Basic System Entity Structure Concepts

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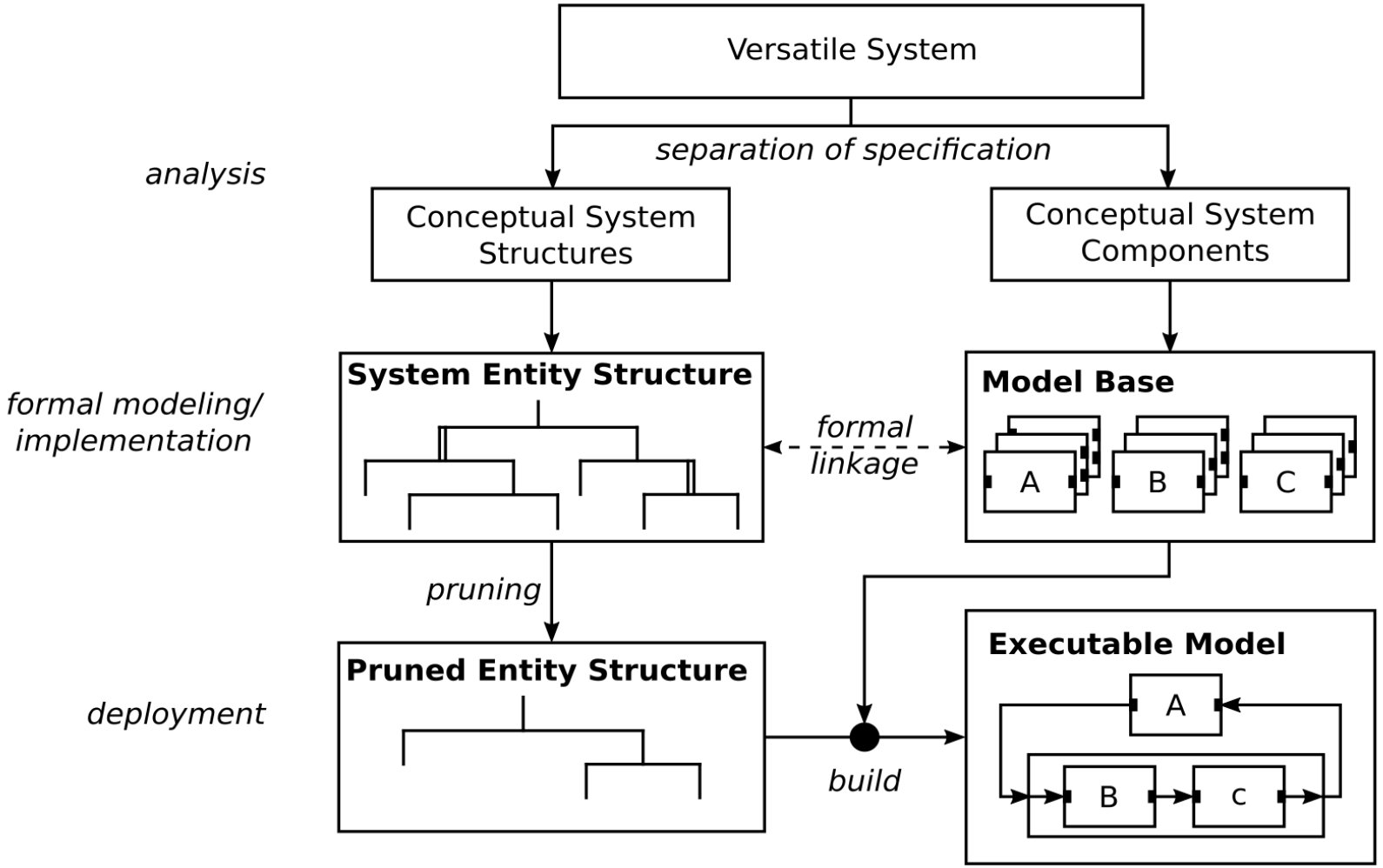
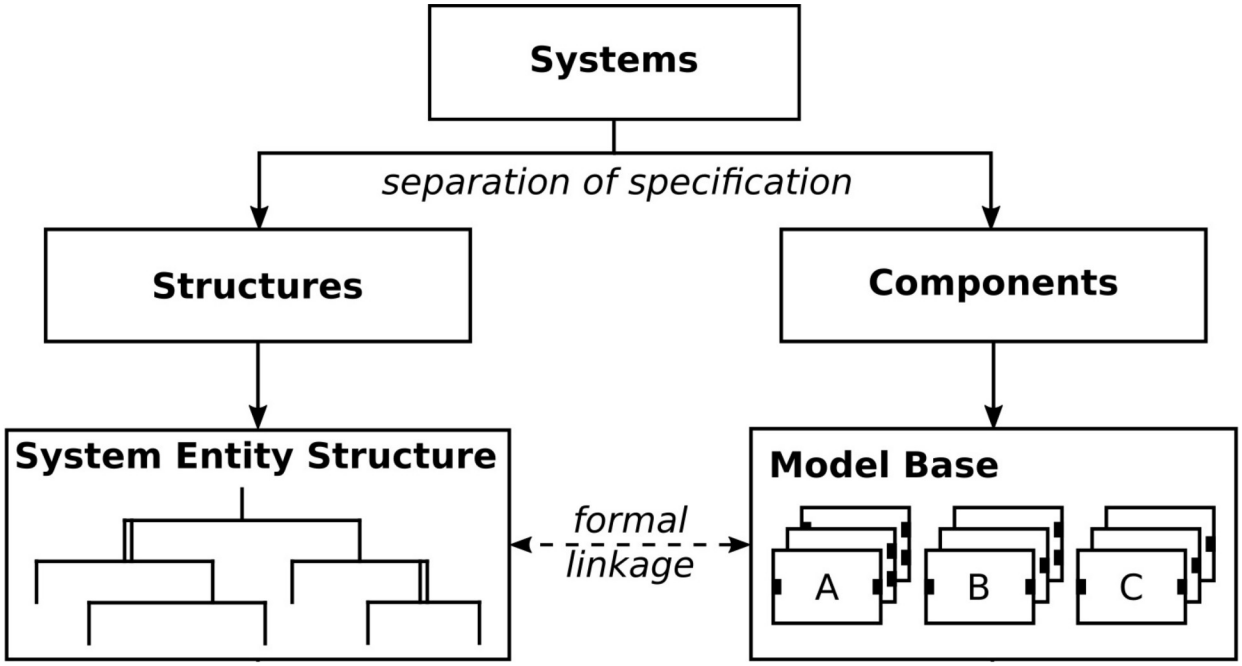
SES/MB Modeling Approach



Source: Pawletta, T. (2023). Model Behavior Generation for Multiple Simulators (Section 1.5). InBook: SCS MSBoK Guide - Body of Knowledge of Modeling and Simulation Guide. T. Ören, B.P. Zeigler, A. Tolk (Eds.).

SES/MB Modeling Approach
Formal Modeling



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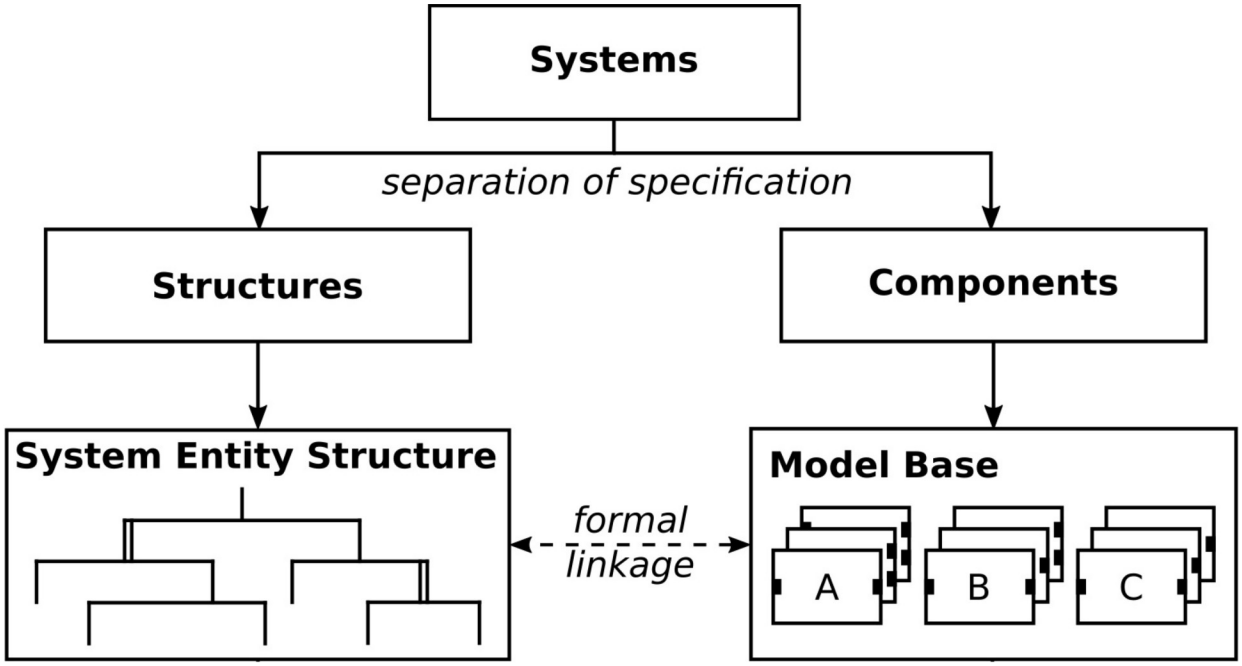

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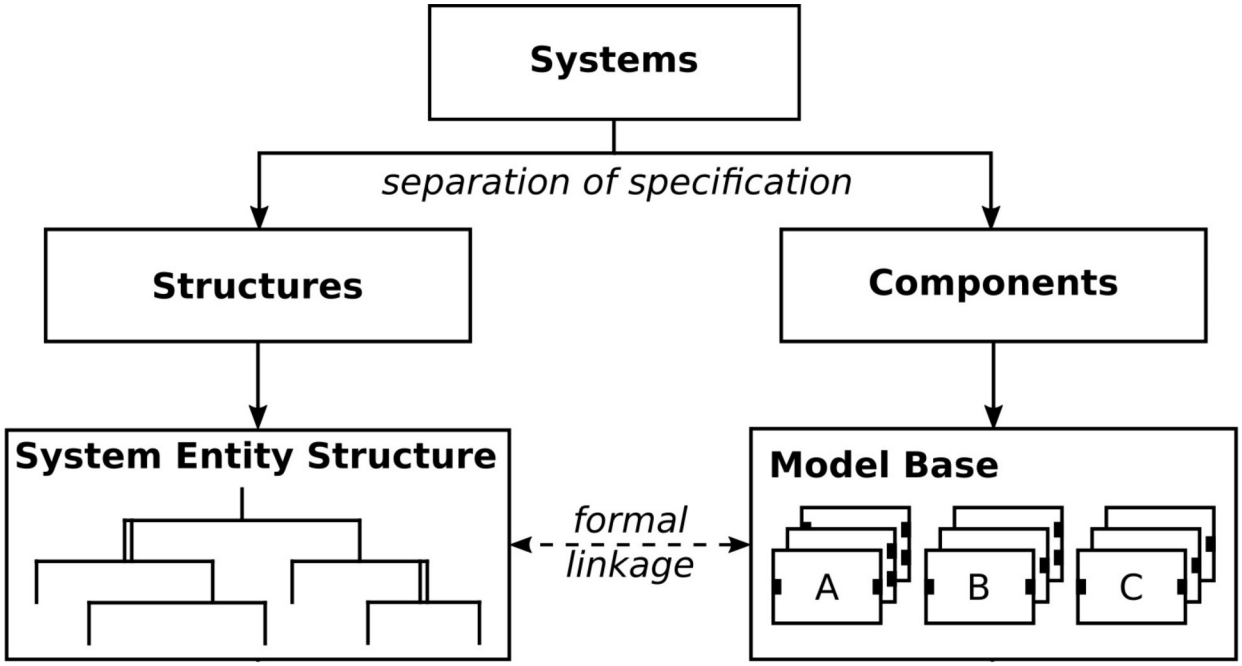

- **SES** describes permissible structure & parameter variants
- **MB** defines basic dynamic models

Basics of the System Entity Structure (SES)

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    - Entity nodes
    - Descriptive nodes

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Entity nodes
real or imaginary objects

Descriptive nodes
Aspect
(Multi-aspect)
Specialization

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  - Three types of edges (relations between nodes)
  - Node/Edge specific attributes
  - Global variables, functions, constraints, ...

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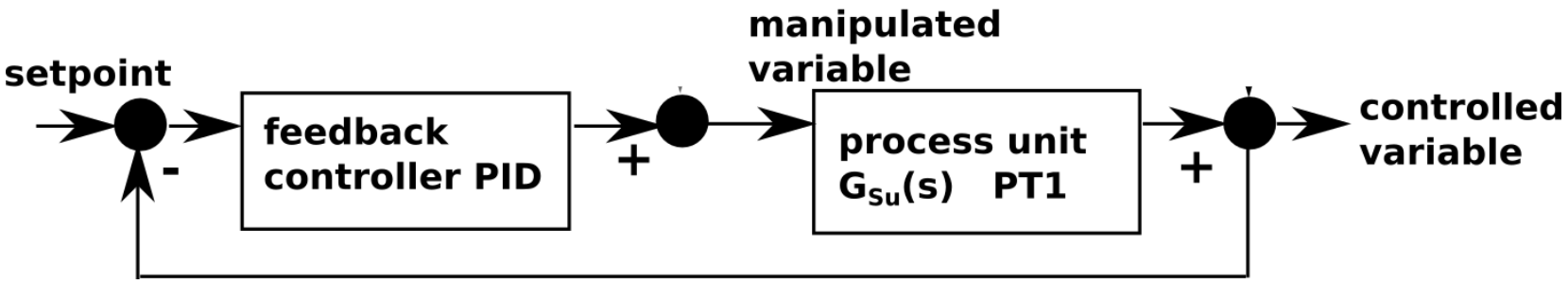
Specialization

Case Study

Case Study

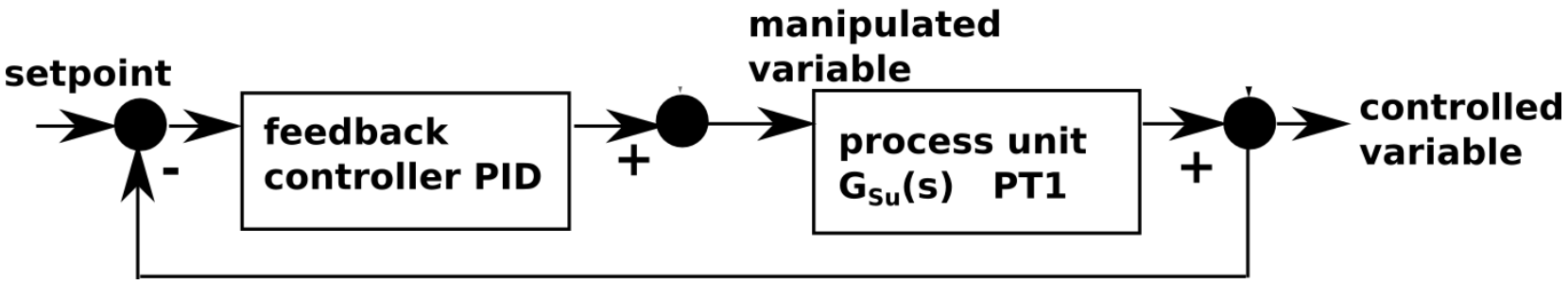
- Feedback control system



Case Study

- Feedback control system
- Described by transfer functions

$$G_{Su}(s) = \frac{1}{20 \cdot s + 1}$$



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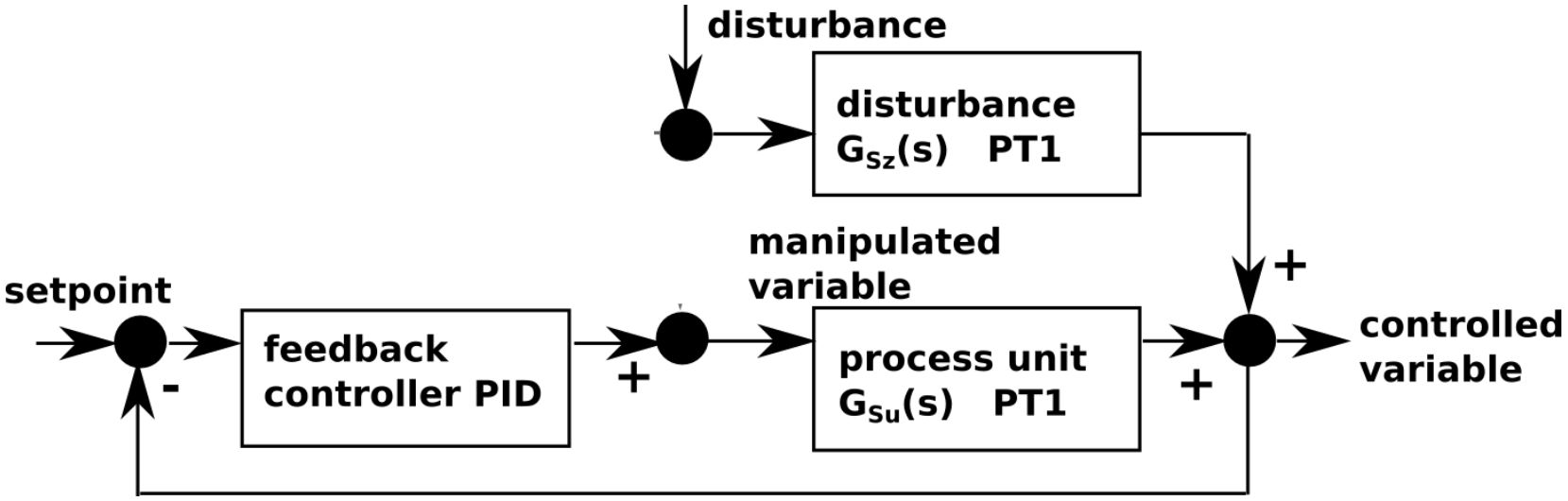


Case Study

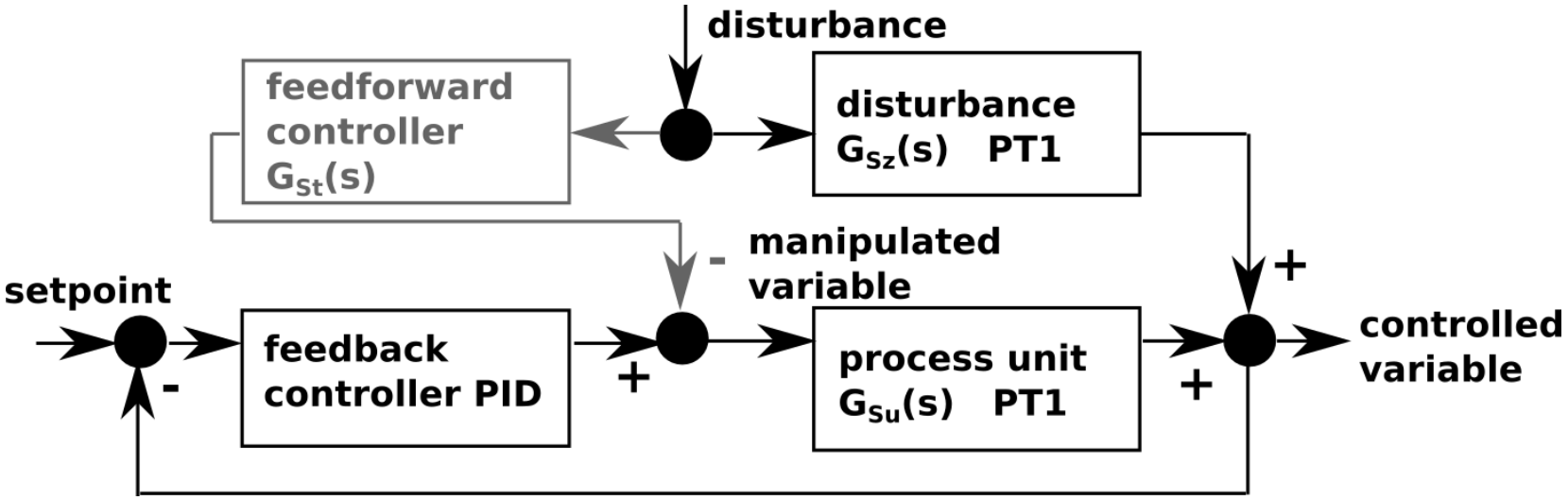
- Feedback control system
- Described by transfer functions
- Influenced by disturbances
- Measurable disturbances

  → Compensated with feedforward control

$$G_{Su}(s) = \frac{1}{20 \cdot s + 1}$$

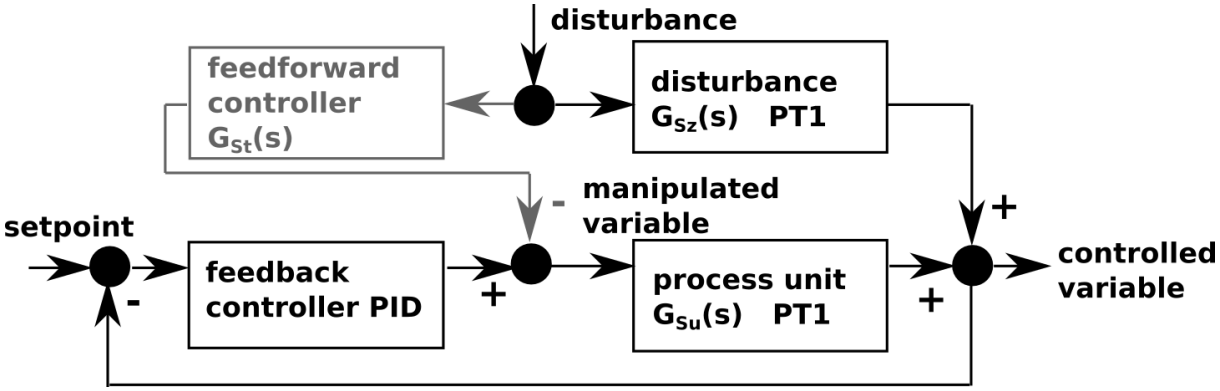
$$G_{Sz}(s) = \frac{1}{10 \cdot s + 1}$$

$$G_{St}(s) = \frac{20 \cdot s + 1}{10 \cdot s + 1}$$



Case Study (2)

- **Two system structure variants**
  - Without feedforward control: `feedforward=0`
  - With feedforward control: `feedforward=1`

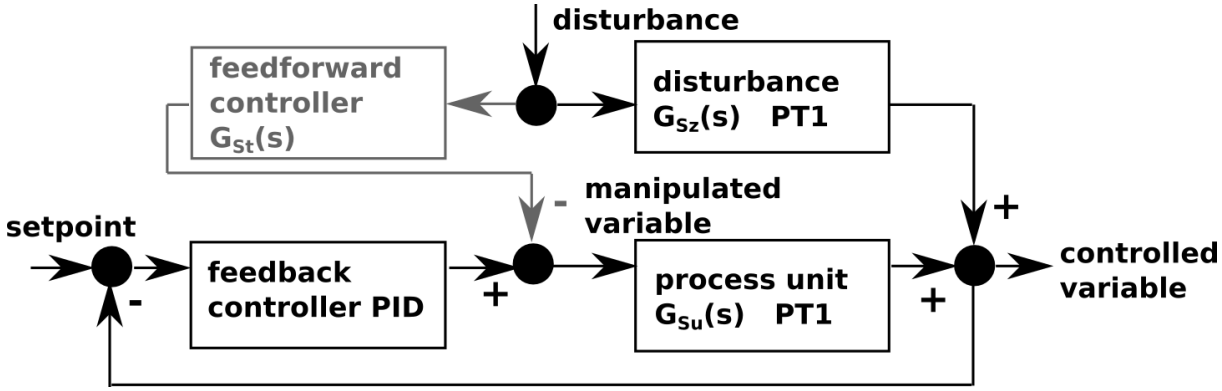


Case Study (2)

- **Two system structure variants**
  - Without feedforward control: `feedforward=0`
  - With feedforward control: `feedforward=1`
- For every structure variant

  → **Different parameter configurations of PID controller**

  (we consider two)



Case Study (2)

Design objective:
Find best control configuration.

- **Two system structure variants**
  - Without feedforward control: `feedforward=0`
  - With feedforward control: `feedforward=1`
- For every structure variant

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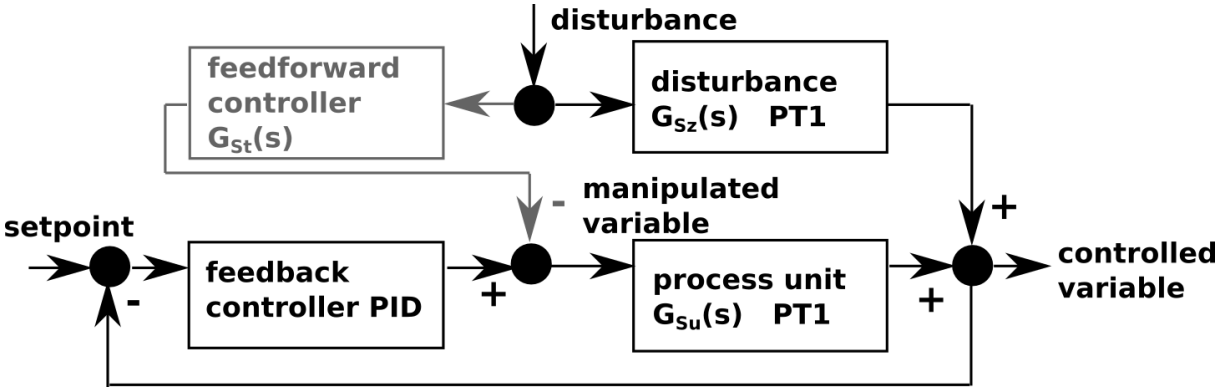
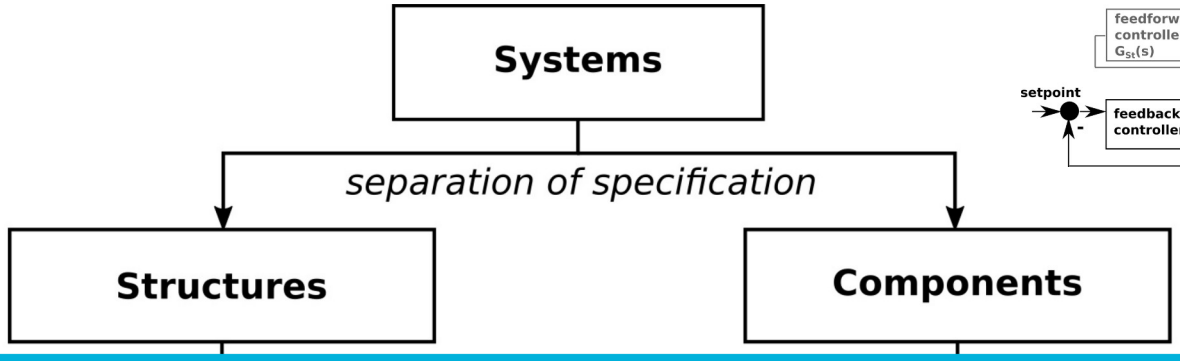
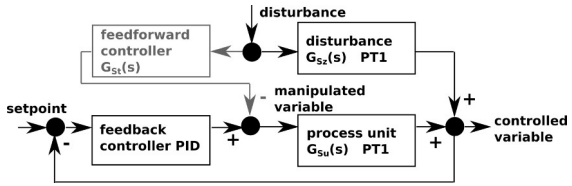


SES/MB-based Modeling of the Case Study





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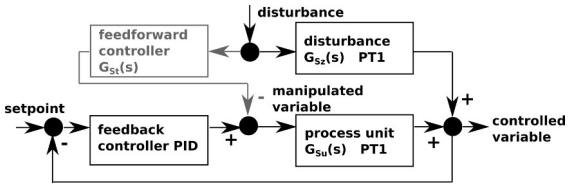

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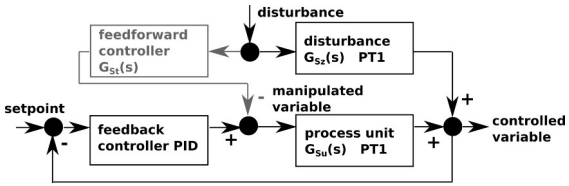

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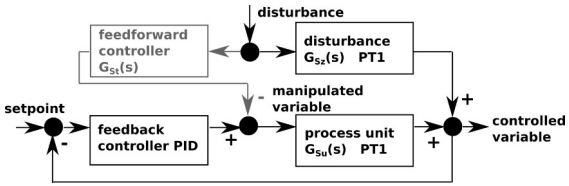

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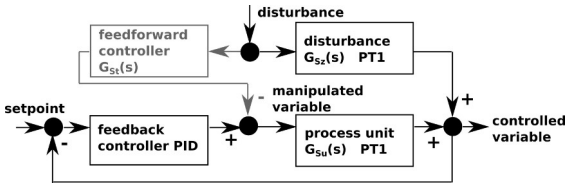

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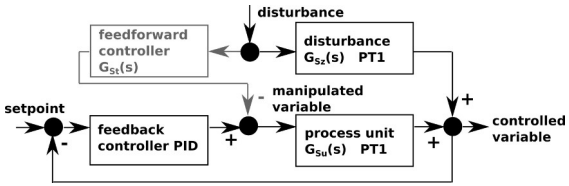

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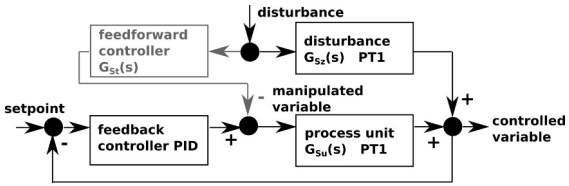

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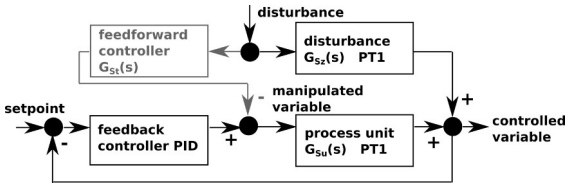

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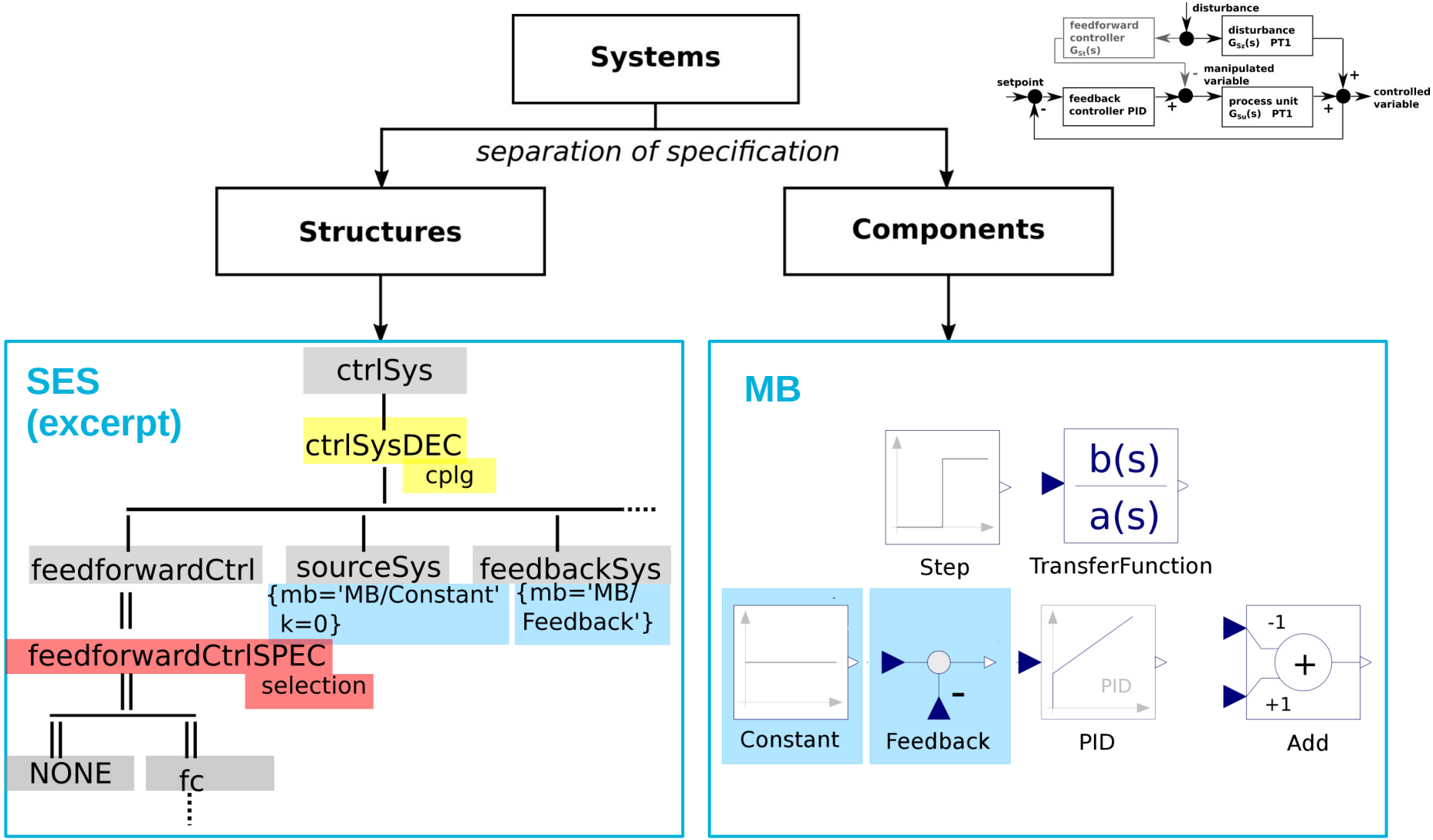
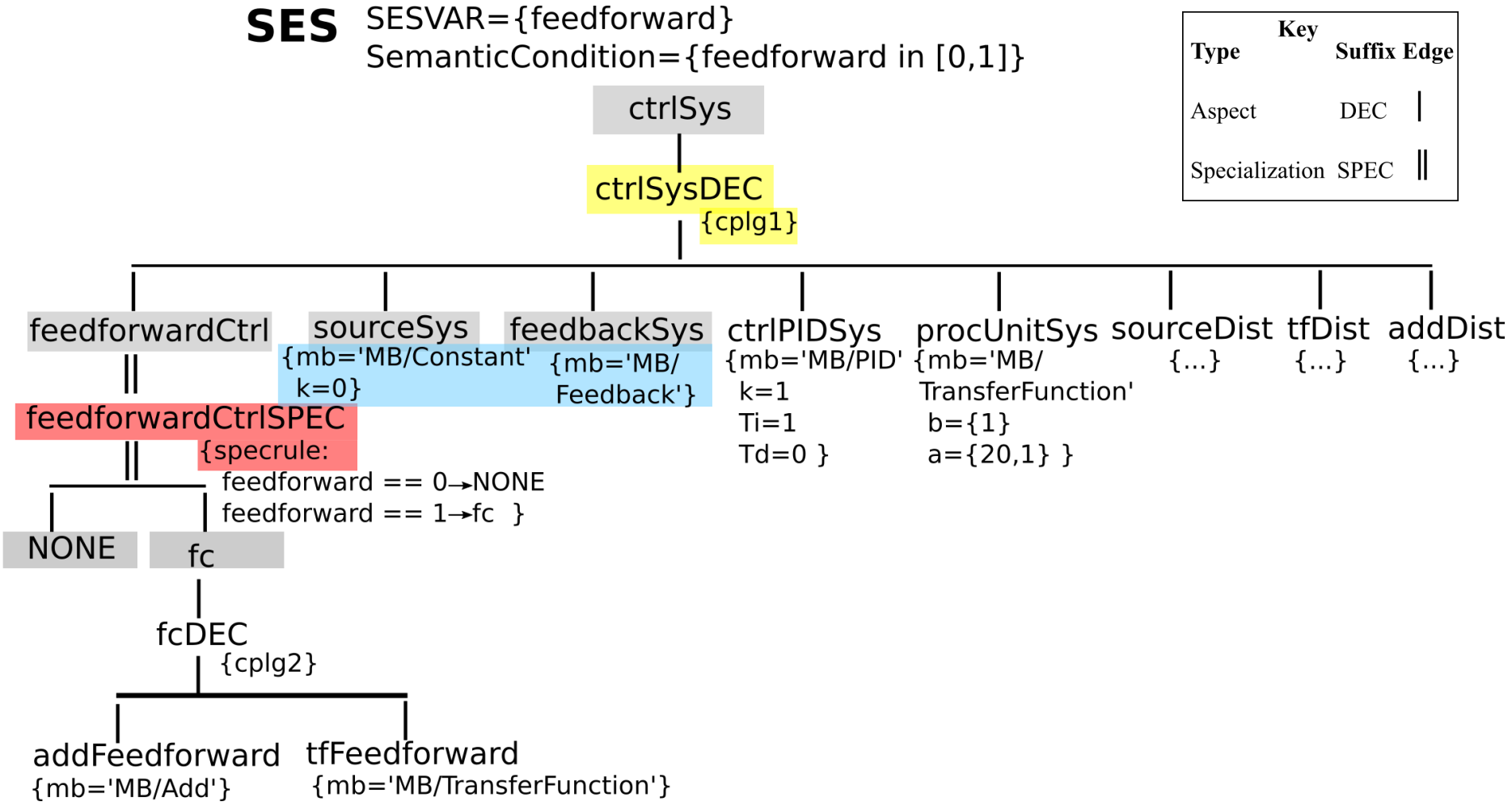


More Detailed Extract of the SES



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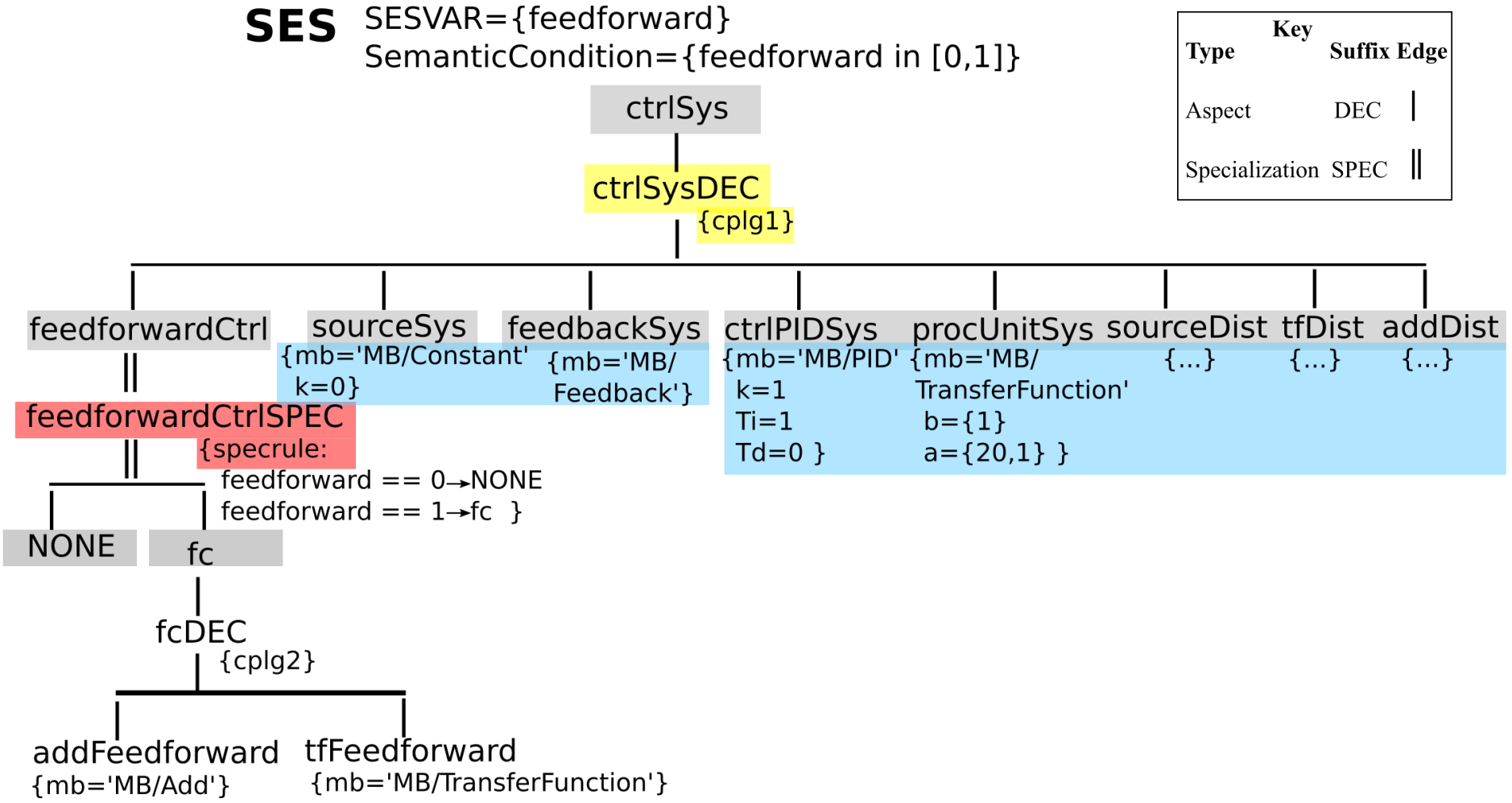

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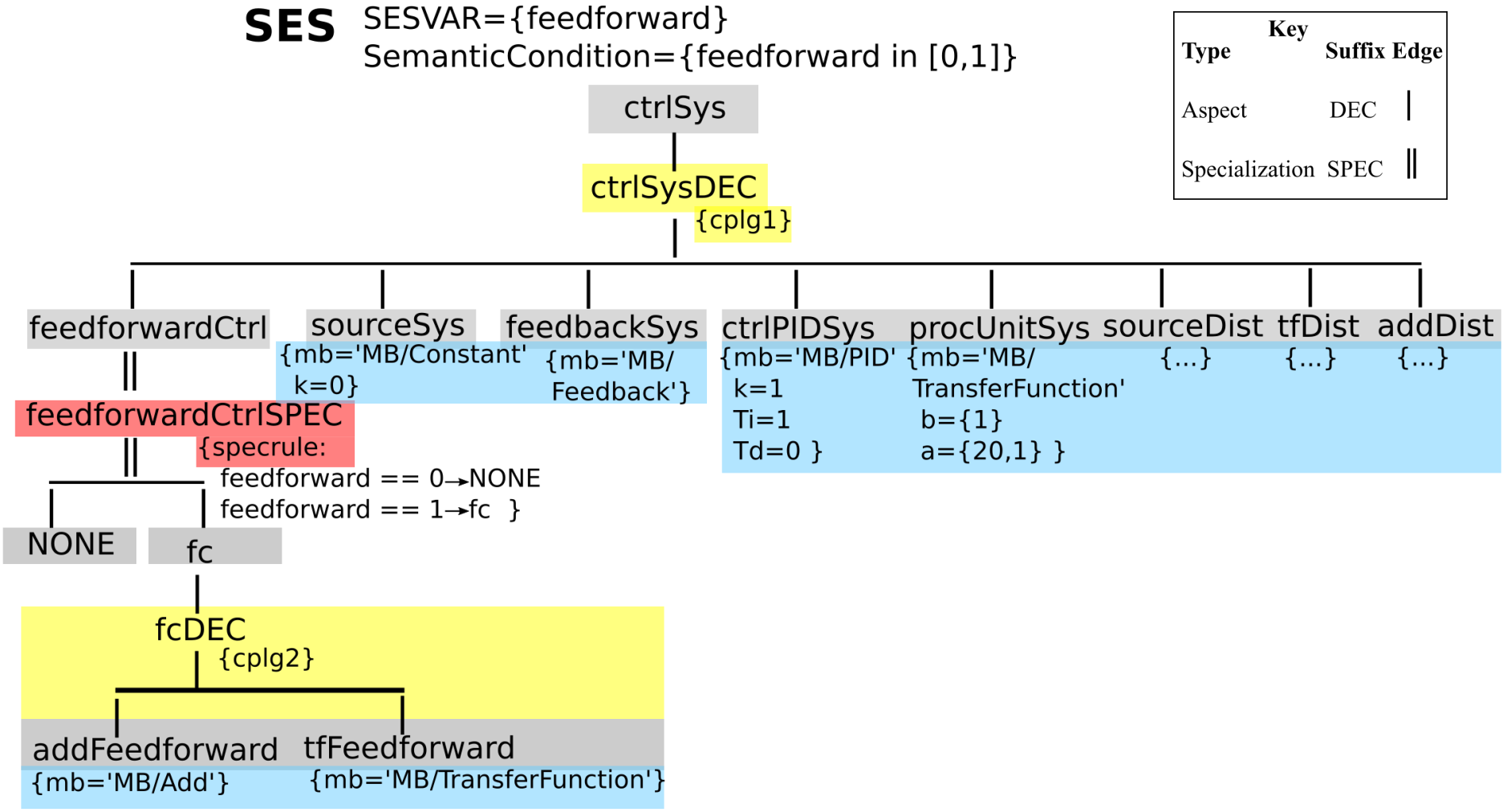

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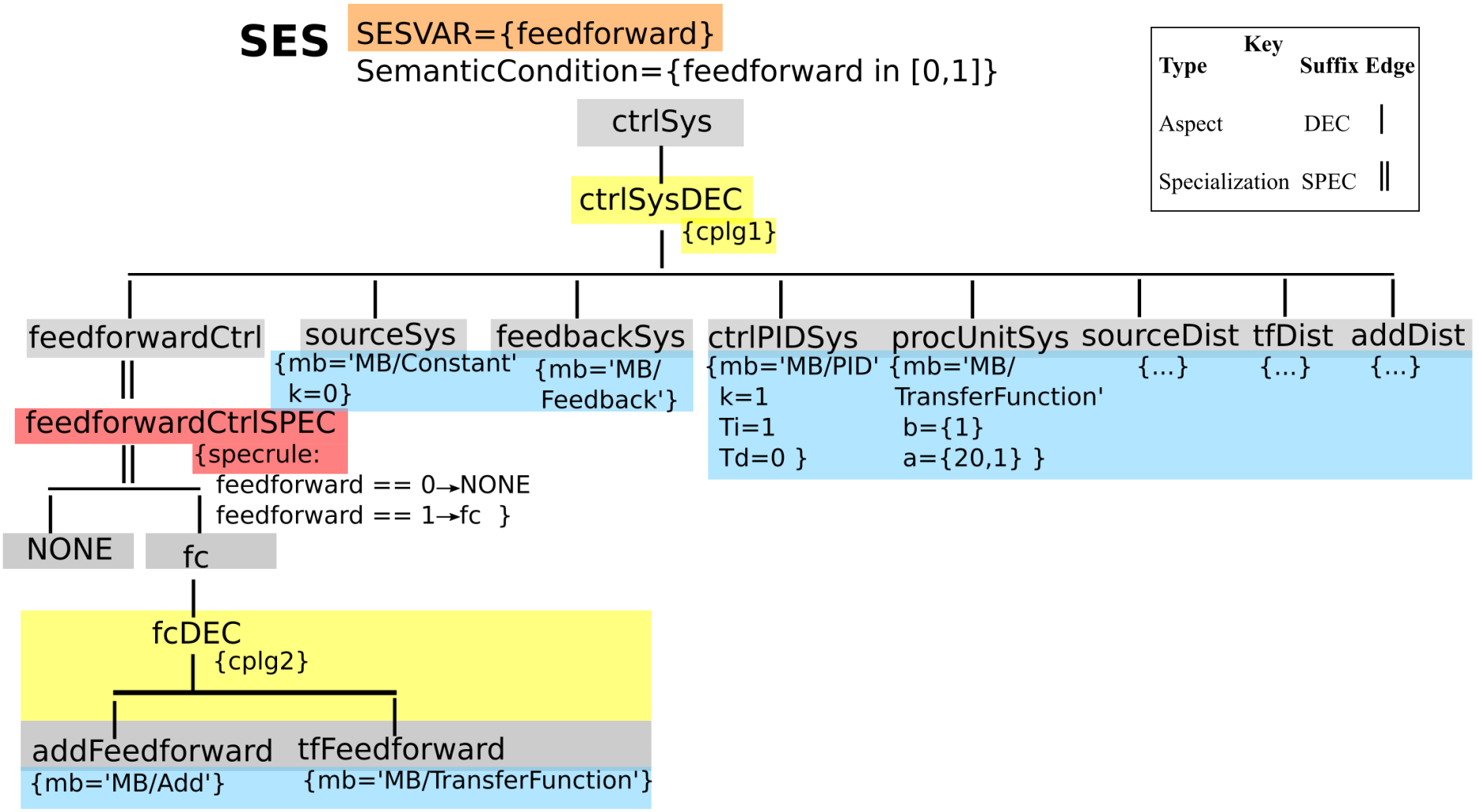

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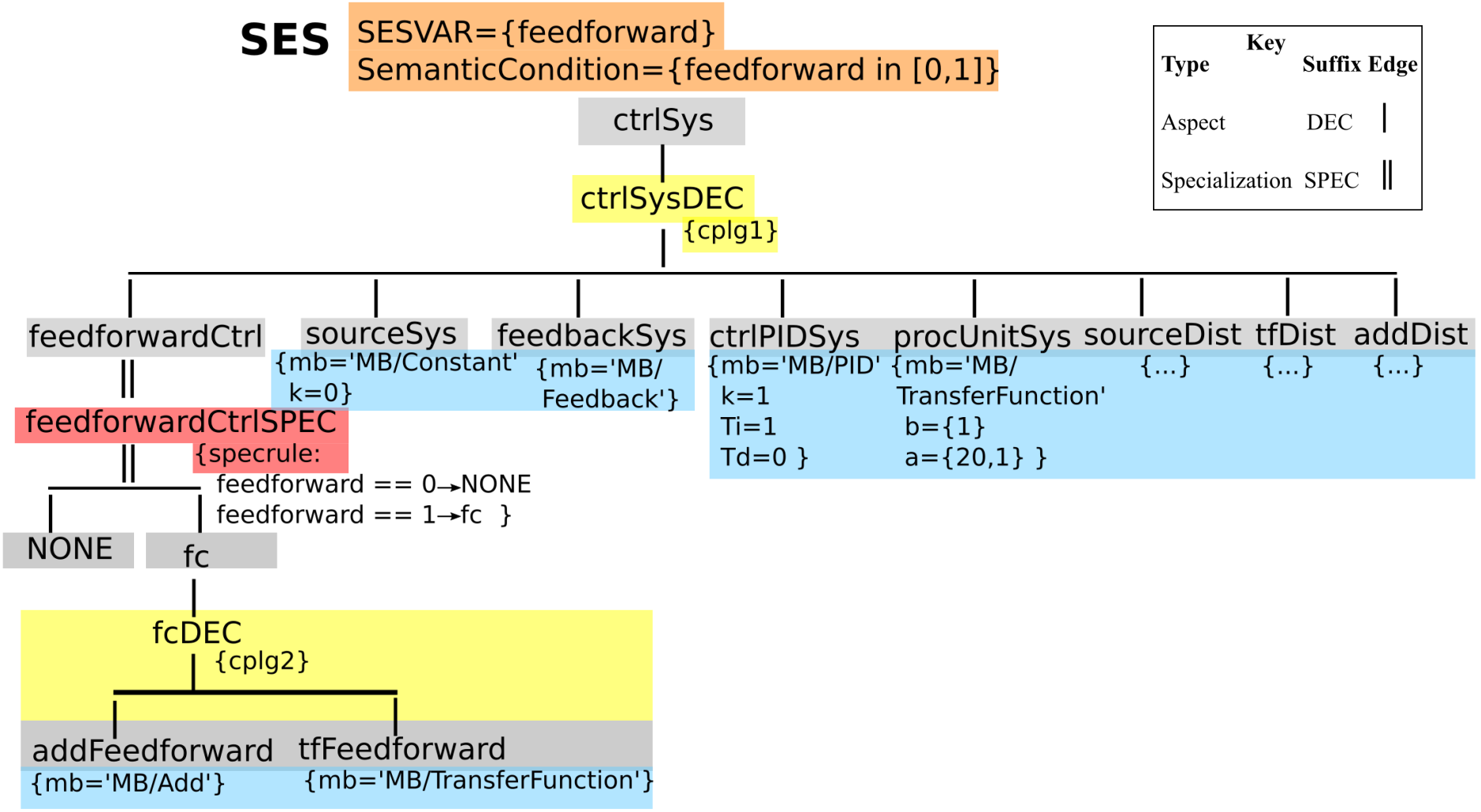

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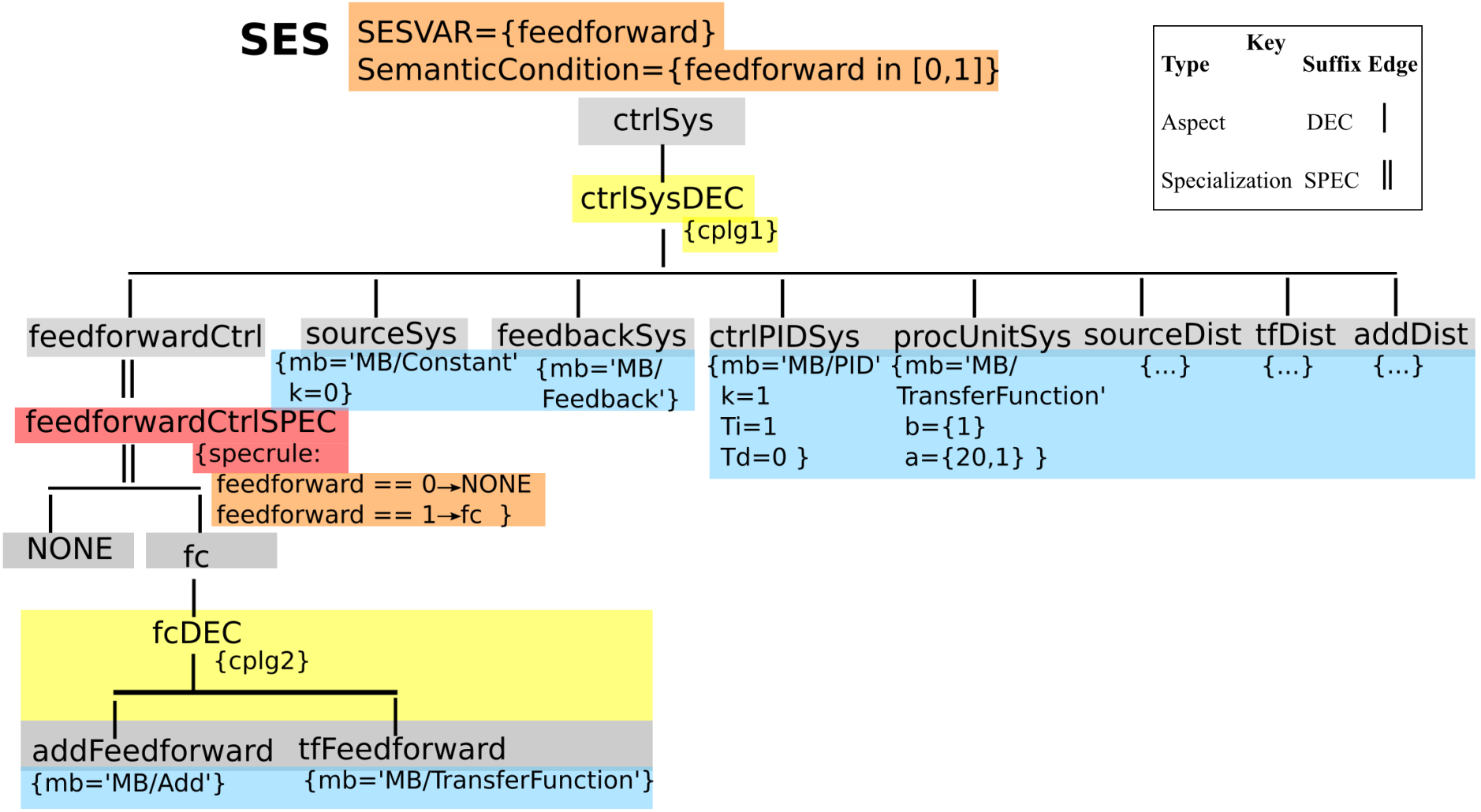

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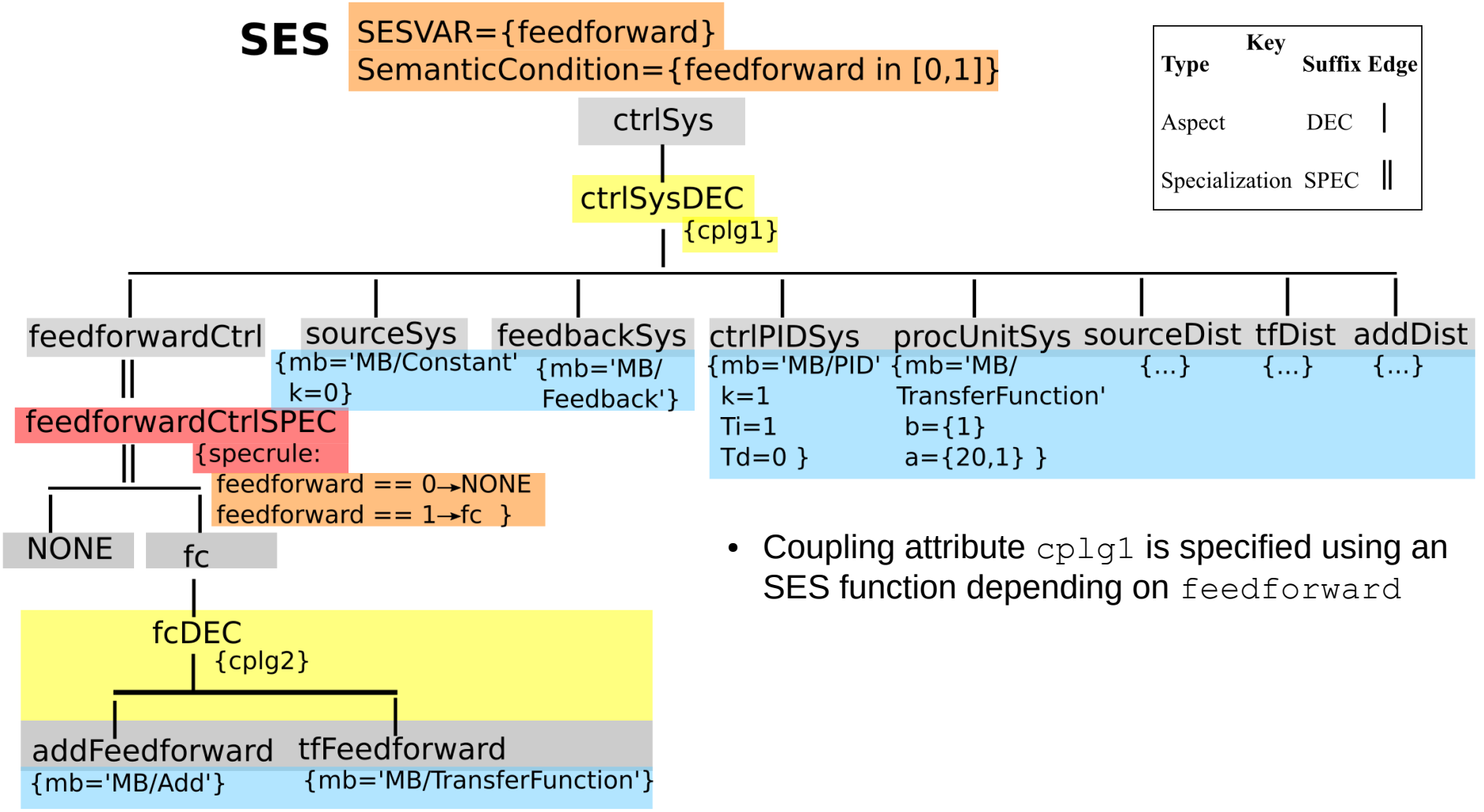

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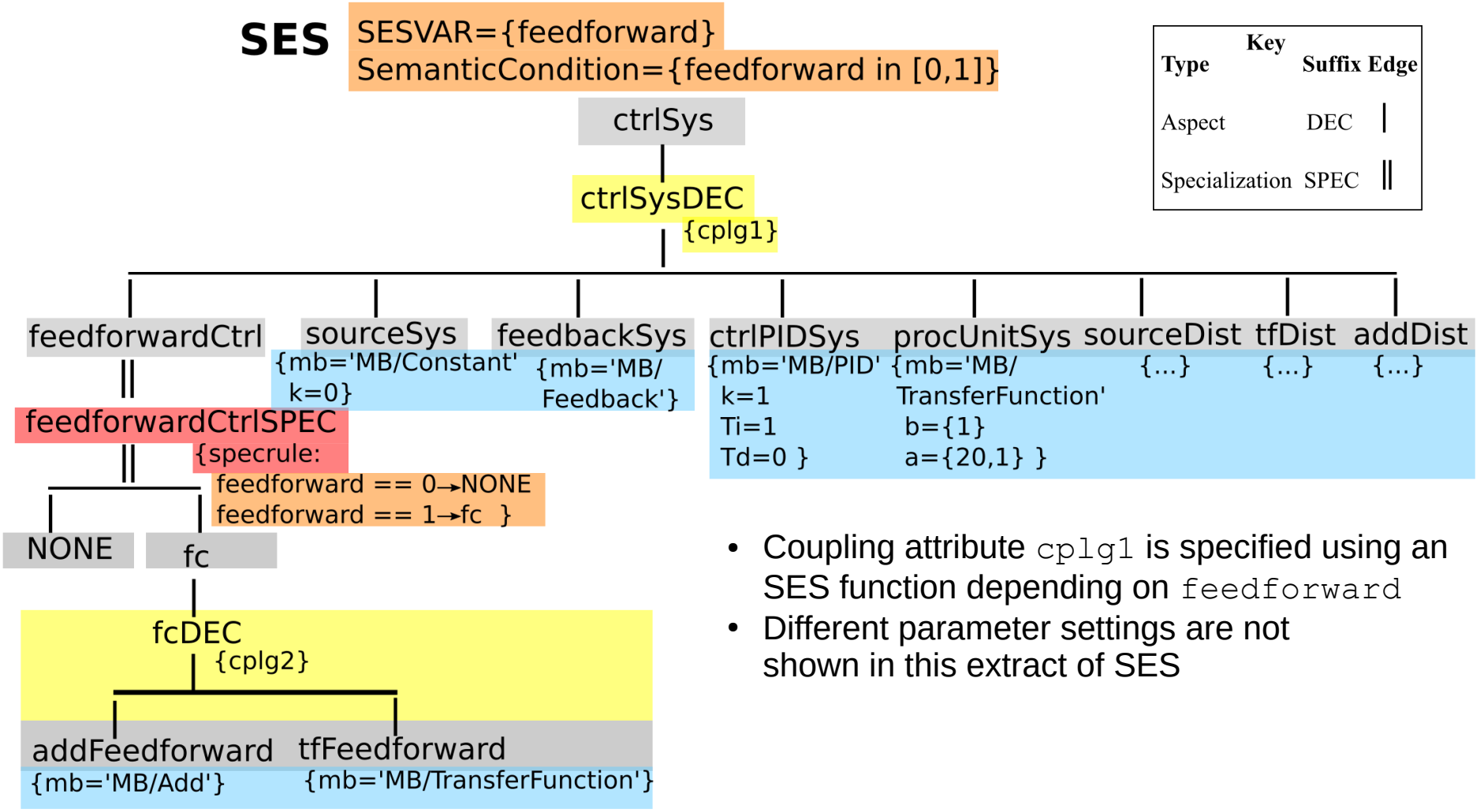
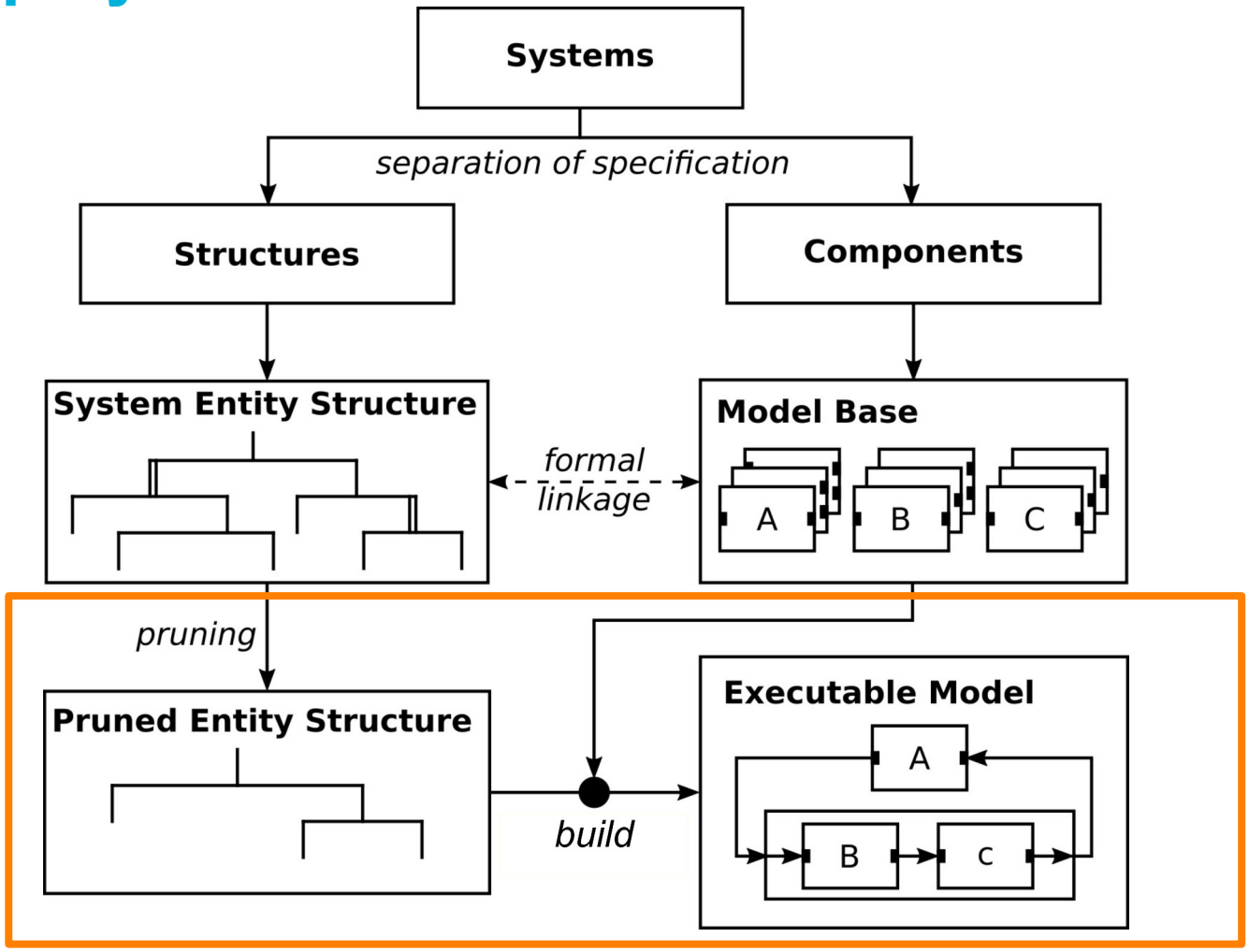


- Coupling attribute `cplg1` is specified using an SES function depending on `feedforward`
- Different parameter settings are not shown in this extract of SES

SES/MB Modeling Approach Deployment



Outlook and Software Tool Support

The pruning and build processes are presented in the supplementary material for Chapter 18.6 in detail. The case study introduced here is revisited, Software tools supporting the SES/MB approach are introduced, the SES developed for the case study is pruned, and models are generated.