Performance Analysis Modeling Applied to Business Processes

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Performance Analysis of Business Processes

To improve efficiency in organizations we need

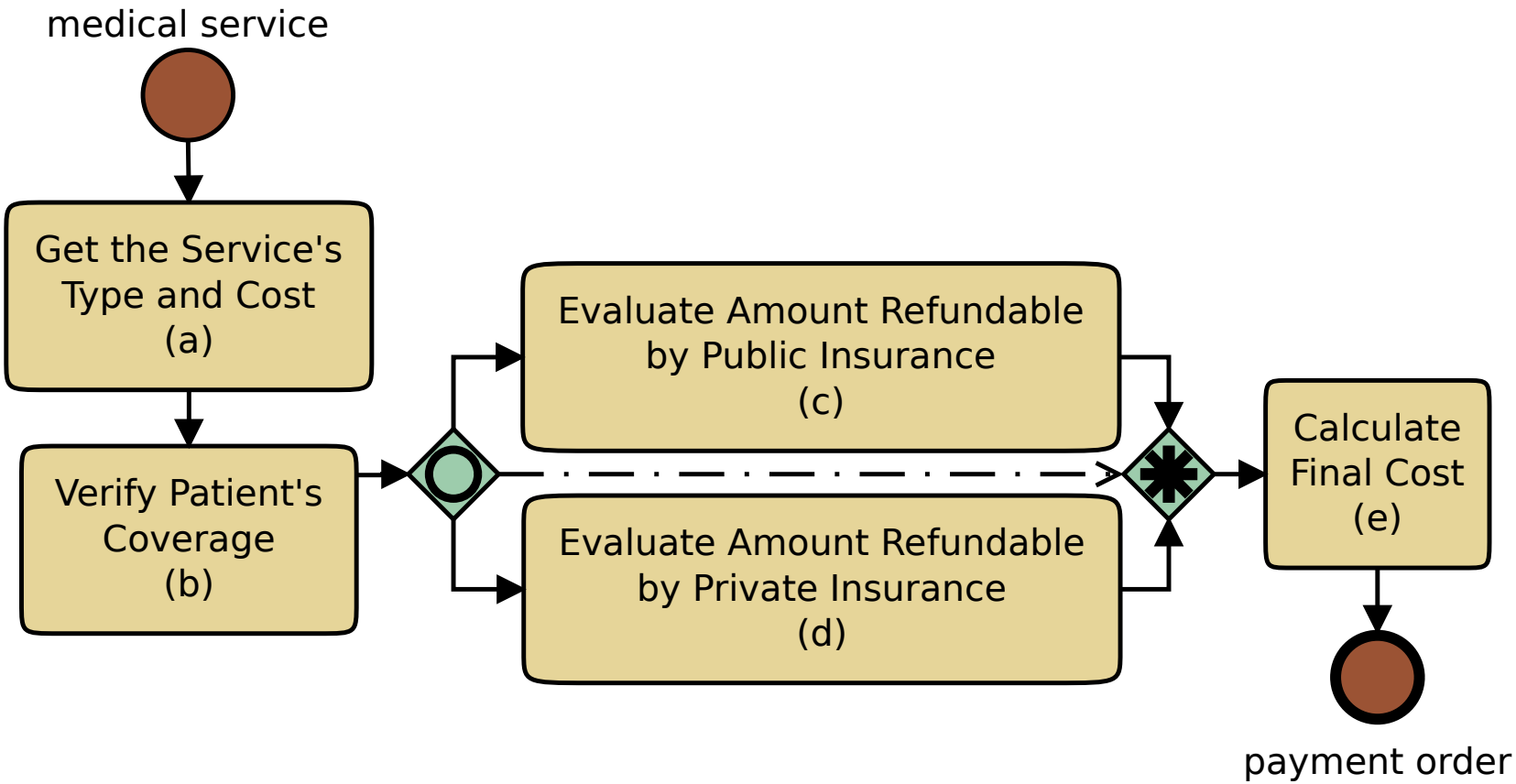
- To understand how the operational processes work
- To optimize their functioning

Main challenges

- Business processes generally are large-scale systems with complex structure
- **Difficulty to express quantitative aspects using business process modeling languages**
- Resource utilization – where and how the business process components are executed

Cost of a Medical Service in the French Health-Care System

⇒ Service used by thousands of people concurrently



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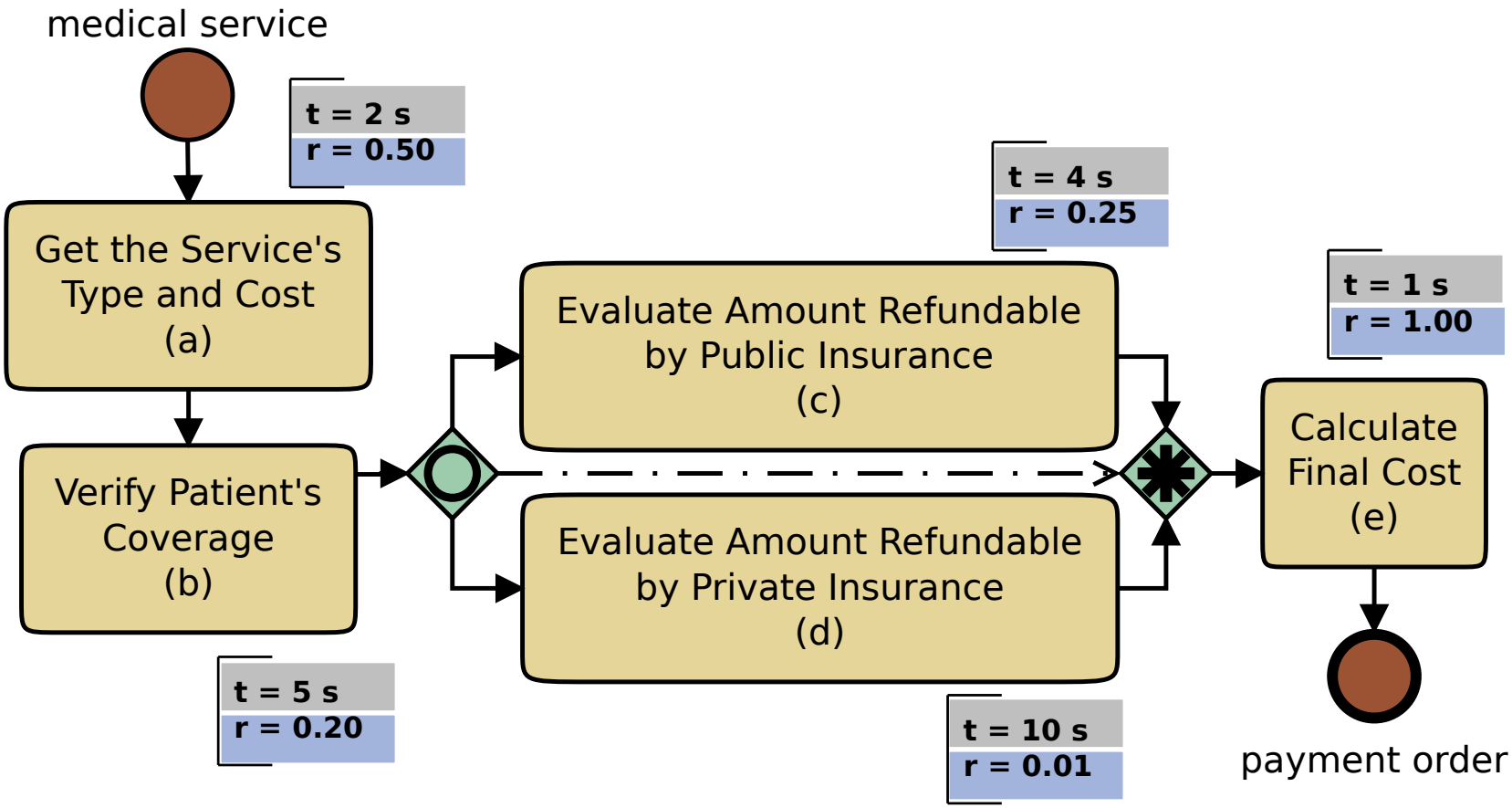

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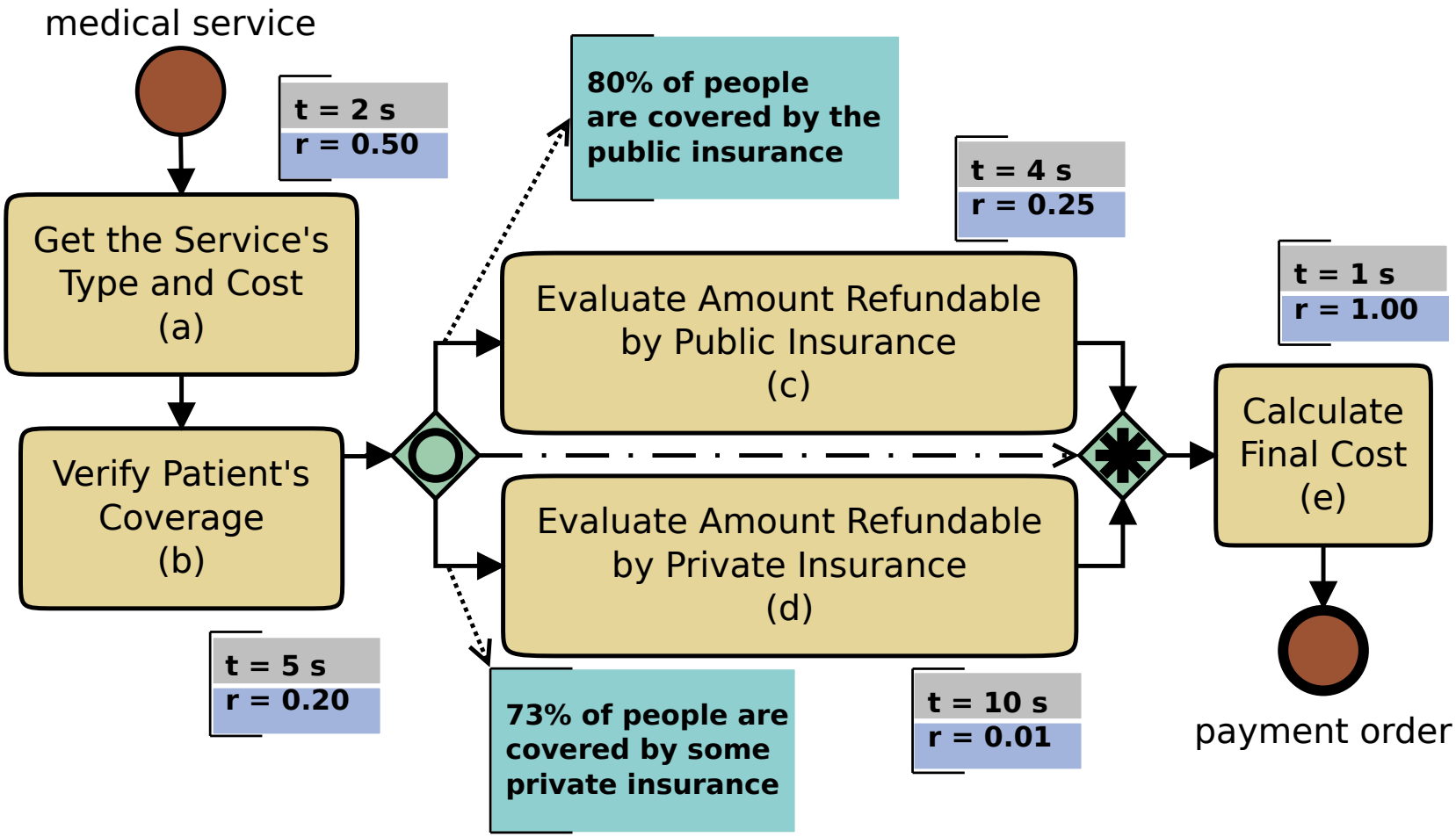

Performance Analysis Modeling Applied to Business Processes

Objective: compare quantitative modeling methods in the business process management domain

Methodology

- Selection of 3 modeling environments to performance evaluation
- Definition of several business process scenarios
- Mapping of the scenarios to performance evaluation models
- Numerical analysis of the models
- Comparison of the results under different criteria

Outline of the Talk

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Selected Techniques for Performance Evaluation

Stochastic formalisms

- Generalized Stochastic Petri Nets (GSPN)
  [Marco Marsan, Gianni Conte, Gianfranco Balbo – 1984]
- Performance Evaluation Process Algebra (PEPA)
  [Jane Hillston – 1996]
- Stochastic Automata Networks (SAN)
  [Brigitte Plateau – 1985]

Software tools

- SMART (`http://www.cs.ucr.edu/~ciardo/SMART`)
- PEPA Plug-in (`http://www.dcs.ed.ac.uk/pepa/tools/plugin`)
- PEPS (`http://www-id.imag.fr/Logiciels/peps`)

Business Process Scenarios Characteristics

Basic structures

- Sequences, OR splits/joins, AND splits/joins and cycles

Complex branching and merging structures

- Examples: multi-choice, multi-merge, etc.

Features of performance modeling formalisms

- Examples: functional transitions, variable activity rates

Comparison Criteria

Modeling perspective

- Expressive power – direct representation of the scenarios
- Abstraction power – level of generality of the process models
- Facility to enlarge – extensions without impacting the previous modeled behavior
- Readability – view of the business logic from the model

Analysis perspective

- Computational resources (execution time and memory consumption)
- Supporting tool

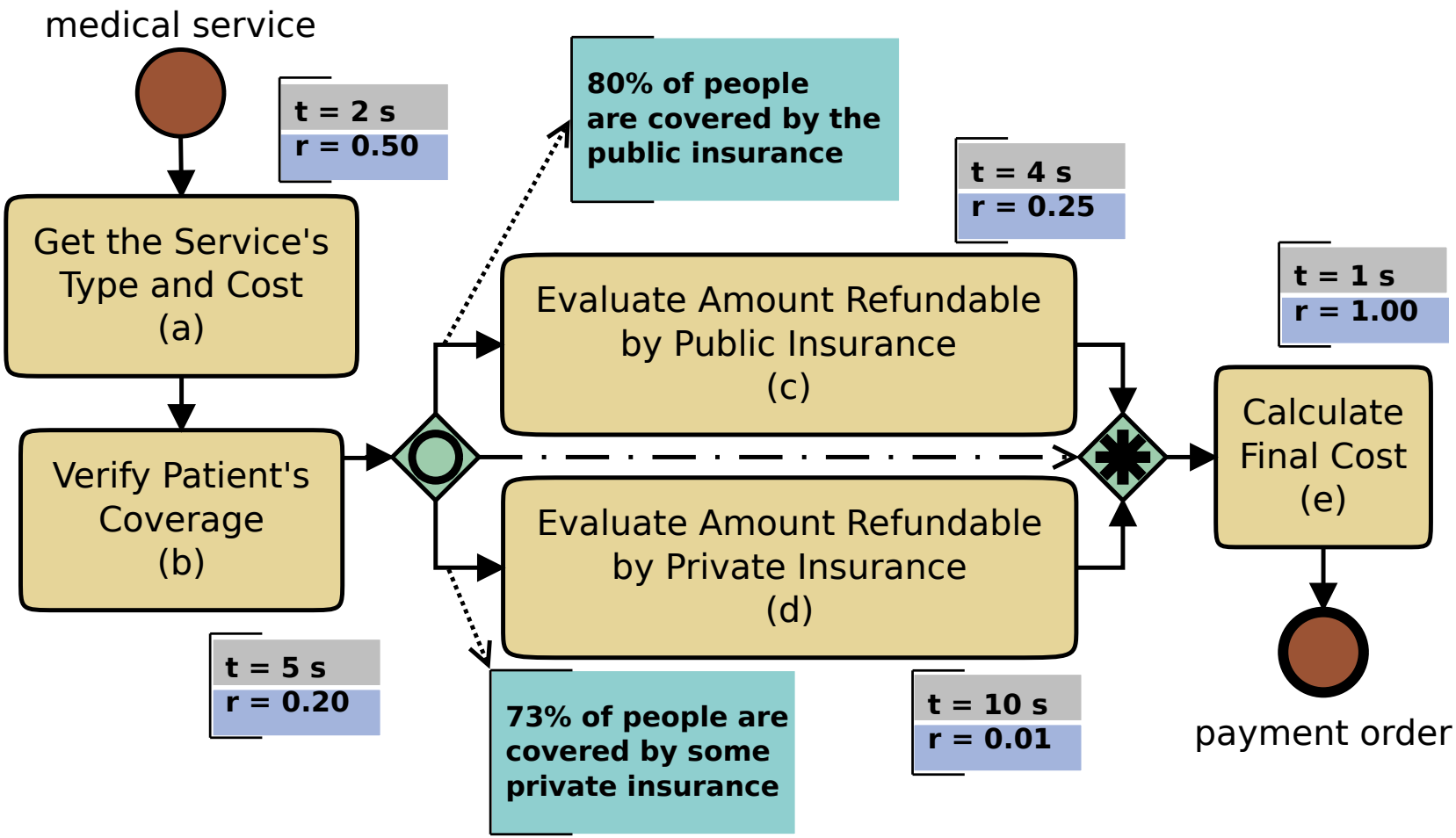
Comparison Summary of the Formalisms

Under the modeling perspective

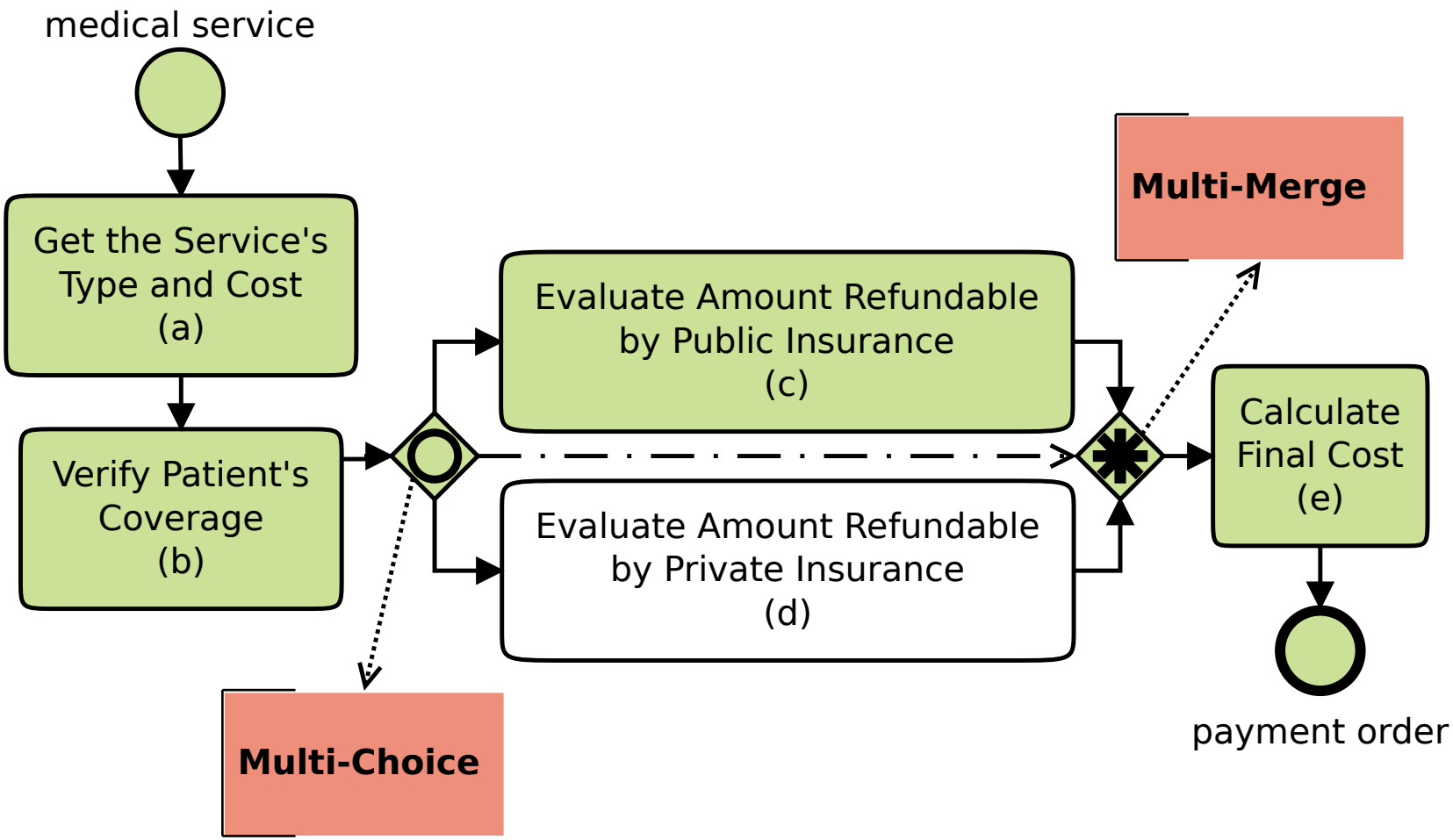
Modeling criteria	GSPN	PEPA	SAN
Expressive power	+	-	+
Abstraction power	+	+/-	+
Facility to enlarge	-	+	+/-
Readability	-	+	+

Outline of the Talk

French Health-Care System (BPMN Annotated Model)



Complexity of the Multi-Choice / Multi-Merge Structure



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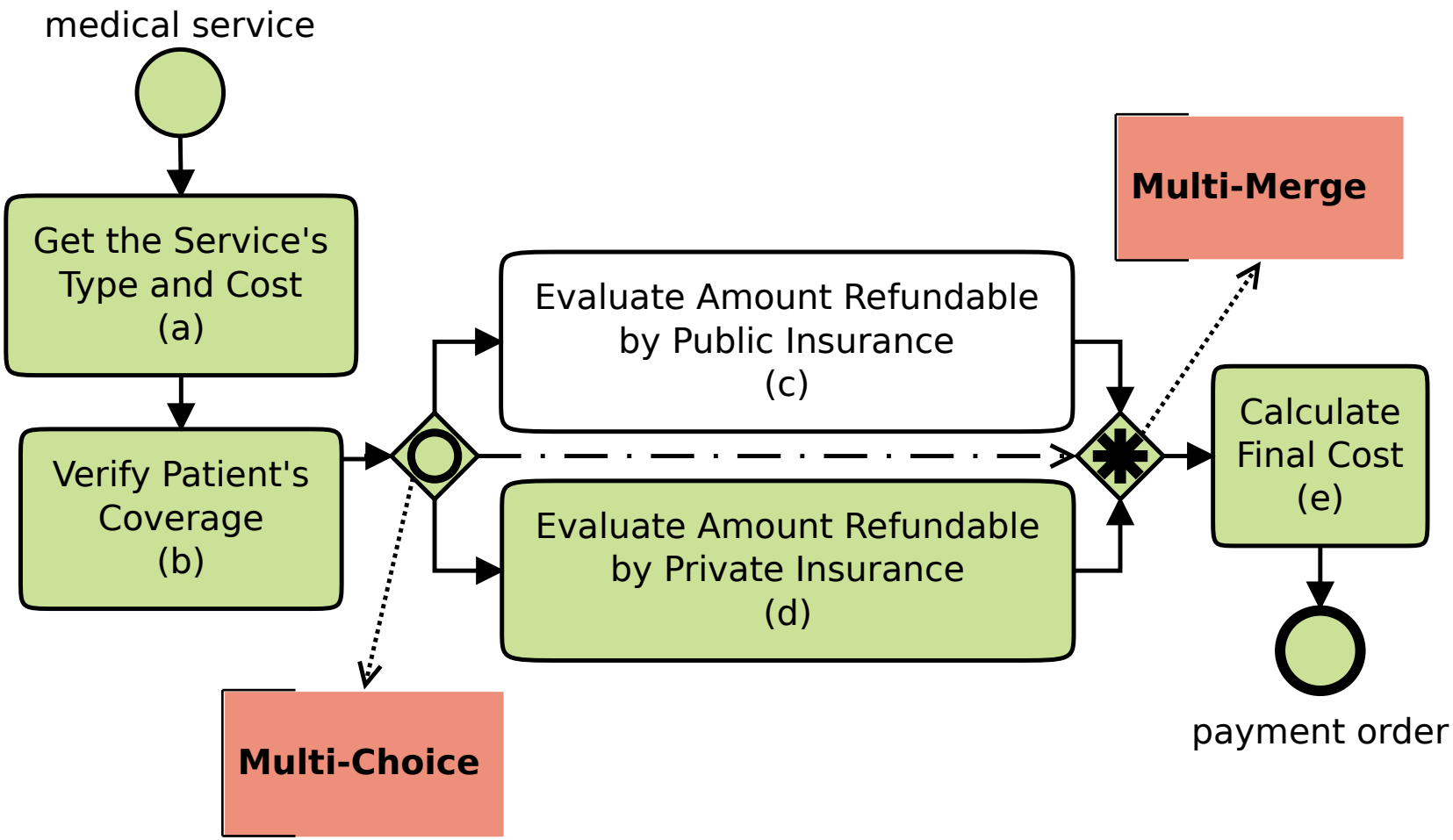

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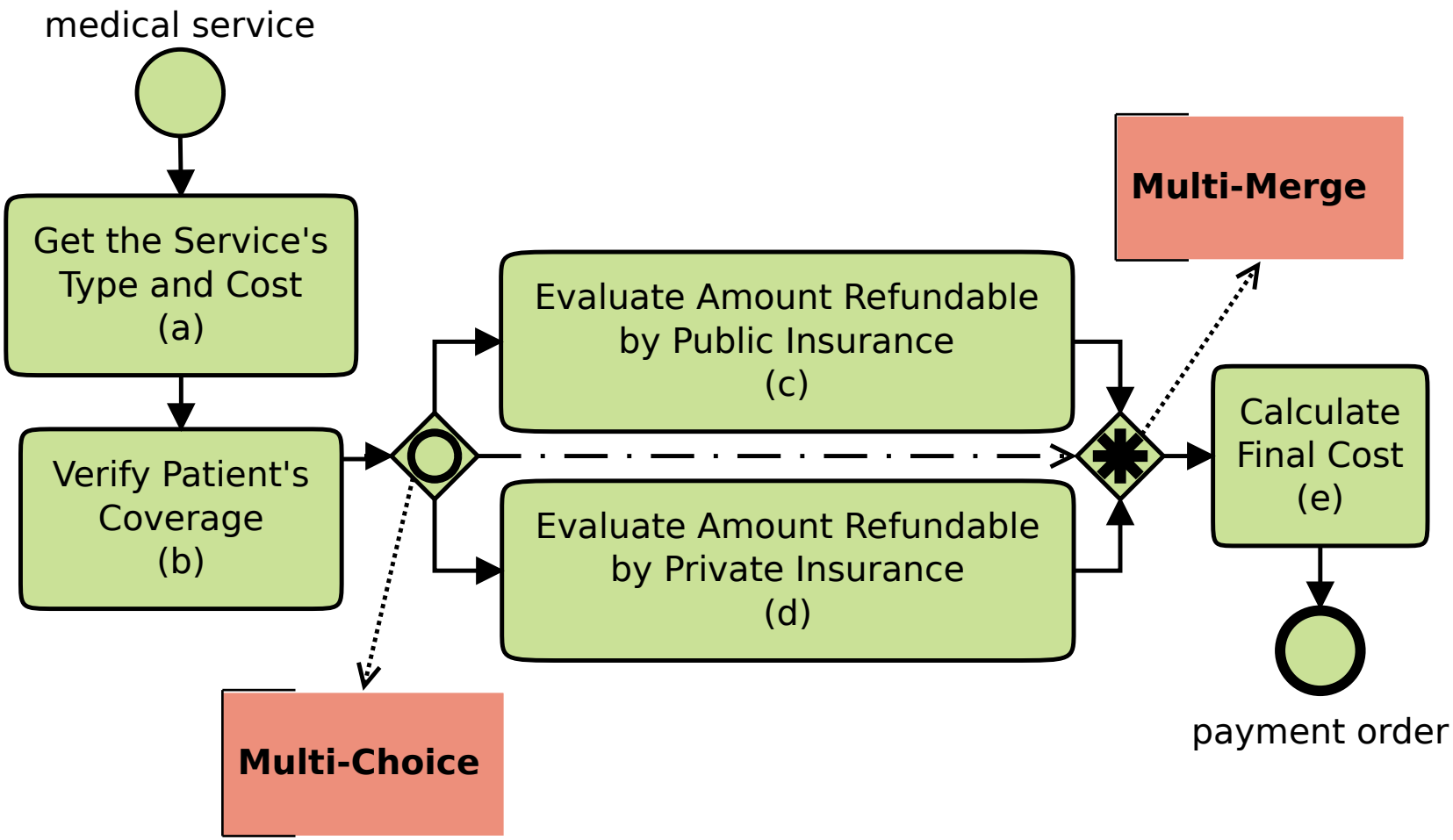

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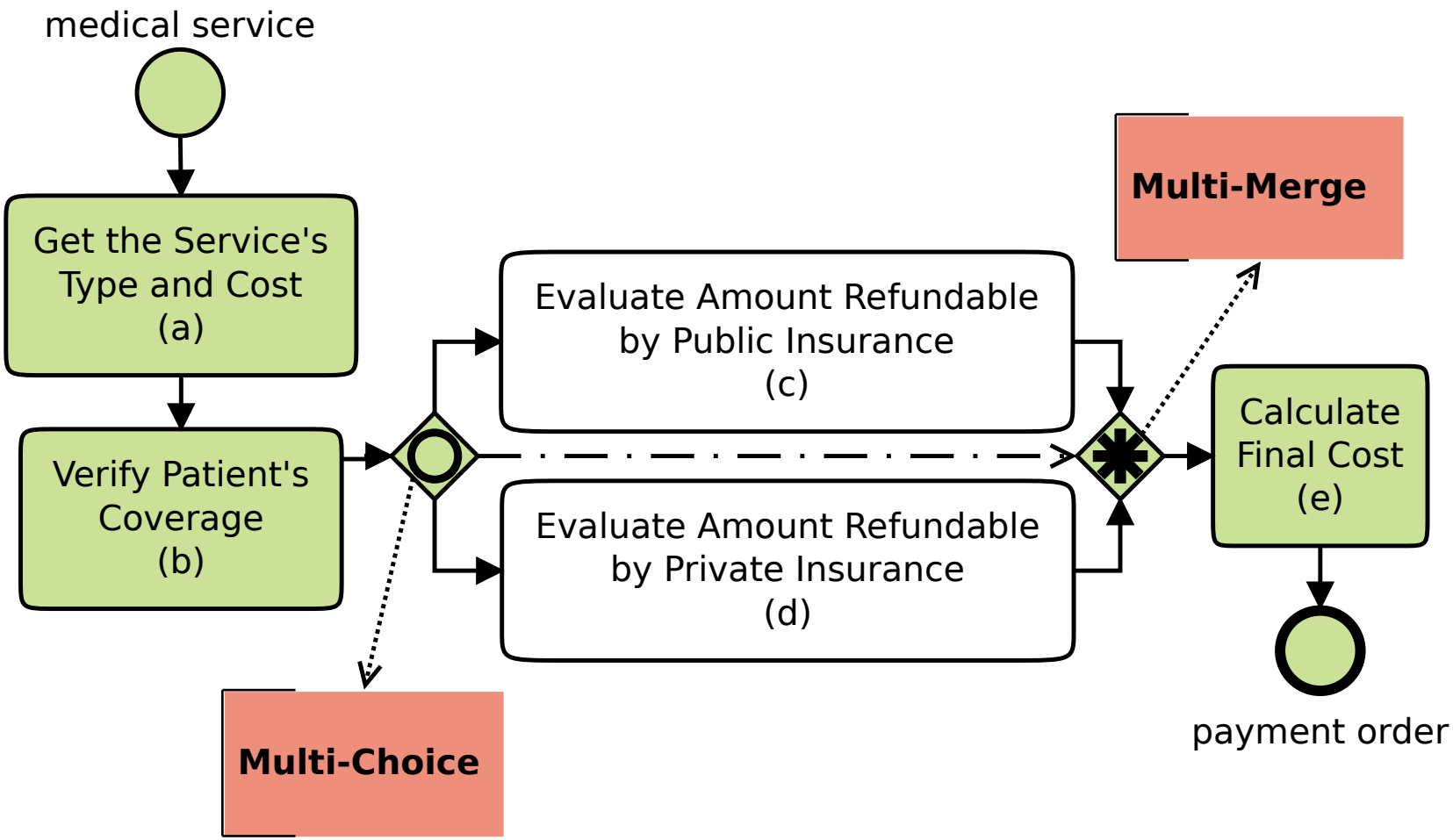
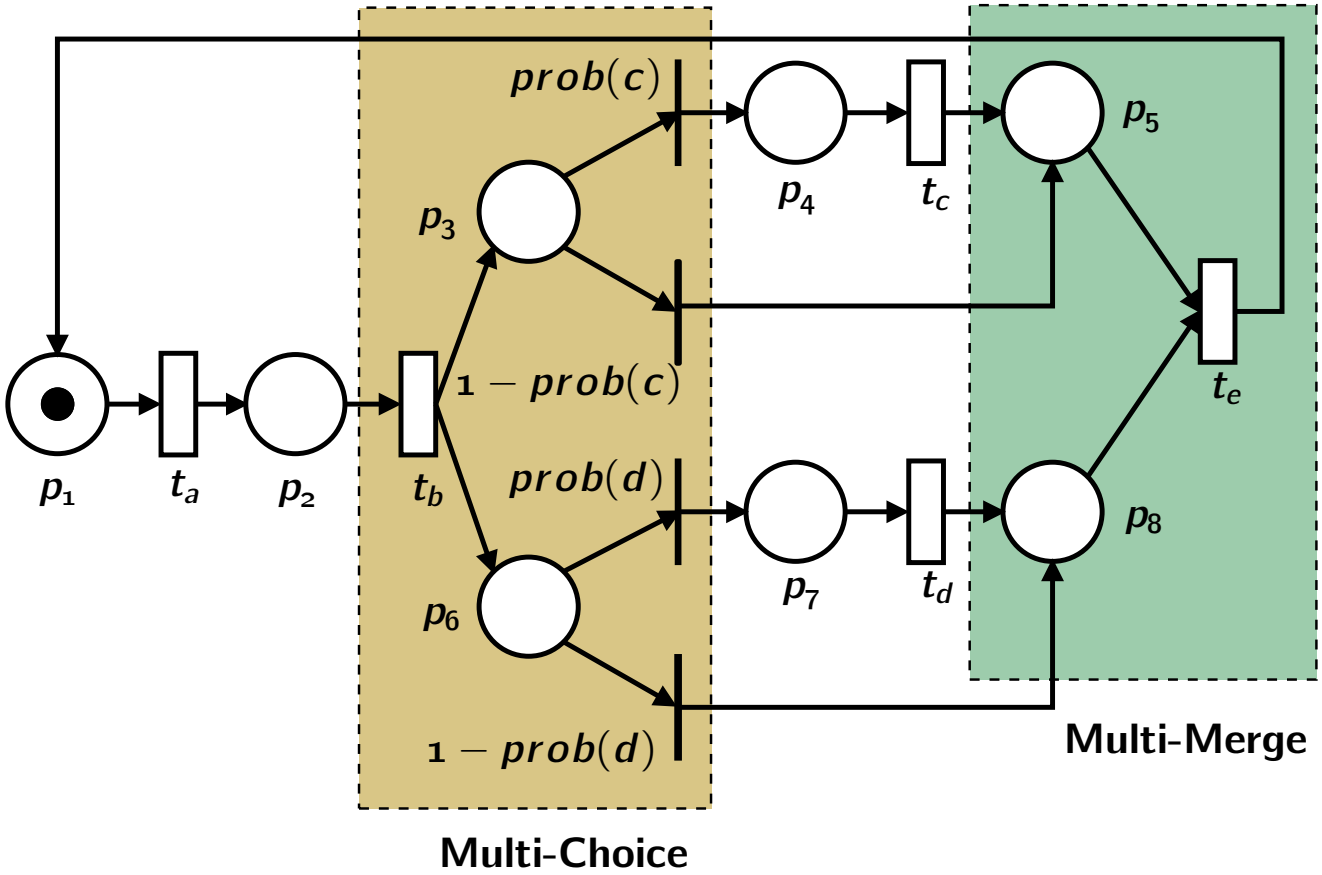
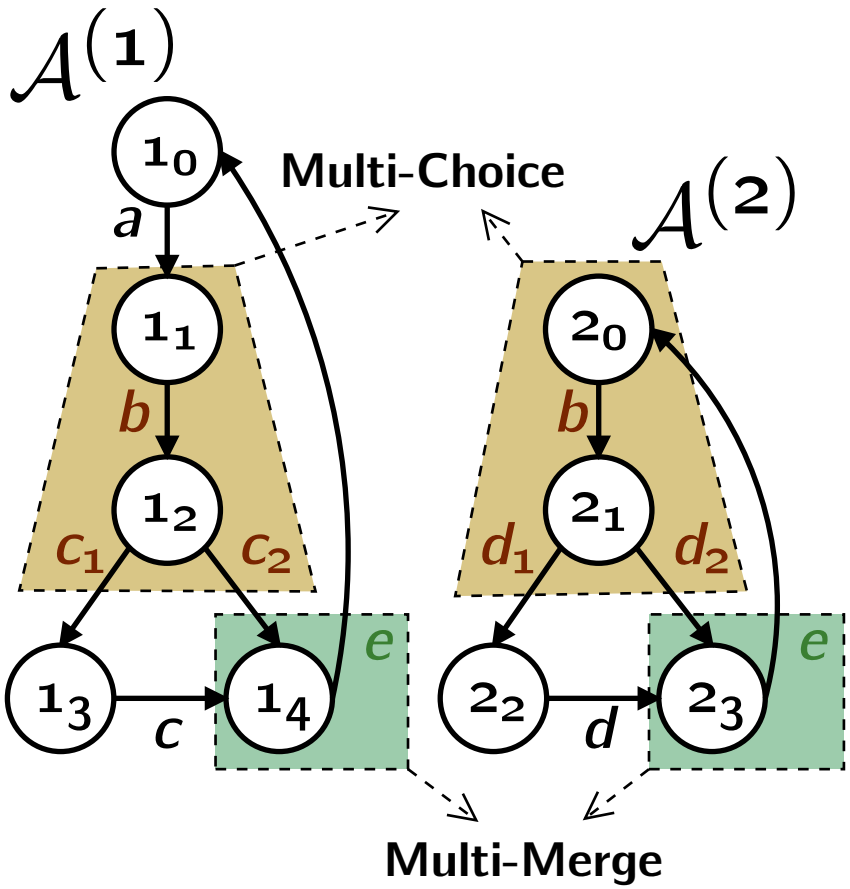


GSPN Model

	Rate
t_a	0.50
t_b	0.20
t_c	0.25
t_d	0.01
t_e	1.00



SAN Model



Event	Rate
a	0.50
b	0.20
c_1	$prob(c) * 50$
c_2	$(1 - prob(c)) * 50$
c	0.25
d_1	$prob(d) * 50$
d_2	$(1 - prob(d)) * 50$
d	0.01
e	1.00

PEPA Model

```
// Execution rates and probabilities associated with the activities
r_a = 0.50;      r_b = 0.20;      r_c = 0.25;
r_d = 0.01;      r_e = 1.00;      r_immediate = 50.00;
prob_c = 0.85;      prob_d = 0.73;

// Medical service cost calculation components
PCalc = (a,r_a). (b,r_b) . (e,r_e) .PCalc;

// Public insurance refund
P1 =  (b,⊤).((c1,prob_c * r_immediate) .(c,r_c). (e, ⊤) .P1 +
          (c2,(1-prob_c) * r_immediate) . (e,⊤) .P1);

// Private insurance refund
P2 =  (b,⊤).((d1,prob_d * r_immediate) .(d,r_d). (e,⊤) .P2 +
          (d2,(1-prob_d) * r_immediate) . (e,⊤) .P2);

PCalc <b,e> P1 <b,e> P2      // Whole system
```

Comparison Summary of the Formalisms

For the example of the Health-Care System

Modeling criteria	GSPN	PEPA	SAN
Expressive power	+	+	+
Abstraction power	+	+/-	+/-
Readability	-	+	+

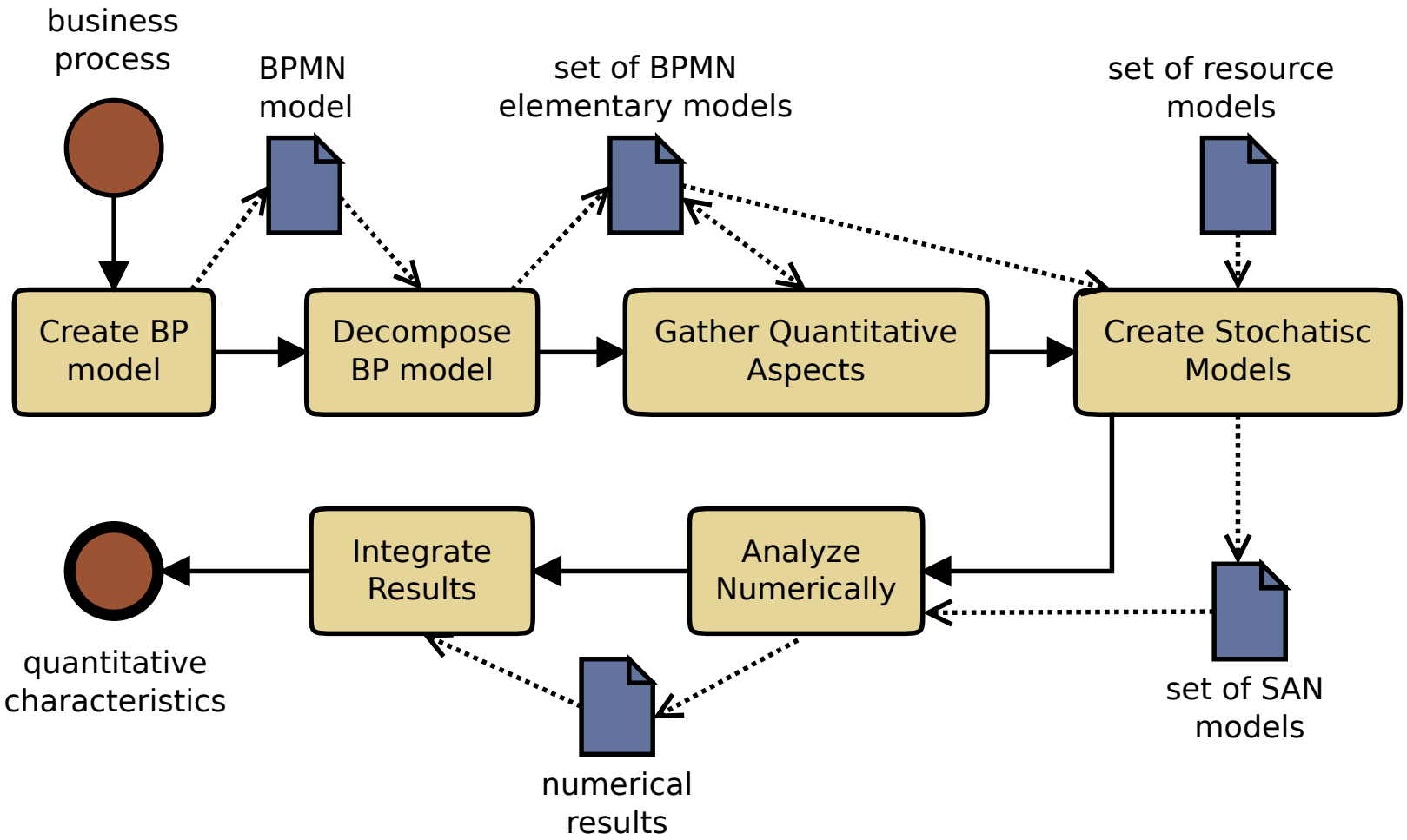
Outline of the Talk

Conclusion

Modeling perspective

- The 3 modeling environments attend the basic scenarios
- Immediate transitions (GSPN) $\longrightarrow$ advanced branching / merging without impacting readability nor analysis results
- Functional transitions (GSPN and SAN) $\longrightarrow$ (i) functional dependencies between activities or (ii) rates that vary with the load of the system or the number of available resources
- Compositionality (PEPA and SAN) $\longrightarrow$ (i) to build the model in a modular way or (ii) to enable a structured analysis

Steps for Performance Evaluation of a Business Process



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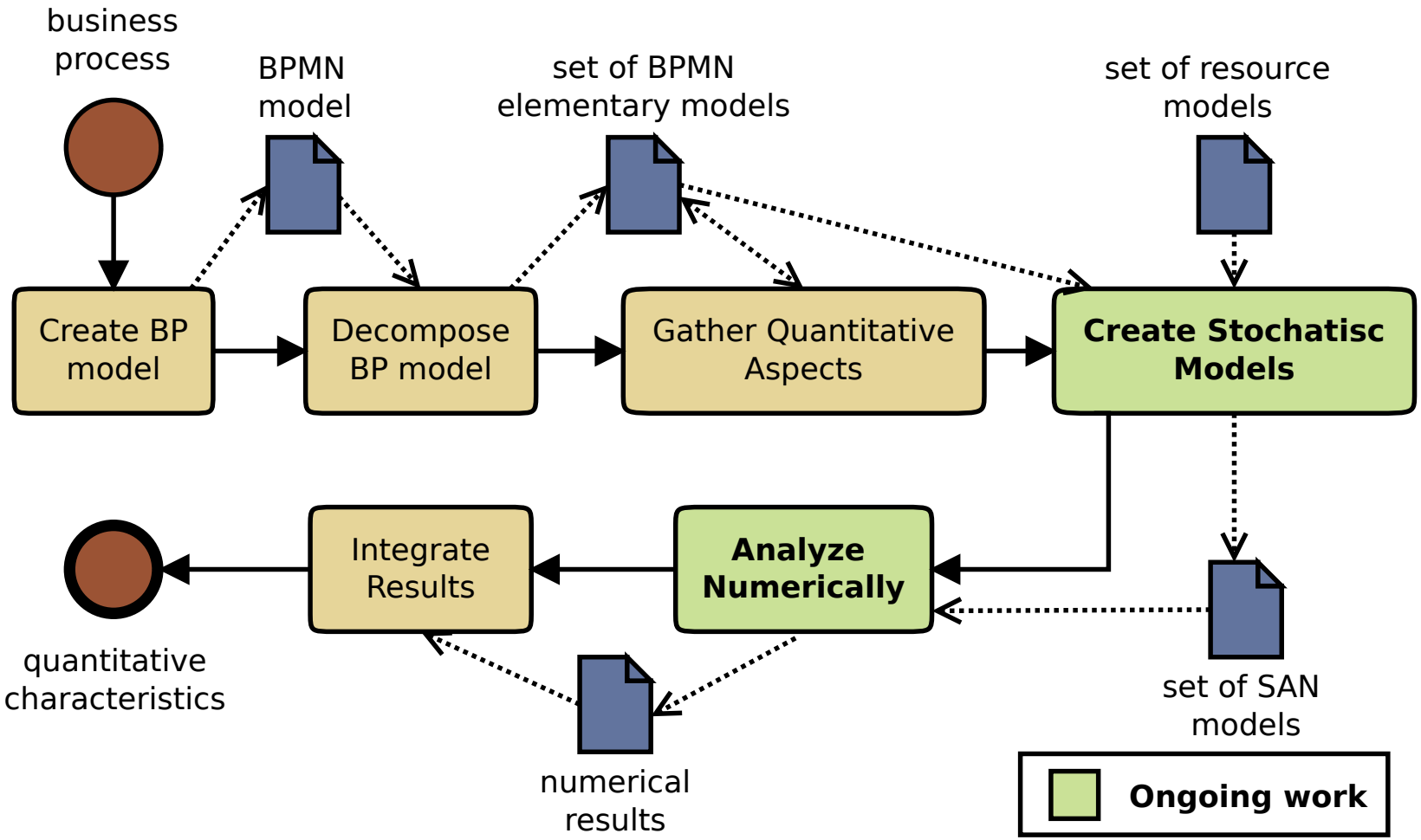

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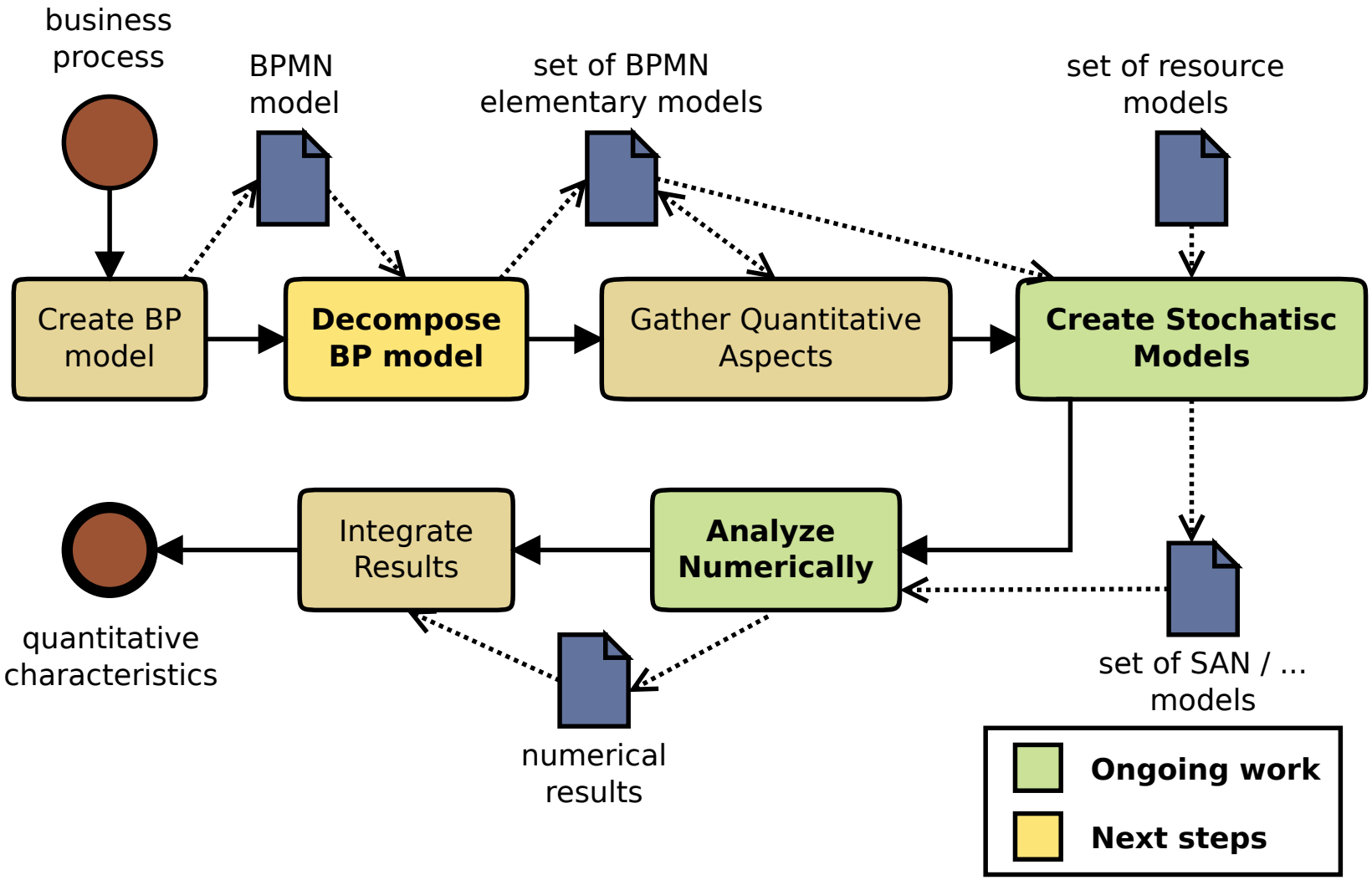

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Thank you for your attention

For more details

- K. R. Braghetto, J. E. Ferreira, and J.-M. Vincent (2009). "Comparison of modeling approaches to business process performance evaluation". Research report, Number: 7065, INRIA.
  Available in: `http://hal.archives-ouvertes.fr/inria-00424452/en`