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## Partnership for International Research and Education A Global Living Laboratory for Cyberinfrastructure Application Enablement Towards Pattern-based Reliability Certification of Services

Ingrid Buckley, PhD student, Florida Atlantic University  
FAU Advisor: Dr. Eduardo B. Fernandez, Florida Atlantic University  
PIRE International Partner Advisor: Dr. Ernesto Damiani, Università degli Studi di Milano



### I. Research Overview and Outcome

#### BACKGROUND

- The widespread diffusion of Web services and SOA is raising interest for SOA-based implementation of life- and mission-critical applications for which reliability is a crucial requirement.
- In Service-Oriented Architectures (SOAs), the mechanism for run-time discovery and selection of services may conflict with the need to make sure that business process instances satisfy their reliability requirements
- We believe the best approach for building reliable services is to incorporate reliability in every phase of the system design and throughout the entire software development life cycle using reliability patterns.
- Reliability patterns support widespread application of best practices and best solutions, and offer an effective guideline for software developers that may not have expert knowledge and experience in reliable system development.
- Specifically, a reliability pattern consists of several parts which provide a detailed description of the patterns' objective, and serves as a tangible reference for an effective reliability solution.
- A pattern is an encapsulated solution to recurrent software or system problems in a given context, and it can be described using UML diagrams.
- Once a system is built using some methodology that uses reliability patterns, It is important to show it has reached a given level of reliability.
- In a SOA environment we can go even further, we can certify that the services satisfy some standards of reliability making digitally signed information available at runtime.

#### OBJECTIVE

- To define an approach for certifying reliable services using reliability patterns.
- To increase the reliability of critical services

#### PROBLEM

- Challenges in software reliability not only stem from the size, complexity, difficulty, and novelty of software applications in various domains, but also relate to the knowledge, training, and experience of the software engineers involved.
- The SOA paradigm which supports runtime selection and composition of services, makes it difficult to guarantee the reliability of a process instance.
- How to certify the level of reliability of a Web Service?

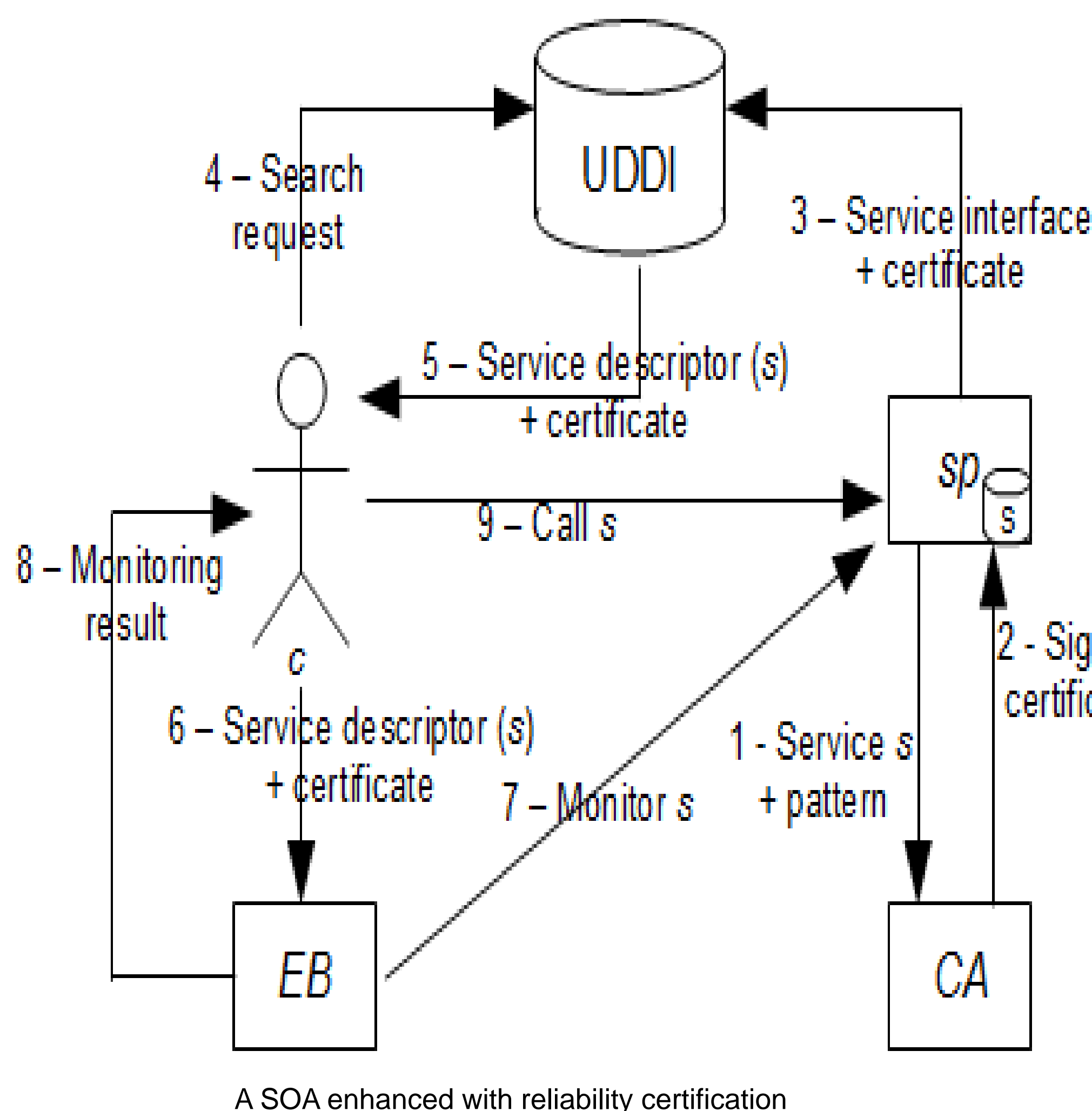
#### Reliability

- The machine-readable certificates for reliability include the following information:
- Reliability property:** a description of the concrete reliability property including class attributes with reference to mechanisms/faults used to assess it.
- Reliability pattern:** a concise description of the reliability solution. We adopt the POSA template to describe reliability patterns.
- Evidence:** a set of elements that specify the metrics and monitoring rules used for supporting the reliability in the certificate as follows:
- Set of metrics:** the metrics used to verify that a given property holds. For each metric, we define the expected value that is requested for the metric.
- **Monitoring rules:** the rules used for monitoring the metrics in the evidence. Each rule contains a human-readable description and a reference to a standard toolkit for reliability monitoring on SOAs that permits to do the measurements of the corresponding metrics. A violation of the monitoring rules produces a runtime revocation of the certificate.

Dual Modular Redundancy (DMR) pattern can detect one fault but does not mask any faults; the Triple Modular Redundancy (TMR) pattern can detect two faults and mask one; the N-Modular Redundancy (NMR) pattern can detect (N-1) faults and mask (N-2) faults. Thus, the DMR pattern provides a lower level of reliability than the TMR pattern. Similarly, NMR provides a higher level of reliability than TMR.

#### METHODOLOGY

- We define a concrete specialization of the reliability property as the one that provides enough information to support monitoring procedures aiming to establish if the property holds or not.
- To define an approach for certifying reliable services using reliability patterns by focusing on a posteriori validation of a reliable service:
- A posteriori validation of service reliability is an evaluation of the level of reliability provided by a given service implementation.
- We can assess the level of reliability in an implemented system that was built with the use of reliability patterns by evaluating different reliability metrics.
  - These metrics can be used to calculate the reliability using data collected by monitoring an implemented system.
- We use a certification scheme based on machine-readable reliability certificates that will enable run-time negotiation.
- Our approach based on machine-readable reliability certificates using reliability pattern provides:
  - Certificates to conduct a posteriori evaluation of reliable services.
  - Our approach can be used to support a wider number of reliability patterns and integrate other types of dependability evidence
- Our certificates describe the reliability mechanism implemented by a service and the reliability pattern used to implement such a mechanism.
- Digital signatures are used to associate the reliability claim contained in each certificate with the party (service supplier or accredited third-party) taking responsibility for it.



- Stage 1 (Steps 1-2):**
- CA grants a reliability certificate to a service provider sp based on a service implementations and a reliability pattern.

- Stage 2 (Steps 3-9):**
- upon receiving the certificate for the service s, sp publishes the certificate together with the service interface in a service registry.
- The client c searches the registry and compares the reliability certificates of the available services.
- Once the client has chosen a certificate, it will ask the trusted component EB to confirm its validity.
- EB checks that the corresponding monitoring rules hold and returns a result to c.
- If the result is positive c proceeds to call the service.

A SOA enhanced with reliability certification

#### CONTRIBUTION

- A novel approach based on machine-readable reliability certificates using reliability patterns which provides a posteriori evaluation of reliable services.
- Our approach is scalable and can be used to support a wider number of reliability patterns as well as and integrate other types of dependability evidence

#### PUBLICATION

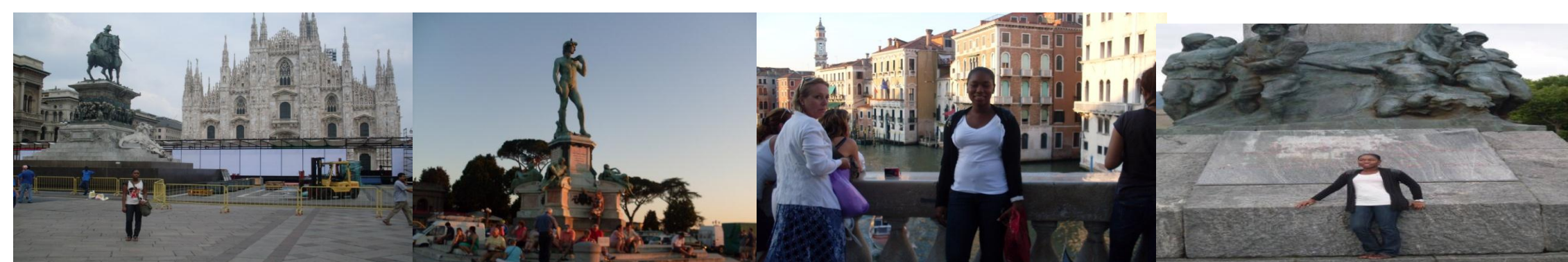
Ingrid Buckley, Eduardo Fernandez, Marco Anisetti, Claudio A. Ardagna, Masoud Sadjadi, and Ernesto Damiani, "Towards Pattern-based Reliability Certification of Services", Proc. of 1st International Symposium on Secure Virtual Infrastructures (DOA-SVI'11), OTM 2011, Part II, LNCS 7045, pp. 558–574, 2011.

### II. International Experience

#### ITALY

My experience was absolutely phenomenal. I went to Italy alone which challenged me to step outside of my comfort zone in many respects. I surprised myself by exploring Italy on my own as a lone female. I enjoyed the cuisine, daily life style and language too much.

The PIRE program gave me the opportunity to conduct collaborative research that allowed me to progress significantly with my PhD research. I was able to develop and hone my previous research skills and this allowed me to progress significantly with my research goals. It also allowed me to bridge cultural gaps and develop camaraderie among international peers with the added benefit of experiencing a new culture and customs. The union formed from this collaboration is priceless and will continue to appreciate in my future academic endeavors.



#### Università degli Studi di Milano



#### Crema



#### Cucina



The Team

### III. Acknowledgement

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