

Smart Cities

SESSION IV: Lecture 1: Big Data and Urban Information Systems

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Outline of the Lecture

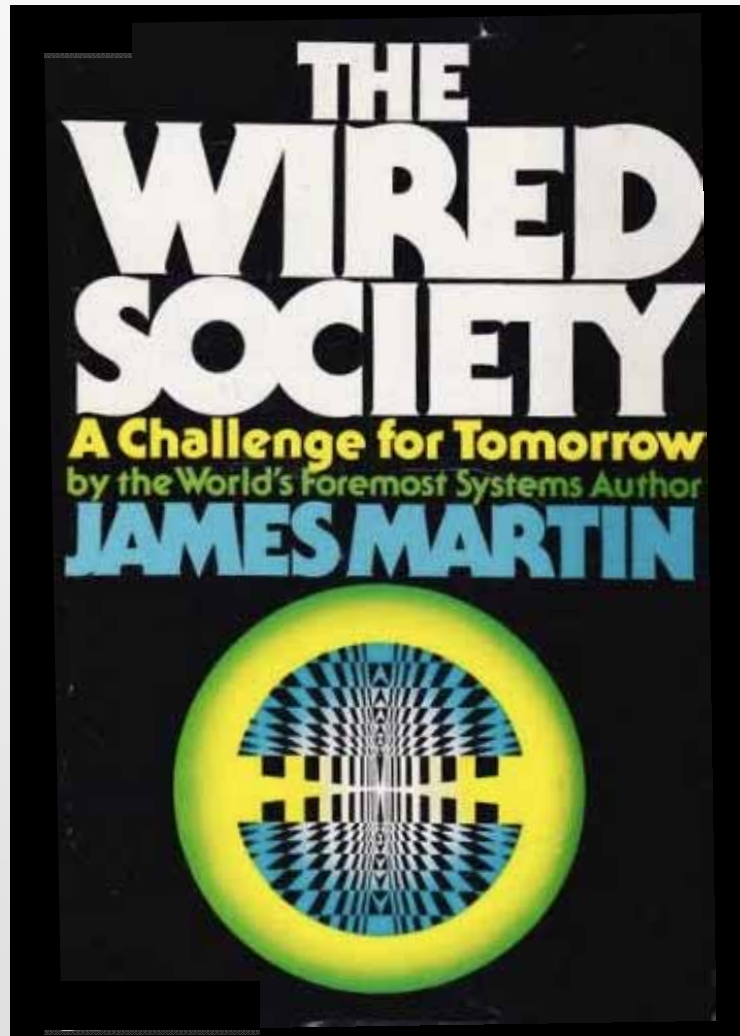
1. The History of the Wired City: The Decentralisation of Computation: City-Wide Computation
2. Data Collection: Traditional, Sensing, Crowd-Sourcing
3. Small to Big Data: A Nice Video
4. Global Computing Platforms: The Web and the Cloud
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7. Cities and Services: Routine to Long Term
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The History of the Wired City: The Decentralisation of Computation: City-Wide Computation

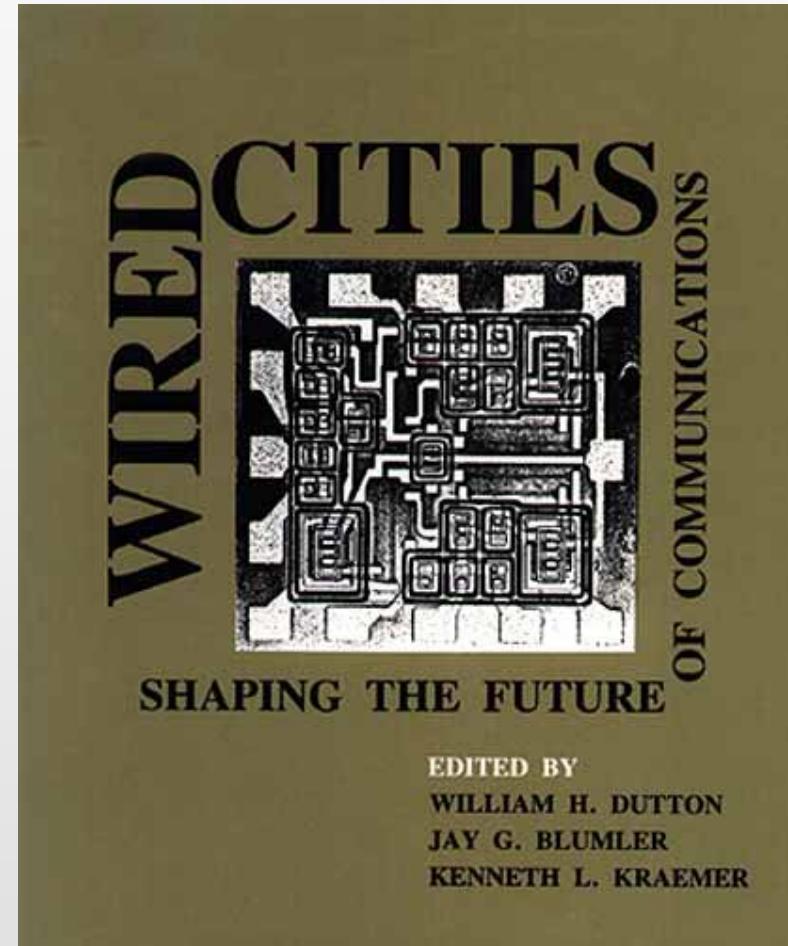
Speculations began as early as computing due to the nature of the computer as a universal machine, but they were wild. Basically the focus was more on intelligent devices than on networks.

A good early 1978 example is James Martin's book **Wired Society** where he focussed on predicting the growth of teleprocessing, online storage, real-time systems, micro-computers, communications satellites, optical fibres, value-added carriers, and leisure computing in the 1960s and 1970s.

Only slowly did the notion that the city might be wired itself take off and Martin of course was an early exponent – he amongst several others saw the future.



Martin, J. (1978) **The Wired Society** (Prentice-Hall, NY)

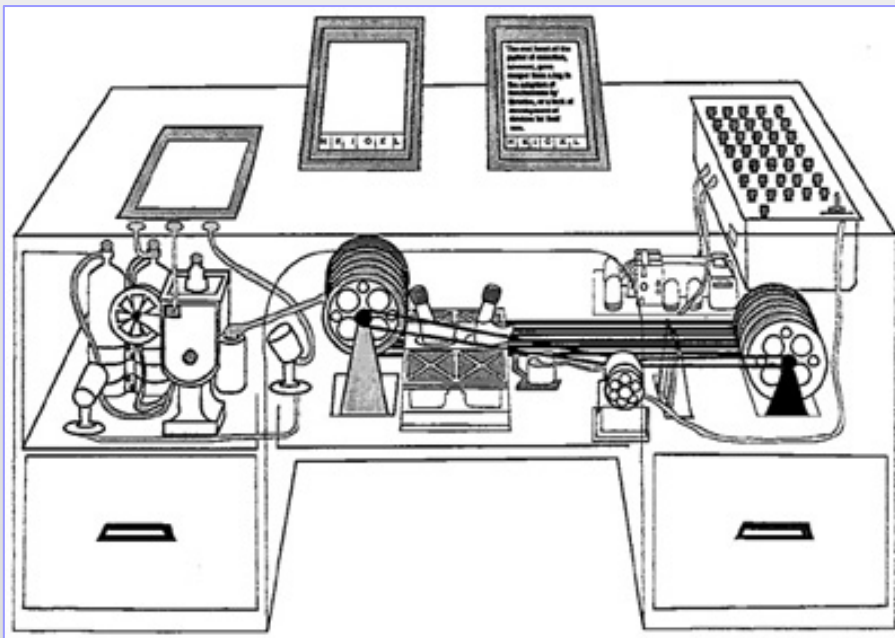


Dutton, W., Blumler, J., Kraemer, K. (1987) (eds.) **Wired Cities: Shaping the Future of Communications** (G K Hall, NY)

I want to insert a bit more history in here because some very early ideas about the spread of computing were made in 1945 by the ex President of MIT Vannevar Bush in his article in ***The Atlantic Monthly*** called As We May Think. Here is the article

<http://www.theatlantic.com/magazine/archive/1945/07/as-we-may-think/303881/>

And also look at <http://u-tx.net/ccritics/as-we-may-think.html>



And this is his Memex – a kind of desk but essentially a personal computer but also networked. Have a look at this article – it is amazing how we anticipate the future

To an extent, this focus on devices rather than networks was extended to the idea of rather inflexible wired cities where telecoms and cable and so on were early examples as catalogued in Dutton's edited collection.

But once there was obvious convergence of computers and communications, the idea of the wired city, the networked city really took off. In a sense it took us by surprise because much of the action in computing was still very specialist and domestically it was related to individual transactions and games. The idea that entire cities and city agencies might develop wide usage was unusual

The growth of the web was unexpected and it lead to a change in what we thought was the smart city – an evolution into actual computable cities rather than the use of computers in cities

The key issue in terms of the smart city is based on the notion that computers with their communications have not only become all pervasive but they have also been **spatially decentralised** in this process.

So in the beginning The mainframe was a hub with spokes and the spokes were people working away from the machine and then bringing their jobs

In the 1950s and 1960s, these were replaced by teletypes where jobs were submitted remotely but 'online' so to speak – it really took until the mid to late 1970s for jobs to be submitted remotely and held in batch and then run. Interestingly this is when the operating system began to interface much more with the user. I don't know when the terms 'online' or 'software' became significant but it was probably the 80s.

This also of course happened with the PC in the late 1970s – basically the machine was brought to the user rather than the user to the machine

Mini computers came onto the scene and once PCs were developed, there was a fusion of PCs into Minis in the form of Workstations

But none of this was essentially about networked computing – this began with servers and clients at Xerox Parc in the 1970s where the Ethernet was invented by Metcalfe and his colleagues

Rapid developments in the 1980s and local area networks (LANs) came first, then wide area networks (WANs) and things really began to spread out in space.

Early wired cities were based on TV, for example, cable rather than the telecoms systems – the phone and it took the internet in the 1990s to change all this from whence there has been very rapid progress. I guess phones and cable which are essentially wireless at some point are more flexible. I showed some 1980s WAN networks in an earlier lecture.

Once all this was in place then the focus on software and services being delivered to those with access to a computer became significant – of course the web produced the graphics interface to make delivering information about services key – this was passive interaction until quite recently – it is Web 1.

Worth noting that once the web became established, computation began to change extensively to the delivery and the creation of new services all based on digital representation. Music and film are the greatest aspects of all of this.

We can speculate on a simple model of this organisation:

First centralised tasks, activities and services being delivered to users – customers – over wires and wireless

Second decentralised acquisition of data to produce services from new methods of data collection – through sensors

Third the use of the web to elicit response – the development of web 2 technologies where users create their own content – through crowd-sourced methods - interaction

There may be other forms of networking and connection but most activities can be classified as being either ‘push’ or ‘pull’ – which is pretty obvious in that information/data/services, anything that is computable/manipulable across networks can be pushed + pulled and altered by human and/or machines

The last thing I want to mention about how computers and communications have changed the smart city involves the way formalised information has been treated pertaining to cities

The first information systems to be built were essentially involved with transactions processing in municipal authorities in the 1950s and it took a very very long time for these to change to embrace graphics, and maps and things of that sort. Look at Dutton's book – the systems were essentially run on mainframes and organized around an agency but some early integration of some data bases began, but only where organisation could integrate similar tasks – often IS systems existed in parallel. By the 1990s, data in graphics and maps was becoming digital but most of these early information systems did not embrace these – GIS for example was developed quite separately as were mapping systems.

So by the mid 1990s we had the rudiments of various services which were essentially delivering information about a service to a user through a browser. The actual service was not necessarily delivered because many of them involve – still involve – physical movements – but it was information about where, and when and how much and so on. In short services are just information about the delivery which still remains material

In the interim, the issue has become delivery of as much digital content as possible, interactivity of the service in that users who require a service are able to interact with the provider and engage in dialogue; and often elements of the physical process are removed – e.g. think of buying a book from Amazon and what happens in terms of physical links in the chain. The smart city is the integration of diverse data bases

Data Collection: Traditional, Sensing, Crowd-Sourcing

If we think of the smart city as one of providing information so that all aspects of urban life and production and learning might be improved, then there are several key issues

Data Integration – associating data which has not been linked in the past but can be and where value is added when it can be, though common keys – e.g. through address points

Manual to Digital Transformations – data still collected manually such as household f to f survey but then made digitally

Remotely sensed data at many scales **captured and used** in real time

Remotely sensed data **captured but not used** in real time; used in hindsight

Data can be captured from dumb sensors embedded in the environment which do not involve any human interaction

Data can be captured by humans activating the transaction in some way but using a device to capture the data digitally – many many transactions are of this type ranging from using credit cards to any form of activating the capture such as by purpose built smart card but also by tags placed on the human as sensor

Data can be generated by humans digitally by responding to digital queries – for example crowd-sourcing. Let me refer you to Steven Gray's Blogs in our CASA group

<http://www.surveymapper.com/> This is not a very active blog now but it gives you the idea of creating your own online survey – more on this is a later lecture.

Small to Big Data

What these new methods of data collection are posing and given advances generally in scanning and sensing, then massive volumes of data are being created in real time and are then available either in real time or perhaps more frequently at present for use in analysis after the event. As for example in our Oyster card tube data that we looked at last time

In the world of cities, most data in the past has been captured non digitally by humans but not at the kind of temporal frequency that is now possible. This is leading to massive data streams that need to captured, stored, mined in new ways.

The definition of big data is tricky because this is relative – relative to the machines and networks one had to handle it.

A good definition I heard was that big data is anything that cannot fit into an Excel spreadsheet and this is quite a nice usable definition but it is relative

Let me refer you to another of Steven Gray's blogs – his Big Data Toolkit <http://bigdatatoolkit.org/>



I now want to show a super video about big data in the past which has many lessons for us – and this is from Steven's site so let me load the site

http://www.youtube.com/watch?v=pcBJfkE5UwU&feature=player_embedded

In fact we could say lots on big data and in a sense, I need to talk to you a little about how computing is being organised in terms of global issues as well as local – one needs to see it as a tension between local and global provision and we will fill in the big data picture as we go along

However first I will refer you to my own one pager on big data that is on the blog. And if you go to

<http://www.spatialcomplexity.info/archives/946> you can download the one pager and also look at the editorial

<http://www.envplan.com/epb/editorials/b3902ed.pdf>

Ok let me now at the risk of telling you what you already know and I must confess that all this is put together without any real reflection on the best way to explain this stuff – let me move to platforms

Global Computing Platforms: The Web and the Cloud

Essentially computation has spread out spatially as it has become more pervasive. More people using computers and interacting clearly means that the networks of communication are now global.

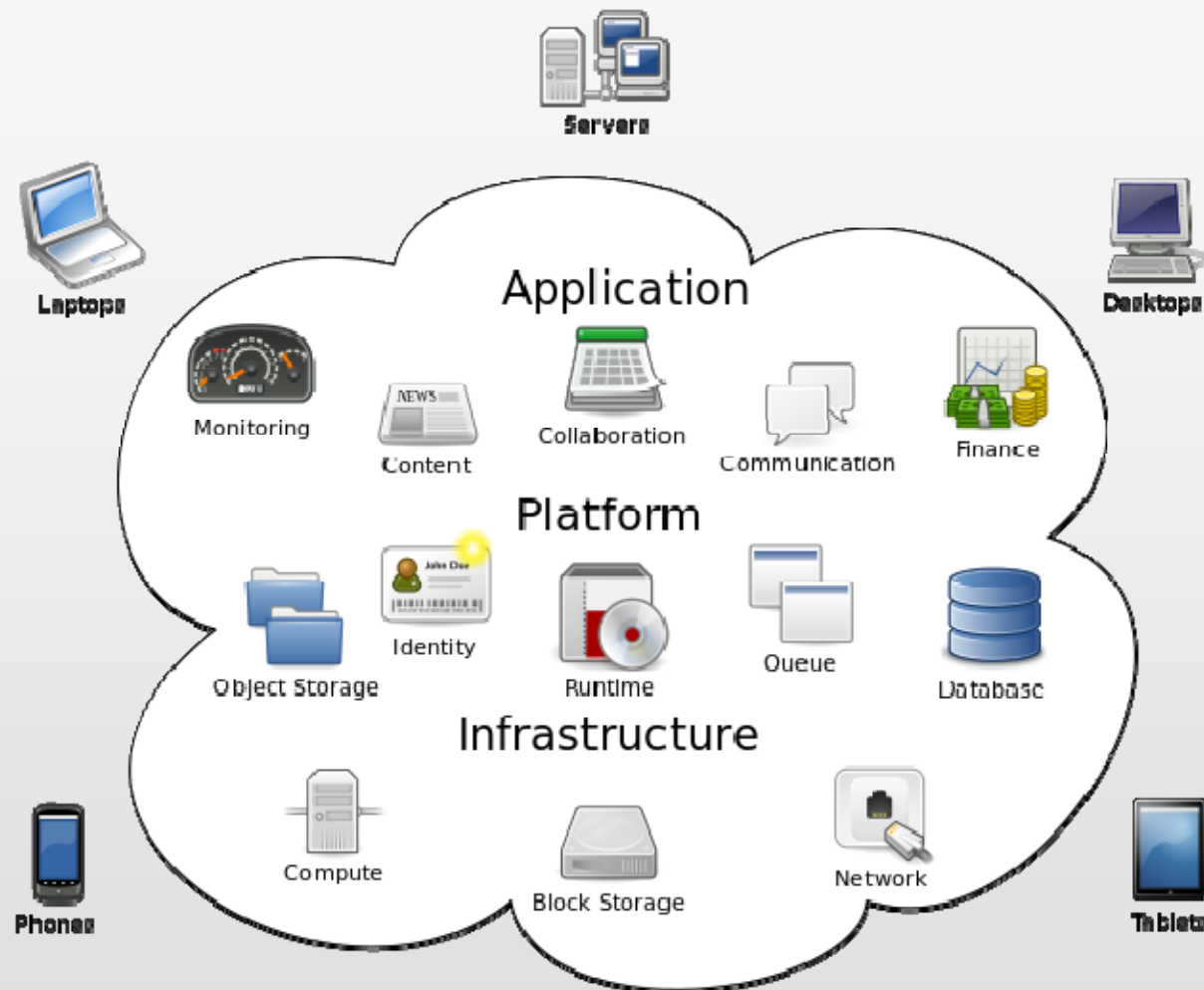
More people using it however also increases the density of local networks.

The big issue is where does one do what – locally or globally. This has always been the issue - mainframes, minis, became more than local, desktops pushed us back to local, handheld devices and laptops and tablets make it local but the whole lot are now networked globally. Where then do we do the computation and where do we store and use the software and the data

For a long time, there were really no such thing as servers apart from memory which was adjacent to a machine and often controlled by those who ran the centre. In the 1990s the network architecture of client and server was introduced with the client letting you access a large memory core called a server, the client often being a computer on which the computations was done and the software held.

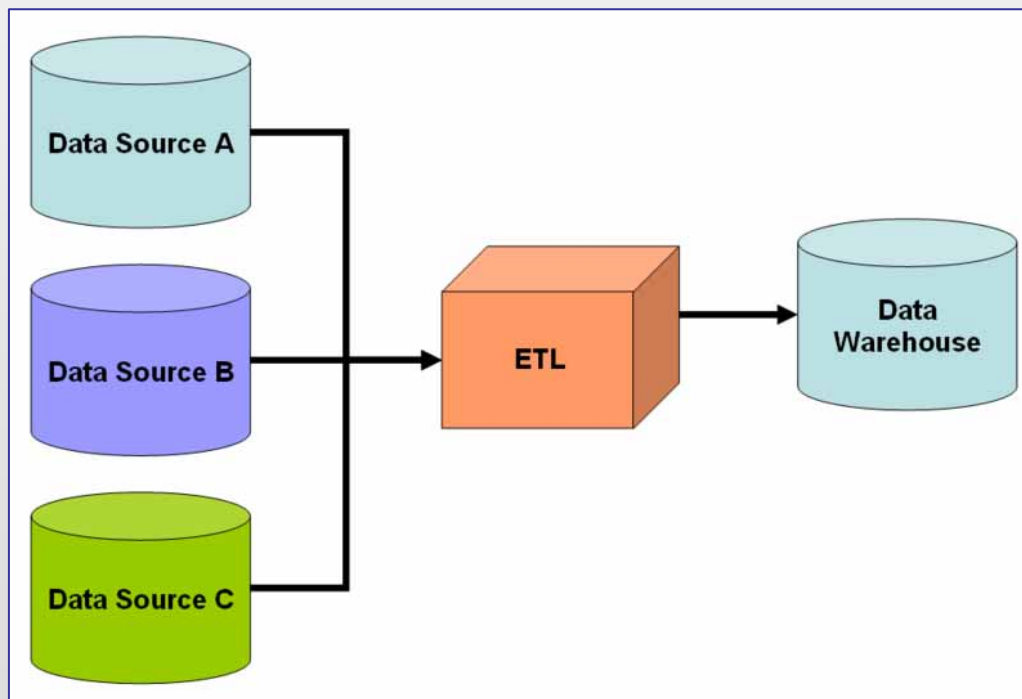
This gradually relaxed so that now a lot of computation is done on the server side where data is also held with software. In short these has been a blurring.

Originally if the client put the computation and data all on the server, it needs a fat pipe to pass data from server to client and vice versa. When these pipes are lower capacity then this model does not work well. But pipes are getting fatter

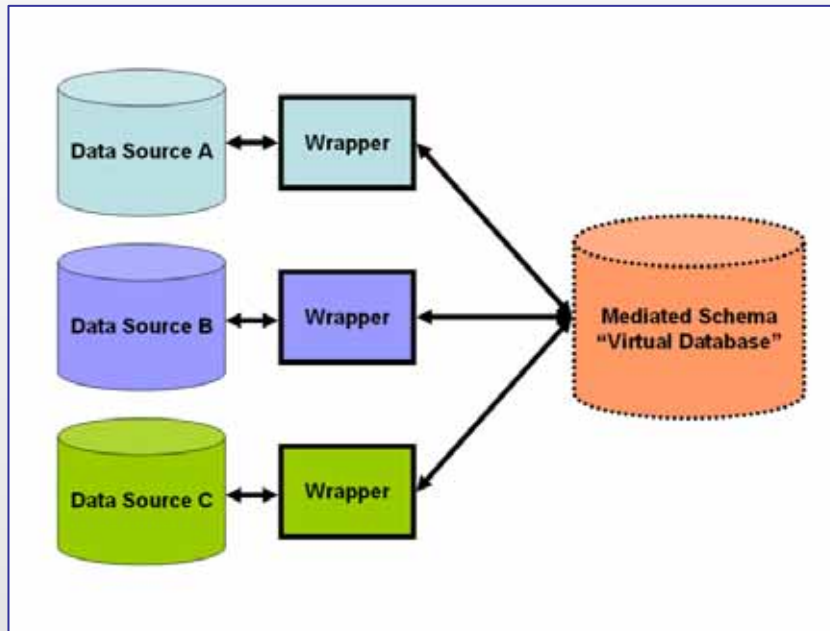


Cloud Computing

The other thing to note which is complicating the picture is that applications are built in layers – one thing on top of another and there are often so many data layers and software layers now – where software and data are integrated, that these need to be stitched together – i.e. integrated. This is the old model



The new model is where things are wrapped – and this is



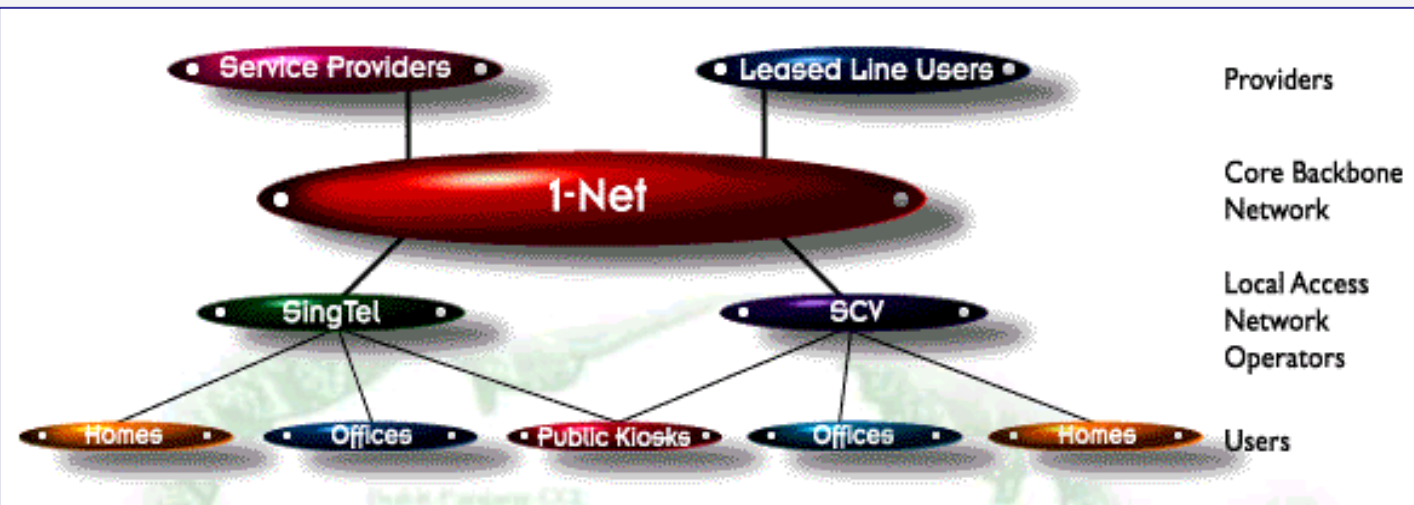
And of course this can be generalised for software as well as data – and it can be decentralised into the cloud and the web in many ways – almost too many possibilities that it is hard to generalise this

Basically *there do not appear to be clear principles* for where one stores data and software and where the computation actually takes place.

This makes the discussion of all this very hard as usually one is confronted with block diagrams that pertain to very distinct solutions to integrate this infrastructure and using it – or to entirely generic not very useful diagrams of people talking to other people through computers and networks. Let me give you an example from 20 years ago of quite a useful diagram and contrast this with the generic cloud diagram above and some of the ones below

This field is plagued by a complete inability to generalise about hardware and software which is highly dependent on resources and is not heavily disciplined by cost in many cases.

Singapore telecoms infrastructure map in 1990



2. Local Access Networks:

Connected to the core network are the local access networks that covers throughout the nation. The two operators [Singapore Telecom](#) and [Singapore Cable Vision](#) will utilise the existing telephony and cable TV infrastructure respectively to deliver broadband multimedia services to the end-users.

They will employ advanced technologies of [Asymmetric Digital Subscriber Line](#) (ADSL) and [Hybrid Fibre Coaxial](#) (HFC) cable modems in their existing infrastructure to deliver multimedia services at high speeds to the end-users at home, schools, offices or public areas.

Operating Systems for Smart Cities

What has become all the rage is this idea of the operating systems for an entire city – this is never very clear as it appears to be a structure for integrating data that has common links.

The structures and I will show two below are very general and I am most unclear to what extent any of what I will show has or can be implemented.

The debate is often also paralleled with discussion of the sustainable city particularly where the OS for the SC – I will call is OSSC – is designed to reach social and well as economic goals. The first statement is by Lewis who runs a company called Living PlanIT which has had a lot of press on this.

Let me throw some web sites at you where you can find loads on smart city examples from large IT vendors and others

IBM - http://www.ibm.com/smarterplanet/uk/en/smarter_cities/ideas/index.html

http://www-03.ibm.com/innovation/us/thesmartercity/index_flash.html

http://videolectures.net/ecmlpkdd2011_verscheure_smart/

Living PlanIT <http://www.living-planit.com/>

http://living-planit.com/planit_valley.htm

<http://newsroom.cisco.com/press-release-content?type=webcontent&articleId=662475>

Cisco http://www.cisco.com/web/strategy/smart_connected_communities.html

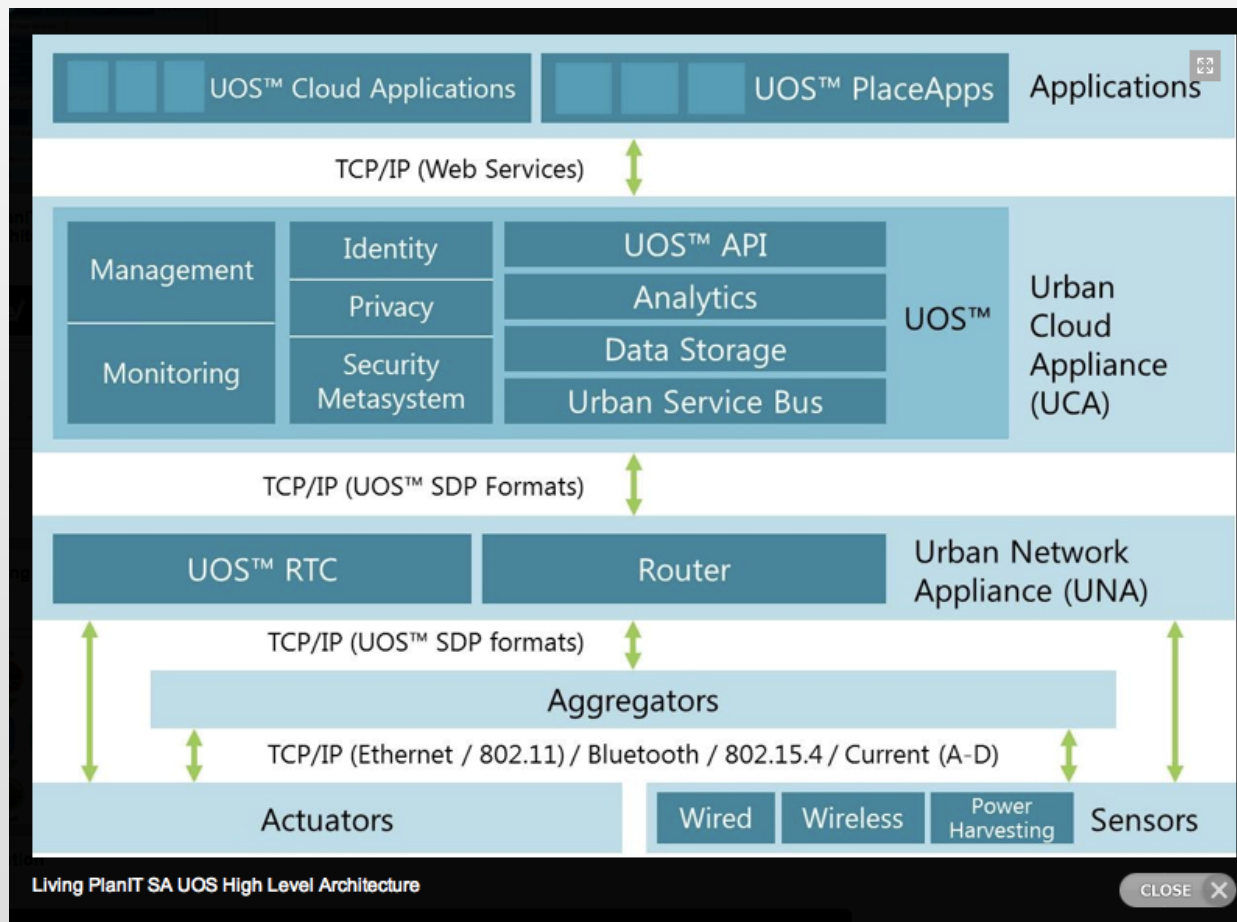
<http://blogs.cisco.com/tag/smart-cities/>

<http://newsroom.cisco.com/songdo>

Urbiotica <http://www.urbiotica.com/en/> &

<http://www.youtube.com/watch?v=Fw1NAZuwpDM>

One thing which is useful here is the separation between Cloud applications and Place Apps – i.e. global and local but how it works is any body's guess



Introduction

The Urban Operating System (UOS™)

The Living PlanIT Urban Operating System™ is a software platform that accelerates the development and deployment of urban technology and connected devices. It provides software-based flexible real-time control, as well as supervisory control, data acquisition and lifecycle management. Its real-time and historic analytical functions, together with a comprehensive Services Oriented Architecture API, simplify the building and operation of advanced data-driven and control-based applications on a variety of end-user devices. For more information on how the UOS™ achieves this, click [here](#).

Living PlanIT primarily focuses the UOS™ on two key markets which constitute subsets of the 'Internet of Things':

- **Living Cities / Smart Urban Developments** – the emerging market for increasingly intelligent, sustainable buildings and infrastructure, whether deployed in new cities, major regeneration projects in existing cities, or individual developments.
- **Machine-to-Machine Communications** - the 'connected device' market, based on increasingly pervasive networks and providing remote sensing and interaction with a wide array of embedded and mobile devices, ranging from smartphones to vehicles, to robotic devices, to sensor 'motes'.

The Urban Operating System (UOS™)

provides the essential platform for the Internet of Things, enabling both Living Cities and Machine to Machine Communication (M2M), which is estimated to expand to 24 billion smart sensors and connected devices by 2020 >>

>> The UOS™ facilitates the industrialization of the Internet - its third stage – which allows an unlimited number of devices to be interrogated, analyzed and controlled, in turn harvesting useful distributed intelligence and also providing management, control and greater efficiency for all city services.

The integration of services provides the technology solution for creating sustainable Living Cities (aka Smart or Intelligent cities), improving energy management, transportation, health services, education and all other aspects of daily life. The UOS™ is that platform, and like Windows or Apple's iOS, it enables applications to be developed independently by large and small companies, as well as public sector agencies, to deliver innovative services and new opportunities that enhance the experience of urban living for all.

How the UOS™ is structured



Examples: Future Scenarios

Weather

Building and vehicle sensors provide microclimate information enabling improved models; transportation and HVAC systems take current local weather into account

Emergency Services

Improved emergency planning and response using real time information and signaling

Sustainability & Utilities

Smart grid, water efficiency, energy demand and supply management, shaping, and remote control

Transportation

Congestion avoidance, green routes, integrated systems of buses, trains, taxis, cars (with parking/charging), bikes, walking, and PRT

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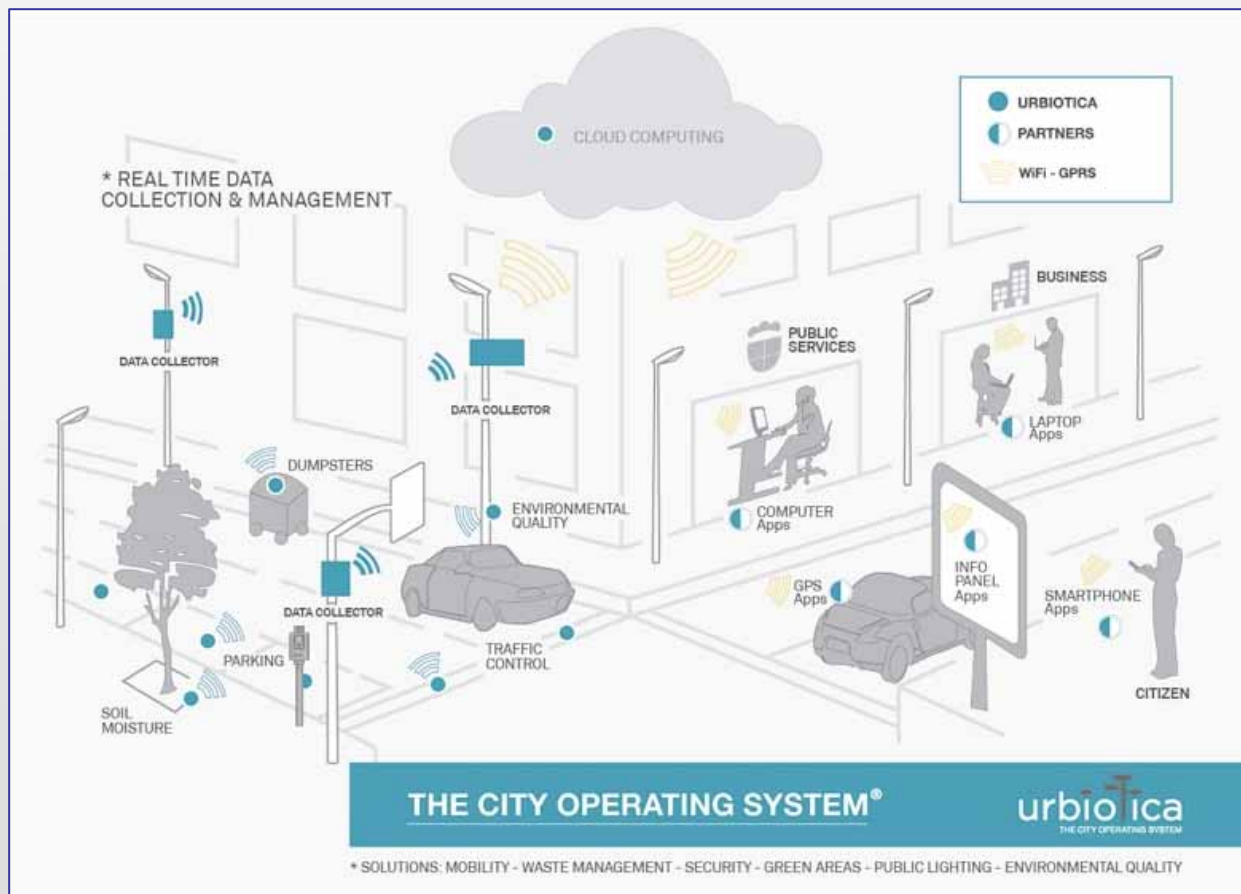
As the global population becomes increasingly urbanised, smart cities are pioneering ways of harnessing IT systems to manage resources more efficiently.

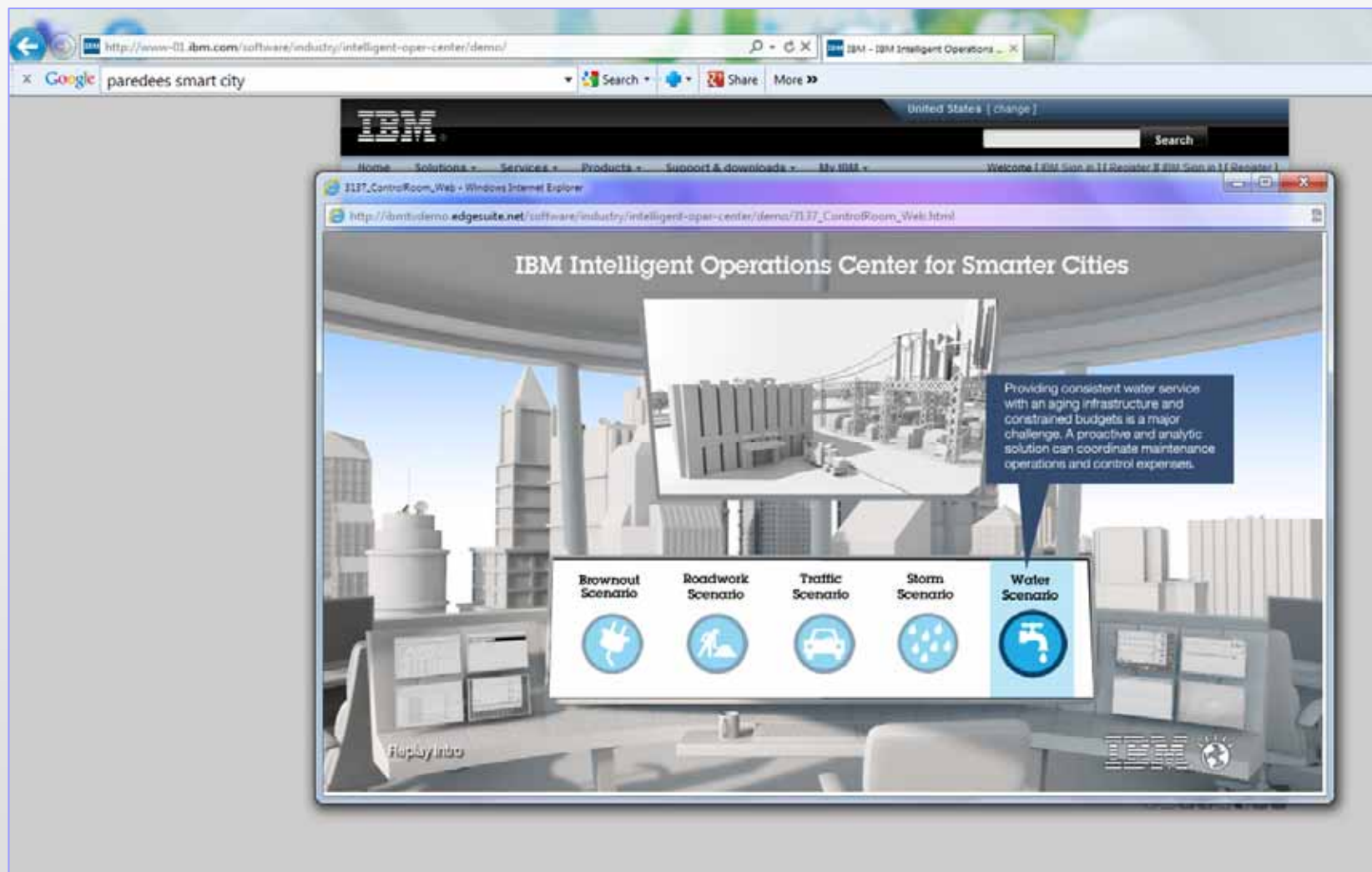
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If you would like to receive regular news about Living PlanIT, new technologies, the partner eco-system, PlanIT Valley and other design wins email register@living-planit.com and we will add you to our email newsletter list.

The second company is a Spanish one called Urbiotica – there are lots of these companies around and all the big IT players, IBM, Cisco, Siemens, and Microsoft are getting in on the act





http://www.ibm.com/smarterplanet/uk/en/smarter_cities/idea/7c0a5mmuk_smgf4it-301203286cmv4f8cx-googlefct IBM - Smarter Planet - Smart Cities

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Smarter Cities



→ New IBM Intelligent Operations Centre for Smarter Cities (US)



→ Visit the interactive Smarter Cities experience



→ Visit the Smarter Cities Virtual Briefing Centre



→ IBM Smarter Trends shares content on key issues such as: transport, energy, water and city development.

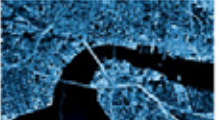
and countries now IBM has been helping local authorities to overcome the data challenge, and provide ways to create a holistic view of a household, and effectively track, manage and act upon trusted information, to better enable early interventions.

Watch the Webinar (00:35:55)

Smarter Cities systems



Public services
As governments infuse the basic systems of our planet with intelligence to stimulate economies, we start to ask: Can the operations of government itself become smarter?
→ Learn more
→ Industry focus – Government



Public safety
Cities large and small are turning to advanced computing capabilities such as data analytics, visualisation and sensor networks to enhance public safety systems.
→ Learn more



Buildings
If a building's systems interoperate, they can be managed centrally, even intelligently. With all their impact on the planet, it's time for buildings to get smart.
→ Learn more
Building Information Modelling – download the paper (586KB)



Energy
With smarter grids, utilities can manage the flow of power through their systems. And consumers can manage their appliances and use of energy at the household (or even automobile) level.
→ Learn more
→ Industry focus



Transportation
Our rapidly urbanising planet depends on getting people and things from here to there. Our cars keep getting smarter. So how about our roadways?
→ Learn more
→ Industry focus

Smart Cities as New Towns: Paredes

Let me show a couple of applications or rather point you to these. Living PlanIT appears to be involved in Paredes in northern Portugal near Porto and In London the Greenwich peninsula.

I will talk a little but about each of these but I recommend you explore the web for similar examples and judge for yourselves whether the combination of hype and technology and what we know about cities makes sense in terms of these proposals

Ok first Paredes and then Greenwich

You can find videos and links on the slide of the web links 6 slides ago

The city that wants to change the world.

Portugal – December 04, 2010: Sensors everywhere, electric vehicles, intelligent and ecological buildings and an operating system that will control everything. The city of the future is being planned in Paredes. Will it be a reality? By Nelson Marques - Expresso

Steve Lewis is an optimist. In a country paralyzed by economic depression, this 45 year old Briton wants to build one of the most ecological cities in the world. A smart and sustainable community that can serve as a model for future cities. The dream is called PlanIT Valley and has an unlikely location: Paredes, a district some thirty miles from Porto, in the North of Portugal, which is better known for its furniture industry traditions than urban harmony. In an area of 1680 hectares (almost 17 square kilometres) will be started, as early as September this year and completed by 2015, a metropolis connected by a network of 100 million sensors, controlled by an operating system that works almost like the human brain and programmed for its inhabitants to interact with it as they do with a smartphone. According to the promoters, within four years, 225 000 people will live there (more than twice the current population of the municipality), about half of whom will be researchers who will be on site with the rest of their families. The first six thousand inhabitants arrive as early as the beginning of next fall, insists Living PlanIT, the holding company managing the project.

BBC Technology Web Site: London to test 'smart city' operating system: Jane Wakefield

An operating system designed to power the smart cities of the future will be put through its paces in London. Living Plan IT has developed its Urban OS to provide a platform to connect services and citizens. With partners including Hitachi, Phillips and Greenwich council, it aims to use the Greenwich peninsula as a testbed for new technologies running on the system.

"We are entering a phase when everything becomes connected, from healthcare to transportation," said Living Plan IT chief executive Steve Lewis. "This is about connecting things that previously never did." Urban OS is different from traditional operating systems in that it is designed to be extremely robust. "If my email is down for 10 minutes, it doesn't matter, but if the network is linked to my insulin pump, then that is different," said Mr Lewis. In one newly built office block, Living Plan IT plans to implant thousands of sensors that will monitor external and internal conditions to create smart lighting and heating systems. Other technologies to be tested with the platform include smart vests that have microensors embedded in them to monitor heart rate and other vital signs.

The idea of smart cities has become the latest hot topic in the tech industry. Living Plan IT estimates that £13tn will be spent in developing and regenerating urban spaces between now and 2020.

Cities and Services: Routine to Long Term

Now there are many different services and my point here and I have made in many time before is that new data – big data from sensors in real time is changing the nature of what we are interested in cities – to the short term from the long term – to the routine.

When these services first emerged, they were simply pointers to more information such as pictures of town and their elements on which one could click and I show two examples here below – Bristol and Bologna in Italy – now the whole basis of this has changed largely due to the fact that one can click ad infinitum on web pages now through search engines and there is a decline in the way these sorts of services are being portrayed through portals like these below



The Next Lecture: Participation

I need to complete our survey after our break very quickly by showing you many examples of how the web and computer is leading to massive interactivity relating to how population participate using digital infrastructure

Some references for this lecture:

Colin Harrison, Ian Abbott Donnelly (2011) A Theory of Smart Cities, **Proceedings of the 55th Annual Meeting of the ISSS**, Proceedings of the 55th Annual Meeting of the ISSS

Ferry, G. (2003) **A Computer Called LEO: Lyons Teashops And The World's First Office Computer**, Fourth Estate London