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.)

"Modeling and Security in Cloud and Related Ecosystems"

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ABSTRACT OF DISSERTATION

Software systems increasingly interact with each other, forming ecosystems. The cloud is one such ecosystem that has evolved and enabled other technologies like IoT and containers. Such systems are very complex and heterogeneous because their components can have diverse origins, functions, security policies, and communication protocols, which makes it difficult to comprehend, utilize and consequently secure them. Abstract architectural models can be used to handle this complexity and heterogeneity but there is lack of work on precise, implementation/vendor neutral and holistic models which represent ecosystem components and their mutual interactions. We attempted to find similarities in systems and generalize them to create abstract models that would make adding security more convenient and precise. We represented the ecosystem as a Reference Architecture (RA) and the ecosystem units as patterns. We started with a pattern diagram which showed all the components involved along with their mutual interactions and dependencies. We added components to the already existent Cloud Security RA (SRA). Containers, being a relatively new virtualization technology, did not have a precise and holistic reference architecture and we have built a partial RA for containers by identifying and modeling the components of their ecosystem. Container security issues were identified from the literature as well as from analysis of our patterns. We added corresponding security countermeasures to the container RA as security patterns to build a container SRA. Finally, using this container SRA as an example, we demonstrated an approach for RA validation. We have also built a composite pattern for fog computing that is an intermediate platform between the cloud and IoT devices. We described an attack, Distributed Denial of Service (DDoS) using IoT devices, in the form of a misuse pattern which explains it from the attacker's perspective. We found this model-based approach useful to build RAs in a flexible and

incremental way as components can be identified and added as the ecosystems expand. This approach provided us with a better insight to analyze security issues across boundaries of individual ecosystems. A unified, precise and holistic view of the system is not just useful for adding or evaluating security, this approach can also be used to apply compliance, privacy, safety, reliability and/or governance functions for cloud and related ecosystems.

This is the first work we know of where patterns and RAs are used to represent ecosystems and analyze their security.

BIOGRAPHICAL SKETCH
Born in Lahore, Pakistan
B.S., Quaid-i-Azam University, Islamabad, Pakistan, 2004
M.S., National University of Science and Technology, Rawalpindi, Punjab, Pakistan, 2011
Ph.D., Florida Atlantic University, Boca Raton, Florida, 2019

CONCERNING PERIOD OF PREPARATION
& QUALIFYING EXAMINATION

Time in Preparation: 2014 - 2019

Qualifying Examination Passed: Semester 2015

Published Papers:

1. Madiha H. Syed and Eduardo B. Fernandez, "The Software Container pattern", 22nd Conference on Pattern Languages of Programs (PLoP 2015), Pittsburgh, PA, October 24-26, 2015.

2. Madiha H. Syed, E.B.Fernandez, M.Ilyas, "A pattern for fog computing", Pattern Languages of Programming (VikingPLoP 2016), 7th-10th April 2016, Leerdam, Netherlands.

3. Madiha H. Syed and E.B.Fernandez, "Cloud ecosystems support for Internet of Things and DevOps using patterns", First International Workshop on Interoperability, Integration, and Interconnection of Internet of Things Systems (I4T), part of the IEEE Int. Conf. on Cloud Engineering (IC2E), Berlin, Germany, April 4-8, 2016.

4. E.B. Fernandez, Nobukazu Yoshioka, Hironori Washizaki, and Madiha H. Syed, "Modeling cloud ecosystems", J. Future Internet 2016, 8, 13.

5. Madiha H. Syed and Eduardo B. Fernandez, "A Pattern for a Virtual Machine Environment", 23rd Conference on Pattern Languages of Programs (PLoP 2016), Champaign, IL, October 23-26, 2016.

6. Madiha H. Syed and Eduardo B. Fernandez, "The Container Manager Pattern", 22nd European Conference on Pattern Languages of Programs (EuroPLoP 2017), Germany, July 12-16, 2017.

7. Madiha H. Syed, Eduardo B. Fernandez and Paulina Silva, "The Secure Software Container Pattern", 23rd Conference on Pattern Languages of Programs (PLoP 2017), Vancouver, Canada, October 22-25, 2017.

8. Madiha H. Syed, Eduardo B. Fernandez and Julio Moreno. 2018. "A misuse Pattern for DDoS in the IoT". ACM Proceedings of European Conference on Pattern Languages of Programs. EuroPLoP (July 2018), 7 pages.

9. Madiha H. Syed and Eduardo B. Fernandez. 2018. A reference architecture for the container ecosystem. In Proceedings of the 13th International Conference on Availability, Reliability and Security (ARES 2018). ACM, New York, NY, USA, Article 31, 6 pages. DOI: https://doi.org/10.1145/3230833.3232854.

10. Madiha H. Syed and Eduardo B. Fernandez, "The Secure Container Manager Pattern", 24th Conference on Pattern Languages of Programs (PLoP 2018), Portland, Oregon, October 24-26, 2018.

11. Madiha H. Syed and Eduardo B. Fernandez, "Building a security reference architecture for Container ecosystems", (in preparation).