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Information and Communication Technology (ICT) for Green and Sustainable Cities



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Majority of world's population now lives in urban areas and this will increase to 60% by the year 2030. In India this figure has crossed 30% and is increasing rapidly putting immense pressure on city resources. Urban areas not only consume more than three fourth of world's energy but are also responsible for 80% of total green gas emissions. The use of energy and other resources can be optimized by innovative use of Information and Communication Technology (ICT). Successful cities will do this by making use of ICT in diverse fields like transportation, healthcare, education, building control, entertainment, safety and security etc, all built on ubiquitous broadband connecting all information sources and enabling sharing of information in real time. Broadband is the next utility after electricity, road and water and city planners and city administrators need to take note of this.

Keywords: Information and Communication Technology (ICT), Sustainability, Smart Cities

Introduction

The world is undergoing a major transition as for the first time in history, a majority of its people live in urban areas. Over the next five years, some 500 million people will be added to the world's cities. The cities are consuming 75 percent of the world's energy and are responsible for 80 per cent of greenhouse gas emissions . Urban areas are responsible for a significant portion of CO2 emissions, with transport-related activities accounting for the lion's share, followed by industrial and residential emissions. Rapid urbanization has led to increased congestion on roads, increased demand for power, water, sewerage, sanitation, education and health infrastructure and increased demand for investment. By 2025, at least 100 new cities will be inhabited by more than ten lakhs (one million) residents . The environmental impact of this shift is significant and it will only continue to grow. How do we plan our cities differently to accommodate the growth without destroying our natural resources while maintaining sense of community, security, and global competitiveness? Thus the need for cities to

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sustainably balance social, economic, and environmental resources is more critical than ever before. Traditional approaches to reducing carbon emissions have been to use less energy, use other forms of energy, and capture and store carbon. The next step was to go for energy efficient building technology, use of CFL in place of incandescent lamps, increasing efficiency of traffic flow etc. While these have worked, they lack the ability to scale fast enough to effectively provide infrastructure to a rapidly growing community in a big way. Thus a need is felt to take a different approach by changing how cities deliver services to residents, how residents work, how traffic flow is managed, how public transportation operates, and how real estate resources are utilized and managed and how cities are made safe and secured. Today, ICT not only enables better and efficient service delivery but also makes the city green and sustainable.

Successful cities of the future will run on information. By providing real-time traffic information to its citizens, cities can enable them to plan their commute to work or use public transportation and thus reduce emission. By providing remote healthcare services and extending healthcare access, cities can reduce health-related expenses. Automating and remotely monitoring building security will mean higher security at lower cost. Similarly innovative use of ICT will reduce energy consumption of buildings making them green and intelligent. All these will be done by putting the network at the centre of how we plan our cities for providing healthcare, transportation, buildings, entertainment, security etc . Cost and benefit optimization takes place when information sources are connected and information is shared in real time. That is achieved by higher level of connectivity. Connectivity will have a profound impact on how cities of the future are planned, to drive economic development and investment, better city management, quality of life for citizens, provisioning of healthcare, transportation, entertainment, safety and security, delivery of government services etc.

Connected and Sustainable Mobility

As cities become wealthier, motor vehicle ownership tends to increase, as do energy consumption, carbon dioxide emissions, traffic accidents, and unproductive time spent on the road. The only way to reverse the trend is to make public transport more convenient, predictable, comfortable and enjoyable. With better planning and service improvements, bus transport can be made more convenient, cost-effective, predictable and sustainable. Innovative solutions based on information and communications technology (ICT) can make it possible and then wean away people from personalized vehicles to public transport system. Some of the ICT based solutions in this field are

- Automatic Vehicle Locator: Increases schedule accuracy, reliability and traffic management. [being used in Delhi BRT and a few other cities]
- Signal Priority: Transmits data to give buses priority through traffic signals. [being used on some BRT corridors]
- User Information: Real time route finder, transit routes, schedules, arrival times, fares,

destinations and way-finding. [through touch screens kiosks at Bus shelters/metro stations/railway stations, public places like malls etc]

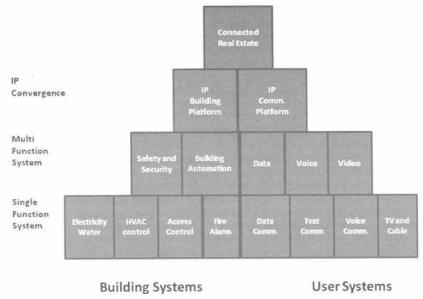
- Automated Announcements: Digital announcements assist passengers and reduce driver/conductor stress. [as done in metro trains]
- Wi-Fi: Wireless Internet access for passengers at bus stop and on buses. [as done in cities like San Francisco]

These require real time flow of data from buses and cameras and sensors installed at bus stations and road crossings to the control room. That in turn requires ubiquitous network across the city. Such a system also generates data on passengers, fare collection and passenger load information which enables faster reconciliation of revenue collected and planning of new buses on crowded routes and generate earning per kilometer of buses for the bus operator. The system also works as vehicle health monitor by tracking engine performance data to help identify potential problems. A connected transportation system improves safety and security inside the bus and on the bus stations by transmitting video to central control room.

By combining real time data from bus, metro and GPS fitted taxis, these solutions provide traffic advisory and best possible mode of travel by public transportation system. They also provide accessible and efficient services that help citizens achieve a healthy and desirable quality of life by offering choice in transportation modes, limiting emissions and waste, and minimizing land use . Success of these applications are measured in terms of decrease of transport demand (in terms of traffic volume), increase of transport speed (in terms of traffic speed and throughput), reduced tonnage of emissions in terms of CO2, NOx etc and increased efficiency of public transport in terms of timeliness, safety and utilization rates.

Connected and Sustainable Buildings

As per Building Owners and Managers Association International (BOMA) 2006 report buildings as a whole consume more than fifty percent of world energy and thus a prime candidate for energy use reduction initiatives like building management systems (BMS). Building management includes heating, ventilation and air-conditioning (HVAC), lighting, water and waste water control, physical security, fire and safety, lift, parking etc. Since most of these solutions are proprietary in nature, it leads to vendor lock-in and higher cost as control systems for each has to be installed. This also leads to interoperability problems as data can't be shared among them. As technology evolved there was a shift from single function systems to multi function system and then to IP based systems, where data from disparate systems are brought on IP and used from one control room sharing one data across many applications, making it possible to have unified control for the whole building from a remote location. This also enables buildings to talk to grid and take decisions on energy consumption based on condition of energy supply and take decision on pre-specified rules.



The benefits of utilising building IP networks do not end with a single property but between buildings. For property owners, there is an incremental multiplier effect as more properties are connected together. Networked buildings can be linked together into a connected township. The open standards-based building infrastructure encourages a centralized (and/or remote) approach to monitoring, maintenance and control of the building environment, where building control systems across all properties can be controlled from a single place. Such integration at the city level leads to benefits such as:

- Control over energy usage
- Energy audit and total control over load
- Light/air-conditioning control
- Rule based controls enabling building to take decision on pre-specified conditions
- Ambient lighting based control
- Unified control
- Remote diagnosis
- Reduced consumption of materials and equipment
- Energy efficiency and greenhouse gas emissions reductions

- Reduced space needs
- Reduced electronic and office waste

Success of these applications, as in case of connected mobility, can be measured in terms of increased energy efficiency of buildings and of energy grids, reduced requirement of space and furnishings and reduced tonnage of emissions: CO2, NOx, PM_{10}. The innovative ICT based solutions have led to better space utilization in terms of less building footprint and furnishings per employee . Some of the projects have achieved more than 40% reduction in the amount of space required per employee while increasing employee comfort, satisfaction, and productivity. In a 100,000 sq ft office this could save 1,500 t concrete, 280 t steel and 2,850 tons of CO2 emissions, which is the equivalent of taking 560 passenger cars off the road for a year.

Connected and Sustainable Energy

Energy, especially electricity, drives the world economy. It lights our homes, powers our factories, runs our technology, and could soon fuel our vehicles. Electric power, however, is facing major challenges. Demand for electricity exceeds available supply. Electricity creates more greenhouse gases than any other source, including transportation, manufacturing, and agriculture. Aged equipment used to produce and distribute electricity suffers from years of underinvestment. The result is an inefficient electricity generation and distribution system that converts only one-third of the total energy it consumes into useful electricity.

Recognizing these inefficiencies, the energy community has started to marry information and communications technology (ICT) with renewable energy to improve how electric power is generated, delivered, and consumed. Technology allows the electric grid to become "smart." Near-real-time information enables power utilities to manage the entire electricity grid as an integrated system-actively sensing and responding to changes in power demand, supply, costs, and emissions across the grid. Also, better information lets consumers manage their own energy use more effectively. As former U.S. Vice President Al Gore has pointed out, "Just as a robust information economy was triggered by the introduction of the Internet, a dynamic, new, renewable energy economy can be stimulated by the development of an electranet or Smart Grid."

The ICT led Smart Grid is based on three main principles namely, improving supply-side efficiency, demand management and distributed energy generation. Improving 'Supply-Side Efficiency' of the electric distribution grid using IT has been the most visible and it includes:

- Grid Monitoring and Control: Utilities install sensors to monitor and control the grid in near real time to detect faults earlier and provide time to prevent blackouts.

- Grid Security and Surveillance: Utilities install surveillance sensors to monitor and secure unmanned, remote equipment that is vulnerable to terrorism.

Demand Management consists of measures to reduce electricity consumption in homes, offices, and factories and it includes:

- Demand Response: During emergency periods of peak energy usage, utility companies send electronic messages to alert consumers about reducing their energy consumption by turning off (or turning down) unessential appliances.
- Smart Meters and Variable Pricing: In many areas, electricity prices rise and fall based on demand at that moment. "Smart meters" let consumers shift energy consumption from high-priced periods to low-priced periods (load shifting and shedding).
- Smart Buildings with Smart Appliances: Traditional, stand-alone building control systems are now converging onto a common ICT infrastructure that allows appliances (heating, ventilation, air conditioning, lighting, and so forth) to "talk" to each other, coordinating their actions and reducing waste.
- Energy Dashboards: Online energy dashboards provide real-time visibility into energy usage while suggesting ways to reduce consumption.

Distributed Energy Generation consists of measures to encourage homes and businesses to install their own renewable energy sources like 'Microgeneration' to generate their own electricity locally using wind generators, photovoltaics etc. These devices are not economical now but are expected to become as affordable as energy from utilities. They produce 50 percent less greenhouse gases and can be used to reduce peak demand on utilities. The other innovation in this area is 'Storage and Hybrid Electric Vehicles' like plug-in hybrid electric vehicles (PHEVs) whose owners can buy energy when it is inexpensive, store it in batteries, and sell it back to the grid when the price goes up.

Connected Public Safety and Security

The 26/11 attack on Taj Hotel and other places in Mumbai highlighted the need for Public Safety and Security system which offers agencies and organizations with responsibility for public safety and security a sustainable, scalable way to share and integrate information and resources across jurisdictional lines. Similar incidents highlight the need to have a system, which can be operated from a distant place even if the local control room is taken over by miscreants. In such incidents it is not uncommon to notice that some agencies can't link up with each other because their hardware is incompatible or older or outdated radios can't "talk" to newer ones, or equipment made by one company has different specifications than another's. It is also noticed that networks operate on frequencies or bands too far apart for ordinary radio gear to bridge and share of security agencies of those frequencies is interspersed across the radio spectrum. One can't send people out carrying eight

different radios what some ambulances used to do in some of the cities in USA. Thus it is vital to let wireless radio systems of various agencies talk to each other seamlessly to respond in a well coordinated manner in times of such exigencies.

ICT today enables and delivers interoperable communications across voice, video and data applications creating an intelligent information network that allows public safety and security agencies to meet their biggest challenges: enhancing intra- and inter-agency communications and productivity, providing coordinated responsiveness during crises and improving situational awareness and control. This leads to increased officer safety, more police presence, better situation and operational awareness, reduced errors, better information sharing with field personnel and between agencies, secures remote access to critical applications and more effective critical incident response and management. IPICS (IP Interoperability and Collaboration System) is one such solution which makes UHF, VHF, PSTN, NXTL, VoIP and Cell phones talk to each other.

The surveillance cameras are termed as a force multiplier by police officers as by using one officer; one can get the work done of another five. It also helps in cost cutting without compromising the efficiency for law enforcement agencies which is already suffering from resource crunch. ICT enables bringing feed from thousands of such cameras at one location and making them intelligent by adding video analytics so that they raise alarm when a pre-specified rule is violated. Another innovation has made these cameras talk, which can be controlled remotely from a centralized control room. These are fitted with loudspeakers and have pre-recorded audio responses for specific situations. So, when someone litters in a public place or smokes there, a personalized audio response is generated from the loudspeaker fitted next to the CCTV camera warning the person. It even suggests where the nearest bin is.

Connected and Sustainable Work Places

As economy grows the proportion of services out of GDP grows. Growing service sector means growing number of knowledge workers. These workers need information to work upon and many of them need not be physically present in an office. ICT brings information to the people in variety of ways apart from making available tools which allows such workers to collaborate and work from remote locations. By enabling workers to work from home one is not only reducing burden on already over-stretched transport infrastructure but also the GHGs. The other innovation in this field has been in terms of Smart Work Centers, which enable people to work from remote locations, conduct meetings using immersive video conferencing technology without need of moving to the city center. All these are now possible as homes, offices and work centers are connected.

Network as the Fourth Utility

All these solutions have one thing in common i.e. 'Connectivity' which in turn is provided by connecting various devices and sensors on one network. Many innovative cities are addressing the challenges / opportunities of this new world by thinking about the network as the fourth utility as network will be at the centre of how we plan our cities which will run on information. By doing this we make our urbanization process intelligent and our cities green and sustainable.

The transformational influences of 21st century information and communications technology and the resulting knowledge-based economy, are as significant as the two major waves of "network" innovation that characterized 20th century urban design and development. The first happened at the beginning of last century, triggered by the age of steel, electricity, and heavy engineering, resulting in electrical networks. The second took place at midcentury, with the automobile and other forms of transportation spurring suburbanization and sprawl through networks of roads, highways, ports, and airports.

Today, worldwide digital communications and the Internet are becoming the fourth utility in cities (in addition to roads, water, and electricity). Similar to the beginning of last century, when newly built electrical networks were the focus, today's citizens, governments, and enterprise organizations are taking advantage of digital services delivered over the Internet.

Relevance to India

Rapid urbanization is an undeniable reality for India and the country is early in the curve and has the opportunity to shape the transition skipping some of the pains experienced by developed countries around the world. Planning Commission estimates are that India's urban population will grow to about 473 million in 2021 and 820 million by 2051-as against only 285 million in 2001-with no great increase in urban area. (Jha, 2010). The sheer size of India's population and the demands that the population will place on basic necessities such as education, healthcare, water, transportation, energy etc makes it compelling for India to look at transformational approaches such as intelligent urbanization. Innovation and use of new technology becomes more important when total amount to be invested is limited.

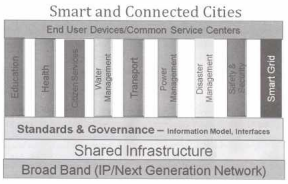
This is relevant to both, brown field (urban renewal of existing cities as being done under JNNURM) or green filed (new cities like Lavasa being developed). The city planners need to make provision of broadband infrastructure as they do for water, road and electricity. Cities need to have an IP-enabled framework for commercial and business real estate and IP-enabled civil infrastructure that connects

roads, railways, gas / electricity / water utility networks, and other city assets such as traffic lights, towers, telephone boxes, etc.

Networked information could be used as an enabler to better manage & plan urbanization and bring about improvement in delivery of urban services. The use of networked information would have positive impact economically, socially and environmentally. It would help improve overall quality of life, bring about improvement in delivery of services and make them faster & cheaper. It would increase accountability, supports effective decision making.

This approach will also help cities in addressing the current challenges being faced by them on various fronts like delivery of services (issue of birth/death certificates, building approvals, shop/trade licenses, payment of taxes); managing hospitals run by them and providing better healthcare to its people; managing schools run by them; managing utilities; mapping underground utilities; managing assets; managing complaints, and managing disasters. For this they need to adopt an integrated approach based on standards and architecture ensuring complete interoperability of data and sharing of resources.

There are many examples of this approach being applied globally. While still nascent in India, projects such as Hi-tech city in Hyderabad, GIFT in Gandhinagar, Lavasa near Pune are evidence of progress. However, to meet the scale of urbanization challenge facing India, key issues related to governance, business model and infrastructure must be addressed. The urban planners, city administrators and urban development policy formulators need to understand these aspects and why broadband needs to be made all pervasive in the cities as one of the main infrastructure pillars.



References

Sources: BOMA 2006, EIA 2006, AIA 2006

Source: Connecting Cities: Achieving Sustainability Through Innovation Nicola Villa and Wolfgang Wagener, Cisco IBSG

http://connectedurbandevelopment.org/toolkit(2010, GeSi Smart 2020, The Climate Group (2008), MIT Mobile Experience Lab., 2010

"Connected and Sustainable Mobility" paper by Jayes Kim, Tony Kim, Todd Litman, JD Stanley, Val Stoyanov of Internet Business Solutions Group and presented at Connected Urban Development Global Conference 2008—Amsterdam

Connected Real Estate Essays from innovators in real estate, design, and construction
Edited by Kevin O'Donnell and Wolfgang Wagener (June 2007)