Challenges in Developing Secure Software

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Hans-Joachim Hof, Technical University of Ingolstadt, Germany

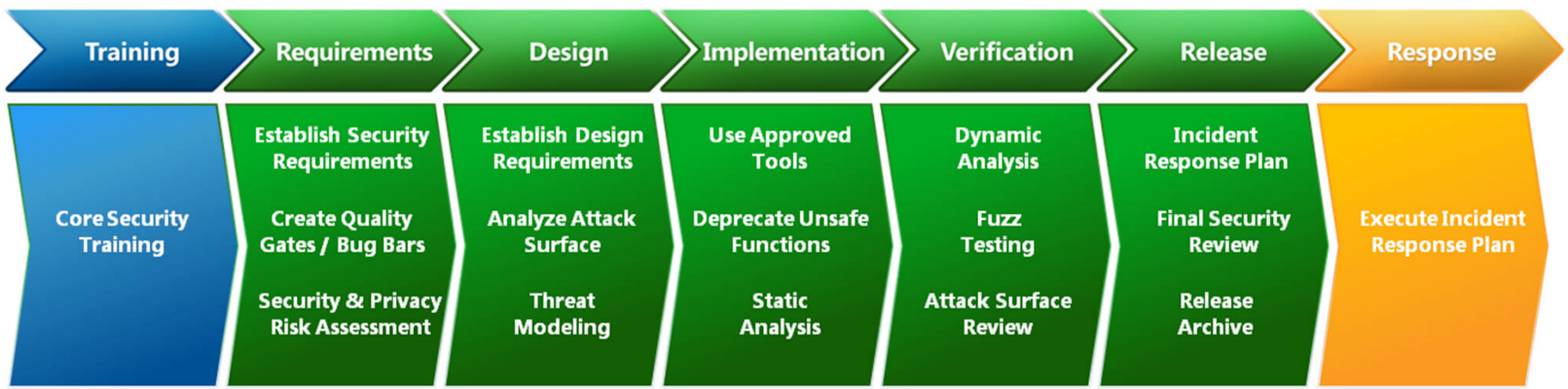
What is SSD

The practice used when developing software aimed at minimizing the application's vulnerabilities to threats.

Types of threats

- Malicious User Penetration
  - Avoiding authorization rules
  - Gaining access to trusted recourses
  - Avoiding licensing
- Denial of Service
- Unavailability due to application crash
- Unavailability due to application partition
- Data integrity violation

Do we have the correct SDLC for secure software?



Do we have the correct programming paradigms for secure software development ?

- Procedural
- Object Oriented
- Functional
- Declarative

Do we value security in the requirements phase?

- Are non-functional requirements 1st class citizens?
- Do we have the ability to model non-functional requirements?

Do we have the correct social norms for secure software development?

- Teach me to Trust
- Trust No-One

Technische Hochschule Ingolstadt

CARISSMA
Automotive Safety Research

MuSe
Munich IT Security Research Group

Ingolstädter Forschungsgruppe
Angewandte IT-Sicherheit
INSicherheit

Panel Discussion

Challenges in Developing Secure Software

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Technical University of Ingolstadt

The Internet of Things

Ingolstädter Forschungsgruppe Angewandte IT-Sicherheit

- Connecting millions of embedded devices to the Internet to gain new insights, save costs

- However:
  - High cost pressure on consumer devices ➔ security often ignored
  - Slow innovation cycles on many other devices ➔ security not included yet, takes long to change things

- Observation: history repeats itself, vulnerabilities from the 90ies have a renaissance, perimeter protection is back, …

The Internet of Malicious Things

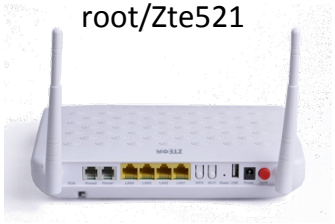
- 2016 Dyn Cyberattack by Mirai Botnet (>620 Gbit/s)

admin/123456

root/anko

root/54321

root/Zte521



IoT devices

Sources: https://krebsonsecurity.com/2016/10/hacked-cameras-dvrs-powered-todays-massive-internet-outage/ , https://krebsonsecurity.com/2016/10/who-makes-the-iot-things-under-attack/
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IoT devices
in a botnet

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IoT devices
in a botnet

Massive
DDoS
Attack

Dyn

Provider of core
services (DNS)

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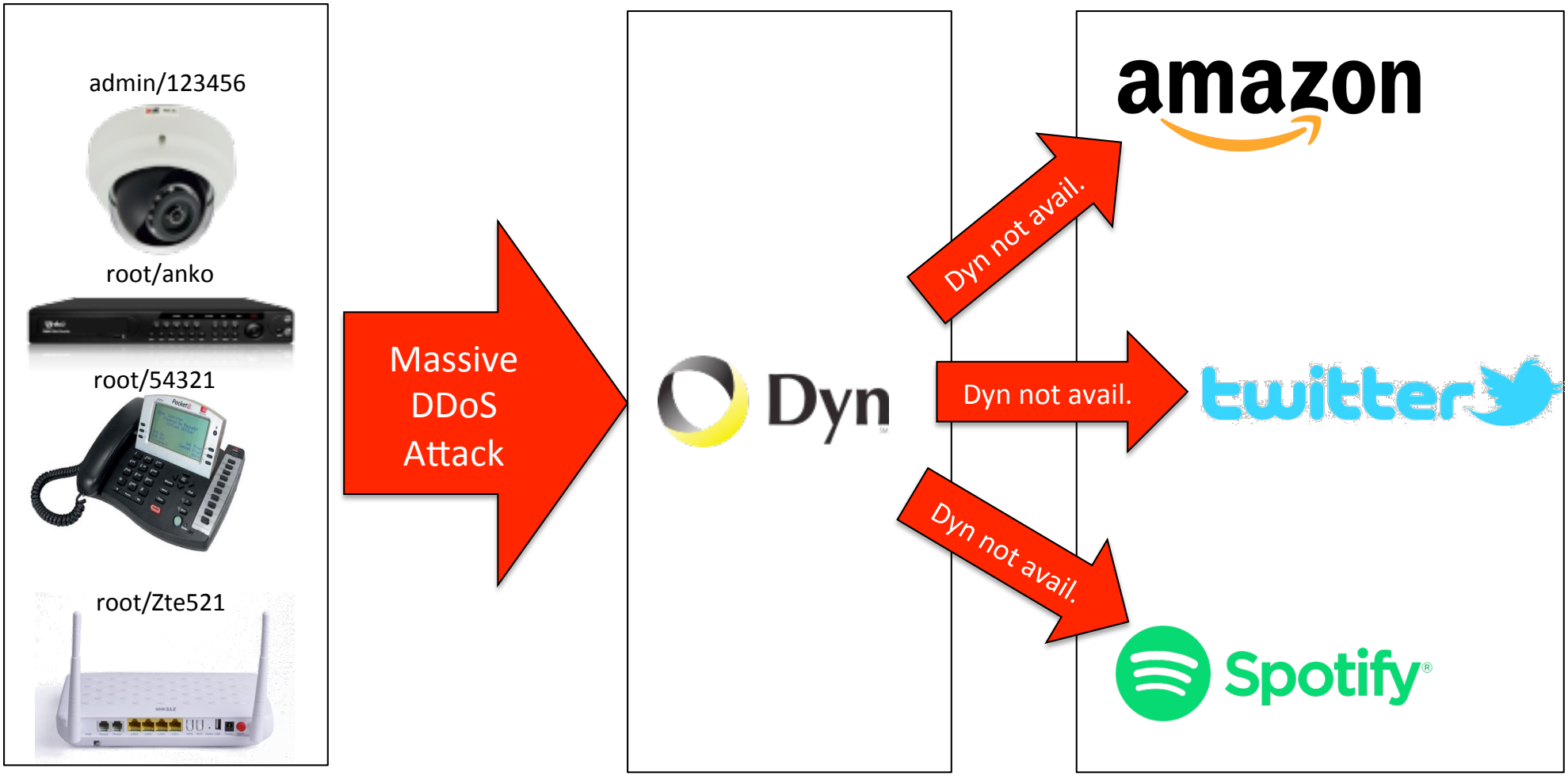

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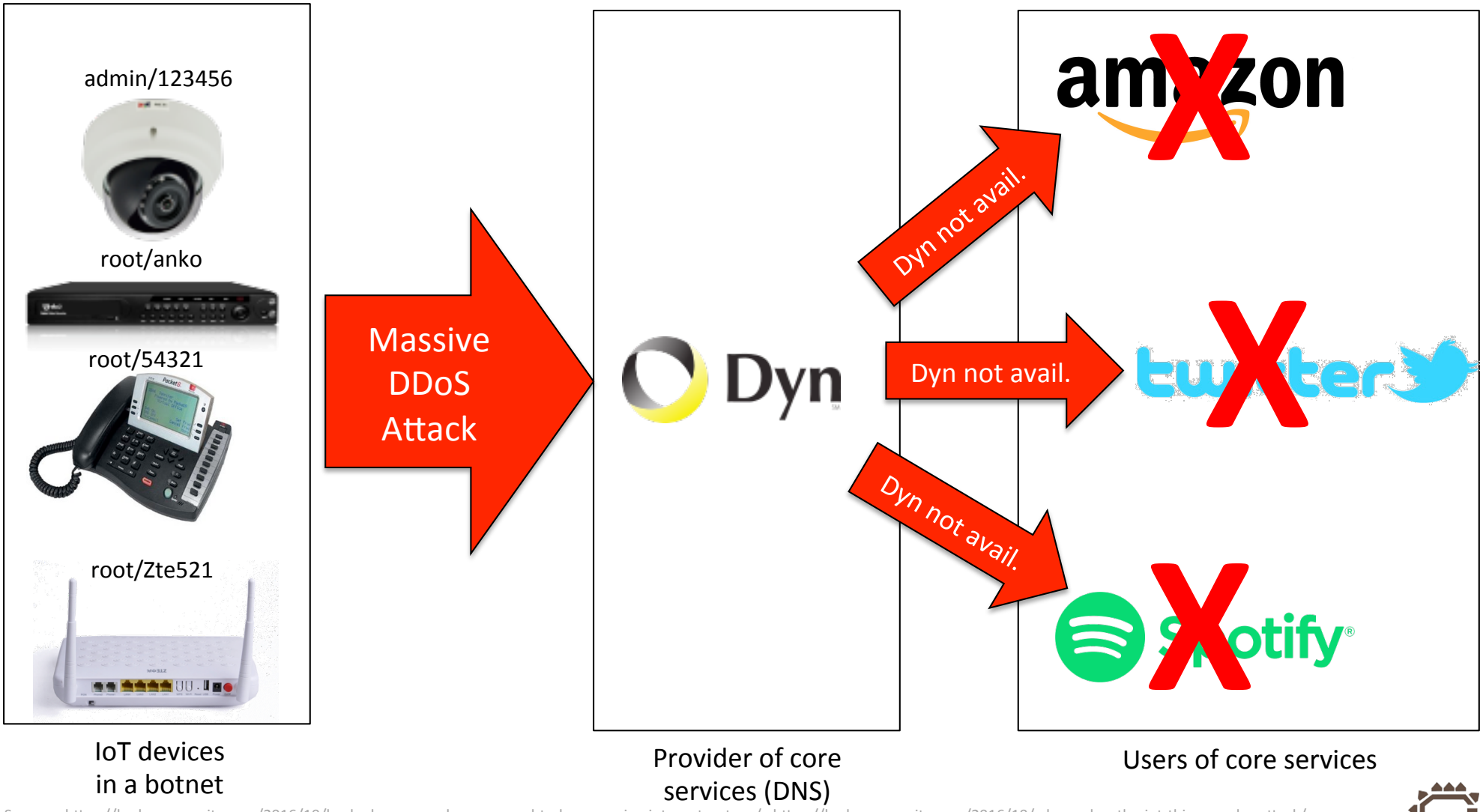

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Challenges in Embedded Systems Software Security

Ingolstädter Forschungsgruppe Angewandte IT-Sicherheit

- Non-functional requirement on device with limited resources/budget
  ➔ security things get "optimized":
  - Use of weak crypto (encryption algorithm, block mode, initialization vector)
  - Key management weaknesses
  - Disabled security checks (e.g., signature check of firmware update)
  - Treating not-protected (integrity/confidentiality) information as security information (e.g., version control by filename, treating a public ID as secret)

- Not enough reuse of security solutions ("you are not THAT special")
  - Individual hardware for special use case hinders reuse
  - A trend to build own security functions (e.g., to avoid TLS)

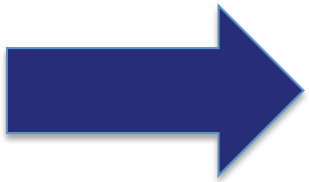
- You need to get it as right as possible in the first try
  - Deploying updates is hard/impossible with some embedded devices

Challenges in Embedded Systems Software Security

Ingolstädter Forschungsgruppe Angewandte IT-Sicherheit

- Special design issues
  - Safety vs. Security
  - Keeping secrets used in M2M secret ("there are no secrets in hardware")
  - Administrative access for field engineers
  - Firmware updates

- Security still not understood
  - Security as an afterthought (…see automotive penetration testing)
  - Default passwords, secret keys in firmware, secret keys from SDL documentation, ...



Biggest issues: security education/ guidance + encourage having respect for security issues

Topic: Challenges in Developing Secure Software

Discussion:

- *Is it possible to develop secure software?*
- *Does the IoT promote or hinder the development of secure software ?*

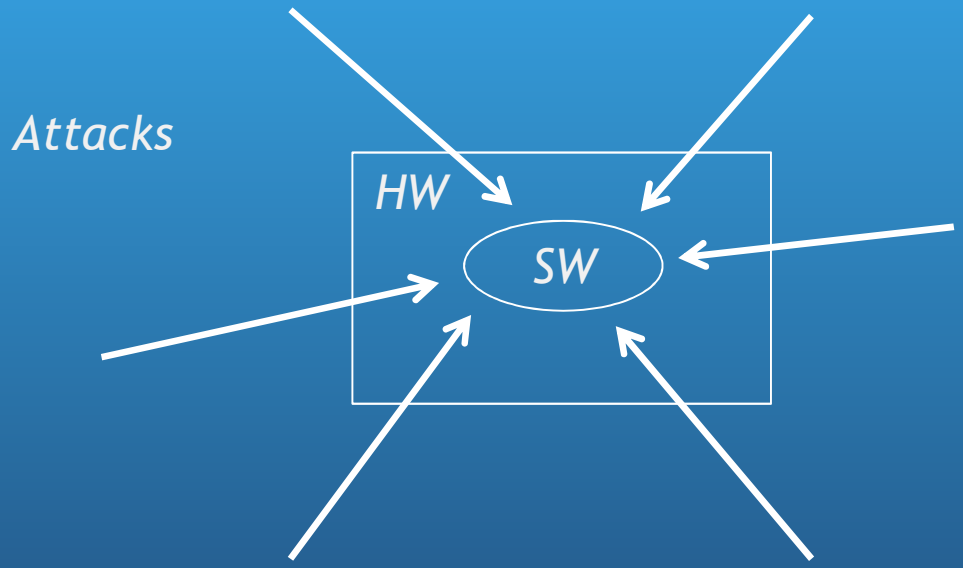
SECURWARE / DEPEND Panel

13 September, 2017

George Yee, Aptusinnova Inc., Carleton University

Is It Possible to Develop Secure Software?

- *What do we understand by "secure software"?*



- *Attackers believe that they have something to gain by attacking the software, e.g. data, notoriety*
- *Attackers identify an associated vulnerability and attack the vulnerability*
- *Secure SW is able to defend against these attacks and still function as intended*

Is It Possible to Develop Secure Software?

- *Adversary Model*[1]
  - *Resources*
  - *Access*
  - *Risk tolerance*
  - *Objectives*
- *Successful Attack*[1]
  - *Diagnose system to identify an attack*
  - *Gain necessary access*
  - *Execute the attack*

Stop attack by preventing any one of these

[1] *C. Salter, O. S. Saydjari, B. Schneier, and J. Wallner, "Toward A Secure System Engineering Methodology," Proceedings of the New Security Paradigms Workshop, pp. 2-10, 1998.*

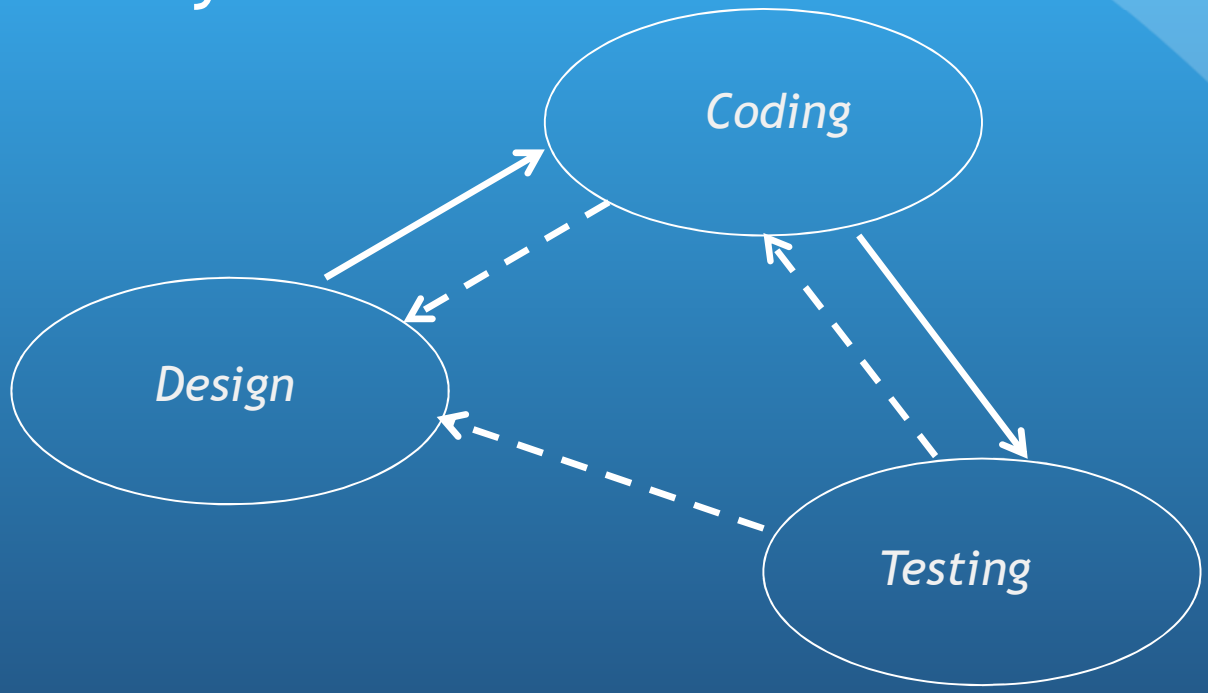
Is It Possible to Develop Secure Software?

- *Vulnerabilities*
  - *Allow confidentiality, integrity, or availability to be compromised*
  - *Allow attacks to be identified*
  - *Allow access*
  - *Estimates the level of security*
    - *More vulnerabilities means lower security*
    - *More secured vulnerabilities means higher security*


EXHIBIT
U.S. CYBERSECURITY
STOP

Is It Possible to Develop Secure Software?

- *Critical phases of software development for baking in security*



To develop secure software, it is essential to find vulnerabilities during design and coding, secure those vulnerabilities, and test to ensure that the vulnerabilities have truly been secured.

Is It Possible to Develop Secure Software?

- *First, the bad news: developing truly secure software is very difficult and maybe impossible*
  - *Existence of unknown vulnerabilities*
  - *New side effect vulnerabilities*
  - *Ineffectiveness of securing vulnerabilities, e.g. attackers finding ways to defeat the security*
  - *Lack of tools that allow developers to better code for security, e.g. a programming language with security constructs*
  - *Lack of OS support for security*
  - *No software warranty, i.e. no accountability*
  - *Insufficient financial resources and time*
  - *…*

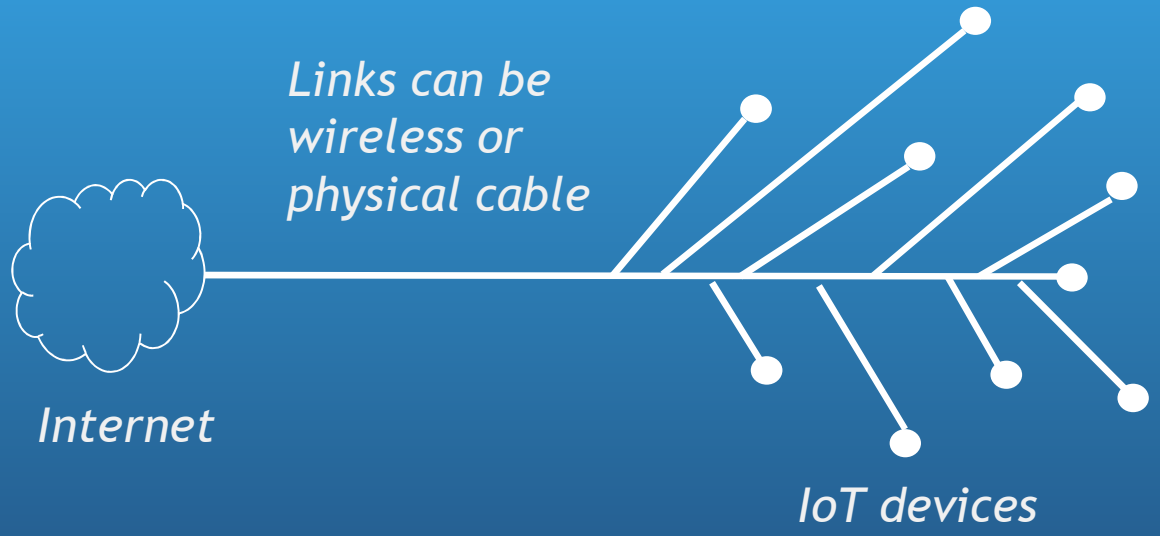
Is It Possible to Develop Secure Software?

- *A little good news: tools and technologies are improving, security more in the public mind*
  - *Static code analyzers*
  - *Secure coding practices*
  - *Research on finding vulnerabilities*
  - *Companies get sued for privacy breaches, e.g. Equifax (unpatched flaw in open source SW)*
  - *Greater public realization of the need for security*

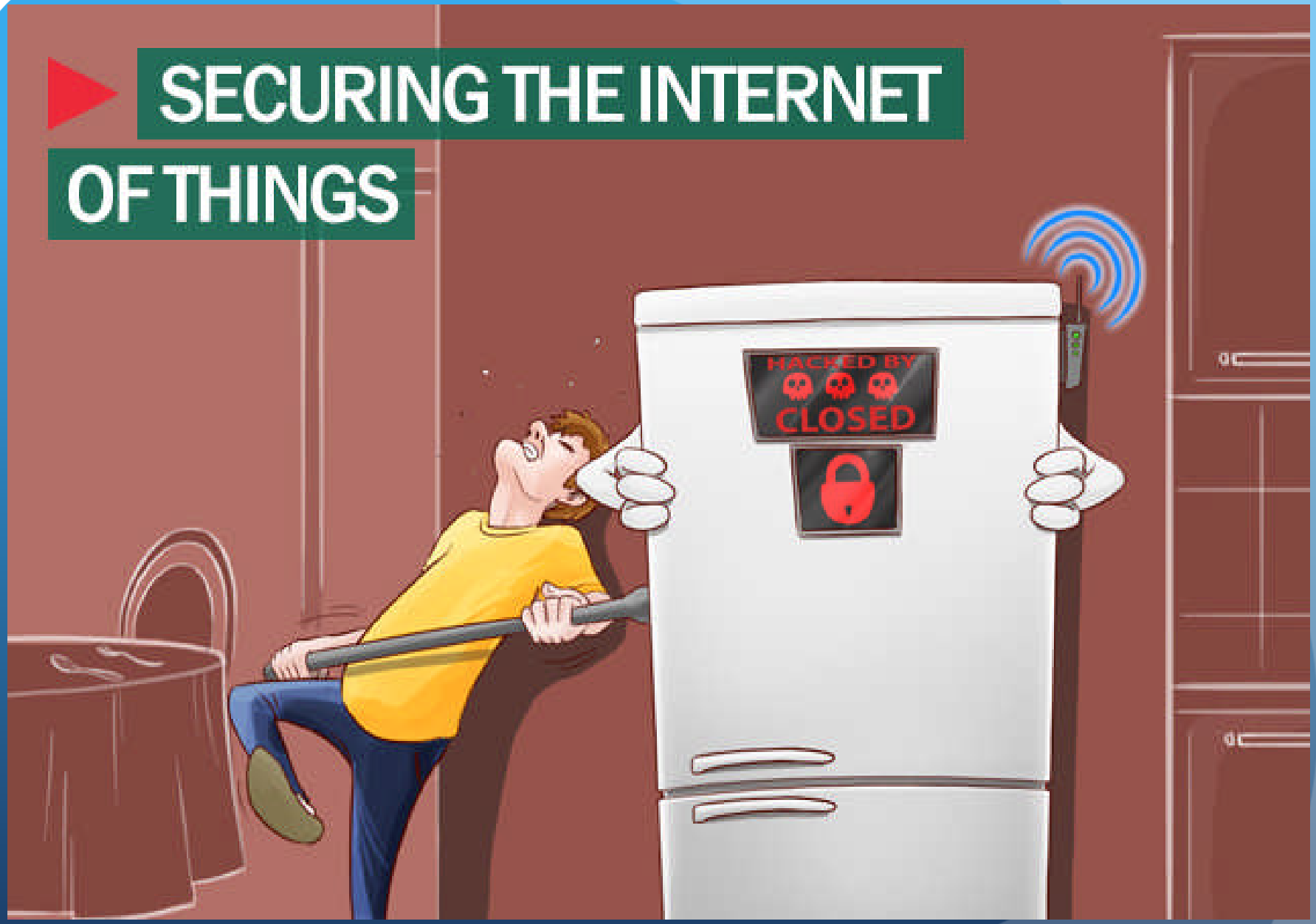
No, for truly secure; maybe, for acceptable risks

Does the IoT promote or hinder the development of secure software?

- Network picture of IoT in a building



- IoT devices characterized as
  - Large variety of devices
  - Connected to the Internet
  - Some with relatively lower computation power, e.g. wearables
  - Some with low electrical energy requirements, e.g. sensors



From https://www.kaspersky.com/blog/securing-the-internet-of-things/2136/

Does the IoT promote or hinder the development of secure software?

- *The case for "hinder"*
  - *Lower processing power may mean that some current security measures are not usable, e.g. encryption and decryption*
  - *Large variety of devices in a local area may invite applications involving inter-device communication, which lead to more vulnerabilities, e.g. home management*
  - *Large number of devices in a given area will lead to a larger number of vulnerabilities in the area, i.e. software will really need to be secure making it harder to develop*
  - *The newness of the technology may call for new software that have vulnerabilities not imagined before*
  - *The newness of the technology means that security is even lower in the mindset than in traditional areas of software development, i.e. devices have no consideration for security*

Does the IoT promote or hinder the development of secure software?

- *The case for "promote"*
  - *Devices with relatively lower computation power may mean relatively simpler software needed, which should make it easier to identify vulnerabilities in the software*
  - *Popular IoT applications involve daily living (e.g. home management, health monitoring) for which security breaches would be "in your face". This may increase pressure for having secure software*

Hinder

INSTITUTO POLITÉCNICO NACIONAL
ESCUELA SUPERIOR DE INGENIERÍA MECÁNICA Y ELÉCTRICA
UNIDAD CULHUACAN

SECURWARE 2017

Panel

Challenges in Developing Secure Software

Lidia Prudente Tixteco
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Ideas

Although the awareness of development of secure software is growing, many developments do not include security principles.

There is a false belief that Firewalls, IDS, and VPNs protect applications.

Software manufacturers are more concerned with releasing new systems than with ensuring their security.

Security Checks Along SDLC

Vulnerability Checks	SDLC Phases	Maturity of Tools, Practices	Injected Vulnerabilities (Not Necessarily Security)
Vulnerabilities in requirements, business processes flow, algorithms	Analysis	Embryonic	15%
Vulnerabilities caused by interrelations of modules and (Web) services, logic and data flow	Design	Embryonic	40%
Vulnerabilities in language instructions, implementation of logic and data flow	Construct	Low	35%
Vulnerabilities in executables, UI. Assembly of secure services could be insecure	Testing	Low	10%
Missing patches, administrative errors, misconfiguration. If vulnerability found — back to analysis	Operations	Low-Medium	

Gartner

How is software development taught?

1. Functional Requirements
2. Non-Functional Requirements
3. Project Requirements
4. Stakeholders Requirements
5. Security Requirements
6. Security Funcional Requirements
7. Security Guaranty Requirements

NIST SP 800-64

	Initiation	Acquisition / Development	Implementation	Operations / Maintenance	Disposition
SDLC	- Needs Determination: • Perception of a Need • Linkage of Need to Mission and Performance Objectives • Assessment of Alternatives to Capital Assets • Preparing for investment review and budgeting	- Functional Statement of Need - Market Research - Feasibility Study - Requirements Analysis - Alternatives Analysis - Cost-Benefit Analysis - Software Conversion Study - Cost Analysis - Risk Management[7] Plan - Acquisition Planning	- Installation - Inspection - Acceptance testing - Initial user training - Documentation	- Performance measurement - Contract modifications - Operations - Maintenance	- Appropriateness of disposal - Exchange and sale - Internal organization screening - Transfer and donation - Contract closeout
SECURITY CONSIDERATIONS	- Security Categorization - Preliminary Risk Assessment	- Risk Assessment - Security Functional Requirements Analysis - Security Assurance Requirements Analysis - Cost Considerations and Reporting - Security Planning - Security Control Development - Developmental Security Test and Evaluation - Other Planning Components	- Inspection and Acceptance - System Integration - Security Certification - Security Accreditation	- Configuration Management and Control - Continuous Monitoring	- Information Preservation - Media Sanitization - Hardware and Software Disposal

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

Challenges in Developing Secure Software

Panel Discussion, SECURWARE 2017
Rome, September 12th 2017

Stefan Schauer, AIT

PERSONAL INTRODUCTION

- **Affiliation**
  - AIT Austrian Institute of Technology
  - Center for Digital Safety & Security
  - Secure Communication Technologies Group

- **Scientific Background**
  - Master in computer science (IT security)
  - PhD in theoretical physics (quantum cryptography)

- **Current Research**
  - Risk and security management for critical infrastructures (CIs)
  - CI interdependencies and assessment of cascading effects
  - Game theoretic approaches for risk management

IMPACT OF INSECURE SOFTWARE

- Security needs to be an integral part of software development
  - IT systems (and software) influences our life in multiple different ways (communication, transport, government, personal data, …)
  - In many fields security is only a by-product or add-on to the developed IT systems
  - Several approaches towards Security by Design are present and need to be integrated from the start

- Flaws and errors in software open doors for attacks
  - Software vulnerabilities are mostly due to error-prone implementation
  - Flaws in software can be used to create unexpected and malicious behavior

IMPACT OF INSECURE SOFTWARE

- IT systems are misused by malicious parties
  - Botnets are created and DDoS attacks are using thousands of IoT devices

- Systems get hacked and encrypted
  - Crypto ransomware like WannaCry and Petya creates data loss and stops the operation of several important services

- Attackers get control of highly-relevant systems or information
  - Electrical power system gets shut down by attackers in Ukraine

The price for developing secure software might be small,
the potential impacts of error-prone systems can be severe!

LET‘S START THE DISCUSSION

Dr. Stefan Schauer
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