

Authentic Execution in Smart Farming

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Smart Farming

What is Smart Farming?

- Application of modern ICT in agriculture
- **Embedded devices** connected to:
 - **Sensors**, to collect data from the physical world (e.g. temperature, humidity, light...)
 - **Actuators**, to perform operations to the physical world (e.g. irrigation, animal feeding...)
- **Central servers** to store data and execute software for computing statistics and/or predictions



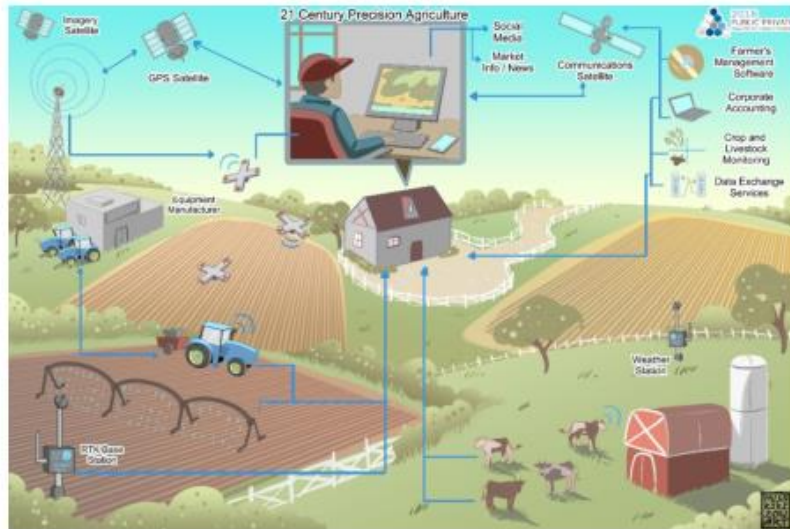
Why?

- In general, the goal is to **maximize profits** and **minimize costs**
- The data collected is processed by servers using specialized software, providing to the farmer statistics and support for decisions
 - Typically, the farmer interacts with the system through a dashboard
- The main benefits of using this approach are:
 - **Improve input efficiency**, by applying the optimal amount of nutrients, seed or chemical products such as pesticides at the right location and time, using the right type of product
 - **Identify anomalies** such as diseases, by analyzing the general health of the crop and livestock
 - **Reduce labor time and costs**, by using actuators and specialized software for performing operations with limited human intervention

Threats to Precision Agriculture

2018 Public-Private Analytic Exchange Program

Threats to Precision Agriculture



- Paper released by US Department of Homeland Security (DHS) in 2018
- *"[...] addresses the security threats related to the adoption and impact of new digital technologies in crop and livestock production."*

Security issues

- **Confidentiality**

- Theft of data
- Leak of data
- Foreign access to data

- **Integrity**

- Manipulation of data
- Introduction of fake data
- Manipulation of actuators

- **Availability**

- Block / alter nodes
- Block / alter communication between nodes



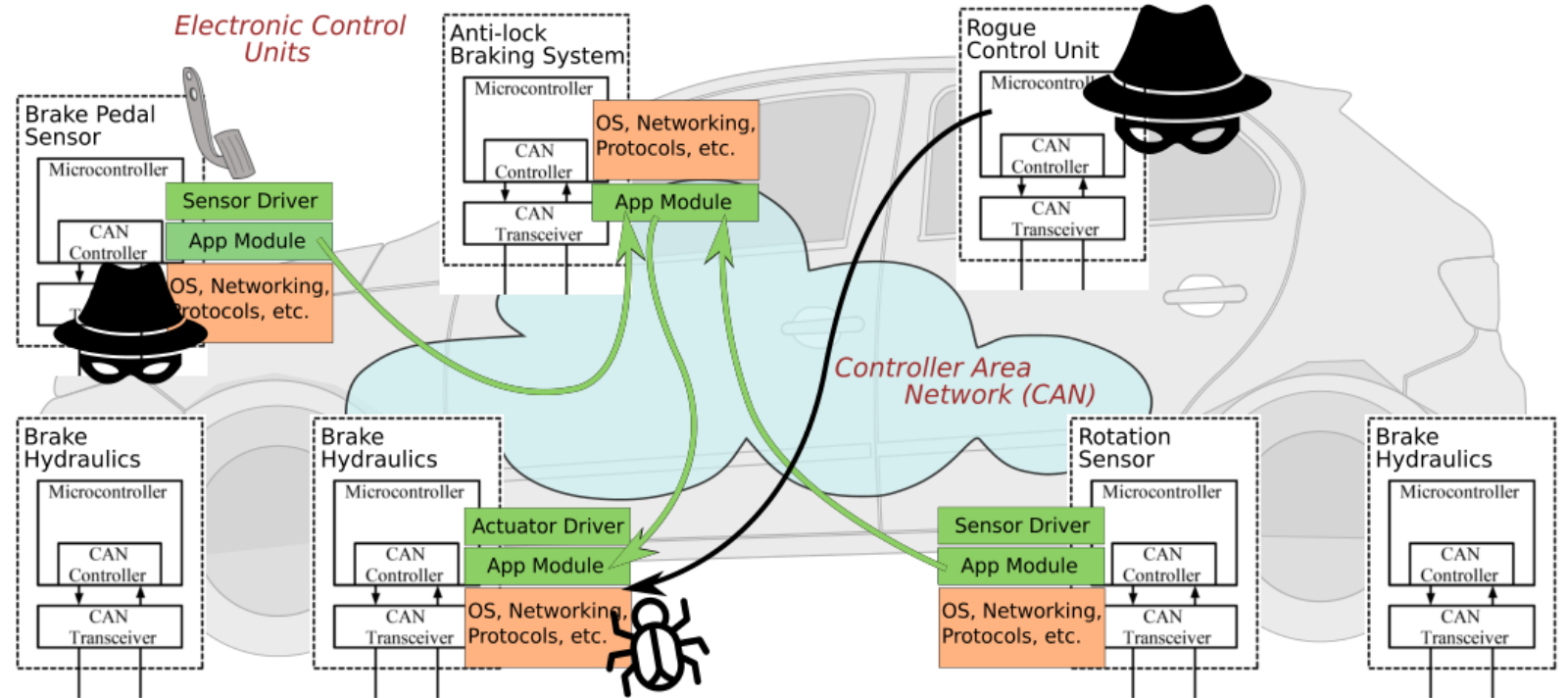
Trusted Computing and Authentic Execution

Trusted Computing

- Technology developed by the *Trusted Computing Group*
- Goal: provide strong guarantees that a software will **not** misbehave
 - Even in a system where all the other components (OS, other SW) are untrusted!
- Key concepts:
 - **Endorsment Key**: unique private key that never leaves the hardware
 - **Memory curtaining**: isolation of sensitive areas of memory
 - **Sealed storage**: bind data to a specific device or software
 - **Remote attestation**: authenticate hw / sw configuration to a remote host
 - **Trusted third party**: an intermediary to provide (ano|pseudo)nymity
- In practice we have many different architectures which implement a subset of these features, and they also provide new features such as *Enclaved execution* and *secure I/O*

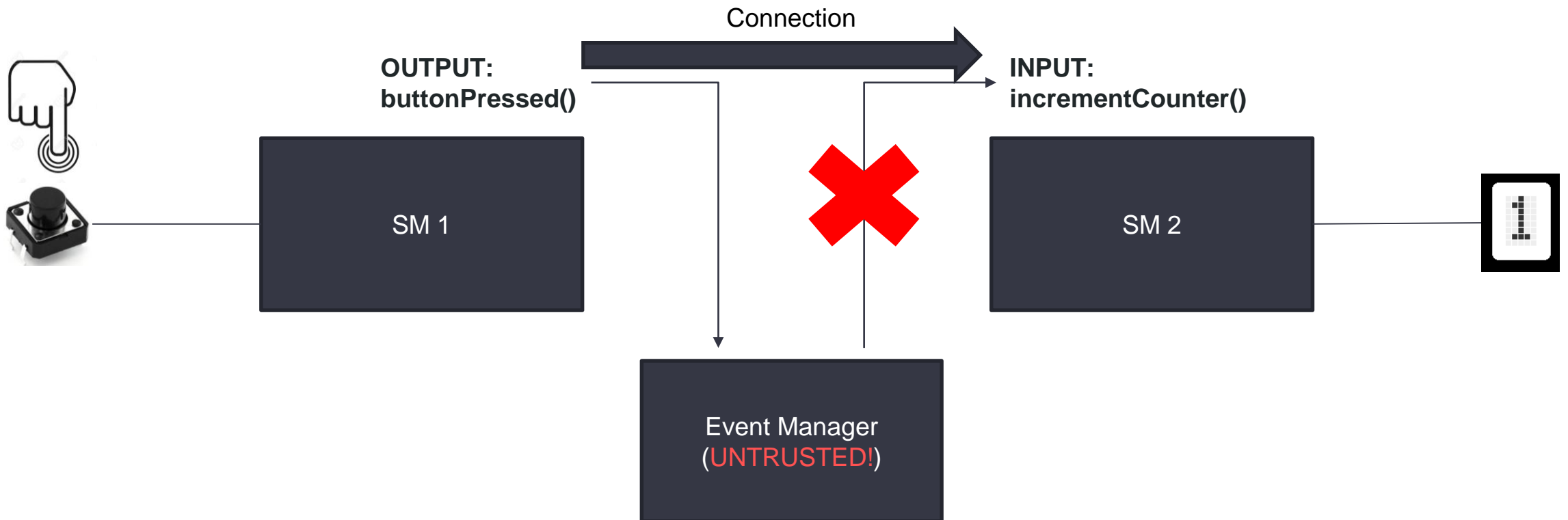
VuICAN

- An application of Trusted Computing in the automotive context
- Force points:
 - Message authentication
 - Software component attestation and isolation



Authentic Execution

«if the application produces a physical output event (e.g., turns on an LED), then there must have happened a sequence of physical input events such that that sequence, when processed by the application (as specified in the high-level source code), produces that output event. »



Limitations of the current implementations

- VulCAN handles a **specific** communication medium (CAN)
 - The code is then adapted for dealing with its characteristics
 - Broadcast network
 - 64-bit packets (-> MAC truncation)
 - ...
- The current implementation of Authentic Execution manages only Sancus devices
 - What about different architectures like SGX?

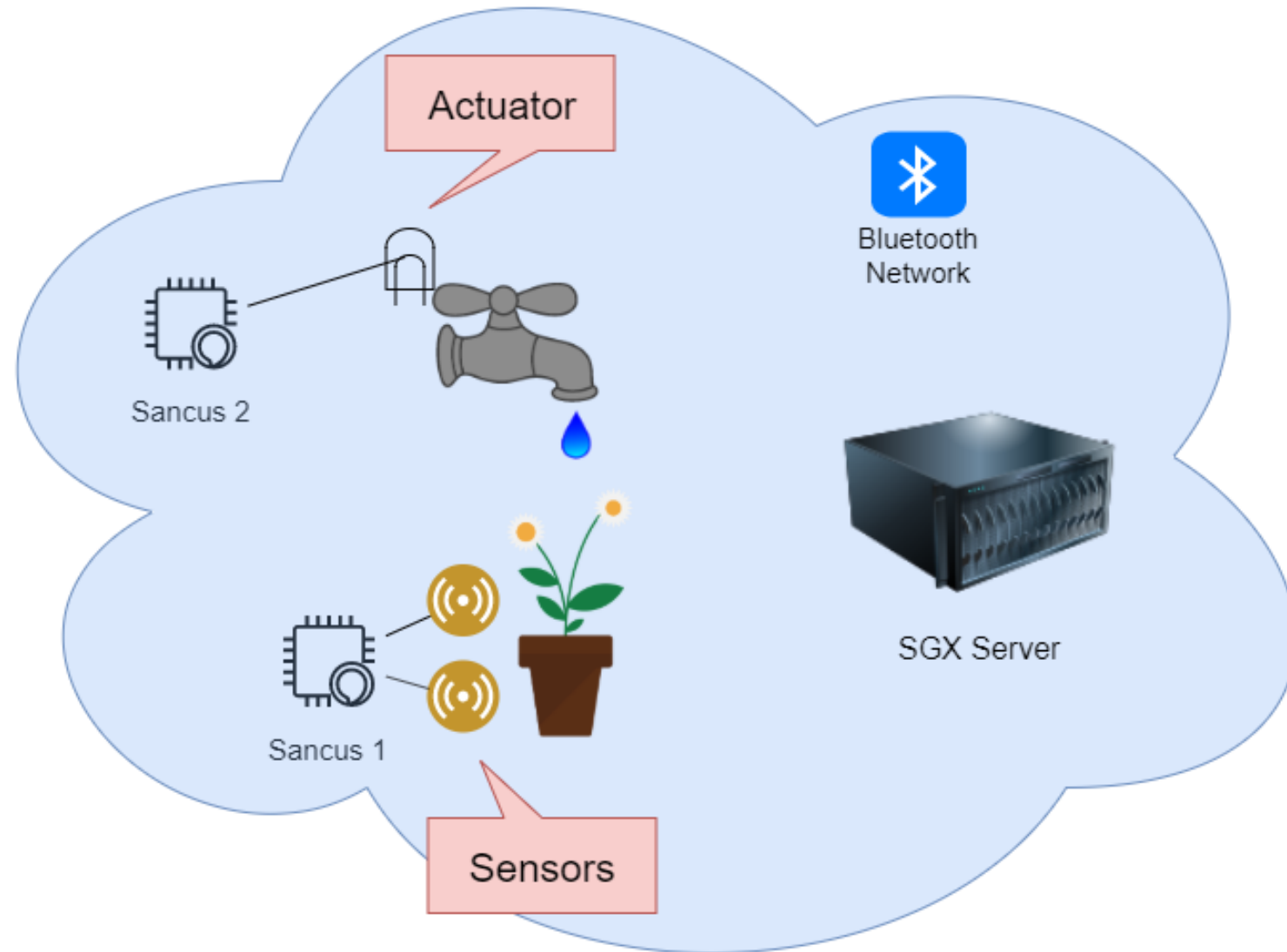
My Master's Thesis

My Master's Thesis work

- Generalize the concept of Authentic Execution
 - Communication medium: provide a sort of ***generic API*** which abstracts the network layer
 - Goal: the code written by the developer should be **transparent** to the communication medium used
 - The developer has only to specify the technology used and its parameters in a configuration file
 - Different architectures: provide support for another architecture (Intel SGX)
 - Goal: we want to simulate a system composed by heterogeneous components (from lightweight IoT devices to desktop/server architectures)
 - Many real scenarios present such situation (e.g. Smart Farming)

A prototype: Authentic Execution for automatic irrigation

- **Goal:** apply the concepts described in the previous slide to a concrete use case in the context of Smart Farming



Schedule

- Within the holidays: completing the reading / planning phase
- From January onwards: implementation phase
 - Authentic execution between two SGX enclaves
 - Authentic execution in a heterogeneous system (SGX + Sancus)
 - Generic API for the communication

Conclusions

Conclusions

- Goal: Create a system which provides strong security properties in presence of malicious actors
 - Confidentiality, integrity features
- Application in a specific context (smart farming)..
 - .. but can be also applied to any other areas with different:
 - Architectures
 - Communication mediums

References

- [*Threats to Precision Agriculture*](#)
- [Tutorial dsn18 slides](#)
- [Article about Smart Farming](#)
- [VulCAN](#)
- [Authentic Execution](#)
- [Image slide 3](#)
- [Image slide 6](#)