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# **MUNICIPAL STRATEGIES FOR LEVERAGING THE INTERNET OF THINGS:**

***HOW IPV6 MESH NETWORKS CREATE  
& ENABLE SMART CITIES***

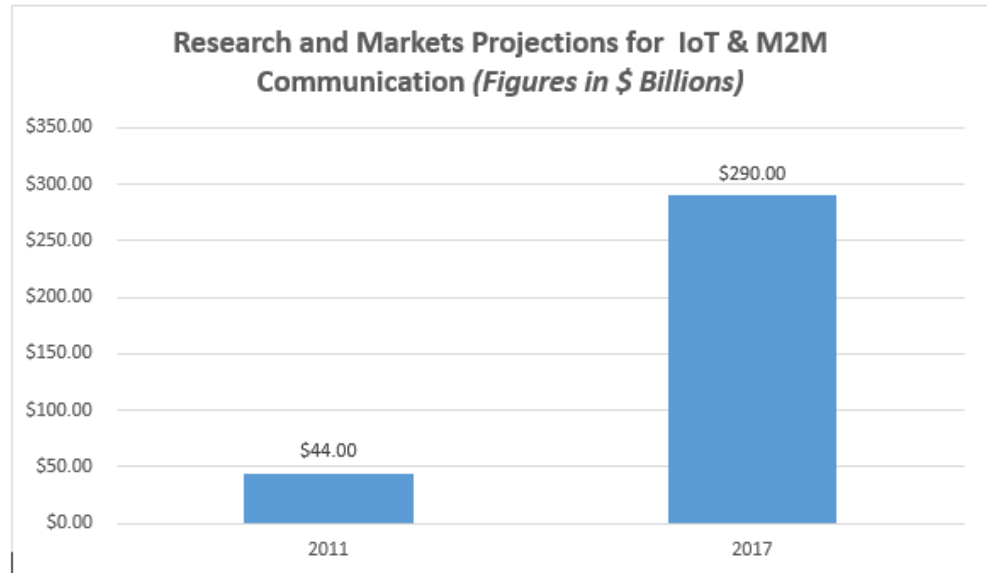
*The Internet of Things (IoT) is reaching a tipping point that will make it a sustainable paradigm for practical applications that can change the future of individuals, enterprises and the public sector...*

### **Municipal Strategies for Leveraging the Internet of Things: How IPv6 Mesh Networks Create & Enable Smart Cities**

#### **Introduction:**

Elected and appointed municipal leaders around the world increasingly are addressing the challenge of improving citizen services in budget constrained environments. While technology long has played a critical role in improving the efficiency and productivity of city workforces, a new concept called the Internet of Things (IoT) is adding new ways to apply technology to address key priorities by improving the productive interaction of devices and infrastructure investments without human intervention.

IT research firm Gartner cited the Internet of Things as one of the top 10 strategic technology trends for 2013, noting that the emerging technology has the potential to deliver a strategic advantage for early adopters.<sup>i</sup> As the IoT gains steam, Gartner sees an expansion of the Internet as items such as physical assets and personal devices are connected. Meanwhile, analysts at Research and Markets expect demand for IoT and machine-to-machine (M2M) communications devices to reach \$290 billion by 2017.<sup>ii</sup>



*Figure 1 source: Research and Markets*

The IoT is poised to become a key enabler of Smart City objectives. According to analysts at IDC Government Insights, by embracing an IoT strategy that leverages the power of IPv6 to collect data remotely from smart objects and sensors, municipalities can achieve the seemingly contradictory benefits of doing more with less: enhancing citizen services and public safety, while gaining extraordinary efficiencies – and even slashing current expenditures.<sup>iii</sup>

***Investment in Smart City technology infrastructure will exceed \$108 billion by 2020. By the end of that period, the analysts anticipate that annual spending will reach nearly \$16 billion...***

“The Internet of Things (IoT) is reaching a tipping point that will make it a sustainable paradigm for practical applications that can change the future of individuals, enterprises and the public sector,” says Massimiliano Claps, Research Director, IDC EMEA Government Insights.

“IoT applications in the public sector can span a variety of domains: public security, defense, environmental protection, transport, and health. In each of these domains, connected objects can provide situational awareness that can help citizens and government personnel act and react at the operational level, monitor the status or behavior of people and assets to make management decisions, and support very fine-grained, sensor-driven analytics that help with planning decisions.”

In this report – commissioned by Freescale Semiconductor, Inc., a company that produces and designs embedded hardware and software – we explore the strategic, operational, financial and technological issues that municipal decision-makers must address to develop and execute successful Smart City initiatives that leverage the power of the IoT.

### **Strategic Impact Analysis: Smart City Initiatives**

Smart Cities are defined as those municipalities that integrate technology into a strategic approach to sustainability, citizen well-being, and economic development. Models for smart urban design differ widely between regions, though, from the ancient inner cities of Europe, to the urban and suburban sprawl found in the United States, to the rapid rise of dense urban areas in Asia, particularly in China.

Over the next two decades, the world population will grow from 6.9 billion to 8.3 billion people. The urban population will grow even faster, from 3.5 billion to 5.0 billion. For the first time in human history, more people now live in cities than in rural areas. The social, economic, environmental, and engineering challenges of this transformation will largely define the 21st century. Cities are responsible for between 60 percent and 80 percent of the world’s energy use and about the same percentage of greenhouse gas emissions.

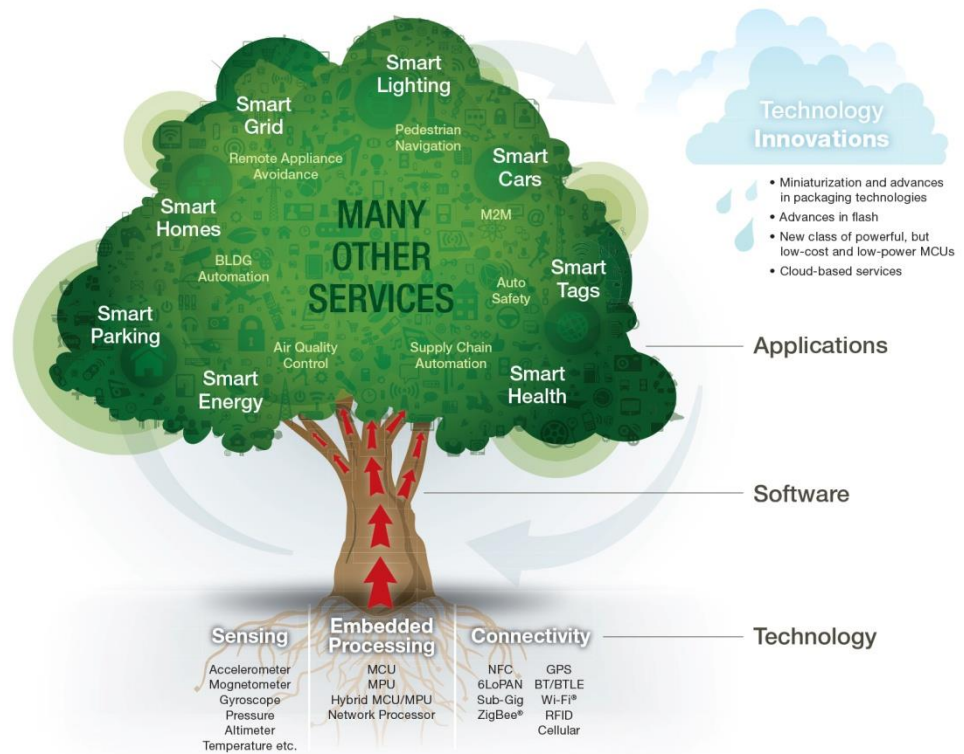
According to analysts at Pike Research, “smart” information and communication technologies that improve the efficiency and effectiveness of urban systems and services not only will help mitigate the environmental effects of mass urbanization, but also will improve the lives of the people who inhabit the world’s burgeoning cities.<sup>iv</sup>

Cities are the focus for new approaches to energy efficiency, building design, transportation, waste management, and energy use. Huge investments will be required to implement these approaches. Pike Research forecasts that investment in Smart City technology infrastructure will exceed \$108 billion by 2020. By the end of that period, the analysts anticipate that annual spending will reach nearly \$16 billion.

“Information and communications – particularly ubiquitous broadband Internet access – are vital elements in any definition of the Smart City,” says Pike Research senior analyst Eric Woods. “But a city only becomes smart if it can make use of these capabilities to deliver real-time services based on the capture of information.”

No single technology defines the Smart City – although a number of iconic technologies can be highlighted as key components of the Smart City vision. Among them are ubiquitous broadband, smart meters for electricity and water use, intelligent transport systems, and extensively deployed monitoring and sensor technologies.

The IoT: Different Services, Technologies, Meanings for Everyone



IoT and the Smart City

The Internet of Things matters to Smart City leaders because it can be leveraged to deliver bottom-line benefits...often by anticipating problems before they manifest themselves.

“City leaders want to understand what’s happening with their infrastructure before something goes wrong,” explains Kaivan Karimi, executive director of global strategy and business development, Microcontrollers group, Freescale Semiconductor.

***The next critical step in the evolution is to connect these smart objects to the Internet...***

“This is because machines and devices today can be programmed to automatically track the health of the infrastructure based on services and predetermined conditions. Add the effect of Big Data analytics and IoT services, and we will have a great infrastructure health and safety monitoring system”

As with any new technology, IoT can mean different things to different people. “In its essence, however, IoT is all about services,” says Karimi.

“The litmus test we have is if there are two widgets that are talking to each other, that’s just automation. If it’s connected to an Internet Protocol (IP) network and has a secured, service-layer infrastructure, it’s got a server hanging off of it and you’re receiving services based on these two widgets communicating, then that’s IoT.”

In the context of Smart City initiatives, the IoT can extend existing Internet investments to small, embedded – typically wireless-enabled – objects.

“It’s really about extending the Internet to sensing and control devices that collect or control various parameters,” explains Robert Assimiti, co-founder and chief technology officer of wireless sensor network systems integrator Centro Technologies. “This can be used to support everything from smart grid-type applications for electrical meters to environmental and agricultural monitoring.”

There are a wide range of applications common to municipalities that can benefit from IoT, points out Assimiti. These include automated and pre-emptive management of lighting, water purification and remediation as well as other resources or tasks that monitor or control parameters using smart objects.

“The more efficiently things run, the better city leaders can allocate resources,” he says. “The more data points you have, the better you can predict the future -- and if you mine this data, you can draw conclusions, enabling more educated decisions.”

### **The Critical Role of IP Infrastructure**

The “Smart City” movement started out as automation initiatives that were based on the deployment of point solutions (they could perform only a single dedicated task) and were connected to proprietary networking infrastructures.

However, as technology and standards have matured, it is increasingly clear that scalability (the ability to leverage automation across a large areas that cover large volumes of devices) and agility (the ability to perform a growing number of different functions) requires the development of highly scalable mesh networks that include smart objects which can communicate with each other and send data over common infrastructure and can be managed on a central dashboard.

*The primary benefit of these Internet of Things technologies is increased safety it can deliver to citizens...The second benefit revolves around the savings that these technologies can generate for municipalities deploying these technologies...*

“That is why the next critical step in the evolution is to connect these smart objects to the Internet,” Assimiti says. “Then you can leverage existing standards that are proven to be highly scalable and effective when it comes to connecting machines.”

A key component to achieving this vision of IoT is the Internet Engineering Task Force’s (IETF) most recent version of the Internet Protocol – IPv6.

IoT extends the role of the Internet beyond connecting people to each other and to information resources. By expanding the Internet to allow millions – perhaps even billions – of devices to interact independently, IP addresses must be available.

“IPv6 is all about increasing address space – and right now, we’re running out of IPv4 addresses,” says Michael Dow, Freescale’s business development expert for smart energy in the company’s Microcontrollers organization.

### **Operational Impact Analysis: Current Benefits**

The operational benefits of IoT in the context of Smart City initiatives are compelling. Indeed, many government entities already are reaping the rewards. Those include, but are not limited to, improving citizen services and safety, gaining cost efficiencies and advancing public policy priorities.

“The primary benefit of these Internet of Things technologies is increased safety it can deliver to citizens,” Assimiti explains. “The second benefit revolves around the savings that these technologies can generate for municipalities deploying these technologies.”

- **Lighting/Energy Management** – Assimiti cites a case in which an IPv6 street light monitoring network was deployed for a municipality. “Today, the process of replacing street lights in most municipalities starts with a citizen notification. As a light starts flickering or goes out, the citizen makes a phone call and the municipality dispatches a truck to replace the light,” he says. “It can cost hundreds – even thousands – of dollars to dispatch that truck.”

But if the city knew when all the bulbs in a particular area would need to be replaced, they could replace them all on the same trip, saving them multiple dispatches to that same location.

Similarly, Karimi notes that automotive highways all over the world leave street lights on over periods of time in which there is very low -- or no -- traffic volume. IoT can be used to connect sensors on vehicles to the street lighting infrastructure, or leverage Vehicle to Infrastructure (V2I) communications system for this purpose. This way, street lights several kilometers ahead of a traveling vehicle will be turned on, and automatically turned off after the traffic has

*While IoT and Smart City initiatives are often described in technical terms, the key to achieving success revolves around establishing multi-disciplinary teams of staff and management...*

passed. This can save millions of dollars in energy consumption over the course of a year, without altering the traveler's experience.

- **Citizen Safety** – On the citizen services and safety front, Karimi cites an application that notifies citizens fleeing an emergency or disaster situation about which routes are safest. For example, if a flood occurs and people need to escape, a bridge could automatically send a signal that it is being washed out and is not a safe route. The municipality then can communicate a warning to vehicles not to evacuate via that particular route.

Likewise, if a particular road is frozen, the embedded road sensors could pick up that information, communicate it to a central location that can dispatch trucks to address that problem. The municipality can de-ice the road before an accident occurs, and also communicate specific conditions to cars and travellers in the region.

- **Public Health/Social Services** – Municipalities can leverage IoT to accomplish policy priorities such as improving the health of their senior citizens.

“If a particular municipality wants to provide telehealth services for their elderly – IoT can enable automatic monitoring of biometric conditions to ensure that medical interventions can occur preventively, rather than reactively. This not only improves the quality of life of senior citizens, but also reduces the cost of expensive emergency medical care,” says Assimiti.

According to IDC Government Insights, a practical example of the threefold impact on service delivery-operations, service management and service planning is provided by assisted living for elderly, or patients that are seriously ill. Wearable readers (known as e-bandages) can measure body temperature, blood pressure, heart rhythm and other parameters and be combined with environmental sensors to measure moisture, temperature, movement and sound; GPS embedded in mobile phones can be used to monitor movements inside and outside of the home.

- **Real-time service delivery** - In case of a sudden increase in blood pressure and slowing down of heart rhythm --combined with a fall --sensors could automatically trigger an operational response by ambulance services.
- **Service management** - Blood pressure parameters over one day, combined with movement and sleeping patterns, also can help the doctor, or the patient himself, decide to adjust the dose of medications. In case of complex systems, sensors could interact with an actuator, such as wearable pump to automatically adjust doses.

*It is so critical to have senior executive involvement. You need to have someone who's concerned about the total cost of everything in the city...*

- **Service planning** - A month's worth of analysis of all parameters can then be used by doctors to adjust doses, or types of medication permanently.

### **Implementation Analysis: Who Owns the IoT?**

While IoT and Smart City initiatives are often described in technical terms, the key to achieving success revolves around establishing multi-disciplinary teams of staff and management, according to Freescale's Dow.

"In some cities, IT departments worry about computers and facilities, managers worry about office buildings and that's it. Meanwhile, the telecommunications department is responsible for the fiber running around the city," Dow explains.

"All of these departments must come together with the officials responsible for water quality, street lights, parking meters, etc., to establish a common vision of what can be accomplished," Dow continued. "It is also critical to keep all parties up to date on what has been accomplished, so that the team knows how to leverage investments that have already been made, and to learn from the challenges that have been overcome as well as the benefits that have been reaped."

In this context, it is also important to discourage individual departments from creating their own stand-alone IoT initiatives. "That is why it is so critical to have senior executive involvement," Dow pointed out. "You need to have someone who's concerned about the total cost of everything in the city."

Analysts at IDC recommend that public sector executives consider multiple management factors that will influence the ability to harness the benefits of the IoT, including the volume, variety, velocity and value data that are going to be generated, the massive scale of the infrastructure, the complexity of governance, the financial sustainability and the legal aspects.

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### Smart City/IoT Checklist for Municipalities

1. **Identify Your IoT opportunity** and make sure it maps to some municipal priority. The first step is to identify an opportunity for proof of concept that's achievable and high-profile. It may not be the most important thing you can do, but it should be something that is achievable in a short time at low cost and that generates an interesting case study to build upon.
2. **Create an interdisciplinary team** of policymakers, technologists and business process experts to identify which processes would be affected and how, what investments need to be made and what impact the initiative would have on the municipality processes that are affected. Don't forget to address how to secure it.
3. **Develop an implementation guide** on selecting the right elements of technology. That guide should be based on an IP open set of standards and should identify the technology to be used in all of the applicable layers.
4. **Assemble an internal and external team of implementers** and agree on a time frame that is achievable. Focus not only on achieving the task at hand – water metering for example – but the infrastructure should be able to be leveraged into other applications of IoT.
5. **Assess and test the environment** – then deploy a proof of concept project.
6. **Design a high-profile communications initiative** to ensure that citizens and other stakeholders are aware of the impact that this project is having and how it contributes to municipal priorities.

### **About Freescale**

Freescale Semiconductor (NYSE: FSL) is a global leader in embedded processing solutions, providing industry-leading products that are advancing the automotive, consumer, industrial and networking markets. From microprocessors and microcontrollers to sensors, analog integrated circuits and connectivity, our technologies are the foundation for the innovations that make our world greener, safer, healthier and more connected. Some of our key applications and end-markets include automotive safety, hybrid and all-electric vehicles, next-generation wireless infrastructure, smart energy management, portable medical devices, consumer appliances and smart mobile devices. The company is based in Austin, Texas, and has design, research and development, manufacturing and sales operations around the world. [freescale.com](http://www.freescale.com)

### **About BizTechReports**

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### **End Notes:**

<sup>i</sup> <http://www.ibtimes.com/gartner-identifies-top-10-technology-trends-2013-852928>

<sup>ii</sup> [http://www.researchandmarkets.com/reports/2228552/internet\\_of\\_things\\_iiot\\_and\\_machinetomachine](http://www.researchandmarkets.com/reports/2228552/internet_of_things_iiot_and_machinetomachine)

<sup>iii</sup> <http://www.idc-gi.com/getdoc.jsp?containerId=prUS24087613>

<sup>iv</sup> <http://www.navigantresearch.com/newsroom/smart-city-initiatives-can-improve-living-standards-reduce-carbon-emissions>