NOKIA

Enabling smart, safe and sustainable cities

Strategic white paper

A successful smart city must incorporate the six s's: a shared, secure and scalable infrastructure that enables human possibilities in a manner that is smart, safe and sustainable. This vision is achieved by a smart network connecting sensors, machines and citizens to cloud-based internet of things (IoT) applications.

NOKIA

Contents

NOKIA

Executive Summary

Cities today occupy just 2 percent of the earth's surface, yet are home to more than half of its people. That will increase to two-thirds by 2050. The profound implications of this global migration require a fresh way of looking at urban centers—one that encompasses a new set of ideas and technologies. Amid increased competition and the imperative to do more with less, cities looking to thrive in the days ahead must get "smart" by investing in the six s's: shared, secure and scalable information and communication technology (ICT) that enables human possibilities in a way that is smart, safe and sustainable.

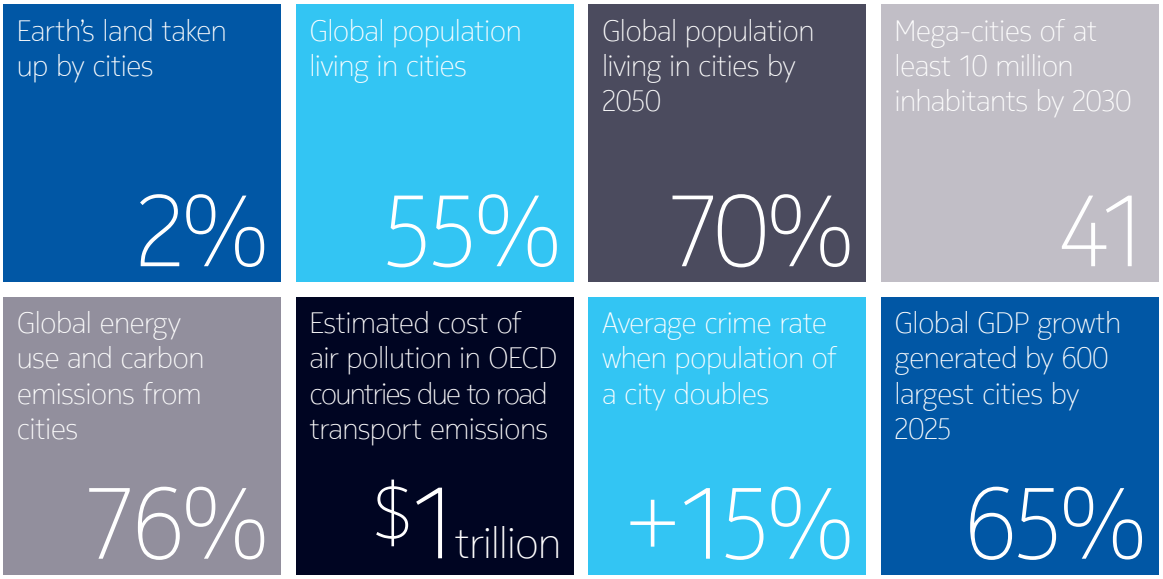
This strategic white paper presents Nokia's vision for the smart city, along with strategies and solutions that will enhance the way each urban area can compete and thrive in the new millennium.

The Challenges

The global population shift toward cities is bringing increased pressure to urban areas in terms of energy use, environmental protection and citizen safety. "Managing urban areas has become one of the most important development challenges of the 21st century," says John Wilmoth, Director, UN DESA Population Division. "Our success or failure in building sustainable cities will be a major factor in the success of the post-2015 UN development agenda." Consider a few of the challenges faced by cities today:

- **Urban competition and the economy:** Attracting business and talent is a priority. New commerce has a direct impact on a city's jobs, economy and the quality of life it can offer its citizens. By 2025, China will be home to more large companies than either the United States or Europe. McKinsey expects that nearly half of the world's companies with revenue of $1 billion or more to be headquartered in emerging markets.
- **Environmental impact:** Seventy-six percent of global energy use and carbon emissions are from cities; while the impact of emissions from air from road transport is estimated at $1 trillion annually, according to the United Nations' Intergovernmental Panel on Climate Change (IPCC).
- **Economic pressure:** As cities have to do more with less amid increased competition, they must find more efficient and sustainable financial models, optimize infrastructure and offer smarter services.
- **Traffic congestion:** The combined annual cost of traffic gridlock in Europe and the U.S. will soar to $293.1 billion by 2030, almost a 50 percent increase from 2013, according to INRIX and the Centre for Economics and Business Research.
- **Safety:** This is a growing problem as cities get larger. When the population of a city doubles, crime rates per capita rise 15 percent on average. (IDC, 2012)
- **Social responsibility:** Authorities need to take care of citizens' wealth, security, privacy and well-being. Urban communities should be inclusive, participatory and social.

Figure 1. Smart city challenges (Sources: GeSi, Gartner, McKinsey Global Institute, GSMA)



The Opportunities

Cities have many opportunities to face these challenges and become "smart." These are enabled by technology, and in particular the internet of things (IoT), where everyone and everything becomes connected through data from billions of sensors everywhere. This vision is being enabled by breakthroughs in technology and finance. For example:

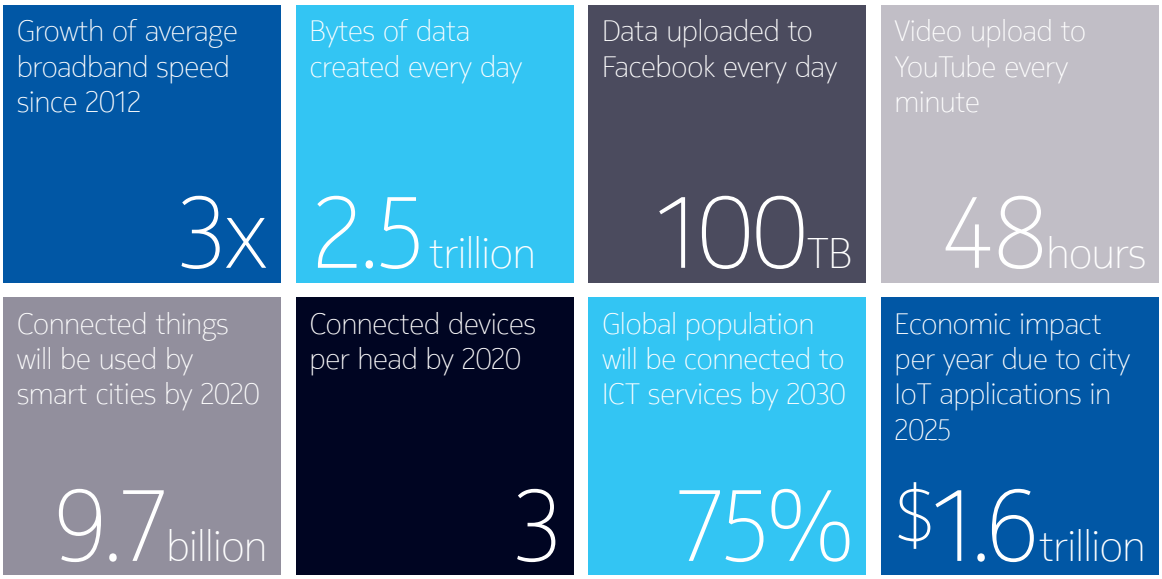
- **Ultra-broadband:** Broadband speed has tripled since 2012, and 9.7 billion connected things will be used by smart cities by 2020, according to Gartner. This will lead to more connectivity options, cheaper sensors and user interface devices, as well as innovative new applications and users. Other external independent studies have shown that a 10-percent increase in broadband penetration for emerging markets can increase a country's growth in gross domestic product (GDP) by 1.4 percent, or even more in some regions depending on their economic situation.
- **Internet of Things (IoT):** The Internet of Things (IoT) refers to the constant exchange of information among "smart" physical devices, including machines, vehicles, buildings and other items embedded with sensors. Network connectivity enables these objects to collect and exchange data, and be controlled and coordinated remotely. City IoT applications for ingesting, managing, storing and analyzing data, including cloud architectures and machine learning, will generate $1.6 trillion in economic impact per year by 2025, Gartner projects.
- **New platforms:** New technology platforms, including the cloud-based platform as a service (PaaS), licensed-based on-demand software as a

service (SaaS), open-source software and open APIs, will further broaden the reach and effectiveness of smart city services and citizen convenience, while creating new cost efficiencies.

- **New financing:** Creative financing models, including public-private partnerships (PPP) and vendor financing, will enable all smart city stakeholders to invest in the technologies they require to compete and thrive in a global economy.

All of these technologies will provide sustainable and productive urban environments—smart cities—that improve quality of life, bolster economic growth, attract business activities and create new jobs. These factors will enhance the way people live and work each day—making the world more productive, smart, safe and sustainable.

Figure 2. Smart city opportunities (Sources: GeSi, Gartner, McKinsey Global Institute, GSMA)



Data, the IoT and the smart city

The centrality of data is a common theme in smart cities. Some collect and use self-generated data to build their own applications and services; others have taken more of a "publishing" approach, seeking to make available their data to stakeholders, or to "curate" data provided by others, which can be obtained via open data portals or through paid-for data marketplaces. In both cases, the expectation is that third parties may be better able to exploit the data than the city could itself.

This data can come from many sources: the operational procedures of the city's agencies (such as demographic and household data); crowdsourced data actively contributed by citizens via smartphone applications and web

pages; passively contributed by automated smartphone apps that make use of the devices' embedded sensors; or from the IoT—those physical devices, vehicles, buildings, infrastructure and other items embedded with electronics, software, sensors and network connectivity so that they can be coordinated for superior performance and benefits.

All urban assets must be used optimally to enable the human possibilities of smart, safe and sustainable cities. That belief is woven into the "DNA" of our technologies to support cities in every stage of smart development.

Three routes to becoming a smart city

Leveraging the IoT with machine-to-machine (M2M) communications technology and reliable telecommunications networks is key to becoming a smart city. The way in which each city leverages the design and capabilities of the ICT infrastructure utilized will affect its evolution and success. No two cities or implementations are the same, but according to Machina Research, which developed the Nokia-sponsored report, *The Smart City Playbook*, they typically take one of the following routes to becoming smart, safe and sustainable:

- **Anchor:** Some cities deploy one or more standalone applications based on their current needs, resources and priorities, and then consider how to expand further into the smart domain. This offers a shorter path to deployment and clear ROI, but can make it hard to integrate applications in the future.
- **Platform:** Some cities focus on building the network infrastructure or platform for smart applications before adopting any specific applications or services themselves. This does allow for synergies between applications and provides flexibility for future deployments, but the absence of mature standards can make specification and choice difficult, leading to the risk of vendor lock-in and significant upfront investment.
- **Beta:** These cities experiment with multiple applications without a finalized plan for operational deployment. The goal is to get practical, hands-on experience with applications and technologies. This reflects the general reality that relatively few smart city applications are fully deployed, operational, costed and budgeted. Most are pilots of varying scales and sophistication. The beta city approach can enable easier access to funding for trials and research, and facilitate greater involvement from start-ups and small, innovative companies. However, if something proves successful, it can be difficult to move beyond the pilot phase to achieve full operational deployment.

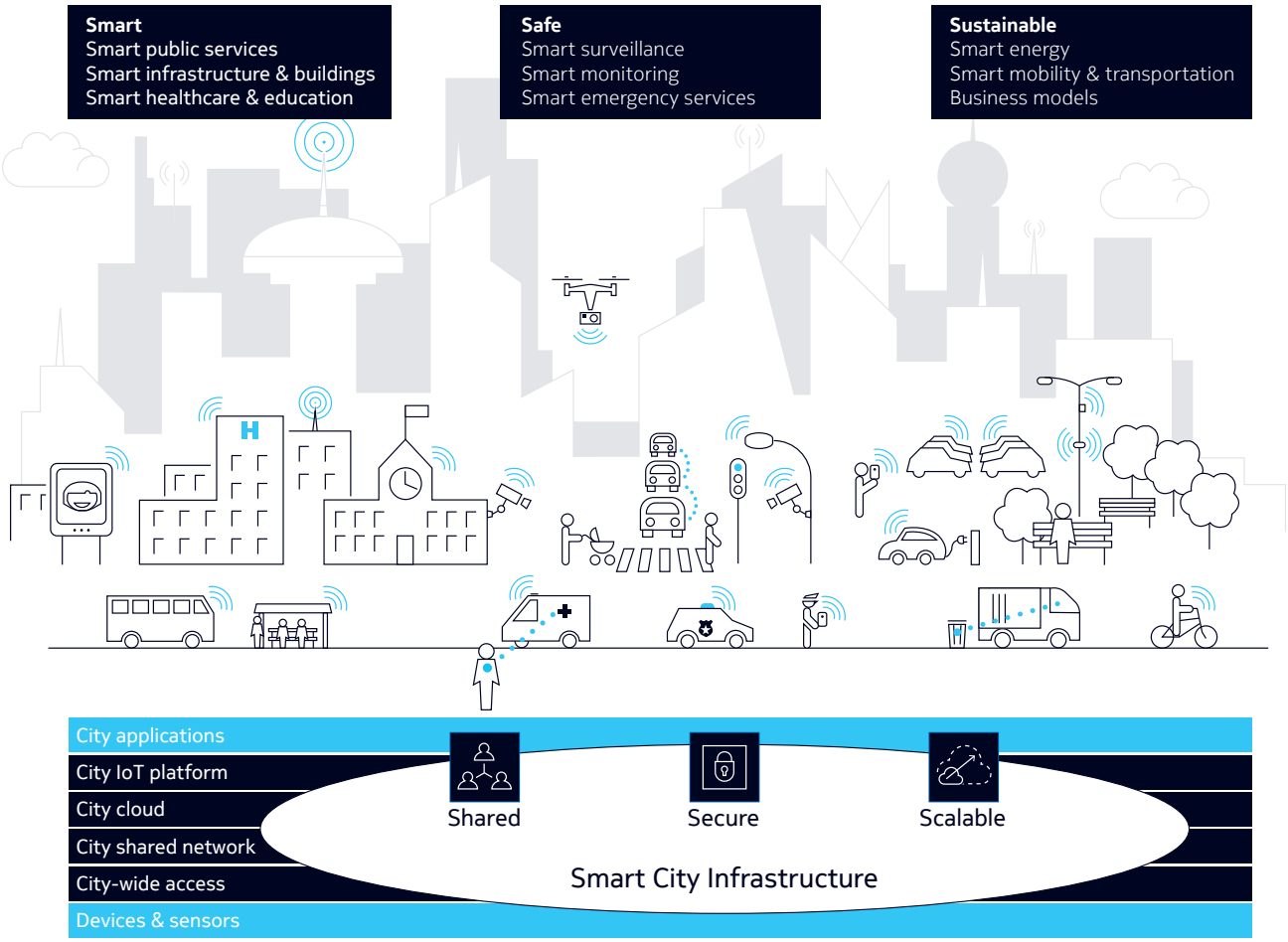
NOKIA

Infrastructure: shared, secure and scalable

For optimal smart city implementation, you need a shared, secure and scalable infrastructure.

- **Shared:** To maximize synergies and minimize costs, city administration services can share reliable wireless and wireline IP broadband network infrastructure, applications and data over a single IP infrastructure. Application and service providers can have access to a 'horizontal' city platform with common set of capabilities, and residents can have ubiquitous and real-time access to applications, anytime and everywhere.
- **Secure:** In a world where cybersecurity and data privacy are high on the agenda, endpoint and data protection, device management, authentication and authorization, traffic profiling and encryption are key points on both governments' and citizens' checklists. And, just like scalability, true security can only be achieved when possible threats are taken into consideration upfront.
- **Scalable:** Many smart city initiatives will start small, but grow fast, and scale big. As such, the time is now for anticipating a massive take-up of sensor devices and applications, as well as an equivalent growth in data and network traffic. This can only be achieved through a city ICT infrastructure that is scalable by design.

Figure 3. Nokia smart city architecture

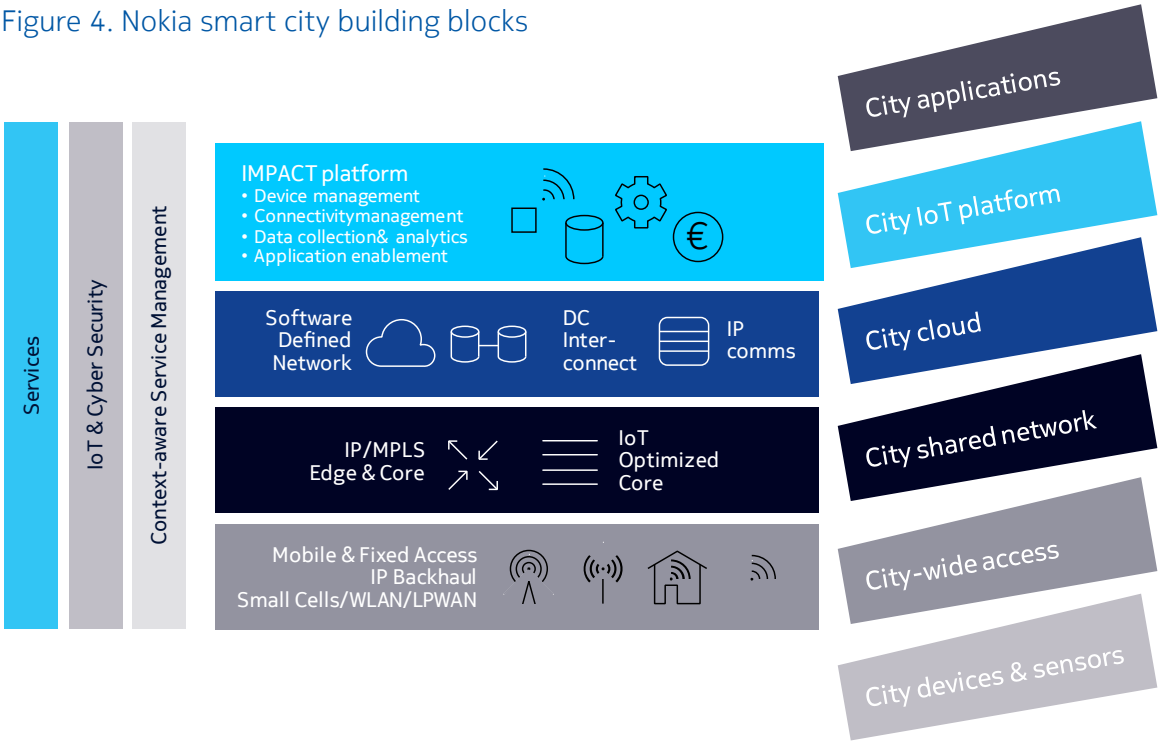


Applications: smart, safe and sustainable

Effective applications are essential for your smart city success. *The Smart City Playbook* groups smart city applications and activities under the categories of smart, safe, and sustainable.

- **Smart:** These applications improve the quality of life for citizens, bolstering innovation, as well as social and economic development. These make cities more attractive places in which to live, visit and do business.
- **Safe:** Applications which prevent or minimize the risks of adverse events, including crime, accidents and natural disasters.
- **Sustainable:** Sustainable applications minimize the environmental impact of the municipality's own operations and the activities of its businesses and citizens. "Sustainable" also means selecting the right business model to fund, invest and cost-efficiently manage innovations.

Figure 4. Nokia smart city building blocks



Nokia smart city buildings blocks

Enterprises, governments and service providers are deploying new IoT services and applications across a wide range of domains and industries. IoT communications and applications across transportation, resources, environment and infrastructure represent an opportunity for cities and municipal authorities to considerably improve the efficiency and effectiveness of administration, as well as the quality of life of citizens.

However, the approach to building out IoT applications is far too often silo-based, which is costly and time-consuming, neglecting interoperability, security, availability, scalability and sometimes the interdependence requirements for each application.

To assure smart city components that you can rapidly create, deploy, integrate and manage, you will require a holistic, horizontally layered architecture based on leading products and solutions. It should align with the larger smart city ecosystem to assure shared, secure and scalable operations support. Our smart city framework is based on a horizontally layered architecture encompassing the following:

- **City-wide connectivity** to provide both fixed and mobile access to connect all people, devices, machines and sensors
- **A city-wide network**, a single converged IP-based network for operational efficiency and lower costs

- **A city cloud** with a virtualized software-defined network to flexibly connect sites, people and applications quickly and securely
- **A city IoT platform** to manage sensors and devices, and collect, analyze and expose data to third-party applications
- **City applications** developed within an innovation ecosystem of trusted partners

City devices and sensors

The "smartness" in smart cities is often about connecting sensors and devices to applications in order to bring services to businesses and people. For a city's devices and device management servers to interoperate, it is not simply a case of implementing a common "specification." Through design and development decisions unique to the device, a "standard" implementation can vary widely between original equipment manufacturers (OEMs) and other devices from the same provider. As a network operator, you may retain some control of the device management (DM) implementation for the devices and ranges you specify, but many other devices will arrive on open networks that you may have never seen previously. This phenomenon can cause time-consuming and costly interoperability issues.

Our MotiveSmart program enables both smart city service providers and device manufacturers to certify and validate their devices for interoperability with Motive service management products prior to deployment. Standards-based testing and evaluation of devices minimizes the risk of potential issues encountered in a production DM environment, which may have a negative impact on customer satisfaction and related costs. Extending beyond interoperability testing, the MotiveSmart program is a robust device knowledge collection, combined with testing of device endpoint operations on Motive products. The result is a seamless customer experience.

Additionally, the Motive M2M Service Management solution enables smart city service providers to cost-effectively manage millions of devices while delivering a richer M2M experience. Motive brings intelligence to M2M device management with advanced features that enable remote provisioning, configuration, operating system and firmware updates, and device troubleshooting.

The Motive M2M horizontal platform is agnostic to the vertical, application, device, network and protocol, resulting in simplicity and accelerated time to market.

City-wide access

Citizens and businesses want broadband wireless access both inside and outside public places, and some city devices and sensors or gateways might also need wireless network access at these locations. This means using optimal broadband access technologies—from fixed to mobile—to provide government, businesses and citizens the high-speed services they expect wherever they are.

Our small cell product families support a multivendor environment, self-organizing/self-optimizing capabilities, advanced interference mitigation and intelligent traffic management, extending 3G W-CDMA and 4G LTE coverage and capacity to hotspots and indoor locations. They offer mobile network operators a cost-effective alternative to macro-only deployments for meeting growing coverage and capacity demands. For end users, small cells improve quality of experience by providing five-bar voice service, more reliable data connections, and higher data throughput.

These technologies are optimized for device locations—for example, in deep building basements, by providing additional coverage and to ensure very long battery life. The IoT-optimized core includes packet core and subscription management, and offers solutions to reduce signaling traffic, optimize resource usage, minimize power consumption and efficiently transmit small data.

Small cells provide a solid option for reaching the ambitious broadband development targets of governments. They improve the aesthetics of the environment and thus the public's general perception and acceptance of wireless networks in several ways.

- These small unobtrusive devices blend in with their environment and address communities' aesthetic concerns brought on by mobile antennas.
- They use up to 70 percent less power than macro cells, reducing greenhouse gas emissions.
- They also make the cellular network more efficient by decreasing the power consumption of nearby macro cells, and by prolonging the battery life of mobile devices by making it easier for them to connect to the network.

To attain these benefits, it is essential to facilitate the deployment of small cells, defining a dedicated administrative procedure that makes the installation much easier and faster than is the case with the macro base stations.

Wi-Fi is another access technology you can use to expand your service footprint. It already enjoys widespread device support and end-user acceptance, as evidenced by the proliferation of both paid and free Wi-Fi services. Because Wi-Fi uses unlicensed spectrum, it is a very cost-effective wireless solution.

Single city-shared network

In some cities, each public service administration has its own network, supported by either leased circuits from a carrier, or by using its own copper or fiber, and supports a complex mix of networking technologies, many of them legacy. Each of these networks may be managed separately, and in many cases are not ready to support cloud services or the IoT.

By connecting these infrastructures—moving from multiple silos to a single converged IP-based multi-service network—you can achieve greater operational efficiencies and lower costs. Our shared network blueprint fully capitalizes on the broad portfolio of IP/MPLS, optical and microwave products.

Data centers, government offices, public safety radio sites, public amenities such as libraries, smart city furniture, and city and public safety vehicles can share foundational network services for a myriad of fixed and mobile applications, ranging from new cloud-based IT applications to critical public safety LMR/LTE systems to legacy industrial supervisory control and data acquisition (SCADA) systems.

Nokia multiservice IP/MPLS was developed to provide an effective infrastructure to carry the voice, data and video traffic offered to businesses and residences by carriers around the world. Those same capabilities are suitable and extremely effective for converged municipal and city networks.

This type of multiservice network can initially converge all the government voice and data traffic, and then expand to offer differentiated access to outside organizations. Ultimately, it can support triple-play services, including video on demand, for the city population when the offer is not available on the market. These simplify operations and improve efficiency across the administrations, supported by a unified network and service management, including:

- Unified service management with an easy-to-use graphical user interface (GUI) to ease and speed provisioning
- Quality of service (QoS) management with priority settings for mission-critical services such as police, fire and ambulance
- Centralized operations center for device and asset management across both wired and wireless networks to enhance provisioning, troubleshooting, device configuration.

In unified network architecture, data centers are shared securely and optimized. Fiber optic resources are used more efficiently, with excess capacity dedicated to enhancing citizen services or generating additional revenues for the city. Furthermore, the solution provides better support for the Wi-Fi services that are often available free of charge in the city's public spaces.

- When a user connects to a Wi-Fi network, the previous service provider not only loses customer visibility, but also the possibility to offer differentiated services and guarantee security. Nokia's dedicated service routers ensure secure connectivity to Wi-Fi access points, and enable integration with user authentication, authorization and accounting systems. The Nokia Wireless Core enables seamless mobility and seamless Wi-Fi-to-cellular roaming.
- Free Wi-Fi services without registration create network security issues. Nokia enables converged and uniform network policy management across all parts of the network, and integration with network intelligence. The implementation of the Access Network Discovery and Selection Function allows users and devices/sensors to be connected to the best network based on flexible criteria such as location, subscription, performance and analytics.

These offer the shared, secure and scalable infrastructure required for smart city success.

Optimized city cloud

Cloud computing, supported by a more dynamic communications network, offers a more agile and flexible framework to meet future city ICT needs. Its virtualized, software-defined network unleashes the power of the cloud and increases flexibility to connect sites, people and applications faster and more securely. Implementing a city cloud enables your departments and public sector agencies to share information and resources, while achieving greater coherence and economies of scale. It gives your citizens and employees secure online access to applications, services and data.

Our rich set of cloud solutions lets you build simple, efficient and secure cloud infrastructures, transform experiences and deliver differentiated cloud services.

- Cloud data center interconnect (DCI) allows you to consolidate and transform multiple data centers to create a secure private cloud. Using Nokia-provided DCI solutions, agencies can connect on-premises data centers to off-premises or hosted resources in a flexible virtual private cloud, scaling to speeds of 100 Gbps and beyond, with the agility and flexibility to enable rapid deployment.
- Data center and software-defined networking (SDN), developed by Nuage Networks, draws on the power of the SDN framework to bring choreography and programmability to the data center network. It transforms the network into an agile environment that can immediately connect applications to useful data. It solves the challenges of virtual networking within and across data centers, and provides policy-driven automation for networks across private, public and hybrid clouds. Its software-defined wide area networking solution extends cloud-based automation to branch locations and remote sites over any network access technology.

As the cloud extends beyond the bounds of a single data center, the DCI portfolio from Nokia and Nuage provides the power and connectivity required for multiple data centers, offering low latency and highly secure connections.

Machine-to-machine service management

The IoT offers huge potential for efficient city services. However, in the municipal space, the effects of the complex IoT ecosystem can be felt in integration cost, management complexity and time to market for new applications. A citywide IoT platform reduces operating costs and simplifies the collection, processing and management of big data by remotely managing the millions of connected devices and sensors. It provides the necessary layers for connectivity management, application enablement and device management that is secure across all endpoints, and enables the effective use of data and analytics that will create value for a city.

A horizontal platform approach, like Nokia's IMPACT, drives down costs while enabling mass adoption of IoT applications. Its modular architecture allows

the city IT department to “mix and match” services like device management or analytics, depending on what third-party components they may already use. It offers components that include device management, communications management and GUIs to display query results or execute an action. The M2M Service Management solution includes the following components:

- Motive M2M Communications Controller
- Motive Unified Device Manager
- Motive Customer Service Console
- Motive Service Management Platform

These are pre-integrated to support deployment as a full or partial solution to address specific needs. The solution’s robust and open integration framework is designed to ease integration with existing third-party systems. It also includes a new edition of Nokia’s Motive connected device platform (CDP), which already supports more than 80,000 device/sensor models, and already has connected and managed more than 1.5 billion devices.

Partnership and collaboration

Many minds and resources are needed to make cities smart, safe and sustainable. Success depends on involving citizens, government, industry, academia and other stakeholders throughout the process, from vision to planning to implementation.

- Engaging citizens early on helps drive people-centered transformation.
- Working with an ecosystem of trusted partners gives cities access to broad expertise and forward-thinking innovation while stimulating the local digital economy. Platforms that bring together city stakeholders with the research community to consider strategic research agendas relevant to social, environmental or other policy areas play an important role.
- Linking administration services by sharing data and infrastructure can enhance synergy, increase efficiency and lower costs.

Public–private partnerships to secure ongoing financial resources so cities can operationalize and maintain smart, safe, sustainable living. This should be fostered by technology that is both open and eco-friendly.

NOKIA

Use cases

Cities around the world — from Dubai to Calgary, Chattanooga and Cape Town — already are using advanced ICT and the IoT to make their environments smart, safe and sustainable. Their advanced infrastructures deliver comfortable and convenient public applications that support innovation, economic growth and social development.

Smart

In an ultra-urbanized future, cities can provide the best quality of life through smart energy, smart mobility, smart transportation, and smart business models to finance it all. Studies already have shown that such investment is worthwhile. More than half of respondents to a survey taken by European Cities Monitor stated that "quality of telecommunications" was a key factor in attracting people and business to cities, and investment in this area will generate rewards. PricewatershouseCoopers has determined that for every euro spent on broadband infrastructure, 14 can be generated for the local economy. Applications include:

- Smart buildings and assets, including monitoring and control of equipment (HVAC, lighting, elevators, security, fire-safety); detailed temperature and environmental monitoring for optimal energy consumption
- Remote monitoring of the condition of assets and city infrastructure such as bridges, minimizing manual checks
- Energy consumption monitoring for usage optimization and public communication
- Smart living applications, such as ultra-broadband connectivity, public Wi-Fi, connected signage, connected street furniture, and smart applications to support tourism and culture
- Smart public spaces: Communication networks, video services and IoT technologies can significantly improve the experience, safety, wellness and utility in public spaces, such as stadiums, event venues, malls, airports, and universities
- Smart lighting: With potential of over 60 percent energy savings, this solution adjusts street lighting for improving security and saving energy, and provides energy monitoring and dynamic control based on need, with automatic flagging of malfunction
- Tourism, augmented reality, and advertising: Using interactive communications and augmented reality provides opportunities to enhance the use/visitor experience, or to push sponsored content based on context. Applications include context-aware signage, and the overlay of augmented information at various points of tourist/commercial interest

Bristol, U.K. has developed “Bristol is Open,” a joint venture between the University of Bristol and Bristol City Council—an on-demand, elastic, software-defined environment dynamically hosts M2M communication, allowing the development of a wide range of applications. In Bristol, citizens, businesses and government services can “slice” the network in thousands of ways to support the unique requirements of each user. The network can be used to improve many aspects of city life, including energy, air quality and traffic flows. It covers the city of Bristol today, and will extend to the surrounding region within two years.

Safe

Safe applications improve quality of life by preventing or minimizing the risks and impact of adverse events, including crime, accidents, pollution and natural disasters. Using advanced video and sound analytics and video orchestration at the network edge, for example, could help emergency service agencies react faster and make better informed decisions about resource allocation. These technologies also greatly enhance situational awareness during a mission — both for the incident commander and first responders. With more sensors integrated in personal protective equipment and wearables, you can improve the safety of first responders while helping commanders make faster decisions in emergencies. Examples include:

- Real-time traffic/crowd monitoring and analytics: Street cameras and CCTV systems are continuously capturing video streams. This important data can automatically be monitored and analyzed to protect lives and property.
- Unmanned aerial vehicle (UAV) traffic management: Multiple industry sectors, including healthcare, logistics, agriculture, news and entertainment are embracing the benefits of drones, which can provide UAV protection and security for critical municipal resources
- Video surveillance of sensitive facilities and neighborhood streets. This provides law enforcement with 24/7 real-time status and situational awareness when responding to incidents.
- Real-time traffic/crowd monitoring and analytics

Chattanooga, Tennessee’s gigabit fiber optic and Wi-Fi mesh networks have become a powerful platform for enhancing public safety and city efficiency. Innovative applications are enabling high-definition surveillance, a smart streetlight system that saves $1 million annually, superior response for police and fire departments, and scores of other benefits. Chattanooga has found that leveraging assets across multiple departments and missions is the key to operational savings across the board.

NOKIA

Sustainable

Sustainable applications reduce environmental impact (including energy consumption and carbon emissions) of municipal operations, local business activities and people's everyday lives.Examples include:

- Smart parking management: Smart parking solutions can help to steer drivers to the most convenient parking space, enabling one-click parking payment and demand-based pricing, while saving time, fuel and pollution.
- Connected bus shelters: Turning shelters from a capital cost to a revenue-generating asset by providing concessions to media agencies, which then monetize through advertising and wireless broadband services. User-generated network data can be used for urban planning.
- Environmental monitoring: The importance of environmental technology has become a vital field of research and development for ecological progression worldwide. Environmental monitoring applications utilize sensors to assist in environmental protection by monitoring air or water quality, atmospheric or soil conditions.
- Smart waste / water leakage detection and prevention: Adopting innovative technologies will result in more integrated waste management solutions. In the area of waste disposal, placing sensors in community waste bins in combination with waste collection fleet and pick-up itinerary management solutions will result in fewer truck runs. An estimated 2.1 trillion gallons of clean, treated water are lost every year to leaks in water infrastructure across the U.S., but wireless sensor networks can monitor water flows and provide significant reductions in water loss.

Nokia and the UAE's General Civil Aviation Authority will develop an end-to-end ecosystem to support regular use of unmanned aerial vehicles (UAVs) for both commercial and government applications. The project will enable Dubai to become world's first city to allow UAV usage in safe and secure environment embracing drone technology as part of smart city operations.

NOKIA

Nokia's commitment to smarter, safer and sustainable cities

High-value IoT and smart city projects are very complex, and require expertise in many different fields to succeed. They get to market faster when they are built through the joint efforts of global leaders and innovators in infrastructure, devices, applications and content. Working with an open ecosystem of trusted partners—including technology vendors, application developers, service providers, system integrators, utility companies, research institutions and others—Nokia continuously explores new systems, applications, content and services.

One example of this high-value collaboration is our partnership with Machina Research, through which we developed the *The Smart City Playbook* to provide strategic, real-world guidance for successful smart city development.

Another case in point is the ng Connect program, through which we have built an ecosystem that enables more than 300 member companies, including leading network, consumer electronics, applications, platforms and content providers. We work with these partners to develop standardization initiatives, solution concepts, end-to-end prototypes, business models and market trials that will unleash the full potential of the IoT and smart cities.

All of this means that Nokia is uniquely positioned to help governments, communications service providers and large enterprises deliver on the promise of smart cities. Already today, we help cities around the globe, such as Chattanooga (US), Dubai (United Arab Emirates), Jeddah (Saudi Arabia), Cape Town (South Africa), Auckland (New Zealand), and Bristol (UK) to build more effective shared network infrastructures. These provide secure connectivity, and deploy scalable IoT services, serving the needs of the CIO and the city agencies, while addressing the smart aspirations of the city council.

These essential elements, combined with business modeling expertise from Nokia Bell Labs, are the foundation of our commitment to the six s's: building shared, secure and scalable infrastructures that enable the human possibilities of smart, safe and sustainable cities. That belief is woven into the 'DNA' of our company, our products and our services.

NOKIA

Acronyms

ADEP	Application development and execution platform
CDP	Connected device platform
DM	Device management
GDP	Gross domestic product
GUI	Graphical user interface
HVAC	Heating, ventilation and air conditioning
ICT	Information and communication technology
IoT	Internet of things
IP	Internet protocol
LMR	Land mobile radio
LTE	Long Term Evolution (4G)
M2M	Machine-to-machine
MNO	Mobile network operator
MPLS	Multiprotocol label switching
NFV	Network functions virtualization
PaaS	Platform as a service
PPP	Public-private partnership
QoS	Quality of service
ROI	Return on investment
SaaS	Software as a service
SCADA	Supervisory control and data acquisition
SDN	Software-defined networking
vEPC	Virtualized evolved packet core
W-CDMA	Wideband code division multiple access
Wi-Fi®	Wireless communications technology trademarked by the Wi-Fi Alliance

Contact

Jacques Vermeulen, Smart City expert, Nokia

Email: jacques.vermeulen@Nokia.com

NOKIA

Nokia Oyj
Karaportti 3
FI-02610 Espoo
Finland
Tel. +358 (0) 10 44 88 000