Séminaire Spécif Vérif

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Modelling Timed Concurrent Systems Using Activity Diagram Patterns

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Introduction

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- Semantics in natural language prevents formal verification

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Our contributions [A., Choppy, Noulamo (KSE'14)]

- Activity diagram patterns:
  TADC (Timed Activity Diagram Components)
- Modular composition mechanism (also refinement)
- Semantics with time Petri nets

Outline

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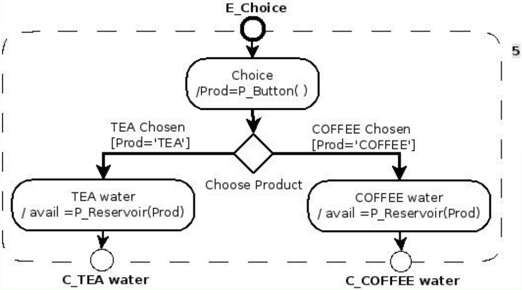
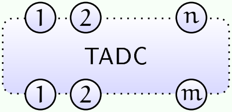
UML Activity Diagrams

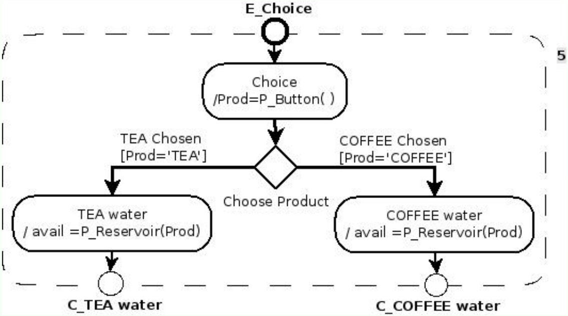
- initial node, activity/flow final nodes, decision nodes (guards), fork/join nodes
- Global variables typed with finite domains (e.g. enumerated types)
- Activities may involve global variables discrete, instantaneous modifications (assignment, function call with side-effects)



Timed Activity Diagram Components (TADC)

- input connectors, output connectors
- "well-formed" activity diagrams, restricted construct set, adding timed constructs
- modular specification with possible refinement
- inductive mechanism





10 TADC patterns

- initial node, flow final node, simple activity . . .

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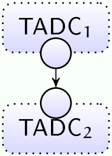
- sequence, non-deterministic delay, deterministic delay, deadline,



sequence

- input connectors = TADC_1 input connectors
- output connectors = TADC_2 output connectors

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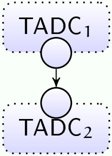

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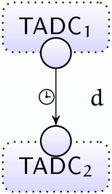
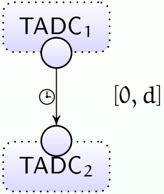
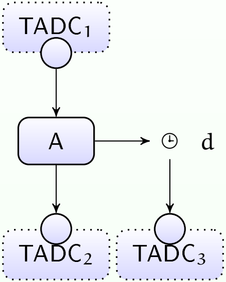


deterministic delay $d \in \mathbb{R}_{\geq 0}$



non-determi- -nistic delay



deadline

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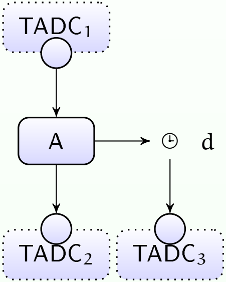
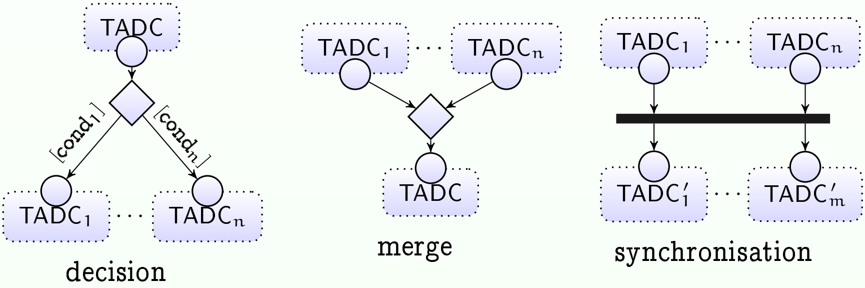


deadline

- $TADC_1$ execution
- activity A
- $TADC_2$ starts after at most d units of time
- alternatively, $TADC_3$ starts after exactly d units of time

10 TADC patterns (followed)

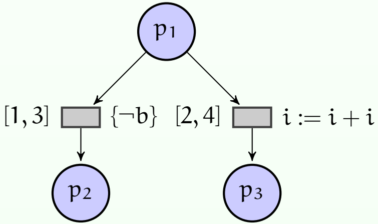
- decision, merge, synchronisation (cf UML)



Outline

Time Petri Nets [Merlin, 1974] with global variables

- A kind of automaton
  - Bipartite graph with places ("standard" tokens) and transitions
  - Transitions associated with a firing interval
  - Enabled (tokens present) transitions must fire at the end of their firing interval (unless meanwhile disabled by another transition)
  - Global variables typed by a finite domain, used to express guards, updated when transition fired
  - Global variables: syntactic extension only
  - Note: Time Petri Nets with global variable: similarities with coloured Petri nets



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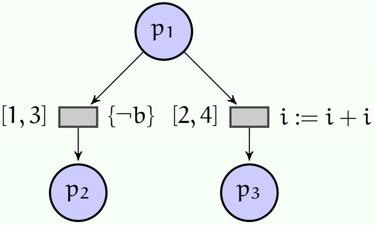
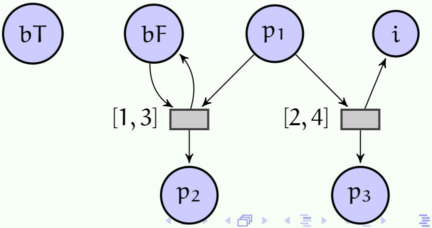




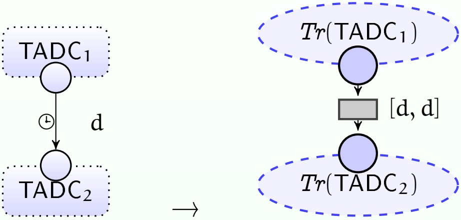
Translation mechanism

- each TADC is translated into a TPN fragment where the connectors are translated into places
- two TPN fragments can be composed by fusing the corresponding connector places together
- simple activity: TPN transition connected to input and output places (to be used for composition)

- assignments are easily translated
- functions involving a user input $\rightarrow$ non-deterministic choice

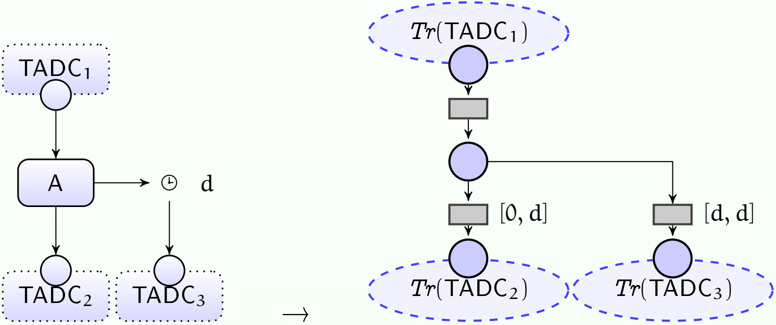
Translation mechanism (cont'd)

- Deterministic delay



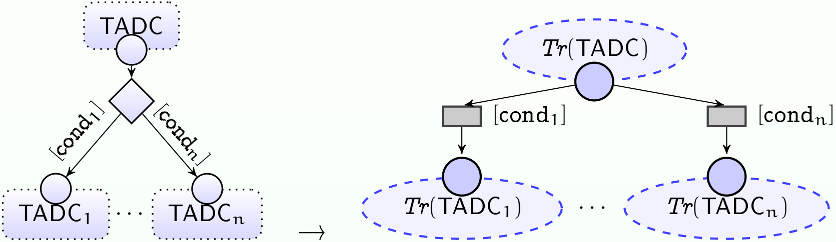
Translation mechanism (cont'd)

- Deadline



Translation mechanism (cont'd)

- Decision



Outline

Conclusion

- Activity diagram patterns with timed constructs for modular composition
- Semantics in terms of time Petri nets
- [A., Choppy, Reggio (SERA'13)] : “precise” activity diagram patterns to model business processes, modular, coloured Petri nets semantics
- Here: focus on time extension, less restrictive patterns (arbitrary number of input and output connectors), easier to “plug in” a higher level scheme.

Conclusion

Element	[UML 2.5]	[ACR13]	This work [ACN14]
Activities	Yes	Yes	Yes
Data	Limited	Yes	Limited
Participants	Limited	Yes	No
Initial / final nodes	Yes	Yes	Yes
Decision	Yes	Restricted	Yes
Merge	Yes	Restricted	Yes
Fork	Yes	Restricted	Yes
Join	Yes	Restricted	Yes
Timed transitions	Limited	No	Yes

Table : Summary of the syntactic aspects considered

Perspectives

- Enrich with more complex features, e.g., timed synchronization of activities
- Refinement
- Tool ...

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