UNIK4750 - Measurable Security for the Internet of Things

L3 – Security of the Internet of Things

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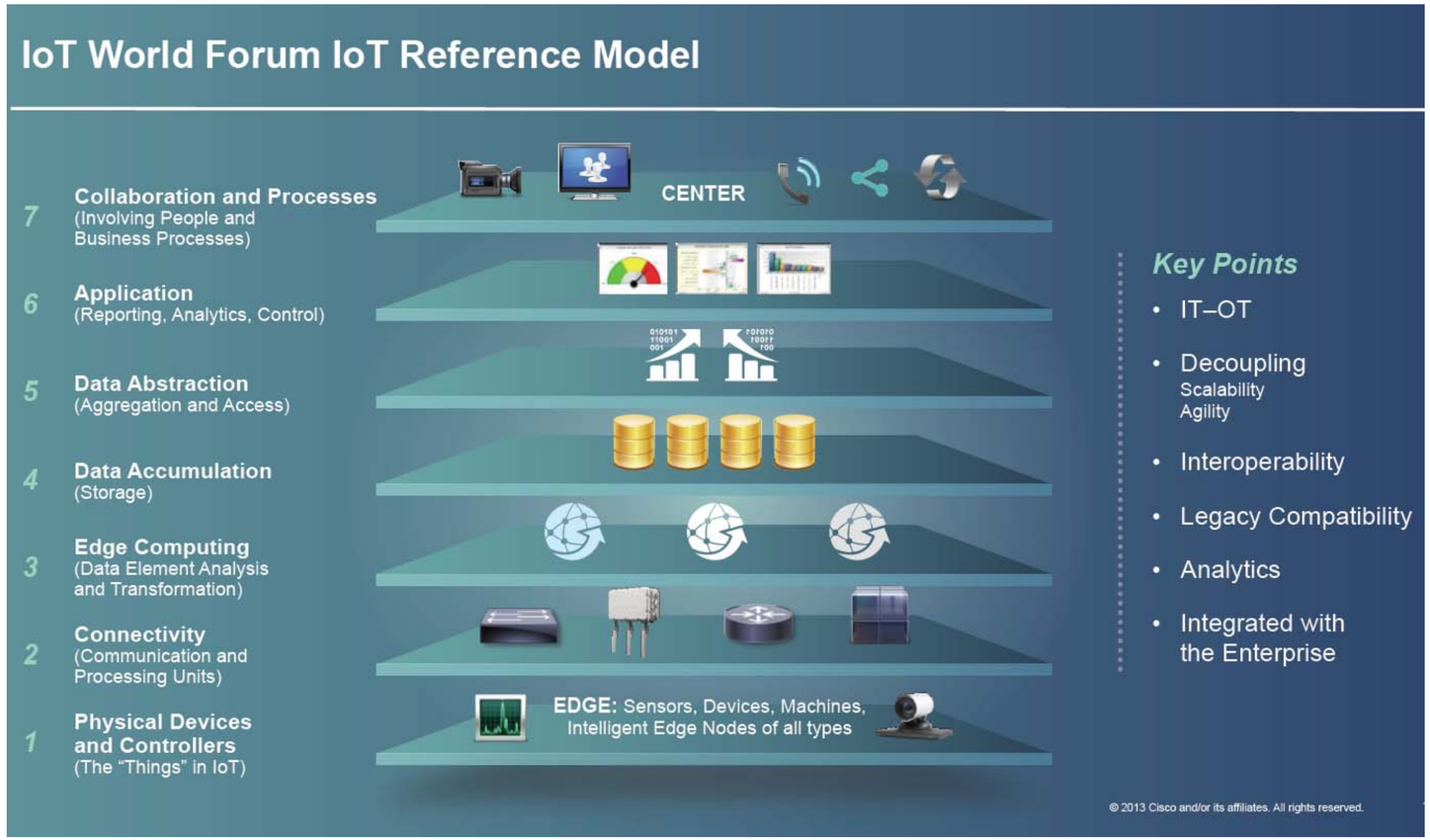
http://cwi.unik.no/wiki/UNIK4750, #IoTSec, #IoTSecNO

Overview

- Recap: IoT
- Resources and Converged infrastructure
- Threat landscape and surface
- Security challenges and needs
- Security life cycle
- Privacy
- Conclusion

Internet of Things - recap

- Heading toward a fully connected world
- The substantial difference is, that these systems have a physical dimension
- Integration of a wide variety of devices with very different capabilities and tasks
- Security is an enabler
- Life-cycle of devices is very different than typical IT
- The attack surface grows



Current situation of IoT

- IoT is not necessarely something big: an IP camera, smart thermostat, door opener, remote controlled power outlet, all is part of the IoT.
- Problems:
  - ➡ Privacy: many of the devices require e.g. to use a Google account for setup
  - ➡ Lack of resources also results in e.g. weak password policies
  - ➡ Confidentiality: using no security is the widest adapted method
  - ➡ Outdated solutions: UI is poorly implemented and is prone to vulnerabilities several years old

Resource-related challenges

- Limited bandwidth
- Latency
- Reliability

- Not feasible to create a ”perfect” system: be prepared to be compromised
  - ➡ Redundancy, reconfiguration, backup
- Security focus points:
  - ➡ Gateway/router
  - ➡ Cloud services

Converged IoT infrastructure

- End-to-end support of processes
- Pirority on availability and reliability
- Scalable, efficient
- Globally identifiable things – have both a dimension in the physical and in the logical world

- Consistent security in the whole value chain
- Deterministic operation (on the scale of the processes running on it)
  - ➡ Machine lines with hundreds of axes, transportation, critical infrastructure
- Management of assets

Converged IoT infrastructure-related challenges

- From closed networks to cloud computing. Not only new possiblities, but also new threats
- Heterogenous infrastructure connects a wide range of devices with a life-cycle mismatch
- Opens up new interfaces to attack
  - ➡ Risk for loss of privacy, functionality, fraud
  - ➡ Phyisical consequences
- Security measures shall be budgeted in accordance with the possible damage, not with the price of the asset
- IoT devices can introduce unexpected traffic into corporate networks (e.g. IPv6), which can be a challenge for the IDS system (if e.g. rules include IPv4 parameters) – one should enforce security controls both on IPv6 native and IPv6 tunneled traffic

Threat landscape

- Vectors:
  - ➡ Physical access (e.g. USB drive – Stuxnet)
  - ➡ Authenticated attacks
  - ➡ Unauthenticated attacks
  - ➡ Trivial access
- Types of attackers
  - ➡ Hack – typically exploits vulnerability in the system
  - ➡ System analysis – side channel attacks, analysis of the running environment and runtime
  - ➡ Lab-based attack – highly skilled attacker supported with special equipment
- Types of attacks
  - ➡ DDoS, botnet, malware, perimeter weakening, data breach
- Defense:
  - ➡ Tamper resistance
  - ➡ Monitoring of equipment status

Security challenges

- IoT intruduces a dramatically larger attack surface
- Wide range of technologies involved:
  - ➡ Sensors: AV, positioning, acceleration, temperature, proximity
  - ➡ Communication: cellular, wireless, wired, light
  - ➡ Identification: rfid, barcodes, tags, biometry
  - ➡ Localization: gps, indoor solutions
- From closed networks to cloud computing:
  - ➡ Security solutions should not build on and depend on to the network technology (heterogeneous infrastructure)
- Cost of security:
  - ➡ Possible mismatch between the value of the device and the data handled
- Misconception: device focus. IoT has many attack surfaces, each of these shall be evaluated.
- All elements of the system have to be considered:
  - ➡ End devices, cloud infrastructure, the application, network intefaces, software environment, use of crypto
- Public acceptance of IoT depends on security of the systems

Security analysis

- It’s not about the device. One shall see the big picture

- Structured approach with well-known steps: e.g. securing a web interface, analysis and setup of protocol parameters (avoid fallback to weak crypto), analysis of data to select correct protection
- Insecure network services: unfortunately, typical for industrial applications
- Transport encryption: use appropriate technological solutions
- Cloud interface
- Mobile interface
- Appropriate granularity in security configuration: e.g. monitoring, logging, password and lockout parameters
- Insecure software
- Phyisical security

Security needs of IoT

- User identification
- Identity management
- Tamper resistance
- Secure storage
- Secure content
- Secure software execution
- Secure communication
  - ➡ Over-the-air updates
- Secure network access

- Gateway as a key customer component: edge device for the LAN, concentrator

Security needs of IoT

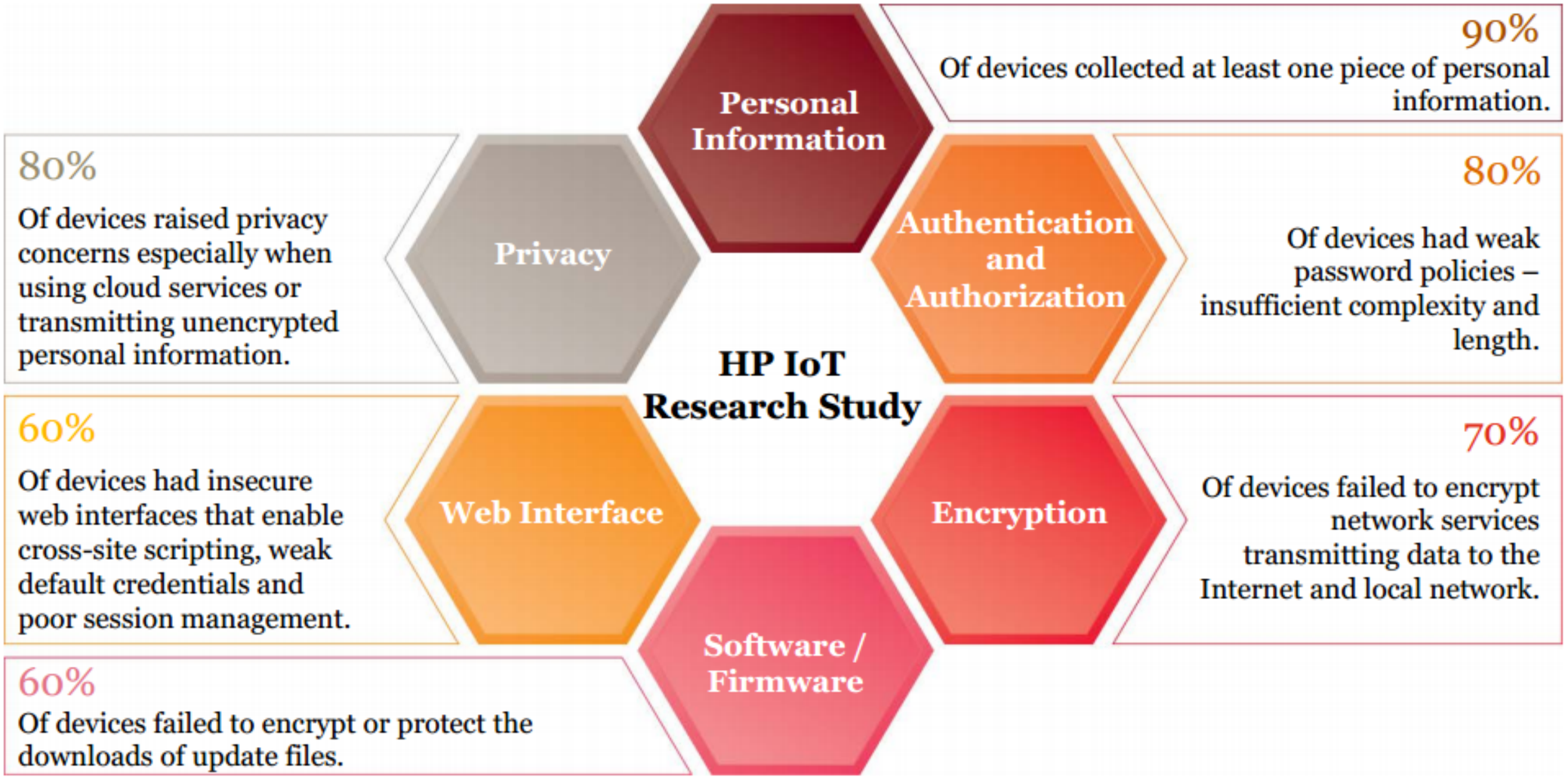


Figure from PwC, data from HP

Threat vectors

- Gateway:
  - physical access,
  - authenticated attacks,
  - Unauthenticated attacks,
  - Trivial access
  - Other problems from the fact, that the gateway has at least two interfaces, one LAN and one WAN.

- Security features for embedded devices (more or less true for the whole LAN ecosystem
  - Integrated crypto hardware
  - Firmware protection,
  - Tamper resistance
  - Vertical integration of security functions
  - Trivial access throughout the vertical

Attacks

- Computational capabilities and permanent internet connectivity
- Can be used to:
  - ➡ Send spam
  - ➡ Coordinated attack against e.g. Critical infrastructure
  - ➡ Act as server for malware
  - ➡ Entry point into an other network (e.g. Corporate)

- Example:
  - ➡ Spike botnet: DDoS attacks, ARM platform, infected devices included routers, smart thermostats, dryers, freezers, raspberry pi appliances.
  - ➡ Control systems, vehicles, and even the human body can be accessed and manipulated causing injury or worse
  - ➡ Health care providers can improperly diagnose and treat patients
  - ➡ Loss of vehicle control
  - ➡ Critical infrastructure damage
  - ➡ Safety-critical information such as warnings of a broken gas line can go unnoticed

Privacy

- Object privacy
  - ➡ Eavesdropping, tracking and stealing data
- Location privacy
  - ➡ Tracking, monitoring, revealing data

- Devices shall:
  - ➡ Only collect data, which is necessary for the functionality
  - ➡ Try to avoid collection of sensitive data and de-identify or anonymize as early as possible

Security profiles

- Authentication, Confidentiality and integrity in relation with the application
- Constratined sub-environments: lightweight protocols and the role of the gateway or concentrator
- Self-healing and resiliency
  - ➡ Make sure, that software updates are possible remotely
  - ➡ Protect and verify the update file
- Actual security funcions in relation with the application

L3 Conclusions

- Converged infrastructure
- IoT expands the attack surface
- Security requirements do also depend on type of data processed
- Devices with multiple intefaces present a risk
- End-to-end security and life-cycle support is key
- Privacy
- Why is this all good for the user?