Adaptivity in Dynamic Service-based Systems

Antonio Bucchiarone, Raman Kazhamiakin, Annapaola Marconi, and Marco Pistore

S-Cube Day – June 5, 2012
Zurich, Switzerland
Within S-Cube the FBK-SOA Unit investigated three research challenges that are fundamental for the adaptation of service-based systems:

- **Dynamic context-aware adaptation**
  - Support the operation in a *continuously changing environment*, both in terms of the system execution context and of the services, users and providers involved.

- **User-centric adaptation**
  - Support the provisioning of *dynamically customized* (context-, profile- aware) service-based applications yet allowing the end-user to control and coordinate the execution.

- **Cross- and multi-layer adaptation**
  - Ensure the correctness of multi- and cross-layer adaptations by properly correlating monitored events and coordinating layer-specific adaptation mechanisms.
Bremerhaven Harbor
- 4 km², 120,000 storage places
- 2 Million vehicles per year
- 18 vehicle brands
- 12 technical treatment stations

**Aim:**
Develop a **Car Logistic System** supporting the management and operation of the port:
- covering the whole car delivery process, from delivery to disposition;
- supporting the co-operation of the numerous actors (i.e., cars, ships, trucks, storages, treatment areas, etc.) respecting their own procedures and business policies.

Car Logistic Scenario: Bremen Harbor
Car Logistic Scenario: Bremen Harbor

Challenges:
- **Customizable** procedures for each car (e.g., brand, model, order)
- **Heterogeneity** of actors/facilities involved (e.g., terminals, storage areas, treatment stations, consignment areas, ships, trucks)
- **System Dynamicity** (e.g., actors/facilities join/leave the system, changes in procedures of system facilities, changes in regulations and norms)
- **Context Dynamicity** (e.g., unavailability or malfunctioning of the different port facilities, accidental damages of cars and trucks, human errors)

Fully exploit the benefits of the service-oriented paradigm to develop a context-aware adaptive system.
A Framework for Adaptive Context-aware SBS

Business processes:
- Partial process specifications that allow **dynamic refinement** and **adaptation** according to available system functionalities
- Modeled via traditional workflow language (e.g., BPMN) extended with abstract activities + preconditions/effects

Process Fragments:
- Offered functionalities that can be **dynamically discovered/used** by other entities
- Modeled as business processes

Context Model:
- Important **characteristics of the environment** and of the entities that operate in it
- Used to define context preconditions/effects on process activities and goals on abstract activities
A Framework for Adaptive Context-aware SBS

G3: CarProgressStoring = yes

REFINEMENT: PLAN FOR G3

Registration@StorageManager

Assignment@StorageManager

StoreToA@StorageAreaA

StoreToB@StorageAreaB

StoreToC@StorageAreaC

Adaptivity in Dynamic Service-based Systems
A Framework for Adaptive Context-aware SBS

Available adaptation mechanisms:

- **Refinement**: dynamic refinement of abstract activity by context-aware composition of available fragments
- **Local adaptation**: identify a fragment composition that allows to re-start a faulted process from a specific activity
- **Compensation**: dynamically compute a compensation process for a specific activity

Can be combined through adaptation strategies to solve complex adaptation problems:

- e.g., re-refinement, backward adaptation
We implemented the framework and evaluated on the CLS scenario.

Demonstrator ASTRO-CAptEvo:
- simulate the CLS scenario, view the adaptation/composition mechanisms in action, inspect the internal system operation

Conclusions

A framework for dynamic adaptation of context-aware SBS:

- **Dynamic**
  - Entities can leave/join the system at run-time
  - Fragment/process models can change at run-time

- **Adaptive**
  - Allows for partial specification of processes (abstract activities) and to leave the handling of improbable/extraordinary situations to run-time (activity preconditions)
  - Provides different adaptation mechanisms properly coordinated through strategies

- **Context-aware**
  - Shared context model describing the system operational environment
  - Can be used to model exogenous events which may affect the system operation

- **User-centric (on-going)**
  - Smart Mobility scenario within the *SmartCampus* project (Trento)

ASTRO-CaptEvo Demonstrator on the CLS Scenario:

- Simulation environment + Adaptation/Composition techniques in action