Standardisation and Certification in the 'Internet of Things'

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What will the IoT change?

- Privacy made the early running with the smart TV and the Cayla doll – but your phone already hears everything and is full of adware
- Denial-of-service was next with the Mirai botnet – but we already have botnets
- But safety looks like the real pressure point
- Phones and laptops don't kill many people directly; cars and medical devices do…

How does IoT change safety?

- Eireann Leverett, Richard Clayton and I did a project for the European Commission
- The EU has complex regulatory regimes for the safety of all sorts of devices
- How will these have to change once there's software everywhere?
- We looked specifically at vehicles, medical devices, and electrotechnical equipment
- But the lessons are more widely applicable!

EU problem statement

- We regulate safety in many industries
- The “Internet of Things” puts computers and communications everywhere
- This creates new safety risks around security
- Indeed, the two are the same in the languages spoken by most EU citizens (sicurezza, seguridad, sûreté, Sicherheit, trygghet…)
- How do we update safety regulation (and safety regulators) to cope?

Background

- Markets do safety in some industries (aviation) way better than others
- Cars were dreadful until Nader's 'Unsafe at Any Speed' fired up the public, got insurance industry involvement and led to the NHTSA
- In the EU, we got the Product Liability Directive 85/374/EES, Framework Directive 2007/43/EC on type approval, and much much else
- Some broad principles, plus many detailed rules

When cars get hacked

Background (2)

- 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
VTBI
Press START


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


ALARM PUMPING ALERT
BACK LIGHT
SILENCE
CLEAR TOT VOL
STOP
ON OFF CHARGE
OPTIONS


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 (3)

- 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
- Many devices needed replacement at Y2K…

Background (4)

- 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
- They balked at recalling 300 similar products
- Software upgrades can break certification!
- Proper safety / security lifecycle is needed

Background (5)

- ENISA reports that the energy sector has one of the highest rates of attacks on CNI
- UK experience: after alarms about smart meter security, GCHQ engaged with the CNI threat but not the lower-level ones
- Examples of what goes wrong:
  - STS rollover in 2024 affects 400m utility meters
  - Hardening ICS protocols will take 20 years or more

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 will 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 …

Institutional Players

- Dozens of European regulators (+ hundreds in Member States)
- Standards bodies (UNECE, ETSI, CEN, CENELEC)
- Safety labs (KEMA, EuroNCAP, …)
- Security labs (CLEFs, Underwriters' Labs, commercial pen testers, ENCS, academics …)
- Other custodians of the many safety and security standards including NIST, IEEE, IEC
- Other principals, e.g. insurance industry

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
- Extending the Product Liability Directive to services
- Updating NIS Directive to report breaches and vulnerabilities to safety regulators and users

Translating this to engineering

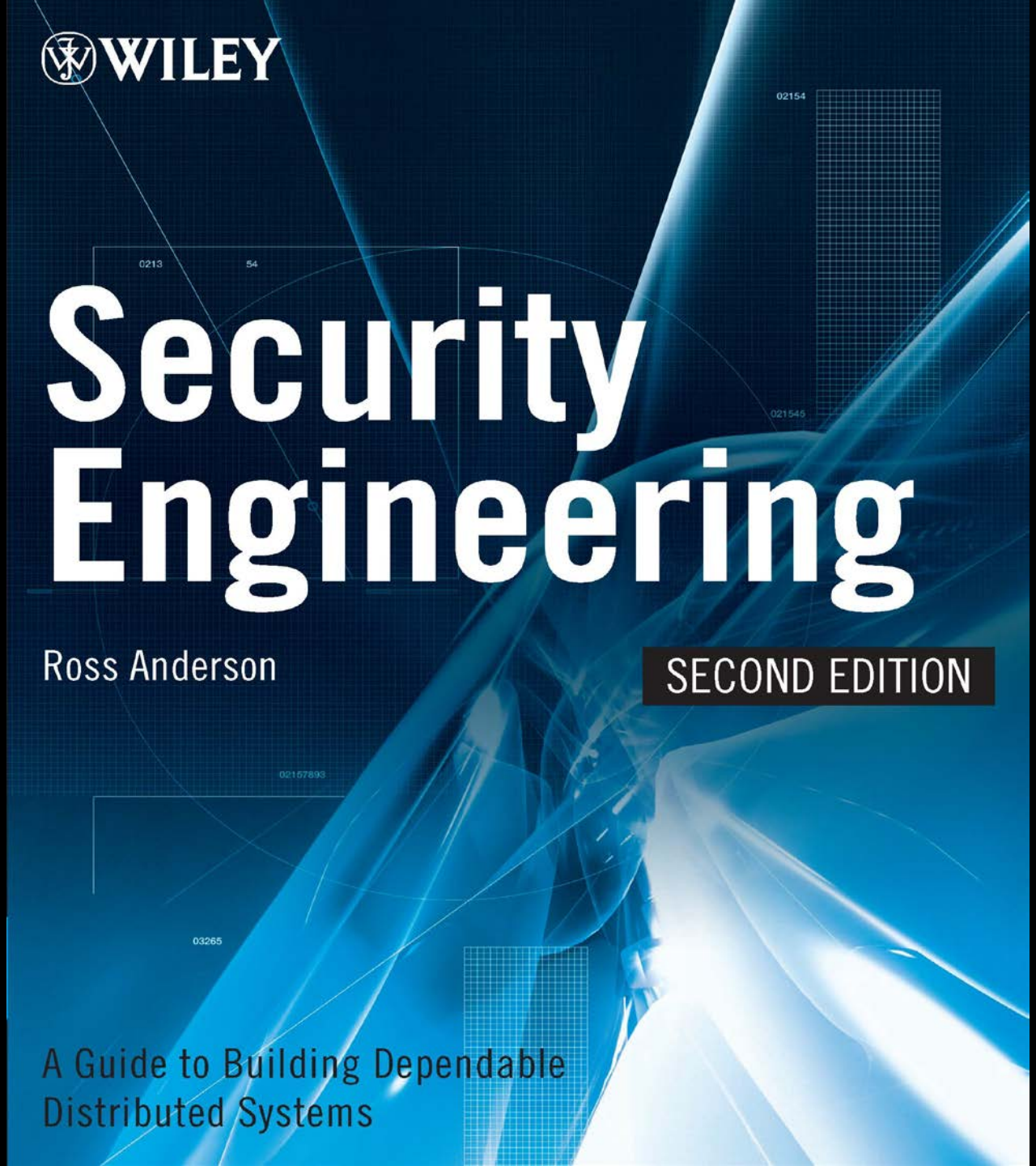
- Research topics to support 20-year patching
  Include a more stable and powerful toolchain
- Crypto teaches how complex this can be
- Cars teach: how do we sustain all the test environments?
- Control systems teach: can small changes to the architecture limit what you have to patch?
- Android teaches: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

Implications for research and teaching

- Since doing this project I've started 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?
- Need better ways for programmers to communicate and document intent

Conclusions

- We had a hard look at what's going wrong with the security of durable goods
- Security will be more about safety in future rather than mostly about privacy
- There are many institutional factors, such as liability, regulation and whether the capability to patch resides in one company or several
- But once safety-critical durable goods can be attacked online, it's patch or scrap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