A Modular Visual Model for Hybrid Systems

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Motivation

- The design of hybrid systems is a difficult task. One has to consider many different aspects like data, behavior, architecture and distribution.
- Moreover it usually involves people from different engineering disciplines.
- Many modern SE methods like UML, ROOM and SDL recommend the use of visual specifications.
- A formal foundation is needed however, to prohibit ambiguities which may be fatal in this context.

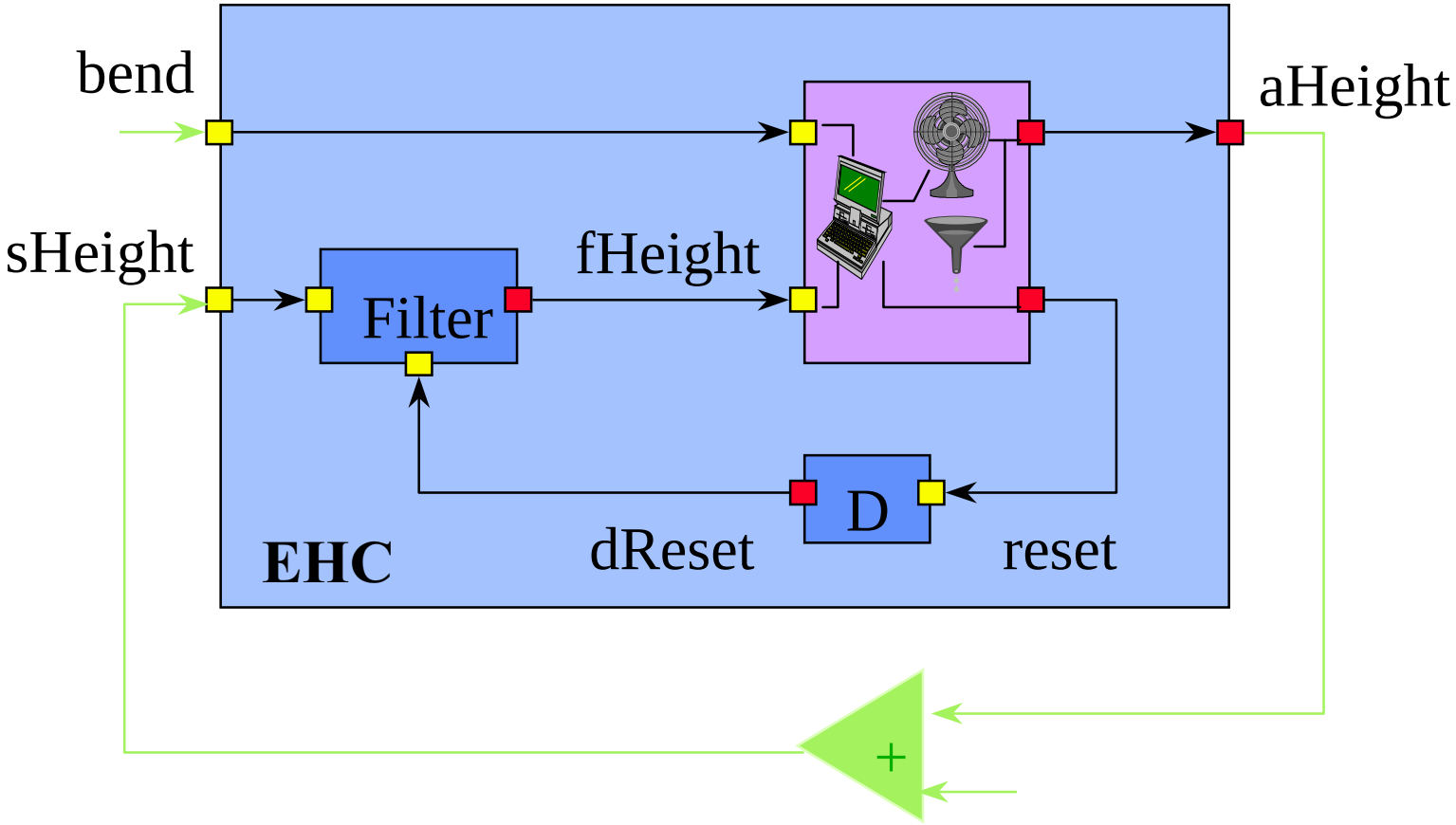
Overview

- An electronic height control system (BMW).
- The computation model.
- Hierarchic graphs and their associated models.
- Conclusions.

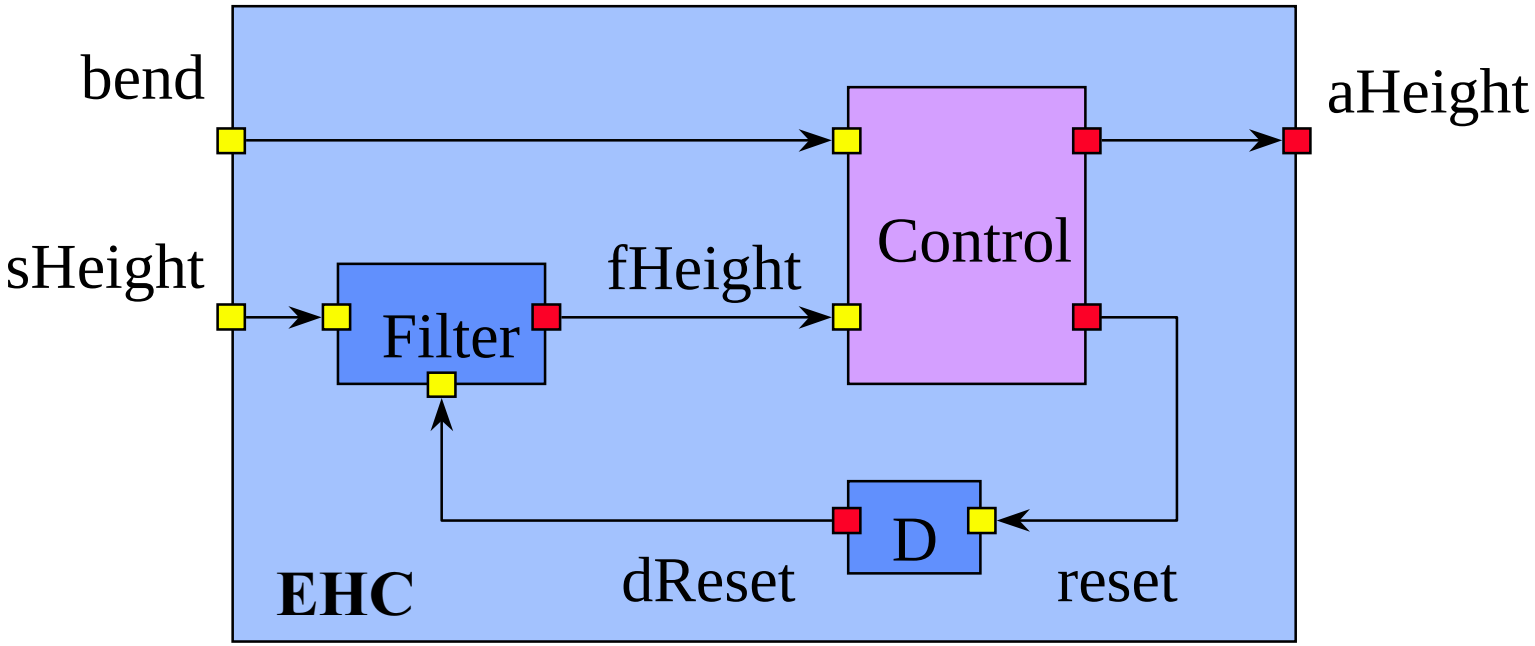
Electronic Height Control System

- Whenever the chassis level is outside of a tolerance interval it has to be increased or decreased to get close to the center of the interval.
- Very short deviations from the tolerance interval should not be compensated.
- After a compensation, some time should pass before the actuator is switched on again.
- The chassis level may not be modified whenever the car is going through a curve.

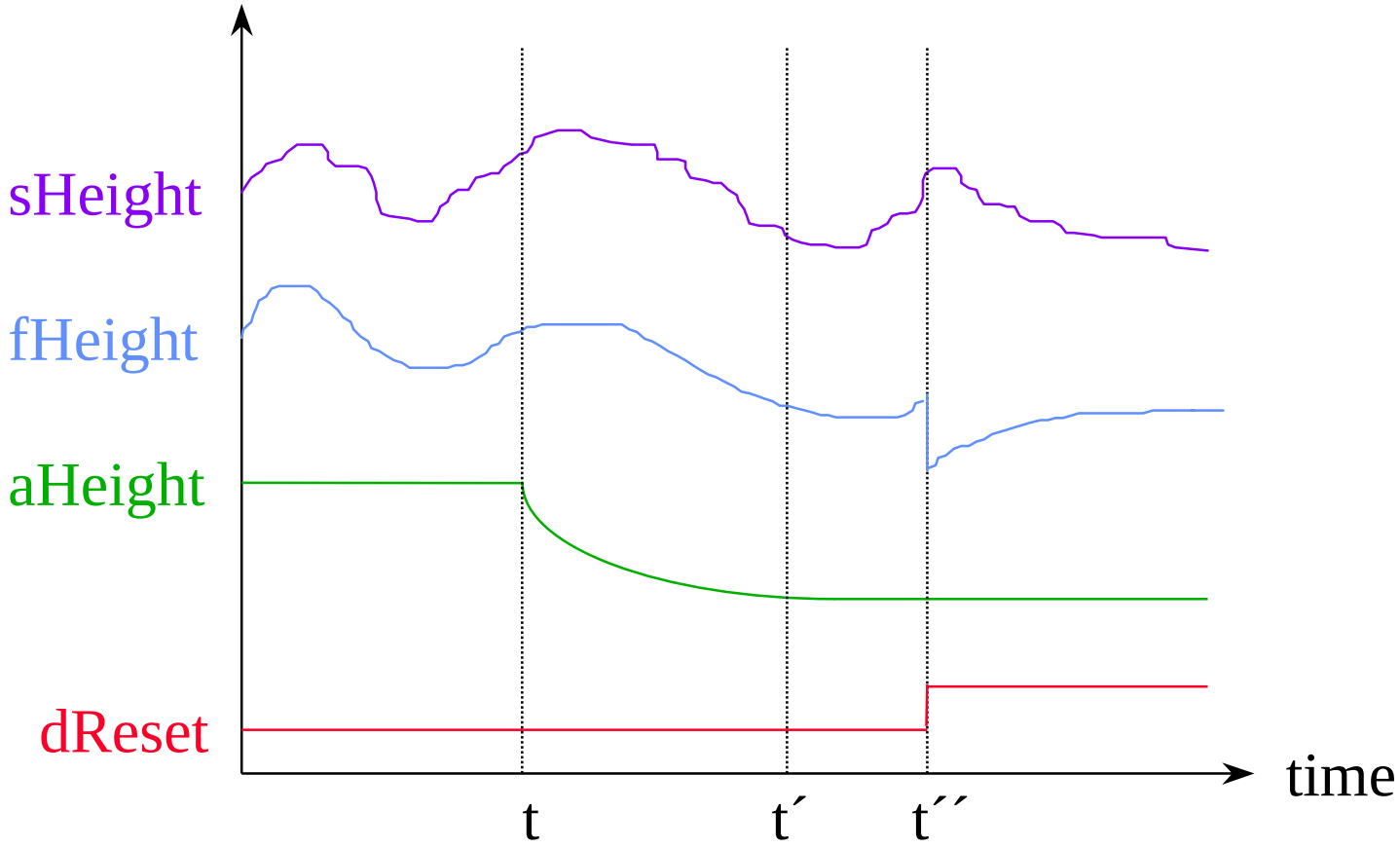
EHC Architecture



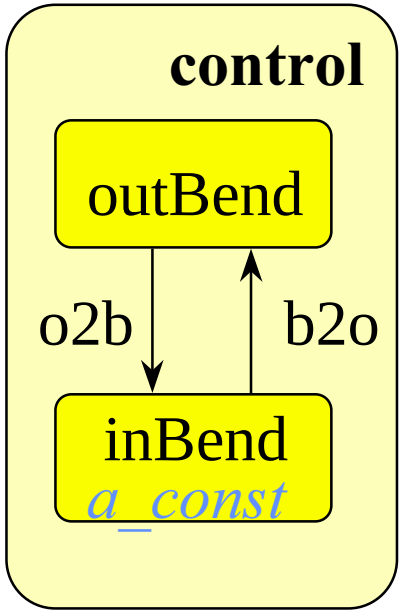
EHC Architecture



Typical Evolution of the EHC



Top Level of the Control Component



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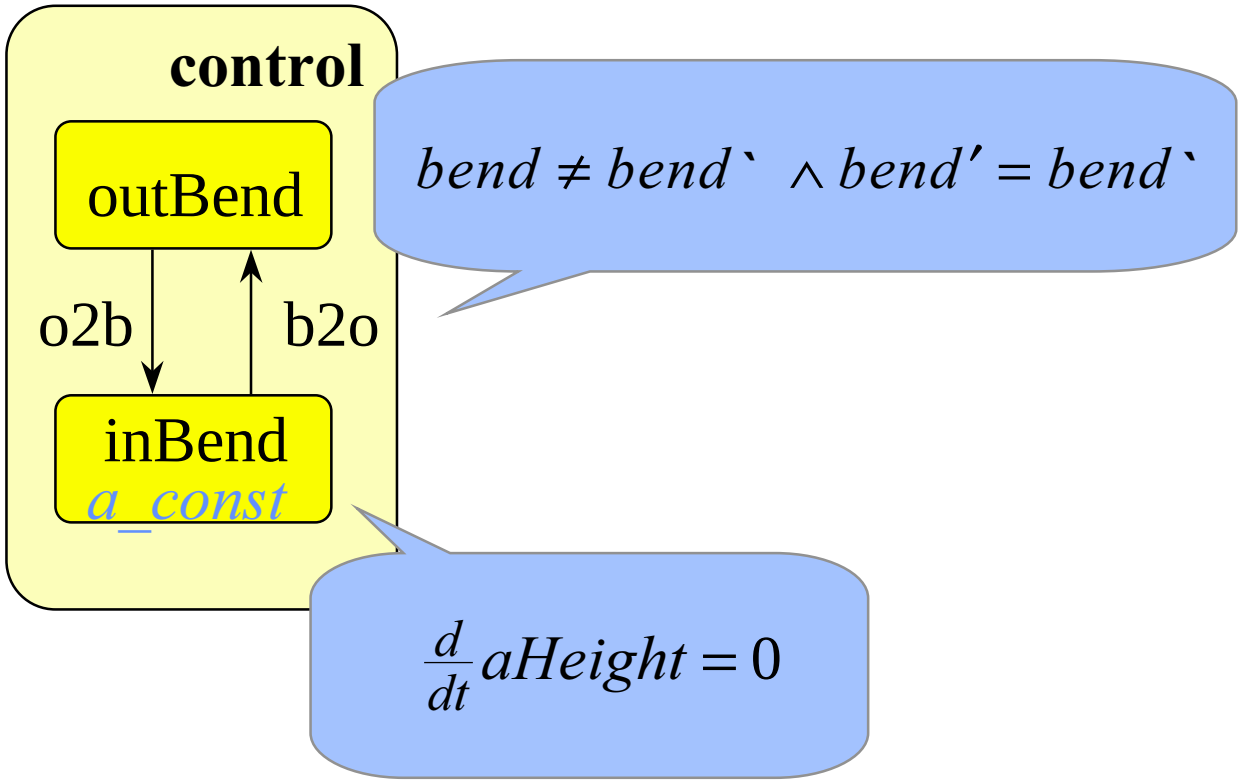
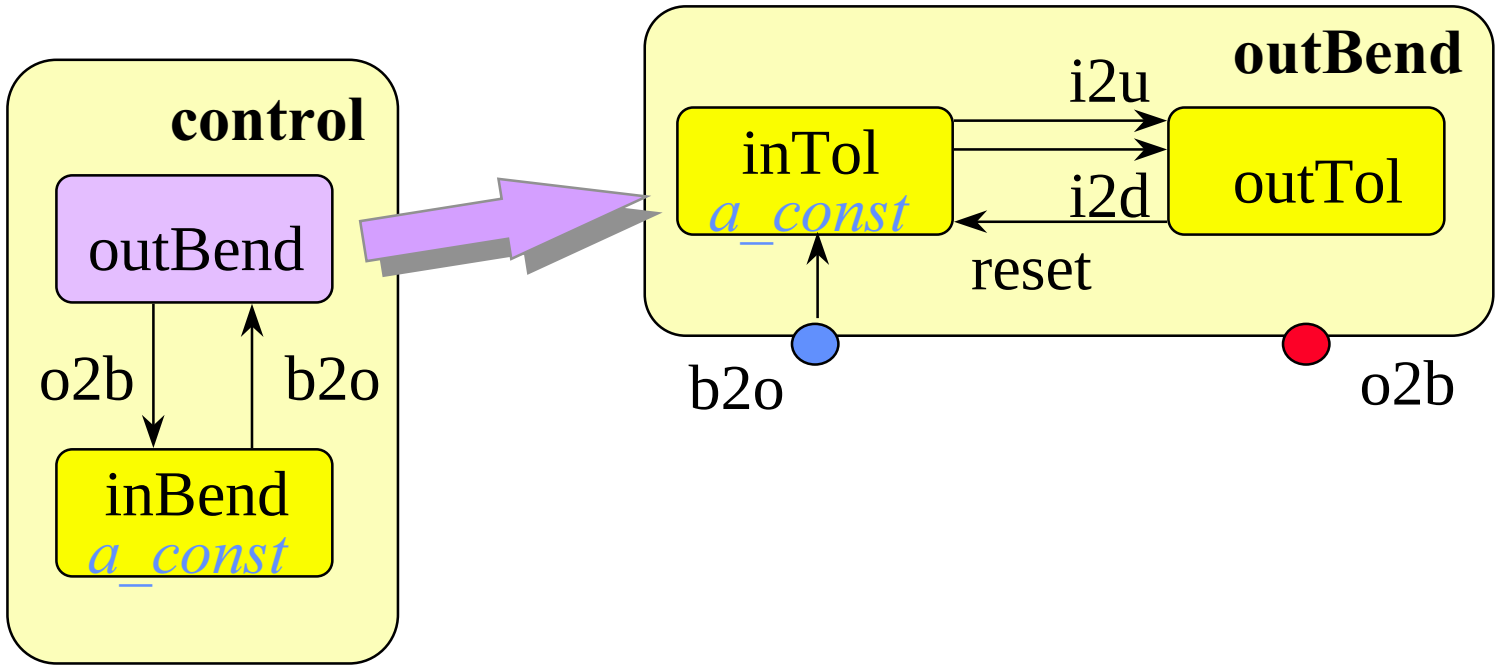


The State OutBend



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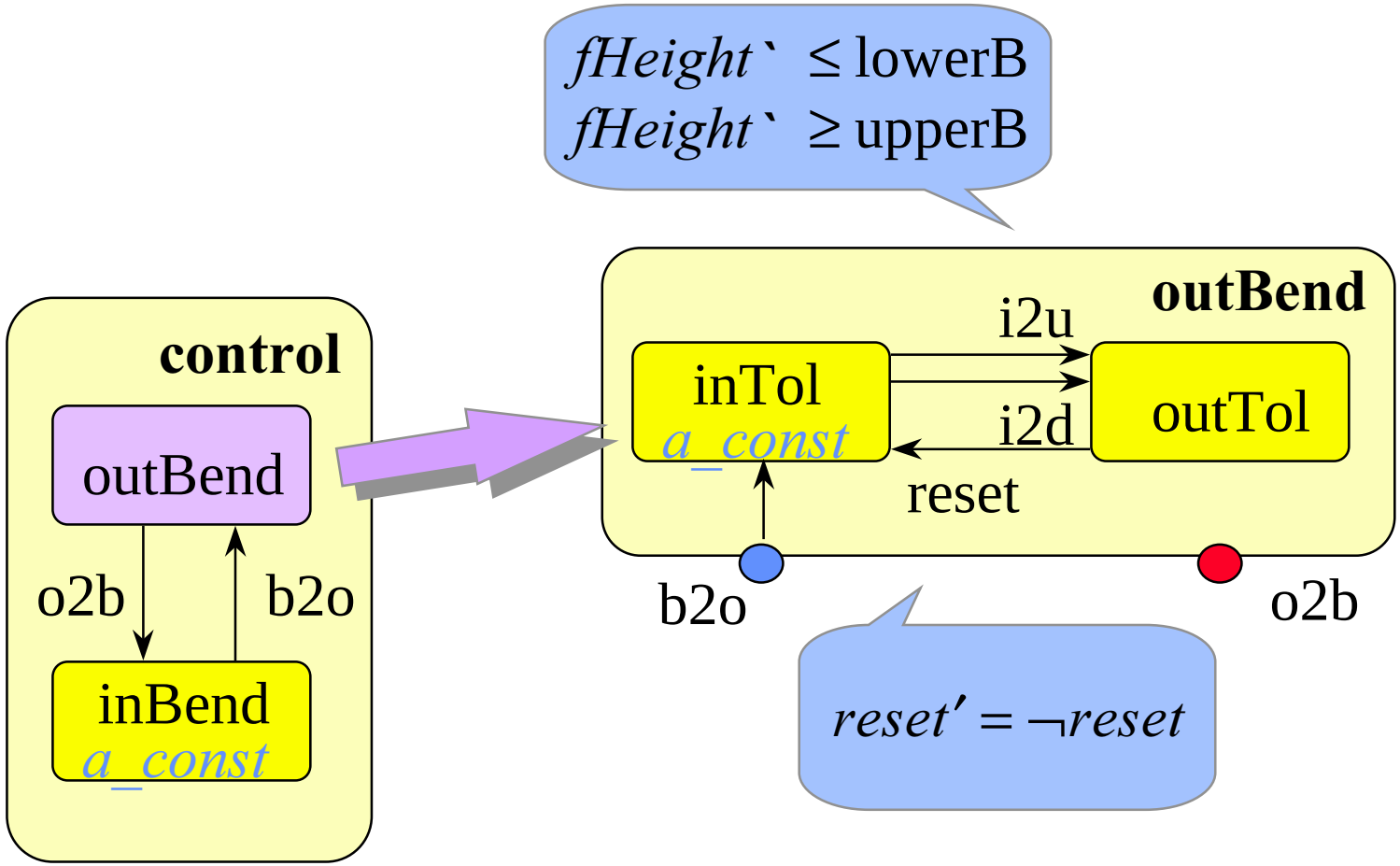

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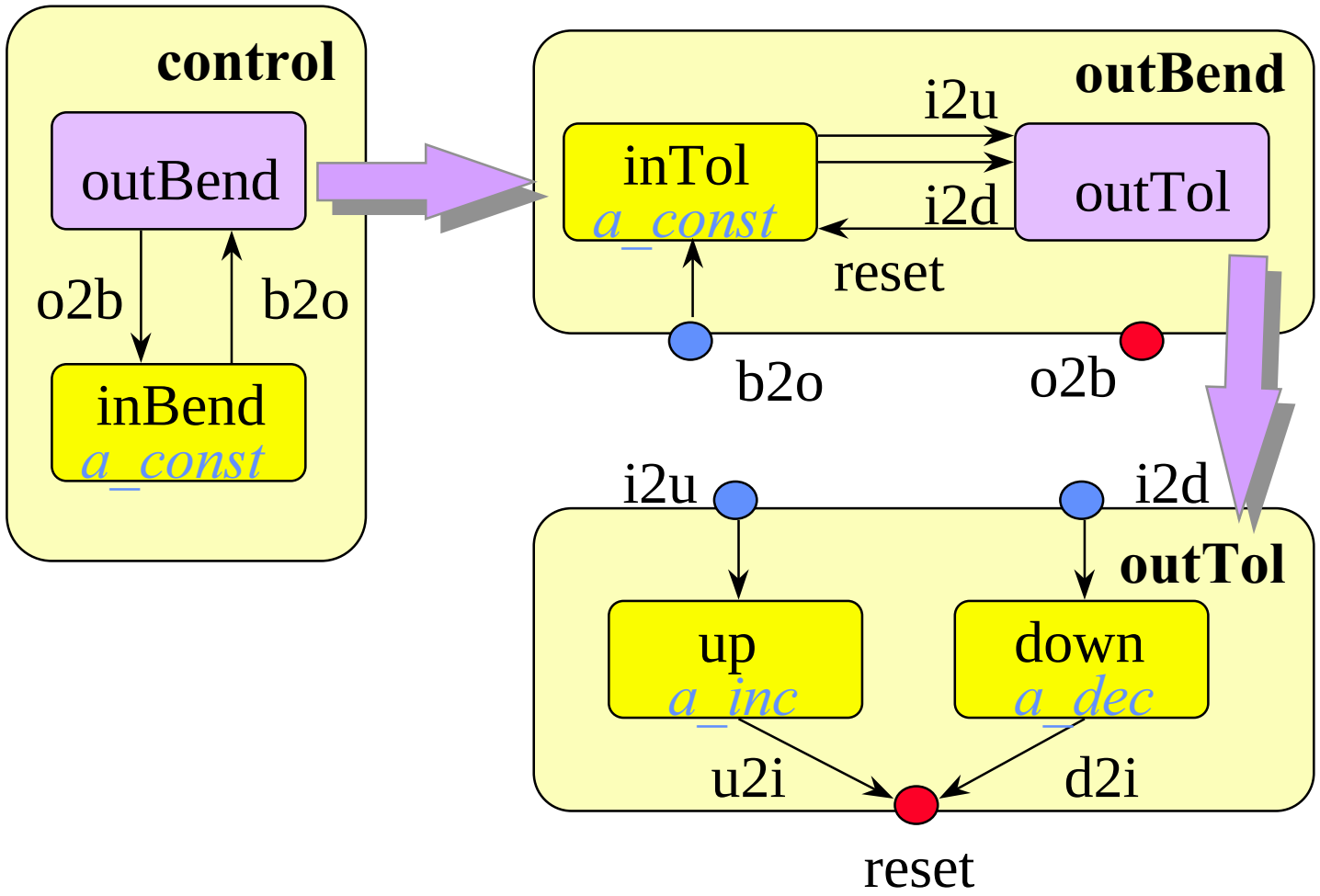

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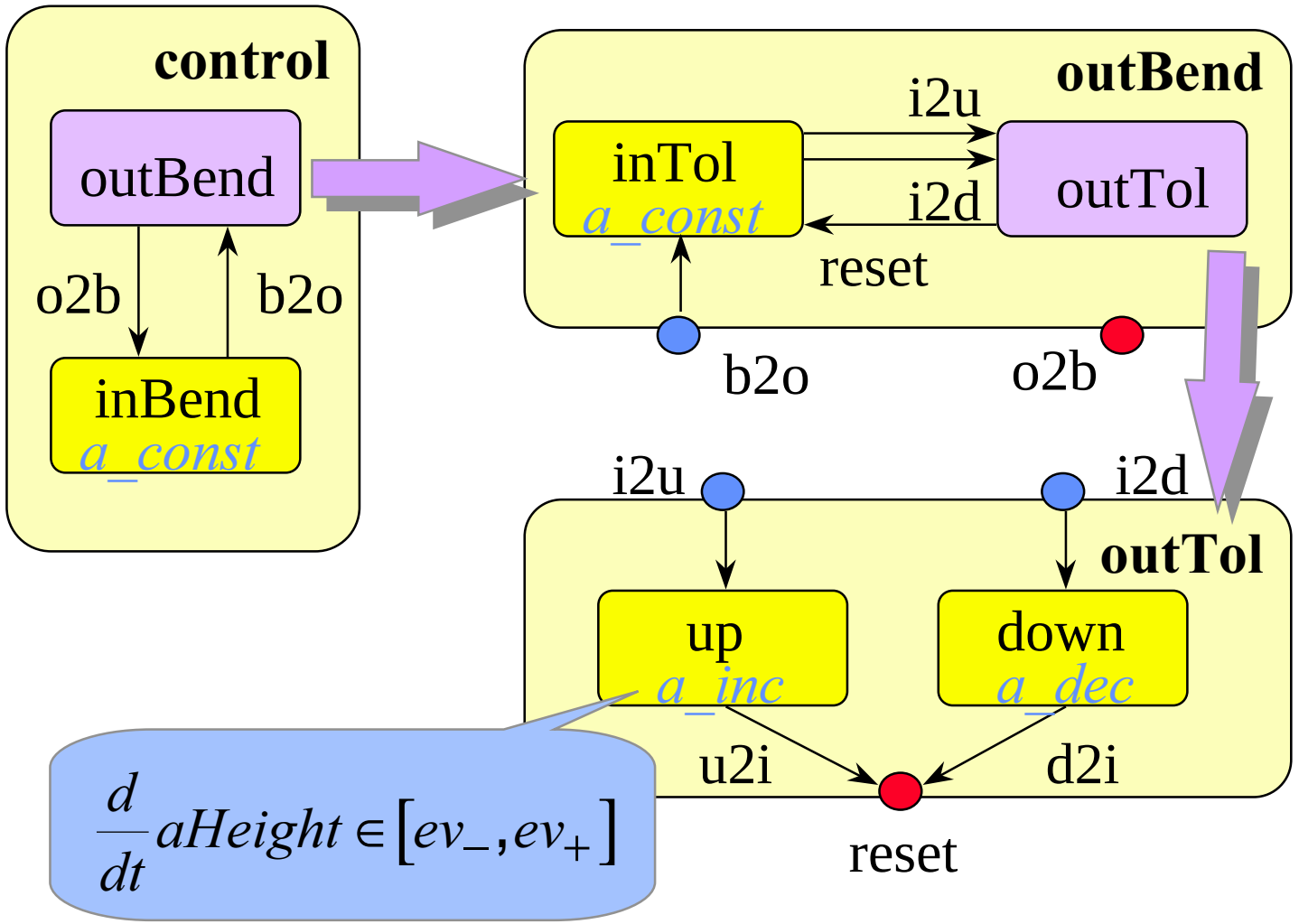

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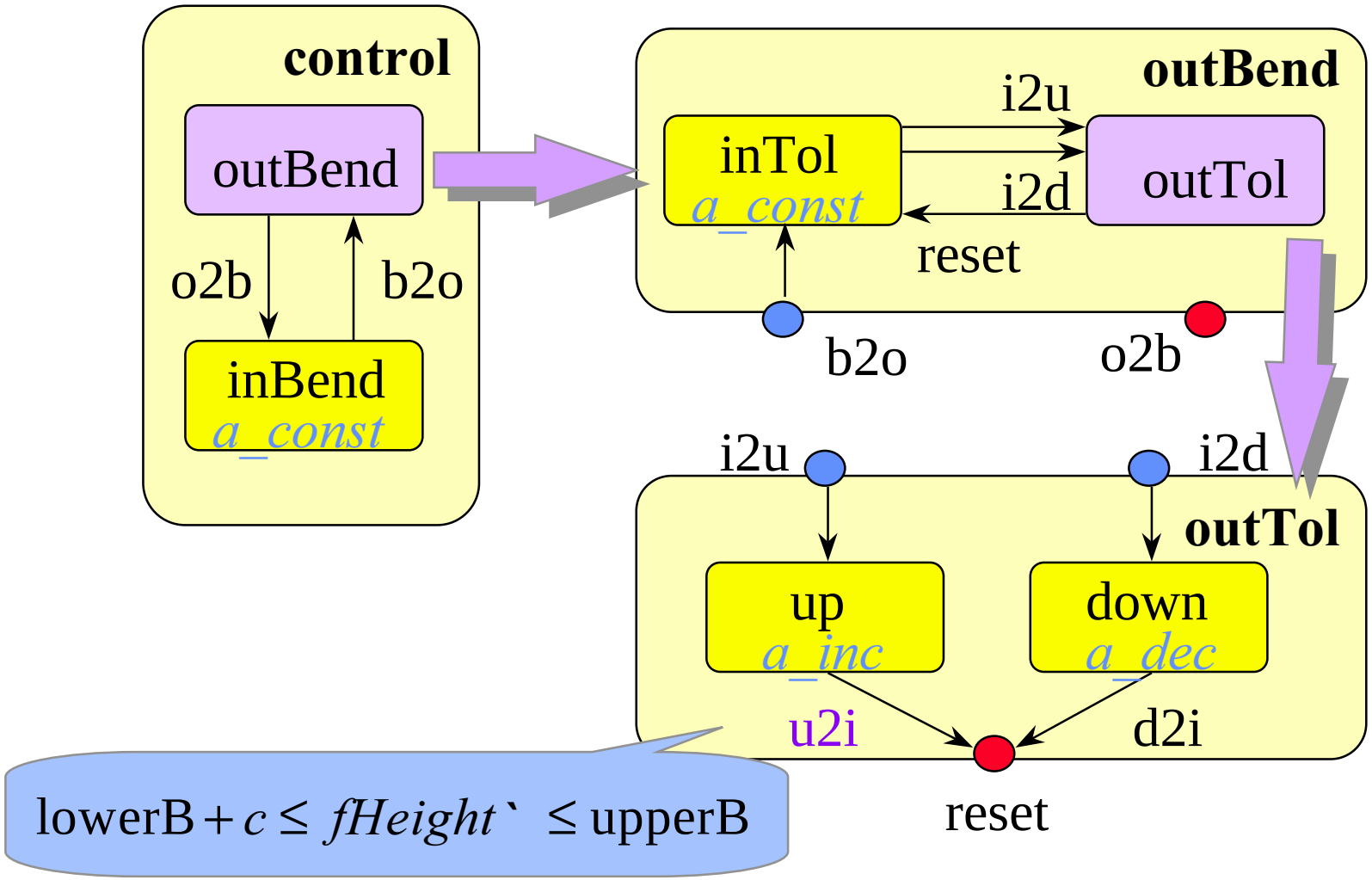
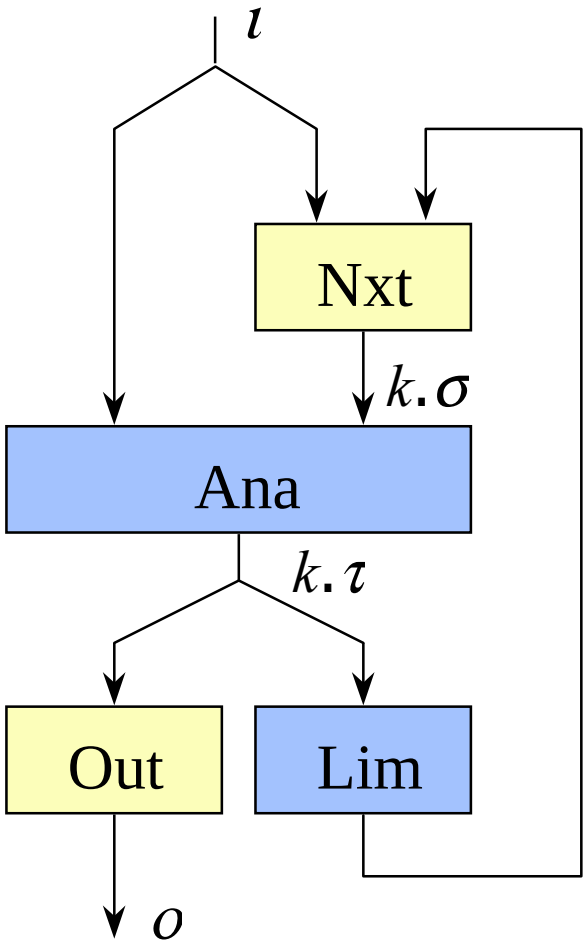
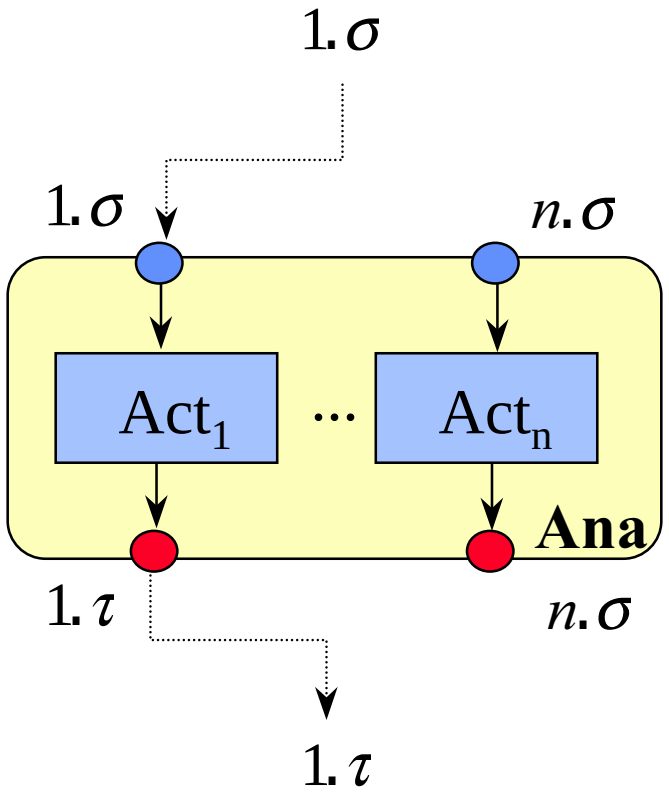


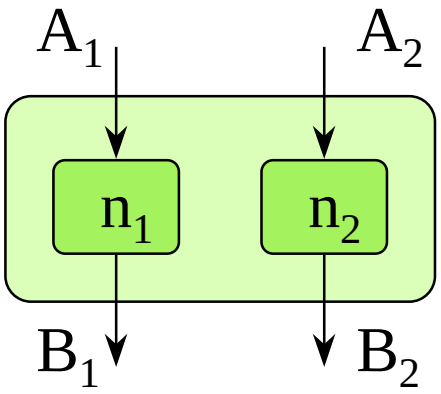
The Hybrid Machine



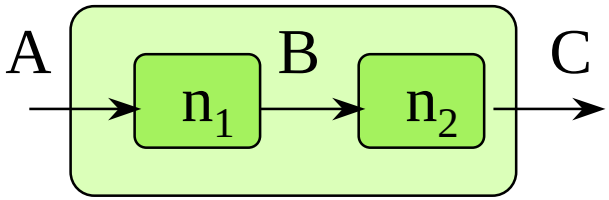


Graph Construction Primitives

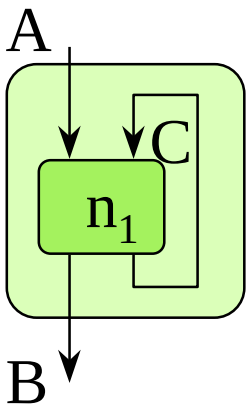
Operators on nodes



visual attachment

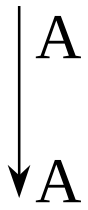


sequential composition

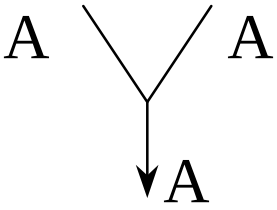


feedback

Connectors



identity



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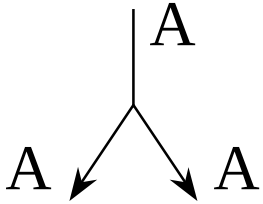
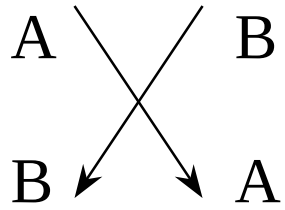


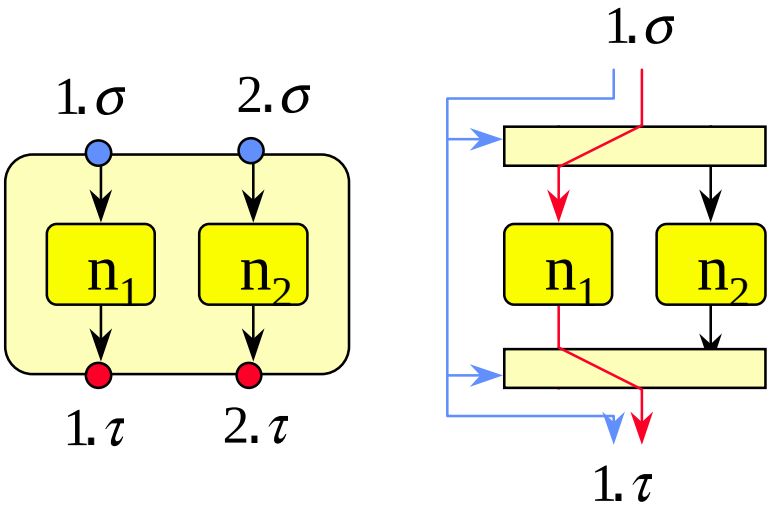
ramification



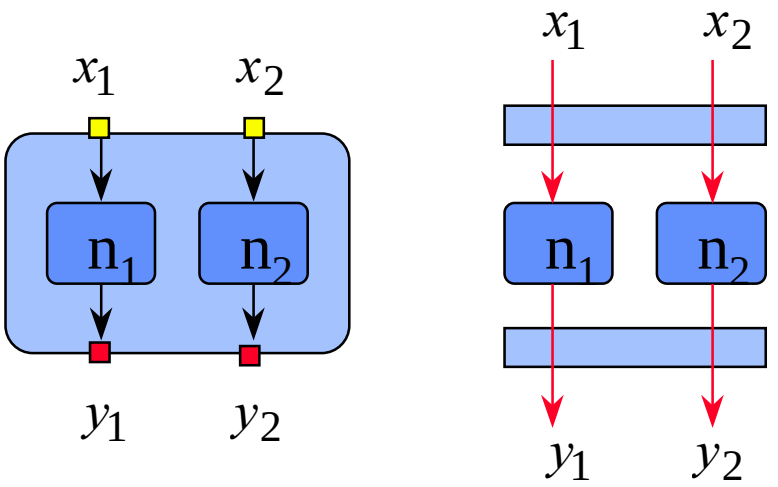
transposition

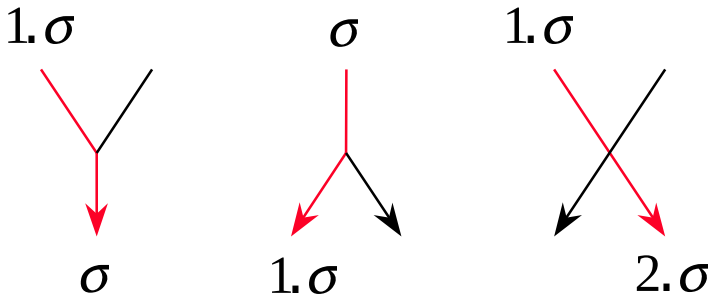
Control- and Data-Flow Models

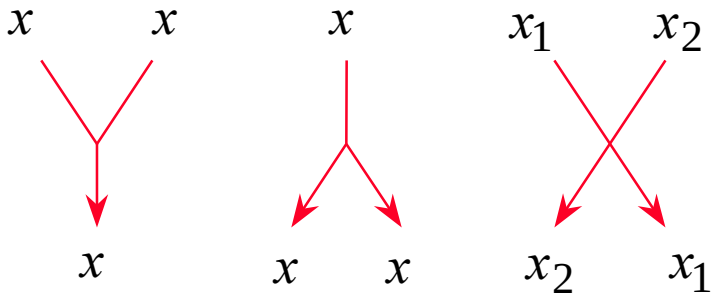
Control-flow model



Data-flow model







Conclusions

- HyACharts allow the hierarchical specification of the structure of a hybrid system.
  - Subsystems may be described with other formalisms.
- HySCharts allow the hierarchical specification of the behavior of a hybrid system.
  - Both discrete and continuous aspects are integrated in a uniform way (activities, preemption, entry/exit actions).
- HyACharts and HySCharts are dual models of hierarchic graphs. Their formal theory allows their verification and optimization.