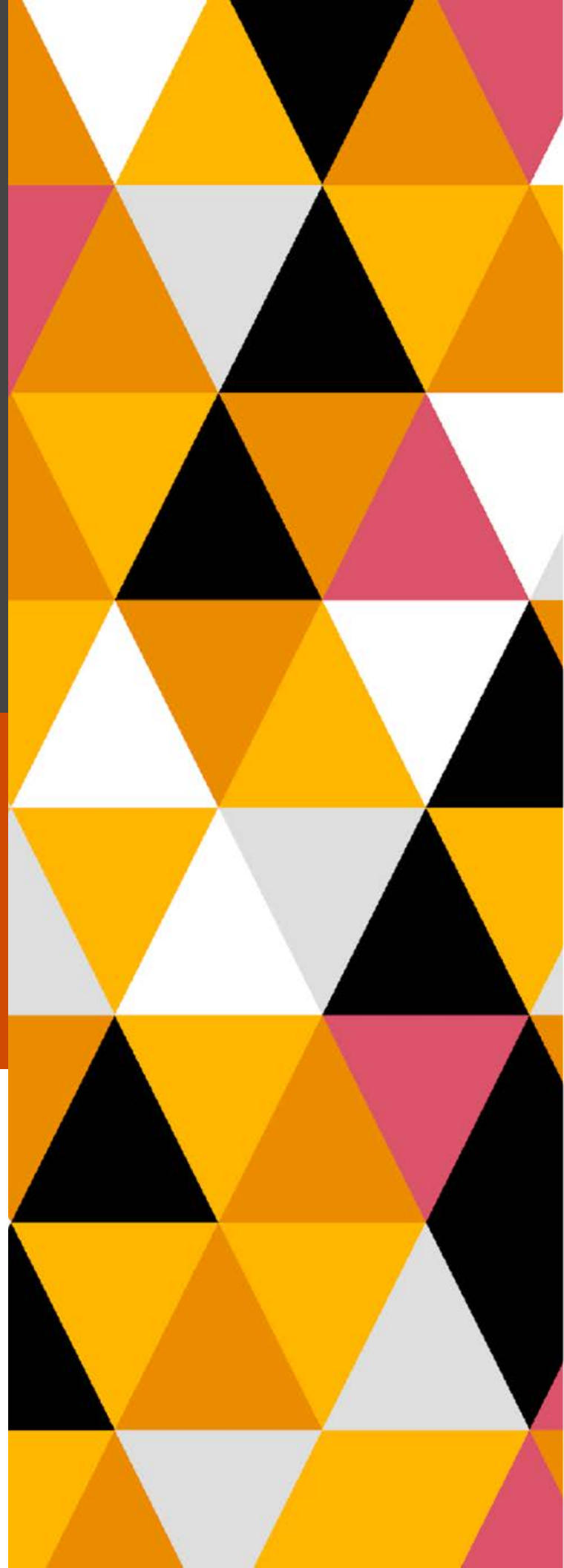


Creating the smart cities of the future

A three-tier development model for digital transformation of citizen services





Executive summary

Mapping out the future for smart cities

The development of smart cities – enabled, powered and integrated by digital technologies – is set to be one of the crowning achievements of societies worldwide in the 21st century. Already, the everyday lives of people living in countless cities are being made easier, more fulfilling and more secure by previously undreamt-of services enabled by digital. Yet the transformation of our cities has barely begun. And looking forward, as citizens' expectations grow, urban populations continue to expand, energy efficiency and sustainability rise in importance and government systems are upgraded over time, the pace of progress and innovation isn't likely to let up.

Yet the evolution of smart cities needs more than technology. Continued progress depends critically on the right relationship between the two primary groups of players most directly involved in building solutions to meet the rising needs and expectations of citizens: namely government authorities, and the private-sector partners who help turn their vision of connected, efficient, 24x7 citizen services into reality. PwC's extensive experience with smart city projects worldwide – including our work with the World Economic Forum on urban development¹ – has enabled us to identify a fundamental progression that's underway in how the public and private sectors work together to deliver the best outcomes for citizens. It's a continuum that consists of three tiers, and it's happening today. In this paper we explain what it is, how it works, and why it matters.

¹PwC/World Economic Forum, *Circular Economy in Cities: Evolving the model for a sustainable urban future*, 2018





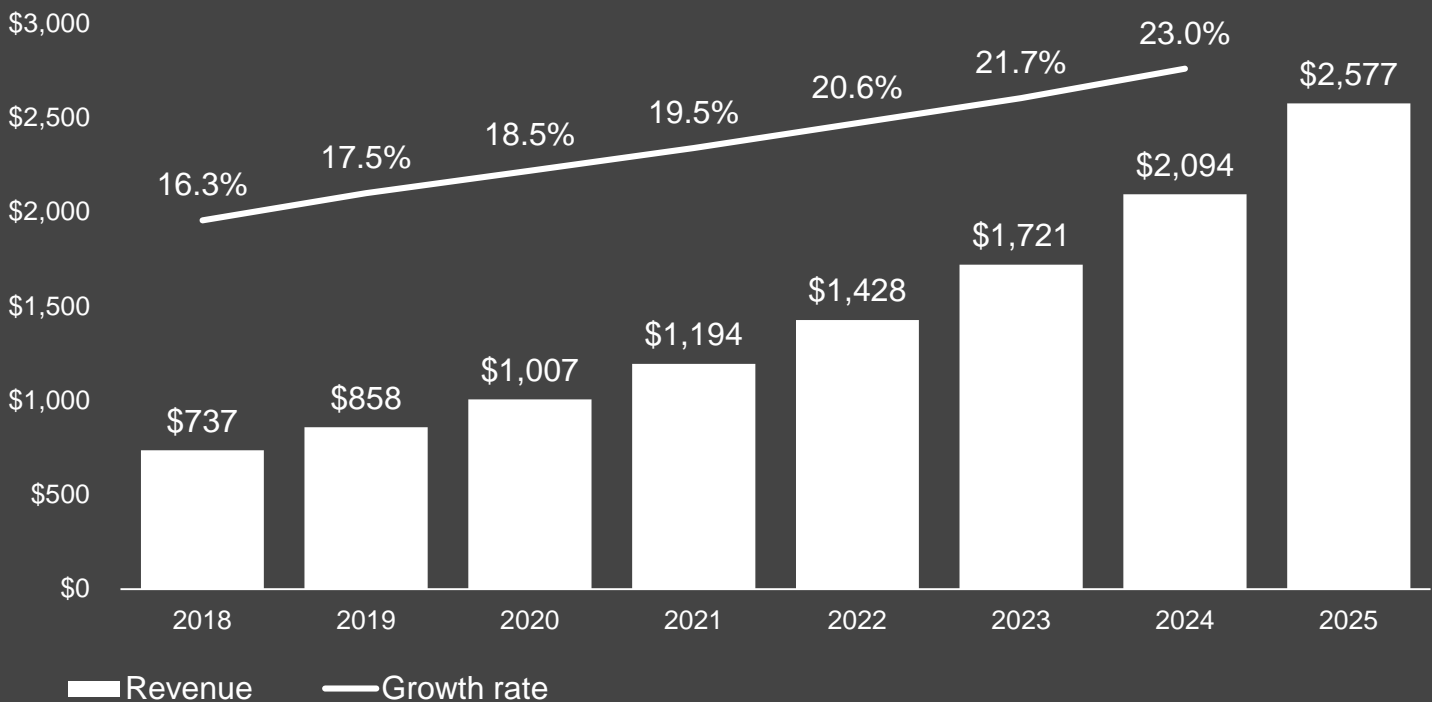
A three-tier development model

The development of smart cities around the world is gathering pace, with the total value of the global smart city market projected to exceed US\$1 trillion by 2020 and US\$2.5 trillion by 2025 (see Figure 1). As this growth continues, one of the most important and dynamic aspects of smart cities is the evolution of the roles and relationships between the key participants involved in envisioning and creating them. These are primarily government bodies aiming to transform the lives, wellbeing and safety

of their citizens; and an ever-widening array of private sector players helping to realize these aspirations, by building, managing and funding digital urban infrastructure and services. While other stakeholders are also involved – including not-for-profit organizations and citizens themselves – it's government and the private sector that are largely building the digital infrastructure of the city.



Figure 1
Global smart city market (US\$bn), 2018-2025



Source: "Smart Cities Market Analysis & Segment Forecasts to 2025", Grand View Research, 2018



A three-tier development model

In PwC's view, the relationship between these two principal stakeholders is evolving along a three-tier continuum – a journey that's reshaping how smart city digital infrastructure will be developed, financed and delivered worldwide in the years and decades to come. The emergence of this continuum is a global trend, but one that's progressing at a varying pace in different markets, and even in different services within the same city. But while the three tiers can all co-exist at the same time, each has distinct characteristics and impacts.

1

Tier one

This tier is based on what might be regarded as fairly traditional contracting structures between public sector entities and the private sector, generally with the goal of delivering a “point implementation” of a specific smart city service, capability or infrastructure. Examples might include the creation of a traffic or parking management system, public Wi-Fi, LED streetlighting, a mobile app for citizens to report potholes, or a system for managing and monitoring water usage.

The dynamics of this tier reflect the fact that, in the initial stages of the move to smart cities, public sector entities engaged the private sector to implement specific technologies or services to meet an expressed need from city planners. Over time, the private sector players they engaged have also been able to suggest and recommend a wide range of other technologies and solutions that could also help the public sector realize a smart city vision or functionality.

Partly as a result, the initial contracting relationship is evolving towards collaboration and joint development of solutions between the public and private sectors, albeit sometimes with conflicting or competing private sector interests, data standards and inter-operability constraints. The primary characteristic of this tier, however, is that the economic arrangements have remained primarily those of a public sector entity contracting with a private sector entity to provide a service, solution or technology.

2

Tier two

Building on the first tier, this second form of relationship facilitates the development and deployment of additional services on the base digital city infrastructure. These services are then offered to – and used by – citizens in other areas of their lives, multiplying the benefits. Examples might include a transit payment card system that is enhanced into a smartphone and/or facial recognition-enabled payments mechanism, and then expanded beyond its core remit in the transit network to act as a broader, even city-wide payment platform infrastructure.

In tier two of the smart city development continuum, the private sector partner has a significantly larger customer base, and the city often receives a share of the revenues generated from these customers' use of the additional services being offered. When properly structured, tier two relationships offer cities the opportunity not only to improve services to citizens, but also to monetize expanded digital services.

While these “public-private partnership” (PPP) type arrangements can be highly attractive both to cities and the private sector, they require a high degree of sophistication in the contracting methods used. If not structured properly, the agreements in this tier can carry risks of creating rigid, even monopoly-like structures, or short-changing the public or private sector on potential services and revenues.



A three-tier development model

3

Tier three

The third tier – which is just beginning to take shape – involves some of the most exciting new developments in smart city projects. The defining characteristic of this tier is the development of a digital ecosystem in and around the city's digital infrastructure, with the result that new products, services, businesses and government revenue opportunities are created on the smart city platform.

Crucially, not all functions or operations of a city need be “smart” before this type of ecosystem can develop. One ready example is streetlighting: in a number of jurisdictions where private sector companies have been contracted to provide lower-cost streetlighting, they've implemented “smart” streetlighting that includes sensors, Wi-Fi, digital displays and other services. The deployment of these technologies has created a digital platform upon which innovative new services and solutions can then be developed and deployed.

The opportunities for such solutions are almost boundless. Beyond the obvious but attractive potential to provide services such as Wi-Fi, 5G, advertising, and traffic and pollution monitoring, the ability – for example – to aggregate and analyze traffic and pedestrian congestion information can be highly useful for retailers, autonomous car manufacturers and other players. Properly managed, such a capability can be monetized directly and/or provide the basis for further innovation around new services. These essentially private-to-private deals signal a major acceleration of the smart city innovation ecosystem, and properly structured will offer citizens new services and governments additional revenue opportunities.

The evolutionary path between these three tiers is illustrated in Figure 2. A key point is that different areas of the city's infrastructure and services can be at different stages at the same time, as they continue to move along the continuum: healthcare can be run on a different basis from mass transit, for example. But once the continuum is established, it can trigger a virtuous cycle of digital development, with the success of tier three projects giving the city authorities the confidence to launch new projects based on tier one or tier two approaches, and then progress them through the continuum.

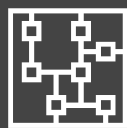


Figure 2
The evolutionary path
of smart city development



Tier one

Relies on traditional contracting structures between public entities and private sector providers, delivering services and infrastructure; e.g., parking management system, public Wi-Fi.

Tier three

Focuses on the development of a digital ecosystem in and around the city's digital infrastructure, creating new products/services, businesses and government revenue opportunities.

Tier two

Facilitates the development and deployment of additional services on the base digital city infrastructure; e.g., mobile transit payment card systems.



A three-tier development model

From a commercial perspective, city authorities may also choose to apply different tiers for different projects. For example, they might use a tier-one “transactional” model for small, quick wins such as mobile apps, while progressing to tier-two PPP structures for larger point projects with clear business cases, such as LED streetlighting. The tier-three domain of platforms and ecosystems is still nascent due to the more distributed and less foreseeable benefits these produce, but we’re already seeing some cities use smart city point projects to subsidize the development of platforms. Going forward, a key determinant of the benefits that the public and private sectors respectively derive from smart city platforms will be ownership of data. Given this, cities must strike a fine balance between keeping control of their hugely valuable data assets, and offering the private sector sufficient incentive to invest and collaborate in smart city initiatives.



Overarching drivers, technology initiatives and challenges

These are the three tiers through which the dynamics of smart city projects are evolving. And cutting across all of them are a number of overarching factors that are driving and shaping the development of smart cities worldwide. As Figure 3 shows, six critical technological and financial developments are acting as the fundamental enablers of smart city growth. The first of these – the use of PPPs to overcome high financing costs – opens the way for cities to exploit the opportunities presented by emerging technologies, with current focus areas now including 5G, blockchain and electric vehicles (EVs). Further drivers include a growing focus on cybersecurity, cloud and big data analytics – all areas where, once again, private sector expertise can be invaluable.

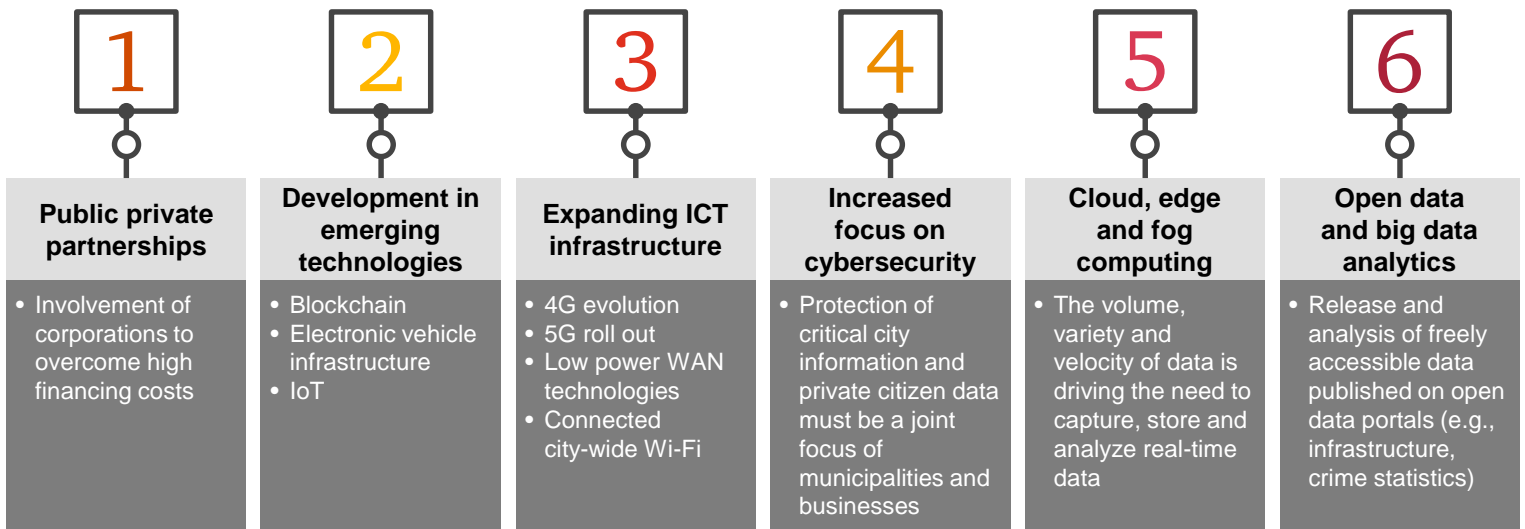


A three-tier development model



Figure 3

Six critical technological and financial developments driving global smart city growth



Sources: PwC analysis, Technavio, Cisco, ITU, IEEE, Smart Cities Dive, GreenBiz

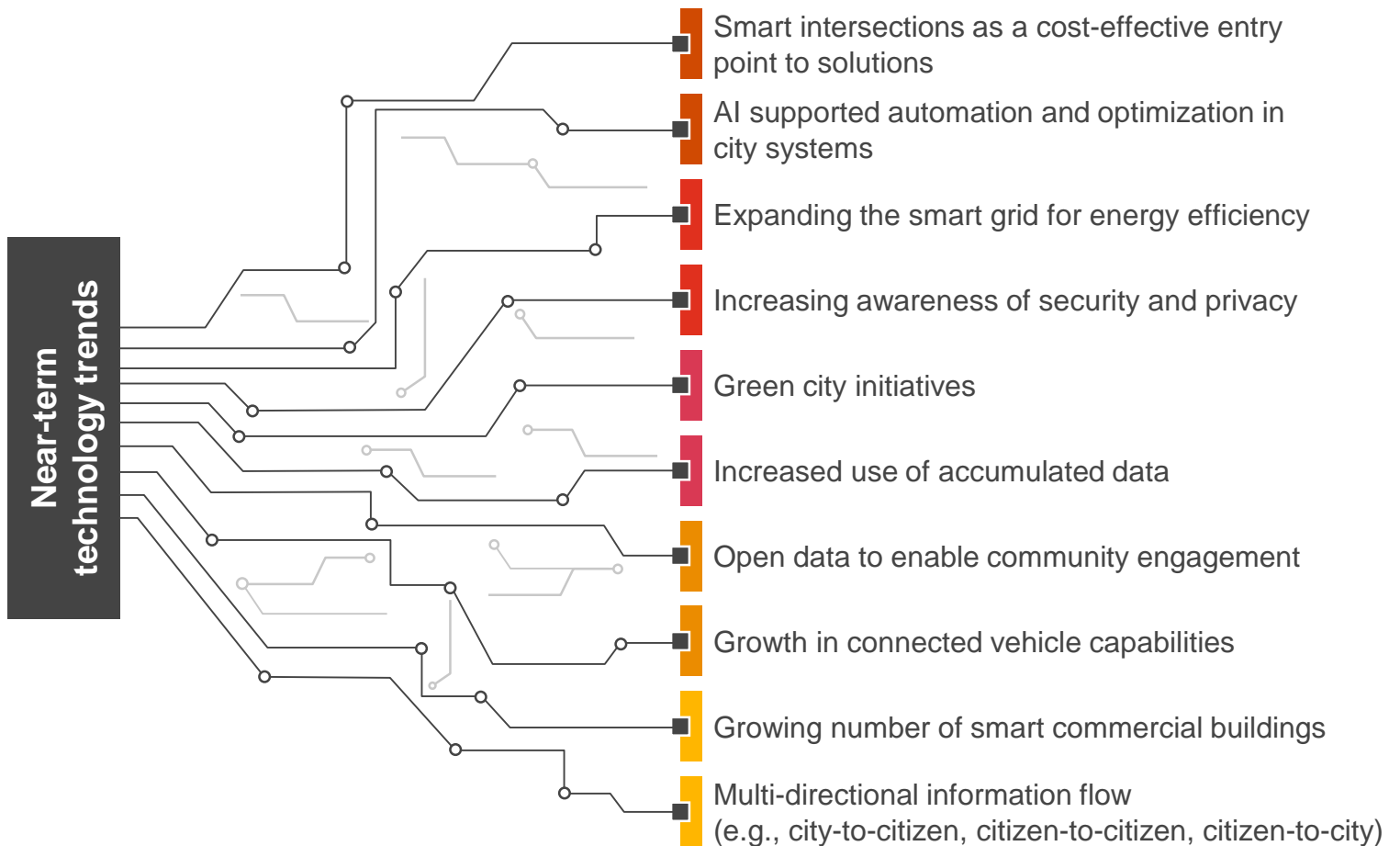
In cities where these enablers are in place and functioning properly, the result has been the generation of a diverse set of near-term technology initiatives that can be broadly grouped into the categories shown in Figure 4. Alongside developments around the green agenda and the creation of smart intersections as entry-points to digital solutions, growing areas of focus include improving community engagement through open and multi-directional data flows, and using AI and accumulated data to make services more personalized and responsive to citizens' needs.



A three-tier development model



Figure 4
Technology outlook: near-term smart city initiatives



Sources: PwC analysis, Technavio, Cisco, ITU, IEEE, Smart Cities Dive, GreenBiz

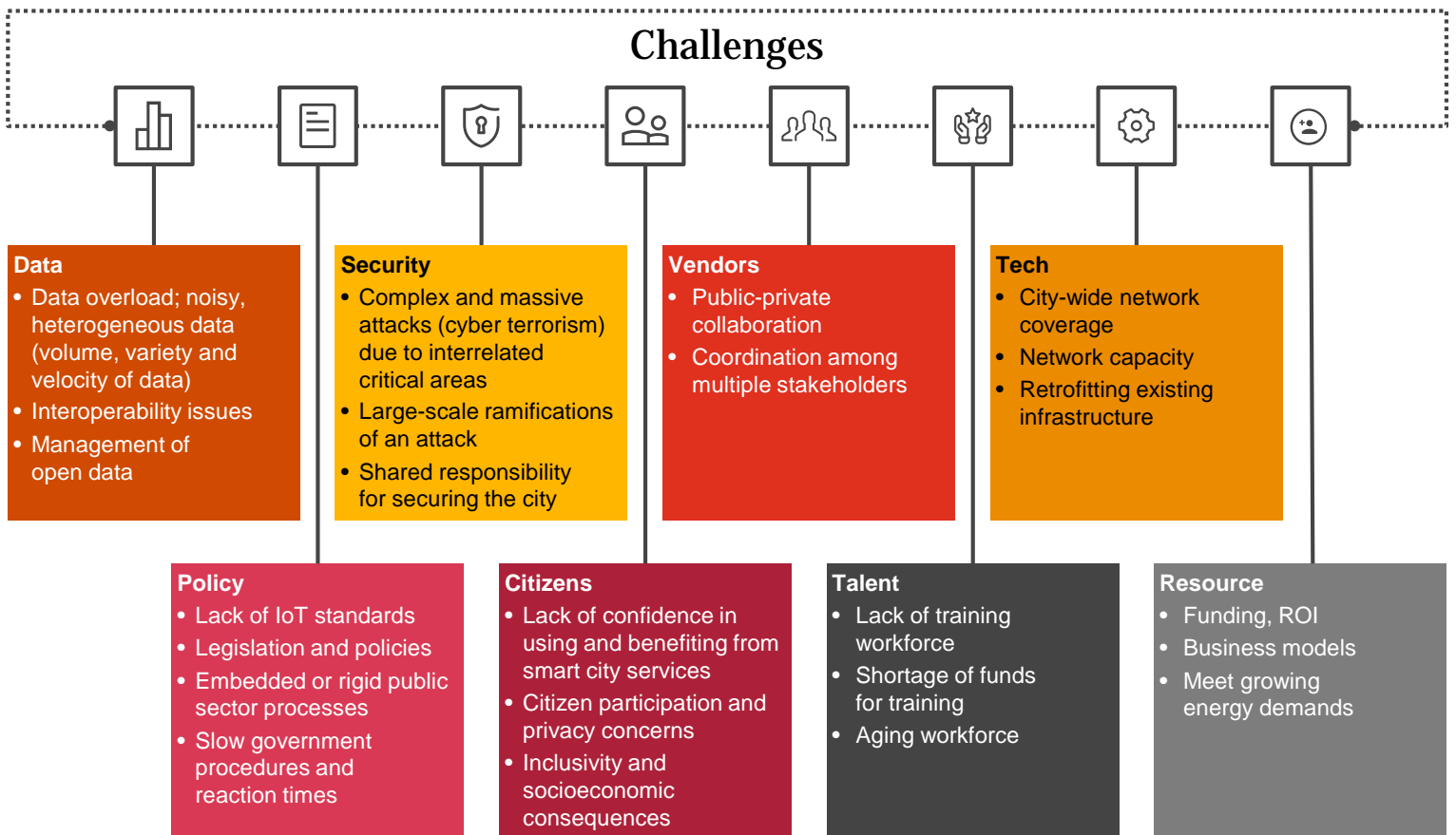


A three-tier development model

Whatever the technology initiatives being undertaken, smart cities are pioneering developments leading our urban environments into new and uncharted territory – meaning they inevitably face a number of challenges. The most prominent of these hurdles are set out in Figure 5. While these challenges can be seen to some degree in all markets globally, their nature and relative importance vary in different territories, reflecting a vast range of factors – technological, infrastructural, political, social, economic and more. As smart cities progress and develop, our three-tier model provides an ideal framework for addressing these challenges while simultaneously opening up new commercial and service opportunities.



Figure 5
Challenges in smart city implementation



Source: PwC analysis, Technavio, Cisco, ITU, IEEE, Smart Cities Dive, GreenBiz



Physical/digital integration in public infrastructure

As the three-tier continuum becomes more established, it's supporting a related trend that's emerging in city infrastructure developments of many types: the tendency for developers to integrate "smart" city elements into large-scale public infrastructure programs. In parallel, we're also seeing the same trend in residential and commercial development, supporting the availability of an ever broader range of Internet of Things (IoT) services to create unique, user-centric experiences in the home, in the office or on the street, while also improving efficiency and sustainability of these communities.

There are many instances of this blending of physical and digital: in the US alone, current examples include the integration of "smart city" elements into large-scale developments including sports stadia, art spaces, seaports and leisure developments. In each case, the developers have identified and positioned "smart" as a defining element of the experience for the consumers, residents or businesses using the asset.

To date, physical/digital convergence in public infrastructure has tended to take place mainly in parallel with what cities themselves are trying to do, rather than as part of public-private projects. However, this is starting to change, as the public sector becomes more involved in these forward-looking programs. It's also worth noting that private sector developers can fulfill a useful function as accelerators and laboratories for new types of smart environments. In playing this role, they're helped by the fact that they're often building on greenfield sites, and can sometimes move faster than public sector entities. The experience that the private sector gains on these projects can be fed into future public-private programs.



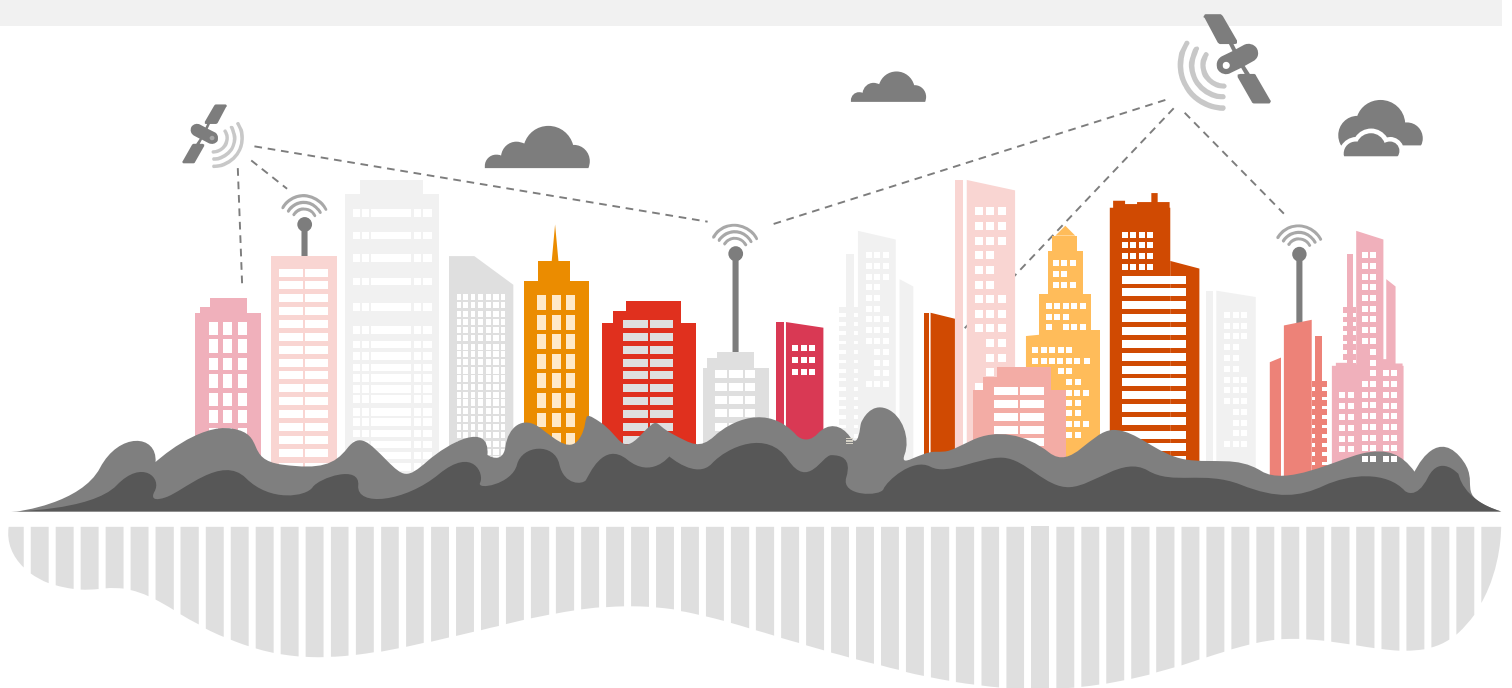


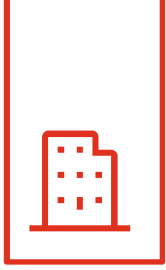
“Smart” maturity is growing among cities worldwide

Looking across the globe, cities vary widely in their readiness and ability to seize the opportunities presented by smart city innovations and investments. Driven partly by a push via public funding, and partly by an increasingly urgent need springing from headlong urbanization, cities in Asia have been among the leaders, taking a proactive and progressive approach to developing smart infrastructure and services. Meanwhile, Europe is pushing through with many smart city investments, often including environmentally friendly elements such as green energy, again with involvement from public funding. Smart city developments in the US are – in some cases – more private-sector driven.

That said, there are many exceptions: in every territory and continent, there are cities with outstanding and highly committed chief information officers (CIOs) and chief technology officers (CTOs) leading the way with the full backing of their mayors, driving the development of the digital environment top-down. In terms of services for citizens, these cities are pulling away from the less digitally mature and more disjointed city administrations that are taking piecemeal, reactive steps, and which may face a struggle to catch up in the years to come.

Ranged around both categories of city are myriad private sector developers and technology providers eager to collaborate with city authorities and tap into the opportunities that smart city services present. What’s clear is that these opportunities are growing for all stakeholders – cities themselves, developers, and the citizens who ultimately use the resulting services. To measure and benchmark city planners’ ability to organize, plan and integrate digitally enabled services, many smart city maturity models have been created in recent years. What’s different about our “three-tier” approach is that it looks more holistically at how the underlying market is developing, rather than simply focusing on specific service areas. Whatever a city’s current position on today’s maturity curve, we believe that our three-tier continuum can help it to map out the optimal route ahead.





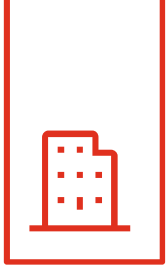
The way forward for government and private sector

So, given the evolving landscape we've described, what should city authorities and private sector technology providers, financiers and developers be doing today to reap the biggest benefits from the three-tier continuum of smart city development?

As innovation will continue to generate new services and solutions, it follows that government and businesses will need to be agile and adaptable in their relationship. It is important that these solutions deliver the fullest possible value to citizens, government and business alike – and deliver this value not just in the present, but for the foreseeable future as well. This shifting environment points to a clear set of characteristics that governments and businesses will need if they're to navigate through this new world while avoiding the pitfalls. To do this, both sides will also have to ask themselves some searching questions.

Some key questions for government to consider:

- As you envision and build your digital smart city platform, what foreseeable additional solutions or services could be built on it?
- How can you assess that citizens are getting best value from both current and anticipated future solutions and services?
- What are the development and monetization rights of the government, the current contractor or third parties with respect to these “add-on” services/solutions?
- Is your current contracting structure limiting the potential for innovation on the digital platform, or creating a protected market for the private sector contractor?
- How can you build a permitting and regulatory framework that facilitates smart infrastructure deployment?
- What considerations around IP and data rights, data security, interoperability and privacy protection arise, related not only to the contracted services but for future potential services on the platform, including private-to-private transactions?
- How might regulatory changes impact these data rights and privacy protections?
- What formulas for sharing revenues and risks should you be considering for tier-two and tier-three services and solutions, and do you have the contracting know-how to secure these?
- How will you manage changes in technology and services under these contracting arrangements?
- How can you ensure the ability to exit from arrangements without incurring undue penalties or disrupting the ecosystem?



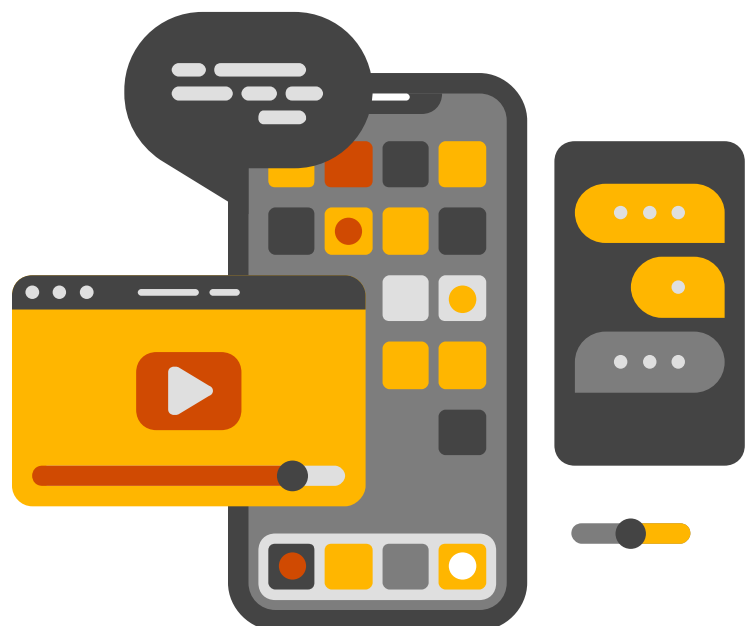
The way forward for government and private sector

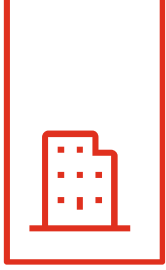
Government has arguably the most important part to play: if successful, it can spur an innovation ecosystem around its smart cities, generating not only world-class services for citizens but also significant new revenue streams. Viewed at its most basic level, government's involvement in smart city projects involves three, sometimes overlapping, roles: as purchaser of services from the private sector; as co-investor/co-participant with the private sector in smart city solutions; and as regulator and protector of the public interest, both overseeing and facilitating smart infrastructure – including aspects such as the permitting/regulatory environment, tax increment financing (TIF) and other economic incentives.

In cases where cities have already developed an overall blueprint for smart technology development and deployment, and have considered the implications of creating a digital ecosystem, government's roles and responsibilities may be easier to identify and implement. But many – arguably most – cities are still in the process of creating such a masterplan while also deploying and contracting for new technologies. In these cases, it's particularly useful to bear in mind the three fundamental roles of government mentioned above.

Fulfilling these multiple roles while getting the dynamics right requires flexibility and know-how on the part of government officials, and coordination both across government bodies and throughout all layers of the smart city value chain. Governments that achieve this can generate powerful results – as demonstrated by the dramatic advances in India, supported by the national government's [Smart Cities Mission](#).

Alongside its core roles, a further important function for government as smart cities evolve is around data integration. City governments are in the ideal position to pull together and integrate government, private (industrial, utility, corporate, community) and citizen data to generate the greatest possible mutual benefits. Their fitness for this role is strengthened by the trust that citizens commonly feel in their local city government, as representatives and protectors of their interests. At the same time, governments have duty of care around privacy and data security, which must be maintained and strengthened.





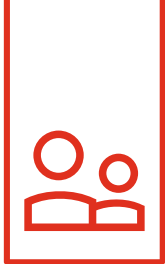
The way forward for government and private sector

Meanwhile, **private companies** across many sectors are energized by the opportunities created by smart city initiatives – but are often still getting their minds, procedures and practices around how to "sell with" as well as "sell to" governments. Most companies are accustomed to the traditional contracting model of bidding on a city contract, winning the work, and delivering the service – essentially tier one of the evolution described above.

While that model still dominates, efforts are under way on both the public and private sector sides to drive forward to tier two and ultimately tier three. For example, companies are increasingly being asked to engage in true public-private partnerships – sharing revenues, intellectual property and risks with governments – with citizens reaping very real benefits. To realize the full opportunities from these partnerships – and truly capitalize on the potential of tier two and tier three – companies need to think creatively and engage with governments in new and more collaborative ways. For those that do so, the smart city-enabled future is bright.

Some key questions for private sector technology and solution providers to consider:

- How can you develop and present technology solutions to government that meet current needs while also offering downstream potential for new solutions and services, without over-complicating the initial proposal?
- How can you enter into contracts that enable you (or third parties) to innovate, develop and deliver new services and solutions based on already-installed technology – and how will you monetize that capability while giving government the latitude it needs to create open markets?
- How can you educate government on the financing, risk and reward scenarios inherent in new technology solutions and services, and share both risks and rewards equitably with government?
- How can you engage early with potential third party participants in this digital ecosystem and secure their participation in the framework of government-invested service/technology solutions?
- How can you foster engagement with citizens to secure their buy-in for smart city development and its benefits for a new "citizen experience"?



A call to action: Time to map out the route together

With the progression towards smart cities gaining momentum worldwide, both the public and private sectors are still learning – and are developing their approaches accordingly. As we've noted, different cities are at very different stages of maturity in their smart city aspirations and actions. However, for both public and private sector organizations, we think that understanding and embracing the three-tier continuum can help them set the right direction of travel and accelerate their progress along the journey.

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