Bath University
Open Programmable City Region
15th January 2015
Paul Wilson
Interim Managing Director
@bristolisopen
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paul.wilson@bristolisopen.com

Agenda

- Why?
- Five mega-trends shaping the next decade
- Our Response
- Working together
    - academics
    - business
    - service delivery and
    - community organisations
- Using an Open Software Defined Network
- To create the world's first 'open programmable city-region'
- How to engage

Why? Use cases

TMT
businesses
& academia

_____

Culture &
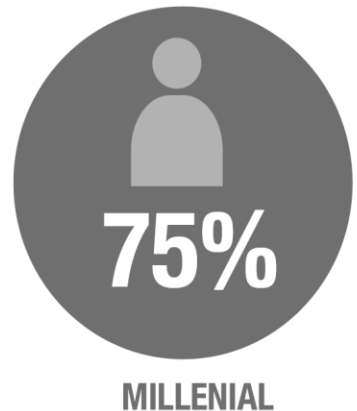creative
content

_____

People,
community,
service delivery

_____

Better
city
management

Mega Trend #1 Technology and data continue to grow

MASSIVE SPENDING IN TECH

$180b
End-user spending on cloud services by 2015

Amount companies will spend on big data by 2019

$282b

2000 — $200m

2011 — $10b

2020 — $200b

DATA SURGE: CONNECTED DEVICES INCREASING

SENSOR NETWORKS CREATE MACHINE TO MACHINE (M2M) COMMUNICATION & INTERNET OF THINGS

Source: McKinsey

Mega Trend #2 People move to cities, using more tech

GROWING CITIES AND GROWING CONSUMERISM

200
New cities in China with 1m+ people by 2025 (Europe = 35)

60%
Amount of new urban consumers in emerging cities by 2025

% WHO USE SOCIAL MEDIA

30%
BOOMER

75%
MILLENIAL

50%
GEN X

EXIT BOOMERS, ENTER MILLENIALS
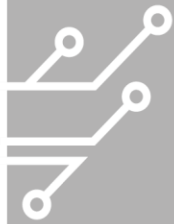
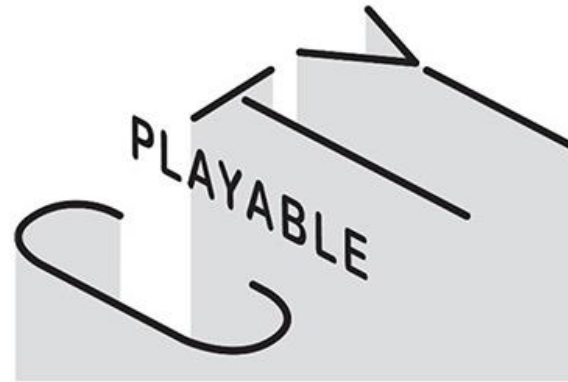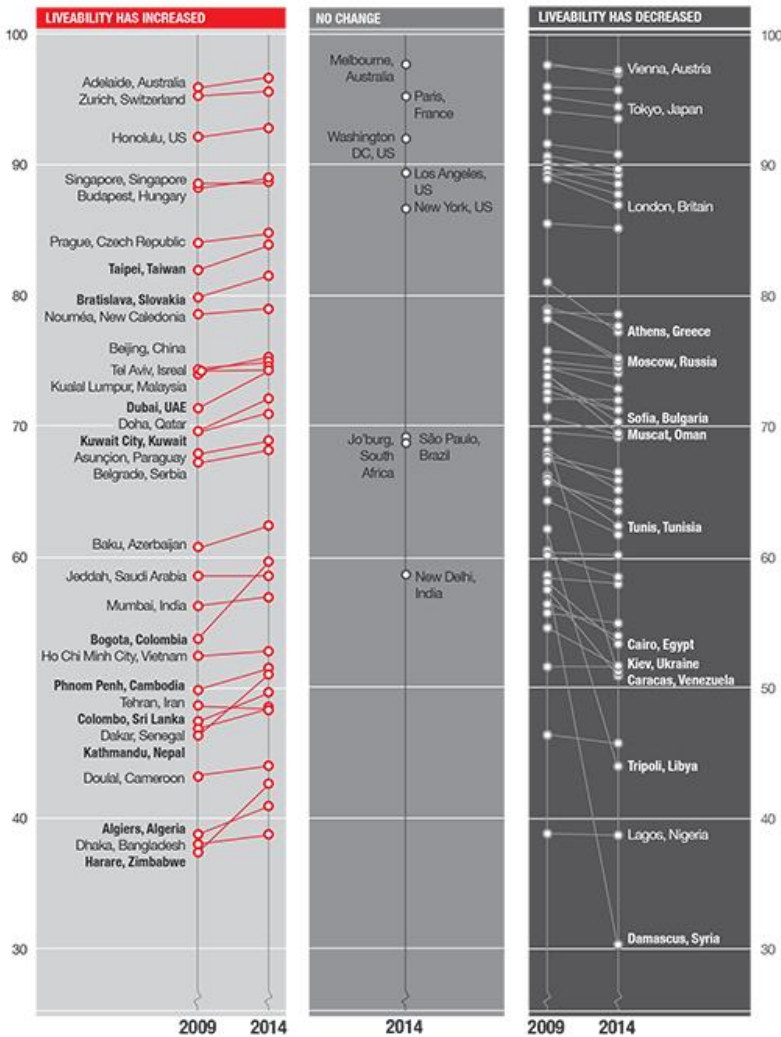## WHO USE TECHNOLOGY TO NAVIGATE DAILY LIFE

Source: McKinsey

Mega Trend #3 Liveable, Sustainable & Resilient Cities Win

CITY "LIVEABILITY" INDEX*

100=ideal, ten cities with ,ost change highlighted in **bold**

LIVEABILITY HAS INCREASED

- Adelaide, Australia
- Zurich, Switzerland
- Honolulu, US
- Singapore, Singapore
- Budapest, Hungary
- Prague, Czech Republic
- **Taipei, Taiwan**
- **Bratislava, Slovakia**
- Nouméa, New Caledonia
- Beijing, China
- Tel Aviv, Isreal
- Kualal Lumpur, Malaysia
- **Dubai, UAE**
- Doha, Qatar
- **Kuwait City, Kuwait**
- Asunçion, Paraguay
- Belgrade, Serbia
- Baku, Azerbaijan
- Jeddah, Saudi Arabia
- Mumbai, India
- **Bogota, Colombia**
- Ho Chi Minh City, Vietnam
- **Phnom Penh, Cambodia**
- Tehran, Iran
- **Colombo, Sri Lanka**
- Dakar, Senegal
- **Kathmandu, Nepal**
- Doulal, Cameroon
- **Algiers, Algeria**
- Dhaka, Bangladesh
- **Harare, Zimbabwe**

2009 2014

NO CHANGE

- Melbourne, Australia
- Paris, France
- Washington DC, US
- Los Angeles, US
- New York, US
- Jo'burg, South Africa
- São Paulo, Brazil
- New Delhi, India

2014

LIVEABILITY HAS DECREASED

- Vienna, Austria
- Tokyo, Japan
- London, Britain
- Athens, Greece
- Moscow, Russia
- Sofia, Bulgaria
- Muscat, Oman
- Tunis, Tunisia
- Cairo, Egypt
- Kiev, Ukraine
- Caracas, Venezuela
- Tripoli, Libya
- Lagos, Nigeria
- Damascus, Syria

2009 2014

*Based on 30 factors spread across five areas: stability, infrastructure, education, health care and environment
Source: Economist Intelligence Unit

PLAYABLE

THE SUNDAY TIMES
BEST PLACES TO LIVE IN BRITAIN

BRISTOL 2015 EUROPEAN GREEN CAPITAL

BRISTOL
winner 2015
EUROPEAN GREEN CAPITAL
An initiative of the European Commission

372 CITIES THAT APPLIED TO BE PART OF THE **100 RESILIENT CITIES** CHALLENGE

Rockefeller Foundation
Innovation for the Next 100 Years

Mega Trend #4 Citizens want more control over daily life

CUSTOMER EXPERIENCE SPANS MANY CHANNELS
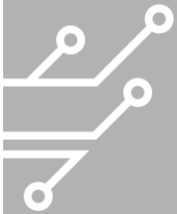
CUSTOMERS USE AN AVERAGE OF SIX DIFFERENT CHANNELS
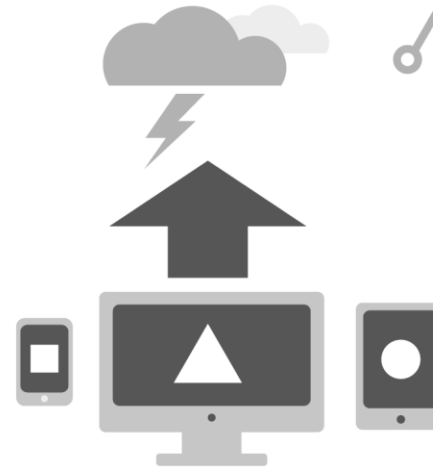
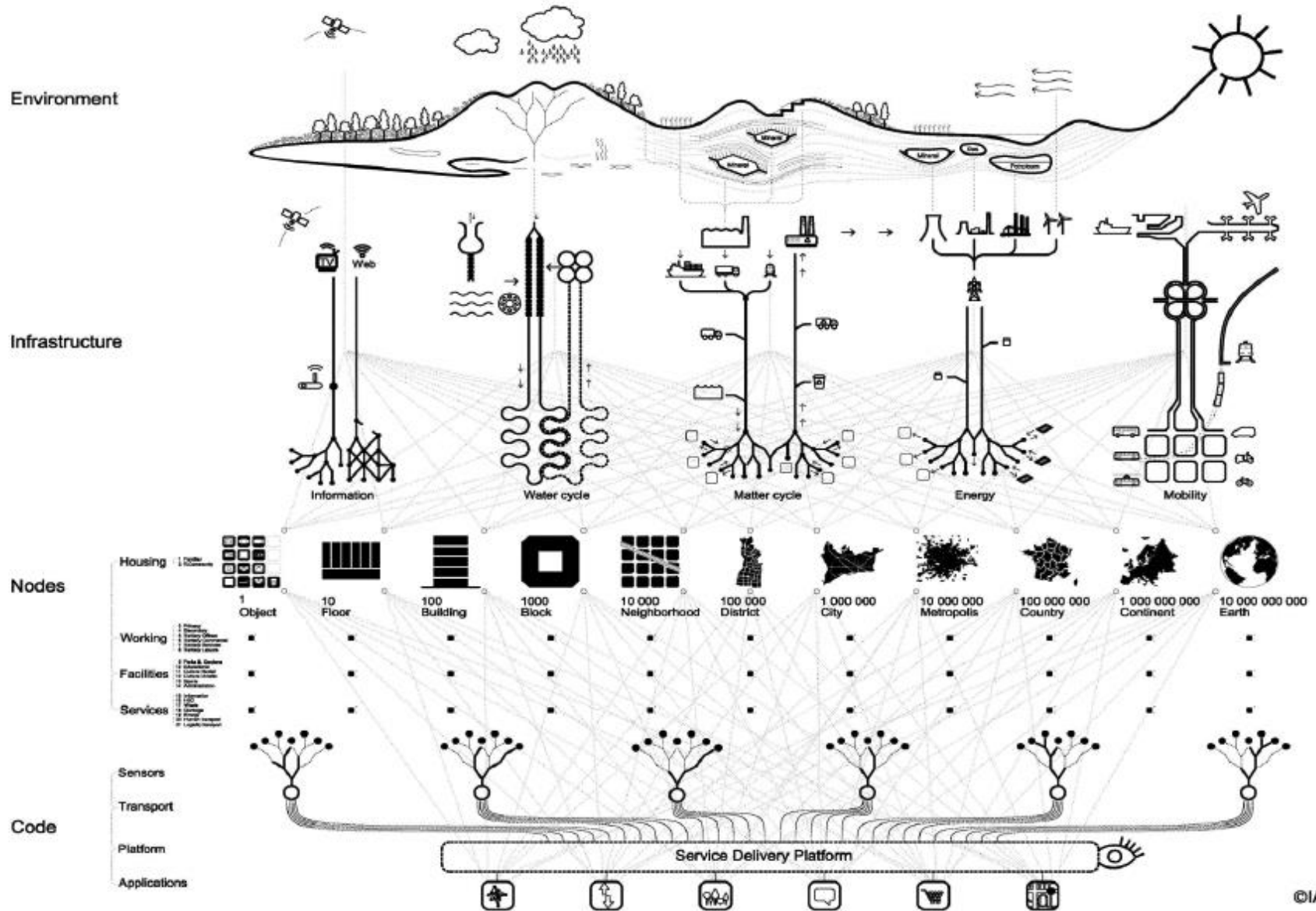**65%** are frustrated when presented with inconsistent experience across channels

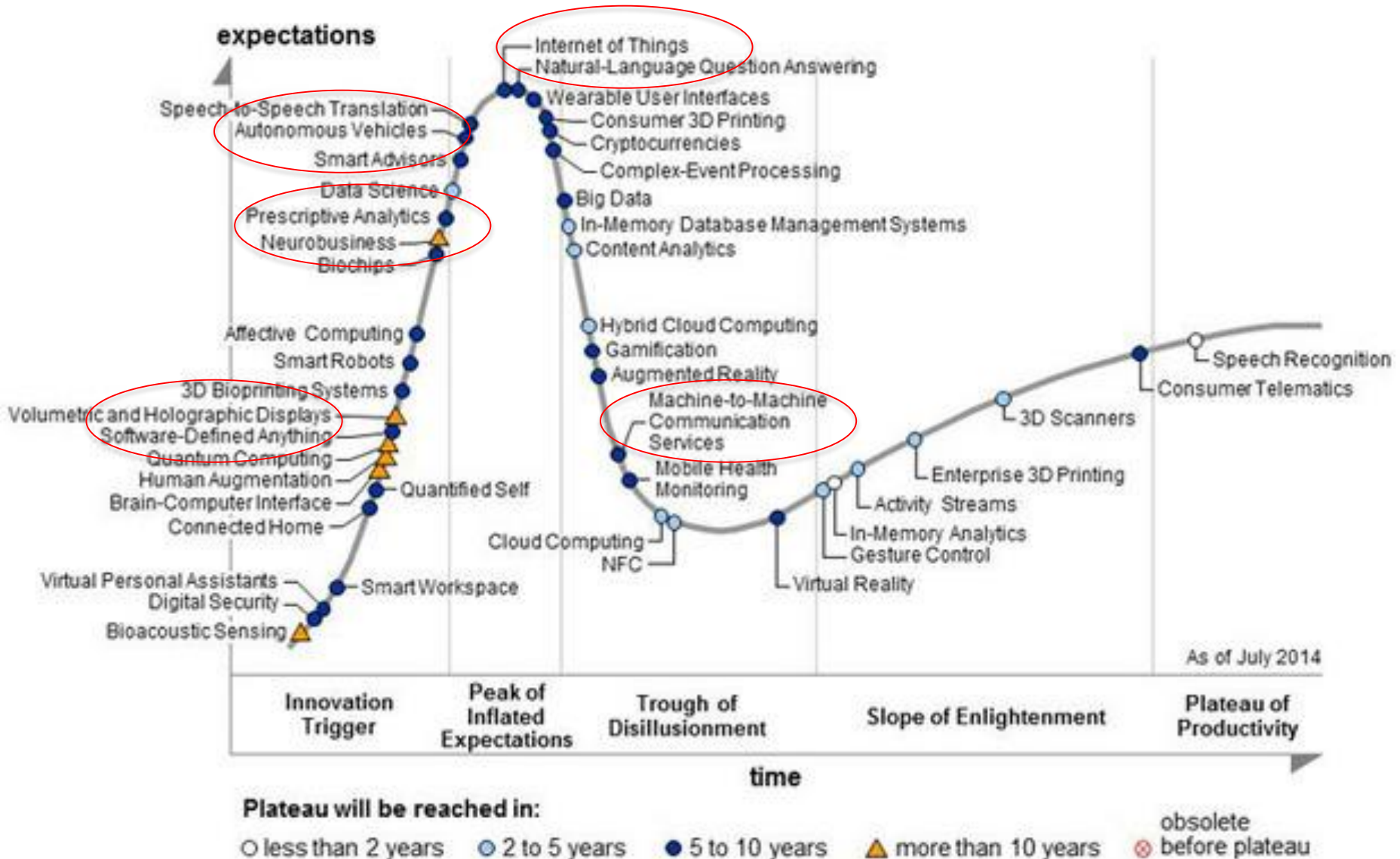**GOVERNMENT EXPENDITURE DECREASES**

MORE SELF GUIDED DECISION MAKING

Source: McKinsey
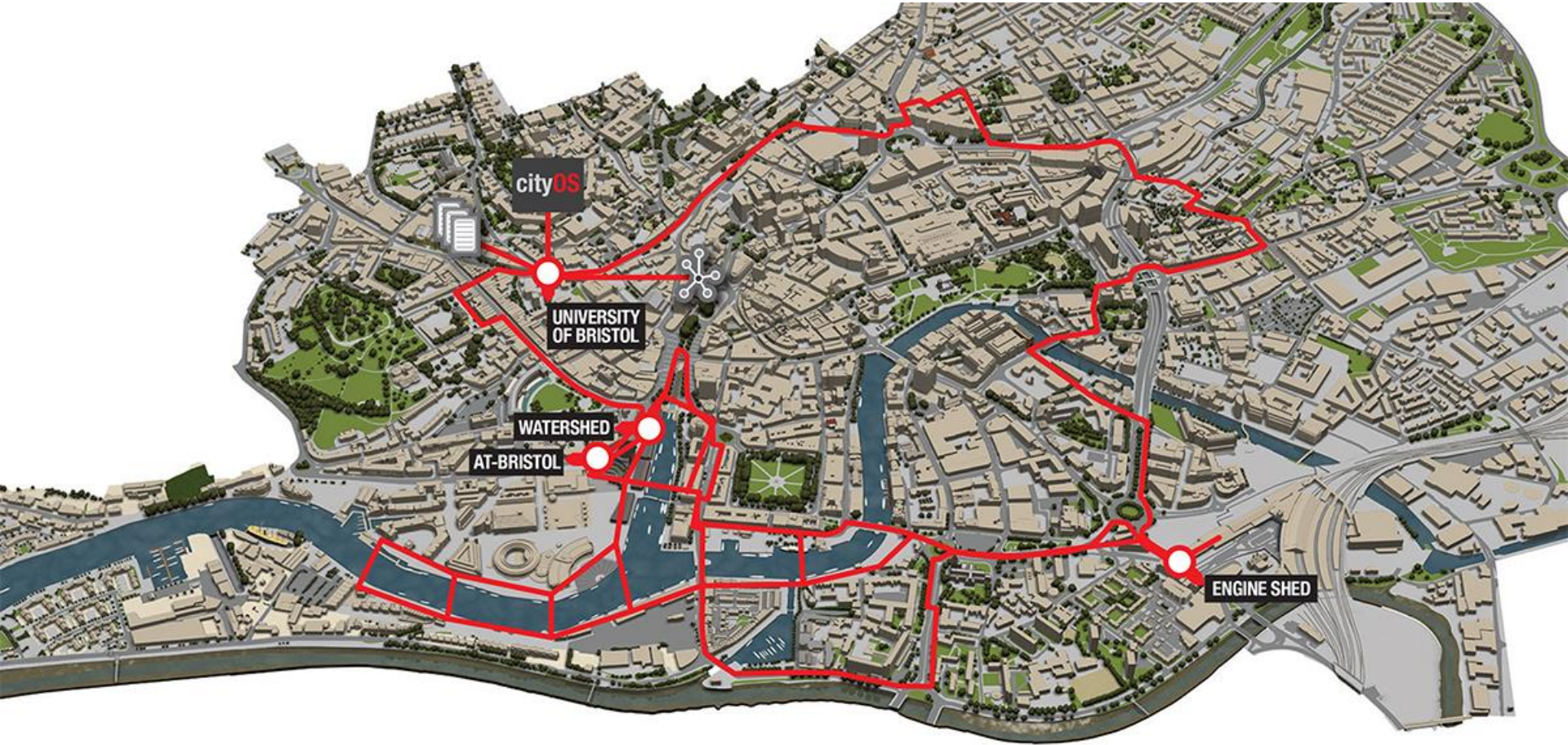
Gartner's Hype Cycle July 2014

OUR RESPONSE...

A LOT OF PEOPLE

INVOLVED

NEEDS GOOD ORGANISATION &

## A CITY-REGION

Our philosophy of innovation, co-creation, governed by a JV

INDIVIDUALS 1   FAMILIES 5-10   COMMUNITIES 10^4 DISTRICTS 10^5 CITIES 10^6 COUNTRIES 10^8 CONTINENTS 10^9 WORLD 10^{10}

PRODUCT

IDEA

NOW — 2 YRS — 3 YRS — 5 YRS — 10 YRS

BUSINESSES
NEW PRODUCT DEVELOPMENT

MARKET DEVELOPMENT

PRODUCT DEVELOPMENT

SME · SME · SME · SME · SME

BRISTOL

UNIVERSITIES
RESEARCH & TESTING

RESEARCH & INNOVATION

PROFITS & TAX

PUBLIC RESEARCH — PUBLICLY FUNDED RESEARCH e.g. H2020

MARKET

TR9 · TR8 · TR7 · TR6

DEVELOPMENT

TR5 · TR4 · TR3 · TR2 · TR1

RESEARCH

An Open Programmable City SDN test-bed

ACTIVE NETWORK

— Fibre network

Core network nodes with accessible rack space

Network emulator

cityOS Software

High performance computer

With evolving technology
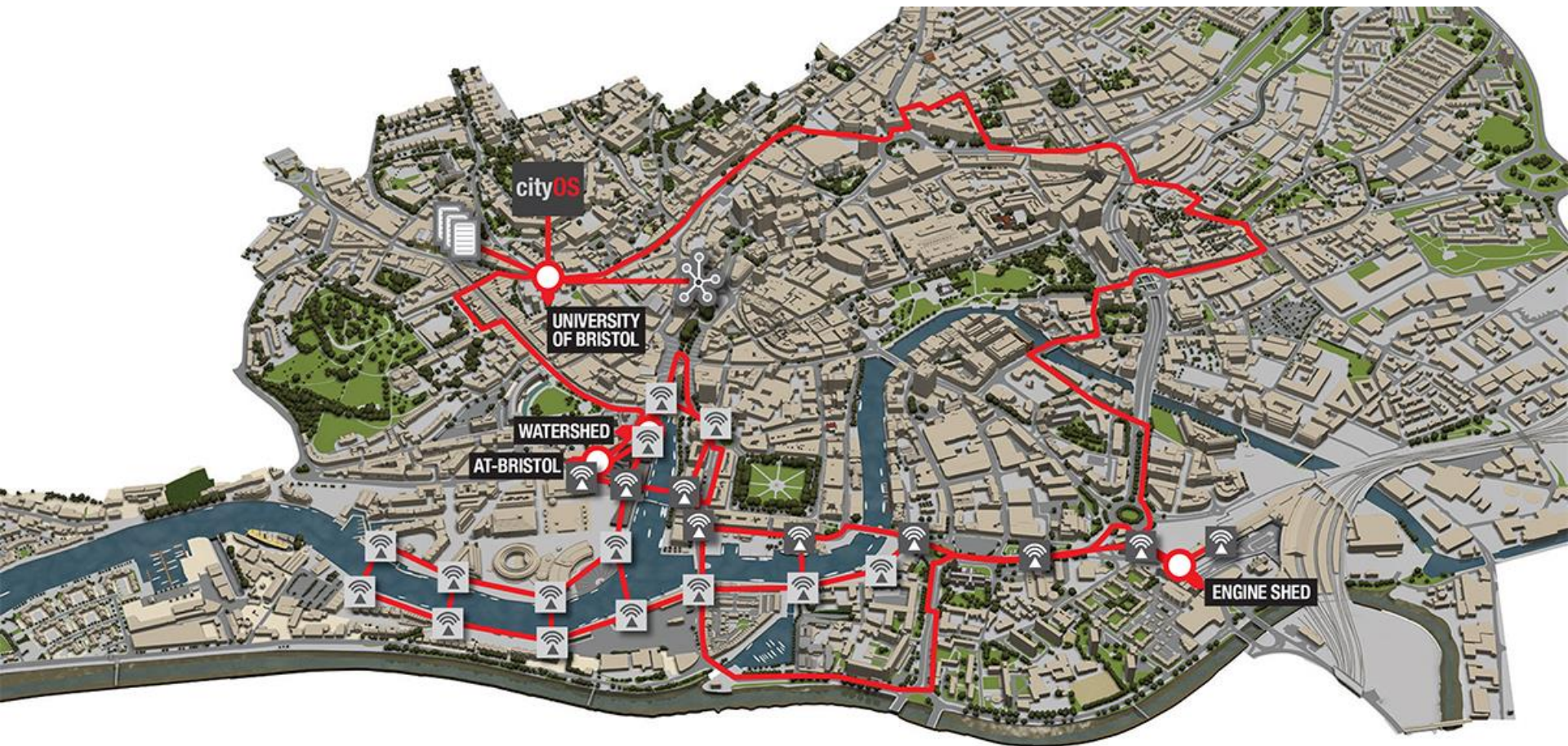
ACTIVE NETWORK

— Fibre network

Core network nodes with accessible rack space

Network emulator

cityOS Software

High performance computer

WIRELESS NETWORK

Main hubs

'Sub-hubs'

Map labels: cityOS, UNIVERSITY OF BRISTOL, WATERSHED, AT-BRISTOL, ENGINE SHED

Where the sky is the limit
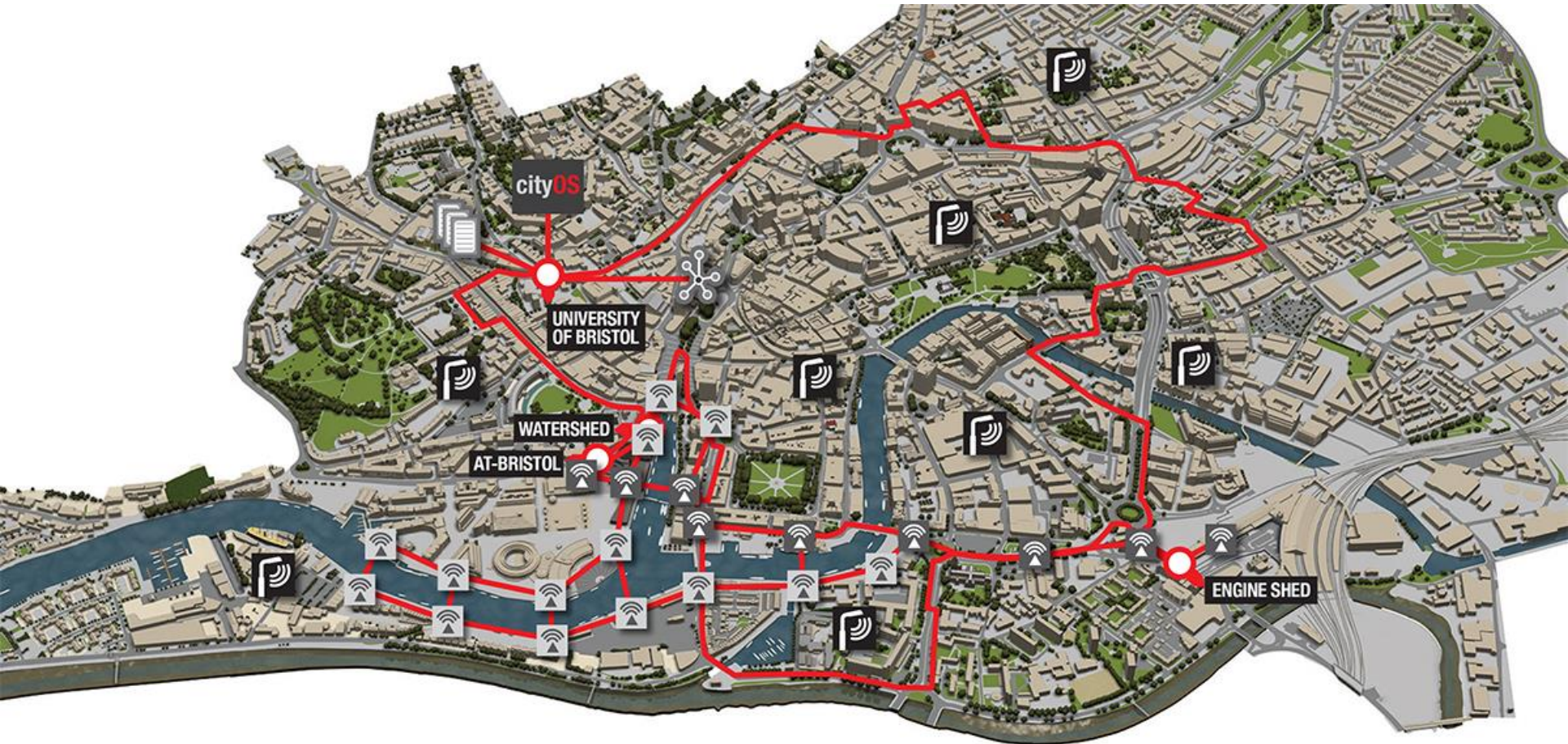

ACTIVE NETWORK
— Fibre network
Core network nodes with accessible rack space
Network emulator
High performance computer
cityOS Software

WIRELESS NETWORK
Main hubs
'Sub-hubs'

MESH NETWORK
54 fibred lamp post clusters

Phase I, Bristol City Centre, live Q2 2015

ACTIVE NETWORK
- Fibre network
- Phase II Extension
- Core network nodes with accessible rack space
- cityOS Software
- Network Emulator
- High performance computer

WIRELESS NETWORK
- Main hubs
- 'Sub-hubs'

MESH NETWORK
- 54 fibred lamp post clusters

cityOS

UNIVERSITY OF BRISTOL

AT-BRISTOL

WATERSHED

SS GREAT BRITAIN

ENGINE SHED

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OPEN PROGRAMMABLE CITY REGION
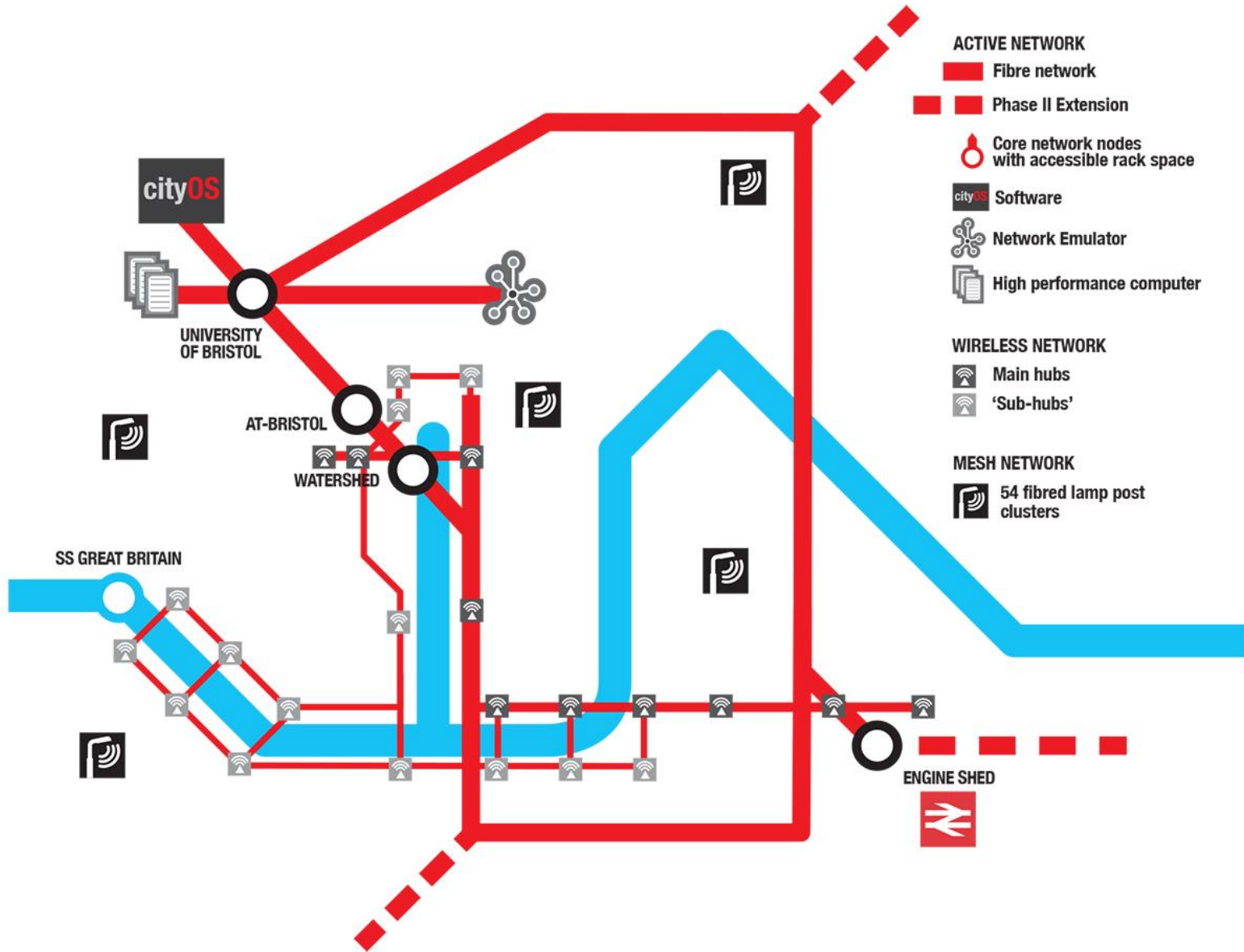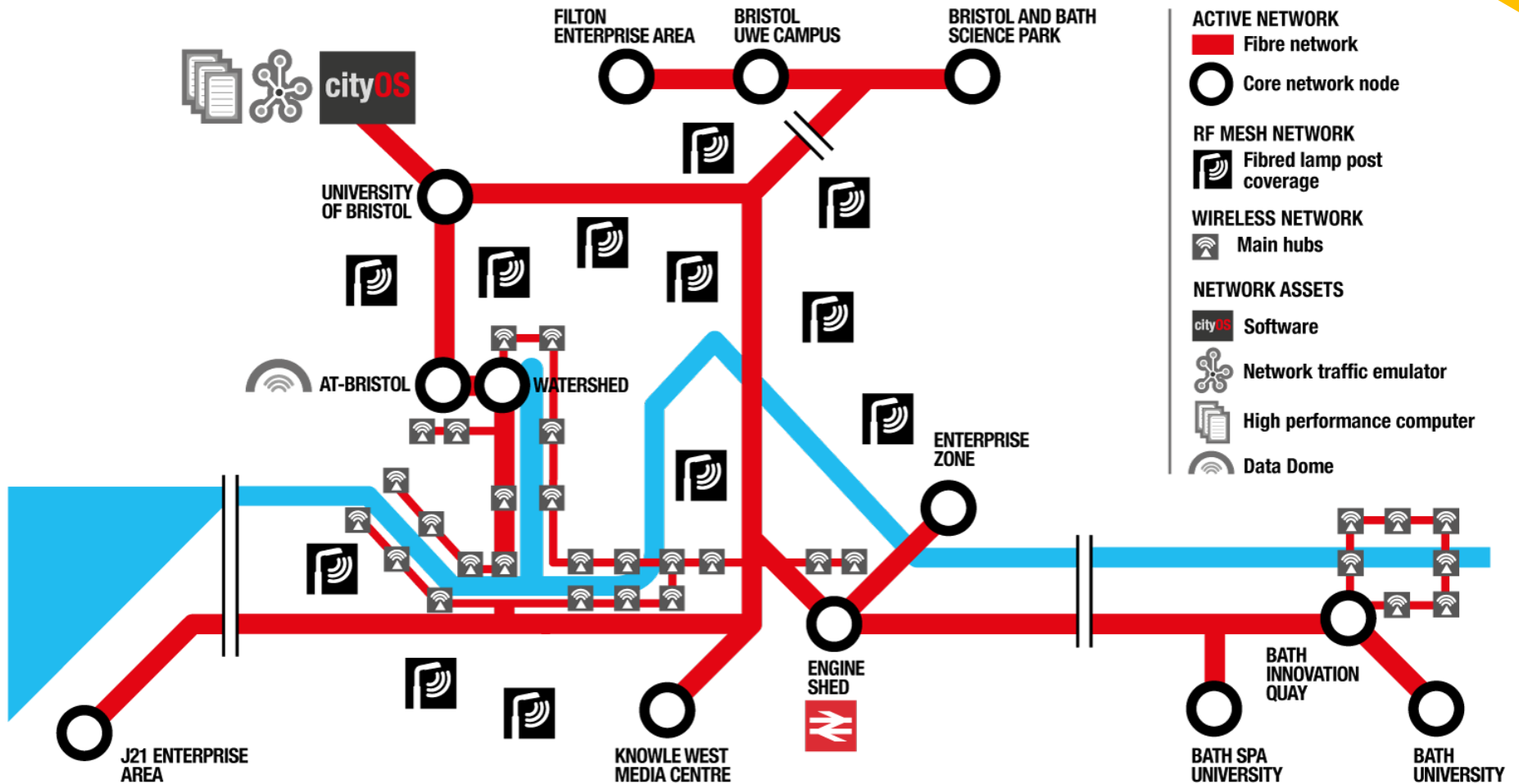
A CityOS: built from a Software Defined Network

OPEN DATA PLATFORM

**SOFTWARE DEFINED NETWORK
CITY OPERATING SYSTEM**

DATA PRE-PROCESSING SERVICES   srv1   srvN

PLATFORM VIRTUALIZATION/SLICING

INFORMATION MODELS

OpenStack, etc.

DATA COLLECTION ENGINE   sync   async

CITY NETWORK(S)   SDN controller

gw/drv gw/drv gw/drv gw/drv gw/drv gw/drv gw/drv gw/drv gw/drv

MULTIPLE SENSORS/PLATFORMS & HARDWARE

**CityOS
kernel**

**£15M
PUBLIC
RESEARCH
FUNDS**

Interoperable IoT platforms

IoT ASSETS

PARKING BAYS	CROWD DYNAMICS	POWER USAGE	NOISE COMPLAINTS	ANTI-SOCIAL BEHAVIOUR
SMART STREETLIGHTS	MET OFFICE	POLICE/CRIME DATA	LICENSING APPLICATIONS	PLANNING APPLICATIONS

DELIVERY METHODS

FTP   MQTT   HTTP   E-MAIL

DATA FORMATS AND SCHEMAS

XML   CSV   SenML   JSON
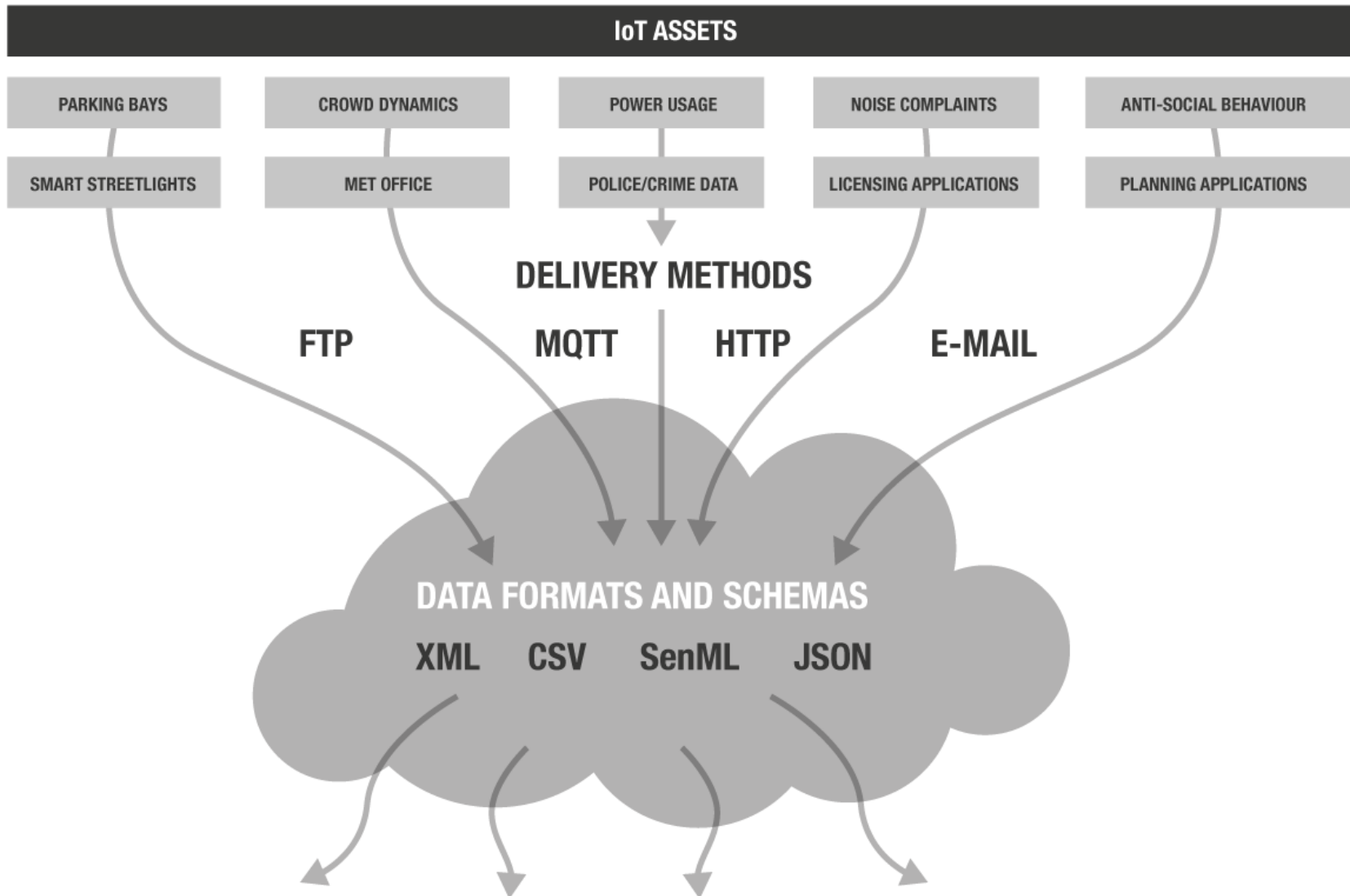
For Example - IoT-Bay Hub Architecture
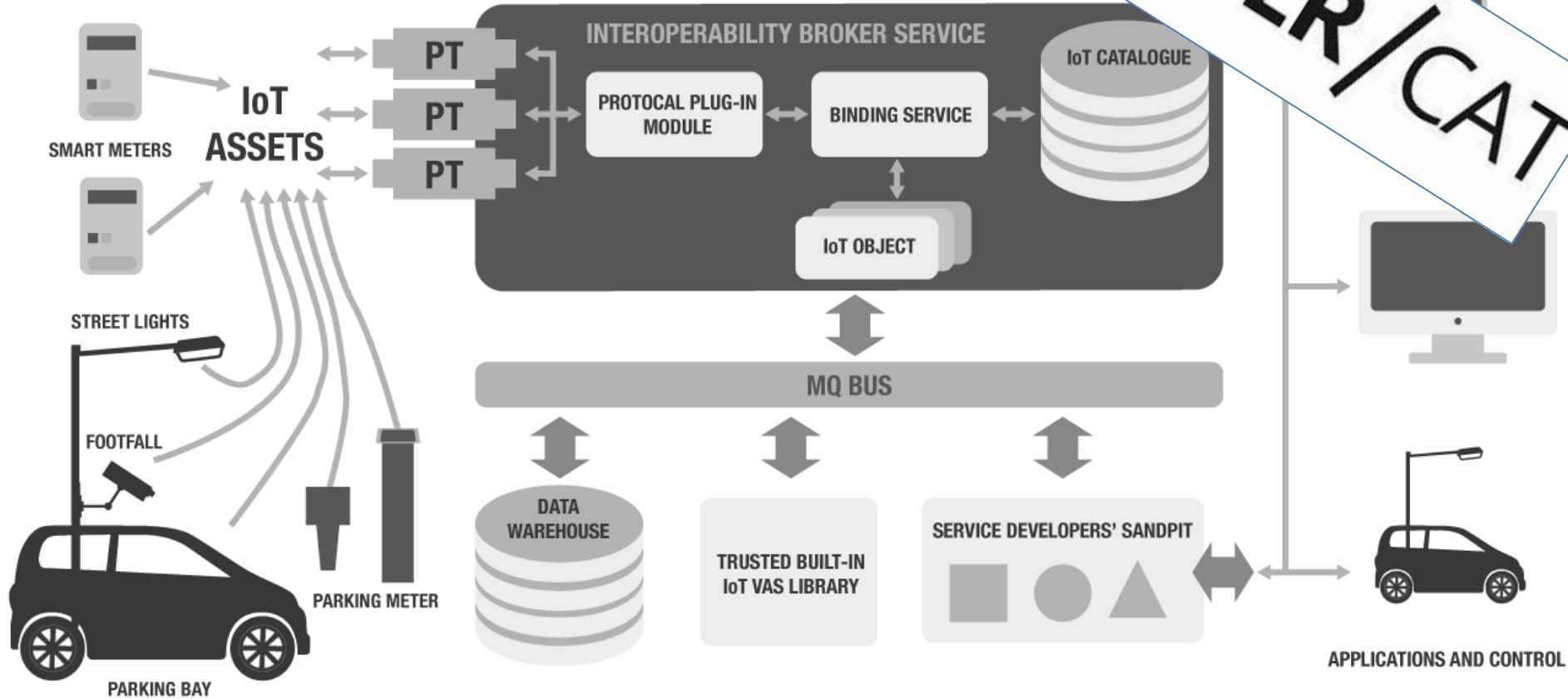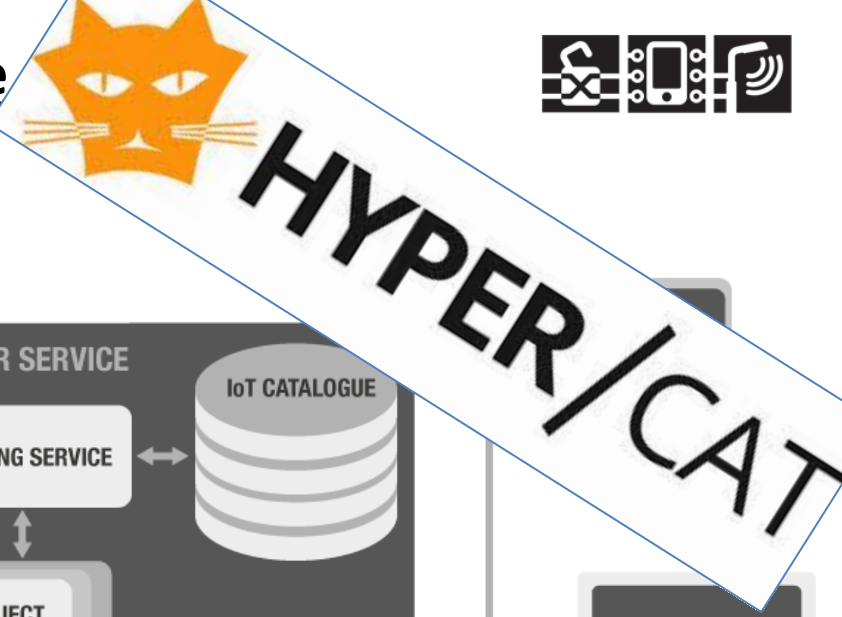
'I see Bristol as a laboratory for change'
Mayor George Ferguson

BIG DATA GENERATION

ASSISTED LIVING & SMART METERING
CCTV
DRIVERLESS CARS
FOUR NODE ACTIVE NETWORK
AT-BRISTOL 70,000 SCHOOL CHILDREN
ENERGY MANAGEMENT
54 FIBRED LAMPOST CLUSTERS
AIR QUALITY AND WEATHER
EXPERIENCE DESIGN & VISUALISATION WATERSHED
WIND TURBINE
OEM TESTING
RADAR EQUIPMENT
AMBULANCE STREAM BACK TO HOSPITAL
WIRELESS NETWORK
RADAR EQUIPMENT
ENGINE SHED CONNECTION SMEs
10 PORTABLE CITY LOCATIONS
DIFFERENT SENSORS
CITY CENTRE TO CITY REGION

SDN + IoT + Big Data Analytics = foundation for developing livable smart city applications
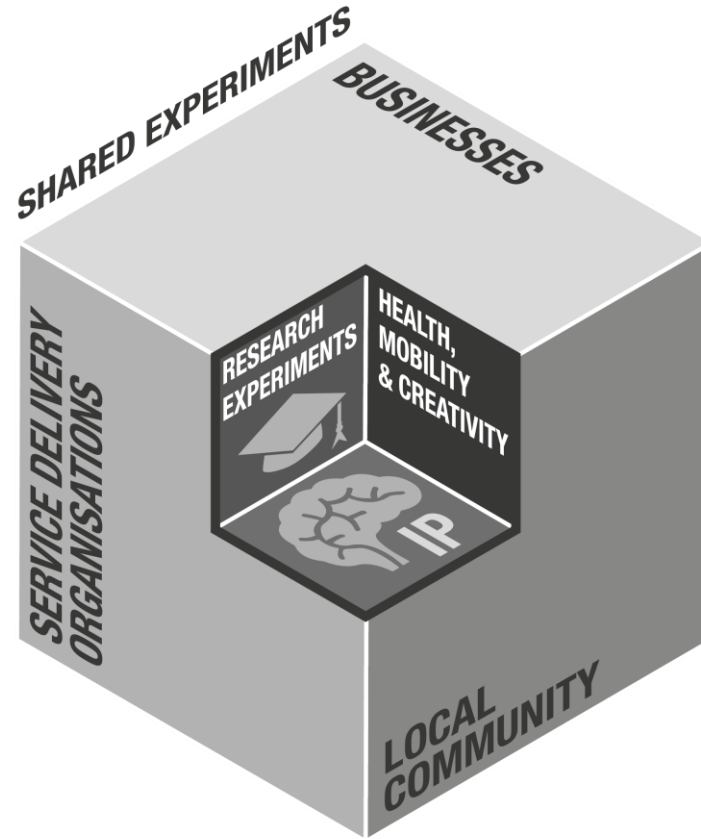
Co-production - local people, businesses, academics, and local government

SERVICE/APPLICATION MANAGER

OPEN DATA PLATFORM

BUSINESSES — ROAD TRAFFIC MANAGEMENT — IP — SERVICE DELIVERY ORGANISATIONS — LOCAL COMMUNITY

BUSINESSES — ASSISTED LIVING — IP — SERVICE DELIVERY ORGANISATIONS — LOCAL COMMUNITY

BUSINESSES — CREATIVE & CULTURAL CONTENT — IP — SERVICE DELIVERY ORGANISATIONS — LOCAL COMMUNITY
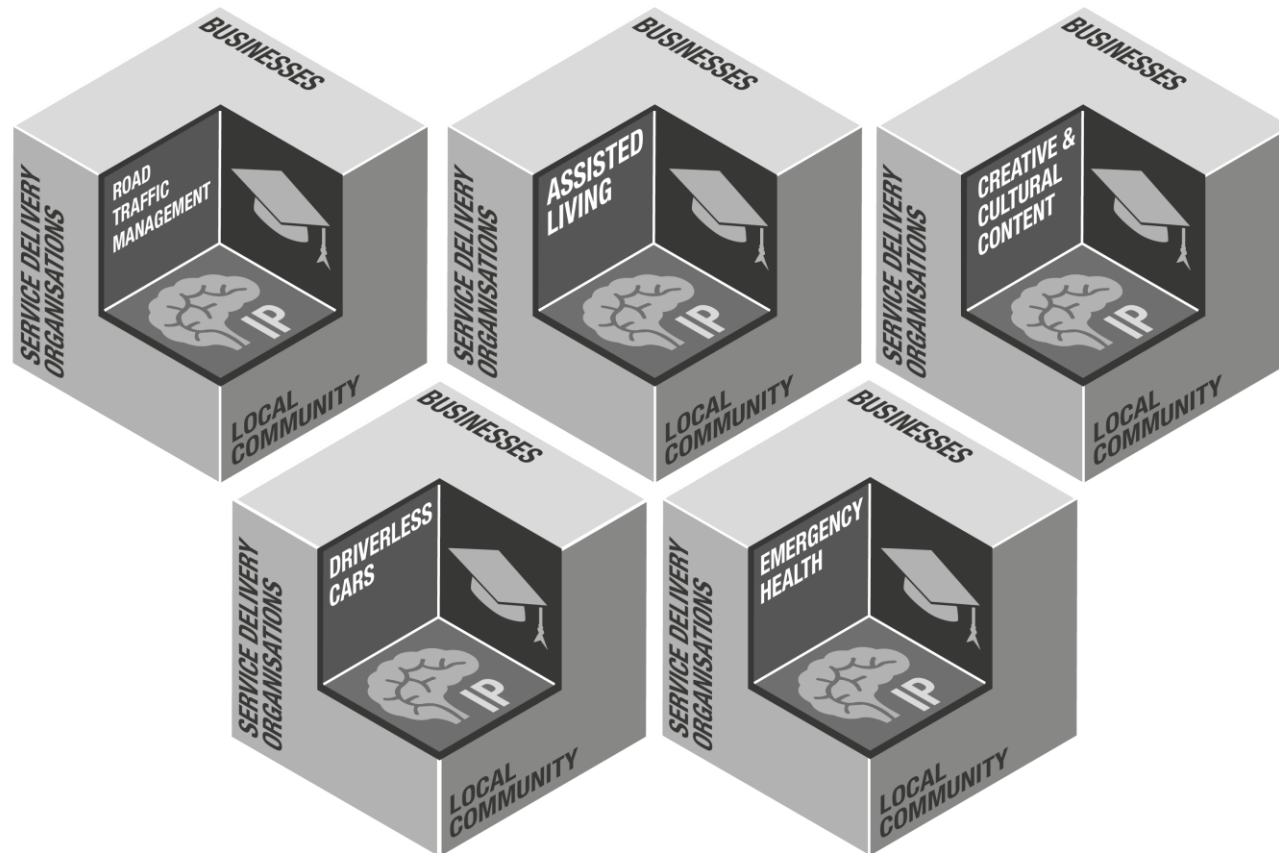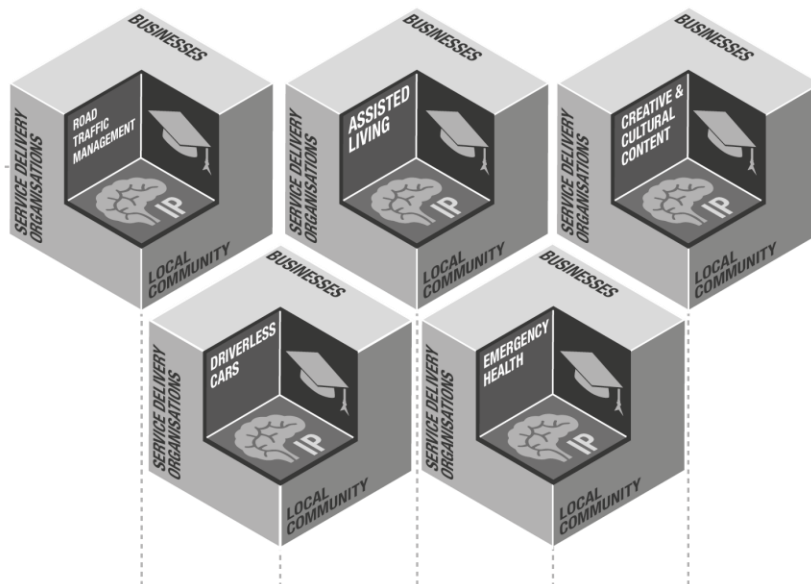
BUSINESSES — DRIVERLESS CARS — IP — SERVICE DELIVERY ORGANISATIONS — LOCAL COMMUNITY

BUSINESSES — EMERGENCY HEALTH — IP — SERVICE DELIVERY ORGANISATIONS — LOCAL COMMUNITY

PROPRIETARY EXPERIMENTS

SOFTWARE DEFINED NETWORK CITY OPERATING SYSTEM

PROPRIETARY NETWORK MANAGEMENT SYSTEM/OS

ICT INFRASTRUCTURE ASSETS

PROPRIETARY ICT INFRASTRUCTURE ASSETS

BLUE CRYSTAL 2 HIGH PERFORMANCE COMPUTER

NETWORK EMULATOR (90 SERVERS)

ASSISTED LIVING & SMART METERING

CCTV

DRIVERLESS CARS

FOUR NODE ACTIVE NETWORK

AT-BRISTOL 70,000 SCHOOL CHILDREN

ENERGY MANAGEMENT

54 FIBRED LAMPOST CLUSTERS

AIR QUALITY AND WEATHER

EXPERIENCE DESIGN & VISUALISATION WATERSHED

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ENGINE SHED CONNECTION SMEs

10 PORTABLE CITY LOCATIONS

DIFFERENT SENSORS

CITY CENTRE TO CITY REGION

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OPEN PROGRAMMABLE CITY REGION

£75m investment

£m	
DUCTING	11
NETWORK PHASE 1	4
NETWORK PHASE 2	14
SOFTWARE	6
SUPERCOMPUTER	3
NETWORK EMULATOR	2
HARDWARE/CAPITAL	40

RESEARCH FUNDS	£m
TOUCAN	15
NDFIS	10
PROBABLE	10
	35

£75M (~$125M)

How is it run?

JOINT VENTURE BOARD

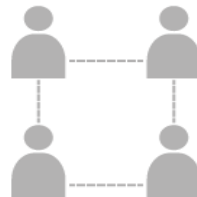| UNIVERSITY OF BRISTOL | BRISTOL CITY COUNCIL | NON-EXECUTIVES |

ADVISORY PANEL
LONG-TERM PARTNERS AND INVITED ATTENDEES

EVOLUTION OF NETWORK INFRASTRUCTURE & ASSETS (SITE BUILDS)

RESEARCH EXPERIMENTS

NETWORK SERVICES

COMMUNICATIONS

- WEBSITE
- PUBLICATIONS
- EVENTS AND CONFERENCES
- MEDIA and GOV'T AND RESEARCH RELATIONS

How to get involved

LONG-TERM PARTNERS

PLATINUM

GOLD

SILVER

EVOLUTION OF NETWORK INFRASTRUCTURE & ASSETS
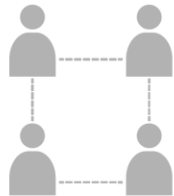
RESEARCH EXPERIMENTS

PROPRIETARY EXPERIMENTS

NETWORK SERVICES

COMMUNICATIONS

WEBSITE

EVENTS AND CONFERENCES

PUBLICATIONS

MEDIA, GOVERNMENT and RESEARCH RELATIONS

PROJECT PARTNERS

BRONZE

BESPOKE ACTIVITIES

ECO-SYSTEM PARTNERS

OXYGEN

SMEs

COMMUNITY ORGANISATIONS

INSTITUTES

LOCAL GOVERNMENTS

FOUNDATIONS

Interim management team

Dick Penny MBE is chair of Bristol Open Programmable City Region. He is managing director of Watershed Media Centre and Pervasive Media Studio, a collaboration with University of Bristol and University of West of England, which hosts a brilliant community of artists, creative companies, technologists and academics exploring experience design and creative technology.

Professor Dimitra Simeonidou is Technical Director of Bristol Open Programmable City Region and Professor of High Performance Networks, University of Bristol. She is one of Europe's leading High Performance Network academics with considerable research funding from both the European Union and the UK Government. Dimitra has extensively contributed to the development of the OpenFlow standard which enables Software Defined Optical Networking.

Paul Wilson is Director of Bristol Open Programmable City Region. He joined from the West of England Local Enterprise Partnership, where he developed a Strategic Economic Plan for the City-region that attracted Government funding of £86m. Prior to this Paul was Chief Marketing Officer of SunGard Financial Systems, a $5bn Fortune 500 technology company.

Professor Joe McGeehan CBE is Emeritus professor at University of Bristol and a Board member of the West of England Local Enterprise Partnership. Previously held the posts of Director of the Centre for Communications Research, University of Bristol and Managing Director of Toshiba's Telecommunications Research Laboratory In 2004 he was listed as one of the world's top technology agenda setters by silicon.com (USA).

Stephen Hilton is Director of Futures Group, Bristol City Council. Bristol Futures brings together Economic, Green, Digital & International teams into a single council unit to ensure that Bristol and the surrounding area benefits from a world-class, inclusive green and digital economy. Stephen passionately believes that wide scale digital literacy can create a fairer, more inclusive, more participative society.

Professor Nishan Canagarajah is Pro-Vice Chancellor - Research, University of Bristol. He is widely published and his research interests include image and video coding, multi-view video compression and synthesis, information fusion, content-based retrieval and the application of signal processing to audio and medical electronics. Nishan's research contributions in image segmentation, texture classification and content-based video compression are internationally recognised

Conclusion

- Five mega-trends shaping the next decade
- Our response: A £75m City-scale test-bed; SDN + IoT + Big Data
- Working together
  - academics
  - business
  - service delivery and
  - community organisations
- An Open Software Defined Network
- A first - 'open programmable city-region'
- With you involved?

Use cases

TMT
businesses
& academia

_____

Culture &
creative
content

_____

People,
community,
service delivery

_____

Better
city
management

Open Programmable City Region

Paul Wilson

Interim Managing Director

@bristolisopen

@__paulwilson