wants to go. While she is walking to the bus stop the app sends this information to the server. The server then combines this information with the real time information of all busses currently on their way in town. The system finds there is a bus (line 34) soon nearby which could bring Sabrina directly to her workplace. But the usual bus route for line 34 does not pass by Sabrina's bus stop. Since there are only a few people on the bus, the system sends the bus driver a message, telling him to make this detour and get Sabrina on the bus. In the meantime Sabrina is waiting at the bus stop and also gets a message on her phone, telling her: "the next bus of line 34 will bring you directly to your workplace." Minutes later Sabrina gets on the bus 34 and gets off at her destination soon after.

Smart meters will be installed in more and more households in the next years. Although Bob can now get a detailed daily report of his energy spending, saving energy is still a boring activity and long-term engagement is hard. With the new Facebook app EnergySaver Bob can compete with his friends for becoming the energy saving king.
Bob was very excited to get his new smart meter. The new electricity meter can measure electricity usage and will send the data every 15 minutes to the operator. Bob can then check his usage on the operator's web page. Still, saving energy is a boring task. Bob is now using the new EnergySaver Facebook. After allowing data transfer, EnergySaver automatically imports Bob's historical electricity usage data. In the future EnergySaver will periodically import current data or get real time data. Every week Bob gets a notification telling him how much energy he used last week and how much he saved compared to the weeks (or years) before. EnergySaver also includes a leaderboard where Bob can compare his energy usage and the amount of saved energy with his friends. He can then publish these notifications ("Bob saved 5% and is now 2nd on the leaderboard. Just 2% more and Bob will become energy saver king!"). Bob now buys a new refrigerator to finally become king.

Michael and Pamela like to visit museums in different cities. The problem is that museums tickets are usually expensive and combined tickets are inflexible. With a smartphone app, tourists can find other interested people and share a group ticket at a museum or zoo.
Michael and Pamela are big fans of modern art and visit museums in different cities all over the world. Usually when they enter the museum lots of other tourists are also there waiting in line. With the new group ticket app Pamela can virtually check in 2 people to the museum while waiting in line for the ticket. They are now waiting in line at the Modern Art Museum (MAM). The MAM sells cheaper tickets for groups of 6 people. Thus, the app knows at which museum how many users are waiting. The app also knows the prices of standard tickets and group tickets. Pamela gets a notification that another group of 4 people arrived earlier and that she and Michael can join the group. Pamela accepts the invitation. Then the other group of 4 people gets a notification to buy the group ticket and meet with Michael and Pamela at the entrance. Thus, everybody pays less and Michael and Pamela get to know other modern art fans.

Smart meters are new electricity usage measurement devices, which will be installed in households over the next years in many places. A smart meter can measure electricity usage every 15 minutes and will send the measurements to the electricity network provider periodically. This data is not only useful for end users but also for network operators to plan and optimize the low voltage electricity distribution grid.
George works for an electricity supplier and is responsible for planning the modernization of the low voltage grid. In order to gain insight in which parts of town have the most problems due to old devices and poor network infrastructure, George scans the reports sent by smart meters and analyzes how often the communication was interrupted. Moreover, he can correlate this information with the temperature of the surroundings at that time and detects an interesting pattern: every time the temperature goes below 3°C, there seems to be a problem with the communication device between smart meters and the transformer station. Using this information, George is able to localize the cause of communication breakdown and replaces the corresponding network controllers.
On a daily basis, the application requests/accesses the load profiles and other metrics (e.g., voltage metrics) from the smart meters. This data is passed on to other applications that can perform simulations and load flow calculations in an automated manner.
The goal of the simulation is to predict precisely and estimate the grid operation parameters at the point to delivery to the end customers. Thus, smart meter readings allow the operator better planning for near-future and far-future of several grid operation parameters, e.g., load of different parts of the grid over the day.
Whenever any abnormal fluctuation or critical state is detected, alarms can be raised by the low voltage grid control system. By using the data of smart meters errors can be diagnosed more accurately and with better location information of the error.

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| You just finished your morning routine and are getting ready to leave your home. Instead of taking your own car you receive a message on your mobile phone that Peter, someone you have car pooled with beforehand, will pick you up in 5 minutes and drop you off in the city near a public transport hot spot. The service that you are using collects information about you to identify your current situation and checks your calendar where you need to be, and when you need to be there, and matches this with other subscribers to the service. |
| You receive detailed information about traffic conditions on your trip including traffic accidents, traffic jams, weather conditions and parking possibilities directly integrated into your personal navigation system, rerouting you (including driving, walking, public transport and car pooling) in the most efficient way and as close as possible to your destination. Persons, cars, and public transport share their situation in the Internet cloud. |
| You are entering the motorway and the car indicates that it will now enter into autopilot mode. On the motorway, cars are driving automatically and are closely spaced, controlling their own speed based on road, traffic and weather conditions. Proximity sensors and other sensor information are used to virtually chain cars together and transport them efficiently to their motorway exit. The system also includes accident avoidance in case the autopilot fails or in case other obstacles are on the road. |
| You are walking along the road to your destination when you receive a message on your mobile phone that a bus, going in your direction, will pass you in a few minutes. You choose to find a good spot to stop the bus using a simple gesture with your mobile phone. Scheduled timetables are something of the past. Public transport now reacts to the passengers' needs. The public transport is a network of nodes that measures supply and demand and over time adjusts itself to the demand side moving away from the periodic survey based update of scheduled timetables. |
| You are taking a bus to work and you receive a message via your mobile phone that you will be charged once you get off the bus based on the number of zones you cross. The information also displays the cost per zone. Payment is performed automatically via your mobile phone. |
| You park your car in a large underground car park, your usual mobile application using GPS is not working; there is no GPS signal to geo-tag your car. Instead you are using the car park's own system to tag your car on a map display in the car park. The car park is equipped with smart car parking spaces and indoor location system that integrates with mobile phones, guiding you to where you parked your car. |
| New underground lines as well as high-speed train railways are equipped with sensors and automatic services to reduce the human factor associated to accidents and improve the performance of the whole railway system. For example, rails are equipped with sensors able to measure the state of the rails and the electrical conditions to ensure the proper operation of the system. In addition, detection of breaks in the rails or obstacles on the railway help avoid accidents. The trains are equipped with sensors to track the status of the wheels and engine, as well as with actuators that take immediate corrective measures to avoid accidents. |
| The Home Central Control (HCC) provides the complete control of your house. It switches the lights automatically on when you enter and switches them off when you leave a room. Arriving home after work, your face is recognized at the entrance and the electronic key in your pocket is detected. The HCC triggers the heating system, by combining data from outdoor and indoor temperature, weather forecast from the Internet, and user preferences. It adjusts the house energy consumption to the real needs of the family, and most importantly it helps you save money. The HCC recognizes which appliances (washing machine, dishwasher, water heater, heating system, etc.) are turned on at a given time and synchronizes them to ensure the best energy efficiency taking into account pricing structure of the utility companies. |

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| You have voluntarily enrolled in a "green house" program. The application on your mobile phone informs you about how far your current energy and water consumption is from your target and what you can do to improve with the help of the data supplied by your home sensor network. A comparison is made between volunteers, your virtual neighbors, in order to get the greenest behavior in an anonymous way. |
| The City Information Model (CIM) collects, analyzes and allows city authorities to act in near real time to the city's situation. The city government operates the CIM, but it is also accessible for third parties via a series of Application Programming Interfaces (API), even though some information is confidential. The status and performance of the building you live in is continuously reported in real time. The facility management services - fed by sensors in the residential and commercial buildings - communicate with each other and CIM. For example, they automatically trade surplus energy with each other and prices are calculated to match supply and demand. In this sense, planning and design are an on-going social process, in which the performance of each item is being reported in real time and compared with others. Population changes can be inferred, as can movement patterns, environmental performance, as well as the overall efficiency of processes such as value chains or objects such as buildings. |
| When taking the underground to go to work, you move through ticketing barriers and walk over terrain that feels like taut, soft responsive material; connected arrays of piezo-elements that generate and store electricity produced by the vibration and pressure of thousands of commuters. By harvesting the traces of mobile devices carried by commuters the transport authorities capture information on the use of the subway. Pedestrians are channeled through the station in an optimal fashion. Gates open and close and signs alter messages in response to the live signals from the ticketing barriers and motion detectors. In turn, each transport system in the wider city is communicating with the subway, such that the volume of passengers delivered by busses and bikes can be factored into the behavior of the station. |
| Smart irrigation of the green areas in the city using sensor and actuator systems will save water and be more cost-effective. In addition, tagging plants and green areas in general will offer a plethora of information to professionals maintaining the areas and citizens enjoying the flora of the city. You can use your mobile phone to investigate the trees and flowers, learn about their care and find out who else shares your interests. |
| The implementation of smart urban waste management will allow a more efficient waste collection, optimizing the way in which it is performed today. It will provide useful information to the public by encouraging and promoting an easier and more environmentally friendly way of collecting waste by identifying and emptying bins and containers when they are close to their fill level but not overflowing at private households, enterprises and public areas. In addition, incentives can be brought forward to encourage citizens to produce less waste and recycle more. |
| Screens displaying information about different events taking place in the city are placed at specific points in the city. These screens will be located near important monuments, in tourist information points, inside museums, or in public spaces accessible for the general public. Users can interact with the screens, using their mobile phones, personal computers or laptops in order to get more information about art in museums, city monuments, download virtual trips inside museums and access information in different languages, also weather and traffic information or other services with useful information to the citizen can be displayed on the screens. |

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| In the Smart Factory, a warehouse worker is moving ‘smart drums’ to a storage area. ‘Smart drums’ generate safety alerts automatically in case of potentially hazardous circumstances and are able to respond to dynamically changing context conditions. If a storage violation is detected, workers are alerted immediately by an alarm in the storage area, and the alert is also propagated to the back-end system for logging and control. |
| Wireless communication networks are a cost-efficient way for remotely controlling industrial facilities and infrastructures: Pressure sensors are located along gas/oil pipelines. Abrupt change of pressure provokes automatic closing of lines. Sensors are placed on each section, depending on the architecture and risk assessment. |
| While a pallet is waiting, at the farm, to be loaded into the truck, it verifies whether it is positioned correctly, near other pallets that are to be loaded into the same truck. When a pallet is not positioned correctly or no peer nodes are found, it raises an alert.<br>The pallets are loaded into the truck transporting them to the harbor. Pallets can detect being loaded by ‘hearing’ the truck. The truck is programmed with an itinerary, containing data about its identity, as well as the goods it is transporting. In the truck, each pallet requests from the truck the company and truck ID, and records these into the log file.<br>The pallets detect being taken out of the truck. When unloaded on the dock, the pallets again verify whether they are positioned correctly to be reloaded into shipping containers. When placed incorrectly, a pallet can directly send an alert message to the dock infrastructure that will inform workers to correct it. For the last stage of the transport, the pallets are loaded into containers. Pallets recognize the containers and on arrival, the distribution center. |
| During the Olympic Games, a smoke sensor within the stadium is triggered, and the data is soon confirmed by another sensor in the same area. As soon as the incident location is known, an evacuation of the area is prepared. To do so, the games’ central command needs to immediately modify the transportation routes throughout the area to both avoid the incident area and to free up capacity to absorb the sudden surge in load on the network (pedestrian, road, underground, rail), if the evacuation is carried out. The central command center invokes the appropriate emergency plan to enforce these changes (evacuation of major venues are pre-planned), and requests data feeds from the relevant sensor networks to be made available to monitor the effects of the plan in real time, in order to assist with decisions around timing and method, should evacuation be required. |
| Before the security staff leave an evacuation area that has become too dangerous for humans, they deploy a robotic monitoring unit and a perimeter surveillance cordon around the area (an autonomic network composed of a dense network of seismic and infrared (PIR) sensors, overlaid with a sparse camera network) to get accurate and real time information. |
| Alert messages are sent to the required service providers when the user feels he/she is in a dangerous and urgent situation (e.g. walking late at night in unfamiliar urban environment) in order to ensure a mobile security monitoring. The person’s body sensor network detects her fear and instructs her mobile phone to send a message to the security officers located at the next train stop. |
| A modern car park with automated valet parkign system registers teh arrival time of all cars and checks their origin of travel. This is done by checking hte registration of the car with the owners home address. A simple algorithms suggests car pooling between people living closeot each other and arriving at the car park roughly at the same time on the same days. |
| Working at the emergency room, emergency staff often has to take incoming alarm messages from different mobile sensor applications. In one instance, an alarm is triggered on a screen accompanied by the sound of a siren, informing the staff about a car accident in the city center. The collision detectors of the two cars involved were immediately activated when the accident happened and their GPS location was automatically sent to the hospital. |

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| Charles has been suffering of hyperglycemia for a long time so his health status is monitored by several sensors including body temperature, pulse, and blood sugar sensors. Since he still wants to enjoy good food and other pleasures in life, his wireless sensor network solution monitors his food consumption when he is food shopping as well as dining out. Thanks to the globalization of Radio Frequency Identification in food retailing and delivery, his mobile phone is able to evaluate the sugar level of all the food Charles eats. |
| Recently the doctors have diagnosed that John's Alzheimer's disease is taking a turn for the worse. As a result his children have decided to upgrade the monitoring solution with sensor applications that enable the monitoring of his locations, posture and mental conditions at home and in the neighborhood. So Charles retains his private and social life which is very important for coping with his condition and happiness. |
| Linda suffers from depression. When she's feeling bad, she's hardly active, does not go out anymore and sleeps a lot. At her last session her psychologist suggested an application to her that will measure her physiological data, and told her that using it could assist her in dealing with the disease. Sensors record her mood status and coach her to become more active and social. |
| In continuous care the concept enables patients with chronic diseases or elderly people with health impairments to stay in their own home despite their health constraint, to reduce cumbersome visits to the doctor and to avoid premature relocation to a nursing home. David's mother Charlotte comes to visit the family and complains about her many consultations at the doctor's surgery just for routine checkups for her low blood pressure and impairments due to age. She feels that she is spending a great amount of time waiting at the doctors and loses her freedom. She knows that she is getting older and her state of health is worsening, but she wants to keep her independence and freedom as long as possible. David shows her the application that he is currently using for the recovery from his heart attack and tells her that he is feeling very comfortable with it. Back in her hometown Charlotte asks her doctor about a similar application and he/she agrees that such a system will be suitable for Charlotte, too. A special device for her home will help her to monitor her blood pressure, blood sugar, etc., and in case she falls will also transmit an alert. She feels relieved and can now spend more time with her friends doing activities she enjoys. |
| Jules is on the beach with his little daughter, Pauline, 2 years. Pauline loves sand and sun as all small children do. However, children have very sensitive skin and despite high protection sun lotion there is always a risk of sunburn. Pauline has a small UV sensor on her cap. Jules's mobile phone monitors the amount of UV radiation by getting measurement information from the sensor. The Sunburn Protection application on the phone sets an alarm when it is time to go to the shade. The safe time in the sun is calculated according to the amount of UV radiation, the age of the person, the skin type, the pigment level and previous suntan. |
| Grandma had opened the bedroom windows to get fresh air, but forgot to close them. The Home monitoring service detects a significant decrease of the home temperature and recognizes that the window is open (and a low temperature outside). To save energy, the system uses the ubiquitous home interface to locate and inform grandma and to advice her to close the window. |
| Alice trains to participate in a marathon later this year. She slips into her sports clothes and attaches the sensors of her body area network. They will measure humidity, heart rate, blood pressure and body temperature while she is running. She puts on her sensor equipped jogging shoes that embed humidity, pressure and activity sensors for her feet. Finally, she also puts her mobile phone in her pocket and activates the personal trainer agent (PTA) that monitors her activities and controls the sensors in her clothes, body area and shoes. The PTA can suggest improvements or training sets to enhance Alice's agility or strength. Using actuators such as vibrators or sound, the PTA can also provide feedback and helps Alice to improve her movements. |

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| The application enables the users to automatically gather some information about the events of their daily life using sensor networks. More and more people have an online diary (e.g. Facebook or blog), allowing their friends and family members to view their activities and interests on a regular basis. Tom keeps updating his status during the day, semi-automatically. Thanks to sensors in his mobile phone, room, and on his body, pictures/sounds and video clips captured with his mobile are uploaded to the secure blog server at regular intervals. His location is tracked in real time and updated, his activities are logged, and his emotional states are translated into icons. |
| The Smart Running Track is a sport and fitness/personal health application. The idea is to provide a smart, competitive environment for runners. The runners should be able to see their position and the position of other runners on the track map displayed on their mobile phones. They should also be able to review their main health parameters (such as blood pressure, body temperature, the amount of calories burned). In order to increase competitiveness, the new ranking criteria other than the usual running order will be provided (e.g. amount of calories burned, or if the track is a trim-track, the number of exercises performed). Personal health monitoring will be performed by a physician, who will use a supervisor computer to review the body parameters of all runners at once. |
| Marie is practicing golf on a practice field. She swings her club and hits the ball. Her golf club is equipped with an Inertial Measurement Unit (IMU), which is used to measure the speed and acceleration of the club in 3 dimensions. The measurement is transmitted to her wrist computer with a short distance radio. Her golf shoes have pressure sensors on them and they too transmit their measurement during the swing to the wrist computer. The mobile phone analyzes the data and decides that Marie leans too much forward and that her grip of the club is not quite optimal. The device generates a suggestion for her and transmits it to her headphones. |
| The trainer who welcomes Marie in the fitness center explains that with a fitness application installed onto Marie's mobile device, the mobile device can recognize each machine in the fitness center as well as communicate with the equipment to monitor her physical condition and register how she has been exercising; based on this information, the fitness application will advice the trainee in setting up the equipment, practicing and also keeping count of the repetitions and intensity of the training. |
| Anna is going to shop in the supermarket. While she enters the store, her intelligent shopping application starts. The shopping list she made during the past days is uploaded and displayed on her phone. Additionally, the system added some items to the shopping list considering needed products at home that Anna did not list. The system guides Anna through the store aisles to help her locate the products. The system considers the proximity of the products first and also freshness: i.e., fresh products are collected at the end. While Anna approaches the products, she gets a ranking of comparable products that are in the section according to her profile preferences (e.g. price, quality, fat free, organic, and allergies). |
| Pointing the RFID reader on the mobile phone at the products, Anna gets additional information about the products such as origin and expiry date. While she takes a product, the device alerts Anna that it “contains traces of nuts” and that it is not suitable for her daughter Lea because of her allergies. While passing nearby products, Anna gets personalized advertisements from the store system considering her profile as well as her recent behavior: “You liked this product the last time… then here we have the complementary/ the new one…” While she places the products in the shopping trolley, the bill is updated in real time. The check out and payment are automatic, avoiding the lengthy queues at the checkout. |

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| Tom is working in a supermarket. He is in charge of the management of a department, beverages. Thanks to RFID and sensors he is able to monitor information about the products, type/variety, state, condition of the storage, expiry date, quantity/stock in the line, the changes in the products' location, time of moves, location, position... and the consumers' profile, time spent in the area or in front of a product, products they are interested in, etc. He infers: The flow of the goods in the section, the efficiency of his marketing strategy in the department, and he learns about the behavior/satisfaction of the consumers according to the supply. In real time, he observes the way the products impact the consumers' behavior. |
| David is a fruit grower (mixed farming) who cultivates apples, pears, peaches, strawberries, melons, and oranges (greenhouse cultivation and natural fields). Depending on the season, he employs season workers. His farm is equipped with sensors that monitor: The conditions of the crops (each area of the farm is separately monitored): Duration and level of light (sunlight), temperature, humidity, level of rainfall, wind, and birds' radars or microphones; The state of the plants: size, humidity of the ground, ripeness of the fruits (size, color, sugar level); The workers: Position in the area (in the farm or outside), equipment in use, physical condition. |
| This system enables welfare-friendly confinement of cattle with boundaries drawn entirely by global positioning system (GPS) – existing as a fence line only on a computer, without wires or fixed transmitters. The system builds on the basic principle of an electric fence, except there is no fence. Instead it includes a wireless sensor network containing microcomputers, radios, and sensors, some of which are fitted into cattle neck collars and emit a sound when the animals approach the virtual boundary. If an animal crosses the boundary it will receive a small electric shock – around one fifth of the voltage used in a conventional electric fence – and will learn to avoid the boundary. The electric stimuli and sound signal will both stop if the animal runs past the virtual fence, and will be re-applied when the animal has stopped moving to encourage it to move out of the exclusion zone. Once the boundary is set, the system is fully automated and self-sufficient. Because it includes a wireless sensor network with two-way communication to the collars, producers can set a new fence line anytime, from the office, as well as continuously monitor where their cattle are located. (Text used from CISIRO website) |
| The application enables the manager of entertainment establishments to promptly adapt the ambiance and animation according to permanent monitoring of the audience's mood and activity. Personalized additional services are offered to the clients based on the clients' experiences. Each nightclub visitor wears some sensor gear, which is able to infer the mood and situation of a person. When the DJ plays a song, the DJ is able to receive feedback from the crowd in the form of a mood distribution (mood map) and is able to make ambient adjustments of audio and visual effects to enhance the users` experience. Other ambient adjustments to room temperature and noise level can be made automatically by the nightclub system, based on current user perception. |
| Using real bicycles, the opponents are on different locations, possibly many kilometers away (hundreds or even thousands). At the beginning the corresponding "length" of the race is agreed (i.e. 10 km or 20 min). The measurements are taken by sensors (GPS, temperature, humidity, speed, etc.). Measurements are exchanged between the bikes. They are used to calculate the equivalent position of the participants and to show them the corresponding state of the race (e.g. "you are leading by 10 m"). |

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| Anna makes a trip to the National Art Gallery. At the entrance she chooses the enhanced experience tour and gets equipped with special gear. The gear consists of a headset, and body sensors, which she attaches to her body. She starts the tour by browsing the different pictures in the contemporary arts section. She points at a picture, which she is interested in and asks questions to obtain more information. As Anna is listening to the information, a crowd of other visitors enters the room and the noise level rises significantly. The system initially increases the volume, but also notices Anna's distress, once it reaches a certain threshold. As a result, it continues to provide the information in a written form on a PDA instead. The system notices the impact of different pictures during her visit and records this in a personal profile. Based on the observation it proposes other pictures she might like and guides her to the respective locations. At the end of the visit, the system proposes alternative venues for future visits. It also provides the user experience as an anonymous feedback to the art gallery's curator. |
| Interactive Street Sensing (ISS) is a scenario aimed at sensing and avoidance of environmental health hazard risks in polluted city streets. This scenario proposes a small, but scalable network. In the first iteration the plan is to use sensor nodes equipped with temperature sensor, humidity sensor, light sensor, and CO sensor. The system should be enabled for communication with mobile networks in order to transfer data to all interested parties and to achieve real time service. A map illustrating the real time and historic data of pollution can be viewed. |
| Through distributed sensors on the public transport infrastructure, the city receives an accurate image of the pollution levels in the city over time and location. |
| Sensors are placed all over the city. A city official from the urban planning department is able to log on to the system and see historical data regarding different substances in the air and meteorological parameters, including noise levels, in all areas of the city. This information helps the city planner to make decisions such as where to plan new residential areas, more green areas (parks), industrial zones, etc. If the city planner notices elevated levels of harmful substances in certain districts, a notification can be sent to the city's Inspection Department to check the source of the pollution. |
| The public has access to visualizations of the current level of pollution in the city. You can see the current and past state of e.g. CO2 emission, noise level, or any incidences of pollution on an official website and on public displays in the city. You can also see actions that the city planners have taken or are planning to implement. As a citizen you are also given the opportunity to leave comments. |
| There are a number of problems facing wind farms: Control, variable power production, maintenance, etc. The role of capillary M2M networks in this scenario is mainly for monitoring and control. A set of spatially distributed wireless sensor nodes (on the order of the number of turbines) will be deployed in the wind farm. Sensor nodes will take measurements of the flow and speed of the wind. Sensors observations will be periodically reported to a centralized device which will make actions in order to control the wind turbines and improve power efficiency (e.g. to determine the correct blade rotation for each turbine). |
| Consumers are able to use their smartphones to connect to remotely read their electricity consumption or shut down the heating in their house, for example. The Energy Service Providers will use the smart energy meters to remotely read the power consumption in order to send the invoice to the consumers. |

| Voice 1 | Voice 2 | Voice 3 |
|---|---|---|
| *Citizen* | *Public* | *Private* |
| (Citizen on a bike) This was so much easier than being stuck in traffic. | (Municipality employee) We have reduced congestion by 20% as well as carbon emissions. | None identified |
| (Citizen in a car) It is so much easier finding a parking space now. | (Municipality employee) Congestion has been reduced by providing our citizens with free parking space information reducing the time to finding a space. | (Car park operator) We are getting some really good information about how citizens are using parking in the city and are tailoring our solutions to their needs. |
| (Citizen by his home) Finally I can see that throwing away less has a real impact if we all work together. | (Municipality employee) It has been difficult changing our citizens behavior regarding waste. But we can show them impact in almost real time now - and it helps them to keep at it. | None identified |
| None identified | (Municipality employee) City planning is a delicate business of balancing many interrelated parameters. | None identified |

| | | |
|---|---|---|
| (Citizen on rooftop) I am growing my food locally. I thought I could never do this as I don't have green fingers. | (Municipality employee) By working together with our employees we are creating green spaces, new responsibilities and local produce. It's pure win-win-win. | None identified |
| None identified | (Municipality employee) Energy consumption in our buildings is a big contributor to our carbon emissions. Now that we can see them being lowered in a holistic way really helps us. | (Energy consultant) We have the know-how of how to make buildings more energy efficient. Now we also have the arguments and can see the customers more clearly. |
| (Citizen jogging) I can now tell the city directly if I don't like something - no need for long forms or processes. | (Municipality employee) We are in more direct contact with our citizens. It really helps us understand their concerns and needs better. | None identified |
| None identified | (Municipality employee) I have a much better overview of all of the different services that the city provides to its citizens now. | Utility company employee) I have a much better overview of all of the different services that the city provides to its citizens now. |
| (Citizen near a train) I don't like to micromanage. This application really helps me find the best route to where I need to go. | None identified | None identified |
| None identified | (Municipality employee) We are really getting a handle on our transport planning issues now. | None identified |

| | | |
|---|---|---|
| None identified | None identified | Now we can react instantly on critical situations like accidents. |
| I don't have to be afraid that I miss my appointments. | We can dynamically respond to changes that affect the infrastructure. | None identified |
| By monitoring my level of pollution, I can now change my behavior. | We can now help citizens becoming environmentally friendly. | None identified |
| It's great that I can compare my green self to neighbors. | None identified | None identified |
| I can see the results of my environmental actions. | None identified | None identified |
| None identified | We can now optimize food costs, and thereby save money and the environment. | None identified |

| | | |
|---|---|---|
| I have the ability to see exactly where I can park when I get to work. | We have reduced pollution and car noise. | None identified |
| It's great that I now have a place to get an idea of the city. | None identified | None identified |
| I can now trust how much time I need for going to work. | None identified | None identified |
| I can see the benefits in taking public transportation. | We have reduced inconveniences by making citizens use public transportation. | None identified |
| None identified | By combining different expert systems we can now leverage from collected knowledge. | None identified |

| | | |
|---|---|---|
| It's nice. I just take a picture with my phone and upload it. I feel like I am more connected to the city. | We are getting so much more information now that we opened this up to the public. | None identified |
| None identified | We have a very good overview of how the city is working now. It is amazing - new ideas and insight are becoming a reality. | None identified |
| It is so easy to find a parking space now. | We can really serve our citizens so much better and at the same time reduce traffic congestion. | As a delivery van driver it is often hard to find a parking space near to the customers. Now it is a lot easier. |
| It is really cool to get a sense of what is happening in the city. | We needed a tool to communicate the complexity of the city - the 3D map is useful and beautiful. | The 3D explorer of data helps me understand what data is available. I can spot my next app project immediately. |
| The "Made with Aarhus" label really helps me filter for the good applications. It is easy to trust it - as it is always good quality. | It is a win-win-win situation. The municipality gets more efficient and attractive, the citizens get great new services and applications and businesses are earning money. | With "Made with Aarhus" we have got the jackpot. We can finally develop those applications that are useful, helping you with traffic congestion, finding the hottest spots in town or just having some fun. |

| | | |
|---|---|---|
| Finally I can take more responsibility. | It is nice to give our citizens a bit more responsibility. We get less complaints too! | None identified |
| I only shower now when it is free! | We can offer our citizens a reduced cost of living if they have a certain flexibility. | We can really load balance out utilities now. |
| I love making stuff - this toolbox really helps me in making useful apps for my friends and fellow citizens. | We got a really good response from our citizens and businesses - the toolbox makes all the difference in accelerating uptake of Open Data. | We can do some really rapid development of new applications as soon as new data sources are added to the platform. |
| Waste is not really something that I want to think about all the time and when the schedule changes I've got to remember - this really helps me and is also good for the environment and the city. | We often had issues with fly tipping - when people just dump their waste in the city somewhere. This was reduced a lot after introducing this service. | Well of course we never did any fly tipping. But it is sure nice to have this service - our workplace is a lot neater now. |

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| Now I can choose a safe route for cycling around the city. | The 'Bicycle cards' help us to collect cyclists' behavior as well as real time dangerous situations. The reorganized cycle routes make the cyclists safe on the roads. | None identified |
| I'm not experiencing any traffic issues on my way to and from work. | We can now do real time optimization of the infrastructure during an event. | None identified |
| I can easily locate my new accommodation in the best area of the city according to my interests. | Better orientation to the new citizens of the city. | Housing associations receive queries from relevant customers. |

| | | |
|---|---|---|
| I will buy my next home in this area because it is safer. And using this app I will be able to keep it safer. | Together with the citizens we will be able to reduce the crime in our city. | Now we can react faster when critical situations are reported. |
| I am supported in saving resources by comparison with others and have excellent overview about my spent resources. | We increase the eco-consciousness of our citizens to make our city greener. | None identified |
| None identified | We can react instantly to citizen requests. | None identified |

| | | |
|---|---|---|
| I am better taken care of, especially in case of medical emergencies.<br>*Caroline* - I can do my job better and more efficiently. | We can respond better to any emergency that the beneficiaries of the homecare system might encounter. | I am glad that the quality of life for the elderly in my town is better. |
| It's convenient and easy to use public transportation in Aarhus because I'm informed on the current traffic information. | When our public transportation is easy and convenient more people will use it. | None identified |
| (Citizen in a car.) It is so much easier to find a parking space now. | (Municipality employee) Congestion has been reduced by providing our citizens with free parking space information reducing the time to finding a space. | (Car park operator) We are getting some really good information about how citizens are using parking at very big events and are tailoring our solutions to their needs. |

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| None identified | We can actually see a small reduction in our energy spending. | It's nice that the room is completely automated, so we can be more green. |
| I can choose the best path for jogging or cycling based on the environmental conditions, such as pollution level along the path, weather condition, etc. taking into consideration my health conditions. | We can allocate green/public spaces according to citizens' needs and pollution levels. | None identified |
| None identified | None identified | It's really great that we don't waste time in traffic jams. |
| This application converts my home into an energy efficient building providing me with rich experience to monitor/control various equipment and take remote actions during faulty conditions. | Reduce consumption of energy and avoid emergency incidents. | None identified |
| This week I will travel with bus 35 because the usual one (bus no 5) will have delays. | The feedback from citizens is good. The app helps us all. | The app has increased our communication with the citizens. |

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| I know directly if I will have the possibility to charge my car today. So I can adopt my plans for today. | We (city) got a greener city by supporting electric vehicles. | We (energy supplier) can plan where parking places with charging possibilities are needed. |
| It's great that the bus is more often on time. | We have better stick to the bus time tables now. | None identified |
| I could get rid of the trouble of searching for a parking space in a crowded commercial area. | We can distribute the traffic in the city evenly, thus avoiding traffic jams. | Public transport as well as other urban activities are not subject to disturbances from traffic jams anymore. |
| It's easy to commute because I'm informed on parking, weather, public transportation and traffic situations. | When it's easy to commute in our city/county it's easier to attract citizens. | None identified |

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| The smart shopping app makes shopping easier and quicker. Now shopping is also less frustrating because I can be sure not to forget items we have run out of and thus I don't have to return to the store for items I've forgotten to buy. | None identified | We can help our customers by creating more targeted customer profiles. We can now improve revenue by showing highly targeted promotions. We can even optimize supply and customer satisfaction by considering supply at the local store. |
| My neighborhood has become more secure lately. | We can react fast on citizen notifications. | None identified |
| Now I can rely on public transport for commuting to work. | Public transportation has been made more convenient and the commuters can now get real time information on their smartphones. | None identified |

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| I get rewards and can compare with my neighbors. | None identified | We can help our customers be more green. |
| The application helped me to get cheaper tickets to visit museums and also company of people with similar interests to explore the museums. | None identified | None identified |
| I don't know why, but after replacing the old meter, I pay less. | We can easier plan the maintenance activities for the electric lines. | It is much easier to plan the energy distribution. |

| | | |
|---|---|---|
| I don't need to drive alone, I can save money and have someone to talk to. | None identified. (But the city will get cleaner as there are less traffic jams because of less cars.) | None identified |
| My route is planned and altered in real time. | None identified | None identified |
| Driving on the motorway is now safer and more efficient. | Less incidents on the motorways. | None identified |
| It's really easy and flexible to jump on the bus. | When it's easy to use the bus, more people will use it. | None identified |
| Now I don't have to worry about which ticket to buy. | Waiting times at ticket counters are reduced. Waiting times at information counters are also reduced. | Waiting times at ticket counters are reduced. Waiting times at information counters are also reduced. |
| I can now find my car when I have been shopping. | None identified | We have added value to the customers parking experience. |
| My safety on trains has been improved. | None identified | The trains are maintained at proper conditions with the help of sensors and the travellers safety is ensured. |
| None identified | None identified | We can see massive decrease in our energy consumption. |

| | | |
|---|---|---|
| Comparing my water/energy consumption with others provides boost to reduce water/energy consumption and contribute to green environment. | Citizens get better understanding of how to reduce water and energy consumption and can eventually adopt to habit which lead to green environment. | None identified |
| I'm paying less for my energy consumption. | Optimizing energy usage can reduce costs. | We can now reroute and negotiate our energy consumption. |
| We don't have to wait for the underground and can get faster to our destination. | We can use our underground trains in an optimal manner. | None identified |
| It's nice to learn while traversing the city. | We can keep our green areas irrigated without extra costs. | None identified |
| I am glad that the waste collection system is on time. | We collect urban waste more efficiently. | Quality of life is increased due to an efficient waste management system. |
| It is really cool to get a sense of what is happening in the city. And I can also get more information on the specific art that I'm looking at, and furthermore I can get information on the weather and traffic which enables me to figure out when I should leave the museum again. | The citizens are attending many more of our cultural activities now that they are better informed. | None identified |

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|---|---|---|
| None identified | None identified | Safety regulations of moving and storing hazardous materials are automatically monitored which allows also fast responses in case of an emergency. |
| None identified | None identified | We have minimized costs by implementing this cyber physical system. |
| None identified | None identified | Pallets can be transported safely and the tracking information will be updated automatically. |
| I feel more safe knowing that evacuation will happen immediately. | We can quickly reroute the traffic. | We can react extremely fast, get everyone to safety and minimize damage. |
| Better evacuation plans in case of emergency. | Smart evacuation and better monitoring of dangerous areas to avoid future incidents. | None identified |
| What a nice guy the security officer is! He knows exactly when I am afraid and helps me. | Let's make a statistic of crime areas in our city. | Nice, now I can collaborate with the security officer from the nearby hotel and we can help the police to reduce crime in our area. |
| I am really pleased. I have some great company now driving to the city and I am saving money. | We think this had a really positive impact on people. | We had underestimated the impact of this service. A lot of people are using it. |
| It's really good that an ambulance is sent immediately when an accident occur. | We have optimized emergency procedures at the hospitals. | None identified |

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|---|---|---|
| I am glad that a sensor network watches out for my health. | By monitoring Charles, we save a bundle on emergency medical care. | None identified |
| Patient: I can stay home for a longer time, ensuring my life quality. Family: Our father can stay at home for a longer time, and we can rest assured that he is okay. | We can save money on the elderly's homes and have happier and healthier patients. | We can sell the equipment . |
| I can get help easier. Obstacle free advice and help are important when suffering from acute depression. | We hope to help people and maybe even decrease suicide rates. | None identified |
| I can monitor my own health state and react in time. | None identified | None identified |
| Now I can let my daughter play on the beach without worrying about sunburn. | None identified | None identified |
| It's great that the house remembers when I forget. | None identified | None identified |
| The application provides great suggestions to improve my body strength and achieve personal training goals. | None identified | None identified |

| | | |
|---|---|---|
| I like this app because I can find my friend who are now in this area and go with them to drink a beer. Even if they are not publishing the location manually on the social media channels. | None identified | None identified |
| We got new motivation for doing fitness as we could compare with other people. Additional someone is watching our health parameters. | None identified | None identified |
| I can now optimize golfing skills on my own. | None identified | We have seen an increase in selling of our "smart golf" kit. |
| I get to have a more efficient workout. | None identified | None identified |
| It's much easier to do the grocery shopping and I receive information about the products I shop, which helps me to pick the environmentally (etc.) best products. | Our citizens are informed on the products. | (Supermarket): Our customers are happy and satisfied, and hence they will come back again. (And we can direct the advertising more specifically.) |
| I can shop quicker and I don't have to pay attention to all the ingredients of the food I buy. It makes handling allergies much easier. It makes checkout easier and less frustrating. | None identified | We can get more detailed and targeted user profiles and can give recommendations thus improving revenue. |

| | | |
|---|---|---|
| None identified | None identified | It's great that we can now optimize our selection of goods. |
| None identified | None identified | Farm is well managed with the help of sensors and the output is maximized. |
| None identified | None identified | We can now control the herd from our offices. |
| This application supports provision of improved environment and experience at entertainment establishments. | None identified | This application enables better management of entertainment establishments and customer satisfaction. |
| It is so easy now to organize the traditional bike contest with my high school colleagues. | None identified | None identified |

| | | |
|---|---|---|
| The system supports my current museum visit and will improve future tours. | We (museum) can react to people visiting our museum. We can plan future exhibitions based on requirements of visitors. | None identified |
| Now that I can see where the city is most polluted, I can avoid that area. | We can react fast to pollution risks and e.g. divert traffic. | None identified |
| I am glad that the pollution levels are monitored. | We have a detailed image of air pollution in the city. | I am confident that measures are taken to combat pollution in real time. |
| The buildings, parks and so forth in my city are placed in the perfect place. | It's easier and faster to decide where to build what. | None identified |
| I can now avoid areas of the city with high pollution levels. I can limit visits to areas I need to go to times where pollution and noise are low. When pollution is high I try to use the subway. | The visualizations increase awareness of environmental and health problems which are not directly observable. | None identified |
| None identified | None identified | We have now optimized the production and durability of our wind farms. |
| I can control my energy consumption remotely. | None identified | Smart metering reduces the overhead and provides up to date usage information and billing to the customers. |

| Voice 4 | Image features | Data sources |
|---|---|---|
| *Privacy* | *"Stuff" in the 3D virtual city* | *Transport, mobile, environment, energy, mobile phone, crowd sourcing, healthcare* |
| My location is being tracked. | Bus, train, bike, taxi, car, people | Transport, mobile |
| My location is being tracked. | Car park, car, people | Transport, mobile |
| My behavior is being tracked. | People, bin, home | Energy, environment |
| None identified | Park, people | Environment |

| | | |
|---|---|---|
| I am offering my personal preferences. | Roof garden, people | Environment |
| None identified | Buildings | Energy, environment |
| I am reporting a problem, but I can do this anonymously. | Street light, people | Energy |
| None identified | Underground pipes and cables, windmills, sewage treatment plant | Energy |
| None identified | Car, people, train | Transport, mobile, environment |
| None identified | Cars, people | Transport, mobile, environment |

| | | |
|---|---|---|
| None identified | Truck, crash, buildings | Transport, mobile, environment |
| None identified | Construction site, school, hospital, cars, water leakage | Energy, transport, environment |
| None identified | Adults, children playing, bike | Environment, energy |
| None identified | Bus, water, plants | Transport, environment, energy |
| None identified | Private house, washing machine, screen showing graphs | Energy, environment |
| None identified | School, children checking in at the school | Energy |

| | | |
|---|---|---|
| None identified | Car, smartphone, radio signaling to the cloud | Mobile, transport |
| None identified | Physical dashboard in the street, person using the board | Environment |
| None identified | Car queue, stray dog, smartphone showing route | Environment, transport |
| None identified | Congestion, smooth public transportation | Transport, environment, mobile |
| None identified | Person sitting in front of a computer screen showing a map, inside a house | Transport, environment, energy |

| | | |
|---|---|---|
| None identified | Something broken, people | Mobile phone |
| None identified | Bird's-eye view of the city | All |
| None identified | Car park, car, van, people | Transport |
| None identified | Bird's-eye view of the city | All |
| None identified | Bird's-eye view of the city | All |

| | | |
|---|---|---|
| None identified | House, lamppost, people | Energy |
| None identified | Bird's-eye view of the city | Energy, transport |
| None identified | Bird's-eye view of the city | All |
| None identified | Bins, waste, waste removal van | Environment |

| | | |
|---|---|---|
| My bicycle is being tracked | Citizens' riding bicycles in an urban environment, smartphone showing the app | Mobile phone (RFID chips connected via mobile/wireless infrastructure) |
| None identified | A park, a street, temporary road block, car, people, bike | Transport, mobile phone |
| None identified | Julie happily standing in front of her house, Julie enjoying her favorite cultural event | Mobile phone |

| | | |
|---|---|---|
| None identified | Bird's-eye view of the city | All |
| My resource consumption is monitored. | People at different situations spending resources and being watched | Environment, energy |
| None identified | Person in a changing room, satisfaction device | None |

| | | |
|---|---|---|
| What I do in the privacy of my own home is no longer private and my behavior can be deducted from sensor data. | Elderly people in front of the TV, some rendering of the sensor data going to a homecare control center. | Energy, mobile phone |
| My location and movement in the city is being tracked. | Person, bus, (“traffic jams”/a bunch of cars on the road”) | Citizens' mobile phone |
| My location is being tracked. | Car park, car, people | Transport, mobile |

| | | |
|---|---|---|
| None identified | Office building | Environment |
| None identified | Jogging and cycling people, green space, smartphone app | Environment (pollution, weather), transport routes), health |
| None identified | Minivan on the street | Transport, environment, mobile |
| My house, equipment within house and energy consumption are continuously monitored. | Energy efficient buildings | Energy, environment |
| None identified | Construction site | Environment, energy |

| | | |
|---|---|---|
| The system knows that I got an electric vehicle and where I want to drive to. | Parking place with charging possibility | Mobile phone (application), energy (parking place with charging possibility) |
| None identified | Bus holding at a bus stop | Mobile phone, transport |
| The Meyer family schedule is no longer private. | A free parking spot in a crowded park lot with a RESERVED sign floating over it | Transport, mobile phone |
| None identified | House, car, car parking, “weather”/snow or rain, train station, train, a person | Environment, transport, public transportation |

| | | |
|---|---|---|
| My bought items are tracked. My items at home in smart storages are tracked. | Shop, people, items, products, fridge | Mobile, cloud (for purchasing history), smart storage at customers' home (fridge, cabinet) |
| Criminals are being identified in the public and registered. | People standing outside a store | Crowd sourcing, mobile phone |
| None identified | Bus, bus stop, commuters, smartphone app | Transport, traffic, mobile (for commuter's location) |

| | | |
|---|---|---|
| None identified | Residential area | Energy |
| None identified | Group of tourists visiting museum | Mobile phone |
| What about the burglars who are now monitoring the energy consumption and can plan their operation | Status of electricity distribution grids | Energy |

| | | |
|---|---|---|
| My whole situation is being tracked, consisting where I am and where I need to be. | Someone at home reading newspaper, ringing mobile phone, nearing car | Mobile phone |
| None identified | Traffic jam, signals coming out of the car | Transport, traffic, mobile |
| I am no longer able, as a driver, to choose my own driving style on the motorway, according to my skills as a driver and the technical abilities of my vehicle, within the limits of the law (I.e. if I drive a small city car, I cannot drive on the motorway with 100 | Long chains of cars in the motorway with a radio signal symbol over each one | Transport |
| None identified | Road, a person, mobile, a bus | Mobile phone |
| My location is being tracked. | Mobile, train, bus, subway, people | Mobile, transport |
| None identified | Parking lot | Mobile |
| None identified | Train, people | Transport |
| None identified | Private house | Energy |

| | | |
|---|---|---|
| My water and energy consumption is being monitored and shared among the neighborhood. | Happy families living in green environment. | Energy |
| My energy consumption is available to everyone. | Apartment building | Environment, energy |
| Our moving behavior is being tracked. | Underground station, arriving people | Transport, mobile phone |
| None identified | Plants in the city | Energy, environment, mobile phone, crowd sourcing |
| Consumer behavior of a family household can be derived from their waste "production". Various info can be derived from this including some social values and attitudes which might be exploited by third parties. | Garbage can with a radio signal symbol over it, garbage truck with a similar symbol over it | Environment |
| None identified | Screen, people, museum/monument | Cultural institutions |

| | | |
|---|---|---|
| None identified | Drums/containers/pallets, people/workers | Smart drums/containers, transport |
| None identified | Wireless, pipes | Energy |
| None identified | Farm/dockland, pallets, truck | Transport |
| None identified | Stadium/playground | Transport, environment, mobile |
| None identified | Robots monitoring, hazardous situation | Environment |
| None identified | Bird's-eye view of the city | Mobile phone |
| I am not really giving away any more information that anyone can look up. It is a bit unnerving that it is so easy though. | Car Park (multistory) Car, People | Transport |
| None identified | Ambulance, car crash | Transport, environment, mobile |

| | | |
|---|---|---|
| My eating behavior is no longer private. Also, the system does not distinguish between the food I buy for me and the food I by for dinner guests. | A supermarket shelf where certain products fly into the basket | Mobile phone |
| The patient is being monitored. | Old person, home, monitoring equipment, relatives | Monitoring sensors |
| My activity rate is tracked. | Person, flat, bed, smartphone | Smartphone |
| None identified | Hospital, residential area | Healthcare |
| None identified | Beach, kids, parents | Environment |
| None identified | Open window, residential area | Environment |
| My physical strength is being monitored and I am also tracked during my workouts. | Alice in marathon/running gear. | Mobile, wearable sensors |

| | | |
|---|---|---|
| And my privacy?!?... Get real, I don't want to have my diary public on the Internet. And even if it is useful to have the diary online, I want only some of it to be public. | People | Mobile phone |
| Our position, sports activities and fitness parameters are tracked. | People doing sports | Mobile phone |
| None identified | Green area/park/golf | Environment |
| My workout behavior is preplanned against maybe preferences I have for certain machines in the workout area. | A workout place where only certain machines are highlighted as Marie walks in. | Mobile phone |
| My shopping habits are being monitored. | Home, fridge, supermarket, shopping cart, person | Mobile phone and fridge |
| The items I buy are tracked. My preferences/allergies are tracked. | Shop, items, smartphone, app | Smartphone |

| | | |
|---|---|---|
| The supermarket can now track every move of the customers. | Store/supermarket | Mobile, environment |
| None identified | Farm, fruits, workers | Environment |
| None identified | Field with cattle | Mobile |
| My moves are being tracked, monitored and stored. | DJ, people dancing | Wearable sensors, temperature, noise level |
| None identified | People | Mobile phone |

| | | |
|---|---|---|
| Museum is tracking my behavior in going through it. They know my interests. | "Anna" visiting museum, group of other people, museum | Environment, PDA equipment |
| None identified | Lampposts in the streets with boxes attached | Environment |
| Any pollution source can be identified within the city. | Information flying from different places of the city into a central server. | Environment |
| None identified | Computer, park, industry, person and people | Environment via sensors |
| None identified | People, smartphone, public display, cars | Pollution sensors, transport, environment |
| None identified | Windmill farm | Environment, energy |
| My energy usage is being monitored real time. | Home, appliances, smart meter, smartphone showing the app | Energy |

| Actor | Sector |
| --- | --- |
| *Public, private, citizen* | *Transport, energy, environment, agriculture, public, health, retail* |
| Public, citizen | Transport |
| Public, private, citizen | Transport |
| Public, citizen | Energy |
| Public | Environment |

| | |
|---|---|
| Public, citizen | Agriculture |
| Public, private | Energy |
| Public, citizen | Energy |
| Public, private | Energy |
| Citizen | Transport |
| Public | Environment |

| | |
|---|---|
| Public, private | Transport |
| Public, citizen | Transport, energy, environment |
| Public, private, citizen | Energy, environment |
| Citizen | Environment, energy, transport |
| Citizen | Energy, environment |
| Public | Agriculture, energy |

| | |
|---|---|
| Citizen, public | Transport |
| Citizen | Environment, transport |
| Citizen, public | Transport, environment |
| Public, citizen | Transport, environment |
| Public, private | Transport, energy, environment, agriculture |

| | |
|---|---|
| Public, citizen | Public |
| Public | Public |
| Public, private, citizen | Transport |
| Public, private, citizen | Public |
| Public, private, citizen | Public |

| | |
|---|---|
| Public, citizen | Public, energy |
| Public, private, citizen | Transport, energy |
| Public, private, citizen | Public |
| Public, private, citizen | Environment |

| | |
|---|---|
| Public, citizen | Public |
| Public, citizen | Public |
| Citizen, public, private | Public |

| | |
|---|---|
| Public, private, citizen | Public |
| Citizen, public | Energy, environment, public |
| Public, citizen | Public |

| | |
|---|---|
| Public, private | Public |
| Public, citizen | Transport |
| Public, private, citizen | Transport |

| | |
|---|---|
| Private, public | Energy |
| Public, citizen | Public |
| Private | Transport |
| Citizen | Energy |
| Public, private, citizen | Public |

| | |
|---|---|
| Citizen, public | Transport, energy |
| Public, citizen | Public, transport |
| Public, private | Transport |
| Public, citizen | Transport, public |

| | |
|---|---|
| Citizen, private | Public |
| Citizen, public | Public |
| Public, citizen | Transport |

| | |
|---|---|
| Private, citizen | Energy |
| Citizen | Public |
| Public, private, citizen | Energy, public |

| | |
|---|---|
| Citizen | Transport, environment, public |
| Public, citizen | Transport, environment |
| Private, public | Transport |
| Citizen, public | Transport |
| Private, citizen | Transport |
| Public, private, citizen | Transport |
| Private, citizen | Transport |
| Private | Energy |

| | |
|---|---|
| Public, citizen | Energy |
| Public, private, citizen | Energy, environment, public |
| Public, citizen | Transport |
| Public, citizen | Agriculture, energy, environment, public |
| Public, citizen | Environment |
| Public, citizen | Cultural, public |

| | |
|---|---|
| Private | Transport, environment |
| Private | Energy |
| Private | Transport |
| Public, private, citizen | Public, environment, transportation |
| Public, citizen | Public |
| Public, private, citizen | Public |
| Public, private, citizen | Transport, public |
| Public, citizen | Transport, environment, public |

| | |
|---|---|
| Private | Healthcare |
| Public | Public (healthcare) |
| Citizen | Public |
| Citizen | Health |
| Citizen | Environment |
| Citizen | Environment |
| Citizen | Public |

| | |
|---|---|
| Citizen | Public |
| Public | Public |
| Private, citizen | Environment |
| Private | Healthcare |
| Private, citizen | |
| Private, citizen | Public |

| | |
|---|---|
| Private, citizen | Retail |
| Private | Agriculture |
| Private | Agriculture |
| Citizens, night clubs, DJ's | Public |
| Citizen | Public |

| | |
|---|---|
| Public, citizen | Public |
| Public, citizen | Environment |
| Public | Environment |
| Public | Public, environment |
| Public, citizen | Environment |
| Private | Energy, environment |
| Private, citizen | Energy |