The little book of

Smart Cities

1spatial®

YOUR WORLD SMARTER

54%

Today, 54 per cent of people
live in an urban area

Are Smart Cities the answer?

The world is urbanising at an astonishing rate. Today, 54 per cent of people live in an urban area. By 2050, the figure will be two thirds.[1] Already, cities produce 80 per cent of global GDP… and more than 70 per cent of global greenhouse gas emissions.[2]

City managers wrestle with reduced revenues, inadequate and ageing infrastructure, and the challenge of truly global competition. At the same time, increasingly mobile city residents demand more from their administrations: more tailored services, greater access to information and better value for money.

Across the globe, city administrations, utility companies, transport providers and others are partnering to explore ways of combining technology trends (such as big data, social media, the ubiquity of smartphones and the emerging Internet of Things) to better connect cities and citizens, to develop more efficient ways of working and to build more attractive urban environments. In short, to create Smart Cities.

Are Smart Cities the answer? Even relatively simple projects, like a website for reporting local vandalism,[3] can have a big impact and the scope for making cities smarter – creating connections, uncovering insights – is enormous. By 2020, $408 billion a year will be spent on Smart City projects around the world.[4]

All these projects are built on a common foundation: geospatial data, i.e. the location-specific information that tells you where something is happening. From the simplest information feed to the most complex, multi-partner, integrated transport system, having a single source of authoritative and reliable location data is of critical importance.

Trusted geospatial data is the foundation of Smart Cities.

This book explores the growth of the Smart City concept and how successful projects have used geospatial data to help their cities get smarter.

Bright lights, big city

Cities are exciting. We humans are social creatures. We love to think, work and play together. And the more people there are, the more connections there are to be made.

As leading urban theorist Richard Florida observed: The World is Spiky.[5] Talent and economic activity, ever more mobile in a landscape of global competitiveness, concentrate in attractive cities.

"Jobs will go where people want to live," [6] and it is the task of city managers to work out how to make cities more attractive and more effective. City Hall is a service provider, certainly, but it also has a leadership role shaping the built environment of the future.

In an increasingly urbanised world, city administrations will have an increasing impact on the planet. As the United Nations reflects, "Cities are where the battle for sustainable development will be won or lost." [7]

However, city managers everywhere face the following overlapping challenges:

► Doing more with less

► Managing inclusion and sustainable growth

► Competing for talent

Doing more with less

Since the financial crisis of 2008, local governments have needed to do more with less.

"More", because an increasingly connected, digitally-literate population is more demanding of the service it receives for the taxes it pays. For many cities, "more" also describes the demands placed on welfare and social services where the local economy has suffered a downturn.

"Less", because cities see reduced revenues as a result of a still-recovering economy, lower central government settlements and increasing competition from other cities.

City Halls are increasingly looking to technology to make their administration more efficient internally, and more effective externally. As Bernard Clerfayt, Mayor of the Belgian municipality of Schaerbeek, observes, "If we think we will manage the city for the next century in the way that we managed it last century, we are making a mistake. We must make use of new technologies."

A Smart City approach can help residents to help themselves at a time and place of their choosing. Paperwork is eliminated, bureaucracy reduced and citizen satisfaction increased.

Managing inclusion and sustainable growth

Today, just over half (54 per cent) of the world's population lives in urban areas. Half of this urban population lives in cities with fewer than 500,000 inhabitants;[8] the challenge is not for mega-cities alone.

Many cities have areas of urban decay and deprivation with challenges that reach beyond poverty to issues of inclusion: how to create a society that is truly participatory.

Often cities are struggling with a legacy of inadequate and under-invested infrastructure: transport systems are congested, sewers are over-full, buildings are energy-inefficient and simply not designed for the demands of the 21st century. Pollution and climate change are of major concern, as evidenced by such movements as the Covenant of Mayors[9] (in Europe) and the Conference of Mayors[10] (in the USA).

The challenge for today's cities is how to grow smarter; to put in place systems and infrastructures that can expand as required, that make the best use of limited resources, that create attractive places for all to live and work, and which enable sustainable, economic growth.

" No longer is geographic information just a back-drop map, it is actually a fundamental part of our users' business solutions. "

**Colin Bray, Chief Executive,
Ordnance Survey Ireland**

Competing for talent

Cities today face competition, not just from the neighbouring town but from all across the globe. As transport and communications have become faster and cheaper, so populations – of people or businesses – have become more mobile. Whether people are attracted by great jobs, or whether great jobs come to where great people reside is almost irrelevant. In today's world, city managers are competing to attract both. Businesses are attracted to cities that offer the best infrastructure – one that reduces friction and facilitates commerce. People are attracted by great environments: jobs, facilities, services and similar minds. Together, smarter jobs and businesses increase a city's revenue and support further investment in great services.

The challenge for many cities is how to establish this virtuous cycle. Which projects will have the greatest impact on building an attractive environment for a city of smart talent?

What is a Smart City?

Many cities are taking a Smart City approach to tackle the aforementioned challenges, but what exactly is a Smart City?

Perhaps the most useful definition was offered by Andrea Caragliu and colleagues in their 2009 paper, Smart Cities in Europe:

"We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance." [11]

Interest in Smart Cities has grown in recent years as relevant technologies have become more affordable and more common. Cheap digital sensors (including utility firms' smart-meters, parking and traffic monitors, and of course the smartphone-carrying citizen-as-a-sensor) collect input data. The ubiquity of wireless and wired networks provides a means to gather data. The continuing influence of Moore's Law (enabling ever greater computing power at lower prices) and the emergence of cloud computing provide a means to store and analyse vast oceans of unstructured ("big") data.

Lower cost and greater familiarity, combined with the fiscal and competitive imperatives outlined, have led to a sharp rise in Smart City projects.

Cities growing smarter

Smart City projects can, of course, be as large and complex as cities themselves. However, for many cities, their first steps take the form of isolated projects to improve the functioning of the city and the life of the inhabitant in discrete ways. Frequently, such projects harvest existing information, for example, re-purposing data from toll-points to manage peak-time traffic. Often, projects combine new and existing data to produce fresh insights.

Example: Schaerbeek's Smart City initiative for warmer, wealthier residents

One of Belgium's largest, but also one of its poorest, cities, Schaerbeek was a finalist in the 2014 Bloomberg Philanthropies Mayors Challenge[12]. The city is noted for its nineteenth and early twentieth century architecture that, while very valuable and beautiful, can be expensive to heat. Schaerbeek's innovative project proposed flying drones fitted with thermographic cameras over the city to record heat emissions.

The data captured would be analysed using 1Spatial's Elyx 3D software to create a complete, three-dimensional map of heat emissions across Schaerbeek. The geo-located thermal readings would then be combined with information from the city's property register to provide its 130,000 residents with personalised, price recommendations for insulating their homes effectively. Accessed through a secure website, the recommended actions (such as loft insulation or double-glazing) would improve insulation whilst respecting the city's architecture.

Mayor Bernard Clerfayt is clear that a Smart City approach is essential for city managers everywhere, "If we want to improve the city, we must improve the way we work. [Like many cities], our budget is very low, so we must be creative."

Schaerbeek has already invested in a number of Smart City initiatives that leverage technology to make the city more effective. For example, it uses 1Spatial's Elyx Mobile Touch software to manage the public spaces. The city recognises the importance of geospatial data in enabling Smart City projects and employs dedicated geospatial analysts to maintain up to date, authoritative data. This is a sizeable investment for a small city but, as M. Clerfayt explains, "it is the only way to cut costs in the future. We must make use of new technologies."

Schaerbeek's focus on geospatial data as the foundation of their Smart City projects reflects a common ethos among successful projects: the importance of maintaining data quality and data interoperability to ensure that the data gathered can be re-used in other initiatives.
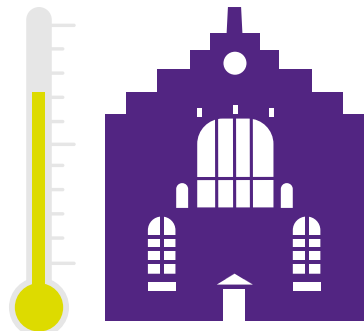
Example: Moorabool Shire shares information

Moorabool Shire, in the Australian State of Victoria, leveraged the state's investment in geospatial data to create a GIS solution for use by both the shire's residents and council staff.

In 2010, Victoria identified that existing geospatial data, published by third parties, had significant quality issues in its currency, completeness and reliability. In response, the state developed Vicmap API,[13] a publicly available data-set designed and maintained to be "authoritative, current and clear".

Moorabool, working with 1Spatial, developed a single, common platform using foundational data from Vicmap API (aerial imagery, road layouts, cadastral information, land contours, vegetation density, planning zones and public facilities such as healthcare centres, emergency services and sports grounds).

On top of this, Moorabool has layered important local information such as refuse collection zones (which day is my bin emptied if I live here?). This information comes from a combination of spatial and corporate databases, including many that are not inherently "spatially aware".

For example, council assets like bridges and footpaths are linked by their asset ID to location and can be represented on the mapping platform where users can see important information like length, width and composition of assets.

For council rangers, the platform offers an animal registration layer that geographically displays 17,000 individual pet registrations. If a stray dog is found, rangers can access the system from a laptop or tablet and search the vicinity by breed or colour to try and locate the owner. Should a local resident contact the council, staff can access the system and potentially reunite pet and owner without the need for a ranger visit at all.

Moorabool can also incorporate third party data using such open standards as GeoRSS feeds. The same platform is used by the public and council staff with individual information layers secured by the identity of the user.[14]

As Moorabool's IT Systems Coordinator Garry Pugh explains:

"We have built the foundation. Now, we are bringing all this information together and seeing it grow as people explore and realise its value."

Moorabool's investment in a single system enables it to provide greater service to its citizens while also making its internal operations more efficient.

17,000

For council rangers, the platform offers an animal registration layer that geographically displays 17,000 individual pet registrations

A Smart City approach is helping many cities to tackle the major challenges they face. With better, more timely and spatially-relevant information, cities are succeeding in doing more with less. They can plan for and manage sustainable growth and they can compete on the global stage to attract talent.
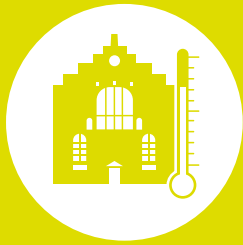
Q How can you connect residents with information on heating their homes more efficiently?

Q How can you create, or support, intelligent transport systems that monitor and manage congestion, parking and emergency response?

Q How can you enable city staff to visualise hitherto unseen patterns across a broad range of information sources?

Q Is there a connection between health and traffic congestion? Unemployment and crime?

Q How can you enable and encourage information sharing within the city administration and across civic partner organisations such as utility companies, health providers or transport firms?

Geospatial data – foundation for a Smart City

If Smart Cities are driven by data and insights, how can cities encourage these connections?

Geospatial data is the foundation of any Smart City project. Everything happens somewhere and only when you know where everything is can you create the connections that make cities smart.

Geospatial data comes from many sources and takes many forms: a resident's postcode, the GPS coordinates of a smartphone picture, the location of a traffic light.

One of the challenges facing many Smart City projects is how to bring this data together in a single, authoritative set.

Geospatial big data

The data required to enable Smart City projects is geospatial big data. "Big data" is broadly defined as sets of data that are too large and complex to manage and interpret using traditional means.

In non-spatial scenarios, a single "piece" of information is quite small (the few words of a Google search term, the digits of a date of birth). With spatial data, however, a single piece of information is much larger: every feature interacts with its neighbours; every building has location, footprint, form and function.

In addition, spatial data is not transient; a building has history, as does a shoreline. A feature's function or form today, is not what it was five, ten or a hundred years ago. Seeing change over time can provide valuable insight: historic flood patterns perhaps, or the London Docklands' evolution from port, through dereliction, to rebirth as an area of upmarket offices and apartments. Geospatial data becomes "big" faster than other data. Users encounter size-related problems much sooner. The location data held by cities is geospatial big data.

58%

By 2025, 58% of the world's GDP will be produced in the largest 600 cities

Sources of geospatial data

Location-specific information for Smart City projects comes from a wide variety of sources.

Basic geographical and property data often comes from the country's national mapping agency (such as Ordnance Survey Ireland) and from cadastral (land registry) agencies. Cities can easily add residential data from such sources as electoral or property tax registers. Aerial photography (photogrammetry) often provides an additional level of detail.

As the Moorabool example shows, cities often have a wealth of data that can be adapted and re-purposed, such as traffic data from toll-points, weather and climate data, crime reports, etc.

The emerging Internet of Things – with its ready availability of low-cost sensors – is enabling cities and partner agencies to add monitoring for a range of information all across their cities. The city of Stockholm gathers information on traffic flow from GPS devices fitted in taxis. This data gives city managers and residents real-time information on traffic flow, journey times and the best commuting option[15]. Information from utility smart meters can also be a useful input.

A further valuable source of data is the smartphone-carrying "citizen-as-a-sensor". The ease with which residents can capture and share information, either on social media sites or on dedicated sites (like www.fixmystreet.com or www.fillthathole.org.uk) provides city administrations with valuable insights.

Beyond paper

Cities have complex geographies. Not least, they exist in three dimensions. Whilst rural areas may be accurately represented on a two-dimensional paper map, this can't adequately represent the complexity of an urban area. Where does the subway run? Does that high-rise building contain a hotel, residential apartments and offices? With retail space on the ground floor? And a public car-park beneath?

Large, covered retail complexes and roof-top gardens blur the distinction between the traditional geographic realm of "outdoors" and the new geography of indoors. Increasingly, urban planners and city managers are looking to 3D technologies to help them understand the subtlety of their spaces. Schaerbeek's Smart City project uses 1Spatial's Elyx 3D software to show heat-loss from both the roof-space and windows of its buildings.

Data Provenance

Knowing data's provenance is important in understanding its usefulness and credibility: data collected for a national survey may not be sufficiently accurate at a street level.

As the State of Victoria found before it developed Vicmap API, publicly available and commonly used data may not be fit for the purposes to which it is put. Understanding data provenance will give insight into the actual quality of the data.

Data Quality

Assessing, understanding, maintaining and improving the quality of geospatial data is fundamental for Smart City projects. Not only can poor quality data result in wasted effort (and even destroy otherwise sound initiatives), it is also essential for safety reasons. As Smart Cities integrate, and then share, information from transport systems, power networks and emergency services, accuracy and reliability become of paramount importance. Just a few metres of inaccuracy on a road layout can send vital emergency services many miles and precious minutes in the wrong direction. Misrepresenting the position of an electricity line can endanger the lives of workers and lead to severe power outages all across the city.

Understanding data quality begins with understanding what's required of the data to hand.

► What is the required level of quality?

► Where are the potential gaps?

► And, how can these be filled to a required level?

With a baseline of data in place, the next step is to bring it up to the required standard and to maintain it there.

1Spatial works with the custodians of the largest geospatial databases on earth and uses its products and services to guide customers through these steps of Data Quality Assessment and Data Quality Management.

Decisions taken at the early stages are critical. It is vital to have a clear view of quality requirements. Poor quality data can be dangerous, but over-engineering can be costly. Successful projects take a view on immediate and foreseeable uses of the data. Cities like Schaerbeek have invested in geospatial analysts to maintain their "one version of authentic data" that enables departments to save money and to collaborate more closely.

Drawing data from a wide variety of sources presents some challenges. It is important for users to understand any data-set's provenance, or lineage

Where did this data come from?

Why was it collected?

?

When was it collected?

How often is it updated?

Effective data maintenance is important too, especially with data coming from disparate sources. Organisations with large geospatial databases deploy tools like the 1Spatial Management Suite that use rules-based automation to maintain data quality to required standards in a cost-effective way. Tools like the 1Spatial Management Suite allow for sub-sets of geospatial data to be extracted, updated, validated and then returned to the database without affecting the usability of the core data. Such systems ensure that data maintenance can be carried out in a timely and cost-effective manner so that the master dataset is always as accurate and reliable as possible for all users.

Data Sharing

Regardless of its quality, data will be of limited use if it cannot be shared by other systems, not just those of the project sponsors, but other city departments and external organisations. Smart City projects frequently involve a broad set of partners: transport providers, health professionals, utility companies etc. Every partner must share the same view of the city, have access to the same set of data. As Schaerbeek's mayor, M Clerfayt observes, "It is like learning a foreign language. All databases must speak with each other."

Holding data in standard format, ideally to internationally recognised standards, such as cityGML[16], is also an essential investment in the future. Over time, hardware and software will change, but data persists. Data is the basis for continuity.

Maintaining data interoperability requires a seamless interface between the city's familiar line-of-business and Enterprise Resource Planning (ERP) systems (such as Oracle or SAP) and any specialist Geographic Information System (GIS) software used (such as Esri). Moorabool's Garry Pugh sees his own role as "the guy who works in between the corporate systems and the mapping systems, acting as a conduit between the two." Any providers of tools or consulting used on the core geospatial dataset need to be very familiar with the requirements of all interfacing systems.

Building on the foundation

Establishing a solid foundation of authoritative, reliable and up to date geospatial data brings tangible benefits:

A single source, open to all, encourages cross team collaboration. It helps break down city siloes to reveal previously unseen relationships in the data.

A single source saves time and money. Future projects can draw on the same dataset, ensuring reliable results as well as saving effort.

A single source makes partnering with other organisations easier, e.g. utility companies, transport providers, healthcare organisations.

If the data is published as open data, it opens the door for innovative solutions to be built by independent developers and entrepreneurial citizens.

The 1Spatial approach

1Spatial manages the world's largest spatial big data. We work with users – and creators – of the largest geospatial databases on earth, helping them collect, store, manage and interpret location-specific information.

We have clients across the globe: in national mapping and cadastral agencies, utilities companies, defence departments and, of course, national, regional and city governments. Our customers include: Ordnance Survey Great Britain, the US Census Bureau, the Brazilian Army, United Utilities, the Environment Agency, Queensland Government, Ordnance Survey Ireland, Moorabool Shire Council, Municipality of Schaerbeek, Staffordshire County Council and City of Marseille.

A leader in our field, we have over forty-five years' experience and a unique approach, built on a rich heritage of geospatial innovation. This is reflected in our range of software tools (such as the 1Spatial Management Suite and the Elyx Suite) and in our consultants who are recognised across the industry as

experts in geospatial data. 1Spatial is also a partner of the other leading players in the GIS and geospatial sector.

We believe that your view of your data is what matters most. We will work with data-users as well as database administrators to understand how your data is used. You know best what you need from your data and we won't shoe-horn your data into the limitations of any given solution.
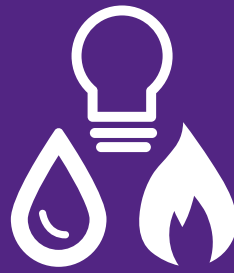
1Spatial's success is built on long-term relationships as a trusted advisor to custodians of geospatial big data. We work alongside you, in partnership, towards long-term goals.

To learn more about how 1Spatial can help make your city smarter, visit:
www.1Spatial.com/smartcities

Natural Resources

Utilities

Telecommunications

Transport

Emergency Services

Government

National Mapping
Authorities and
Land Management

Defence

"

Across government, there is now an understanding of the value of spatial information in more effective decision making.

"

Colin Bray, Chief Executive, Ordnance Survey Ireland

Conclusion

Cities are exciting. Cities are our future. Not only is the world's population increasingly urbanised, but our wealth, global GDP, is increasingly concentrated in urban areas.

Cities are also the source of most of our greenhouse gas emissions, but this too is a cause for hope. Cities are where our efforts to reduce such emissions can be most effective.

Our cities are growing smarter, too. Smart City projects are already helping to solve the challenges of the built environment. Technology is helping city halls to manage their business more efficiently. Smart City projects are helping cities to resolve issues of inclusion and to build a basis for sustainable growth. Smart City solutions are also creating a competitive advantage, helping cities compete for talent across the globe.

Successful Smart City projects are necessarily built on a foundation of accurate and reliable geospatial data – you can only make things better if you know where they are. Investing in the creation of a single authoritative source of geospatial data is an investment in the future.

1Spatial has 45 years' experience working with the largest geospatial databases on earth. We help national mapping agencies, utility companies, defence departments and the governments of countries, regions and cities to collect, store, manage and interpret location-specific information.

To learn more about how we could help you build the foundation of your Smart City, visit: www.1Spatial.com/smartcities
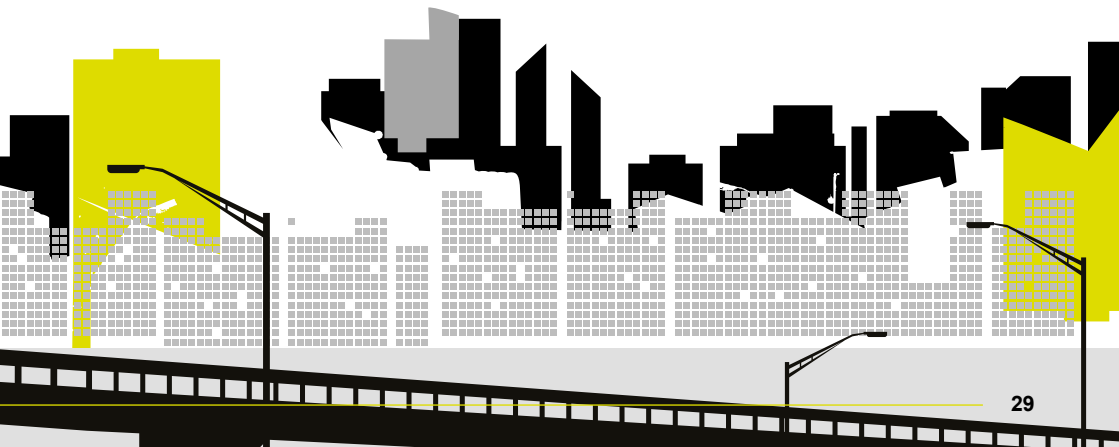
End notes

[1]Source: United Nations, World Urbanization Prospects, the 2014 Revision, (http://esa.un.org/unpd/wup/)

[2]Source: World Bank, http://www.worldbank.org/topic/ urbandevelopment/overview

[3]For example, https://www.fixmystreet.com/

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[5]Florida, R., The World is Spiky (The Atlantic Monthly, 2005) http://www.theatlantic.com/ pastdocs/images/issues/200510/world-is-spiky. pdf

[6]Reiter, W., quoted in Challenges and Opportunities Facing Cities Today, (Urban Land, 2011) http://urbanland.uli.org/economy-markets-trends/challenges-and-opportunities-facing-cities-today/

[7]United Nations, A New Global Partnership: Eradicate Poverty and Transform Economies Through Sustainable Development (2013), http://www.post2015hlp.org/wp-content/ uploads/2013/05/UN-Report.pdf

[8]Source: United Nations, World Urbanization Prospects, the 2014 Revision.

[9]See: http://www.covenantofmayors.eu

[10]See: http://www.usmayors.org/

[11]Caragliu et al, Smart Cities in Europe (2009), http://degree.ubvu.vu.nl/repec/vua/wpaper/ pdf/20090048.pdf

[12]See: http://mayorschallenge.bloomberg.org/

[13]See http://api.maps.vic.gov.au/ for further history and information about Vicmap API.

[14]Some information is publicly available, other layers are visible only to certain job roles, controlled by information held in the council's Microsoft Active Directory.

[15]UK Government Department of Business, Innovation and Skills.

[16]See http://www.citygml.org/ for further details of this open standard for 3D city modelling.