IoTNOW

ANALYST REPORT

SMART CITIES

Drivers, challenges, developments & ecosystems

STRATEGY ANALYTICS
Research, Experts, and Analytics

The author of this exclusive report is **Andrew Brown**, executive director, Enterprise and IoT Research, Strategy Analytics

Smart Cities: Drivers, challenges, developments and ecosystems

1. Defining the Smart City

1.1 What is a City?

A city is an organic system that enables trade between people and helps meet their needs. Cities in general are more than a pure concentration of dwellings or workplaces. Cities have economies of scale. Positive parameters, such as wages, patients and hospitals, scale at a ratio of 1.5 for a doubling of city size. Negative parameters such as crime and some diseases also tend to follow the same rule – if the infrastructure of the city can manage the scale.

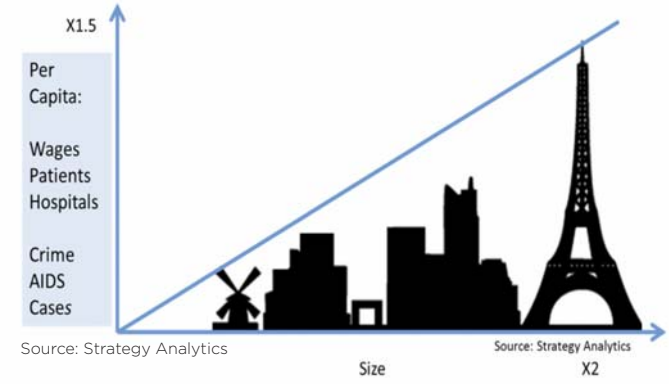


Figure 1: City Parameters Increase 1.5X as City Size Doubles

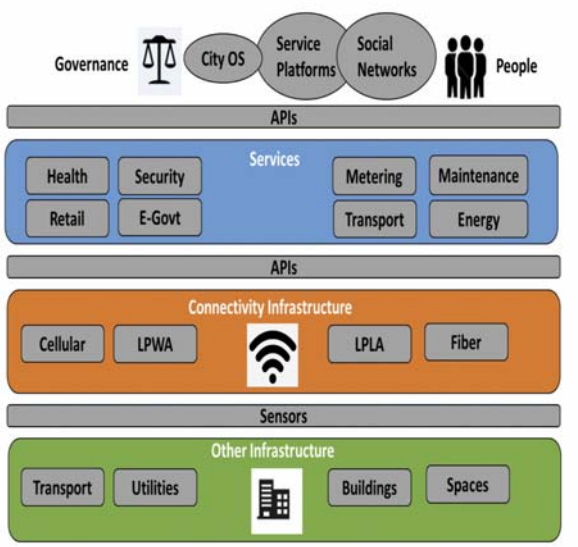
Historically, cities have had three important characteristics that set them apart from other forms of human dwelling:

- **Places of trade** – built around businesses and/or industries, with a social and commercial centre. Location plays a strong role.
- **Resilient** – many cities have survived and even regenerated after war and disaster. Again, the role of physical location is very important.
- **Evolutionary** - cities adopt and adapt to social and technological changes, sometimes over thousands of years. Technologies (and the companies who provide solutions) have tiny lifespans in comparison.

A Smart Sustainable City is a city that
"Meets the needs of its present inhabitants without compromising the ability for other people or future generations to meet their needs, and does not exceed local or planetary environmental limitations and where this is supported by ICT"

2. Smart City Components

At a system level, the smart city can be considered as a classic system 'sandwich':



Source: Strategy Analytics
Figure 2: Smart City Components

The key to giving local governance visibility and control of the available connections to and sensing / actuation at the city infrastructure is some sort of service platform, often dubbed the CityOS:

Source: Bristol is Open
Figure 3: CityOS Architecture

Valencia City Council plans to centralise all of its municipal information through a smart cityOS solution. The open platform is provided by Telefonica, and

1 http://www.santafe.edu/research/cities-scaling-and-sustainability
2 Smart Sustainable Cities- Definition and Challenges by Mattias Höjer and Josefin Wangel, Centre for Sustainable Communications CESC / Division of Environmental Strategies Research, KTH Royal Institute of Technology, Sweden
3 http://ec.europa.eu/information_society/newsroom/image/smart_cities_-_valencia_-_ramon_ferri_7819.pdf
4 http://www.oracle.com/us/industries/public-sector/national-local-government/city-platform/index.html

based on the European FI-WARE standard. The initial scope is simple, with 350 sensors monitored over the city.

Several cities have taken a more traditional approach to the smart city platform, building on an enterprise resource planning (ERP) suite. Oracle provides a tailored ERP as a City Platform Solution, with components implemented in cities including Espoo, Finland; Edinburgh, Scotland; St. Petersburg; and Oakland, California.

3. Smart City Applications

Smart answers to city challenges can be grouped around the following application areas:

- Smart Energy and Smart Grids
- Smart Water
- Smart Transportation
- Smart Buildings, and
- Smart Government.

3.1 Smart Energy and Smart Grids

Of the world's total energy consumption (currently about 20 terawatts continuous), electricity production and consumption accounts for about a third of that energy. In 2008, the world consumed over 20 terawatt hours of electricity. Consumption is forecast to rise to over 35 terawatt hours in 2035.

Smart grids combine IoT (smart meters) with ICT to sense and respond with electricity supply that meets the demands of consumers and industries. In the US market, where many meters are over fifty years old, a combination of smart meter and smart grid technology can save almost 10% of the electricity consumed nationwide.

Smart grids have three main characteristics:
- Smart power systems that have remote monitoring and control, are automated, and that are self-healing.
- Networking power systems that communicate and cooperate with smaller networks, or microgrids.
- Interactive power systems that inform and educate users about how best to use the networks.

Cities are favourable places to exploit all three characteristics of smart grids. Smart buildings can become both storers and suppliers of electricity, as part of a microgrid.

Smart grid projects differ in nature from city to city, dependent upon the maturity of the 'old' electricity network, and the desired goals of the project.

3.2 Smart Water

Disrupted water supplies can have a rapid, negative effect on many cities.

Smart water controls include:
- Continuously monitoring and diagnosing supply issues and applying maintenance measures
- Optimising performance
- Conserving resources, detecting and managing leaks
- Managing disruptions in supply
- Improving customer service
- Managing consumption proactively.

Many water authorities lack an effective end-to-end monitoring and control system for an increasingly valuable resource. In the UK, Thames Water forecasts that the water supply shortfall for London will be equivalent to the consumption of two million people by 2040 . In addition, the water nets in many mature markets need extensive renewal over the next three decades.

Water utility companies using smarter solutions could save between $7.1 billion and $12.5 billion each year.

California has severe water restrictions (lawn watering limited to 10 minutes per week). The Long Beach, California district started a smart water meter pilot programme in March 2015. Water meter add-ons were provided by T2, and the solution uses Verizon cellular wireless communication, web-based analytics use Microsoft Azure Cloud.

3.3 Smart Transportation

A transportation network and its evolution is unique to its city. Road vehicle congestion management is a problem common to almost all cities, and IoT sensors will play an increasingly important role in connecting traffic management.

Cheap, low-power sensors built into the road or kerb can detect free kerbside parking spaces in cities, and the information can be analysed in a road traffic management system. The system outputs can then be relayed to cars directly via smartphone apps, or to street signs. Wireless mesh networks are suited to efficiently deploy regularly spaced parking sensors in an urban environment, and hundreds of parking sensors can be handled by a single cellular backhaul.

Crowd-sourced citizen applications such as Waze successfully help citizens navigate traffic congestion optimally. However, if this solution is disconnected from central traffic management, it can create other problems. Los Angeles has a million active Waze users, and the backlash is reported to be hazardous traffic flows along small residential roads.

3.4 Smart Buildings

Buildings account for about 40% of energy consumption worldwide. Smart energy management of buildings across their life cycle can reduce this figure by at least 20%.

Building monitoring and control covers multimedia (video surveillance), and basic alerts such as: do the fire sensor batteries need to be changed, is the office temperature lowered after office hours, etc.

IoT can make a major contribution to building automation in cities:
- Contingency solutions for connected safety sensors that will continue to work if the building broadband (or cellular) fails. Broadband outages reduce 'triple-play' to 'zero-play',

5 National Geographic, World Electricity Outlook http://environment.nationalgeographic.com/environment/energy/great-energy-challenge/world-electricity-mix/
6 Smart Grid Consumer Collaborative (US) http://www.whatissmartgrid.org/
7 Thames Water, http://www.thameswater.co.uk/media/press-releases/17391.htm
8 Water 20/20 Bringing Smart Water Networks into Focus, SENSUS 2012

and contingency plans and solutions will be needed as society relies more on online security monitoring and alerts. Contingency solutions need to have a low incremental cost per connection, and will combine low sensor cost with low-cost wireless that needs to penetrate the thick walls of energy-efficient buildings (e.g., LPWA wireless solutions).
- Affordable solutions for wide deployment by local authorities. Home and office security solutions can be paid for publicly, but there is an interest for public authorities to monitor fire and safety alarm health.

Buildings are being rethought from their total net energy deficit (and even contribution), over their life cycle. This needs solutions for energy generation, storage and management, combined with optimised services and material usage.

Building systems have traditionally existed as 'silos' (Elevator systems, HVAC, lighting) with separate protocols, and one of the most important steps for a smart building is to have a common data policy, for managing data across systems.

Microsoft has implemented an Energy-Smart Buildings (ESB) initiative to benefit from best smart building practice at its Redmond campus. The solution includes centralised fault-finding and management of building systems, and the full deployment had a payback period of about two years.

Microsoft's campus consists of over 120 buildings with a total floor area of over 1,4 square km. Microsoft chose to focus on the Heating, Ventilation and Air Conditioning (HVAC), a total of 35,000 components which accounted for over 40% of energy usage.

3.5 Smart Government

Governance (including at city level) involves managing hard factors (information, command and control of the city environment) and soft factors (citizen-government relationships).

Governments are presented with IoT and ICT as means to increase awareness, command and control of the city environment, and to increase the flow of information between government and citizen. The biggest challenges are, however, in the soft factors. Citizens of today's information society are aware of the sphere outside their local and national government on an unprecedented scale. This puts new demands on the citizen-government relationship.

Citizen trust in government, as measured by Eurobarometer, has huge regional variations (62% in Finland to 7% in Greece). In the USA, the citizen trust metric has fallen from 75% in 1964, to 25% the last decade.

The World Economic Forum '*Future Government Smart Toolbox*' identifies the following areas where IoT/ICT can make a difference in future governments:
- Trust in government
- Leadership
- Service Delivery
- Political Representation
- Anti-Corruption
- Bureaucratic Cooperation
- Conflict Management, and
- Innovation.

Trust enablers may include sites such as the US government's Data.gov which makes government data visible, and publicly available through APIs for new applications. Another site is The UK's TheyWorkForYou.com which makes personal data of local government representatives visible.

4. Regional Smart City Developments

The most rapid urban growth is forecast in the APAC region. By 2050, the U.N. predicted last year, 3.3 billion people will live just in Asia's cities.

Source: Valerie Pieris

Figure 4: Urbanisation and the APAC Circle

The three most urbanised regions (as percentage of population living urban) are:
- North America (82% in 2014),
- Latin America and the Caribbean (80%),
- Europe (73%).

Africa is the least urban continent (40%), but urbanisation can be rapid - this is forecast to rise to 56% by 2050.

Smart city activity does not map uniformly to regions, since:
- A smart city may exist in isolation to the surrounding region. This is especially true for 'scratch-built' pilot smart cities, such as Songdo, Korea and Masar, Abu Dhabi.
- The greatest urban growth may be happening in towns that will become cities. The UN Economic and Social Affairs noted in 2014 that many of the world's fastest growing urban agglomerations are in Asia and Africa, and have less than 1 million inhabitants.

9 LA's Love-Hate Relationship with Waze continues: http://www.citylab.com/commute/2015/04/las-lovehate-relationship-with-waze-continues/391832/
10 Source: Intelligent Buildings Institute (IBI)
11 http://www.weforum.org/reports/future-government-smart-toolbox
12 http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf

Source: Elegant Embellishments
Figure 5: Smog Dispersing Building, Mexico City

4.1 Asia-Pacific

APAC as a region has the greatest accumulation of people, and the world's three largest cities:

- Tokyo with 38 million inhabitants
- Delhi with 25 million
- Shanghai with 23 million
- Mumbai is a shared fourth place with 21 million people.

Tokyo is projected to shrink to 37 million by 2030. This is because more than 22% of Japanese are already 65 or older. Delhi will remain number two, but rise to 36 million people by 2030. Delhi will need smart, new infrastructure whilst Tokyo's needs will focus more on rationalised and renewed infrastructure (new infrastructure needed for the 2020 Olympics being an exception).

Japan's has several Smart Community pilots which are focused on smart residential home technology (e.g. smart meters) and are heavily dependent on subsidies from central government.

Japan's biggest city challenge (after the Fukushima accident) is securing electricity supply vs demand, as Japan imports about 84% of its energy requirements. Japan will install 80 million smart meters by 2025, with Toshiba and Landis+Gyr among the vendors.

The Indian government has allocated over $15 billion over five years for the creation of 100 new smart cities, and renewal of the infrastructure for 500 other towns and cities. This is in addition to a smart transportation budget of $7 billion for ports, and additional financing for 200 new railway stations and upgrades for another 1000.

Chinese cities have millions of rural immigrants per year. The environmental challenges are among those at the top of the list (eight of 74 major Chinese cities meeting government basic air quality standards in 2014).

There are over 50 smart city projects defined for Chinese cities, with energy management and transport management at the top of the needs list.

4.2 Central and Latin America

The CALA region contains the joint fourth most populated cities in the world - Mexico City, and São Paulo, each with around 21 million inhabitants.

Mexico City has pioneered activities in digital governance and smart buildings. The 'Torre de Especialidades´ tower at Mexico City Hospital can disperse the smog equivalent to 1000 cars per day. It does this by using a titanium dioxide coating on a honeycombed structure, catalysing air particles. The design is one of the first products of Elegant Embellishments, a German firm.

Rio de Janeiro was early to adopt a centralised city Operations Centre, built by IBM in 2010. It can manage traffic control and emergencies in real time, by coordinating data from 30 municipal and state agencies.

Central and Latin American cities have several initiatives to 'smarten' traffic. Mexico City has a car-sharing scheme that includes Electric Vehicles, whilst Bogota has introduced both an Electric Vehicle taxi fleet and a bike share programme.

4.3 North America

US infrastructure faces a challenge of flat-rate net infrastructure spending – the money spend on infrastructure maintains the old, with little left over for the new. IoT can help break the deadlock. Smart city projects initiated in New York City and Chicago have together a projected benefit of $20 billion in savings by 2020.

In New York, the Hudson Yards development project is the largest private development building project in US history, planned to cater for 5,000 residences, 100 shops, and offices in a high-rise complex with over 1,5 square km of floor area. Smart infrastructure investments include:

- Fibre loop throughout the area, and Distributed Antenna (DAS) solution for cellular communication
- A centralised, vacuum-tube system for waste management
- Micro grid, allowing building systems to be selectively powered up and down
- Building data capture and environmental sensors.

In Chicago, the Array of Things project is a pilot network of sensor nodes. The project has been running for a year, funded by the Argonne National Laboratory. The proposal is to deploy 500 additional nodes in the city of Chicago, with public funding, by 2017. In July 2015, the project received $300,000 in additional funding (50/50 from the Argonne National Laboratory, and the Chicago Innovation fund). The funding will cover the next 50 nodes in the city.

4.4 Europe

Many European cities have historically had a focus on energy control and sustainability. For example, Copenhagen has the most aggressive carbon reduction plan, aspiring to achieve carbon neutrality by 2025. In addition, there is a high number of local authorities willing to cooperate with local start-ups with smart solutions. The cities of London, Stockholm and Paris are rated among the top start-up ecosystems in the world. In addition there are many cities with open data sets. The result is a strong innovative environment for new projects:

- The city of Helsinki has more than 1,000 open datasets. The local government has been actively promoting engagement with developers through hackathons.
- HafenCity in Hamburg is Europe's largest urban regeneration project. The project budget is €414 billion to 2025, to create a port, a university, residential and commercial areas with modern transit.
- Stockholm Royal Seaport is a major urban development project to provide 10,000 homes and 30,000 workspaces, with an emphasis on smart energy solutions.

4.5 Middle East and Africa

The Middle East has several high-profile city projects:

- Dubai (with the World Expo 2020 as catalyst),
- Saudi Arabia –The government has invested in four city projects worth $70 billion, and
- Bahrain Bay, in the planning stage.

The IoT focus per project has been mixed – cellular M2M is

13 Elegant Embellishments homepage http://www.prosolve370e.com/pr_torre1.htm

available through the region, but focus is shifting to IoT middleware and sensors.

Etisalat has launched (July 2015) what it claims is the region's first IoT development and device management platform. Etisalat partners with Oberthur Technologies and ThingWorx, to build and manage the platform.

Africa has the lowest level of urbanisation, and is forecast to experience the highest urban growth, percent-wise. Africa traditionally has a rapid adoption rate of ICT and is the launchpad for pragmatic and innovative solutions.

5. Smart City Drivers

Smart ICT solutions as a part of city development are driven from several different directions:

- **Government:** Local and/or national authorities see smart city solutions as:
  - A means of awareness, command and control of the city environment.
  - As showcases of local development, and/or as a means to secure sustainable city development. Sustainable city development may entail new economic / trade models, improving local conditions or making them more sustainable.
  - Governments also can see 'Smart Government' as a means of evolving the actual governance model, and increasing citizen interaction and trust.
- **ICT Players:** As enterprise and consumer markets have matured in developed markets, vendors and service providers have seen the evolution of cities as:
  - A potentially stable and growing business for the 'Internet of Things'
  - A test bed for advances in computing, connectivity and sensors
- **Citizens:** A citizen with a smartphone has access to more computing power today than NASA had for the first moon landings. 2.7 billion smartphone subscriptions worldwide today can more than double by 2020.

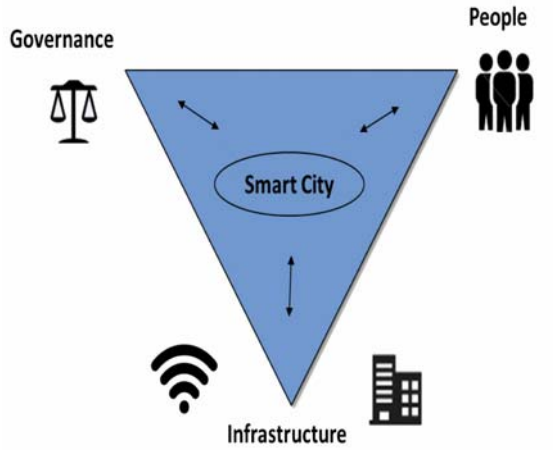
Citizens will:

- Seek personal and community benefits (productivity, security). Communities can apply ICT to change aspects of a city faster than a local authority or large ICT player can.
- Be service providers themselves.
- Be empowered. Citizens have an increasingly digital part of their identity. Services that have been historically tied to the local authorities such as justice and health can (in part) be delivered independently of location and time.

The European Commission eGovernment Action Plan 2011-2015 is one attempt to provide new eGovernment services on a wider scale. A common digital citizen identification is a key enabler to services such as eProcurement, eJustice, eHealth, and mobility (i.e. enabling personal mobility independent of age and physical ability). The goal is that the services will deliver net benefits to businesses and governments in Europe, as well as the citizens themselves.

There may be a dominant driver or driver combination for a particular smart city solution, e.g. 'scratch-built' smart cities which often serve both as ICT player technology demonstrators and showcases for the local/national government.

The smart city definition in a multi-stakeholder world is not found at one point, but between three points:



Source: Strategy Analytics

Figure 6: Smart City Triangle of Opportunity - Three corners of Challenge

The 'smartness' of a city is extended from its governance, the infrastructure and its people. City solutions can legitimately address one corner – but the 'smartness' will be measured in relation to the other two corners of the triangle (e.g. infrastructure-centric solutions will have to show innovation in its interfaces towards the citizens of the city and the governance of the city (policies and trade).

Focused smart city projects show early potential, and the pioneers are cities where government prioritises a clear control infrastructure, e.g. Dubai, Singapore.

Wider, long-term benefits may come from 'empowered citizen' models where services and control may be more distributed. That will need an applied local government, with a readiness to remove legal and regulatory barriers for potential benefits.

6. Smart City Challenges

In addition to the traditional city challenges such as sustainability, safety and security, smart cities face two specific challenges:

- New city services coming from an independent player with expansive business drivers can change the city landscape, sometimes to the detriment of other infrastructure or players.
- Safety and security concerns cross over from cyber to critical, physical infrastructure. A connected city is potentially a hackable city.

6.1 New Services Disrupting Existing Infrastructure

The mobile internet paradigm has moved from disruption of

14 http://www.emarketer.com/Article/Smartphone-Users-Worldwide-Will-Total-175-Billion-2014/1010536
15 http://www.phonearena.com/news/A-modern-smartphone-or-a-vintage-supercomputer-which-is-more-%20powerful_id57149
16 Ericsson Mobility Report http://www1.ericsson.com/news/1872291
17 http://;:eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0743:FIN:EN:PDF

traditional IT providers (e.g., telecommunications) to almost every service industry. Then term 'Uber-for-X' has been coined to describe the brokerage of services in verticals, as a tribute to Uber seen as a pioneer of the model.

Disruptive service brokering has been enabled by three important ICT trends:
- On-demand, elastic and scalable (Cloud) computing through companies like Amazon.
- High performance mail services at low cost, through e.g. SendGrid and MailChimp.
- Simple digital payment enablers like PayPal.

Common trends for disruptive services are:
- They usually leverage users' smartphones.
- They are attractive to users by offering a low-price, convenient service that replaces one or more 'middle men' in a service chain – hence the disruption.
- They scale regionally, nationally and sometimes internationally.

The disruptive aspect means that local and national legislation has changed in response to new services to protect the interest of workers in a certain vertical.

The services often thrive in urban environments with high service demand. The most highly adopted services (e.g. Uber and AirBnB) have shown themselves able to change an environment before service providers and vendors can respond.

6.2 Sharing Economy and Smart Cities

The pioneers of 'sharing economy' businesses have been on the market long enough to expand nationally or internationally, disrupt markets and have to cope with negative reactions such as legislation against their services.

This is likely to lead to a maturing of 'sharing economy' services rather than a long-term backlash.
The long-term effect of 'sharing economy' services on urban environments is likely to be positive:
- The new services excel at sharing resources. The local government in Paris has curtailed some Uber operations. At the same time, Uber has shown it can reduce cars on the road, something that Paris like other cities want.
- Sharing services are driven by user demand, and positive user experiences will also affect legislation.
- New services rapidly adapt, get acquired or copied. It is not uncommon for a start-up company to change its business model within a two-year period.
- They generally empower citizens.

Future urban governance will in general need to reckon with citizens that are empowered through sharing services. Social interaction between government and citizens will become increasingly important.

6.3 Safety and Security

ICT security is often a compromise, when combined with critical city infrastructure it can be something of a paradox. The more that critical infrastructure is connected for the sake of 'smartness', the more direct internet access needs to be avoided. The figure below is a selection of the more well-known (reported) cyberattacks on infrastructure:

Infrastructure Attacked	Country Attacked	Attack	Date	Physical Damage
Industrial programmable logic controllers (Nuclear centrifuges)	Iran	Stuxnet worm	2010	Est. 20% of all centrifuges (self-destruction)
Blast furnace (steel production)	Germany	Phishing	2014	"Massive" physical damage to a furnace via control override
Armaco oil pipelines	Saudi Arabia	Spear-phishing	2012	30 000 affected computers, oilflow reduced
Water tower control system	USA	Virus	2012	None (tower was a decoy to exploit cyber attacks)

Source: Strategy Analytics

Figure 7: Connected Infrastructure Security Concerns

IT security infrastructure spending is expected to accelerate in growth to counter the breadth and depth of new threats. Recent hacker attacks on heavy industrial plants have underlined that enterprise networks must be separated from control systems:
- Firewalling is essential.
- Deep Packet Inspection is recommended.
- Physically separate networks may be necessary in some cases.

Ultimately, critical data needs situational awareness that is almost real-time. This is something that could be provided as an ICT service, together with data forensics.

7. Smart City Ecosystems

Given the disparate nature of cities and the temptation for many cities to "go it alone", a number of bodies are seeking to drive standardised ecosystems to assist with the development of smart cities.

7.1 C40Cities Climate Leadership Group

C40Cities is an association of 75 cities seeking to collectively address climate change.

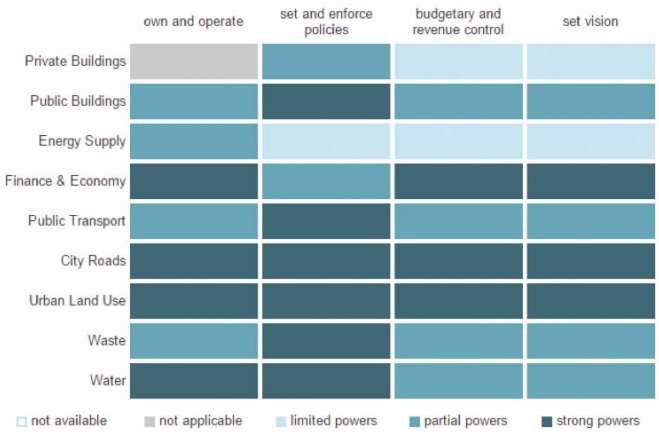
Whilst the C40Cities group is as its name implies focused on climate control per city, the nature of the problem addressed requires smart urban solutions. The group is influential because:
- The member cities account for 25% of the global GDP, or one in 12 people worldwide
- The focus is on technical expertise and best practice, with designated 'innovator cities' and 'observer cities'
- Over 8000 action shave been defined to combat climate change.

Source: C40 Cities

Figure 8: C40Cities Overview

C40Cities facilitates a number of peer-to-peer networks between city staff members who have implementation responsibilities. The networks are used for knowledge sharing and joint problem solving. Solution areas include low-energy buildings, transit networks and city metrics.

For players outside the network, the website c40.org provides common metrics for 75 cities. This includes a common measure of the investment power of local authorities – e.g., the chart below for the City of Copenhagen.



Source: C40 Cities

Figure 9: C40Cities Profile, Copenhagen

7.2 Connecting Europe

Connecting Europe is an initiative within the European Commission's "Digital Agenda for Europe". It targets the ICT correlation with regional and national growth" – for example, 10% of households connected to high-speed broadband are associated with 1.5% higher GDP by 2020.

The initiative provides guidelines for local governments deploying broadband and digital service infrastructures. It has a budget of 1.14 billion euros; most of the budget is focused on Digital Service Infrastructures (DSIs), defined as cross-border services for governments, citizens and small enterprises.

8. Smart City Evolution

8.1 Standardisation

Several 'Smart' ICT investments have been focused on what can be done in terms of technology solutions, with an associated vendor-specific focus.

Smart cities will need:

- A standardised way to measure and compare smart solutions across cities.
- A standardised way to implement them, i.e., common technology platforms.

The British Standards Institute (BSI) has identified over 100 standards relevant to smart cities at technical, process and strategic levels.

8.2 Standardised Measurement

Cities have lacked common parameters to measure:

- The overall net benefit of smart ICT (e.g., a project may disrupt a city more overall than it's worth for the one area that it benefits).
- The relative net benefits of smart ICT c.f. other 'smart' areas such as spatial planning.

Emerging standardisation will shift the focus to 'what makes sense to do?'

The ISO 37120 Standard is the first International standard on how to measure and compare different cities. It was launched 1 Dec 2014. The standard uses 100 indicators, specified fewer than 17 themes:

Themes	
Economy	Health
Education	Recreation
Energy	Safety
Environment	Shelter
Finance	Solid Waste
Fire and Emergency Response	Telecommunication and Innovation
Governance	Transportation
Wastewater	Urban Planning
Water and Sanitation	

Source: Strategy Analytics

Figure 10: ISO 37120 Standardisation

8.3 Standardised Platforms

A common technology platform can make it easier to share applications between cities. For example, Apple's ecosystem for mobile application developers launched with the offer of a global market for application developers, was an opportunity that was much wider than that of the siloed business offerings from both telecom operators and other phone vendors at the time. Business thresholds were lowered. In the same way, smart city platforms will become a more attractive playing ground for smaller companies.

8.3.1 FIWARE

FIWARE is a digital platform initiative based on:

- An open-source software platform (the 'CityOS') with open APIs towards multiple industry verticals, and reference implementations.
- A lab or non-commercial test environment.
- Tools for platform deployment and operation.
- An accelerator program targeting SMEs and entrepreneurs, with €80 million in funding.
- A liaison programme towards local governments across the world.

FIWARE offers several benefits for developers with smart city device solutions:

- The lab reduces the needs for developer to have its own test environment.
- The accelerator programme can help facilitate go-to-market.
- The liaison programme can help with both go-to-market, and give access to specific R&D partner facilities.

FIWARE lab offers cloud hosting based on OpenStack, so the enablers can be offered 'as-a-Service'. The environment status is available in real-time over the public internet; the snapshot below shows a snapshot of lab node and OpenStack component availability:

18 http://www.ericsson.com/thinkingahead/the-networked-society-blog/2014/09/25/society-needs-security-data-needs-integrity/

Source: lab.fiware.org

Figure 11: FIWARE Lab Operational Node Snapshot

The initiative has vendor traction, with Telefonica, Orange, Engineering and Atos announcing joint development of the FIWARE standards.

SIGFOX and FIWARE have announced a joint API, allowing SIGFOX developers to use the FIWARE platform with minimal additional development . SIGFOX is an existing standard for Low-Power, Wide-Area (LPWA) networking, with nationwide deployments in several European countries. The API deal gives FIWARE developer traction and makes it easier for the platform to connect to the 'Things' in IoT.

FIWARE gives government's access to over 500 participating companies (developers + vendors), a pan-European lab environment with over 2000 users, and a business network to engage developers to meet local needs.

The city of Malaga uses the FIWARE platform to collect data from citizens using a smartphone app where they voluntarily submit anonymous data such as temperature, humidity, noise, and mobile signal. This is combined with the city's own open data and information from hundreds of beacons deployed ion the city. The FIWARE platform allows the citizens to report and receive information on the city status in real time.

FIWARE is used for small-scale deployments today, and it is unclear whether it will lend itself to large-scale, industrial internet applications. Its immediate value is that it gives local authorities and developer's feedback on what makes sense to do in a smart city.

9. Conclusions

Cities are resilient, evolving places of trade. Smart use of ICT and IoT can help cities maximise on their economies of scale whilst managing the risks associated with high urban growth. Urban living may encompass 86% of the developed world, and 64% of the developing world by 2050. About a million people are added each week to the world's cities. Urban development and ICT evolution have a common ground for potential solutions, often dubbed 'smart city'.

- Truly smart cities will meet the needs of current and future generations – maximising benefits and minimising the negative aspects of daily living.
- A variety of business models will be needed, especially where net public infrastructure investment is low or zero. There is a gap between investment needed for technology demonstrators and the mass market.
- Standardisation and smart citizens will play a greater role in defining future smart cities. Solutions to visualise city data will become more important, as IoT solutions will greatly increase the data available.

Urban ICT revenues are forecast to reach $977 billion by year 2022. North America and Europe will dominate urban ICT revenue by 2022, with Asia-Pacific the fastest growing market.

Standard city metrics are emerging. They are needed to understand:

- The net overall benefit of ICT projects, compared with other infrastructure investments.
- The gaps between the public spend needed for infrastructure projects, and the 'grand vision'.
- The sustainability aspect of new solutions (what will give the best net benefit for this generation and the next).

Cloud-based, 'CityOS' solutions are good for addressing a range of solutions with standard, common frameworks but the major challenge will still lie in addressing and integrating legacy infrastructure systems.

Projects addressing 'scratch-built' smart cities can demonstrate clear benefits from specific solutions. However, 'mixed' development as in 22@Barcelona may give better long-term answers in how to evolve a city, with resilience and with less exclusivity.

The definition of a smart city will evolve over a long time, and ultimately the definition will come from the users (Government and Citizen) rather than a single ICT vendor or service provider. ■

STRATEGY ANALYTICS
Research, Experts, and Analytics

Andrew Brown is executive director, Enterprise and IoT Research. He leads a team that advises on all aspects of the enterprise ecosystem; from cloud computing to mobilising line-of-business applications, enterprise and mobile broadband devices, IoT, and M2M Communications.

Prior to joining Strategy Analytics he was a program manager at IDC, where he was responsible for mobile computing research as well as the lead analyst on mobile computing, mobile devices, smart phone platform trends and developments and other key important issues in the mobile and wireless markets.

With over 19 years of experience, Andy is quoted in both trade publications and the wider national and international press. He also speaks frequently at conferences and acts as a judge for a number of prestigious awards. He is considered a thought leader in the wireless, IoT and enterprise domain.

www.strategyanalytics.com

19 http://www.bsigroup.com/LocalFiles/en-GB/smart-cities/resources/BSI-smart-cities-report-Mapping-Smart-City-Standards-UK-EN.pdf