



**COLLEGE OF ENGINEERING
AND COMPUTER SCIENCE**
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

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for the degree of Doctor of Philosophy (Ph.D.)

“Cyber-Physical Systems: Building a Security Reference Architecture for Cargo Ports”

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Virtual Dissertation

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ABSTRACT OF DISSERTATION

Cyber-Physical Systems: Building a Security Reference Architecture for Cargo Ports

Cyber-Physical Systems (CPS) are physical entities whose operations are monitored, coordinated, and controlled by a computing and communication core. These systems are highly heterogeneous and complex. Their numerous components and cross domain complexity make attacks easy to propagate and security difficult to implement. Consequently, to secure these systems, they need to be built in a systematic and holistic way, where security is an integral part of the development lifecycle and not just an addition to the components. These systems present a multitude of implementation details in their component units, so it is fundamental to use abstraction in the analysis and construction of their architecture. In particular, we can apply abstraction through the use of patterns. Pattern-based architectural modeling is a powerful way to organize and describe security and other non-functional aspects of a system. Patterns also have the potential to unify the design of the computational, communication, and control aspects of CPS. Architectural modeling can be performed through UML diagrams to show the interactions and dependencies between different components and its stakeholders. Also, it can be used to analyze security threats and describe the possible countermeasures to mitigate these threats. An important type of CPS is a maritime container terminal. Maritime container terminals or cargo ports are facilities where cargo containers are transported between ships and land vehicles; for example, trains or trucks, for onward transportation, and vice versa. Every cargo port performs four basic functions: receiving, storing, staging and loading for both, import and export containers. We present here a set of patterns that describe the elements and functions of a cargo port system, and a reference architecture (RA) built using these patterns. We analyze and systematically enumerate the possible security threats to a container terminal in a cargo port using activity diagrams derived from selected use cases of the system. This RA provides a framework to determine where to add security mechanisms to stop or mitigate these threats and build a Security Reference Architecture (SRA) for CPS. We also present security and misuse patterns used for its construction. An SRA is an abstract architecture describing a conceptual model of security that provides a way to specify security requirements for a wide range of concrete architectures. The analysis and design are given using a cargo port as our example, but the approach can be used in other domains as well. This is the first work we know where patterns and RAs are used to represent cargo ports and analyze their security.

BIOGRAPHICAL SKETCH

Born in Lima, Peru

B.S., The University of Tennessee, Knoxville, TN, 1981

M.S., Florida Atlantic University, Boca Raton, FL, 2011

Ph.D., Florida Atlantic University, Boca Raton, Florida, 2021

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2012 - 2021

Qualifying Examination Passed: Fall 2012

Published Papers:

V.M. Romero, E.B. Fernandez, "Misuse Patterns for Remote Controllers of Container Terminal Cranes", Procs 9th Asian Conference on Pattern Languages of Programs, Asian PLoP'20, March 4-6, 2020, Taipei, Taiwan (due to COVID-19 pandemic, the conference was held online September 2nd - 4th, 2020)

V.M. Romero, E.B. Fernandez, "A Pattern for Controlled Access to a Cargo Port Terminal Physical Structure", 12th Latin American Conference on Pattern Languages of Programs, SugarLoaf PLoP'18, Nov 20-23, Valparaiso, Chile

V.M. Romero, E.B. Fernandez, "Building a Reference Architecture for Cargo Ports using Patterns", Proceedings of the Sixteenth Latin American and Caribbean Conference for Engineering and Technology, July18-20,2018, Lima, Peru

V.M. Romero, E.B. Fernandez, "A Pattern for Secure Cargo Port Drayage", Procs 7th Asian Conference on Pattern Languages of Programs, Asian PLoP'18, March 1-2, 2018, Tokyo, Japan 9 pages

V.M. Romero, E.B. Fernandez, "Towards a Security Reference Architecture for Cyber Physical Systems", Proceedings of the Fifteenth Latin American and Caribbean Conference for Engineering and Technology, July19-21,2017, Boca Raton, FL-USA