Collaborative Service-Based Processes, a Formal Methods Perspective

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IWAISE'14, November 11, 2014

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Joint work with Jörg Desel, Samir Tata and Hanen Ochi

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Outline

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Abstraction and Verification of Collaborative Service-Based Processes

- **Service-Based Process (SbP)**: A series of logically related activities or tasks (services) performed together in order to accomplish a specific organizational goal.

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- **Service-Based Process (SbP)**: A series of logically related activities or tasks (services) performed together in order to accomplish a specific organizational goal.
- **Collaborative Service-Based Process (CSbP)**: Collaboration of several local SbP designed seperately

CSbP: Caracteristics and requirements

- Relatively simple models
- Loosely coupled (in general)
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What is the right abstraction?

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What is the right abstraction?

- Sufficiently detailed for potential partners
- Hides the local organisation/structure (privacy)
- Suitable for checking the correction of the CSbP

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Event-Based SOG

Phd Thesis Kais Klai 2003, S. Haddad, J-M. Ilié and K. Klai ATVA'04

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Principle: Compute a reduced abstraction of the state space

- Event based $LTL \setminus X$ formula
- Observed events: events occurring in the formula (Obs)
  - $\mathsf{G}(a \implies \mathsf{F}\ b) \longrightarrow \text{Obs}=\{a, b\}$

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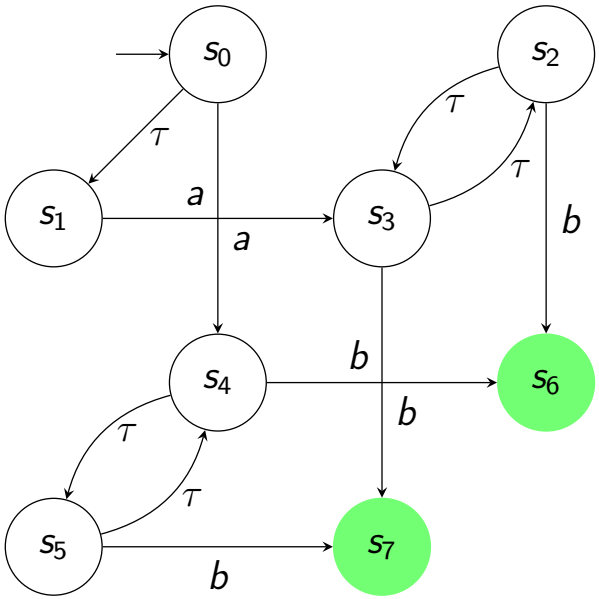
SOG

- Hybrid Graph
  - Nodes (aggregates): sets of explicit states
    - Symbolic encoding (BDDs)
    - Symbolic algorithms (deadlock, livelock)
  - Edges: labelled by observed events

Event-Based SOG

Phd Thesis Kais Klai 2003, S. Haddad, J-M. Ilié and K. Klai ATVA'04

a LTS



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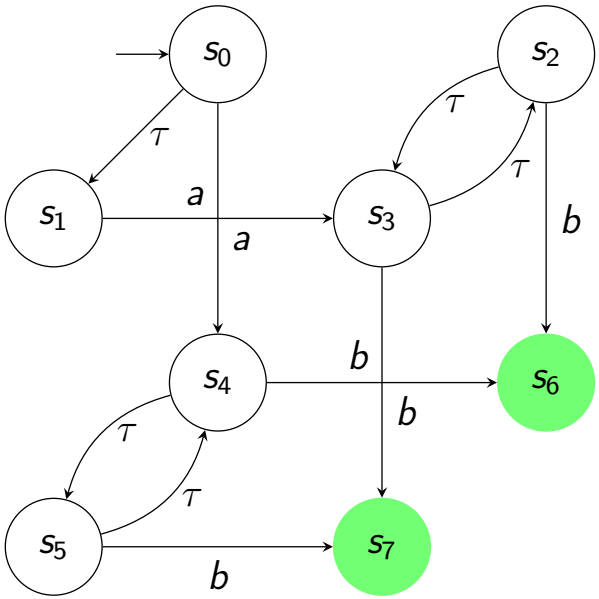

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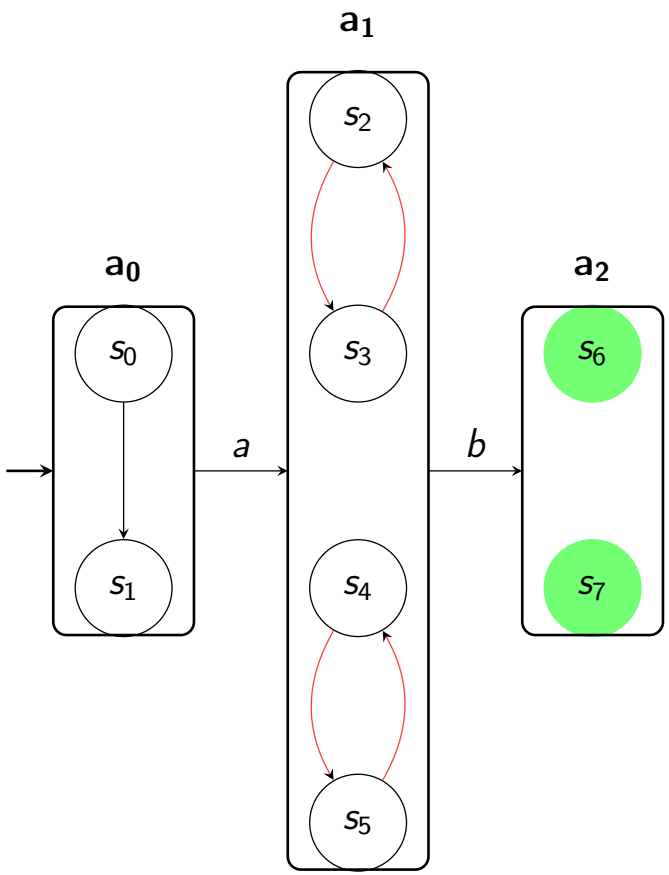

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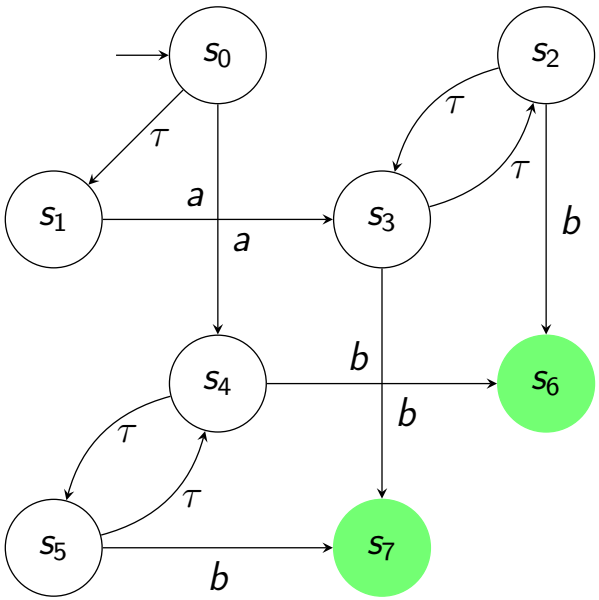

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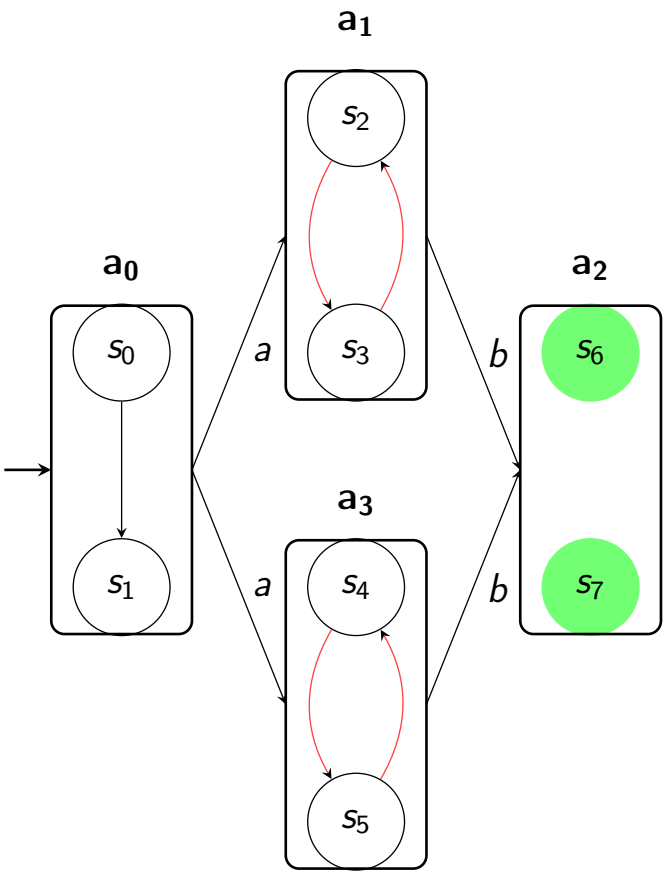

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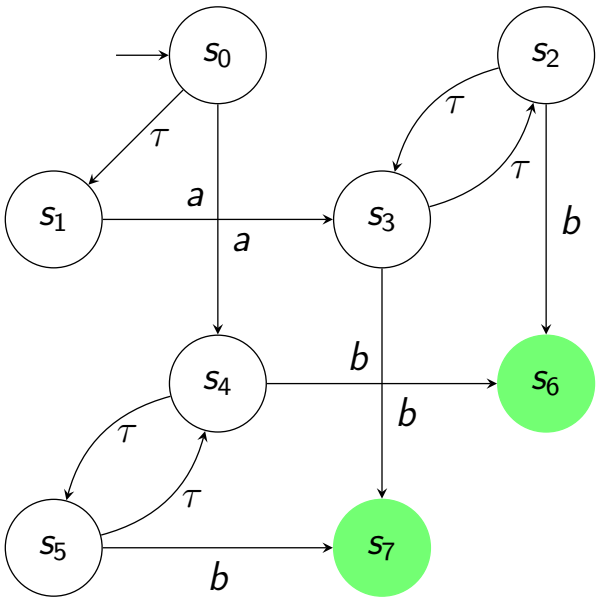

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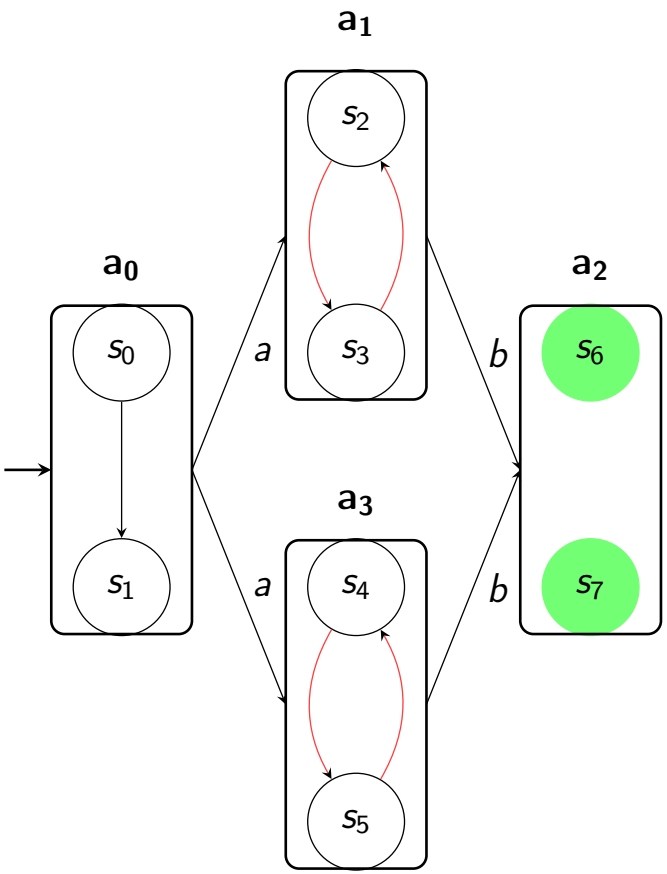

Observe collaborative actions and hide local ones

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Approach

Bottom-Up approach [K. Klai, S. Tata and J. Desel BPM'09-DKE'11]

The composite model is unavailable

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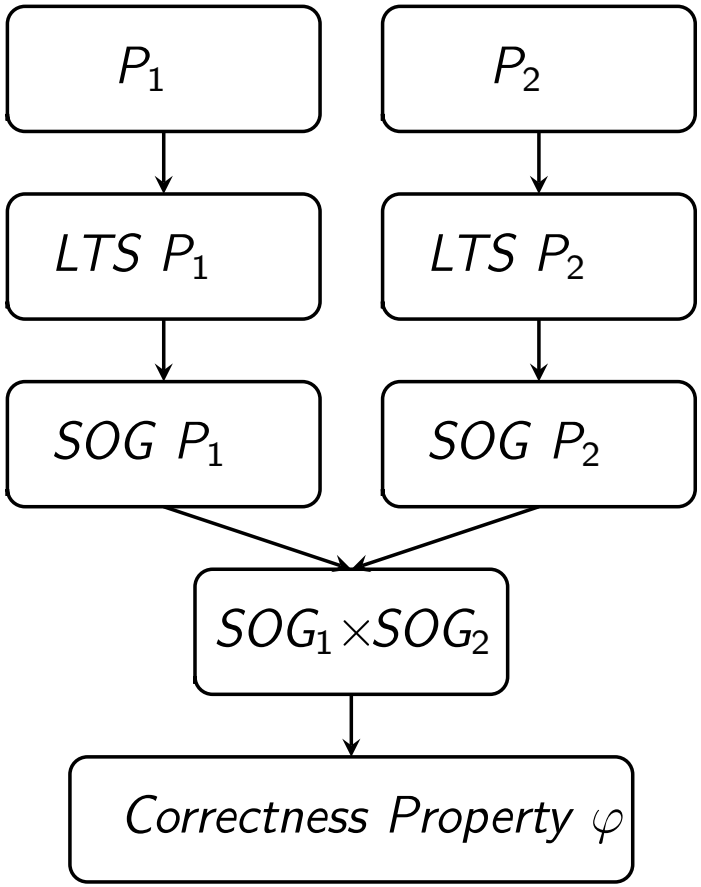

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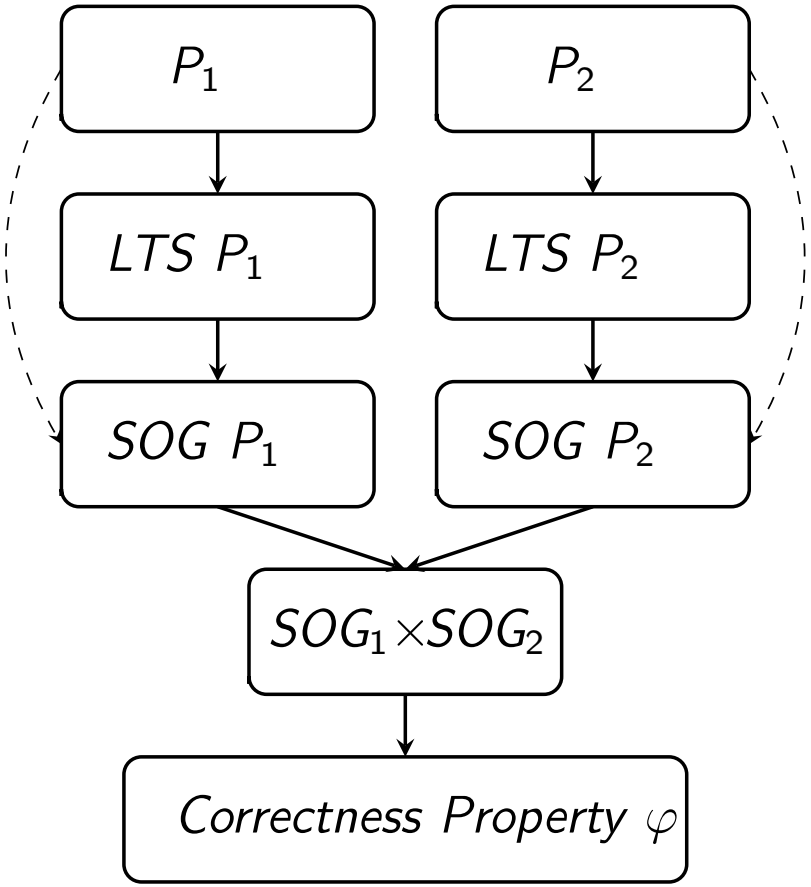

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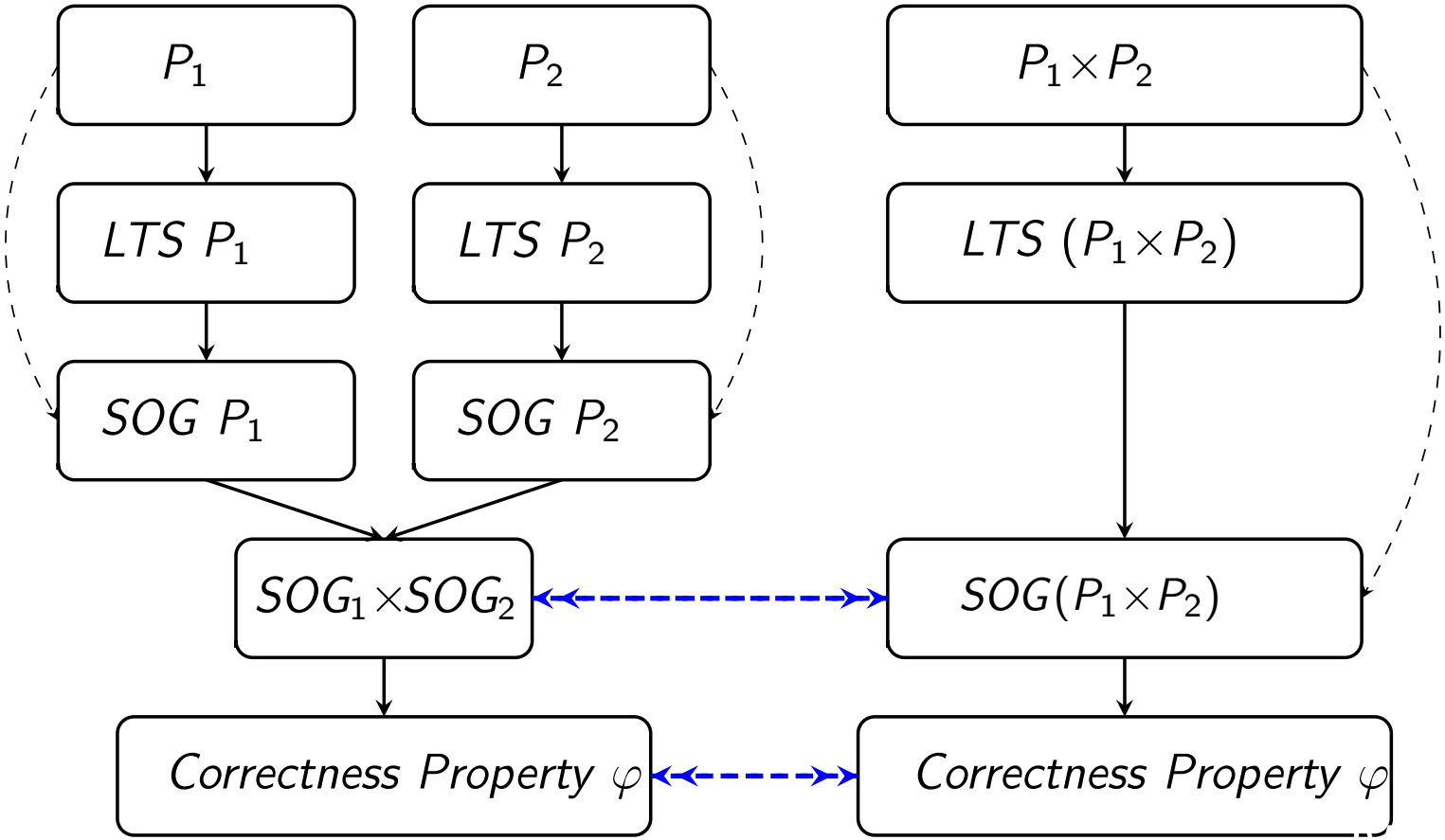

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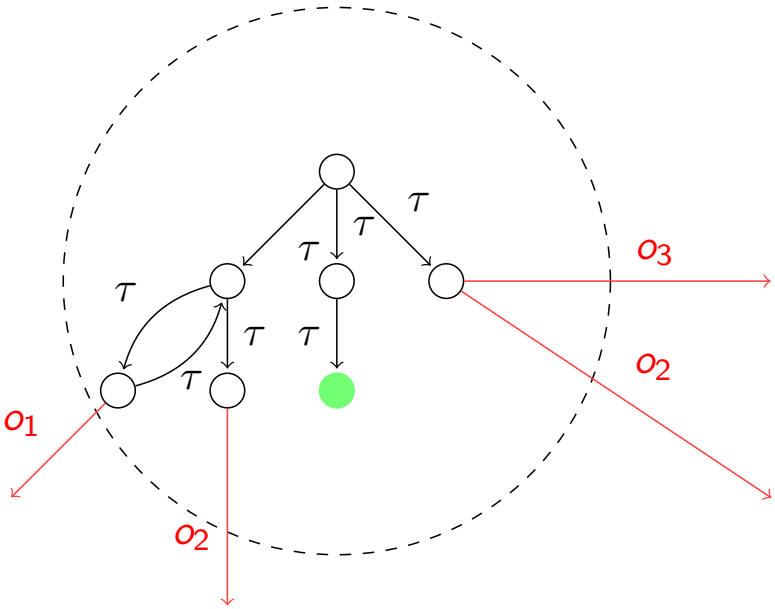
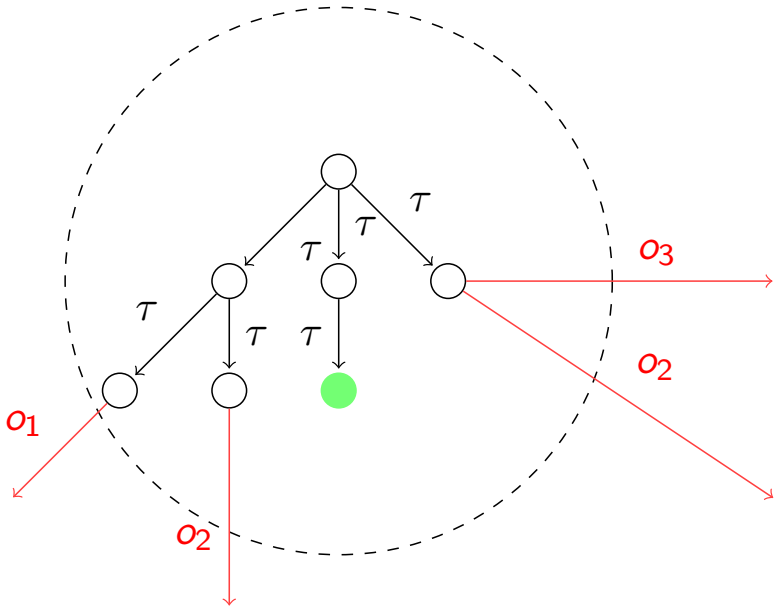
Composition of SOGs: Deadlock freeness property





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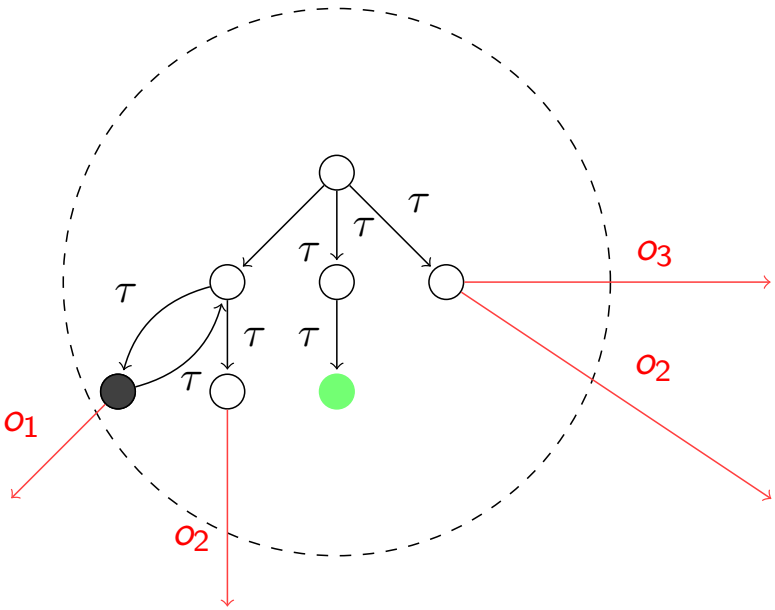
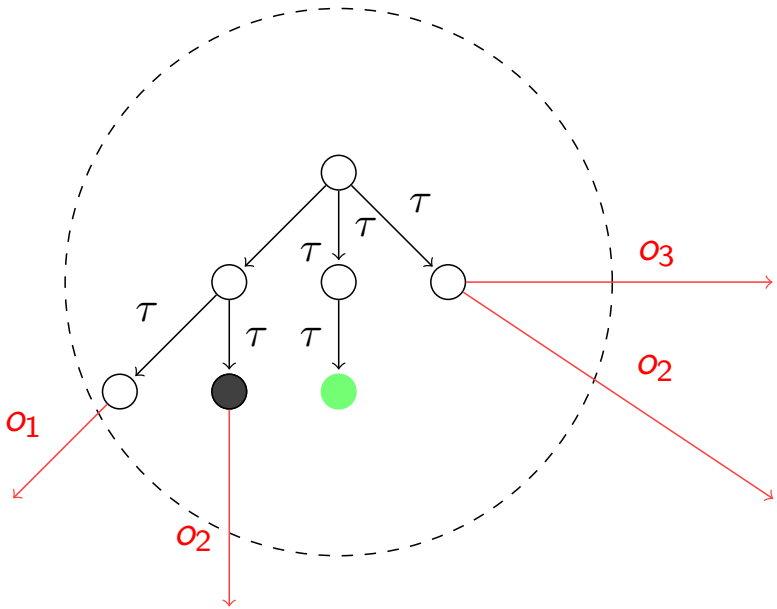
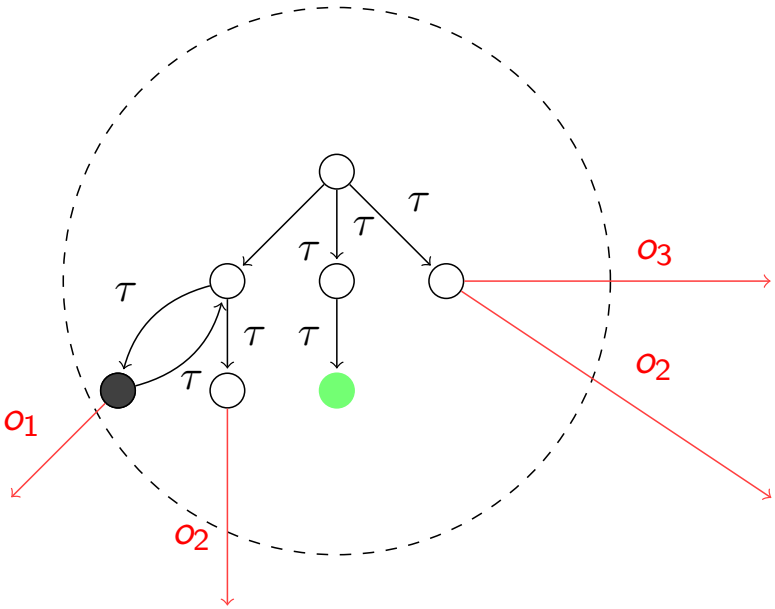


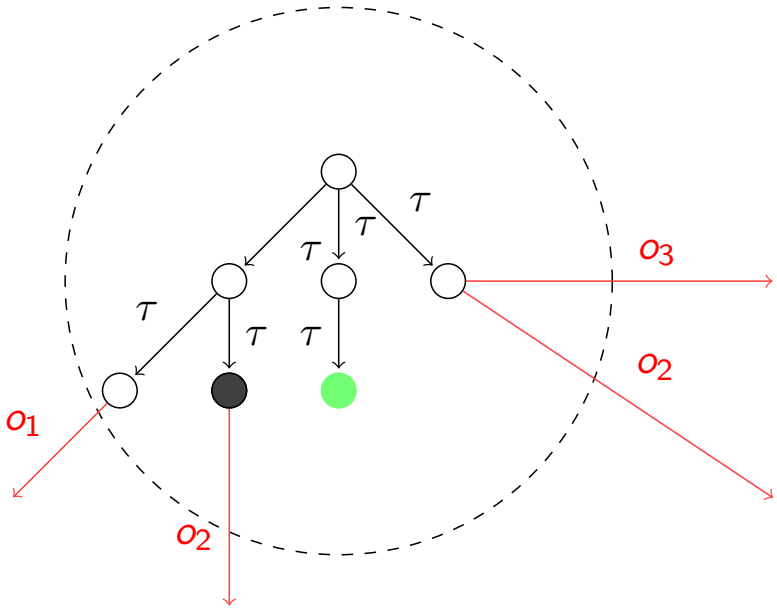


- Interlock: Deadlock caused by the interaction

Composition of SOGs: Deadlock freeness property



$\lambda(a_1) : \{\{o_1\}, \{o_2\}, \{term\}\}$

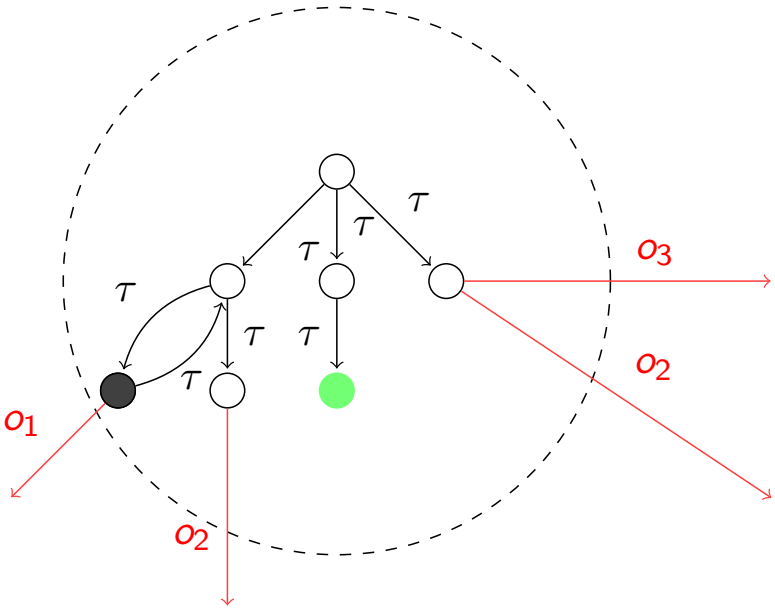


$\lambda(a_2) : \{\{o_1\}, \{o_2\}, \{term\}\}$

- Interlock: Deadlock caused by the interaction

Composition of SOGs: Deadlock freeness property

- $a = \langle a_1, a_2 \rangle$: $\lambda(a)$ obtained from $\lambda(a_1)$ and $\lambda(a_2)$



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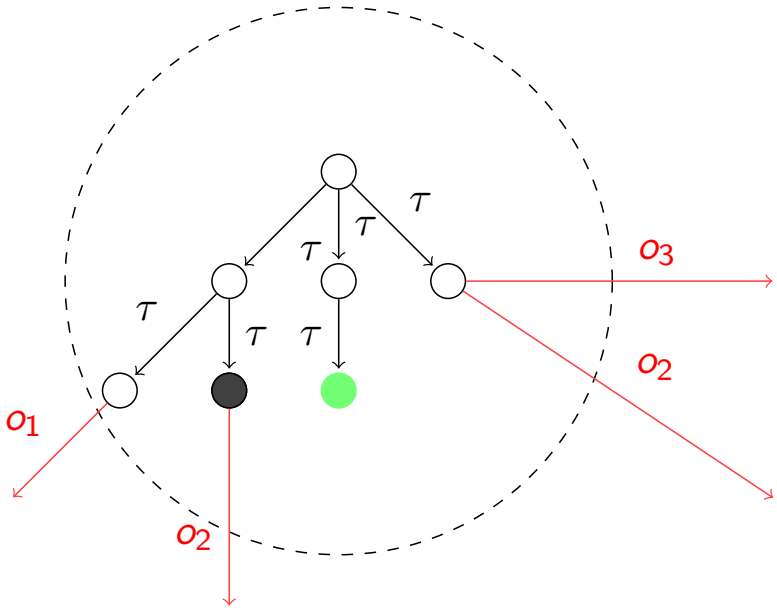

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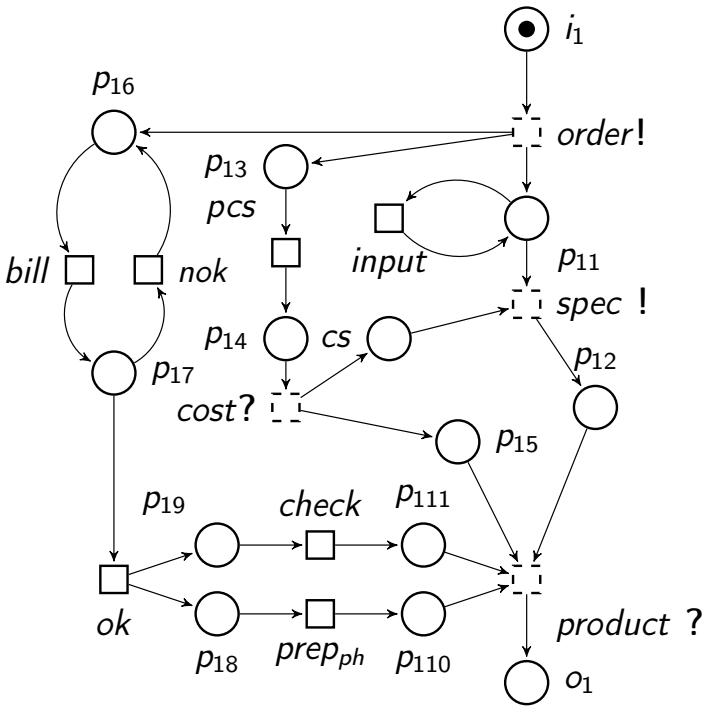
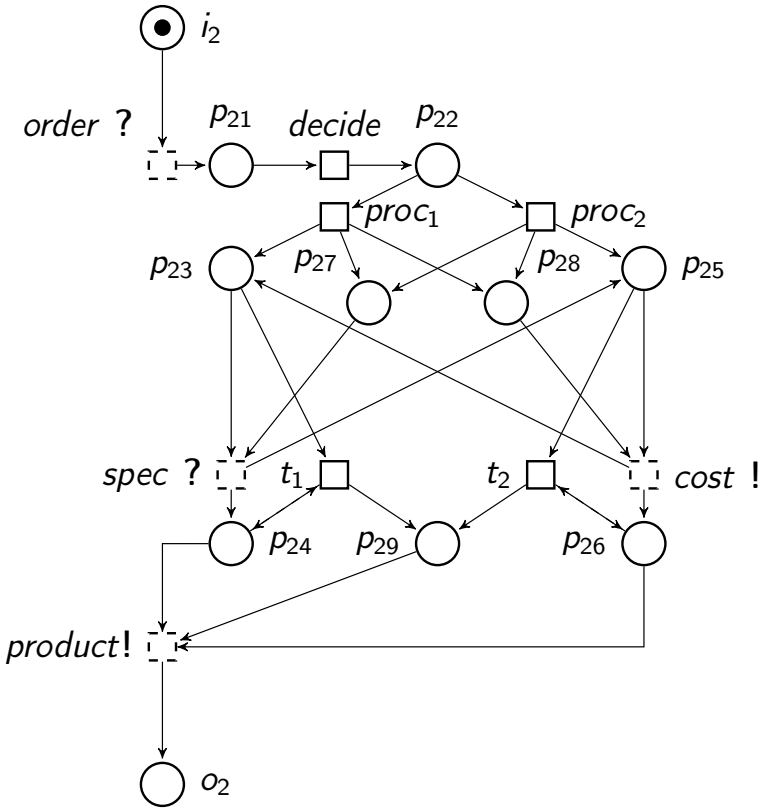
From BP models to Petri nets

WF-nets [Van Der Aalst 98]

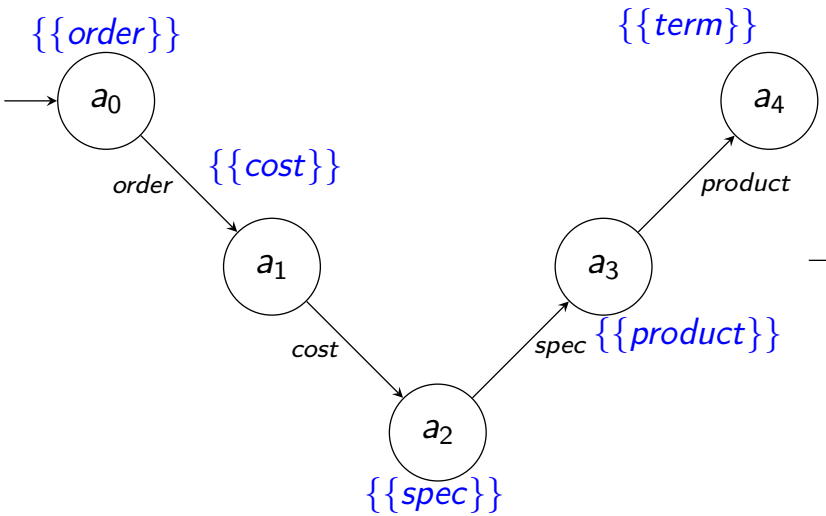


WF-net contractor

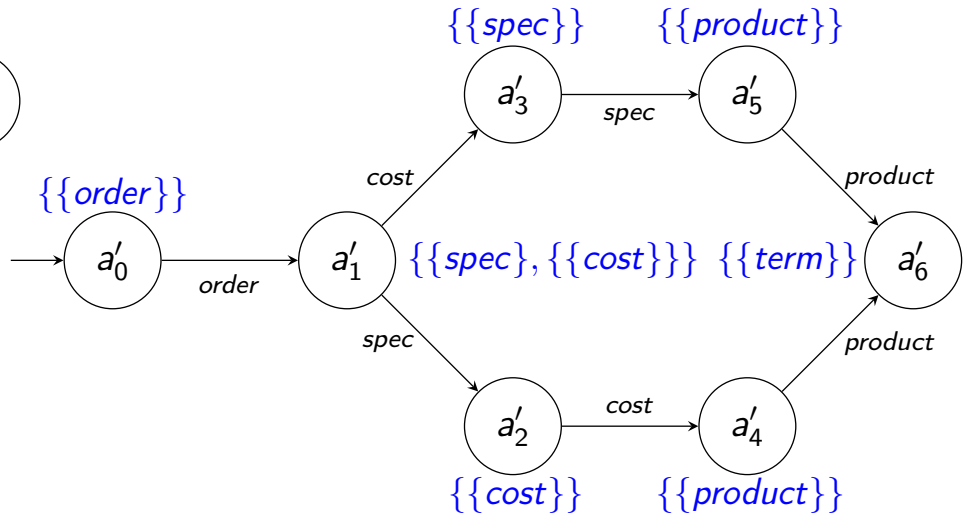


WF-net sub-contractor

Event-Based SOGs: Example



SOG contractor



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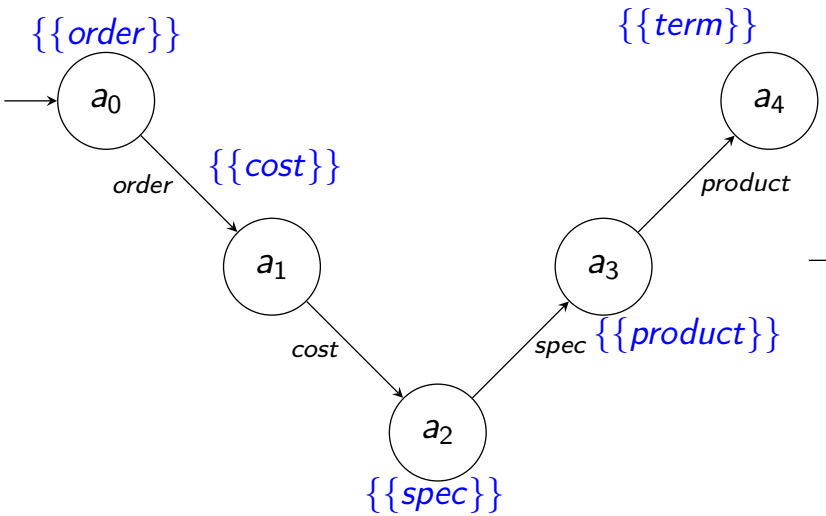
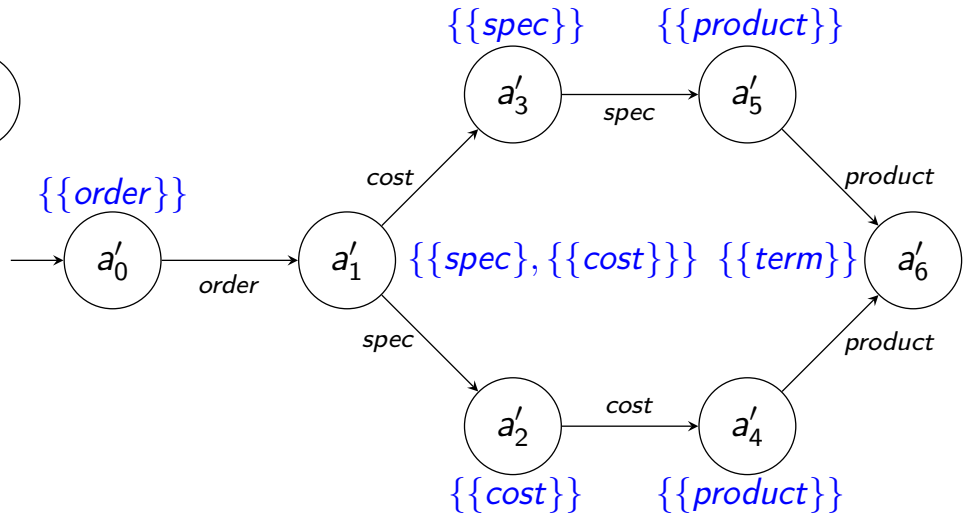
Event-Based SOGs: Example

explicit size: 38/104



SOG contractor

explicit size: 14/22



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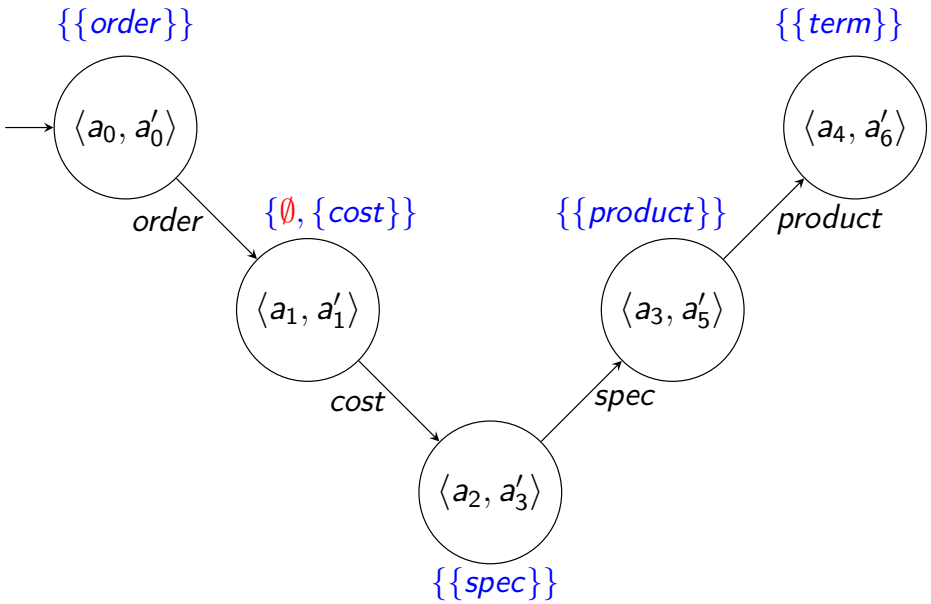
Synchronous Composition



Synchronous SOGs product

Synchronous Composition

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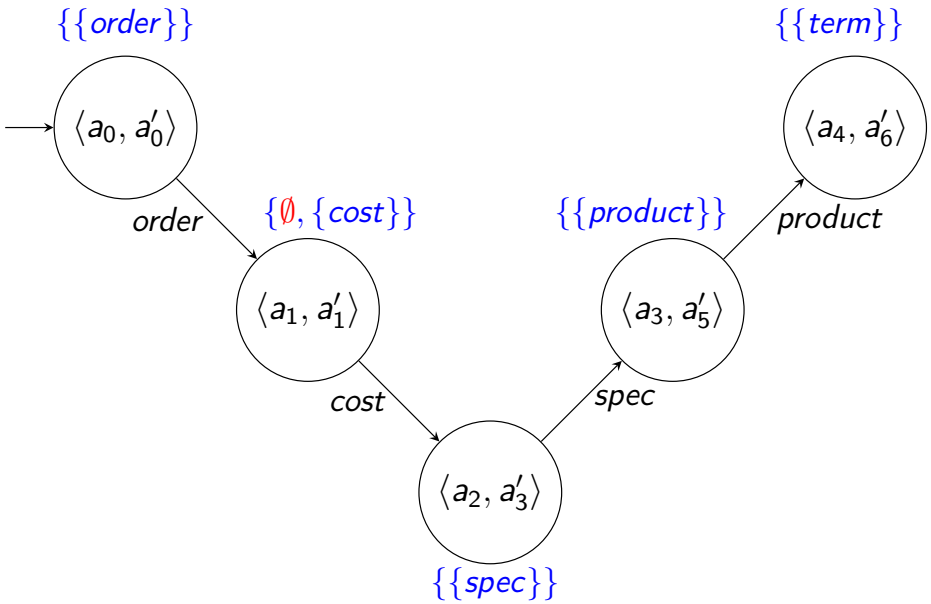

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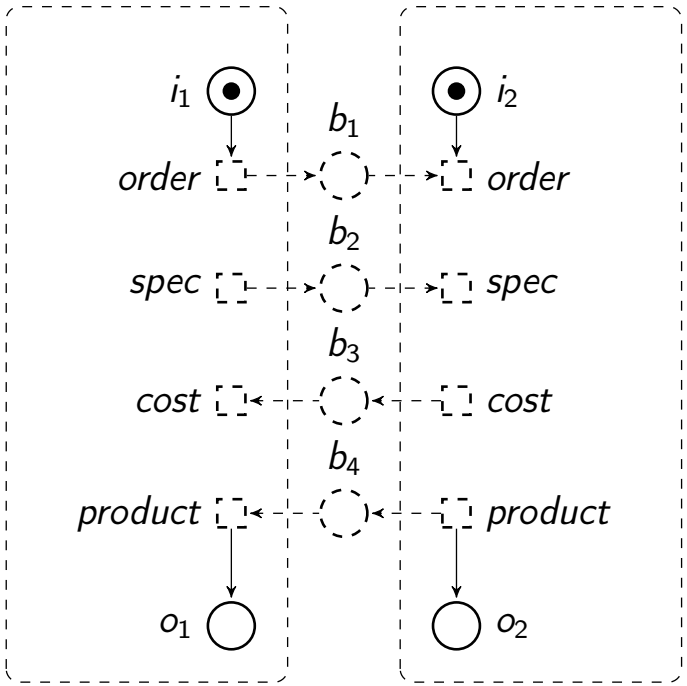
Interface medium



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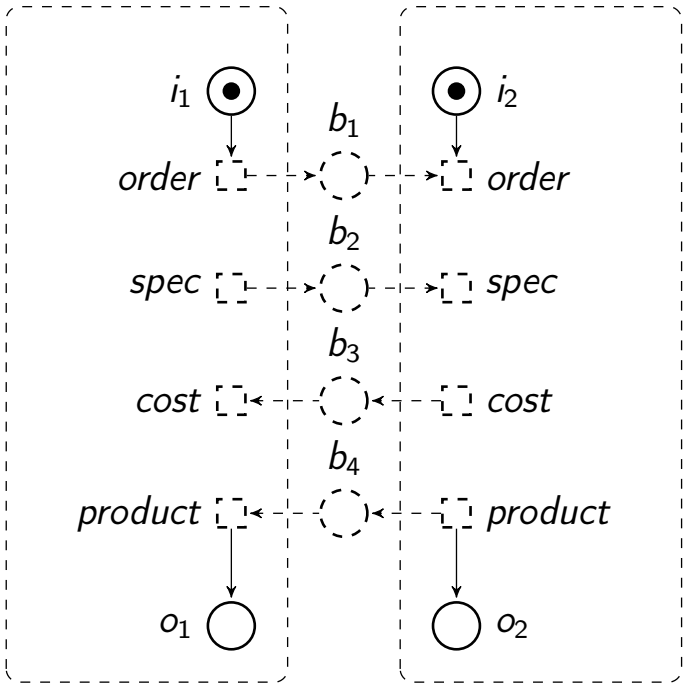
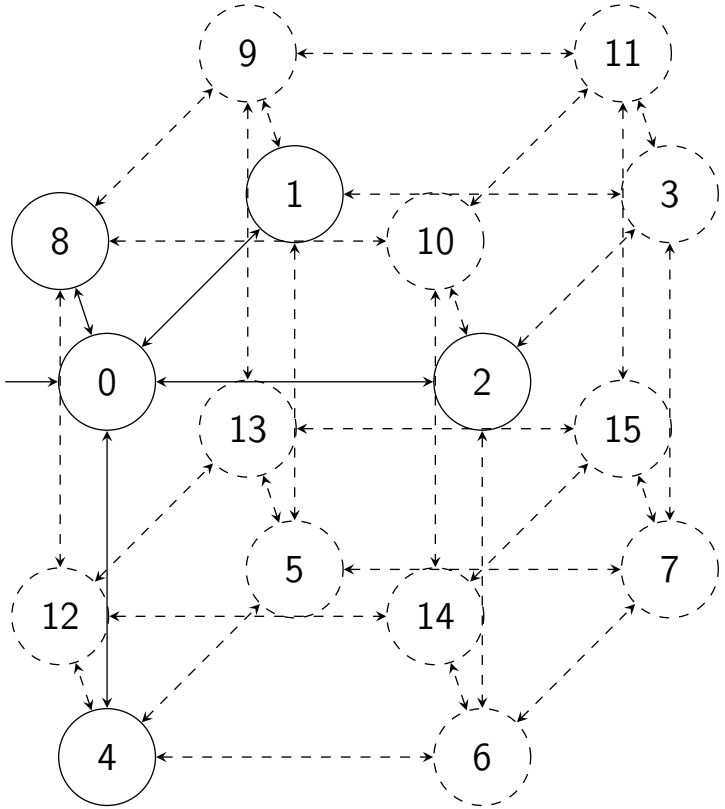


Interface Graph



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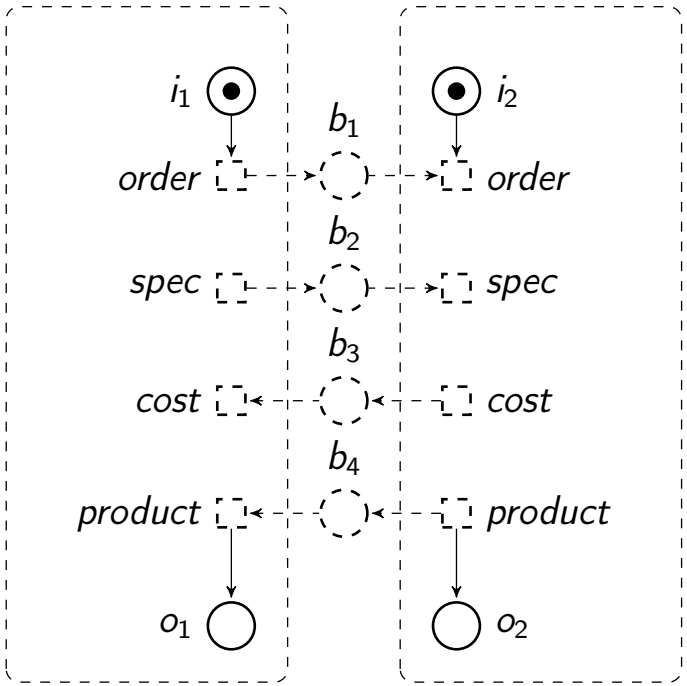

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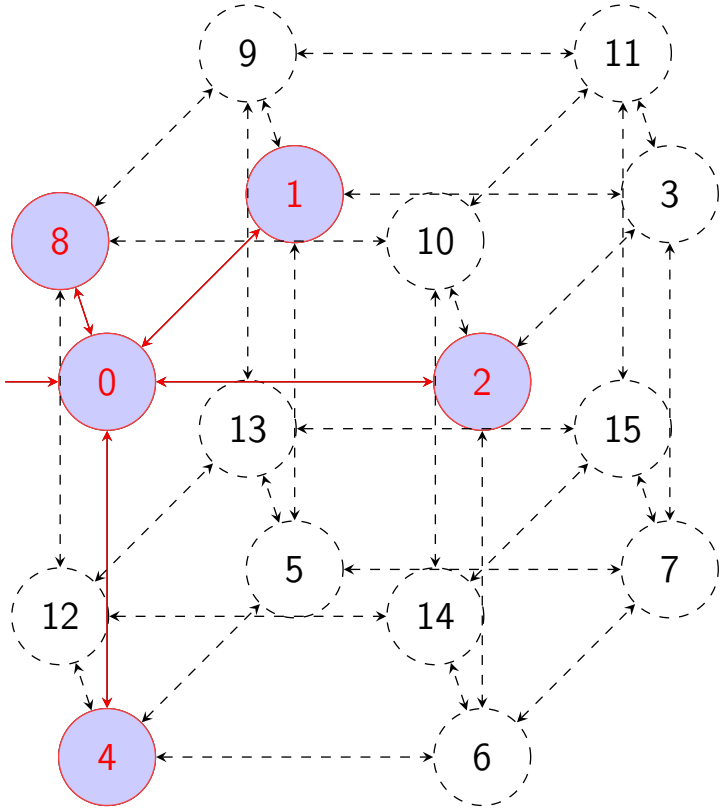

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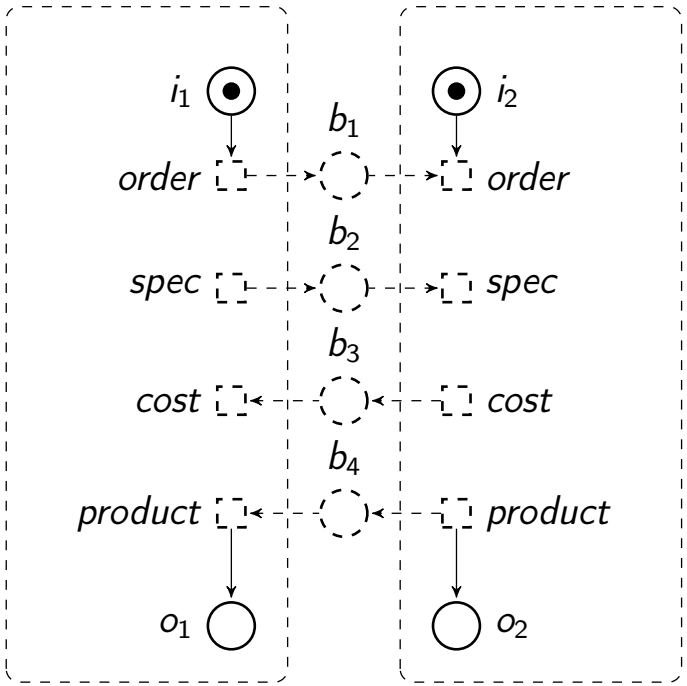

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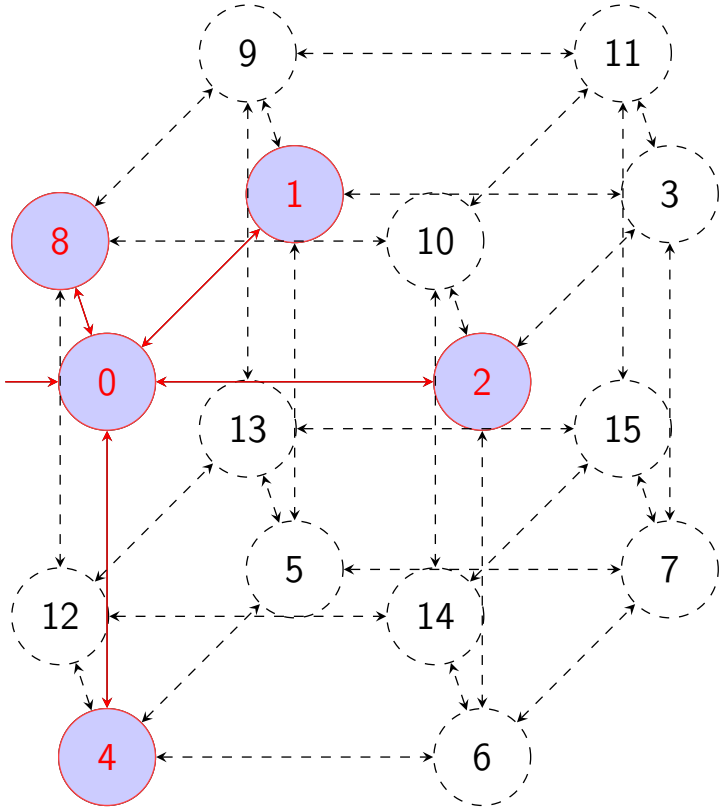

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Enrich aggregates with locally computed information

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Applying Formal Methods to CSbP

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Conclusion and Perspectives

Applying Formal Methods to CSbP

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- generic criteria (deadlock, soundness variants)
- specific criteria (expressed with LTL)

Implementation:

- Deadlock-freeness (integrated to CosyVerif)
- Soundness variants
- LTL modular model checking (not finished yet)

Performs much better than LoLA and better than Woflan

Conclusion and Perspectives

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  - Monolethic Verification
  - Domain-specific Verification

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    - Elastic Processes [K. Klai and S. Tata SCC'13, M. Amziani et al [CloudCom'13]]
    - Multi-tenancy, ...

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    - Multi-tenancy, ...
  - Security Properties (Opacity [N. Hamdi, K. Klai and N.B-H Alouane WETICE'14])

THANK YOU