TWO WAYS CITIES CAN UNIFY THEIR IoT SYSTEMS

By Thibault Werlé, Rachid El Ameri, and Rodolphe Baronnet-Frugès

CITIES ARE EAGER TO harness the power of the Internet of Things (IoT). And with good reason. Smart streetlights can dim during quiet periods, for example, saving cities money. And connected parking technologies can help drivers locate scarce parking spaces.

But there's a hitch. Today's supplier landscape is highly fragmented, and products use an array of different standards. This prevents IoT solutions from working together, sharing data, and creating even greater benefits for cities. For example, if a city could connect its smart streetlights to its traffic management system, it could program lighting situated in danger spots to automatically increase the level of illumination in the event of congestion or an accident.

Presented with such diverse use cases, cities are relying on vendors whose end-to-end solutions meet a specific need, such as smart metering, but are barely compatible with other IoT systems. Besides limiting planners' ambitions for new smart city applications, such dependence risks locking cities into using just a handful of suppliers, with little scope to switch to more cost-effective solutions as they arise.

Cities cannot leave it to the market to solve the interoperability problem. Instead, they must take the lead. Planners can accelerate interoperability in either of two ways: by selecting a uniform set of IoT standards, or by building a cross-vertical platform that integrates different IoT solutions. Singapore is taking the first approach and prioritizing common standards, while Tokyo is developing a smart city platform through a joint initiative with Japanese companies Toyota and NTT. Both options pose challenges and require cities to be proactive and create a consensus among stakeholders if they are to unlock the benefits of IoT solutions.

The Interoperability Imperative

The global installed base of IoT-connected devices will rise from about 11 billion in 2019 to about 125 billion in 2030, according to DBS Bank. IoT-enabled solutions are

already changing the urban landscape in significant ways. In addition to adopting smart lighting and parking systems, cities are using sensors to perform real-time monitoring of the flow, consumption, and chemical composition of their water, thereby improving resource management, lowering costs, and safeguarding public health. These solutions are effective as far as they go. But to maximize the advantages of the IoT, devices must be interoperable so they can seamlessly exchange information.

The United Nations' United 4 Smart Sustainable Cities initiative makes interoperability a key priority in its ongoing promotion of more connected and sustainable metropolises—part of the organization's sustainable development goal 11.

By attaining interoperability, cities stand to benefit on several levels. Interoperability across solutions means that data generated by one city department or one function within a department can help another organization to meet its objectives. For example, a residential smart smoke alarm that detects a fault in an electricity meter could warn members of the household of the danger individually via their smart watches, alert the appropriate emergency services, and inform the utility company of the problem.

Most cities are far from achieving these advantages. Suppliers tend to provide integrated end-to-end solutions that function in closed silos and aren't designed to share data with other IoT solutions, hindering cities' efforts to add new applications to the mix.

Limited interoperability also makes it far more difficult and expensive to change suppliers, leaving cities overly reliant on a small number of vendors. For example, if a city depends on a proprietary technology from a single vendor, it may have trouble replacing the vendor—or even accessing its own data—when a more cost-effective solution emerges. And if the supplier fails to deliver to an agreed work standard, the IoT solution's functionality, scalability, and security can suffer.

How IoT Solutions Share Data

To achieve interoperability, cities must first understand how IoT solutions communicate and work together. Solutions can be interoperable at three different levels, each more complex and value enhancing than the preceding one:

- **Technical interoperability.** The simplest level, technical interoperability enables components such as sensors to communicate simple data, such as temperature measurements for environmental monitoring, over a shared network using a common technology such as Bluetooth or NB-IoT. A communications standard determines the specific technology to be employed.

- **Syntactic interoperability.** By using a common format, syntactic interoperability allows IoT solutions to share more complex information, such as structured data, and send messages to devices supporting other solutions. For temperature measurements, the format might be recordings to two decimal places.

- **Semantic interoperability.** This level of interoperability enables solutions to interpret information by means of a common understanding. With temperature recordings, the understanding might be that all measurements are to be expressed in Celsius degrees rather than Fahrenheit degrees.

Municipalities can drive interoperability by introducing regulations that require suppliers to use a common set of standards so that IoT solutions can interact better. Alternatively, they can work with the private sector to develop a cross-vertical platform that connects different IoT solutions, thereby breaking down vendor silos. Some cities combine both strategies. Each option offers different degrees of interoperability.

A Uniform Set of Standards

Several countries and cities are studying the possibility of using common standards to achieve greater interoperability between IoT devices. This approach can solve two

major legacy issues that have hampered cities' efforts in the past:

- IoT devices contain many components that were developed before the internet even existed and that use incompatible standards. With the rise in connected technologies, the weak interoperability of these standards has become self-evident.

- Different standards-developing organizations and industry consortia have, over time, produced standards to meet their own needs. This has led to a proliferation of diverse standards, some of which are more advanced than others. Initiatives to consolidate these standards have largely failed, owing to disagreements between organizations and companies.

For these reasons, a common set of global industry standards is unlikely to appear unaided in the short to medium term. If city governments and regulators can create a consensus among private-sector players, however, they may be able to develop a set of standards that will accelerate smart city initiatives, lower market entry barriers to alternative providers, and promote greater innovation.

In theory, if a city applied uniform standards across all of its IoT-connected devices, it could achieve full interoperability. Nevertheless, we believe that cities and regulators should focus on defining common communication standards to support technical interoperability.

The reason: Although different versions exist, communications standards are generally mature and widely used by IoT players. In contrast, the standards that apply to messaging and data formats—and are needed for syntactic interoperability—are less mature, and semantic standards remain in the early stages of development and are highly fragmented.

Some messaging and data format standards are starting to gain broad acceptance, and it shouldn't be long before policymakers can prudently adopt the leading ones. With that scenario in mind, planners should ignore semantic standards until clear favorites emerge.

Benefits of a Cross-Vertical Platform

Building a platform that works across use cases can improve interoperability. The platform effectively acts as an orchestrator, translating interactions between devices so that they can share data and work.

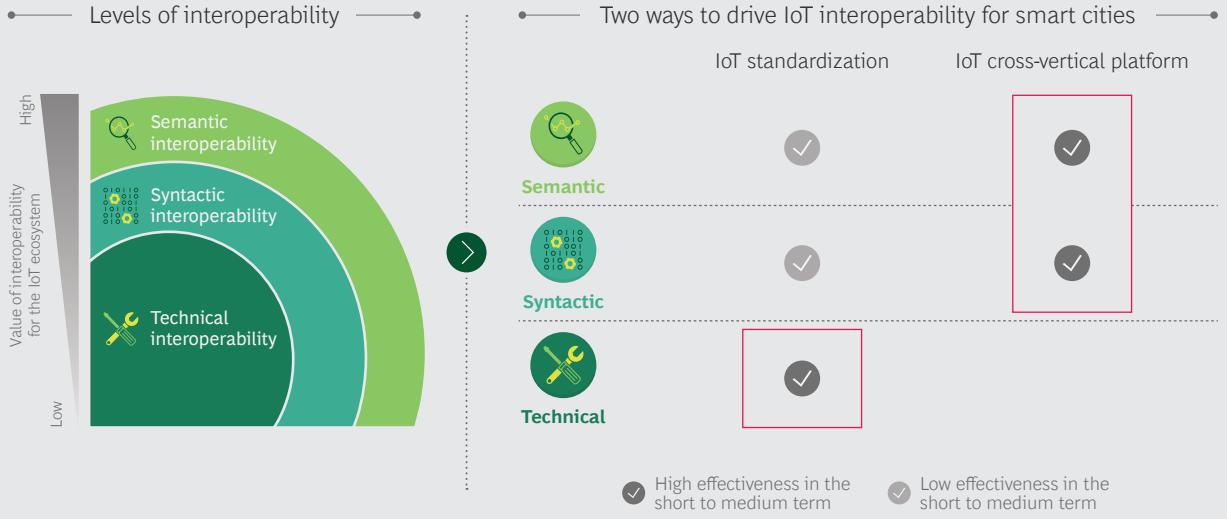
In a city context, a cross-vertical platform offers significant interoperability benefits over standardization. Because such a platform functions as an interface between IoT solutions, devices can continue to use their existing standards. Moreover, because the platform, rather than a set of common standards, is responsible for interoperability, cities can achieve both syntactic and semantic interoperability and so introduce more advanced smart city applications. (See Exhibit 1.)

Platform economics also support their use in metropolises that have a large number of smart city solutions. Revenues consist of subscription fees from participating cities, together with a transaction fee for every use case added to the platform. The more use cases (such as smart lighting or smart parking) a city maintains, the more money the platform makes.

This arrangement makes platforms more commercially viable in cities with relatively well-developed IoT ecosystems that can combine existing solutions to create additional use cases. Indeed, whether with cross-vertical platforms or with common standards, pursuing interoperability for its own sake won't create significant value. Players must apply it to generate entirely new use cases. (See Exhibit 2.)

Although a private-sector consortium typically builds, owns, and maintains the cross-vertical platform, city governments can initiate the platform's development by offering the consortium financial support and providing access to their data.

EXHIBIT 1 | The Two Approaches to IoT Interoperability Have Different Immediate Benefits



Source: BCG analysis.

Cross-vertical platforms remain a relatively new concept. Owing to the diversity of IoT solutions and standards, developing a platform is a very complex undertaking, and most projects are still in the planning or testing phase. What's more, the interests of cities and private-sector players do not naturally align. Although municipalities and platform providers can derive significant interoperability benefits or revenues from cross-vertical platforms, participating companies tend to have less incentive to share their data through a platform. Resolving these challenges would help platforms gain popularity.

Three Steps Toward a Connected Future

To unlock the full benefits of IoT solutions, cities should take the following steps:

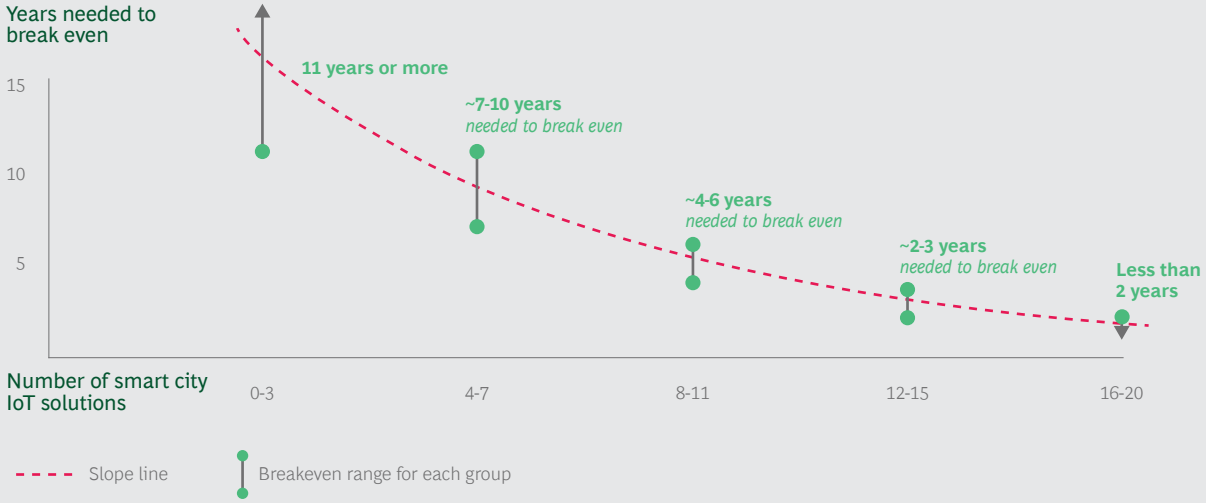
- **Select an approach.** Metropolises must decide which approach is likely to work best for them. In making this determination, they should first look at their existing IoT solutions. If they have only a handful of solutions, standardization is probably the better option. If they have more than a few solutions, commercial and interoperability considerations favor opting for a cross-vertical platform. Other factors are likely to influence cities' decisions as well, however. In highly regulated cities and regions, we expect standardization to be more popular; meanwhile, in deregulated markets that encourage competition, cross-vertical platforms are likely to be more prevalent.

- **Ensure early buy-in.** For either approach to succeed, cities must create a consensus among key stakeholders. Defining IoT standards that work for all participants requires the involvement of all important private-sector players from an early stage of the process. The same is true of platforms, as cities will have to persuade participating companies to share their data—perhaps by offering revenue-sharing agreements or other incentives.

- **Promote IoT adoption.** Cities should be proactive in increasing IoT adoption so they can reap maximum benefits from smart city solutions. They can do this by funding training, offering subsidies and tax credits, and providing centralized procurement support for public- and private-sector organizations that are developing solutions. They can also build their own IoT wireless communications network to support adoption.

EXHIBIT 2 | Platforms Are More Commercially Viable in Cities That Have Several IoT Solutions

Analysis of initial number of IoT smart city solutions relative to breakeven years



Source: BCG analysis.

WITH SMART CITY solutions, metropolises can transform the urban landscape and improve their citizens' quality of life. To realize this ambition, IoT solutions must be interoperable and capable of seamlessly exchanging data so that one city department or function can help another meet its objectives. Achieving interoperability is a huge challenge. But by making savvy decisions, creating early buy-in from stakeholders, and proactively promoting adoption, cities can overcome obstacles and unlock IoT's potential.

About the Authors

Thibault Werlé is a managing director and partner in the Dubai office of Boston Consulting Group. You may contact him by email at werle.thibault@bcg.com.

Rachid El Ameri is a principal in the firm's United Arab Emirates office. You may contact him by email at elameri.rachid@bcg.com.

Rodolphe Baronnet-Frugès is a senior advisor for BCG.

Acknowledgments

The authors would like to thank the following people for their help with this article: Olivier Beaujard, LoRa Alliance board member and chairman of its regulatory work group; Christophe Fourtet, co-creator and technical director at SigFox Wireless; Jamal Cheema, general manager for Australia at the IntelliHUB Group; Barbara Pareglio, senior director, IoT technology, at the GSMA; Bak Chor Sim, senior manager, Infocomm Development Authority of Singapore; Ahmed Alsohaily, chief technology advisor at the Communications and Information Technology Commission of Saudi Arabia; Rushil Goel, vice president and general manager, fleet management, at Samsara; and Ingrid Wistrand, vice president of business strategy and execution at Deutsche Telekom.

To succeed, organizations must blend digital and human capabilities. Our diverse, global teams bring deep industry and functional expertise and a range of perspectives to spark change. BCG delivers solutions through leading-edge management consulting along with technology and design, corporate and digital ventures—and business purpose. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, generating results that allow our clients to thrive.