

GRESHAM COLLEGE

# The Internet of Things

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**YOKOHAMA, Japan** (Jan. 25, 2018) – Combining the ultimate in traditional hospitality with Nissan's autonomous driving technology, one Japanese inn is treating guests to some unusual amenities: self-parking slippers, tables and floor cushions.

#### self parking slippers ...







#### The Internet of Things: making the most of the Second Digital Revolution

A report by the UK Government Chief Scientific Adviser

# The Internet of "Things"

What is a 'thing'?



(diagram reproduced with permission from Professor Bashir Al-Hashimi FREng, University of Southampton)

## iKettle

- Save time and remote boil from anywhere in the house
- Set wake up alarms and gain an extra 5 minutes in bed
- Arrive home to the iKettle boiled and ready to pour
- Boil ready notifications allow you to save energy by never having to re-heat
- Avoid that bitter taste and brew at the right temperature. Choose from 65, 80, 95 and





Photo: Construction and Administration Bureau of South-to-North Water Diversion Middle Route Project



Photo: Construction and Administration Bureau of South-to-North Water Diversion Middle Route Project

#### **IOT** on the body:

devices attached to the body or inside it, such as fitness monitors, pacemakers and smart pills that can report when they have been ingested ...









### loT in the home:

internet connected kettles, refrigerators, heating, lights, toys, locks, baby monitors, smart meters, alarms, cameras, televisions, voice assistants (e.g. Alexa <sup>TM</sup>)...







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## loT in shops

Shops: self checkout, inventory control, data collection, security cameras ...











#### IoT in work places

robots, security, energy management, lighting, surveillance







## loT in Hospitals



#### loT in: Worksites, buildings, vehicles ...



# loT everywhere ....

predictive maintenance, condition monitoring, control and instrumentation, equipment location, remote control of cranes and access platforms ...

- •Vehicles: control and monitoring of cars, vans, lorries, ships aircraft, conditionbased maintenance, usage analysis ...
- •Cities: traffic sensing and control, metro and light rail control and monitoring, law enforcement, information and advertising displays and sensors, monitoring and control of smart buildings, energy usage optimisation, taxi and courier tracking, air quality monitoring ...
- •Outside: inter-urban and inter country navigation and real-time routing, shipment tracking, weather sensing, fisheries protection, control, monitoring and security of offshore platforms and wind farms ...



[Sources: GrowthEnabler Analysis/MarketsandMarkets]

#### **Global IoT Market Share by Sub-Sector**



## **Examples of Benefits**

Sensors in **Rolls-Royce aircraft engines** stream data about the engines' usage and condition back to the manufacturer so that they can optimise maintenance; this has allowed them to change their business model to to sell engine usage rather than physical engines

Embedded health devices such as heart pacemakers can provide early warnings of deteriorating medical conditions and can allow reprogramming without the need for invasive surgery

Data from **connected vehicles and consumer smartphones** has allowed traffic flow to be monitored in real time and fed back to satnavs to provide route guidance to motorists;

**Connected CCTV cameras and automated numberplate recognition** allow law enforcement agencies to track vehicles in real time;

IoT devices enable retailers to manage stock levels efficiently and to detect shoplifting;

IoT devices enable **monitoring of the environment** in places ranging from deserts to the Arctic and to outer space.

Streetlights in San Diego and elsewhere have CCTV and sensors for sound, temperature, pressure, humidity, vibration, and magnetic fields. They can monitor parking spaces, locate gunshots, report car accidents, estimate traffic density and much more.

# **Engineering Issues**

- IPv4 address space is only 4,294,967,296 unique addresses
- Long lifetimes in buildings, products or infrastructure that should last longer than most software stays under maintenance.
- Hostile environments: chemical, radiation, electronic, weather, marine
- Power batteries? Harvesting power from radio waves?
- Cost?
- network access, perhaps through mesh networks
- Local legislation such as GDPR ...

Security

- IoT devices often have weak security: Mirai botnet was 300,000 cameras, printers and DVD recorders running Linux
- Medical equipment and industrial control systems are networked to save cost - or by accident
- Networked devices are probed and attacked within minutes
- The threat from cyberattacks is high and growing
- Shodan searches the whole internet even the dark net

#### Mirai Botnet device list

Username/Password	Manufacturer	Link to supporting evidence
admin/123456	ACTi IP Camera	https://ipvm.com/reports/ip-cameras-default-passwords-directory
root/anko	ANKO Products DVR	http://www.cctvforum.com/viewtopic.php?f=3&t=44250
root/pass	Axis IP Camera, et. al	http://www.cleancss.com/router-default/Axis/0543-001
root/vizxv	Dahua Camera	http://www.cam-it.org/index.php?topic=5192.0
root/888888	Dahua DVR	http://www.cam-it.org/index.php?topic=5035.0
root/666666	Dahua DVR	http://www.cam-it.org/index.php?topic=5035.0
root/7ujMko0vizxv	Dahua IP Camera	http://www.cam-it.org/index.php?topic=9396.0
root/7ujMko0admin	Dahua IP Camera	http://www.cam-it.org/index.php?topic=9396.0
666666/666666	Dahua IP Camera	http://www.cleancss.com/router-default/Dahua/DH-IPC-HDW4300C
root/dreambox	Dreambox TV receiver	https://www.satellites.co.uk/forums/threads/reset-root-password-plugin.101146/
root/zlxx	EV ZLX Two-way Speaker?	?
root/juantech	Guangzhou Juan Optical	https://news.ycombinator.com/item?id=11114012
root/xc3511	H.264 - Chinese DVR	http://www.cctvforum.com/viewtopic.php?f=56&t=34930&start=15
root/hi3518	HiSilicon IP Camera	https://acassis.wordpress.com/2014/08/10/i-got-a-new-hi3518-ip-camera-modules/
root/klv123	HiSilicon IP Camera	https://gist.github.com/gabonator/74cdd6ab4f733ff047356198c781f27d
root/klv1234	HiSilicon IP Camera	https://gist.github.com/gabonator/74cdd6ab4f733ff047356198c781f27d
root/jvbzd	HiSilicon IP Camera	https://gist.github.com/gabonator/74cdd6ab4f733ff047356198c781f27d
root/admin	IPX-DDK Network Camera	http://www.ipxinc.com/products/cameras-and-video-servers/network-cameras/
root/system	lQinVision Cameras, et. al	https://ipvm.com/reports/ip-cameras-default-passwords-directory
admin/meinsm	Mobotix Network Camera	http://www.forum.use-ip.co.uk/threads/mobotix-default-password.76/
root/54321	Packet8 VOIP Phone, et. al	http://webcache.googleusercontent.com/search?q=cache:W1phozQZURUJ:community.freepbx.org/t/packet8-atas-phones/4119
root/0000000	Panasonic Printer	https://www.experts-exchange.com/questions/26194395/Default-User-Password-for-Panasonic-DP-C405-Web-Interface.html
root/realtek	RealTek Routers	
admin/111111	Samsung IP Camera	https://ipvm.com/reports/ip-cameras-default-passwords-directory
root/xmhdipc	Shenzhen Anran Security Camera	https://www.amazon.com/MegaPixel-Wireless-Network-Surveillance-Camera/product-reviews/B00EB6FNDI
admin/smcadmin	SMC Routers	http://www.cleancss.com/router-default/SMC/ROUTER
root/ikwb	Toshiba Network Camera	http://faq.surveillixdvrsupport.com/index.php?action=artikel&cat=4&id=8&artlang=en
ubnt/ubnt	Ubiquiti AirOS Router	http://setuprouter.com/router/ubiquiti/airos-airgrid-m5hp/login.htm
supervisor/supervisor	VideolQ	https://ipvm.com/reports/ip-cameras-default-passwords-directory
root/ <none></none>	Vivotek IP Camera	https://ipvm.com/reports/ip-cameras-default-passwords-directory
admin/1111	Xerox printers, et. al	https://atyourservice.blogs.xerox.com/2012/08/28/logging-in-as-system-administrator-on-your-xerox-printer/
root/Zte521	ZTE Router	http://www.ironbugs.com/2016/02/hack-and-patch-your-zte-f660-routers.html

#### Shodan

"The scariest search engine"

- crawls the Internet IP address space
- Finds Internet of Things devices such as webcams, printers, medical and control systems ...
- It's then easy to find open ports, Operating System type, default services often with default user names and passwords ...

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	81.171.175.68	80	Star Technology Services Limited
	178.73.238.43	80	Portlane Networks AB
	113.245.76.199	5900	China Telecom HUNAN
	149.210.160.163	80	Transip B.V. nowarkrengelink.com
	23.92.216.117	80	Res.pl Isp S.c. mailingrolout.com
	202.69.233.212	443	Verio Web Hosting kubota-rvc23-0727001.com
	190.78.179.228	8080	CANTV Servicios, Venezuela 190-78-179-228.dyn.dsl.cantv.net
	192.3.4.108	443	ColoCrossing sxi.pw
	160.246.182.223	80	Hayashi Telempu Co., Ltd.
	198.104.15.120	443	Verio Web Hosting wholesalechildrensclothing.com.au
	208.64.139.67	80	Desync Networks 119-a.webmasters.com
	212.227.51.115	443	161 Internet AG s535322526.online.de
	75.98.17.22	443	Internap Network Services Corporation
	178.208.77.241	81	McHost.Ru v112059.vps.mcdir.ru
	63.249.80.153	443	Cruzio www12153.cruzio.com
	87.243.209.223	8080	HotChilli Internet static-87-243-209-223.adsl.hotchilli.net
	183.89.74.87	81	3BB Broadband mx-11-183.89.74-87.dynamic.3bb.co.th
	178.236.77.90	80	Excellent Hosting Sweden AB
	54.201.193.170	80	Amazon.com ec2-54-201-193-170.us-west-2.compute.amazonaws.com
	106.186.28.222	80	Linode, LLC li608-222.members.linode.com
	54.85.166.63	80	Merck and Co. ec2-54-85-166-63.compute-1.amazonaws.com
	208.131.128.136	80	WestHost greenstreetstudios.org



Privacy

"Although the Internet of Things can be conceived as billions of benign devices transmitting tiny amounts of data, value will be generated from aggregating and analysing large quantities of it. There is considerable research into novel techniques to secure connected devices, networks and data individually. However, protecting whole systems will become just as important as protecting individual components. In addition, people will be an integral part of those systems."

**UK Government Office for Science** 

## Is there any Privacy Left? and does it matter?







#### Online cameras with default passwords



Watch Axis camera in United Kingdom, London



Watch WebcamXP camera in Portugal, Coimbra



Watch DLink-DCS-932 camera in Bulgaria, Sofia



)Link-DCS-932 camera in France, Boulogne-Billancourt





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# Strava Heatmap showing a military base in Helmund



A military base in Helmand Province, Afghanistan with route taken by joggers highlighted by Strava. Photograph: Strava Heatmap

# Amazon working to fix Alexa after users report random burst of 'creepy' laughter

The company acknowledged the issue after some reported their devices had developed an unsettling new skill



Alexa is laughing, but her owners don't think it's very funny. Photograph: Elaine Thompson/AP

The robot wars are coming, and Alexa will have the last laugh.

Amazon acknowledged on Wednesday that some of its Alexa-enabled devices have developed a new skill: creeping out their owners with unexpected and unwarranted bursts of robotic laughter.

## **Regulation and Governance**

- The IoT is already very important how is it regulated?
  - Inadequately if at all
  - Regulators lack the resources, the skills and often the legal powers to enforce safety or security
  - See our recent lecture on *Computer Bugs in Hospitals*
- The Government has no appetite for increased regulation

#### **Proposed IoT Code of Practice**

- 1. No default passwords
- 2. Implement a vulnerability disclosure policy
- 3. Keep software updated
- 4. Securely store credentials and security-sensitive data
- 5. Communicate securely
- 6. Minimise exposed attack surfaces
- 7. Ensure software integrity

- 8. Ensure that personal data is protected
- 9. Make systems resilient to outages
- **10. Monitor system telemetry data**
- 11. Make it easy for consumers to delete personal data
- 12. Make installation and maintenance of devices easy
- 13. Validate input data

# Conclusions

- The IoT is here
- The IoT is important
- The IoT is growing and offers great opportunities for jobs, productivity, wealth creation, and improved quality of life
- The IoT will affect our lives more and more and decisions taken this year and next will affect our grandchildren

#### But

- Security is inadequate. Safety is inadequate, regulation is inadequate .....
- We need to invest in resilience, development, training, research and education

Above all, we need strategic thinking to plan for a safe and secure digital society

Government Office for Science

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# Questions?