Mars Society University Rover Challenge 2020 rules

Webel Parsing Analysis SysML demo model (partial)

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Provided as a partial tutorial and for assessment of engagement of **Webel IT Australia** for SysML Training or SysML/MBSE Consultancy

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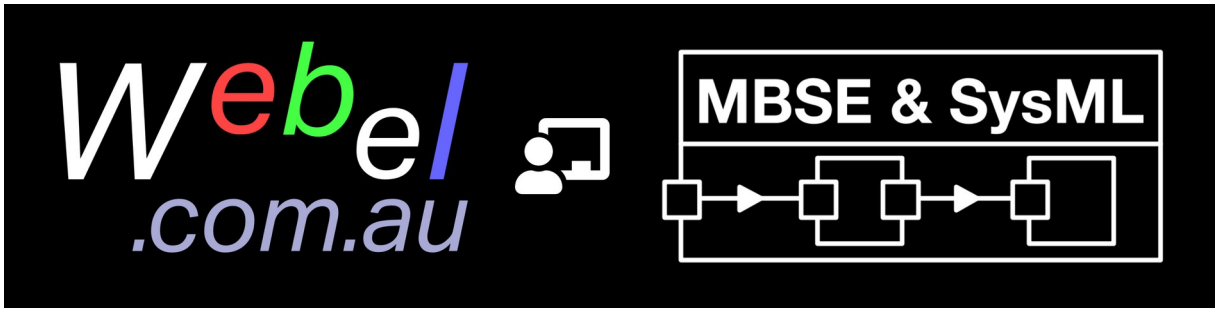

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About this slide set

- This presentation contains selected diagrams from a Systems Modeling Language (SysML) project model prepared using the **Webel Parsing Analysis** recipe for SysML/MBSE applied to (some of) the rules text from the Mars Society *University Rover Challenge* (2020).

  http://urc.marssociety.org/home/requirements-guidelines

- The model and diagrams were prepared using MagicDraw SysML 19SP3 and the Cameo Simulation Toolkit (CST) Plugin tool (equivalent to the Cameo Systems Modeler product bundle).

- *Thanks to Prof. Michael Vinarcik of University of Detroit Mercy and SAIC for the kind invitation to use the rover challenge rules to demonstrate the Webel Parsing Analysis technique applied to the rules text encapsulated as SysML Requirements in a Cameo model.*

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About **Webel Parsing Analysis**

- The **Webel Parsing Analysis** recipe for SysML is a technique for traceable elicitation of SysML model elements from text extracts from domain source documents. This technique has been refined over two decades by Dr Darren Kelly of Webel IT.
- The current version employs a customised extension of the SysML1x. ElementGroup called a **Snippet** to encapsulate analysed text extracts:
  - A simplified version of the profile is available in this demo model.
- Such Snippet elements are also employed as text commentary in diagrams.
- In general, the technique is applicable to **any** domain source document text, not just to the text of Requirements (and typically the technique is used to also elicit explicit and implied Requirements and Constraints).
- A full description of the method is beyond the scope of this document;
  for a detailed description and accessible tutorial trails please visit:

  https://www.webel.com.au/sysml/parsing_analysis

  https://www.webel.com.au/node/3332

  TRAIL: Theory and best practices for the Webel Parsing Analysis recipe for SysML v1.x

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Caveats and scope of the model (1)

- Time spent on this demonstration of application of the **Webel Parsing Analysis** recipe to the Mars Rover Rules 2020 was necessarily capped (all time spent was tracked, and most diagrams are time-stamped).
- Only text from selected target Requirement elements was mapped (and always via a Copy relationship so that finer-grained, owned, sub-requirements could be elicited). See also the Requirements section.
- Use of Satisfy with Requirements is indicative only; Some matrices and tables are provided to indicate that most Requirements are at least “addressed” by an elicited or implied/assumed model element.
- There is no systematic treatment of functional allocation at all (yet).
- The model does not yet contain a clean separation of Block structure and Behavior (so these often appear within the same Package/Model).
- No use was made of SysML Parametrics for calculations (yet).

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Caveats and scope of the model (2)

- As there is no pre-described Rover design solution, the focus of the model so far is on representing the Challenge, Entry, Mission, and Stage points and penalty system – rather than modelling a Rover solution that meets the Requirements.
  - This also helps prevent any clashes between this SysML work and students' real Rover entries.
- Representation of Rover block structure and values is limited to aspects indicated directly in the rules. No parts specific to an assumed design solution are introduced.
- To make testing of the various included mini simulations easier, the Activity diagrams for Challenge, Entry, MissionAttempt and StageAttempt are not yet glued together (one can't yet simulate a Team's entire competition Entry for a Rover across all Mission types).
- Of the mission types, only the AutonomousNavigationMission is modelled in any detail, and only its MissionStages are handled (not the individual Legs).
- Ample use is of made of abstract Blocks and Generalization to demonstrate how reuse of such a model can be optimised. For example, there is a the general concept of a Platform, of which a Rover (for any planetary challenge) and MarsRover (for the specific Mars Rover Challenge) are specialisations:
  - Many (not all) Requirements are assumed to apply to any planetary Rover (not just a MarsRover).
  - Webel-style "redefinition ladders" are used liberally throughout with Property defaults.

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About the simulations and video

- Some (only) of the Activity Diagrams and StateMachines can be simulated in Cameo:
  - Some dedicated test launch diagrams are indicated in the top-level *index* Package Diagram.
  - Some Blocks with classifier Behaviors can be run.
- The model and these slides are accompanied by an **informal** narrated screencast video of some of these mini simulations in action, available on Vimeo via this private link:

  https://vimeo.com/465331737/108a185e6d

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About Parsing Analysis «pa» diagrams

To avoid any confusion, the following can't be emphasised too often:

- Parsing Analysis diagrams (as indicated by the «pa» keyword) are NOT final presentation diagrams! They are used once (to elicit model elements from a text extract tracked via a **Snippet**) and then their job is done forever:
  - They therefore do not have to be tidy or particularly legible.
  - They are not intended for **any** audience (other than for educational purposes).
- Any new elicited model elements are then always moved into the main project area and represented in (typically much tidier) model diagrams.
- As the main project model evolves, older Parsing Analysis diagrams often "break"; **this is completely expected, it is not a flaw in the methodology.**
- In this slide set document, the Parsing Analysis diagrams as they were used are collated in an **Appendix** with clear timestamps.

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Table of all analysed text Snippets

#	Source	△ Owner	Criterion
1	2020 University Rover Challenge	1.b.1. Operations	Coordinates will be provided in latitude/longitude format (e.g. decimal degrees; degrees decimal minutes; degrees minutes seconds).
2	2020 University Rover Challenge	1.b.1. Operations	Teams will operate their rovers in real-time from designated command and control stations.
3	2020 University Rover Challenge	1.b.1. Operations	The GPS standard shall be the WGS 84 datum.
4	2020 University Rover Challenge	1.b.1. Operations	Visibility of the course to the operators in the control station will be blocked.
5	2020 University Rover Challenge	2.a.1. Stand-alone Platform	A single connected platform must leave the designated start gate.
6	2020 University Rover Challenge	2.a.1. Stand-alone Platform	In the open field, the primary platform may deploy any number of smaller sub-platforms, so long as the combined master/slave sub-platforms meet all additional requirements published.
7	2020 University Rover Challenge	2.a.1. Stand-alone Platform	Tethered power and communications are not allowed.
8	2020 University Rover Challenge	2.a.1. Stand-alone Platform	The rover shall be a stand-alone, off-the-grid, mobile platform.
9	2020 University Rover Challenge	2.a.2. Rover Size	Failure to fit within the specified dimensions at weigh-in will result in a 40% penalty.
10	2020 University Rover Challenge	2.a.2. Rover Size	For weighing the rover must fit completely within a 1.2 m x 1.2 m box.
11	2020 University Rover Challenge	2.a.2. Rover Size	Rovers may articulate/fold/bend to fit within the “transport crate,” but may not be disassembled to do so.
12	2020 University Rover Challenge	2.a.2. Rover Size	Rovers shall be weighed by the judges during the set-up time of each mission.
13	2020 University Rover Challenge	2.a.2. Rover Size	There is no vertical height limit for 2020, and the rover may be placed in any orientation.
14	2020 University Rover Challenge	2.a.2. Rover Size	This includes wheels, antenna, and any other system protruding from the rover.
15	2020 University Rover Challenge	2.a.3. Rover Mass	... the total rover plus arm plus sensor must be less than 70 kg.
16	2020 University Rover Challenge	2.a.3. Rover Mass	For each event in which the rover is overweight, the team shall be assessed a penalty of 5% of the points scored, per kilogram over 50.
17	2020 University Rover Challenge	2.a.3. Rover Mass	For example, a modular rover may have a robotic arm and a sensor that are never on the rover at the same time.
18	2020 University Rover Challenge	2.a.3. Rover Mass	The combinations of rover plus arm and rover plus sensor must each be under 50 kg ...
19	2020 University Rover Challenge	2.a.3. Rover Mass	The combinations of rover plus arm and rover plus sensor must each be under 50 kg, but the total rover plus arm plus sensor must be less than 70 kg.
20	2020 University Rover Challenge	2.a.3. Rover Mass	The maximum allowable mass of the rover when deployed for any competition mission is 50 kg.
21	2020 University Rover Challenge	2.a.3. Rover Mass	The total mass of all fielded rover parts for all events is 70 kg.
22	2020 University Rover Challenge	2.a.3. Rover Mass	The weight limits do not include any spares or tools used to prepare or maintain the rover, but does include any items deployed by the rover such as sub-rovers, cameras, communication relays.
23	2020 University Rover Challenge	2.a.6. Kill Switch	This switch shall immediately stop the rover’s movement and cease all power draw from batteries in the event of an emergency such as a battery fire.
24	2020 University Rover Challenge	2.a.6. Kill Switch	All rovers shall have a “kill switch” that is readily visible and accessible on the exterior of the rover.
25	2020 University Rover Challenge	2.b.1. Remote / wireless operation	Line-of-sight communications are not guaranteed for all of the missions.
26	2020 University Rover Challenge	2.b.1. Remote / wireless operation	The operators will not be able to directly view the rover or the site
27	2020 University Rover Challenge	2.b.1. Remote / wireless operation	The rover shall be operated remotely using wireless communications with no time delay.
28	2020 University Rover Challenge	2.d.7. Intervention Penalty	Multiple intervention penalties in a single mission are additive: e.g. two interventions would result in a score of 60% of points earned.
29	2020 University Rover Challenge	2.d.7. Intervention Penalty	Teams will be penalized 20% of the total points in that mission for every intervention.
30	2020 University Rover Challenge	2.d.7. Intervention Penalty	The mission clock will continue to run during an intervention.
31	2020 University Rover Challenge	3.a.1. Mission Scoring	Each event and the SAR shall be worth 100 points, for a total of 500 points.
32	2020 University Rover Challenge	3.a.1. Mission Scoring	it is not possible to score less than zero on a mission
33	2020 University Rover Challenge	3.a.1. Mission Scoring	Missions are scored independently
34	2020 University Rover Challenge	3.a.1. Mission Scoring	Missions are scored independently and it is not possible to score less than zero on a mission.
35	2020 University Rover Challenge	3.a.1. Mission Scoring	Penalties for overweight rovers, interventions, and other penalties are additive: e.g. penalties of 10% and 20% would result in a score of 70% of the points earned.
36	2020 University Rover Challenge	3.e.1. Stage Timing	Any time remaining at the completion of a stage is added to the allotted time of the subsequent stage, which begins immediately.
37	2020 University Rover Challenge	3.e.1. Stage Timing	Failure to complete a stage will result in the end of the mission.
38	2020 University Rover Challenge	3.e.1. Stage Timing	Rovers shall be required to autonomously traverse to posts or between gates in this staged mission across easy and moderately difficult terrain.
39	2020 University Rover Challenge	3.e.1. Stage Timing	Teams must complete each stage within the allotted time in order to proceed to the next stage.
40	2020 University Rover Challenge	3.e.3. Leg Definition	A leg is defined as the rover autonomously navigating to the next post or passing completely through the next gate.
41	2020 University Rover Challenge	3.e.4. Post and Gate Markers	Each marker will display a black and white AR tag.
42	2020 University Rover Challenge	3.e.4. Post and Gate Markers	Each gate will consist of a pair of posts 2 – 3 m apart.
43	2020 University Rover Challenge	3.e.4. Post and Gate Markers	Each post will have a large (20cm x 20cm) marker 30 – 100 cm off the ground.
44	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 1: GPS coordinates of the post provided.
45	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 2: GPS coordinates of the post provided.
46	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 3: GPS coordinates up to 5m from the post. Rovers will need to autonomously detect AR tag on the post and drive to it.
47	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 4: Autonomously drive completely through a gate with posts 3 m apart. GPS coordinates between gate posts provided.
48	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 5: GPS coordinates up to 10m from gate. A small autonomous search pattern may be required to locate the gate, if gate not initially detected by autonomous vision recognition.
49	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 6: GPS coordinates between posts provided. One or more obstacles will likely prevent a bee-line from the previous gate. Autonomous obstacle avoidance will be required to reach the gate.
50	2020 University Rover Challenge	3.e.5. Leg Requirements	Leg 7: GPS coordinates up to 10m from gate. Obstacles will complicate the search for the gate, requiring obstacle avoidance and/or autonomous route finding.
51	2020 University Rover Challenge	3.e.5. Leg Requirements	Legs will increase in difficulty
52	2020 University Rover Challenge	3.e.5. Leg Requirements	Stage 1. Autonomously drive to a post and stop within 3m of the post. Flat easy terrain.
53	2020 University Rover Challenge	3.e.5. Leg Requirements	Stage 2. Autonomously drive completely through a gate. Gate posts 2 m apart.
54	2020 University Rover Challenge	3.e.6. LED Indicator	There must be an LED indicator on the back of the rover, visible in bright daylight (e.g. large LED or LED array), that will signal:, · Red: Autonomous operation, · Blue: Teleoperation (Manually drivir
55	2020 University Rover Challenge	2020 University Rover Challenge	

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SECTION

Webel Parsing Analysis profile (simplified)

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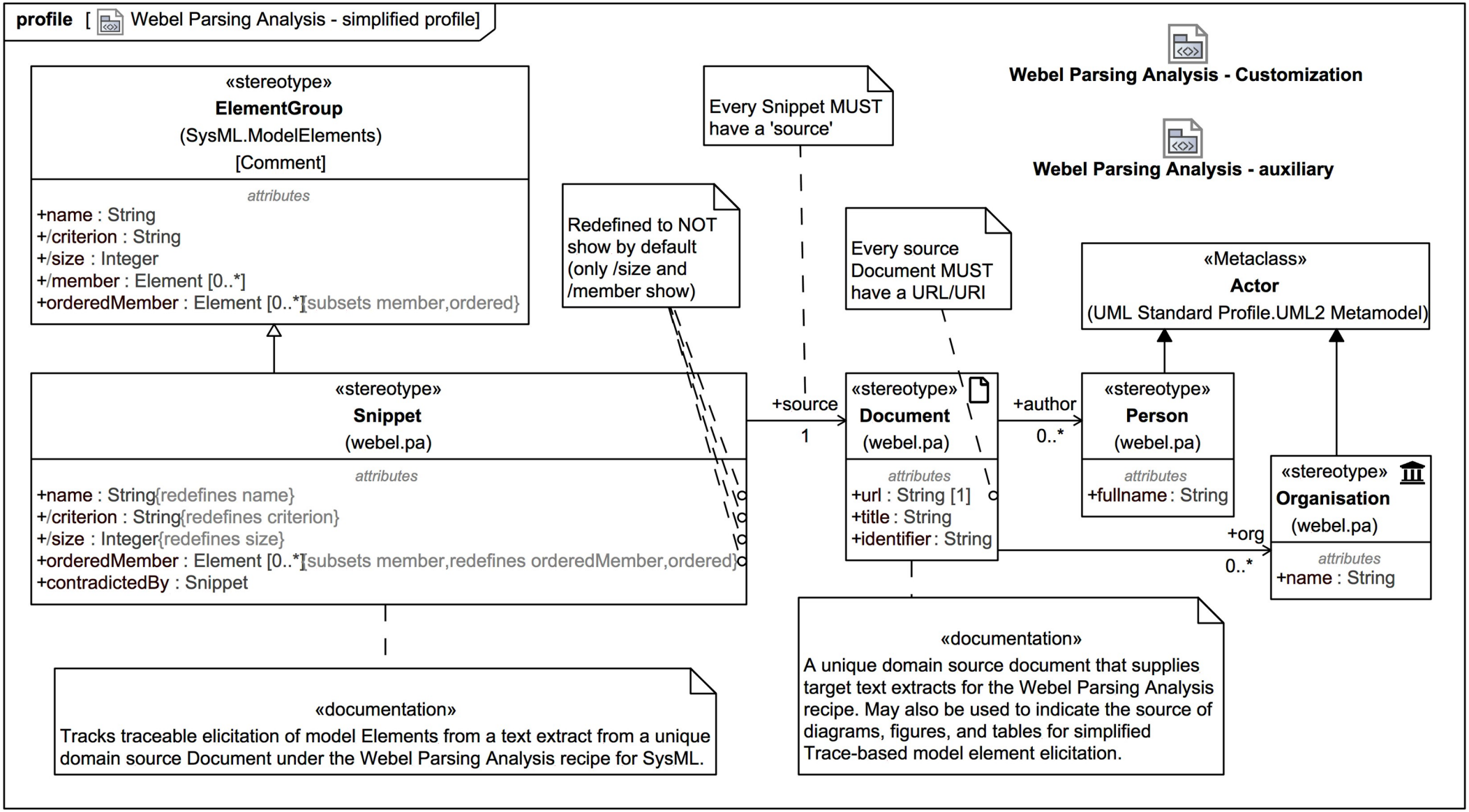

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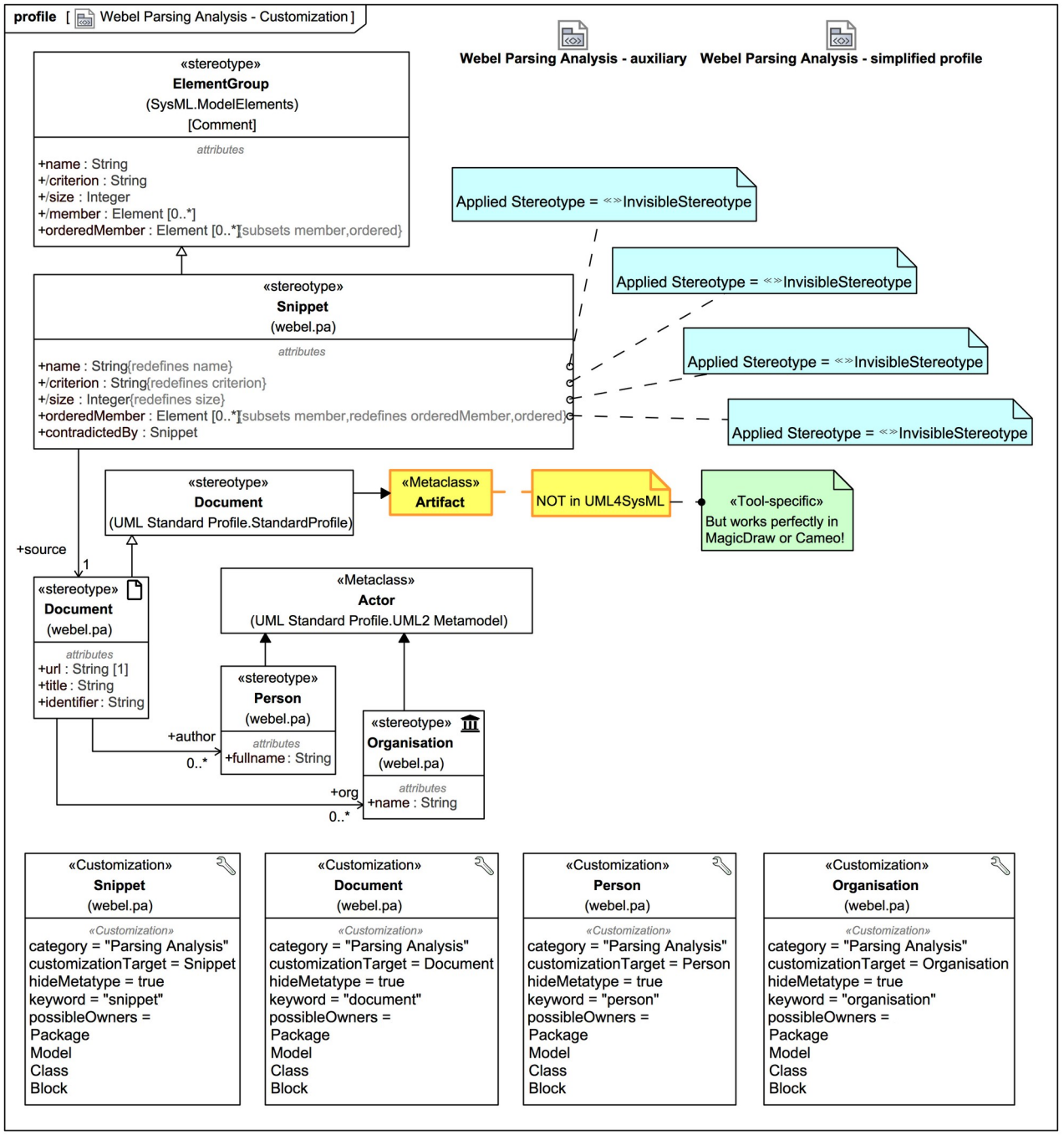

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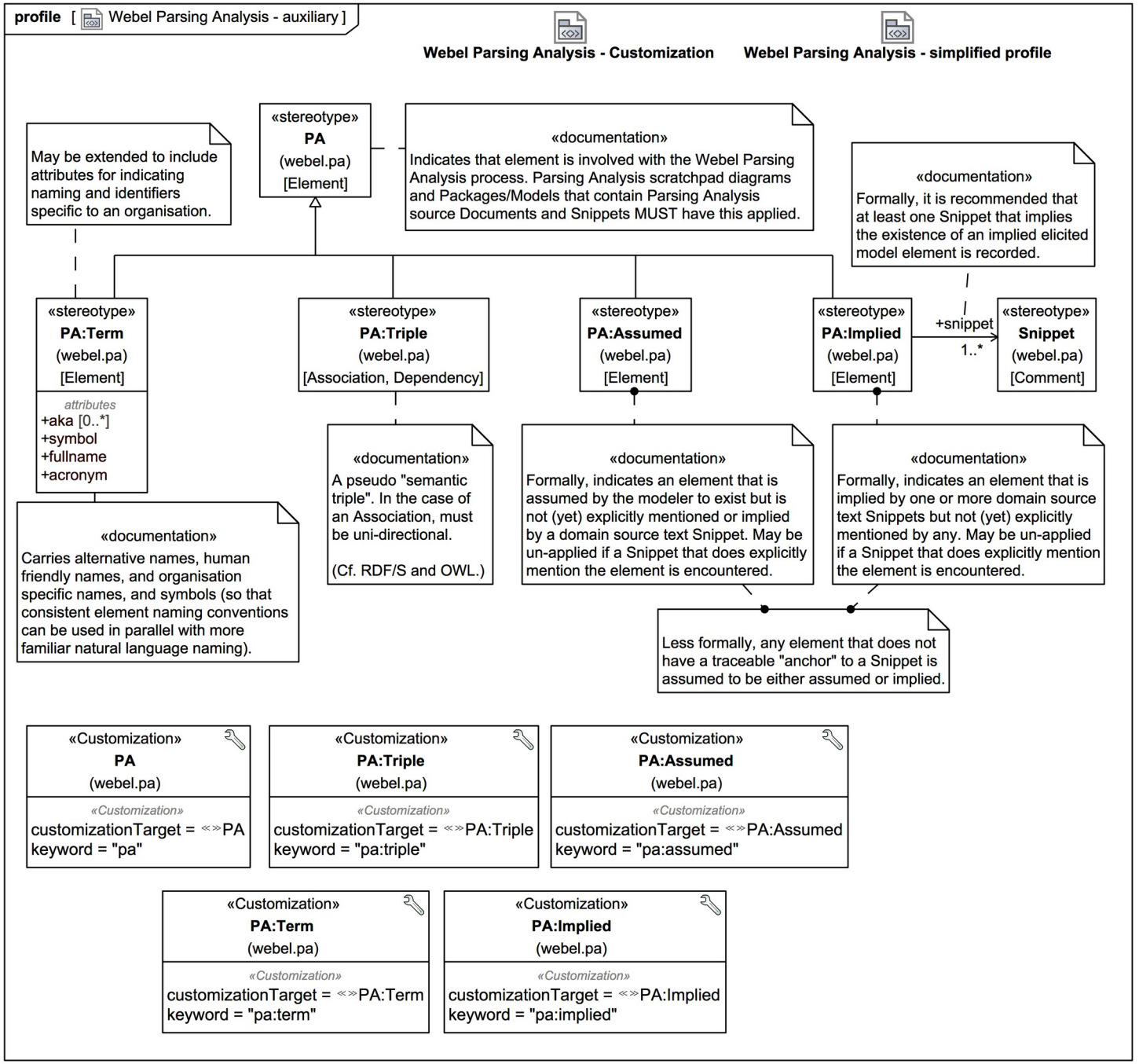

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SECTION

Index, RoverSystem, and context

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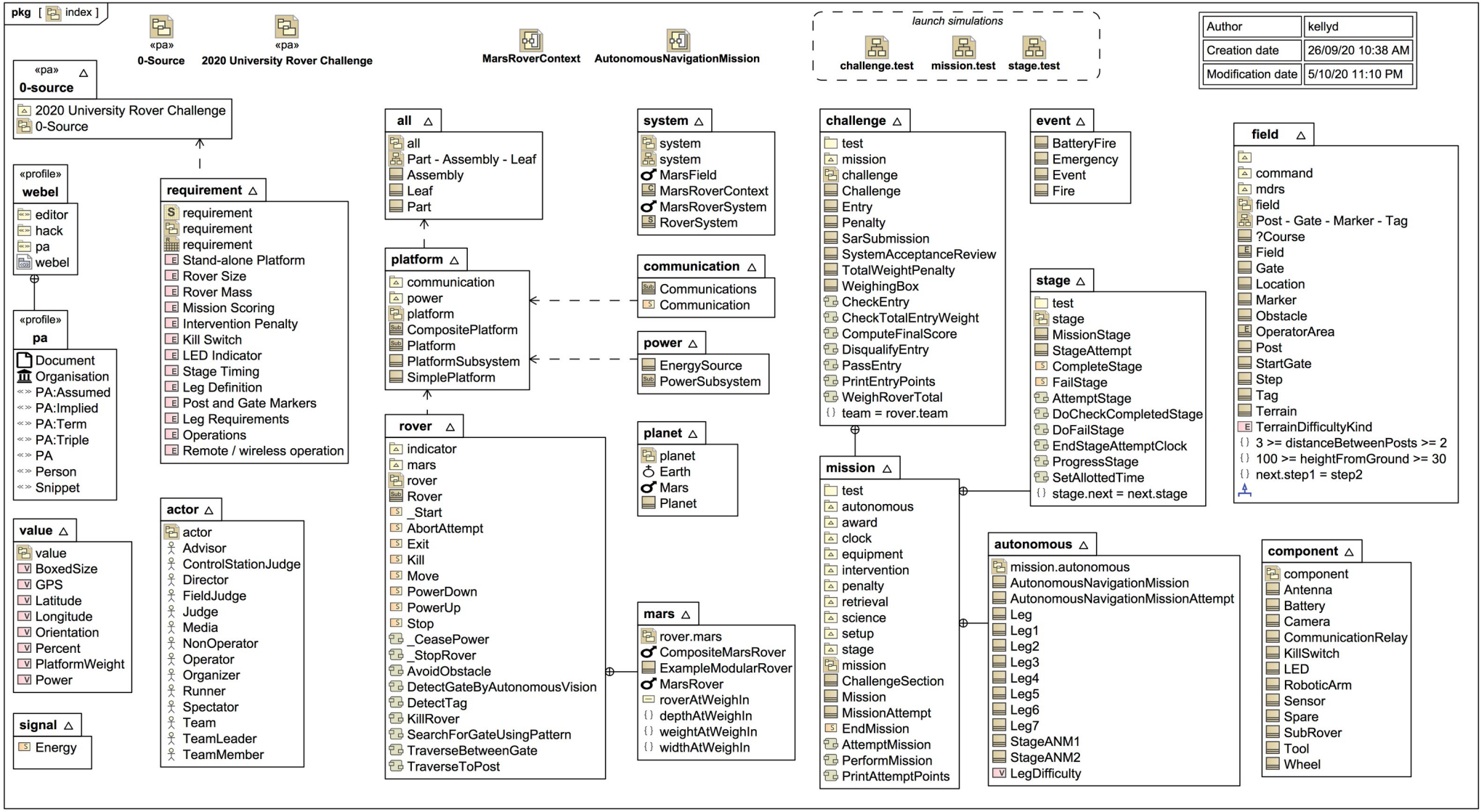

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Table of Blocks, Behaviors, attributes

#	Name	Classifier Behavior	Owned Behavior	Owned Attribute
1	?Course			
2	Antenna			
3	Antenna			station : ~F_Communication rover : F_Communication
4	Assembly			child : Part [1..*] isLeaf : Boolean [1] = false
5	AutonomousNavigationMission			stage1 : StageANM1 [1] stage2 : StageANM2 [1] isStaged : Boolean = true leg1 : Leg1 [1] leg2 : Leg2 [1] leg3 : Leg3 [1] leg4 : Leg4 [1] leg5 : Leg5 [1] leg6 : Leg6 [1] leg7 : Leg7 [1] /leg : Leg [7]
6	AutonomousNavigationMissionAttempt			mission : AutonomousNavigationMission [1]
7	Award			name : String
8	Battery			
9	BatteryFire			battery : Battery
10	Box			width : length[metre] [1] height : length[metre] [1] depth : length[metre] [1]
11	Camera			
12	Challenge			/totalAvailablePoints = 500.0 entry : Entry [1..*] penalty : Penalty [*] totalWeightPenalty : TotalWeightPenalty [1] /section : ChallengeSection [0..*] equipmentServiceMission : EquipmentServiceMission [1] scienceMission : ScienceMission [1] stageThreingMission : AutonomousNavigationMission [1] retrievalMission : RetrievalMission [1] /mission : Mission [4] sar : SystemAcceptanceReview [1]
13	ChallengeSection			availablePoints : Real = 100.0
14	Clock	Clock(classifier behavior)	Clock(classifier behavior) printTime	time : time[second]
15	CommandStation			: Operator : Controller : ControlStationJudge
16	CommunicationRelay			
17	Communications			isTethered : Boolean [1] = false
18	Communications			
19	CompositeMarsRover			
20	CompositePlatform			isComposite : Boolean [1] = true subPlatform : Platform [2..*]
21	Controller			antenna : F_Communication : Operator : Display
22	Display			
23	DummyAward			points : Real = 100.0 name : String [0..*] = Dummy award (100 points)
24	Earth			
25	Emergency			
26	EnergySource			: PowerSubsystem
27	EnergySource			: PowerSubsystem
28	Entry			team : Team [1] challenge : Challenge [1] /missionAttempt : MissionAttempt [0..*] rover : Rover [1] qualifies : Boolean /totalEarnedPoints : Real submission : SarSubmission [4] scienceMissionAttempt : ScienceMissionAttempt [4] equipmentServiceMissionAttempt : EquipmentServiceMissionAttempt [4] retrievalMissionAttempt : RetrievalMissionAttempt [4] autonomousNavigationMissionAttempt : AutonomousNavigationMissionAttempt
29	EquipmentServiceMission			
30	EquipmentServiceMissionAttempt			mission : EquipmentServiceMission [1]
31	Event			
32	ExampleModularRover			arm : RoboticArm [1] sensor : Sensor [1]
33	Field			location : Location gate : Gate [1..*] start : StartGate [1] : OperatorArea [1] post : Post [0..*] terrainDifficulty : TerrainDifficultyKind rover : Rover : Obstacle [1..*]
34	Fire			
35	Gate			isStart : Boolean location : Location /post : Post [2] post1 : Post [1] post2 : Post [1] distanceBetweenPosts : distance[metre] [1] gps : GPS [0..1]
36	Gate4			distanceBetweenPosts : distance[metre] [1] = 3.0 m post1 : Post4a [1] post2 : Post4b [1] gps : GPS [1]
37	Gate5			post1 : Post5a [1] post2 : Post5b [1] distanceBetweenPosts : distance[metre] [1] = 2.0 m
38	Gate6			gps : GPS [1] post1 : Post6a [1] post2 : Post6b [1] distanceBetweenPosts : distance[metre] [1] = 2.0 m
39	Gate7			post1 : Post7a [1] post2 : Post7b [1] distanceBetweenPosts : distance[metre] [1] = 2.0 m
40	Indicator	IndicatorSTM(classifier behavior)	IndicatorSTM(classifier behavior) SetIndicatorMode	led : LED [1..*] mode : IndicatorMode [1] luminance : luminance[candela per square metre]
41	IndicatorMode			operationMode : IndicatorOperationModeKind [1] signalColor : IndicatorSignalColorKind [1]
42	IndicatorModeAutonomous			operationMode : IndicatorOperationModeKind [1] = autonomous signalColor : IndicatorSignalColorKind [1] = red isFlashing : Boolean [1] = false
43	IndicatorModeSuccessful			operationMode : IndicatorOperationModeKind [1] = successful signalColor : IndicatorSignalColorKind [1] = green isFlashing : Boolean [1] = true
44	IndicatorModeTele			operationMode : IndicatorOperationModeKind [1] = tele signalColor : IndicatorSignalColorKind [1] = blue isFlashing : Boolean [1] = false
45	Intervention			
46	InterventionPenalty			percent : Percent [1] = 20.0 name : String [1] = Intervention penalty
47	KillSwitch			isVisible : Boolean [1] = true isAccessible : Boolean [1] = true isExterior : Boolean [1] = true
48	Leaf			isLeaf : Boolean [1] = true
49	LED			
50	Leg			finish : Step [1] start : Step [1] next : Leg [1] difficulty : LegDifficulty
51	Leg1			start : StartGate [1] finish : Post1 [1] next : Leg2 [1]
52	Leg2			start : Post1 [1] finish : Post2 [1] next : Leg3 [1]
53	Leg3			gps : GPS [1] start : Post2 [1] finish : Post3 [1] next : Leg4 [1]
54	Leg4			start : Post3 [1] finish : Gate4 [1] next : Leg5 [1]
55	Leg5			gps : GPS [1] finish : Gate5 [1] start : Gate4 [1] next : Leg6 [1]
56	Leg6			finish : Gate6 [1] start : Gate5 [1] next : Leg7 [1] obstacle : Obstacle [1..*]
57	Leg7			gps : GPS [1] obstacle : Obstacle [1..*] finish : Gate7 [1] start : Gate6 [1] next : Leg [1] = null
58	Location			isOpenField : Boolean field : Field gps : GPS
59	Marker			tag : Tag [1] width : length[centimetre] = 20.0 cm length : length[centimetre] = 20.0 cm heightFromGround : length[centimetre]
60	Mars			
61	MarsDesertResearchStation			
62	MarsField			rover : MarsRover [0..*] : FieldJudge : Runner
63	MarsRover			isStandAlone : Boolean [1] = true isOffTheGrid : Boolean [1] = true isMobile : Boolean [1] = true location : Location weightAtWeighIn : PlatformWeight field : MarsField [0..*]
64	MarsRoverContext			: MarsRoverSystem : Judge : MarsField : OperatorArea : Spectator : Media : NonOperator : Director : SarSubmission : WeighingBox : Mission [4] : TeamMember : Organizer : TeamLeader : MissionAttempt
65	MarsRoverSystem			rover : MarsRover [1]
66	Mission			stage : MissionStage [0..*] setupTime : SetupTime [1] penalty : Penalty [1..*] isStaged : Boolean sizePenalty : SizePenalty [1] weightPenalty : WeightPenalty [1] interventionPenalty : InterventionPenalty [1]
67	MissionAttempt			mission : Mission [1] entry : Entry [1] pointsEarned : Real = 0.0 /rover : Rover penaltyPercentTotal : Percent = 0.0 isPenaltiesApplied : Boolean = false penalty : Penalty [0..*] award : Award [0..*] clock : Clock stageAttempt : StageAttempt [0..*]
68	MissionStage			timeAllottedBase : time[second] next : MissionStage [0..1] mission : Mission [1]
69	Obstacle			
70	OperatorArea			: CommandStation : Antenna
71	Part			isLeaf : Boolean isVisible : Boolean isAccessible : Boolean isExterior : Boolean
72	Penalty			failMessage : String passMessage : String percent : Percent [0..1]
73	Planet			
74	Platform			isStandAlone : Boolean isOffTheGrid : Boolean isMobile : Boolean subsystem : PlatformSubsystem [1..*] communications : Communications [1..*] powerSubsystem : PowerSubsystem [1..*] isComposite : Boolean isPrimary : Boolean master : Platform [0..1] slave : Platform [0..*] weightAtWeighIn : PlatformWeight /sizeAtWeighIn : BoxedSize widthAtWeighIn : length[metre] isFoldable : Boolean depthAtWeighIn : length[metre] isBendable : Boolean isArticulated : Boolean isDisassembled : Boolean wheel : Wheel [0..*] antenna : Antenna [0..*] orientation : Orientation weight : PlatformWeight
75	PlatformSubsystem			isTethered : Boolean
76	Post			location : Location [1] gps : GPS [0..1] marker : Marker [1]
77	Post1			gps : GPS [1]
78	Post2			gps : GPS [1]
79	Post3			
80	Post4a			
81	Post4b			
82	Post5a			
83	Post5b			
84	Post6a			
85	Post6b			
86	Post7a			
87	Post7b			
88	PowerSubsystem			source : EnergySource [1..*]
89	PowerSubsystem			isTethered : Boolean [1] = false source : EnergySource
90	RetrievalMission			
91	RetrievalMissionAttempt			mission : RetrievalMission [1]
92	RoboticArm			
93	Rover	RoverSTM(classifier behavior)	RoverSTM(classifier behavior) Operate	communications : Communications [1..*] powerSubsystem : PowerSubsystem [1..*] isPrimary : Boolean [1] = true entry : Entry weightTotalAllEvents : PlatformWeight killSwitch : KillSwitch [1] indicator : Indicator [1] team : Team [1] antenna : ~F_Communication field : Field [0..*]
94	RoverSystem			antenna : Antenna rover : Rover [1] controller : Controller [1]
95	SarSubmission			sar : SystemAcceptanceReview [1] entry : Entry [1]
96	ScienceMission			
97	ScienceMissionAttempt			mission : ScienceMission [1]
98	Sensor			
99	SetupTime			
100	SimplePlatform			isComposite : Boolean [1] = false
101	SizePenalty			percent : Percent [1] = 40.0 name : String [1] = Size penalty
102	Spare			
103	StageANM1			next : StageANM2 [1] allottedTimeBase : time[second] [1] leg1 : Leg1 leg2 : Leg2 leg3 : Leg3 leg4 : Leg4
104	StageANM2			next : MissionStage [1] = null allottedTimeBase : time[second] [1] leg5 : Leg5 leg6 : Leg6 leg7 : Leg7
105	StageAttempt			clock : Clock [1] missionAttempt : MissionAttempt [1] timeAllotted : time[second] [1] = 0.0 s isCompleted : Boolean [0..1] timeUsed : time[second] [0..1] stage : MissionStage [1] isCompletedInTime : Boolean [0..1] next : StageAttempt [0..1] isPassed : Boolean [0..1]
106	StartGate			isStart : Boolean = true distanceBetweenPosts : distance[metre] [1] = 2.5 m
107	Step			
108	SubRover			
109	SystemAcceptanceReview			submission : SarSubmission [0..*]
110	Tag			
111	Terrain			isFlat : Boolean difficulty : TerrainDifficultyKind
112	TestAttemptStage	TestAttemptStage	TestAttemptStage	stageAttempt : StageAttempt [1]
113	TestEntry	TestEntry	TestEntry	entry : Entry [1]
114	TestMission			
115	TestMissionAttempt	TestMissionAttempt	TestMissionAttempt	missionAttempt : MissionAttempt [1]
116	Tool			
117	TotalWeightPenalty			name : String [1] = Total weight disqualification penalty failMessage : String = Total weight over all events exceeds 70kg passMessage : String = Total weight over all events does not exceed 70kg
118	WeighingBox			width : length[metre] [1] = 1.2 m depth : length[metre] [1] = 1.2 m
119	WeightPenalty			name : String [1] = Weight penalty
120	Wheel			

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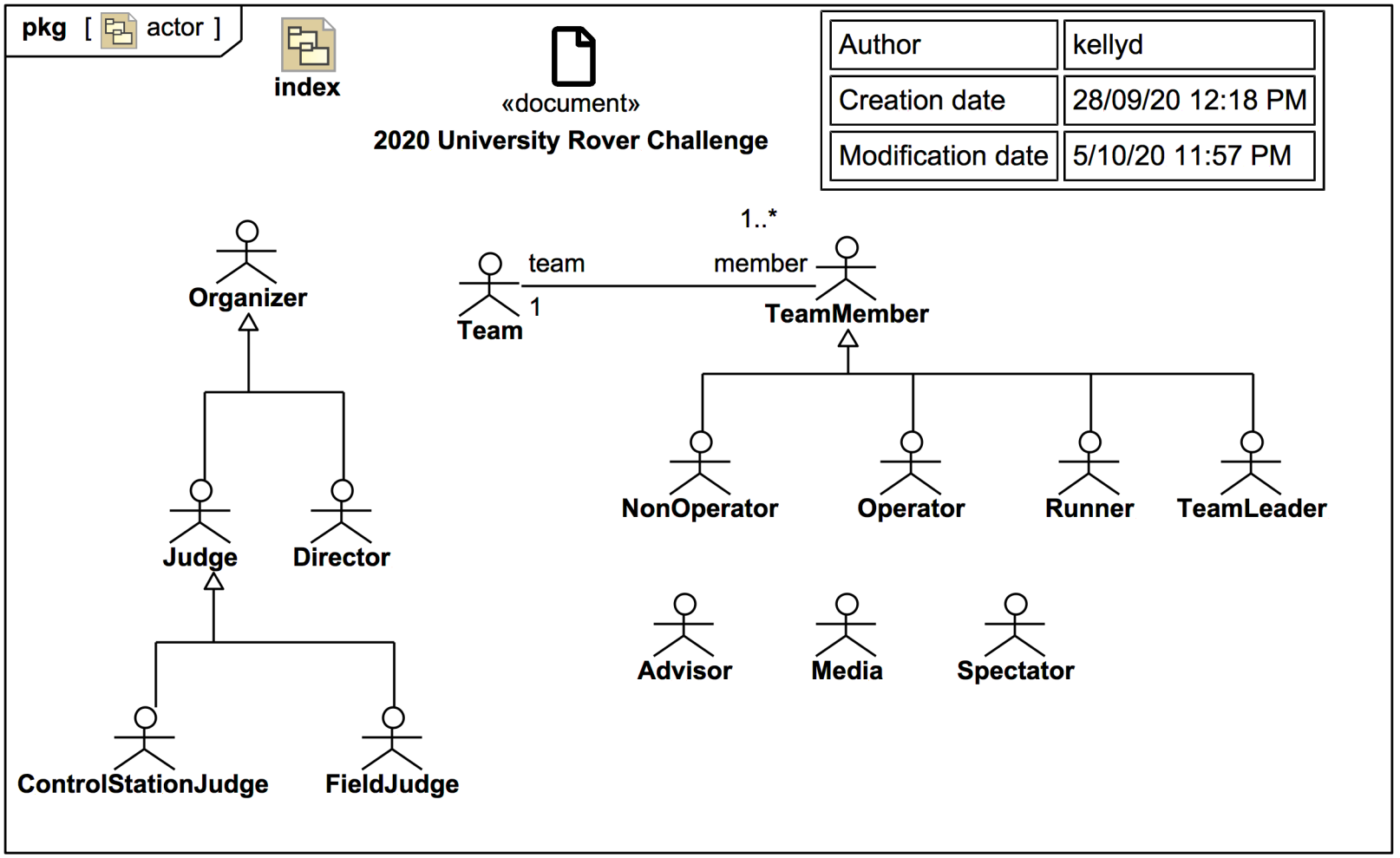

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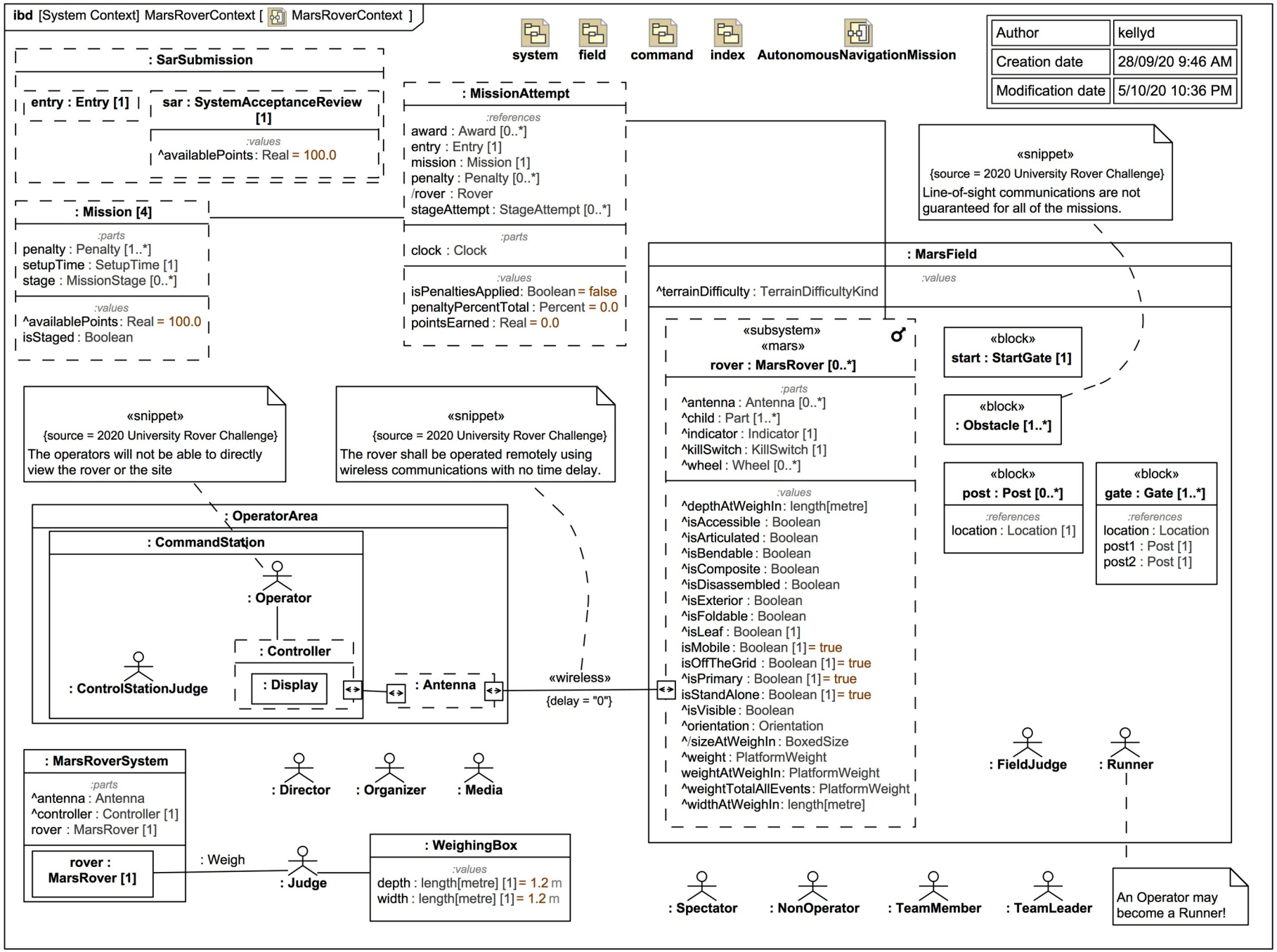

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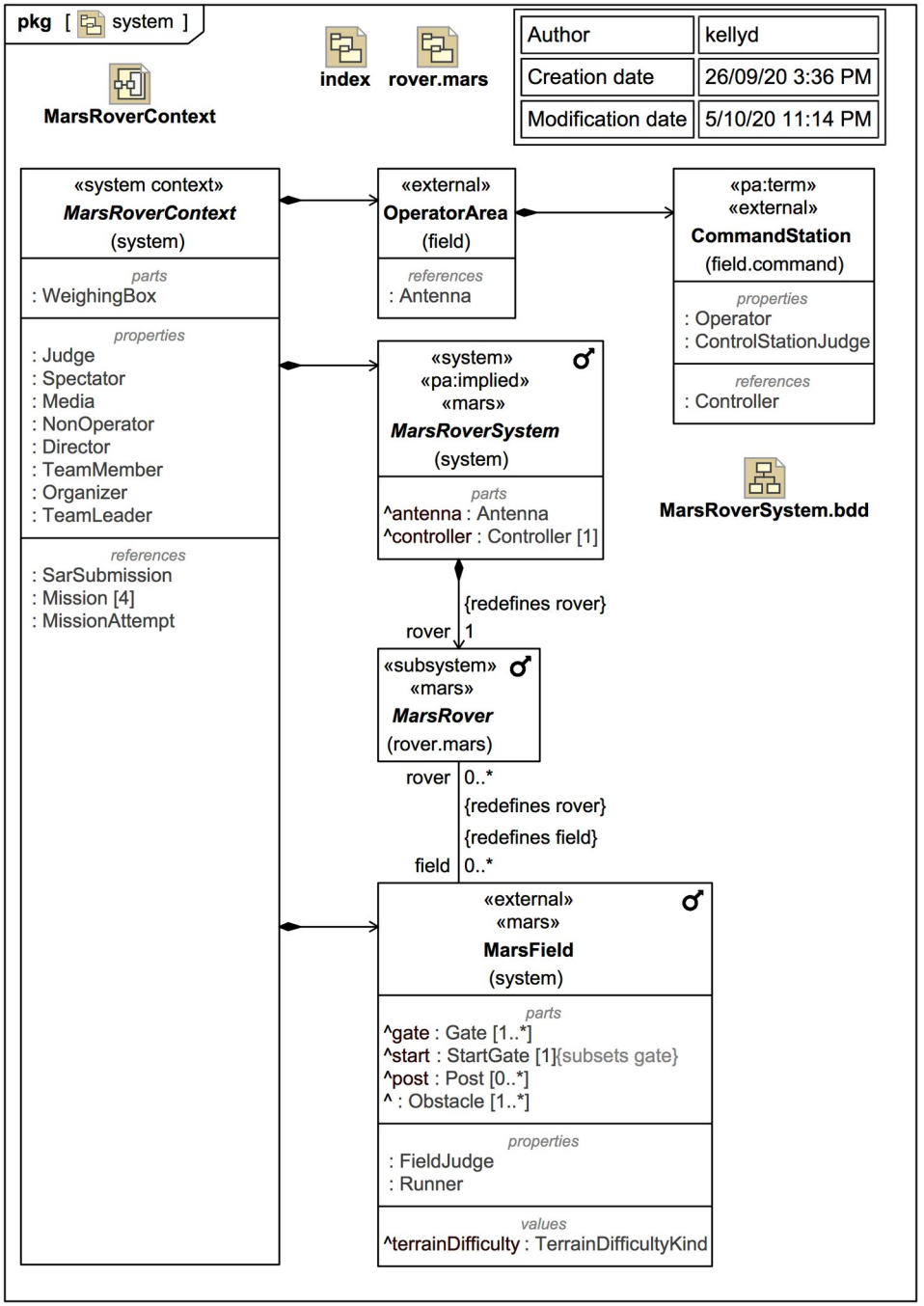

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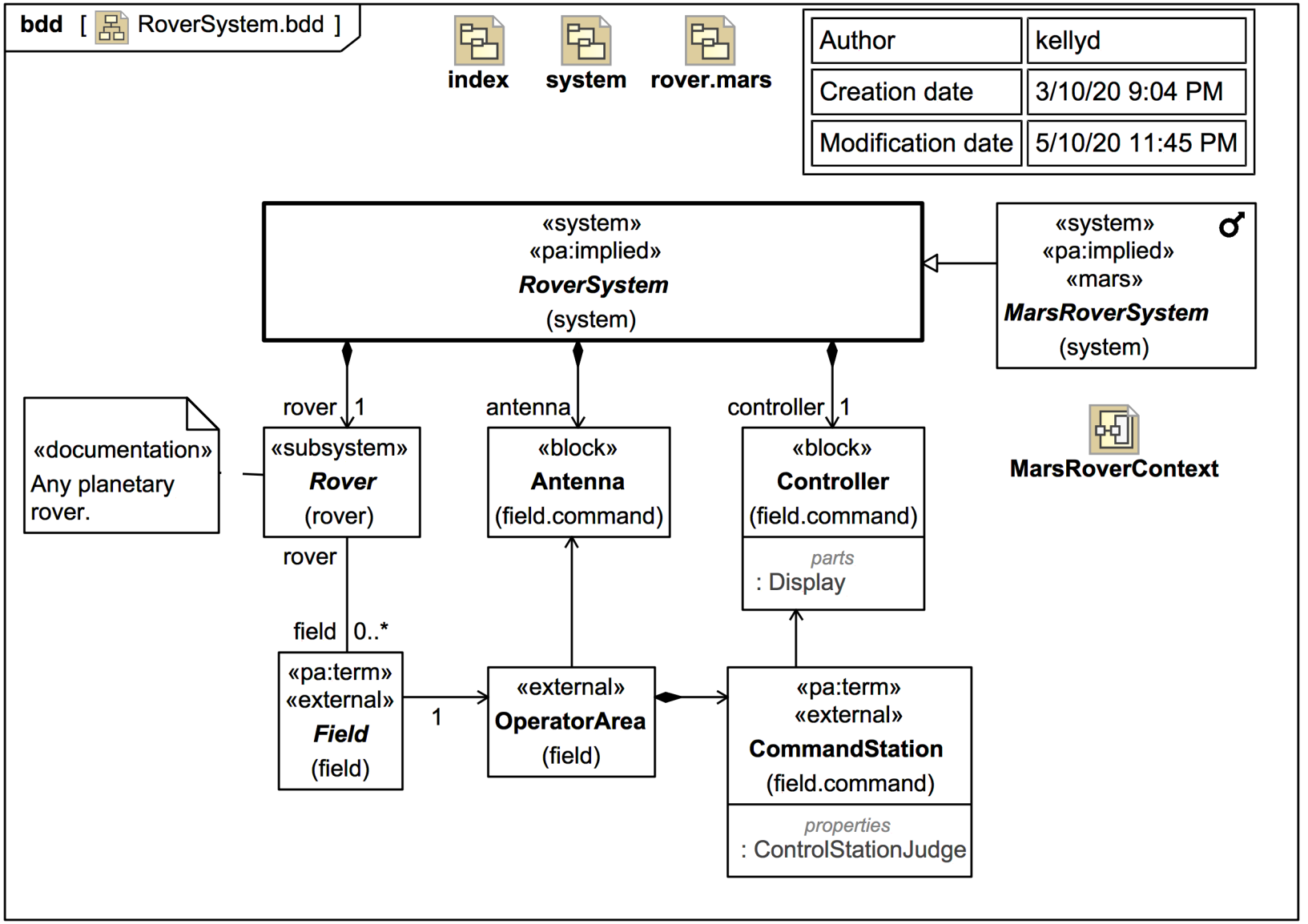

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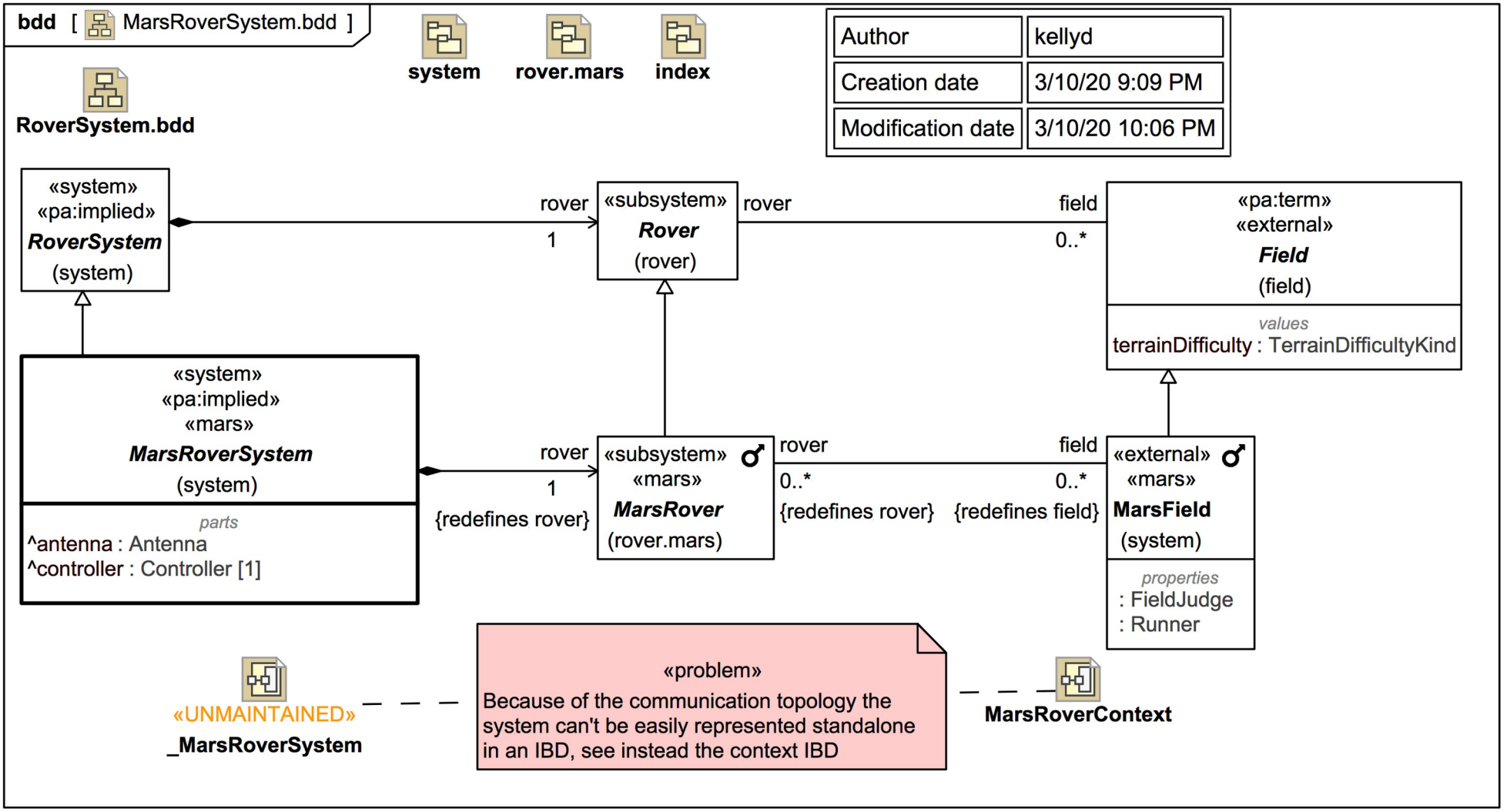

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SECTION

AutonomousNavigationMission

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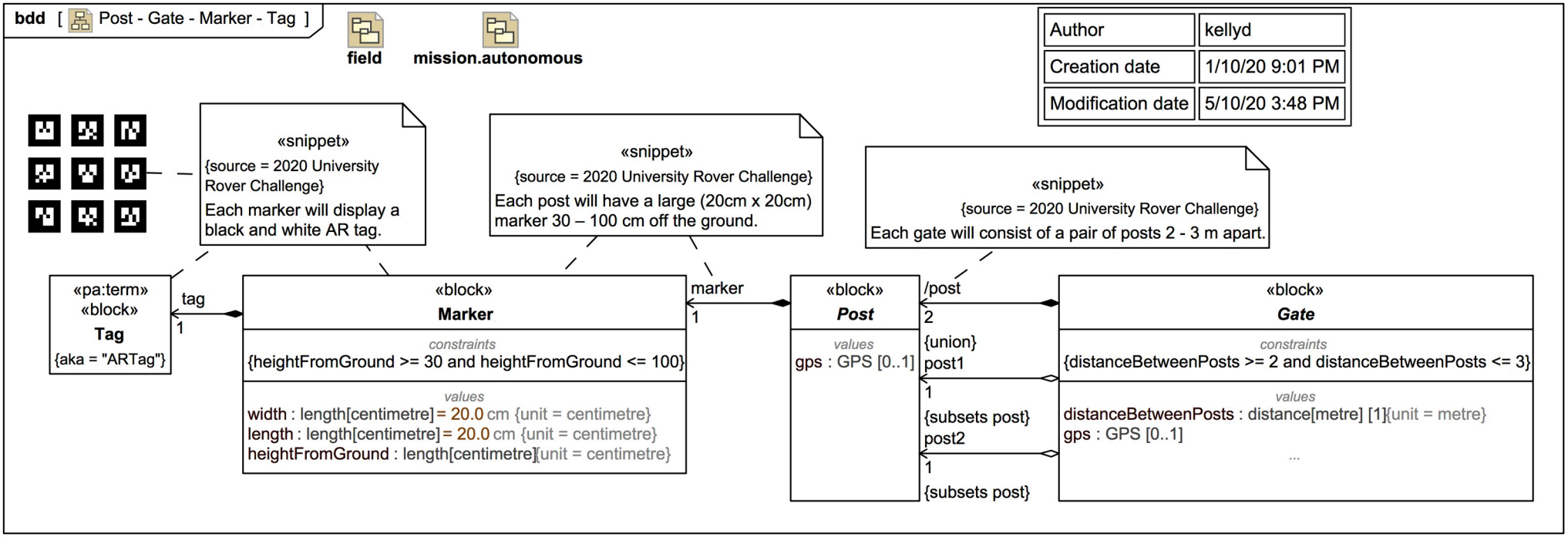

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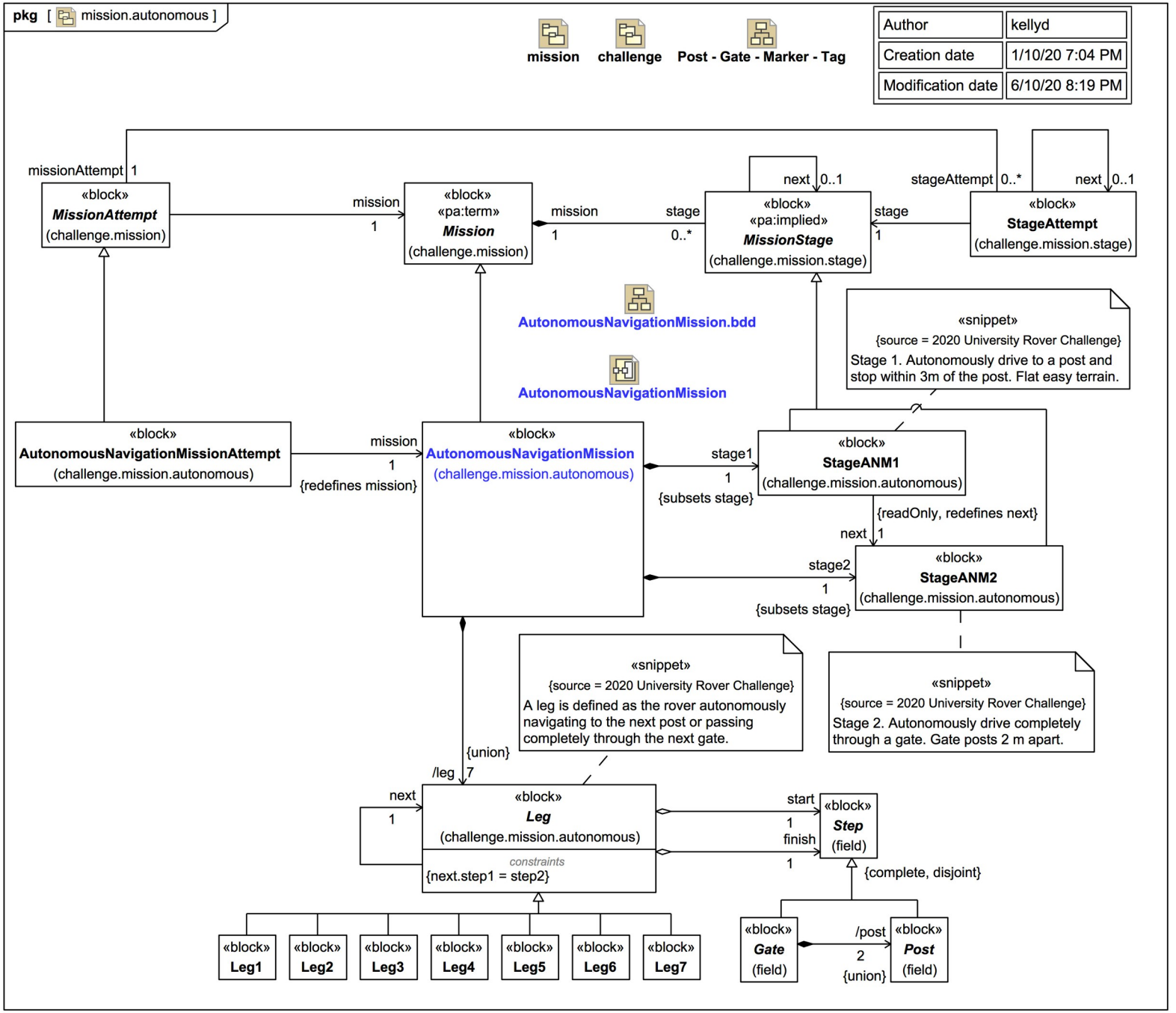

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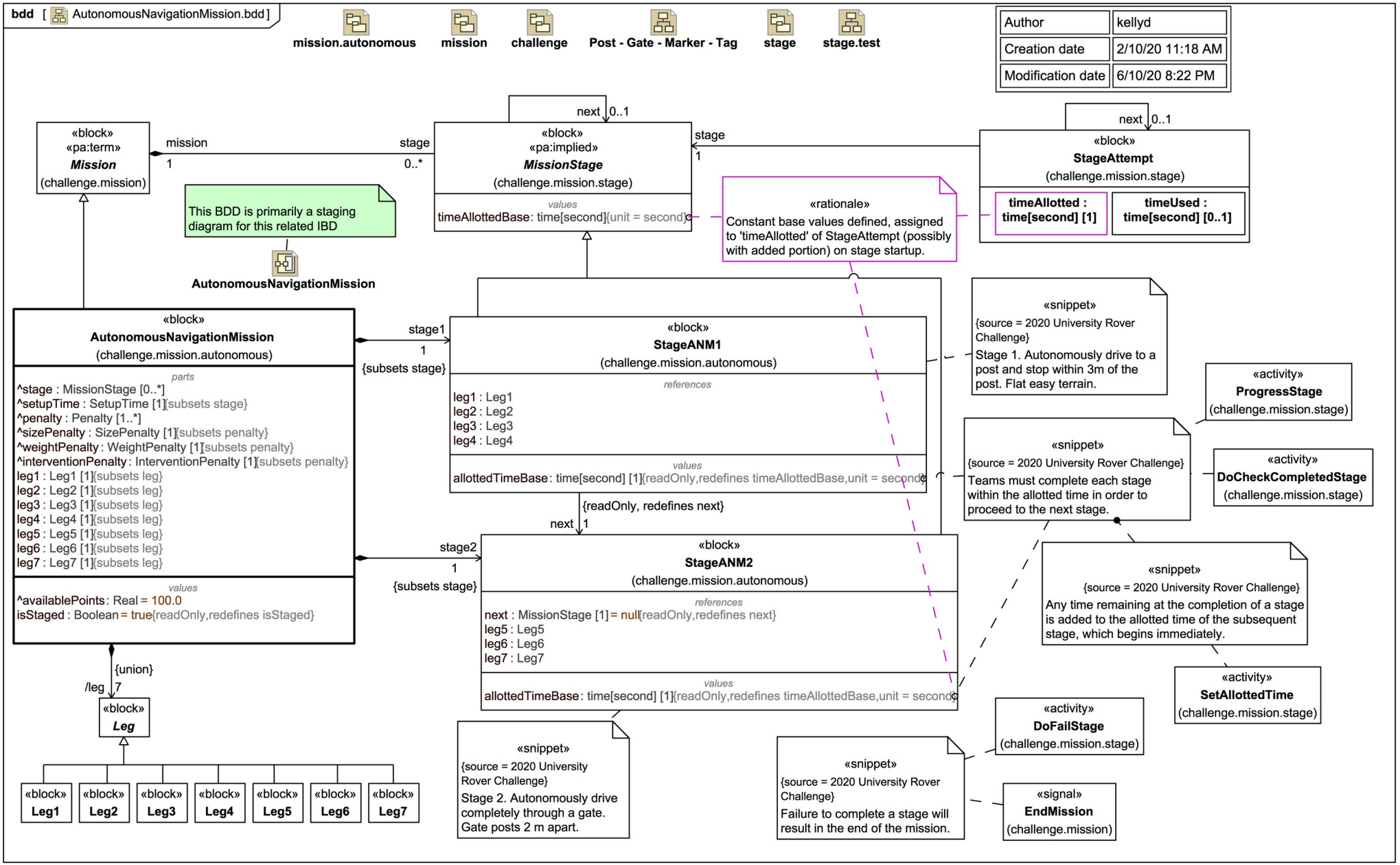

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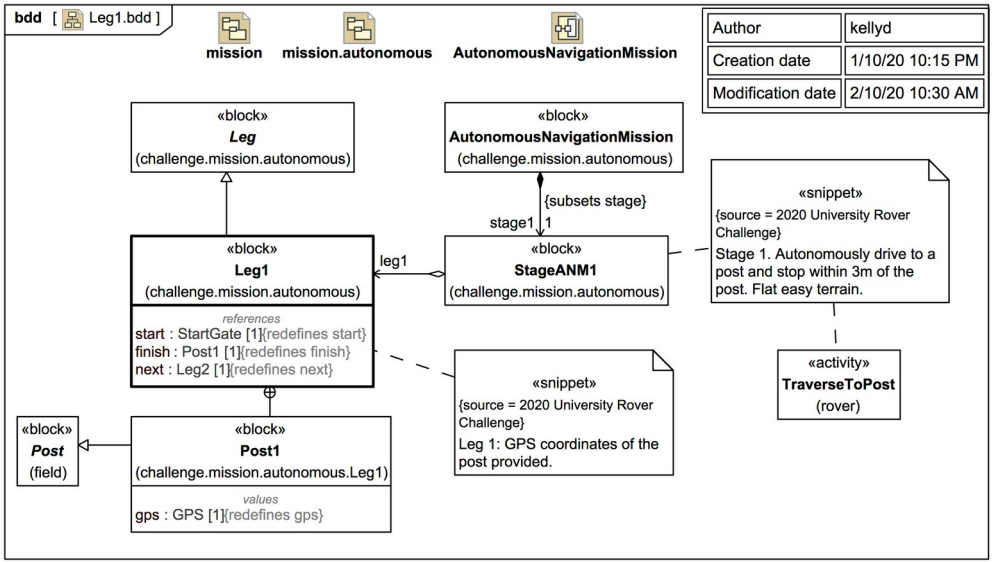

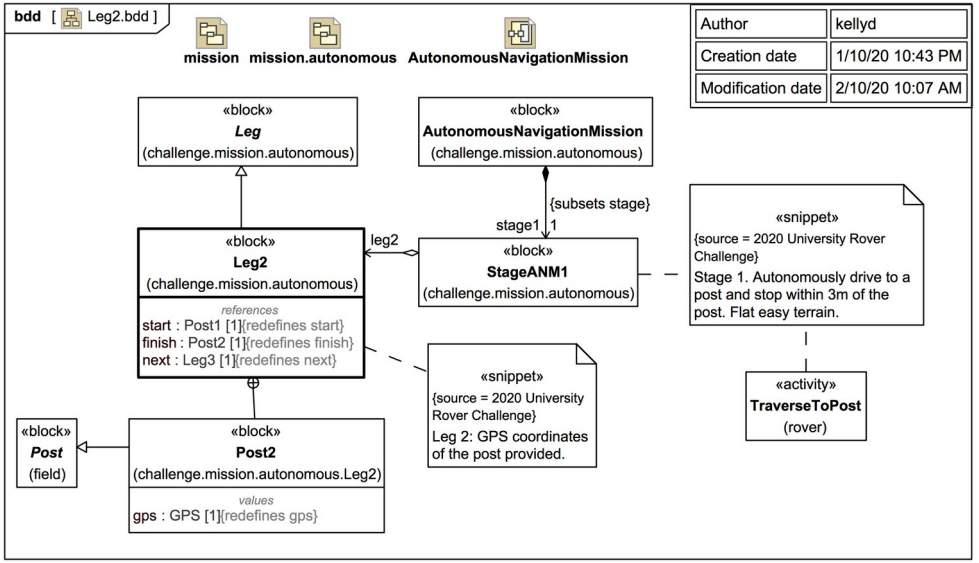

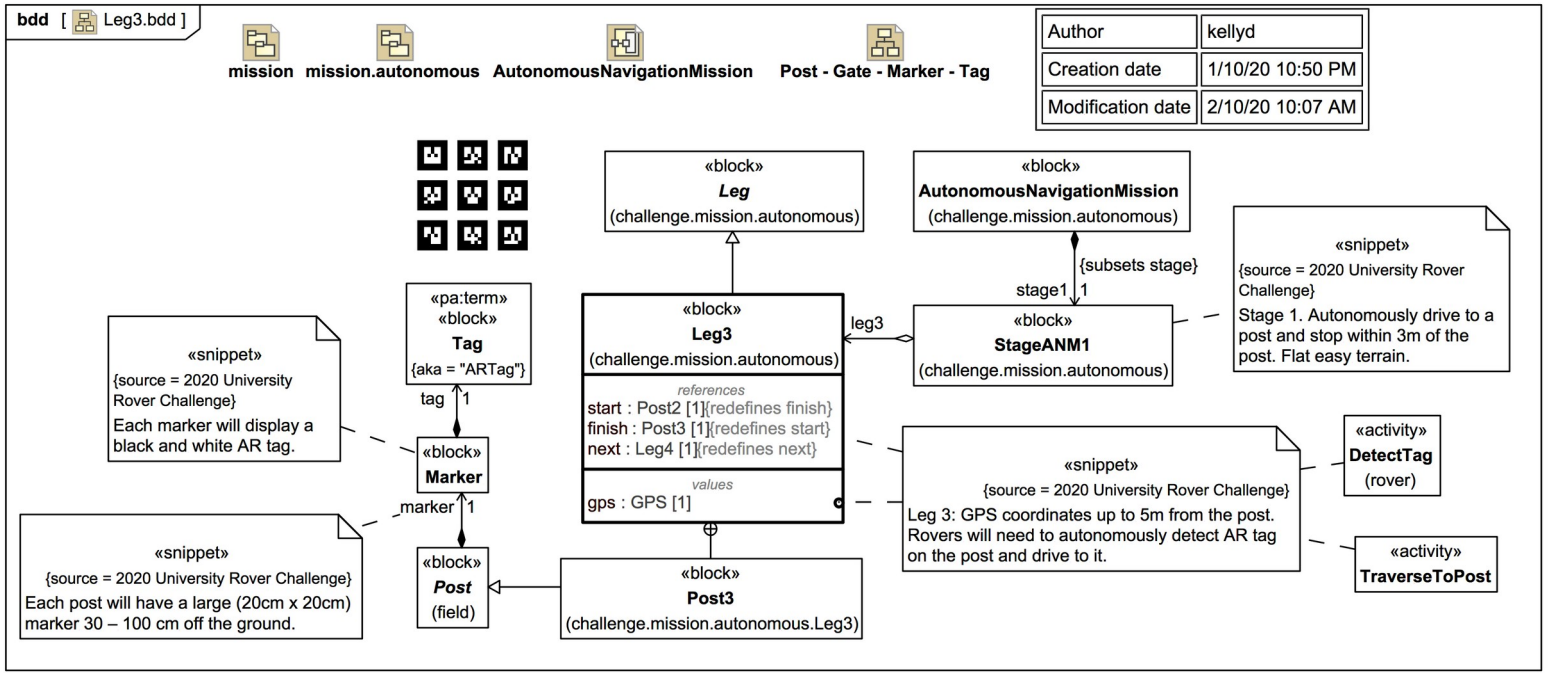

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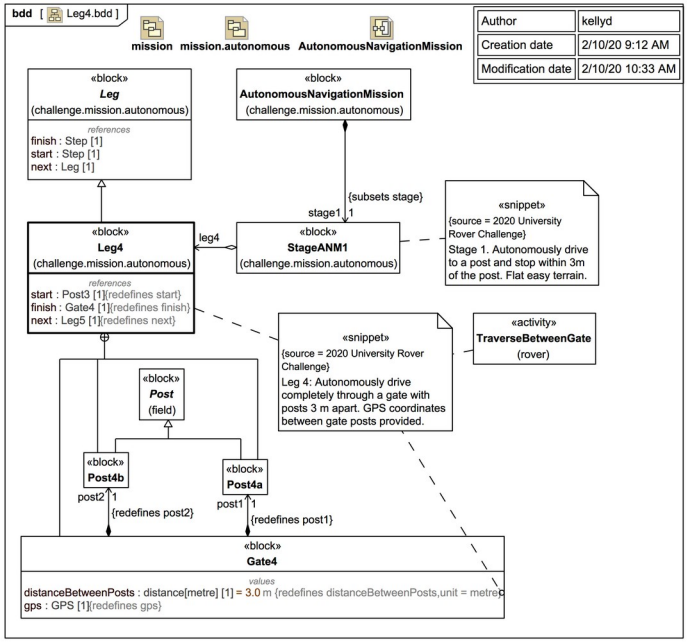

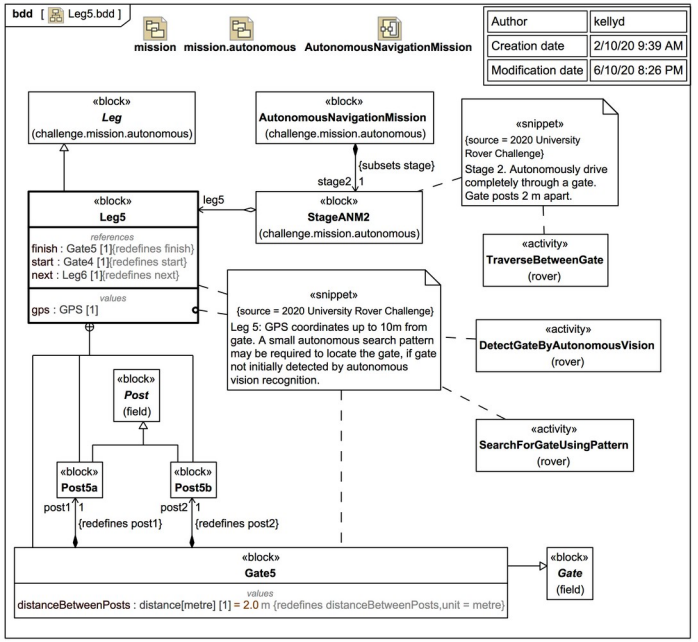

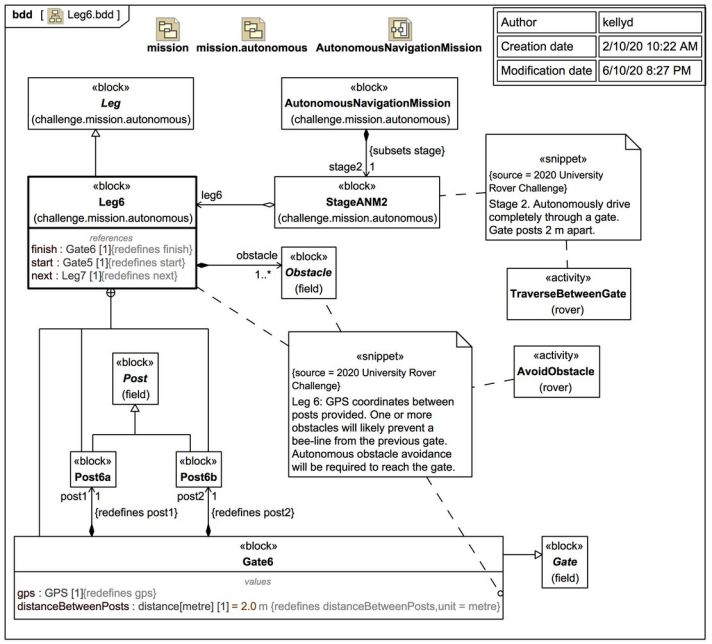

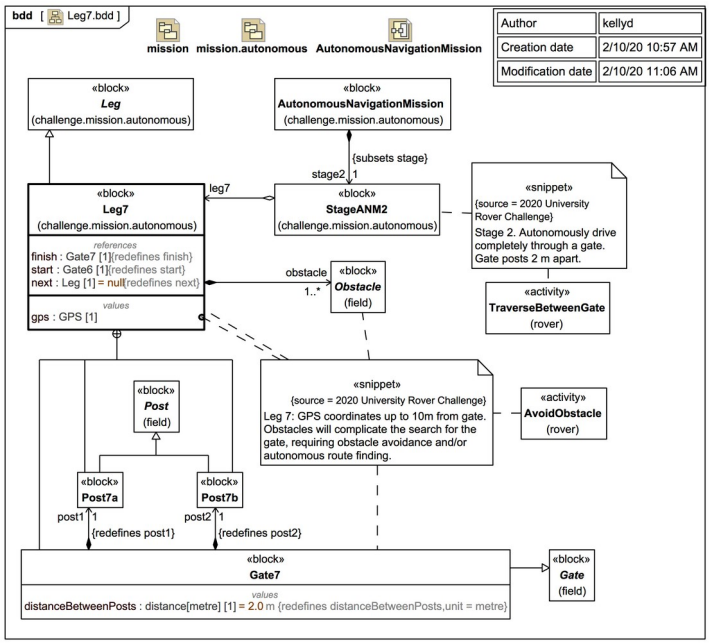

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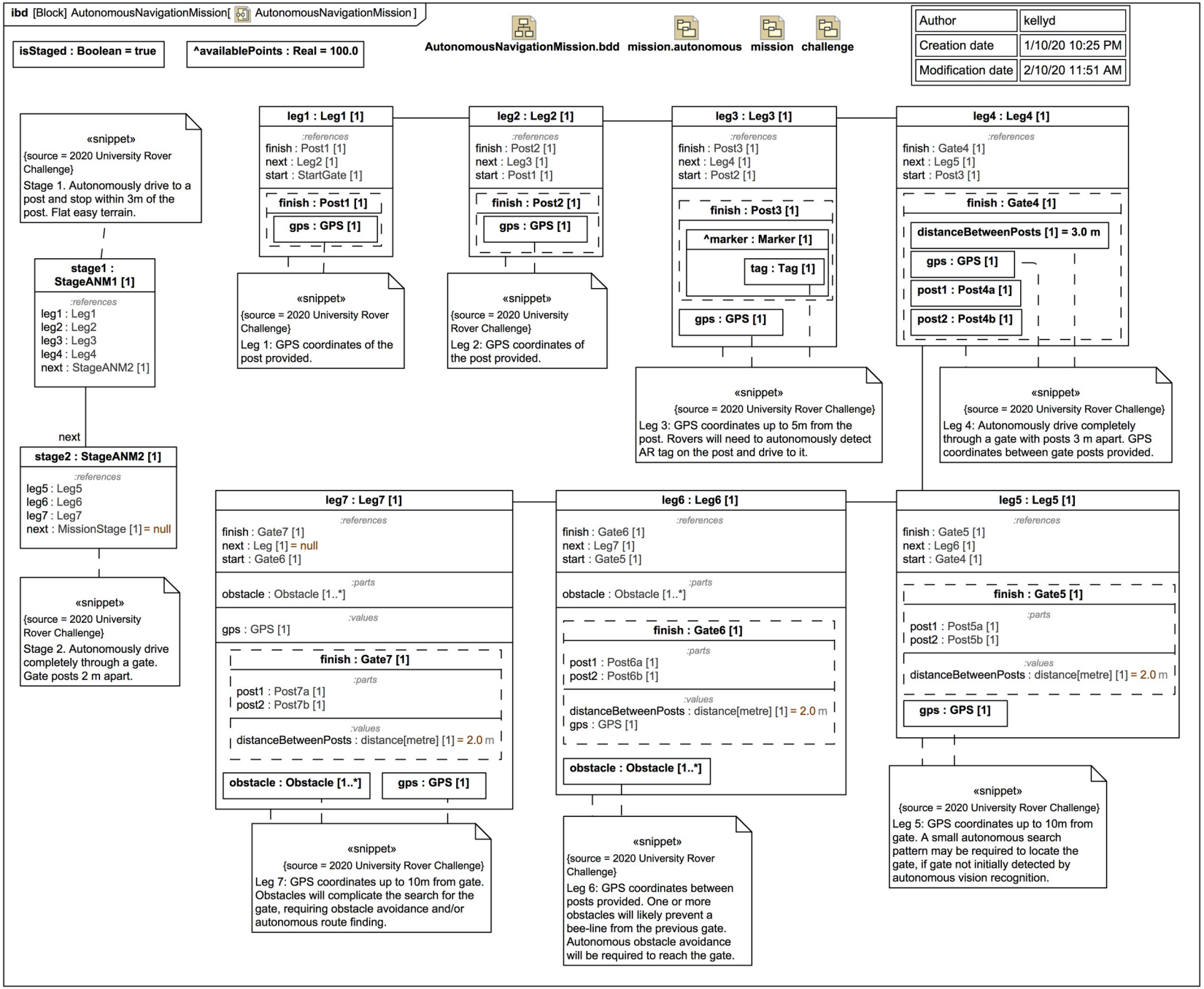

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SECTION

Structural base

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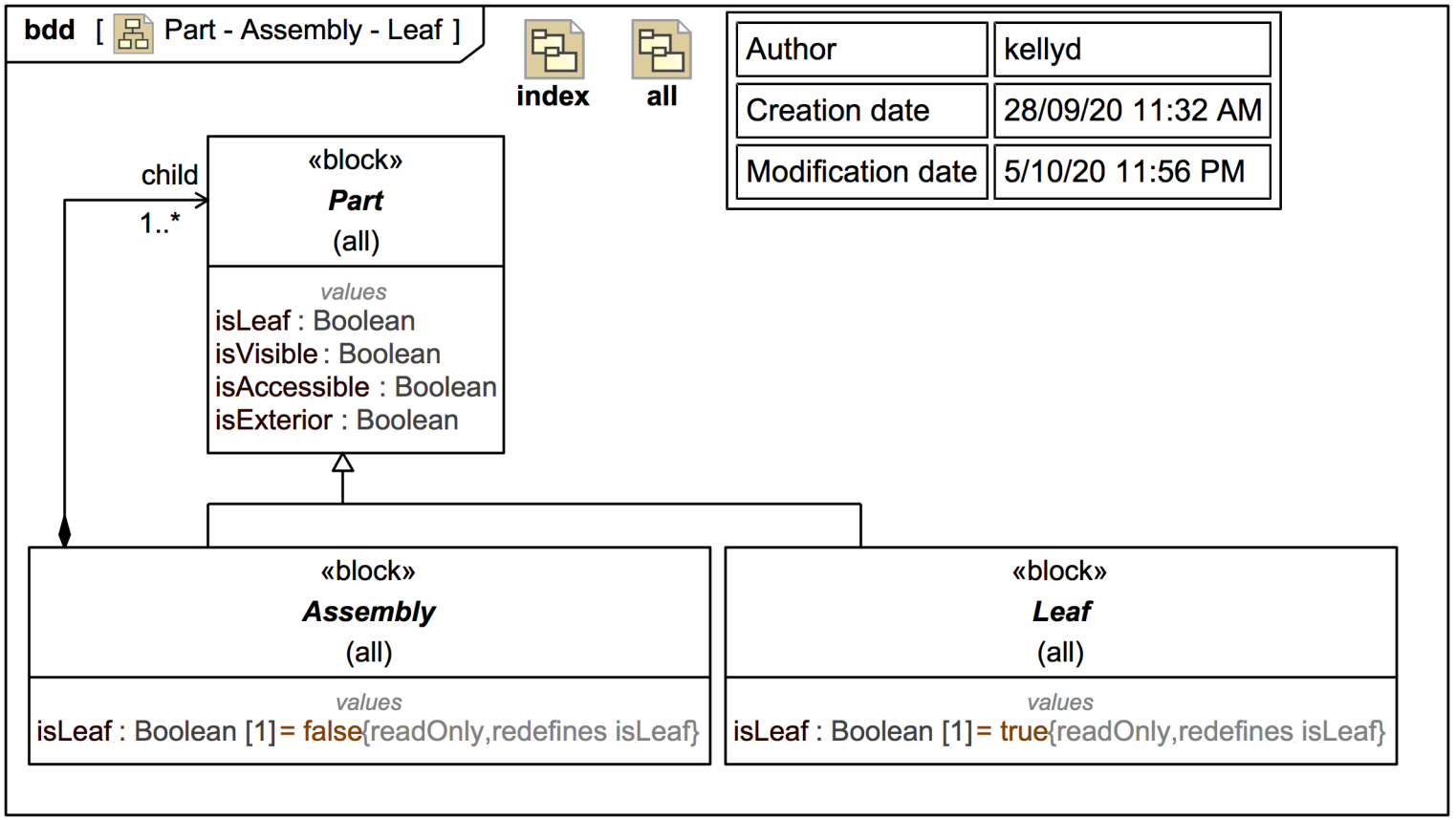

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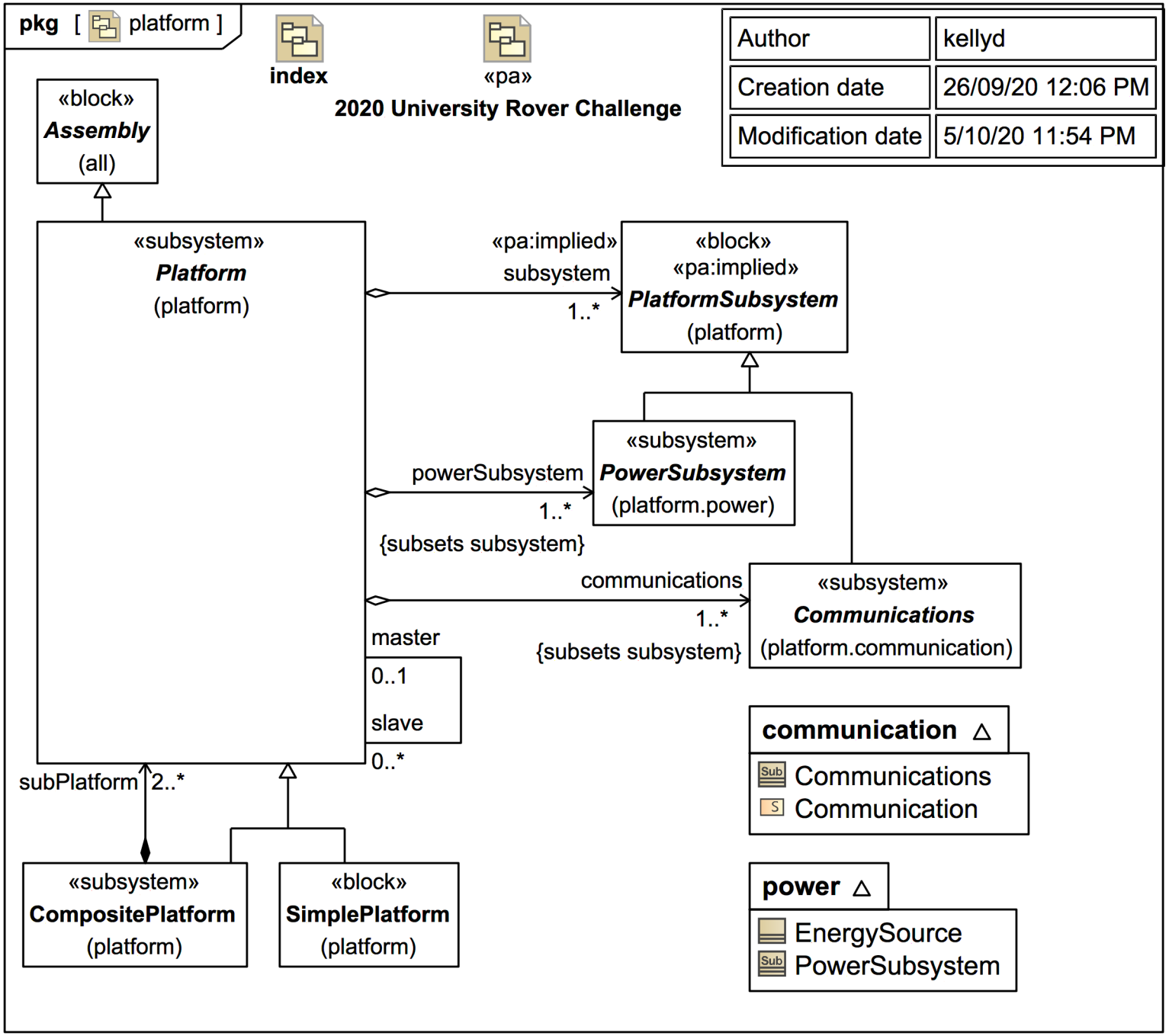

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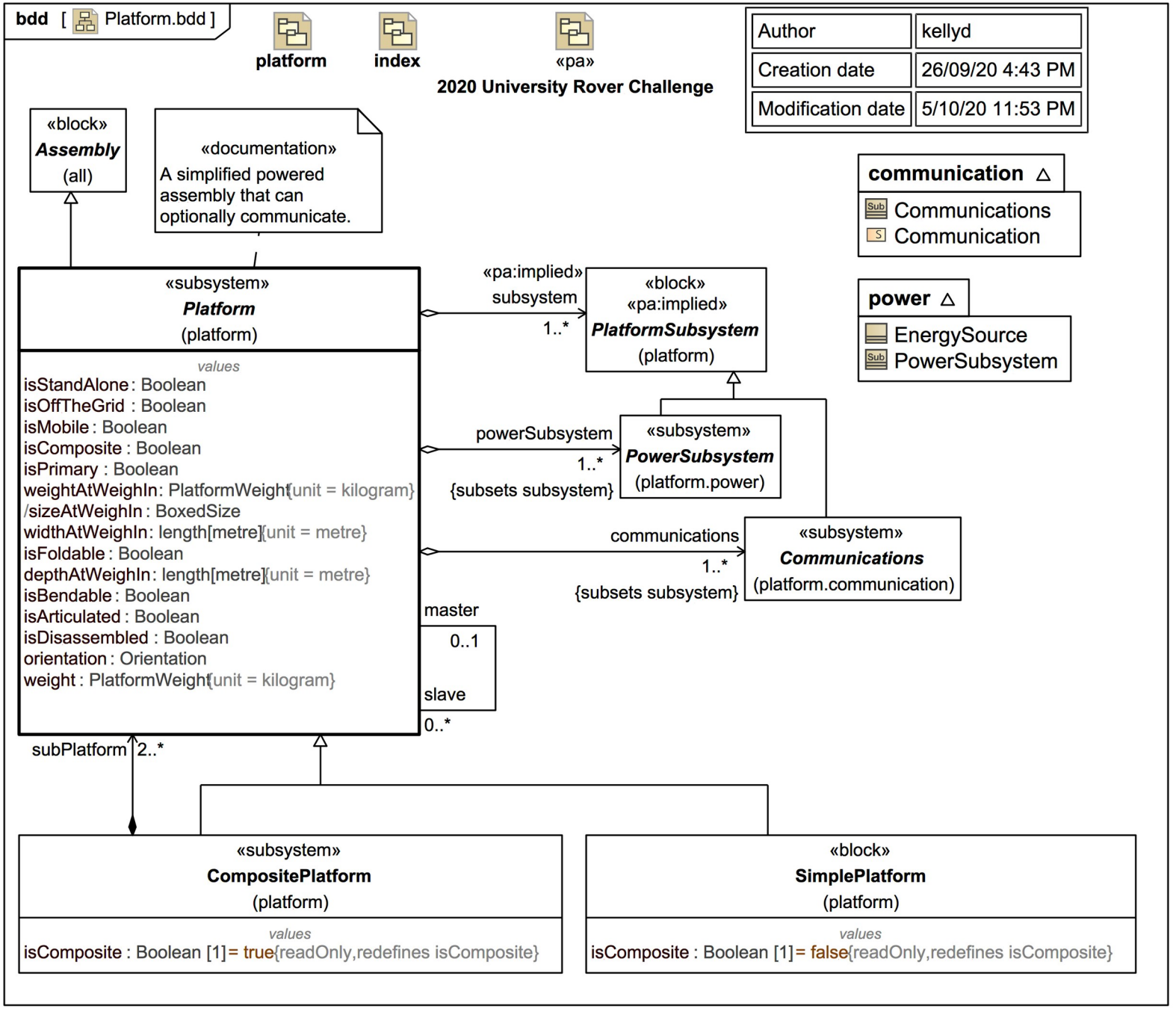

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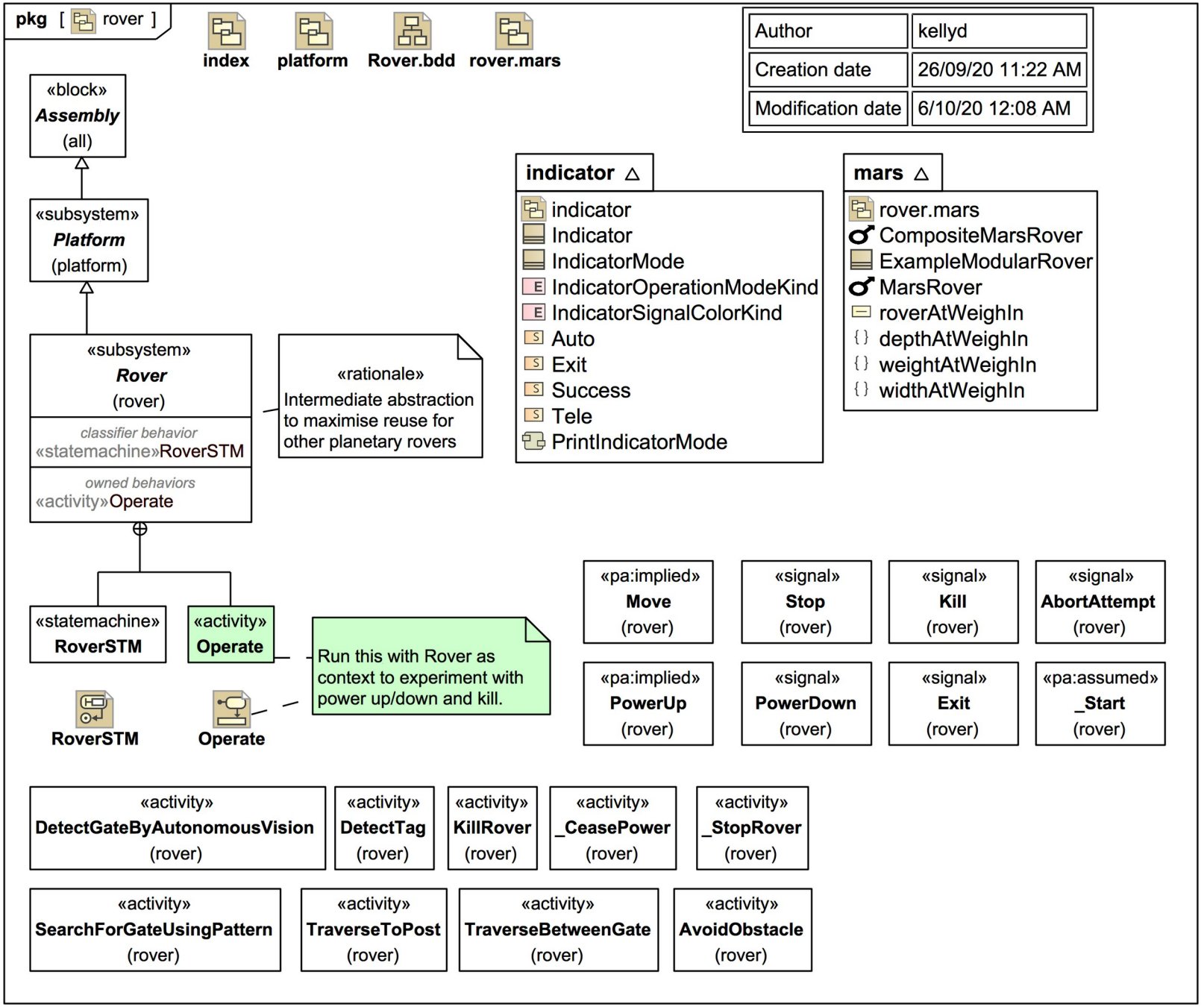

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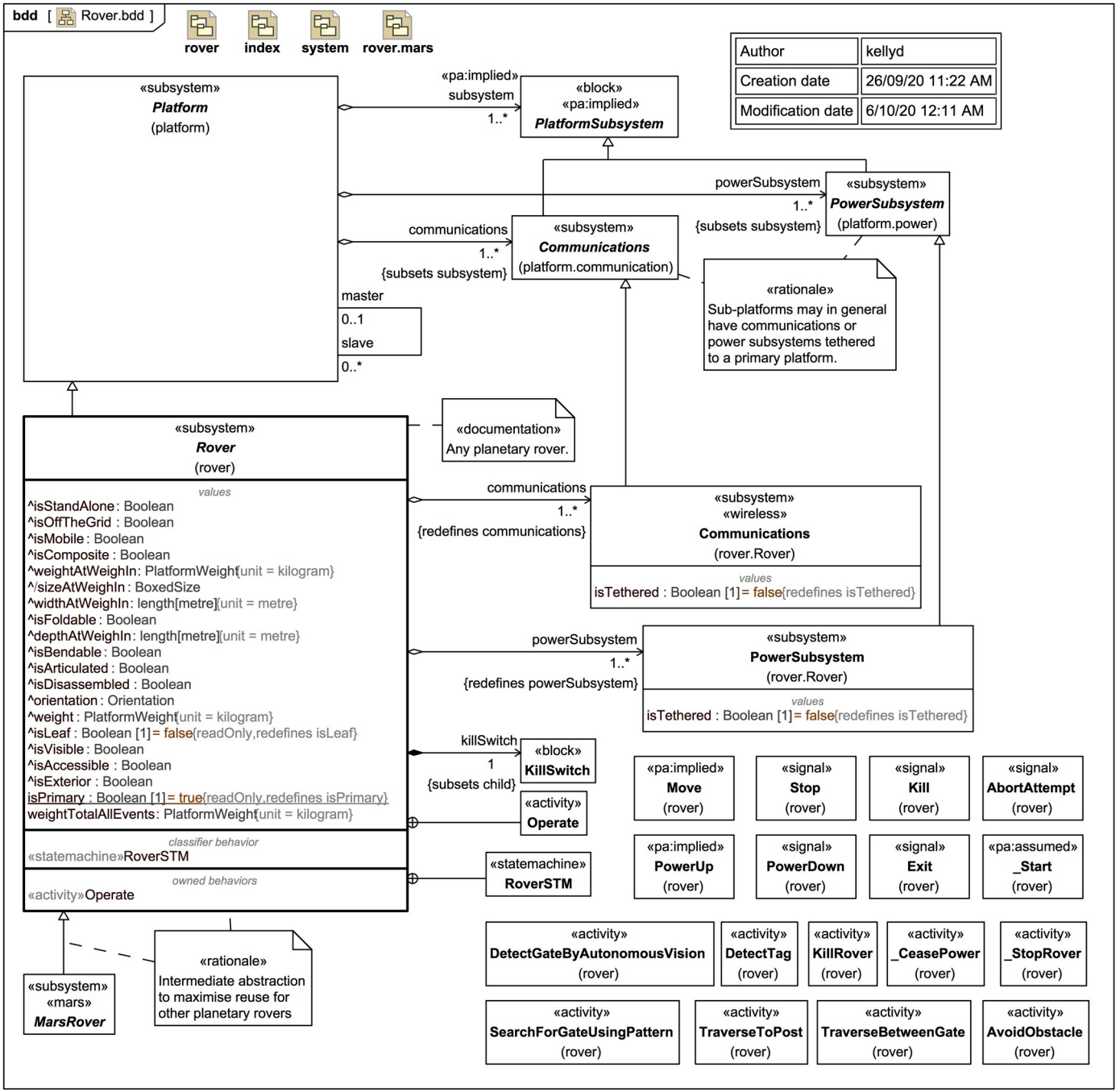

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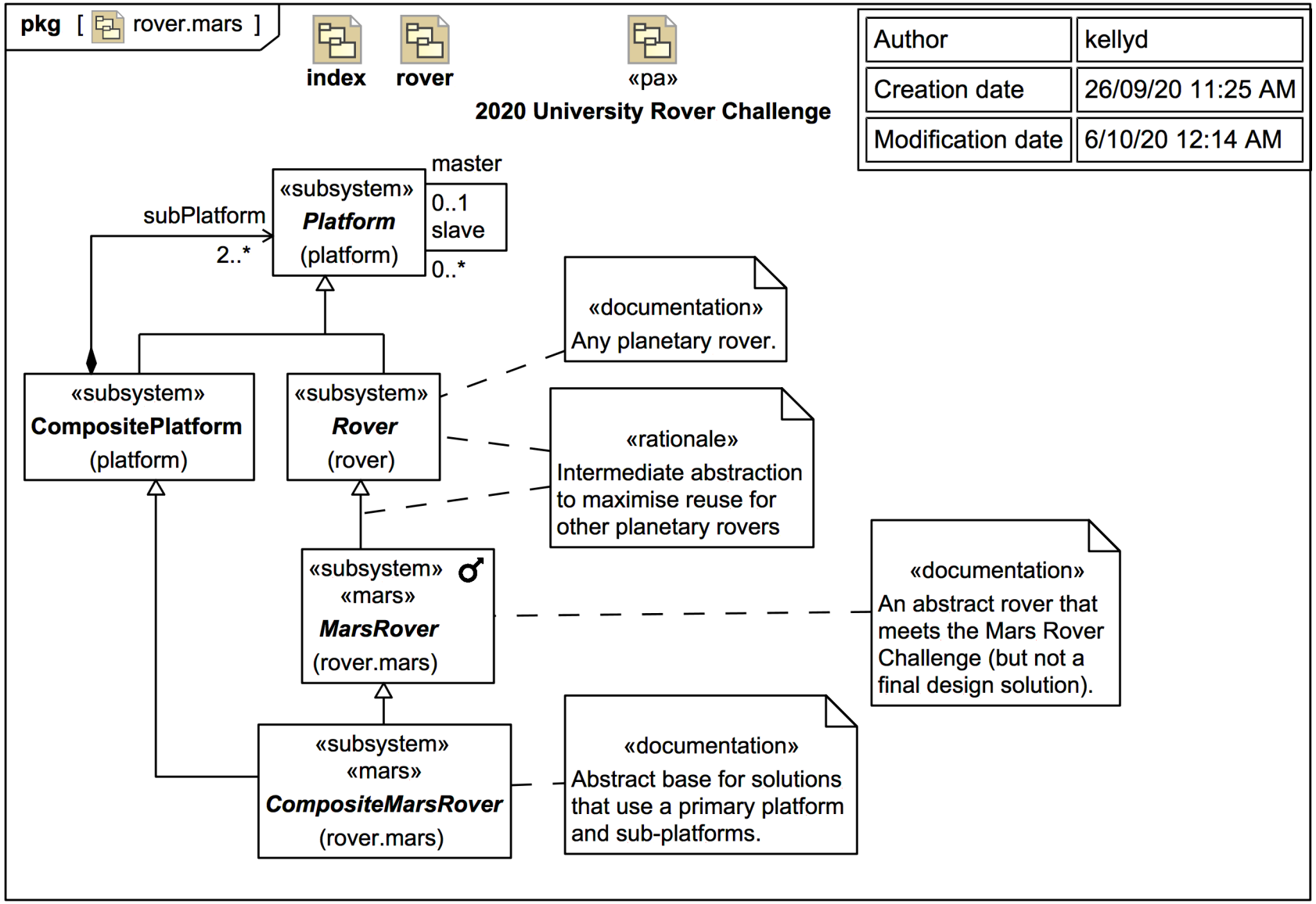

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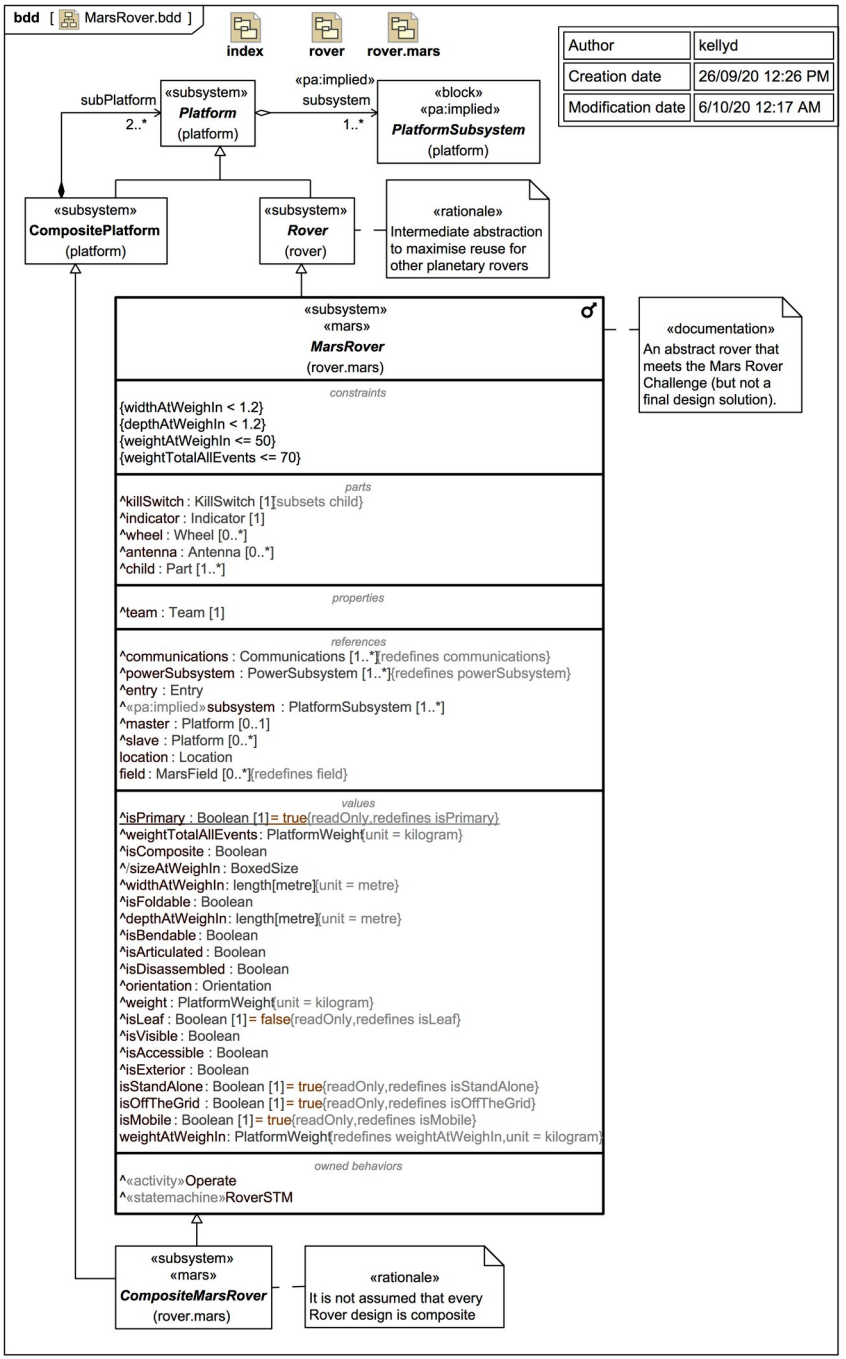

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SECTION

Rover and StateMachine and KillSwitch Indicator StateMachine

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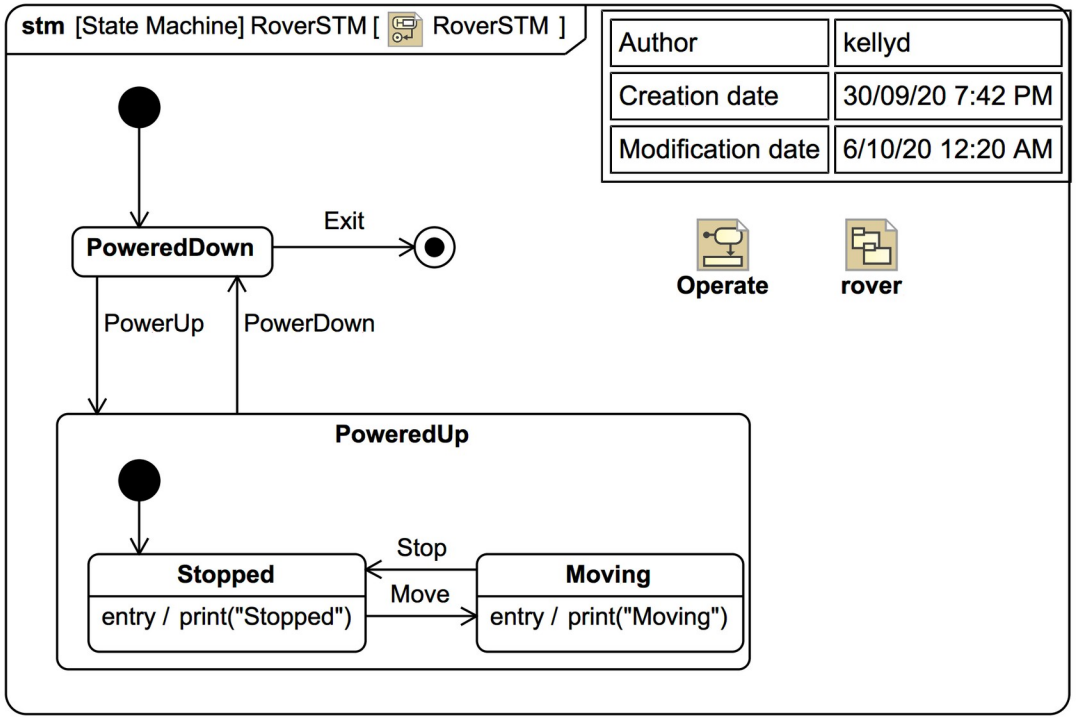

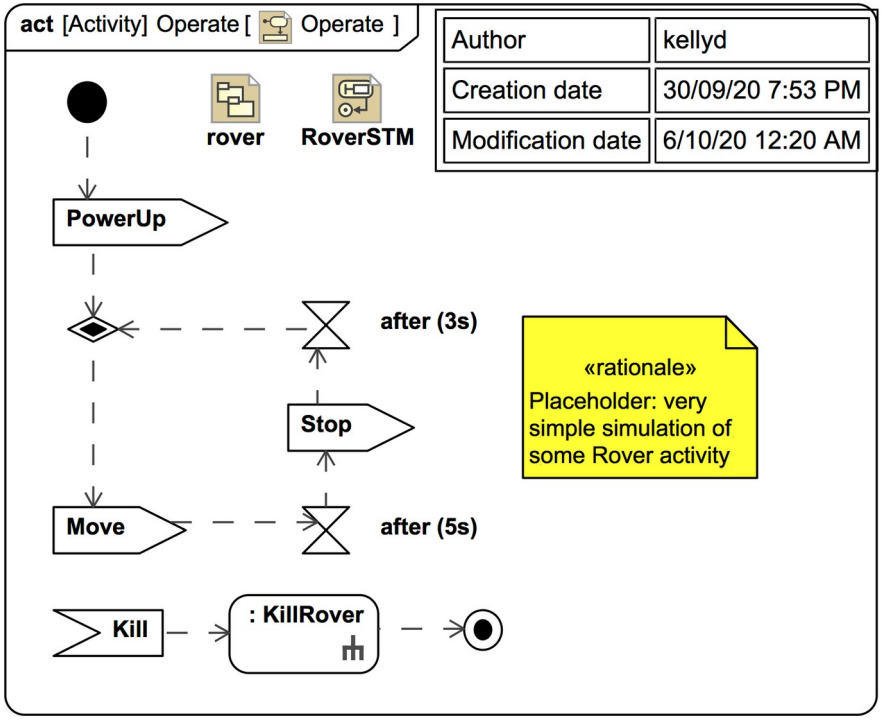

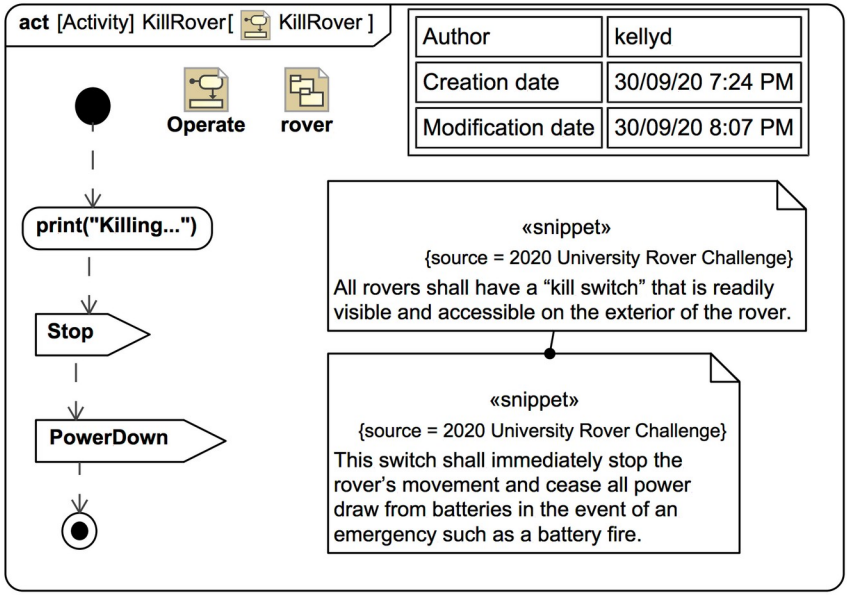

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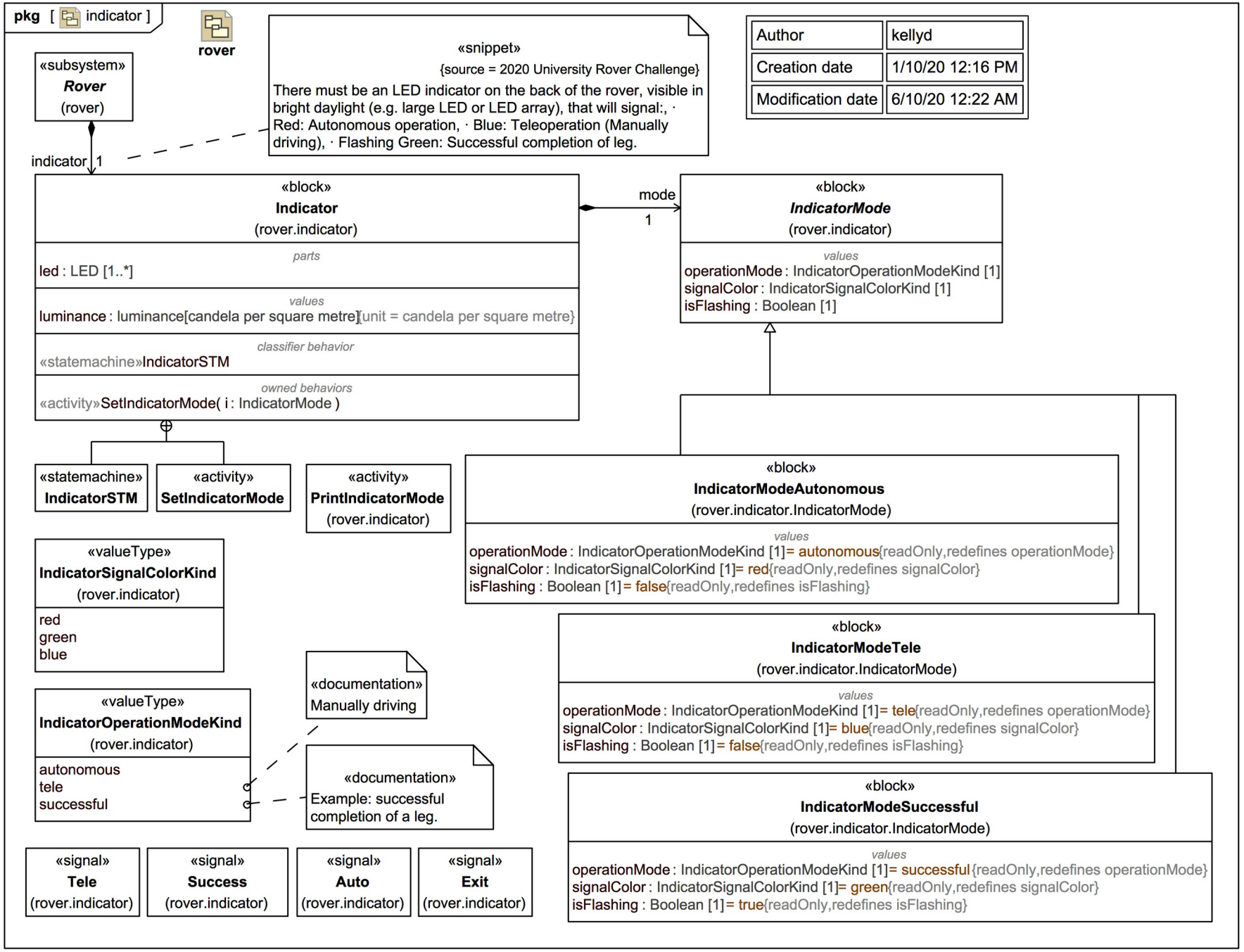

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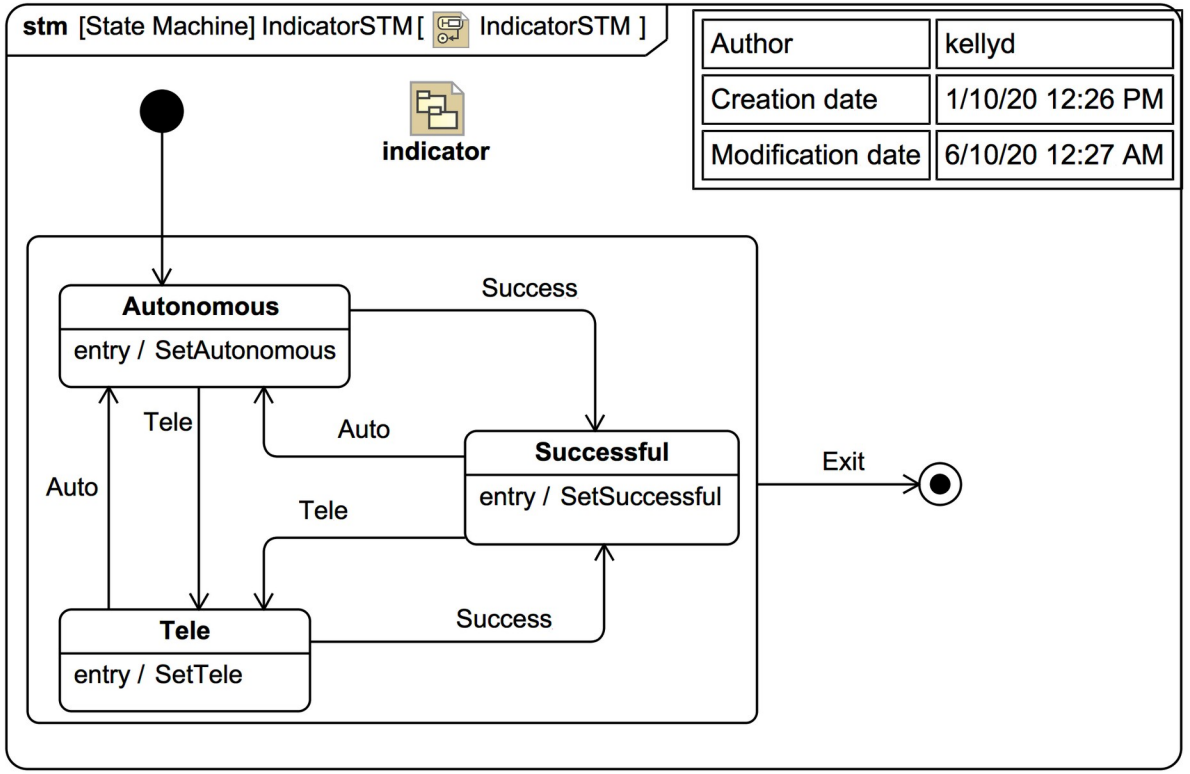

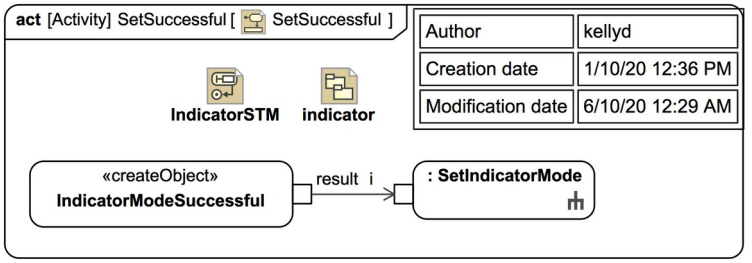

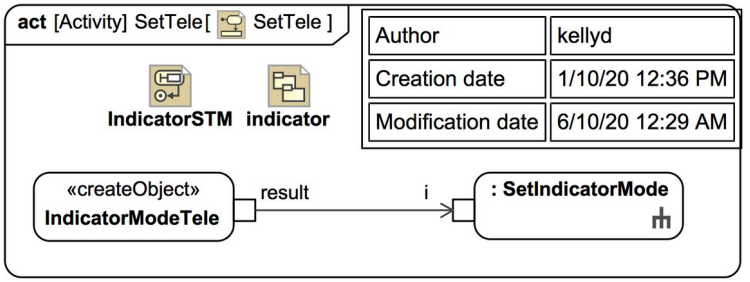

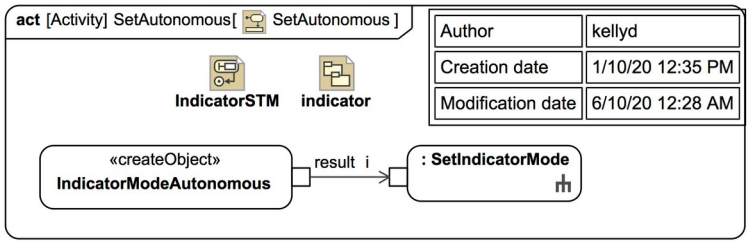

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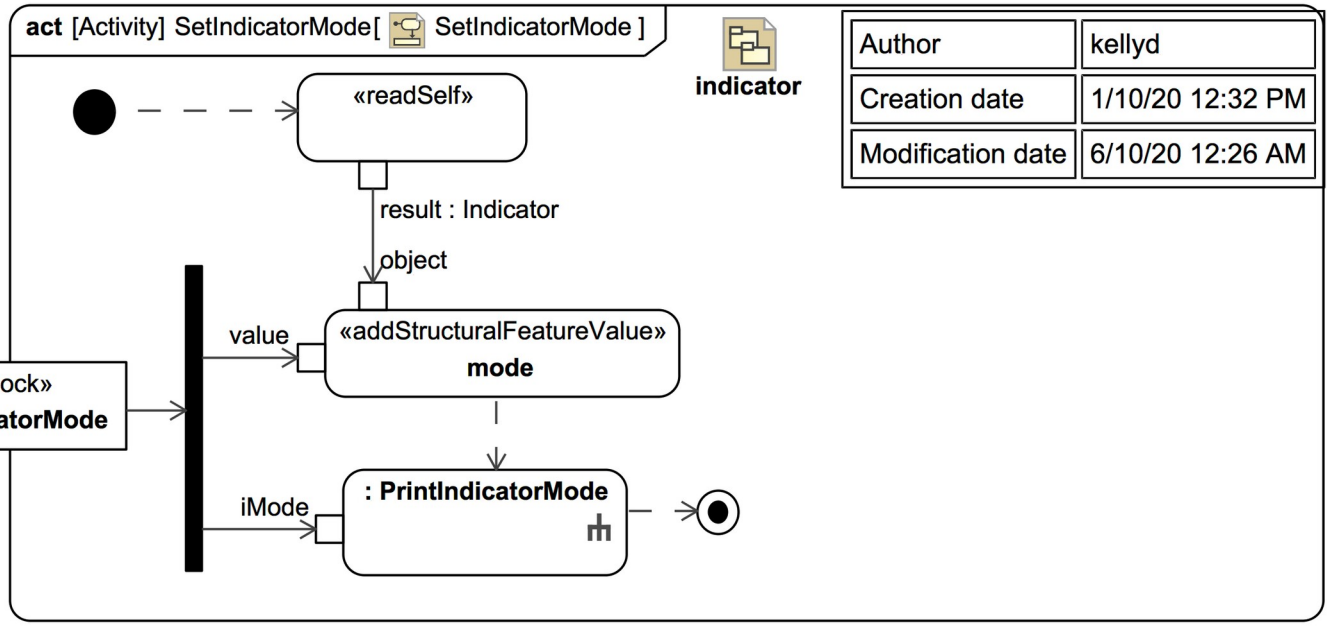

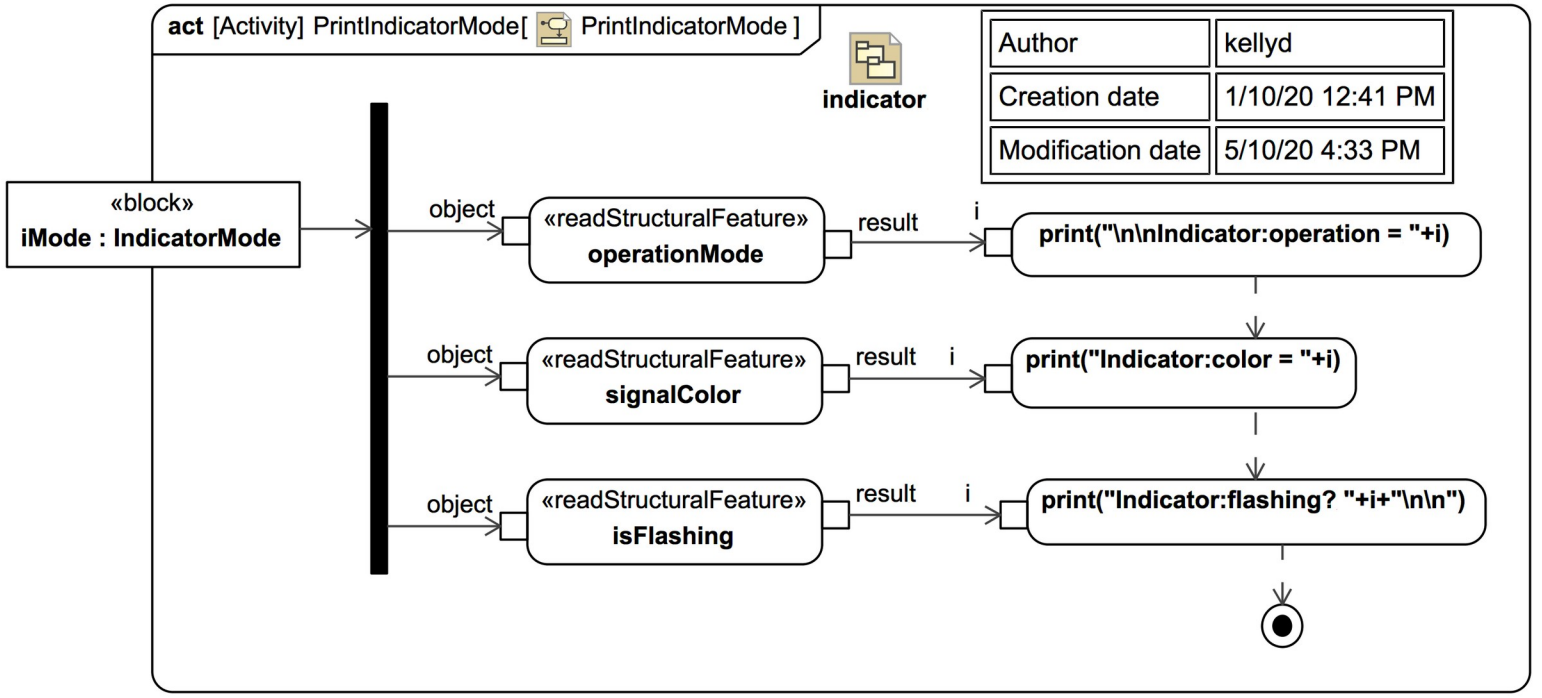

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SECTION

Challenge (competition)
Team, Entry

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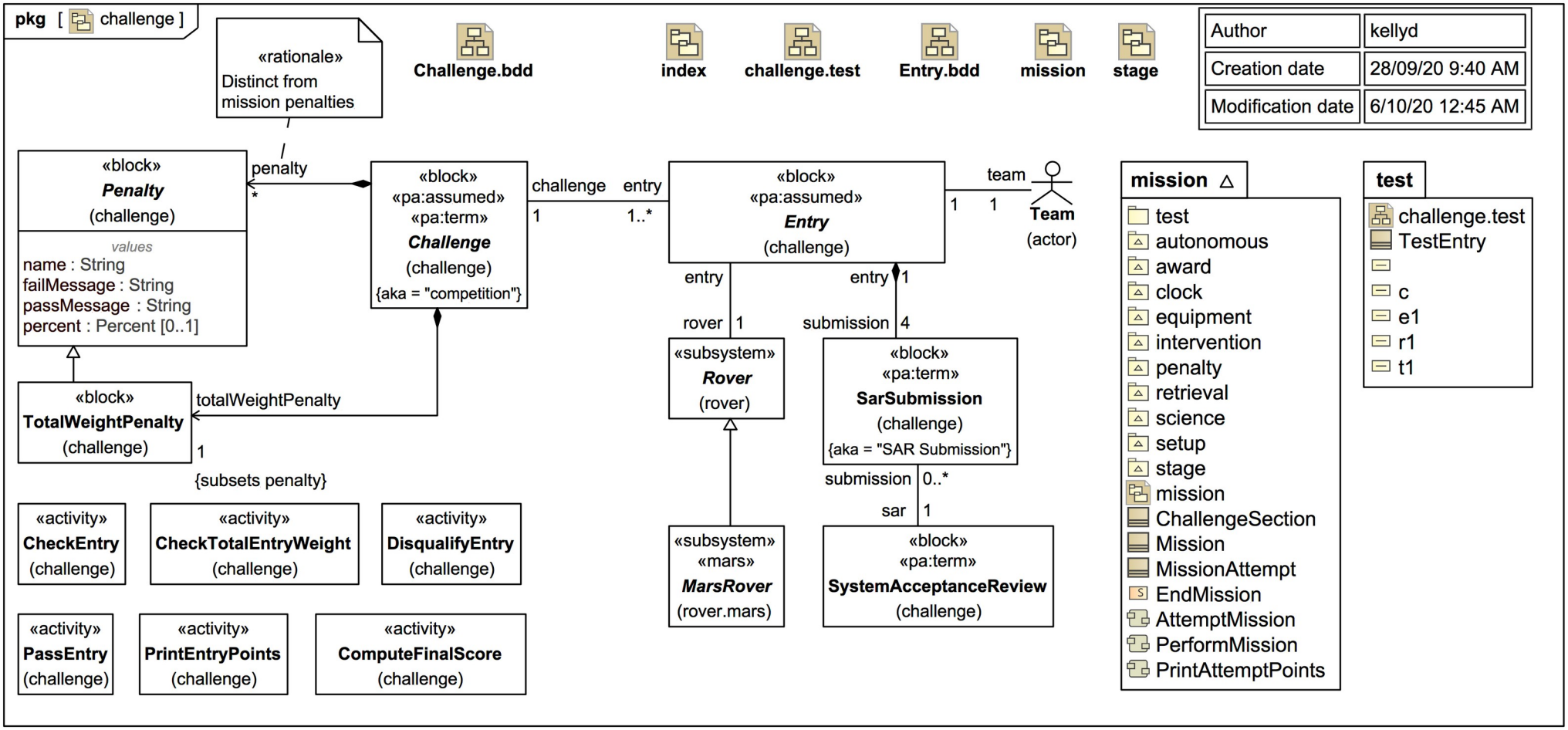

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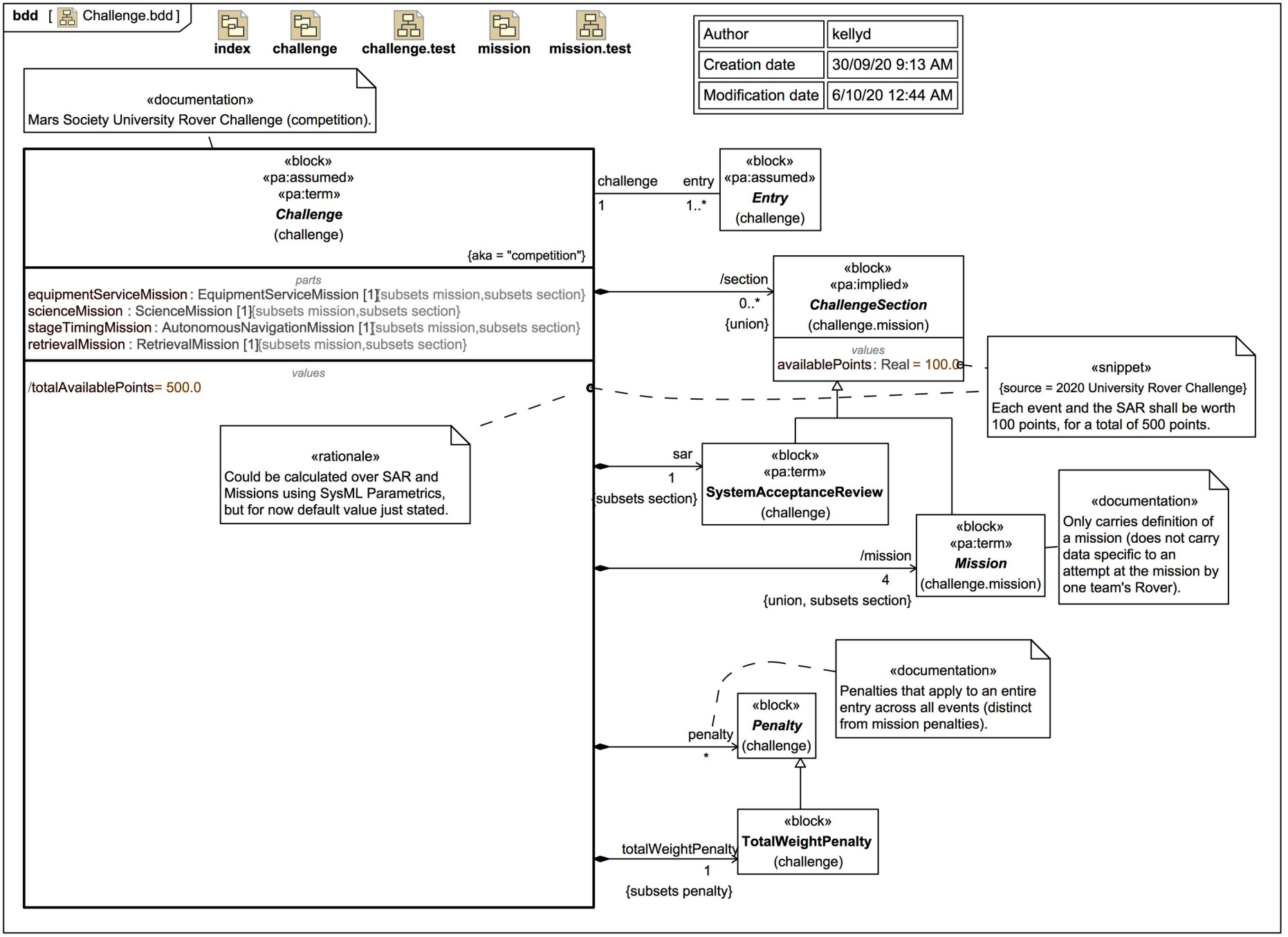

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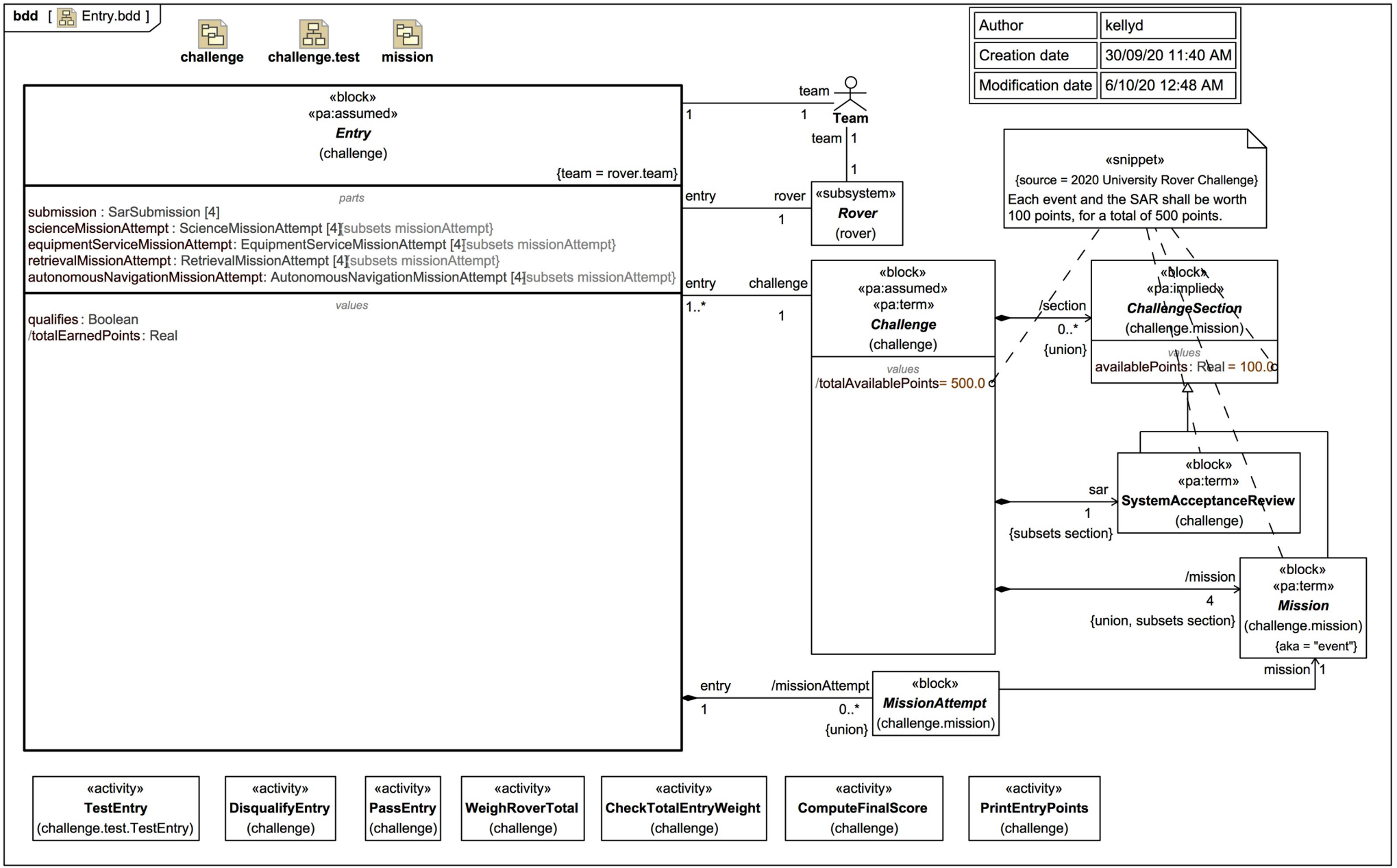

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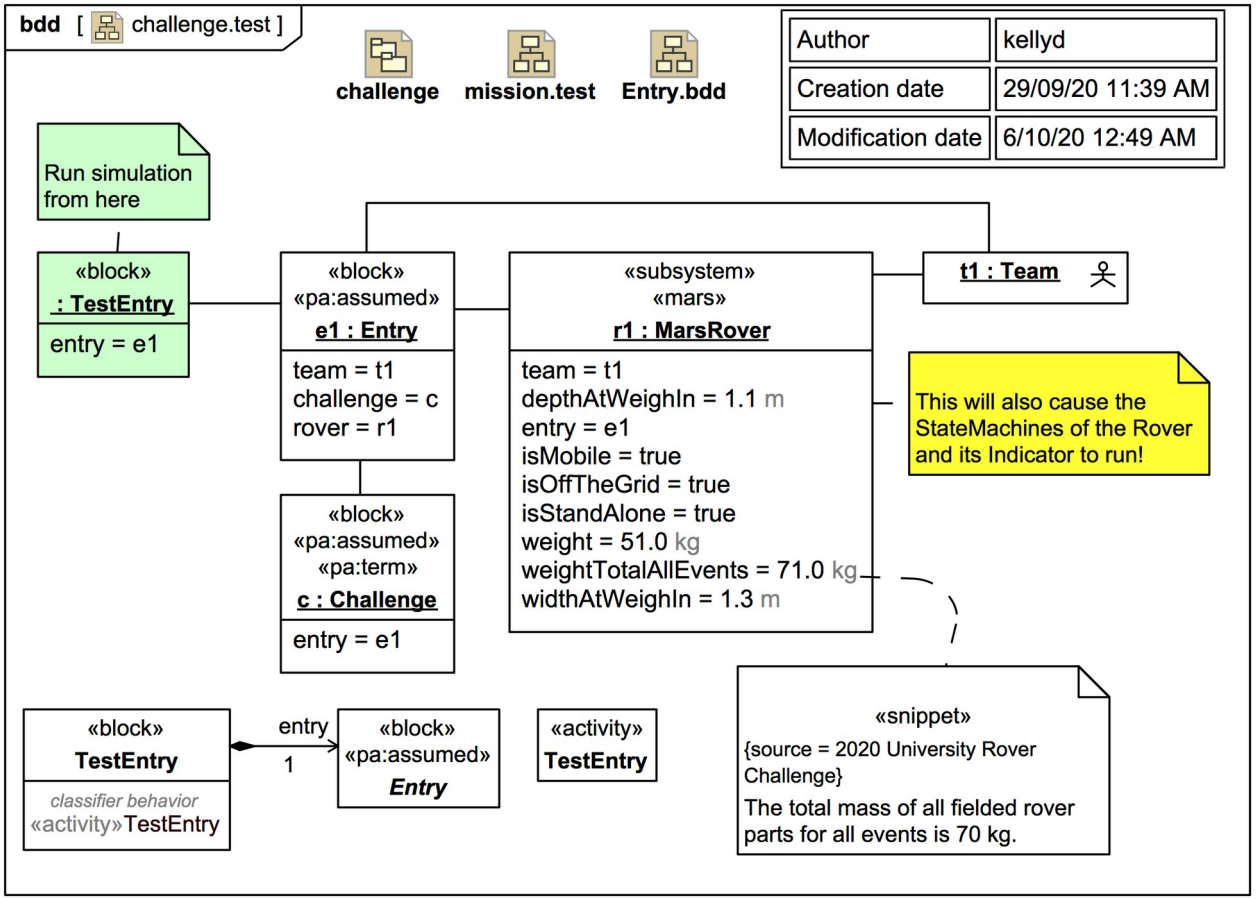

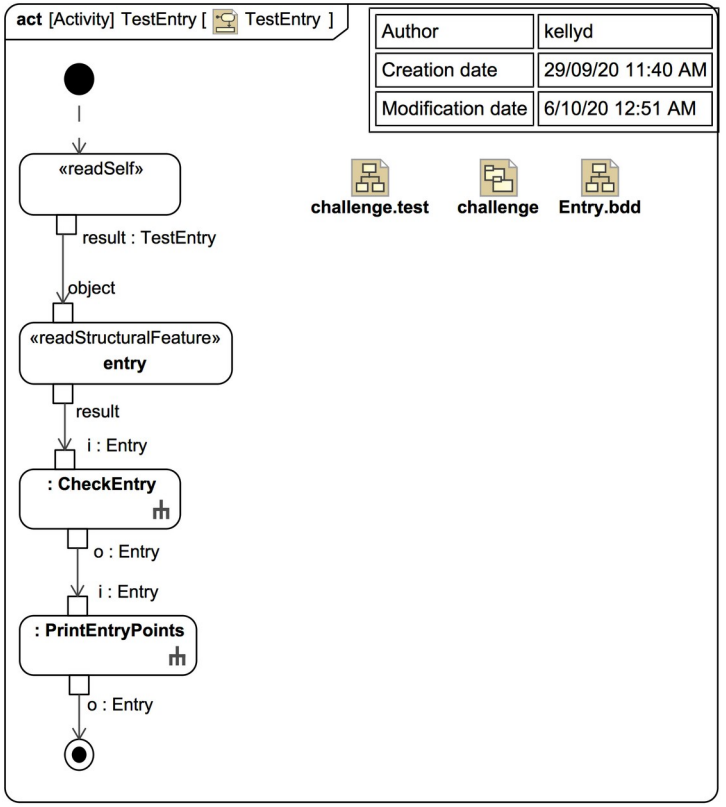

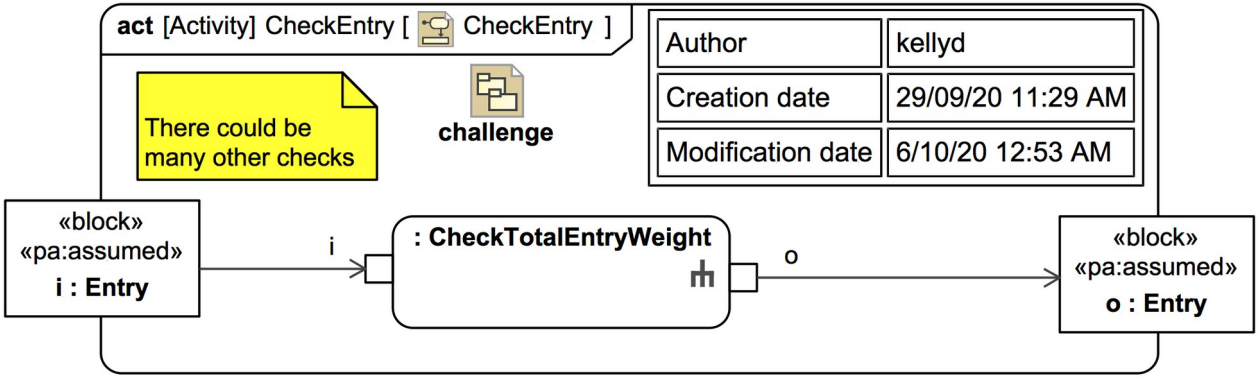

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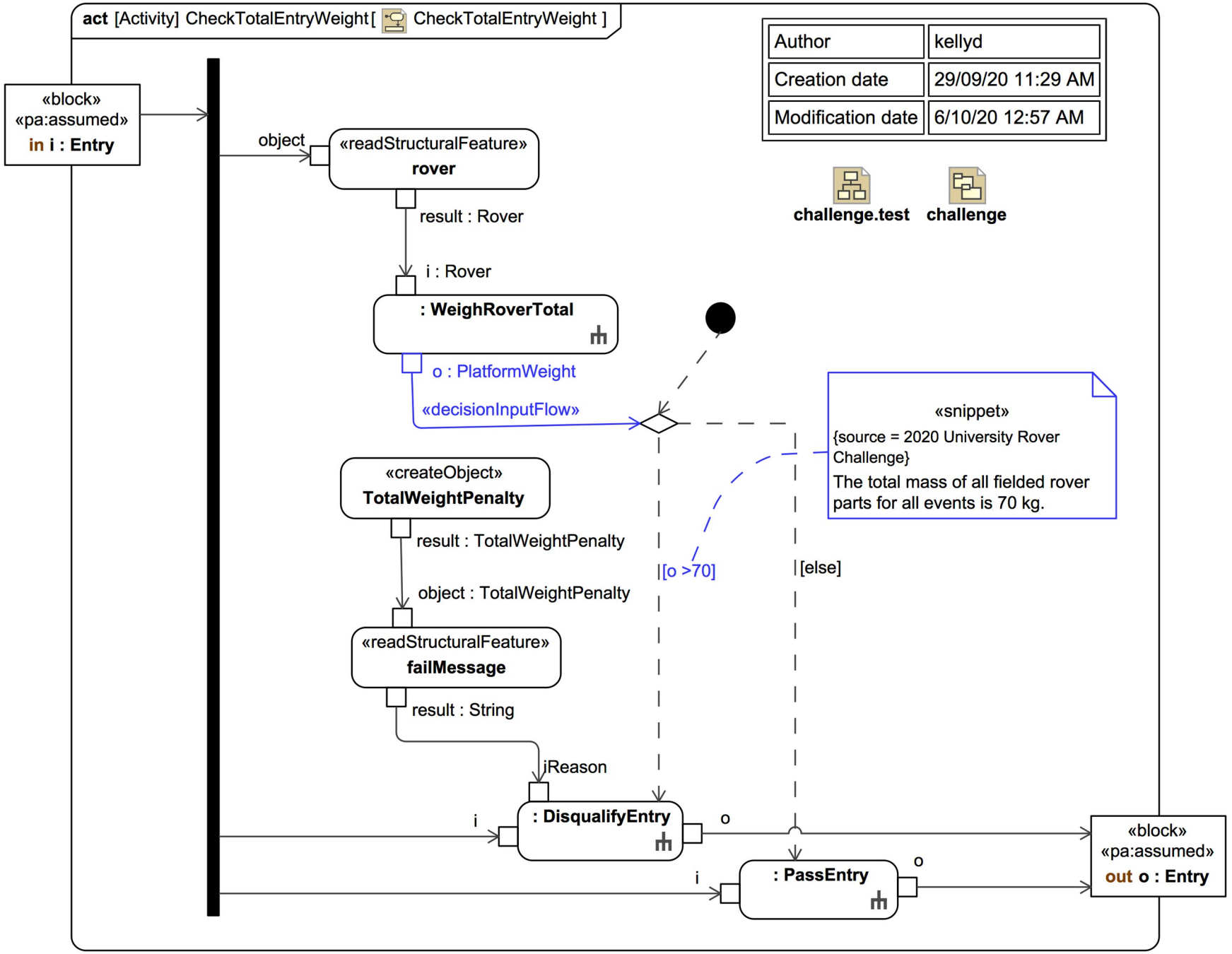

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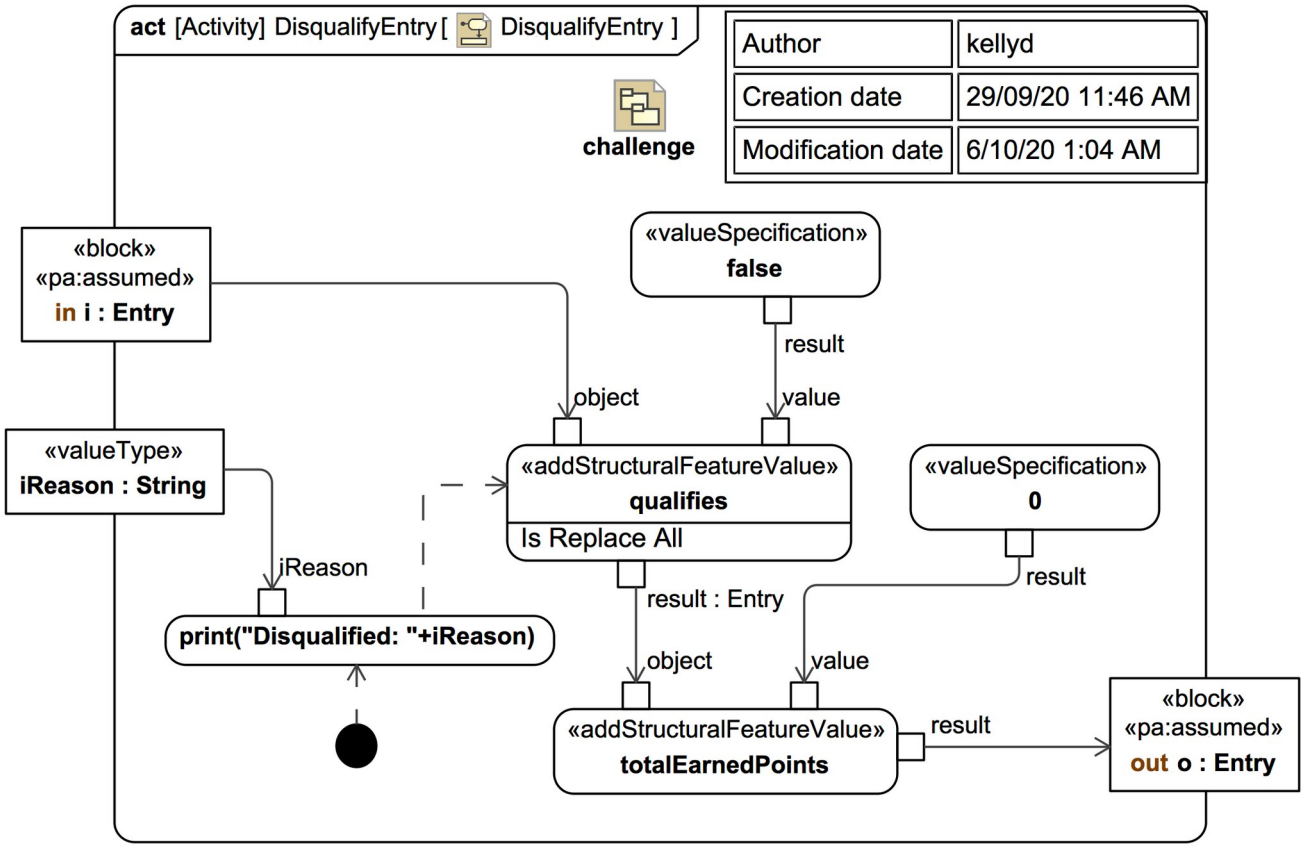

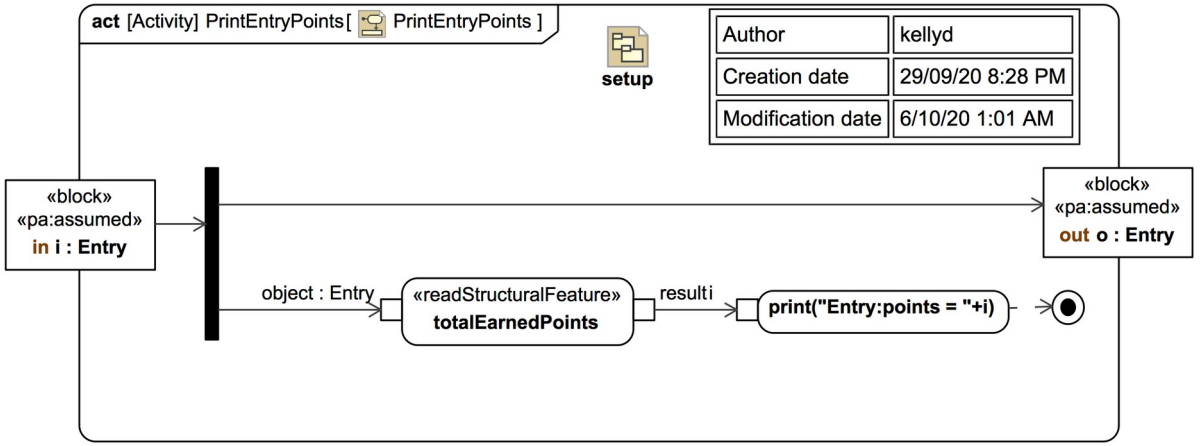

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SECTION

Mission, MissionAttempt, Penalty and points system

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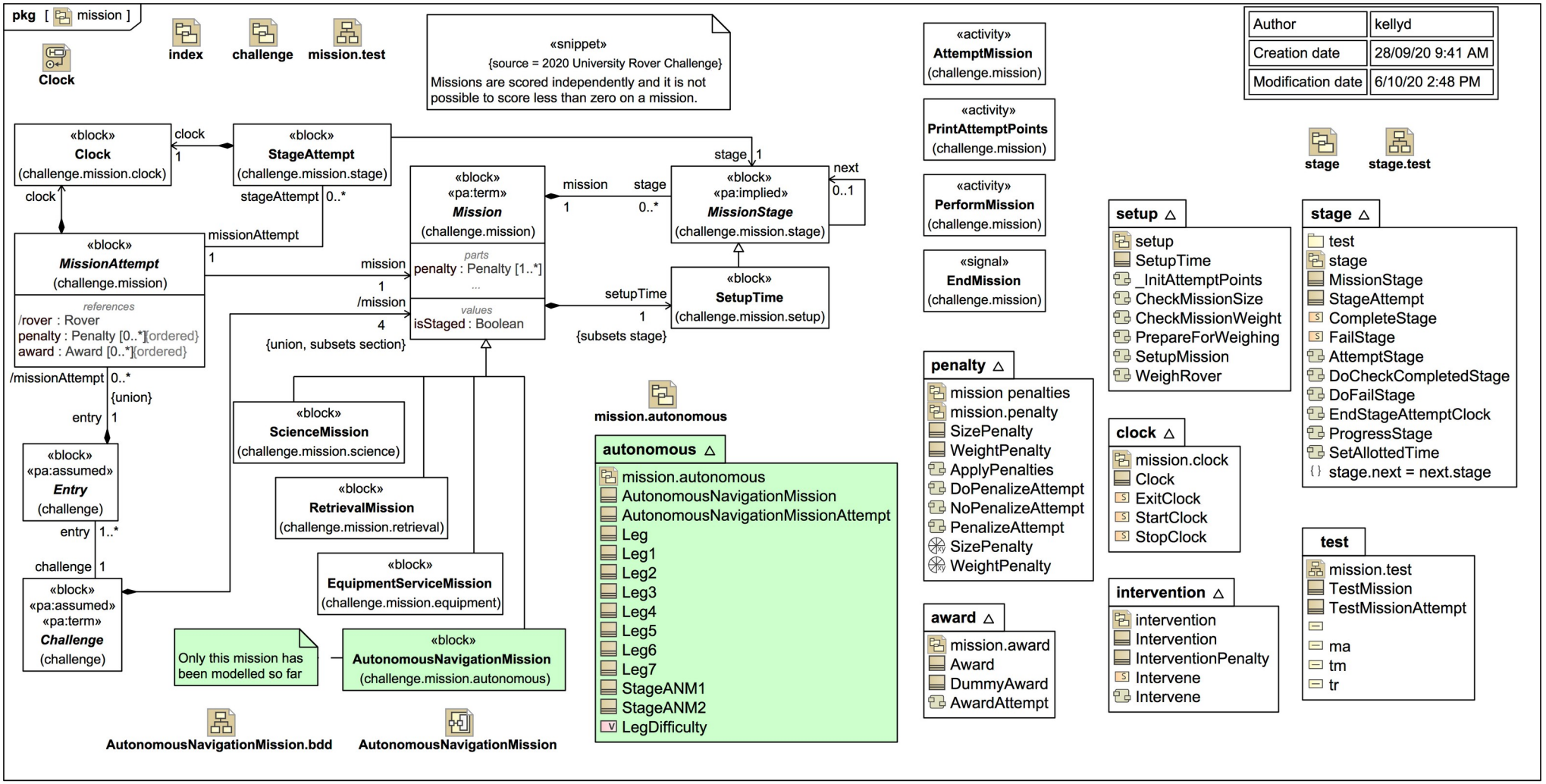

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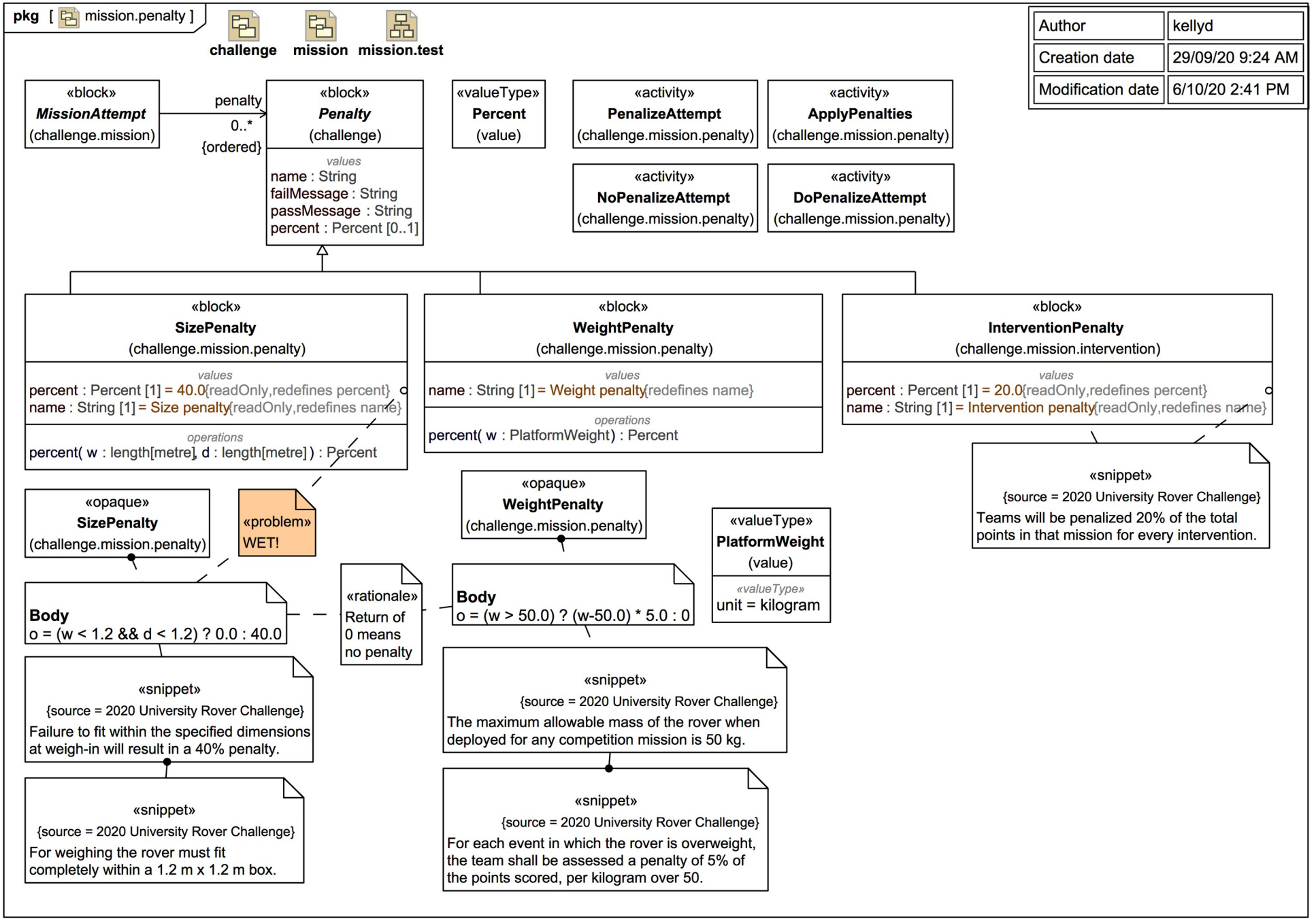

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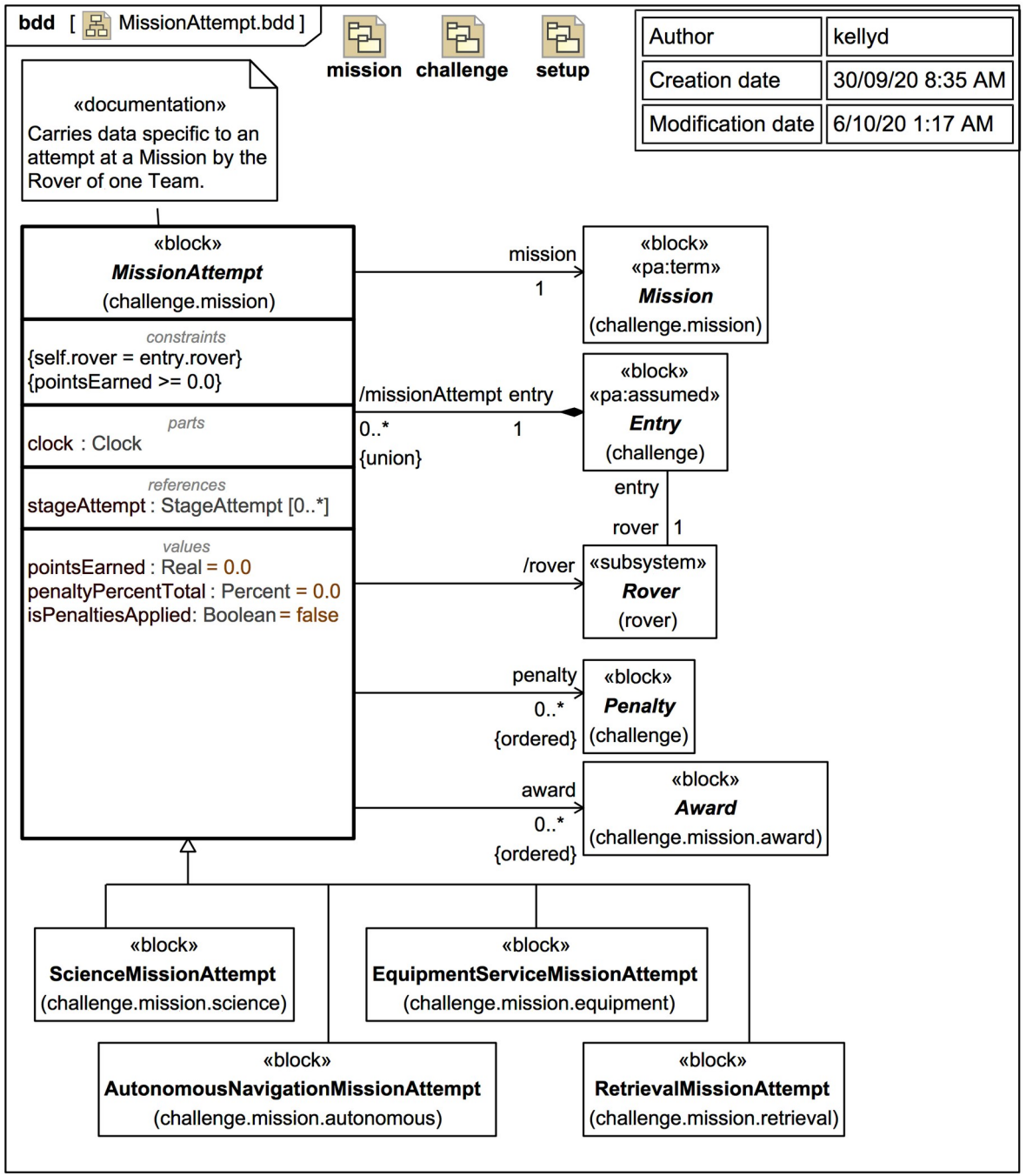

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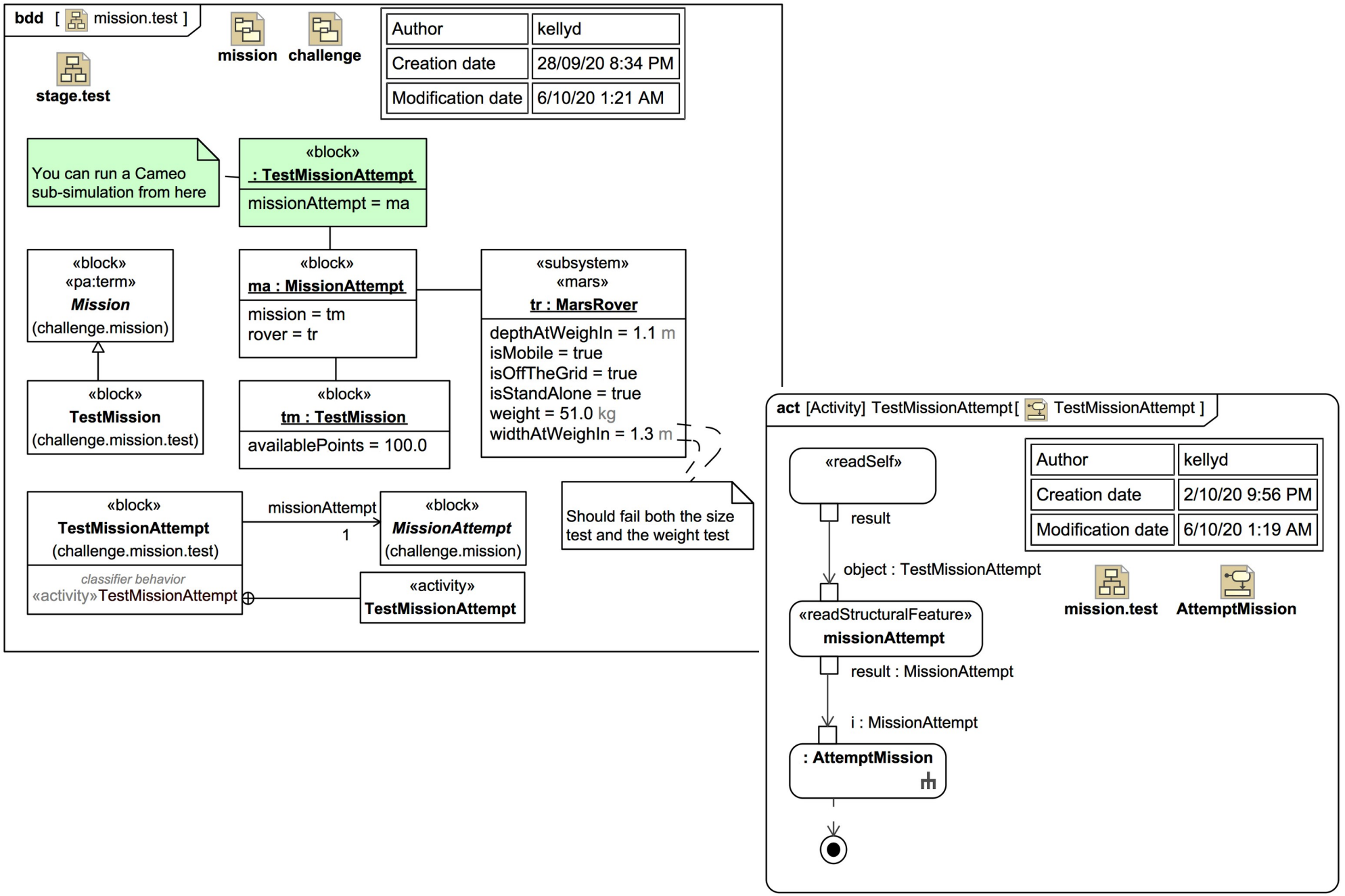

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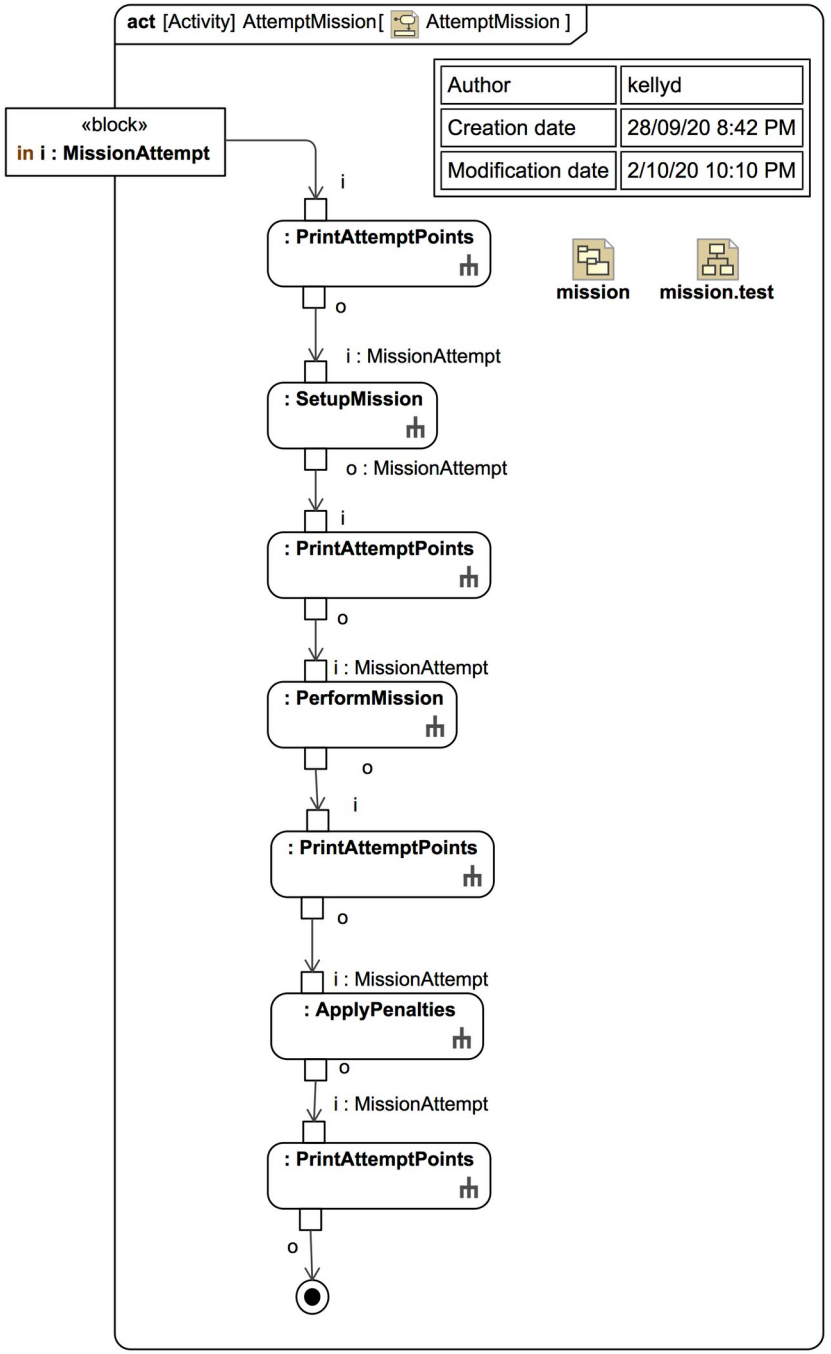

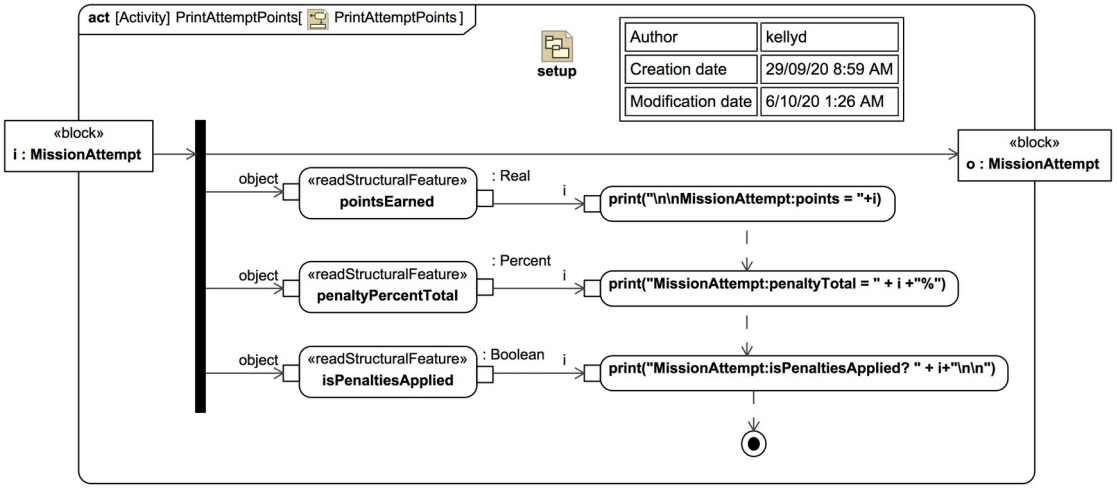

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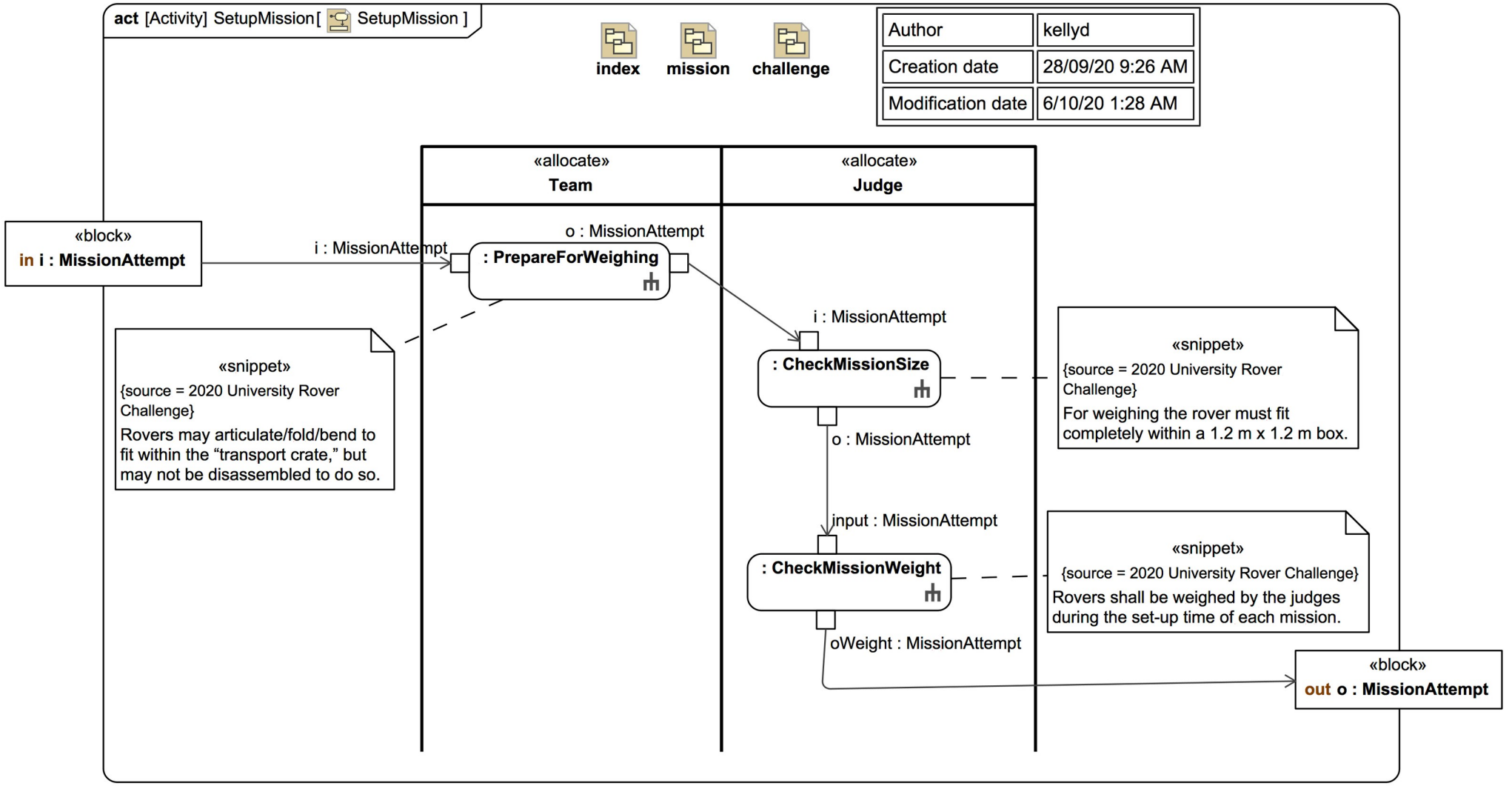

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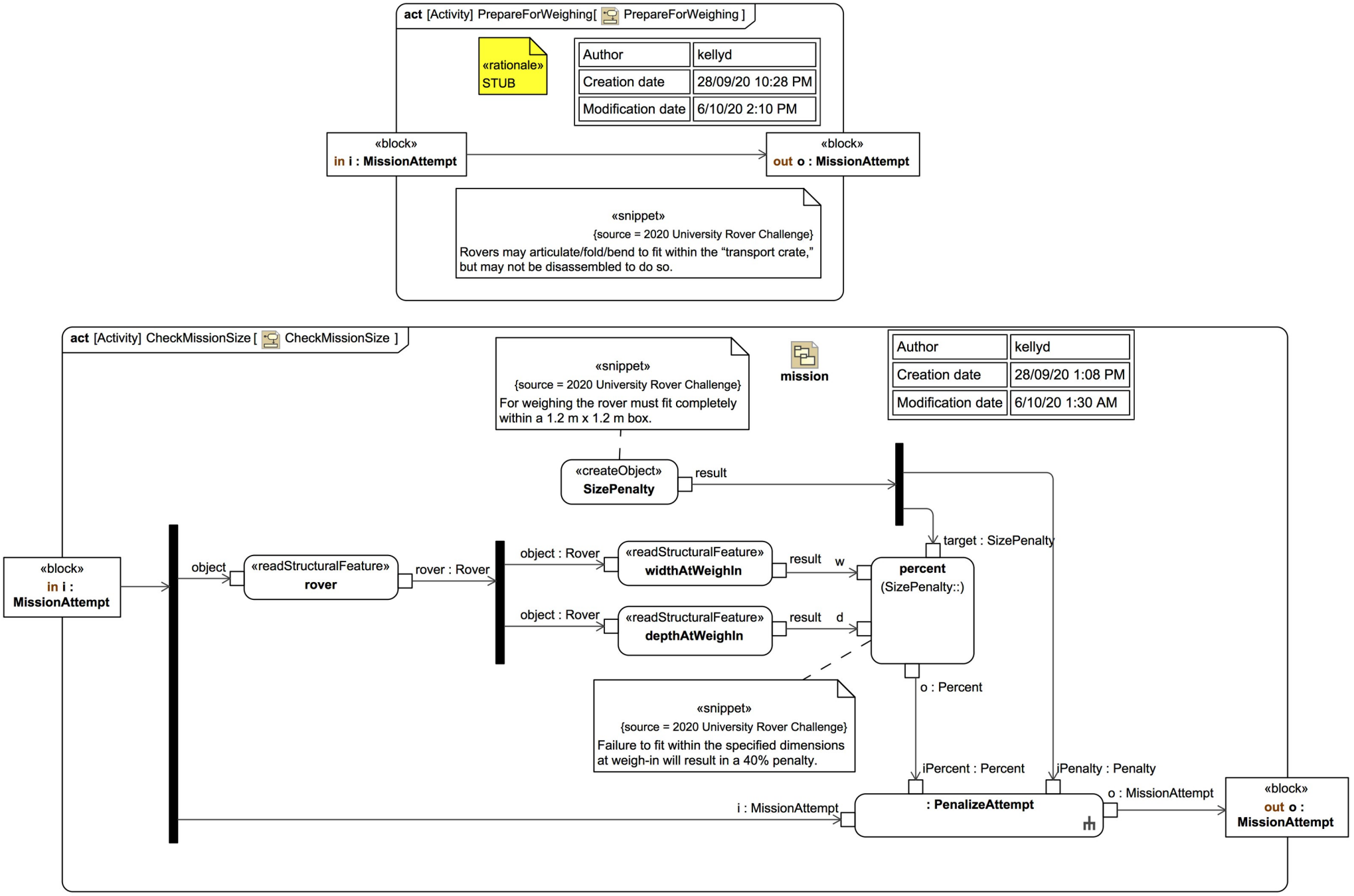

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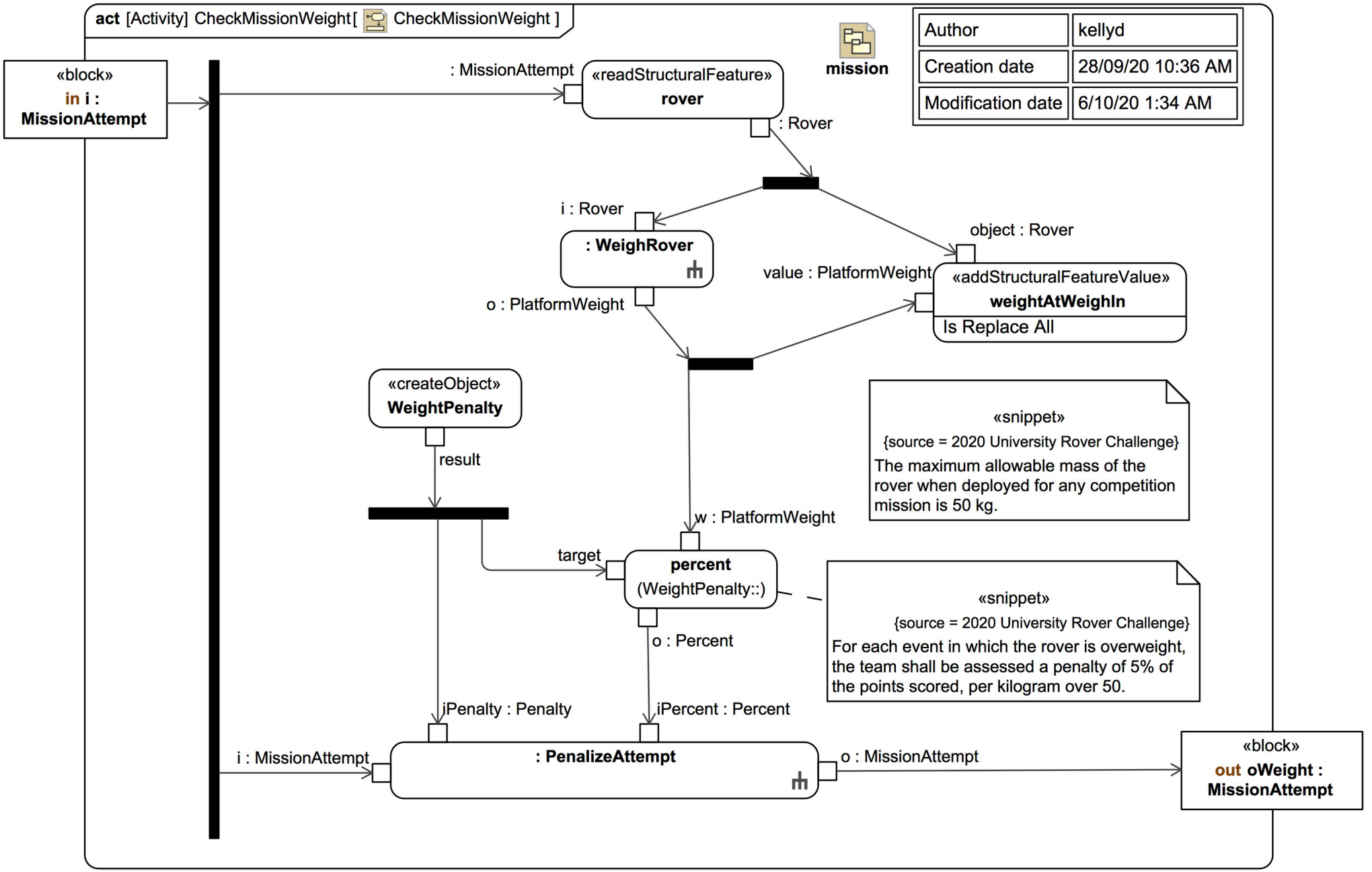

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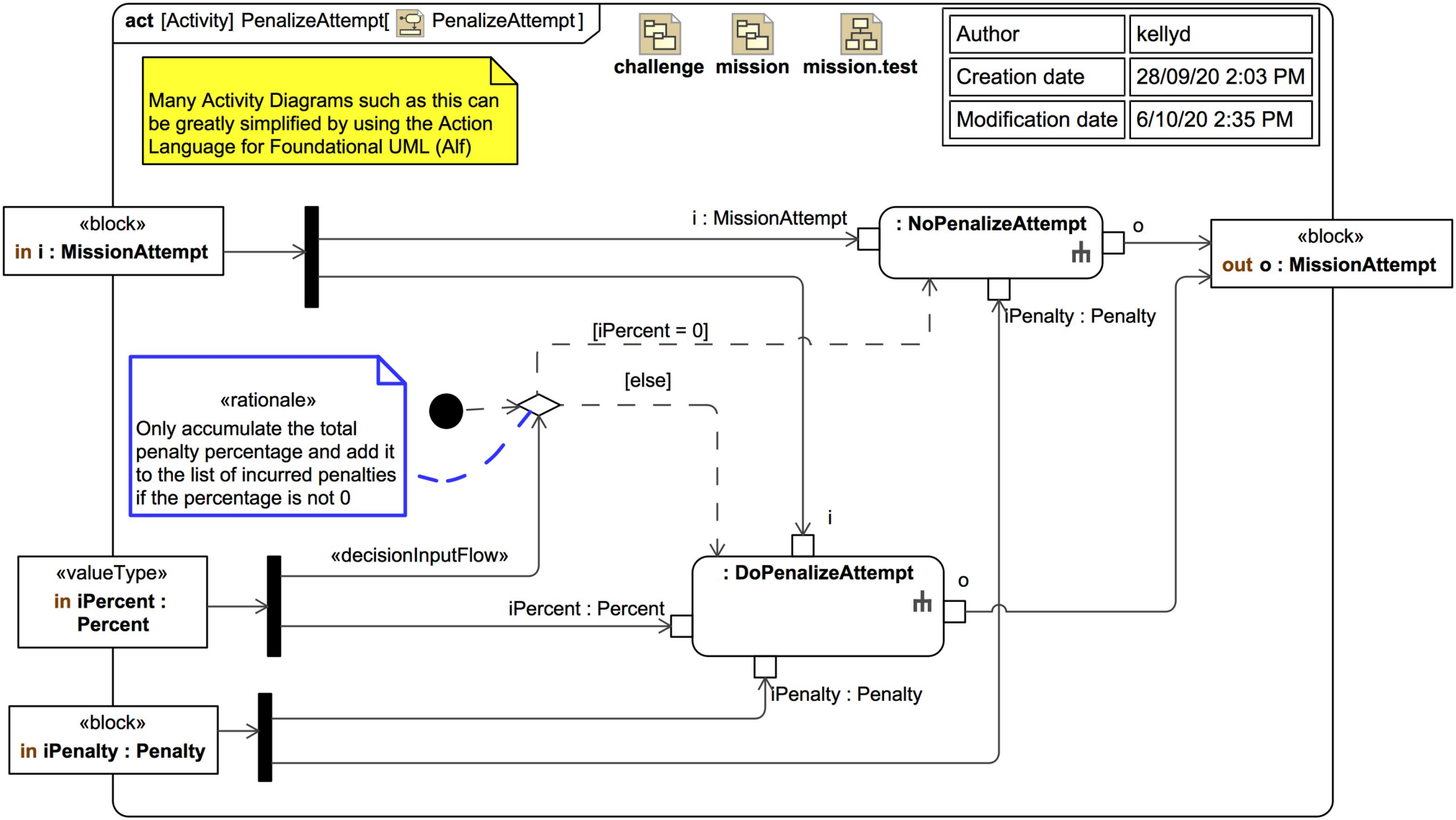

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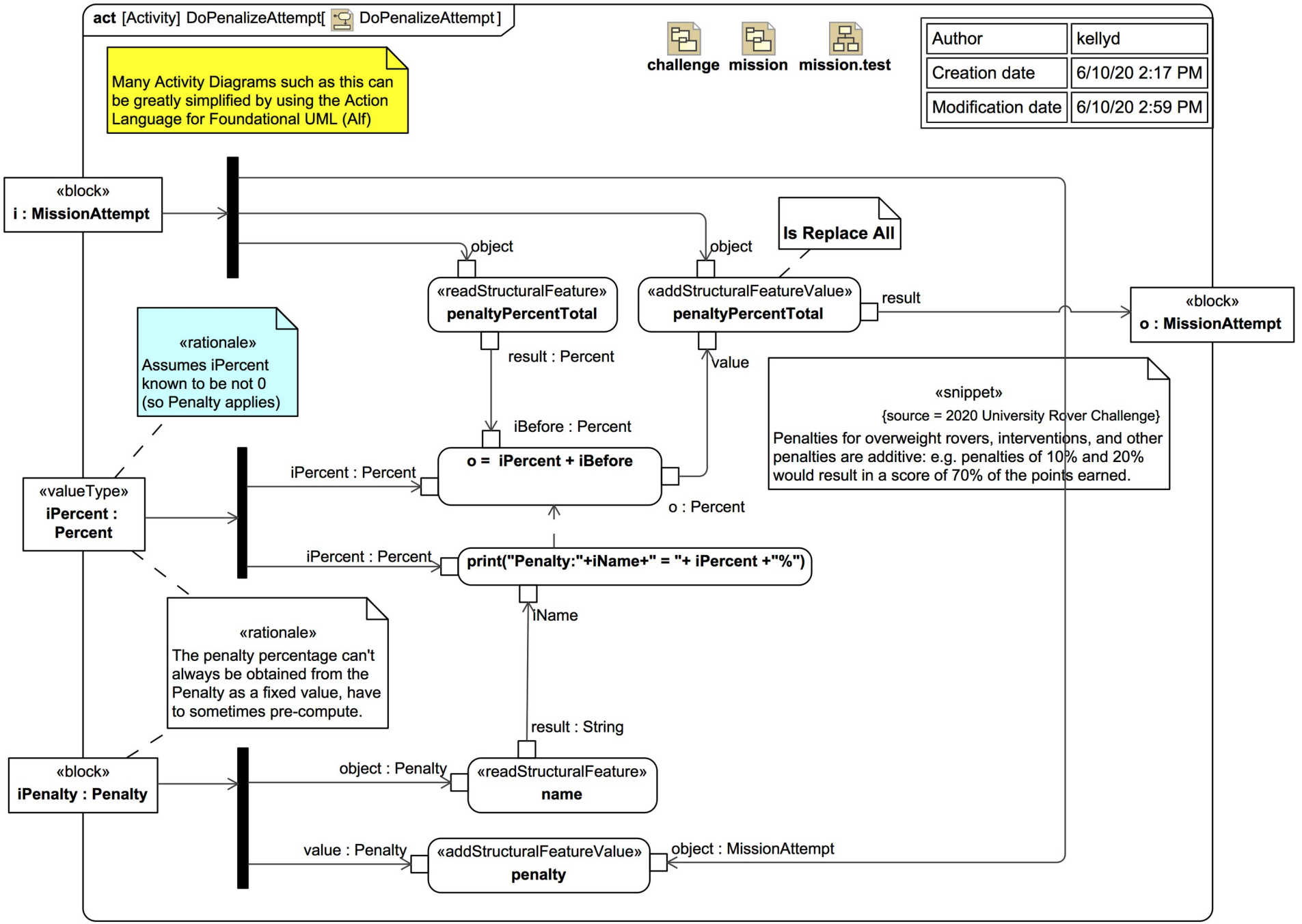

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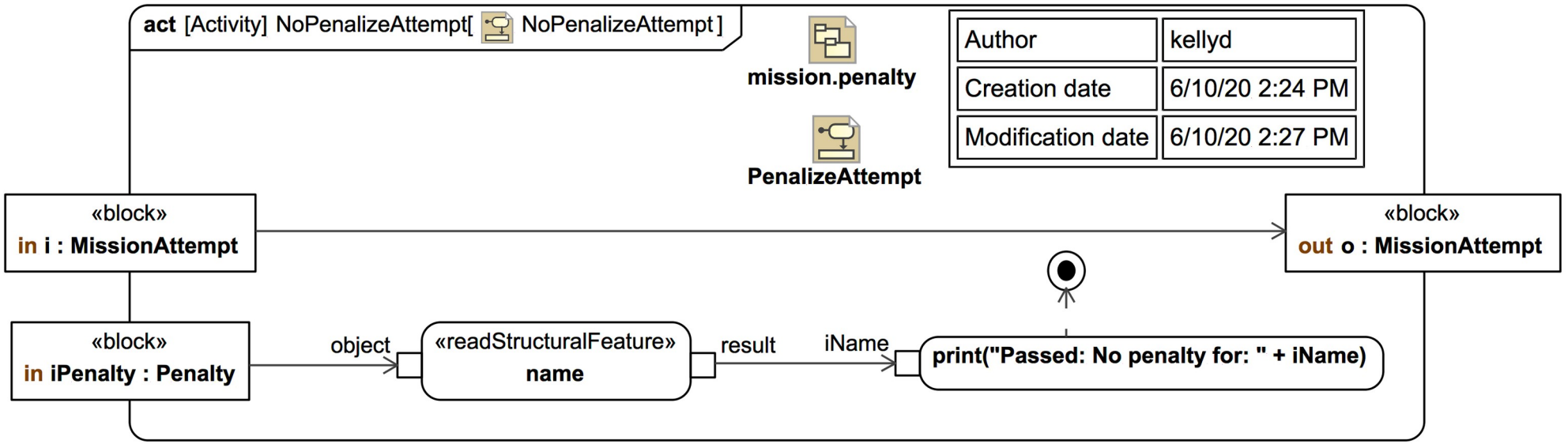

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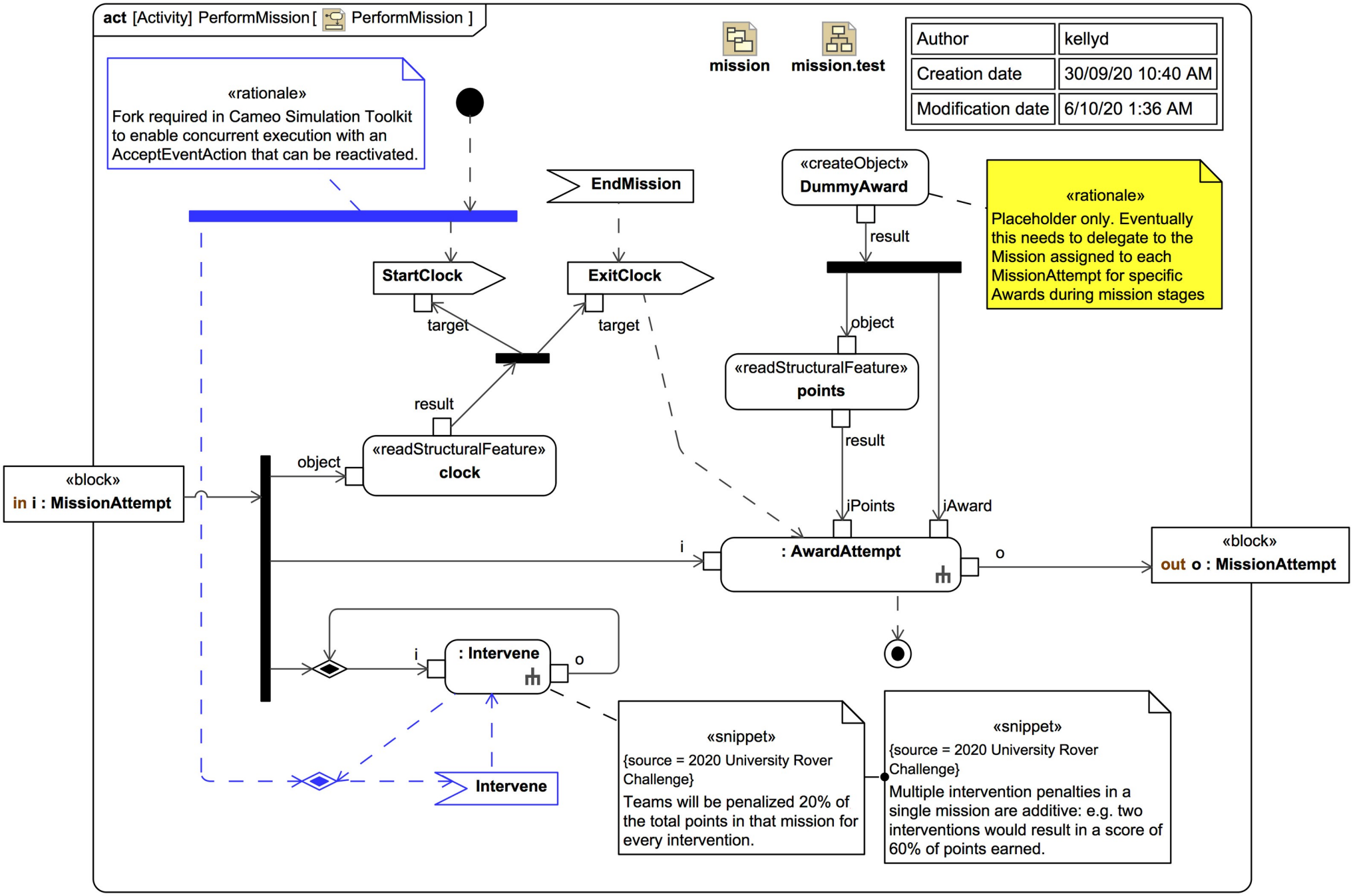

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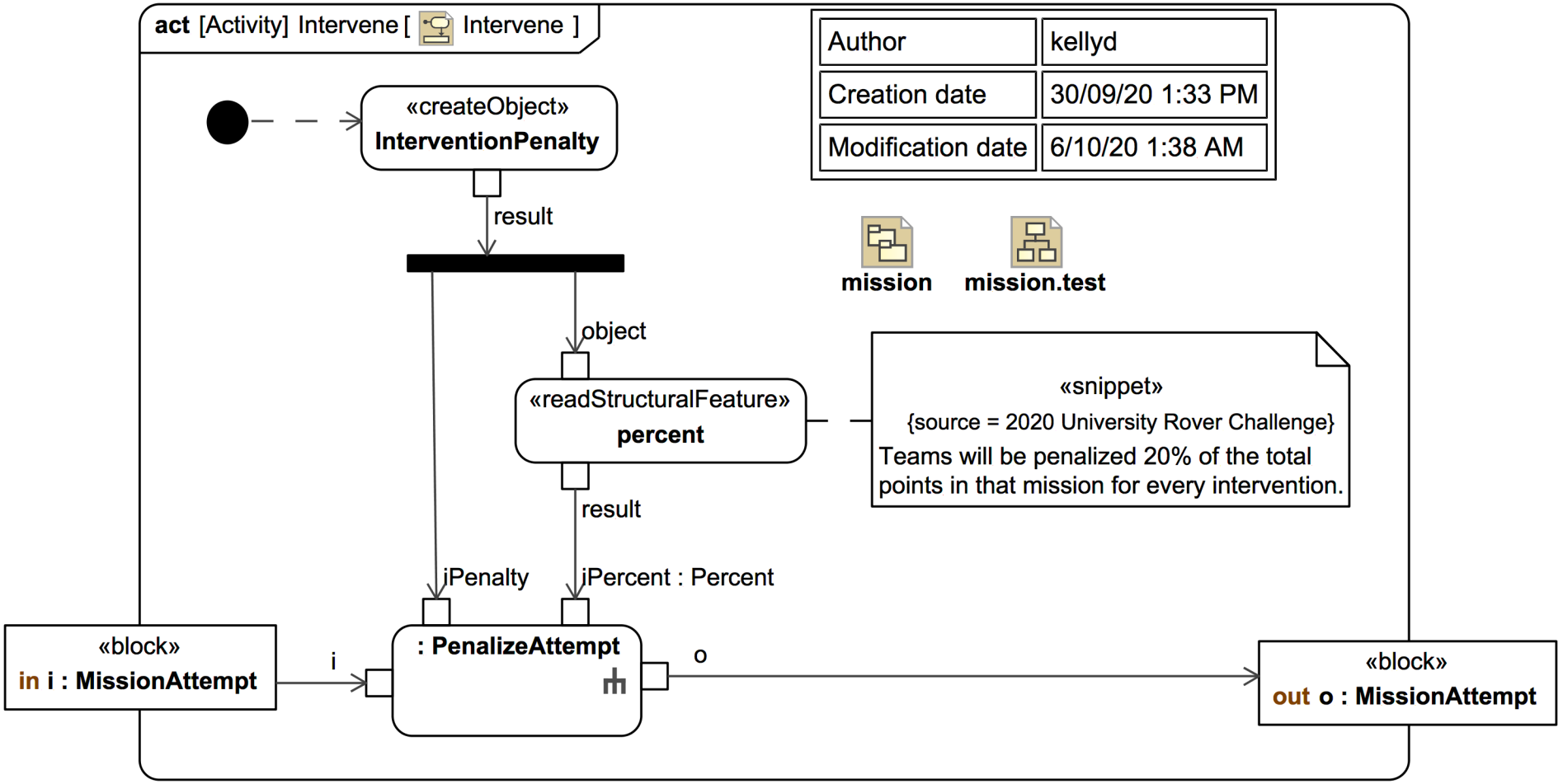

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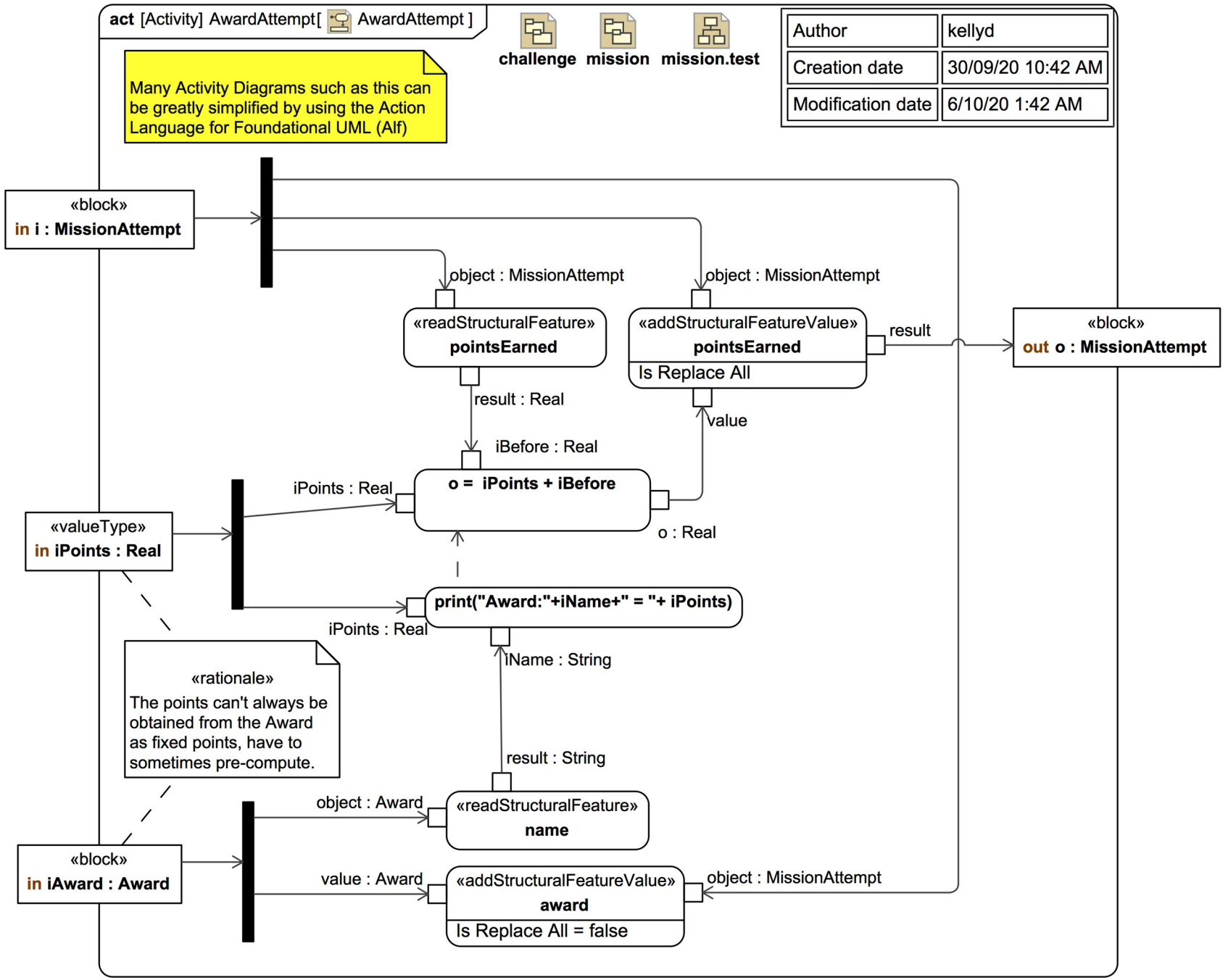

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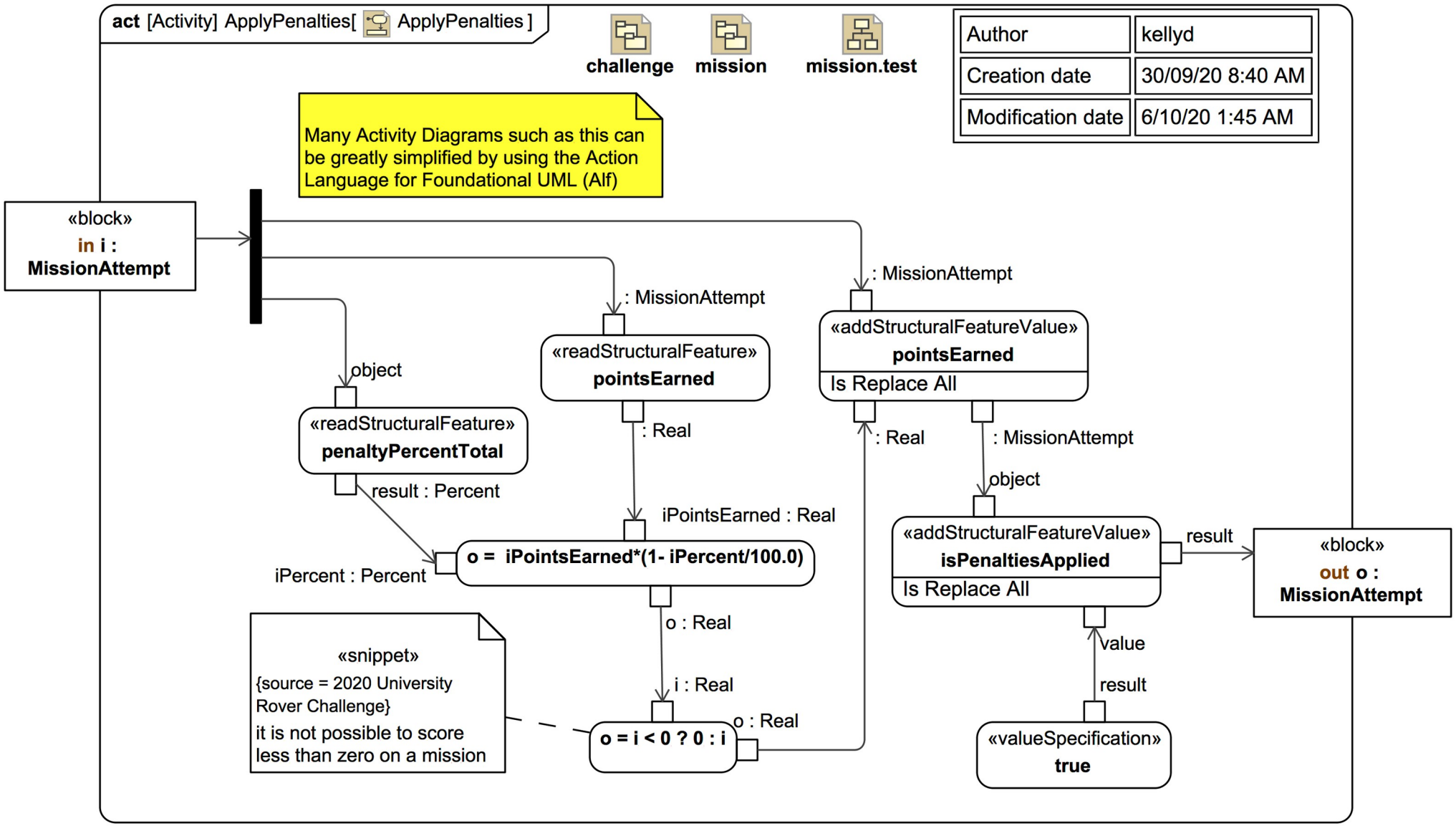

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SECTION

MissionStage, StageAttempt, Clock

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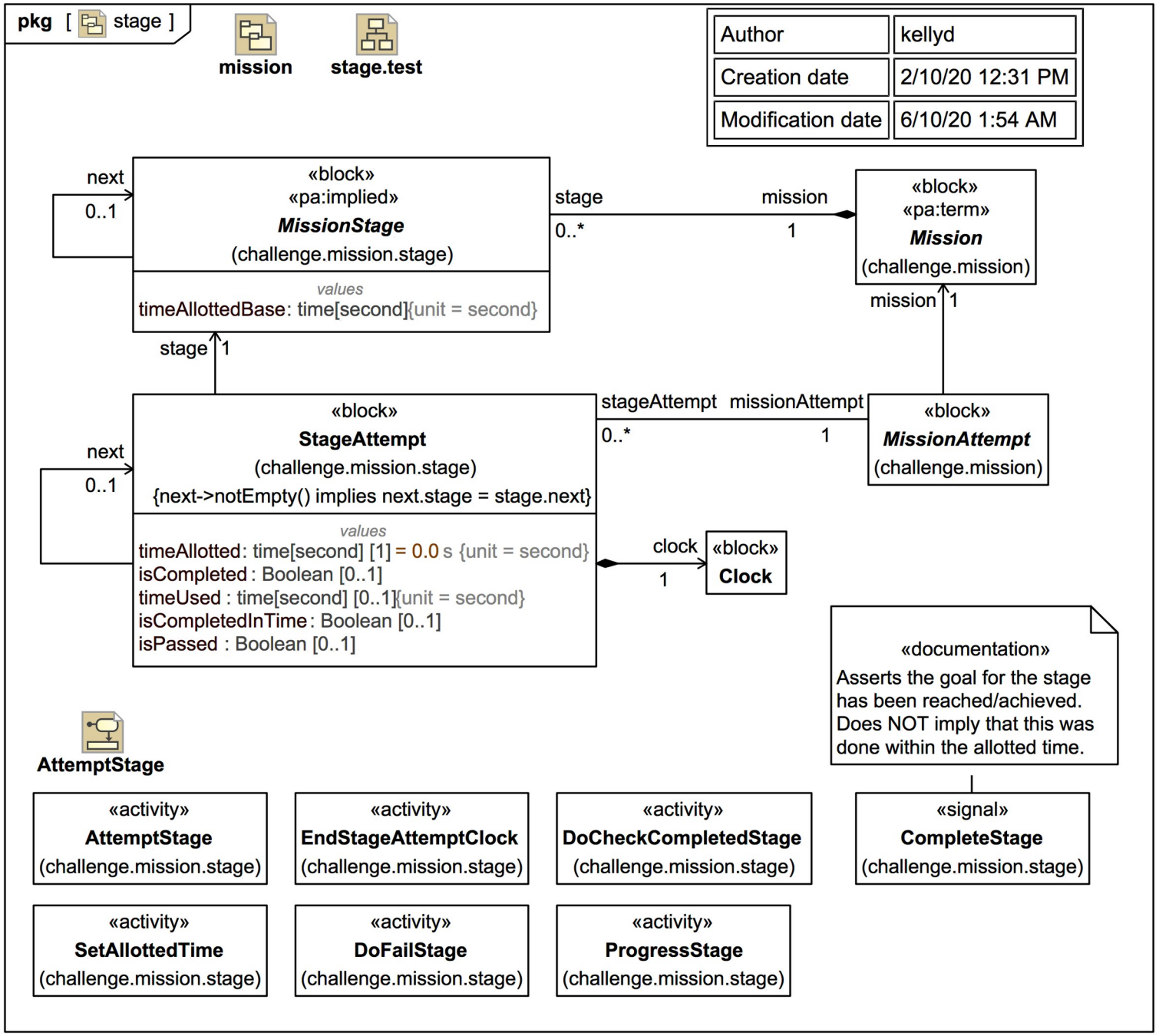

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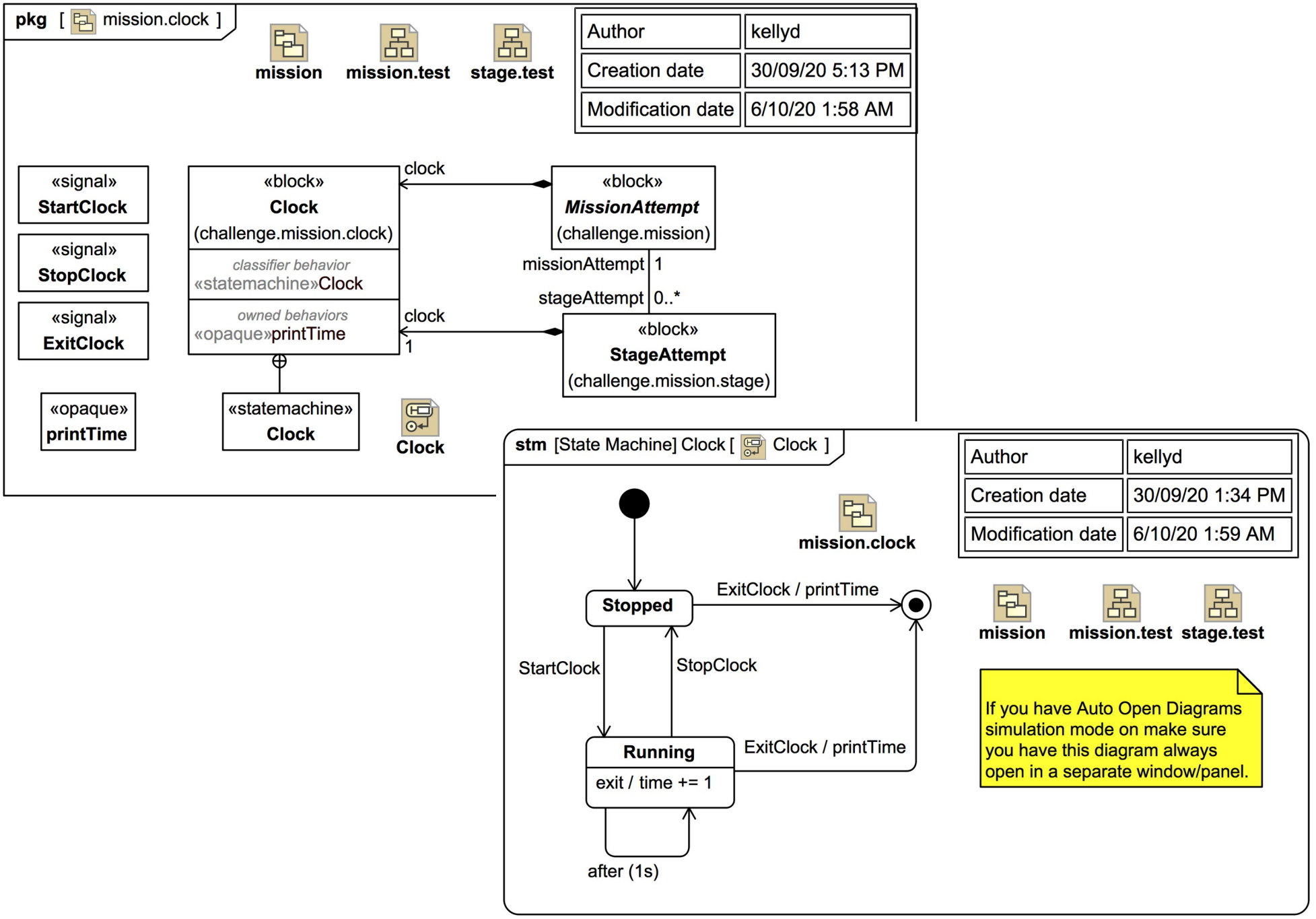

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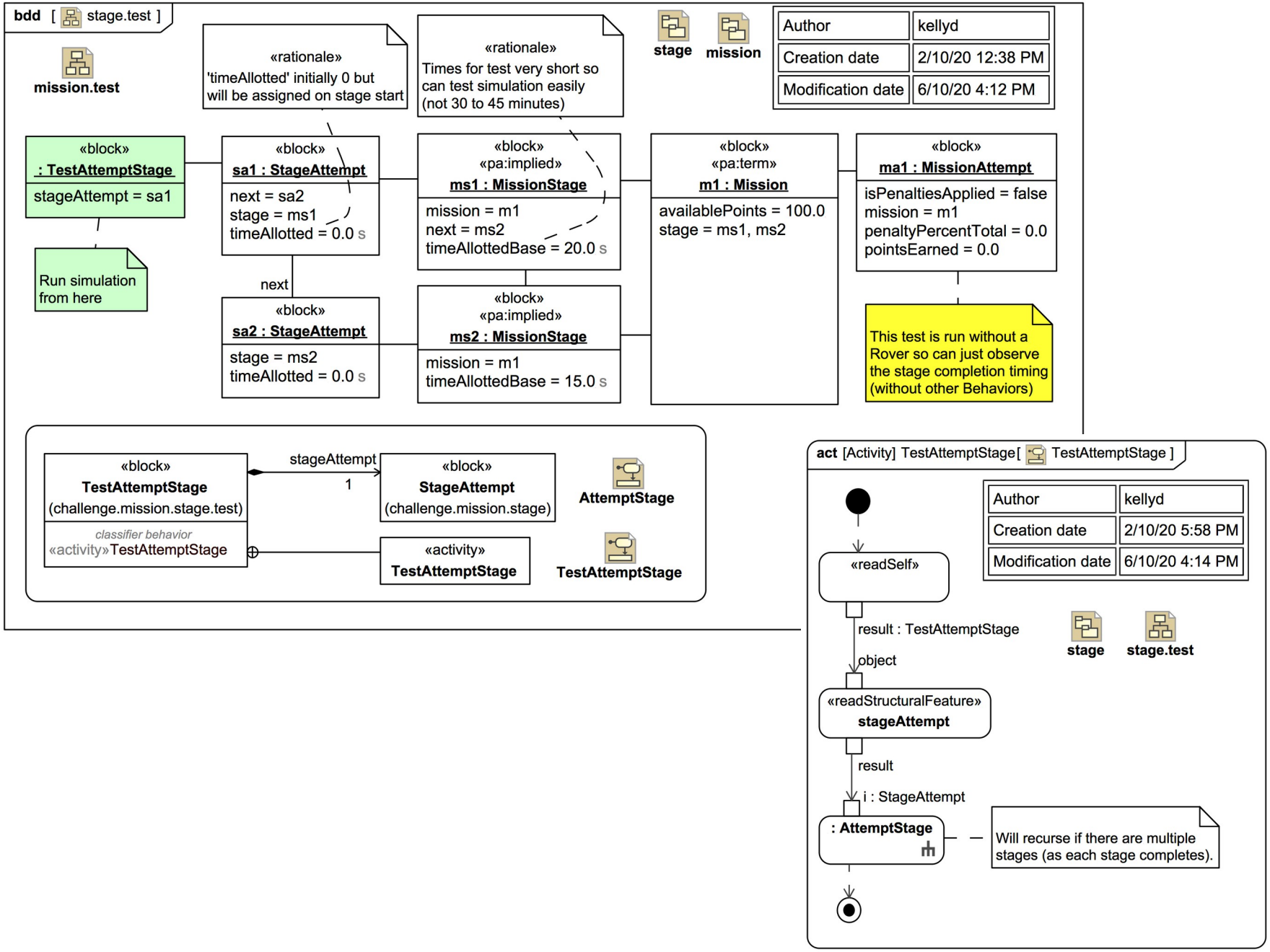

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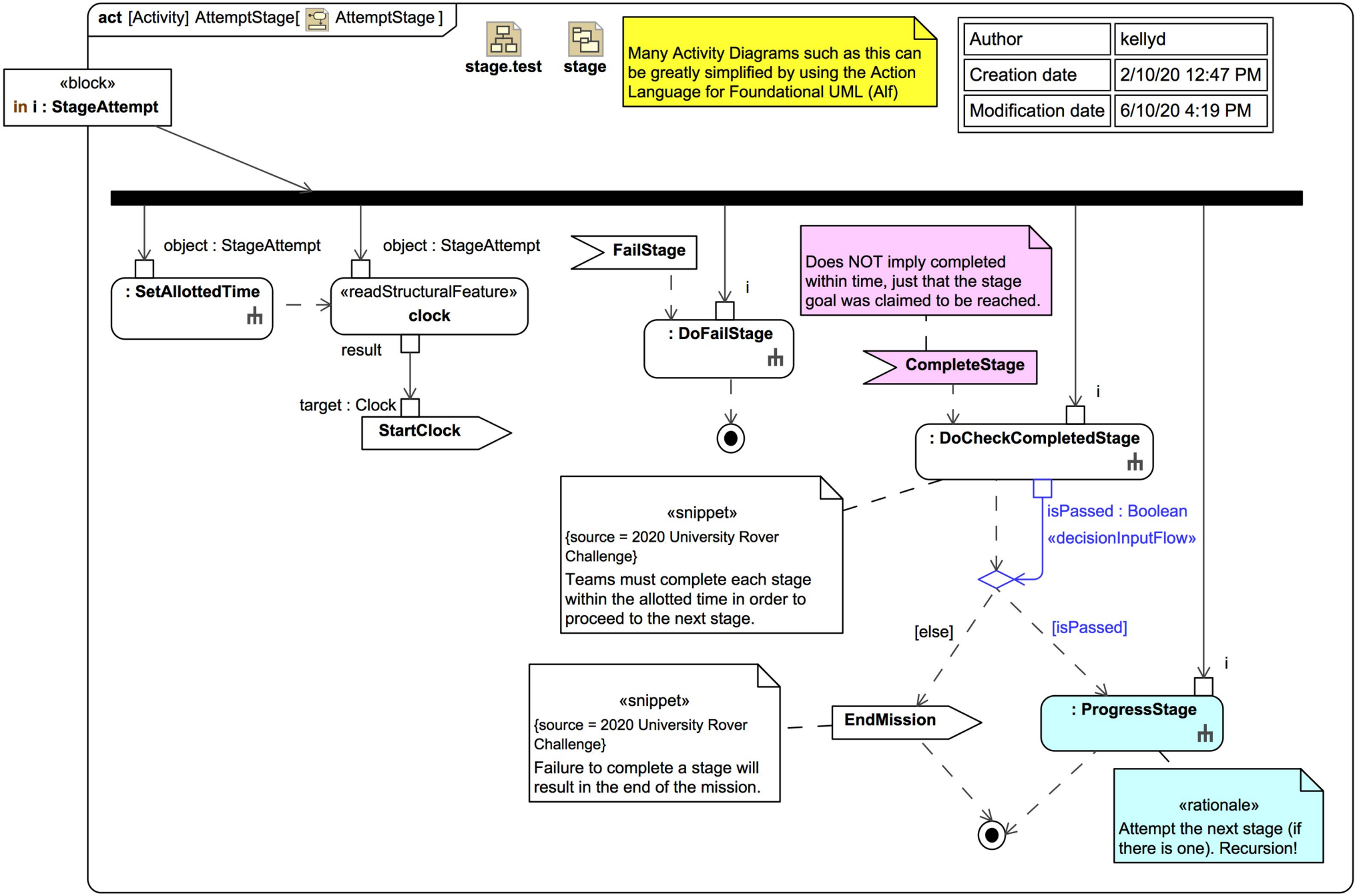

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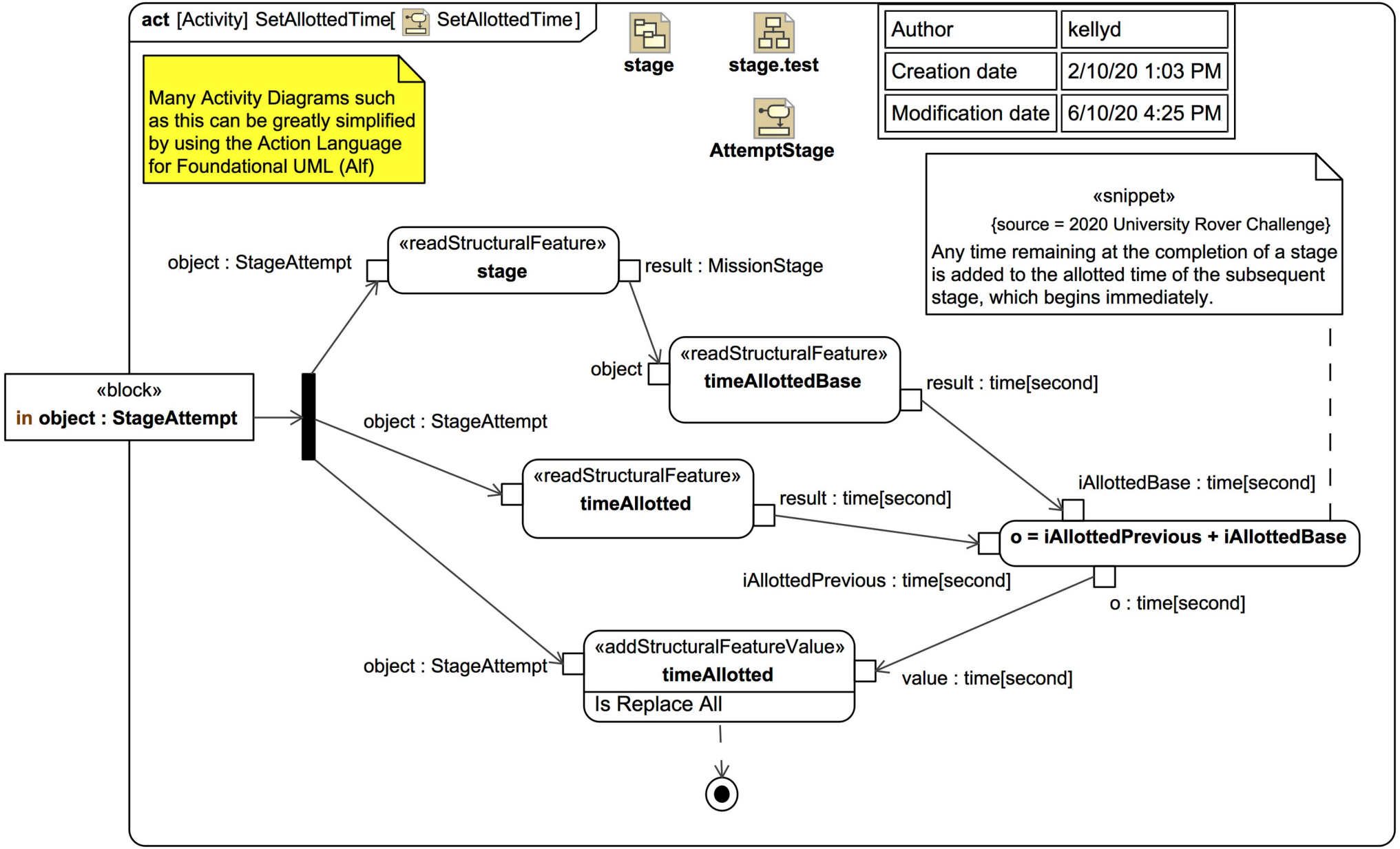

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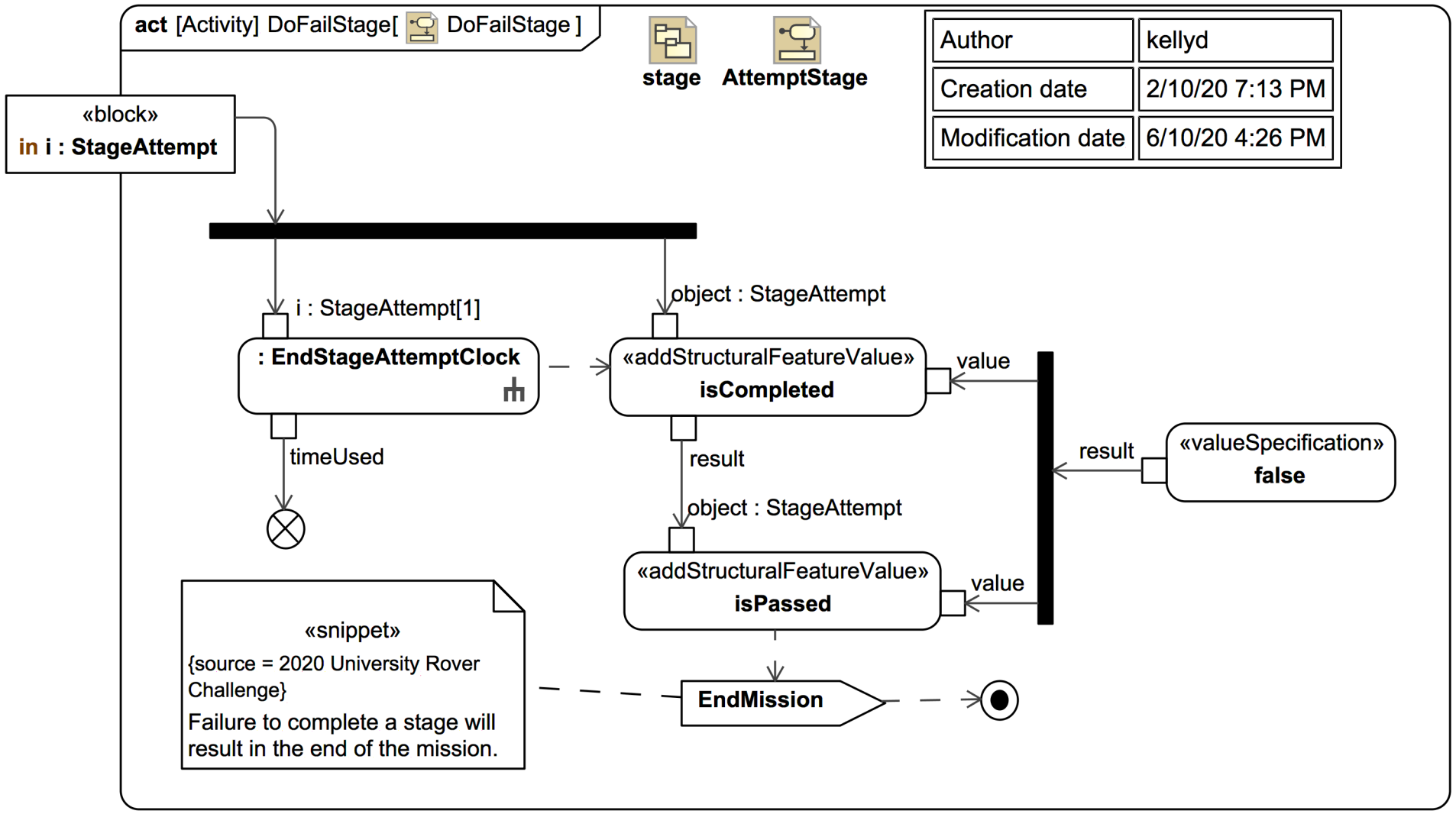

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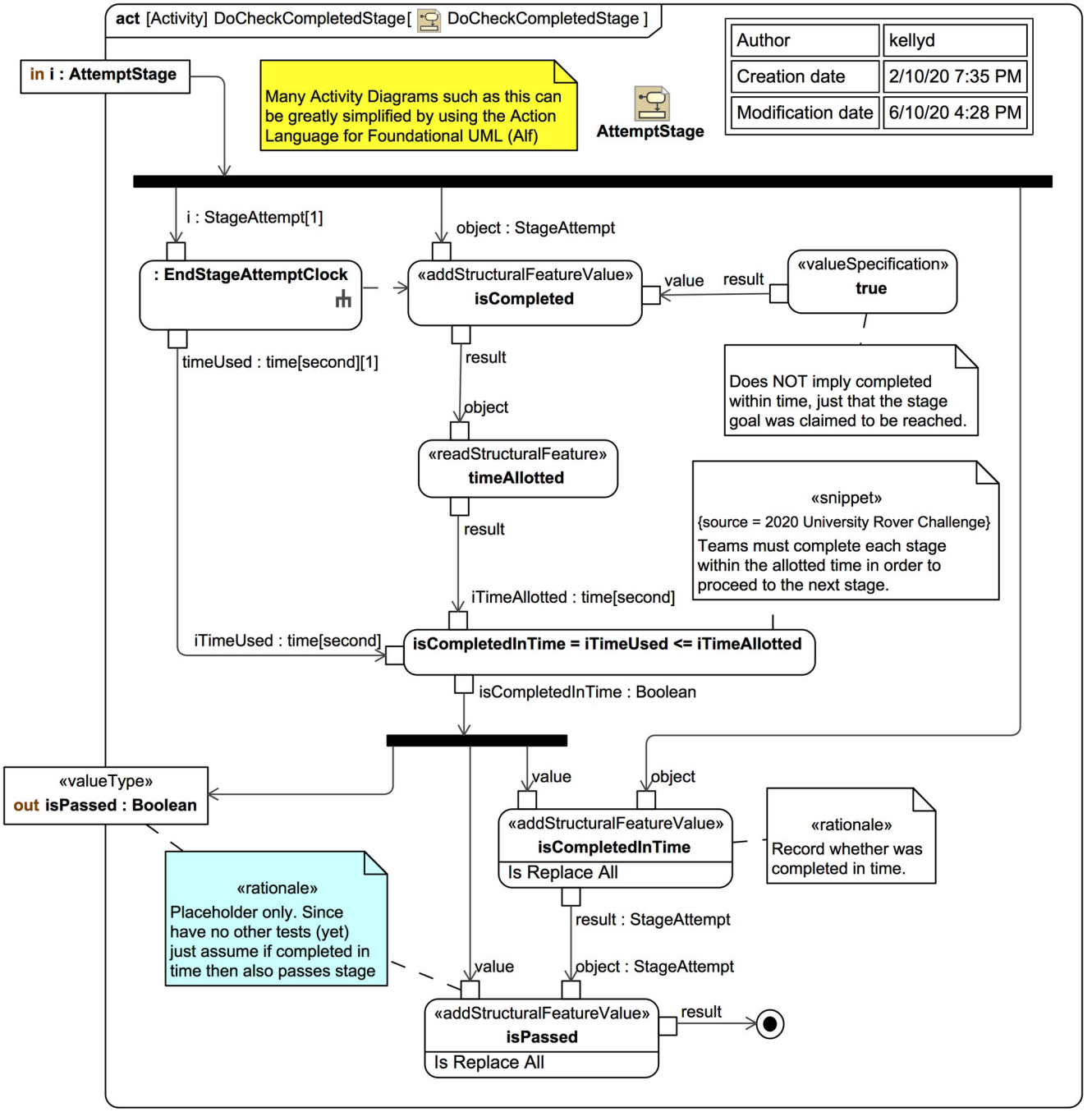

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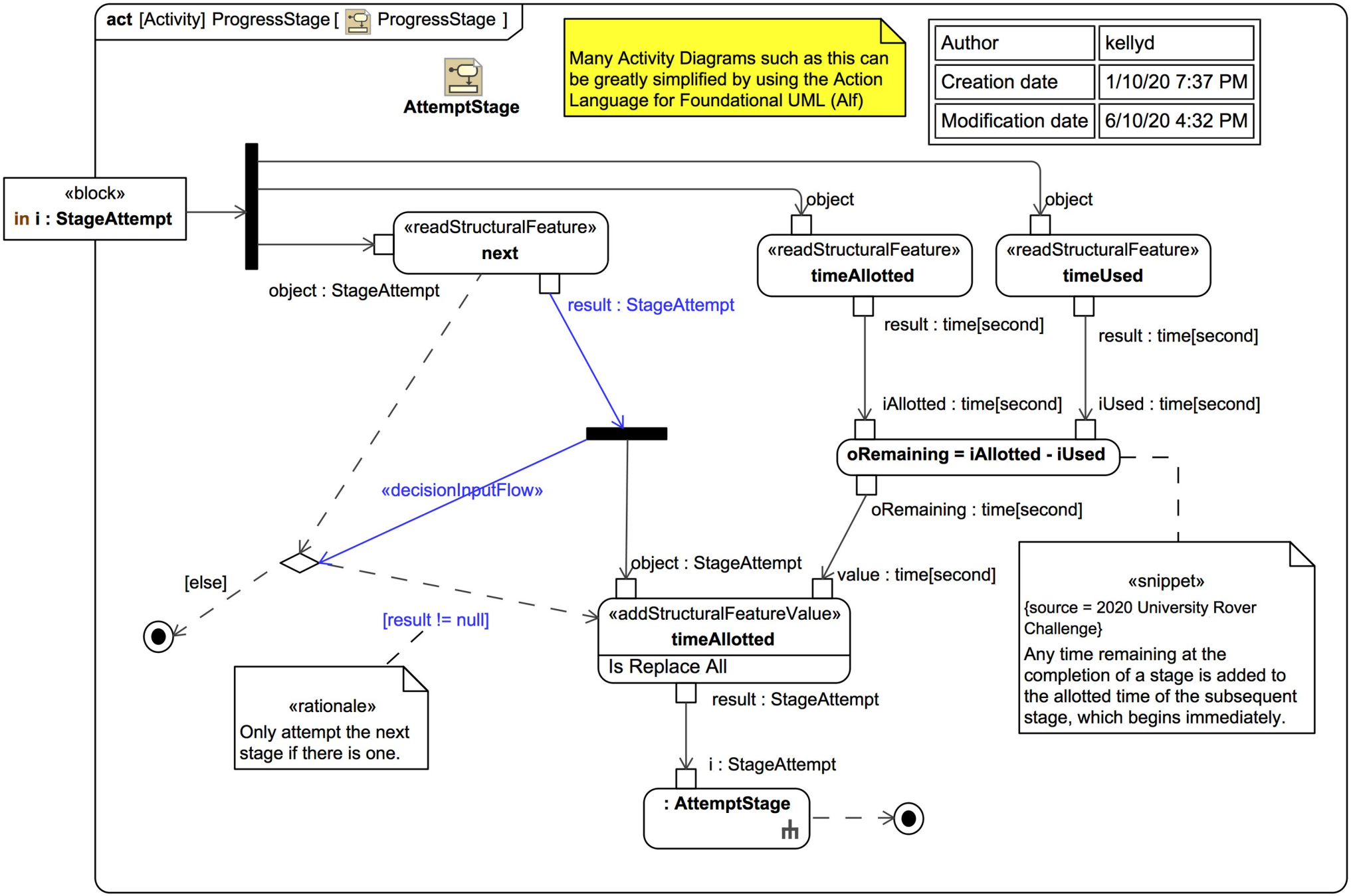

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SECTION

Mapped Requirements

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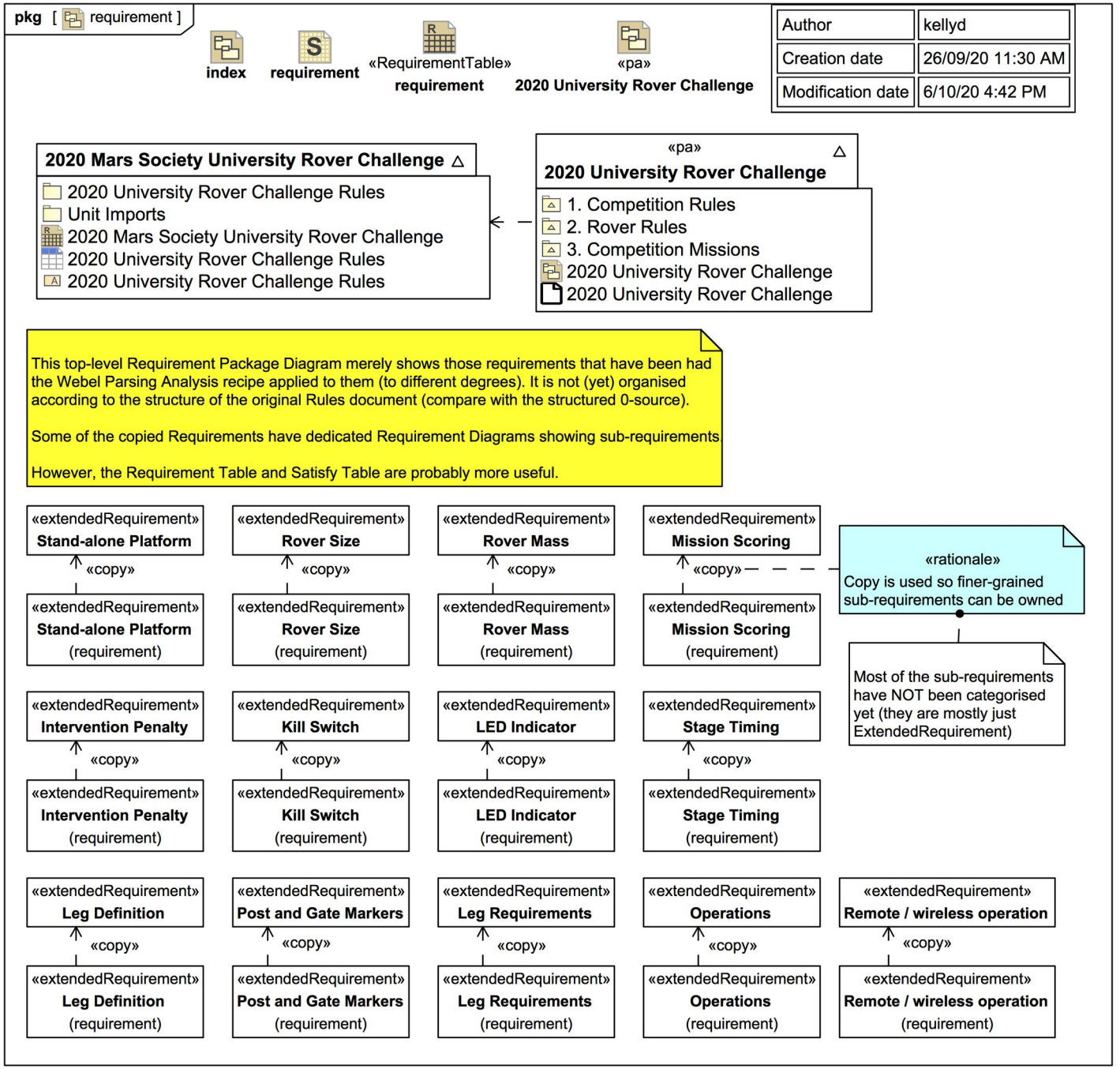

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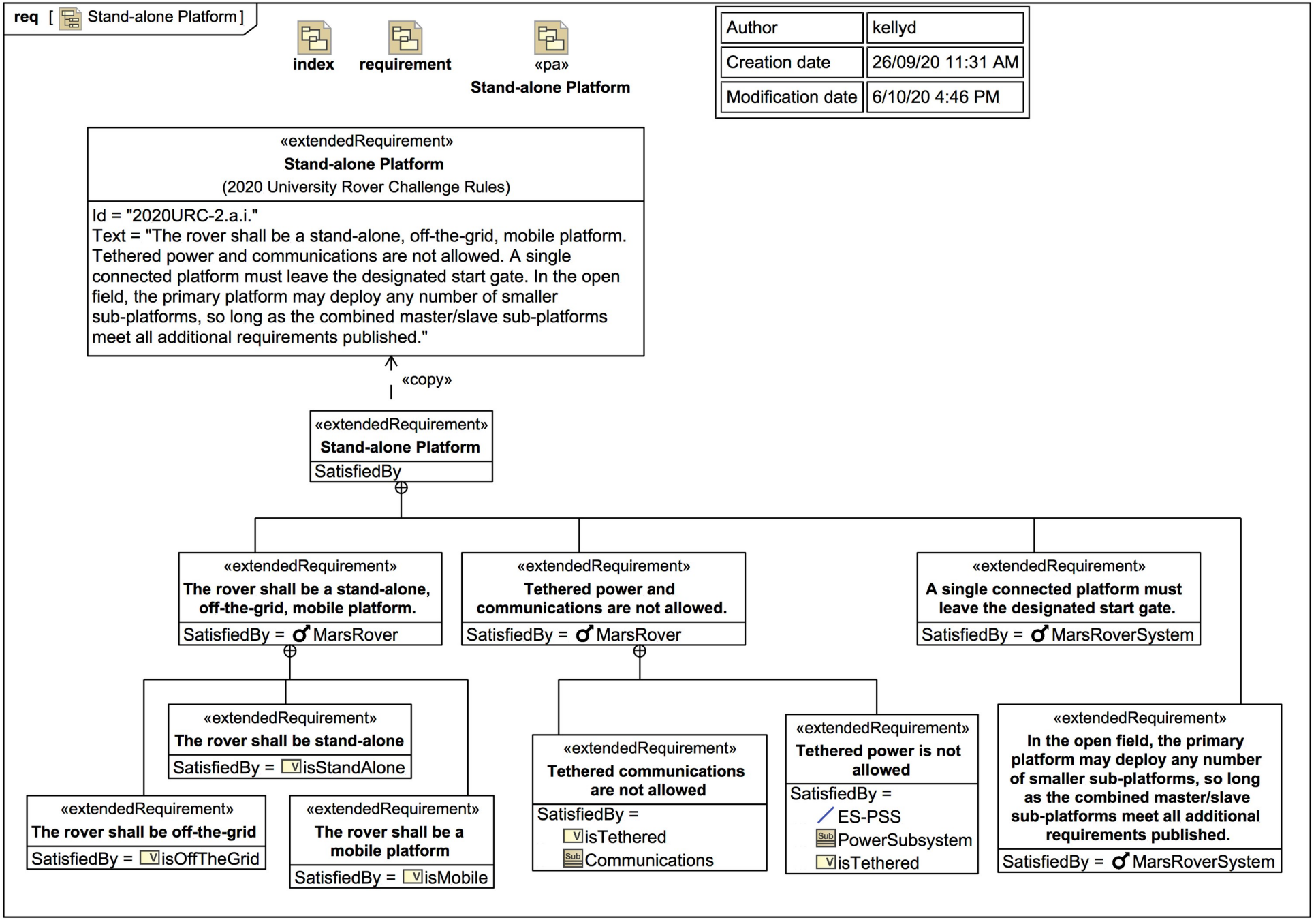

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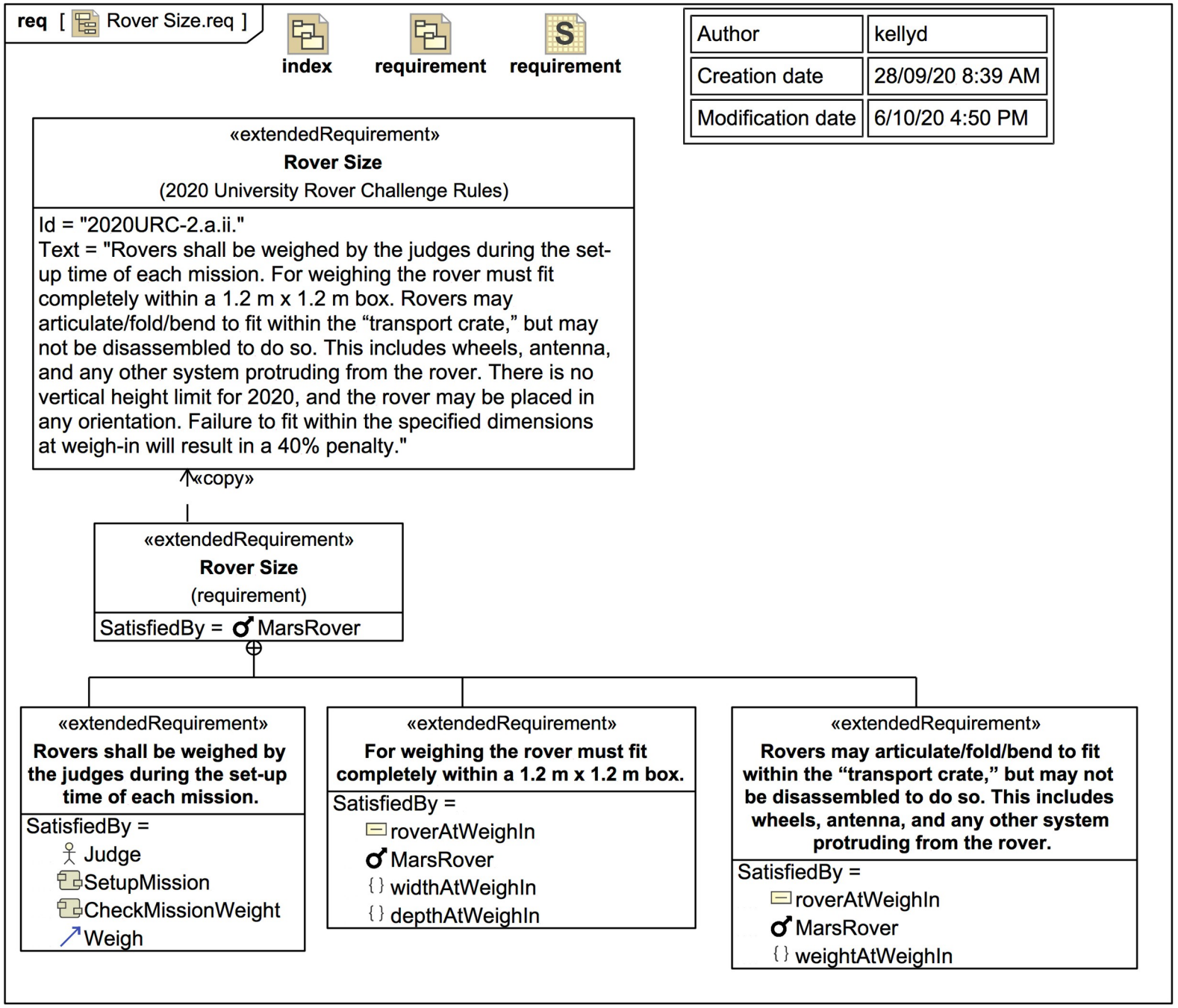

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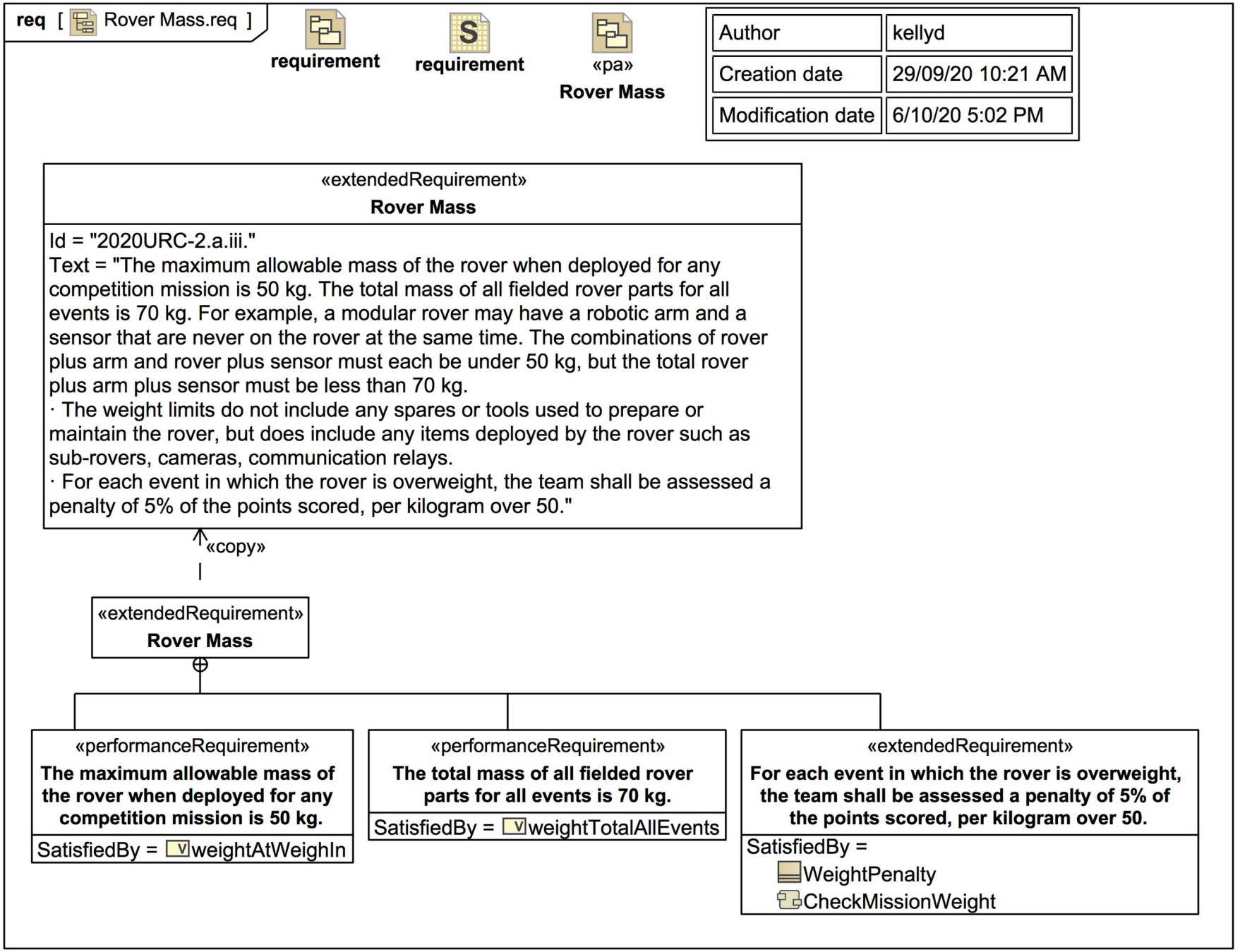

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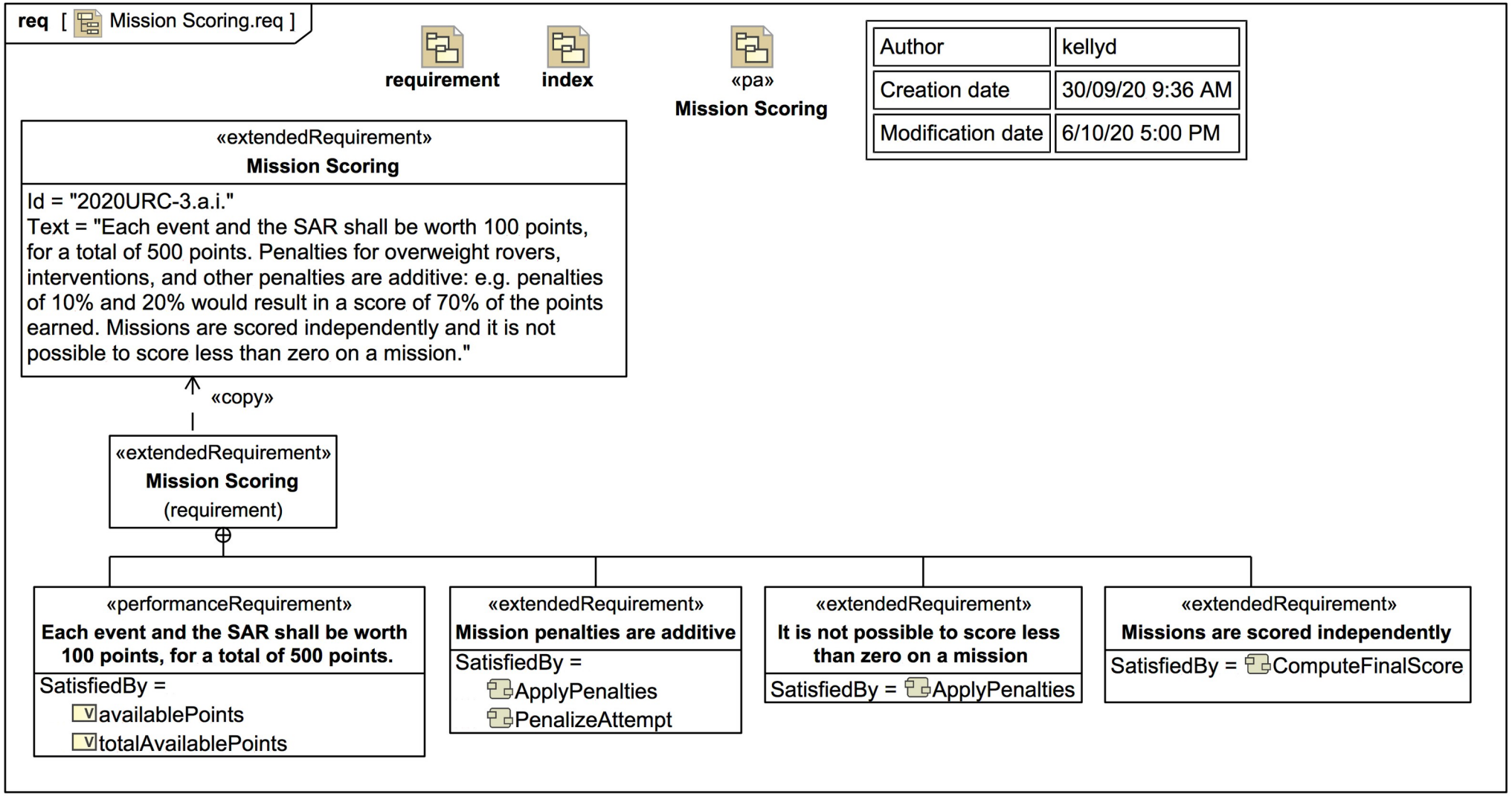

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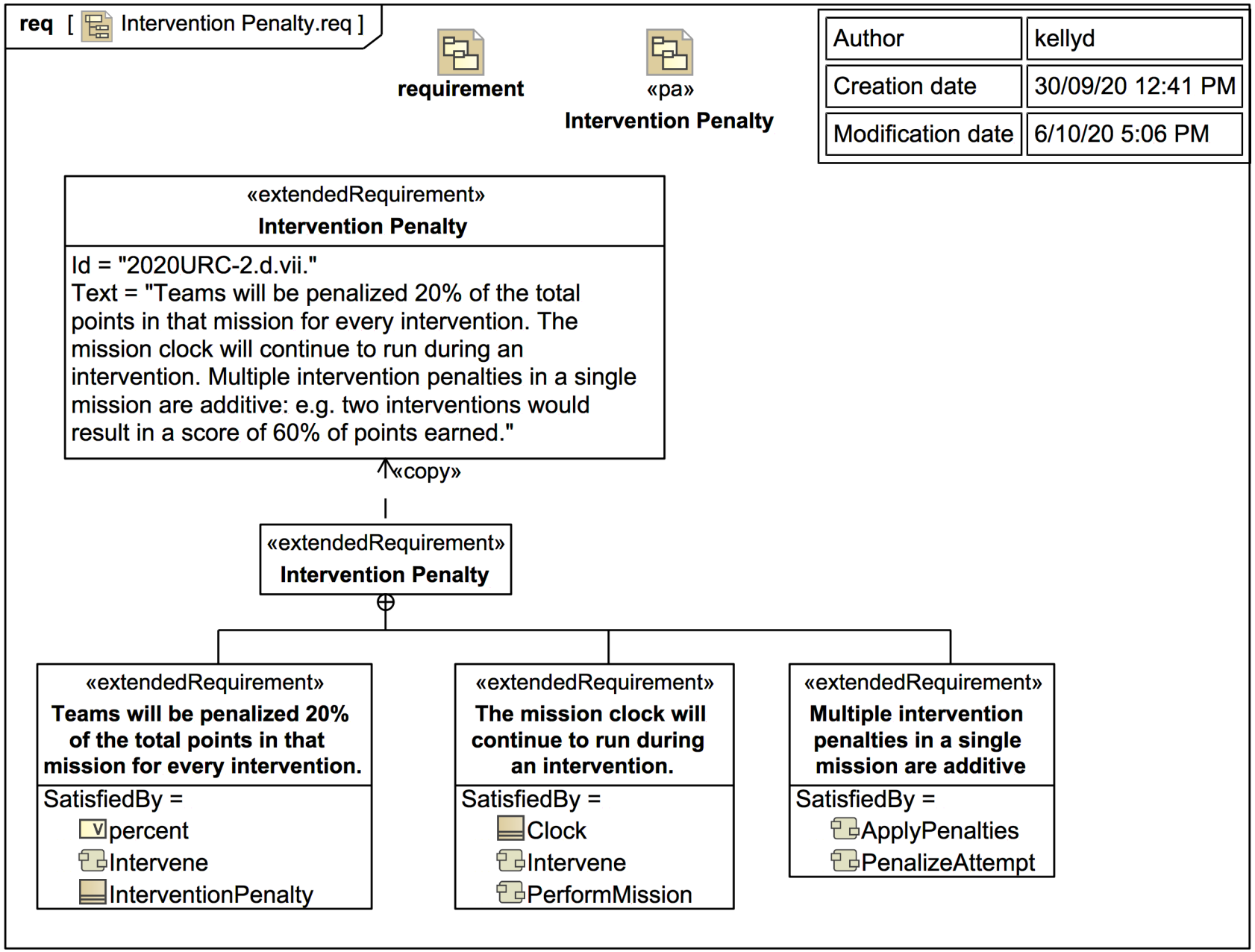

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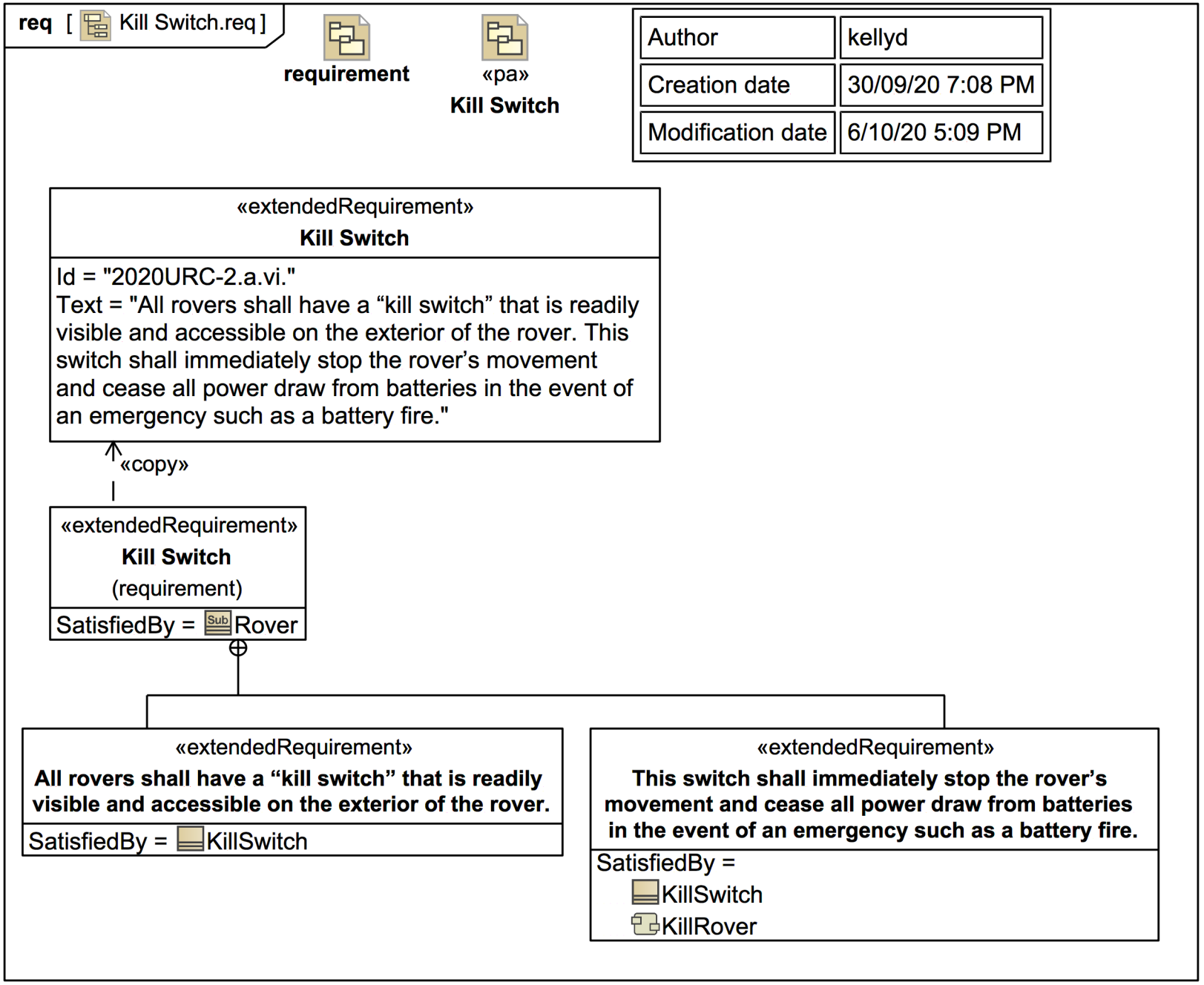

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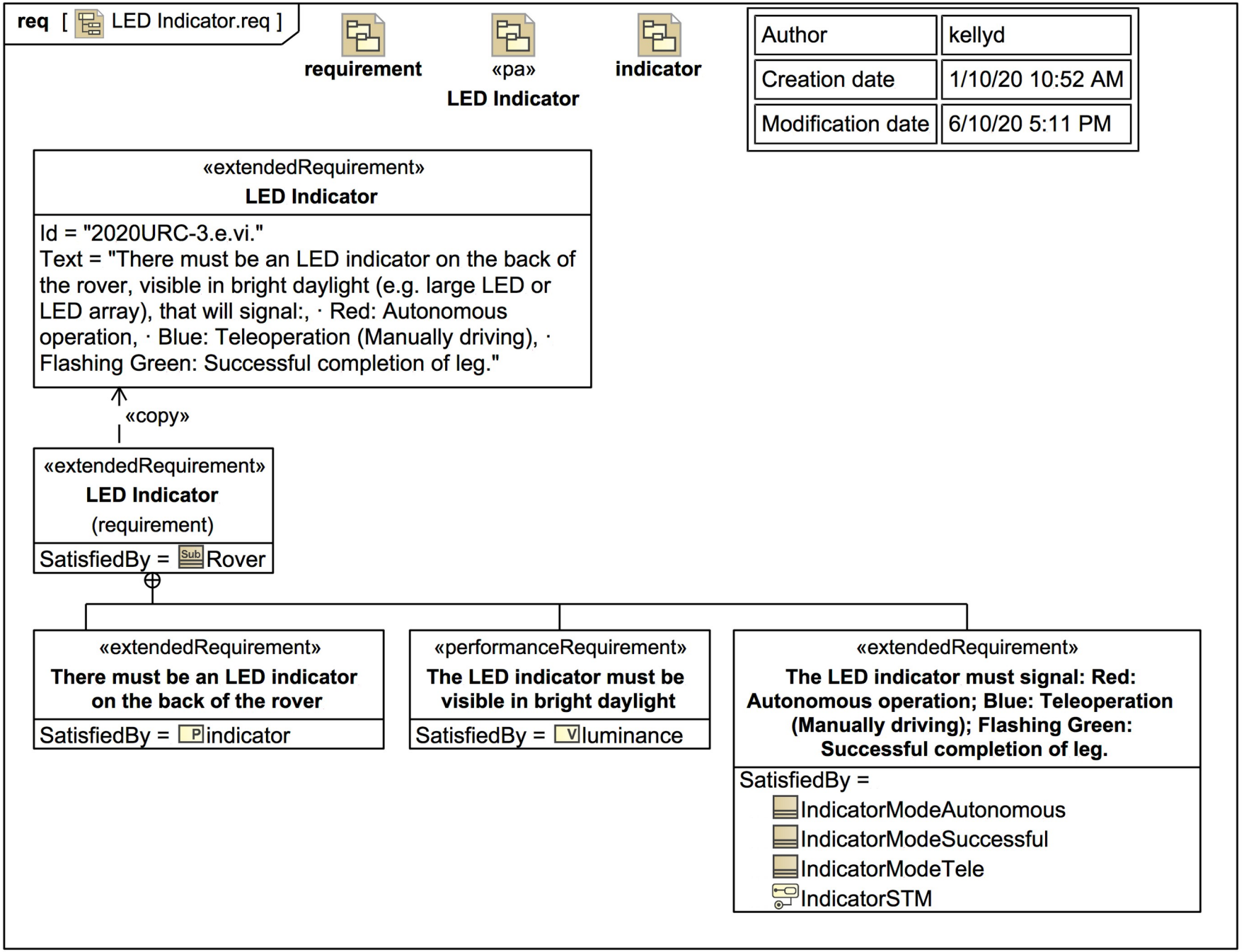

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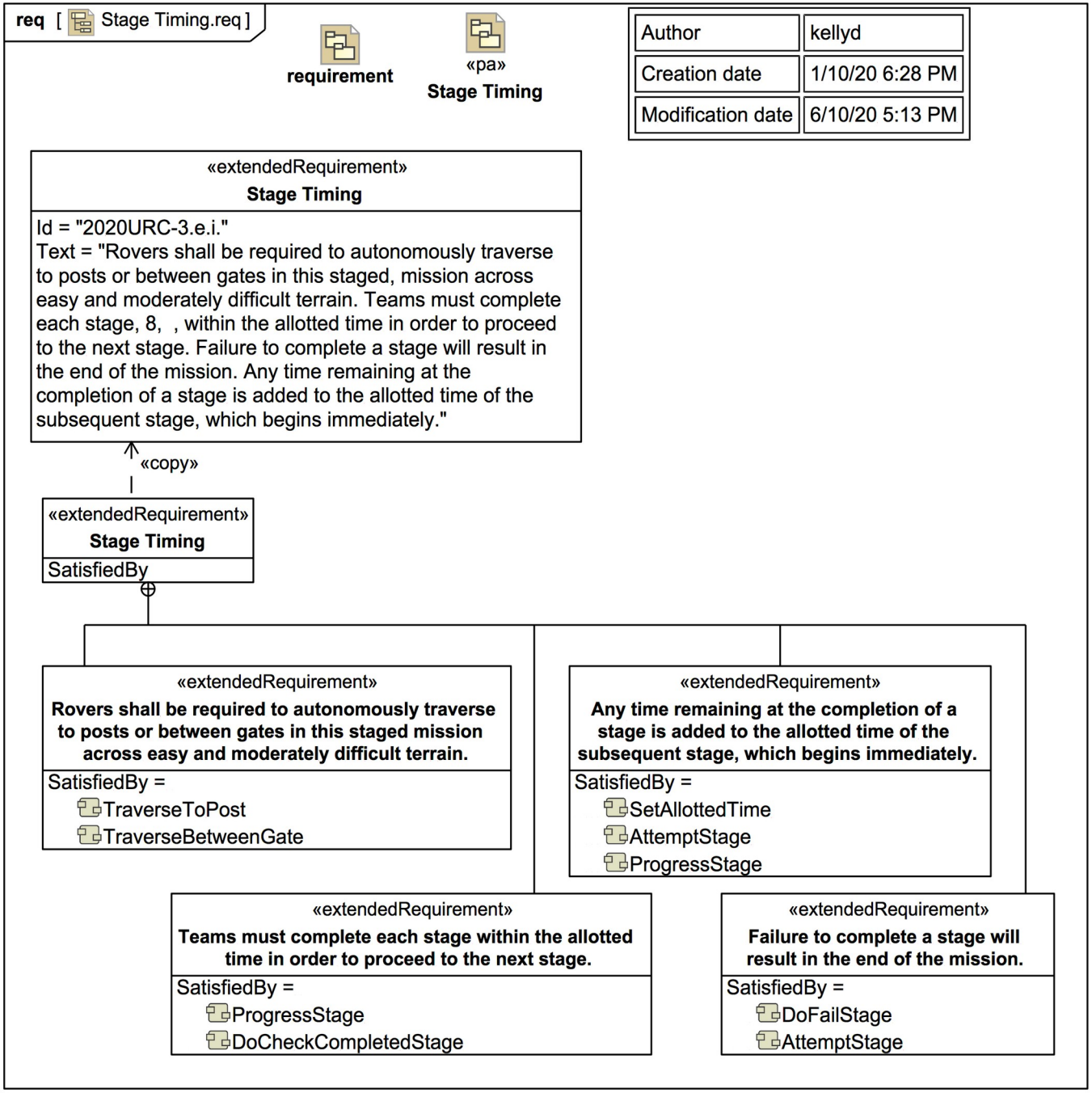

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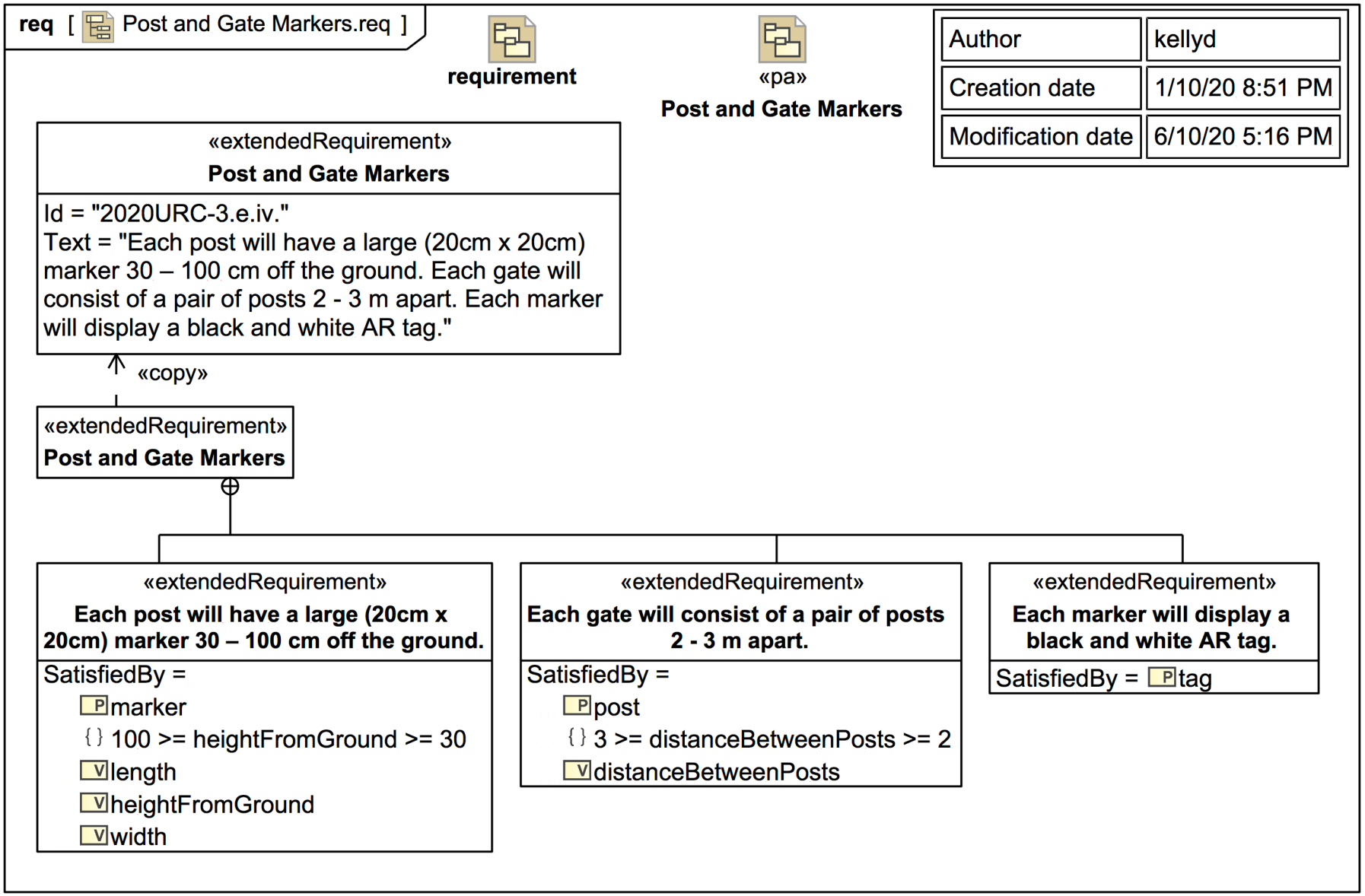

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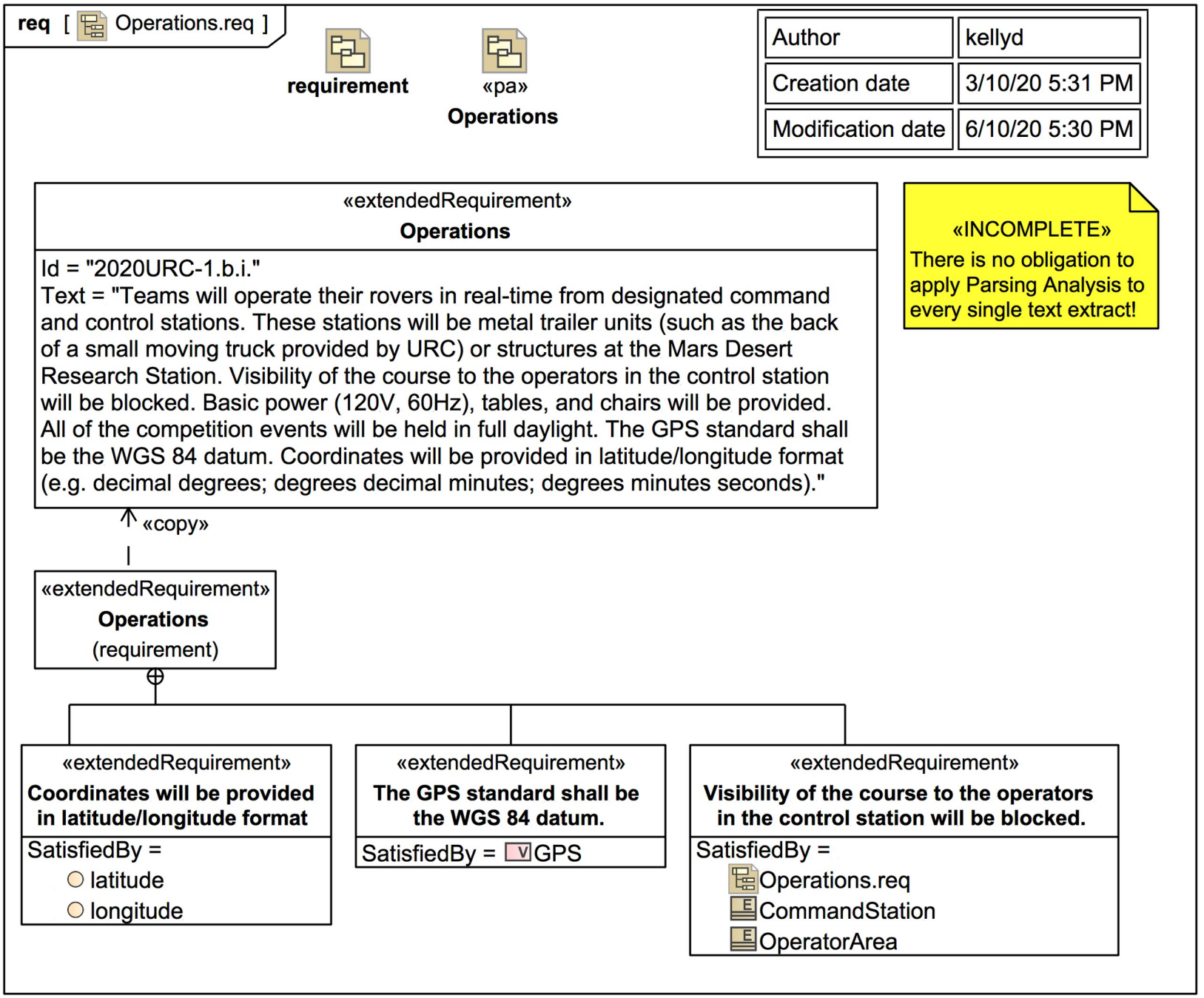

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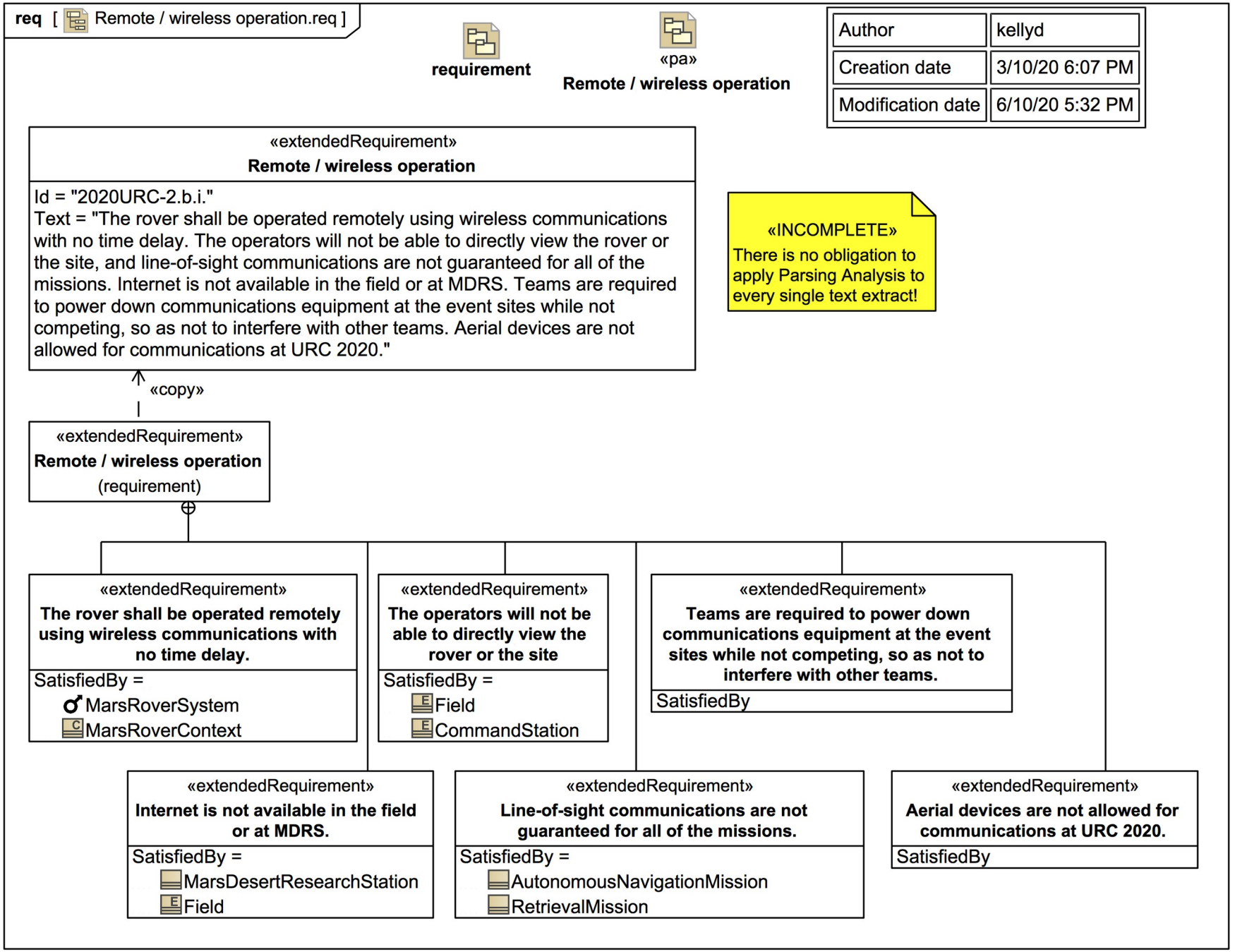

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#	△ Name	Text	Satisfied By
1	1 Stand-alone Platform	The rover shall be a stand-alone, off-the-grid, mobile platform. Tethered power and communications are not allowed. A single connected platform must leave the designated start gate. In the open field, the primary platform may deploy any number of smaller sub-platforms, so long as the combined master/slave sub-platforms meet all additional requirements published.	
2	1.1 The rover shall be a stand-alone, off-the-grid, mobile platform.		*MarsRover*
3	1.1.1 The rover shall be stand-alone		isStandAlone : Boolean [1] = true
4	1.1.2 The rover shall be off-the-grid		isOffTheGrid : Boolean [1] = true
5	1.1.3 The rover shall be a mobile platform		isMobile : Boolean [1] = true
6	1.2 Tethered power and communications are not allowed.		*MarsRover*
7	1.2.1 Tethered power is not allowed		Association:ES-PSS[source:EnergySource - PowerSubsystem] *PowerSubsystem* isTethered : Boolean [1] = false
8	1.2.2 Tethered communications are not allowed		isTethered : Boolean [1] = false Communications
9	1.3 A single connected platform must leave the designated start gate.		*MarsRoverSystem*
10	1.4 In the open field, the primary platform may deploy any number of smaller sub-platforms, so long as the combined master/slave sub-platforms meet all additional requirements published.		*MarsRoverSystem*
11	12 Rover Size	Rovers shall be weighed by the judges during the set-up time of each mission. For weighing the rover must fit completely within a 1.2 m x 1.2 m box. Rovers may articulate/fold/bend to fit within the "transport crate," but may not be disassembled to do so. This includes wheels, antenna, and any other system protruding from the rover. Failure to fit within the specified dimensions at weigh-in will result in a 40% penalty.	*MarsRover*
12	12.1 Rovers shall be weighed by the judges during the set-up time of each mission.		Judge SetupMission CheckMissionWeight Association:Weigh[Judge -> Rover]
13	12.2 For weighing the rover must fit completely within a 1.2 m x 1.2 m box.		roverAtWeighIn : MarsRover *MarsRover* {} widthAtWeighIn=widthAtWeighIn < 1.2 {} depthAtWeighIn=depthAtWeighIn < 1.2
14	12.3 Rovers may articulate/fold/bend to fit within the "transport crate," but may not be disassembled to do so. This includes wheels, antenna, and any other system protruding from the rover.		roverAtWeighIn : MarsRover *MarsRover* {} weightAtWeighIn=weightAtWeighIn <= 50
15	13 Rover Mass	The maximum allowable mass of the rover when deployed for any competition mission is 50 kg. The total mass of all fielded rover parts for all events is 70 kg. For example, a modular rover may have a robotic arm and a sensor that are never on the rover at the same time. The combinations of rover plus arm and rover plus sensor must each be under 50 kg, but the total rover plus arm plus sensor must be less than 70 kg. · The weight limits do not include any spares or tools used to prepare or maintain the rover, but does include any items deployed by the rover such as sub-rovers, cameras, communication relays. · For each event in which the rover is overweight, the team shall be assessed a penalty of 5% of the points scored, per kilogram over 50.	
16	13.1 The maximum allowable mass of the rover when deployed for any competition mission is 50 kg.		weightAtWeighIn : PlatformWeight
17	13.2 The total mass of all fielded rover parts for all events is 70 kg.		weightTotalAllEvents : PlatformWeight
18	13.3 For each event in which the rover is overweight, the team shall be assessed a penalty of 5% of the points scored, per kilogram over 50.		WeightPenalty CheckMissionWeight
19	17 Mission Scoring	Each event and the SAR shall be worth 100 points, for a total of 500 points. Penalties for overweight rovers, interventions, and other penalties are additive: e.g. penalties of 10% and 20% would result in a score of 70% of the points earned. Missions are scored independently and it is not possible to score less than zero on a mission.	
20	17.1 Each event and the SAR shall be worth 100 points, for a total of 500 points.		availablePoints : Real = 100.0 /totalAvailablePoints = 500.0
21	17.2 It is not possible to score less than zero on a mission		ApplyPenalties
22	17.3 Mission penalties are additive		ApplyPenalties PenalizeAttempt
23	17.4 Missions are scored independently		ComputeFinalScore
24	18 Intervention Penalty	Teams will be penalized 20% of the total points in that mission for every intervention. The mission clock will continue to run during an intervention. Multiple intervention penalties in a single mission are additive: e.g. two interventions would result in a score of 60% of points earned.	Intervention Penalty.req
25	18.1 Teams will be penalized 20% of the total points in that mission for every intervention.		percent : Percent [1] = 20.0 Intervene InterventionPenalty
26	18.2 The mission clock will continue to run during an intervention.		Clock Intervene PerformMission
27	18.3 Multiple intervention penalties in a single mission are additive		ApplyPenalties PenalizeAttempt
28	20 Kill Switch	All rovers shall have a "kill switch" that is readily visible and accessible on the exterior of the rover. This switch shall immediately stop the rover's movement and cease all power draw from batteries in the event of an emergency such as a battery fire.	*Rover*
29	20.1 All rovers shall have a "kill switch" that is readily visible and accessible on the exterior of the rover.		KillSwitch
30	20.2 This switch shall immediately stop the rover's movement and cease all power draw from batteries in the event of an emergency such as a battery fire.		KillSwitch KillRover
31	21 LED Indicator	There must be an LED indicator on the back of the rover, visible in bright daylight (e.g. large LED or LED array), that will signal:, · Red: Autonomous operation, · Blue: Teleoperation (Manually driving), · Flashing Green: Successful completion of leg.	*Rover*
32	21.1 There must be an LED indicator on the back of the rover		indicator : Indicator [1]
33	21.2 The LED indicator must be visible in bright daylight		luminance : luminance[candela per square metre]
34	21.3 The LED indicator must signal: Red: Autonomous operation; Blue: Teleoperation (Manually driving); Flashing Green: Successful completion of leg.		IndicatorModeAutonomous IndicatorModeSuccessful IndicatorModeTele IndicatorSTM(classifier behavior)
35	25 Stage Timing	Rovers shall be required to autonomously traverse to posts or between gates in this staged, mission across easy and moderately difficult terrain. Teams must complete each stage, 8, , within the allotted time in order to proceed to the next stage. Failure to complete a stage will result in the end of the mission. Any time remaining at the completion of a stage is added to the allotted time of the subsequent stage, which begins immediately.	
36	25.1 Rovers shall be required to autonomously traverse to posts or between gates in this staged mission across easy and moderately difficult terrain.		TraverseToPost TraverseBetweenGate
37	25.2 Teams must complete each stage within the allotted time in order to proceed to the next stage.		ProgressStage DoCheckCompletedStage
38	25.3 Failure to complete a stage will result in the end of the mission.		DoFailStage AttemptStage
39	25.4 Any time remaining at the completion of a stage is added to the allotted time of the subsequent stage, which begins immediately.		SetAllottedTime AttemptStage ProgressStage
40	26 Leg Definition	A leg is defined as the rover autonomously navigating to the next post or passing completely through the next gate.	*Leg* {} next.step1 = step2=next.step1 = step2 TraverseBetweenGate
41	27 Post and Gate Markers	Each post will have a large (20cm x 20cm) marker 30 - 100 cm off the ground. Each gate will consist of a pair of posts 2 - 3 m apart. Each marker will display a black and white AR tag.	
42	27.1 Each post will have a large (20cm x 20cm) marker 30 - 100 cm off the ground.		marker : Marker [1] {} 100 >= heightFromGround >= 30=heightFromGround >= ... length : length[centimetre] = 20.0 cm heightFromGround : length[centimetre] width : length[centimetre] = 20.0 cm
43	27.2 Each gate will consist of a pair of posts 2 - 3 m apart.		/post : Post [2] {} 3 >= distanceBetweenPosts >= 2=distanceBetweenPost... distanceBetweenPosts : distance[metre] [1]
44	27.3 Each marker will display a black and white AR tag.		tag : Tag [1]
45	31 Leg Requirements	Legs will increase in difficulty:, Stage 1. Autonomously drive to a post and stop within 3m of the post. Flat easy terrain., · Leg 1: GPS coordinates of the post provided., · Leg 2: GPS coordinates of the post provided., · Leg 3: GPS coordinates up to 5m from the post. Rovers will need to autonomously detect AR tag on the post and drive to it., · Leg 4: Autonomously drive completely through a gate with posts 3 m, apart. GPS coordinates between gate posts provided., Stage 2. Autonomously drive completely through a gate. Gate posts 2 m apart., · Leg 5: GPS coordinates up to 10m from gate. A small autonomous search pattern may be required to locate the gate, if gate not initially detected by autonomous vision recognition., · Leg 6: GPS coordinates between posts provided. One or more obstacles will likely prevent a bee-line from the previous gate. Autonomous obstacle avoidance will be required to reach the gate., · Leg 7: GPS coordinates up to 10m from gate. Obstacles will complicate the search for the gate, requiring obstacle avoidance and/or autonomous route finding.	
46	32 Operations	Teams will operate their rovers in real-time from designated command and control stations. These stations will be metal trailer units (such as the back of a small moving truck provided by URC) or structures at the Mars Desert Research Station. Visibility of the course to the operators in the control station will be blocked. Basic power (120V, 60Hz), tables, and chairs will be provided. All of the competition events will be held in full daylight. The GPS standard shall be the WGS 84 datum. Coordinates will be provided in latitude/longitude format (e.g. decimal degrees; degrees decimal minutes; degrees minutes seconds).	
47	32.1 The GPS standard shall be the WGS 84 datum.		GPS
48	32.2 Coordinates will be provided in latitude/longitude format		+latitude : Latitude +longitude : Longitude
49	32.3 Visibility of the course to the operators in the control station will be blocked.		Operations.req CommandStation OperatorArea
50	36 Remote / wireless operation	The rover shall be operated remotely using wireless communications with no time delay. The operators will not be able to directly view the rover or the site, and line-of-sight communications are not guaranteed for all of the missions. Internet is not available in the field or at MDRS. Teams are required to power down communications equipment at the event sites while not competing, so as not to interfere with other teams. Aerial devices are not allowed for communications at URC 2020.	
51	36.1 The rover shall be operated remotely using wireless communications with no time delay.		*MarsRoverSystem* *MarsRoverContext*
52	36.2 The operators will not be able to directly view the rover or the site		*Field* CommandStation
53	36.3 Line-of-sight communications are not guaranteed for all of the missions.		AutonomousNavigationMission RetrievalMission
54	36.4 Internet is not available in the field or at MDRS.		MarsDesertResearchStation *Field*
55	36.5 Teams are required to power down communications equipment at the event sites while not competing, so as not to interfere with other teams.		
56	36.6 Aerial devices are not allowed for communications at URC 2020.		

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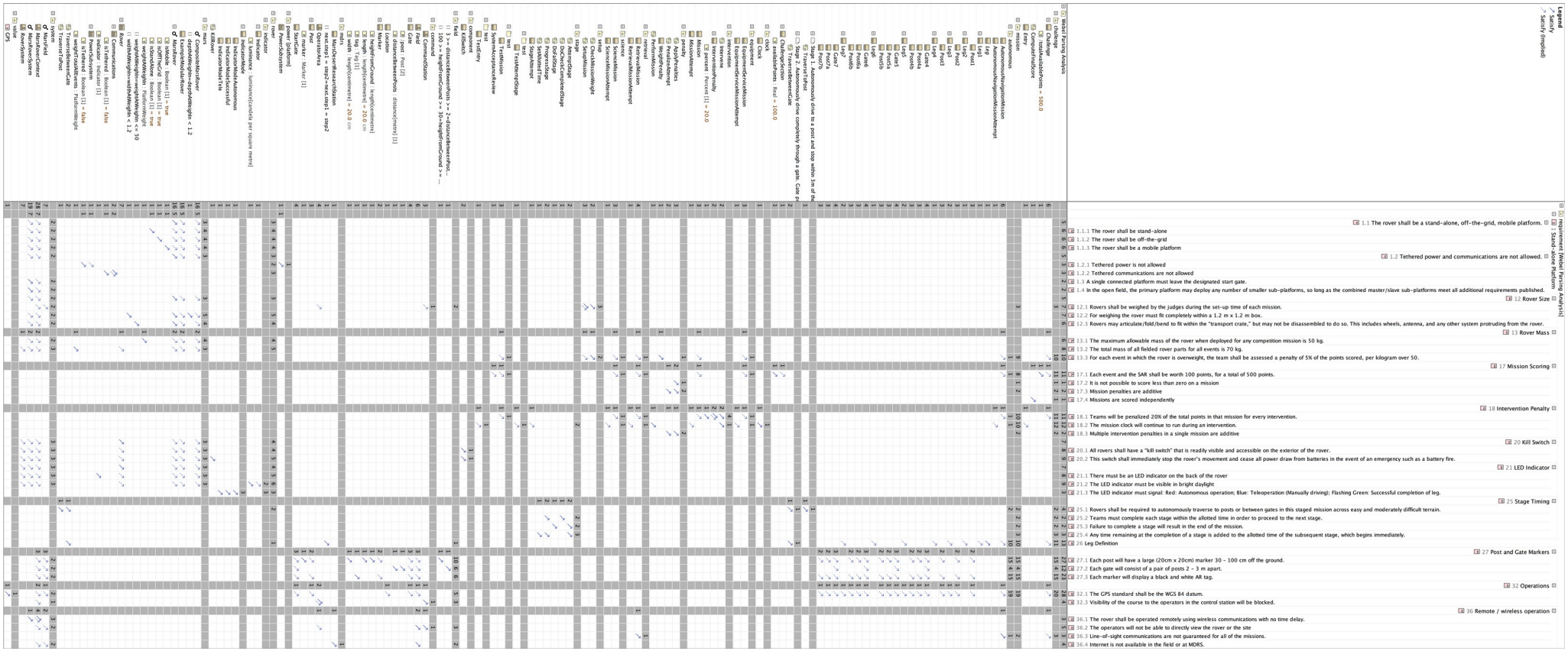
Satisfy matrix

(only satisfied Requirements displayed)



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Appendix

Parsing Analysis diagrams

These are NOT presentation diagrams!

They are used once to elicit model elements
and then they have served their purpose.

The order in which they are presented here is not the same as the order of processing/analysis. See also the creation timestamps in the diagrams.

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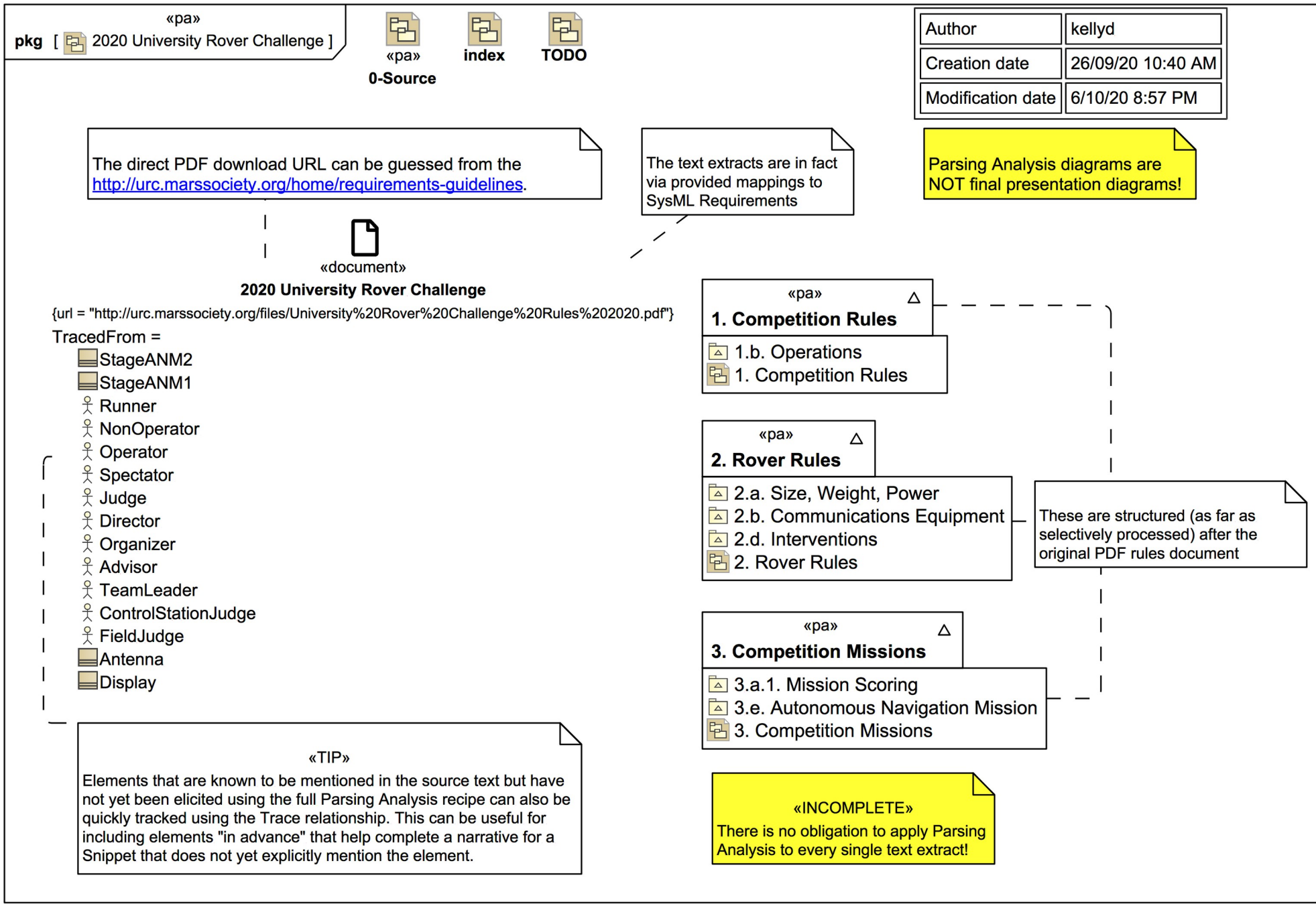

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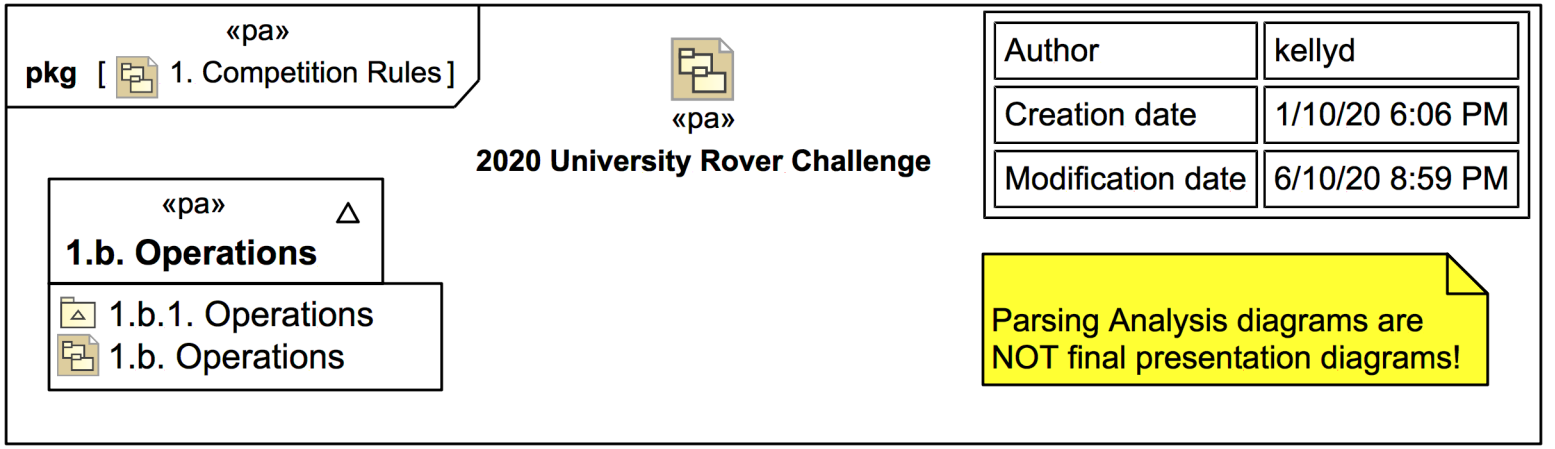

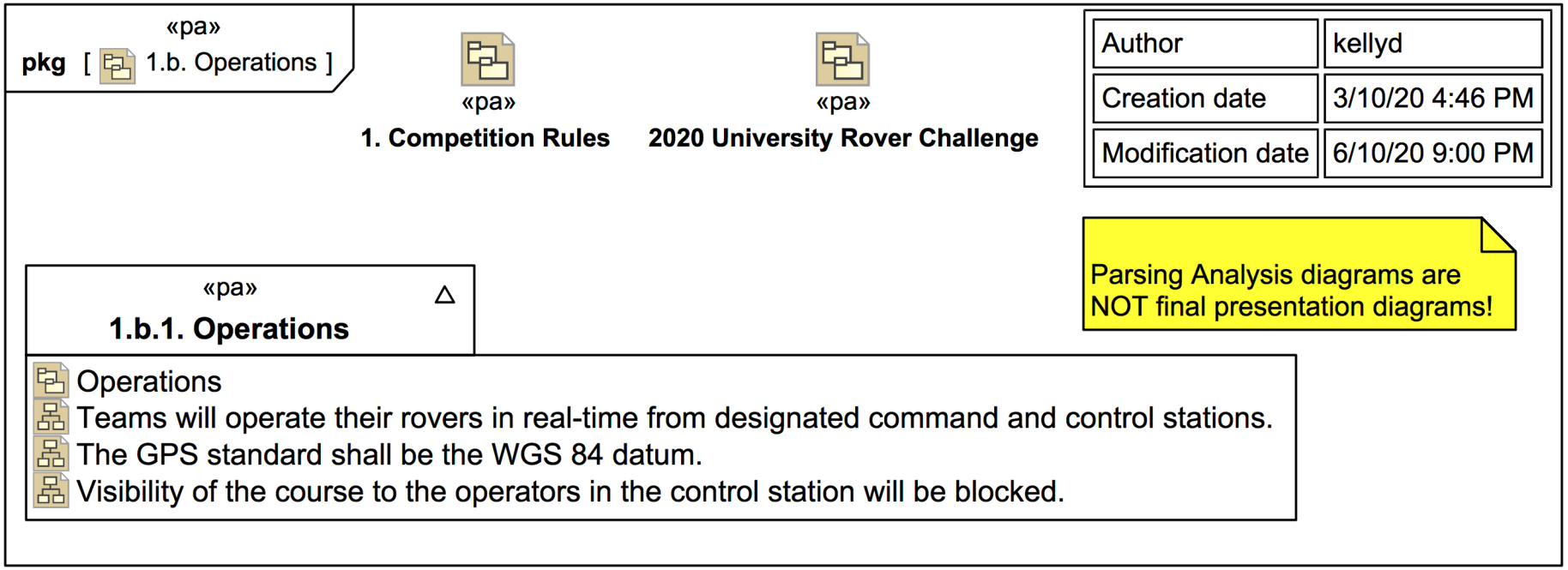

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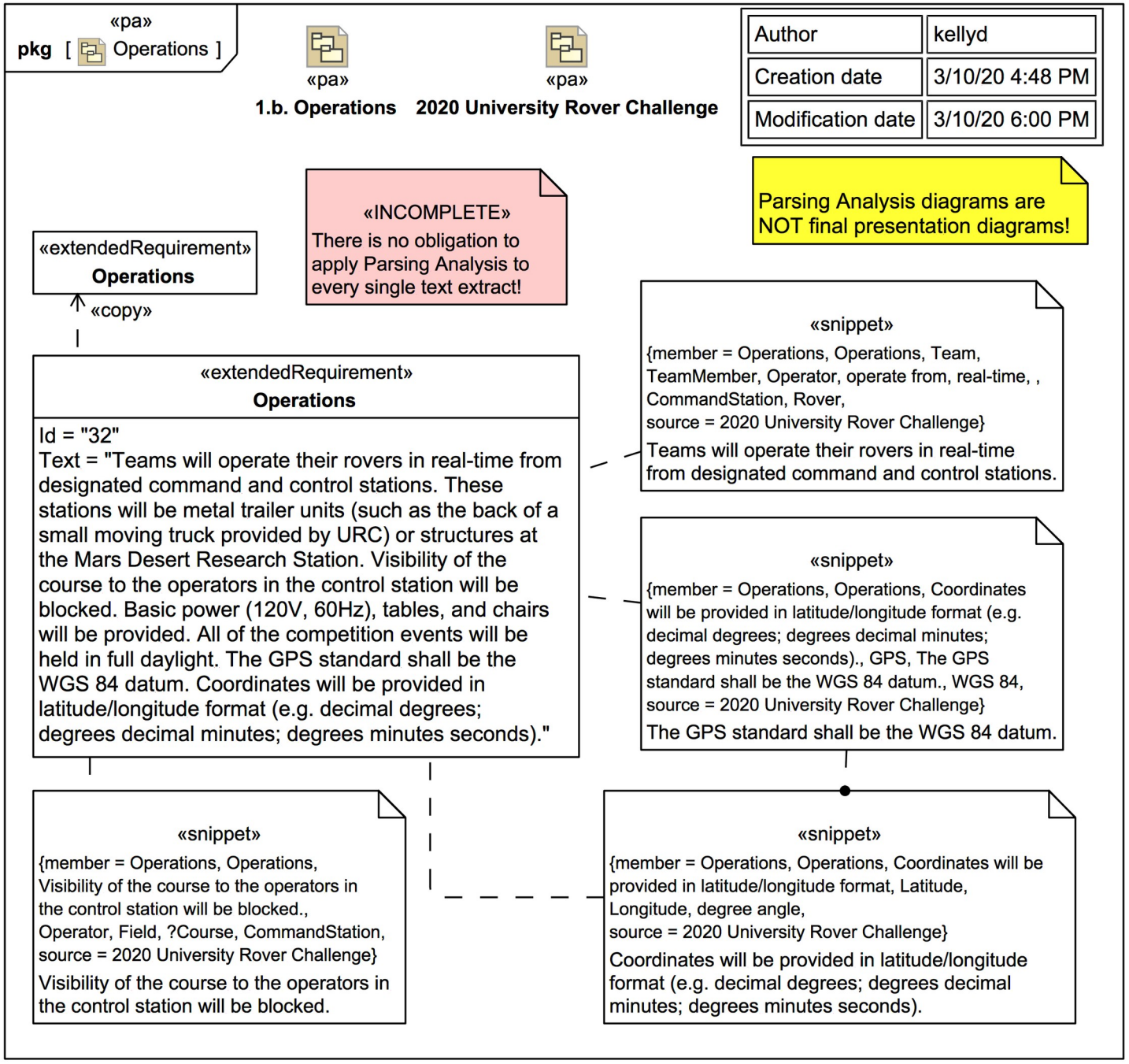

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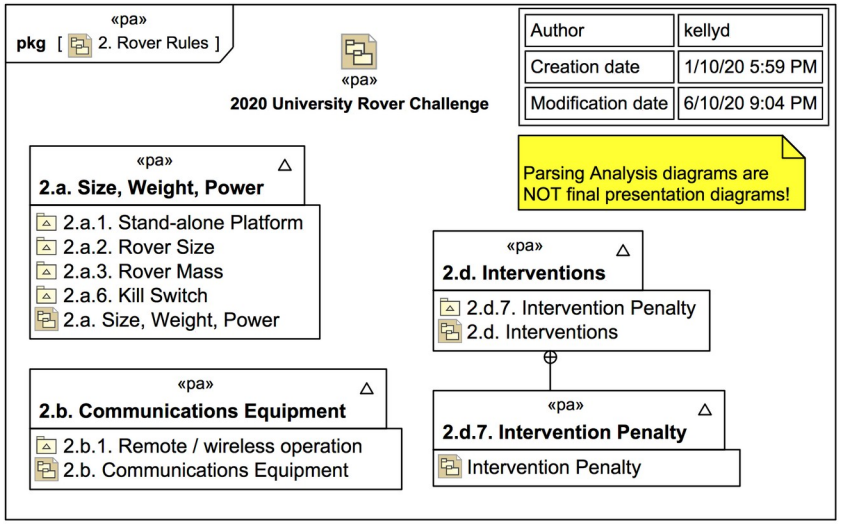

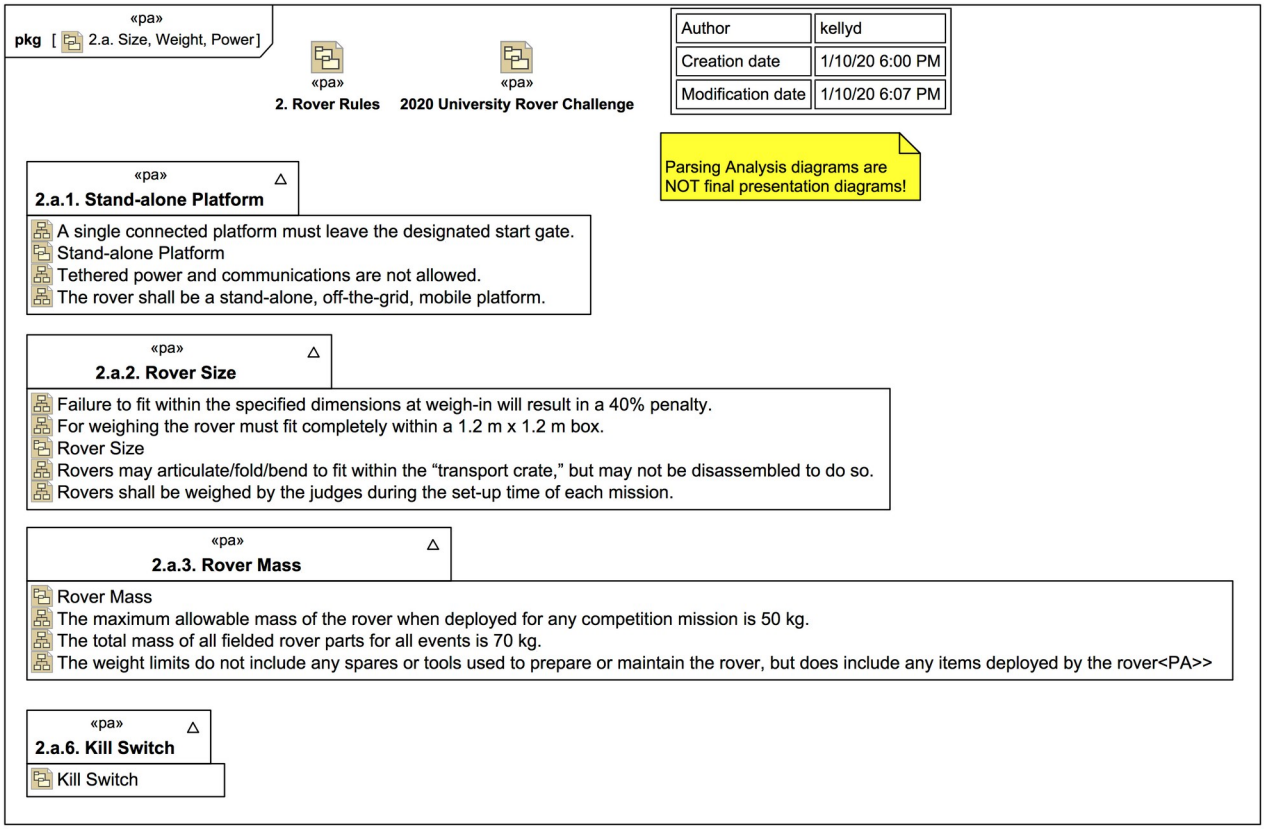

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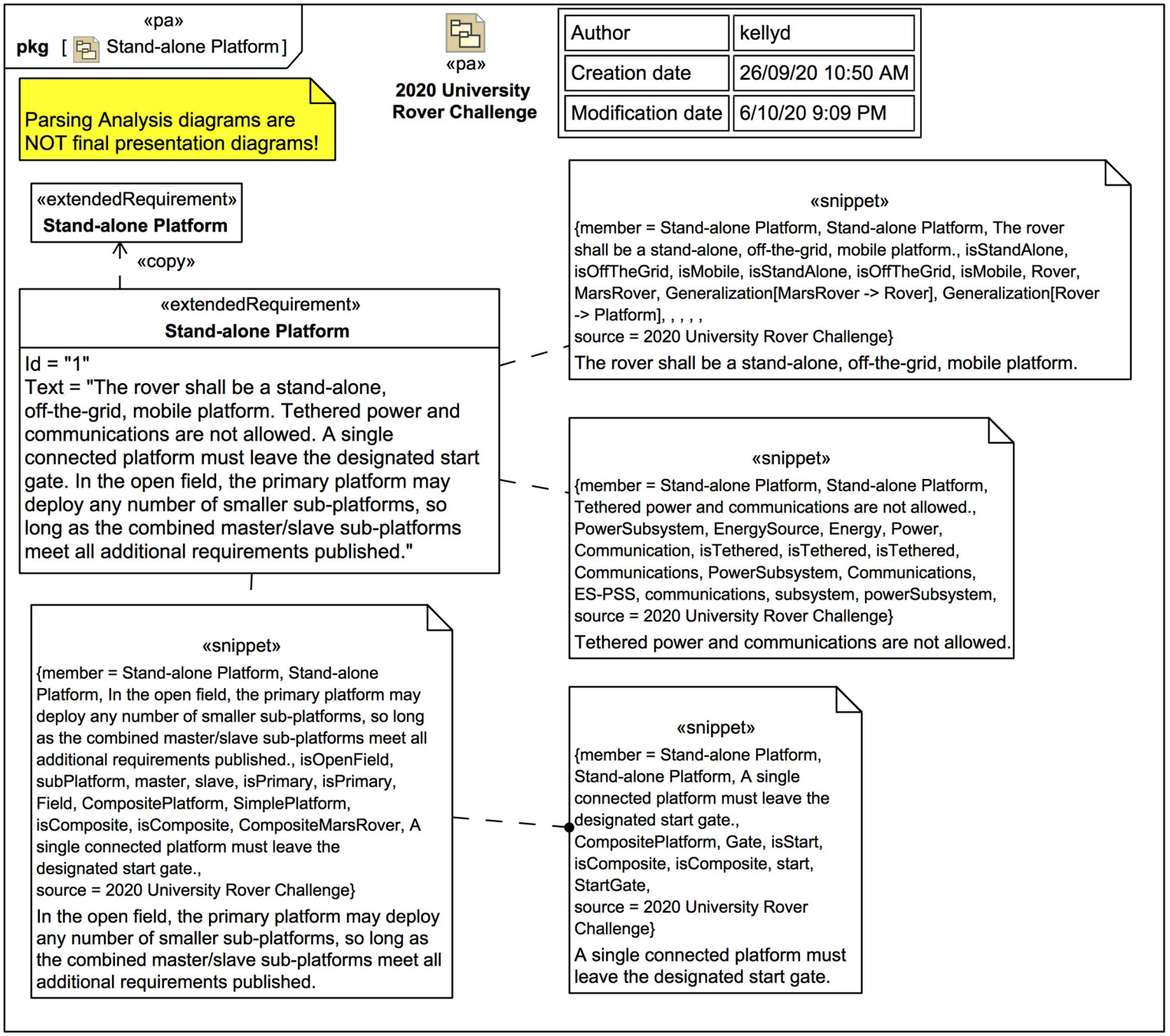

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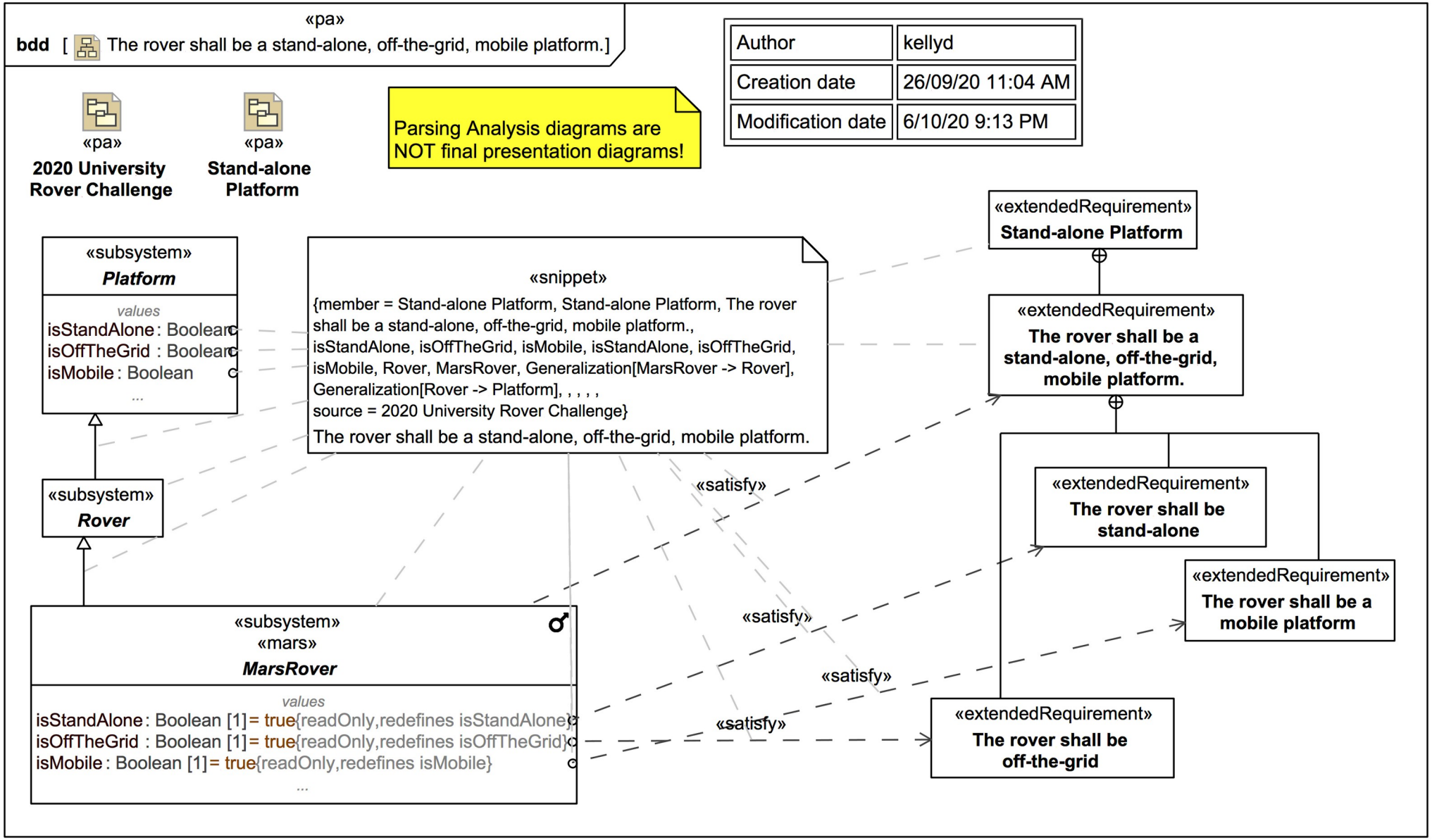

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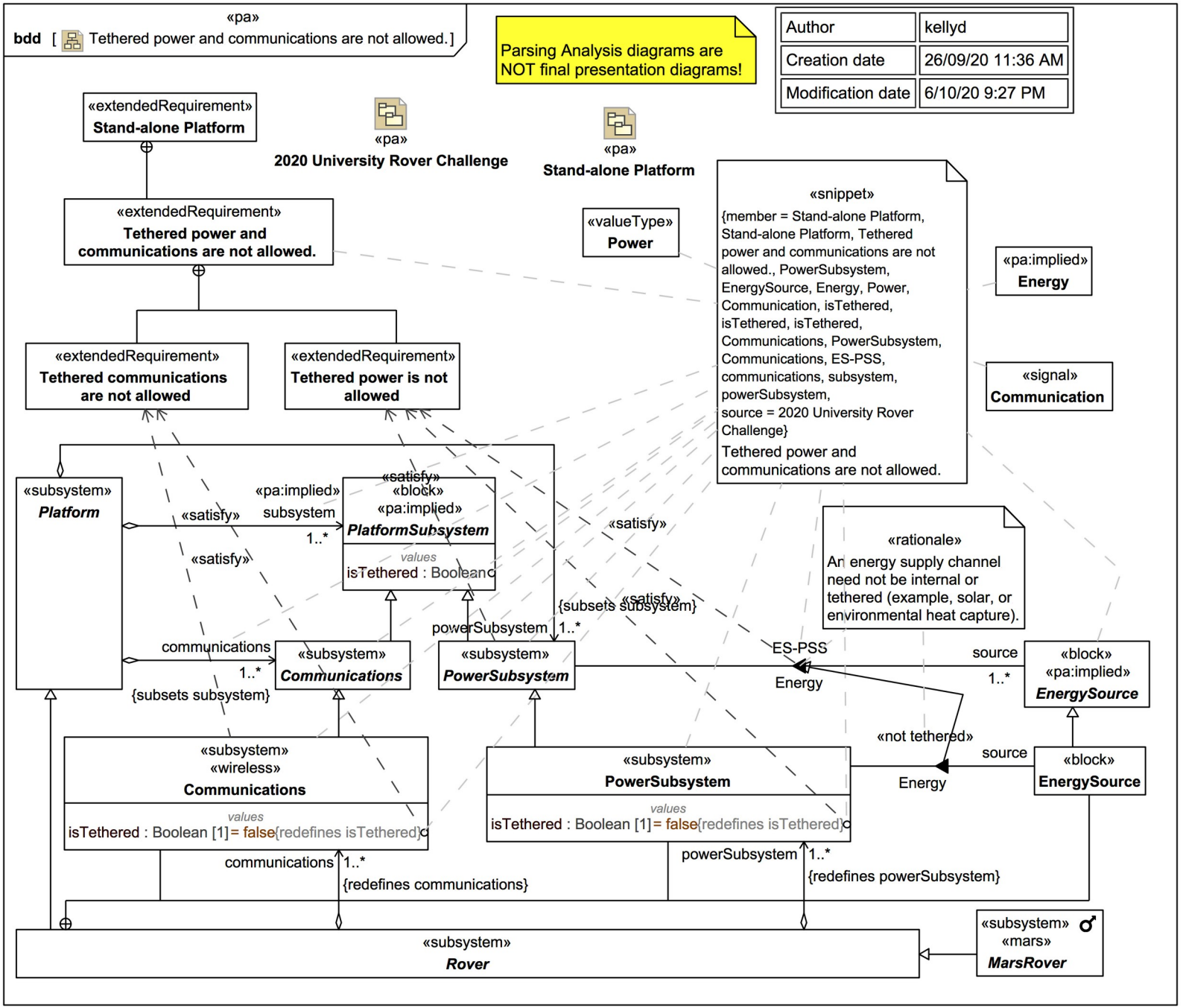

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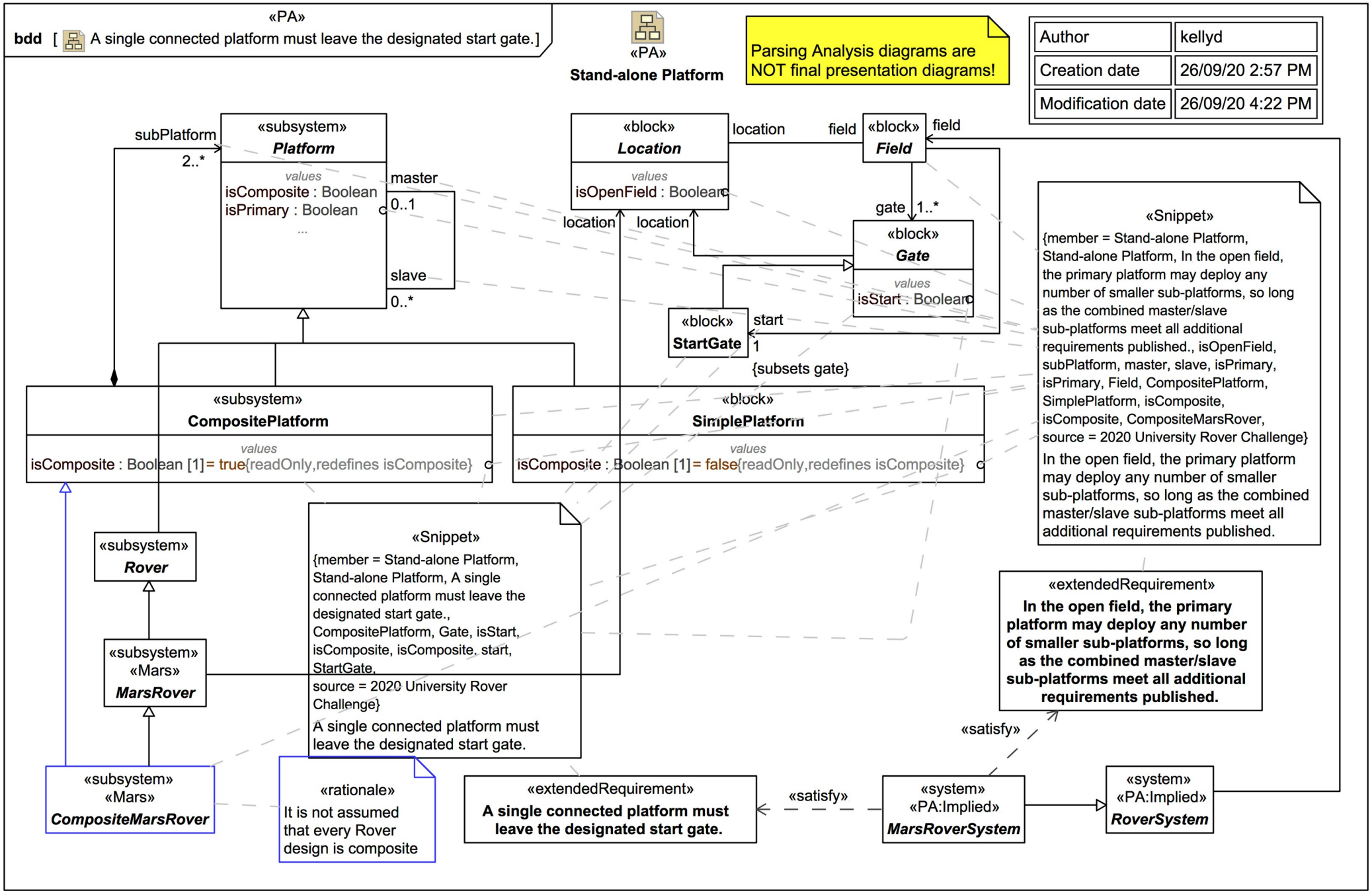

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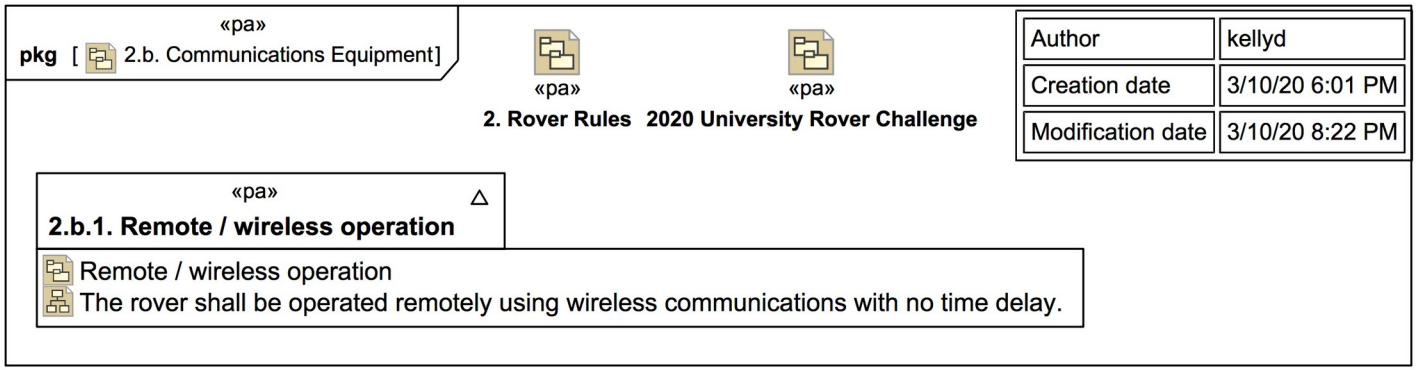

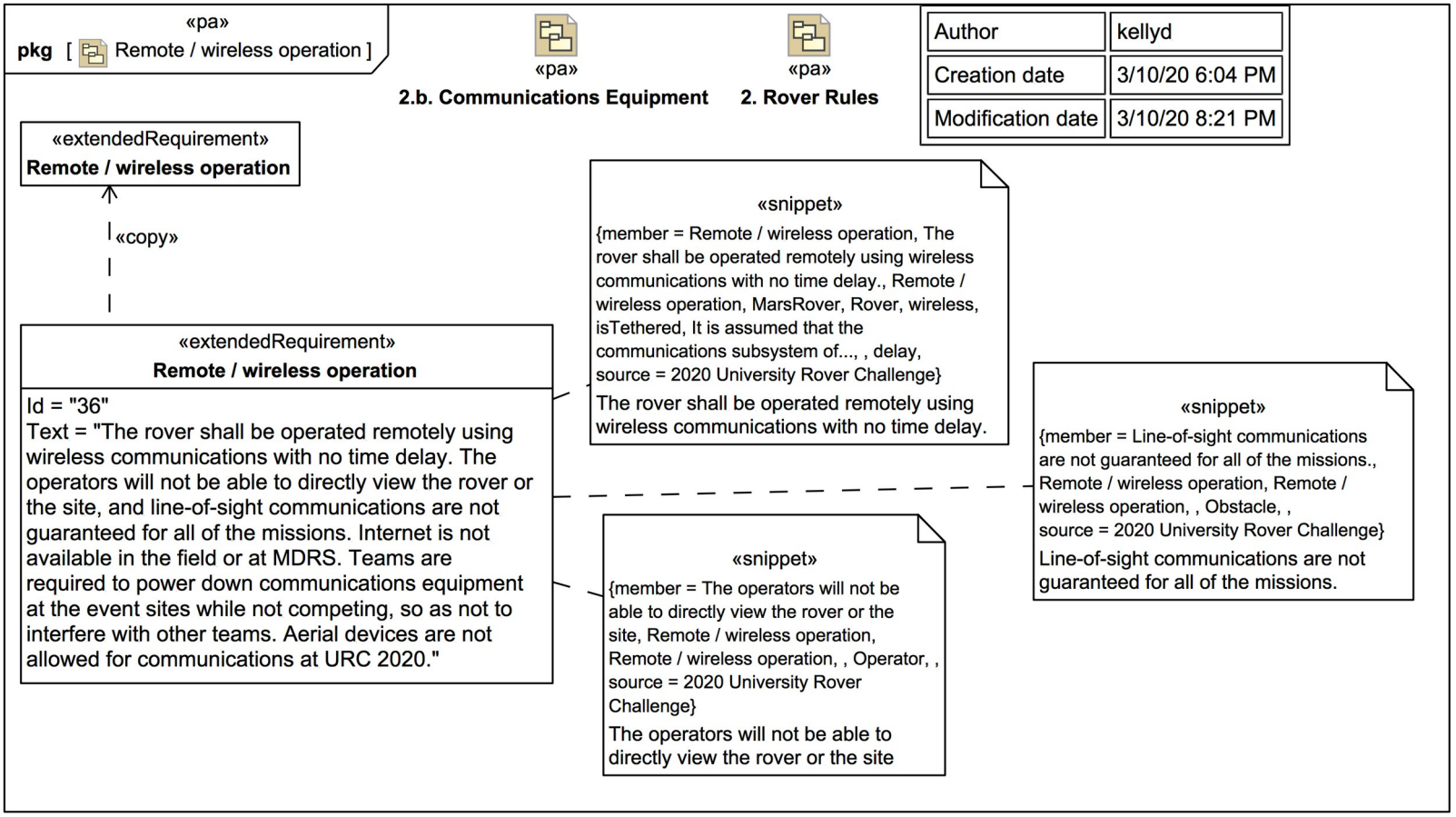

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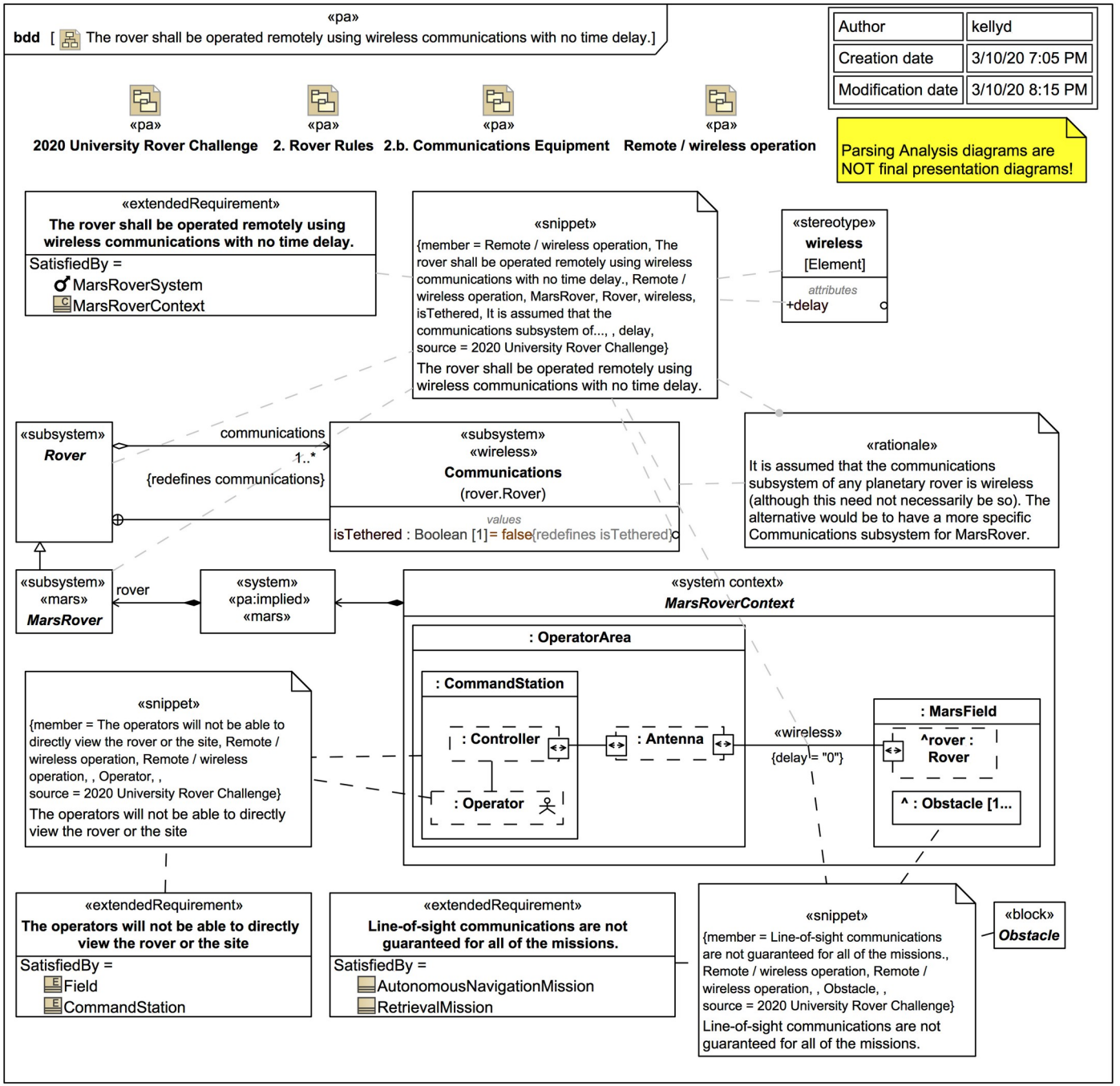

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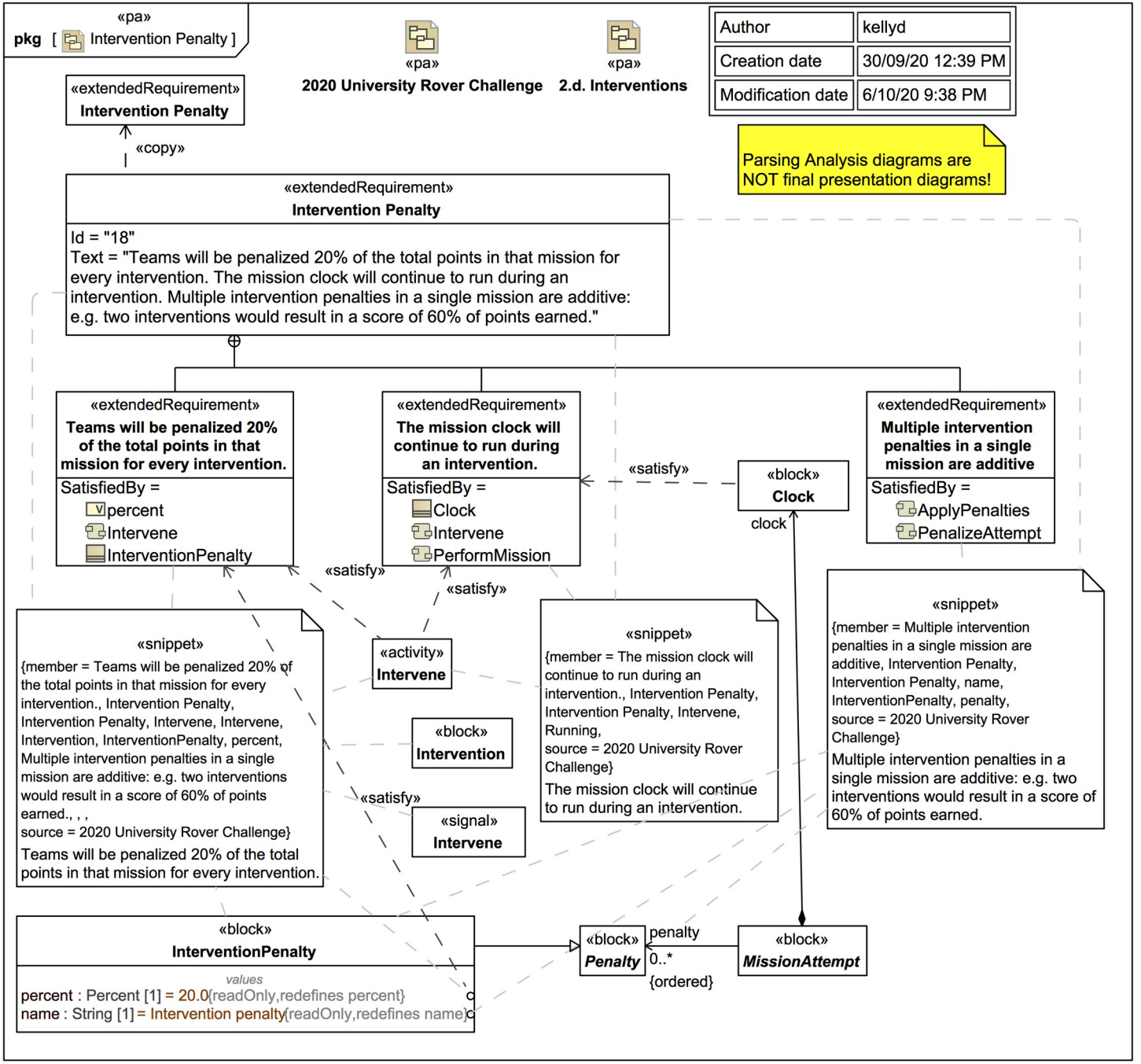

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