Technical Report TR2011-001

Innovation Radar
Citizen-centric Cities

December 2011
Synopsis:
Technical Foresight Report on Citizen-Centric Services for Digital Cities, based on Open Architectures and Social Computing. The report includes trends, challenges and recommendations as well as state of the art for further TDCT activities and carrier project proposals.
Executive summary

This report aims to identify trends, challenges and recommendations in regard of Citizen-Centric Services for Digital Cities of the Future. This foresight will help expose future themes with high innovation and business potential based on a timeframe roughly 15 years ahead, or 2030! The purpose is to create a common outlook on the future of ICT and to establish a strong community across EIT ICT Labs nodes and partner organizations.

Trends

1. Information technologies are very rapidly converging and evolving into pervasive services where the users no longer consider that they interact with computing systems.

2. The European citizens use of the Internet will soon become ubiquitous, where mobile access and applications based on open data are two important enablers together with social computing aspects.

3. People from Generation E are increasingly different from previous generations, through acceptance and adaptation to modern computing and communication technologies.

4. The European legislation is already requiring governmental bodies to provide access to open data (PSI Directive). The provisioning is however not yet generally widespread but by 2030 most municipalities and governmental bodies are expected to provide open data access.

Challenges

1. To motivate municipalities and governmental bodies to invest in openly accessible databases that support (near) real-time procurement of data.

2. To enable automatic creation of micro-communities based on social context while using proper user and identity management.

3. To support virtual communities in the future digital cities, enabling a ‘village’ feeling based on social context.

Recommendations

1. Use Sweden as a test-bed for Europe due to the widespread acceptance and adoption of new technology.

2. Utilize social computing to make (communication) services more pervasive and easy to use.
Open Data in combination with Social Computing and User-Centric Design are key to enabling Citizen-Centric Cities, where for instance virtual communities can achieve an increased social inclusion through enabling a ‘village’ feeling based on usage of social context. The Digital City of the Future is one of the areas most prone to new innovation due to the combination of personal needs and empowerment.
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# Table of Contents

Executive summary .......................................................................................................................... 2  
Document Details .......................................................................................................................... 4  
Contributors .................................................................................................................................. 5  
Table of Contents .......................................................................................................................... 6  
Foreword by Michael Nilsson ........................................................................................................ 7  
Foreword by Khalidoun Agha ........................................................................................................ 9  
1 Introduction ................................................................................................................................ 12  
  1.1 Outline ................................................................................................................................... 12  
  1.2 Exponential Growth of Technology ......................................................................................... 12  
  1.3 Swedes and the Internet 2011 .................................................................................................. 14  
  1.4 Generation E ............................................................................................................................ 15  
  1.5 Scenario - TrekService ........................................................................................................... 15  
  1.6 Scenario - Social Group Communication .................................................................................. 17  
2 Background ................................................................................................................................. 19  
  2.1 Open Data ................................................................................................................................ 19  
    2.1.1 The 8 Principles of Open Government Data ...................................................................... 19  
    2.1.2 The European PSI Directive ............................................................................................... 20  
    2.1.3 FIREBALL ............................................................................................................................ 21  
    2.1.4 Open data in the UK ............................................................................................................ 22  
  2.2 Social Networking and Group Communication ....................................................................... 23  
    2.2.1 Social Graphs ...................................................................................................................... 23  
    2.2.2 Social Recommendation ..................................................................................................... 24  
    2.2.3 Social Recommendation Framework .................................................................................. 25  
    2.2.4 Socially Aware Applications ............................................................................................... 26  
  2.3 User-Centric Design ................................................................................................................ 28  
    2.3.1 Service Innovation .............................................................................................................. 28  
    2.3.2 Design of Citizen-centric Services ..................................................................................... 29  
    2.3.3 Users as Actors or Factors .................................................................................................. 29  
    2.3.4 User Toolkits for Citizen-centric Service Design ............................................................... 29  
    2.3.5 Dynamic and Sustainable Business Models ................................................................. 30  
    2.3.6 SatinII .................................................................................................................................. 31  
      2.3.6.1 Mobile Application Development - Background and Trends ................................ 31  
      2.3.6.2 Technical Building Blocks ........................................................................................... 32  
      2.3.6.3 Co-creation of Mobile Services .................................................................................... 35  
  2.4 Ethics – Privacy and Integrity .................................................................................................... 35  
3 Foresight Results .......................................................................................................................... 37  
  3.1 Trends ....................................................................................................................................... 37  
  3.2 Challenges ............................................................................................................................... 37  
  3.3 Recommendations ................................................................................................................... 37  
4 Conclusions .................................................................................................................................. 38  
References ...................................................................................................................................... 39
Foreword by Michael Nilsson

By the end of 2008 a milestone was reached, there was now more people living in the cities than outside. This has of course affected and will even more affect people’s life in the future. A higher density of people creates its challenges, problems and needs.

Today’s society and economy is totally depending on a working and always accessible Internet 24/7. This fact changes and creates opportunities among people in cities and elsewhere. In the cities there is a high density of almost everything and therefore the need of services is special - citizen centric services.

Early 2010 the topic Smart Cities was not very much known in the research community of Future Internet (FI). So far FI had focused on the next generation internet, building large scale test-beds, having in mind that this is a 30 year old design. Visions like 50 billion connected devices by the year 2020 (Ericsson), Internet of things creates new opportunities.

The last ten years another topic called Living Labs, sometimes also described as open user driven innovation, entered the European research scene. Methods, tools and processes have been developed in how to involve users as co-creators and this in parallel to FI research. Today there are tools ready to be used involving end users, many end users, to participate in the development of new services and products as co-creators. Not in the end of the product development cycle but early, for, with and by, the users of the new services/products. These new services can be developed by the end users in the cities (citizens).

Up to now many services that already from the start didn’t attract a huge amount of potential customer was never created. Phenomena like the entry of the iPhones and Android mobile phones completely changed the game plan in the telecom world. Services for a very small group of users was possible to develop to a small cost and by the users of their own. Still though, you have to be a rather skilled “programmer” to create a mobile “app” or service so the challenge today is to lower the threshold, the barriers of becoming a “programmer”.

By providing the users, the citizens with tools in order to make their own mobile services the expectation is booming regarding potential new needs to be solved by citizens developing their own services. Internet of things, 50 billion connected devices, open and accessible public data, both from static servers in the city but also by dynamic sensor data in the street will create a totally new scenario about a more intelligent use of smart technology creating a better quality of life and entrepreneurship in cities.
Initiatives today like (www.fireball4smartcities.eu) brings together communities of Future Internet Research and Experimentation (FIRE), Living Labs (Open user driven innovation) into the cities fostering the connected SMART Cities community.

One definition of a Smart City is “We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communications infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance” (A. Caragliu, C. del Bo, P. Nijkamp (2009)).

The trend is to allow anybody to become a developer of services, even for a small target group usually not in focus by telecom operators and thereby contribute to a better society in many aspects, step by step. Smart Cities is very close to the thematic area Digital Cities within the EIT work and the importance of citizen centric services can not enough be seen as a strong driver of new services, products and companies but to reach full effect, there is also a need to lower the threshold, provide the tools, and utilise peoples creativity and the cities advantage as a multicultural melting pot driving societal changes will reach its full potential.

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Foreword by Khaldoun Agha

Digital Cities of the Future

Democratic city space through a citizen centric model

Statistics, forecasts and population studies confirm the continuous migration of population towards cities. There, people find jobs, better access to services and living conditions improvement. The current urban environment is not adapted to this massive migration. This means, new challenges in the fields of security, environmental issues, transportation systems, water distribution and – more general – resource management will rapidly occur.

Today, large cities are faced with problems such as waste or misuse of resources, which could be changed by increased in-time information. In Digital Cities, people will arrive just in time for their public transportation as exact information is provided to their device in due time. Even parking your car will be easier as free parking spots around you are shown on your device. Real time information will always be available to optimize time, save energy and make life easier.

Always connected - everywhere

The Citizen-Centric Cities (CCC) is a new paradigm, allowing governments and municipalities to introduce new policies. This enhances the participation of citizens in the information, decision, and implementation processes for a better life in the city within democratic governance. These new policies will aim in particular at increasing the awareness of the citizens of their individual and collective capabilities, both in the decision making process and in the implementation of these decisions. The ultimate goal in this area is to realize a migration from the customer-centric to the user-centric model.
Digital Cities – from people to people

Citizen participation could take different forms:

- Collection of data to be broadcasted, or to be used to analyse and “sense” the status and the dynamics of the city
- Citizen participation in democratic decisions for the evolution of the city
- Execution of necessary actions to improve the city’s performance and sustainability

Expected Results

To realize the CCC model, ICT will provide tools to offer facilities and features for citizens. Those tools could be summarized in the following items:

- Create infrastructure to offer large-scale telecommunication systems to facilitate data exchange
- Provision of distributed schemes for scalable systems aiming at large numbers of participants
- Optimized data management
- Identification, security and privacy
- Customized and new intelligent services
- Intelligent and ergonomic Human Machine Interface
- Business model innovation: an open foundation of software/service components that can be utilized for building highly personalized services
- The business and innovation model is based on engaged citizens supported by the digital cities open foundation for service creation.

Foresight

The EIT ICT Labs foresight studies will help achieve the expected outcomes in the area of Citizen-Centric Cities (CCC). We believe that the probably key drivers of innovation are the citizens themselves based on their own needs and skills.
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EIT ICT Labs Thematic Activity Line Leader for Digital Cities of the Future
1 Introduction

This technical report is part of the EIT ICT Labs Foresight Study and Innovation Radar within the thematic action line of Digital Cities of the Future (TDCT), through the Digital Cities Spearhead activity (10890).

The report aims to identify key trends, challenges and recommendations in regard of Citizen-Centric Services for Digital Cities of the Future. This foresight will help expose future themes with high innovation and business potential based on a timeframe at least 15 years ahead, or 2030! The purpose is to create a common outlook on the future of ICT and to establish a strong community across EIT ICT Labs nodes and partner organizations.

1.1 Outline

Chapter 1 introduces characteristics for future citizens and presents a few scenarios for citizen-centric services based on open data. Chapter 2 gives background information on open data, social networking and user-centric design. Chapter 3 presents trends, implications and recommendations with a 2030 baseline in mind. Chapter 4 draws conclusions for future EIT ICT Labs activities.

1.2 Exponential Growth of Technology

"We won’t experience 100 years of progress in the 21st century - it will be more like 20,000 years of progress (at today’s rate). There’s even exponential growth in the rate of exponential growth."

- Ray Kurzweil

Figure 1, Kurzweil’s predictions based on Moore’s Law (Courtesy of WikiPedia).

The predictions made by Gordon Moore and Ray Kurzweil builds on that the number of transistors that can be placed inexpensively on an integrated circuit doubles approximately every two years (Moore’s Law). This exponential growth is a
phenomenon found in regards of many related technologies and can according to Kurzweil be explained by the fact that each technological development builds on previous ones, thus accelerates accordingly. By 2030 the cost of computing will have passed the point where we for 1000 USD could buy a computer with an equal capacity to the human brain (see figure 1 above).

Figure 2, Development in Speed and Latency (Courtesy of Ericsson Research)

This acceleration is reflected on network technologies (as depicted in figure 2 above). A prediction is that we by 2030 will have near ubiquitous network access through interworking heterogeneous networks. Recently developed technologies like software-defined radio and antennas integrated into LCD glass etc, shows that the Internet technologies can be pervasively integrated into almost anything.

Ericsson’s prediction\(^2,3\) is that mobile broadband is to grow explosively, with a subscriber growth to 3.4 billion by 2015, and that up to 50 billion devices are expected to be connected by 2020. They also envision the social web of things\(^4\) where everything is connected and acts within a social context. A challenge will be to integrate these technologies pervasively into society.

Alan Kay, Apple Inc, stated that what we are experiencing is “the 3\(^{rd}\) paradigm of computing”, where ubiquitous computing (one person, many computers) will replace the paradigms of mainframes (one computer, many people) and personal computers (one person, one computer). The advent of cloud computing hints at a more complex reality where all paradigms are intermixed. By 2030, this may be

1 Transcendent Man: Acceleration Technology http://youtu.be/X-cy4_Z9Rd0
2 As described in the Ericsson 2020 vision.
4 The Social Web of Things http://youtu.be/ZiwnyO3xygA
seamlessly integrated in a way that we no longer think of computers and interact with technologies in the same way we do with automatic doors today – so that technology becomes a pervasive part of our daily lives.

This will have a tremendous effect on society until 2030! The challenges for our Digital Cities of the Future are possibly only partly technological and instead mainly on interaction design and ethics (privacy and integrity).

1.3 Swedes and the Internet 2011

Sweden is in many ways a forerunner in regards of Internet usage in Europe and in the world, with among the most mobile phones and computers per capita. A recent report shows that:

- 88% of the population over 12 years has access to the Internet
- 85% of the population have access to broadband at home
- 81% of all Internet users use the Internet on a daily basis
- 90% of the population has a personal computer (80% a laptop)
- 2 of 3 in the younger age groups use mobile Internet
- 52% of the population use social networks
- 57% of the population downloads and listen to music online
- 50% of the population play digital games
- 50% of all 3-years olds have used the Internet at least occasionally

As stated in the .SE report; an analysis of shared user patterns demonstrates that there are two extreme groups: advanced enthusiasts who use the Internet’s full range of possibilities more than everyone else, and the cautious group who is more restrictive and cautious in its use. In between these are the traditionalists, who primarily use the Internet to acquire information, and the modernists, who are more interested in the Internet’s communicative, entertaining and social aspects. However, four of ten users are more cautious and restrictive in their Internet use.

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Using Sweden as a test-bed for Citizen-centric Services is thus a good idea, given the number of Internet users and the maturity of on-line communities.

1.4 Generation E

Many anthropologists states that there are great generational differences that can be seen today, where the new generation is intrinsically accustomed to computers and mobile technologies. Ida Hult, CEO of Trendethnography, defines these as “Moklofs” or Mobile kids with lots of friends. This Generation E is used to getting rapid feedback on their opinions and actions, through a big flora of tools.

“Those ages 8 to 18 spend more than 7,5 hours a day with such devices, compared with less than 6,5 hours 5 years ago, when the study was last conducted. And that does not count the 1,5 hours that youths spend texting, or the 0,5 hour they talk on their cellphones. And because so many of them are multitasking — say, surfing the Internet while listening to music — they pack on average nearly 11 hours of media content into that 7,5 hours.”

-- Kevin Drum, MotherJones.com

A challenge is to study phenomena related to our new generations so that we build a society that gives the best possibilities for enabling new behavior across generations, thus empowering people to change throughout society.

1.5 Scenario - TrekService

TrekService – a Personalized App based on Open Data

Katarina is 78 years old and is living in a home for elderly Kiruna since she had an accident a couple of years ago. She is very active in community activities, even if her hip limits her movement somewhat. Her favorite activity is painting, so she takes a walk to the painter’s studio 15 minutes walk from her apartment.

Today there has been a snowfall during the night, so Katarina wonders whether she should walk or take the bus. She opens up her pad and starts the Kiruna TrekService, which shows pedestrian information for the city. The app is already configured for her conditions, to take slippery or other inhibiting conditions into account. She sees that her regular walking path through a park has not been cleared for snow, but that a longer path along a road has been cleared.

6 DN 2010-06-15 “Generation E går sin egen väg”  
Katarina hesitates to walk the longer path, so she selects an overlay bus schedule and decides to take a bus to the town center and then walk around a small lake instead, as that path has been cleared for snow and is not as busy with cars. She picks up her bag and leaves for the painter’s studio.

On the way back opens her smartphone with the TrekService app to find the best alternative to return home. It is soon dark and she does not feel comfortable walking alone. She selects the overlay with city lighting and selects a lit walking path that passes a shopping center, as she also needs to post a congratulations card to her niece.

This scenario exemplifies usage of an open interface for a city, where big amounts of data are available in near real-time. A user can create a lightweight application tailored or customized to meet individual needs.

The challenge is to create platforms for open data presented in semantic formats (how to make data available) and to study how lightweight applications can be designed with personalization, privacy, integrity, trust and security in mind (cooperative service creation etc).

**TrekService - The Smart City Travel Companion**

When Johanna wants to plan a trip, she uses the TrekService application available both in her normal web browser as well as in her phone. Based on her current local position (e.g. home) she enters her destination (or several) for the day and the system suggests several alternatives including different modes of transportation. Even though she normally bikes to work, today the primary suggestion is to take public transportation as the current bike road conditions are very icy and the forecast for the afternoon is mixed heavy sleet. The TrekService notifies her when she needs to leave for the bus stop based on real-time bus arrival information allowing her to stay warm inside as long as possible. The TrekService also includes current information about broken lights and as she doesn’t want to walk in the dark, the TrekService selects a path for her to walk where the lights work.

Another example is Peter that usually takes the car to work, but today the TrekService notifies him that they have started renovating the main road on his way to work and the detour road is already highly congested. Instead he takes his bike and a bike trailer to transport his 4-year-old son to daycare. The bike trailer also allows him to transport groceries home after shopping after work as well as picking up his son from daycare. The TrekService automatically shows him the optimal path to bike between his various destinations.
This scenario depicts how the user can plan, organize and make her travel more efficient in a Smart City where information about the current conditions is gathered in real-time via sensors “everywhere” (Internet of Things). Information gathered includes road and walkway conditions, status of roads lights (e.g., broken lights not yet repaired), traffic congestion and accident status, road repair status, bus traffic conditions and exceptions, geographic information including maps, weather conditions and forecast for the day etc.

The TrekService is built around a large number of Open Data Sources with open APIs provided by several different data providers. Some data services are provided by public entities and even if the number of public sources available today is rather small it is foreseen that the number will increase in the near future as availability of public data is governed by the “Directive on the re-use of public sector information” (PSI directive) where many sources that today are closed will be forced to be opened in the near future. A few examples of existing data source that are available today and related to the TrekService include real-time information about all roads and trains in Sweden (Trafikverket); weather-data from the Norwegian weather service (YR) and crime reports from the Swedish Police. Further, sensor networks are being built in several Swedish cities and it is foreseen that the project will tap into these data sources. Finally, it is also foreseen that during the project new data sources will be created by close partners to the project (e.g., municipalities).

1.6 Scenario - Social Group Communication

The following scenario about Amanda and her friends points out the usefulness of the social recommendation framework to arrange a party.

Amanda is a very socially active girl and she spends a lot of her free time communicating with large number of her contacts. Most of these contacts are family, friends and colleagues, while some only share common interests or goals. She communicates with them on Facebook, by twittering or through mobile calls, but she struggles with keeping herself updated with the most important activities in her social networks. Her 30th birthday is coming up, so she plans on having a party together with Melvin and Ebba, two of her friends at work that also have birthdays the same month as her. She gives them a call and they start planning what to do and whom to invite.

They open up their group management tool which first filters out all their shared contacts that they have no personal relation to and then prioritizes the remaining contacts based on how much they interact and how strong their social relation is. Several of their contacts are quite busy persons but they manage to select a date that fits the majority of them. They decide to invite 50 of the persons and generate a group invitation for the party. Amanda then sends out the invitations using any of the
convenient tools for example, Facebook to users frequently there and by SMS to the others, while starting a Twitter feed about the ongoing party activities inside the invited group members. She ends the call by promising to organize the food for the party.

Amanda likes to cook Italian food so she filters the party group for persons interested in cooking and invites a handful of them to come early to the party to help with the preparation of Italian food in return for free beer - and all accept. She makes a shopping list and emails that to her two friends. The party is on!

The scenario illustrates that simple group management can be very useful. Information about Amanda is harnessed by the group management tool, which utilizes a social recommendation engine to list, filter and prioritize her contacts based on the related social strengths. This is done by creating a weighted social graph that can be pruned in many ways; here by using additional information from Melvin and Ebba, as well as presence information from their contacts (calendar data). Knowledge about how she usually communicates with the persons she would like to invite is used to send out the invitations in the most suitable way to each and every one on the invitation list. She also selects a few persons from the invitation list by pruning it based on interests, with the purpose of getting help with cooking the party food.

This shows how presence information can be utilized together with social filtering and prioritization for the purpose of initiating group communication among users.
2 Background

2.1 Open Data

According to the Open Government Data website\(^7\) the public government records in the U.S. and the public sector information (PSI) in Europe can be shared with the public over the Internet to promote analysis and reuse of data such as government spending records, cartographic information, and public health and safety monitoring data.

“The power of digital information to catalyze progress is limited only by the power of the human mind. Data are not consumed by the ideas and innovations they spark, but are an endless fuel for creativity. A small bit of information, well found, can drive a giant leap of creativity. The power of a data set can be amplified by ingenuity through applications unimagined by the authors and distant from the original field. “

--- "Harnessing the Power of Digital Data for Science and Society"

U.S. OSTP, 2009

2.1.1 The 8 Principles of Open Government Data

A 2007 U.S. working group developed 8 principles of open government data, which is stated to have become the de facto for evaluating openness in government records. The principles state that government data shall be considered open if the data are made public in a way that complies with the following:

1. **Data Must Be Complete**
   All public data are made available. Data are electronically stored information or recordings, including but not limited to documents, databases, transcripts, and audio/visual recordings. Public data are data that are not subject to valid privacy, security or privilege limitations, as governed by other statutes.

2. **Data Must Be Primary**
   Data are published as collected at the source, with the finest possible level of granularity, not in aggregate or modified forms.

3. **Data Must Be Timely**
   Data are made available as quickly as necessary to preserve the value of the data.

4. **Data Must Be Accessible**
   Data are available to the widest range of users for the widest range of purposes.

5. **Data Must Be Machine Processable**
   Data are reasonably structured to allow automated processing of it.

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\(^7\) [http://www.opengovdata.org/](http://www.opengovdata.org/)
6. **Access Must Be Non-Discriminatory**  
Data are available to anyone, with no requirement of registration.

7. **Data Formats Must Be Non-Proprietary**  
Data are available in a format over which no entity has exclusive control.

8. **Data Must Be License-free**  
Data are not subject to any copyright, patent, trademark or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed as governed by other statutes.

Finally, compliance must be reviewable.

- A contact person must be designated to respond to people trying to use the data.
- A contact person must be designated to respond to complaints about violations of the principles.
- An administrative or judicial court must have the jurisdiction to review whether the agency has applied these principles appropriately.

These 8 principles have since been developed by Tauberer [1] to include 16 principles and best practice recommendations. They are also the basis for the 7 principles used in Sweden for open digital public information [8].

### 2.1.2 The European PSI Directive

The European Council and the European Parliament have adopted *The Directive on the re-use of public sector information* [9], which deals with the way public sector bodies should enhance re-use of their information resources while maintaining transparency and fair competition. European member states had to implement the directive by 1<sup>st</sup> of July 2005. The directive contains rules regarding:

- the procedures to deal with requests for re-use;
- the availability of documents for re-use in all formats and languages in which the information exists; where possible, the material shall be made available by electronic means;
- an upper limit for charging; the upper-limit is based on costs incurred to produce the information, together with a reasonable return on investment; lower charges (or no charges at all) can certainly be applied, and public sector bodies are encouraged to do so; on request, public sector bodies have to indicate the calculation base for the charges;
- transparency of conditions applicable to re-use; charges and other conditions have to be preestablished and published; it also has to be clear where applicants can complain about decisions that affect them;

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• an obligation to avoid discrimination between market players in the conditions for re-use;
• a provision to avoid cross-subsidies between the public part and the commercial part of the same public sector body, that re-uses the information;
• a prohibition of exclusive arrangements, with an exception for exclusive rights necessary for the provision of a service in the public interest;
• the availability of standard, on-line licences; in any case, licences should not unnecessarily restrict possibilities for re-use or be used to restrict competition;
• practical tools that make it easier to find the material available for re-use; this could be lists of information assets or portal sites.

The Swedish availability of Open data is highlighted by opengov.se\textsuperscript{10}, which contains a catalog of government datasets, their formats and usage restrictions.

2.1.3 FIREBALL
An example of Open Data initiatives in Europe is the FIREBALL project and communities\textsuperscript{11}. FIREBALL establishes a network of Smart Cities across Europe that engage in long term collaboration for adopting User Driven Open Innovation to explore the opportunities when bringing together the Future Internet, Living Labs and Smart Cities constituencies.

The FIREBALL project is said to be conceived as a response to a situation where different constituencies in the domain of Future Internet research of innovation are operating in a state of relative isolation and fragmentation, using their own practices, methodologies and assets (such as knowledge and facilities). These constituencies include:

(1) Future Internet research and experimentation (including test-beds and experimental facilities),
(2) User driven open innovation (such as in Living Labs), and
(3) City innovation environments (representing the demand side).

Additionally, FIREBALL recognizes that open innovation and user engagement demonstrates a key potential to bridge the gap between research and development of Internet technologies and actually using Internet-based applications in cities for societal and economic benefits in areas such as healthcare, business enterprising, participative government, energy efficiency and quality of life.

Closing the gap is important in order to create ecosystems of Internet innovation that are more effective, open and user driven, where methodologies, approaches and

\textsuperscript{10} http://www.opengov.se/sidor/english/
\textsuperscript{11} http://www.fireball4smartcities.eu/
technical assets of the constituencies can be aligned and shared more easily and effectively, benefiting rapid adoption of Internet services and economic and social development in cities and stimulating more effective networking and experience sharing among cities to accelerate adoption.

The role of cities is said to be of profound importance as they are considered a key driver of innovation in Future Internet services and applications. Forming Internet innovation-ecosystems across existing constituencies will increase the prospects to resolve barriers in the take-up and adoption of services, for example addressing the lack of interoperability and absence of open platforms.

FIREBALL is just one of many ongoing initiatives in Europe to use Open Data together with foremost mobile Internet technologies and in close collaboration with real users (citizens). The drive of cities like Barcelona and Helsinki shows that this is happening now and that it is highly probable that the majority of cities will have similar services by 2030.

2.1.4 Open data in the UK

The leading country in Europe for opening up government information is possible the UK, where a government portal12 make resources easily available for the public as well as for developers.

Figure 4, Crime Spy UK app based on the open UK Police API

OpenlyLocal13 lists an impressive number of UK councils (currently over 140 local authorities) that provide open access to their public information. All in all, the trend

12 http://data.gov.uk/
13 http://openlylocal.com/
towards provisioning of public information openly is clear, even if many institutions have expressed considerations for providing data especially in real time. Many examples, such as the public data corporation\textsuperscript{14}, imply that a key driver for providing open public data is to drive innovation.

2.2 Social Networking and Group Communication

On-line social networking and communication services are increasingly popular methods to communicate with friends, family and communities. Statistics shows that users of services like Facebook and Twitter stretches across geographical locations, professions, age groups and habits. Smart mobile devices with Internet connectivity simplifies access to these services at anytime and from almost anywhere. However, the huge amount of user-generated content makes it difficult to identify useful information. A challenge is to create micro-communities where users may join from heterogeneous social networks using proper user and identity management. The increasing number of social networks and communication services are also creating new challenges in social media content filtering, micro-community discovery, and automatic group communication initialization.

2.2.1 Social Graphs

A social graph describes the relations (who is connected with whom) of actors/contacts where the actors may contain media contents and share such contents among other actors in the community \cite{2}. Facebook adopts a hierarchical structure, the first-degree relationship between users enables two-way access to content \cite{3}. In Twitter on the other hand there is only one-way access to content; the follower has access to the content of the host, but the host does not automatically have access to the content of the follower \cite{4}. Furthermore, another social network, LinkedIn, is organized around the shortest relationship path between members in the social graph \cite{5}. Therefore, connections among the actors/users are application dependent. Figure 5 depicts an aggregated social graph, where actor U presents its contacts with and without social strength. Here, social strength is a measure, where higher strength indicates higher connectivity with the contact.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Figure 5, Formal Model of an Aggregated Graph}
\end{figure}

Social strength is considered as a way of providing relative weight to a particular user among the contacts. It helps to identify trusted networks, prioritizing phone-

calls, e-mails, and discovering groups. In Figure 5, ASG(U with strength) corresponds social strength of U among the contacts n1, n2, n3, and nn. Social strength is limited to a particular user, which means first degree contacts of the particular user will be considered for calculating strength. The user calculates strength to the contacts with whom he/she has direct interactions. **Social ranking** exploits the social strength to rank contact individuals and social contents.

An **aggregated social graph** associates all social contacts globally with the objective of managing a complete contact list rather than processing it separately for different social networks and communication services. Calculating social strength in an aggregated social graph forms a weighted social graph. In that case, all the contacts in the graph will contain a relative strength. This provides a sophisticated way of ranking contacts. However, the interaction history of the contacts is needed for such calculations. In Figure 5, ASG(U) corresponds to the aggregated social graph of the user U. It considers only first degree contacts, which are the contacts directly connected with U.

A **dynamic group** is considered as a micro-community of contacts, which may be discovered in real-time [6]. The group can be used both on a short-term and long-term basis. For example, creating a group for sharing content for which the life-time is very low can be considered as short-term groups, while a group for participating in collaborative activities in a project is long-term. A central concept is that members can come and go, depending of interest or activity for instance, just like in the Google+ Hangouts.

### 2.2.2 Social Recommendation

A recommendation system assists on-line users to complete transactions in different Web services from the last decades. It provides a recommendation on a particular item. For instance, purchasing books in Amazon or purchasing an iPhone in E-bay, recommendation systems play an important role in selecting an item. Having access to the social data, the performance of the recommendation system can be improved [7, 8]. Social data is in this work used to form a personalized communication history. In Roth et al. [9], email communication history is used to identify potential groups to enhance group communication. In Ankolekar et al. [10], recommendation system phone-call logs are used as communication history, which help to discover trusted groups or forming networks.

Aggregator services such as Vodafone People, Social Life are mapping different communication services to keep track of communication in more manageable ways [11]. Users may have different Social Networks (Facebook, Twitter, mySpace, Linkedin, etc), Calendar data (events), Sensor data (location, temperature), Call-logs and Contact list [12]. However, there is not much work done where user communication pattern can be analyzed based on aggregated social data.
Social networking analysis and methods for social community discovery have been discussed in [13, 14, 15, 16], where discovery methods generally use static attributes such as location, profession and/or interests for identifying communities. Anupriya et al. propose the idea of using communication history for finding the strongest communities [9]. The problem of discovering group based on communication history is however not addressed in that work.

Activity-oriented social networking can collect and aggregate real-time presence status from different communication services [17, 18], which can provide recommendations considering the user’s current activity. CenseMe, the personal sensing system, automatically shares presence and activity information within social graphs, where social filtering may be useful [19]. Apart from Google’s page-rank algorithm, social search techniques typically operate on a social network and perform ranking by analyzing social data [20, 8]. These techniques expose tags, bookmarks and taggers (users) as social data, while the thesis aggregates communication history considering as social data. Integration of social networks, such as Del.icio.us and Flickr, Web 2.0 applications can improve accuracy in social search and recommendation systems [21, 22]. Martin et al. propose an approach of aggregating social data where user profiles are always integrated with the service provider [23].

The conflict of interest is measured by scientific communities mostly based on aggregated social networks populated by FOAF (friend-of-a-friend) based dataset (collecting data from Swoogle in 2005-2006) and DBLP data source [41]. In this work, social relationship is based on the publication relationship, which is domain specific.

### 2.2.3 Social Recommendation Framework

A social recommendation framework based on social ranking can be used for many purposes, such as to filter social information and to identify groups dynamically to enhance group communication and reduce information overload.
Figure 6 shows the high level architecture of a framework for social recommendation. The framework consists of five components, the aggregated social graph (ASG) service, the communication history aggregator and the social ranker which are the main components while the end-user application and third party communication services (e.g., Myspace, Twitter) are considered as external components.

Social ranking is one of the most challenging problems, in particular for services such as context-based group discovery, social content filtering, prioritization of social content, and content sharing. Algorithms for social strength calculation based on social graphs can be simplistic in design yet very effective in practice, for instance using utility functions and similarity coefficients.

Typically, the end-applications send queries to the ASG service and receive recommendations. The social ranker analyzes the communication history log and preferences taken as input from the communication history aggregator service. The communication history aggregator component collects the communication logs from the different communication services.

The recommendations are context dependent, which means that this supports applications in different purposes such as ranking for prioritizing information, ranking for prioritizing contacts, creating dynamic groups, etc. In the framework, both the ASG service and social ranker utilize communication history for building the graph (i.e. global contact lists of a specific user), for generating the social strength and for providing open HTML-based API to end-user application developers.

2.2.4 Socially Aware Applications
As noted in [24, 25, 26, 27] socially aware application can effect group communication positively. The presented social recommendation framework is similarly based on a recommender engine that harnesses users’ communication patterns and context from multiple social networks, communication services, sensor systems, and mobile devices. The harnessed information is used to create weighted social graphs, which express the social strength between users. The framework then utilizes the social strength to improve group communication applications through filtering, prioritization and recommendation, as depicted in figure 7 below.
Figure 7, Socially Aware Applications

The process of discovering user patterns is important for improving the social recommendations made by the framework. The presented communication model describes how multiple communication tools can be utilized to better understand users’ communication patterns. This means that users’ communication habits, in both private and public settings, can be analyzed by for instance studying users’ history of using email, on-line social media and mobile communication. The recommender engine can then weight the social graph based on preferred tools, users or contexts.

The framework can also be used to user recommendations on behalf of a user or a group of users. For instance, groups can be discovered and maintained dynamically based on users’ needs and social context. It is clear that communication services can benefit from the framework by using the social strength among users to improve group communication. This may be particularly beneficial for interaction within social networks, where the large amount of user generated content needs to be filtered and prioritized for easy navigation and consumption.

In conclusion, understanding of users’ communication patterns and then carefully weighting of a social graph is central for successful filtering, prioritization and recommendation. If this achieved, then group communication tools can benefit greatly through simplified interaction, such as creating a group and starting a digital
conversation with a single action, or personalized services, where the tools used are configured based on users’ activity or intent.

2.3 User-Centric Design

2.3.1 Service Innovation

There has been a huge shift from a product based economy to a service economy, especially digital services as expressed by Williams et al in 2008 [28]. The drivers in the economy worldwide are changing from production of hardware to services. By almost all accounts, the economic future lies in services. According to Aas and Pedersen in 2010, the service industry accounts for more than 70% of the GNP and employment in most developed countries [29]. Researchers agree that service innovation is critical for both service and manufacturing firms’ success, both in the short and long terms and as indicated by e.g. Bitner et al., Chesbrough, Shelton, and van de Vrande et al. [30, 31, 32, 33]. For companies survival it is important to turn to innovation in services, which can mean to wrap a service around a product, or reimaging a product as a service, such a software-as-a-service firms have done. Also companies that do not view of themselves as service providers will have to develop services to feed future growth, this includes manufacturers who need to shift their innovation focus from products to services [31]. At this stage, services is the only thing that can sustain differentiation in a competitive environment that commoditizes product almost as fast as they emerge.

There are several reasons why the service management area is growing. Rai and Sambamurthy states that in the highly competitive market where globalization, rapid product and service innovation leadership, operational excellence, and customer intimacy are important drivers of competitive performance, firms are discovering that they have significant structural barriers to agility and competitive performance [34]. The growth in services is also fueled by firms using is as a defense against the standardization of products and as a strategy for productivity, growth and retention.

The concept of service has been defined in many different fields such as marketing, economics and information technology [34]. Examples of definitions of services are:

- Services are capabilities or competencies that one person, organization, enterprise or system provides for another as defined by Vargo and Lusch [35].
- Kotler & Armstrong means that any activity or benefit that one party can give to another, that is, essentially intangible and does not result in the ownership of anything. Its production may or may not be tied to a physical product [36].
- Service offerings provided for and/or co-created with customers such as professional services, retail, financial, telecommunication, healthcare and many others. Included is also services that are offered in conjunction with goods such as training and network support services in a technology company and even service that is derived from a tangible product. What all
of these services have in common is an interface with an actual customer whether through technology or interpersonal interactions [30].

2.3.2 Design of Citizen-centric Services
The effect-logic with user involvement in innovative processes is that:
- users generates more ideas,
- the ideas are of more innovative character [37],
- there is a positive correlation between user involvement and users attitude towards the end product,
- users’ become more positive to actually use the final product [38], and
- the understanding between developers and users increases which leads to a decreased development time through their continuous involvement in tests [37].

2.3.3 Users as Actors or Factors
When designing citizen centric services different user involvement strategies and perspectives could be applied depending on the purpose of the user centricity. Kaulio has identified three different types of customer involvement: design for customer, design with customer and design by customer [39]. Here, we choose to replace the word customer with the term user. The first type, design for users, means that the object is being developed on behalf of the user. Data about the users, general theories, and models of users’ behaviour are used as a base for the design. This approach often includes specific studies of users, such as interviews or focus groups. The second type, design with users, denotes a product development approach, focusing on the user, utilizing data on user preferences, needs and requirements as in a design for approach, but, in addition, includes a demonstration of different solutions/concepts for the users, so they can react to the differing design solutions [39, 40]. In the third type of user involvement, design by users, a product development approach is applied, in which the users are actively involved and partake in the design of their own product [39, 40].

2.3.4 User Toolkits for Citizen-centric Service Design
We can now discern a trend within user involvement moving from designing for users, being stationed in designing with users where users are naturally involved in evaluation of innovations, towards designing by users where users are given toolkits to design their own desirable solutions [41, 42]. With this shift in perspective, it is becoming progressively easier for many users to get precisely what they want by designing it for themselves. It is important to give innovative users ways to combine and leverage their efforts since innovation by users tends to be distributed rather than concentrated among a few innovative users. One way for users to achieve this is by engaging in different forms of cooperation. Direct, informal, user-to-user cooperation is common. Organised cooperation is also common, with users joined together in networks and communities that provide useful structures and tools for their interactions and for the distribution of innovations [43]. Innovation communities
can increase the speed and effectiveness with which users and manufacturers
develop, test and diffuse their innovations (von Hippel 2005).

2.3.5 Dynamic and Sustainable Business Models

In recent years, business model development have been partially driven by trends of
open innovation in services, such as shift from product to service, user
empowerment in innovation, etc [44]. These trends contribute to the importance of
understanding the impact of contingency aspects on the development of business
model components and hence designing sustainable business models.

Figure 8, Dynamic business model

In order to illustrate this impact, we propose a conceptual dynamic business model
(Figure 8 above) that extends earlier frameworks on business models by adding
contingency aspects and the view of core resources into a dynamic business model.
One of the sectors exposed to rapid pace of change is the mobile service sector. The
extended model is based on empirical findings from the Vinnova funded MeMo
project\(^{15}\) that ended in June 2011.

Two main contingency aspects are proposed in the dynamic business model:

1. Pace of change regarding technology development and industry
   characteristics;
2. Regulatory constraints. Still the mobile service industry is fragmented and
   lacks established structures and norms. It is characterized by discontinuity in
   technological change and a high degree of technical uncertainty driven by
   highly complex technological systems and short product development-to-
   market cycle times and product life cycles. The number of competitors
   increases rapidly as firms identify opportunities in the market as argued
   earlier by Jones et al [45].

\(^{15}\) http://www.cdt.ltu.se/~memo
As in all types of contexts, the human, social, and financial resources are important for designing a sustainable business model in an open innovation context. In the mobile service industry, access to a useful social network has shown to be important, particularly for SMEs. The human resources composed by e.g. the founders appear crucial in compensating for financial constraints [46]. Entrepreneurs in SMEs lacking basic resources (human and financial capital) tend to mobilize support in their social networks, as stated by Brüerl and Preisendörfer [47]. Our findings suggest that entrepreneurs with experience from similar businesses may bring relevant knowledge and relationships that significantly reduce liability of newness\(^{16}\), which appears especially important when the pace of change is fast.

However, from a long-term perspective, constrained financial resources may result in companies being outdistanced by copycats (of e.g. mobile applications) who imitate and quickly innovate the business idea. Firms lacking financial capital during their development period face significant competition difficulties, especially in an open innovation context. Such firms are at the risk of being out-innovated by financially stronger firms. The business model deals with both short- and long-term perspectives for enabling management of resources and developing activities and businesses that fit with the current resources available, as well as with the planned future resource acquisition. While the human, social, and financial resources are seen to influence all components of the business model, the relationship is reciprocal as decisions regarding components define what type and amount of resources will be required.

2.3.6 SatinII

The SatinII project provides a good example of a user-centric environment for building mobile applications using a visual interface. The overall vision of SatinII is to create a tool to allow for non-programmers to create applications using modern web-tools, which are to be consumed in a mobile setting.

2.3.6.1 Mobile Application Development - Background and Trends

How are applications developed for mobile consumption? First of all, what is a phone? A clear trend is that we will get a number of new high-end devices during 2010-2011 and onwards that are a hybrid between phones and laptops, e.g. the Apple iPad as well as the several Android based devices with 5-12 inch touch screens. This will allow users to use the same applications on both their day to day-to-day phone (typically iPhone or Android based phone) as well as on other types of devices. We here assume that the mobile application future lies in modern phones with high capacity (a lot of RAM and storage, GPS, WiFi, Camera, various types

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\(^{16}\) Liability of newness means a greater risk of failure than older organizations.
sensors etc.) and thus the project will not support "older" types of phones even if they are produced and sold.\textsuperscript{17}

Secondly, we have to take a look at how successful mobile application vendors develop their applications. One observation here is that most of the development is done fast and swift. Develop an application and release it in several steps, i.e. release early, release often. By doing it that way feedback from early users can be incorporated into the final application and this method is the proposed way of working in the SatinII project.

Currently, many applications developed for a modern mobile setting are developed as downloadable applications distributed via various online markets (E.g. Apple App Store or Android Market). The reason for this is not purely technical as in many cases the same functionality could just as easily be created using modern HTML5 features. It is important to note that much work is currently being done on extending the HTML5 standard with support for many typical native functions that earlier only were available in native applications (geo-info, background processing, advanced graphics handling, data storage etc.). This division between native applications and pure HTML5 applications is something that is addressed within the SatinII project, but we foresee that initially only purely web-based applications will be supported.

Finally, an additional clear trend is towards the real-time web where data is delivered to readers as soon as it is published. This is already seen for social applications where updates are distributed directly, and this is something that will move into more 'advanced' applications in the future. An example can e.g. be that changes in collaboratively authored documents are shared in real-time with all interested parties. How this is applied in the mobile field is a very interesting problem and this challenge is something that needs to be addressed within the SatinII project.

One very interesting idea to make application development more open and social is that one developer might release an early draft of an application (fully running and working) and others might change and contribute to the application after it has been released. Compare this to collaborative web page development, or a social media application (e.g. Google Buzz or FaceBook) where different users collaborate and generate the 'final' content together. An extension of this is to allow running applications collaboratively and making all SatinII applications shared and collaborative by default.

2.3.6.2 Technical Building Blocks
The SatinII architecture is divided into 6 primary building blocks, as described below.

\textsuperscript{17} E.g. Symbian is still the operating system in a large number of phones being sold today.
The Services Components

The SatinII environment will include a number of service components that can be used in the application editor to create new applications. The service components will be added to the SatinII environment initially by members of the project itself and later by allowing service providers to add new services using a published and open API.

Open technical and research questions include:

- How to specify the components, i.e. name, functionality, icon, financial constraints etc. An interesting metaphor is the usage of Intents in the Android environment where separate applications be integrated into a richer user experience as well as extended with new functionality even after the application has been deployed on mobile devices.
- How to specify the service level of the component. What will happen if the component relies on some external source and that source is no longer available? How quickly will the component be fixed?
- How to handle financial constraints where the usage of the component will incur a monetary cost.
- How should the service component be certified? Should a developer just be able to upload a new service and then based on feedback be graded as good or bad? This method is used successfully by the Android Market, with the benefit that components can be published and updated without any delay. Another alternative is to follow the Apple App Store model where each application is pre-certified via testing by humans. This creates a delay in publishing and also puts a bigger financial burden on the SatinII environment provider as human resources are needed.

The Application Editor

This is the most important and critical part of the whole SatinII environment for the project to be successful. It has to be very easy for the user to create new applications by combining service components. We need to allow users to simply drag-and-drop components and very easily combine them into something “useful”\(^\text{18}\). E.g. if has to be easy to understand what a service component does by just looking at the icon and also very easily be able to get more information about the service. It is also important not to overwhelm the user with a lot of boxes and popups, and instead let the user focus the current operation at hand. Various wizards can be beneficial at initially to help the user get going.

\(^{18}\) The term ‘useful’ is very subjective and individual to every user of the SatinII application.
Something to keep in mind, is that not all users will have an understanding (initially) of sequential programming as well as typical logical programming and the editor should also cater to this group of non-technical users. What this implies in practice should be further discussed.

The Execution Environment

Some services will require backend support and in some cases this will be provided directly by the service component provider (i.e. the running component will communicate directly with the service providers servers). Other components might require the application to be run in an execution environment provided by the SatinII project. An open question here is if the project should provide such an environment or if it should rely on some external execution engine, e.g. Google App Engine to which the SatinII environment could automatically upload applications using the Publisher building block (see below) or the service provider could be encouraged to use that kind of external execution environment directly.

The Publisher

After the new application in built using the SatinII editor, the application has to be published to be available to end-users. Depending on the type of application that the editor generates, various paths are needed. E.g. if a native application is generated it is natural to provide a means for the application to be automatically published on the Apple App Store and/or the Android Market. Integrating towards these environments is rather straight forward, especially the Android Market which has an open API for publishing.

Another view of the publisher is to provide a package that can be deployed on the execution platform described above. Exactly how this should be handled depends on the execution environment itself and is left for further discussion.

The Shopping Window

Independently of where the application is published there will be a need for the user of the SatinII environment to promote her application, either to a small select group (friends or family) or to the whole world. We foresee the need for such a Shopping Window in the SatinII project where added-value might be that the user can aggregate information about her applications independently of where they are published (various online markets) and also might want to aggregate several applications into one published package.

Just like a real physical shopping window, it is important to allow for the user's SatinII shopping window to be customizable to allow for creating a specific look and feel. This is an area where a lot of effort can be invested and can be rather costly for the
project to develop and to what extent this should be done within the project is an open question.

**The Integration Part**

It is important to remember that for the SatinII project to be successful, it cannot live in an isolated world and it has to allow for integration with other environments on various levels.

There will be a number of similar application environments\(^{19}\) out there and instead of competing with these, the SatinII environment should instead try to be open and allow for integration with these the environments. We should strive for an openness where e.g. SatinII service components could be published in other similar environments, or applications developed using other editors should be importable into the SatinII environment.

**2.3.6.3 Co-creation of Mobile Services**

The SatinII environment can be seen as an example of what is being made available within a couple of years, where technologies are made available as components that easily can be composed into a mobile services by just about anyone. This has tremendous impact on the feasibility of citizen-centric services where citizens create apps based on their current needs. It also shows that co-creation is technically feasible and that a market for components and configurable apps can be made available on private or commercial terms.

**2.4 Ethics – Privacy and Integrity**

The European legislation is currently lagging when it comes to the use of pervasive and mobile technologies, but there are a few general directives that can be applied. For instance, the European telecommunication directives\(^{20,21}\) protect personal integrity to some extent, as they detail a user’s right to choose whether to grant (opt-in) or deny (opt-out) any use of personal information at any time.

In particular, users of mobile location services:

- must be protected by privacy safeguards,
- must be fully informed of the purposes of the usage of the mobile location services, and

\(^{19}\) e.g. AppWhirl. [http://www.appwhirl.com/](http://www.appwhirl.com/)


\(^{21}\) Directive 95/46/EC describes the protection of individuals with regard to the processing of personal data and on the free movement of such data. The Swedish law [1998:224] on personal data (personuppgiftslagen) is based on this directive.
must have the right to determine the use of their personal information.

This should lead to the possibility of a user temporarily disabling a service, as an on/off option is required, but this is seldom implemented in that way as most services instead build on an often-complex agreement between an individual user and a service provider before the individual can use a service. This means that users generally sign off their rights through the legal agreement before starting to use a service, which most users ignore to review. By doing this they also generally give away the rights to their personal information (not only giving the service provider access to the information but also giving the provider the ownership of any such information).

Instead the user should be the logical owner of any kind of private information and, most importantly, the user should be able to make informed decisions thus control what is allowed or not under certain circumstances. This is perhaps one of the greater challenges to achieve until 2030 because of its inherent nature of complexity.
3 Foresight Results

3.1 Trends

1. Information technologies are very rapidly converging and evolving into pervasive services where the users no longer consider that they interact with computing systems.
2. The European citizens use of the Internet will soon become ubiquitous, where mobile access and applications based on open data are two important enablers together with social computing aspects.
3. People from Generation E are increasingly different from previous generations, through acceptance and adaption to modern computing and communication technologies.
4. The European legislation is already requiring governmental bodies to provide access to open data (PSI Directive). The provisioning is however not yet generally widespread but by 2030 most municipalities and governmental bodies are expected to provide open data access.

3.2 Challenges

1. To motivate municipalities and governmental bodies to invest in openly accessible databases that support (near) real-time procurement of data.
2. To enable automatic creation of micro-communities based on social context while using proper user and identity management.
3. To support virtual communities in the future digital cities, enabling a ‘village’ feeling based on social context.

3.3 Recommendations

1. Use Sweden as a test-bed for Europe due to the widespread acceptance and adoption of new technology.
2. Utilize social computing to make (communication) services more pervasive and easy to use.
4 Conclusions

The advances in technology and the resulting anthropological change in how we interact with technology will most definitely change our society remarkably until 2030. The advent of pervasive and social computing is in itself a pillar stone for future generations and thus for the Digital Cities of the Future. The identified trends and recommendations are important for the European community to react on, through the EIT ICT Labs knowledge and innovation community.

Open Data in combination with Social Computing and User-Centric Design are key to enabling Citizen-Centric Cities, where for instance virtual communities can achieve an increased social inclusion through enabling a ‘village’ feeling based on usage of social context. A good example is the Urbanflow Helsinki\(^{22}\) initiative which has identified a clear disconnect between the city and its citizens:

“The general challenge is that while cities are fast, municipal decision making is slow by nature. The heavy and invisible decision-making process within cities causes disconnect with citizens, and despite an abundance of commercial messaging platforms, there is yet to be a dedicated platform where the city and its citizens can meet.”

The Digital City of the Future is one of the areas most prone to new innovation due to the combination of personal needs and empowerment, especially since personalized services by and for citizens are quite appealing for many\(^{23}\).

Also, very interestingly the 2012 TED Prize Winner\(^{24}\) is “The City 2.0”, which is stated to be “not a sterile utopian dream, but a real-world upgrade tapping into humanity’s collective wisdom”. That is, individuals working collectively with challenges for the Digital Cities of the Future.

Finally, completely new cities are being built around the world at enormous costs, such as New Songdo in South Korea, Fujisawa in Japan, Masdar City in Abu Dhabi and Peredes in Portugal\(^{25}\). In Sweden the mining cities of Kiruna and Malmberget are being relocated due to the mines expansion. The Digital Cities of the Future will for sure be a source of innovation and novelty for decades to come.

\(^{22}\) http://helsinki.urbanflow.io/

\(^{23}\) As indicated by the Speakers Corner (Video booth) exercise at Luleå University of Technology.

\(^{24}\) http://www.tedprize.org/announcing-the-2012-ted-prize-winner/

\(^{25}\) http://computersweden.idg.se/2.2683/1.420803/smart-stad-skapas-fran-grunden
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