SST

Introduction to the SysML v2 Language Graphical Notation

(2021-04-09)

This presentation of the SysML v2 language uses the proposed graphical modeling notation that is intended to be in the specification. However, the graphical syntax has not yet been formally specified or implemented in the SST pilot implementation. The graphical syntax is intended to complement the textual syntax.

Agenda

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- Overview
- SysML v2 Functional Areas
- Summary

SysML v2 Functional Areas

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1. Packages & Element Names
2. Definition Elements
3. Usage Elements
4. Part Decomposition
5. Part Interconnection
6. Variability
7. Actions
8. Action Flow
9. States
10. Sequences
11. Individuals
12. Timeslices & Snapshots
13. Expressions & Calculations
14. Quantities & Units
15. Constraints
16. Requirements
17. Analysis Cases
18. Verification Cases
19. Dependency & Allocation Relationships
20. Annotations
21. Element Filters
22. View & Viewpoint
23. Language Extension

General Caveats

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- The graphical representation of the model is based on the Jupyter vehicle model, which is defined using the textual notation
  - The textual notation has been formally specified
  - The graphical notation is proposed, and has not been formally specified yet
  - The graphical visualization for this review is captured in Visio
  - Two visualization prototypes are under development (Tom Sawyer and PlantUML)
- Some areas of the language have not been implemented yet and are marked as in process
- SysML v2 Marker v2
  - Some of the more significant SysML v2 changes in functionality and terminology relative to SysML v1 are designated with the SysML v2 marker

Overview

SysML v2 Objectives

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Increase adoption and effectiveness of MBSE
by enhancing…

- Precision and expressiveness of the language
- Consistency and integration among language concepts
- Interoperability with other engineering models and tools
- Usability by model developers and consumers
- Extensibility to support domain specific applications
- Migration path for SysML v1 users and implementors

Key Elements of SysML v2

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- New Metamodel that is not constrained by UML
  - Preserves most of UML modeling capabilities with a focus on systems modeling
  - Grounded in formal semantics
- Robust visualizations based on flexible view & viewpoint specification and execution
  - Graphical, Tabular, Textual
- Standardized API to access the model

SysML v2 Language Capabilities

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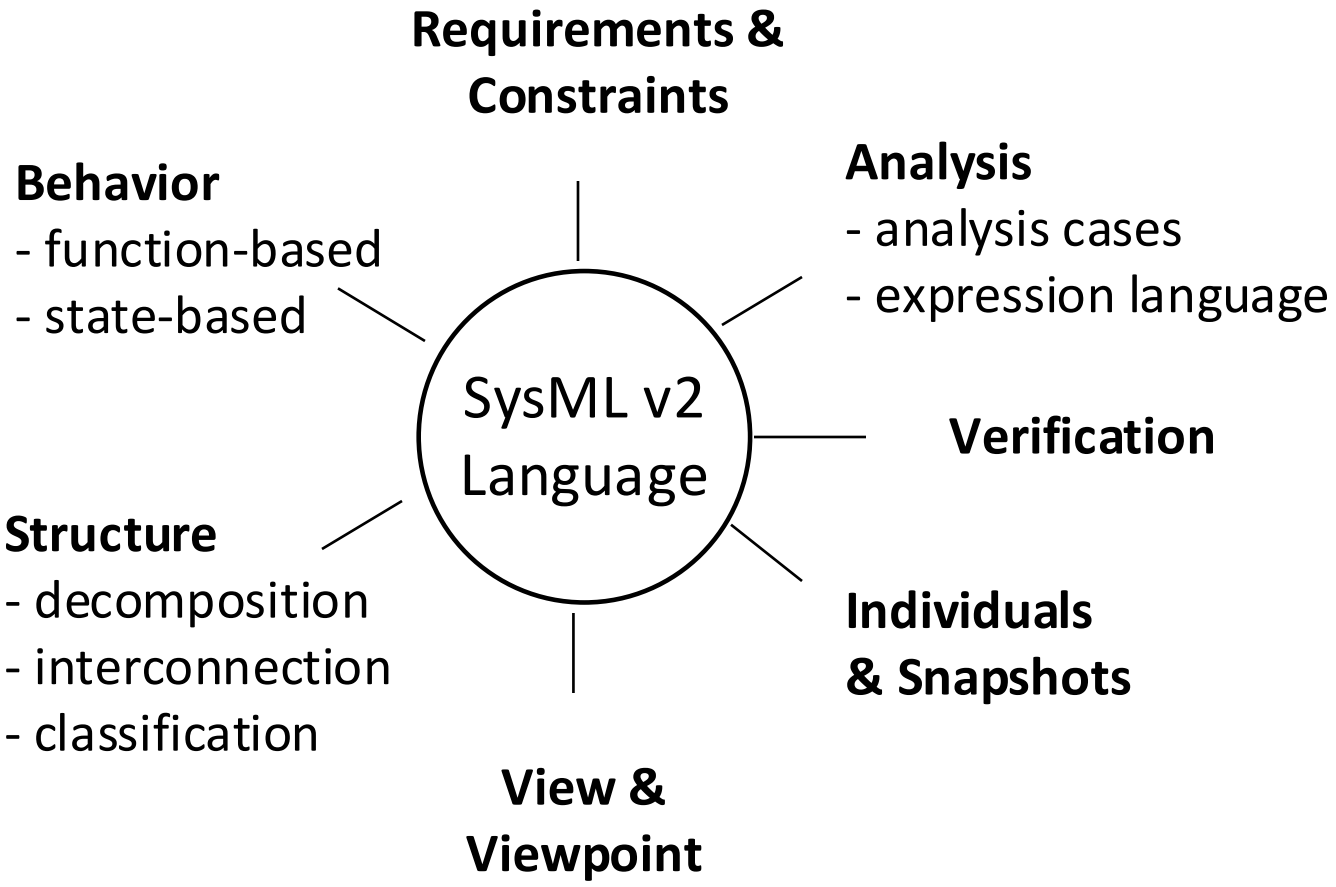

Definition and Usage Reuse Pattern

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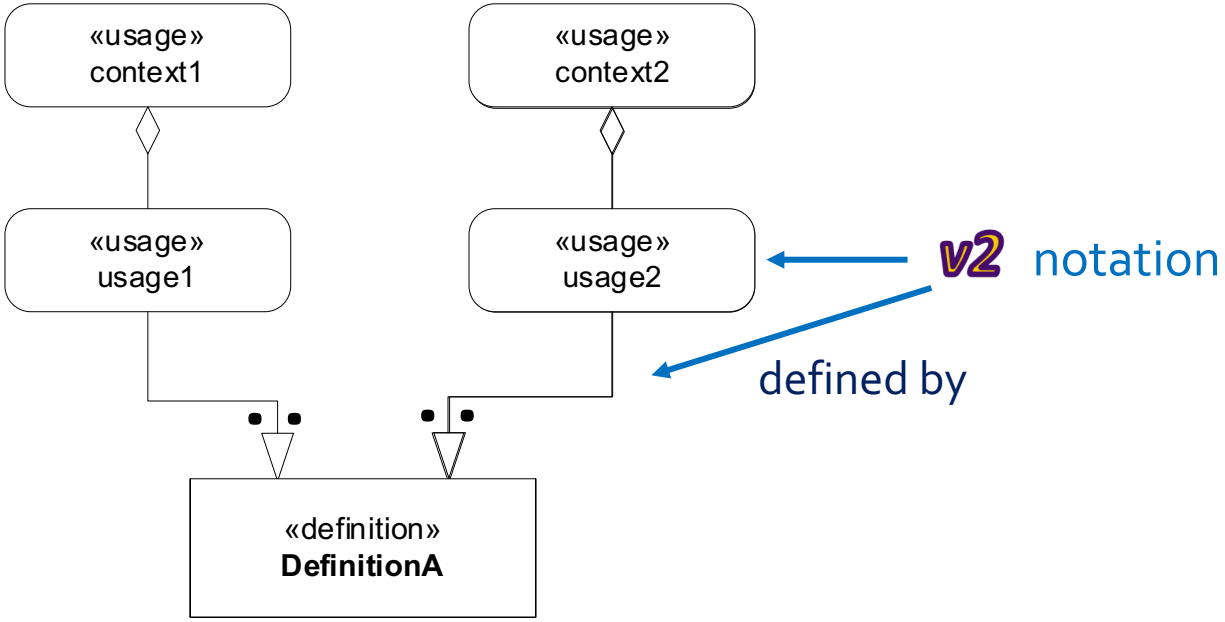
- A definition element defines an element such as a part, action, or requirement
- A usage element is a usage of a definition element in a particular context
  - There can be different usages of the same definition element in either different contexts or the same context
- Pattern is applied consistently throughout the language v2



SysML v2 to v1 Terminology Mapping (partial)

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- SysML v2 includes consistent usage/definition terminology

SysML v2	SysML v1
part / part def	part property / block
attribute / attribute def	value property / value type
port / port def	proxy port / interface block
action / action def	action / activity
state / state def	state / state machine
constraint / constraint def	constraint property / constraint block
requirement / requirement def	requirement
connection / connection def	connector / association block

SysML v2 Notation (1 of 2) Textual and Graphical

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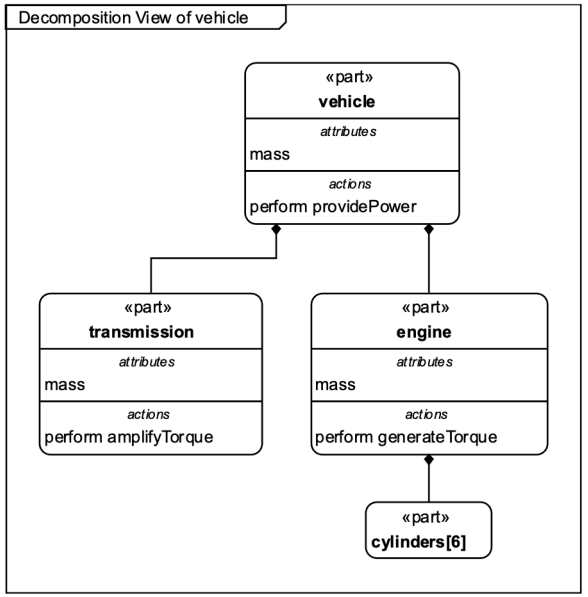
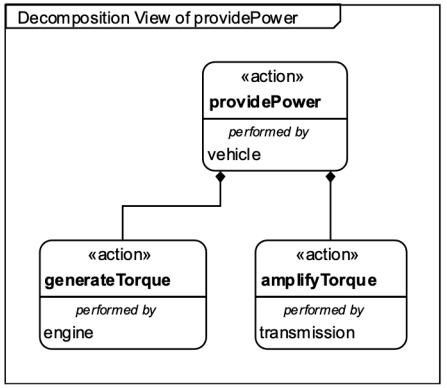
```
package 'Vehicle Parts Tree' {
  part vehicle {
    attribute mass;
    perform providePower;
    part engine {
      attribute mass;
      perform generateTorque;
      part cylinders [6];
    }
    part transmission {
      attribute mass;
      perform amplifyTorque;
    }
  }
}

  package 'Vehicle Action Tree'{
      action providePower {
        action generateTorque;
        action amplifyTorque;
      }
    }
```





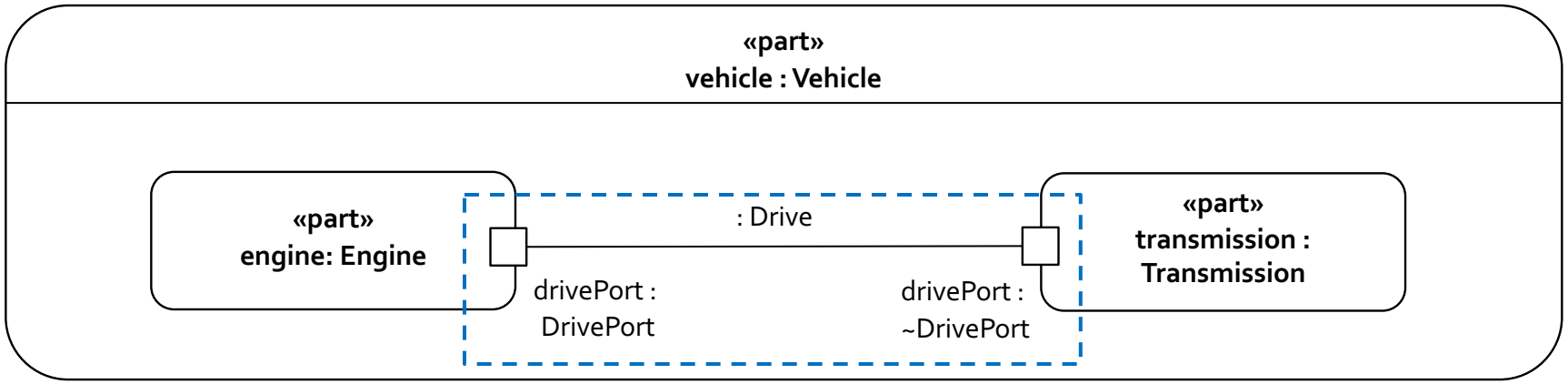
SysML v2 Notation (2 of 2) Textual and Graphical

SST

```
interface def Drive {
    end enginePort : DrivePort;
    end transmissionPort : ~DrivePort;
}

part vehicle : Vehicle {
        part engine : Engine { port drivePort : DrivePort; }
        part transmission : Transmission { port drivePort : ~DrivePort; }

        interface : Drive
            connect engine::drivePort to transmission::drivePort;
}
```



Tom Sawyer Visualization Prototype

Module 1
Packages & Element Names

Model Organization [1 of 3]

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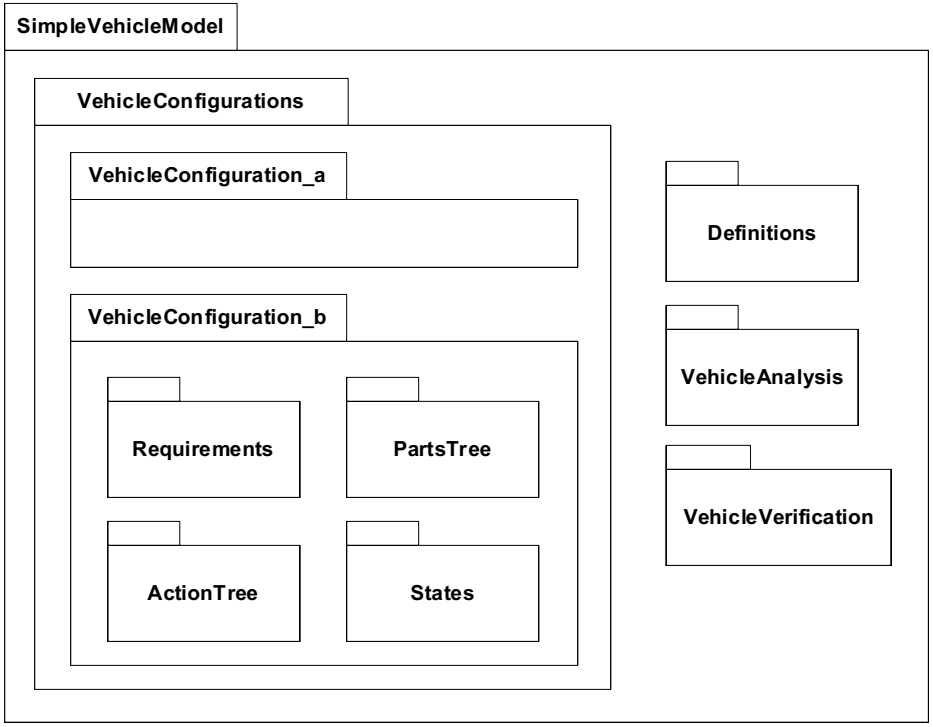
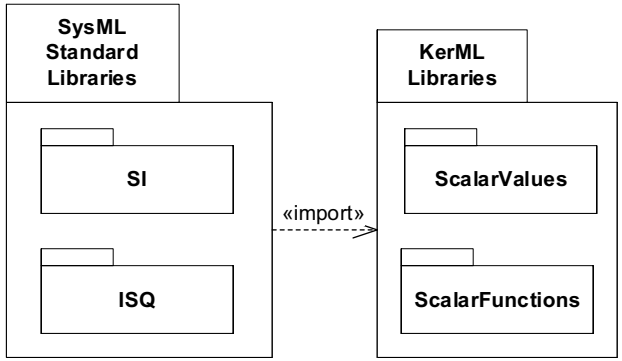
- A hierarchy of packages, where packages can contain other packages and elements
- Packages are namespaces that contain member elements that may be owned or unowned
- A package can import members of another package as unowned members, where deletion semantics do not apply, and they can be referred to by their unqualified name

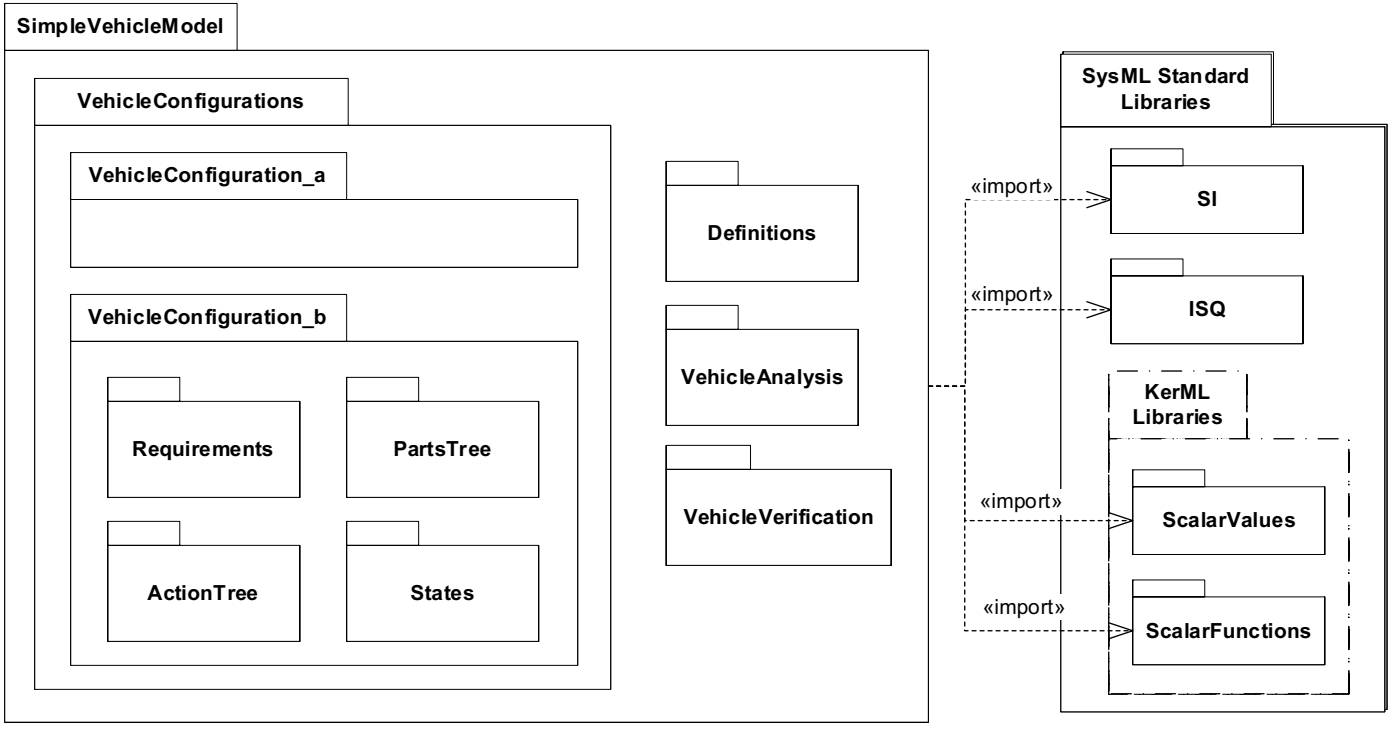




Model Organization [2 of 3]

SST

- A hierarchy of packages, where packages can contain other packages and elements
- Packages are namespaces that contain member elements that may be owned or unowned
- A package can import members of another package as unowned members, where deletion semantics do not apply, and they can be referred to by their unqualified name
  - Nested import notation enables flexible organization v2



Model Organization [3 of 3]

SST

- A hierarchy of packages, where packages can contain other packages and elements
- Packages are namespaces that contain member elements that may be owned or unowned
- A package can import members of another package as unowned members, where deletion semantics do not apply, and they can be referred to by their unqualified name
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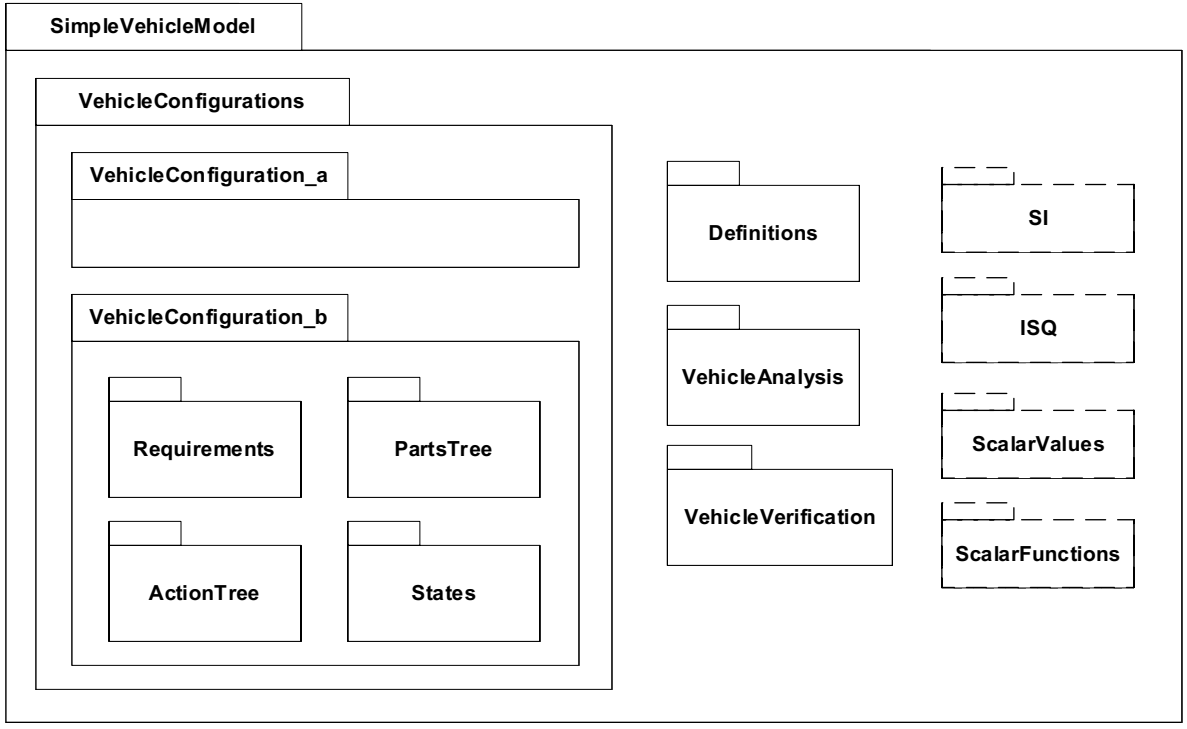

Definitions Package

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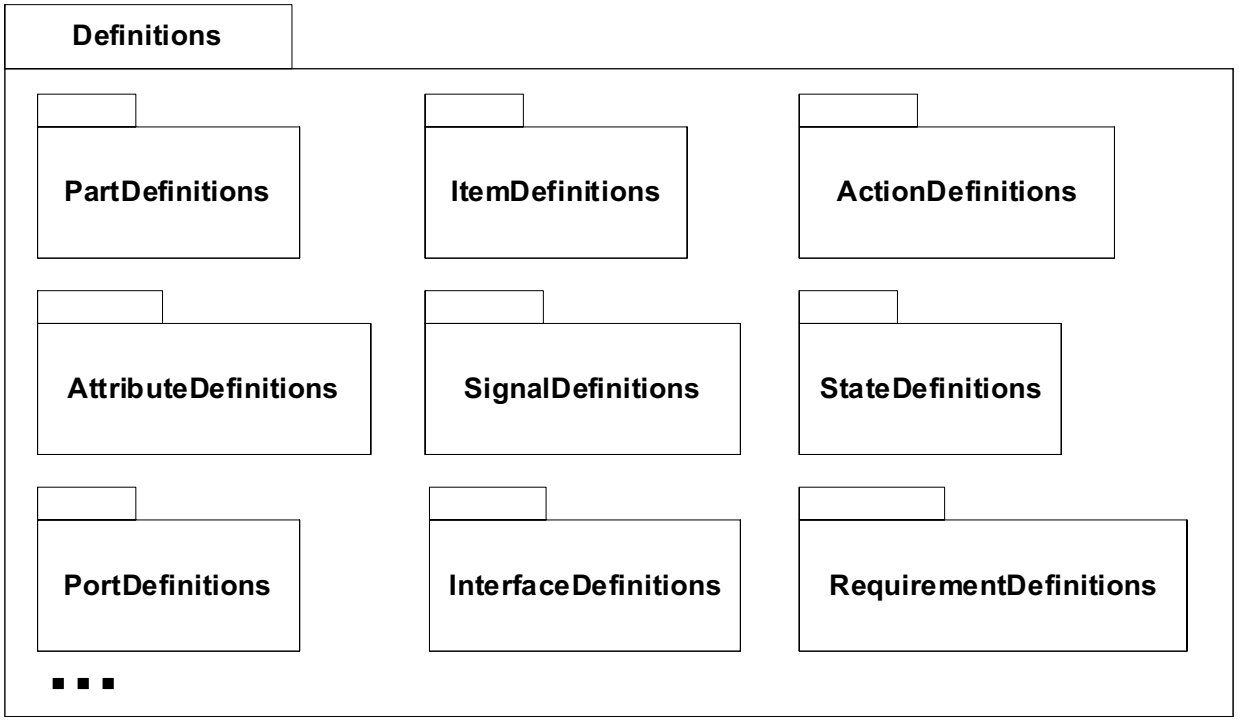
- Example: Definitions package contains packages to define different kinds of elements
  - Ellipsis indicates there is more content



Element Names

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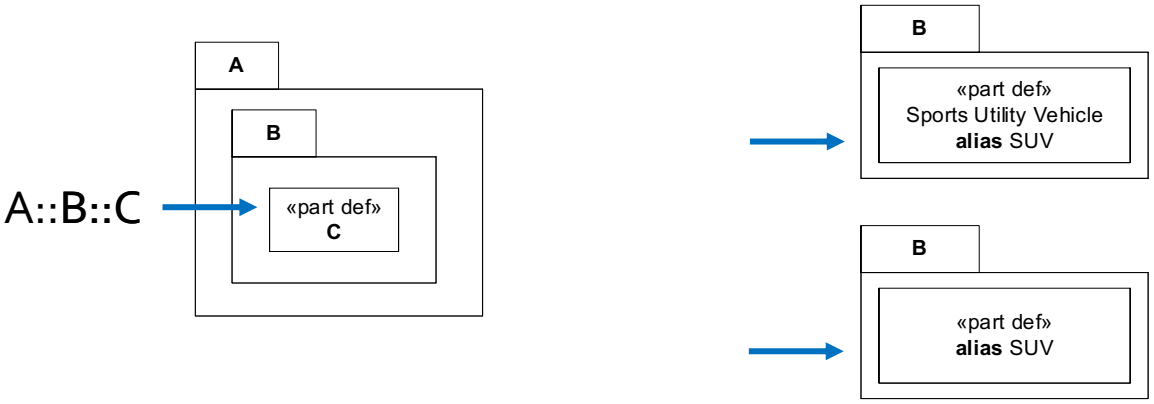
- A qualified name of a model element is prepended by the name of its owner followed by a double colon (::)
- A fully qualified name is prepended by the concatenated names of its owners in its containment hierarchy separated by double colons (::)
- An element can have one or more aliases v2
- Each element includes a UUID and optionally other id's, such as a uri v2



Module 2
Definition Elements

Part Definition

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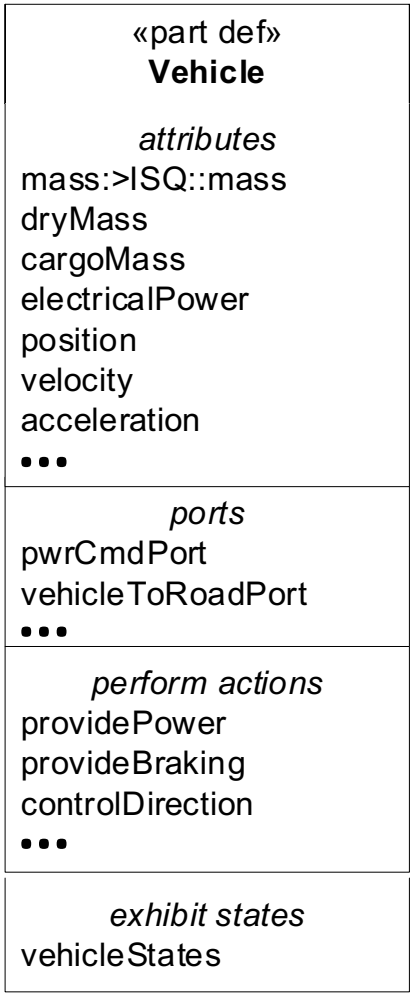
- A Part Definition can contain features such as attributes, ports, actions, and states
  - A modular unit of structure

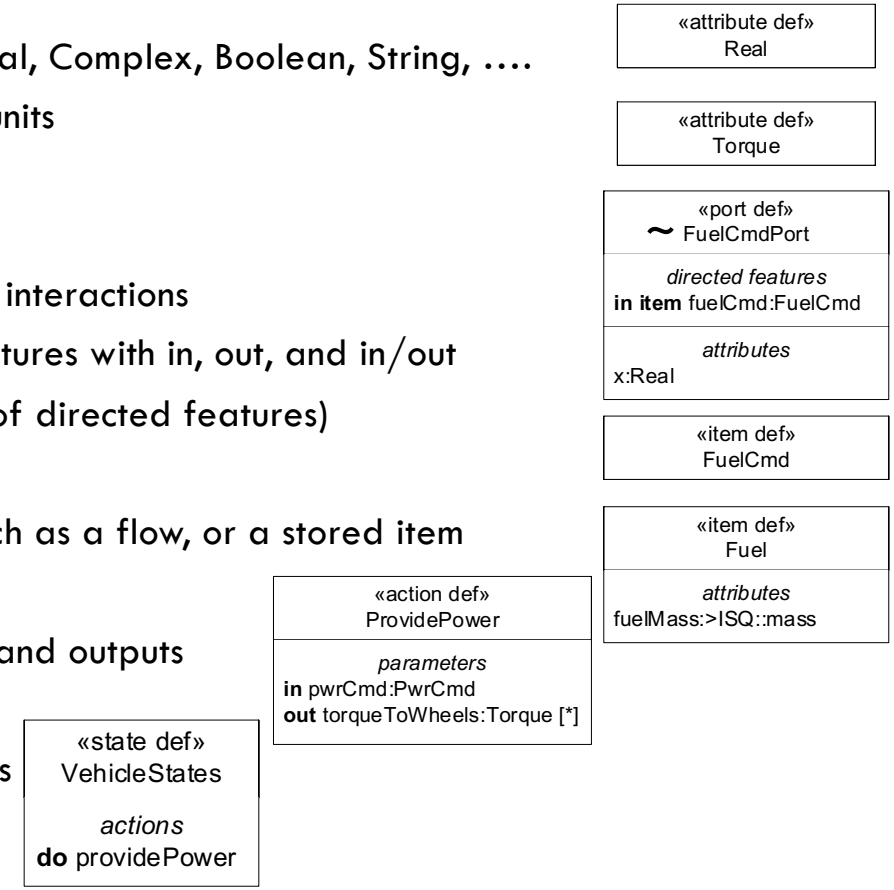


Other Kinds of Definition Elements

Terminology v2

SST

- Each kind of definition element can contain specific kinds of features
  - Attribute definition
    - Data type that defines a set of data values
    - Primitive attribute definitions include integer, Real, Complex, Boolean, String, ….
    - Can include quantity kinds such as Torque with units
    - Can include complex data types such as vectors
  - Port definition
    - Defines a connection point on parts that enable interactions
    - Contain kinds of features including directed features with in, out, and in/out
    - Ports can be conjugated (i.e., reverse direction of directed features)
  - Item definition v2
    - Defines kind of entity that may be acted on, such as a flow, or a stored item
  - Action definition
    - Defines kind of behavior that transforms inputs and outputs
  - State definition
    - Defines kind of behavior that responds to events
    - Enables entry, exit, and do actions



Specialization

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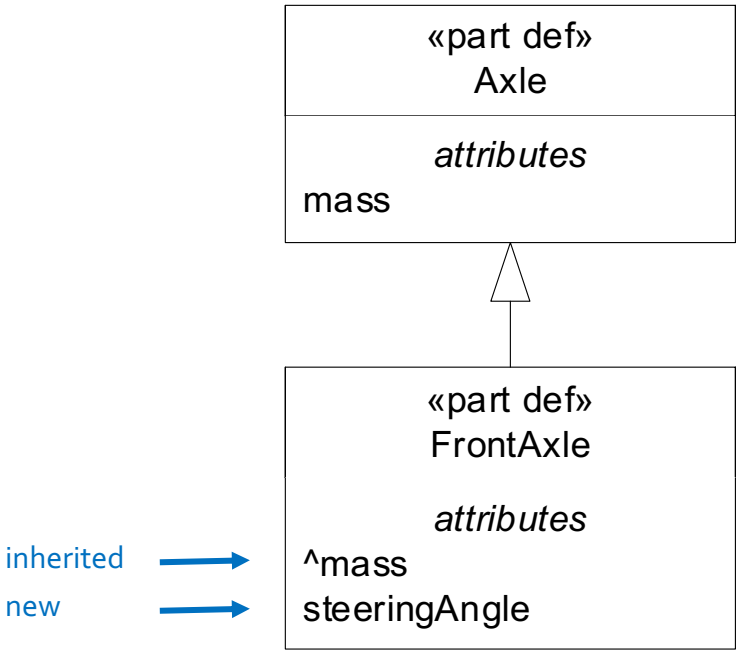
- Definition elements can be specialized
  - Subclass inherits features of superclass and can add new features
  - Can be subclassed by more than one superclass (i.e., multiple inheritance)



Redefinition and Subsetting

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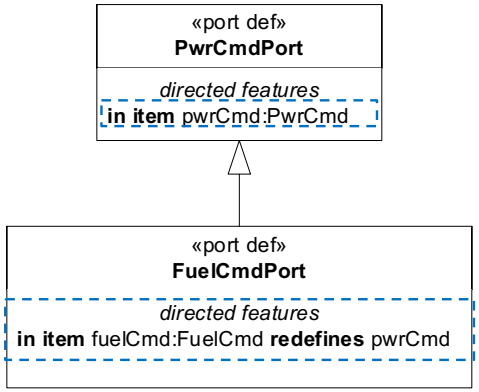
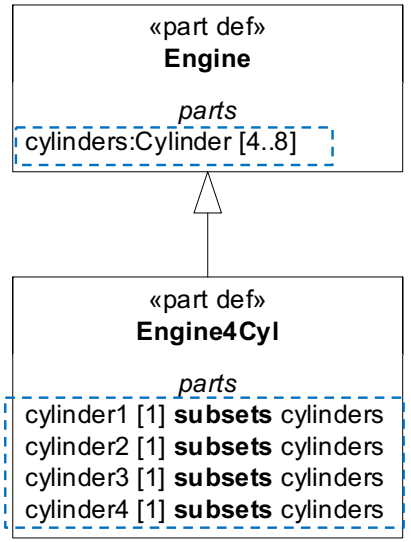
- An inherited feature can be **redefined** by a feature whose definition is more specialized
  - The more specialized feature overrides the inherited feature
  - Symbol for redefines (:>>) v2



- An inherited feature can be **subsetted** by one or more features with a more constrained multiplicity
  - The Engine4Cyl contains a subset of the cylinders contained by Engine
  - Symbol for subsets (:>) v2

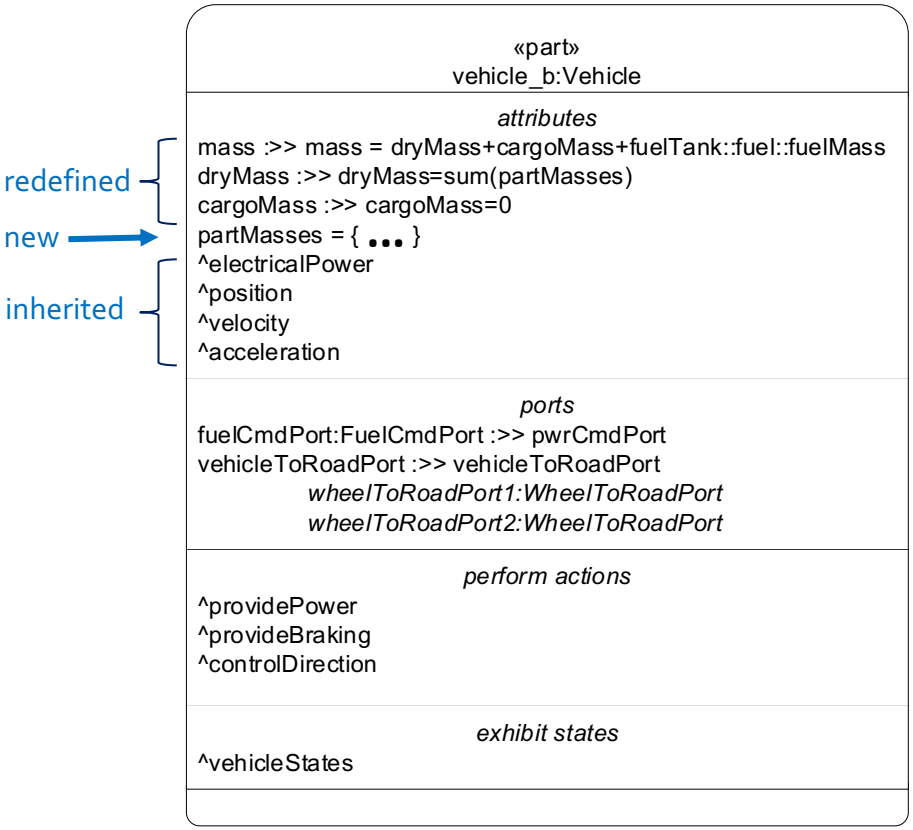


Module 3
Usage Elements

Part

SST

- A part is a usage of a part definition
- Part inherits its features from its definition v2
- Inherited features can be redefined or subsetted, and new features can be added



Other Usage Elements

Terminology v2

SST

- Other kinds of usage elements are defined by specific kinds of definition elements
  - Attributes defined by attribute definition
  - Ports defined by port definition
  - Items defined by item definition v2
  - Actions defined by action definition
  - States defined by state definition

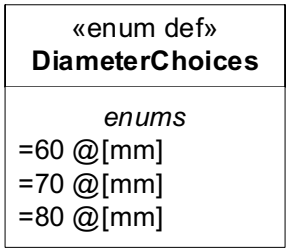
Enumeration

SST

- A data type whose range is restricted to a set of discrete values
  - Without units
    - Definition: **enum def** Colors {red; blue; green;}
    - Usage: **attribute** color1: Colors = blue;

  - With units:
    - Definition:

```
enum def DiameterChoices :> ISQ::LengthValue {
    enum = 60 @[mm];
    enum = 70 @[mm];
    enum = 80 @[mm];
}
```



v2

    - Usage: **attribute** cylinderDiameter: DiameterChoices = 80 @[mm];

Usage Elements Defined By Default Definition Elements

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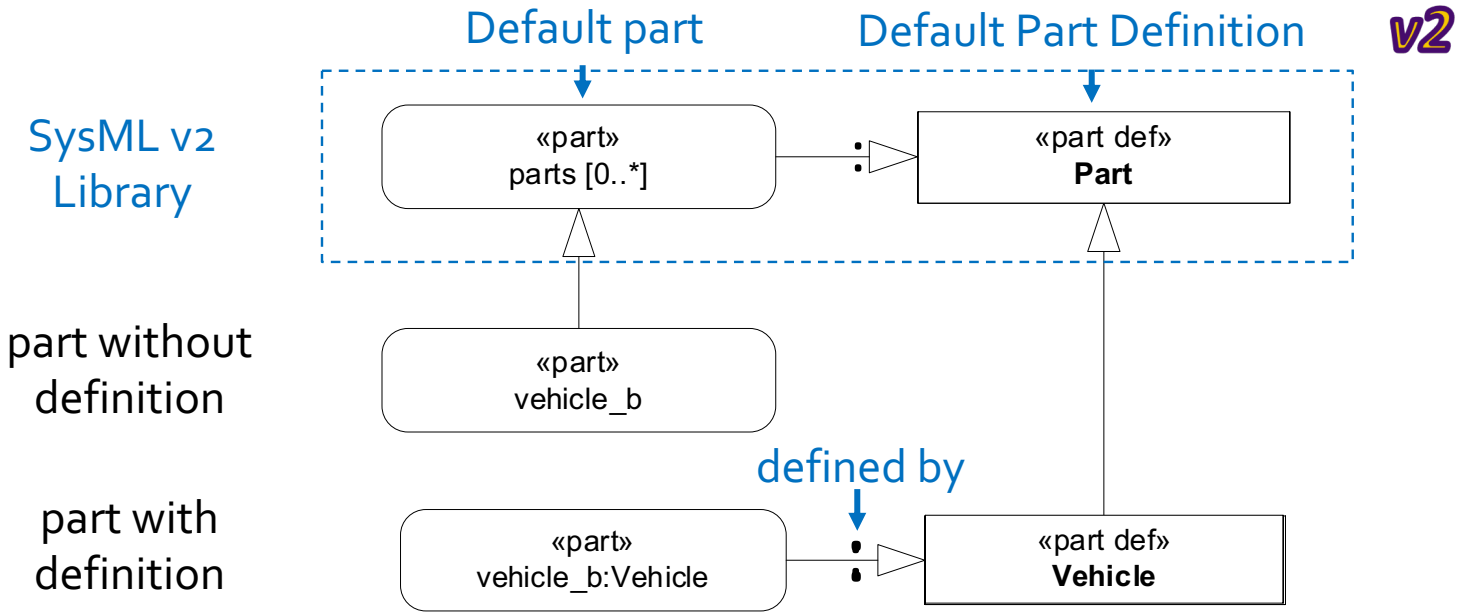
- A definition element is a subclass of the most general definition element in the SysML v2 library (e.g., Part) v2
- A usage element is defined by a definition element
  - *defined by* is a kind of specialization
- A usage element that is not provided a definition by the modeler is a subset of the most general usage element in the library (e.g., parts)



Module 4
Part Decomposition

SysML v1 Decomposition in SysML v2

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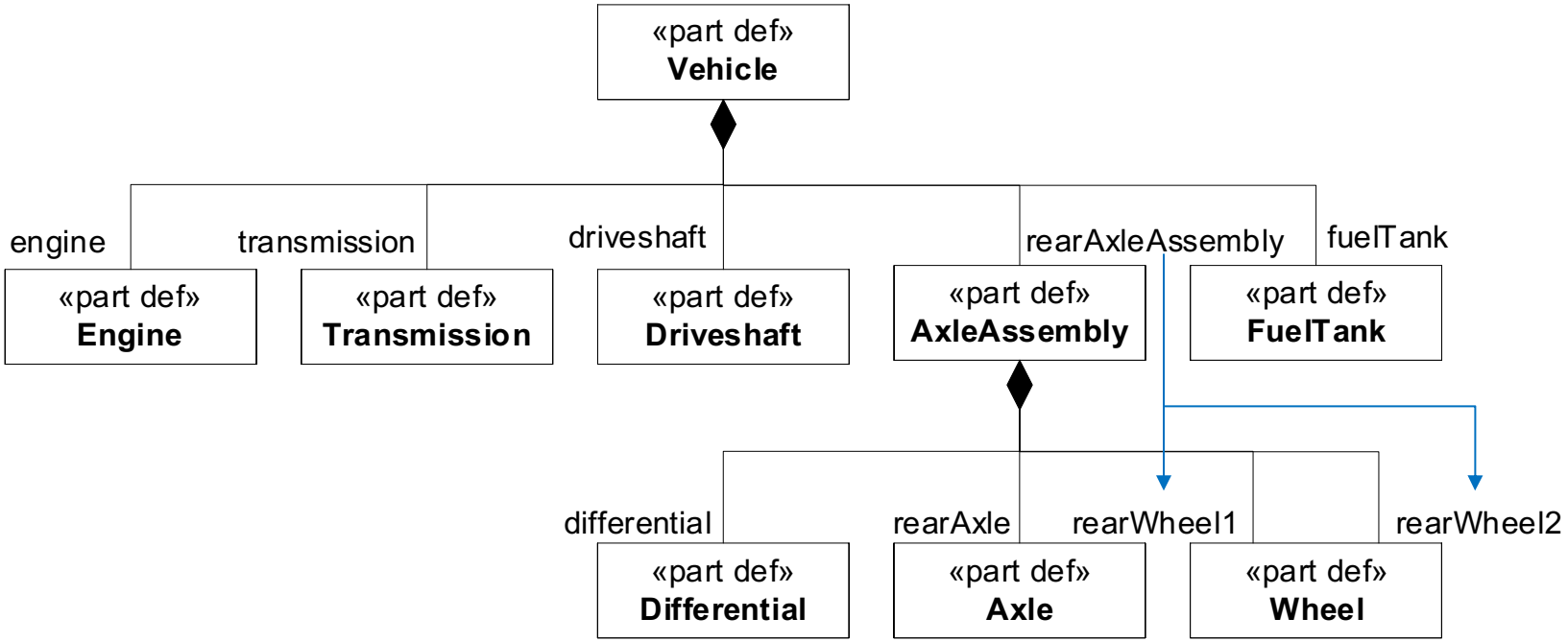
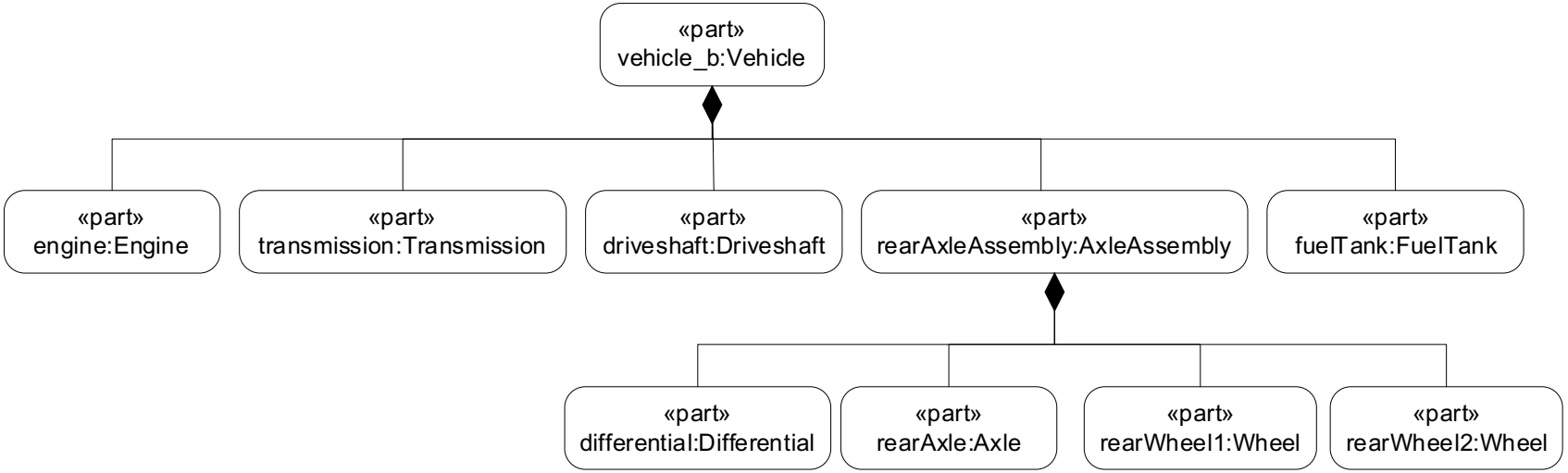
- Can create the equivalent of SysML v1 block decomposition using part definitions
  - No part to part relationships in SysML v1



Parts Decomposition

SST

- A parts tree is a composition of a part from other parts v2
  - SysML v1 only supports block decomposition
  - Definition element serves as black box specification that is not decomposed
    - Does not commit to an internal structure (e.g., decomposition)
  - Can provide significant advantages (more intuitive, less ambiguous, easier to modify a design configuration)



Parts Tree Reuse & Modification
Subsetting a Part

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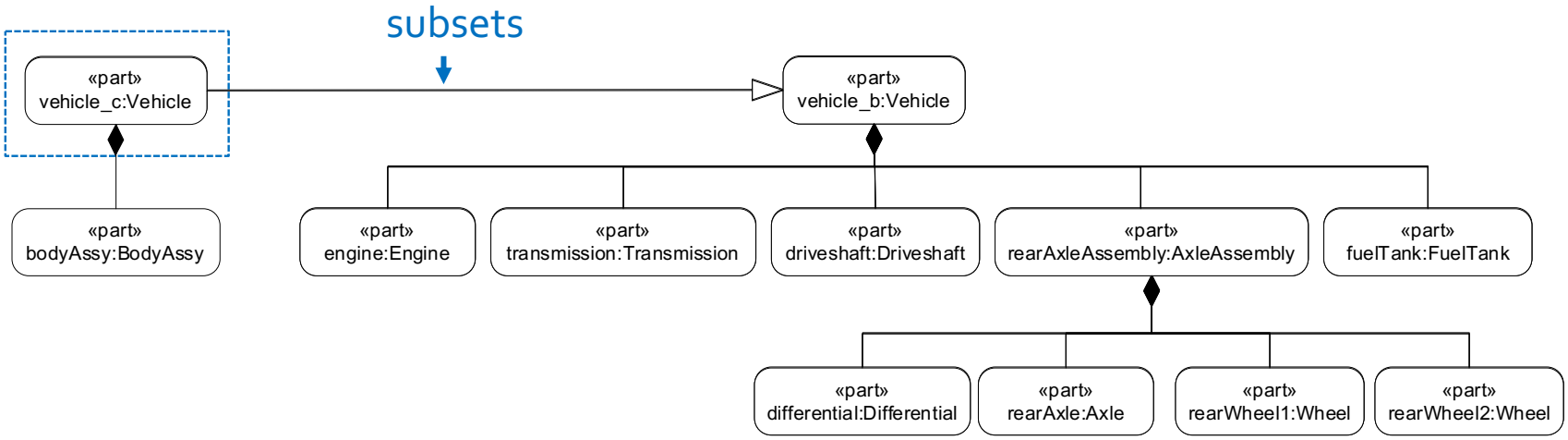
- A part can be a subset of another part
  - Equivalent to specializing a part v2
  - Inherits the part decomposition and other features
  - Can modify inherited parts and features through redefinition and subsetting
  - Can add new parts v2



References

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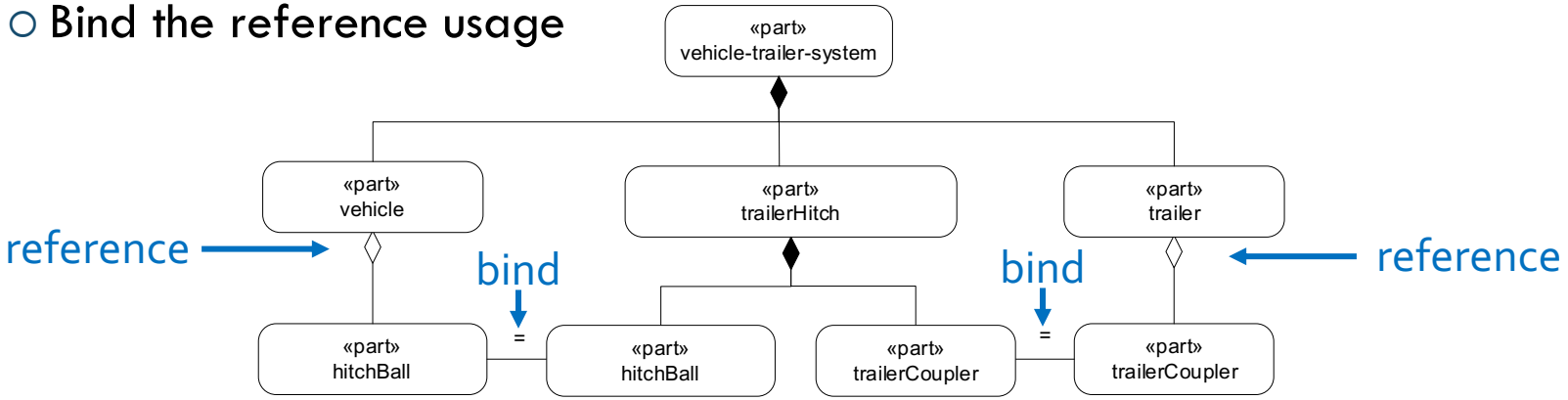
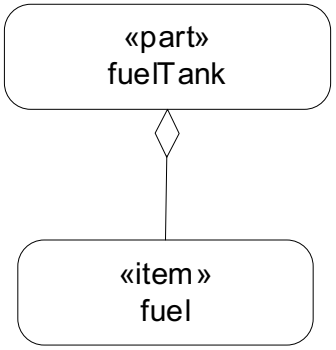
- A part can refer to other parts that are part of another decomposition v2
  - Not composite (i.e., lifetime semantics do not apply)
  - Bind the reference usage



- A part can refer to an item that it stores v2



Multiplicity

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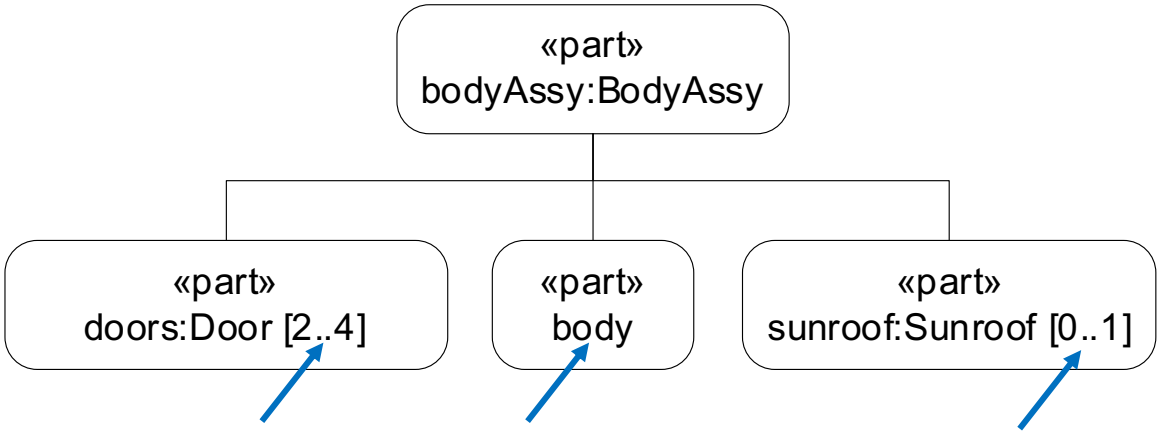
- Defines the number of features (e.g., parts) in a particular context
  - Defines a range with a lower bound and upper bound
  - Lower and upper bounds are integers
  - Default multiplicity is [1..1]
  - Optional multiplicity [0..1]



Module 5
Part Interconnection

Connecting Parts

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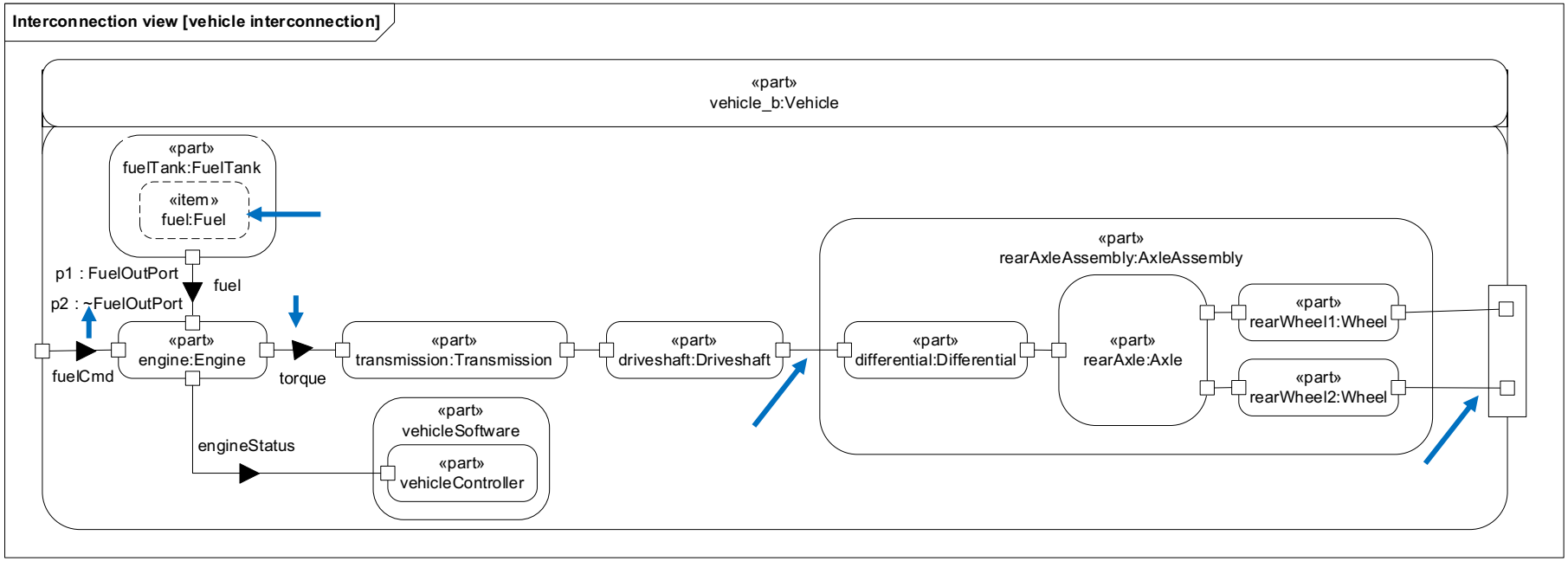
- Parts can be connected via their ports or without ports
  - Parts can be connected directly without connecting to the composite part
  - Ports can contain nested ports
  - Flows can be shown on connections
  - References are dashed
  - Conjugate port



Interfaces [1]

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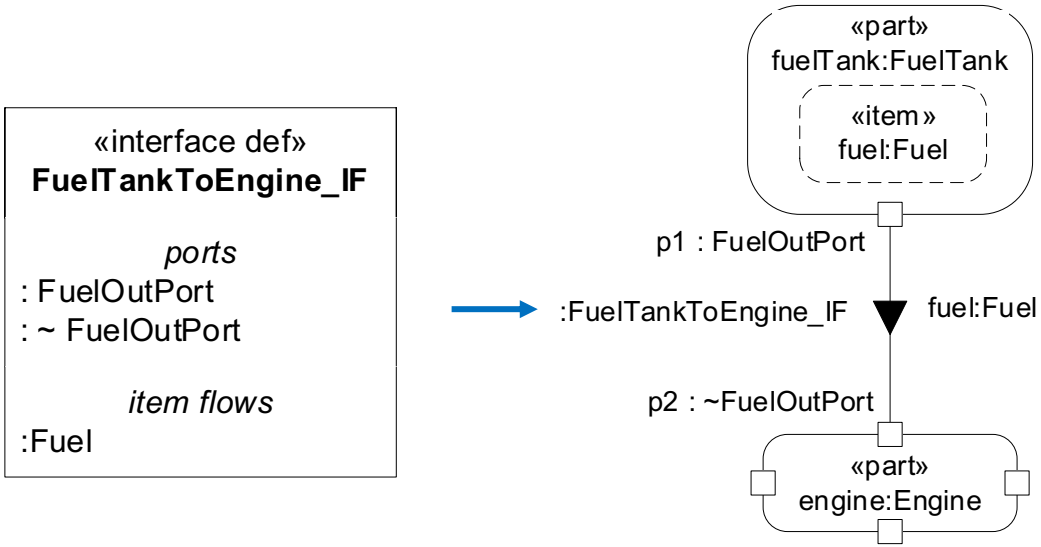
- A connection definition connects two usage elements (e.g., two parts)
- An interface definition is a connection definition whose ends are compatible ports
  - Can contain item flows
  - Can contain other kinds of features
- An interface defined by an interface definition is used to connects parts
  - Ports on parts must be compatible with the interface definition



Interfaces [2]
Connecting a Wheel to a Hub

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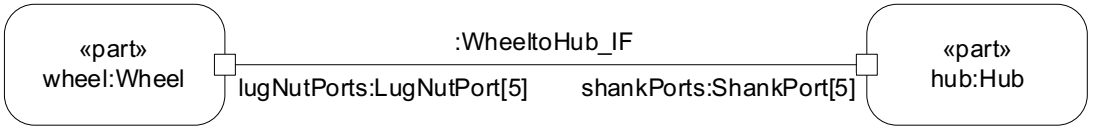
- Wheel Fastener interface species a compatible connection between a lug nut and shank
  - Specifies attributes needed for a compatible connection
- Wheel to Hub interface specifies a compatible connection between a wheel and hub (i.e., 5 lug nuts and 5 shanks)
  - Decomposes into 5 Wheel Fastener interfaces
- Usage of Wheel to Hub interface definition connects wheel to hub



«interface def»
WheelFastener_IF

ports
lugNutPort:LugNutPort
shankport:ShankPort

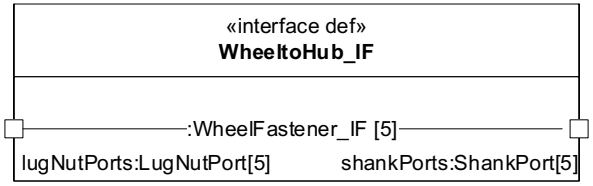
attributes
threadDia = 14 @ [mm]
threadPitch = 1.5 @ [mm]
shaftLength = 70 @ [mm]
maxTorque = 90 @ [ft-lbs]

«interface def»
WheeltoHub_IF

ports
lugNutPorts:LugNutPort[5]
shankPorts::ShankPort[5]

interfaces
: WheelFastener_IF[5]

Shows connection in compartment



Module 6
Variability

Variability v2

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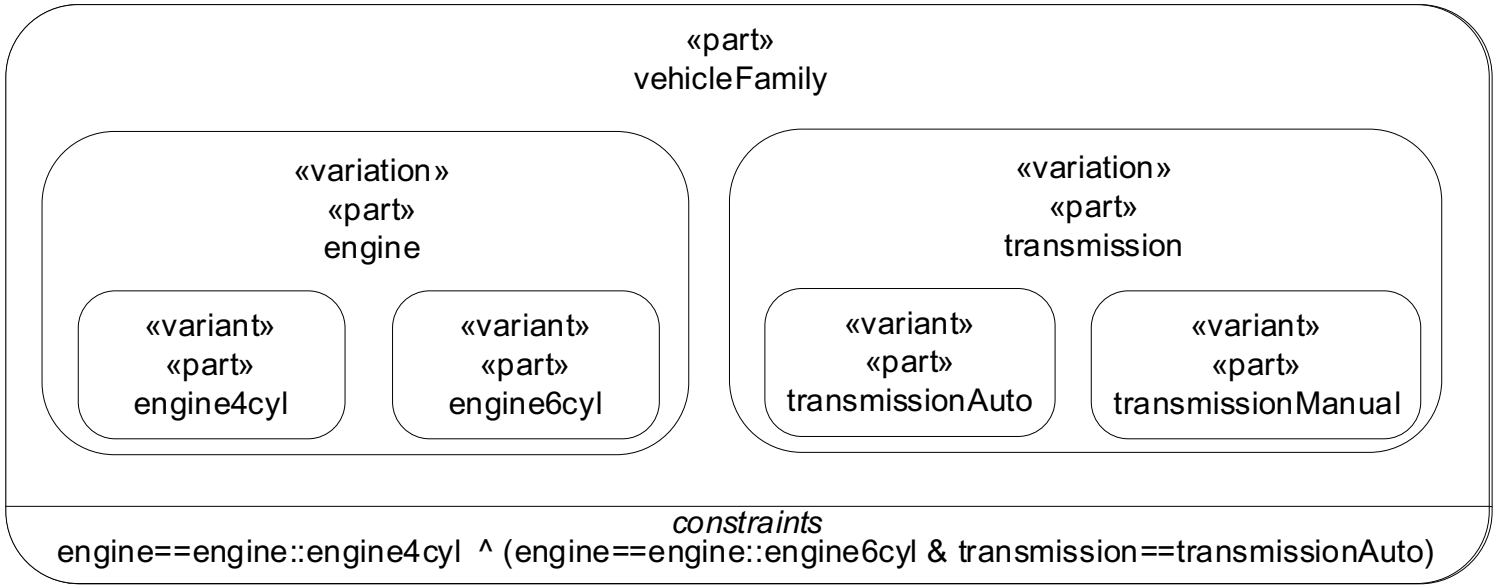
- Vehicle family is the superset model (150%)
- *Variation* points represent elements that can vary
  - *Can be* applied to all definition and usage elements
- A variant represents a particular choice at a variation point
- A choice at one variation point can constrain choices at other variation points
- A system can be *configured* by making choices at each variation point



Selected Vehicle Configuration

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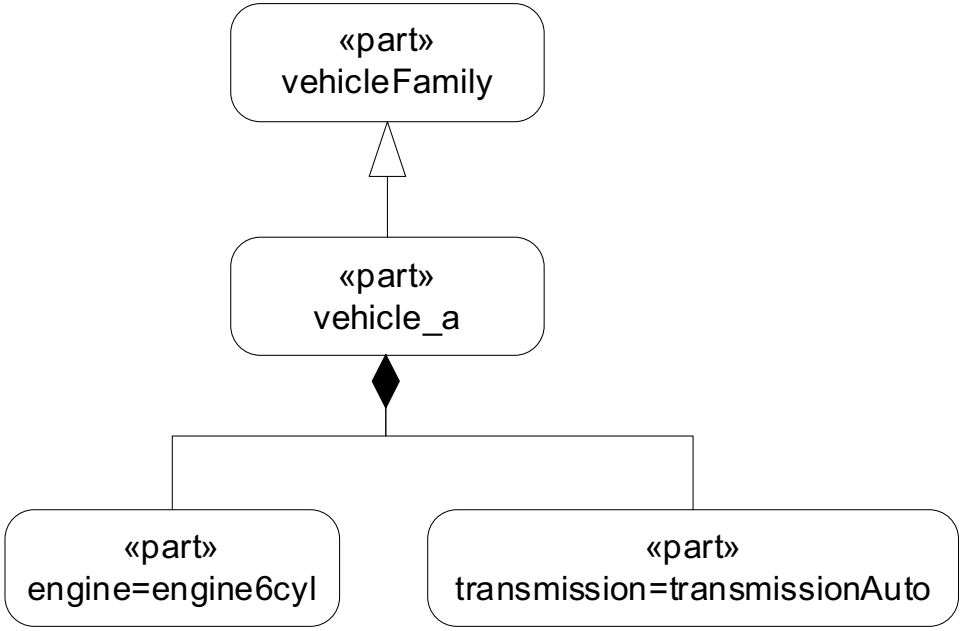
- vehicle_a subsets vehicleFamily to represent a particular design configuration
- parts are selected that conform to variability constraints
  - model is invalid if constraints are not satisfied
  - Variability modeling applications can automate the selection of valid configurations



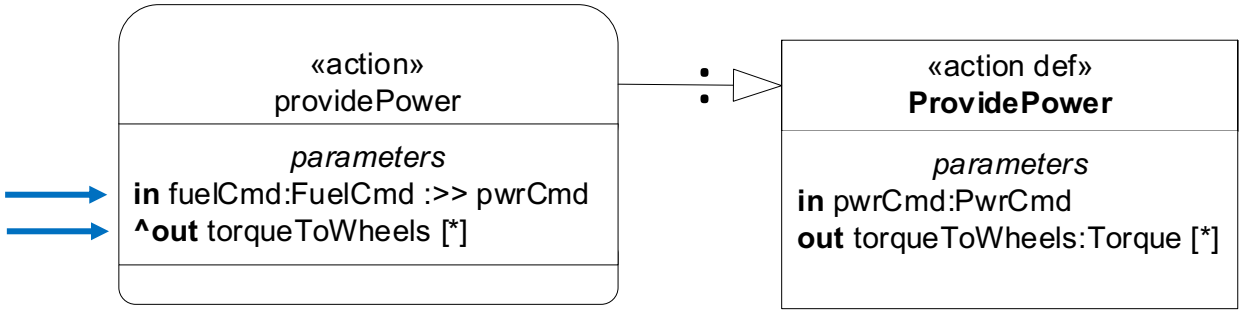
Behavior

Module 7
Actions

Actions

SST

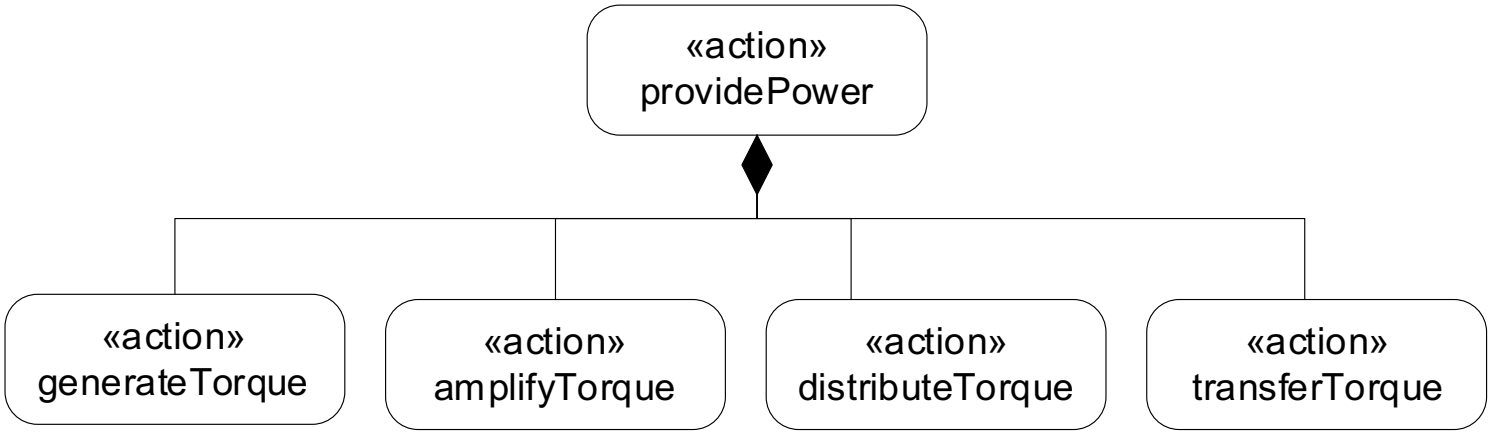
- Actions are defined by action definitions v2
  - Inherit features (e.g., input and output parameters)
  - Features can be redefined



Action Decomposition

SST

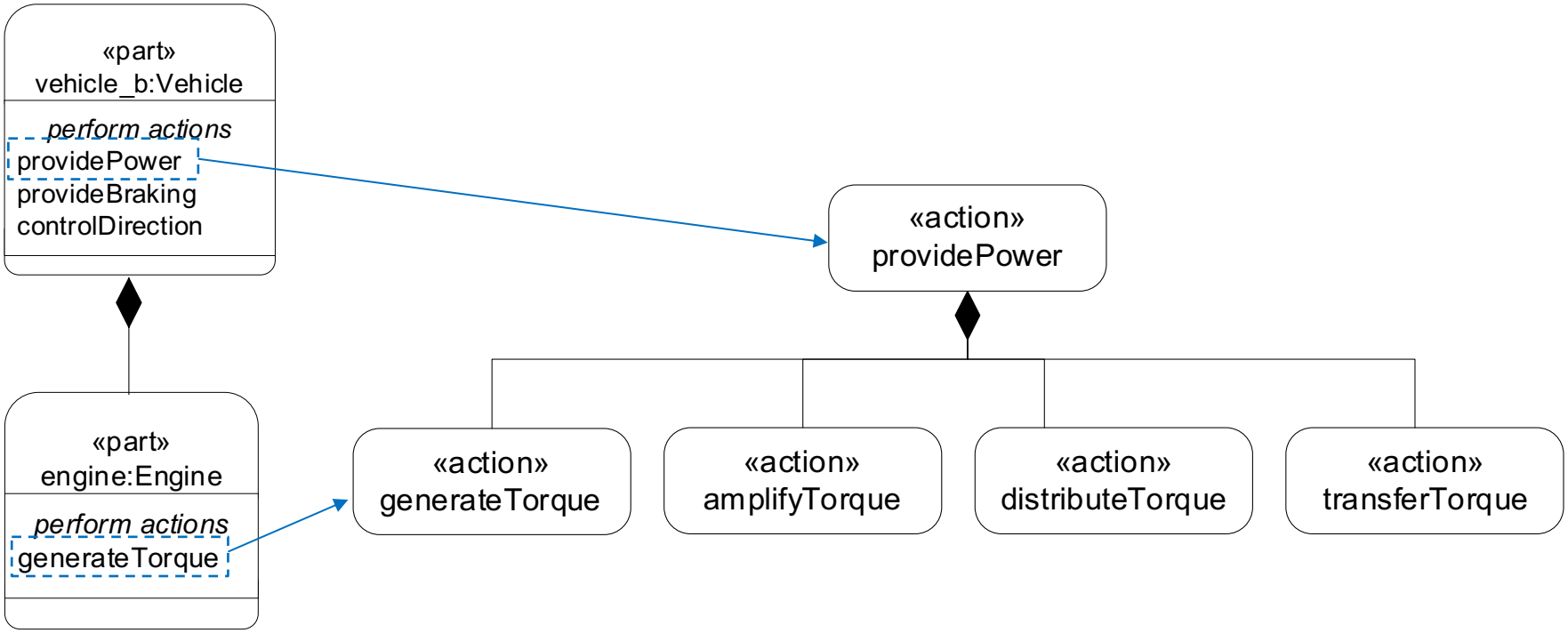
- Actions can be decomposed in a similar way as parts v2



Part Performs Actions

SST

- A part that performs an action can refer to an action in an action tree

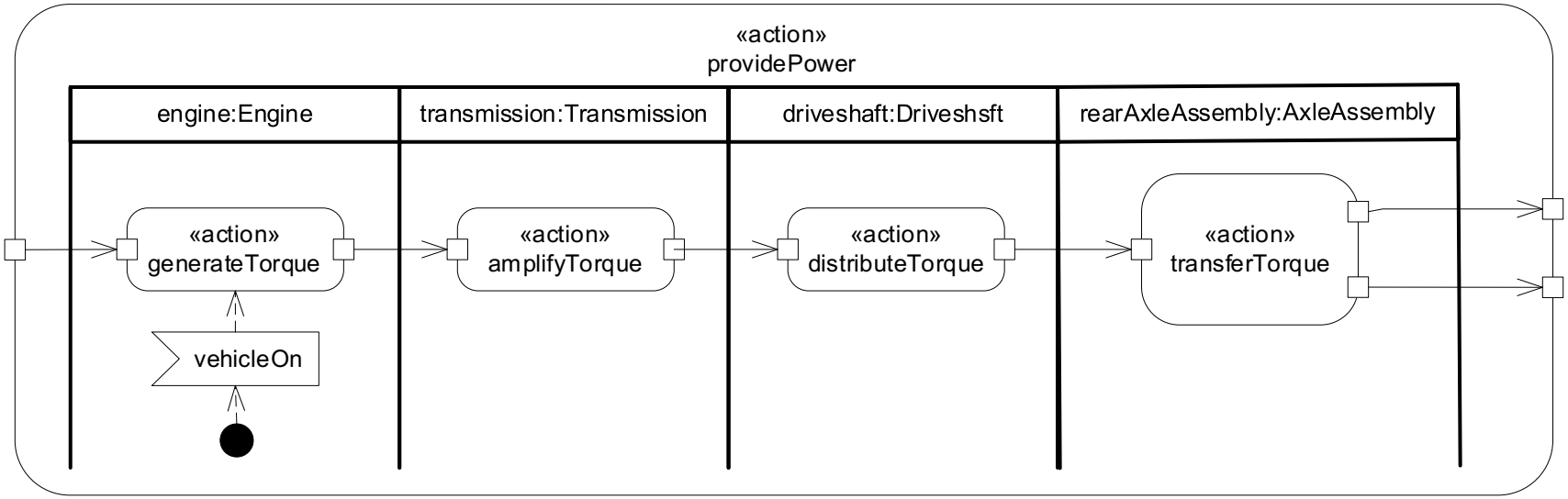


Module 8
Action Flow

Action Flows

SST

- Action flows can include control flows and input/output flows
- Control nodes include decision, merge, fork, and join nodes
- Actions can include send and accept actions
- Swimlanes represent performers of actions

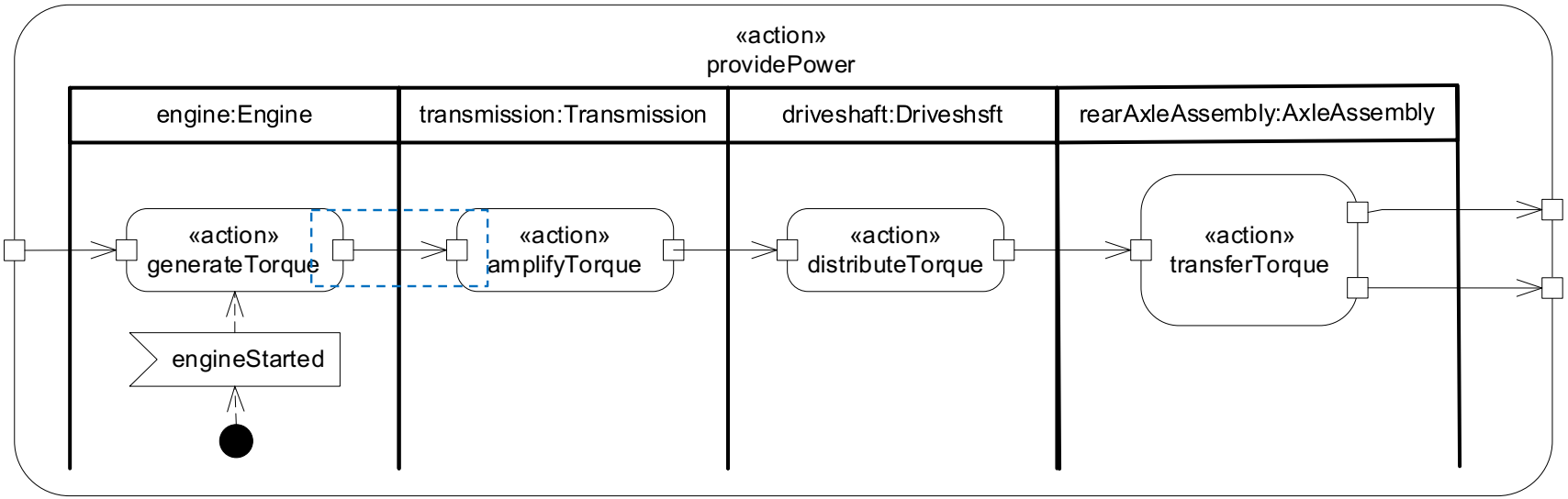


Note: Control nodes cannot currently be applied to input/output flows

Streaming and Non-Streaming Flows

SST

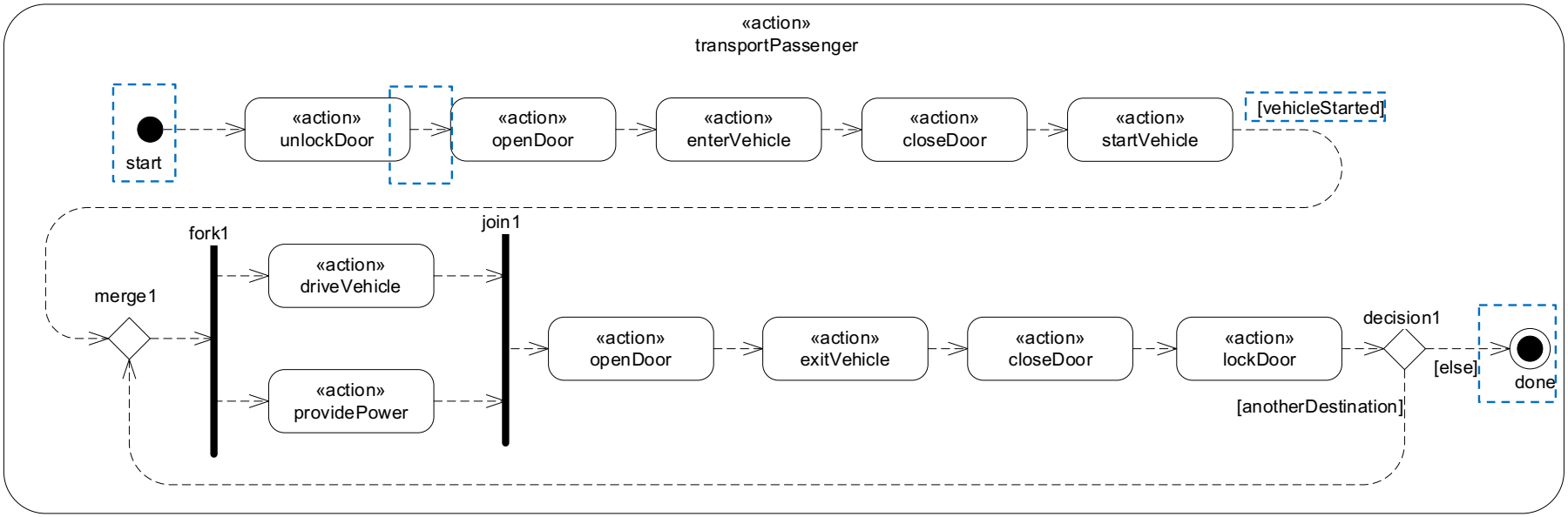
- An item flow is a kind of connection that transfers items from a source output to a target input
  - An item flow is streaming if the transfer continues while the source and target actions execute (this is the default) v2
  - An item flow is non-streaming if the transfer only occurs after the source action ends and before the target action starts



Controlling Actions [1]

SST

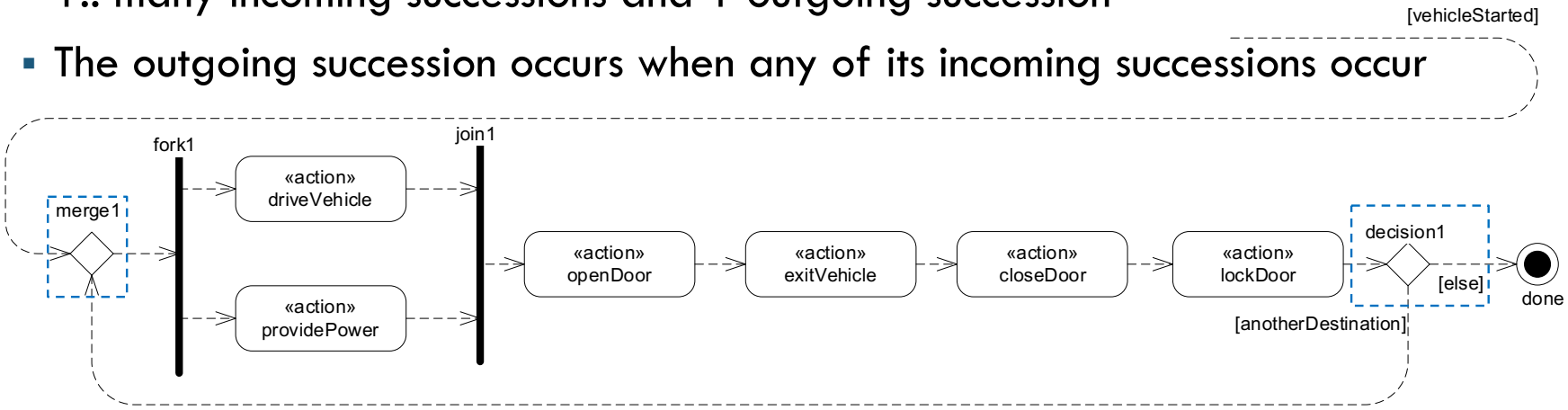
- A start action and done action represent the start and end of an action sequence
- A succession asserts that the target action can start execution only after the source action ends execution v2
- A conditional succession asserts that the target action can start only if the guard condition is true (if…then). If the guard is false, the target action cannot start



Controlling Actions [2]

SST

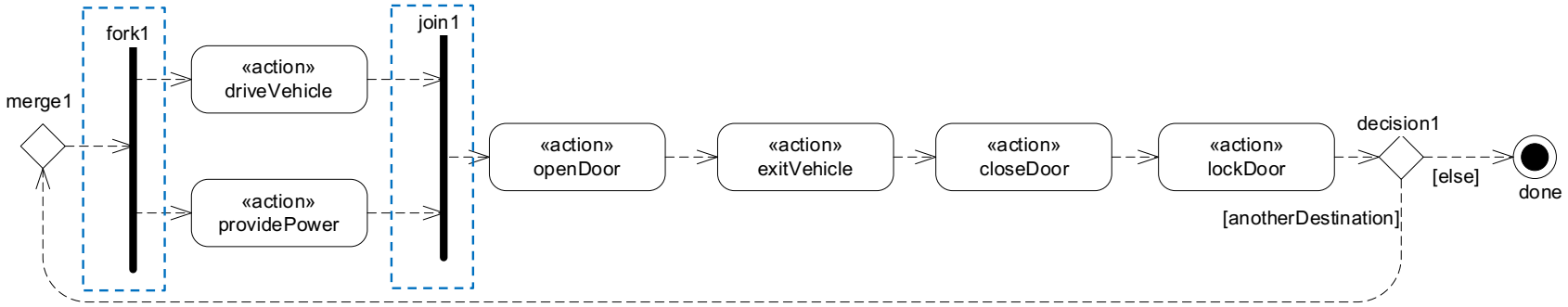
- Control nodes are kinds of actions (*with names*) that control outgoing successions in response to incoming successions v2
  - Decision node
    - 1 incoming succession and 1.. many outgoing successions
    - One outgoing succession is selected based on the guard condition that is satisfied ("else" condition is the complement of all other guard conditions)
  - Merge node
    - 1.. many incoming successions and 1 outgoing succession
    - The outgoing succession occurs when any of its incoming successions occur



Controlling Actions [3]

SST

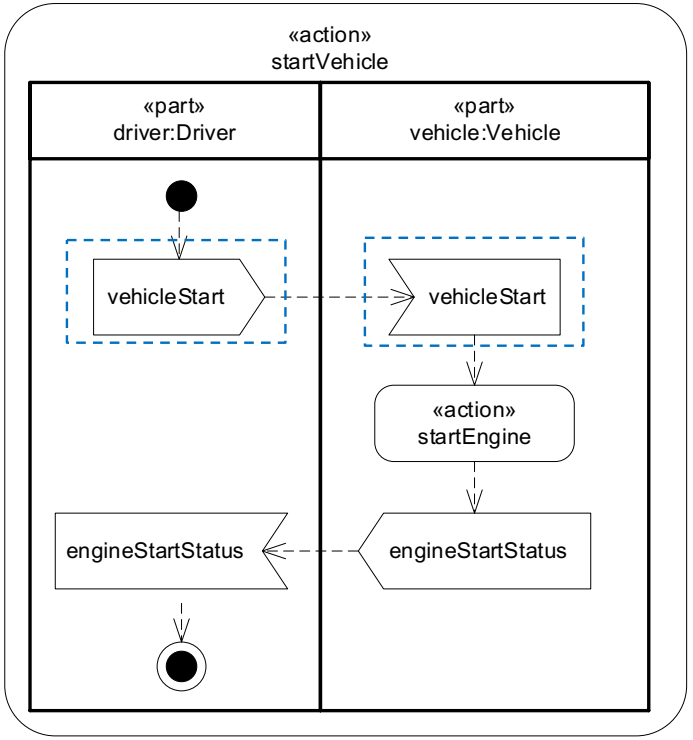
- Control nodes are kinds of actions (with names) that control outgoing successions in response to incoming successions
  - Fork node
    - 1 incoming succession and 1.. many outgoing successions
    - All outgoing successions occur when its incoming succession occurs
  - Join node
    - 1.. many incoming successions and 1 outgoing succession
    - Outgoing succession occurs when all its incoming successions occur



Controlling Actions [4]

SST

- Accept actions and send actions
  - When a send action executes, it transfers an item to a target part
  - When a triggering input item is received, an accept action executes and can transfer the input item to another action



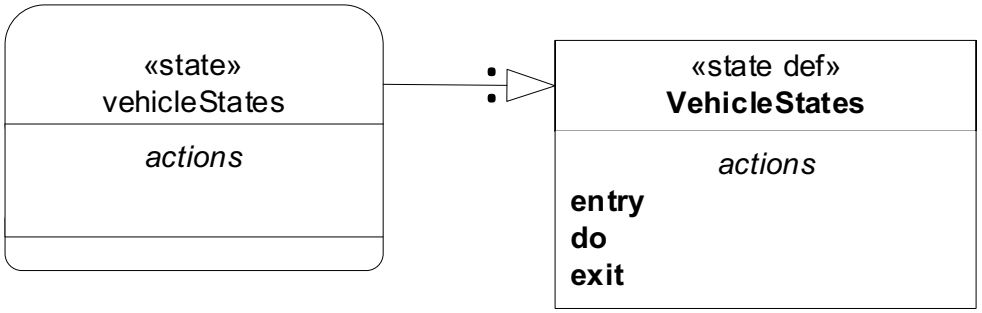
Driver and vehicle are in a shared context

Module 9
States

States

SST

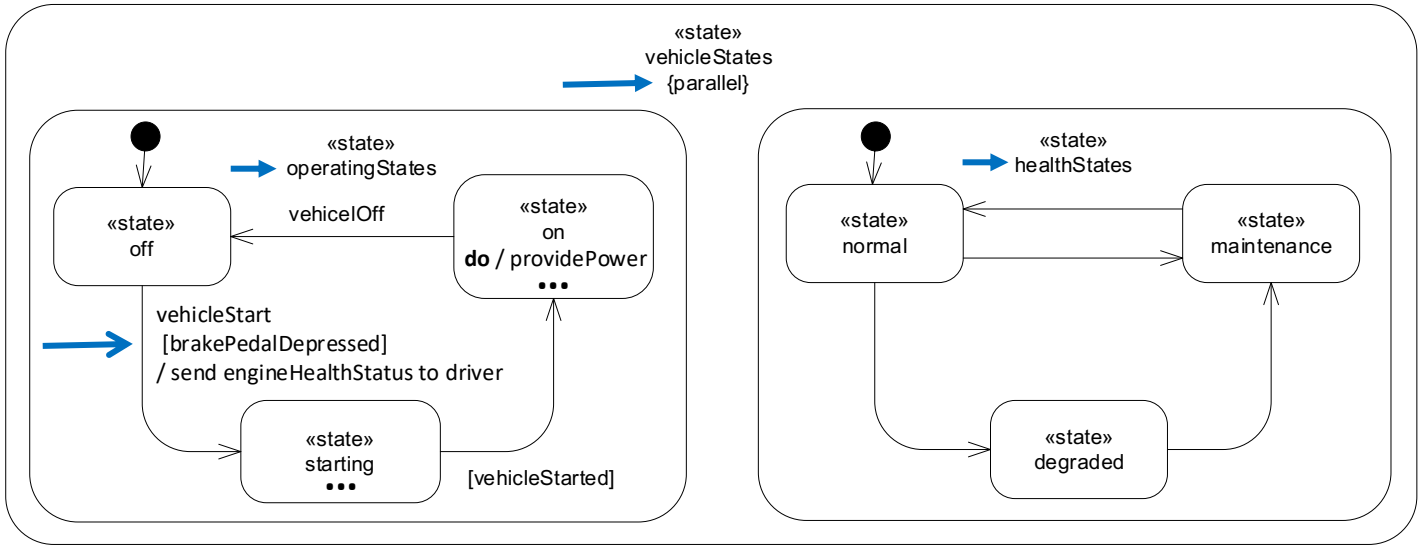
- States are defined by state definitions v2
  - Inherit features (e.g., entry, exit, and do actions) from its state definition
  - Features can be redefined



State-based Behavior [1]

SST

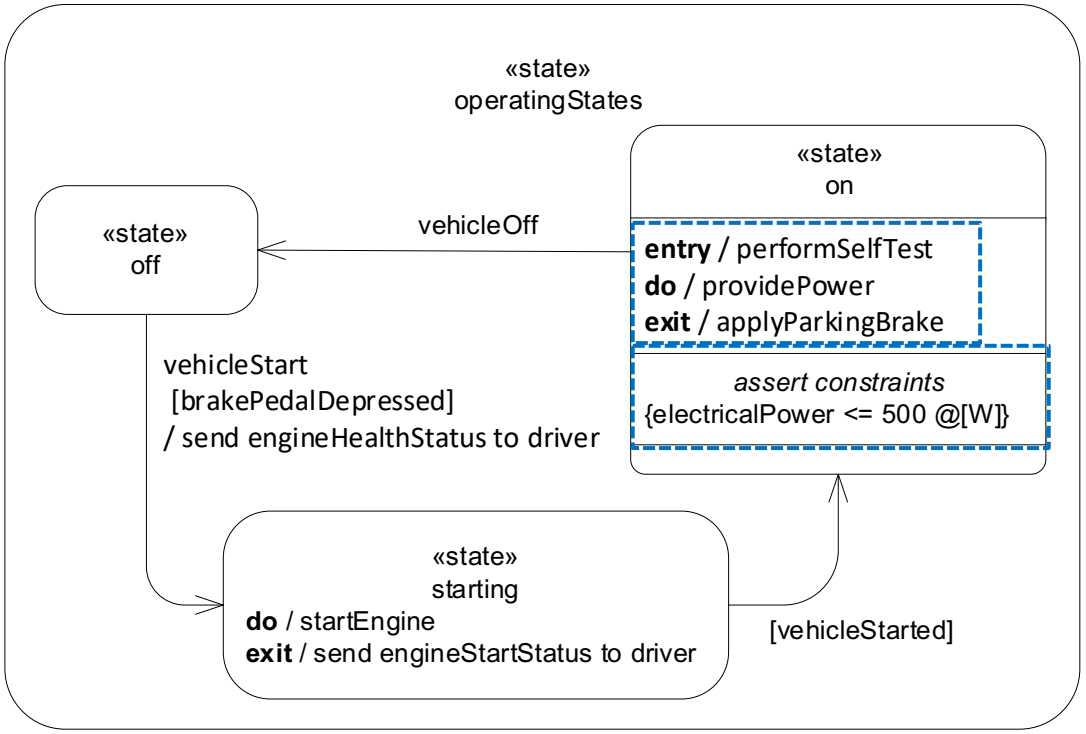
- States decompose into nested states (*without regions, which were in SysML v1*) v2
  - A parallel state decomposes into concurrent states
  - A non-parallel state (default) decomposes into sequential/exclusive states
- Transitions between sequential states
  - Triggered by events
  - Can include guard and action



State-based Behavior [2]

SST

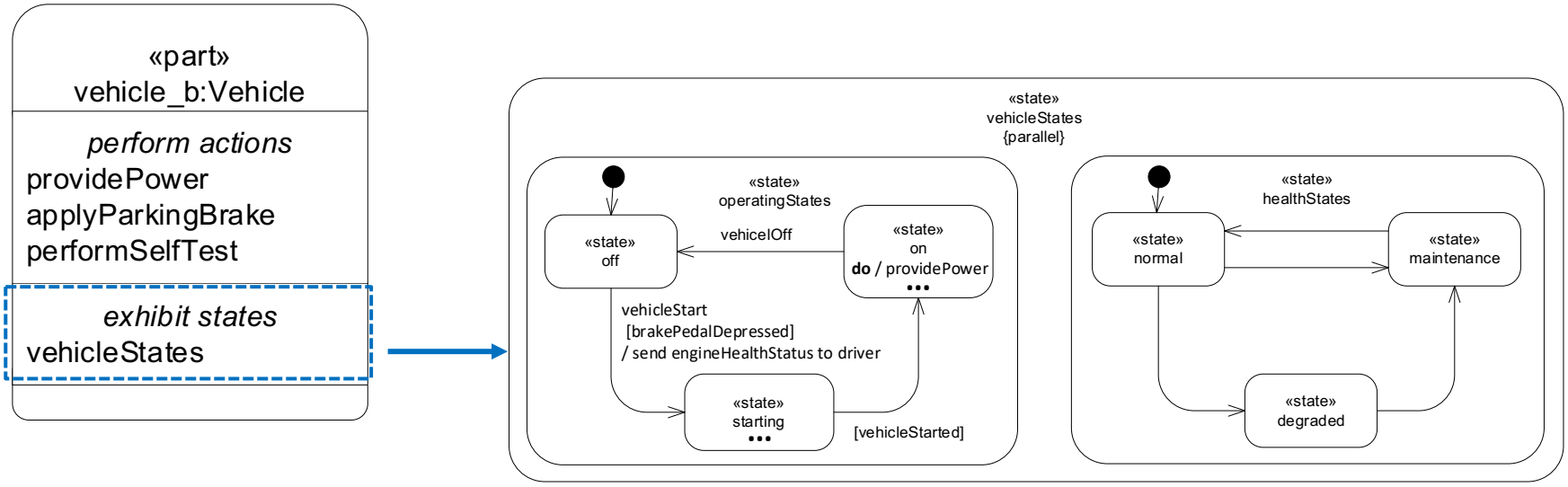
- States can have entry, exit, and do actions that can refer to actions in action trees or be defined locally
- States can include constraints (i.e. SysML v2 state invariants)



Part Exhibits States

SST

- A part that exhibits states can refer to state-based behavior v2



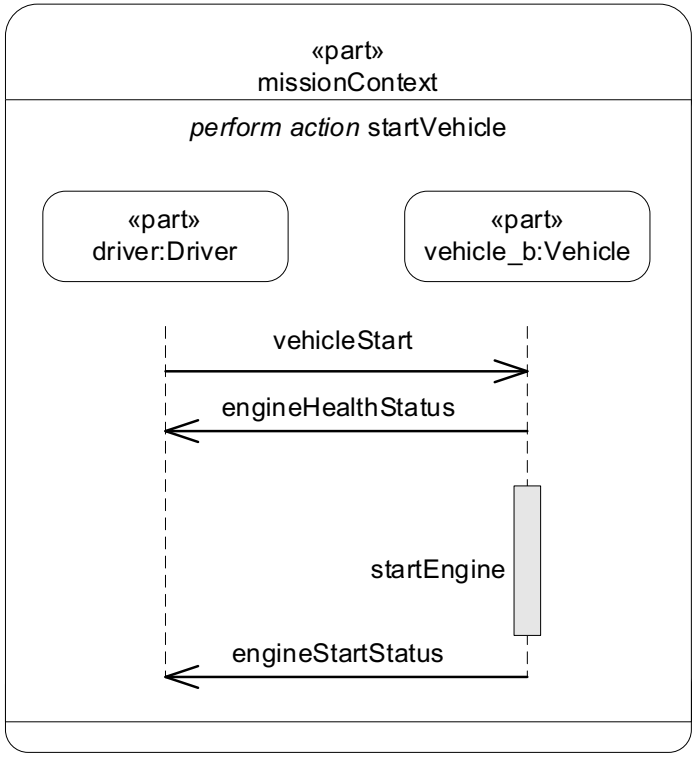
Module 10
Sequences

Sequences

In Process

SST

- Represents a sequence of messages between send and accept actions
  - Asynchronous – sender does not wait for reply
  - Synchronous – sender waits for reply (under discussion)

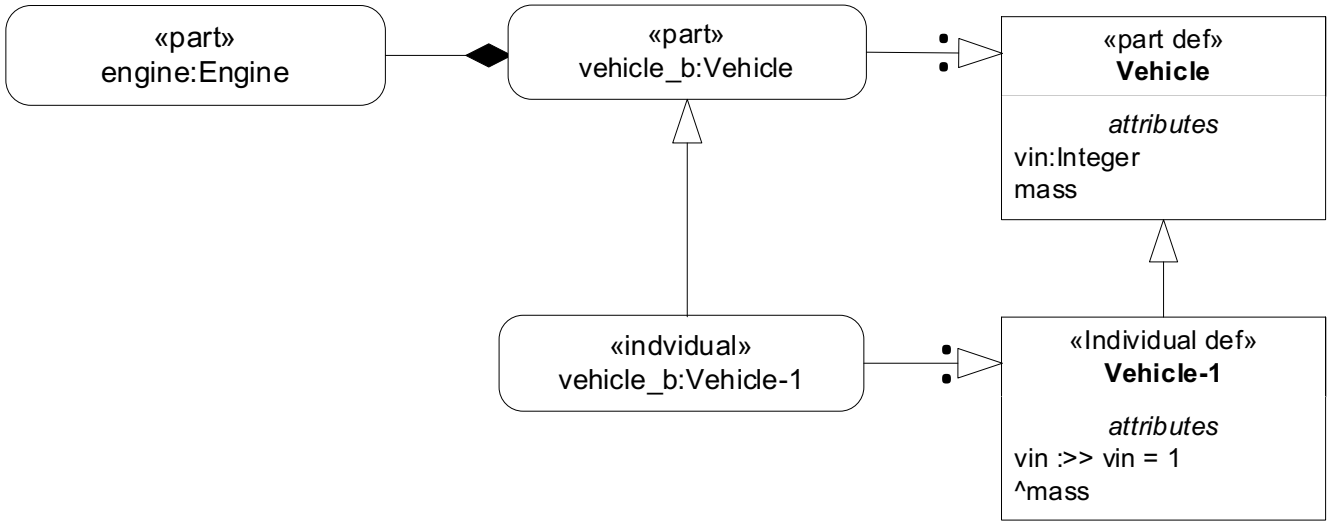


Module 11
Individuals

Individuals v2

SST

- An individual definition is a unique member of a class with identity
  - A specialization of a class, having only one member
  - Has a unique lifetime
- An individual is a usage that is defined by an individual definition
  - Can subset a part to represent a particular configuration
  - Can have different configurations across Vehicle-1 lifetime



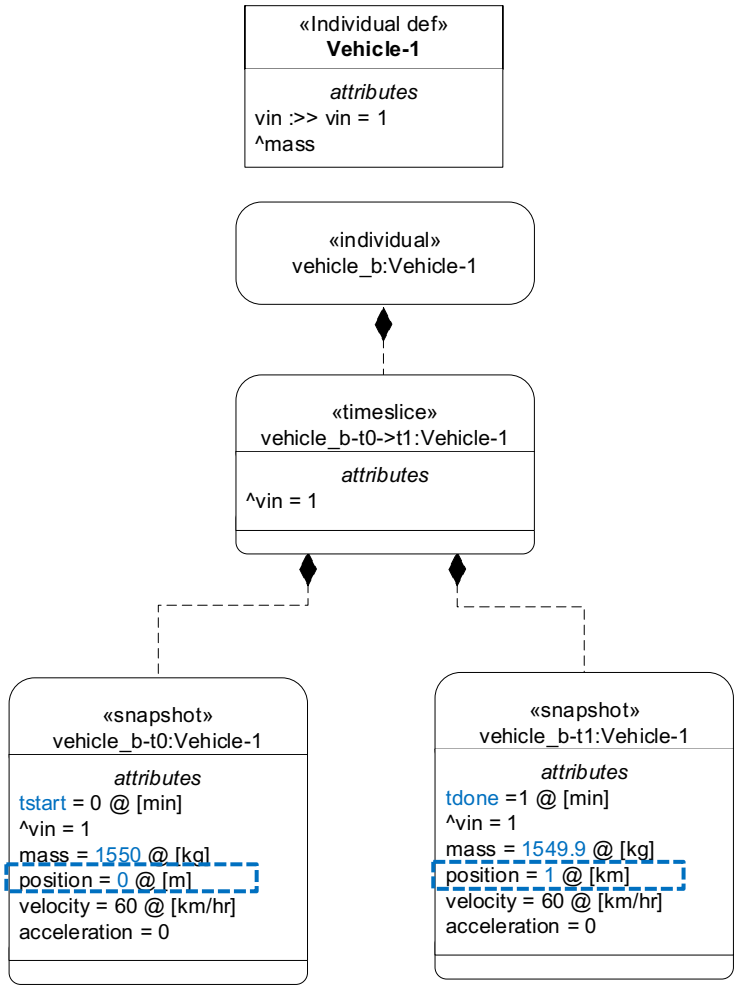
Module 12
Timeslices & Snaphots

Lifetime with Snapshots and Time Slices v2

SST

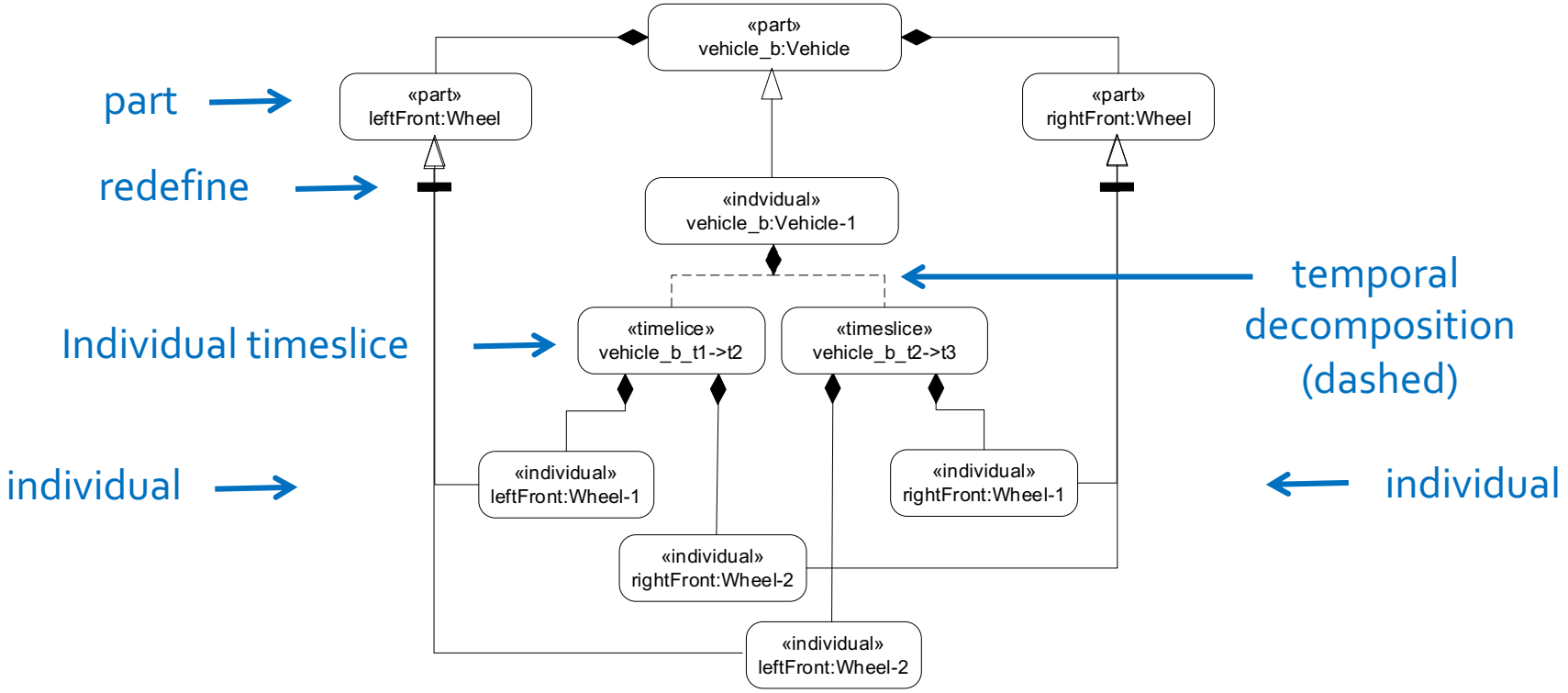
- Each individual definition has a unique lifetime
  - Begins when it is created
  - Ends when it is destroyed
- Individual usage exists over some portion of Vehicle-1 lifetime
- Individual lifetime can be segmented into timeslices (i.e., durations of time)
- A timeslice whose duration is zero is a snapshot
  - Beginning and ending snapshot of a time slice is designated as start and done snapshot
- The condition of an individual for a timeslice or snapshot can be specified in terms of the values of its features

Note: *The temporal decomposition is dashed*



Individuals Playing Different Roles v2 SST

- An individual can play different roles and have different configurations in different timeslices
  - Individual wheel (wheel-1) is left front wheel during vehicle_b_t1-t2 timeslice
  - Individual wheel (wheel-1) is right front wheel during vehicle_b_t2-t3 timeslice

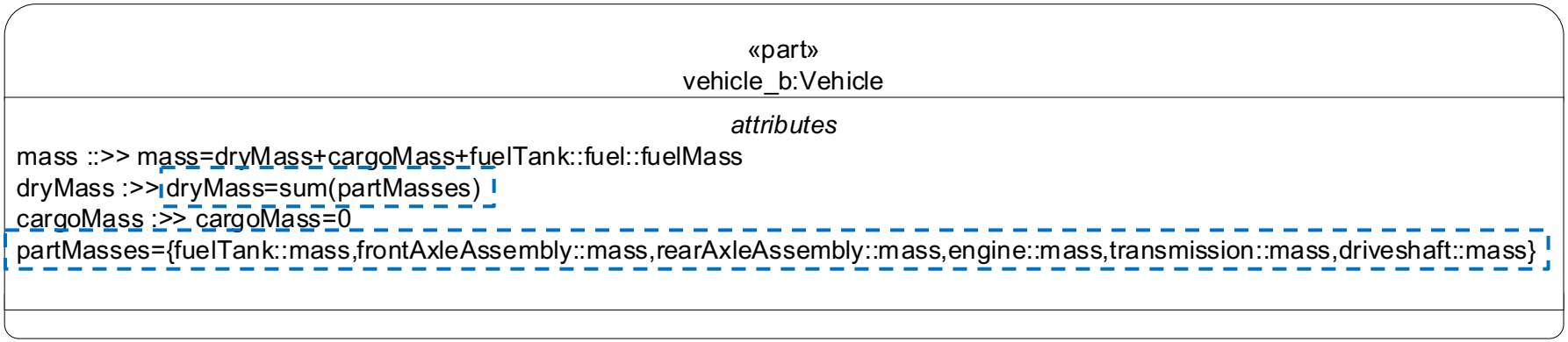


Module 13
Expressions and Calculations

Expressions v2

SST

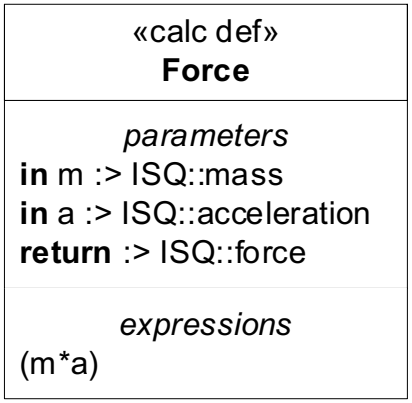
- Used to compute a result
- Library of mathematical functions (e.g., sum, max, …)
  - Includes arithmetic operators that also apply to vectors and tensors



Calculations v2

SST

- A kind of behavior generally used to represent reusable mathematical functions
  - Inputs
  - Expression
  - Returns a single result



- Represent a calculation using the textual notation
  - **calc def** Force (m : >ISQ::mass, a : >ISQ::acceleration) : >ISQ::force = (m * a);
- Evaluate usage
  - Bind values to input parameters. Then evaluate expression and return a result
  - **calc** forceCalc : Force (m=1500 @[kg], a=9.806 @[m/s^2]) f;
  - f = Force (m=>1500 @ [kg] , a => 9.806 @ [m/s ^2])
- Usage can be owned by a part, action, constraint, package, ….

Binding Connection

SST

- A binding is a kind of connection where both sides of the connection are asserted to be equal at all times
  - Symbol is «bind» or =
  - If both sides are not equal, the model is invalid (e.g., 3=4) is invalid
  - A tool could make both sides equal if the values are not the same
    - In the above example, the values can be set to (3=3) or (4=4)
    - For y = x+3, when x is 1, then y can be set to 4 so that both sides are equal
  - Different from the Boolean operator '==', which evaluates whether both sides of the '==' have the same value or not, and returns a value of true or false (e.g., {3==4} returns a value of false)
- Binding is used more broadly to establish equality of any kind of feature
  - A part can be set to be the same value (e.g., engine = engine4cyl)
  - A port on a composite part can be bound to a port on a nested part to constrain them to have equal values

Module 14
Quantities & Units

Quantities and Units

SST

- Quantity is an attribute (e.g., mass) v2
- Quantity is defined by an attribute def of a quantity kind (e.g., MassValue)
- Units conform to the quantity kind
- Units are associated with the value v2
- A change in a unit will apply the unit conversion factor (if a tool supports this)
  - ***attribute*** *m:MassValue = 25 @[kg] (if kg is changed to lbs, the value is changed to 55.1 @[lbs])*
  - In SysML v1, a change in unit requires a change in the value type
- Complex quantities and units can be derived from primitive quantities and units
- Libraries
  - International System of Quantities (ISQ)
  - International System of Units (SI) v2
  - US Customary Units (USCustomaryUnits)

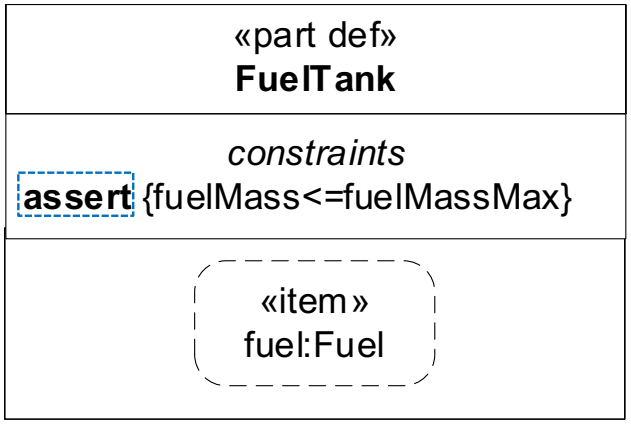
Module 15
Constraints

Constraint Expression [1]

SST

- A Boolean expression that evaluates to true or false, which includes v2
  - Constraint operators (==), (>), (>=), (<), (<=), (!=)
    - Used to compare expressions (e.g., {a < b})
  - Boolean operators include AND (&), Inclusive OR (|), Exclusive OR (^), NOT (!)
    - Used to logically combine expressions (e.g., {A & B | C})
- Asserting a constraint to be true means the evaluation must be true for the model to be valid

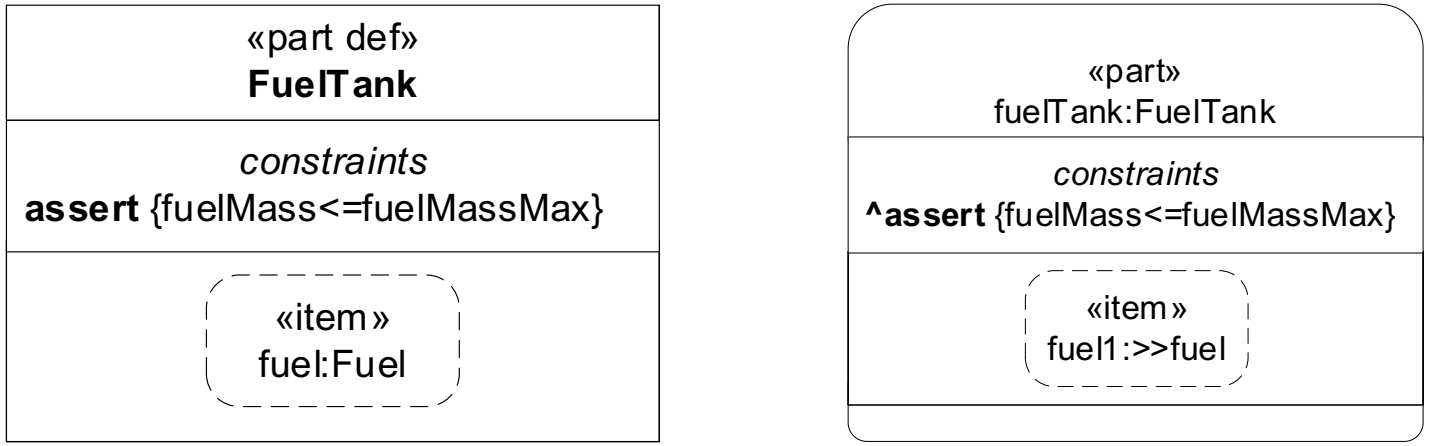
```
part def FuelTank {
        attribute mass :> ISQ::mass;
        ref item fuel:Fuel{
          attribute redefines fuelMass;
        }
        attribute fuelMassMax:>ISQ::mass;
        assert constraint {fuel::fuelMass<=fuelMassMax}
}
```



Constraint Expression [2]

SST

- Usage inherits constraint expression



Constraint Definition

SST

- A reusable constraint expression
- Default parameter direction is 'in'

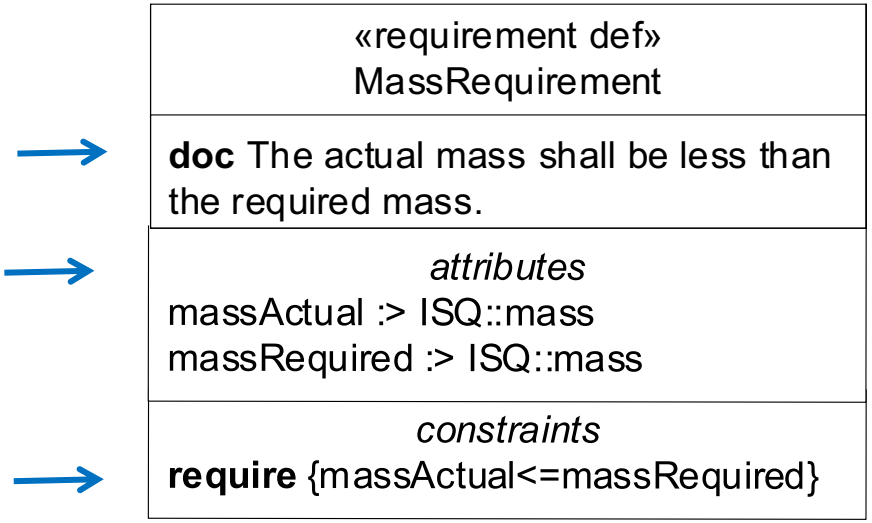
«constraint def» **StraightLineDynamics**
parameters power :> ISQ::power m :> ISQ::mass delta_t :> ISQ::time x_in :> ISQ:: length v_in:>ISQ: speed x_out :> ISQ::length v_out :> ISQ::speed a_out :> ISQ::acceleration
constraints **assert** {a_out **==** power/(mass*v_avg) & v_out **==** v_in +a_out*delta_t & x_out **==** x_in+v_avg*delta_t}

Module 16
Requirements

Requirement Definition

SST

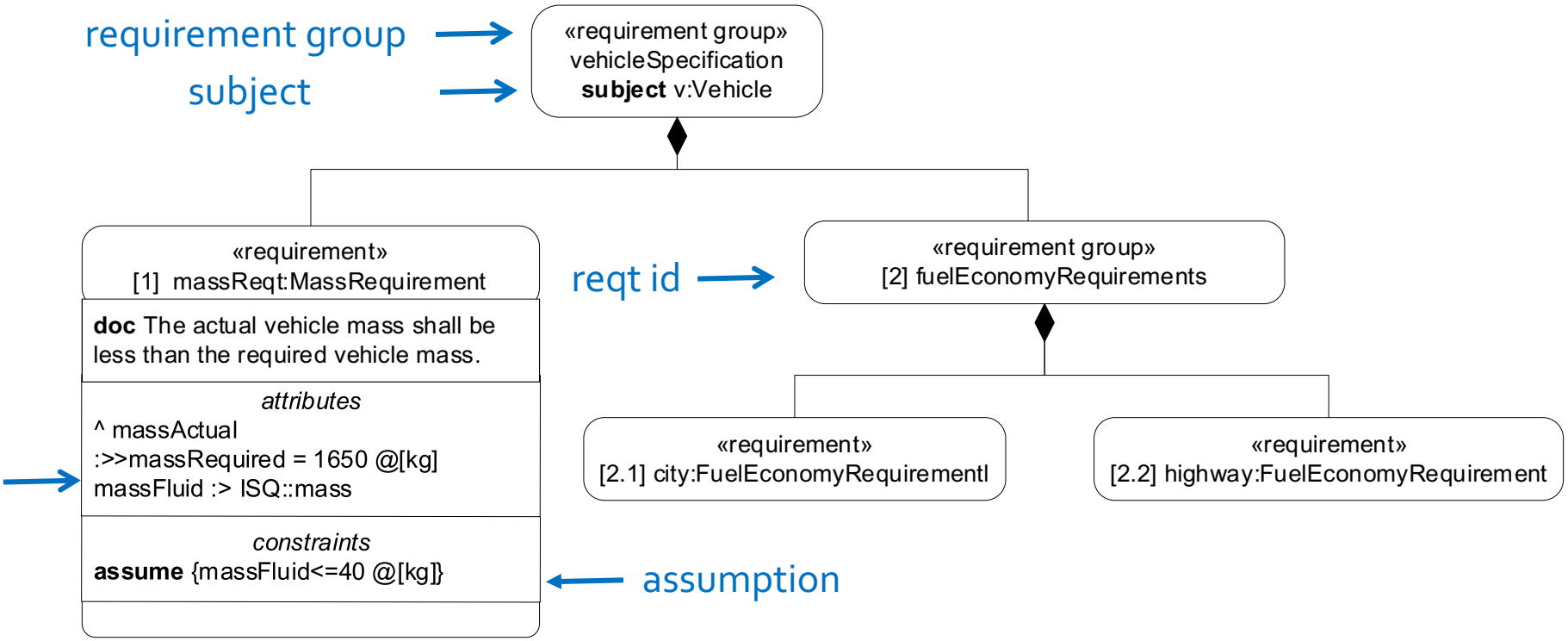
- A constraint definition that a valid design solution must satisfy that can include: v2
  - Identifier
  - Shall statement
  - Constraint expression that can be evaluated to true or false
    - can apply to performance, functional, interface and other kinds of requirements if desired
  - Assumed constraint expression that is asserted to be true for the requirement to be valid
  - Attributes of the constraint expressions



Requirement Specification

SST

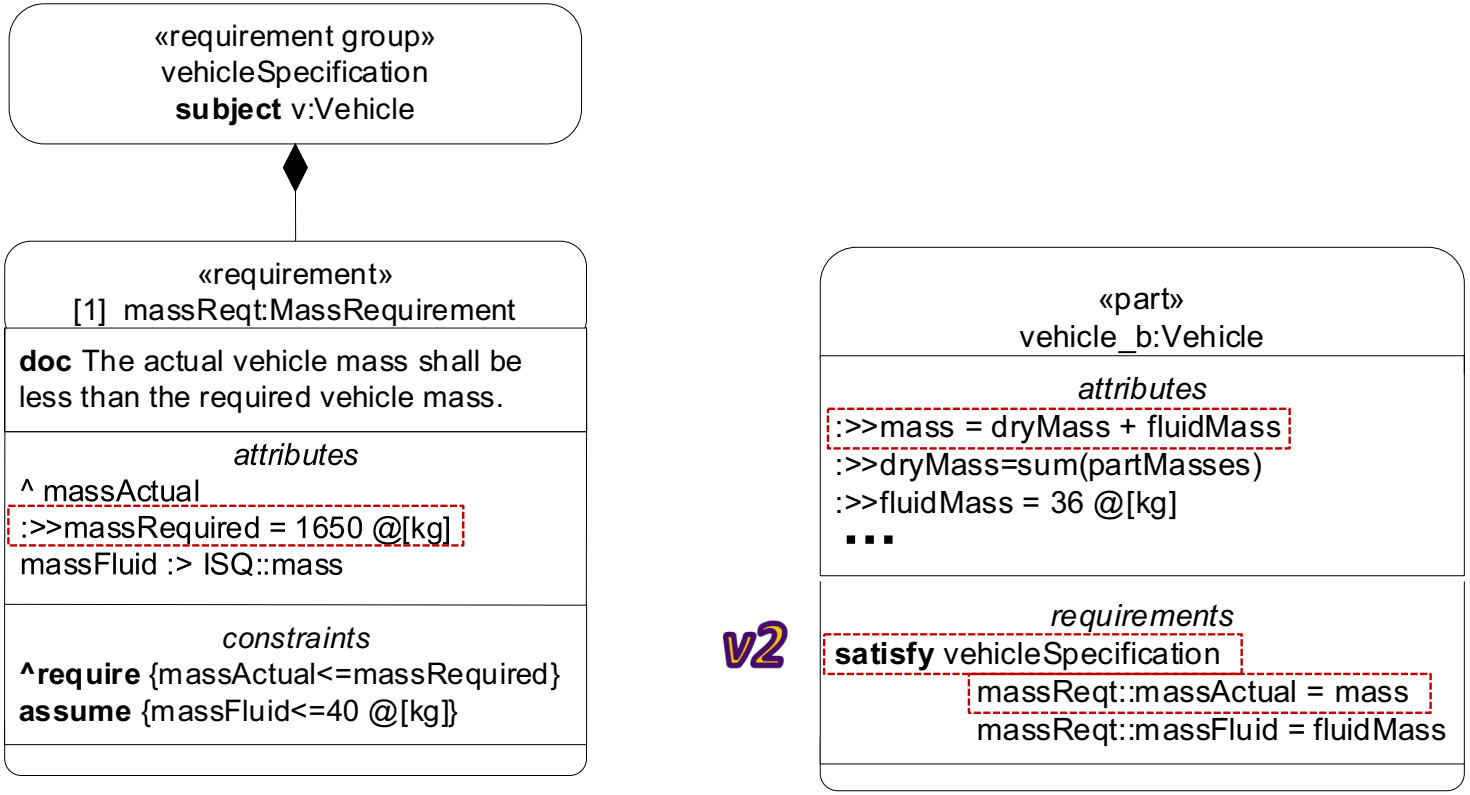
- A tree of requirements that contains nested requirement usages v2
  - Requirement group can own or reference other requirements
  - Subject of nested requirements is the kind of entity being specified
  - Requirement features can redefine features of the requirement definition



Satisfying a Requirement

SST

- The vehicleSpecification is used to impose constraints on the vehicle
  - The modeler can assert the vehicle mass satisfies the mass requirement
    - Bind the vehicle mass to massActual of the requirement

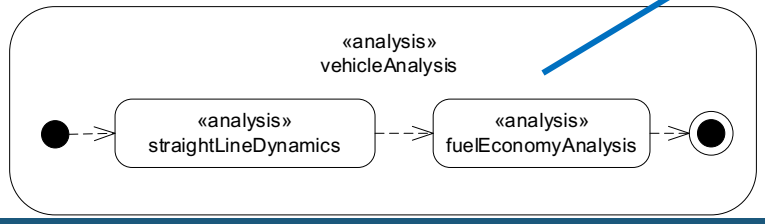


Module 17
Analysis Cases

Analysis Case v2

SST

- A set of steps with an objective to evaluate a result about a subject of the analysis
  - A kind of behavior
  - Each step can be an action, calc, or an analysis case that can contain
    - subject
    - objective
    - input and output parameters
    - Single return parameter (i.e., the result)
    - Attributes bound to calculations and/or constraints to be solved by a solver
    - Bind input & output parameters to the subject



«analysis»
fuelEconomyAnalysis
subject v = vehicle_b

objective

doc Determine whether the vehicle design configuration can satisfy the fuel economy requirements

parameters

in scenario:Scenario
return calculatedFuelEconomy :> km/l

attributes

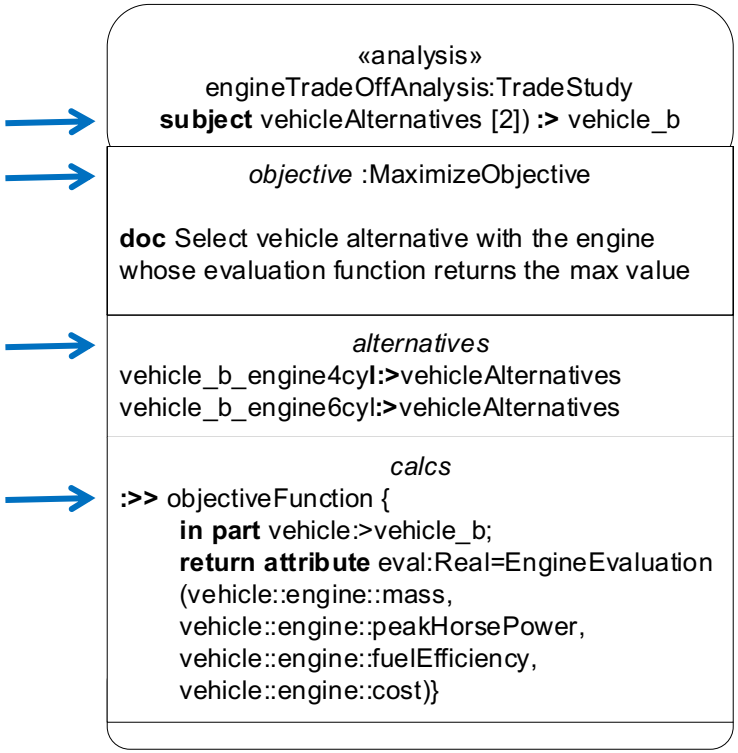
distance = TraveledDistance(scenario)
tpd_avg = AverageTravelTimePerDistance(scenario)
bsfc = ComputeBSFC(vehicle_b::engine)
f_a = BestFuelConsumptionPerDistance(vehicle_b::mass, bsfc, tpd_avg, distance)
f_b = IdlingFuelConsumptionPerTime(vehicle_b::engine)
calculatedFuelEconomy=FuelConsumption(f_a, f_b, tpd_avg)

convert to liters / 100 km

Trade-off Analysis v2

SST

- A kind of analysis case
  - Trade study objective is to select preferred solution that maximizes or minimizes some objective function
  - Subject of the trade study are the vehicle alternatives with different engines
    - Alternatives can be modeled as variants
  - Evaluate objective function for each alternative
    - Criteria are parameters of objective function
    - Each criteria may require separate analysis
  - Rationale is a kind of annotation

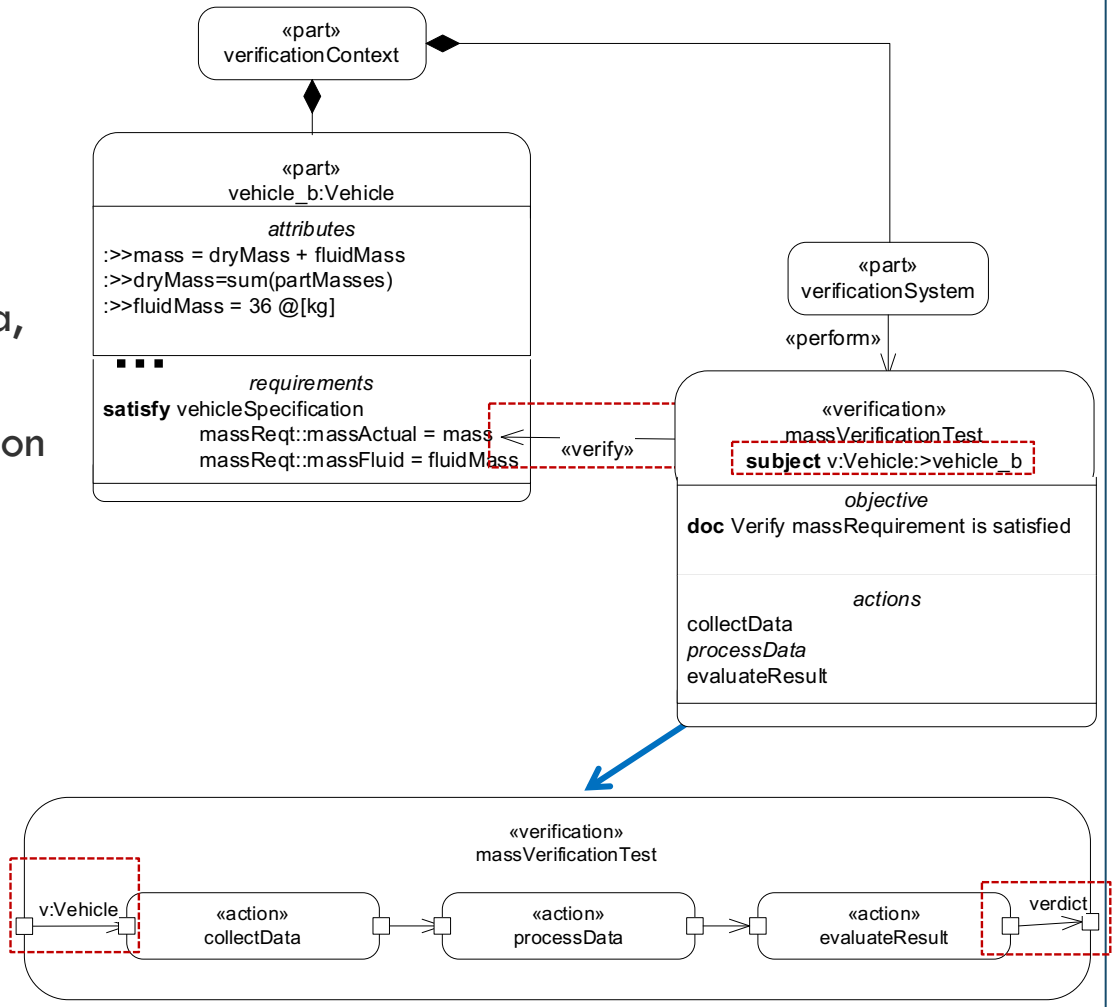


Module 18
Verification Cases

Verification Case

SST

- A set of steps with an objective to evaluate whether the subject of the verification satisfies one or more requirements
  - A kind of behavior
  - Steps typically include collect data, process data, evaluate result
  - Input is the subject of the verification
  - Returns a result called a verdict whose value is pass, fail, inconclusive, or error
  - Verify relationship binds verification case to subject
  - Verification case is performed by a verification system in a context

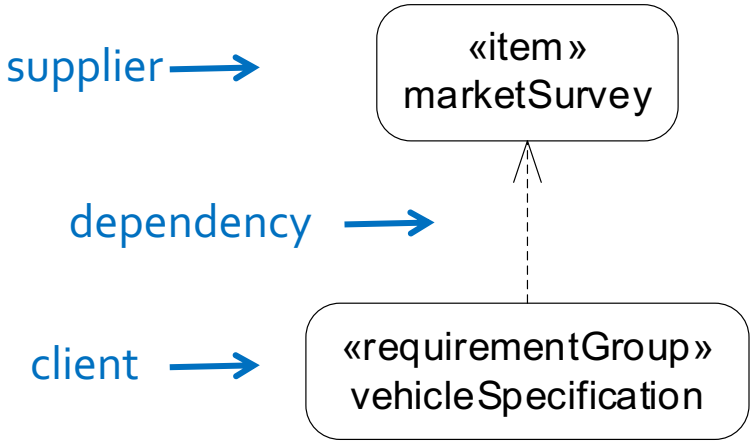


Module 19
Dependency and Allocation Relationships

Dependency

SST

- A directed relationship where the element on the client end may be impacted when the element on the supplier end changes
  - Example: Use of dependency to represent traceability between specification and source document
  - Can have 1.. many clients and 1.. many suppliers

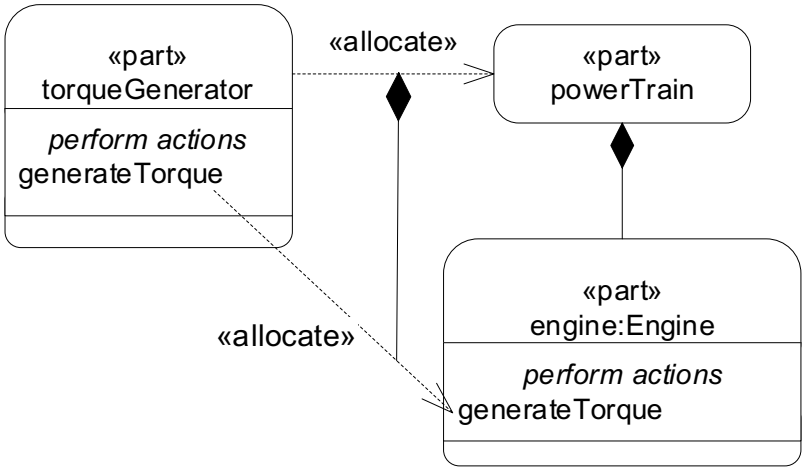


Allocation

SST

In Process

- A statement of intent that assigns responsibility from one set of elements to another set of elements
  - A kind of mapping (1 to n)
  - Includes definition and usage v2
  - Can include suballocations v2
- Examples
  - Actions to components
  - Logical components to physical components
  - Logical connections to physical connections
  - Budget allocation (e.g. weight budget)
  - Software to hardware
  - Requirements to design elements
  - …



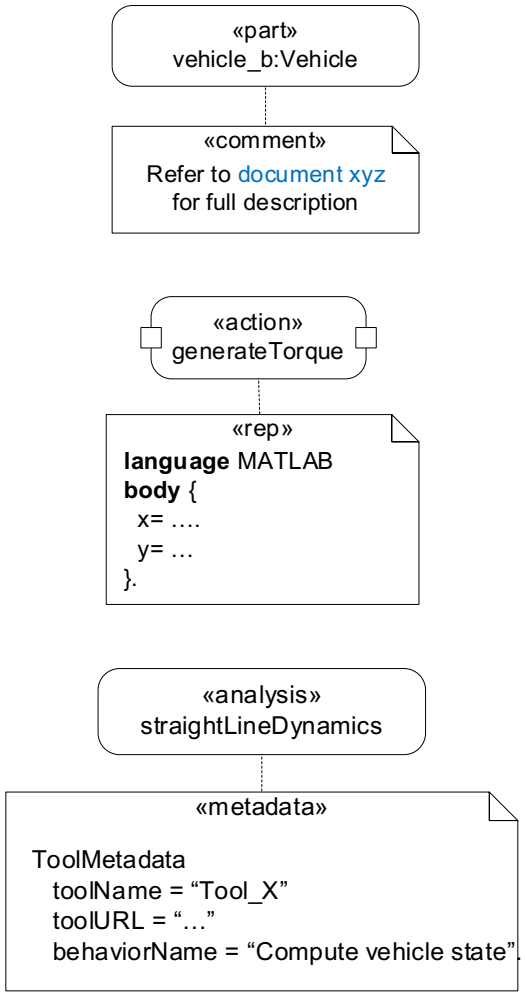
The torque generator
Is allocated to the powertrain,
and realized by the engine

Module 20
Annotations

Annotations

SST

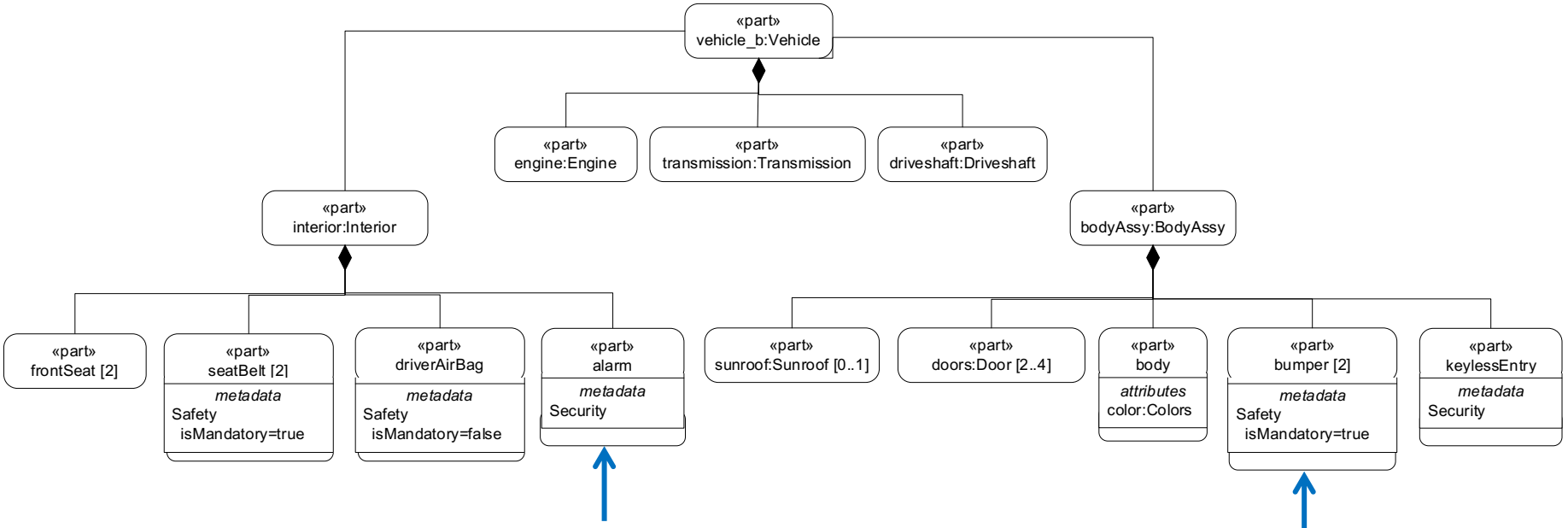
- An Annotating Element is an Element that is used to provide additional information about other elements
  - Can be named
  - Can apply to 0.. many elements
- An annotation is a kind of relationship that relates the annotating element to the element being annotated
- Kinds of annotating elements
  - Comment
    - Documentation is an owned comment
  - Textual representation (e.g., opaque expression)
    - Includes name of language and body
  - Annotating feature
    - Used to add structured metadata



Metadata

SST

- Use metadata to mark elements v2
  - Identify parts that are Security or Safety parts (e.g., members of Security of Safety group)
  - Can add additional security and safety information

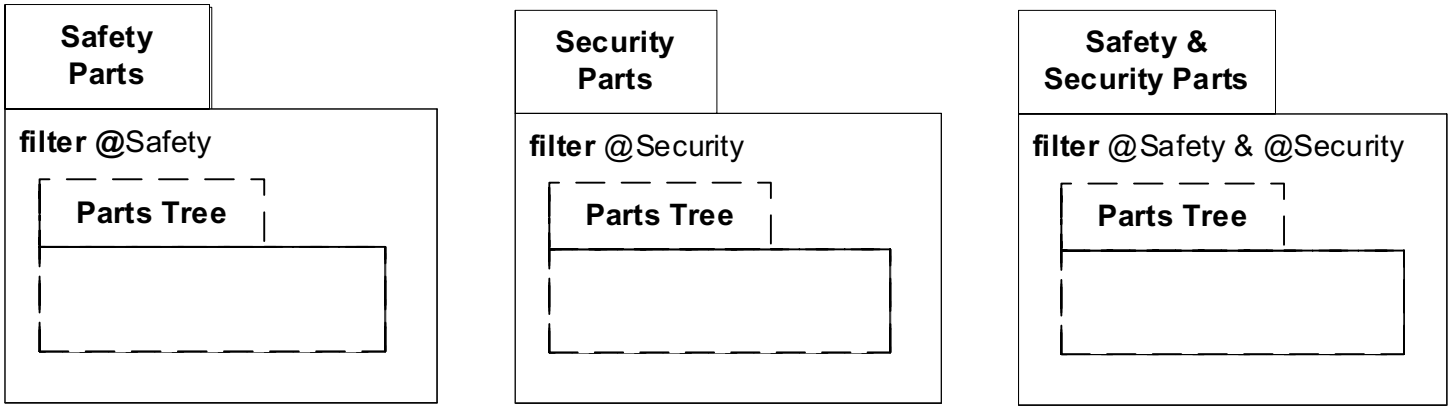


Module 21
Element Filters

Element Filters

SST

- Used to select elements from a group of elements
  - Create a package
  - Import the part of the model that contains the elements of interest
    - Use a recursive import to include all nested elements
  - Define the filter expression to select the imported elements based on the selection criteria



Filter selects parts marked with Safety metadata

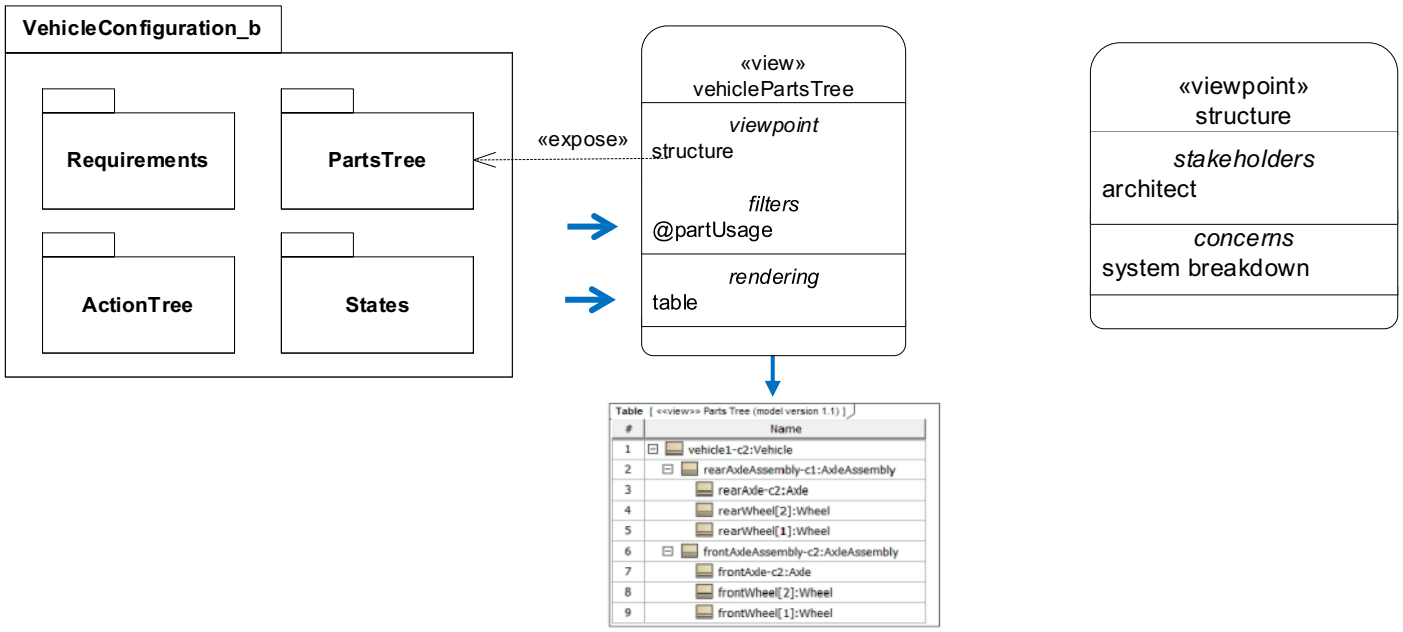
Module 22
View & Viewpoint

View and Viewpoint

SST

In Process

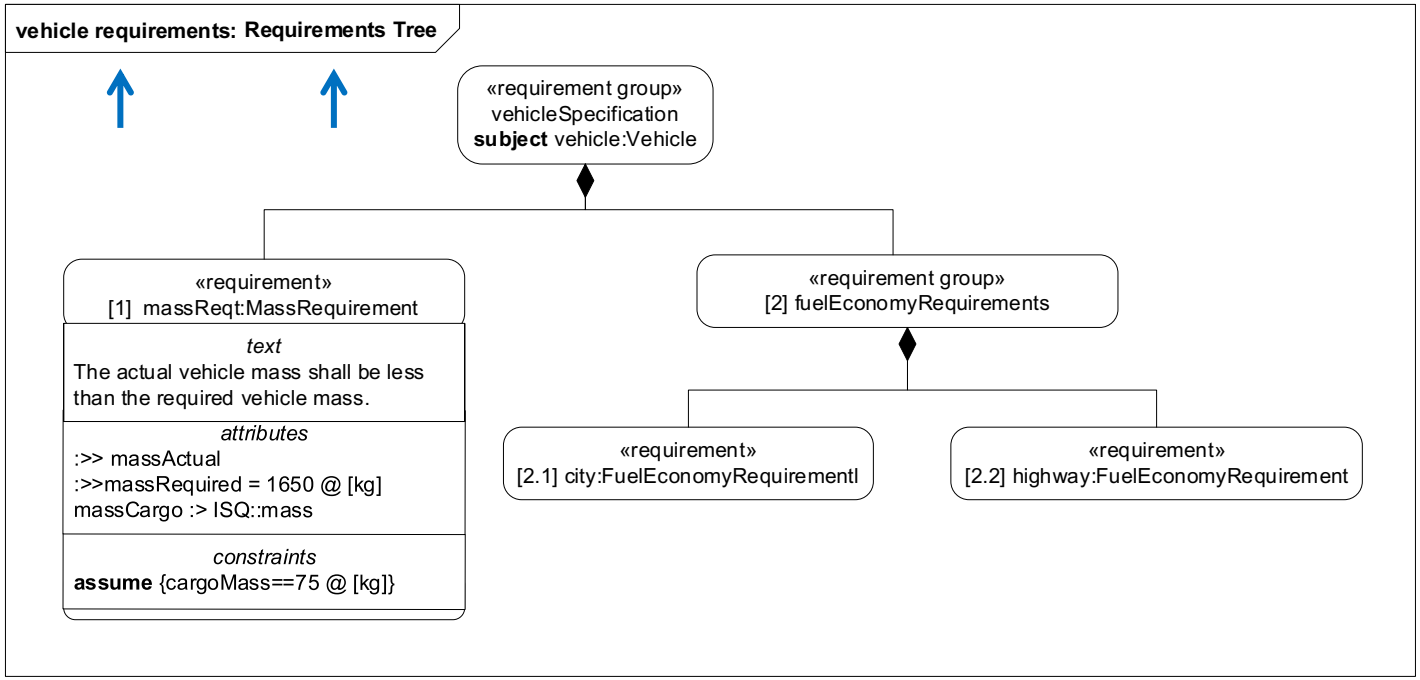
- A Viewpoint specifies the perspectives of one more stakeholders in terms of what they care about relative to a domain of interest
- A View specifies an artifact to present to a stakeholder to satisfy their viewpoint
  - Exposes the scope of the model to be viewed
  - Filters the model to select a particular subset based on a scope and filter criteria
  - Renders the filter results using a particular presentation form and style
  - Intended to support document generation (e.g., OpenMBEE)



SysML v2 Diagrams

SST

- Diagram is a View v2
  - Frame represents a view that renders model elements which are exposed and filtered
  - View definition (e.g., diagram kind)
  - View name (e.g., diagram name)
  - View content



SysML v2 Diagrams / Views

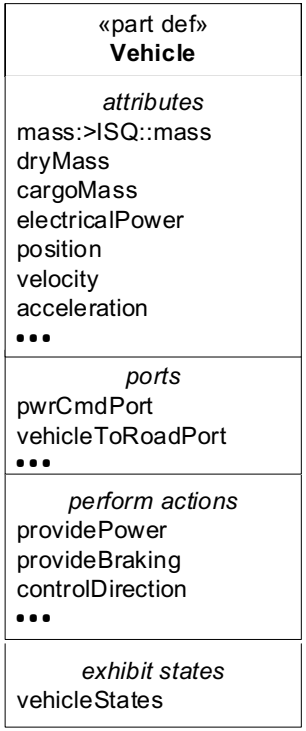
SST

- Standard diagram kinds / view definitions
  - Tree (hierarchy) views
  - Nested (interconnection) views
  - Relationship view (navigable nodes and edges)
  - Tabular/Matrix views
- A diagram/view can contain nested diagrams/views (e.g., sub views)
- User defined views
  - Users are not constrained to the standard views

SysML v2 Compartments

SST

- Compartments are views of the element represented by the node
- Compartment names represent view definitions
- Standard compartments / view definitions
  - List view of contained elements of a particular kind (e.g., attributes, actions, ports)
  - List view of elements at the other end of relationships (e.g., allocation, specialization, …)
- A compartment can be rendered using textual (e.g., list view) or graphical notation
- Nested view is a kind of graphical compartment where elements are represented as graphical symbols



Module 23
Language Extension

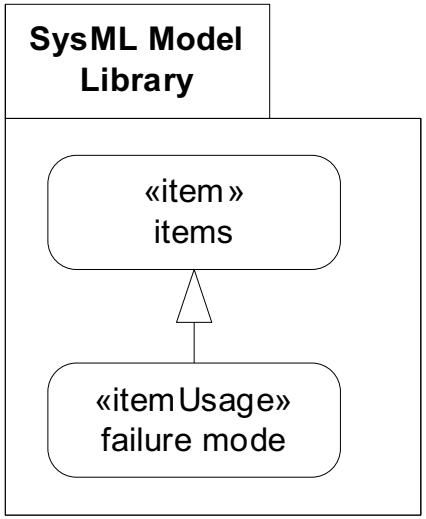
Language Extension

SST

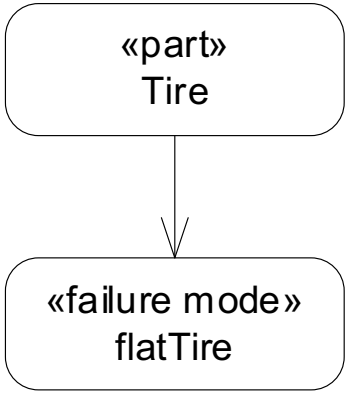
In Process

- Provides ability to extend concepts in SysML v2 to address domain-specific concepts and terminology
- Define concept by subclassing an element in the SysML Model Library v2
- Apply the concept to an element

define the concept →



apply the concept →



Summary

Contrasting SysML v1 with SysML v2

SST

- **Simpler to learn and use**
  - Systems engineering concepts designed into metamodel versus added-on
  - Consistent definition and usage pattern
  - More consistent terminology
  - Ability to decompose parts, actions, …
- **More precise**
  - Textual syntax and expression language
  - Formal semantic grounding
  - Requirements as constraints
  - Reified relationships (e.g., membership, annotation)
- **More expressive**
  - Variant modeling
  - Analysis case
  - Trade-off analysis
  - Individuals, snapshots, time slices
  - More robust quantitative properties (e.g., vectors, ..)
  - Filter expressions
- **More extensible**
  - Simpler language extension capability
    - Based on model libraries
- **More interoperable**
  - Standardized API

References

SST

- Simplified Vehicle Model (modeled in Jupyter using textual notation)
- Monthly Release Repository
  - https://github.com/Systems-Modeling/SysML-v2-Release
- SysML v2 Specification (release 2021-01)
  - Note: refer to Annex B for Example Model using textual notation
- Introduction to the SysML v2 Language Textual Notation (release 2021-01)
- Friedenthal S., Seidewitz E., A Preview of the Next Generation System Modeling Language (SysML v2), Project Performance International (PPI), Systems Engineering Newsletter, PPI SyEN 95 27 November, 2020