




Web Service Diagnosability, Monitoring and Diagnosis

B. Pernici
Politecnico di Milano




Outline

- Presentation of project
- Main goals
- Self-healing composed services
- Examples
- Design of self-healing services

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

2




Introduction to the WS-Diamond project


- EU FET Open project no. IST-516933
- Sept. 2005-June 2008

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

3



Partners



- Dept. Informatica Univ. Torino (I)
- IRISA Univ. Rennes (F)
- LRI Univ. Paris Sud (F)
- LAAS - CNRS Univ. Toulouse (F)
- Dept. AI Vrije Univ. Amsterdam (NL)
- Dept. CS and manufacturing Univ. Klagenfurt (A)
- Workflow Research group Univ Vienna (A)
- Dept. Electronics and Information Politecnico Milan (I)

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

4

The Context

- Complex service
 - based on composition of other services
 - May fail (functional / QoS)
- Which are the responsible services (diagnosis)?
- How can we recover at run time (Repair)?

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

Fault-Error-Failure cycle in WS-Diamond

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

Project objectives in 1 Slide

- operational framework for self-healing service execution of conversationally complex Web Services
 - Monitoring service execution
 - Fault detection
 - Diagnosis
 - Recovery/repair
- a methodology and tools for service design that guarantee effective and efficient diagnosability/repairability during execution

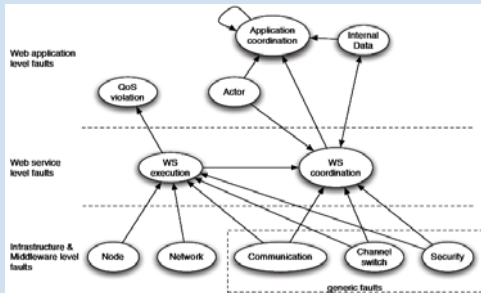
Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

Integration of methodologies

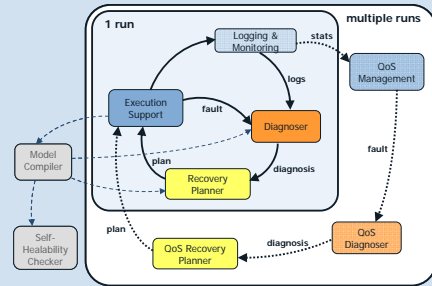
- Achieving the goals require integration of different methodologies:
 - service composition languages and technologies
 - Workflow systems
 - model-based reasoning and diagnosis
 - Information Systems
 - Semantic Web languages

Web-Service Diagnosability, Monitoring & Diagnosis
WS-DIAMOND

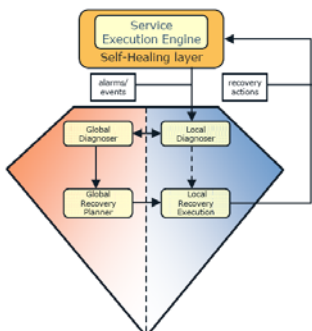
Exceptions and self-healing



The WS-Diamond repair cycles



Execution and instance repair: "Diamonds"

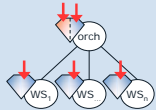


L. Console and WS-Diamond Team. WS-DIAMOND: an approach to Web Services. DIAGNOSABILITY, MONITORING and DIAGNOSIS. In International e-Challenges Conference, The Hague, Oct. 2007.

Overview: Involved Modules

- **Diagnoser:** *finding the cause*
 - Receives an exception from the services and tries to determine where the process started to go wrong and which service was responsible for the problem.
- **Recovery Planner:** *deciding what to do*
 - Given the output of diagnosis, computes a recovery plan made of the recovery actions made available by the Self-Healing Layer.
- **Self-Healing Layer:** *doing what needs to be done*
 - Allows the execution of proper recovery actions over an orchestrated process.

Diagnoser: decentralized architecture



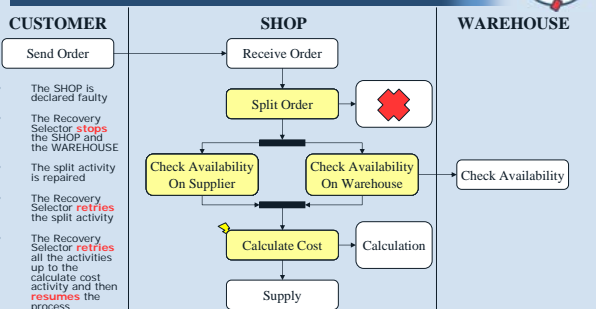
- Several Diagnostic Modules
- Each WS → a **LOCAL** Diagnoser
 - Local Diagnostosers exploit model-based reasoning techniques
 - They produce LOCAL hypotheses on the causes of the observed problems
- Orchestrator → a **SUPERVISOR**
 - The Supervisor correlates hypotheses from Local Diagnostosers
 - Can decide which Local Diagnostosers should be invoked

Instance Repair Actions

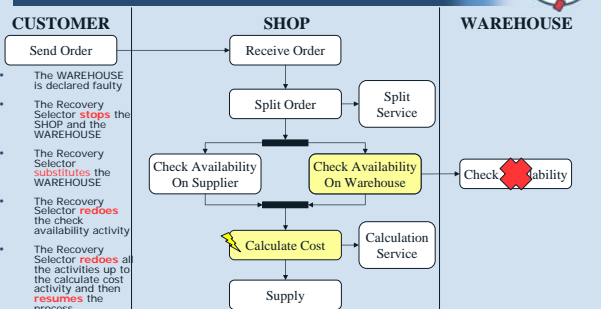
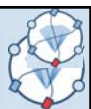


- *Retry/Execute* an activity
- *Compensate* an activity, that is invoking an operation which is defined as a compensation for a given one in a given state
- *Substitute* a Web service
- Problems: session and state management, choreography

Case 1: Temporary Fault



Case 2: Permanent Fault

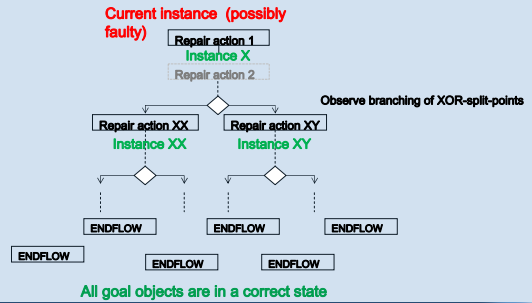


Modules: the Self-Healing Layer

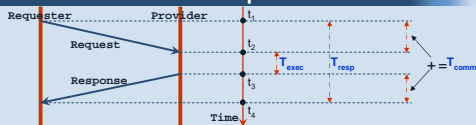


- The **Self-Healing Layer** is **realized** by means of **SH-BPEL**, a Self-Healing extension for WS-BPEL engines
- Its purpose is to **allow** the execution of proper **recovery actions** over faulty **BPEL processes**
- The SH-BPEL engine can be easily adapted to work with any existing WS-BPEL engine **without** introducing **modifications** in their code
- The SH-BPEL engine can be **controlled** and **configured** by means of a **WSDM-based** management interface

Completion plan generation



Class level repair Considered QoS parameters



- **Execution Time**: The time that the provider needs to achieve the processing of the request:
 - $T_{execution} = t_3 - t_2$
- **Response Time**: The time between sending a request and receiving the response:
 - $T_{response} = t_4 - t_1$
- **Communication Time**: The time that the SOAP message needs to reach its destination:
 - $T_{communication} = T_{response} - T_{execution}$

Class level repair characteristics



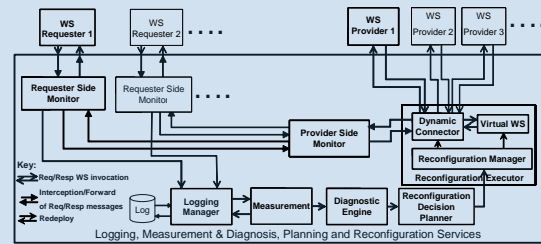
- QoS degradations are the handled faults.
 - Their detection is based on statistical analysis of logged QoS parameters.
 - Two models are considered: chronicles, and Markovian models.
- Monitoring and repair based on :
 - Intercepting & processing communication messages between providers and requesters,
 - Meta-level communication extending message headers by metadata describing QoS information (parameters and values)
- Repair by reconfiguration
 - Is based on class-level substitution and duplication
 - Acts by re-routing requests to different services

Measurement: The approach



- Main goal of measurement: detection of QoS degradation
- Approach based on identification of temporal chronicles as QoS degradation symptoms
- Some experimented temporal chronicles:
 - Example 1: N "consecutive" $Texec$ greater than the average time :
 - $Texec_i > (AVG_{Texec} + delay)$
 - Example 2: N "consecutive" accelerations of $Texec_i$: (without deceleration between $Texec_i$)
 - $Texec_N > Texec_{N-1} > \dots > Texec_2 > Texec_1$
 - Example 3: $Texec$ increases abruptly:
 - $Texec_2 \gg Texec_1$

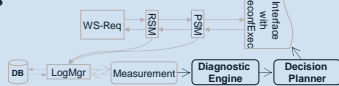
QoS-Oriented, Monitoring-based self-healing architecture



Diagnosis & planning: The implemented module



- Provided functions:
 - A diagnosis by reasoning about the alarms received from the measurement module
 - Generates the repair plan to be performed by the reconfiguration execution module
 - For local diagnosis and repair, plans are composed of a single elementary reconfiguration action involving the targeted web service.
- Internal architecture and implementation: two web services



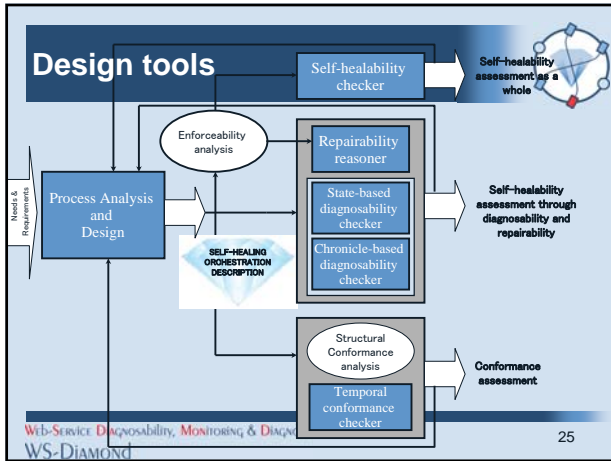
Repair: The approach



- Main goal: eliminate source of detected QoS degradation
- Approach based on architectural reconfiguration targeting class-level repair
- Considered elementary reconfiguration actions:
 - Service duplication
 - Service substitution



Duplicate(WS1,WS2)... same network
Substitute(WS1,WS3)... different networks



Concluding remarks

- Exploitation phase:
 - New projects
 - Industrial dissemination, looking for partners
- Further research needed:
 - Automatic learning, automatic generation and improvement
 - Management of repair
 - Design of adaptive and self-healing service-based systems

Recent publications

- The WS-Diamond Team. WS-DIAMOND: an approach to Web Services – DIAGNOSABILITY, MONITORING and DIAGNOSIS. Proc. E-Challenges Conference, The Hague, October 24-26, 2007.
- The WS-Diamond Team. WS-DIAMOND Web Services – DIAGNOSABILITY, MONITORING and DIAGNOSIS. To appear in "At your service: An overview of results of projects in the field of service engineering of the ISTI programme" MIT Press Series on Information Systems, J. Mylopoulos and M. Papazoglou (Eds.), 2009
- L. Ardissone, R. Furnari, A. Goy, G. Petrone, M. Segnan. Monitoring choreographed services. In T. Sobih, Innovations and advanced techniques in computer and information sciences and engineering, Springer, 2007.
- D. Ardagna, M. Comuzzi, E. Mussi, B. Pernici, P. Plebani. PAWS: A Framework for Executing Adaptive Web-Service Processes. IEEE SOFTWARE, 24(6): 39-46, November 2007.
- J. Eder, A. Tahamtan. Temporal Consistency of View Based Interorganizational Workflows. In Proc. UNISCON 2008, Klagenfurt, April 22-25. Lecture Notes in Business Information Processing 5, Springer Verlag 2008, ISBN 978-3-540-78941-3, pp. 96-107.
- L. Ye and P. Dague. Decentralized Diagnosis for BPEL Web Services. Proc. of 4th International Conference on Web Information Systems and Technologies (WEBIST'08), Funchal, Madeira, Portugal, May 4-7, 2008, pp. 283-287.
- M.-O. Cordier, Y. Pencolè, L. Travé-Massuyès, T. Vidal. Characterizing and checking self-healability. Proc. of 18th European Conference on Artificial Intelligence (ECAI'2008), Patras, Greece, July 21-25, 2008.
- X. Le Guillou, or M.-O. Cordier, or S. Robin, or L. Roze. Chronicles for On-line Diagnosis of Distributed Systems. Proc. of 18th European Conference on Artificial Intelligence (ECAI'2008), Patras, Greece, 2008.
- O. Nabuco, R. Ben Halimam K. Drira, M.G. Fugini, S. Modafferi, E. Mussi. Model-based QoS-enabled self-healing Web Services. Proc. of EN-FINES'08 DEXA Workshop, Torino, September 1-4, 2008.
- R. Ben Halima, M. Jmaiel, and K. Drira. A QoS-Oriented Reconfigurable Middleware for Self-Healing Web Services. Proc. of IEEE International Conference on Web Services (ICWS 2008), 2008.
- Y. Yan, P. Dague, Y. Pencolè and M.-O. Cordier. A Model-based Approach for Diagnosing Faults in Web Service Processes. International Journal of Web Services Research (IJWSR), 5(4), Oct.-Dec. 2008.