CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

UNIVERSITÉ NICE SOPHIA ANTIPOLIS

Synchronous Interface Behavior

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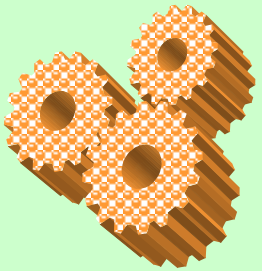
I3S

Motivation



Control-dominated systems

Expressiveness

Efficiency

Structuring

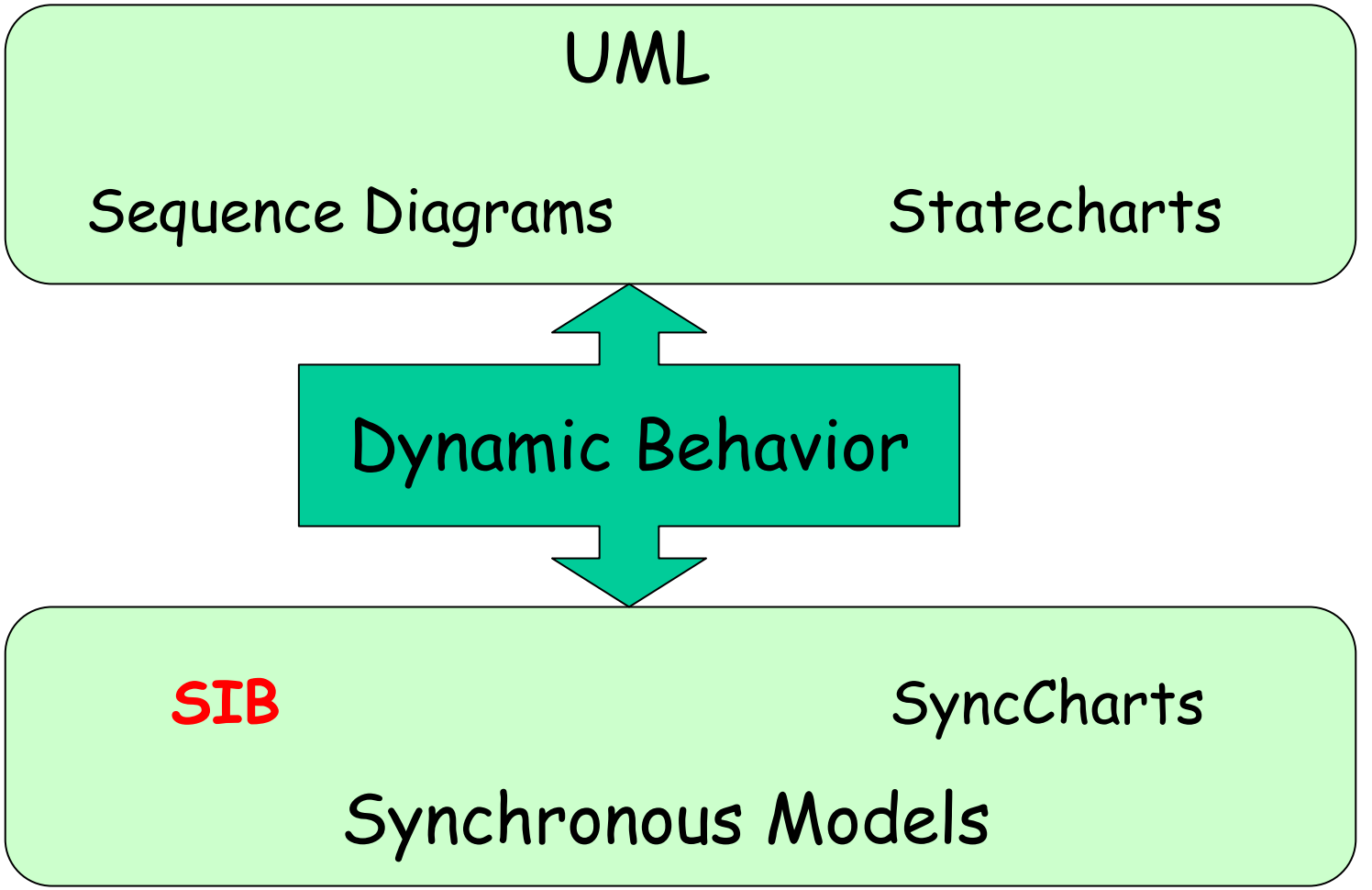
Synchronous languages (mid 1980's)

UML

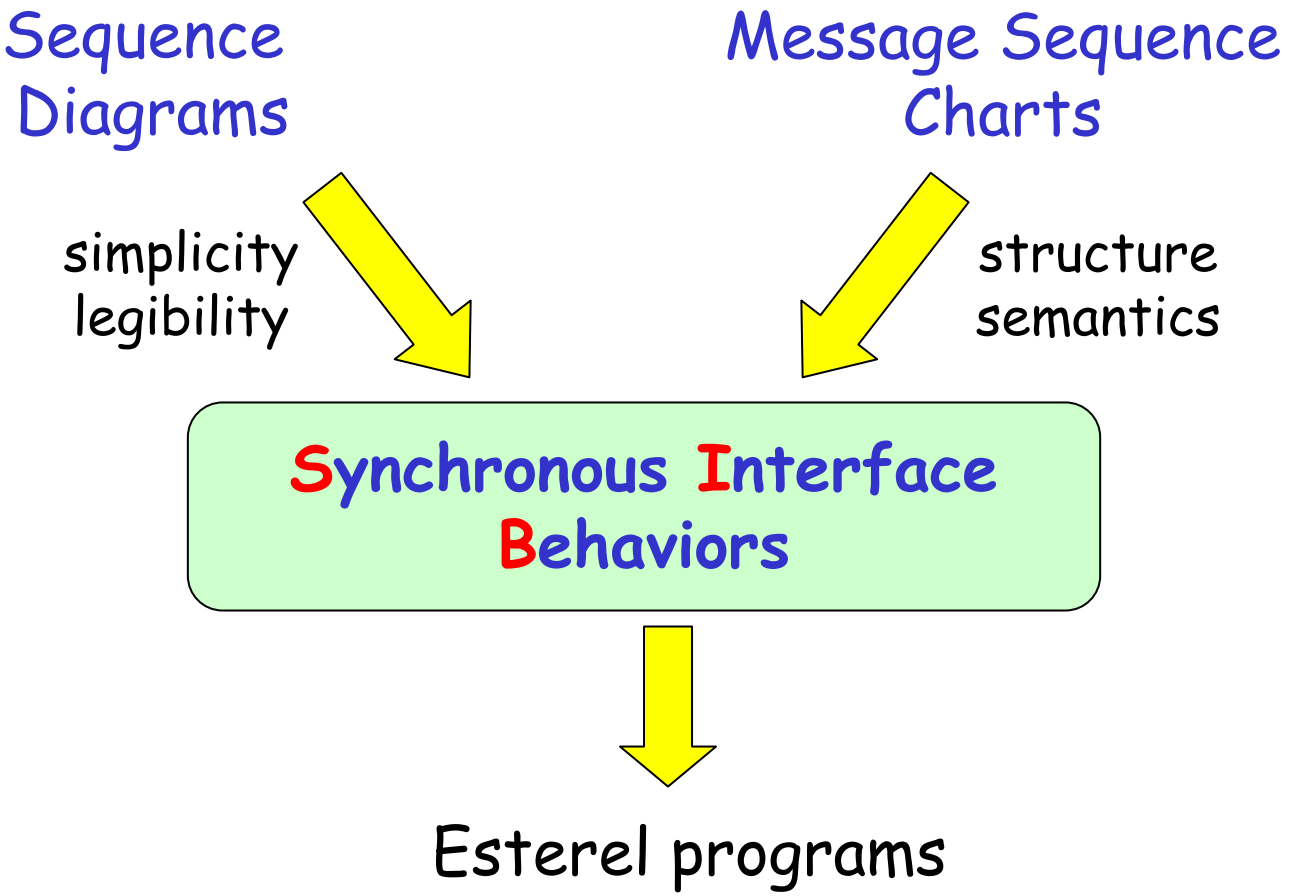
Reactive Behavior

Software Engineering

Motivation (cont'd)



Sequences


Sequence Diagrams
Message Sequence Charts
simplicity legibility
structure semantics
Synchronous Interface Behaviors
Esterel programs

The Synchronous Approach

- Abstract and ideal view of reactive systems
- Observation: Discrete instants
- Execution model: 0-duration
- Communication: Instantaneous broadcast of signals
- Semantics: mathematically defined
- Support for validation

SIB: overview

- Syntax
  - Graphical language
  - Block-structured
  - A few constructs
- Semantics
  - Mathematical semantics

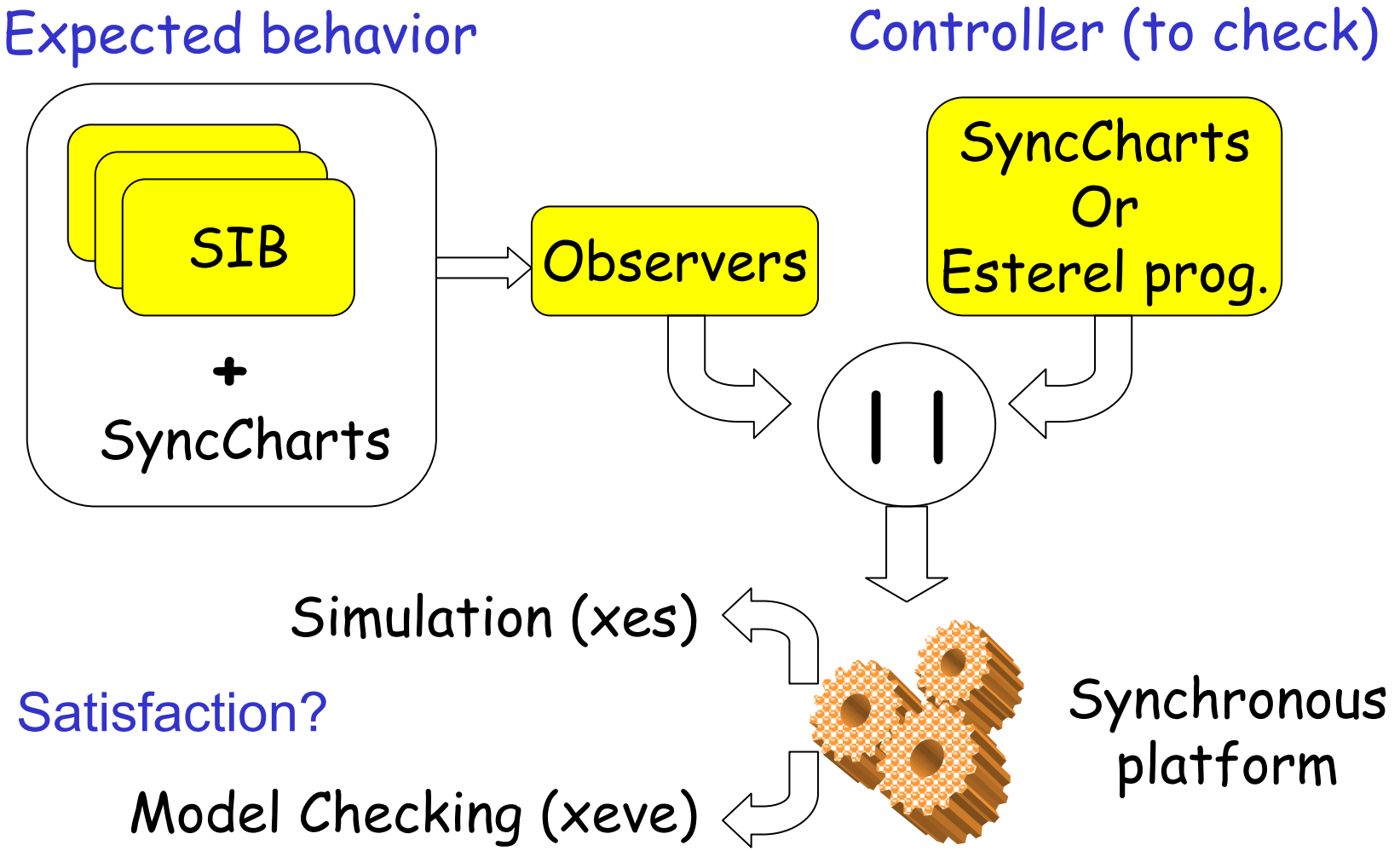
    Synchronous processus algebra

a SIB —Semantically equivalent→ an Esterel program

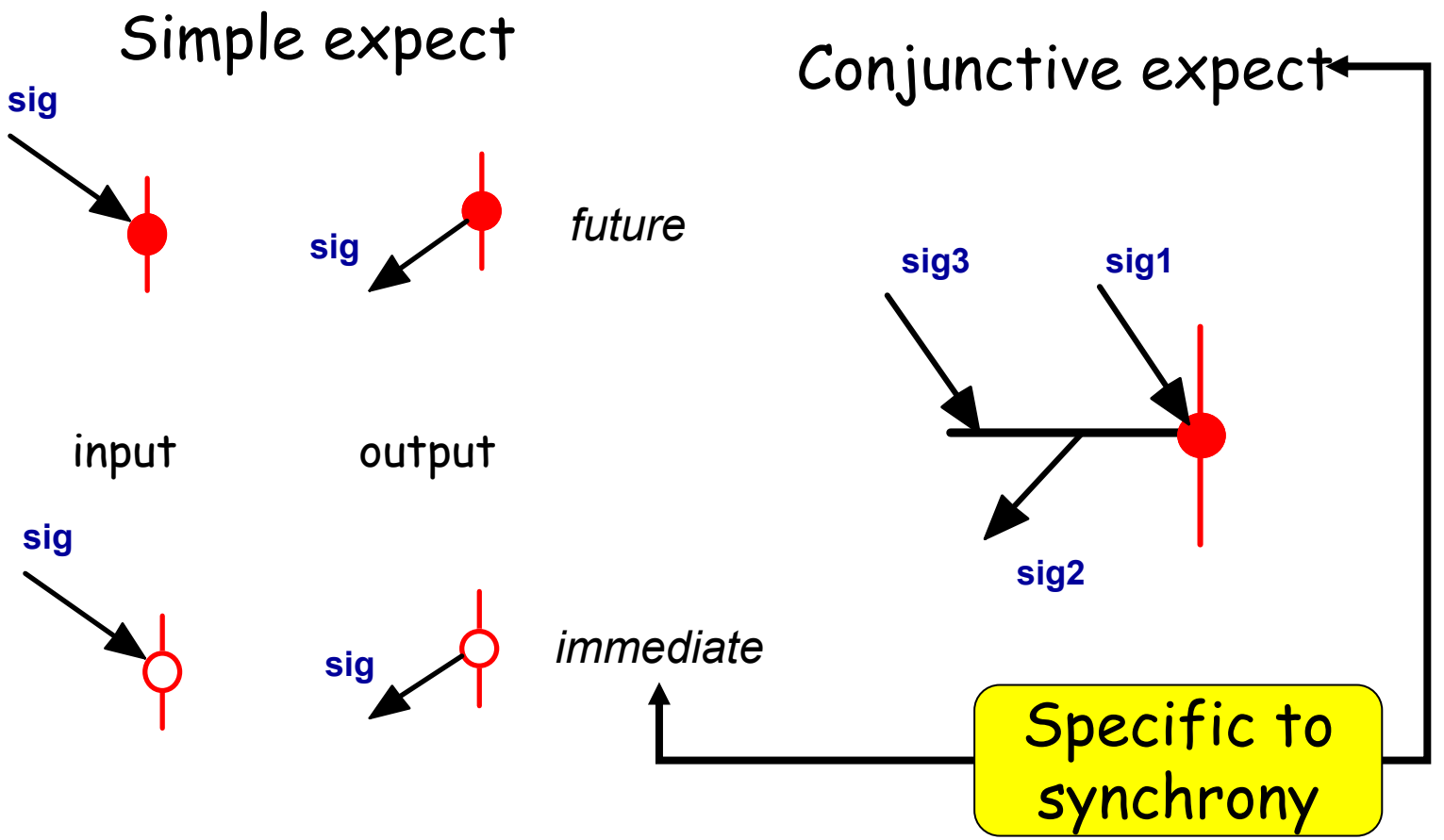
SIB: What for?

- Expressing expected behaviors
  - Discrete-event model
  - Partial order of events (signals)
  - Temporal constraints
- Interactive simulation
- Property checking

SIB: How?


Expected behavior
Controller (to check)
SIB
+
SyncCharts
Observers
SyncCharts
Or
Esterel prog.
||
Simulation (xes)
Satisfaction?
Model Checking (xeve)
Synchronous
platform

Syntax: Expect

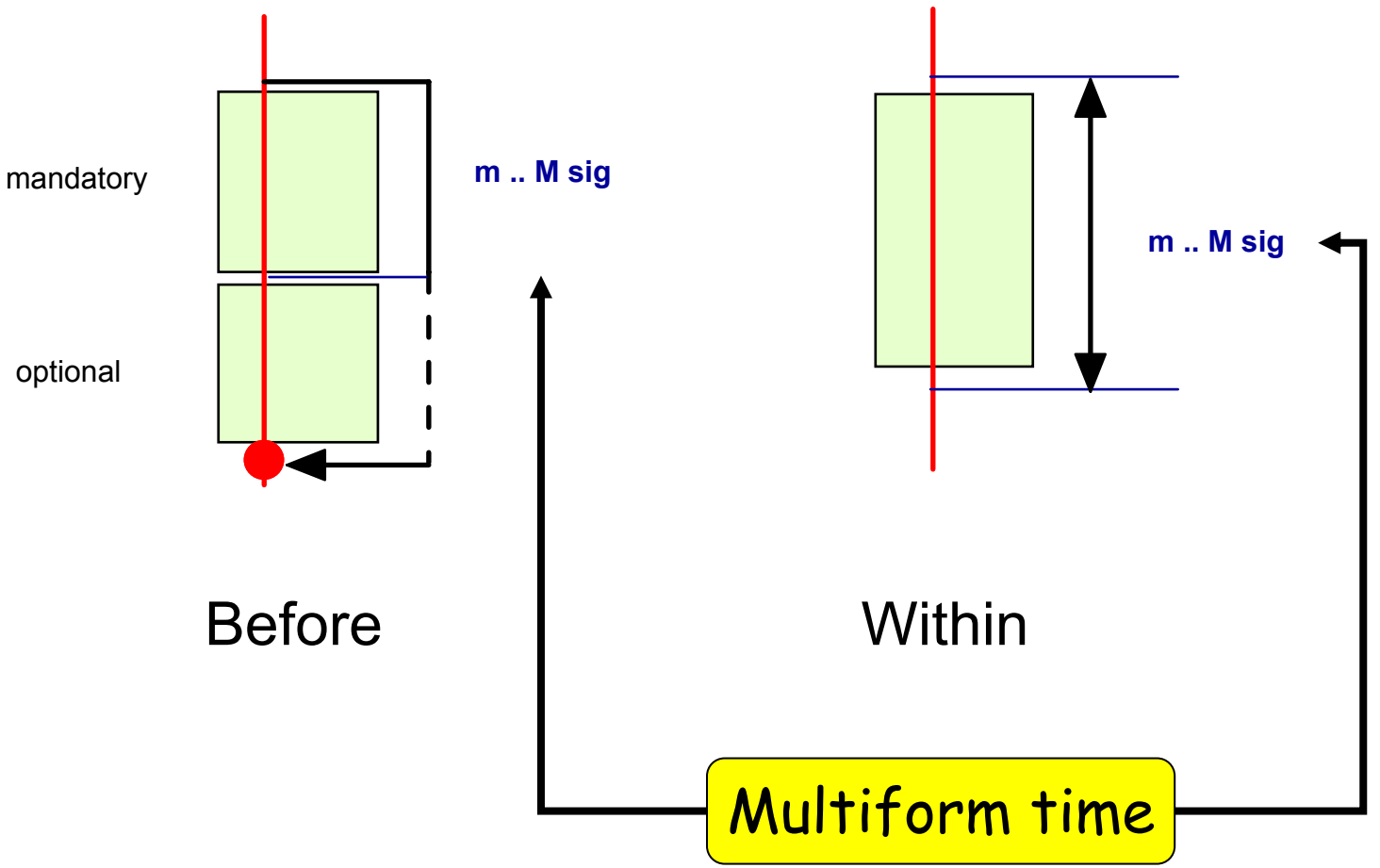


Other Constructs

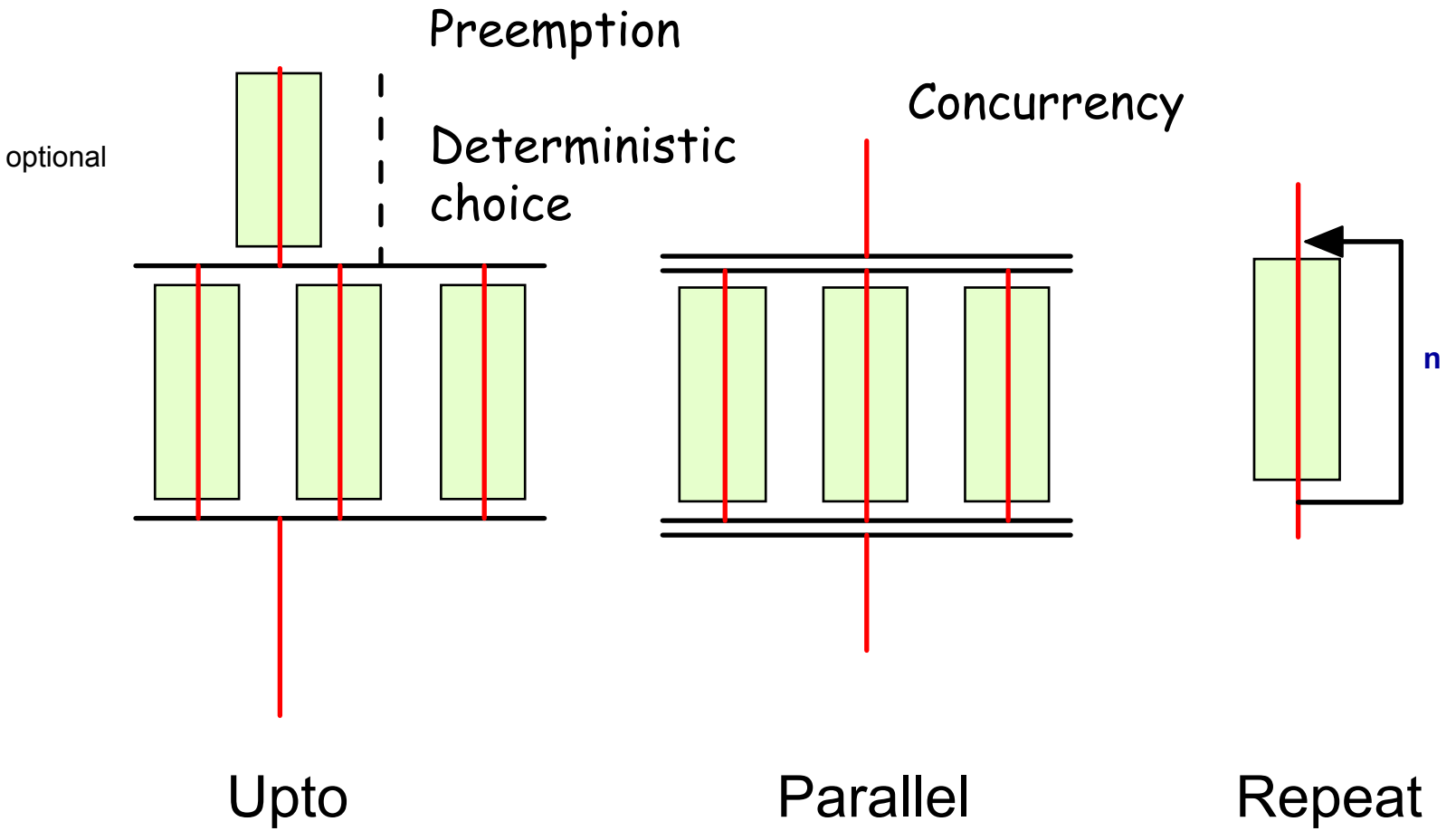
(block-based description)

- Temporal constraints
  - Before (with some degree of non determinism)
  - Within
  - Watchdog
- General control
  - Upto (pre-emption + deterministic choice)
  - Parallel
  - Repeat

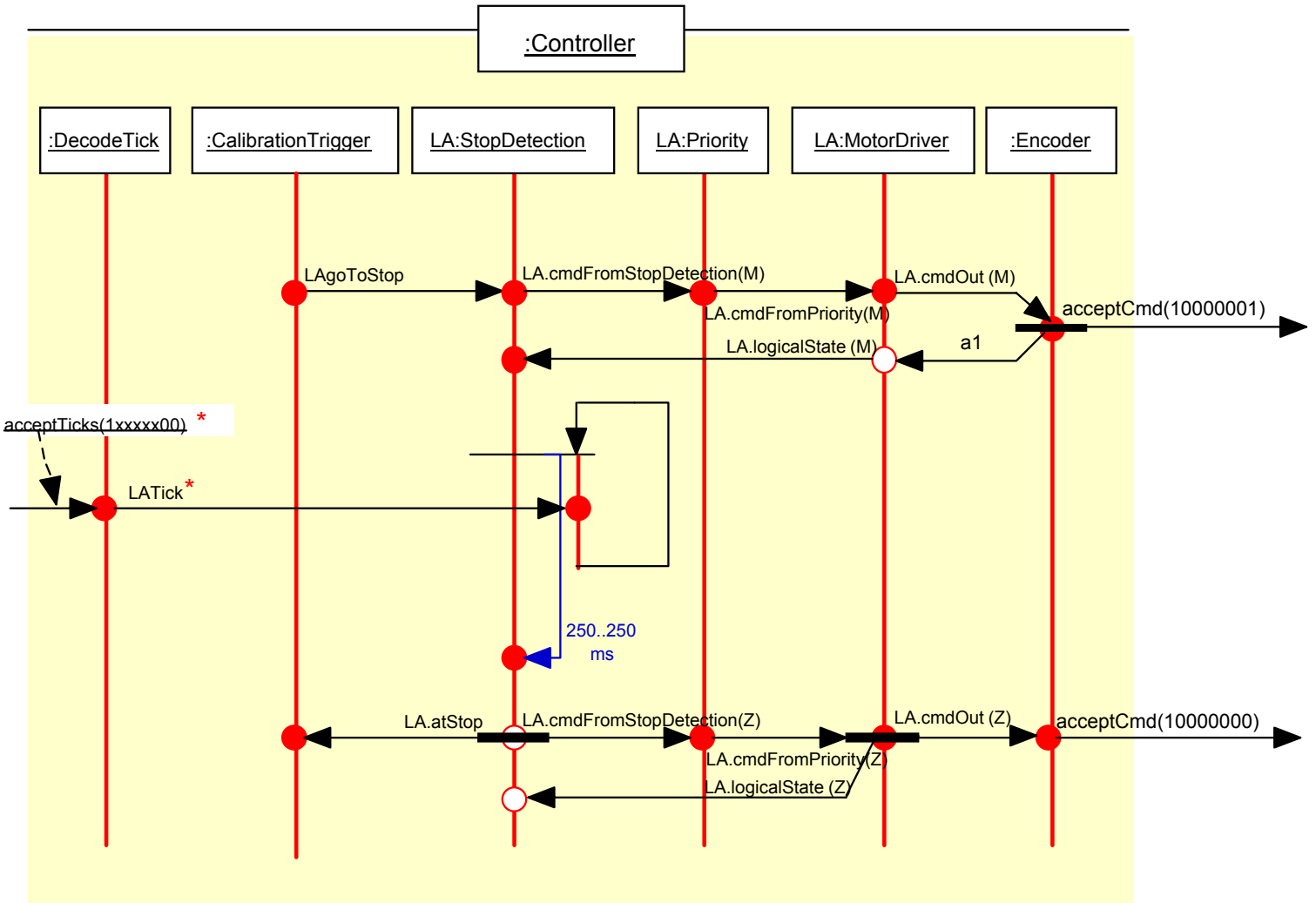
Syntax: temporal constraints



Syntax: Other constructs



Example


:Controller
:DecodeTick
:CalibrationTrigger
LA:StopDetection
LA:Priority
LA:MotorDriver
:Encoder
LAgoToStop
LA.cmdFromStopDetection(M)
LA.cmdOut (M)
acceptCmd(10000001)
LA.cmdFromPriority(M)
LA.logicalState (M)
a1
acceptTicks(1xxxxx00)
*
LATick
*
250..250
ms
LA.atStop
LA.cmdFromStopDetection(Z)
LA.cmdOut (Z)
acceptCmd(10000000)
LA.cmdFromPriority(Z)
LA.logicalState (Z)

Semantics

A synchronous process algebra.

Let $\mathcal{I}$ be the set of signals seen by the application.

Let Observed and Timebase two sets of signals s.t.

$$\text{Observed} \cup \text{Timebase} \subseteq \mathcal{I}$$

$$\mathcal{O} = \{Active, Accepted, Not\_Applicable\}$$

Let $I_1 \bullet I_2 \bullet \cdots \bullet I_n \bullet \cdots \in \mathcal{I}^*$ be an input sequence

The behavior of sib p is defined by a sequence of reactions:

$$p = p_0 \xrightarrow[I_1]{O_1} p_1 \xrightarrow[I_2]{O_2} p_2 \cdots p_{n-1} \xrightarrow[I_n]{O_n} p_n \cdots$$

Semantics (Cont'd)

$$p = p_0 \xrightarrow[I_1]{O_1} p_1 \xrightarrow[I_2]{O_2} p_2 \cdots p_{n-1} \xrightarrow[I_n]{O_n} p_n \cdots$$

For some $n \in \mathbb{N} \cup \{\omega\}$

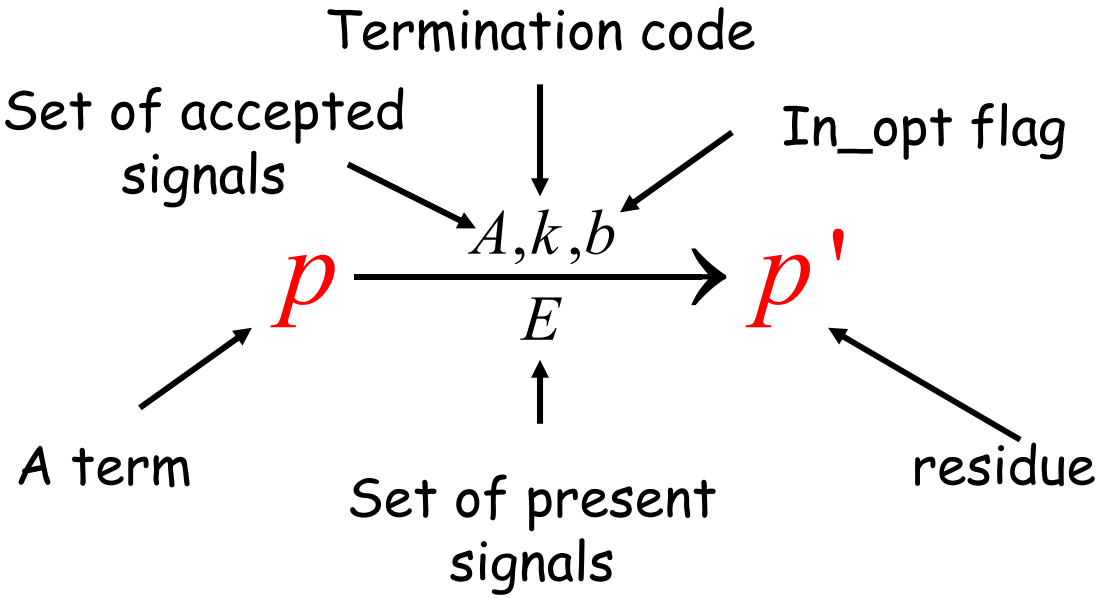
and for $O_j \in \{\{Accepted\}, \{Not\_Applicable\}, \{Active\}\}$

If n is finite, then the execution of p terminates at instant n.

A reaction is computed by induction on the structure of the term, using rewriting rules.

$$p \xrightarrow[E]{A,k,b} p'$$ Structural transition

Semantics (Cont'd)



$I_j^{'} = I_j \cap \text{Observed}$

if $\left(I_j^{'} \setminus A \neq \varnothing\right) \vee \left(k = \omega\right)$ then $O_j = \{Not\_Applicable\}$ and p terminates

elseif $\left(I_j^{'} \setminus A = \varnothing\right) \vee \left(k = 0\right)$ then $O_j = \{Accepted\}$ and p terminates

else $O_j = \{Active\}$ and the execution pauses till the next instant.

Tools

- A Tcl-Tk based implementation
  - Graphical editor
  - Compiler to Esterel code
  - Automated instrumentation for
    - Interactive simulation
    - Model checking
  - Circuit generation (blif)
- Inherits from the Esterel S/W environment

Conclusion

- Control-dominated systems
  - Expression of the expected behavior,
  - and validation
- Sequence Diagrams: no clear semantics, Synchronous Interface Behavior (SIB)
  - Formal foundation
  - Synchronous programming platform
- Still to assess
  - Scalability
  - User-friendliness