A systemic approach for IoT security

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Summary

1. Our perspective of the IoT
2. Security in the IoT
3. Proposed systemic approach for the IoT security
4. Actors
5. Tensions
6. Multidimensional Risk in IoT
NIC (National Intelligence Council) forecasts that by 2025, IoT nodes will reside in everyday things such as food packaging, furniture, and documents.

- Tens of billions of communicating objects.

1. IoT penetration
   ⇒ Quantity of attacks will grow exponentially

2. Convergence of physical and virtual worlds
   ⇒ Quality of attacks will involve sensitive systems and services
Type of threats

- Against data and networks
- Against privacy
- Against system and physical world
IoT Actors

- **Person**: Refers to IoT users.
  - Potential target (privacy abuse, id theft, physical harming, etc.)

- **Technological ecosystem**: Software and hardware assets
  - Vehicle for security attacks and potential target (data integrity, confidentiality, DoS, etc.)

- **Process**: Orchestration of interaction among IoT actors to reach objectives
  - Deviation from initial objectives

- **Intelligent Objects**: Active smart participants perceive and act on environment.
  - Weak link of the chain, tightly linked to sensitive systems, persons, etc.

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Tensions

**Connections and interactions between nodes imply security tensions:**

- **Identification/authentication**:
  - Efficient resolution scheme to identify different entities, their owner and their users.

- **Trust**:
  - Level of confidence that can be granted to intelligent objects and environment

- **Reliability**:
  - Guaranteeing the achievement of initial objectives

- **Safety**:
  - A means to reduce the possibility of damage

- **Privacy**:
  - Factors, techniques and technologies used to protect sensitive and private data, and communications

- **Responsibility**:
  - Capability to demonstrate who did what
Towards a systemic IoT Risk analysis

- Risk = Vulnerability X Threat X Cost

- According to our systemic vision:

- **Vulnerability** = [ Ecosystem Vulnerability (**V** ecosystem), Person Vulnerability (**V** person), Object Vulnerability (**V** object), Process Vulnerability (**V** process)]

- **V** = [**V** ecosystem, **V** person, **V** object, **V** process]

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Tensions Threat Matrix

- **Threat** = [Threat ecosystem, Threat person, Threat object, Threat process]

Where:

- **Threat** ecosystem = [Threat against Ecosystem (**T** ecoy), Threat against Privacy (**T** privacy), Threat against Trust (**T** trust), Threat against Reliability (**T** relia)]
- **Threat** person = [Threat against Privacy (**T** privacy), Threat against Person (**T** person), Threat against Identification (**T** identification), Threat against Safety (**T** safety)]

Do the same for **Threat** object, **Threat** process
### Tensions Threat Matrix

- **Threat** =
  - $T_{Ecosystem}$
  - $T_{Privacy}$
  - $T_{Trust}$
  - $T_{Reliability}$
  - $T_{Privacy}$
  - $T_{Identification}$
  - $T_{Object}$
  - $T_{Responsibility}$
  - $T_{Reliability}$
  - $T_{Safety}$
  - $T_{Responsibility}$
  - $T_{Process}$

### Cost Matrix

- **Cost estimation if threat comes to happen:**
  - **Cost** =
    - $C_{ecosystem}$
    - 0
    - 0
    - 0
    - 0
    - 0
    - $C_{person}$
    - 0
    - 0
    - 0
    - 0
    - 0
    - 0
    - 0
    - $C_{object}$
    - 0
    - 0
    - 0
    - 0
    - 0
    - $C_{process}$
Multidimensional Risk

Risk = Vulnerability X Threat X Cost

= [Vecosystem, Vperson, Vobject, Vprocess] X [Tthreatecosystem, Tthreatperson, Tthreatobject, Tthreatprocess] X Cost

Risk = [ V x T x Ci ]i€{ecosystem, person, object, process}

= [ Riskecosystem, Riskperson, Riskobject, Riskprocess ]

- Compound Weighted Risk = Risk X Weights [wecosystem, wperson, wobject, wprocess]
- Compound Weighted Risk =

\[ \sum_{i\in\{ecosystem, \, person, \, object, \, process\}} w_i \cdot V_i \cdot T_i \cdot C_i \]

Conclusion

- Early stage systemic approach for IoT Security analysis
- We introduced evaluation of multidimensional risk in IoT