Future Cities

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Summary

• Topics covered
  – London future city of the past and maybe the future
  – Global fibre data rivers & Security
  – Some British Standards for Future Cities
  – Service Oriented Architecture & ESB
  – Security for Citizens
  – Social program example – helping the aged and disabled
  – Equatorial Guinea, New City: Oyala
London – 19th Century – The first megacity

- London was the World's largest city and capital of the British Empire
- Population expanded from 1 million in 1800 AD to 6.7 million AD 1900
- Rivalled by Paris and New York by the end of the century
- London was also a city of Poverty Charles Dickens wrote Oliver Twist in 1810
Future City Services started in London via Evolution

- In 1855 the Metropolitan Board of Works (MBW)
- Sewer and water supply system started in 1859
- Robert Peel established the Metropolitan Police in 1829
- Railway infrastructure started to be created in 1836
- London underground started in 1863
- Horse drawn trams started in 1860
- Workhouse laws revised 1832
- DC electrical supply system 1882
- The Telephone Company Ltd formed in 1878
- Elementary Education Act 1870
- NHS 1946
In the middle of the century the system of local government had to be upgraded.
In 1855, the Metropolitan Board of Works (MBW) was created to provide London with adequate infrastructure to cope with its growth.
MBW was the principal means of London-wide government until 1889 when the London County Council (LCC) was established and lasted until 1965.
The LCC was responsible for:

- Public Assistance;
- Health Services, Housing and Sanitation
- Regulation and Licensing
- Protective Services
- Education and Museums
- Transport
Work on Joseph Bazalgette’s Sewer System started in 1859 finished in 1870

• "The Silent Highwayman" (1858). Death rows on the Thames, claiming the lives of victims who have not paid to have the river cleaned up. (*Punch*)

• Thousands of people in London were dying of Cholera
Key to Map of the London sewerage system from 1882
Map of the London sewerage system from 1882
Drinkable water, Healthcare - 19th Century

- Cholera and other diseases arose from extraction of water from the Tidal Thames river
- **Metropolis Water Act 1852** allowed water extractors 3 years to find wells or other non-tidal sources
- NHS wasn’t created until 1946
Public Transport & infrastructure management - 19th Century

• The railways (1836) and underground allowed the development of the middleclass suburbs and facilitated commuting to the centre

• Horse drawn trams started in 1860, they were replaced by electric vehicles in 1901 to 1915

• B-type buses built and operated by the London General Omnibus Company (LGOC), first bus in 1911, by 1913 around 2500 were in service, 34 seat capacity, 16 mph
Crossrail Project – started in May 2012 due to finish in 2018

• Teams of dedicated construction workers are working 24 hours a day to complete the tunnels for Europe’s largest civil engineering project.
Welfare

• 1832 Royal Commission into the Operation of the Poor Laws
  – Separate workhouses for different types of paupers
  – The grouping of parishes into unions to provide workhouses
  – The banning of outdoor relief so that people had to enter workhouses in order to claim relief
  – A central authority to implement these policies and prevent the variation in practice which occurred under the old poor law
Michael Faraday – below, discovered electromagnetic induction in 1831

The world’s first public electric supply was provided in Godalming, Surrey 1881 – Water wheel - Siemens generator – arc lamps, 50 years after Faraday’s discovery.

In 1882 Edison opened the world’s first steam powered electricity generating station at Holborn Viaduct in London – street lighting and some homes – DC system. One mile range.

Alternating current arrived in the mid 1880’s
Street lighting for security – 19th Century

- First gas public street lighting was demonstrated in Pall Mall, London in 1807 by Frederick Windsor
- Opposite - Victoria Embankment 1878 Jablochkoff Candle Arc light alternating with original gas lamps
- In 1884 the original gas lamps were re-established as electricity was not competitive
Telephone communications – 19th Century [1]

- Telephone 1876 Alexander Bell
- Telephone exchange 1876 - Tivadar Puskás
- In 1878 The **Telephone Company Ltd** (Bell's Patents) was formed to market Bell's patented telephones in Great Britain.
- It had a capacity for 150 lines and opened with 7 or 8 subscribers.
- Another two exchanges towards the end of the year 1879 at 101 Leadenhall Street, EC2 and 3 Palace Chambers, Westminster, the number of subscribers totalled 200.
Telephone communications – 20th Century

- The **Director telephone system** was a development of the step by step (SXS) or Strowger system used in London and five other large cities in Britain from the 1920s to the 1960s.

- In 1927 Holborn, the first Director automatic exchange in London

- Bishopgate and Sloane exchanges were to follow in six weeks, followed by Western and Monument exchanges.

- The London area contained 80 exchanges
Education - 19th Century

- Prior to the 19th Century, there were very few schools
- Until 1870 schools were either private or run by charities
- Elementary Education Act 1870, due to the requirements of the Industrial revolution
- Required local authorities to provide education for 5 to 13 year olds
- Nevertheless there was opposition to mass education
Automobiles - 19\textsuperscript{th} Century

- 1886 is regarded as the birth year of the modern car – Karl Benz
- The model T Ford was first car accessible to the masses in 1908, opposite 1927 Model T
- Cars did not become widely available until 20\textsuperscript{th} Century
Air Pollution in the 21st Century

- The government admits air quality laws will be breached in 15 regions until 2020.
- Londoners will have to wait until 2025 for pollution to enter legal limits.
Air Pollution in the 21st Century

• About 29,000 early deaths each year in the UK are blamed on air pollution – more than obesity and alcohol combined, the attitude from before 1859 still prevails.

• Pollution from road traffic, particularly diesel fumes, is the most significant cause of poor air quality in most cities.

• The pollutants of most concern are tiny airborne particles, "PM10s", and nitrogen dioxide.

• By encouraging drivers to turn to diesel vehicles to reduce CO₂ emissions, the Government has partly contributed to the problem.
Commercial Organizations' Offering 21st Century Smart City Products – partial solutions

- IBM
- Oracle
- SAP
- and others

- For success software products require extensive training
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Migration into cities will rise to 75% of global population

- In 1960 34% of the global population lived in cities, this has now risen to 54%
- 1,000,000 people per week are migrating to cities (UN figure)
Future Cities must have DWDM connections internally & between each other
Future City Communications
Three Generic Stages of Deployment for Optical IP Networks [3], [4]

ASYNCHRONOUS TRANSFER MODE (ATM)
SYNCHRONOUS DIGITAL HIERARCHY (SDH)
SYNCHRONOUS OPTICAL NETWORK (SONET)

Existing & inefficient
Starting up
Future goal
Dense Wavelength Division Multiplexing

- Consider 100 channels with channel separation of 10 GHz
- For 100 channels, this means a total spectrum width of 7 nm with a wavelength spacing of 0.07 nm
- A typical wavelength shift due to temperature is 0.1 nm/K for single mode lasers
- Compared to the 0.07 nm channel separation, we see it is difficult to have a close channel separation in WDM without a good frequency stabilisation scheme
The Syntune S3500 is a tunable DBR laser module

C-band tunable 10 Gb/s transmitter

Full C-band tuning
(89 channels at 50 GHz spacing)

High, flexibly adjustable output power, from 9 to > 13 dBm
Low power consumption, typically < 2.5 W at 75°C

High side-mode suppression ratio > 40 dB

Applications
DWDM transmission systems
Tunable DWDM transponders and transceivers
Optical packet or burst-mode switching

Independent power and wavelength control stabilisation to within ±2.5 GHz over life, compatible with 50 GHz ITU grid spacing
Polarisation maintaining fiber pigtails
Course Wavelength Division Multiplexing (CWDM) for metropolitan networks

- CWDM systems are medium capacity wavelength division multiplexing systems used over distances up to 80 km (50 miles).
- Typically used in access networks and on shorter, single-span interoffice routes.
- They are defined by the International Telecommunications Union (ITU) recommendation (standard)
- G.694.2 (2003) as 18 wavelengths spaced 20 nm apart starting at 1271 nm and continuing to 1611 nm, carrying data rates up to and including 10 Gb/s.
G.694.2 (2003) as 18 wavelengths spaced 20 nm apart starting at 1271 nm and continuing to 1611 nm.

Figure 1 - CWDM Wavelength Grid Specified by ITU-T G.694.2
• A prime application for CWDM is providing capacity for cellular backhaul.

• A cell site will often have three to four cellular providers, each one requiring a dedicated fibre for their backhaul capacity needs.

• A single cellular service provider can require 300 Mb/s to 1 Gb/s, eliminating the ability to use a copper facility.
CWDM - Cellular Backhaul
The 9,300 square metre data centre near Frankfurt

- European data centres consumed 56TWh of electricity in 2007 and in the UK they are responsible for almost three per cent of electricity use.
GCHQ's headquarters are in Cheltenham, Gloucestershire. There are two much smaller sites in Cornwall and Yorkshire but most of the 5500 staff work at the impressive state of the art building at Benhall in Cheltenham.
Common city challenges

- Socio-economic
  - Growing population
  - Aging population
  - Economic prosperity
  - Health and inequality
  - Skills and market access
  - Job creation and retention
  - Infrastructure stress

- Political
  - Public sector budget
  - Changing service needs

- Environmental
  - Climate change
  - Resource scarcity
  - Energy resilience

Common elements of city visions

“The overwhelming core focus of the visions is an improvement of local quality of life.

Following on from this, and linked to it, are improvements in economic opportunity, community engagement and integration; and a reduction in environmental footprint”

Source: Solutions for cities: An analysis of the feasibility studies from the Future Cities Demonstrator Programme (2013) [3]. This report draws out the common trends and themes that emerged from city responses to the Technology Strategy Board’s Future City Demonstrator competition.
Traditional operating model: where cities have come from

Often under-resourced on Computing Infrastructure and training

Impact:
- Unconnected
- Not customer-focused
- Inefficient
- Closed systems, not open to externally-led innovation
- No ability to drive cross-system innovation
- No ability to drive city-scale change at speed
New Integrated Operating Model: where smart cities are moving to

Requires huge investment in IT infra-structure and training

- City data unlocked from individual silos
- Logical separation of data, service and customer delivery layers
- Externally-driven innovation:
  - Enablement of new marketplace for city information and services
  - Citizens, SMEs and social entrepreneurs enabled to co-create public services and create new value with city data
- Internally-driven innovation:
  - Improved and integrated service delivery
  - Resource optimization
- Ability to drive city-wide change at speed
Benefits being targeted in 29 UK smart city initiatives
How can we integrate Future Cities?
Service Oriented Architecture (SOA)

• A Service can be described as a well-defined, encapsulated, reusable, business aligned capability

• **Service design can be addressed using the “service-orientation principles”, described by Thomas Erl #**

• These principles address issues such as “How services should be designed?”, “How messages should be designed?” and “How should the relationships between services be defined?”

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SOA principles [5]

- **Loose coupling**: Minimizes dependencies and relations between services.
- **Service contract**: Defines an agreement that describes the service and terms of information exchange.
- **Autonomy**: The service has control over its own logic implementation.
- **Abstraction**: The service implementation logic is hidden from the service consumers.
- **Reusability**: The services are designed in ways that support potential reuse.
- **Composability**: Services can be used to build other services.
- **Statelessness**: Services are designed in a way that minimizes retention of information related to specific activities.
- **Discoverability**: Services can be discovered and accessed by service consumers.
Several methods have been developed in order to incorporate the SOA principles

- SOA-RM and the Service Component Architecture (SCA) maintained by OASIS. (Organization for the Advancement of Structured Information Standards)

- The SOA-RM is a Reference Model that provides definitions and vocabularies at a high level of abstraction that applies to all SOA and SCA in a set of specifications specifically designed to build distributed applications based on SOA.

- SCA represents the next step in the evolution of SOA, raising the level of abstraction and addressing two critical issues in software development namely: complexity and reusability.
Service Component Architecture

• SCA hides the complexity such as specifying security, reliability and other quality of service elements from the application code.
• The SCA effort started in 2005 by a group of vendors that includes IBM, Oracle, SAP, and others and handed over to OASIS in 2007.
• Some of the open source implementations include Apache Tuscany, Fabric3, FraSCAti and Red Hat SwitchYard.
• Services can be implemented using different technologies and programming languages such as Java, C++ or specialised languages like the Business Process Execution Language (BPEL).
SCA Component

- The main specification is the SCA Assembly model, which provides a standardized XML representation to define the configuration of the SCA application.
- SCA defines a model for the SCA component and a model for the SCA composite.
SCA services, references, properties

- As is shown opposite SCA components provide functionality through “services.”
- Their dependencies are defined through “references.”
- Properties allow configuration of the application using external values.

SCA component diagram
• Component A is connected or “wired” to Component B in order to create a composite service.
SCA composite will provide a required function via promoted services & references

• Inside the SCA composite, services can be promoted
• The functionality of the SCA composite service will be provided by the promoted service.
• Similarly, references can be promoted, which define dependencies with external resources.
• The composite services and references define how the SCA composite will be exposed and connected to dependencies.
• Composite applications are deployed in a SCA runtime, which is usually a part of an Enterprise Service Bus (ESB)
Enterprise Service Bus (ESB) supports SOA

- The ESB is a software pattern that can provide the necessary infrastructure to support service orientation.
- ESB acts as an intermediary, routing, transforming or enriching messages between service providers and service consumers.
- ESB is often used to provide the “infrastructure services”.
Patterns and sub-patterns supported by the ESB

- Event-Driven Messaging
- Asynchronous Queuing
- Intermediate Routing
- Service Broker
- Protocol Bridging
- Data Format Transformation
- Data Model Transformation
ESB-centric architecture supports SOA

Communicates with a disparate group of protocols, such as SOAP, REST, CORBA, JMS, MQ Series, MSMQ, FTP, POP3, and HTTP, etc.
Example scenario: co-existence of multiple architectural patterns

The SOAP-based interactions between the organizations are defined by the Web Service Choreography Description Language (WS-CDL).

Organization C uses an orchestrator engine to deploy processes that define clinical pathways.

The ESB provides connectivity with other systems and monitors service interactions in order to detect health-specific patterns.
SOA Elements

• Business process management BPM;
  – BPM refers to software that can be used to model and execute workflow processes.

• Enterprise decision management, EDM;
  – EDM is about extracting the decisions and rules that are today embedded into applications or people and systematically exposing them as rule assets that can be centrally managed and authored.
SOA platform

- JBoss Enterprise SOA Platform is a standards-based platform built on a flexible ESB
- The ESB integrates applications, SOA services, and business events, and automates business processes.
Public Safety Example

[Image of a circular diagram with various elements such as Government and Agency Administration, City Planning and Operations, Buildings, Energy, Water, Education, Transportation, Social Programs, Smarter Care, and People and Infrastructure, with Public Safety highlighted.]
Urban Surveillance

Smart IP Cameras mapped into 3D space

Data & Meta-
Data Storage

Alerts & Meta-
Data

Control Room

IP Network

Responders
Real time decision making via a Command and Control Platform

• Associate and retrieve related data to a person, location and incident

• Create customized “Incident reports” with all details in real-time which can be passed on to respective agencies

• Integrates with voice / communication channels to enable coordination among various agencies
Multi Touch Command and Control Center

3 D MAPPING & NAVIGATION

- Maps complex structures
- Enables both map & 3D view
- Navigates both external and internal views
- Enables a user to annotate the scene with a few finger strokes
- Defines any area by drawing that area and enables viewing of all cameras / alarms for that particular area for any period instantly
- Enables viewing of mobile assets on maps in real time and facilitates interaction with them through the communication module
- Enables automatic tracking across multiple cameras

CAMERA SELECTION OF REAL-TIME FEED

- Enables selection through the map, location, thumbnails by street etc.
- Navigation through context sensitive menus enables greater intuitive capability
- Enables viewing of all defined video from any time / place and their linked events

Selection of simultaneous multiple real-time video feeds
Touch, show and size the frame instantly
SELECTION AND RETRIEVAL OF METADATA

- Facilitates collaboration with multiple data sources
- Retrieves all associated metadata
- Provides extensive data mining capabilities and complex analysis

CUSTOMISED INCIDENT REPORT

- Enables creation of incident report containing location, time, screen shots, real time feeds, current status and other associated information
- Facilitates circulation and sharing of the report with multiple relevant agencies, both fixed and mobile
Analytics Algorithms built on a customized library, enabling accurate alerts, both on the ‘edge’ & in a centralized environment \[10\], \[11\], \[12\]

- Performs Analytics “On the Edge” or in a Centralized Environment (Server based)
- Developed against PETS and i-LIDS Datasets [Tested for robustness with counts of 0.75 - 0.91 (on i-LIDS Standards)]
- Ported to a TI chip which makes it easy to embed into stand alone cameras

### Sterile Zone Application:
Perimeter security

**Key Feature:**
- No fine tuning needed for changing conditions

### Abandoned Object Application:
Train Stations and Abandoned Security

**Key Feature:**
- Accurate performance in busy environments

### Parked Vehicle Application:
Traffic Management

**Key Feature:**
- Usable in a wide range of traffic management scenarios

### Doorway Surveillance Application:
Access Control

**Key Features:**
- Can be configured for access control or people counting
- Works with single and double door

### Multi-Camera Tracking Application:
Security tracking

**Key Features:**
- Complex multi filter algorithms
- Overlapping and non overlapping cameras
- Works within 2020 mapping framework
Helping the aged and disabled
Typical Tablet Computer Home Screen for the Aged
Typical Healthcare Tablet Icons
Typical Household Services Tablet
Simple Customisable Tablet Icon
Menu’s for the Elderly in the Home
A Lego Style Service Based Citizen IT System

Service Component Architecture (SCA)
- Composite services
- Low level Services development

Decision Support
Business Process Management
Business Rules Management

Cloud Based Service Bus
- protocol adapters
- and message transformation

Personal sensor network
- Aftercare Systems & Tertiary Care
- Housing services
- Adult Social Services
- Transport

Knowledge & Data Warehouse

GP, Dentist, Optician, Chiropodist, etc
- Meals on wheels

Meals on wheels

Community Engagement dealing with loneliness
- Customer Relationship Management (CRM)

Legacy Systems

Heterogeneous Applications And Legacy Systems
Personal Sensor Network
Oyala – New Capital City to replace Malabo
Oyala – Equatorial Guinea

- Oyala is a new capital city that is currently under construction in the middle of the jungle
- It has been projected to have a population of 200,000 inhabitants
- Population of Equatorial Guinea is about 1.5 million
- Designed by Future Architecture Thinking (FAT) – from Portugal
- Power supply will come from the nearby 120 MW Djibloho Dam
- Oyala will be the new headquarters of the President (Teodoro Obiang), government administration, police and military leadership
Oyala – Masterplan by FAT
New University of Oyala – managed by Boston University
Oyala Communications to enable Future City status

• Oyala will use the ACE sub-sea DWDM subsea optical fibre for global connections

• Management and Protection
  – OTN fault isolation
  – Protection switching
  – Easy to use network management software

• Long Reach
  – Amplification
  – Dispersion Compensation
  – Regeneration
  – OTN FEC
  – Multidimensional ROAD System is used in the central Node of the WDM network.
Fibre Network in Oyala

• High Capacity
  – Up to 80 channels
  – Up to 40 Gb/s
  – Muxponding/Aggregation
  – 96 fibres

• Agile
  – Reconfigurable
  – Adaptable
  – Tunable
Fibre Network in Oyala

- Transparent
  - Ethernet
  - SDH Technology
  - Legacy - PDH
    - Video
  - ESCON, FICON, Fibre Channel
- Multi-Purpose
  - Media conversion
  - Multi - Protocol
  - Media conversion
  - Hardened for outside plant
Oyala DWDM backbone network

- **Phase I**
  - 9 metro nodes, with one central node, 16*20G bandwidth in total
  - 9 GoTa base stations to provide radio trunking coverage for the city

- **Phase II**
  - 880 km of DWDM optical fibre cable between buildings, 1600 sets of access network CPE wireless systems
  - VoIP system
The broadband network will be capable of supporting:

- High-speed Internet, voice and video service, video surveillance, video conferencing, office automation service and other services.

- It will be part of the foundations for the city’s future sustainable development.

- From the simulations the metro backbone will support Oyala’s data traffic needs for 10 years.
## Basic requirements

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Simulation Scenario I

Bata

ACE landing point

Data Center

Oyala
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Simulation Scenario II

Bata ACE landing point

Data Center A

Data Center B

Oyala
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Simulation Scenario III

Bata  ACE landing point  Oyala

Data Center A

Data Center C

Data Center B
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## Conclusion

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Hydro Electrical System

- **Electricity System**

  Hydroelectricity Power will be used with a capacity of 426MVA

  Initial capacity 110KVA

  Demand by 2020 130MVA

  Demand by 2030 276MVA

- A Fibre Optic communication system is going to be implemented which is going to be used to distribute, deliver and monitor the electricity system in a most efficient way and smart.

- Smart electricity meters and monitors are included in this system.
Questions
References

1) http://www.britishtelephones.com/histuk.htm, downloaded, Feb 2015
2) DEMOGRAPHIA WORLD URBAN AREAS, 11TH ANNUAL EDITION, (Built Up Urban Areas or World Agglomerations), 2015
3) S Pazi, C Chatwin, “Assessing the economic benefits and challenges of Tanzania’s National ICT Broadband Backbone (NICTBB),”