Side-Channel Analysis

Hardware Hacking from a Distance

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OUR VISION
pioneering for
a better future


what's a new way to cure cancer?
THE ANSWER IS IN THE DATA

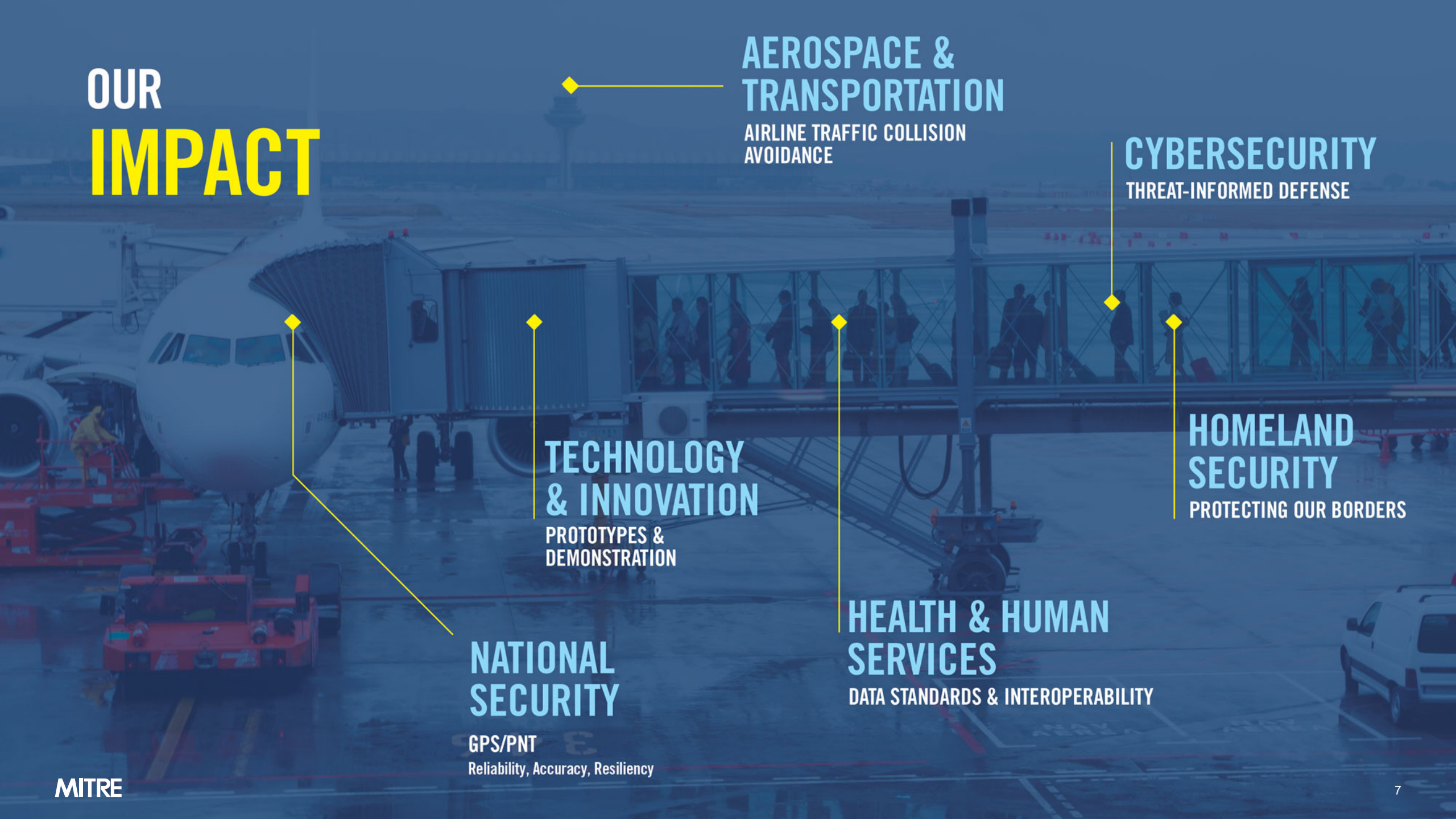
OUR DIFFERENTIATED VALUE

- Mission-Driven
- Innovative Approach
- Objective Insight
- Unique Vantage Point
- Technical Know-how
- Pioneering Together

NEXT LEVEL INNOVATION

requires extraordinary people

OUR IMPACT



AEROSPACE & TRANSPORTATION

AIRLINE TRAFFIC COLLISION AVOIDANCE

CYBERSECURITY

THREAT-INFORMED DEFENSE

TECHNOLOGY & INNOVATION

PROTOTYPES & DEMONSTRATION

HOMELAND SECURITY

PROTECTING OUR BORDERS

NATIONAL SECURITY

GPS/PNT

Reliability, Accuracy, Resiliency

HEALTH & HUMAN SERVICES

DATA STANDARDS & INTEROPERABILITY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EVERY DAY

eCTF Embedded Capture the Flag

Annual embedded security competition

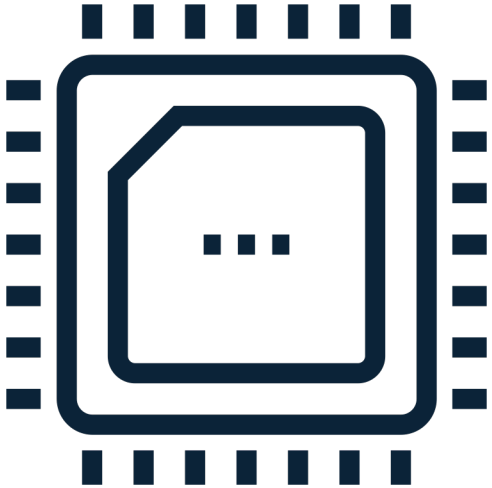
Teams design, build, and attack secure embedded systems

Over the spring semester

Opportunity for course credit

Excellent opportunity

Unique Competition Design



Focus on Embedded

Physical and emulated hardware opens scope to physical and proximal attacks

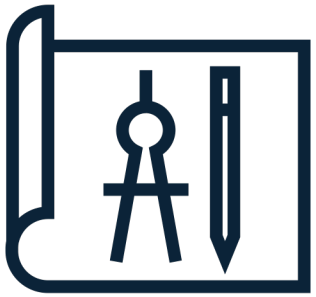
Attack and Defend

Students wear both “hats” by acting as both red team and blue team

Extended Time

Semester-long competition opens door to advanced attacks and countermeasures

Competition Phases



Design Phase

Teams design and implement systems that meets security and functionality requirements

Handoff

Organizers test each design for functionality

Attack Phase

Teams analyze and attack each other's designs for points

Real-World Scenarios

Smart Door Lock

ATM Machine

Self-Driving Car

Drone Delivery

Video Game Player

Avionics

Why do the eCTF?

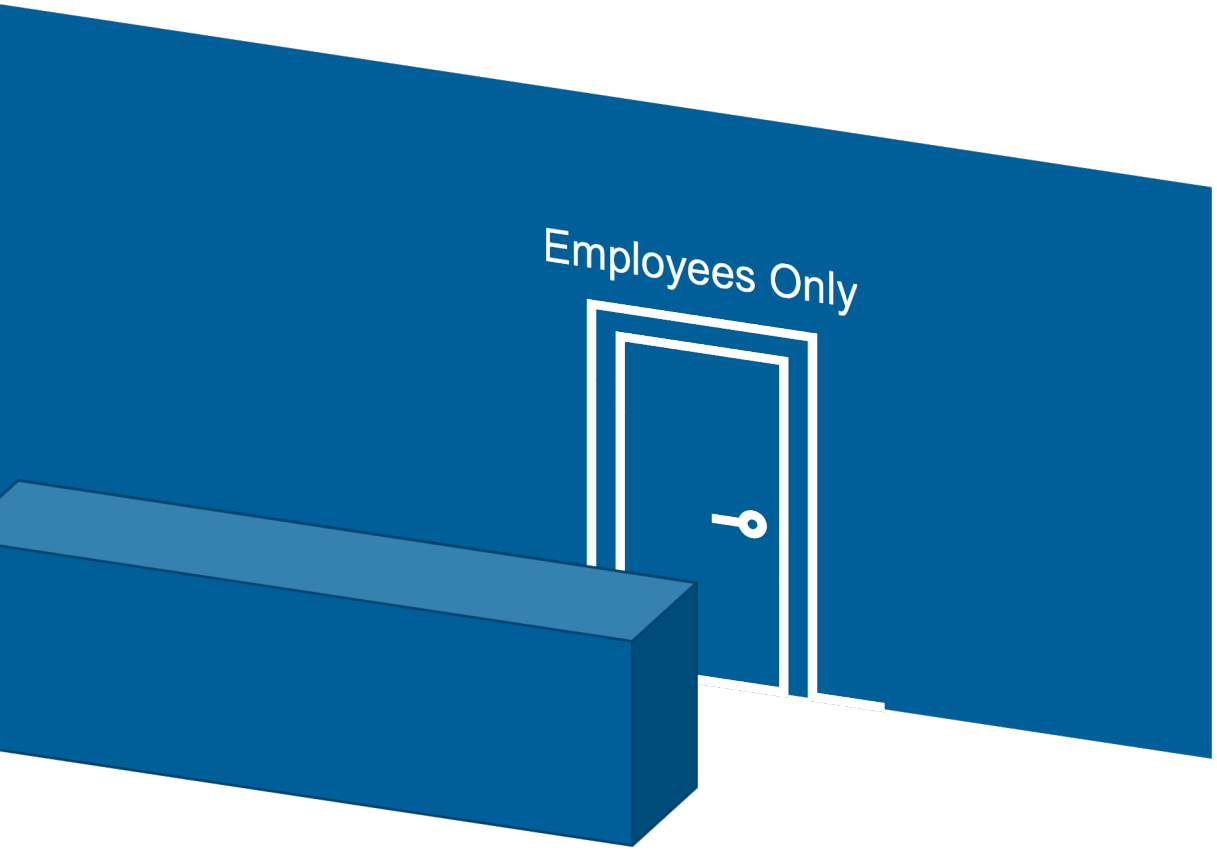
- **Unparalleled hands-on experience**
  - Crypto/protocol design
  - Low-level C programming
  - Real-world offensive security
  - Project management
- **Career advancement**
  - Looks great on a resume
  - Massive talent supply shortage in embedded security
- **It's fun! (but a lot of work)**

What is a Side-Channel?

Side-Channel Example: Store Backroom

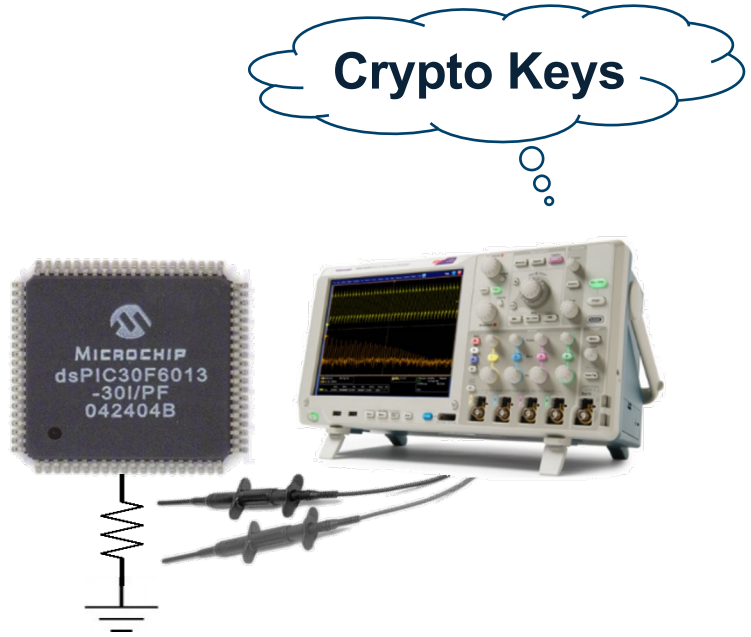
By only asking employees for items in the back and without going in yourself, figure out:

How is the backroom organized?
Where are different items located?
What shelves are items stored on?
How many items per bulk box?



Side-Channel Analogy

Acoustic Side-Channel



Power Side-Channel

Side-channel analysis (SCA) leverage *unavoidable side-effects* of performing computation

Side-Channel Attacks

SCA commonly used to:

Reverse engineer system operation

Extract information (e.g., keys)

Monitor and validate system behavior

Execution Time

https://commons.wikimedia.org/wiki/File:Dtjohnnymonkey-Stopwatch-no-shading.svg

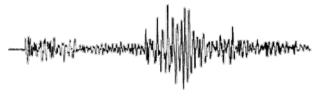
Instantaneous Power

EM Radiation

http://www.itp.net/573498-intel-core-i7-920

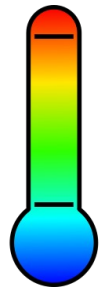
https://www.kisspng.com/png-light-electromagnetic-spectrum-electromagnetic-rad-1233022/

Acoustic Vibrations



https://commons.wikimedia.org/wiki/File:1989_Loma_Prieta_earthquake_seismogram.jpg

Thermal



https://pixabay.com/en/thermometer-temperature-rainbow-305319/

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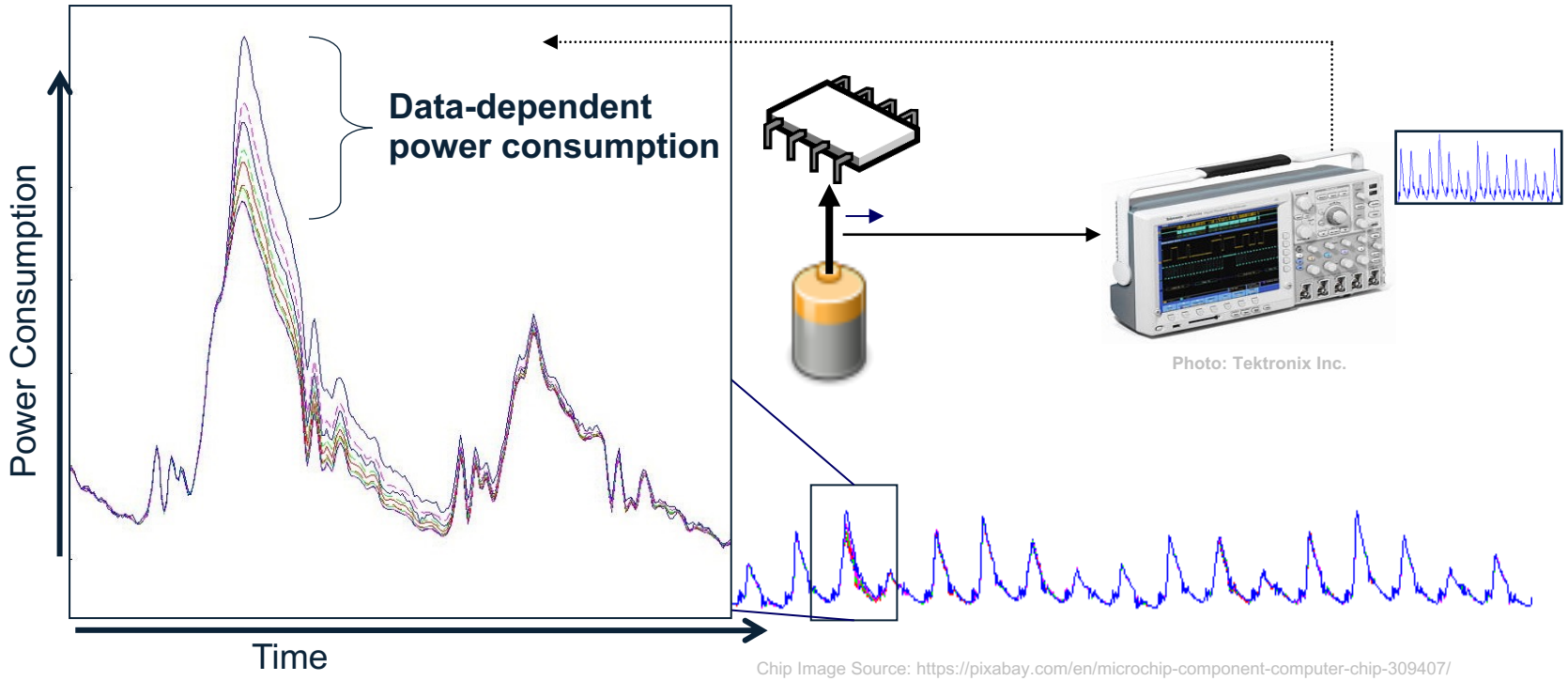
Side-Channel Capture

Side-channel leakage is captured during normal device operation

- Target device is instrumented with sensors (e.g., current monitor)
- Device commanded to perform its sensitive operation
- Captured side-channel data is stored along with the corresponding inputs and outputs

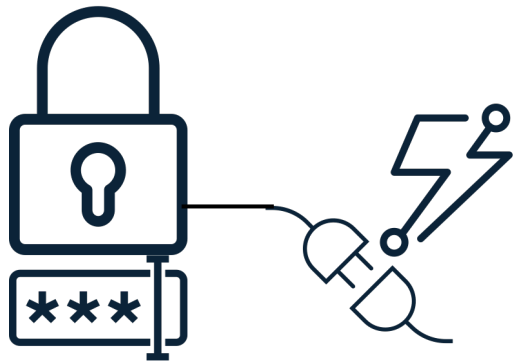


Chip Image Source: https://pixabay.com/en/microchip-component-computer-chip-309407/
Battery Image Source: Tango Desktop Project

Side-Channel Workshop: PIN Lock

Scenario:

- A door is secured by a smart door lock
- We want to figure out the 4-digit PIN to open it



Data available to us:

- Success / failure of PIN guess
- Power consumption of the lock device
- Knowledge that the lock uses strcmp

Side-Channel Workshop: strcmp

strcmp(correct_pin, incorrect_pin)

Correct PIN:	1	2	3	4
	≠	>		
Pin Guess:	1	1	1	1

Side-Channel Workshop: strcmp

strcmp(correct_pin, incorrect_pin)

Correct PIN:	1	2	3	4
	=	<		
Pin Guess:	1	3	1	1

How could we exploit this?

Side-Channel Workshop

https://mybinder.org/v2/gh/janisbent/sc-lab/v3.0?filepath=lab.ipynb

https://bit.ly/3ogwoQn

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