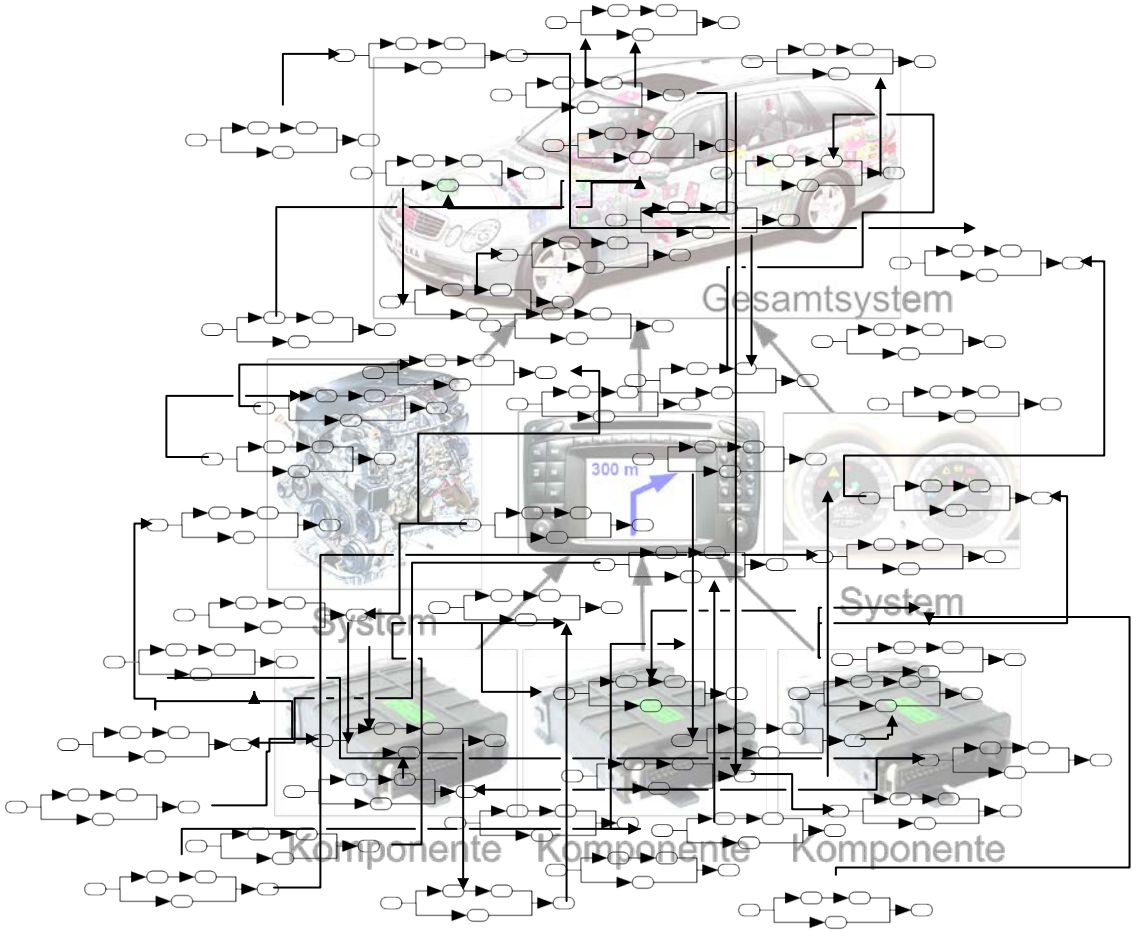
ulm university universität ulm



Collective Adaptive Process-Aware Information Sytems:
Challenges, Scenarios, Techniques

Manfred Reichert

Agenda

Adaptive Collective Systems

Backgrounds

Adaptive Collective Object Lifecycles

Adaptive Cross-Organizational Processes

Adaptive Collective Systems

- *"Heterogeneous collections of autonomous task-oriented systems that cooperate on common goals forming a collective system…"*

- Purpose (cf. FoCAS):
  "*The socio-technical fabric of our society more and more depends on systems that are constructed as a collective of heterogeneous components and that are tightly entangled with humans and social structures. Their components increasingly need to be able to evolve, collaborate and function as a part of an artificial society.*"

Adaptive Collective Systems

Relevant issues …

- ***Nature***
  A strong orientation to working the way that natural systems work.

- ***Automated or Facilitated?***
  Some of the research oriented toward facilitating humans in an organization, and some is toward replacing humans with automated, yet flexible, systems.

- ***Non-Uniform***

  - *There may be many diverse components interacting in complex ways, i.e., it is not assumed that there is a single uniform process system*

  - *Diversity is the important ingredient for stability in the face of unexpected changes.*

Source: K. Swenson, 2014

Agenda

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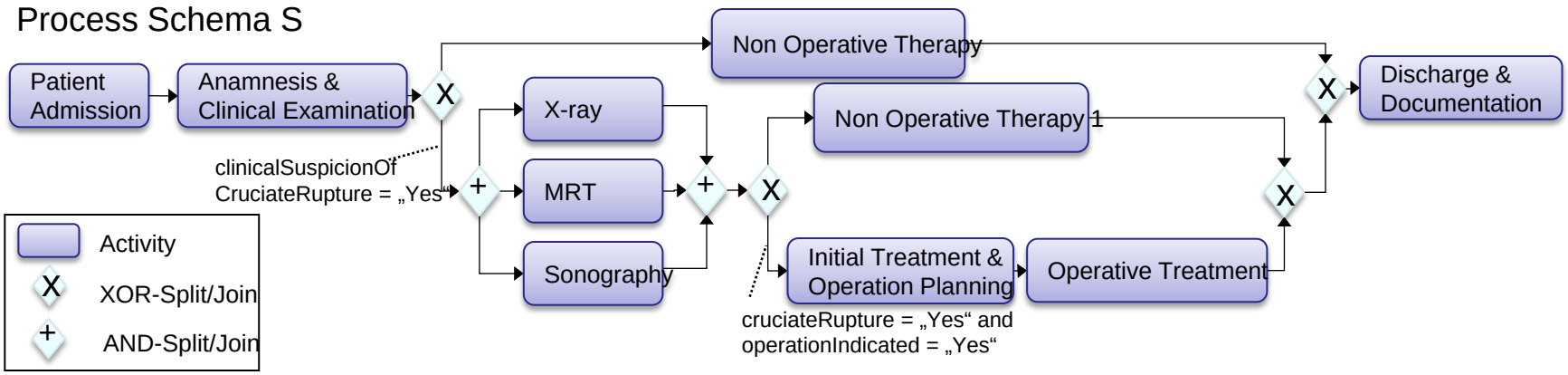
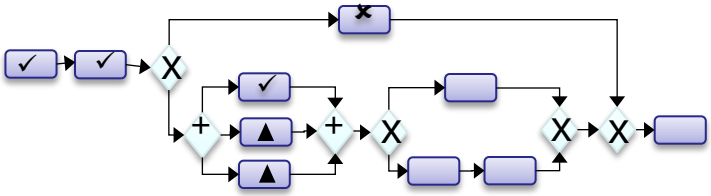
Process-Aware Information Systems (PAIS)

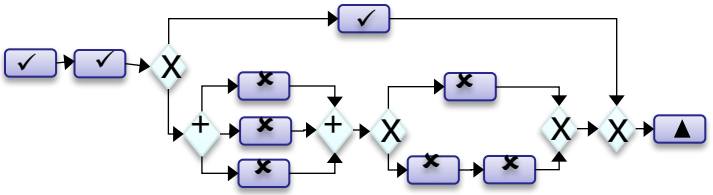


Process Instance I1



Execution Trace:
σ_1 = < „Patient Admission“, „Anamnesis & Clinical Examination“, „X-ray“>

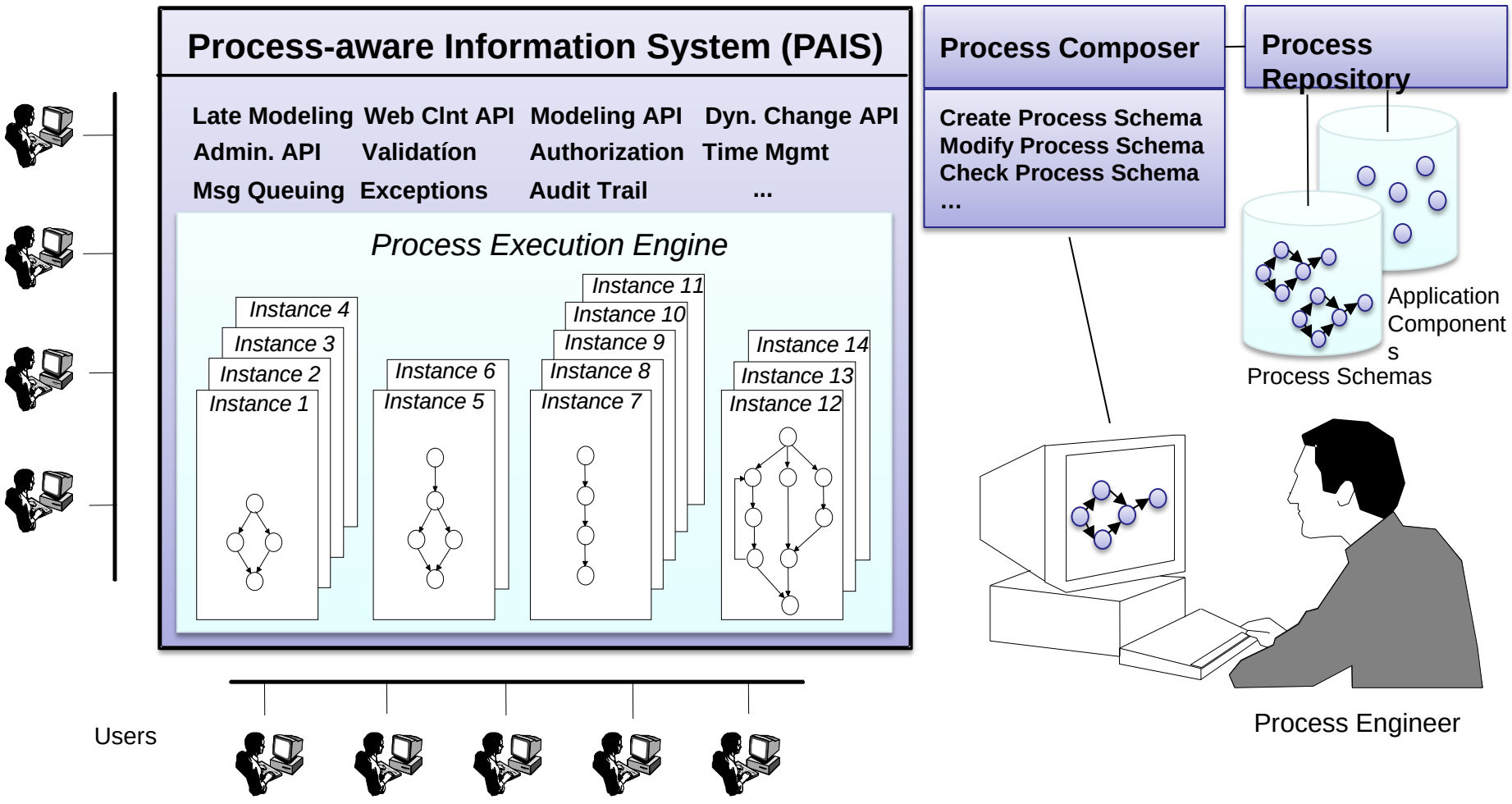
Process Instance I2



Execution Trace:
σ_2 = < „Patient Admission“, „Anamnesis & Clinical Examination“, „Non Operative Therapy“>

Activity States: ▲ Activated ✓ Completed ✘ Skipped

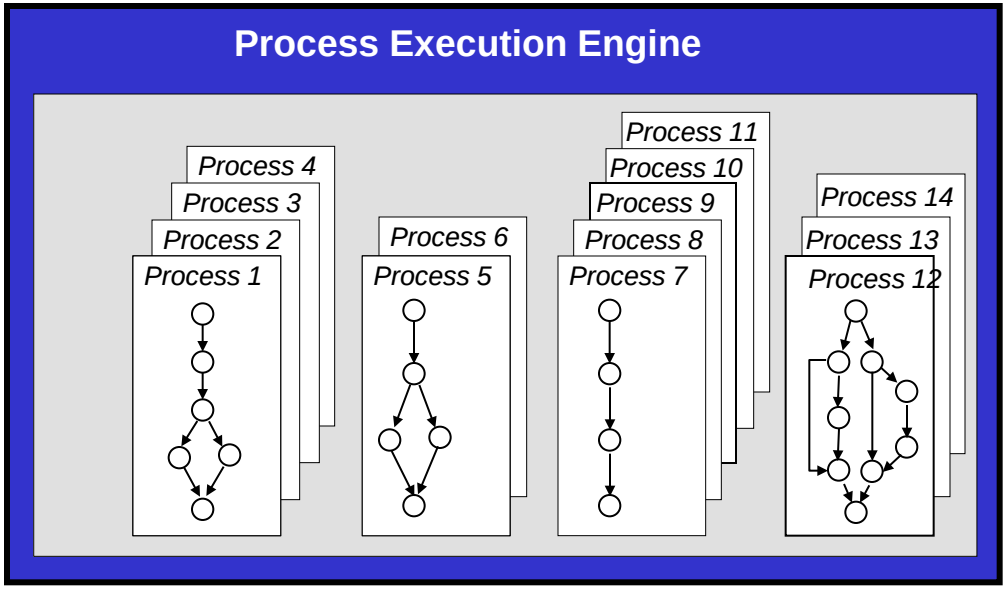
Process-Aware Information Systems (PAIS)



Adaptive PAIS: Instance Changes

ADEPT

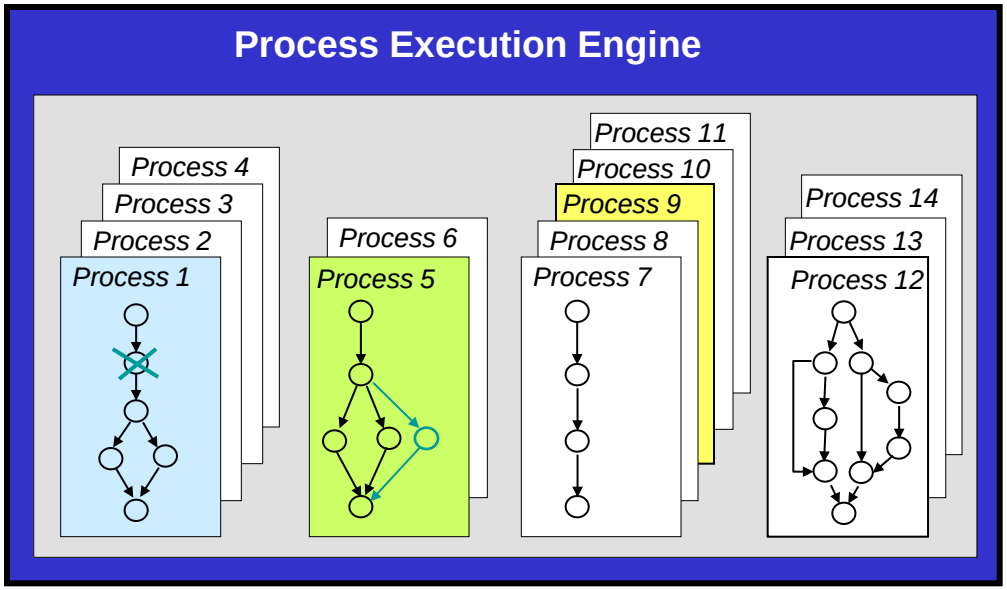
Individually adaptable Process Instances



Adaptive PAIS: Instance Changes

ADEPT

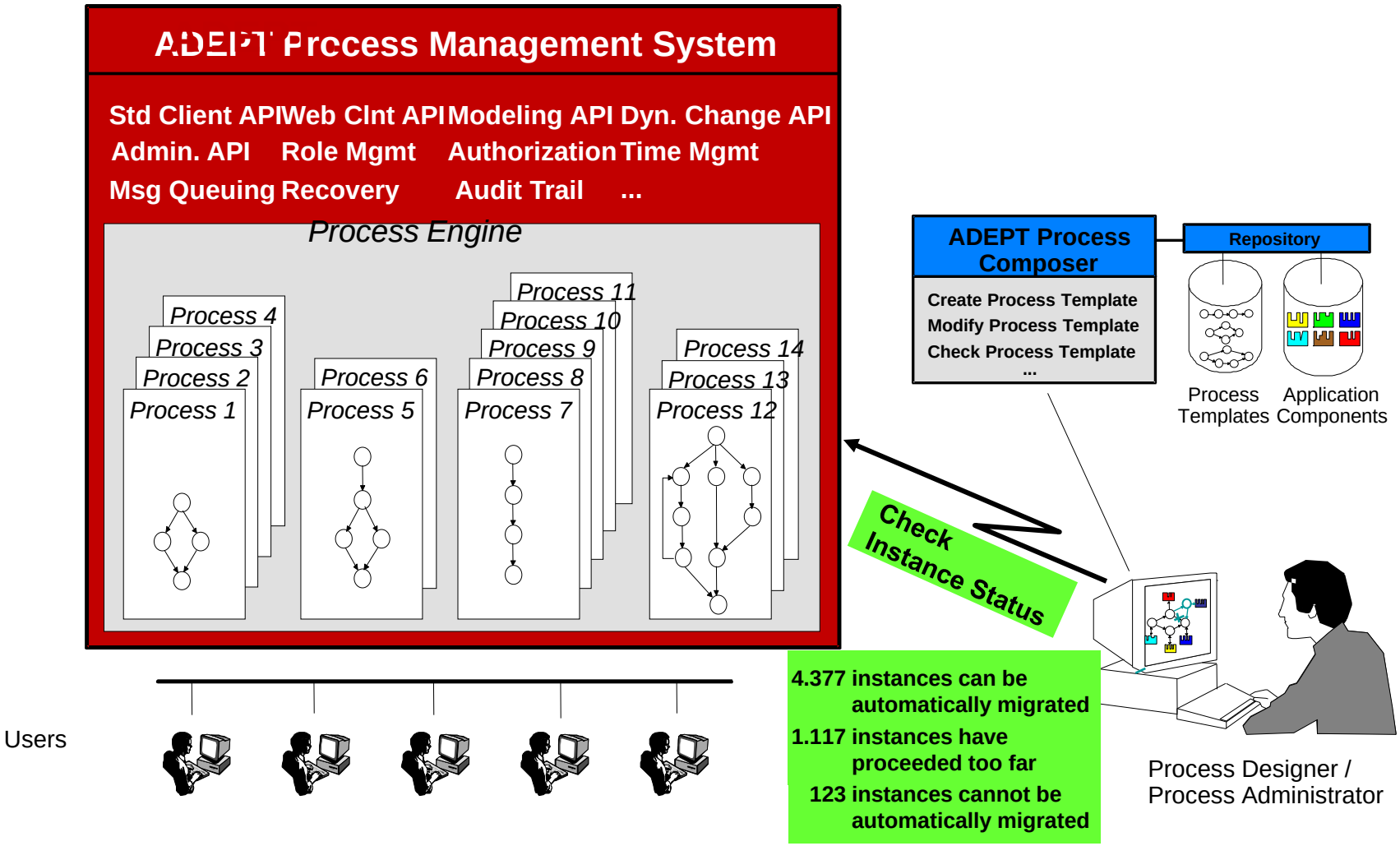
Individually adaptable Process Instances



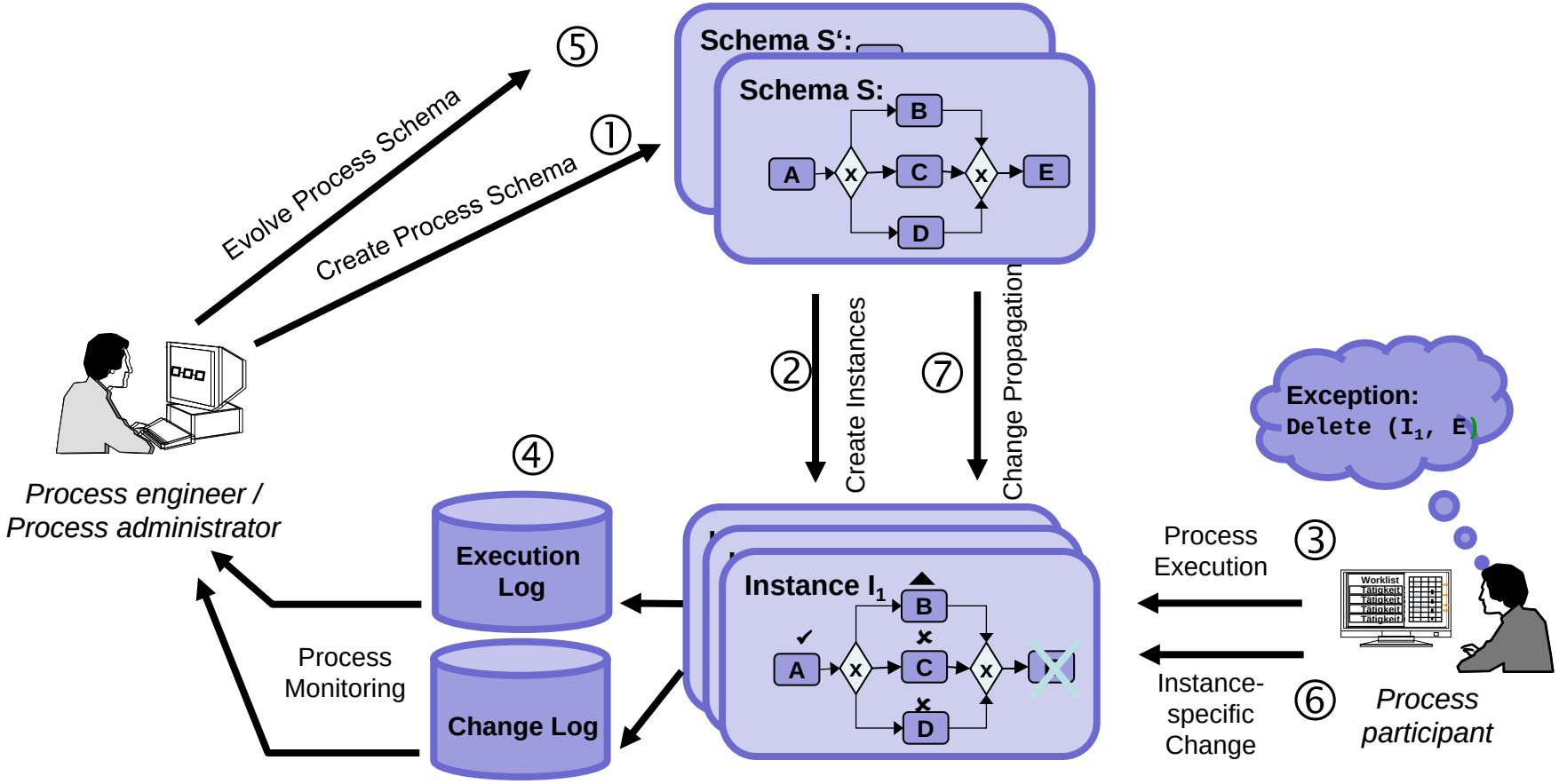
Achievements:

- **Formal and expressive process meta model**
- **Formal Criteria for Change Correctness**
- **Efficient, build-in consistency checks** („no bad surprise")
- **Support of a high number of change patterns**
- **API for accomplishing ad-hoc changes**

Adaptive PAIS: Schema Evolution



Adaptive PAIS: Extended Process Lifecycle



Transferring ADEPT to Industrial Practice

ARISTAFLOW

www.aristaflow-forum.de

Reichert · Weber

Enabling Flexibility in Process-Aware Information Systems

Manfred Reichert
Barbara Weber

Enabling Flexibility in Process-Aware Information Systems

Challenges, Methods, Technologies

Springer

Agenda

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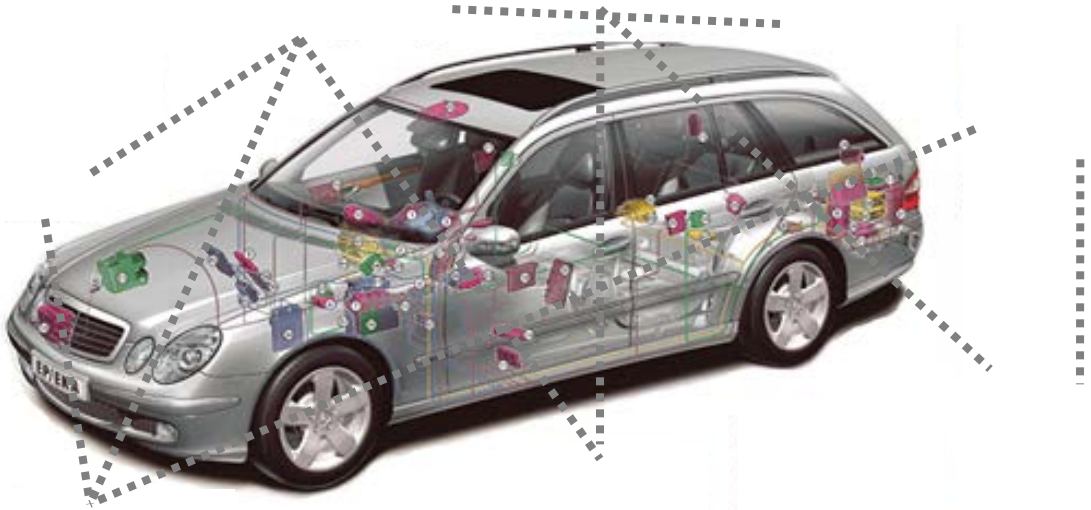
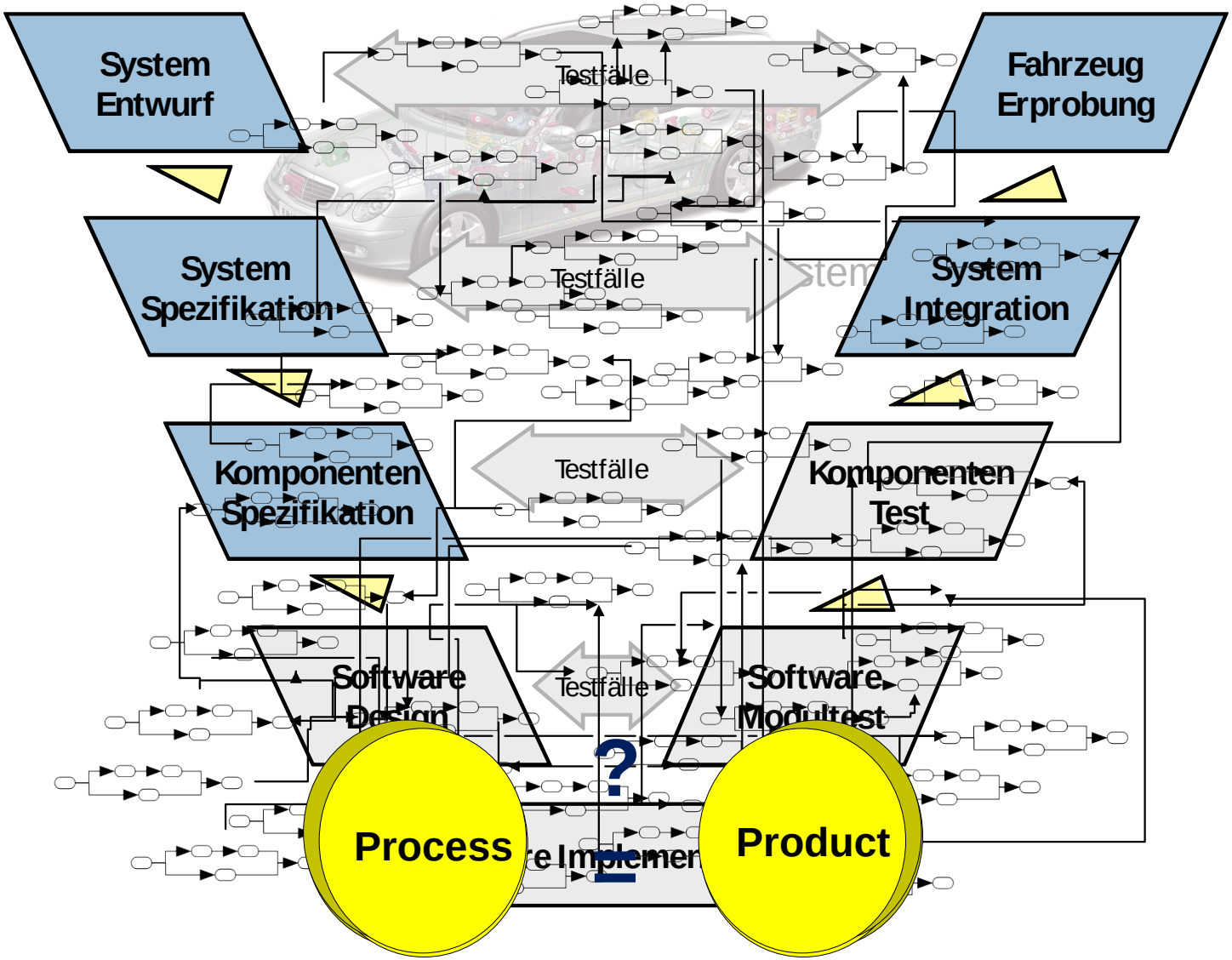
Adaptive Cross-Organizational Processes

Adaptive Collective Object Lifecycles

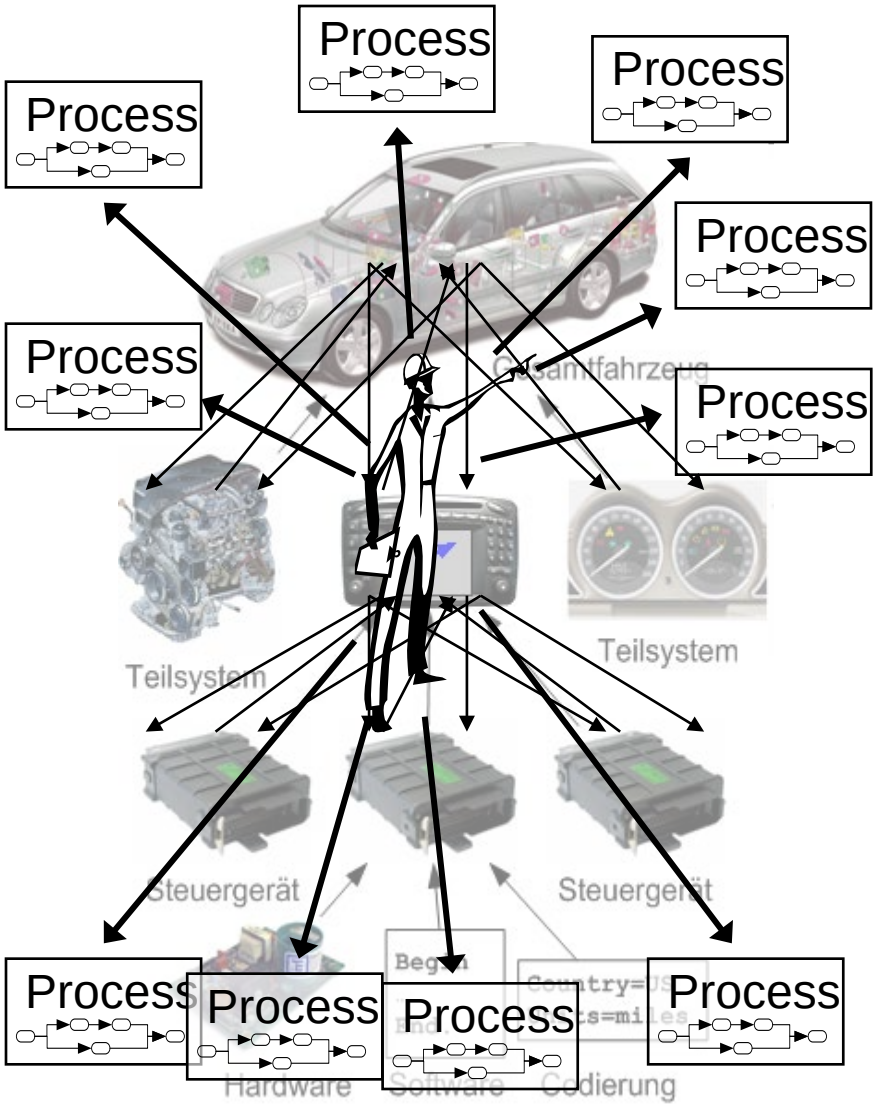


Adaptive Collective Object Lifecycles

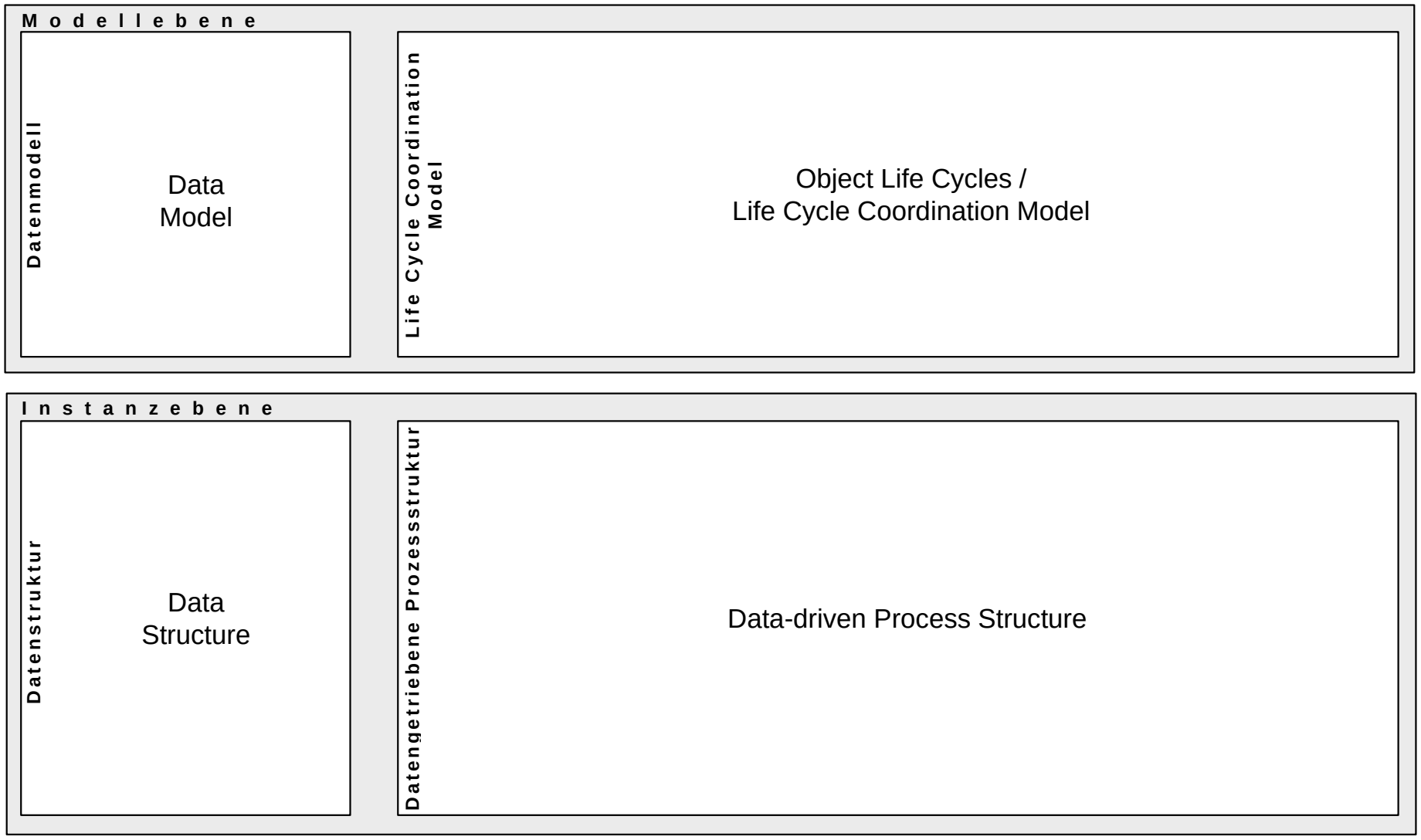


Adaptive Collective Object Lifecycles: Drivers

- Modeling
- Execution
- Dynamic Adaptation
- Exception Handling



The Corepro Framework: Overview



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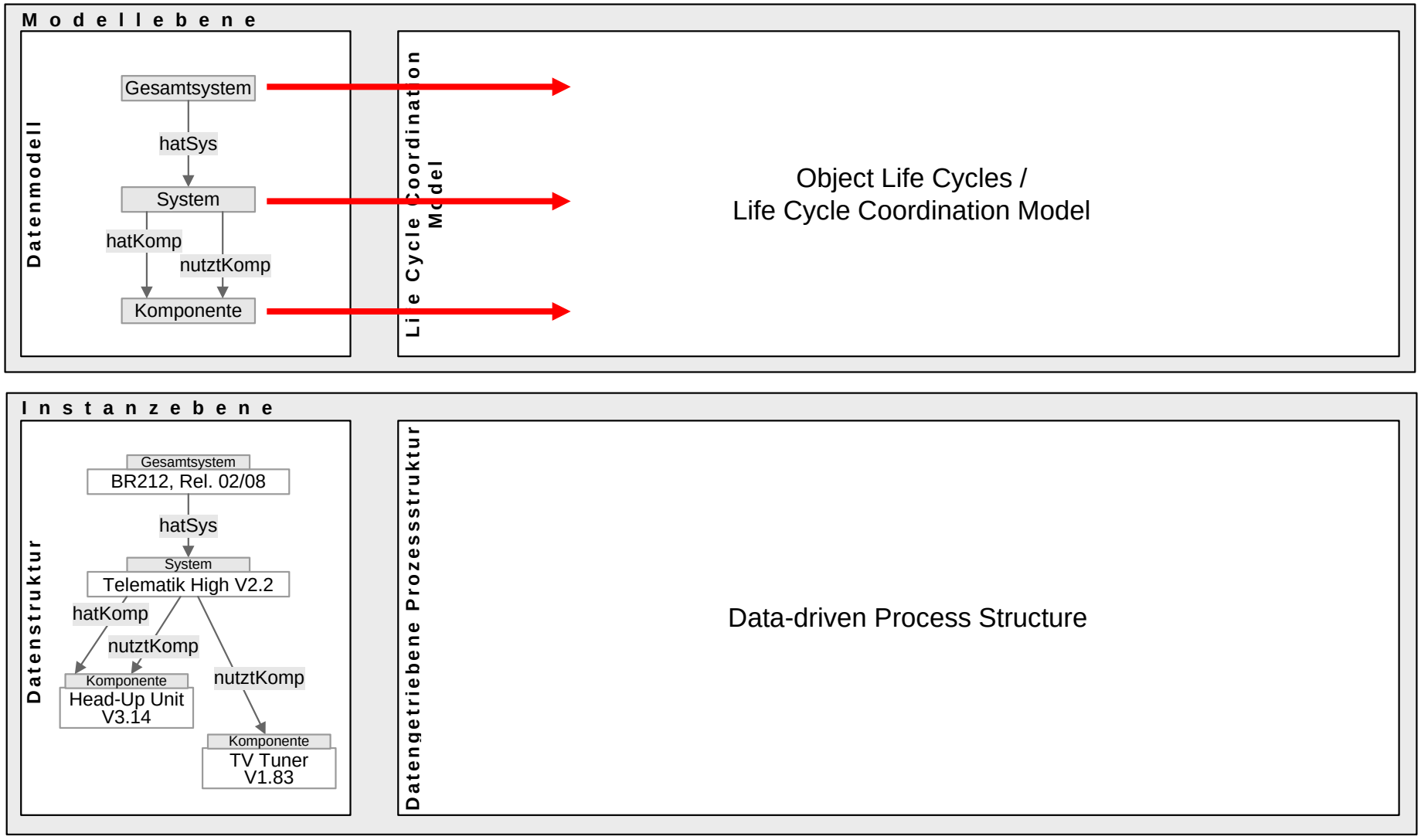
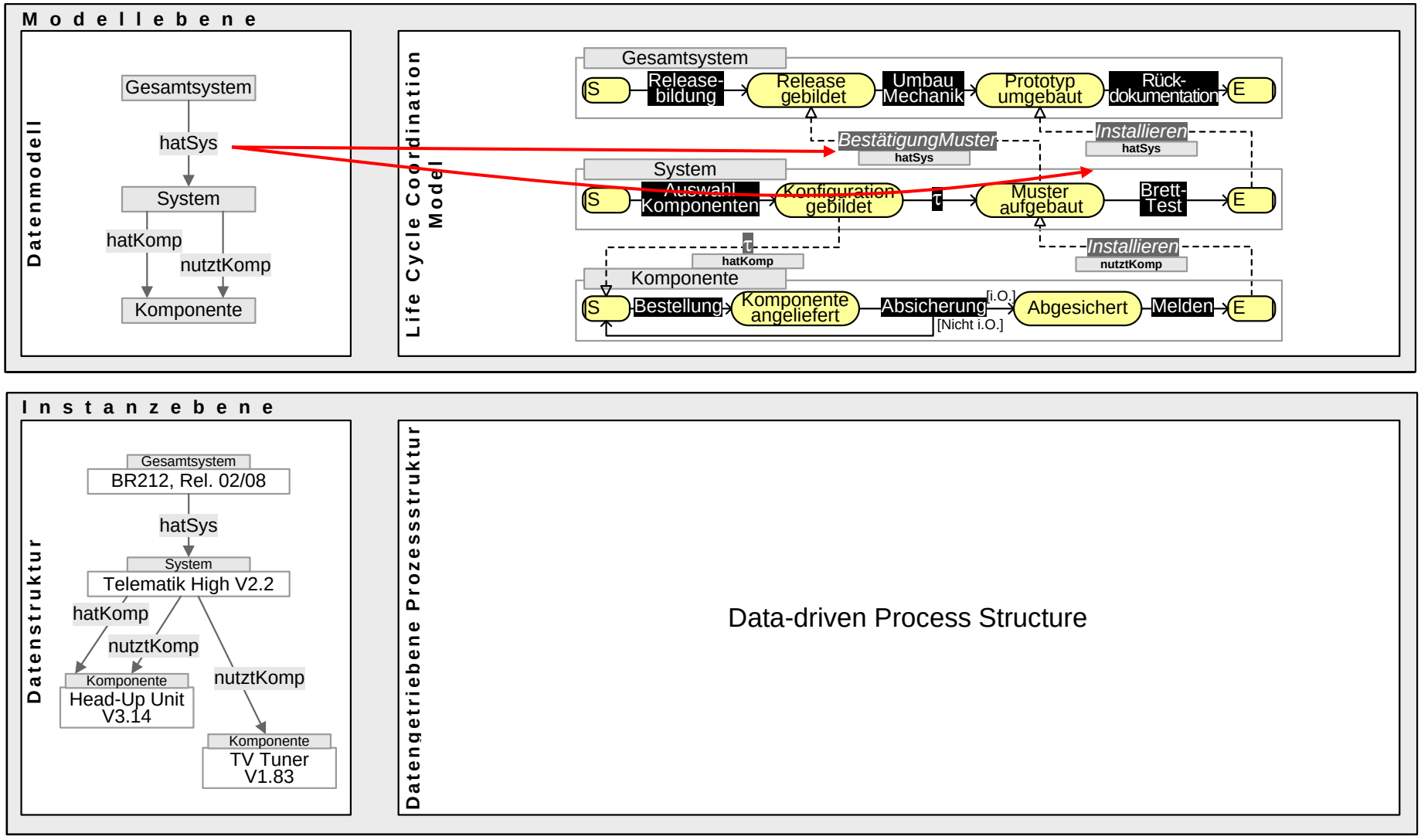
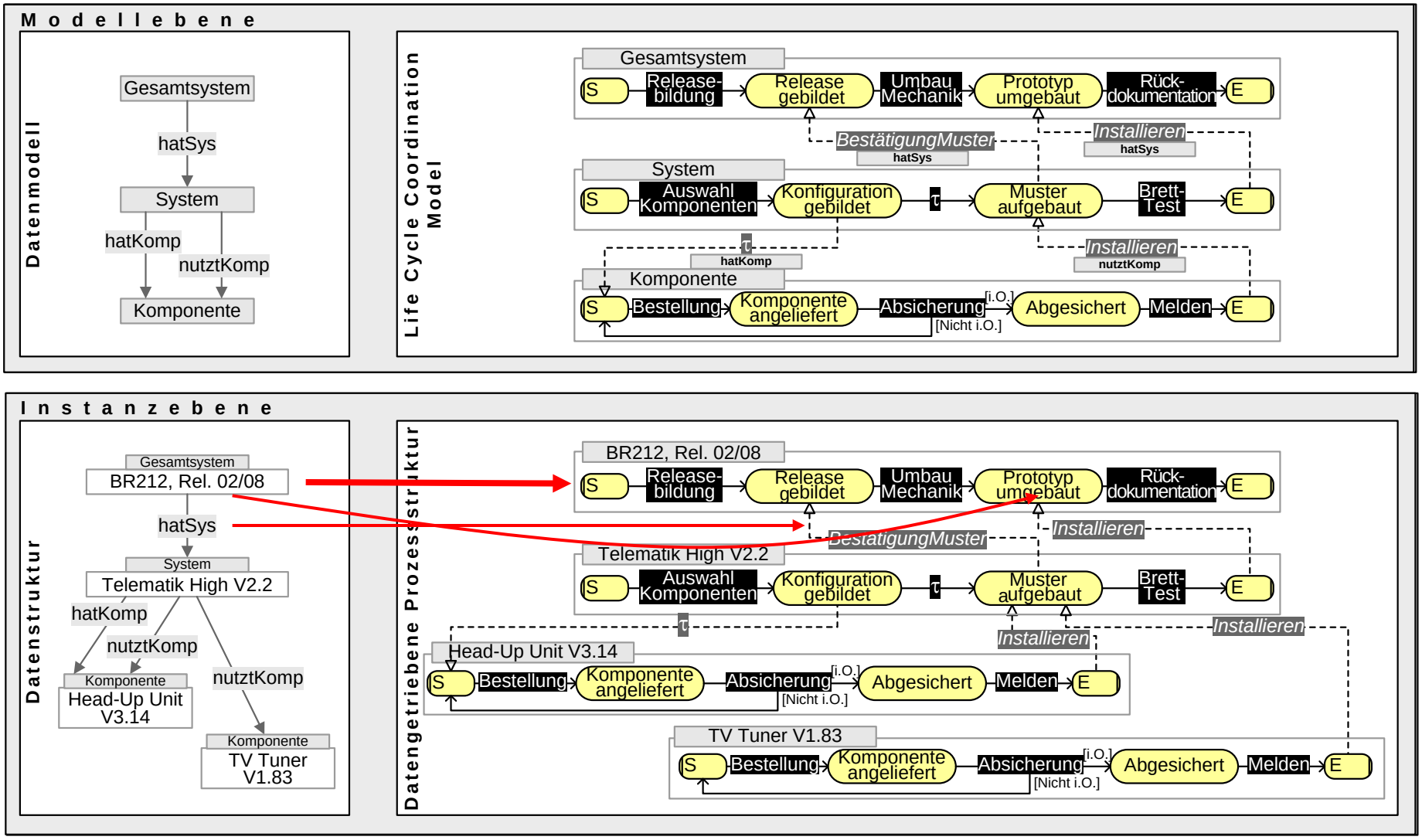
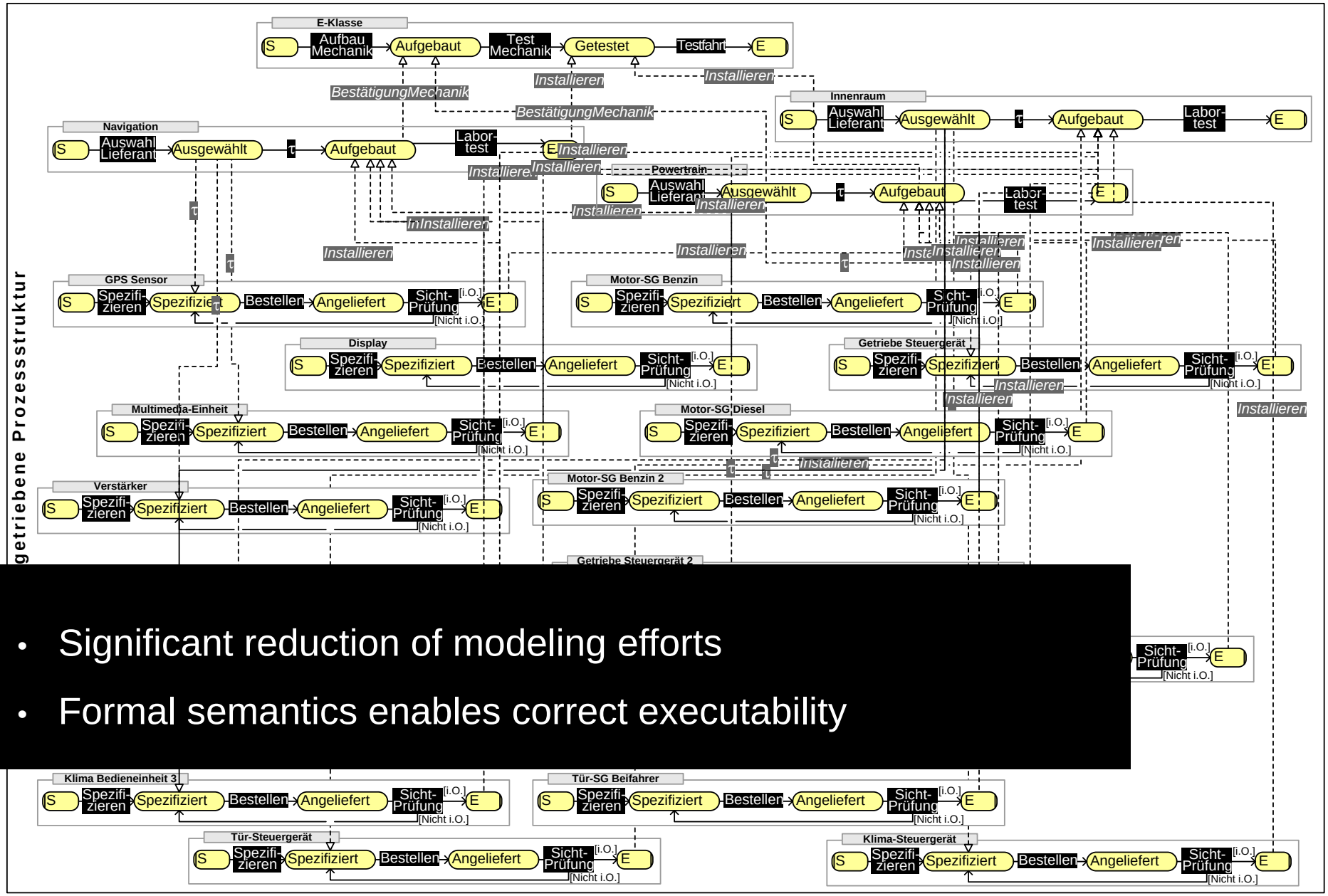


The Corepro Framework: Overview



The Corepro Framework: Overview





- Significant reduction of modeling efforts
- Formal semantics enables correct executability

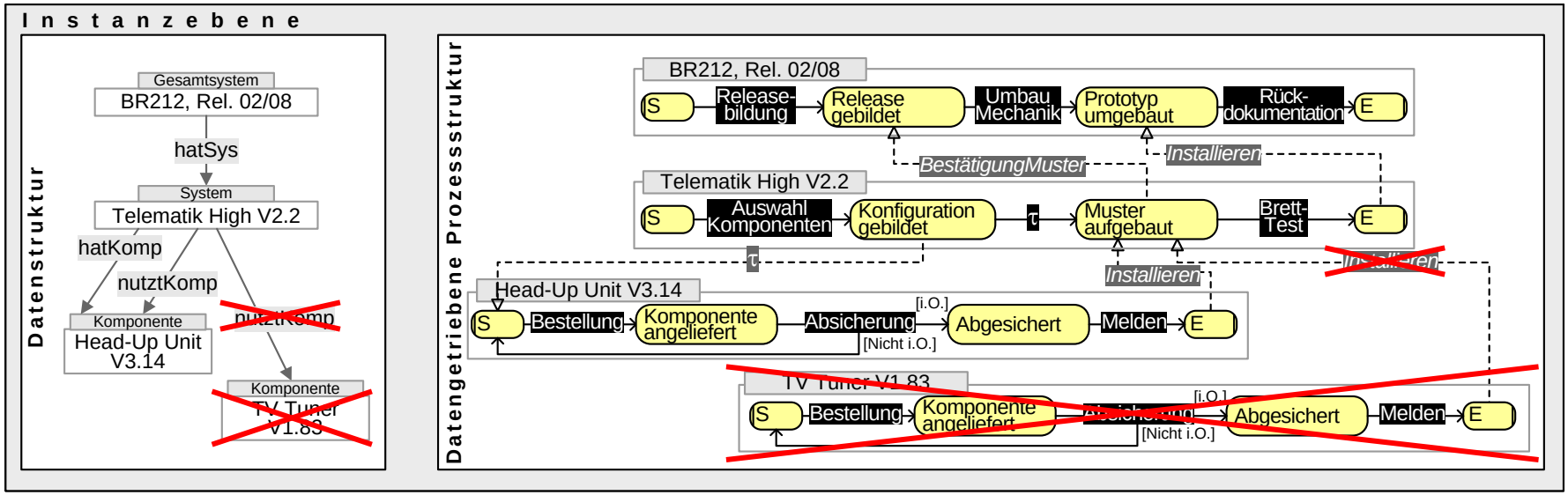
The Corepro Framework: Data-Driven Adaptation

Change Operation (Data Structure)

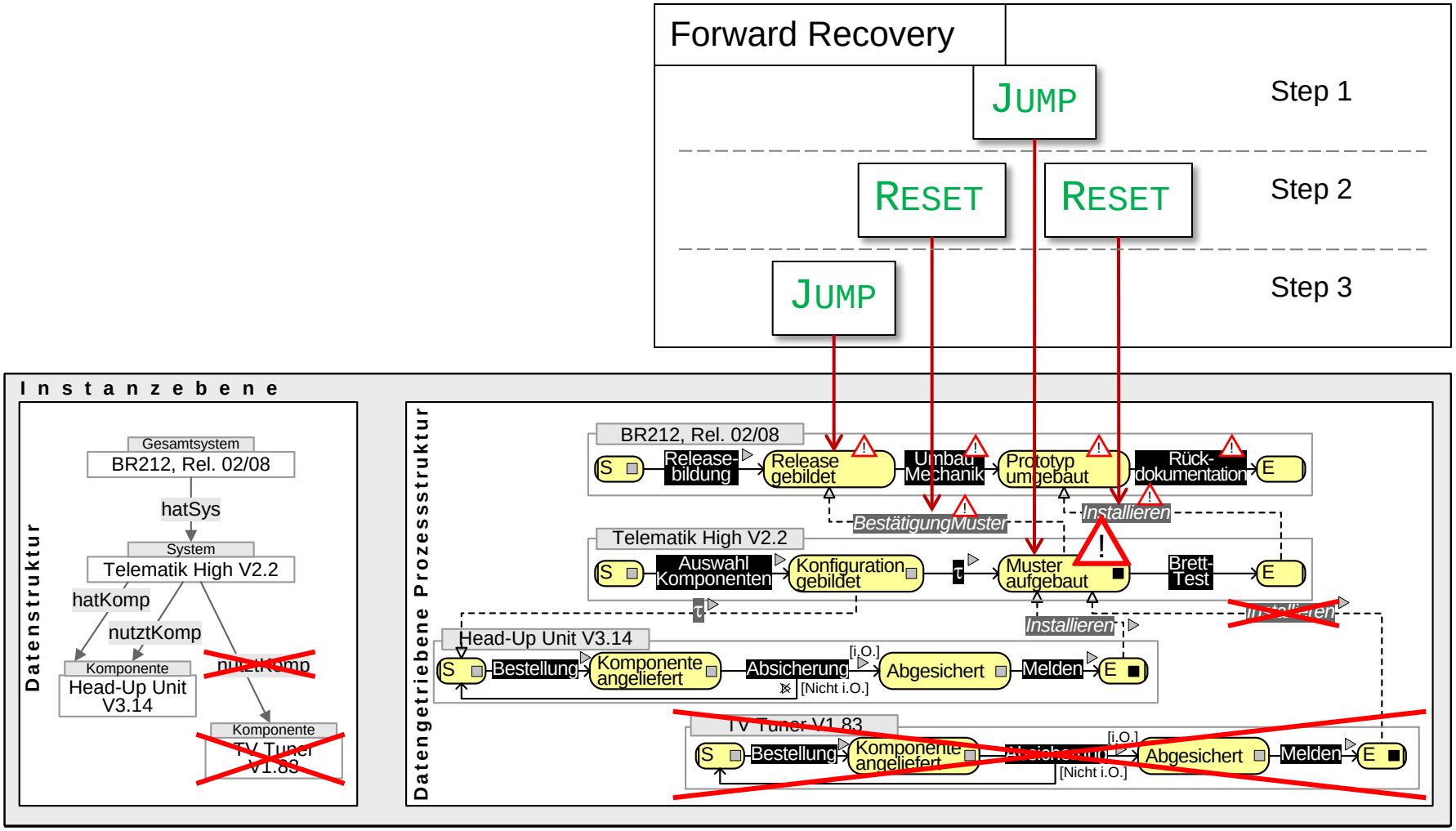
```
1) removeRelation(Telematik High
   V2.2, TV Tuner V1.83,
   nutztKomp);
2) removeObject(TV Tuner V1.83);
```

Change Operation (Process Structure)

```
1) removeExtTrans(Telematik High V2.2 .
   Muster Aufgebaut, Installieren, TV
   Tuner V1.83 . E);
2) removeOLC(Tuner V1.83);
```

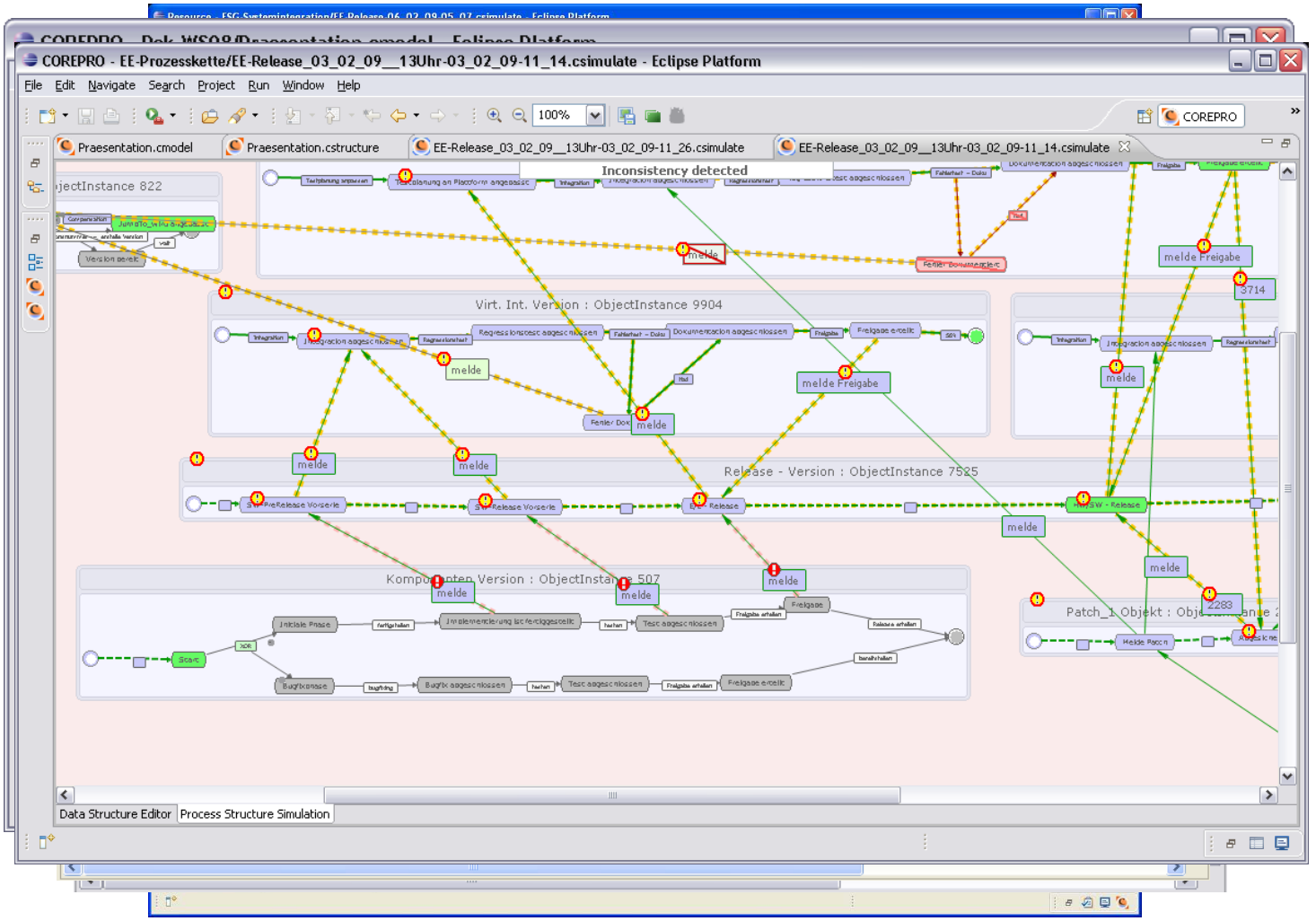


The Corepro Framework: Exception Handling



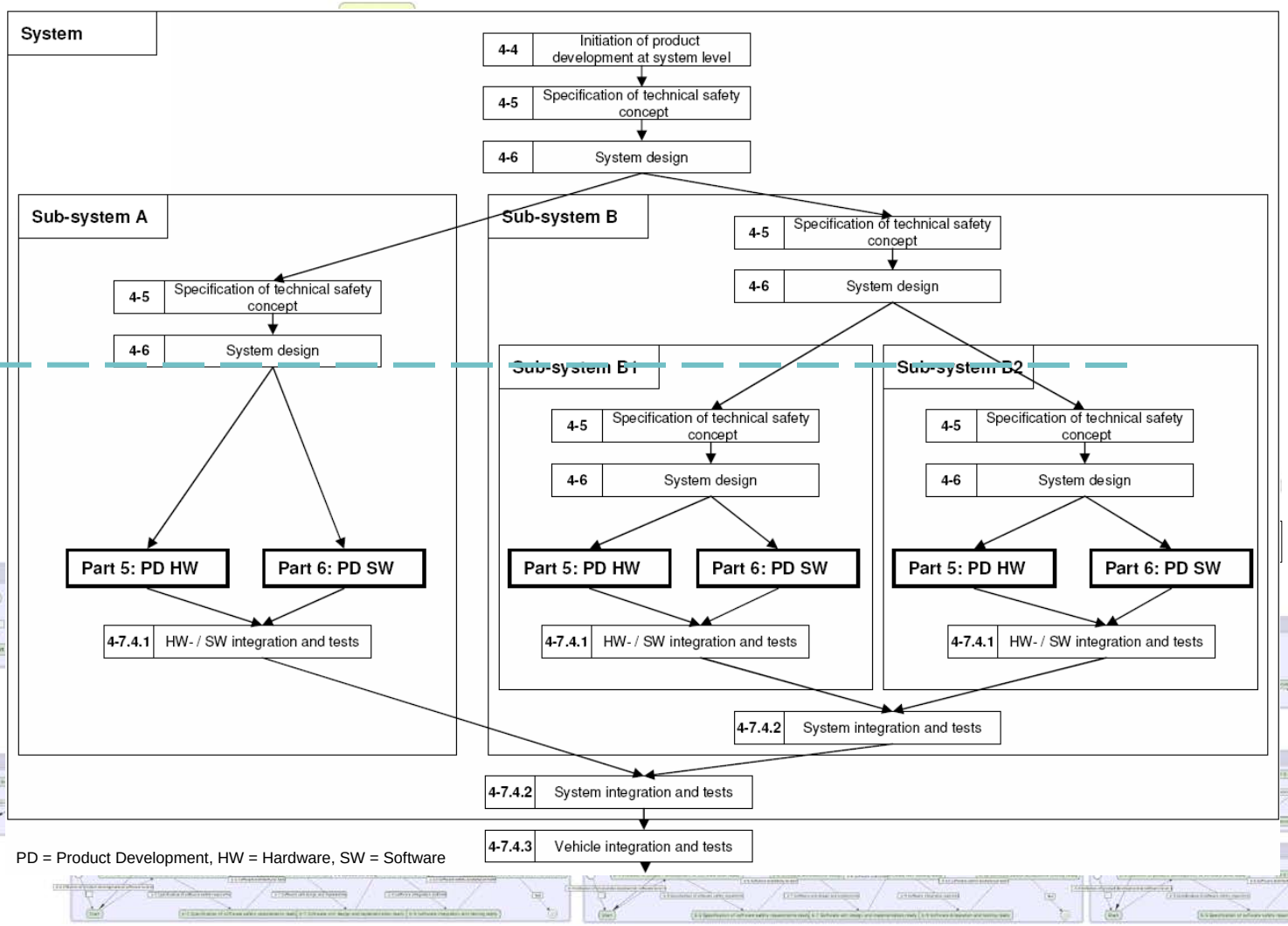
The Corepro Framework: Proof-of-Concept

Au[illegible]sture



The Corepro Framework: Case Study

Instance Level: Data Flow Oriented Process Structure



PD = Product Development, HW = Hardware, SW = Software

Agenda

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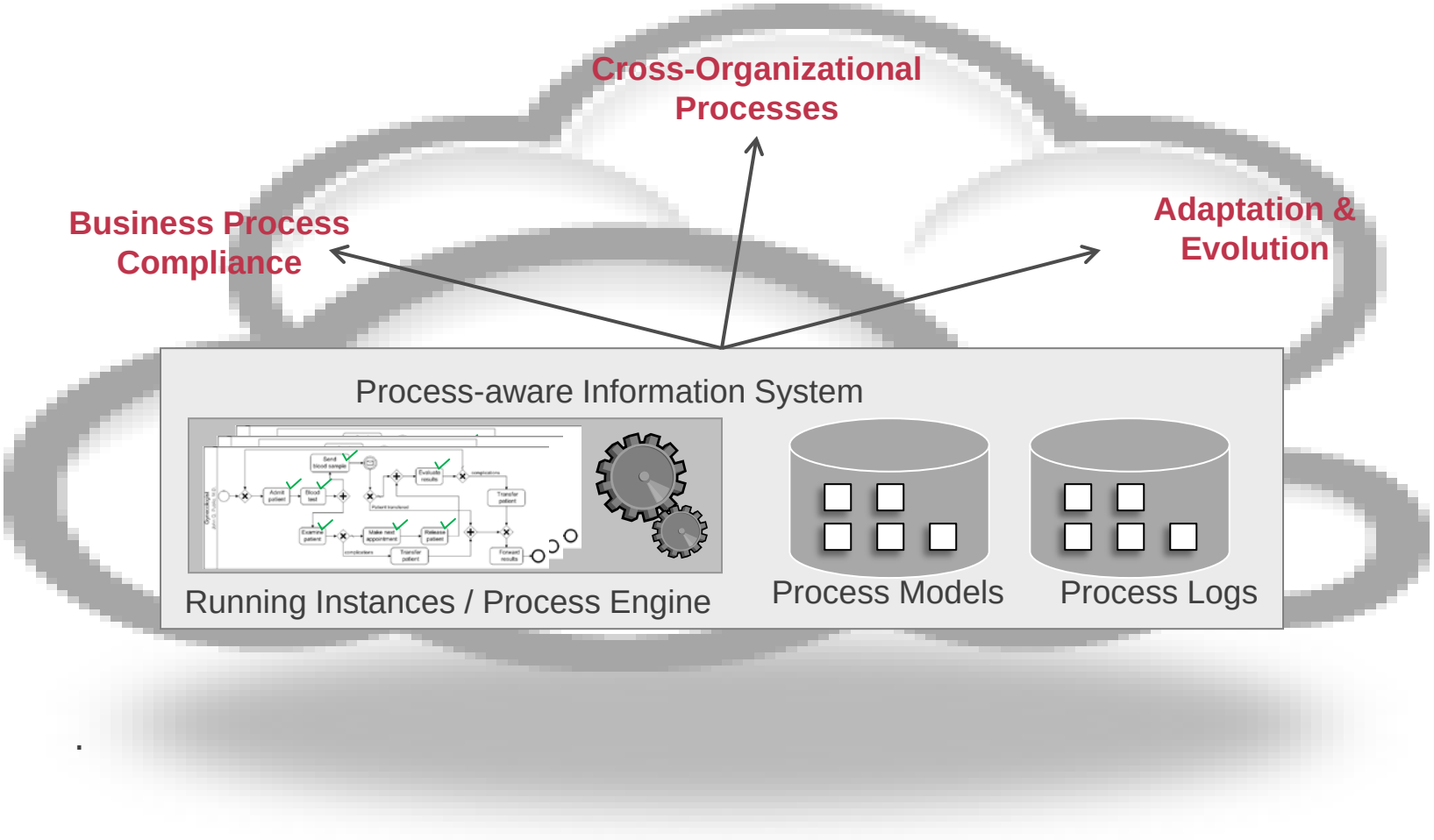
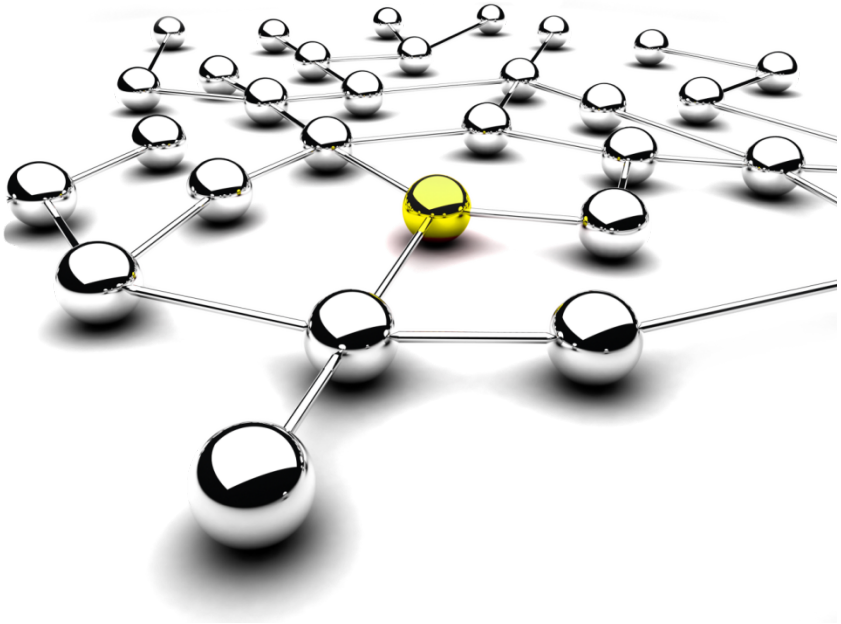
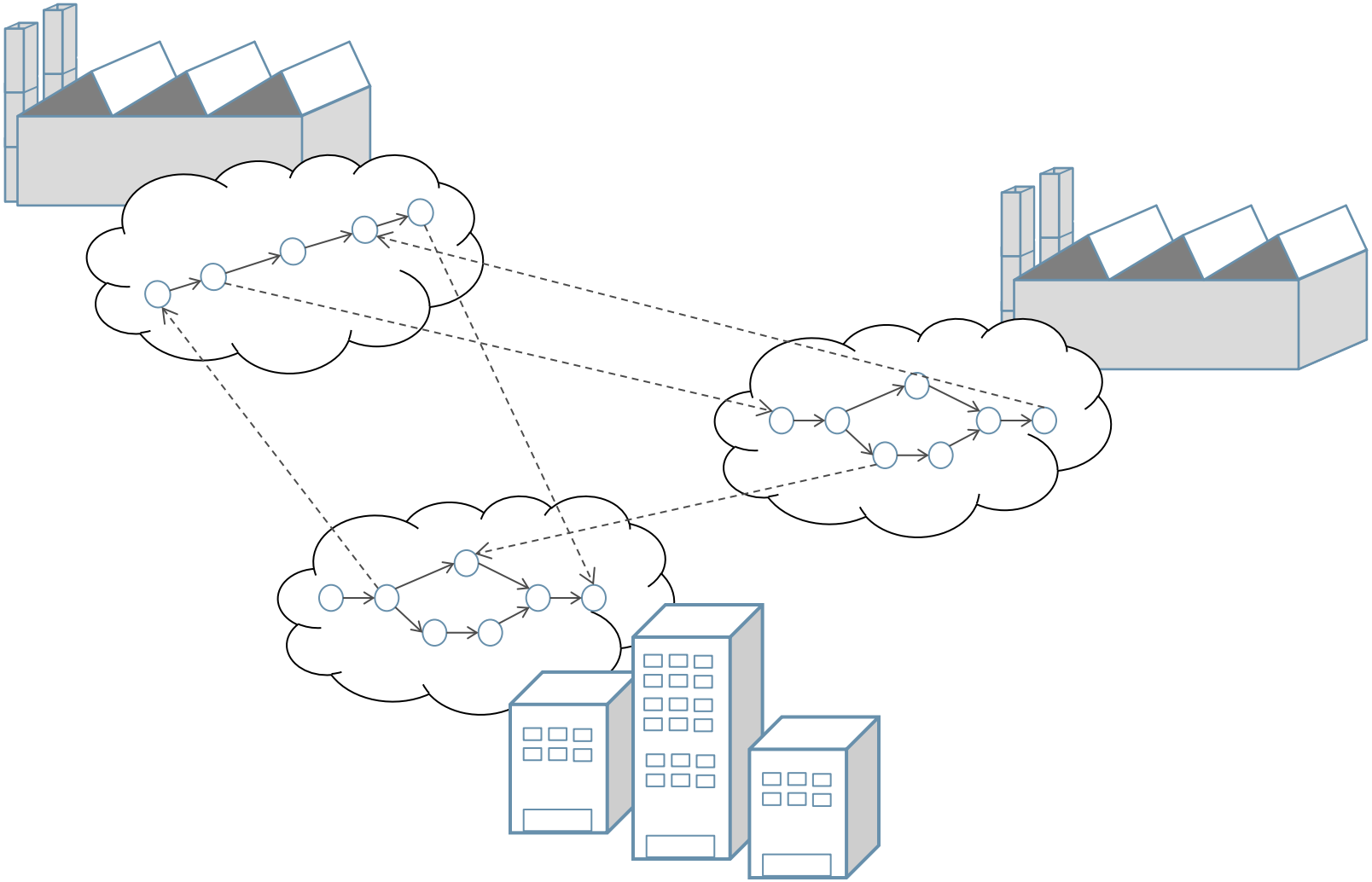


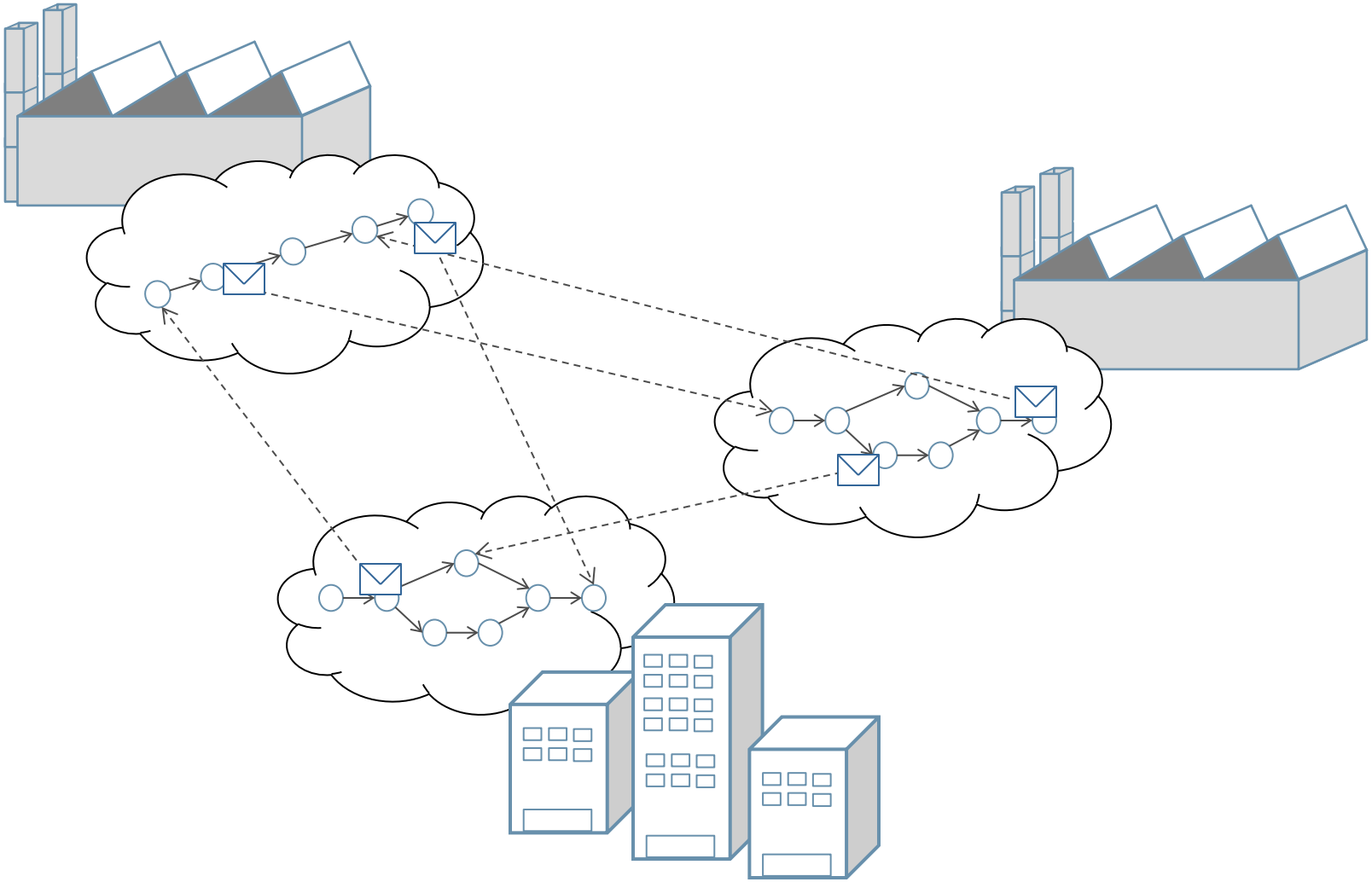


Modeling Cross-Organizational Processes: Interaction Modeling

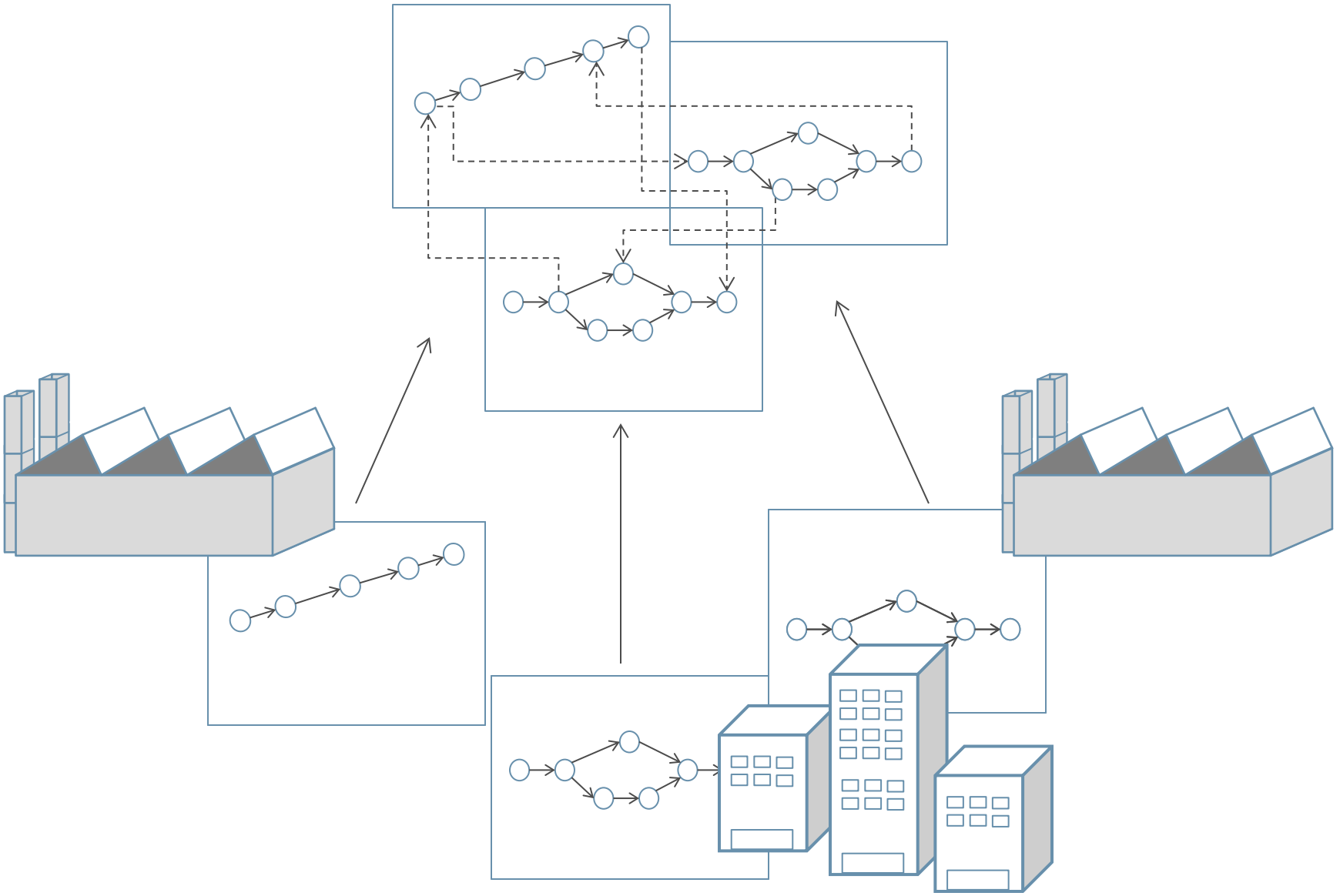
Cross-Organizational Processes



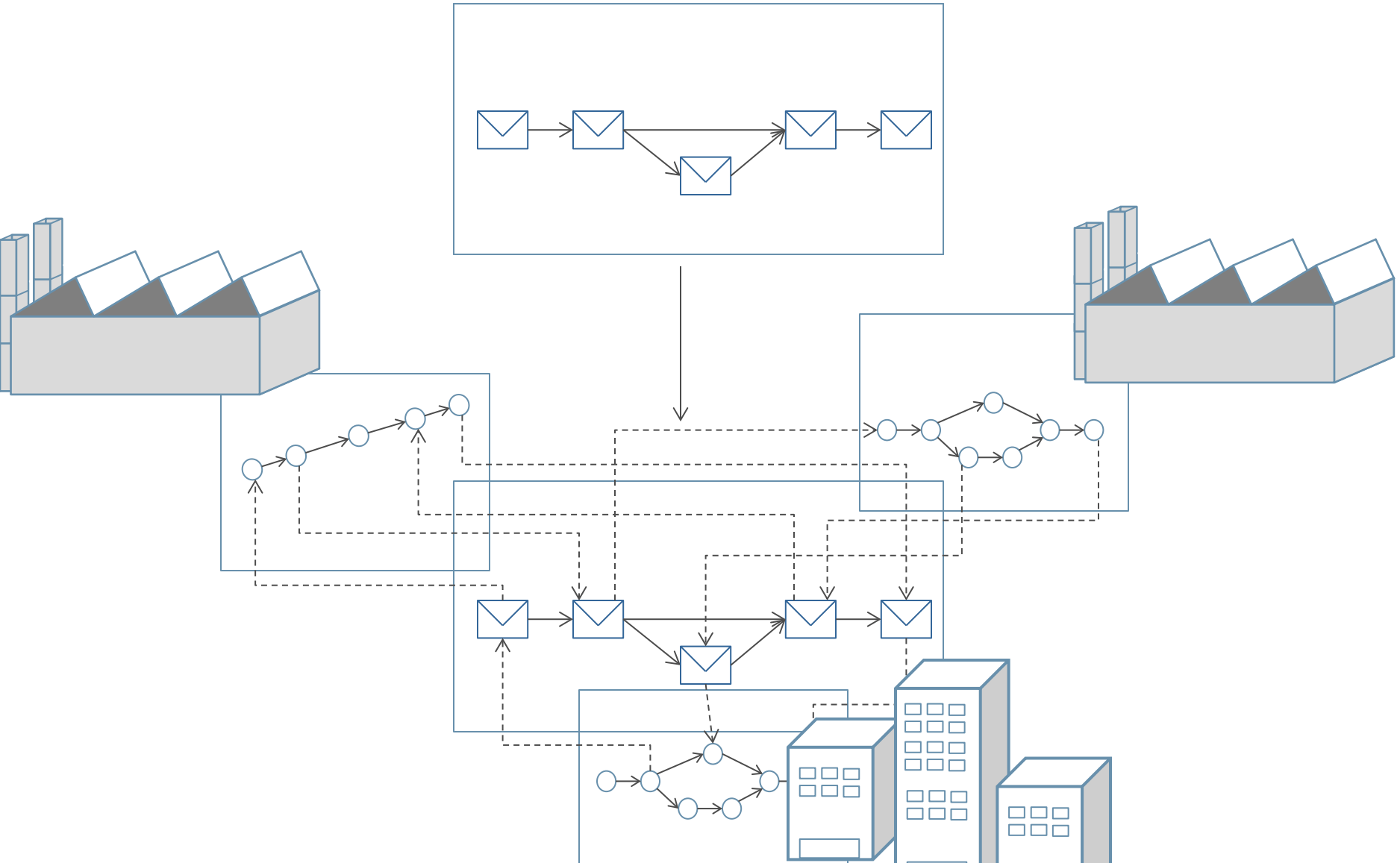
Cross-Organizational Processes



Cross-Organizational Processes:
Interconnection Modeling



Cross-Organizational Processes:
Interaction Modeling



Interaction Modeling:
Languages, Notations, Standards

- Chor
- Conversation protocols
- Interaction Petri-Nets
- Let's Dance
- iBPMN
- WS-CDL
- BPMN 2.0 Choreography
- DAChor

$$
\begin{array}{lcll}
A & ::= & BA & \text{(basic activities)} \\
 & | & A;A & \text{(sequential composition)} \\
 & | & A \sqcap A & \text{(choice)} \\
 & | & A \parallel A & \text{(parallel composition)} \\
BA & ::= & \mathsf{skip} & \text{(no action)} \\
 & | & a^i & \text{(activity in role } R^i\text{)} \\
 & | & c^{[i,j]} & \text{(communication)}
\end{array}
$$

$$
\begin{array}{ll}
\textbf{Basic:} & [\![\mathsf{skip}]\!] \mathrel{\widehat{=}} \{\langle\rangle\} \qquad [\![a]\!] \mathrel{\widehat{=}} \{\langle a\rangle\} \\
 & [\![c^{[i,j]}]\!] \mathrel{\widehat{=}} \{\langle c^{[i,j]}\rangle\} \\
\textbf{Sequential:} & [\![A_1;A_2]\!] \mathrel{\widehat{=}} [\![A_1]\!] \frown [\![A_2]\!] \\
\textbf{Choice:} & [\![A_1 \sqcap A_2]\!] \mathrel{\widehat{=}} [\![A_1]\!] \cup [\![A_2]\!] \\
\textbf{Parallel:} & [\![A_1 \parallel A_2]\!] \mathrel{\widehat{=}} \mathit{interlv}([\![A_1]\!], [\![A_2]\!])
\end{array}
$$

Qiu Zongyan, Zhao Xiangpeng, Cai Chao, and Yang Hongli:
Towards the Theoretical Foundation of Choreography, WWW'07, 2007.

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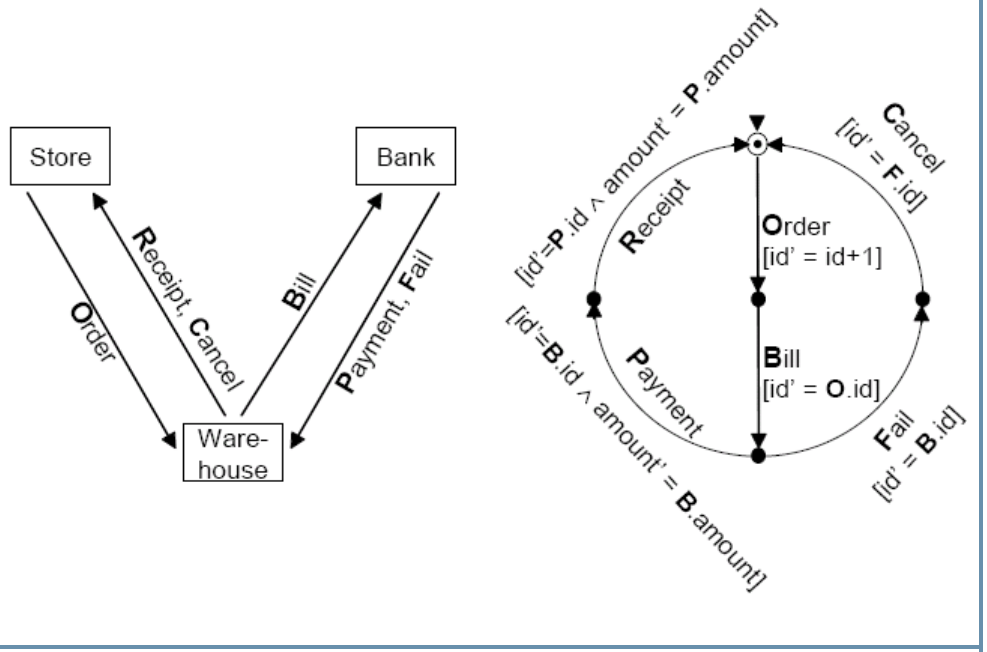

Xiang Fu, Tevfik Bultan, Jianwen Su: *Conversation Protocols: A Formalism for Specification and Verification of Reactive Electronic Services.* CIAA'04, 2004.

Xiang Fu, Tevfik Bultan, Jianwen Su: *Realizability of conversation protocols with message contents*. Web Services Research 2(4), 2005.

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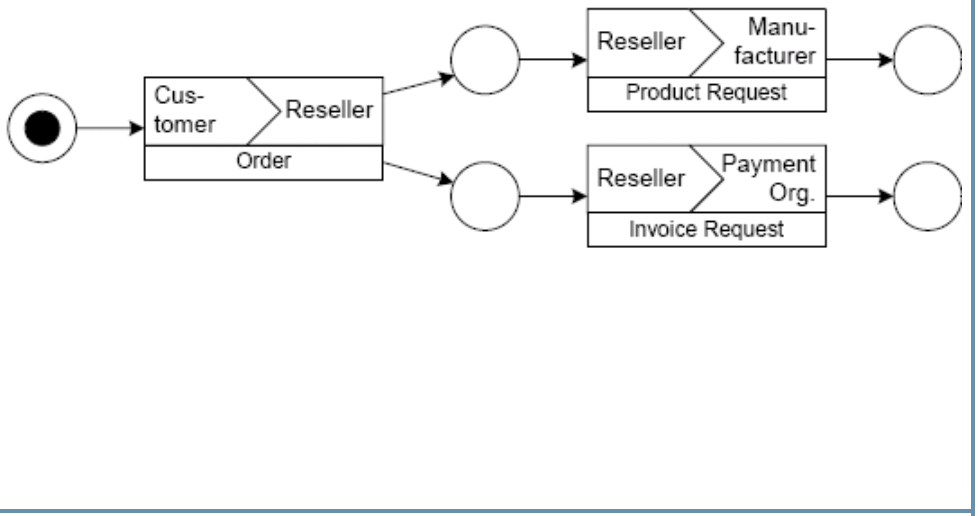

Gero Decker, Mathias Weske:
Local Enforceability in Interaction Petri Nets, BPM'07, 2007.

Interaction Modeling:
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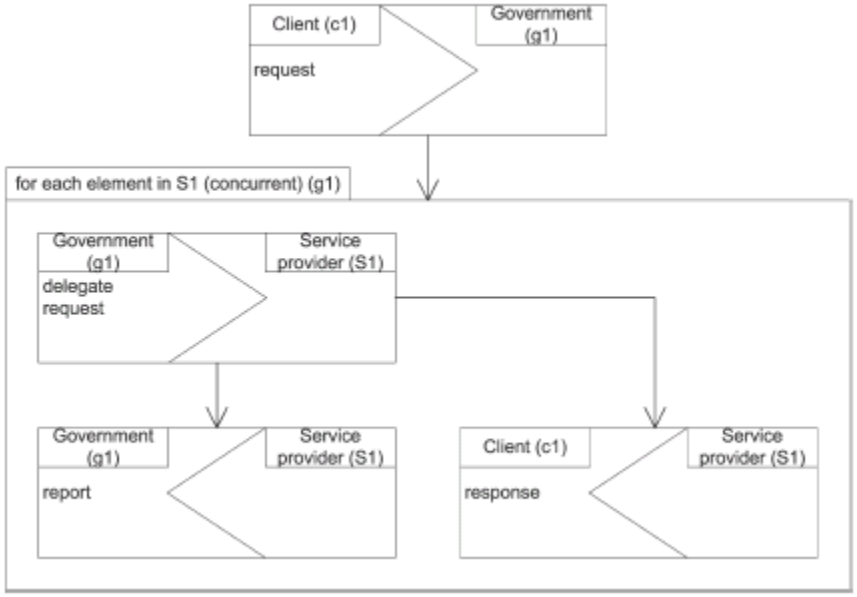

Johannes Maria Zaha, Alistair Barros, Marlon Dumas, Arthur ter Hofstede: *Let's dance: A language for service behavior modeling*. CoopIS'07, 2007.

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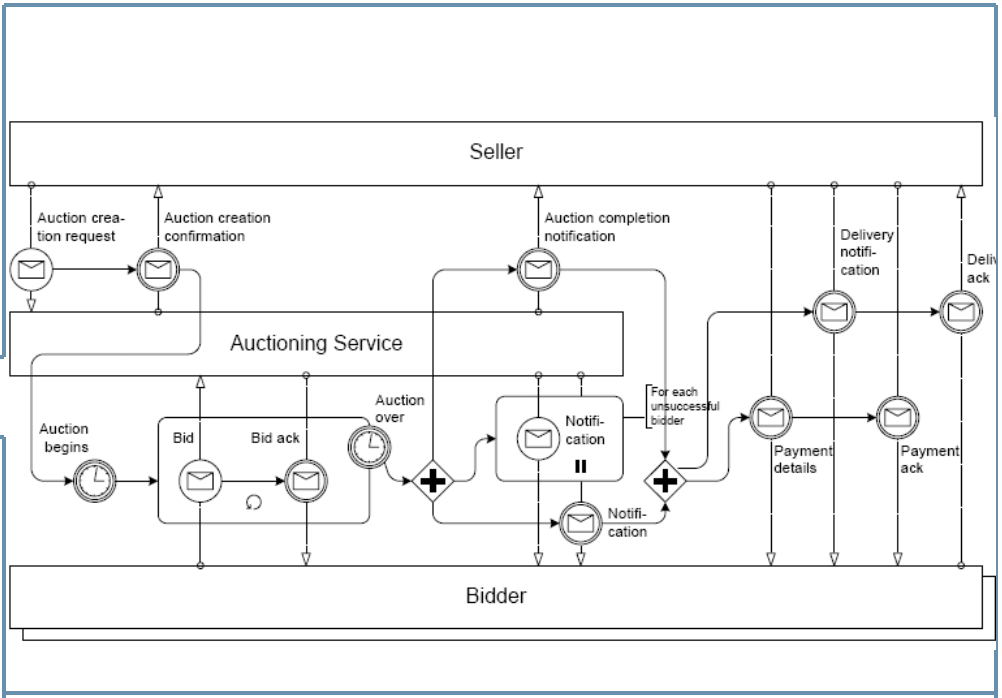

Gero Decker, Alistair Barros: *Interaction Modeling using BPMN*, BPM'07, 2007.

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- DAChor

```
<informationType name="creditDeniedType" />

<!-- Coordinated CreditAuthorization Choreography without finalizerBlocks-->
<choreography name="CreditAuthorization" root="false" coordination="true">
   <relationship type="tns:CreditReqCreditResp"/>
   <variableDefinitions>
      <variable name="CreditExtended" informationType="xsd:int" silent="true"
                roleTypes="tns:CreditResponder"/>
      <variable name="creditRequest"/>
      <variable name="creditAuthorized"/>
      <variable name="creditDenied" informationType = "tns:creditDeniedType"/
   </variableDefinitions>

   <!-- the normal work - receive the request and decide whether to approve --
   <interaction name="creditAuthorization" channelVariable="tns:CreditRequest
                operation="authorize">
      <participate relationshipType="SuperiorInferior"
                   fromRoleTypeRef="tns:Superior"
                   toRoleTypeRef="tns:Inferior"/>
      <exchange name="creditRequest" informationType="creditRequest"
                action="request">
         <send variable="getVariable('tns:creditRequest','','')"/>
         <receive variable="getVariable('tns:creditRequest','','')"/>
      </exchange>
      <exchange name="creditAuthorized" informationType="creditAuthorizedType
                action="respond">
         <send variable="getVariable('tns:creditAuthorized','','')"/>
         <receive variable="getVariable('tns:creditAuthorized','','')"/>
      </exchange>
```

W3C: Web services choreography description language 1.0, 2005.

Interaction Modeling:
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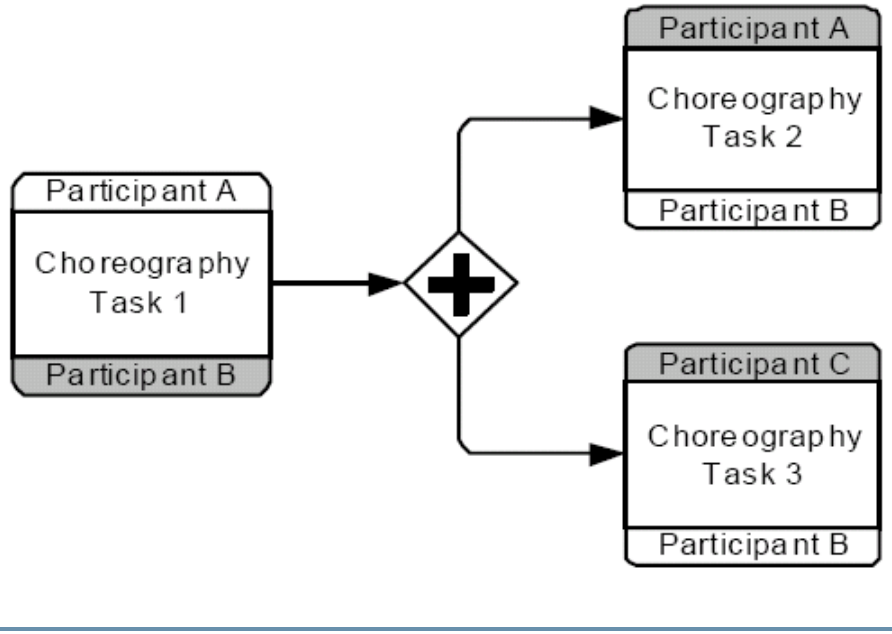

OMG/BPMI: BPMN 2.0, 2011.

What about Data?

Interaction Modeling:
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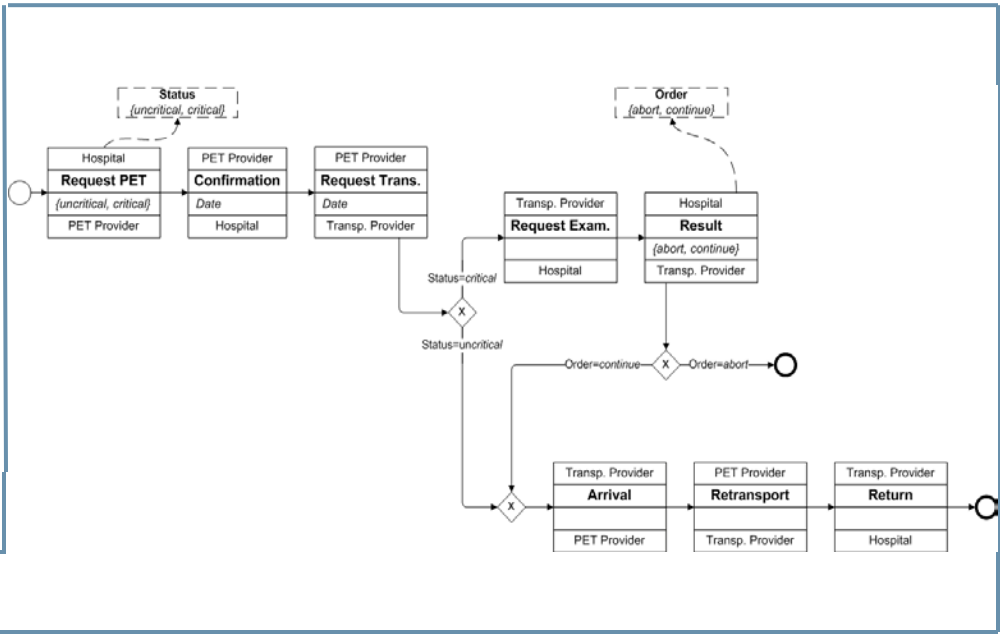


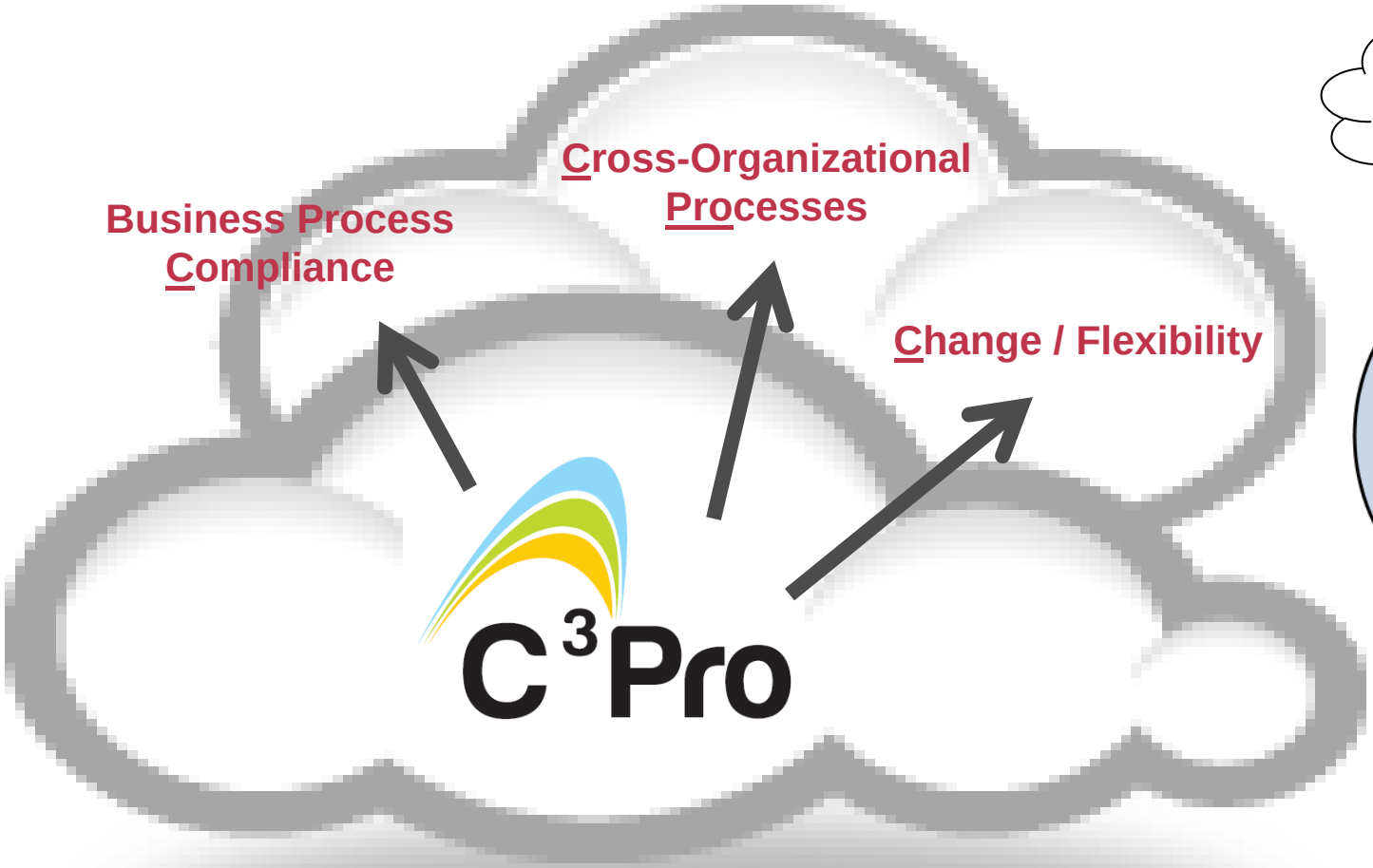
Ensuring Compliance of Cross-Organizational Processes

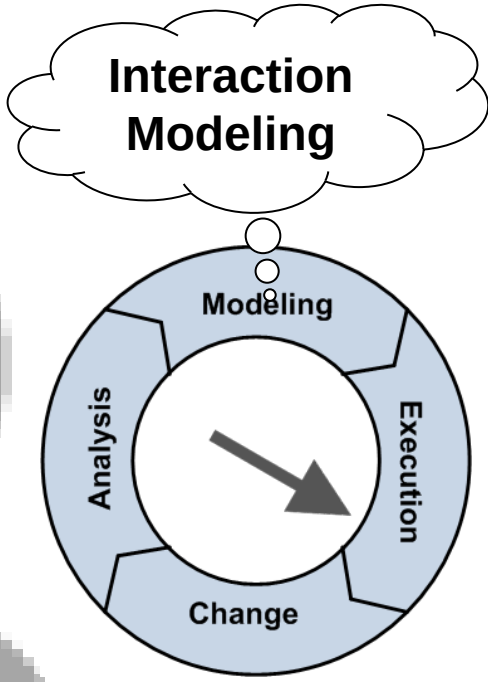
D. Knuplesch, M. Reichert, W. Fdhila, S. Rinderle-Ma, (2013) *On Enabling Compliance of Cross-Organizational Business Processes.* In: 11th Int'l Conference Business Process Management (BPM'13), Beijing, 2013

D. Knuplesch, M. Reichert, R. Pryss, W. Fdhila, S. Rinderle-Ma, Stefanie (2013) *Ensuring Compliance of Distributed and Collaborative Workflows.* In: 9th IEEE Int'l Conference on Collaborative Computing: Networking, Applications and Worksharing (CollborateCom'13), Austin, 2013, IEEE Computer Society Press

D. Knuplesch, M. Reichert, T. Ly, A. Kumar, S. Rinderle-Ma (2013) *Visual Modeling of Business Process Compliance Rules with the Support of Multiple Perspectives.* In: 32nd Int'l Conference on Conceptual Modeling (ER 2013), Hong Kong, 2013

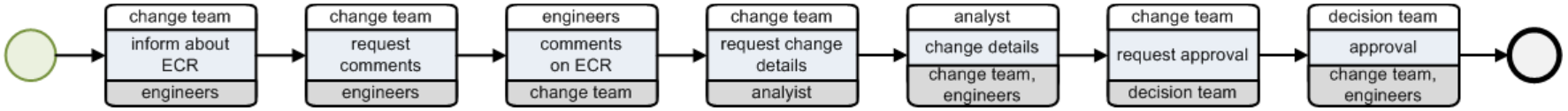
Cross-Organizational Process Compliance



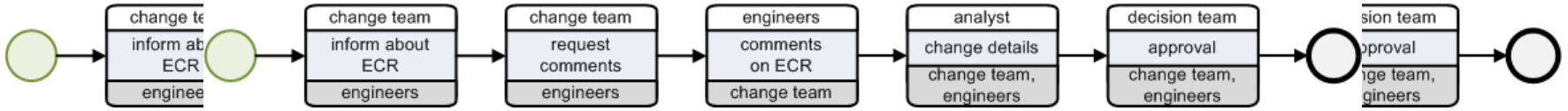


Scenario: Electronic Change Request

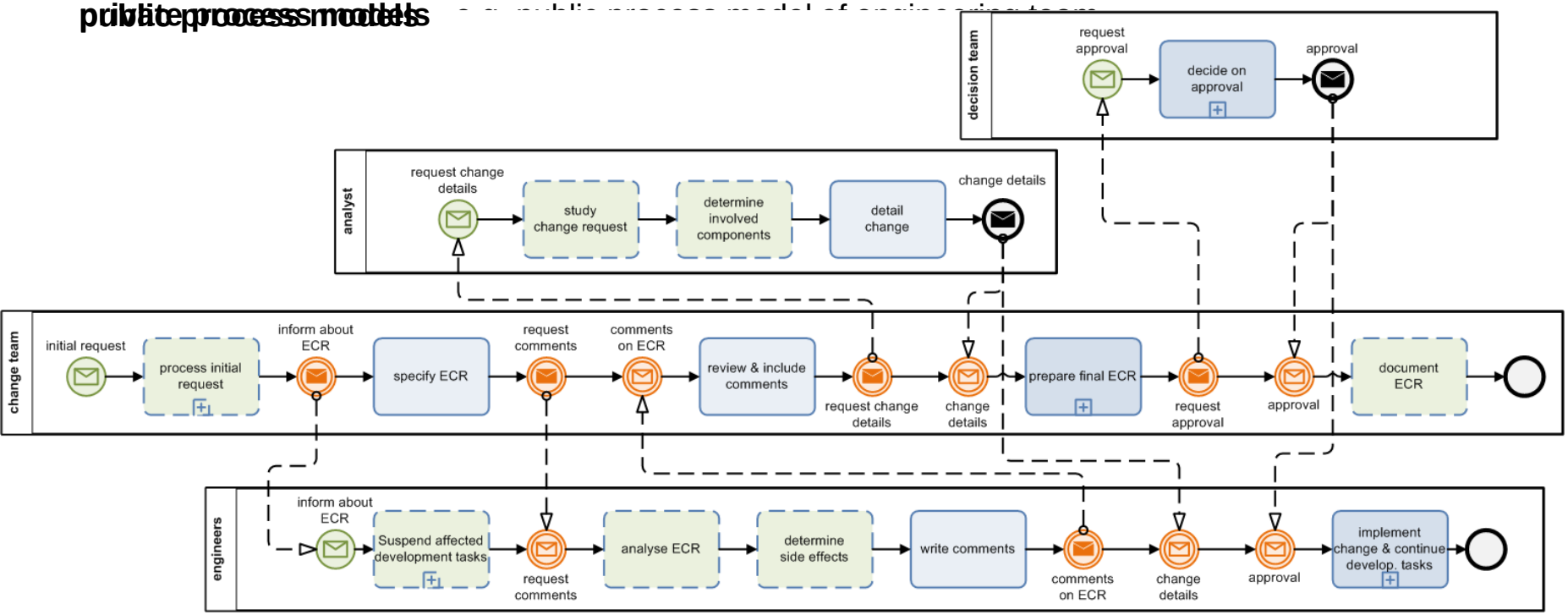
interaction model



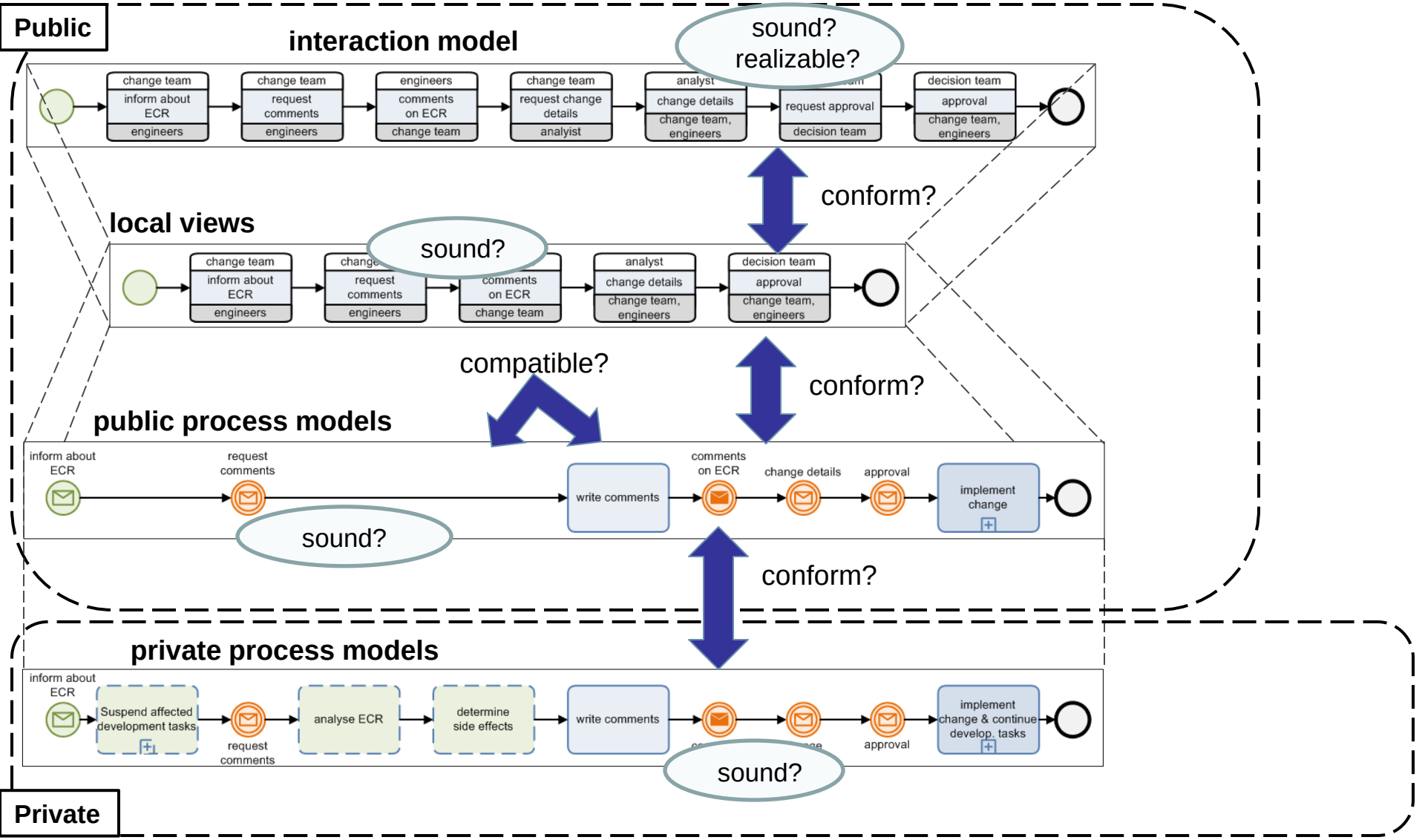
local views – e.g. local view of engineering team



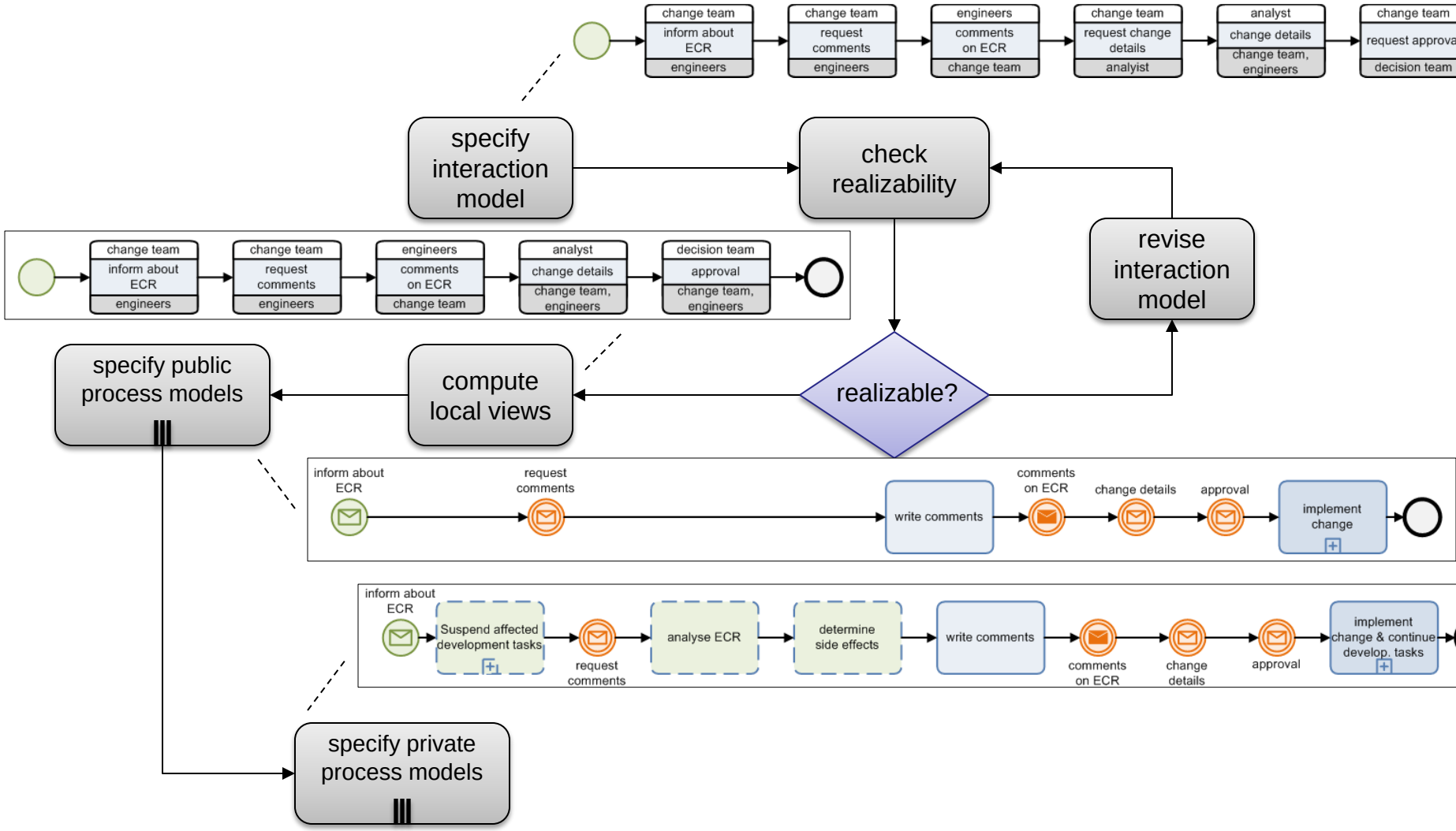
private process models – e.g. public process model of engineering team



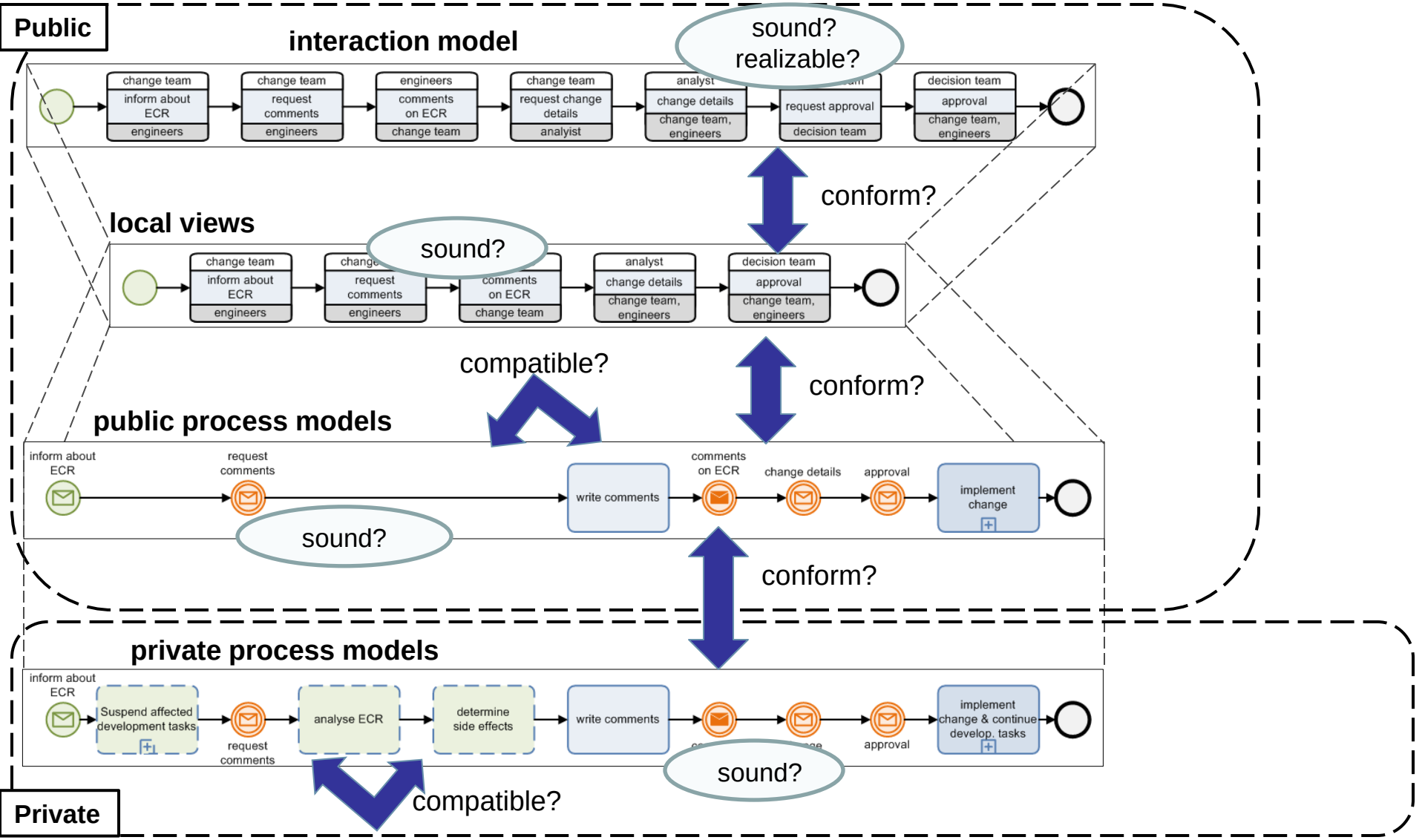
Relevant Layers



The Process of Interaction Modeling



Relevant Layers and Compliance Rules



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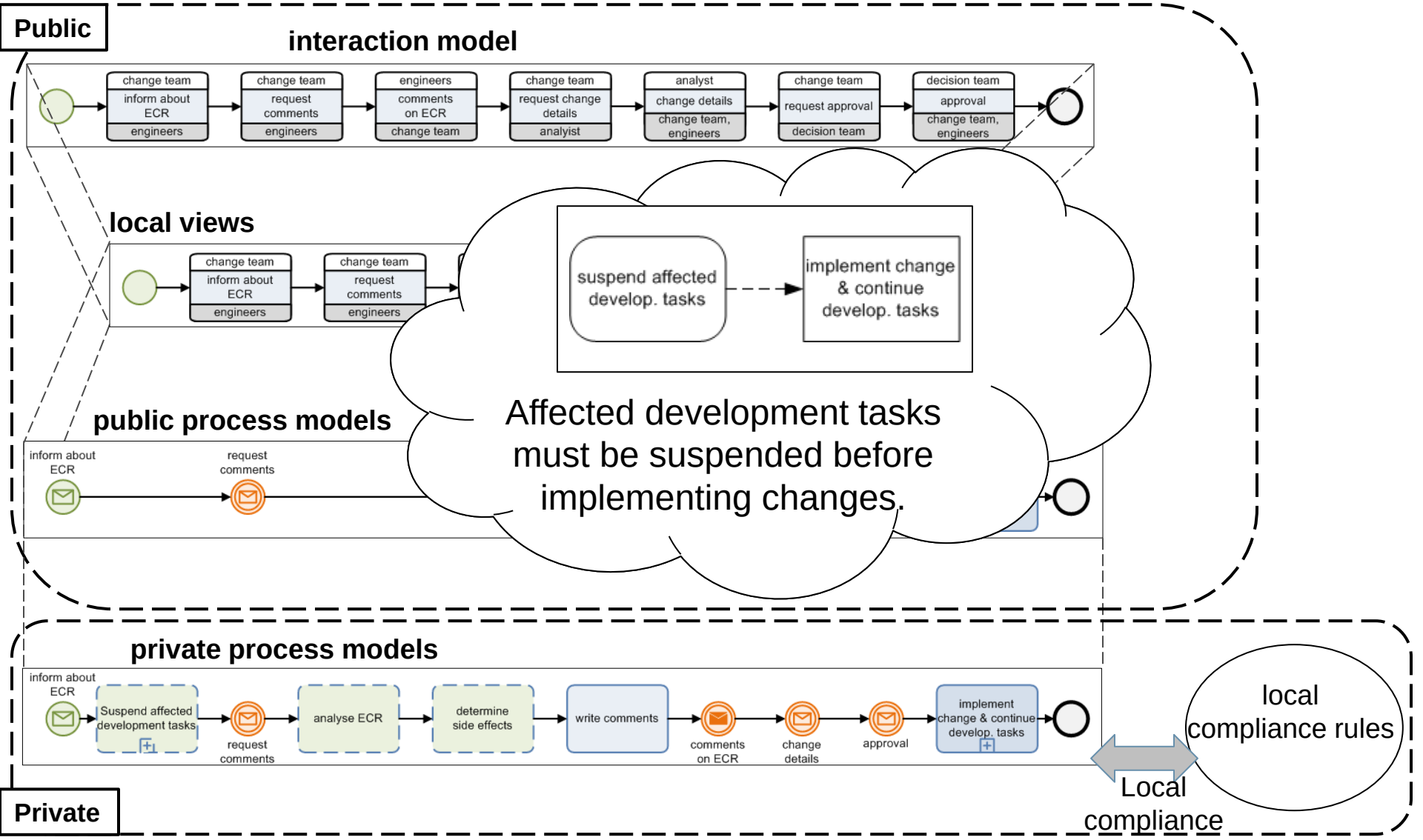

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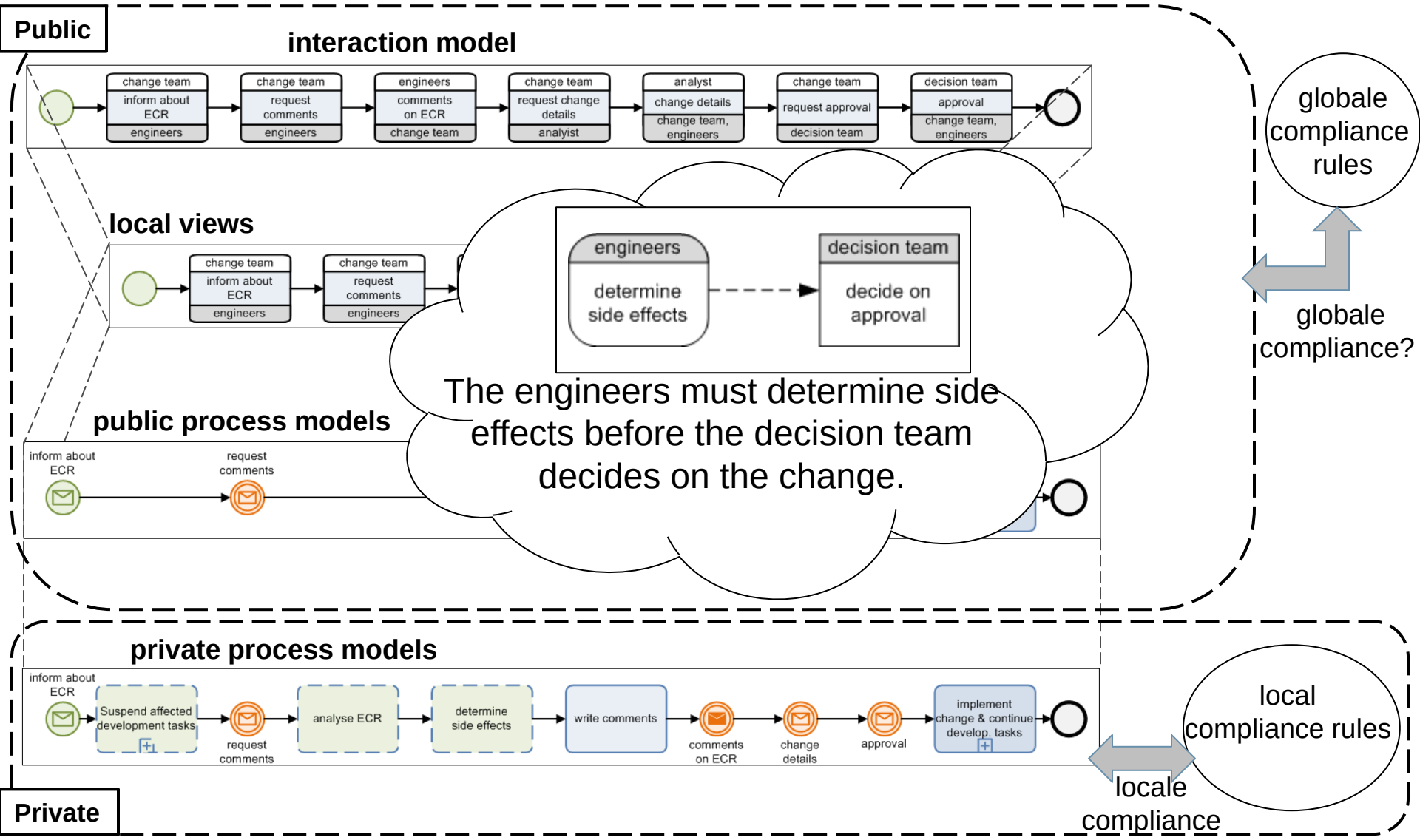

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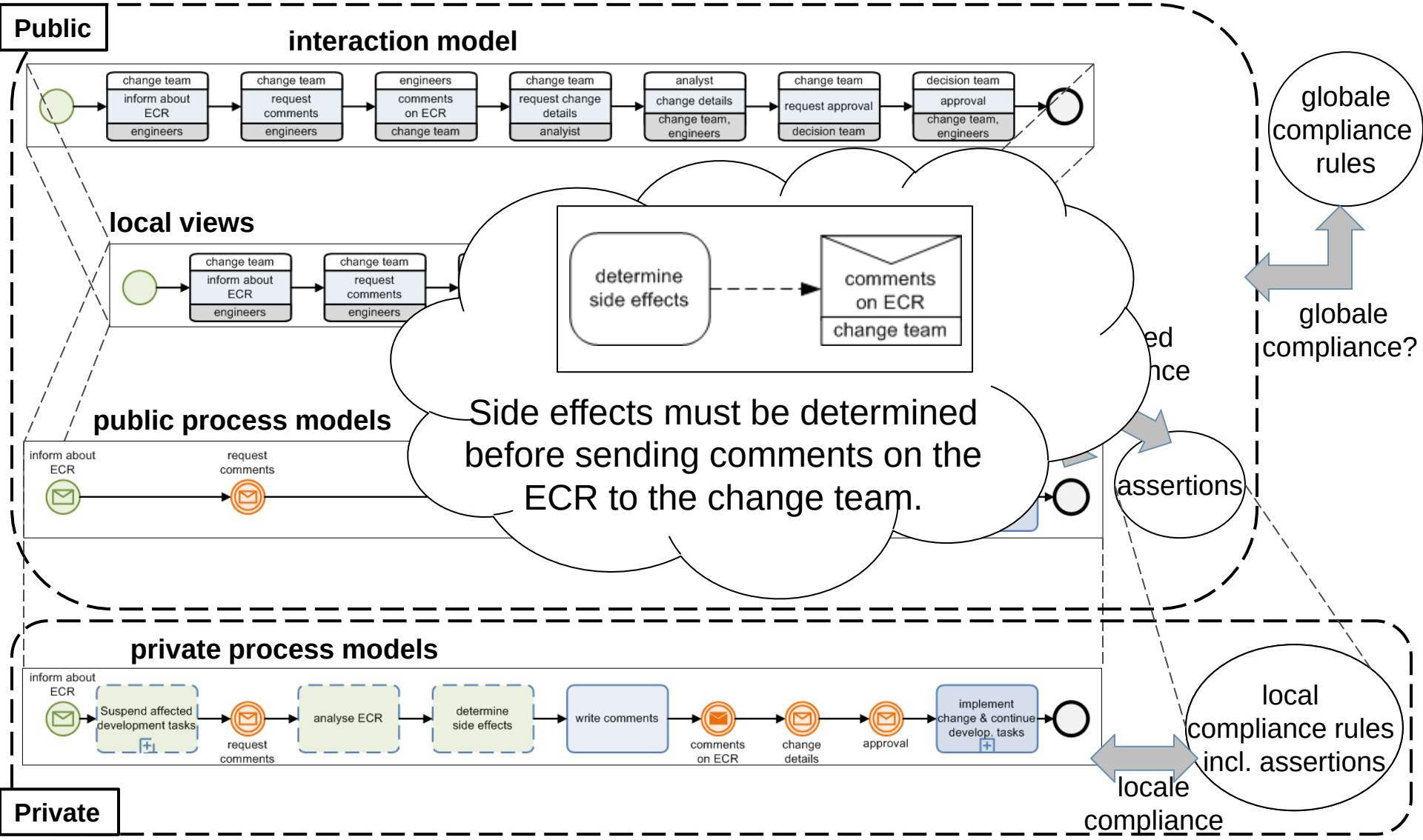
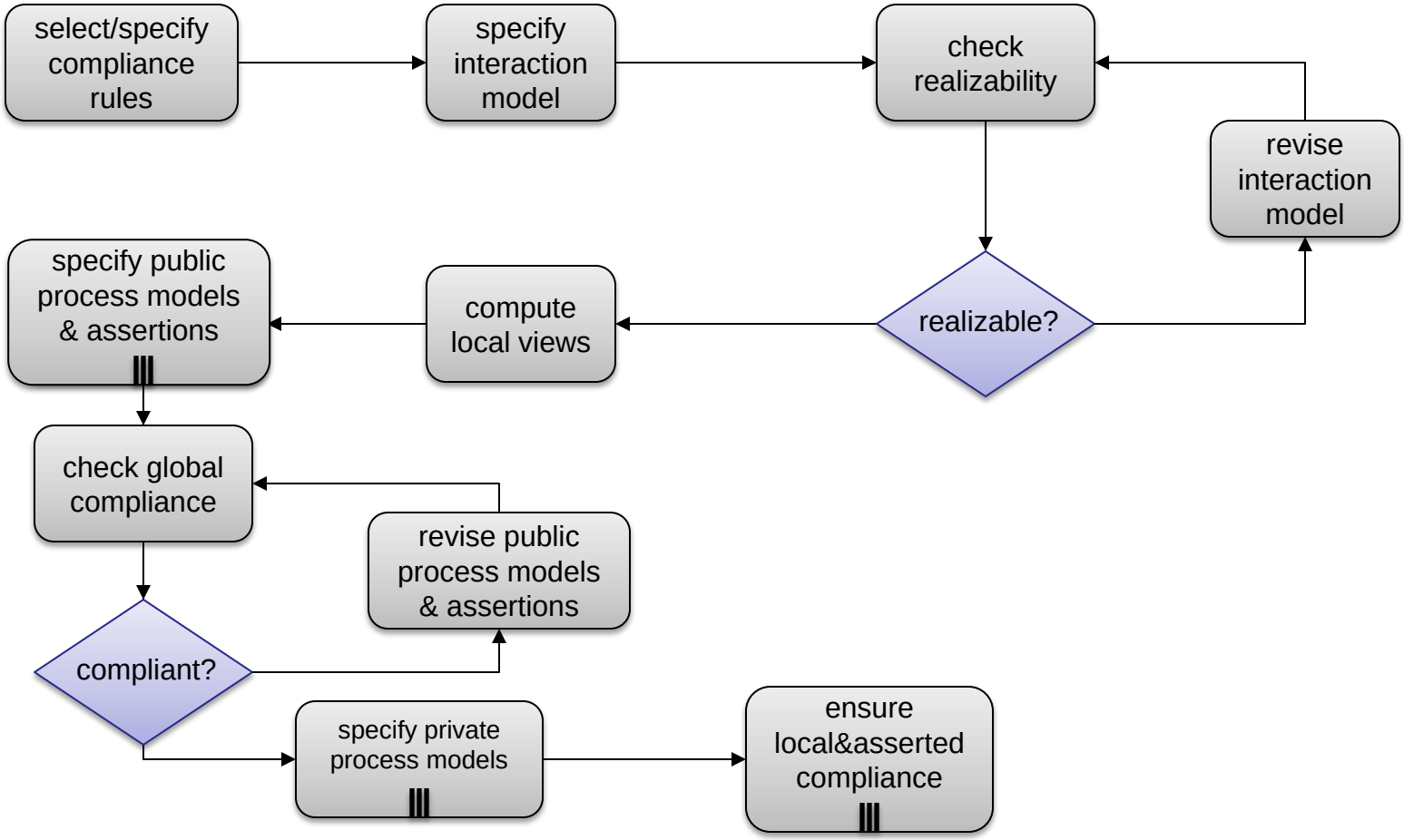
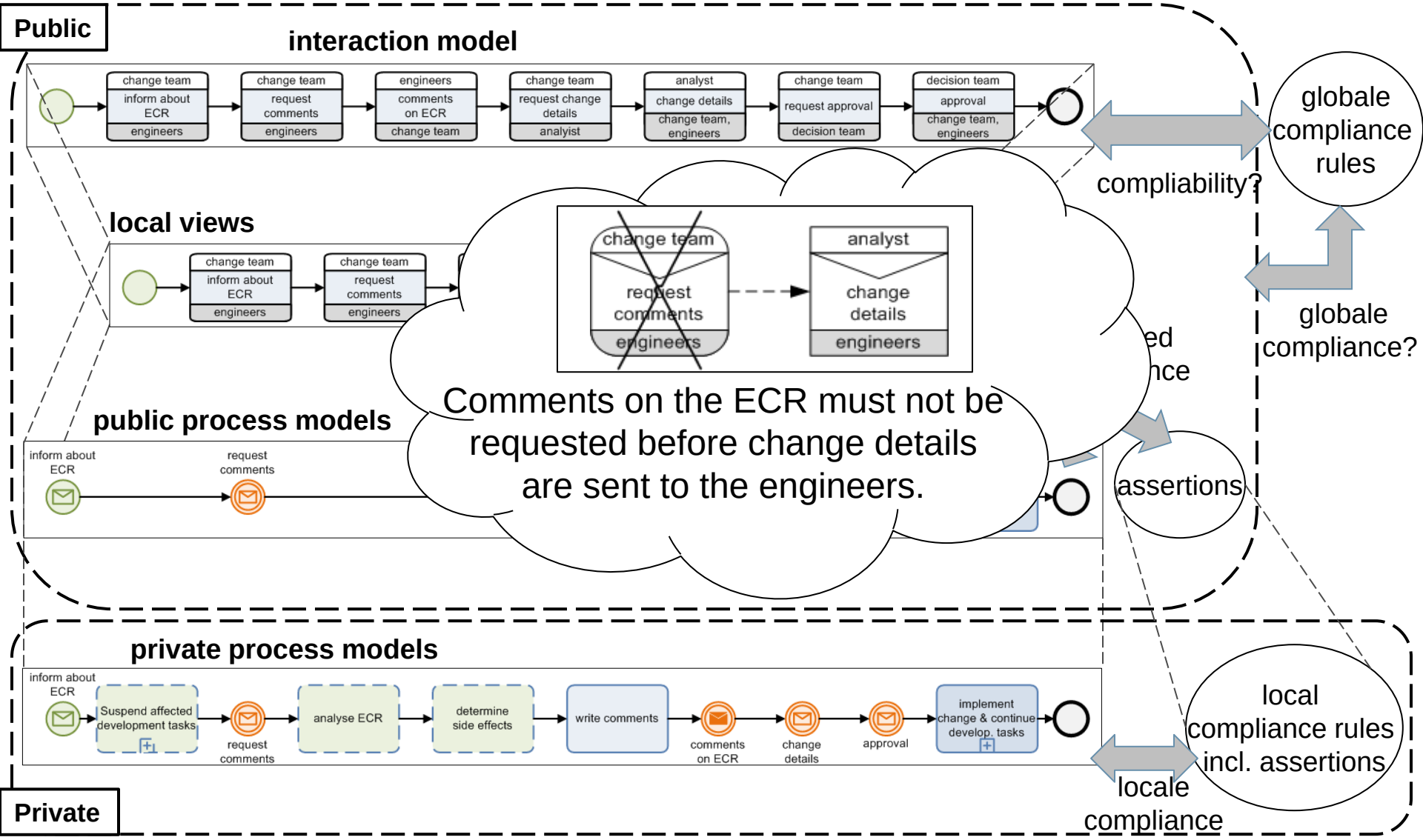


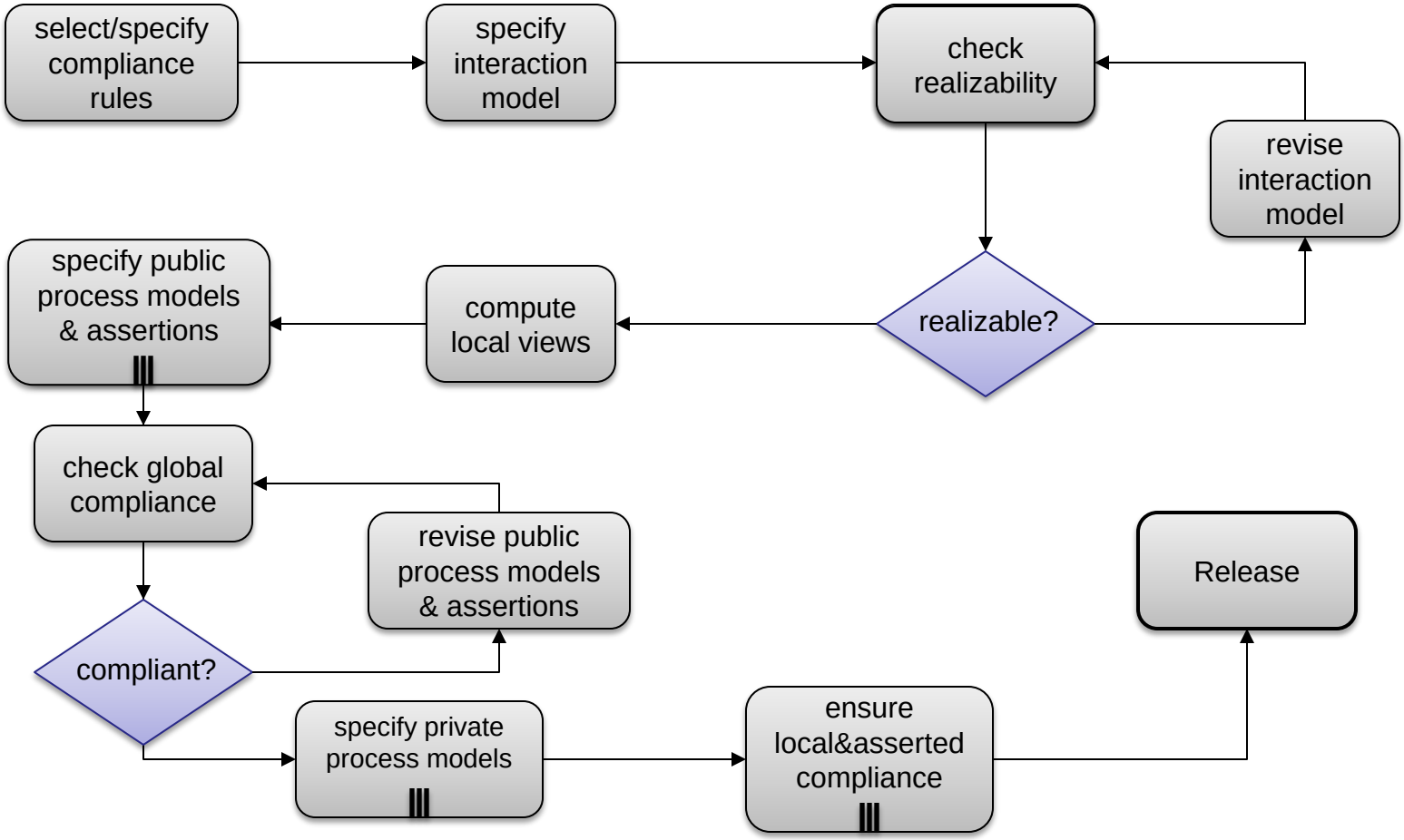
The Process of Interaction Modeling



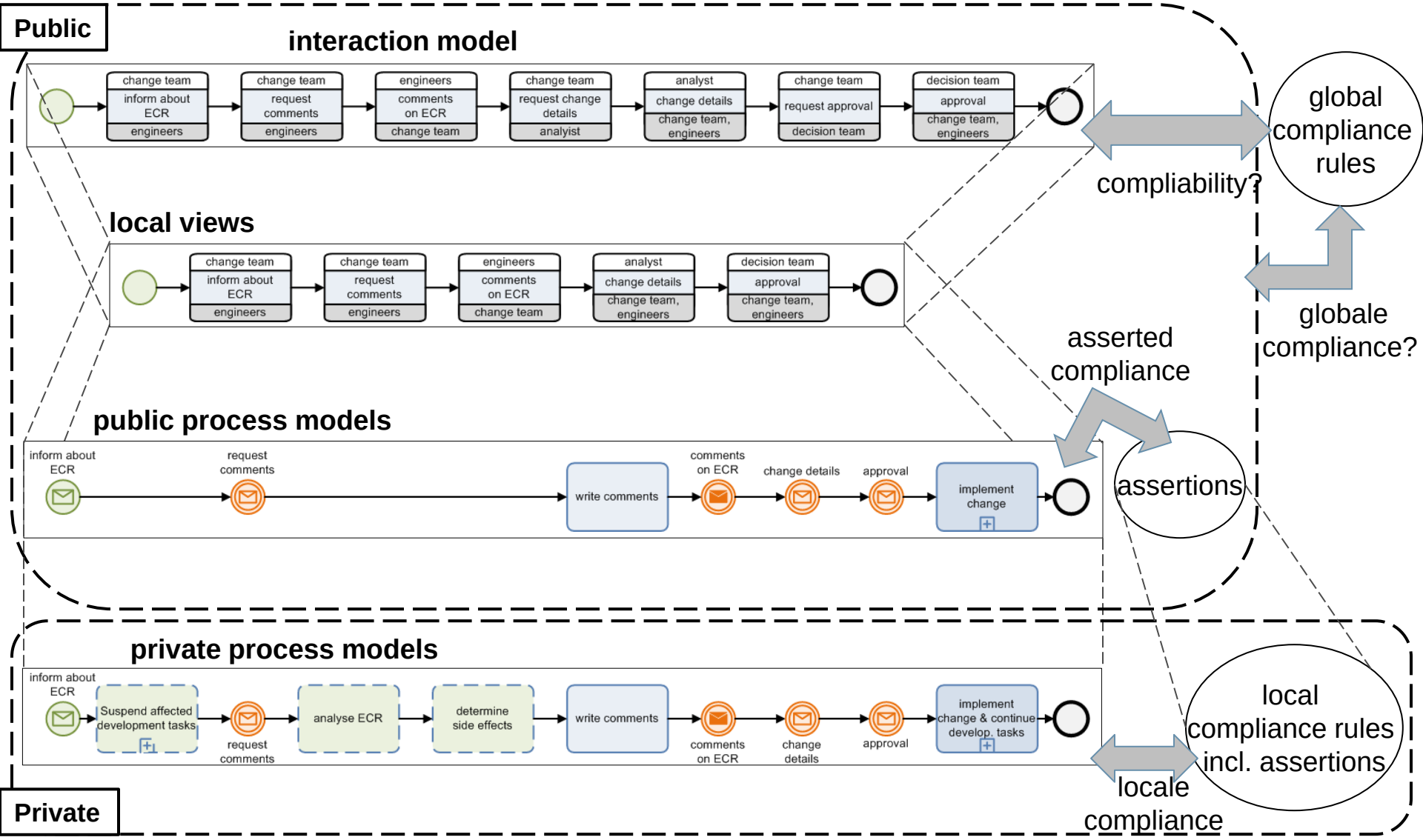
Relevant Layers and Compliance Rules



The Process of Interaction Modeling



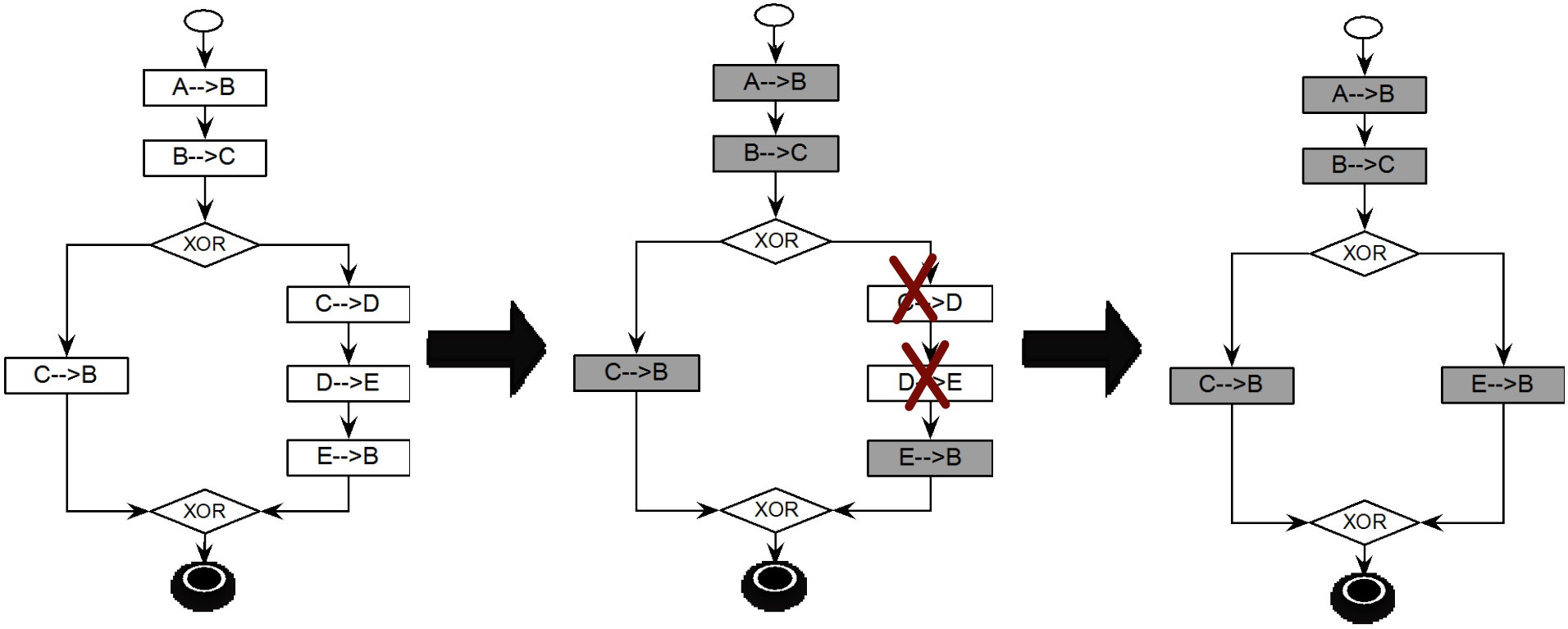
Relevant Layers and Compliance Rules



Enabling Adaptations and Changes of Cross-Organizational Processes

W. Fdhila, S. Rinderle-Ma, M. Reichert (2012) *Change Propagation in Collaborative Processes Scenarios.* In: 8th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing (CollaborateCom'12), Pittsburgh, 2012

Basics

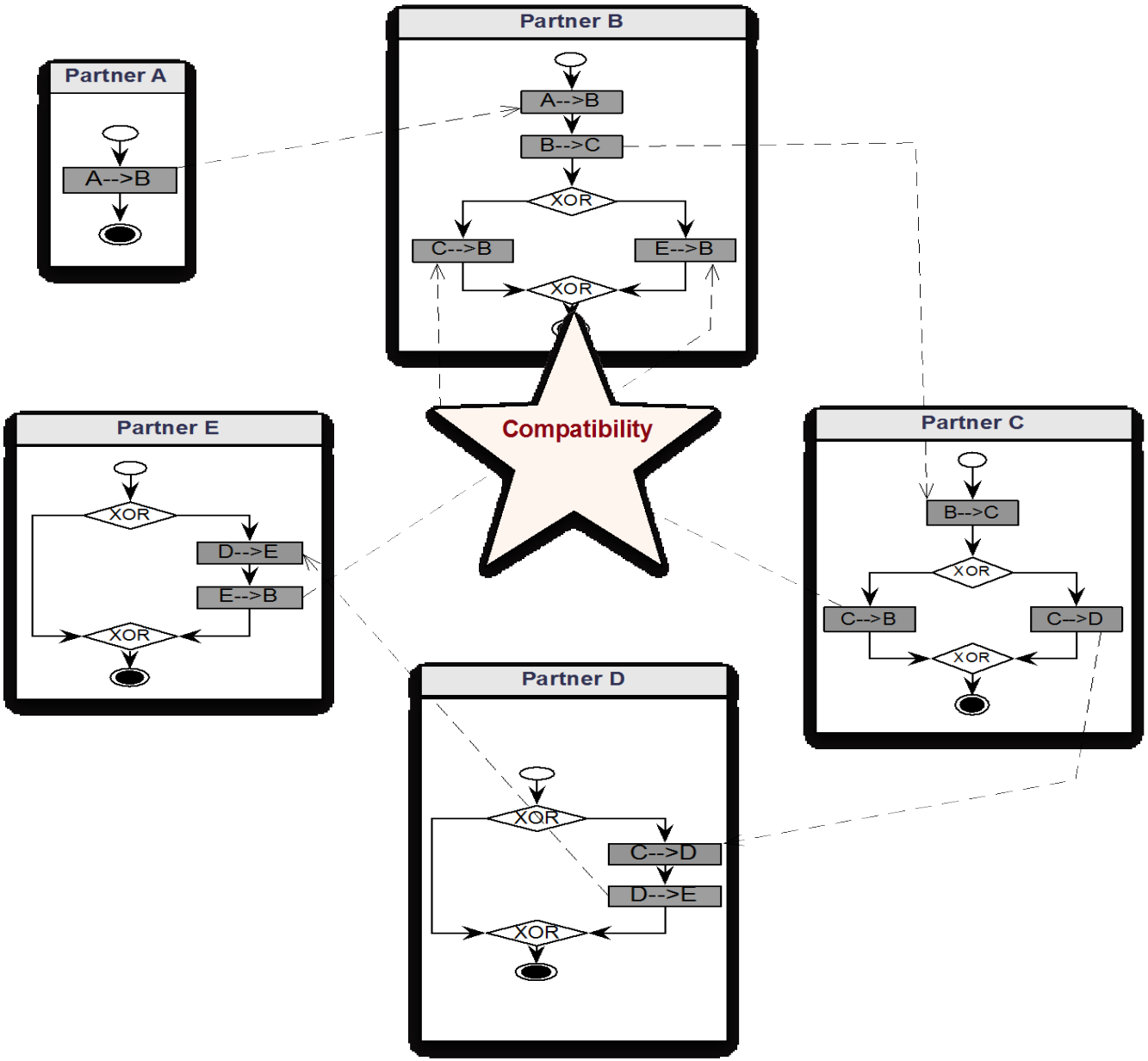


Global Choreography Model (Interaction Model)

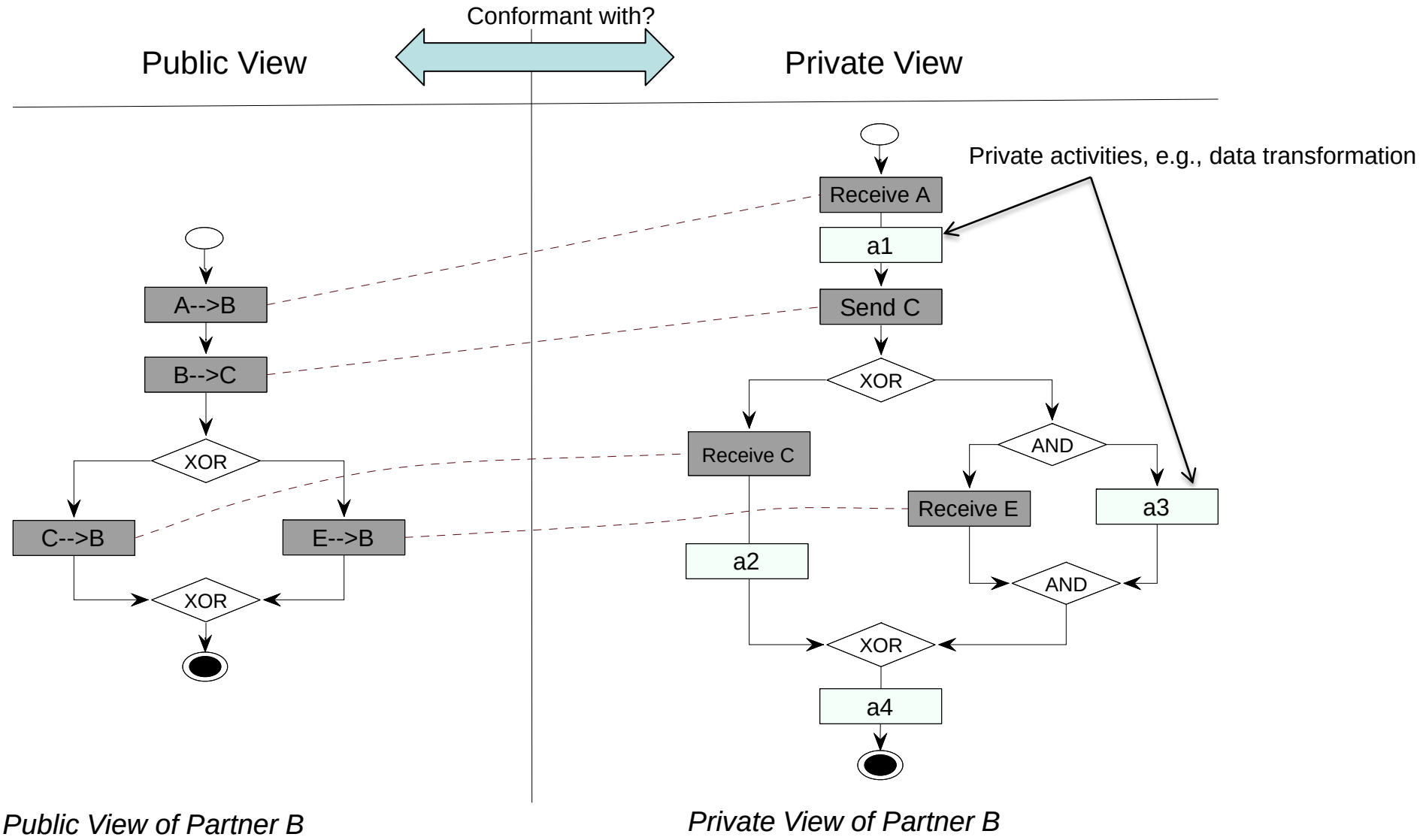
Model Abstraction

Public View of Partner B

Basics


Partner A
A-->B
Partner B
A-->B
B-->C
XOR
C-->B
E-->B
XOR
Compatibility
Partner E
XOR
D-->E
E-->B
XOR
Partner C
B-->C
XOR
C-->B
C-->D
XOR
Partner D
XOR
C-->D
D-->E
XOR

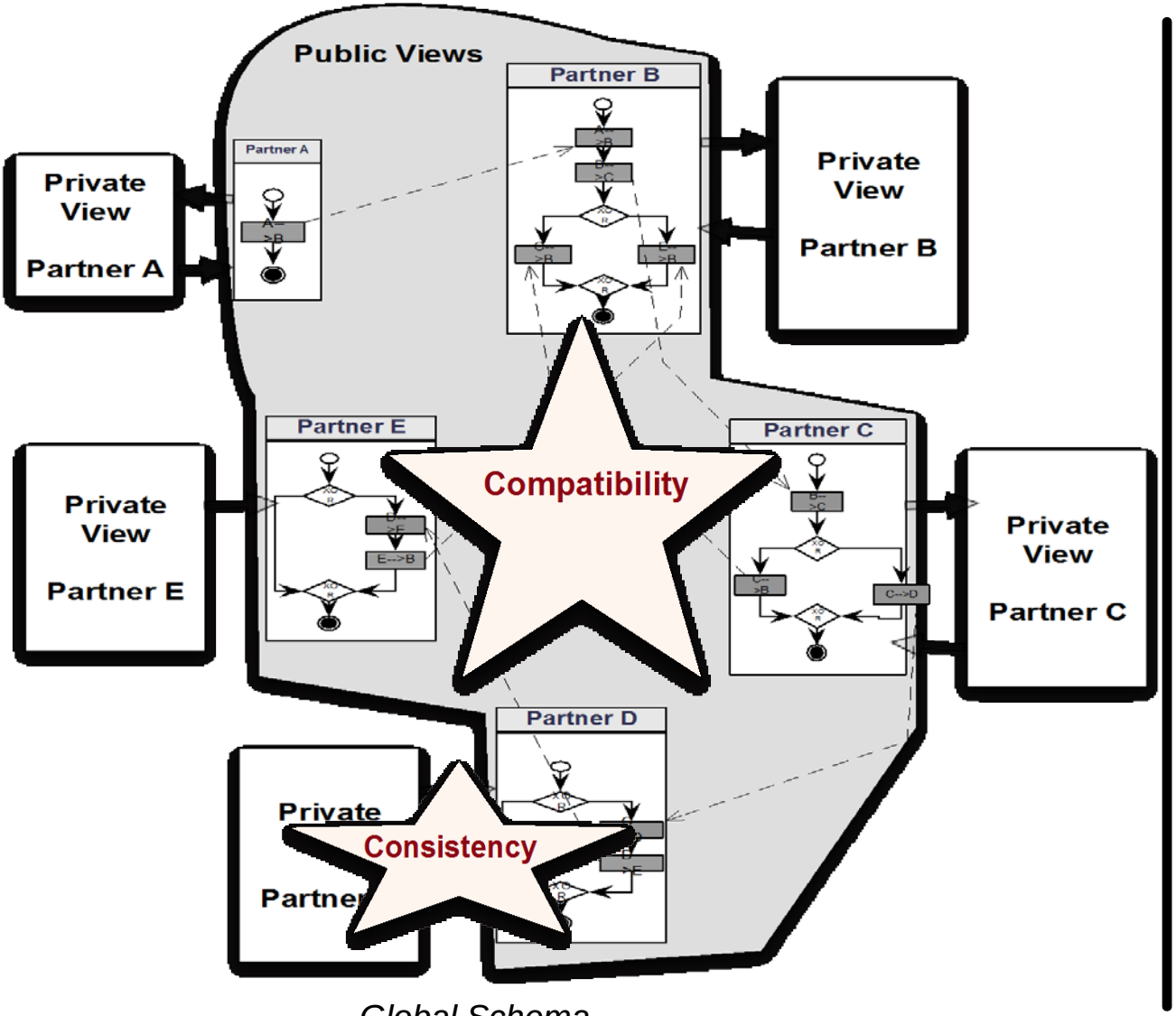
Basics



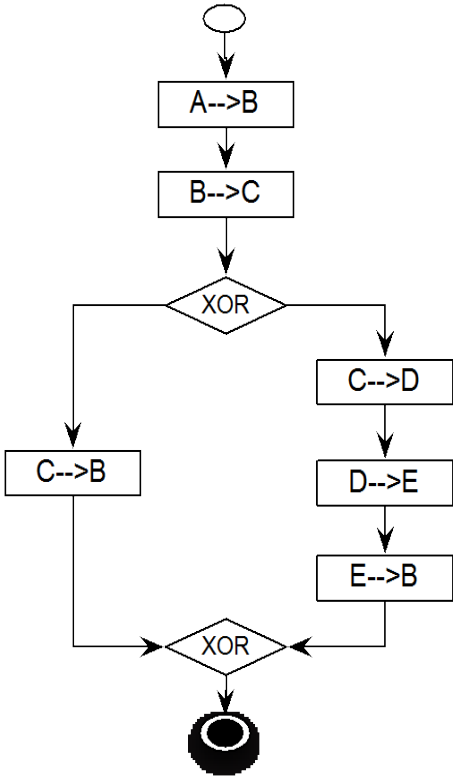
Public View of Partner B

Private View of Partner B

Basics



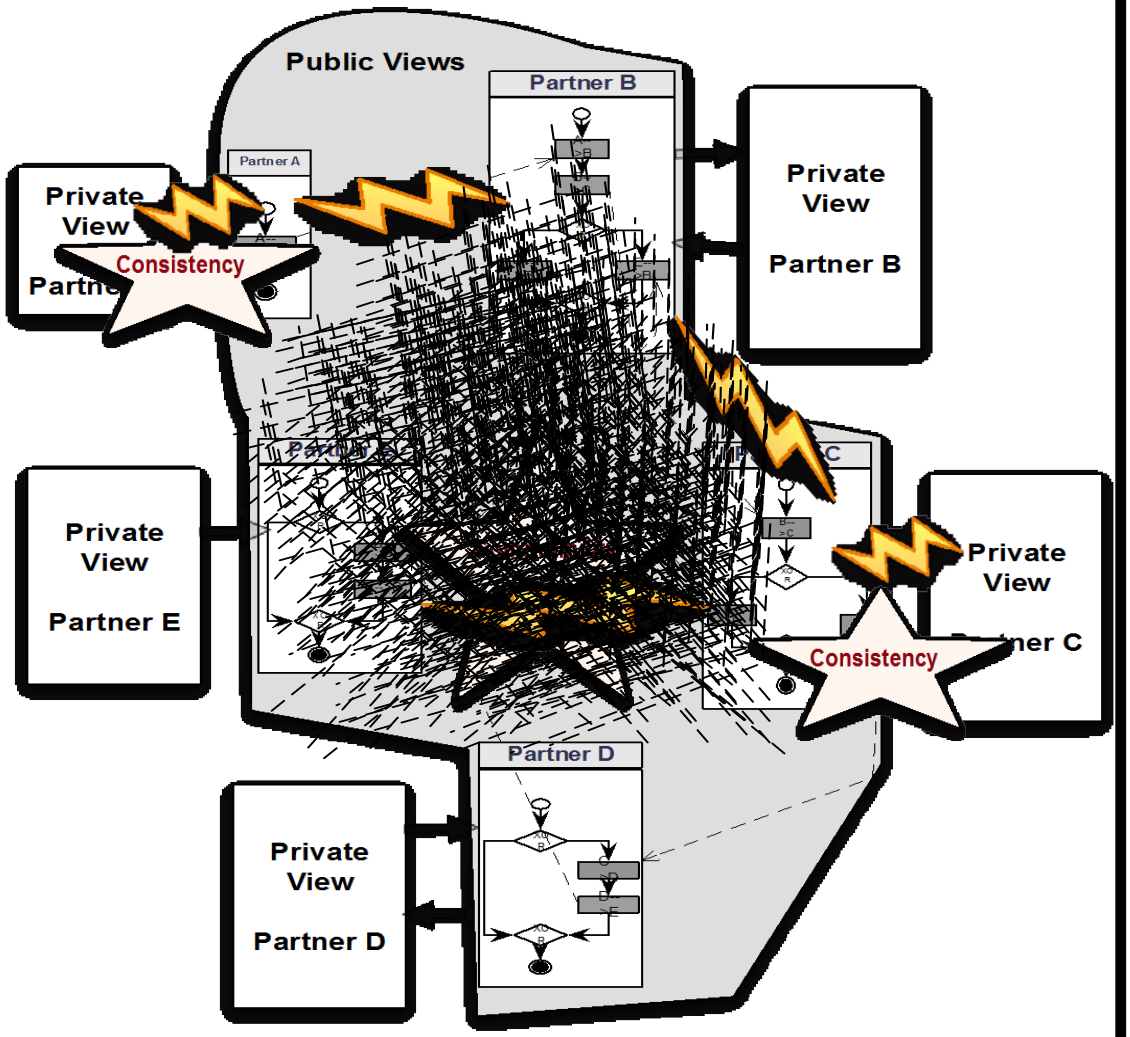
Global Schema



Global Choreography Model

Basics

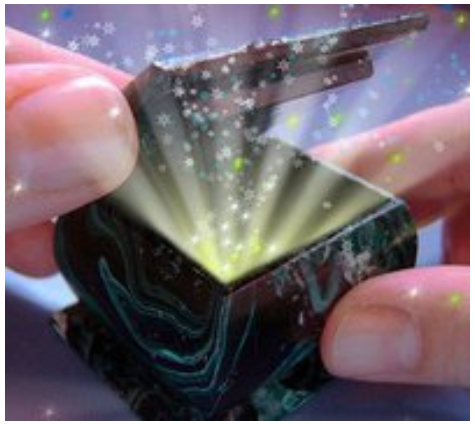
- Ok! and what is the problem then?



- ❑ Conformance (Consistency)
- ❑ Behavioral Compatibility
  - Waiting for a message which will never arrive
  - Sending message which will not be consumed
- ❑ Structural compatibility
- ❑ Transitivity effects
- ❑ Negotiation

Change Propagation

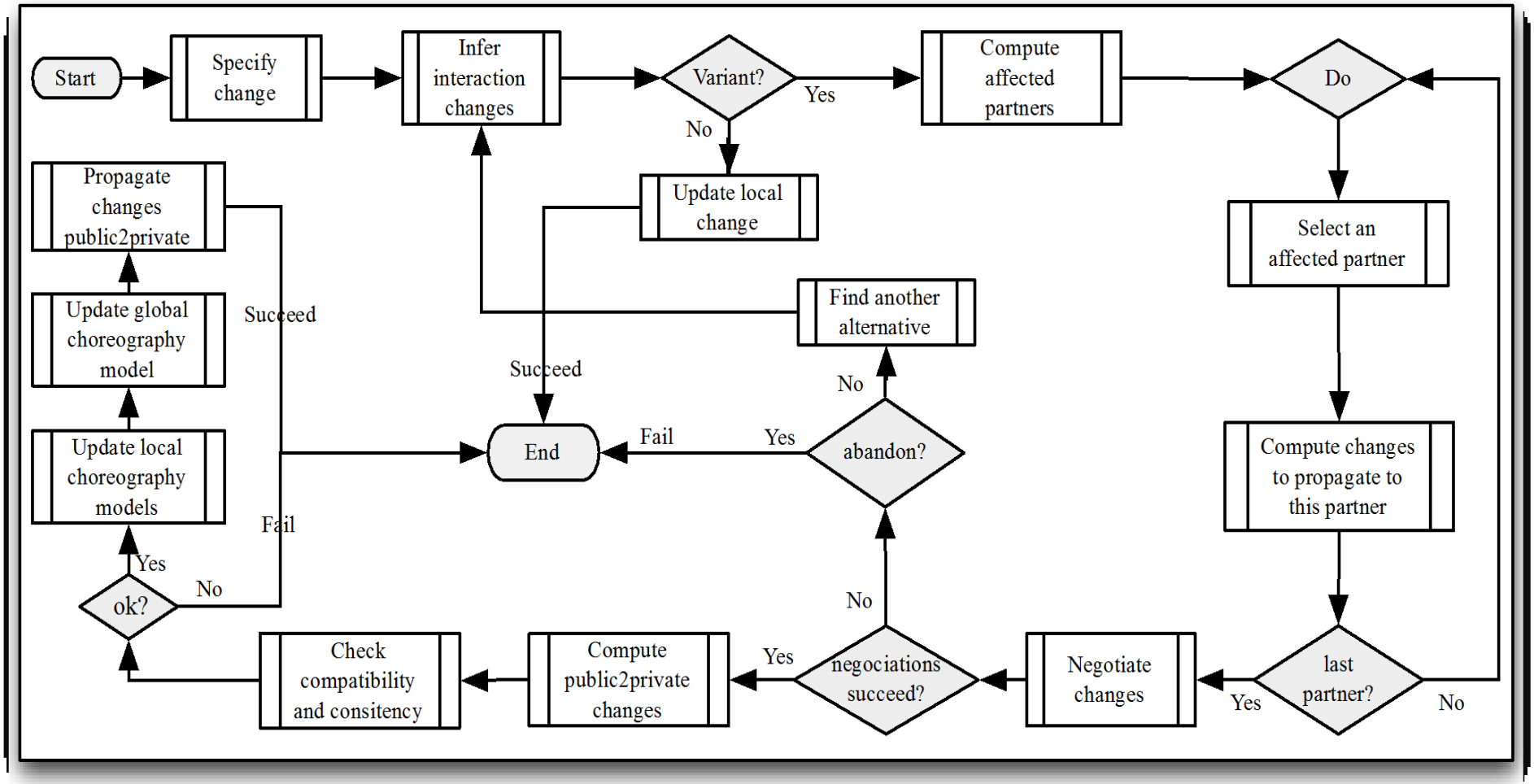
Choreography Model
+
Public views
+
Change Specification



Partners affected by the change
+
Changes to be propagated

- Preserve Conformance
- Preserve Compatibility
- Transitive effects
- Negotiation

Change Propagation: Negotiation



Change Propagation: Change Patterns

INSERT(fragment, how, in, out)

- inserts a new fragment in a process model.

DELETE(fragment)

- Deletes an existing fragment from a process model.

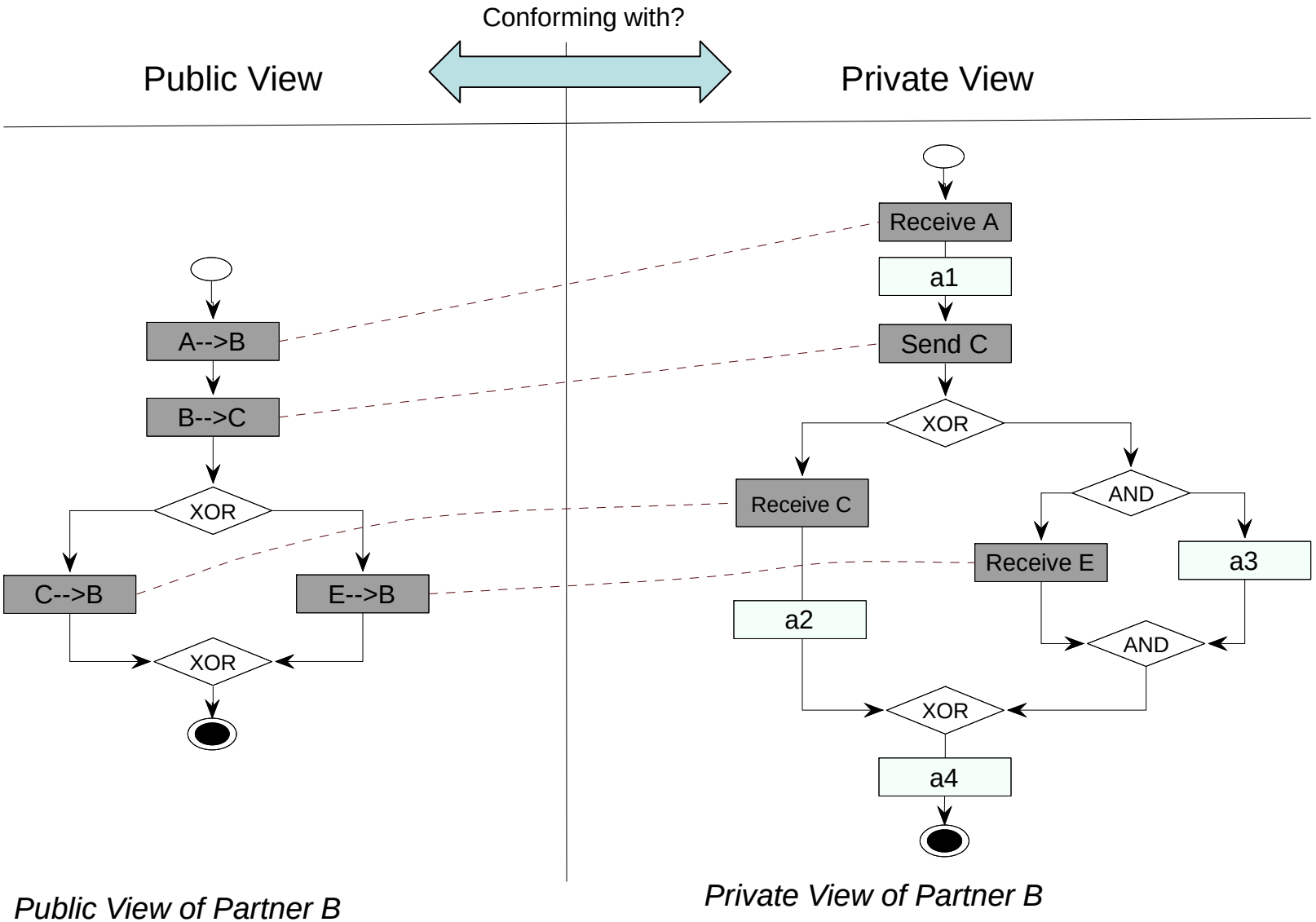
REPLACE(oldFragment, newFragment)

- Replaces an existing fragment by a new one in the process model.

UPDATE(activity, attribute, newValue)

- Updates the attributes of a single activity of a process model.
- *Attribute could be: partner, role, input, output, etc.*

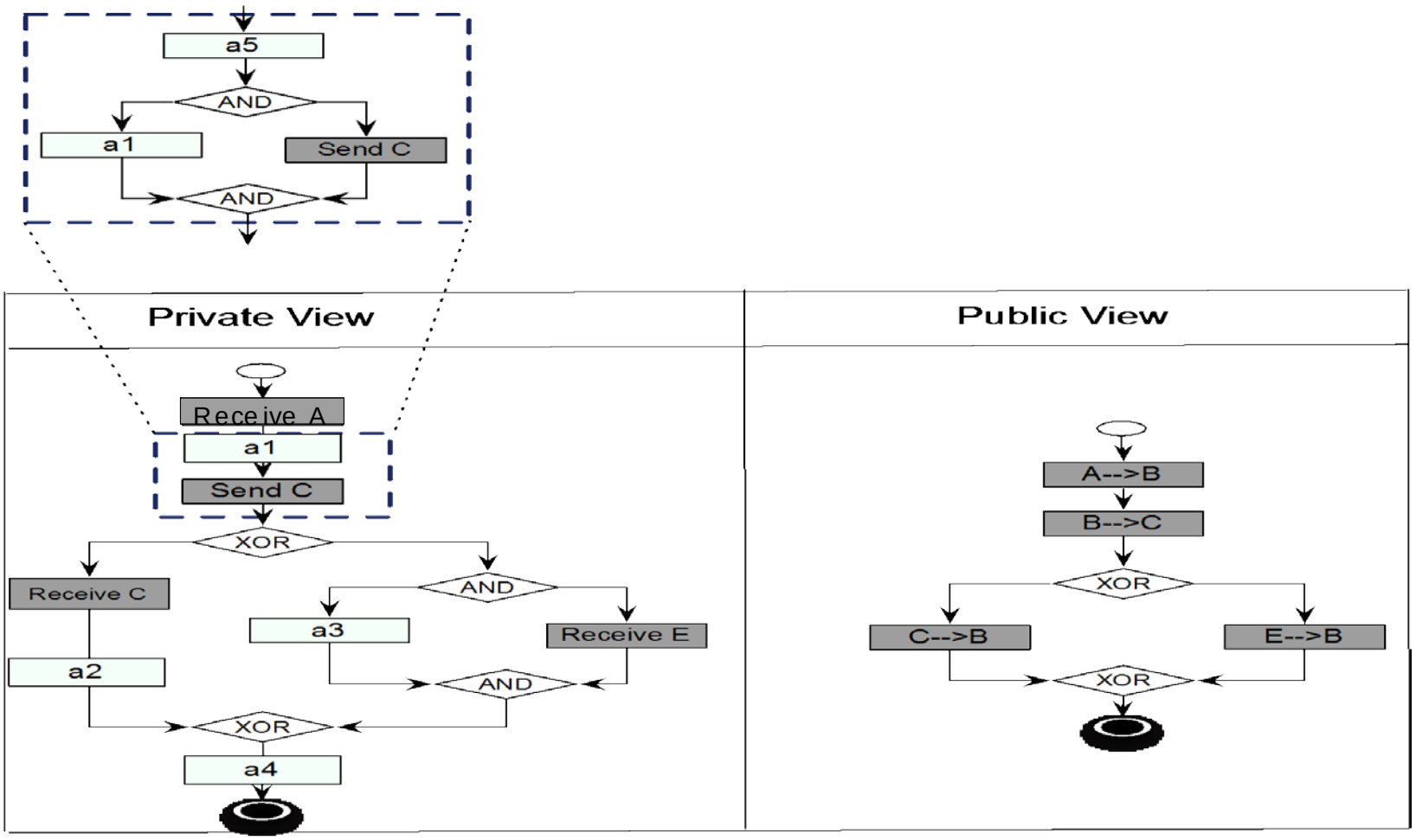
Change Propagation: Replace Pattern



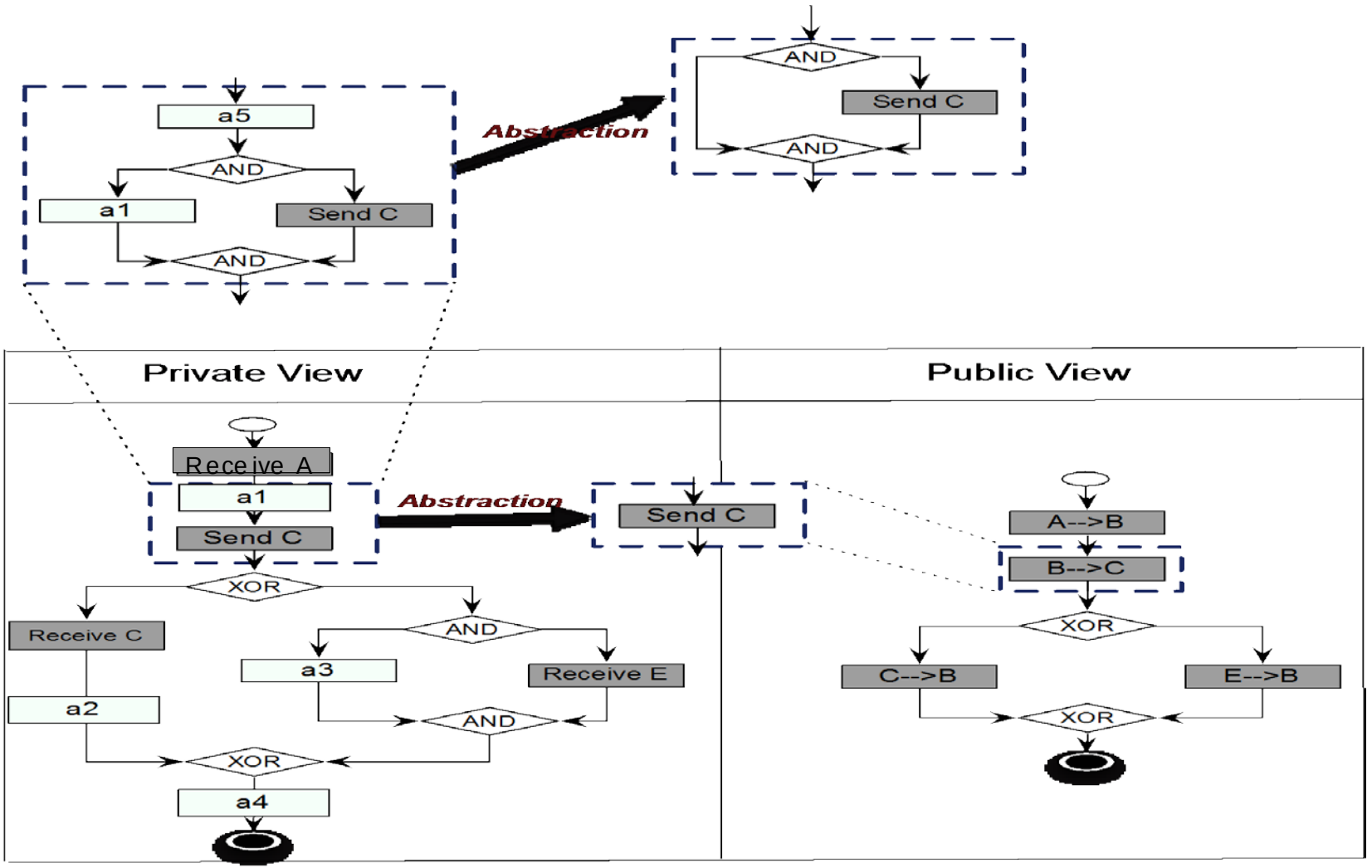
Public View of Partner B

Private View of Partner B

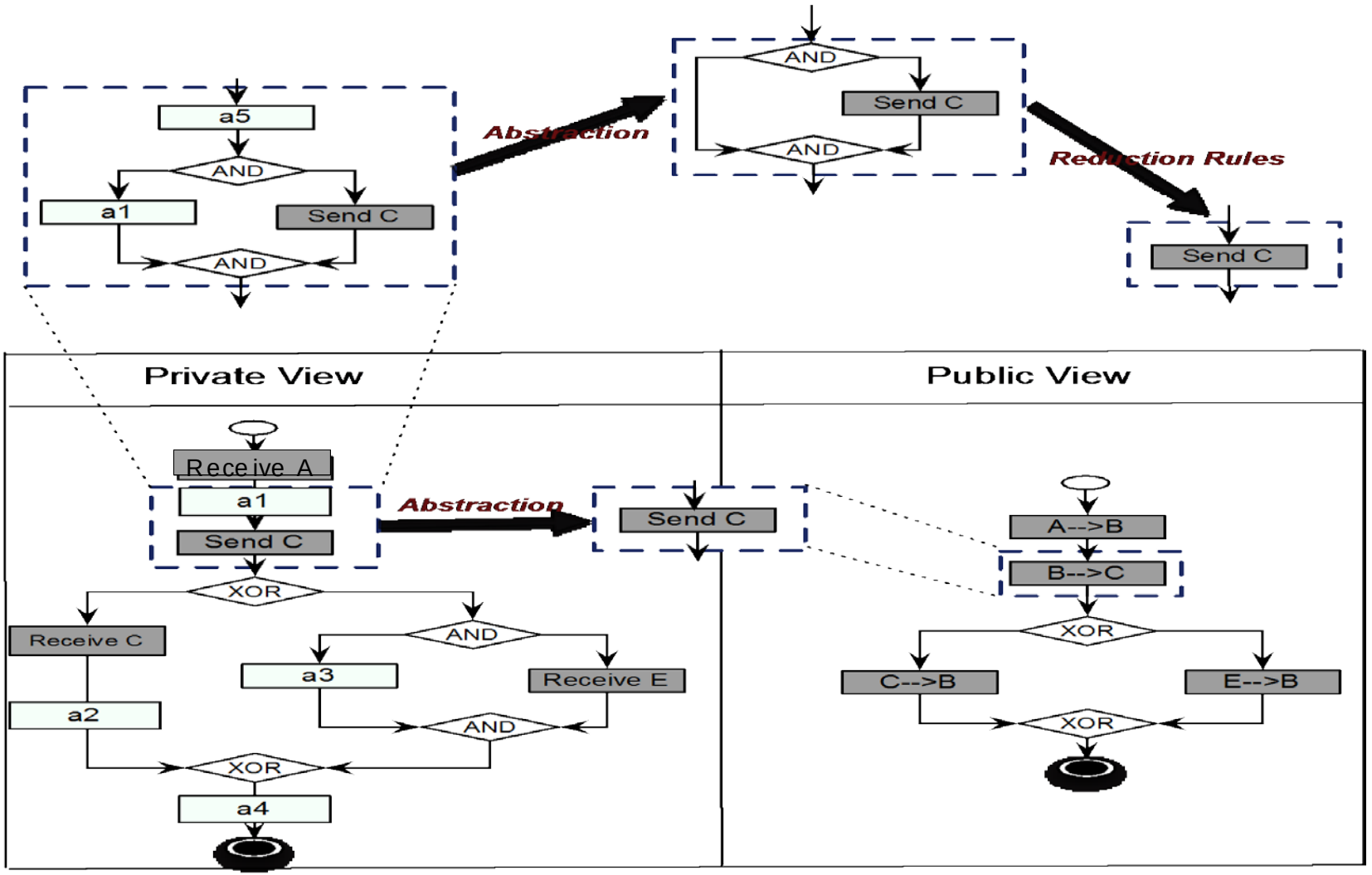
Change Propagation: Replace Pattern



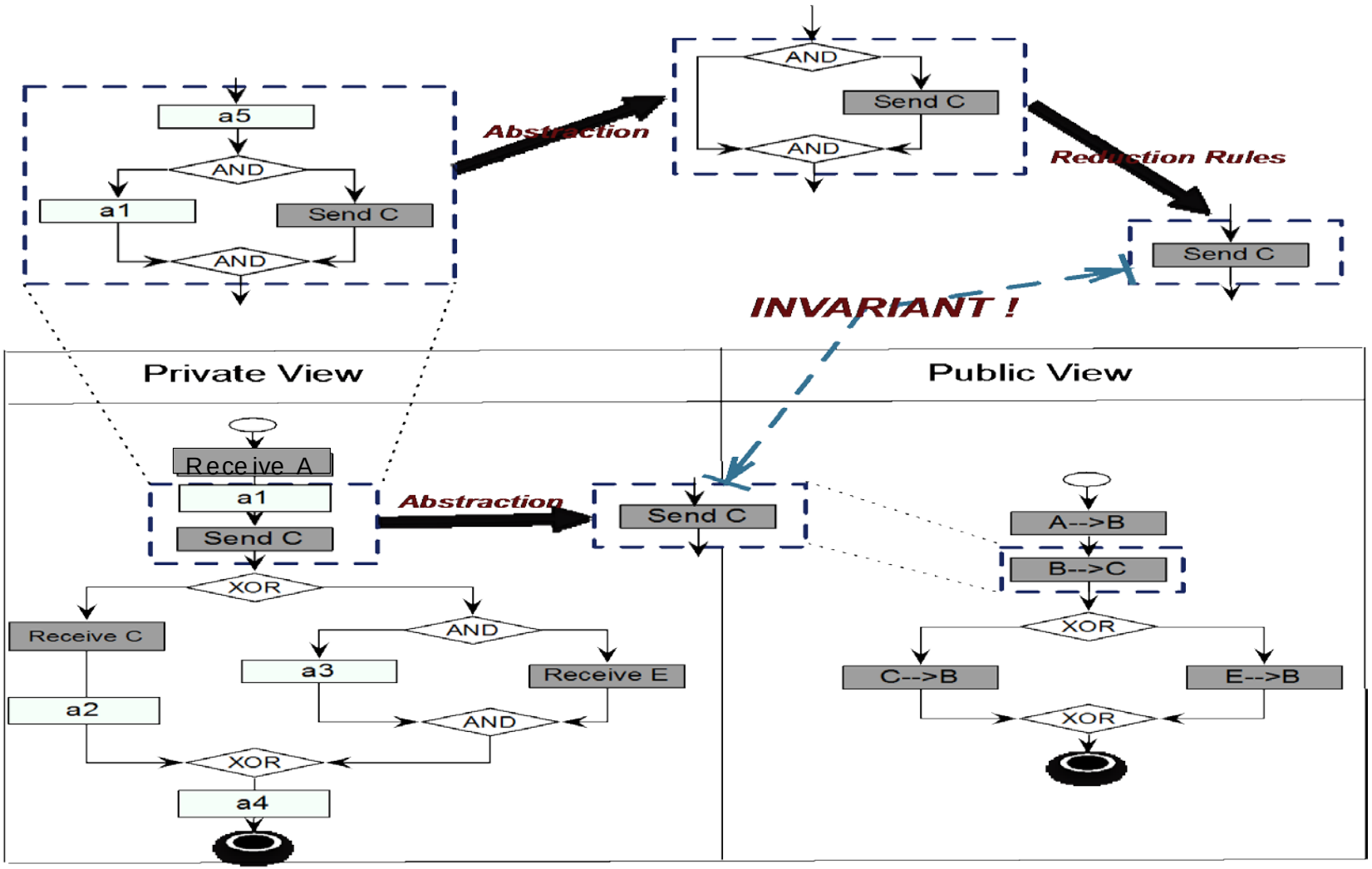
Change Propagation: Replace Pattern



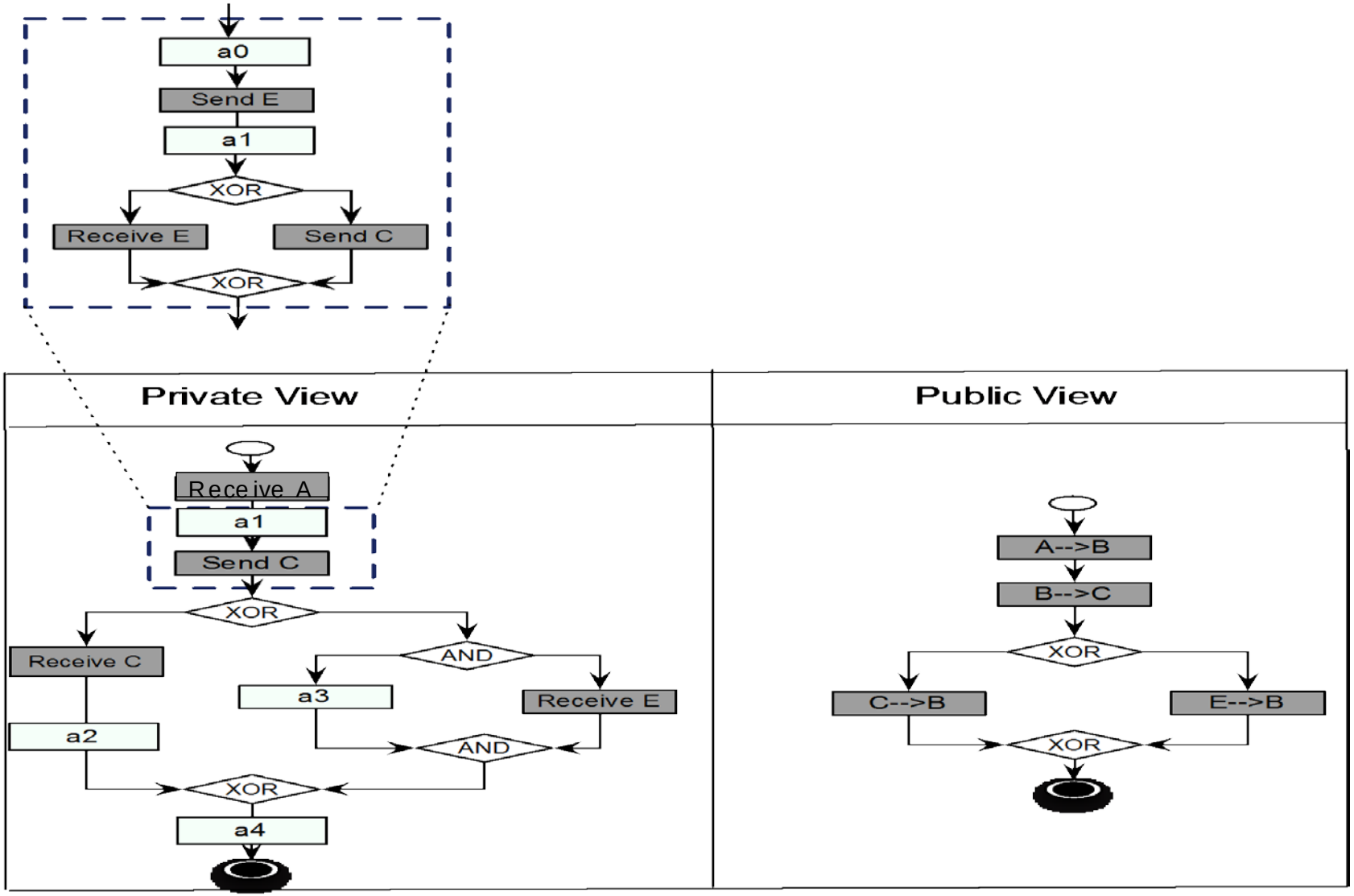
Change Propagation: Replace Pattern



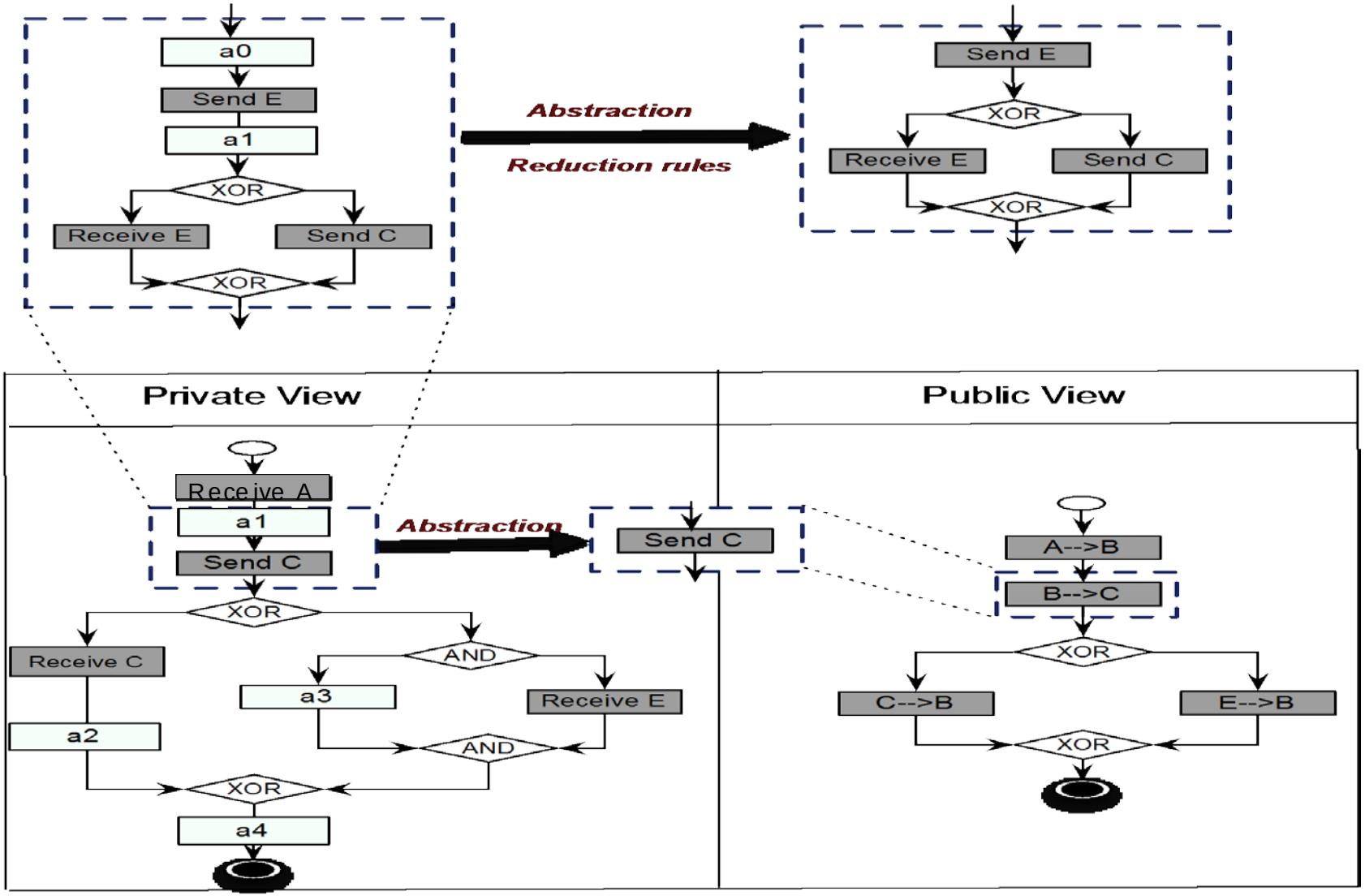
Change Propagation: Replace Pattern



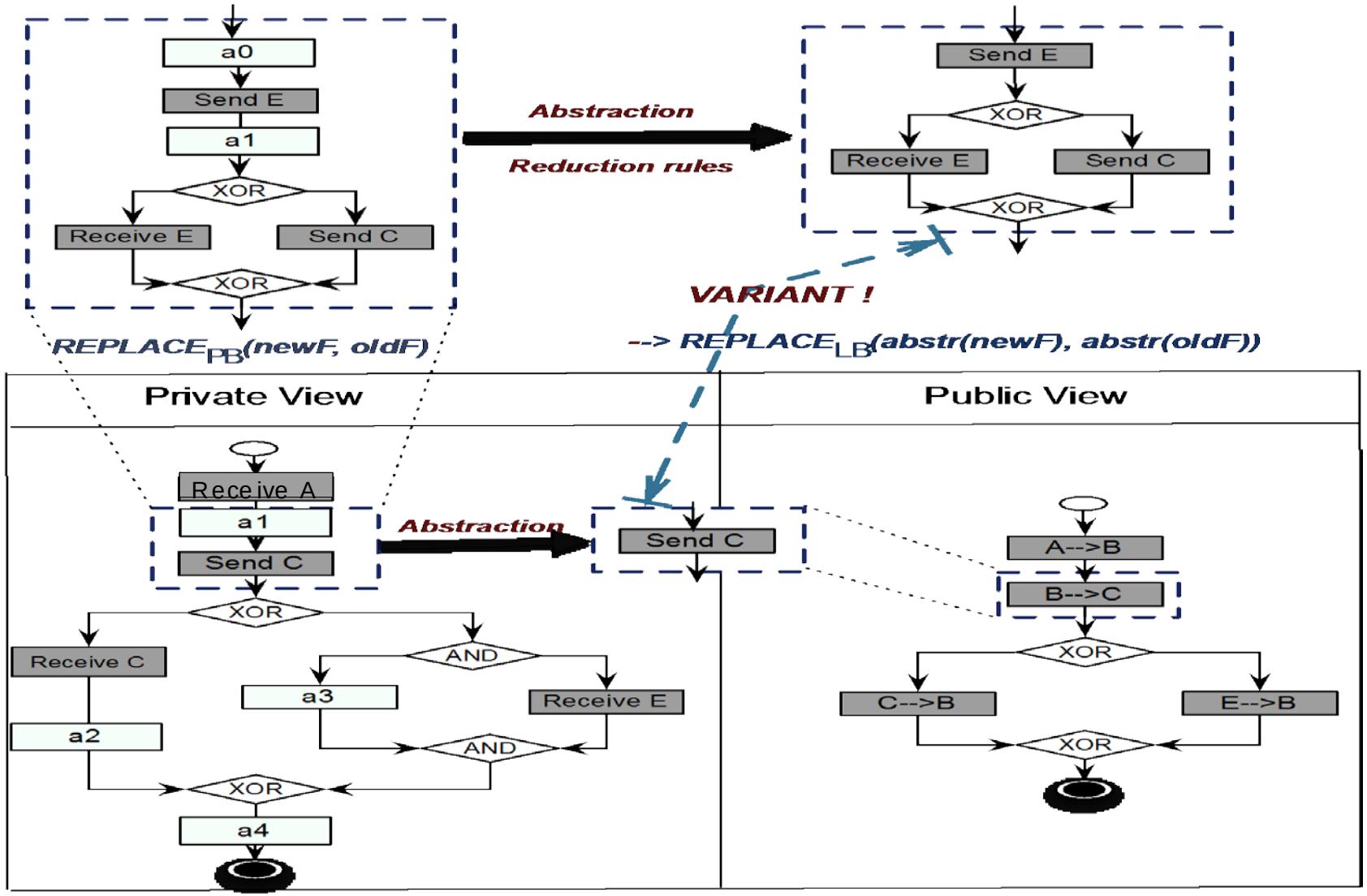
Change Propagation: Replace Pattern



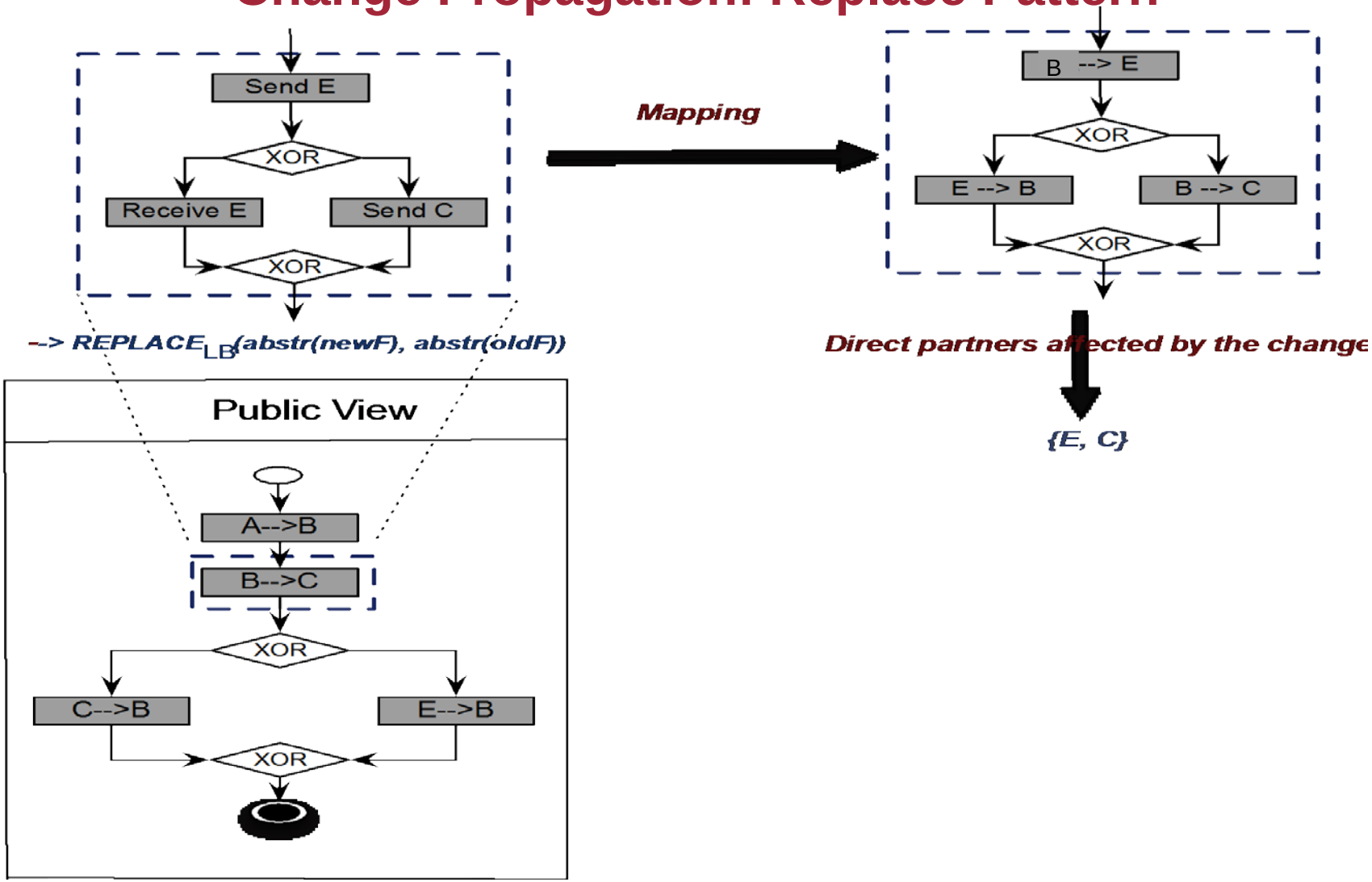
Change Propagation: Replace Pattern



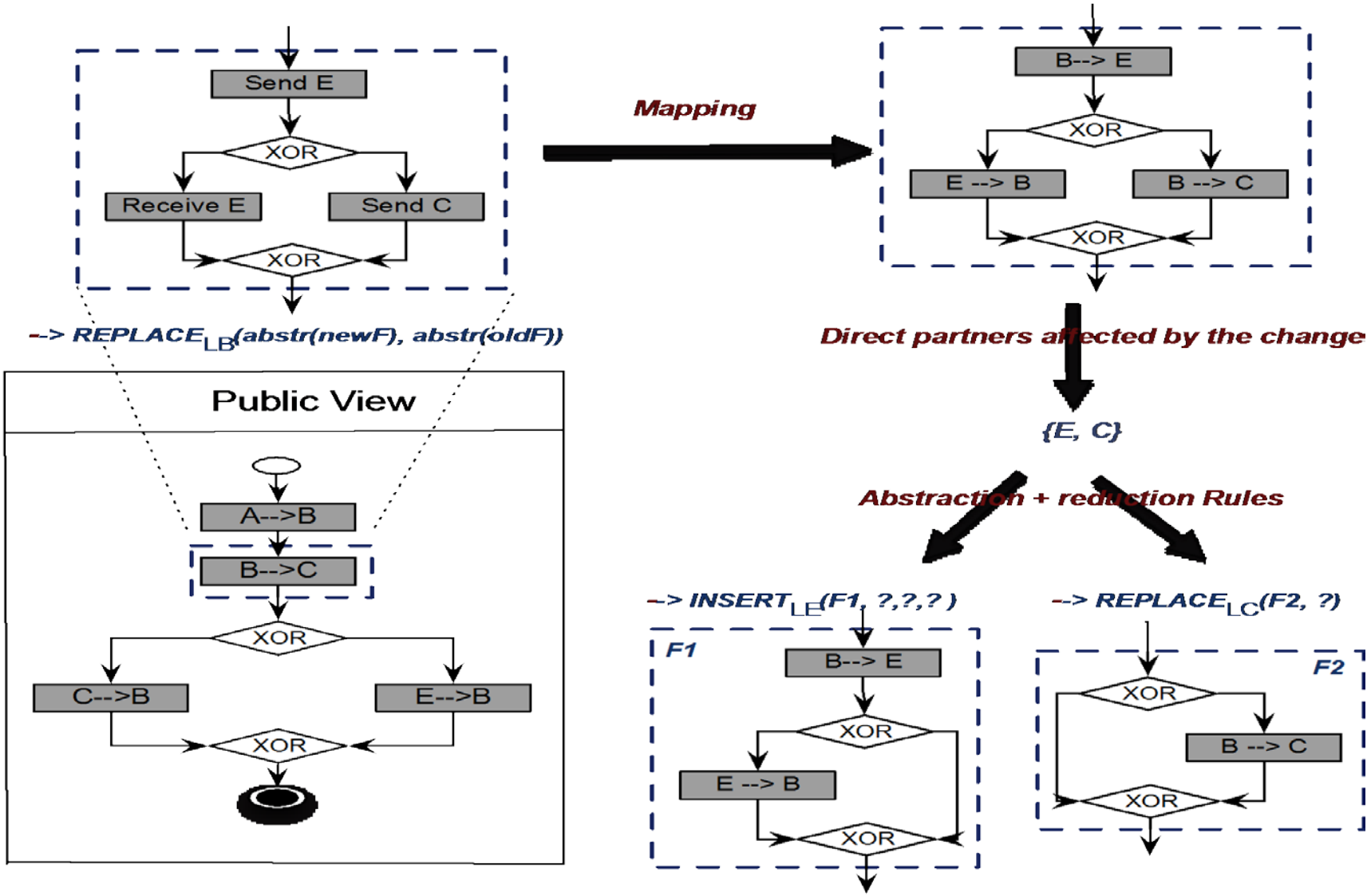
Change Propagation: Replace Pattern



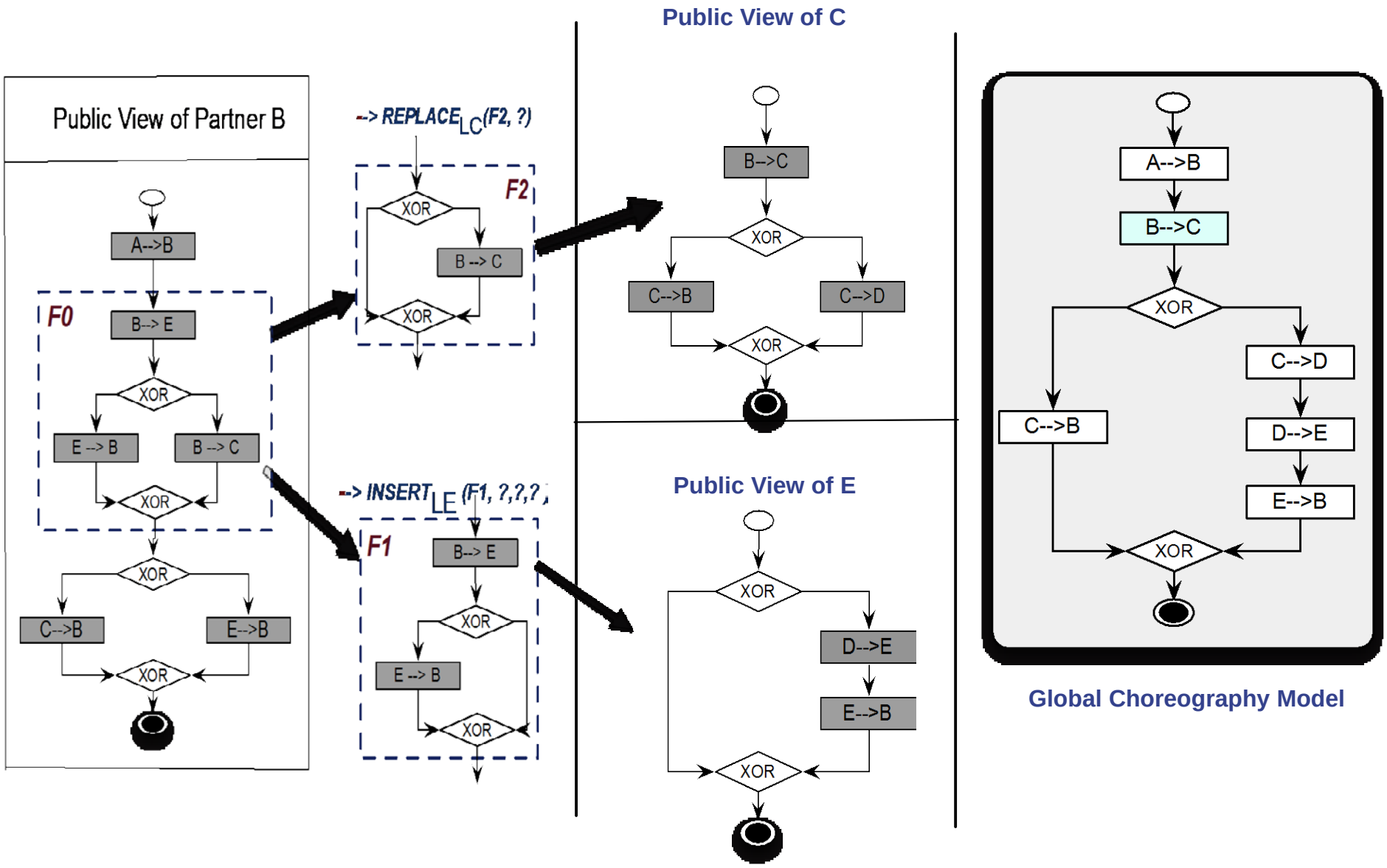
Change Propagation: Replace Pattern



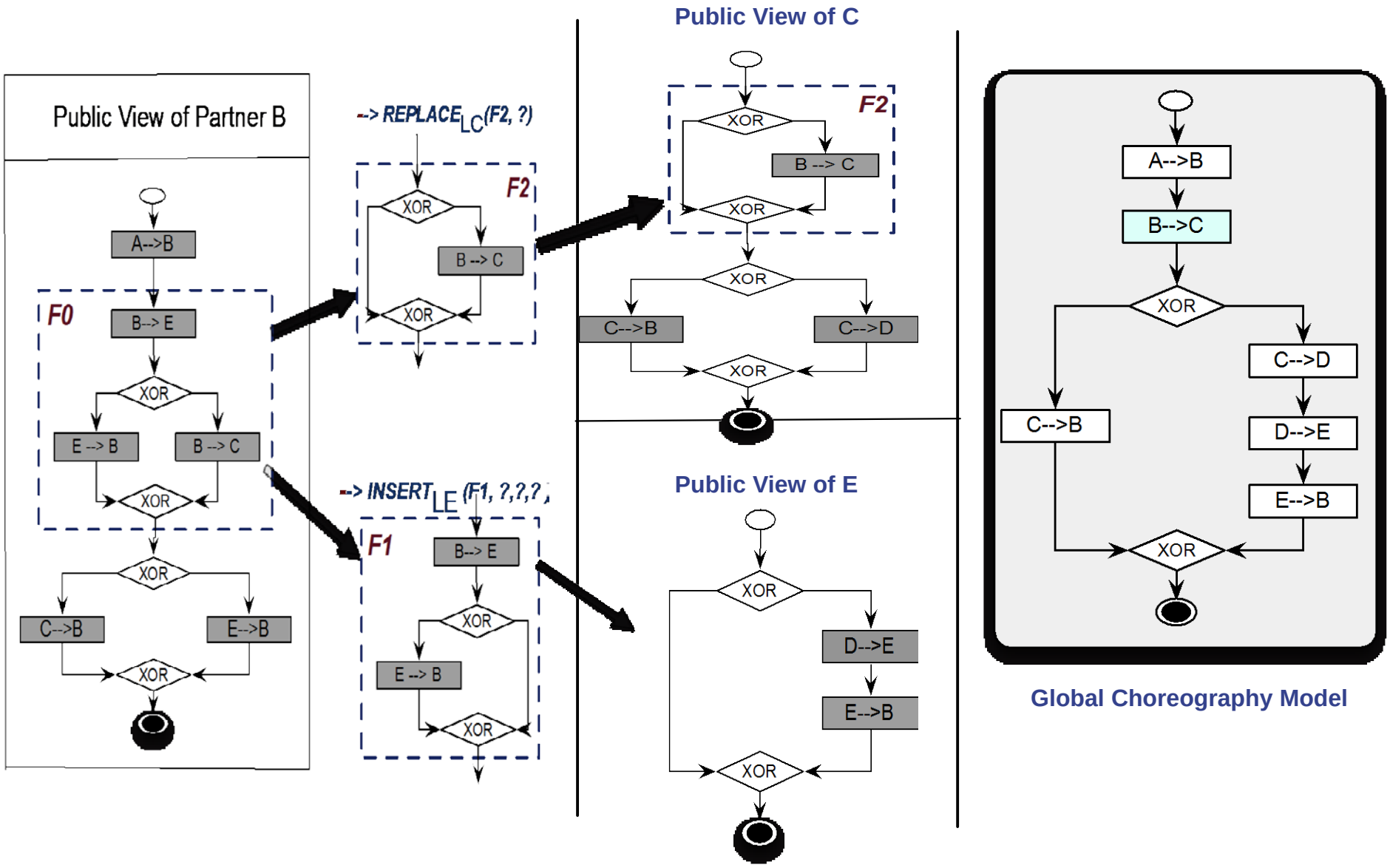
Change Propagation: Replace Pattern



Change Propagation: Replace Pattern

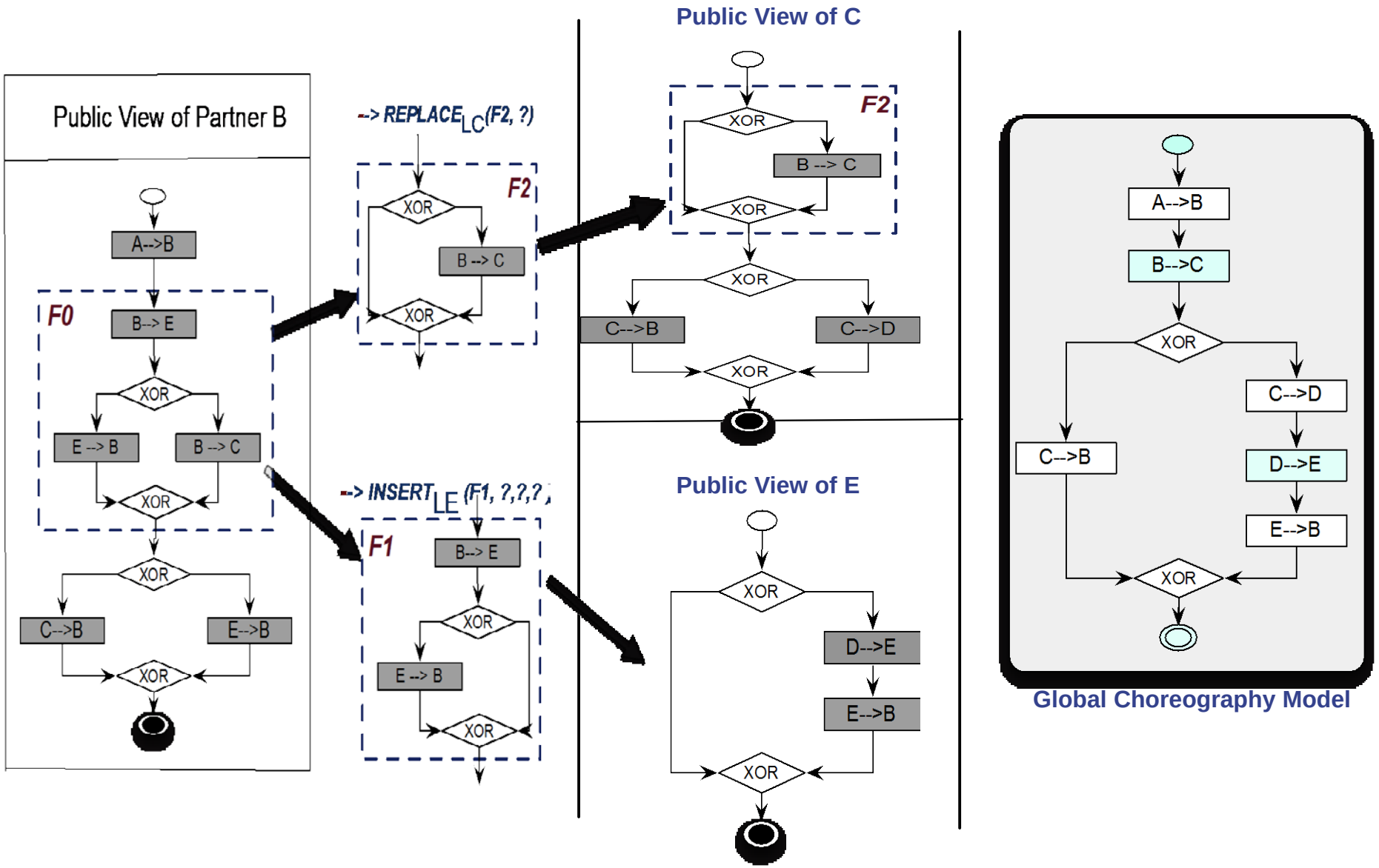


Change Propagation: Replace Pattern



Global Choreography Model

Change Propagation: Replace Pattern



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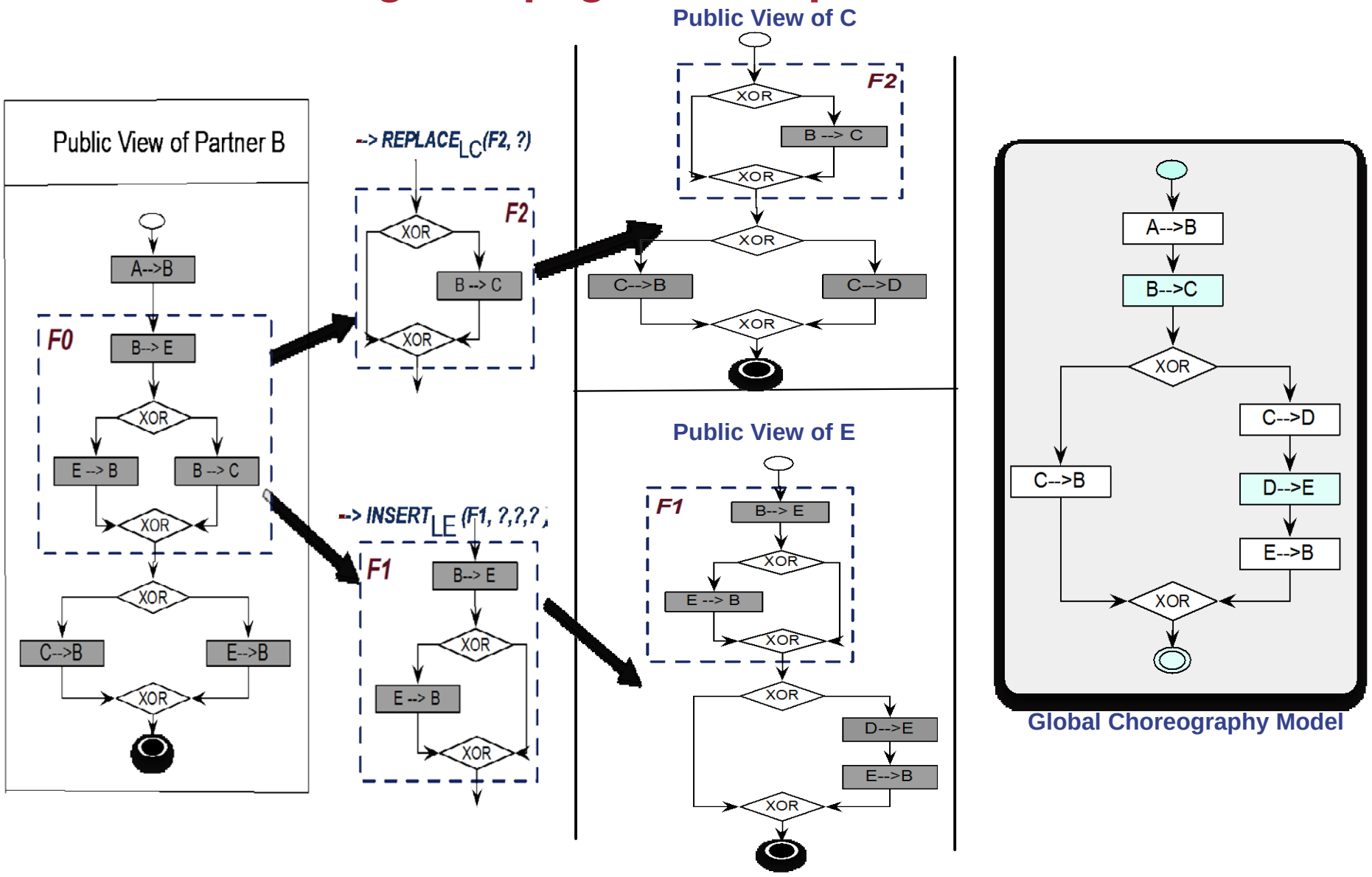

C³Pro
Change
and Compliance
for Collaborative Processes