IoT: City-wide networks
October 2, 2014

Vast Numbers of Connections Expected

IoT

Increasing attached

Average throughput 10,000-100,000 x lower

Queries from internet could exceed messages from UE

devices per customer could be millions

Smart Phone

M2M

MBB

Increasing throughput

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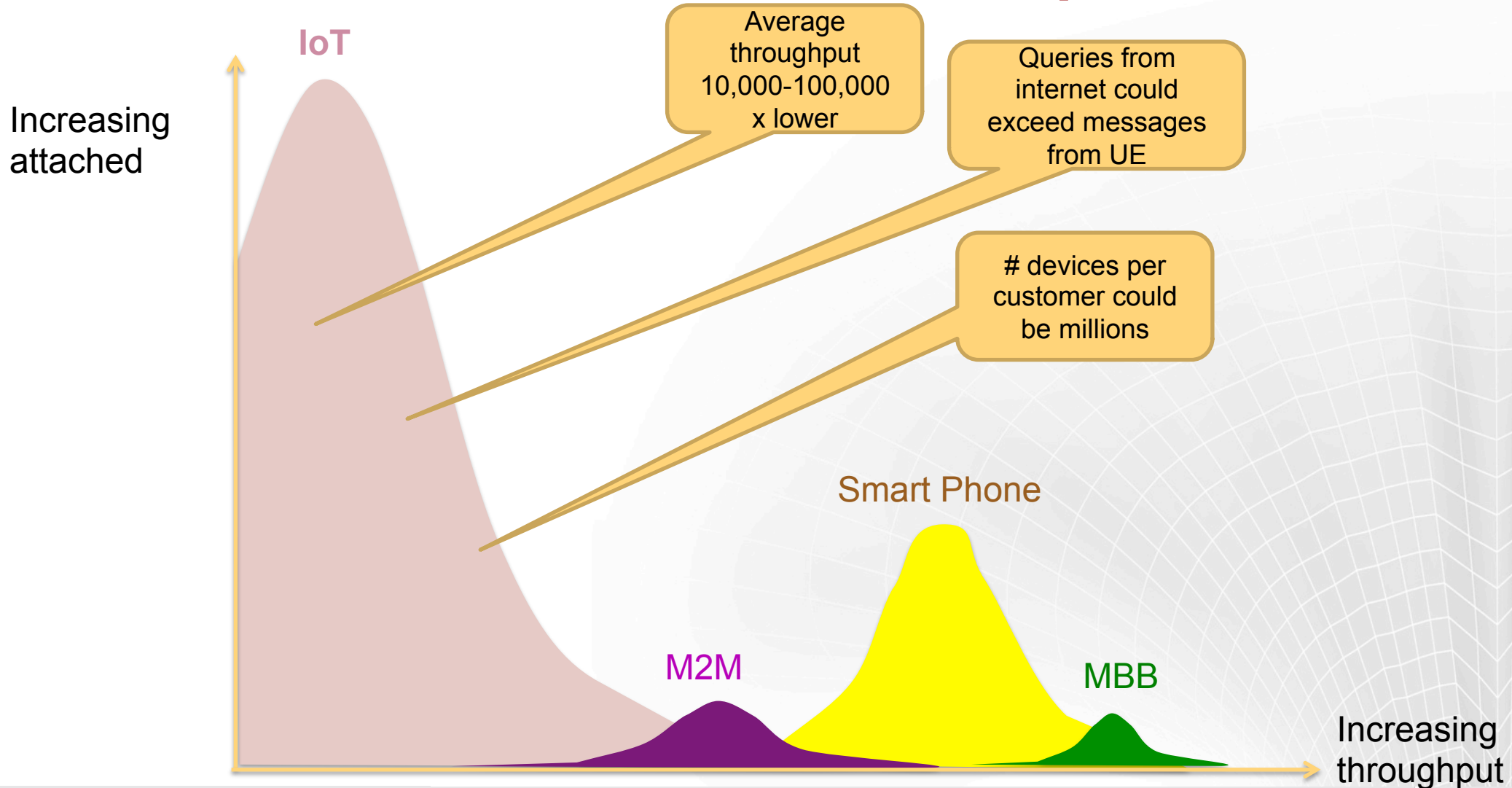
What type of Things will be connected?

- **Anything with current going through it**

- **And a lot of things that don't, today**

Literally, almost anything and anyone!

What's needed: WAN 'Internet of Things' air interface

1. System scaleable to billions of devices

2. Very long battery lives: cost of truck rolls >> modules

3. Ultra-cheap user equipment (UE)

4. Longer reach than today's cellular

5. Strong and uniform security

6. Works globally in harmonized spectrum

7. Easy access through cloud-based APIs

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Two approaches to achieving this

1. **MNOs deploy in cellular spectrum**
   › Licensed use, no other interferers
   › Use existing RAN infrastructure
   › Higher permitted power
   › Heavy standardization process

2. **Fixed line or private operators deploy in license-exempt spectrum**
   › Shared use of spectrum
   › Requires new basestations/backhaul
   › Lower permitted power
   › Duty cycle restrictions
   › Quicker standardization process

Much of the technology can be common and both approaches have a place in the market
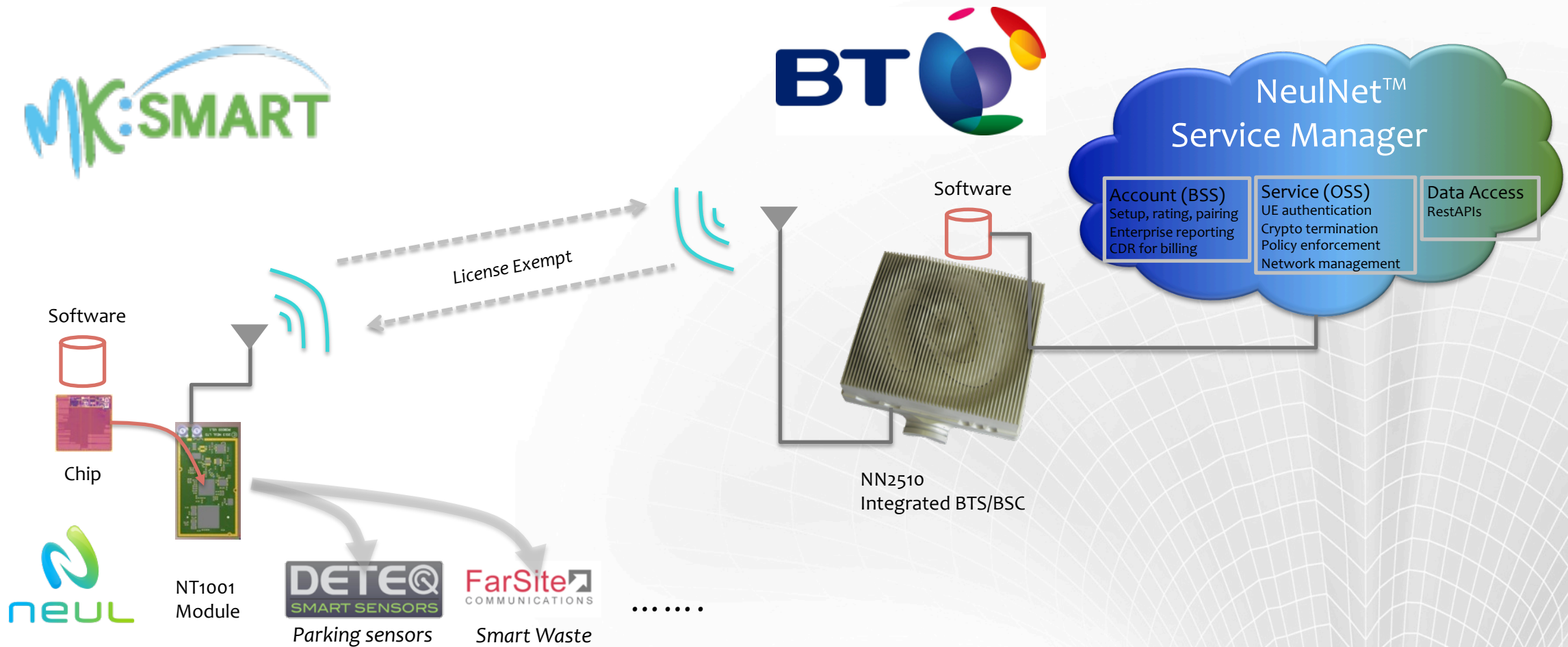
Milton Keynes: City-wide IoT

Objective is to spur economic growth

License-exempt wide area network for IoT

Rory Cellan-Jones for BBC World at One

License-exempt City-Wide Low Power WAN network

Software

Chip

NT1001 Module

Parking sensors

Smart Waste

....

License Exempt

Software

NN2510 Integrated BTS/BSC

NeulNet™ Service Manager

Account (BSS)	Service (OSS)	Data Access
Setup, rating, pairing Enterprise reporting CDR for billing	UE authentication Crypto termination Policy enforcement Network management	RestAPIs

Module Costs approaching $3 (1Mu 2016)

	2013 Final Module	2016 Final Module (est)
GPRS	$8.19	$5.00
LTE-MTC	$14.60	$9.00

Total eBOM below $2

18mm

11mm

Module sales price ~ $3.28 (excl SEP%)
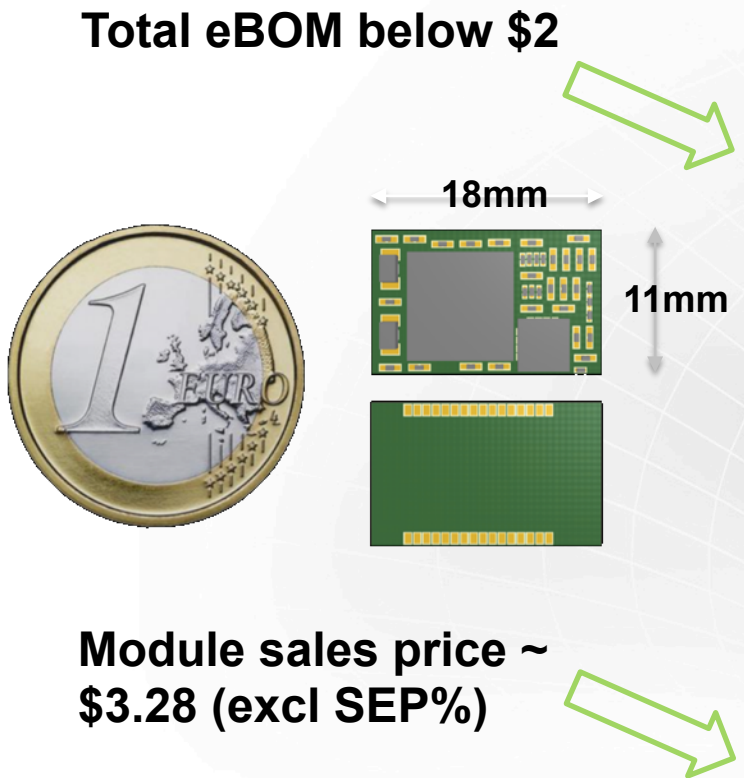
eBOM	2016 Estimates
Boudica single chip RF/BB/security	$0.90
PA/switch module	$0.40
26MHz XO	$0.18
32kHz XO	$0.11
RF filter	$0.14
Other discretes	$0.20
Total eBOM	**$1.93**
Mechanical, Assembly & Test	
PCB (4 layer FR4, 175mm2)	$0.13
Shield	$0.04
Assembly	$0.40
Test	$0.10
Yield loss (2%)	$0.05
Packaging/labelling	$0.10
Total ex-works cost	**$2.75**
OEM value-added	
Freight (shipped)	$0.14
Allowance for swap/RMA (2%)	$0.06
OEM margin (10%)	$0.33
Total expense to MNO or channel	**$3.28**

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Modules approaching 20 years service lives on 50¢ batteries

Coverage enhancement vs. GSM	Battery life for 2500 mAH x 3.7V capacity Report = 100 bytes uplink, 20 bytes downlink		
	6 reports/hour	1 report/hour	1 report/day
0 dB	6.7 years	> 20 years	> 20 years
0 – 10 dB	3.0 years	14.7 years	> 20 years
10 – 20 dB	0.4 years	2.3 years	> 20 years

eg
parking
sensor

eg
gas or
electric
meter

eg
fire alarm
or water
meter

GSM coverage

GSM coverage + 10dB

GSM coverage + 20dB

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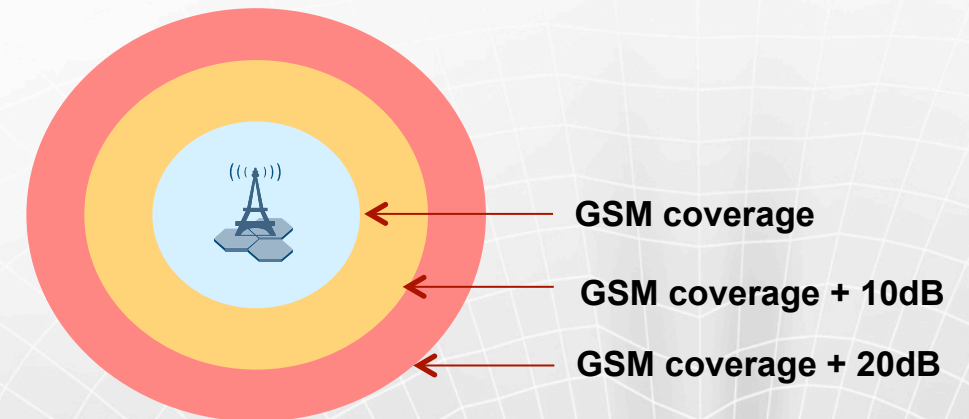
Dev kit for applications

Web-based configuration tool
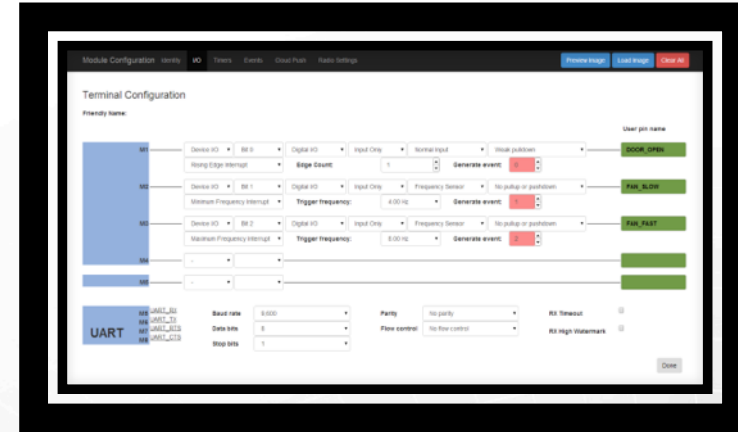
Stubby antenna

NT1001 UE Module

Raspberry Pi cable

Motherboard

2xAA batteries

Example sensor

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Initial Applications

Communal waste management

Pest control management

Future applications
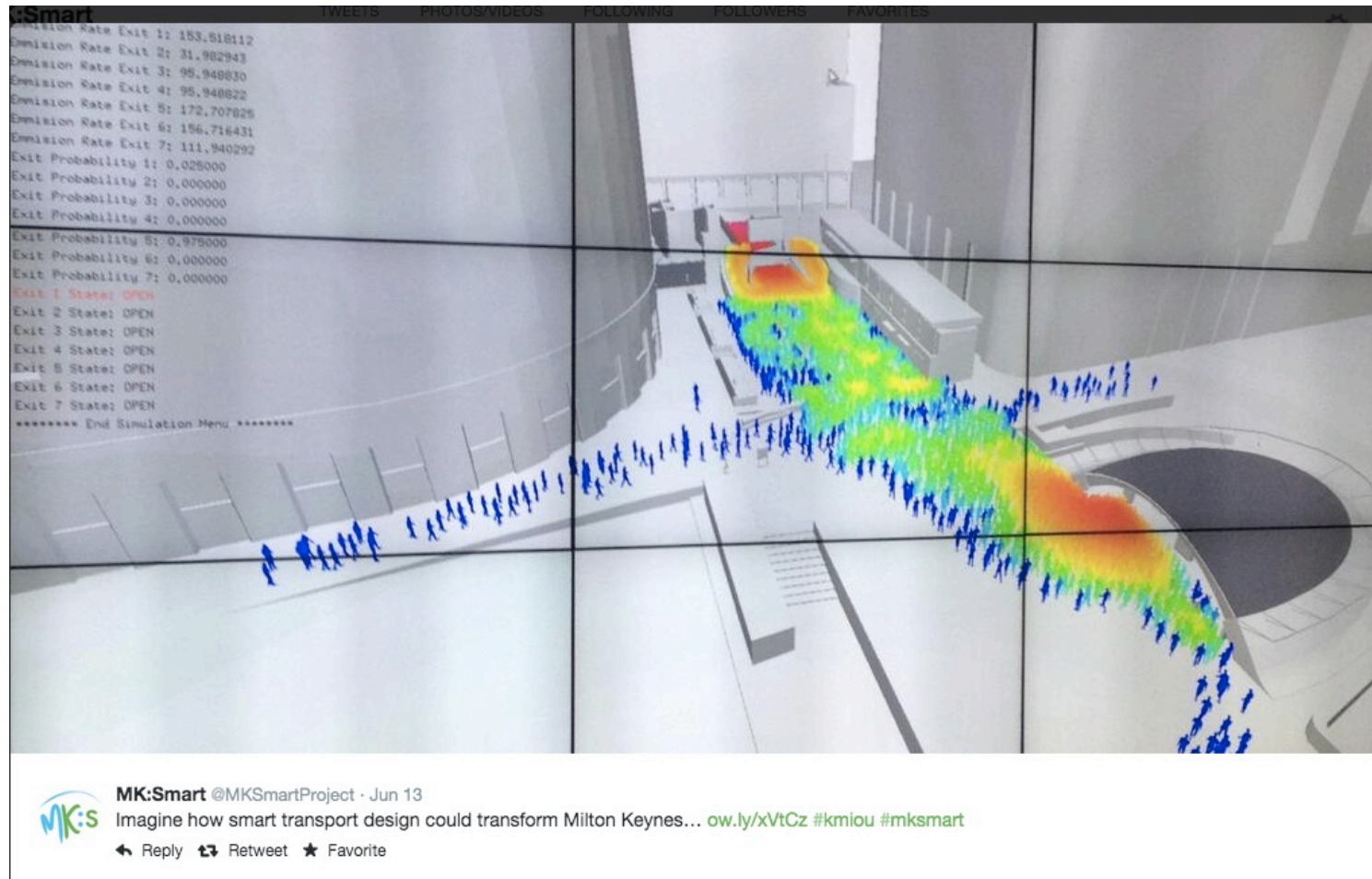
Traffic management
Parking
Smart Grid
Metering
Buildings HVAC
Buildings security
Asset tracking
Healthcare
Assisted Living
Wearables
Consumer goods

Summary

- **We are at the dawn of a new era**
  - › WAN technologies are emerging fast for IoT connectivity
  - › They are needed and will open up the IoT market for us all
- **UK is at the epicenter of this**
- **Cellular licensed technologies are one way of doing this**
- **Milton Keynes is BT's WAN test bed in the UK for license-exempt systems**
- **Join with us in establishing the necessary standards and eco-systems to ensure UK leadership**