A Coordination Model and Algebra for Domain Polymorphism

preliminary results

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Goal and application issues:

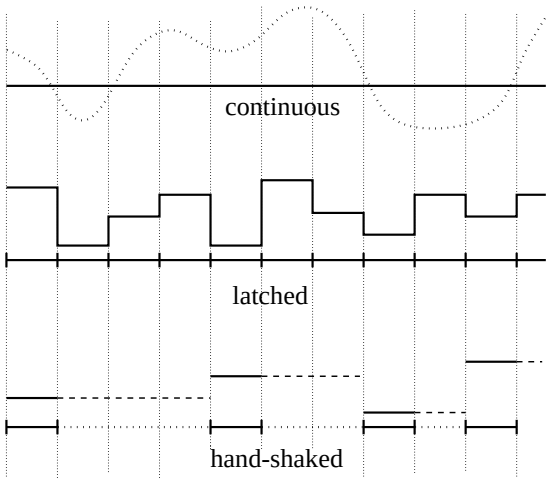
goals:

- unified model of polymophic components,
- formalizing coordination domains,
- reducing coordination overhead,
  - light-weight co-ordination,
  - compile-time vs execution time issues.

application domains:

- embedded systems
- signal processing
- co-design (hwr and swr)

Time model:



Port types:

Given port P:

- with reference to an output port:
  - $\tilde{p}$ a continuously (time) varying source.
  - $\bar{p}$ a latched source.
  - p a hand-shaking source.
- with reference to an input port:
  - $\tilde{p}$ sensitive to continuous input excitations.
  - $\bar{p}$ sensitive to input at clock event,
  - p a hand-shaking sink.

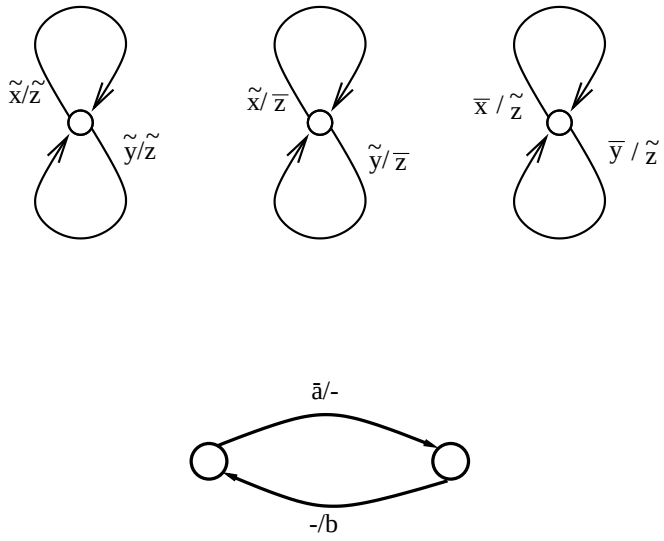
Dependencies:

- *Internal*: between the input "a" (or $\tilde{a}$ or $\bar{a}$) and output "b" (or $\tilde{b}$ or $\bar{b}$) of a module.
  - *isochronic*: written as "a/b", a is available for generation of b in a predictable way.
  - *sequential*: written as "a, b", delayed influence of a on b, by an unknown number of clock *ticks*,
- *External*: between environment and input a. Written as $a/-$ (or $a?$), indicates a's sensitivity to the environemt. Timing depends on the type of a.
- *Interface*: between the output b and the environment. Written as $-/b$ (or $b!$), indicates a source ready to influence the environment. Timing depends on the type of b.

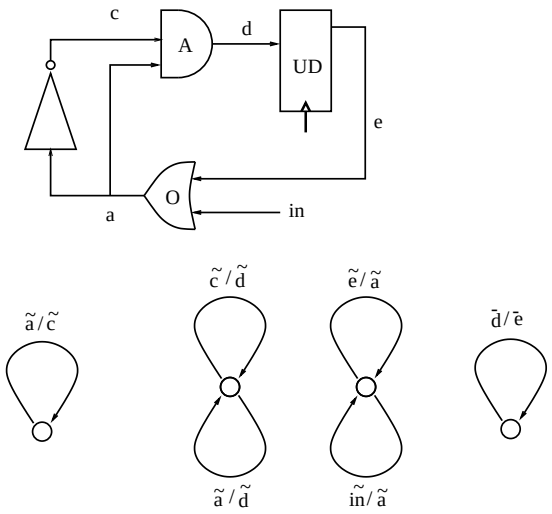
Intra module: between the input "a" ($\tilde{a}$ or $\bar{a}$) and output "b" ($\tilde{b}$ or $\bar{b}$) of a module:

$\tilde{a}/\tilde{b}$:	e.g. an ideal adder,
$\tilde{a}/\bar{b}$:	e.g. a sample-and-hold (S&H) device
$\bar{a}/\tilde{b}$:	e.g. output of an integrator
$\bar{a}/\bar{b}$:	e.g. a shift register,
$\tilde{a}/-$:	also written as $\tilde{a}?$, continuous software input
$\bar{a}/-$:	also written as $\bar{a}?$, clocked input to software,
$a/-$:	also written as $a?$, a hand-shaked input.
$-/\tilde{b}$:	also written as $\tilde{b}!$, continuous software generated output
$-/\bar{b}$:	also written as $\bar{b}!$, a software generated register output,
$-/b$:	also written as $b!$, a hand-shaked output,

Module examples:



synchronous reactive example:



$i\tilde{n}/\tilde{a}/[\tilde{a}/\tilde{c}/\tilde{c}/\tilde{d}/\bar{d}/\bar{e}, \tilde{a}/\tilde{d}/\bar{d}/\bar{e}]$

Inter module: Co-ordination:

$\tilde{a}/\tilde{a}$: current source value passed to sink (wire),

$\tilde{a}/\bar{a}$: source value at clock tick passed to sink,

$\tilde{a}/a$: source value at (one sided) hand-shake passed to sink,

$\bar{a}/\tilde{a}$: *constant* source value passed to sink,

$\bar{a}/\bar{a}$: source value at clock tick passed to sink,

$\bar{a}/a$: latest source passed to (one sided) hand-shaking sink,

$a/\tilde{a}$: source value at (one sided) hand-shake passed to sink?,

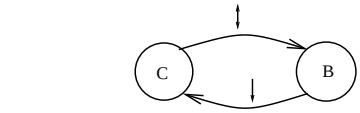
$a/\bar{a}$: source value at (one sided) hand-shake passed to sink?,

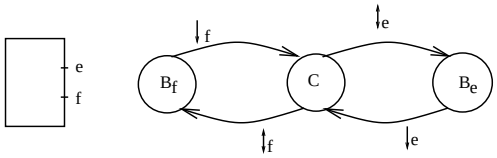
a/a: value passed at the time of (two-sided) hand-shake.

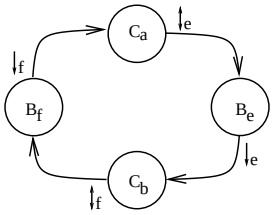
Coordination Basics:

- "↕": The "blocking" operator has two types: *internal* and *external*.
  - An *internal* block is generated by a running application process and shown by an edge leaving a computation state.
  - An *external* block indicates waiting for an external (blocking) event and shown by an edge leaving a blocked state.
- "↓": The "unblocking" operator has two types: *internal* and *external*.
  - An *internal* unblock is generated a running coordination process. This is shown by an edge leaving a computation state.
  - An *external* block is waiting for an external (unblocking) event. This is shown by an edge leaving a blocked state.

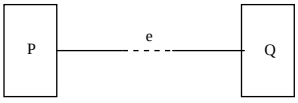
coordination basics:

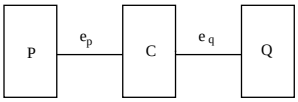


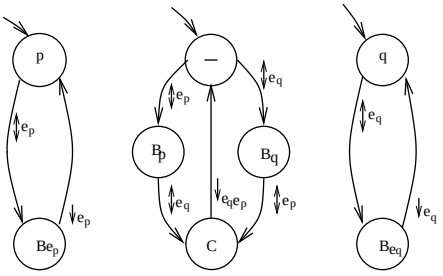




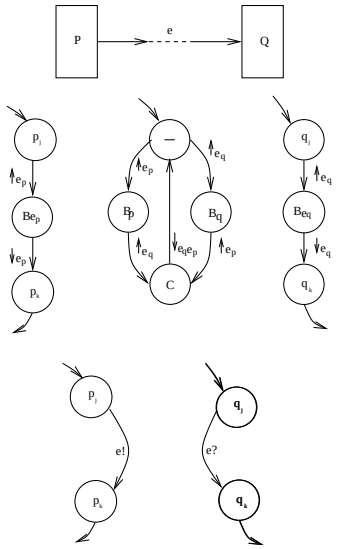
a/a coordination:



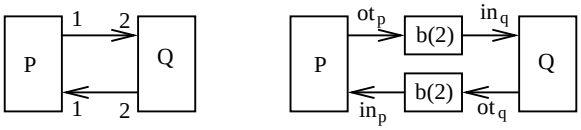


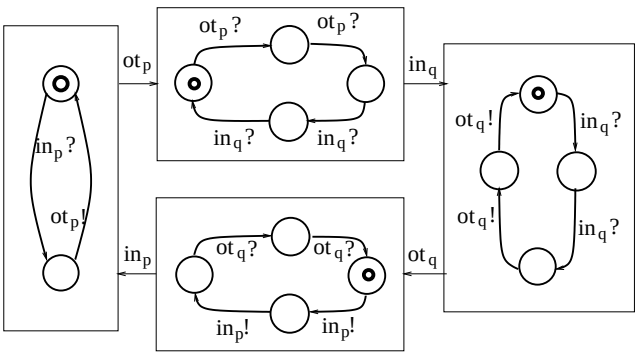


a/a abstraction:

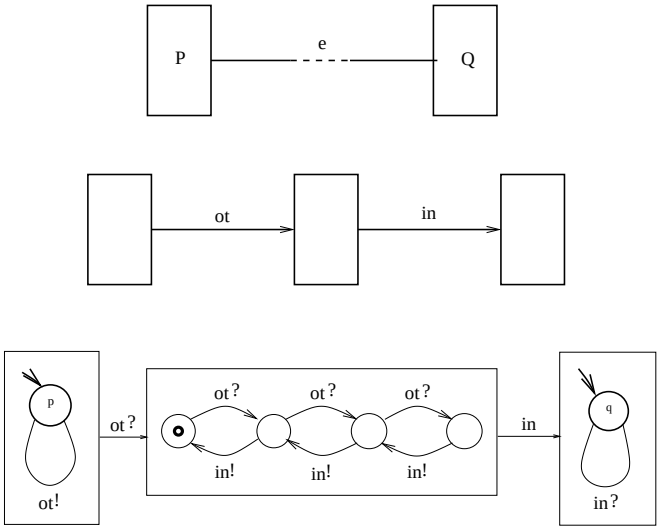


SDF:

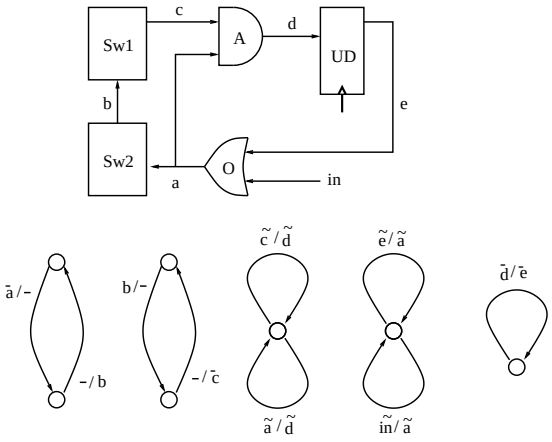




PN:



Design example: software+synchronous components:



$\triangleright \bar{d}/\bar{e}/\tilde{e}/\tilde{a}/[\bar{a}/-/-/\tilde{b}/\tilde{b}/-/-/\bar{c}/\tilde{c}/\tilde{d}/\bar{d}/\bar{e}, \tilde{a}/\tilde{d}/\bar{d}/\bar{e}]$