

THE NEXT AGE OF MEGACITIES

NETWORKED
SOCIETY



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INTRODUCTION

Megacities may be congested and complex but they are also among the planet's most exciting places to live. They have proven effective in stimulating creativity, innovation and economic development; factors that often lead to improved quality of life.

It's a diverse matrix that needs to balance social, economic and environmental pressures in a sustainable way, while providing everything from essential services such as water, food and electricity, to public safety, job creation and better use of resources.

Realizing this potential requires a holistic, proactive and collaborative approach at all levels of society, from city planners, businesses and citizens, using a city management system to achieve a common vision.

This is where ICT can play an important role. By mining the vast amount of data produced by the array of connected things within any megacity, ICT is instrumental in the efficient day-to-day management of the city, but perhaps more importantly, provides the mechanisms to support balanced views when implementing solutions that affect several interconnected challenges and opportunities.

Of course, no two cities are the same. While there is some commonality in terms of underlying challenges, the needs of citizens not government or technology – must dictate the way megacities evolve. In a previous report, we highlighted the need for new urban models to tackle social, economic and environmental pressures sustainably as megacities evolve. Here we discussed the strong parallels between the challenges and opportunities of megacities at key stages in their development – or in other words as they mature in terms of socioeconomic status and infrastructure. The maturity level of a megacity will therefore, to a degree, determine the type of ICT solutions that can be beneficial at each particular stage of development.

This second report takes a closer look at how the largest cities in the world can use ICT to address their evolving challenges in a holistic, proactive and collaborative way, through a city management model comprising:

- > **A knowledge and reasoning layer** – the intelligence of the system, which gathers information from various sources in the city, and then searches for meaning in the large amount of data.
- > **Sustainable city models** – functions and methods that can plan, track and assess the potential of ICT solutions for sustainable development.
- > **Community and business participation** – enabling a dialog between the city, people and businesses and to allow collaborative bottom-up creativity.
- > **Dynamic city operations centers** – for dynamic responses and the daily management of complex city systems.

This model of city management, and its usefulness in addressing the complexity of megacities today while preparing decision-makers for the future, is exemplified in two scenarios: dynamic response to an event and using the findings to mitigate future events; and a hub concept that gives citizens the kind of opportunities that can really transform life.

WHAT DEFINES A MEGACITY?

A megacity is a metropolitan area with a total population in excess of 10 million. It can be a single metropolitan area or two or more metropolitan areas that converge. It is difficult to define the outer limits and accurately estimate the population of megacities. Even if the rise of the megacity has made a significant contribution to the development of society, there is a desperate need for new urban models to tackle the social, economic and environmental pressure in a sustainable way.

MEGACITY CHALLENGES AND OPPORTUNITIES

Today, 50 percent of the world’s population lives in cities – a figure set to increase to 70 percent by 2050. For individuals, it is about improving quality of life for themselves and their families – seeking

opportunities, freedom and a sense of belonging. This urbanization trend is reinforced by pull and push factors alike. Economic opportunities, better schools and hospitals, and things to experience – made

MATURITY LEVEL	LOW	MEDIUM	HIGH
CHARACTERISTICS	<ul style="list-style-type: none"> > High growth rate due to migration and birth rates > Large population living in informal settlements > Young population 	<ul style="list-style-type: none"> > Declining growth rate > Increased demands as a result of increasing wealth > First signs of an aging population 	<ul style="list-style-type: none"> > Slow growth rate > Infrastructure built one or two generations ago > A significantly aging population
CHALLENGES	<ul style="list-style-type: none"> > Empower and recognize people in poor areas > Meet basic infrastructure and public service needs > Reduce corruption and increase transparency to improve trust in city leaders 	<ul style="list-style-type: none"> > Create growth and inclusivity > Promote the efficient use of resources when trying to meet increasing demands > Have a people-centric view on urban planning 	<ul style="list-style-type: none"> > Optimize the efficiency of aging infrastructure and systems > Balance workforce demand and supply to tackle unemployment > Incentivize behaviors that increase sustainability
ICT OPPORTUNITIES	<ul style="list-style-type: none"> > Increase inclusion through access to information > Bypass traditional development processes > Enable more collective forms of urban development 	<ul style="list-style-type: none"> > Make public services efficient and accessible > Take opportunities to transform when new systems are introduced > Connect citizens and businesses to support innovation 	<ul style="list-style-type: none"> > Build on the significant role ICT already plays > Retrofit and prolong the life of existing systems > Use ICT to help people to make more informed decisions
CITY EXAMPLES	<ul style="list-style-type: none"> > Dhaka, Lagos, Karachi and Delhi 	<ul style="list-style-type: none"> > Istanbul, São Paulo and Shanghai 	<ul style="list-style-type: none"> > London, Tokyo, New York and Paris

possible by the economies of scale not seen in rural settings – pull people to the cities, while poverty, low standards of infrastructure, and climate change push people out of the countryside.

The flow-on effect of more compact living is more efficient use of resources. There is, however, a worldwide awareness that urbanization and economic growth come at a cost in terms of wealth distribution and environmental impact.

Harmonizing the needs of people and organizations, and their respective activities, may be one of the most important considerations in future megacities.

DIVERSE MEGACITY CHALLENGES

Megacity challenges can be loosely categorized as practical or subjective, based on the underlying need.

Practical matters, most commonly associated with smart cities, cover transportation, carbon emissions, energy, water, unemployment and segregation, and have traditionally been driven top down by the need for efficiency and productivity. While each megacity will need a customized solution for its practical challenges, based on culture, location and the like, common challenges and ICT opportunities become apparent based on the megacity's socioeconomic and infrastructure development – its maturity.

The needs of city dwellers are not always as easy to categorize. The definition of what constitutes a good quality of life is subjective depending on individual perceptions, attitudes, aspirations and value systems resulting in different priorities and attitudes not only between cities but within populations. Subjective challenges often require more complex cross-service solutions, which by their nature are hard to define and measure, and therefore have generally received less attention.

In this sense, the countless connections in a megacity provide the basis for both broad-brush solutions applicable to the common challenges faced in any compact urban setting and specific answers to a population's unique concerns.

MATURITY LEVEL AS A GUIDE TO ICT SOLUTIONS

We looked closely at the connection between ICT and megacity maturity in our previous report (see table on page 4).

50% of the world's population lives in cities today – a figure set to increase to 70 percent by 2050. For individuals, it is about improving quality of life for themselves and their families – seeking opportunities, freedom and a sense of belonging.

In summary, in low-maturity megacities a large proportion of inhabitants are focused on securing an income, somewhere to live, and access to basic utilities such as water and electricity. In high-maturity megacities, these fundamentals are most likely already in place, leaving residents to focus on issues such as gaining transparency in terms of their rights, and participating in activities that give them a sense of belonging, increased convenience and self-fulfillment.

MEGACITY MANAGEMENT

While maturity level provides a guide as to how ICT can be utilized to solve megacity challenges, long-term success will only come from taking a holistic, proactive and collaborative approach at all levels of society – from city planners, businesses and citizens – using a city management system to achieve a common vision.

LONG TERM APPROACH

Historically, megacity challenges have been dealt with reactively, with the focus on solving existing problems. Consequently, change can lag behind shifts in the way people live and work. Ideally, megacities should be developed so they can respond dynamically to events as they occur and prepare for future scenarios, while taking into account the relationships between diverse stakeholders.

This requires a long-term vision, shared by the city and its citizens, and proactive approaches to reach that vision. Sustainable living conditions, housing, employment, effective infrastructure, public safety, inclusive growth and giving citizens the chance to have an active dialog with local government are all part of the equation. It is also essential for city leaders to understand how solutions affect citizens, businesses and organizations, and how these groups can be part of shaping the future vision.

Such a harmonized approach can only be achieved when all parties have the information needed and willingness to take a holistic view. ICT can contribute to both factors. From the information perspective, ICT systems acquire, integrate and analyze information from diverse sources and present this according to the needs and context of the involved parties. From the second perspective, ICT can increase transparency by bridging cognitive gaps and thereby present opportunities and alternatives for people to explore. In this way, megacities are armed with the

tools and desire to identify and resolve root causes of problems, not merely react to the symptoms.

A MODEL OF CITY MANAGEMENT

For the difficult choices that inevitably lie ahead of megacities, it is crucial that city leaders find a balance between environmental care, economic growth and quality of life. Different aspects of city development need to be addressed and, if they contradict each other, be prioritized or renegotiated according to the holistic vision. Here, ICT can provide mechanisms to support balanced views when implementing solutions that affect several interconnected challenges and opportunities.

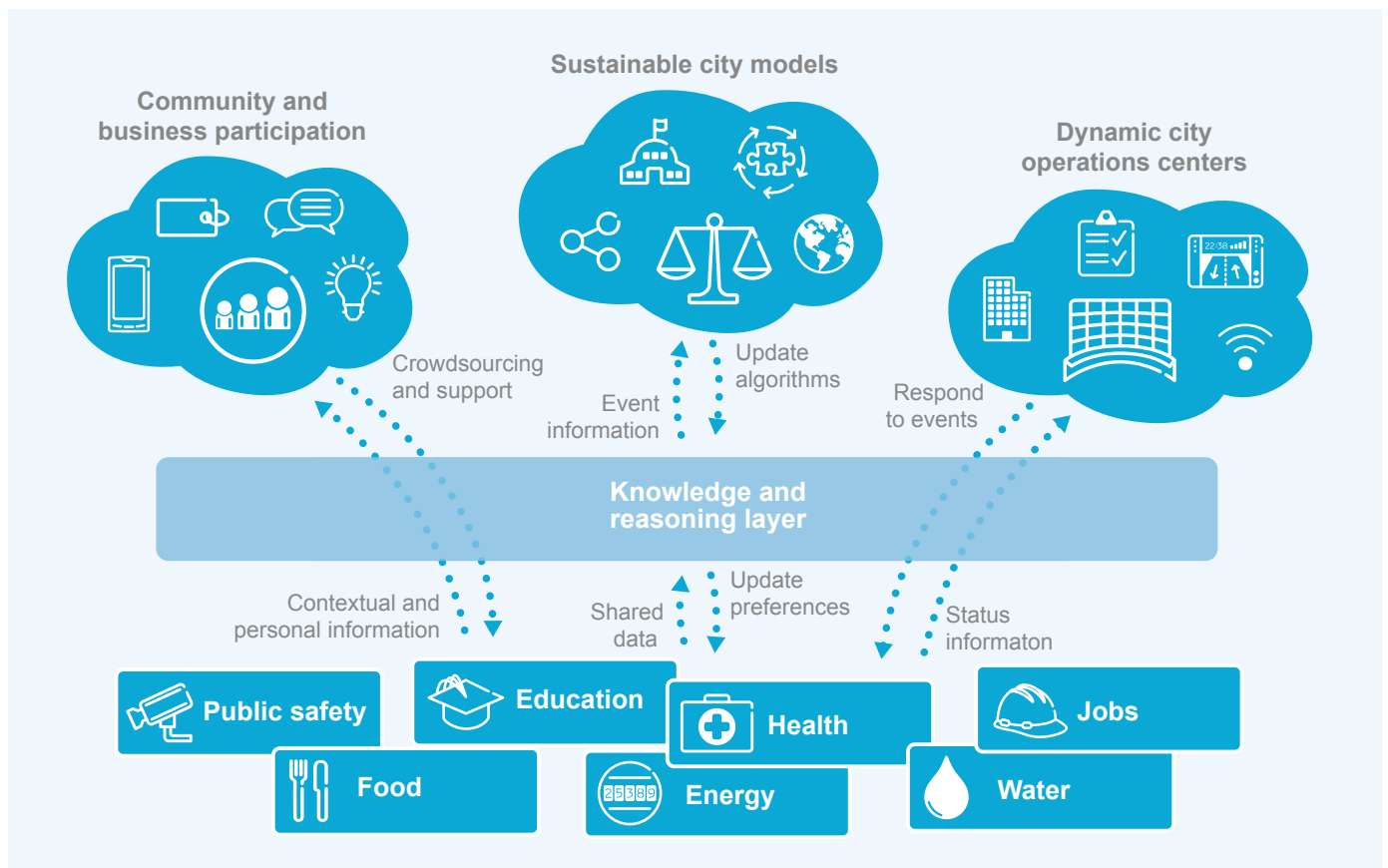
In the model of city management presented here, four areas interplay using the data available, to address both challenges and opportunities in terms of the underlying drivers and activities encountered in megacity society, be it health, energy, the environment or food.

Knowledge and reasoning layer: This set of functions can be likened to the intelligence of the system, gathering information from various sources in the city, and then searching for meaning in the large amount of data. The knowledge that is gained through this reasoning is collected in a knowledge base and made available to the other functions to support a holistic view.

Sustainable city models: Here we see functions and methods that can plan, track and assess the potential of ICT solutions for sustainable development. These functions use data from public services, regulations and other cities as input to proactive analytic tools. From a day-to-day management perspective, these functions give other systems in the city, such as waste management, guidance and feedback in order to respond to situations in line with the long-term vision.

Community and business participation: This part enables dialog between people, businesses and organizations, either implicitly through sensors or explicitly through active feedback and social networks. Citizens, organizations and businesses must be given a platform that allows access to city data and knowledge to allow collaborative bottom-up creativity. This is one way to ensure wide participation in development towards a shared vision. Furthermore, the functions could provide interfaces for incentives and rewards to citizens and businesses that support sustainable development.

Dynamic city operations centers: These functions support resilient responses and target the daily management of complex city systems. They offer decision support, efficient use of available resources and optimization of systems. These functions are more reactive in nature and are supported by connected objects, sensors, actuators, services and so on. It is important that all city data is presented in context, for example through visualizations that give a snapshot of the current situation, to give meaning to abstract and scattered information.



FUNCTIONAL COMPONENTS

The model for megacity management that we have described requires smarter networks that are better suited to different types of services, a secure high-speed backbone and cloud infrastructure, and interconnected objects, sensors and organizations. In all this, the management of various data flows, sometimes in real-time, will be central to give people, businesses and society access to information at any time and in any place. This will not be an easy task, but Ericsson's solutions for handling large amounts of complex data in telecom networks are a solid foundation to build upon. The functionality of our operational and business support systems provides the backbone of a city management system.

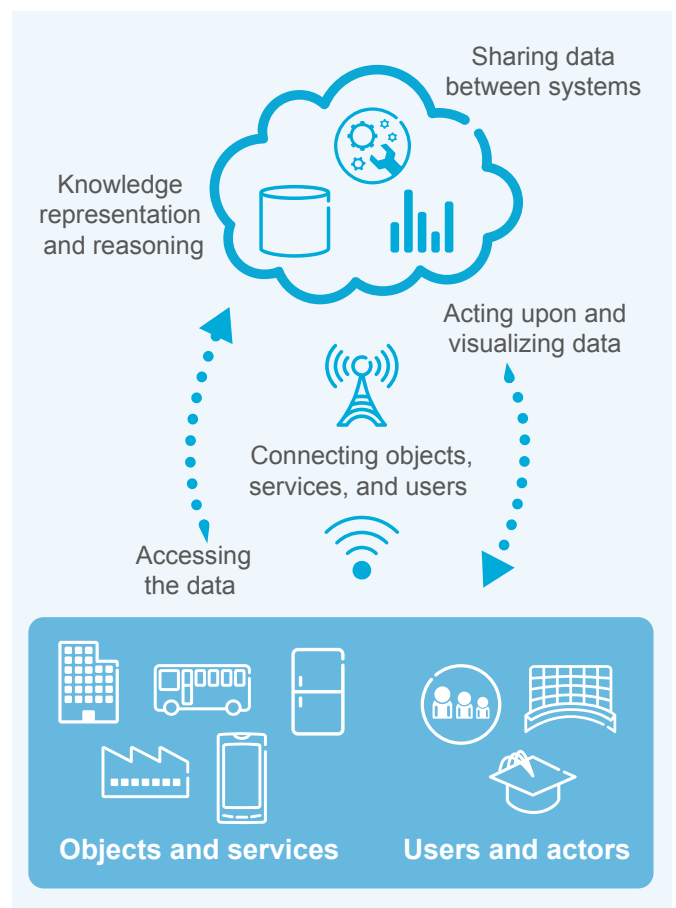
BASIC FUNCTIONAL BUILDING BLOCKS

The following section outlines some of the functional components that serve as basic building blocks when creating ICT solutions for megacity challenges. These building blocks form the base of a system that can be tailored to local requirements.

Connecting objects, services and users: There will be a multitude of service needs requiring everything from high-speed to low-speed connections, different traffic delay requirements from best-effort to low-delay or real-time, and different needs for service prioritization and QoS.

Many types of networks – fixed-line, short-range and mobile – will be needed to accommodate the numerous types of solution designs. Networks will also have to be smarter and adapt to different needs based on the requirements of the services using them. This necessitates attention to data security and appropriate levels of data integrity.

Accessing the data: Cities have an array of objects and services that collect data – ranging from different types of sensors to advanced video cameras – with



varying levels of intelligence; some can only send data updates to the system while others can process the data before forwarding it. These objects reside on both public and private networks and use different access technologies for connecting to their network and different protocols for communication. Resource management – keeping track of where resources are hosted and providing information about how to access them – is an important part of a successful city operations solution or other systems (waste management, traffic control, energy supply and so on) for city management.

Knowledge representation and reasoning: Real-world objects need to be modeled and represented in a database (often referred to as a knowledge base) along with the data they produce. This data is then analyzed as input to decision making and guiding actions. Different types of reasoning or analysis mechanisms, such as logical reasoning, are applied to data in the knowledge base to infer new knowledge and make decisions. Many city systems may have low-latency requirements, meaning data processing may need to work in real-time and methods such as Complex Event Processing can be used to filter large amounts of data on the fly. However, this does not imply that all data processing must be performed in a centralized location. It could also be done further out in network nodes, such as a radio base station, so that only relevant data is pushed to the cloud.

Sharing data between systems: Many of the systems operated by the city, government and businesses could benefit from being connected. A data broker component can enable data sharing between systems and can apply rules on what data is shared. This is a key aspect for citizen participation and stimulation of innovative and sustainable business practices. But, this openness presents a technical challenge – how to

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preserve the privacy of various actors and therefore their trust in the system.

Acting upon and visualizing data: City management systems must support all types of users by presenting data in a way that simplifies decision making. Effective data visualization and presentation is critical, as it allows city operations centers and public authorities to make informed decisions. But it is equally important that citizens and businesses are able to use this data to understand alternatives and the long-term effects of actions. Hence, ways need to be identified to represent city data, and the knowledge stemming from it, to people in a way that makes sense given their current context.

SCENARIOS

The following scenarios are just two examples of how ICT can utilize the vast amount of data and accumulated knowledge available within megacities to address the challenges and opportunities we have outlined throughout this report. They illustrate how the functional components of a city management system interact in proactive and reactive use cases, and the range of applications for the data gathered from connected things. These examples highlight the holistic monitoring of resources from a governance perspective and how the knowledge gained from city data can be relevant for planning and to initiate transformation of services.

DYNAMICALLY RESPONDING TO AN EVENT

Unexpected events take place in every megacity but intelligent technologies based on the models and components we have introduced above can help to limit the impact of these events. This scenario

illustrates how city resources can be used in a coordinated and effective way, and how the smart use of these resources, based on data from an event, can provide knowledge to all affected parties.

Reporting an accident: Imagine a megacity during the evening rush hour with hundreds of thousands of vehicles in motion. A truck driving through an intersection has to swerve to avoid a car driving against a red light. The car is unharmed but the truck crashes into a wall and completely blocks the road. All available connected resources in the area – the truck, sensors, cameras, smart street and traffic lights, and so on – immediately react, sending data in real-time to the city management system, where it is aggregated and analyzed.

Dispatching emergency services: The reasoning component of the system analyzes the available



INTELLIGENT RESPONSE

The response to an accident includes a number of actions beyond alerting the relevant emergency services and people close to the scene.

To limit the impact on both the immediate and the surrounding area, the city management system takes a number of additional actions. One is to use connected streetlights to brighten the area. Another is to redirect traffic around the site of the incident, allowing emergency services quicker access.



contextual information, such as speed of impact, the truck's load, location, traffic status and so on. It then forwards the recommended actions to the relevant city operations centers as the basis for decision making, and where relevant, completes actions autonomously, enhancing efficiency. One example is automatically allocating the nearest and most appropriate emergency services and informing them about the situation. After this initial action, the component continues to search for and analyze data streams to build on the understanding of the situation before emergency services arrive on scene, and if necessary request additional types of support.

Asking the community for support: In some cases, only limited information from the nearby connected things will be available to the knowledge-reasoning engine. In this case, a community interface is critical to a successful outcome. The knowledge and reasoning component can advise the operator to ask people near the accident for help, for example, by submitting live video. The system can also notify people traveling in the vicinity of the accident to take alternative routes or use other means of transport. This has the dual benefit of clearing traffic that would otherwise hinder the emergency response and helping citizens carry out their activities with limited delay. Citizens who provide support can be rewarded by the city with, for example, a free public transport trip or free data usage corresponding to a suitable multiple of the data used for the video feed.

This scenario shows how a collaborative and cross-domain effort from an intelligent city management system, public services and citizens limits the impact of an unexpected event. In addition, the effectiveness with which the event was handled can be added to the knowledge base. Collected data can be used to give feedback to city operations centers, as well as input for handling future scenarios – not only in this particular megacity but in other cities. The analysis can also be used to avoid similar events altogether by, for example, changing traffic routes or traffic light settings to reduce traffic in that area. These proactive plans should, of course, be aligned with the sustainable city models.



LOCAL COMMUNITY SERVICE HUBS

The first scenario, with an advanced city operations center, is more oriented towards a high- or medium-maturity megacity. ICT solutions for megacity management can, however, take many shapes. In low-maturity megacities where digital literacy is low and technical infrastructure less developed, the vast amount of city data can be a starting point for more transformational changes to optimize resource use. Information about how people and businesses utilize

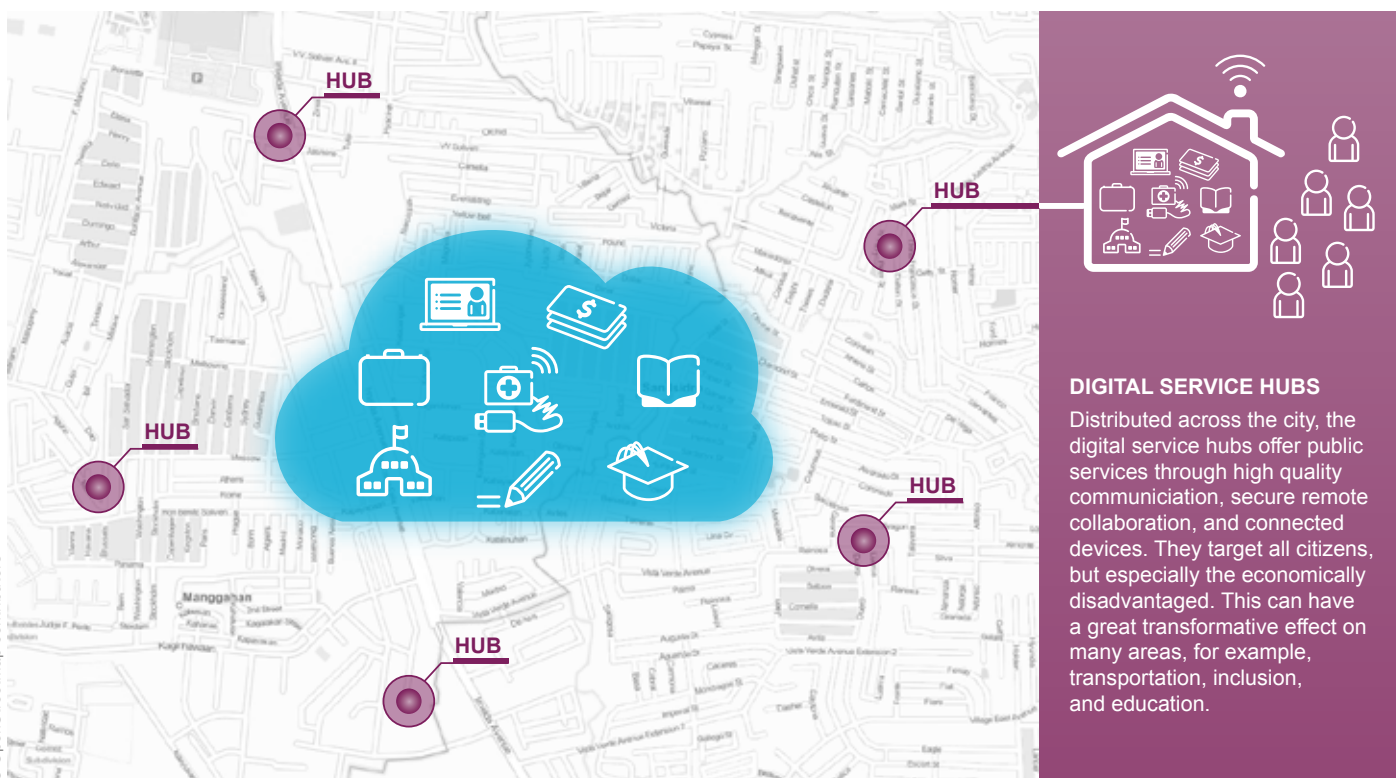
the city today, together with sustainable visions for the future, can be the base for improving the availability of public services.

Building on local community centers: Imagine how traditional hubs for services or natural meeting points could be enhanced with 24-7 digital services to improve citizens' contact with governments, bank services, tax institutions, health providers, legal services and so on. These centers would bring opportunities for more transparent communication with public services, a more efficient use of resources, and a strengthened community with increased empowerment. The location and capabilities of these service hubs are carefully planned based on city data and citizen needs to ensure a positive effect for the community and its sense of belonging in the megacity.

Access to public services, 24-7: People who previously had to visit several places to manage their limited contacts with authorities can now go to one place for numerous errands, significantly increasing the accessibility of public services. General service staff providing personal service ensure the hubs also help people who are not IT literate. The centers provide high quality communication and remote collaboration capabilities, and include connected devices and tools that can facilitate, for example, remote healthcare-services. All sessions require secure identification, such as biometric data or through mobile ID solutions.

Voice within government: Another advantage of these centers is that they give a larger part of the population the opportunity to collaboratively express their opinion. From a public services perspective, the hubs are a way to gather information from citizens that could add valuable data to the city management system. Perhaps sharing data at the hubs will mean a higher level of perceived privacy and security from a better understanding of how personal information is used and for what purpose. These forms of citizen contributions would help to meet short-term needs and the long-term vision of the city.

Hubs, like the ones described in this scenario, can have a great transformative effect on many areas, for example transportation, inclusion and education. Take for example, transportation. As the community matures toward a more knowledge-based society, the hubs could be used as tele-commuting points, allowing people the opportunity to work close to home a few days per week. This not only cuts congestion but also empowers individuals who have more time to focus on quality of life concerns, such as spending time with family. Having access to many city services at the same physical place should, hopefully, reduce bureaucracy. When different authorities integrate their back offices by, for example, sharing certain information securely in the cloud, they can better collaborate and take holistic viewpoints.



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CONCLUSIONS

Citizens should define life in megacities together with governments, and with the support from ICT solutions and technology. We therefore need to create functional building blocks that equip communities to drive change in a direction that suits both their immediate and long-term needs, in a proactive, holistic and collaborative way.

As no two cities are the same, the fundamental building blocks we create for city management systems must have the flexibility to be tailored and applied in megacities around the world. The purpose is to solve problems and support all types of actors in the community to grasp the opportunities ICT presents in terms of improving quality of life, increasing socioeconomic development and reducing environmental impact.

At the same time, systems need to build on common components, for efficiency and cost-effectiveness, taking into account the uniform, but differing, needs presented at each stage of megacity maturity. For instance, the lack of infrastructure in low-maturity megacities may increase the need for citizen action and innovations, while the wasteful use of resources in high-maturity megacities may require strong

long-term visions and incentives for behavioral change. Ericsson provides a number of telecom-grade ICT technologies and enablers that will play an important role in addressing these megacity challenges. Our experience of integration and implementation of advanced systems is backed by best-practices gained from our global operations. Our solutions include smart networks for connected city objects and services, secure high-speed backbone and cloud infrastructure, and the facilitation of services based on components to handle data flows.

These examples of functional components will enable a holistic understanding, more informed citizens and cross-domain reasoning for city governance – aspects that can contribute to balanced views of development, and in the end improve quality of life for people.



SOURCES

This report contains a summary of collected information about megacities and the ICT solutions already in use. Sources include publicly available material from international organizations, academic studies and business papers from management consultants. In-house research conducted by the User Experience Lab and Sustainability Solutions and Assessments at Ericsson Research, Ericsson Networked Society Lab and Ericsson ConsumerLab are also key sources.

According to the United Nations, Department of Economic and Social Affairs, Population Division (2012). World Urbanization Prospects: The 2011 Revision the following 37 cities will be megacities in the year 2025. Population in millions and current within parenthesis:

- > Tokyo, Japan, 39 (37)
- > Delhi, India, 33 (22)
- > Shanghai, China, 28 (20)
- > Mumbai, India, 27 (19)
- > Mexico City, Mexico, 25 (20)
- > New York, USA, 24 (20)
- > São Paulo, Brazil, 23 (20)
- > Dhaka, Bangladesh, 23 (15)
- > Beijing, China, 23 (15)
- > Karachi, Pakistan, 20 (14)
- > Lagos, Nigeria, 19 (11)
- > Kolkata, India, 19 (14)
- > Manila, Philippines, 16 (12)
- > Los Angeles, USA, 16 (13)
- > Shenzhen, China, 16 (10)
- > Buenos Aires, Argentina, 16 (13)
- > Guangzhou, China, 15 (10)
- > Istanbul, Turkey, 15 (11)
- > Cairo, Egypt, 15 (11)
- > Kinshasa, DR Congo, 15 (8)
- > Chongqing, China, 14 (10)
- > Rio de Janeiro, Brazil, 14 (12)
- > Bangalore, India, 13 (8)
- > Jakarta, Indonesia, 13 (10)
- > Chennai, India, 13 (9)
- > Wuhan, China, 13 (9)
- > Moscow, Russia, 13 (11)
- > Paris, France, 12 (11)
- > Osaka-Kobe, Japan, 12 (11)
- > Tianjin, China, 12 (9)
- > Hyderabad, India, 12 (8)
- > Lima, Peru, 12 (9)
- > Chicago, USA, 11 (10)
- > Bogotá, Colombia, 11 (9)
- > Bangkok, Thailand, 11 (8)
- > Lahore, Pakistan, 11 (7)
- > London, UK, 10 (9)

More information about Ericsson's activities within the two areas of city Life and sustainability:

http://www.ericsson.com/thecompany/sustainability_corporateresponsibility/enabling_a_low_carbon_economy
http://www.ericsson.com/thinkingahead/networked_society/city-life/

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