Business Processes Modelling

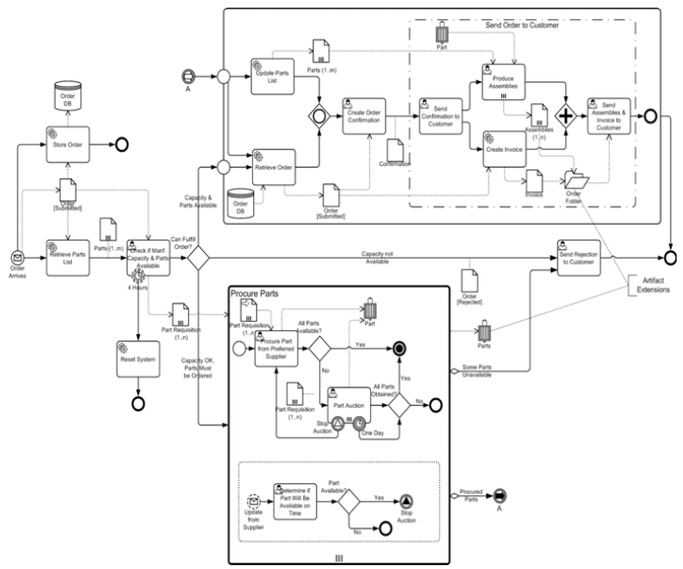
MPB (6 cfu, 295AA)

Roberto Bruni

http://www.di.unipi.it/~bruni

16b - BPMN analysis

Object



We overview the main
challenges that arise when analysing
BPMN diagrams with Petri nets

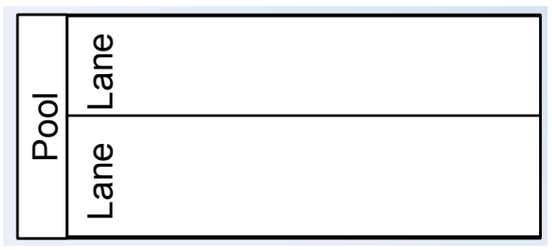
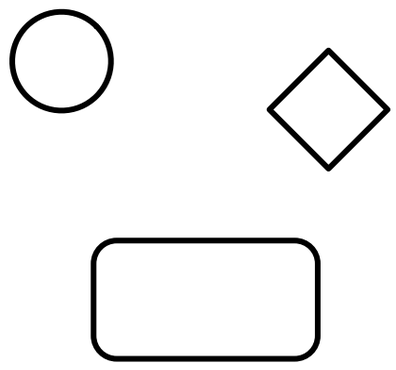
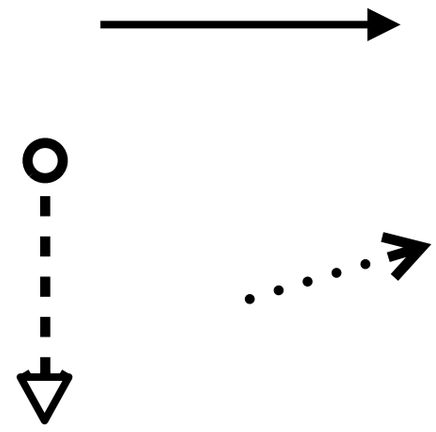
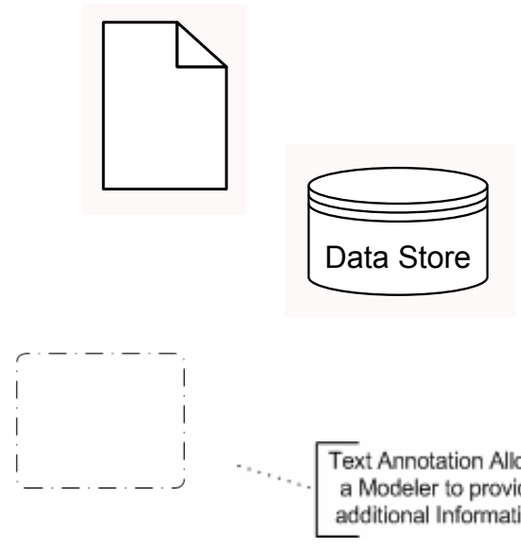
Ch.5.7 of Business Process Management: Concepts, Languages, Architectures

BPMN Diagrams

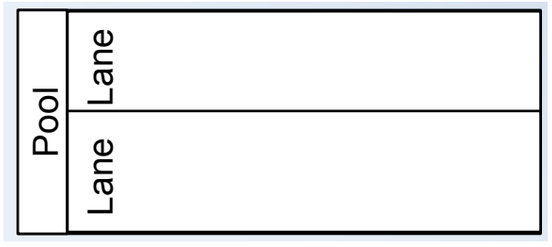
Business process diagrams

BPMN defines a standard for
Business Process Diagrams (**BPD**)
based on **flowcharting technique**

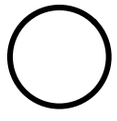
Four categories of elements

swimlanes	flow objects	connecting objects	artefacts
			

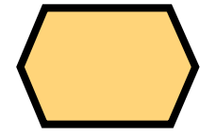
BPMN vs EPC (roughly)



swimlanes

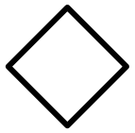


event

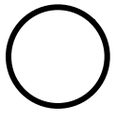
event 

activity

function 



gateway

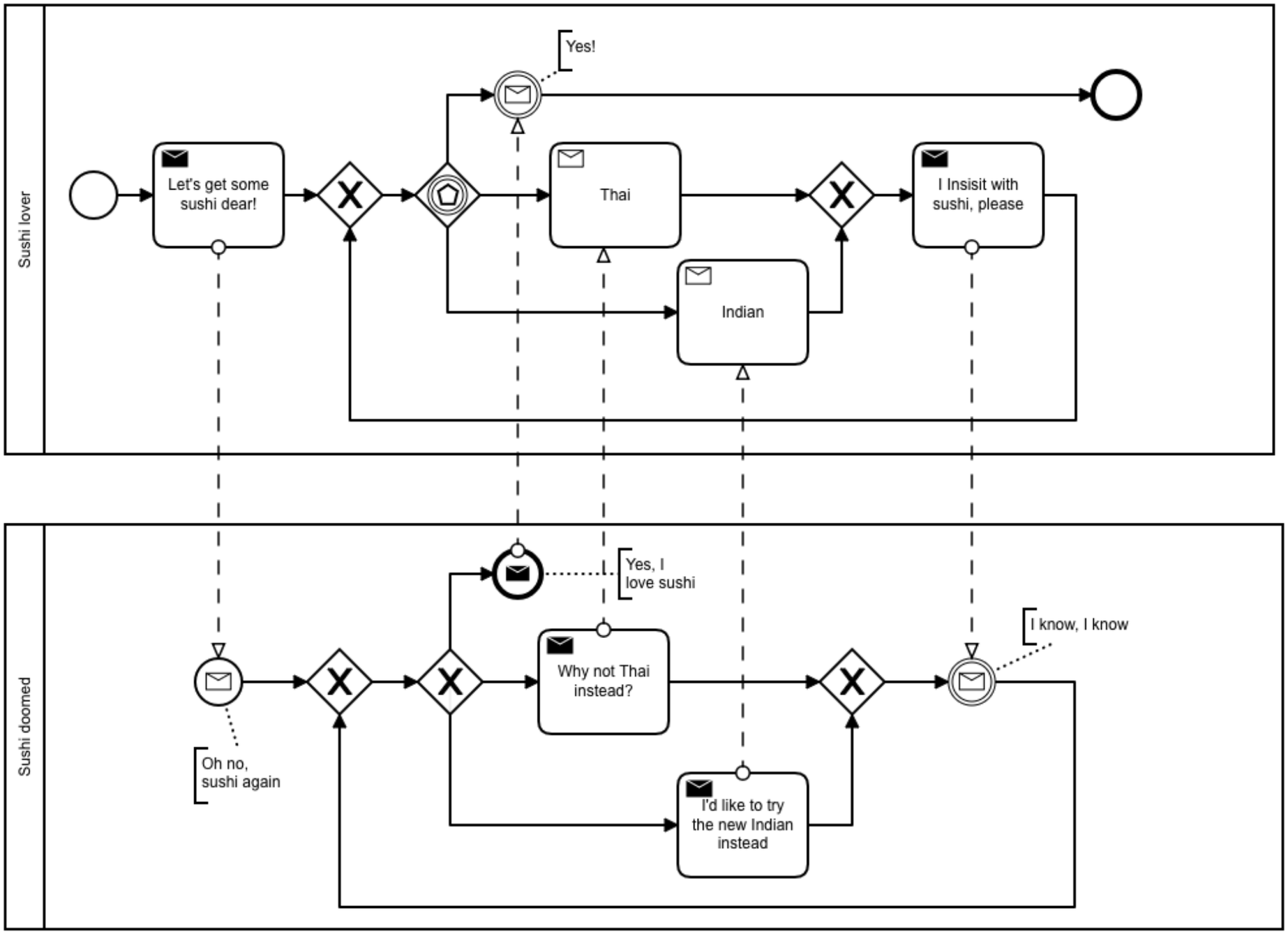
connector 

sequence flow

control flow 

message flow

A negotiation without choice



BPMN Semantics

BPMN formal semantics?

Many attempts:
Abstract State Machines (ASM)
Term Rewriting Systems
Graph Rewrite Systems
Process Algebras
Temporal Logic
…
Petri nets

(Usual difficulties with OR-join semantics)

Sound BPMN diagrams

We can exploit the formal semantics of nets
to give unambiguous semantics to
BPMN process diagrams
BPMN collaboration diagrams

We transform
BPMN process diagrams to wf nets
BPMN collaboration diagrams to wf systems

A BPMN diagram is sound if its net is so

We can reuse the verification tools
to check if the net is sound

Translation of BPMN to Petri nets

From BPMN to Petri nets

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ScienceDirect
Information and Software Technology 50 (2008) 1281–1294
INFORMATION AND SOFTWARE TECHNOLOGY
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Semantics and analysis of business process models in BPMN

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Simplified BPMN

a start / exception event has just one outgoing flow
and no incoming flow

an end event has just one incoming flow
and no outgoing flow

all activities and intermediate events have exactly
one incoming flow and one outgoing flow

all gateways have either
one incoming flow (and multiple outgoing)
or one outgoing flow (and multiple incoming)

Simplified BPMN

The previous constraints are no real limitation:

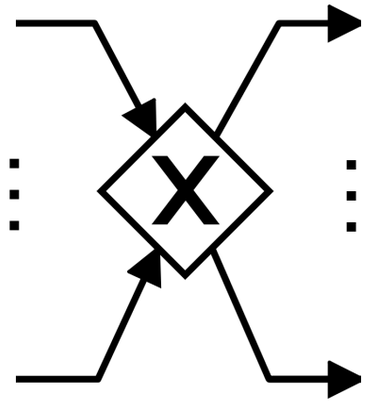
events or activities with multiple incoming flows:
insert a preceding XOR-join gateway

events or activities with multiple outgoing flows:
insert a following AND-split gateway

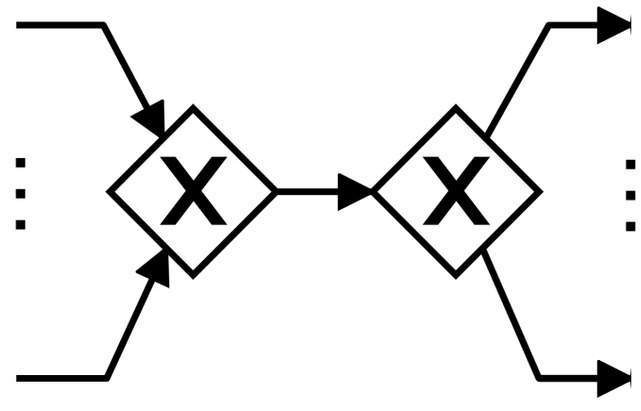
gateways with multiple incoming and outgoing flows:
decompose in two gateways

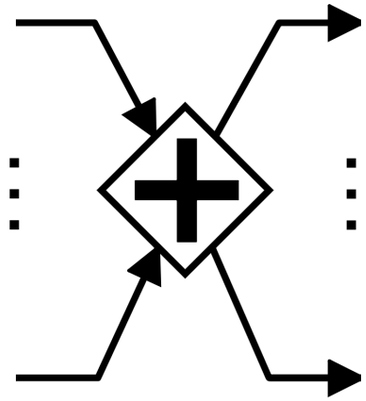
insert start / end events if needed

Pay attention to gateways

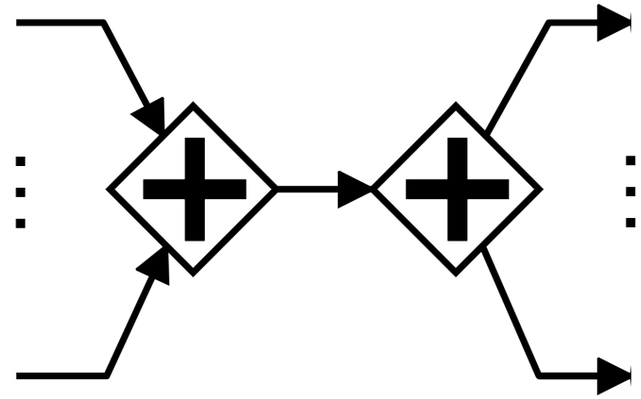


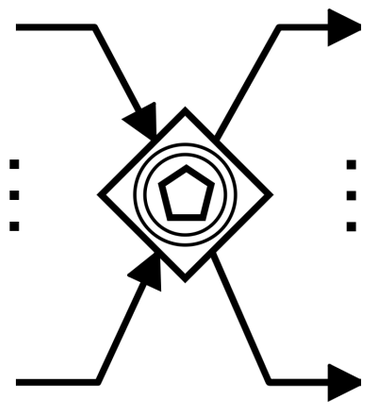
stands for



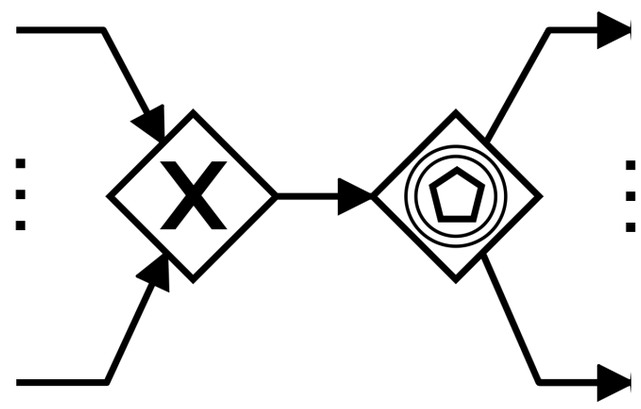


stands for

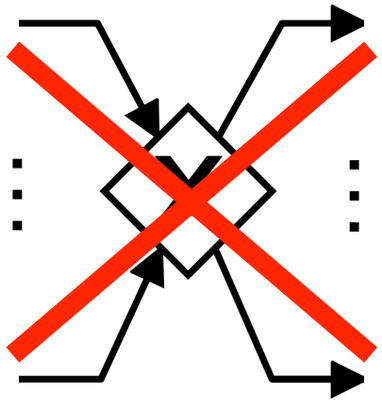




stands for



My suggestions



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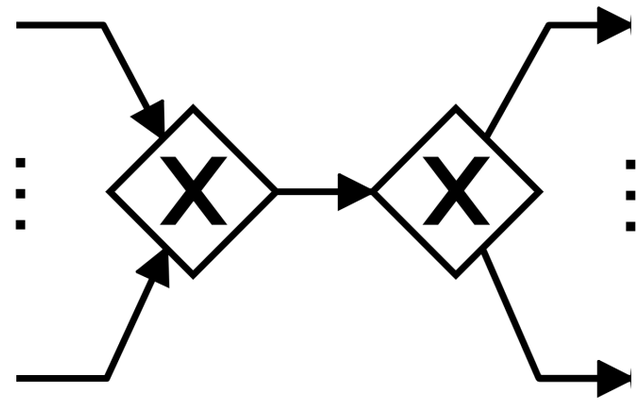

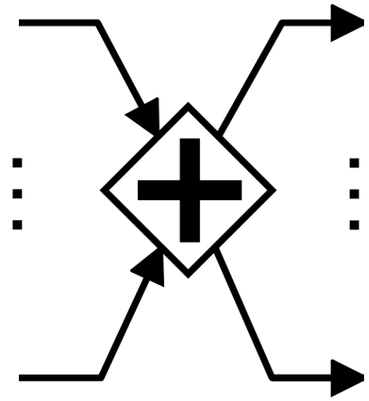

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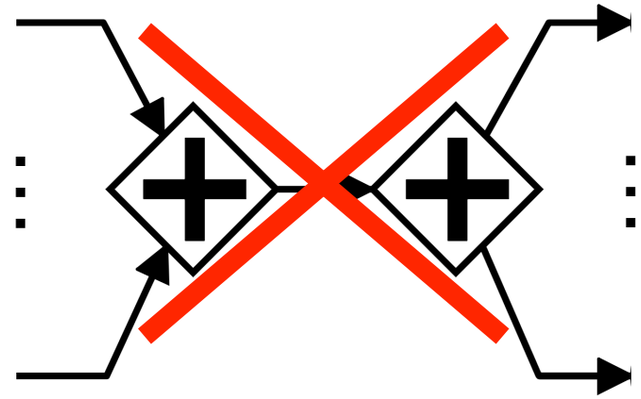
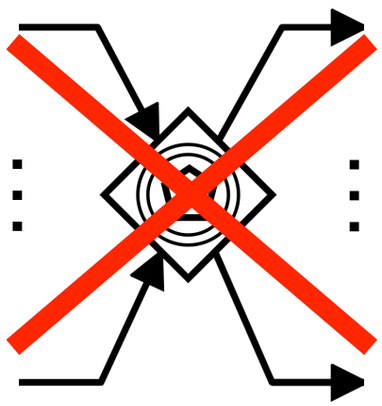
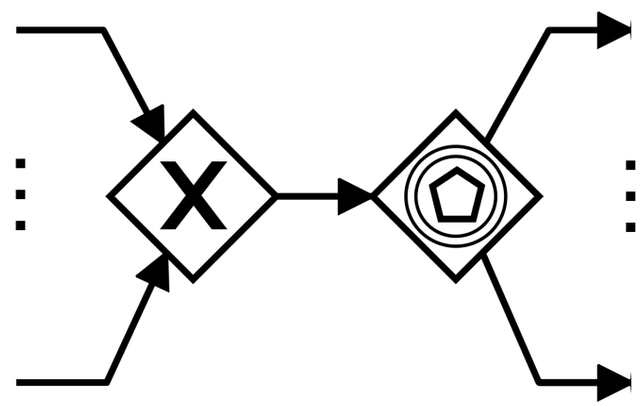


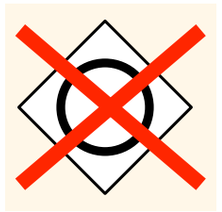


stands for



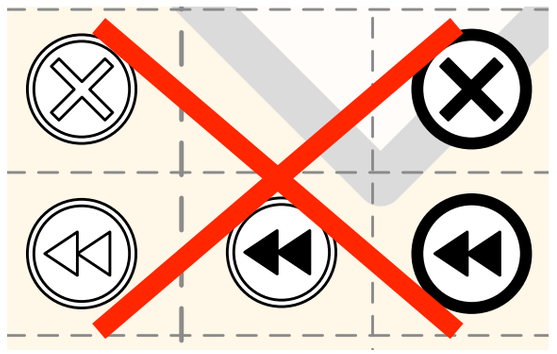
Simplified BPMN

Avoid OR-gateways
(all problems seen with EPC apply to BPMN as well)



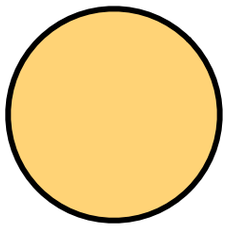
Limited form of sub-processing

No transactions and compensations

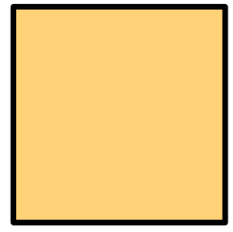


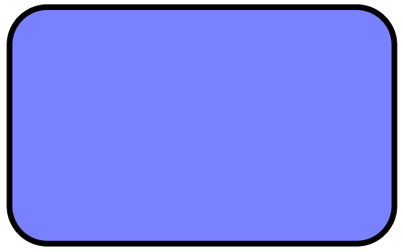
The twist!

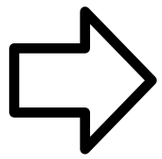
BPMN object **net fragment**

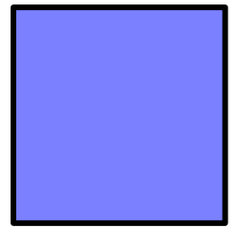


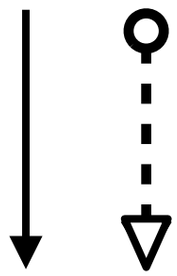
event

transition 

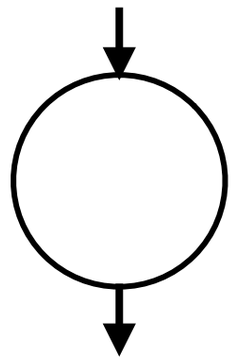


activity 

transition 



sequence flow
message flow

place 

Roughly

A place for each arc

one transitions for each event

one transition for each activity

one or two transitions for each gateway

…

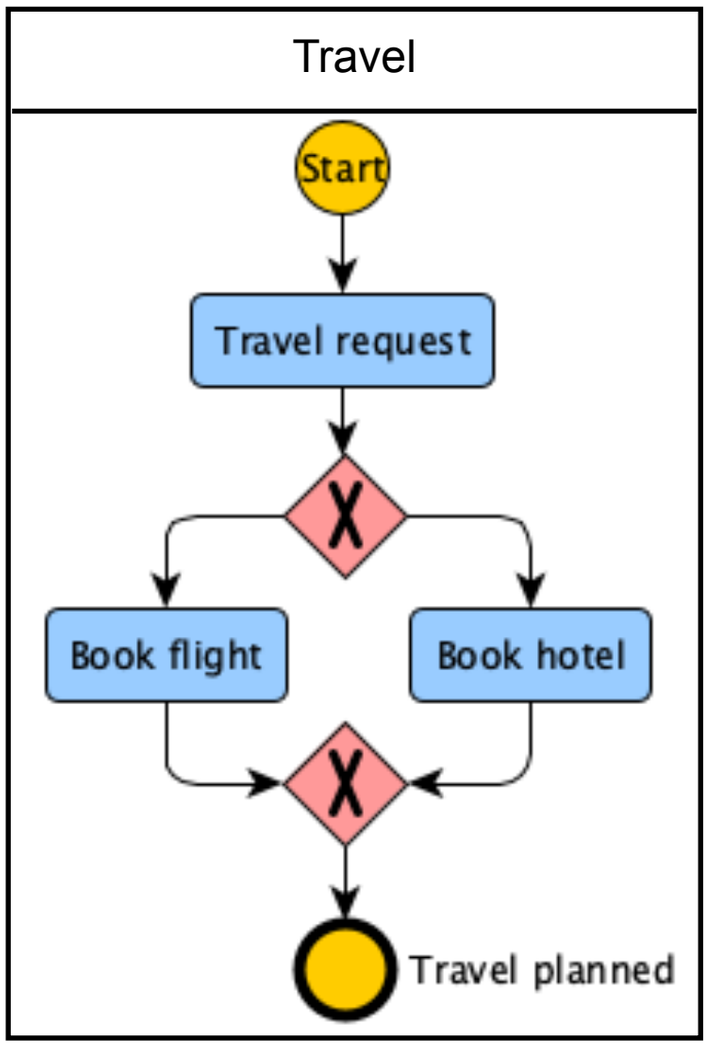
with some exceptions!

(start event, end event, event-based gateways, loops, …)

no dummy objects!

The strategy

From BPMN process diagrams to wf nets in three steps



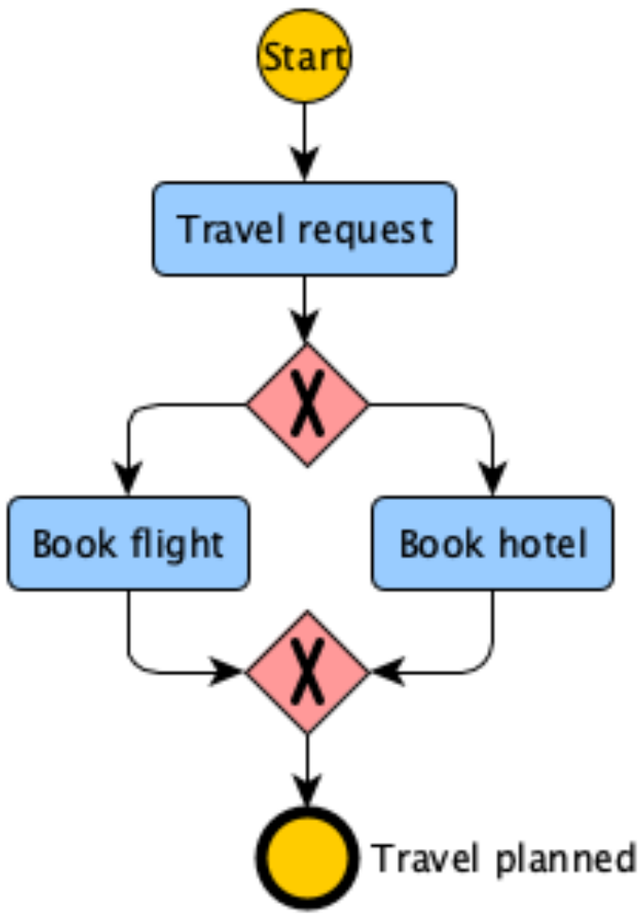
Step 1
convert
sequence flow
message flow

Step 2
convert
flow objects

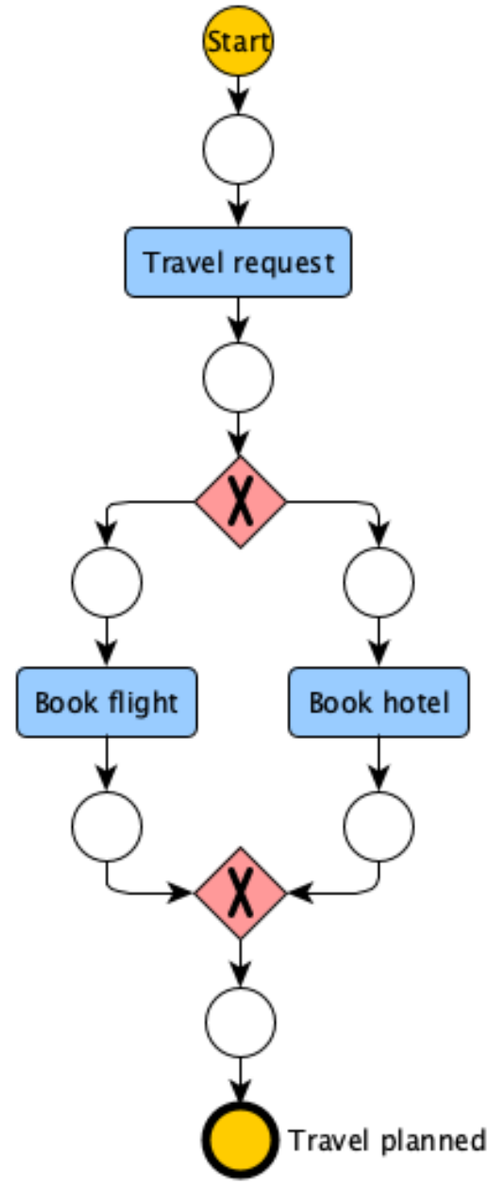
Step 3
enforce
initial place
final place

Step 1: convert flows

We insert a place for each sequence flow and message flow

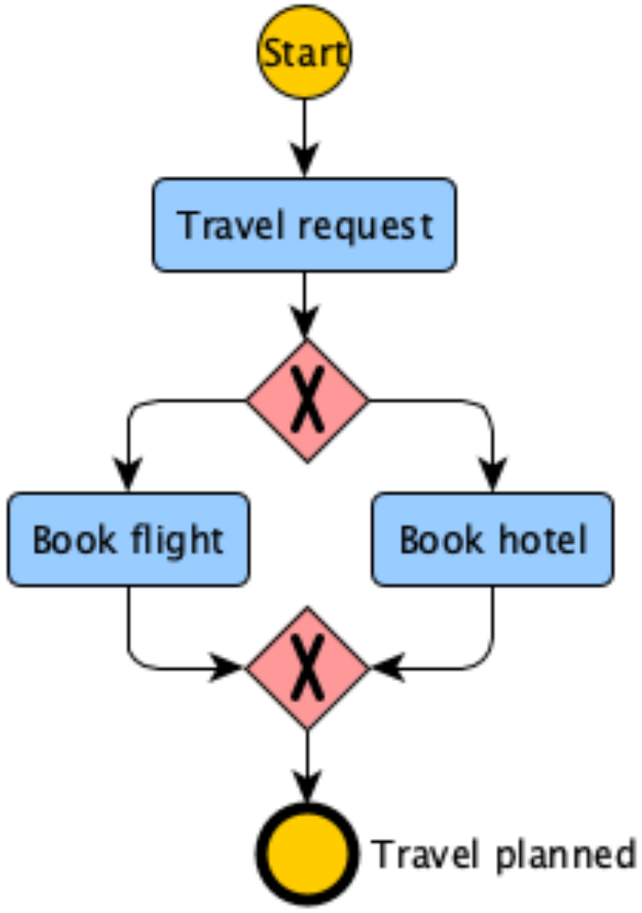


Step 1
sequence flow
message flow

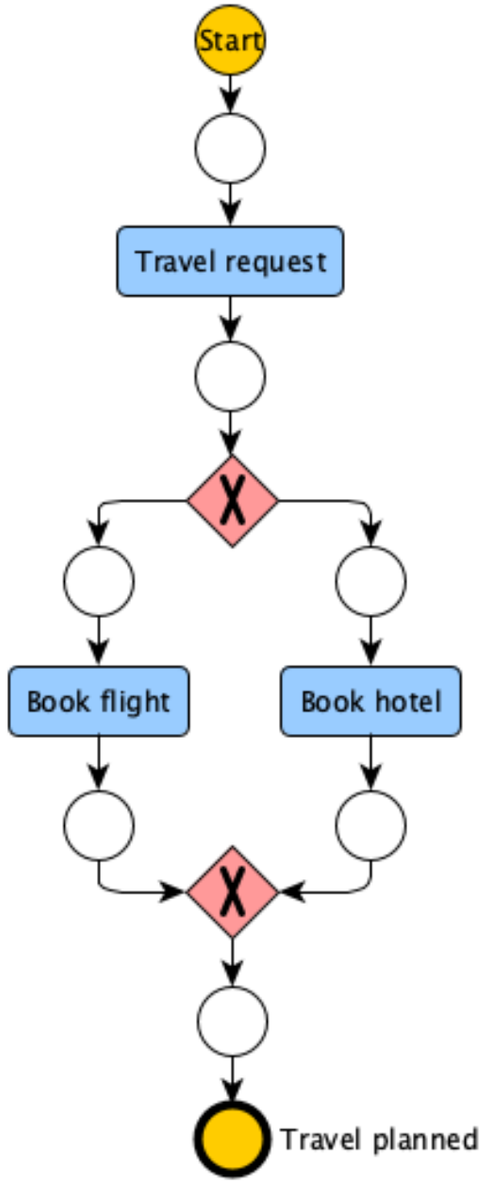


Step 2: convert flow objects

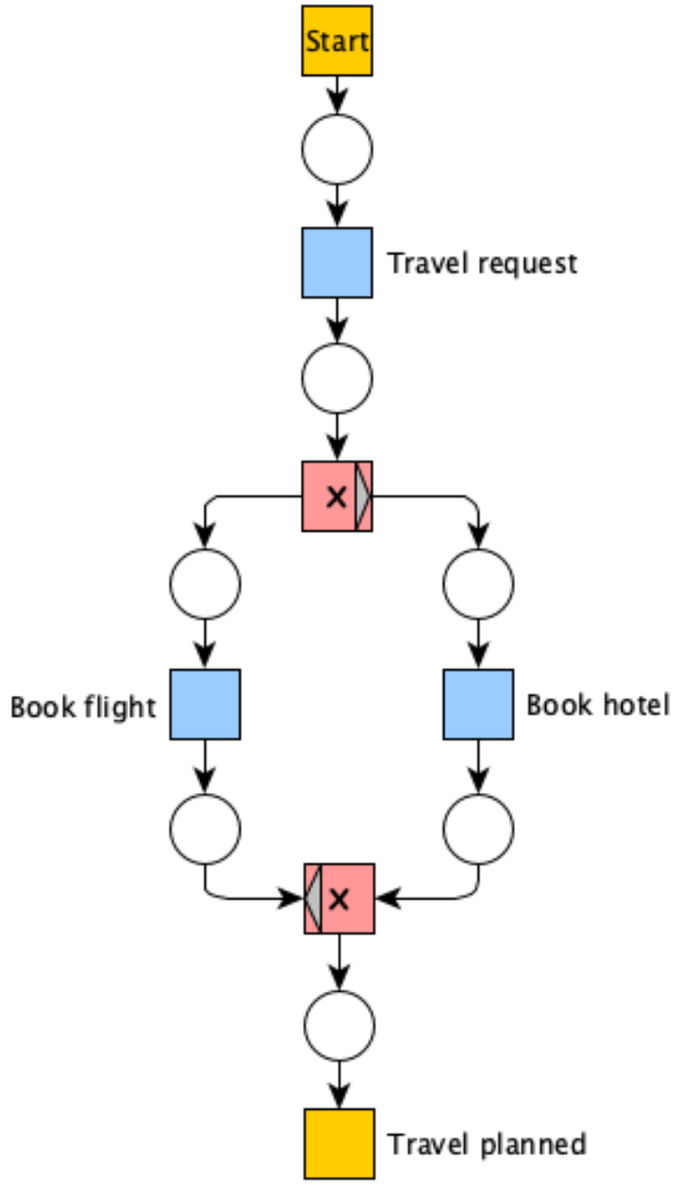
Then insert transitions



Step 1
sequence flow
message flow

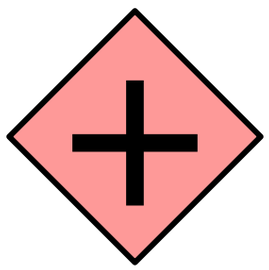


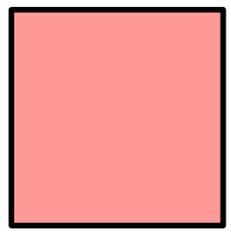
Step 2
flow objects

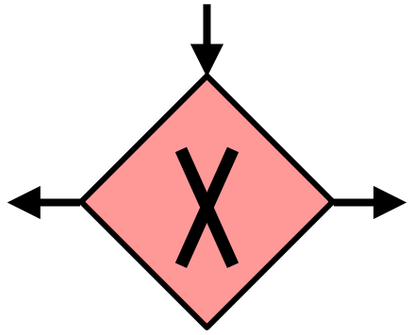


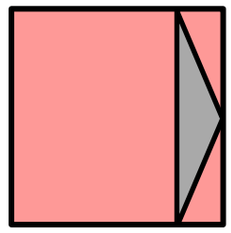
Step 2: gateways

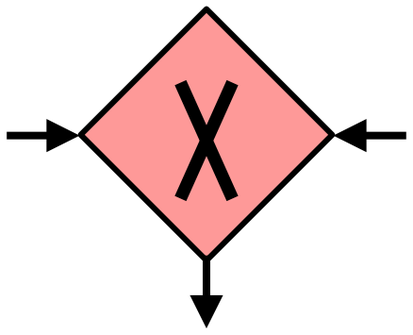
BPMN object **net fragment**

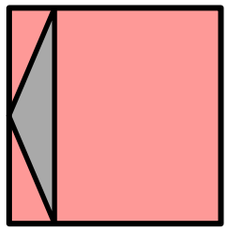


AND split / join transition 



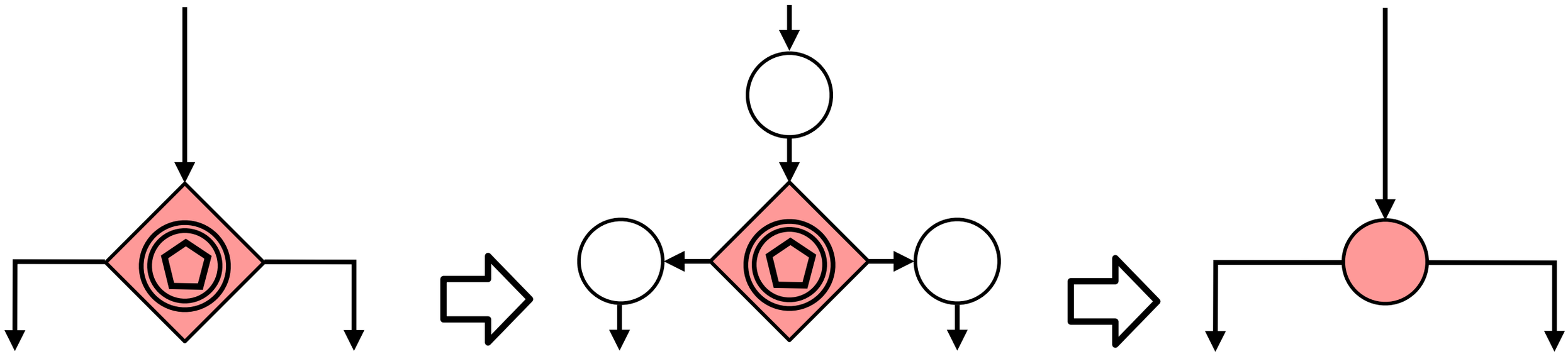
XOR split ⇨ transition 



XOR join transition 

Step 2: event-based

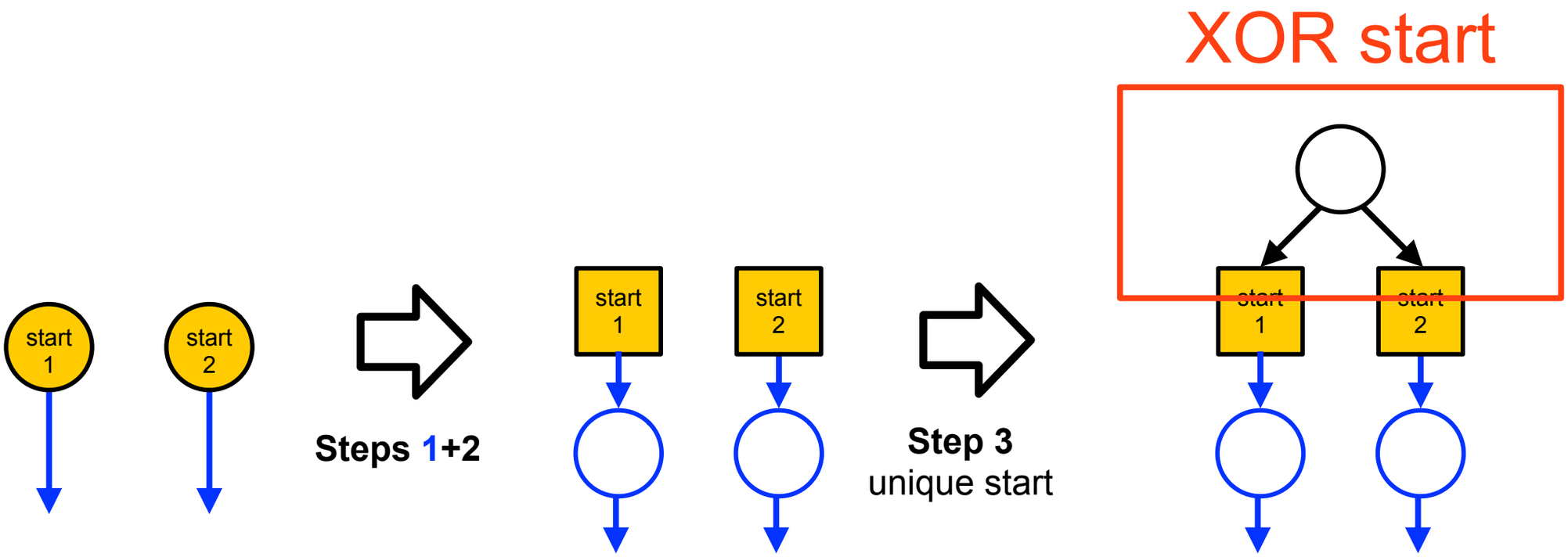
BPMN object **net fragment**



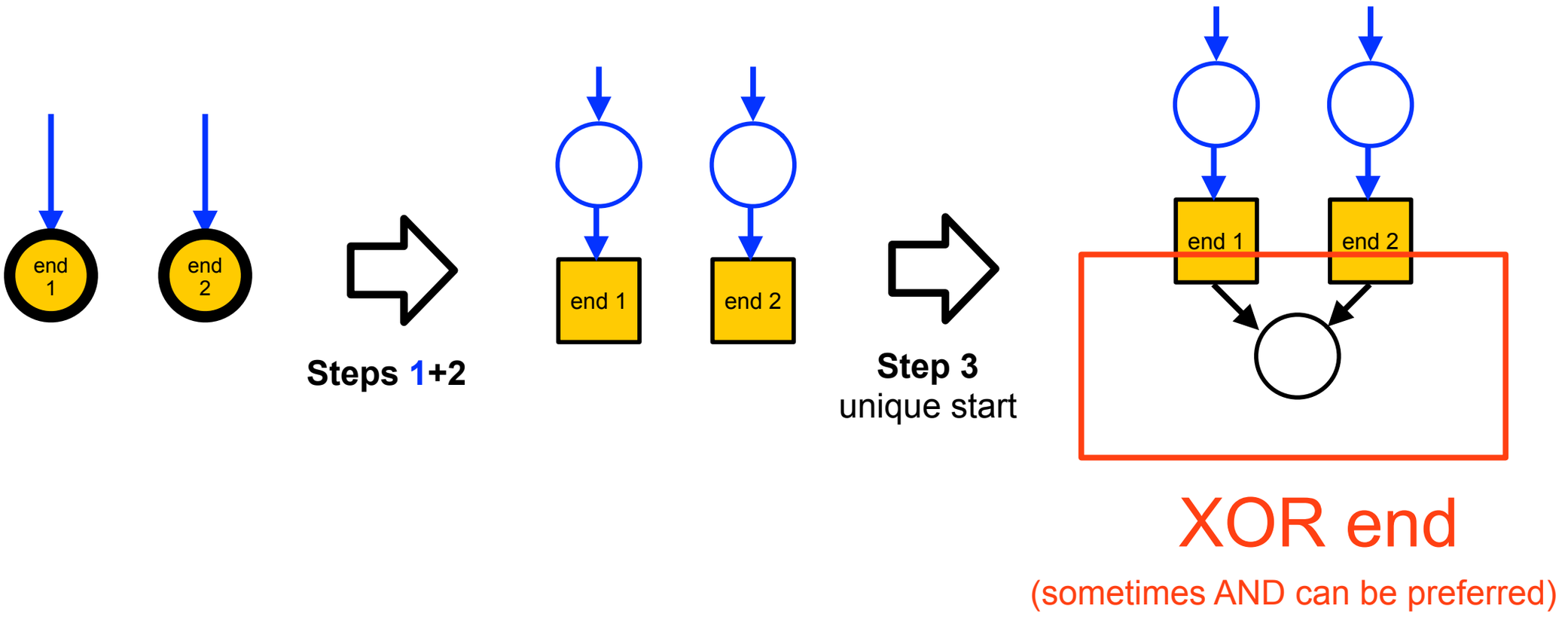
Step 1
sequence flow
message flow

Step 2
place fusion

Step 3: add unique start



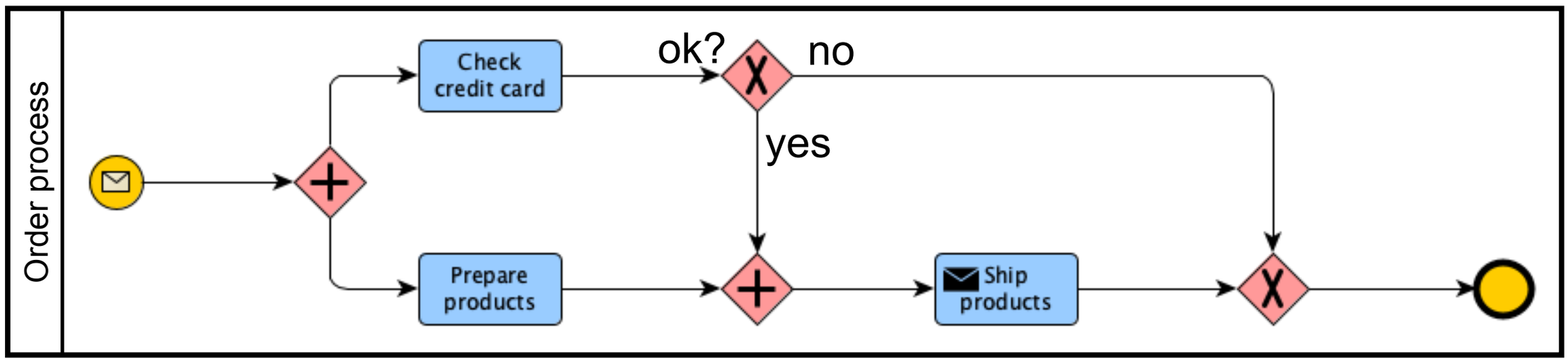
Step 3: add unique end



Example:

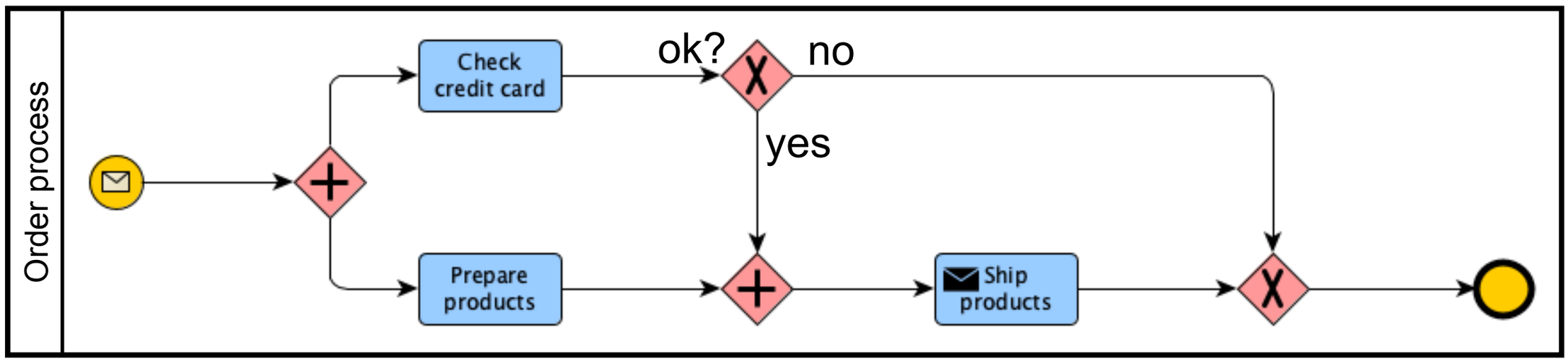
Order process

Order process

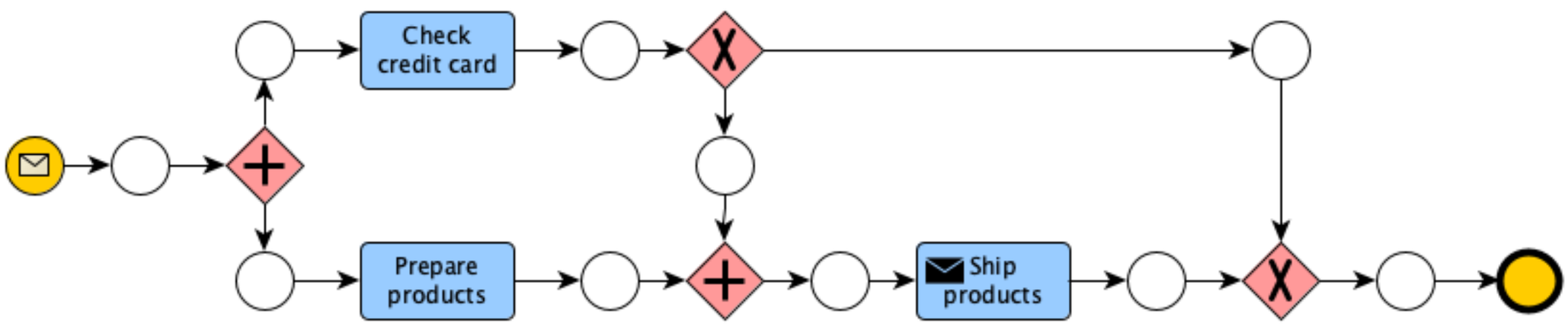


Sound?

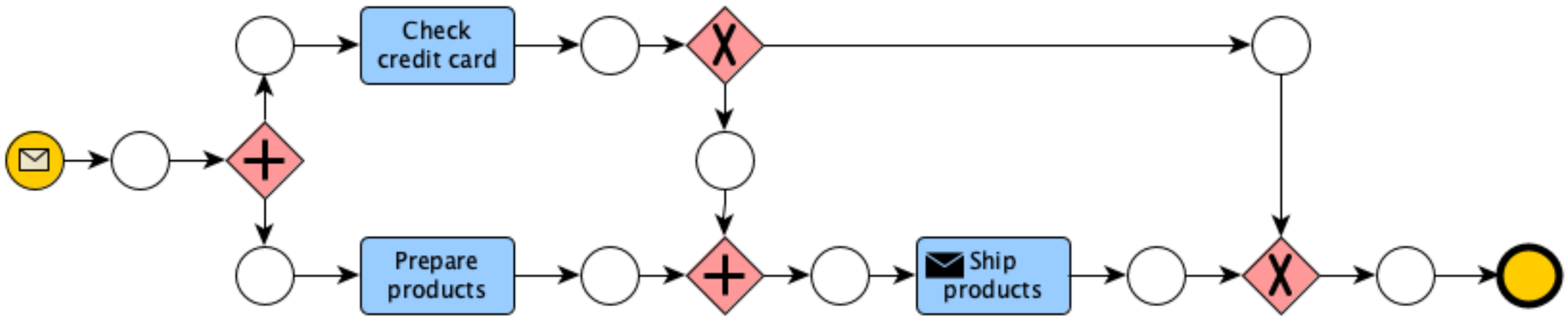
Order process: step 1

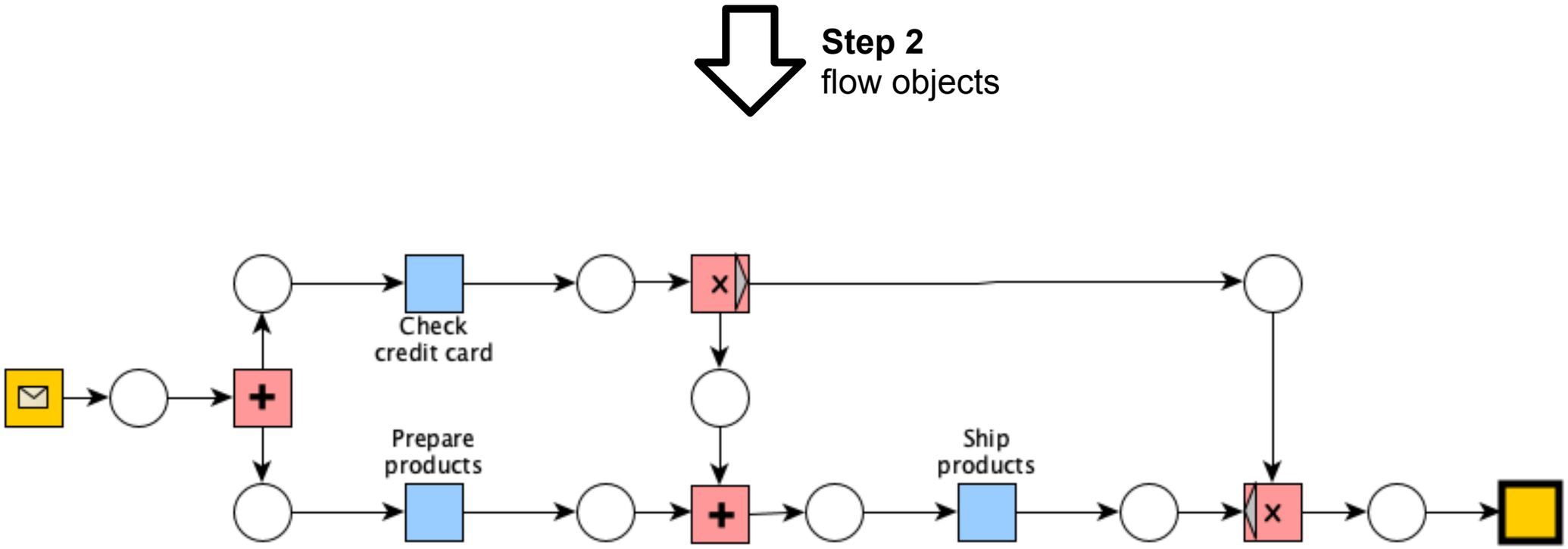


Step 1
sequence flow
message flow

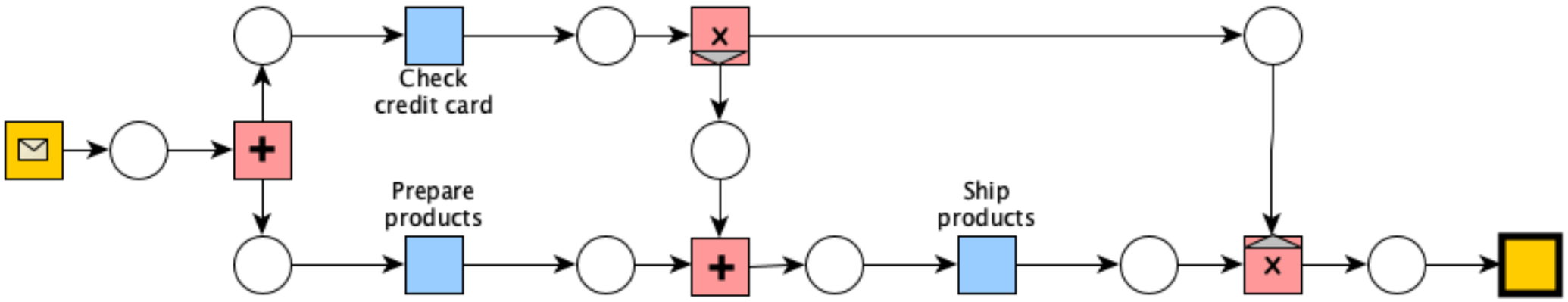


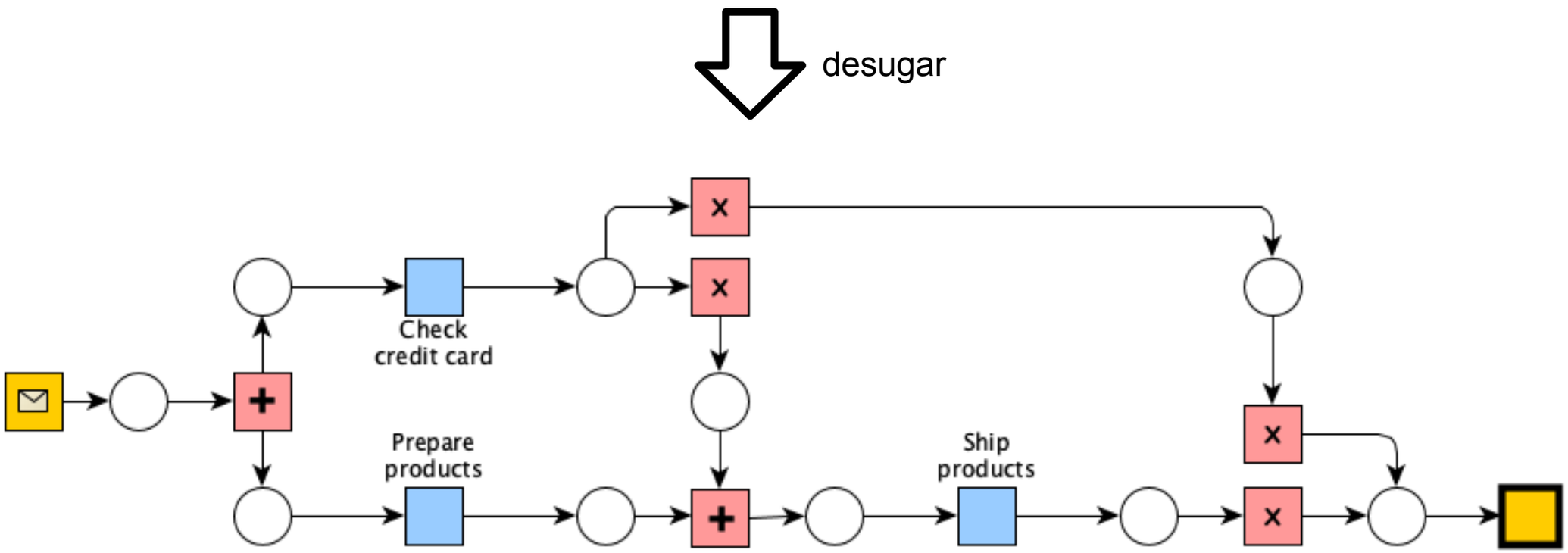
Order process: step 2



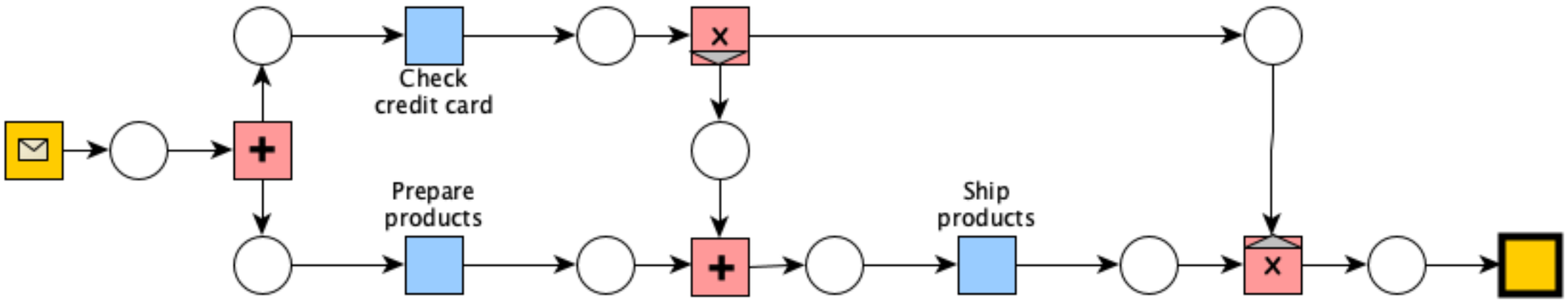


Order process: (desugar)

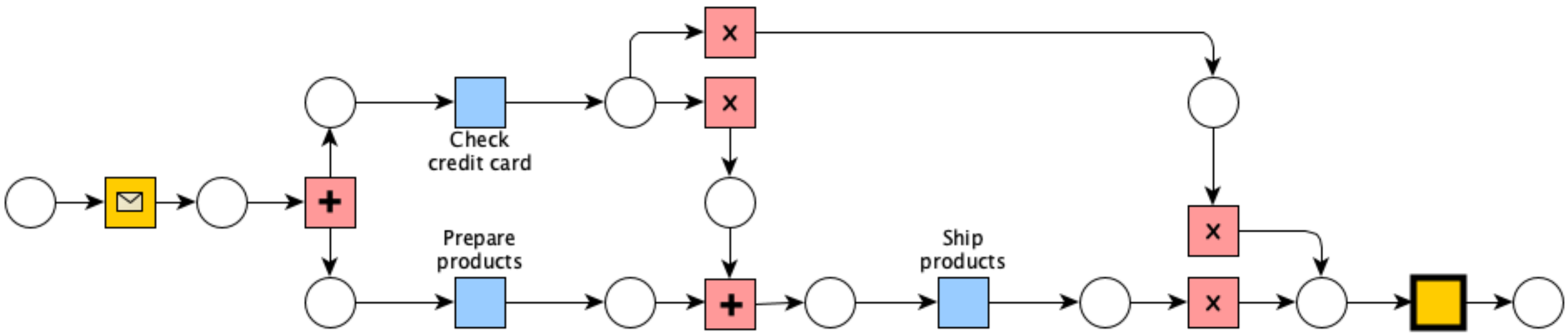




Order process: step 3

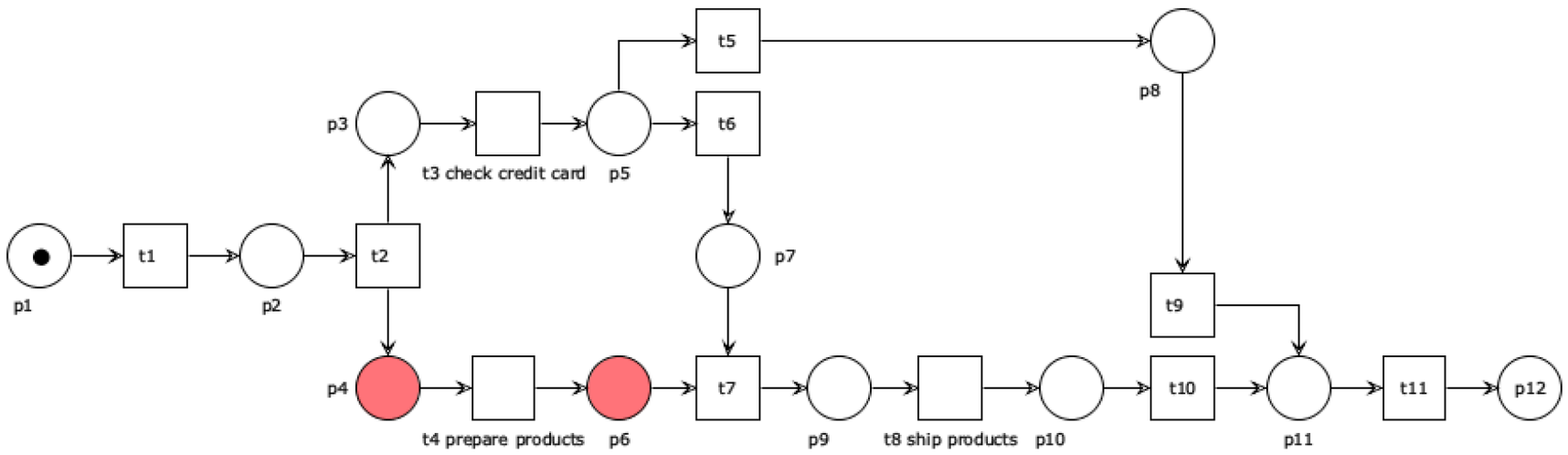


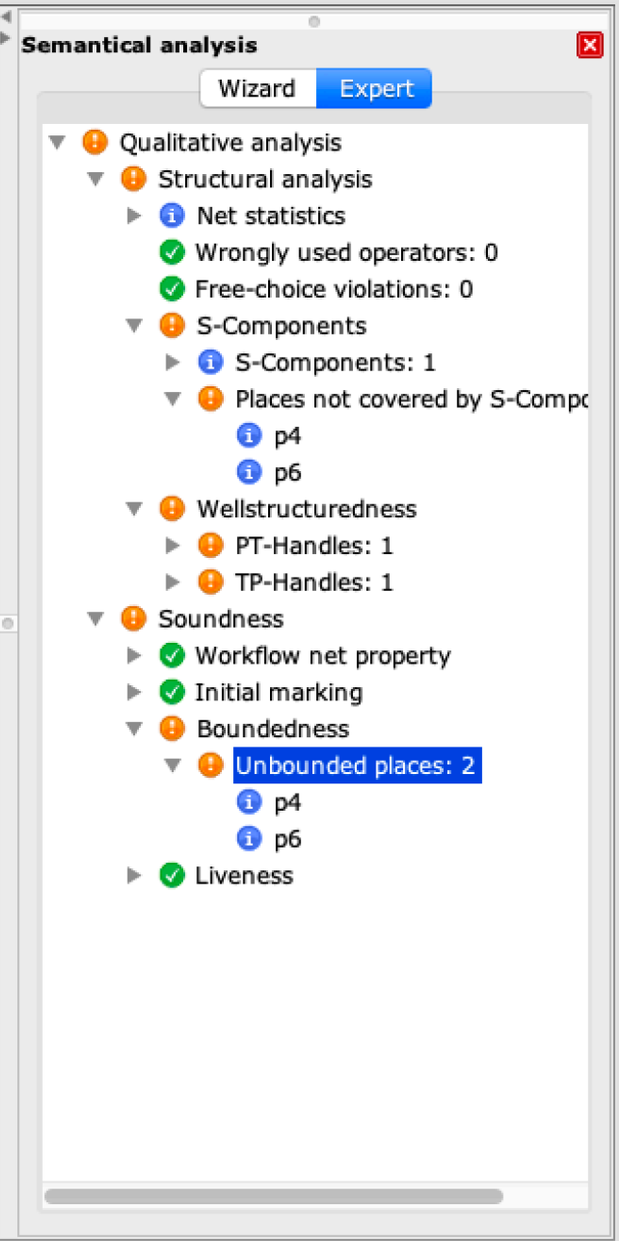
Step 3
enforce
initial place
final place



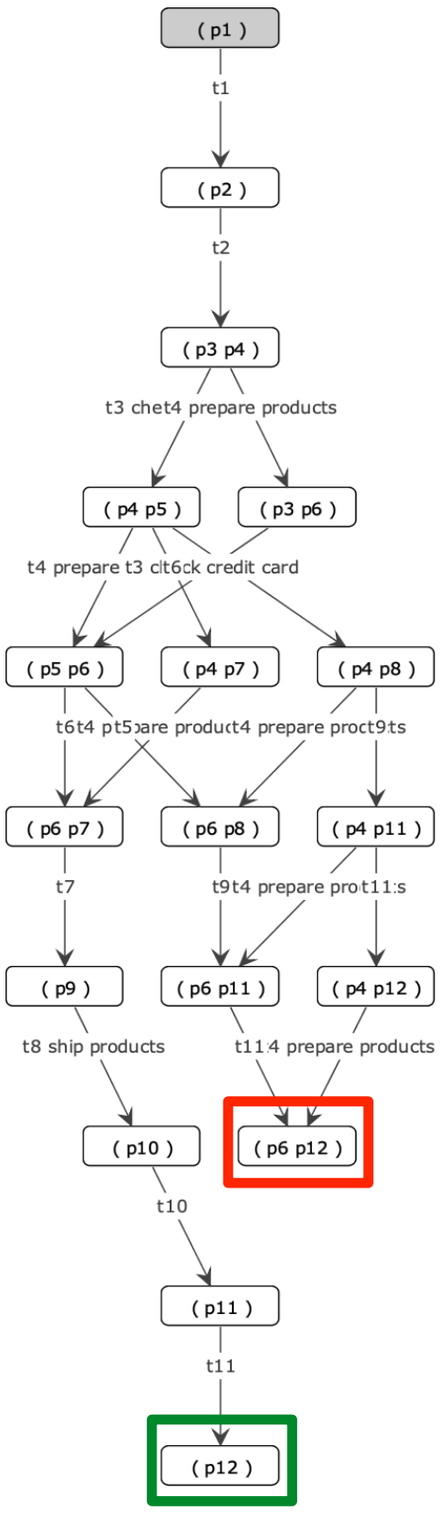
Soundness analysis

Not sound!

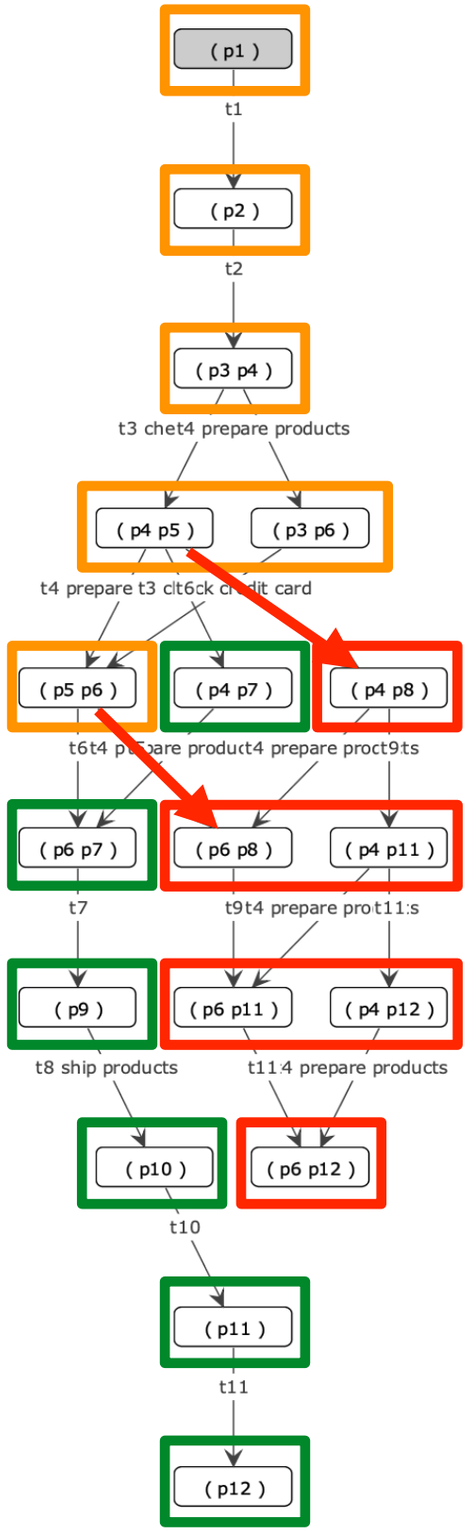




Soundness analysis



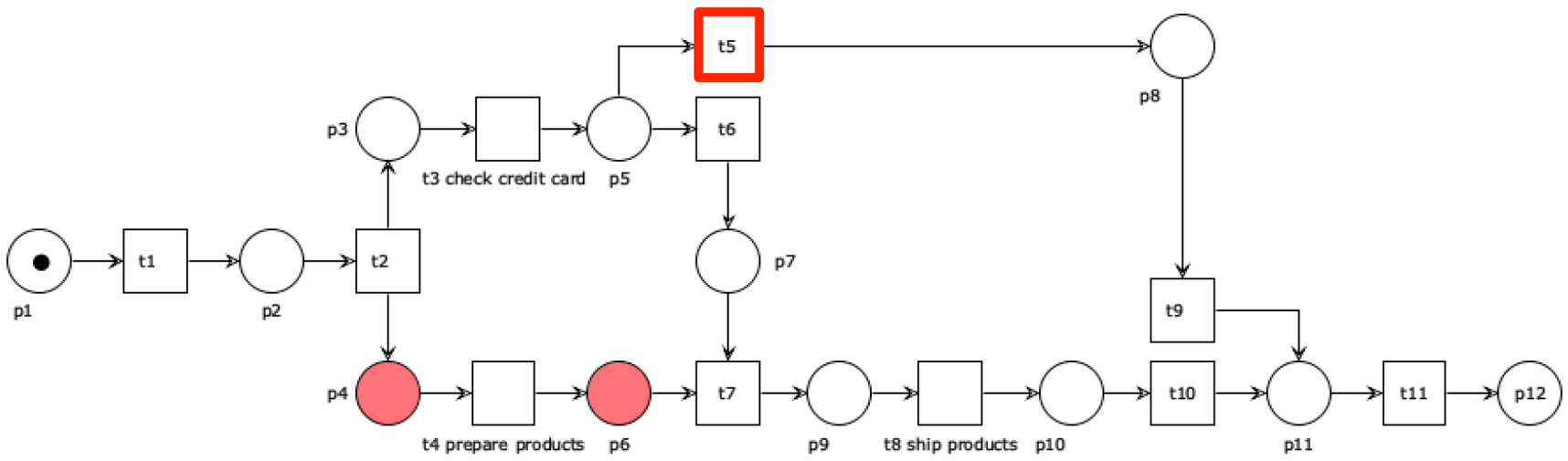
Soundness analysis

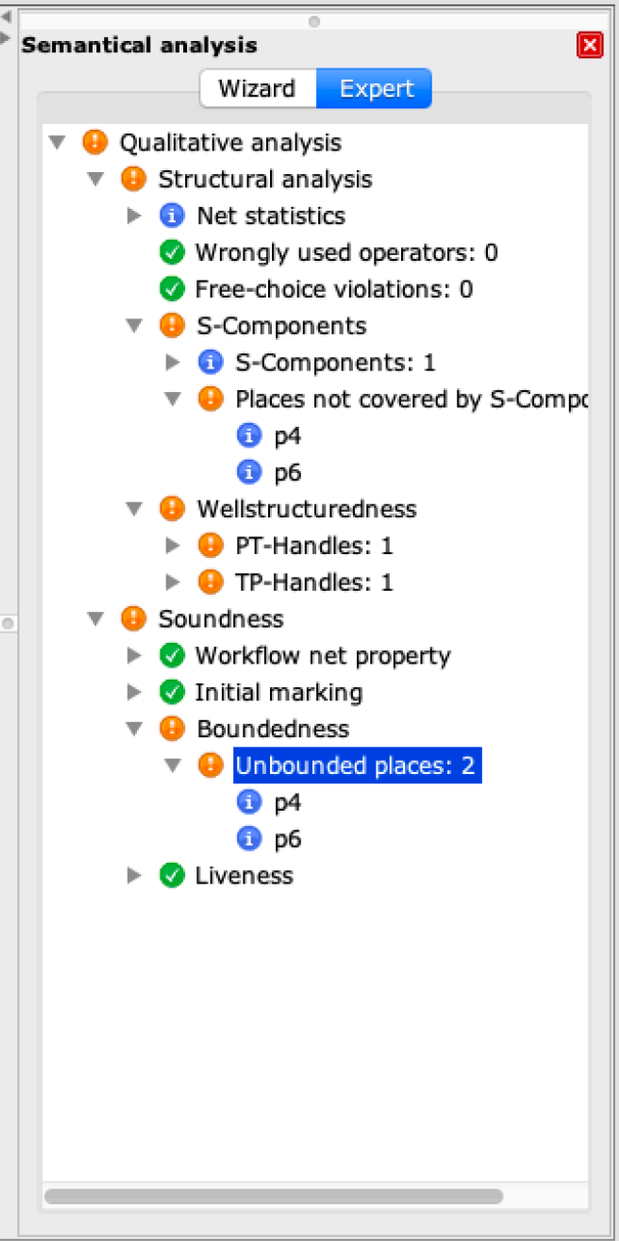


t5

Soundness analysis

Not sound!

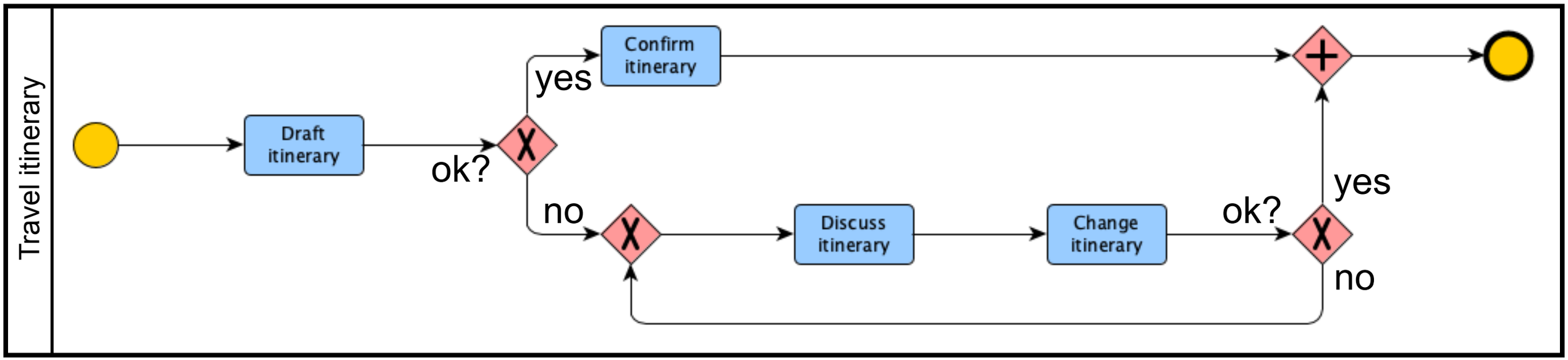




Example:

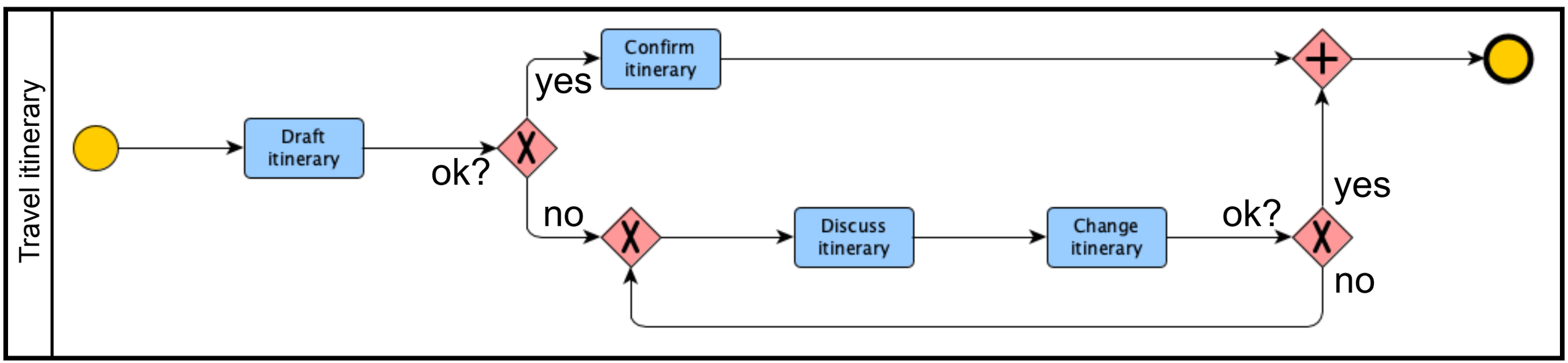
Travel itinerary

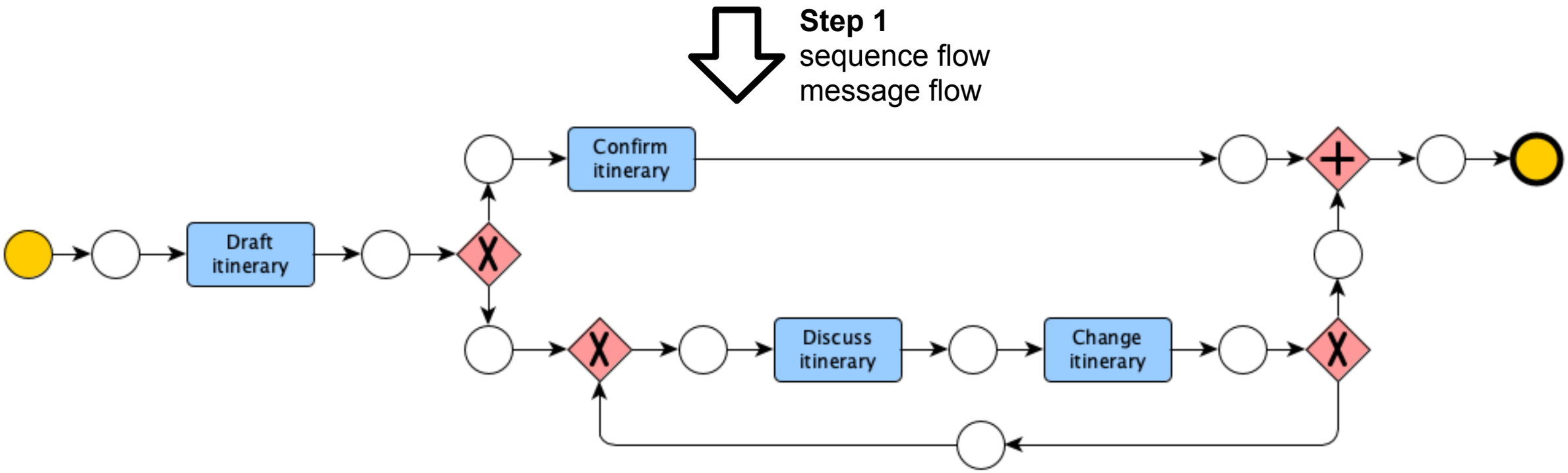
Travel itinerary



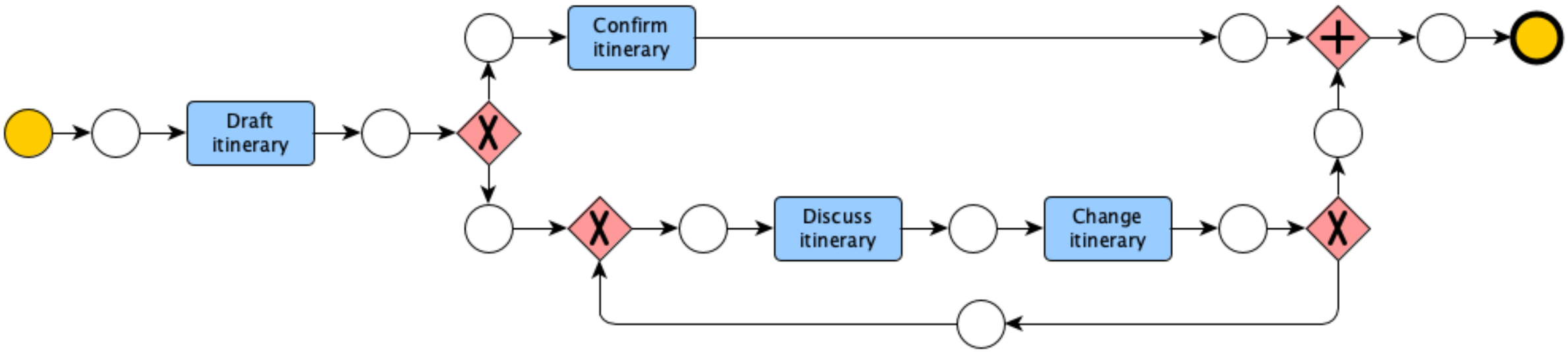
Sound?

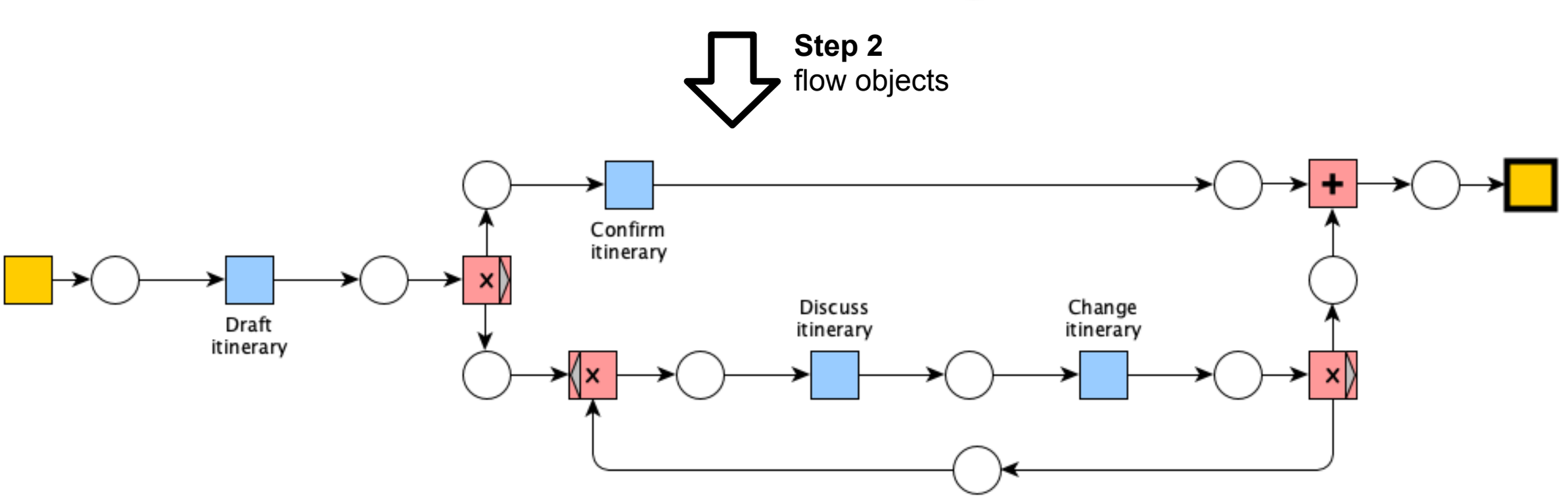
Travel itinerary: step 1



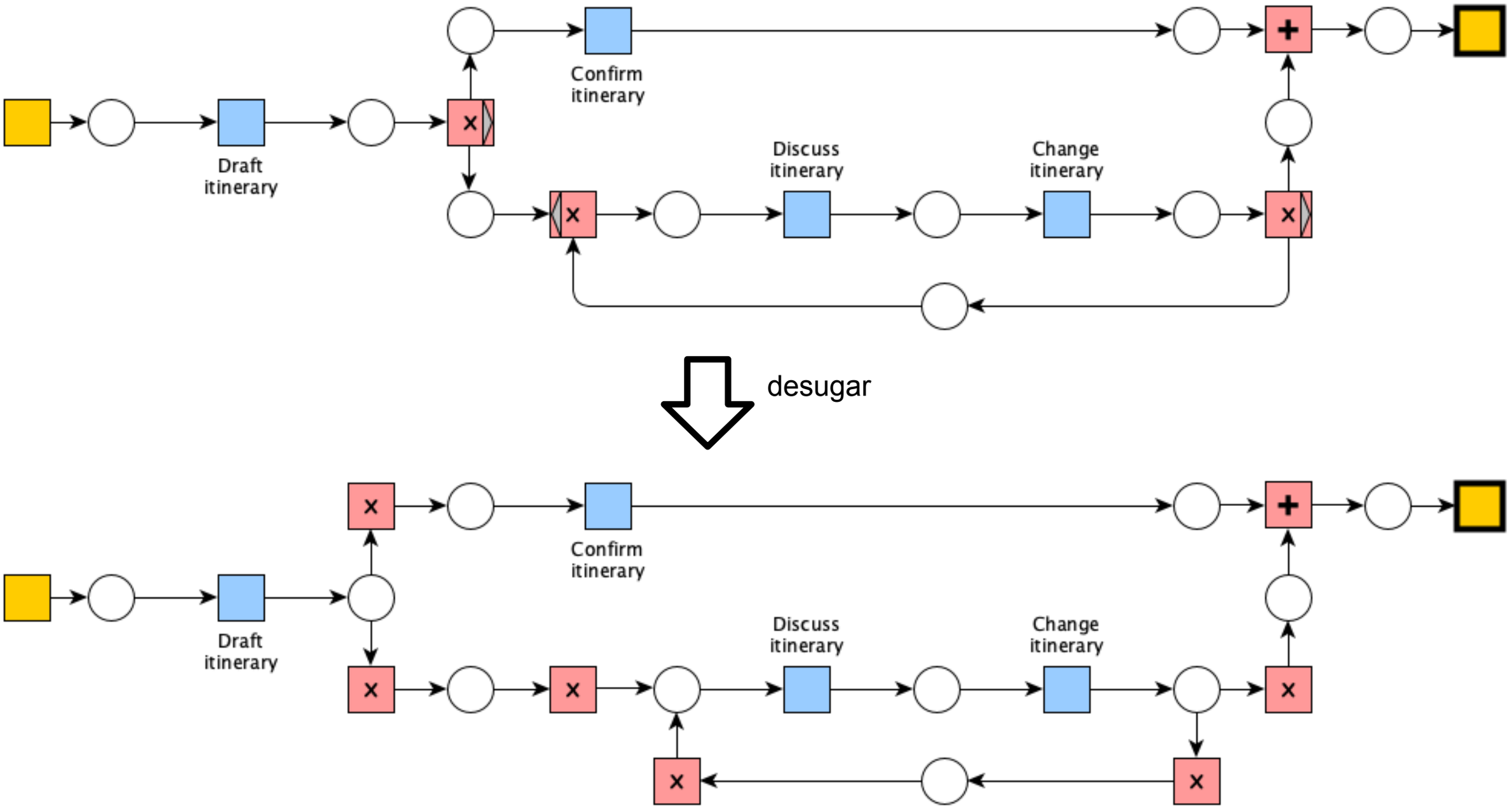


Travel itinerary: step 2

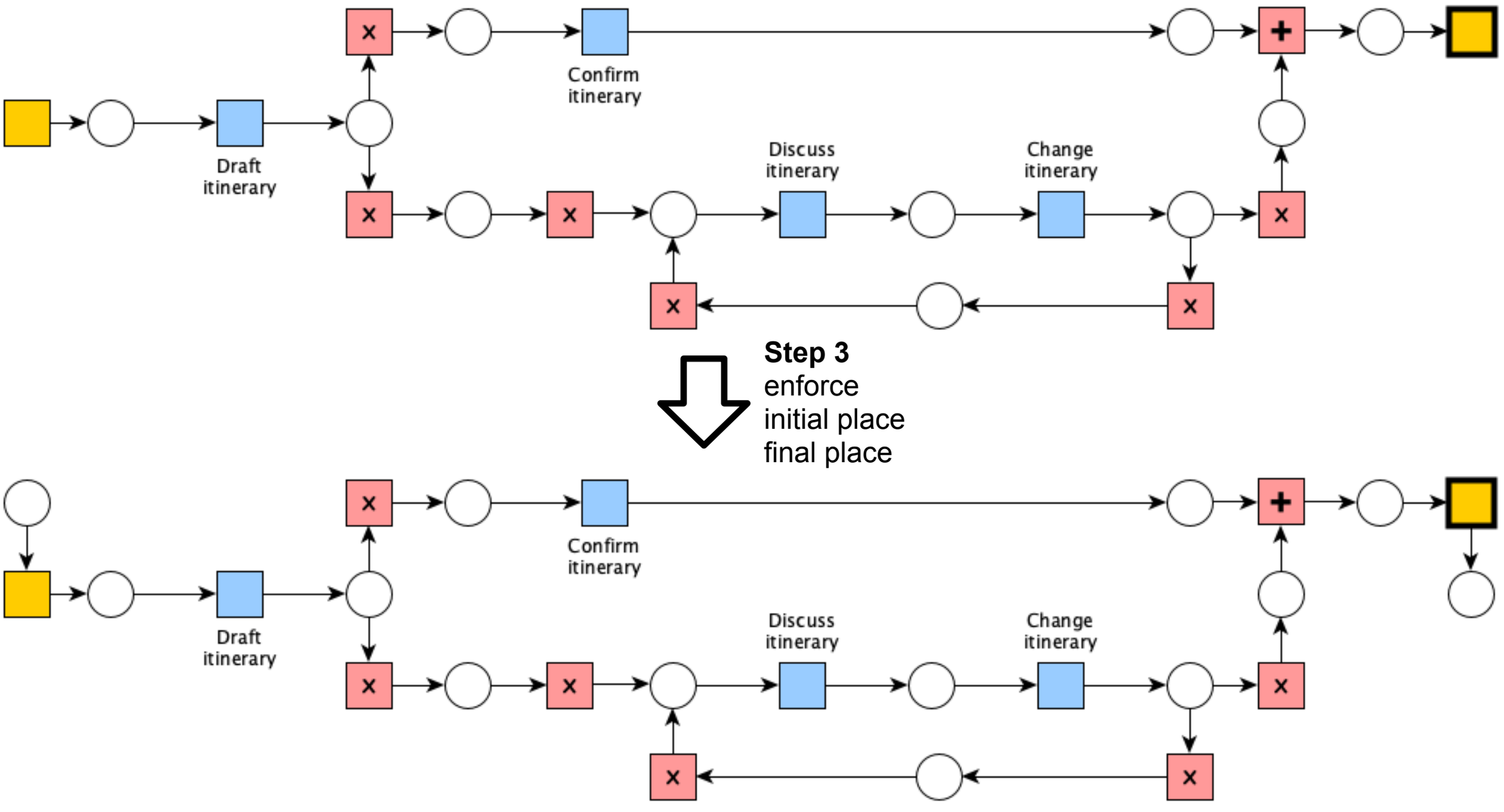




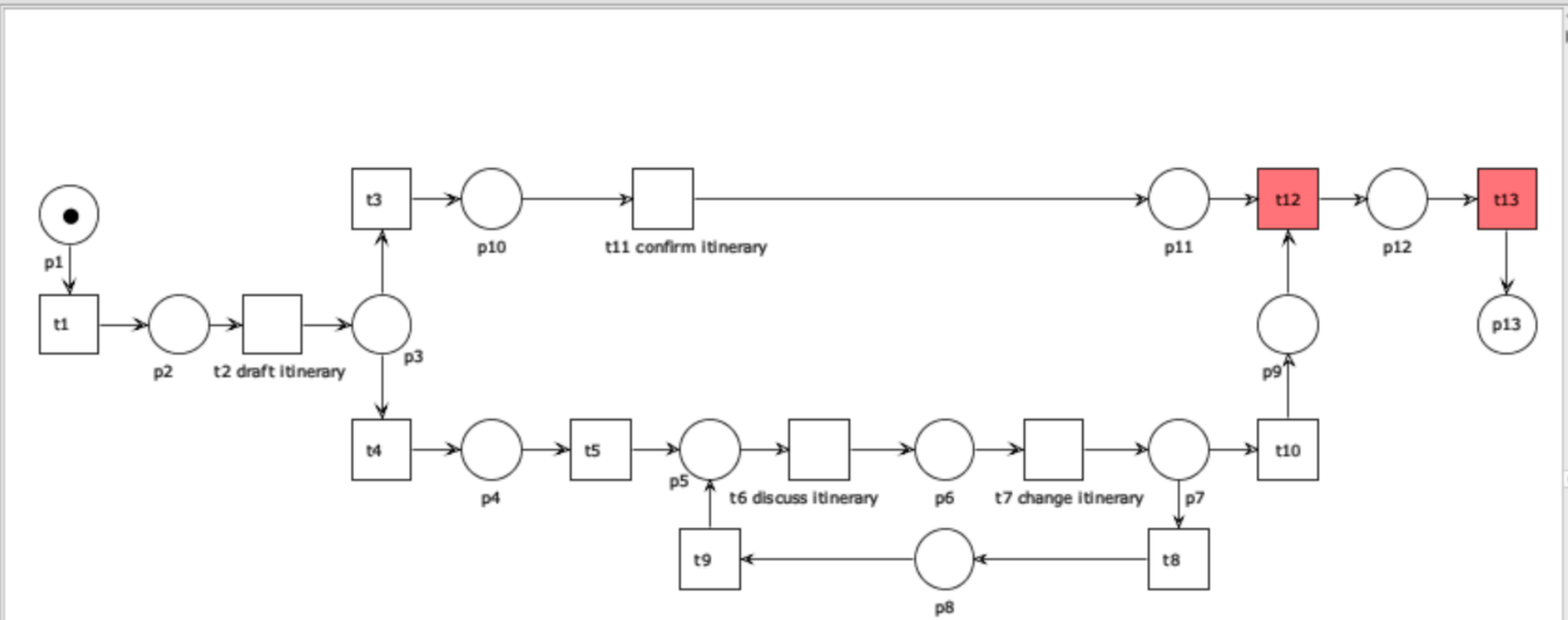
Travel itinerary: (desugar)



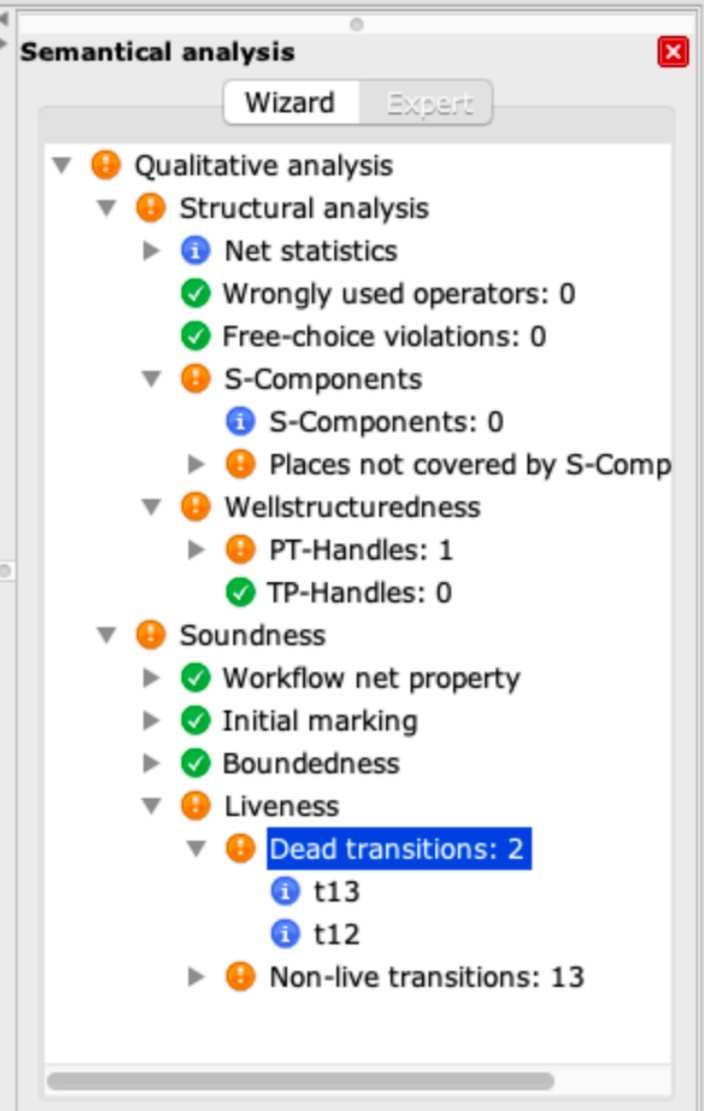
Travel itinerary: step 3



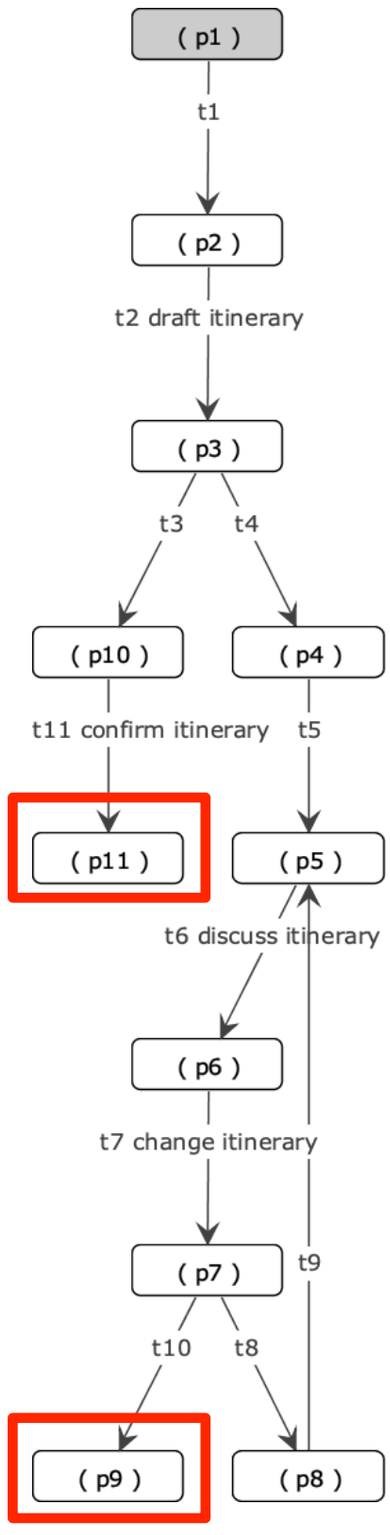
Soundness analysis



Not sound!



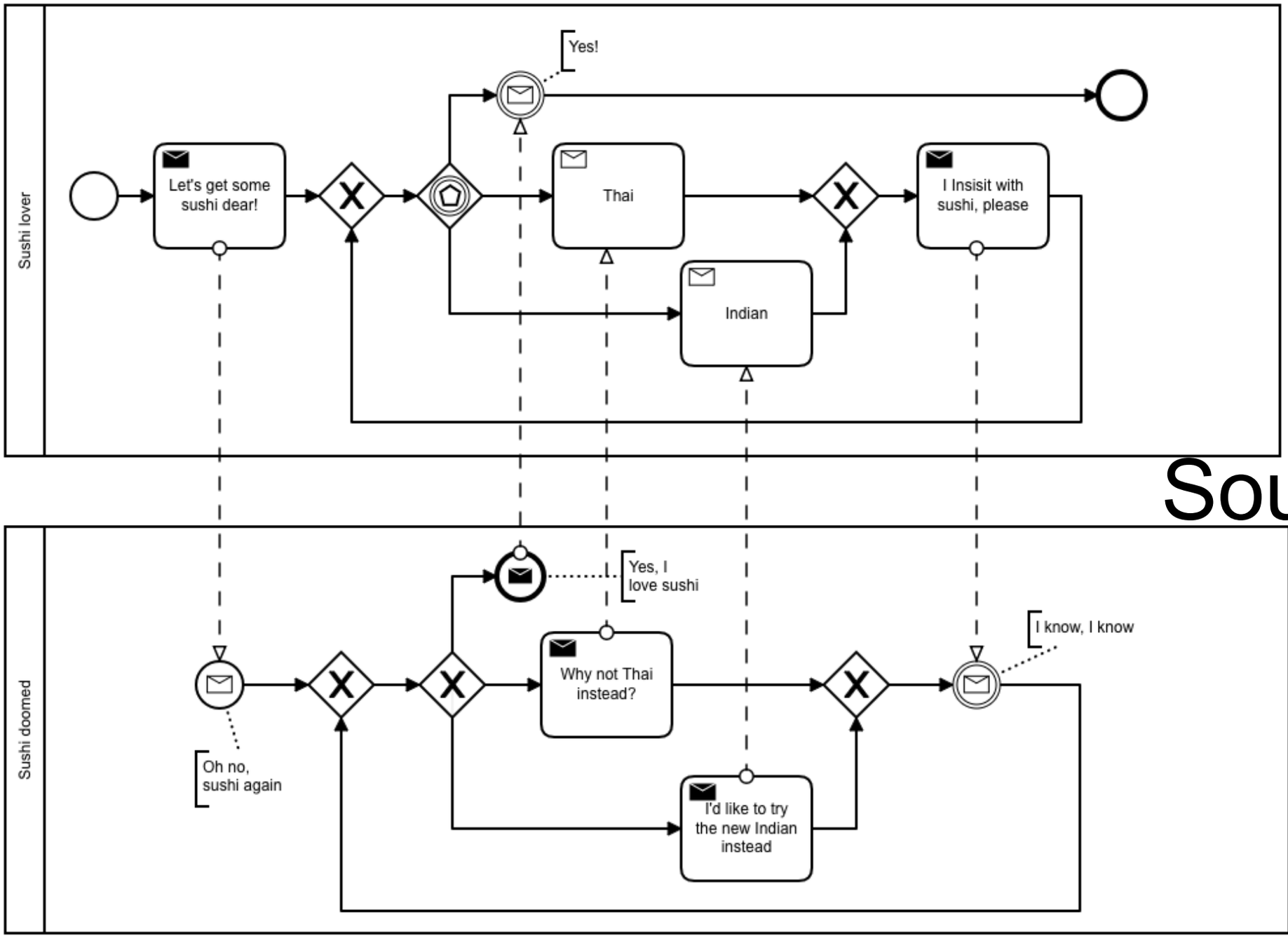
Soundness analysis



Example:

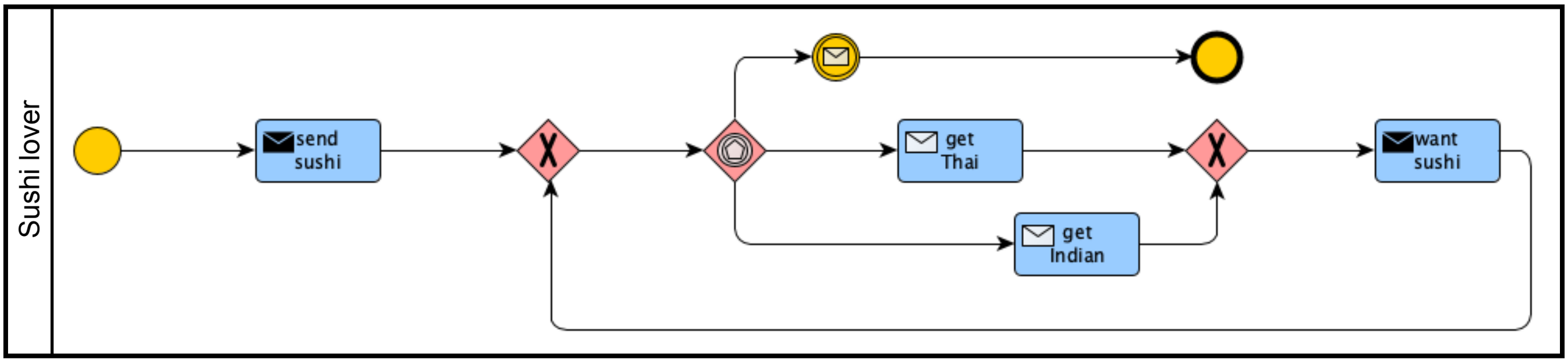
Always sushi

Always sushi



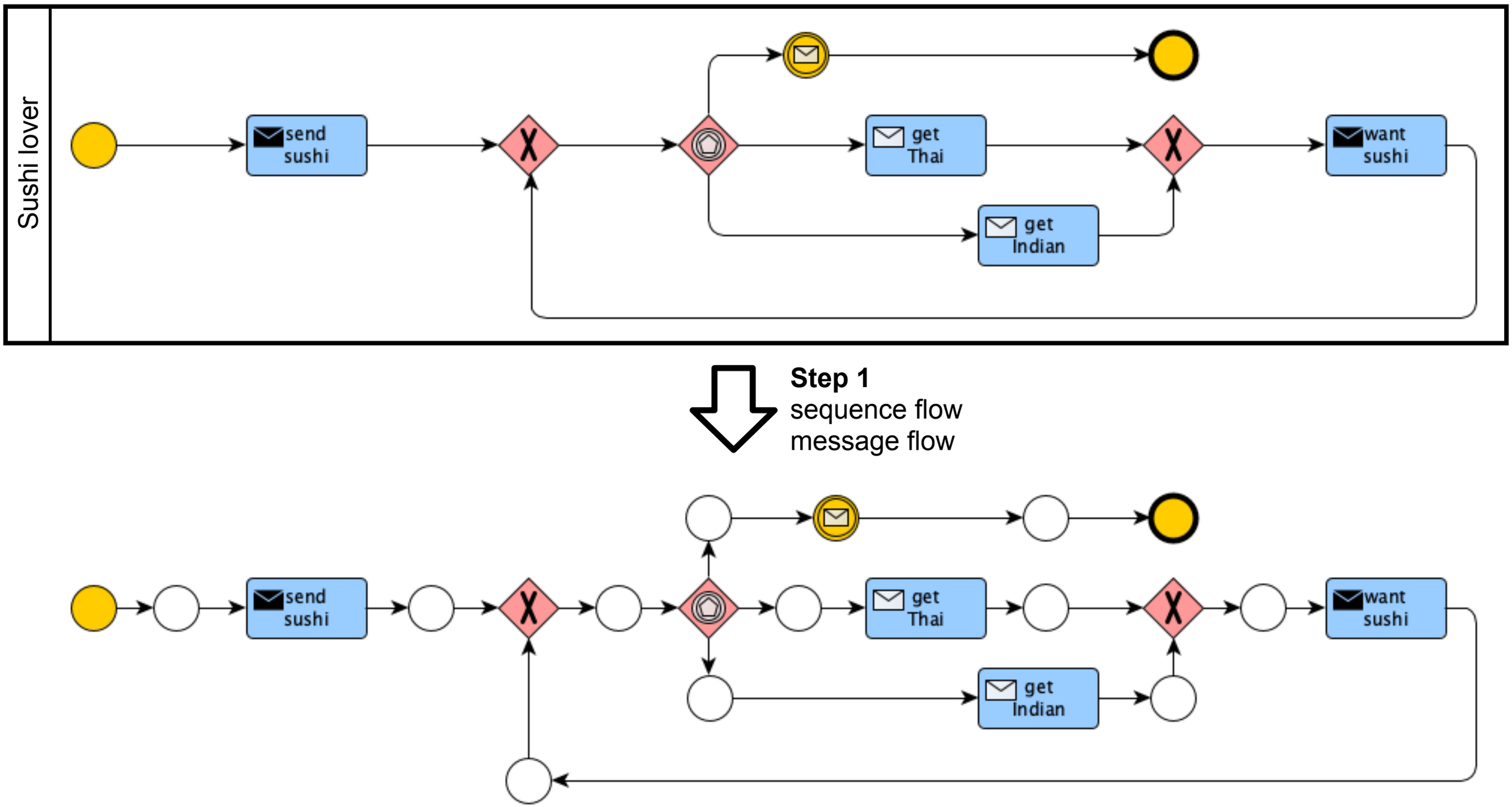
Sound?

Sushi lover

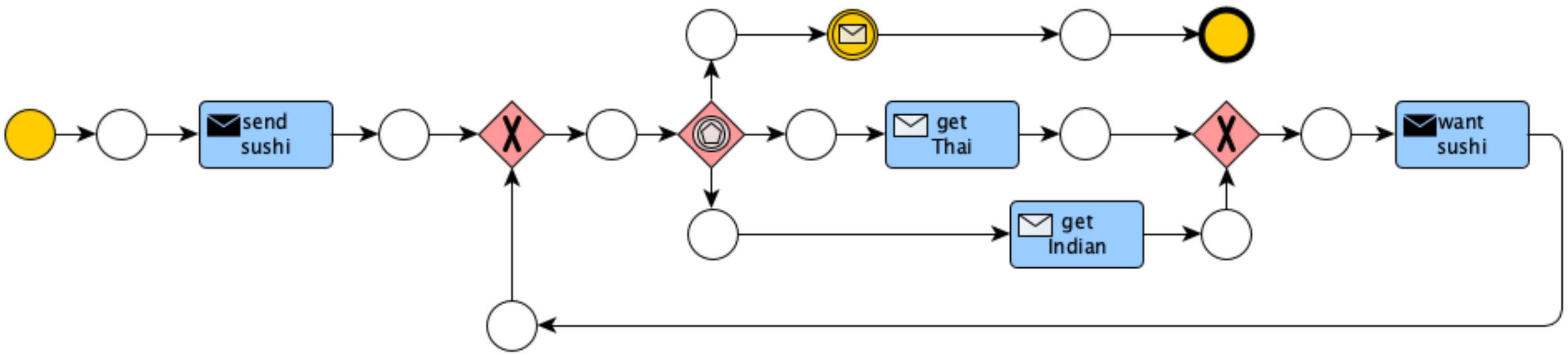


Sound?

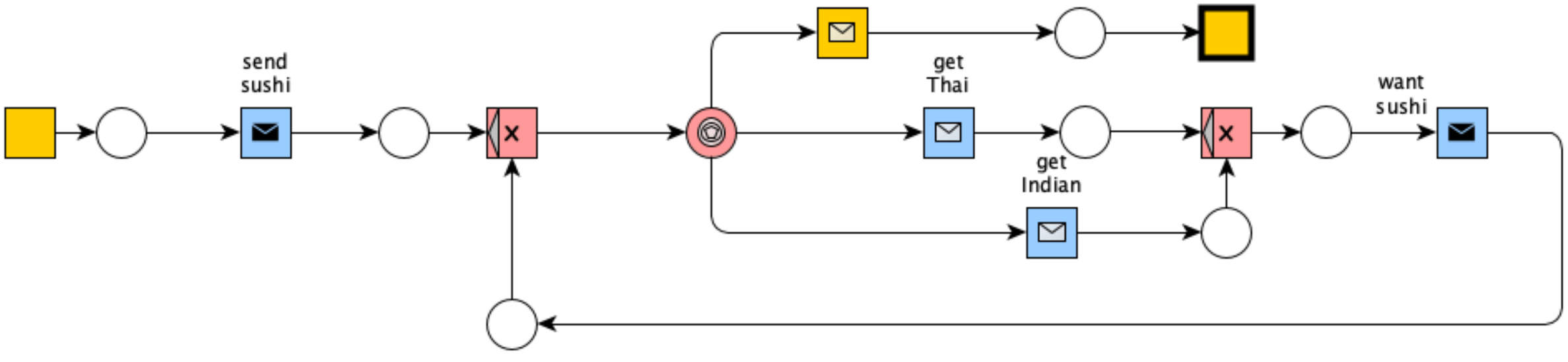
Sushi lover: step 1



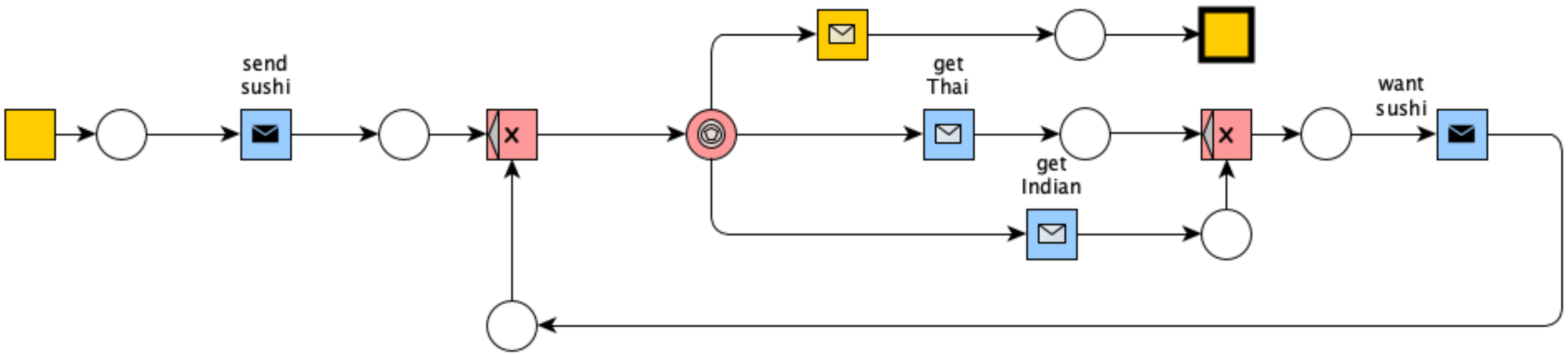
Sushi lover: step 2



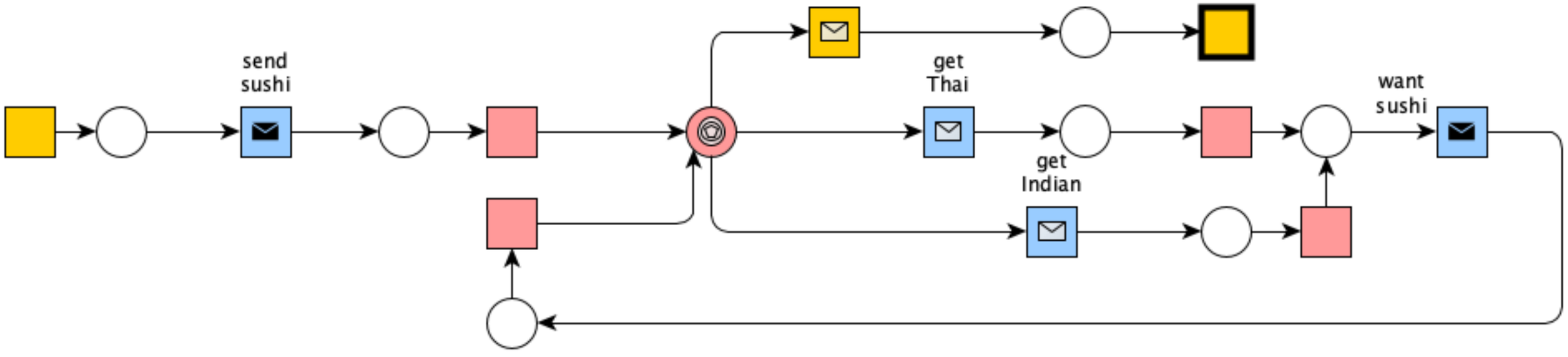
Step 2
flow objects



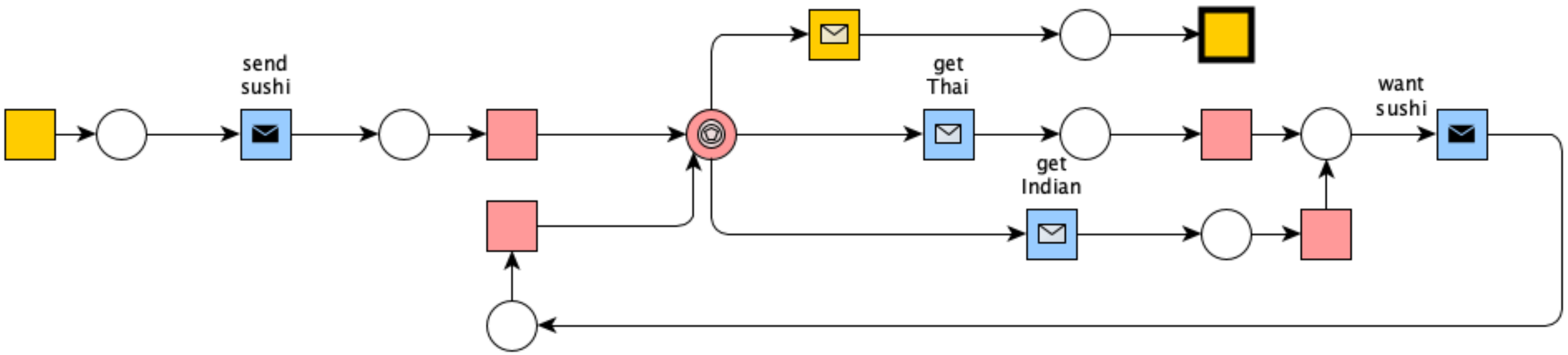
Sushi lover: (desugar)



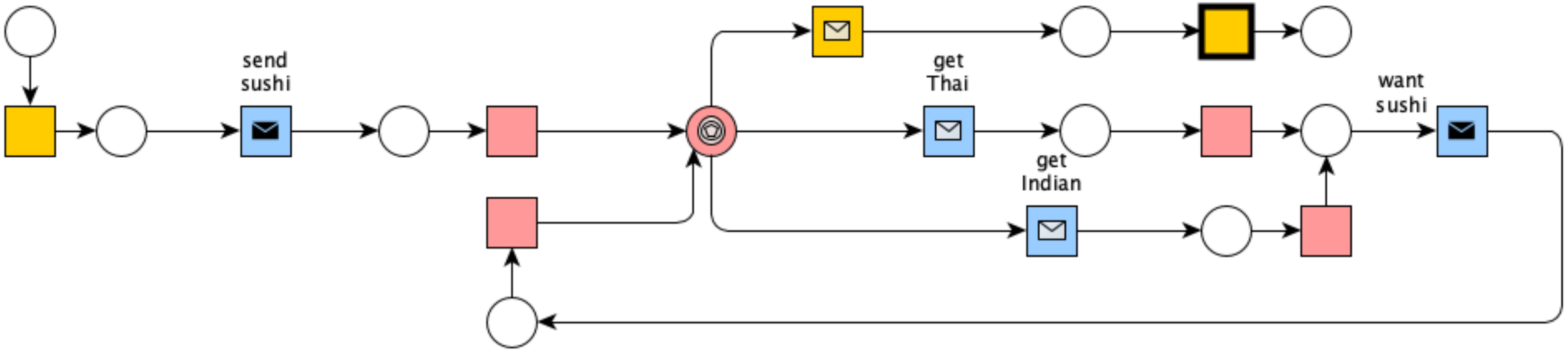
desugar



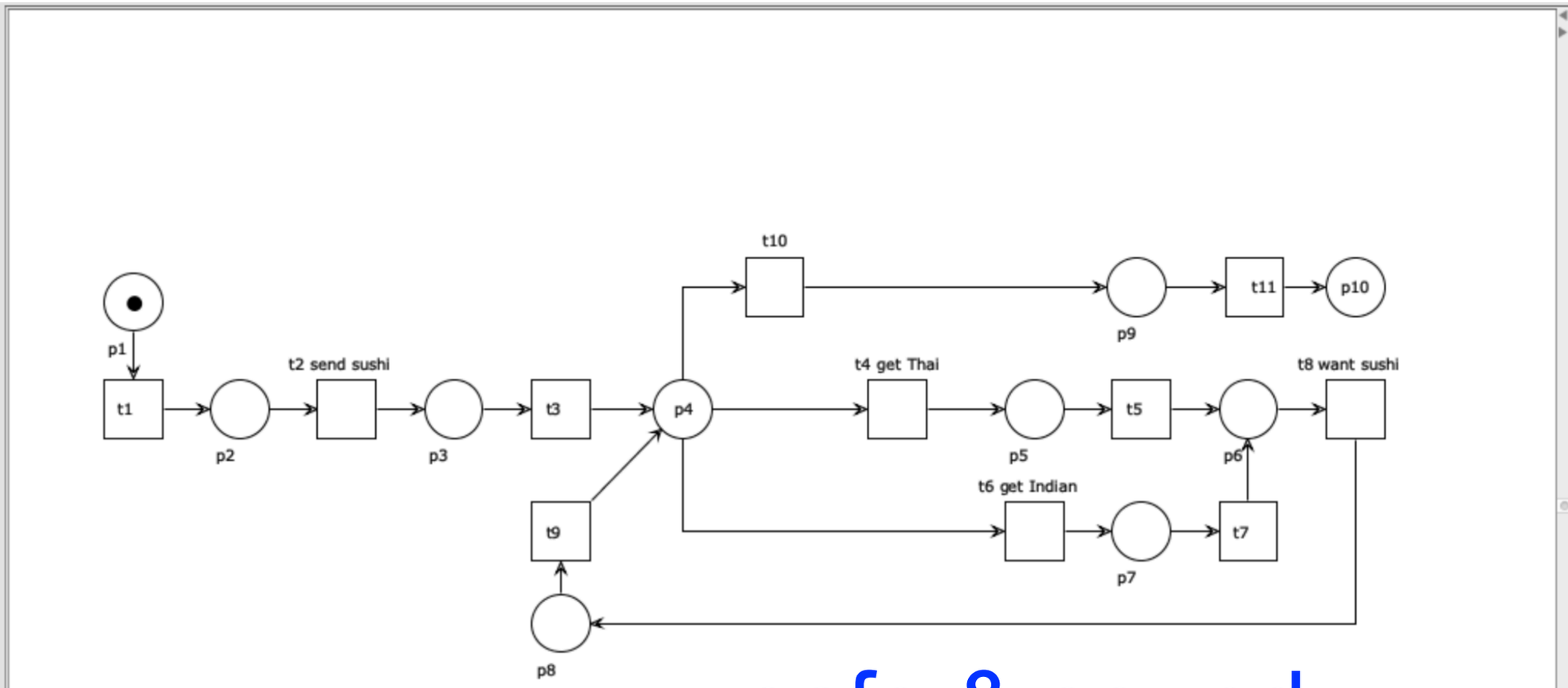
Sushi lover: step 3



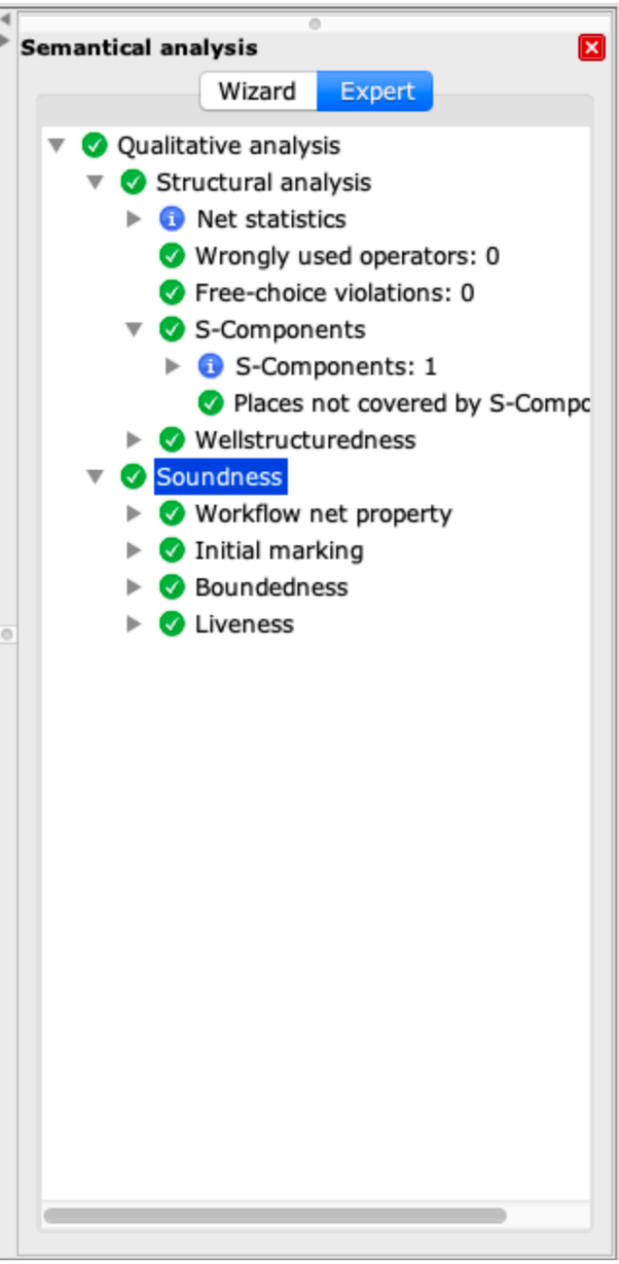
Step 3
enforce
initial place
final place



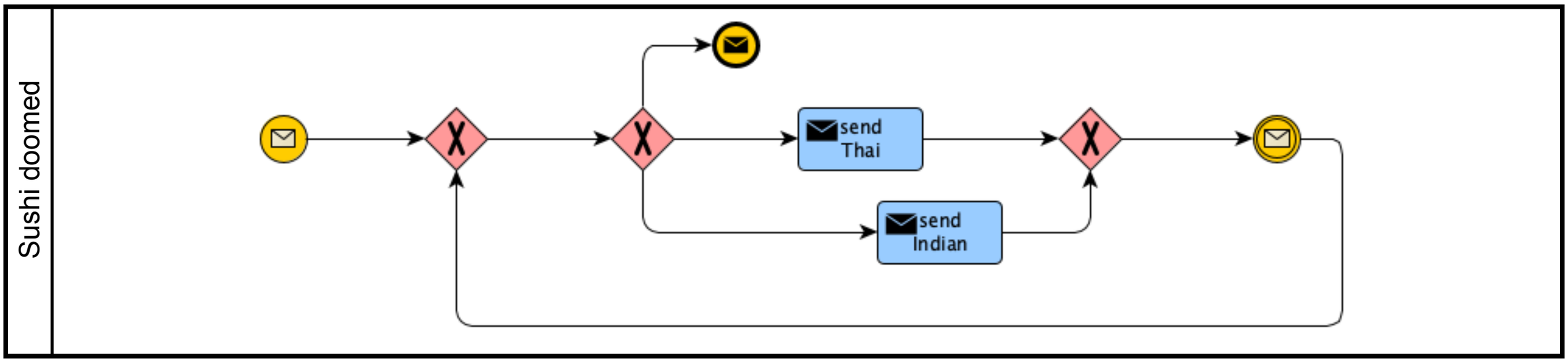
Soundness analysis



safe & sound
(s-net)

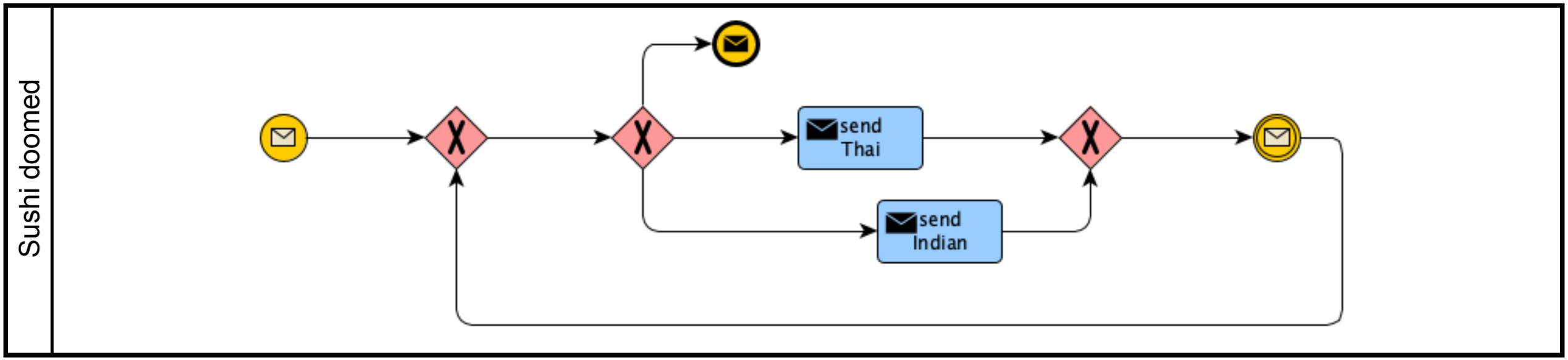


Sushi doomed

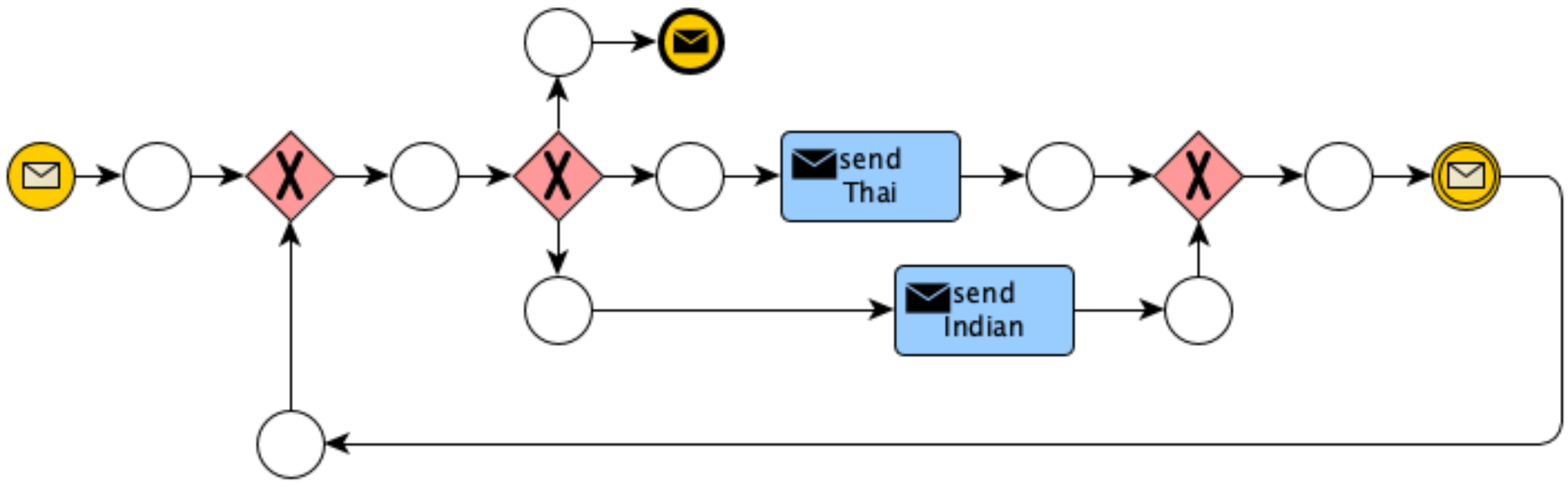


Sound?

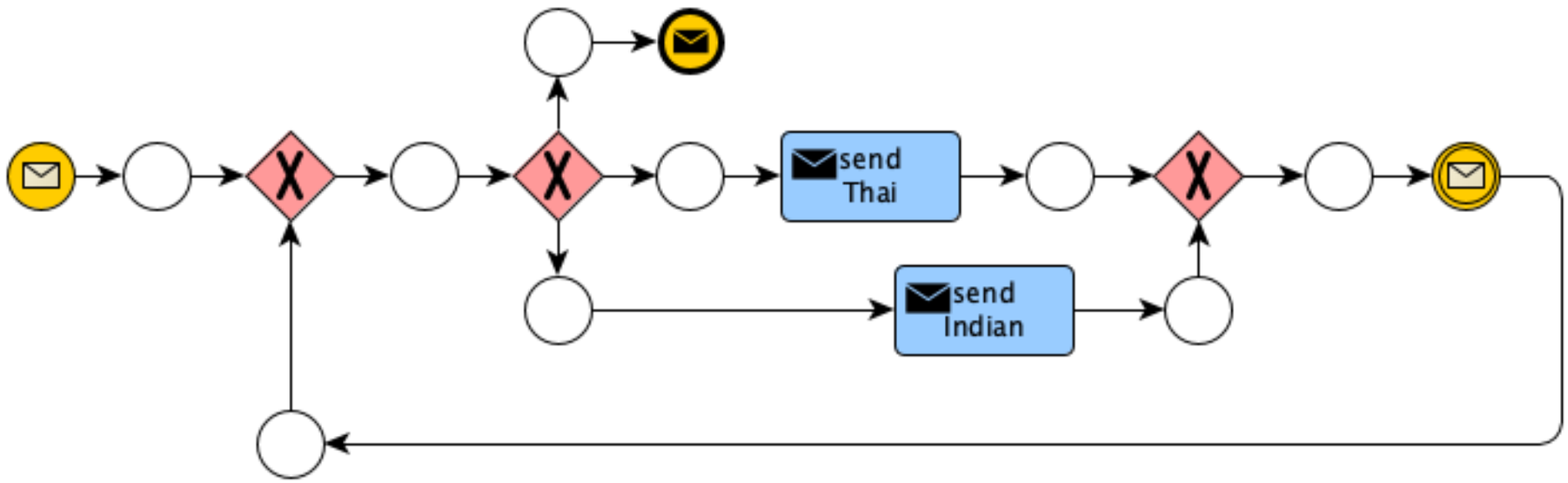
Sushi doomed: step 1



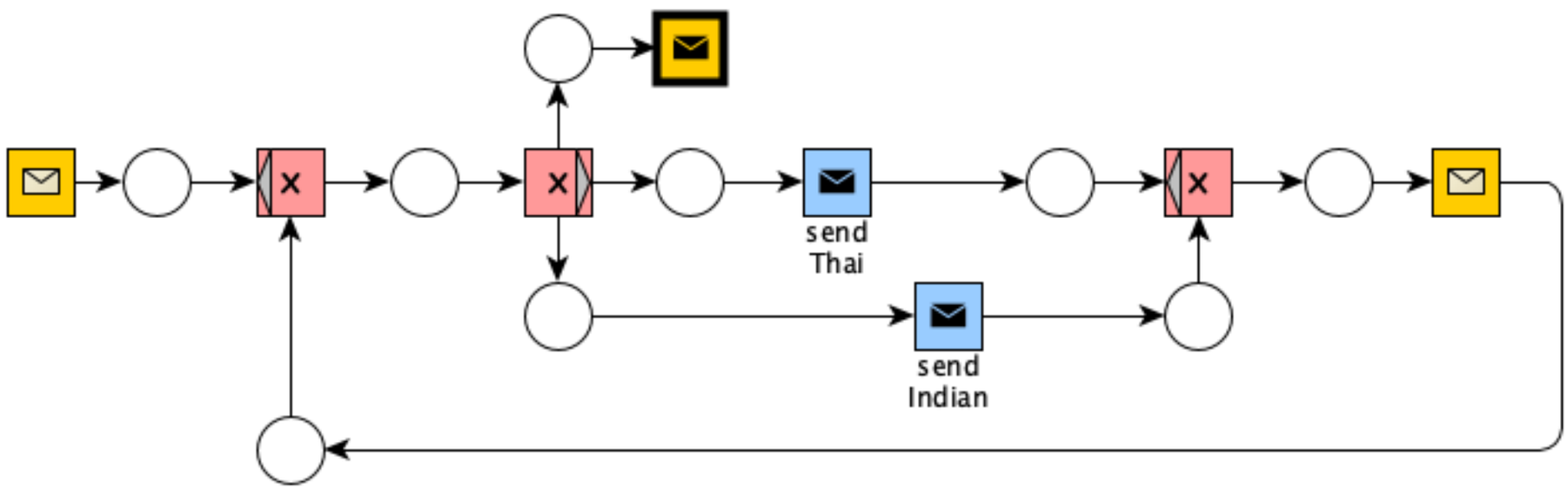
Step 1
sequence flow
message flow



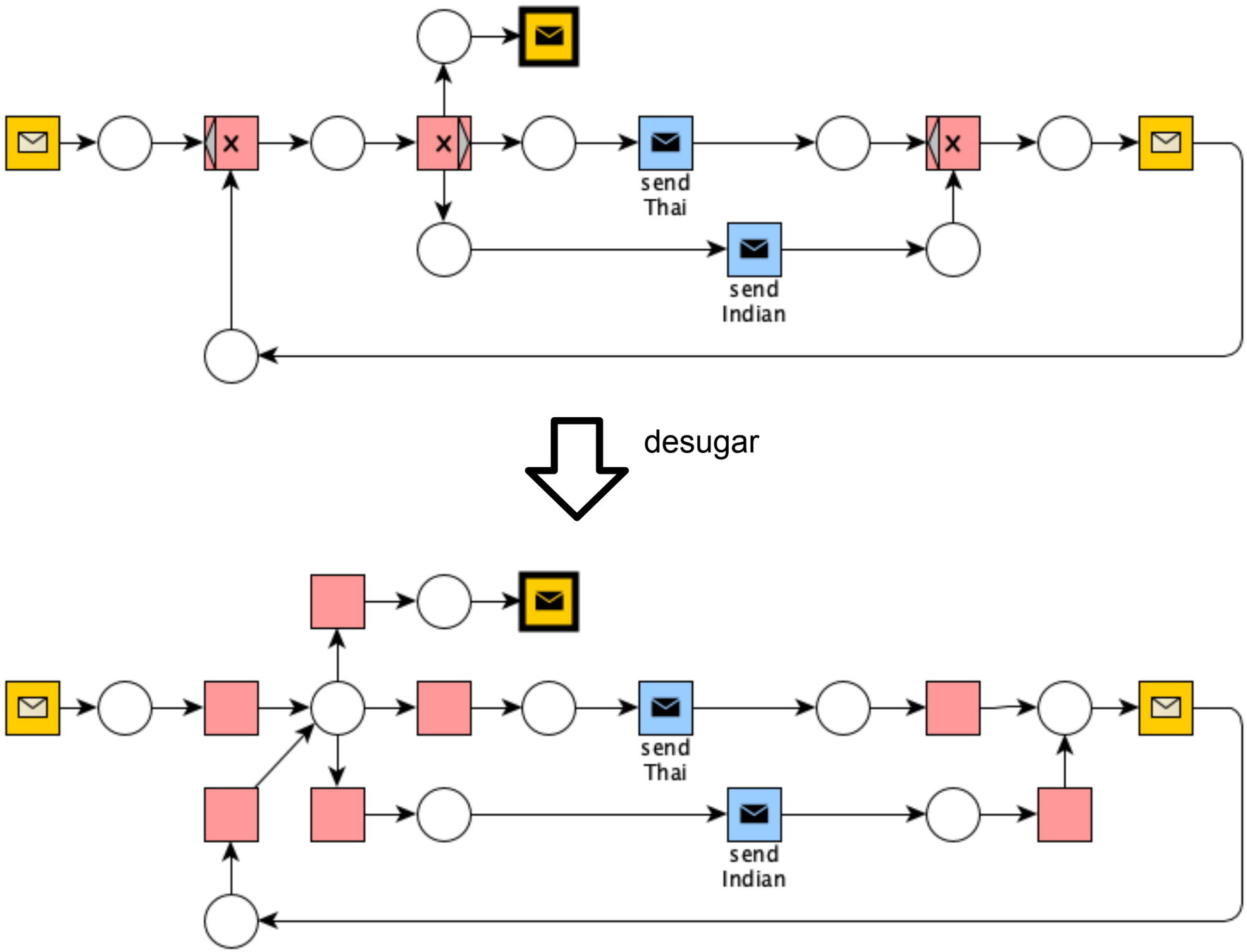
Sushi doomed: step 2



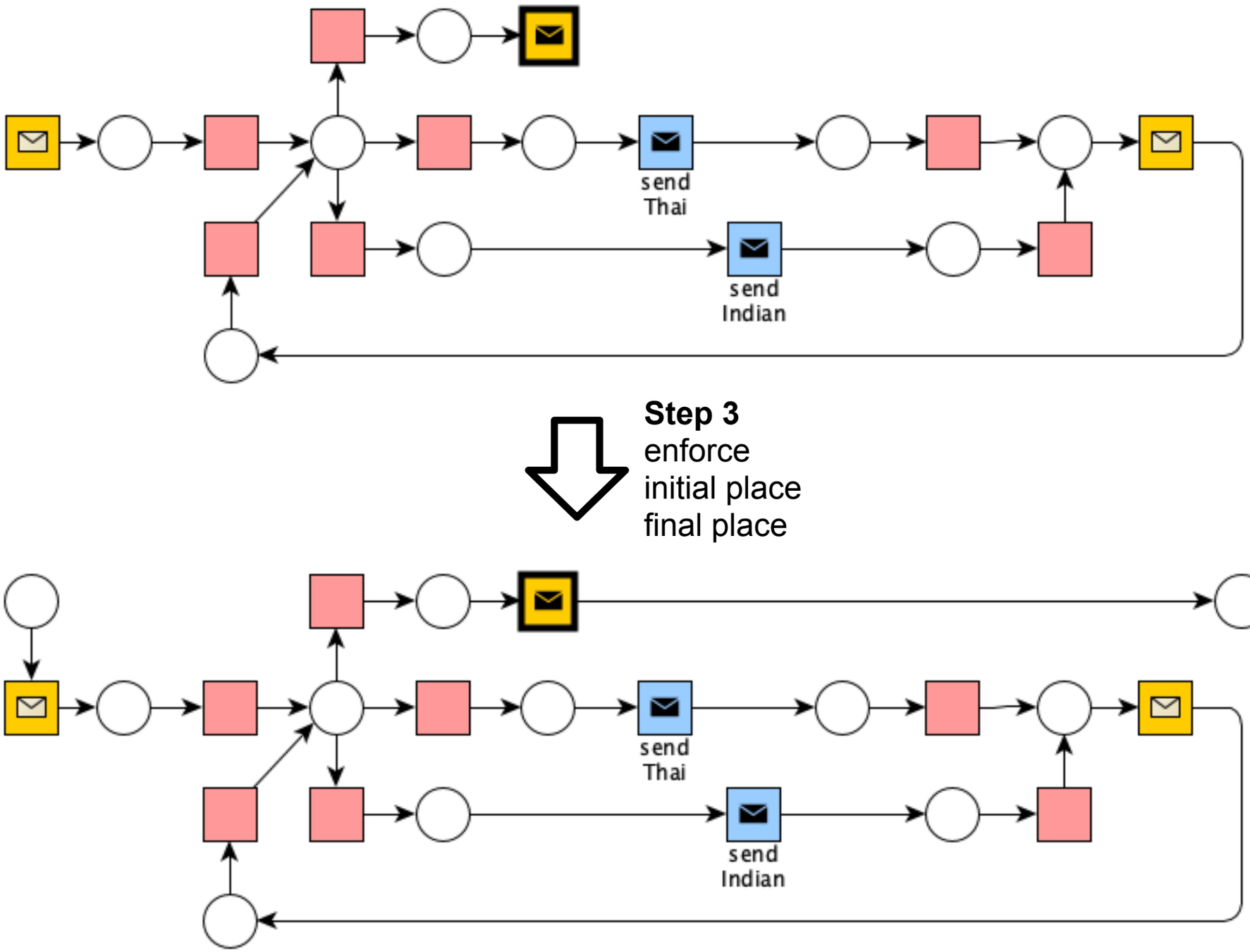
Step 2
flow objects



Sushi doomed: (desugar)

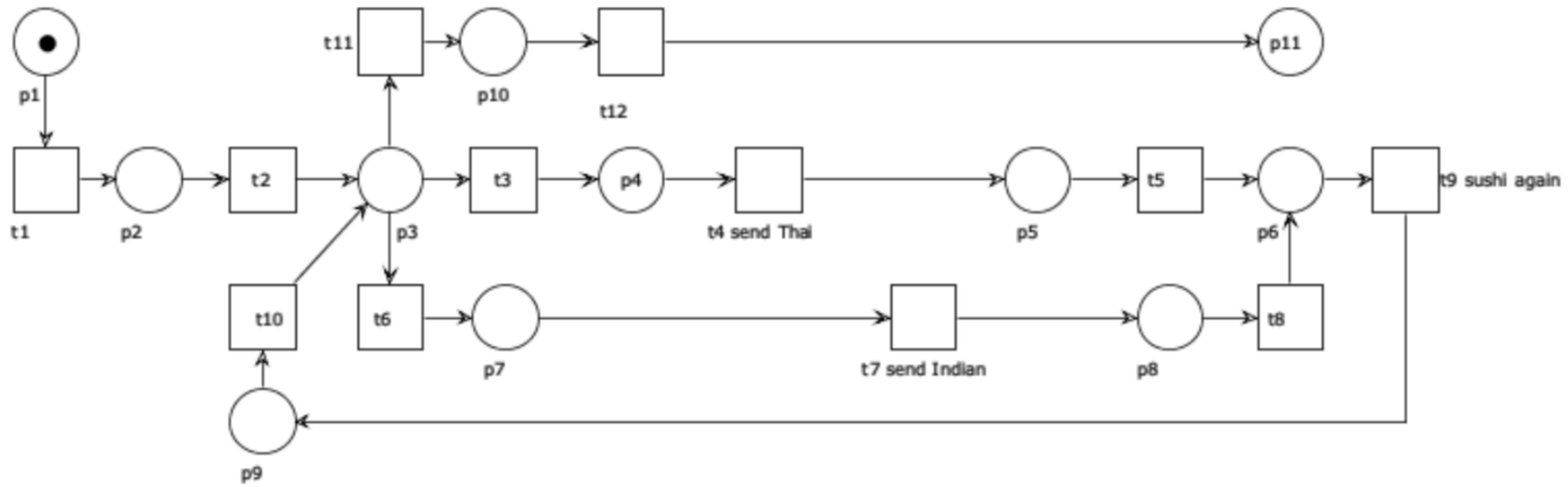


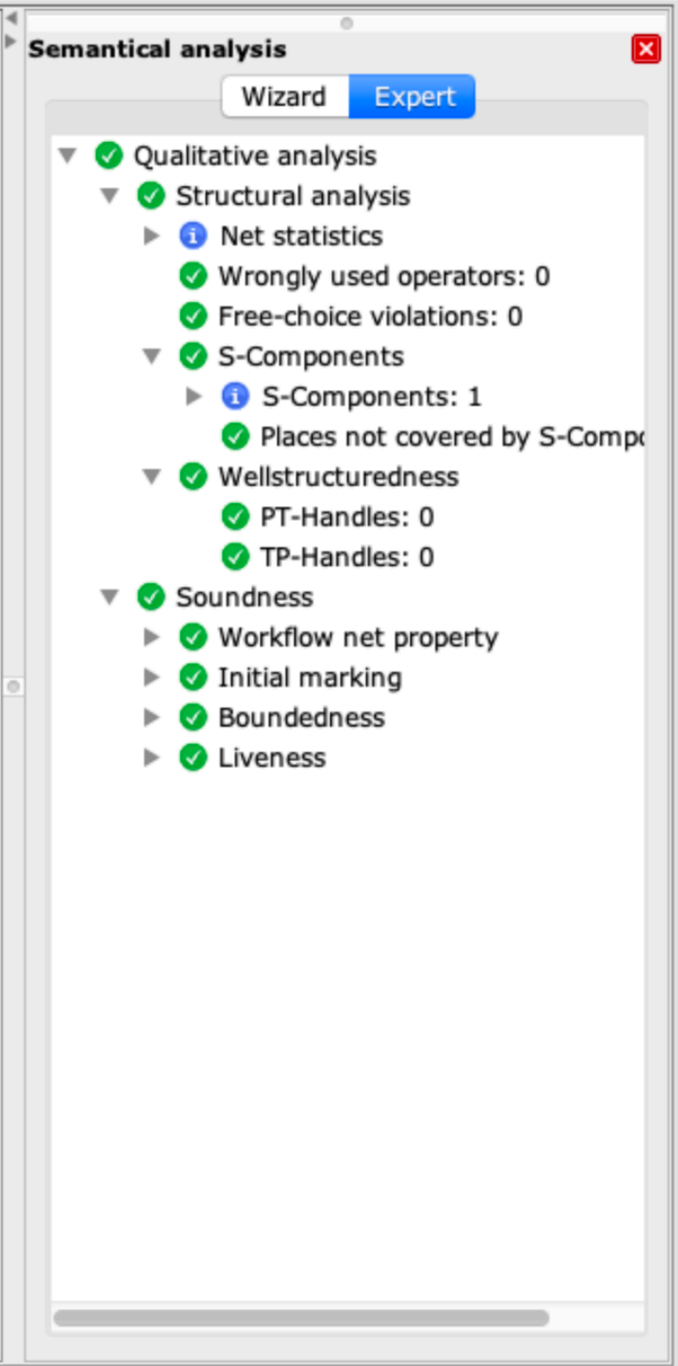
Sushi doomed: step 3



Step 3
enforce
initial place
final place

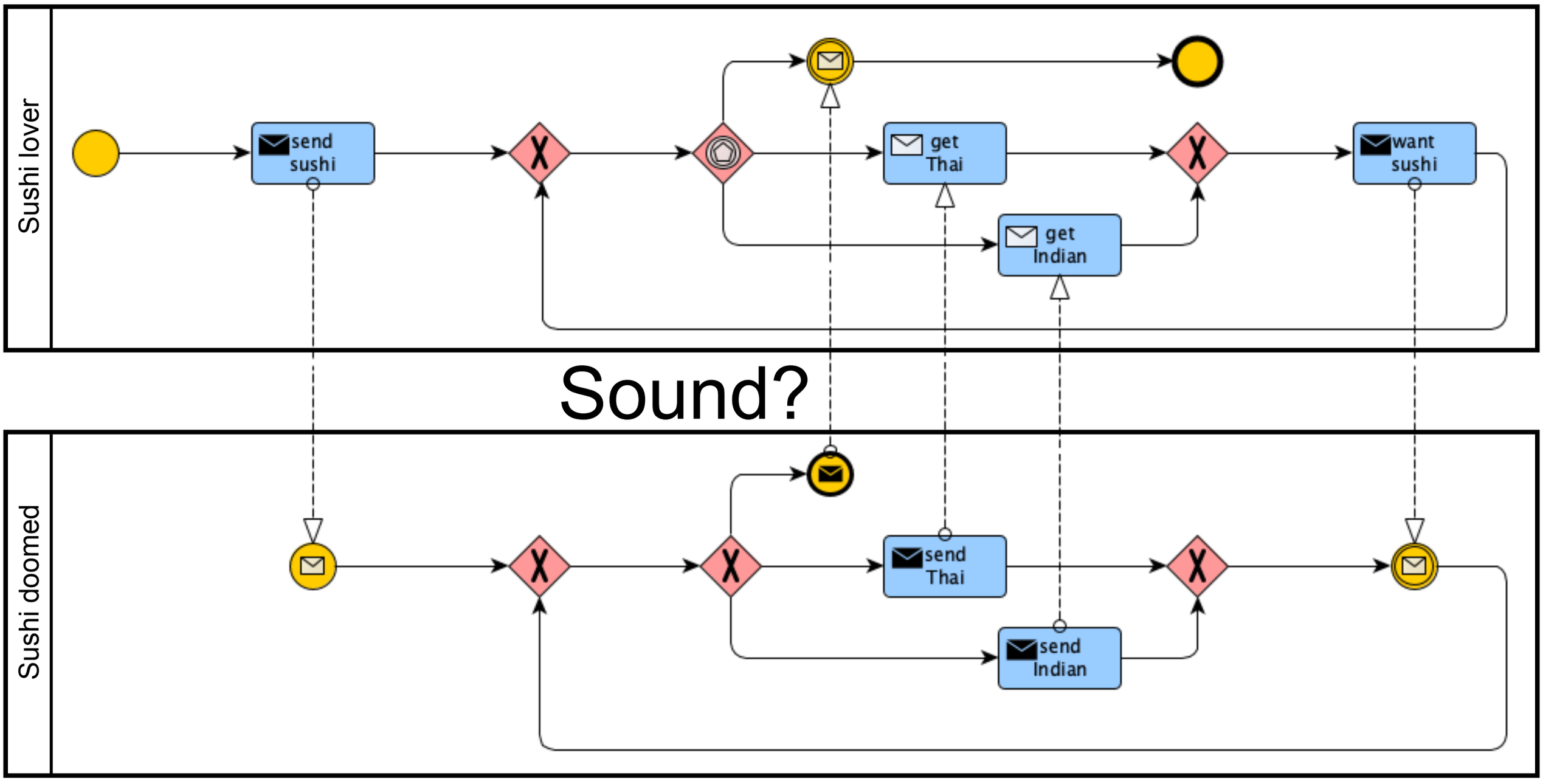
Soundness analysis





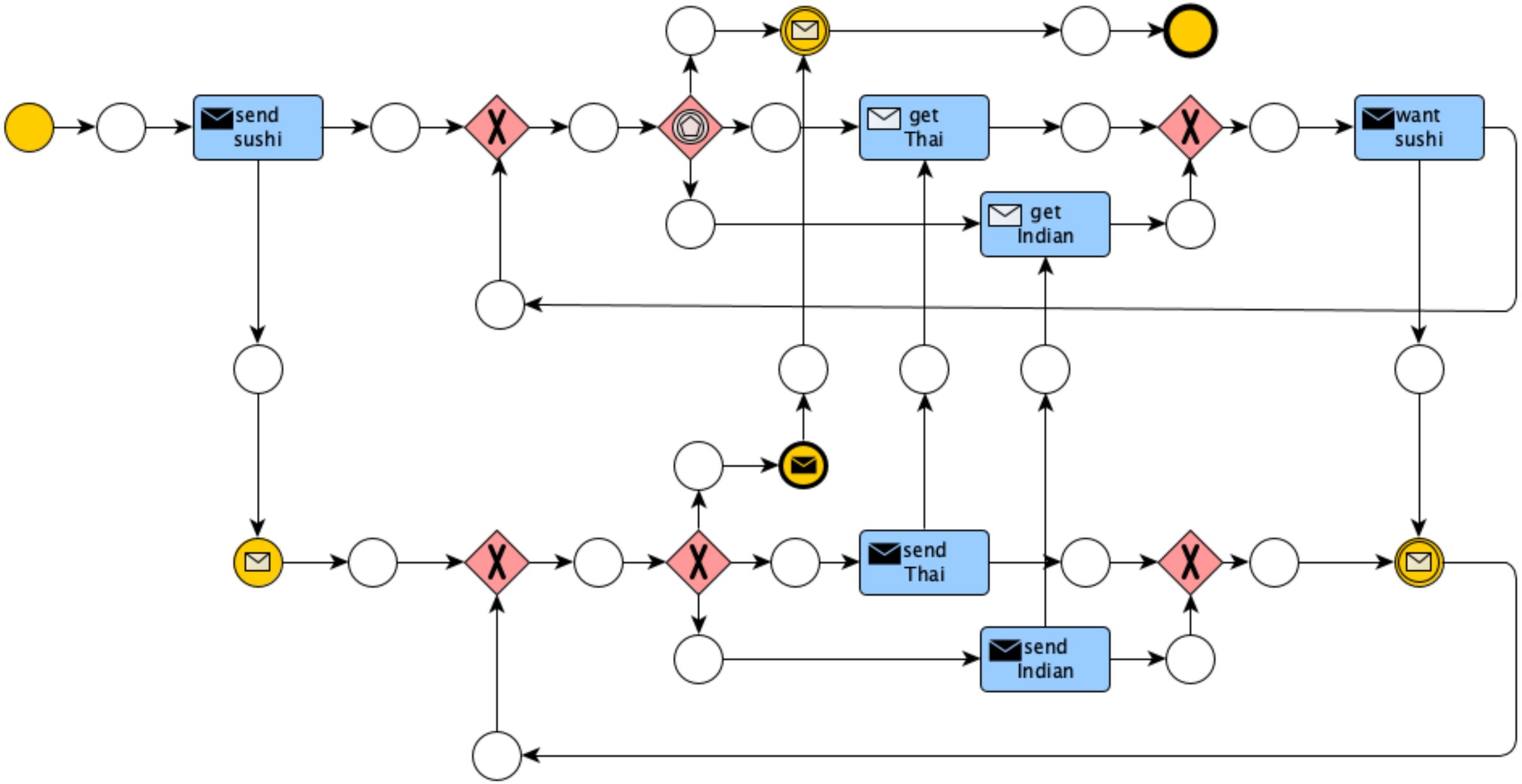
safe & sound
(s-net)

Sushi system

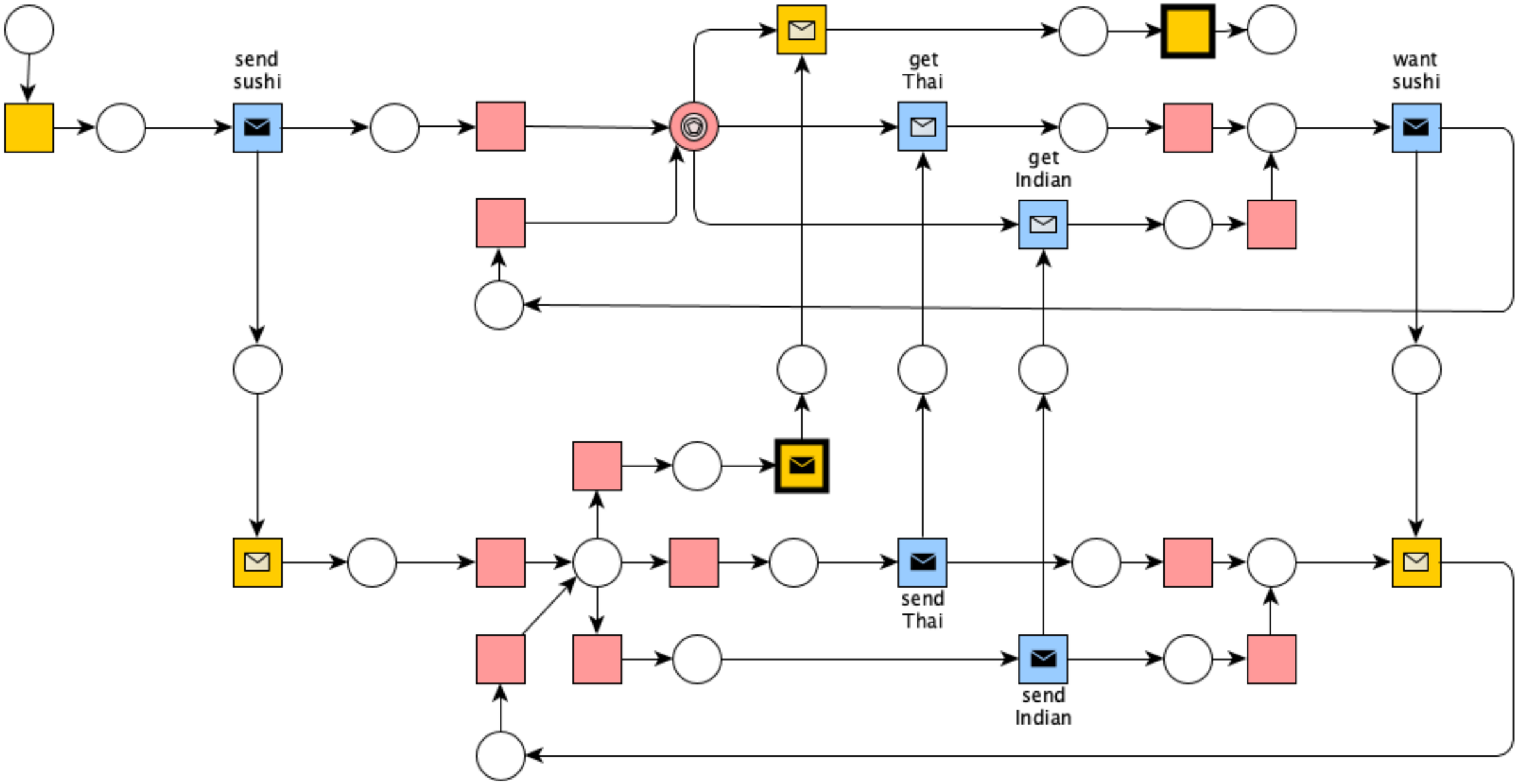


Sound?

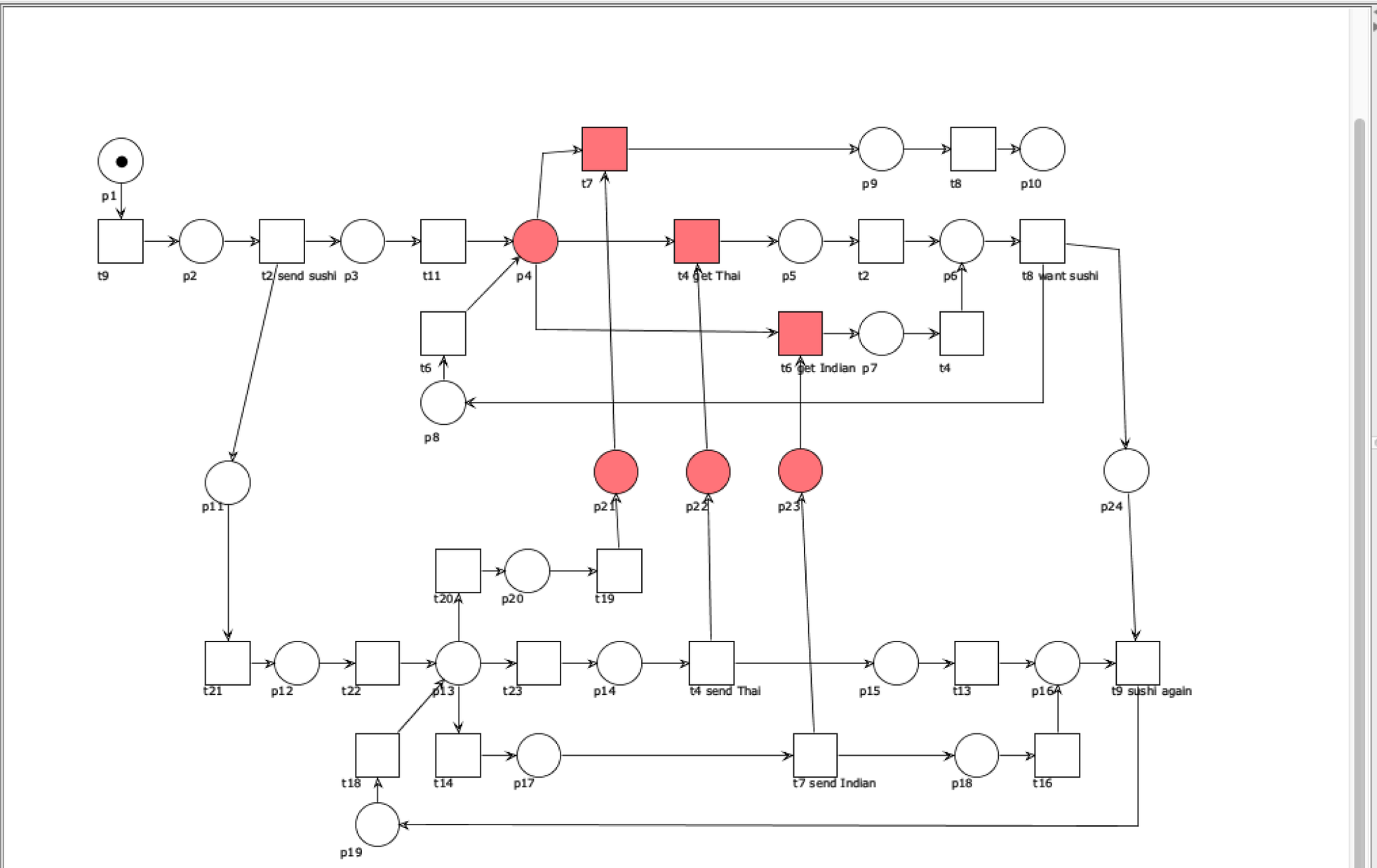
Sushi system: step 1

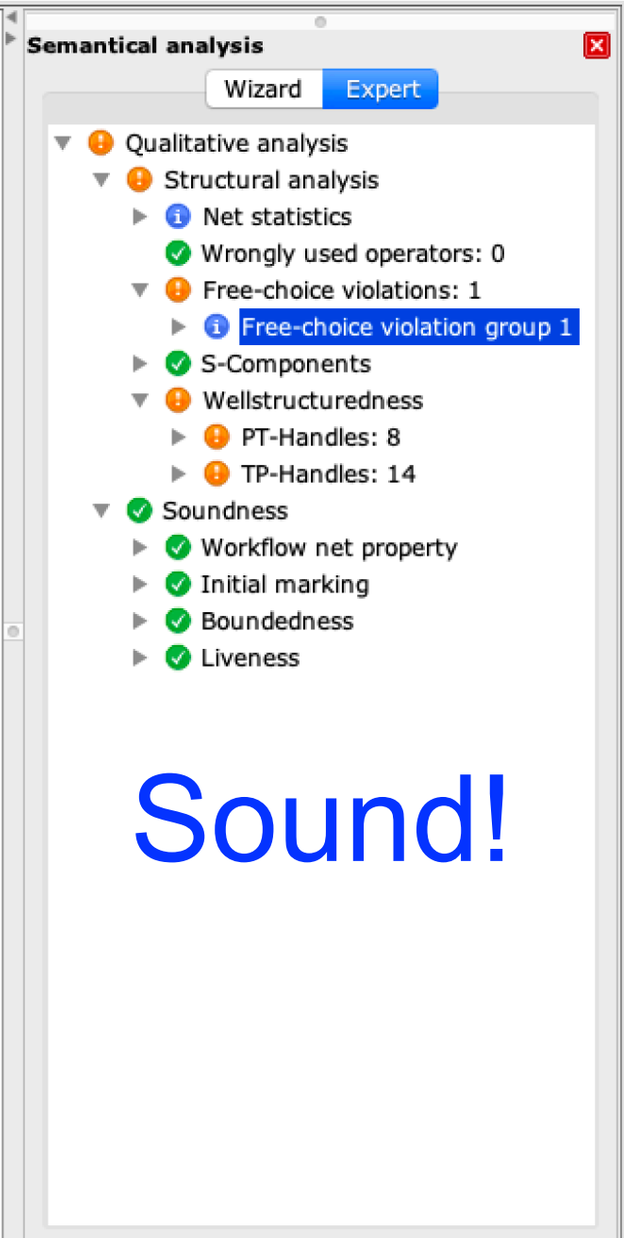


Sushi system: step 1+2+3



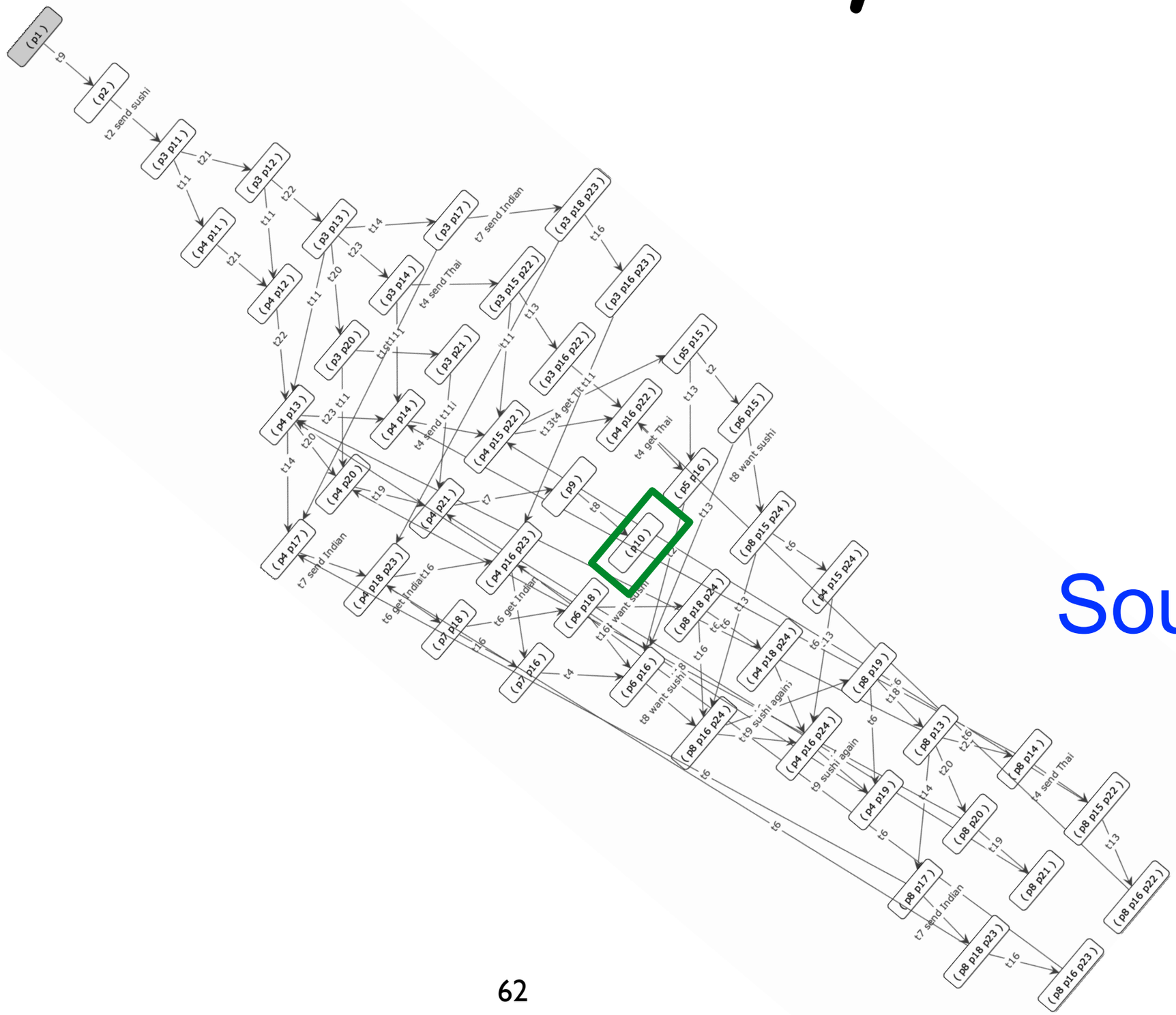
Soundness analysis





Sound!

Soundness analysis

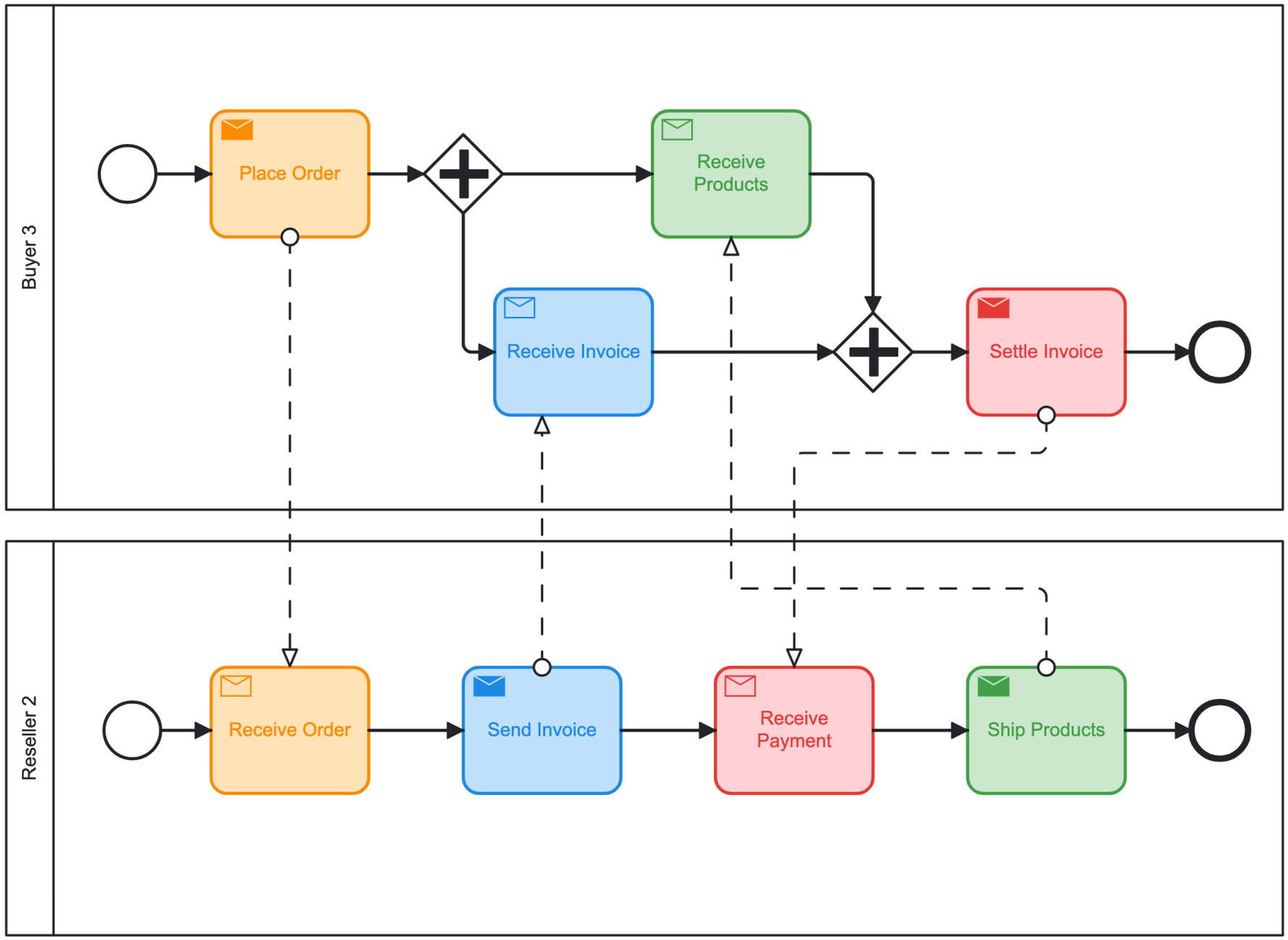


Sound!

Example:

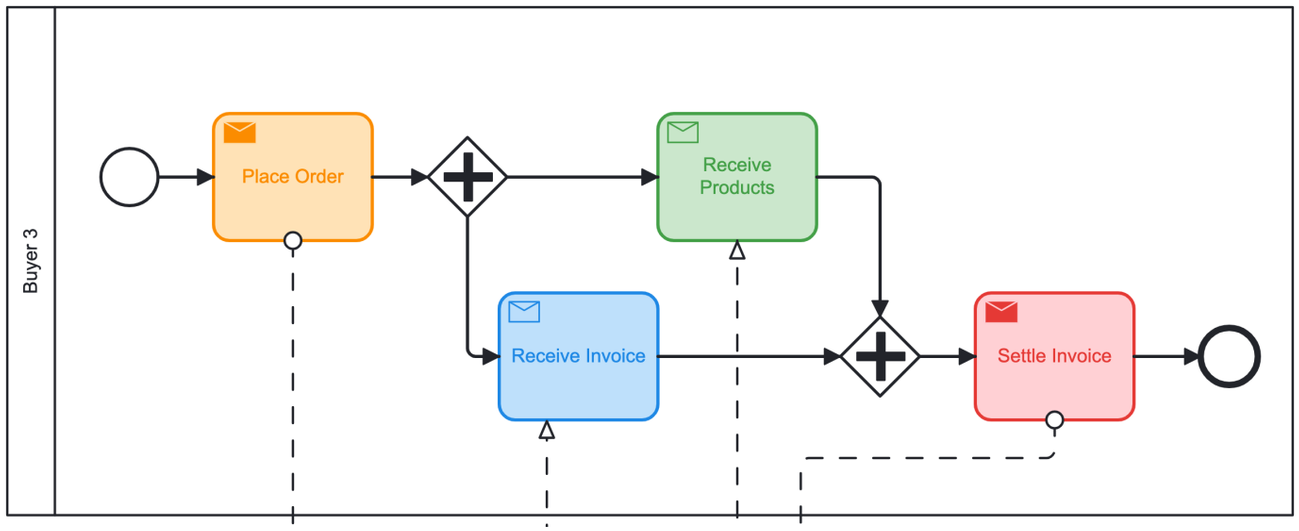
Buyer - Reseller

Buyer 3 and Reseller 2

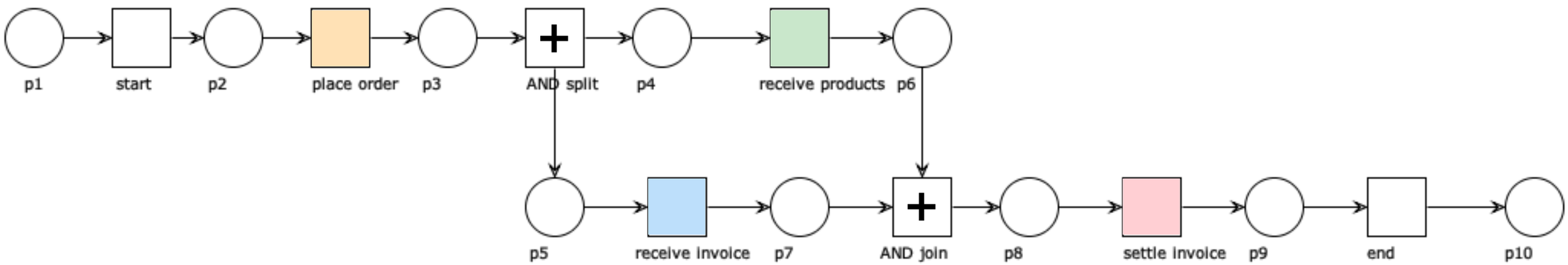


Sound?

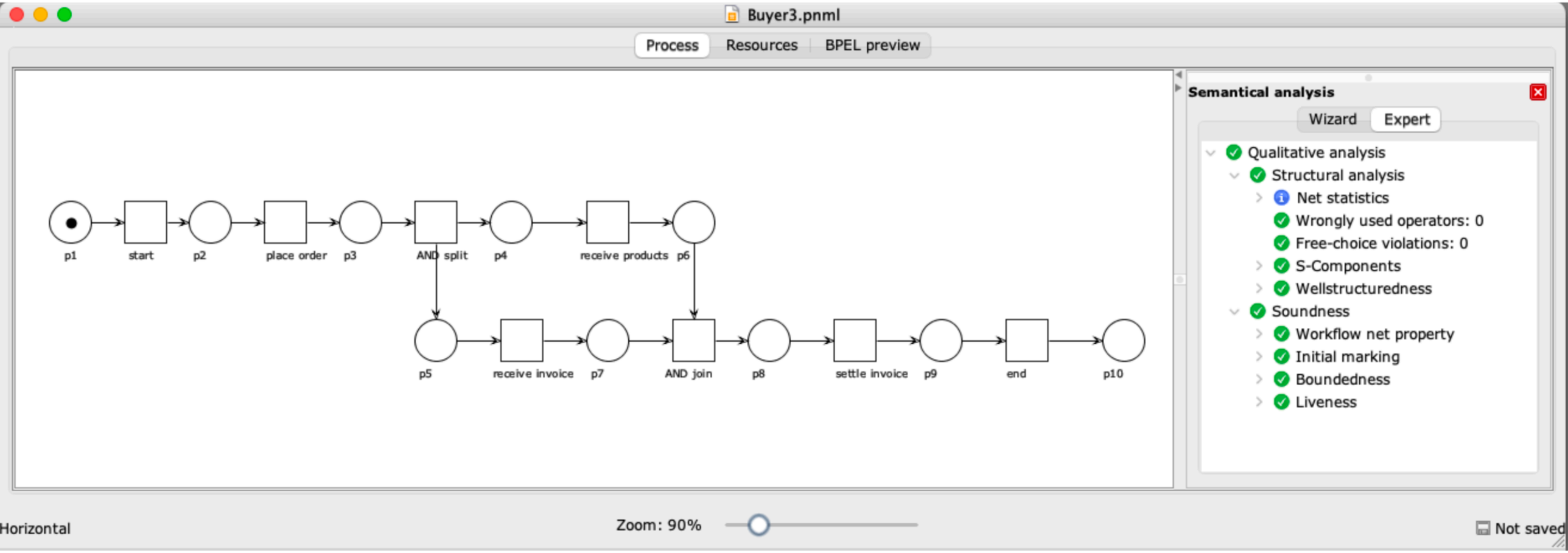
Buyer 3 sound?



Step 1 + 2 + 3

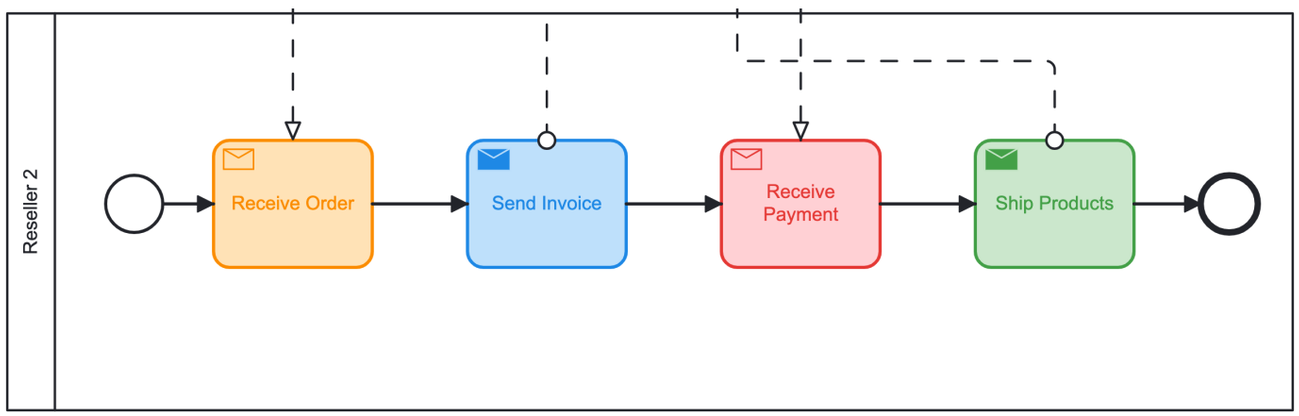


Buyer 3 soundness analysis

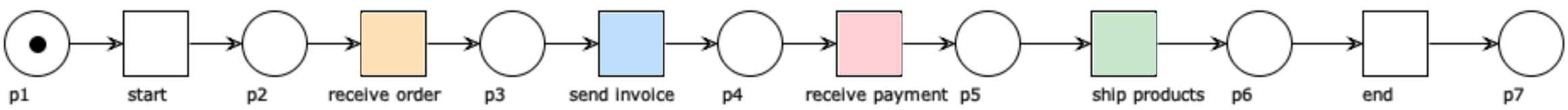


Safe and sound!

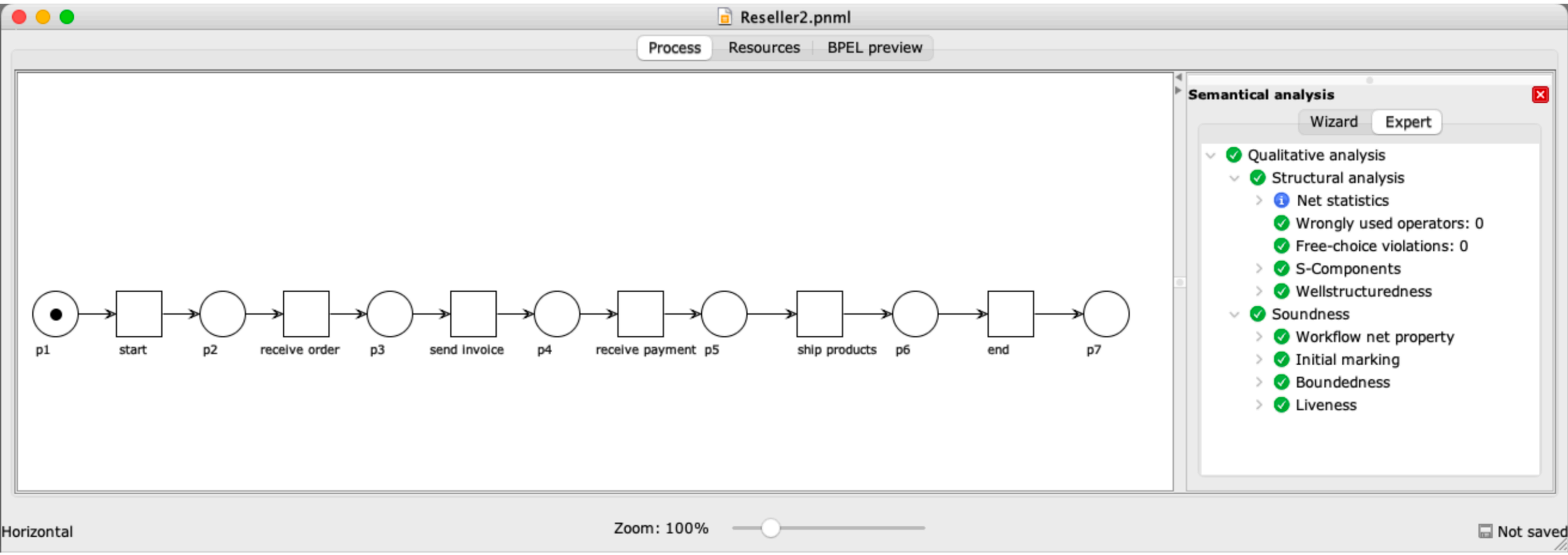
Reseller 2 sound?



Step 1 + 2 + 3

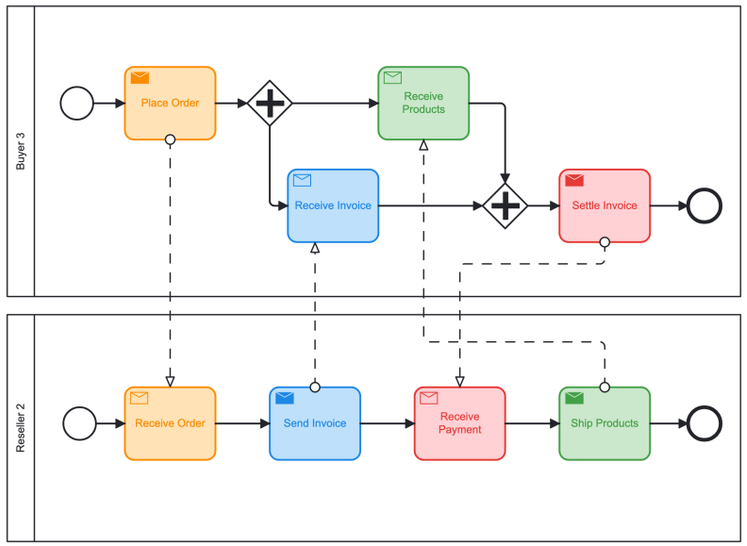


Reseller 2 soundness analysis

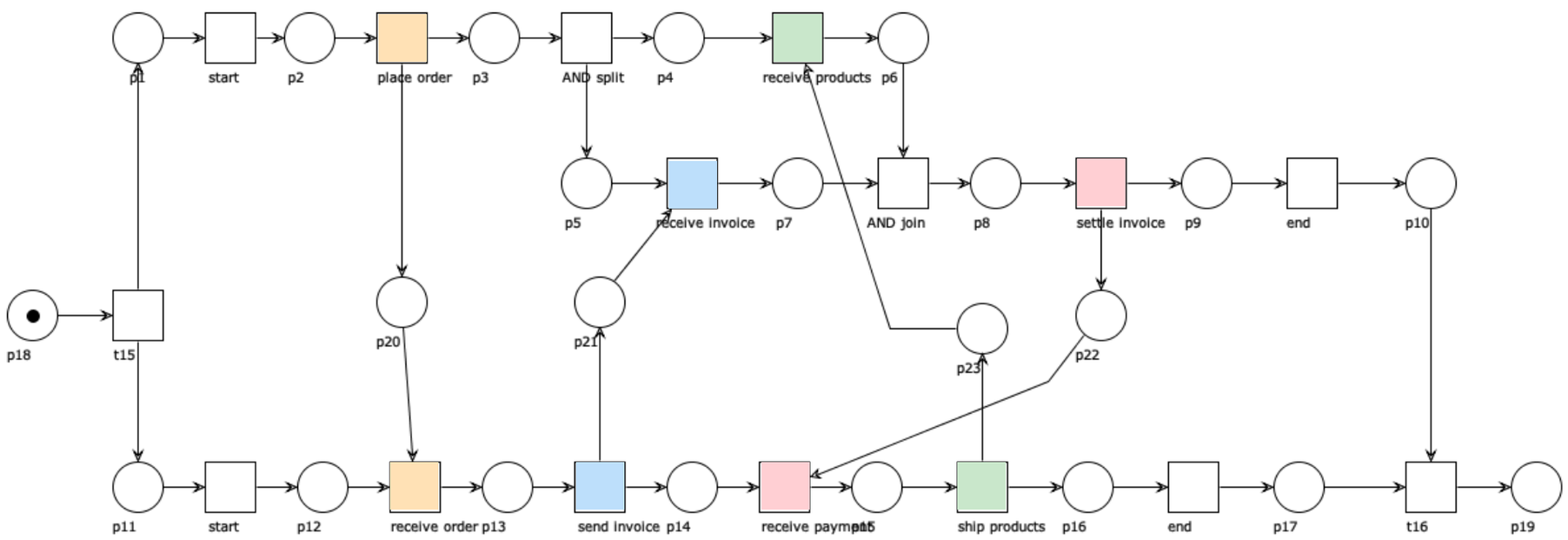


Safe and sound!

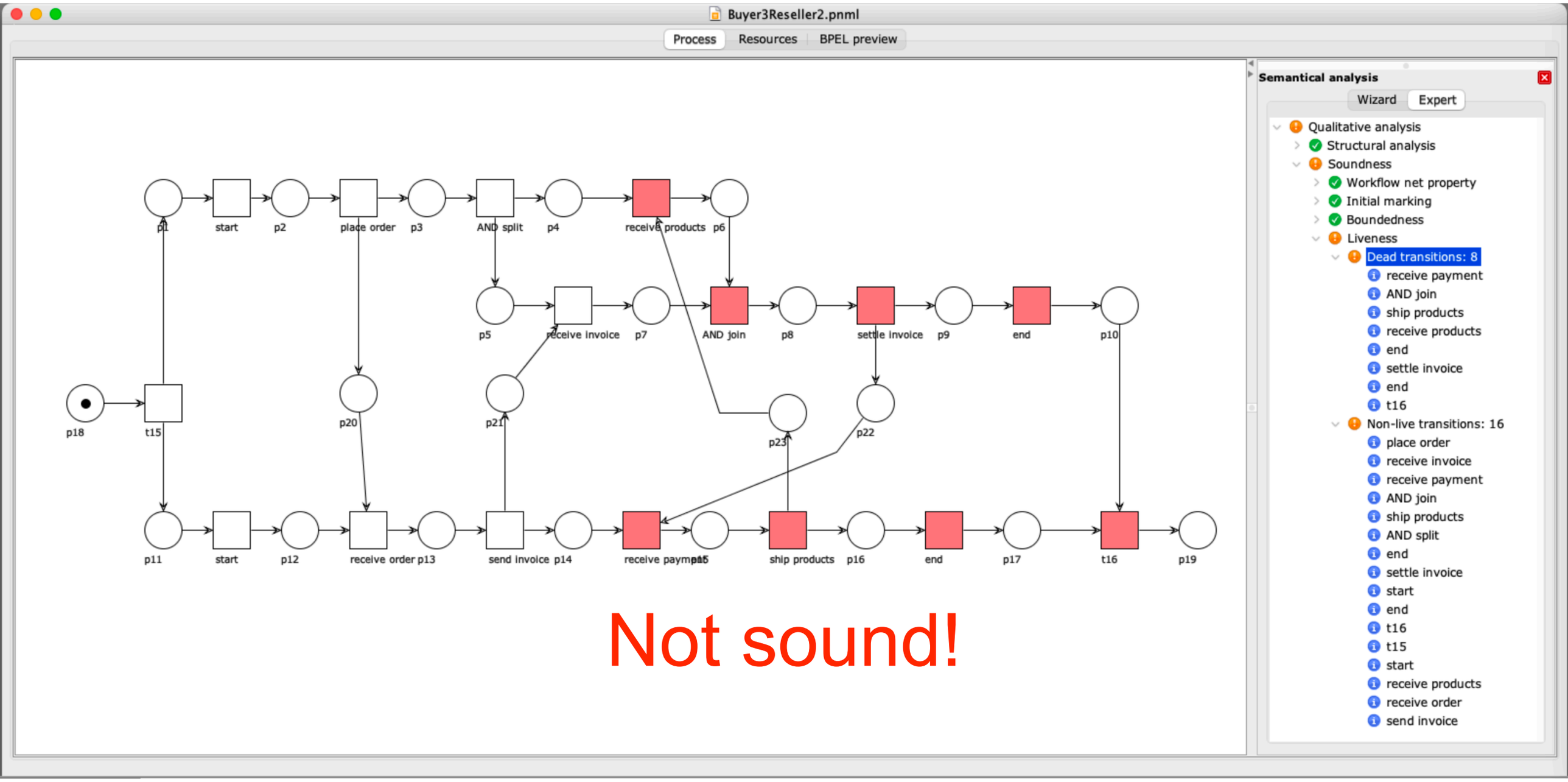
Buyer 3 + Reseller 2: sound?



Step 1 + 2 + 3

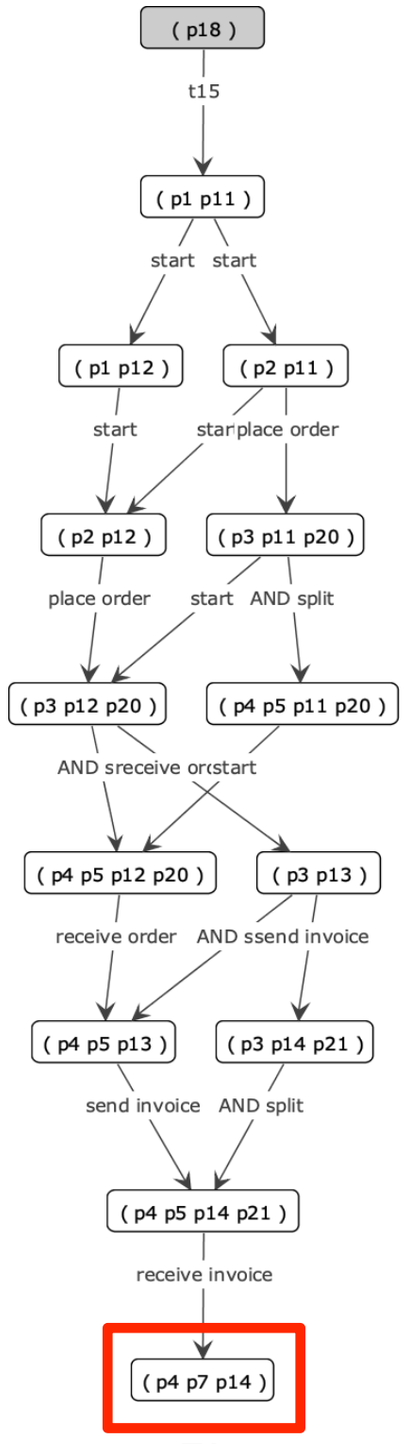


Buyer 3 + Reseller 2: analysis



Not sound!

Buyer 3 + Reseller 2: analysis



Not sound!

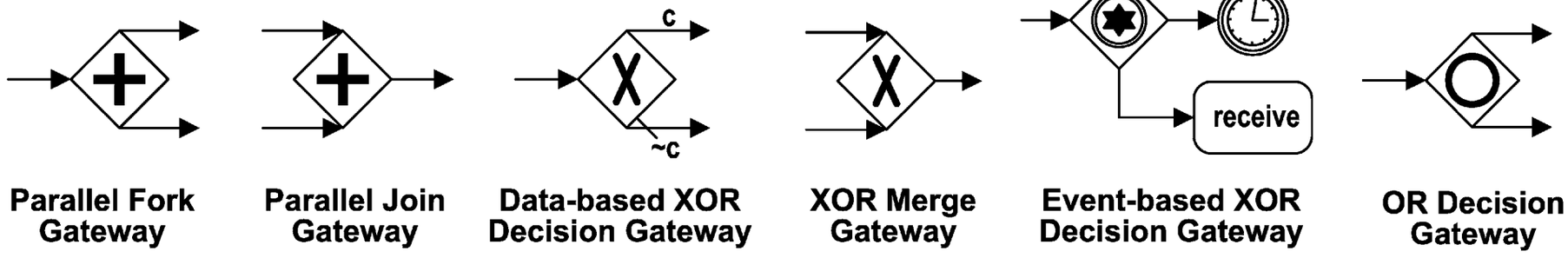
Step 0: preprocessing BPMN diagrams

Overview

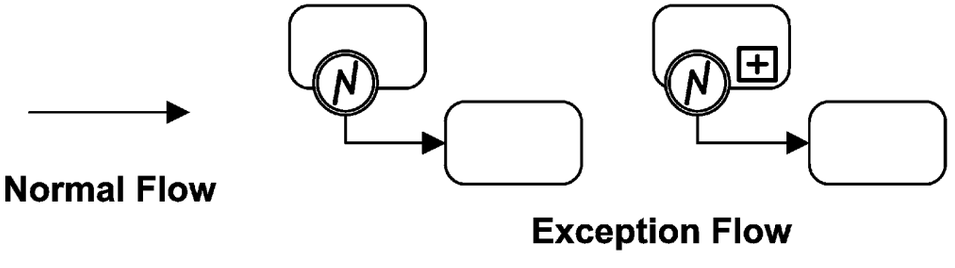
EVENT

ACTIVITY

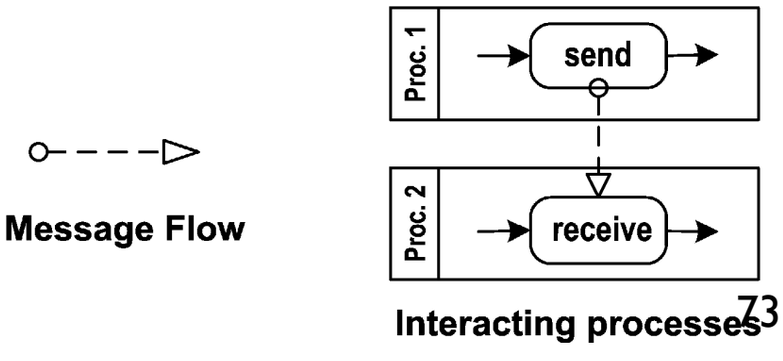
GATEWAY



SEQUENCE FLOW



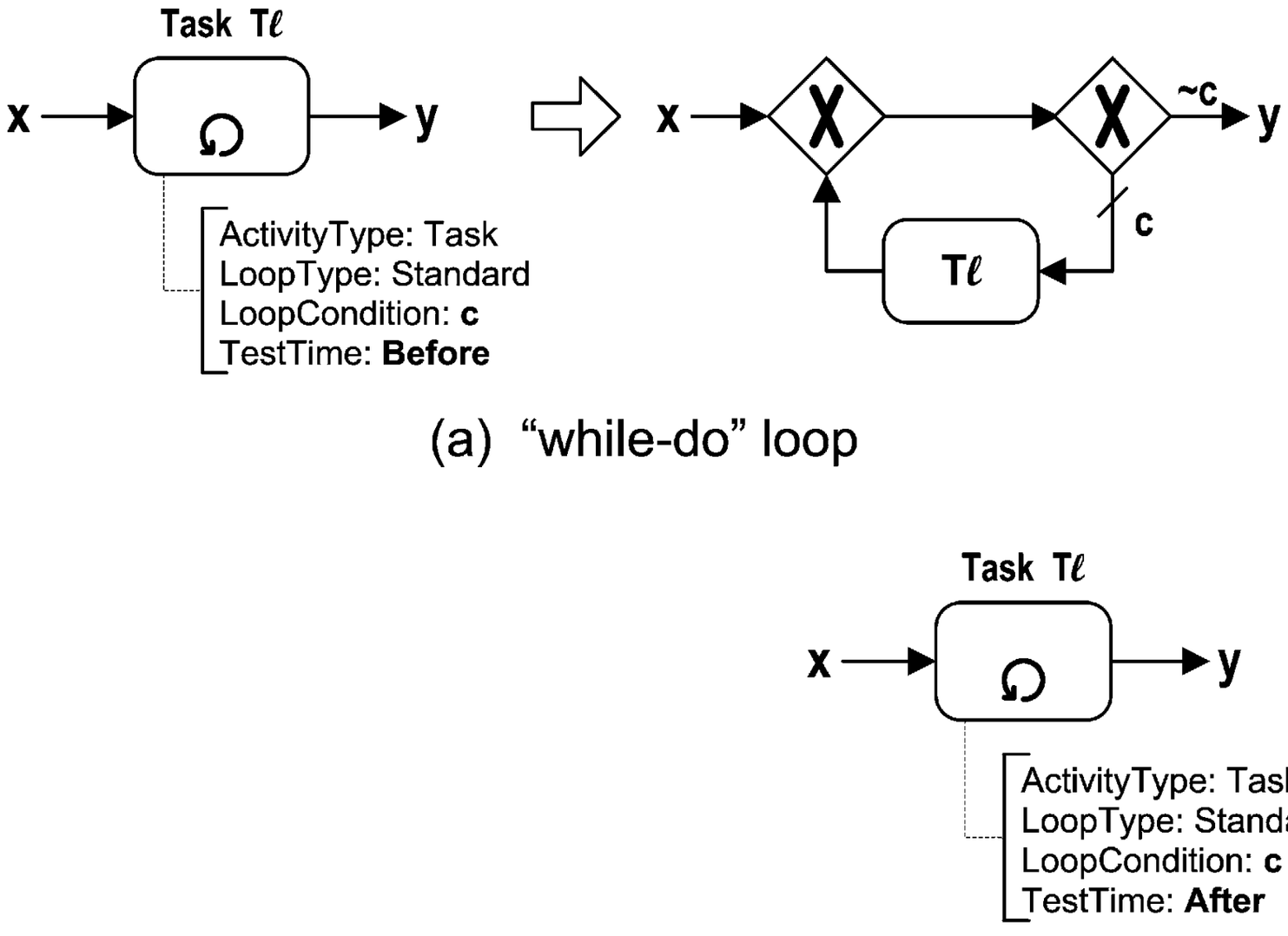
MESSAGE FLOW



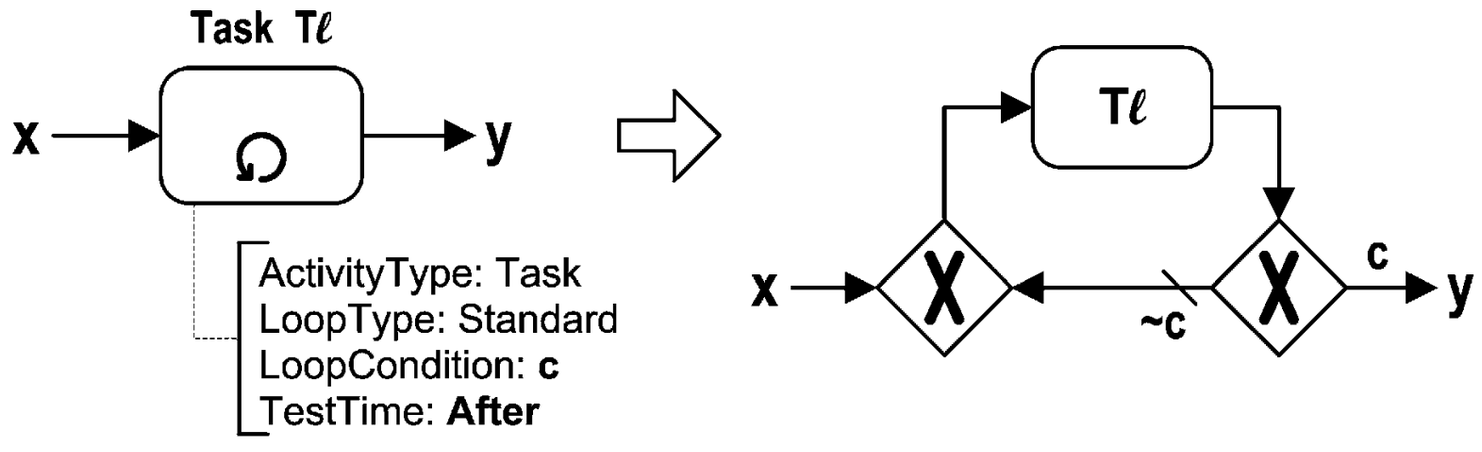
[Note]:

1. **Apart from intermediate error events, intermediate message or timer events may also be the source of exception flows.**
2. **A message flow may link task to task, end event to task, task to start event, and end event to start event.**

Activity looping

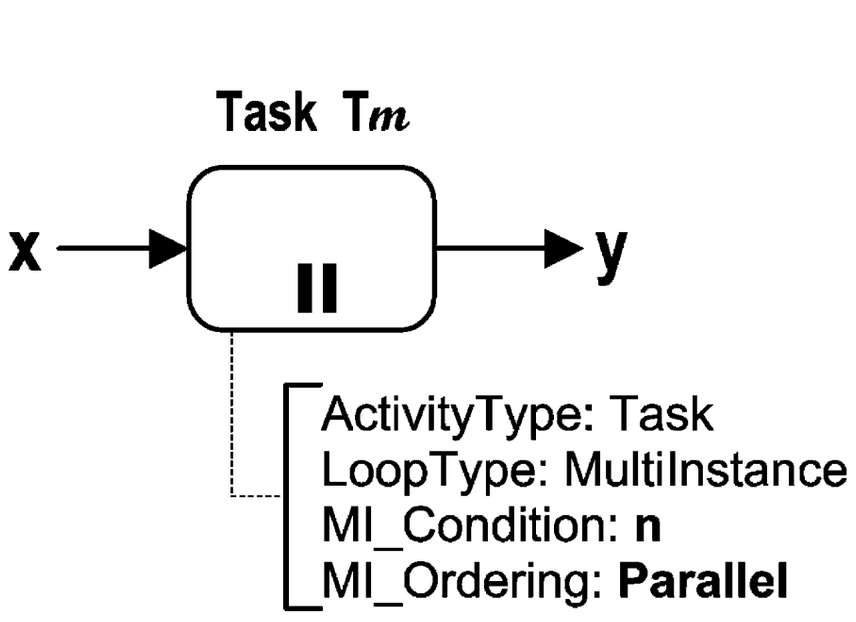


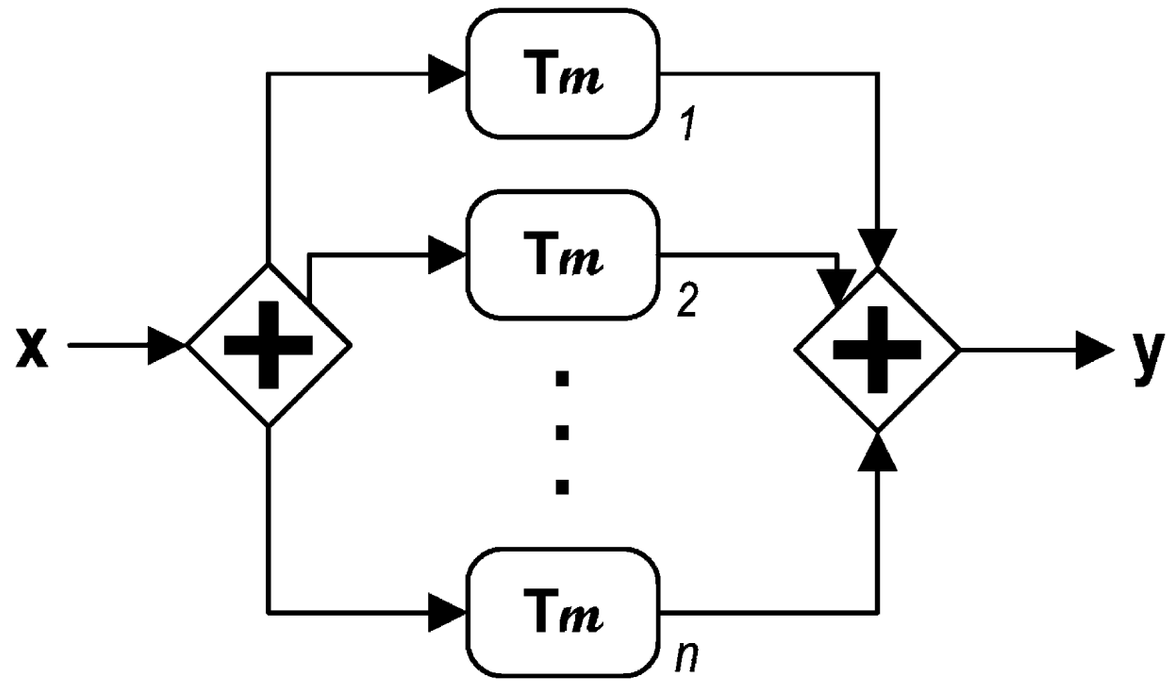
(a) “while-do” loop



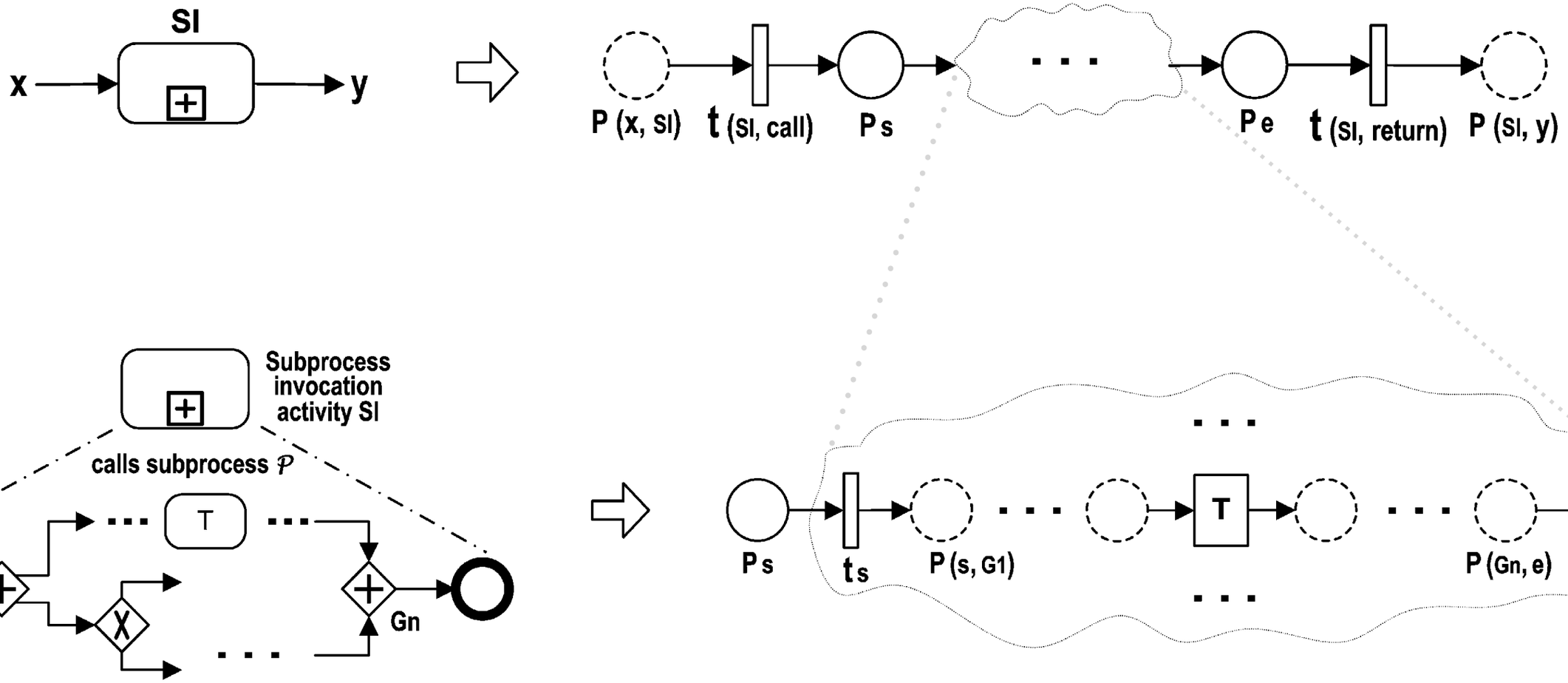
(b) “do-until” loop

Multiple instances (design-time bounded)

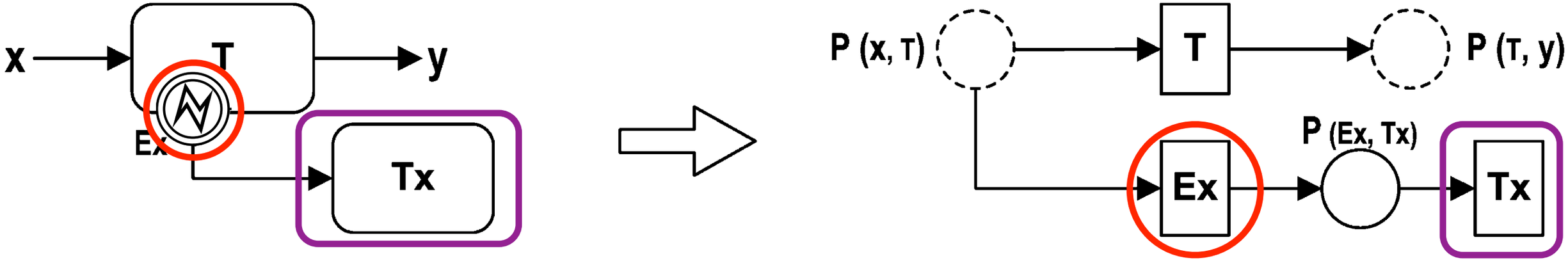




Sub-processes



Exception handling: single task



Exception handling: sub-processes