HARDWARE SECURITY CHALLENGES FACING THE IOT NODES

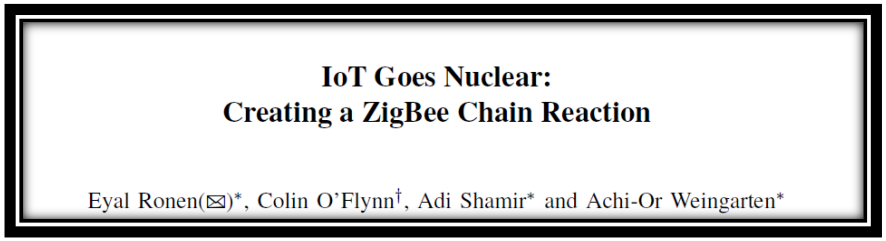
LA CYBER SECURITE AU SEIN DE L'IRT NANOELEC | FOURNIER Jacques | November 24, 2016

IOT SECURITY « GOES NUKE »!

Recent events that have been rocking the field of IoT security

- **DDoS attack on Dyn's DNS nameservers**
  - 100s of websites (GitHub, Twitter, Netflix, AirBnb…) unaccessible for several hours.
  - Knocking off entire countries (Liberia)
  - Estimated over a million of Mirai infected devices involved!
  - > 1TBps attack!

- **Chain-reaction of worm spread on Philips' Hue connected bulbs**
  - http://iotworm.eyalro.net/iotworm.pdf



IoT Goes Nuclear:
Creating a ZigBee Chain Reaction

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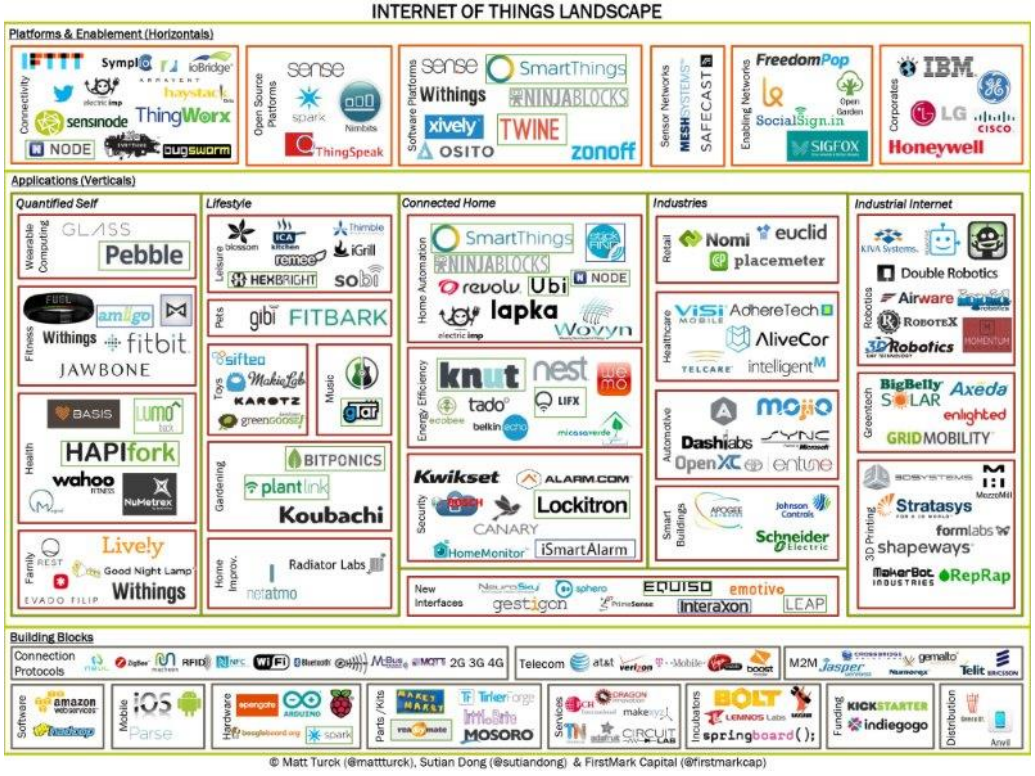
PARTICULARITIES OF THE IOT

- **50 billions of connected devices estimated [1] by 2020…**
  - … but not so big finally… More towards 10s of billions by 2027 according to a latest IDTechEx report [2]

- **Limiting factors**
  - Lack of clear standards
  - Heterogeneity
  - Scale of deployment
  - Increasing bargaining value of manipulated data
  - Legacy management

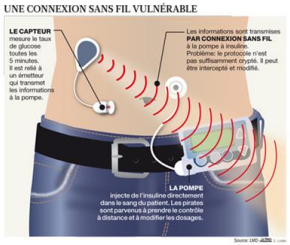


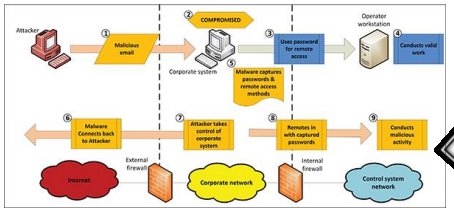
[1] « Ceo to shareholders: 50 billion connections 2020", Ericsson Press Release, April 13, 2010. http://hugin.info/1061/R/1403231/357583.pdf

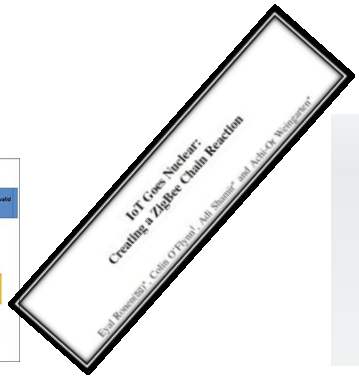
[2] "Internet of Things (IoT) 2017-2027 Things that think: IP addressed sensor node systems" by Dr Jon Harrop, Dr Peter Harrop and Dr David Pugh, Nov 2016. http://www.idtechex.com/research/reports/internet-of-things-iot-2017-2027-000499.asp

SECURITY PRIORITIES OF THE IOT

- **Defined today by the 'vertical' applications with their specificities:**
  - Not an exhaustive list…







Smart Health | **Smart Grids** | **Smart Cities** | **Smart Vehicles** | **Smart Industries**

Public safety

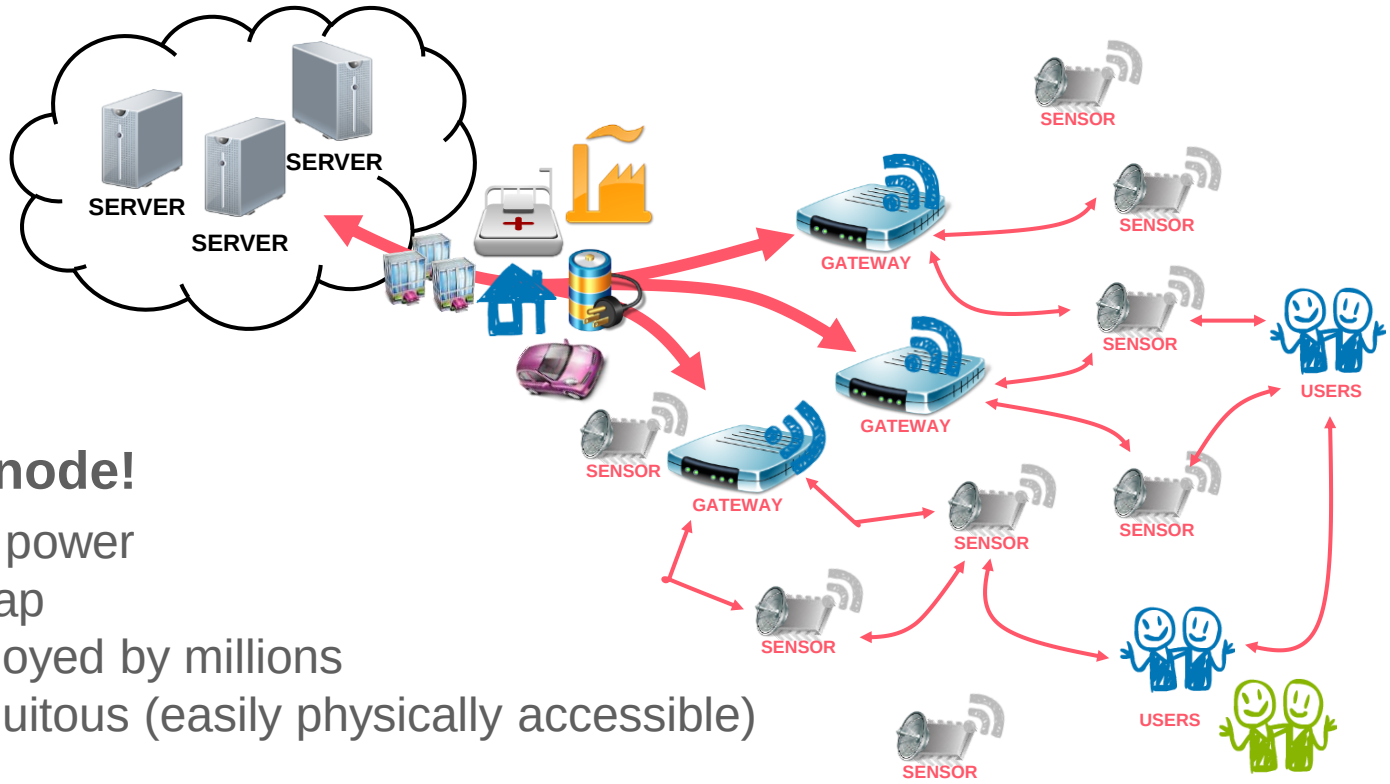
System Resilience

Cost Impact

User privacy

AAA : Accountability, Auditability & Assurance

(ONE OF) THE MOST VULNERABLE PART OF THE IOT



- **It's the node!**
  - Low power
  - Cheap
  - Deployed by millions
  - Ubiquitous (easily physically accessible)

CORE CHALLENGES

- Trusted hardware / counterfeiting
- Low power, fast cryptographic primtives for confidentiality, integrity, authenticity & privacy
- Massive deployment & on-the-field management
- Long lived security
- Protocols for end-to-end security

HOW TO TACKLE THE HARDWARE SECURITY CHALLENGES?

- **Consider short-term and long-term challenges**

- **Short term : Securing the Internet of *existing* Things (IO_ET)**
  - Enhancing the security of existing systems and devices
  - Using existing and proven security technologies
  - Integrating them « at-design-time »
  - So that in 5-10 years' time things are more or less done securely.

- **Long term : Securing the Internet of *future* Things (IO_FT)**
  - Researching fundamentally new paragdims and architectures suited to the IoT constraints.
  - Thinking « out the box ».
    - **Being disruptive innovationwise while not disrupting existing infrastructures!**
  - Beyond the 10-year perspective.

SHORT TERM SECURITY CHALLENGES

- **Trusted hardware & designs**
  - Solutions to verify the integrity and genuiness of ICs
  - Compatible with industrial constraints of IC manufacturing [1].
  - Eventually more invasive low cost approaches [2].

- **Lightweight cryptography resistant to physical attacks**
  - Classical cryptography does not satisfy the performance and power requirements of IOT devices & are vulnerable to physical attacks.
  - A new breed of crypto algorithms, Light Weight Crypto (LWC), has to be designed to be intrinsically resistant to physical attacks [3].

- **Efficient on-chip key generation and storage**
  - Physically Unclonable Functions (PUFs) [4] have been extremely complexe to design [5] so far.
  - A new breed of PUFs needs to be researched, most probably on the technological level.

- **Power efficient & secure low-level protocols**
  - Many IoT devices will be in-the-field for decades, so they need to be updated and secure firmware and data update mechanisms have to be defined and standardised [6].
  - Low level secure wireless communications have to be researched and deployed (6LoWPAN) for privacy-by-design architectures [7].

LONG TERM SECURITY CHALLENGES

- **Disruptive processor architectures**
  - One fundamental problem with current IOT nodes is that the underlying processor cores are vulnerable to a series of physical & logical attacks.
  - The concept of CIA (Confidentiality-Integrity-Authenticity) must be integrated with the processor core itself in an energy and cost-efficient way for off-the-shelf devices!

- **Rethinking the key management and distribution problem**
  - Current traditional PKIs,
    - an exponential $O(n^2)$ number of transactions are necessary to share keys among n parties
    - Complexe management of certificates and revocation lists, which might be a problem when dealing with billions of objects
  - Alternative solutions like Identity Based schemes based on Pairings should be investigated ! The number of necessary transactions for sharing the keys is linear with the number of parties involved.

- **Computing power of the IOT node for end-2-end security**
  - Homomorphic cryptography is being touted as the « ultimate » way of securely handling and working on data on the server side
    - No decryption of the data is required.
    - Cross-encryption schemes can be implemented
  - IOT infrastructures must be rethought in integrate those homomorphic concepts from one ‘node’ end to another ‘server’ end (and from there probably to other ‘node’ ends)!

FINAL WORD… WHY NOT THE « INTERNET OF NOTHING »?

- **Finally, if we want to have some disruptive thinking, we might ask ourselves:**
  - Why the INTERNET of Things?
  - Do we want to connect « everything » to the « internet »?

- **Why not some other form of « connection » that would be intrinsically secure against the plethora of attacks that poison our day-to-day life?**

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