

# Digital City Exchange: A New Digital Economy Programme

Prof D. Gann<sup>1,a</sup>, Prof E. Autio<sup>1,b</sup>, Prof Y. Guo<sup>2,c</sup>, Dr A. Leiponen<sup>1,d</sup>, Dr R. Ozaki<sup>1,e</sup>, Prof J. Polak<sup>3,f</sup>,  
Prof N. Shah<sup>4,g</sup>, Prof E. Yeatman<sup>5,h</sup>

<sup>1</sup> Imperial College Business School, Imperial College London, SW7 2AZ, UK

<sup>2</sup> Department of Computing, Imperial College London, SW7 2AZ, UK

<sup>3</sup> Department of Civil and Environmental Engineering, Imperial College London, SW7 2AZ, UK

<sup>4</sup> Department of Chemical Engineering, Imperial College London, SW7 2AZ, UK

<sup>5</sup> Department of Electrical and Electronic Engineering, Imperial College London, SW7 2AZ, UK

Email: <sup>a</sup>d.gann@imperial.ac.uk, <sup>b</sup>e.autio@imperial.ac.uk, <sup>c</sup>y.guo@imperial.ac.uk, <sup>d</sup>a.leiponen@imperial.ac.uk,

<sup>e</sup>r.ozaki@imperial.ac.uk, <sup>f</sup>j.polak@imperial.ac.uk, <sup>g</sup>n.shah@imperial.ac.uk, <sup>h</sup>e.yeatman@imperial.ac.uk

Telephone: <sup>a</sup>+44 (0)20 7594 5950, <sup>b</sup>+44 (0)20 7594 1991, <sup>c</sup>+44 (0)20 7594 8335, <sup>d</sup>+44 (0)20 7594 1292,

<sup>e</sup>+44 (0)20 7594 5942, <sup>f</sup>+44 (0)20 7594 6089, <sup>g</sup>+44 (0)20 7594 6621, <sup>h</sup>+44 (0)20 7594 6204

## ABSTRACT

Digital City Exchange is a new multidisciplinary RCUK Digital Economy research programme, exploring ways to digitally link utilities and services within a city. The motivation for this major research programme and the over-arching research challenge are outlined. The programme's specific research objectives and methodology are also described. Digital City Exchange promises to revolutionise urban infrastructure – integrating energy, transport, waste and utility resources – generating significant technological, economic and societal impact.

## Categories and Subject Descriptors

C.3 [Special-Purpose and Application-Based Systems]: *process control systems, real-time and embedded systems, signal processing systems*. C.4 [Performance of Systems]: *design studies, fault tolerance, measurement techniques, modeling techniques, performance attributes, reliability, availability, and serviceability*. J.4 [Social and Behavioral Sciences]: *economics, sociology*. K.4.4 [Computers and Society]: *Electronic Commerce – electronic data interchange, intellectual property, security*.

## General Terms

Management, Measurement, Performance, Design, Economics, Experimentation, Security, Human Factors.

## Keywords

Digital, Services, City, Data, Business, Infrastructure, Resources.

## 1. DIGITAL CITY EXCHANGE

The Digital City Exchange (DCE, [www.imperial.ac.uk/digital-economy-lab/partnernetworks/dce](http://www.imperial.ac.uk/digital-economy-lab/partnernetworks/dce)) is a Digital Economy research programme, enabling new technical and business opportunities by linking utilities and services within cities. It focuses on harnessing next generation digital systems to transform the management of

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

*Digital Engagement 2011*, November 15–17, 2011, Newcastle, UK.  
Copyright 2011 ACM 1-58113-000-0/00/0010...\$10.00.

energy, transport, waste and utility resources.

### 1.1 Motivation

Cities are at the heart of economic growth and social activity and new digital services provide a foundation for the knowledge economy. The share of the global population living and working in cities is expected to continue to grow rapidly. Increasing concentrations of people, business and technologies and their underlying patterns of activities mean that cities are the areas where problems resulting from infrastructure bottlenecks, congestion and communication network failures are most acute.

#### 1.1.1 Existing city infrastructure

Most existing cities have evolved without strategic planning. Thus urban services are not efficiently connected and configured; transport, energy, water and waste resource issues are resolved independently. Utilities and services are governed and managed by distinct entities, with different incentives and constraints (competitive, technological, legal). This piecemeal, conventional approach to city asset management and pricing policy gives rise to the costly characteristics of city life associated with peak demand.

#### 1.1.2 Technological opportunity

Responsive networks characterise modern communications, including digital media, social networking and e-commerce. Meanwhile, developments in pervasive sensing, large-scale modelling, new analytical and optimisation techniques and web services technologies, the Internet-of-Things and cloud computing all offer a new wave of opportunities to revolutionise an integrated urban infrastructure, both digital and physical.

#### 1.1.3 Business need

Stimulating economic growth through the development of cross-sector services cannot happen without the development of new business models. Encouraging businesses to open up their data, and application developers to add value by creating new business opportunities, requires appropriate, flexible pricing structures amongst other interventions to stimulate the creation of the digital city ecosystem.

### 1.2 Research challenge

DCE research is seeking to find innovative solutions to optimise the use and planning of cities, promising new, coordinated ways

of managing peak demand and ultimately benefiting business, citizens and the environment.

Whilst many major research programmes are targeting individual segments such as smarter road-traffic or energy networks, no others are exploring the opportunities of integrating data-flows across traditional boundaries.

The DCE programme offers the first cross-sectoral investigation of city resources and services. This novel approach reflects the true interconnected nature of urban infrastructure.

### 1.2.1 Case study: managing peak demand

Easing symptoms of peak demand, such as traffic congestion and power outages, requires the provision of expensive infrastructure or, alternatively, a mechanism for spreading demand more evenly. The latter, low-cost approach of smoothing service demands across multiple systems will conserve resource, improve environmental performance, stabilise prices and maximise capacity.

## 2. RESEARCH

DCE research combines engineering, systems analysis, business model innovation and use studies, with analysis of data security and privacy, to create and analyse models for integrated service delivery. The DCE programme of research is defined by six work packages (outlined in Table 1).

**Table 1. Digital City Exchange work package (WP) objectives**

WP	Measurable objective(s)
1	Creation of a metadata standard and intelligent summarisation model
2	Case studies of service adoption and experiments on user behavior within systemic service innovations in transport, energy and other sectors
3	Pilot implementation of sensing, modelling and service architecture
4	Development of tools for innovation management and business modelling
5	Development of a prototyping capability for new digital services and their delivery pathways based on data from multiple sources developed in WP3 and WP4
6	Quantification of services performance, and impacts on users, enterprises and the urban system

## 2.1 Research objectives

### 2.1.1 Managing peak load

Large-scale modelling, the development of a multi-agent, cross-sector system, new analytical and optimisation techniques and web services technologies are being researched for service demand peak mitigation: addressing topics such as security, robustness, resilience and standards.

### 2.1.2 Harnessing disparate data sets

New markets for digital services will grow from the ability to integrate, analyse, model, and act upon data from multiple sources. DCE is exploring pervasive sensing as a means of integrating data analytics across previously discrete activities.

Challenges associated with harnessing data from multiple sources include: the deployment of sensor networks; complexity of scale and data quality; engineering and provision; and user engagement.

### 2.1.3 Service innovation

Based on data analytics from pervasively sensed environments, DCE is unlocking business opportunities by: creating and testing new business models; investigating consumer behavior at a systemic level; creating new services. This challenge demands consideration of: the size and nature of potential markets; privacy, governance and ownership of data; investment and service delivery; protection and management of intellectual rights; a framework to deliver and capture value.

## 3. METHODOLOGY

### 3.1 Multi- and inter-disciplinary approach

Drawing on a multidisciplinary research base, DCE unites researchers from Chemical Engineering, Civil and Environmental Engineering, Computing, Electrical and Electronic Engineering and the Business School.

DCE interdisciplinary research focuses on the development of advanced virtual prototyping capabilities, visualisation of large complex data-sets, and of commercialisation pathways.

### 3.2 Test-bed scenarios

The programme's vision of market-facing innovation means research is focused around test sites where city and community data can be accessed, aggregated and analysed in activity nodes such as at supermarkets and hospitals.

Researchers are working to identify potential business opportunities by conducting real-world trials with industrial partners – such as Sainsbury's and IBM (Table 2) – and engaging with the SME community. Innovative services may then be trialled before implementation via virtual prototyping across the test-bed network.

**Table 2. Partners of Digital City Exchange**

Sector	Partner
Node managers	Sainsbury's
	Imperial College NHS Trust
Systems engineering and analytics	IBM
	Arup
Network managers	National Grid
	Transport for London

## 4. IMPACT

By developing more integrated infrastructure, transport and resources, innovation from DCE will come at the intersection between developments in systems, services and business models by creating platforms on which to build our future city services. The DCE will: enhance the quality of life in cities; maximise the opportunities for new businesses; and enable valuable new services to emerge.

## 5. ACKNOWLEDGEMENTS

DCE is a five-year programme at Imperial College London funded by Research Councils UK's Digital Economy Programme (EPSRC Grant No. EP/I038837/1). It was awarded £5.9M (over five years) and commenced activity in October 2011.