SmartCitiesWorld Trend Report

Creating truly open cities

The importance of building interoperable smart cities from the ground up

In association with

PARADOX ENGINEERING
MINEBEAMITSUMI GROUP

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***SmartCitiesWorld* Trend Reports examine an emerging or growing trend in smart cities, highlighting progress so far and future potential, as well as spotlighting case studies from cities around the world.**

In this report, we examine the importance of building interoperable smart cities from the ground up.

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Why interoperability matters

Cities, and the citizens who reside in them, increasingly rely on connected devices and services. Whether it's to improve quality of life, tackle climate change, increase public safety or promote inclusion and equality, it will be the technology embedded in cities that helps authorities achieve their aims in these areas and more in the future.

Running this technology requires a robust network infrastructure. And the more interconnected and integrated this network is, the more this technology will be able to deliver on its promises, the more valuable the data obtained from it will be to city authorities and citizens, and ultimately, the smarter, more sustainable and resilient the city will be.

To achieve this, cities must be able to integrate a number of different devices and applications on the network, scale up and add new functionality, and crucially, exchange and share data, the lifeblood of any smart city.

This is why interoperability is paramount. But sadly, vendor-locked proprietary technologies are stymying the progress of smart city projects. According to recent research by the open standards body uCIFI Alliance, 82 per cent of smart city pilots fail due to a lack of maturity.

Gianni Minetti, CEO of Paradox Engineering, believes it does not have to be that way. He says: "If based on interoperable technologies and open data models, smart city projects have a far higher success rate since they grant superior flexibility and scalability with virtually no limit on how many devices and applications can be added."

Learning from history

Anyone who needs reminding of the importance of the open approach uses the clearest example of its power every day: the internet and the World Wide Web. The roots of the former go back to the 1960s, while the three core technologies that remain the foundation of today's World Wide Web (HTML, URI and HTTP) were written in 1991 by Sir Tim Berners-Lee. He had clear in his mind that if the technology had "been proprietary and under his total control", it probably wouldn't have taken off.

This didn't mean that the computing industry was going to be open and free of proprietary systems in the years that followed. And while closed, best-of-breed software systems have kept many customers happy over the years, in the Internet of Things and digital transformation age, interoperability needs to become the priority to achieve the same impact and ubiquity of the internet.

6LoWPAN, or Internet Protocol version 6 over Low Power Wireless Personal Area Networks, is an open standard defined by the Internet Engineering Task Force (IETF) standards body. Just as the internet allowed different networks to be able to talk to each other and share information, 6LoWPAN performs a similar function for the Internet of Things (IoT) by allowing plenty of devices on networks to talk to each other and share information.

As such, it has the potential to be one of the most significant developments yet for smart cities. In order to truly succeed, smart cities need to put in place a scalable infrastructure capable of running applications from different suppliers with devices that communicate with each other. 6LoWPAN allows this to be achieved.

Paradox Engineering's PE Smart Urban Network, the next-generation connectivity platform and applications ecosystem that allows cities to manage a range of urban services, is based on 6LoWPAN and an open data model.

In this guide we explain the importance of 6LoWPAN to creating truly open and interoperable smart cities as well as examine other developments in the open standards movement that will be key to helping city authorities ensure future smart projects reach full maturity.

What is 6LoWPAN and why it's important

The Internet of Things has transformed the likes of meters, sensors and other objects by adding intelligence and data transmission capabilities through connectivity. However, given the disparity between devices' size, power and processing capabilities, manufacturers have connected to networks via various means, whether Bluetooth, NB-IoT and so on.

6LoWPAN is an open source protocol stack whose various component parts make it ideal for connecting all sorts of devices to an IP network and transmitting IPv6 data packets end-to-end across low power wireless networks. Based on the IEEE 802.15.4 standard, it enables all nodes to communicate in a mesh network using IPv6, the newest internet protocol.

While originally developed to support the IEEE 802.15.4 low power wireless networks, 6LoWPAN has been adapted to support others such as Bluetooth, low-power Wi-Fi and power line control networks.

Why it's a game-changer

The standard brings a step change when it comes to connecting devices to the IoT. As an open public standard, it is designed to be generally available to facilitate interoperability among products and services from different vendors and providers.

Existing proprietary network architectures such as ZigBee and Bluetooth do not offer transparent end-to-end connectivity and have more complicated gateways when it comes to connecting to the internet and other IP-based networks. 6LoWPAN gets around this issue courtesy of an "adaptation" layer within its stack that converts data bits into IPv6 packet format that can then be transmitted.

"6LoWPAN enables all nodes to communicate in a mesh network"

As the most recent version of internet communication protocol, 6LoWPAN guarantees complete interoperability with all internet-oriented applications. This is one of its chief selling points for smart cities. It also brings a raft of other benefits though in areas such as speed, range and security:

- It can establish large mesh networks with dynamic communication paths between nodes that overcome complexities generated by the physical topology of cities, for instance buildings and other obstacles.
- It can facilitate a high data rate for real-time communication and support demanding data transmission applications. Remote device upgrades can be carried out over the entire network.
- Low latency of less than a second and device-to-device communication allow near real-time application and distributed processing.
- It is natively designed to be energy-efficient and, coupled with short range transmissions and mesh networking, this ensures low power consumption for devices.
- It offers free unlicensed bands with no recurring fees or costs.
- Based on the newest internet protocol (IPv6), it supports current and future security algorithms. These same features provide a way to certify the security capabilities of a device on the network. Added to this, the distribution intelligence of each device makes them harder to hack and an authenticated chain of trust can be built with Public Key Infrastructure (PKI) on each device.

6LoWPAN is helping to fuel the development of the Internet of Things globally and is being used across a broad range of sectors. These include cities, utilities, home applications, smart manufacturing and e-healthcare, demonstrating the flexibility of the technology.

Its potential is a long way off being fully exploited, especially in the smart city space. There needs to be much more education in terms of its interoperability and how this can avoid costly integration and potential vendor lock-in that hampers many smart city projects. There also needs to be much more discussion and explanation on its ability to build scalable and flexible network infrastructures that enable smart city projects to progress beyond pilot stages to add more functionality, applications and devices in the medium and longer term.

Interoperability from the ground-up

Open standards and protocols hold the key to realising truly smart cities that deliver benefits to both citizens and cities on a number of levels, chiefly enhancing quality of life for the former and enabling the latter to work more efficiently and cost-effectively as well as make themselves more resilient and sustainable.

Clearly, no single application can achieve this, so cities need a flexible underlying infrastructure such as a mesh network that allows them to pilot different solutions and scale up or down in capacity, size and functionality.

Cities cannot afford to be locked into a single vendor and historically this is one of the reasons far fewer smart city projects have reached maturity than they should. According to research carried out by uCIFI Alliance, more than half (55 per cent) of cities have a smart roadmap but only 16 per cent have mature projects up and running. It is also estimated that smart city projects using proprietary technology cost 30 per cent more than those using open technology.

Added to this, proprietary systems introduce more complexity, can lead to duplicated implementation and maintenance costs as well as incur impossible or expensive integration with other systems and run the risk of obsolescence and ultimately a poor return-on-investment.

This is why Paradox Engineering has built its PE Smart Urban Network on open standards such as 6LoWPAN. In doing so, it eliminates the risk of the above and, importantly, provides the city with the flexibility it needs to address its most pressing challenges as well as strategically plan for future application roll-outs.

Many cities begin with smart lighting because the nature of the installation and infrastructure required provides it with basis of an urban network on which to run future applications, whether these are focused on traffic congestion and parking or the environment and waste. It can be confident in the knowledge that there will be no barriers to interoperability when it comes to adding new devices and applications to the network.

As Minetti points out: “Interoperability allows a concrete and measurable improvement of city management and provides the opportunity to start a gradual journey towards innovation mirroring local needs and available resources – but always maintaining a far-sighted perspective.”

Broader benefits

While interoperability is key, 6LoWPAN delivers a raft of other benefits which also make it easier for city authorities to make a business case for their smart city projects.

Smart city networks are extremely busy, even if you only have one or two applications running on them. This may add up to a lot of devices that need to be communicated with. 6LoWPAN facilitates multiple data transmissions per minute from, for instance, smart lighting, air quality sensors, smart parking technology and more. It can do all of this at the same time with no data traffic cost.

Enabling the data to flow across the network and be exchanged with different departments can also help to break down the siloed approach to delivering services that has existed within many cities for so long. For instance, if those working in the traffic department can easily access data from environmental sensors, city leaders can acquire a much more holistic picture of what is happening across the city.

This approach to data sharing can promote a far more transparent and collaborative way of working. It can also extract maximum value from the collected data by supporting decision-making and future strategic planning.

Summary of 6LoWPAN's benefits to cities
Its openness and vendor agnostic approach allows it to add unlimited devices, products and services from different providers.
It allows cities to be more responsive to the city and citizens' demands with bi-directional communication facilitating near real-time command and control over applications. Its low latency enables it to handle a high volume of data messages extremely quickly.
The mesh network allows cities to scale projects in capacity and size and add new functionality as and when appropriate.
It enables cities to be more energy efficient and lower their carbon footprint.
Its built-in security features take advantage of the latest and most advanced security algorithms and provide a way of certifying the security capabilities of each device on the network.

"Cities need flexible underlying infrastructure to pilot different solutions and scale in capacity, size and functionality"

Interoperability, the road ahead

Many organisations and individuals continue to invest considerable time and effort into developing standards and protocols that are helping to build a more open and collaborative future for everyone.

In recent years, organisations have adopted an ecosystem approach to further innovation and the aims of their sectors. Such ecosystems are made up of suppliers, distributors, customers and other stakeholders as well as relevant government agencies and even competitors. Some of the best examples of these exist in sectors such as MedTech, FinTech and PropTech. However, the smart cities sector still isn't taking enough advantage of the benefits of working openly and collaboratively.

Minetti believes in collaboration and ecosystems. "Cooperation and knowledge-sharing would speed up progress for everyone," he says, adding: "We should focus on education and contribute to mature technological competences and skills. More than half of cities still have difficulty in understanding whether a technology is interoperable or not."

Unifying the industry

One of the organisations to have made great strides in this area is the non-profit uCIFI Alliance. Its aim is to expand and complement existing international IoT connectivity standards by specifying a unified data model and interface across multiple IoT technologies.

The Alliance members include a number of industry players, including Paradox Engineering's parent company MinebeaMitsumi, utilities and cities. These include Gijon in Spain, Nantes in France, Stockholm in Sweden, Auckland Transport in New Zealand, and the Australian Smart Communities Association (ASCA) in Australia.

The Alliance states that while existing IoT international connectivity standards homogenize the physical layer and the messaging protocol, they do not specify a data model for smart city and utility use cases.

Put simply, a data model organises and documents elements of the data (for instance, how they are stored, accessed and relate to each other). Each solution provider ends up using a specific proprietary data model for each IoT network. This then becomes a barrier to interoperability and potentially locks a city in with a particular vendor or forces them to pay for expensive API integration.

uCIFI's mission is to create a unified data model for all smart city objects based on the standardised OMA LwM2M data format so they can be implemented in any IoT network. This means street lighting controllers, electrical cabinet controllers, water/gas/electricity meters, environmental sensors, pressure or water quality sensors, furniture equipment, traffic measurement sensors and other assets become interchangeable from one manufacturer to another, without integration effort or cost.

Sharing practice and experience

As Minetti stresses, more collaboration is needed. One of the challenges of interoperability in the smart city space is that so many vertical sectors are involved. uCIFI Alliance has done a good job of bringing together experts from many of these as well as recruiting cities but we now need to build on these achievements and collectively work towards an interoperable future.

Case study:

Gijón

The Spanish city of Gijón is playing a major part in trying to accelerate the shift towards more open and interoperable smart cities.

It undertook its own smart city journey in 2016 and from the outset wanted to deploy a public, open and interoperable Internet of Things (IoT) infrastructure on which to build on it its smart city applications. As the basis for this, it put in place the PE Smart Urban Network which is built on the open standard 6LoWPAN.

Once the next phase of implementation has been complete, the network will connect 44,000 streetlights, 135 municipal buildings, 100 homes, 200 shops and 16 air quality control stations. Further applications and devices will be added to the network in the coming months and years.

The city's smart vision goes beyond its own operations though. Central to the Gijón-IN (Innovative, Intelligent and Integrated City) smart city programme is the ability to connect IoT devices for a range of applications that could not only provide valuable data to the city authorities but also to the wider community of developers, innovators, academia and other third parties through an open data platform.

Gijón City Council recognised the importance of working collaboratively to achieve this and brought together relevant players from the public and private sectors, universities and research centres to share knowledge and expertise and contribute to the programme. It also created a Smart Cities Chair together with the University of Oviedo, a laboratory that has replicated the city's IoT infrastructure, and established the DemoLAB, a space for the conceptualisation, development and implementation of private initiatives for the development of new products and services.

But beyond the work done to promote more open standards, it is necessary to promote a greater exchange of experiences between cities. “We also need to improve when it comes to designing and showcasing repeatable and scalable pilots, approaches and applications,” says Minetti. “With every city on a learning curve – even the more mature ones – there is a pressing need to see good practice in action, as communities can’t be asked to reinvent the wheel each time, nor they have the time or resources to do so.”

A major challenge to creating a completely open and flexible smart city network is that IoT standards do not currently specify a data model for smart city and utility use cases, which can prevent cities taking a multi-supplier approach when it comes to adding new applications and devices to the network. Hence, Gijon joined the uCIFI Alliance to help define a common smart city data model that can be used by IoT device makers.

Gijon wants cities to incentivize and encourage manufacturers to adopt such an open and interoperable data model and network stack (for example, the 6LoWPAN interoperable mesh) rather than to develop proprietary networks and data models which require the development and integration of translators, gateways and/or interfaces.

With this in mind, the uCIFI Alliance and the Gijón City Council are working jointly to assist IoT device manufacturers with uCIFI interoperability checks on their devices in the Gijon DemoLAB space. Each manufacturer is invited to join the alliance, implement the uCIFI LwM2M-based data model (already available to uCIFI members) and contribute to the uCIFI 6LoWPAN-compatible wireless network mesh stack, before proposing their uCIFI-compliant products to further Gijón’s tender process.

Jose Antonio Rodríguez Cortés, IoT project manager, Gijón City Council, says it is essential that the industry works together. “The benefit of a data model for us will be the ability to launch new services quickly and create new application functionalities without expensive API integration or the need to move data from third-party platforms,” he says.

He adds: “It’s important to enable us to scale and keep pace with new ideas and requirements for visitor services. It’s fundamental to help us realise the new concept of the model of Gijón.”

Conclusion

Smart cities: beyond data and interoperability
No-one has perhaps made a better case for interoperability than Tim Berners-Lee when he talked about the importance of the World Wide Web being free and available for everyone to use.

Indeed, all the technical workings that go into creating open standards, open data and open hardware and software should never be underestimated. Interoperability is all about connecting countless devices, adding new applications and sharing data but, ultimately, what is important is what this helps us achieve.

For a start, interoperability and openness offer a tremendous opportunity for growth, as Minetti highlights: “Taking advantage of the same urban network and mashing-up different data streams, universities, start-ups and local businesses can design their own innovative services, sharing innovation and stimulating mutual development.”

And he contends that what interoperability really allows cities to head for is truly open and shared innovation: “Smart cities cannot be limited to connecting devices and automating services; they are about data becoming tangible value for the benefit of all.

“Information is the new asset class for cities and it’s time to turn investments aimed at cost-savings into opportunities for sustainable, inclusive growth, engaging citizens and local stakeholders in open innovation cases.”

About Paradox Engineering and MinebeaMitsumi

Established in 2005 and headquartered in Switzerland, Paradox Engineering offers an integrated portfolio of future-proof IoT solutions for smart urban networks. Unique competences in data collection systems, radio design and wireless sensor networks are at the core of its offering. Since 2015 it has been part of MinebeaMitsumi Group, global provider of Electro Mechanics SolutionsTM that combine control technology with machine and electronic technology. Its unique, broad range of solutions is aimed at creating new value through difference.

The Group is striving to create products to contribute to an IoT, connected society. **www.pdxeng.ch; www.minebeamitsumi.com**

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