
Development through Intelligent Infrastructure: An Evaluation

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Abstract

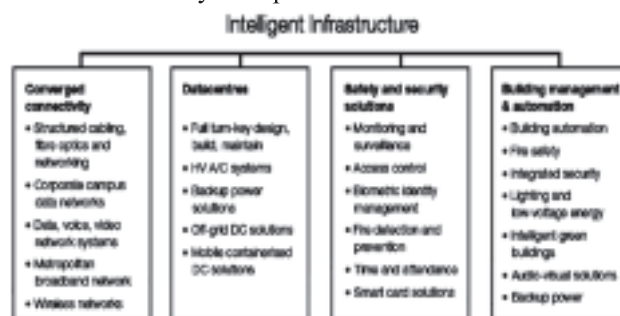
Intelligent infrastructure is to create ambient intelligence as a result and outcome. Intelligent infrastructure is a vision which surrounds intelligent and intuitive interfaces, supported by computing, communication and networking technology that is now prevailing everywhere, embedded in everyday objects and infrastructure as mobiles, laptops, tablet, feblet, vehicles, roads, homes, systems and working places, etc. Intelligent Infrastructure enables greater user friendliness, more efficient services, user empowerment, and support for human interactions. Services using intelligent infrastructure provide context specific unique information at all occasions and events. A lot of information is produced and made available using intelligent infrastructure regarding real-time business information also. The volume and occurrence of the desired information is likely to increase drastically in future. Ensuring data interoperability between different unique systems is a key task. The intelligent infrastructure comes from technology and the way information is transformed, distributed and shared is important. The present research paper explores the potential for the deployment of value added intelligent infrastructure to optimize scarce resources, enhance competitiveness and create new enterprise opportunities at lower cost with a widened base. It also focuses on usage of the intelligent infrastructures specifically on energy, water, transport and waste management.

Keyword: *Intelligent Infrastructure, Computing, Communication and Networking Technology, Real-time Business.*

Introduction: The 20th century witnessed the development of an entirely new technology based on semiconductors, integrated circuits, microprocessors and ultimately a wide range of information communication technology systems and devices that embedded them. The last quarter of the century witnessed a parallel development in the world of networks, based on emerging tele-communication technologies, as fibre optics, and the eventual dominance of the Internet. Both sets of developments have had a profound effect on the service sector, especially the computing industry and telecommunications carriers, on how business in general operate, on what consumers need and are willing to pay for, and on how society's institutions operate and relate to one another, that it is commonplace to refer to what happened during that fifty-year period, without hyperbole, as the ICT revolution (Building an Intelligent Infrastructure, 2004).

The Internet has broken this mould in two important ways; firstly, it has made it increasingly possible for any kind of message to be communicated over a network of networks that, effectively constitutes a single medium; second, the Internet places control over the production and consumption of services with users operating at the edge of the network and communicating through the end-to-end principle, instead of vesting it in the hands of

central network operators and service providers. An Intelligent Infrastructure Solution (IIS) provides the missing link between real-time network management tools and the traditionally passive structured cabling infrastructures that connect network devices together (Intelligent Infrastructure, 2011). The Intelligent Infrastructure may be depicted as follows:



Source: http://www.intellient.co.za/content/intelli_infrastructure.jpg.

The services and applications available on today's Internet are crude in comparison to those that will become available on the intelligent networks. Nonetheless, they point the way to a future in which the purpose of infrastructure is to enable users to communicate transparently and seamlessly, regardless of the

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technologies they are using, their natural language, or their preferred medium of communication (Building an Intelligent Infrastructure, 2004). Intelligent Infrastructure Solution helps IT professionals and network managers to ensure the efficiency of their network by providing accurate reports for capacity management; generating real-time alerts to detect, locate and resolve any unauthorised changes within the network; providing automatic discovery and tracking of physical location of devices connected to the network in real-time, and proactively applying changes utilising electronic work orders in support of change management (Kenneally, 2011).

Rationale: Emergence as Sustainable Community:

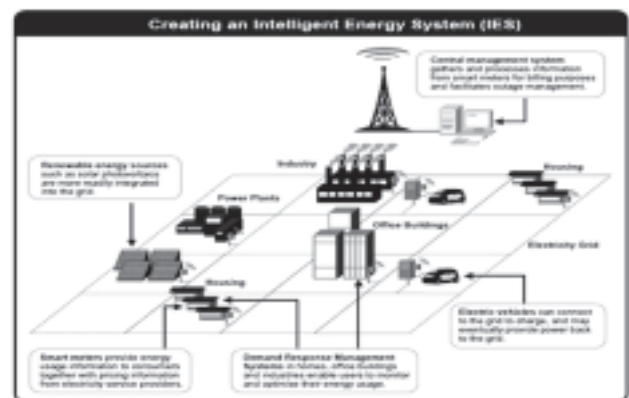
The sustainable community is the prime and very important aspect of intelligent infrastructure. Emerging as an intelligent sustainable community, it is to be distinguished as: a world-class community of eco-intelligence implementing the most innovative development strategy; an urban ecosystem of sustainable living, well being, and quality of life; a master-planned knowledge ecosystem and innovative business environment, fostering a climate and culture of innovation, creativity, quality lifestyle and modern entrepreneurship, health and well-being; an integration of living/residential, working, commercial, retail, recreating, learning, and public spaces, buildings and facilities; and a common model/paradigm for globally emerging sustainable communities and smart cities (Abdoullaev, 2011).

Dimensions and Scope: Intelligent Infrastructure may be used as synonyms to Intelligent ICT Infrastructure. The Intelligent ICT Infrastructure consists of three main dimensions: systems for collection of data monitoring and positioning systems; systems and protocols for communicating data between traffic control centres and to and from vehicles, quality of the data accuracy, timeliness and; core systems include collection of data, satellite navigation systems, monitoring of traffic stationary and mobile sources, traffic control centres, data fusion, communication protocols, data exchange (Mobility and Transport, 2012). To update the physical infrastructure of the organizations, states or nations for the e-Economy, the challenges are to: enhance and expand 'next generation' networks, ubiquitous, broadband, mobile networks that provide internet protocol based multimedia services, including network-based applications and grid computing; develop applications, content and knowledge repositories for these new network architectures, including digital rights management; and establish standards for networks, services, applications and content in the new environment and for the common language that will

enable all of them to communicate; and secure the financial and human resources required to develop an intelligent infrastructure in the face of global competition (Building an Intelligent Infrastructure, 2004).

To meet the challenges of building physical infrastructure, the institutional structure of the ICT sector and its relationship to its customers needs to change. Until the advent of the Internet, ICT infrastructure had been built around different technologies, each of which was designed to provide specific goods and services for particular sets of clients on terms and conditions that were largely set by the producer, whether the product was plain old telephone service, cable television, computer networking, information management, publishing, sound recording or online learning. The institutions that grew up around this infrastructure reflected this pattern of technological separation, service differentiation and central control over the production and consumption of services (Building an Intelligent Infrastructure, 2004).

Intelligent ICT in Urbanization: As for as intelligent infrastructure is concerned, Intelligent ICT has now, switched to Intelligent - Waste and Water, Mobility, Energy, and Security. Using waste as a source of renewable energy is crucial to the long-term health of cities. Water scarcity is now recognized as the greatest risk resource of the 21st century. It is essential that cities tackle the low value perception of water towards a cultural change that will preserve this crucial commodity (Intelligent City Expo, 2013). Water and waste-specific stakeholders, attendees and exhibitors are to meet public and private sector individuals and companies involved in the interconnected fields of intelligent - energy, transport, mobility, security and, importantly, the intelligent ICT, which can offer crucial insight into city-wide service delivery. In case of Intelligent Mobility, Urban Mobility is essential to productivity, health and quality of life within a city. As cities become increasingly congested, all these things are under threat.



Source: <http://www.cleantechinvestor.com/portal/images/stories/magazine/creating%20an%20intelligent%20energy%20system.jpg>.

In order for a city to maintain the dynamics at an efficient level, it requires a network of intelligent transport systems that are accessible, secure, reliable and sustainable. Intelligent interconnected transport systems, combined with the widespread adoption of electric vehicles, can revolutionize the way people move around cities. In case of Intelligent Energy it is estimated that by 2050 there will be an additional 3 billion people on Earth, 70% of them, will be living in cities, and these cities will be generating 80% of global emissions, accounting for 75% of the world's energy consumption. The growing pressure on resources means that cities must become increasingly efficient, and self-sufficient. With energy consumption drastically more than energy production, in order to maintain and improve living and economic conditions, cities must increase the level of energy efficiency. Intelligent Transport Systems serve as both a valuable source of data for assessing the environmental impacts of transport, and a powerful mechanism to influence operational performance and reduce their bad impacts (Transport and Environment, 2013).

Intelligent Transport Systems (ITS)



- Car-to-car and car-to-infrastructure communication network
- Traffic/energy management (support systems):
 - Emergency vehicles
 - Speed congestion control
 - Green light zone
- Safety (dependable systems):
 - Repeat driver line-of-sight hazardous
 - Collision & Curve Speed Warning
 - Lane change warning
 - Collision Warning
 - Car as a Mirror
- Supported by dedicated wireless standards:
 - IEEE802.11p, Cellular Communications
 - DSRC

Source: http://electronics.wesrch.com/User_images/wiki/b073feda3de2b18c6b33f4b3edf4b96e_1376305993.jpg.

Smart Cities: The challenge of managing sustainable urban ever increasing growth is one of the defined challenges. Urban Development Authorities, Urban Body Corporations, city leaders, mayors, Urban NGOs and other politicians are already wrestling with this challenge and are looking to make changes that will position their cities for growth, as attractive centres for investment, innovation and worth living places. The set of challenges represent a significant opportunity for investments in 'the smart city'. The ultra modern cities employ innovative digital services layers, that use sensing and control, analytics and ubiquitous communications, to optimize their scarce and limiting resources. Empowered to make better decisions about how to travel or transport goods more efficiently and to understand the real time cost of using electrical appliances, the city's citizens and businesses will make better use of these resources. As a result, cities will allocate resources more efficiently; in parallel saving costs and transitioning to a low carbon economy. A Smart City is a city well performing in following characteristics,

built on the smart combination of endowments and activities of self-decisive, independent and aware citizens (Smart-Cities, 2013).

There are so many forcing factors of any Smart City being part of Intelligent Infrastructure of any country and economy. Demographic, environmental, economic, political and socio-cultural factors are forcing the urban world to design and implement smart/intelligent cities. As a sustainable community, a smart city is a unified urban entity with three critical layers/levels/spaces, all planned, developed and managed as its integral parts: Digital/ICT/Hi-Tech/Ubiquitous/Cyber/Mobile/ Digitally Smart and Intelligent City Augmented on Virtual Reality, Virtual Lifestyle; Sustainable/ Ecological/Green/Zero-Carbon/Zero-Waste/Eco Friendly/Clean City Natural Capital; Natural Urban Spaces and Ecosystems, Green Energy Network, Real Eco Estate, Ecological buildings, Green Lifestyle; Knowledge/Learning/Innovation/Intelligent/Science/Intellectual/LivingLab/Creative/Human/SocialCity/ Knowledge Capital; Innovation Systems, Meaningful Urban Spaces, Collective Intelligence, Knowledge Triangle/Ecology, Health Triangle, Human Social City, Intelligent/Smart Lifestyle (Abdoulaev, 2011). A true Smart City is committed to the following Value Propositions: Eco-Intelligent Infrastructure, Sustainable Living, Well Being and Quality of Life, Eco-polis smart environment/natural capital and resources, eco-health, safety and security, engineering and sanitation, conservation and protection, landscape integrity, and awareness; re-use, reduce, recycle and recover of resources, materials and energy; Smart Connected People, Communities, and Society, Social and Human Capital; Future Proof Smart Technologies; Network Integrated Township, Ubiquitous Eco City; City Intelligence Knowledge and Health Triangles, Intelligent Management Urban Platform; Environmental Infrastructure, Smart Utilities and Energy Networks; Smart Mobility innovative transportation, Fibre Optic ICT Networks; Intelligent Green Lifestyle and Quality of Life regarding facilities, culture, health, safety, housing, education, touristic, and entertainment; Smart Governance i-Services, social, cultural and political cohesion; Innovation Economy and Knowledge Industry and Sustainability Standards; Private, Public and Civil Society Partnership; Financing Schemes: BOT, BOOT, BOO, BLT, DBFO, or DCMF i.e., Design, Build/Construct, Own, Operate, Transfer, Manage, Finance, Lease; Intelligent Investment Projects i.e., Impact/Socially Responsible Investment. A truly smart city is three innovative cities in one, the Urban Trinity of Information Cyber City, Intelligent/Knowledge City and Ecological/Clean City (Abdoulaev, 2011).

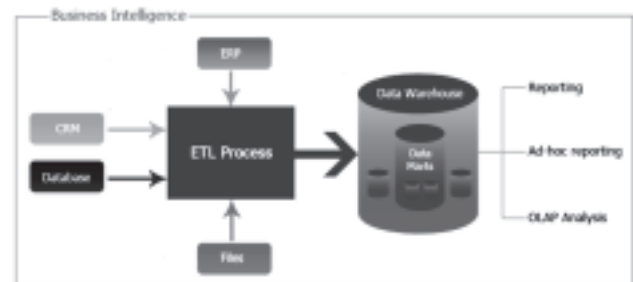
e-Society: ICTs can be extremely useful in providing access to communication, education and open up opportunities for the people with physical disabilities. The education sector is arguably one major area that ICTs are playing remarkable a role. These technologies help in facilitating learn ship and exchange of educational materials. ICTs are helping library professionals to store and manage academic information. ICT applications can also help in collecting data about environmental issues. They allow access to information and provide support system to manage and monitor environmental issues. At the micro level, ICTs applications can be used to impart information directly to farmers and the farming community. There are expert system designed to handle agricultural issues such as water utilisation and management, pest control, harvest management and so forth (Mansell and When, 1998).

e-Learning: *e-Learning* is beginning to make an appearance in high and secondary education systems in most of developed countries and on a narrow scale in developing countries. The improvement of online courses and the attractiveness of the diplomas on offer open up new opportunities, especially in the most lucrative sectors such as high-level university education, vocational training and continuing education. In the short term, mixed models are expected to expand most in formal education the same does not, of course, apply to informal education. With the technology all cultural production are homogenized. Producers, dramatists, newspaper journalists and Web site designers all are to become content-producers (Vosloo, Terri and Andjelkovic, 2005).

e-Governance: The Public Information Terminal (PIT) entails the installation of Internet kiosks in post offices and all around the country. The kiosks will provide instant access to the Internet, e-Mail, government and educational services through e-Governance as well as e-Commerce. The link to government websites will provide information on aspects of regulation, legislation, welfare, support, grants and rebates. Interactive directories of various tertiary institutions are also be available (Matsepe-Casaburri, 2001).

Business Intelligence: Business Intelligence (BI) is an umbrella term that refers to a variety of software applications used to analyse an organization's raw data. BI as a discipline is made up of several related activities, including data mining, online analytical processing, querying and reporting (Mulcahy, 2013). BI is a set of theories, methodologies, architectures, and technologies that transform raw data into meaningful and useful information for business purposes. BI can handle large amounts of information to help, identify and develop new opportunities. Making use of new opportunities and

implementing an effective strategy can provide a competitive market advantage and long-term stability. Generally, BI has increasing number of components, they are: multidimensional aggregation, de-normalization and standardization, reporting with analytical alert, statistical analysis, group consolidation, budgeting and key performance indicators as analytics (Rud, 2009). The business intelligence as an integral part of intelligent infrastructure should have its own composition as follows:



Source: http://www.sundewsolutions.com/services_data_warehousing_BI.php.

Previously, BI has been only for the few specialists who have been trained to query and format data. Now, it's time to think bigger about BI. Whether at the personal, departmental, or organization level, BI provides all workers with easy access to relevant, actionable information set, whenever they require it. Organizational BI is used to achieve larger strategic initiatives, as operating margin, return on investment on strategic investments, and quality of care goals. Servers can make it easy to share and collaborate on progress toward organizational goals; Departmental BI help people to work more effectively as a team, ensuring the goals of the department that they are met. Workers can create reports and dashboards in Excel that display key process metrics; and Personal BI helps workers in tasks they do every day and continuously. Using internet and specific softwares workers can manage individual goals and tasks and it can help workers develop and manage processes (Business Intelligence for Healthcare Providers, 2013).

Challenges: Challenges include cultural issues around the ability of institutions and individuals to share data, and to trust the data that is being provided by outside parties (Times Raconteur, 2010). Authorities in managing the growth and changes based upon key performance indicators related to various areas such as traffic, environment, and finance (IT Solutions, 2012). Which uses sustainability indicators on greenhouse gas emissions generated through energy, waste and water use that are compiled in a 'dashboard' for the master developer and project managers showing whether potential buildings, transportation, infrastructure and even the travel activities of construction contractors can

meet the city's carbon neutral goals (RFP, 2008; Falconer, 2010 and; Karlenzig, Chao and Peck, 2011). Apart from this the development of technology, switching of the technology, financing, administrations and development of along with increasing urbanization and population are among the important challenges.

Conclusion:

Against the backdrop of this rapidly changing landscape, several themes and trends are identifiable as follows: The network as a transformative force, enabling communication between people, attracted by opportunities and driven by competitive pressures, able to alter the way businesses operates to an efficient way, and the growing dependence on the network, the ICT revolution is entering a new dynamic ever improving phase. This new auto-steering phase has three important characteristics that make it quite unlike the previous one. First, in this new phase, historically separated is latest infrastructure of the ICT environment. To provide services in the new environment, ICT infrastructure requires be interoperable. To support the new dynamic demands, networks supposed to be responsive to the requirements of the applications being linked together. The entire environment is, from a service point of view, new standards and protocols are required to ensure that it functions properly, smoothly, effectively and moreover, efficiently. Second, businesses and other organizations are recognizing a new requirement to coordinate their business processes across organizational and political boundaries in order to reap the productivity gains of the new technologies. Third, the power and functionality of intelligent networks has to create an insatiable demand for greater capacity and bandwidth on real time basis all across the intelligent infrastructure.

It may also be concluded that Intelligent Infrastructure is the need of hour for any country to keep pace with increasing expectations of increasing population bundled with limited resources. For this, Smart Cities, Business Intelligence, Intelligent Energy, Intelligent Transport System, Intelligent Water and Waste Management, e-Society, e-Education and Learning System, and e-Governance, etc., are essential part of an Intelligent Infrastructure.

Suggestions:

Inclusive Growth: Any intelligent infrastructure without inclusive growth can find itself long lasting. In India Twelfth Five Year Plan has set the goal faster, sustainable and more inclusive growth. With vision of towards an e-Inclusive Society charting inclusive progress, breaking barriers, the following objectives have been set in the proposed plan: e-Inclusive Services providing, through ICT, critical health, livelihood,

training, education and citizen services to create a more inclusive society; e-Accessibility - make ICT accessible to all, meeting a wide sections of people's needs, in particular any special needs; e-Competences - equip citizens with the knowledge, skills and lifelong learning approach needed to increase social inclusion, employability and enrich their lives; Socio-Cultural e-Inclusion: enable minorities, migrants and marginalized young people to fully integrate into communities and participate in society by using ICT; Differently-abled: Differently-abled people to fully participate in the economy and society, continue independent lifestyles and enhance their quality of life; Geographical e-Inclusion: increase the social and economic well being of people in rural, remote and economically disadvantaged areas with the help of ICT (Chandrashekar, 2011). The wide spread use of ICT requires the Government to take adequate measures to promote ethical use of data and technology and create a safe and secure cyber world and thus a good life experience.

Intelligent Infrastructure Utilization: An intelligent infrastructure utilizes business demands and priorities as a guidance system to deploy highly available, secure utility computing. It delivers value in three specific areas: business agility, aligning business requirements with ICT service delivery by leveraging comprehensive business model's 3D Blueprints; business lifecycle management, correlating, capturing, and analyzing business and infrastructure events in real time and dynamically adjusting the business models and ICT resources; and business quality of service, providing real-time sense and respond capabilities to monitor and react to business requirements, thereby, maintaining the highest levels of availability and service-level agreement compliance. With the ability to dynamically react to changes in the business and continuously maintain and improve business performance, an intelligent infrastructure completes the connection between business and ICT. By continuously monitoring, measuring, and analysing business performance and feeding the results back in real time cycle. Models can be reviewed and adjusted in response to the feedback driving changes to the ICT infrastructure to make the cycle as self-guided system. An intelligent infrastructure provides the ability to correlate business change with business service delivery through ICT. It puts the mechanisms in place to monitor business performance problems and relate them to IT deficiencies in a rigorous fashion (Salsburg, 2008).

Implication: It is implied that for an economy and country not only infrastructure but intelligent infrastructure is the essential. The Smart Cities along with intelligent business infrastructure and intelligent ICT are essential subsystems are an integral part

intelligent infrastructure. As the population is increasing the intelligent infrastructure can only meet out the increasing requirements.

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