Björn Raunio

The Internet of things

A report from the November 5, 2009 seminar

The Internet of things

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Introduction

Anyone who says that the Internet has fundamentally changed society may be right, but at the same time, the greatest transformation actually still lies ahead of us. Several new technologies are now converging in a way that means the Internet is on the brink of a substantial expansion as objects large and small get connected and assume their own web identity.

Following on from the Internet of computers, when our servers and personal computers were connected to a global network, and the Internet of mobile telephones, when it was the turn of telephones and other mobile units, the next phase of development is the Internet of things, when more or less anything will be connected and managed in the virtual world. This revolution will be the Net's largest enlargement ever and will have sweeping effects on every industry — and all of our everyday lives.

During Internet Days 2009, an entire day was devoted to illuminating this exciting development from different perspectives. Participants acquainted themselves with the technology behind the Internet of things and representatives from various parts of the industry were invited to talk about their plans and visions. To provide information and inspiration, and to underscore the fact that the Internet of things is already here, a number of applications and pilot projects that are already a reality were presented.

Finally, legislation's role in both regulating and stimulating the new technology was discussed. The responsible official at the European Commission presented an action plan established at European level for the Internet of things and described the thinking behind it.

Eleven speakers were invited to the seminar, and their presentations are stored as sound files at http://www.internetdagarna.se/program-2009/5-november under the tab "Opportunities Presented by the Internet of things". Their slide shows are also available in pdf format there. This document summarizes their presentations.

Stockholm 2010-11-11
Staffan Hagnell

Opening session

A combination of technologies from different areas

Adam Dunkels is a scientist at SICS who has worked with the technology behind the Internet of things for close to ten years. He opened the seminar by quoting a visionary prediction from Ericsson that as many as 50 billion things may become connected to the web by as early as 2020, and a Cisco prediction that the Internet could grow to a thousand times its current size. He then pointed out the irony in that the cornerstone of the new technology predicted to have such enormous consequences are but tiny microchips implanted in objects that will communicate with each other.

Throughout the day it was very clear that this was not a matter of distant future visions. A countless number of actual applications were spotlighted by the speakers. Even the handful of projects Adam Dunkels mentioned demonstrated the breadth of what the technology is capable of achieving. He talked about everything ranging from an exhibition at the Liljevalchs art venue in Stockholm and real-time monitoring of water quality in the Gulf of Bothnia through sensors connected to a buoy that send information via the GPRS net, to the monitoring of containers being shipped around the world, tradesmen who can keep a constant eye on which tools are in their pick-ups and smart power grids that create conditions for more rational production planning and consumption.

But it will take more than mere microchips to bring about the Internet of things. Developments are the result of technologies from several different industries combining in new ways. Adam Dunkels explained that apart from embedded systems, i.e. microchips implanted in everyday objects or used for different industrial applications, it deals with three additional areas of technology. To start with, there is telemetry, i.e.

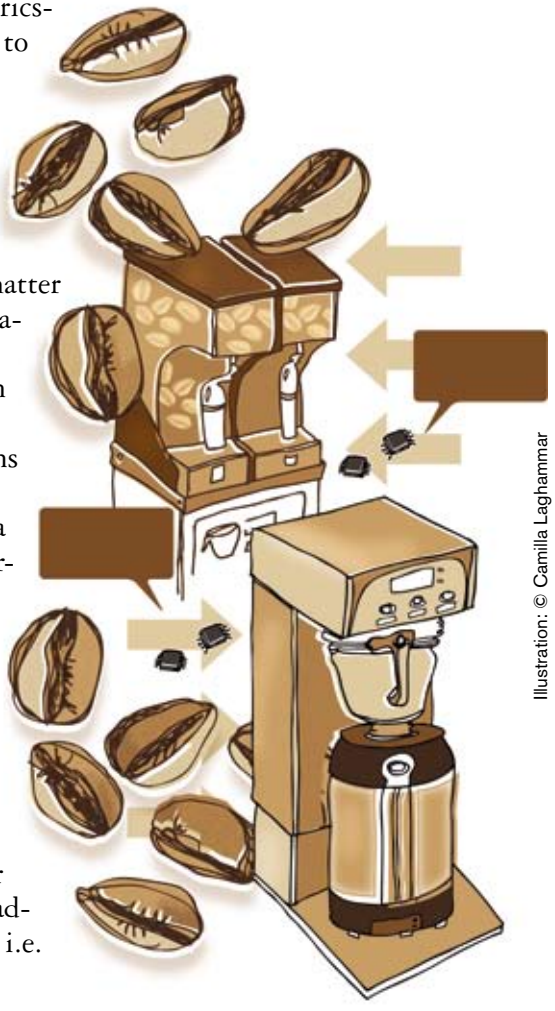

Illustration: © Camilla Laghammar

the remote reading of sensors and activities with the aid of such communications technologies as GPRS. Secondly, the development within sensor networks and ubiquitous data systems, or systems that are integrated into their surroundings and easily accessible at any time; this is the technology behind e.g. intelligent houses and offices. The final piece of the puzzle is of course the Internet and mobile telephony communications technology that make it possible to build low-cost Internet-based solutions and services. When technologies from all of these areas are combined, the result is the Internet of things.

Photo: Sara Arnald

Adam Dunkels is a researcher at SICS.

So what specific technology is required? Not only will it be hardware in the shape of extremely small computers (microcontrollers), some kind of communication device that is able to make use of things like low-power radio or power lines, and a power source — usually a battery, but there are examples where power can be obtained from radio signals or vibrations. It will also need software — lightweight, low-power network operative systems that can be run on 10 kilobytes of RAM and 100 kilobytes of ROM. In addition to hardware and software adapted for low power, standards for connecting everything to existing Internet systems are also necessary.

Adam Dunkels describes two standards within low-power radio. One is called IEEE 802.15.4 and only uses 60 mW when transmitting information, which can take place at a rate of 250 databits per second. When the device is in sleep mode it consumes only 0.01 mW. The other is called Low-power WiFi and consumes 300 mW when transmitting and 0.02 mW in sleep mode. A special challenge for these standards is how units should be able to listen for communications from others when they are sleeping, so that they may be activated on demand. This has been solved by switching on the units at regular intervals for very brief moments to hear if there is something attempting to contact them.

Examples of protocols that can be used in low-power radio are Link Layer, ISA 100A, WirelessHART, ZigBee and IPv6. When it

comes to the last of these, SICS together with Cisco tested the suitability of the new Internet protocol for low-power radio. IPv6 proved to work well in this type of light-weight, low-power application through the use of 6lowpan-header compression (6lowpan stands for IPv6 over low-power wireless personal area network). The model used in the tests has been certified as IPv6 ready. The advantage of using IPv6 in Adam Dunkels' opinion is that it meets the challenge of different existing systems having to work together. Because this inter-operability is possible, the system of objects connected together via the Internet can develop in the same way that the existing Internet has developed.

"In order to emphasize that the Internet of things is a technological innovation on the threshold of a great breakthrough ... that it was listed among the best inventions of 2008 by the American Time magazine."

In order to emphasize that the Internet of things is a technological innovation on the threshold of a great breakthrough, Adam Dunkels also pointed out that it was listed among the best inventions of 2008 by the American Time magazine. When something technological makes its public debut in this manner it says a lot.

What the IT companies say

The Internet returns to its roots

Patrik Fältström, Internet expert at Cisco, was first among the speakers invited to give the IT industry's perspective on developments. One important point in his talk was that the Internet of things is not some strange, new phenomenon; on the contrary, it is a natural development of the existing Internet. In order to illustrate his point he showed the first implementation of a webcam from 1991. The camera was connected by a group of scientists so that they could keep an eye on how much coffee was left in the pot on another floor. The coffee maker got its own Internet identity and thus became a connected object.

Patrik Fältström, Internet expert at Cisco.

Patrik Fältström is of the opinion that what we are witnessing now is a return to the Internet's original design. The very idea in the beginning was to connect things to other things. Not before the World Wide Web appeared did the Internet change and the standard become that everything should be designed around a person being at one end of the communication.

Today there are already many things that communicate with other things, but historically they have used protocols other than IP, and communication only takes place over short distances. An example is electronic locks and key cards. What is new about the Internet of things is that communication can take place independent of location. It is increased distance that opens up new solutions such as better electrical distribution planning. By using this technology your electricity supplier will be able to tell your house what part of the day is cheapest for heating water. It's easy to do, but requires long-distance communication, and this is the greatest advantage of transferring the protocol to IP.

"What is new about the Internet of things is that communication can take place independent of location.

Another big advantage with IP is that the technology built on this protocol is cheapest today regardless of the application concerned. IP has become the standard for all data communication and

"IP has become the standard for all data communication and it is therefore easy to move things over to the Internet."

it is therefore easy to move things over to the Internet. And by using open protocols we allow competition with all the advantages this involves regarding efficiency and quality. Patrik Fältström gave examples of alarm systems that currently use provider-specific systems, where a change of provider would require a large investment. But he is still of the opinion that there will always be local specialist networks at the ends of the Internet of things. Networks other than IP will also survive, at any rate for a while.

But at Cisco the view is definitely that we will see more and more use of IP. This is good in that the protocol is independent of the type of physical medium used, and it is therefore possible to choose whatever works best at the end of the network in each individual case. It will often be short-distance radio. It is true that we are currently witnessing an explosion of special solutions, but he predicted that their range and scope will be limited compared to open solutions based on IP.

Patrik Fältström emphasized that the standards supported by the industry research body IPSO Alliance (IPSO stands for Internet Protocol for Smart Objects), such as 6lowpan, do not compete with IP, but are solutions which supplement the Internet protocol. IP will continue to be at the core also in the Internet of things.

When it comes to what will actually form the great explosion of connected objects, Patrik Fältström believes it will above all be sensor networks. But he enumerated a number of constraints that require adaptation:

- The energy consumption of connected objects.
- Limited processing power.
- Limited amount of memory.
- The need to re-learn how to write software for a limited amount of memory.
- The influence of network topology.
- The combination of limited memory and CPU power and a dynamic network topology.

- Data may require processing at the nodes.
- Many units will be used in very difficult environments.
- In many cases networks will need to build themselves.

Patrik Fältström concluded his address by once again emphasizing that Cisco supports open architecture. This encourages innovation and competition where providers survive through the quality of what they provide. Regarding public regulation it is important that it always maintains the open market.

In order for the Internet of things to be successful, the architecture in itself must not lead to specific business models, regardless of what part of the network or hierarchy you are in. Another prerequisite is the introduction of IPv6 so that communications can remain unbroken from sender to receiver. Gateways and NAT solutions will make this kind of system too complicated to build. On the other hand, the development of the Internet of things may contribute to the rapid introduction of IPv6.

Wireless broadband is a prerequisite

Martin Körling from Ericsson Research explained that Ericsson also believes in the Internet as a delivery model as ever more things become connected. IP will be the layer where most things take place. He pointed out that operators have a decisive role to play in developments. In his presentation, he looked at the Internet of things from a number of different perspectives.

One possible point of view is to start from the connected devices. Ericsson envisages a wide range of different types of connected objects and predicts that the functionality they provide will be valued by the market. Martin Körling mentioned personal objects we carry around, things we have in our homes and cars, smart power grids, industrial applications, and things fitted with smart tags so that they can be connected to a local net.

According to Martin Körling it is difficult to speak of a uniform

" … personal objects we carry around, things we have in our homes and cars … and things fitted with smart tags so that they can be connected to a local net."

concept when it comes to the Internet of things. Different types of applications place entirely different demands on technology and business models. Energy supply may be a problem in many cases such as tags, while in others, such as homes and vehicles, this will present no challenge at all.

Looking at what is driving the development of the Internet of things provides another perspective. It includes both private citizens, for example those interested in convenient solutions in the home, and companies, that want to reduce costs and increase productivity, as well as society at large, which can advance in various ways through use of the technology.

What is necessary from a purely technological standpoint? It is extremely important that broadband be accessible everywhere. Costs for connected devices must not be too high, and this will require sufficient volumes. Martin Körling said that Ericsson believes that everything that benefits from a network connection will have one.

The quote about 50 billion connected things by 2020 that Adam Dunkels referenced should be seen as a vision and not a

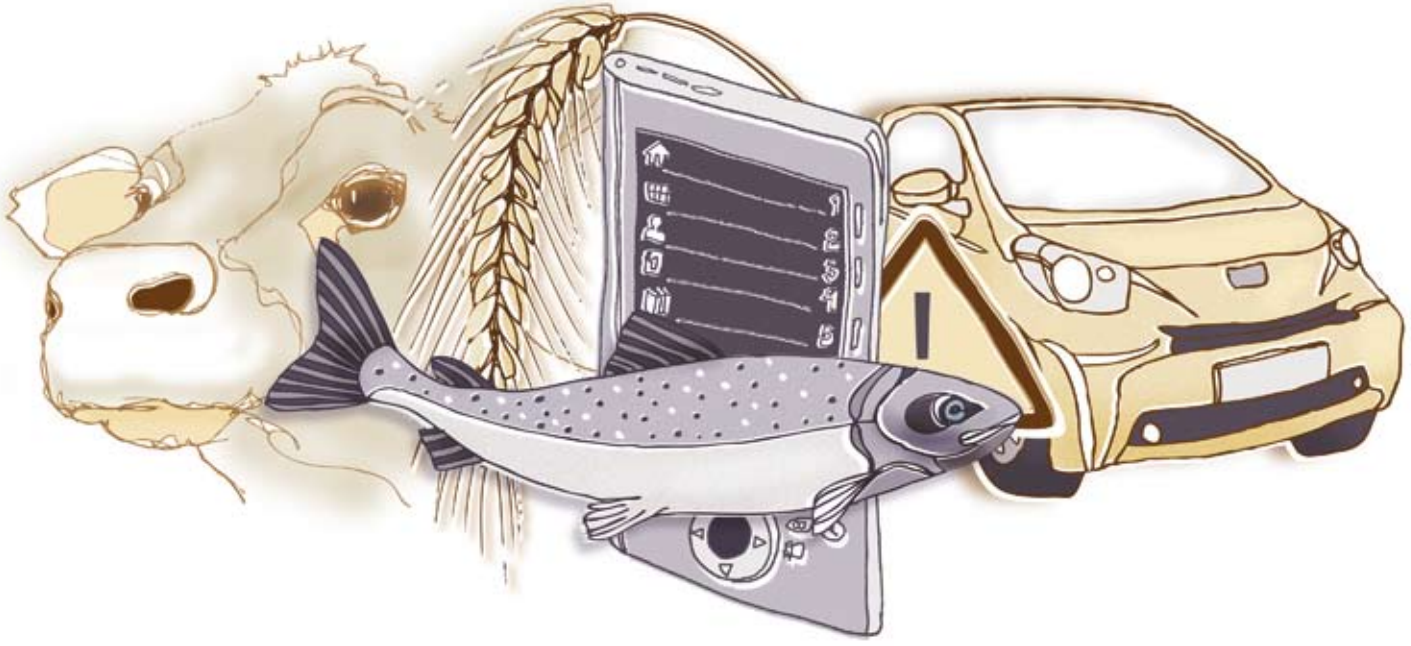

Illustration: © Camilla Laghammar

statement of fact. But Martin Körling calculated aloud that if the global population is around 8 billion and poverty continues to decline, then each person may have on average 5 connected units of some kind, which would be 40 billion in total. If you add connected objects that have nothing to do with individuals, then perhaps we will reach 50 billion. He also mentioned a report from the Gartner IT research company that points to the possibility of there being 14—15 billion connected objects by 2014. Martin Körling observed that things look very exciting, no matter what the exact figures turn out to be.

He explained that Ericsson sees great advantages of scale in the world of wireless Internet. Modules will become smaller, volumes greater and costs lower. Mobile telephone coverage will be an important component in many applications such as e-book readers and connected vehicles to which different services can be added, and in environmental monitoring in e.g. agriculture or fish farms and smart power grids. One important role here will be to act as broker between net operators and service providers — a market in which Ericsson is already established. The company is also working on the development of integrated net functionalities that make various new services possible.

Numbers as the global language

Then it was the turn of **Bo Raattamaa**, Director for the Swedish branch of the international standards organization, GS1. The development of the Internet of things is to a large degree dependent on the availability of standards and identification systems recognized across industry and national boundaries. GS1 works with developing standards that facilitate business between different companies and countries. It is active at different levels within more than 25 different sectors. GS1 develops standards within 4 areas; bar codes, electronic business languages (e.g. XML), data synchronization networks that provide additional information about parts, and RFID based identification.

Bo Raattamaa, CEO GS1 Sweden.

In the case of the Internet of things it is above all GS1's RFID standards that are interesting. The electronic RFID tags can be read wirelessly, and based on the codes in GS1's standards you can find information via the network regarding what the RFID tagged object is, where it has been and when. It is also possible to work out why it was there, and with the aid of data from sensors, what the conditions were like. This helps companies in many different industries to achieve efficient and rational processes in retail stores and throughout the entire supply chain. The technology is currently making a breakthrough, not least within transport and logistics. In Sweden it is used for example in railway goods traffic to keep track of rolling stock.

Bo Raattamaa explained that over the past few years the technology has begun to progress from a period of hype, pilot projects and trials to become part of normal business development in many areas in Sweden. RFID implementations can be found in health care, transport and logistics and the manufacturing industry. RFID can be used for such things as efficient logistics, traceability, patient safety and authentication of an object's identity. It is possible to use the Net to check that a product really does come from a certain producer, for example. Numbers are a global language and numerical codes in RFID tags simplify communications within companies or industries, across industry boundaries and between different countries.

Illustration: © Camilla Laghammar

He predicted that the development of the Internet of things may proceed quickly and an RFID system at the end of a network provides great handling advantages. In contrast to normal bar codes, RFID tags can be read away from the line of sight. RFID is also an established global standard in companies' supply chains and the numerical codes are independent of any other context. But Bo Raattamaa underscored that even normal bar codes can also be used in the Internet of things as they are able to carry much more information than a mere article number.

Logistics examples from the real world

Hein Gorter de Vries from GS1 in the Netherlands explained in more concrete detail how RFID can be used in practical applications. He talked about a 2008 pilot project in which RFID technology was used to trace and keep track of containers that were shipped between Tokyo and Amsterdam.

Hein Gorter de Vries, Director of Strategy, GS1 Nederland.

Hein Gorter de Vries began by explaining that much hard work had been done to make the RFID standard a success. The tags are very small and can be used for consumer goods, even though it may be difficult to get down to such a low price that it would be profitable to eliminate the points of sales and checkout staff in supermarkets — something that the everyday commodity industry sees as an interesting possibility. But RFID may be usable for other types of efficiency advances in the retail industry. As an example he brought up a Dutch bookshop that keeps track of its entire inventory using RFID tags, which provides real-time stock keeping and allows them to avoid having too many copies of the same book in stock. In this way they are able to provide their customers with a wider range of books and the book store has become more profitable through the introduction of the system.

An important area of use for RFID is in the registration of goods transport data. Events can be registered along the entire transport route so that a shipment becomes transparent for the seller, purchaser and everyone involved in it. This can improve the planning and administration surrounding a shipment. Because goods move across national boundaries and different regulations for radio frequencies apply in different places, GS1 has had much to do in providing support for several different frequencies in the development of RFID tags. GS1 standards are now ISO standards and are also used outside the RFID ambit in completely different contexts, e.g. for tagging baggage at airports.

The pilot project Hein Gorter de Vries talked about was carried out on behalf of the Japanese NYK shipping company, which was interested in examining what opportunities the new technology offered in practice. In the part of the project GS1 Netherlands was

involved in a number of containers from the Canon factory in Japan were shipped to their warehouse in Amsterdam in February 2009. The objective was to render visible everything that transpired along the way from departure to destination.

RFID tags were attached to the containers, boxes and pallets included in the shipment and were then read at a number of points along the way. Containers were also sealed with RFID tags that would register any attempt to open them. Whenever a tag passed a reader the time and location were transmitted, from which it was possible to deduce why it was there. Readings were taken when the haulier picked up the container in Tokyo, again during loading in the port of Tokyo, once more when it arrived in the port of Amsterdam and finally when it reached the Canon distribution centre in Amsterdam. All of this data was reported and stored in one or more EPCIS repositories, i.e. databases established according to GS1's Electronic Product Code Information Services standard. In this way it was possible to monitor every step along the way.

"A number of questions can be answered via an EPCIS interface for those with authorized access to the information stored".

A number of questions can be answered via an EPCIS interface for those with authorized access to the information stored. The manufacturer gets to know which products have arrived in the port of Amsterdam on any given day, the logistics provider finds out how many containers must be collected that day, the distributor can see the status of his order, and Dutch customs can establish the container's shipping history and evaluate whether they should inspect the shipment or not.

Hein Gorter de Vries concluded his presentation with an enumeration of the benefits provided by the project for different parties involved:

- **Shipper**: increased supervision of goods during transport, improved interconnection between logistics and transactional information, simplified fulfilment of international safety requirements and customs clearance, and better information to the customer.
- **Consignee**: better supervision of delivery times.
- **Third party logistics providers**: transparency possible in rela-

tion to the shipper and consignee, better service and lead times, easier to fulfil customs clearance requirements, improved management of transport resources such as pallets and containers.

- **Customs**: opportunity to test the standard and investigate possible simplified inspections at clearance.
- **Port of Amsterdam**: improved profile within logistics services; test of possible simplified inspections at customs clearance.
- **GS1**: evaluate what can be done to add value within import/export.

Experiences from the trial were positive. It is a matter of speed, efficiency and security. RFID has the potential to provide transparency and better shipment supervision in the delivery chain while unnecessary obstacles to international trade can be eliminated. The conclusion was that there are great business benefits to be derived from this.

A smarter planet

The last representative from the IT industry to come on stage was **Anders Westberg**, IT architect at IBM. He declared that as more and more things are connected together a whole lot of data becomes available on which to base smarter decisions. In line with several previous speakers he used the power grid as an example and mentioned that, in certain parts of the world, only one third of the energy available in the grid is utilized today, the rest is wasted. This could be remedied by a smart grid.

Anders Westberg emphasized that IP need not be utilized all the way out to the ends of the types of application the Internet of things will be made up of. The important thing is that the information is reachable via the Internet. IBM sees great potential in developments, both as a hardware and software supplier and as a service provider when solutions need to be constructed. To illustrate how this potential has already come to be realized he ran

Anders Westberg, IT Architect at IBM.

through a number of different real-world projects that IBM has been involved in.

The first example was a pilot project carried out by IBM together with a Danish shipping company and involved creating a secure trade corridor which provided full supervision of container movement from one place to another, much like the GS1 example earlier in the seminar. Solutions such as these are sought after in the transport industry as large parts of a company's container inventory go astray. It would therefore be of great interest for a shipping company to know where a container is during the entire journey from manufacturer to end user and to make sure that nobody attempts to gain entry to it during shipment. IBM built the middleware for this solution, but the shipping company has not implemented it since the pilot trial.

However, the next solution Anders Westberg talked about was put to use by their customer Heineken. Information from an EPCIS repository containing all the data from RFID readers along the transport route is connected to the Heineken SAP system used to run all production and shipping etc. Dutch customs are informed via email and IBM supervision ensures nobody tries to gain entry into the containers. This is thus a real-world example of how GS1 RFID tags are used in a system to provide supervision of goods under transport.

Another example Anders Westberg talked about was from SL — Stockholm Public Transport. IBM linked around 30 different existing systems based on different technologies in the local networks. SL wanted to be able to monitor all of the equipment in these systems from one central point, and IBM delivered a system that makes this possible. How to gather data from e.g. fire alarms and ventilation systems into one single system in a manner that allows seeing the relationship between them is not self evident, but if this integration can be implemented more intelligent decisions will be able to be made based on the information. By coordinating the systems it will for example be possible to disregard false alarms in escalators.

But achieving this will involve the integration of something that

is able to transform the information from the different local systems into data that can be transmitted via IP. Anders Westberg pointed out that it is not always necessary to run IP networks all the way out to the nodes as long as it is possible to transform their signals such that they can be merged in a consistent manner. Something that also would help SL would be the installation of cameras for monitoring e.g. escalators.

"... it is not always necessary to run IP networks all the way out to the nodes as long as it is possible to transform their signals such that they can be merged in a consistent manner".

Anders Westberg's final example involved Norwegian North Sea oil platforms. IBM assisted a company with a large number of platforms. Equipment used in such inhospitable environments as the bottom of the North Sea or on actual platforms requires the highest level of maintenance work. Every installation uses several applications to monitor equipment, and every platform is different.

Because the company concerned had not previously had any proper central control of incidents, they lost capacity. In a typical case there is a network out on the platform, so IBM established standardised web services (exchange of information between websites) that gathered together all the networks in order to create a pipeline for real-time information to the mainland. In this way a decision support system with real-time production monitoring was created, where it is possible to drill down to individual components in order to plan maintenance, for example.

Anders Westberg concluded his address by saying that the Internet of things is a gigantic opportunity for the entire industry, and a natural development of what it is already doing.

In the panel discussion following this part of the seminar, one of the more sensitive issues regarding the Internet of things raised its head — the question of how such developments will affect personal privacy. GS1's Hein Gorter de Vries underscored that information available in an RFID tag is merely a number that contains no information per se. Making use of the number requires access to data that is protected against general admission.

Experiences and expectations

Many hot areas in public transport

Åke Lindström, Business Developer at SL, was the first speaker in the next seminar segment where representatives from different industries talked about their experiences of, and expectations for, the Internet of things. Åke Lindström started out from the general trends that everything will become mobile, everything can be localized and everything will be connected. He pointed out a number of hot areas in public transport connected to this comprehensive development:

- **Information** will become real-time based, person specific and localized, delivered via the Internet to your mobile phone for example, and packaged as services with standard APIs through which others will be able to add services.
- **E-tickets** that utilize RFID technology. This also includes single sign-on for bus drivers so that the bus "knows" who is driving.
- **Fleet management** of connected buses, where the bus driver has real-time information about everything he or she needs to know in order to do the job.
- **ISA (Intelligent Speed Adaptation),** where information is provided about bus speed limitations. There is also an environmental variant where the driver gets help with driving in the best possible way in order to reduce fuel consumption.

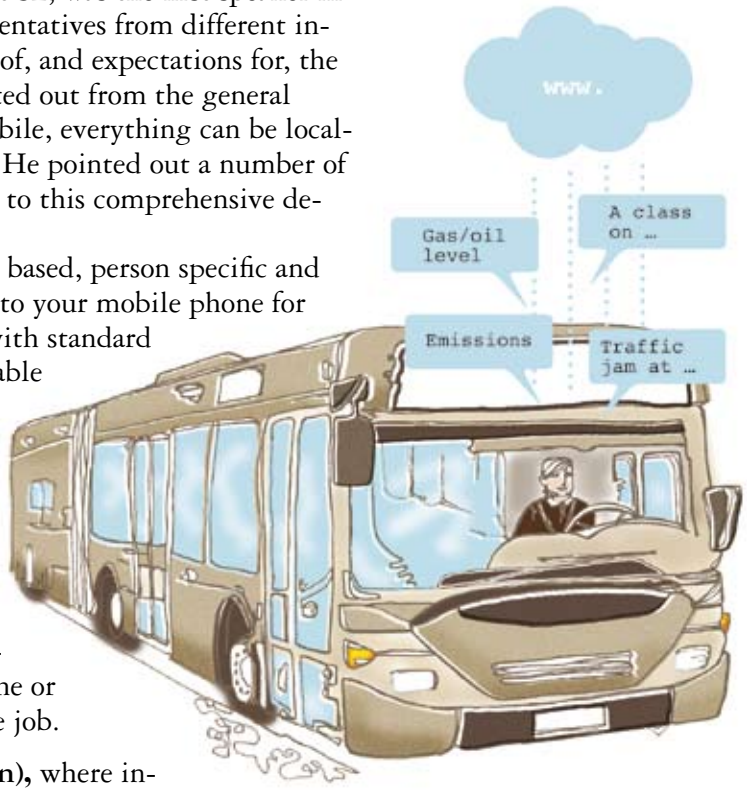

Illustration: © Camilla Laghammar

Åke Lindström, Business Development at SL.

- **Personnel management** where personnel dispersed throughout the public transport system receive role-specific and individually adapted information via a wireless connection.
- **Asset management** where onboard-cameras are used to monitor buses, for example. All road traffic systems at SL's traffic control centre have been integrated onto a platform and supplemented with a decision support system in order to provide better decision support information.

Åke Lindström predicted that the entire traffic system will be integrated and that different means of transport will be combined in the most efficient manner possible.

Good business case for services to private vehicles

As the previous speaker already made clear in his address, the vehicle industry is an area where a lot is happening around the Internet of things. **Martin Rosell,** Managing Director at WirelessCar, came to the seminar to talk about all the telematic services in the pipeline or already available. WirelessCar, a provider of just such services, was formed in 1999 by Volvo AB, Telia and Ericsson, but the company was taken over in 2008 with Volvo AB as sole owner.

Telematics is a term that describes the interconnection between vehicles and telecommunications. Martin Rosell said that things are really beginning to move ahead for services based on telematics technology; WirelessCar received more requests for quotations during 2009 than in the previous ten years put together. But this corresponds quite well with the principle for technology-driven trends, or as Martin Rosell puts it, it takes around ten years from PowerPoint to reality.

Notable among WirelessCar's customers are Volvo cars, BMW, Nissan and the Allianz insurance company. The company provides services on assignment for eight customers in 33 countries on four continents. Despite being owned by Volvo AB, it does business on the open market. The chief interested parties for these services are

vehicle manufacturers and the dealership networks that provide services to the end customer.

In order to be able to use WirelessCar's services, vehicle industry customers will need to invest in equipping vehicles with the necessary infrastructure such as modems, SIM cards and GPS. This is expensive and the industry is extremely cost conscious when developing new models, so WirelessCar strives hard to create real business benefits in the services the company provides. According to Martin Rosell, an important motivator is that the technology makes it possible to provide connected customer relationship management. Say you are planning a skiing trip to the mountains this coming weekend and on the way home from work during the week you receive a message from the dealer who sold you the car that your brakes will soon fail and that an appointment has been made with the workshop to fix them before the weekend; the dealer has not only saved your weekend but maybe even your life and those of your family. You will probably remain faithful to your brand of car for a long time to come. Martin Rosell explained that this is a simple service to arrange today, if only we invest in the infrastructure.

"… create real business benefits in the services the company provides. … an important motivator is that the technology makes it possible to provide connected customer relationship management."

The argument for connected vehicles is above all that the technology can be used in a way that builds trust and loyalty. If a customer can be persuaded to buy original replacement parts or use a certain workshop there is a lot of money to be made. Despite the fact that 70 per cent of car manufacturer sales currently come from vehicles sales, it only represents 30 per cent of net profits, while the relationship is the converse for peripheral services, workshop time, and spare parts etc. — 30 per cent of sales and 70 per cent of net profits.

Logistics companies are among those that can draw great benefit from telematic services through efficiency increases. For example; if they use a service that helps them consume fuel more efficiently they eliminate up to 20 per cent of their fuel consumption, which not only saves a great deal of money but also reduces a company's environmental impact.

Martin Rosell also explained that authorities can draw benefit from connected vehicle technology in a number of different ways such as road taxes, emission controls, dangerous goods transport

Martin Rosell, CEO Wireless Car.

monitoring, anti-theft solutions and last but not least, automatic emergency alarms. The latter is driving telematics forward in Europe today as the EU is in the process of introducing regulation concerning this. Volvo cars, Renault and BMW have all introduced telematic solutions with emergency alarms.

The list of industries that can draw benefit from telematics goes on — financing companies, insurance companies and so forth.

"The Volvo group is to commence serial production of connected vehicles beginning in 2012."

The Volvo group is to commence serial production of connected vehicles beginning in 2012. One great gain for their customers is that the vehicle's driving uptime can increase; the costs for a truck standing idle for a day are extremely high. In order to demonstrate how things might look for a logistics company that uses connected vehicles, Martin Rosell showed a picture from a service that uses Google Earth to display thousands of vehicles spread out across the roads of Europe. It is possible to select a vehicle and immediately know if there is a problem with it and find a solution to it, e.g. a workshop in the vicinity. It is possible to integrate many other services around a connected vehicle based on being able to monitor it constantly and knowing what it is doing.

Hardware that is able to communicate must be installed in order for a vehicle to have the necessary intelligence. The more sensors installed, the more information can be retrieved. Information can be transmitted to the vehicle and from it. For example, if a vehicle's braking system is monitored it is possible to know when the roads are slippery, which can then be passed to a weather monitoring system in order to warn other drivers and thus prevent accidents.

If this type of infrastructure is integrated into vehicles, today's wireless infrastructure will not be able to transfer so much information, but with the 4G network on the way, this will change. However, Martin Rosell believes that telematics will be reserved for more crucial services than pure entertainment. Streaming video for the kids in the back seat or similar services will probably come via ordinary mobile telephones. As Martin pointed out, 90 per cent of everyday car journeys are shorter than five kilometres, so we need to be realistic and use our common sense regarding the services that will come via personal vehicles. He believes in things such as digi-

tal maps, intelligent route planning, rescue services, recovery and guidance to points of interest or services along the way.

Martin Rosell concluded with some real-world examples of services such as BMW's ConnectedDrive services with recovery, information about the closest dealership, emergency alarms and a call centre to ring to find out where the nearest pizzeria can be found, for example. There is a service for Volvo construction vehicles into which a virtual fence can be entered so that an alarm will sound if the vehicle moves outside a given area. This is to prevent vehicles from being used privately without the consent of the vehicle owner. A similar service could be built for the parents of teenagers who wish to keep track of where their children drive to when they borrow the car. Another concept is an eco-rating which will provide feedback regarding how fuel efficient a person's driving is; the idea is to launch a competition around this between Volvo drivers.

A smarter Gothenburg

Business Developer **Lars Bern** from Göteborgs Energi (Gothenburg Energy) was able to tell us about an interesting solution that is fully implemented in Gothenburg, an initiative known as Smart City. The background to this investment is the fact that in 2007 Sweden became the first country to introduce legislation that obliges electricity suppliers such as Göteborgs Energi to base monthly billing on actual consumption. The law made it more or less impossible time wise to manually read every electricity meter, so all Swedish electricity companies today have introduced some form of automatic meter reading system.

Lars Bern, Business Development at Göteborg Energi.

Göteborg Energi, the public utility responsible for electricity, gas and district heating grids in Gothenburg city, handled the new legislation by issuing a request for tender that did not specify a given system but instead requested a given function. This resulted in a system based on the new ZigBee wireless network standard. Göteborg Energi is the first utility in the world to cover an entire city with a ZigBee network and the concept is for it to be able to

be used for applications other than just meter reading. When somebody in the audience asked Lars Bern why they didn't simply use the existing electricity grid for automatic meter reading he explained that it would be difficult to get a sufficient return on investment as it was hard to envisage other areas of use. They chose instead to spend a little more initially in order to get a better return on investment.

Göteborgs Energi has installed approximately 270,000 electricity meters that use ZigBee. In each house and building there is an electricity meter that communicates wirelessly with a local collecting unit which is connected in turn to a network operations centre, either via fibre optics or mobile modem. On average there are 25—30 meters per collecting unit. The entire ZigBee system was supplied by Korea's NURI Telecom.

ZigBee is a low-power wireless network protocol based on the IEEE 802.15.4 standard. It has a range of around 100 metres and a bandwidth of 250 kbps and is suitable for ubiquitous sensor networks. The biggest advantage is low energy consumption which means nodes can use energy from batteries that last several years. Furthermore, ZigBee works in two-way communications, has integrated security, is scalable and supports mesh networks which allow the bypassing of network nodes when necessary. The ZigBee protocol does not currently support IP, but this can be solved with gateways that convert the protocol. Future versions of ZigBee will probably support IP.

The objective of the Gothenburg Smart City project is to provide customers with security and convenience, climate advantages and economic improvements. Göteborg Energi's customers are primarily real-estate owners (landlords). They are happy when they are able to communicate any improvements they make on the environmental front, but in order to reduce their consumption they want to draw economic advantage at the same time, either in the form of reduced costs or increased revenues. They have reduced their consumption, which has reduced costs and allows them to announce that they have done their bit for the environment. Sustainability is a core Göteborgs Energi value and this solution makes a reduction

in environmental impact and operating costs possible through better monitoring and supervision.

Future services under study as additions to the system are such peripheral services as a planned network for charging electric vehicles. They calculate that in ten years a large number of our vehicles will be electrically driven. The ZigBee system is able to add intelligence to a charging network and it will be possible for example to package services that let the consumer know when it is cheapest to charge a vehicle or warn if there is a risk of a fault. They are also looking at connecting the water supply system so that it will be possible to monitor leaks, which are currently around 10—20 per cent. They are also looking at street lighting.

"The ZigBee system is able to add intelligence to a charging network and it will be possible ... to package services that let the consumer know when it is cheapest to charge a vehicle ..."

As mentioned, Göteborg Energi's biggest customers are landlords and what is interesting for them is the ability to meter what individual tenants consume in the way of electricity, water and heating. In this way they can charge for consumption and influence tenant behaviour. Because such costs are often included in the rent, the monitoring of actual consumption can also be a way for the landlord to save money and reduce environmental impact. There are also a lot of security related opportunities for apartment buildings such as monitoring battery levels in fire alarms — often a cause of fires spreading. Different types of sensors can also be used for rapid evacuations and fire service call-outs. Burglar alarms are another possibility.

If we are to reduce energy consumption it is of course appropriate to involve the tenants e.g. through the use of smart sockets capable of doing things like switching off the plasma TV at night. One can also conceive of a fourth screen in every household — after the TV, mobile and computer — that shows energy consumption in a simple way, but which also has other functions such as informing when the next bus will arrive at the nearest bus stop.

Lars Bern also mentioned that future possibilities include:

- **Health care**, where people are treated at home instead of in hospital.
- **Asset tracking** e.g. in hospitals to keep track of various pieces of equipment with the aid of RFID tags.

- **SIM cards** for mobiles to support ZigBee, already introduced by Telecom Italia. Based on this it is possible to build own functions such as localization-based services, chat services or smart locks.
- **Mobile positioning** via a ZigBee net rather than GPS

New ways to care for an aging population

Stefan Lundberg from the KTH School of Technology and Health focused on a future social problem on the macro level that must be tackled by the entire developed world. The demographic shift with lower mortality and birth rates means that populations are aging. As an ever larger proportion of the population passes 80 years of age the need for treatment and care increases, at the same time as there are both fewer gainfully employed available to finance public health care and to work within it. And it's not just demography that is the problem behind attracting a sufficient number of people to work in elderly care; such jobs have low status and young people have no interest in them.

Illustration: © Camilla Laghammar

With the advent of the Internet of things there is an opportunity to use technology to help in managing the problem by transferring more care from institutions and hospitals to the home. It is simply a matter of merging facilities management and health care. Stefan Lundberg explained that in Sweden there are especially good conditions for developing and testing this type of solution because a relatively large proportion of homes are in apartment buildings — 2.5 million out of a total of 4.5 million homes, of which 1.7 million are rental properties. The

Swedish market is also characterized by strong owners who are able to establish de facto standards relatively easily.

One especially wide-ranging problem is the care of dementia sufferers. It is difficult to get a place at an elderly care facility and if a sufferer lives at home it often involves great strain on close relatives. It is largely a matter of assisting those who care for their relatives. Statistics clearly show how an aging population affects the extent of this care requirement; at 65 years old 1 per cent of the age group are dementia sufferers while at 85 years old the proportion rises to 20 per cent.

What will this mean for landlords if the home is to become a functioning care environment? What is required of a health care building? Stefan Lundberg mentioned such things as reliable communications systems, which should be the responsibility of the landlord, UPS (uninterruptible power supply), alarm systems independent of an increasingly unreliable telephone system, electronic locks instead of keys, medicinal waste systems that prevent medications from ending up in drain water and measures to render the working environment safe. Those responsible for the management of such facilities must have health care qualifications so that they are able to provide technological support for health care service providers. They will need a program for handling medicinal waste and finally an organization for 24/7, year-round remote building monitoring.

The necessary systems must however be easy to install as it is not possible to know ahead of time who will need them or for how long. A building's existing infrastructure should be utilized. Stefan Lundberg showed a diagram of what a consultant in the area would like to see as standard solutions. The conclusion there was that wireless systems were not of sufficiently high quality and the attitude remained cold toward the use of IP networks already utilized for Internet connections, TV and telephony. Apartment monitoring sensors that for example measure water consumption and light usage should instead be connected to robust, safe — and also expensive — proprietary telemetry systems. There is scepticism toward

Stefan Lundberg is a researcher at KTH School of Technology and Health.

using Internet-based systems because they are so open. One way to solve this is to extend telemetry systems already in buildings into the apartments.

Telemetry systems can also be used for such things as sensors, reminder signals, emergency alarms and electronic locks. But Stefan Lundberg believes it will be necessary to avoid special equipment if the home is to be capable of conversion to a health care facility. Bearing in mind the scale of things it must not cost too much and therefore we should begin to use the Internet for this technology. He predicted therefore a future transition from closed telemetry systems to open Internet systems, especially for such things as ECGs, the taking of blood pressure and measuring oxygenation.

Regarding the types of illnesses systems such as these can be used for, Stefan Lundberg mentioned — in addition to dementia where he emphasized the need to develop working methods to help sufferers — also lung conditions, cancer and diabetes. In the latter case large sums could be saved at many levels if more people could avoid weekly visits for blood tests.

European Commission comments on regulation and stimulus

Manuel Mateo, European Commission.

A sign that the Internet of Things is a technology on the threshold of a great breakthrough is that the European Commission has begun to involve itself at EU level and has formulated an action plan for the Internet of things. It takes up what the Commission thinks the EU and its member countries should do and consider. **Manuel Mateo** from the Commission was invited to the seminar to talk more about this action plan.

As had other speakers before him, Manuel Mateo emphasized that the Internet of Things is not a new idea but rather something that has been discussed for more than two decades, and which had received a lot of recent attention. The theme he was asked to discuss was “Stimulate or Regulate?” but he highlighted the impor-

tance of remembering that regulation per se can act in a stimulating manner and he referred to the Swedish regulation on electricity billing that indirectly contributed to Göteborg Energi's Smart City investment. The same applies to the eCall initiative which implies vehicles automatically calling in case of emergency throughout Europe.

Manuel Mateo then ran through the main points, which the commission made public in June 2009, after a period of open consultation.

- To begin with, Member States were called upon to think, under the so-called "governance of the Internet of Things", over the types of control and division of responsibility that should apply when the Internet of things becomes part of everyday life. For example, who should be held responsible if the infrastructure stops working? How should it be regulated? Authorities always have the responsibility of safeguarding the interests of citizens.
- Additionally, there are issues of personal privacy and information security to manage. Here again, a point is made on the need to safeguard the citizen's fundamental rights to privacy and confidentiality.
- As individuals become ever more connected to the network environment through mobiles, portable computers, the connected home and security cameras etc., there could also be a way of informing different systems that we do not wish them to know we are there; that they may not register what we are doing. To address this question, different authors have suggested that a "right to thesilence the chips" should be reflected upon.
- Security is also an important concern for both individuals and companies, and is one which the Commission will follow carefully. In the same way, it will follow up the extent to which the Internet of things, like today's Internet, develops as an infrastructure that is critical for society. Should this become reality, Member States should establish crisis plans in order to be able to handle an infrastructure failure.

"... who should be held responsible if the infrastructure stops working? How should it be regulated? Authorities always have the responsibility of safeguarding the interests of citizens."

- The establishment of standards will benefit development by creating interoperability, economies of scale in manufacturing, low market barriers and fair competition. The commission is monitoring developments here and is open for suggestions. It is important to ensure standards are developed in an open and transparent manner, characterized by consensus.
- The Commission is also participating in financing research and development in the area, among other things through investments in green cars, energy-efficient buildings, factories of the future and the Internet of the future. It sponsors innovation through the support and encouragement of various pilot projects.
- In order to support global developments the commission has also established close international dialogues around these issues with countries such as the USA, Japan, South Korea and China.
- One issue the commission wishes to evaluate is the adverse effects that RFID tags, which are made of different metals, can have on the recycling . At the same time, the tags may aid the source sorting process.
- The commission points out in the conclusion to its action plan that the technology is in its infancy and it is therefore continually monitoring events, among other ways through beginning to publish statistics about the Internet of things via the EU Eurostat statistics office.

Manuel Mateo concluded by expressing a hope that in our discussions about the Internet of things we remember the important role so-called social engineers can play in developments. They work with how people accept/reject and interact with technology. The think tank *The Internet of things Council* focuses on this aspect of the Internet of things and Manuel Mateo recommended their website at www.theinternetofthings.eu.

Panel discussion concluded

All of the speakers at the seminar participated in a final discussion where, among other things, the issue was raised of whether we will witness a ketchup bottle effect with ever more applications of the Internet of things. The panel was of the opinion that there is a pretty broad aversion toward the introduction of new technology, but at the same time much happens without people in general society knowing a great deal about it — the monitoring of trucks for example.

"... we must be honest and admit that personal privacy and company confidentiality are big issues and they present a hurdle to get over in some way if the technology is to flourish."

The focus on combating climate change was highlighted as an example of a possible driving factor. However, developments may lead quickly to the occurrence of many new business opportunities as illustrated by the example of power companies and wireless networks where it is possible to add new systems for services to e.g. the home, the car and buses.

Regulation by authorities was a recurrent issue in the panel discussions, and there was great unity for regulations to address functions and processes, but not technology per se. This was perhaps hardly surprising considering the fact that most of the speakers were engineers of one kind or another.

Privacy issues were also taken up, and here the panel showed great respect for the potential problems. The objective of storing information must always be transparent. As Manuel Mateo said, we must be honest and admit that personal privacy and company confidentiality are big issues and they present a hurdle to get over in some way if the technology is to flourish.

Glossary

4G — Fourth generation mobile communications that comes beyond 3G and chiefly is meant for ultra broadband Internet connection, with speeds of 100 megabit per second to mobile users.

6lowpan-header compression — 6lowpan stands for *IPv6 over low-power wireless personal area networks*. It is a compression mechanism that makes it possible to send and receive IPv6 packets via low-power radio using the standard IEEE 802.15.4, which works with very low bandwidth and power consumption.

API — API stands for *Application Programming Interface* and constitutes an application's interface to other applications, i.e. the set of rules you must follow when developing applications that will be able to communicate directly with a certain application.

EPCIS repository — EPCIS stands for *Electronic Product Code Information Services* and is a standard for accessing and sharing data connected to the electronic product codes that are stored in, for example, RFID tags. An EPCIS repository is a kind of database for storing and providing access to this information.

gateway — A gateway is a network device or software run on a computer in the network that can communicate with other networks, even if these use a different protocol.

GPRS — GPRS stands for *General Packet Radio Service* and is a platform for mobile data services in GSM mobile telephony networks.

IP — IP stands for *Internet Protocol* and is one of the most fundamental protocols used for data communication on the Internet.

IPv6 — IPv6 stands for *Internet Protocol version 6* and is a new version of IP, where the addresses are made up of 128 bits and the number of addresses possible is huge.

low-power radio network — This is also refered to as WPAN (*Wireless Personal Area Network*) and is a network with limited range that enables smart objects to communicate with each other wirelessly. Besides the standard IEEE 802.15.4, which is mentioned in this document, Bluetooth is another example of a low-power radio standard.

NAT — NAT stands for *Network Address Translation* and is a technology that enables the connection of several computers to an Internet connection with one or a few common IP adresses.

RFID — RFID stands for *Radio Frequency Identification* and is a technology for reading information at a distance from transponders and memories in RFID tags. The most common kind of RFID tag has a very simple design and sends out a unique number a short distance.

single sign-on — When you only have to enter your name and password once in order to get to several password protected systems in one working period. Once you have logged in, a central network application sees to it that you will be able to access all the resources that you are entitled to.

ubiquitous computing — Systems that are integrated in their surroundings and easily accessible whenever, without traditional interfaces like screens and keyboards.

XML — XML stands for Extensible Markup Language and is universally used to describe content on websites or other information that can be read by machines.

ZigBee — ZigBee is a low-power radio protocol based on the IEEE 802.15.4 standard. It has low power consumption, a range of about a 100 metres and a bandwidth of 250 kbps.

Sources for this glossary outside the seminar: Wikipedia and Computer Sweden's language website

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- **IPv6 and DNSSEC** are two important technology projects aiming to secure the stability of Internet infrastructure. Read more: ipv6forum.se and dnssec.se
- **Bredbandskollen** Broadband Check is Sweden's only independent consumer service for checking a broadband connection directly in a web browser. Read more: bredbandskollen.se
- **Internet Statistics** The goal of the Internet statistics project is to ensure access to current, reliable and interesting statistics and facts about the Internet in Sweden. Read more: internetstatistik.se
- **Internet fund** .SE's Internet Fund is a way for .SE to finance Internet development by supporting independent projects. Read more: iis.se/en/se-ar-mer/internetfonden/
- **Internetdagarna** is .SE's annual conference for Internet professionals. Read more: internetdagarna.se/pages/english

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