# On the Challenges of Model Decorations for Capturing Complex Metadata


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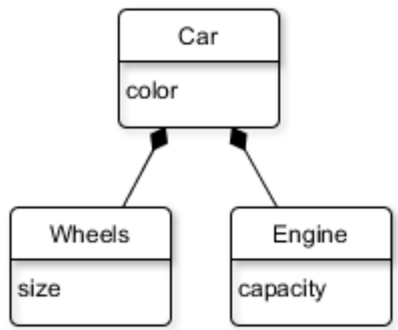
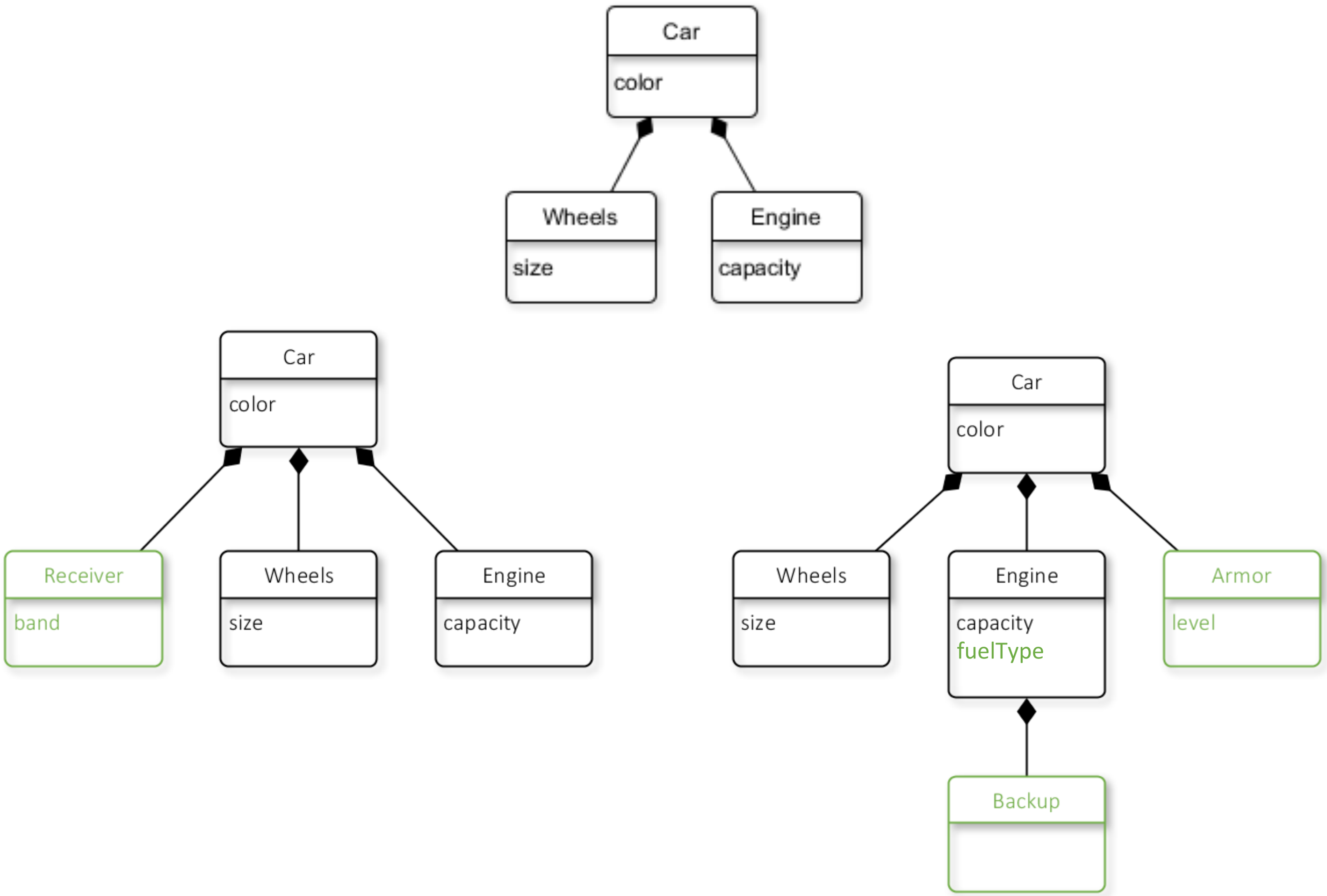
# The Problem

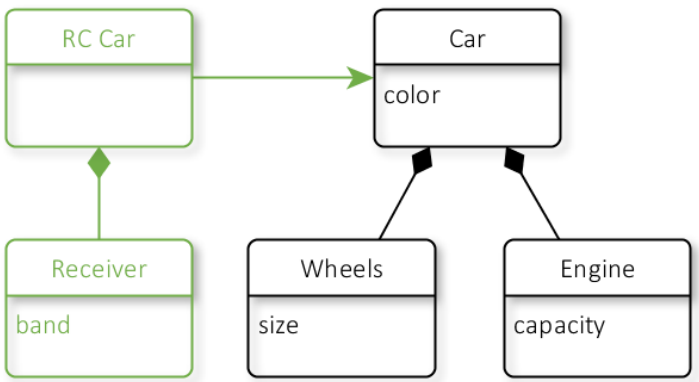
# Planning for the future



# Planning for the future

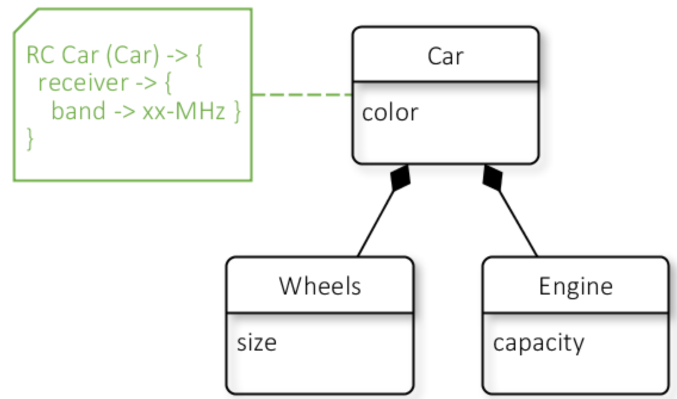


# Decorator languages




## Same technologies

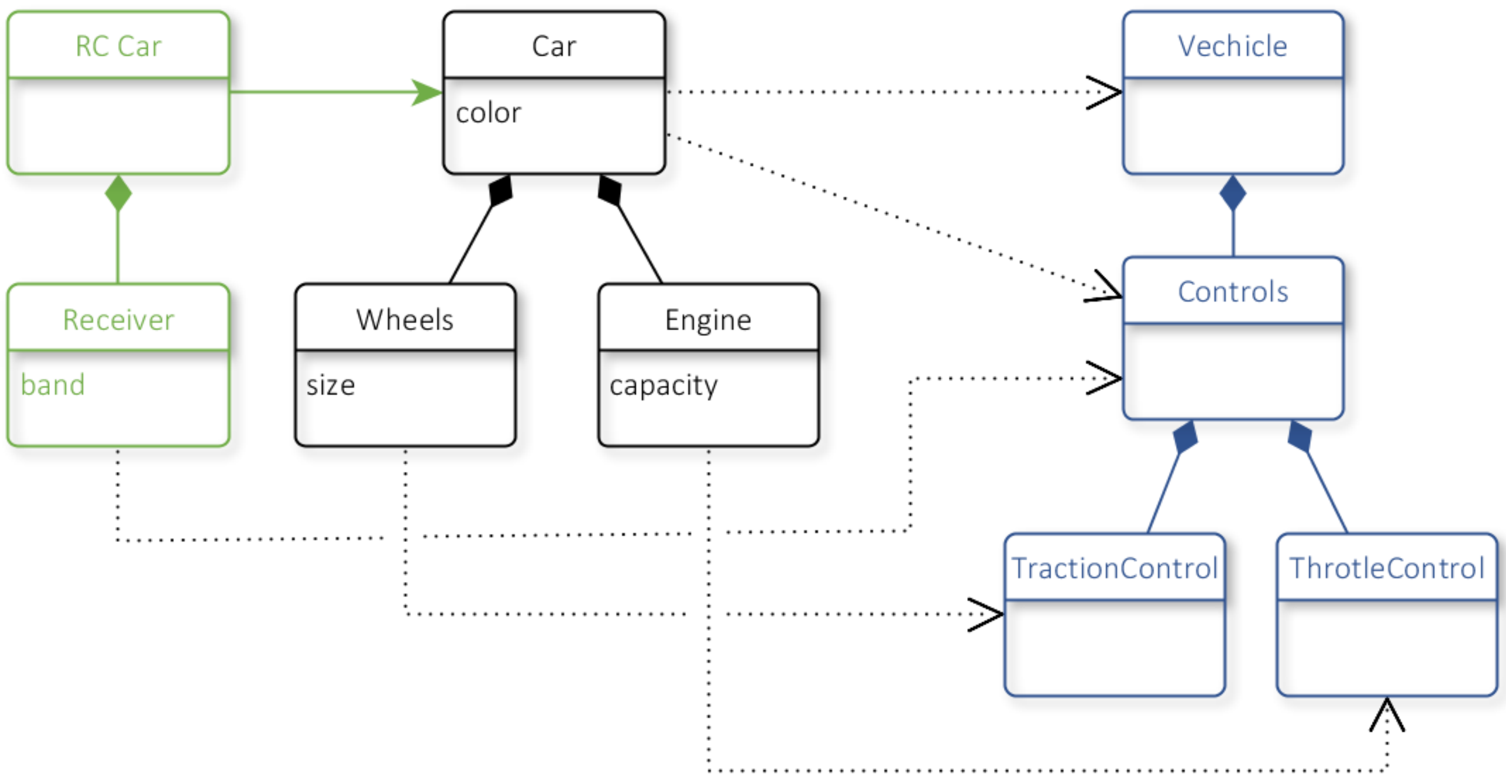
- Additional information is seamlessly captured in the model, i.e. its feasible to navigate between a **Car** and its **RC Car**.
- Tooling can be reused (with work)



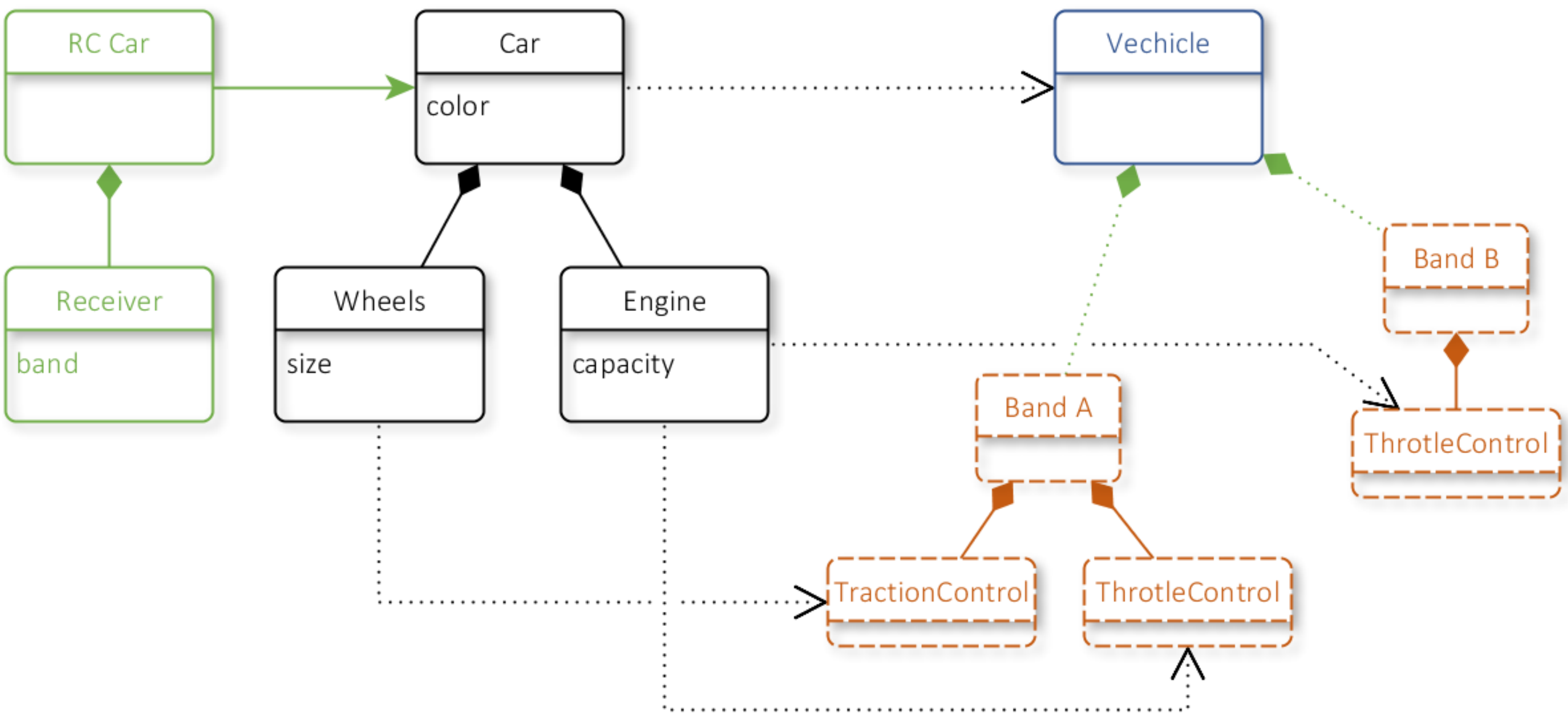

## Other technologies

- Separate artefact available during model management (i.e. as other model)
- Seamlessly navigation is not possible
- Tooling is not reusable

# Purpose of metadata



# Purpose of metadata

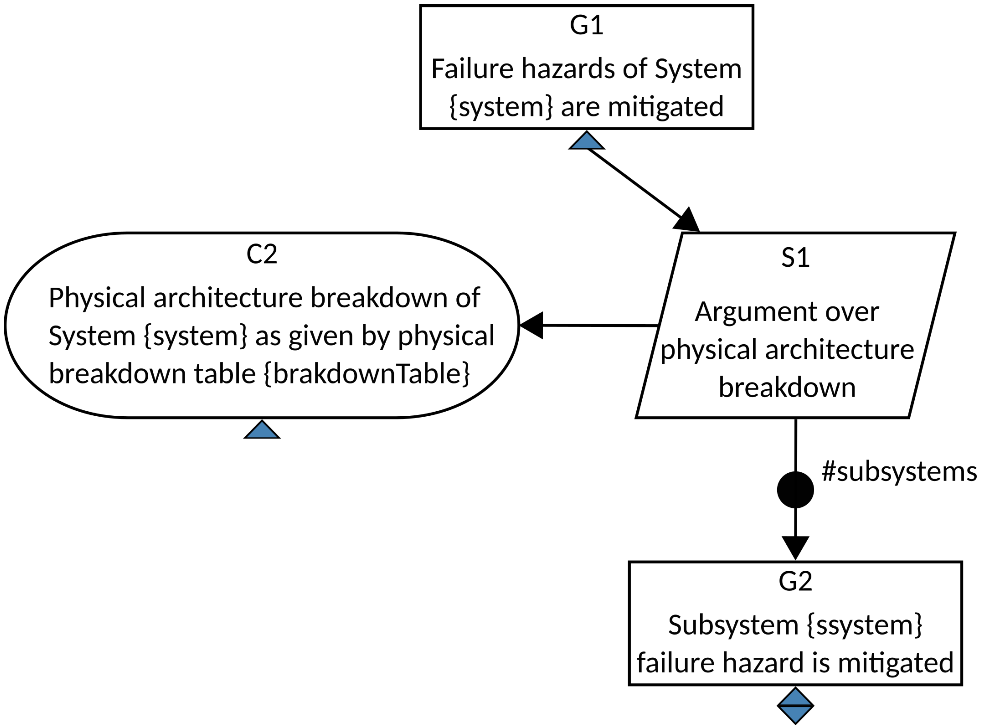


# Goal Structuring Notation (GSN)

- The development of assurance cases is a key part of engineering safety critical systems.
- An assurance case presents a structured argument aimed at ensuring that the safety or security of a system can be demonstrated with respect to evidence


- Safety cases are typically constructed manually, since many tools rely on diagrammatic drawing support input
- Interested in how the safety cases could be auto-generated and how the information required to generate them could be captured

# GSN Patterns

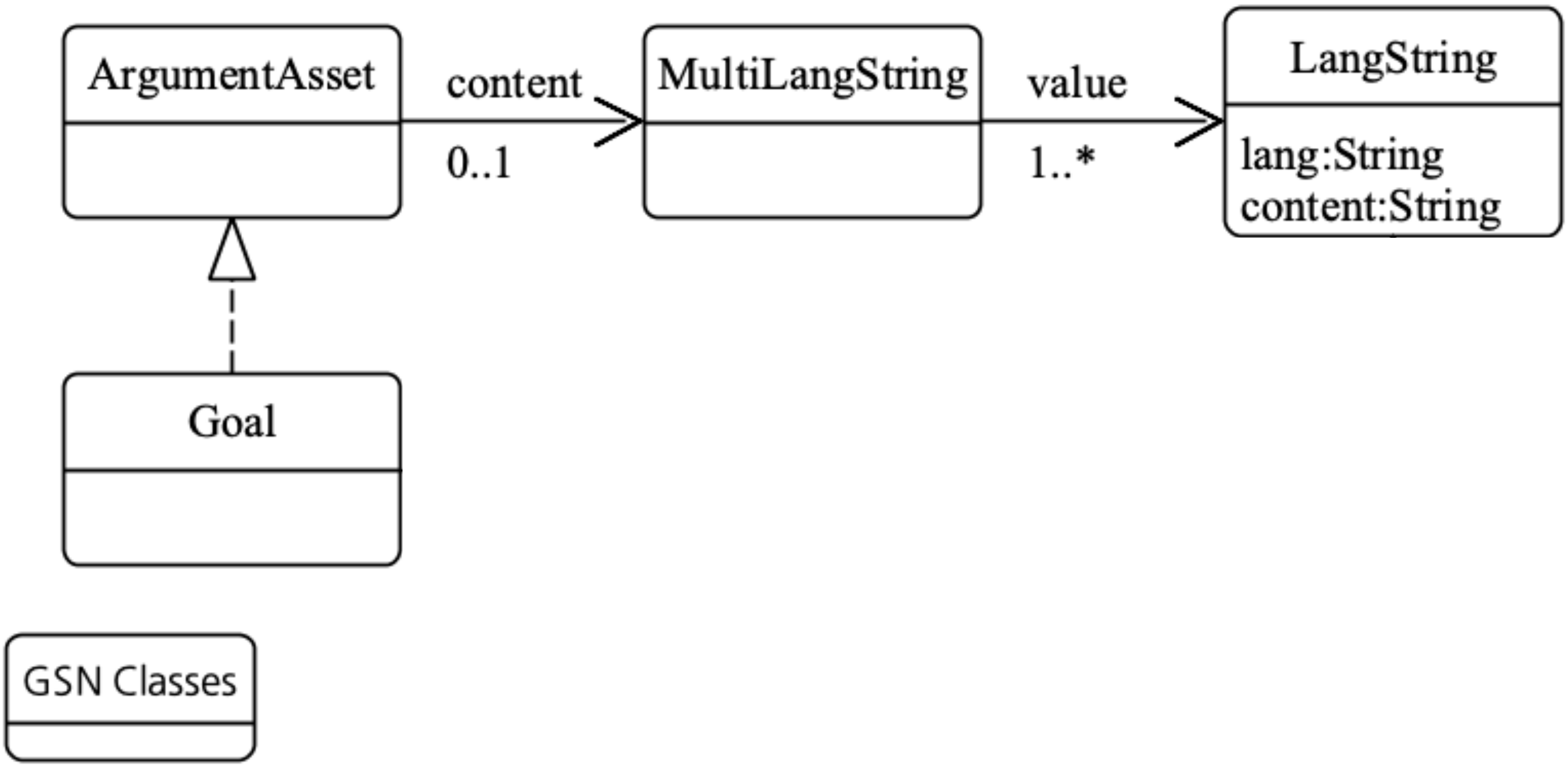



Pattern Instantiation

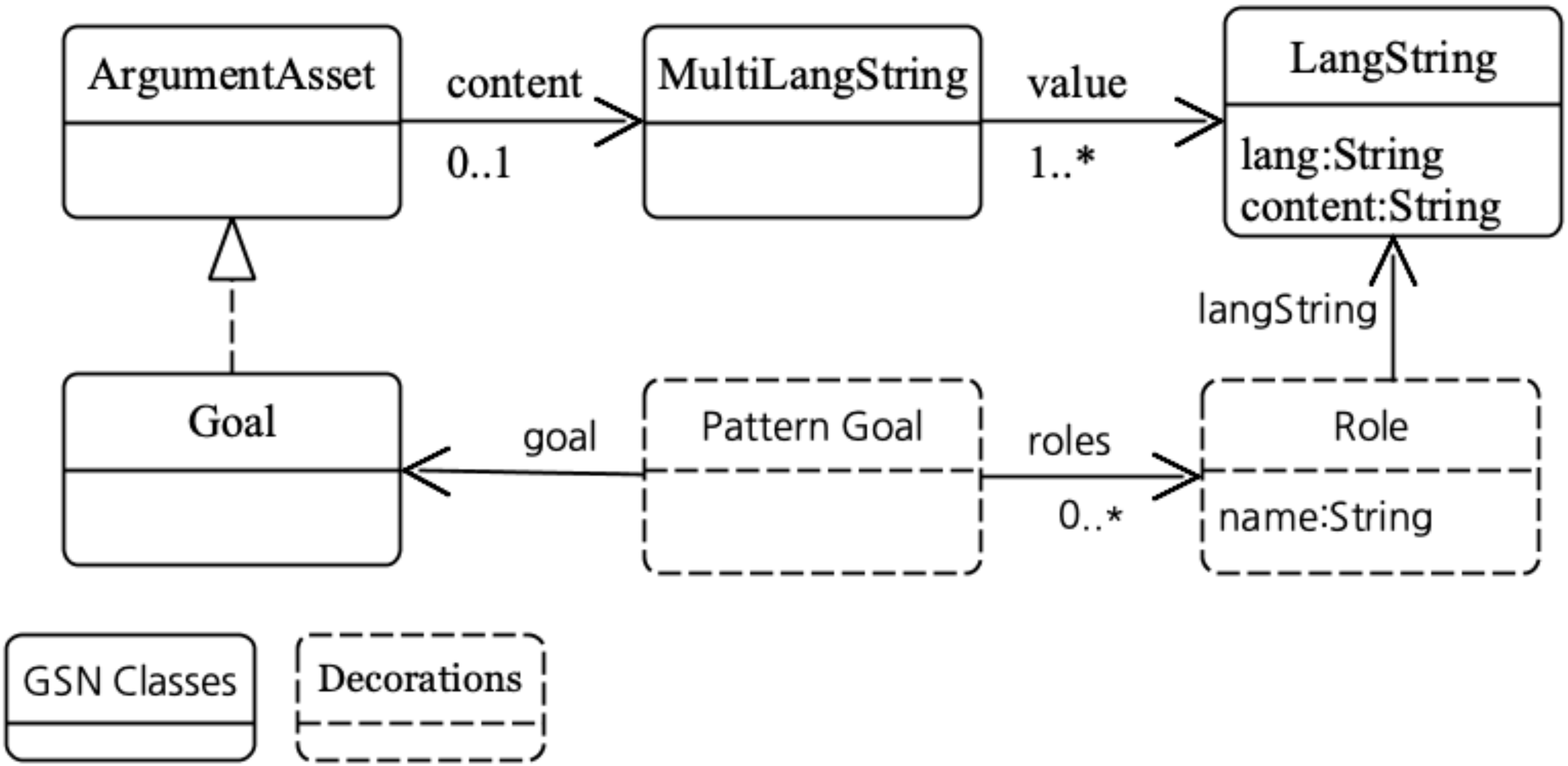
- Pattern elements are copied
- Roles replaced
- Multiplicities "unfolded"

{system} -> CarControl
{breakdownTable} -> ControlTable
#Subsystems -> 2
1. {ssystem} -> Throttle
2. {ssystem} -> Traction

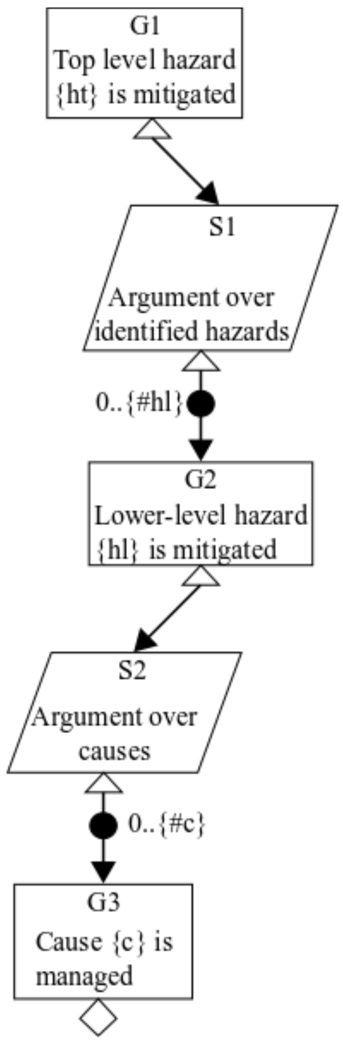
# Challenge 1: Capturing role metadata



# Challenge 1: Capturing role metadata

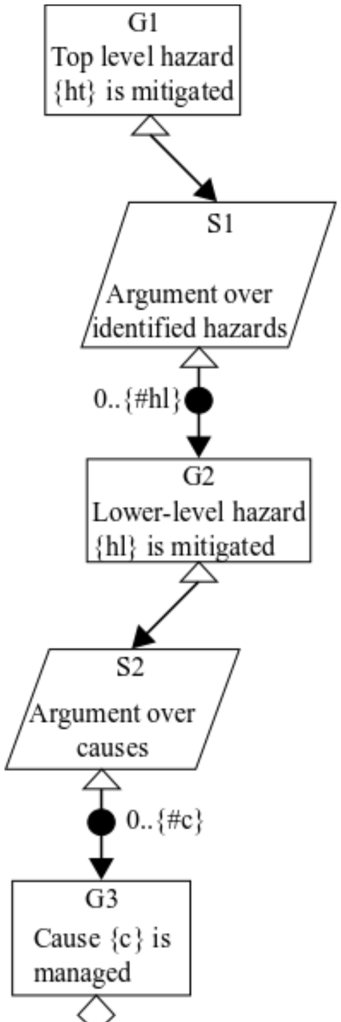


# Challenge 2: Capturing multiplicity metadata




- Nested multiplicities cause combinatorial role values: for each **ht** there are many **hls**, and for each **hl** there are many **c** values.

# Challenge 2: Capturing multiplicity metadata

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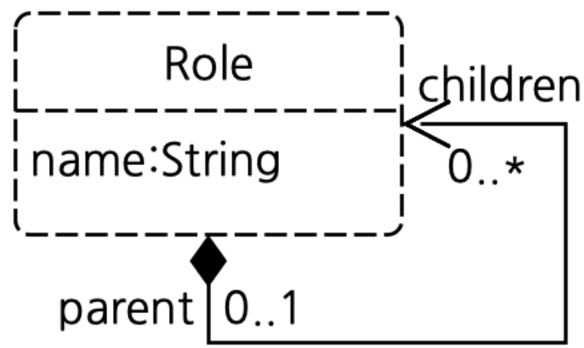

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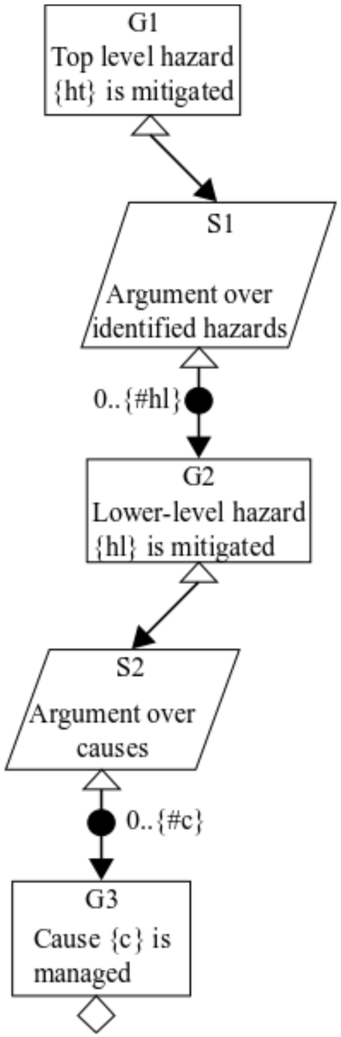


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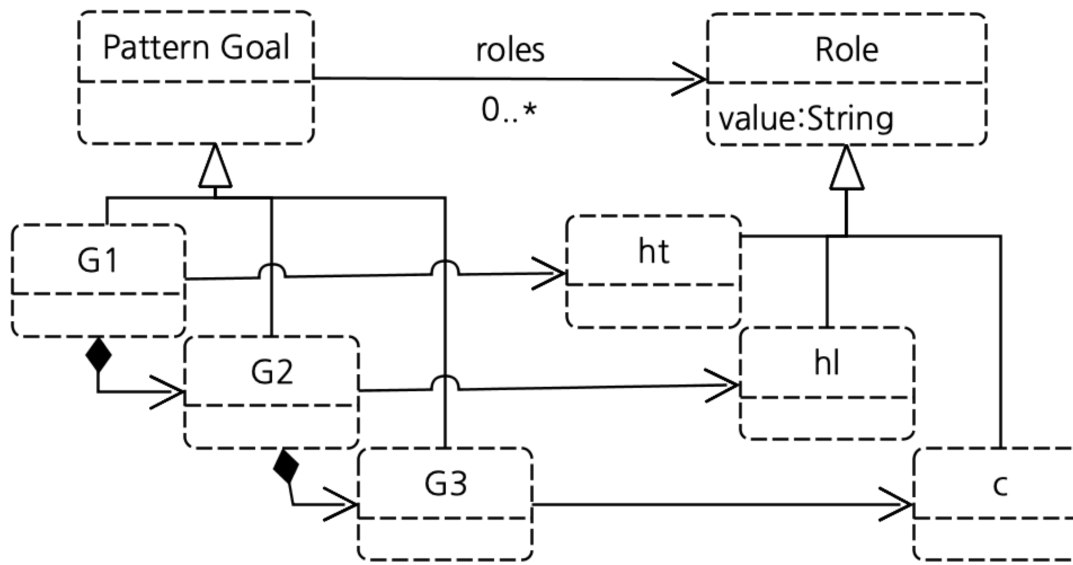


# Challenges

- Complex metadata places additional requirements on the decoration language.
- Decorations can be required *per-model basis.* The decoration activity is much more time-consuming.
- A side effect of this fine-grained granularity is that reuse of decoration languages is reduced.
- In a nutshell, when metadata is tightly coupled to the semantics of model operations, a different approach to define more fine-grained decorations and model more complex relations is required.

# Generating decorators

Dealing with fine-grained decorations and complex metadata

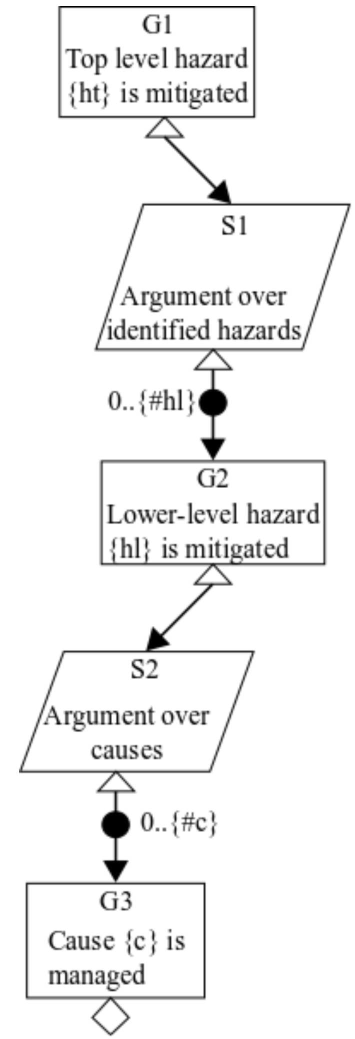
# GSN Observations

- Complex metadata is structured as a tree where
  - branches are related to the SupportedBy relations: multiplicity, optionality or selection,
  - each node can capture specific role information.
- Roles are often reused throughout the pattern.
- We call the *role:value* pairs a *link* and each node in the tree can have 0 or more links.

- Given that the nature of links is to capture text values, we opted for creating decoration languages that use textual notation.

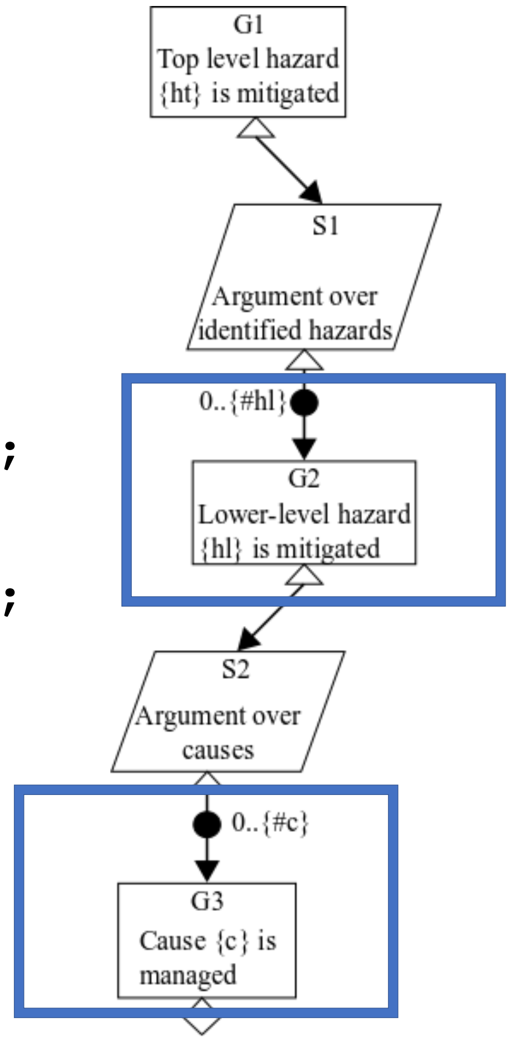
# GSN Decorator template (BNF)

```
data ::= variable* <gsnnode>*;
variable ::= ID '=' STRING;
<gsnnode> ::= (count <branchnode>) | <node>;
<branchnode> ::= '<name>_br' ':' <node>*;
<node> ::= '<node_name>'':'<link>* gsnnode*;
<link> ::= '*<role>' '=' ID | STRING;
count ::= <max> | (<min>,<max>)
```



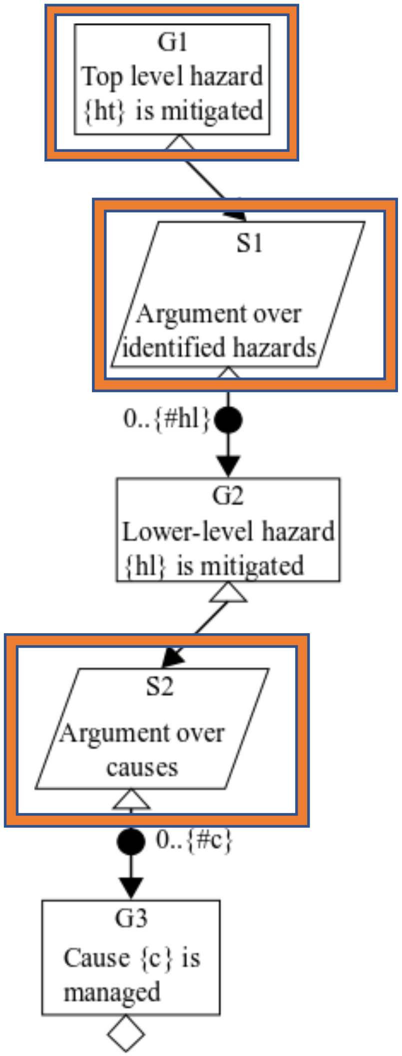
# GSN Decorator template (BNF)

```
data ::= variable* <gsnnode>*;
variable ::= ID '=' STRING;
<gsnnode> ::= (count <branchnode>) | <node>;
<branchnode> ::= '<name>_br' ':' <node>*;
<node> ::= '<node_name>'':'<link>* gsnnode*;
<link> ::= '*<role>' '=' ID | STRING;
count ::= <max> | (<min>,<max>)
```



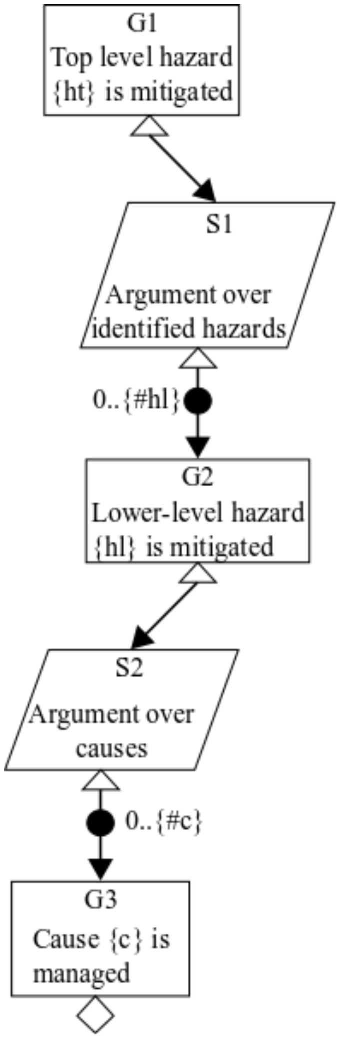
# GSN Decorator template (BNF)

```
data ::= variable* <gsnnode>*;
variable ::= ID '=' STRING;
<gsnnode> ::= (count <branchnode>) | <node>;
<branchnode> ::= '<name>_br' ':' <node>*;
<node> ::= '<node_name>'':'<link>* gsnnode*;
<link> ::= '*<role>' '=' ID | STRING;
count ::= <max> | (<min>,<max>)
```



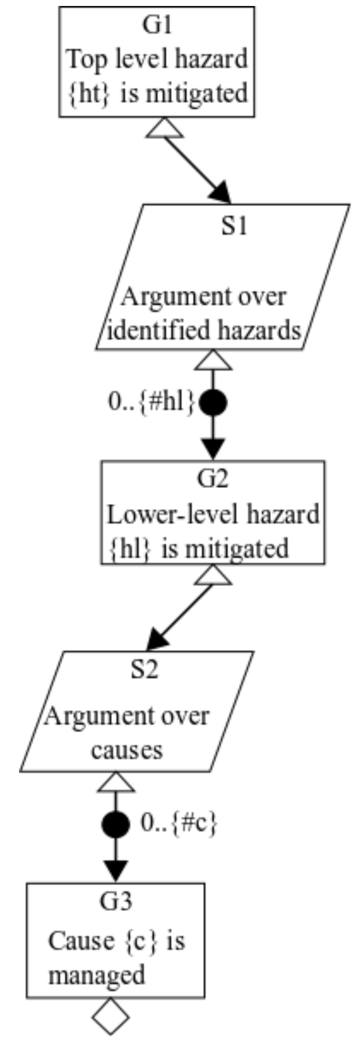
# GSN Decorator template (BNF)

```
data ::= 'G1' ':' g1 s1;
g1 ::= '*ht' '=' ID | STRING;
s1 ::= 'S1' ':' hl g2_br*;
g2_br ::= 'G2' ':' g2 s2;
hl ::= 'hl_count' '=' INT;
g2 ::= '*hl' '=' ID | STRING;
s2 ::= 'S2' ':' c g3_br*;
g3_br ::= 'G3' ':' g3;
c ::= 'c_count' '=' INT;
g3 ::= '*c' '=' ID | STRING;
```

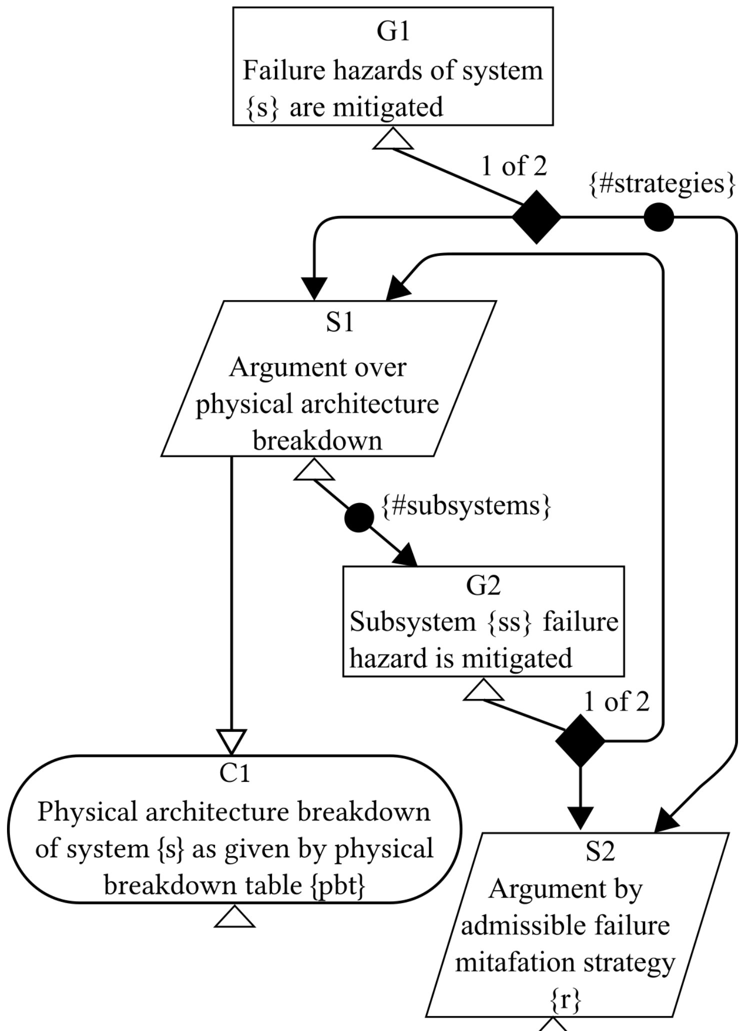


# GSN Decorator template (BNF)

```
G1:
 *ht = 'Hazard1'
 S1:
  hl_count = 2
  G2:
   *hl = 'LowHazard1'
   S2:
    c_count = 1
    G3:
     *c = 'LowHazard1 cause'
  G2:
   *hl = 'LowHazard2'
   S2:
    c_count = 2
    G3:
     *c = 'LowHazard2 cause1'
    G3:
     *c = 'LowHazard2 cause2'
```

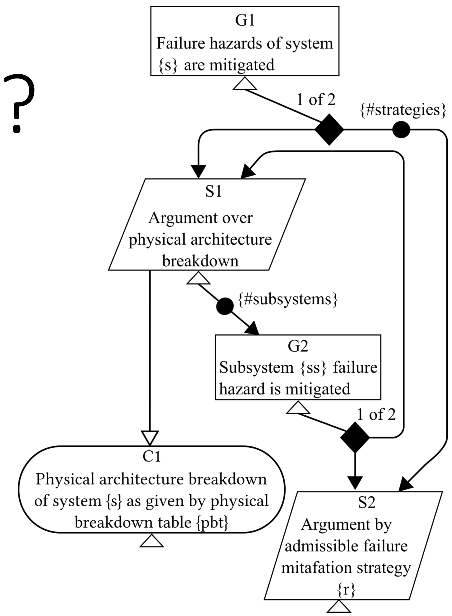


# What about more complex patterns?



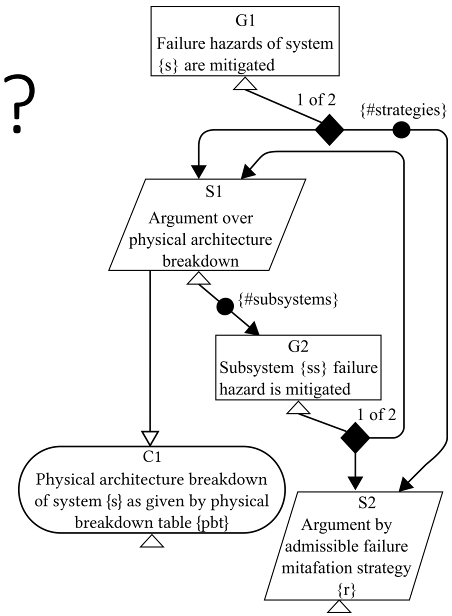
# What about more complex patterns?

```
data:
  (vars+=Var)*
  top=g1;
g1:
  'G1'':'
    BEGIN
    '*s' '=' s=(STRING | VarRef);
    g1s1=s1 | (count=s2_count g1s2+=s2_br*);
    END;
```



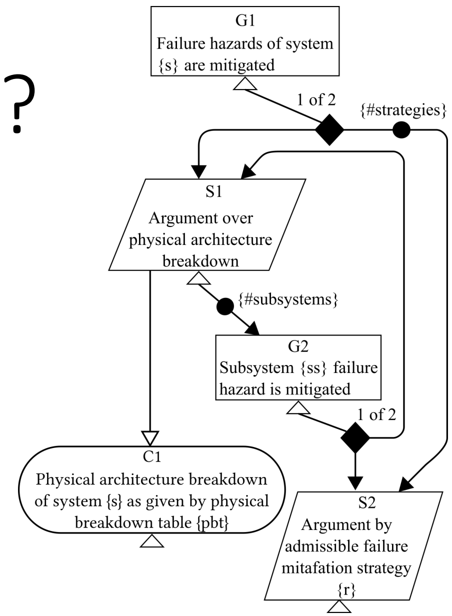
# What about more complex patterns?

```
s1:
  'S1:'
    BEGIN
    s1c1=c1 (count=g2_count s1g2+=g2_br)*;
    END;
c1:
  'C1'':'
    BEGIN
    '*s' '=' s=(STRING | VarRef);
    '*pbt' '=' pbt=(STRING | VarRef);
    END
g2_br:
  BEGIN
    top=g2 (g2s1=s1 | g2s2=s2);
  END
g2_count:
  'subsystems_count' '=' INT;
```

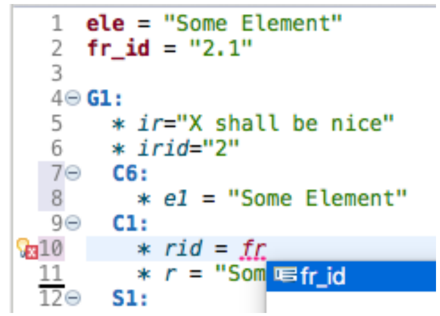


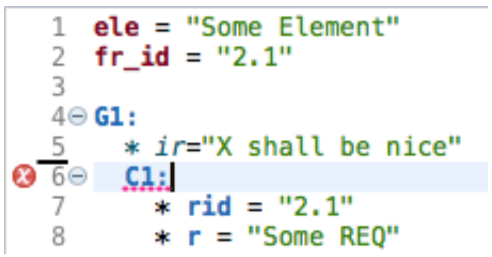
# What about more complex patterns?

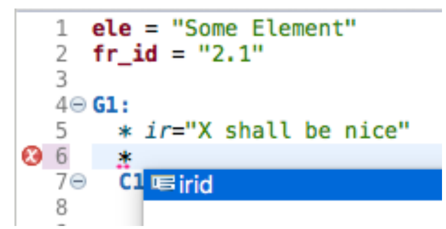
```
g2:
  'G2'':'
    BEGIN
    '*ss' '=' ss=(STRING | VarRef);
    END
s2_gb:
  top=s2
s2_count:
  'strategies_count' '=' INT;
s2:
  'S2'':'
    BEGIN
    '*r' '=' r=(STRING | VarRef);
    END
Var:
  name = ID '=' value=STRING;
VarRef:
  ref = [Var];
```

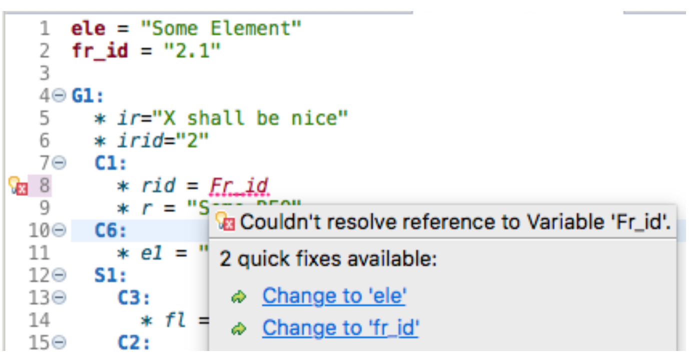


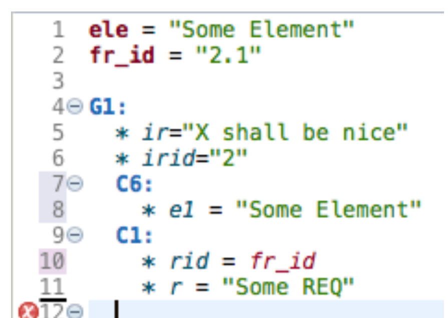
# The Editor


ele = "Some Element"
fr_id = "2.1"
G1:
* ir="X shall be nice"
* irid="2"
C6:
* el = "Some Element"
C1:
* rid = fr
* r = "Som
fr_id
S1:


ele = "Some Element"
fr_id = "2.1"
G1:
* ir="X shall be nice"
C1:
* rid = "2.1"
* r = "Some REQ"


ele = "Some Element"
fr_id = "2.1"
G1:
* ir="X shall be nice"
*
C1
irid


ele = "Some Element"
fr_id = "2.1"
G1:
* ir="X shall be nice"
* irid="2"
C1:
* rid = Fr_id
* r = "S
C6:
* el = "
S1:
C3:
* fl =
C2:
Couldn't resolve reference to Variable 'Fr_id'.
2 quick fixes available:
Change to 'ele'
Change to 'fr_id'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G1:
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C6:
* el = "Some Element"
C1:
* rid = fr_id
* r = "Some REQ"

# Questions?

Acknowledgments

This work was supported by the SECT-AIR project, funded by the Aerospace Technology Institute and In- novate UK, as project number 113099 This work was partially supported by the EU through the DEIS project (#732242).