How to protect Industry 4.0 Sensitive Industrial Plants from cyber and physical attacks

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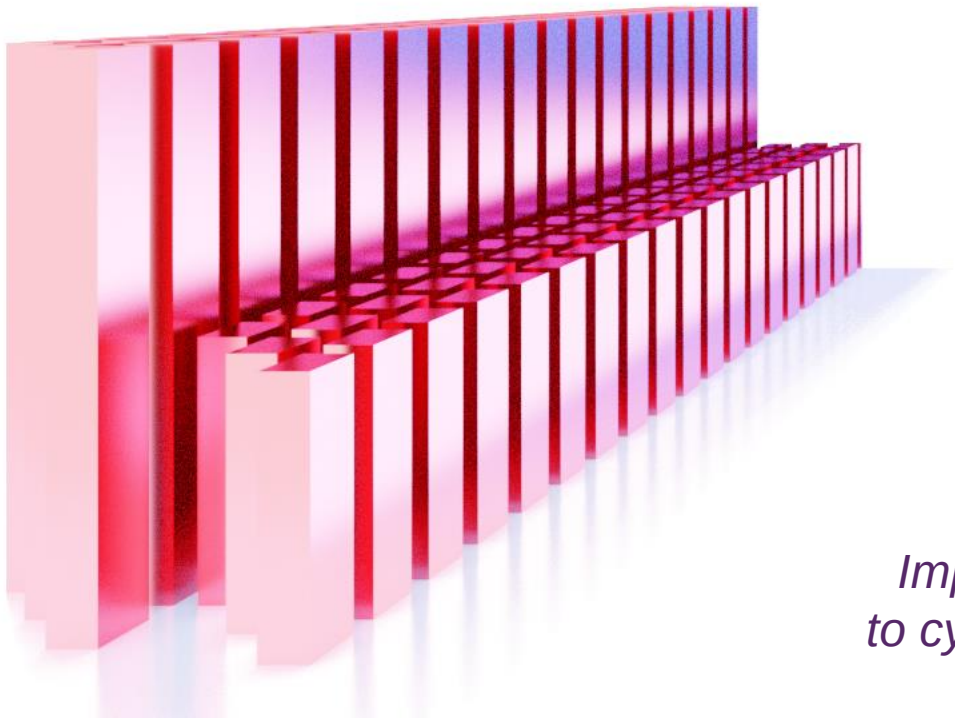

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Improving resilience of sensitive industrial plants & infrastructures exposed to cyber-physical threats by means of an open testbed stress-testing system

Outline

- The importance of cyber-security for Sensitive Industrial Plants and Systems (SIPS)
- Examples of cyber-physical attacks
- Challenges when IT and OT coexist
- An advanced SIEM solution implemented in the context of InfraStress:
  - The detection of attacks in IIoT (LP-WAN) deployments
  - The Intrusion Detection System monitoring the compliance of the business process

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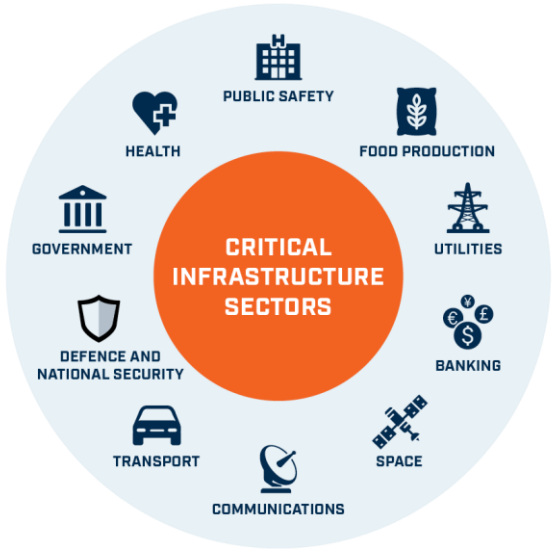
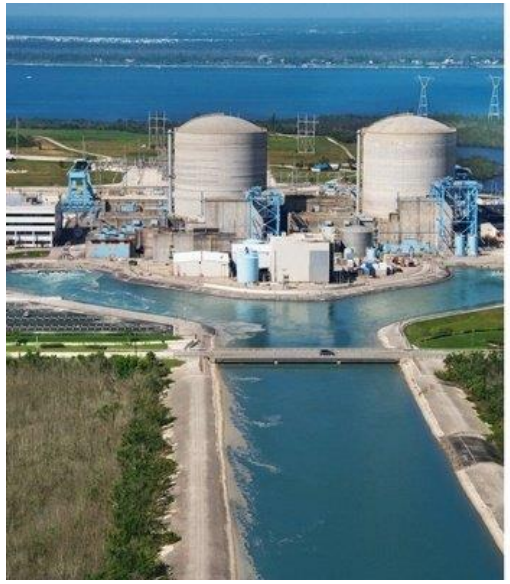
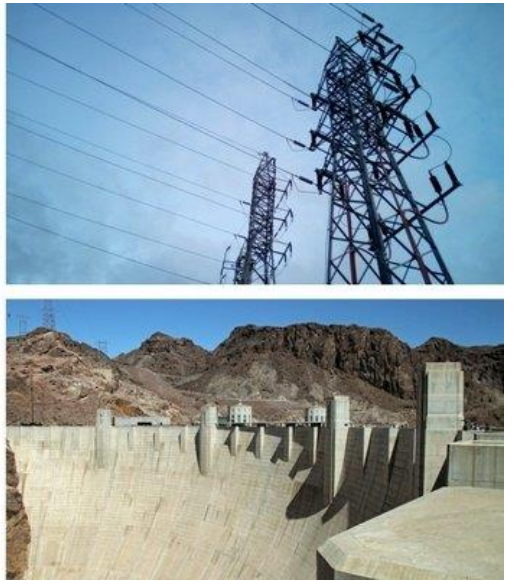
Cyber-security is key in SIPS

- Attacks to Industrial Control Systems of SIPS cost money, reputation, and even human lives







- Domino effects in the physical world could arise from cyber attacks, causing environmental disasters or serious damage to production lines

* The Official 2019 Annual Cybercrime Report https://www.herjavecgroup.com/the-2019-official-annual-cybercrime-report/

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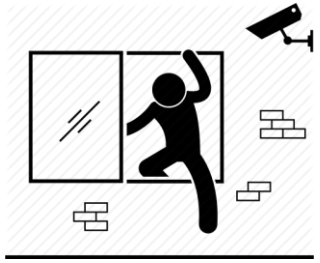
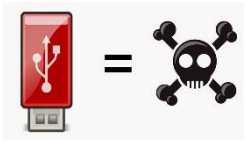
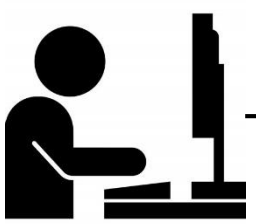
Environmental Disaster Example



The malicious user violates the site's security





A malware is inserted in the control room desktop machine.
It exploits a vulnerability to achieve privilege escalation

The attacker can now inspect the internal industrial network

The malware forces the valve of a critical tank to remain in an open state

Flammable liquid leaks, causing a fire

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Production Line Damage Example

An insider attacker injects a **malicious G-code** in a **CAD machine** and in the **product control system**

The CAD machine will use the malicious G-code to build, e.g., a medical prosthesis, with different specifications

The entire product line is compromised

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Why the SIPS protection is challenging?

- In Industrial Control Systems, two different technologies coexist:
  - **Information Technologies (IT)** → e.g., database, app server, web server, log server, …
  - **Operational Technologies (OT)** → e.g., valves actuators, sensors, tanks, robotic arm controllers, pumps controllers, …
- Typically, weaknesses are due to the usage of legacy technologies to link IT and OT solutions
- The security mechanisms should be able to take into account the two worlds together

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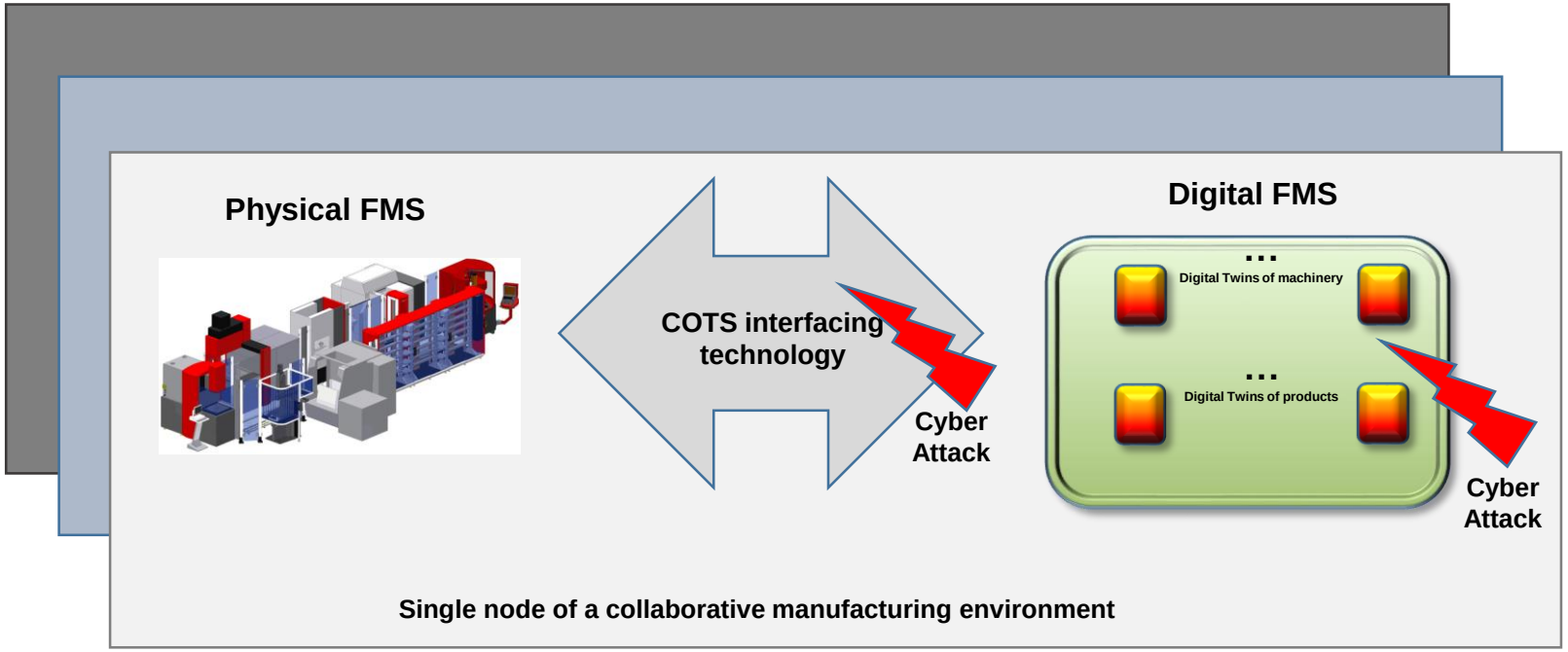
The InfraStress DePuy Case Study

- In Septemer 2018 DePuy has been recognized as one of the nine Industry 4.0 Lighthouse projects/companies
- It was explicitly mentioned that they “use legacy technology to build Digital Twins”



DePuy Synthes
COMPANIES OF Johnson&Johnson

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The InfraStress Solution for Situational Awareness

- In the context of the InfraStress project we build tools for monitoring the situation in the SIPS infrastructure
- We propose a **SIEM** (*Security Information and Event Management)* system that provides real-time analysis of data coming from OT and IT worlds by correlating their on-going events
- With respect to the state-of-the-art, the InfraStress SIEM encloses:
  - **IIoT IDS** → A detection system that monitors attacks in IIoT (LP-WAN) deployments
  - **BAM-based IDS** → A detection system that monitors business process violations

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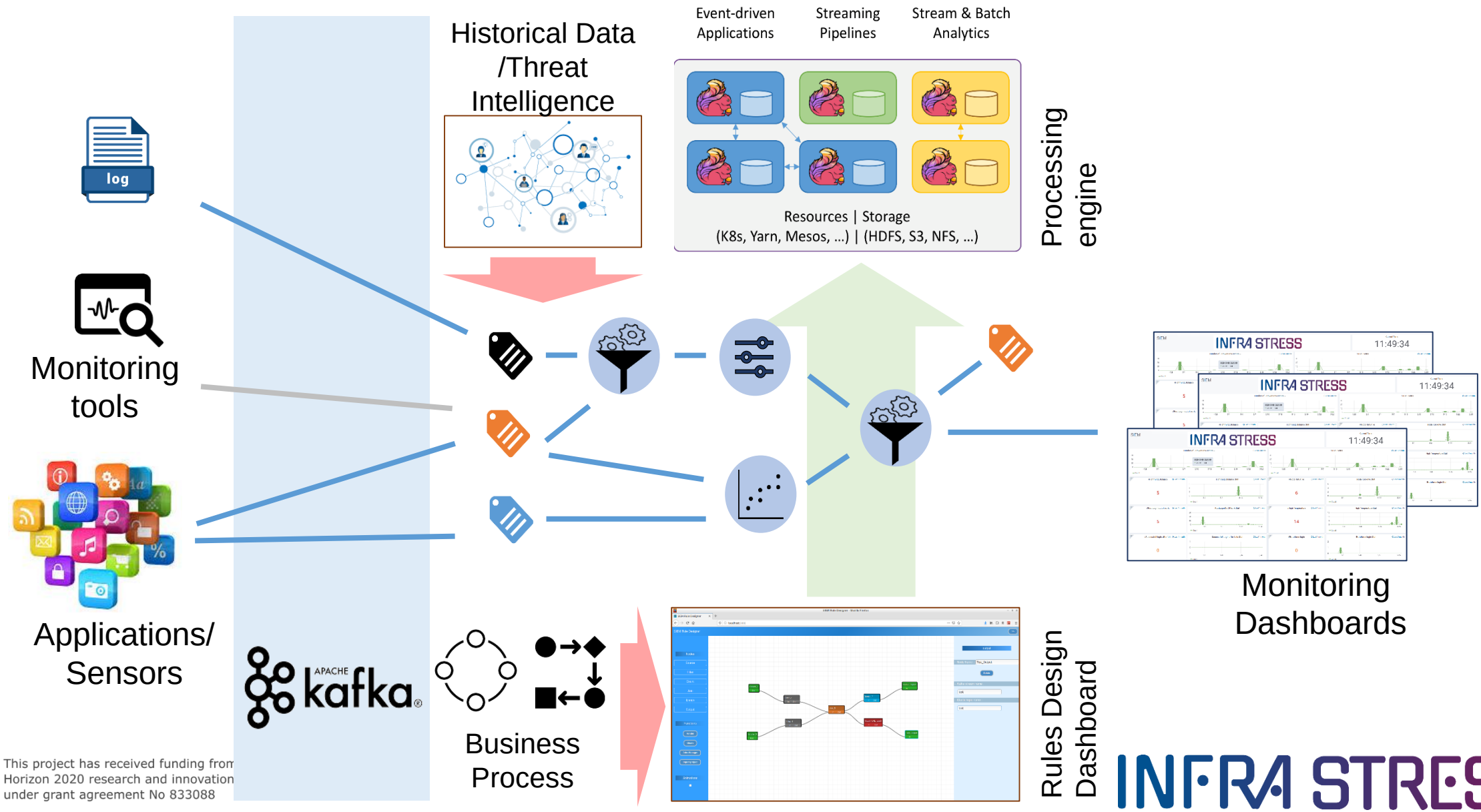
Architecture of the InfraStress SIEM



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Intrusion detection based on Business Process knowledge

- A business process can be fully monitored through a *smart contract*
  - » A *smart contract* is an agreement embedded in a program managed by a blockchain
  - » The program contains a set of rules under which the parties of that smart contract agree to interact with each other
- A finite state machine (**FSM)** representation provides a clearer view of the business process

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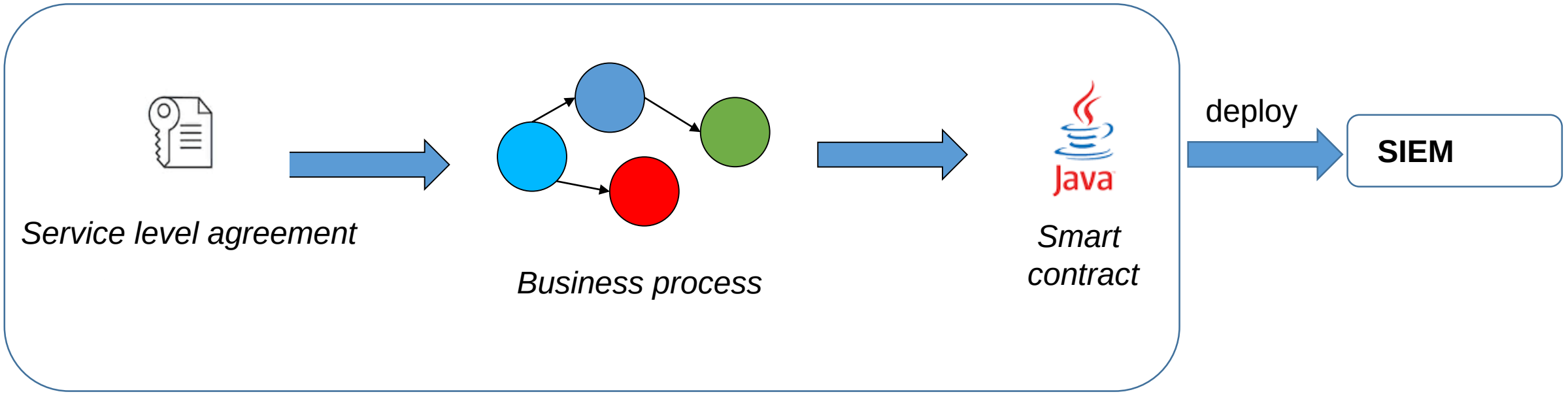
IDS based on BP knowledge



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Intrusion Detection in the IIoT world

- We have implemented an IDS that analyzes traffic in a LoRa-based IIoT network:

» Design and implementation of **LoRa-specific IDS probes**.

» Design and implementation of an intelligence module **for detecting the possible attacks** on the LoRaWAN protocol.

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Why LoRa

- **LoRa is widely used in IIoT since its features are:**
  - ✓ low energy consumption;
  - ✓ high coverage;
  - ✓ secure communication;
  - ✓ high scalability;
  - ✓ minimal infrastructure;
  - ✓ end nodes may not be connected to the internet

- **LoRa (Long Range) is a LPWAN (Low-Power Wide Area Network) technology that refers to a stack consisting of two levels:**

» **The first level is the physical layer** (PHY) which exploits a proprietary modulation derived from the Chirp Spread Spectrum (CSS).

» **The second level is the protocol** for the MAC level called LoRaWAN.

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Possible attacks on LPWAN

ATTACK	Attack Typology	Details
RF Jamming	*DoS*	Disrupting radio transmission with Malicious radio signals in proximity of application devices
Beacon Synchronization	*DoS*	Setting up a GW to send fake beacons to put EDs and GWs out-of-sync
Flooding	*DoS*	Increasing the number of packets to be sent to the gateway
Firmware Replacement	*DoS or Information Leak*	Replacing firmware to either steal keys or enforce some DoS attack
Key Disclosure	*Information Leak*	Dumping the memory to steal keys exchanged with the radio module
Parameters Manipulation	*DoS*	Manipulating frequency parameters in the GW to increase power consumption of EDs

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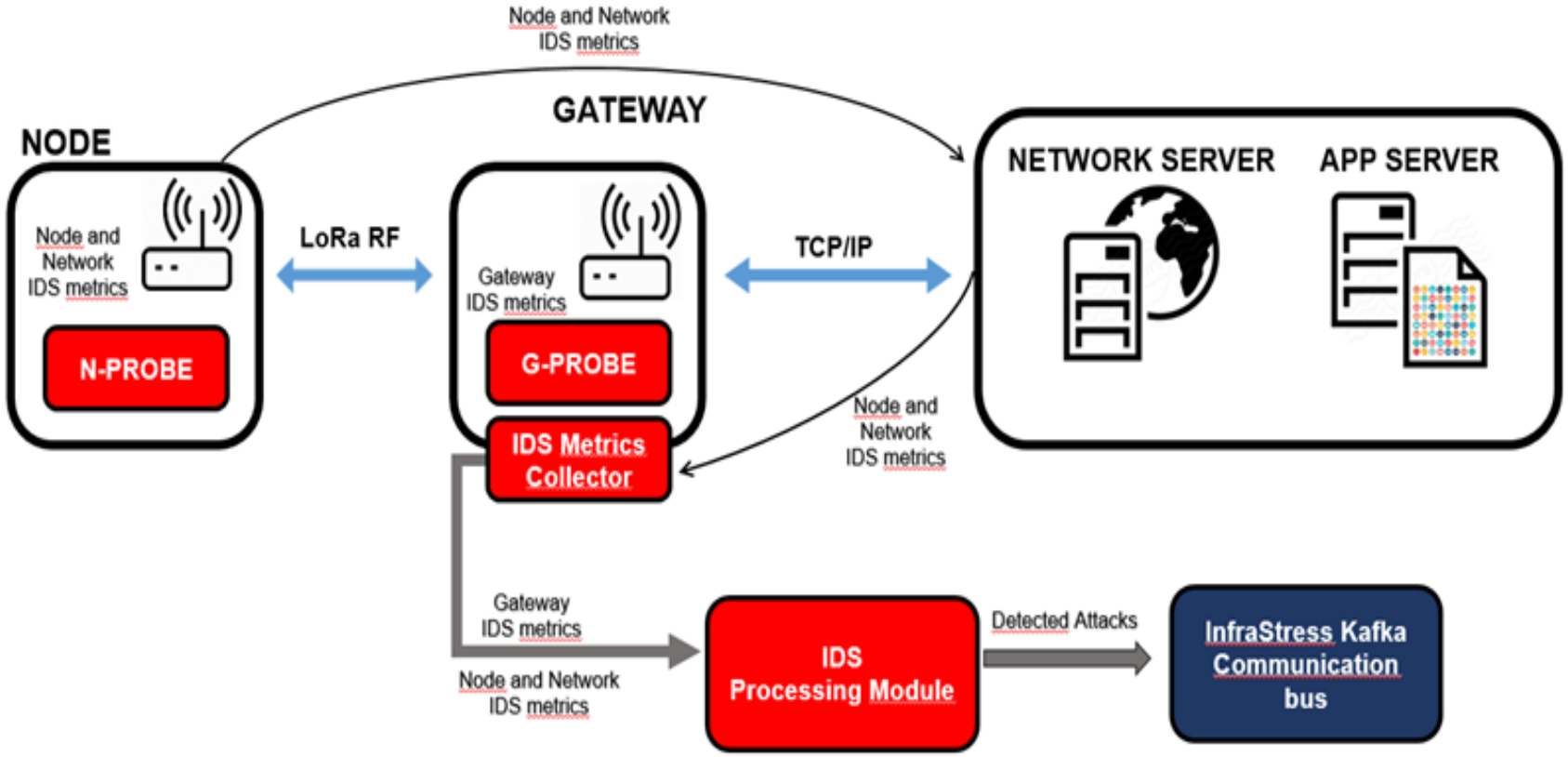
InfraStress LoRa IDS Architecture



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