Mars Society University Rover Challenge 2020 rules

Webel Parsing Analysis SysML demo model (partial)



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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.



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



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 timestamped).
- 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).



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.



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



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.



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 sincle connected platform must leave the designated start gate. |
| 6 | 2020 University Rover Challenge | 2.a.1. Stand-alone Platform | is the one 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 nower 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-orid mobile platform |
| 9 | 2020 University Rover Challenge | 2 a 2 Rover Size | The rover shall be a same divide, of the grid, modile pladorm. |
| 10 | 2020 University Rover Challenge | 2 a 2. Rover Size | Tailude of it mutual the specified dimensions at weight in which such a two penalty. |
| 11 | 2020 University Rover Challenge | 2 a 2 Rover Size | The metging die totel mast in completely main a 1.2 m 5 1.2 m box. |
| 12 | 2020 University Rover Challenge | 2 a 2 Rover Size | Rovers may ancounter/four-bend to intervent when the transport clack, but may not be disassembled to do so. |
| 13 | 2020 University Rover Challenge | 2 2 2 Rover Size | Notes a share be weighed by use judges during the sect-up mile or each mission. |
| 14 | 2020 University Rover Challenge | 2 2 2 2 Pover Size | There is no venue a negrit mint of 2020, and the lover may be placed in any orientation. |
| 15 | 2020 University Rover Challenge | | This includes wheels, anemala, and any other system producing non-the rover. |
| 16 | 2020 University Rover Challenge | | the total rover plus arm plus sensor must be less than 70 kg. |
| 10 | 2020 University Rover Challenge | | 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. |
| 10 | 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. |
| 10 | 2020 University Rover Challenge | | 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 | | 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 | |



SECTION

Webel Parsing Analysis profile (simplified)



A SysML model of the Mars Society University Rover Challenge 2020 rules Webel IT Australia, SysML Parsing Analysis demo model (partial) as of 2020-10-06 © Copyright 2020 Webel IT Australia. All rights reserved. (Excludes text from the Mars Society.)













SECTION

Index, RoverSystem, and context



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Table of Blocks, Behaviors, attributes

| | Name | Classifier Behavior | Owned Behavior | Owned Attribute | | | operationMode : IndicatorOperationModeKind [1] | 72 | Penalty | | | L3 failMessage : string |
|----------------|-----------------------------------|-------------------------------------|---|--|----------------------|---|---|---------------------------------|--|--------------------------------|--------------------------------------|---|
| 1 | 2 ?Course | | | | 41 | IndicatorMode | signalColor : IndicatorSignalColorKind [1] | | | | | Descent Recent (0, 1) |
| 2 | Antenna | | | | | | Is is Plashing : Boolean [1] | 73 | Planet | | | En percent / Percent (01) |
| 3 | Antenna | | | Im station : ~F_Communication | 42 | Indicator/Mode Autonomous | signalColor : IndicatorSignalColorKind [1] = red | | | | | SisStandAlone : Boolean |
| | | | | Drover : F_Communication | | | 3 isFlashing : Boolean [1] = false | | | | | 🖼 isOffTheGrid : Boolean |
| 4 | Assembly | | | Wisteaf : Roolean [1] = faise | | | operationMode : IndicatorOperationModeKind [1] = successful | | | | | 🚯 isMobile : Boolean |
| | | | | E stage1 : StageANM1 [1] | 43 | IndicatorModeSuccessful | signalColor : IndicatorSignalColorKind [1] = green | | | | | Subsystem : PlatformSubsystem [1*] Communications [1*] |
| | | | | E stage2 : StageANM2 [1] | | | Lis isPlashing : Boolean [1] = true | | | | | powerSubsystem : PowerSubsystem [1*] |
| | | | | 🖼 isStaged : Boolean = true | 44 | IndicatorModeTele | (3) operationMode : IndicatorOperationModeKind [1] = tele (3) signalColor : IndicatorSignalColorKind [1] = blue (3) isFlashing : Boolean [1] = false | | | | | 3 isComposite : Boolean |
| 5 | | | | Beg1:Leg1 [1] | | | | | | | | 🔝 isPrimary : Boolean |
| | | | | E leg2 : Leg2 (1) | | Intervention | | | | | | master : Platform [01] |
| | Autonomousivavigationivission | | | E leg4 : Leg4 [1] | 46 | haten metion@an.bu | percent : Percent [1] = 20.0 | | | | | I slave : Platform [0*] |
| | | | | E leg5 : Leg5 [1] | 40 | Intervention Penalty | Image: String [1] = Intervention penalty | 74 | Platform | | | /sizeAtWeightn : RoxedSize |
| | | | | E leg6 : Leg6 [1] | | | isVisible : Boolean [1] = true | | | | | widthAtWeighin : length[metre] |
| | | | | 🖪 leg7 : Leg7 [1] | 47 | kilSwitch | S isAccessible : Boolean [1] = true | | | | | 🖾 isFoldable : Boolean |
| | | | | E /leg : Leg [7] | 40 | - Ind | Sisterior: Boolean [1] = true | - | | | | depthAtWeighin : length[metre] |
| 6 | AutonomousNavigationMissionAttern | N | | mission : AutonomousNavigationMission [1] | 40 | Lear | (3) ISLEAT : BOOREAN [1] = true | | | | | 🔄 isBendable : Boolean |
| 1 | Award | | | in name : string | 45 | | TR finish - Stan [1] | | | | | is is Articulated : Boolean |
| 0 | Battery | | | Destant . College | | | Start : Step [1] | | | | | B wheel : Wheel [0, *] |
| , | iiii satteryrite | | | Sourcey - battery | 50 | iiii Leg | 🗷 next : Leg [1] | | | | | E antenna : Antenna (0*) |
| 10 | Box Box | | | beight : length[metre] [1] | | | I difficulty : LegDifficulty | | | | | 3 orientation : Orientation |
| | | | | G depth : length(metre) [1] | | | I start : StartGate [1] | | _ | | | 3 weight : PlatformWeight |
| 11 | 🔛 Camera | | | | 51 | 🖬 Leg1 | If finish : Post1 [1] | 75 | PlatformSubsystem | | | isTethered : Boolean |
| | | | | ItotalAvailablePoints = \$00.0 | | | B next : Leg2 [1] | | | | | I location : Location [1] |
| | | | | entry: Entry [1*] | 52 | ang lang | start : Post2 [1] | 76 | i Post | | | 3 gps : GPS [01] |
| | | | | E penalty : Penalty [*] | | | I next : Leo3 [1] | 77 | Post1 | | | ES marker : marker (a) |
| | | | | E (saction : ChallanceSection [0, *] | | | 3 aps : GPS [1] | 78 | Post2 | | | El gos : GPS [1] |
| 12 | Challenge | | | equipmentServiceMission : EquipmentServiceMission [1] | 6.2 | 1.00 | I start : Post2 [1] | 79 | Post3 | | | CD 300 1010 (1) |
| | | | | E scienceMission : ScienceMission [1] | | | I finish : Post3 [1] | 80 | Post4a | | | |
| | | | | StageTimingMission : AutonomousNavigationMission [1] | | | [3] next : Leg4 [1] | 81 | Post4b | | | |
| | | | | E retrievalMission : RetrievalMission [1] | 5.4 | E land | Les start : Post3 [1] | 82 | 🔛 Post5a | | | |
| | | | | mission : Mission [4] SustemácrentanceReview [1] | | Legy | In most : LeoS [1] | 83 | Post5b | | | |
| 13 | ChallengeSection | | | Ty availablePoints : Real = 100.0 | | | 3 aps : GPS [1] | 84 | Post6a | | | |
| | changescelli | | Clock(classifier behavior) | Ty time : time[second] | | | I finish : Gate5 [1] | 85 | Postbb | | | |
| 14 | E Clock | 양 Clock(classifier behavior) | () printTime | | 22 | uu tego | 🖼 start : Gate4 [1] | 87 | Post/a | | | |
| | | | | ⊘ : Operator | | | Image: next : Leg6 [1] | 88 | PowerSubsystem | | | Source : EnergySource [1, *] |
| 15 | CommandStation | | | I : Controller | | | If finish : Gate6 [1] | 00 | - Fowersabstytem | | | IN isTatharad : Boolean [1] = false |
| | | | | O : ControlStationJudge | 56 | Eq6 | start : Gate5 [1] | 89 | PowerSubsystem | | | Ill source : EnergySource |
| 16 | CommunicationRelay | | | | | | Es next : Leg7 [1] | 90 | RetrievalMission | | | |
| 17 | Communications | | | S isTethered : Boolean [1] = false | | | En obsade : Costade [1] | 91 | RetrievalMissionAttempt | | | mission : RetrievalMission [1] |
| 18 | M Communications | | | | | | B obstacle : Obstacle [1*] | 92 | RoboticArm | | | |
| 19 | 6 CompositeMarskover | | | The formation and the state of the state | 57 | Eg7 | I finish : Gate7 [1] | | | | PROVERSTM(classifier behavior | communications : Communications [1*] |
| 20 | CompositePlatform | | | E subPlatform : Platform [2, *] | | | 📧 start : Gate6 [1] | | | | 3 Operate | powerSubsystem : PowerSubsystem [1*] |
| | | | | antenna : E Communication | | | Image: | | | | | SisPrimary : Boolean [1] = true |
| 21 | Controller | | | O : Operator | | | 3 isOpenField : Boolean | | | | | weightTotal@lEvents : PlatformWeight |
| | | | | E : Display | 29 | Location | Le field : Held | 93 | iiii Rover | PRoverSTM(classifier behavior) | | E killSwitch : KillSwitch [1] |
| 22 | Display | | | | | | TE the i The [1] | | | | | indicator : Indicator [1] |
| 23 | DummyAward | | | S points : Real = 100.0 | | | width : length[centimetre] = 20.0 cm | | | | | 📀 team : Team [1] |
| | | | | Image: String [0*] = Dummy award (100 points) | 59 | Marker | Image: Second | | | | |) antenna : ~F_Communication |
| 24 | ð Earth | | | | | | heightFromGround : length(centimetre) | | | | | B field : Field [0*] |
| 25 | Energency | | | DownSubrurtem | 60 | d' Mars | | 94 | RoverSystem | | | B rower : Rower [1] |
| 20 | Energysource | | | PowerSubsystem PowerSubsystem | 61 | MarsDesertResearchStation | | | Koversystem | | | Controller : Controller [1] |
| | in chargeource | | | o team : Team [1] | 63 | and the second se | rover : MarsRover [0*] | | | | | I sar : SystemAcceptanceReview [1] |
| | Entry | | | El challenge : Challenge [1] El missionAttempt : MissionAttempt [0*] El rover : Rover [1] El challe : Rovel [1] El challe : Rovel [1] | | 0 Marsheld | Image: Source Image: S | 32 | Limi SarSubmission | | | entry : Entry [1] |
| | | | | | | | | 96 | ScienceMission | | | |
| | | | | | | | | 97 | ScienceMissionAttempt | | | mission : ScienceMission [1] |
| | | | | | 62 | of Manshama | | 98 | Sensor | | | |
| 20 | | | | //otalcamedipoints : Keal //otalcamedipoints : Keal //otalcamedipoints : SarSubmission (4) | 0.0 | | | 99 | Setup Time | | | |
| | | | | sourceMissionAttempt : ScienceMissionAttempt [4] geuipmentServiceMissionAttempt : EquipmentServiceMissionAttempt [4] | | | | 100 | SimplePlatform | | | V ISCOMPOSITE : Boolean [1] = Taise |
| | | | | | | | | 101 | SizePenalty | | | IN name : String [1] = Size penalty |
| | | | | retrievalMissionAttempt : RetrievalMissionAttempt [4] | | | invalue aystern invalue | 102 | Spare Spare | | | The second for the second for |
| 20 | Contract Contract Contract | | | B autonomousNavigationMissionAttempt : AutonomousNavigationMissionAttemp | | | E : MarsField | | | | | next : StageANM2 [1] |
| 29 | EquipmentServiceMission | | | Fill minutes - Ferriement for the Marian 191 | | | 🕼 : OperatorArea | | | | | allottedTimeBase : time[second] [1] |
| 31 | Event | | | Est mission : compretension(1) | | | Spectator | 103 | StageANM1 | | | 🗷 leg1 : Leg1 |
| | | | | F arm : RoboticArm [1] | | | C : NerOperator | | | | | III leg2 : Leg2 |
| 32 | ExampleModularRover | | | B sensor : Sensor [1] | 64 | MarsRoverContext | O : Director | | | | | 🗷 leq4 : Leq4 |
| | | | | Incation : Location | | | I : SarSubmission | \square | | | | next : MissionStage [1] = null |
| | | | | 🖼 gate : Gate [1*] | | | E : WeighingBox | | | | | 3 allottedTimeBase : time[second] [1] |
| | | | | LB start : StartGate [1] | | | III : Mission [4] | 104 | StageANM2 | | | I leg5 : Leg5 |
| 33 | Field | | | Post: Post [0, *] | | | Croanizer | | | | | Las lego : Lego |
| | | | | I terrainDifficulty : TerrainDifficultyKind | | | ⊘ : TeamLeader | \vdash | | | | E derk - Clerk [1] |
| | | | | rover : Rover | | | Image: MissionAttempt | | | | | ImissionAttempt : MissionAttempt [1] |
| | | | | : Obstacle [1*] | 65 | of MarsRoverSystem | 📧 rover : MarsRover [1] | | | | | timeAllotted : time[second] [1] = 0.0 s |
| 34 | Fire Fire | | | | | | Istage : MissionStage [0*] | | - | | | S isCompleted : Boolean [01] |
| | | | | isstart : Boolean | | | setupTime : SetupTime [1] | 105 | StageAttempt | | | TimeUsed : time[second] [01] |
| | | | | ER (nest : Post [2] | 66 | Mirrian | Expendity : Pendity [1] | | | | | I stage : Missionstage [1] |
| 35 | Gate Gate | | | B post1 : Post [1] | | | E sizePenalty : SizePenalty [1] | | | | | mext : StageAttempt [01] |
| | | | | I post2 : Post [1] | | | B weightPenalty : WeightPenalty [1] | | | | | 🖼 isPassed : Boolean (01) |
| | | | | S distanceBetweenPosts : distance[metre] [1] | | | interventionPenalty : InterventionPenalty [1] | 106 | StartfGate | | | SisStart : Boolean = true |
| | | | | gps:GPS[0.1] distanceRetweenPosts:distanceImpton1[1] = 2.0 m | 1 | | I mission : Mission [1] | | and the second s | | | distanceBetweenPosts : distance[metre] [1] = 2.5 m |
| | _ | | | ConstancesetweenPosts : distance[metre] [1] = 3.0 m | 67 | | List entry : Entry [1] | 107 | Step | | | |
| 36 | Gate4 | | | E post2 : Post4b [1] | | | R /rover : Rover | 108 | Subkover | | - | Restantation - Carlob mission (0, 1) |
| | | | | [] gos: (FS(1) [] post2 : Post5a [1] [] post2 : Post5b [1] | | | S penaltyPercentTotal : Percent = 0.0 | 1109 | JystemAcceptancekeview | | - | La submission . safsubmission (0*) |
| | | | | | | MissionAttempt | IsPenaltiesApplied : Boolean = false | 110 | | | | isFlat : Boolean |
| 37 | Gate5 | | | | | | Impenalty : Penalty [0*] | 111 | - Terrain | | | G difficulty : TerrainDifficultyKind |
| | | | | S distanceBetweenPosts : distance[metre] [1] = 2.0 m | | | award : Award [0*] | 112 | TestAttemptStage | 1 TestAttemptStage | 1 TestAttemptStage | E stageAttempt : StageAttempt [1] |
| | | | | S gps : GPS [1] | | | Ef clock : Clock | 113 | TestEntry | 1 TestEntry | 1 TestEntry | B entry : Entry [1] |
| | | | | En posta : Postoa [1] En posta : Postob [1] | | | TimeAllottedBase : time[second] | 114 | TestMission | | | |
| 38 | Gate6 | | | | | | La ante note a sub- | 115 | TestMissionAttempt | TestMissionAttempt | All Manual Production and the second | |
| 38 | 📟 Gate6 | | | G distanceBetweenPosts : distance[metrel [1] = 2.0 m | 68 | MissionStage | next: MissionStage [01] | | in reambaicheachipt | | 10 TestMissionAttempt | ImissionAttempt : MissionAttempt [1] |
| 38 | 📟 Gate6 | | | distanceBetweenPosts : distance[metre] [1] = 2.0 m Dest1 : Post7a [1] | 68 | MissionStage | In next : MissionStage [01] Im mission : Mission [1] | 116 | Tool | | 10 TestMissionAttempt | CEI missionAttempt : MissionAttempt [1] |
| 38 39 | Gate6 | | | IstanceBetweenPosts : distance[metre] [1] = 2.0 m post1 : Post7a [1] Impost2 : Post7b [1] | 68 69 | MissionStage Obstacle | [#] next : MissionStage [01] [#] mission : Mission [1] | 116 | | | 1 estmissionattempt | (II missionAttempt : MissionAttempt [1] (II = Total weight disqualification penalty |
| 38 39 | Gate6 | | | Ci distance@etweenPosts : distance[metre] [1] = 2.0 m Ci post1 : Post7a [1] Ci gost2 : Post7b [1] Ci distance@etweenPosts : distance[metre] [1] = 2.0 m | 68 69 70 | MissionStage Obstacle Opencification | next: MissionStage [01] mission: Mission [1] " CommandStation | 116 117 | Tool | | 10 TestmissionAttempt | ImissionAttempt : MissionAttempt [1] ImissionAttempt [1] ImissionAttempt : MissionAttempt [1] ImissionAttempt [1] ImissionAttempt : String = Total weight disqualification penalty ImissionAttempt : String = Total weight over all events exceeds 70kg |
| 38 39 | Gate6 | | P IndicatorSTM(classifier behav | SistanceleneenPosts: sistance(metre) 11) = 2.0 m Epost1: Post7a 11) Epost2: Post7a 11) SistanceleneenPosts: sistance(metre) 11) = 2.0 m El eol: El eol: 11.0 m | 68 69 70 | MissionStage Obstacle GoperatorArea | Bin next: MssionStage [0.1] Bin ission : Mission [1] Bin ission : Mission [1] Bin : CommandStation Bin : CommandStation Gin : Antenna | 116 117 | Tool | | 10 LessmissionAttempt | (II missionAttempt: MissionAttempt[1] (In anne: String [1] = Total weight disqualification penalty () () faithessage: String = Total weight over all events exceeds 70kg (II) pastMessage: String = Total weight over all events does not exceed 70kg (III) and the faithermann (III) = 1.2 *********************************** |
| 38 39 40 | Cate6 | IndicatorSTM(classifier behavior) | P IndicatorSTM(classifier behav | Si distance@etweenPosts : distance[metre] [1] = 2.0 m (P post1 : Post7 i] (P post2 : Post7 bi] (S distance@etweenPosts : distance[metre] [1] = 2.0 m (P distance@etweenPosts : distance[metre] [1] = 2.0 m (P distance@etweenPosts : distance@metre] [1] = 2.0 m (P distance@etweenPosts : distance@metre] [1] = 2.0 m | 68 69 70 | Misiotitage Obsack Osack Osack | Cill next: MissionStage (0.1.) Cill mission: Usion (1) Cill : Antenna Cill sklaaf: Bookan | 116 117 118 | Tool TotalWeightPenalty WeightngBox | | 199 restmissionAttempt | The missionAttempt : MissionAttempt [1] TransionAttempt : MissionAttempt [1] anne : String [1] = Total weight disqualification penalty (3) faiMessage: String = Total weight over all events exceeds 70kg by assistersage : String = Total weight over all events does not exceed 70kg wdb : lengthinere(1) = 1.2 m |
| 38 39 40 | Eate6 | IndicatorSTM(classifier behavior) | ም IndicatorSTM(classifier behav 중 SetIndicatorMode | StatuscelenseePosts distance(metre] [1] = 2.0 m B post1 = Post7a [1] B post2 = Post7a [1] StatuscelenseerPosts : distance(metre] [1] = 2.0 m B det LSD [1-7] B det LSD [1-7] B mode : indicatoMode [1] B lummance: lummare(anreldu per square metre] | 68 69 70 71 | Missionage Ostade Ostade Ostade Ostade Ostade Ostade Ostade Ostade | [2] meter :: MissionStage [0,] [2] mission :: Mission [1] [2] : CommandStation [2] : CommandStation [2] : Autemat [3] State1 : Boolean [3] State1 : Boolean | 116 117 118 | Tool Tool Tool Weightpenalty WeightpBox | | 10 restmissionAttempt | Im missionAttempt : MissionAttempt [1] In anne : Skring [1] – Total weight disquification penalty Total weight over all events exceeds 70kg passMessage : Skring = Total weight over all events does not exceed 70kg width : kengthemeter[1] = 1_2 m To event for (1). Which is exceeding |
| 38 39 40 | Cate6 | 양 IndicatorSTM(classifier behavior) | 양 IndicatorSTM(classifier behav 중 SetindicatorMode | Gitacceleteneerboxs: distance(metre) [1] = 2.0 m Dipati: 70x17 [1] Dipati: 70x17 [1] Gitacceleteneerboxs: distance(metre) [1] = 2.0 m Red: UD [17] Tende: IndicatorMode [1] Dimmer: limitance(calcular par square metre) Giogratestholdes: IndicatorDetection([1]) | 68 69 70 71 | Misiotitage Obside Obside OperatorArea Part | [2] rest: MissionStape [0,-1] [2] restor: MissionStape [0,-1] [2] : CommandStation [2] : CommandStation [2] : Kettersa [3] Kettersa [3] Kettersa [3] Kettersa [3] Kettersa [3] Kettersa | 116 117 118 119 120 | TotalWeightPenalty WeightPenalty WeightPenalty WeightPenalty WeightPenalty WheightPenalty | | | missichMempt: MosioNetemp(1) man: Sing (1) = Total weight dispublication penalty faldbassage: Sing = Total weight over all events exceeds 70kg publications and a single over all events does not exceed 70kg width lengthemet [1] = 1.2 m man: Sing (1) = Weight penalty |























SECTION

AutonomousNavigationMission



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SECTION

Structural base



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SECTION

Rover and StateMachine and KillSwitch Indicator StateMachine



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SECTION

Challenge (competition) Team, Entry



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SECTION

Mission, MissionAttempt, Penalty and points system



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SECTION

MissionStage, StageAttempt, Clock



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SECTION

Mapped Requirements



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| req [🗟 Rover Mass.req] 🛛 🗗 requireme | ent requirement | «pa» | Author Creation date | kellyd 29/09/20 10:21 AM | |
|--|---|--|-------------------------------|---|---------------------------------------|
| | | NOVEL Mass | Modification date | 6/10/20 5:02 PM | |
| «ext | endedRequirement» Rover Mass | | | | |
| Id = "2020URC-2.a.iii." Text = "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." | | | | | |
| √«copy» I «extendedRequirement» Rover Mass | | | | | |
| <pre> «performanceRequirement» The maximum allowable mass of the rover when deployed for any competition mission is 50 kg. SatisfiedBy =</pre> | «performance The total mass o parts for all e SatisfiedBy = ♥w | eRequirement» of all fielded rover events is 70 kg. /eightTotalAllEvent | S SatisfiedBy = WeightP | extendedRequirement» t in which the rover is o I be assessed a penalt scored, per kilogram o enalty issionWeight | overweight, y of 5% of over 50. |



































| | ∆ Name | Text | Satisfied By |
|----------------|---|--|---|
| 1 | 🗆 🔝 1 Stand-alone Platform | not allowed. A single comme work form a given by place to a commerciant of the more place than one of the place the place of the place | |
| 3 | I.1. The rover shall be a stand-alone, off-the-grid, mobile platform. 1.1.1. The rover shall be stand-alone | | of MarsRover 🔝 IsStandAlone : Boolean [1] = true |
| 4 10 1 | 1.1.2 The rower shall be off-the-grid 1.1.3 The rower shall be a mobile platform | | № isOffTheGrid : Boolean [1] = true № isMobile : Boolean [1] = true |
| 2 | In the second power is not allowed In 2.1. Tethered power is not allowed | | Association:ES-PSS[source:EnergySource - PowerSubsystem] PowerSubsystem |
| ∞ | II 1.2.2 Tethered communications are not allowed | | ☑ isTethered : Boolean [1] = false ☑ isTethered : Boolean [1] = false I Communications |
| 9 10 | \blacksquare 1.3 A single connected platform must leave the designated start gate. \blacksquare 1.4 h the open field, the primary platform may deploy any number of smaller sub-platforms, so long | | of MarsRoverSystem of MarsRoverSystem |
| 1 | a sthe combined mater/stave sub-platforms meet all additional requirements published. I 12 Rover Size | Rovers shall be weighted by the judges during the set-up time of each mission. For weighting the rover must fit completely which a 1.2 m vt. 1.2 most. Rowers and rought followed to fit which the "transport crate," but may note be disastembed to do so. This includes wheele, antenne, and any other system protruiting from the rower. There is one ordination for 2.020, and the rower may be dired in any otherdison. | d MarsRover |
| 12 | 12.1 Rovers shall be weighed by the judges during the set-up time of each mission. | raule to it with the specified differious at weight in will feature a the periary. | 운 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. | | o ^d MarsRover) widthatWeighlin=widthatWeighlin < 1.2) depthatWeighlin=depthatWeighlin < 1.2 |
| 14 | $\blacksquare~12.3$ Rovers may articulate (fold/bend to fit within the "transport cate," but may not be cleasesembled 12.3 to do so. This includes wheek, antenna, and any other system prortuding from the rover. | | roverAtWeighln : MarsRover MarsRover weightatWeighln=weightatWeighln <= 50 |
| 15 | El 🔟 13 Rover Mass | The maximum allowable must of the over when deployed for an competition mission is 50 kg. The total must of all leided over prior to real reserve. For 50 kg, one emerge, a possibility over the postex and point a some must are here over 50 kg, but we teal now. The monitorino of more plaus are redorder and point a some must are over one 50 kg, but we teal now. The monitorino of the the hard 70 kg. The weight the dots of the postex are poster and the some more plans are also be the some of the some and the some more and the some | • • • |
| 16 17 18 | 13.1 The maximum allowable mass of the rover when deployed for any competition mission is 50 kg. 13.2 The total mass of all fielded rover parts for all events is 70 kg. 13.3 For each event in tho the rower is coenvegin, the team shall be assessed a penalty of 5% of the maximum event any relinear new 50. | | weightattweight: PlatformWeight weightTotalAllEvents : PlatformWeight weightTotalAllEvents : PlatformWeight Cheventheisenwöhehe |
| 19 | E 🖬 17 Mission Scoring | It such were need to be shared to point, or a stand of SOO points, Panalles for evenergier news, instances, and news peralities are additiver, as provinties of 10% and 20% would result in a score of 20% of the points carried. Missions are scored independently and it is not possible to score less than zero on a mission. | |
| 20 | In 1.2.1 Each event and the SAR shall be worth 100 points, for a total of 500 points. | | xvalablePoints : Real = 100.0 √totalAvailablePoints = 500.0 AvatabaseNee |
| 22 23 23 | La 1.4. As to the positive are added these and action a mission [1] 1.7. Mission prendities are added the [2] 1.4. Missions are obtained to the positive and action are added to [2] 1.4. Missions are added to the positive added to the positive added to the positive added to the positive added to the positive added to the posit | | ApplyFonduces |
| 24 | I8 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 intelligite intervention intelligible intervention. The mission are addine: e.g. two interventions would result in a zone of 60% of points earned. | 📓 Intervention Penalty.req |
| 25 | $\blacksquare 18.1$ Teams will be penalized 20% of the total points in that mission for every intervention. | | ☑ percent : Percent [1] = 20.0 ☑ Intervene InterventionPenalty |
| 26 | $\blacksquare 18.2$ 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 | E 🖬 20 Kill Switch | All rovers shall have a "till south" that is readily visible and accessible on the exterior of the rover. This south 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 foreers shall have a "kill switch" that is readily visible and accessible on the exterior of the reamont. This switch shall immediately stop the rover's movement and cease all power draw from | | KillSwitch |
| 31 | 20.4 batteries in the event of an emergency such as a battery fire. Ell 21.1 EED 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, | வ KillRover Marer |
| 32 | 21.1 There must be an LED indicator on the back of the rover 7 21.2 The LED indicator must be ostable in briefly classified. | Green: Successful completion of leg. | Indicator : Indicator [1] Immanane : Imminance/candela ner couste metre) |
| 34 | 21.3 The ELB values of values of values in value values. | | Intransace: - Intrinsace.concourse per aquate intervery Indicator/ModeAutonomous Indicator/ModeSuccessful |
| 35 | al as Stage Timing | Rovers shall be required to automonously traverse to posts or between parts in this staged, mission across sear and model and the required to automonously traverse to posts or between parts in the staged, mission across to store and to the next rates. Failure to complexe act has used to the mission, Any time no dor to the start of the mission. Any time to complexe act has used to the mission, Any time no dor to the start of the mission. Any time to complexe act has the start in the mission Any time no dor to the start of the mission. Any time to complexe act has the start in the mission. Any time no dor to the start of the mission. Any time to the start of the mission active to the mission. Any time to do the start of the mission active to the start of the mission. Any time to do the mission active to the start of the mission active to the start of the mission. Any time to do the mission active to the start of the mission. Any time to the start of the mission active to the mission active to the mission active to the start of the mission. Any time to do the mission active to the mission active to the mission active to the start of the mission active to the mission. Any time to do the mission active to the mi | 🚰 IndicatorSTM(classifier behavior) |
| | | remaining at the completion of a stage is added to the allotted time of the subsequent stage, which begins immediately. | |
| 36 | 35.1 Rovers shall be required to automonously streams to posts or between gates in this staged 35.1 Rovers stay and modentately offficult errain. 35.2 Teams must complete each stage within the allotted time in order to proceed to the next stage. | | 1 i averse rorost Traverse8etweenGate ProgressStage 50 Dricherc/Crmnibre/Stage |
| 38 | \blacksquare 25.3 Failure to complete a stage will result in the end of the mission. | | 🔁 DofailStage |
| 39 | $\blacksquare 25.4$ 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 | Is the perimeter of the second sec | A leg is defined as the rower autonomously navigating to the next post or passing completely through the next gate. | Leg () next.step1 = step2 = next.step1 = step2 Trawnseletweendate |
| 41 | E 🖪 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 At tag. | |
| 42 | 🔝 27.1 Each post will have a large (20cm x 20cm) marker 30 - 100 cm off the ground. | | The marker that Marker (1) (1) 100 >= heightfromfcound >= 30=heightfromGround >= Skenght rengationermister = 200 cm SkenghtfromGround : kenghtfreammerel = 200 cm |
| 43 | 27.2 Each gate will consist of a pair of posts 2 - 3 m apart. | | (B) (DOST: POST (2) (1) 3 >= distanceBetweenPosts >= 2=distanceBetweenPost (2) distanceBetweenPosts: distance[metre] [1] (2) distanceBetweenPosts: distance[metre] (2) |
| 45 45 | I Leg Requirements I Leg Requirements | Legs will increase in difficulty. Sage 1. Autonomously drive to a post and stop within 3 m of the post. Flat every errors, | 11 Det : : 600 A |
| 46 | E 🖬 32 Operations | Transversions: the manage of the form designated command and control stations. These stations Transversion and operate their covers in real-time from designated command and control stations. These stations Multis Benefit Research stations visibility of the course to the operations in the common will be belocked. Basis covers (1500: 601): Jubies and charst will be provided. Jul (161) control stations will be held in full dishtling. The comparison of control stations will be held in full dishtling. The CFS statiand shall be the WCS 84 datum. Coordinates will be norded in | |
| 47 | 32.1 The CPS standard shall be the WCS 84 datum. | lattude/longtude format (e.g. decimal degrees; degrees decimal minutes; degrees minutes seconds). | ☑ CPS ○ +latitude |
| 49 49 | III 32.2 Coordinates will be provided in lattude /fongitude format III 32.3 Visibility of the course to the operators in the control station will be blocked. | | ● +longtude : Longtude ■ Operations.req ■ CommandStation |
| 50 | 🗆 🗐 36 Remote / wireless operation | The roser shall be operated remotely using wireless communications with no time delay. The operators will not be able to directly view the rower or the ake, and line-od-sight communications are not guaranteed for all of the missions. The internet is not available in the field or AIMDST caracter are required lower down minications supported at the versi state, while not competing, so as not to interfere with other farms. | 🕰 OperatorArea |
| 51 | 36.1 The rower shall be operated remotely using wireless communications with no time delay. | Aerial devices are not allowed for communications at URC 2020. | of MarsRoverSystem |
| 52 | $\blacksquare 36.2$ The operators will not be able to directly view the rover or the site | | MarsRoverContext Field CommandStation |
| 53 | 36.3 Line-of-sight communications are not guaranteed for all of the missions. | | AutonomousNavigationMission RetrievalMission MarsDescritesearchStation |
| 55 | 36.4 Internet is not available in the field or at MUKS. 36.5 Transition required to power down communications equipment at the event sites while not an arrow or as run in interface who there teams. | | Efetd |
| 56 | 36.6 Aerial devices are not allowed for communications at URC 2020. | | |



87/100

Satisfy matrix (only satisfied Requirements displayed)

| Constant of the second se | Chromotoport (Carlos et al. (Ca | Bender Farvage Analysis Conversional and a second and a secon | > Sector > Sectory > Sectory (implied) |
|---|---|---|--|
| | | | The roor shall be stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be a stand-alone, off-the-grid, mobile platform, III The roor shall be along the stand state of the roor shall be along the state of the odd state state of the odd state. The induces wheel, antenna, and any other rytem protodeplatform be roor. IIII The roor III The roor state of the roor shall along the roor shall be along to roor along the roor shall be along to III Boyer Mas state of the roor shall be along to III Boyer Mas sto III The roor state of the shall be new tho roor state of the shall be along to III Boyer Mas state of the shall be new the roor shall allow the roor shall |
| | | | taken i a received independention a received in |



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.









| «pa» «pa» 1. Competition Rules 2020 University Rover Challenge (creation date 3/10/20 4:46 Modification date 6/10/20 9:00 (pa» Δ (pa» Δ | ation date 3/10/20 4:46 PM lification date 6/10/20 9:00 PM |
|---|---|
| 1. Competition Rules 2020 University Rover Challenge Modification date 6/10/20 9:00 «pa» △ 4 b 4 Operations △ | lification date 6/10/20 9:00 PM |
| «pa» △ Parsing Analysis diagrams are NOT final presentation diagrams! | |
| 1.b.1. Operations P Operations P Operations P Teams will operate their rovers in real-time from designated command and control stations. | |
| Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the WGS 84 datum. Image: The GPS standard shall be the GPS standard stan | |



















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97/100

| «pa» pkg [🛱 2.b. Communications Equipment] | EP. | P | Author | kellyd | | |
|---|----------------|---------------------------------|-------------------|-----------------|--|--|
| | «pa» | «pa» | Creation date | 3/10/20 6:01 PM | | |
| | 2. Rover Rules | 2020 University Rover Challenge | Modification date | 3/10/20 8:22 PM | | |
| «pa» 2.b.1. Remote / wireless operation | Δ | | | | | |
| Remote / wireless operation E The rover shall be operated remotely using wireless communications with no time delay. | | | | | | |











