Systems Modeling Language (SysML) Overview & Update

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Rick Steiner
SysML Submission Team
Raytheon
(858) 522-2008
fsteiner@raytheon.com

Caveat

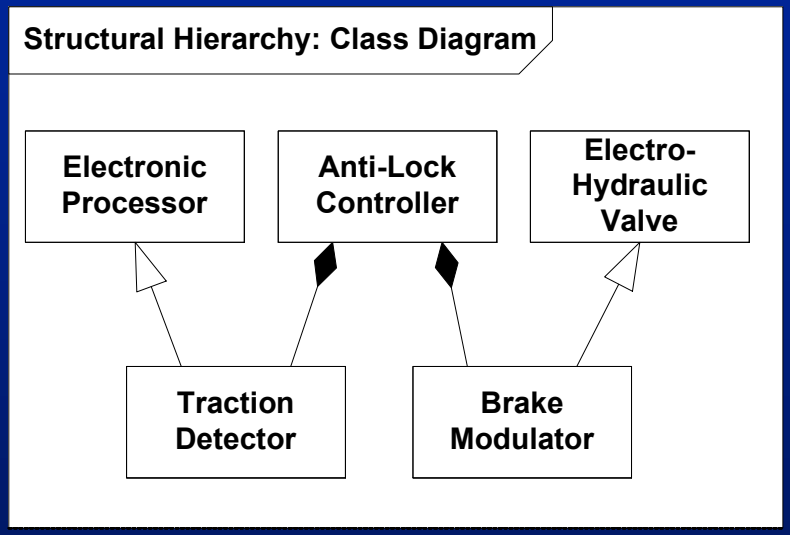
- Current baseline for SysML is v0.9 submitted to OMG in January 05
- SysML Submission Team and SysML Partners are two competing teams working to finalize the specification and submit for adoption to the OMG in February 2006
- This material is based on current status of the SysML Submission Team

Need for SysML:

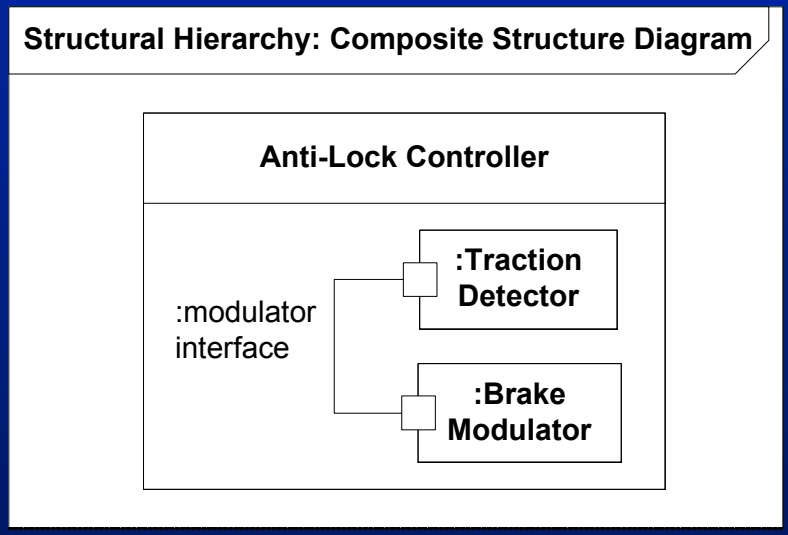
- Systems Engineers need a robust language for analyzing, specifying, designing, verifying and validating systems
- Many different modeling techniques
  - Behavior diagrams, IDEF0, N2 charts, …
- General purpose language must:
  - satisfy broad set of modeling requirements integrate with other disciplines (SW, HW, ..)
  - be scalable, adaptable to different SE domains, supported by multiple tools
  - **A Systems Engineering Modeling Language based on UML 2 has a good chance of meeting these objectives!**
- Joint INCOSE / Object Management Group (OMG) Initiative to extend UML to SE
  - Systems Engineering Domain Special Interest Group (SE DSIG) kickoff in Sept '01
    - Aligned with ISO AP-233 Systems Engineering data interchange standard to support tool interoperability
  - UML for SE RFI issued in 2002
  - UML for SE RFP (ad/03-03-41) issued March 28, 2003

Structure in UML 2 – A Useful Concept for Systems Engineers

Definition
(Class Diagram)



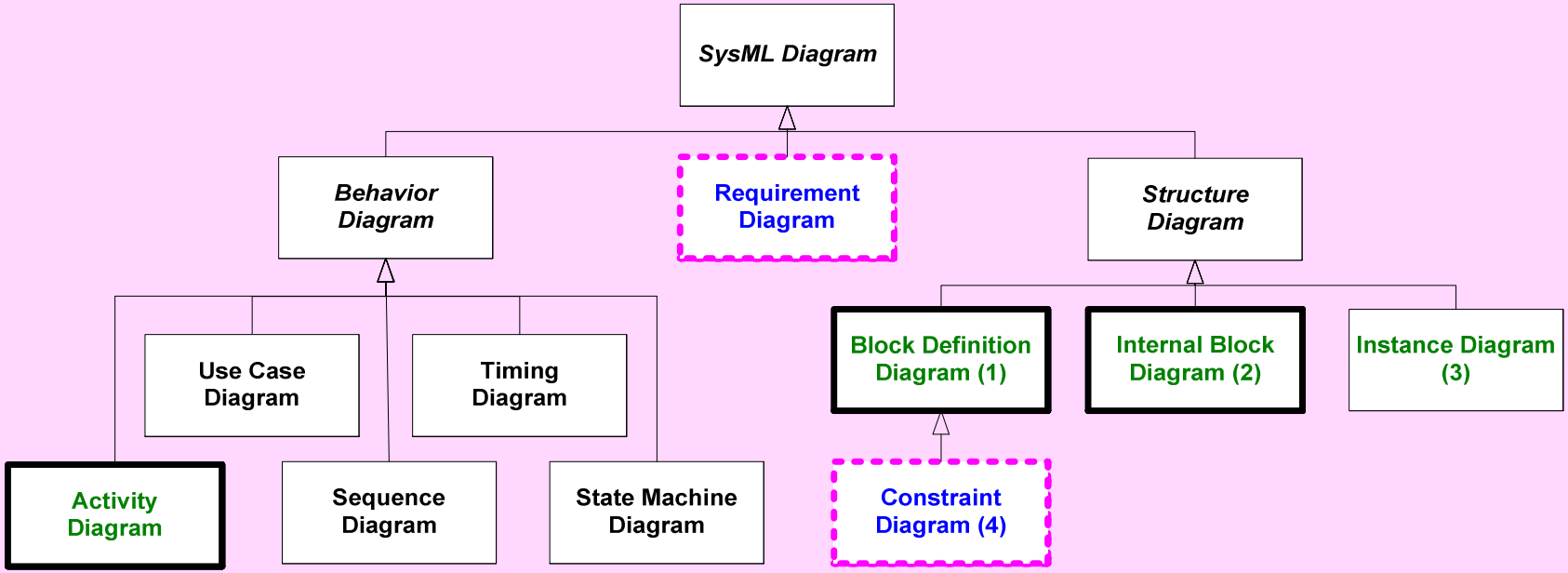
Use
(Composite Structure Diagram)



SysML Submission Status

- SysML Partners formed in March, 2003
  - SysML V0.9 submitted to OMG on Jan 10, 2005
    - Profiles chapter addendum submitted May 30
  - 4 tool vendors piloted use of SysML 0.9 in their tools, and presented at INCOSE 2005 symposium in Rochester
    - Artisan, EmbeddedPlus, iLogix, and Telelogic
  - Missed goal for revised submission update in May and August '05
- SysML Submission Team announced split from SysML Partners on August 30, 2005 to finalize spec
  - Goal to submit Final Revised Submission for presentation at December '05 OMG meeting
  - Request vote to recommend adoption at February '05 OMG meeting
- SysML 1.0 should be ready for use early in 2006
  - Already appearing in tools (0.9x version)

SysML Diagram Taxonomy

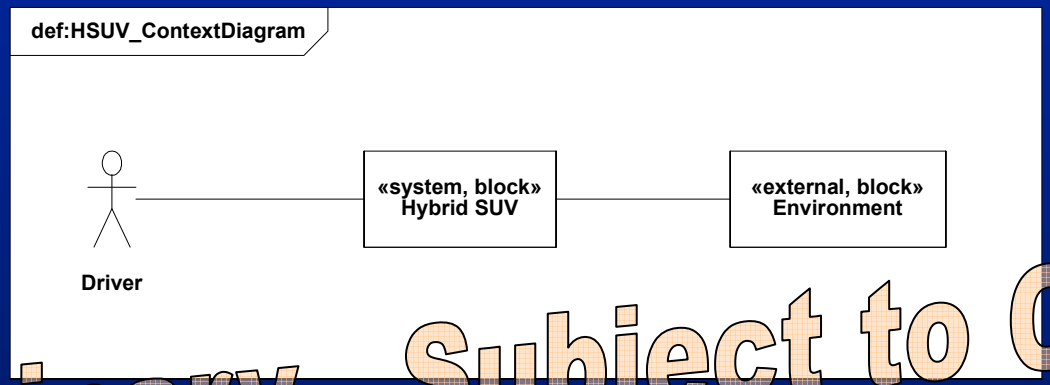


Modified from UML 2

New diagram type

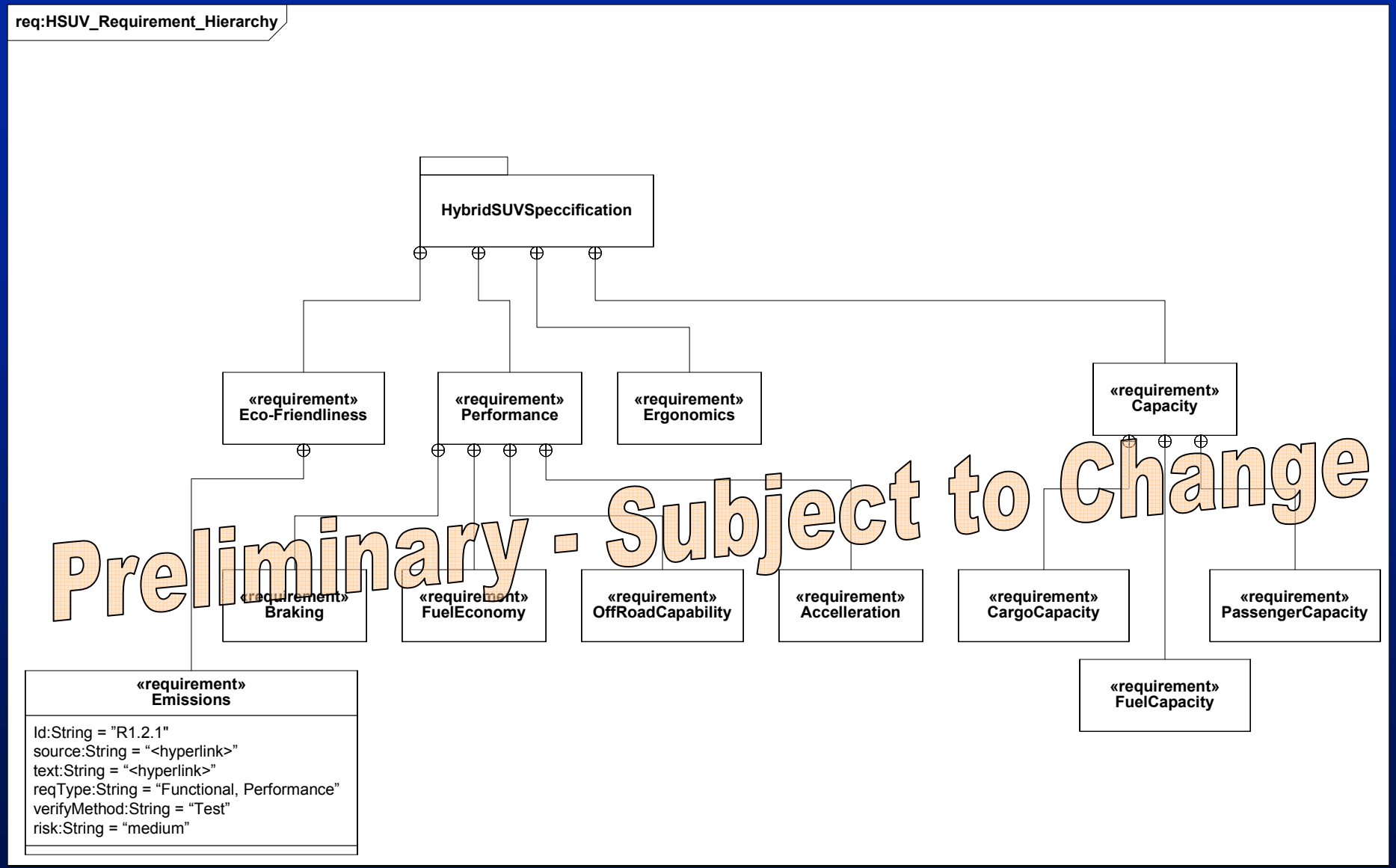
(1) Simplified Class Diagram
(2) Derived from UML 2 Composite Structure Diagram
(3) Same as UML 2 Object Diagram
(4) Parametric Diagram in SysML v0.9

Hybrid SUV Example – Context Diagram

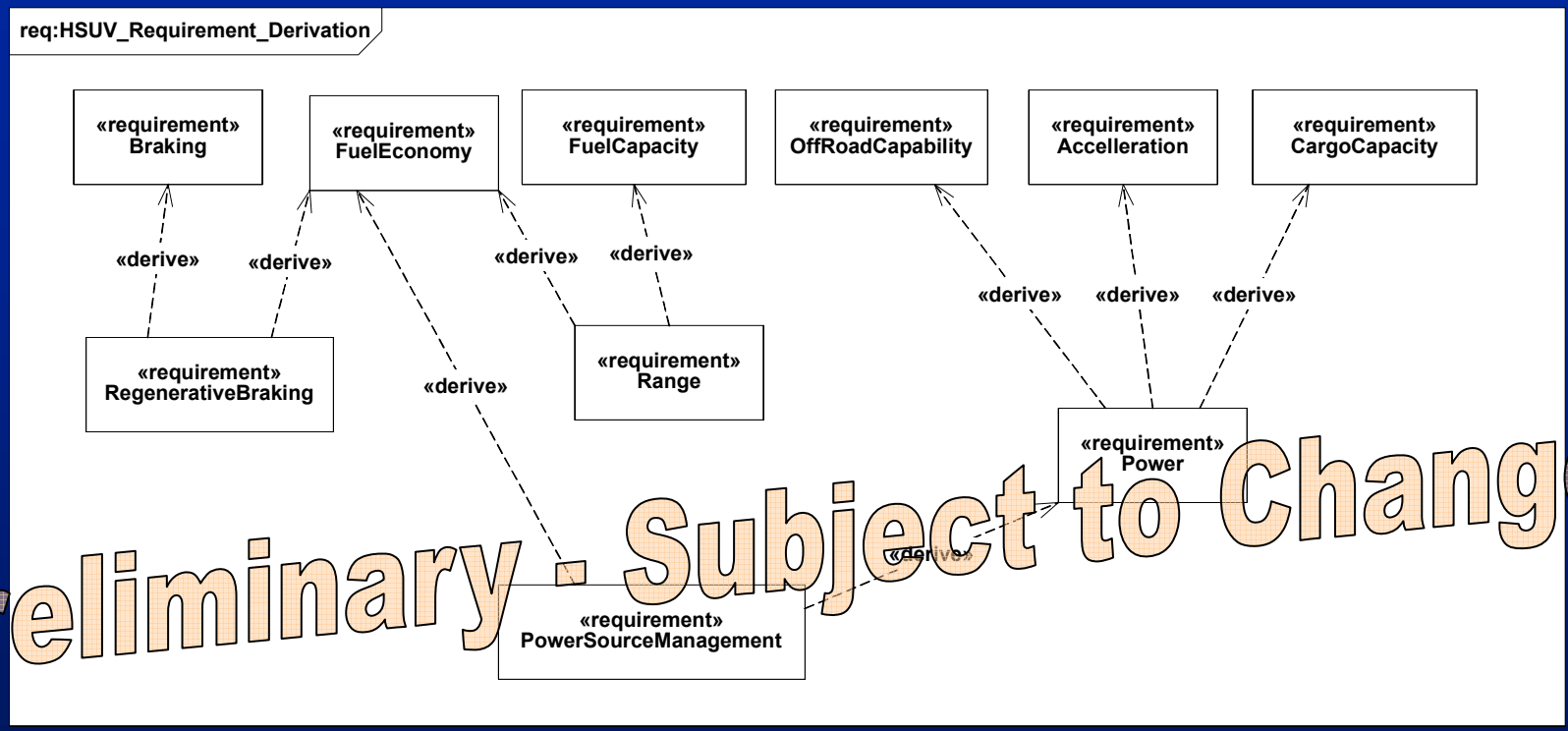


Preliminary - Subject to Change

Hybrid SUV Example – Requirements Hierarchy

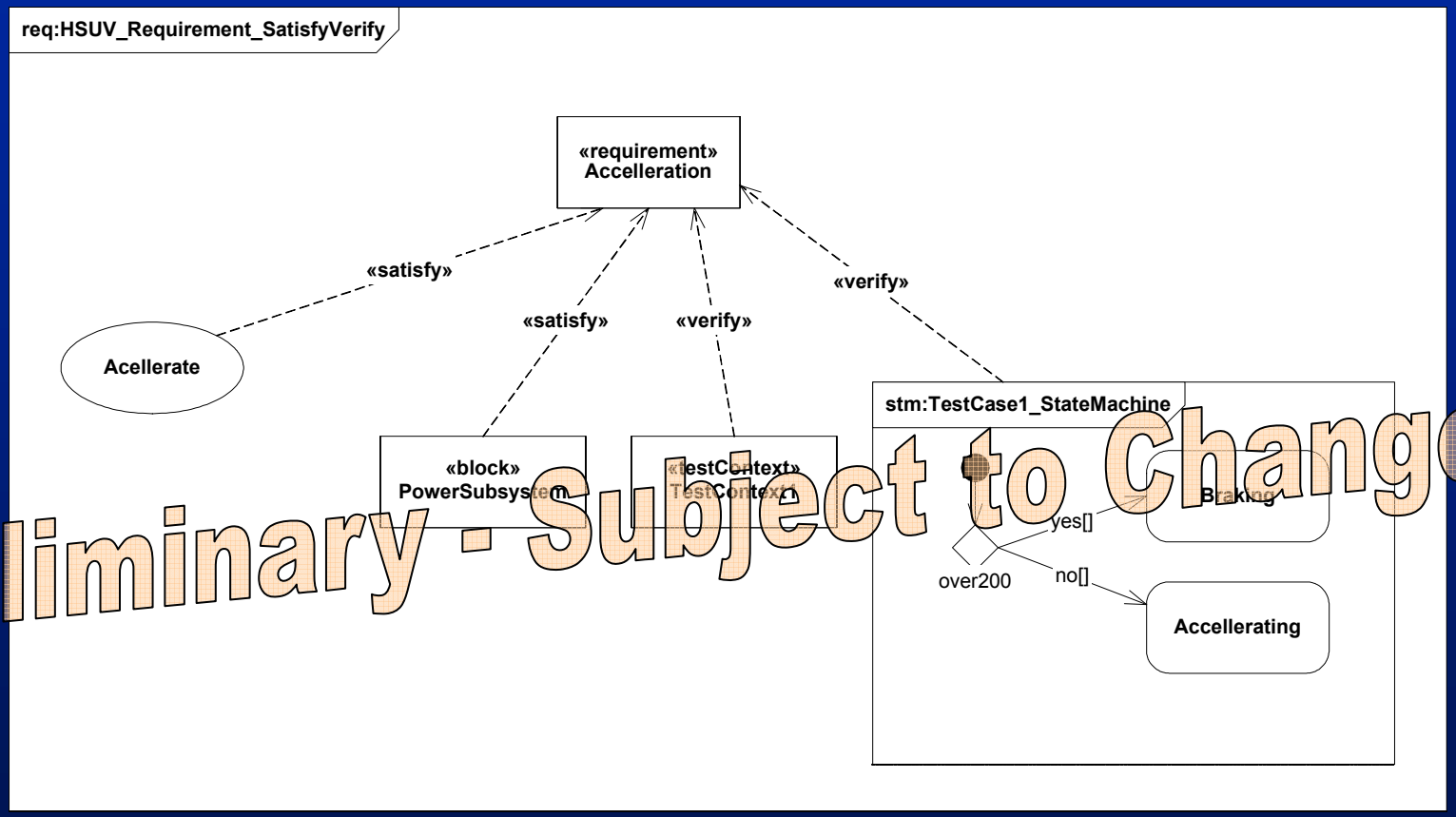


Hybrid SUV – Requirements Derivation

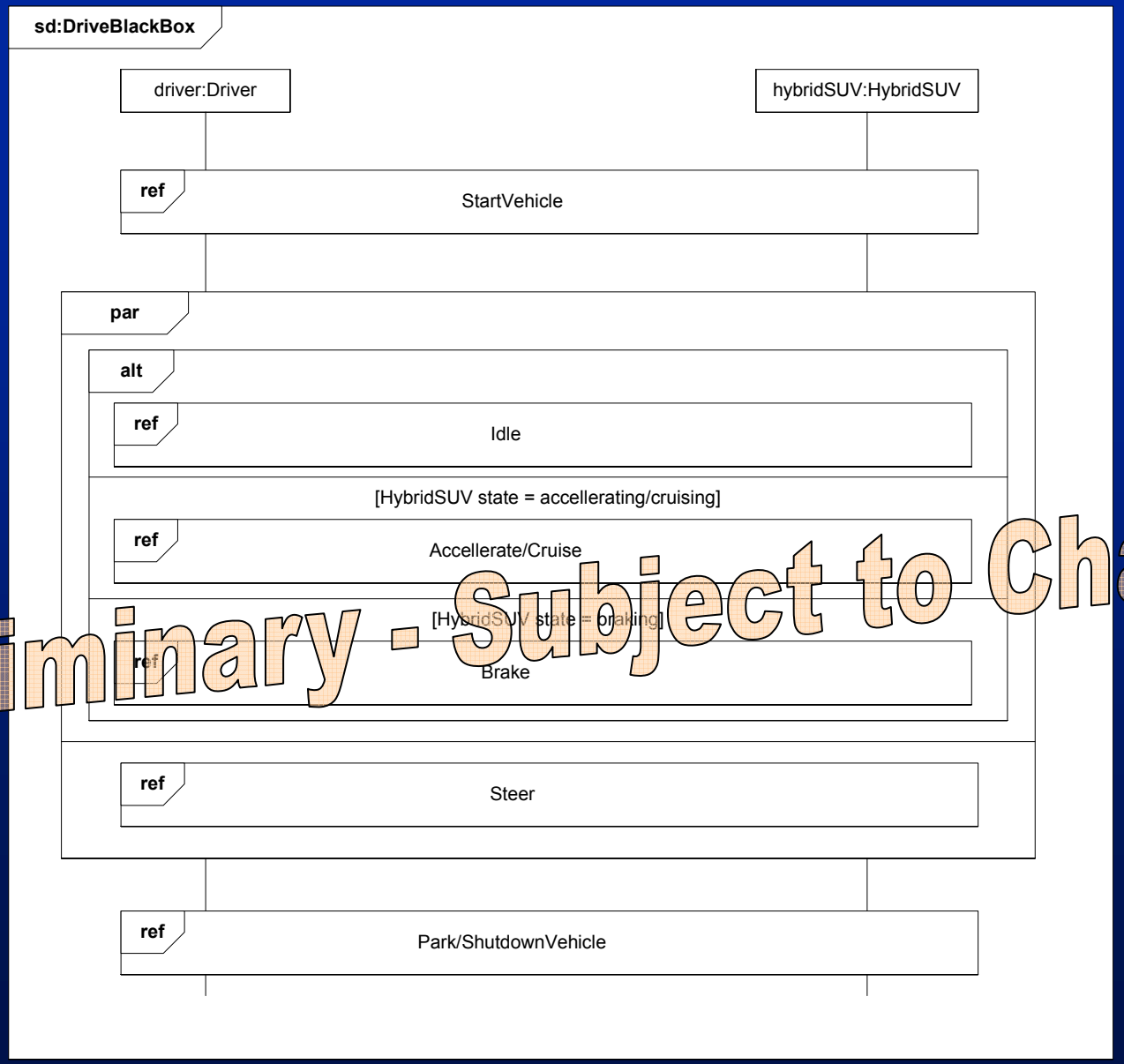


Preliminary - Subject to Change

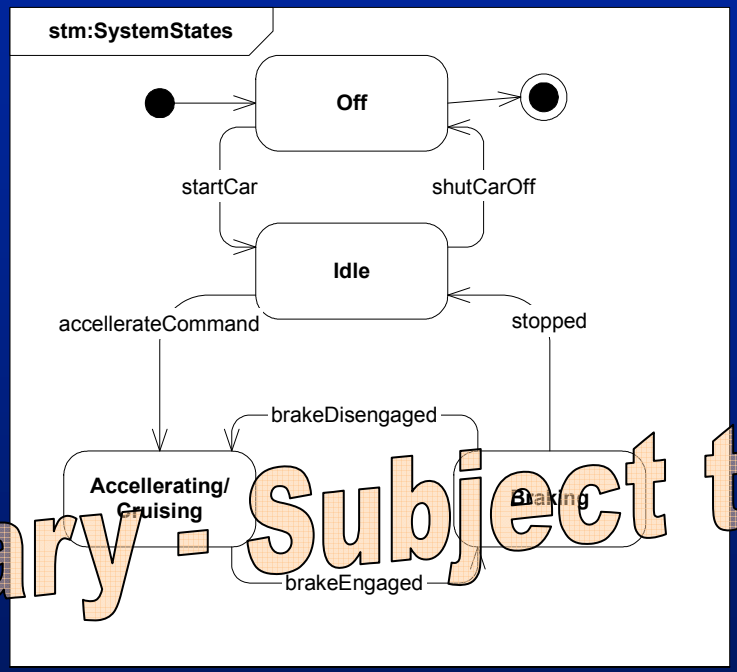
Hybrid SUV – Satisfy/Verify Requirements



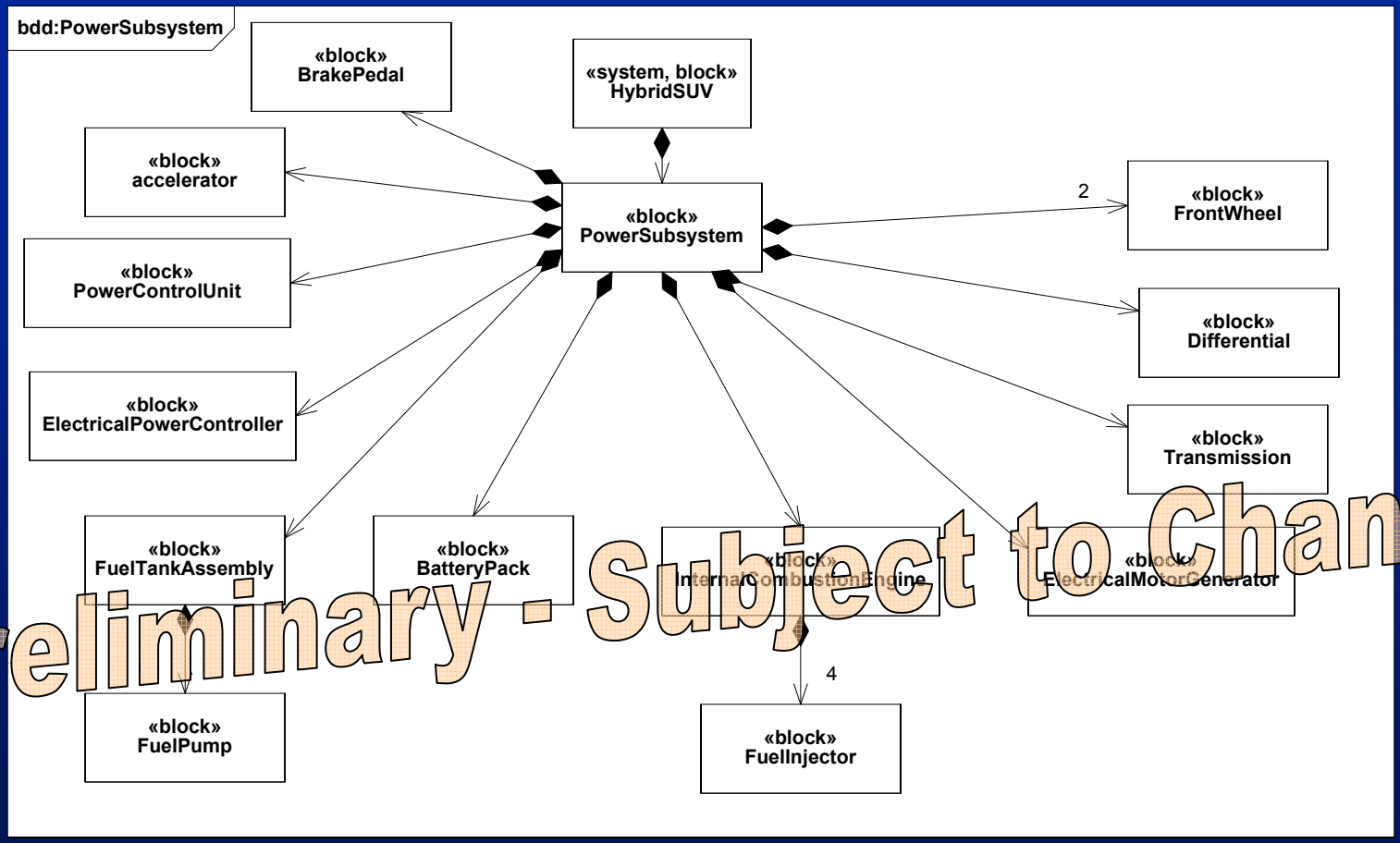
Hybrid SUV – black box Sequence Diagram



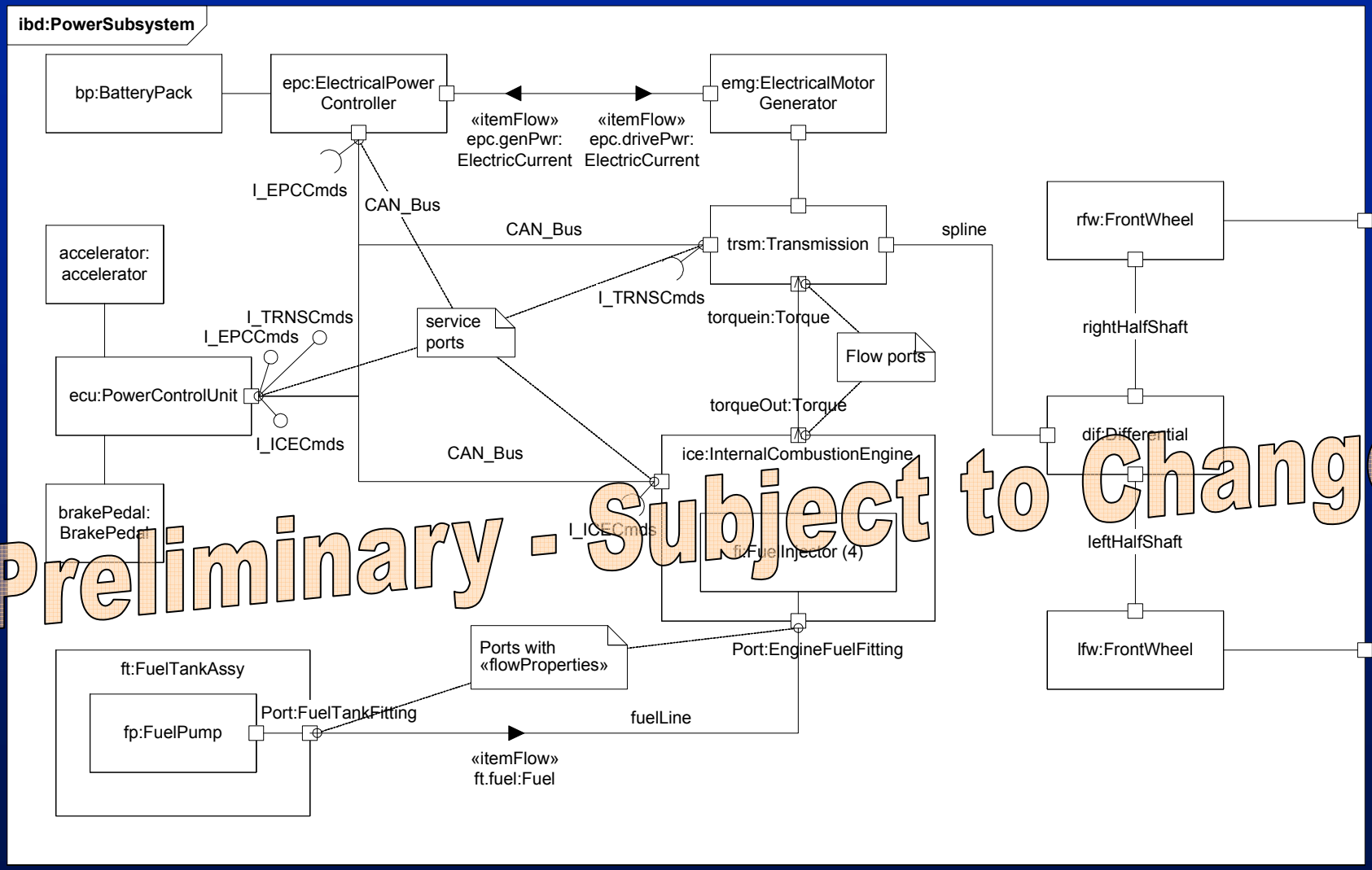
Hybrid SUV – Top Level State Machine



Hybrid SUV– Power System Block Definition Diagram

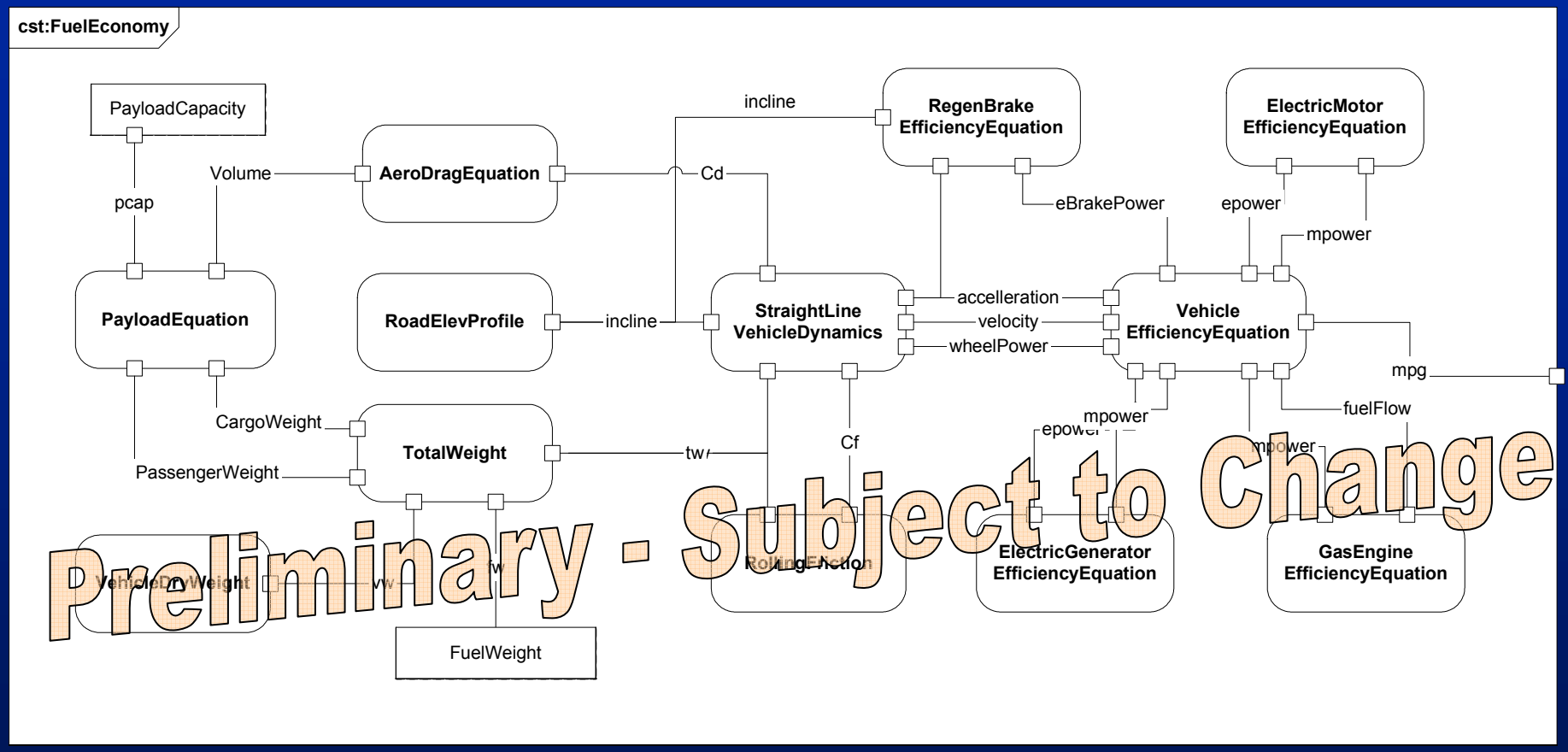


Hybrid SUV – Power System Internal Block Diagram

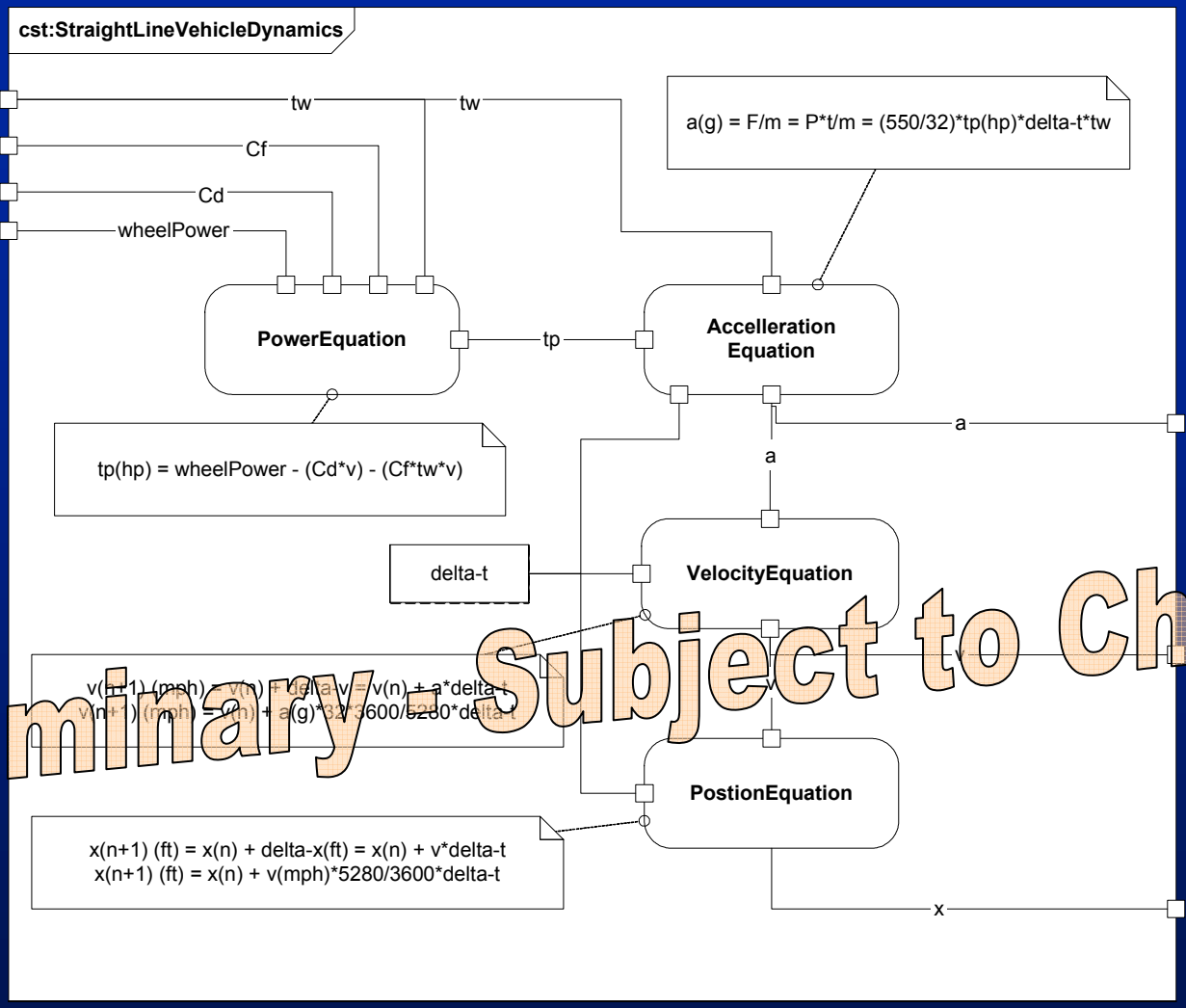


Preliminary - Subject to Change

Hybrid SUV – Fuel Economy Equation Constraint Diagram



Hybrid SUV – Vehicle Dynamics Constraint Diagram



Hybrid SUV – Acceleration Timing Diagram

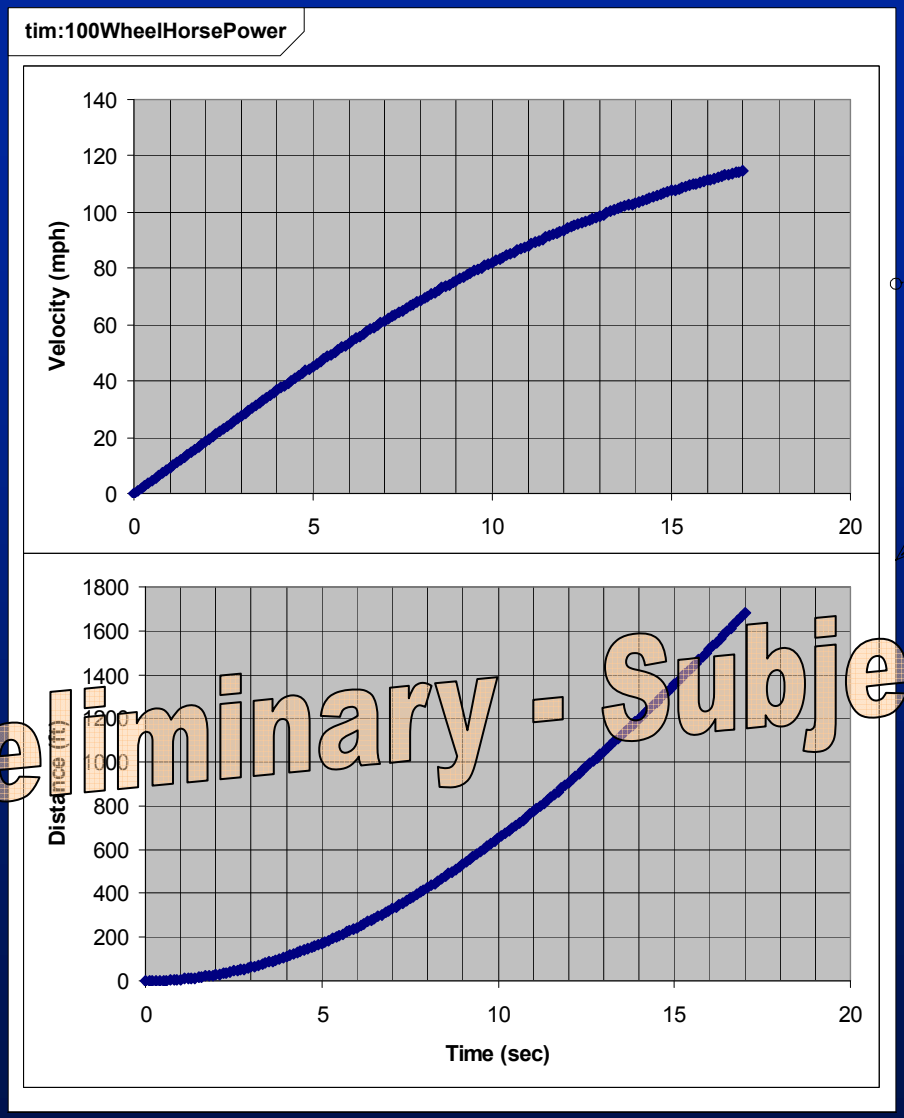
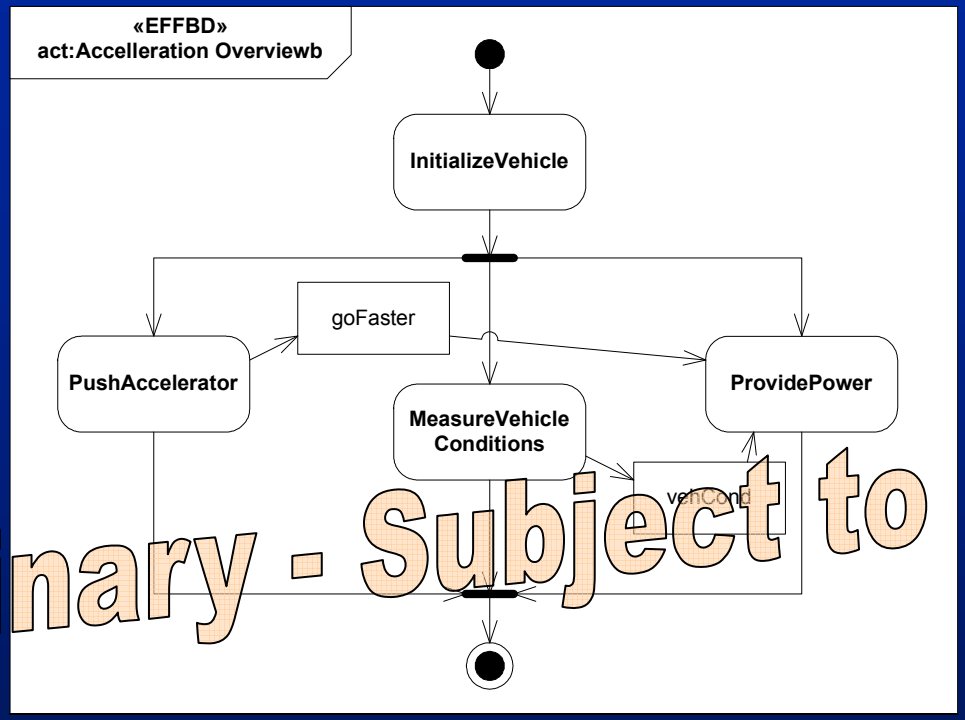


Diagram:
Constant 100 wheel horsepower
4000 lb total vehicle weight

«verify»

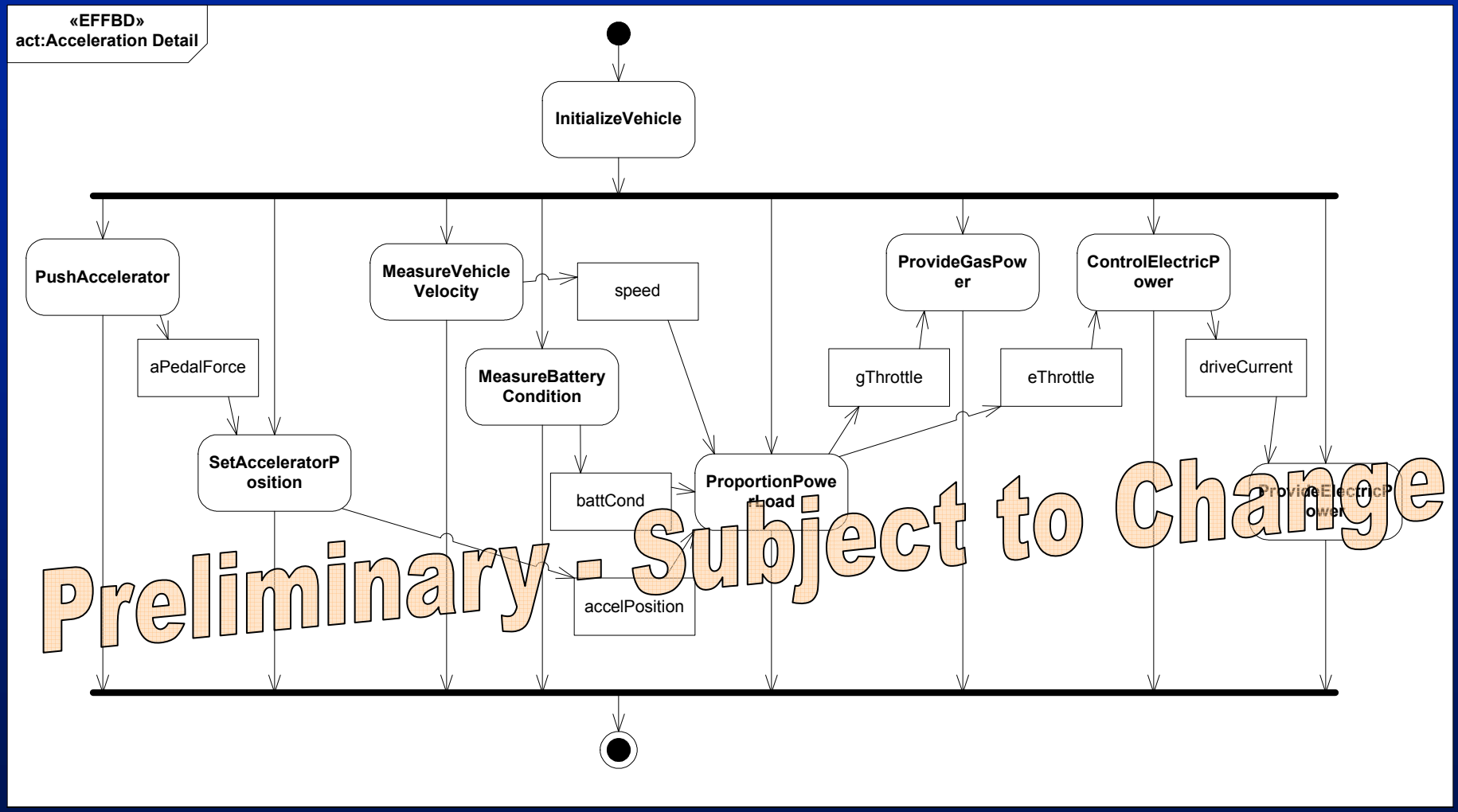
«requirement»
Accelleration

Hybrid SUV – Acceleration Activity Diagram (EFFBD - 1)

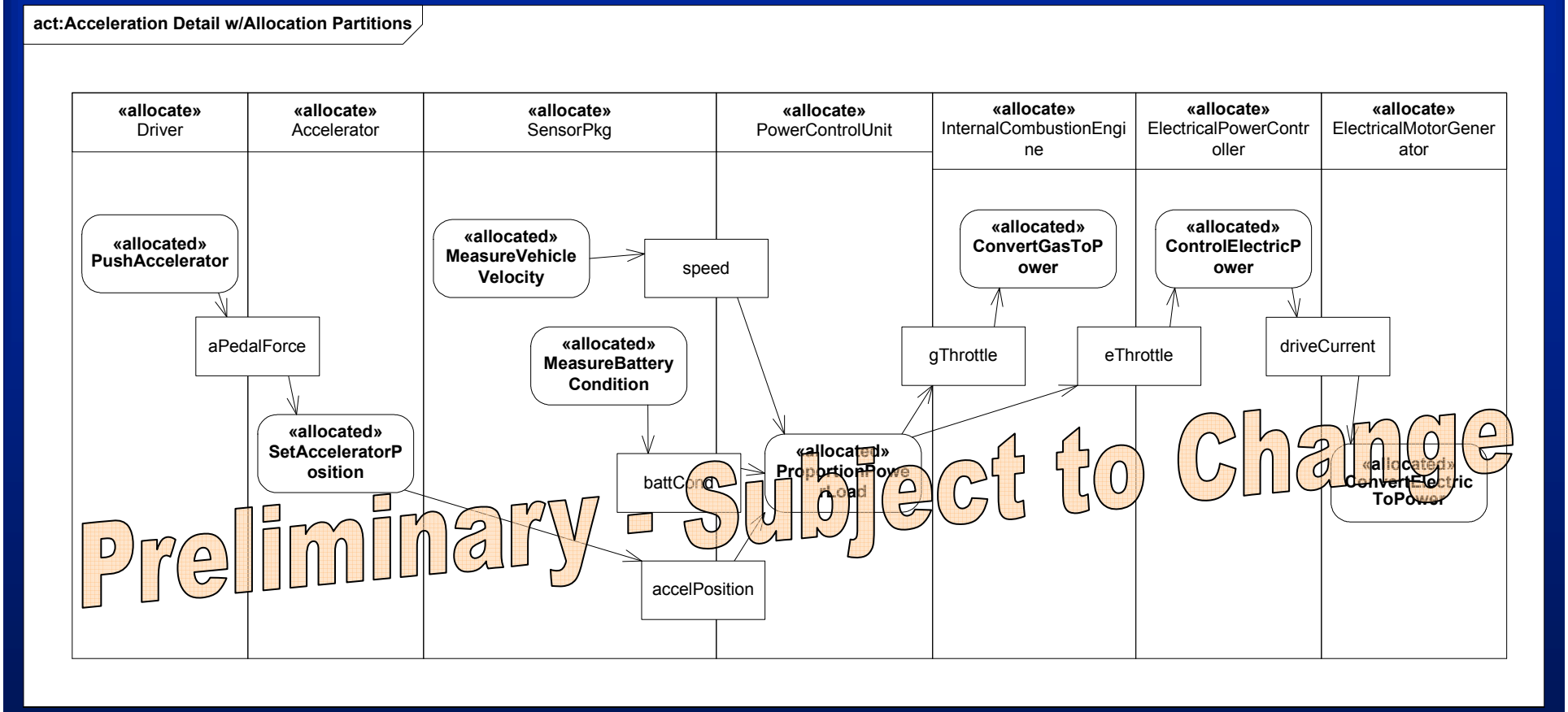


Preliminary - Subject to Change

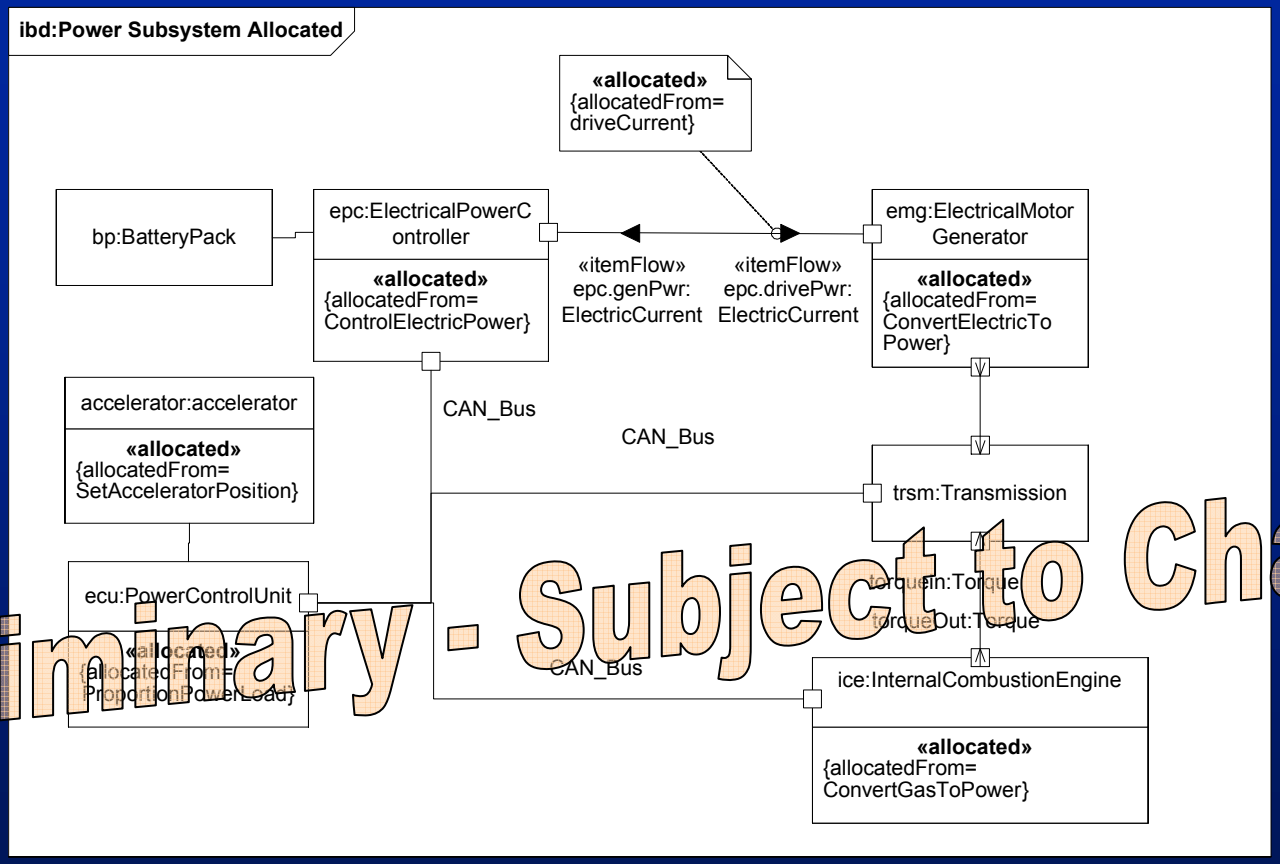
Hybrid SUV – Acceleration Activity Diagram (EFFBD - 2)



Hybrid SUV – Acceleration Activity Diagram (Allocation)



Hybrid SUV – Internal Block Diagram with Allocation



Backup Charts

SysML Submission Team

- Members
  - Industry & Government
    - American Systems, BAE SYSTEMS, Boeing, Lockheed Martin, NIST, oose.de, Raytheon, THALES, Eurostep, EADS Astrium
  - Vendors
    - Artisan, EmbeddedPlus, IBM, I-Logix, Mentor Graphics, Sparx Systems
- Collaborations
  - Deere & Company
  - Georgia Institute of Technology
  - INCOSE, AP-233

SysML Milestones

- UML for SE RFP issued – March 28, 2003
- Kickoff meeting – May 6, 2003
- Overview presentation to OMG ADTF – Oct 27, 2003
- Initial draft submitted to OMG – Jan 12, 2004
- INCOSE Review – January 25-26, 2004
- INCOSE Review – May 25, 2004
- Revised draft submitted to OMG – Aug 2
- 2nd Revised submission to OMG – October 11
- OMG technology adoption – Q1 2005 (Goal)

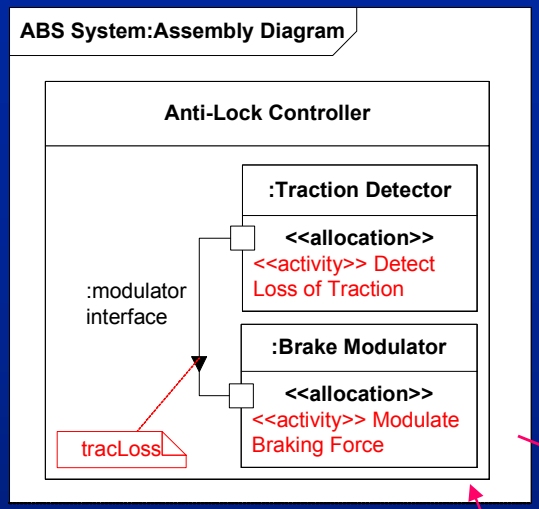
Modeling Language Requirements Refer to UML for SE RFP

- **Structure**
  - **e.g., system hierarchy, interconnection**
- **Behavior**
  - **e.g., function-based behavior, state-based behavior**
- **Properties**
  - **e.g., parametric models, time property**
- **Requirements**
  - **e.g., requirements hierarchy, traceability**
- **Verification**
  - **e.g., test cases, verification results**
- **Other**
  - **e.g., trade studies**

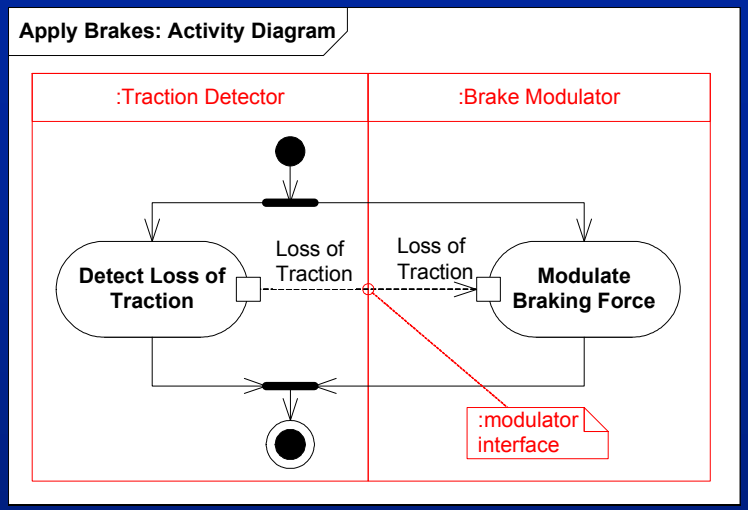
4 Pillars of SysML

Structure

Behavior

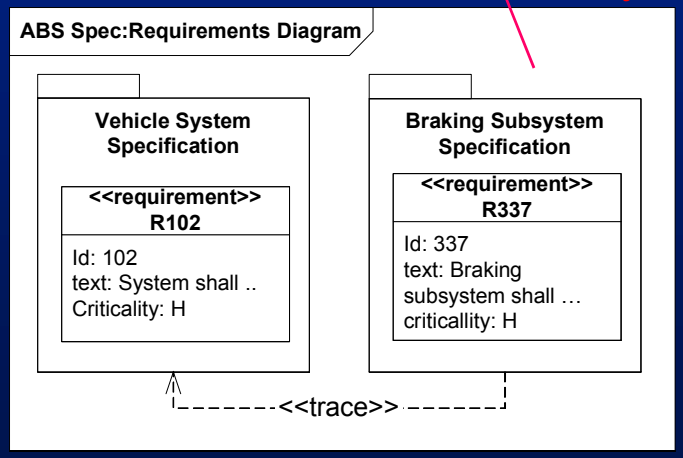


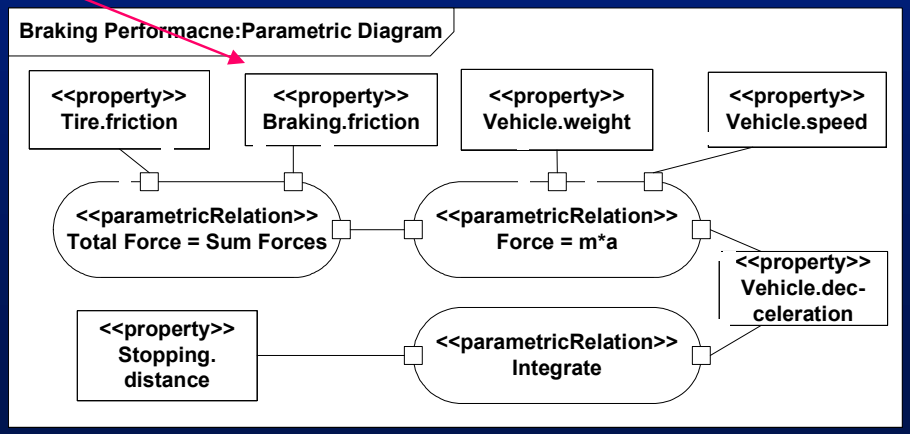
allocation



value binding

satisfy

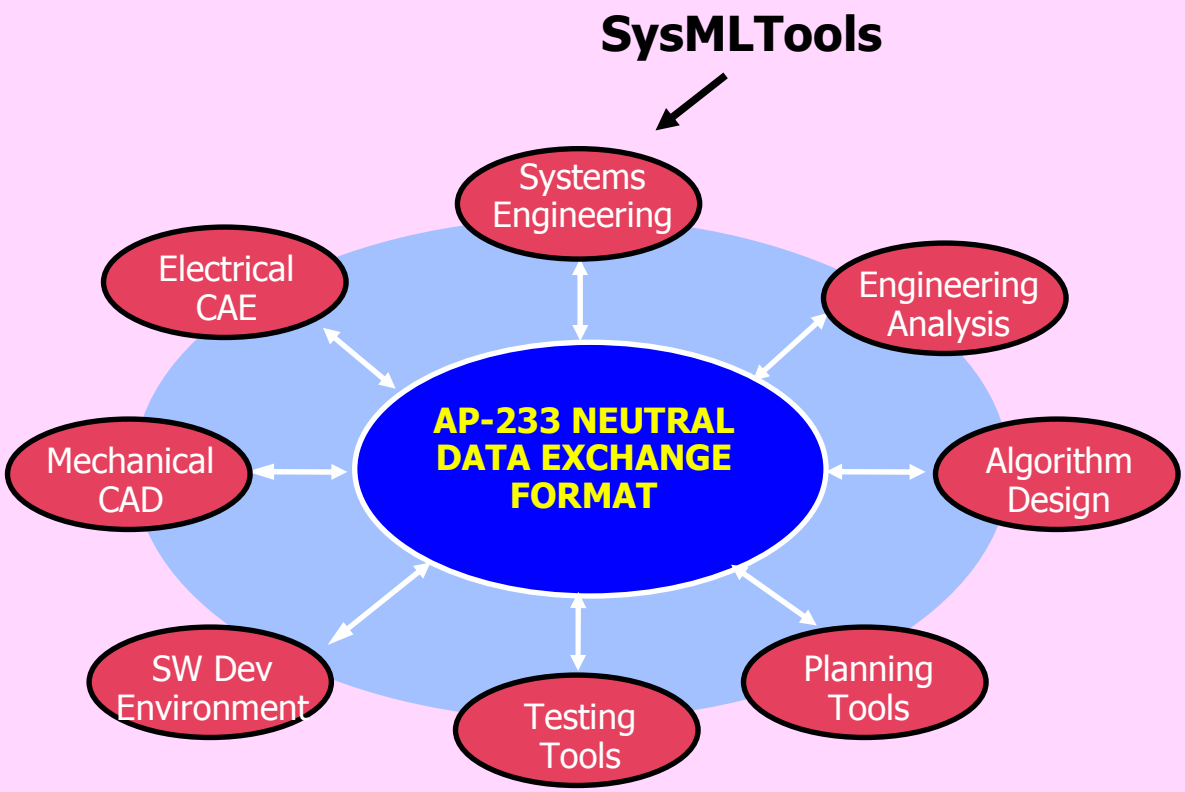




Requirements

Constraints

SysML / AP-233 Alignment



References

- UML for SE RFP
  - OMG doc# ad/03-03-41
- UML 2 Superstructure
  - OMG doc# formal/05-07-04
- UML 2 Infrastructure
  - OMG doc# ptc/04-10-14
- INCOSE 2004 Symposium Paper “Extending UML to Support a Systems Modeling Language” – S. Friedenthal, C. Kobryn
- INCOSE 2003 Symposium Paper “Extending UML from Software to Systems” – S. Friedenthal, R. Burkhart
- INCOSE Insight (June 2004)
- [Bock 2003] "UML 2 Activity Model Support for Systems Engineering Functional Flow Diagrams," Journal of INCOSE Systems Engineering, vol. 6, no. 4, October 2003 – C. Bock