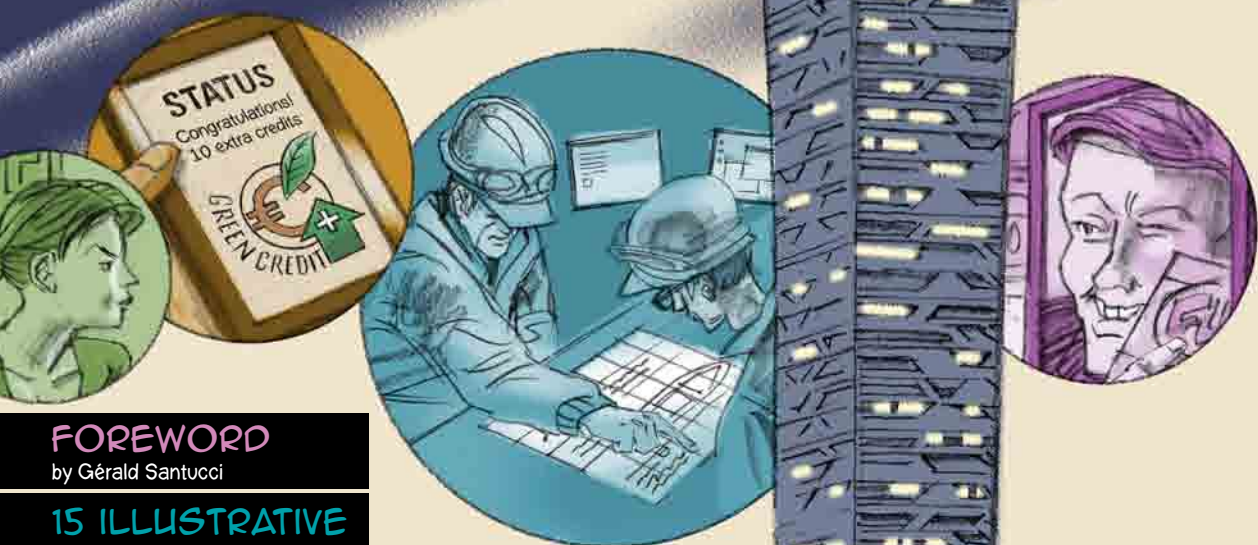


INSPIRING THE

INTERNET OF THINGS!



FOREWORD

by Gérald Santucci

15 ILLUSTRATIVE

IoT application scenarios

over **25 IoT CONCEPTS**

4 IoT EXPERT INTERVIEWS

by Stig Andersen

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Printed by PrinfoAarhus

Comic Book powered by the Alexandra Institute and partially funded by the FP7 ICT 'Internet of Things Initiative' Coordination Action, contract number 257565



Throughout this comic you will find Quick Response Codes or QR Codes pointing you to additional content such as videos, webpages or pdf-files via the internet.



Use a QR Reader for your smartphone to find the content

We call it "the Comic Book"

But in reality, we never aimed at making a comic book!

About a year ago, I started working on a – then new – European project called the Internet of Things Initiative (IoT-I) on a topic that was supposed to find strategically important IoT applications.

We managed to gather about 150 application scenarios, short texts describing an IoT application in a situation. Quite diverse material and mainly from other European projects – past and present.

After categorisation, combining and elimination we ended up with just fewer than 60 application scenarios that we presented to the public in a survey to find out what scenarios would be strategically important.

About 300 persons, mainly from the ICT community, from over 30 different countries, took the survey.

Now this is not bad – but it is staying within the ICT community. We need to branch out.

We need to engage the general public, public authorities and business stakeholders that will be the contributors and end users of the Internet of Things.

We need a new medium to communicate the idea of the Internet of Things, its challenges, its problems and its benefits; encouraging people to think about this new disruptive technology.

There are few things better than telling a story with pictures.

This "comic book" is aimed at everybody. Everybody can look at the stories that are being told and form an opinion. Use them as a basis for deep discussions or just as inspiration; agree or disagree and anything in between – but talk about it.

We invite you to use the material in this book to communicate and think about the Internet of Things.

Mirko Presser
The Alexandra Institute
Autumn 2011



More about The Internet of Things Initiative on the official webpage

Foreword

by Gérald Santucci

When objects can sense the environment and communicate, they become powerful tools for understanding complexity and responding to it effectively. Though such smart objects can interact with humans, they are likely to be interacting even more with each other automatically, without human intervention, updating themselves their daily schedules.

This evolution marks indeed a technological disruption, which is perfectly illustrated in this IoT Comic Book, but it also heralds the onset of a new paradigm for the relationship between human beings and objects.

In 2000, there were 6 billion humans living on Earth and 500 million devices connected to the Internet. During 2008, while the EU Presidency was organising its “Internet of Things – Internet of the Future” Conference in Nice, France, the number of devices connected to the Internet exceeded for the first time the number of people on Earth.

Today in 2011, the world population reaches 7 billion and the number of connected devices 13 billion. By 2015, there will be over three times the amount of connected devices as people on the planet and five years later, there will be 50 billion connected devices for only 7.6 billion

humans. At that time, imperceptibly, the world will no longer be the same.

Then, will the prophecy of Trajan Koruga, the poet in The Twenty-Fifth Hour of C. Virgil Gheorghiu be fulfilled? “A society which contains [billions] of mechanical slaves and a mere [seven billion] humans (...) will reveal the characteristics of its proletarian majority (...).

We are learning the laws and the jargon of our slaves, so that we can give them orders. And so, gradually and imperceptibly, we are renouncing our human qualities and our own laws.”

Or will an enlightened version of the Internet of Things emerge in which the desirable power relationship between human beings and machines will be reflected in system design?

“If we take today’s Idea of Man in the Western world, which views

men as responsible and mature, able to act rationally, and capable of defining themselves through moral autonomy and freedom of choice, we establish high level guidance for how systems should be built and what an Internet of Things could, or should not, do for us.” (Sarah Spiekermann, 2011).

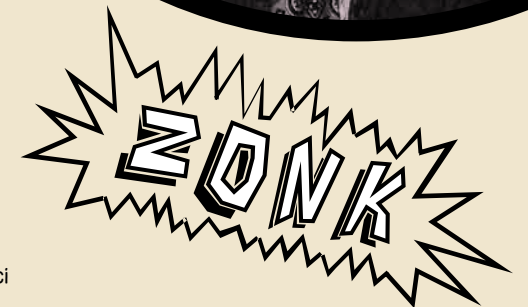
We must realise that the object is at the same time a communication channel and a stock of information, which reflects social relationships in a society at a certain moment. Human beings communicate through the objects that they trade. The nature of the objects and the terms of their exchange are the symbol of the way a society watches and represents itself. Therefore, the future of the objects in the Internet of Things is not only important for understanding how we should address policies such as spectrum, standardisation, privacy, security, numbering, open data, education, recycling, global coop-

eration, smart communities, and governance, but also for getting an idea whether the Internet of Things will actually bring raw data to the individual and the society and whether it will empower the individual and the society to generate new data.

Whether we will be able to escape the enslavement of reification – the essential tendency of capitalism to place the human condition under the reign of commodities – and to propose a re-enchantment of the world grounded in the real, intimate and powerful connection between humans, objects, and nature. “By letting comics illustrate the narratives of the many facets of the Internet of Things – in particular society, technology, industry, etc. – this book gives a large space to imagination and creativity, and also to excitement and trepidation. It’s witty, charming, funny, and so instructive and interesting! Opt in and have a nice journey into the future!”



Gérald Santucci



Gérald Santucci

Head of Unit,
‘Networked Enterprise and RFID’

European Commission
– Directorate-General Information
Society and Media

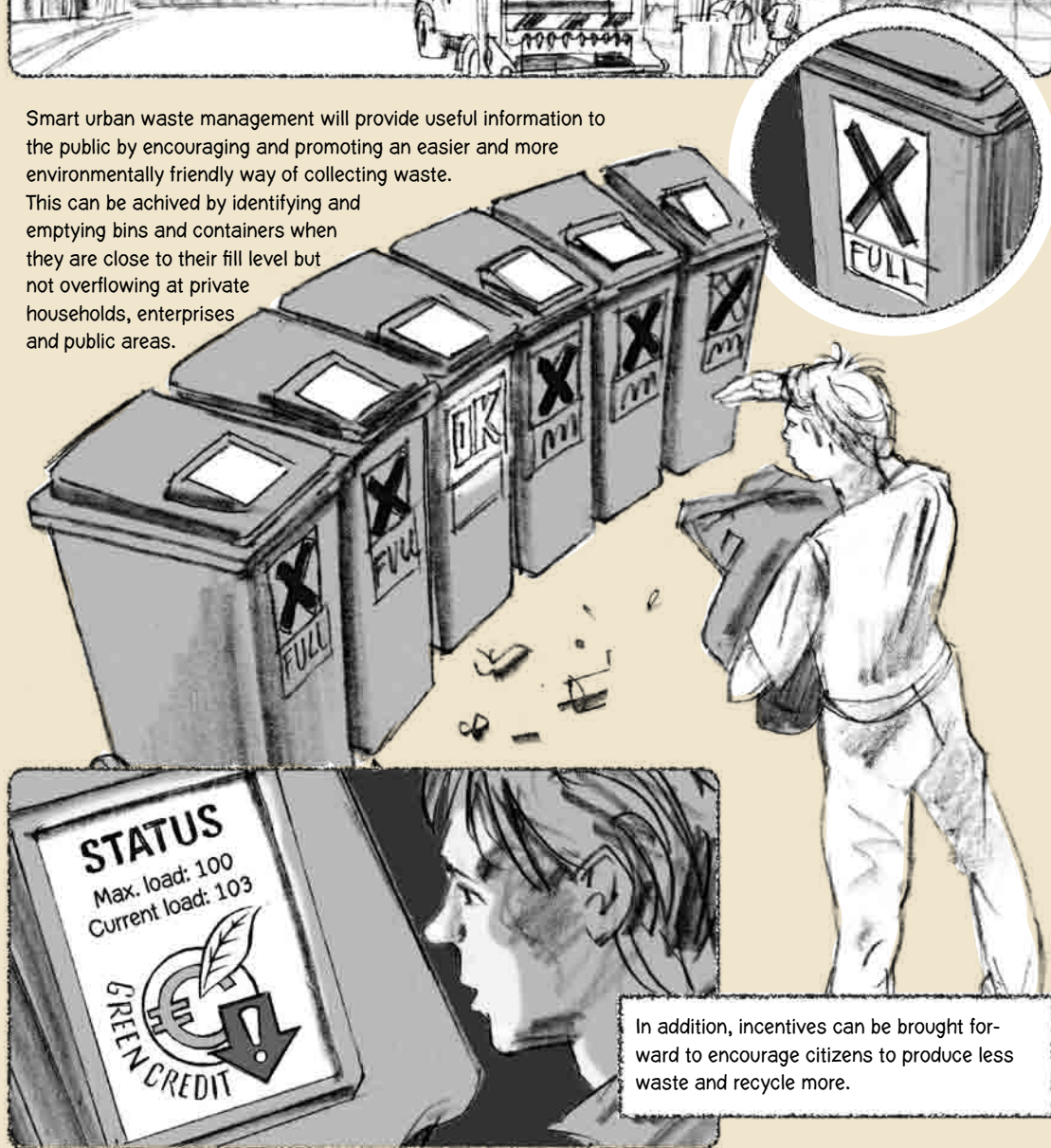
WASTE

Management

The implementation of smart urban waste management will allow a more efficient waste collection and optimising the way in which it is performed today.



Smart urban waste management will provide useful information to the public by encouraging and promoting an easier and more environmentally friendly way of collecting waste. This can be achieved 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.



Optimisation

The Internet of Things will optimise processes happening in the real world.

Logistics, utilities or event operation are complex tasks that are governed by many parameters that are today estimated or simply unknown.

The IoT enables detailed data gathering of information on a much higher granularity and much better precision than ever before.

In the "Smart Urban Waste Management" application scenario garbage collection can be optimised e.g. in terms of route optimisation based on fill levels. Empty bins are bypassed, full bins are emptied, and broken bins can be repaired quickly. Optimisation saves time and reduces costs – an important factor for today's economically challenged cities.

Optimisation is, however, a challenge in such scenarios. The development of algorithms to find the right patterns out of masses of data and feed the results into reliable business processes will need much experimentation until the right level of confidence is achieved.

Incentives

The Internet of Things will enable a world where we can have more incentives, and not just financial incentives.

Financial incentives have been employed for decades with a moderate degree of success – in some areas they work; in others they have limited impact. It is all about instant feedback.

Computer games are great examples where there is always a task to be performed that is just challenging enough to engage in but easy enough to achieve (maybe after a few tries, but nevertheless).

In the "Smart Urban Waste Management" application scenario citizens get instant feedback in the form of 'green credits' (a virtual currency) for their behaviour – overuse of a resource (in this case the bin space is the resource) is 'punished' by removing credits; and efficient use is rewarded with 'green credits'.

Credits can then be used to gain financial rewards such as tax returns or simply in comparing each other to your friends and fellow citizens in social real-world games.

Experimentation with other than financial incentives is an important area that knowledge from the Internet of Things will enable. But finding out what triggers human behavioural changes, is altogether another area of research.





Interactive Street Sensing gathers data about the city – the city's pulse. Sensors on every lamppost in the city measure data about noise, traffic, environment, crowds, temperature – literally anything. Data is transmitted and processed and information is presented as ...

– dynamic infographics, showing interesting detail about the city as a living organism, e.g. how it is used by people, flow of traffic and impact on the environment ...



–for example, a map illustrating real-time and historic data of pollution can be viewed.



Urban planning

Traditional urban planning happens with government-generated data sets. These are relatively stable and are sourced with well established methods.

What if this is supplemented with much more detailed data? Data coming from a plethora of sources, public and private.

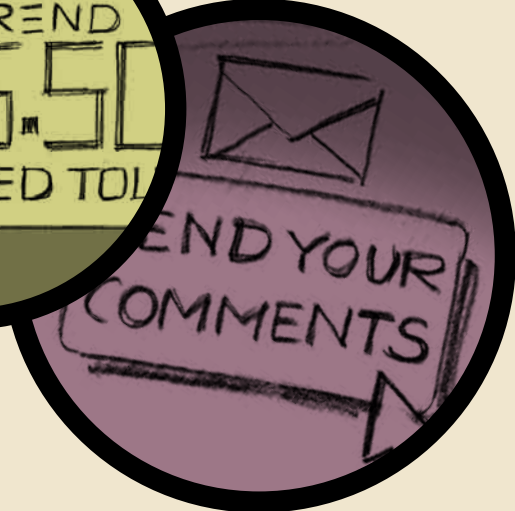
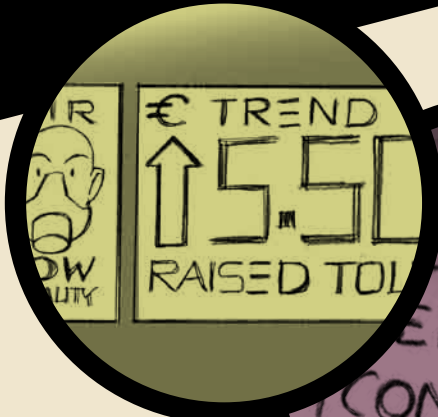
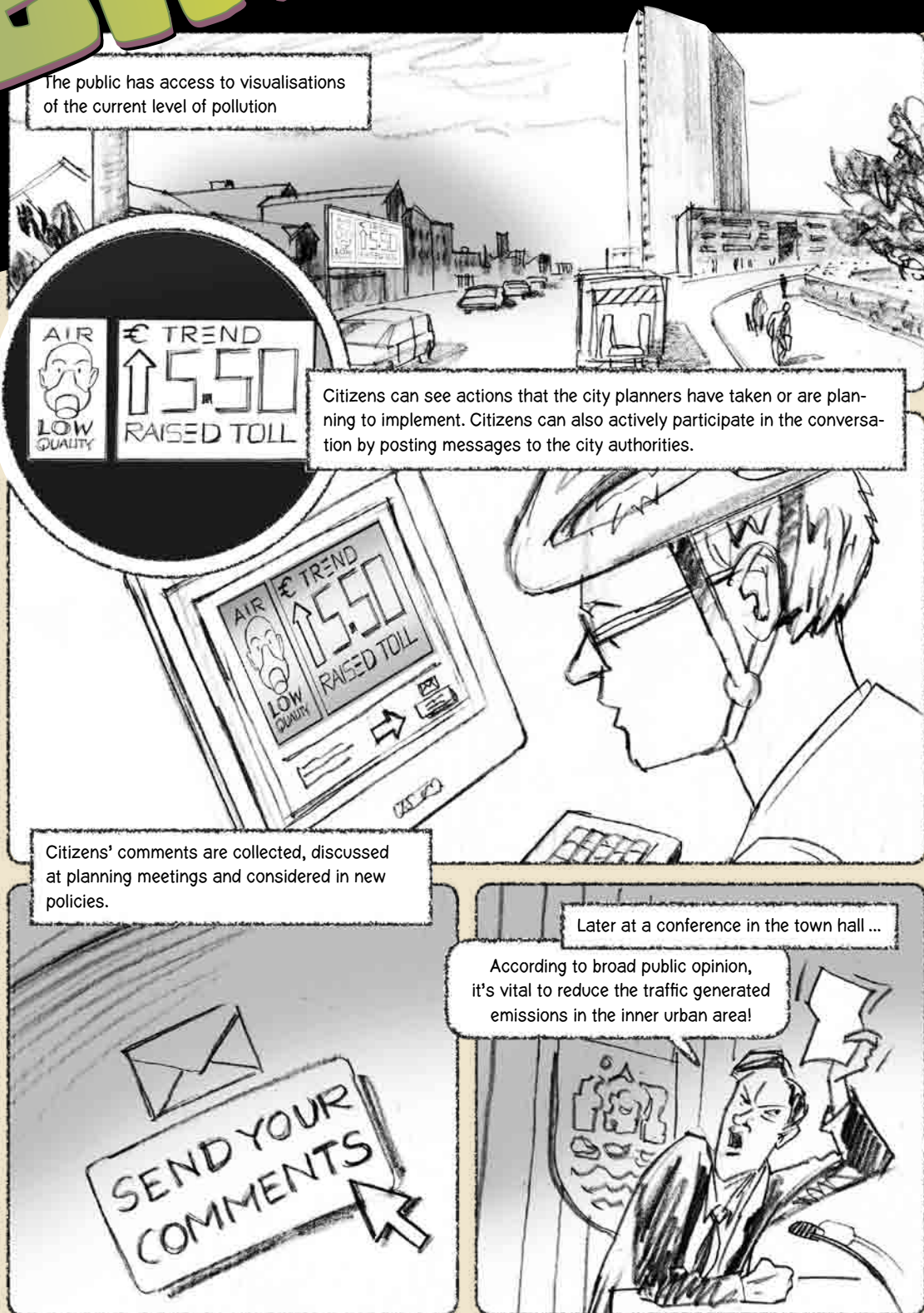
- Crowd-sourced data from citizens – for example pictures of things they want to have fixed, like a pothole in the road.
- Environment data from sensors placed all over the city – sensors might be owned by private or public organisations and need to be combined to form a complete picture.

There is no doubt that city planners can benefit from using large data sets that are stable and proven.

But there is only a small step to envisaging dynamic data being fed into the urban planning process. Those dynamic data could, in particular, be used for real-time assessments of the long-term effects of the planning.



Environment



Making policy

The Internet of Things will make policy.

With the increase in ever more detailed knowledge about our world, and in particular our environment, policy decisions can be made based on real data. And more importantly, their impact can be monitored almost in real time.

For example a new emission charging zone is implemented: Does it have the desired impact on lowering congestion and the environment? How do commuters now get to the centre? Are there additional problems such as for instance the overcrowding of certain public transport routes that were not foreseen?

The interpretation of data for decision-making is a key challenge that the Internet of Things is facing. The development of algorithms that can sift through massive and diverse data to find the patterns that explain our world without bias is a complex problem. Only then can the Internet of Things help us plan, operate and influence our world for the better.



We need a killer business model

Alessandro Bassi interviewed by Stig Andersen

Much technological development goes hand-in-hand with larger trends in society and is fuelled by other driving forces than the wet dreams of the geek world; and being a techie does not mean that you do not care about what lies around and beyond technology

The response of Alessandro Bassi, Alessandro Bassi Consulting, to the question "Does the Internet of Things need a killer app?" is a case in point:

"I don't think we need a killer app, but we need a killer business model. Just look at the impact that Apple's App Store has had on the app business."

According to Alessandro Bassi, one model could be based on the idea of borrowing and lending objects instead of buying them. Obviously, with the whole process made much easier than it is today.

"Take the example of a drill, which you will see in many households. A drill can be pretty expensive, so given the fact that you may in total use it for about 10 minutes in its lifetime makes for quite a high price per minute. Renting one in your local DIY store is quite a hassle, so imagine putting a stupid chip into the drill and being able to track it and borrow it through some kind of community service instead."

He points to logistics and health as sectors that will certainly benefit

from the developments within the Internet of Things. Together with the energy sector, these are also the sectors where practical implementations of the Internet of Things are most easily available.

Alessandro Bassi does in fact see some impatience among consumers for Internet of Things solutions that would make their daily lives easier.

"We are in a similar situation as with the Internet in 1992. The Internet of Things is in its infancy, but people are getting much more excited much faster. Why not just walk out of the supermarket with the food in the trolley without having to take it out in order to pay?"

But what is the Internet of Things - really? The answer is obviously influenced by the fact that Alessandro Bassi has worked for years within the area of advanced networking technology.

"I tend to see the Internet of Things as the interconnectivity of objects. It is the capability to uniquely identify and communicate with objects by electromagnetic means." And he continues:

"We are pretty much at the beginning, both in terms of number of interconnected objects and ways to interconnect them. To a large extent, we are still using wireless or RFID technologies to develop solutions for specific tasks. The Internet of Things will encompass these technologies, but we need to go much further. This also goes for everything related to the supply of energy to individual sensors or other devices. We cannot just stick a battery into all objects, so we need to find a way to harvest ambient energy."

In fact, he says, we need to get away from the idea of adding something to objects to enable interconnectivity.

"We need real integration of components, for instance by the use of non-silicone transistors like transistors made of plastic. This would mean that we did not need to stick a chip on everything, but the transistor and thus the ability to communicate would be embedded in the object itself. This is a very important aspect."

Again, technology is only part of the story.

KAPOW



"Proper governance, in particular with respect to privacy and security, also needs to be developed. You don't want everyone to know which objects you have in your home.

There is a risk of intrusion by governments and companies, and if you look at some of the current attempts at controlling the Internet, this is pretty scary. So privacy and security need to be addressed from the point of view of both technology and governance."

Alessandro Bassi is confident that the potential of the Internet of Things will eventually be realised. But short-term, he also sees the risk of actual implementations not being able to match the hype.

"Technical development takes a long time, and I think that some of the current hype about the Internet of Things may wear off. I don't think that anything major will happen within a timeframe of about five years in the field, which may cool down the general interest."

Alessandro Bassi considers the IoT-i forum to be an important instrument in the process of developing the

vision of the Internet of Things. "Work on the Internet of Things is carried out in a lot of different fields, so there is a need for a place where the tech people, the policy people, end users and science staffers can meet and exchange ideas and experiences. But we need to find a good "story line" - it shouldn't be yet another board, yet another standardisation body or yet another conference."

Alessandro Bassi is confident that the IoT-i Forum will be a community where everything from protocols to architecture and governance can be discussed openly.

"The IoT-i Forum is a community in the sense that individuals can contribute with their input and insights, and exchange of ideas can take place without any company policies or other external factors blurring the picture."

Alessandro Bassi has worked with the Internet of Things since 2004 when he joined Hitachi Europe as a researcher for advanced networking topics. When asked what excites him about it, he does not mince words: "The Internet of Things will be a much bigger revolution than the Internet and the mobile telephony put together!"



Alessandro Bassi

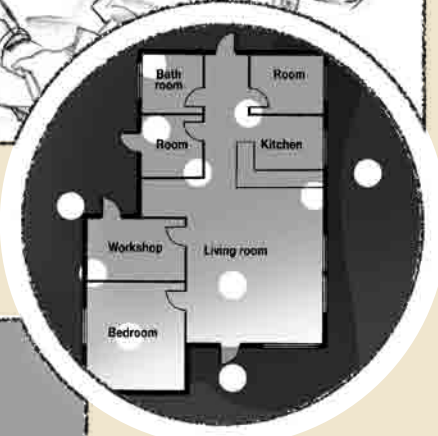
ALZHEIMER'S DISEASE



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 whereabouts and mental condition at home and in the neighbourhood. John's doctor and his children can now monitor him remotely and receive a message in case of a problem.



Quality of life

Internet of Things applications can improve quality of life, in particular, for the elderly.

In the domain of healthcare, Internet of Things applications are able to support not only the well-being of individuals but they can also indicate prevailing sanitary problems.

For example, body sensor networks can be used as direct feedback during athletic exercises but they may also reveal that a person suffered a dangerous fall. The latter case is in particular relevant to elderly people that face those situations due to for instance their mental conditions or frailty; they would be not able to contact their family, a nursing service or the medical doctor without assisting technologies in case of an emergency.

In those situations, the Internet of Things application would contact a responsible person with time and location information of the person concerned such that further action can be taken as soon as possible.

From the end-user perspective, such a service allows elderly people to live more autonomously and self-determined, important factors that positively influence the quality of life.

Privacy

Internet of Things applications must address privacy concerns to be successfully adopted by society.

Current IT-related discussions in mass media often reveal de facto concerns about privacy features of web applications such as social networking sites. Accordingly, upcoming Internet of Things applications must clearly address the potential invasion of privacy, too.

Particularly with regard to their ubiquitous character and embedded sensors in every-day environments as exemplified by the ageing scenario on the left, these applications differ significantly from traditional office or home office situations.

As a result, various data such as geographical location and time of service access can be tracked unobtrusively, without people being aware of it. One potential implication would be the fraudulent generation of user profiles that could be misused or sold to third parties. Even though this kind of data is often required for business models and services to work properly, transparent privacy policies and secure data transfer mechanisms are inevitable for the successful adoption of Internet of Things applications.

Designing Internet of Things applications must therefore cover at least two topics regarding privacy concerns:

First, service providers must clearly communicate purpose, frequency and details on why, how often and what kind of personal information is being tracked.

Second, latest and up-to-date encryption technologies must be employed to ensure safe data communication between end user and service provider.

The development of international laws and provisions by public bodies is thus strongly recommended.



Continuous Care

The continuous care 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.



Well, I am not getting any younger and healthier, but I want to keep my independence as long as possible...

- but these many time-consuming consultations at the doctor's just for routine checkups are annoying.



The next day during a visit at her son's who is suffering from a heart condition, she discovers a possible solution ...

I very seldom even notice this device anymore. Perhaps something similar would work for you as well?



Back in her own town ...

Sure, this personal monitoring device for your home will help with the checkups and reduce the visits to the doctor's as we can monitor you remotely.



She feels relieved and can now spend more time with her friends doing activities she enjoys.

Saving time

The Internet of Things will save you time and improve your quality of life.

Primary healthcare systems around the world are stretched to a breaking point.

A good indicator of this is the 'waiting time' for treatment. Many of the visits are routine and part of a well-defined set of recommendations to provide the best care for patients. However, this is unsustainable.

The ageing population and an ever-increasing demand for healthcare services are the cause. Telemedicine is a public-private partnership-driven concept that can turn this around.

Telemedicine allows patients to be monitored remotely for routine checkups, using a wearable or portable device at home and on the move. Routine visits become less frequent while treatment can still be adjusted with the information from the telemedicine systems, giving patients more flexibility to enjoy their life.

Telemedicine is a fast moving area, and applications and devices are offered commercially for the private user, but only a very limited number are linked to the healthcare system.

For telemedicine to join the healthcare system, a high degree of maturity is necessary from both parties: the ICT and the Health communities.

The ICT community needs to develop robust and open products that are certified by the regulators, and the Health community needs to move into the digital space, enabling electronic patient records and open (enough) platforms for devices to plug into.

Choice and acceptance

Consumers want to choose their products, and choice makes the world a better (acceptable) place.

The "Continuous Care" application scenario illustrates the patient choosing a telemedicine device. This is an important action for the acceptance of new technology in a very personal and intimate part of people's lives.

It is an iterative process of end user engagement in experimental living labs that get us to the point where good products are created.

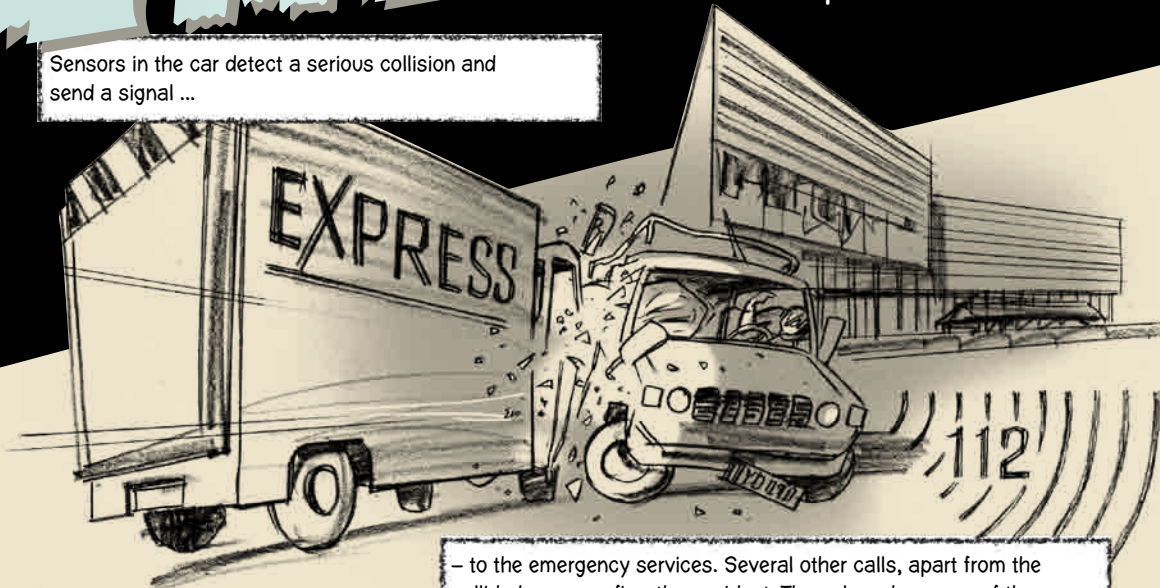
Understanding what the user wants is a key issue for the Internet of Things not to become a 'Big Brother' or a 'Damocles Sword'.



EMERGENCY

Response

Sensors in the car detect a serious collision and send a signal ...



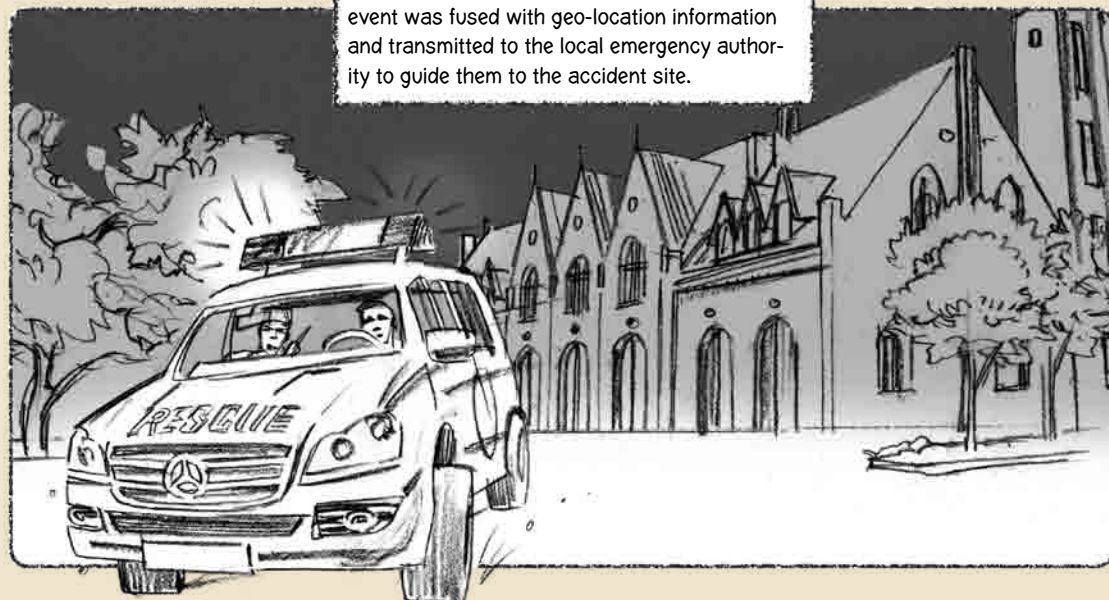
– to the emergency services. Several other calls, apart from the collided cars, confirm the accident. The onboard sensors of the two cars ...

Two cars crashed at the intersection downtown.

I'll alert the emergency services!



- immediately detected the accident and the event was fused with geo-location information and transmitted to the local emergency authority to guide them to the accident site.



Events

“Early in life I had noticed that no event is ever correctly reported in a newspaper.”

– George Orwell

Event detection and interpretation is a key element for the Internet of Things.

In the “Emergency Response” application scenario the event of a car crash has to be determined accurately and from multiple possibly conflicting sources.

The cars both report a crash to the emergency services and possibly the number of passengers and the force of impact, bystanders report the crash calling on their mobile phones – location and time are key factors in determining if the events are linked and can be combined into one emergency call.

Ultimately, the event should be described in the most timely and accurate manner as possible to allow for the best suitable response.

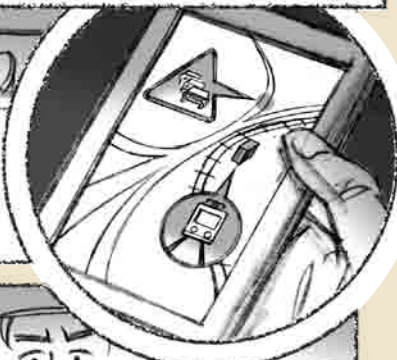
How many people are injured and how severe? Are there dangerous chemicals involved?

Detecting events accurately is an important challenge of the Internet of Things and something that seems limitless in terms of complexity.



COMMUTER

Ted is leaving for work in the morning; he is using the intelligent commuter application on his mobile phone to find the best route to work. The application receives live traffic and public transport updates and computes the best route for Ted. Today, It looks like there is a traffic jam on his route.



Damn traffic!



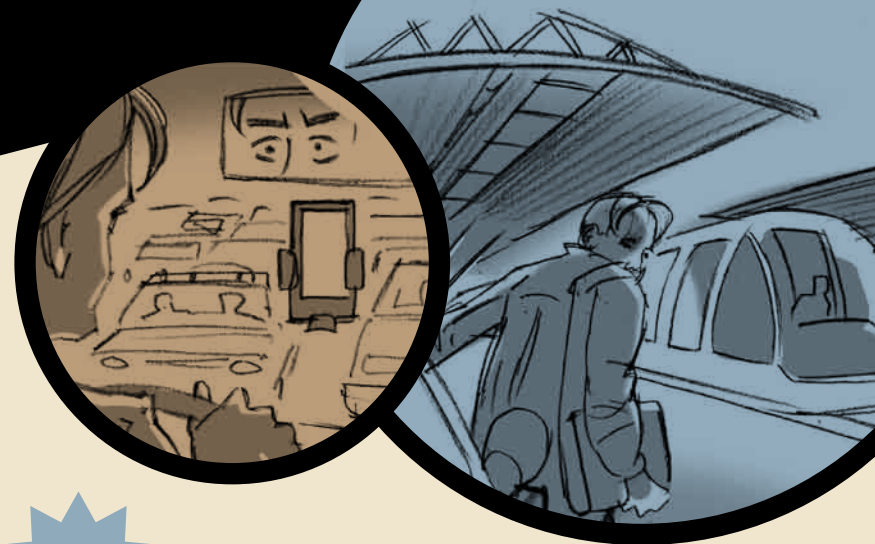
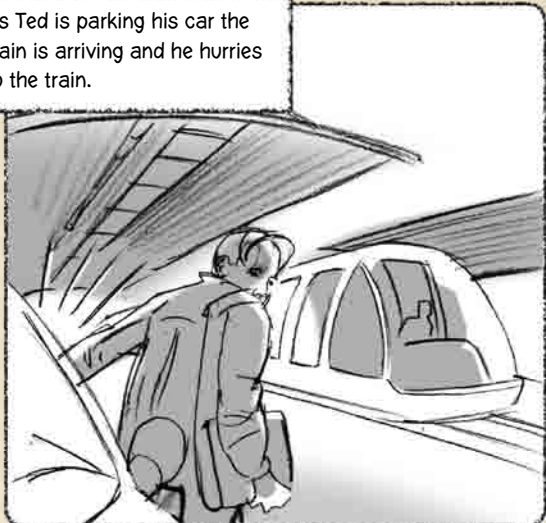
I'll try the motorway, I can always take the earlier exit if things are getting worse



There is a traffic jam ahead, if you take the next exit and park at the park and ride, you will save 10 minutes and still get to work on time.

Using live traffic and public transport data, the intelligent commuter application has guided Ted to the light rail saving him valuable time. As an additional benefit, Ted's "green" profile has increased, giving him a few green credits that he can use in his tax return.

As Ted is parking his car the train is arriving and he hurries to the train.



Navigation

GPS-based navigation has become a norm in everyday life of tourists and commuters alike – it helps us to find that museum and restaurant at places we are not familiar with or plan our daily commute, taking into account the current traffic conditions.

IoT will provide additional feeds into the navigation systems and make the information mix even richer by combining weather conditions en route, feedback from commuters already on the road, measurements from road sensors, etc.

Such rich information mix will make planning of a trip even more efficient and the trip itself more pleasant.

6th sense

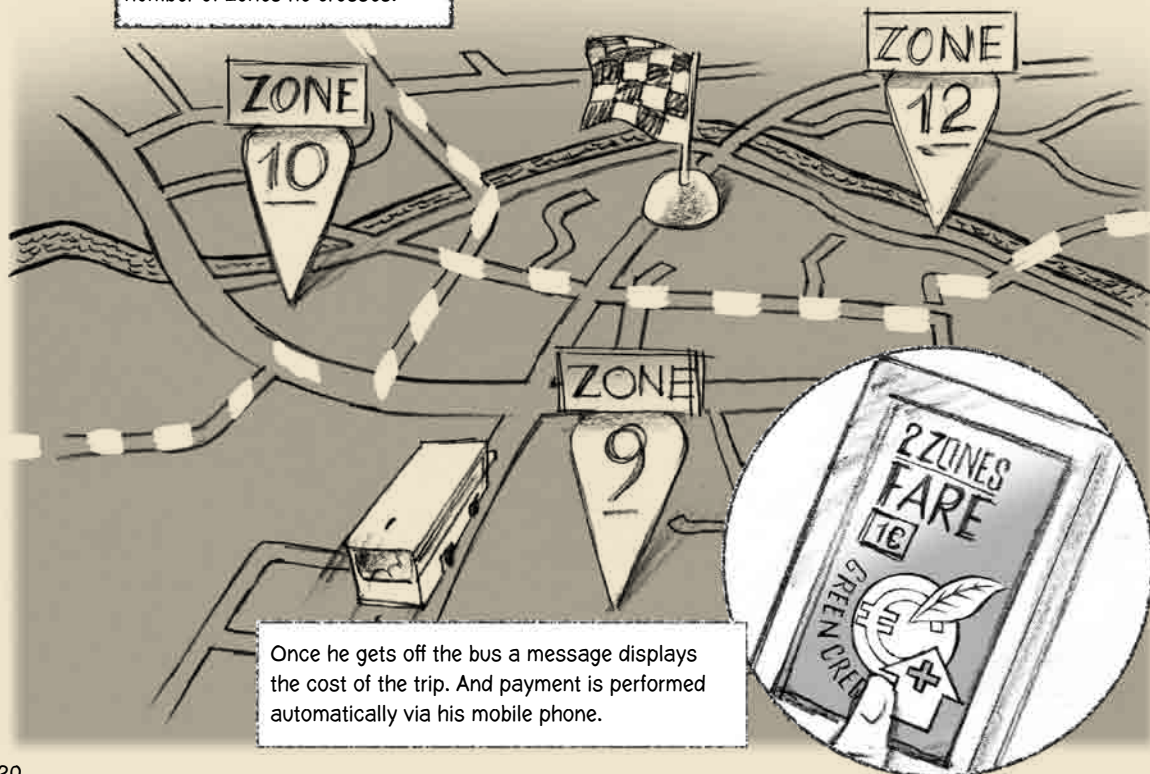
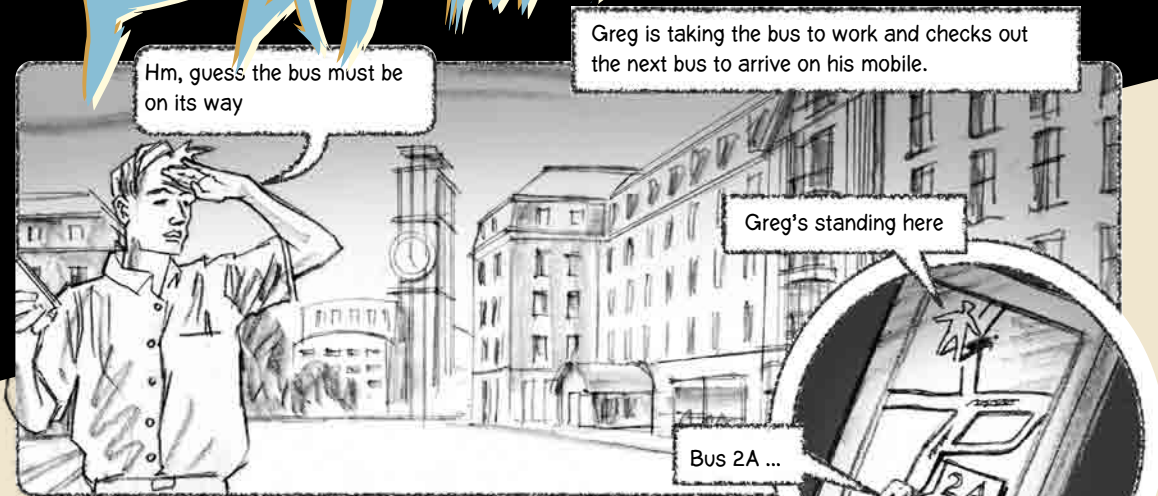
Ever wondered, while stuck in a traffic jam on a motorway, would you already be at home having your dinner if you had left the motorway at the previous exit? No need to wonder anymore, Internet of Things can give you all the information needed to make decisions – before that motorway exit!

Real life is continuously evolving, new events happening, schedules changing, procedures being disrupted. To make the right decisions in such an environment, one needs to collect and process information about numerous events taking place in the real world and to do it in real time.

Internet of Things will play a crucial role in enabling such decision-making by collecting information relevant to the current context of each user – traffic conditions on the roads leading to selected direction (querying road sensors, sensors attached to traffic signs and built into the cars), bus and railway schedules taking into account the location of the user and the intended destination, number of free parking spaces at the railway station, road works, public events and all other activities that can disrupt or be beneficial for the user to reach his or her destination as efficiently as possible.



PAYMENT



NFC

Near Field Communications (NFC) is an important technology of the Internet of Things.

NFC is closely linked to the mobile phone and is a specialised technology in the radio frequency identification (RFID) technology family.

It enables many mobile phone applications such as for instance secure payment transactions.

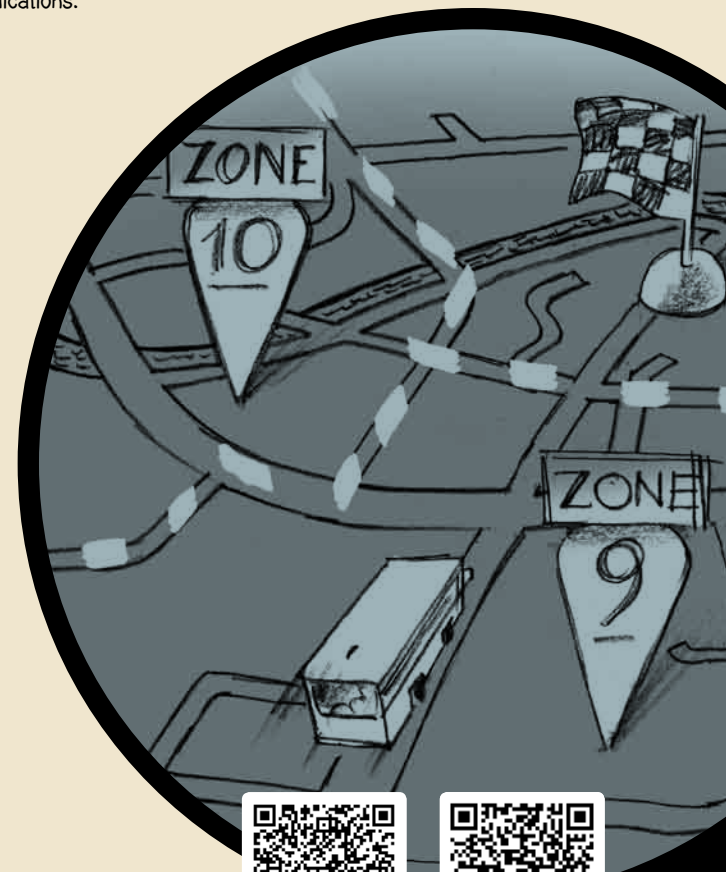
insights can be formed if we know where transactions take place: storing this and accessing it like a virtual database with structured queries will provide business intelligence and enable a new set of useful applications.

Location-based services

The Internet of Things and location-based services empower a whole new view of the world.

RFID tags provide an identification of an object in their most primitive form. But if this is combined with location information, it is a powerful means of tracking objects, people and animals.

What if we can do reverse look-ups – where has a person been? Where are my competitors' products mostly sold? Where is the packaging of my products being disposed of? Many useful but also sensitive



"Ultimately, it is about making people's lives better"

Harish Viswanathan interviewed by Stig Andersen

"To me, the vision of the Internet of Things is to enable communication and to exchange useful information between and with everyday objects in order to improve the quality of life for people. Ultimately, it's about making people's lives better,"

– says Harish Viswanathan, CTO Advisor on M2M and Devices, Alcatel-Lucent.

Harish Viswanathan has a background in wireless network solutions, and three years ago he joined the Chief Technology Office within Alcatel-Lucent's research arm Bell Labs, working on machine-to-machine and sensor network strategy. A move he has not regretted.

"It was really an emerging field at the time, and it has been growing exponentially ever since – in the company and in the industry. I'm happy that I got an early start within this very exciting area," he says. To realise the vision of the Internet of Things, a whole range of challenges are to be met. According to Harish Viswanathan, one is to make communication with everyday objects more intuitive.

"Today, we can do a lot in terms of human-to-human communication at the push of a button. But the Internet of Things aims at enriching life by creating more intelligent connections between devices and people. In a sense, we are extending the human intelligence by intelligently processing data to the point where

you can almost talk about an extra level of perception," he says. Healthcare technology allowing us to stay longer in our own homes and intelligent parking solutions enabling us to much more easily find a parking space are just two examples of how Internet of Things solutions can improve our lives. So for Harish Viswanathan, achieving the vision of the Internet of Things is really about enabling individual applications in our day-to-day lives that pursue that very goal.

Although many Internet of Things applications are sector-specific today, e.g. within healthcare, transport and utility services, Harish Viswanathan points to a number of fields where solutions per definition need to be cross-sector.

"Smart cities is a good example of cross-sector Internet of Things solutions. Here a number of sectors deploying machine-to-machine communication have to come together to create a smart city including efficient and smart traffic management, security, parking, etc. All with the objective of making people's lives easier. Also smartphone applications to control your home devices

relating to energy consumption, security, etc. need to bridge different sectors."

One of the major bumps on the road towards cross-sector implementations of Internet of Things solutions is the lack of standards, or rather, lacking interoperability between different standards.

"Today, many manufacturers reinvent the wheel and start building solutions from scratch with a slightly different protocol. This results in incompatible solutions and much higher development costs than if standard components and protocols had been used," says Harish Viswanathan.

He believes that the different sectors will eventually come together in a machine-to-machine communication infrastructure similar to that of a mobile network. This will mean that multiple applications can interact through a service platform infrastructure deployed by service providers.

"There is talk about creating a partnership project like 3GPP for machine-to-machine communica-

tion. I see a lot of potential in that and believe that sooner or later, it will materialise," says Harish Viswanathan.

Alcatel-Lucent is offering solutions for the Internet of Things today – like a Machine-to-Machine service platform with management functionality, applications and services. But research and development is continuing. Harish Viswanathan points to areas where work is still to be done – areas that he is also personally involved in through his work at Alcatel-Lucent.

"The wireless connectivity itself needs to be improved. The wireless networks we have today are not designed for machine-to-machine communication that really only requires very small amounts of data to be processed. Further research needs to be done on how to optimise networks to handle a large number of small data transactions. As part of that, the issue of scalability also has to be addressed." Device management, low-power consumption and security and privacy issues are other important focus areas, according to Harish Viswanathan.

And returning to his initial point about communication and exchange of useful information, he points to the issue of semantics.

"We have a challenge of analysing all the data available. What we need is a data model that enables billions of deployed devices to generate information that could be connected in a useful manner. There is ongoing research in the semantics involved here, and I believe that the results will have an important impact on the deployment of Internet of Things solutions," he says.

Harish Viswanathan sees the Internet of Things Initiative as a very good opportunity for people from different areas and industries to meet in order to understand the requirements of all the different stakeholders.

"One of the strong points of the Internet of Things Initiative is that it is international. Also, a lot of the other forums are industry forums focusing on partnerships within individual businesses, whereas the Internet of Things Initiative also has a research focus, which to a much higher degree provides a long-term perspective," he concludes.



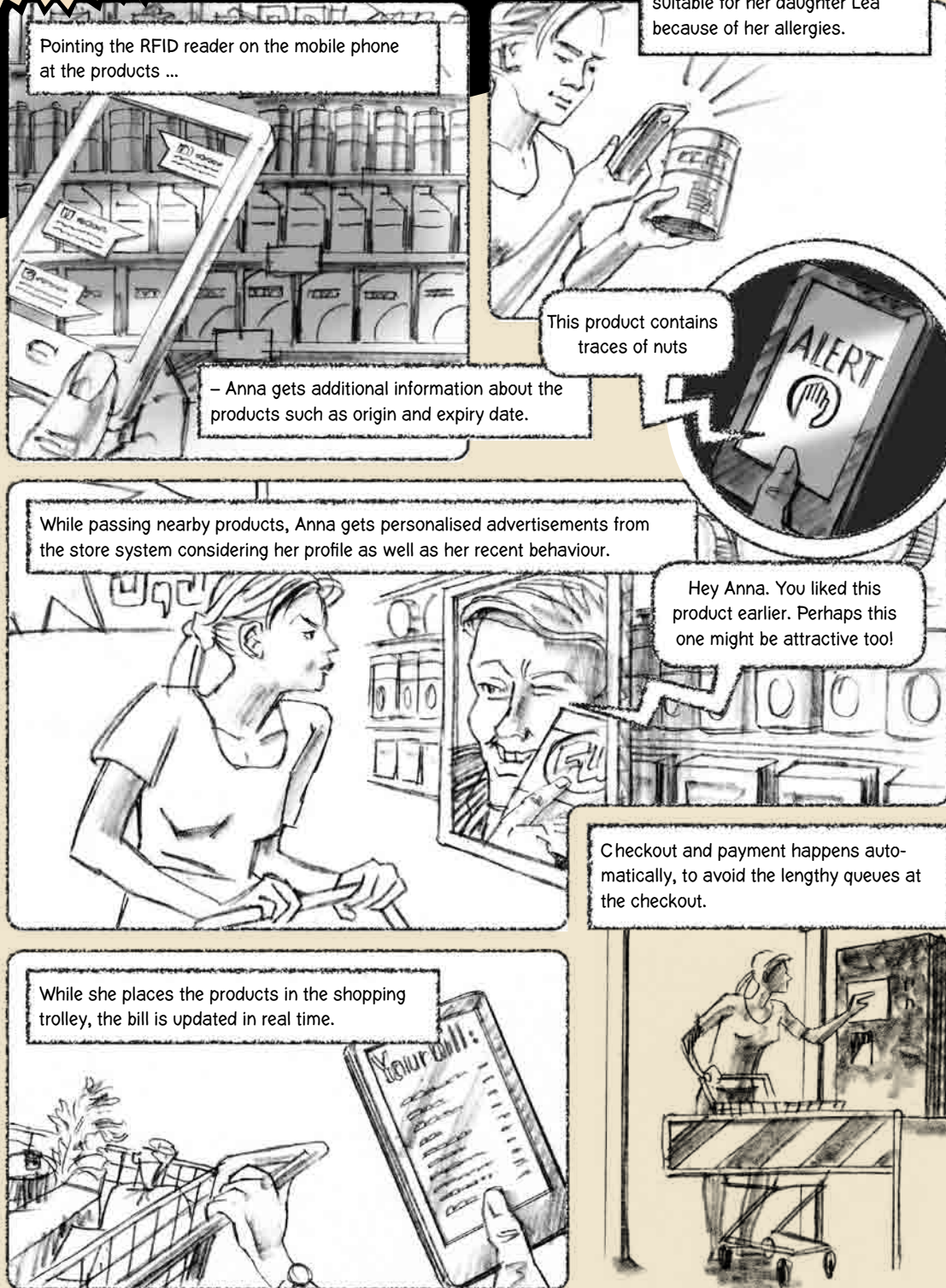
BLING



Harish Viswanathan

SHOPPING

Application



Augmented reality

The Internet of Things will enable augmented reality.

With increased detail of information from sensors and tags, new forms of visualising this as knowledge will be important. Overlaying this information on a camera view, i.e. augmented reality, will be just one of the many ways of making sense of large streams of information from sensors on the spot.

In the "intelligent shopping" application scenario, Anne is using augmented reality to scan through the supermarket to find products that she needs and obtain more detail about these products. At a glance, she can see where that missing ingredient is, if the product contains anything that her family is allergic to, or where the product comes from. It helps her navigate the shelves and make more informed choices about her shopping.

Visualisation of information from the Internet of Things will be an important part to sift through the masses of information.

Irritation versus responsible use

Knowledge generated by the Internet of Things is power. "With great power comes great responsibility." Benjamin 'Ben' Parker.

You can call it a privacy issue. But actually it is just a perception. Staying with the example of supermarkets, loyalty cards collect information about their users.

And many users seem to be happy to pass this information on. But loyalty cards only collect data about what is purchased, not what is looked at, picked up and put back on the shelf.

The Internet of Things will offer a much higher level of granularity of data about shoppers' behaviour than previously possible. This information can then be used for the good of the shoppers, for instance to encourage a more healthy diet, or in targeted advertising to plainly sell more.

There is a balance between gathering data and offering clear benefits towards the consumer.

What falls under privacy issues and rejection of a technology, and what is a new and beneficial service towards end users is a fine line of success.



PRODUCT Management

Tom is working in a supermarket. He is in charge of the management of a the beverages department.



All products are fitted with RFID tags and sensors, allowing him to monitor information about ...

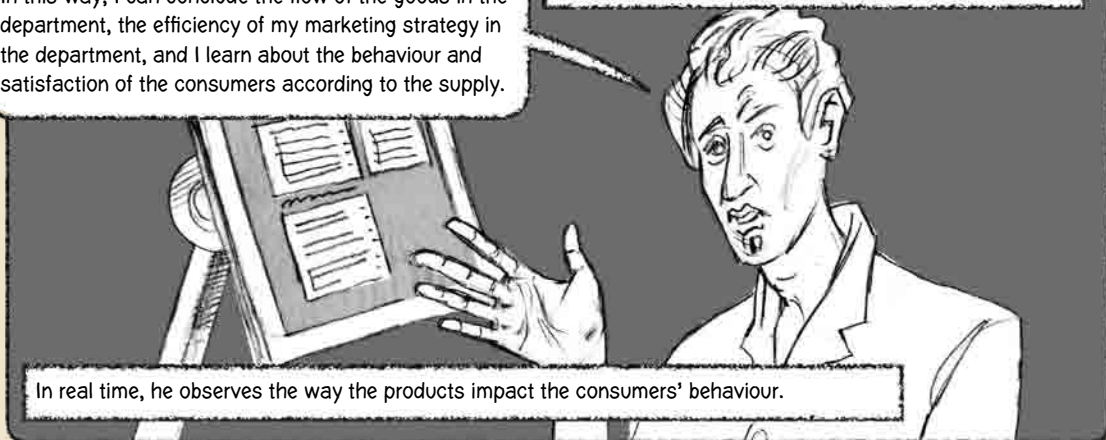


– the products, type and variety, state or packaging, storage conditions, expiration date, remaining stock, changes in the products' location and ...



– consumers' profiles such as time spent in the area or in front of a product or products they are interested in (e.g. picked up but not bought).

In this way, I can conclude the flow of the goods in the department, the efficiency of my marketing strategy in the department, and I learn about the behaviour and satisfaction of the consumers according to the supply.



In real time, he observes the way the products impact the consumers' behaviour.



Optimised product management

The Internet of Things will allow for extreme streamlining of all processes related to product management in logistics, such as to be found in supermarkets.

By employing different technologies such as RFIDs, sensor networks and intelligent accounting software, a supermarket manager will be able to keep track of his inventories without having to count manually – everything will be automated. In addition, the software will be able to produce statistics on which products are favoured by the customers – for instance by just counting how much of a product has been sold, but also by monitoring customers' behaviour in front of the shelves. It is then much easier for the manager to decide where to place which products on the shelf in order to optimise the offer – and certainly the sales.

With such up-to-date information available, a manager can react much more quickly to important events or changes in current situations, such as low inventory or changing customer needs and wishes – and all this without any manual work, just through automatic monitoring.

RFID

Radio Frequency Identification (RFID) is probably the most important basic technology for the Internet of Things.

Based on so-called RFIDs, all kinds of things – in this example products in a supermarket – can be first uniquely identified, and second their location can be precisely determined.

RFIDs can take different forms. The best known is probably the one you can see in this comic book: here, it is a kind of electronic label or tag which can be attached to basically any item or group of items. But there are also RFIDs which have the size and form of a grain of rice and can be implanted under the skin of an animal or a human.

The most common form of RFIDs (and the one relevant here) is passive: whenever they receive a certain signal from an RFID reader, they send back a signal to this reader. This signal is unique for this tag, so the reader can uniquely identify the tag – and thus the product attached.

RFID tags do not need energy supply – the energy of the incoming signal is sufficient to produce the outgoing one, at least for a distance of typically a few centimetres, which is usually sufficient.

In combination with a reader and a product information system (a piece of software), RFIDs show their extreme power: it becomes very easy to count huge amounts of products by just moving the reader in front of them.

When a customer takes a product from the shelf and puts it into his cart, the shelf reader will take note of this by reducing the amount of that product in the repository. The reader in the cart can automatically register the product so that payment at the cashier can be done in zero time.

It should not go unmentioned that many people have some fears concerning their privacy – they think that with RFIDs, everything they do can be taken note of and accounted to them.



Beyond fragmentation and sector-specific deployments

Jan Höller interviewed by Stig Andersen

"Today, we make a separation between the real or physical world and the Internet. As I see it, the two should be blended. Whatever real-world interest I have, I should be able to get access to online."

This could be the route I should follow to get to work, my summer cottage or other points of interest that I would actually like to be able to add to my online "phonebook" or social network", says Jan Höller, Master Researcher for Connected Things at Ericsson Research.

Above the personal level, the Internet of Things will also have an important impact on enterprises and on society in general.

"For enterprises, it is very much a question of having access to all their assets and seamlessly integrate them into their business processes, and for society, it is typically about furthering sustainability, dealing with environmental issues, monitoring water quality, developing new healthcare solutions etc.," he says.

Jan Höller is not waiting for a specific event or technological breakthrough to boost the Internet of Things implementations. We are already in the middle of it.

There is already a lot of machine-to-machine communication going on out there; parking meters are

connected, and vending machines automatically report when new supplies are needed. Each minute of the day, huge amounts of data are being exchanged between machines for various purposes within various sectors.

However, according to Jan Höller, there is a big challenge in moving beyond application-specific devices and establishing an information model that will create re-use of the data generated by the devices for new applications in different application domains. Finding the right horizontal points in the solutions is key.

Approaches differ on how to pursue this kind of horizontalisation, "Some sectors are obviously more mature than others, but most industries have now realised that so far, devices and applications have been tailor-made for specific purposes and using proprietary or industry-specific technologies. However, as we see convergence on consumer electronics devices and mobile devices around the use of operating systems, APIs, SDKs and the use of web protocols, we already see the same evolution on the IoT and

M2M device side with the use of the standard technologies, e.g. IP moving into very small devices. This is a necessity for costs to come down, and the technology is now mature for this to happen."

On the subject of making use of generated data beyond the original purpose of the deployment: "There are already useful deployments within the transport, automotive, building, health and utility sectors, but everything is still very sector-specific. We need to create a kind of information fabric that will make information generated from a car or a building understandable not only within their own very specific application or domain but across applications and domains."

Jan Höller believes that semantic annotations and linked data models, or other semantic technologies will have a role to play.

"It is really about how to turn vast amounts of specific data into knowledge to share, to be able to reason about the knowledge in an intelligent and automated fashion and to come to conclusions and decisions. This should be done without the need

BAM

for having humans in the loop. This could employ some of the developments from the semantic web, and, who knows, we might even see a revival of some kind of artificial intelligence.

However, the foundation for the Internet of Things is still the devices and smart objects. To see the possible aggressive growth of applications and innovation for IoT requires confronting some near-term challenges for this very foundation."

Jan Höller summarises: "There is still work to be done in commodifying the tiny devices with which we instrument the world - the sensors and the actuators.

For this, we have to eliminate the fragmentation in used technologies and protocols and promote the use of standard IP and web technologies as well as e.g. operating systems. We also have to make sure that the devices can be used across applications and that the service the individual device is providing is properly exposed.

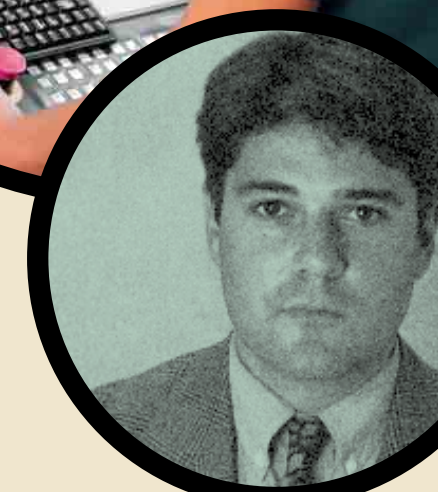
And not least, we need to find a way to actually carry out the necessary and massive deployment of devices

in a cost-efficient way. So we need to put more effort into the design of tools to automate deployment and configuration of devices."

He is looking forward to the continued work within the Internet of Things Initiative.

"I would be very happy if we would see representatives from different industries come together and talk about what are the common challenges in terms of technology, business processes and models, etc. There are a lot of forums out there, but they tend to focus on specific industries. So it is my hope that the Internet of Things Initiative will be a venue where we can meet and

talk about problems in different domains and discuss solutions that can span different sectors. We have a challenge in front of us, but it is definitely worthwhile to try to meet this challenge," he concludes.

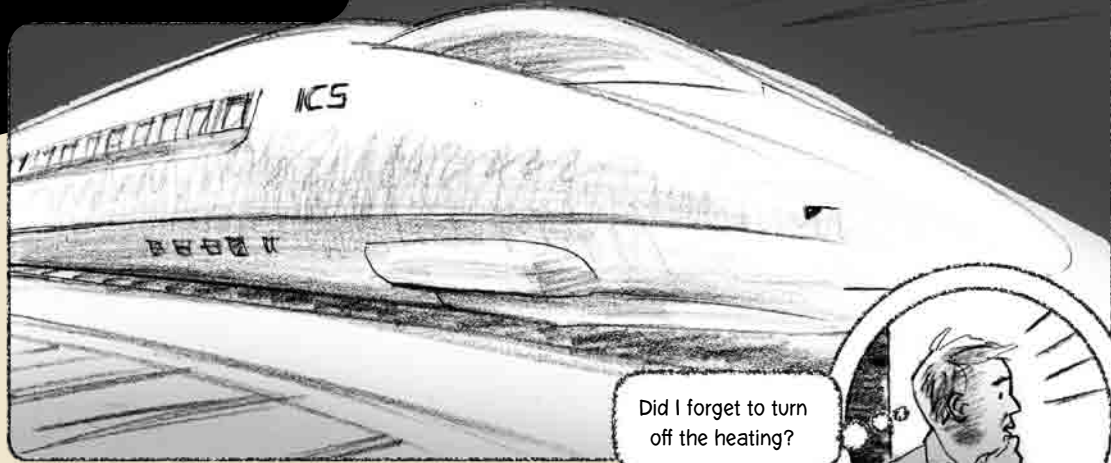


Jan Höller

SMART METERS

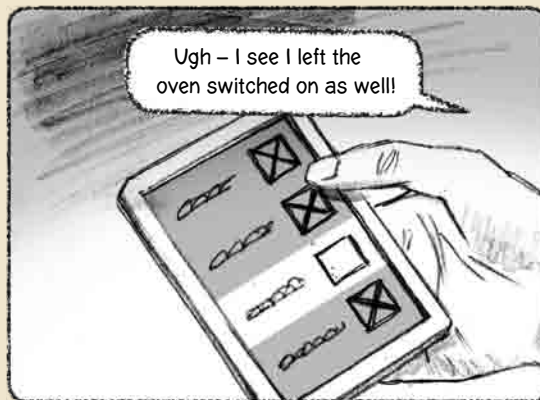


Tom is on a business trip and will be away from his home for a few days ...

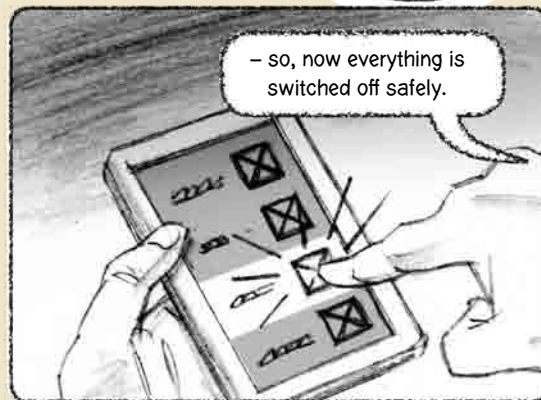


Did I forget to turn off the heating?

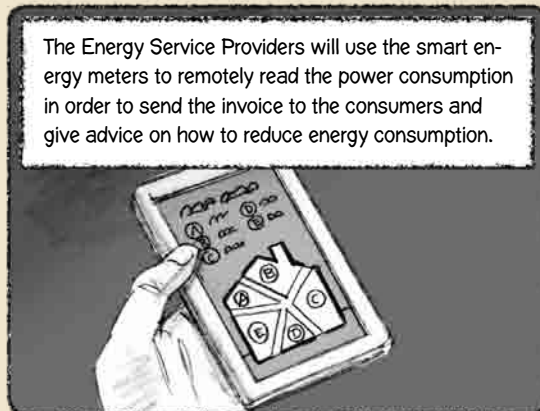
Consumers are able to use their smart phones to connect and remotely read their electricity consumption and shut down the heating in their house, as well as other appliances.



Ugh – I see I left the oven switched on as well!



– so, now everything is switched off safely.



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 and give advice on how to reduce energy consumption.



Ok, seems like a new fridge would do magic to my energy bill.



Extended memory

The Internet of Things is your extended memory.

The Internet of Things will tell us – or at least help us – find out if everything is OK. In the “Mobile Application for Smart Meters” scenario Tom cannot get a niggling thought out of his head – did he switch off the heating or didn’t he?

How many times have you walked back to the front door, the car or the office to check if you locked it? How many times have you thought about having forgotten something to switch off?

The Internet of Things will enable an extended knowledge base that we can query.

Remote control

But it is not just extended memory – we can also remote control things.

On/Off are just some basic functions of remote controlling things. Actuation, as it is called in the IoT community, will be an important part of domesticating things in our private life and optimising business and industrial processes in our professional life.

It is best to make decisions based on knowledge – but only if we understand it.

Knowledge

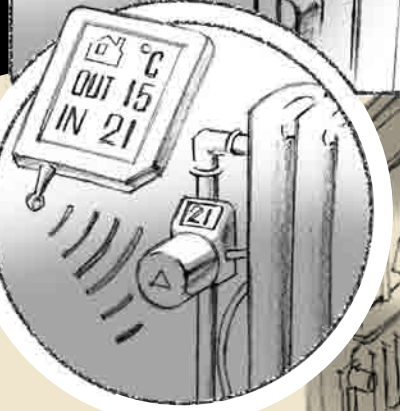
Much like in other application scenarios, data streams are not easy to understand if they are complex. Additional processing of data is required to form knowledge that can be used in decision-making.

Visualisation of data is a great way of forming knowledge – just like in this scenario. Tom is presented with a graphical view of his energy consumption and hints on how to improve the performance and become more efficient. So he can make decisions on for example the return of investment on a new fridge.

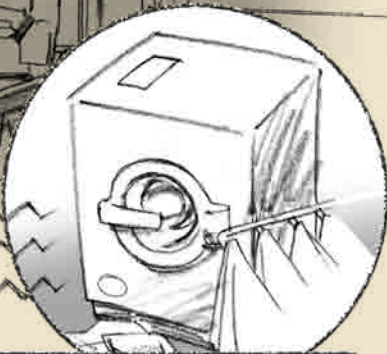
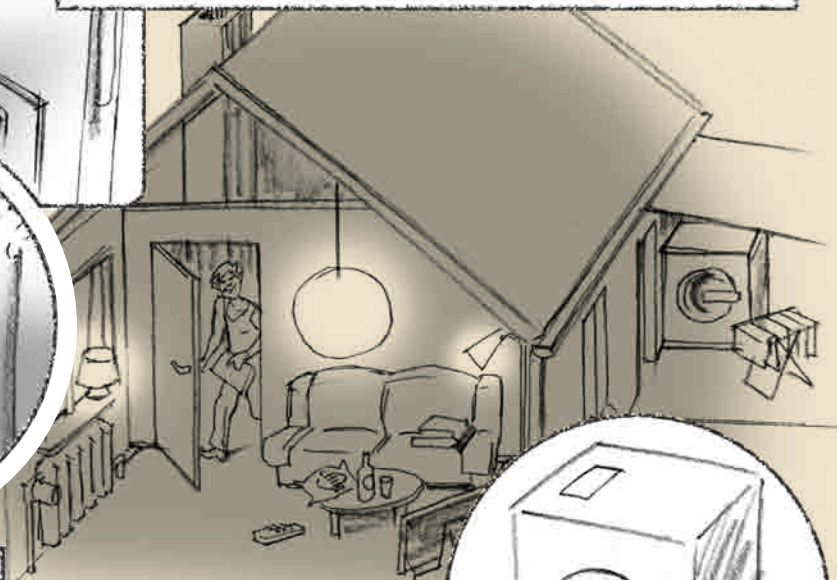


AUTOMATION

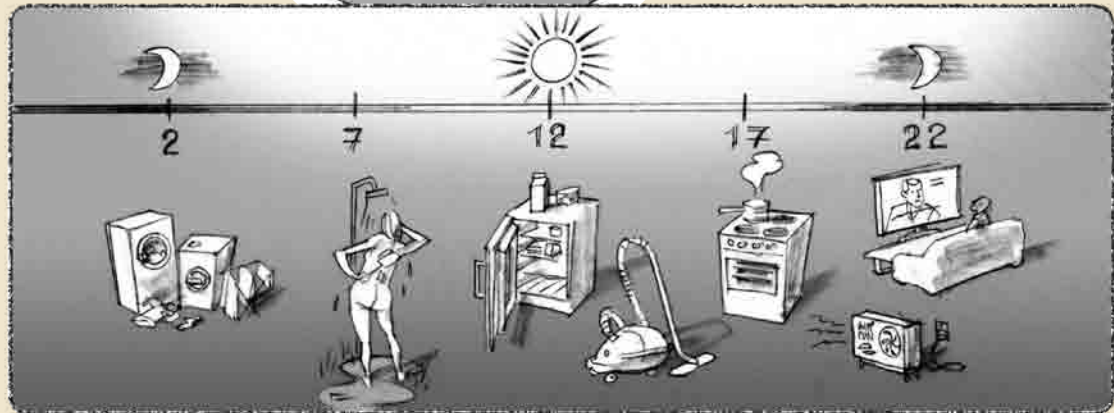
The Home Central Control (HCC) provides the complete control of your house. It controls access, energy, heating according to your profile, environmental conditions and price.



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 recognises which appliances (washing machine, dishwasher, water heater, heating system, etc.) are turned on at a given time and synchronises them to ensure the best energy efficiency taking into account pricing structure of the utility companies.



Behaviour

The Internet of Things will show us who we are!

Well, maybe it will not look into our "soul", but it will tell us what we did for how long, where and when. We constantly interact with things – a lot with our mobile phone – and we leave footprints already today with our actions.

How much of this will be recorded and processed is an open question, but Facebook and foursquare for example already provide hints on how much some people are willing to share.

So why not record everyday actions around the house to figure out where our time and money goes – what is a good and what is a bad day.

Sensors and tags in objects will record when they are being used and for how long – linking this with who is just another step.

The Internet of Things enables a trace of how we interact with our surroundings, information that can lead to knowledge on how to improve our day, find ways of saving costs and energy, or simply remembering and sharing what we do and did.



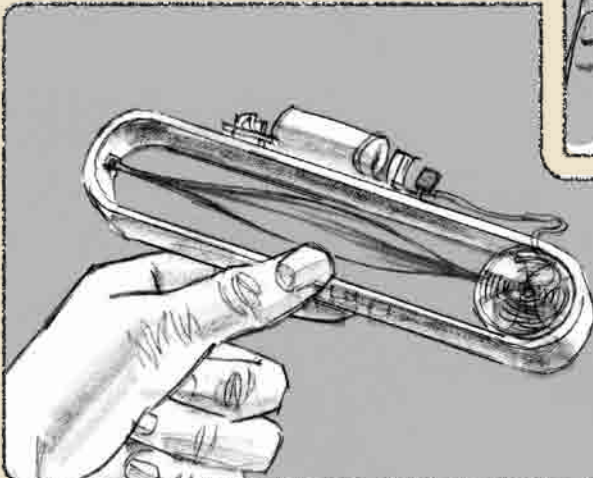
ENERGY



There are a number of problems with wind farms: control, variable power production, maintenance etc. Machine-to-Machine networks can help with the information flow needed for distributed control.



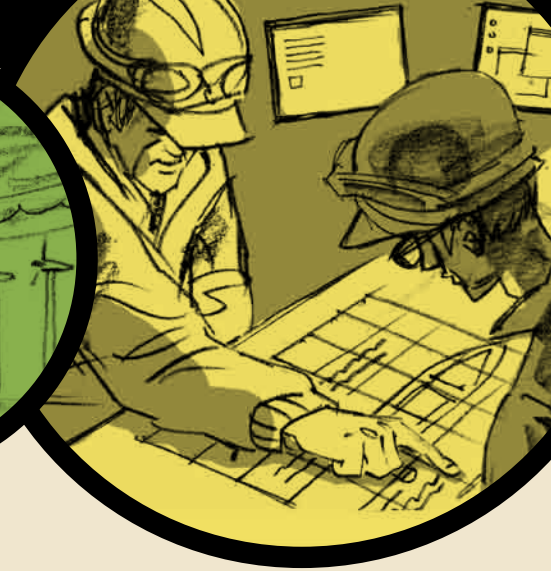
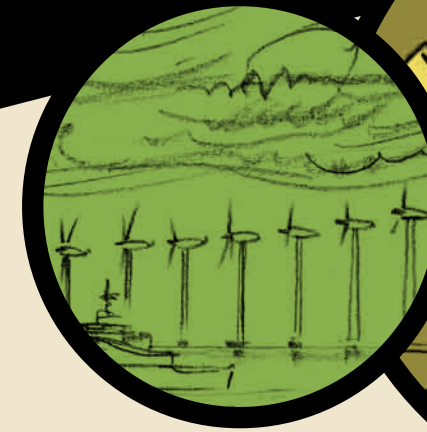
A set of spatially distributed wireless sensor nodes will be deployed in the wind farm, and sensor nodes will take measurements of the flow and wind velocity.



Sensor observations will be periodically reported to a centralised unit, where the performance of the wind farm can be monitored and optimised ...



– maintenance can be scheduled based on real time data and historic data can be used for future development and planning.



Smart grid

Climate change, carbon footprint reduction, global warming and renewable energy – all have entered the realms of everyday speech and life.

There is general agreement on the need for change, and one of the key steps to be addressed is the modernisation of the, mostly century old, electrical power system and creation of a “smart grid”. The smart grid concept refers to the integration of the power grid with communication and information technologies aimed at increasing performance and reliability.

The main elements of the grid are the centralised generation system, the transmission grid, the distribution grid and distributed energy resources. The distributed energy resource (DER) is localised source of energy production and storage in the distribution grid, such as solar and wind farms, fuels cells, micro-turbines, heat recovery systems, storage (batteries, ultra capacitors), diesel generators etc.

The Internet of Things is one of the crucial elements of the smart grid that will enable autonomous communication and interaction between numerous components of a grid, thus enabling efficient coordination of the DERs in line with the current energy requirements.

Planning

The Internet of Things will enable very accurate planning and selection of sites for green energy production installations based on the potential and ability of each site to generate energy.

Continuous observation of a large number of parameters like weather conditions, wind velocity and direction, amount of rain, number of sunny days, the height, frequency and duration of waves etc. will be enabled by an abundance of IoT devices dispersed around the globe.

The measurements collected will be processed and analysed together with historical data to produce recommendations for optimal placement of energy generation equipment.

This will enable increased predictability and reliability, improve lost production factor figures and provide more accurate production estimates for a given site, thus driving down the cost per kWh produced.

IoT will also make it possible to monitor and predict energy consumption patterns in real time, thus making optimisation of energy consumption in line with the energy demands.

Smart meters and other similar IoT equipment will monitor energy consumption across the grid and interact to exchange information with other smart grid components.

By combining this real-time data with historical data and input from the weather sensors, the system will make it possible to predict sudden surges in energy consumption and react adequately to optimise energy generation across the grid, in particular by numerous small energy generation installations.

The information collected and processed can be used to plan maintenance work at most beneficial time.



The entity of interest is a cow

Stephan Haller interviewed by Stig Andersen

Stephan Haller, Development Architect - Internet of Things, SAP Research Zürich, would rather talk about "entities of interest" than "things" in relation to the Internet of Things.

Sometimes people think about the devices when talking about the "things" in the Internet of Things. However, I would like to focus on the entity that we are directing our interest to for some purpose or other. This can be a pallet, a truck, any consumer item, or also animate things like a person or a cow. Using a cow as an example is sometimes useful to make the distinction to devices, since most people would agree that we do not connect directly to the cow!"

Stephan Haller is a veteran within the field of the Internet of Things. His interest dates back to 1998 when he was working in the SAP Labs in Tokyo. A local distributor demonstrated RFID technology to him and his colleagues, and they immediately realised its potential in supply chain management applications.

"What interested me then, as it does now, is bringing closer together the physical world and the virtual world of IT. I am a software engineer by training, but it is stimulating and motivating to work at the edge of the software world where it touches real life."

To Stephan Haller and his research colleagues at SAP, the Internet of Things is basically the concept of integrating the physical and the digital world using Internet technology. And the connectivity enabling this integration is what needs to be part of the Future Internet.

"The Internet of Things poses different challenges at several layers of a Future Internet. Also the Future Internet will be largely IP-based, in particular IPv6. It has been shown that also Internet of Things devices can be efficiently integrated based on IPv6, so with regard to the connectivity layer, we are in fact getting there."

When it comes to the service layer, Stephan Haller sees more interesting and also challenging issues ahead.

"The heterogeneity of devices is certainly a challenge. What we want though is interoperability, but one thing is the technical interoperability, another is the semantic interoperability needed for the devices to "understand" each other, and for data from different resources to be comparable and linked together."

Another important issue is how to locate the resources relevant to the task at hand.

"In terms of resources, we need to be able to find them, for example temperature sensors that are adapted to a certain environment and that have a certain accuracy. So we probably need an infrastructure service for that - a kind of advanced search engine for sensors or resources."

Stephan Haller also sees a need for a common platform for connecting sensors inspired by the global social networks.

"We would need somebody to provide a service in the form of a platform on which to develop applications that make use of the relevant sensors. It would be a kind of social network of sensors, but there are some important issues here: What should the business model for such a service be, and can such a platform be reliable enough for the services that you would want to develop?"

According to Stephan Haller, the current implementations of the

Internet of Things are primarily directed at tracking and monitoring, e.g. goods in the supply chain. Energy, health and to some extent manufacturing are also sectors that can benefit from the technology. However, relatively few of the implementations can be said to be proper instances of the Internet of Things, rather, they can be regarded as Intranet of Things.

"Truly Internet-based implementations are probably still rather rare. Most of the monitoring that takes place is running on company-internal systems, meaning that it is not Internet-related. In addition, monitoring is actually just half the picture. The actuation, that is the triggering of events, is also a very important part of the concept of the Internet of Things."

Regarding the IoT-i Forum, Stephan Haller's ambitions are high. "If we just have another forum like many others, the value is limited. The ambition of the IoT-i Forum should really be to unify the forces of the globe behind the idea of the Internet of Things. It should be a place to exchange information and to gather requirements in order to

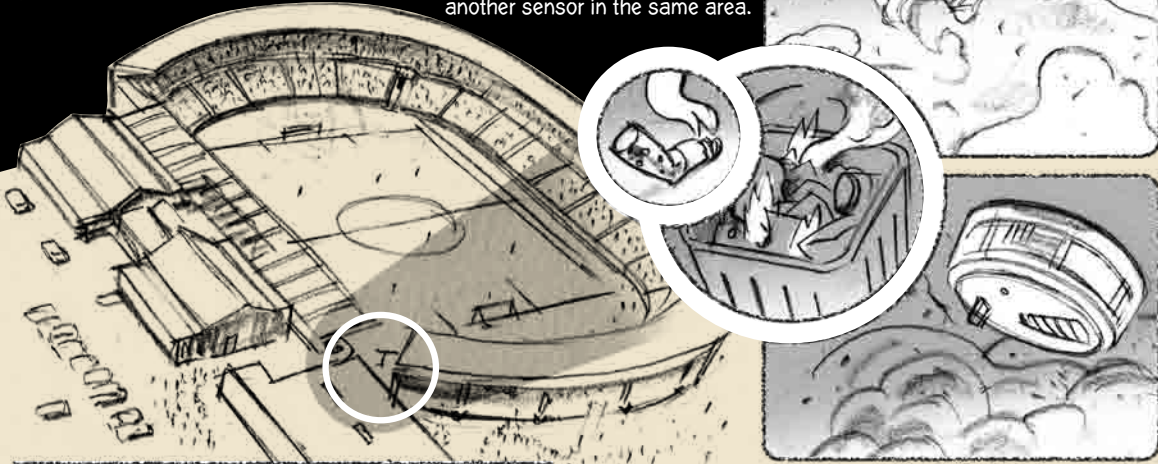
push research in the right direction. It should also be a place to exchange information about what works and what does not work in order to promote best practices within this area."

Stephan Haller



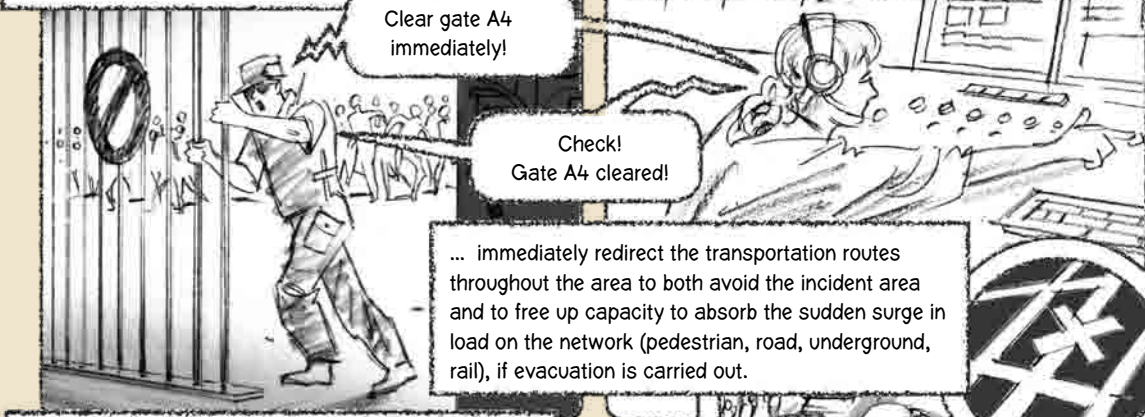
Smart Events

During a football game a smoke detector in the stadium triggers an alarm 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 stadium's central command needs to ...

Meanwhile – at the central command unit ...

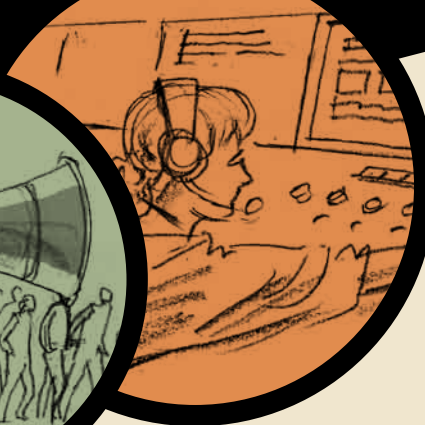


... immediately redirect the transportation routes throughout the area to both avoid the incident area and to free up capacity to absorb the sudden surge in load on the network (pedestrian, road, underground, rail), if evacuation is carried out.

The central command unit invokes the appropriate emergency plan to enforce these changes ...



... 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.



Improving safety

The Internet of Things will improve safety in our society if it is well integrated with processes and procedures in a regulated environment.

In the "Smart Events" application scenario a group of sensors confirm an event – a fire – and provide this data to the command unit. The command unit can action a pre-planned emergency evacuation of the event. During the evacuation each step can be monitored by the sensors giving instant feedback about the plan's effectiveness at the command unit.

At the ground level the sensor information can be used to maintain a coordinated effort across emergency staff and to 3rd parties such as the transport system operators in the case of this scenario. In addition automation of some processes within the plan can be used to improve response time and limit human error.

However, integrated scenarios such as evacuation are highly regulated and traditional environments – innovation from the IoT can only be achieved with a certain maturity and robustness of the technology. Confidence is key.

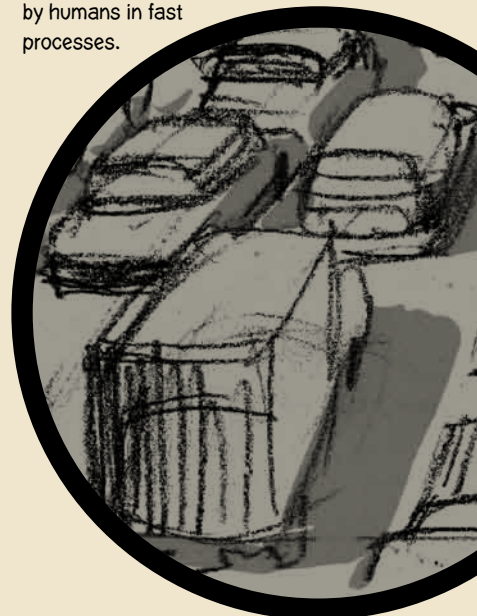
Heterogeneous data sources

The Internet of Things will be made up of billions of heterogeneous devices such as sensors, actuators and tags that are all networked together. They will be deployed by many different organisations and individuals, maintenance is not always guaranteed; some will be reliable and trusted data sources, others will be rogue. The data that they provide will range from streaming video in HD quality to sending one bit every so often.

In the "Smart Events" application scenario a number of smoke detectors and cameras confirm a fire at a particular location – simple enough.

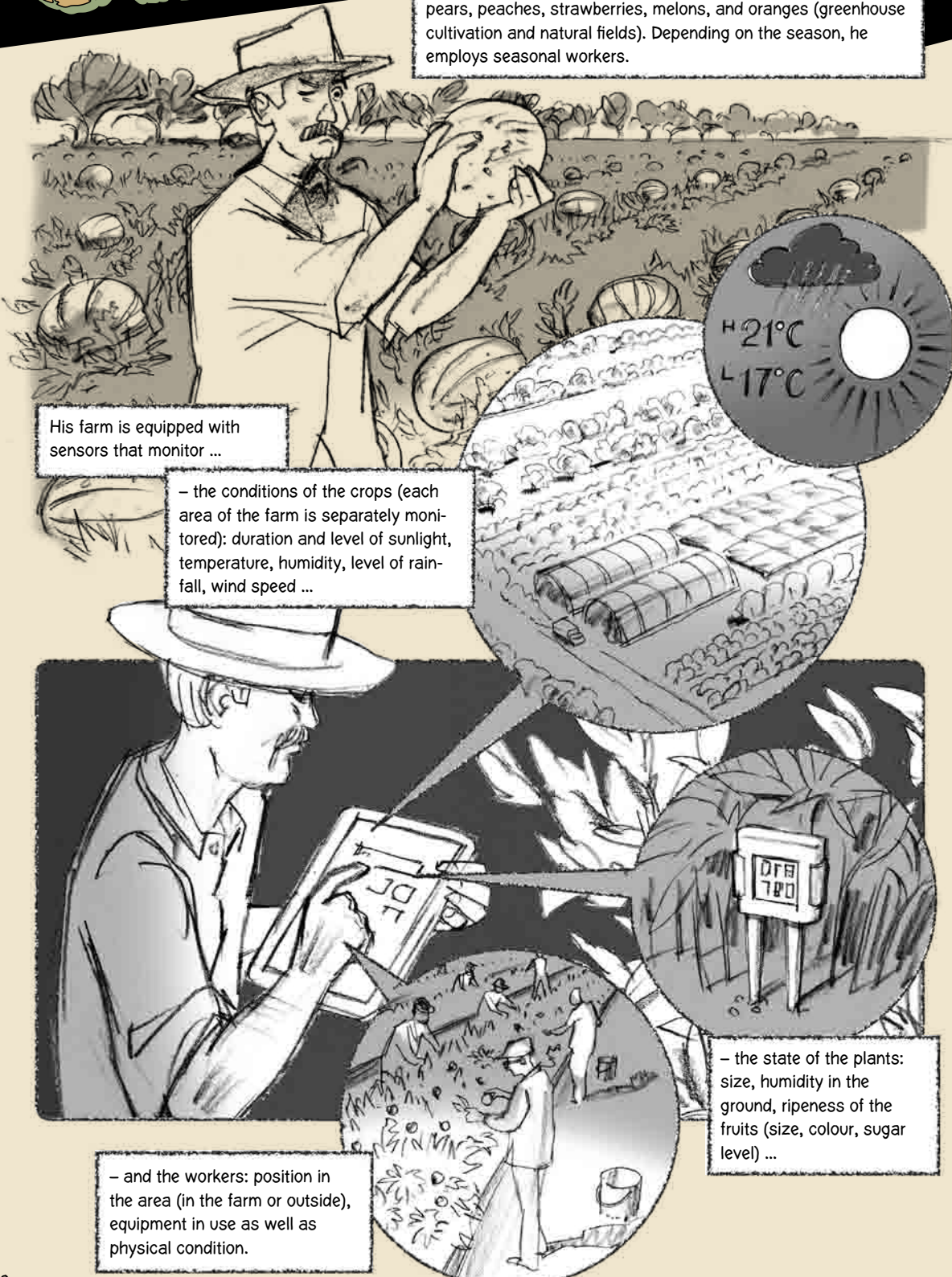
However, during the evacuation procedure numerous sensors facilitate the feedback to the command unit and provide the knowledge and certainty that it is safe and timely to go to the next stage of the evacuation plan. Have the transport routes been set up? Is there an element of panic in the crowd? Have the gates been opened correctly?

Semantics makes the generation of knowledge from these heterogeneous data sources possible. The semantic annotation of data coming from sensors allows different data to be fused, reasoned and interpreted by machines to form knowledge that can be easily understood and read by humans in fast processes.



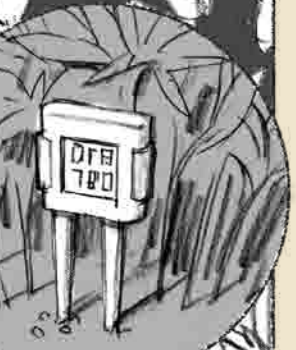
ORCHARD

Frank 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 seasonal 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 sunlight, temperature, humidity, level of rainfall, wind speed ...



– the state of the plants: size, humidity in the ground, ripeness of the fruits (size, colour, sugar level) ...

– and the workers: position in the area (in the farm or outside), equipment in use as well as physical condition.

Reusable sensor networks

Internet of Things infrastructures can improve farming but their data can also be sold to third parties.

Managing a farm as depicted on the left requires various activities that can be supported by Internet of Things applications.

For example, Frank must always have a detailed picture of weather, crop and soil conditions. This monitoring requires effort and is time-consuming, in particular for a large farm or even in situations where Frank owns fields that are geographically dispersed.

A sensor network allows Frank to get current data about temperature or ground humidity from all of his fields. Based upon this data, he is able to make better decisions in the planning of upcoming activities.

Moreover, data gathered by these sensor networks can also be sold to organisations such as weather agencies, the crop industry or other research communities. Accordingly, investments into sensor networks must not only rely on Frank alone but they might be part-funded by the entire surrounding business ecosystem.

Overall, Internet of Things applications have not only the potential to improve decision-making in a specific sector but they can also be keystones for a service business ecosystem from which various stakeholders benefit.

Ethics versus safety

Internet of Things applications are often a mixed blessing when it comes to benefits and risks.

In the farming scenario, the sensor networks can be used to track the location and even the activities of the workers on the field. This can help Frank to make better decisions regarding the planning and progress of his workforce.

Additionally, this monitoring can be helpful in situations where a worker has a serious accident and needs immediate assistance. In this regard, sensor networks address safety needs in working environments.

But in contrast to these anticipated benefits, sensor networks may also be used for controlling and comparing the workers on the field.

Calculated performance scores could be used as basis for dismissing workers accordingly even though these scores might not reflect the actual working behaviour and performance.

The design, deployment and use of such Internet of Things applications must therefore always address ethical principles too. And it must be the first and foremost interest of all stakeholders to discuss these issues in advance of a roll-out because otherwise, user acceptance suffers and expected benefits would not be present.



ABOUT IERC

IoT European Research Cluster

The aim of the European Research Cluster on the Internet of Things is to address the large potential for IoT-based capabilities in Europe and to coordinate the convergence of ongoing activities.

European Dimension

IoT has the potential to enhance Europe's competitiveness and is an important driver for the development of an information based economy and society.

Global Dimension

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互联网 + 物联网 = 智慧的地球
Internet + Internet of Things = Wisdom of the Earth

Project contributions

About The IoT initiative

The IoT initiative (IoT-i), an EU 7th Framework Programme project initiated in September 2010, brings together key actors from all relevant but currently fragmented IoT communities in Europe. The purpose of the project is to work jointly towards a common vision for the Internet of Things. It represents the first serious attempt in building a unified IoT community in Europe, going across boundaries of disparate technology sectors, in order to create a joint European strategic vision for the Internet of Things and aligning this vision with the current developments on the Future Internet.

iot-i.eu

About The Open Minds project

The Open Minds project is a collaboration among the Association for Automatic Identification and Mobility, the Technical University of Denmark, the Technology College Aalborg and the Alexandra Institute. The project aims at developing new technological applications based on industry needs within the food, construction and entertainment sectors. Results of the project have helped shape the ideas presented in this book.

alexandra.dk/uk/Projects/Pages/Open-Minds.aspx

About OUTSMART

OUTSMART is a usage area project of the Future Internet Private Public Partnership: Provisioning of urban/regional smart services and business models enabled by the Future Internet. The goal of OUTSMART is to contribute to the Future Internet by aiming at the development of five innovation ecosystems in Aarhus DK, Berlin DE, Santander ES, Birmingham UK and Trento IT. These ecosystems facilitate the creation of a large variety of pilot services and technologies that contribute to optimised supply and access to services and resources in urban areas. This will contribute to more sustainable utility provision and, through increased efficiency, lower strain on resources and on the environment.

fi-ppp-outsmart.eu

About SmartSantander

SmartSantander proposes a unique in the world city-scale experimental research facility in support of typical applications and services for a smart city. This unique experimental facility will be sufficiently large, open and flexible to enable horizontal and vertical federation with other experimental facilities and stimulates the development of new applications by users of various types, including experimental advanced research on IoT technologies and realistic assessment of users' acceptability tests.

smartsantander.eu

About the national project

The national project on the subject of the Internet of Things is operated by the Alexandra Institute. Competences on infrastructure, algorithms, platforms and security issues related to the Internet of Things are strengthened through this work, and these competences have been fed into this Comic Book.

en.fi.dk/councils-commissions/the-danish-council-for-technology-and-innovation

WE BRIDGE ACADEMIA AND INDUSTRY

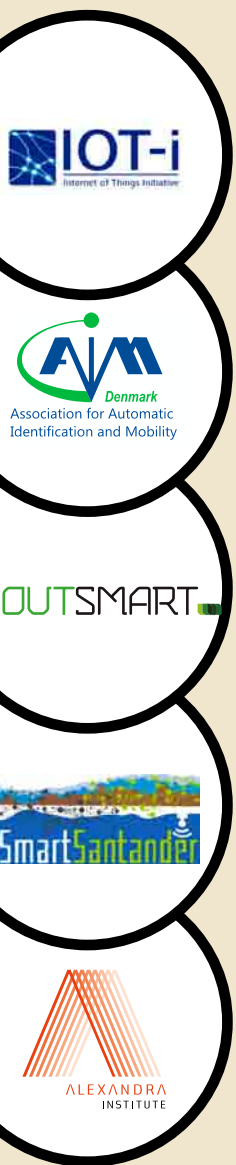
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The Alexandra Institute is a non-profit company that works with application-oriented IT research.

Our focus is pervasive computing, and we activate the business potential of our members and customers through research-based userdriven innovation.

The Alexandra Institute is a member of GTS – Advanced Technology Group – a network of independent Danish research and technology organisations.

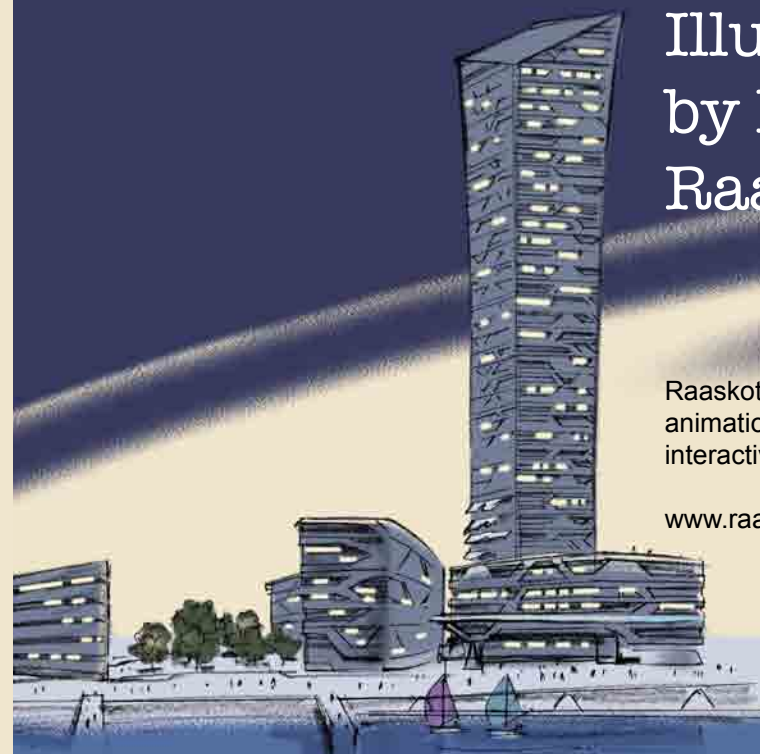
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Illustrations by Mikael Skotting, Raaskot Visual

Raaskot creates creative visual concepts, animations and illustrations for printed and interactive media.

www.raaskot.dk



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Part of the work leading to this book has been funded by the 7th framework programme of the European Commission.

The contributions came from the Internet of Things Initiative (IoT-I) coordination action, contract number: 257565. Thanks and acknowledgements go to the European Commission, the IoT-I project and participants.

The comic book also used and re-mixed scenarios from the following 6th and 7th framework projects:

- FP7 ICT SmartSantander
- FP7 ICT SENSEI
- FP7 ICT EXALTED
- FP7 ICT FLORENCE
- FP7 ICT PROSENSE
- FP7 ICT LOLA
- FP6 IST e-SENSE
- FP6 IST MIMOSA

