Ten Unsolved Problems
with the Internet of Things

Rae Earnshaw, Mohan de Silva, Peter Excell

Overview

- Growth of the Internet of Things

- Increasing pervasiveness

- Unsolved problems

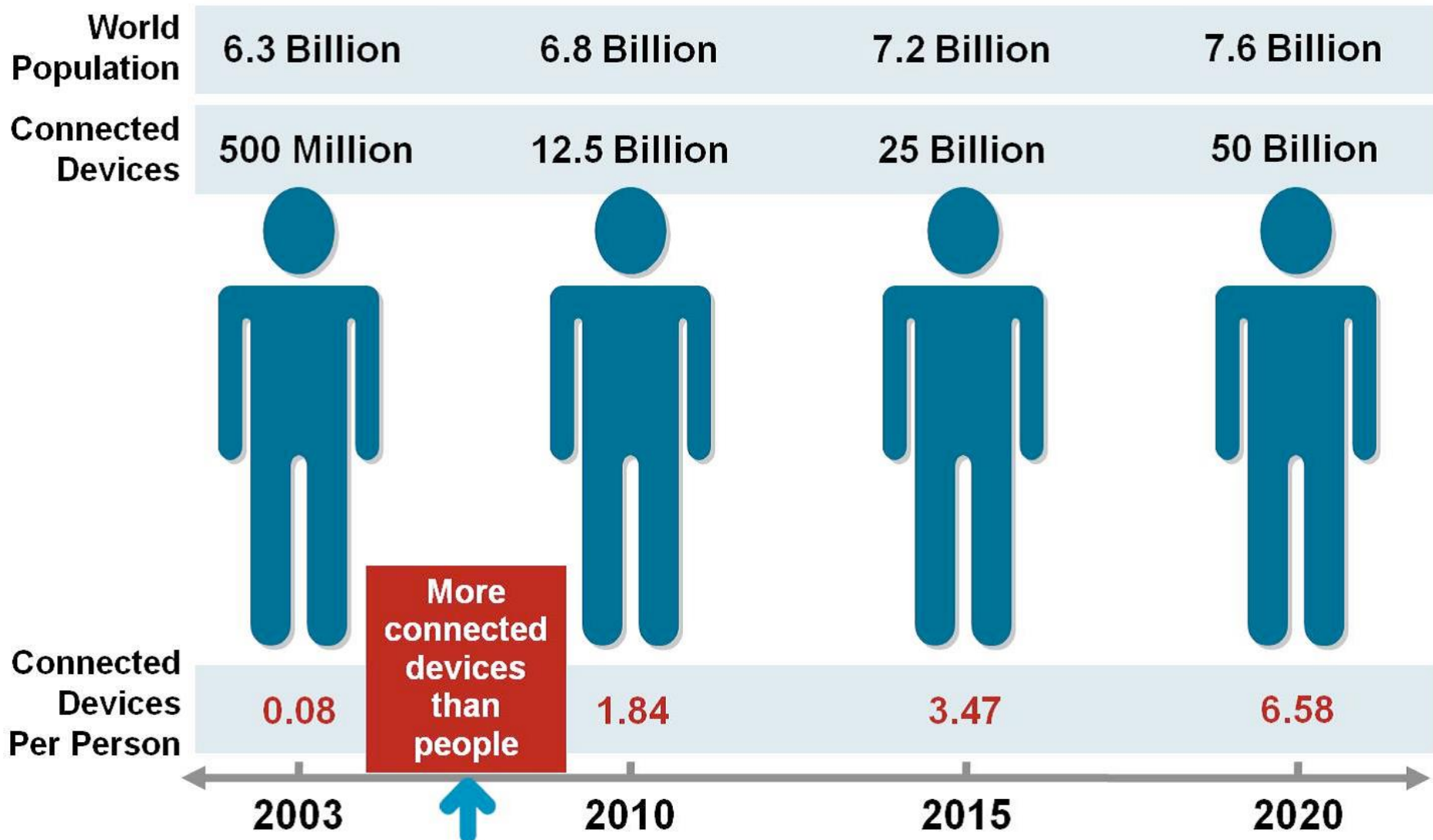- Project funded by Innovate UK

- Conclusions

- *"Any fact becomes important when it's connected to another."* Umberto Eco
- *"Everything is a sensor for everything else".* David Weinberger, Senior Researcher, Harvard Berkman Center for Internet and Society

Predicted growth

- It is estimated that there will be over 26 billion devices connected to the Internet by 2020
- Which will deliver $9 trillion annual sales and $2 billion global economic added value
- Embedding of connectivity can expand via –
  - a variety of devices in the foreground
  - invisible monitoring in the environment
  - or somewhere in-between, and a combination of the two

World population and connected devices

Source: Cisco IBSG: April 2011

	2003	2010	2015	2020
World Population	6.3 Billion	6.8 Billion	7.2 Billion	7.6 Billion
Connected Devices	500 Million	12.5 Billion	25 Billion	50 Billion
Connected Devices Per Person	0.08	1.84	3.47	6.58

More connected devices than people

Connections are becoming increasingly more pervasive in the Internet of Things

Growth in connections generates an unparalleled scale of data

Billions Connections
Millions
Thousands
Hundreds
Tens

Machine-to-Machine

Smart Homes
Connected Cars
Intelligent Buildings
Intelligent Transportation Systems
Smart Meters and Grids
Smart Retailing
Smart Enterprise Management

Sensors
Devices
Systems
Things
Processes
People
Industries
Products
Services

Internet of Things

Building automation Manufacturing Security Utilities

telemetry and telematics

Monitored

Remotely controlled and managed

Smart Systems (Intelligence in the Subnets of Things)

Isolated
(autonomous, disconnected)

Machina Research

Internet of Things

4

Unsolved Problems - 1

- Online devices that can have disruptive effects
- Data privacy and invasion of personal spaces
- Extracting validated meaning from big data
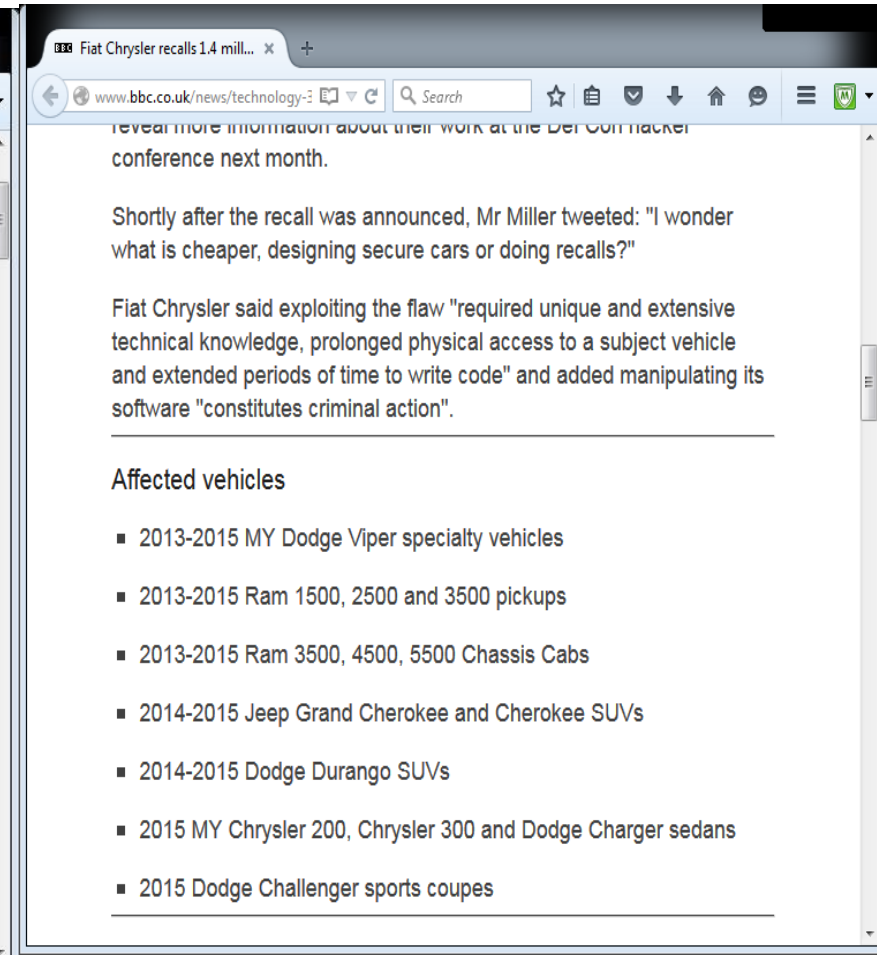- Security and safety against internal and external breaches

Security breaches
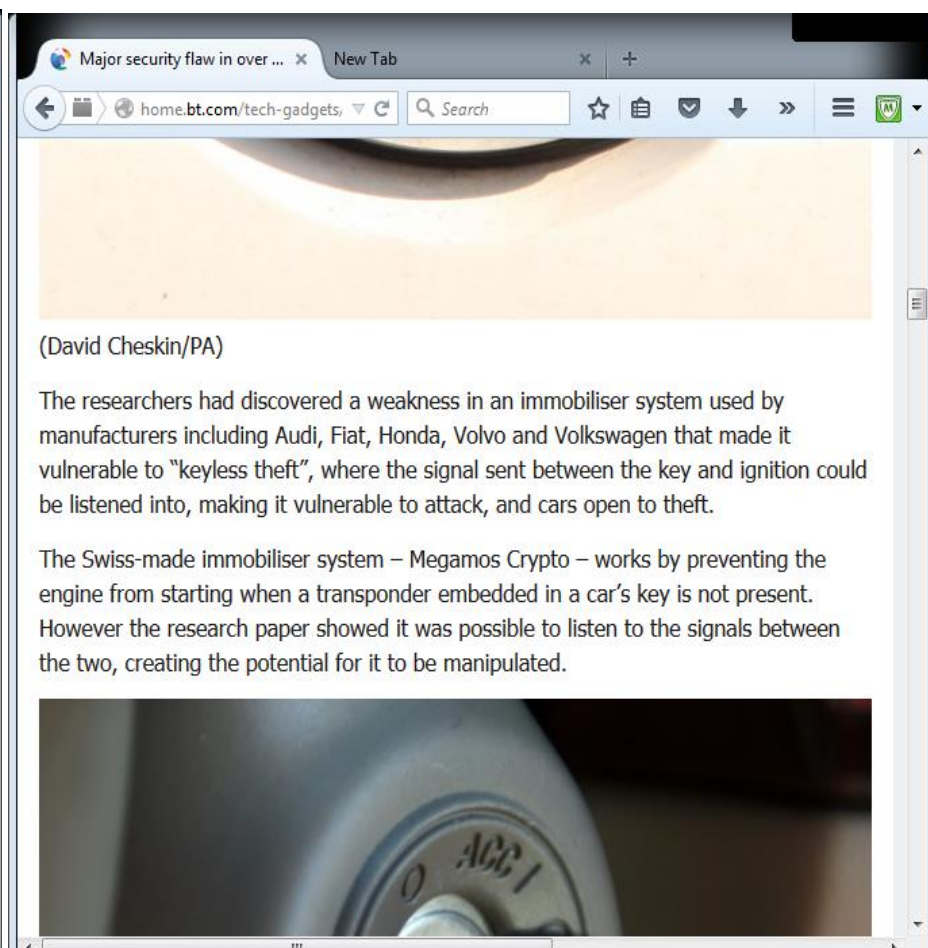## via car's Internet-connected entertainment system
July 2015

http://www.bbc.co.uk/news/technology-33650491

BBC Fiat Chrysler recalls 1.4 mill... ×

www.bbc.co.uk/news/technology-3

Fiat Chrysler recalls 1.4 million cars after Jeep hack

24 July 2015 | Technology

BBC Fiat Chrysler recalls 1.4 mill... ×

www.bbc.co.uk/news/technology-3

reveal more information about their work at the Def Con hacker conference next month.

Shortly after the recall was announced, Mr Miller tweeted: "I wonder what is cheaper, designing secure cars or doing recalls?"

Fiat Chrysler said exploiting the flaw "required unique and extensive technical knowledge, prolonged physical access to a subject vehicle and extended periods of time to write code" and added manipulating its software "constitutes criminal action".

Affected vehicles

- 2013-2015 MY Dodge Viper specialty vehicles
- 2013-2015 Ram 1500, 2500 and 3500 pickups
- 2013-2015 Ram 3500, 4500, 5500 Chassis Cabs
- 2014-2015 Jeep Grand Cherokee and Cherokee SUVs
- 2014-2015 Dodge Durango SUVs
- 2015 MY Chrysler 200, Chrysler 300 and Dodge Charger sedans
- 2015 Dodge Challenger sports coupes

Security flaws may be suppressed

Major security flaw in over 100 car models revealed by scientists

Researchers uncovered a flaw in an immobiliser system that left it open to attack, but have been prevented from publishing for two years.

Comments 101

43

(David Cheskin/PA)

The researchers had discovered a weakness in an immobiliser system used by manufacturers including Audi, Fiat, Honda, Volvo and Volkswagen that made it vulnerable to "keyless theft", where the signal sent between the key and ignition could be listened into, making it vulnerable to attack, and cars open to theft.

The Swiss-made immobiliser system – Megamos Crypto – works by preventing the engine from starting when a transponder embedded in a car's key is not present. However the research paper showed it was possible to listen to the signals between the two, creating the potential for it to be manipulated.

Smart Devices Circle of Trust

Who are we comfortable sharing personal data from smart devices with?

TRUST

63% Spouse/Significant Other

41% Close Friends

40% Health Professionals

30% Police

28% Insurance Companies

26% Boss

22% Supermarkets

20% Energy Companies

14% Ad Companies

14% Government
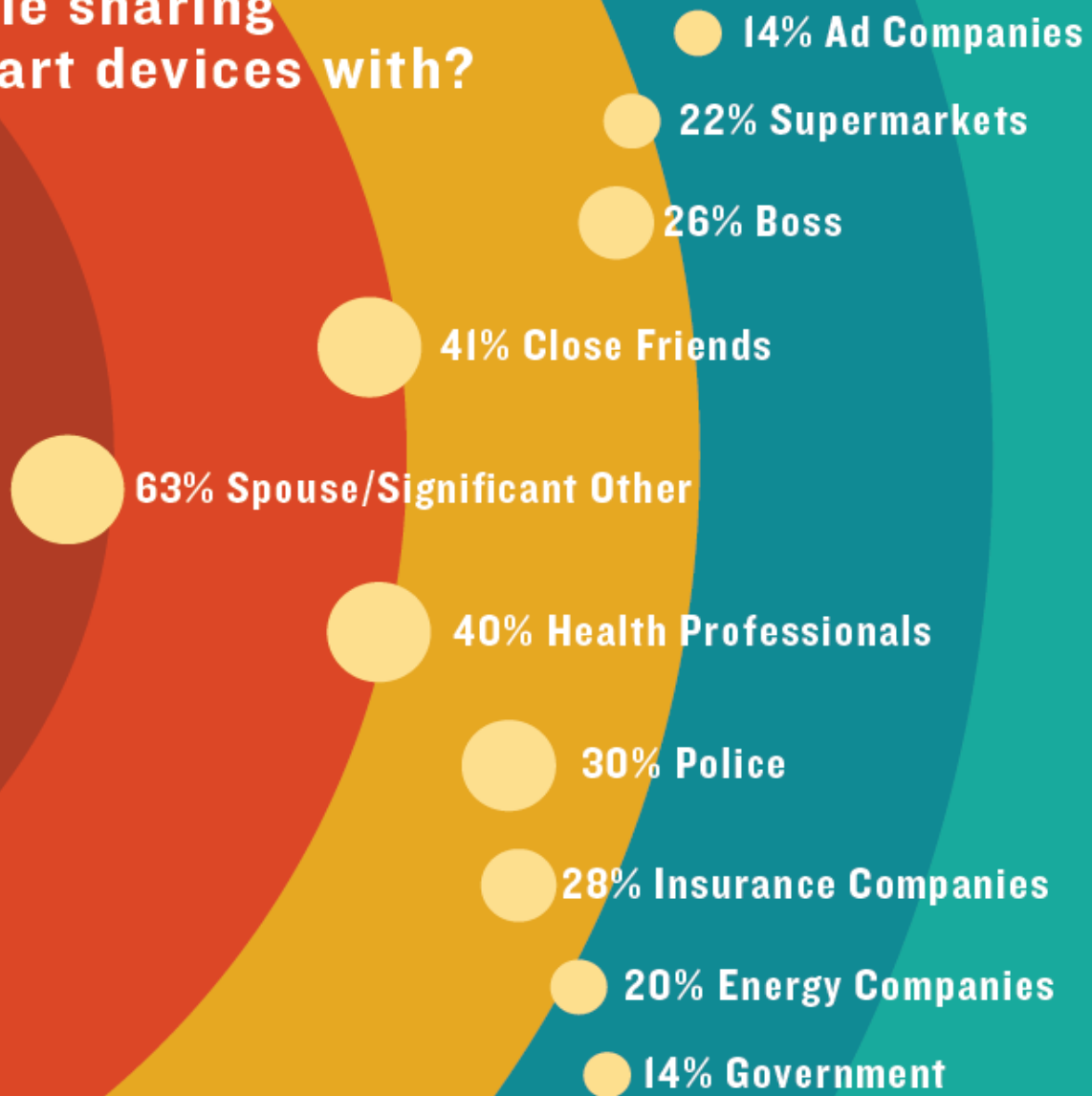
TRUSTe PRIVACY INDEX

2015 INTERNET OF THINGS EDITION

SMART DEVICE OWNERSHIP

35% own at least one smart device other than a phone

Which smart devices are most popular?

20%
Smart TV

12%
In-Car Navigation System

5%
Fitness Tracker

4%
Home Alarm System

2%
Smart Watch

1%
Smart Fridge or other Home Appliance
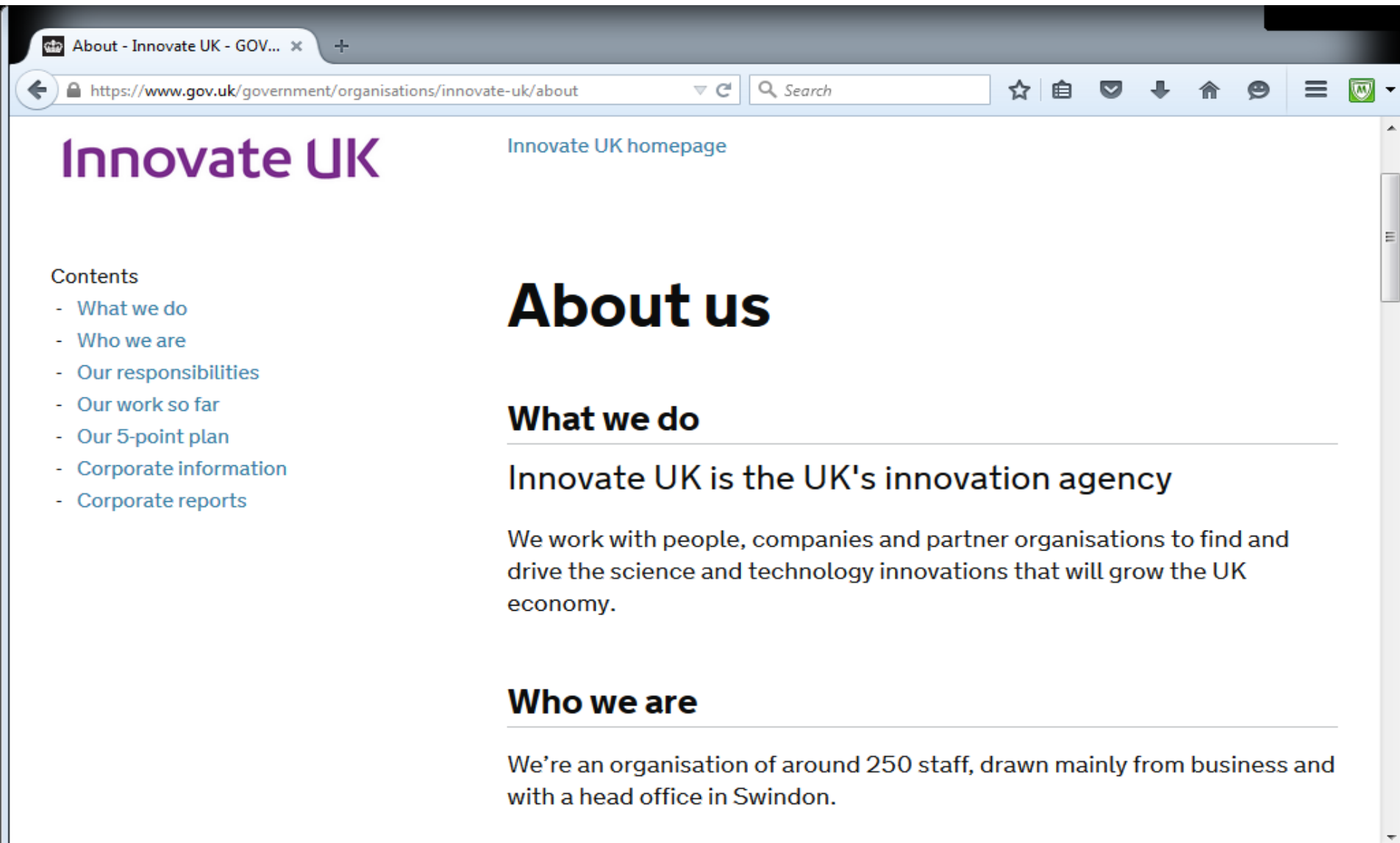
Surveys of user concerns

- Surveys reveal that 59% of US internet users and 47% of UK internet users know that smart devices can collect data about their personal activities without their knowledge (e.g. smart TVs, fitness devices, and in-car navigation systems)

- 85% of US internet users and 83% of UK internet users want to know more about data being collected before using smart devices

- Additionally, 88% of US internet users and 87% of UK internet users would want to control the data that was being collected by smart devices

- http://www.truste.com/blog/2014/05/29/internet-of-things-industry-brings-data-explosion-but-growth-could-be-impacted-by-consumer-privacy-concerns/

Unsolved Problems - 2

- Standardisation (IoT-GSI Global Standards Initiative)
- Interoperability across systems
- Unseen programs loaded into devices
- Granularity of building blocks
- Latency issues and bandwidth limitations
- Trust management and governance

Project funded by Innovate UK
(formerly UK Technology Strategy Board)

Proposal – Pro forma sections

- Business proposition
- Project details
- Project management
- Exploitable outcomes
- Economic impacts
- Key risks
- Funding and added value

10 sections – 10 points each; 5 reviewers; total divided by 5 and total put in a list.

Score for each section has to be justified by comments of the reviewer. All 5 reviews and scores are returned to the proposer.

Funding is allocated to the list in rank order.

The Project

Companies based on Business and Industrial parks in the UK collaborated using smart devices to –

- Create business opportunities
- Share assets not currently being used
- Retain and fully utilize staff between companies
- Identify potential partnerships between businesses that have a mutual benefit

Resulted in –

- Reduction in costs
- Reduction in carbon footprint by 50%

The Business Proposition

Mobile based technology platform to enable –

- Businesses based on business and industrial parks (BAIP`s) in the UK to collaborate on a local and national level, share resources, improve efficiency and effectiveness in resource allocation and work practice, work together to share costs and help reduce costs, generate business opportunities, sustain existing jobs and create new jobs, create partnerships and improve profit margins

- Currently there are no solutions that actively seek to encourage collaboration between businesses on business and industrial parks in the UK

Business and Industrial Parks

Industrial Unit in the Park
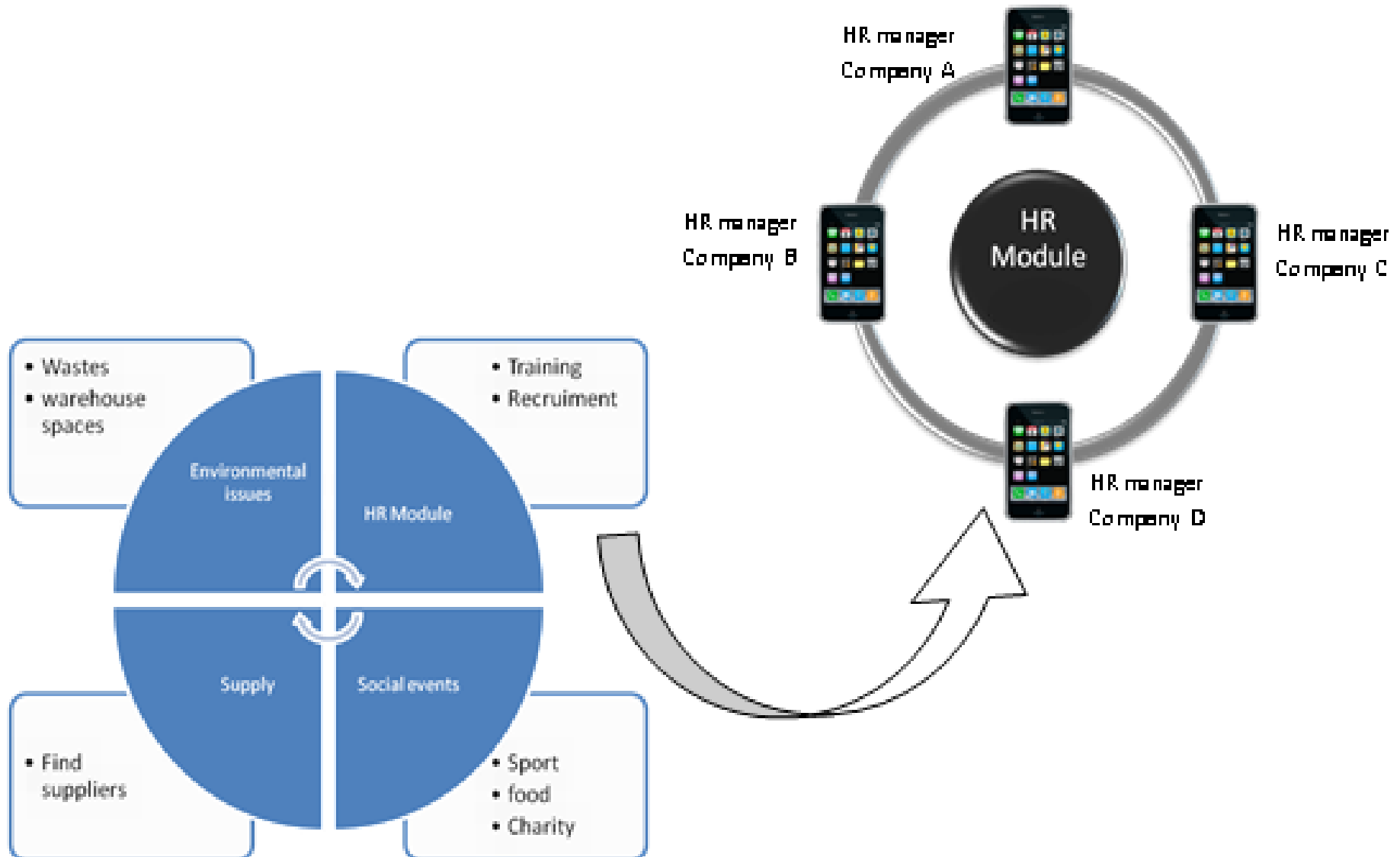## (Businesses vary in size from 4 to >50 people)

Industrial Units in the Park

Matching needs to resources

- Based on the needs survey - users recognised the need/importance of sharing and collaborations

- More likely to proceed when they can relate their own operations to it, whether being from supply side or demand side.

- The key is to match the 'demand' with 'supply'

- Example - assisting greater collaboration within businesses from the aspect of Human Resource (HR) function

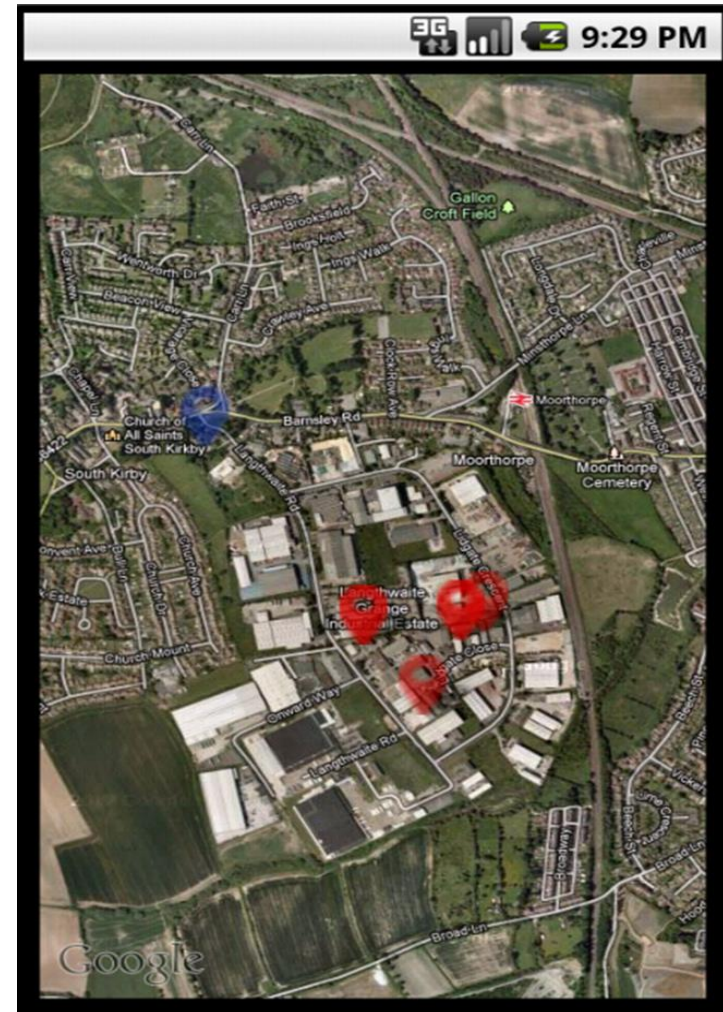# Application Model – An Example on Human Resource Sharing
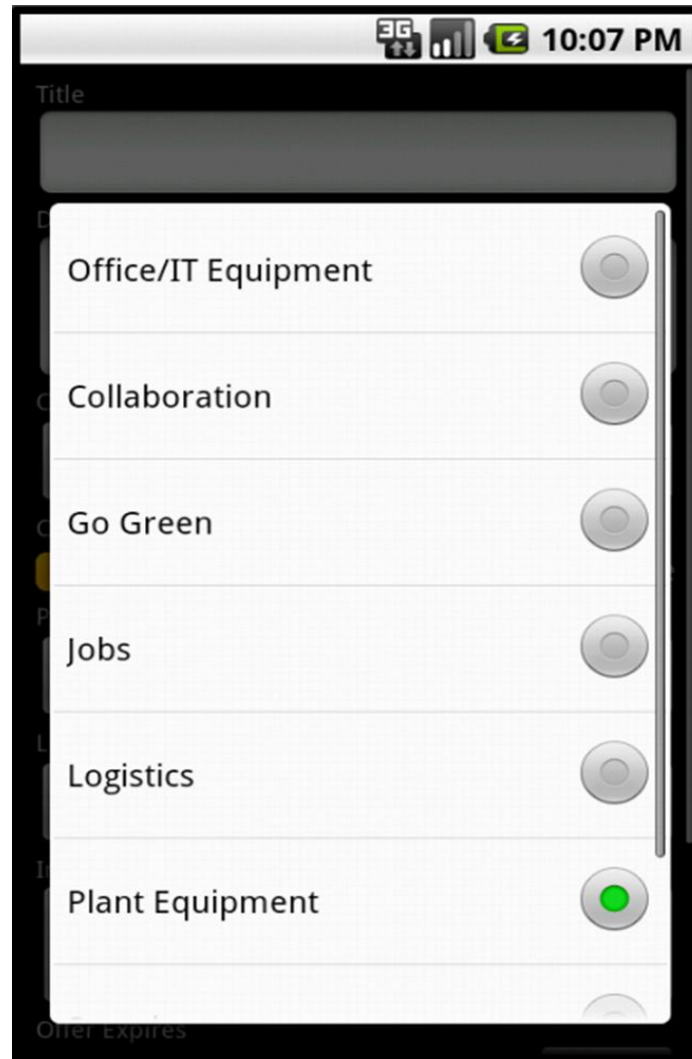
Available Resources and their Locations

Top Line Menu

KPIs

Developer	Users	Community
Number of downloads	Time saved/ delay caused	Reduction in crime rate
Level of usage of each service	Costs saved	Increase employment
Number of users under each price range (e.g. free ~ premium account)	Number of employees registered/ downloaded	Enhanced reputation/image of BAIPs using the technology
Frequency of usage from users	Frequency of usage	Increase BAIPs' occupancy
Number of views on categories of services/items shared	Number of transactions with third parties	Enhanced image of the local community
Duration of visit	Number of inter-company transactions	Increase in local & regional trade
Rate of increase in new users/accounts	Duration taken to reach deals	Increase in local & regional investment
Number & frequency of reported fault	Percentage of reduction in carbon footprint	Percentage of reduction in regional carbon footprint
Time taken to respond to and rectify a fault	Percentage of increase in conducting businesses at local & regional level	Percentage of reduction in business waste
Frequency of 'app' update	Percentage of waste reduction	Increased use of recycled resources
Site traffic	Percentage of increase in operational capacity/efficiency	Increase in number of business networking events
Frenquency of system down time	Increase in customer base/sales	Increase in knowledge sharing
Duration of system down time	Increase in supplier networks	Increase in number of social/community events
Capacity, e.g. threshold of traffic before system failure	Employee sense of social and community belonging	Stronger sense of community belonging

Conclusions

- Potential for connected businesses to deliver a greater overall rate of return on external investment

- Continuing concerns about data, security, trust, and privacy

- Degree of interconnectedness of devices, systems, and users

- Machine to machine communications (M2M) need to be reliable and trustworthy, as this is currently expected to be an area of significant expansion

End

These slides are at –

https://sites.google.com/site/raearnshaw/presentations