Final report from the VINNOVA-funded project
Consumer-Facing Internet of Things products

Executive Summary

The consumer-facing IoT-product eco-system is on the one hand at the top of the Gartner hype-curve, with a predicted turn-around somewhere between 275-1600 BUSD, and at the same time struggling with a whole range of issues that prevents its growth. The problems can be summarised as:

- missing **de facto standards** for communication, wireless connectivity, data, sensors and actuators
- missing IoT-platforms connecting smart objects without locking consumers and their data into **proprietary** solutions, belonging to big companies, not sharing it between applications and settings
- missing **use-case infrastructure** providing compelling applications desirable to consumers, beyond creating 'Thing +1': that is, everyday objects to which an internet connection is added, without adding much to the utility or user experience
- requires **new business models**, which in turn often requires completely new business ecosystems to be built. This requires companies and organizations to cocreate on a level that has been rare before
- a lack of **design thinking** to bring out compelling solutions and applications
- missing **killer interface paradigm** that can go across many different services, domains, situations, as you move between your home, garden, city, public transportation and so on, to make interactions compelling rather than nightmarish
- lack of **privacy** solutions in existing platforms hindering developments

These problems can be seen as obstacles or opportunities for the Swedish IoT-ecosystem to take on and attempt to tackle in order to unleash its, potentially, huge commercial potential, and bring solutions of relevance to society and consumers. We propose engaging in the following topics:

- **If it is not for all, it is not a revolution:** IoT standards – of various kinds – need to support everyone, including those less affluent, elderly, young, those with illnesses or disabilities
- **Open data and data standards:** to unleash creativity and bring out compelling use cases, open data in structured data standards are required
- **People in power need to procure & regulate:** we need highly engaged, knowledgeable politicians and industry actors to engage, meet, and bring out the necessary policies, regulations and "first buyer" situations that will drive the development forwards while at the same time protecting consumers and citizens
- **Interdisciplinary knowledge and training – design thinking:** education to train professionals from many different backgrounds in what IoT offers is needed in order to bring out compelling and relevant IoT-solutions
- **Branding Sweden as an IoT-nation:** Swedish standards, values, participatory processes and the overall Scandinavian design model could help place Sweden on the map, once again making Sweden into a testbed and innovation hub in the world

Consumer-Facing Internet of Things products

1   Project goals

The project set out to tackle two goals. First, to map out and predict the **size, focus and commercial** potential of IoT for the already existing consumer-product companies as well as consumer-facing IoT-start-ups in Sweden today. Second, to identify **common problems** – be it technologies, toolkits, infrastructure, design competence, creative disruptions in business modelling or spectrum access – for this sector, both from the developer and end-user perspectives.

We saw a great potential in the area as many components are in place for taking the first steps towards strategic leadership in this area. Strong commercial actors (large and small); long experience of research and development where academic and industrial researchers join forces; the Swedish legacy of IT leadership and public transparency (as open data will be necessary); strong tradition of design-led development of high-tech products and services.

To address the goals, we put together a strong consortium, consisting of some of the most forward-looking industrial actors and research centres including Ericsson, Yanzi, Husqvarna Group, IKEA, Sophiahemmet, Boris Design Studio, Ziggy Creative Colony, WeMeMove, BioSync Technology, Twiik, STING, Arvax, Mobile Life, SICS, Wireless@KTH, Uppsala University, IOTAP.

The project focused on IoT for domestic, body-based and games purposes.

2   Background & motivation to project

As consumers, we are looking for technology that fits with our everyday lives, inside our homes, in our pockets or even on our bodies, not because it makes us more efficient, but because it is *desirable*. Today, we note how consumers have started buying Internet of Things-products. The growth has been spurred by the increasing commercial success of IoT devices – devices such as the Google's Nest, Fitbit, Philips Hue and Belkin WeMo. These devices, and the Internet of Things more broadly, are dependent upon longstanding technical advances in fields such as ubiquitous computing, distributed systems and low power electronics. However the proximate cause that has made these products successful has not been purely technical but innovative design and business models. The Nest worked in a completely different way from earlier thermostats; the Fitbit supported a new type of use; and the Hue and Wemo made use of connected smartphone apps.

Clearly the Internet of Things is not a solely technical endeavour; it is dependent on understanding new uses, user needs and innovative, desirable design, because despite its importance in our lives. Technology is still frequently frustrating, dehumanizing, or just plain boring. While our everyday life is *saturated* with technology, our relationship to it is still very far from perfect.

3 Empirical work & joint workshops

Several different empirical studies were completed in the project – each described and attached as appendices to this report:

- A thought leader interview with 25 interviewees from companies such as IBM, Google, Ericsson, Yahoo as well as start-ups (Lewandowski & Mercurio, submitted)
- A study of people's homes, documenting any existence of interactive objects in the home, ranging from entertainment systems to setups for performing work from home (Glöss & Tollmar)
- A study of sports applications, determining what is needed to maintain interest in IoT products beyond the novice excitement (Markendahl)
- An attempt to scope the size of this market (Gullikson)
- A study of opportunities and challenges of IoT for Health or "Connected Health" (Titkova)

Apart from regular project meetings, we had two joint work activities in the project – results from each are attached as appendices to this report:

- A two-day synthesis workshop in August 2015, where all the empirical material was used as a basis for a future scenario exploration (using scenario analysis)
- A brainstorming day with Julian Bleeker where we mapped out the future through designing a fictive IKEA-catalogue for the year 2040. The fictive catalogue contains e.g. the Unconnected Sofa, a sofa that is extra expensive as it is not connected to the internet.

The results of each individual study and activity in the project can be requested from the project manager, Kristina Höök.

4 High-level insights gained

Putting all our empirical material alongside the considerable expertise of the project partners, we derived some high-level conclusions.

First, it is clear that Internet of Things is thriving in contexts where there is already a lot of technology integrated with some controlled process, such as in factories, mines or other closed systems. The reason is that the whole infrastructure can easily be put in place, there is no need to rely on non-existent standards for wireless communication protocols or unreliable sensors placed in settings where the companies do not have any control. All the data can be shared as it is a closed system.

The consumer-facing smart products, on the other hand, are still facing difficulties. Let us outline some of the obstacles hindering development, before we discuss a couple of unique Swedish opportunities in the general field of consumer-facing IoT-products.

4.1 Obstacles

The project identified several obstacles that need to be removed before consumer-facing IoT-products can be launched on a big scale.

4.1.1 De facto standards

First, there is a lack of ***de facto standards*** for communication, wireless connectivity, and there are worries amongst industrial actors about unreliable sensors and actuators placed in messy environments, such as the home or city, where they have to interact with technologies of different origins and ages.

4.1.2 Walled gardens

Second, there is a lack of IoT-platforms connecting smart objects without locking consumers and their data into ***proprietary*** solutions, belonging to big companies, not sharing it between applications and settings.

4.1.3 Compelling use case infrastructure

But what was most often mentioned in our thought leader interviews as well as inferred from our study of people's homes, was the lack of integrated interface solutions and compelling use cases – or as one of our interview subjects expressed it: the lack of a ***use case infrastructure***. As long as this is lacking, actors on the market as well as consumers are not willing to take risks and invest in systems, applications and smart objects that might not deliver what they promise.

Let us develop the complexities of this somewhat. If each smart object you buy for e.g. your home comes with its own mobile app that needs to be installed and managed, using proprietary platforms that do not allow for sharing of data between applications, interesting applications cannot be built and therefore consumers remain reluctant to buy. This in turn makes it doubly hard to create use cases that thrive on data from several different machines or data sources. Without several data streams from different machines or processes in your environment, we will not be able to deliver those compelling use cases. Nobody is interested in a fridge that connects to the internet to tell you that its temperature is within the normal range – the user experience and benefit from this use case is lacking. It is only when all your household machines are connected, streaming their data in a unified format to open platforms that we can create entirely *novel* applications, such as really controlling energy consumption or other tedious information.

We not the development of HomeKit[1], HealthKit[2] and similar platform solutions that again will put the main profits with Apple and Google.

The problem of sharing data between applications is particularly true for e.g. biosensor data. If an app can only access either your bicycle data or your FitBit data, but not both, it becomes hard to make new interesting applications thriving on both.

The home is currently the target of most IoT consumer product offerings, yet as was noted, the notion of automating your home is not something most people find necessary or appealing. When it comes to controlling lights (remarked upon as the 'sweet spot' for IoT), light switches are more reliable, easy to use, and allow users to control individual lights. The point being that for most, managing light switches is currently not problematic enough, the product offerings may not

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[1] https://developer.apple.com/homekit/
[2] https://developer.apple.com/healthkit/

be compelling enough, or the market may not be mature enough to justify the switch to an IoT setup. One UX design consultant with clients developing consumer IoT products framed the issue with sarcasm, "*It's so hard to turn on my light switch. I can't do it.*"

We end up in a situation where the offered IoT-services and smart objects become quite limited, not really addressing a real need or a delightful interaction. For example, we see many "Things +1", that is, everyday objects to which an internet connection is added, without adding much to the utility or user experience, such as e.g. an egg minder keeping track of how many eggs you have in your refrigerator.

In addition, each of these smart objects does not add enough value to warrant all the work we have to invest in them – "value-added ≥ maintenance". That is, smart objects or applications need to convey a perceived value that is higher than the requirements on maintenance, such as upgrading software, dealing with battery consumption or repairing sensors or actuators.

4.1.4 Business models – painful transformations

The problem is often not just the product itself, it is the ecosystem around it.

Rather than selling a car, tomorrow's sustainable business models will primarily innovate new service offerings based on autonomous vehicles in smart environment, where individuals pay for comfort level and distance rather than today. This (and in owning the platforms that make it happen) is where the big value add will come.

In addition, consumer-product companies like IKEA or Husqvarna, take a very high risk if they enter into this domain with the wrong data format, wrong wireless communication protocol, or faulty business model. A sofa from IKEA is used for 10 years and any sensors or actuators placed in it, needs to come with the same life-span, robustly keeping it up to date (similar to how a Tesla is delivered with a software upgrade once a month through a licensing agreement). It is an entirely different business model to enter such a long-term relationship with a customer instead of selling a product once and for the all after which the customer relationship is over. On the other hand, if you can enter into a long-term relationship with your customer, you can build loyalty and delightful products with licensing business models – entering into the age of sharing economy. The traditional consumer-product companies are therefore worried that the big telecom- or IT-companies might come in and take over this side of their business, ultimately disrupting their business, reducing them to "hardware" providers – a notably less lucrative role.

4.1.5 Trust & privacy

In some of the scenarios we worked with in the workshop, the risk of a failure for IoT was strongly connected to situations where consumers cannot trust the companies (or governments) with their data. IoT thrives off data, without data there are no services.

Largely, trust is not the main issue from a consumer perspective, but uncertainties around the issue creates a lot of hesitation and risk aversion within business.

Legislation is an issue. In many areas, it is unclear what information can be used and how. Other times, data that would be beneficial for society cannot be shared or used.

4.2 Opportunities

At the same time the hype-curve (according to Gartner) for IoT is at its peak. There are estimates saying that this market will have a turnaround of somewhere between 275-1600 BUSD (Gullikson).

While the complexities of the interdependencies of an ecosystem in formation are far beyond what this particular project can tackle, there is a window of opportunity for researching and creating key puzzle pieces that strategically support Swedish industry to focus on a compelling, delightful use case infrastructure for consumer-facing Internet of Things products.

The project identified several interesting opportunities that would be of benefit not only to the commercial market, but also to create for a better society.

4.2.1 Health and wellbeing

Health and wellbeing was identified as a strong market. We can already see a growth in sports and wellbeing applications (Gulliksen, Markendahl).

We see new opportunities arising focusing on life-long illnesses and life-style related problems. Various forms of IoT, such as sensor-based diagnosis and management, interactive applications supporting movement or meditation, may help in dealing with stress-related illnesses, diabetes, MS, obesity and encourage movement and exercise.

In the project we have done some findings related both to end-user experience as well as to market aspects and potential business models for products and services based on IoT and connected devices for sport and wellbeing.

When it comes to solutions and devices linked to market structure and business aspects we can make a number of observations:

- Current health apps and devices make use of or depend on smartphones
- For both sport and healthcare applications the telecom industry look into standalone devices directly connected by cellular systems
- The market is very fragmented with a multitude of solutions and devices
- The end user value varies and depends on the service context
- There are several business model options (different revenue potential), ranging from selling a device to providing services on top of one or several devices.

4.2.2 A new take on Folkhemmet

A potential market, as of yet unexplored, would be if Sweden showed the way towards a society where IoT is serving all – a new "folkhemmet".

Sweden has a long-standing tradition of participatory influence on technology developments. Democracy on local as well as national level has been driving societal developments. The aims of the society has been to give everyone equal opportunity and provide everyone with reasonable living standards. The IoT-development needs to pick up on these values and make sure that the benefits of the digitalisation is for all.

Historically, Swedish industry has benefitted immensely from those goals. When the state required that everyone in Sweden could be reached by telephony and later by broadband, Ericsson and Televerket (Telia) collaborated and created technical solutions that were later exported. The 24/7 principle of how we can reach authorities has pushed municipalities, the health organisation and the state to very early on digitalise many of their services and ways of working, in turn building a strong IT-industry in this sector.

In industry, we note how, e.g., the strong values of designing for "the many people" that has governed the development of IKEA enforced highly innovative thinking, shaping their products and solutions to make them affordable.

In general, the Scandinavian design model, forming both aesthetic ideals of the light, easy-to-use, accessible and beautiful, as well as forming strong participatory values, has been of great benefit to shape and brand Sweden and Swedish industry.

Similar values should govern the development of IoT in Sweden: participatory developments, democracy as a strong driving factor, equal opportunities in reaching and benefitting from the digitalisation of society, healthcare, wellness, homes or leisure time activities.

We need to reduce fragmentation and support open platforms to make this happen. IoT solutions need to become affordable and of benefit for all.

4.2.3 Smart Data Layer

As noted above, the real benefits from digitalisation, is sometimes only achieved when many objects, services and processes are connected. Only then is it possible to create innovation that go across many different data sources, governing interesting 'actuation' in the world. One way of putting a finger on the problem, would be to think of it as a *smart data layer* that many different applications can thrive upon.

A smart data layer requires access to several continuously streaming data sources. It requires orchestration, access to open data, and a uniform way of treating the interaction without relying on a centralised system, owned by one stakeholder. To have any effect, it needs to go across several applications, produced by different stakeholders.

While this may seem utopian, we can compare it with the web- and mobile-based applications. Data is collected both 'locally', for each service on the net, using cookies, location as well as other sensors (such as the gyro and camera in mobiles). Data is also collected across applications, using both proprietary data, but also any open data sources available (see e.g. the open data initiative at Stockholm City Municipality). Translations systems are built on data from the whole web using, e.g. wikipedia. Predictions of the future or identification of terrorist acts is done through harvesting data from the net, social media and mobile interactions (as in the works by companies such as RecordedFuture). All this modelling allow these services to silently adapt the interacting for us, filling in fields for us, showing us where we are on a map as well as where a nice restaurant can be found nearby or where the next Über-taxi will be coming from, placing relevant adds in front of us, pro-actively adapting the prices of the trips we are planning, placing the systems in the right context for us to use. Obviously, not all of these interactions are benevolent, and strong regulations and policies are needed in

order to protect consumers and organisations from crimes and intrusions. But overall, it has made interactions accessible, easy to understand, better integrated with our everyday activities. We need a similar development for the IoT apps and services. If such a smart data layer was available, many applications and smart objects would be better fitted to our everyday practices and thereby easier to use as well as more relevant to us.

5   Recommended actions

To remove some of the obstacles that are currently hindering development in this area, we jointly arrived at the following recommendations.

5.1   If it is not for all, it is not a revolution

As IoT and the digitalization of society and industry is potentially disruptive, changing everything from business models to how the government organises its work, it is of key importance that the government provides support for technological equality – if it is not for all, it is not a revolution.

IoT standards – of various kinds – need to support everyone, including those less affluent, elderly, young, those with illnesses or disabilities. This becomes key in any products aimed for consumers. The interfaces must be accessible to many, that is the way upgrades are made, the maintenance, the ways in which they serve us, helping us to save energy in ours homes, improving our healthcare system, or any of the other visions for IoT, must be *usable for all*.

5.2   Open data and data standards

To unleash creativity and bring out compelling use cases, open data in structured data standards are required. The more data we can make accessible to entrepreneurs, companies and institutions, the more likely it is that we will innovate services of relevance to consumers and citizens. We need to reduce fragmentation and support open platforms. We might even need to regulate against proprietary data solutions when the data is thriving off people who are not getting paid to share it, or when the government is gathering the data. We would like to emphasise that the IoT development is not so much about technological standards as it is data standards.

In addition, data can serve interesting bridging roles. Health data for research as well as for innovative health services creating bridges between consumer facing products (e g smart watches) and the health sector, or within the transport sector and ODB2-connected consumer products in vehicles.

Sweden lacks structured governance for such standards, which should be a given task for authorities such as Transportstyrelsen, eHälsomyndigheten.

5.3   People in power need to procure & regulate

IoT has the potential of addressing major societal problems – healthcare, wellbeing, efficiency in use of joint infrastructures and (energy) resources, as well as more compelling and aesthetically appealing applications for end-users. But in order to do so, we need highly engaged, knowledgeable politicians and industry actors to engage, meet, and bring out the necessary policies, regulations and "first buyer" situations that will drive the development forwards.

This in turn requires that knowledge on IoT spreads to industry actors as well as politicians and that meeting arenas are created where these discussions can take place.

We foresee huge problems with privacy and trust, unless regulations and policies, foreseeing the complexities of these new interactions, can be put in place

5.4 Interdisciplinary knowledge and training – design thinking

As discussed above, doing design in this area requires interdisciplinary knowledge. We need to educate more designers (whether engineers, industrial designers, political science, business economics or some other professional background) to work in this complex landscape.

In particular, we would like to emphasis the importance of design knowledge and design research. Design thinking supports investigations of "what may be rather than simply what is". Training in design thinking helps not only those who are professional design practitioners, but anyone aiming to create innovative solutions. In a design-driven process, the exploration of a problem is done through creating many imagined solutions, opening a whole design space, solutions that in turn help us see what the problem really is and what may address it properly. We gain new knowledge via the act of making. This can be applied to problems that are otherwise framed as wicked problems (problems where there is no obvious simple solution).

In interdisciplinary teams (such as the one behind this project) where everyone has sufficient understanding of what IoT is and might offer, design thinking and designerly ways of working can bring out highly innovative and compelling applications and services.

5.5 Branding Sweden as an IoT-nation

We see an opportunity to brand Sweden as an IoT-nation. The Swedish standards, values, participatory processes and the overall Scandinavian design model could help place Sweden on the map, once again making Sweden into a testbed and innovation hub in the world.

6   Authors & acknowledgment

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