

INSPIRING THE

INTERNET OF THINGS!



FOREWORD
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20 ILLUSTRATIONS
by Mikael Skotting

OVER 30 IOT CONCEPTS

**10 IOT EXPERT
INTERVIEWS**
by Stig Andersen

**5 BUSINESS
IDEAS**

BUSINESS EDITION!

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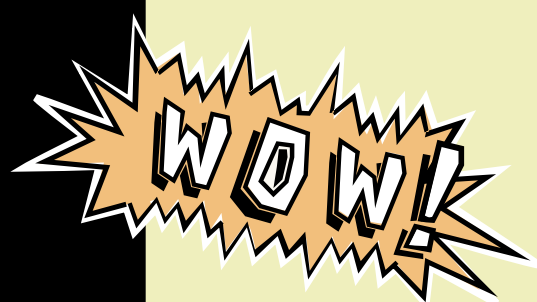
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We call it "the Comic Book"

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

We had 2000 copies of the special
edition printed. We launched it at the
Future Internet Assembly in Aalborg in
May 2012. In June 2012 we started
rationing the copies that we had.

Even though we have an online ver-
sion, people keep asking for the hard
copy. Well, we could just print more
copies, but we think that would be
cheating.

All of the people that have contributed
to the comic book have new ideas
and ways to present their material, so
why not add something new to each
edition?

The original has all of its content
included in the special edition. We
added several scenarios and inter-
views; well, and glossy pages. The
difference between the special edition
and the business edition is a new
way of highlighting the business case
of the IoT.

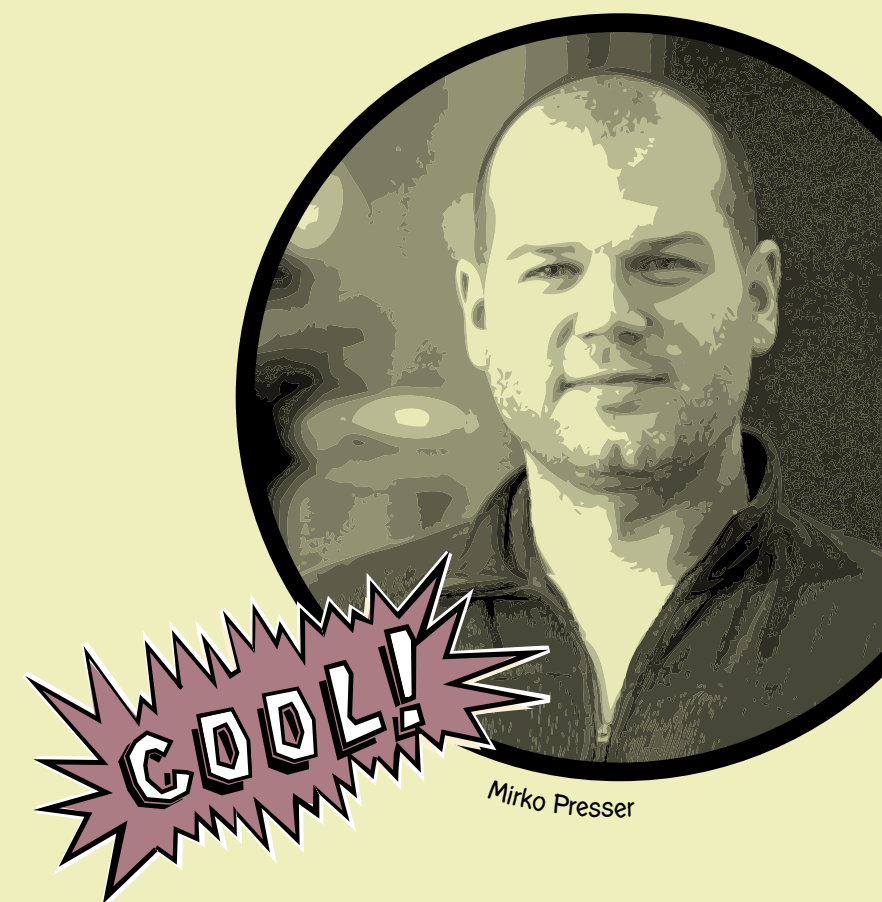
5 of the scenarios were analyzed for
their application value proposition and
their IoT added value proposition; i.e.
what value does the application for
e.g. smart street lighting offer, and
what value does the application offer if
brought into the bigger context of IoT?

Although this is far from a blueprint
for starting your new billion Euro
start-up, we hope that it inspires you
to think "platform" and not just "ap-
plication".

In addition, the comic book is now a
publication of the Internet of Things
International Forum (iot-forum.eu).

Enjoy the read and please tweet us
your feedback (@mirkopresser).

Mirko Presser
The Alexandra Institute
Summer 2013



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.

In 2011, the world population reached 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 cooperation, 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.

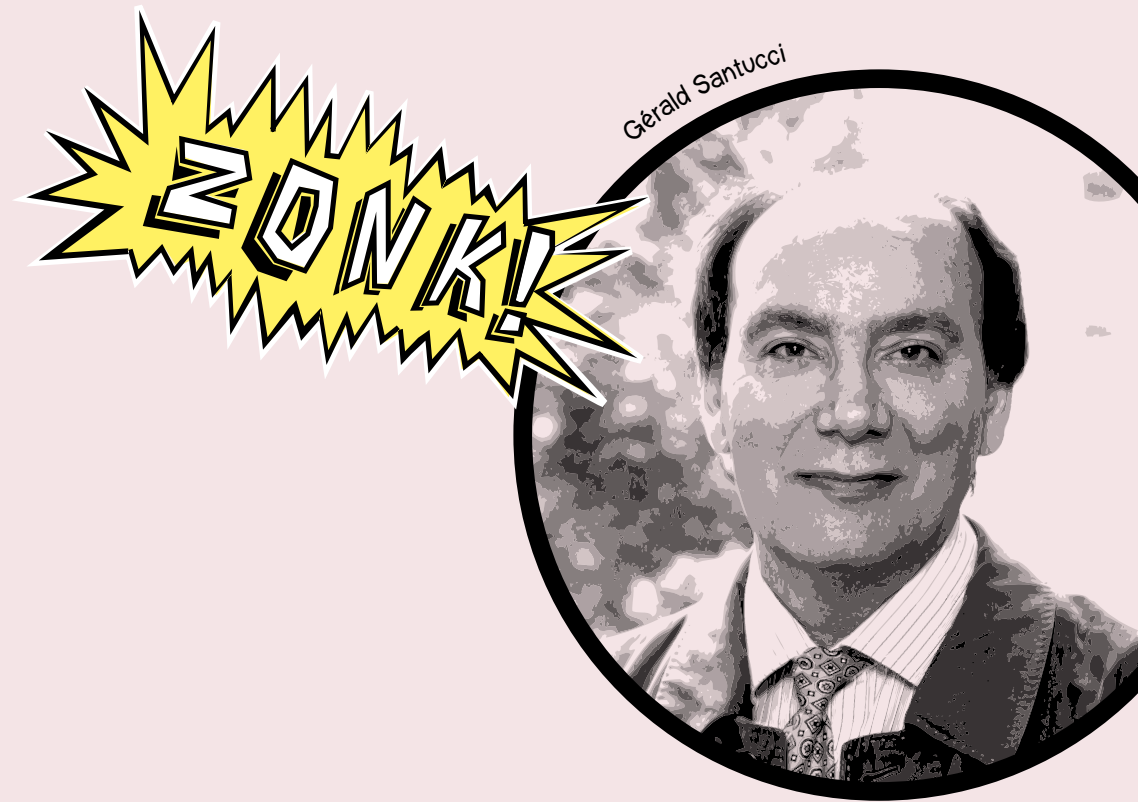
Whether we will be able to escape the enslavement of reification – the essential tendency of capitalism to place the human condition under the reign of commodities – and to propose a re-enchantment of the world grounded in the real, intimate and powerful connection between humans, objects, and nature.

“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!”

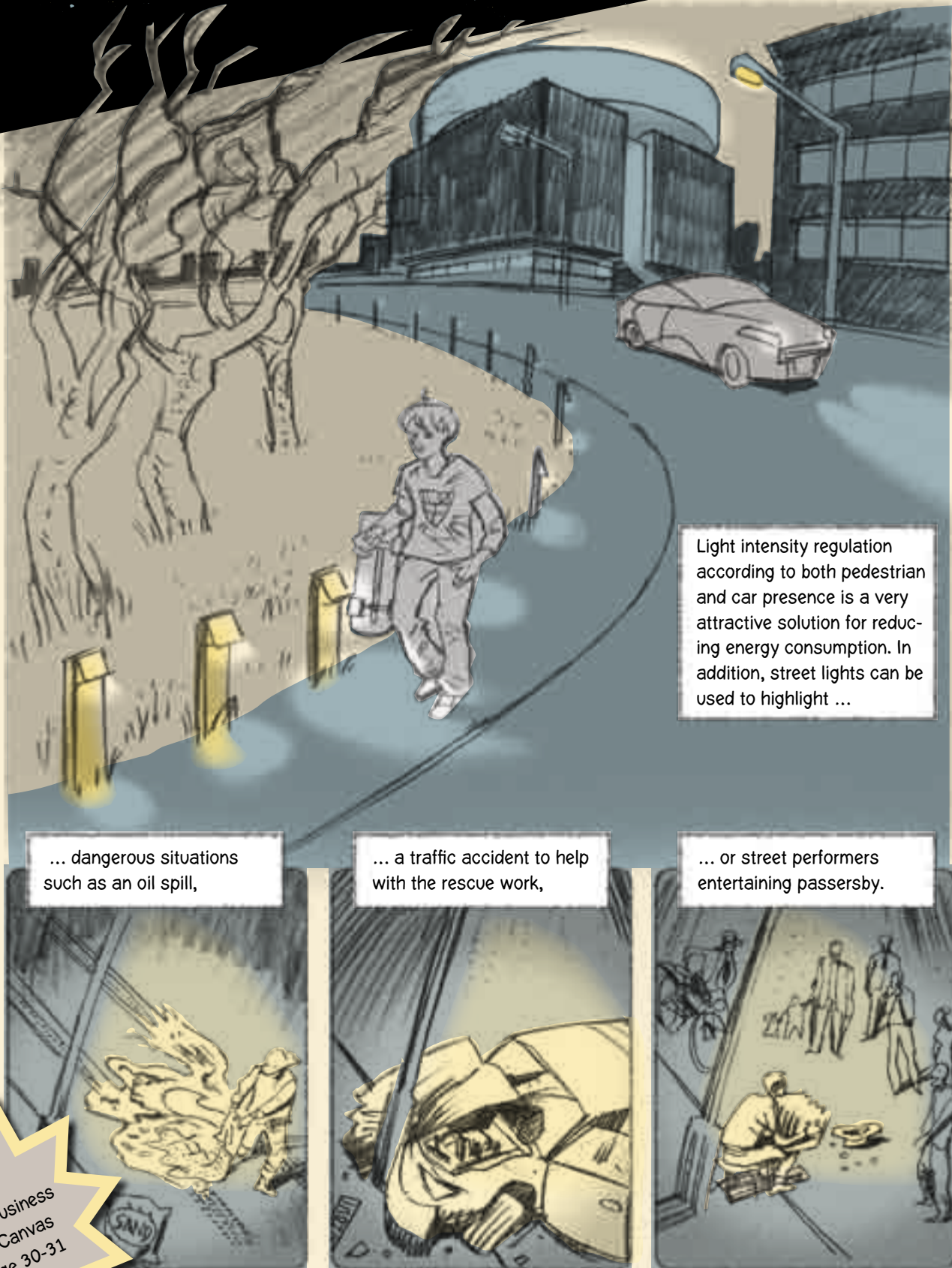
Gérald Santucci

Head of Unit,
‘Networked Enterprise and RFID’

European Commission
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Society and Media

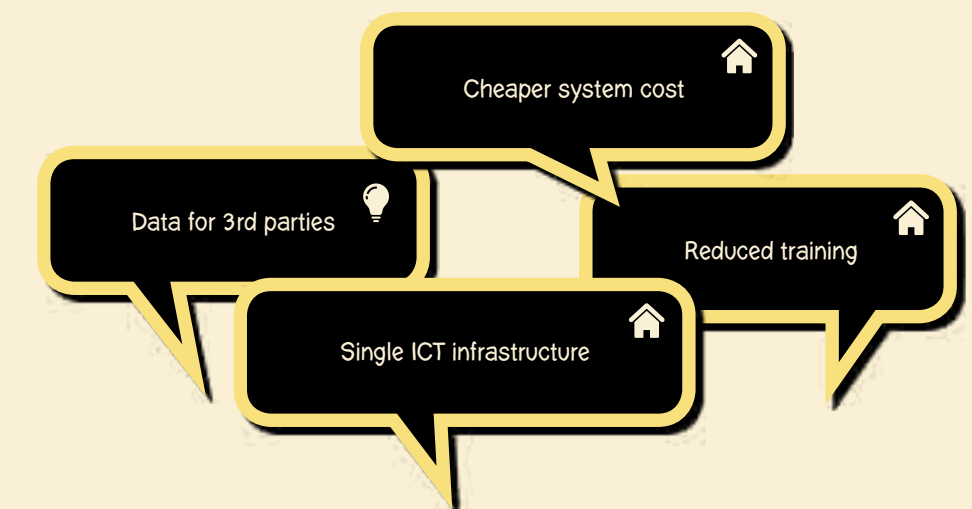
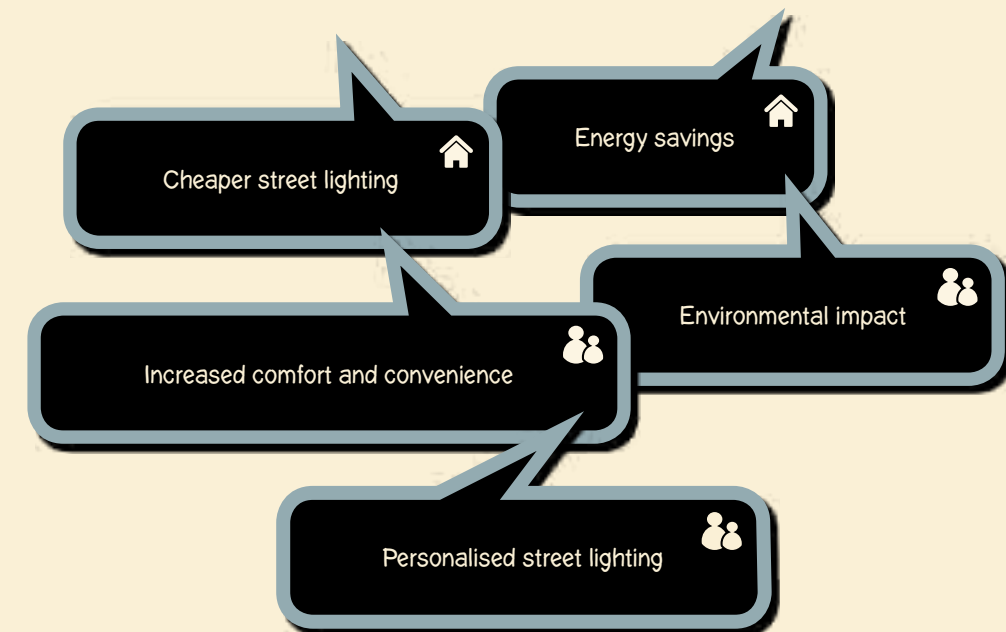


STREET LIGHTING



See the Business Model Canvas on page 30-31

APPLICATION VOICES (vertical value proposition)



IoT VOICES (horizontal added value proposition)



IoT means radical transparency and tremendous agency to end users

Rob van Kranenburg interviewed by Stig Andersen

"The Internet of Things to me is like the wind. You see everything moving. You know that something is moving it, but you don't know exactly what. In some places, trees are shaking and buildings are destroyed, in other places, it is all calm and quiet. To some extent, it is predictable, but often not at all."

To Rob van Kranenburg, teacher, writer, author of "The Internet of Things. A critique of ambient technology and the all-seeing network of RFID" and co-author of "The Internet of People for a Post-Oil World" – to mention just a fragment of what he is and what he does – the Internet of Things evades any attempt of evaluation along a conventional scale of good or bad.

"You might as well ask: Why are we on this planet, or are humans good? It is just human logic to use the tools and data that are at our disposal to out-source our memories into the environment to keep our minds free to focus on other things," he says.

The technology is already available. Our personal settings are in the cloud. RFID tags, 2D and 3D barcodes, sensors, IPv6 and a whole gamut of other technologies are there to ensure that objects and people can be connected in a larger grid. The question is which use we make of it and how it will impact human beings in civil society.

"You have to admit that the current state of the world is pretty messed up, and our track record on this planet is not very good. But I am actually

very positive, and we simply have to assume that we can find better ways to relate to each other than banging each other's heads in!" says Rob van Kranenburg. He sees two possible scenarios – a positive and a negative one.

"In the positive scenario, the existing institutions in society are maintained, but they will open up their databases and their infrastructures will be made publicly available in order for everybody to make good use of them."

The message from civil society to the powers that be as formulated by Rob van Kranenburg is clear:

"Let us help you transform into flatter structures and networks. You may still work - not in your towers, but at street level, and we will use real-time data to make better decisions. You did your best, at least you tried, but now the time has come to build a public backbone supporting inclusive structures - all the rest is local decision-making." In the positive scenario, the Internet of Things will bring radical transparency into decision-making and tremendous agency to end users placing them at the same level as corporations and states. A protocol of sharing and col-

laboration will reach a critical mass vis-à-vis the forces of competition, and business models that neglect this will crack.

However, the old institutions will find it very hard to adapt to this new order of things. The history of these institutions shows a deep-rooted tradition for blocking the access to knowledge to maintain power. So embracing a development that entails a de facto dismantling of their own power structures is not a tempting scenario. Rob van Kranenburg uses the image of a house.

"Before the internet, these institutions had one door to guard, which they did with diplomas and strict security measures. With the internet, people come in through the door, the windows and all other openings in the house. Eventually, the house will be transparent to the point where it will disappear along with the very notion that data can belong to a certain institution."

In the positive scenario, a completely flat world will emerge, where the key question is how to organise solidarity and public infrastructures.

"I think it can be done by getting control at device level. It is a very critical moment right now, and maybe we can actually do it for the first time. But the technical expert community has to become political and has to stop being focused on the backend processes," says Rob van Kranenburg, and he continues:

"Imagine that we get a public infrastructure on all layers open for everybody to build services upon. This is a change that needs to come about – if not, there will be no Internet of Things. Instead, there will be private networks, gated communities, and the seamless infrastructures will only be available for smart and privileged, but isolated groups."

According to Rob van Kranenburg, the tendency towards societal disintegration is already there.

"More and more people are asking what the existing institutions are actually doing for them and if they should keep on supporting them through the paying of taxes. If technology allows you to take care of your own security, energy, etc. through sharing and collaboration in social net-

works, why continue to support these institutions. So large groups of people will break away from this system - not with a revolution, but with a simple whisper. The system is about to crack, and people will no longer think in terms of the nation, solidarity, etc."

Claiming that it was the least useful thing he could find, Rob van Kranenburg originally studied literature. Already then, he felt that he was living in a strange and badly managed place, and literature became a way in to some kind of understanding of the underlying mechanisms.

In the 80s, he encountered hypertext and was fascinated by the experience of being able to click yourself out of a given situation and onto a new level.

"Hypertext was a liberation of the narrative and to me, it was an empowering moment. I began to get very interested at a content level. I was basically interested in how the words worked."

Since then, Rob van Kranenburg has been deeply involved in debating and forming visions on new technologies in a variety of functions, including as co-founder as co-founder of Bricolabs

(www.bricolabs.net), a network for global and local development of generic infrastructures incrementally developed by communities, and as founder of the Council, a think tank for the Internet of Things (www.theinternetofthings.eu). Rob van Kranenburg is also Chair of the Working Group Societal of the IoT Forum.

Insisting that he is optimistic at heart, Rob van Kranenburg says that over the years, his message has always been the same:

"The Internet of Things will create a better balance between end user, government and industry. It will expose inefficiencies and will give people more agency on mission-critical services. There is so much negativity around at the moment, and it is admittedly difficult to be very positive. However, it is urgent that we go to the institutional actors and explain that they are on a breaking course, and they are losing the opportunity to take the best out of the current institutions and put it to good use for the public."

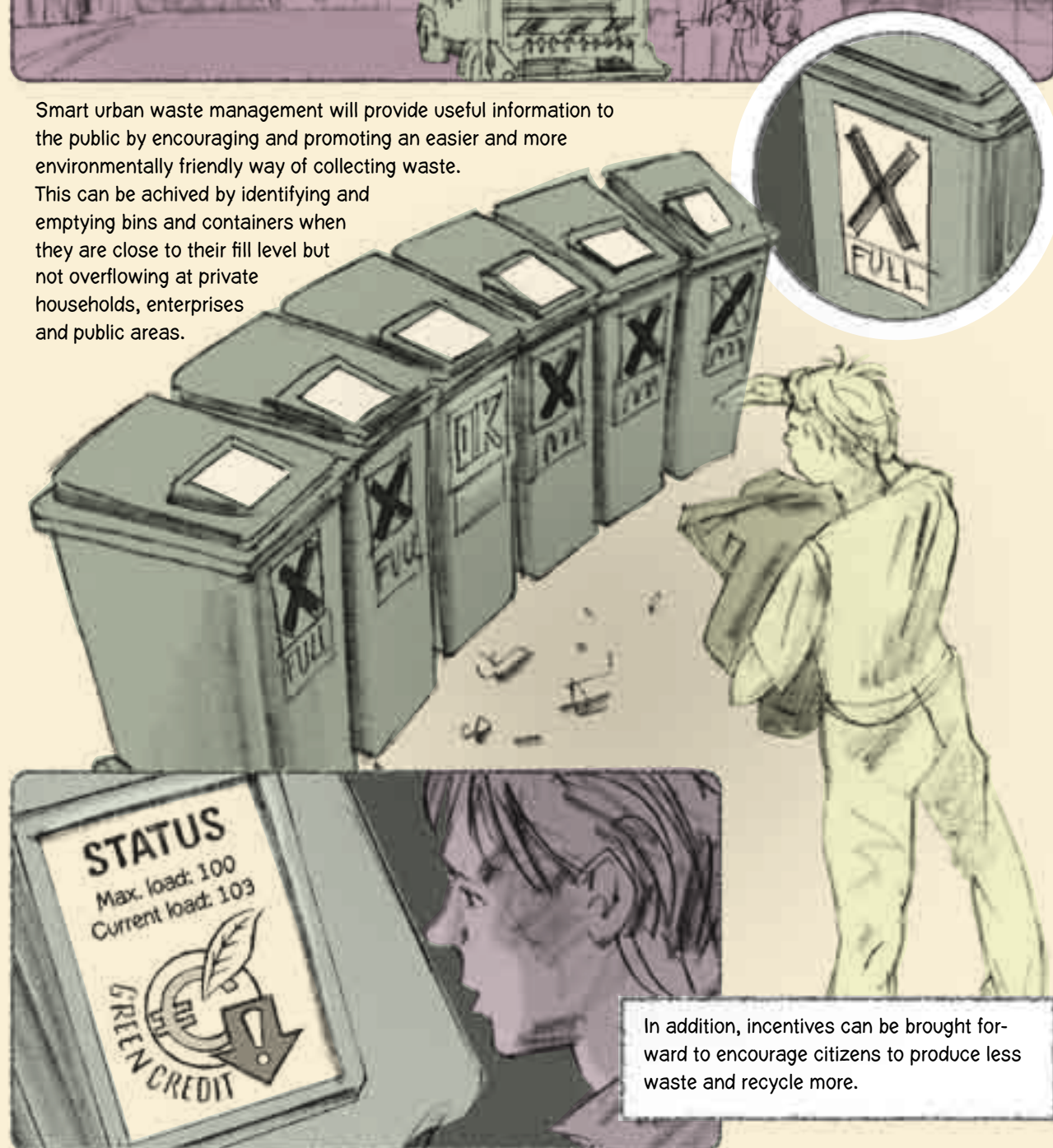


WASTE Management

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

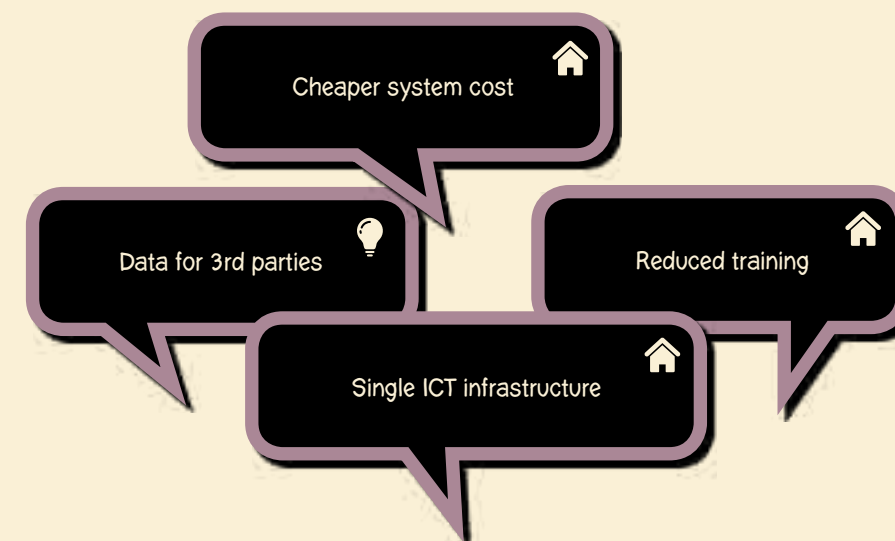
Smart urban waste management will provide useful information to the public by encouraging and promoting an easier and more environmentally friendly way of collecting waste.

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.

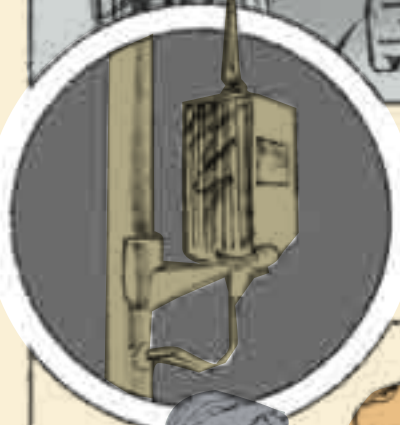
APPLICATION VOICES (vertical value proposition)



IoT VOICES (horizontal added value proposition)

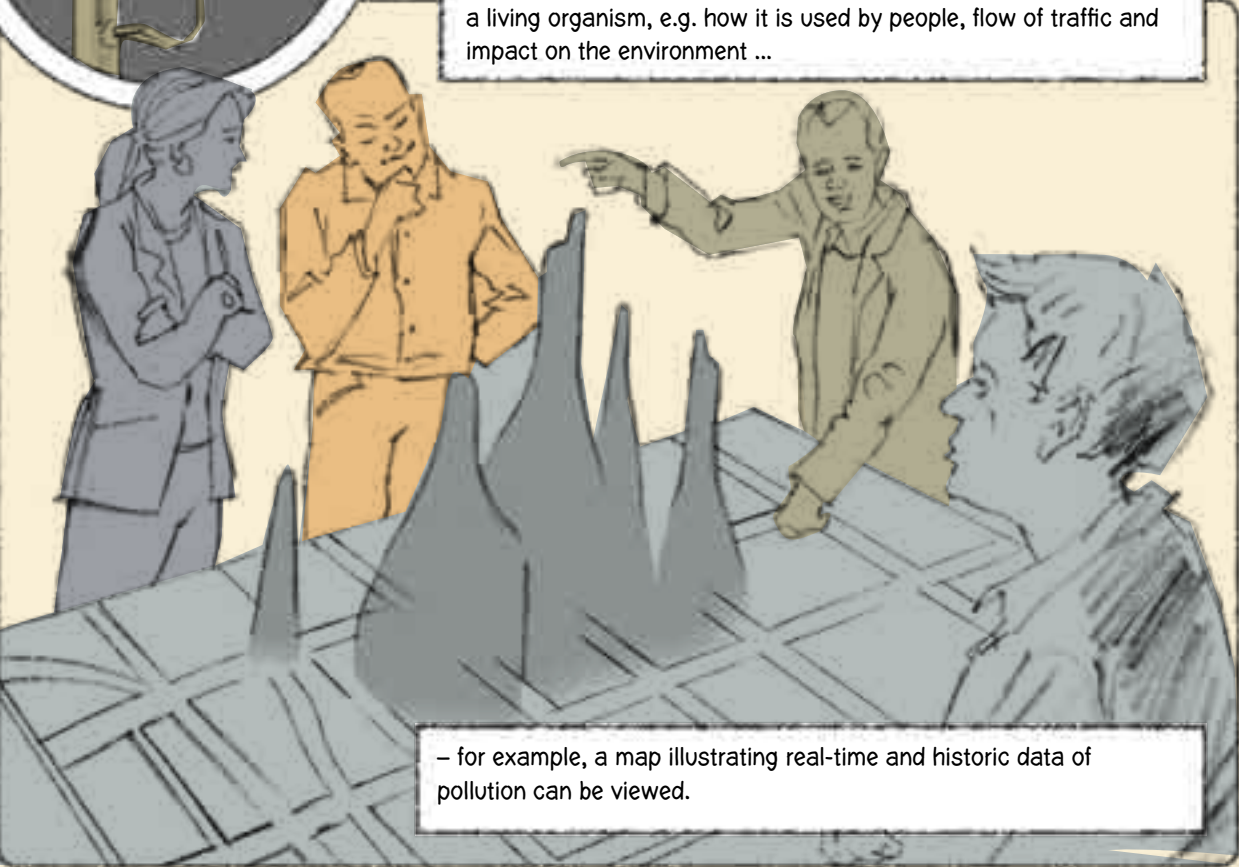


Planning



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.

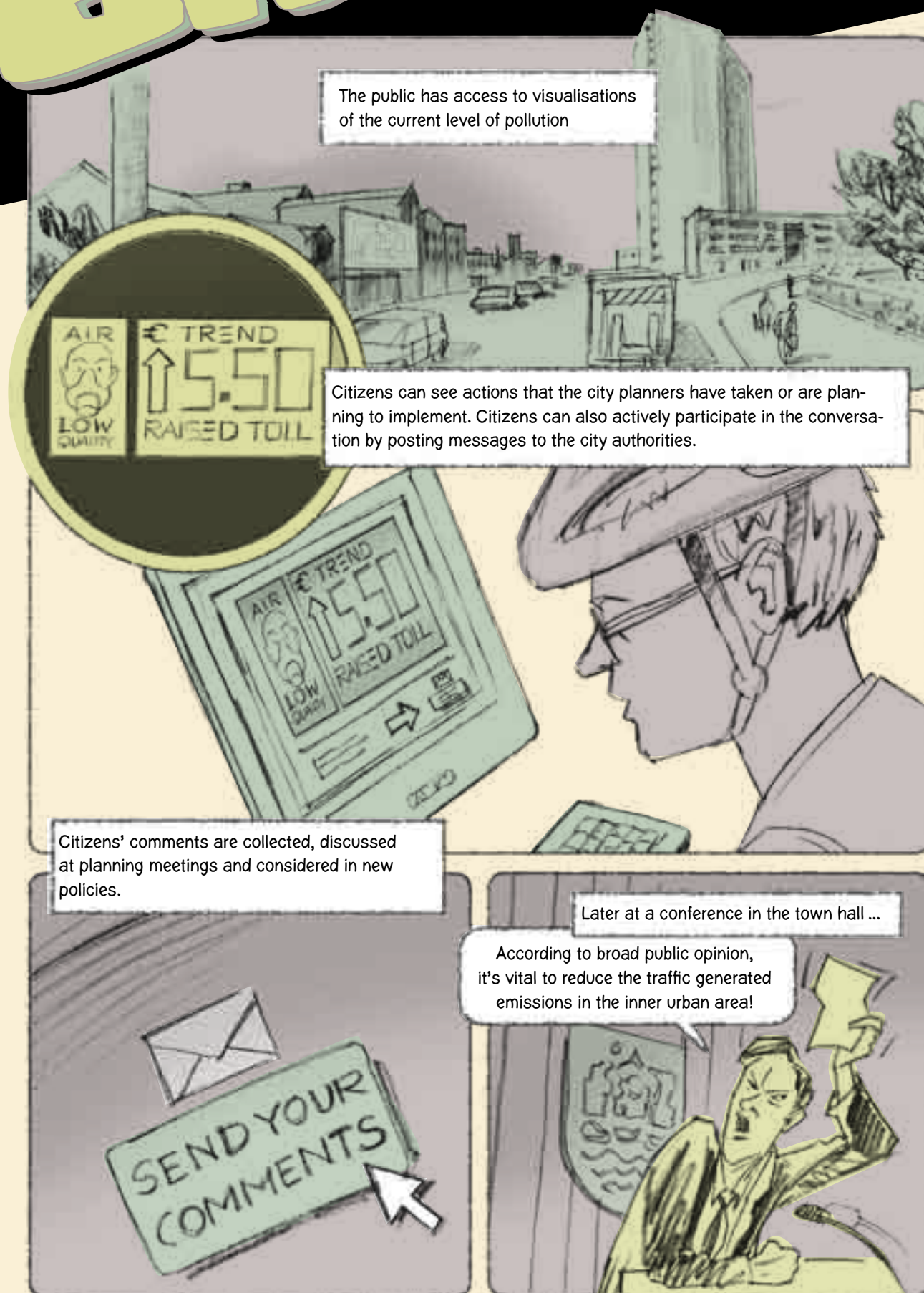
- Crowd-sourced data from citizens – for example pictures of things they want to have fixed, like a pothole in the road.
- Environment data from sensors placed all over the city – sensors might be owned by private or public organisations and need to be combined to form a complete picture.

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-silicon 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.

"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 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

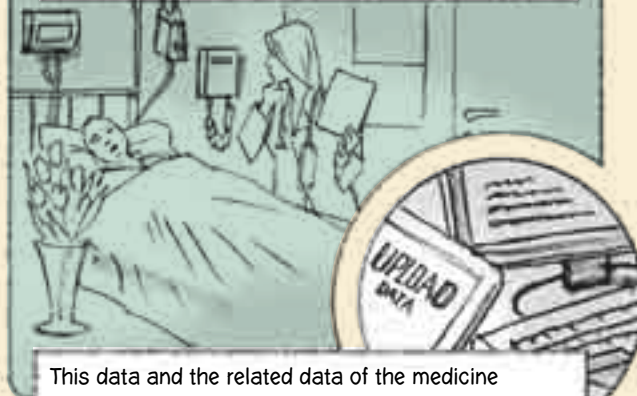


MEDICATION

Angela is a doctor at the general hospital. On her visits she often prescribes medication to patients. The medication is then administered by nurses.



On one of her visits Angela decides that Robert, a patient, needs to be medicated twice a day, once in the evening and once in the morning.



This data and the related data of the medicine (like dosage) are registered to the EHR* of Robert.

For the evening medication the medicine within the tagged ampoule arrives from the hospital's pharmacy.

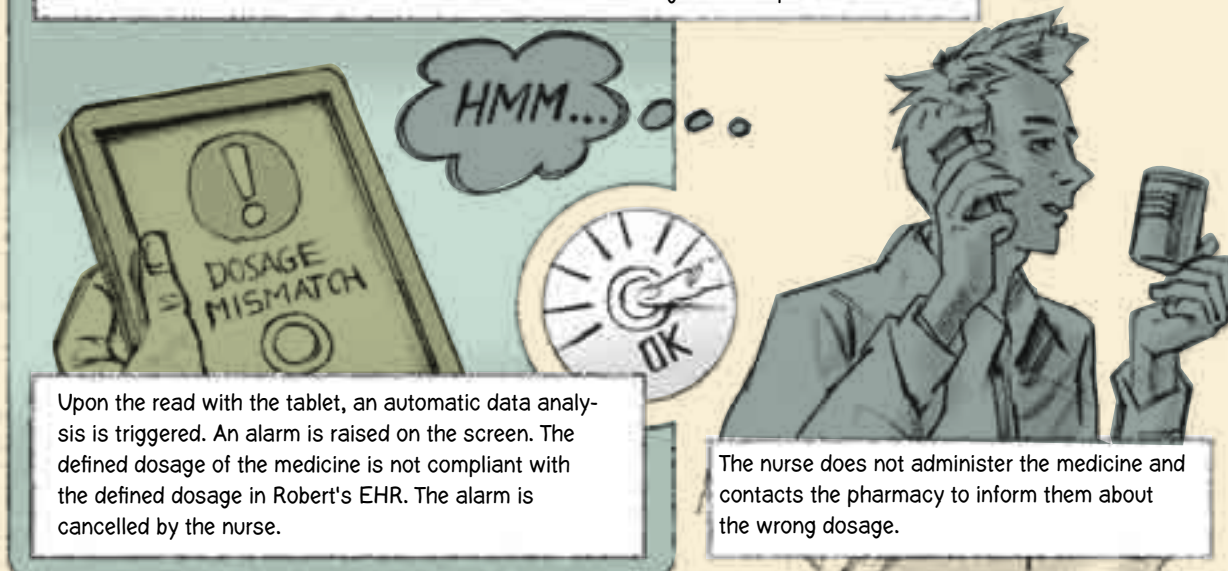


The nurse uses his tablet with a special software package to read both the NFC** bracelet of the patient ...



– and the RFID*** tag of the ampoule.

When the nurse reads Robert's bracelet with the tablet application, he has access to his EHR information. For the medication he must read the RFID tag of the ampoule.

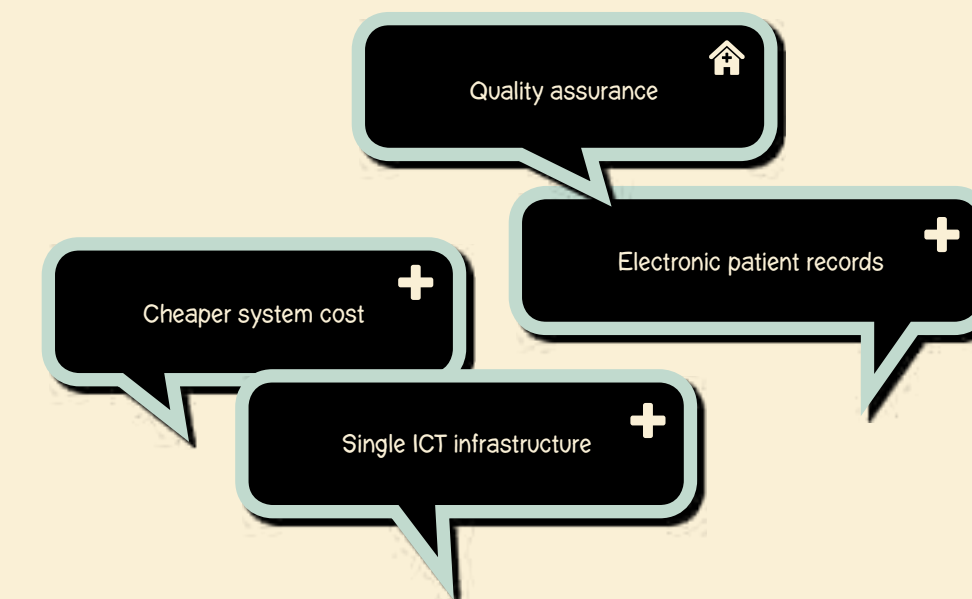
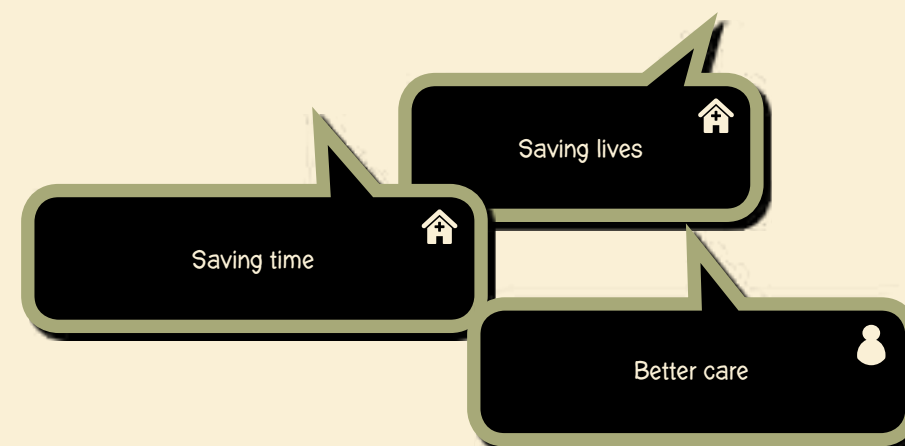


Upon the read with the tablet, an automatic data analysis is triggered. An alarm is raised on the screen. The defined dosage of the medicine is not compliant with the defined dosage in Robert's EHR. The alarm is cancelled by the nurse.

The nurse does not administer the medicine and contacts the pharmacy to inform them about the wrong dosage.

* EHR: Electronic Health Record. ** NFC: Near Field Communication. *** RFID: Radio Frequency Identification.

APPLICATION VOICES (vertical value proposition)



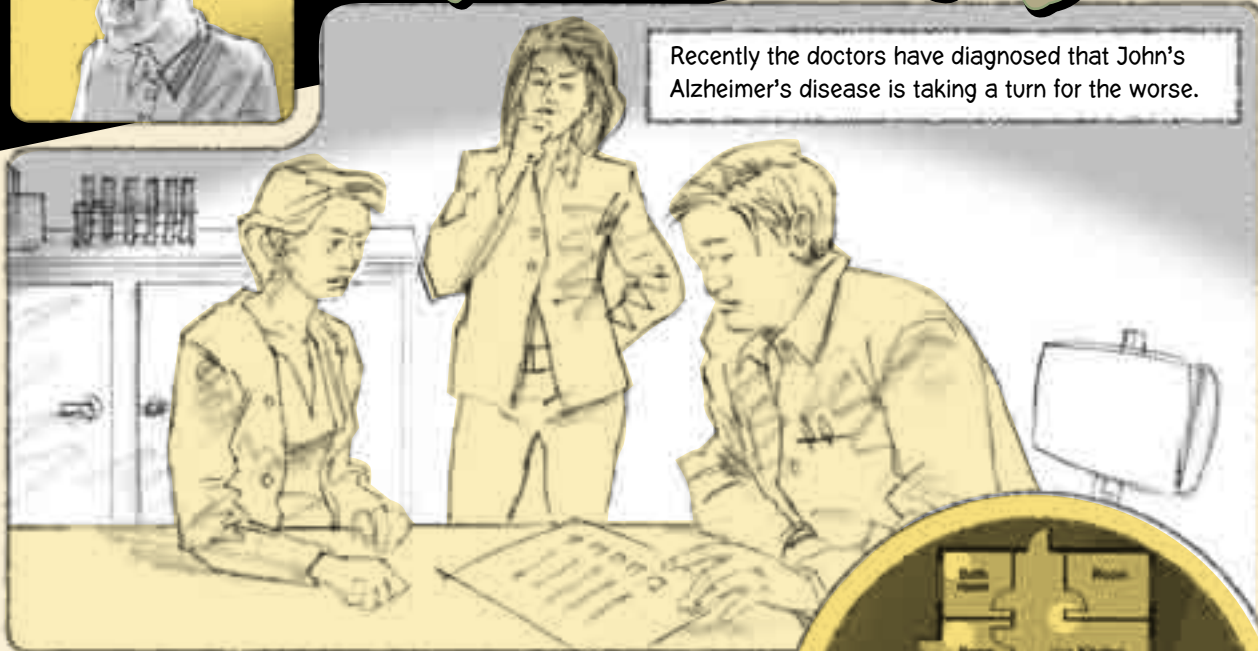
IoT VOICES (horizontal added value proposition)



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.

Privacy

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. 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 everyday 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.



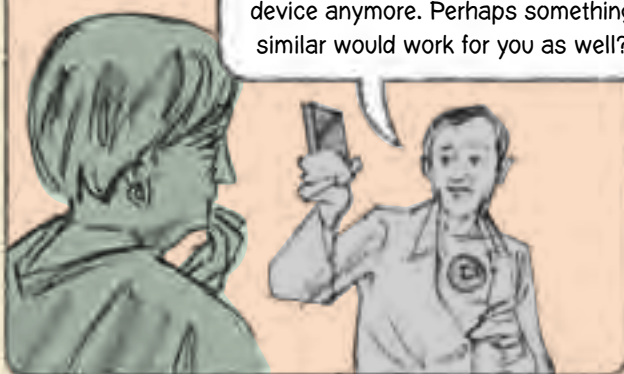
Well, I am not getting any younger and healthier, but I want to keep my independence as long as possible...

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



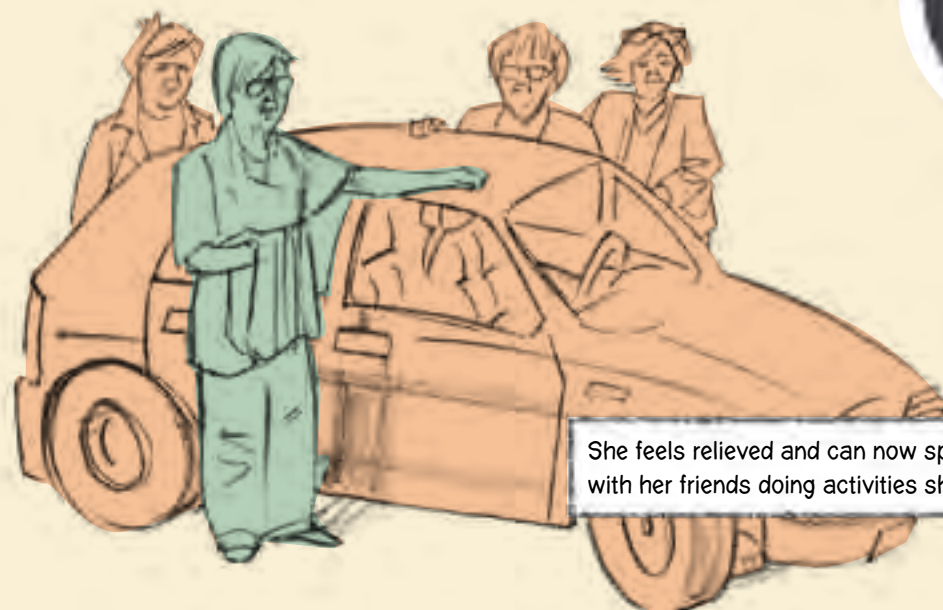
The next day during a visit at her son's who is suffering from a heart condition, she discovers a possible solution ...

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 check-ups, 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'.



IoT means smart living in a real world

Peter Friess interviewed by Stig Andersen

To Peter Friess, Scientific and Policy Officer at the European Commission and Coordinator at IERC – Internet of Things European Research Cluster, IoT can be defined by a combined technology and societal perspective. IoT is the phenomenon of an ever-increasing number of interconnected objects that is gradually changing – and improving – people’s lives.

Sophisticated health systems, intelligent homes, always-on connectivity enabling new ways of communication and forms of decentralised intelligence – these are just some of the facets of the broad spectrum of IoT applications that are already impacting our daily lives. Peter Friess stresses that in his book: IoT does not mean that we are heading towards life in a virtual world.

“I like the idea of smart spaces providing rich and easy living and working environments. You have a lot of information at your disposal and you can easily communicate. I do like this kind of smartness, but I still want to interact with real people in the real world, not live in some kind of virtual world.”

At a global level, we are facing some major challenges where, according to Peter Friess, IoT has a role to play.

“There are serious societal challenges that we need to solve. The population on our planet is growing rapidly, more and more people are moving into the cities, and people are concerned about their personal safety and about losing their jobs. IoT has the potential

to contribute to ensuring personal safety, job opportunities, improved city management and better management of our resources.”

IoT services will become as important as the traditional utility services like water and electricity, and a whole range of IoT applications will be developed. The aim is not to kill time, but to make the best of it.

“People do not need an application because they have to wait five minutes at the bus stop and get bored. They need an application because they have to work at two or three workplaces to have a decent income and need to get to these places as efficiently as possible. Most people are basically concerned with living a convenient and safe life.”

In order to support the kind of smart living and working environments supported by IoT, there are technological requirements that need to be met, e.g. secure and reliable infrastructures, application frameworks, common standards and interoperability. But perhaps more importantly, according to Peter Friess, we need smart people.

“We need smart people who know how to behave in this kind of environment. The amount of data available is so huge that people need to be able to distinguish which data to trust. So in addition to the technology platforms, there is a need for application training and basic concepts of security and privacy in order for people to be able to interpret and control data.”

The possibilities to create smart living environments via IoT technology may depend very much on socio-economic and political conditions, and less on regional and national differences.

“IoT technology will transform the way we live, but it will of course be at different speeds in different parts of the world. But the advance of IoT is more subject to differences in living conditions, income, social security and political stability and priorities than to geography.”

To Peter Friess, it is very important that IoT does not evolve into national projects, but does in fact cross boundaries.

“Even in Europe, IoT develops at different speeds, and we need to ensure that it does not become a national project. The roaming issue within mobile telecommunications or standardisation are examples of what we need to confront also in this domain. Seen from the perspective of the European Commission, we need to further the take-up of IoT all over Europe.”

Peter Friess also sees a requirement for what he calls a “liability framework”. If IoT technology becomes an integrated and crucial part of the infrastructure of our societies, somebody needs to assume responsibility if something does not work. This also relates to the question of business models and possible operators of the IoT infrastructures.

“I anticipate a model similar to what we know from traditional utility services. The operators are primarily private companies, but governments maintain a grip on things in order to ensure that, for example, also remote regions are covered.”

There are, however, other possible business models. Peter Friess points



to pachube.com as an example of the kind of platform that may be used to share sensor data.

“The idea is basically to provide a reliable platform and let people use it to develop IoT applications. The business model for this kind of platform could be that it is free in its basic form, but there is a charge for additional services or storage capacity.”

Peter Friess believes that we will see parallel actors and systems within the IoT scope; not least when access to data may be restricted.

“For different reasons, governments and corporate businesses will want to maintain control over their data. So parallel systems will emerge as part of a democratisation process as illustrated by an example from the Netherlands. Authorities did not want to share traffic flow data, so private individuals set up sensors and shared data for free that, in some cases, was more accurate!”

Peter Friess has a short and a long-term perspective on the further development of IoT technology.

“I think that short and mid-term we will see a focus on cheap devices and sensors with low energy consumption and energy-harvesting mechanisms. We could certainly also do better when it comes to creating richer interface devices. Today, much data is still processed using keyboard and mouse. We also need to develop and deploy security and privacy by design mechanisms.”

“In the long term, there may be a spillover from other research areas like biotech or nanotech that will provide new ways of processing and presenting data. New devices and sensors may be developed, and human beings will be connected in other ways than via the classical mouse and keyboard. Virtual world and simulation approaches might also impact the development of IoT technology.”

This interview expresses the personal views of the interviewee and in no way constitutes a formal/official position of the European Commission.

EMERGENCY

Response

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



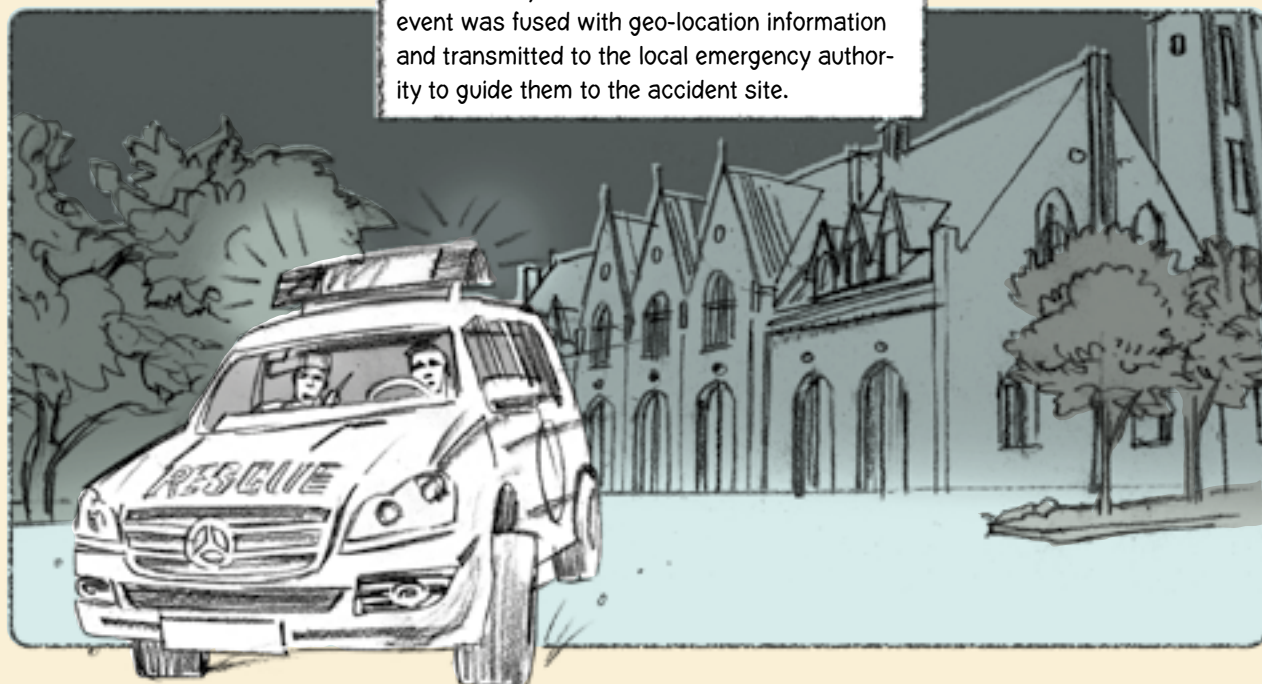
Two cars crashed at the intersection downtown.

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



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.

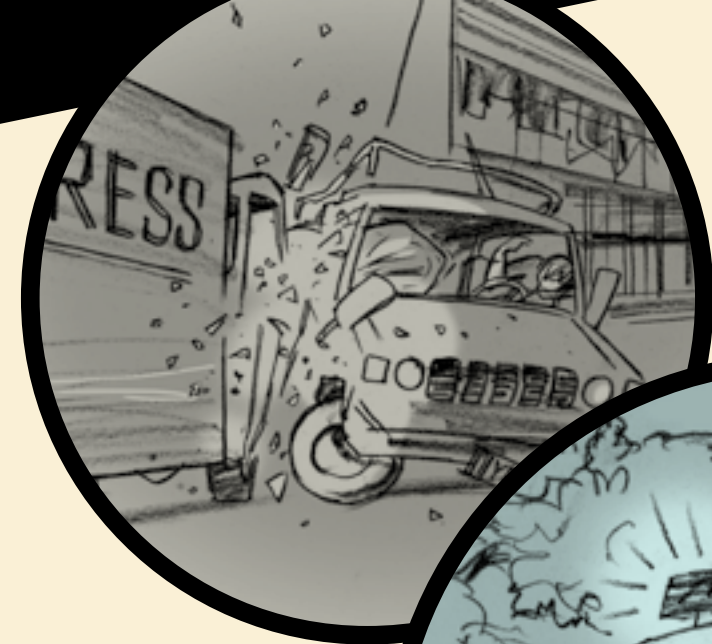
In the "Emergency Response" application scenario the event of a car crash has to be determined accurately and from multiple possibly conflicting sources.

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



APPLICATION VOICES (vertical value proposition)



Data for 3rd parties

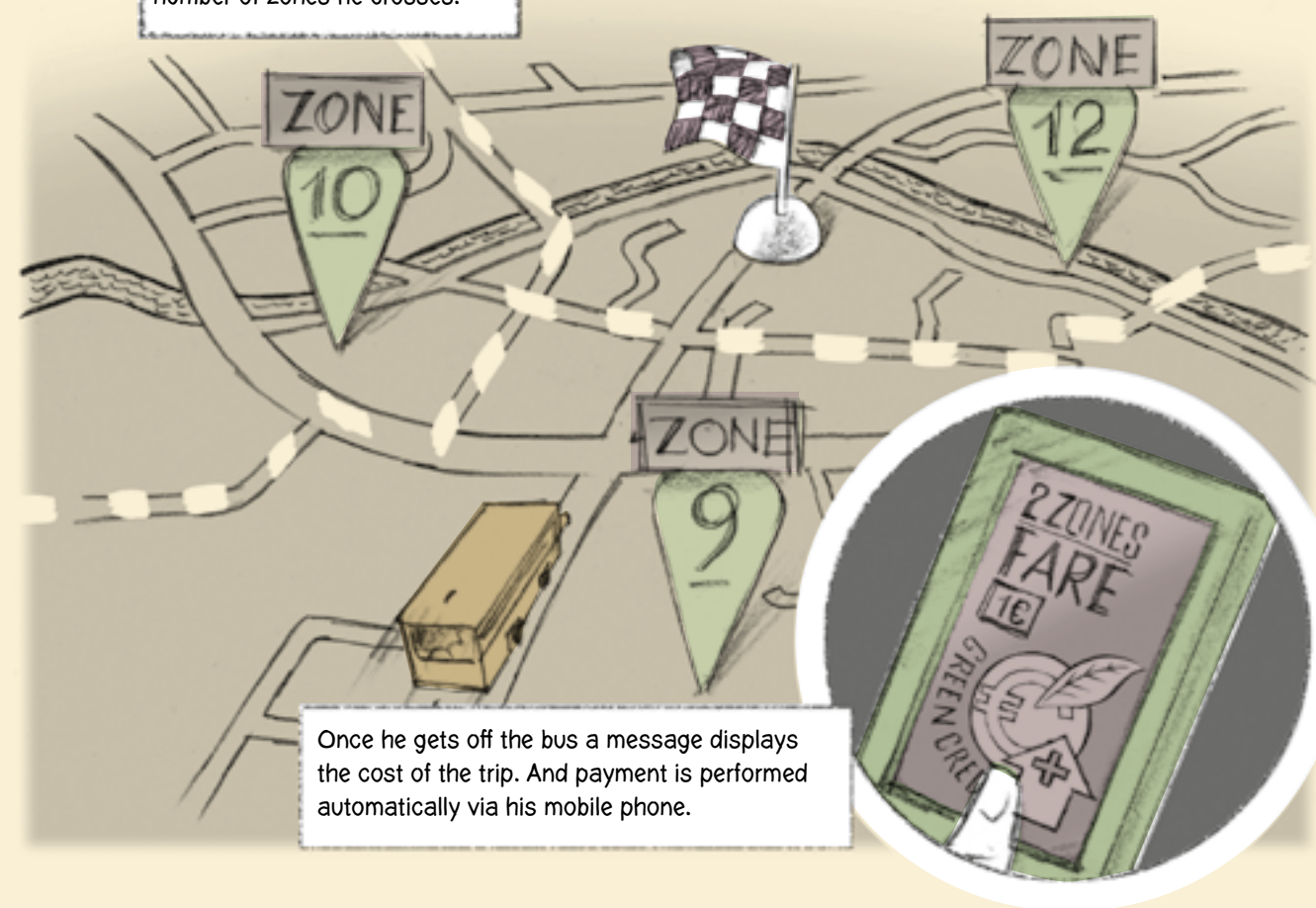
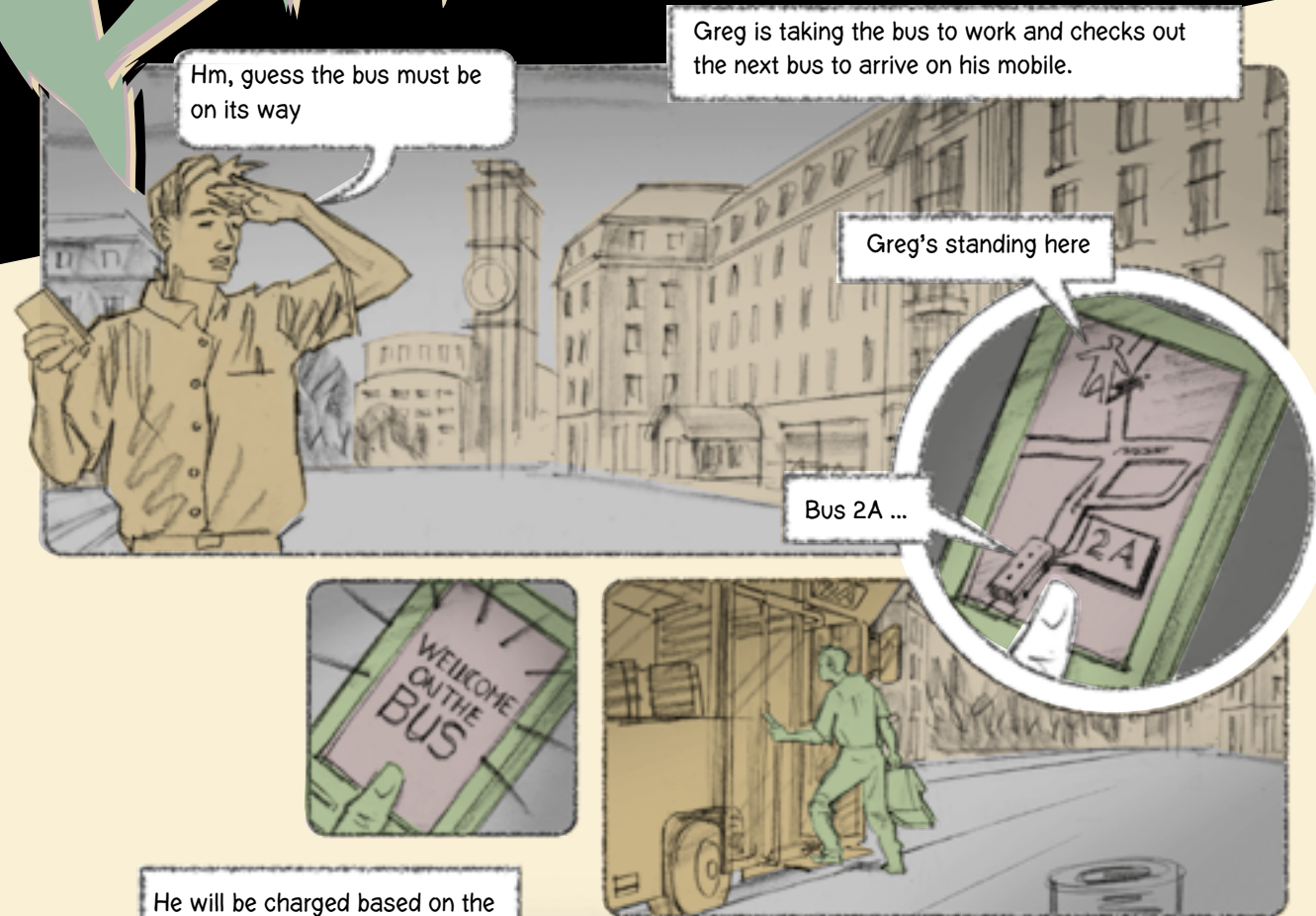
Cheaper system/app cost

Richer experience through more data

IoT VOICES (horizontal added value proposition)



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.

Location-based services

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

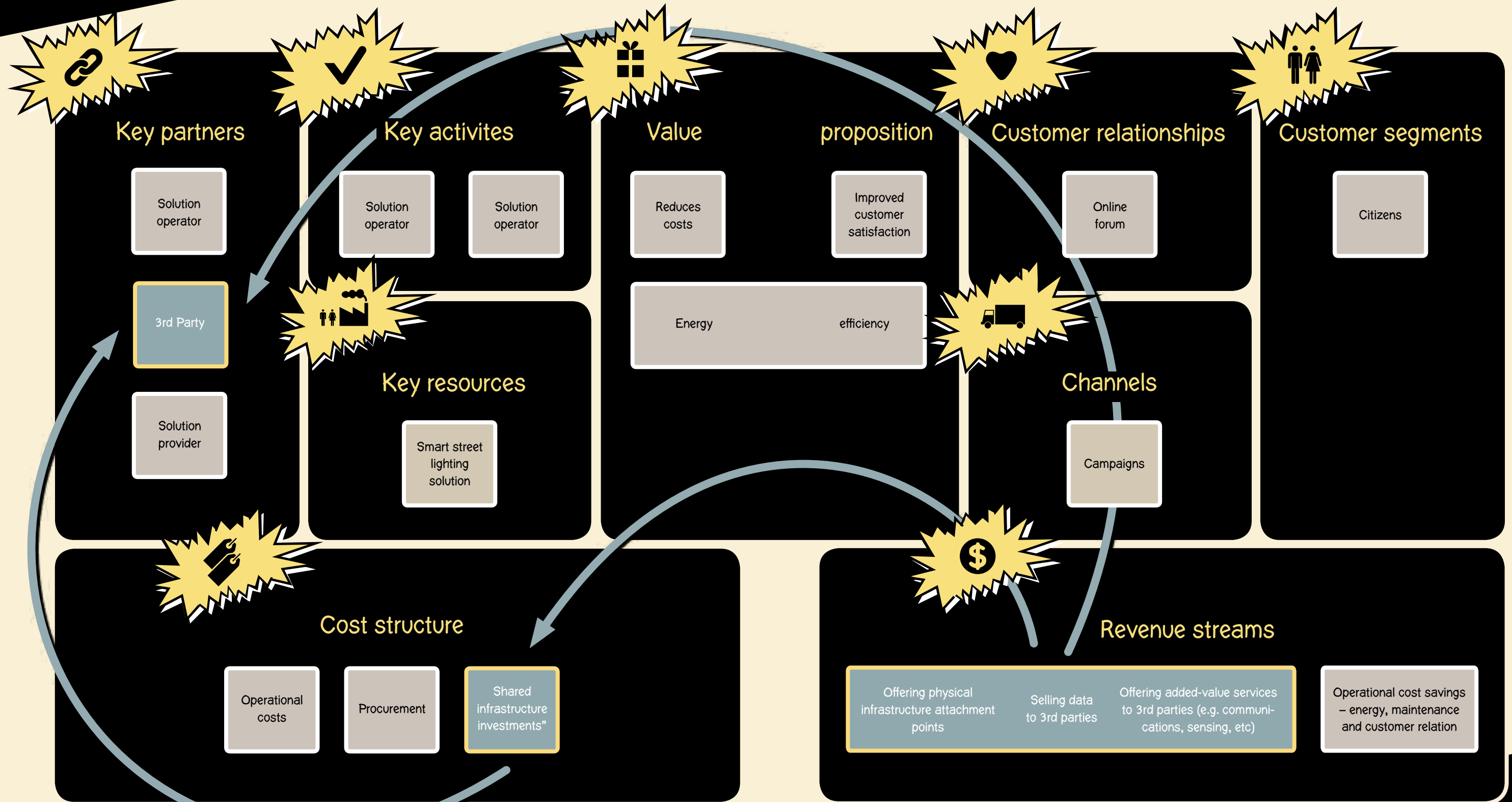
RFID tags provide an identification of an object in their most primitive form. But if this is combined with location information, it is a powerful means of tracking objects, people and animals.

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?



STREET LIGHTING

The Business Model Canvas



"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 develop-

ment 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 communication. 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 informa-

tion 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.

Harish Viswanathan



LOGISTICS

Ted, the truck driver, arrives at the gardener's production site to pick up some goods he has to transport.

To get more information, he checks in by holding his IoT phone above the check-in terminal of the manufacturer. The NFC reader inside the terminal reads the tag located in his IoT phone and sends a notification to the manufacturer.

This retrieves the transport order which has been assigned to Ted from the transport order database and sends all information including the gate number to Ted's IoT phone.

After he got the information, Ted drives to the appropriate gate and starts loading the intelligent load carriers containing orchids into his truck.

All load carriers are equipped with a sensor node which measures temperature and humidity. Every time Ted puts a carrier into the truck, he uses his IoT phone to scan the load carrier's barcode to mark it as loaded and to sign up for sensor events of the attached sensor node.

After he finished loading, Ted confirms it to the manufacturer, receives his shipping order, and starts driving.

Human Error

"All men are liable to error; and most men are, in many points, by passion or interest, under temptation to it."
John Locke

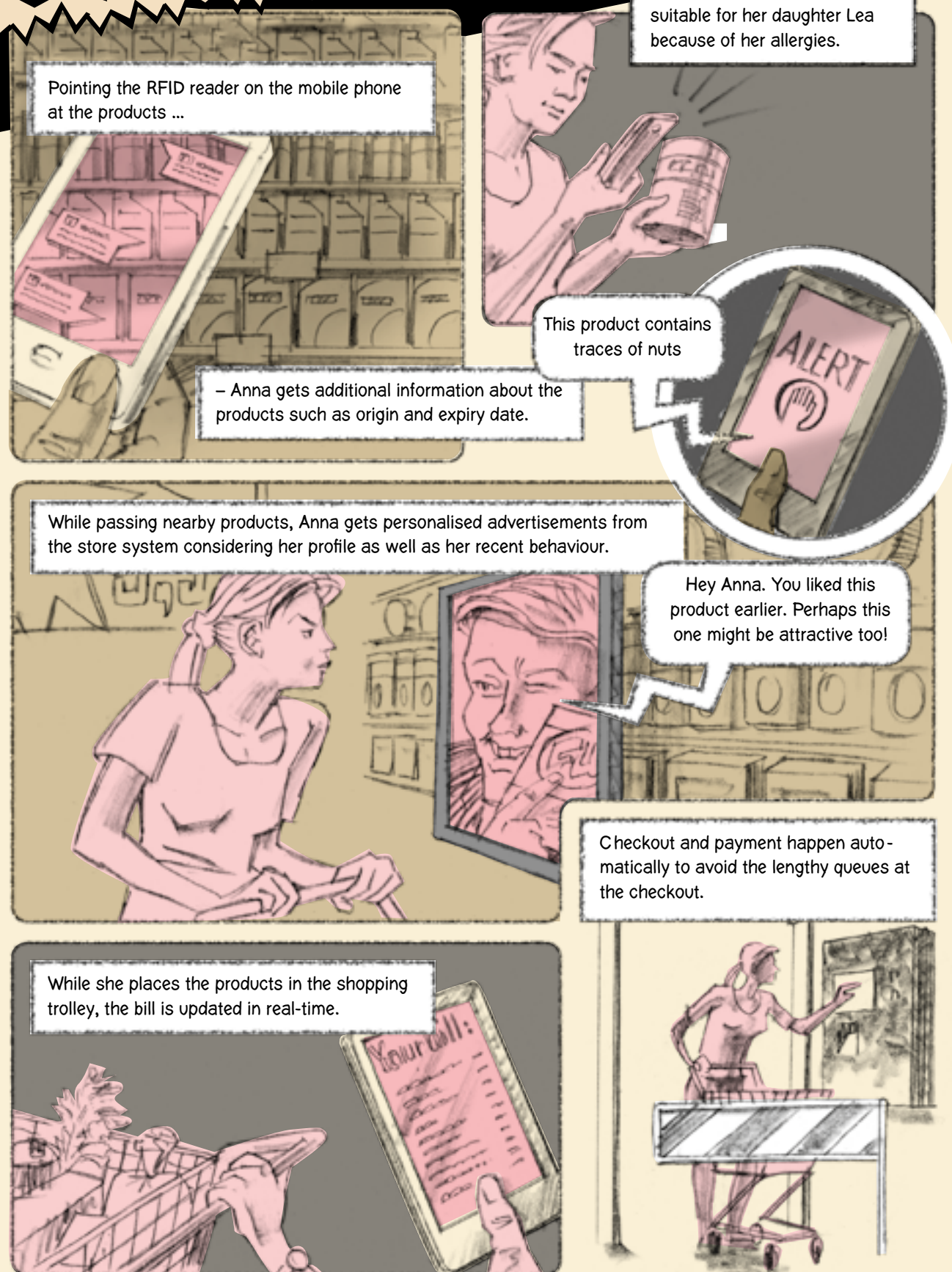
The Internet of Things will remove elements of human error. In one way the Internet of Things will look us over the shoulder, in another, it might just remove us to be a pawn without a brain.

It is a horrible thought to have someone (or better even something) always double check or even worse make all of your decisions. But to optimise processes and increase performance, it is an important tool.

So where does this leave us? We need to be careful in designing systems that don't make us zombies – listening to only the mechanical voice of the Internet of Things, but make it a tool that we use to help us function better and with more satisfaction of having done the perfect job.

This does not just count for logistics, but across the board of jobs, and private life, where the designers have to think, co-develop with the user and test solutions carefully to maintain a high level of user acceptance.

SHOPPING



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, Anna 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 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 im-

plementations. 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 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."

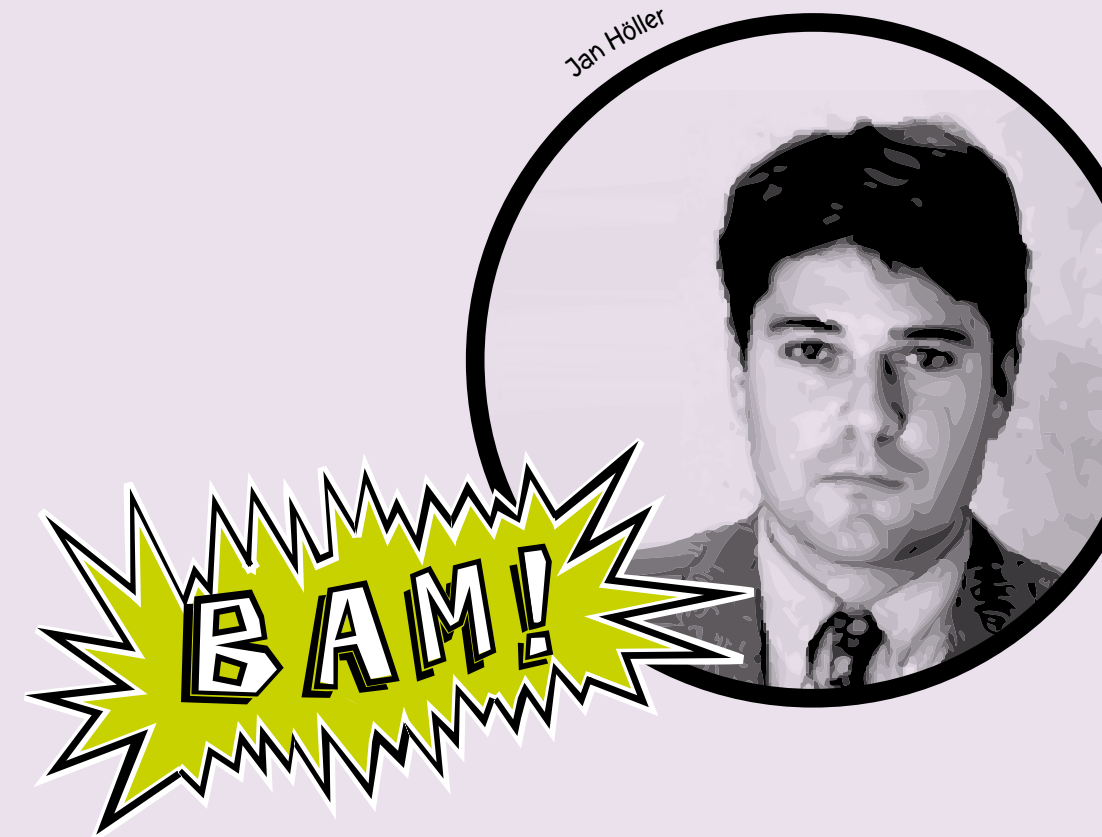
Jan Höller summarises:

"There is still work to be done in modifying 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."

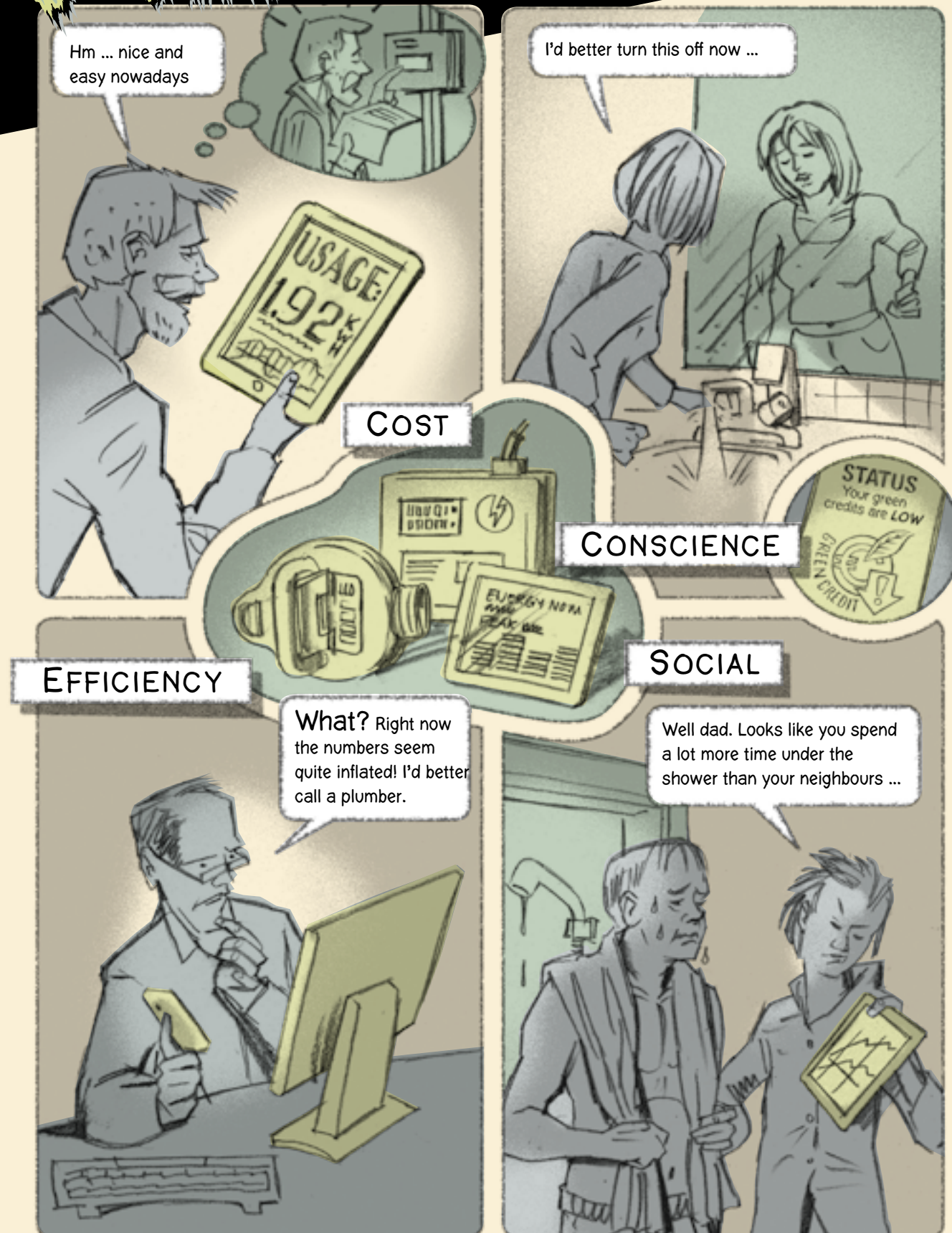
He is looking forward to the continued work within the Internet of Things Initiative.

"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



METERING





APPLICATION VOICES (vertical value proposition)


Reduced environmental impact 


Reduced energy consumption 

Reduced cost 

Reduced threat of vendor lock-in 

Richer experience through social interactions 

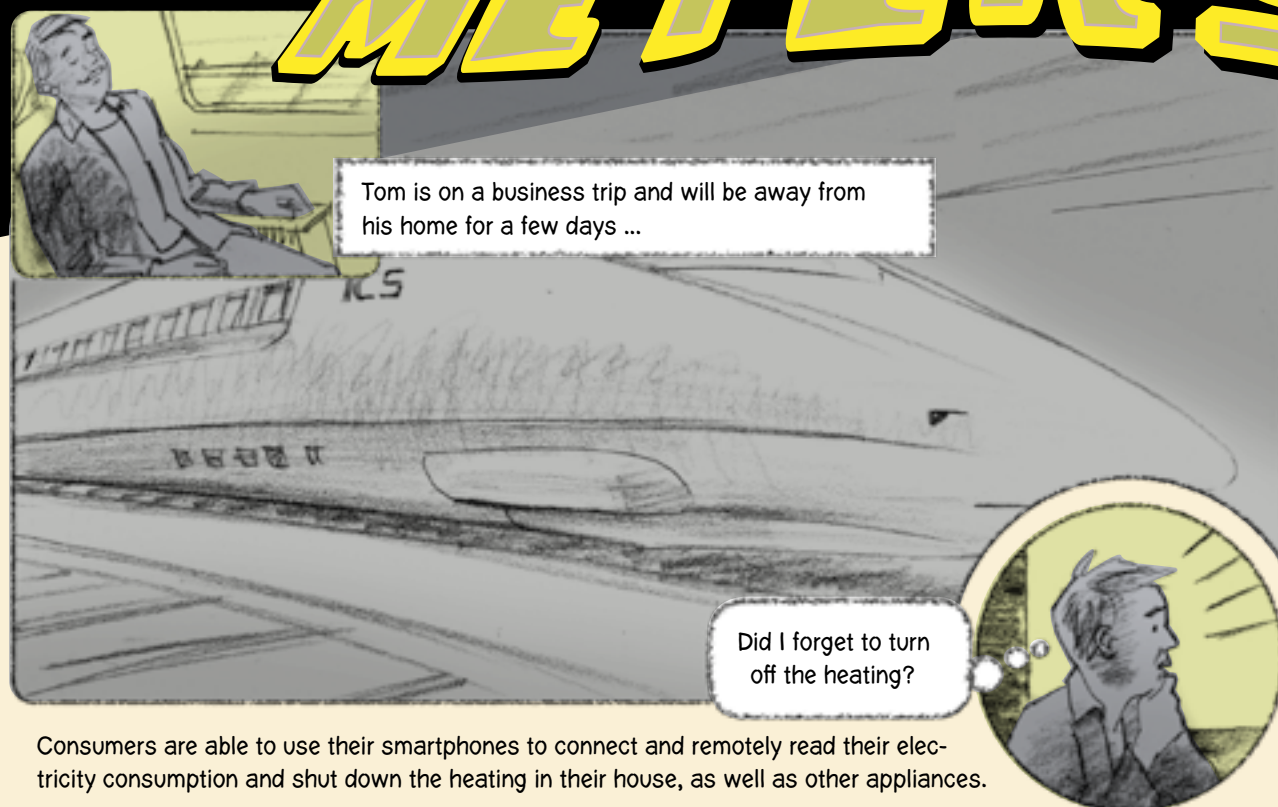
Data for 3rd parties 

Being part of something bigger 

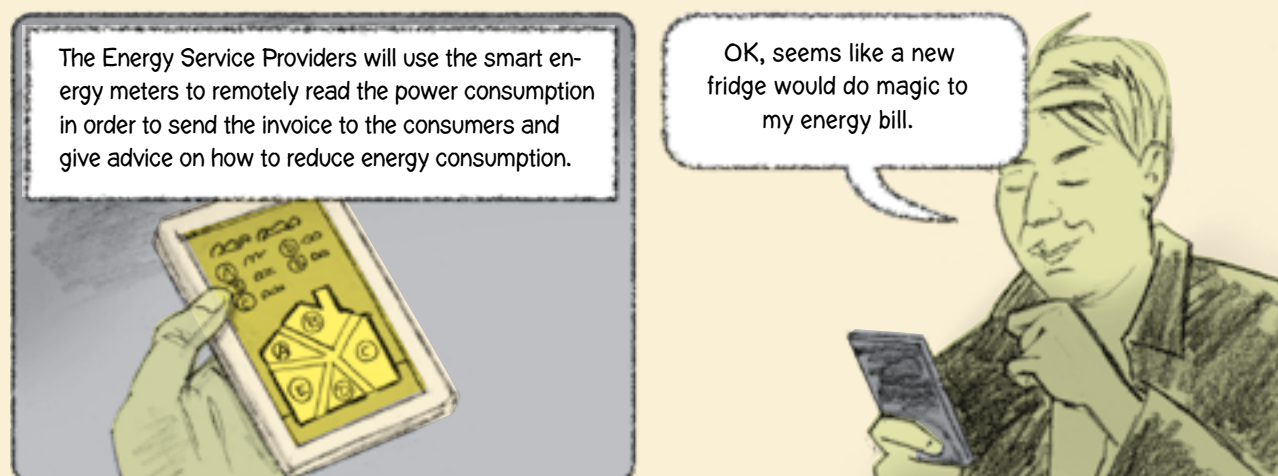
IoT VOICES (horizontal added value proposition)



SMART METERS



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



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 nagging 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 to switch something 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.



The story starts when you sell the product

Stefan Ferber interviewed by Stig Andersen

To Stefan Ferber, Vice President for Business Development at Bosch Software Innovations, bringing services to people beyond the product itself is the interesting aspect of the Internet of Things. The challenge is to find viable business models.

Through its 127 years history, the industrial giant Bosch has undergone a number of transformations: Small-scale manufacturing evolved into mass production, mechanical products over time turned electronic and the company itself was transformed into a global corporation far beyond the modest beginnings in 1886 when Robert Bosch opened his Workshop for Precision Mechanics and Electrical Engineering in Stuttgart, Germany.

More than a million pieces of equipment produced every day and around 1500 different product types on the shelves ranging from coffee machines to security systems tell the story about a company that has indeed been more into hardware than software. However, the company's activities within the IoT area is a clear sign that something is changing.

Stefan Ferber, Vice President for Business Development at Bosch Software Innovations, talks about yet another industrial transforma-

tion that implies an enhanced focus on the services and thus the added value that can be provided around the individual pieces of equipment.

"I refer to the 'Internet of Things & Services', because the interesting part of the interconnectivity between real-life entities that at a basic level defines the IoT are the services that it allows us to bring to people," he says.

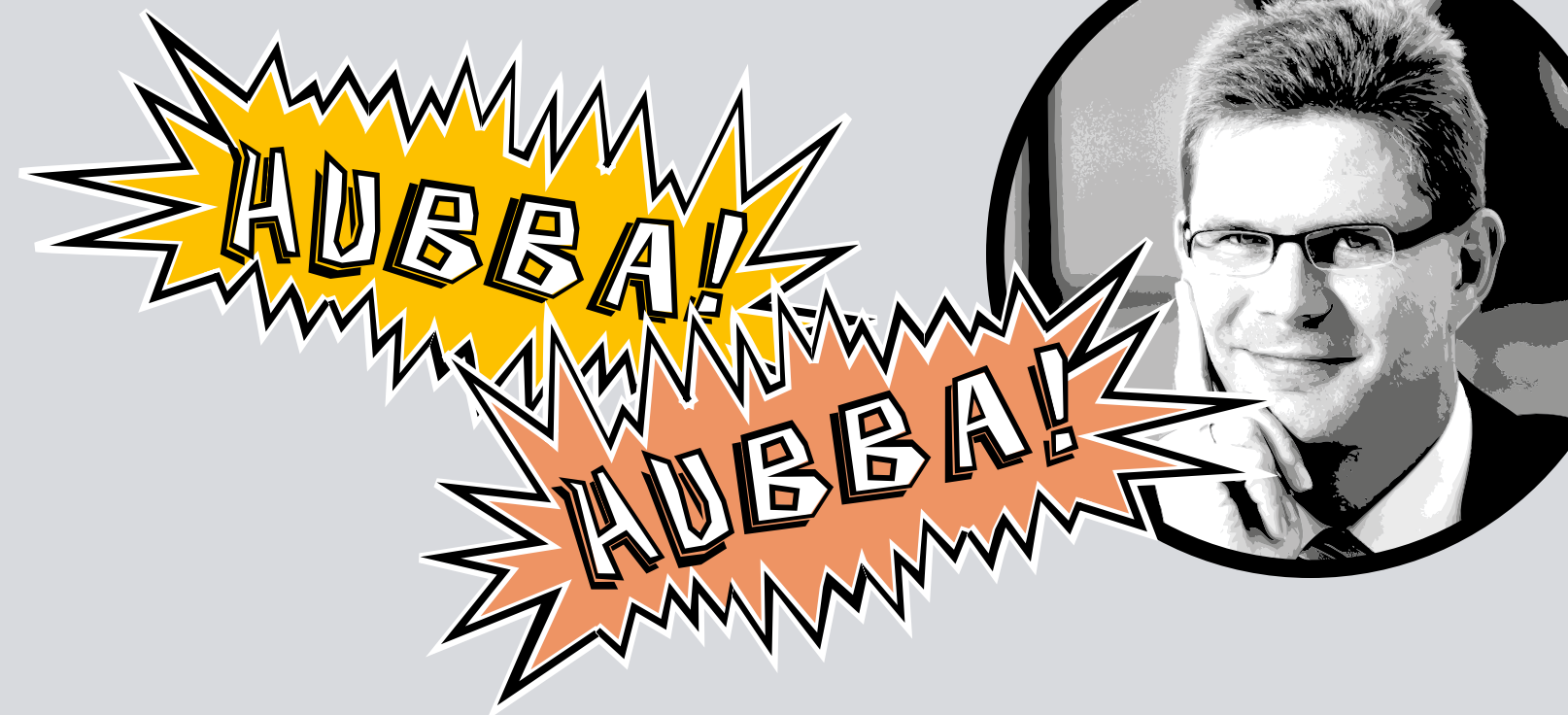
A prime example of the movement towards a service-oriented approach is the Bosch eMobility Solution in Singapore. When signing up for this service, the owner of an electric car is provided with an entire infrastructure including access to networked charging stations and a web portal with all relevant information – and it all comes with a flat fee. This model represents a major shift away from the well-proven business models of earlier days.

"Traditionally, products were mass-produced, sold and then the contact with the customer more or less ended

there. Now, the story starts when you sell the product, because it is when the product is operating that the service around it starts providing the customer with the added value that is such a crucial factor today," says Stefan Ferber.

Providing services that include connectivity via your smartphone, to take but one example, is a major step for a company like Bosch, and with it comes the challenge of defining the appropriate business model.

"A service-based approach is very much about convenience for the customer, but are people willing to pay for this convenience? For example, Bosch Thermotechnology manufactures resource-efficient heating products and hot water solutions and distributes outwall temperature sensors as part of the heating systems. This could lead to a new business model to deliver additional value for our customers by improving weather forecasts through all these sensors to optimize the efficiency of buildings'



energy systems for instance. But are people or organizations willing to pay for such a service? It is difficult to come up with a good business model, but the discussion is certainly open," says Stefan Ferber.

Stefan Ferber points to the combination of deep domain knowledge and software-driven solutions as key to success within IoT-based solutions. But the example with the data from the heating systems triggers the question of vertical versus horizontal business models. Would it, for example, be possible to think about solutions that went beyond products and services that have to do with the comfort in your home?

"The models we currently have at Bosch are designed to distinguish ourselves within the individual domains. We rather look at the areas where we have domain knowledge and package it as a service. It is important to develop towards a more connected approach and to work less in verticals. In order to provide a

horizontal IoT platform for the market, we established the Bosch software and systems house 'Bosch Software Innovations'," says Stefan Ferber.

Bosch addresses both the business and technology issues relating to IoT from multiple angles including a community-based approach that includes external experts and startup communities. According to Stefan Ferber, this reflects an early decision on the part of Bosch to take an open approach in this area.

"There is no doubt that the shift from ready-made products to services requires that we open up and interact with partners at multiple levels and in many different communities. We are not talking about exchanging information in a Facebook kind of way, but rather an open dialogue among the stakeholders that are relevant in relation to production - and it is very much a question of trust. Earlier, trust-building was between our suppliers and our customers, now it is multi-faceted and for sure

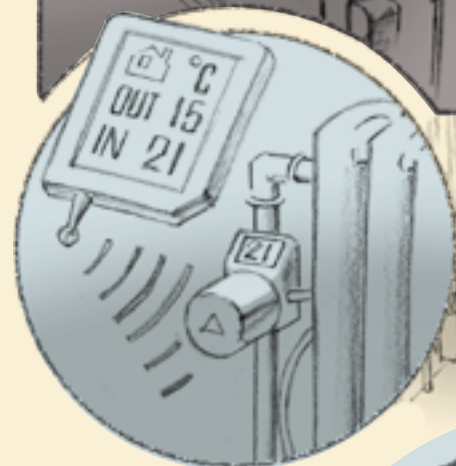
a challenge and something that we are still learning," he says and adds that over the last year or so he has detected a change towards more openness among traditional mass-manufacturers.

Establishing strategic partnerships and opening up to various communities are in fact some of Stefan Ferber's key tasks – and something that he enjoys doing.

"I have always liked to work in very visionary areas where you could really be at the forefront of important developments, not least when they serve higher purposes like improving our way of living and supporting increased sustainability – and IoT is indeed such an area," he says.

AUTOMATION

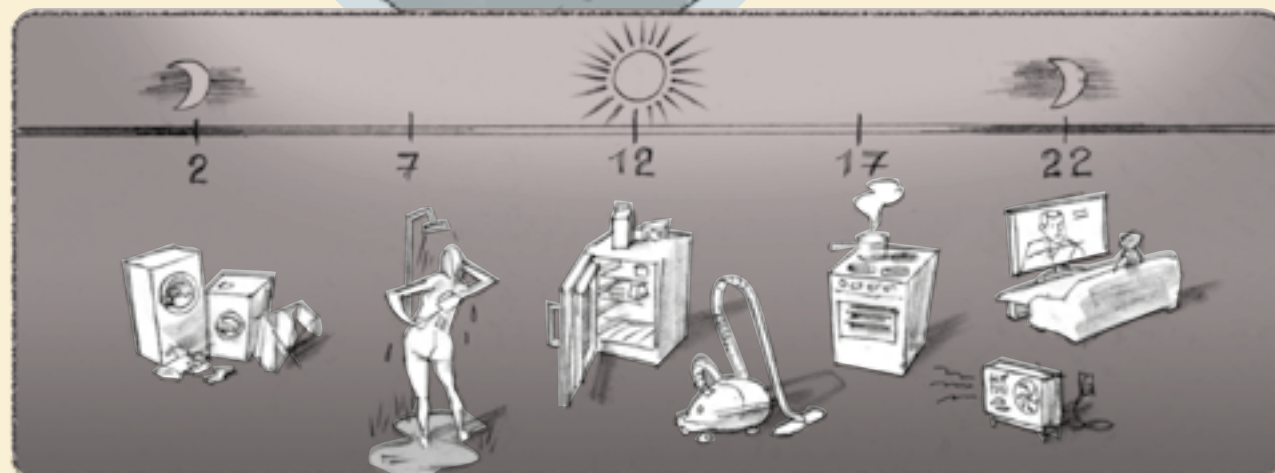
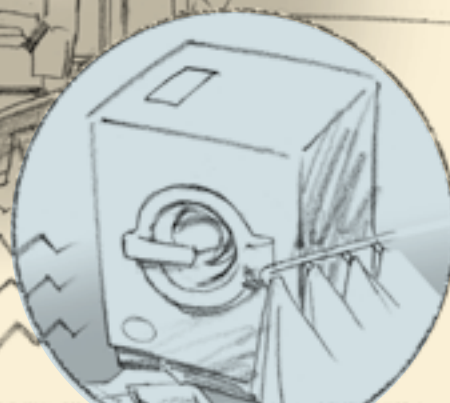
The Home Central Control (HCC) provides the complete control of your house. It controls access, energy, heating according to your profile, environmental conditions and price.



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 already today our actions leave footprints.

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.

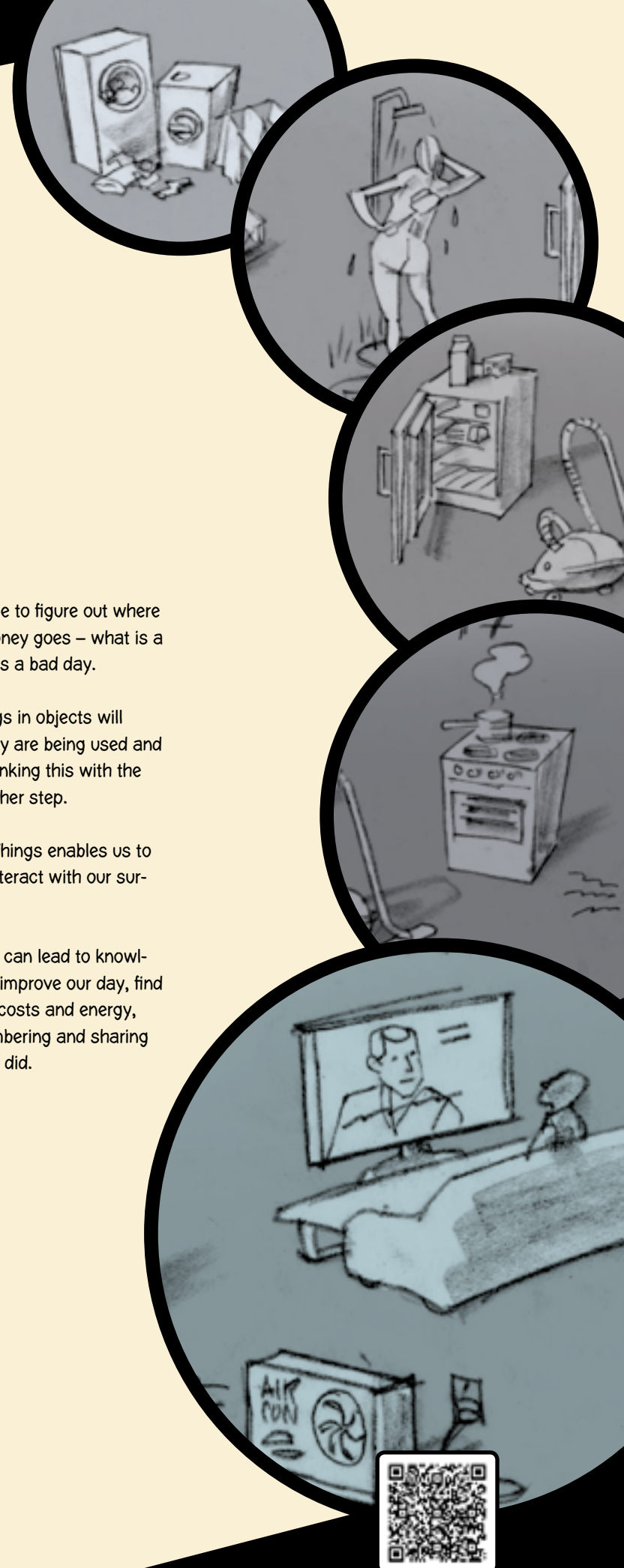
So why not record everyday actions

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 the user is just another step.

The Internet of Things enables us to trace how we interact with our surroundings.

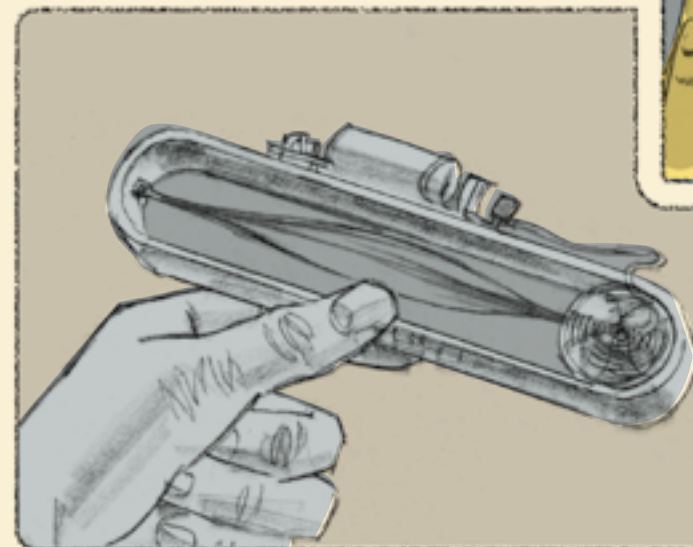
This information can lead to knowledge on how to improve our day, find ways of saving costs and energy, or simply remembering and sharing what we do and did.



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, fuel 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.

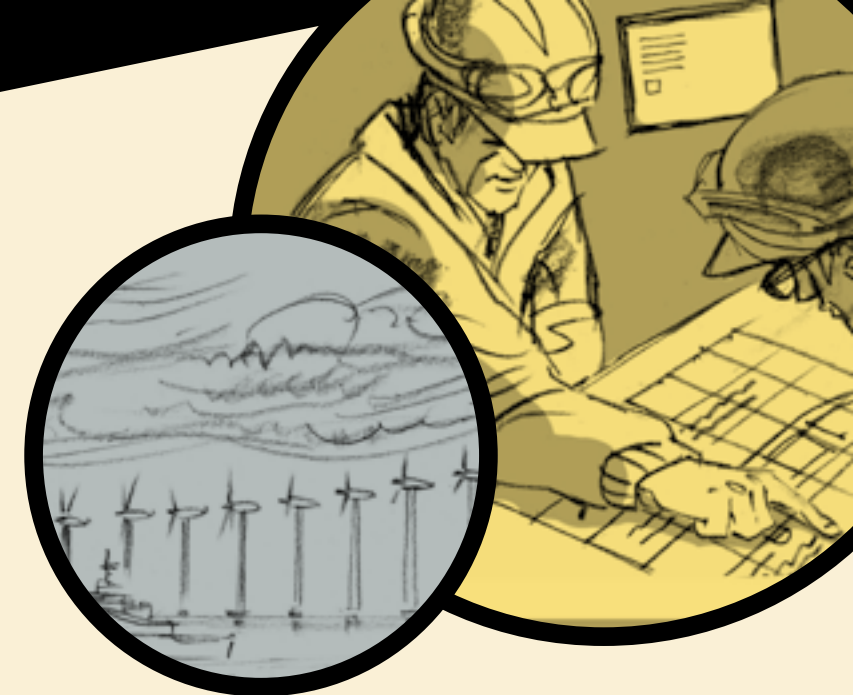
This will enable increased predictability and reliability, improve lost production factor figures and provide more accurate production estimates for a given site, thus driving down the cost per kWh produced.

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 the 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 activation, 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.

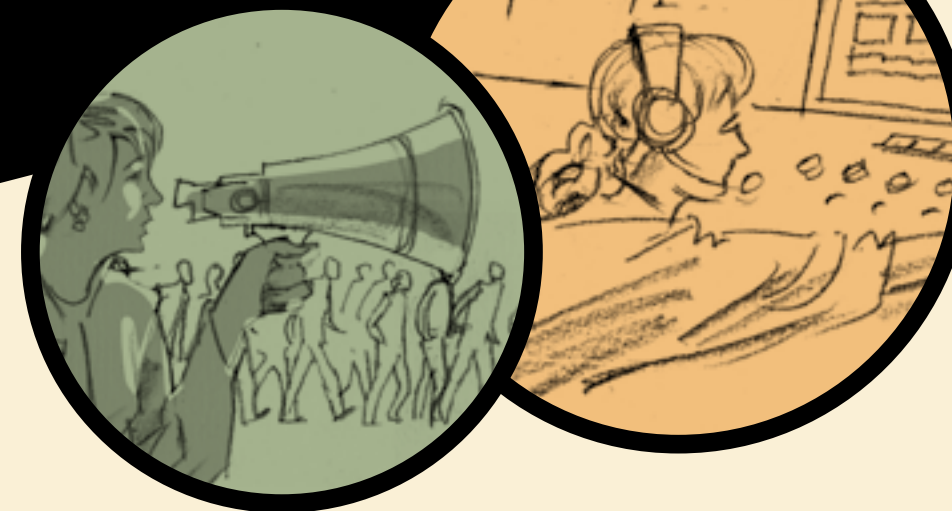
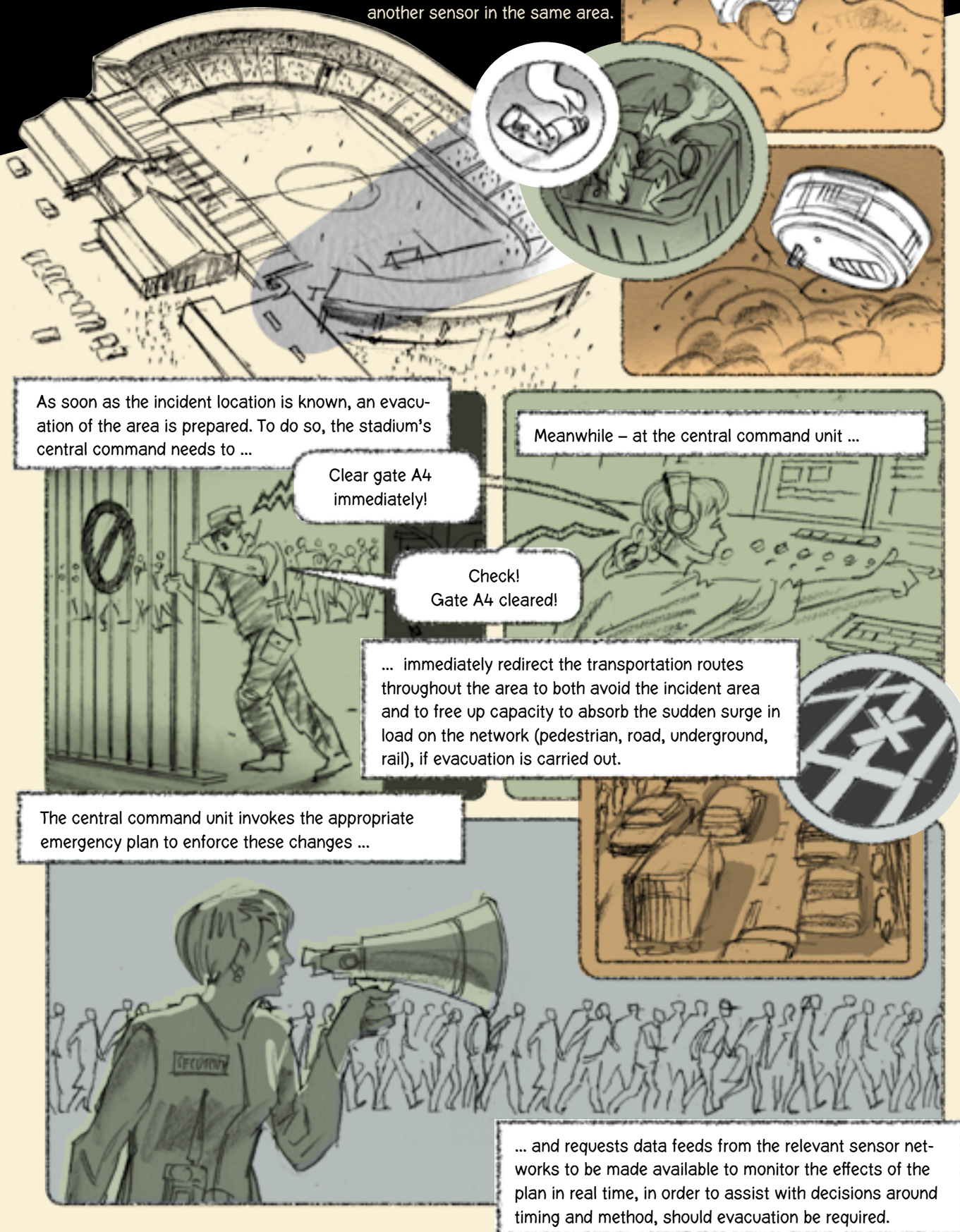
"If we just have another forum like many others, the value is limited. The ambition of the IoT-i Forum should really be to unify the forces of the globe behind the idea of the Internet of Things. It should be a place to exchange information and to gather requirements in order to push research in the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



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 third 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

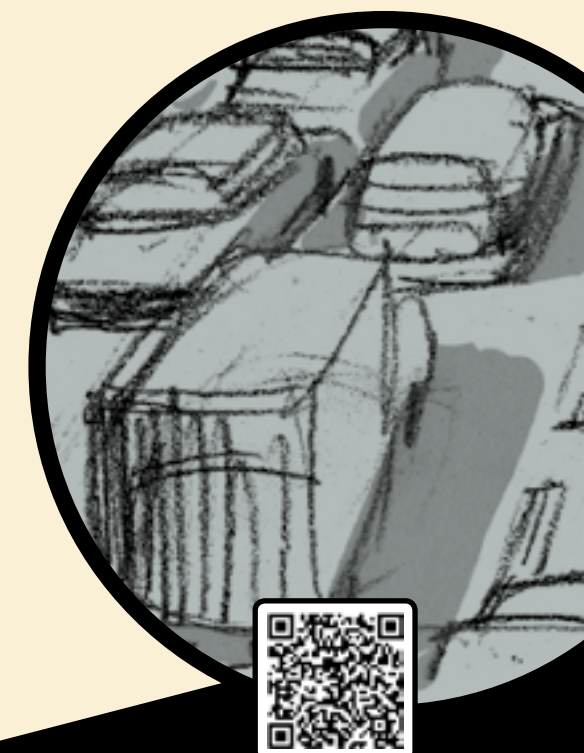
The Internet of Things will be made up of billions of heterogeneous devices such as sensors, actuators and tags that are all networked together. They will be deployed by many different organisations and individuals, maintenance is not always guaranteed; some will be reliable and trusted data sources, 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.



“The purpose of IoT is to improve life”

Ovidiu Vermesan interviewed by Stig Andersen

Ovidiu Vermesan’s answer to the question of “what is it all for?” is as concise as it is quick: “The purpose of IoT is to improve life”. No more, no less. Ovidiu Vermesan is a Chief Scientist at SINTEF in Norway, the largest independent research organisation in Scandinavia, and Coordinator at the IERC – Internet of Things European Research Cluster.

Ovidiu Vermesan sees the IoT as a new concept of how interconnected smart devices can create new applications and new services. IoT is emerging in a whole range of sectors all prefixed by “smart”: health, living, transport, industry, buildings, cities and energy.

“You can in fact compare the IoT to the way our brain functions. The interconnection between billions of neurons creates new knowledge and new ideas. In the same way, the value of the IoT applications is in the interconnection between the individual smart devices.”

According to Ovidiu Vermesan, IoT research and development is becoming more complex, due to the already highly advanced level of technology, the global, inter-sectorial and interdisciplinary collaboration needed and the ever increasing demands of society and the economic global marketplace. Development of certain enabling technologies such as nanoelectronics, communications, sensors, smartphones, embedded systems, cloud

computing and software technologies will be essential to support important future IoT product innovations affecting the different industrial sectors and applications.

Ovidiu Vermesan points to healthcare as a good example of the IoT vision. Using micro sensors, we can monitor our bodies and transmit the parameters via a gateway, most probably our smartphone, to a central database. Combined with other information about the environment, we will be able to get a real-time status on our well-being. Further, this status may automatically provide us information about what to eat, what to change in our environment to improve our condition, etc.

“The point is that we are able to monitor our current status and trigger the correct reaction and behaviour without human intervention,” says Ovidiu Vermesan and continues:

“Parts of the IoT vision are already in the process of materialising, but there are still many areas where we need

further development. Miniaturisation of the enablers, i.e. the devices, battery technology using more efficient materials, energy-harvesting mechanisms and improved intelligence of the devices; all of this is very important when implementing autonomous wireless smart systems.”

Other aspects need to be addressed. Privacy, security and trustworthiness are among them together with accountability issues.

“In our research, we are focusing on these issues by insisting that devices should by design support common standards for privacy, security and trustworthiness. In addition, with devices being independent of human interaction, there is an accountability issue to deal with. Some devices will be publicly owned, and some will be privately owned. So if bad behaviour is detected, we need to know who is responsible,” says Ovidiu Vermesan.

Standardisation is also key to the proliferation of IoT services. In a European context, Ovidiu Vermesan

points to CEN/CENELC and ETSI as the organisations in which these efforts should come together. At an international level, ITU-T and ISO are the main players.

“There is a degree of competition between the different standardisation organisations. What is needed is cooperation and division of work, so that the individual organisations specialise in specific domains, and when they propose a standard, it should be adopted by the other organisations.”

Some standardisation organisations are private, and here the same principle should apply: If a private organisation proposes a standard, it should be adopted by the public organisations.

In his capacity as coordinator at the IERC, Ovidiu Vermesan is part of the effort to build a common vision of the IoT and to coordinate activities to avoid overlaps between projects.

“It is important that we enable the communication between all the

projects in order to benefit from the potential synergies. This endeavour is in fact very much in tune with the very vision of IoT, which is basically about communication and exchange of information between nodes. The same principle has to apply to the projects, because without this type of communication and interoperability, it is not possible to implement the vision of IoT.”

One of the obstacles towards realising the vision of IoT is indeed lack of common standards. Ovidiu Vermesan acknowledges and accepts that solutions will be implemented using heterogeneous communication protocols and devices. But to ensure free exchange of data, communication interoperability and data exchange standardisation should be assured at a high level. He anticipates a mixture of solutions.

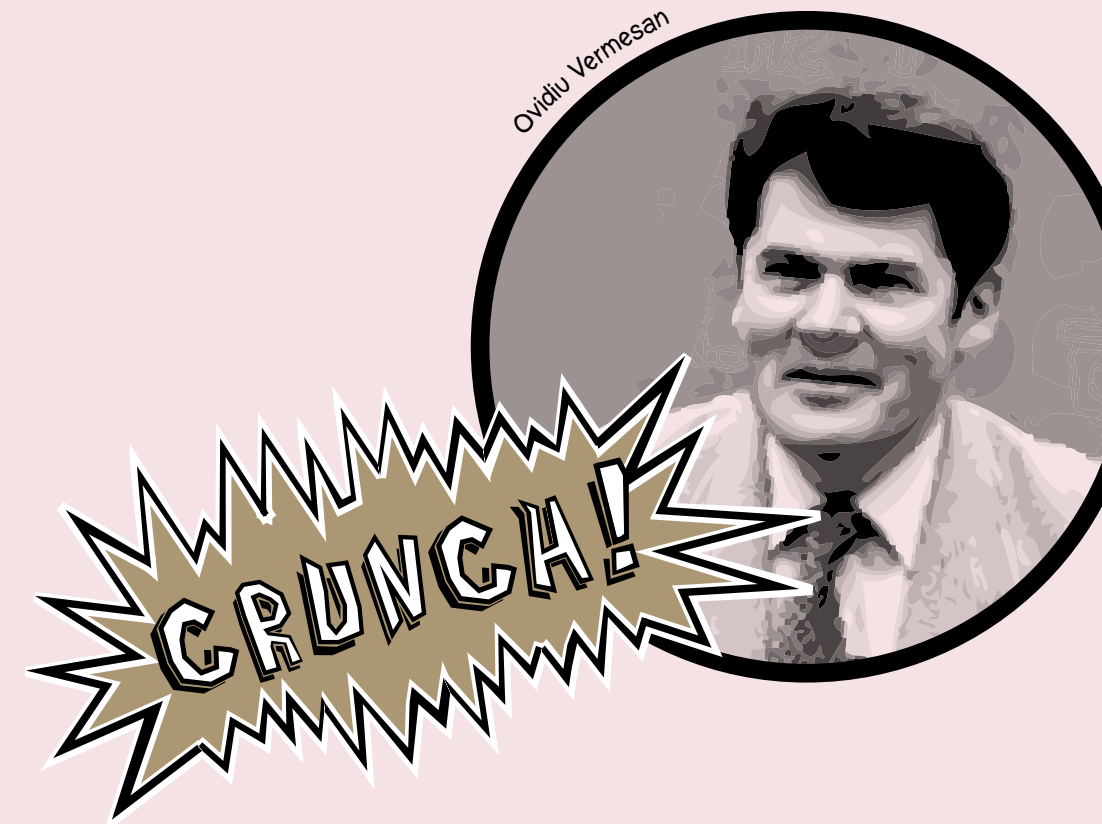
“There will be different hardware or software gateways. The smartphone is a very powerful gateway, because it is able to collect and aggregate data, and it provides interconnectiv-

ity via the Internet. Other gateways may be a home gateway with one unit connecting wireless sensors, entertainment devices, etc. The TV with increased interactivity and Internet connection is another potential gateway.”

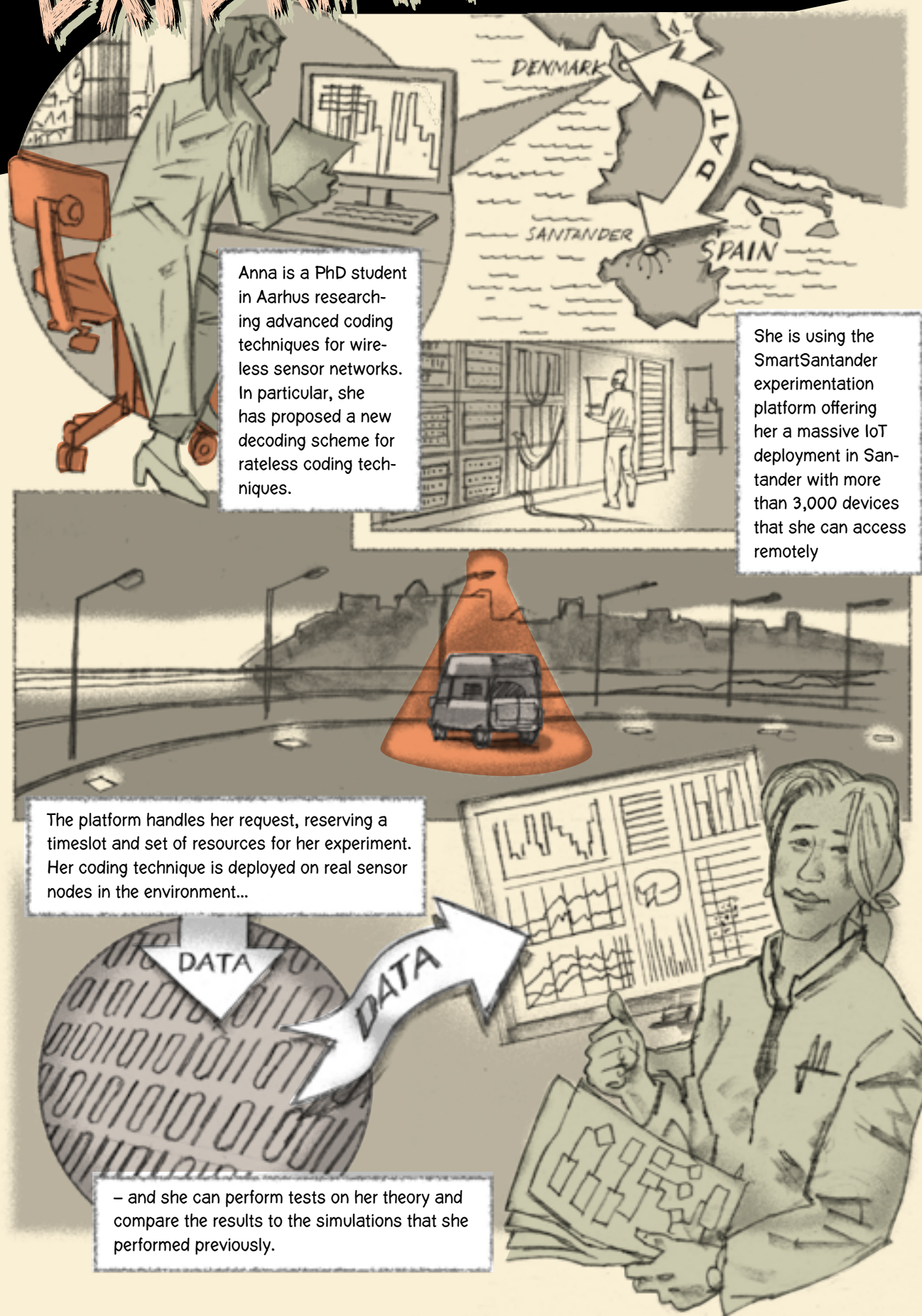
Ovidiu Vermesan points to the GSM telephone technology that exemplifies the features needed for implementing IoT applications.

“The GSM telephone enables communication, interoperability and compatibility. This allows us to be connected to other devices wherever you are. The same principle applies to IoT, where things should have the capability to be connected anytime, anyplace, with anything and anyone ideally using any path/network and any service. The difference is that, in most of the cases, it will take place without direct human intervention.”

Ovidiu Vermesan



EXPERIMENTATION



Anna is a PhD student in Aarhus researching advanced coding techniques for wireless sensor networks. In particular, she has proposed a new decoding scheme for rateless coding techniques.

She is using the SmartSantander experimentation platform offering her a massive IoT deployment in Santander with more than 3,000 devices that she can access remotely

The platform handles her request, reserving a timeslot and set of resources for her experiment. Her coding technique is deployed on real sensor nodes in the environment...

– and she can perform tests on her theory and compare the results to the simulations that she performed previously.

Experimental research

We have real life experience in the Internet and the web, both running for over 20 years commercially.

We know much about mobile networks, platforms and tools. We have built from experience privacy, identify and security features, developed content, applications and services – all using practical – experimental experiences.

What about the Internet of Things?

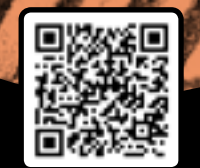
We have a network of 200 sensors homogeneously spread over a gym floor to test a new routing algorithm. Experimental, yes; realistic, no.

To truly understand the Internet of Things, its advantages and challenges we need to move into the real world and build it, step by step, sensor by sensor, platform by platform, application by application.

We need large-scale committed places such as cities or industry sectors that are willing to take a risk and reap the benefits.

They need to be willing to join a private public partnership on research and innovation.

“All progress is experimental.”
John Jay Chapman



Like Pulling Your Hand through an Aquarium

Rasmus Blom interviewed by Stig Andersen

With openness and transparency being inherent components in an interconnected environment, value-based companies are well-positioned to play a leading role within IoT, according to Rasmus Blom, Director of Grundfos Connect.

If you were ever in need of a metaphor explaining the essence of the Internet of Things, try this one: “The Internet of Things is like pulling your hand through an aquarium: Your movement is registered by the immediate environment, which in turn affects you.”

The words are those of Rasmus Blom, Director of Grundfos Connect, a newly established business unit at the world-famous Danish pump and water technology company. The purpose of Grundfos Connect is to define a digital strategy that will form the basis for the development of future solutions. For Grundfos, this represents a major shift of emphasis from hardware to software-driven solutions.

“We see digitization as a major factor in creating intelligent solutions around the hardware that we have developed and refined to the highest degree of efficiency and built-in intelligence over half a century. From being exclusively

a manufacturer of hardware, we are therefore also beginning to develop solutions and services around the hardware to provide even more value to our customers. And in the light of this strategic move, the internet-driven interconnectivity is a focal point for us,” says Rasmus Blom and continues:

“Pumps account for 10% of the world’s electricity consumption and are almost everywhere. Water scarcity will be a reality in few years, and we believe that the water and energy nexus is one of the key challenges of our planet and something we, as a company, has an important role to play in solving. IoT technology is one of the means.”

A “Google of water”

It is still early days, but basically it is a question of developing smart water grids somewhat analogue to the electricity smart grids. Millions of Grundfos pumps are already out there as key components of the water

infrastructure, and as in the case of electricity, the challenge is very much that of balancing.

“It is basically a question of load balancing entire water systems. We are involved in projects where we develop smart solutions to avoid flooding of basements and overflow in the sewage system in heavy rain scenarios,” Rasmus Blom explains.

An important business driver in relation to the IoT-related work at Grundfos is increased efficiency – both from an industrial point of view and in society at large – including the possibility to develop large-scale distributed solutions that are unique to the individual customer. The strategic headline is “from mass manufacturing to mass customisation”. Rasmus Blom goes even further than that when explaining the vision.

“There is no reason why we should not aim at creating a “Google of water” where the ultimate goal is



sustainability to the benefit of us all. By providing an open platform with data repositories fed by a number of data streams, we will be able to invite innovative developers to use these data to develop smart solutions within environmental technology.”

Acute focus on added value

In more concrete terms, GateSense is the open platform being developed by Grundfos together with project partners including the Alexandra Institute and Trifork of Aarhus, Denmark. The pursuit of sustainability is part of the formulated mission for Grundfos. Openness and transparency are other elements in the set of values that form the basis for the operation of the company. And with interconnectivity between objects from a host of different manufactures as a core element in the Internet of Things, these are crucial factors.

“I believe that due to the nature of the Internet of Things, value-based companies are very well positioned

to be successful in that domain. In a world of connectivity, it becomes increasingly difficult to maintain a business model relying on proprietary solutions and silo thinking. Today, there needs to be an acute focus on the value that companies can provide to their customers and in that context, collaboration and openness are key factors in creating what I would call ‘open parks’ as opposed to ‘walled gardens’,” says Rasmus Blom.

To many well-established companies, this would represent a major paradigm shift and go against a company culture and business models that have been developed over many years. Rasmus Blom is therefore not too confident that the necessary change will come from inside companies, unless they are able to embrace the fundamental changes IoT will bring along.

“I believe that the pressure on the established players in the market for energy solutions will come from smaller

companies within software development rather than from the traditional industrial companies. As the importance of digitised solutions increases and the technology becomes more available, relatively small development companies will be able to make an impact in the market, and we are more than willing to collaborate with these companies,” he says.

Finally, on a more personal note, what is it about the Internet of Things that is so exciting?

“A sensible use of our natural resources is crucial to our future, and if we are able to develop intelligent solutions through Internet of Things technology that – without being invasive in relation to individuals – can successfully pursue that goal, that is really optimal and something that it would be great to be part of,” says Rasmus Blom.

SmartSantander

– the European Smart City Experimental Platform

SmartSantander is a unique in the world city-scale experimental research facility. It connects several thousand fixed and mobile sensors to one single platform and uses their output for different applications such as smart parking and irrigation. It also connects several mobile applications to the platform adding user generated and participatory sensing data.

Apart from the technology achievement, many city processes and organisational shifts have come about with the deployment of the platform. And all of it is available as a smart city experimental platform.



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GateSense

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Internet + Internet of Things = Wisdom of the Earth

January 2009

Ole Lehmann Madsen, Managing Director, the Alexandra Institute

“Internet of Things is the highway to a smarter world”

May 2012

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IoT European Research Cluster

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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

IERC will facilitate the knowledge sharing at the global level and will encourage and exchange best practice and new business models that are emerging in different parts of the world.



www.internet-of-things-research.eu

Internet of Things International Forum

L'internet des objets sans frontières: **The Internet of Things without borders** is the motto of the Internet of Things International Forum.

No borders for research, collaboration and our joint vision: a united Internet of Things fostering business, societal development, knowledge, innovation and growth.



www.iot-forum.eu

50%
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Neelie Kroes, European Commissioner for Digital Agenda

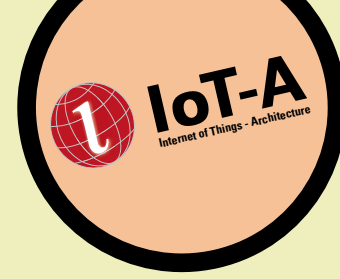
“The Internet of Things is about values and fundamental democratic choices on the future of our society.”

June 2010

Megan Richards, Director, Converged Networks & Services, Information Society and Media Directorate General

“It is clear that the Internet of Things will be central in ensuring the future growth and development of Europe's economy by providing consumers with new products and services at lower cost and greater variety.”

October 2011



Project contributions

About The IoT-A initiative

The overall technical objective of the IoT-A project is to create the modelling and architectural foundations of the Internet of Things, allowing seamless integration of heterogeneous IoT technologies into a coherent fabric. In other words, IoT-A aims at the identification of a unique Reference Model for IoT, and possibly several Reference Architectures related to the IoT domain. These Reference Architectures will be dependent from abstracted requirements, creating design guidelines for real systems that can be built using precise, application-specific requirements.

www.iot-a.eu

About URBGrade

The URBGrade project designs, develops and validates a platform for decision Support that will allow the city authorities and utilities to promote and choose the correct actions to upgrade a district to become more energy efficient, cost effective and to increase comfort for its citizens in a district-as-a-service platform approach.

www.urb-grade.eu

About SmartSantander

SmartSantander proposes a unique 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.

www.smartsantander.eu

About IoT Lab

IoT Lab is a European Research project which aims at researching the potential of crowdsourcing to extend IoT testbed infrastructure for multidisciplinary experiments with more end-user interactions. It will research crowdsourcing, testbed as a service, privacy and data protection by design, as well as end-user driven research, with a multidisciplinary approach to maximize the economic and societal value creation.

About Smart Action

SMART-ACTION is a two-year project (09/2013-09/2015) that supports the development of IoT strategic research agendas, including other sciences, and serves as an enabler for the dissemination and further integration of results into future research and industrial developments, while coordinating international efforts. SMART-ACTION is an addition to IERC (IoT European Research Cluster).

www.smart-action.eu

About City Pulse

"The CityPulse project designs, develops and tests a distributed framework for semantic discovery, processing and interpretation of large-scale real-time Internet of Things and relevant social data streams for knowledge extraction in a city environment."

www.ict-citypulse.eu

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L'internet des objets sans frontières!

The Internet of Things without borders!

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