

CPS: TTP Option: Medium: Collaborative Research: Cyber-Physical System Integrity and Security with Impedance Signatures

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Counterfeit goods have compromised human safety (fake aircraft parts), caused catastrophic financial loss (interception and resale of authentic goods), jeopardized human health (counterfeit vaccines and falsely advertised masks), and are expected to cost over \$4 Trillion in losses by 2022. Signed Physical Unclonable iDentities (SPUDs) combined with piezoelectric transducers and electromechanical impedance represent a promising direction for asserting both cyber and physical information for counterfeit detection.



Challenges

- In a distributed supply network, preserving the integrity of cyber-physical system components is difficult.
- One of the challenges is to ensure that the cyber-information of a part and the associated part instance are not tampered with.

Solution Approach

- The proposed solution is to leverage the electromechanical impedance of a part to generate an unclonable part identity.
- The Impedance signature is inherent to an individual part, due to its intrinsic physical characteristics. Physical characteristics (including the sensor properties) are unique for each part instance.
- Linking this unclonable impedance signature to its cyber-information improves security guarantees by requiring authentication of both cyber (answer: who currently holds the part?) and physical (answer: which part instance?) information.

Scientific Impact

- Linking the physical identity of a part instance to its cyber-information ensures robust CPS infrastructure.
- Using the electromechanical impedance signature of a part to create a physical identity creates an asymmetric attack cost for malicious actors to create undetected counterfeits.

Broader Impacts

Potential Impact

- With the proposed research, the security and safety of the CPS systems would be enhanced.
- This would prove beneficial to develop a powerful defense mechanism which can be employed by manufacturers to secure parts under circulation.

Society

- Industries producing high-value parts for safety-critical applications can ensure their goods are not tampered with or exchanged for inferior replicas.
- In medicine, this may mitigate circulation of counterfeit drugs and medical devices.
- In manufacturing, the same approach can ensure aircraft components are safe to use in construction of e.g., a commercial airliner.

Education & Outreach

- Educating the current and future workforce about the importance of CPS security and the consequences of vulnerabilities from one domain manifesting in the other (e.g., plane crash from counterfeit oil filter).
- Improving multidisciplinary workforce development in CPS topics.