Configurable Services in the Cloud

Supporting variability while enabling cross-organizational process mining

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Where innovation starts

Acknowledgements

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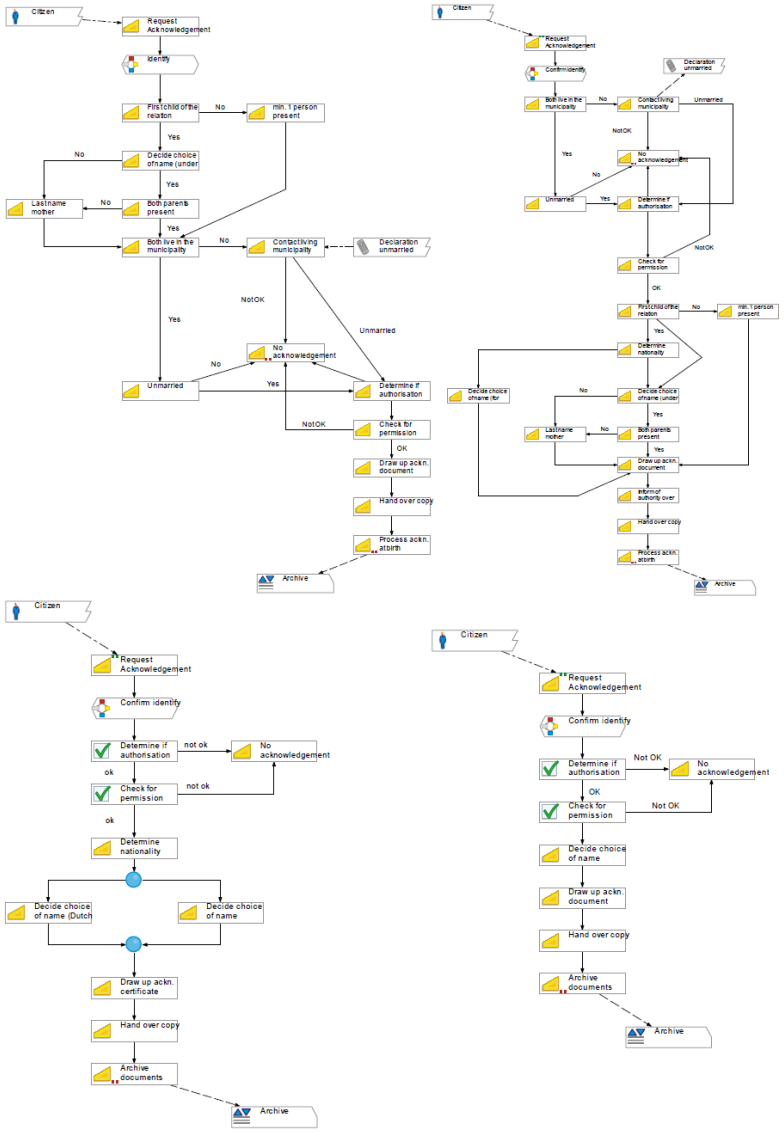
- Marlon Dumas, Arthur ter Hofstede, Niels Lohmann, Michael Rosemann, Jan Mendling, …
- ProM team (www.processmining.org)
- YAWL team (www.yawlfoundation.org)

The need for configurable process models: CoSeLoG project

+/- 430 Dutch municipalities



The need for configurable process models: Suncorp case

End to end process has between 250-1000 process steps

- 25+ steps
- 50+ steps
- 75+ steps
- 100+ steps

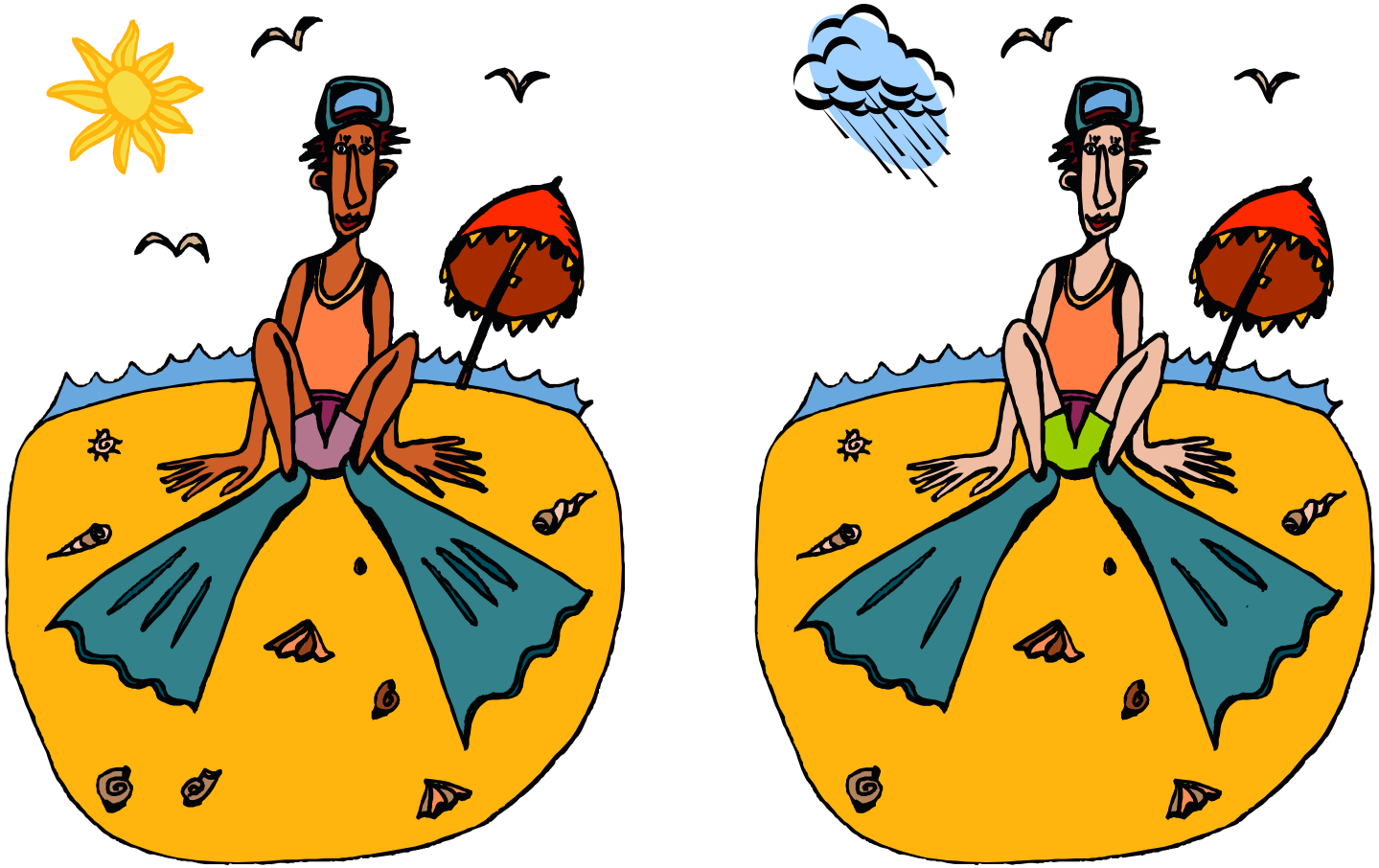
500
steps

Sources: Guidewire reference models, GIO CISSS Project, CI US&S P4PI Project

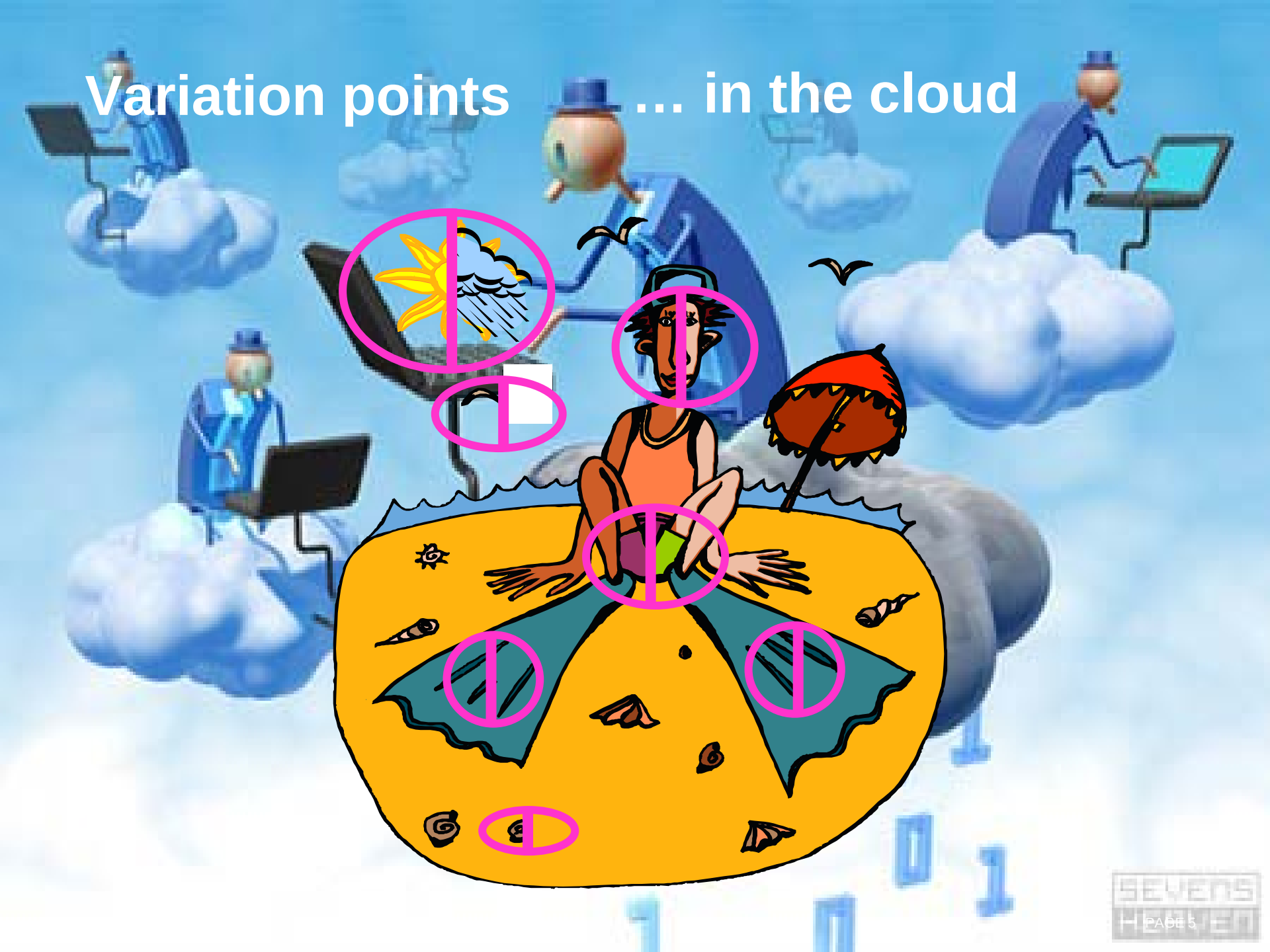
	Home	☑	☑			☑		☑	☑	☑
	Motor	☑	☑	☑		☑	☑	☑	☑	☑
	Commercial	☑			☑	☑			☑	☑
	Liability	☑	☑			☑			☑	☑
	CTP / WC	☑	☑			☑ ☑		☑	☑	

30
variations

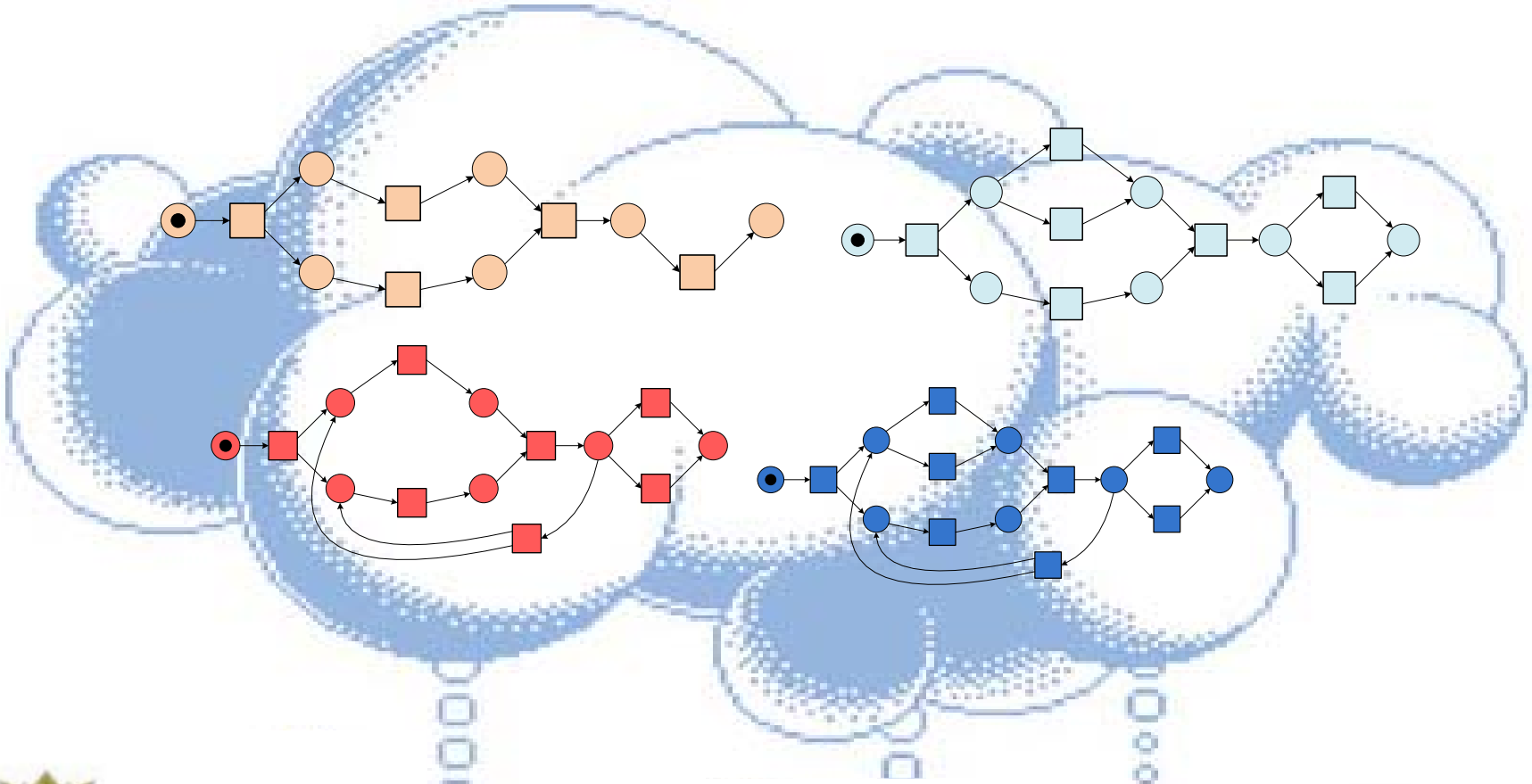
Two variants of the same process …



Variation points … in the cloud



Cloud computing

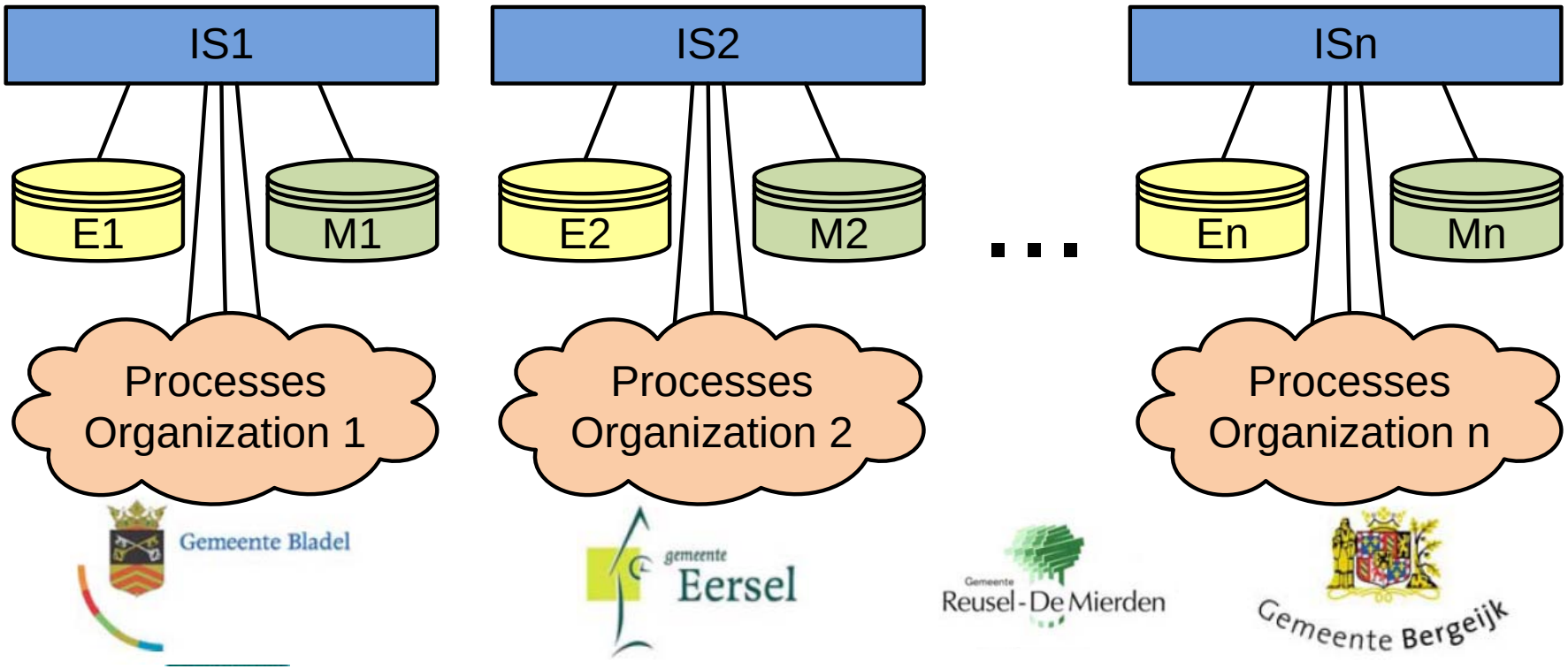


Gemeente Bladel

gemeente Eersel

Gemeente Bergeijk

Traditional Situation

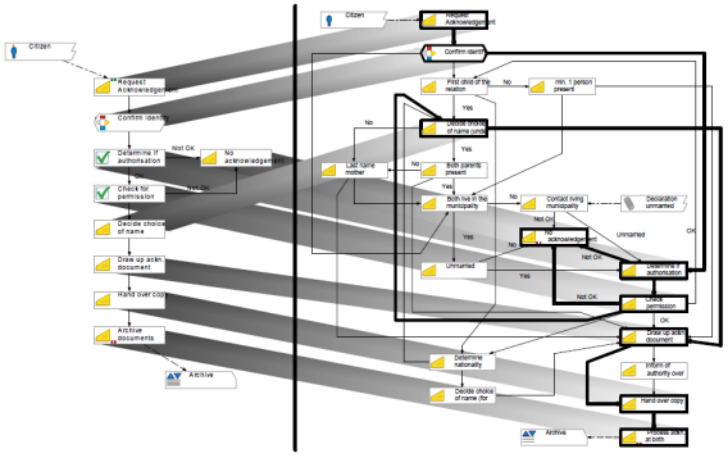


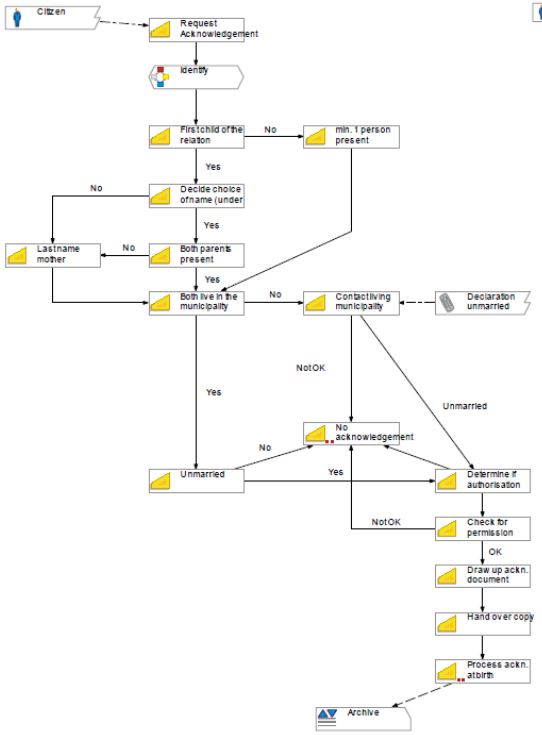
IS = Information System
E = Event log
M = Models

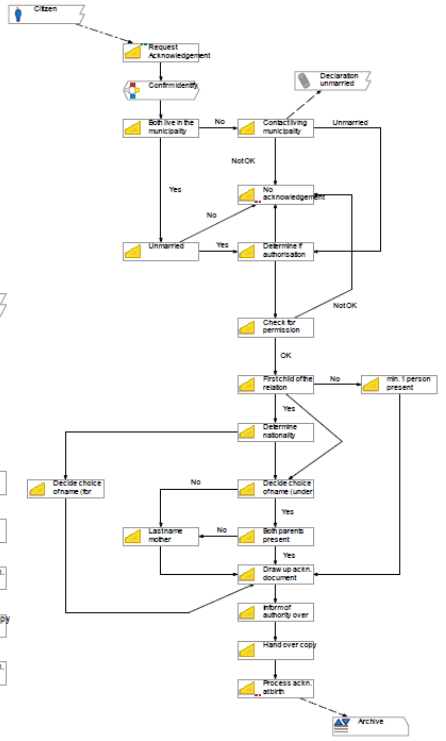
Example

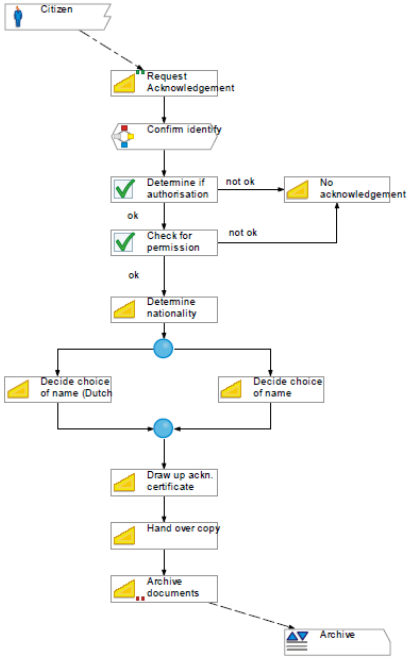
Acknowledgement of an Unborn Child

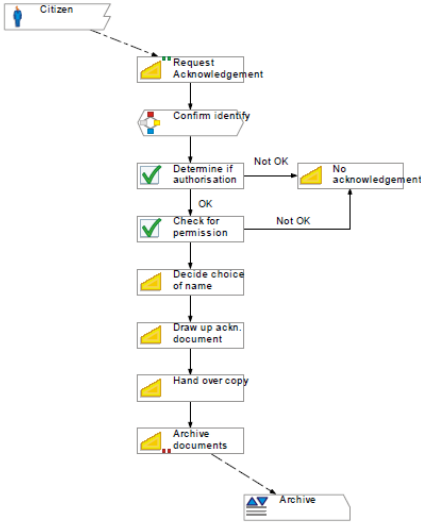
- Same but different …
- “Couleur Locale”
- Different from NVVB models.
- Configurable process models!



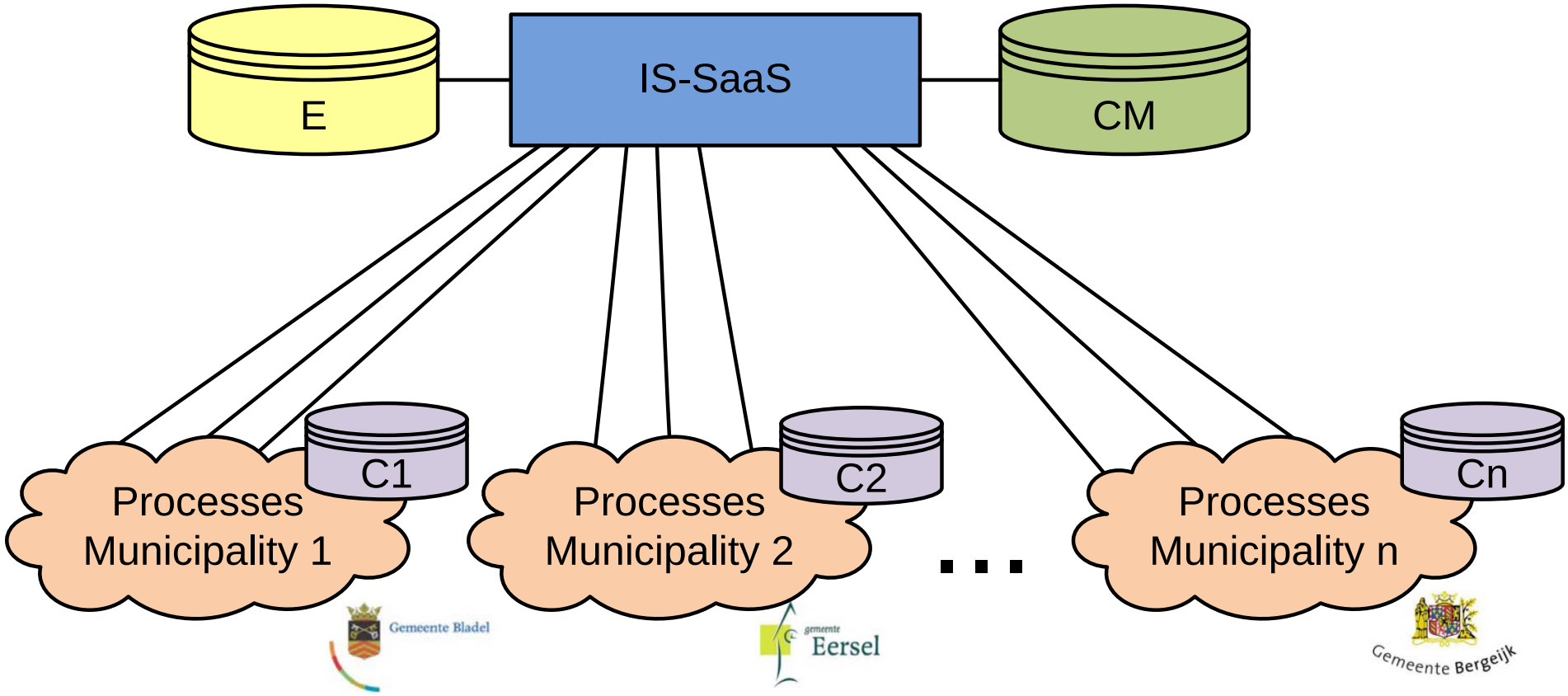






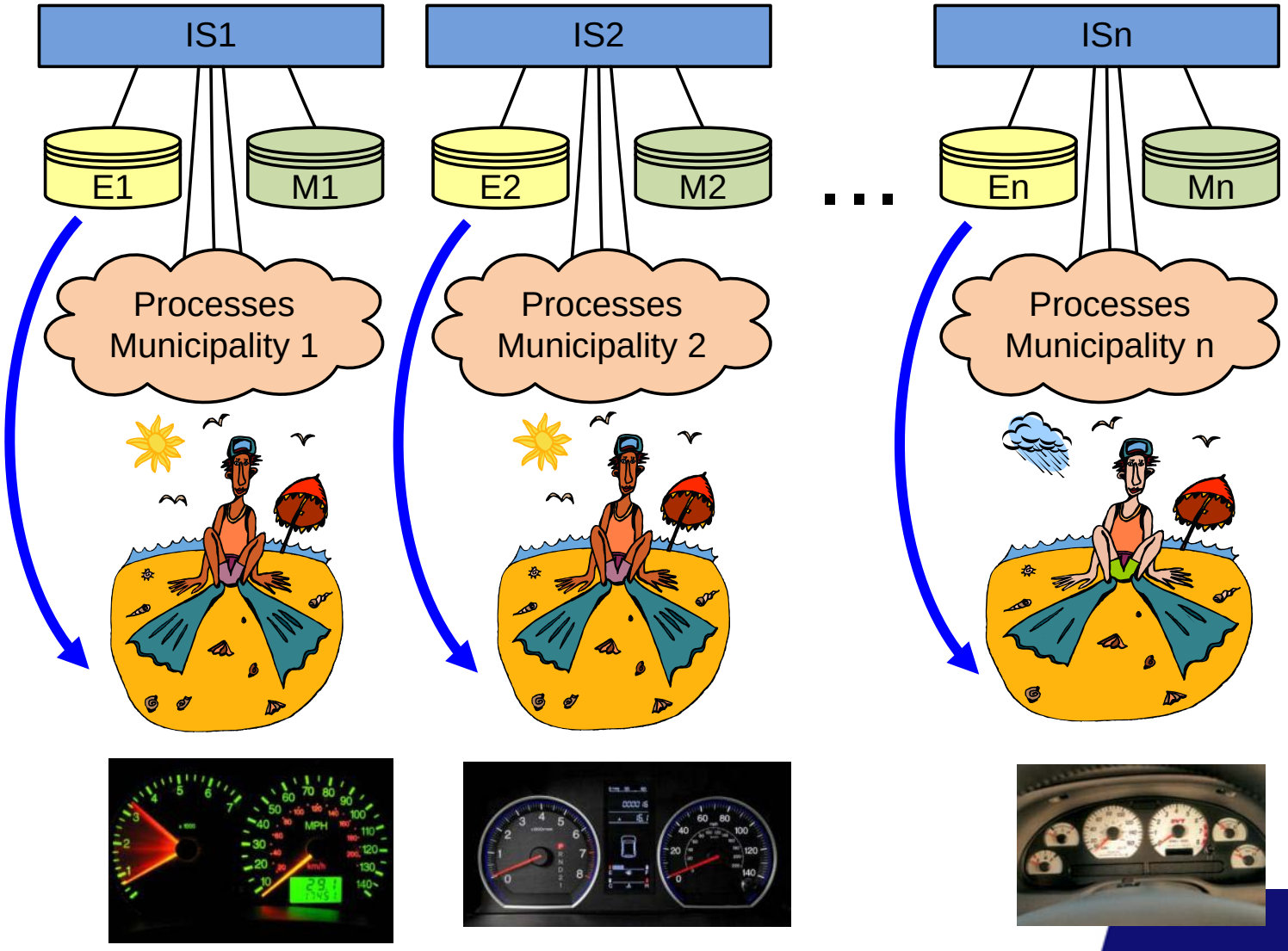


Using SaaS Technology

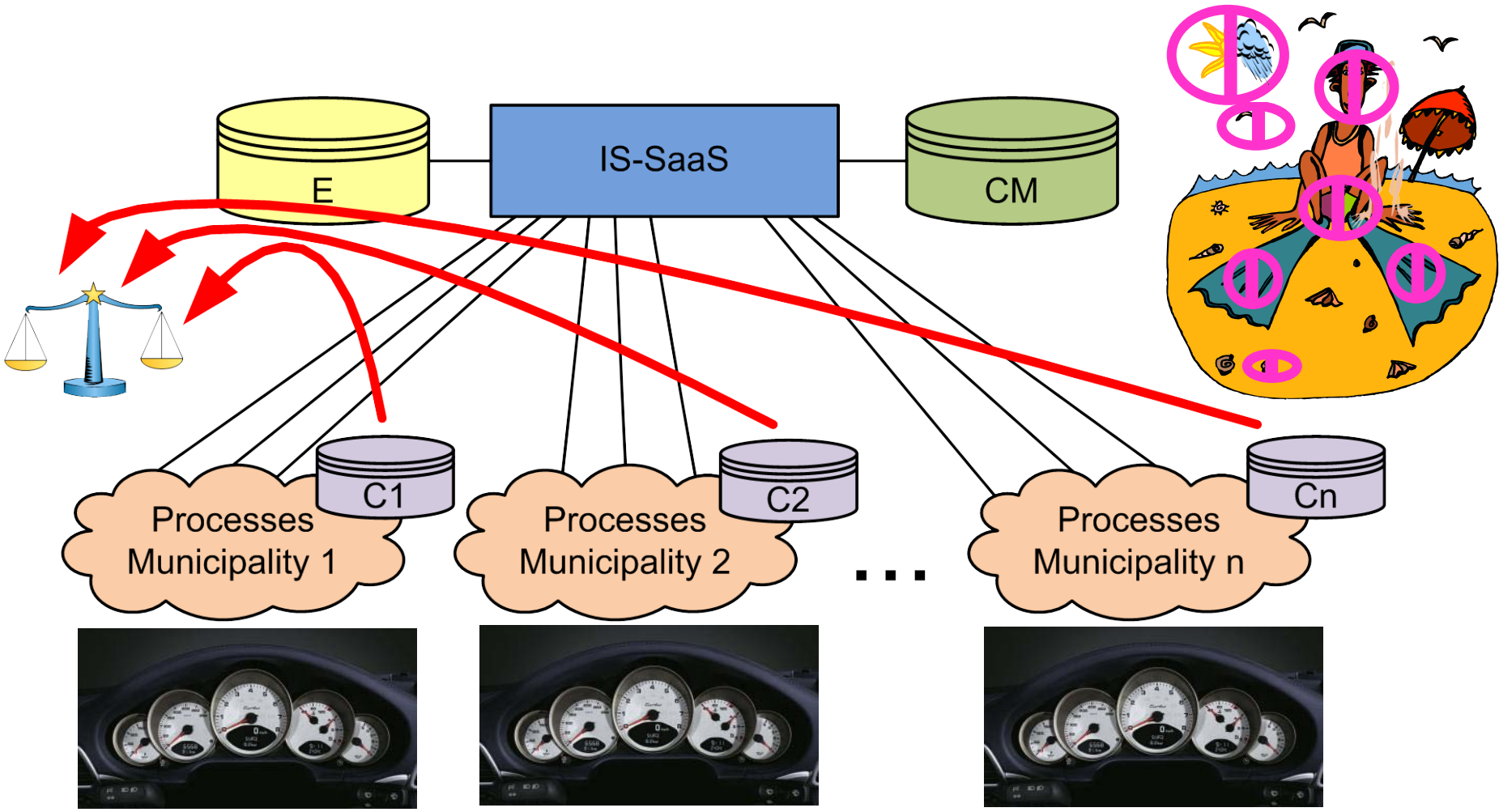


IS-SaaS = Information System (using a SaaS-based BPMS)
E = Event log
CM = Configurable Models
C = Configuration

Process Mining: Before



Process Mining: After



cross-organizational process mining


Configuration

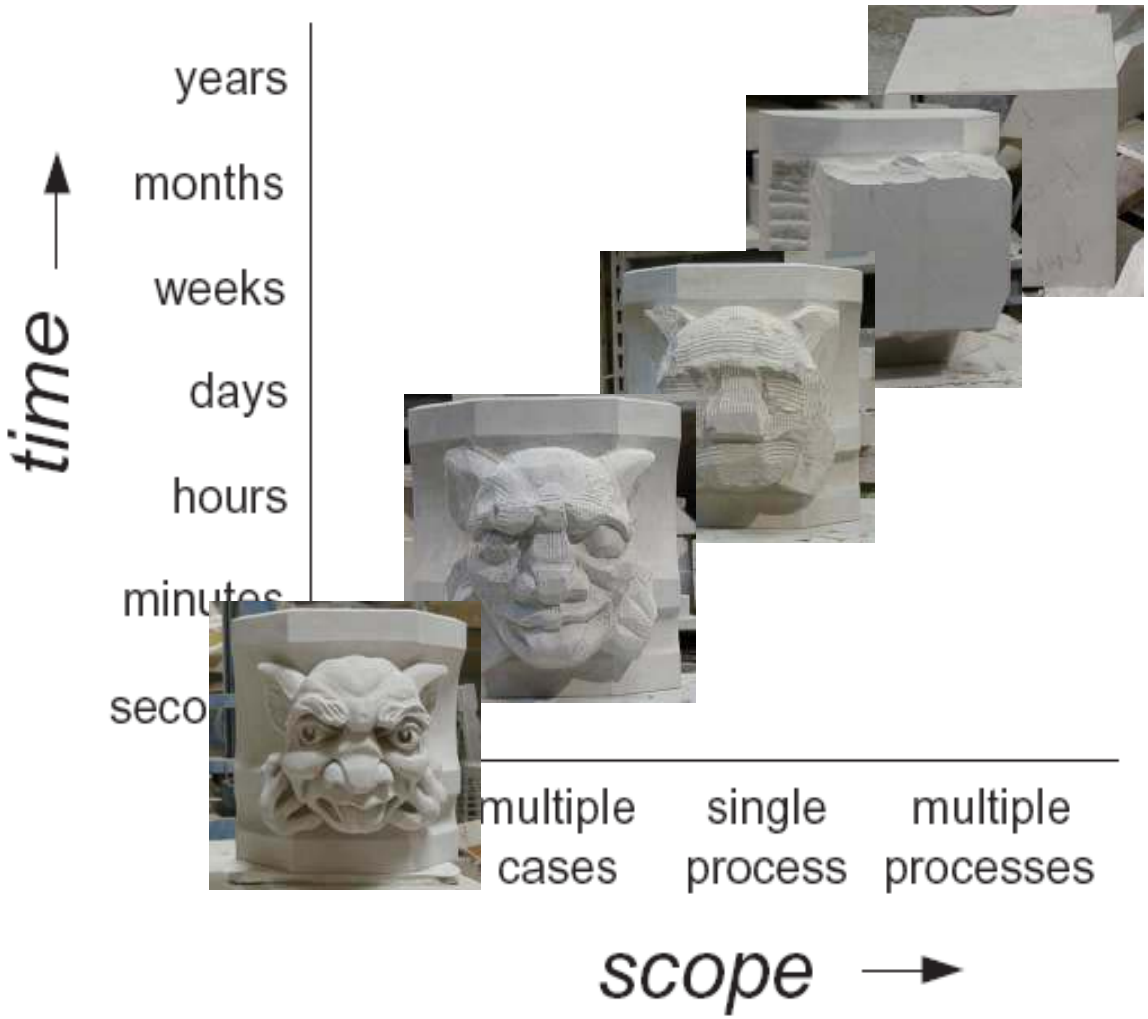
Positioning of Configuration

Some quotes from Michelangelo

- **“Every block of stone has a statue inside it and it is the task of the sculptor to discover it.”**
- **“I saw the angel in the marble and carved until I set him free.”**
- **“Carving is easy, you just go down to the skin and stop.”**

Michelangelo's David

Life is about making choices …



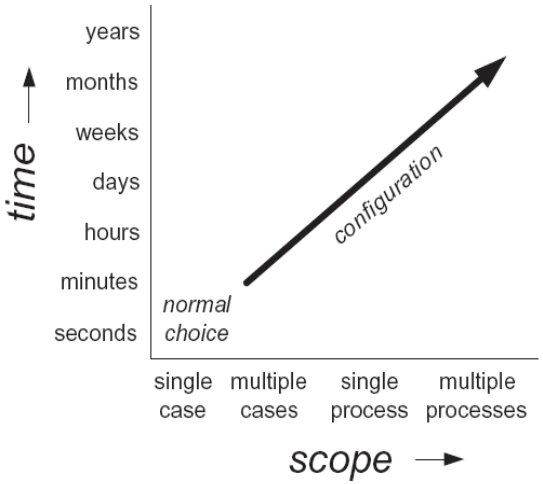
Time and artifacts

- Design time (generic model, i.e., is not released for instantiation)
- Configuration time (specific model, i.e., can be instantiated)
- Instantiation time (specific model + instance)
- Run time (specific model + instance + state/partial trace)
- Auditing time (specific model + instance + full trace)

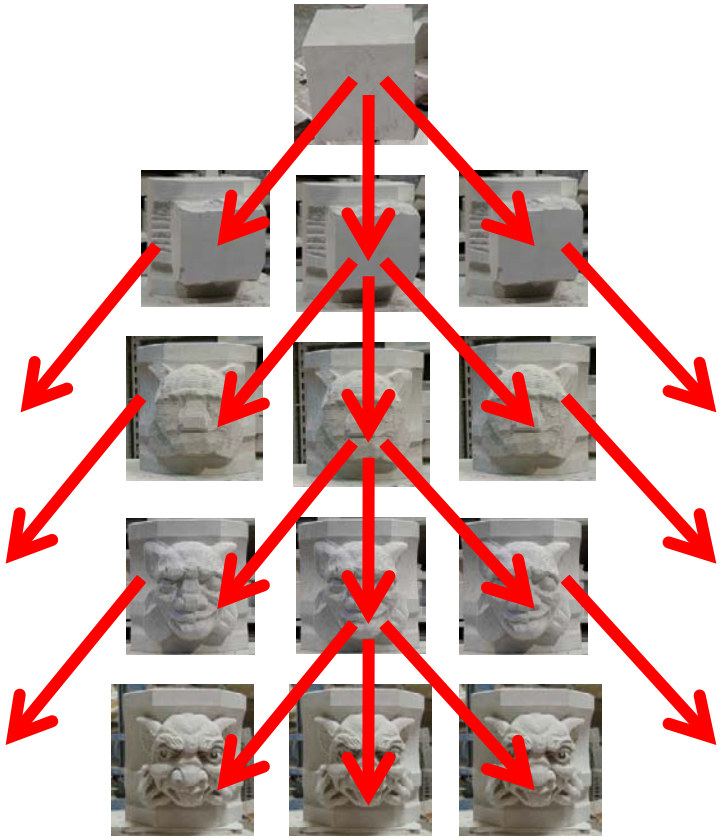




Continuum



- **In The Netherlands, …**
- **In Brisbane, …**
- **When the sun shines, …**
- **On Sunday, …**
- **When very busy, …**
- **For these customers, …**
- **…**



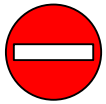
Branching structure

Hiding and blocking

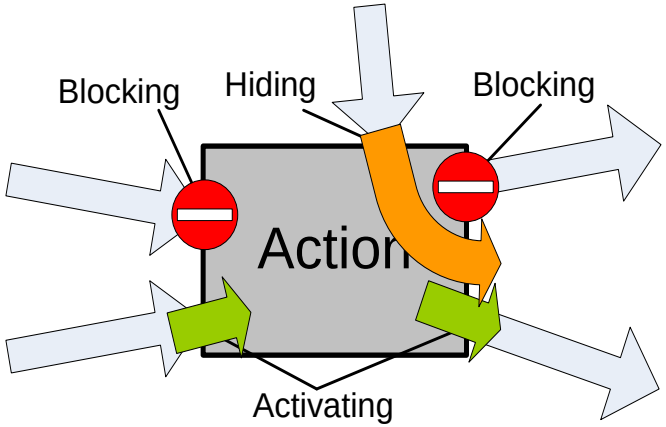
Configuration = limiting behavior !

Activate

Hide/skip



Block



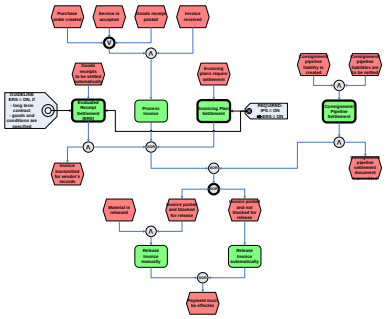
Configurable Process Models

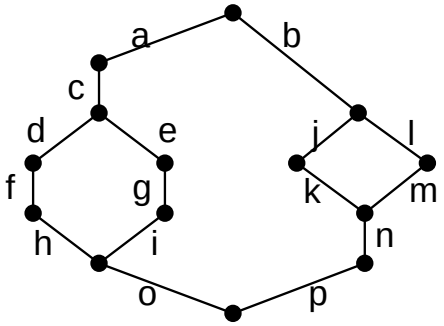
C-EPC

C-Petri Net

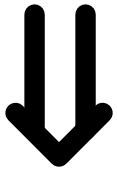
C-YAWL

C-BPEL

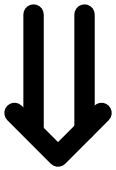




C-LTS



Configuration



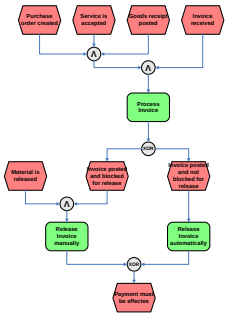
Blocking Hiding

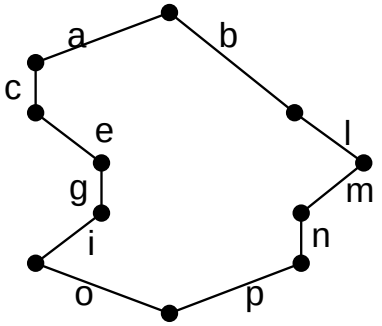
EPC

Petri Net

YAWL

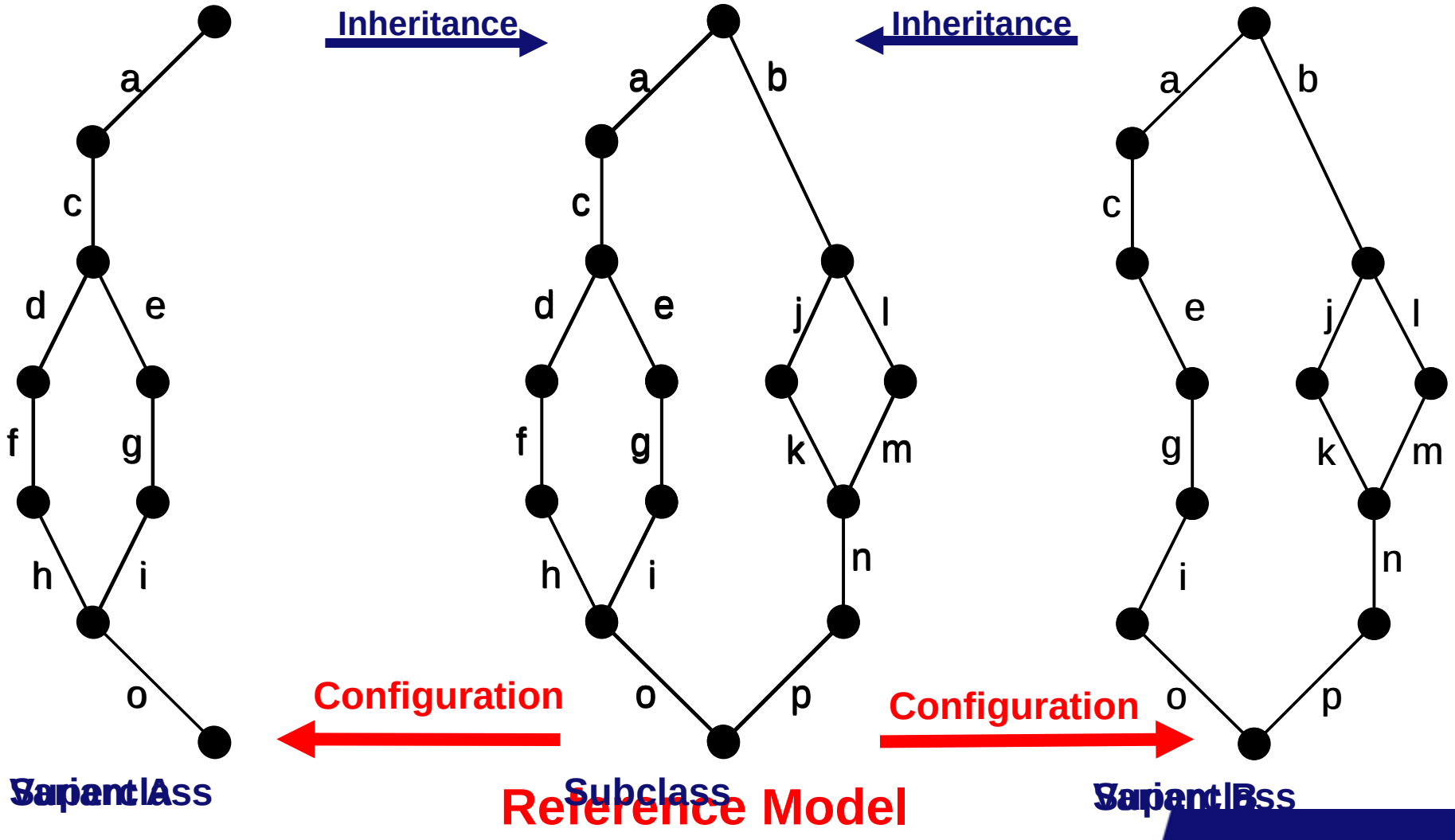
BPEL





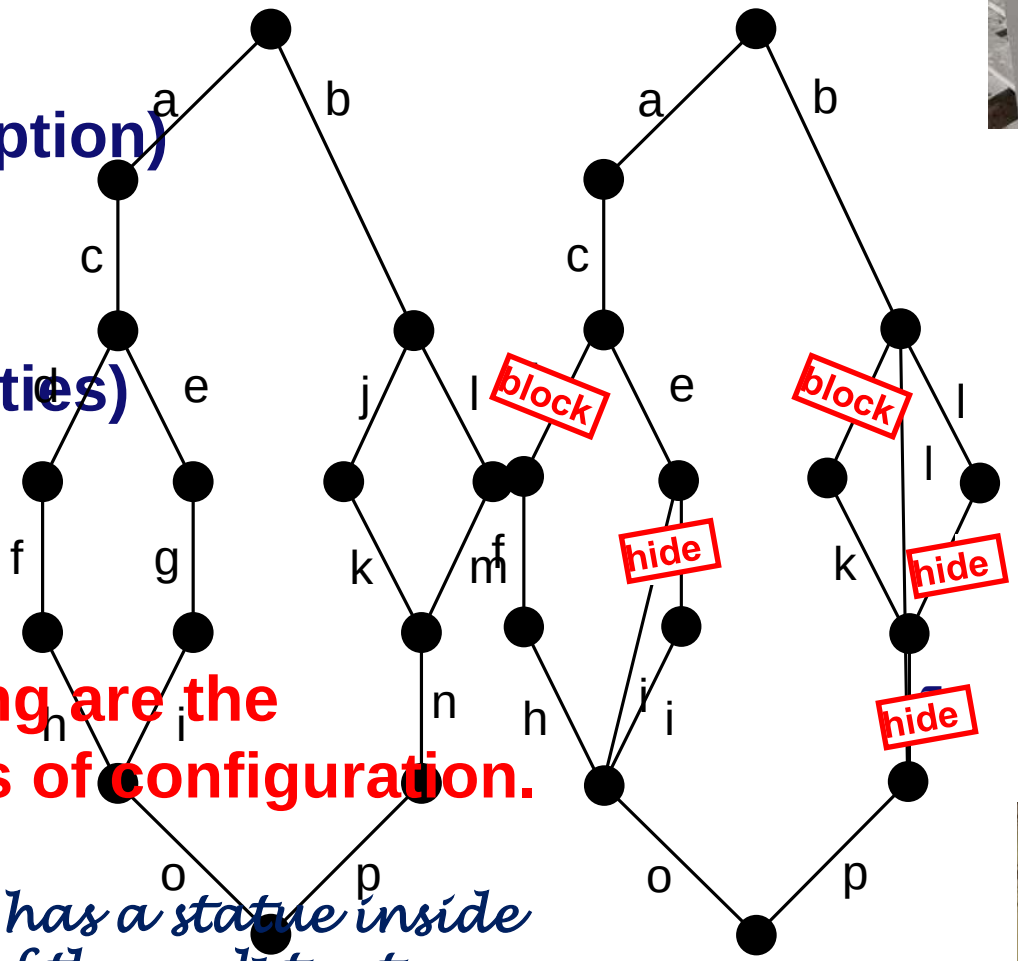
LTS

Inheritance of dynamic behavior



Configuration Techniques

- **Blocking (removing an option)**
- **Hiding (skipping activities)**

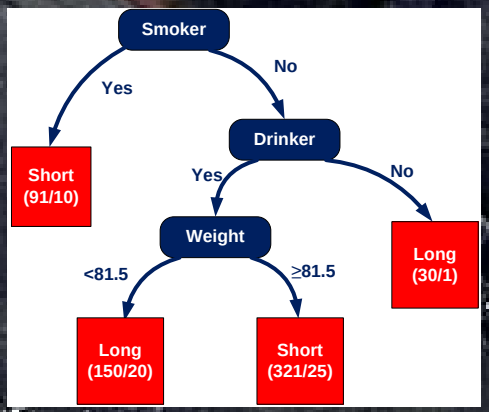


Blocking and hiding are the essential concepts of configuration.

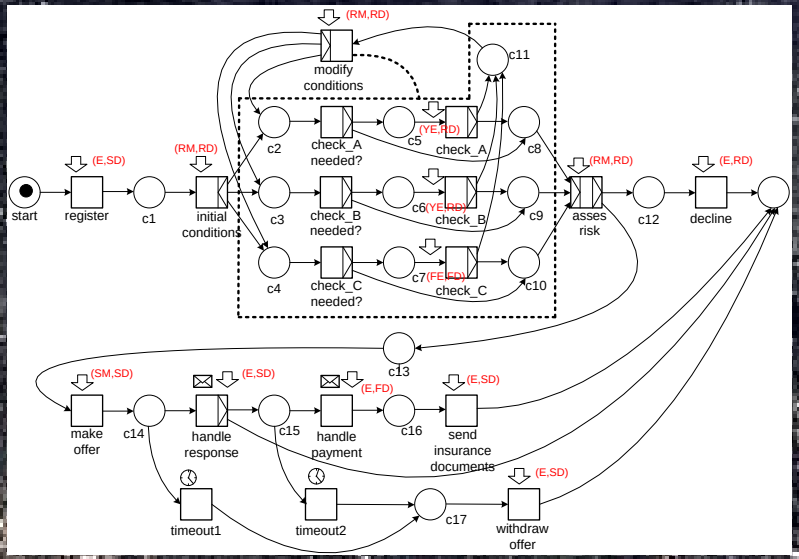
"Every block of stone has a statue inside it and it is the task of the sculptor to discover it."

Cross-organizational mining

Process Mining =

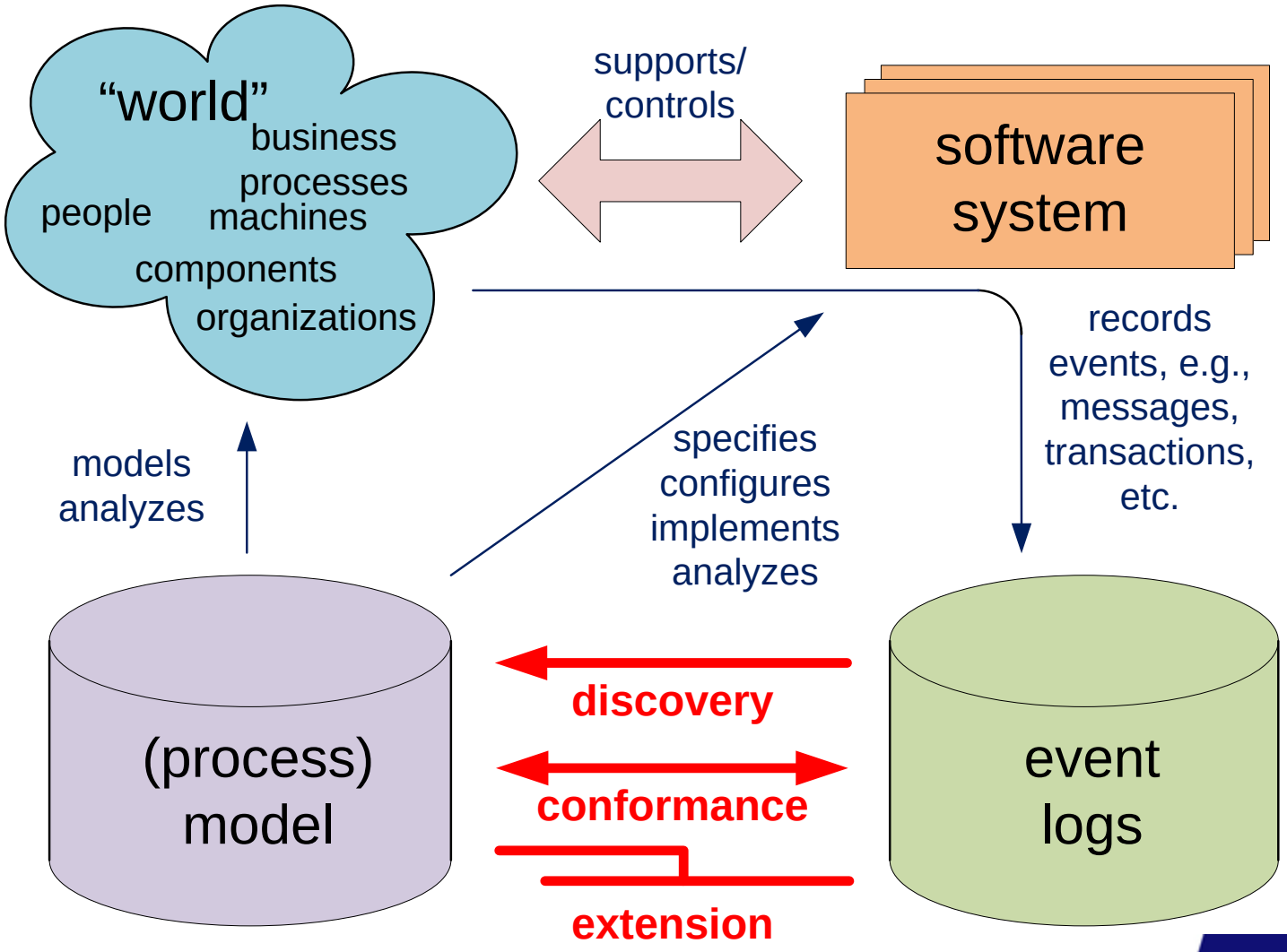


+



Data Mining Process Analysis

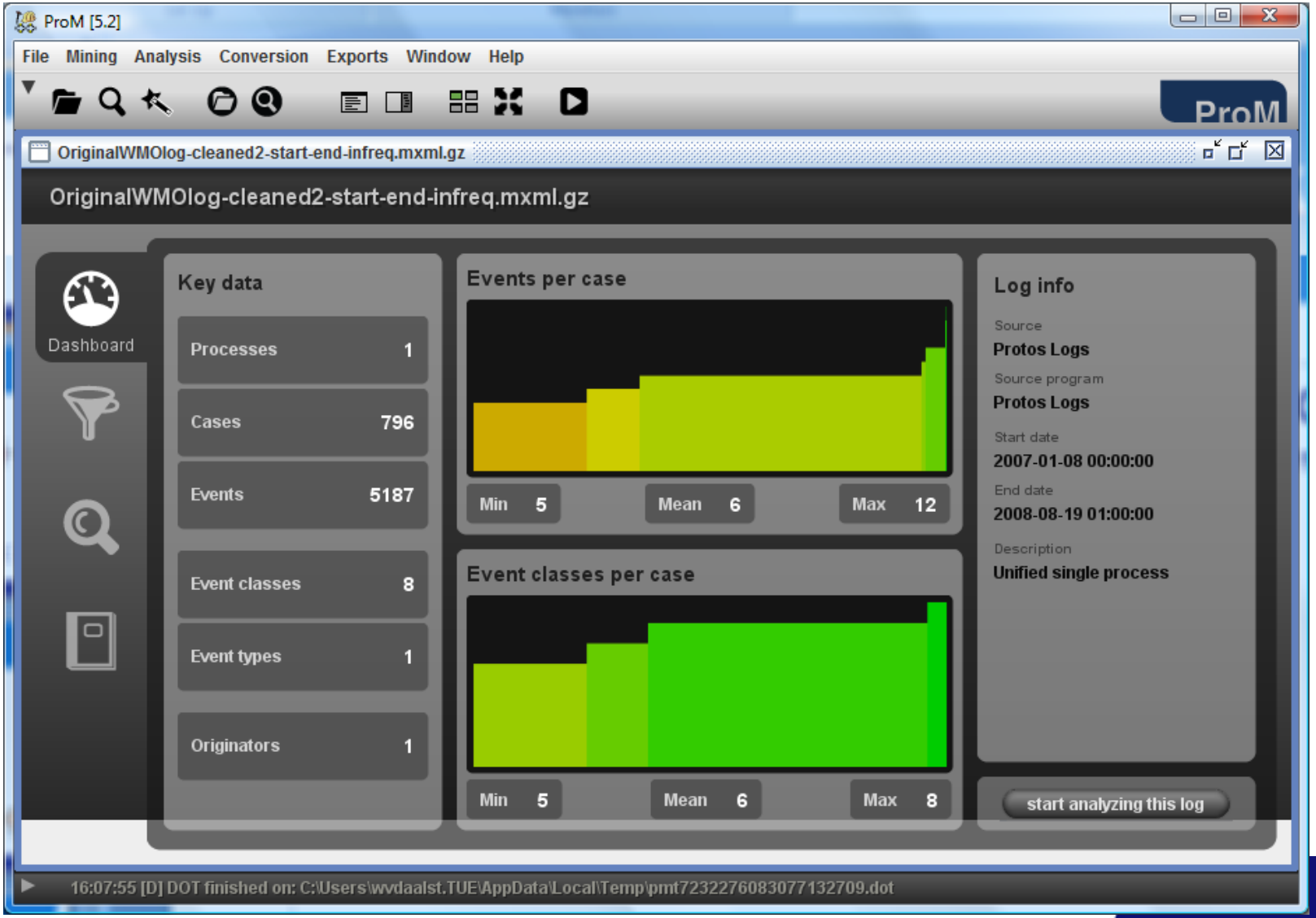
Process mining: Linking events to models



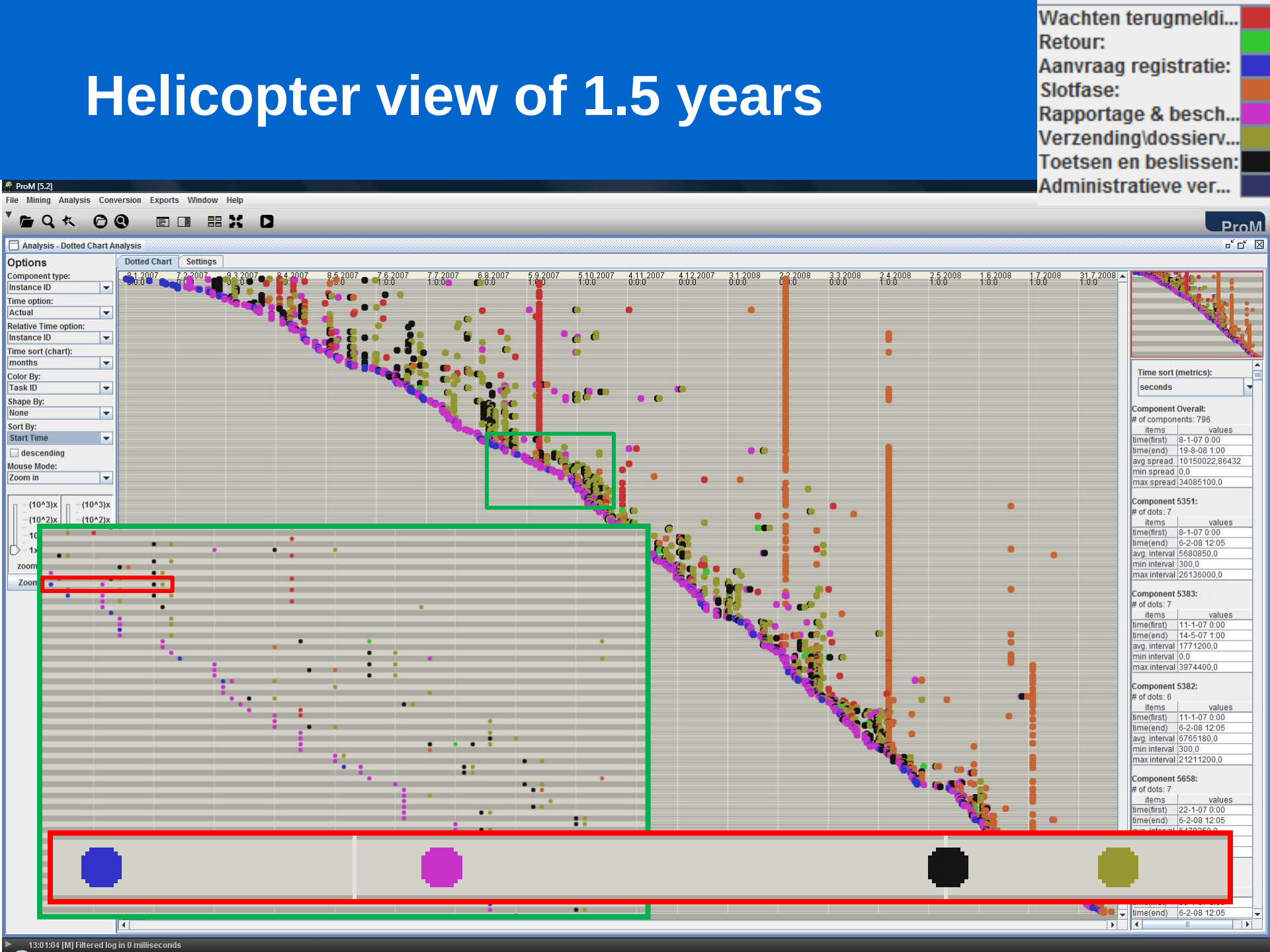
Example: WMO Harderwijk

- **Process related to the execution of “Wet Maatschappelijke Ondersteuning” (WMO) Harderwijk**
- **Handling WMO applications**
- **WMO: supporting citizens of municipalities (illness, handicaps, elderly, etc.).**
- **Examples:**
  - **wheelchair, scootmobiel, ...**
  - **adaptation of house (elevator), ...**
  - **household help, ...**

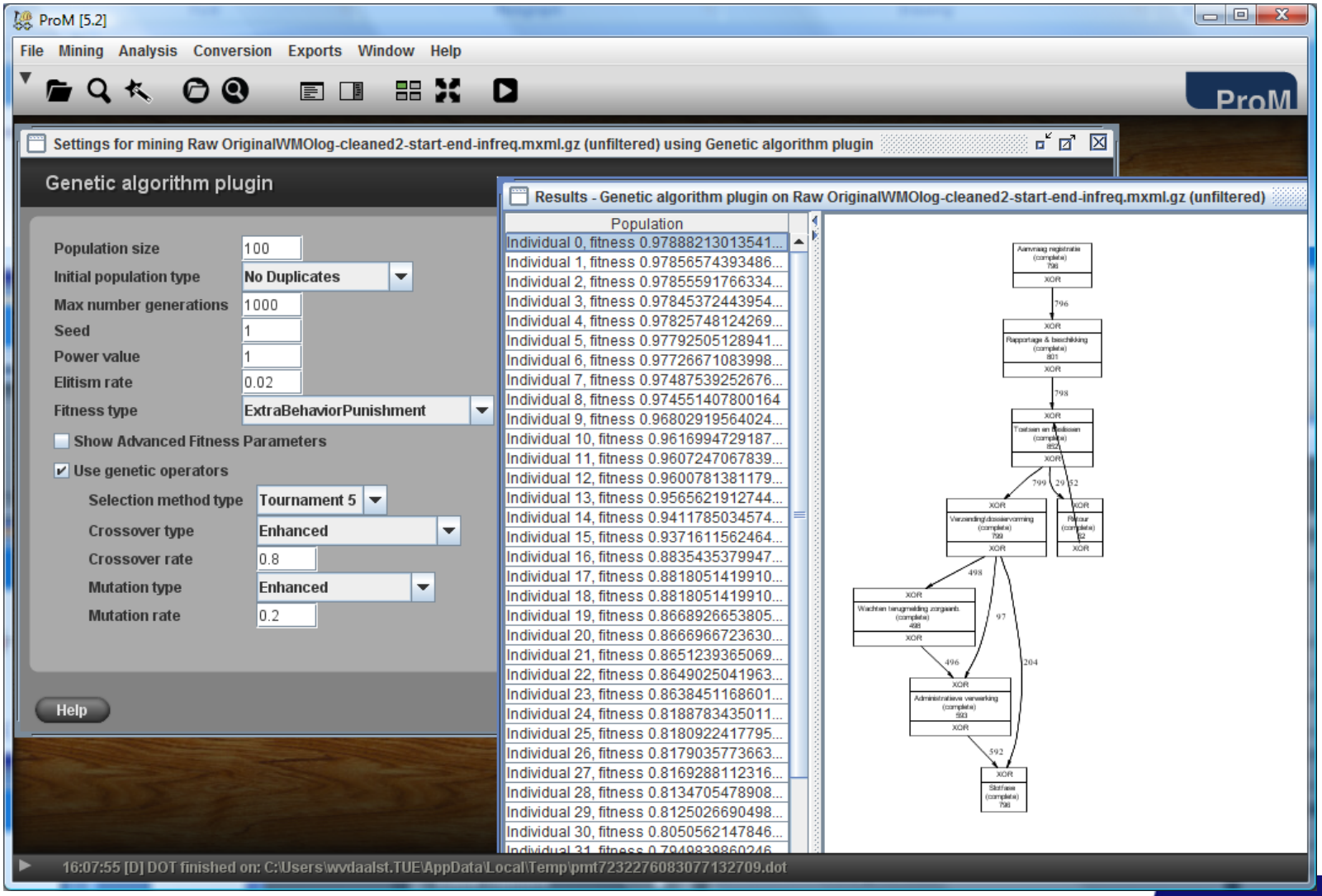
Event log
(796 applications, 5187 events)



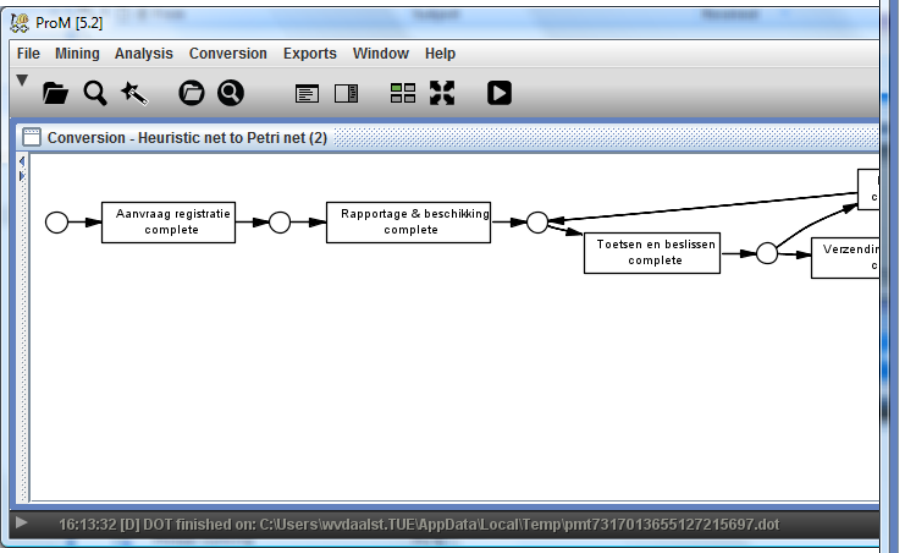
Helicopter view of 1.5 years

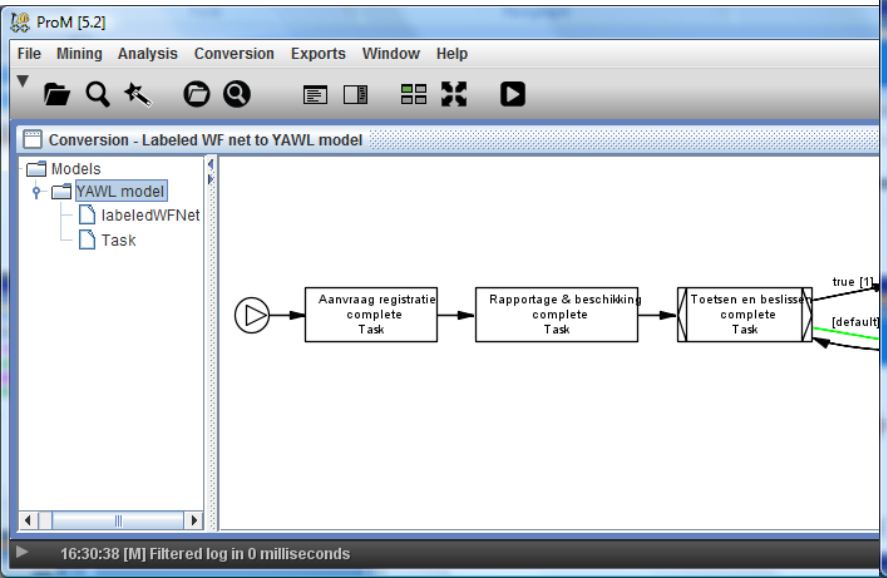


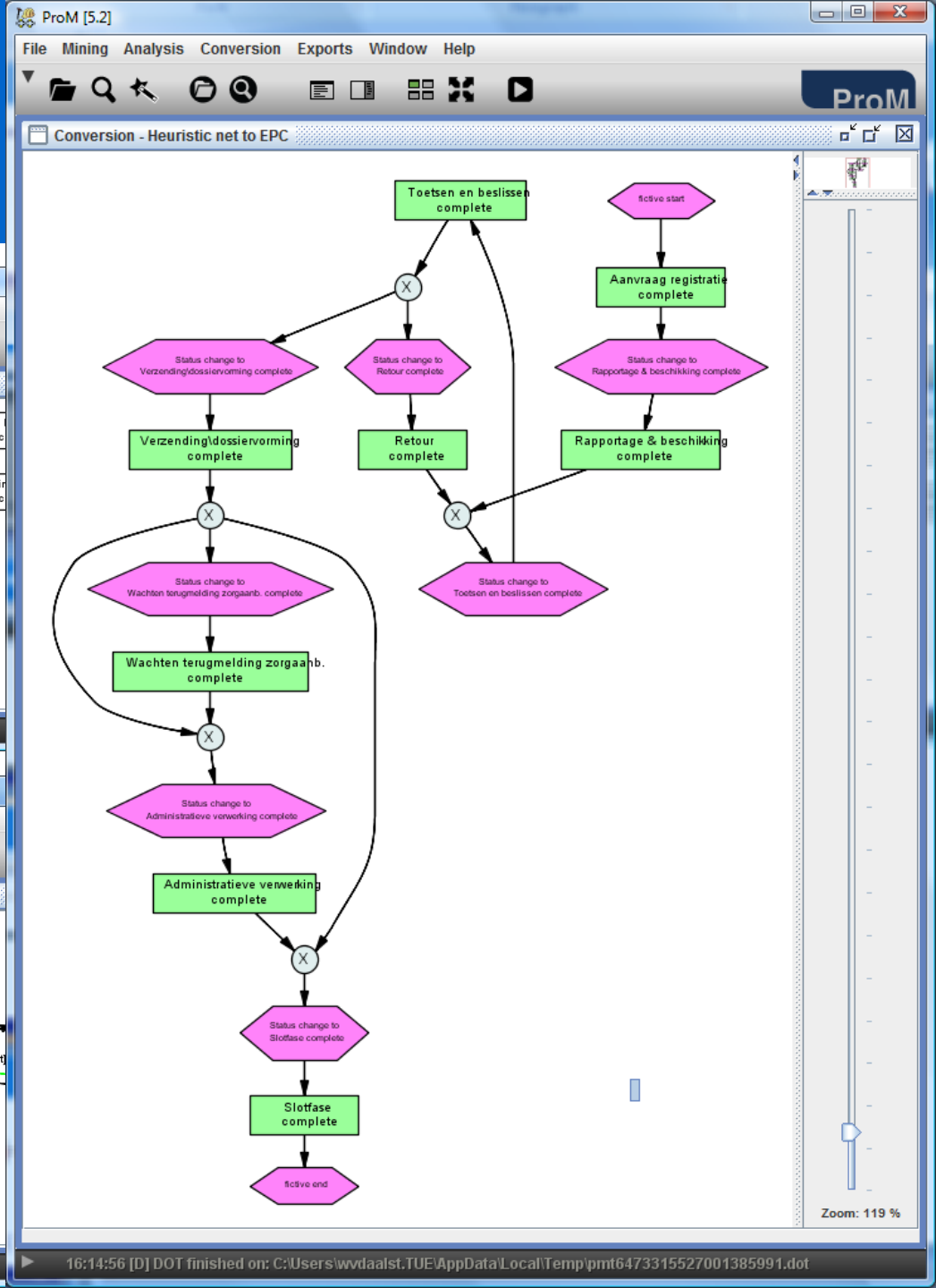
Process discovered using Genetic Miner



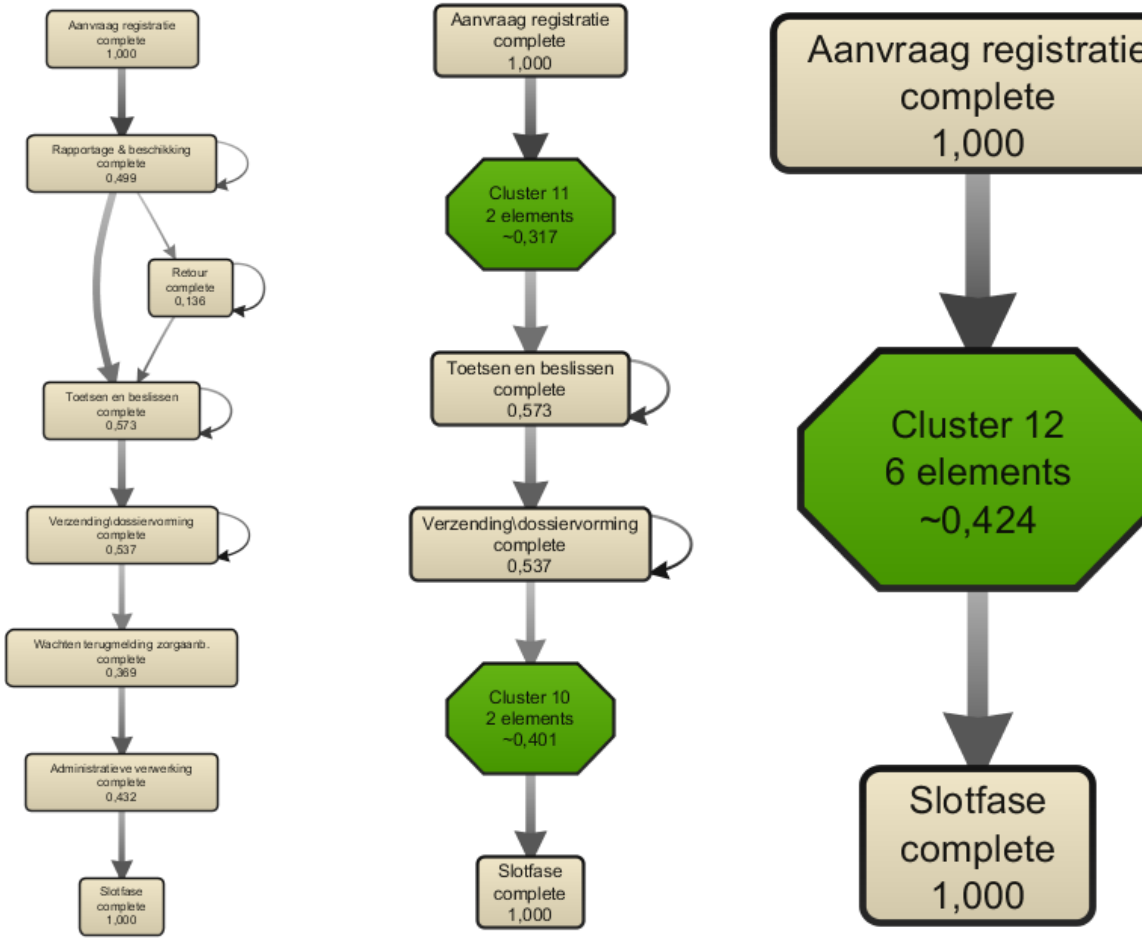
Various representations

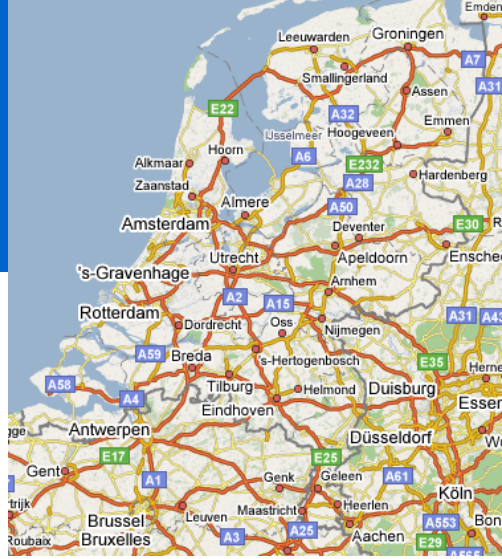




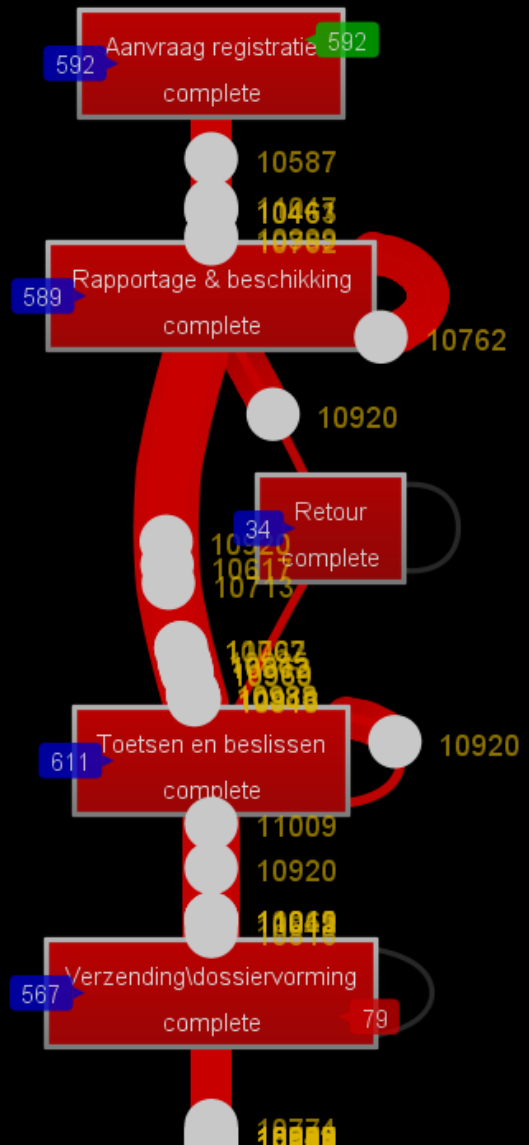


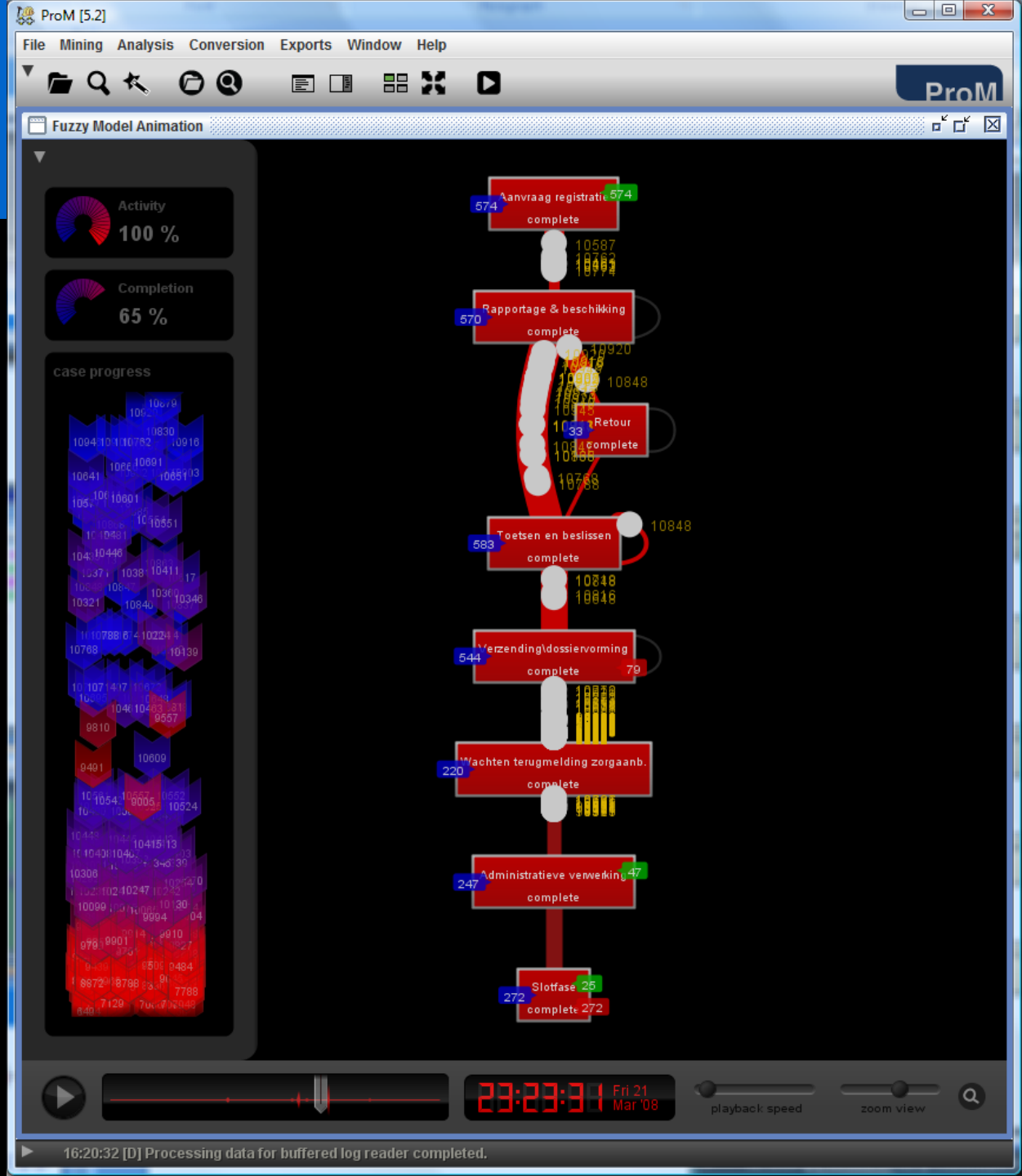
Seamless abstraction





Fuzzy Replay

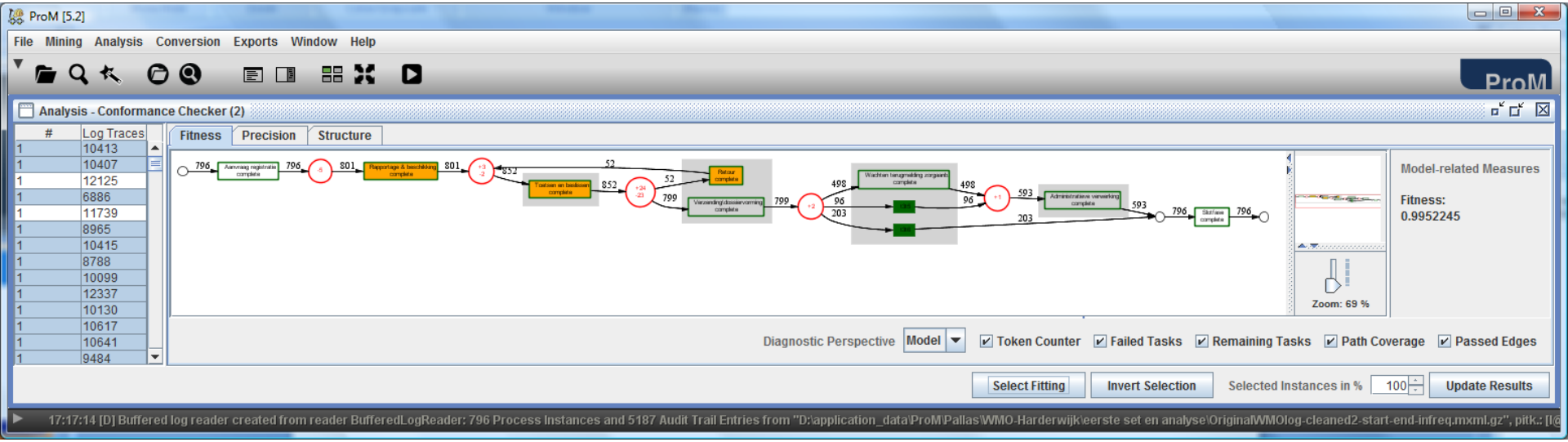


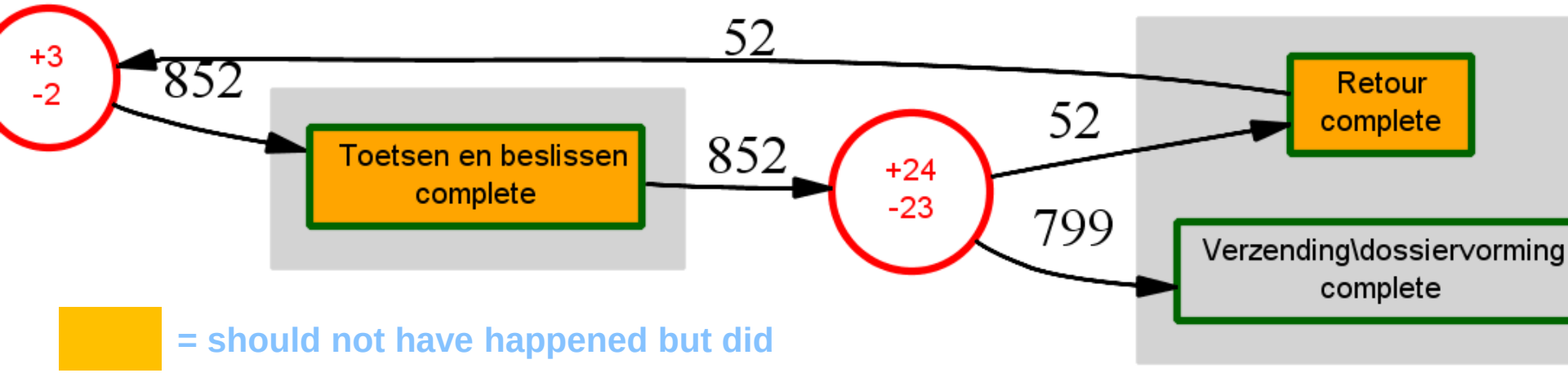


Conformance checking using Replay

Model-related Measures

Fitness:
0.9952245

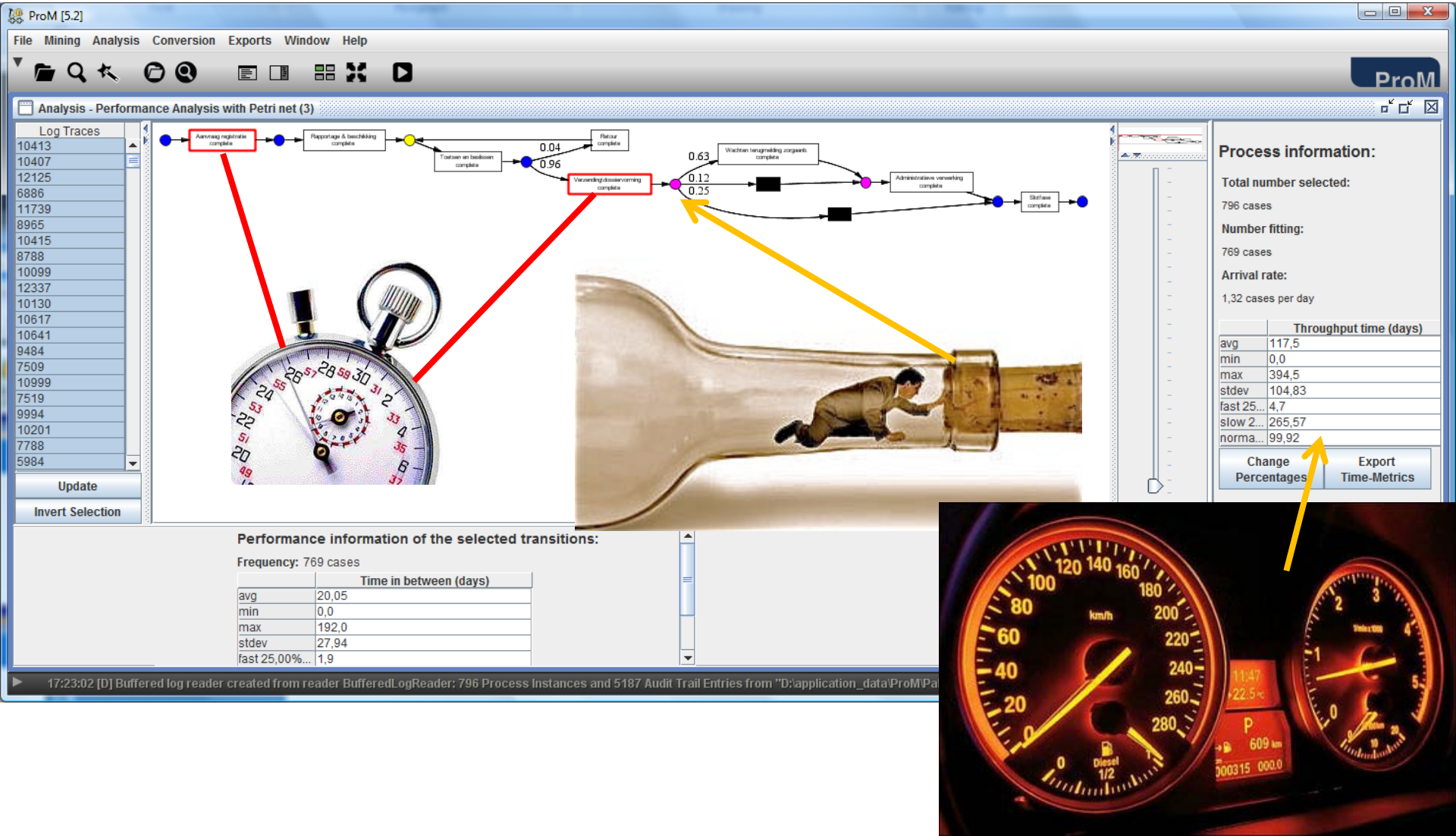




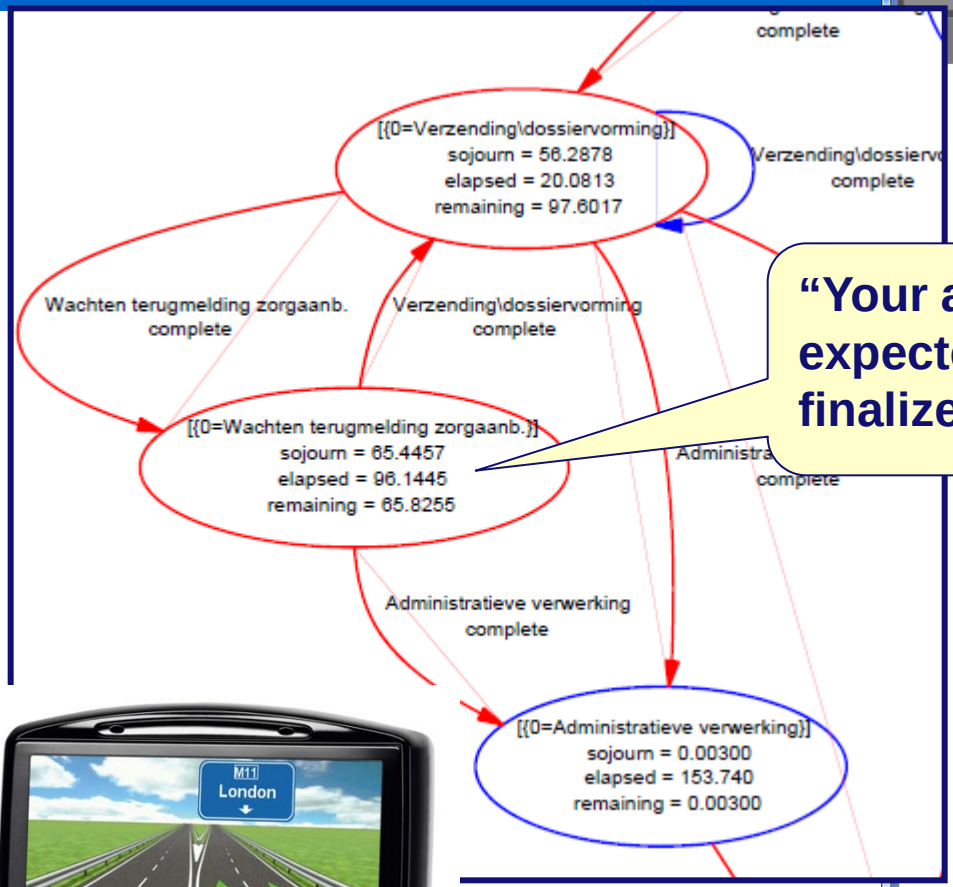
= should not have happened but did

= should have happened but did not

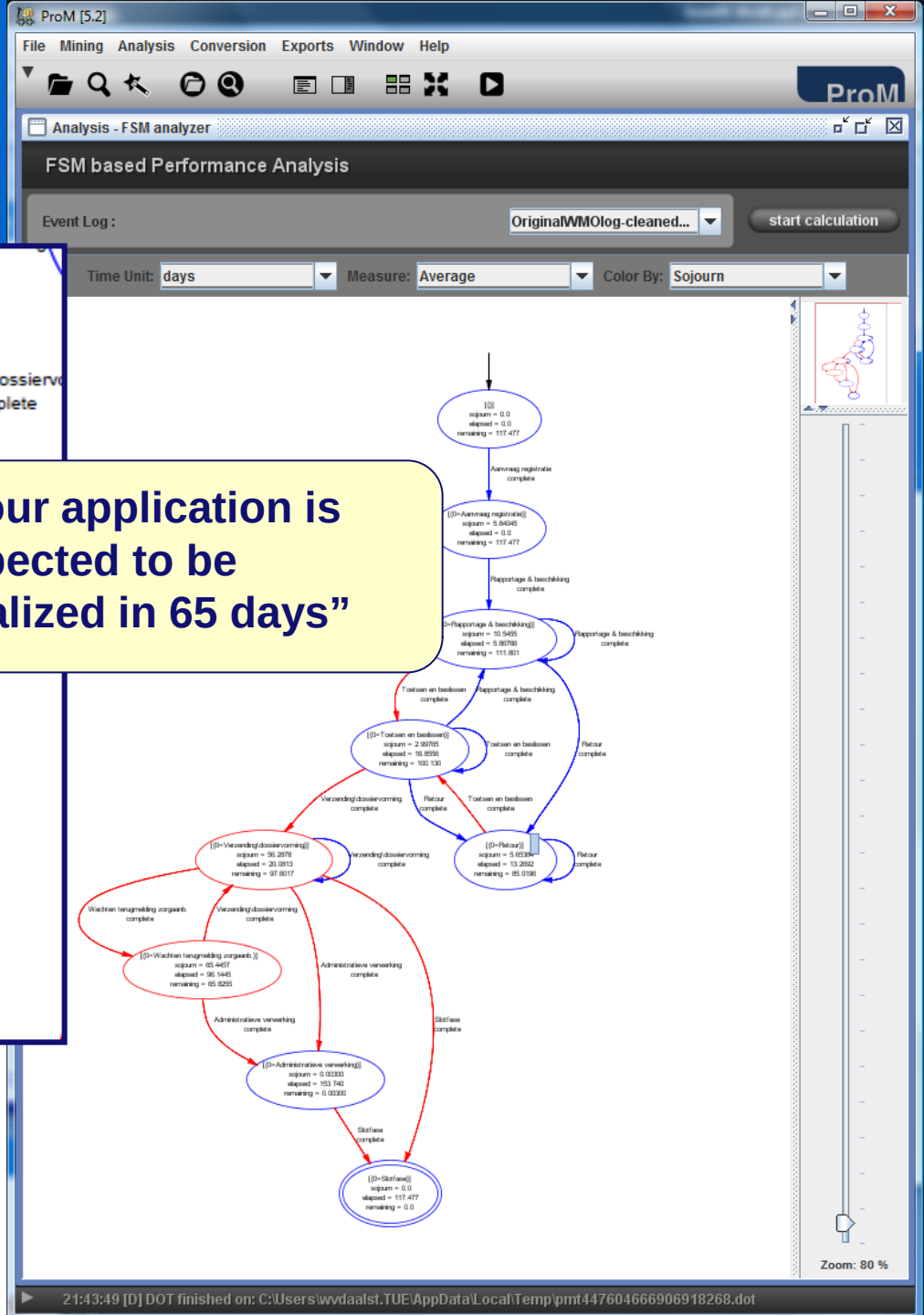
Performance analysis using Replay



Prediction based on Replay



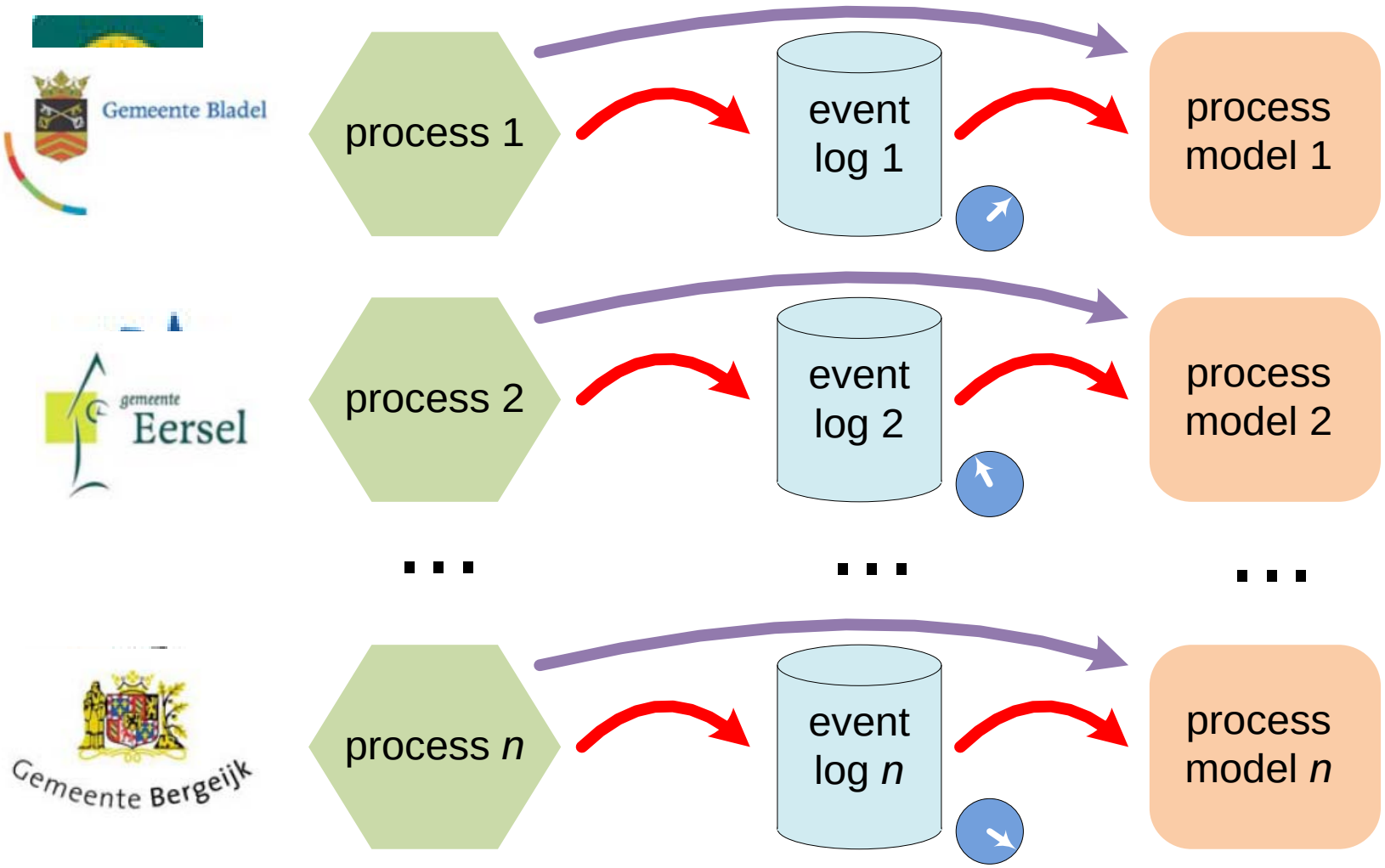
“Your application is expected to be finalized in 65 days”



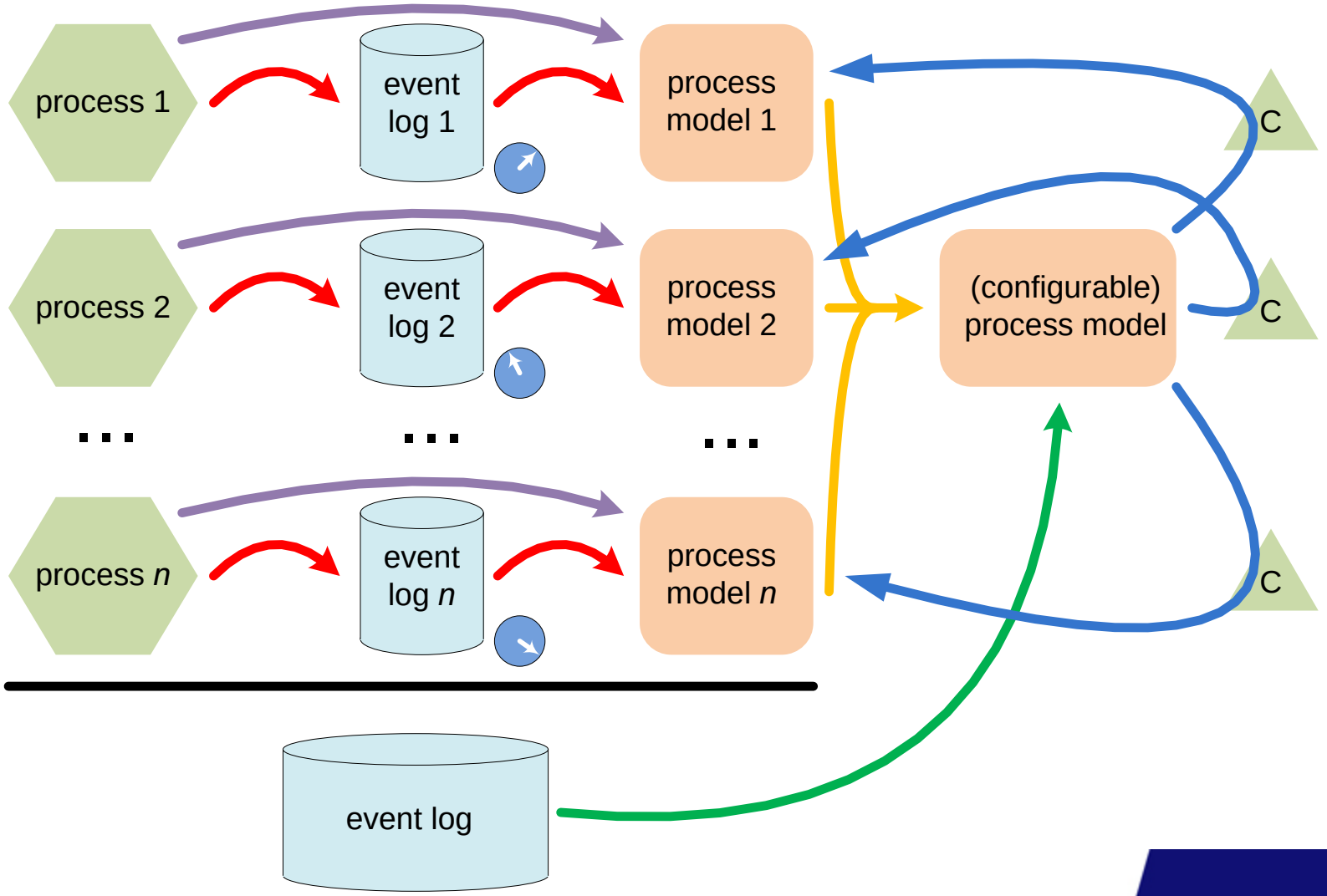
From one to many organizations

- More than 80,000 organizations are using Salesforce
- More than 1 million organizations are using Google Apps
- All 430 Dutch municipalities are implementing the same set of processes
- All 94 U.S. District Courts in the United States share the same set of workflows
- All car-rental offices of Hertz, Avis, …
- …

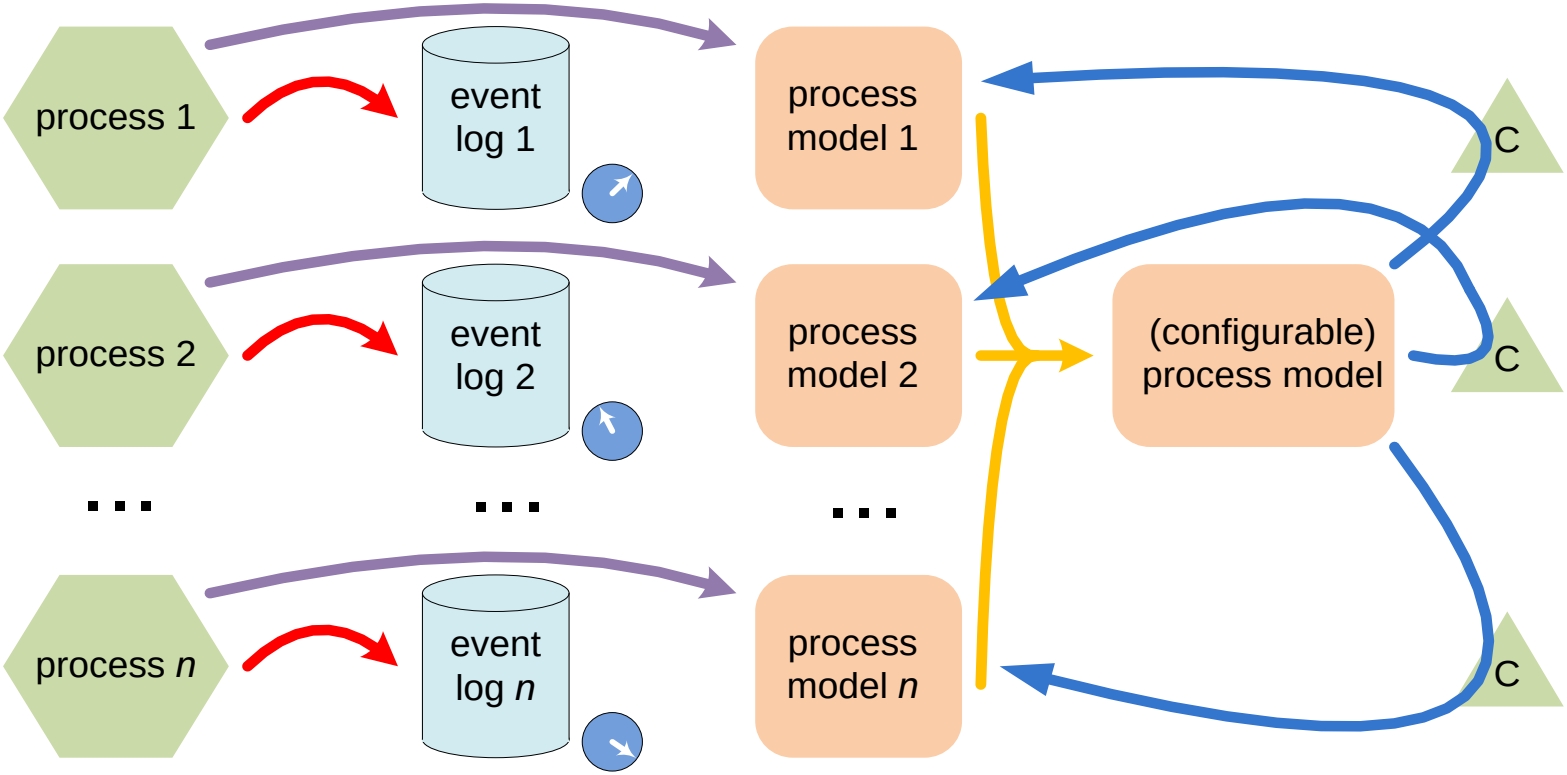
Consider *n* organizations



Cross-organizational process mining



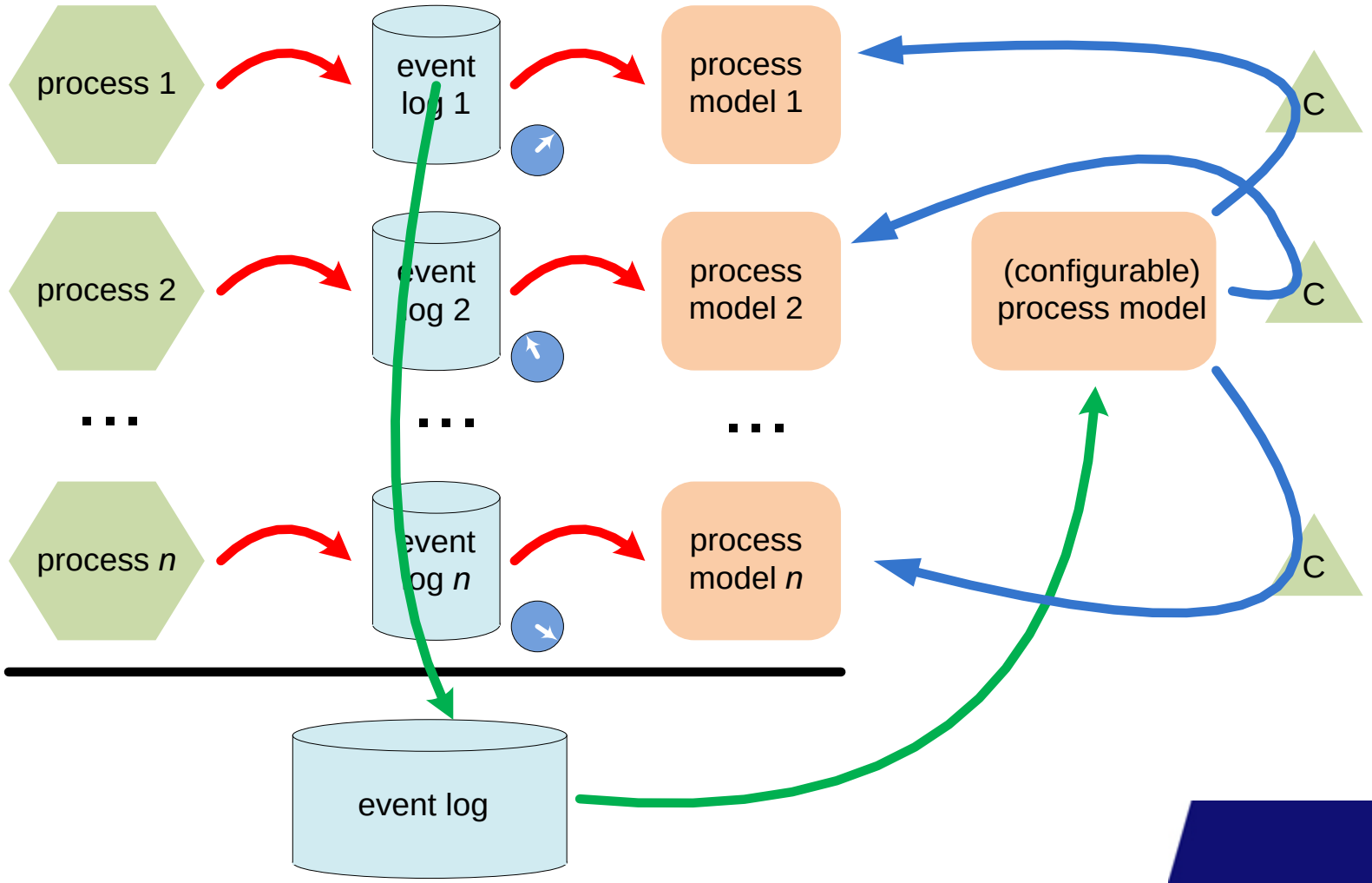
Pure model-based

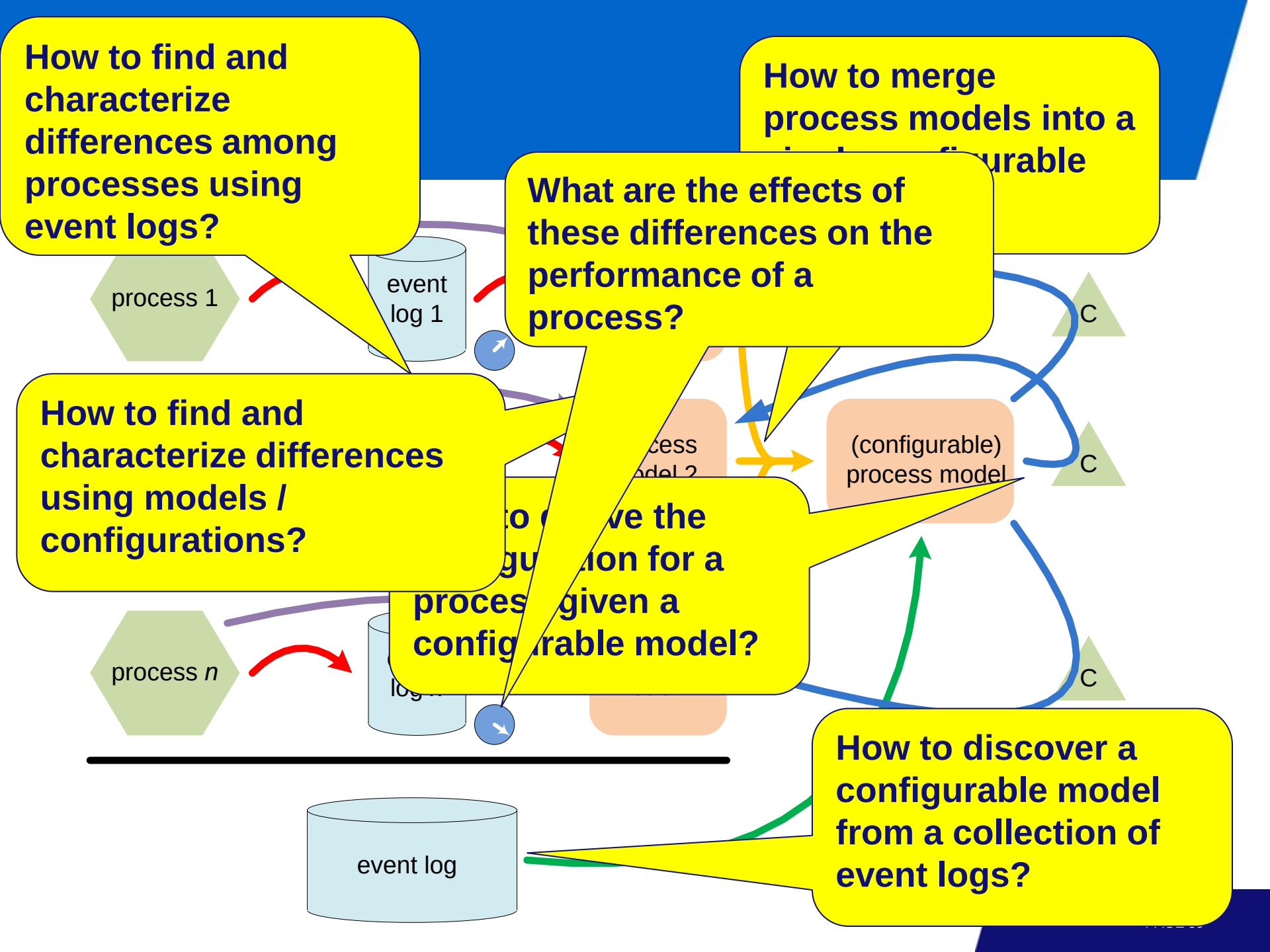


$$PM_1 + PM_2 + \ldots + PM_n = CM$$

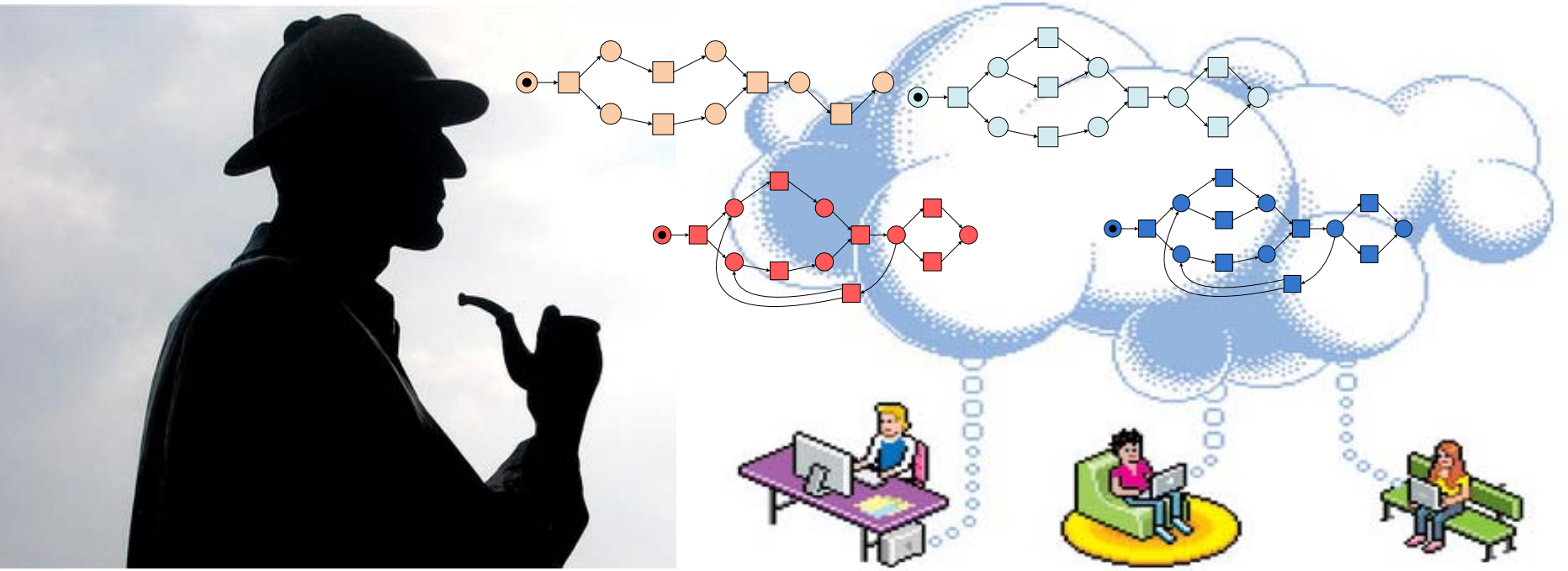
Pure log-based

$$\alpha(EL_1 + EL_2 + \ldots + EL_n) = CM$$




How to find and characterize differences among processes using event logs?
How to merge process models into a
What are the effects of these differences on the performance of a process?
How to find and characterize differences using models / configurations?
process 1
event log 1
process n
(configurable) process model
C
C
C
event log
How to discover a configurable model from a collection of event logs?

Evidence-based “best practices”



- Organizations can learn from each other.
- Configuration support and diagnostics.
- Software vendors/service providers can improve their products/services.


Correctness

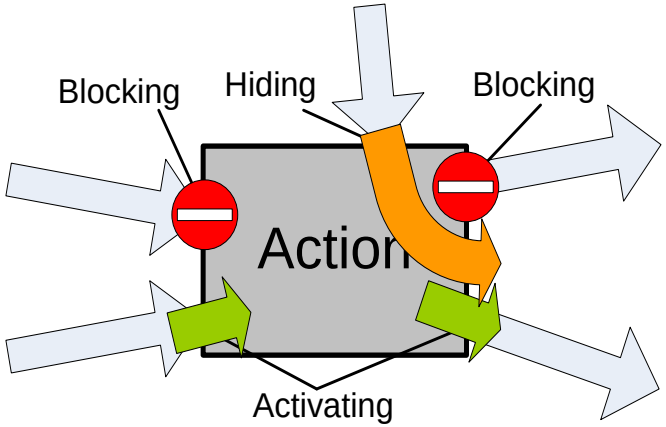
Remember …

Configuration = limiting behavior !

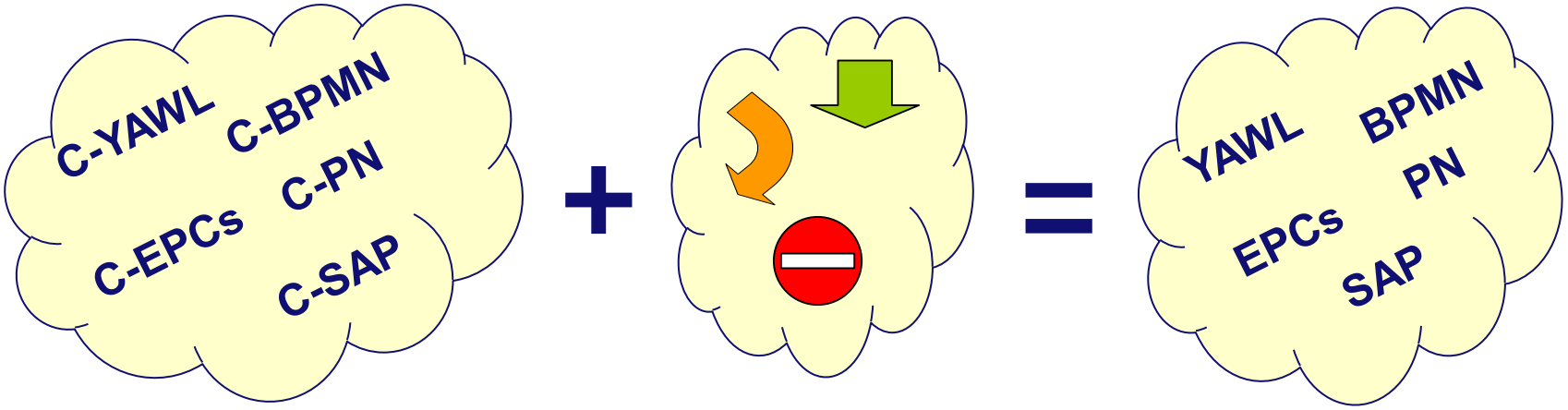
Activate

Hide/skip

Block



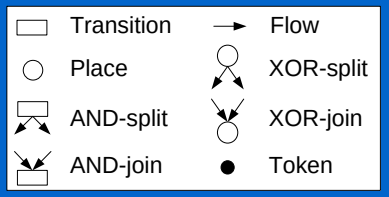
Correctness of configurations

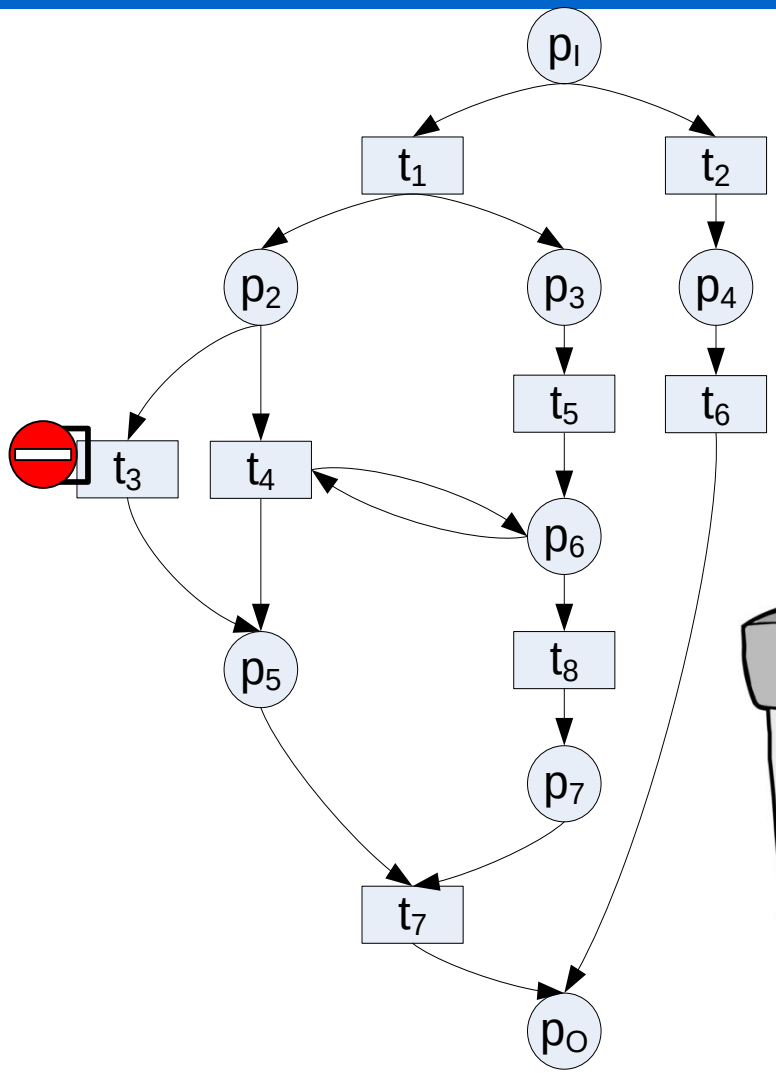


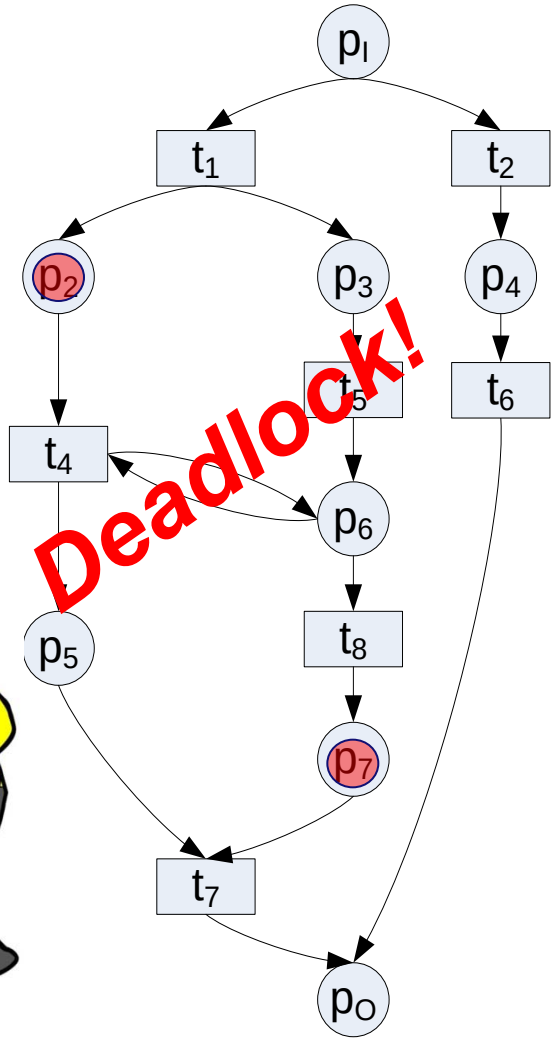
Configurable Model + Configuration = Configured model

- **Question 1:**
  Is a particular configuration correct?
- **Question 2:**
  Is there a correct configuration?
- **Question 3:**
  How to characterize the set of all correct configurations?
- **Question 4:**
  How to auto-complete a configuration?

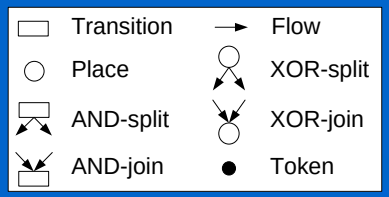
Can t_3 be blocked?

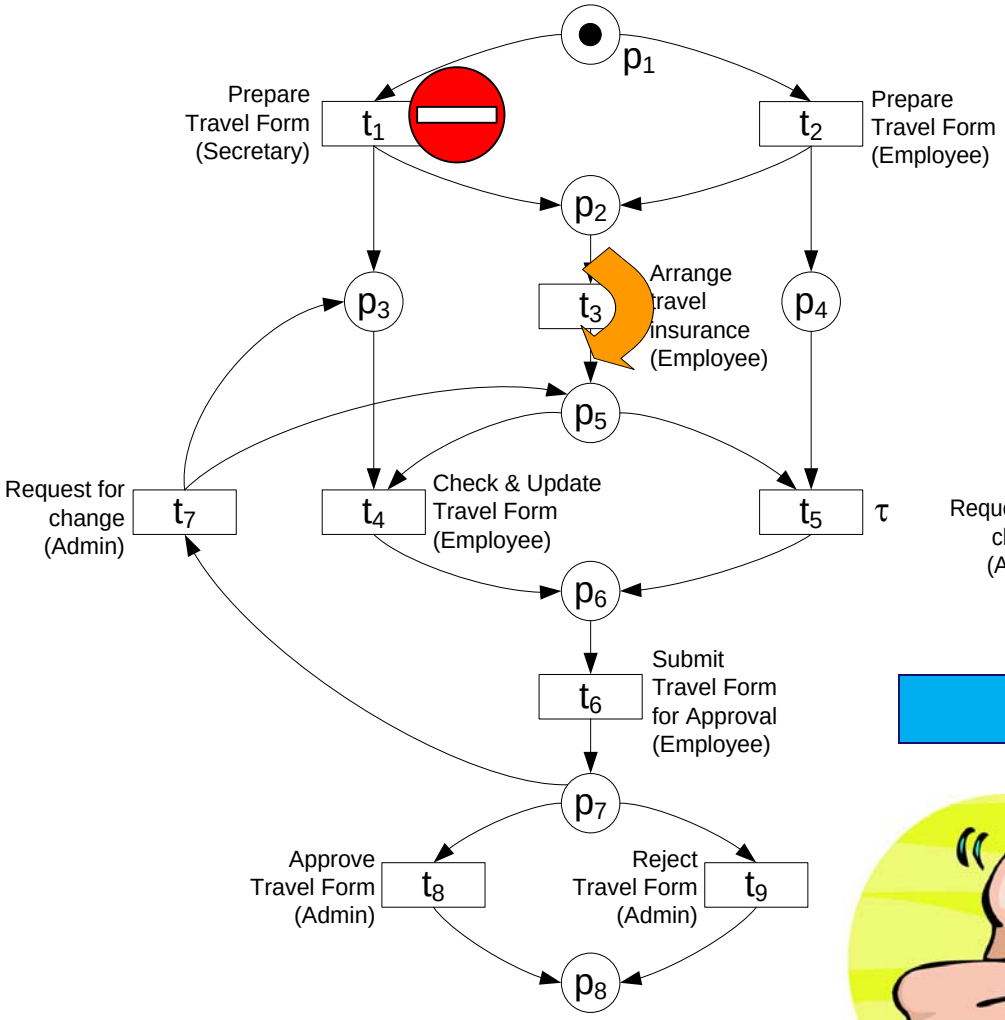




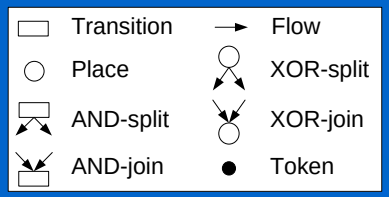


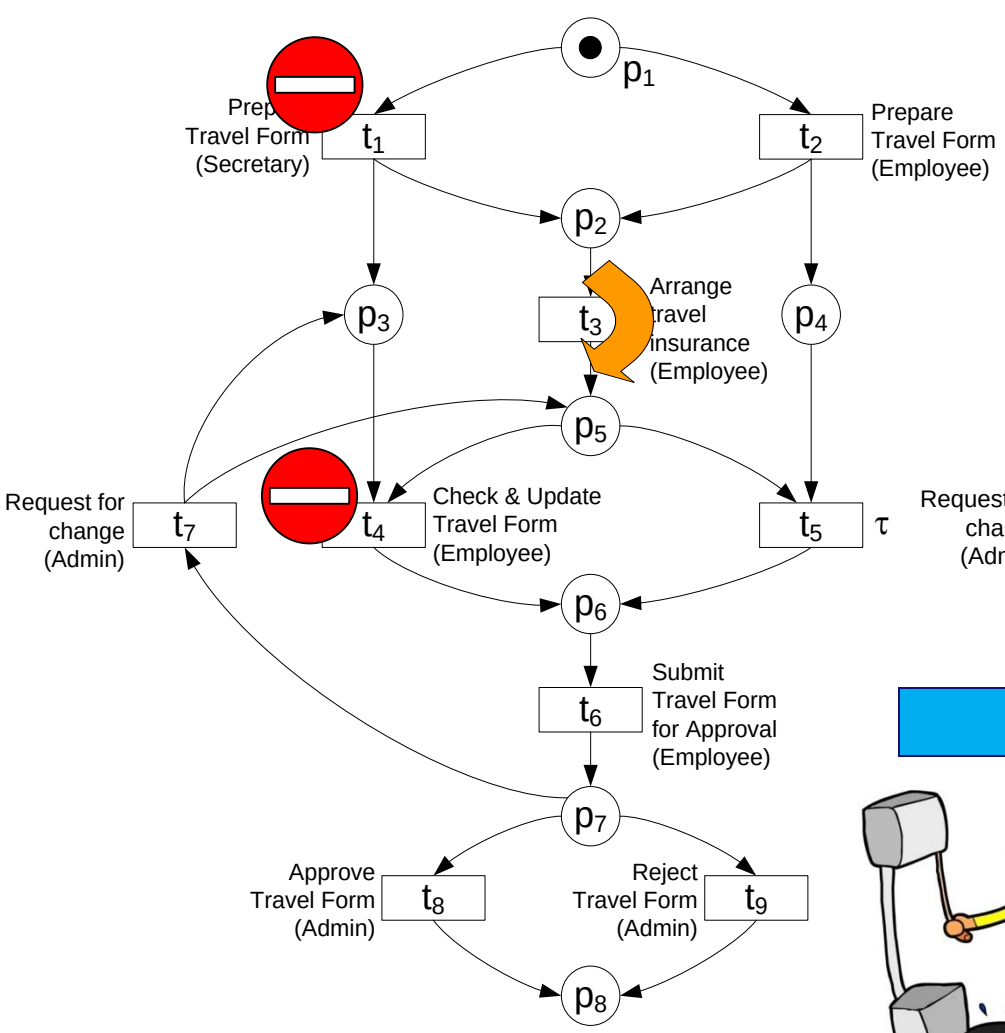
Block t_1 and hide t_3 ?





Block t_4 also?



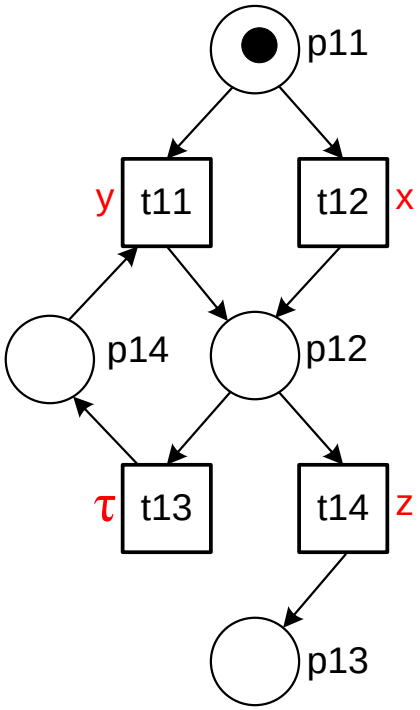


Existing approaches

- **Most approaches only consider the syntactical issues or simply create the configured model and analyze it (i.e., trail and error).**
- **Naïve approach: enumerate all possibilities and check, or trail-and-error at configuration time.**
- **Better approach based on partner synthesis: construct a configuration guideline at design time!**

W.M.P. van der Aalst, N. Lohmann, M. La Rosa, and J. Xu. Correctness Ensuring Process Configuration: An Approach Based on Partner Synthesis. In *BPM 2010*, volume 6336 of *Lecture Notes in Computer Science*, pages 95-111. Springer-Verlag, Berlin, 2010.

Partner synthesis



$\Omega = \{[p13]\}$

$\oplus$

partner??

=

desirable property e.g. weakly terminating

Given a service:

- **Is this a partner?**
- **Is there a partner?**
- **How to describe all partners?**

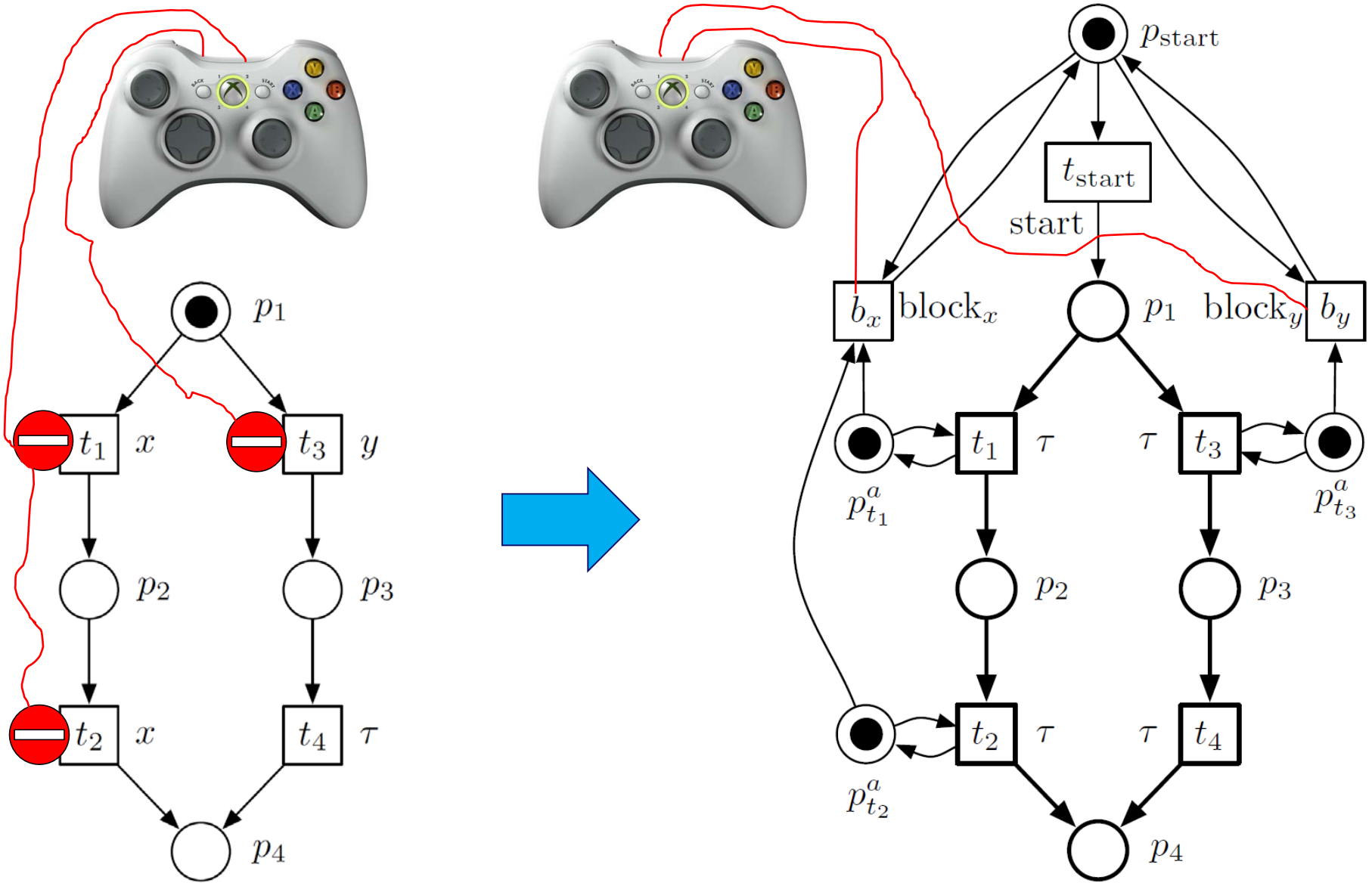
Partner synthesis

- **Existing approaches can do the following:**
  - **Check whether there exists a partner.**
  - **Construct partners having desirable properties.**
  - **Characterize all such partners.**

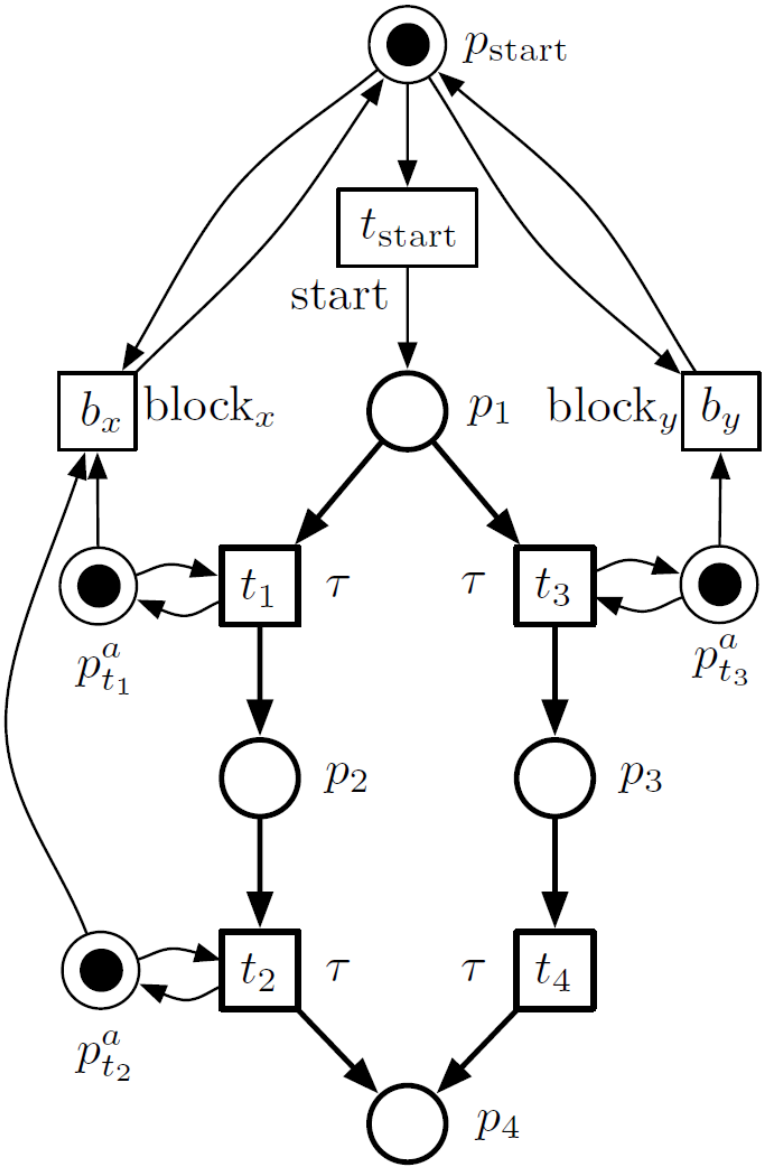
  cf. [Karsten Wolf. Does My Service Have Partners?. T. Petri Nets and Other Models of Concurrency 2: 152-171 (2009)]
- **These are implemented in Wendy.**
  cf. [Niels Lohmann, Daniela Weinberg. Wendy: A Tool to Synthesize Partners for Services. Petri Nets 2010: 297-307.]

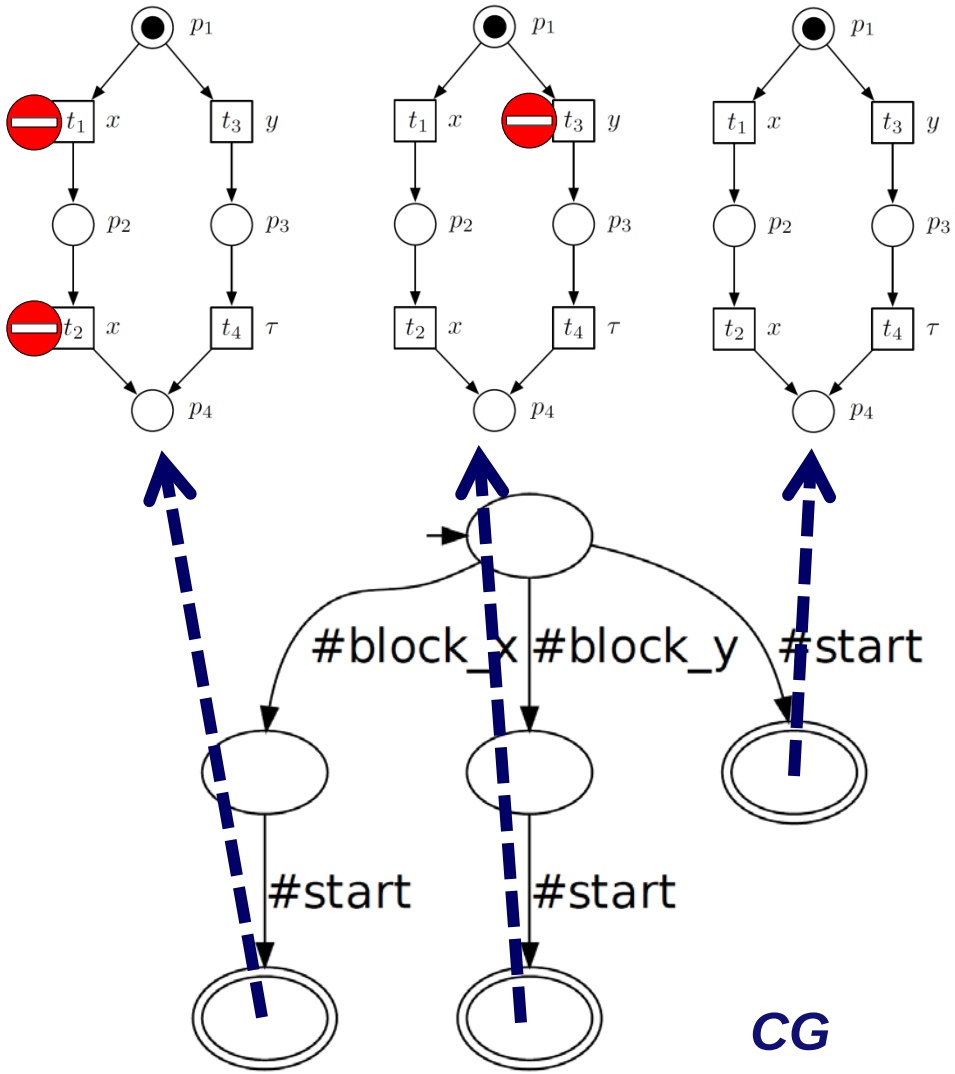
- **How can this be used for ensuring the correctness of a configurable model and its configurations?**

Configurable interface (allow by default)

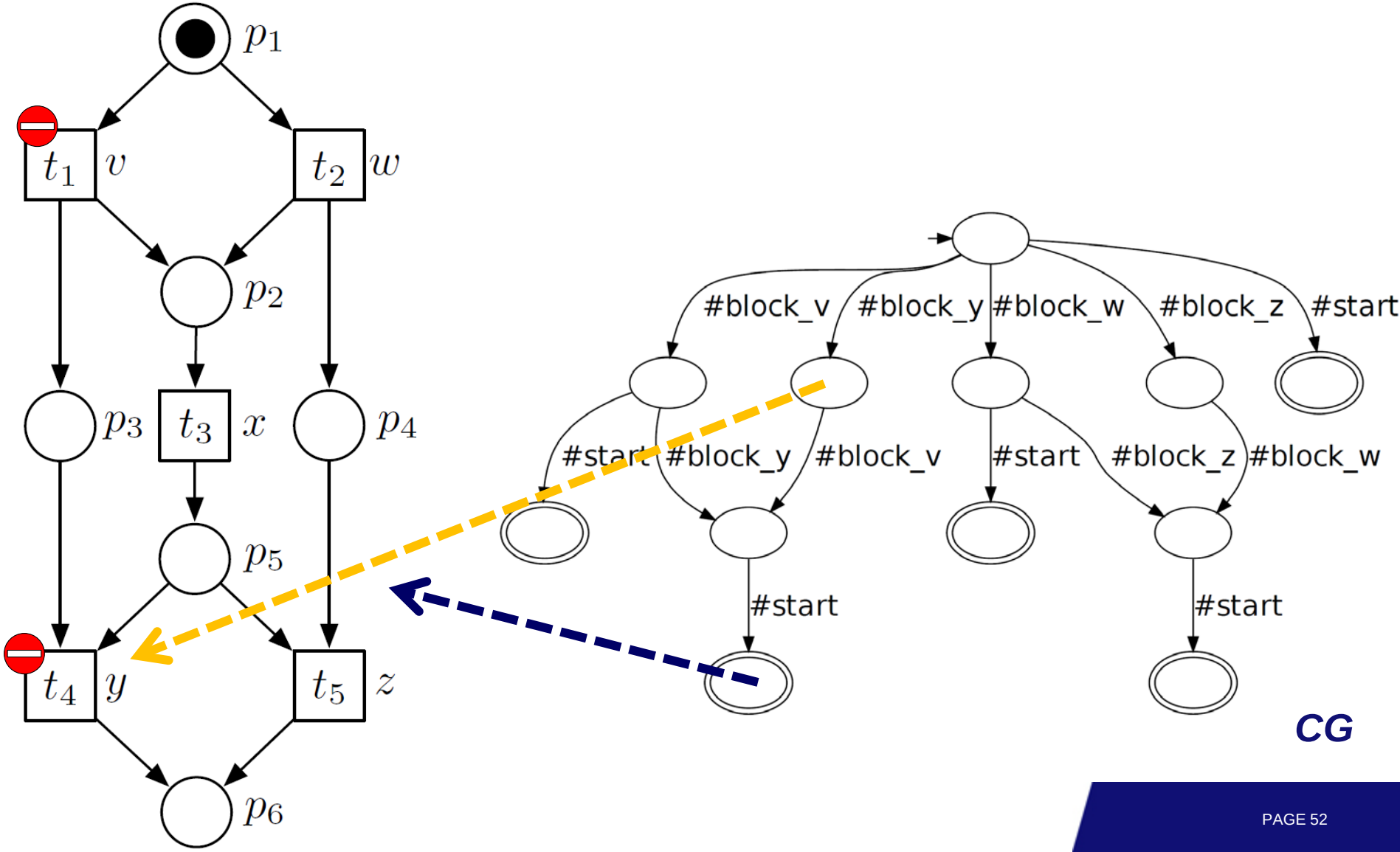


Configuration guideline (allow by default)



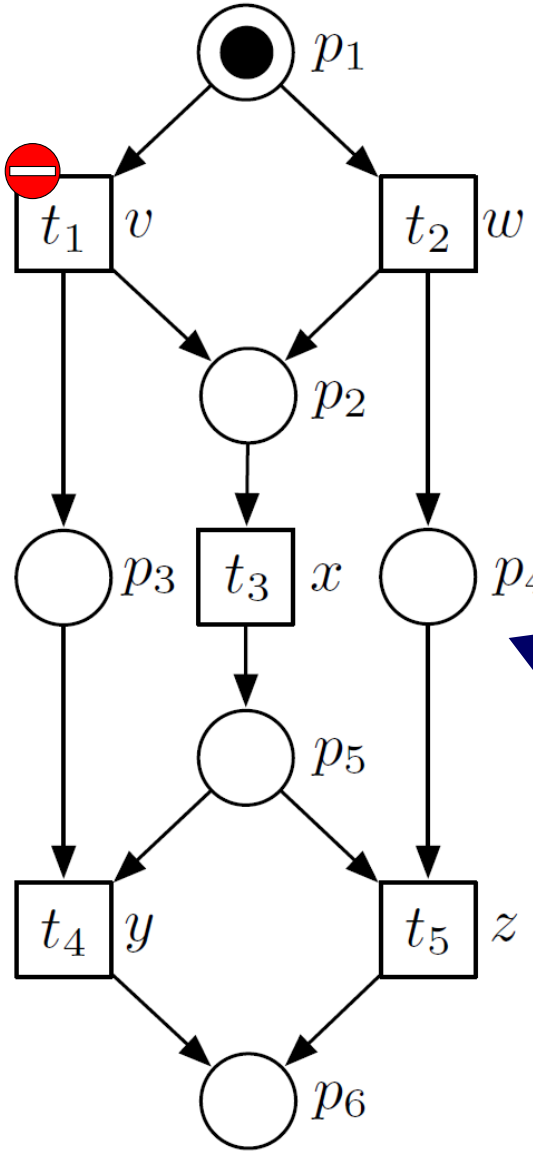


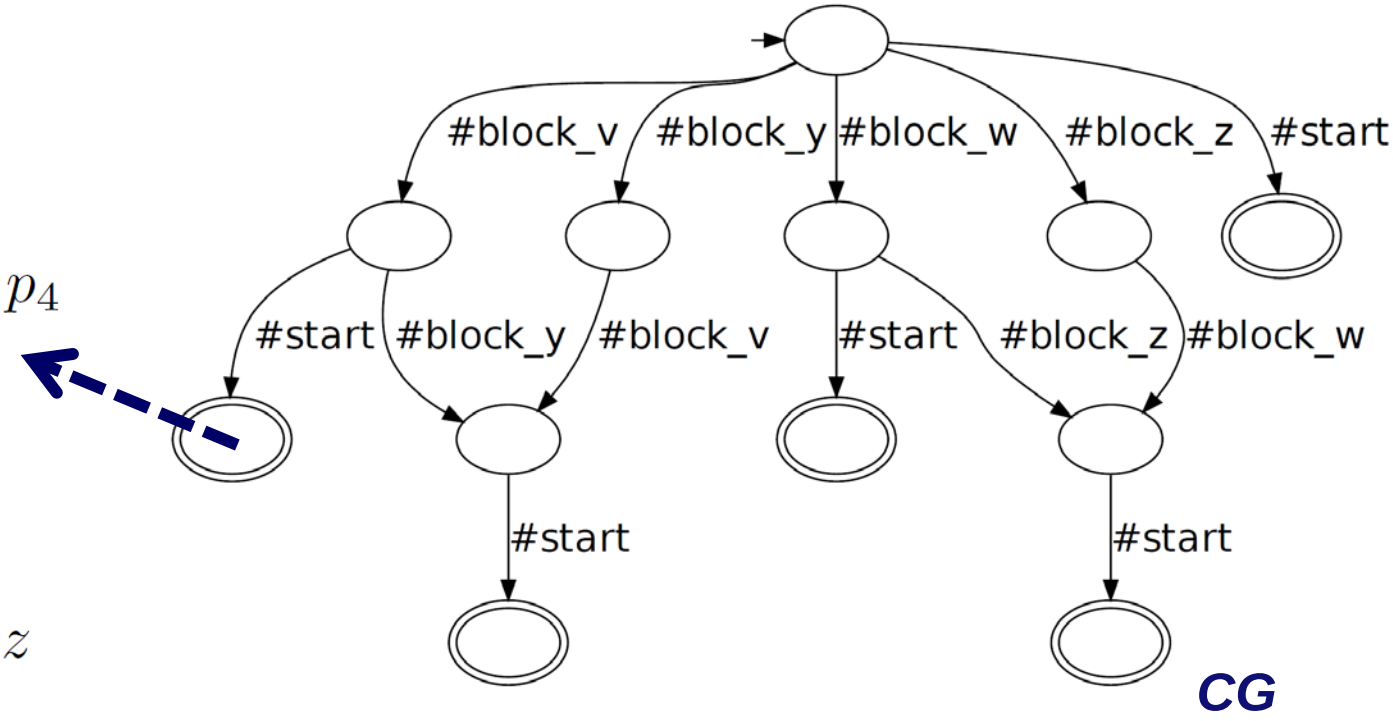
Configuration guideline (allow by default)



CG

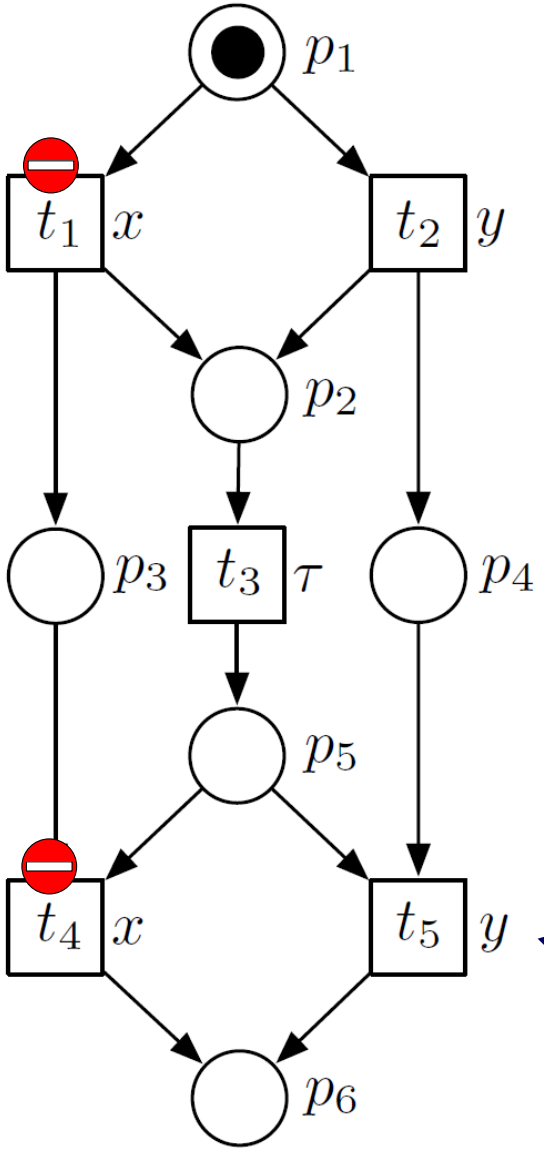
Configuration guideline (allow by default)

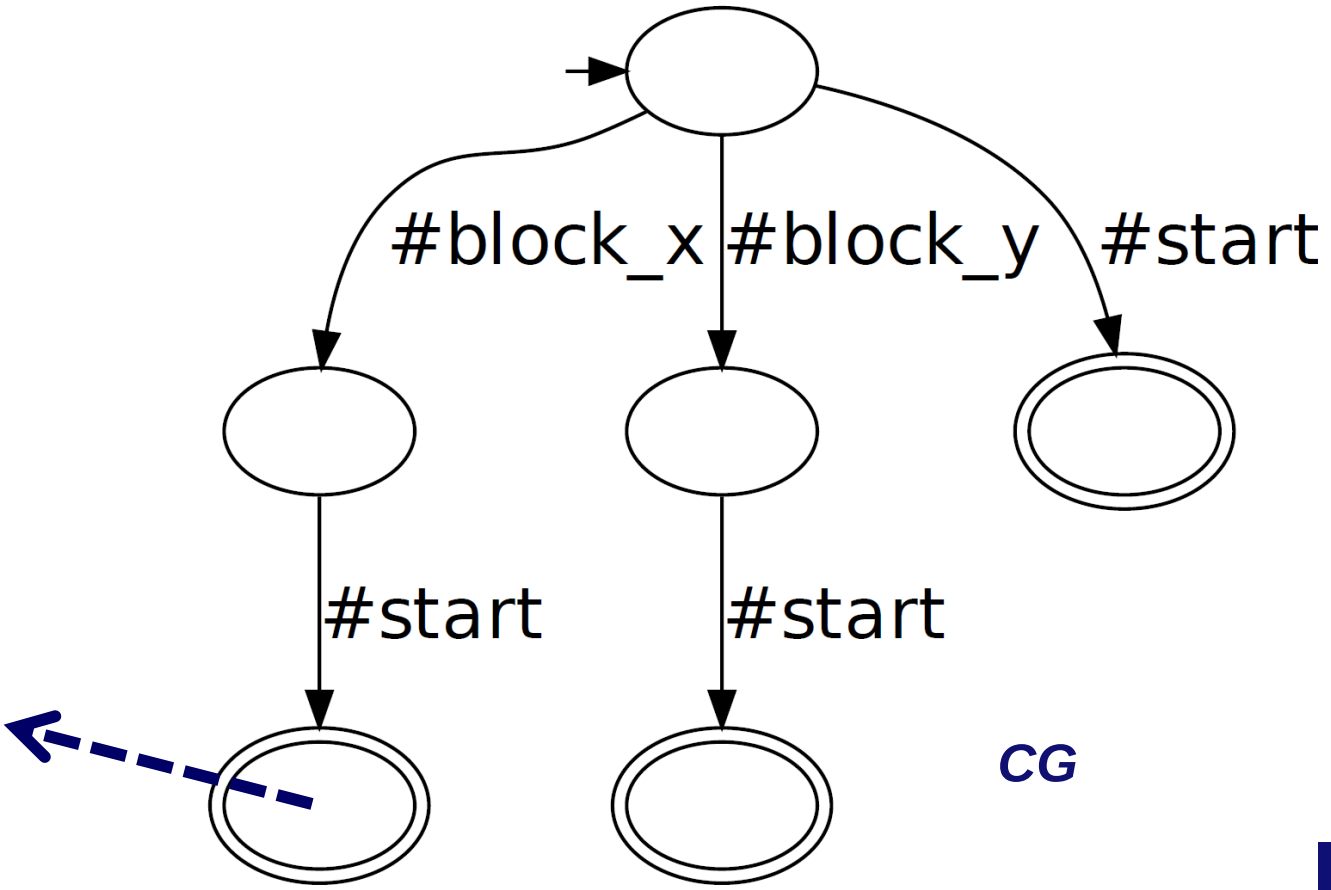




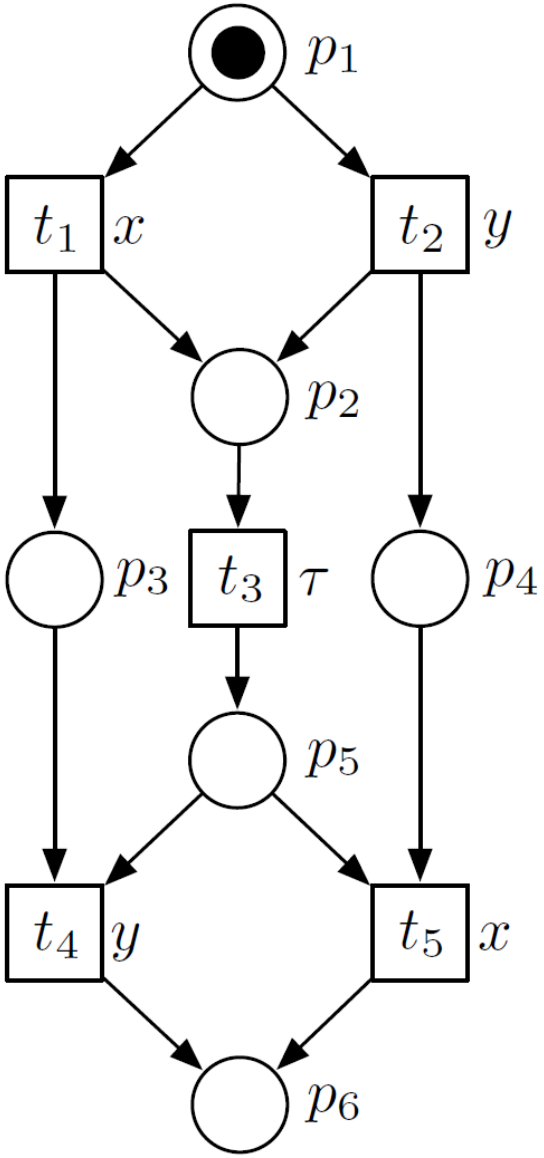
CG

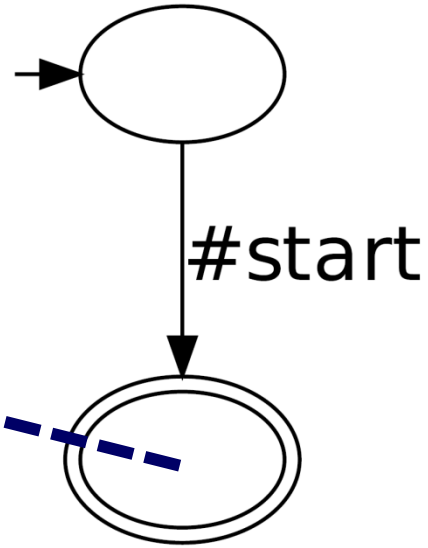
Configuration guideline (allow by default)





Configuration guideline (allow by default)

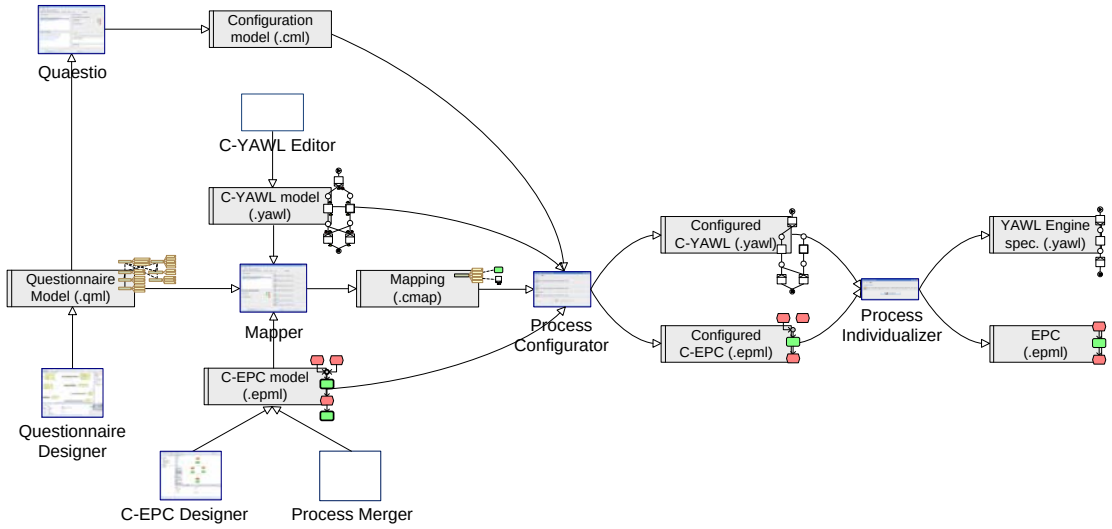




CG

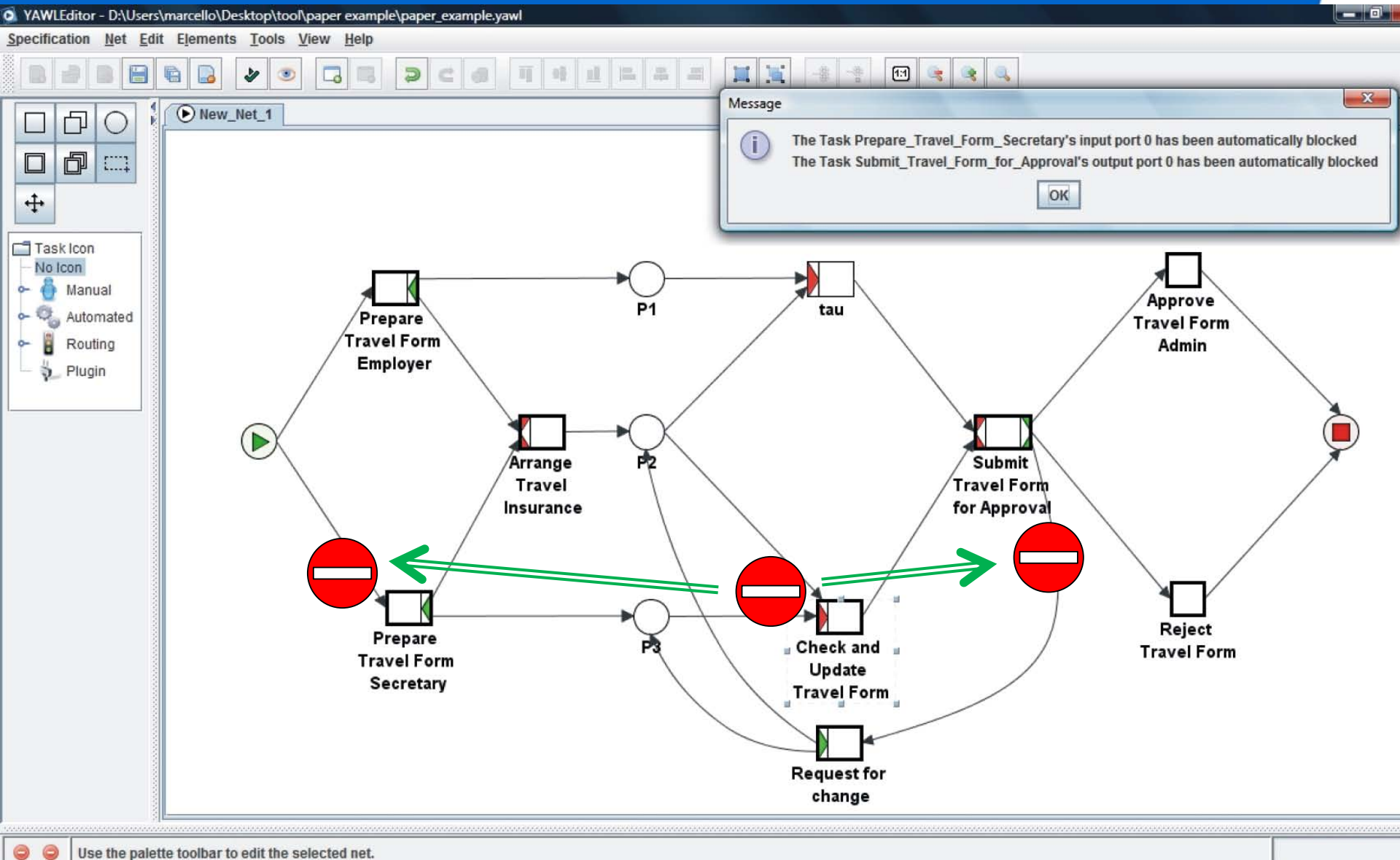
Tool support

- YAWL editor
  - Creating C-YAWL models
  - Configuring C-YAWL models
  - Verification and auto-completion (using SAT solver and/or Wendy)
- YAWL engine
- YAWL services



cf. www.processconfiguration.com

C-YAWL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Specification Net Edit Elements Tools View Help
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The Task Submit_Travel_Form_for_Approval's output port 0 has been automatically blocked
OK
Task Icon
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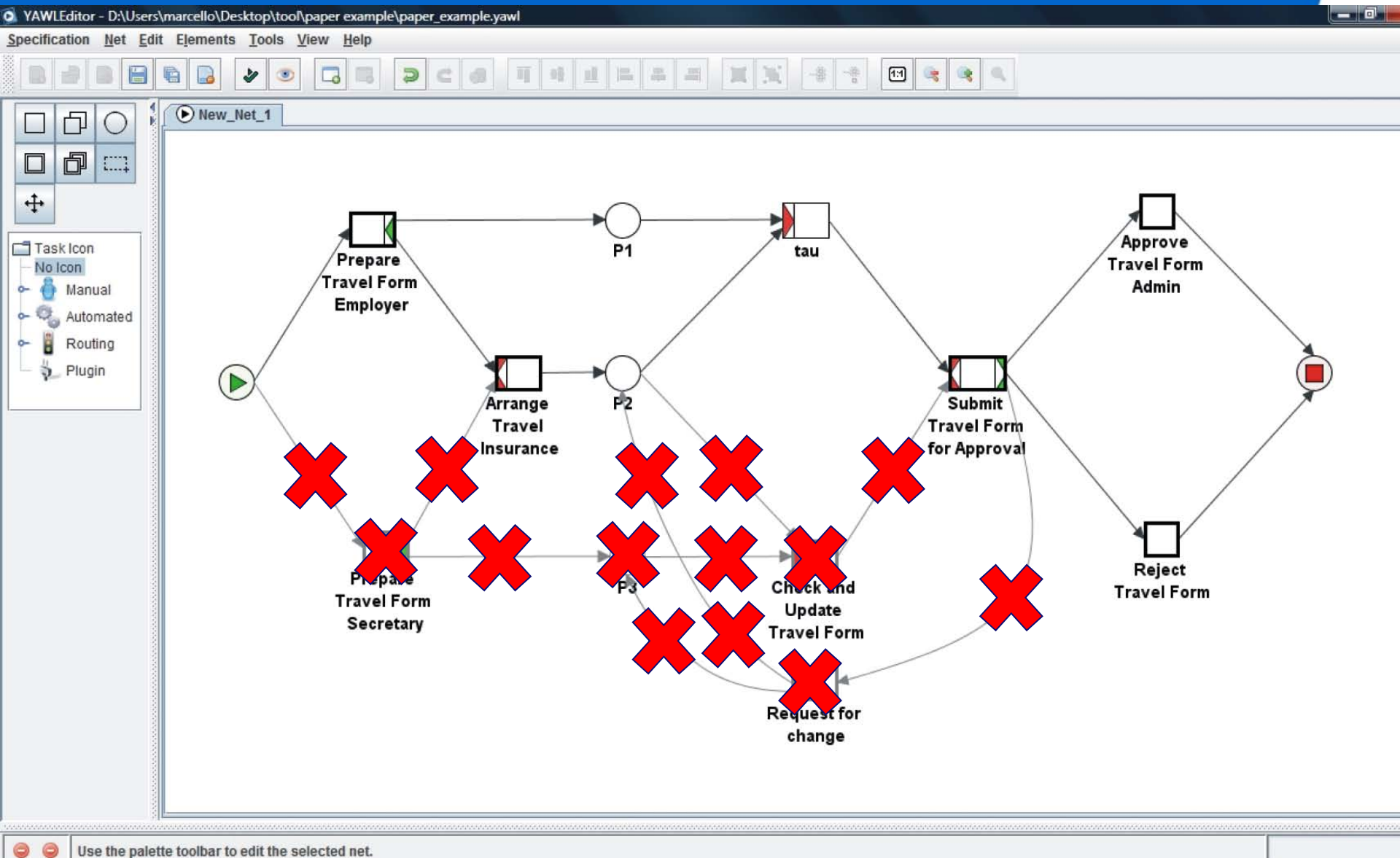
Automated
Routing
Plugin
Prepare Travel Form Employer
P1
tau
Approve Travel Form Admin
Arrange Travel Insurance
P2
Submit Travel Form for Approval
Prepare Travel Form Secretary
P3
Check and Update Travel Form
Reject Travel Form
Request for change
Use the palette toolbar to edit the selected net.

C-YAWL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Specification Net Edit Elements Tools View Help
New_Net_1
Task Icon
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Prepare Travel Form Employer
P1
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Approve Travel Form Admin
Arrange Travel Insurance
P2
Submit Travel Form for Approval
Prepare Travel Form Secretary
P3
Check and Update Travel Form
Reject Travel Form
Request for change
Use the palette toolbar to edit the selected net.

Conclusion

- **BPM in the cloud triggers the need for configurable process models.**
- **Configuration is important, however, existing reference models are crap!**
- **Challenges:**
  - **Design of configurable models (language+approach)**
  - **Analysis of configurable models, e.g., ensuring correctness**
  - **Discovering configurable models**
  - **Cross-organizational process mining**

More information

- **www.processconfiguration.com**
  (various references to configuration literature and a comprehensive toolset)
- **www.win.tue.nl/coselog**
  (webpage of the CoSeLoG project)
- **www.processmining.org**
  (webpage for process mining)
- **www.yawlfoundation.org**
  (C-YAWL)
- **service-technology.org**
  (analysis of services)

References (Configurable Process Models)

- M. Rosemann and W.M.P. van der Aalst. A Configurable Reference Modelling Language. *Information Systems*, 32(1):1-23, 2007.
- F. Gottschalk, W.M.P. van der Aalst, and M.H. Jansen-Vullers. SAP WebFlow Made Configurable: Unifying Workflow Templates into a Configurable Model. In *BPM 2007*, volume 4714 of *Lecture Notes in Computer Science*, pages 262-270. Springer-Verlag, Berlin, 2007.
- F. Gottschalk, W.M.P. van der Aalst, M.H Jansen-Vullers, and M. La Rosa. Configurable Workflow Models. *International Journal of Cooperative Information Systems*, 17(2):177-221, 2008.
- M. La Rosa, W.M.P. van der Aalst, M. Dumas, and A.H.M. ter Hofstede. Questionnaire-based Variability Modeling for System Configuration. *Software and Systems Modeling*, 8(2):251-274, 2009.
- F. Gottschalk, W.M.P. van der Aalst, and H.M. Jansen-Vullers. Configurable Process Models: A Foundational Approach. In F. Lehner, H. Nosekabel, and P. Kleinschmidt, editors, *Proceedings of the Multikonferenz Wirtschaftsinformatik 2006 (MKWI '06)*. GITO-Verlag, Berlin, 2006.
- …

References (Correctness Issues)

- W.M.P. van der Aalst, M. Dumas, F. Gottschalk, A.H.M. ter Hofstede, M. La Rosa, and J. Mendling. Correctness-Preserving Configuration of Business Process Models. In *FASE 2008*, volume 4961 of *Lecture Notes in Computer Science*, pages 46-61. Springer-Verlag, Berlin, 2008.
- W.M.P. van der Aalst, M. Dumas, F. Gottschalk, A.H.M. ter Hofstede, M. La Rosa, and J. Mendling. Preserving Correctness During Business Process Model Configuration. *Formal Aspects of Computing*, 22(3):459-482, 2010.
- W.M.P. van der Aalst, N. Lohmann, M. La Rosa, and J. Xu. Correctness Ensuring Process Configuration: An Approach Based on Partner Synthesis. In *BPM 2010*, volume 6336 of *Lecture Notes in Computer Science*, pages 95-111. Springer-Verlag, Berlin, 2010.
- M.T. Wynn, H.M.W. Verbeek, W.M.P. van der Aalst, A.H.M. ter Hofstede, and D. Edmond. Business Process Verification: Finally a Reality! *Business Process Management Journal*, 15(1):74-92, 2009.
- H.M.W. Verbeek, T. Basten, and W.M.P. van der Aalst. Diagnosing Workflow Processes using Woflan. *The Computer Journal*, 44(4):246-279, 2001.

References (Process Mining)

- M.H. Jansen-Vullers, W.M.P. van der Aalst, and M. Rosemann. Mining Configurable Enterprise Information Systems. *Data and Knowledge Engineering*, 56(3):195-244, 2006.
- F. Gottschalk, T. Wagemakers, M.H. Jansen-Vullers, W.M.P. van der Aalst, and M. La Rosa. Configurable Process Models: Experiences From a Municipality Case Study. In *CAiSE'09*, volume 5565 of *Lecture Notes in Computer Science*, pages 486-500. Springer-Verlag, Berlin, 2009.
- W.M.P. van der Aalst, A.J.M.M. Weijters, and L. Maruster. Workflow Mining: Discovering Process Models from Event Logs. *IEEE Transactions on Knowledge and Data Engineering*, 16(9):1128-1142, 2004.
- W.M.P. van der Aalst, H.A. Reijers, A.J.M.M. Weijters, B.F. van Dongen, A.K. Alves de Medeiros, M. Song, and H.M.W. Verbeek. Business Process Mining: An Industrial Application. *Information Systems*, 32(5):713-732, 2007.
- …