Authentic Execution in Smart Farming

Student: Gianluca Scopelliti

Supervisors: Frank Piessens, Jan Tobias Mühlberg, Fritz Alder

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

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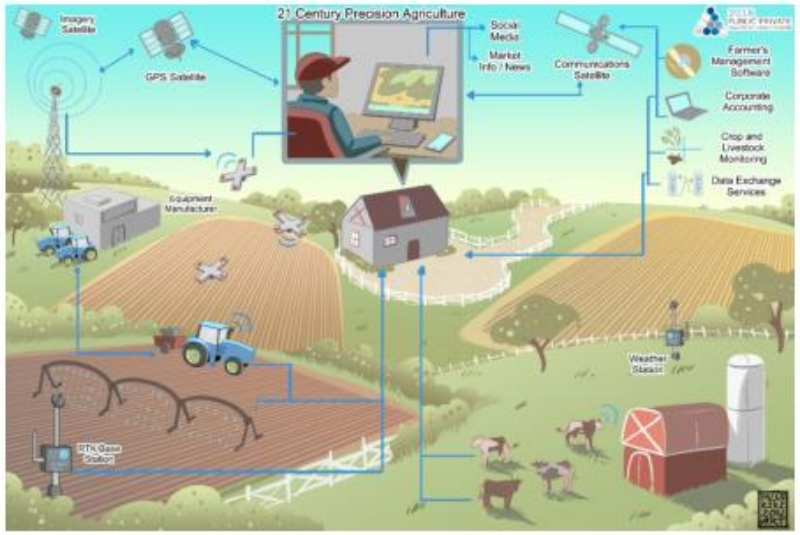
- The main benefits of using this approach are:
  - **Improve input efficiency**, by applying the optimal amount of nutrients, seed or chemical products such as pesticides at the right location and time, using the right type of product
  - **Identify anomalies** such as diseases, by analyzing the general 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."*

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- **Availability**
  - Block / alter nodes
  - Block / alter communication between nodes

Trusted Computing and Authentic Execution

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- Goal: provide strong guarantees that a software will **not** misbehave
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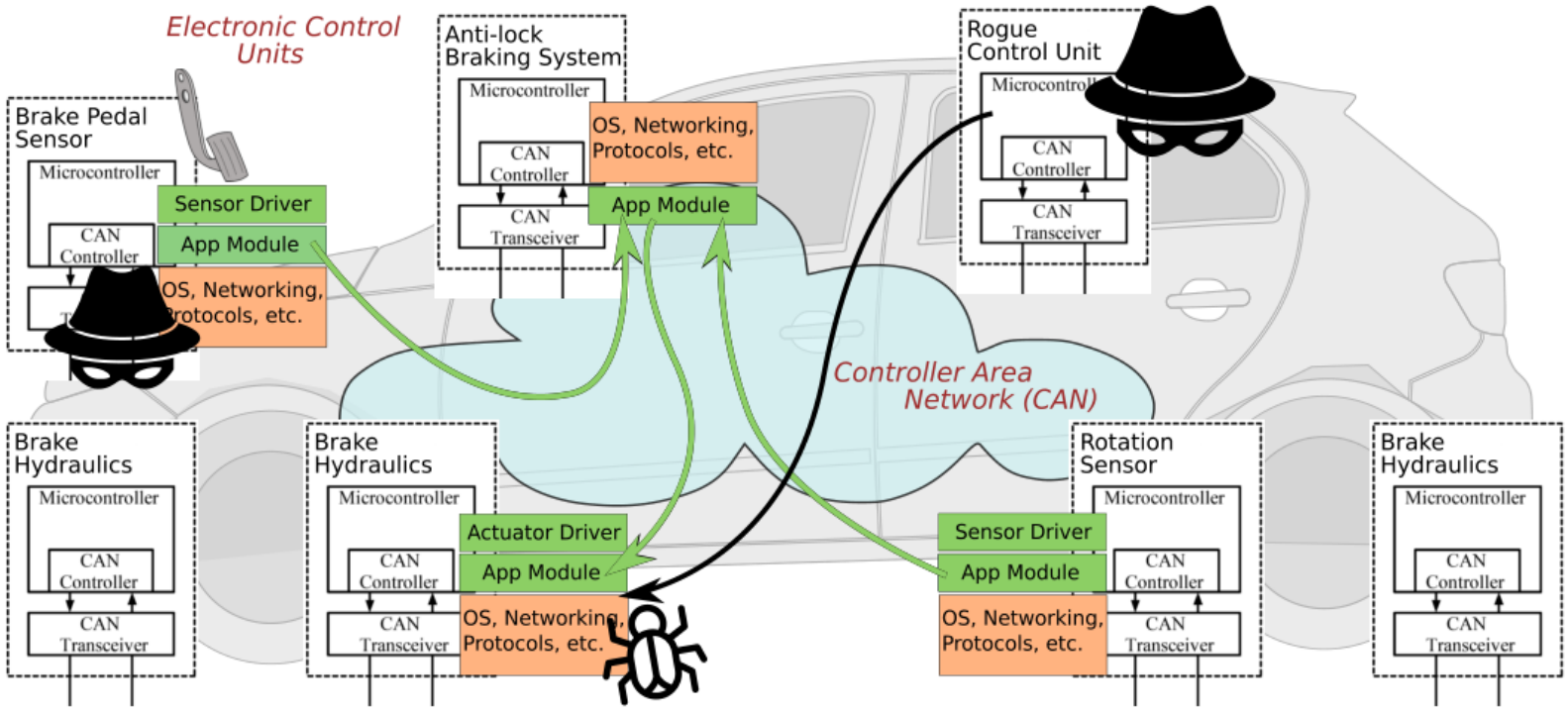
- In practice we have many different architectures which implement a subset of these features, and they also provide new features such as *Enclaved execution* and *secure I/O*

VulCAN

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



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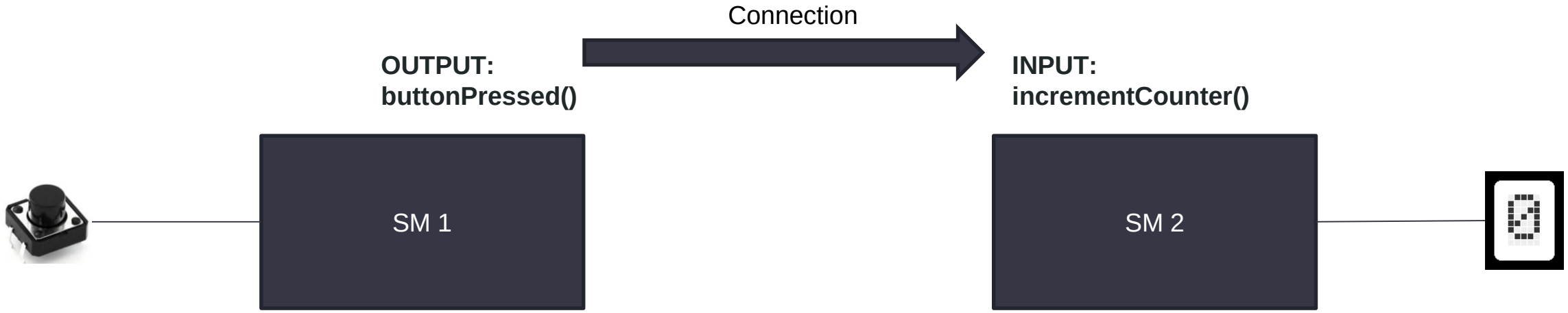

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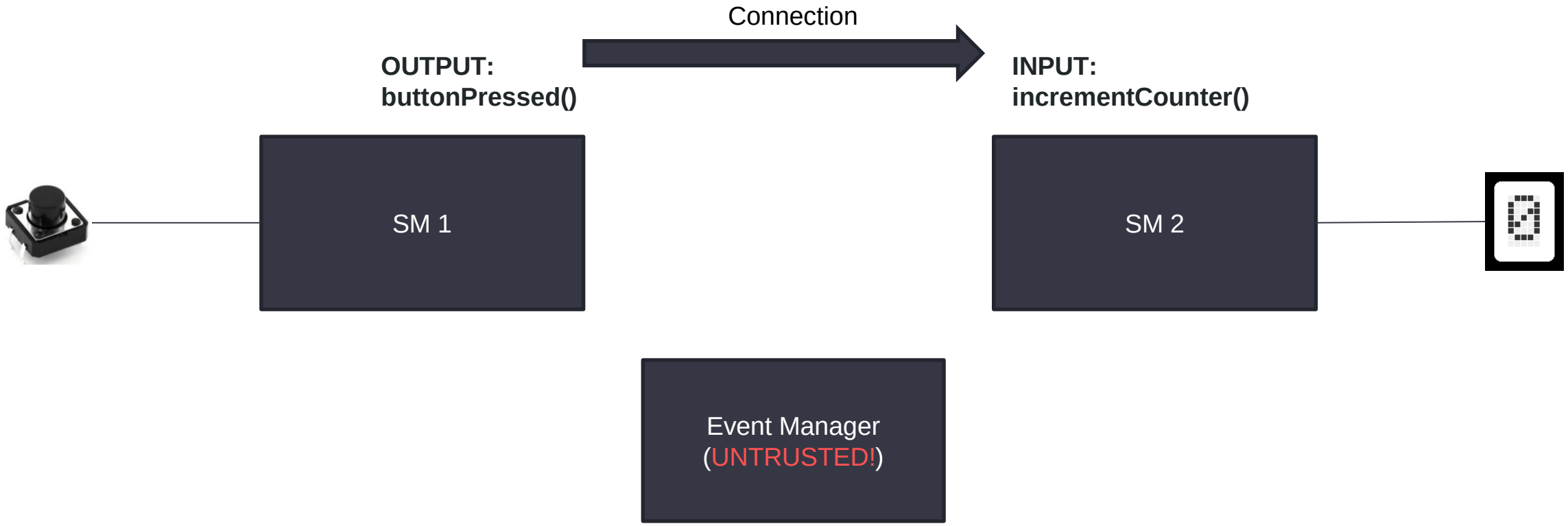

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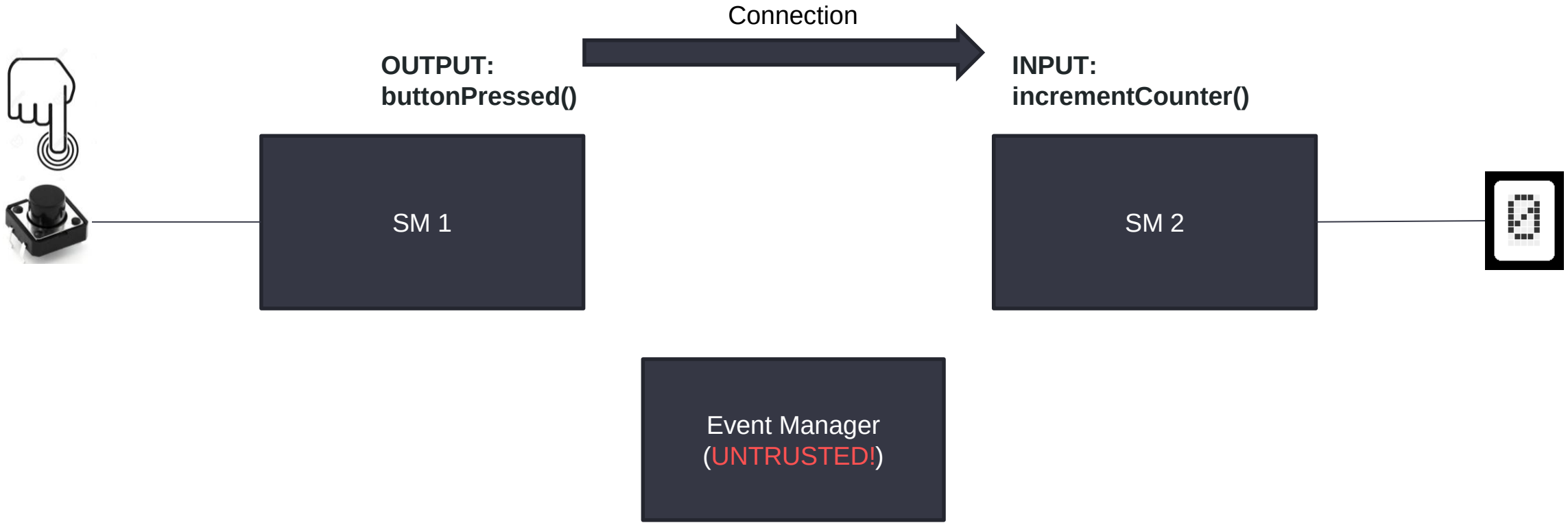

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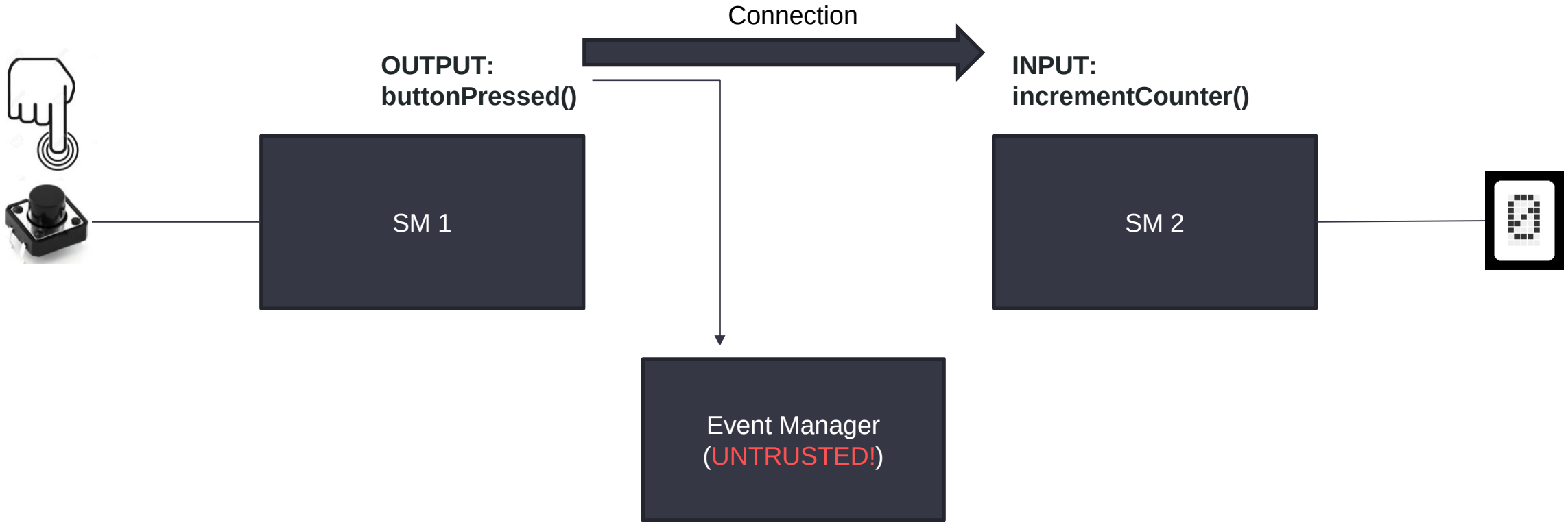

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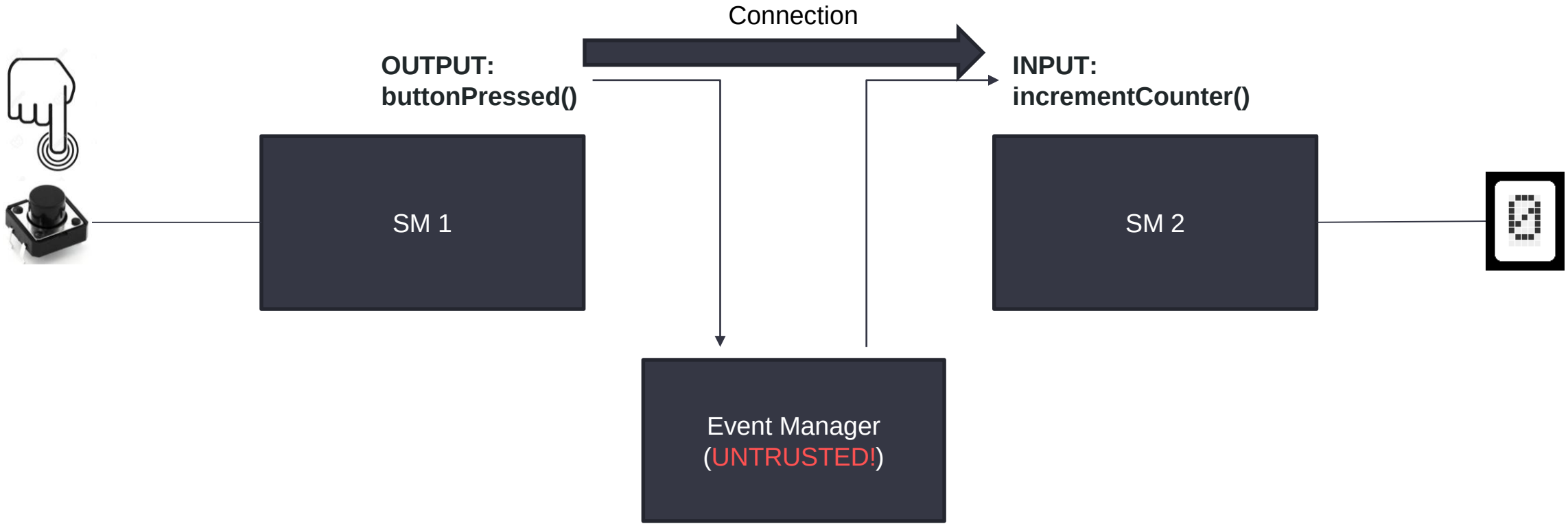

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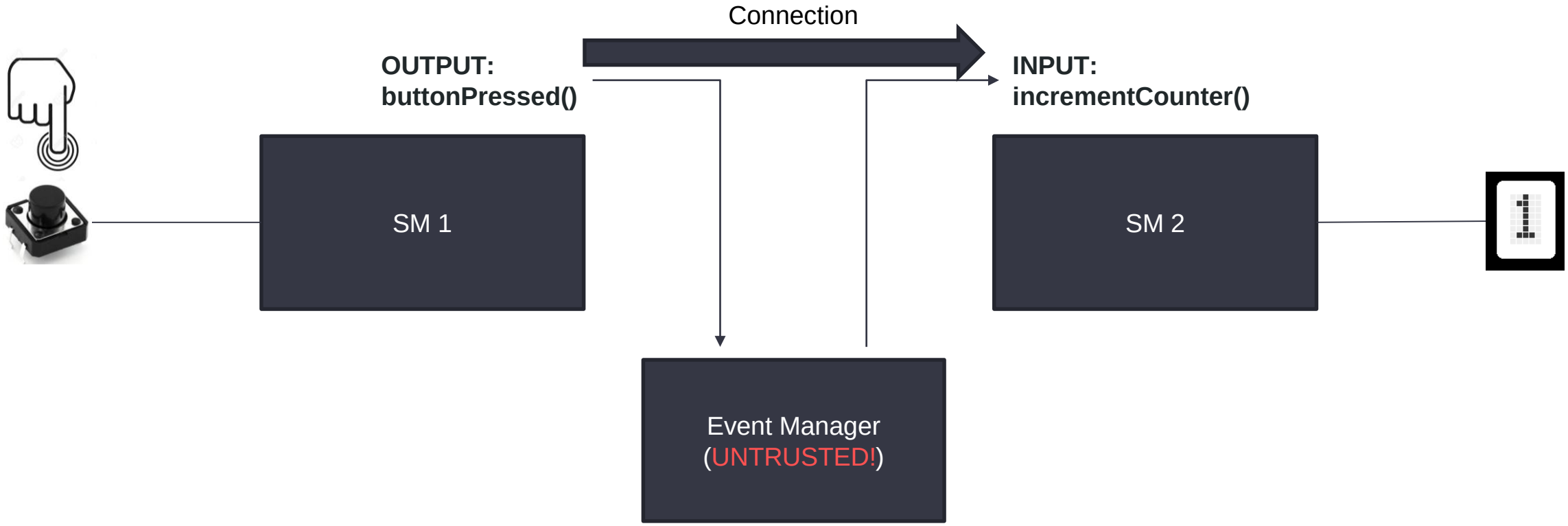

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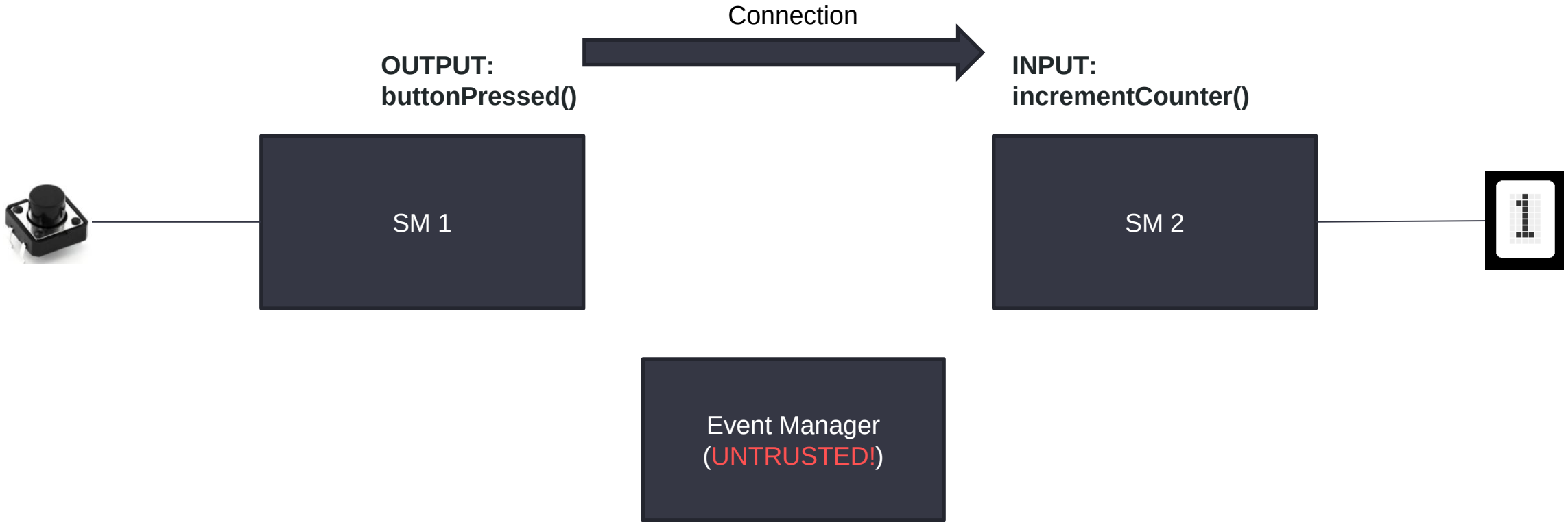

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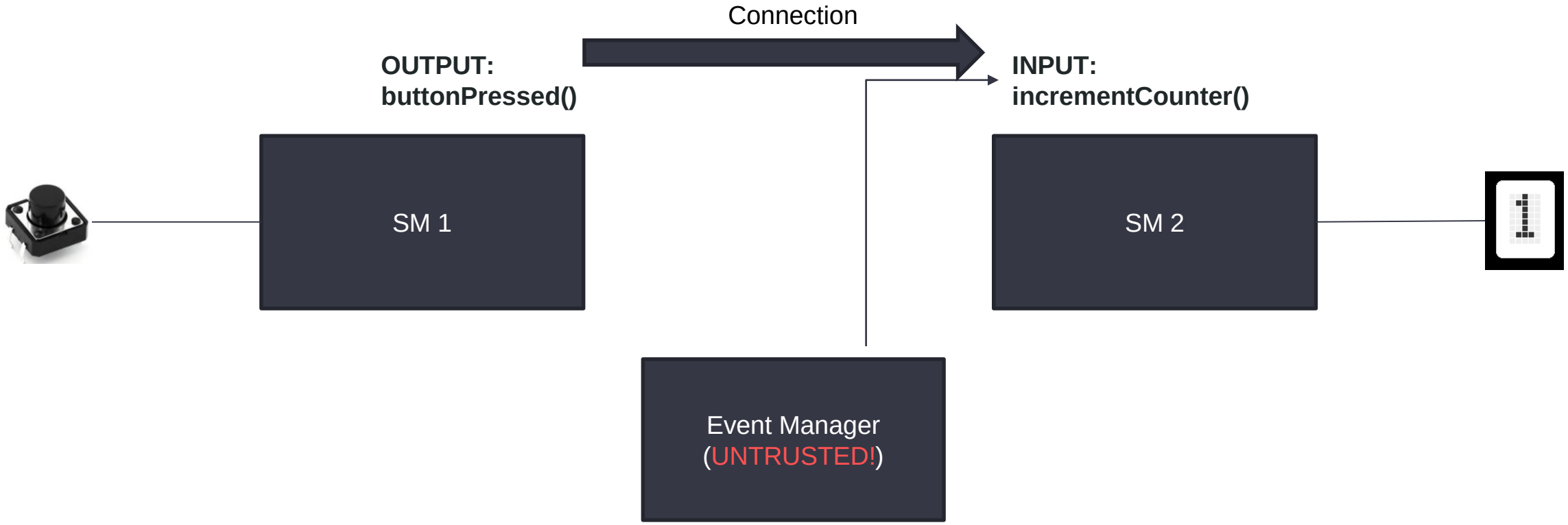

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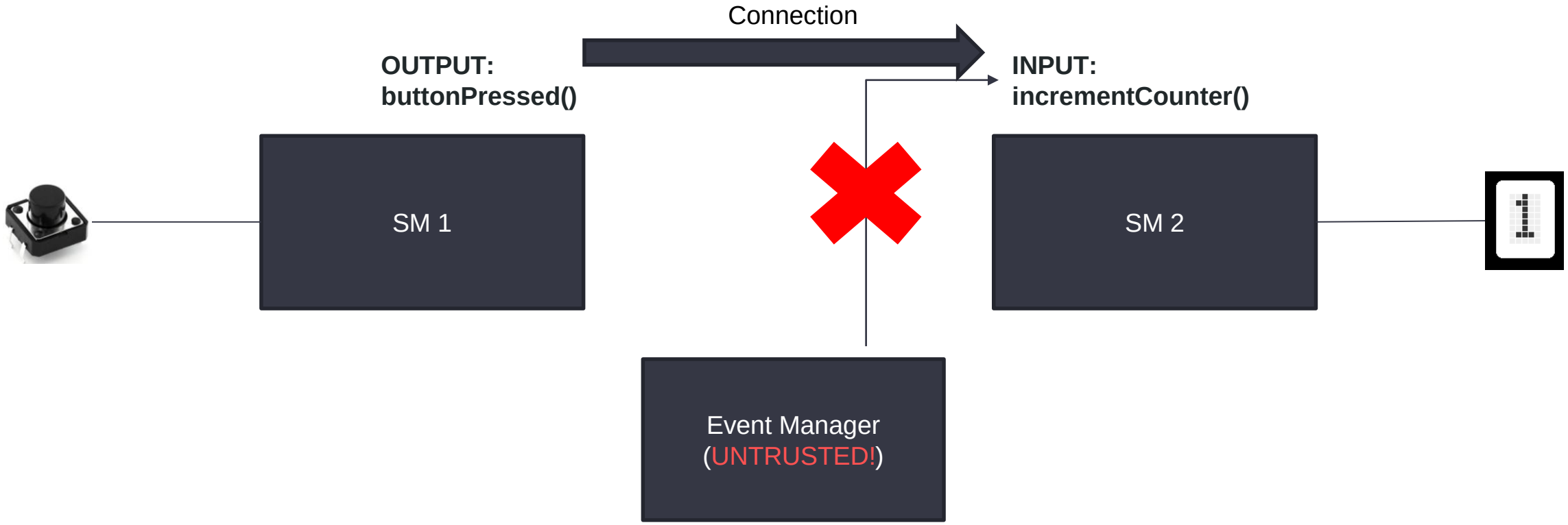

Limitations of the current implementations

- 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

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- Generalize the concept of Authentic Execution

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  - 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
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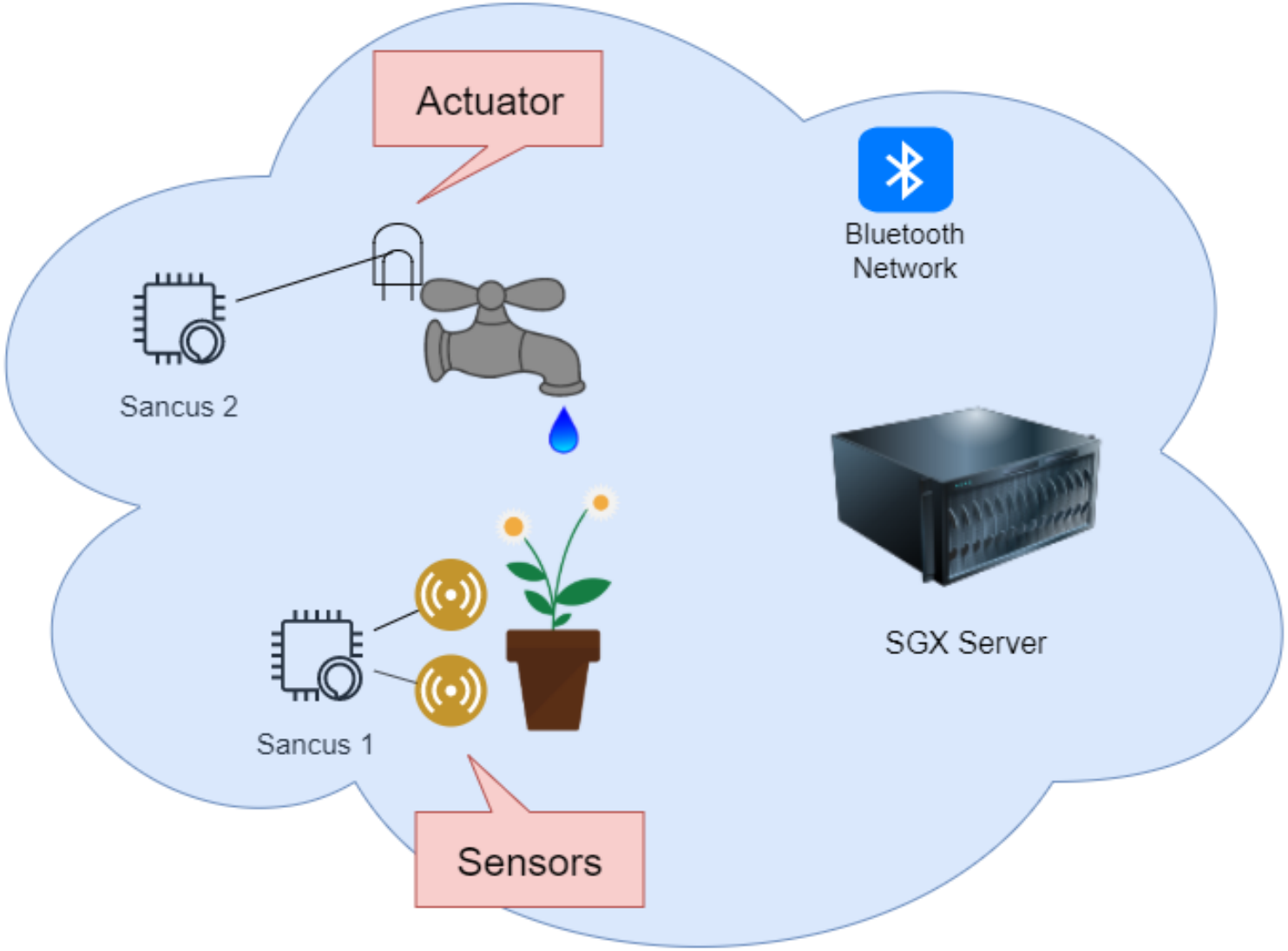
My Master's Thesis work

- 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

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- 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