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Towards Dynamic Adaptation of Probabilistic Systems

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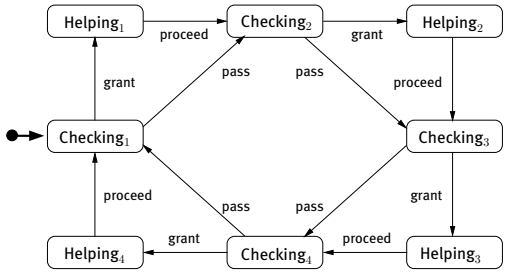
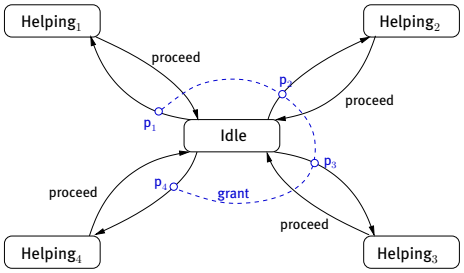
Migration of a client-server system

- one server and four clients
- critical section problem
- changing policies
- how to migrate without quiescience?



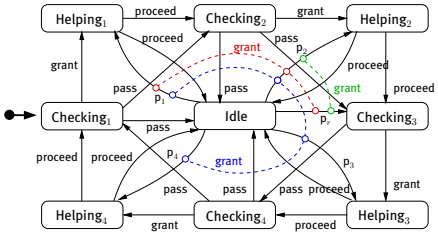
server as-is: deterministic checking, helping if needed



server to-be: polling of clients, probabilistic choice

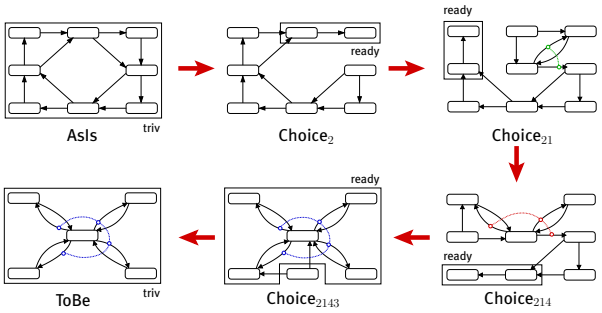
Migration in phases

- server from as-is via four *adaptation phases* to to-be: AsIs, Choice$_2$, Choice$_{21}$, Choice$_{214}$, Choice$_{2143}$, ToBe
- separation of dynamics: *local transitions* between states and *global transfer* between phases
- consistency preserved by *coordination rules*
- migration guided by special component McPal



collective server behaviour: as-is, migration, to-be

Server during migration



transfer between server phases: from as-is to to-be

Typical coordination rules

- orchestration: McPal transition coupled to transfer of server and clients in role Evol

$$\begin{array}{l}\text{McPal}: \text{StartMigr} \xrightarrow{\textit{kickOff}} \text{Migrating} \ * \\ \quad \text{Server}(\text{Evol}): \text{AsIs} \xrightarrow{\textit{triv}} \text{Choice}_2, \\ \quad \text{Client}_1(\text{Evol}): \text{AsIs} \xrightarrow{\textit{triv}} \text{ToBe}, \ \ldots\end{array}$$

- choreography: coupled transfer of server and a client; rule selection based on trap information

$$\begin{array}{l} * \ \text{Server}(\text{Evol}): \text{Choice}_2 \xrightarrow{\textit{ready}} \text{Choice}_{21}, \\ \quad \text{Client}_2(\text{CS}): \text{Checked} \xrightarrow{\textit{notYet}} \text{Disallowed}\end{array}$$

$$\begin{array}{l} * \ \text{Server}(\text{Evol}): \text{Choice}_2 \xrightarrow{\textit{ready}} \text{Choice}_{21}, \\ \quad \text{Client}_2(\text{CS}): \text{Checked} \xrightarrow{\textit{request}} \text{Allowed}\end{array}$$

- probabilistic coordination: server as conductor

$$\begin{array}{l} p_2 \cdot [\,\text{Server}: \text{Idle} \xrightarrow{\textit{grant}} \text{Helping}_2 \ * \\ \quad \text{Client}_2(\text{CS}): \text{Disallowed} \xrightarrow{\textit{triv}} \text{Allowed}\,] \ \oplus \\ p_{134} \cdot [\,\text{Server}: \text{Idle} \xrightarrow{\textit{grant}} \text{Checking}_3 \ * \\ \quad \text{Client}_3(\text{CS}): \text{Without} \xrightarrow{\textit{triv}} \text{Checked}\,]\end{array}$$

probabilities p_2, p_{134} with $p_2 + p_{134} = 1$

Adaptation analysis with mCRL2 and Prism

- qualitative static properties
  "unique access to critical section"
- quantiative dynamic properties
  "expected number inspections during migration"
  "worst case waiting time for service"

see www.win.tue.nl/~andova for mCRL2 and Prism code

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