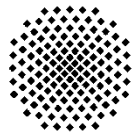


Interaction Choreography Models in BPEL: Choreographies on the Enterprise Service Bus

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Overview

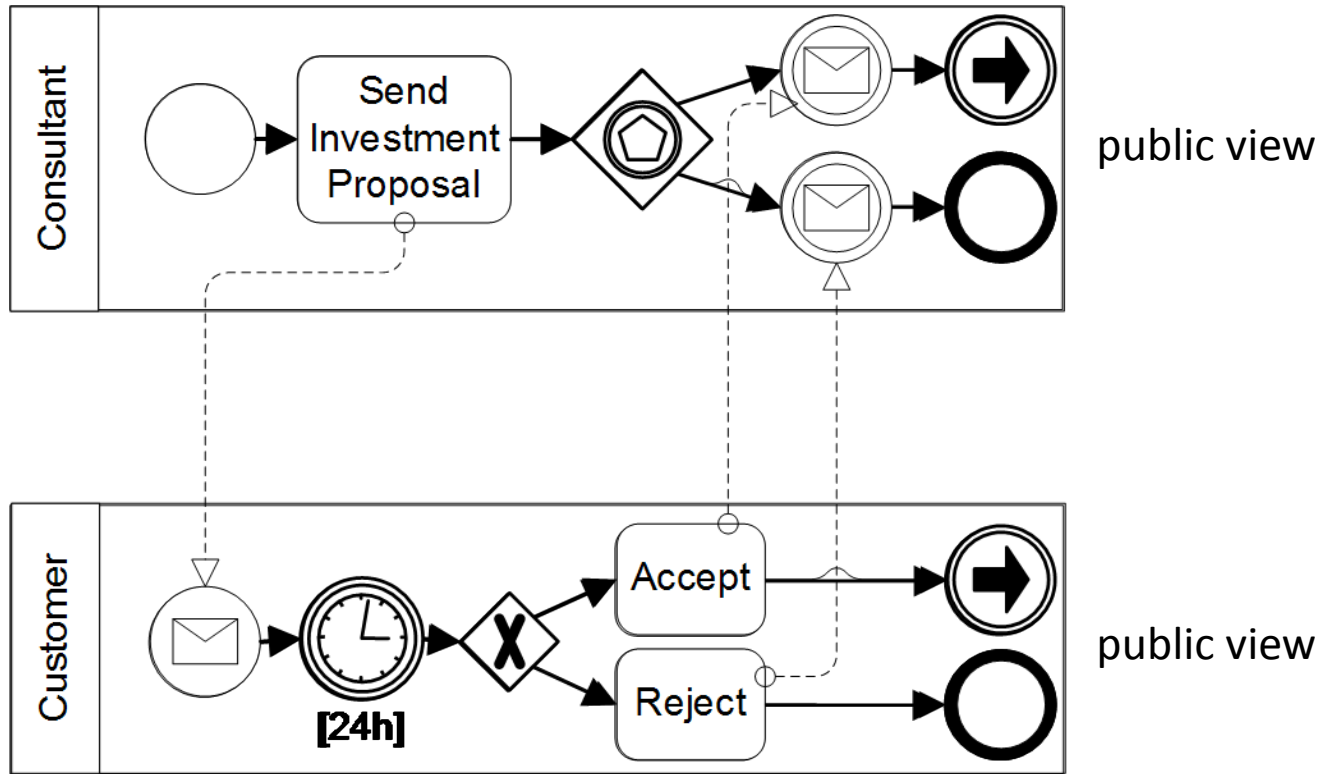
- State of the art in choreography research
- Motivation for interaction models expressed using BPEL
- New language: BPEL^{gold}
- BPEL^{gold} and the Enterprise Service Bus
- Evaluation of BPEL^{gold}
- Conclusion and outlook

Why Choreographies?

- Services may be stateless and stateful
- Behavior of stateful services may be described using ...
 - Textual descriptions
 - Abstract WS-BPEL processes
 - Operating Guidelines
- What about the interaction between two or more services?
 - Business protocol
 - ⇒ Choreography

Choreography Modeling Paradigms

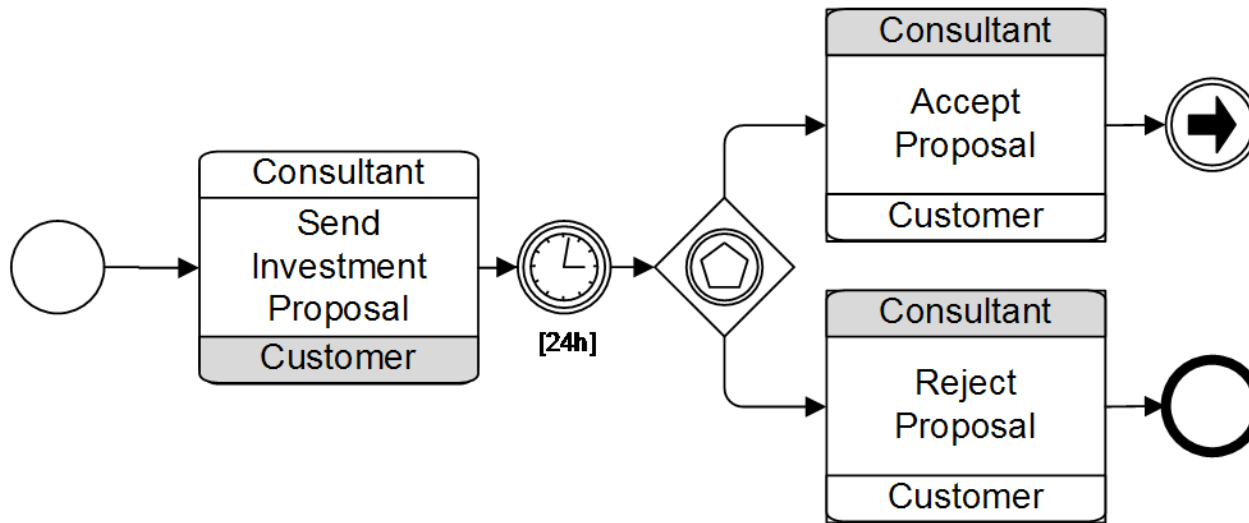
Introduction to Service Choreographies



Modeling Language used:
BPMN 2.0 as of 2010-06-05

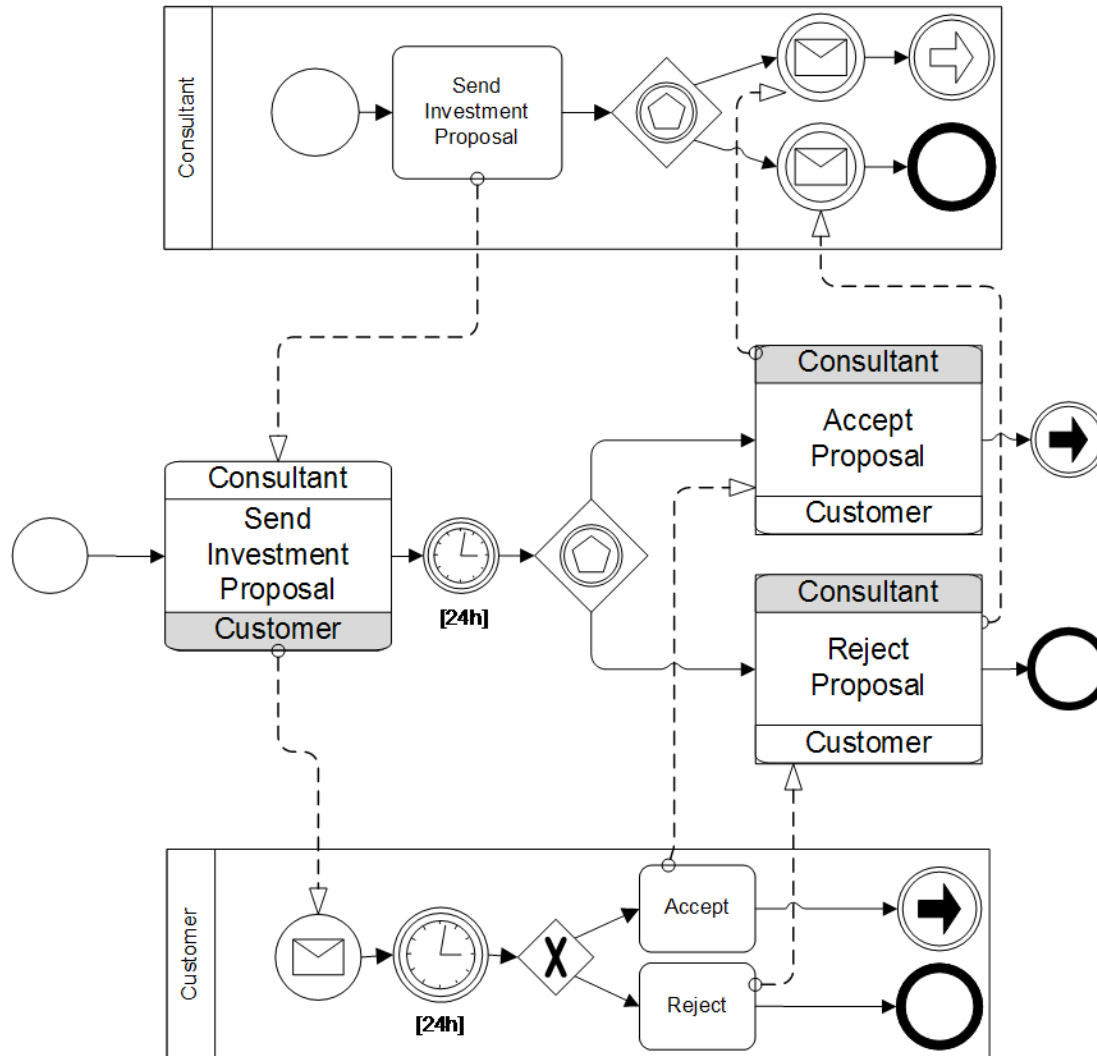
- Interconnected public views
 - Alternatively: Interconnected participant behavior descriptions
- ⇨ Interconnection models (“collaboration” in BPMN 2.0)

Alternative Modeling Approach



- Interactions **globally captured**
- Basic building block:
atomic interaction between two parties
- ⇨ Interaction models (“choreography” in BPMN 2.0)

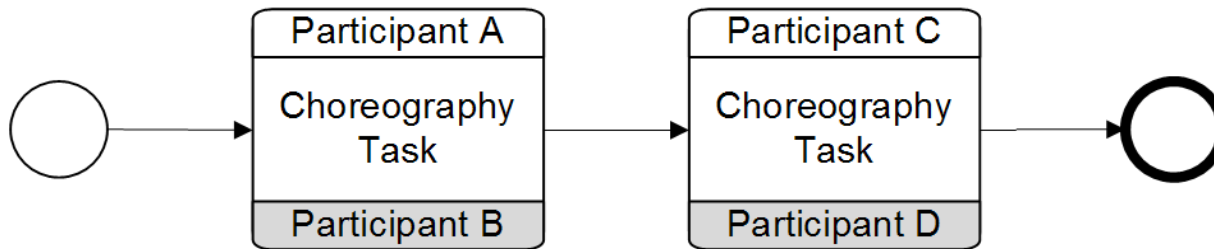
Both "Views" Together



Properties of Interaction Models

Realizability

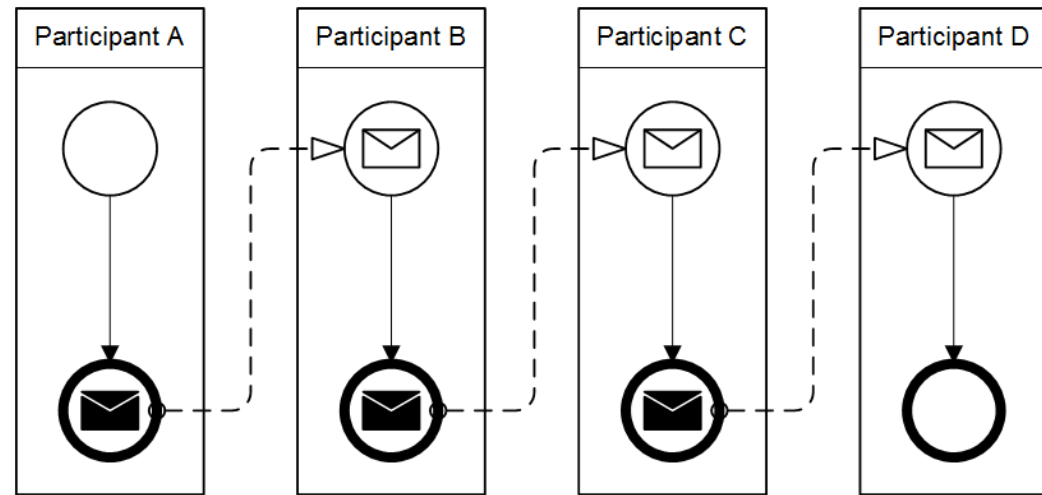
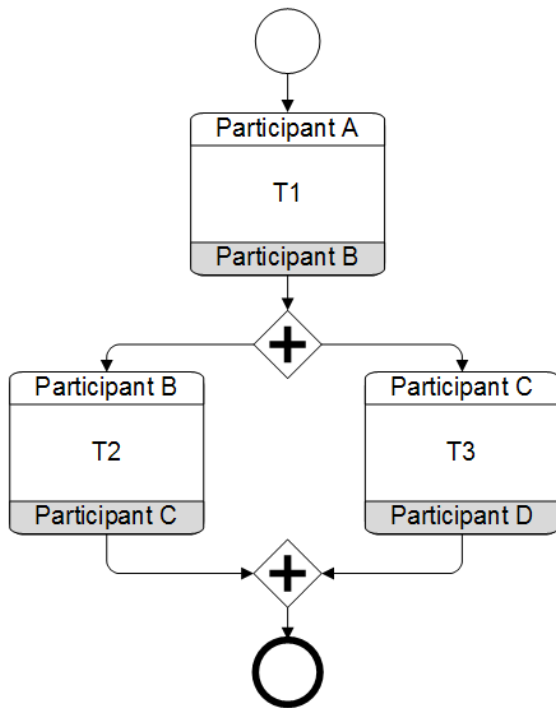
- There exist orchestrations showing equivalent behavior as the choreography
 - Synchronous communication changes to asynchronous communication
- **All** interactions have to be produced by the orchestrations
- Orchestrations may not introduce additional communication



Properties of Interaction Models

Local enforceability

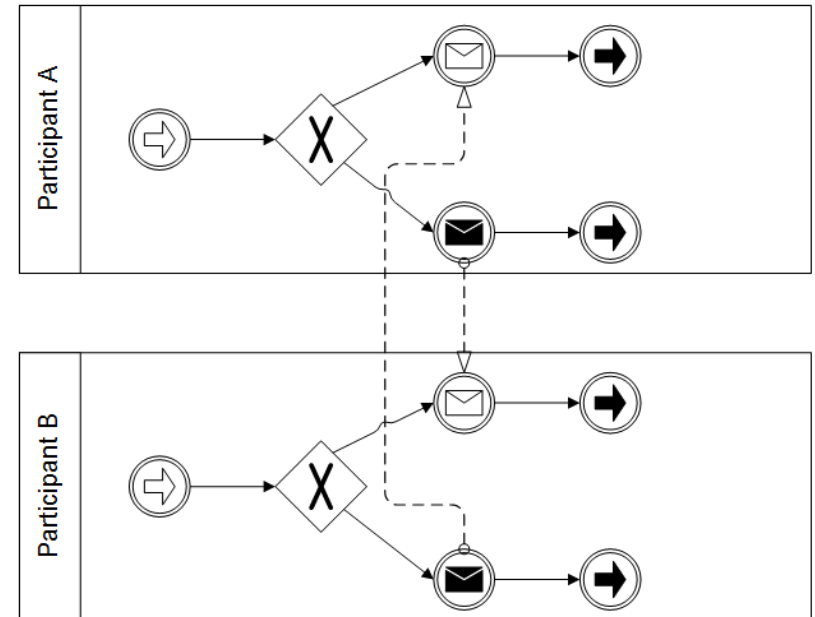
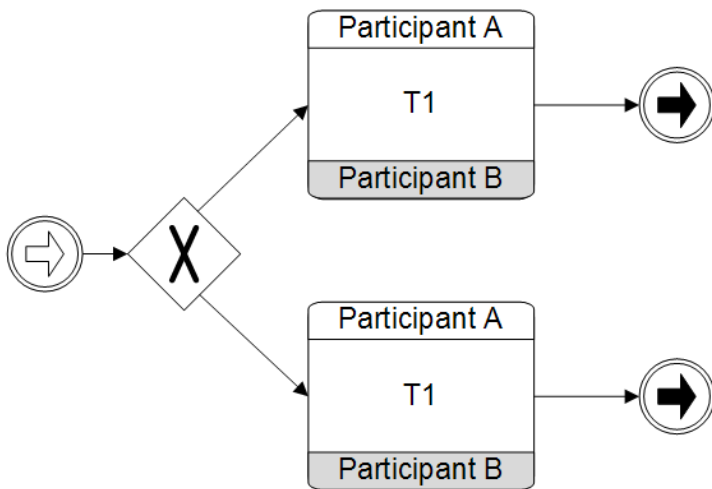
- Weaker than realizability
- Contain only interactions specified in the choreography
- Are able to enforce all constraints expressed in the global model



Properties of Interaction Models

Desynchronizability

- Strong than realizability
- Orchestration together “weakly terminate”
- Example for non-desynchronizability: mixed choices



Evaluation of Choreography Languages

- Service Interaction Patterns
 - What kind of interactions have to be supported by the language?
 - Send/receive, one-from-many receive, relayed request
- “Requirements Framework”
 - Multi-literal interactions
 - Service Sets
 - Service Topology

Barros, A.; Dumas, M. & ter Hofstede, A. Service Interaction Patterns
Proceedings 3rd International Conference on Business Process Management (BPM), Springer

Decker, G.; Kopp, O.; Leymann, F. & Weske, M. Interacting services: From specification to execution
Data & Knowledge Engineering, Elsevier Science Publishers, 2009, 68, 946-972

Requirements on Choreography Languages (1)

- Multi-lateral Interactions
 - More than two participants
- Service topology
 - List of participants and their links
- Service sets
 - Sets of same type of participants
 - Possibly a priori unknown size
- Selection of services and reference passing
 - Link passing mobility
- Specification of message formats
 - Message formats can be standardized

Requirements on Choreography Languages (2)


- Interchangeability of technical configurations
 - The protocol stays the same, but the port types change
- Time constraints
 - E.g., specification of behavior due to timeouts
- Exception handling
 - Capable of expressing derivations of the “happy path”
- Correlation
 - Identification of the right „choreography instance“
- Integration with orchestration languages
 - **WS-BPEL** compatibility

Evaluation of Existing Languages

	BPMN 2.0 Collaboration interconnection	BPMN 2.0 Choreography interaction	BPEL4Chor interconnection
Modeling Style			
Graphical Notation	yes	yes	no
R1. Multi-lateral interactions	+	+	+
R2. Service topology	+	+	+
R3. Service sets	+	+	+
R4. Reference passing	-	-	+
R5. Message formats	+	+	+
R6. Interchangeability of technical configurations	-	-	+
R7. Time constraints	+	+	+
R8. Exception handling	+	-	+
R9. Correlation	+	+	+
R10. Integration with service orchestration languages	+/-	+/-	+

Current Available Languages

Type	BPMN	BPEL
Interaction	BPMN 2.0 Choreographies	BPEL ^{gold}
Interconnection	BPMN 2.0 Collaboration	BPEL4Chor



- BPEL^{gold}: BPEL **global** definition
- BPEL4Chor: BPEL for choreographies

BPELgold

Participant Topology

Resued and adpated from BPEL4Chor

List of participant types

```
<topology name="investment" gl:interactionDescription="inv:interactions">
```

```
<participantTypes>
```

```
<participant name="Consultant" />
```

```
<participant name="Customer" />
```

```
</participantTypes>
```

List of participants

```
<participants>
```

```
<participant name="consultant" type="Consultant" />
```

```
<participant name="customer" type="Customer" />
```

```
</participants>
```

Connecting participants

```
<messageLinks>
```

```
<messageLink name="investmentProposal" sender="consultant" receiver="customer" />
```

```
<messageLink name="acceptance" sender="customer" receiver="consultant" />
```

```
<messageLink name="rejection" sender="customer" receiver="consultant" />
```

```
</messageLinks>
```

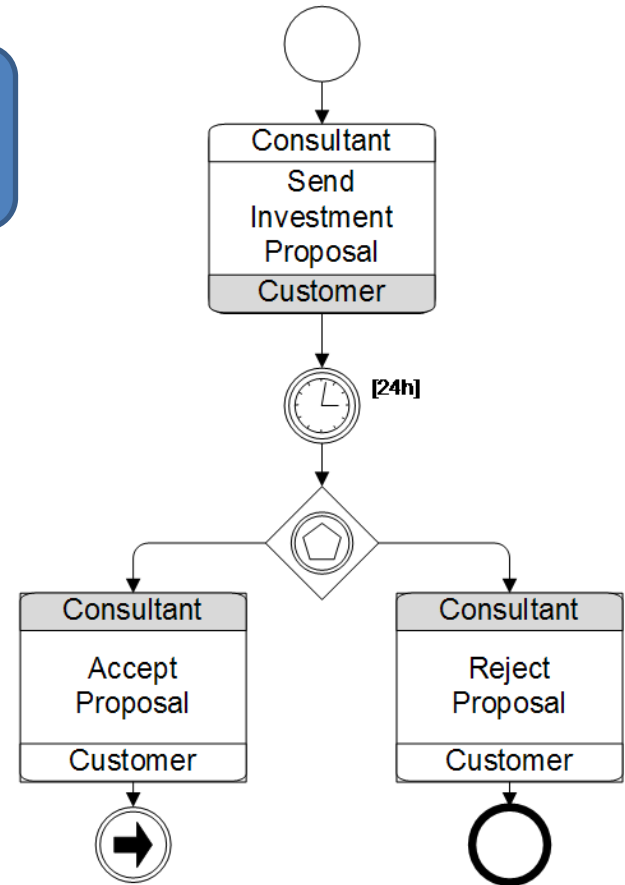
```
</topology>
```

Interaction Description

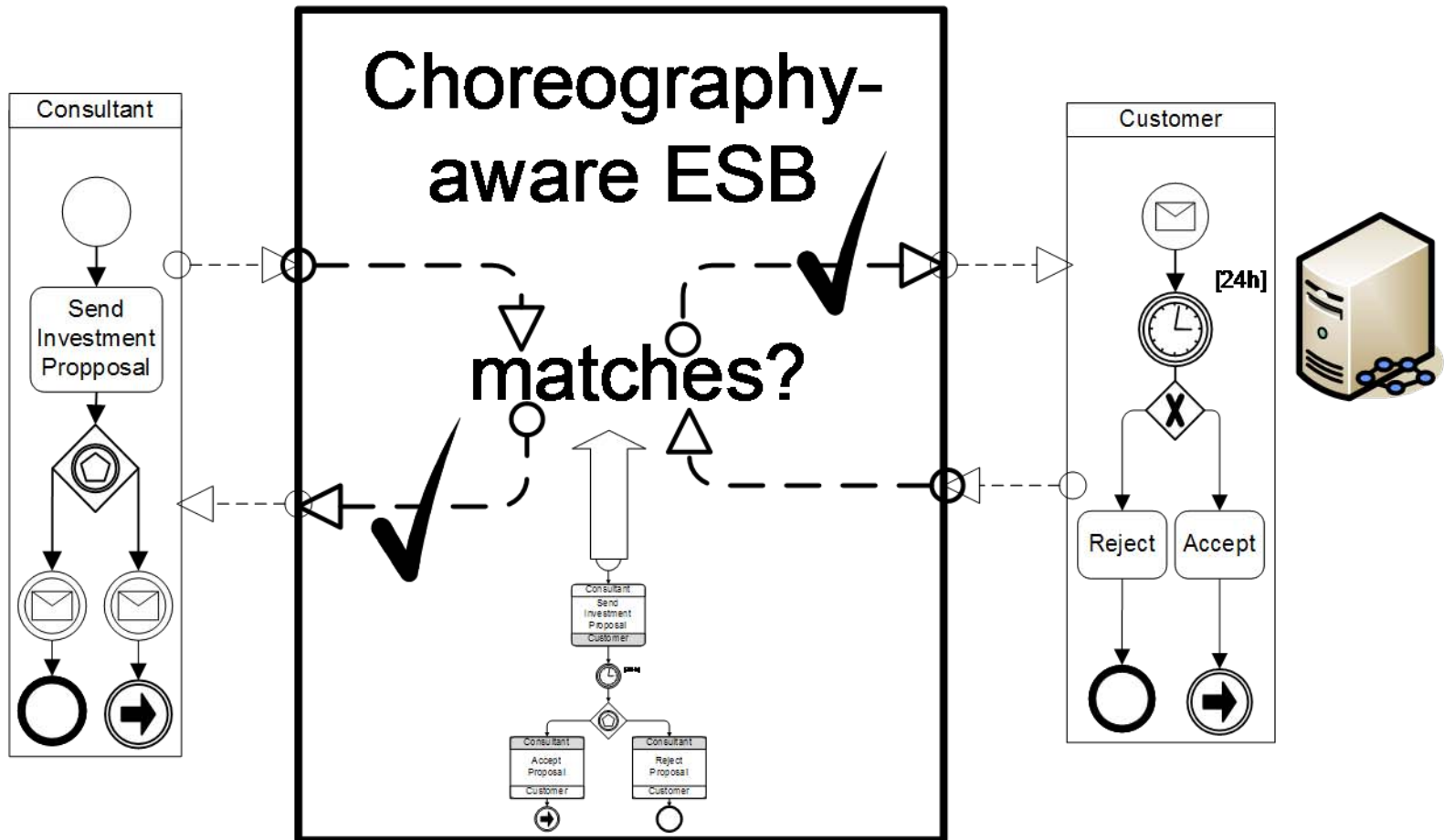
```
<process>
  <sequence>
    <extensionActivity>
      <gld:interaction messageLink="investmentProposal" />
    </extensionActivity>
    <wait for="P1D" />
    <pick>
      <gld:onInteraction messageLink="acceptance" />
      <gld:onInteraction messageLink="rejection" />
    </pick>
  </sequence>
</process>
```

New extension activity modeling atomic interactions

New extension supporting choices on atomic interactions

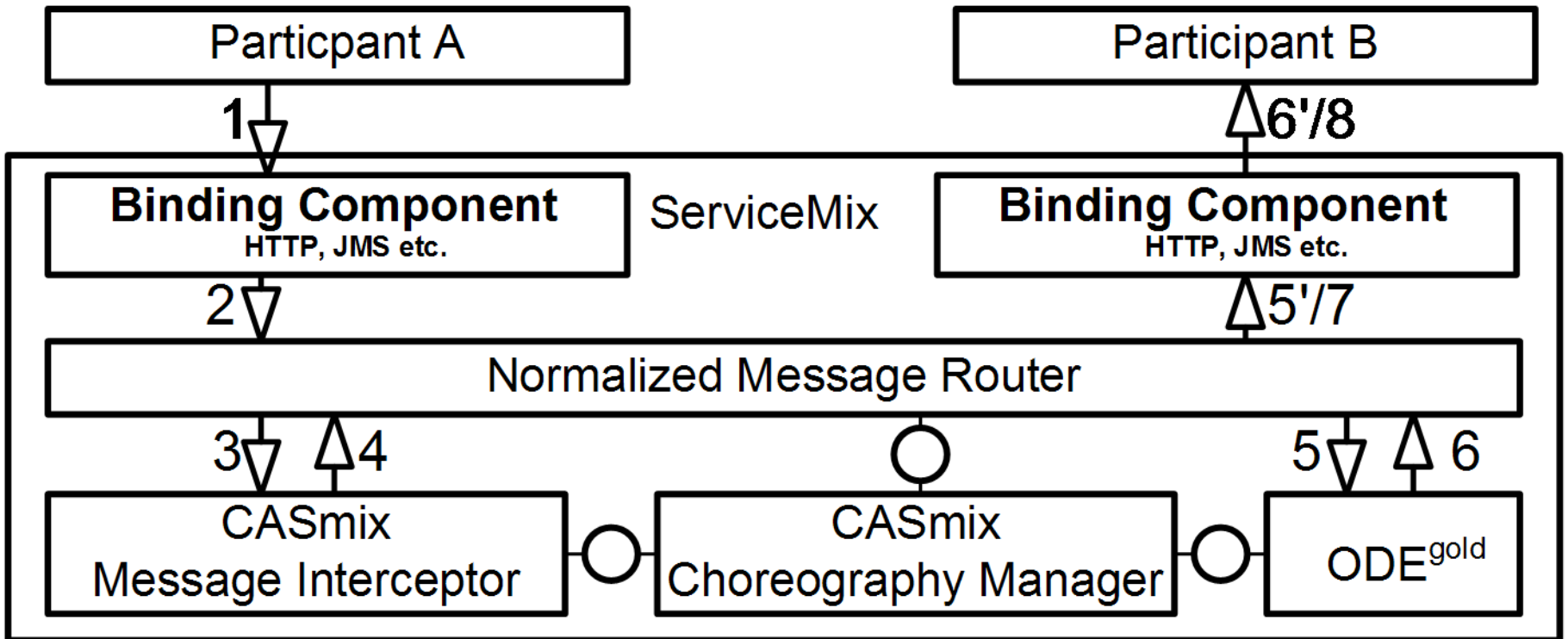


Usage in the Enterprise Service Bus



Implementation: CASMix

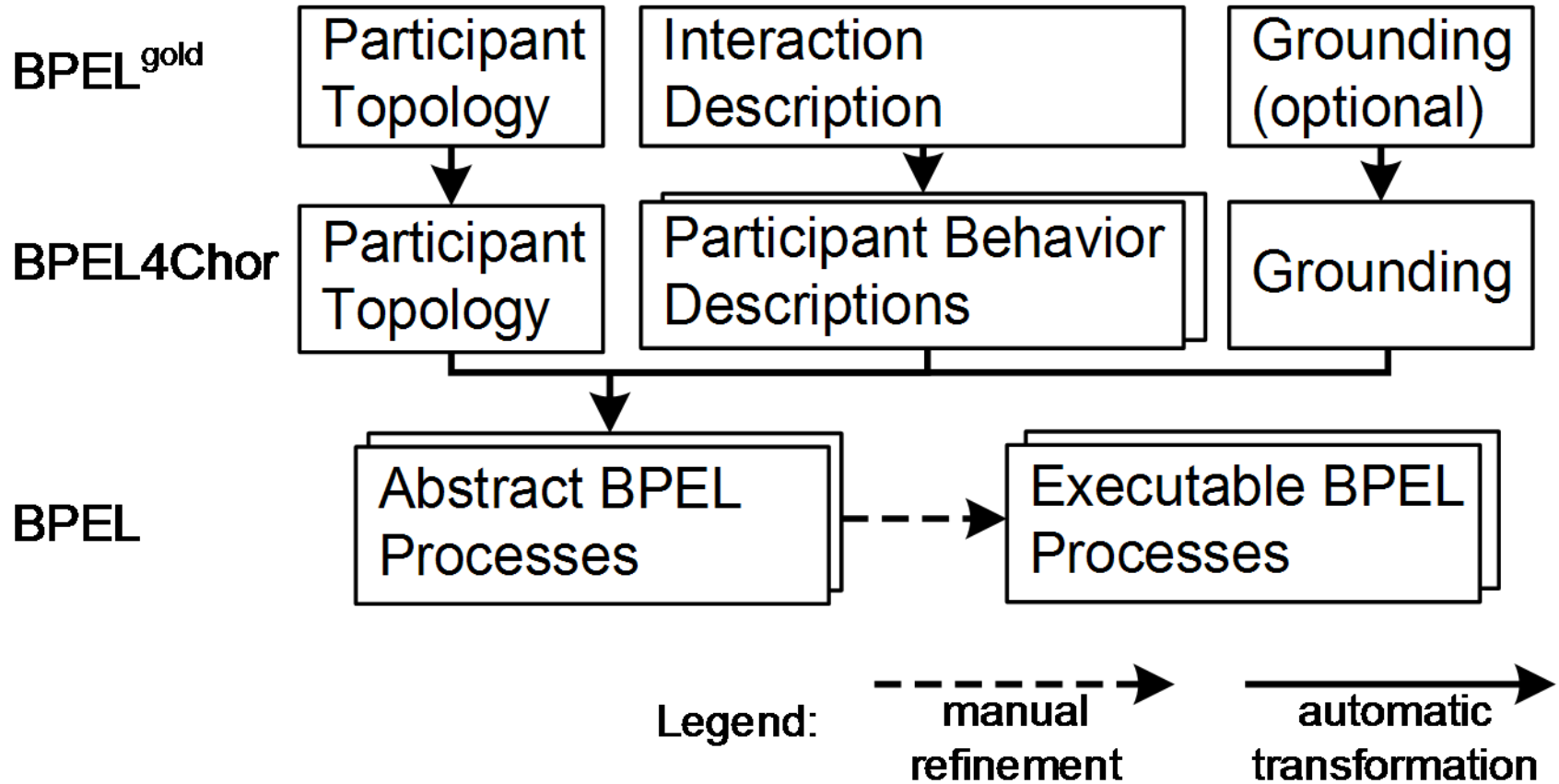
Choreography-aware ServiceMix



What if a Violation Occurs?

- A violation triggers ODE^{gold} to throw a `gld:choreographyViolation` fault
 - This indicates non-compliance of the execution to the choreography model
- A fault leads to a termination of the choreography
- Alternative behavior desired
- Fault handler may be used to specify the alternative behavior
 - Full BPEL scope semantics
 - Interaction with the service bus is enabled
 - Unique to BPEL^{gold}, not existing in BPMN, ...

Usage of BPEL^{gold}



Evaluation of BPEL^{gold}

	BPEL ^{gold}
Modeling Style	interconnection
Graphical Notation	no
R1. Multi-lateral interactions	+
R2. Service topology	+
R3. Service sets	+
R4. Reference passing	+
R5. Message formats	+
R6. Interchangeability of technical configurations	+
R7. Time constraints	+
R8. Exception handling	+
R9. Correlation	+
R10. Integration with service orchestration languages	+

Conclusion and Outlook

- BPEL^{gold} as interaction choreography language based on BPEL
- Enables interaction modeling using BPEL's execution semantics

- Improvements of tooling
 - ODE^{gold}
 - BPEL^{gold} modeller (based on Oryx)
 - Mappings to/from BPEL^{gold}
- Integration of cross-partner fault handling concepts in BPEL^{gold}

End of Presentation

Evaluation of Current Languages

<i>Requirements</i>	BPEL	BPEL ^{light}	WSFL	WS-CDL	Let's Dance	BPMN	iBPMN	BPSS/UMMI	SCA
R1. Multi-lateral interactions	+	+	+	+	+	+	+	-	n/a
R2. Service topology	-	-	+	+/-	-	+/-	+	-	+
R3. Service sets	+/-	+/-	-	-	+	-	-	-	+
R4. Selection of services and reference passing	+/-	+/-	+/-	+/-	+/-	-	-	-	n/a
R5. Message formats	+	+	+	+	-	+	+	+	+
R6. Interchangeability of technical configurations	-	+	+	-	-	-	-	-	-
R7. Time constraints	+	+	-	+	+/-	+	+	+	n/a
R8. Exception handling	+	+	+	+	-	+	+	+	n/a
R9. Correlation	+	+	-	+	-	-	-	-	n/a
R10. Integration with service orchestration languages	+	+	+/-	-	+/-	+/-	-	+/-	n/a

Verification of BPEL4Chor and BPEL

■ BPEL4Chor Verification

- Lohmann, N.; Kopp, O.; Leymann, F. & Reisig, W.
Analyzing BPEL4Chor: Verification and Participant Synthesis
WS-FM 2007, Springer-Verlag, 2007

■ Verification respecting data dependencies

- Monakova, G.; Kopp, O.; Leymann, F.; Moser, S. & Schäfers, K.
Verifying Business Rules Using an SMT Solver for BPEL Processes
Proceedings of the Business Process and Services Computing Conference: BPSC'09, Gesellschaft für Informatik e.V. (GI), 2009

■ Overview on all verifications (as of 2006):

- van Breugel, F. & Koshkina, M. Models and Verification of BPEL
<http://www.cse.yorku.ca/~franck/research/drafts/tutorial.pdf> **2006**

Further Reading

- Decker, G.; Kopp, O. & Barros, A.
An Introduction to Service Choreographies
Information Technology, Oldenbourg Verlag, 2008, 50, 122-127
- Decker, G.
Design and Analysis of Process Choreographies
PhD thesis, *Hasso Plattner Institute, University of Potsdam, 2009*
- Kopp, O.; Wieland, M. & Leymann, F. Towards Choreography Transactions
ZEUS 2009, CEUR-WS.org, 2009, 438
- Kopp, O.; Martin, D.; Wutke, D. & Leymann, F.
The Difference Between Graph-Based and Block-Structured Business
Process Modelling Languages
*Enterprise Modelling and Information Systems, Gesellschaft für Informatik
e.V. (GI), 2009, 4, 3-13*
- Lohmann, N.; Massuthe, P. & Wolf, K.
Operating Guidelines for Finite-State Services
ICATPN 2007, Springer, 2007