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MORE THAN 50 BILLION CONNECTED DEVICES

MORE THAN 50 BILLION CONNECTED DEVICES – TAKING CONNECTED DEVICES TO MASS MARKET AND PROFITABILITY

Everything that can benefit from a connection will have one. As people we are already online. The next step is to get things and places online. And we are moving fast in that direction. The vision of more than 50 billion connected devices by 2020 may seem ambitious today, but with the right approach, it is within reach.

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DRIVING FORCES

The vision of more than 50 billion connected devices will see profound changes in the way people, businesses and society interact. With ubiquitous mobile broadband-enabled internet access, connectivity and networking are becoming completely independent of location. Combined with falling prices for communication modules, connectivity services and embedded computing, the drivers for new services and functionality – broadband ubiquity, cost of connectivity, and openness and simplicity – will lead to more efficient business models and improved lifestyle for individuals and society.

We are already heading full-speed towards connectivity for everyone. In 2010, more than twice as many connected devices as subscribers were added to carrier networks in the US market.

Different kinds of gadgets are gradually turning into hybrid devices that are services as much as they are physical objects. Smartphones and tablets – in all their different shapes and forms – are also expected to be the portals to an integrated ecosystem of services and applications. And the trend is spreading to devices such as television sets, audio equipment, and even cars. This marks the beginning of a new era of innovative, intertwined, combined products and services that utilize the power of the networks.

Unlike connected consumer electronics, the essence of connecting industrial devices, objects or machines lies within enriching or rationalizing the business processes of the companies or organizations using the technology within their value chains.

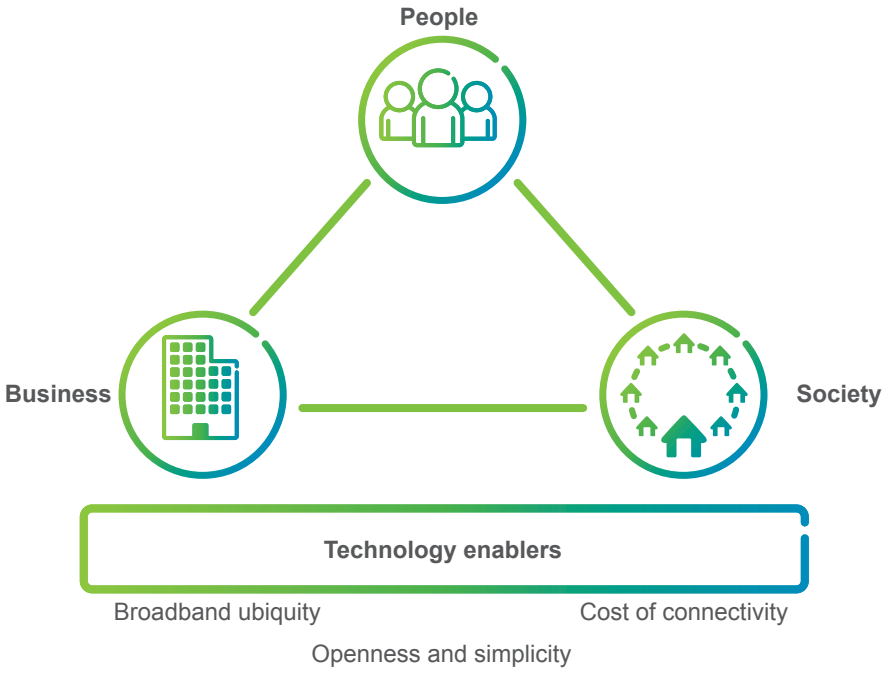

Figure 1. Drivers for device connectivity come from people, business and society in general.

At the forefront of adopting machine connectivity are utilities, government, transportation, health care and finance. Intelligent transport solutions can speed up traffic flows, reduce fuel consumption and save lives. Smart grids can lower energy consumption and enable more renewable energy sources. Remote monitoring will provide convenient access to health care, raise its quality and save money.

There are numerous examples of remote monitoring, improving security in homes and airports, for instance, or monitoring patients in a discreet way – for example, shoes or doors can be programmed to send a signal if they are not used for a certain period of time. Connecting your wallet, or rather turning your mobile device into a wallet or even a bank, is another example of the radical impact that connecting an everyday object may have – in this case redefining the whole financial industry.

Without too much trouble, a vending machine can tell service staff when it needs to be replenished – to avoid unnecessary travel. On a larger scale, whole industries can use wireless sensors to monitor different processes and connect their entire business end-to-end. In Swedish sawmills for example, logs are harvested deep in the forests in specific lengths based on timber ordered by customers. Even individual trees are being monitored to ensure a better crop and to plan the harvest more efficiently.

The characteristic common to all of these usage cases is their reliance on large, ubiquitous networks to transmit information and distribute products and services to end users. Networks that can support the exponential growth in the number of devices and meet the needs of specific vertical industries are crucial elements in the vision of more than 50 billion connected devices. Real-time capabilities and quality-of-service (QoS) guarantees will be crucial. The solutions must be open and standards-based to provide interoperability between ecosystem players and vertical industries.

Wireless technologies and computing will be embedded in all kinds of products, from computers to

coffee makers. As the cost, size and power requirements of wireless modules fall, all kinds of devices are becoming connected – not just stationary computers and laptops, but also tablets, ultra-mobile PCs, portable game consoles, TV sets, cameras and home appliances. Reduced cost, size and power requirements will enable a paradigm shift, after which connectivity can be used to monitor and/or control almost anything.

As wireless capabilities become increasingly integrated within computer chips, the benefits of the computing world – innovation, short development cycles and low cost – are extending into mobile communications. As a result, traditionally unconnected devices are becoming connected – varying from television to cars and industrial machinery to farmland equipment.

NUMBERS BEHIND THE NUMBER

To understand how the number of connected devices could reach more than 50 billion over the next decade, it is worth considering some high-level, macro-economic trends and statistics. As a few examples, by 2020 there will be:

- 3 billion subscribers with sufficient means to buy information on a 24-hour basis to enhance their lifestyles and improve personal security. In mature markets, these customers will typically possess between 5-10 connected devices each.
- 1.5 billion vehicles globally, not counting trams and railways.
- 3 billion utility meters (electricity, water and gas).
- A cumulative 100 billion processors shipped, each capable of processing information and communicating.

Development of the networked world is progressing through a number of waves, as shown in Figure 2.

NETWORKED BUSINESS

The adoption of connected devices by business will be largely driven by customer-service enhancement, as well as opportunities to increase productivity, cost-efficiency, monitoring and control of assets. Other factors will include the need to comply with new legislation, whether in sustainability, security or other areas. Connectivity will be a core component of future service and application development. Thanks to rapid technology development, the cost of connectivity is no longer a significant factor when considering if it is worthwhile to connect an application to a network. Opportunities in connectivity are emerging in parallel with the development of cloud-based services, which are accelerating the development of applications and offering faster and simpler reuse of applications and application components across industries.

In today's globalized business world, networks are fundamental to commercial activity and production. Production is increasingly organized among separate players and their complex web of interactions creates value chains that help drive the global economy. Global networks cover many areas of activity, including networked

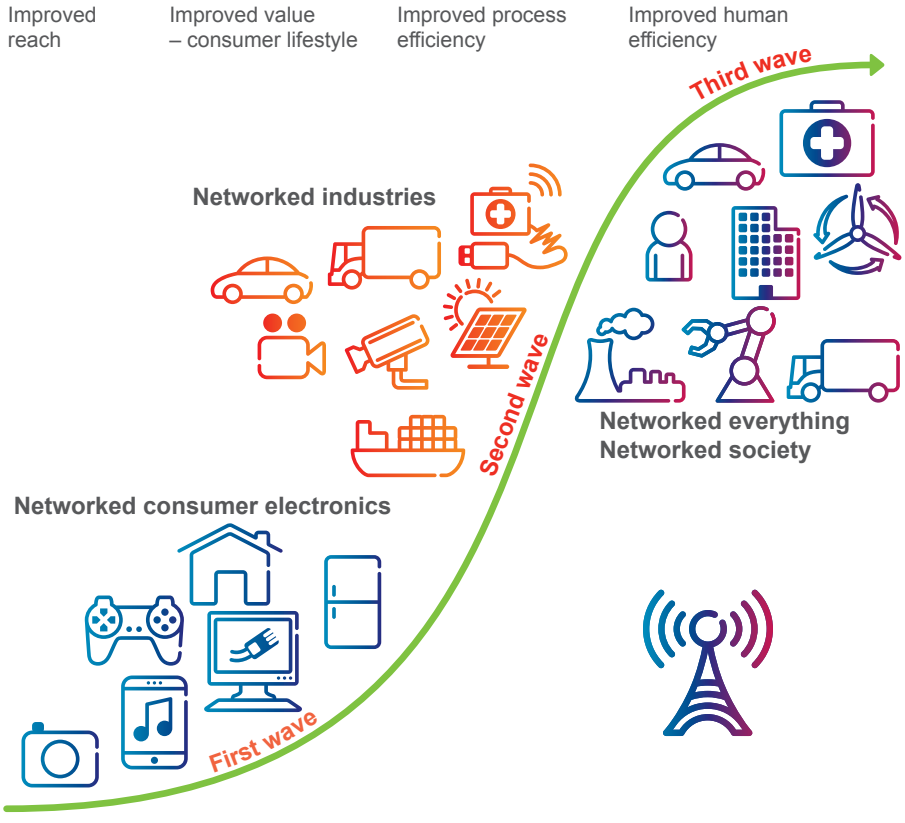

Figure 2. The three waves of connected device development.

research and innovation, networked production and e-business.

Connecting a machine or an object (like a truck or a building) primarily results in the following benefits:

- Automated software updates.
- Automated after-salesservice.
- Remote service and maintenance.

It's about improved customer and product management. The focus will be on improved operation and features; devices and machinery will work differently in an all-connected world. There will be a shift from asking "do we need to connect it?" to "what can we do differently now that it's connected?" This is the new mindset that the networked society will create.

In the business-to-consumer segment, there is huge potential for the creation of new value chains. For example, manufacturers of audio-visual hardware can offer content through networking capabilities as an over-the-top service.

In addition, businesses can reach previously inaccessible markets thanks to the rollout of mobile broadband and networked devices.

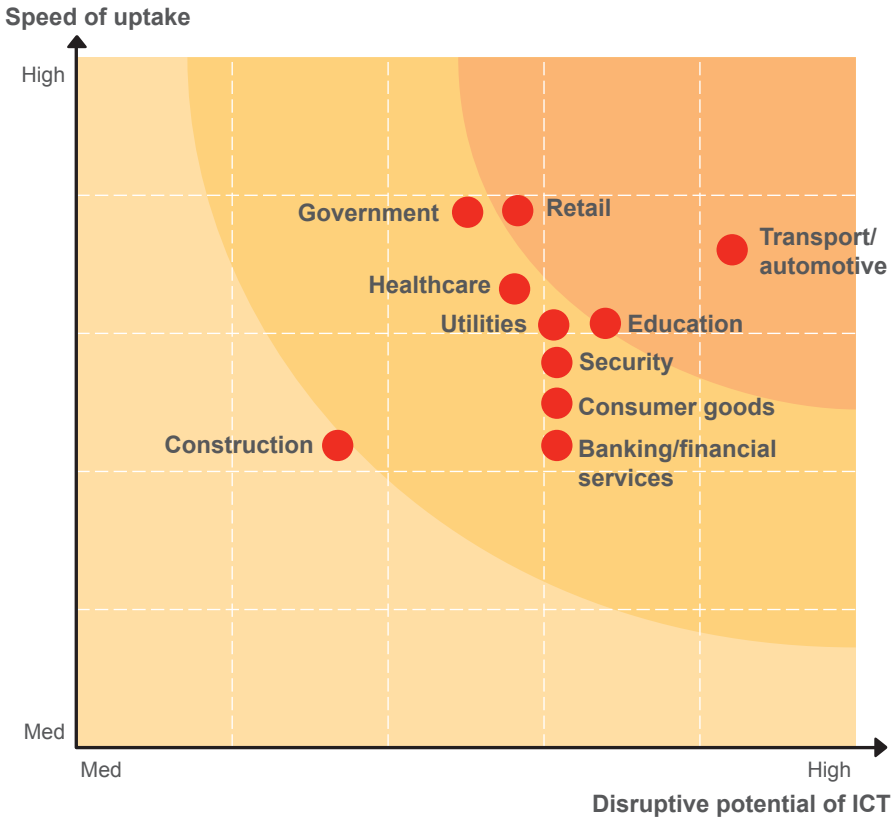

Figure 3. The disruptive potential of connectivity across various industry sectors.

The relative size of vertical industries today is one indicator of future business volume when it comes to connected devices, but not the only one. Other indicators include speed of uptake, the disruptive potential of connectivity and structural factors such as the need for mobility or ease of deployment by avoiding wired solutions.

Many sectors across industry, services and government will undergo significant transformation in the coming years, as illustrated in Figure 3. There will be disruption of established value chains, with new players who innovate and exploit networking and digitalization entering stable industrial structures and changing the game.

In the utility sector, the smart grid vision is being enabled by the convergence of internet-based infrastructure and the energy domain. Smart grids will control future decentralized power generation, distribution and storage networks, perform on-demand optimization and consumption control, and support innovative models for trade based on momentary supply and demand in the electricity market. Device connectivity will enable services such as electronic marketplaces, which facilitate the buying and selling of electricity, not only for utility companies but also for decentralized consumers and producers. Electric cars, in significant volume, could for example act as accumulators and be part of a trading network to smooth out load on the grids.

In transport and logistics, there are many new services enabled by device connectivity that improve efficiency and traceability. Such services deliver more efficient logistics management, integrated with traffic control and management systems that will provide increased efficiency. In addition, connectivity will lead to a considerable reduction in natural resource consumption. Intelligent transport systems and connected cars will also open up huge opportunities for the insurance sector to differentiate products. For instance, insurers could monitor the status of a customer's car by connecting to in-car devices, enabling policy premiums to be based on actual usage and behavior.

Greater connectivity is also leading to efficiency gains and innovative services in the public sector. Areas such as e-education and e-healthcare are likely to be large growth segments for connectivity in the coming years.

NETWORKED CONSUMERS

Among individual consumers, demand for connected devices is driven by a slightly different logic. A growing and increasingly globally harmonized middle class is seeking capabilities and gadgets that reinforce their modern lifestyle – preferably in a way that increases convenience, adds fun to life or enriches leisure time. Anything that saves time or enhances the user experience will be welcome – be in gaming or in new ways of keeping in touch and informed.

While the term "globally harmonized" might imply a greater degree of similarity across countries, innovation for the "new middle class" – primarily in China and India – may well offer more sustainable ways to achieve a new lifestyle.

The move towards connected consumer electronics is an important trend, in which embedded connectivity itself delivers a noticeable service enhancement – for example, in gaming, digital cameras, navigation, toys and sports equipment.

Aging populations in the developed world will help drive the market for new solutions in health care. Governments and health-care providers will want to encourage cost-efficient solutions to enable people to remain at home as long as they can receive good care and feel that they have good medical advice and emergency services within easy reach.

Personal safety is, and will continue to be, a growing concern, and new safety solutions will be demanded by people to protect themselves and their belongings. Connecting homes for monitoring and control is a contributor both to safety and sustainability, while connected commuting provides value in terms of planning and saving time.

NETWORKED AREAS IN SOCIETY

For governments and society in general, sustainability, safety and security – in combination with cost reduction – are top priorities. There is a need for innovation that reduces energy consumption, improves access to public services and cuts social costs.

Networking is one way of achieving higher service levels and a more sustainable society at a reasonable cost. For example, connected transport systems will improve traffic flows, provide hazard warnings, offer emergency calls and improve the quality of information made available to commuters. Smart utilities will help reduce the consumption of electricity, water and gas, provide more efficient distribution and avoid power outages through monitoring and efficient control. New health solutions that can prevent unnecessary hospitalization or doctor's visits will dramatically reduce health-care costs while continuing to meet people's needs.

New health solutions are seen as beneficial to both society and individuals. As an example, remote patient monitoring could save as much as USD 200 billion in the treatment of chronic diseases across OECD and BRIC countries[1]. The current global shortage of health-care workers, estimated to be about 2.4 million, could be compensated for through smart solutions.

Smart cities will optimize resource usage, efficiency and sustainability, as well as quality of life for residents and new business opportunities. Monitoring of borders, city streets, public transportation and other areas will increasingly be used for safety and security.

Naturally, there is some overlap across these driving forces for connectivity. Sustainability solutions will be requested by consumers, regulated by society and implemented by businesses – for example, in the shape of smart grids and smart homes.

[1]GSMA, McKinsey&Company, mHealth: A new vision for healthcare, 2010

ECOSYSTEM CHALLENGES

Building the various ecosystems that will connect more than 50 billion devices is a truly multidisciplinary challenge.

For the ICT industry, the key challenge is to attract investment in solutions that offer an attractive business case and to stand out in a highly competitive market. Knowledge of the potential opportunities is growing, but is still limited. The ICT industry must enter into macroeconomic discussions to show, for example, that investments in remote monitoring of patients or traffic have an impact on investments needed in hospitals. Considerable education and cross-disciplinary work is required and the ICT industry needs to help to make this happen.

An entry point to such a discussion is the more immediate issue of how to build the networks for more than 50 billion connected devices. An organization's choice of connectivity technology is not always based on the best long-term solution, but is often driven by short-term cost-efficiency, sometimes in combination with a wish to stay in control and own, or at least operate, the networks. This is often not the most sustainable, efficient solution. Instead, more ecosystems can be built over public networks.

SERVING COMPLEX ECOSYSTEMS

The development and provisioning of connectivity-enabled applications will demand different business approaches according to the type of ecosystem. These ecosystems will vary widely, and will be integrated and built along different lines. For example, a network of sensors and control units within an enterprise is a very different system to a set of connected consumer devices exchanging information.

What is more, the deployment of connectivity gateways – for example in a connected car – enables the connection of a multitude of different applications and devices, each serving different purposes. This requires forward planning and cooperation among the players involved to make the gateway serve all involved applications according to the set priorities.

The way applications are developed and ecosystems are integrated will vary widely. Connected cars or connected home ecosystems will need to be open and allow different parties to interact, while an enterprise application will often be delivered by a single integrator. There is, however, a need to find commonalities between different ecosystem domains to enable as much reuse of common elements as possible. Horizontal solutions that bridge the gap between applications and connectivity, and ecosystem stakeholders – developers, service-provider partners and consumers – will simplify and speed up the development of applications as well as open up new revenue streams.

MEETING CONSUMER EXPECTATIONS

Device integration needs to be carefully considered, as it must take service enablement into account. The objective of device integration has to be to facilitate application development based on available and approved devices.

Consumers increasingly use a multitude of devices in their day-to-day lives. There will be connected consumer electronics and services based on embedded devices in appliances, vehicles, homes and other parts of the personal domain. For consumers, applications need to be non-intrusive and intuitive: adding services in a truly connected world should be just an extension to the already established and accepted forms of person-to-person communication – building on social networking, for example.

There is a real challenge in balancing information processing and control with time. Added to this are growing concerns around maintaining integrity and privacy, especially when it comes to things like individually targeted advertising. Consumers will want to know that devices and applications make life easier, as this helps to justify the money and time spent on them.

Mobile phones and smartphones will be the interface for many services, and the rules about being non-intrusive and intuitive will certainly apply. The aim will be to provide a relevant and optimized experience for consumers. Connected commuters would rather receive updates tailored to their own route than every timetable for all seven buses at their current stop, for example. Unwanted, irrelevant information or obtrusive advertising makes services unappealing.

SERVING MULTIPLE APPLICATIONS OVER MULTIPLE NETWORKS

An additional challenge to consider when developing new ecosystems is the need to integrate applications over different networks, and even different network technologies. For devices that already have connectivity to the internet, for example over Bluetooth, WiFi and WAN, this is not an issue.

In industrial applications that need to interact with various, always-on devices, integration across networks may become a necessity. The simplest level of integration is using national roaming to secure coverage. On top of that there may be the challenge of integration across different generations of mobile networks or integration of fixed and mobile services, and even integration across different mobile standards.

There are also challenges in allowing a single device to be used by multiple services. For example, a connected home appliance may be part of several applications, each of which need to interact with it based on a specific set of rules, with security and integrity. The choice of connection must cater for the full set of needs and the device needs to integrate with all the different services.

GETTING TO 50 BILLION

The expectation is that everything that can benefit from a network connection will have one. Realizing this expectation will be the result of a number of different initiatives – some from loose constellations of ecosystem players, others based on well-defined projects.

The necessary first step is to provide tools and interfaces for simple application development. The capabilities and services of the connected devices should be made available to applications in a way that hides the complexity of the underlying network offering the connectivity. Once open connectivity interfaces are in place, service innovation will follow. This will require tools that support service innovation, including reusable service components that make application development easier and remove the barriers between fixed and mobile networks.

HIGHER MARGINS, LOWER COSTS

Machine-to-machine (M2M) communication services have already proved to have a positive impact on the bottom line for operators. From an operator's point of view, there is a sound business case for M2M communication services based on mobile connectivity, provided that the right organizational set-up and solutions are employed. The watchwords include:

- No subsidies
- Simple provisioning
- Little or no connectivity customer support, with self-service
- No churn
- One bill for 1,000 devices
- Global modems for integration into all types of devices.

The cost of cellular M2M modules is estimated to be falling at an annual rate of 15 percent, which makes connectivity-based services increasingly affordable. The cost of connectivity is already as low as USD 1.50 per gigabyte

The increased dependence on mobile systems will introduce demands for constant availability, resilience, coverage, latency and bandwidth. These demands, in turn, necessitate service level agreements (SLA) and policy-enforcement solutions to ensure that the application can be run cost-efficiently and in accordance with agreements.

REGULATORY MOVES

Regulation will help to create platforms for new services.

For example, the eCall standard will be a requirement in all new cars in the EU by 2014, creating a platform for all kinds of services that employ connectivity, if the standard is suitably adapted.

Eighty percent of all utility meters in the EU must provide smart metering by 2020, providing a platform for demand response as well as a driver for smart grids and the smart home.

The latest emission reduction targets will drive the development of smart transportation systems and connected commuters.

SERVICE ENABLEMENT

The internet model will undoubtedly dominate the development of new services, enhanced by the emerging cloud-computing business model. Reuse of functionality within or across verticals, will be accelerated – which will drive the commoditization of functionality and the need for platforms that can provide generations of new service concepts.

Some services may run across several networks, either because they employ different devices or because devices roam between different networks. Here, the service enablement part of the ecosystem needs to offer conformity in interfacing with the applications while hiding the specific characteristics of the underlying networks and devices.

There will also be new business opportunities in this intermediate layer in the shape of payments, brokering and advertising. Data mining and analysis will contribute to improving applications and consumer experience across devices, thus providing further business opportunities.

Standardization and reuse across this intermediate service enablement layer is a key enabler for growth of the ecosystem, provided it can be done in a way that meets the needs of service providers.

Open Application Programming Interfaces (APIs) for third-party development and the creation of app stores are fundamental ways of quickly extending the application level of ecosystems. This requires controlled and managed access to devices and data.

TECHNOLOGY CHOICES

The choice of connectivity technology is a key issue, especially as there are alternative or complementary technologies across three generations of mobile networks.

Short-range radio technologies such as Bluetooth, WiFi and Zigbee complement mobile networks by providing capillary networks – both for consumer devices and enterprise applications.

Factors influencing the choice of technology include coverage, mobility demands, bandwidth requirements, device power consumption and cost. Considering that M2M ecosystems will continue to exist for many years to come, the need for device changes and upgrades is also an important consideration.

Over time, the demands made of communications solutions for different verticals and applications will change. Smart living may start with a single application for energy control, but is likely to develop over time. For example, the washing machine will get connected to the smart building system and the appliance manufacturer, a web application that allows the user to download the right wash cycle, and provide some means of remote control.

Applications will need to share devices and control them in a logical way. Capillary networks based on short-range wireless technologies are viable solutions for some applications where demands are less complex, such as meter reading and power outlet monitoring and control.

The integration of smart homes with gateways, or other similar communication solutions, presents an attractive business opportunity. Service providers could offer managed networking for the home, based on the mobile model, where devices, communication security, media storage and transfer, and home automation are all offered in combination with cost-efficient communication – initially based on cloud-based services, for example.

SIMPLIFY AND CONTROL

The human aspect of more than 50 billion connected devices goes way beyond smart living and new gaming devices. Ubiquitous connectivity is about being able to control things in a way that saves time and simplifies life. It's about using solutions that are intuitive, that do not require technical skills or understanding. And it's about accessing information that we want; not unwanted ads or excessive, irrelevant information.

What's needed is networking on a logical level, where devices communicate with each other and with people in a way that is quick and easy to relate to and understand.

Consumers would prefer not to be bombarded with generic, irrelevant information and messages. If consumers choose to opt in to advertising- or promotion-funded services, the messages and information they are sent needs to align with their interests, whether they are out shopping or visiting a new area.

Such capabilities are already about to be realized, but can be enhanced through service enablement and data analyses, for example of location, interests and history. Information will initially be disseminated in a simple way, but could develop into a full-blown augmented reality offering that will enhance the user experience.

However, personal integrity and privacy always need to be taken into account.

SIX STEPS TOWARDS THE MASS MARKET

Our world is already highly connected: today there are well over 5 billion mobile subscriptions worldwide. Soon there will be more mobile subscriptions than people on the planet, as devices and things of all kinds become connected. Ericsson envisions an order of magnitude increase in the number of connected devices over the coming decade.

While solutions for connecting devices over mobile technologies are nothing new, the market is entering a new phase of rapid growth and development, as the cost of connecting devices falls and the value of connectivity rises – for individuals, businesses and society in general.

The ICT industry needs to take a few vital actions in order to participate and drive the development towards more than 50 billion devices.

First, the ICT industry needs to secure awareness of the opportunities enabled by ubiquitous and cost-efficient mobile connectivity and device management, both for device-centric and service-centric applications. Players need to engage in innovation clusters with other industries in their respective ecosystems, and contribute to the formation of ecosystems based on their own capabilities.

Second, the industry must drive integration across networks and access technologies to support simple and seamless device connectivity and services. Connectivity and service brokering, with national and international roaming agreements, are key. Tariffs and subscription models need to adapt to the way in which devices and services are actually used. Payment is an important element linked to brokering in this integration process.

Third, the industry needs to create tools to facilitate application development, building on an already huge application-developer community, and minimize the need for the adaptation of applications taken from one network and used on another. It must create and standardize the common elements of service enablement that facilitate reuse of services and applications with common APIs. Mobile networks and applications must be bridged in such way that data acquisition, filtering and analysis take place in a way that serves existing applications.

Fourth, the industry should employ and develop cloud computing to offer smooth reuse and dissemination of new functionality.

Fifth, service innovation is vital both in open development (app stores, open APIs, cloud-based capabilities) and “closed” application environments (device reuse, enablement of common functionalities to reduce costs, standardized interfaces in devices and for application enablers, cloud-based computing for cost efficiency, service-oriented architecture (SOA) and service orchestration tools such as composition).

Finally, the industry must approach consumer applications from the perspective of creating convenient, non-intrusive and intuitive solutions based on context awareness. These must incorporate relevant information, integration and managed networking to provide hassle-free services with intuitive and simple communication and messaging. The industry needs to understand how it can make devices network in a way that’s easy to understand and where interworking and operation match people’s mental picture of a network.

REFERENCES

[White Paper: Device Connectivity Unlocks Value]

GLOSSARY

API	Application Programming Interface
BRIC	Brazil, Russia, India and China
EU	European Union
ICT	information and communication technologies
M2M	machine-to-machine
OECD	Organisation for Economic Co-operation and Development
QoS	quality of service
SOA	service-oriented architecture
SLA	Service Level Agreement
WAN	wide area network
WiFi	wireless fidelity