Security in transportation systems

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Drivers for security needs

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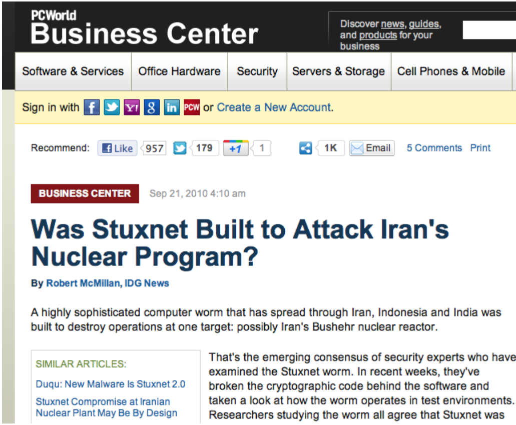
Implications: Creates multiple attack possibilities.

What makes CPS security different?

- Information security insufficient.



BUSINESS CENTER Sep 21, 2010 4:10 am

Was Stuxnet Built to Attack Iran's Nuclear Program?

By Robert McMillan, IDG News

A highly sophisticated computer worm that has spread through Iran, Indonesia and India was built to destroy operations at one target: possibly Iran's Bushehr nuclear reactor.

SIMILAR ARTICLES:

Duqu: New Malware Is Stuxnet 2.0

Stuxnet Compromise at Iranian Nuclear Plant May Be By Design

That's the emerging consensus of security experts who have examined the Stuxnet worm. In recent weeks, they've broken the cryptographic code behind the software and taken a look at how the worm operates in test environments. Researchers studying the worm all agree that Stuxnet was

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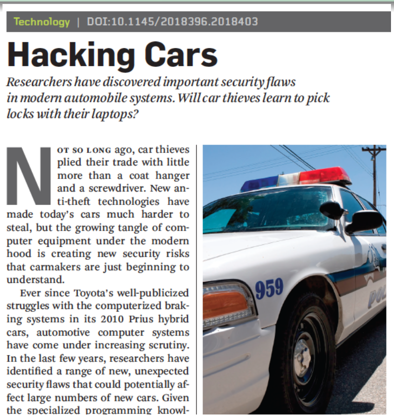

Technology | DOI:10.1145/2018396.2018403

Hacking Cars

Researchers have discovered important security flaws in modern automobile systems. Will car thieves learn to pick locks with their laptops?

Not so long ago, car thieves plied their trade with little more than a coat hanger and a screwdriver. New anti-theft technologies have made today's cars much harder to steal, but the growing tangle of computer equipment under the modern hood is creating new security risks that carmakers are just beginning to understand.

Ever since Toyota's well-publicized struggles with the computerized braking systems in its 2010 Prius hybrid cars, automotive computer systems have come under increasing scrutiny. In the last few years, researchers have identified a range of new, unexpected security flaws that could potentially affect large numbers of new cars. Given the specialized programming knowl-

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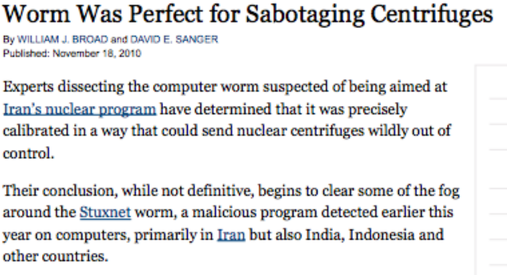

Worm Was Perfect for Sabotaging Centrifuges

By WILLIAM J. BROAD and DAVID E. SANGER
Published: November 18, 2010

Experts dissecting the computer worm suspected of being aimed at Iran's nuclear program have determined that it was precisely calibrated in a way that could send nuclear centrifuges wildly out of control.

Their conclusion, while not definitive, begins to clear some of the fog around the Stuxnet worm, a malicious program detected earlier this year on computers, primarily in Iran but also India, Indonesia and other countries.

Attack vectors:

- Software/hardware attacks: implementation vulnerabilities.
- Communication attacks: Changing information bits, delays, impersonation etc.
- Physical attacks: Sensor/actuator attacks and spoofing.

Message: Vulnerability in both software/cyber and physical sides.

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  - Shared control.
  - Multiple time-scales.

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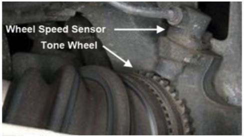
Fooling ABS sensors

ABS sensor



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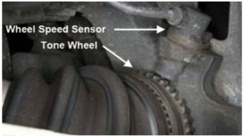
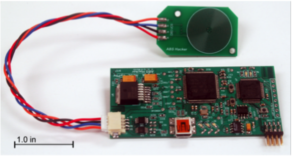


Spoofing device



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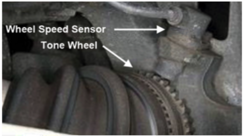

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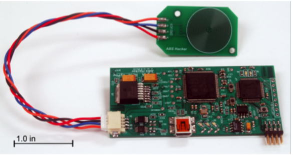

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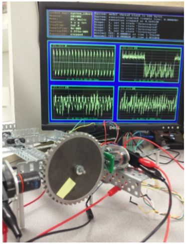

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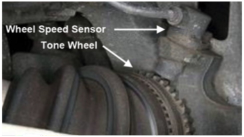

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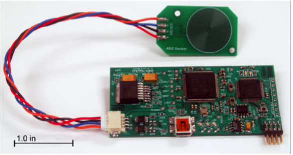

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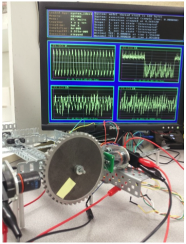

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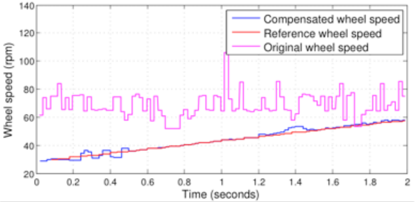

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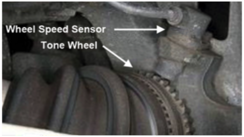

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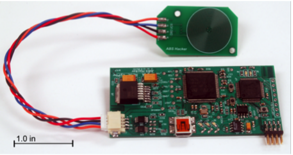

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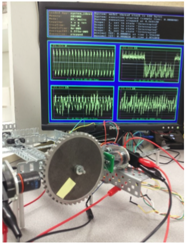

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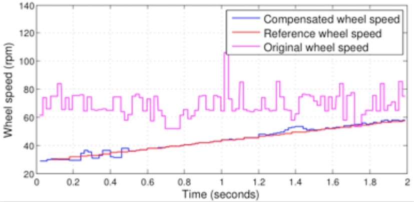

Implication: Cryptography cannot protect against (analog) sensed signal manipulation.

Shoukry etal CHES 2013.

Potential goals of attack

- Cause catastrophe.

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- Change system behavior.

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- Move system to undesirable state.

Defense: Will depend on type of attack.

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NSF CPS project “Foundations of secure CPS”

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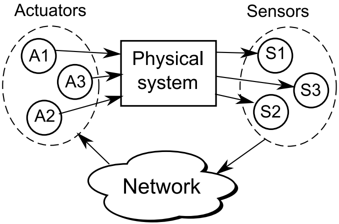
Illustrative idea: Use the redundancy inherent to physical system dynamics to provide “error-correction” capability.

Secure state estimation and control

Physical process modeled as a linear dynamical system:

$$x^{(t+1)} = Ax^{(t)} + Bu^{(t)}$$

$$\underbrace{y^{(t)}}_{\in\mathbb{R}^p} = Cx^{(t)}$$



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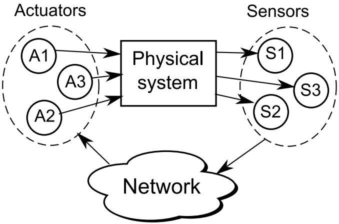

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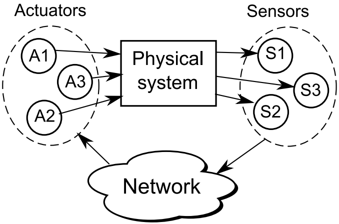

Results:

- If $q = \mathrm{supp}(e) < \frac{p}{2}$ then can estimate state (a.e. system) $\longrightarrow$ real error correction.
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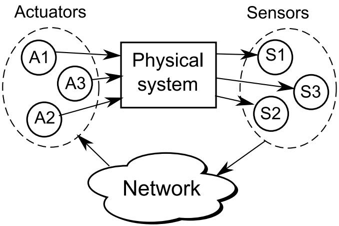

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Bottomline: Using physical dynamical model we can defend against (some) sensor/actuator attacks.

Fawzi, Tabuada and Diggavi, Trans. Aut. Control.

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New ideas needed: Mix of security, control, networking, error correction and human/social behavior.

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- **Secure networked control:**
  - Overlay monitoring system?
  - No single point of failure: no one with complete view.
  - Secure sensing/actuation (analog domain).
  - Offline design: added security around points of vulnerability.