Sustainable security – an Internet of durable goods?

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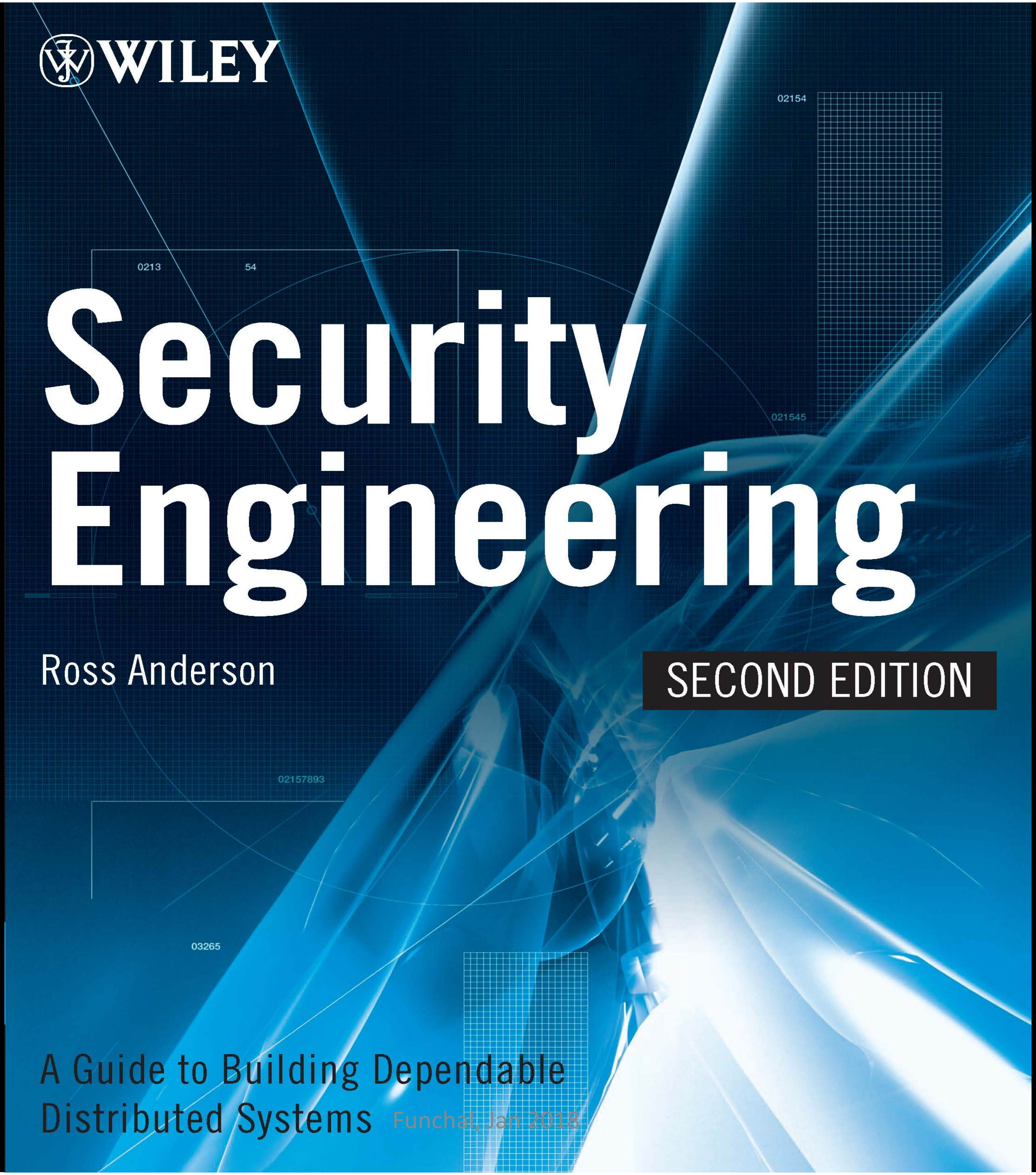
Funchal, Jan 2018



Funchal, Jan 2018

How does IoT change safety?

- The EU regulates safety of all sorts of devices
- They asked Éireann Leverett, Richard Clayton and me to examine what IoT means for this
- Once there's software everywhere, safety and security get entangled
- (The two are the same in the languages spoken by most EU citizens – segurança, sicurezza, sûreté, Sicherheit, trygghet…)
- How will we have to update safety regulation (and safety regulators) to cope?

Background

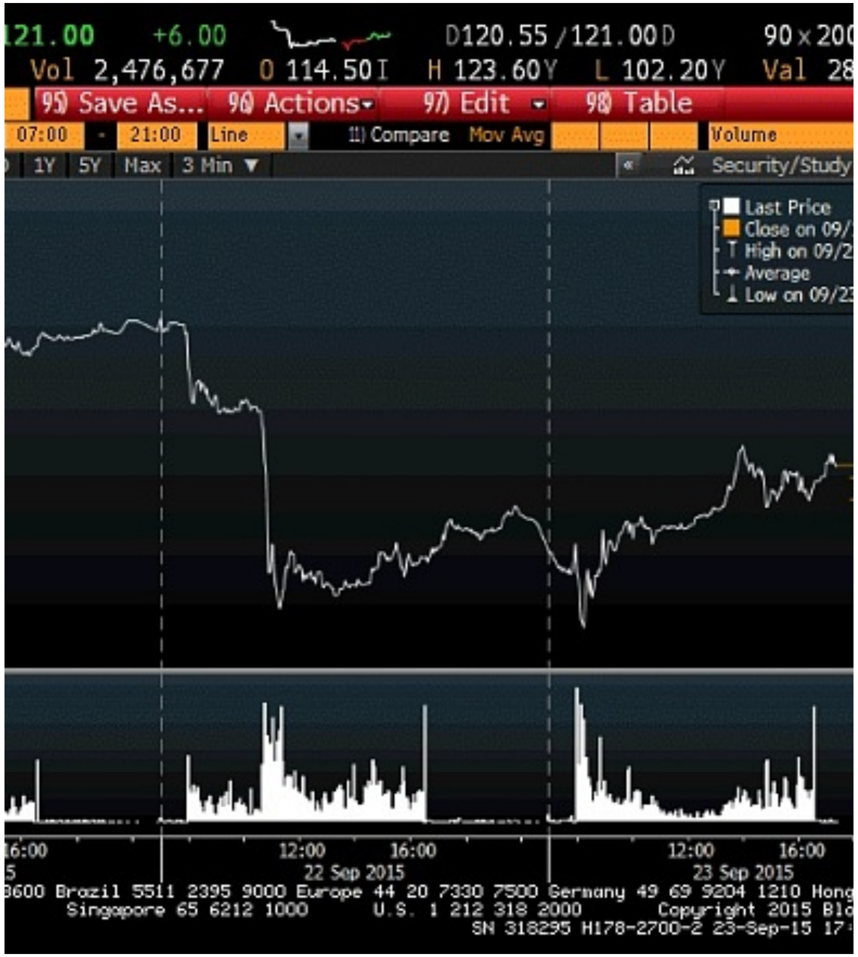
- Markets do safety in some industries (aviation) way better than others (medicine)
- Cars were dreadful until Nader's 'Unsafe at Any Speed' led to the NHTSA
- In the EU, we have broad frameworks such as the Product Liability Directive 85/374/EES, Framework Directive 2007/43/EC on type approval, plus many detailed rules
- Over 20 EU agencies (plus UNECE) in play

When cars get hacked

When cars get hacked (2)

- 2011: Carshark needed physical access
- 2015: Charlie Miller and Chris Valasek hacked a jeep Cherokee via Chrysler’s Uconnect
- So now we just need your IP address!
- Suddenly people cared…
- Chrysler recalled 1.4m vehicles for software fix

When cars get hacked (3)


121.00 +6.00 D120.55 / 121.00 D 90 x 200
Vol 2,476,677 O 114.50 I H 123.60 Y L 102.20 Y Val 28
95) Save As... 96) Actions 97) Edit 98) Table
07:00 - 21:00 Line 11) Compare Mov Avg Volume
1Y 5Y Max 3 Min Security/Study
Last Price
Close on 09/
High on 09/2
Average
Low on 09/23
16:00 12:00 16:00 12:00 16:00
22 Sep 2015
23 Sep 2015
3600 Brazil 5511 2395 9000 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong
Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2015 Blo
SN 318295 H178-2700-2 23-Sep-15 17

Scaling…

- Traditional car makers moving to autonomy in steps (adaptive cruise control, automatic emergency braking, automatic lane keeping…)
- Challengers like Google, Tesla moving faster
- Tesla has already moved to regular upgrades and the others are racing to follow
- One problem: the test rig (the ‘lab car’) is big, expensive, and gets recycled for new models
- So how will we patch a 2017 car in 2037?

CareFusion
Alaris® PC
PRIMARY INFUSION
RATE 2 mL/h
VTBI 175.0 mL
Press START

Options
Total Volume
Occlusion Alarm Setting
Primary
Secondary Bolus
Rate
Volume to be Infused
Run
Hold
On Off Charge
Silence
GRASEBY
500

Bag Vol: 250ml
Volume Left 246.9
Infused 3.1
Press OK to start
START OK
STOP NO
BOLUS
ON OFF
BodyGuard 545

DOOR OPEN
CLOSE CLAMP
ALARM
PUMPING
ALERT
125
1000
BACK LIGHT
SILENCE
TOT VOL STATUS
CLEAR TOT VOL
TIME
STOP
ON OFF CHARGE
OPTIONS
Baxter
Flo-Gard

SILENCE
STOP
START
POWER
ABBOTT
GEMSTAR
ON/OFF
BACK-UP
CHANGE
OPTIONS
PURGE
HELP
NO
YES ENTER
1-800-241-4002

1 SELECT mg/mL
2 SELECT µg/mL
3 SELECT mL
HOSPIRA
aim plus
OPTIONS
STOP
START
HELP
BACK-UP
CHANGE
SILENCE
PRIME
NO
YES/ENTER

Epidural
A:Bupivicaine/Fentanyl
500ml
Rate :
0 mL/hr
Pt Bolus 0
mmHg 0 720
ON OFF
info
STOP NO
START OK
PRIME BOLUS
cme medical
BODY GUARD 545

Background (2)

- The Medical Device Directives (90/385 EEC, 93/42/EEC, 98/79/EU) are now being revised
- Research by Harold Thimbleby: in the UK, hospital safety usability failures kill about 2000 p.a. (about the same as road accidents)
- Priority: get regulators to do post-approval studies and adverse event reporting
- At present devices are typically approved on paperwork alone

Background (3)

- Usability failures that kill are typically blamed on the nurse (if noticed at all)
- But attacks are very much harder to ignore – a wifi tampering demo in 2015 led the FDA to blacklist the Hospira Symbiq infusion pump
- 2017: recall of 450,000 St Jude pacemakers
- Software upgrades can break certification!
- Proper safety / security lifecycle is needed

Background (4)

- Electricity substations: 40-year lifecycle, protocols (DNP3) don’t support authentication
- IP networking: suddenly anyone who knows a sensor’s IP address can read from it, and with an actuator’s IP address you can activate it
- Only practical fix: re-perimeterise!
- Have one component that connects you to the network and replace it every 5 years (harder for cars which have multiple RF interfaces)

The Big Challenge

- Established non-IT industries usually have a static approach – pre-market testing with standards that change slowly if at all
- The time constant is typically a decade
- When malicious adversaries can scale bugs into attacks, industries need a dynamic approach with patching, as in IT
- The time constant is then typically a month

Broad questions include…

- Who will investigate incidents, and to whom will they be reported?
- How do we embed responsible disclosure?
- How do we bring safety engineers and security engineers together?
- Will regulators all need security engineers?
- How do we prevent abusive lock-in? Note the US DMCA exemption to repair tractors …

Policy recommendations included

- Requiring vendors to self-certify, for their CE mark, that products can be patched if need be
- Requiring a secure development lifecycle with vulnerability management (ISO 29174, 30111)
- Creating a European Security Engineering Agency to support policymakers (now: ENISA)
- Extending the Product Liability Directive to services
- Updating NIS Directive to report breaches and vulnerabilities to safety regulators and users

The punch line

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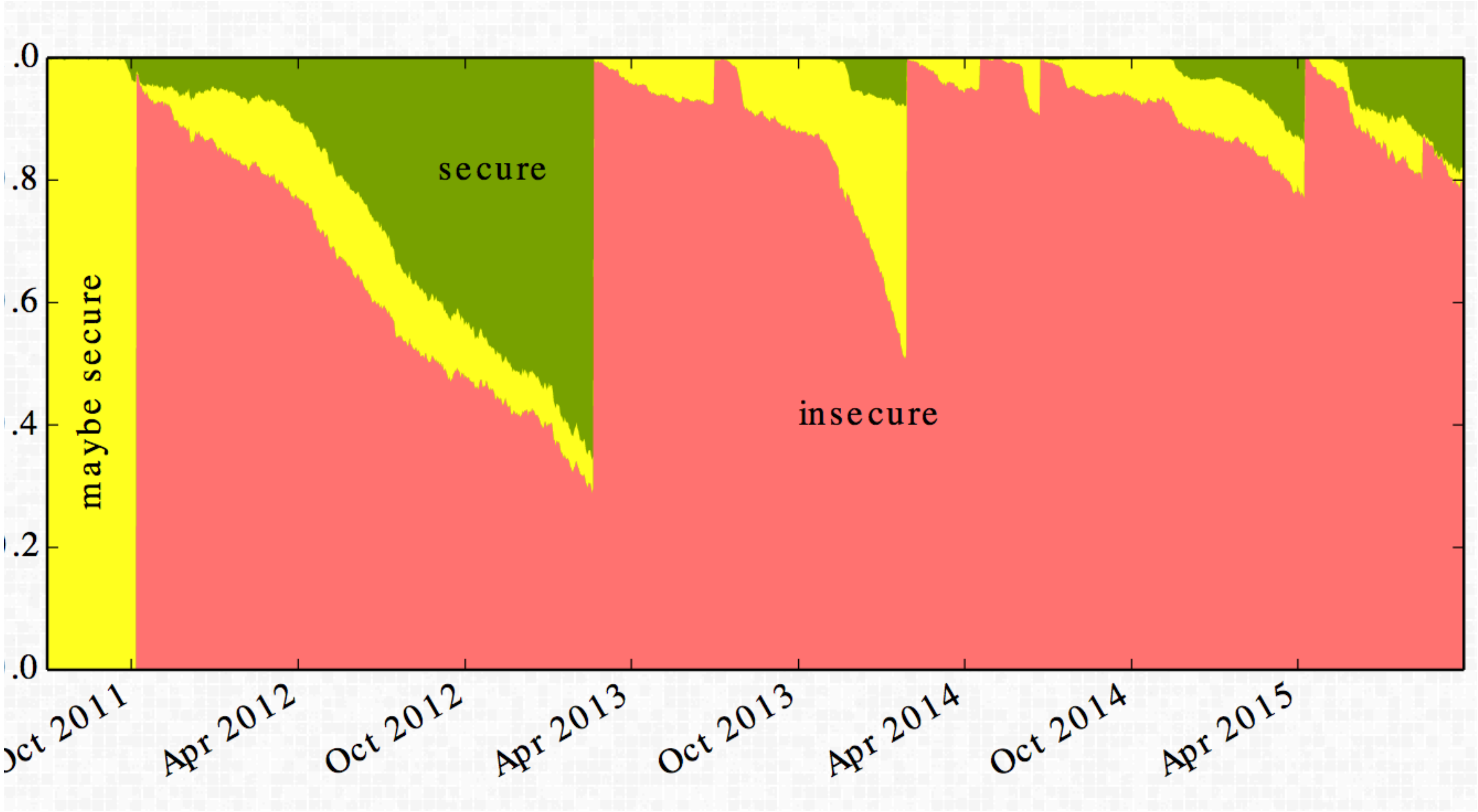
- Phones, laptops: patch them monthly, but make them obsolete quickly so you don’t have to support 100 different models
- Cars, medical devices: we test them to death before release, but don’t connect them to the Internet, and almost never patch
- So what happens to support costs now we’re starting to patch cars?

Security support costs

- Big problem in Android: patching old versions
- The typical OEM’s engineers only work on the current model and the next
- Google started Android OEM incentive program in 2010, with little effect
- So its own brand Nexus phones were next
- But my Nexus 5X – bought last year – will get patches only till 9/2018. I am not happy!

Is Android secure?



Vehicle lifecycle economics

- Vehicle lifetimes in Europe have about doubled in 40 years
- Average age at scrappage in UK now 14.8y
- Vehicle makers might like to say “scrap it after 7 years and buy a new one!”
- But the embedded CO_2 cost of a car often exceeds its lifetime fuel burn
- And what about Africa, where most vehicles are imported second-hand?

Implications for R&D

- Research topics to support 20-year patching Include a more stable and powerful toolchain
- Crypto teaches how complex this can be
- Cars teach: how do we sustain all the test environments?
- Control systems teach: can small changes to the architecture limit what you have to patch?
- Android teaches: how do we motivate OEMs to patch products they no longer sell?

Implications for research and teaching

- Since this year I’m teaching safety and security together in the same course to first-year undergraduates
- We’re starting to look at what we can do to make the tool chain more sustainable
- For example, can we stop the compiler writers being a subversive fifth column?
- Better ways for programmers to communicate and document intent might help…

Example of sustainable security

- Laurent Simon and David Chisnall are working with me on compiler support for crypto
  - Easy problem 1: zeroising sensitive variables
  - Easy problem 2: constant time loops
- Can we do these properly, with compiler annotations that make intent explicit?
- Answer: yes, but doing it right is nontrivial!
- See paper coming at EuroS&P this April…

Who will pay for it all?

- There will be talk of “new business models”
- Vendors would love to sell more cars – but society won’t accept halving car lifetimes
- The main direct beneficiaries of maintenance are garages and component suppliers
- Example: what does a wing mirror cost?
- Can you sell upgrades with new hardware (as in aviation) or software alone (Tesla)?

The grand challenge for research

- If the durable goods we're designing today are still working in 2037 then things must change
- Computer science = managing complexity
- The history goes through high-level languages, then types, then objects, and tools like git, Jenkins, Coverity …
- What else will be needed for sustainable computing once we have software in just about everything?

More …

- Our paper “Standardisation and Certification in the Internet of Things” is on my web page

  http://www.cl.cam.ac.uk/~rja14/

- Or see “When Safety and Security Become One” on our blog

  https://www.lightbluetouchpaper.org

  which also has a couple of videos