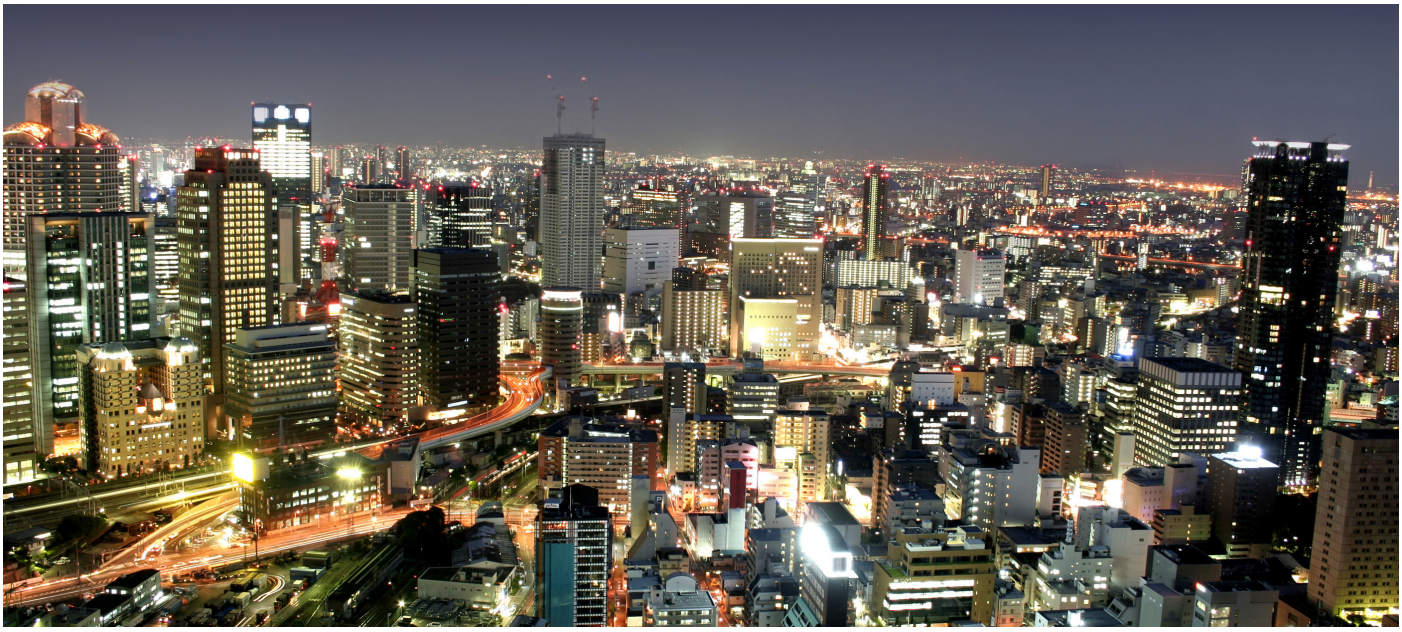

GETTING SMART ABOUT SMART CITIES

UNDERSTANDING THE MARKET OPPORTUNITY IN THE CITIES OF TOMORROW

Telecommunications service providers are not playing a primary role in smart city projects, even though they have strengths and assets that can be leveraged to enable smart city environments. Telecom networks are, in many cases, essential to realize the objectives of the other industries driving the development of a smart city, and machine-to-machine (M2M) and machine-to-machine-to-human (M2M2H) communications technologies (also known as the Internet of Things) are basic requirements for an effective smart city. However, service providers tend to take a reactive, back seat role in the smart city development process. Their involvement remains limited, which means they run the risk of having to compete with utilities, cable companies, and other types of service providers, to provide information and communications technology (ICT) services. This report presents an analysis of the smart city concept, and provides insights into opportunities for service providers to leverage their assets in a proactive way by partnering with the key players in a smart city project.

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SITUATION: THE SMART CITY OPPORTUNITY

There are many definitions of a smart city. Although most differ primarily in their emphasis on a few key characteristics, all point to the use of technology and networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development.

The smart city concept is really a framework for a specific vision of modern urban development. It recognizes the growing importance of information and communication technologies (ICTs) as drivers of economic competitiveness, environmental sustainability, and general livability. By leveraging ICT as a core element of their development, the smart cities of the future will foster economic growth, improve the lifestyle of citizens, create opportunities for urban development and renewal, support eco-sustainability initiatives, improve the political and representative process, and provide access to advanced financial services. The right ICT infrastructure will affect the way each city will be created and evolve. It will enable smart cities to include vastly enhanced sustainable areas, such as smart buildings, smart infrastructures (water, energy, heat, and transportation) and smart services (e-substitutes and e-services for travel, health, education, and entertainment), which drastically change the urban experience for city dwellers and travelers.

To work together, all technologies and services used in smart cities require common open platforms and an underlying ubiquitous ICT infrastructure, which includes high-speed Internet access, wired infrastructure and wireless networks. They also need an ICT application and service enablement suite, which includes smart media service enablers and citywide open access to sensors and actuators.

For telecommunications service providers and alternative operators, such as utilities and cable TV companies, and the telecom equipment vendors who supply the hardware and software that enable broadband networks, this means that each smart city infrastructure must have:

- **An all-IP core network**, which creates a converged infrastructure for buildings and ICT systems, and seamlessly integrates wireless and wireline technologies
- **A broadband access network**, which can support the integration of numerous components via wireless, wireline, copper, fiber, and other access nodes to make a city "smart" by enabling advanced services and applications, such as telecommunication coordination, urban traffic management, building automation, lighting and energy management, access and security networks

At first glance, this implies that smart cities offer a major market opportunity that can be easily exploited by telecommunications service providers and their telecom equipment partners. However, although the opportunity exists, capitalizing on it is not as straightforward as it seems.

A variety of players and objectives

A close study of 52 smart cities (Table 1) conducted in 2011 by the Alcatel-Lucent Market and Consumer Insight team revealed a variety of ecosystem players involved in the realization of smart city projects. These players span many government levels and multiple disciplines, and those from the business world range from small private firms to large multinationals. Interestingly, there is no single definitive way in which all players behave and work together. Roles vary based on the nature of each player's business and the smart city's goals.

Table 1. Smart city projects researched

CITIES	
1. Amsterdam (The Netherlands)	27. Malmö (Sweden)
2. Ballarat (Australia)	28. Masdar (UAE)
3. Besançon (France)	29. Moncton (Canada)
4. Birmingham (U.K.)	30. Ottawa (Canada)
5. Bottrop (Germany)	31. Paredes (PlanIT Valley, Portugal)
6. Bristol (U.S.A.)	32. Pedra Branca (Brazil)
7. Cape Town (South Africa)	33. Porto Alegre (Brazil)
8. Chattanooga (U.S.A.)	34. Quebec City (Canada)
9. Cleveland (U.S.A.)	35. Recife (Brazil)
10. Copenhagen (Denmark)	36. Riverside (U.S.A.)
11. Curitiba (Brazil)	37. Rotterdam (The Netherlands)
12. Dakota County (U.S.A.)	38. Shanghai (China)
13. Dongtan (China)	39. Shenyang (China)
14. Dublin (Ireland)	40. Songdo (South Korea)
15. Dublin (U.S.A.)	41. Sopron (Hungary)
16. Eindhoven (The Netherlands)	42. Suwon (South Korea)
17. Gdansk (Poland)	43. Tallinn (Estonia)
18. Gold Coast City (Australia)	44. Taoyuan (Taiwan)
19. Gujarat International Financial Tech-city (GIFT, India)	45. Tianjin Binhai (China)
20. Ipswich (Australia)	46. Toronto (Canada)
21. Issy-les-Moulineaux (France)	47. Trikala (Greece)
22. Jubail (Saudi Arabia)	48. Trondheim (Norway)
23. Kalundborg (Denmark)	49. Urumqi (China)
24. Lavasa (India)	50. Windsor-Essex (Canada)
25. Lyon (France)	51. Winnipeg (Canada)
26. Malaga (Spain)	52. Wuxi (China)

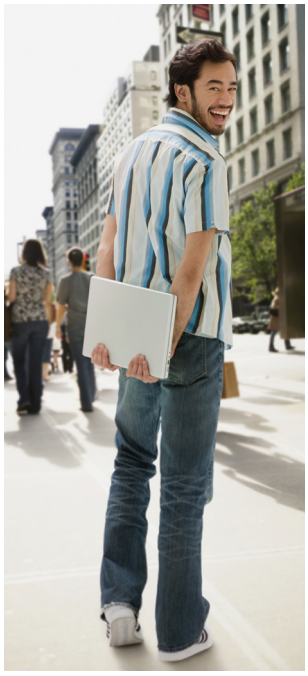
In addition, although ICT plays a major role in the development of a smart city project, the value propositions of most smart city initiatives do not position ICT as the key to the project's value. On the contrary, value propositions are typically more aligned with the respective motivations for the initiation of each project, while ICT is considered an enabler of the ultimate objective.

How and where ICT is used to create smart cities varies from project to project (Table 2). However, it is usually applied to improve a mix of public and private services:

- **City administration,** to streamline management and deliver new services in an efficient way
- **Education,** to increase access, improve quality, and reduce costs
- **Healthcare,** to increase availability, provide more rapid, accurate diagnosis, provide wellness and preventive care, and become more cost-effective
- **Public safety,** to use real-time information to anticipate and respond rapidly to emergencies and threats
- **Real estate,** to reduce operating costs, use energy more efficiently, increase value, and improve occupancy rates
- **Transportation,** to reduce traffic congestion while encouraging the use of public transportation by improving the customer experience and making travel more efficient, secure, and safe
- **Utilities,** to manage outages, control costs, and deliver only as much energy or water as is required while reducing waste

Table 2. Examples of main areas in which the smart city concept has been adopted in selected smart cities

AREA OF ADOPTION	EXAMPLE
Energy	• Energy networks, such as smart grids, smart meters, smart buildings (Amsterdam, Chattanooga, Dublin, Malaga, Masdar) • Renewable energy sources in a smart grid (Malaga) • Electric vehicles (Amsterdam, Malaga) • Power quality monitoring (Lavasa) • Energy conservation monitoring (Shenyang)
Telecom network	• Broadband development (Chattanooga, Dakota County) • Home automation (Lavasa, Malaga, and Masdar) • Internet access in public libraries (Cape Town) • ICT sector support and ICT training (Cape Town)
Transport	• City transport systems (Dublin, Lavasa, Shenyang, Trondheim, Dakota county) • Consolidated parking management technology (Lavasa) • Geographic Information System (GIS) (Lavasa)
Business support	• Library business corners for starting and running small businesses (Cape Town) • Digital business centers with telephones, faxes, scanners, photocopiers, etc. (Cape Town) • Retail (Masdar) • Business incubation center (Suwon) • Climate street (Amsterdam) • Electronic trade office (Suwon)
Intelligent community framework	• Guide for planning (Dakota County) • Education (Gdansk) • Recreation (Gdansk, Chattanooga, Dakota County) • Integrated security command center (Lavasa) • Automated messaging/mass Short Message Service (SMS) from a citizen call center (Lavasa) • Consolidated billing (Lavasa) • Residential (Masdar, Trondheim) • City administration center (Suwon)
Public utilities	• Water and sewage (Gdansk, Shenyang) • Streets (Gdansk) • Waste management (PlanIT Valley) • Food supply (Shenyang)
Industry sectors	• Petrochemical (Jubail).
Eco-sustainability	• Integrated environmental measures (Lavasa) • Smart building (PlanIT Valley, Masdar) • Environment management (Shenyang)
Technology development and innovation (academic based)	• Technology and innovation centers (Masdar and MIT)



ICT building block requirements

According to EUROCITIES[1], the major ICT requirements for a smart city will be future Internet technologies and services because they are and will be at the core of the society and economy. This includes disruptive Internet technologies that are now emerging, such as location-based services, the Internet of Things, trust and security platforms, and multimodal user interfaces. However, to work together, all these technologies and services will require common open platforms and must be introduced at the right time.

The Celtic-Plus Purple Book[2], an initiative of European telecom operators and telecom vendors, sees a smart city being created through four progressive stages of "smartness":

- **Stage 1 – Network infrastructure:** The infrastructure for the single Internet Protocol (IP) network must be considered during the planning stage and, for maximum impact, should be a part of the master development plan. Fiber optics should be installed as an integral element of each building during construction, so that it can be used to control all other utilities with the addition of active components, such as switches and routers.

- **Stage 2 – Content and communications:** During the second stage, the infrastructure lights up core services for the city, delivering telephony, broadband Internet access and video-on-demand (VoD) over a single network to enable smart homes, smart hotels, and smart businesses.

- **Stage 3 – Building intelligence:** In the third stage, intelligent infrastructures (environment management systems, mobility and transport systems, smart buildings, and smart energy grids) are introduced. Wireless sensors are enabled to automatically control pollution, lighting, cleaning, and waste optimizing carbon footprints, and reduce energy bills.

- **Stage 4 – E-services to citizens:** Finally, services and applications are introduced for information sharing, healthcare (remote medical care and ambient assisted living), education, entertainment, culture (museum, cultural activities), and commerce and exchange (micro-payment and micro-commerce). In addition, the community is made safe by closed circuit television integrated with a communications system. With these services, citizens can use Wi-Fi® at Internet cafes or portals in shopping malls or civic buildings for information or transactions. During a day in the city, a resident or visitor can buy movie tickets, pay for parking, place a bet, vote for a political representative, use a telemedicine facility, call an intelligent transportation system, or just order a pizza online.

To make all this happen, the two fundamental building blocks of a smart city infrastructure must be engineered to support immediate and future ICT requirements.

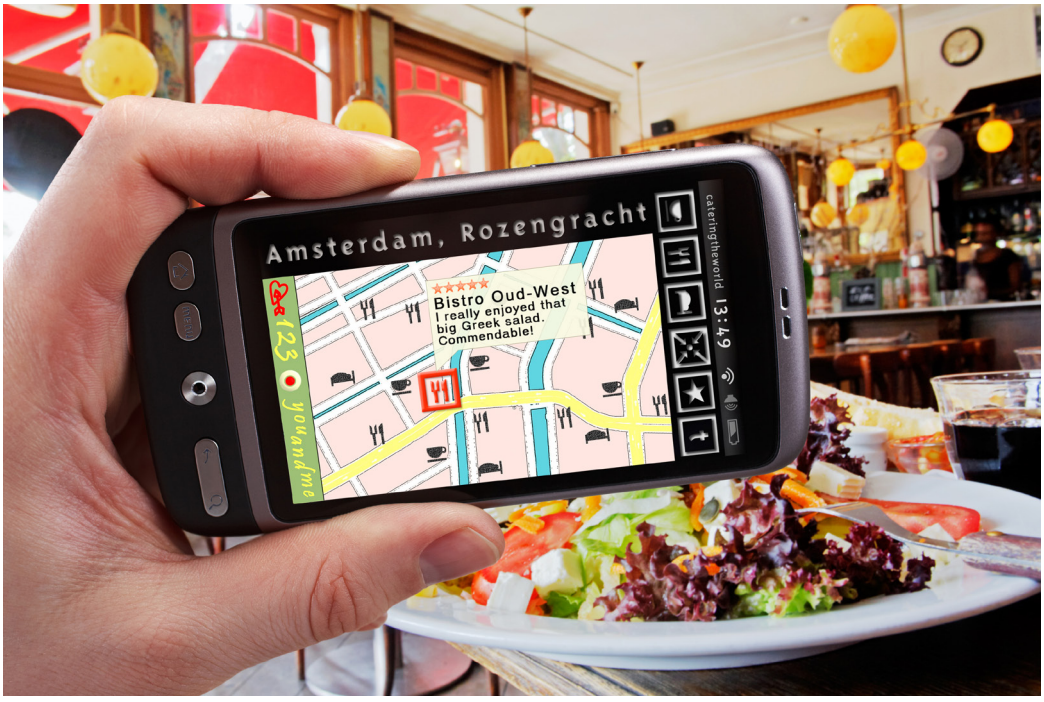
First, the **core network** must leverage IP Multimedia Subsystem (IMS)-based IP Centrex or IP Private Branch Exchange (PBX) technology. This is needed to support the enterprise level unified communications (UC) services that form the foundation of a smart city economy. Both solutions are suited for different scenarios. An IP PBX is suitable for a single enterprise, while a Centrex solution is more suited for service providers to deliver hosted Centrex services for several companies or large multinational enterprises. However, IP PBX requires professional maintenance personnel, which translates into increased maintenance costs. On the other hand, the IMS-based IP Centrex, which is usually deployed to deliver hosted PBX services, eliminates the need for separate maintenance.

Secondly, the **access network** must be built on Fiber to the x (FTTx). For the last mile in a smart city infrastructure some developers are choosing Gigabit-capable Passive Optical Network (GPON) technology, in addition to wireless technologies, such as Long Term Evolution (LTE), while others are exploring the feasibility of point-to-point (P2P) fiber connections. The multi-service bearing capabilities of GPON are assumed to outperform P2P Ethernet, because GPON supports Time Division Multiplexing (TDM), Asynchronous Transfer Mode (ATM), and IP services and integrates traditional interfaces with Ethernet interfaces. This is important because a smart city access network must accommodate legacy terminals and high-security services from organizations that require highly secure communications (banks, retailers). In addition, it must carry all the services of a variety of terminals, including voice over IP (VoIP) and Internet Protocol Television (IPTV) that require high reliability and quality of service (QoS).

A 2011 report from Ovum[3] provides a more detailed explanation of the key elements that make up these two fundamental building blocks (Table 3).

Table 3. Ovum's explanation of smart city ICT building block requirements

REQUIREMENT	EXPLANATION
Ubiquitous connectivity	• The essential, always on, element of a smart city infrastructure • Provides anytime/anyplace access to high-bandwidth, competitively priced Internet and mobile networks
Anytime/anyplace devices (convenience)	• Devices primarily designed for accessing services from the cloud via a Wi-Fi or 3G network
Collaboration platforms (teamwork)	• Unified communications and collaboration platforms that bring previously discrete technologies together (voice, SMS, e-mail, calendars, office automation tools, online meetings, and video conferencing)
Cloud computing (IT as a service)	• Computer processing, storage, and applications as a service over the Internet or a secure private network on a pay-as-you-go basis
Open standards	• Service-oriented Architecture (SOA), and ecosystems (IT assembly), with vendors producing interoperable hardware and software systems within a SOA
Geospatial platforms (place-based data)	• Easier, faster, and cheaper abilities to present and manipulate data on a map or aerial image
Internet of Things (real-time data)	• Increasing possibilities for connecting a wide range of sensors to the Internet
Advanced analytics (fact-based decisions)	• Rapid growth in innovation associated with making fact-based decisions and controlling events based on real-time data
Open access to public data (many eyes)	• Government agencies with "more eyes" that add value to data
Digitally controlled devices (real-time control)	• Integration into computerized home, building, and infrastructure control systems
Social networking (interactivity)	• Enabling and supporting community activity



The actual ICT elements used to create a smart city can vary significantly from city to city. This is a function of what is available and the requirements of each project. In general, greenfield cities typically require larger ICT projects because they usually involve new builds from scratch. However, brownfield cities require an evolution/transformation of existing ICT capabilities. Beyond product capabilities, smart cities also need a variety of services, including consulting, design, planning, monitoring, and maintenance (Table 4).

Financing challenges

Ensuring that the right ICT building blocks are in place in a smart city project requires a substantial financial investment, and financing remains one of the greatest challenges facing smart city initiatives. Therefore, success in the smart cities market by service providers requires an understanding of how smart cities are funded.

Although the benefits of smart city developments may be realized over the long term, the Harvard Business School notes that the staggering capital cost of such projects (estimated between 10 billion United States dollars for PlanIT Valley and 35 billion United States dollars for Songdo) typically requires funding from both the public and private sectors[4]:

- For some projects, such as Masdar, Nanjing, Meixi Lake, and Tianjin, governments provide a significant portion of the funding through state-owned banks or direct public sector financing. However, in some cases, it is expected that private developers and third parties will provide most development capital after the initial development phase is completed.

Table 4. Examples of ICT building block elements required in five of the 52 smart cities studied

CITY	ICT BUILDING BLOCKS
Chattanooga	**Services** • EPB will go head-to-head with providers, such as Comcast, to offer its existing customers an ultra-high speed Internet connection. **Customers** • EPB has 22 large industries ready to use the time-of-use pricing, which they forecast will save a combined 2.3 million United States dollars per year by allowing businesses to time their processes with when energy usage is least expensive.
Dakota County	**Services** • There is 74 percent residential broadband penetration and 95-100 percent penetration in business and education markets. • Dakota County is the first market where Comcast installed DOCSIS 3.0. **Customers** • Rural areas represent an opportunity for growth/penetration. • Data centers of multinational companies also form the core of a growing ICT cluster, while medical devices and logistics are emerging areas that could create interesting opportunities. • Public-private effort has already helped generate new ICT-dependent jobs equal to eight percent of the total population.
Lavasa	**Services** • ICT solutions that are needed include structured cabling, a citywide network, intelligent home solutions, digital lifestyle, gaming services, voice-data-video services, GPON-based network design, and Fiber to the Home (FTTH).
PlanIT Valley	**Services** • Given the importance of network and sensor technologies to the PlanIT Valley project, there was also a need for a simple and cost-effective infrastructure to enable easy integration of systems for monitoring and actuating building features, and to allow communication between multiple devices and sensors. • Approximately 100 million sensors will eventually be deployed throughout the city. **Suppliers** • Living PlanIT acquired its innovative sensor technology from McLaren Electronic Systems. The sensor and control technology will be embedded in the routers and software infrastructure to create a high-density network of low-energy and environmentally-hardened sensors, some of which will be embedded in material structures. • The Living PlanIT team includes engineers who were responsible for the development of the Simple Object Access Protocol (SOAP), the standard developed by Microsoft for web service integration and for Microsoft's .NET architecture. These engineers have used the same principles for easy integration of the PlanIT Valley infrastructure, which allows for development of new services and capabilities by partners. For example, PlaceApps allows location-based M2M applications to be built using services that interact with building systems, such as lighting or heating controls.
Suwon	**Technologies** • Technologies that are likely to be featured in u-cities include broadband convergence networks, radio frequency identification, ubiquitous sensor networks, home networking, WiBro, digital multimedia broadcasting, telematics, geographic information systems, location-based systems, smart card systems, and videoconference technologies.

- Other projects, such as Songdo and PlanIT Valley, rely on investments and capital from international companies, with governments providing incentives through various forms of indirect support and tax relief.
- All smart city initiatives expect to collect some revenue from real estate sales, long-term leases, and office rentals, while some include technology-based royalties to offset the capital requirements. This revenue is used to repay banks and other capital providers.
- Several projects plan to offer government-based economic and tax incentives to encourage corporations to establish offices in the city, which will drive demand for both office space and residential real estate.
- Some projects have developed an economically viable low-carbon model or a sustainability-oriented approach.
- PlanIT Valley is expected to become economically self-sustaining through revenue sharing arrangements and royalties for the use of intellectual property developed by Living PlanIT and its partners, annual partner fees, and PlanIT Valley participation fees.

The bottom line is that smart cities can only thrive if, as Accenture notes[5], they diversify their capital base and generate cash flow for reinvestment. As a result, public funding is used to unleash private and philanthropic capital, which is critical for future growth. Therefore, the policy and investment environment must be conducive to investment by private organizations, and the social, economic, and political benefits of investment must be clearly articulated in terms that each investor values. In addition, both development capital and procurement capital must be stimulated and supported differently to create supply and demand for low carbon technologies.

To date, the majority of smart city projects are centered on government service models. Therefore, for many projects, government funding is critical. Moreover, greenfield smart cities tend to have more structured financing models with well-defined contracts and licenses for industrial and residential development (Table 5).

Business models

To ensure the right level of financing is available through each stage of the development process, smart cities must choose an effective business model. In the past, urban development was viewed as a form of public works handled by national, regional, or other government agencies. In smart cities, development is increasingly being undertaken as an investment, particularly in emerging markets. As a result, smart cities are being constructed and operated as commercial enterprises. This has created a need for more efficient urban development and city management, especially in the early planning stages.

Table 5. Examples of financing in 18 smart city projects studied by Alcatel-Lucent

SMART CITY PROJECT	GREENFIELD/BROWNFIELD	INVESTMENT	FINANCING SOURCE
Amsterdam	Brownfield	200 m Euros	• Partly European fund for regional development
Birmingham	Brownfield	20 b BP	
Cape Town	Brownfield	355 m Rands	• City of Cape Town, national and provincial government
Chattanooga	Brownfield	$111.5 m US	• Grant from Department of Energy for smart grid • Internet funded separately
Dakota County	Brownfield		
Dublin	Brownfield		• European regional development fund for GREENOV
Gdansk	Brownfield		
Jubail	Greenfield	650 m Euros	• Loans from the Saudi Industrial Development Fund • Government assisted housing loans from Real Estate Development Fund
Malaga	Brownfield	31 m Euros	• Partly European fund for regional development • Ministry of Science and Innovation center for the development of industrial technology
Masdar	Greenfield		
PlanIT Valley	Greenfield	10 b Euros	
Shenyang	Brownfield	250 m RMB	• Local government
Songdo	Greenfield	$35 b US	• Loans from Korean banks
Suwon	Brownfield	$27 m US/year	• Local government
Trondheim	Brownfield		• EU-funded ECO-city project
Wuxi	Brownfield		

Based on the openness of the commercial enterprise, and the ICT network construction and service deployment required, a smart city may have one of four possible business models:

- **Private:** A developer independently builds a network to deliver services and undertakes network operations and maintenance. Dubai World Central in the UAE, a 140 square kilometer development zone, has adopted this model. It has established a subsidiary called Smartworld to undertake network construction, operation and maintenance, and provide certain services unrestricted by local telecom regulations, while licensed services are outsourced to local providers. Contrary to free market efforts and telecom licensing policies, this model is difficult to implement because it may face many regulatory issues.
- **Exclusive:** A developer chooses a provider to construct an ICT network and provide services. Only the chosen provider has the right to operate within the designated area. Because of the open network trend, this approach may face the same regulatory issues as the private model.
- **Managed:** A developer appoints a provider to construct the only network in a specified area and this provider has exclusive rights for network operation and maintenance. All qualified providers can deliver services through this network. This model can be easily implemented because it minimizes repeat construction, provides more options for subscribers and eliminates the need for additional providers to obtain a new license. Nevertheless, finding the right party to construct and operate this kind of network remains a pressing problem.
- **Open:** Similar to operations within a public area, all qualified providers can construct a network and provide services in the area, and subscribers can choose any network and service.

In the future, the business models that will govern investment and revenue distribution in a smart city will be determined by:

- **The competitive positioning of providers** with the broadest service offerings for transformational change and smart grid enablement. Partnerships in operational, communications and consumer technology are critical to the success of a smart city strategy.
- **The state of the information utility business model and its evolution** over the next 10 years, which will open the door to new service market entrants with retail and financial services platforms and consumer marketing expertise.
- **Collaborative initiatives** by providers with industry associations, regulatory bodies and universities, which facilitate long-term success through sustained engagements with policymakers, standards bodies, industry consortia, and energy utility customers (co-development) to address consumer concerns and enable R&D.

COMPLICATION: THE SMART CITY LANDSCAPE

Because ICT is not a driving force in smart city projects, the implementation of the necessary layers related to ICT services (the communication infrastructure layer, the IT layer and the applications layer) is usually determined by the motivations behind the project and those who initiate it. This does not mean that telecommunications infrastructure and telecom services are not important for the development of a smart city. Telecom networks are, in many cases, essential to realize the objectives of the other industries guiding the project, and M2M and M2M2H communications technologies are basic requirements for an effective smart city. However, because service providers tend to take a reactive, back seat role in the smart city development process, their involvement remains limited. As a result, they run the risk of having to compete with utilities, cable companies, and other types of service providers, to provide ICT services.

For example, in some markets, utility providers have become ICT suppliers and compete directly with telecom companies. A report from the Cranfield School of Management[6] confirmed that telecom service providers believe they have a major role to play in smart city networking and communications by providing wired and wireless networks like 3G, WiMAX, and broadband that will support data transfers from smart meters in consumer homes to an operator's administrative and operational infrastructure. However, utilities are uncertain about collaborating with telecom service providers. Reliability of service and security are of utmost importance to them, and they are not confident that the telecom infrastructure is robust enough and has the reach to support these smart services. Therefore, they want full control of the network.

But utilities are one of many stakeholders in a smart city project that service providers must deal with. The number of stakeholders varies from project to project, but the one thing all projects have in common is that they must all work within a complex set of relationships that are usually based on who initiated the project and why.

Governments initiate or drive projects

Typically, governments initiate a smart city project. Sometimes this happens in cooperation with other partners. However, private companies can also initiate development efforts. When this does happen, the initiative still needs government backing (Table 6).

In addition, government and top government officials are usually drivers – key influencers and decision makers – of most smart city projects. Birmingham, Dublin, Gdansk, and Shenyang offer very good examples of projects where government and government officials play this role.

In some areas, laws and regulations sometimes impose this role on local governments. This is the case in Dakota County, where the Metropolitan Land Planning Act requires the local government to have comprehensive strategies to develop the 2020 plan. Likewise, in Masdar, Law No. 22 of 2007, issued by His Highness Sheikh Khalifa Bin Zayed Al Nahyan (President of the United Arab Emirates, in his capacity as Ruler of the Emirate of Abu Dhabi), established Masdar and authorized it to establish the city as a special economic zone in the Emirates.

In these and other smart cities, governments often form project or development teams, which include leads from governments, academia, and industries, to direct independent yet coordinated sets of programs. This is the case in Amsterdam, where the project team includes citizens, businesses, and the government. It is also the case in Chattanooga, where government, business and school leaders kicked off the smart city project. And in Jubail, the overall development and operation of the smart city project is the responsibility of the Jubail Directorate of the Royal Commission for Jubail and Yanbu. In addition to the Royal Commission, other ministries, including Industry and Electricity, Petroleum and Minerals, are involved along with the Saudi Basic Industries Corporation and the Saudi Arabian Oil Company.

But governments are not the only ones initiating smart city projects. In some cases, private companies take the initiative. This is the situation in Lavasa, where a subsidiary of the HGC Group started the development. Songdo smart city was backed by Gale, Morgan Stanley and Korean steelmaker Posco, while the Trondheim project was initiated by Bellona in cooperation with Siemens.

Governments act as primes

Governments and government departments also typically act as primes – project or program leaders – on smart city projects.

For example, the projects in Amsterdam, Gdansk, and Masdar were all undertaken by government departments on their own, such as the Office of Urban Revitalization in Gdansk, or in cooperation with private partners, such as the Liander grid operator in Amsterdam.

Table 6. Key initiation models for smart city projects

INITIATOR	EXPLANATION
Government	The government alone takes the initiative with the key objective to rationalize infrastructure (existing or to be deployed). Examples: • Masdar City, where a presidential law created a special economic zone • Cape Town, where the local government issued a decree transforming the way local government services are delivered • Suwon city, where the Korean Ministry of Information and Communication, in collaboration with the Ministry of Construction and Transportation, created a task force to cope with issues related to Ubiquitous City (U-city) environments that will be realized mainly in newly created communities
Government with partners	Governments work closely with private companies or other partners to improve existing processes and reach pre-defined targets. Examples: • Amsterdam, where the city government (Amsterdam Innovative Motor) in cooperation with an electric grid operator (Liander) started a project to reduce energy consumption and tackle related ecological challenges • Birmingham, where the city council worked with partners from the business, public, and local communities to stimulate economic growth and inward investment • Dublin, where the city government cooperated with an energy agency (Codema) to reduce energy consumption and CO_2 emissions
Private companies	Private companies take the initiative, backed by the government, to realize well-defined development projects. Examples: • Jubail, where Bechtel started the project to make better use of natural gas resources and to develop related industries with the active support of the government • Lavasa, where the Lavasa Corporation in partnership with Wipro (MyCity Technology, Ltd.) plans, builds and manages ICT services • Malaga, where the Spanish energy company Endesa took the lead managing over 50 partners for a project to reduce energy consumption and CO_2 emissions • Songdo city, where Gale International, a U.S. real estate firm, and Posco, a Korean steelmaker, were the main backers of a project to build a new city on a 1,500 acre man-made island off the coast of Incheon

However, industry leaders often act as primes for specific aspects of a project. For example, in Jubail, Bechtel was chosen to kick off the project and even managed 274 prime contractors at key points in the development cycle. In Lavasa, Wipro and Lavasa Corporation established the MyCity Technologies Company to provide ICT services. Later, Cisco signed definitive agreements to participate in this company. Plus, the master plan for the Lavasa project was developed by the American design consultant HOK.

Many stakeholders with complicated relationships

In all cities, a variety of relationships have developed between primes, main contractors and sub-contractors. However, it is unclear how these relationships are created. The most obvious example of this is in Chattanooga, where the Electrical Power Board became an electric utility as well as a communications company, providing communications services for local businesses using its fiber optic infrastructure. Meanwhile, in Shenyang, Northeastern University is working closely with IBM, and in Songdo architects Kohn Pedersen Fox Associates co-operated with ARUP.

Likewise, it is not clear how the relationships between the main contractors are created and what determines the level of engagement among these players.

For example, in Amsterdam, many private companies are involved in various projects (for example, West Orange, Geuzenveld, Climate Street, sustainable mobility), but it is not clear how these companies came together to implement these projects. Interestingly, one constantly recurring fact is that the two initiators of the project (Liander and Amsterdam Innovative Motor) are always involved.

Meanwhile, in Chattanooga, the main contractors are S&C Electric, which provides pulse-closing technology, and Tantalus, which provides software and communications equipment. The smart city project in Malaga is led by Spanish power utility Endesa and GreenWave Reality is the latest company to join the project to provide an energy management platform for residential users. In Trondheim, the Perduco analysis agency helped to gather and collate information regarding potential energy efficiency in different areas. And in Wuxi, China Telecom, Dawning Information Industry Co., Ltd., UDG (Urban Design Group), engbom (Swedish Planning), and Jingui Li (SPG Land and designers Pelli Clarke Pelli) are all working as main contractors.

It is also not clear how relationships are established between sub-contractors. There is no evidence to suggest whether or not contractual agreements are created to guide and monitor engagement, as well as manage and minimize competitive behavior among ecosystem partners and sub-contractors. This is a key question, since most projects can have multiple sub-contractors. For example, the Jubail smart city project includes contributions from 500 smaller contractors, while in Songdo United Technologies and 3M are involved as sub-contractors.

Finally, it is unclear how the relationships between the many suppliers involved in a typical project are created and maintained. For example, in the Jubail project, contract award winners in 2009 included the Saudi Binladin Group, the National Contracting Company, Khonaini International, the Abdulla Ahmad Dossary Company, the Rawabi Fayfa Company and Saudi Arabian Trading and Construction, but there is no indication of how these relationships happened and evolved.

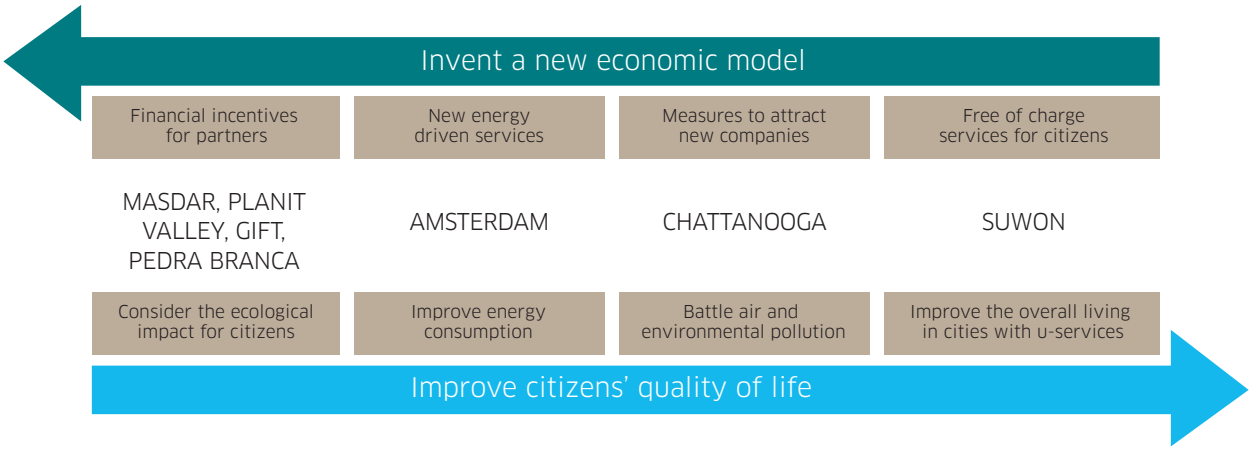
A variety of motivations

Along with the many stakeholders involved in a smart city development, each project is also driven by a variety of motivations. The Alcatel-Lucent analysis of smart city projects revealed that there are typically three major motivating thoughts behind a smart city project:

- **The need to construct or invent a new economic model (the economic motivator):** This was clearly the case in Masdar, where the driving idea was to change the oil-based business model of Abu Dhabi Emirates to one based on renewable and alternative energy sources. In PlanIT Valley, the motivator was to become a model city for world urbanization, in which future challenges are dealt with in the most economical and ecological way. The motivator for GIFT was to set up a new financial hub for India that can target and attract domestic and international financial companies with cutting-edge professional services and residential lifestyle. Pedra Branca also belongs to this category because it wants to create a new model for a sustainable city environment with clear ecological targets.
- **The need or wish to reduce energy consumption (the eco-sustainability motivator):** The best example here is the Amsterdam smart city project, where reducing energy consumption and more efficient energy usage were the key motivations for the project.
- **The need to improve the quality of life in a city environment (the social motivator):** This is best exemplified by the Suwon smart city project where the initial goal was to improve the lives and education of citizens, and improve government services. Another example is Chattanooga, which initially wanted to improve the life of its citizens by battling air pollution.

These three motivators are not exclusive from each other. They are all major reasons behind the establishment of smart cities, and they can all be found playing a role in the initiation of a project. They do not exclude that in a specific smart city context another motivator may be present, but considered less important. In fact, the Alcatel-Lucent analysis revealed aspects of different motivators in each smart city project.

Figure 1. Scoring of two key motivators in seven smart cities



However, what is different is how each city rates the importance of each motivator in the initiation of the project. For example, Figure 1 provides a visual picture of how the "Invent a new economic model" and "Improve citizens' quality of life" scored in seven of the smart city projects analyzed.

IMPLICATION

Because governments are involved in most initiatives, smart city projects are considered to be "secure" in terms of execution and return on investment. That's because they are normally part of a long-term government plan that covers a variety of other strategies and policies. As such, they are more likely to be executed, even in times of economic crisis.

Suwon and Masdar are two examples of this approach. Both were mandated by the central government as part of a bigger plan that encompasses key national policies, strategies and economic directions.

Even when a project is initiated or managed by private companies, the government still plays a key role. The level of national pride linked to the project ensures that governments will not and cannot allow the project to go in the wrong direction. A clear example of this is PlanIT Valley in Portugal, where the government, which is not a partner in the project, is providing incentives for companies that join the development effort.

As noted earlier, regardless of who initiated the idea, who the major players are, and why the project was initiated, every smart city can be categorized as either greenfield or brownfield based on:

- **Scope:** Greenfield projects are very broad in size and scope and they can be very huge because they are usually turnkey projects. Brownfield projects, on the contrary, are much smaller in size and are focused on a limited number of implementation areas.
- **Timeline:** Greenfield projects start with a long-term plan (for example, over 10 years) for realization of the project. This implies that revenue realization and return on investment will need to have the same long-term view. Brownfield projects, however, look at a much shorter term for project execution (three to six years), with revenue realization and return on investment happening, in general, much faster. This can be important for attracting investors.
- **Constraints:** Greenfield smart city projects have fewer constraints during implementation. There is a lot of freedom because these projects start from scratch. Brownfield smart city projects, however, have a more restricted degree of freedom because the project needs to take into account existing field conditions and infrastructure, which, by definition, limit the options and choices in the implementation phase.

Financial scale varies

In general, greenfield projects, have a budget that is up to ten times higher (on average) than the budgets of brownfield projects. This is no surprise given the turnkey approach that is behind greenfield projects. However, there can also be important differences in budget among brownfield projects, which can be directly related to the scope and dimensions of the individual programs covered within the context of the overall project.

It must also be noted that most budgets are "phased". This means that different phases are foreseen in the execution of the project and that parts of the global budget are attributed to each phase.

These budgets, in general, also cover ICT investments. But in most cases, the ICT investment is not budgeted independently and ICT spending can range from five percent of the total project investment to as high as 30 percent.

In addition, project budgets are also affected by the proposed timeline for execution. Alcatel-Lucent research has revealed that greenfield projects usually have a longer timeline than brownfield projects. However, one brownfield project (Chattanooga) had an exceptionally long timeline, although there was no clear reason why it would take so long to complete the project.

Finally, there is no apparent difference between developed and developing countries with respect to financial scale or timeline.

Financing model is unclear

Unfortunately, the financing model of most projects is not clear. Primary and secondary sources of information for this study did not want to discuss this aspect of smart city programs. However, as noted earlier, what is common among the various cities is that financing is based on a combination of private and government funding. Any external investment usually comes from regional banks and investment funds (for example, the Asian Development Bank, Inter-American Development Bank and Brazilian Development Bank). In some cases, local banks also provide loans and financing, as is evident in GIFT where several local Indian banks are among the key investors in the project, and in PlanIT Valley, where UBS and Deutsche Bank are providing loans. Finally, additional financing is available through partnerships that provide equity funding, as is the case in Masdar with Total and Abengoa.

Usually, government financing takes the form of loans at zero or very low interest rates, or grants. And some governments fund smart city initiatives in an indirect way by awarding incentives to companies that invest in the project or contribute to its realization.

Finally, even though governments often play a major role in initiating smart cities, private funding is of utmost importance for the long term viability of each project because, at the end of the day, return on investment is what keeps such projects going.

Revenue model composed of various elements

With that in mind, all smart city projects have conceived and developed a revenue model that ensures initial investments and spending by the players involved are reimbursed in one way or another. The revenue model is composed of various elements, such as the purchase or rental of space, the offering of improved services against payment, and the possibility of generating revenue by replicating the model or specific smart city solutions elsewhere in the world.

Usually, greenfield smart cities get most of their revenues from the sale and/or rental of residential living space or office space. But brownfield smart cities focus on attracting companies and services to improve revenue generation.

For example, PlanIT Valley and Masdar have the most complete and most sophisticated revenue model based on the sale and rental of space, offering improved services against payment, and replication of solutions and models for cities all over the world. The GIFT revenue model is based on the same elements, with the exception of the replication possibilities, which are limited for a variety of reasons to India. And Pedra Branca's revenue model takes into account sales and rental of space and offering improved services against payment. The other cities have models based on offering improved services. However, Suwon has no model because the services are offered free of charge and indirect revenues are collected through the synergy effects of services. Suwon also expects it can replicate its solutions and models in South Korea.

POSITION

Despite the many factors that must be taken into consideration, smart cities present a viable business opportunity to service providers. But given that the market is still in the early stages of development and the broad range of smart city projects being initiated across the globe, service providers run the risk of over-committing resources without any clear payback. Therefore, a successful engagement model is one that is carefully tied to a smart city strategy. And that strategy must be based on a clear understanding of the ICT opportunities in each smart city.

To that end, every smart city has characteristics that make it easy to categorize it as a specific type of project (Table 7).

Table 7. Categories of smart cities

CATEGORY	EXPLANATION
IT box	This type of smart city is characterized by the fact that an IT company initiates the smart city project and manages it, with the focus, of course, on IT excellence. Moreover, the business model is based on private companies providing funding for the project.
Dream box	Dream box projects present themselves as turnkey smart cities in which many dimensions are covered in a very ambitious and wide-ranging plan created at the very beginning of the project. The business model for this type of initiative involves a public-private partnership, which is crucial for funding, with an important contribution provided by governments or government agencies.
Fragmented box	In this type of smart city there are many projects defined, which cover various aspects of the smart city, but these projects are treated as independent and separate, with little or no integration or link to a global smart city plan.
Black box	A black box smart city project is usually led and managed by a government or government-affiliated agencies. A closed ecosystem exists that only includes "invited" companies, which are, in most cases, government-affiliated companies. It is very difficult to get a clear view of what happens inside this ecosystem. Moreover, it is very difficult for private companies to enter.

Understanding IT Box smart city opportunities

Cities in the IT Box category strive for IT excellence. To achieve this objective, these cities focus their efforts on creating a citywide IT network, which will control and manage the city's major functional areas and crucial aspects of daily life. In essence, this type of city can be compared to a giant computer. The project's business model is usually based on public-private partnerships, and funding by private companies is crucial for project execution. As a result, private companies drive project management efforts.

The scope of IT Box smart cities can vary greatly. Therefore, cities in this category can be further segmented into one of three types:

- **All-encompassing IT Box** smart cities, which are conceived and designed to run entirely on a citywide IT network. Everything from government services to public utilities is targeted for network integration and monitoring, and the network is an integral part of daily life
- **Special Purpose IT Box** smart cities, in which the application of IT technologies is intended to serve a special purpose, which can range from energy management networks that will help the city save energy, to healthcare networks that provide a variety of healthcare services
- **Economic Recovery IT Box** smart cities, which use IT to better respond to the consequences of declining economies

Understanding Dream Box smart city opportunities

Cities in the Dream Box category are conceived as turnkey smart cities in which many dimensions of daily life and many functional areas (for example, transportation, smart grids, construction, water treatment, waste management, and telecommunications) are covered in a very ambitious and wide-ranging plan created at the very beginning of the project. The business model for this type of initiative involves a public-private partnership, which is crucial for funding, with an important contribution provided by governments or government agencies. Government agencies are in charge of project management, either alone or in cooperation with private companies for the entire project or specific initiatives.

Dream Box smart cities can be further segmented based on the economic or industrial areas that are driving the project:

- **All-inclusive Dream Box** smart cities, which are conceived as complete, turnkey projects and the key objective is to construct or retrofit a city that will be "smart" in all aspects of residential and professional life and all functional areas
- **Financial Dream Box** smart cities, which are conceived to create a functional and residential environment for banks, private and public investors, and other financial institutions, in which these organizations can execute their business with cutting-edge technologies and services at their disposal, and with up-to-date residential spaces available for their employees
- **Oil and Gas Dream Box** smart cities, which are conceived to create an industrial base for the oil and gas industry, with all necessary and supporting infrastructure and services for the industrial activity provided in an end-to-end solutions approach
- **Sustainable Urbanization Dream Box** smart cities, which are conceived to provide a citywide infrastructure across various functional areas, industries and commercial activities that promote and encourage the use of eco-friendly energy sources, environment-friendly living facilities and a self-supporting urban ecosystem

Understanding Fragmented Box smart city opportunities

Cities categorized as Fragmented Box smart cities cover a limited number of projects, a limited number of dimensions, or a limited number of functional areas. These areas are defined as crucial at the beginning of the smart city project. However, each requirement is treated as independent and separate, with little or no integration or link to a global smart city plan. The smart city project can include more dimensions or more functional areas as it evolves, but these projects are also treated as independent and separate during implementation.

The business model for each of these smart cities is based on public-private partnerships, but the importance of private financing and public financing for project initiatives is defined on a case-by-case basis. Therefore, management and execution of each initiative is determined based on the financing model.

These smart cities can be further segmented as:

- **Multi-dimensional Fragmented Box** smart cities, which are conceived to provide "smartness" – based on ICT and related technologies – in the implementation and realization of a number of well-defined functional areas or commercial and societal aspects of urban life
- **Green Fragmented Box** smart cities, which are conceived to focus on various aspects of urban life that are key to the environmental sustainability of professional and residential life in an urban environment
- **Innovation-centric Fragmented Box** smart cities, which are conceived to concentrate urban planning and "smart city" efforts on dimensions and functional areas that are crucial to industrial, commercial, and/or social innovation
- **Education and Leisure Fragmented Box** smart cities, which are conceived to develop the necessary ICT-based infrastructure, applications and services required to improve and refine educative functions, the use of such functions, as well as "free time" activities in an urban environment

Understanding Black Box smart city opportunities

Black Box smart cities cover many dimensions and functional areas and a government or government-affiliated agency (or agencies) is in charge of drafting the overall plan for execution of the smart city. The project is usually undertaken by a closed ecosystem of government-affiliated companies, in which only "invited" private companies can enter. The government agency in charge of the project implementation is also in charge of "inviting" companies and players into the ecosystem, and it is difficult to determine what happens within the ecosystem.

The business model for these types of smart cities is based on funding by the government or government agencies. Funding by private companies is accepted as a sign of goodwill of the private companies towards the project. But the management of the smart city project and related initiatives is the responsibility of appointed government agencies.

Based on the original smart city plans, two types of Black Box smart cities are apparent:

- **All-embracing Black Box** smart cities, which are conceived as ubiquitous city projects with a master plan that covers all aspects of living in a smart city (personal, family, and professional) and which are created to reduce the information service gap between older and newer areas of the city
- **Livable City Black Box** smart cities, which are conceived by governments to focus on a greener, more livable and more sustainable city for a variety of aspects of modern city life, and for which reducing energy consumption is considered as important as using state-of-the-art information technology to enable buildings, railways, power lines and gas lines to talk to each other without human intervention

ACTION

With so many smart city projects at various stages of development, and with so many types of smart cities, some opportunities are better for service providers to target on their own, while others will need cooperation and partnership with other players in the smart city ecosystem:

- **IT Box** projects are the best fit with a service provider's product and service offerings
- **Dream Box** projects can only be pursued in cooperation or partnership with the key companies in the industry that is driving the project
- **Black Box** projects can only be successfully approached if and when a service provider is invited to participate
- **Fragmented Box** projects require a case-by-case evaluation, and even a project-by-project evaluation within each smart city, to better understand the covered functional areas and develop an appropriate strategy (go it alone, or enter into a partnership)

However, identifying the opportunities is only the first step of an effective market strategy. To conquer the smart city market, and position themselves as key enablers of the smart city vision, service providers must also understand the motivations that first stimulated the key players involved. These motivations continue to play an important role in the smart city's development and must be taken into consideration before creating a solution offering and approaching key decision makers.

Market to project motivations

Obviously, as with any undertaking, these motivations can evolve during project execution. But it is still important to know which functional domains were imagined as key at the start because this indicates how ICT was expected to be used to make the city smart. These insights can then be leveraged to properly position a service provider's efforts within the smart city market.

An analysis of the research collected during the various phases of this study revealed three defining motivations:

- **Social motivations**, which lead to a distinct and observable intention to improve the quality of life for citizens and businesses in the urban environment. Since living and working in a city involves many different activities (reside, study, travel, wine and dine, entertain), the social motivations cover one or more of these dimensions of urban life.
- **Economic motivations**, which lead to a distinct and observable advocacy for economic growth and the construction or implementation of a new economic model. These motivations require a series of measures and actions to be taken to stimulate the smart city economy. Often, these measures are accompanied by the construction or implementation of a new economic model, which breaks with the previous prevailing model, or results in the birth of smart city initiatives that cultivate new revenue sources, new operating structures, or new ways of doing business.

- **Eco-sustainability motivations**, which lead to a distinct and observable intention to hit targeted sustainability goals that will lead to recognizable and sizeable environmental benefits. This is usually initiated to reach "green" targets established by national or international institutions. The initiatives position the development as a "green city" or "eco-city". Ultimately, these projects have a positive impact on environmental sustainability. In some regions, they have resulted in initiatives that promote the green aspect of smart cities in greenfield and brownfield developments. For example, the "Europe Green Digital Charter" was established in November 2009 to encourage cities to reduce the carbon footprint of their ICT and establish ICT solutions that lead to more efficient energy usage in areas such as buildings, transportation, and energy.

By understanding the type of smart city they are approaching, service providers can develop an integrated strategy that targets individual smart cities with focused solution and service offers. And each offer can be tailored based on a better understanding of the motivations that led to the initiation of the project (Table 8).

Leverage key assets

Luckily, service providers have many assets that they can use to build a foundation for an integrated smart city strategy, and to position themselves as the key ICT providers in smart city value chains, including:

- A trusted brand, valued for high availability, QoS, privacy, security
- Sophisticated authentication and billing capabilities, potentially integrated across multiple bearer networks (fixed, mobile, Wi-Fi®)
- Mass-market customer care and self-service capabilities
- Consumer and commercial distribution and marketing channels
- Real-time customer insights (presence, location, usage)
- Data center scale
- Technology expertise in networking, telecom, and IT

These and other assets can be applied to a variety of business opportunities.

For example, the complex billing systems for the smart grids of the future require advanced customer information systems, and this is an ideal entry point for service providers who have

Table 8. Smart city opportunities identified in Table 1 classified by motivations and categories

SMART CITIES — CLASSIFICATION BY MOTIVATIONS AND CATEGORIES			Motivations												
			Social			Economic					Eco-sustainability				
			Improve communications	Improve government services	Improve living conditions	Morphing industrial basis	Staying competitive	Creating jobs	Innovation and high-tech	Beachhead	CO_2 footprint	Renewable energy sources	Water and waste treatment	Smart/greener buildings	Eco-friendly industries
Categories	IT box	All-encompassing				31		43	21		37				
		Special purpose	7	4, 47		6	50	33, 41, 46	34		48				
		Economic recovery	18			36	9, 29, 44	44	15, 20						
	Dream box	All-inclusive		45	52	28, 35			24						32
		Financial				19									
		Oil/gas				22					22				
		Sustainable urbanization									27	13			
	Fragmented box	Multi-dimensional					12								
		Green			8, 39						1,5, 10, 14, 25, 26				11
		Innovation-centric				2			16, 30	38			23	49	
		Education/Leisure	51		17				3						

Note: Numbers listed in "Motivations" columns correspond to numbers associated with cities identified in Table 1.

delivered similar products and services in the telecom, cable and satellite verticals. To take advantage of this opportunity, service providers must scale their infrastructures and develop security solutions designed specifically for smart cities. At the same time, they can pursue managed service offers as the foundation for alternative business models. Whatever the approach, service providers must clearly differentiate their value add or pursue partnerships with utilities, which lack the scale, financial resources, or specific skills to effectively address the ICT needs of smart cities.

Many service providers have recognized the opportunities and have established separate/dedicated business units to address the smart city market with M2M and M2M2H communications strategies. Some are already extending their M2M offers to the smart city market, and others are involved in smart city research and development. To date, the engagement model has been mostly based on establishing a partnership with the company managing the project. In the early stages, these partnerships may be concerned with conceptual planning. As such, they may bear little fruit, except if a consulting engagement is required. But in the long run, smart city business prospects for telecom service providers are greatly enhanced where they have played a vital, early stage consulting role.

BENEFITS

Service providers have all the assets they need to position themselves as key providers of ICT services in the smart city value chain. They offer the ability to manage and ensure delivery of large amounts of data over protected, secure, and reliable network infrastructures that are required to enable all of the different visions of an ideal smart city. But they have a better chance of success in the smart city market if they approach it and each city with a targeted strategy. The insights provided by this study into the types of smart cities being developed and the motivations that drive each project can be leveraged to develop that strategy.

With a strategy built on a deeper understanding of the smart city landscape, service providers can change their role in each smart city ecosystem. They can enable the seamless integration of the unique sub-systems that must be created to support each city's services over a single telecommunications infrastructure, which is a convincing selling point for smart city planners and investors. They can better deliver solution and service offerings that fit the specific objectives, needs and priorities of each project and its stakeholders. And they can establish strategic partnerships with the specific vendors and application developers that will support unique service and application development efforts for each city.

A strategy built in this way will make service providers prime players in smart city development efforts. It will change their role from that of facilitators of other industry objectives, to that of strategic partners of the key industries and governments involved. Most importantly, it will allow service providers to make the transition from that of providers of basic M2M and M2M2H carrier services to that of key enablers of the smart city vision.

ABOUT MARKET AND CONSUMER INSIGHT

Market and Consumer Insight (MCI) investigates links between consumer behavior, market and technological trends to help Alcatel-Lucent and its clients, communication service providers, make more informed and impactful business decisions. MCI experts dig deeper and reach farther to provide information that helps communication service providers formulate new thinking, including:

- Global and regional, urban and rural, insights
- Research on consumer, market and technological trends

For more information related to planning, strategizing and executing adeptly in smart cities, please contact the Alcatel-Lucent Market and Consumer Insight team at mcinsight@alcatel-lucent.com.

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