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SysML v2 Submission Team (SST)
A Look Ahead at SysML v2

INCOSE 2020 International Workshop

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Presentation Purpose

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- Provide an update from the 2019 IW on the status of SysML v2 Submission that includes the following:
  - Background and motivation
  - Submission team approach
  - What to expect from SysML v2

Systems Modeling Language™ (SysML®)

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Supports the specification, analysis, design, and verification and validation of complex systems that may include hardware, software, information, processes, personnel, and facilities

- SysML has evolved to address user and vendor needs
  - v1.0 adopted in 2006; v1.6 is current version; v1.7 in process
- SysML has facilitated awareness and adoption of MBSE
- Much has been learned from using SysML for MBSE

SysML v2 Objectives

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

SysML v2 Requests for Proposals *SST*

- SysML v2 RFP issued December, 2017
  - Initial Submission: May, 2020
  - Revised (Final) Submission: May, 2021
- SysML v2 API & Services RFP issued June, 2018
  - Initial Submission: May, 2020
  - Revised (Final) Submission: May, 2021
- SysML v2 Submission Team (SST) formed December 2017
  - Leads: Sandy Friedenthal, Ed Seidewitz

Initial and revised submission dates reflect extensions accepted by OMG

SysML v2 Submission Team (SST) *SST*

- A broad team of end users, vendors, academics, and government liaisons
  - Over 100 members representing over 60 organizations
- Developing submissions to both RFPs
- Driven by RFP requirements and user needs

SST Participating Organizations

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Academia/Research
End User

Tool Vendors
Government Rep

INCOSE rep *

- Aerospace Corp
- Airbus
- ANSYS medini
- Aras
- Army Aviation & Missile Center
- BAE
- BigLever Software
- Boeing
- CCDC Armaments Center
- CEA
- Contact Software
- Draper Lab
- Elbit Systems of America
- ESTACA
- Ford
- Fraunhofer FOKUS
- General Motors
- George Mason University
- GfSE
- Georgia Tech/GTRI
- IBM
- Idaho National Laboratory
- IncQuery Labs
- Intercax
- Itemis
- Jet Propulsion Lab
- John Deere
- Kenntnis
- LieberLieber
- Lightstreet Consulting
- Lockheed Martin
- LSST
- Maplesoft
- Mgnite Inc
- MITRE
- ModelAlchemy Consulting
- Model Driven Solutions
- Model Foundry
- NIST
- No Magic/Dassault Systemes
- OAR
- Obeo
- OOSE
- Ostfold University College
- Phoenix Integration
- PTC
- Qualtech Systems, Inc (QSI)
- Raytheon
- Rolls Royce
- SAF Consulting *
- SAIC
- Siemens
- Sierra Nevada Corporation
- Simula
- System Strategy *
- Tata Consultancy Services
- Thales
- Thematix
- Tom Sawyer
- UFRPE
- University of Cantabria
- University of Alabama in Huntsville
- University of Detroit Mercy
- University of Kaiserslautern / VPE
- Vitech
- 88solutions

SST Tracks / Leads

1. Project Management – Ed Seidewitz, Sandy Friedenthal
   - Infrastructure – John Watson, Chris Delp
2. Requirements V&V – Sandy Friedenthal
3. Profile Development – Yves Bernard, Tim Weilkiens
4. Metamodel Development – Chas Galey, Bjorn Cole
5. API/Services Development – Manas Bajaj
6. Pilot Implementation – Ed Seidewitz

SysML v2 Validation Cases

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- The following 16 validation cases capture initial required language functionality

  Reflects 2/3 of the SysML v2 RFP requirements

  - ○ 1-Parts Tree
  - ○ 2-Parts Interconnection
  - ○ 3-Function-based Behavior
  - ○ 4-Functional Allocation
  - ○ 5-State-based Behavior
  - ○ 6-Individuals and Snapshots
  - ○ 7-Variant Configuration
  - ○ 8-Requirements
  - ○ 9-Verification
  - ○ 10-Analysis and Trades
  - ○ 11-View and Viewpoint
  - ○ 12-Dependency Relationships
  - ○ 13-Model Containment
  - ○ 14-Language Extension
  - ○ 15-Properties, Values, & Expressions
  - ○ 16-Proxy validation case

Current preliminary design baseline and pilot implementation

Key Elements of SysML v2

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- New Metamodel that is not constrained by UML
  - Grounded in formal semantics
- Robust visualizations based on flexible view & viewpoint specification and execution
  - Graphical, Tabular, Textual
  - Document generation
- Standardized API to access the model

Usage Focused Modeling Approach

A paradigm shift to make SysML v2 more precise and more intuitive to use

- Emphasizes modeling of *usages (e.g., parts on an ibd)*
  - Decompose, connect, relate, and group usages
- Supports other language requirements
  - variant design configurations, individuals, …

Usage Focused Modeling Approach
Usage & Definition

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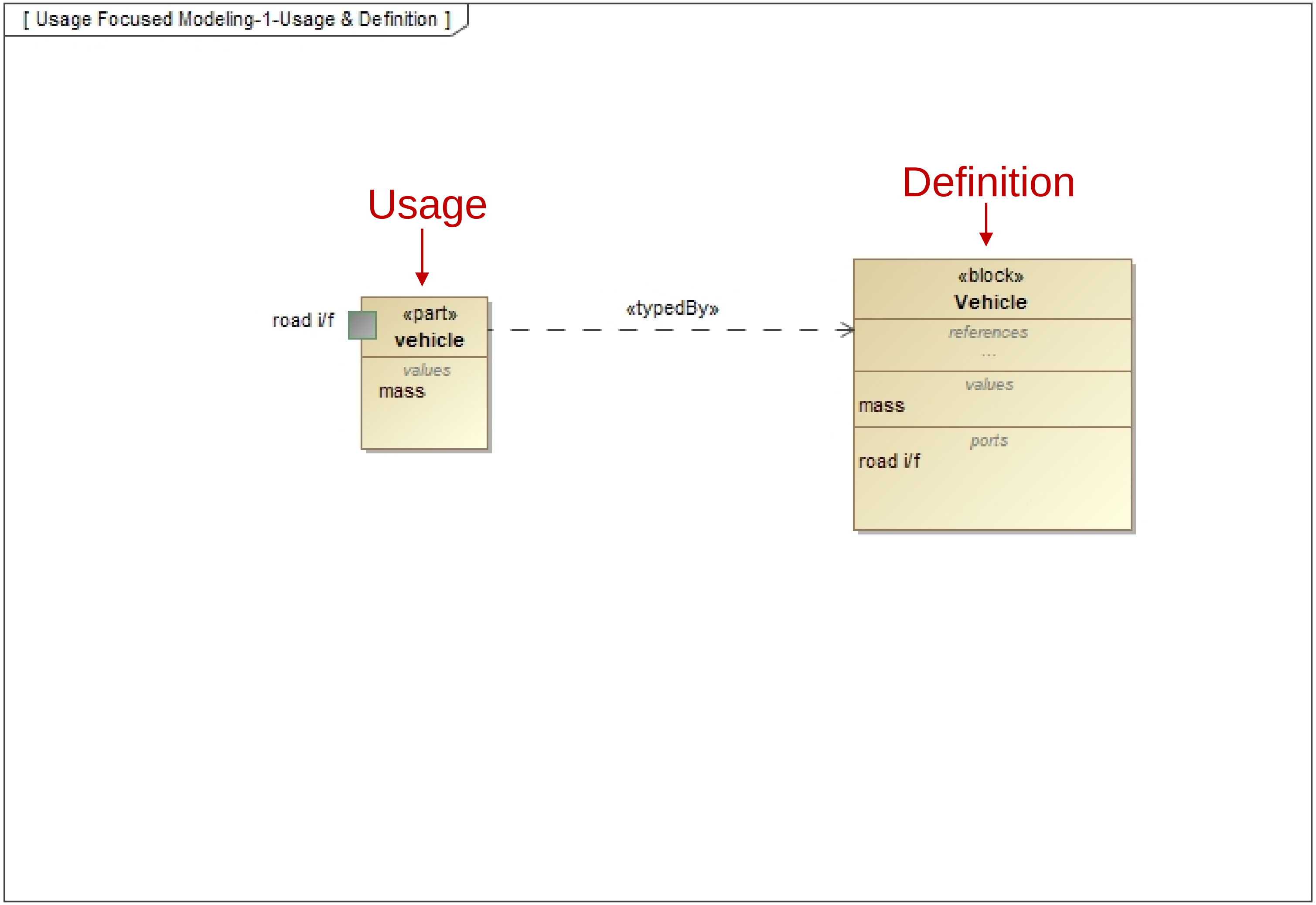

Usage Focused Modeling Approach
Multiple Views of a System

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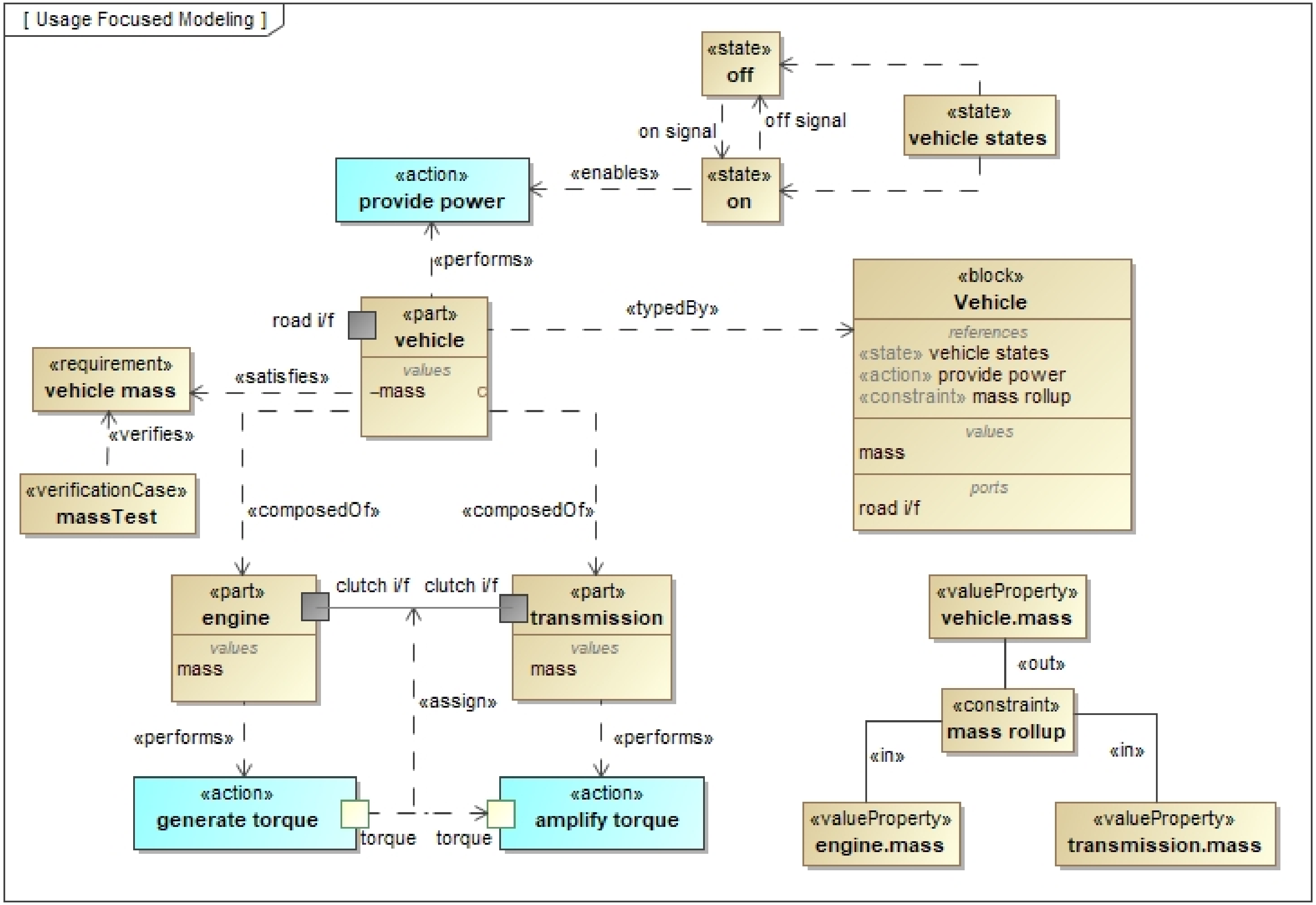
Graphical notation for illustrative purposes only



Example Using Textual Notation Definitions

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```
package sfriedenthal_VehicleModel_1{
   package Definitions{
      package PartDefinitions{
         block Vehicle {
            value mass :> ISQ::mass;
         }
         block Engine;
         block Cylinder;
         block Transmission;
      }
      package PortDefinitions{
         port def FuelCmdPort;
         port def VehicleToRoadPort;
      }
      package ActionDefinitions{
         activity ProvidePower (
            in fuelCmd:FuelCmd,
            out wheelToRoadTorque:Torque[2]
         );
      package StateDefinitions {
         state def VehicleStates;
         state def ControllerStates;
      }
      package ValueDefinitions{
         import ScalarValues::*;
      }
   }
```

Some simplifications have been made for the purposes of presentation

Example Using Textual Notation Usages/Configuration_a

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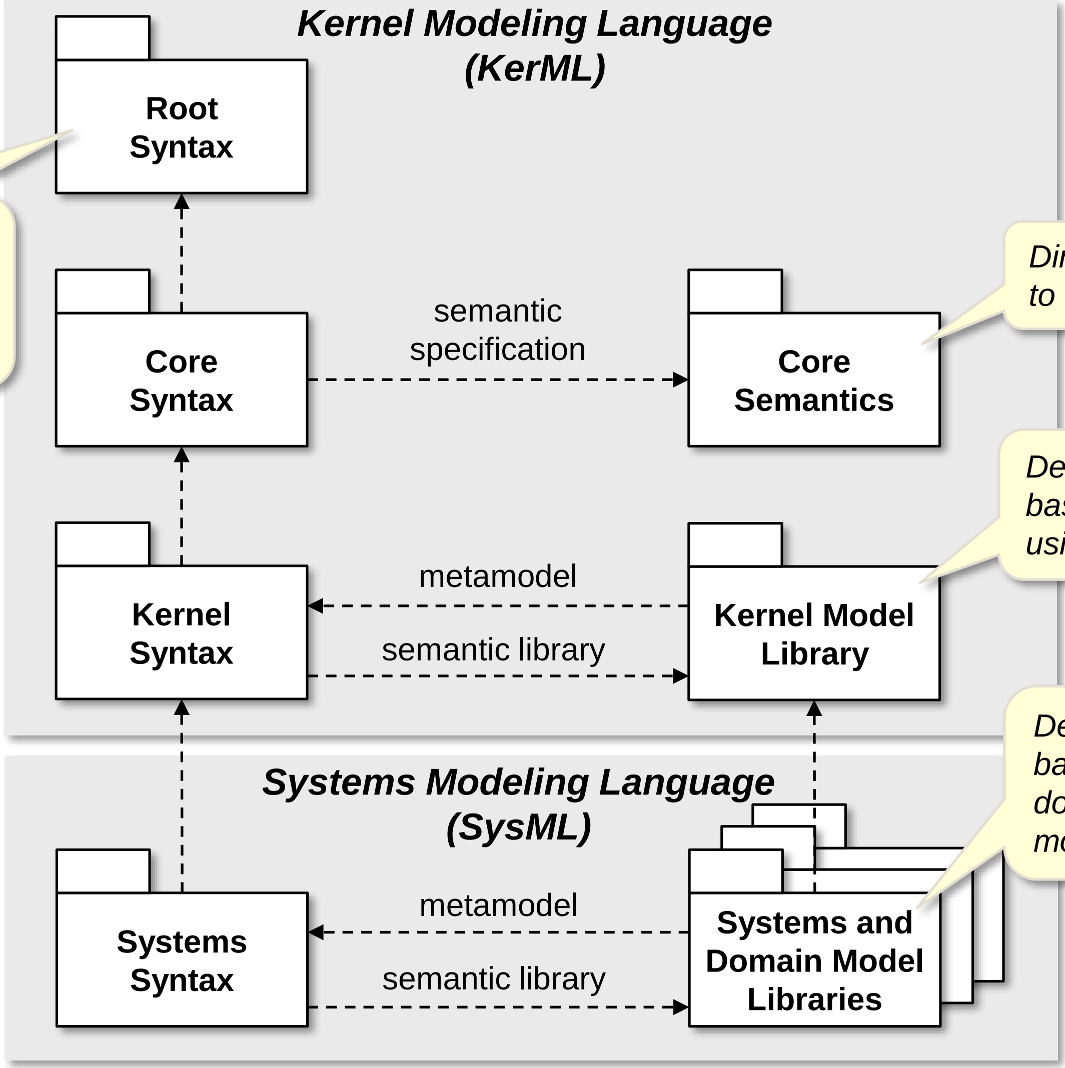
```
package VehicleConfigurations{
    import Definitions::*;
    package VehicleConfiguration_a{
      package VehiclePartsTree{
        part vehicle_a:Vehicle{
          value mass redefines mass=1750;
          part frontAxleAssembly:AxleAssembly{
            part frontAxle:Axle;
            part frontWheels:Wheel[2];
          }
          part rearAxleAssembly:AxleAssembly{
            part rearAxle:Axle;
            part rearWheels:Wheel[2];
          }
        }
      }
    }
```

vehicle_a is typed by Vehicle

Some simplifications have been made for the purposes of presentation

SysML v2 Language Architecture

SysML v2 Language Architecture SST



Root syntactic elements without model-level semantics (e.g., packaging)

Direct semantic mapping to formal logic

Declarative semantic base elements modeled using KerML

Declarative semantic base elements and domain-specific libraries modeled using SysML

SysML v2 API & Services

SysML v2 API & Services

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- Enables other tools and applications to access SysML models in a standard way
- Provides services to:
    - Create, update, and delete elements
    - Query and navigate model
    - Other services including support for model management, analysis, view generation, transformation, and file export generation
- Facilitates use of different implementation technologies such as Rest, Java, and OSLC

Pilot Implementation Using Standard API

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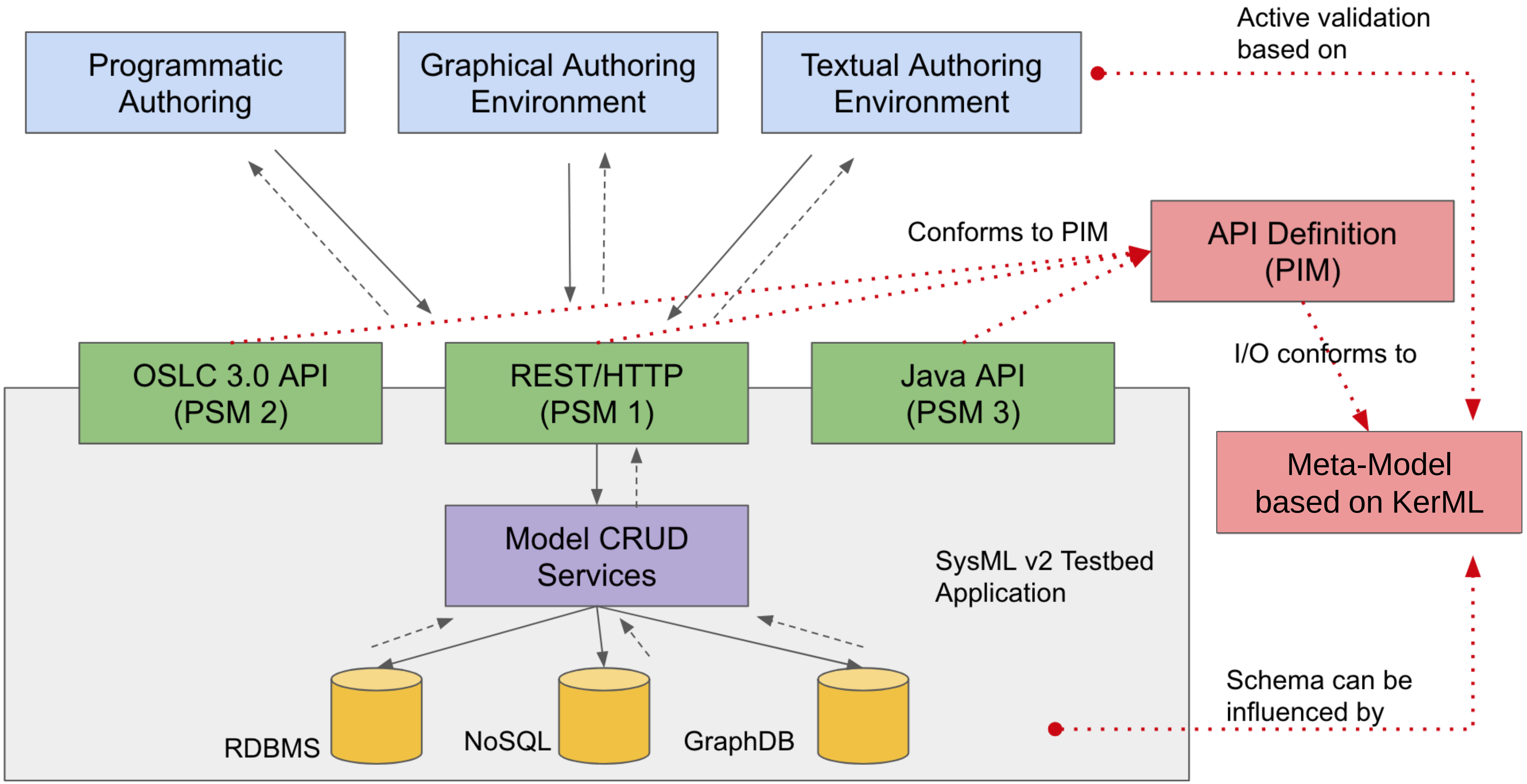
High-Level Architecture of SysML v2 Testbed


Active validation based on
Programmatic Authoring
Graphical Authoring Environment
Textual Authoring Environment
Conforms to PIM
API Definition (PIM)
I/O conforms to
OSLC 3.0 API (PSM 2)
REST/HTTP (PSM 1)
Java API (PSM 3)
Meta-Model based on KerML
Model CRUD Services
SysML v2 Testbed Application
Schema can be influenced by
RDBMS
NoSQL
GraphDB

Summary

2nd Public Incremental Release (2019-12 release)

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- Publicly available on Google Drive as of January 13, 2020
  - http://openmbee.org/sysml-v2-release/2019-12
- Google group for comments and questions
- Content
  - Read me file (includes installation instructions)
  - Specification documentation (Parts 1, 2, 3)
  - Training material for SysML textual notation
  - Installation file for Jupyter tooling
  - Installation site for Eclipse plug-in
  - Web access to Tom Sawyer tooling/repository

Progress since 2019 IW

- Language architecture has been solidified
- Extended language design and implementation from basic structure to include function-based and state-based behavior
- Defined SysML v2 textual notation consistent with language design
- API & Services now fully integrated with metamodel
- Stood up SysML v2 modeling environment using Jupyter
- Drafts specifications produced from the model

Summary

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- SST is addressing RFP requirements and issues associated with SysML v1 to improve adoption and effectiveness
  - Precision and expressiveness
  - Consistency and integration among language concepts
  - Interoperability with other engineering models and tools
  - Usability by model developers and consumers
- Initial approach
  - SysML v2 metamodel that overcomes fundamental UML limitations
  - Flexible graphical notations and textual notation
  - Formal semantics
  - Standardized API for interoperability
- Steady progress towards initial submission in 2020

SysML v2 Open Session

Sunday, January 26 from 1:00 – 4:00 PM PT

Room: Pier 9+11

Purpose: Provide early look at current state of SysML v2 in advance of initial submission (expected June – Sept, 2020)

Format: Presentation and Demonstrations with Project Leads, Ed Seidewitz and Manas Bajaj

Thank you!!