CBSE 2014

Quantifying the Parallelism in BPMN Processes using Model Checking

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Presented by Lina Ye, 03 July 2014

CONVECS, Inria Grenoble

Outline

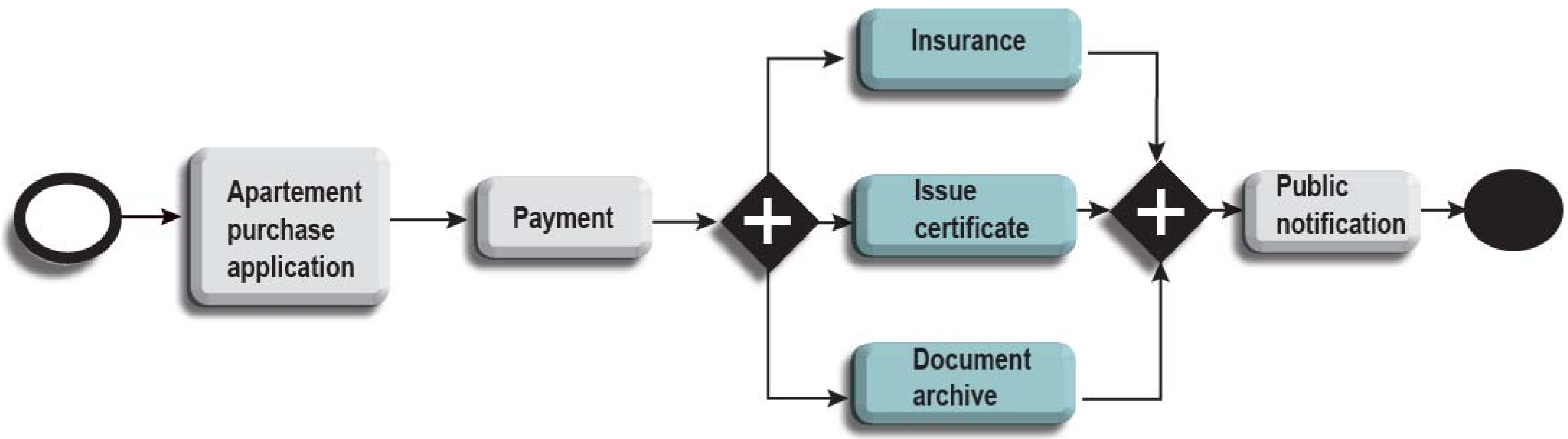
- Background
- BPMN Model
- Formal semantic model
- Compute the degree of parallelism
- Conclusion and perspectives

Background

- BPMN: published as ISO/IEC standard in 2013
- BPMN process: specific ordering of a set of structured, related tasks
- Degree of parallelism: maximum number of tasks executable in parallel
- Degree ↑ efficiency ↑ complexity ↓
- Valuable guide for resource allocation

Peak Workload Demands

Apartement purchase



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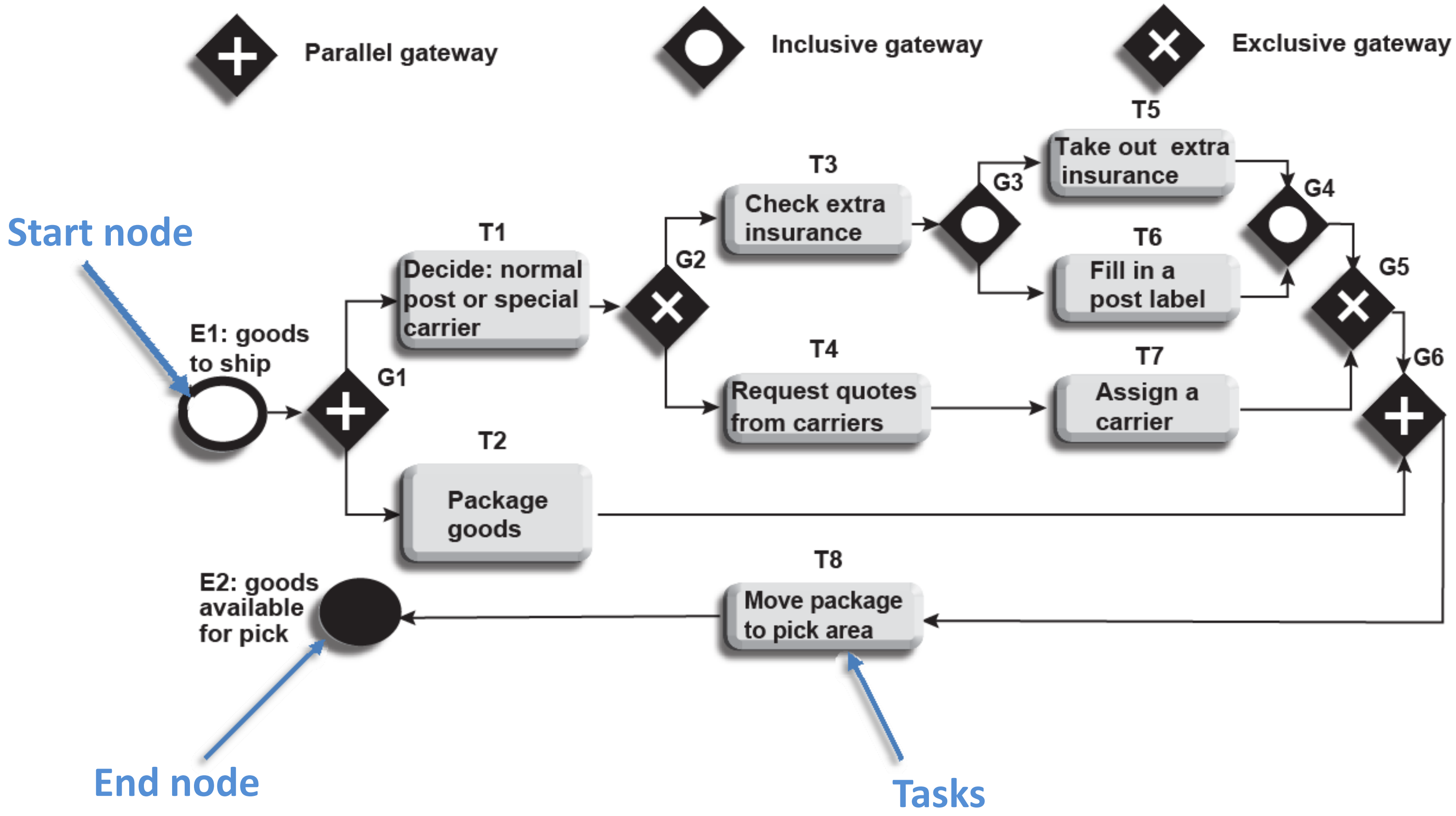
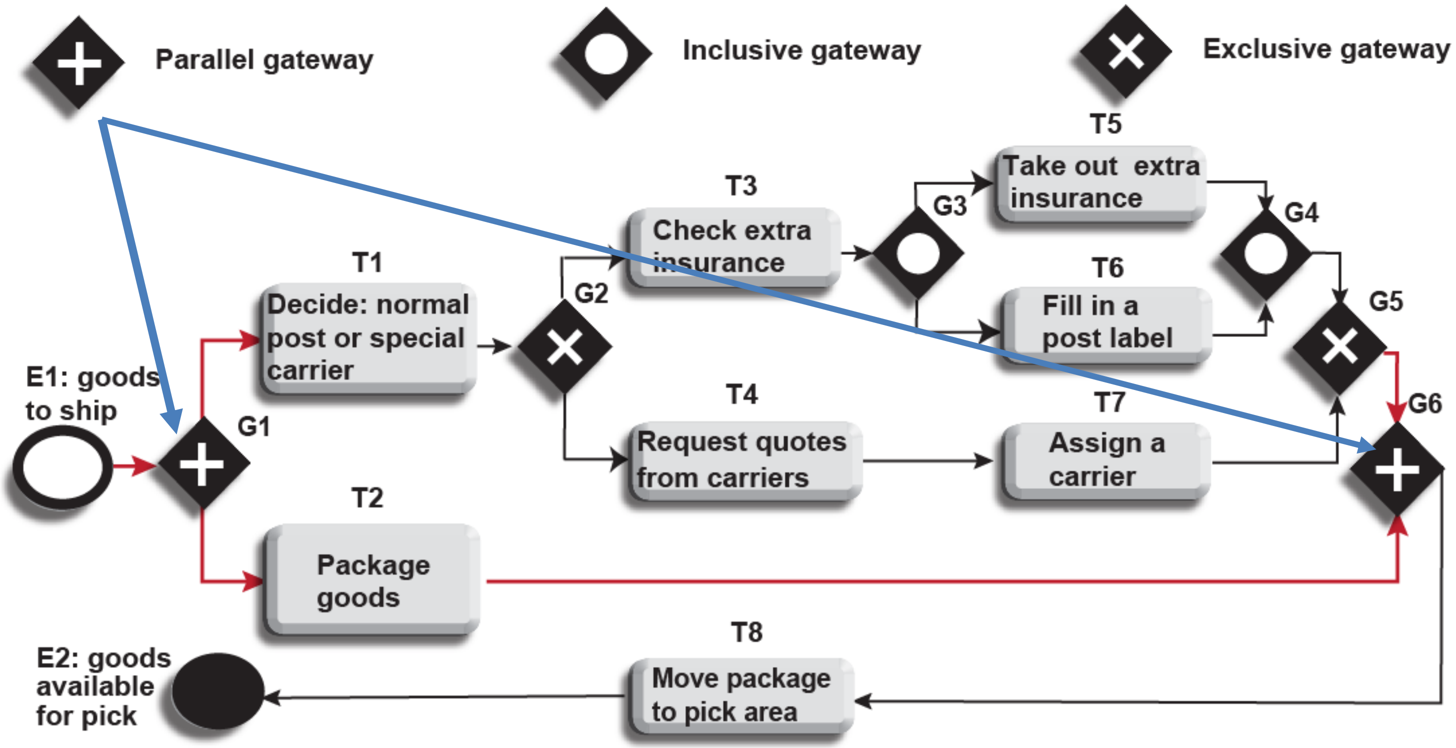
BPMN Model



Parallel gateway
Inclusive gateway
Exclusive gateway
Start node
E1: goods to ship
G1
T1
Decide: normal post or special carrier
T2
Package goods
G2
T3
Check extra insurance
T4
Request quotes from carriers
G3
T5
Take out extra insurance
T6
Fill in a post label
T7
Assign a carrier
G4
G5
G6
T8
Move package to pick area
E2: goods available for pick
End node
Tasks

BPMN Gateways



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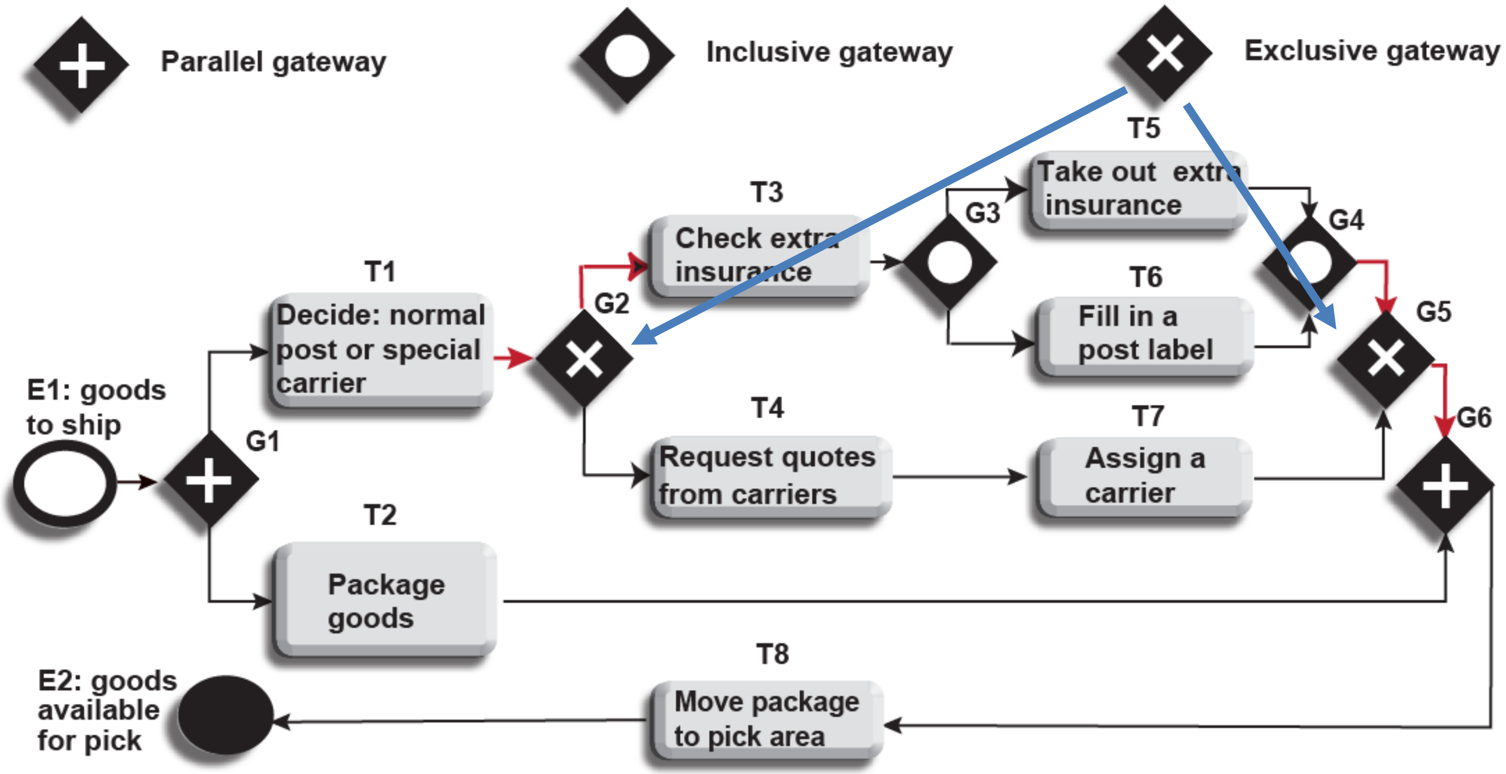

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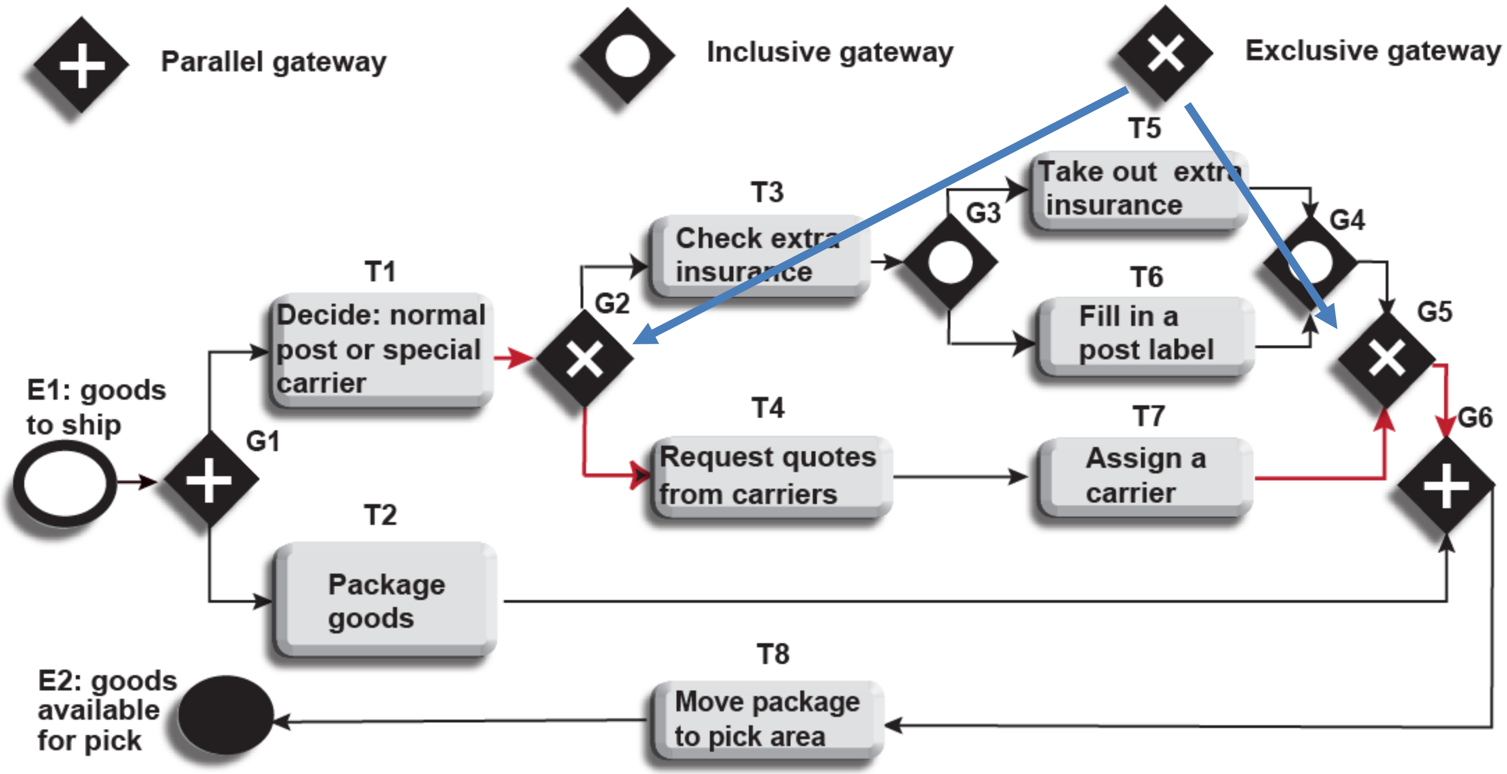

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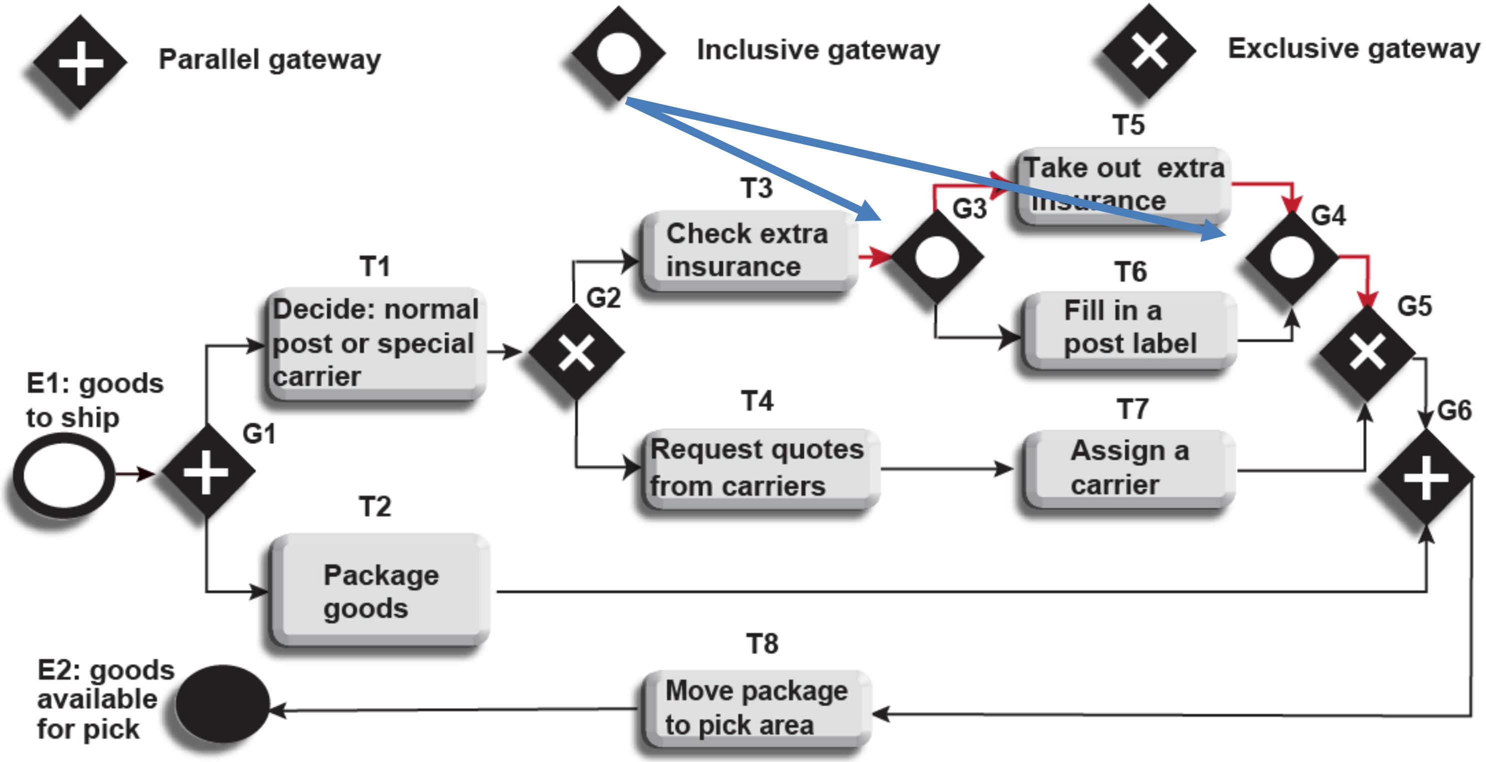

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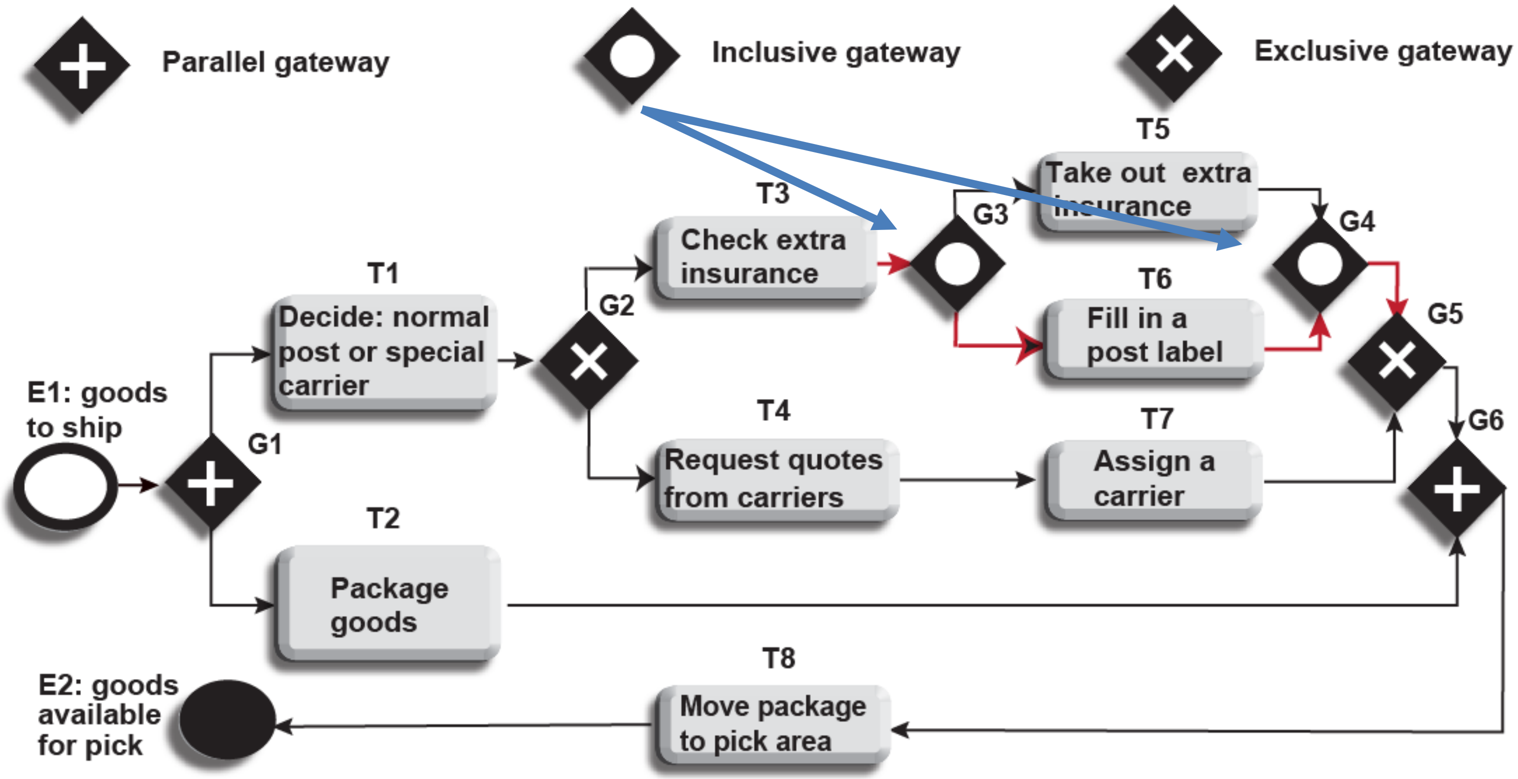

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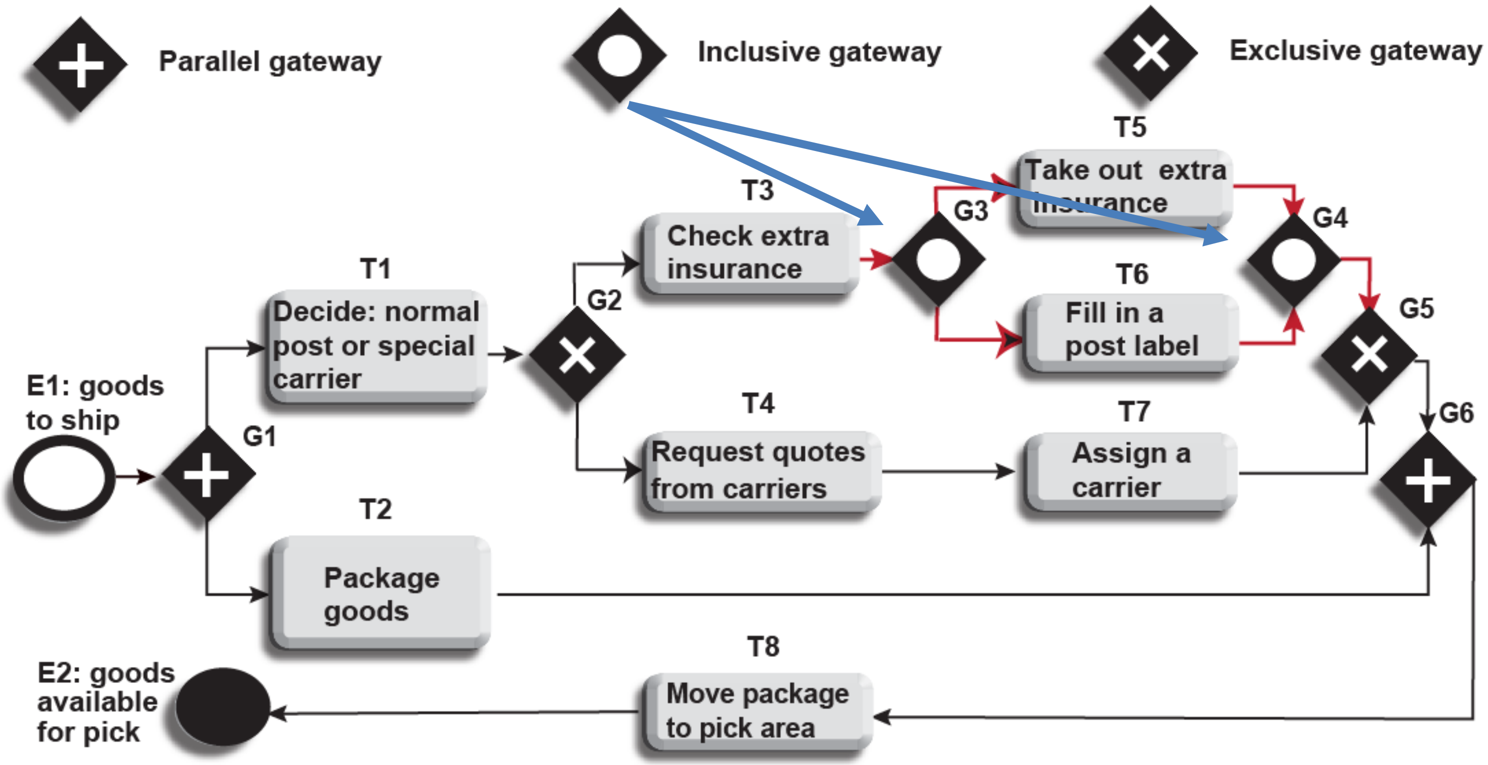
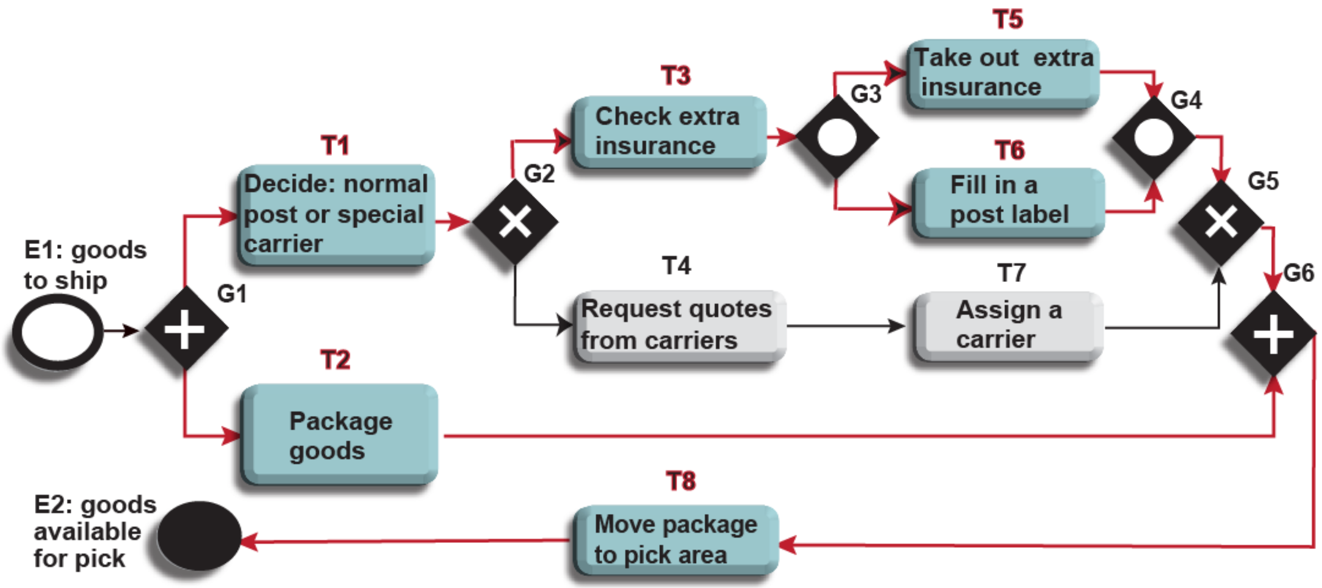


Degree of Parallelism

To comput the degree of parallelism: maximum number of executable tasks at the same time



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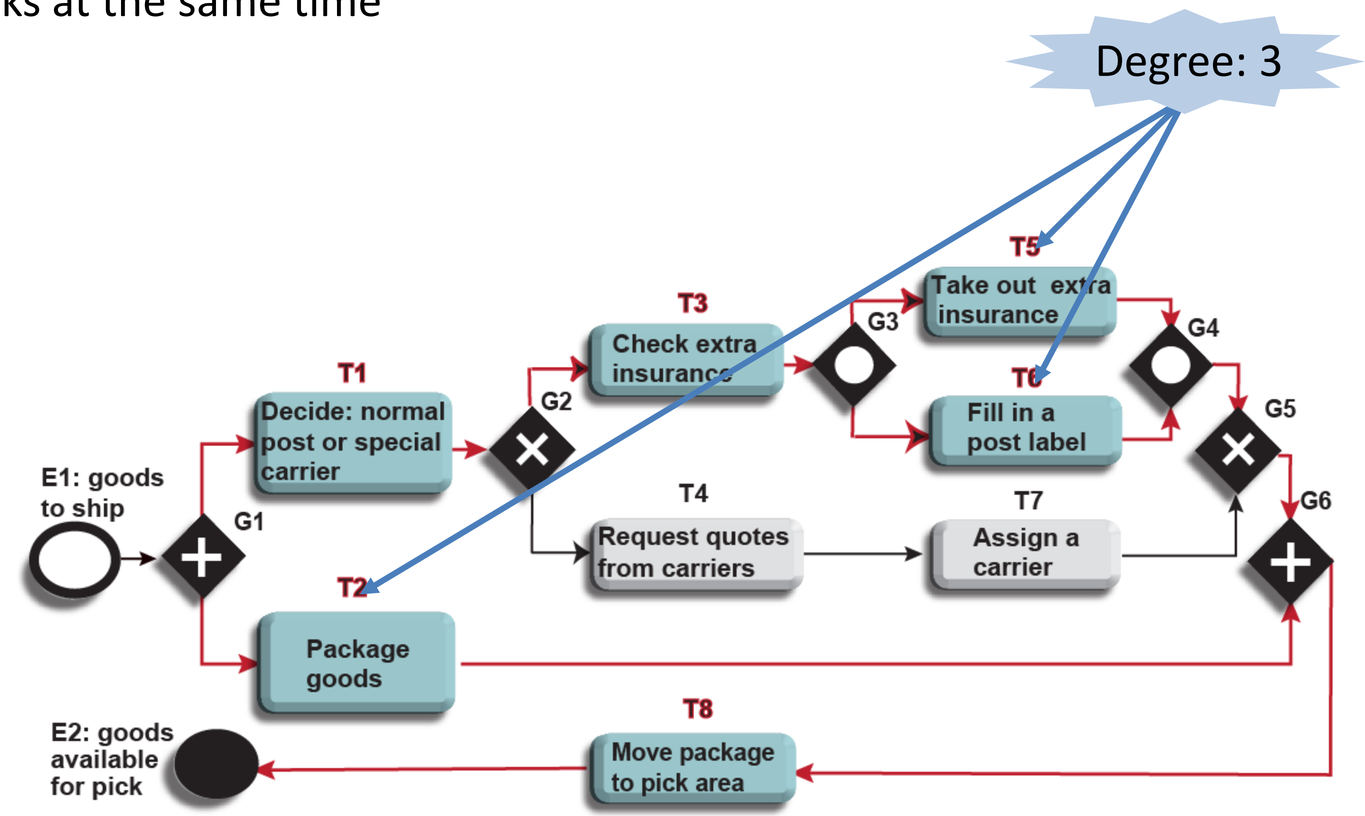
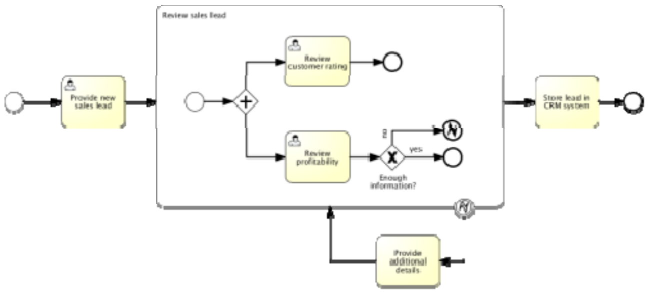


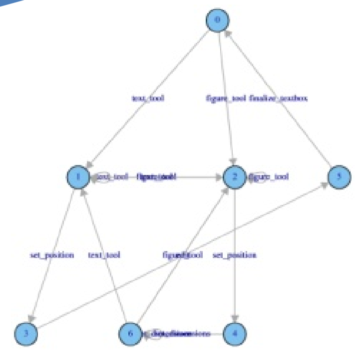
Contributions



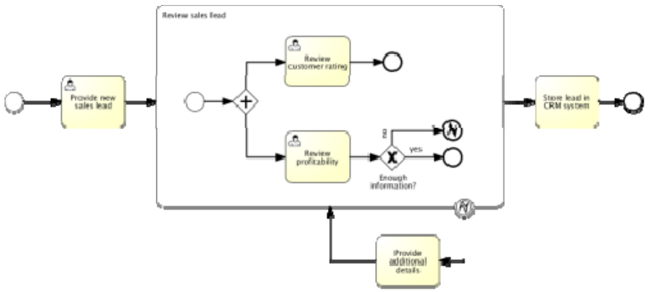
LNT

Information about parallelism

Process algebra



Contributions



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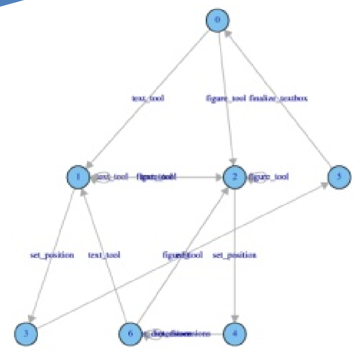
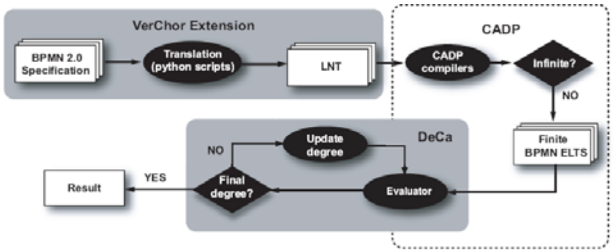


Model-checking

Degree of parallelism



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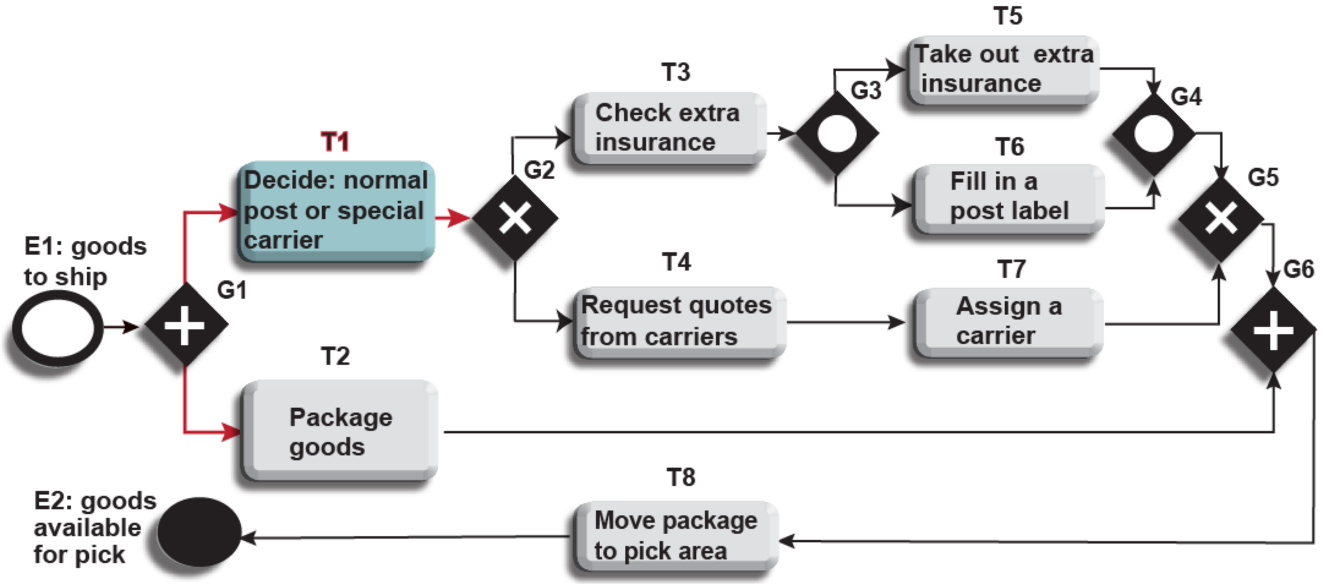
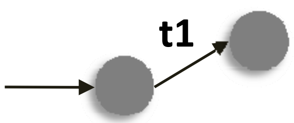
From BPMN to LTS





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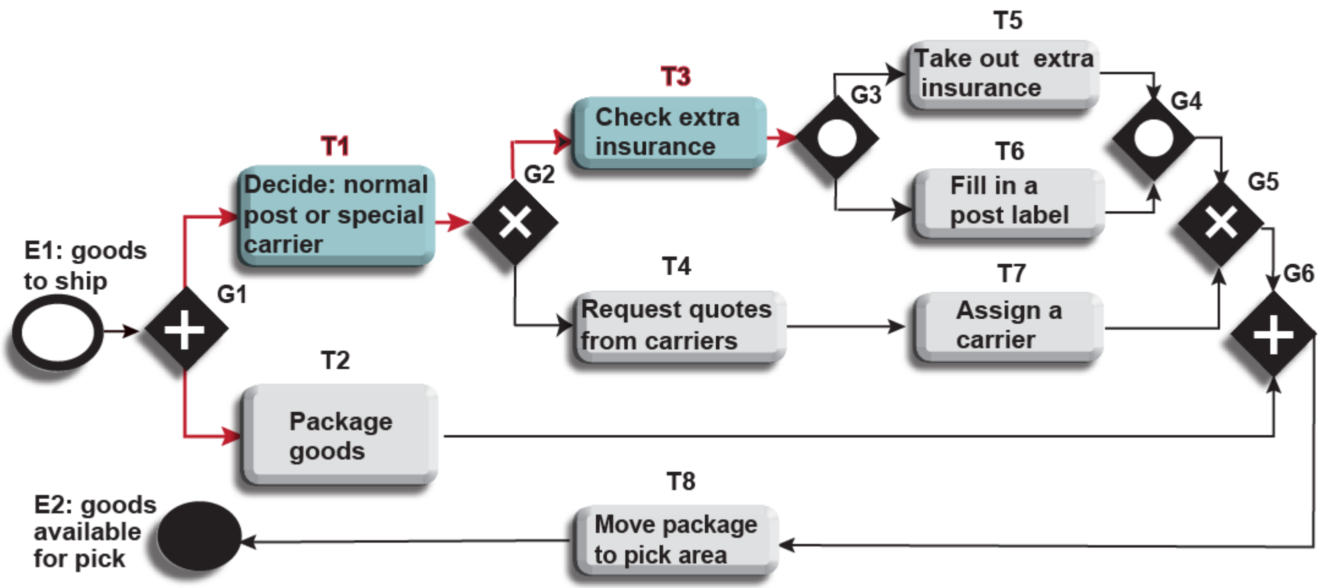

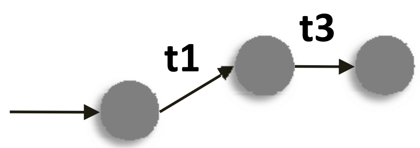

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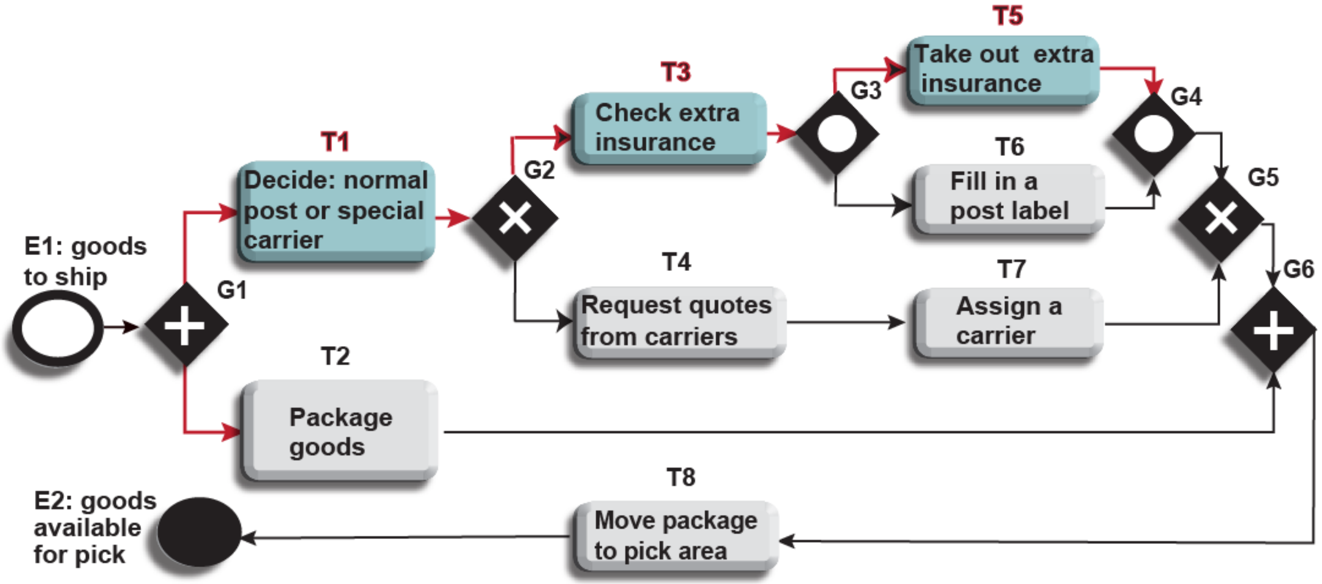

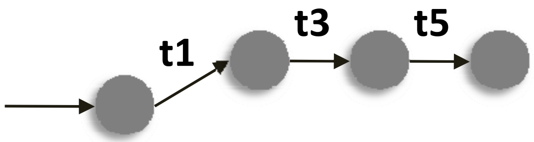

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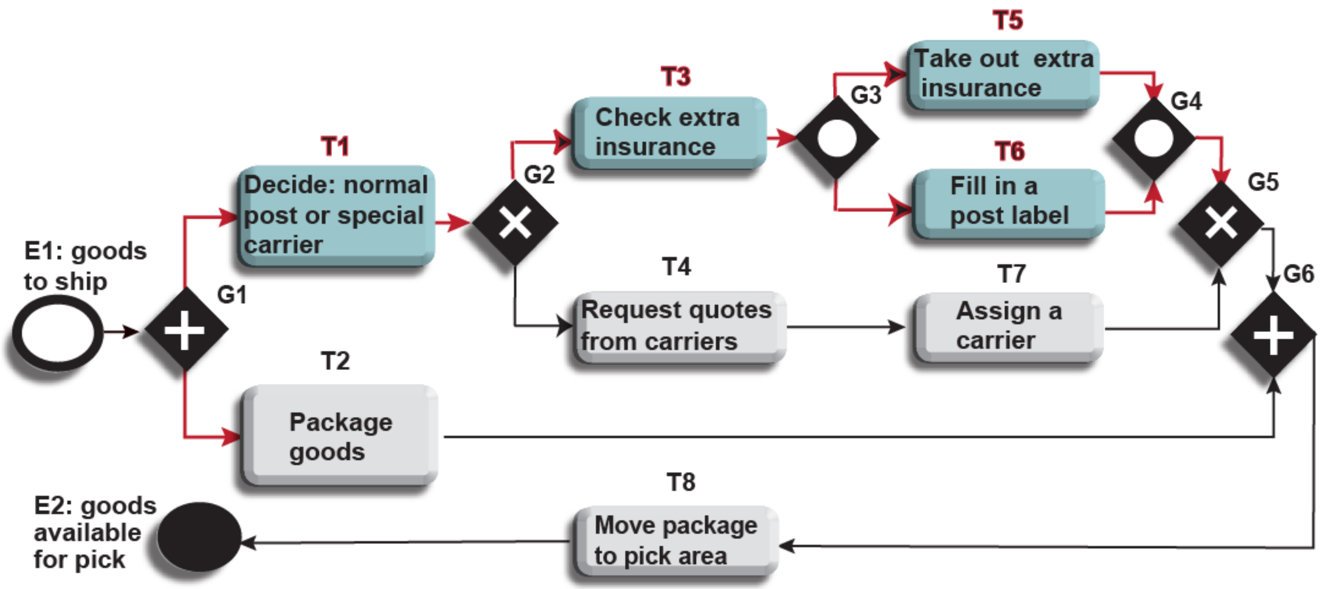

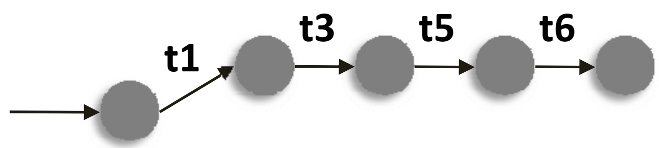

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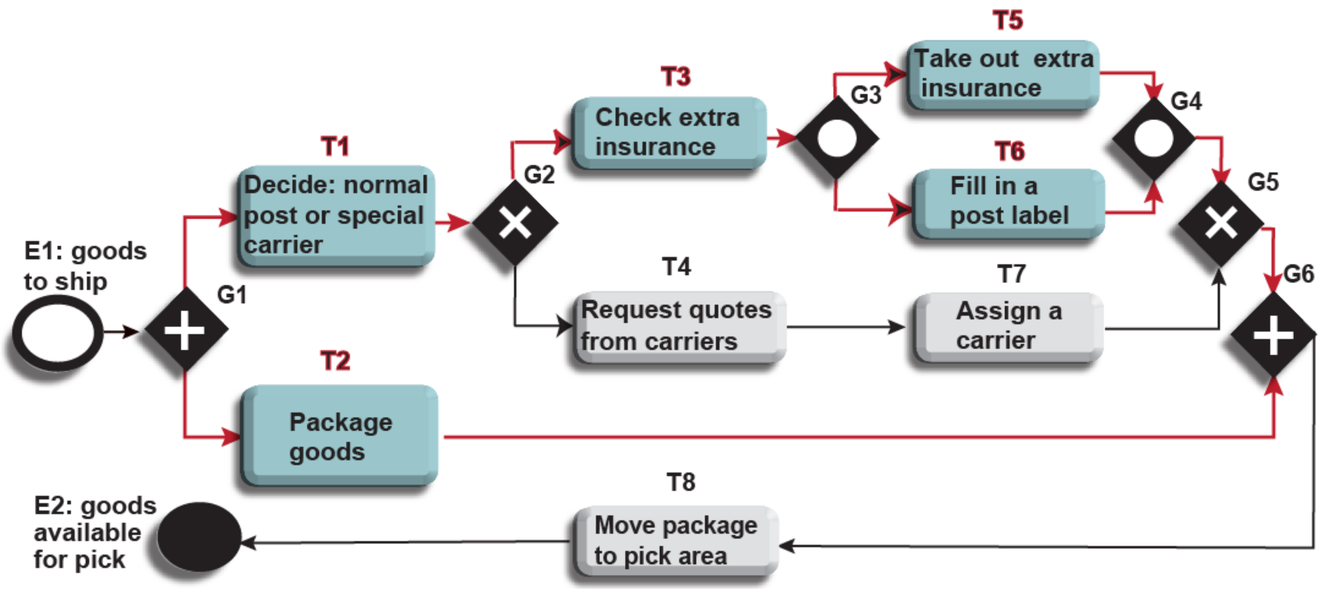

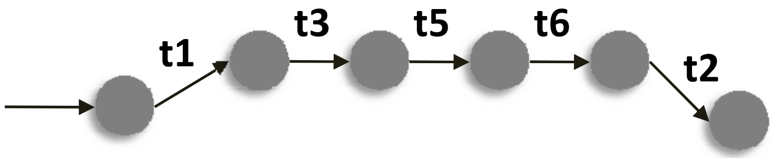

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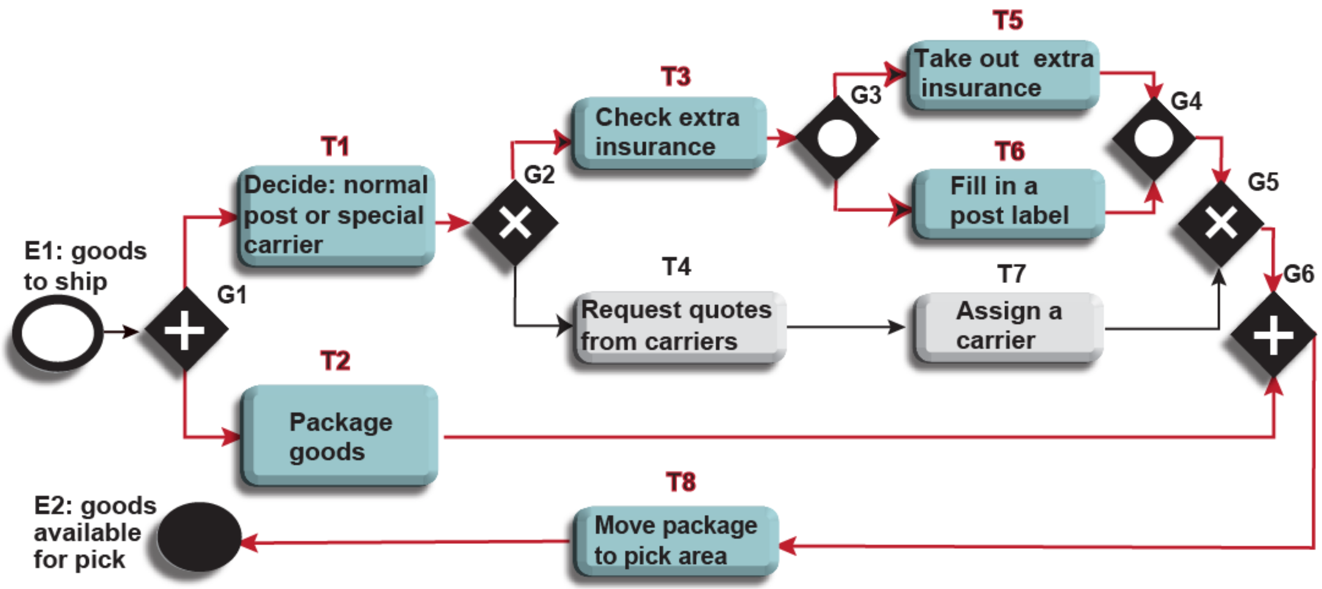

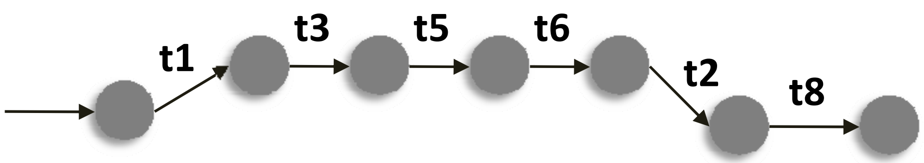

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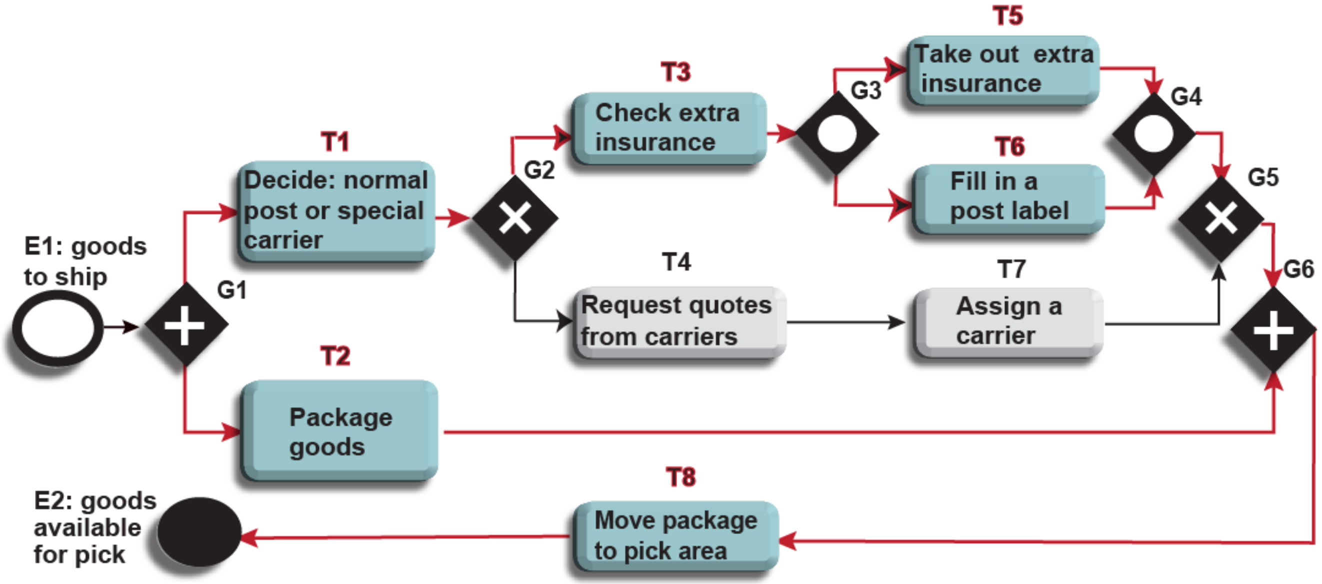
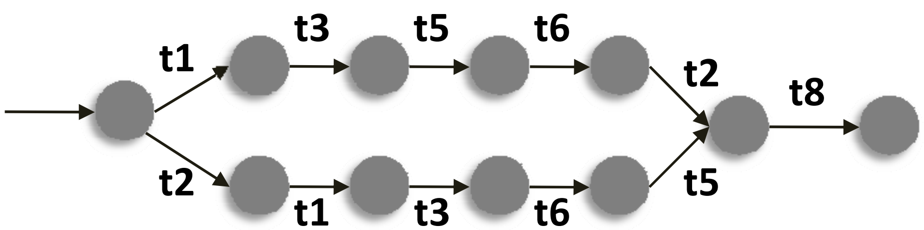
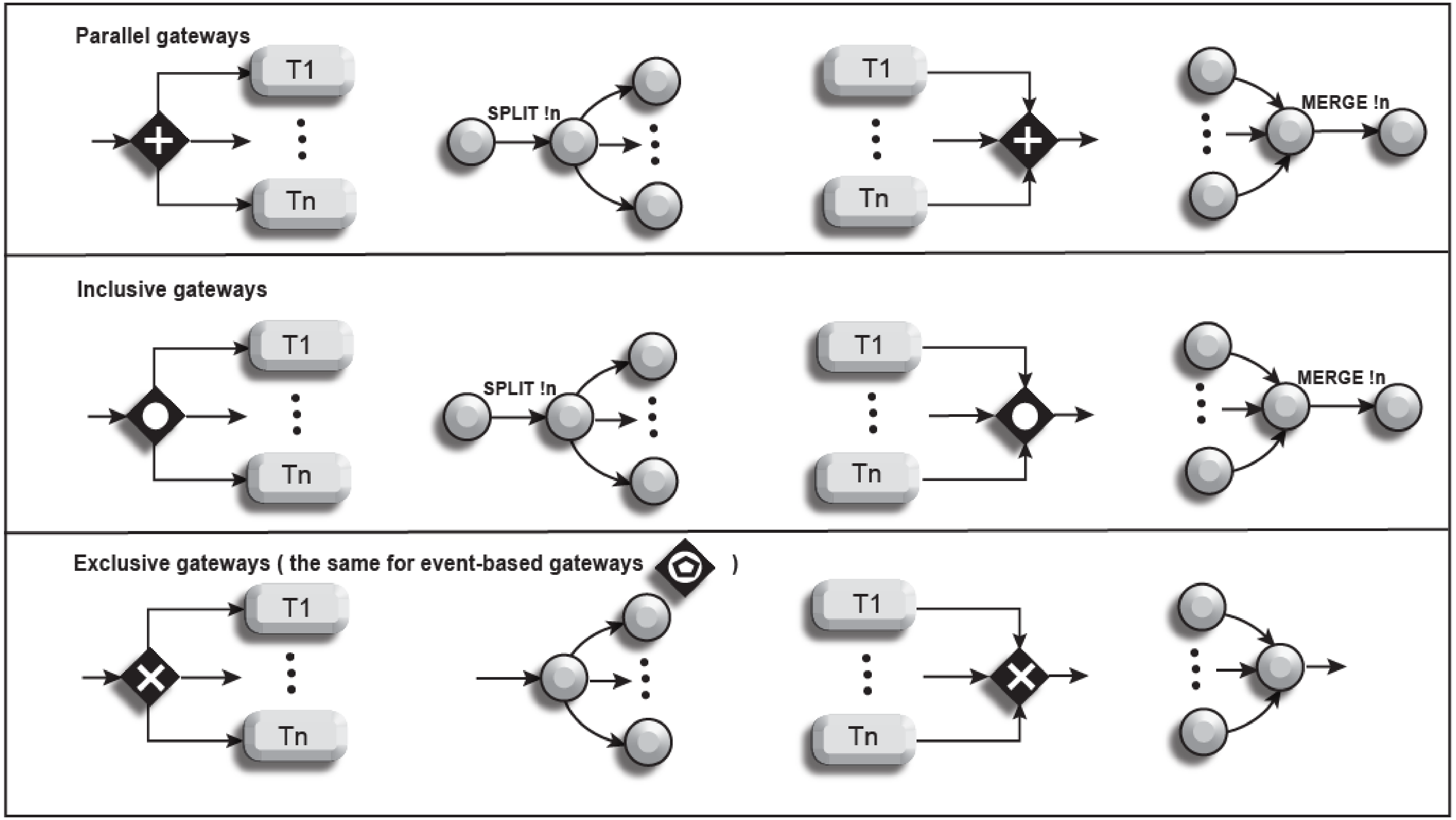




Extended LTS



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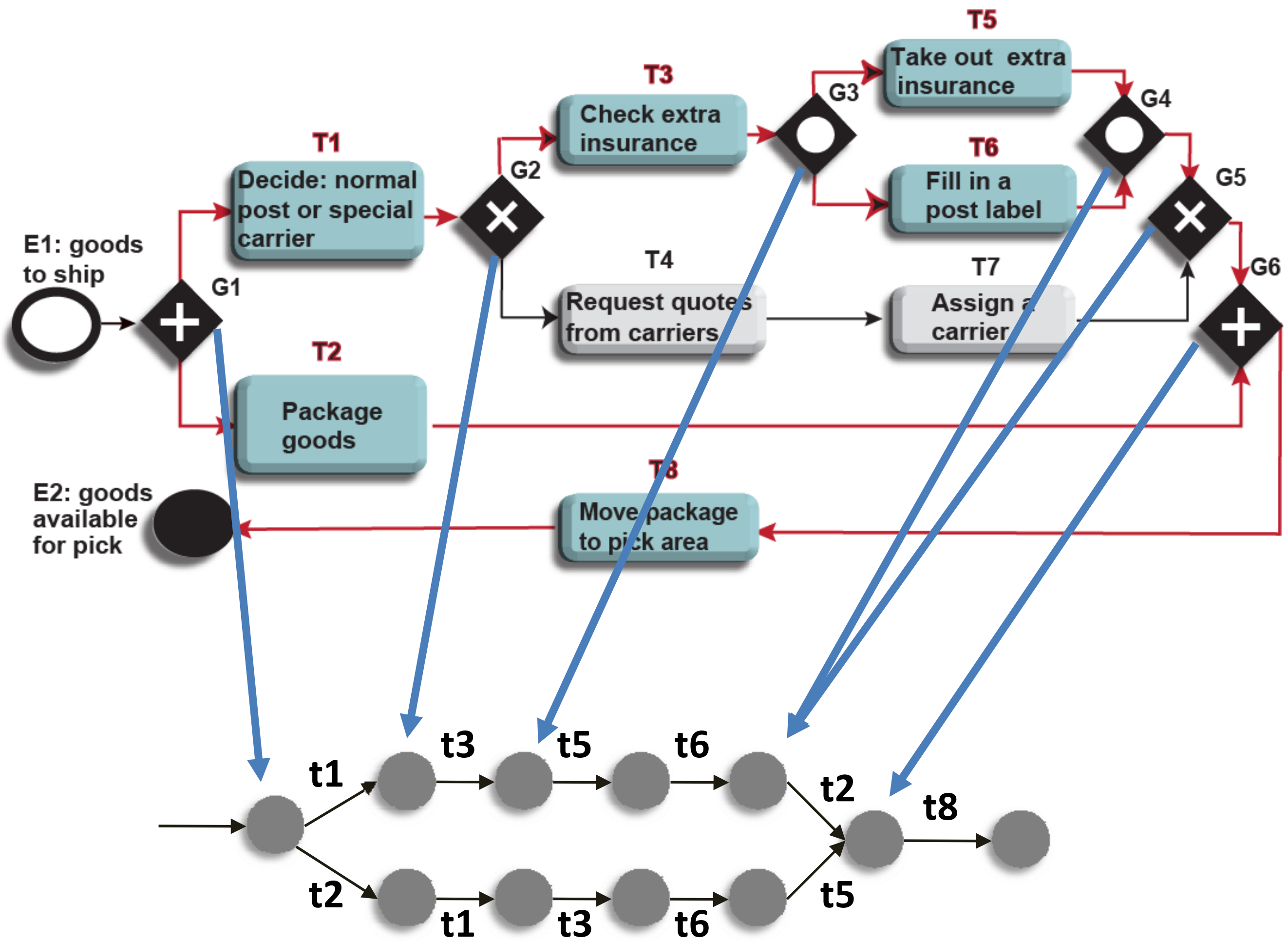

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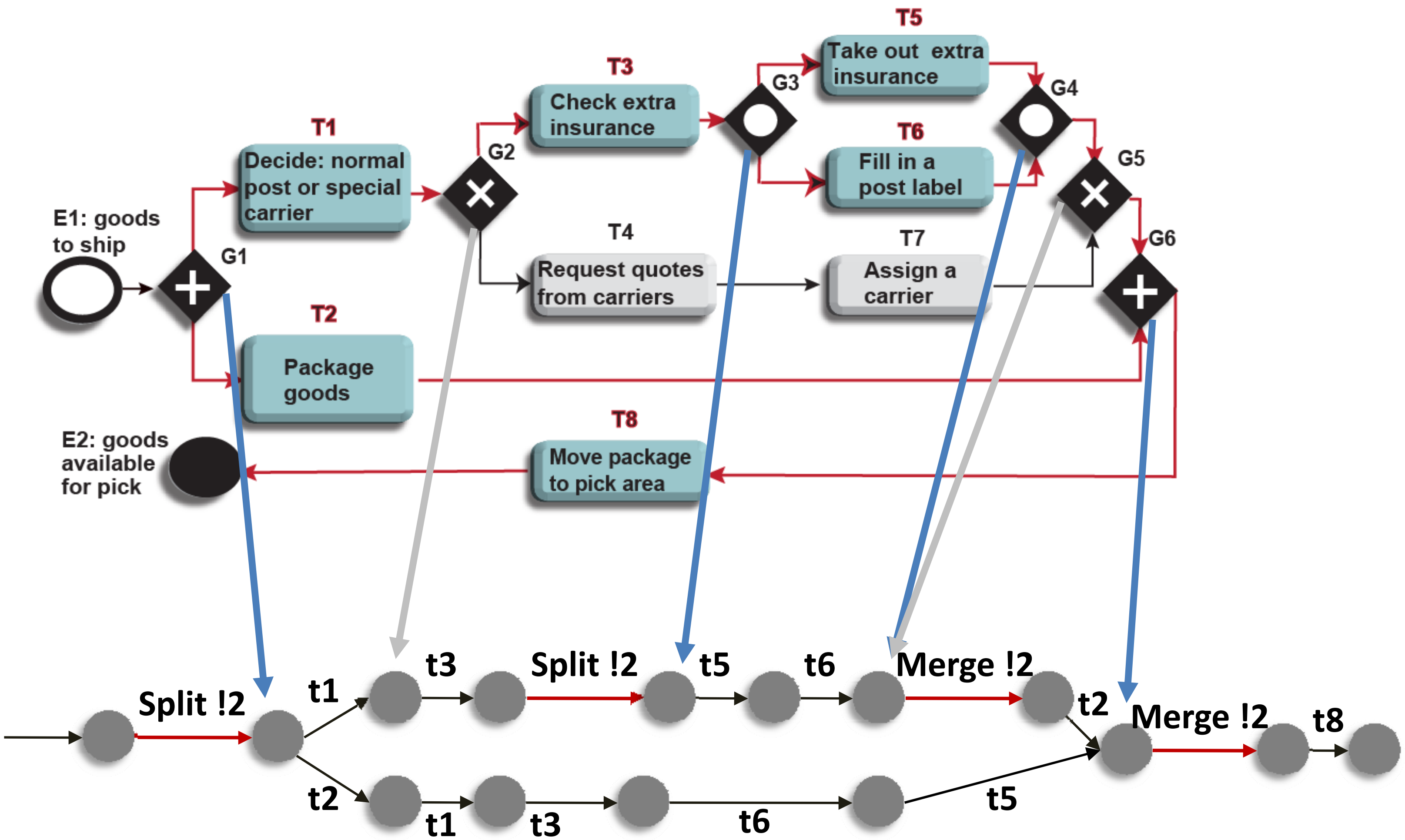

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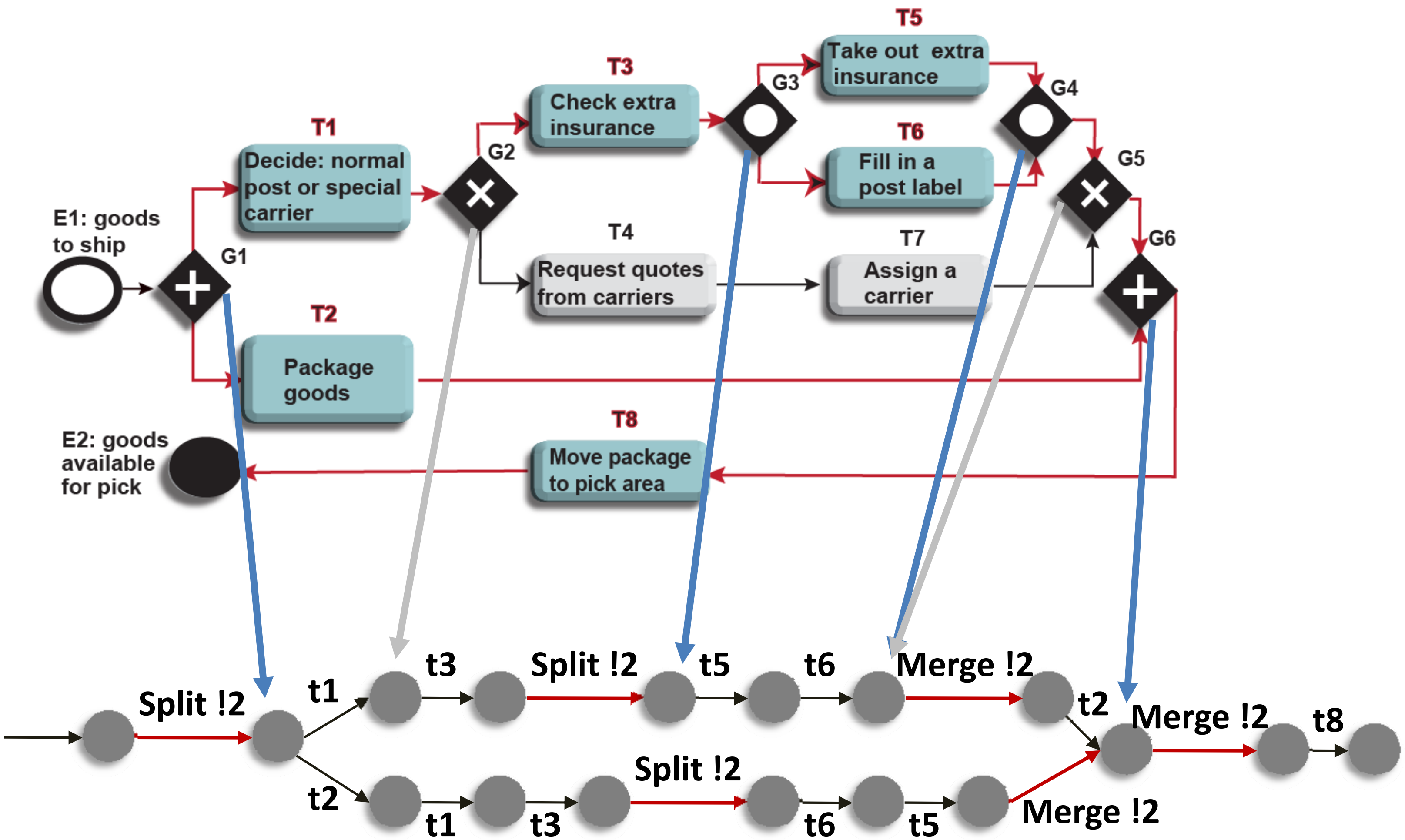

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Model Checking

Formula 1.

$$SPLIT\_MERGE(N) = \tag{1}$$
$$mu\ X\ (c : Nat := 1). \tag{2}$$
$$((c >= N)\ or \tag{3}$$
$$< SPLIT\ ?\ fan\_out : Nat > X(c + (fan\_out - 1))\ or \tag{4}$$
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$$< not(SPLIT...\ or\ MERGE...) > X(c)) \tag{6}$$

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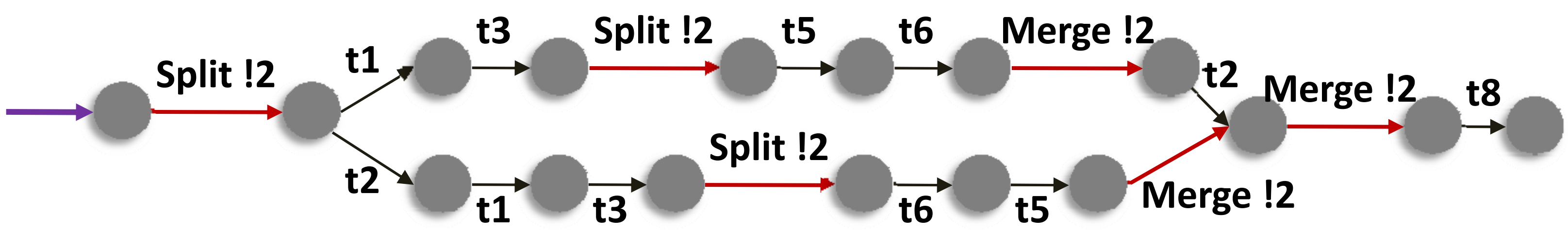
If N=2, c=1



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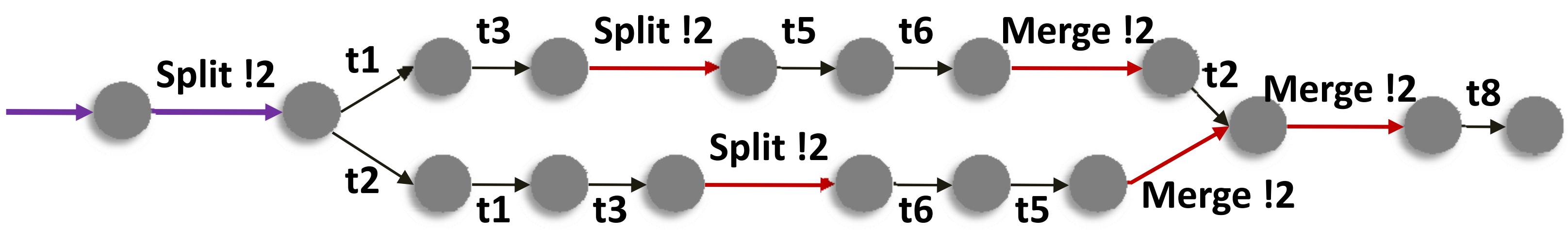
If N=2, c=2 return true



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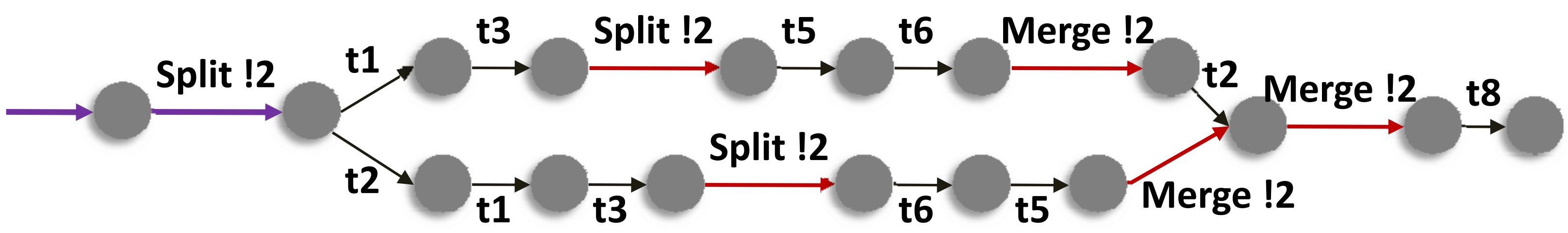
If N=5, c=2



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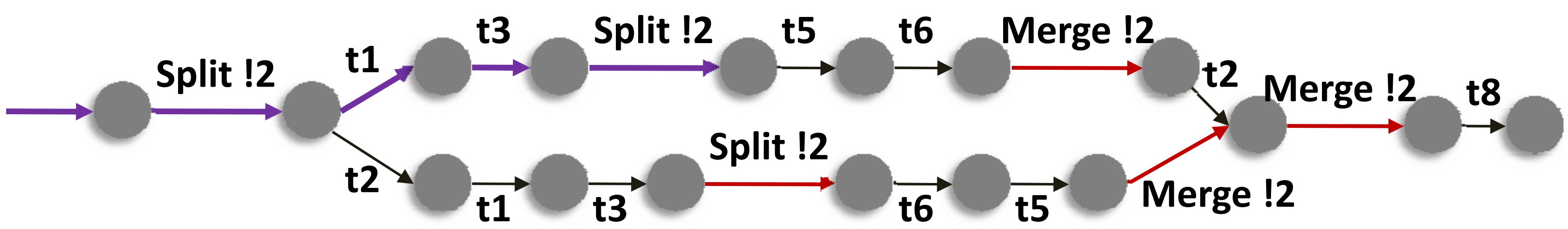
If N=5, c=3



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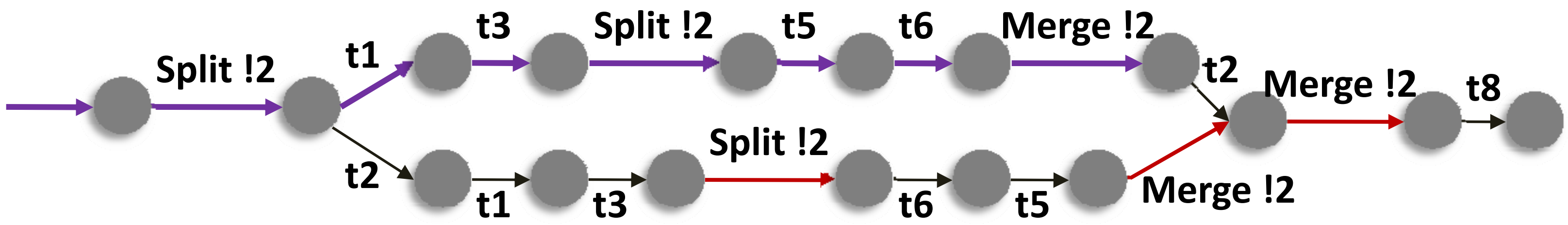

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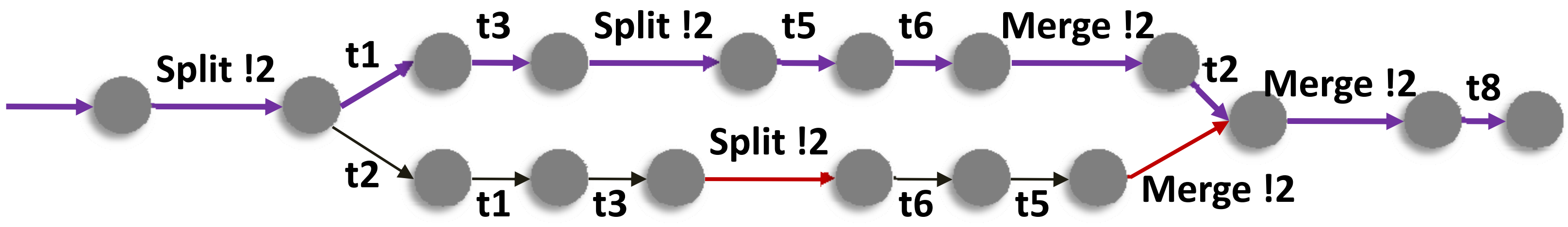
If N=5, c=1



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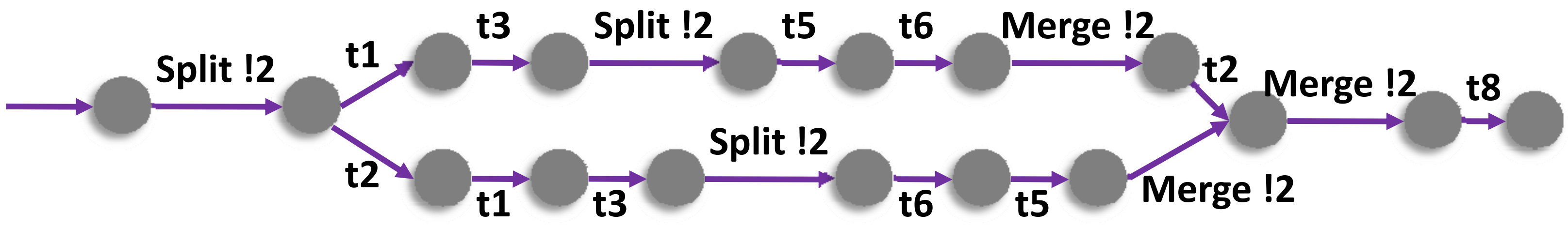
\end{aligned}
$$

If N=5, c=1, return false



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Binary search for N to compute final degree

true true true false

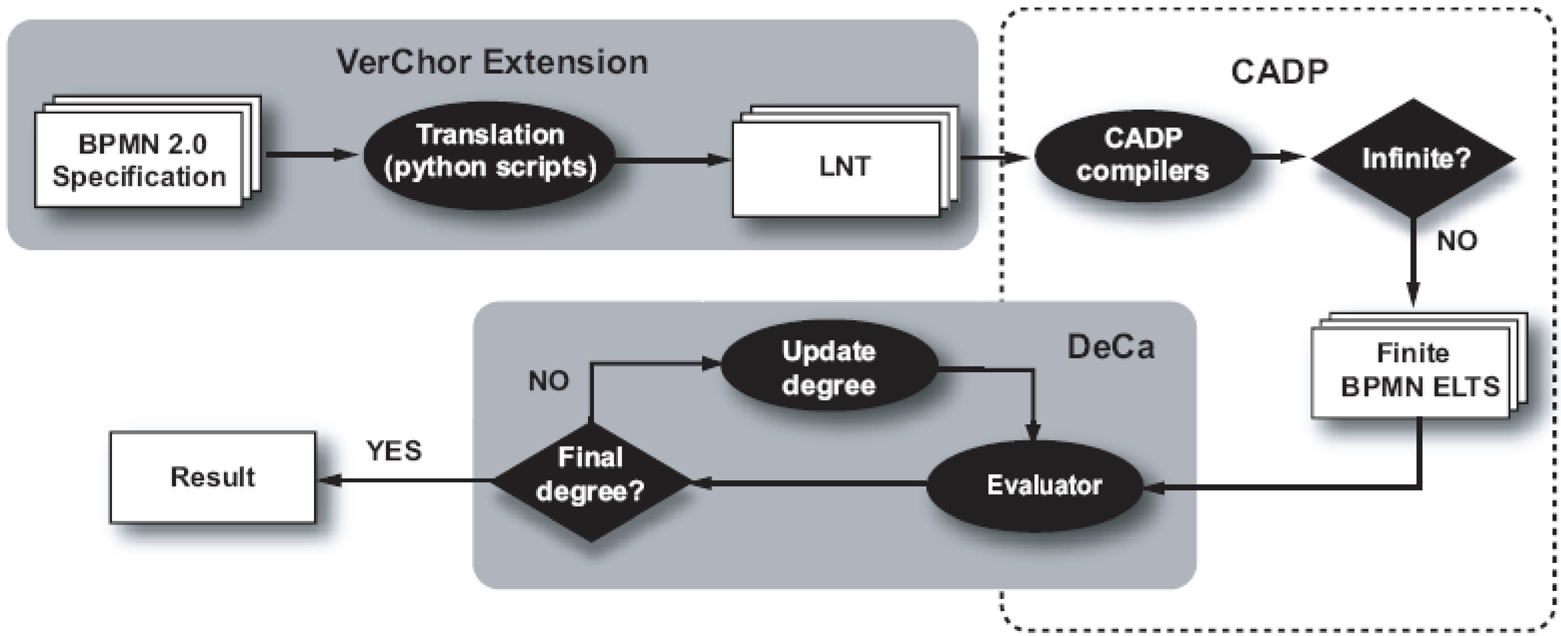
$2^1 \longrightarrow 2^2 \longrightarrow 2^3, \ldots, 2^{n-1} \longrightarrow 2^n \longrightarrow$

if $2^n - 2^{n-1} = 1$: 2^{n-1} is the degree

else $(2^n - 2^{n-1})/2$ ......

until the difference is 1

Tool Support



Experimental Results

BPMN	|TS|	|P|	|I|	|E|	raw ELTS($\|S\|/\|T\|$)	abs. ELTS($\|S\|/\|T\|$)	|D|	time
Shipment [21]	8	2	2	2	56/96	9/11	3	2s01
PizzaOrder [21]	9	2	0	0	30/51	3/2	3	1s53
ChoreOs1 [1]	6	4	0	0	20/26	6/5	3	1s56
ChoreOs2	6	0	4	0	22/37	7/8	3	2s03
BookingSystem [22]	6	1	0	1	12/12	2/1	2	1s23
P010	4		4	2	134/275	30/63	3	3s05
P050	5	6			95/220	8/7	4	2s21
P060	8	4	2		576/1596	40/68	5	3s31
P070	30	2		4	20,745/100,234	3/2	6	3s27
P080	40	2			746,505/4,852,234	3/2	8	3s58
P110	25	4	2	2	32,849/245,932	24/36	15	8s15
P111	45	4	2	2	33,554,513/335,544,492	24/36	15	8s18
P120	31	3	2	4	983,188/9,847,132	14/19	17	7s72

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P120	31	3	2	4	983,188/9,847,132	14/19	17	7s72

Reduction: abstract ELTS with null replacing tasks in raw ELTS

Results: raw ELTS for P111 requires 36m and abs ELTS for P111 requires only 8s

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Conclusion and Perspectives

Conclusion

- Represent BPMN in terms of ELTSs through LNT
- General enough to handle nested gateways and infinite loops
- Replace tasks with empty statements while keeping control flow labels

Perspectives

- Consider a larger subset of BPMN
- Degree more precise when consider data objects