Hype Cycle for Smart City and Sustainability in China, 2021

Published 9 July 2021 - ID G00747462 - 107 min read

By Analyst(s): Milly Xiang, Uko Tian, Kevin Ji

Initiatives: Government Digital Transformation and Innovation

Smart city initiatives form an important part of the Chinese government's aim for sustainable economic and social development. This research helps local governments and technology providers assess emerging technologies and solutions to achieve digital society and sustainability outcomes.

Additional Perspectives

- Summary Translation + Localization: Hype Cycle for Smart City and Sustainability in China, 2021
  (03 August 2021)

Analysis

What You Need to Know

China's most important annual political meetings, commonly known as "Two Sessions," set the national socioeconomic and political priorities for 2021. It also approved China's 14th Five-Year Plan (FYP) (2021 through 2025), the strategic blueprint for the next half decade, as well as longer-term goals for 2035.

The Two Sessions provided a critical bellwether for taking stock of how Chinese central and local governments intend to steer the smart city development in the years through 2025 and beyond. There are two key themes closely relevant to smart city development:

- People's well-being — achieving "common prosperity" through new urbanization and rural revitalization strategies.
- Green development — accelerating the drive toward a low-carbon economy to help achieve the 2030 and 2060 climate goals

These trends are critical factors to frame the key themes and changes of the technological innovations in this year's Hype Cycle for Smart City and Sustainability in China.

The Hype Cycle

This Hype Cycle is designed to help CIOs in government and the urban ecosystem evaluate emerging trends and technologies in terms of their maturity and impact on smart city and sustainability initiatives. It provides guidance in terms of technology and standardization risk, privacy, and data orchestration to support their implementation roadmap. Government officials can also use this as a reference to set technology, artificial intelligence (AI) and data policy to provide smart city governance for scale and adoption of intelligent urban ecosystem services.

The smart city and sustainability in China are experiencing an increasing level of technological innovations that are critical to:

- Supporting sustainability initiatives, such as heavy-duty EV charging, environment monitoring and management

- Enabling effective and contextualized services and improving people's well-being through optimizing city infrastructures and government processes. They are natural language technologies for government, intelligent street pole, underground infrastructure management, and smart city transportation strategy.

All these are in addition to the existing Hype Cycle entries that we are tracking, which are categorized into four groups:

- Fundamental enabling technologies of smart cities, including government cloud and open government data, computer vision in smart cities, IoT in smart cities, and blockchain in government, quickly maturing around the trough.
- City infrastructure and government services such as intelligent connected infrastructure, smart building, smart Parking, smart lighting, intelligent street pole, advanced metering infrastructure, citizen Twin, and digital twins of government. These technologies are demonstrating different maturity levels, but all are moving steadily toward the next level of maturity.
- Sustainability initiatives including urban waste management, food safety and traceability, water management analytics, energy-water nexus, and sustainability and COP 21, slow in maturing due to the complexity of different stakeholders involved and the lack of orchestrated efforts.
- Other hot topics such as data and analytics for good privacy in China and more.

Meanwhile, we replaced cybersecurity with CPS security to reflect the increasing convergence of IT, operational technology, IoT and physical assets, which drives demands for capabilities aligning to security and safety requirements in cities.

In addition, we removed the following technologies from the Hype Cycle:

- Mobility as a service, which is combined into smart city transportation strategy
- New-type smart city framework, as smart city is merged as part of government digital business platform
- Digital government, as this is a bigger concept than smart cities

With this combination, Gartner believes the Hype Cycle better addresses the audience's interests and provides a more comprehensive view of the technologies specific to the Chinese market.

Figure 1: Hype Cycle for Smart City and Sustainability in China, 2021

Source: Gartner

Downloadable graphic: Hype Cycle for Smart City and Sustainability in China, 2021

The Priority Matrix

The smart city experiences a variety of pressures related to sustainability and climate change concerns and associated use cases that can be supported through a broad array of technologies. Most of these technologies are between two and 10 years from mainstream adoption. The following Hype Cycle entries are introducing transformational benefits to cities:

- Computer vision in smart cities brings transformational benefits within five years, driven by surveillance with facial recognition and behavior analysis for public safety and number plate recognition for parking and traffic monitoring. The role it has played in support of combatting COVID-19 has been widely recognized in disease diagnosis, prognosis, prevention, control, treatment and management.
- The IoT in smart cities is expected to mature in two to five years, to transform the way city planners and government organizations monitor and visualize city infrastructure and environment to support data-driven decision making.
- Smart building, as well as sustainability and COP 21, are transformational strategies whose technology solutions are expected to mature in a five-to-10-year time frame. These solutions offer high risk-reward benefits and require careful planning and prioritization as governments exploit the potential benefits that these technologies can bring.

A large proportion of Hype Cycle entries will see high benefit:

- Smart lighting will reach the mainstream within two years, bringing high benefits to adopters, given that the basic features for energy-saving purposes are advancing rapidly to become well-established technology.
- The Hype Cycle entries that will witness mainstream adoption in two to 10 years include:
  - 5G (in China)
  - Advanced metering infrastructure
  - Environment monitoring and management
  - Government cloud in China
  - Privacy in China
  - Smart parking
  - Urban waste management
  - Water management analytics

- Some technologies are composites and consist of multiple elements or systems of systems, which require a big collaborative effort across different government departments and industry sectors, as well as interoperabiltiy and standardization. The complexity brings uncertainty to technology adoption speed. The Hype Cycle entries that will take more than five to 10 years to reach mainstream adoption include:
  - Blockchain in government — China
  - Citizen twin
  - Digital twins of government
  - EV and charging infrastructure
  - Food safety and traceability
  - Heavy-duty EV charging
  - Intelligent street pole
  - Natural language technologies for government
  - Open government data
  - Smart city transportation strategy
  - Underground infrastructure management

CPS security has high benefits but will not see mainstream adoption for more than 10 years, since it takes time to improve uneven security and risk management practices in China.

Table 1: Priority Matrix for Smart City and Sustainability in China, 2021

(Enlarged table in Appendix)

Benefit	*Years to Mainstream Adoption*			
	Less Than 2 Years	*2 - 5 Years*	*5 - 10 Years*	*More Than 10 Years*
Transformational		Computer Vision in Smart Cities IoT in Smart Cities	Smart Building Sustainability and COP 21	
High	Smart Lighting	5G Advanced Metering Infrastructure Environment Monitoring and Management Government Cloud in China Privacy in China Smart Parking Urban Waste Management Water Management Analytics	Blockchain in Government — China Citizen Twin Digital Twins of Government EV and Charging Infrastructure Food Safety and Traceability Heavy-Duty EV Charging Intelligent Connected Infrastructure Intelligent Street Pole Natural Language Technologies for Government Open Government Data Smart City Transportation Strategy Underground Infrastructure Management	CPS Security
Moderate		Data and Analytics for Good	Energy-Water Nexus	
Low				

Source: Gartner (July 2021)

On the Rise

Intelligent Connected Infrastructure

Analysis By: Venecia Liu, Ivar Berntz

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Embryonic

Definition:

Intelligent connected infrastructure (ICI) is an integrated mesh of technologies to enable the transportation infrastructure to exchange data with surrounding entities, such as vehicles, technicians and equipment. The mesh is made up of elements such as AI, IoT, cloud, analytics, edge computing, telecommunications and autonomous technologies. The transportation infrastructure can include ports, bridges, roads, airports and airways, and highways.

Why This Is Important

CIOs can use ICI as a technology vision roadmap for how technologies can be used in combination to further improve business operations and impact the business. ICI also provides a mechanism for how data assets can be linked to other data assets.

ICI could help achieve better safety, less congestion, shorter wait times and better asset utilization.

Business Impact

Benefits of ICI can improve traffic flows, safety, infrastructure maintenance and notification of asset conditions to avoid hazardous conditions, accidents and roadblocks. Smart ports would benefit from ICI in optimizing operations and improving terminal management by communicating with cranes, rails, port authorities and trucks. Smart airports would benefit from an increased capacity enabled through better orchestration and coordination of members in the airport ecosystem.

Drivers

- Stand-alone technologies such as IoT or AI have provided some benefit to the transportation industry. However, a force multiplier can be achieved when technologies come together to communicate and exchange data to provide combined insights and to empower decision making to execution.
- ICI combines diverse data sources to provide a more holistic view. ICI can also improve asset utilization.
- Asset-intensive industries have been using sensors to track assets and predict maintenance failures. With ICI, they can further impact the business by taking the data and communicating it to other business operations, sharing it with external partners or leveraging the insight to communicate relevant information to passengers.
- Transportation CIOs are pressured to do more with less, and the advantages of ICI inspire methods for how asset data can be further applied to other business scenarios to become data-driven.

Example ICI use cases include:

- Notifying drivers about different road conditions (such as ice or obstacles)
- Monitoring vehicles going into, or currently inside, tunnels, parking lots, facilities, and restricted-access areas and roads to organize assistance or evacuation in case of fire or accidents
- Orchestrating cargo prioritization at the port yard for rail and trucks
- Pulling in diverse data points from ground operations to air traffic control and airlines to decrease airplane gate turnaround time

Obstacles

- ICI is still an emerging area, since it requires digital mesh orchestration and collaboration to be realized across the transportation infrastructure and across various technology touchpoints and entities in the ecosystem.
- The investment to tie all the technologies together is challenging, and it requires coordination by different entities with different reporting structures and goals.

- The risk level is high. New technologies offer new possibilities, but also come with unknown risks. For example, absence of standards and immature technologies can lead to unintended consequences and can facilitate hacking. These will need to be considered in the design, development, implementation and operation of resilient ICI components.

User Recommendations

CIOs seeking to advise COOs and operations managers on how to optimize operations should consider the following:

- Identify stakeholders in your ecosystem who could benefit from better data insight, such as truck drivers waiting for unloaded cargo, pilots, tugboats, crane operators, rail cargo, shipyard equipment, shippers and emergency services.
- Assess existing data sources, and identify areas where data collection (such as maintenance, planning, forecasting, safety and traffic flow) can impact other business operations.
- Build a technology roadmap with this ICI vision to ensure edge computing or 5G implementations can be leveraged in multiple ways as a data exchange to multiple stakeholders.

Sample Vendors

Alibaba Cloud; Bosch Group; Cisco; Ford Motor; Huawei; IBM; Mercedes-Benz; Qualcomm; Rolls-Royce Motor Cars; Siemens

Gartner Recommended Reading

Market Guide for Vehicle Routing and Scheduling

Market Insight: Roadmap for V2X Technologies for Autonomous Driving — When to Invest

Hype Cycle for the Internet of Things, 2020

Hype Cycle for the Future of CSP Networks Infrastructure, 2020

Hype Cycle for Connected Vehicles and Smart Mobility, 2020

Market Trends: Monetizing Connected and Autonomous Vehicle Data

CPS Security

Analysis By: Katell Thielemann, Sandy Shen, Jie Zhang

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Cyber-Physical Systems (CPS) are engineered systems that orchestrate sensing, computation, control, networking and analytics to interact with the physical world (including humans). When secure, they enable safe, real-time, reliable, resilient and adaptable performance. CPS security addresses software, hardware, network and data protection for vendors bringing CPS solutions to market, as well as end users using them.

Why This Is Important

Deployed in smart cities, smart grids or autonomous vehicles, CPS also underpin smart manufacturing and technology deployments under the OT, IIoT and IoT umbrellas. They represent the merging of physical and digital systems to connect people, data and processes. Unfortunately, “first to market” often takes precedence over “security by design,” and CPS are increasingly targeted by hackers seeking to reap maximum gain by stealing data or to inflict maximum pain by impacting operations — or both.

Business Impact

Unlike enterprise IT systems that mainly transact data, CPS connect both the cyber and the physical worlds, and are usually deployed in operational or mission-critical environments. This means that CPS security efforts need to focus on human safety and operational resilience above and beyond traditional information-centric security efforts, as the impact of an incident could be felt both in the real world and on an organization’s bottom line, mission or the public at large.

Drivers

- Rapidly increasing initiatives from governments and companies alike in domains ranging from smart cities, to utilities, healthcare, food, agriculture, public safety or transportation makes focusing on CPS security a pressing need.
- CPS transforms these domains by orchestrating data flows between previously disconnected systems, automating unstructured processes, shortening production cycle times, improving product and service quality, or promoting real-time information gathering and processing.
- Since CPS connect both cyber and physical worlds, security efforts are particularly critical in production and operational-centric industries. As risks extend to the physical world, concerns over physical perimeter breaches, jamming, hacking, spoofing, tampering, command intrusion or malware implanted in physical assets also need to be addressed above and beyond cybersecurity.
- In 2020 there has been a marked increase in attacks moving from enterprise IT systems, to impact operations and production environments in manufacturing and critical infrastructure. Because these areas are where value is usually created, CPS will continue to be targeted.
- The consequences of a successful attack on CPS go beyond cybersecurity-centric data loss, to include operational shutdowns, environmental impacts, damage and destruction of property and equipment or even personal and public safety risks in the case of smart city efforts.
- Some countries such as China are leading in the deployment of AI and IoT sensors technologies that involve large amounts of personal and business data and represent an uncharted risk territory. Citizens, customers and partners expect organizations to take good custody of their data. This creates privacy concerns, and CPS security solutions are needed to ensure the data is well-protected or of little/no use when/if exposed.

Obstacles

- CPS are often deployed by business units without consultation with the security team.
- Most organizations still focus mainly on IT security-centric risk management.
- Due to the emerging nature of CPS, security tools and vendors are still emerging and not as well-established as those for IT security.
- Most organizations are still in the awareness phase when it comes to CPS security, and their security and risk management strategies are only forming, starting with asset discovery.
- Lack of collaboration across siloed teams running systems such as IT, OT and IoT hamper CPS security efforts that require cross-functional collaboration.
- Security disciplines (cybersecurity, physical security and supply chain security) are also usually functionally siloed, whereas effective CPS risk management mandates their convergence.
- Many organizations don't have structured security programs or skills that sufficiently cover the scope of CPS especially for those high-value/mission-critical assets.

User Recommendations

- Educate business executives of the importance of CPS security to digital business initiatives.
- Discover all connected assets in the organization's environment, whether born out of information technology/operational technology (IT/OT) convergence or new Internet of Things (IoT)/industrial Internet of Things (IIoT)/smart "x" programs.
- Evaluate which CPS assets are high-value or mission-critical, identify specific CPS security controls already in place, and determine whether any gaps need to be prioritized based on potential organizational impact.
- Create an investment plan to update security and risk management strategies and programs in relation to CPS, starting with those high-value and mission-critical assets.
- Engage functional business leaders to define domain-specific controls for CPS to balance between growing the business and improving security.

Sample Vendors

Darktrace; FORT Robotics; LOCH; Sepio Systems; Viakoo; Xage

Gartner Recommended Reading

Focus More on the Realities of Cyber-Physical Systems Security Than on the Concepts of IoT

Commercial IoT Use Case: Accelerate IoT-Enabled Physical Security Adoption

How Cyber-Physical Systems Impact Organizational Risks

Smart Building

Analysis By: Gavin Tay, Rashmi Kotipalli

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A smart building is a facility where multiple functions cooperate to achieve sustainable outcomes. Such outcomes include automation, efficiency, experience, sustainability and security through the analysis of contextual and real-time information, shared among Internet of Things (IoT), information and communication technology (ICT), and operational technology (OT) systems.

Why This Is Important

Much of what has made a building “smart” (mostly operational efficiency) has been heavily reliant on building management systems (BMSs). Due to the legacy nature of how BMSs are implemented, adoption rates are fairly slow. Hardware for HVAC and lighting implemented with new construction has a lifetime of 10 to 20 years. System failure retrofits are now more regular postpandemic, with stringent standards of safe management accelerating the importance of experience, well-being and safety.

Business Impact

- Optimize building performance and improve predictive and preventive maintenance by learning real-time human preferences based on activities, emotions and reactions. Smart buildings respond to change, resulting in healthy, delighted and productive occupants.
- Insights come from multiple sources of information further calibrated by understanding occupant journeys. Formulating such holistic solutions will stretch alignment of cross-functional teams to address work-life ambience and sustainability.

Drivers

- Postpandemic, much of what real estate and facilities managers have to deal with when managing a building will involve the CIO or their ICT counterparts. Today, the operating elements of a smart building typically include space, environment and maintenance management, along with wellness, energy management and sustainability. Such rapid evolution of smart buildings means that facilities and real estate professionals will want to leverage the ICT expertise that is part of the CIO portfolio.
- Integration will be a key component, and it remains difficult for data residing in various custom-made BMS repositories to interact with one another. The demands and expectations of workers are shifting from merely going to an office that has good air, temperature and now hygiene to a place where they have work-life ambience. As this shifts, a smart building experience requires the exploitation of an ever-growing number of IoT business solutions.
- IoT and AI have the potential to speed up the implementation of more IT into the BMS space by extending and augmenting existing equipment. Depending on the age of the equipment, BMS software companies can often tap into the data stream or APIs. If the system is older, it is possible for sensors to be economically placed on boilers, chillers, air conditioning units and other hardware to enable real-time monitoring of legacy equipment. Wireless connectivity can reduce the installation overhead of this retrofit. Cost savings that can be achieved by integrating the sensors with BMS software could help to accelerate the adoption of integrated BMS in older buildings. In some cases, it might be more economical to upgrade rather than adapt to an older system.

Obstacles

- CIOs assembling smart buildings with IoT business solutions must possess two qualities: a clear vision of the architectural building blocks comprising the IoT platform, and an understanding of the privacy and data security implications. Delivering digital experience, given limited exposure to governing moving parts and the flow of activities in smart buildings, can be diverse and complex. CIOs must become accustomed to managing the complexity of a multivendor IoT landscape and technology architecture.

- By 2028, Gartner estimates over four billion intelligently connected IoT devices in commercial smart buildings. CIOs will struggle with provisioning them, managing them, connecting to them and analyzing their data.

- There will be no dominant IoT platform in any smart building, so CIOs must compose end-to-end IoT solutions from multiple providers.

- Coordinating varied expectations, use cases and budgets from different stakeholders such as facilities, HR and security adds to existing complexity.

User Recommendations

- Recover energy inefficiencies by using real-time data from the IoT and IT infrastructure to enable communication between the different BMS in a building. According to ENERGY STAR, average buildings waste 30% of their energy through inefficiencies in lighting, heating and cooling areas that are not occupied.

- Leverage the significance of IoT to build holistic, engaging experiences while increasing building efficiency and competitiveness.

- Opt for flexible payment methods instead of treating such investments as a capital liability. Channel savings obtained from building efficiencies to the repayment of these solutions or services make it an operating expense instead (e.g., energy management contracts).

- Alleviate the potential business and technical challenges of creating a piecemeal smart building. Gartner predicts by 2022, IoT will save consumers and businesses $1 trillion a year in maintenance, services and consumables.

Sample Vendors

Eutech Cybernetic; GE; Honeywell Forge; Intel; Johnson Controls; Schneider Electric; Siemens; Signify; Spacewell; Terminus

Gartner Recommended Reading

Pivot Your Smart Building Value Proposition to Address the New Normal

Competitive Landscape: IoT-Enabled Smart Building Management Platforms

Emerging Technology Analysis: Smart Spaces

Emerging Technologies and Trends Impact Radar: Internet of Things

Emerging Technologies and Trends Impact Radar: Artificial Intelligence

Citizen Twin

Analysis By: Alfonso Velosa

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

A digital twin of a citizen is a digital representation of an individual. National, state and local governments use citizen twins to support citizen services such as health or safety management. The citizen twin core elements are the model, data, a unique one-to-one association, and ability to monitor it. It integrates data into the twin from siloed sources such as health records, credit scores, phone location logs, criminal records, customer 360 records and infrastructure such as cameras.

Why This Is Important

Governments are developing digital twins of citizens to monitor the environment citizens live in and address health, safety, travel and social media impacts on society. The spectrum of complexity of the models and tools can help governments make better decisions for monitoring and supporting patients, prisoners, passengers or the elderly. Some governments, such as China's, are building a scoring methodology. Aggregated citizen twins can help map broad patterns and drive resource allocation.

Business Impact

- Governments will use digital twins to better orchestrate citizen services and other digital services, and even manage crises, such as pandemic protection.
- Aggregate data can help citizens access and expedite government services
- Citizens or governments can drive citizen-twin-based crowdsourcing sentiment analysis to assess government services in near to real time.
- Integrate government services to other systems including the Chinese social credit systems and shopper tracking solutions.

Drivers

- Proliferation of both structured and close-to-structured data on creating digital citizen journey maps.
- Increased integration of government, financial and commercial systems and interest in creating citizen 360 models.
- Citizen interest in systems that help drive their health and safety, such as vaccination passports or solutions to monitor elderly patients using IoT-enabled trackers.
- An increased desire for personalized services from government and other organizations.
- The need to implement proactive services, such as healthcare, mental health, fraud detection, and so forth, with a particular driver for government services for COVID-19 pandemic responses.
- Investment by a broad range of law enforcement, justice and corrections authorities, for example for smart camera monitoring systems that track to a specific police officer, or inmate tracking solutions under home arrest.
- The flexibility of digital twin models from simple to complex models, and the ability to integrate data from siloed services enable governments agencies to build out citizen services both in aggregate as well as servicing individuals.
- The need for both real-time services customized to citizens, for example for emergency medical services, and longer term, more complex solutions that serve elderly patients or inmates.

Obstacles

- Strong concern for privacy and the merits of government access to citizen data is leading to grassroots citizen pushback or government regulations such as the EU Privacy Directive or California Consumer Privacy Act (CCPA) to limit access to citizen data.
- Cost and scope slither without clear benefits to citizens or government agencies, as government bureaucracies increase the types and quantity of data collection.
- Government curation of aggregated citizen data creating a security risk for government data and a potential privacy and safety risk for the individual citizen.
- Conflicting government agencies' objectives, political infighting on data rights, and incompatible regulation on the use of citizen data, and on how to respect rights to privacy.
- Incompatible systems across different government, financial, commercial and healthcare silos driving exorbitant costs for integration, analytics and visualization.
- Lack of skills in the government agencies to drive the use of the citizen twin.

User Recommendations

- Build robust privacy and digital ethics policies that clarify what data is collected, who has access to it, how it is protected, and what citizen remediation actions exist or comply with existing remediation processes.
- Establish clear benefits to citizens such as certifying all passengers on an airplane or train are healthy or vaccinated, simplifying medical triage to get a citizen to medical care, or aligning toll payments to a citizen's car for use of a toll road or during city congestion fees.
- Test IoT sensor and analytics capability to ensure accuracy and validity for the physical part of a citizen digital twin.
- Invest in integration skills to connect into a heterogeneous set of applications and data sources.
- Build data exchanges to protect data, while enhancing the granularity of citizen data support personalized and contextualized citizens services through the government ecosystem.

Sample Vendors

Alibaba Cloud; Apple; Google; Tencent; Vantiq

Gartner Recommended Reading

Getting Started With a Digital Twin of Government

Top 10 Plausible Directions Resulting from COVID-19

Top Trends in Government for 2021: Hyperconnected Public Services

Top Trends in Government for 2021: Data Sharing as a Program

Top Trends in Government for 2021: Multichannel Citizen Engagement

Digital Twins of Government

Analysis By: Bill Finnerty, Milly Xiang

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A digital twin of government is a virtual representation of government and partner assets, people and operations to provide real-time analysis, operations automation and scenario-based planning. Key features include a single point of visualization and access to supporting data, APIs for issuing commands to things and processes, and the ability to execute scenario planning and urban modeling. A mature digital twin of government is a system of systems, requiring strong integration capabilities.

Why This Is Important

Having a single view of the multiple, interdependent systems that impact the operations of a jurisdiction has long been a struggle for governments. Digital twins of government address this challenge, providing a single interface to the operations of a jurisdiction, and are starting to be used by governments around the globe. Many digital twins of government often start as GIS models; a fully realized future state will:

- Include command-and-control capabilities
- Drive scenario planning at scale

Business Impact

- In the short term, governments need to identify a focused business use case for piloting a digital twin of government.
- In the midterm, governments will leverage digital twins for command and control of operations, frequently enabling greater automation.
- Over time, digital twins will be used to model and test scenarios related to policy, legislation, and infrastructure rollout and changes.

Drivers

- There are three drivers to the increased adoption of digital twins of government. The first driver is advances in vendor solutions, including both advances in technology and the number of vendors providing solutions. The second driver is progress on government programs intended to establish national standards and adoption of digital twins. The third driver is the growing application of digital twins to real-world problems, providing a research base on which to justify future investments.
- In addition to a larger number of vendors entering the market for digital twins of the built-world, many providers are expanding their capabilities. These vendors are increasingly including easier, low-code integration to IoT datasets; integration with indoor GIS, BIM and computer-aided drafting solutions; and inclusion or extension to AI and ML capabilities.
- Progress on governmental standards in Australia, China, the U.K. and other countries is establishing national working groups and standards for digital twins of the built world, including those used for government. These programs are further advancing the interoperability of digital twins of government, an essential component of their future use across jurisdictions.

- The number continues to grow of prominent digital twins of government being developed, used to solve problems and integrated with other capabilities, such as data marketplaces. They provide examples and inspiration for other governments to consider developing a twin. They include Virtual Singapore, New South Wales government's Spatial Digital Twin, Shanghai's digital twin, the Dutch government's digital twin of The Hague, Helsinki's Kalasatama Digital Twin and Boston's digital twin of the city.

Obstacles

A number of challenges to digital twins of government may impede their implementation and growth:

- Foundationally, they are integrated systems that will span the silos of government, and silos are an ongoing challenge for governments. This requires both coordination on data standards and integration capabilities.
- In many jurisdictions, expectations of digital twins of government are high. However, sustaining interest, budget and business unit participation in developing a digital twin of government will require focus over multiple administrations.
- CIOs planning for digital twins of government will need to address fundamental questions of any emerging technology — privacy, ethics and business value. This will ensure that the question asked is not, "Can we do this?" but, "Should we do this?"
- The skills to develop digital twins are limited in most markets. Thus, governments will need to compete with other entities for the available talent.

User Recommendations

CIOs leading the development of a digital twin of government:

- Engage elected officials and program leaders in defining the vision in business terms to maximize understanding and buy-in.
- Use future planning exercises (that is, scenario planning) to develop use cases that can demonstrate the "art of the possible" and prioritize investments.
- Establish a guiding principle to protect citizen data by implementing privacy controls and end-to-end encryption.

- Make a digital manifestation of a single aspect, particularly in early states. The digital twins of government need not be a complete clone of the jurisdiction. For instance, transportation-related digital twins have been created for rail stations in China and for city mobility in Colombia.
- Access relevant solutions that could support your vision, based on their ability to integrate with existing systems, use of nonproprietary data standards, ability to scale using cloud services and vendor technology roadmaps.

Sample Vendors

Cityzenith; Esri; Estudios GIS; Eutech Cybernetic; IBM; Idrica; OSIsoft; Worldsensing

Gartner Recommended Reading

What to Expect When You're Expecting Digital Twins

Governments Are Developing a Unique Kind of Digital Twin

Getting Started With a Digital Twin of Government

Use 4 Building Blocks for Successful Digital Twin Design

Heavy-Duty EV Charging

Analysis By: Pedro Pacheco

Benefit Rating: High

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

This pertains to technology used to efficiently charge heavy-duty electric vehicles, including buses, trucks and electric ships, in a way that allows those to perform with a high degree of operational efficiency, i.e., limiting vehicle charging time and maximizing operation time.

Why This Is Important

Regulations across several markets like Europe, China and California will boost adoption of electric buses and trucks. For instance, the EU will mandate a CO2 tailpipe emission cut of 30% by 2030 (in comparison to 2019 levels). However, using large EVs for long distances is not practical without a dense fast-charge infrastructure. This caveat makes these vehicles commercially nonviable for long-distance traveling.

Business Impact

For heavy-duty OEMs in areas like Europe, it will be essential to have a dense network of purpose-made EV chargers; electric trucks and buses will not reach mass adoption without it. The Association of European Automobile Manufacturers (ACEA) has pledged to impose specific regulations prompting member states to install at least 11,000 chargers for heavy-duty vehicles every year until 2025 — up from practically zero today. As such, this clearly defines an urgent necessity for heavy-duty chargers.

Drivers

- The Paris Agreement has prompted several nations to reduce vehicle CO2 emissions through legislation. As this is already visible in passenger cars, heavy-duty vehicles are now next in line. As OEMs need to raise sales volumes of electric buses and trucks, their use in long trips is only practical when a network of dedicated fast chargers is in place across the main roads. Given that buses and trucks require a much larger battery than a passenger car, they also need higher-power chargers, reaching 2 MW and beyond. These vehicles are driven much more than a passenger car, and their profitability depends on it, so a short recharge time is even more crucial. Besides the need for a dedicated charging infrastructure, a high number of chargers is also essential. For instance, in Europe, truck stops across main road corridors are frequently packed during nights and weekends. If parking is already an issue, then imagine what this says in terms of the needed number of chargers.
- Similar drivers apply to the shipping sector, but to a lesser degree. Even though shipping produces 2.5% of global greenhouse gas emissions, regulation lags well behind road vehicles in supporting zero-emission ships.
- As road-going EV technology evolves fast, this will make it more economically feasible to adopt it in shipping — especially since electric powertrains have considerably lower operating costs. Currently, this enables a steady pace of adoption in ships like recreational boats and ferries for short sea connections.

Obstacles

- Absence of standards. There still aren't standards deployed for this type of charger. The Megawatt Charging System is currently being developed by the CharIN consortium, but is not expected to be ready prior to 2022, which means infrastructure and trucks can only be developed after that.
- Regulation. While some regions have already developed stringent legislation prompting the progressive phase-out of internal combustion engines in heavy-duty vehicles, this still doesn't happen in most of the world. This heavily conditions the need for a heavy-duty EV charging network.
- Risk aversion. Even in regions where incentives for EV charger installation are in place (like the EU), charge point operators fear a long investment payback period. The higher power of these chargers also requires upgrades to the public grid, which adds to the size of investment. The utilization rate of each charger is crucial, and these companies fear investing too early, before there are enough vehicles to justify it.

User Recommendations

- For any type of incumbent: Invest in a dedicated heavy-duty charger network only in regions adopting a strong regulatory framework that supports the electrification of this type of vehicle. Without regulation, vehicle adoption will grow slowly, which is a threat to infrastructure profitability.
- For vehicle OEMs: Take a chance to invest and build partnerships for developing a heavy-duty charging network. Infrastructure may not grow fast enough to respond to vehicle user needs. Start by investing in roads where infrastructure is needed to unlock major deals with large customers.
- For charge point operators: Overcome risk aversion. Partner with OEMs, utilities and investors to set up infrastructure. Monitor vehicle sales penetration to judge the right time to deploy infrastructure. Implement loyalty models where charging will be an enabler to profit from selling other services and products.

Gartner Recommended Reading

Guide to New Business Models in the Electric Vehicle Ecosystem

Top 10 Trends Driving the Utility Industry in 2021

Underground Infrastructure Management

Analysis By: Milly Xiang

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Underground infrastructure management refers to using digital technologies like 3D mapping, Internet of Things (IoT), augmented reality (AR) and virtual reality (VR), to visualize and monitor buried utilities and underground infrastructure in real time. The aim is to provide on-demand maintenance and avoid costly damage and accidents, via data exchange and collaboration across different owners of these infrastructure.

Why This Is Important

Underground infrastructure is essential to providing services to society, especially in congested urban areas. Lack of awareness and poor visibility of location and condition of underground infrastructure lead to:

- Higher cost and longer time for construction and maintenance
- Inefficient coordination across owners of underground assets
- Negative social impact due to congestion led by unplanned road closures
- Safety issues such as injuries and fatalities to workers and the public

Business Impact

Visualization of complex underground infrastructure can:

- Improve urban planning and decision making
- Reduce unnecessary digging to find, repair and maintain assets
- Avoid construction delays and damages of other underground assets
- Increase productivity with on-demand, event-based maintenance and repair
- Reduce safety incidents through remote monitoring and predictive maintenance

- Improve citizen satisfaction by reducing construction noise, road closures, traffic, etc.

Drivers

- The need for spatial data (both above and underground) is a key element in the design of smart cities. In particular, high-resolution, 3D data frameworks are essential components of cities' digital twin roadmaps. Hence, many initiatives to improve knowledge of location and condition of underground infrastructure are already underway, including related policies, collaborative working across public and private sectors, and innovation on enabling technologies.
- Governments are playing an increasingly critical role in locating and mapping underground infrastructure and setting up supporting policies, collaborative frameworks and launching of pilots.
- The growing recognition of the benefits of accurate mapping and data sharing of underground infrastructure by different owners and contractors accelerate momentum to create a digital twin at the municipal level.
- The growing number of startups focused on technological innovation makes cost-efficient, safe and rapid capture and processing of data more feasible, to create accurate 3D maps of the underground. These include underground detection, reality capture, augmented reality and software that can extract 3D underground information from consumer digital photos and videos, etc.

Obstacles

- The complexity and scope of underground infrastructure management prevent most cities from making such work a priority.
- The stakeholders of various underground infrastructure and assets are still focusing on the value of finished assets, rather than the entire life cycle of an infrastructure asset.
- Integration of underground infrastructure data with other city data and services is essential to generate more value but very difficult on account of different data format, standards, interfaces and platforms.
- Data sharing and coordination across multiple stakeholders are complicated by lack of documentation of the exact information on assets; varying data formats and standards across different stakeholders; and multiple versions of information captured over and over again for different projects.

User Recommendations

- Form cross-sector collaboration to combine multiple data sources, such as existing GIS, building information modeling (BIM) and IoT data, to create an initial, virtual, up-to-date map of the underground space and infrastructure.
- Build and optimize a mapping platform that combines data collection, verification and visualization based on roles in the organization and other stakeholders.
- Develop a conceptual action framework to improve underground infrastructure data interoperability, governance and exchange across multiple stakeholders.
- Research with academic partners into underground detection and modeling, emerging image capturing and surveying techniques, augmented reality, high-accuracy positioning, digital twin, etc., to digitally map, document and interact with underground infrastructure.

Data and Analytics for Good

Analysis By: Julian Sun

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

"Data and analytics (D&A) for good" is a movement in which people and organizations transcend organizational boundaries to use data and data-driven insights for a good cause. This data usage may be within a data sharing, analytics and business intelligence (BI) context or in more sophisticated data science and machine learning use cases, but the purpose is focused on social impact.

Why This Is Important

China is implementing a national big data strategy centered on strengthening the country by nurturing a digital China and smart society. Amid COVID-19, the demand for data and analytics from public sector and NGOs grew exponentially but these sectors lack data literacy and technology. As commercial organizations have both the technology and the people required to make things better for the good of society, these two groups are starting to make joint efforts to build better cities based on data.

Business Impact

According to Gartner's most recent CIO survey, data and analytics solutions are CIOs' top investment priority in China. But culture and lack of analytics skills continue to be obstacles, especially for nonprofit organizations and the public sector. D&A for good provides an option to have technology and expertise at lower cost, but with a higher social impact.

Drivers

- D&A for good initiatives are social responsibility rebranded. Local data and analytics service providers are engaging more with nonprofits and the public sector, and getting more deals for smart city projects. As the Chinese government builds a more centralized and digital system, vendors taking a D&A for good approach will get more social impact investment.
- Chinese government has collaborated with commercial organizations to develop multiple analytics applications such as "Health Code" to prevent and combat epidemics. This is reinforcing people's understanding of the power of D&A for good.
- D&A for good provides an option to have technology and expertise at lower cost, but with a higher social impact. The benefits of this type of crowdsourcing come to prominence because of China's unique population dividend.

Obstacles

- D&A for good is specifically advantageous for organizations that are both contributing the data and using it. To date, such contributions are often considered altruistic and justifications for participating can be difficult to develop. D&A for good initiatives could extend and witness growth post-COVID-19.
- China-based data and analytics vendors are a bit behind international vendors on D&A for good approaches.
- The low data literacy of organizations in China will cause less engagement with D&A for good initiatives from citizen users.

User Recommendations

- Use D&A for good initiatives instituted in response to COVID-19 as a launching point for continued, extended D&A for good initiatives.
- Collaborate with international companies and vendors to prototype D&A for good strategies as a way to improve employees' data literacy.
- Use analytics based on open data, such as COVID-19-related data, to solve social problems through internal training programs.
- Encourage employees to participate in more community events hosted by organizations that have D&A for good projects.
- Pilot data visualization technologies about smart cities to bring more visibility about how data can improve city life.
- Make useful internal data public to solve the urban problems while adhering to privacy regulations.

Sample Vendors

Alibaba Cloud; China Unicom; SAS; Tableau; TigerGraph

Gartner Recommended Reading

Coronavirus (COVID-19) Outbreak: Short- and Long-Term Actions for CIOs

Modernize Your MDM Program With External Master Data Sharing

Dare to Dream! Give Your Data and Analytics Initiatives a Purposeful Mission to Improve the World

Magic Quadrant for Data and Analytics Service Providers

Smart Data Sharing — Five Insights to Get It Right

At the Peak

Privacy in China

Analysis By: Bernard Woo, Jie Zhang

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Privacy in China is preserved by a national standard for privacy and a cybersecurity law, and is enforced by other relevant regulations. In 2020, China took the next steps in regulating the privacy of individuals by enacting a civil code (effective 2021) that introduces new protection requirements for personal data. In addition, a draft law titled Personal Information Protection Law (PIPL) was introduced and comments solicited.

Why This Is Important

In 2019 and 2020, Chinese regulators actively administered penalties against commercial organizations over the mishandling or insufficient protection of personal data. These demonstrate the will of the central Chinese government to control and regulate personal data protection practices. This has further evolved with the introduction of a draft omnibus law PIPL and additional rights (such as right to access) in the civil code to control personal data processing in all aspects of life.

Business Impact

- Compliance risks and potential penalties for violations are real and significant. Business leaders must account for privacy in their market growth strategy, particularly in highly regulated sectors such as financial services or multinational operations expanding in China.
- While the regulatory framework is evolving toward principles found in laws in other regions, there are complex data localization requirements, which must be carefully analyzed and addressed as part of the privacy strategy.

Drivers

- Rapid adoption of digital business (especially mobile payment; large and complex third-party data sharing and processing especially in financial services; online shopping; and news and information content platforms) continues to increase risks for personal data to be breached or mishandled.
- China is the world's No. 1 market for digital commerce in terms of transaction value and online penetration of total retail sales (see What CIOs Need to Know About China). Overall, trailing privacy practices in society, fraud activities, excessive data collecting and trading and more have driven Chinese lawmakers and regulators to establish guardrails for protecting its citizens' privacy.
- The regulatory framework follows a path of continued evolution. The Cybersecurity Law (CSL) in 2017 began establishing requirements around the processing of personal data. This was then supported by the Personal Information Security Specification ("Privacy Standard") in 2018, the Guideline for Internet Personal Information Security Protection plus the effectuation of the Multi-Level Protection Scheme (MLPS) 2.0 in 2019; and, then, in 2020, a new Chinese Civil Code and draft PIPL.
- There is evidence that Chinese consumer and employee expectations toward privacy are aligning with individuals in western countries that have more mature privacy regulations. For example, Gartner's 2021 Digital Worker Experience Survey revealed that the percentage of Chinese workers who expect zero monitoring (14%) was similar to that of U.S. workers (16%; see Data View: A Country-by-Country Guide to Productivity Monitoring Methods for Your Remote Workers).

Obstacles

- Requirements are extensive and documented not in one law but in a framework of regulations, standards and guidelines.
- Assessment and certification by locally approved entities is needed. As such, local partnerships are critical in helping organizations understand requirements, implement correct measures and keep up with changes in a rapidly maturing environment.
- Processes for assessment and certification are extensive, requiring significant volumes of documentation to be prepared and filed.

- Detailed requirements around disclosure of information for obtaining certification means a carefully tailored strategy is needed in order to balance against the practices for protecting sensitive data.
- Potential significant investments in order to obtain certification may be needed. Possible new technology investments include IT infrastructure, application architecture and data management solutions. New roles, controls and policies will also be needed.

User Recommendations

- Extend existing corporate privacy practices to incorporate China's regulatory requirements where appropriate; establish new processes when required.
- Discover, map and classify personal data being processed to lay the foundation for gaining control over processing activities and addressing localization requirements.
- Focus on building a privacy user experience (UX) to bring transparency to personal data processing activities, collect and manage user consent plus preferences, and support subject rights requests.
- Establish and document purposes for processing personal data as part of privacy impact assessment (PIA) process; ensure a minimum amount of data is processed for each purpose.
- Implement controls to protect personal data commensurate with that information's sensitivity, such as encryption, data masking/anonymization or access controls (including logging and monitoring).
- Ensure localization requirements are addressed within the overall business strategy.

Gartner Recommended Reading

China's Data Privacy Standard Unfolds Measures for Its Cybersecurity Law

Address Chinese Cybersecurity Law With This Playbook

Mitigate U.S.-China Technology Disruptions With Scenario Planning

Urban Waste Management

Analysis By: Milly Xiang

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Urban waste management refers to collection, transportation, disposal and recycling of municipal solid waste, hazardous waste, wastewater and others. It encompasses management of all processes and resources for proper handling of waste materials, to comply with health codes and environmental regulations, as well as behavioral changes. It's either managed by government entities or outsourced to a third-party waste management company.

Why This Is Important

Waste management is a fundamental pillar of a smart city and the movement toward a more circular economy. It poses a great impact to the overall citizen experience and environmental sustainability. Effective waste management empowers cities to battle ever-growing volumes of municipal waste and environmental challenges as a result of large-scale urbanization and industrial growth.

Business Impact

- City officials can optimize their decisions on regulations, infrastructure and cross-stakeholder collaboration, and achieve sustainability goals through better visibility into the waste management life cycle.
- Waste collection companies can increase efficiency and productivity, and reduce carbon emissions from waste transport and logistics costs.
- Waste recycling companies proactively adopting innovative and smart technologies would be able to gain a competitive advantage over the laggards.

Drivers

- Advances in waste management are driven by tightening environmental regulations and targets, as well as the growing importance that citizens across the world attach to sustainability and equality. For example, food waste in cities is driving attention to the inequality in food supply and poverty. Plastic waste is generating a pollution crisis in waterways and landfills, raising attention from a public sector mission to a social predicament.

- Increasing number of countries are committed to net-zero targets. For example, the Chinese government officially announced its aim to hit peak emissions before 2030 and carbon neutrality by 2060. As a part of the effort to achieve these targets, urban waste management is being carried out step by step, supported by laws and regulations, government-funding commitment, and participation from private sectors. The regulations on mandatory classification of household waste have been enforced and the penetration of garbage classification within 46 Chinese cities exceeded 85% by the end of 2020, and the practice is now starting to be promoted in lower-tier cities.

- Cities continue to push boundaries of what can be done with waste, from recycling network innovation to sensor technologies and smart sorting processes, where digital technology plays an important role in reshaping how urban waste is collected, delivered and recycled.

- New technologies and business models are emerging to modernize the entire waste management processes. For example, NarrowBand Internet of Things (NB-IoT)-powered smart trash bins to automate and optimize when and how waste to be collected, and optical sorting machines that use sensors to separate composable and other recyclable material.

- In the meantime, the waste-to-energy model becomes increasingly evaluated and trialed by the government as a part of the clean energy initiative along with partners from the private sector.

Obstacles

- Urban waste management is challenged by imbalanced execution in different geographies.
- Lack of well-accepted classification standards for wastes, like food and recyclable wastes, waste used for energy generation and so on, leads to varying data collection and reporting methods on waste; statistics can be unreliable in terms of quality and comparability.
- The adoption of digital technologies in waste management is at an early stage, leading to low penetration of technologies.
- The achievement of waste management objectives requires joint efforts from the government, local business and citizens. However, this is slowed down by the absence of a comprehensive and integrated waste management system across local industries; the lack of funding and resources for businesses to invest in efficient technologies; and the lack of knowledge about cost-effective waste management options.

User Recommendations

City planners and technical professionals in waste management organizations may focus on the following advice, to gradually introduce smart technologies to enhance the efficiency and productivity:

- Prioritize use cases where they can generate immediate results in cost reduction and sustainability of the cities. Examples include optimized garbage pickup scheduled on a real-time basis through bins equipped with wireless sensors, and data-based management and logistics platforms and smart devices in waste collection trucks.
- Evaluate emerging technologies, such as pneumatic systems, waste collection robots and autonomous driving waste collection trucks, and technologies to manage specific waste, such as plastics, batteries and e-waste, to gradually upgrade waste management in cities.
- Utilize and analyze data across the waste management life cycle to optimize cross-stakeholder collaboration, infrastructure optimization and so on.

Sample Vendors

Ecube Labs; H3C; Huawei; Location AI; XiaoHuanggou Environmental Technology; Zoomlion Environmental Industry

Gartner Recommended Reading

Key Trends and Considerations for Vehicle Routing and Scheduling and Last-Mile Delivery Solutions

Market Guide for Vehicle Routing and Scheduling

From Smart City to Intelligent Urban Ecosystem — Unlocking Data Value Is the Key to Cities' Industrial Partnerships

Energy-Water Nexus

Analysis By: Bettina Tratz-Ryan

Benefit Rating: Moderate

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

Energy production and water use are closely interdependent. The energy-water nexus is a term for the complex interplay of cause and effect between water and energy supply and consumption in smart cities, industries and homes.

Why This Is Important

According to the UN-Water facts, 129 countries are off track to have sustainably managed water resources by 2030, of which less than 10% is consumed residentially, the remaining 90% is consumed by industry and agriculture. The energy-water nexus is impacted by:

- Supply and water quality
- Water demand and climate change
- Desalination (highly energy intensive), and black and gray water treatments are energy expensive, exposing the poor and vulnerable communities to a water crisis

Business Impact

Business is greatly affected by the availability and cost of energy and water as well as by the competing sources for other industries such as agriculture and food production. Cost of operations to produce water as well as desalination-induced energy consumption based on industrial water use presents the potential stigma or a reputational risk. Reporting, transparency and communications will mitigate the concerns for depletion or water quality risk relative to business operations.

Drivers

- Analytics and data generation through the Internet of Things (IoT) opens the insights into which processes in generation and use of water and energy can be optimized for sustainable societal development.
- As sustainability measures such as UNSDG or GRI frameworks go mainstream, they are exposing industry players to reputational risk. For instance, the fracking industry in the southern U.S. is experiencing mitigation issues, as it is using water from urban centers to bring it to the fracking locations, causing discussions about droughts and water availability in the community. In different industries, the energy-water nexus has caused businesses to change their business processes. The textile industry is dyeing without water, saving the water and energy as the textiles do not need to be dried.
- For organizations operating in countries in which the water prices are subsidized, the exploitation of water should be positioned more about responsible use versus scarcity that may lead to economic penalty. Or, in a more disruptive approach, calculate the total cost of water including the entire life cycle of production and water treatment. Companies like Nestle and Unilever are setting their internal water prices to ensure true price of water throughout the operations.

Obstacles

- While sustainable management of water and energy addresses sustainability-environmental risks, the absence of a true water price is hindering investment in management. Regions and countries with increasing cases of droughts and shifts in water allocation are challenged in their economic and industrial performances, especially with those regions highly dependent on oil and natural gas.
- The population growth in urban regions and rapid industrialization in developing countries are also major contributors.

User Recommendations

CIOs in water-intensive industries:

- Invest in a water management tool that will dashboard, simulate and manage the water life cycle across the operation. This will include water price costing for internal water use and mapping the price volatility of energy in case of desalination.
- Apply or evaluate technology solutions such as sensors, IoT and analytics together with modeling and simulation for energy use.

IT leaders in industry:

- Perform real-time tracking of energy price volatility by analyzing data through smart city, water and energy management platforms. End users need to involve new energy sourcing that includes waste to energy and circular economy principles.
- Explore the business benefit of microgrids, distributed grids and energy management with dispatchable pump loads that can leverage process buffers such as storage in critical peak periods.

Sample Vendors

ABB; ADASA; Black & Veatch; Deloitte; Fujitsu; Hitachi; Schneider Electric; SUEZ

Gartner Recommended Reading

Predicts 2020: Resilient Smart City Development Requires Data-Driven Engagement of Citizens and Businesses

Maverick* Research: Water Will Become the World's Most Precious — and Disruptive — Commodity

Industry Insights: Sustain the Future of Water With Utility Digital Business

Sustainability and COP 21

Analysis By: Bettina Tratz-Ryan

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Cities are becoming environmental and sustainability centers of excellence due to commitments made to the U.N. Framework Convention on Climate Change in 2015 to limit global warming to 2 degrees Celsius. The 450 cities that made this commitment are focusing on climate change risk management and opportunity identification.

Why This Is Important

Cities face climate-change-related challenges in the form of rising sea levels, rising temperatures and biodiversity loss. In addition, the COVID-19 pandemic's aftermath has exposed social issues, including sustainability inequality. City governments around the world are addressing these issues with "resilience strategies" to rebuild infrastructure, support sustainable industries and ensure holistic citizen engagement through focusing on sustainable development goals (SDGs).

Business Impact

Smart cities demand more user-focused environmental services and experiences. COP 21 declarations of city leaders and nonstate parties such as R20, ICLEI and C40 offer CIOs opportunities to innovate by linking technology projects to green initiatives. Data becomes instrumental for policy decision making, and CIOs can develop architectures and shared infrastructure that balance services with the related greenhouse gas emissions from IT itself.

Drivers

- For example, the European Green Deal is making carbon emission reductions and circular economy as key enablers for sustainable living. The diversity of political and demographic environments will, however, change the momentum for local governments due to funding and economic discussions, which leaves this innovation profile in the same place on the Hype Cycle as it was in 2020.
- The momentum and adoption rate are being driven by citizen and business concerns about climate change. Interest groups such as C40 for cities and European Green Capital share insights on carbon reduction, sustainability initiatives and KPIs to measure impact.
- Based on some local impacts and the social cohesion and contextualization of the urban service environment generated through projects that address cities' distinctive needs, cities will outpace countries and regions in sustainability and environmental momentum and execution.

Obstacles

- The climate crisis expresses itself in climate change, loss of biodiversity, pollution and the loss of resources. The intelligent urban ecosystem can manage sustainability impacts only if there is good data on primary and secondary material impacts on the city and citizens. Those datasets are rarely available in scale from the industry and need to be standardized, especially for Scope 3 GHG.
- Data sharing needs to include GHG emission data so that industry partners from insurance, real estate development, banking, and logistics and supply chain organizations can model their impacts to avoid a business risk. It also involves consideration of data security.
- Reaching sustainability goals needs to become more transparent, which provides CIOs with options for frameworks such as STAR Communities and World Bank Group's CityStrength diagnostic to orchestrate data.

User Recommendations

- Apply technology to understand operational efficiency, data sharing and business process alignment to condense the urban asset footprint, while visualizing this impact in various channels. Support the development of collaboration and dashboarding of sustainability-minded citizens who will engage in environmental activities such as restricting high-emission vehicles in city centers and offering energy conservation and green energy options for streetlights and buildings.
- Define the KPIs of smart city initiatives in sustainability terms. Create advisories on the use of IoT by citizen advisory boards for measuring emissions, air pollution, waste and recycling rates. Cooperate in public-private partnerships with utilities, waste management companies and consumer goods providers to create business awareness and end-to-end circular city life cycle applications in microgrids, recycling, and smart building and home ecosystems.

Sample Vendors

Deloitte; E.ON; Esri; The Nesting Co.; Sphera

Gartner Recommended Reading

Leading Sustainability Ambition, Goals and Technology in the 2020s

Predicts: Smart City Resilience and Citizen Experience Will Drive Sustainability and Urban Attractiveness

How Can CIOs Keep the COVID-19 Pandemic From Overshadowing Their Sustainability Efforts?

Predicts 2020: Resilient Smart City Development Requires Data-Driven Engagement of Citizens and Businesses

Intelligent Street Pole

Analysis By: Bettina Tratz-Ryan

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

An intelligent street pole is an asset that hosts a variety of different IoT and networking devices, cameras, monitors and displays. It is controlled and monitored from a single operator, and enables EV charging, interactive lighting, parking management and crowd control. It can provide the backbone for a citywide Wi-Fi or 5G network that can enable computing and communications for intelligent street and district services.

Why This Is Important

Intelligent street poles are an evolution of smart street lighting, which moved rapidly into mainstream adoption. Compared with light posts, street poles host a variety of different city- and ecosystem-relevant sensors and technologies, and enable a concerted aggregation of location-based data. The maturity of context-based analytics will be accelerating around parking options, asset management in the vicinity of smart buildings and real estate, and retail locations in downtown areas.

Business Impact

Intelligent street poles are expected to become valuable real estate, as their location and the ability to connect many sensors can avoid multiple installations and provide cost-efficiencies. New designs of street poles may include charging stations, parking meters and other consolidated road management systems. Business momentum will come from the transparency and value generation through data exchanges between ecosystem partners, such as retail, parking and e-charging, and advertisements.

Drivers

- As the postpandemic activities in locations in cities increase, especially in heavily frequented spaces, intelligent street poles will become the center of monitoring and communications platforms. User experiences in tourism and public safety will highly benefit from situational awareness mapped to location- and user-centric data. Cities like Amsterdam and Los Angeles are using the availability of data analytics to manage lighting, music, public messaging, and other features directly mapped to crowd or vehicular movement.
- Street poles, as well as devices mounted on the poles, are owned by public works, utilities or private-sector stakeholders and, therefore, serve a variety of different business purposes. Many urban planning decisions that are on spatial development and services for micromobility, climate change and green spaces, last-mile logistics, and development of new business districts, can evaluate smart street poles. The poles can serve as valuable urban real estate for a 5G base station, EV parking and concierge services, and private-sector curb pricing for property insurance or retail per square foot of curb space.
- Business momentum will be triggered by the gains from managing the data complexity that will drive ROI and future-proof implementation in greenfield locations and districts. CIOs and their teams in urban ecosystems have to determine location, connectivity and compute power to gain ROI and value streams. Google Sidewalk Labs is measuring the location value of curbs by square feet, with all the assets that belong to this area.
- Smart street poles will be deployed in parking garages or as part of smart real estate development from the private sector. Urban leaders could apply them to revitalize locations or create innovation hubs by offering data from street poles to ecosystem partners, with new AI and video analytics technology.

Obstacles

- Obstacles to ecosystem development include the complexity of ownership and the volatile expectations of ROI benefits.
- Issues around management of assets mounted on poles, together with maintenance, data orchestration and cybersecurity, need to be addressed to enable scalability and drive adoption. Utilities, CSP and real estate developers emerge as deployment stakeholders.
- Privacy concerns should be managed upfront, with the understanding that intelligent street poles will initially be available as lampposts.

User Recommendations

- Classify sensor data and insights gained from the street pole through analytics to generate value for smart city, smart street or district deployments. Develop scenarios to calculate the connectivity, computing and powering requirements for multiple IoT sensors and other products on the pole. This is critical, as cyber-physical systems and mesh technologies may define and execute on the linked data analytics or data graphing off the post.
- Manage upfront how you will mitigate privacy concerns. For example, inform others that intelligent street poles will initially be available as lampposts.
- Enforce digital security at the individual asset level of the pole, as well as at the edge gateway and transmission to the core of the street pole ecosystem. With the increasing mesh of interactions and value generation, access is increasing for potential digital intrusions, as well as privacy violations.

Sample Vendors

Acuity Brands; CIMCON Lighting; Fluentgrid; GE; Signify

Gartner Recommended Reading

Turning Smart Cities Into Intelligent Urban Ecosystems

From Smart City to Intelligent Urban Ecosystem — Unlocking Data Value Is the Key to Cities' Industrial Partnerships

Predicts 2020: Resilient Smart City Development Requires Data-Driven Engagement of Citizens and Businesses

5G

Analysis By: Peter Liu, Sylvain Fabre

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

5G is the next-generation cellular standard by the 3rd Generation Partnership Project (3GPP). The standard targets maximum downlink and uplink throughputs of 20 Gbps and 10 Gbps, respectively, latency below 5 milliseconds, and massive scalability. New system architecture includes core slicing as well as wireless edge.

Why This Is Important

5G is a critical enabler of the digital transformation of the enterprise and is key to China's "new infrastructure" strategy. Leverage 5G capabilities like network slicing along with low latency and high bandwidth. New services that have more strict connectivity requirements can be enabled, such as AR/VR, smart cities, autonomous driving, IoT and smart manufacturing. China is leading the global 5G development and adoption, and enterprise CIOs are showing continued interest in the evolution of 5G.

Business Impact

- 5G brings up to 10 Gbps of capacity and provides high-quality connectivity options for enterprise networking, which can effectively support various digital transformation initiatives.
- The introduction of network slicing and edge computing allows a business to tailor virtual networks that map to its IT needs.
- 5G enables other emerging technologies, such as AR/VR, robotics and Internet of Things (IoT), to further drive enterprise digital transformation both internally as well as externally in customer engagements.

Drivers

- As part of its post-COVID-19 relief package, China is ramping up plans to construct new digital infrastructure across the country — including 5G networks, artificial intelligence (AI), IoT. These drive the 5G investment and deployment.
- 5G offers fiberlike bandwidth and latency capabilities, but with significantly shorter deployment time, as there is no need to lay cables to the office/branch. With this advantage, 5G can be positioned as a comparable alternative to fiber for the enterprise data network.
- The growing number of cloud-based applications accessed from mobile devices creates a gap that translates to a new requirement for connectivity: secure, reliable and high-bandwidth wireless networks.
- 5G features, such as network slicing and service-based architecture, allow networks to be purpose-built for use cases (e.g., ultra-low latency and security) and be more responsive to the application and IT environments they support. These networks can potentially work with existing SD-WAN solutions or overlay fixed networks.
- There is a growing interest in private mobile networks across multiple industries. 5G is expected to be the preferred option for enterprises for their private wireless network, especially to support future applications such as robotics and mixed reality.
- Chinese enterprise CIOs show great interest in 5G and proactively collaborate with CSPs and vendors to develop 5G services, which drives innovation and accelerates adoption.
- Fast shipment and penetration of 5G devices is another driver for 5G network rollout.

Obstacles

- Alternative connectivity options such as Wi-Fi and fiber continuously challenge the necessity of 5G adoption in enterprise networks.
- Costs of the equipment and devices are major concerns for enterprise CIOs when considering 5G technology especially for enterprises that want to build their own private 5G network. Current private 5G networks normally are deployed in a silo mode to support niche applications, which hardly justifies the investment.
- The majority of 5G vertical use cases are still in the conceptual and developmental stage. These use cases are mainly driven by the network vendors and CSPs. While 5G will enable various industry applications, the real value to the end users remains unclear.
- The 5G-related capabilities and standards are still evolving. Therefore, 5G continues to suffer from immaturity, substantial hype, and unrealistic expectations about features and availability sets. In addition, major enterprise innovation opportunities are based on 3GPP R16 and R17, which are not largely available in today's 5G deployment.

User Recommendations

- Plan for 5G adoption by considering the match between the 5G connectivity service and use-case requirements. Cut through the "5G washing," and set realistic expectations by understanding the multilevel technology dependencies that impact 5G adoption.
- Assess the potential for initial 5G adoption as a continuum of services, such as SD-WAN or IoT-type applications. Proactively engage with CSPs to understand the deployment specifics of how these services integrate with their business-focused 5G services.
- Enhance your customer experience and brand advantage through leveraging 5G to offer new applications such as AR/VR on mobile devices in the mass market.
- Validate expected network performance by requiring the underlying CSPs to provide the coverage data for branch locations, frequencies used and expected throughput.

Sample Vendors

Baicell; Comba; China Information and Communication Technologies Group (CICT); Ericsson; Huawei; Nokia; Qualcomm; Samsung; ZTE

Gartner Recommended Reading

U.S. Telco 5G Plans Take Shape

Invest Implications: Emerging Technologies: Emergence Cycle for mmWave 5G

Product Leaders to Communicate 5G Value Through Practical Use Cases

Emerging Technologies: 5G Technology Spending, 2020 Survey Trends

5G as a Service: Deployment Scenarios of Private Networks in the 5G Era

Market Guide for 5G Network Ecosystem Platform Providers

Creating Your Enterprise 4G and 5G Private Mobile Network Procurement Strategy and RFQ

Sliding into the Trough

Environment Monitoring and Management

Analysis By: Milly Xiang

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

Environment monitoring and management leverages new technologies such as IoT, connectivity, big data, machine learning and analytics to gather environment data, including air, water and soil pollution levels. It enables governments and urban ecosystems to measure, view, correlate and analyze data in real time, set thresholds for critical measurements, and effectively communicate the information to multiple stakeholders to make real-time, science-based and more conscious environmental decisions.

Why This Is Important

Sustainability change is affecting cities and their inhabitants more regularly. This brings new challenges for urban planners, such as the need to improve air, water and soil quality, and control noise pollution to create a healthy and enjoyable environment for city inhabitants and local businesses. Monitoring the consequences of extreme weather, COVID-19 hot spots, resource allocations, pollution and more will reduce inefficiencies and help to mitigate and manage impacts.

Business Impact

Effective environmental monitoring and management enables cities and businesses to keep track of changes over environmental conditions and matrices in real time. This allows them to catch problems before drastic damage, assess causes and impacts, and make decisions on interventions, policies and communications across the urban ecosystem. It will also identify the industry ecosystem activities' impact on pollution (noise, environment waste) and hold them accountable.

Drivers

- In cities, NOX/NO2 emissions are a big driver for environmental monitoring in the near term. The local health impact from such emissions has been made a big emphasis globally.
- More countries than before are committed to reach net zero carbon emissions by midcentury to achieve a balance between the total emissions put into the environment and those removed. Monitoring of the environment and improving awareness of the latest dynamics will support policy development and monitor their progress in achieving the target.
- Most cities include sustainability targets as their smart city KPIs, driving initiatives to help improve air, water and soil quality toward cleaner cities. Cities are in great need of powerful tools to measure impacts of activities from residential, vehicular, commercial, industrial and other sources to the quality of the environment. They need data to act on industries and businesses that violate compliance standards.
- Technology advances make environmental monitoring possible with higher levels of sensing accuracy with lower cost. By applying data analytics and AI techniques, cities and businesses are able to apply real-time analysis, document daily and seasonal changes in its quality or identify areas that need immediate attention, and practice prediction and simulation to support their decisions around environmental issues.
- The deployment of smart street poles is emerging with a significant number of pilot projects being developed in many countries. The poles are increasing a strategic infrastructure for smart city deployment thanks to their capillarity, connectivity and electrification. And they can be used for hosting various environmental sensors and devices to meet the densification requirements for microlevel monitoring.
- Consumer devices recording environmental pollution or noise levels and pushing into the cloud to a citizen entrepreneurial application are proliferating, keeping the government accountable.

Obstacles

- Environmental monitoring and management is very dependent on government-based stations, which are usually sparsely distributed, thus the data from these stations may not be able to provide microlevel environmental information for assessments.
- To accurately measure the environmental quality data at the microlevel, the high cost often limits the quantity of deployments, resulting in gaps in coverage.

- Sensors for environmental monitoring have lower accuracy as compared with regulatory-grade instruments and are easily affected by environmental parameters such as temperature and relative humidity. They also require regular calibration and maintenance.
- Complex regulation, with several entities engaged, requires different parties to find the right way to collaborate.
- The government is facing the pressure of ensuring economic growth with models of a circular economy, optimal resource conservation and utilization, and emission reduction.

User Recommendations

For city planners:

- Adopt new urban planning standards to improve efficiency and minimize environmental impact as well as creation of a resilient community.
- Employ innovative technologies and methodologies to support regulation implementation and cultural changes that facilitate sustainable standards and practices.
- Leverage data generated from monitoring systems to measure the effectiveness of policies, therefore adjustment and enforcement can be adopted.

For city CIOs and IT leaders in environmental functions:

- Design architecture and measurement parameters, focusing on baseline data collection and generating trends, then improving accuracy and precision.
- Crowdsource citizen data collected through consumer devices as additional sources.
- Feed monitoring data to the central command and control center (CCC) for analysis and advice for immediate and long-term actions.
- Enable data sharing with the public to empower them with real-time information to arrange their daily activities.

Sample Vendors

China Unicom; IBM; UROS; Vortex IoT

Food Safety and Traceability

Analysis By: Andrew Stevens, Milly Xiang

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Emerging

Definition:

Food safety and supply chain traceability solutions are fragmented with diverse technology functionality. Their key use case is to ensure robust physical product security, integrity and transparency across each stage of the supply chain journey of a food product from source through to point of sale (food retail) or consumption (food services).

Why This Is Important

Food safety and traceability is a global challenge but has been a long haunting issue for the Chinese government and consumers. China's 2015 Food Safety Law is seen as a major development for sweeping changes for food safety regulations. Food counterfeiting continues to be a significant problem. High profile incidents in China have been a catalyst for companies to elevate urgency for new generations of solutions that are both scalable and agile to meet diverse risks associated with food products.

Business Impact

China's large geographical size and population, huge number of food growers and distribution enterprises, and historic lack of comprehensive regulations have made food safety a pervasive problem. The Chinese government has responded by new laws and policies including implementation of the Food Safety Law in 2015 (with further amendments), including 10 chapters and 86 articles, in areas including labelling, safety standards, inspection, import/export and surveillance.

Drivers

- There are several vertical and horizontal market implications stemming from a wave of high-profile food safety incidents and risks that largely align with the concepts of the overall food “value chain” and farm-to-fork models. This also has impacts on solution maturity and across which products risks or requirements these capabilities will deliver against.
- Food value chains increasingly take a broader, product/risk-centric approach to the full life cycle brand protection by consolidating traditional agricultural sourcing supply chains (Agri-tech) in addition to final production, distribution and services provision of the food products (including food services). Naturally, any government mandates will be a boon to the food safety use cases for IoT and the associated technology and service providers.
- Farming and agriculture will be impacted from IoT through optimizing food production and enhancing transparency and traceability, as will food processors and manufacturers.
- Sources of raw materials and ingredients must have full transparency and real time visibility across each phase of supply networks to facilitate robust protocols in the event of a recall or safety incident.
- Distribution and transportation will be impacted by cargo being monitored for temperature and other products’ condition and environmental factors that affect food quality and safety, as well as product freshness, and for some premium products security.
- Retailers including markets, grocers and sole traders will be positively impacted by improved shelf life, enhanced quality, reduced consumer returns and significantly reduced liability for selling unsafe food to consumers.
- Ultimately, food safety and traceability is a shared and collaborative responsibility across an ecosystem of companies and stakeholders. Developing solutions in this area will need to continually reflect this in solutions and services offered especially for onboarding, governance and interoperability.

Obstacles

- The food value chain constitutes many stakeholders and vast ecosystems of participants (such as in supply or distribution networks), many of which are frequently exiting or joining due to the very dynamic nature of the business. Regulatory requirements could struggle to capture all events or scenarios.
- Organizations involved in China's food supply chain must understand broader concepts of food traceability requirements outside of the four walls of their own business operations. This might include assessments of certifications and regulations from the government, suppliers and customers to have context for identifying appropriate technologies and solutions.
- Consumer perception directly relating to a string of historic food safety incidents may be difficult to change quickly. Companies will need to be cognizant of solutions and services that boost end-consumer confidence or reinforce collaboration and progressive change through immersive digital applications and continuous communications.

User Recommendations

- Encourage industrywide collaboration spanning government down through to individual growers to enforce food safety and traceability across the supply chain, and help in developing authentic solutions that can mature and scale effectively.
- Conduct segmentation exercises and risk assessments across extended physical product criteria, recommended for being able to assess the more appropriate technology solutions for immediate high-risk objectives. For example, dry good products with long shelf lives versus fresh fruit products.
- Leverage falling technology costs (for example, new generation QR codes or RFID) as well as increasing provider competition.
- Develop core competency for solutions delivering key sensor measurements including temperature, humidity, inertia, critical for short shelf-life categories or sensitive food products, to determine the best aligned solution(s), stakeholder ecosystems, domains in which to start pilots and POCs.

Sample Vendors

FoodLogiQ; HarvestMark; Kezzler; Mojix; Oritain; Safefood 360°; SafetyChain; Sourcemap; TraceGains; Transparency-One; TraQtion; Zest Labs

Gartner Recommended Reading

Vertical-Industry Context: 'Magic Quadrant for Multienterprise Supply Chain Business Networks'

Market Guide for Quality Management System Software

Ignition Guide to Conducting a Materiality Assessment

Water Management Analytics

Analysis By: Bettina Tratz-Ryan, Aanchal Mair

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Water management describes a solutions approach to holistically monitor water throughout the hydrological cycle. Water management solutions include water sourcing as well as water demand and rainfall forecasting, groundwater monitoring, water analysis for water supply, water treatment plants, wastewater treatment facilities, and water-loss analysis.

Why This Is Important

Water management requires a differentiated set of technology and service skills to cater effectively for: distribution for residential and commercial customers; water pollution, water treatment and recycling; rainwater runoff and natural disasters. Water management data will require more solution capabilities related to an entire management cycle that includes operations, user billing and monitoring, and forecasting of demand and quality.

Business Impact

Consolidating data points to manage and control water issues — from supply to reuse and recycling — provides water suppliers and municipalities with the ability to achieve cost-effective potable water quality. It improves the interface between asset tools for pumping stations, meters and monitors for better customer services, with fewer water-supply failures and better water quality. Partnerships with IT and water operations have to be built to connect data and information sources.

Drivers

- Artificial intelligence (AI) is being used to address an infrastructure resilience issue. Adoption is accelerating as emergency response around water crises in drought and flooding, relative to shifts in weather patterns, has captured the attention of local governments and utilities from a risk perspective.
- Water quality issues triggered by agriculture fertilization are driving up water prices in cities by 50% year over year in countries like Germany. That is accelerating the deployment of new water management solutions and increasing the time to deliver water to customers.
- Climate change priorities are shifting toward water sustainability, capturing the attention of industry players. Government initiatives and the developments in pricing of water will also drive water management — once meters are installed to monitor true consumption.
- Water management is a growing application area for industry and business uses, including touristic sites like beaches and lakes. It also offers insights into disaster recovery for water-related issues in manufacturing operations.
- Cities are applying Internet of Things (IoT) sensors across wastewater infrastructure to measure COVID-19 hot spots and epidemiology through the wastewater streams, like Vienna in Austria or Stafford County in Virginia.
- Residential water needs will compete with business needs, and analytics will be needed to resolve it. South Africa and the state of California are examples for this competition.

Obstacles

- The position of the profile has moved slowly in 2021 in the Hype Cycle because water management has developed more complex use cases.
- While local utility and freshwater supply is experiencing more water intelligence, shortage of climate-related resources and natural disruption is not priced in the supply, thus artificially keeping the delivery cost low.

User Recommendations

- Evaluate the implementation of data management and analytics for water infrastructure and quality. Users (industries and commercial) and suppliers (municipalities) must report, or comply with, tightening wastewater regulations, while improving efficiency and reducing loss and waste-disposal costs.
- Implement security standards in the water management process, the physical infrastructure and the privacy policy on consumer data. For municipal water utilities or sewage plants, water management dashboards will assist in providing real-time data on water quality.
- Develop an adaptive and flexible water management strategy, integrating the legacy of IT and OT. IT professionals in utility and municipal contexts can develop strategy based on intelligent information received from environmental sensor and satellite networks, smart water meters and deep computing, and analytics engines.

Sample Vendors

ABB; ADASA; Arcadis Gen; Atos; EcoExam; KISTERS; Schneider Electric; SUEZ

Gartner Recommended Reading

Predicts 2020: Resilient Smart City Development Requires Data-Driven Engagement of Citizens and Businesses

Maverick* Research: Water Will Become the World's Most Precious — and Disruptive — Commodity

Industry Insights: Sustain the Future of Water With Utility Digital Business

Vital Digital Technology Investments for Water Utilities

Open Government Data

Analysis By: Uko Tian

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Open government data is a philosophy, and increasingly a set of policies, promoting transparency, accountability and value creation by making government data available to all. Public institutions become more transparent and accountable to citizens when they make their datasets publicly available. By encouraging the use, reuse and distribution of datasets, governments promote business creation and innovative, citizen-centric services.

Why This Is Important

Open government data is an important initiative in the Chinese government's digitalization plan to improve management and service capability. Greater data transparency is expected to help the government establish higher citizen trust and more effective policy formulation and implementation. It also enables third parties to develop new digital applications and value-added services based on the open data. Open data is one of the tasks listed in the government's 14th five-year plan (2021-2025).

Business Impact

Open government data is expected to gain greater penetration and expand to data pertaining to the environment, transportation, healthcare and public security. Making government data available to the public increases government transparency and accountability, enhancing citizens' and private sectors' engagement with the government. Businesses can use open government data to launch new products, services and business models. It is also a foundation for data exchange in the urban ecosystem.

Drivers

- Open government data is one of the tasks listed in the Chinese government's 14th five-year plan to ensure top-down support and management sponsorship. It includes the establishment of a mechanism to promote data flow and integration among various departments, levels and regions within the government.
- Opening government data serves as a new type of public service to society, establishing a unified data platform and encouraging innovations in data operation and utilization.
- Bureaus for big data administration have been widely established at the provincial and municipal levels to enforce national guidance. The mission of these organizations is to drive data sharing and openness by establishing unified data standards and platforms, as well as designing related processes. They also undertake the task of promoting local innovation based on shared data.
- During COVID-19, both government and public have realized the importance of using timely and accurate data from various entities to respond to prevention challenges.

Obstacles

- Open government data effort is used to focus more on technical aspects, such as data collection, processing, storage and dedicated portals. Lack of innovative use cases hinders further discovery of the value of data.
- Transforming government operations into a more data-driven model will bring significant changes in public governance and decision-making processes. This is a great challenge and may result in open data failing to deliver on its promised benefits.
- Weak data governance and data protection, especially privacy compliance management, hinder further openness of government data as well as private sectors' willingness to participate.
- Establishing practices on the ethical use of data, justification on data that needs to be kept closed, and updating relevant legislation or regulations are significant challenges. It may take longer to construct data governance mechanisms across all entities than to deploy technology.

User Recommendations

- Build up data governance mechanisms, including drafting standards on data classification, data quality, data trading and defining security levels of data. Based on this, the government should continue to drive further openness and sharing of data horizontally and vertically.
- Ensure local governments build a scheme on open data, set clear objectives, and explore possible use cases and business models to accelerate adoption.
- Explore innovation opportunities in products, services and business models, and improve decision making by leveraging the open government data.

Gartner Recommended Reading

Top Trends in Government for 2021: Data Sharing as a Program

7 Ways to Maximize the Impact of Open Government Data: Lessons From France

4 Steps to Drive Sustainable Value for Government Shared Data Initiatives

Smart City Transportation Strategy

Analysis By: Pedro Pacheco, Bill Finnerty

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Smart city transportation strategy defines goals for a sustainable and holistic technology and data exchange collaboration between different transportation- and mobility-related urban ecosystem stakeholders. This collaboration includes a variety of mobility, local transport, parking and new last-mile logistics applications.

Why This Is Important

A transportation strategy can help cities address fluctuating mobility and transportation requirements of urban ecosystems, especially during postpandemic recovery. For instance, while public transport is often coping with less passengers and more individual journeys, last-mile logistics is booming in different form factors, like drones and e-bikes.

Business Impact

A smart city transportation strategy supports a future-proof investment plan for governments in parking, street and intersection domains, together with the designation of carriers for passengers in public transport. It takes into consideration congestion and travel velocity for commuters, logistics, tourism and other travel forms. Data platforms and analytics will be key to develop sustainable and carbon-neutral transportation options, as well as social and equitable mobility concepts.

Drivers

- Smart city transportation strategy is approaching the Trough of Disillusionment. Urban ecosystems and local governments have realized the need for a revised comprehensive postpandemic approach as mobility and transportation behavior will affect investment strategies. However, a certain lack of strategic planning capabilities from a number of transit agencies will lead smart city transportation strategy to dip into the Trough of Disillusionment before it can reach the Plateau of Productivity and an advanced level of maturity.
- These local governments have also started to address themes like spatial planning, data sharing and management of solutions. For instance, several cities are starting to take steps toward the creation of their own mobility as a service (MaaS) ecosystems and platforms. This is a decisive step toward the deployment of a fully integrated mobility strategy in a user platform. In some cases, there are also projects to build an open data ecosystem encompassing the entire transportation ecosystem — something that can provide major future benefits by enabling an overall improvement of transportation at several different levels.
- Cities are dealing with increasingly complex problems — like congestion and pollution. These highlight the growing need for technology investments — in transportation and other areas — as a way to solve these complex problems. These demand advanced planning and technological foresight, both incorporated into a smart city transportation strategy.

Obstacles

Local transit authorities with the power to develop smart city transportation strategies usually encounter the following obstacles:

- Limited know-how or skepticism hinders transit planners when defining long-term investments into innovative transportation technologies.

- Changes in political power sometimes create a problem of continuity for the fulfillment of a long-term strategy.
- Local transit authorities often cannot define long-term targets or KPIs that are specific, measurable, attainable, relevant or time-bound. As such, this generates major obstacles in defining a clear strategic course.

User Recommendations

- Set the policies and governance to enable a transportation open data ecosystem. This will enable, later on, major gains in terms of transportation planning and an overall improvement of transportation services.
- Ensure your smart city transportation strategy assesses the impact of these socioeconomic changes and defines appropriate action. COVID-19 will bring permanent changes to cities, like people moving out of urban centers due to remote work.
- Develop an overall transportation strategy around specific, measurable and time-bound targets. This will make it easier to choose the right technology to enable reaching those targets. Focus on KPIs and other references like ISO 37120 or ITU-T.
- Build a technology radar to provide visibility of all major transportation technologies coming up in at least the next10 years. This enables a greater understanding on how technology can best help your organization fulfill its smart city transportation strategy.

Sample Vendors

MaaS Global; Mott MacDonald; Optibus; PTV Group

Gartner Recommended Reading

COVID-19 Scenarios for Automotive and Transportation CIOs

3 Ways Transportation CIOs Can Shape a Mobility-as-a-Service Ecosystem Effectively

Use Scenarios to Plan for the Future of Mobility 2025: The Scenarios

Smart Parking

Analysis By: Roger Sheng

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Smart parking uses various sensors, IP cameras, connectivity technologies and third-party service providers' data to identify available and occupied parking spots, recognizing the number plates and navigating to the spot to offer the parking service. Sensors can be installed in the entrance/exit, a parking surface and/or in parking meters. The collected parking data analytics can improve the efficiency of parking and transfer to relevant commercial business opportunities.

Why This Is Important

China is the largest market of automobiles with over 280 million passenger vehicles by 2021. In the many large cities, such as Shanghai and Beijing, car parking has become one of the critical issues of the car users. Smart parking is an important solution which can maximize parking service efficiency to ease parking problems and generate potential business opportunities. It can also contribute to sustainability by reducing emissions and potentially reducing traffic congestion.

Business Impact

Smart parking can lead to new revenue sources and optimized resource management for cities, solution providers and end users (for example, drivers and fleet operators). Public managers and real estate owners can leverage smart parking technology to improve the utilization of parking spaces and create new business opportunities, such as providing parking service to the residential areas which have limited parking spots.

Drivers

The major drivers for smart parking in China include the government, parking lot owners, real estate owners and car service providers.

- Government's smart city initiatives accelerate the investment in smart parking systems in the large cities, which have large numbers of cars. Smart parking can increase the satisfaction of users.

- Smart parking can help parking lot owners to improve working efficiency and reduce labor costs, especially during the pandemic period. The smart parking service can be linked to a mobile payment platform to collect the parking fee automatically.
- Real estate owners can generate new business opportunities by providing intelligent parking service in their commercial buildings and residential areas. Users can get promotion information or a discount coupon when the smart parking system is linked to a digital business platform in the shopping mall.
- Car service providers can collect the information from smart parking systems to promote their services, such as gasoline, power charging service, car cleaning and various types of service, by cooperating with parking service providers.

Obstacles

- The smart parking systems will include many heterogeneous systems with various standards and protocols to be connected, which will raise the challenges to system integration. It is inconvenient for users to install multiple service providers' apps due to the absence of a uniform smart parking platform.
- With the growth of smart parking penetration, city governments might face some challenges. For example, fewer ticketing workers are needed, as the system can cover a wider range of parking spaces.
- Another issue is that drivers may be unfamiliar with the mobile apps for parking payment.

User Recommendations

- Parking lot owners, real estate owners, car service providers, and government CIOs should prioritize smart-parking-related investments because of their high potential to reduce congestion, decrease fuel consumption and develop local merchant business.
- End users should link the smart parking platform with digital business platforms among multiple organizations (for example, parking garage owners, parking application providers, real estate management service providers and commercial merchants). They should prepare incentive programs to promote the service to car owners by installing smart parking apps in their smartphones or follow service accounts in Alipay or WeChat.
- City governments and commercial parking service providers should invest to encourage car owners to use the smart parking service at more attractive prices. Also, owners should protect smart parking lots with surveillance systems.

Sample Vendors

Alibaba; ETCP; JIESHUN; Keytop; Tencent

Gartner Recommended Reading

Hype Cycle for Smart City and Sustainability in China, 2020

Market Trends: Collaboration Is the Key to Service Providers' Success in Smart City Projects

Connected Cities: Road Traffic Management — IoT Opportunities Include Road Tolling and Smart Parking

Computer Vision in Smart Cities

Analysis By: Tracy Tsai

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Computer vision (CV) for smart cities in China is the process of capturing, processing and analyzing images and videos to extract meaningful, contextual information. CV for smart cities in China includes but is not limited to various applications, such as public surveillance and security, identification for boarding transportation, finding lost people, traffic flow control, parking lot management, and other video and image analytics use cases.

Why This Is Important

CV technology is important for smart cities in China for the following:

- Operation efficiency to handle large population and geography
- Operation quality to mitigate the risk of human errors
- Citizen and public safety, which can include identifying possible crimes, monitoring large crowd gatherings and social distancing, and monitoring luggage via X-ray inspections
- Citizen satisfaction for government services
- Government operation transformation with measurable outcomes

Business Impact

CV for smart cities in China can:

- Effectively allow governments to monitor communities, and identify and recognize individuals during emergency events (e.g., natural disasters)
- Allow law enforcement officials to find suspects and reduce crime rates through surveillance systems
- Improve transportation management, such as traffic flow.
- Improve citizens' experiences, such as face scanning for a fast pass in theme parks
- Enhance civil engineering facility safety and quality, such as inspecting tunnel walls

Drivers

- Drones or infrared cameras for thermal images that effectively monitor quarantines in communities during a pandemic
- Continual expansion of CV applications to support the Chinese government's digital transformation initiative.
- Competition among local cities, provincial and central governments with regard to implementing advanced technologies that support government transformation
- Large number of populations and geography that require an effective approach to manage citizen safety and civil engineering operation quality
- Maturity of technologies and large number of solution providers available in China

Obstacles

- Lack of collaboration between line of business (LOB) or domain users, and IT making it difficult to identify or validate new applications.
- Lack of third-party support for the niche applications in which the buyers are limited or market demand is not big enough to justify the investment. For these niche use cases, it is hard to find solutions, especially when it needs research development and good data quality.
- Lack of IT resources and professionals to launch AI projects, along with a gap of unbalanced resources and IT maturity, exists among cities and provincial and central governments.
- Lack of central data and application governance that results in different standards and rules in selecting vendors and also duplication of efforts and investments.
- Citizens' increasing concerns about their data privacy, possibly leading to resistance to the applications.

User Recommendations

- Form a centralized IT department that manages the governance of data, application, vendor selection and security requirements and so forth. The centralized IT department can provide relevant information and build a standard for local governments to improve the success rate of CV projects.
- Form a center of excellence team within the centralized IT department that assigns each team different tasks to manage CV applications.
- Build a CV application marketplace platform by collecting successful CV cases, solutions and vendor lists, and provide access to other cities, thus inspiring new CV application creations.
- Work with LOB staff to jointly identify and prioritize use cases that deliver high impact and measurable business outcomes.
- Gain citizens' trust by building privacy protection guidance for application development and assessment.

Sample Vendors

AInnovation; Alibaba Cloud; Baidu; DJI; Huawei; JD.com; MEGVIIi; SENSCAPE; SenseTime; Tencent

Gartner Recommended Reading

Competitive Landscape: Top Cloud-Based AI Services in China

Hype Cycle for Smart City and Sustainability in China, 2020

Emerging Technologies: Tech Innovators for Computer Vision

Blockchain in Government — China

Analysis By: Arnold Gao

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Technically, blockchain is an expanding list of cryptographically signed, irrevocable transactional records shared by all participants in a network. Each record contains a time stamp and reference links to previous transactions. Conceptually, blockchain refers to a broader, decentralized architecture that has the potential to disrupt, for example, data sharing, business model transformation or governance.

Why This Is Important

Blockchain in China has more advanced progression compared to the rest of the world due to strong support from the government. In 2019, blockchain was designated a "national priority" and has become part of China's 14th five-year plan in 2021. Blockchain, together with digitalization are the two most frequent keywords mentioned in local governments' strategy planning reports.

Business Impact

Blockchain can be used as a digital platform:

- To enable data sharing among various government bodies.
- To build a technology infrastructure to support the smart city and digital government initiatives.
- To form a novel social governance model, where the government plays a key role to reinforce the trust in the society.

Drivers

- In April 2020, blockchain was officially included in China's "new infrastructure" initiative, as a new technology infrastructure. In the public sector, there are increasing demands to transform governments' digital platforms in order to improve the efficiency of public services. For example, the local government of Hangzhou issued a bid in December 2020 for its blockchain-empowered digital stamp platform to enable trusted transactions between government bodies, enterprises and individuals.
- In addition, the investment amount in blockchain projects has increased over the past few years. In 2016, a blockchain POC project for government cost less than 1 million renminbi, while a recent blockchain technology platform project for the government Xiong'an cost 38.51 million renminbi, and another blockchain-empowered financial service platform project cost Xiong'an 35 million renminbi.
- In 2021, more than 20 local governments in China have mentioned blockchain projects in their annual work reports, with e-government and digitalization as the main use cases. China's fiat digital currency (DC/EP) also uses blockchain as part of its technology infrastructure. The initiative is being tested in a few selected locations in China and will move to wider adoption to replace paper cash in the future.

Obstacles

- Blockchain is still facing challenges to massive adoptions, although the local governments have started the implementation in various use cases.
- As the technology itself is still nascent, many government-led applications can be built by blockchain but also by other alternative technology solutions.
- While the government has determined to move forward with blockchain, there are limited use cases that have truly exploited the value from this technology.

User Recommendations

- Avoid having the expectation that blockchain can solve business problems as a single technology, and make significant investments with a limited number of solid use cases.
- Apply blockchain as an enabling technology together with other matured technologies to improve the efficiency of existing business operation digital platforms.
- Create blockchain-inspired solutions to provide services to unserved or underserved customers; solutions that do not meet all the aspects of blockchain, but that adopt blockchain's notion.

Gartner Recommended Reading

Guidance for Blockchain Solution Adoption

Evaluate Promising and Maturing Blockchain Use Cases in Government

Promising, Practical Blockchain Use Cases for Governments

Advanced Metering Infrastructure

Analysis By: Uko Tian, Milly Xiang

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Advanced metering infrastructure (AMI) is a composite technology comprising several elements — consumption meters, a two-way communications channel, a data collection engine and a data repository (meter data management). Jointly, they support all phases of the meter data life cycle — from data acquisition to final provisioning of energy consumption information to utility applications, corporate users or end customers. AMI in this document focuses on electricity, gas and water.

Why This Is Important

AMI is a vertical example of an Internet of Things (IoT) technology that plays a significant role in utility digitalization. As state-owned enterprises, China's utility companies are tasked with digital transformation to ensure energy supply, improve energy efficiency and generate new revenue streams. By integrating with AI and data analysis tools, the government can also achieve better social governance based on AMI data.

Business Impact

AMI enables dynamic pricing of energy so the government can improve the structure of the energy market and stabilize energy demand and supply. Utility companies use AMI to reduce cost on meter reading and increase revenue through theft prevention. AMI enables enterprises to dynamically plan based on energy usage and pricing to optimize business operations and energy management. It also enables business innovation in value-added services by providing two-way communications.

Drivers

- AMI adoption is expected to increase as it is an essential part of smart cities as well as "smart water" and "smart gas" initiatives listed on many cities' agendas. China's "new infrastructure" initiative will further drive integration of emerging technologies, such as big data and cloud, with AMI.
- The implementation of stepladder prices for gas and water will directly lead to an increase in the demand for smart meters and metering data analysis.
- In 2020, the penetration rates for smart electricity meters, smart gas meters and smart water meters in China were estimated to be 90%, 50% and 30%, respectively. There is still great potential for growth.
- Three Chinese telecom operators have established nationwide NB-IoT networks, as the first choice for smart meters connection. With the increase in usage, the module cost has also reduced, easing users' concerns about the cost of adopting AMI.

Obstacles

- Most AMI players are traditional smart meter providers with industry know-how, but their IT knowledge is limited. Hence, AMI deployment focuses on the establishment of front-end devices and connections, but the platforms and application development remain relatively weak. Lack of capability to utilize the collected metering data will make it difficult to fully realize the value of AMI.
- Utility companies currently run in a planning mode. To leverage AMI, they need to transform their business models from planning systems to become more market-oriented or consumer-oriented. This culture shift is greater than the technical challenges.

User Recommendations

- Have a clear understanding of project ownership, expected deliverables, governance issues, security, consumer communication, technology maturity and the vendor's expertise before adopting AMI as it spans both OT and IT domains.
- Ensure IT asset management best practices are followed when considering the operation and management of AMI assets. Maintaining smart meters is increasingly becoming a part of IT's job.
- Ensure your AMI meets a wide spectrum of requirements for data latency, persistence and the scalability of energy consumption data to support a variety of applications and end-user needs.
- Deploy advanced metering with frequent meter readings to understand energy consumption patterns and uncover potential savings opportunities.

Sample Vendors

Goldcard Smart Group; Itron; Suntront Technology; Wasion Group; Xylem

Gartner Recommended Reading

Market Guide for Meter Data Management

Industry Insights: Utility Market Trends and Analysis Roll-Up

Top 10 Trends Driving the Utility Industry in 2021

EV and Charging Infrastructure

Analysis By: Roger Sheng

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Electric vehicle (EV) and charging infrastructure are both in the new energy vehicle application domain. EVs can use battery-stored electricity to power vehicles' engines and can be recharged with a power socket. Charging infrastructure provides electric charging service in public or residential areas.

Why This Is Important

Reducing carbon emission to realize carbon neutrality is one of key initiatives in China to ease the greenhouse effect. The development of EVs to replace traditional internal combustion engine (ICE) vehicles has been an effective solution to reduce carbon emissions. In 2020, over 1.1 million EVs were sold in China, which has been the largest EV market for years. To support this penetration of EVs, there are more than 1.8 million charging piles and stations in China.

Business Impact

Automakers in China must produce more EVs to reduce carbon trading costs, and transportation service providers must adopt EVs to reduce carbon emissions in commercial operations. As EVs and charging infrastructure escalate power demand, balancing power usage in the nighttime versus daytime is important; more individual EV users will charge overnight. To meet EV charging requirements, such as fast charging and safety, utility energy service providers need to redesign the power infrastructure.

Drivers

- **Government:** The Chinese government is enabling adoption of EV and charging infrastructures in the country to meet carbon neutrality objectives and establish an independent EV manufacturing industry. The huge government subsidies have reduced the entry barriers in the EV market to accelerate market growth. Especially in the public transportation area, billions of dollars are spent on subsidies to realize city bus electrification. Individual EV buyers can also receive government subsidies for charging pile installations. In many large cities, consumers can get a free license plate for EVs if traditional license plates are expensive or difficult to obtain.
- **Automakers:** Emerging EV automakers in China are aggressively promoting their products. They are improving product quality and expanding their sales channels to gain more market share. In 2020, Tesla sold 139,000 EV cars in China after its gigafactory started production in Shanghai. Local emerging brands, like NIO and XPeng Motors, have also had significant shipment growth despite huge financial losses in the beginning stages.
- **Utility companies:** Utility companies are investing in EV and charging infrastructure for business growth. State-owned power utility companies are offering cheaper prices at night, reducing the cost of EV charging.
- **Power charging service providers:** Service providers are aggressively expanding charging services in public areas by building more charging piles and stations. They have already built charging infrastructure in shopping malls and public areas in most cities to provide convenient charging service to EV users.

Obstacles

- **Shorter driving distance compared to the traditional ICE cars:** Although more EV cars supporting more than 500km battery driving cycle are now being introduced, the real driving distance per charging reduces significantly with high-speed driving or during the cold weather.
- **Slower charging performance compared to oil and gas:** It usually takes more than eight hours to fully charge the vehicle in the normal charging pile and around two hours in the fast-charging station. This will pose a huge challenge when EV reaches the mainstream market without sufficient charging infrastructure.
- **High battery cost:** Currently, the battery is the single most expensive part of EVs, to the point that the battery cost decides the price of EVs. Battery cost reduction is essential to reduce the price of EVs and drive market penetration.

User Recommendations

EV or plug-in hybrid electric vehicle (PHEV) manufacturers:

- Engage with car manufacturing partners to build local factories close to the target market.
- Develop innovative business models such as car rental business models as a part of smart transportation service for smart city initiatives.
- Cooperate with relevant internet automotive service providers to implement connected functions and an advanced driver-assistance system (ADAS) on new platforms preparing for the transformation of a smart car service provider.

Power-charging service providers:

- Work with digital map and navigation service providers to provide location charging facility information for EV users.
- Develop a price matrix for different kinds of EV users (individual, commercial or public) and for different charging places (residential, commercial or public areas) to ensure return from infrastructure investment.
- Adopt a sharing business model for power charging stations to increase utilization.

Sample Vendors

BYD; NIO; Star Charge; Tesla

Gartner Recommended Reading

Hype Cycle for Smart City and Sustainability in China, 2020

IoT in Smart Cities

Analysis By: Milly Xiang

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

The Internet of Things (IoT) is the network of dedicated physical objects that contain embedded technology to communicate and sense or interact with their internal states and/or the external environment. IoT applications are enabling smart city initiatives, providing the ability to remotely monitor, manage and control devices, and to create new insights and actionable information to support city administration and citizen engagement.

Why This Is Important

The expectation of a 65% urbanization rate in China in the next five years will drive more cities to technologies and advanced networks to manage resource constraints. The number of smart city IoT projects is significantly increasing, driven by:

- Urban infrastructure renewal
- “New Infrastructure” initiative
- Transition to data-driven city planning and administration

Areas with early deployment and benefits from IoT include public safety, road toll and traffic management, parking, and so forth.

Business Impact

IoT deployment in smart cities potentially impacts the entire urban ecosystem:

- Government organizations — To increase visibility of the city infrastructure status and improve decision making and planning
- Citizens — To irrevocably change their environments in all aspects of urban experience and government services, including living, commute, entertainment, etc.
- Local industry — To harness the IoT data gathered through sensors to optimize their business models and analyze user behavior

Drivers

- According to Gartner's Internet of Things Forecast Database, 2021 will see a quick rebound of spending in IoT smart cities following the pandemic. The total worldwide IoT endpoint shipment is expected to increase by 23.5% and then grow with a 2020 through 2025 compound annual growth rate of 12.8%.
- China is leading the recovery, with market activities resumed in smart cities since the second half of 2020.
- Many of the changed requirements and behaviors by the pandemic (such as touch-free, safety-oriented and community resilience) will persist even when the crisis wanes, driving IoT deployment in smart cities.
- The value of IoT adoption will be further enhanced by technologies such as artificial intelligence (AI), edge computing, digital twin and more to shift from simple monitoring to more complicated applications through prediction and simulation.
- Cities are increasingly realizing that the value of IoT deployment lies in the enablement of more applications and are exploring more insights out of data to transform city operation and core service delivery. For example, leading cities in China are starting to shift from an infrastructure-centric approach toward a data-centric approach in their IoT strategies. This shift will help to unlock more value out of the IoT-enabled infrastructure and data assets when these deployments are not considered in isolation, but rather planned and leveraged across different government organizations and across the entire urban ecosystem.
- To address budget issues, various municipalities are exploring public-private-partnership (PPP) models, such as management contracts, operating contracts, long-term leasing, build-operate-transfer, design-build-own and others. This will help release the initial capital expenditure burden from the government organizations and accelerate adoption.

Obstacles

The IoT scale-up challenges in smart cities remain. Gartner's 2020 IoT Implementation Trends Survey shows that technical complexity and immaturity, security or privacy concerns, and integration challenges are the biggest barriers in scaling IoT activities:

- The majority of IoT technologies are still two to five years from mainstream adoption, and many may require over five years.

- IoT blurs the line between physical and digital worlds, thus leading security concerns beyond cyber to the safety of residents and the reliability of the physical environment.
- IoT projects in cities need to be not only technically effective, but also socially acceptable, by observing compliance with local privacy laws and regulations, practices, and ethical standards.
- New integration challenges, compounded by the lack of industry standards, are inherently introduced because of diverse IoT endpoints, event-driven IoT data streaming and new IoT analysis-based workflows to drive back-end city applications.

User Recommendations

- Adopt a platform-based approach to integration rather than multiple siloed point solutions.
- Prioritize IoT deployments, focusing on accelerated initiatives that shape the post-COVID-19 future of cities and address the sustainable market and behavior change.
- Work across departments to build a holistic smart city IoT strategy and priorities by engaging the city stakeholders to identify short- and long-term projects.
- Build new skills around technologies such as AI, edge computing and digital twin, and develop a phased strategy to align IoT deployment with these technologies by expanding use cases over time as technologies mature.
- Be alerted to potential events around social, legal and ethical issues. Review strategy and policies in this area on a regular basis.
- Retrain government workforce to leverage these new technologies to fully realize the benefit of IoT, by helping them handle the challenges of disrupted work processes and policies, different skills and toolset requirements.

Sample Vendors

Alibaba Cloud; Baidu; China Telecom; H3C; Hikvision; Huawei; SenseTime; Tencent Cloud; Terminus Technologies

Gartner Recommended Reading

Market Trends: 5 Smart City IoT Deployment Trends to Drive Innovation Opportunities

Market Trends: 3 Trends Impacting the Measurement of Smart City Technologies Benefits

Climbing the Slope

Government Cloud in China

Analysis By: Kevin Ji, Tao Wu, Evan Zeng

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

In China, the government cloud is a form of community cloud that is constructed by cloud providers and hosted either by the government's on-premises data center or in an authorized colocation, most likely in a local carrier's facility. The goal is to achieve data sharing, operation efficiency and citizen service convenience.

Why This Is Important

The current fragile infrastructure cannot support innovative demand in the digital era, and legacy systems do not have the capability to support agile innovation solutions. The Chinese government has planned to build the digital system through government cloud service to improve the delivery agility and enable innovative services, especially in citizen service, through digital channels, powerful data analytics enablement and consolidated infrastructure to improve utilization.

Business Impact

- Government needs to keep data in an authorized location, so it is hard to use commercial public cloud services to operate the government cloud services.
- Government pursues new distributed computing technology to replace current fragile legacy infrastructure. National CSPs provide government-only instances as a private cloud.
- Government built the capability to manage the private cloud, which may engage new vendor ecosystems that can enable outsourced private cloud.

Drivers

When IT leaders in government agencies implement government cloud, they must:

- Evaluate the impact of COVID-19. We expected the acceleration of government cloud adoption in China, since it is part of new infrastructure that can enable digital government and strengthen government service.
- Improve government efficiency. The One-Shop initiative is a well-known flagship government solution in China. In the past, citizens spent a great deal of time raising several requests to different government agencies to deal with one thing. The One-Shop initiative helps citizens get things done with one request. This transformational initiative drives the government's role from controlling the economy to enabling the economy through servant leadership.
- Challenge budget funding. To make efficient progress on the digital government initiative, big data agencies may engage in every government IT budget approval process to validate the feasibility. This drives many government agencies to start using government cloud and migrate data into the cloud platform. But this also generates extra cost on migration.

Obstacles

- Unmatched procurement process. Government agencies have a solid and complex open-bidding process in order to mitigate the risk. Government cloud bidding transforms from a capital asset allocation model to a service consumption model.
- Lack of talent pool. Existing resource focus on traditional IT infrastructure support. It is hard to engage enough talent because of the challenge of an attractive salary and planned career path.
- Data-sharing enablement. If a government agency plans to build the solid data structure to process data analysis, it is a big challenge to modernize the application architecture and standardize the data structure across different agencies.

User Recommendations

- Align digital government initiatives with stakeholders, and engage high-value delivery first. It is easy to set procurement priorities accordingly.
- Build suitable data governance to consolidate and share the data with authorized agencies or apps for citizens.
- Change the resource-funding process from asset procurement (capital cost) to a service subscription model (operational cost) in order to fit the new cloud service usage practice.

- Build solid cloud governance and delivery based on a multiyear plan and multidiscipline representatives, as government agencies are accountable for the delivery result.

Gartner Recommended Reading

Responsibility for 'Cloud First' in Government Must Be Spread Widely

Quick Answer: Is Government Migration of Cloud Successful?

Natural Language Technologies for Government

Analysis By: Adrian Lee, Tracy Tsai

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Natural language technology (NLT) is a subfield of linguistics, computer science, artificial intelligence and the use of machine learning techniques to enable intuitive forms of communication between humans and systems, and analysis of those contents. Governments use NLT applications (such as chatbots) and services (such as text analytics) to interact with its citizens or businesses, ultimately to improve the operational outcomes of both external- and internal-facing processes.

Why This Is Important

Speech-to-text technologies were the earliest adopted NLT applications in China. In the pandemic, NLT was used to extract insights from social media regarding patient symptoms and spread of infection. The Chinese government also uses NLT to gauge citizen sentiment in state government interactions. NLT — supported by the need to handle high volumes of citizen interactions and the national AI development plan — will play a central role in government administration and citizen services.

Business Impact

NLT for government enables:

- Chatbots and virtual assistants for delivering low-friction customer services to citizens and for providing internal government workforce services
- Speech-to-text technologies to facilitate easier information capture in forms for citizens
- Automation for case management, citizen services and grant award processing
- Sentiment analysis for market research on services and conversion into insightful data
- Multimodal integration as part of biometric-driven citizen identity solutions

Drivers

- Focus on citizen experience and service efficiency, together with support for social risk management and postpandemic recovery, to contribute to the Chinese government's use of chatbots and virtual assistants, especially in organizations with high customer service demand.
- Strong and growing interest in the adoption of other NLTs, such as text analytics, emotional AI and other value-added services, to improve the overall conversational experience.
- Real-time and asynchronous machine translation for communication and correspondence between officials of different countries.
- Growing adoption of business intelligence and analytics with NLT-enabled applications, lowering the adoption barrier for citizen scientists in the government and public sector.

Obstacles

- User reluctance to adopt NLT applications like chatbots, when communicating sensitive personal information, such as medical or health records.
- Highly specific language models (such as low-resource Chinese dialects or variants) need to be created by vendors to improve the NLT performance across different government domains.
- There are concerns over citizen privacy and security when used for monitoring of public citizens.

User Recommendations

- Identify your organization's objectives and the kind of incremental value-add to citizens that the NLT-based applications will bring.
- Seed and scale by starting with text-based applications before moving into voice-enabled ones.
- Collaborate with line-of-business stakeholders on how to scope your NLT product requirements, features and experiences, such as building a shared understanding and common agreement on the taxonomy and ontology to ensure the data scope and quality.
- State your requirements during preliminary vendor qualification to ensure that automatic speech recognition (ASR), STT, text to speech (TTS), NLP, domain knowledge graphs and ease of use are offered.
- Request vendors to provide an inference model for testing with citizen data. Each model needs to be trained and optimized with a new set of data.
- Be prepared to change to or add new providers of conversational platform applications.

Sample Vendors

Alibaba Group; Baidu; Emotibot Technologies; iFLYTEK; Tencent; Xiaoi

Gartner Recommended Reading

Cool Vendors in Natural Language Technology

Hype Cycle for Natural Language Technologies, 2020

Product Manager Insight: Drive Growth From Hyperautomation With 5 Natural Language Technology Areas

Competitive Landscape: Top Cloud-Based AI Services in China

Entering the Plateau

Smart Lighting

Analysis By: Nick Jones

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

Smart lighting is a lighting system connected to a network that can be monitored and controlled from a centralized point or via the cloud. These systems typically include controls, connectivity, analytics and intelligence. They usually exploit LED technology for energy efficiency. Advanced smart lighting systems can also integrate Bluetooth beacons, support location tracking, provide sensor information to other systems and (in a few cases) deliver networking using Li-Fi.

Why This Is Important

Smart lighting provides substantial energy savings compared to “dumb” lighting by combining energy-efficient LEDs with dynamic control systems. Some smart lighting systems include features such as spectrum control for visual effects or circadian lighting. Also, the light fittings, networks and control systems for smart lighting can support a range of sensing and wireless communications technologies for smart building or smart city applications.

Business Impact

- Energy-efficient dynamic lighting to improve citizen safety and quality of life
- High-quality indoor lighting that can be integrated with building management systems to optimise smart building energy usage
- Customisable or circadian lighting to improve the working environment
- Spectrum-controlled lighting for decorative indoor and outdoor effects
- Reduced maintenance costs by networked monitoring

Drivers

- Sustainability demands, which require more efficient use of energy, with up to 70% less energy consumption with the usage of smart lighting
- Need for operational cost reduction in managing and maintaining indoor and outdoor lighting systems
- Need to improve quality of life in indoor offices or outdoor public spaces
- A desire for potential health and well-being benefits from circadian lighting
- A need for sensing and communications to deliver new capabilities such as utilisation sensing, workplace analytics and indoor navigation
- Opportunity to use the control network as a backbone network for smart city sensing
- A desire to improve occupant satisfaction and convenience, by providing personal and dynamic control over lighting levels and effects
- Financial savings from innovative “light as a service” business models that reduce the capital cost of deployment or retro fitting into existing buildings
- Ability of smart lighting to provide data networking services in a few cases using Li-Fi, although this is rather niche

Obstacles

- High capital cost to replace existing indoor or outdoor lighting systems
- Li-Fi integrated with smart lighting being niche because it provides limited value
- The need to adopt new strategies for using and controlling lighting and the spaces it supports, to gain the maximum benefits
- Challenges of cost-justifying intangible benefits in the areas of working conditions and well-being
- Use of proprietary communications and control protocols by many smart lighting systems, limiting interoperability and creating large integration costs with other systems such as building management

User Recommendations

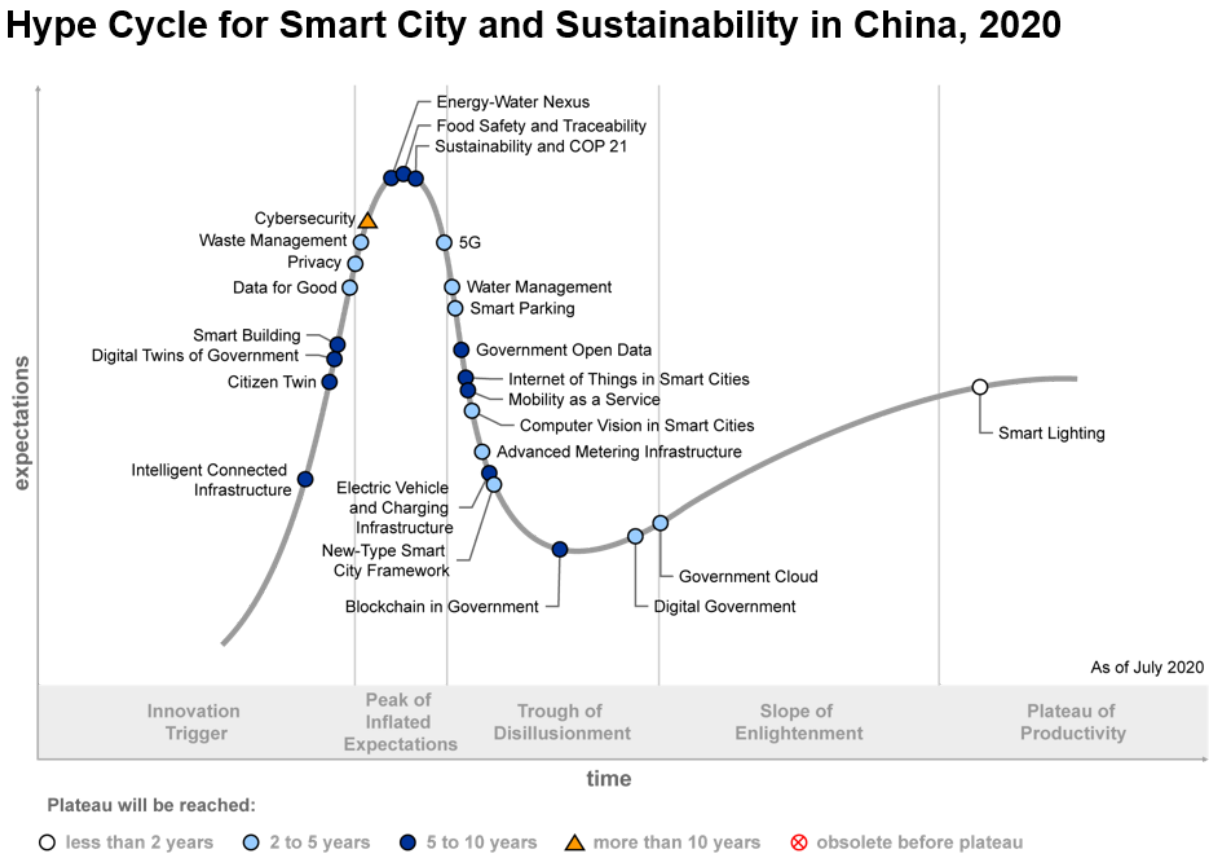
- Replace legacy street lighting with smart lighting systems to reduce operational costs, achieve sustainability goals and improve citizen experiences. (Recommended for city administrators.)
- Replace indoor lighting systems with smart lighting in offices and factories to improve the working environment and save money. Look for vendors that can provide business models that reduce the capital cost. (Recommended for facilities managers.)
- Ensure there is a business and technology solution to obtain sensor and operational data from new smart lighting system deployments to support goals such as integration with space booking and workplace space optimisation systems. (Recommended for CIOs.)

Sample Vendors

Acuity Brands; OSRAM; Signify; Telensa

Appendixes

Figure 2: Hype Cycle for Smart City and Sustainability in China, 2020



Source: Gartner
ID: 448109

Gartner

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 2: Hype Cycle Phases

(Enlarged table in Appendix)

Phase	Definition
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
Trough of Disillusionment	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the innovation to reach the Plateau of Productivity.

Source: Gartner (July 2021)

Table 3: Benefit Ratings

Benefit Rating ↓	*Definition* ↓
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2021)

Table 4: Maturity Levels

(Enlarged table in Appendix)

Maturity Levels	Status	Products/Vendors
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constrains replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2021)

Document Revision History

Hype Cycle for Smart City and Sustainability in China, 2020 - 31 July 2020

Hype Cycle for Smart City and Sustainability in China, 2019 - 26 July 2019

Hype Cycle for Smart City and Sustainability in China, 2018 - 18 July 2018

Hype Cycle for Smart City and Sustainability in China, 2017 - 28 July 2017

Hype Cycle for Smart City and Sustainability in China, 2016 - 14 July 2016

Hype Cycle for Smart City and Sustainability in China, 2015 - 27 July 2015

Hype Cycle for Green IT and Sustainability in China, 2014 - 21 July 2014

Hype Cycle for Green IT and Sustainability in China, 2013 - 29 July 2013

Hype Cycle for Green IT and Sustainability in China, 2012 - 2 August 2012

Recommended by the Authors

Some documents may not be available as part of your current Gartner subscription.

Understanding Gartner's Hype Cycles

Create Your Own Hype Cycle With Gartner's Hype Cycle Builder

Postpandemic Scenarios: The Future of Smart Cities

Market Trends: 3 Trends Impacting the Measurement of Smart City Technologies Benefits

Communicate the Value of a Smart City Solution Using a Tiered Outcome Approach

Infographic: Artificial Intelligence Use-Case Prism for Smart Cities

Predicts: Smart City Resilience and Citizen Experience Will Drive Sustainability and Urban Attractiveness

---

Table 1: Priority Matrix for Smart City and Sustainability in China, 2021

Benefit ↓	*Years to Mainstream Adoption*			
	Less Than 2 Years ↓	***2 - 5 Years*** ↓	***5 - 10 Years*** ↓	***More Than 10 Years*** ↓
Transformational		Computer Vision in Smart Cities IoT in Smart Cities	Smart Building Sustainability and COP 21	

Benefit ↓	*Years to Mainstream Adoption*			
	Less Than 2 Years ↓	*2 - 5 Years* ↓	*5 - 10 Years* ↓	*More Than 10 Years* ↓
High	Smart Lighting	5G Advanced Metering Infrastructure Environment Monitoring and Management Government Cloud in China Privacy in China Smart Parking Urban Waste Management Water Management Analytics	Blockchain in Government — China Citizen Twin Digital Twins of Government EV and Charging Infrastructure Food Safety and Traceability Heavy-Duty EV Charging Intelligent Connected Infrastructure Intelligent Street Pole Natural Language Technologies for Government Open Government Data Smart City Transportation Strategy Underground Infrastructure Management	CPS Security
Moderate		Data and Analytics for Good	Energy-Water Nexus	
Low				

Source: Gartner (July 2021)

Table 2: Hype Cycle Phases

Phase	*Definition*
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
Trough of Disillusionment	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the innovation to reach the Plateau of Productivity.

Phase ↓	Definition ↓

Source: Gartner (July 2021)

Table 3: Benefit Ratings

Benefit Rating ↓	Definition ↓
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2021)

Table 4: Maturity Levels

Maturity Levels ↓	*Status* ↓	*Products/Vendors* ↓
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constrains replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2021)