The Security of Cyber Physical Systems

April 13, 2016

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CS 470

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# Abstract

# Introduction

# Background

In this section, there are three basic questions that need to be answered:

* What are cyber physical systems?
* How do cyber physical systems work?
* How are cyber physical systems used?

## What Are Cyber Physical Systems?

Cyber physical systems, or CPS, are feedback systems that require merging physical components and computational components (National Science Foundation).

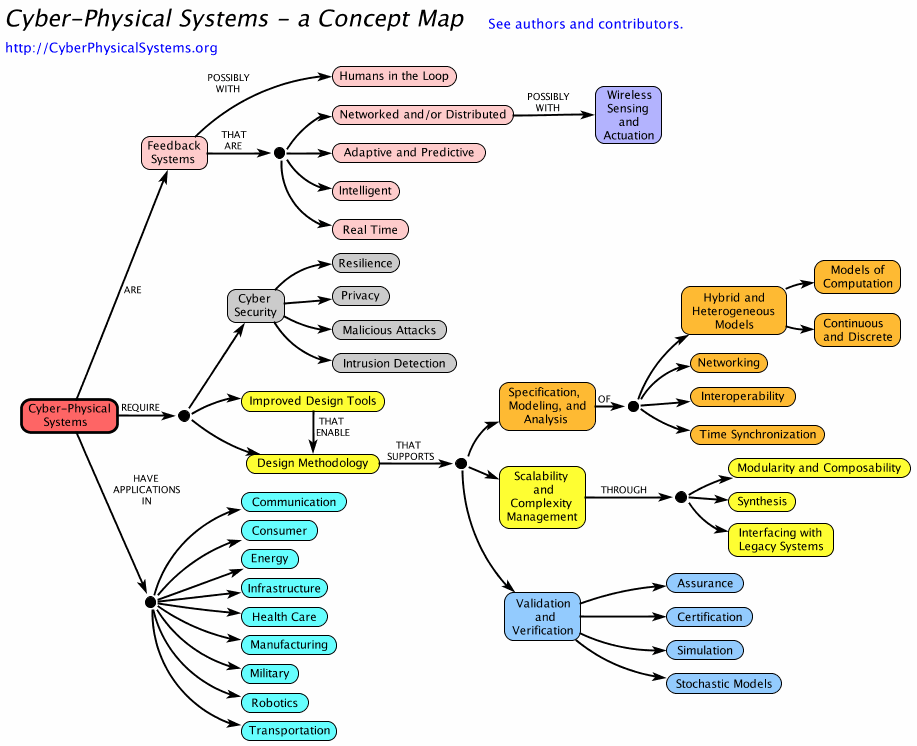


Figure 1 - A tree explaining cyber-physical systems (Cyber Physical Systems)

Cyber-physical systems can be explained using a well-designed flowchart, (see Figure 1 above). These systems usually have distributed using wireless technology. They must be able to change due to certain conditions and even expected changes to come in how the processes execute. CPS can learn from its environment, changing its behaviors. All of these can be done while it is executing commands in real-time to meet the required time restraints. (Cyber Physical Systems)

## How Do Cyber Physical Systems Work?

Cyber physical systems require strong cyber security. They have to be able to have strong privacy to protect the user’s information. They should be able to prevent malicious attacks such as viruses, Trojan horses, and denial of service attacks. Open networks are much easier to attack because there are more exposed vulnerabilities. Sometimes the CPS will still get attacked even if it is on a closed network though. No matter what, the cyber physical system should be able to handle something as mall as the wrong inputs or even something as big as a subsystem failing. (Cyber Physical Systems)

The cyber physical systems also need better tools that allow for the best design of the system. The design of the system needs to allow for the system getting more complex, while still allowing it to scale up in size. It also should be able to be verified and validated to the user’s specifications and best practices of the time. By keeping all these requirements in mind, the cyber physical system’s product owner can specify how they want their CPS to be modeled. The product owner can analyze their CPS and other CPS to determine the optimal product. (Cyber Physical Systems)

## How Are Cyber Physical Systems Used?

Cyber physical systems can be used in many different fields. Examples of each are listed below.

|  |  |
| --- | --- |
| Consumer | Examples of a consumer using CPS would be video systems, interactive games, and audio systems. |
| Health Care | In the health care field, technology provides important information to health care workers, such as the heart rate of a patient. The CPS can be used to help the flow of medical visits and assist in patient safely by integrating all the information into one location. |
| Energy | Smart buildings are become more popular from their use of CPS. CPS allows smart buildings to control and monitor functions such as lights and air conditioning from a control system. |
| Military | There is a large part of all military systems that are cyber physical systems to aid in the exchanging of information. |
| Transportation | Systems used for automotives, railroads, planes, traffic control, and even elevators and escalators are depended upon cyber physical systems. |
| Infrastructure | Infrastructure for society, such as power, roads, and water, can be maintained using cyber physical systems. These examples include monitoring of water safety, helping in disaster recovery, and working on the water distribution in the city. |
| Communication | Wireless communication is an example of a communication system that uses CPS. |
| Manufacturing | Computer-controlled systems and machinery used in production uses cyber physical systems. |
| Robotics | A couple of areas that CPS assists in the robotics field would be artificial intelligence and robotic motion control. |

Table 1 - Applications and examples of cyber physical systems (Cyber Physical Systems)

## Cyber Physical Systems and the Internet of Things

Cyber physical systems are also known as the Internet of Things (NIST).

# Purpose

The purpose of this report is to examine the various issues that affect security of cyber physical systems.

# Scope

This report will discuss the various security issues and vulnerabilities that occur within cyber physical systems, and give examples of potential solutions to these issues.

# General Discussion

The security of cyber physical systems is a major concern. As seen in Figure 1 above, cyber security is a requirement of cyber physical systems. The following areas fall under the umbrella of cyber security in our cyber physical system flow chart (Cyber Physical Systems):

* Resilience
* Privacy
* Malicious attacks
* Intrusion detection

## Security Objectives of Cyber Physical Systems

Before discussing the security concerns of cyber physical systems, we must first establish the security objectives that must be accomplished by these systems. Table 2 (below) enumerates the four main security objectives of cyber physical systems.

|  |  |
| --- | --- |
| Objective | Description |
| Confidentiality | To prevent an adversary from interfering with the state of the physical system by eavesdropping on the communication channels. |
| Integrity | To achieve physical goals by preventing, detecting, or blocking deception attacks on the information sent and received by the system. |
| Availability | To always provide service by preventing computing, controls, communication corruptions due to hardware failures, system upgrades, power outages, or denial-of-service attacks. |
| Authenticity | To realize authentication in all the related processes such as sensing, communications, and actuations. |

Table 2 – Security objectives of cyber physical systems (Wang, Ye and Xu)

## Vulnerabilities of Cyber Physical Systems

# Conclusion

# Bibliography

Baheti, Radhakisan and Helen Gill. "Cyber-Physical Systems." n.d. *IEEE Control System Society.* 13 April 2016. <http://www.ieeecss.org/sites/ieeecss.org/files/documents/IoCT-Part3-02CyberphysicalSystems.pdf>.

*Cyber Physical Systems*. 2012. 12 4 2016. <http://cyberphysicalsystems.org>.

National Science Foundation. *Cyber-Physical Systems (CPS)*. n.d. 13 April 2016. <https://www.nsf.gov/funding/pgm\_summ.jsp?pims\_id=503286>.

NIST. 8 July 2015. 13 April 2016. <http://www.nist.gov/itl/ssd/cyber-physical-systems.cfm>.

Wang, Eric Ke, et al. "Security Issues and Challenges for Cyber Physical System." *2010 IEEE/ACM International Conference on Green Computing and Communications & 2010 IEEE/ACM International Conference on Cyber, Physical, and Social Computing*. IEEE Computer Society, 2010.