A Framework for Secure Service Composition

Achim D. Brucker Francesco Malmignati
Madjid Merabti Qi Shi Bo Zhou

presented by
Brett Lempereur

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The Aniketos Project

Enable composite services to establish and maintain security and trustworthiness

Goals of the Aniketos platform:

- Design-time discovery, composition and evaluation, threat awareness
- Runtime adaptation or change in service configuration
- Runtime monitoring, detection, notification

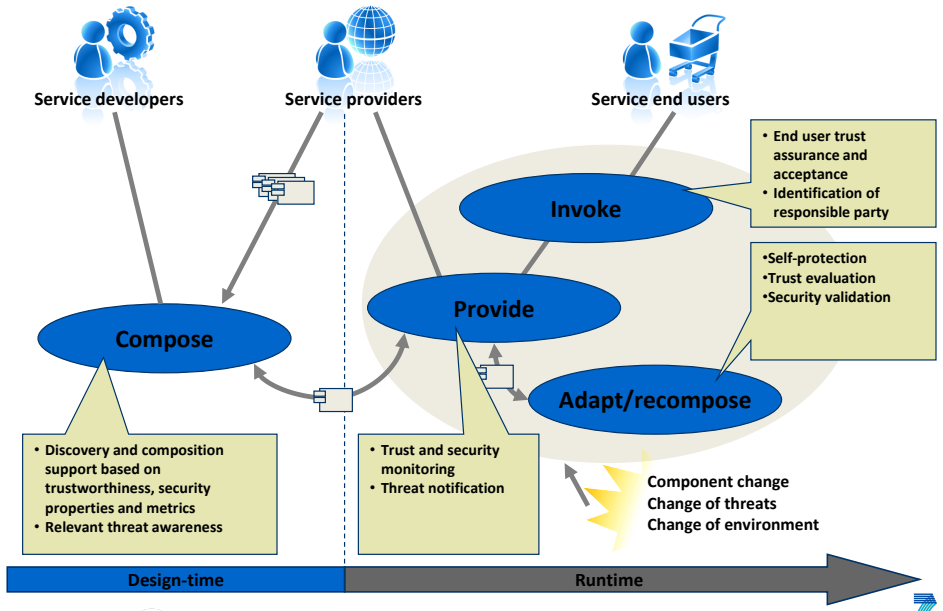
Two related dimensions:

- **Trustworthiness:** Reputation, perception, centralized vs. distributed
- **Security properties:** Behavior, contracts, interfaces, formal verification

Aniketos Fact-Sheet:

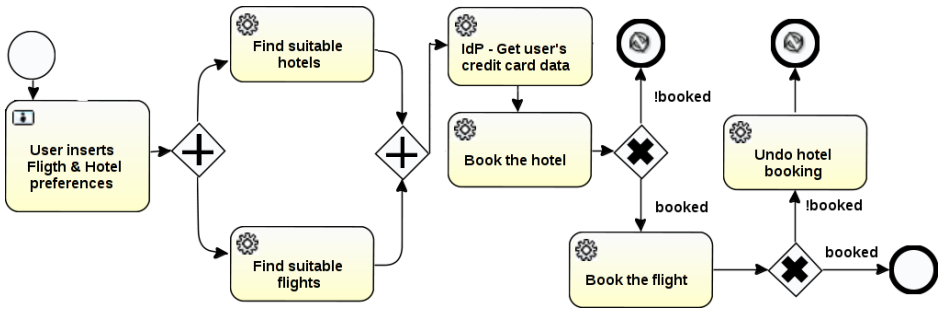
- EU Integrated Project (IP), FP7 Call 5
- Budget: € 13.9 Mio (€ 9.6 Mio funding)
- 42 month (Aug. 2010 – Feb. 2014)
- Coordinator: Sintef (Norway)

The Aniketos Process



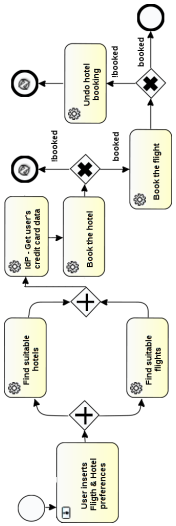
Outline

Modeling Composition Plans using BPMN



- Human-centric tasks
- Automated tasks (services)
- Orchestration of services
- Start/end states
- Logical control flow (if/and/or)
- Error states

Security and Trust Properties in Service Compositions



Access control

- Authenticated users
- Authorization of users

SoD/BoD

- No approval of own travels
- Separation of finding and booking flights

Need-to-Know

- Finding flights: only travel data
- Payment: only price and credit card data

Trust

- Use only trustworthy services
- Trustworthiness may change over time

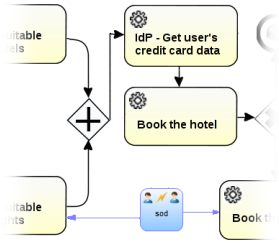
How to ensure security, compliance, and trustworthiness at design time and runtime?

Outline

The Problem: RBAC with Separation of Duty

Role-based access control (RBAC)

- Subjects are assigned to roles
- Permissions assign roles to tasks (resources)



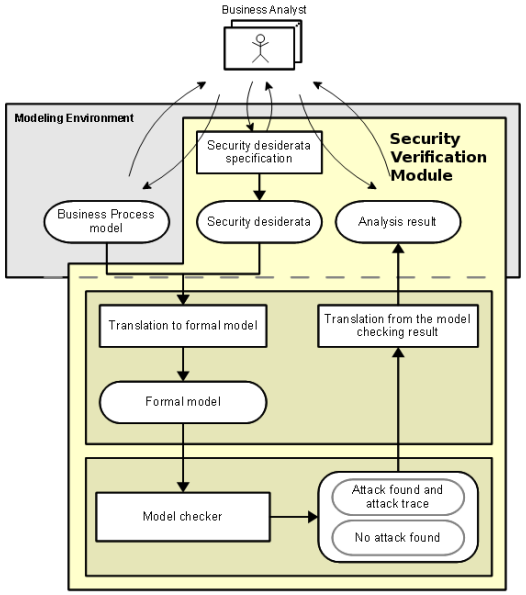
Separation of duty (SoD)

- restrict subjects in executing tasks

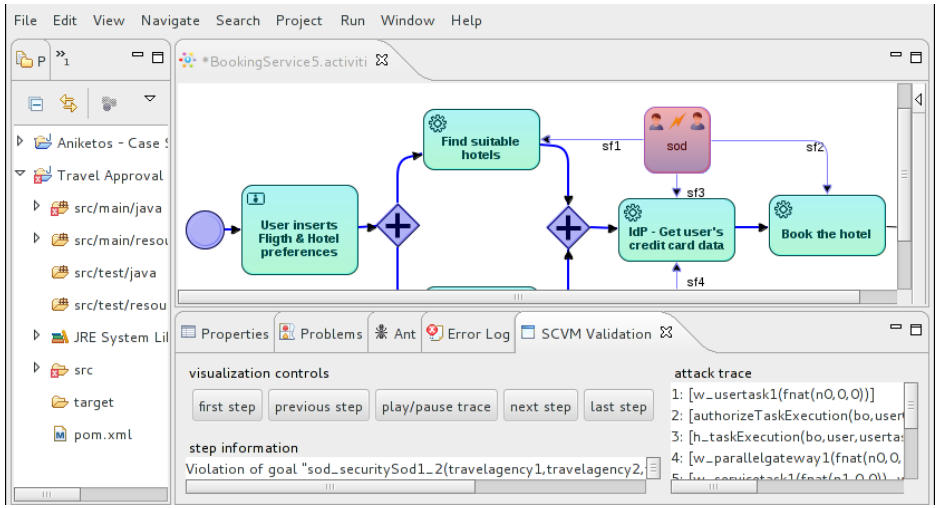
We analyze:

- Does the RBAC configuration comply to the SoD requirements?
  - yes: static SoD
  - no: dynamic SoD
- In case of a compliance violation:
  - change RBAC configuration
  - ensure dynamic enforcement of SoD

Security Verification Module (RBAC/SoD Check)

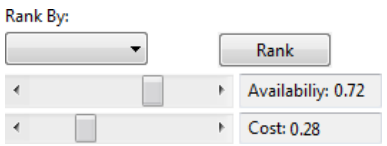


User Interface for the Service Designer



Outline

The Problem: Selection of the Optimal Composition



- Ranking of service compositions
  - property of the composition
  - compositions provide the same
    - functionality
    - security and trustworthiness
- Ranking according to
  - Availability
  - Costs

Ranking Secure Service Compositions

- Calculating the availability:

	Description	Calculation
○→○	Sequence	$\prod_{i=1}^{n} A_i$
⊕	Parallel	$\min(A_1, \ldots, A_n)$
⊗	Exclusive	A_i

- Calculating the costs:

$$C = \sum_{i=1}^{n} C_i$$

Example: Ranking Service Compositions

- Assume the following availability values:
  - Find suitable hotels: 0.99
  - Find suitable flights: 0.96
  - Get user's credit card data: 0.97
  - Book the hotel: 0.99
  - Book the flight: 0.98
  - Undo hotel booking: 0.94
- We compute:

$$A = \min(0.99, 0.96) \times 0.97 \times 0.99 \times 0.98 = 0.90$$

- Assume the weights to 0.72 (availability) and 0.28 (cost)

$$V = 0.72 \times A + 0.28 \times \frac{B - C}{B}$$

Outline

Conclusion and Outlook

- Secure service compositions require:
  - **Design time:**
    modeling, analysis and ranking of secure services
  - **Run-time:**
    enforcement, monitoring, service replacement, and re-planning
- Today, we presented design time support for
  - Analysing security properties of service compositions
  - a method for ranking service compositions
- Our work is part of the Aniketos secure Composition Framework
- Further information about Aniketos: `http://www.aniketos.eu`

Further Readings

Achim D. Brucker, Francesco Malmignati, Madjid Merabti, Qi Shi, and Bo Zhou.
A framework for secure service composition.
In *ASE/IEEE International Conference on Information Privacy, Security, Risk and Trust (PASSAT)*. IEEE Computer Society, 2013.

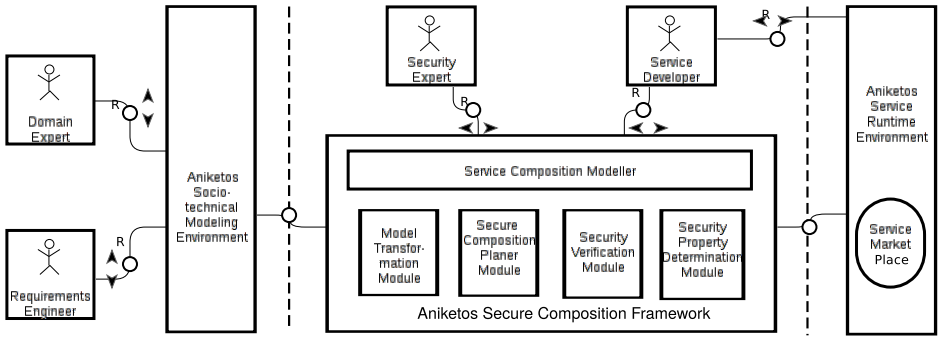
Thank you for your attention!

Any questions or remarks?

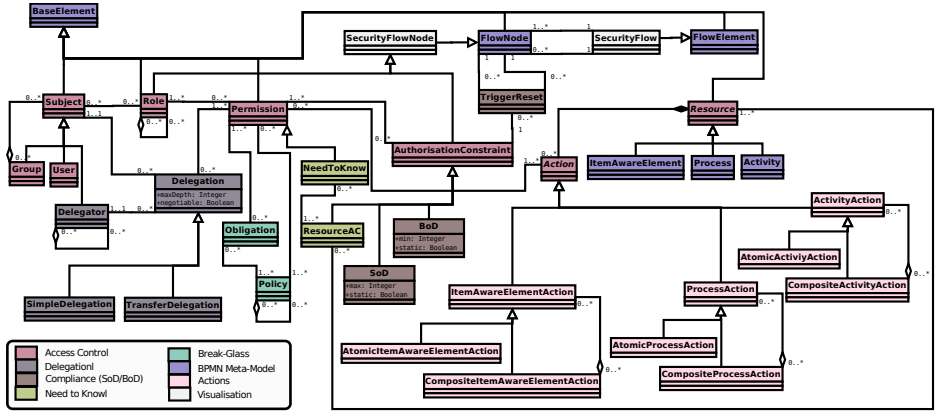
Part II

Appendix

The Aniketos Secure Composition Framework



SecureBPMN: Adding Security Specifications



- Access Control
- Delegation
- Separation/Binding of Duty
- Need to Know
- Break Glass

Analyzing (Dynamic | Static) Separation of Duty

Does the access control enforce a separation of duty constraint

- Translate the composition plan to ASLan

```
hc rbac_ac(Subject, Role, Task) := CanDoAction(Subject, Role, Task)
          :- user_to_role(Subject, Role), poto(Role, Task)
hc poto_T6 := poto(Staff, Request Travel)
hc poto_T6 := poto(Manager, Approve Absence)
hc poto_T7 := poto(Manager, Approve Budget)
```

- Specify the test goal

```
attack_state sod_securitySod1_1(Subject0,Subject1,Instance1,Instance2)
   := executed(Subject0,task(Request Travel,Instance1)).
      executed(Subject1,task(Approve Budget,Instance2)).
      executed(Subject3,task(Approve Absence,Instance3))
      &not(equal(Subject0,Subject1))
      &not(equal(Subject1,Subject2))
      &not(equal(Subject2,Subject3))
```

- Run the model checker
- Translate the analysis result back to BPMN (visualization)