
The well connected city

A report on municipal networks
Supported by The Cloud

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Imperial College
London


The Cloud®
Your WiFi route to the Internet

Introduction

As part of our commitment to helping City Authorities get the most from new technologies we have supported Imperial College London in producing this independent assessment of “well-connected cities”. It provides examples of how cities around the world are exploiting pervasive broadband networks to deliver better government services, attract firms and enable higher business performance, as well as promote greater community involvement and social cohesion.

You will also be able to read some of the latest research on the social and economic impact of municipal broadband initiatives, as well as guidance on what it takes to get such deployments right first time and avoid the pitfalls. This is the first of a series of papers supported by The Cloud, and we hope you will find all of them helpful in providing insight into the processes, priorities and planning of other cities as well as offering you some practical advice on planning your own deployment.

Ben van Dongen

Managing Director
Metropolitan Network Services
The Cloud Networks Limited

About Imperial College London

Consistently rated in the top three UK university institutions, Imperial College London is a world leading science-based university whose reputation for excellence in teaching and research attracts students (11,000) and staff (6,000) of the highest international quality. It is ranked first in Europe and fourth world-wide for technology according to the Times Higher Education Supplement Rankings (2006). This paper has been written by Nick Leon, Innovation Studies Centre who is researching the impact of pervasive broadband on the social and economic vitality of cities. Prior to joining Imperial College London in 2005 he was Director of Business Development, IBM Global Services with responsibility for leading IBM's business in the telecommunications sector in Europe.

About the Cloud

Founded in 2003, The Cloud is Europe's leading WiFi network operator, providing access to a sophisticated wireless local area network (WLAN / WiFi) covering many cities and municipalities and with more than 8,500 hotspot locations throughout the UK, The Netherlands, Germany and The Nordics. The Cloud's neutral model ensures that cities can take full advantage of the applications and services available today including those from The Cloud's partners such as BT, O2, Vodafone and Skype, and also exploit innovative new services that will arrive on the market in years to come. This approach means that The Cloud can offer its city customers the greatest level of consumer choice, as well as secure, reliable support for private city applications.

Acknowledgements

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Innovation is the battleground for international competitiveness in the 21st Century and cities are the cauldrons of that innovation

1. The imperative of innovation

The battleground of international competitiveness in the 21st century is innovation¹, and cities are increasingly viewed as the cauldrons of innovation, enriching not only their surrounding regions, but their nations as a whole.

Across the globe we see massive renewal taking place in our cities, fundamental shifts in the nature of work and the workplaces they host, and transformation of their output as well as their consumption. And in the rapidly industrialising countries we see small towns being transformed into metropolises and entire new cities being planned. From the City of London to Chennai, Shoreditch to Shanghai, or Amsterdam to Dubai, cities are growing, transforming and repositioning themselves as players on a global stage.

Historically cities grew up at the intersection of trade routes or where geography favoured production and distribution of goods. These advantages were reinforced through agglomeration, economies of scale, the development of sophisticated infrastructures, especially road, rail and air links, and the enrichment and diffusion of expert knowledge through universities and research centres.

But in today's knowledge based, services led economy where communications networks can sometimes seem more important than rail and road networks, global cities have emerged as the command and control centres of international business.

2. The Knowledge Based, Networked Economy and the role of ICT

Linked one to another and in turn to secondary nodes of production, distribution and consumption, it's easy to see how the stronger cities get stronger while others may be relegated. And the climb back to prosperity is long and tortuous. For instance New York is the only one of the 16 largest cities in the northeastern or mid-western United States with a higher population today than it had 50 years ago. In that time, the decline of some great cities has been precipitous, with their population halving over the last 70 years while the total US almost doubled in the same period. So the stakes are high².

History rarely favours the underdog, yet it also shows how once dominant cities of the industrial era have failed to adapt to the knowledge based economy, as well as how globalisation is moving the knowledge based jobs to the rapidly industrialising nations in Eastern Europe, Asia and South America.

Just as roads, railways and electricity helped transform cities in the industrial era it is the new technologies that will help establish the competitiveness of cities in the knowledge based economy

So what does it take for a city to succeed in this knowledge based economy, and specifically what role can communication technologies play. Just as the roads, railways and airports, electricity and telecommunications helped transform cities in the 20th Century, how might these new technologies turn underdogs into the top dogs, and strengthen the position of leading cities in a rapidly shifting world? Let's first understand what we mean by a Knowledge City and how it innovates, then we will look at the role that ICT plays in enabling this.

2.1 Knowledge Cities

In a report prepared by Dr. Pascale Michaud for the Montreal Knowledge City Advisory Committee³, she put forward the notion that three factors determine the intensity of knowledge:

- The degree of knowledge production within the region
- The pace of assimilation and use of new knowledge produced worldwide
- The scope of knowledge circulation among communities.

Knowledge Production: All cities, at any point in time, display some acquired knowledge, including the inherent skill base and existing competencies embedded in their firms, institutions and individuals as well as the linkages between them. But to build on these existing assets and grow new sources of knowledge, requires a balanced combination of business firms, universities, public and private research centres, as well as a creative community of designers and artists. When talented individuals from these various organisations work together and not only as separate pillars, it becomes a powerful engine for new knowledge production and dissemination, spurring regional economic growth.

Quite simply the larger the proportion of the city's labour force involved in science, technology, art and design as well as advanced business services, the greater will be the city's development of knowledge capital. And when this is combined with the current acquired knowledge, such as the deep expertise and specialisation that set say Manchester apart from Birmingham during the industrial revolution, and is found today in cities as diverse as Stanford, Singapore, or Taipei then it becomes an especially potent mix.

It is this stream of innovation, this capability to produce new knowledge that drives the creation of new companies, improves the competitiveness of existing organisations and accelerates the emergence of whole new sectors.

Having the skilled labour force is a necessary but not a sufficient condition, and many other factors come into play: organisational, institutional, spatial – after all people need to get together, and of course the technological factor – people need to easily communicate together. As we will see later, communications technology and knowledge networks will play a crucial role in enabling the necessary communication, building social networks, and providing the tools for knowledge development and management.

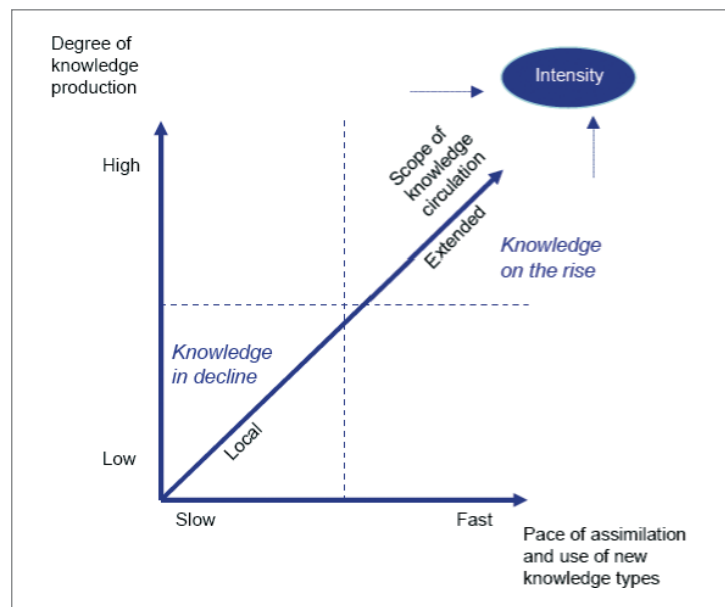
Knowledge Assimilation and Use: The generation of new knowledge will achieve nothing on its own for a city, without the ability to assimilate and exploit that knowledge and turn creative ideas and technological value into social and economic value. And a city that can reap the benefits not only of its own innovation, but also import and integrate pools of innovation from elsewhere, therefore generating new and differentiated value will enrich itself still further. The pace of knowledge assimilation and use depends on the ease of access, insight into the often tacit power of specific sources of innovation, the power of integration, and the ability to extract value through access to capital, exploitation of available channels of distribution, production or leveraging an existing client base, and so on. This process relies not only on the competencies of individuals, firms and institutions, but also their capacity to join creative and often informal networks or rapidly establish new entrepreneurial networks. Again, having pervasive ICT networks and relevant services that facilitate access, help identify potential partners, and create new networks, is fundamental to enabling this process of assimilation and intense use.

Knowledge Circulation: Finally, not mutually exclusive from the others, there is the scope of knowledge circulation: whether it is shared among small groups of people, literally kept in silos, or whether it is openly shared among careful targeted networks and organisations. Innovation is increasingly generated by combining ideas and insights from different disciplines and communities and doing so using multidisciplinary teams, and generally across much greater geographies than just a city and its economic hinterland. Crossovers from nanotechnology to pharmaceuticals, media industry and biotechnology, supply chain and stochastic analysis are common. And these multidisciplinary teams,

who are at the cutting edge of innovation, frequently rely on specialists from a number of technological disciplines: engineering, business, ethnographers, as well as designers from an art and design background. They often also depend on people from well beyond the city-region.

A city that is able to nurture these crossovers, embed them in its ways of doing business, one that is able to bring fresh eyes and therefore insights to challenging problems, and maintain vitality in its innovation pool will not only be one step ahead in this new knowledge-based economy, but will be able to reinvent itself when faced with economic, technological or social upheavals in the future.

Overall Knowledge Intensity: Leading knowledge cities score highly in all three elements and the following figure helps illustrate this. It also shows how a city in the wrong quadrant (lower left) may start with a high level of acquired knowledge but will wilt under the competitive heat of more knowledge intensive cities. In sections 3 and 4 of this report we will examine how different cities are employing broadband networks and services as a means of asserting their position in the knowledge economy, and how they support these three dimensions of knowledge production, assimilation and use, and circulation.



Degree of knowledge production	X	Pace of knowledge assimilation	X	Source of knowledge circulation	=	Intensity of a knowledge city
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3. Cities in the Midst of Transformation

In this section we review how five cities and districts are exploiting municipal broadband networks in their quest to transform themselves for the knowledge economy, deliver improved community services and support greater social inclusion. As we will see, each of these initiatives is driven by a different set of imperatives. First an overview:

Barcelona: Their quest is to create a new form of city for the knowledge economy, and a city that is highly inclusive socially and culturally. There is a comprehensive renewal of infrastructure covering almost 200 hectares of the older industrial sector of the city. But the city is taking enormous care to preserve its cultural heritage, bridge the digital divide especially with the older inhabitants of the district, as well as create new opportunities and skills amongst the young.

The City of London and Canary Wharf: London is a global hub for the financial services industry. To attract and retain international firms it's imperative that they offer the finest amenities; amenities that help improve the operational effectiveness of the business community. So deploying an umbrella of wireless internet access will allow a highly mobile business community to have the latest information at its fingertips anywhere, in a sector where every second counts.

Corpus Christi, Texas: The city saw the opportunity to transform the quality and effectiveness of its services. With this clear cut cost justification it was able to create a pervasive broadband network that could provide wireless access for its citizens too. And now they are extending it to create a rich suite of services for small business.

Stuttgart: The Stuttgart Regional Economic Development Corporation saw how important mobility was for local firms, both in terms of physical transportation as well as information access for the community. They extended the use of a network deployed initially as part of an intelligent transportation system, and created a wireless internet service with a rich information portal for the community across the region. It helps the Stuttgart city region differentiate itself from other regions in Germany as a place to live and work.

Case Study 1

Barcelona



Aims and Objectives

"Our goal is to create a new form of city for the knowledge economy"...
Miquel Barcelo, CEO of 22@ Project

Barcelona is undertaking a major renewal of one of its core industrial and residential zones. The project is known as 22@. The district undergoing this renewal has been one of the most industrious areas of Spain over the last century. It was once known as the Manchester of Catalonia due to the scale and importance of its cotton industry. As this industry declined, it was replaced by the printing industry and engineering workshops, but in the last decades light industry and distribution have characterised this part of the city. And as the old industries struggled for competitiveness in a global economy, employment opportunities declined still further.

The 22@ project is currently transforming this district of the city to spearhead the knowledge based industries, bringing higher density of employment, renewal and creation of public spaces, new housing including special social housing, and a massive deployment of new infrastructure

Deployment

The 22@ initiative covers almost 200 hectares of downtown Barcelona. The target is to create between 100,000 and 130,000 new jobs in the knowledge industries. The plan involves building over 4 million m² of floor space for the new industries, and almost 9,000 new or renewed housing units. The scale of the project is substantial with over ?180 million for new infrastructure and ?12 billion for property investment.

The project was started in 2000, with the overall urban plan completed by 2001. Infrastructure renewal and building construction began in 2004, and the target for completion is 2010. So far around 30% of re-urbanisation has been completed. It adds up to one of the most ambitious urban renewal projects in Europe today.

The infrastructure renewal is total. It covers power with a strong focus on renewables, communal heating and cooling, water and vacuum waste management, and a rich telecommunications infrastructure. The city is also deploying its own dark fibre, and between each block they have built 2 metre high galleries so extra dedicated connectivity can be provided between buildings. Around the top of each block they have implemented a ring for both power and data networks so an approved set of antennae and radio nodes can be added without ruining the historic sky line in the district.

Requirements

The wireless network is in the planning stage right now but is considered as an essential component of the cities infrastructure. The model is to be a

Case Study 1

Barcelona



Transformation to a new kind of city for the knowledge economy ... but eager to preserve the social and cultural heritage of its industrial past, as well as deliver greater social inclusion

neutral operator, supporting the city's own requirements, providing a range of community services, and providing an infrastructure that is open to other operators to deliver their broadband service.

Barcelona is implementing a series of industry clusters that incorporate firms both large and small, research centres, universities, incubators and offices designed for start ups, showcases and demonstration facilities and residential space. Industry zones include Biotech, ICT, Media and Hi-tech.

The design of the fixed and mobile networks is customised to reflect the different needs of each industry grouping, as does the spatial organisation of each cluster. It is unusual to see this degree of integration backed by regulatory actions and business incentives to accelerate the interaction between academia, research and business, aid innovation and encourage new business start ups

Community Benefits

With so much renewal taking place great care has been focused on retaining the cultural heritage of the district and one project "Virtual Memoria" not only achieves this, but also helps bridge the digital divide and grows the social capital. So far, around 150 school children have been trained in media and IT skills. They then go out and meet older residents of the district and interview them about their lives, their experiences at work and within the community, of great and historic events, and of friends and family. Their photographs, interviews and video are edited, loaded into a central repository and then made available over the internet.

The children then go back to the residents and show them what now constitutes truly compelling content for these older people who up until then will never have used the internet or touched a computer. They are clearly enthralled by the experience and the children go on to show them how the internet can help them, especially in using some of the community applications for healthcare and social benefits. The result is that the children's aspirations for working in the knowledge based industries as well as their skills have been transformed; the history of the district is preserved; and the older people have been shown compelling content which has helped them over that initial hurdle that so often characterises the digital divide

Summary

In Barcelona we see a highly planned approach to transforming a major tranche of the city. This plan requires a comprehensive renewal of infrastructure to support the 21st century knowledge based economy. It also recognises not only the importance of supporting the transformation of the physical infrastructure but also the social and cultural aspects which enable the economic transformation. Its approach with Virtual Memoria is exemplary and reflects the thoroughness of planning visible in every dimension of the 22@ regeneration programme.

Case Study 2



The City of London has always thrived on communication, and wanted the best in technology to maintain its leadership in the 21st century

City of London

The City of London, known as the Square Mile covers just over 1.1 square miles or 315 hectares of London and is Europe's leading financial centre. It is home to approximately 350,000 jobs yet has only 9000 residents. It is extraordinarily dense with over 7 million square metres of office space. It is a truly global district and each day trades \$753bn foreign exchange (31% global share), has 43% of the global foreign equity market and is home to over 264 foreign banks.

Aims and Objectives

"The City of London has always thrived on communication and in the 21st century it needs the best in communications technology to maintain its competitiveness"

Simon McGinn, City Surveyors Office, Corporation of London

In 2005 the City of London Corporation saw the opportunity WiFi could offer the business community. The key requirement was to ensure that the business community had world class communication capabilities. Any applications for the city's own work force or enhancing the delivery of community services were considered as potential added value, but the priority was to support the hundreds of thousands of people working in the City.

"In the City, every second counts and being able to have access in real time to rapidly changing data from anywhere, anytime is the difference between success and failure."

Simon McGinn

Key Requirements

The Chief Officers and Members needed to be convinced as they perceived the new technologies as unproven, risky and City of London has such visibility it could not be allowed to fail. As the year went by the requirement became even more intense as other cities deployed networks, so executing a WiFi network with confidence was essential and doing so immediately was imperative.

The key requirements were that the network would be open, neutral and be available across the entire city, which bearing in mind the density and twisting streets of the original medieval street layouts, was clearly going to be a challenge.

"A series of hot spots was not an option. The city is highly mobile in nature; face to face meetings are essential, whether in one another's offices or neutral venues and the business community needs consistent and continuous access to information ... with applications such as voice over IP, continuous communication is essential and there can be no dead spots."

Case Study 2

City of London



Key business users were also canvassed at the outset of the project. They welcomed the initiative and stressed their requirements for no compromises on security, performance, coverage and top quality management.

Decision Criteria

The key criteria in selecting a partner, as well as determining the design point for the network were rapid deployment, openness, robustness, mobility, adaptability, expertise, ability to trial and enhance new services, as well as having access to new and continuously evolving technologies. The business model had to reflect the enormous value and prestige of the City, as well as the business opportunity of delivering services to the largest and densest international financial services community in the world.

Business Model

The City of London selected The Cloud and in exchange for initially 5 years exclusive right of way on the city's street infrastructure, The Cloud would design, deploy, own and operate the network. They were encouraged not only to facilitate but project manage the entire deployment including working with key content and service partners to bring added value to the business community.

Deployment

This was much more complex than expected as both parties gained a better understanding of the real requirements and also constraints. Ensuring close to 95% coverage required different technology than originally planned and Bel Air was finally selected as the technology provider. They fitted best with the City's requirements and over 135 of their multidirectional dual radio nodes are currently being deployed. Using a mesh approach they were able to reduce the number of connections for back haul to just 6. Another challenge was finding that some of the 800 items of powered street furniture did not exist, were not tall enough, were not in the coordinates provided, were corroded or were not owned and controlled by the City. Only about half of them were viable locations for nodes. With this added complexity and increased investment, the City agreed to extend the period of exclusivity beyond the 5 year period. Importantly the relationship between The Cloud and the City was one of strong partnership and openness as the challenges materialised and both parties were willing to find ways of addressing them equitably. The new service goes live at the end of the first quarter 2007.

Benefits

The focus has always been to give exemplary services to the business community, and ensure the City continues to attract and retain the world's most successful international financial services companies. The WiFi network is essential in providing the amenities those companies need to operate effectively. But it also opens up the possibilities of enhancing delivery of community services, with areas under consideration including CCTV and surveillance, traffic management and enforcement, and providing special wireless access to Bart's Hospital.

Case Study 3



Making Stuttgart a better place to do business, and a better place to live ... exploiting an open network, leveraging multiple content providers and working with a partner to operate and extend the network for the future

Stuttgart Region

The Stuttgart Regional Economic Development Corporation supports the development and introduction of new technologies in enterprises and communities of the region. Especially in the field of mobility technologies, integrated environment engineering, regenerative energies and new information – and communication technologies. The Region Stuttgart consists of the city of Stuttgart and the following counties: Böblingen, Esslingen, Göppingen, Ludwigsburg and Rems-Murr. Within the Corporation there is a dedicated mobility group that focuses on the large car manufacturing firms based in the region and the automotive industry supplier network, traffic management and intelligent transportation systems, and the delivery of the MobilCity Programme.

Aims and Objectives

The original aim of this project was to make the region a better place to do business and to support local firms as well as attract new firms to the region. It could also improve the delivery of local services especially transportation, offer free access to a portal with important community services over a wireless network, and provide an infrastructure that could allow firms and agencies to create new innovative services.

In 2004 a decision was made by the city authorities to offer wireless access in local government buildings as well as selected public areas and that such a network and its assets would be owned and controlled by the city authorities. In its initial phase it would support the city authorities own internal needs but later it would be made available to the public.

Deployment

The MobilCity portal is available free of charge from more than 60 wireless internet access points across the city including the popular street cafés on the Schlossplatz in down town Stuttgart, or from any of the 32 stops of the light rail transportation system. Users can have full internet access for an additional fee. And the current network of hotspots is being extended in partnership with The Cloud to many other locations across the city.

The MobilCity portal covers events, e-government services, leisure time activities, restaurants, hotels and other tourist information. It also provides real time information on the transportation system and in partnership with Hitradio Antenne 1 provides updated traffic information. One of the special features is its ability to recognise the nature of the device accessing the service, and then automatically render the content for the particular cell phone, PDA or notebook.

The project began with the Transport Group who managed the light railway system. Fibre had already been laid along the railway tracks so a decision was made to use this as the core network. At that time it was only used for credit authorisation from ticketing machines in the stations. It offered 100mb/s and could be used to provide hot spots to support communication with vehicles.

Case Study 3

Stuttgart Region



The project team started by building up hot spots in the Central Bus Station and used WiFi to check all the data on the vehicles as they came into the bus stations e.g. problems with engines, refuelling etc, but soon began to think what else they could do. They brought together all the city agencies to determine the next steps, ensure there were no overlaps in applications, services or infrastructure and two working parties were formed; one addressing infrastructure and the other focused on content

The team worked with a subsidiary of Arcor the local telecommunications company and later with The Cloud. They needed a telecommunications partner because they were not licensed to set up and operate hot-spots for the public. They were naturally anxious about the commercial risk and looked for content as well as telecommunications partners. They also sought a partner who could operate and maintain the network, even extend it into new locations such as the convention centre or concert hall.

Business Model

The Cloud was selected not only to manage the existing infrastructure but also to extend it into new locations. They were ready to do this at their own cost in return for a share of revenues and exclusive rights of way to city street furniture and equipment. Working with their partner, The Cloud, they can respond to new and developing requirements across the city. And because The Cloud is a neutral operator, and the network is open, they can work with additional service providers to add new content or services.

The management contract for the network is with The Cloud but the infrastructure is retained under City ownership or the relevant agency e.g. transportation.

Benefits

The Stuttgart consortium believes it has a unique service in Germany and by having such a comprehensive infrastructure they can attract more firms to the district. They also believe the service can only get better in terms of content and services as new service providers are attracted by their strong user base and an open and extensive network. They can demonstrate that using this network is much lower cost than using 2.5/3G access from laptops and PDAs for their own workforce as well as for firms in the regions. However they recognise they need to have road show to encourage existing local companies to use the service and also the Voice over IP facilities it enables.

One of the unexpected benefits was the ability to bring people and functions together and through this cooperation and participation they came up with innovative new capabilities.

Future Plans

As for what's coming up next, the MobilCity group are planning to set up community blogs, and forums, and the transport group is looking at an equivalent of London's Oyster Card, payment system for wireless internet access using SMS, as well as wireless ticketing applications.

Case Study 4

Canary Wharf



“To attract international firms means having the infrastructure that’s in line with or exceed their expectations”

“.....in this industry every second counts and you can’t afford to be out of date or you’re out of business”

Canary Wharf, in East London is one of the most prestigious commercial centres in Europe. 80,000 people work there each day, mostly in the international financial services industries and another 15% of people visit. The estate has over 24 major buildings, 5 shopping malls, 2 DLR Stations and the London Underground. There are around 1.4 million square metres of office and retail space and the overall estate extends to over 35 hectares. It is managed by Canary Wharf Group plc. The group has a totally integrated approach to communications. They facilitate effective mobile phone coverage across the estate, and work with data network partners such as BT, Cable and Wireless, Verizon, Colt, NTL and others, who deliver hi-speed, secure data and voice services essential to the international financial services community. In 2005 they decided to extend this with a WiFi capability across the entire estate.

Aims and Objectives

Tony Partington, CEO explains that *“We wanted to make Canary Wharf a truly attractive place to live and work. ... Canary Wharf is first and foremost an international business centre. Its roots are firmly in the finance industry. To attract international firms, means having facilities and infrastructure that are in line or exceed their expectations.”*

“In the same way that a 5 star hotel does not seek to individually justify all of the amenities it supplies, we recognise that to give the customers an experience that matches or exceeds their expectations we need to offer a high level services and amenities. And that’s why we’ve deployed this network”

Tony Partington continued. *“For our users a typical business scenario is you’re travelling to a meeting, heading through the public space, the mall the car park. Meanwhile the team back at base is adapting your presentation with new and important data. You download this via email onto your PC and you’re ready to go with the most current version for your business meeting. ... Every second counts and in this industry you can’t afford to be out of date, even by minutes.”*

Requirements

Canary Wharf Group plc’s tenants are very security conscious. Few of them have deployed wireless inside their buildings, or are even too concerned with 2G/3G connectivity within the buildings. But deploying a wireless network in the public space, atria, retail malls, and stations is crucial for the workforce when they’re on the move, or meeting with other firms in the many bars, cafes and restaurants.

Deployment

For mobile cellular communications, they wanted one partner to provide central coordination, deployment of the enabling infrastructure, especially through the different property interests. They selected NTL who provided central coordination of all the cellular mobile connectivity across the site and within buildings. They worked with each of the mobile as well as the voice and data network service providers, identified the need for additional antennae, boosters, etc and were able to deploy these discretely, sensitive to the appearance and aesthetics of the buildings and architecture of Canary Wharf. Almost everything has to be registered with the land registry and

The Well Connected City

Case Study 4

Canary Wharf



planning approvals are required, and with so many tall buildings and complex open spaces, the Group wanted a single partner to manage the deployment of the mobile network.

Naturally, once they had decided to deploy the WiFi network they also decided to follow this same model and go with one principle partner, in this case The Cloud.

Business Model

The financial model was important, especially the extent of commercial risk. They therefore issued an “expressions of interest” request to communications and technology firms. This focused not only on the design of the service but also on the potential business models they proposed. They did not want to be a service provider, or a telecommunications company, but wanted a partner to handle this. They considered taking a bigger participation in the revenue stream in exchange for reducing the upfront costs, but in the end decided their job was to deliver the best infrastructure not turn themselves into a Telco. The key criteria for selecting a partner were experience, evidence of the way the partner could really make it work, life cycle management, and partnership orientation. And in 2005 The Cloud were selected.

Benefits

One year in, they started in September 2005, Tony Partington explained how the service was well accepted and proving popular. ...*“of course you are a bit like a football referee, no-one notices when everything is going well, that’s how you want it to be.”... “you only really hear when people have complaints. People just expect WiFi to be there, and pretty much everywhere.”*

“It helps to distinguish the brand, of Canary Wharf versus other places to locate your firm, even if it’s subconscious. Lots of people, employees come and visit Canary Wharf and they can influence a firm moving here if they find it hard to do business in the place. ... We always need to be one step ahead to draw people to Canary Wharf from London. ... or compete with other cities around the world, ”

Futures

The Group are keen to add more services such as Voice over IP and work with service partners for instance Vonage, Skype and others to deliver those services. They foresee VoIP as being very attractive; especially to the independent traders. *“You can call using a flat rate service half way around the world from your laptop, wherever you are.”*

The WiFi network is not currently used for facilities management Group’s own mobile field force, but this may be considered in the future.

Summary

Canary Wharf Group plc had the vision to deploy a WiFi network to create a more attractive place for business. They see this as an important facility, part of an extensive package of amenities that distinguishes Canary Wharf as a global centre for international finance. Having the very best in communications is only fitting for an estate that prides itself on the quality of its infrastructure, architecture, accessibility, and retail and leisure amenities, all of which which make it an exciting and vibrant place to live and work.

Case Study 5

Corpus Christi, Texas



Aims and Objectives

Corpus Christi, Texas is located on the Gulf of Mexico and has a metropolitan population of just over 400,000. It is the 63rd largest city in the US according to the 2003 census and the fifth busiest port. The city ranks fourth in new investment, behind New York, Detroit and Chicago yet ahead of Dallas-Fort Worth and Houston, according to Site Selection magazine.

As such a dynamic city at the forefront of much new investment, its goal was to provide affordable wireless broadband access to every citizen and business throughout the city region as well as improve public safety and city services. The project began in 2004 with a decision to implement an Automated Meter Reading application using a WiFi network. The network could be justified on this initial application, but the view from the outset was to build on this and deploy a network that could improve the quality of government services, as well as deliver benefits to the community

Deployment

The City is using a combination of WiFi radio technology including a mesh network and WiMAX. The network can currently be accessed for free though there will be an "affordable charge" at a later date to cover implementation and operation costs. It can be accessed from a suitably equipped lap top, PDA or WiFi phone and indoor business and home use is possible using a WiFi range extender.

The City successfully completed its initial pilot project that covered two residential neighborhoods with AMR (over 2,200 homes) within a 300 radio-node cellular WiFi network. This provided WiFi access covering over 18 square miles of the central and shoreline area. In September 2005, the City Council approved the expansion of the WiFi network to serve the City's AMR needs on a city-wide basis, and by the end of 2006, the network should provide access across the entire city area, with a total of over 1600 nodes.

The City authorities believe that the metropolitan area WiFi network has the potential to do to broadband Internet access what cell phones have done to phone access. It can provide all residents with a more powerful and affordable alternative to cable/DSL access, empower local business with tools to more effectively manage and sell their products and services across the region and the world. It also enables the City to transform its services for public safety, as well as enhance other service delivery and operational effectiveness.

... the savings alone from automated meter reading helped justify the wireless network

It gave the city a platform to build upon in its goal of delivering affordable wireless broadband for every citizen and business as well as improve public safety and city services

Case Study 5

Corpus Christi, Texas



Benefits

The current deployment provides:

- The water and gas service organisations with automated real time meter reading, this has now been extended with automation of distribution using remotely managed valves and sensors
- Law enforcement officers with secure mobile access to criminal history, incident reports and video surveillance
- Code enforcement inspectors with mobile access to research properties and file reports, this has reportedly reduced the time taken for inspections from 30-50 days down to 10-15 days, saving about 25% of the time on new building construction
- Construction and repair crews with remote access to critical infrastructure data
- Emergency responders with mobile access to building and infrastructure requirements
- Enhanced traffic management through interconnecting traffic signals
- Emergency health care providers with mobile access to medical records so that first responders can extend treatment beyond first aid, bypass triage and provide data on vitals and video for ER Doctors
- Schools, teachers, students and parents with community access to education, grade book, and calendar applications

Meanwhile the community applications are allowing people to gain access to thousands of live and interactive university, business and self improvement programmes; access their child's school network to view their progress report, upcoming assignments; research medical issues and use Voice over IP applications.

Case Study 5

Corpus Christi, Texas



Futures

The city has recently gone through a call for partnership exercise to attract outside firms. This has special focus on services for small business. The goals are to improve the effectiveness of local small businesses through online business services and applications, and increase revenue for local small businesses by selling through local and global online market channels. The approach for small business is to offer a portal which delivers:

- Awareness and Training – provide small business articles and case studies that provide examples of how other small businesses have successfully used technology to improve operations and sales. The portal should also provide training using online webcasts and interactive training tools.
- Online Services – provide online business service solutions including web hosting, eCommerce, eProcurement, marketing, sales, business email, business telephone, VPN, net meeting, etc. These services can be provided by the portal sponsor or partners or advertisers.
- Products and Solutions – provide a directory of trusted solutions for small business operations including financial, customer services, sales, and work force solutions

Summary

What distinguishes Corpus Christi is its ability to find an application where the payback could justify the core network deployment, in this case Automated Meter Reading and management. On the back of this a wide range of additional services could be added with low incremental costs. This created quantifiable benefits from improved operational effectiveness, and a network that could then be opened up to the community to deliver low cost, or even initially free broadband services. With this infrastructure in place it created the potential for other partners to come on board and offer value added services in partnership with the City Authorities, to business and the community

A pre-requisite for innovation is communication and knowledge exchange between firms and other institutions, individuals and teams

And teams are no longer collocated, nor made up from just one organisation

4. Exploiting Technology – Driving Transformation

In reviewing these cases we see five main areas where cities are deriving significant benefits, these are:

- Attracting new business and supporting innovation
- Business workforce effectiveness
- Efficiency in local service delivery
- Transformation of community services
- Social Cohesion and inclusion

Now let's take a look at each of these in turn.

4.1 Supporting Innovation

A pre-requisite for innovation especially in business, is communication and knowledge interchange both within and between firms and other institutions⁴. Innovation differs from creativity and invention in as much as it leads to the launch or deployment of new products, services and processes which have a commercial or social impact⁵. And while creativity and invention may sometimes have a sole originator, it is in general teams or even complex networks of firms and individuals who are necessary to successfully innovate. Communication between all the different stakeholders is crucial to this process.

When organisations were vertically integrated and people came to work 9-6pm, innovation took place in an office environment. Creativity might have been evident over lunch, but the hard work of turning that creativity into real innovation took place in the office. And new workplace design has focused heavily on spaces that stimulate innovation. But now we've moved on and a stimulating workplace is not enough:

- Today we often work in large extended teams not only within the enterprise but with a great web of partners, clients, and suppliers outside of the organisation who are crucial to new innovation and business operations. Firms are less vertically integrated and the products and services are normally offered as part of much broader systems.
- Secondly firms and organisations are much more distributed than ever before, including at an international even global level. And enabled by technology, many people will not even regularly work from the office. They have become nomadic.

In the knowledge economy,
disconnected means
disadvantaged

And since business takes place
anywhere, anytime you need to
have the same ease of access
everywhere

- Finally the nature of the information we are dealing with has changed too. Communication in business has always relied on a combination of both tacit as well as more formally codified information⁶. “Codified” information can be readily documented, found on the internet, or corporate databases. It can normally be accessed from almost anywhere, and on its own does not bring any special advantage to one location over another. By contrast, “tacit” information is less structured, it’s the information we hold in our head, it may include partially formed ideas that are still gestating, or information on relationships both between people and between organisations, and crucially, it’s what brings value and competitive differentiation to the codified information. Today, the information we exchange is not separated easily into the "tacit" and "codified" information. In fact individual value is more likely to be generated when we put a wrap of highly personal "tacit" information around more formal codified information.

So to drive innovation, it requires people from different firms getting together not only over the phone but also face to face, in their offices or some neutral location, and share a combination of tacit and codified information.

The PDA, the laptop, the smart phone are all mechanisms for accessing dynamic corporate data as well as the broader internet and without them people feel disconnected and disadvantaged.

Having all the information at your finger tips, anytime, anywhere and being able to access it, share it, and incorporate personal insights are essential in a city that supports innovative firms. And being able to do this in real time, with the much more complex webs of stakeholders that firms and individuals operate within today, is crucial for personal and business success. That is the value that a wireless enabled city or district wide network brings. And if you can access your systems anywhere using interfaces that are identical to the ones you would use in your own office or from your own dedicated network services provider, then this facility is more likely to be taken up.

As we saw in several of the case studies, this implies either the city acting as a neutral operator, or finding a partner who will do that; and a partner that will provide open access to the

A city that can enable better communication plays host to more innovation and enables business growth. But it's crucial that the network is truly open

network, even encouraging other parties to come and deliver services over it. This accelerates take up, delivers additional value to all users, and can generate a slice of revenue for the city authorities too. This is exactly what we saw in the Stuttgart, City of London and Corpus Christi case studies.

A city that enables this will play host to much more innovation than one which prescribes a limited set of locations, and needs individuals to timetable every meeting and encounter so they can be prepared with information that is still never quite current. By providing for instance a “guest” facility, people from different firms could access their own private corporate databases securely from each others offices, and if this service is provided by a neutral third party, then issues of security and confidentiality are mitigated.

What we see in the City of London or Canary Wharf are city districts that are agile and flexible and allow businesses to literally create the space and time they need to function, rather than face the rigidities of the traditional city, or private data network.

4.2 Delivering Higher Workforce Effectiveness

In the previous section we looked at innovation, but the day to day success of an enterprise is based on the efficiency and effectiveness of its operations.

We will look first at how the provision of a pervasive broadband networks can enable firms to improve the efficiency of their mobile work force. The combination of WiFi enabled central districts complemented with mobile cellular networks at the periphery can provide ubiquitous connectivity so long as the applications and smart devices have been enabled to move seamlessly across these networks, cell to cell, while maintaining connectivity to the applications.

Field Force Automation: These applications require ubiquitous and secure access to corporate systems so that while an engineer is resolving a problem with one customer, the parts that are required for the next call are being shipped directly to a drop off and collection point en route, or the days call plan might be rerouted should there be a hold up on parts delivery. Continuous feeds of data to the field engineer, as well as access to diagnostic support including 2D and 3D images aid field productivity, and the integration of parts

Saving 40% to 60% on real estate costs through telecommuting programmes

logistics and field operations can transform the completed call rates. Complement this with Voice over IP and voice communications costs can be reduced as an engineer gets guidance directly from say a 2nd level support organisation that could be in India. Additional location based services can include locating the nearest fuel station on the way to a call to minimise the distance travelled, improve the call rate and reduce the response time. For instance, IBM reports how it helped one of its British utilities customers deploy a mobile working programme, enabling them to work on 287,000 more repairs annually, free up 2.6 million working hours, replace over 4.5 million paper forms, reduce the distance driven by front line response teams by more than 15 million miles and thereby save around 2.7 million litres of fuel.⁷

Distributed Working: According to The Agile Workplace: Supporting People and Their Work; “By 2006, about 30 percent of the Global 2000 enterprises will have adopted a model where 35 percent of the knowledge workforce will be empowered to work outside the formal workplace.” And it continues...”After 2006 workplace agility will be achieved in 30 percent of the Global 2000 enterprises by adopting an explicit strategy to support a highly distributed, connected and autonomous workforce.”⁸ This is driven by a combination of productivity benefits, employee preference and improved recruitment, and cost savings by reducing real estate costs through hot-desking and flexible work models. For instance IBM claims that its mobile working programme has demonstrated that telecommuting programmes can save on average £10,000 annually per employee and reduce physical infrastructure costs by 40-60 percent.

Vitality in the Small Business Sector is essential to Urban Vitality. Finally there are many small businesses in cities that have neither the resources nor scale to deploy rich ICT based business solutions. Small businesses by their nature, often involve proprietors and managers moving rapidly from their clients’ offices, their homes, and main business premises, and have access to their business data and colleagues using a combination of messaging, email and voice from any of these locations or on the go. As we saw in the Corpus Christi case study, a city that employs a pervasive network can work with a series of partners to offer a small business portal that brings

Growth of employment in cities depends on the vitality of the small business sector

Delivering added value ICT based services for that sector is a priority

Mobile and field force workers represent at least a third of the work force in local government and mobile applications can deliver productivity gains of 20% to 30%¹²

together a rich suite of applications such as office and collaboration applications, e-mail, instant messaging, teleconferencing, VoIP, e-learning, e-procurement, e-marketplaces, e-HR as well as other IT infrastructure outsourcing services such as disaster recovery, back-up and restore, remote IT management. Many of these could of course be offered over existing broadband links, but by providing a pervasive network, it enhances the benefits for proprietors and managers of small businesses who need to be able to work flexibly from any location and have access to this rich suite of services. As we saw again in the Corpus Christi case study, they are using their pervasive network to attract a range of new service providers to deliver just such services, and see the revenue opportunities that would accrue to them while benefiting the 99.6% of businesses in the city who have less than 50 employees.

4.3 Efficiency in Local Service Delivery

We saw earlier the benefits for field force workers in business. It is no different in the public sector, where mobile workers may constitute a third or more of the local government labour force. And in some cases it may be much greater as we saw in the case studies where one city had around 70% of its employees in the field force.

Typically cities begin their deployment with those applications where there is significant direct and early impact, as well as those where they have the most direct local control. These include transportation and traffic management, public safety, healthcare, emergency response meter reading, CCTV Surveillance. There may be many additional applications that the city is interested in deploying, for instance equipping building inspectors with PDAs and digital cameras to record site inspections and reduce delays in the construction cycle. But, by rolling out one or more of these principle applications, the basic network infrastructure and platform deployments can be justified, and the incremental cost of adding further functionality is modest. A good example of this was the Automatic Meter Reading (AMR) deployment in Corpus Christi, Texas. With this infrastructure in place they were then able to move on to deploy many more applications.

Mobile CCTV surveillance cameras with a WiFi connection may cost only a fifth of setting up a fixed camera with a DSL connection

CCTV and Surveillance: the cost of deploying a CCTV camera using a wireless connection and the subsequent network operating costs are far lower than a DSL or Cable connection. Because roads need not be dug up to lay fibre, mobile cameras cost about a fifth of fixed ones, and they can be moved to hot spots that develop over time allowing a far more flexible as well as efficient deployment model. Security is a concern naturally due to potential radio-frequency jamming but with appropriate technology and overall design this risk versus a fixed network model can be minimized.

Automated meter reading: AMR not only cuts the cost of field visits, reduces issues of estimated or disputed bills and fraud, but also allows constant monitoring of the network and optimization of supply. This has environmental as well as efficiency gains and with automated and remotely operated valves the distribution network can deliver improved quality of service to end-users as well as lower operating costs to the municipality or utility operator.

Code Inspectors: We saw the how at Corpus Christi building inspectors were equipped with digital cameras and PDAs and could photograph work on site, complete the documentation before leaving and provide the photographic material and reports to the client or contractors to speed up resolutions of non-compliance with codes. This reportedly saved 25% on the building cycle, and whether it's building codes, health and hygiene codes in restaurants, these technologies can certainly aid city authorities in code compliance.

Health Care and Social Service Delivery: Cities report how equipping nurses, care workers, and emergency services with intelligent devices improves the productivity of the work force. More importantly however, they can transform the quality and effectiveness of the service itself. First on the scene responders can have information on exactly where to go from geographic information systems with detailed layouts of buildings. They also have access to medical records, so vital treatments can be carried out before the patient gets back to hospital. And on a purely administrative level, they can provide efficiency savings in scheduling calls, reporting case notes, and providing accurate information to the patient or client.

It takes more than just a browser based front end to transform community services. Real gains are achieved through re-engineering the end to end delivery of those services

Traffic Management: Linking traffic lights; providing telematics to help in the maintenance and management of fleets of city vehicles, buses and trams; providing real time information to commuters using public transport or in their cars; congestion management; and parking enforcement; these are just some of the techniques that cities are using today to operate more efficiently. We saw examples of this in the Stuttgart region as well as Corpus Christi, Texas and other good examples include Westminster in London. This is a strong payback area and there are significant financial savings reported by cities, as well as greater flexibility by delivering the service using WiFi instead of dedicated DSL lines from bus stops, traffic lights, depots etc.

It takes more than just a browser based front end to transform community services. Real gains are achieved through re-engineering the end to end delivery of those services.

4.4 Transformation of Community Services

Putting a tactical web front end on existing services so they can be accessed over the web and deemed a self-service application is missing the point. Doing this is like the early days of e-commerce when say a web-enabled, consumer front end was glued on to the existing supply chain applications. Companies like Amazon who designed an end to end service prospered, while so many others fell by the way side because web added so little value. And so it is with too many of the community services that have been web-enabled. Paper forms have been translated almost one to one on to the web, with little impact on the back end service delivery. Too often they are difficult to use, provide little extra value to the citizen or consumer, and clog help lines with calls from the few people who actually attempt to use them.

While this has been happening at the front end, some dramatic changes have taken place at the back end. Many of the traditional services provided by the city's own workforce are now outsourced to private service providers. Requests to the local authorities for community services are fed, often indirectly, to the private service provider, and resources from the city constantly monitor the service providers to ensure compliance with agreed service levels; has the graffiti been cleaned from the wall within a week of reporting or a vandalised car removed within 72 hours?

It's crucial to have a secure, truly scalable and integrated network, that's accessible using a variety of different devices from mobile phones to interactive TV

The Digital Bridge project in Shoreditch has shown that there is another way but it requires a joined up approach to service delivery. But this is where real savings can be made, the community engaged in the process of service delivery, and the solutions can be scaled as community engagement drives higher levels of reporting.

Digital Bridge provides compelling content to residents using interactive TV and Video on Demand. High quality short TV programmes are filmed locally, within 10 minutes walk of most people, and produced by a small team at ITN. They might go out with the police on say a raid on a "Crack" house. Alternatively the production team might interview the Mayor of Hackney about changes taking place in the borough, or the talk with the local Headmaster and teachers about educational initiatives that will affect their children.

These video shorts are linked with messages about service delivery, so a police video might be followed up by a request along the lines "if you see graffiti or a vandalised car that's new, report it now using your key pad and something will be done about it directly". All interactions are immediately acknowledged and the person reporting the incident told they will be informed by email or sms when the car will be removed or graffiti cleaned up. And if it's not removed then, they are encouraged to report it as well. As most of these services are outsourced, it ensures public involvement in not only monitoring their built environment directly or using the CCTV which is streamed to their homes over the network, but they also are monitoring the firms whose job it is to service that environment. And these services are fully enabled with a mobile platform.

The impact is compelling; the audience share for flagship videos such as the "Crack" house Raid is 35% and this is comparable to leading broadcast programmes like the BBC's East Enders with 38%. Importantly 46% of users are now reporting crime, compared to just 8% reporting to the Local Authority previously. This underlines the need to have truly scalable solutions, an integrated fixed and wireless network and end to end service delivery⁹. It also demonstrates the power of a joined up approach.

4.5 Social Cohesion and Inclusion

There is a clear link between age, employment status and education in the use of the internet in Europe, and in rural areas. Lack of broadband as well other factors exacerbates these differences. The digital divide is substantial and an analysis across the European Union in 2004 showed that only 25% of those with at most lower secondary education used the internet during the first quarter of 2004, while the proportion rose to 52% for those who had completed secondary education and 77% for those with a tertiary education. Similarly just 13% of the retired used the internet, compared to an EU25 average of 47% for individuals aged from 16 to 74.¹⁰

Wireless internet combined with the smart delivery of services, as we saw in Shoreditch, can be an important means of bridging the digital divide. And when a network can be deployed, justified by other service delivery and cost benefits, then the cost of extending services to the disadvantaged becomes a modest incremental cost. But it is when the network is combined with compelling content, is made highly accessible and imagination is brought to bear, then the greatest gains are evident.

Let's look at an example in Barcelona which does just that, it's called Virtual Memoria. As we saw in the first case study, over 200 hectares of Barcelona are being transformed as part of a programme known as 22@. The 22@ project is turning the disused building, warehouses and workshops into a thriving centre for the knowledge economy. But there is a great deal of history and character that needs to be preserved and not just by leaving a few landmark buildings. The community has many older people who are on the very periphery of the knowledge economy yet live right at its heart. Finally the future of this district will only be sustainable if children growing up in the schools at the heart of 22@ can develop skills for the knowledge economy. It was these imperatives that drove the Virtual Memoria programme.

Over 150 children have been trained to interview the older people over the district, film them, collect interesting documents and photographs and then edit and transfer their work to a central repository, accessible over the internet. The children work in teams with a designated older resident from the

There is strong evidence of a direct relationship between growth in broadband usage and improvements in educational attainment, employment, incomes and house prices

community and when their work is completed, they take it to the interviewee and show them their history, their photographs, and their memories which they have recorded on the internet including live interviews which can be streamed to them.

For the older people this can be quite magical, and the content appears compelling. The young team then show them how to access important additional information using the internet such as booking hospital appointments, checking on social services. So their introduction to the internet is made possible through engaging them first with truly compelling content. The project achieves three major goals. It helps bridge the digital as well as social divide of age and attitudes, it captures the precious individual and collective memories of a district going through an astonishing rate of change, and finally it teaches an entire spectrum of internet and media skills to a community of children whose aspirations may not have included the knowledge based and creative industries before this experience.

Ubiquitous connectivity is the goal of the 22@ team, and with creative programmes such as this, they aim to improve social cohesion and bridge the digital divide across the new district.

5. New Research Findings

There are more than 350 large scale deployments of community fixed and wireless broadband projects in place or underway today, and this is a global phenomenon. Cities have themselves reported significant productivity gains but up until now there has been only modest independent analysis of the direct impact of the use of broadband at a city or even district level. Research undertaken at Imperial College London is indicating that there is strong relationship between growth in broadband usage, the nature of that usage, and a number of key social and economic indicators.

Findings: The study is at the level of Metropolitan Standard Areas (MSAs) for 166 cities in the United States. The preliminary results indicate that the growth in broadband usage is associated with growth in a number of key social and economic indicators including: Per Capita Income, House Prices, Employment, and Educational Achievement.

Data Sources: The US Current Population Survey March 2004 Supplement provides data on the nature of both broadband connections and usage at a zip code level. The research effort then compared the growth of broadband usage, with growth data from the following sources and found a consistent and positive relationship between all these indicators and the growth of broadband through a series of multivariate regressions:

- House Prices: Office of the Federal Housing Enterprise Oversight
- Education: Institute of Education Sciences – National Center for Education Statistics and American Community Survey (US Government Census)
- Employment: Bureau of Labour Statistics
Population: US Census – Population Estimates
- Per Capita Income: Bureau of Economic Analysis

Further information on this is available from nleon@imperial.ac.uk

An Explanation: We can relate these findings back to some of the earlier case studies to better understand the mechanisms at work. Edward Glaeser showed that the skilled city is better able to adapt and survive in a period of technological change¹¹. So we can see how the impact of broadband on education as well as learning in the workplace might contribute to the economic growth of the city. In a knowledge based economy, especially where products and services might be distributed over information networks and firms may be distributed across the globe, it is proximity to a skilled workforce that will primarily determine where a firm relocates, hence the impact on employment.

Per capita income is dependent on the nature of employment and productivity. Cities that function better for the reasons we saw in the City of London or Canary Wharf, or have more efficient delivery of services such as Corpus Christi, will contribute to the productivity of employees in both the public and private sector. And in a city hosting firms at the forefront of innovation enabled by these technologies, it is not surprising to see incomes rise along with property prices.

And cities with these technologies appear to be accelerating their transformation to the knowledge based economy

But there is a wide variation in outcomes and some obvious as well as less obvious pitfalls

Role of ICT in transformation to the knowledge economy:

Further work is underway by Imperial College which also looks at the relationship between these technologies and the transformation of employment to the knowledge economy, especially the growth of high end service industry jobs. For many cities the decline of their traditional manufacturing base has not been accompanied by a surge in new technology employment and quality service industries employment. Instead they too often end up with low end, often casual services industry employment. Such cities can be caught in a cycle of social and economic decline. The initial findings show a relationship between the growth of these new technologies and the transition to more sustainable and high end services employment

However, all the findings indicate a significant variance between cities and this is not surprising when one reflects on the differences in investment, deployment approaches, training, applications, content, service levels and support. There is currently no blueprint for success nor are there reliable benchmarks for best practice.

6. Technology Considerations

For a city looking to invest in pervasive broadband with city wide coverage, the technological landscape can be confusing. Fixed or wireless; and if wireless, WiFi or WiMAX, and where does cellular mobile play, and then what about EDGE, UMTS and EVDO?

Western Europe is fortunate in having comprehensive broadband coverage for homes and businesses in most cities, so the decisions come down to what is the most effective approach for wireless connectivity, as well as how a city can stimulate use of those existing home or office broadband connections with compelling services. In the previous section we looked at some of the compelling content that the Digital Bridge initiative was delivering in Shoreditch and Virtual Memoria in Barcelona using fixed broadband connections. So in this section we focus primarily on Wireless where the standards have evolved more recently and technological innovation is proceeding apace.

The reality is that a hybrid network using a variety of different fixed and mobile technologies will be required in most cities, and that applications offered by the city, or in partnership with service providers, should be easily able to exploit that network, and render their content meaningful to a variety of different devices.

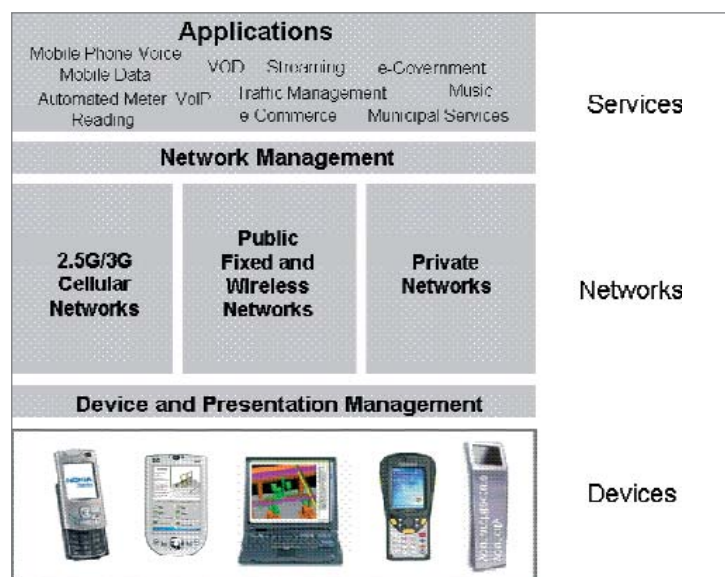
WiFi and WiMAX: A WiFi network using 802.11 standards can reach the widest selection of smart terminals and devices today. WiMAX and the 802.16 standard are attracting a lot of attention right now, and it's reported that Intel is planning to ship its Centrino chipset with embedded WiMAX connectivity by 2007. However the number of available devices with WiMAX capability in the next few years will be small in comparison to WiFi which has achieved a dominant position over the last few years. WiMAX however is a strong option for backhaul where no fibre or DSL connection is either available or cost effective for a small community. So we see a model where WiFi is the logical choice for connecting to the smart devices, at least within the city, and either a meshed WiFi network, WiMAX or a fixed broadband connections might provide the backhaul. WiMAX is currently being piloted over longer and longer distances, and in a rural environment there is a strong case for deploying WiMAX instead of cable or DSL to reach a community perhaps at the very periphery or even quite remote from the city. But again, the availability of suitable terminals that use WiMAX means that in that community WiFi will still be the most common way of connecting users locally, and WiMAX provided as the backhaul.

Attributes of the network

Within the confines of the city WiFi can provide the local connection, but once outside of the city the existing coverage of 2.5G and 3G connectivity makes the most sense. This means that it's important to have an open access network and smart terminals, where users can get access to the data they need over whichever network is available, and that they can switch between networks as well as cells without losing application connection.

All of these factors imply that the network needs to offer open access; that hooks should be provided between the wireless WiFi network and say the 2.5G or 3G network service provider so applications and services can switch between networks without dropping the user, and the network is smart enough to recognise the device accessing it, and provide this information to the application or a presentation layer within the network itself, so that the content can be rendered in a way that's readable on that device.

The following figure shows a schematic view where the city is host to a variety of network resources, is able deliver the applications and services it manages, as well as services provided by other parties. And it enables users to interact through a variety of devices to these services. The device management layer makes it easier to deliver the right content rendered properly to each device, as we saw in Stuttgart. The network management layer allows the applications to use whichever network is most appropriate for the delivery of that content to a specific user, as well as providing important network operations and security monitoring capabilities. While the network architecture is such that changes in the technology should not require changes to applications. This is the converged network view which implies any content over any network to any device and should be the design goal of municipalities and cities wanting to make available these kinds of facilities.



Not just Quality of Service, focus on Quality of Experience:

Crucial in all of this is having an application aware network. If someone standing next to you at the bus stop is using their PDA/MP3 player to download a 25MB music and video file, while you're trying to make a call using VoIP, then you don't expect the service quality to deteriorate. So the network design needs to be sympathetic to the nature of the application, the end-user device, and the priorities given to specific subscribers. It is easy to speak in terms of the Quality of Service (QoS) but it's more meaningful to think and execute a network design and operations approach that is based on ensuring consistency in the "Quality of Experience".

Security

Confidence in the network is vital to the take up of the service, especially by business as well as in supporting any financial transactions. And with CCTV surveillance applications, there are legitimate concerns about RF jamming. It demands careful physical specification and design as well as the deployment of a security system to mitigate these risks. This system needs to provide pro-active and continuous network monitoring both at the RF layer as well as at the IP layer. This pro-active monitoring needs to be able to identify any kind of strange behaviour such as someone, or a virus generating traffic to many different ports, trying to hack in or find a weak spot for instance. The security system needs to be able to identify this and then shut down selective nodes immediately while the attack is investigated.

Implications

Where the city has decided to use a partner for the deployment of this network, key decisions on technology selection, network design and operations need to be addressed together and at the outset. It also implies a governance model which allows for new technology to be deployed as new standards as well as unlicensed spectrum come on line and manufacturers ship increasing volumes of devices enabled with technologies such as WiMAX.

The network architecture also needs to be able to adapt and incorporate these technologies without impacting the investment in end-user applications and other services that use the network.

Governance should allow users to feel a real sense of ownership and participate in the selection of new services

This means it's crucial that the network be open and if operated by a partner, they should take a neutral stance

Another crucial aspect, especially where the City is working with one or more partners, is that the network is truly open, and the partner behaves as a neutral operator. The partner's role along with the City Authority's is to bring on board new service providers to deliver greater value to the community of business and private users. In fact the community should be encouraged to feel a real sense of ownership, identifying even building new services themselves and playing a prominent and participatory role in their selection; perhaps using the network itself as the vehicle for voting on new services and offering up innovative new services created by the community.

7. Getting it Right first time and avoiding the pitfalls

This study and other individual case studies of cities have shown that there is a wide variation in the success, and there are some obvious as well as less obvious pitfalls.

From our analysis we believe there are eight attributes that are critical for success

1. Functionality
2. Accessibility
3. Compelling Content
4. Deployment and Delivery
5. Service Integration
6. Spatial Integration
7. Governance
8. Sustainability: economic, technological, environmental

We will now look at each of these in turn.

Functionality: this addresses the nature of the infrastructure, the technologies supported, its capacity, latency, availability and quality of service. Cities such as Taipei, Songdo in Seoul, and the Canary Wharf are leading examples of high performance networks with rich functionality and a broad range of technologies supported. Cities where coverage is patchy, performance inconsistent or poor will find users rapidly give up on the service. And where security is not robust, content providers will give up too, and the enterprise market will not take up the services.

Users need to be able to gain access from public spaces, their offices as well as when they are a guest in another firms office

Accessibility: this recognises the need to provide access via a wide range of devices, ease of access either through a single portal with a single sign-on to multiple applications, or via a familiar interface regardless of the technology. Again in London, we find the City of London has deployed a wireless network that enables users to work through their existing vendor interfaces.

These are the same interfaces they would use at home or in the office, which in turn facilitates take up and makes it easier to support users. It is also essential to allow employees from other firms to have access to their own systems through the provision of guest capabilities on the wireless network in the firm they are visiting.

Compelling Content: Taking existing content and simply enabling it for delivery over a broadband network is missing a trick. Both information and service content have to be highly relevant to users, and they need to be deeply involved in the process of defining, even creating the content to deliver compelling value. So far the Digital Bridge team is one of the best examples as we saw earlier. And key to having compelling content is to regularly refresh it, both in terms of content as well as style. You don't read old magazines with the same relish as the latest copy and so it goes for the content; its currency is crucial.

Deployment: You can have great content and superb functionality but if resources are not put in place to help new users learn about the services and their value, train them in their use, and support users as they climb the learning curve, then all the rest of the investments will be a waste. Too often we find cities have invested heavily in the infrastructure and service creation, but the usage rates are low, or because the services and their delivery are not well thought through, the support costs are too high. Working with a third party who has deployed networks in many other cities can also help avoid mistakes, though it is important to understand the different social, cultural and economic context as no two cities are the same.

Service Integration: Pervasive mobile networks are not simply a new way of delivering existing services and content, they give the opportunity to transform these services. Cities and districts such as Corpus Christi, Westminster, and Shoreditch are transforming their services for end to end service delivery as a basis for higher effectiveness and efficiency. The big gains are in workforce productivity as well as greater community engagement. The risk of not doing this or making just cosmetic changes is poor take up of services, or take up that peaks then falls away. This impacts the longer term sustainability as if no real as well as measurable savings are generated the initiatives will die.

Spatial integration: Deploying these technologies changes lifestyles, work patterns and the nature of service delivery. It also brings new meaning to public spaces, malls, parks, city squares as these spaces become places where people can meet to work or access community services. So a new trend is emerging as cities begin to take this into account. An excellent example is Barcelona and the 22@ regeneration project. Here, for instance, the spatial organisation of the new industrial zones where firms, universities, research centres and incubators are clustered, has taken into account the different work patterns and interactions for each of the designated industry cluster e.g. biotech, media, ICT, Hi-Tech.

Governance: This addresses a number of areas and the most fundamental is about who owns the network, controls its evolution and sets the strategy for the future. And exactly the same needs to be considered for the content that's delivered over the network. It is vital that the governance model extends to include the community and their role in specifying the content and nature of the services that will be delivered to them. And as described earlier, the governance model should ensure that whoever operates the network, they take a neutral stance on content and new services. A city does not want to be constrained by a partner who is pressing for provision of their own services.

From the outset communication of the agreed aims and objectives needs to be clear to all the stakeholders as well as agreement on the key performance indicators. Continuously changing these or vacillating on them at the outset can destroy confidence and impact the sustainability of the initiatives.

Unless there is a robust business model and cost justification from the outset, the eventual outcome is unlikely to be sustainable

Most will expire within 3 years of inception

They are not fixed forever by the governance model, but there needs to be a formal change management process to allow adaptations and refinements of not only the services but also their performance measurement.

Sustainability: Unfortunately too many of these initiatives run out of steam and money. They are seeded with initial funds but unless they have a sustainable business model in place from the start, most have a tendency to expire within 3 years. The initial funding launches them hopefully to great acclaim, but at the end of the year even if the results are good, budgets for the next year are already set and it may be too late for departments to reallocate funding. Typically, some time in the second year they may secure funding for the third year but by then new investment is required to refresh the technology.

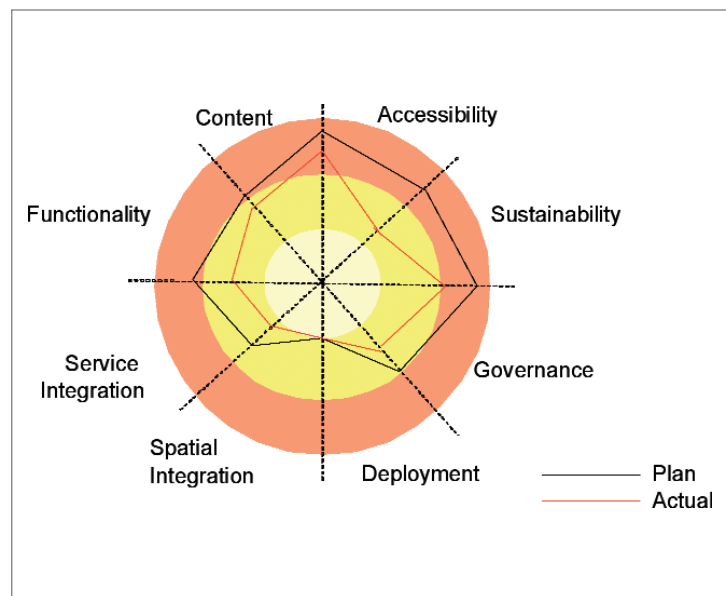
One solution to this is working with a partner as we saw at the City of London, who can make the investments to deploy and operate the network, and bring with them a range of additional content and services partners who bring added value services from the start.

Such an approach lowers the costs of getting the systems deployed and regularly refreshed. Another approach is to have an initial “killer” application, for instance automated meter reading as we saw in Corpus Christi, CCTV surveillance in Westminster, or intelligent transportation systems in Stuttgart, where the tangible and direct budgetary savings from deploying these networks justifies the initial deployment and running costs. The incremental cost of adding the applications with “softer” benefits is then relatively modest and not subject to changes in the political priorities of the incumbent administration.

One size does not fit all but working with a partner that is ready to invest, maintain and regularly refresh the infrastructure in exchange for rights of way is proving popular

Summary of attributes

Cities and districts don't have to excel at all of these, but leave one out of consideration and they can negate the value of the investment, or set off on an unsustainable path. It's about balance. Spending a lot on services but not enough on accessibility, deploying a network without a business model that's sustainable, developing content without involving the users or spending enough on deploying the service in the community, and the result is predictable.



A city can use a map like the one shown above to determine its priorities and then assess the different options according to how well they fulfil each of the eight key requirements. Once the system is deployed then regular self-assessment or third party assessments can be used to determine how well the actual performance compares to the original plan.

We call this the ICT Integration Quotient or IIQ
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8. Options for Moving Forward

There are three options which are most commonly employed by cities when it comes to deploying networks. Let's look at these first and then look at some of the criteria that most frequently come up in selecting a vendor and the best way forward.

- **City Owned:** The City Authorities work with a number of ICT vendors or an integrator to design and deploy a network. The city retains ownership of the infrastructure and might either operate it themselves or use a service partner to operate and maintain the network. The city works with a variety of third parties to deliver services over the network to the community or businesses, taking a share of the revenues generated to offset their own costs of operation. Examples include Barcelona and Corpus Christi.
- **Partnership Model:** In return for partial or exclusive property rights, a services partner such as The Cloud designs and deploys the network infrastructure at their expense. They own and operate the assets. The city may act as an anchor tenant and buy services from the partner to meet its own network requirements. The partner acts as a neutral operator and provides the service to firms such as Vodafone, Skype, Vonage, BT Openzone etc who pay the service partner a slice of each subscribers' revenue, or pay a single annual payment for the use of the service. The service providers promote the service to end-users, in conjunction with the partner, and may enter into a revenue sharing deal with the city. Examples include City of London, Canary Wharf, and M-Taipei.
- **Outsourcer Model:** The City retains ownership of the assets but outsources the operation and maintenance of the network to a services partner. The partner then shares or offsets their fees for operating and maintaining the network with the revenue generated from selling its services to end-users and enterprises. Like the Partnership Model, the city is likely to have its own requirement for network services and be a tenant on the network. An example of this is the deployment at Stuttgart.

So which is the right model, and the answer is, of course, that it all depends. And while these are the most common models there are others which are a combination of the above.

One common factor, in almost every case, is that the city will almost certainly need a partner rather than try and do it in house. There is a lot of complexity involved not only in the specialist design and deployment requirements, but also in the support of end-users, the provision of new services, the management of relationships with multiple service providers, provisioning and billing, as well as licensing issues such as acting as a telecommunications operator, or having a public sector organisation generating profits in competition with private firms. And all of this is compounded by the need to continually refresh and evolve the services on offer as well as the underlying technology.

Common Decision Making Criteria on Partnership

- **Experience:** The decision making criteria in choosing a partner are first and foremost the experience and expertise of the partner and the robustness of their business over the long haul.
- **Flexibility and Openness:** The next is flexibility, especially in terms of the openness of the network and the partner's ability and willingness to bring on board other key partners who can deliver added value services to the end-users. In the case studies we saw that cities strongly favour a neutral operator model as this is likely to provide a level playing field so that other operators such as BT, Vodafone, Skype, MSN can deliver their service over the network, compete one with another and deliver the best combination of breadth of services and price performance to the market. These service providers can also accelerate the take up of the service by making it immediately available to their existing subscriber base as well as act as a channel for the promotion and sales of the service.
- **Business Model:** Cities in most countries have legal obligations to demonstrate best value and having a partner that is ready to deploy a network and regularly refresh that technology at their cost in return for property rights of way and sharing of their revenues can be very attractive. But then good governance is crucial in ensuring

the city determines the overall strategy, can bring in other partners especially for the delivery of new content and added value services, and that the governance model avoids lock-in for a protracted period or implies end-user rates that exclude large elements of the community.

- **Subsidising Services to bridge the digital divide:** Offering a free pervasive community broadband service is an admirable goal for any city, however nothing comes for free. Everything has to be paid for ultimately through taxes or subscriptions, and so it is with a citywide network. Nearly every utility consumed within the city and most other amenities are charged for, so what matters more is that the service is affordable. Naturally, special needs communities can be subsidised, even receive free services, and again the right model needs to be negotiated with the partner so as not to preclude this.
- **Trading Rights of Way to lower the upfront cost, mitigate risk and gain a share of the revenue:** The property rights of way are very valuable, yet any vendor is going to be involved in many challenges when it comes to deploying the network. Not all the property may be under the direct control and ownership of the city; street furniture shown on maps may turn out to be in different places or not there at all, and as the City of London found, some of it may not only need to be moved, but may be badly corroded and need replacing. And then there are the practical issues of getting power to the devices where the electrical utility may need several weeks to coordinate their efforts with the deployment group. So although the property rights are valuable, the costs of deployment can be substantial and the prospective partner needs to be able to recover these costs over a reasonable period of time.
- **Functionality – Performance, Roaming, Security, and Aesthetics:** Naturally functionality plays an important role in terms of ensuring not only hot spot style coverage, but continuous dynamic roaming and low latency. When emergency services are using WiFi in one hotspot to gain crucial information as they drive to another, it's vital that they don't lose contact and handovers between cells is seamless. Whether it's a VoIP call or a software application, you need to have access anywhere including

Whatever the starting point, or final vision, some elements are ever present: partnership, openness, rich and compelling content, user involvement, good governance and a sustainable business model

even a handover on the edge of the network from say WiFi to a cellular 2.5G or 3G network. And this form of availability and persistence, as well as low latency, especially for VoIP needs to be accompanied with high and very visible levels of security.

- For international financial institutions in say Canary Wharf, there can be no compromise on security. Their take up of such services and willingness to have their employees gain access to their in-house systems over these networks will depend on demonstrating the highest levels of security.
- Finally the aesthetic design of nodes is considered an important factor in many dense older and historic cities or simply those with a lot of trees. The combination of cellular mobile and WiFi antennae can destroy the appearance of the streetscape. Having a partner and equipment vendors that are sensitive to this is important, and as Canary Wharf commented; it is important to have a single partner who is accountable and responsible for coordinating all the equipment choices to meet their own as well as the other network partners' requirements across the estate.

9. Conclusions

At the outset of this paper we considered how cities were deploying new technologies to enhance their attractiveness to new industries, aid innovation, deliver services more efficiently, and generate greater social cohesion. We examined 5 cities and saw how each had different priorities, starting points and business models.

Common to all them were the following: partnership, adopting an open network model, working with a partner who acted as neutral operator, and heavy involvement with business users and/or the community in the design of the services.

We also saw from the quantitative assessment of US cities how the growth of broadband appears to be associated with growth of key social and economic indicators and we discussed the theoretical as well as the practical mechanisms that lay behind that relationship. It's clearly too soon to make a detailed quantitative analysis on the impact of wireless networks in cities. However there is plenty of qualitative evidence from early deployments and direct feedback from users and their self assessments which points

to a similar if not even greater impact from the availability of wireless broadband, and the richer and broader range of services wireless networks enable.

We saw however a significant variance in how different cities were performing which points to the importance of getting it right first time and avoiding the pitfalls.

In the last two sections we looked at eight key attributes of successful deployments and how cities might prioritise these according to their different aims and ambitions, as well as the context for their deployment. However, neglecting or failing to execute any one of these attributes effectively could result in failure.

So in summary, cities can gain advantage in a highly competitive global economy by deploying the right ICT infrastructure, making it pervasive and easily accessible across businesses of all sizes and to serve the community. Delivering relevant services and providing compelling content are essential to the take up of the services by business and individuals. Openness and neutrality are equally important; at the end of the day the value delivered by the network is a function of the richness of the services offered. This means there should be no formal or informal inhibitors for a city bringing on the services it needs to support the business and private community.

A number of business models exist and can be tailored to meet most cities' needs but almost all involve strong partnership, trust, and good governance. And finally detailed planning and execution, as in all things, can make or break their success.

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