Natallia Kokash

Using Reo for Compliance-driven Design of Service-Oriented Applications

Introduction

- COMPAS overview
  - Motivation and goals
  - Partners, work packages and case studies
  - WP3: Behavioral models for service compositions and their verification
- Business Process Modeling
  - Mapping BPMN to Reo – events, gateways, message exchange, exception handling, compensation activities, transactions
- Complaince Modeling
  - Expressing compliance constrants using Reo – some ideas and examples
- Related Work
- Conclusions and Future Work

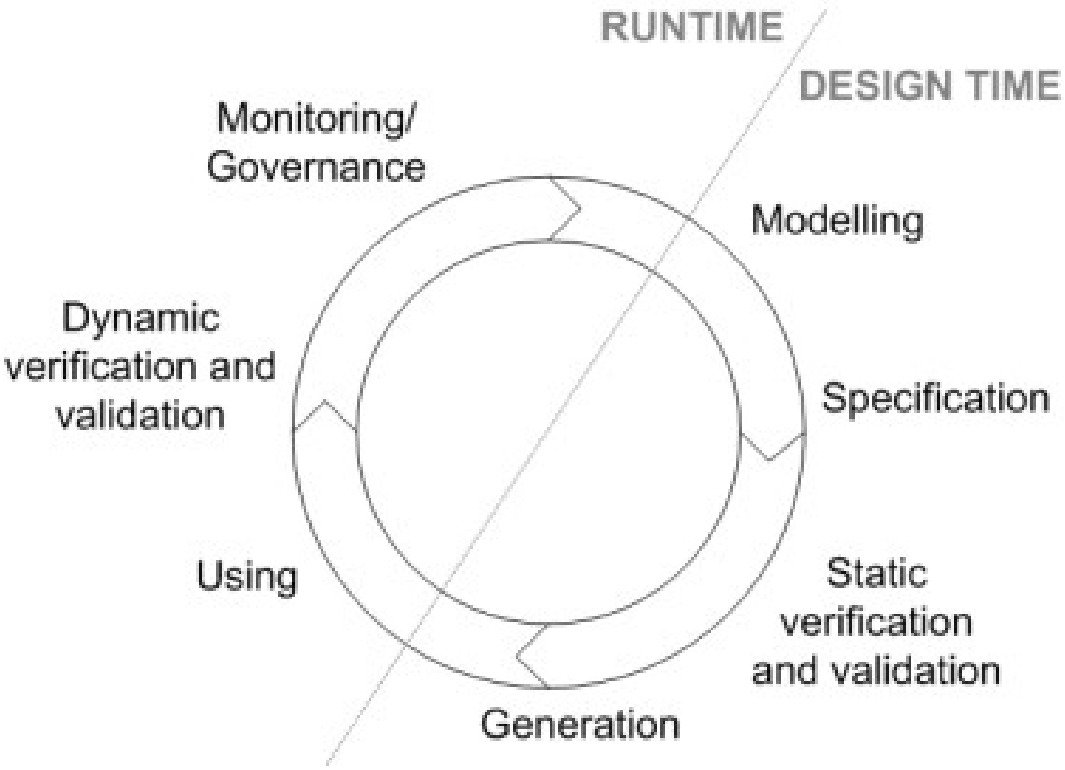
COMPAS goals

- COMPAS = Compliance-driven Models, Languages, and Architectures for Services
- http://www.compas-ict.eu/
- *Ensure dynamic and on-going **compliance** of software **services** to business **regulations** and user **requirements***
- *Help organizations to develope business **compliance solutions** easier and faster*
- *Use **model-driven techniques**, **domain-specific languages**, and **service-oriented computing***

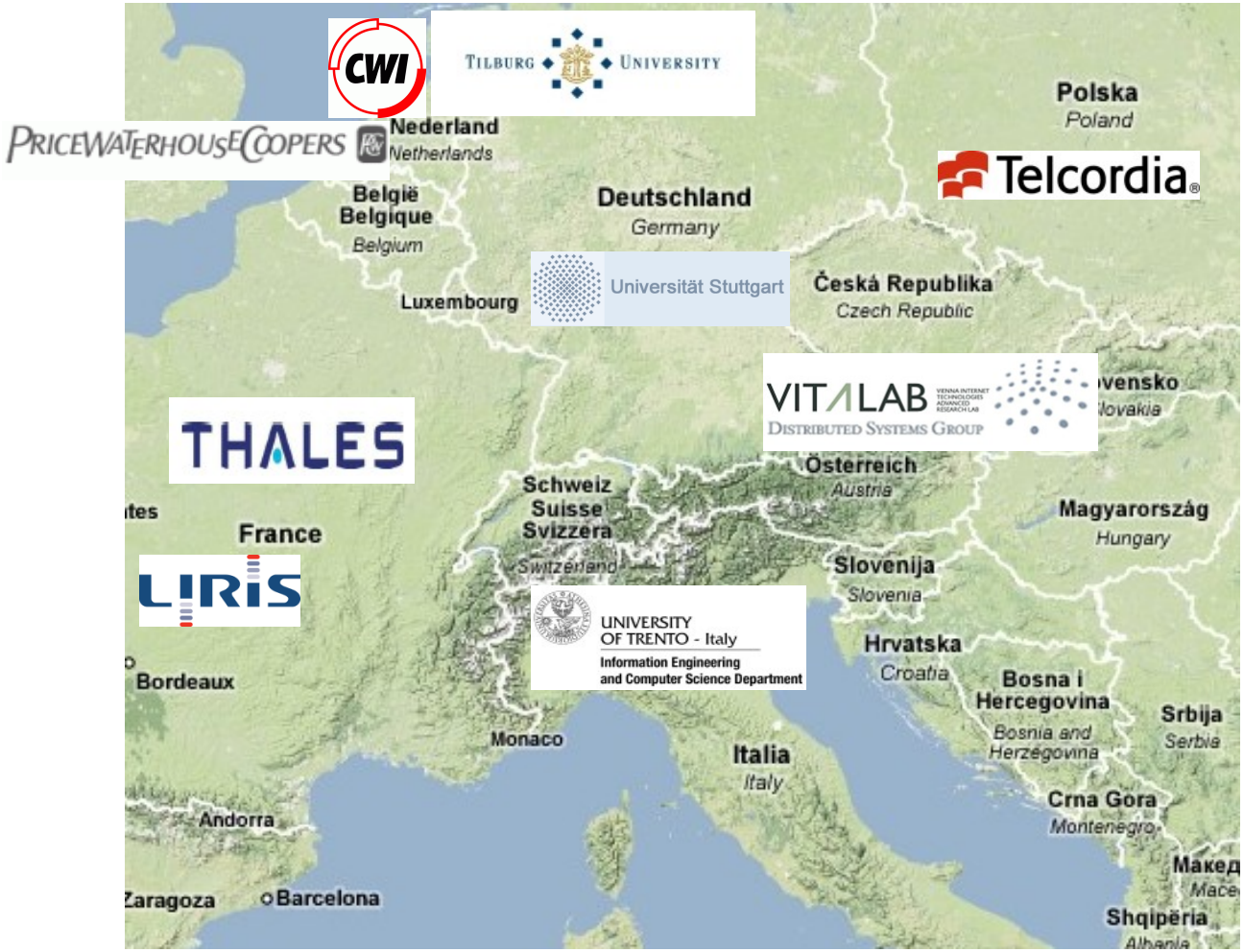
Compliance is

- a multi-faceted concept that encompasses the capability of an organization to meet requirements coming from
  - Regulatory/legislative documents
    - Basel II2, Sarbanes-Oxley6, IFRS2, MiFID3, LSF4, HIPAA, Tabaksblat5, etc.
  - Internal movements towards quality of service
  - User-defined constraints…
- a state of "adherence of one set of rules (source rules) against another set of rules (target rules)"
- a process, which is about "ensuring that business processes, operations and practice are in accordance with a prescribed set of norms"

COMPAS lifecycle



COMPAS partners



COMPAS
work packages

WP	Description	Leaders
1	Core concepts and model-driven compliance framework	VITALAB Distributed Systems Group, CWI, Universität Stuttgart
2	Expressive languages for compliance concerns	Tilburg University, Telcordia, CWI
3	Behavioral models for service compositions and their verification	CWI, LIRIS
4	Reusable business process fragments augmented with compliance concerns	Universität Stuttgart, VITALAB Distributed Systems Group
5	Compliance governance	University of Trento - Italy, Information Engineering and Computer Science Department, LIRIS
6	Exploitation, dissemination, standardization	THALES, Telcordia, PricewaterhouseCoopers
7	Validation of the results through case studies	COMPAS
8	Project management	VITALAB Distributed Systems Group

Case studies
(> 5 scenarios)

Telcordia

- *Unified Incident Command System*
  - Coordination compliance:
    - Role/task assignment to involved organizations
    - Obligations to add/remove activities, controls or data
    - Constraints on activities and corresponding service ordering and data flow
    - Time constraints
  - Information exchange compliance
  - Access control compliance
  - Quality compliance
    - Dynamic (runtime) process and service adaptation to meet process metrics
  - Resource compliance
- *Advanced Telecom Services*
  - Contract and legal compliance
  - I icensing compliance…

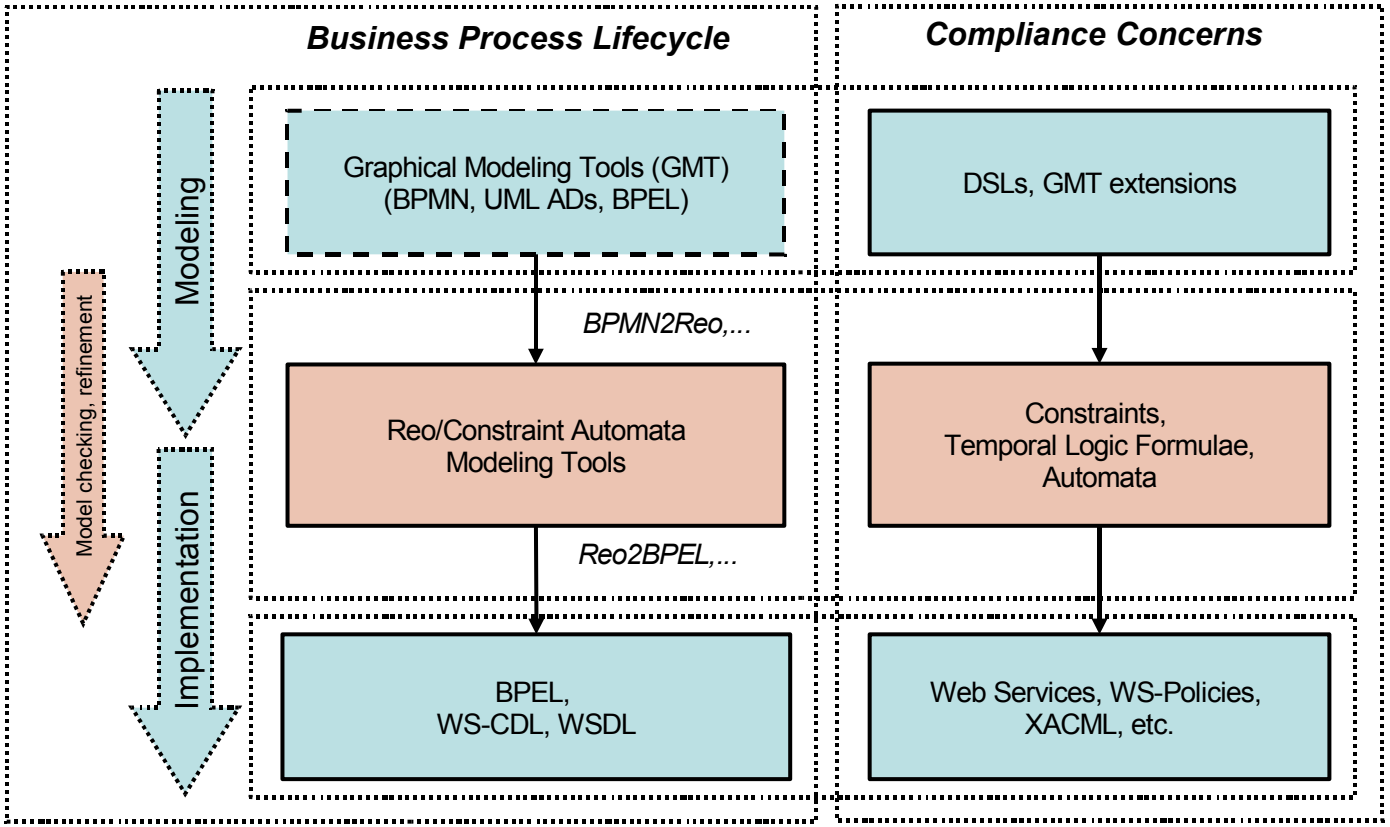
THALES

- *Loan origination process*
  - *Focus on security*

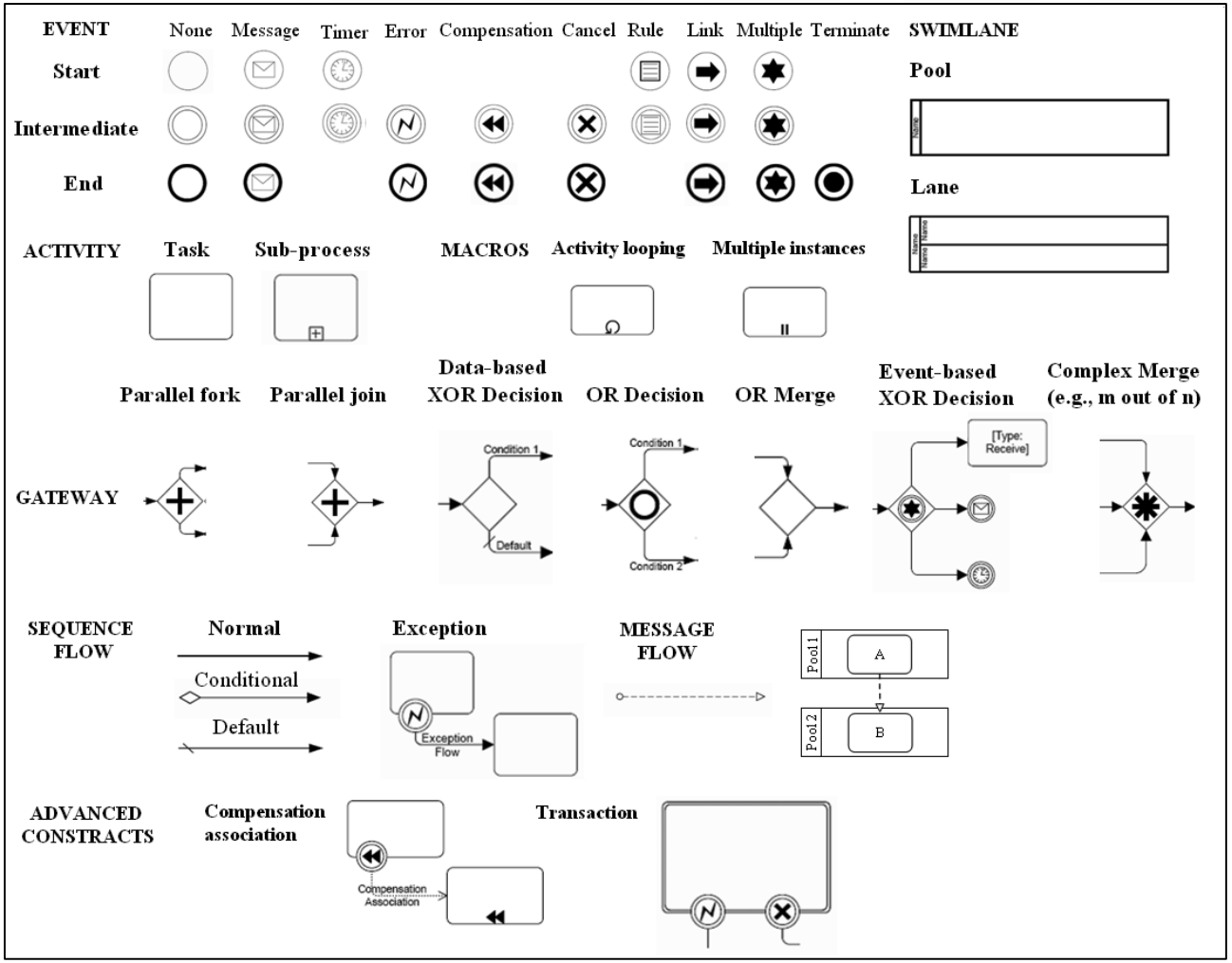
WP3 (leaded by CWI)

Task	Description	CWI expected contribution
1	Formal behavioural models for services	Develop a (Reo / constraint automata based) model for composite services able to support multi-partner processes with compliance concerns
2	Visual environment for service description	Develop a graphical language and a GUI editor in Eclipse for specification of service interfaces.
3	Tools for service description verification	Develop a suitable tool
4	Tools for service compliance behavior management	Develop a suitable tool
5	Service model interpretor/simulation engine	Develop a suitable interpretor engine

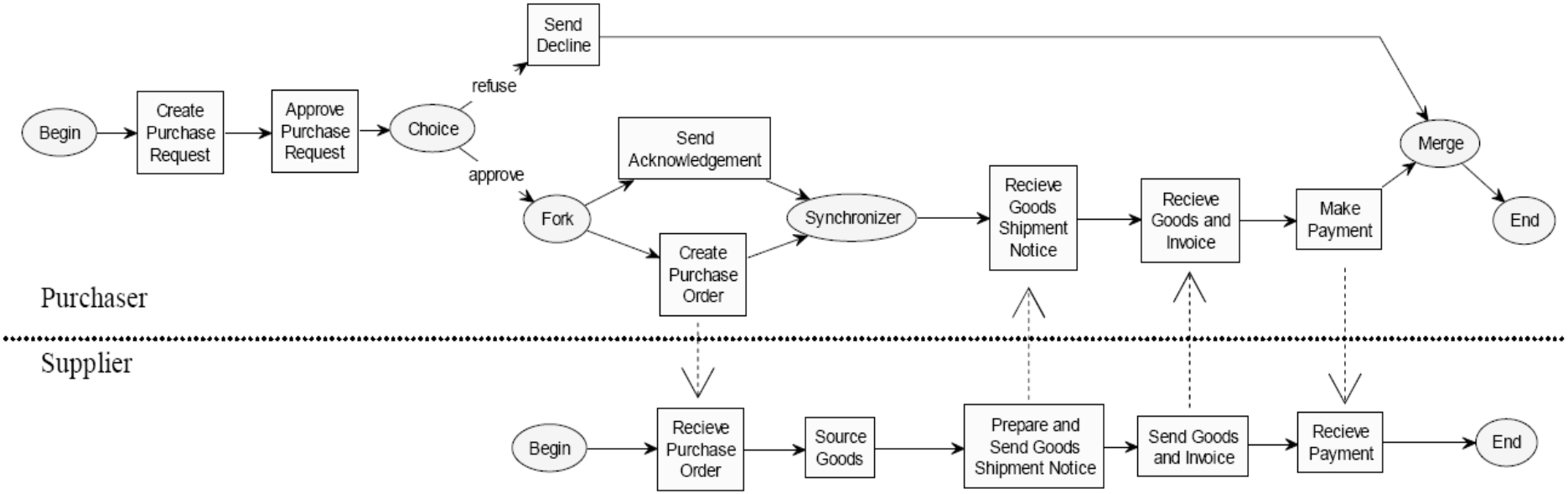
WP3 initial work plan



BPMN

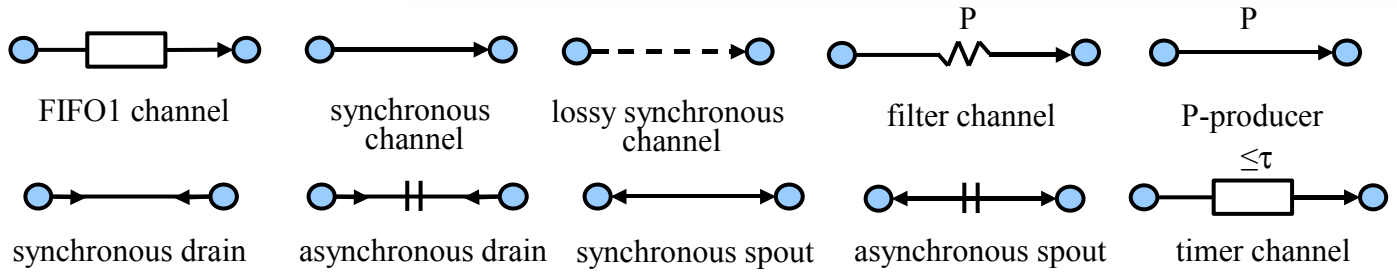

EVENT
None
Message
Timer
Error
Compensation
Cancel
Rule
Link
Multiple
Terminate
SWIMLANE
Start
Intermediate
End
Pool
Lane
ACTIVITY
Task
Sub-process
MACROS
Activity looping
Multiple instances
Parallel fork
Parallel join
Data-based XOR Decision
OR Decision
OR Merge
Event-based XOR Decision
Complex Merge (e.g., m out of n)
GATEWAY
Condition 1
Default
Condition 1
Condition 2
[Type: Receive]
SEQUENCE FLOW
Normal
Conditional
Default
Exception
Exception Flow
MESSAGE FLOW
Pool1
A
Pool2
B
ADVANCED CONSTRACTS
Compensation association
Compensation Association
Transaction

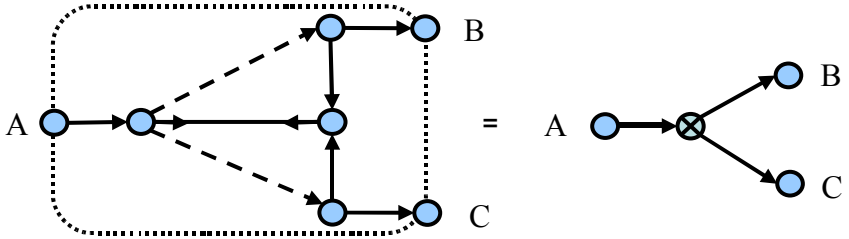
Purchase-to-pay: process model



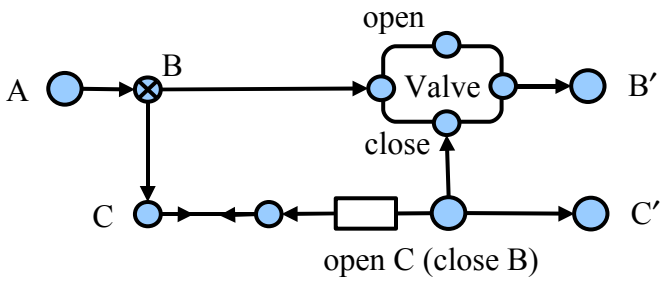
[Sadiq et al, BPM'07]

Reo



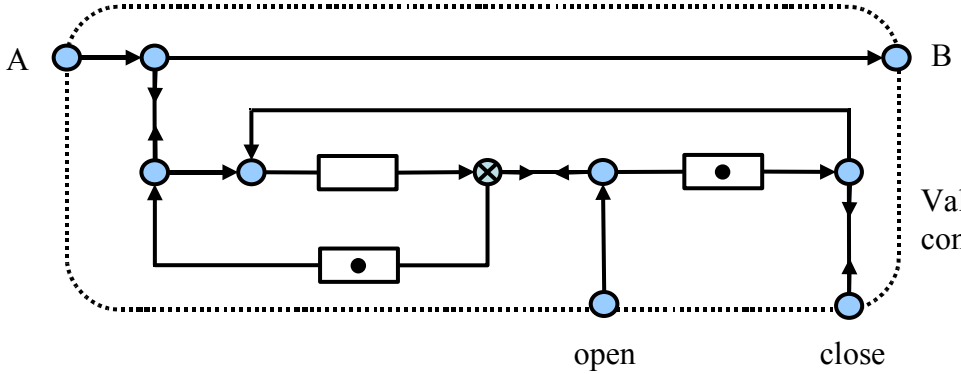


Exclusive choice (deffered XOR)



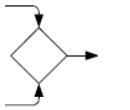
open C (close B)

Exclusive choice with priority

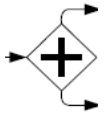


Valve connector:
controls flow from A to B

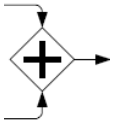
BPMN2Reo: basic gateways



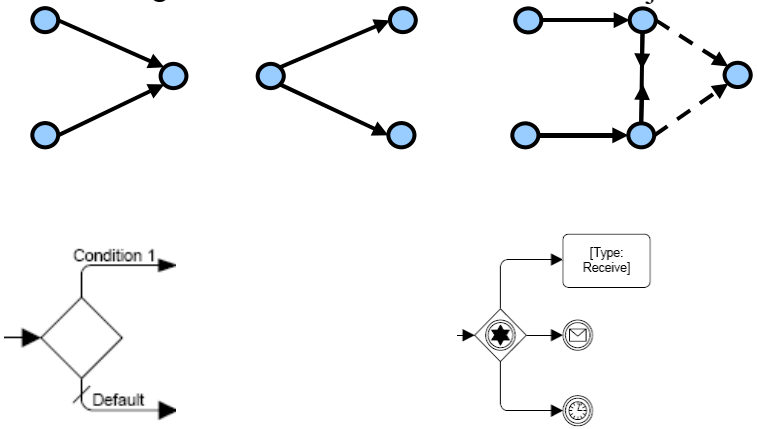
XOR merge



Parallel fork

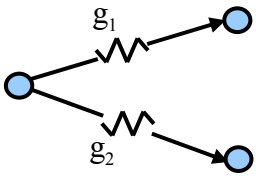


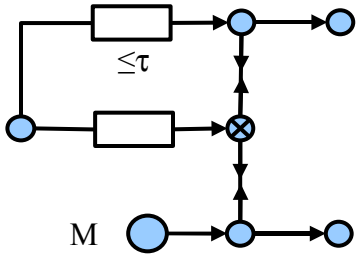
Parallel join

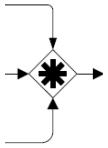


Data-based XOR decision

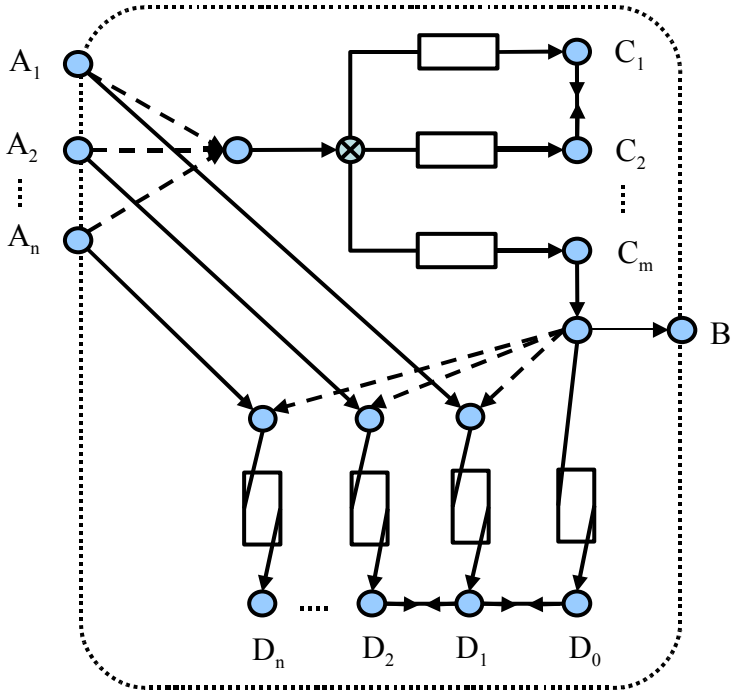
Event-based XOR decision



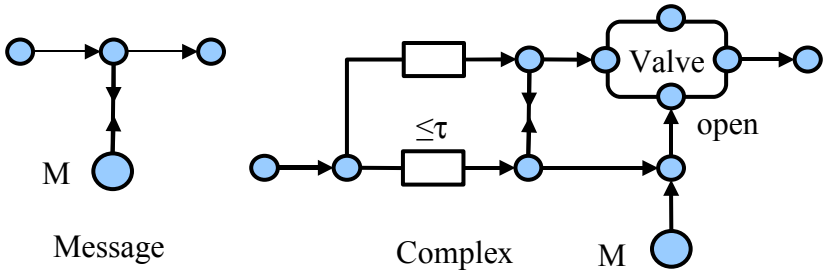


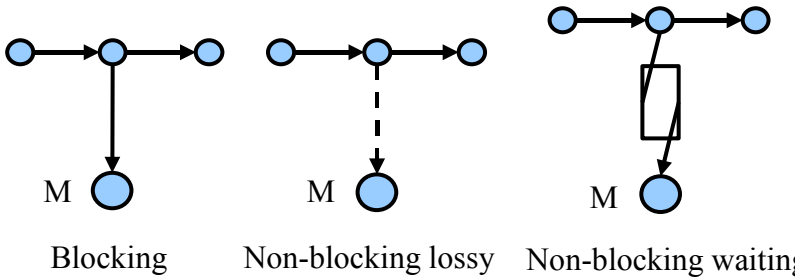


Complex Merge
(e.g., m out of n)

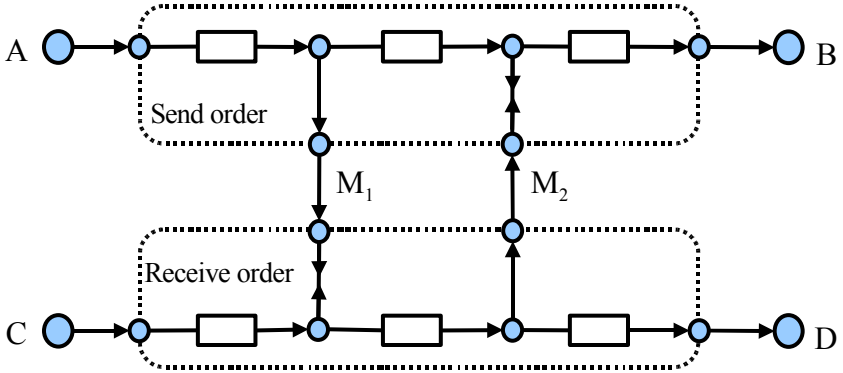


BPMN2Reo: events and messages

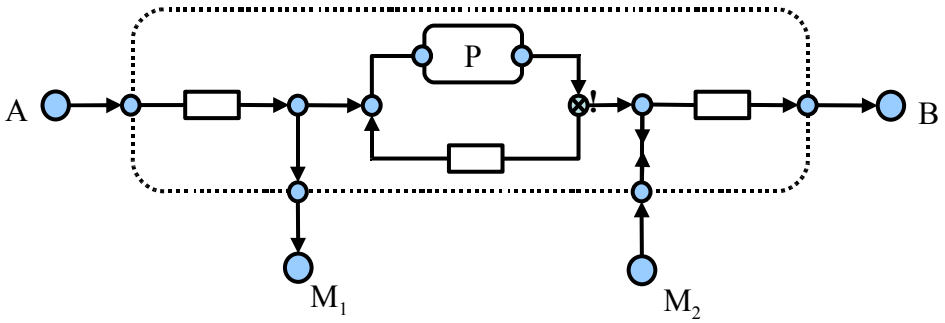




Outgoing messages

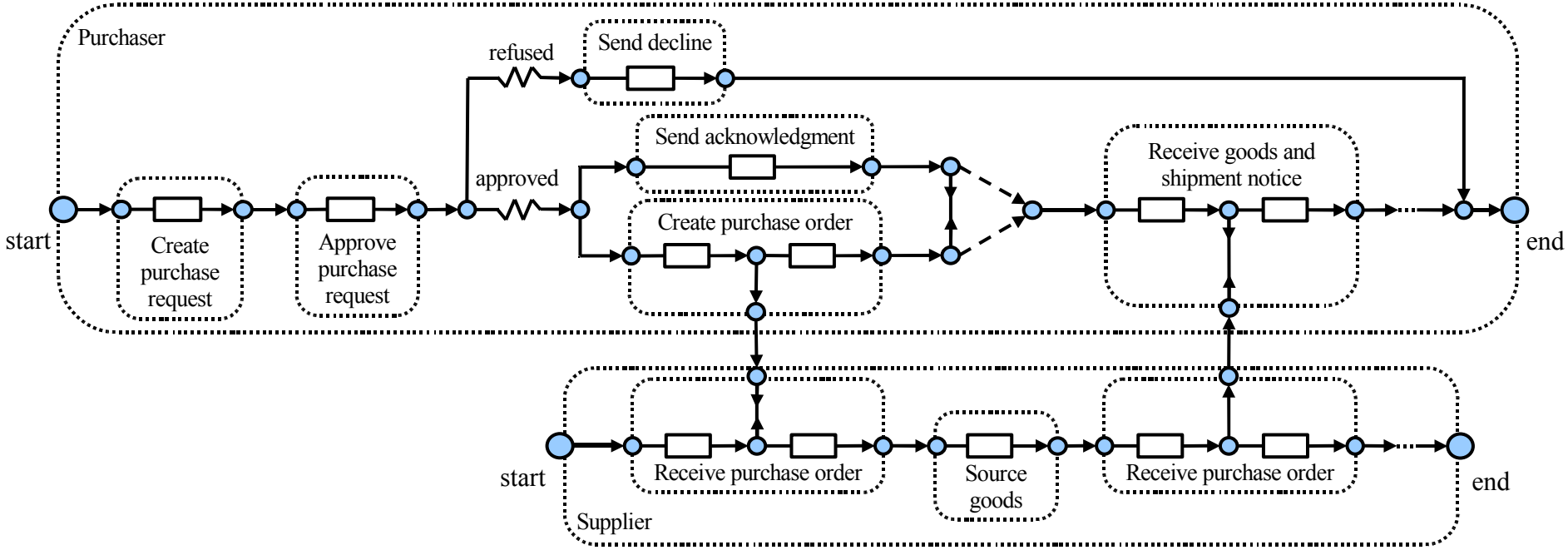


Synchronous message exchange

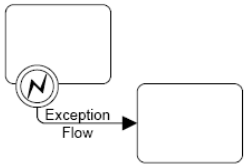


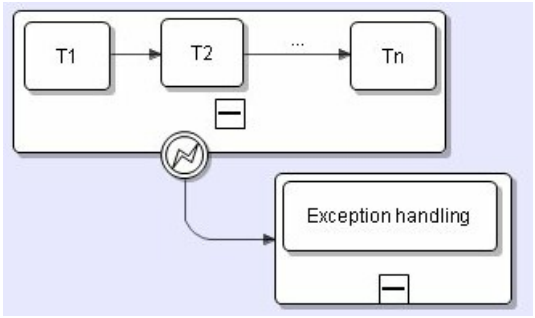
Asynchronous message exchange

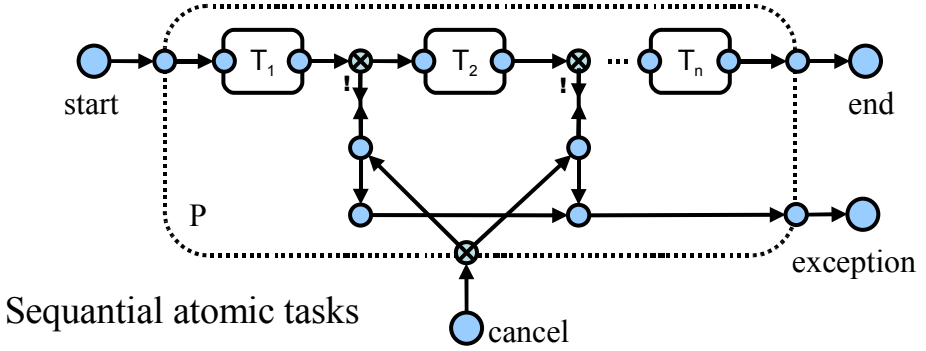
Purchase-to-pay: Reo model



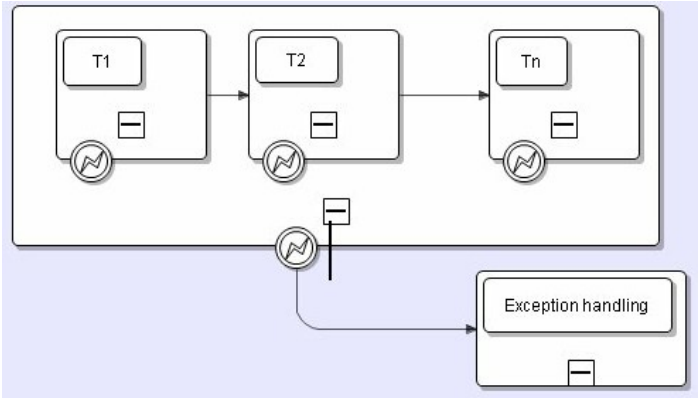
BPMN2Reo: exception handling in sequential processes

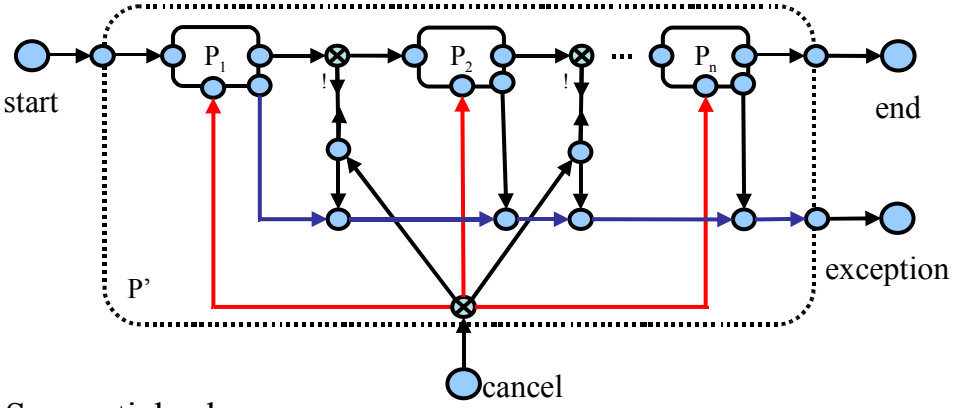






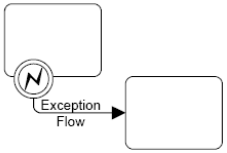
Sequantial atomic tasks

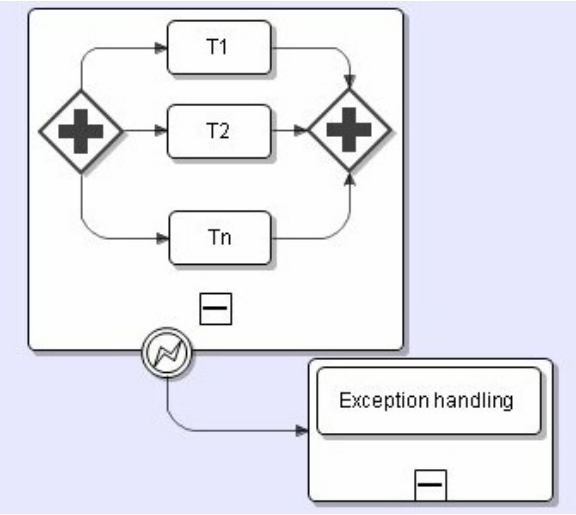




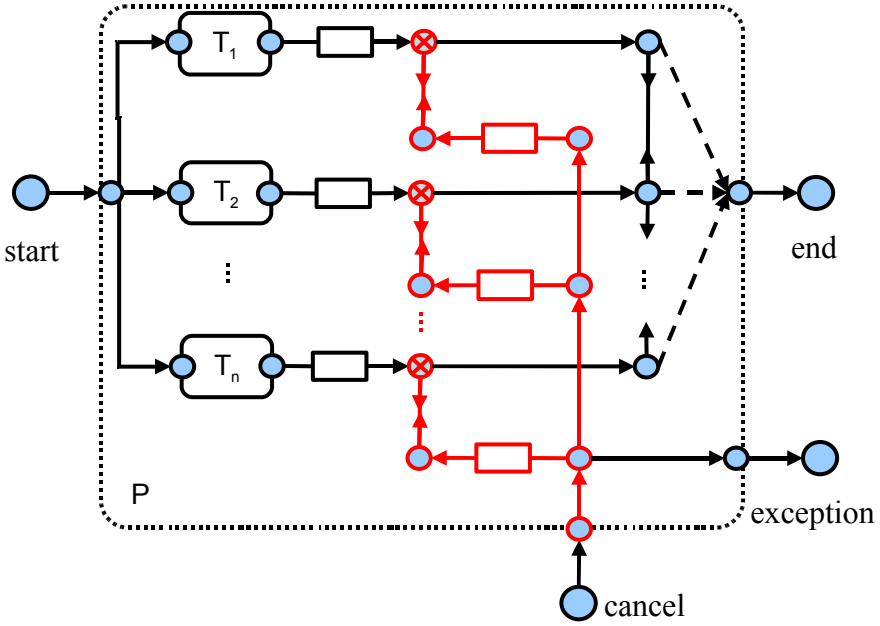
Sequantial sub-processes

BPMN2Reo: exception handling in parallel processes (1)

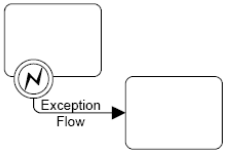




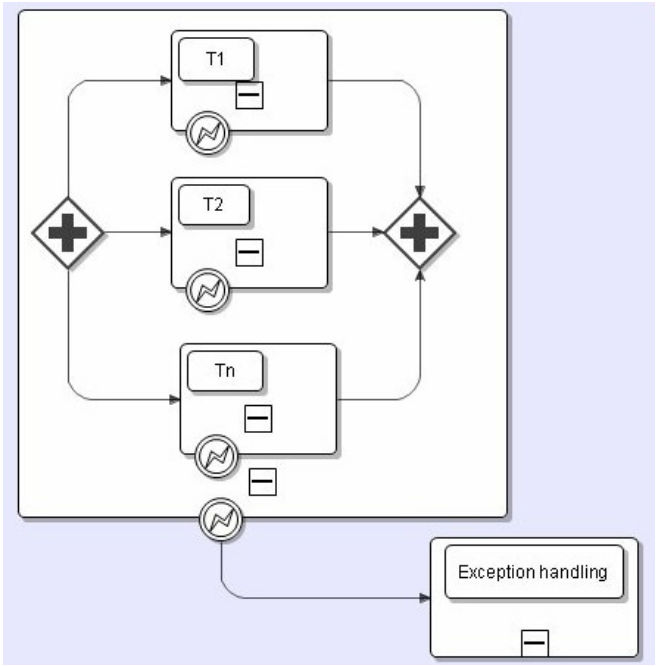
Parallel atomic tasks

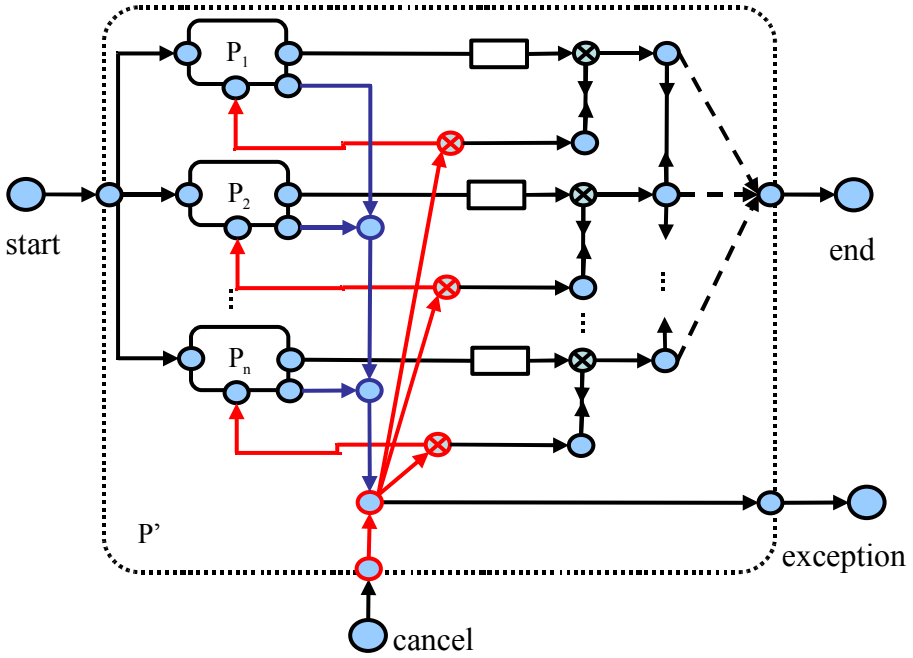


BPMN2Reo: exception handling in parallel processes (2)

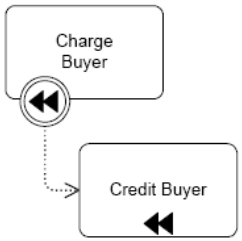


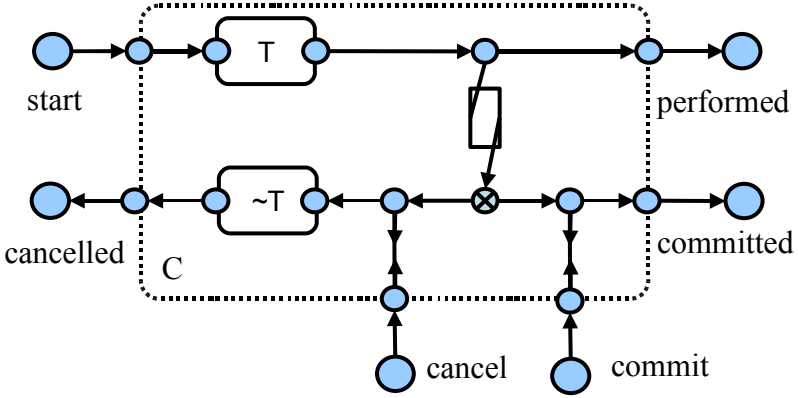
Parallel sub-processes

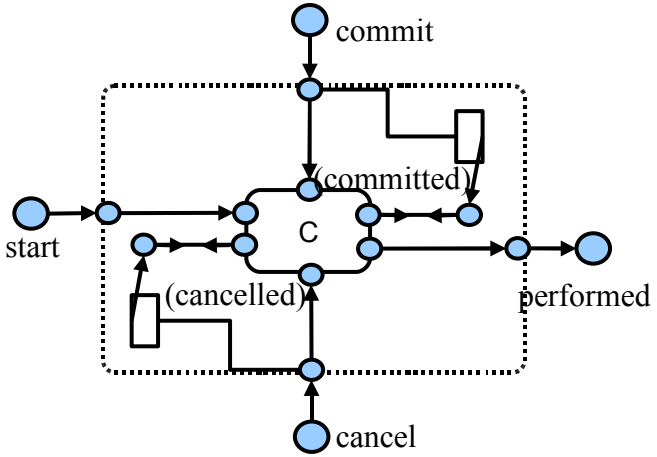


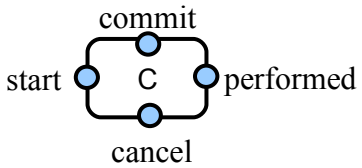


Reo2BPMN: compensation activities

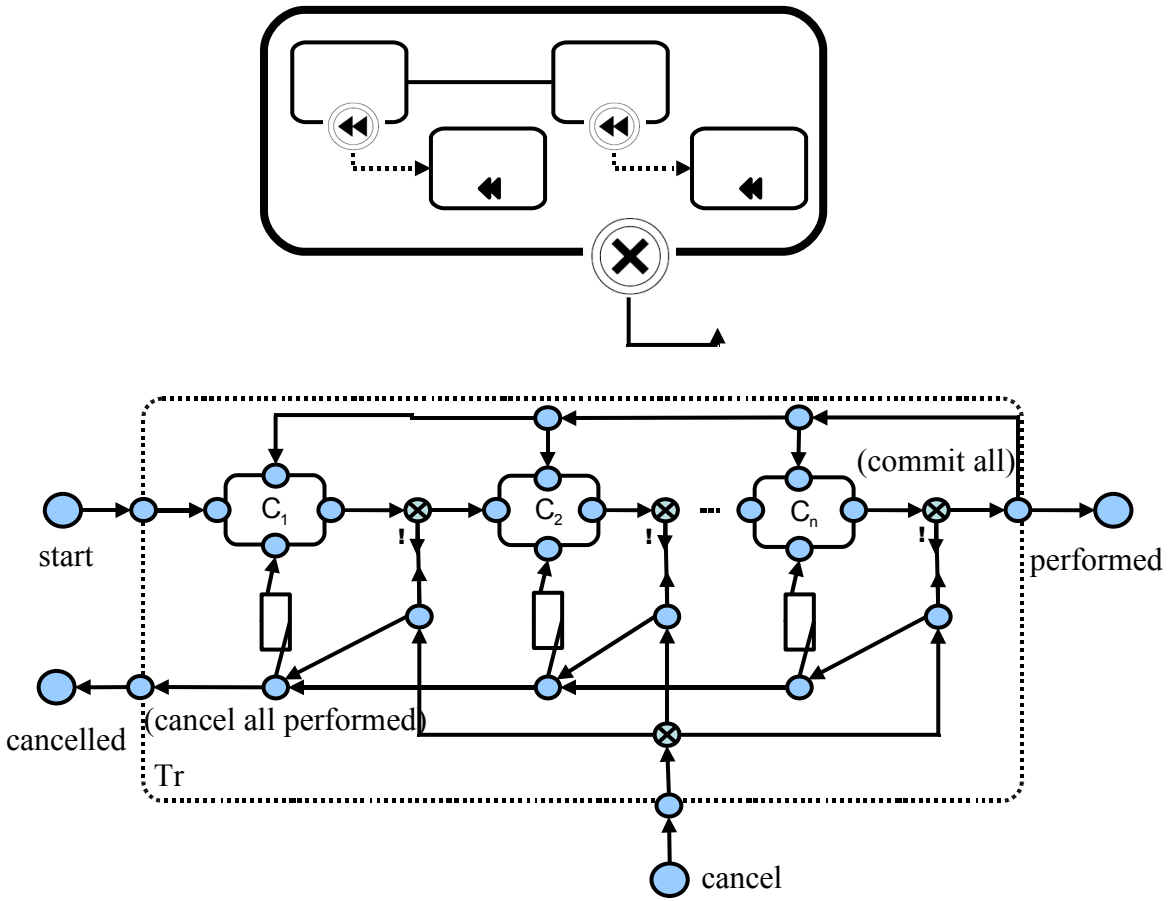




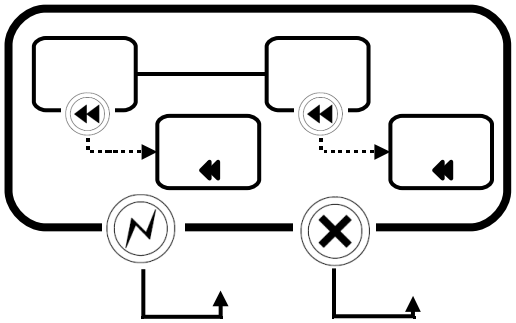


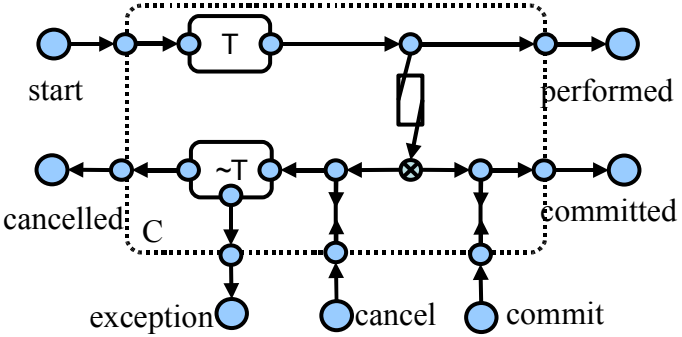


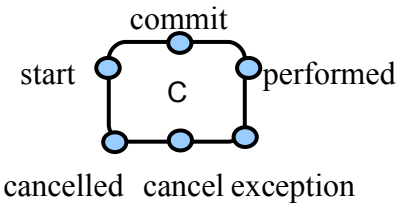
BPMN2Reo: transaction sub-processes

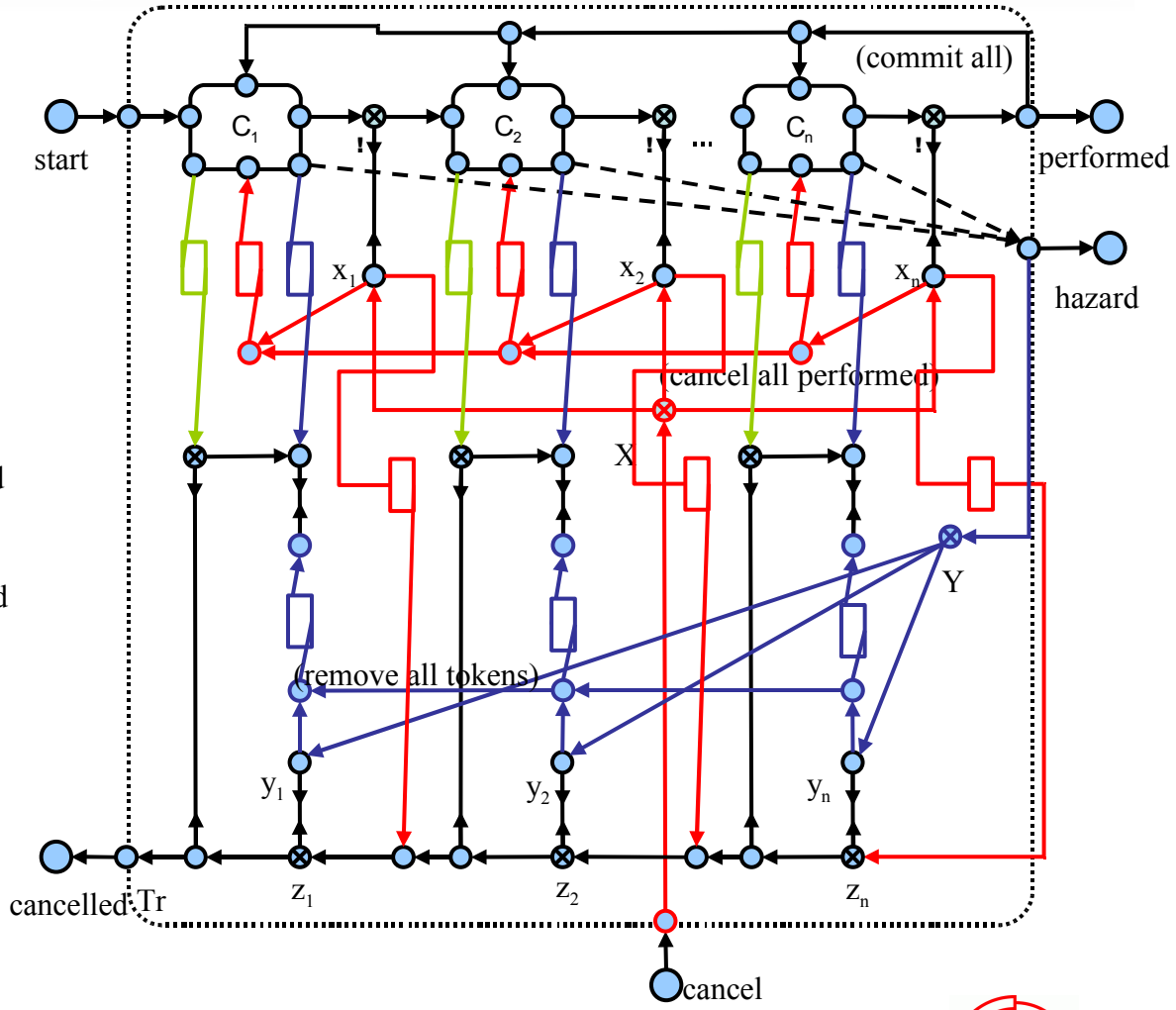


Reo2BPMN: transaction with hazard





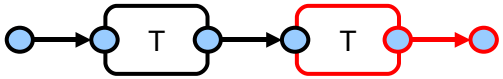




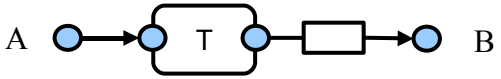
BPMN Macros

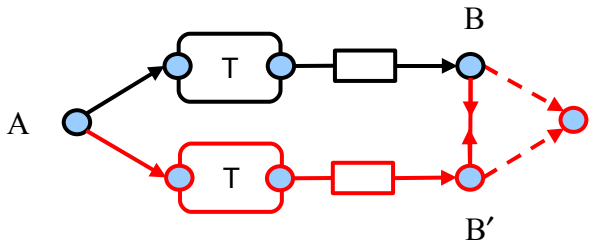
- Number of activities may depend on data flow
- Run-time reconfiguration by graph transformation

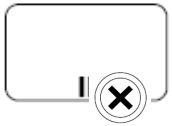
Activity looping

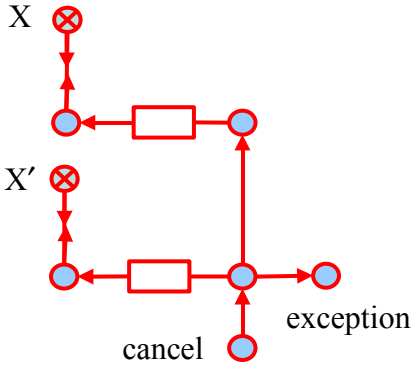


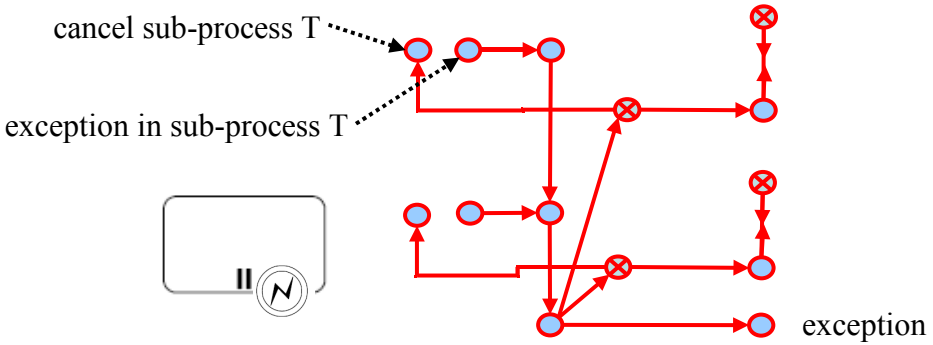
Multiple instances



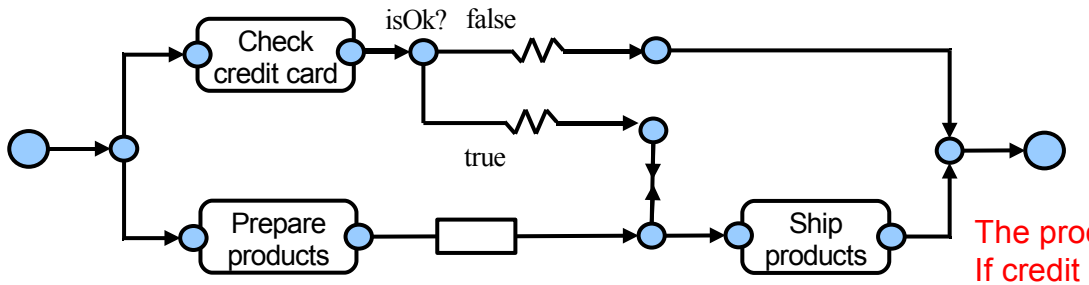






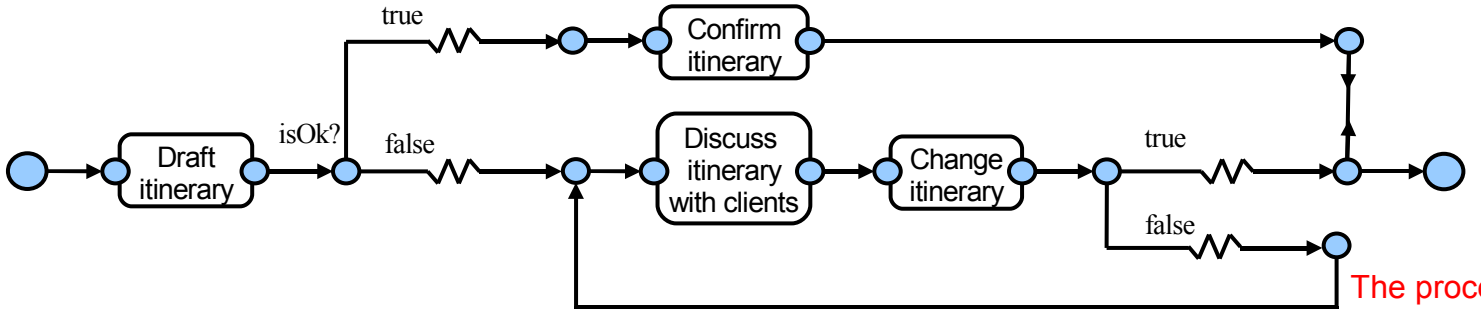


Workflow analysis

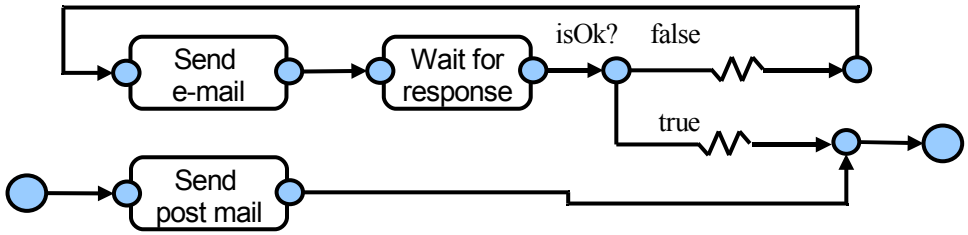


[Dijkman et al., 2008]

The process may be completed incorrectly:
If credit card checking fails the products remain prepared

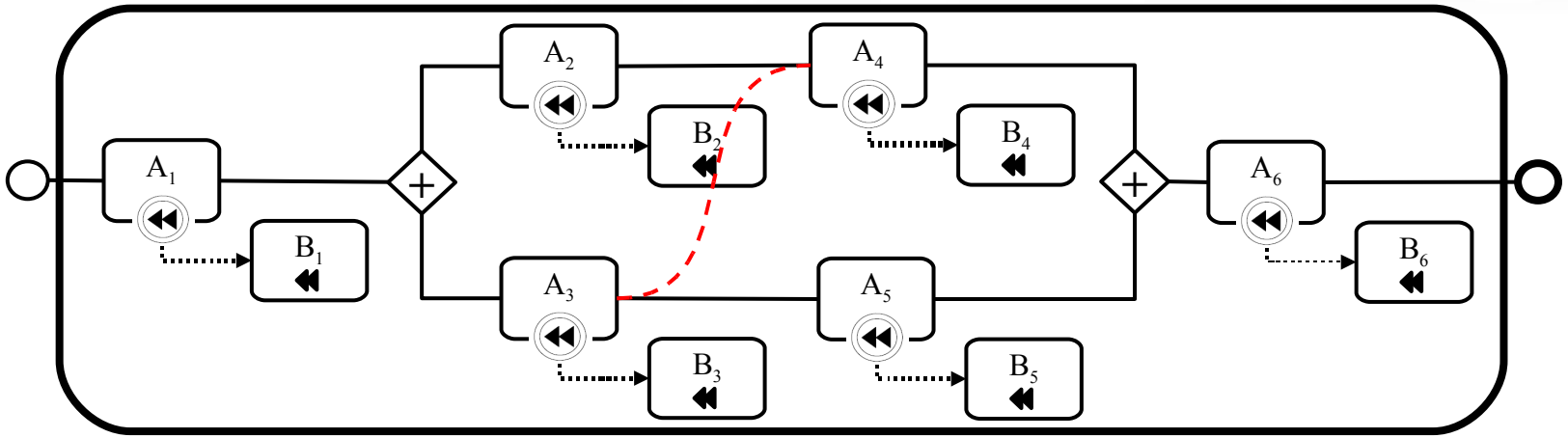


The process never completes

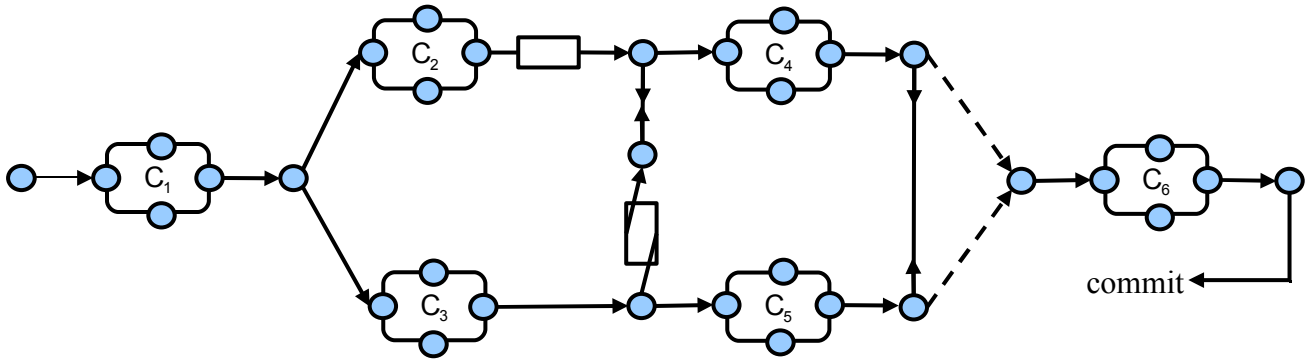


The process contains unreachable activities

Synchronization of concurrent flows



Constraint: A_4 must be executed after A_3



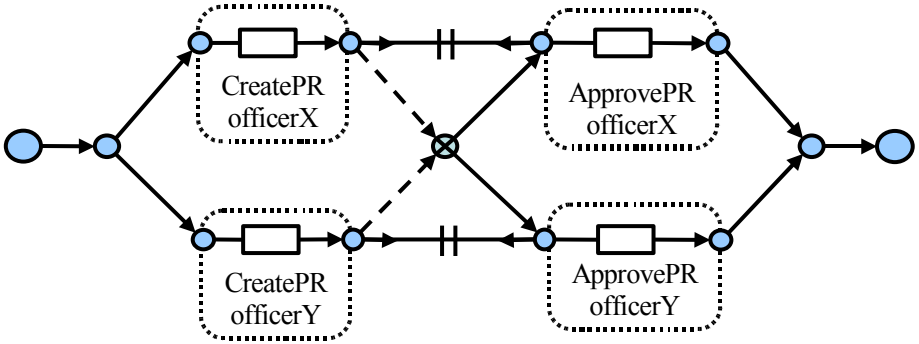
Using Reo for compliance modeling

[Sadiq et al, BPM'07]

Category	Description	Tools
Flow	Impact on BP activities and their coordination	Reo circuits, connector reconfiguration, graph transformations
Data	Constraints on data retention and transfer	Constraint automata operating on special data domains (e.g., privacy)
Resource	Controls related to the access and management of resources	Resource-sensitive CA [Meng & Arbab, FMOODS'07], Quantitative CA [Arbab et al., Coordination'07]
Time	Time constraints (activity start-ups, deadlines, durations, etc.)	Timed CA [Arbab et al., JSSM'07]

Purchase-to-pay: compliance concerns

- Creation and approval of purchase requests must be undertaken by 2 different purchase officers



1. Supplier can be charged a penalty if a customer did not receive goods within *k* days after goods shipment notice
2. Purchase requests which are not closed within *k* days should raise an allert to purchasing manager

Related work on BPMN analysis

- Dijkman, R.M., Dumas, M., Ouyang, C.: Formal semantics and analysis of BPMN process models. In: Information and Software Technology (IST). (2008)
- Wong, P., Gibbons, J.: A process semantics for BPMN. Technical report, Queensland University of Technology, http://www.comlab.ox.ac.uk/publications/publication454-abstract.html (2007)
- Wong, P., Gibbons, J.: A relative timed semantics for BPMN. Technical report, Queensland University of Technology, http://www.comlab.ox.ac.uk/publications/publication1496-abstract.html (2007)
- Egon Borger: “Semantics of business process modelling notations”, International Workshop on Algebraic Development Techniques (WADT) invited talk – Abstract State Machines (ASM)

Related work on compliance checking

- Liu, Y., Muller, S., Xu, K.: A static compliance-checking framework for business process models, pp. 335-361
- Governatori, G., Milosevic, Z., Sadiq, S.: Compliance checking between business processes and business contracts. In: Proc. of the Int. Enterprize Distributed Object Computing Conf. (EDOC'06), IEEE Computer Society (2006) 221-232
- Giblin, C., Liu, A.Y., Mauller, S., Pitzmann, B., Zhou, X.: Regulations expressed as logical models (REALM). In: Proc. of the Conf. on Legal Knowledge and Information Systems. (2005) 37-48
- Ghose, A.K., Koliadis, G.: Auditing business process compliance. In: Proc. of the Int. Conf. on Service-Oriented Architectures (ICSOC'07). Volume 4749 of LNCS., Springer (2007) 169-180
- Awad, A., Decker, D. and Weske, M.: Efficient Compliance Checking using BPMN-Q and Temporal Logic, Proceedings of the International Conference on Business Process Modeling (BPM'08), to appear
- Many works dedicated to particular areas as privacy, trust, security, QoS
- Brandt, C., Engel, T., Braatz, B., Hermann, F., Ehrig, H.: An approach using formally well-founded domain languages for secure coarse-grained IT system modelling in a real-world banking scenario. In: Proc. of the Australasian Conf. on Information Systems (ACIS'07). (2007) 386-395
  - ISO 27001:2005, ISO 27002:2007, SOX, CobiT (e.g., firewall placement and secure connection)

Related work on transaction modelling

- M. Butler, C. Ferreira: “An Operational Semantics for StAC, a Language for Modelling Long-Running Business Transactions”, Coordination Models and Languages, volume 2949 of LNCS, Springer 2004, pp. 87-104.
- R.Bruni, H. Melgratti, U. Montanari: “Theoretical foundations for compensations in flow composition languages”, Proceedings of the ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages, ACM Press, 2005, pp. 209-220.
- M. Butler, T. Hoare, C. Ferreira: “A Trace Semantics for Long-Running Transactions”, Communicating Sequential Processes, volume 3525 of LNCS, Springer, 2005, pp. 133-150.
- R. Bruni, M. J. Butler, C. Ferreira, C. A. R. Hoare, H. C. Melgratti and U. Montanari: “Comparing Two Approaches to Compensable Flow Composition”, Concurrency Theory, volume 3653 of LNCS, Springer 2005, pp. 383-397.
- Zongyan Qiu, Shuling Wang, Geguang Pu and Xiangpeng Zhao: “Semantics of BPEL4WS-Like Fault and Compensation Handling”, Proceedings of the International Symposium of Formal Methods, volume 3582 of LNCS, Springer 2005, pp. 350-365.

Conclusions

- Reo can be used as a language for business process modeling
  - Expressive
    - Capable of expressing complex BPMN constructs
    - There exists a repository of Reo workflow patterns
  - Compositional
    - The structure of BPMN diagrams is preserved – important for manual process refinement
- Reo mathematical abstractions can be useful for compliance-aware process development
  - Time-, data-, resources-, QoS-related constraints

Future work

- Implementation
  - Converters from graphical models to Reo/CA and from Reo/CA to executable models (EMF/BPEL/Java)
- Languages for expressing compliance concerns
  - Expressiveness (e.g., must deal with time constraints, parameterized roles, permissions/obligations/violations)
  - Formal reasoning
- Transaction modeling
  - Various compensation strategies
    - compensation activity ordering,
    - compensation in tricky patterns such as discriminator,
    - definition of compensation scope,
    - nested transactions, etc.
  - Selective/alternative compensation (e.g., some activities must be compensated while others may remain uncompensated depending on the nature of the exception)
  - Exception handling (failures of compensation activities, default exception handlers, etc.)