Adding Reconfiguration to Zielonka's Asynchronous Automata

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Motivation

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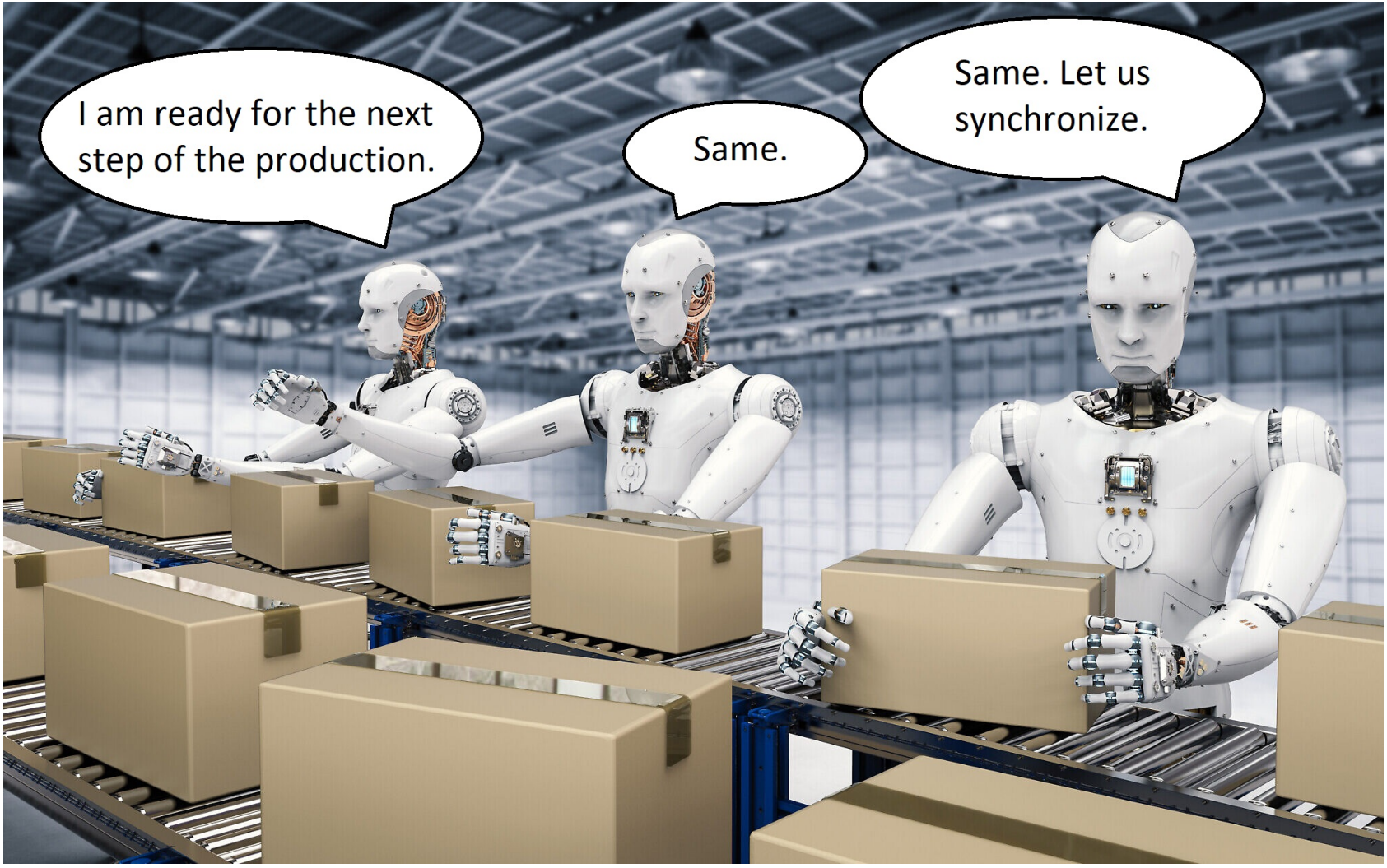
I am ready for the next step of the production.
Same.
Same. Let us synchronize.

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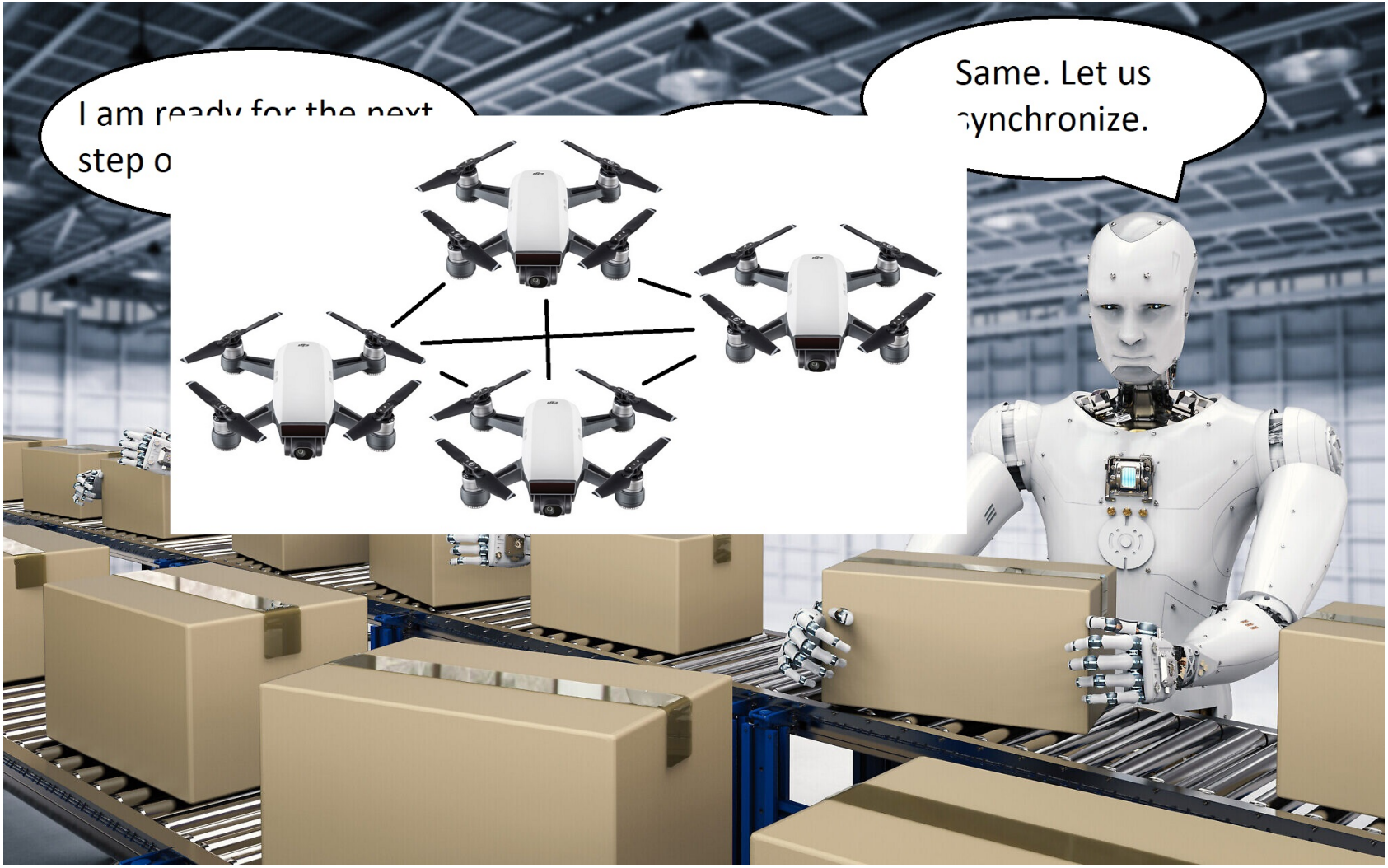

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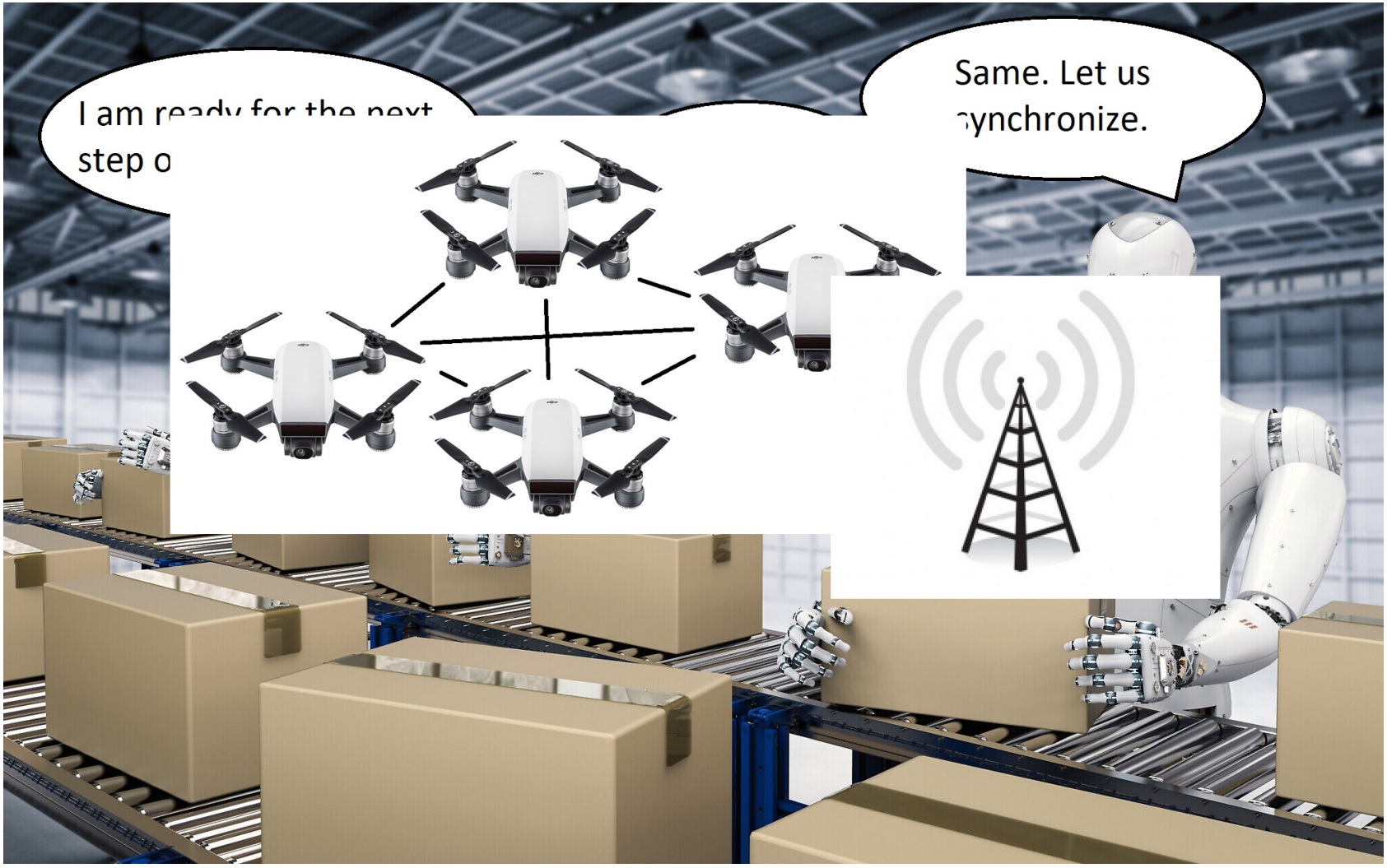

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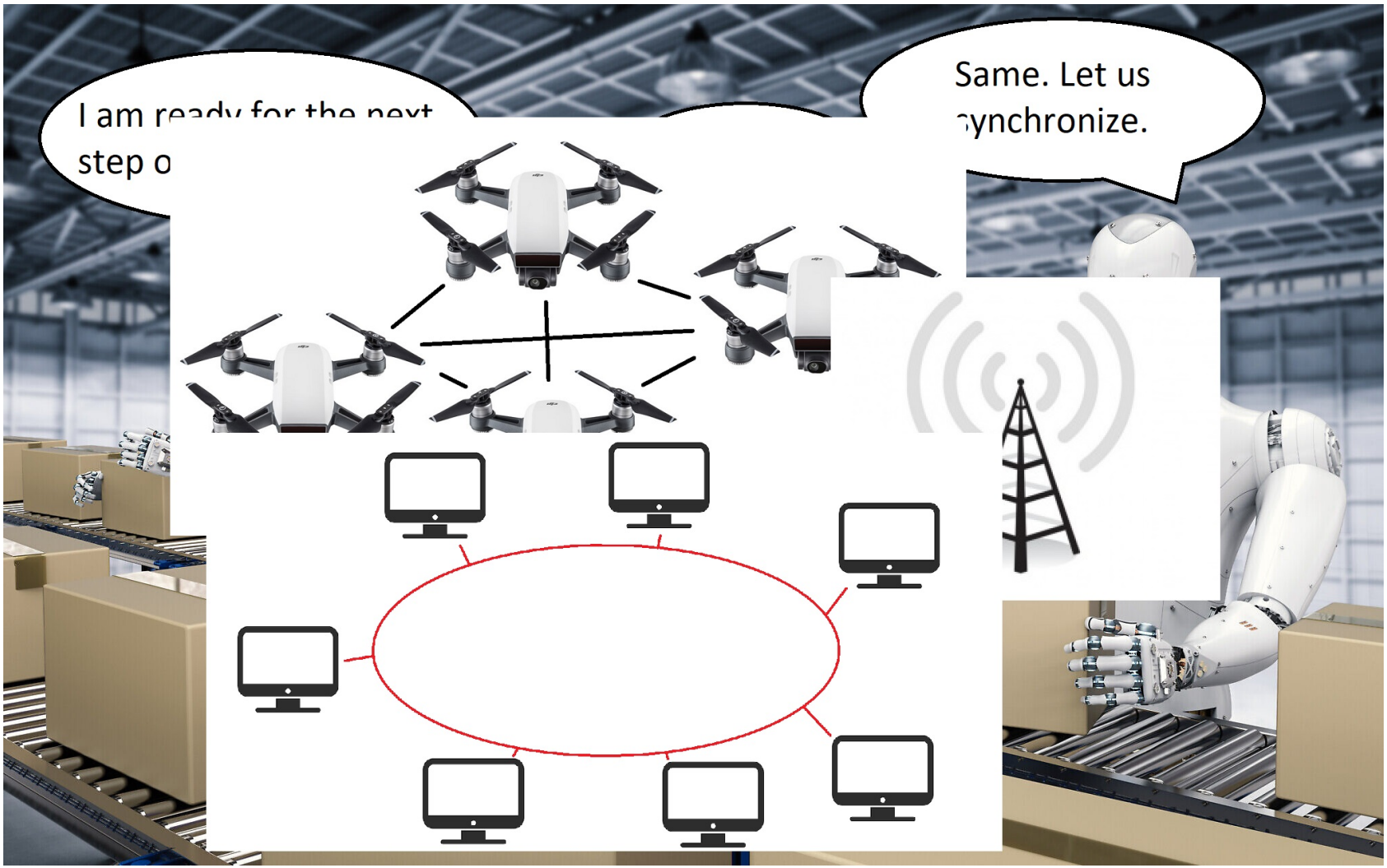
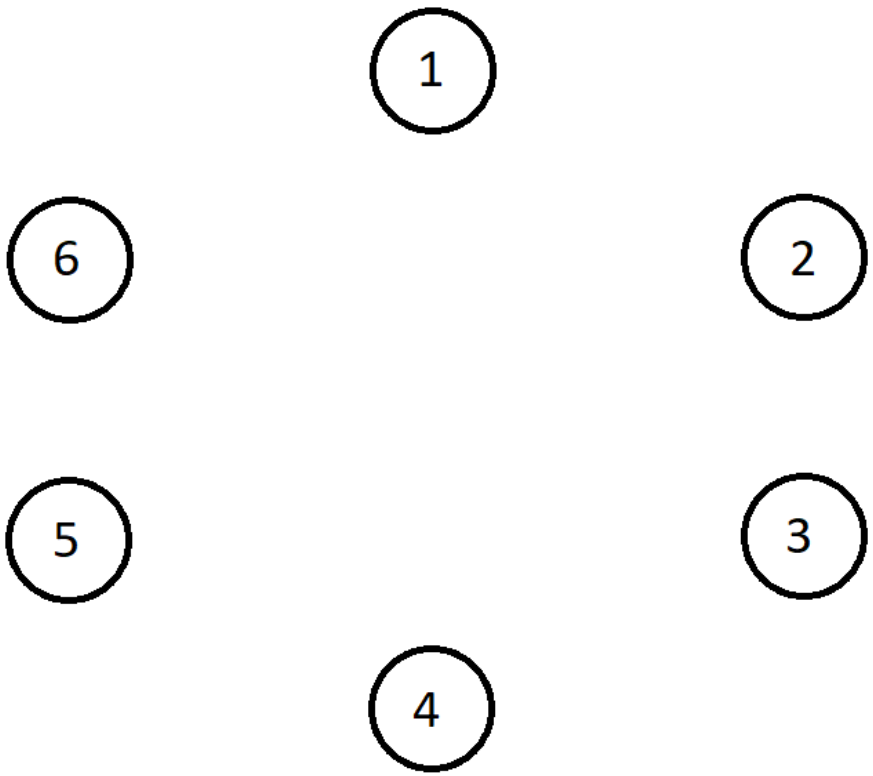


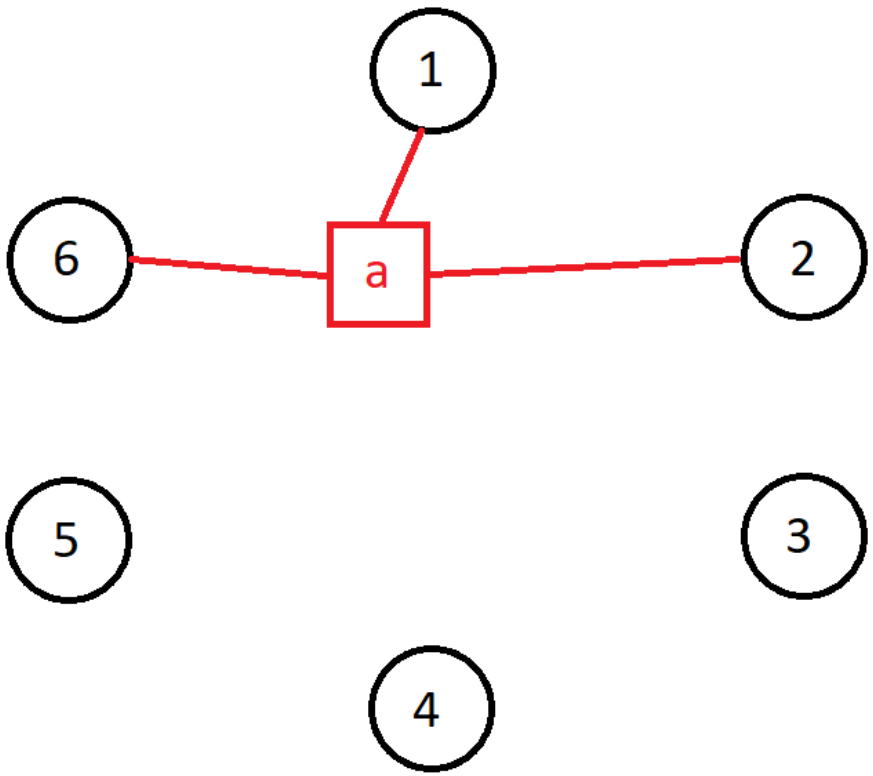
Distributed setting

Independent processes



Distributed setting

Independent processes communicating over channels



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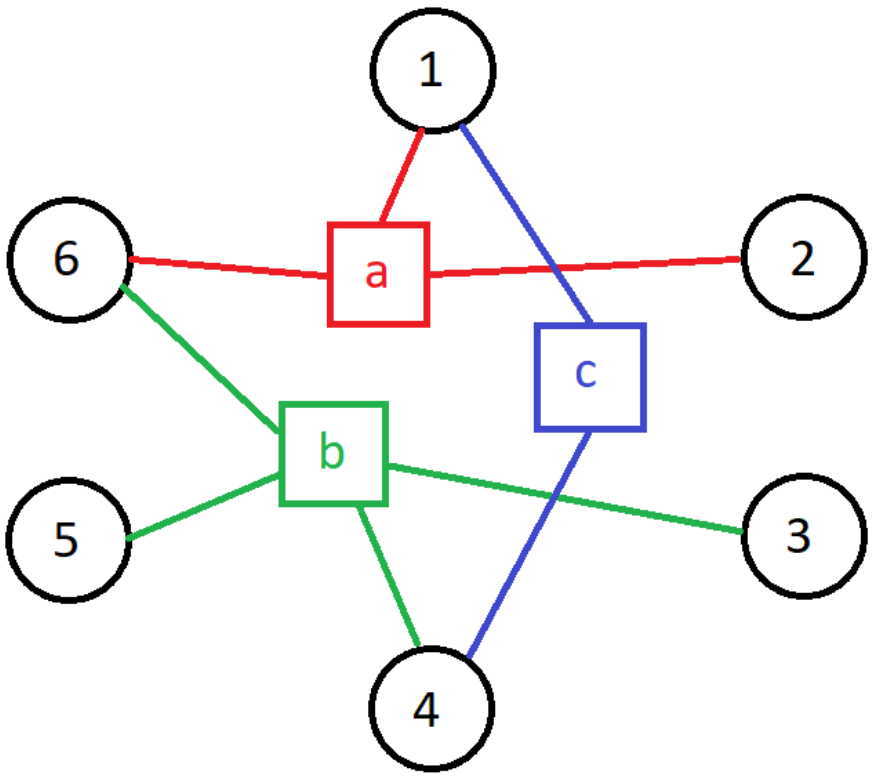

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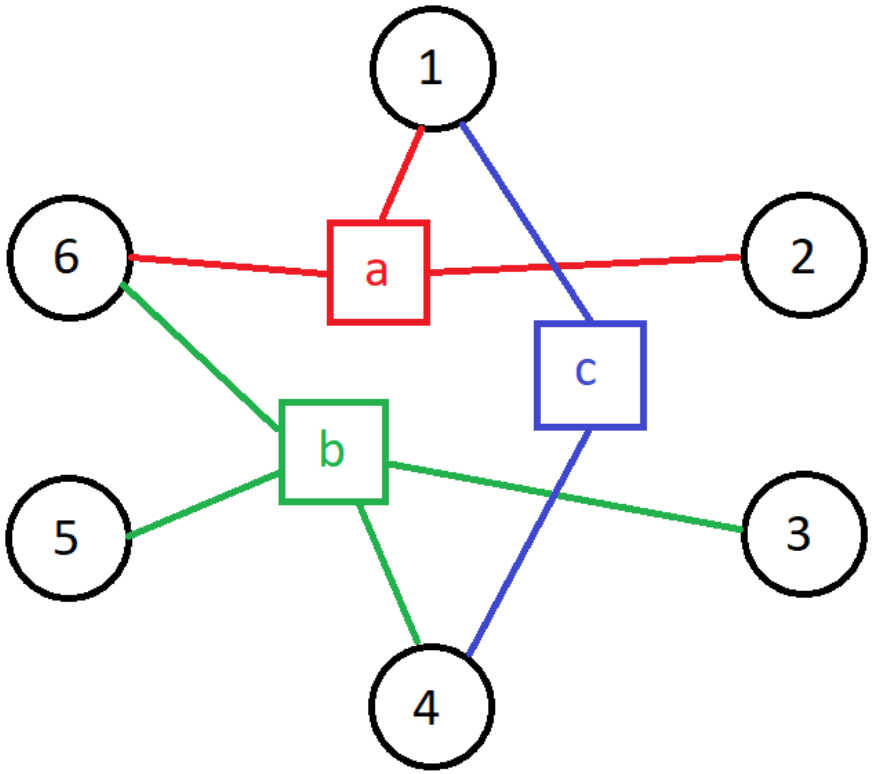
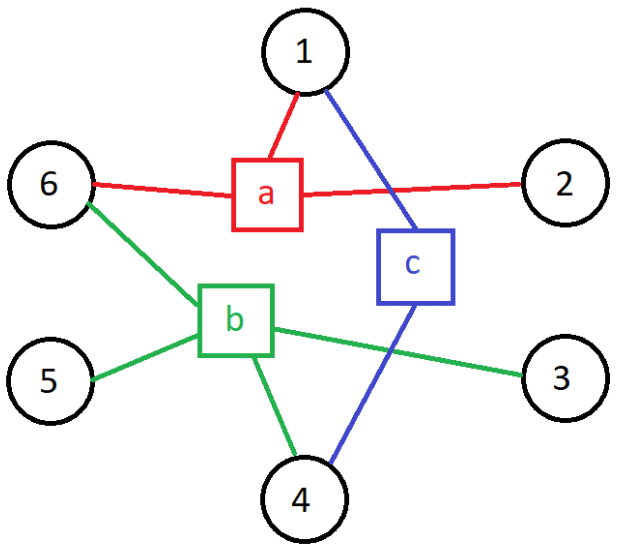


Some assumptions

- Asynchronous system
- Rendez-vous communication
- No sender/receiver distinction

Fixed or reconfigurable communications

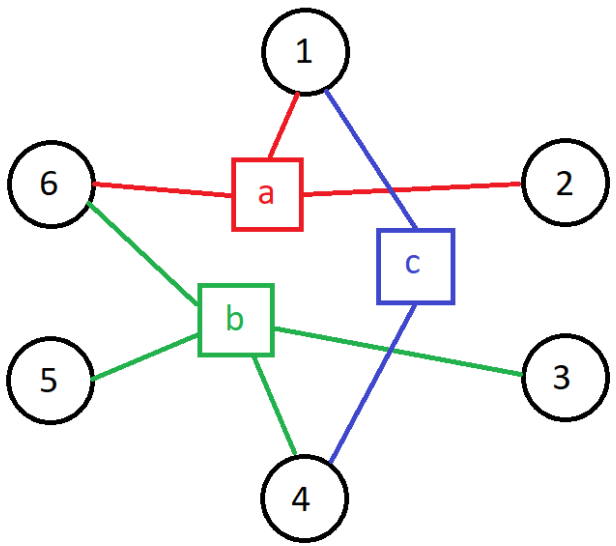
Fixed topology:



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

Fixed or reconfigurable communications

With reconfiguration: before...



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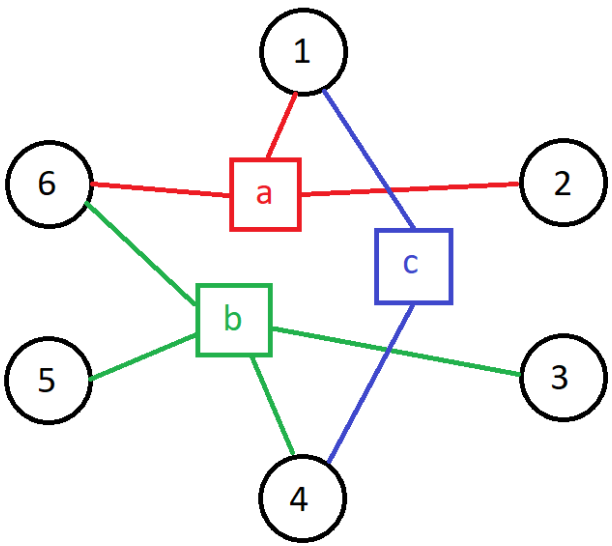
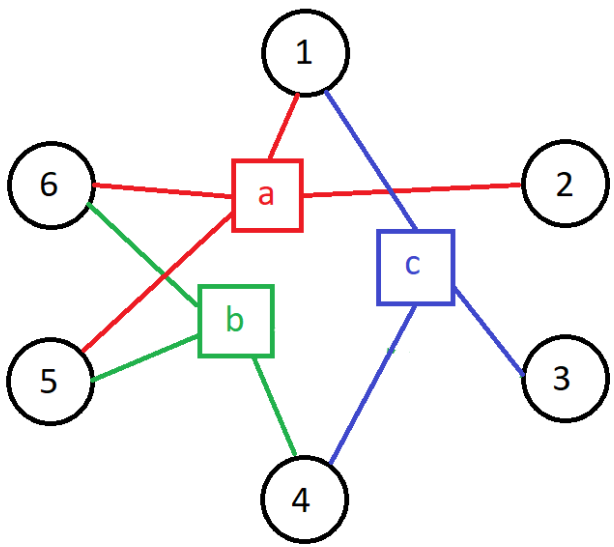
Fixed or reconfigurable communications

With reconfiguration: before... ... and after





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Zielonka's Asynchronous Automata (AA)

Fix set of processes, channels, and communication structure

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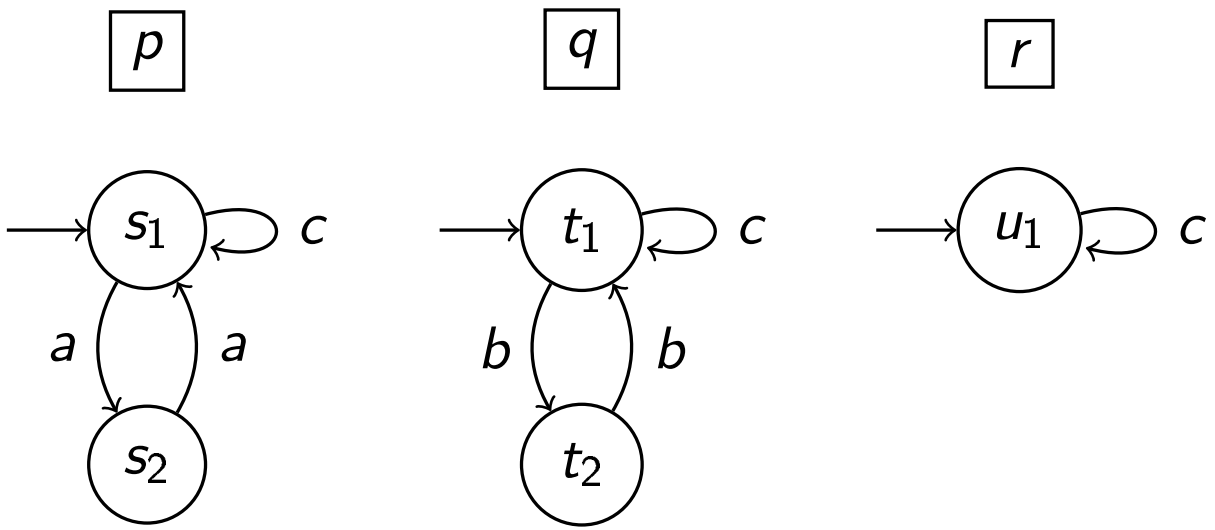

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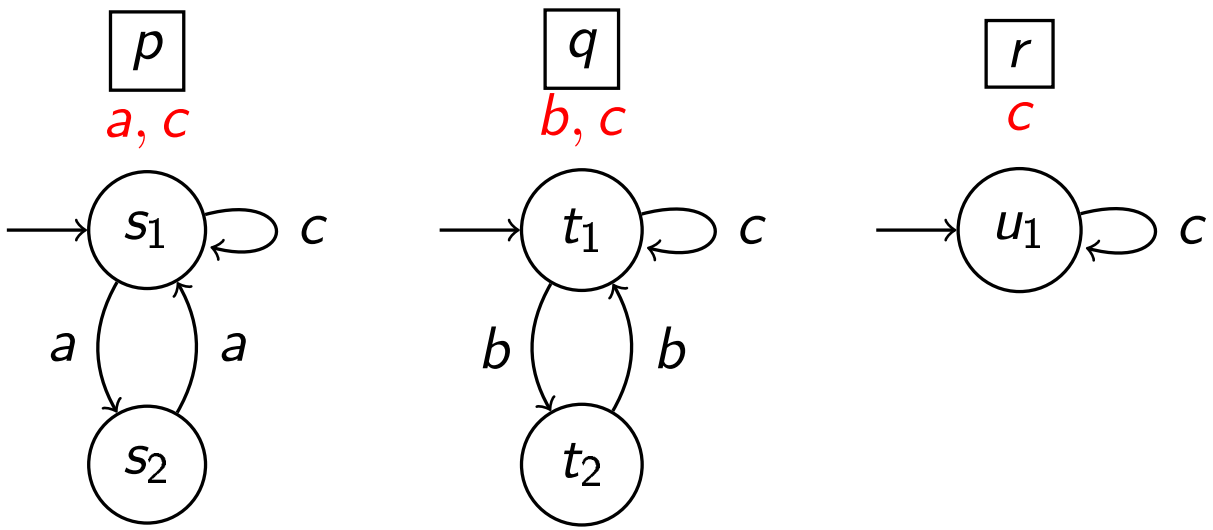

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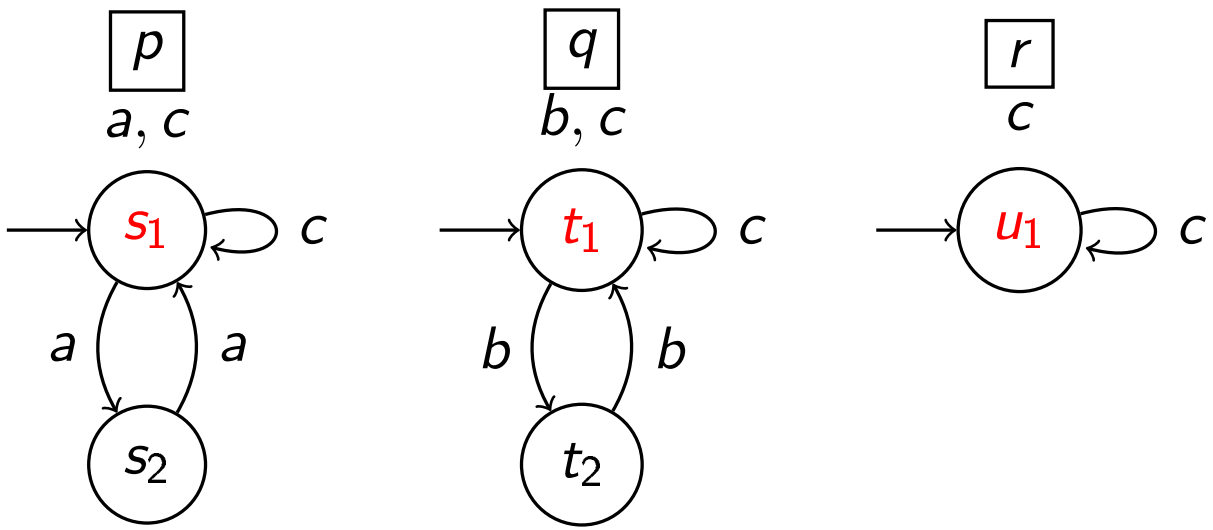

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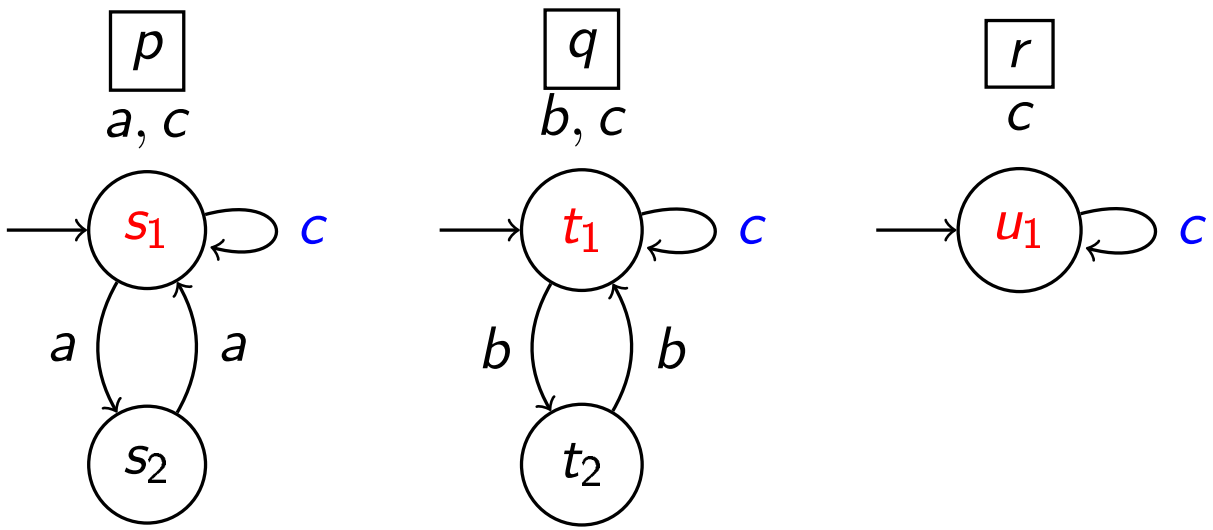

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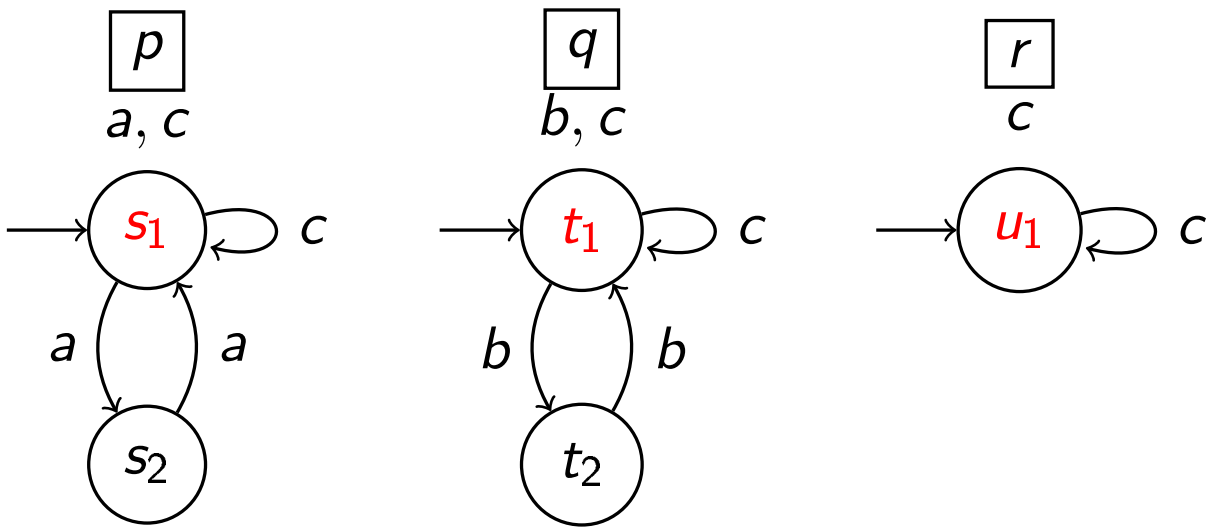

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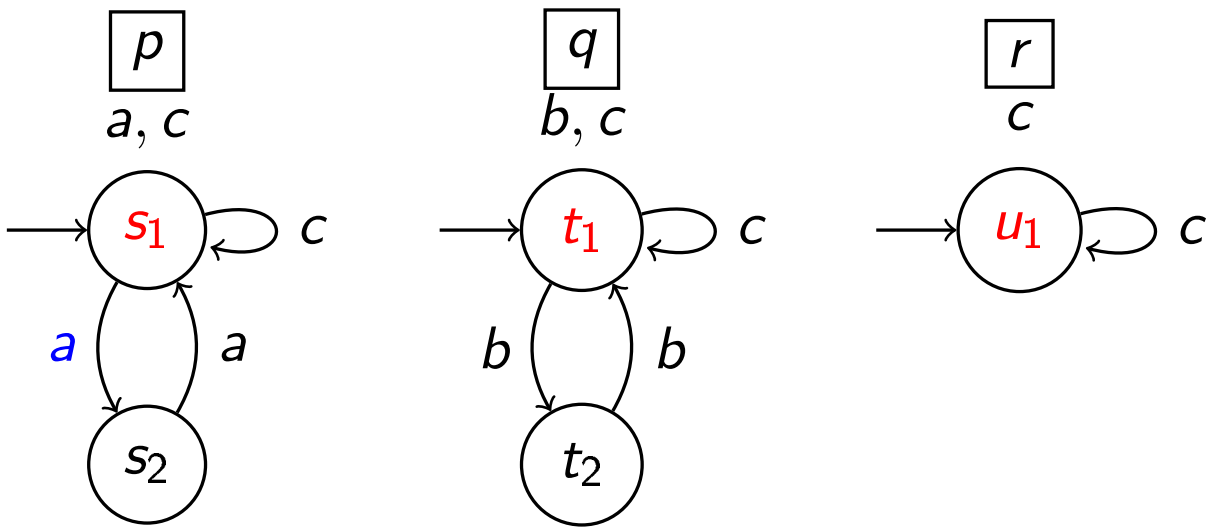

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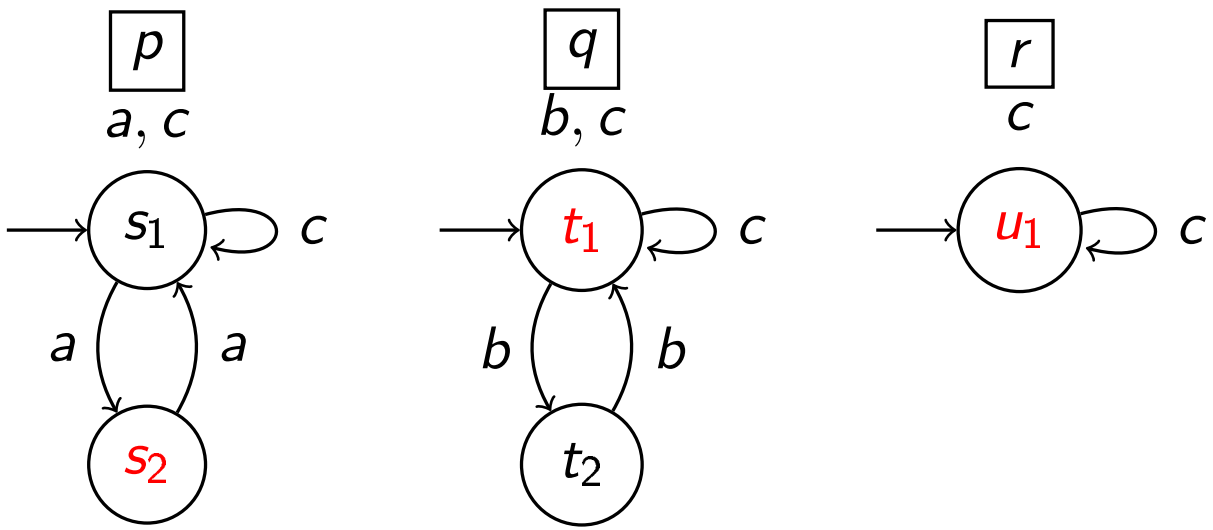

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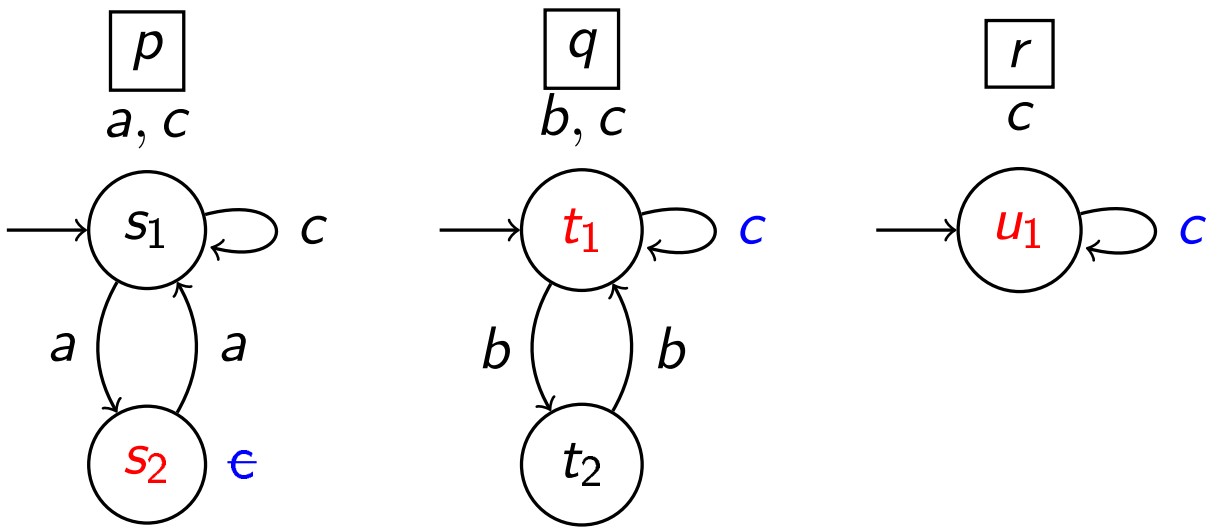

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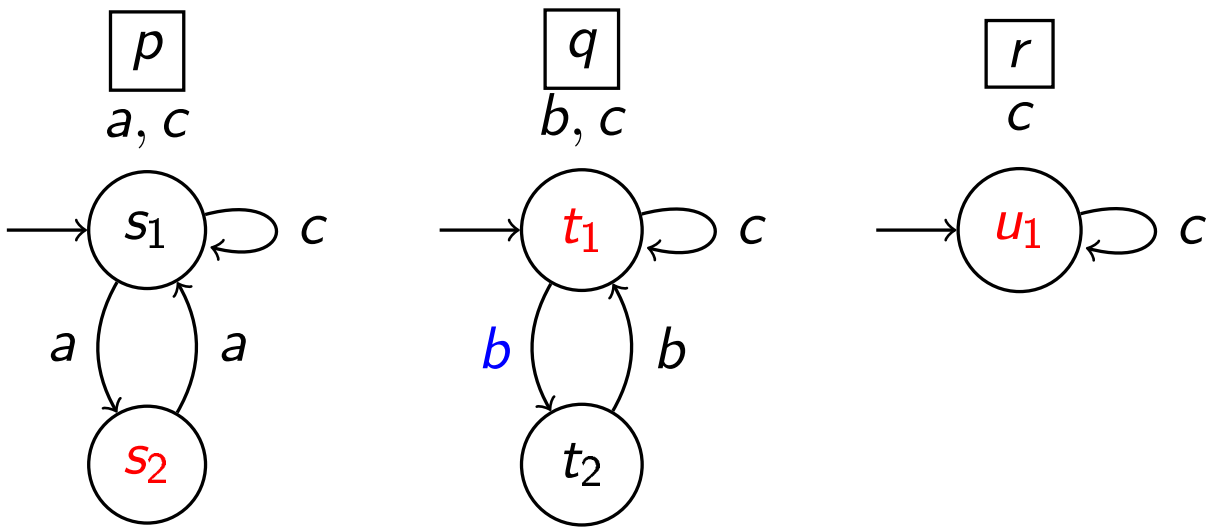

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$w = cab\ldots$

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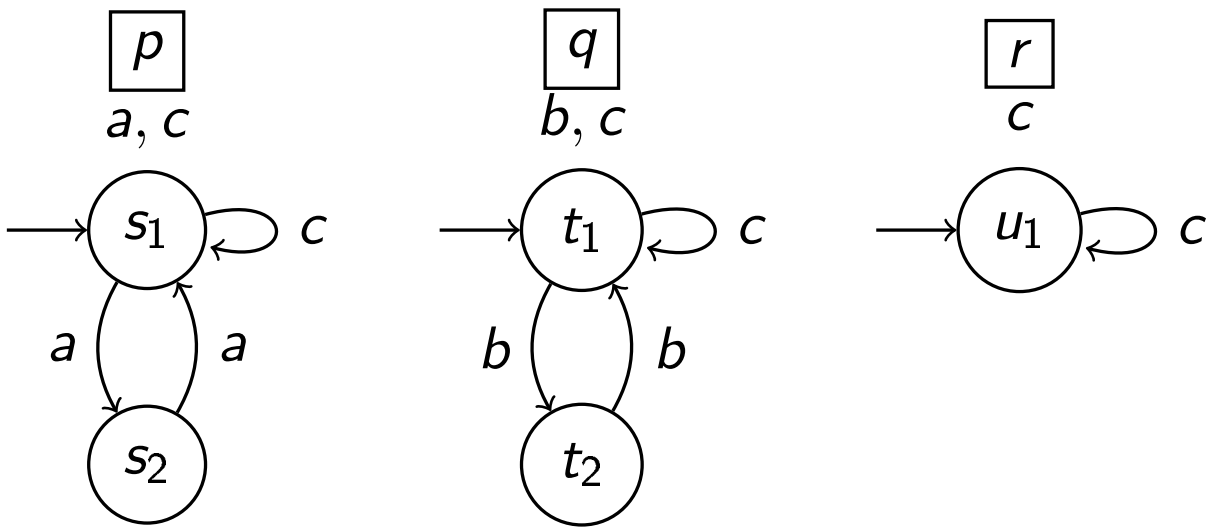

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$w = cab\ldots$ Language: all c preceded by even number of a & b

Reconfigurable model

Reconfigurable Asynchronous Automata (RAA)

Fix set of processes, channels, and ~~communication structure~~

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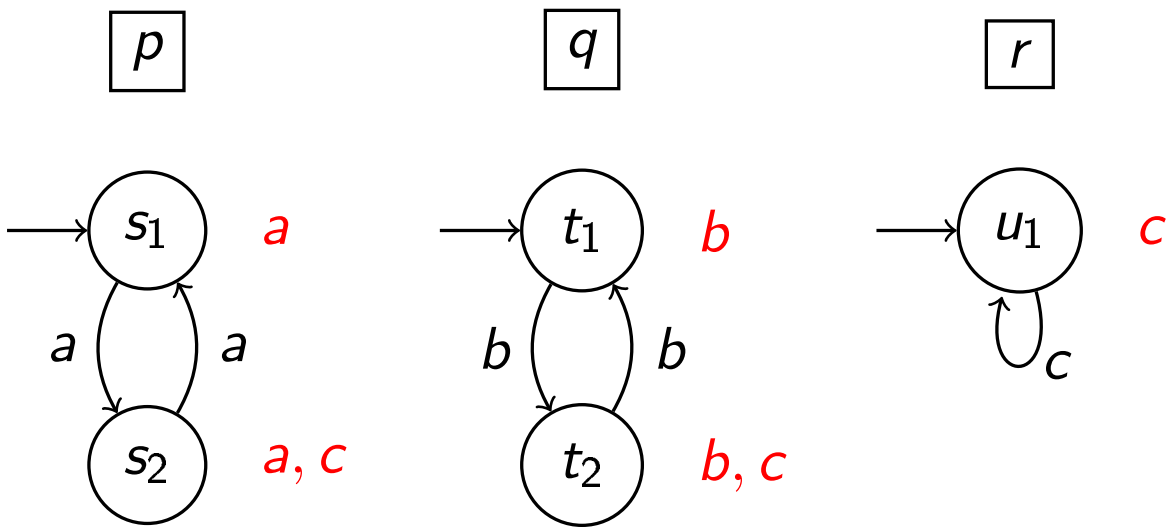
Communication structure is state-dependent



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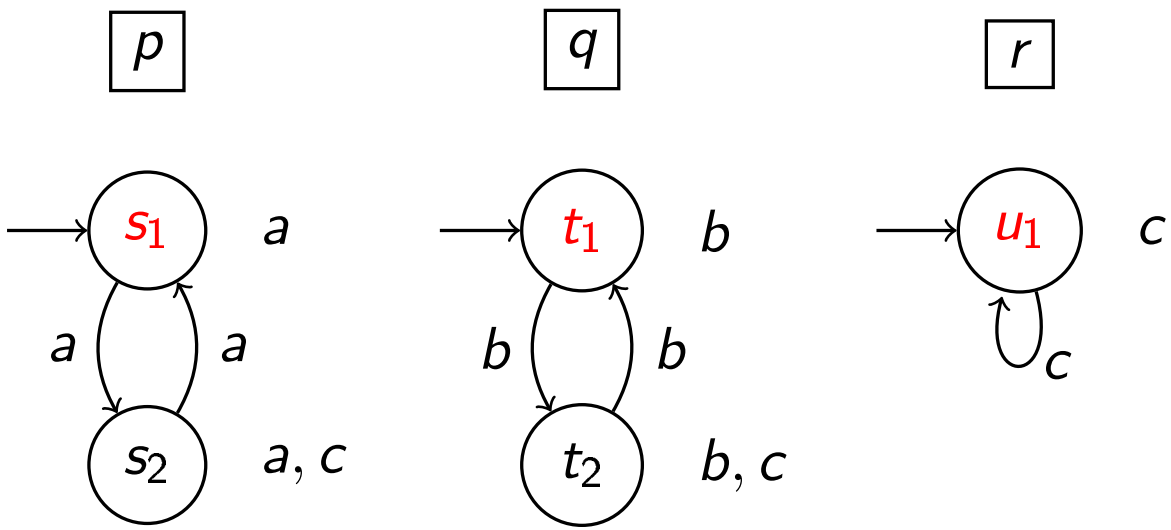

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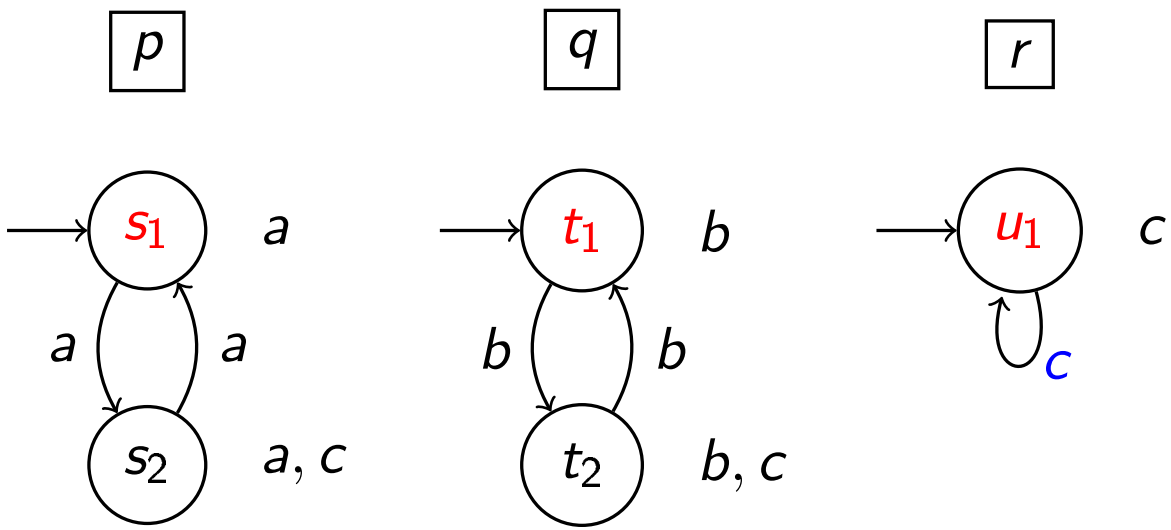

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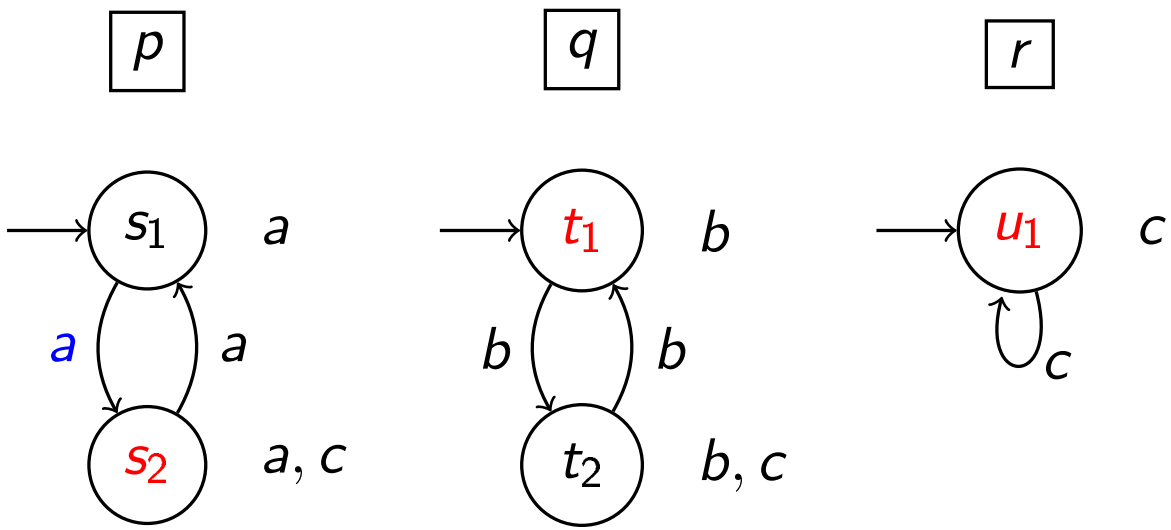

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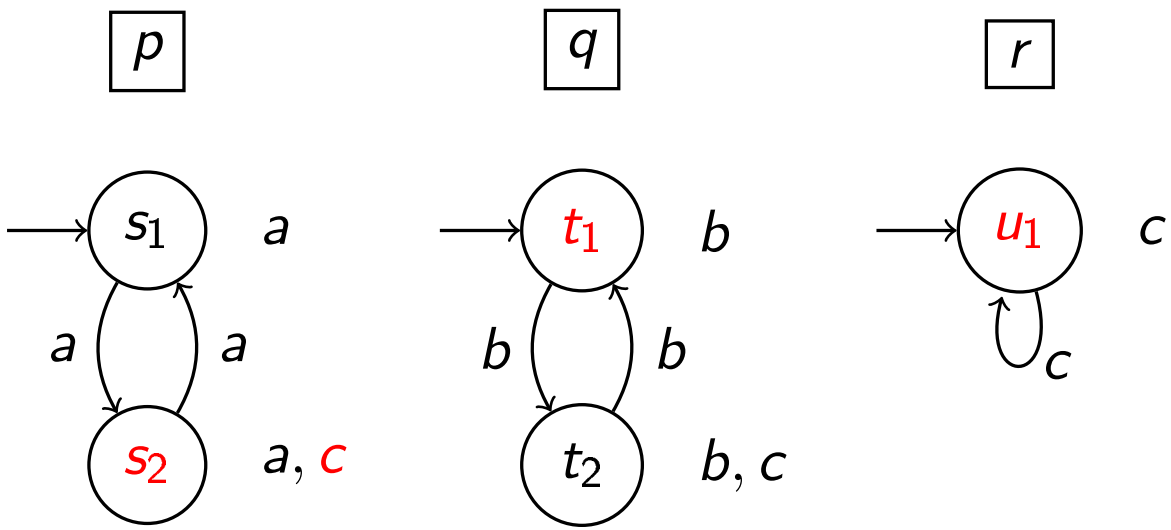

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Result 1: Fixed → Reconfigurable

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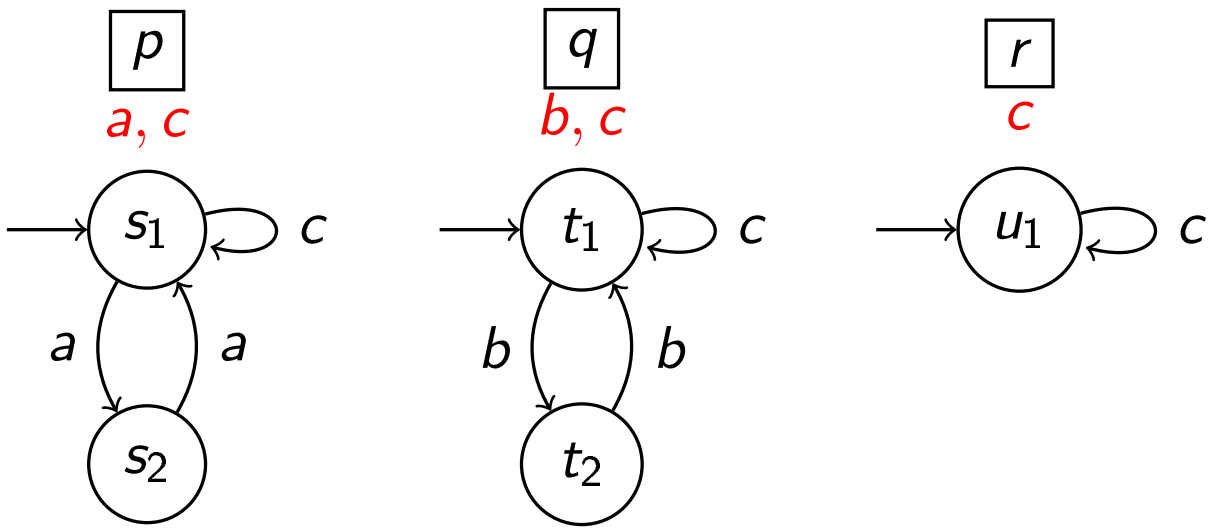

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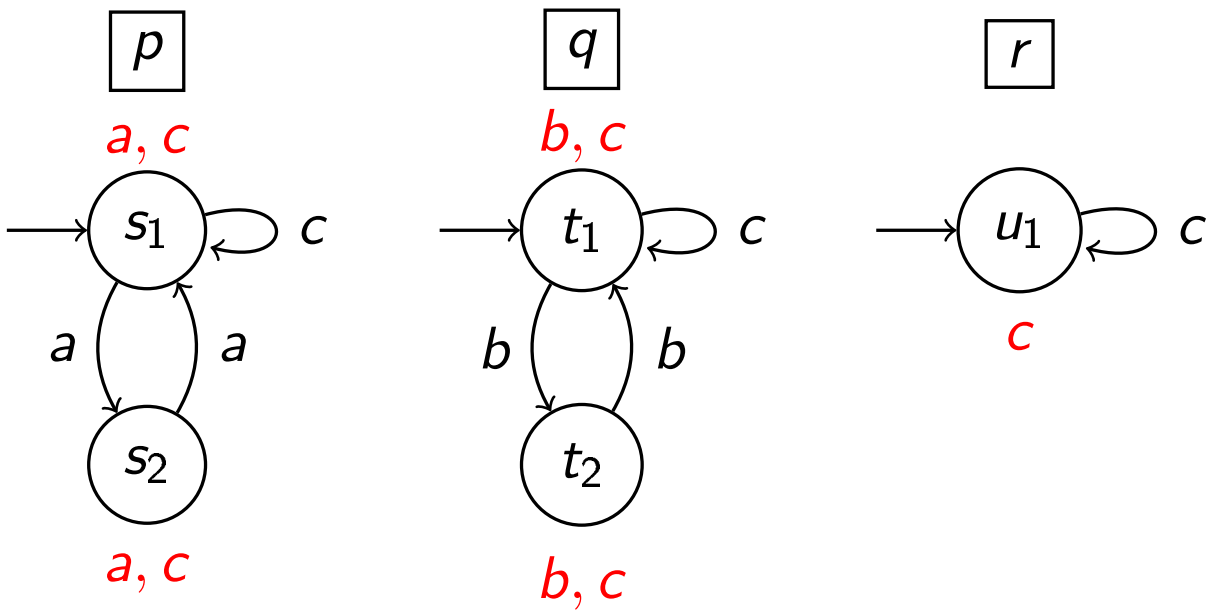

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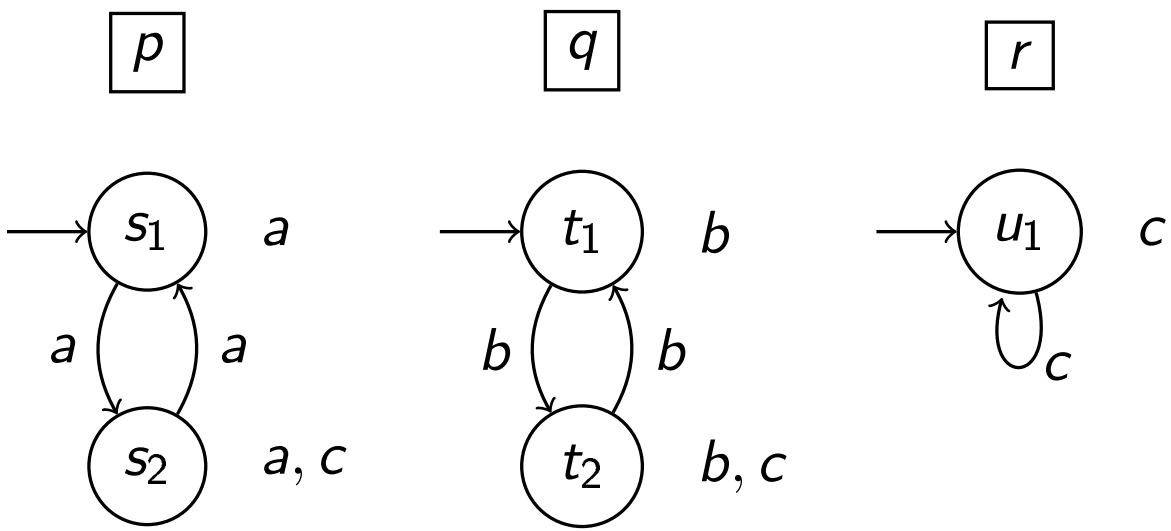

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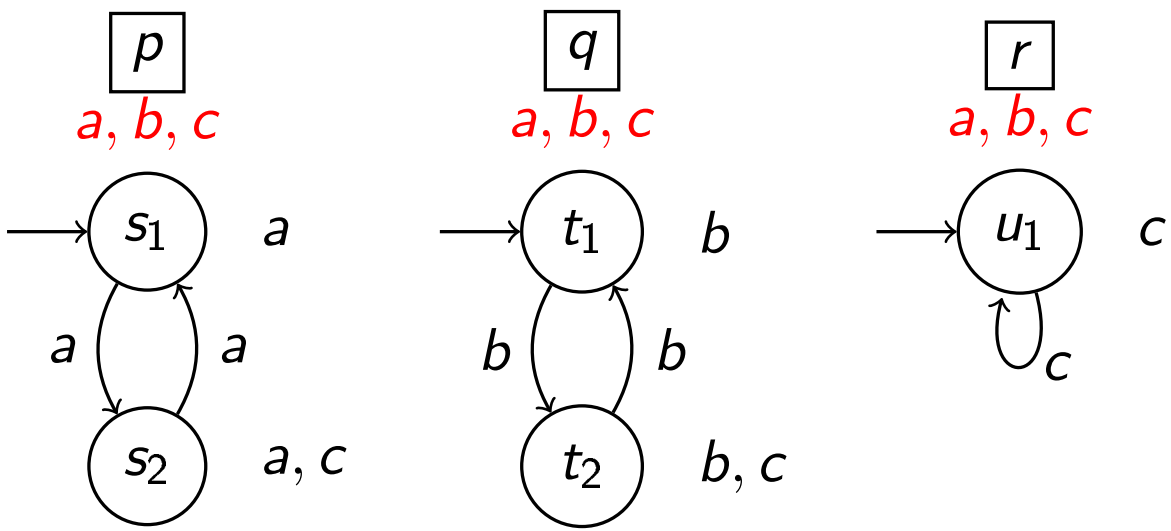

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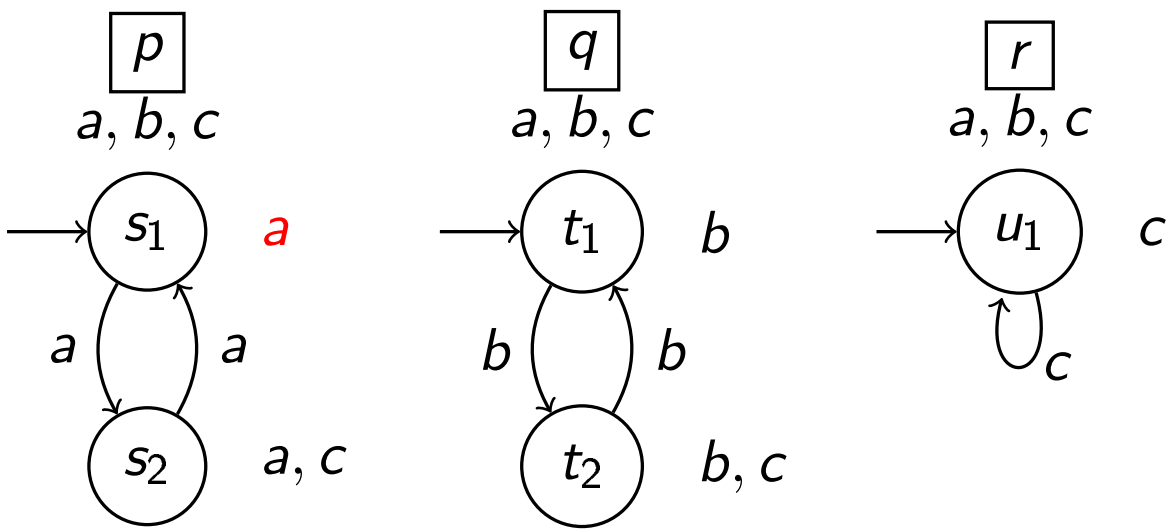

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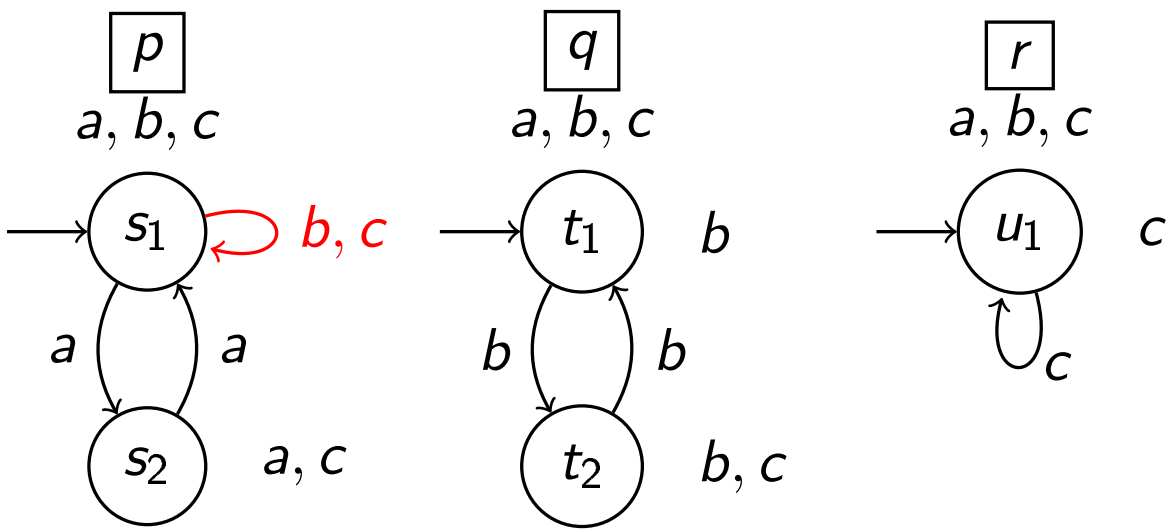

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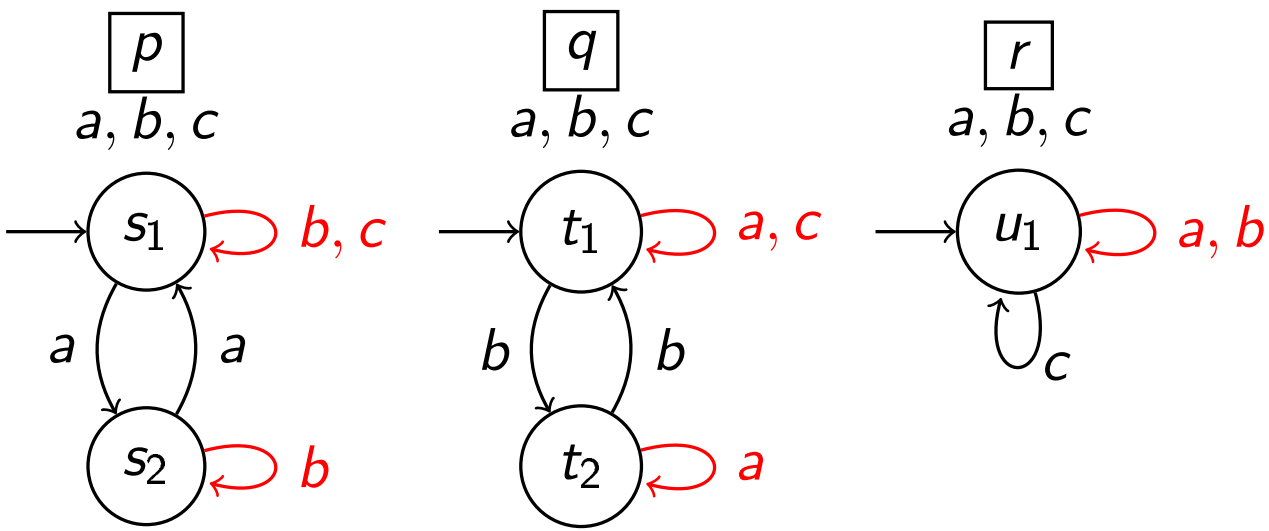

Now what?

Adding reconfigurability does not increase expressiveness.

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Can we do better?

Now what?

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But...

Previous construction is unsatisfactory:
All processes listen to all channels

Can we do better? Not really...

Result 3: No better general construction

There is a RAA such that in any equivalent AA, every process:

- either listens to every channel, or
- can be lead to a passive all-accepting state.

Proof idea

Main ideas

- We build an RAA with n processes and $n+1$ channels.
- The behavior (blocking/allowing communications) of a process changes when receiving instructions from a special *switching channel*.

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- The behavior (blocking/allowing communications) of a process changes when receiving instructions from a special *switching channel*.
- After enough communications, a different channel assumes the role of the switching channel, and so on.
- With a fixed topology, not listening to the switching channel means accepting everything.

More results about this construction

Previous statement

There is a RAA such that in any equivalent AA, every process:

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More results about this construction

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There is a RAA such that in any equivalent AA there is an alternative initial configuration from which the same language is accepted, and every process:

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"Complexity"

Every process in the RAA listens to at most 3 channels at a time ($O(1)$ connections).
Every non-trivial process in the AA listens to all channels ($O(n)$ connections).

Summary and future works

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Thank you for your attention!

The switching RAA for $n = 2$