eit Knowledge & Innovation Community

EIT ICT Labs

Technical Foresight Report

Mobile and Social Business Media Services

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October 2013

Knowledge & Innovation Community

EIT ICT Labs

Executive summary

This report outlines trends and challenges in social interactions, business processes and technology, and its impact on mobile and media services. This foresight will help expose future themes with high innovation and business potential based on a timeframe roughly 15 years ahead. 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. Digital natives and mobile social collaboration preferences will shape the ICT of enterprises. How we learn and interact with others will change the way we work. The ubiquitous access to information, mobility, collaboration and the use of social media will drive the change. This will have deep impact on what we expect from ICT.

2. New information and communication technologies will transform business processes. Both the administrative processes and the production processes will be transformed. Moreover, the way enterprises interact with their customers will radically change.

3. Business will be information integrated. Relevant information will be available in real time to a mobile workforce based on their roles. Cloud, with SaaS, will provide a flexible infrastructure. Businesses will be intelligent. Data and information will be central to all businesses, and businesses will be 'interconnected information-wise'. Information will be traded, shared and federated, and the information will be used for knowledge creation and providing intelligent and automated business process support. The information will be consumed by the software providing the intelligence to the businesses.

4. The new services and communication methods will put high demands on the infrastructure. When the applications and the information are located in the cloud, the connections to the cloud becomes mission critical. Wires will yield for radio technologies that provide the needed flexibility. New requirements quality, traffic capacity, capacity of number of devices, security, availability etc. has to be accommodated.

5. The services on the intranet will open up in several dimensions. The access to the intranet has to support mobility of devices, persons and services. The persons and devices will be on premises or out and about. The services will be a combination of outsourced, delivered as a service and company specific services. Bring your own device and bring your own applications will have to be embraced.

6. Communications infrastructure is completely intertwined with critical infrastructure and has become critical infrastructure itself.

7. Security and integrity in all forms will be key issues. Regulatory requirements, role-based security, the new security zones that are transformed to roles, and security between enterprises, will have to be accommodated.

Document Details

Action Line:	NSM
KIC Activity Name:	NSM Innovation Radar
KIC Activity Identifier:	12 186
Task:	T1203 / T1207
Catalyst:	Innovation Radar
Deliverable:	D1207 / D1211
Type:	Technical Foresight Report
Date:	2013-10-11
Status:	Final. Updates and replaces report with same name by Dag Helmfrid (ISBN 978-91-87253-16-4) dated 2012-12-17.
Partner:	Ericsson AB
Editors:	Dag Helmfrid / Erik Kruse

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This report is based on work done in several Ericsson internal projects and studies. A first version was submitted for peer review at the end of 2012, and later published. That published version went through several rounds of updates and revisions in 2013, and this new version had its final edits done by Magnus Boman (SICS) and Henrik Abramowicz in October 2013.

Note that contributions from Ericsson should be seen as individual input and not as officially endorsed statements by Ericsson.

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1 Introduction

This technical report is part of the foresighting driven by the thematic Action Line of Networking Solutions for Future Media. The report aims to identify key scenarios, trends, challenges and recommendations in regard of the Action Line to better understand the enterprise aspects. This foresight will help expose future themes with high innovation and business potential based on a timeframe at least 15 years ahead.

Most of the findings in this report is based on internal work in Ericsson on understanding the future of enterprise but does not give any official statements on behalf of Ericsson. Instead we see this as input to trigger more discussion and dialogue, thereby creating a broader understanding of the future of business media services and networking.

This report is divided into three sections where Section 1 gives an introduction and background, and the main part of the report, Section 2, deals with capturing future development trends characterizing the future enterprise. That main section describes the new workforce generation in a network society, how the business processes are transformed through ICT, and how businesses will be information integrated. We also look the impact of IoT and how Intranet and connectivity is changing as well as on the impact of new devices and mobility. Section 3 describes the conclusions.

2 Foresight Results

2.1 The New Workforce Generation in a Networked Society

2.1.1 Digital culture

In pre-digital culture there was a transaction cost connected to all types of communication, mediation, broadcasting, and publishing. In digital culture this type of information transferring has no (or a very small) transaction cost and is therefore freely available in the culture. Communication is present everywhere and can be mediated by anyone, and anybody can broadcast or publish either information or their own being.

The traits of digital culture are: Tribal (topic-oriented networks), Interactive, Instantaneous, No boundaries, Constant change, Availability, Infinite sources of information, Peer community, User-generated, Mass-creative, Entrepreneurial, Sharing, Stage-like, Continuous relocation of power, Controlled visibility.

2.1.2 Digital natives

The new workforce generation will be 'digital natives'. They have grown up in a digital culture and will bring their values and way of operating into the new workforce. This will drive the selection of communication tools and methods.

Digital natives appreciate freedom and flexibility and want to structure and organize their own work. They act as idea driven micro-entrepreneurs in large organizations. They want to have fun at a social workplace where they work selectively with only the fun tasks. They require everything at once. They wiki-work, according to internet procedure. Their loyalty is focused on their profession rather than the organizations they work for. And most of all, they would prefer their job being part of their lifestyle.

At the workplace, they are networking, using the internet and social media to accomplish work tasks, although they are also using internet for private reasons. Digital natives add their personal networks to the organizational platforms provided by the employer and use both platforms in their work. Accordingly, more and more, the professional sphere and the private sphere are being merged as digital natives stay in the work loop 24/7, but also bring with them their private life to the workplace by the use of social media and other communication tools. Stepping into a professional role, digital natives become more aware of their behaviour online, as they understand that the tracks they leave on internet becomes part of their résumé.

The main challenge for organizations is, however, how to reorganize for digital culture. Ideally, digital natives would like to work autonomously on a network platform, just like they act online in social networks. Organizations aiming to change from traditional hierarchical structures to more organic network structures have to shorten the distances in the organizations, let information flow more freely throughout the organizational network, connect management with the employees, let culture grow more organically in the organization, empower the employees to a higher degree, and open up the internal network to the outside world. This will weaken the position of traditional power players in organizations, like middle management, but at

the same time release the new stars, namely information specialists and analysts, people with cultural and social capital, and people who are natural network nodes.

The change in organization and way of working will be reflected in the choice of communication and information tools. The digital natives will be empowered in their work by enterprises that understand to have an ICT context that supports the digital natives' values and social way of working. Enterprises that understand this will have a big competitive advantage.

2.1.3 Digital natives' mobile social collaboration preferences

2.1.3.1 Social preferences

Digital natives value their freedom and independence from others very highly. They do not always naturally understand hierarchies, and if they do, they do not necessarily accept them, as they do not want to serve authorities submissively. They are inductive discoverers, and thus learn through discovery rather than through explanation.

They get things done by being interactive. They consume by interacting rather than by receiving. They know how to make their voices heard by interacting with brands and organizations and they join forces with their peers and use interactive communication tools to speak their mind or rebel against something. They get many of their kicks from social feedback from their peers. Moreover, the sociality of digital natives is not limited to local contexts, but happens on a global scale.

2.1.3.2 Information and knowledge creation

They are so used to having all information one search click away that they are always checking information, checking facts, and checking up the meaning of words, checking up brands and products, and checking up organizations, companies and people. They are aware of details and discuss different phenomena with friends, either IRL or online in social networks or forums. With the aid of the web, they are scrutinizing their life world and everything that is in it. They gather information from multiple sources by default, which is a consequence of (among other things) the unreliability of information online. They are trained in quickly scanning vast amounts of information and they are able to read and interpret visual images and icons, rather than only relying on text. They are proficient at assessing information and understanding how to value and use the information. They are proficient at interpreting messages depending on the channel and understand that things have different meaning depending on the context (channel) it is expressed in.

2.1.3.3 Collaboration

Digital natives constitute the first generation that does not really experience any distinct transaction costs for social activities. They are quick to think in terms of what can be accomplished peer-to-peer, they enjoy collaboration and use friends, contacts, and social networks to get things done, they constantly discuss things and exchange ideas (often online), and overall they have a very reciprocal attitude and believe that if they do something for someone, they will get something back from that someone at some other point in time. They deliver immediate responses to questions

and queries. They have switched from linear thinking to parallel thinking, meaning they are better than previous generations at keeping several threads of thought in their head. They are good at shifting attention between tasks and can keep several smaller and larger projects going at the same time.

2.1.3.4 Urgency

Digital natives have grown up in a society that moves fast and with an internet that moves faster. They are used to things happening instantly and without any significant time lag and they want things to happen fast, otherwise they quickly get bored. They are used to being able to act immediately on a thought by using their mobile phone or computer and any time lags between thought and action are annoying. They are skilled in adapting to constant change, repositioning them selves whenever the context is changing. Being raised on the availability internet and mobile phones enable, it is only natural that digital natives have become brats in terms of availability. They want easy access to everything, instantly, everywhere, at anytime, and preferably at no cost.

2.1.4 Working in a networked society

The wide adoptions of smartphones and tablets in the early 21st century have brought technology and people closer together than ever before. This trend will continue and around 2020 most people will constantly be connected to the Internet via new types of devices such as smart contact lenses or smart glasses providing almost immersive Internet experience. Users will be able to seamlessly and effortlessly communicate with anyone on the planet using any device they carry, or via sensors or tangible devices available in the surrounding environment.

New types of social media and collaboration tools will fundamentally change how people communicate, socialize and collaborate. Traditional telecommunication services such as telephony will be transformed into new modern integrated cloud-based tools, capable of utilizing new networking functionality to provide high efficiency and scalable communication. Advances in cloud computing will accelerate this development even further by making it possible to develop and deploy new tools even faster while leveraging almost unbelievable computing power and online storage.

Most of our interactions, conversations and communication history will be stored online. This information will be used to make people communicate more efficiently, but also make people remember and understand each other better. For example, users will be able search and replay old conversations. Smart agents will be able to automatically make meeting notes, or even check the accuracy of facts presented at meetings, thus making people act and think smarter.

Advances in collaboration technology will make it possible to share and interact more effortlessly. Any physical objects or appliances that could benefit of being connected will eventually be connected. Any of these objects can automatically be transformed into a shared online object to make collaboration easier. For example, medical equipment could automatically be attached as needed to an online shared space, to allow for a doctor to make a reading from a distant location. In this way, the user

interface of the communication tools can be adapted to support the tools most critical to solve a particular task. It would almost be like the communication tool assembled itself.

Development of better user interface frameworks (e.g., WebGraphics Library) and more powerful mobile devices will make it possible to develop virtual worlds mapped into our real-world through pervasive and ubiquitous computing. This will make it possible for people to access and control appliances as if they were really here. This technology could also be of great benefit in e-health and e-learning environment. For example, students would be able to access virtual classrooms from anywhere as if they were almost there. Students sitting in the same room would still connect to access shared notes done by other students, or access interactive content dynamically shared by the teacher during a lecture.

Presenting a workshop scenario

The setting for this scenario is a customer; we can call him Mr C, who has a problem with a faulty warning light indication in the dashboard. Mr C has therefore scheduled a video call appointment with a car repair shop in order to get a first opinion on what the cause of the problem might be. At the moment Mr C is at home in front of the TV (video call enabled and equipped with a camera), the car is standing in the driveway outside the house, and mechanic that has been assigned to the case is at the car repair shop.

Having established a 'trusted' communication Mr C can then explain the problem with the warning light. In order for the mechanic to find the cause of the problem he needs to remotely examine the car by accessing its information system and asks Mr C to allow him to do that. Mr C, brings the car keys into the dialog as a token of ownership.

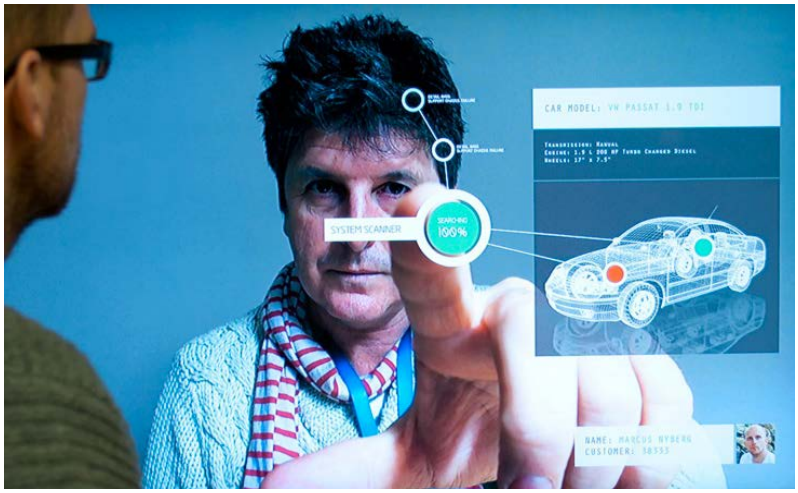

Figure 1. The mechanics can access the actual car which has a representation in the dialogue

After only a few minutes the mechanic is able to locate an error in the software controlling the warning lights. He did so by consulting a colleague, found in the shop's social network, who had commented this type of problem and combined it with the database of bulletins from the car vendor. Luckily this problem can be fixed

with a software update and does not require Mr C to bring the car to the repair shop. Mr C pays for the service using his credit card (like the key to the car the credit card is a token to connect to his account) and a confirmation of the transaction is visible to both parties.

At the base of all these collaborative activities during the video communication is of course the idea of a networked society, such as the digital interconnections between the communication system, the customer, the objects (i.e., their information systems), the repair shop and other services. The customer identification requires access to an electronic ID service in order to create a trusted communication. The remote access to the car builds on the established trust between the customer and the mechanic (or repair shop), and then utilizes the existing relationships between the customer, the car, and the car key when providing the mechanic with an interface to the car information system. In the same way the credit card payment requires access to the system of the card issuer.

The shared information and services are presented on a semi-transparent layer on top of a full screen video, giving the impression that the shared interactive space is right in between the two contexts. The purpose is to create a shared perspective of the 'material' that is being used in the collaborative video communication, but also to be able to clearly visualize (for all parties) the recognition of physical objects and the services that they trigger. In the scenario, e.g., the customer can follow the actions of the mechanic to understand what kind of information he is accessing remotely but also to provide him with input when possible.

2.2 Transformation of Business Processes enabled by new ICT

Enterprises today are under a transformational pressure to automate and optimize their internal and external ICT processes. The reason driving this trend is the constant acceleration of change coupled with the ever strengthening need to differentiate through innovation. Both of these factors are driven by the need to avoid commoditization and loss of competitiveness resulting from globalization and disruptive technology.

Increasingly companies will buy communication as part of applications for business processes. The total needs of communications are increasing but the communications methods may be less universal. However, business communication and collaboration will be unified and coordinated to maximize personal user experience and enterprise efficiency; in general and when communication is part of enterprise processes and support functions (e.g. a presence enabled help desk or sales support.) The as-a-service delivery model strengthens this trend. It allows the provider to include new options to a basic package and make that available in the market without the need to convince 'middlemen' that this is beneficial.

For specific industry sectors/verticals the integration of process and communication is key. Machine to machine (M2M) is a currently small but strongly growing and disruptive area, where business model innovation and geographic boundary limitation removal are needed.

The changes on processes are not only driven by new needs. The new technologies, mobile broadband, smartphones and social interaction support will open up for

process changes. The cost for the new way to interact lowers thresholds for process changes.

2.2.1 Automation and flexibility removes borders

Gains can be achieved through automation by lowering hurdles in execution, as well as transaction costs. Fundamental to this transformation is a flexible, adaptable and ever-evolving technical infrastructure that allows continuous improvement without disruption to core processes. At the core of this infrastructure is online data, structured in a way that all functions can access it and realized in a Service-Oriented Architecture (SOA), which encourages an industrialized way-of-working based on collaboration and re-use in a business network resulting in innovation across organizational boundaries. An increasingly important piece of this infrastructure is the aggregation of disparate data for decision making real-time analysis of business events. Moreover, process automation gradually extends to the orchestration of role-based human activities as part of an overall industrial SW process. Outperforming organizations use SOA and use collaborative tools i.e. Business Intelligence, compared to their peers.

It is important to emphasize that focusing on iterative technical improvements does not translate into effective business innovation. The key lies in assembling all of the parts into a system with a strong value proposition in its entirety. Consider that companies have laboured for years to introduce processes for distributed development, central repository, shared services and approval processes. Compare that with the rapid success Apple had globally launching its App Store with very similar application management processes.

2.2.2 Event-driven business processes and business intelligence

Business rules processing and policy-based SOA move to the mainstream, they automate highly conditional transactions and enable high degrees of automation in applications that are ‘built for change’. A particularly critical aspect of technology evolution here is technology to handle event-driven patterns. Architects and developers will need to understand when to handle events with custom code, or event-driven composition and adapt event processing mind-sets to SOA environments. A specific example of such evolution is Next-gen Business Intelligence (BI), combining real-time access with pervasiveness, agility, and self-customization. ICT providers need to enable successful end user BI self-customization to keep system integration and maintenance costs low.

2.2.3 More communications are used in new contexts

Large enterprise and their eco system are mainly driven by their business processes. They constantly try to improve and rationalize what they do and the supporting IT systems that they use. They will be happy to embrace new communications feature they find, and use them in their processes. They will view the communication features in the light of what problems they solve and how fast they can be available, not if it is a large standard. Any solution must provide an omni-channel approach using web, mobile, applications, social, contact centre and a seamless user experience.

2.2.4 Different industries with different requirements

The utilities market evolution has gone from being generation/supplier-driven to demand/consumer-driven. Utilities will have made significant investments in enterprise systems, information technology, communications access networks and smart meters to allow a single consumer monitor their energy consumption on a daily basis. The nerve centre of a utility is communication and access network architecture that enable real-time bi-directional information to flow across the utility value chain. And the brain is a management framework that can control, learn, expand and integrate all utility functions and mission critical operations, from generation to consumers. The Smart Grid is designed to be self-organizing.

New industry verticals often have new rules. Below are examples of regulatory requirements and laws from North America:

- Health Insurance Portability and Accountability Act (HIPAA) requires healthcare and other organizations to protect sensitive health records of patients and others. Business associates of physicians, medical practices, hospitals, etc. are also required to comply with HIPAA rules, i.e. accountants, benefits providers, attorneys.
- The Securities and Exchange Commission (SEC), the Financial INdustry Regulatory Authority (FINRA), and the Financial Services Authority (FSA) are regulatory bodies which require that electronic record-keeping rules focused on financial services organizations monitor and archive communications between registered firms and their customers.
- Federal Information Security Management Act of 2002 (FISMA) requires the transparency of transactions and the types of information that must be captured when clients place trades. FISMA specifically requires instant messaging compliance by retaining conversations that reference trades.

New verticals require different approach, with new certifications, competences and the proper management of their inherent risks. As it is a regulated sector there are different starting points according to the different laws in each country. Administrative Law is not fully harmonized even on an EU level, and therefore still has significant deviations per country.

2.3 Information-Integrated Businesses

2.3.1 Enterprises under transformational pressure

Enterprises are increasingly adopting an industrialized way of working in their use of ICT as part of supporting their business processes. Industrialization shall here be interpreted as the usage of ICT as a widespread, repeatable process with predictable results, economies of scale to achieve productivity gains and dramatically lower costs. Services and products are standardized to some varying extent and their production and delivery becomes deterministic and rapid. The change in business processes is not only affecting the administrative aspects of the businesses, but the core production. Different industry segments like utilities, media, transport, health, mining, etc. will have started the integration of communications technologies with

their core processes. This is a consequence of that all information will be online and real-time. This will enable innovation and change the entire way the enterprises are run and managed. Apart from all information integration all the things connected with M2M will be integrated into the processes as well.

2.3.2 Integration of business process applications, communication, analytics and performance management

The focus of transformation is different in different industries and types of companies. In a large process-oriented industry, the focus may be on automation and rational handling of core processes using M2M communication, coupled with adaptable resource planning, such as Enterprise Research Planning (ERP), Work Order Management (WOM), and Field Force Automation (FFA). The possibility to analyse all parts of the overall process in an integrated way, including trouble handling, increases the possibilities for incremental efficiency improvements.

For smaller companies and industries with a strong and diverse customer focus at the centre of business, Customer Relationship Management (CRM) is the key to success. Businesses that excel in customer relationship management make each prospect and customer interaction matter, enriching it with the insight and intelligence gathered throughout the organization. The key is to replicate that level of performance across thousands of customer interactions a day, regardless of communications or selling channels.

Across industries and companies sizes, employees effectively communicate and collaborate internally as well as across enterprise borders with partners and suppliers. Identity management and trust must be extended across borders in well controlled ways. Social media has raised expectations across all industries when it comes to being available to engage and interact with prospects and customers. Only by integrating new business process (CRM, ERP, WOM, FFA, etc.), legacy, third party, enterprise and cloud-based systems, including real-time and non-real-time data from ICT services, can a company stay in-step with these continually increasing expectations and deliver the level of responsiveness and attentiveness required to build long-term relationships

2.3.3 Enterprise communications for internal and external communication

The specific enterprise communication need falls into two basic categories:

• Enterprises need communications to effectively communicate with their customers, suppliers and partners. The choice of communication mode is determined by the customers including mobile and social networks. The driver is for enterprises to link their customers with the employees in the most effective way to improve sales and customer satisfaction

• Enterprises need to effectively communicate internally, between their employees and between employees and their business processes. Often, this is tied to the way the organization works and hence hard to change. Please observe that this means also collaboration across enterprise borders and multiple means of communications, e.g., a secretary will be ordered to support and monitor both the CEO phone and mail in an effective way.

These represent different aspects of Unified Communications. PBXs have developed advanced functions to support these capabilities and evolve to Unified Communication as a Service (UcaaS) due to better integration with all other information and collaboration tools. In fact with the involvement of mobility, the enterprise needs for the first time to span its own internal IT networks and public networks in a more complex way than ever before.

2.3.4 SaaS business platforms

The continued success of large Application Service Providers (ASPs) and cloud services further accelerates change by commoditizing the execution platform and enabling the rapid and cost-effective deployment of very large scale services.

The extreme centralization introduced by cloud computing will enable rapid and low-cost integration, thereby creating new convergence opportunities, as well as greater demand for process automation and service-oriented way of working. SW-vendors will migrate their customer base to SaaS offerings that will enable the vendors and the Enterprise customers to integrate much more of their business processes and collaborate more efficiently and more effectively. Vendors will use the insights from customer communities to produce better products and services, strengthen their brand, and lower costs.

2.3.5 Asset-oriented business support

Enterprises have an increasing interest in using ICT to monitor and control their own assets or the assets of their customers. The driving motivation is increased performance, cost reduction and more efficient processes. Well known areas include utility networks and other infrastructure monitoring applications. Moreover, there is an increasing need to monitor assets over the full life-time of the asset, e.g. to be able to do remote diagnostics or update of software.

To this end, data and information regarding the assets are key, and are collected continuously or at discrete intervals. Data is used either as is into the supporting business (e.g., utility meter measurements) or used as raw information into business analytics. Nevertheless, a cornerstone capability is the collection and intermediate storage of data. This data-centric view can be seen as the duality to an event-driven business process.

2.4 Internet of Things and Cyber-Physical Systems

2.4.1 Evolving M2M

During the last few years, Machine-to-Machine (M2M) has gained increased attention. Though having been around for decades, M2M is now at a rapid expansion. This is due to three coinciding events; the ubiquitous availability of viable communications, affordable devices and embedded computing with sensing capabilities, and simply the emerging needs from across industries and society. The needs mainly come from a societal focus on sustainable lifestyles (e.g. health, safety, travel) and environmental impacts, as well as enterprise needs to better compete in a global environment by increasing efficiency, effectiveness, process automation and overall cost reductions.

The main capability of any M2M system is the remote monitoring and control of real world properties of different environments and places (air quality, mines, cities) or of a diverse set of assets (buildings, vehicles, goods, other infrastructures).

The key characteristics of M2M are: M2M solutions are highly specialized stove-pipes with hard-coded integration of devices into the applications. M2M devices are deployed with a single purpose in mind. M2M rely on vertical device solutions with a tight coupling between the actual device and back-end specific software. M2M is plagued by technology fragmentation across application domain as well as within a particular use case segment. M2M solutions are not developed with re-use in mind. M2M is primarily deployed as an IT solution on the enterprise premise. The Telecom industry approach to M2M is communications, whereas the Enterprise approach is smart applications supporting the business processes. Application development and service integration require highly specialized and scarcely available competence and people.

At the core, M2M is data and information centric. The data is 'consumed' by the enterprise systems to fuel the enterprise business processes. The business processes can provide business 'commands' that translate to actuation tasks carried out by the M2M devices. Actuation refers to controlling properties or assets, e.g., turning on or off electrical equipment, etc.

M2M will evolve into two main areas for the future, Internet of Things (IoT) and Cyber-Physical Systems (CPS). The border between IoT and CPS is somewhat blurry, but some main distinguishing features can be identified.

2.4.2 Internet of Things as an open environment

The Internet of Things is by definition an open environment, and is not a separate Internet but an extension of the existing internet.

The key characteristics include: IoT devices are multipurpose devices in the sense that applications can make use of any device. Devices and applications are hence decoupled. Hence, IoT devices do not contain any application-specific software and are therefore simplified compared to M2M. IoT is data, information and service centric. IoT builds knowledge from data. IoT resembles the human cognitive process since it builds information and knowledge from raw data in order to provide decision support. IoT targets usages in all domains, i.e. enterprise, society and people.

IoT challenges include the number of data sources, the amount of data each source produces, and the heterogeneity of data sources. Data is typically 'small data' as opposed to big data, but the number of sources and size of data time series, even real-time streams of data, make two distinguishing points compared to the traditional view of big data.

IoT data will not only be data produced by IoT devices (sensors, including re-use of sensors on smartphones). IoT data (real-world observations) will also be extracted from other sources. Primary sources include data bases of both static and dynamic information (e.g., road data bases, GIS databases, weather forecast services), and people themselves. The social interactions between people is also a source of real world observations as social network feeds can be filtered for keywords relating to real-world observations (e.g., "the pavement here is very slippery").

The heterogeneity of data requires efficient tools for integrating data in the IoT context so that the data has a meaning and can be understood. Semantic annotation is a key tool. Another key tool is the linked data models used for creating the larger 'global data fabric' of IoT when considering the multitude of diverse data sources.

The abundance of small data does not necessarily imply meaningful information. Methods taking the wealth of small data to information and knowledge will be very important. Data and information fusion and analytics are key technologies. Applying reasoning and cognitive technologies will create knowledge. Knowledge is also domain specific, so domain knowledge will also have to be inserted besides knowledge built by cognitive methods. Tools for verification will also be needed. Knowledge will be used for decision support, recommendations and even automated control, hence causing closed automated 'monitor-control loops'.

The open nature of IoT requires new capabilities to support applications and application development. Means for making resources available (publication, discovery) will be needed, means for trading and creating a marketplace of IoT data and services (compensation, incentives for participation), and means for modelling and creating on-line representations of real-world entities (things, places, assets) where the properties are dynamically available and recorded.

The openness of IoT and the multitude of diverse data sources from various providers also require means for ensuring the accuracy and quality of information as data is aggregated, fused and turned into information. Different applications can have different quality requirements on the information, and a particular information item may have an acceptable quality level for a sports application but not for a medical application. Reliability and trustworthiness of data is required, and data provenance tools are needed for the data and information from various sources, as well as when being processed and refined. Liability also becomes an issue as data and information in an open setting is used for decision making. Furthermore, privacy of individuals as well as enterprises needs to be ensured. Security is important, but it is not foreseen that new tools or technologies for data and information security are required.

The role of actuation in the context of IoT is less prominent. Actuation does not typically occur on an open large scale in the same way as sensor data can be collected, fused and consumed. However, actuation capabilities equally need to be available (publishable, discoverable and reachable) in IoT so that application developers can provide appropriate monitor-and-control services for single users. This is no stranger than having means to manage, produce and consume personal content on the internet as of today. An open IoT actuator, potentially accessible by the whole world, needs access and concurrency control that is already covered by existing security and operating system techniques. What is not covered today is the safety aspect of an open actuator that translates to protection of animate creatures and inanimate assets. This is the equivalent of Asimov's first law of robotics (that a robot must not harm a human being), which is extended beyond the human beings and towards assets of interest.

2.4.3 Cyber-Physical Systems for specialised operations

The main different feature between CPS and IoT is that CPS is usually 'closed' systems that are specialized and focused on a specific set of tasks. Closed here means that a CPS is not openly accessible for information by third parties (control of a nuclear power station), CPS can operate in very closed environments (a mine) and can be very specialized in solving complex tasks (control of production and distribution of electricity in a Smart Grid).

A specifically important field of CPS is robotics (e.g. mobile CPS). Robots are typically employed for operating in inaccessible, harsh or dangerous environments. Robots can rely on distributed 'intelligence' in the sense that some automated tasks can be localized to the actual robot, other automated tasks can be remotely placed in a back-end, and yet some tasks can be handled remotely via human intervention.

Any distribution of sensing and control in a CPS will usually require fulfilling stringent requirements on the supporting infrastructure. Service Layer Agreements (SLAs) must be in place from an end-to-end perspective, i.e. of the underlying communications networks and cloud infrastructures. Furthermore, data and information for decision support typically need more accuracy compared to an IoT context.

It can be envisaged that localized CPS deployments can be distributed and "move to the cloud". Unmanned mines is one example, another is smart factories which can be remotely controlled from an Operations Centre. CPS may also be augmented in the cloud with additional data and information, thus relying on IoT as one additional source of information (e.g. environmental conditions related to the locality of the physical part of the CPS). CPS may thus rely on IoT and the border between IoT and CPS becomes fuzzy.

In summary, CPS is more stringent in requirements, whereas they are more relaxed in IoT. But IoT is more complex in terms of understanding the meaning and making use of data due to the open nature compared to CPS where data is typically coming from a finite deterministic set of sources with well-known characteristics.

2.4.4 Common needs

An overall trend is the use of standard technologies and non-specialized solutions components for IoT. An overall trend is also the distribution of capabilities across the topology, and the introduction of cloud oriented solutions. Many challenges are common between IoT and CPS and therefore benefit from and require the same set of technologies. Below follows a summary of future needs to support IoT and CPS.

2.4.4.1 Embedded technologies and devices

Devices for IoT and CPS will rely more on standard technologies for software environment and development, as well as communications. Devices also need to be further commoditized compared to today's M2M vertical device solutions. Devices must be general-purpose devices with very simple application profiles exposing their capabilities for sensing and control.

Communications will move to using the TCP/IP stack even in microcontroller, thus reaching even single sensors with microcontrollers and very small memory.

The RESTful web paradigm will also reach the single sensor device, thus practically hosting small web servers and clients. Technologies for using web and IP in very constrained environments are already available.

The use of IP and the Web paradigm will lead to a significant cost reduction for application development and TTM as the related application developer community is orders of magnitude larger than the specialized and typically closed developer community of M2M today. Thanks to the Web paradigm, any web developer can be employed for CPS and IoT application development. The Web paradigm will also significantly ease enterprise and business process integration and systems integration thanks to 'web end-to-end'. App stores will emerge that specialize on the IoT device and application segment as device application platforms will also become standardized. The general availability of mobile smartphone technologies will expand its use into both the IoT and CPS space thanks to technology benefits like processing and memory capacity, multiple interface technologies, multiple sensor modalities, application and software development environment.

2.4.4.2 Infrastructure and back-end

A distributed system across devices, communication networks and back-end servers including cloud for automated monitoring and control will require tight control of both distribution of logic ("what goes where and why") and the right support from the underlying infrastructures. End-to-end SLA concepts will be needed that integrate the different parts of the solution.

Tools are needed for data and event integration that come from a plethora of heterogeneous devices. Semantic annotation in the integration process is required, as is the addition of other necessary metadata. Simple as well as advanced tools are needed to filter data and events, perform data analytics of large set of diverse data with both spatiotemporal and semantic spread including real-time stream analytics. Semantic tools are needed to aggregate and create more abstract information from the underlying data. Tools are also needed to handle Quality of Information in the information fusion process, and data provenance will be required. This will create information and knowledge at different abstraction levels. Different data and information fusion and analytics tools will be distributed across the system based on metrics like criticality, latency, performance and cost. Matchmaking of application needs information availability will be required, as well as verification of appropriate availability of information to make the right decisions (e.g., "is the information at hand enough, or do I require more and different information from additional sources?"). Tools such as linked data are needed for federation of data, information and knowledge across the different levels of abstraction.

Knowledge creation and cognitive methods will be important to provide the right means for decision support or automated operation. Verification of behaviour will be central. In addition to knowledge creation, insertion of domain specific knowledge for domain specific reasoning and inference will be needed. Exposure and APIs at the appropriate semantic levels will be required for application development.

Closed control loops from embedded devices to cloud-based applications will rely on distribution rules based on the simplicity and complexity of the automated task and the required characteristics such as reliability, latency and criticality.

Marketplace tools will be needed for publication and discovery of available capabilities. The tools will also have to provide tools for accountability, compensation and authorized access. Further, tools for matchmaking will be needed based on, e.g., Quality of Information needs and availability, respectively.

2.5 Intranet Services Opening Up

2.5.1 Ubiquitous access to information and people

There is a trend towards the hyper-networked enterprise with instant access to vital information and people, also when on the move, presenting a set of unprecedented challenges for the enterprise to manage all aspects of its communications and information networks. This makes it the first time that the enterprise CIO has to consider networks, applications and devices which are well out of their control.

The use of video for collaboration will rise from 15% to over 50% of workers in the next five years, imposing requirements on bandwidth, devices and user experience and interoperability across networks.

2.5.2 Collaboration trends

This (large scale) trend is that, as enterprise communication becomes integrated in business processes, the move of enterprises from viewing voice and other forms of communication as separate and independent, to acquiring integrated unified communication is accelerated.

The focus of Enterprise Unified Communication and Collaboration is to minimize the difference in business rules and user interaction when communicating using different media and access forms, the purpose being to increase the effectiveness of the enterprise user in performing their work tasks. The scope is real-time (voice, video), semi-real-time (chat) and non-real-time (deferred messaging, email, voice/video mail) communication. Integrated support functions, such as presence, secretary functions, Customer interaction on public social media (monitoring, moderating). Collaboration includes ads (desktop-, app-, file-) sharing, and co-browsing. This includes support for all fixed and wireless accesses and a variety of endpoints.

Enterprise Unified Communication and Collaboration, and in particular real-time communication, must be coordinated to be useful for the user as well as company support functions (presence, secretary, attendant functions, etc.) This is an important UX, Personal and enterprise efficiency. In summary, this game-changer is already taking place in the market. In practice, a large part of current products and solution are still a collection of different no integrated functionality.

2.5.3 The new security landscape stretches outside the intranet

Communications infrastructure is completely intertwined with critical infrastructure (power, heat, water) and has become critical infrastructure itself. People, all around the world, rely on wireless data for not just communication, but for managing aspects

of their private lives, paying bills, authenticating themselves to third parties, using public transport and allowing access to their public records.

Data protection as we look at it today seems hopelessly naïve compared to 2020. Firewalls, central data storage and device protection no longer provides any level of safety for an organization's valuable data; instead, the accesses to the files themselves have become much more restrictive as the protection moves closer to the devices.

People have become used to real-time demands for their data; instead of an application getting permission when it is installed to share your info, regulators have moved in and forced apps to allow a user to approve the access each time access is granted. Likewise, when a citizen's private information is requested, a real time notification is sent to ask the user to allow it, or in some cases to notify the user that it has already taken place (like a digital version of Upplysningscentralen in Sweden, or basically what is happening in Estonia today). Data privacy for Personal Identity Information (PII) and sensitive personal data (like healthcare) has become more important to society with several requirements being demanded by the public and regulators. This proves to be a difficult barrier for SMEs who handle "Sensitive PII", particularly in the areas of data portability, "the right to be forgotten" and "Do not track".

The loss of a device no longer means the loss of all the information, as information is stored in the cloud instead of on a per device basis. The access to the cloud and the storage on the cloud itself have both become massively commoditized, with freedom of movement guaranteed between providers due to regulation. People pay a monthly fee to their storage provider, in the same way as they pay a fee to their ISP today.

Cybercrime does not exist anymore. In 2020, it is now just crime. Law enforcement agencies and their supporting agencies—perhaps similar to the Child Exploitation and Online Protection Centre (CEOP), the Information Commissioner's Office (ICO), and the Serious Organised Crime Agency (SOCA) in the UK—have begun to adapt their ways of working to enforce protections around data breaches, identity theft, unauthorized access and misuse of computing resources. Rights Protection Lawsuits, as seen today, have proven to be ineffective in stopping illicit access to music, games and movies, as alternative modes of access have been established which reduce the desire to 'pirate' art. Investigations now always involve the seizure and investigation of IT devices while cross border jurisdictions for information access are being established. Safe havens for rogue services, such as spam, malware and illicit material still exist, however ISPs and backbone providers have become more efficient at blocking access to network traffic in transit.

2.6 The New Connectivity to Services

2.6.1 Who builds and owns the access?

Enterprises rethink their equipment strategies, including LAN, from a Technology and Business model perspective and optimize for a Mobile and Cloud centric future. The nature of small-cell (with 3G, LTE and Wi-Fi access) deployment means there will likely be many hundreds of thousands of units installed across an operator's network. This means the effort and cost involved in planning, provisioning and installing these

small cells must be kept to a minimum. One way to achieve this is through collocation and integration with micro and pico cells, in order to reduce mounting, power and backhaul requirements. This will require advanced features, such as RF interference management and dual-band architecture that can support backhaul between access points – enabling operators to make the most of their available cell site, fibre or hybrid fibre-coaxial (HFC) assets. Addressing the power, mounting and backhaul challenges alone does not ensure a cost-effective and replicable deployment model, however. To ensure timely deployment and provisioning, smooth operation and ease of management, self-organizing networks (SON) and self-optimizing network features are key.

Business intelligence tracks usage data by device, location and time of day, enabling proactive network planning and investment that optimize the operator's return on investment. Network management needs to be scalable to support potentially 100,000 access points in a single network, and to be able to offer real-time and remote management with detailed visibility – from a single access point to network-wide. The operating system can help provide carrier-grade features, such as edge-based policy enforcement integrated with the operator's authentication, authorization and accounting (AAA), mobility and support for virtual access points. SON capabilities will help drive automation in everything from planning, through installation to on-going maintenance and optimization. These capabilities will span several nodes and technologies, and help ensure the small cell solution is scalable.

2.6.2 Ubiquitous high-capacity access

The heterogeneous network vision is that small-cell technologies with multiple accesses should become an integral part of a complete mobile-broadband solution, and to deliver high-quality services wherever users need them.

By the end of 2018, it is estimated that the typical mobile PC will generate 11GB, a tablet 2.7GB and a smartphone around 2GB per month. Wi-Fi delivers the high-speed, convenient access to the internet that can satisfy the hungry data appetites of millions of smartphone and tablet users.

Operators are uniquely positioned to bring Wi-Fi access into the telecom mainstream, as users do not care if they are connected over 3G, LTE or Wi-Fi. With Wi-Fi fully integrated into mobile-access and core networks—offering seamless, secure roaming, intelligent radio access type selection, session mobility and carrier-grade scalability and manageability—users will enjoy seamless access to high-performance mobile broadband, whether they are connected over 3GPP or Wi-Fi. And operators will be able to optimize the user experience and take advantage of new business opportunities by supporting a variety of flexible business models.

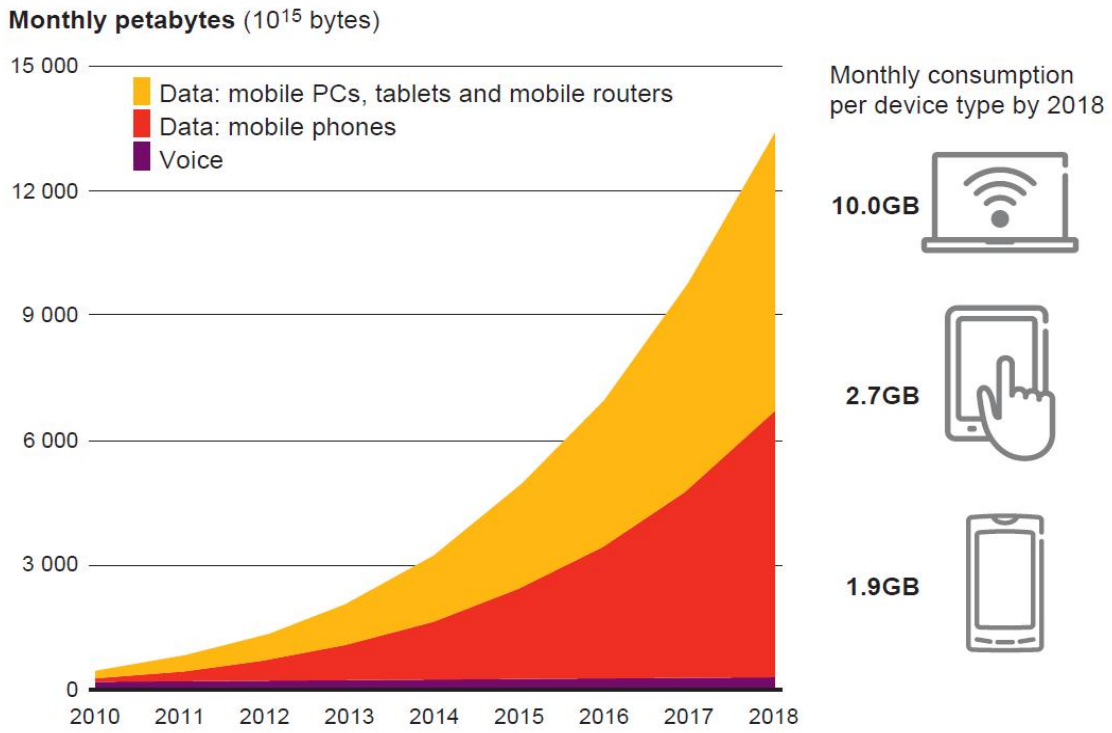

Figure 2: Mobile data traffic growth (Source: Ericsson Mobility Report, November 2012)

2.6.3 Access for many and diverse set of devices

Enterprises that have transformed their production processes will have to support their Internet of things and cyber-physical systems. They typically contain devices, that are part of a process flow, and require new characteristics, ranging from real time, security to availability, of the access network. The volume of devices can be very large so management support will be vital. That support has to be integrated between access provides and enterprises.

2.6.4 Network application support

A substantial part of the traffic in the Mobile Broadband supporting the enterprise is the delivery of content: WEB, video, file-sharing, document, business applications, etc.) and with the rapid increase in traffic, the overwhelming traffic volume causing a QoE challenge. The content is located both in the enterprise servers or cloud and the services outside the physical network but inside the logical, the SaaS delivered services with content. Thus the network needs to accelerate content access. For instance, office application accelerators in base stations, many people accessing same collaboration site in the same building.

The use of policy control and dynamic per packet prioritization in 3G/4G primarily for downstream will become a necessity. Security solutions have to accommodate acceleration. For instance, data might be confined to the enterprise network security zone and open for acceleration.

2.7 New Devices and Mobility

2.7.1 Multimodal communication

Employees, partners and customers will communicate using the most suitable channel and device at hand for the purpose of communication. A customer interaction on a given sale, may take place across a number of different channels, over an extended time: perhaps starting with the customer browsing a web site, reviewing social media, calling or emailing a representative, closing the deal, using the web chat help desk, upgraded to desktop sharing, commenting (hopefully) on twitter about the excellent product and customer service. The employees handling this interaction may be using a smartphone for voice, starting a chat on the phone and transferring it to a tablet or PC, which is also suitable for co-browsing. To be efficient, all these channels and terminals should offer aligned user experience, possibility for terminal and context switching as well as integration with communication logs and CRM information.

The Communication as part of the business process is most efficiently started and maintained as part of the business application or process tools which are used for the process. This requires use of widget communication tools and integration points in applications. Then all the relevant presence, communication and other sharing functions will be available ‘one click away’ at all times at work.

2.7.2 Bring-Your-Own

The 'Bring Your Own'-movement is well documented and established in the market.

- BYOD (Bring Your Own Device)

  Employees using their own private devices to run and access enterprise apps. Mostly common today for smart phones and tablets and not as common for PC/laptops. In practice, the device can be partly reimbursed by the company but it comes down to the employee making the choice of device.

- BYOA (Bring Your Own Application)

  The trend toward employee use of third-party applications and cloud services in the workplace.

- BYOSP (Bring Your Own (connectivity) Service Provider)

  Employees accessing enterprise applications and resources using their own devices and their own access providers. Usually the case for fixed today (RVI) but not as common for mobile and mobile enterprise apps.

Devices used by knowledge workers are going through a rapid transformation. We have started to abandon the classic phone and the laptop/desktop for more mobile tools. The smart phone has taken the market by storm. The tablet revolution has turned keyboards into an accessory. The rapid evolution of consumer technology and devices has made 3-4 years of device depreciation schemes obsolete and employers have started to outsource the mobile devices to their employees. Bring your own mobile devices and we pay for the service usage. This trend lowers the entrance barriers for new providers of enterprise communication. In the traditional PBX world

proprietary system desktop phones represented half the investment, with a considerable lock-in effect. In the future all solutions will be based on clients on a few dominant mobile terminals and OSs. This opens up for more rapid service innovation.

BYOx is not just confined to employees but will also need to address partners and customers mobile access into the enterprises' business processes. Bring Your Own Device is a major trend and seen as an enhanced customer service since the user can select a device based on his/her preferences. It has been seen as a major issue to handle correctly. Due to market forces we are however observing a slight twist to the trend; the devices present on the market are increasingly supporting a common set of criteria defined primarily by Exchange AirSync. These include, e.g., local encryption, remote wipe/poison pill support, and local pin lock policy.

To an extent we could argue we no longer have Bring Your Own Device but rather Submit Your Own Device to Enterprise Policies; in essence the user loses control over his/her 'own' device ("no I don't won't to change to a new 14 digit alphanumeric password with upper and lowercase and no repetitions and at least one digit…because I just managed to memorize the old one…").

3 Conclusions

Enterprises will have automated and optimized their internal and external ICT processes.

Enterprise communication is integrated in business processes, the shifting from viewing voice and other forms of communication as separate and independent process. The need for an integrated unified communication is accelerated since the multitude communications will create complexity to the user.

Communications infrastructure is completely intertwined with Critical Infrastructure and has become critical infrastructure itself. Both information and physical objects will be part of the social interaction and media flow.

An increasingly important piece of this infrastructure is the aggregation of disparate data for decision making real-time analysis of business events. Moreover, process automation gradually extends to the orchestration of role-based human activities as part of an overall industrial SW process.

Enterprises rethink their equipment strategies from a Technology and Business model perspective and optimize for a Mobile and Cloud centric future. Several accesses 3G, LTE and Wi-Fi will be integrated in a heterogeneous network with small-cell technologies to deliver the user experience needed.

Information infrastructure built for real time, information orientation and flexibility

SaaS and cloud-based SW become standard. This requires the adoption of new application support practices for SaaS, while completely re-evaluating capacity issues as well as architecture standards for applications developed or hosted in the cloud.

Highly conditional enterprise transactions that staff members perform manually may be automated or supported with the help of event-driven telecommunications technology.

Real-time Business Intelligence combines real-time access with pervasiveness. Increased pressure towards agility drives companies to analytics to improve their speed of response to changing market conditions. The integration of business intelligence functionality with telecommunications assets and event-driven technology open up new opportunities.

What empowers the new generation users will prevail

The new generation are the digital natives. They have grown up in a digital culture and will bring their values and way of operating into enterprises. This will drive the change of communication tools and methods.

Employees, partners and customers will communicate using the most suitable channel and device at hand for the purpose of communication. Devices used by

knowledge workers are going through a rapid transformation. We have abandoned the classic phone and the Laptop/Desktop for more mobile tools. Bring Your Own Device is a major trend since the user can select a device based on his/her preferences.

Sharing and social availability the new norm and competitive edge

Advances in collaboration technology will make it possible to share and interact more effortlessly. Information will be accessible to all staff from any device and can be shared in collaboration.

Social media has raised expectations across all industries when it comes to being available to engage and interact with prospects and customers. Across industries and companies sizes their employees effectively communicate and collaborate internally as well as across enterprise borders with partners and suppliers. Identity management and trust must be extended across borders in well controlled ways.

Imprint:
EIT ICT Labs IVZW
22 Rue d'Arlon, 1050 Brussels
BELGIUM

ISBN 978-91-87253-19-5

Innovation Radar