Fixed vs. Reconfigurable Communication & Safety+EL LTL Synthesis

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Joint work with Daniel Hausmann, Nir Piterman

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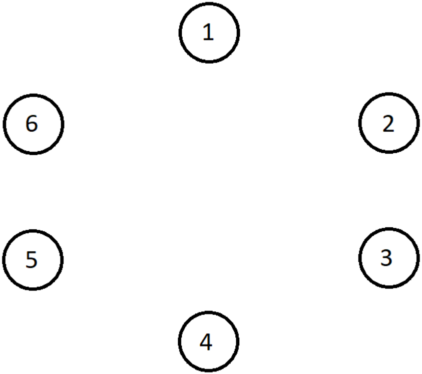
Distributed setting

Agents communicating over channels



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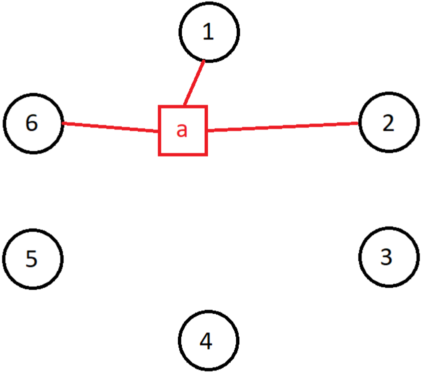

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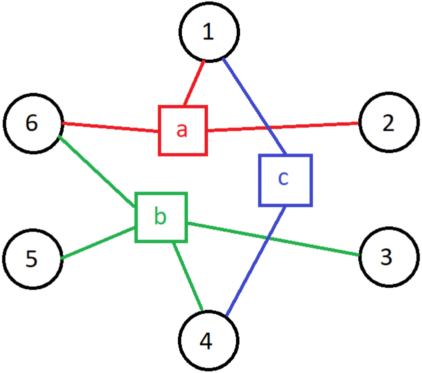

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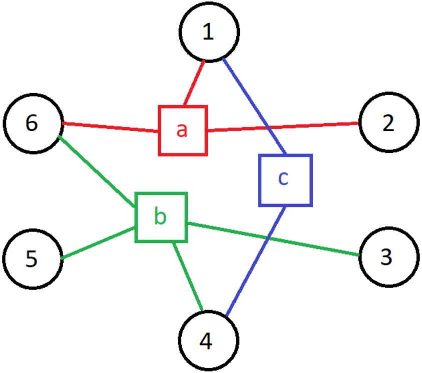
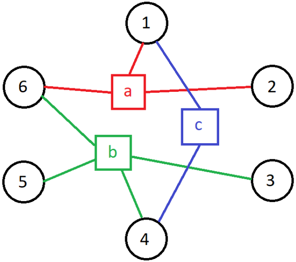


Assumptions

- Instant communications
- No sender/receiver distinction
- No loss
- Communication only if all agents are available

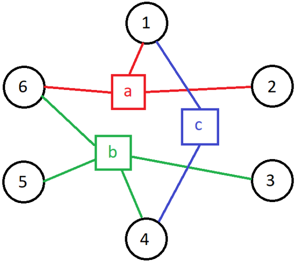
Static or reconfigurable communications

Static:



$1 : a, c \quad 2 : a \quad 3 : b$
$4 : b, c \quad 5 : b \quad 6 : a, b$

Reconfigurable:



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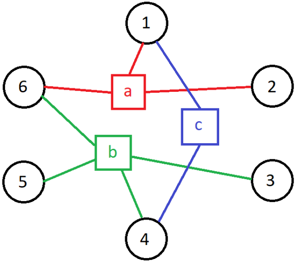

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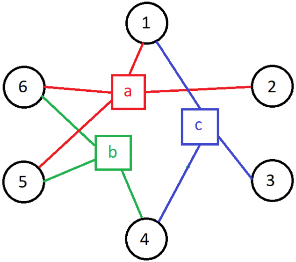

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Comparisons

Automata models used

- Static: Zielonka's Asynchronous Automata (AA)
- Reconfigurable: Channeled Transition Systems (CTS)

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Results

- Static $\rightarrow$ Reconfigurable: Always possible (and local AA $\rightarrow$ empty-message CTS)

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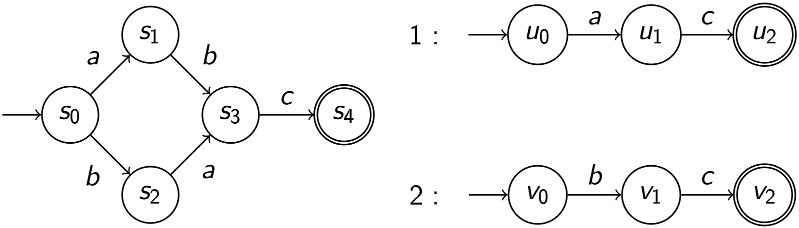
Results

- Static → Reconfigurable: Always possible (and local AA → empty-message CTS)
- Reconfigurable → Static: May require a "central supervisor" agent

Conditions for distributability



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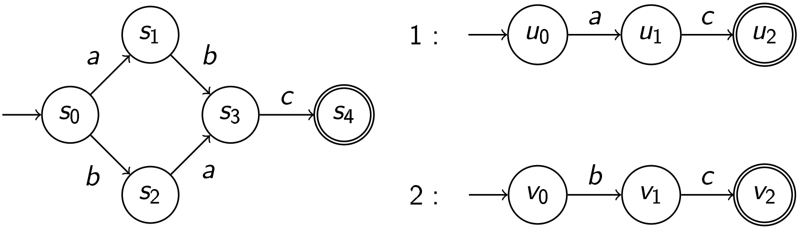

AA distributability

$\mathcal{A}$ has an equivalent AA iff $\mathcal{A}$ satisfies the diamond property.

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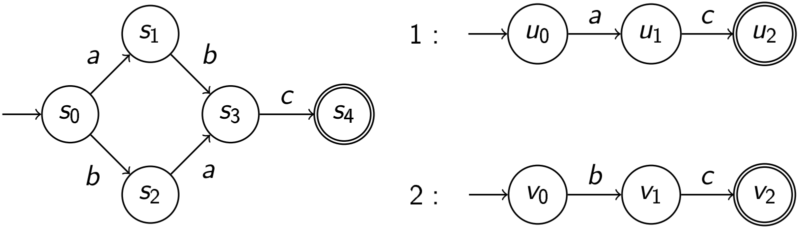

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Similar property for reconfigurable communications? (WIP)

Part two

Symbolic Reactive Synthesis for the Safety and Emerson-Lei fragment of LTL

Safety and Emerson-Lei fragment of LTL

LTL

$\varphi := \top \mid p \mid \neg\varphi \mid \varphi_1 \wedge \varphi_2 \mid X\varphi \mid \varphi_1 U \varphi_2 \mid \varphi_1 R \varphi_2 \mid F\varphi \mid G\varphi$
for $p \in$ AP set of atomic propositions

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Safety LTL

No U or F allowed. Ex: $\varphi_{\text{safety}} = G(a \rightarrow Xb) \wedge G(b \vee c)$

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EL fragment

Boolean combinations of $\mathrm{Inf}\,\sigma$, $\mathrm{Fin}\,\sigma$ for $\sigma \in \mathbb{B}(\mathrm{AP})$
ex: $\varphi_{EL} = \mathrm{Inf}(c) \wedge \mathrm{Fin}(a \wedge b)$

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Safety+EL

Safety formula $\wedge$ EL formula

Reactive synthesis for Safety+EL

Reactive synthesis

Fix AP $= I \uplus O$, φ LTL formula
$\exists$? strategy $s : (2^I)^+ \to 2^O$ s.t. $i_0 o_0 i_1 o_1 \ldots \models \varphi$

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