Who Can you Trust in the IoT?
Internet Enabled Devices with Integrity

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Cisco Board representative to TCG

Agenda

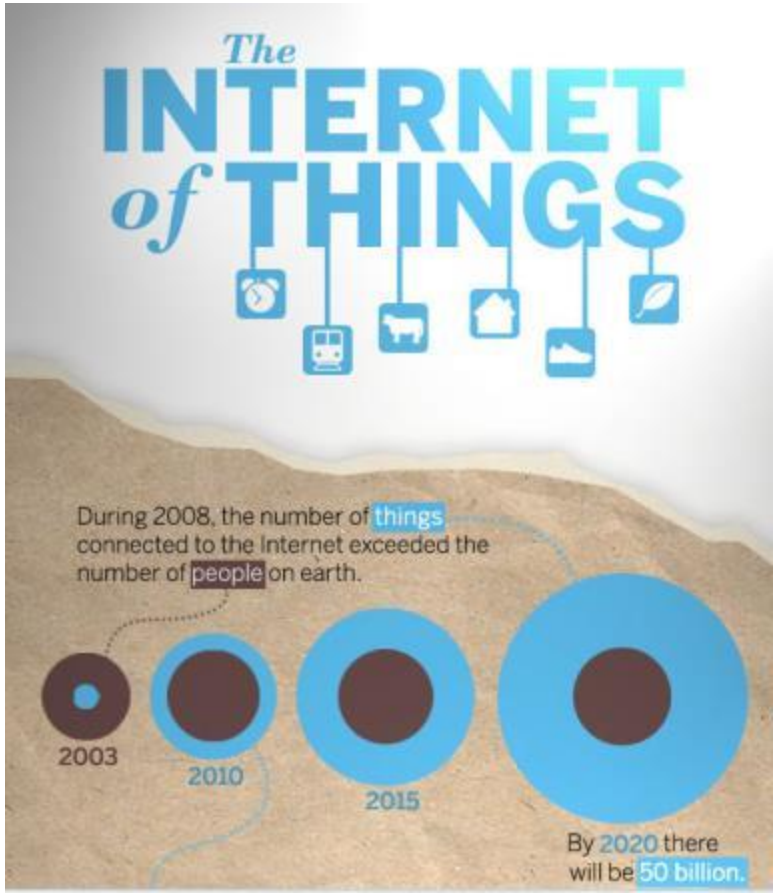
- Background – What's the Point?
- First Point – Identity and Integrity pillars – starting in a trusted state
- Second Point – Mandatory Access Control – staying trusted
- Third Point – Virtualization – security and trust that saves money
- Bonus – Types of Virtualization and Audience Resources

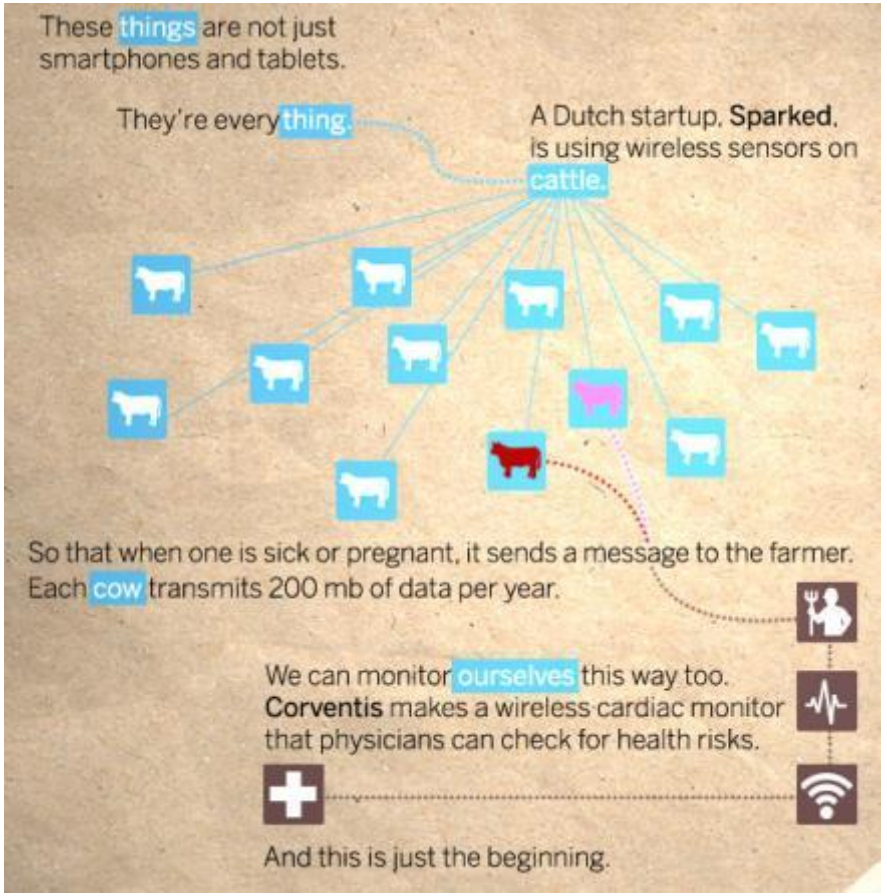
Background – what's the point?

The point is that we can't trust the IoT!

- We don't **trust** our computers. We **hope** that they will do what we bought them to do and nothing more.
- We have no evidence that computers we use shall perform only the tasks we bought them to perform
- We often have evidence that they have been compromised to do something else…..

Internet of Things and the Risks We Face





http://blogs.cisco.com/diversity/the-internet-of-things-infographic/

Securing IoT:
First Point – Identity & Integrity, Starting in a trusted state

Do I know you?
Can I trust you?

TCG and two basic security problems for computers

- **Identity** – An asymmetric private key stored in secure hardware inside the device

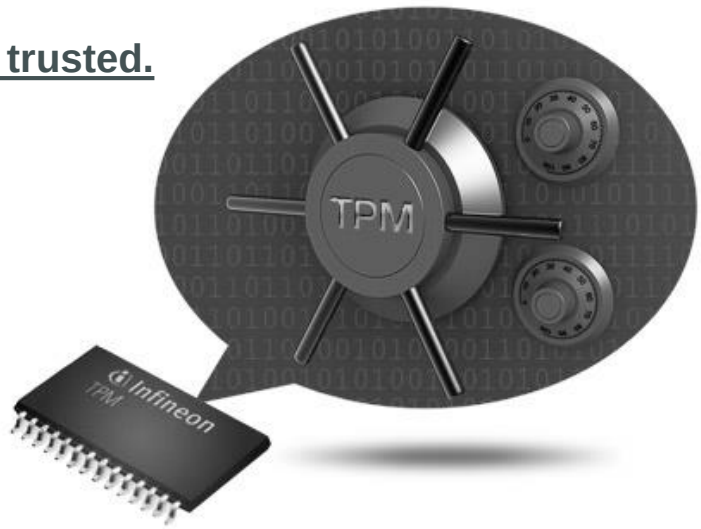
- **Integrity** – Measure code before executing it

  CurrentHash(application.dex) vs. GoldenHash(application.dex)
  CurrentHash(firmware) vs. GoldenHash(firmware)
  CurrentHash(OS Kernel) vs. GoldenHash(OS Kernel)
  CurrentHash(config files) vs. GoldenHash(config files)

  If CurrentHash() = GoldenHash(), then the code can be trusted.

"Golden" means the expected measurement, assuming the code hasn't been changed

www.trustedcomputinggroup.org



Example: TPMs Help Avoid Stranger Danger

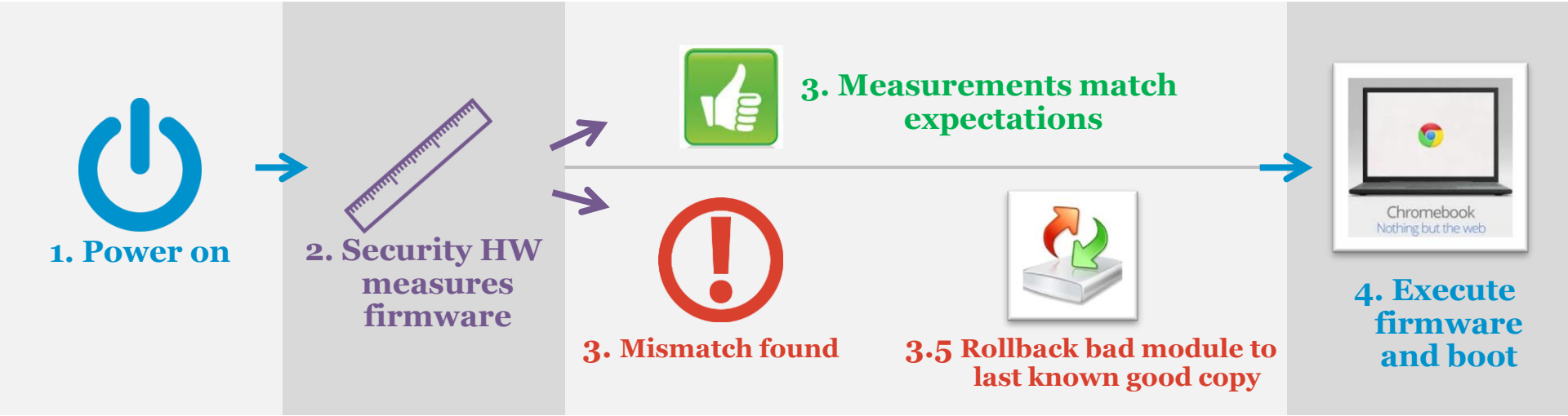
- Problem: Pharmaceutical Company requires high level of confidence that **all** end points in the network belong to them

- Solution:
  - VPN Logon requires a digital certificate
  - Certificate is protected by a TPM
  - Therefore only company owned end-points can connect to the network

Example: The value of integrity Measurement
Google's Chromebook –A Self-Healing Computer

- Security hardware and firmware measure firmware at boot
- Measurements are internally verified
- If a mismatch is found, the offending module is rolled back to the Last Known Good version, kept on board
- Then boot continues

The computer always comes up in a known state



Second Point – Mandatory Access Control

Enforcing process and data isolation to stay in a trusted state

Isolate process from each other and from the OS

- SE Linux and SE Android –
  - "Security Enhanced" Linux and Android –
    - Kernel mods, tools and configuration files
    - Initial work done by the NSA, then open sourced
  - SE Android is built on top of SE Linux

- SE Security Model:
  - Mandatory Access Control – **nothing** happens unless it is allowed to happen
  - The basic security model: there are **Subjects / Actions / Objects**
    - Subjects are processes
    - Actions are anything a process might do to an object
    - Objects are anything a process might take action on
  - The Security Server process must permit a Subject to take Action on an Object -

    Subject="Stacy" Action=Write Object=Syslog ALLOW

Application Security

- Secure by design
  - Threat modeling
  - Use Least Privilege
  - Use sandboxing
- Secure Coding – see Resources page
- Include security as part of App testing
  - Define the attack surface
  - Exercise that surface with the right tools
  - Fuzzing and robustness tests
  - Red Team hacking
  - Static analysis

Example, Motorola's AME 2000

- Smartphone user experience
  Commercial, off-the-shelf devices offer the latest capabilities, form factors and user interface
  Secure deployable data
  Extend the security and functionality of the network to the field via integrated Suite B IPSec VPN and Data at Rest protection
- Defense in depth
  Integrated security layers provide confidentiality, integrity and availability of VoIP and data communications
  Hardware root of trust
  Hardware security module provides tamper protection for keys, tokens
- Integrated security solution
  Complete end-to-end solution with single-source accountability for complete security of voice, video and applications

From Motorola's AME 2000 product page, at http://www.motorola.com/Business/US-EN/Business+Product+and+Services/Assured+Mobile+Environment/AME2000

Third Point – Virtualization: Security and trust that saves the OEM money

Third Point: Virtualization

- Business value: Separate hardware from software
  - Saves software migration costs as HW evolves
  - Maximizes use of available resources
  - Virtualization saves the OEM **$$$$**

- Security & Trust value:
  - Process isolation
  - Ability to create a layered security model within the embedded device

Bonus material –
Types of Virtualization and audience resources

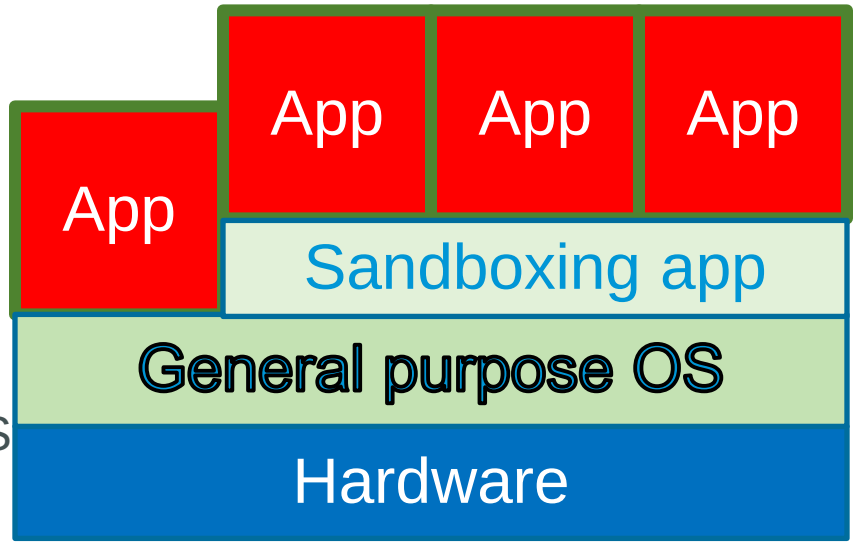
“Sandboxing” –

This is how application isolation is done in Android / iOS today.

Might be better thought of as hardened process isolation.

- Pros:
  - Widely supported under Linux
  - Lightweight and fast
  - Can support lots of virtual instances.
- Cons:
  - Weak isolation of instances and data
  - All instances must support the host OS

Example: All iPhones



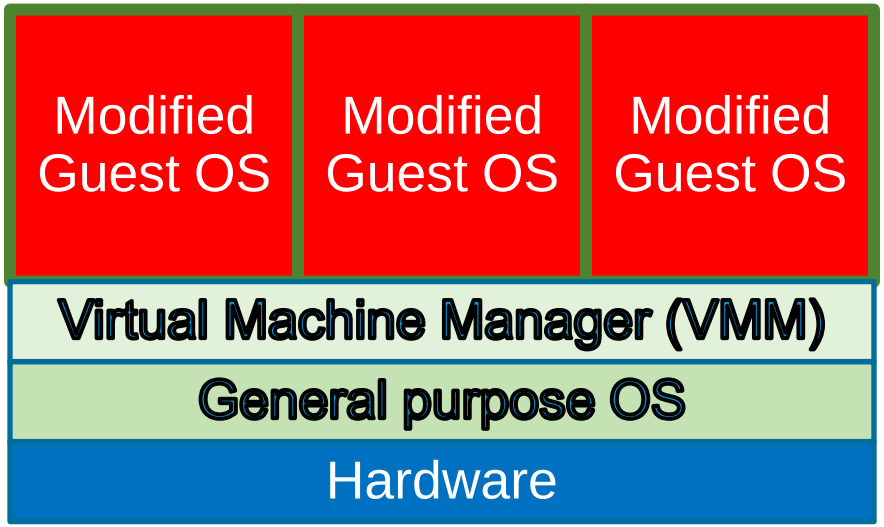
Paravirtualization or Type 2 Virtualization

A host OS runs the modified guest as an application

The guest OS is modified to be aware that it is running under another OS

- **Pros:**
  - Lightweight and fast
  - Guest OS Images are significantly smaller
  - Can be used on processors that do not support virtualization
- **Cons:**
  - Guest OS must support hypercalls instead of native functions.

Example: Samsung Knox, today



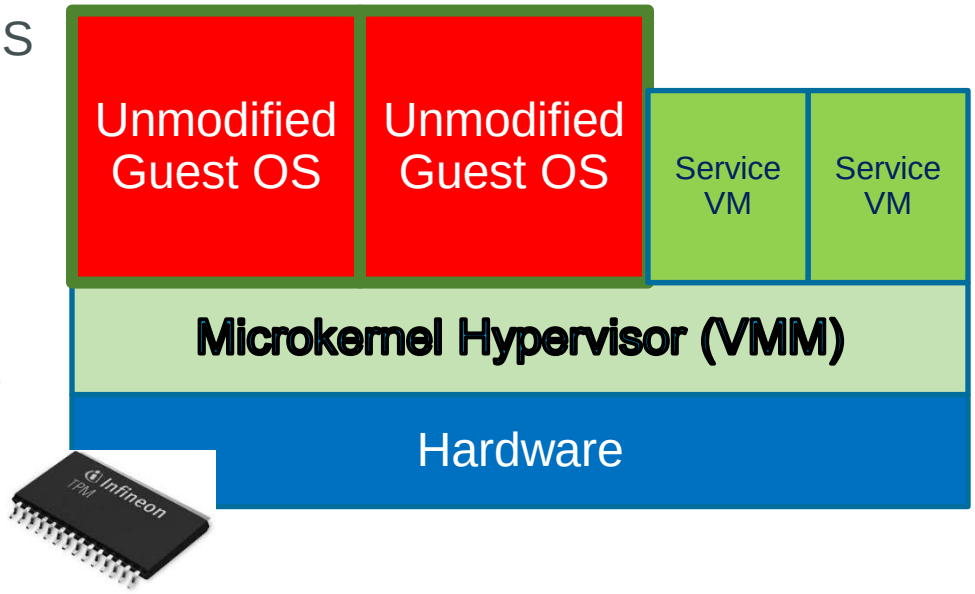
Full Virtualization or Type 1 Virtualization

The VMM represents itself as real HW to the Guest OS. The Guest OS does not know it is a VM

- **Pros:**
  - Can support any OS, without modification to that OS
- **Cons:**
  - Requires virtualization hardware (at least memory re-mapping)
  - Requires full installation of the OS

Example: Motorola AME 2000

Samsung Knox, roadmap



Resources 1/2

- Trusted Computing: www.trustedcomputinggroup.org
- SE Linux and SE Android:
  - http://selinuxproject.org/page/Main_Page
  - http://selinuxproject.org/page/SEAndroid
  - http://www.centos.org/docs/4/pdf/rhel-selg-en.pdf
- Secure coding:
  - www.safecode.org
  - http://www.android-permissions.org/
  - http://www.cert.org/secure-coding/
  - http://csrc.nist.gov/publications/nistpubs/800-64-Rev2/SP800-64-Revision2.pdf
  - http://msdn.microsoft.com/en-us/library/ms995349.aspx

Resources 2/2

- Virtualization / paravirtualization primers
  - Solving real time needs in a virtualized world: http://embedded-computing.com/articles/the-multiprocessor-multi-os-systems/
  - http://www.vmware.com/files/pdf/VMware_paravirtualization.pdf
  - http://softwarekishorekoney.blogspot.com/2011/06/full-virtualization-vs-para.html
  - http://msdn.microsoft.com/en-us/library/dd430340.aspx (Image reference)
- Virtualization – hypervisors
  - Source for a bare-metal hypervisor for ARM-7: http://dev.b-labs.com/
  - http://www.xen.org/products/xen_arm.html
  - http://www.sysgo.com/products/pikeos-rtos-and-virtualization-concept/
  - www.ok-labs.com
  - http://www.ghs.com/products/rtos/integrity_virtualization.html
  - http://www.windriver.com/products/hypervisor/
- Paravirtualization –
  - http://www.linux-kvm.org/page/Main_Page
  - http://en.wikipedia.org/wiki/Operating_system-level_virtualization
- Samsung Knox
  - http://www.samsung.com/global/business/mobile/solution/security/samsung-knox#con01

Hacking IoT for Fun!

- Texas students fake GPS signals and take control of an $80 million yacht

  http://blog.chron.com/sciguy/2013/07/texas-students-fake-gps-signals-and-take-control-of-an-80-million-yacht/

- Polish teen derails tram after hacking train network

  http://www.theregister.co.uk/2008/01/11/tram_hack/

- You may hate parallel parking, but you're going to hate it even more when somebody commandeers control of your car with you in it.

  http://news.cnet.com/8301-1009_3-57596847-83/car-hacking-code-released-at-defcon/

- Hacking insulin pumps and other medical devices

  http://www.forbes.com/sites/ericbasu/2013/08/03/hacking-insulin-pumps-and-other-medical-devices-reality-not-fiction/