ExoMars Rover Vehicle

3rd Exo Mars Industry Day-2018 Mission
Turin 9th October 2013

Van Odedra
Rover Vehicle Project Manager
Astrium
Rover Vehicle

- Introduction
- Key Requirements and Design overview
- Rover Vehicle Product Tree
- Current status of the Project
- Selected or Negotiated Subcontracts
- ITTs currently running
- Planned ITTs
A Tranational Company
No. 1 space company in Europe
Employees: 18,000
Turnover: €5.8 billion

World-class expertise and extensive prime contractorship experience across all sectors of the space business

Astrium UK is playing a major part in all sectors of Astrium Space business
Astrium-Earth Observation, Navigation & Science Division

- Planetary Science
- Solar Science
- Fundamental Physics
- Astronomy

3rd Exo Mars Industry Day
Astrium UK are leading the development of the Exo Mars Rover Vehicle

Key Requirements:
- Delivery of Flight Rover to meet 2018 Launch
- Compatibility with Descent Module and Proton launcher
- Accommodation of Drill and a suite of analytical instruments
- Autonomous surface mobility
- Lifetime of 218 Sols at Ls324
- Planetary protection and cleanliness
- Compatibility with harsh Martian environment

Budgets:
- Mobile Mass ~310Kg
- Power ~300 W

Models: LVM, STM, GTM and PFM

- A dedicated Bio Clean Facility In Stevenage for PFM integration
Key Features of Rover Vehicle

- PanCam
- Deployable Mast Assembly
- Fixed Solar panel
- Sun Sensor
- Deployable Solar panels
- Primary Structure (Bath Tub)
- Drill
- NavCam
- UHF Antennas
- LocCam
- Fixed Solar panel
- Primary Structure (Bath Tub)
Key Features of Rover Vehicle

- Drill
- Locomotion Bogies
- Bulkhead Connectors
- Actuator Drive Electronics
- Umbilicals
- WISDOM Antennas
Internal Accommodation
Electrical Architecture

Key
- Other
- Secondary Power
- SpaceWire
- Motor Control
- Power
- Discrete

- RS-422
- CAN Bus
- Cross / WG
- Power
- Data Handling
- ESA Payload
- Drill
- Communications
- Ancillary Items
- Actuators

Components:
- PanCAM
- NavCam
- ISEM
- Deployable Mast Assembly
- Mast
- LocCam
- CLUPI
- Drill
- ALD (Analytical Laboratory Drawer)
- DSEU
- PCDE (Power Conditioning & Distribution Electronics)
- OBC (Onboard Computer)
- BEMA (R/L)
- ADE (R/L)
- Solar Cells
- Solar Array Hinge Mech.
- Sun Sensor
- ADRON
- WISDOM Electronics
- MJU
- UHF Transceiver
- UHF Transceiver
- Battery
- ISEM EB
- Service Module
- Lander Platform
- Wheel HDRMs
- DM Umbilical
- HDRM Umbilical
- Lander Platform
Product Tree and items for ITT

FM Rover Vehicle

Structure
- Rover Vehicle Structure
  - Barhubs Structure
  - SVM Structure
  - Solar Array Panels
  - (Starkiteks)
  - Gas Gap Structure
- SVM Frames
- Body HEPA Filters
- Rover Body HDRMs

Mobility
- Navigation Cameras
- Localisation Cameras
- Sun Sensor
- Inertial Measurement Unit
  - Gyro + Redundant Accelerometers
- Localisation Algorithms
- Visual Local. Algorithms
- Navigation Algorithms
- Control Algorithms
- Regio Electro-Mechanical Assembly
  - Rolling Chassis
  - Wheel HDRM
  - Locomotion Manoeuvre Control Algorithm

Vehicle Models & Ground Support Equipment
- Mast Structure
- Pan Tilt Mechanism
- Deployment Mechanism
- HDRMs

Deployable Mast Ass'y

Thermal
- Loop Heat Pipes Ass'y
- TCS EEE Parts
  - Heaters
  - Thermistors
- Thermal Straps
- Insulation Materials
- Radio-Isotope Heater Unit [CFI]

Power
- Power Conditioning & Distribution Electronics
  - Battery
- Solar Array Assembly
  - Solar Cells
  - Hinge Mechanisms
  - Solar Array HDRMs
- Actuator Drive Electronics
  - ADE EGSE
  - BDC SCOE

Communication
- UHF Transceiver
- UHF Antenna Ass'y
  - UHF Antenna
  - UHF RF Dist. Network
  - UHF Test Cap

RV On-board Software
- RV Application Software
- Recovery Software Image

Data Handling
- Onboard Computer

Harness
- Rover Vehicle Harness
  - Umbilical Release Mechanism
    - Umbilical Connector
    - Bulkhead Connectors
Product Tree and items for ITT

Ground Support Equipment & Vehicle Models

MGSE
- Transport Containers
  - Rover Container (S/W)
  - Rover Container (Aseptic)
- Trolley MGSE
  - Turnover Trolley
  - Vertical Stand
- Handling MGSE
  - Lifting Frame
  - Handling Slings
  - SA Support Frames
  - Alignment Jigs
  - Rover Vib. Test Adaptor
  - SVM Vib. Test Adaptor
- Mass Thermal Dummies
  - Unit MTD's
  - RHU Simulators

EGSE
- Electrical Test Bench Structure & Harness
- Central Checkout System (S/W)
- Central Checkout System (H/W)
- TM/TC SCOE
- Power SCOE
- RF SCOE
- Electrical Test Aids

RV Models & Test Benches
- Electrical Test Model
- Avionics Test Bench
- Ground Test Model
- UHF RF Suitcase
- Locomotion Verification Model

FV-I Elements
- Real-Time Environment
  - OBC Simulator
  - Real-Time Simulator
  - Simulator Front End
- Functional Verification Bench
- Numerical Software Verification Facility
- Hardware Software Verification Facility
- SIF & DSU
- SimOPS

Verification Facilities
- Mars Yard (Stevenage)
- Cleanroom Equip

RV System Database
The Rover Vehicle is currently in Adv CD Phase

- System level design consolidation and industrialisation activities are on going
- Rover Vehicle Design and verification plans consolidated through a PDR held end of Sept 2013
- Interface definition with the Descent Module on going with TAS-I and LAV
- Full CD phase is expected to start from June 2014
- RV CDR planned in mid-2015
- Delivery of RV to TAS-I by end of 2016 for integration of scientific instruments and drill
- Environmental testing at TAS-I during H2 2017
# A challenging Schedule for the 2018 Mission

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Start</th>
<th>Finish</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RV Equipment Activities</td>
<td>01/05/2013</td>
<td>31/03/2016</td>
<td>152.4w</td>
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<tr>
<td>2</td>
<td>RV Equipment Development &amp; Qualification</td>
<td>01/05/2013</td>
<td>30/06/2015</td>
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<td>3</td>
<td>PFM SVM-E Equipment Manufacture &amp; Test</td>
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<td>31/12/2015</td>
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<td>5</td>
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<td>04/01/2016</td>
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<td>RV Software V1 Development</td>
<td>01/05/2013</td>
<td>05/05/2015</td>
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<td>RV Software V2 Development</td>
<td>06/01/2014</td>
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<td>8</td>
<td>Rover Vehicle ETM Activities</td>
<td>06/05/2015</td>
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<td>9</td>
<td>RV ETM Functional Qualification (V1)</td>
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<td>11</td>
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<td>12</td>
<td>PFM SVM-E Integration &amp; Test</td>
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<td>13</td>
<td>PFM RV Integration</td>
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<td>14</td>
<td>PFM RV Test &amp; Transport</td>
<td>04/07/2016</td>
<td>22/08/2016</td>
<td>7.2w</td>
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<tr>
<td>15</td>
<td>PFM Rover Module AIT</td>
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<td>17</td>
<td>PFM RM EVT</td>
<td>29/11/2016</td>
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<td>18</td>
<td>PFM RM Integration to SCC</td>
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<td>10/07/2017</td>
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<td>19</td>
<td>ESA Contingency</td>
<td>11/07/2017</td>
<td>08/01/2018</td>
<td>26w</td>
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<td>20</td>
<td>Launch Campaign</td>
<td>09/01/2018</td>
<td>07/05/2018</td>
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Tasks 15-20 are under Prime contractor’s responsibility
## RV - Selected or Negotiated Subcontracts

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Item</th>
<th>Selected Company</th>
<th>Procurement status</th>
<th>Notes</th>
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<tbody>
<tr>
<td>EPS</td>
<td>PCDE</td>
<td>Astrium GmbH</td>
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<tr>
<td>EPS</td>
<td>Actuator Drive Electronics ADE</td>
<td>TAS-E</td>
<td>Selected</td>
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<tr>
<td>EPS</td>
<td>Actuator Drive Electronics ADE subco</td>
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<td>Subcontractor to TAS-E</td>
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<td>EPS</td>
<td>Actuator Drive Electronics ADE subco</td>
<td>active space technologies</td>
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<td>Subcontractor to TAS-E</td>
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<tr>
<td>Communications / RF</td>
<td>UHF Transceiver</td>
<td>QinetiQ</td>
<td>Negotiated</td>
<td></td>
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<tr>
<td>Structure</td>
<td>Rover Vehicle Primary structure</td>
<td>ProDrive</td>
<td>Negotiated</td>
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<tr>
<td>Mechanisms</td>
<td>Body HDRMs</td>
<td>EADS Casa</td>
<td>Selected</td>
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<tr>
<td>Mechanisms</td>
<td>Bogie ElectroMechanical Assy (BEMA)</td>
<td>MDA</td>
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<tr>
<td>Mechanisms</td>
<td>Bogie ElectroMechanical Assy (BEMA)</td>
<td>Maxon</td>
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<tr>
<td>Data Handling System</td>
<td>OBC</td>
<td>RUAG Sweden</td>
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<tr>
<td>Data Handling System</td>
<td>OBC (co-processor)</td>
<td>TAS-I</td>
<td>Selected</td>
<td>Subcontractor to RUAG Sweden</td>
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<tr>
<td>Data Handling System</td>
<td>OBC (power board)</td>
<td>RUAG Austria</td>
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<td>Subcontractor to RUAG Sweden</td>
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<tr>
<td>Navigation</td>
<td>Camera System</td>
<td>Neptec</td>
<td>Negotiated</td>
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<tr>
<td>EGSE</td>
<td>SCOE-TMTC</td>
<td>SSBV</td>
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</table>

Notes:

“Negotiated” means the MPP is endorsed by ESA and on esa-p

“Selected” means that the SPB has given mandate for negotiation and it has been completed successfully.
### RV - ITTs currently running

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Item</th>
<th>Selected Company</th>
<th>Procurement status</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Harness</td>
<td>Harness</td>
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<td>ITT Running</td>
<td>Planned ITT release date is 25/9/13</td>
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<tr>
<td>Communications / RF</td>
<td>UHF Antenna</td>
<td>N/A</td>
<td>ITT Running</td>
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<tr>
<td>Mechanisms</td>
<td>Deployable Mast Assembly</td>
<td>N/A</td>
<td>ITT Running</td>
<td>Discussions under way with preferred supplier</td>
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<tr>
<td>Navigation</td>
<td>IMU</td>
<td>N/A</td>
<td>ITT Running</td>
<td></td>
</tr>
<tr>
<td>Navigation</td>
<td>Sun Sensor</td>
<td>N/A</td>
<td>ITT Running</td>
<td>Planned ITT release date is 25/9/13</td>
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<tr>
<td>Navigation</td>
<td>Vis_Loc Algorithms &amp; SW development</td>
<td>N/A</td>
<td>ITT Running</td>
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<tr>
<td>FVI</td>
<td>Sim_FE HW</td>
<td>N/A</td>
<td>ITT Running</td>
<td>Planned ITT release date is 4/10/13</td>
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<tr>
<td>EGSE</td>
<td>SCOE-Power</td>
<td>N/A</td>
<td>ITT Running</td>
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</tbody>
</table>

**Notes:**

“ITT running” means that the procurement action is between the ITT publishing and the selection.
# RV – Planned ITTs

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Item</th>
<th>Selected Company</th>
<th>Procurement status</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>EPS</td>
<td>Solar Array Assembly</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 08/11/13 [Intended ITT published]</td>
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<tr>
<td>EPS</td>
<td>Battery</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 15/10/13</td>
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<tr>
<td>Mechanisms</td>
<td>Umbilical Release Mechanism</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 01/01/14 [Intended ITT published]</td>
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<tr>
<td>Mechanisms</td>
<td>Locomotion Verification Model Integrate/Test</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 01/07/14</td>
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<tr>
<td>Software</td>
<td>Software Tranche A (Outside ASU)</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 01/04/14</td>
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<tr>
<td>Software</td>
<td>Software Tranche B (Outside ASU)</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 03/11/14</td>
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<tr>
<td>Software</td>
<td>Software Tranche C (Outside ASU)</td>
<td>N/A</td>
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<tr>
<td>MGSE</td>
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<td>N/A</td>
<td>To be selected</td>
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<td>MGSE</td>
<td>MGSE Lot 2</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 01/10/13 [Intended ITT published]</td>
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<tr>
<td>EGSE</td>
<td>ATB-ETM benches and harnesses</td>
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<td>EGSE</td>
<td>RF/UHF SCOE</td>
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<td>EGSE</td>
<td>CCS</td>
<td>N/A</td>
<td>To be selected</td>
<td>Planned ITT release date is 01/01/14 [Intended ITT published]</td>
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</tbody>
</table>

Notes:

“To be selected” means that procurement process has not yet started.

Overall scope of the RV AIT is currently under review and some element may be considered for future ITT.
## Solar Array Assembly

<table>
<thead>
<tr>
<th>Item: Solar Array Assembly</th>
<th>Procuring Company: Astrium Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT issue: Nov 13</td>
<td>K/O: Apr 14</td>
</tr>
<tr>
<td>Contract duration: Complete Feb 16</td>
<td></td>
</tr>
</tbody>
</table>

### Short description:
Five Solar Array Assembly Panels, electrically configured to six Solar Array electrical sections, one on each primary and secondary panel and two on the fixed, centre panel. The Solar Panel substrates (CFRP faced sandwich panels with integrally-bonded polyimide layer) will be CFI items.

### Main requirements:
The ExoMars Rover Vehicle Solar Array Assembly (SAA) will comprise of the following major components:
- Fixed Solar Array Panel with Photo Voltaic Assembly (PVA) and wiring harness
- 2 Deployable and tiltable SA Panels each consisting of a primary and secondary panel with PVAs and wiring harness (left & right)
- String blocking diodes & bleed resistors
- Hinge Mechanisms including actuators and latches
- SA Hold-Down & Release Mechanisms
- Thermal Control Hardware, including thermal finishes, heaters and temperature sensors
- Solar array Power and signal harnesses to RV body.
- HDRM and hinge actuator signal and power harnesses to the externally mounted Actuator Drive Electronics
- Fasteners & shims between panels and hinges
- Solar array string design to minimise energy loss due to camera mast shadowing.

### Models:
- STM, Partial DM / EQM (actuators with mass dummies), FM

### Main Reviews:
- PDR, CDR, QR, MRR, TRR, TRB, DRB

### Notes:
Deployable / tilt able panels are tilted towards the Sun when RV is stationary and are held in same orientation as fixed panel when RV is moving.
Solar Array energy output per sol varies seasonally and is major constraint on Rover mission capability.
<table>
<thead>
<tr>
<th>Item: Battery</th>
<th>Procuring Company: Astrium Limited</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT issue: Oct 13</td>
<td>K/O: Mar 14</td>
</tr>
<tr>
<td>Contract duration: Complete Jul 16</td>
<td></td>
</tr>
</tbody>
</table>

**Short description:** The Battery provides a nominal 28v DC output to the Rover power bus by utilising Li Ion technology compatible with the Rover power sub-system. The Battery is to include an Output Isolation Switch Mechanism, operated by a DC motor, for ground safety during Rover launch preparation. It also provides isolated temperature and voltage monitoring circuits allowing for control by the Rover power sub-system and external interfaces.

**Main requirements:**
- Size envelope: 320mm x 270mm x 90mm
- Mass: < 9kg
- Capacity: > 45Ah
- Output voltage range: 20v – 30v
- Charge/Discharge regime: ± 6A
- Peak discharge current: < 15A @ 0° C
- Telemetry circuits: Temperature, voltage, switch position
- Operating temperature range: -20° C to +30° C
- Survival temperature range: -30° C to 40° C
- Qualified for ground operation, space flight transit and > 250 sols of operation on Mars

**Models:**
- Deliverable Models: STM, EM, QM, FM, Spare (FM)
- Test Models: 3 x LTM

**Main Reviews:**
- PDR, CDR, QR, MRR, TRR, TRB, DRB

**Notes:** Battery capacity is a major constraint on Rover mission capability and should be maximised within the limitations given by the size envelope and mass requirements.
# Umbilical Release Mechanism

<table>
<thead>
<tr>
<th>Item: Umbilical Release Mechanism</th>
<th>Procuring Company: Astrium Limited</th>
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<tbody>
<tr>
<td>ITT issue: Jan 14</td>
<td>K/O: Jul 14</td>
</tr>
<tr>
<td>Contract duration: Complete May 16</td>
<td></td>
</tr>
</tbody>
</table>

**Short description:** The Umbilical Release Mechanism provides the electrical connection between the Rover and the Lander Platform during the launch, cruise, entry, descent and landing phases of the mission. After landing, the umbilical remains connected whilst the Rover deploys its wheels and lifts itself up from the Lander Platform. It is then released on command and the Lander side of the umbilical is collapsed down onto the Lander Platform to ensure the Rover can drive over it and egress onto the Mars surface.

**Main requirements:** The Umbilical Release Mechanism includes the umbilical wiring harness, separating connectors, fixed interface connectors, harness support structure/mechanism, interface brackets and a release device. The separating connectors are a low separating force type, which will be qualified as part of a separate contract and specified for this equipment.

Two Umbilical Release Mechanisms are fitted to the Rover on the left and right sides of the body; one carrying nominal power & signal lines and the other carrying redundant power & signal lines.

**Models:** EM x 1, QM x 1, FM x 2

**Main Reviews:** PDR, CDR, QR, MRR, TRR, TRB, DRB

**Notes:**
## Locomotion Verification Model Test

<table>
<thead>
<tr>
<th>Item: LVM Test</th>
<th>Procuring Company: Astrium Limited</th>
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<tbody>
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<td>K/O: Nov 2014</td>
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<tr>
<td>Contract duration: Complete May 16</td>
<td></td>
</tr>
</tbody>
</table>

**Short description:** The “Locomotion Verification Model” (LVM) is used by the supplier to characterise and verify the performance of the Locomotion of the Rover. The LVM is composed of representative models of the “Actuators Drive Electronics” (ADE), the “Bogie Electro-Mechanical Assembly” (BEMA – Locomotion actuators), and a structural frame which allows to adapt the Rover centre of mass. The LVM is Mars representative weight and an input for this activity.

**Main requirements:**
- Build a test facility with the ExoMars soils (four soils in total) and with measuring equipment allowing the characterisation and verification of the Locomotion
- Produce the tests plans
- Conduct the tests storing the necessary information
- Produce the tests reports
- Hold the associated TRRs and TRBs

**Models:** LVM (ADE, BEMA and structural frame) used

**Main Reviews:** Locomotion characterisation/verification TRRs and TRBs.

**Notes:** Scope could be extented to include LVM integration and structural frame.
## Rover Vehicle Software

<table>
<thead>
<tr>
<th>Item: Software Subcontract Tranche A</th>
<th>Procuring Company: Astrium Ltd</th>
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<tbody>
<tr>
<td>ITT issue: Apr 14</td>
<td>K/O: Aug 14</td>
</tr>
</tbody>
</table>

**Short description:**
- Coding and Unit Testing of a subset of the RVSW functionality, likely encompassing platform equipment management functions and elements of vehicle level system control.

**Main requirements:**
- Real time embedded software development
- ANSI C
- Familiarity with industry coding standards (e.g. MISRA)

**Models:** Contractor will be expected to deliver pre-validated batches of code to Astrium.

**Main Reviews:** KO, design review, test readiness review, test results review, AR

**Notes:** Contractor will need to collocate on Astrium premises when required to support detailed design co-engineering, system integration and system verification.
**Rover Vehicle Software**

<table>
<thead>
<tr>
<th>Item: Software Subcontract Tranche B</th>
<th>Procuring Company: Astrium Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITT issue: Nov 14</td>
<td>K/O: Mar 15</td>
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</table>

**Short description:**
- Design, Code and Test of the Recovery Software Image encompassing the complete lifecycle development starting from requirements provided by Astrium Ltd.

**Main requirements:**
- Real time embedded software development
- ANSI C
- Familiarity with industry coding standards (e.g. MISRA)

**Models:** Single V cycle SW development at subcontractor level.

**Main Reviews:** KO, SRR, PDR, CDR, DRB, QR/AR

**Notes:** RSI software development will comply with ECSS criticality category B rules
## Rover Vehicle Software

<table>
<thead>
<tr>
<th>Item: Software Subcontract Tranche C</th>
<th>Procuring Company: Astrium Ltd</th>
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<tbody>
<tr>
<td>ITT issue: <strong>Apr 15</strong></td>
<td>K/O: <strong>Aug 15</strong></td>
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</table>

**Short description:**
- Coding and Unit Testing of a subset of the RVSW functionality, likely encompassing elements of the GNC functionality and vehicle level system control.

**Main requirements:**
- Real time embedded software development
- ANSI C
- Familiarity with industry coding standards (e.g. MISRA)

**Models:** Contractor will be expected to deliver pre-validated batches of code to Astrium.

**Main Reviews:** KO, design review, test readiness review, test results review, AR

**Notes:** Contractor will need to collocate on Astrium premises when required to support detailed design co-engineering, system integration and system verification.
### MGSE Lot 1

<table>
<thead>
<tr>
<th>Item: MGSE Lot 1</th>
<th>Procuring Company: Astrium Limited</th>
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<tbody>
<tr>
<td>ITT issue: Nov 13</td>
<td>K/O: Mar 14</td>
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<tr>
<td>Contract duration: Complete Oct 15</td>
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</table>

**Short description:** Mechanical Ground Support Equipment (MGSE) for the Rover Vehicle to be used during assembly, integration and test. To be used in Precision Clean Rooms (ISO Class 8) and Aseptic Clean Rooms (ISO Class 7) as required by the ExoMars project. The items will be interfacing with Flight Hardware and as such will be required to meet applicable requirements for cleanliness and planetary protection.

**Main requirements:**

**The Multi-Purpose Turnover Trolley (MPT)** will support the main flight hardware whilst the **Service Module Trolley/Stand** will support the Service Module (SVM) during integration. Both items of hardware will require containers which will be required to accommodate the precision cleanliness and planetary protection standards required of the ExoMars project during transport.

**Lifting mechanisms** (Lifting Frame, Lifting Sling, Lifting Brackets, Interface Plates) are required to lift the flight hardware and Service Module in different configurations.

**Models:** MPT (3), SVM Trolley/Stand (3), Lifting Mechanisms (2 sets)

**Main Reviews:** PDR, CDR, DR, MRR, TRR, TRB, DRB

**Notes:**
### MGSE Lot 2

<table>
<thead>
<tr>
<th>Item: MGSE Lot 2</th>
<th>Procuring Company: Astrium Limited</th>
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<tr>
<td>ITT issue: Nov 13</td>
<td>K/O: Mar 14</td>
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</table>

**Short description:** Rover Vehicle Transportation Containers. The containers will interface with flight hardware and as such the internal compartment of the containers will be required to meet applicable requirements for cleanliness and planetary protection.

**Main requirements:** In addition to the transportation container, an integral trolley, which will interface between the container and flight hardware, will be required to transfer the flight hardware from the container into the Aseptic clean area (ISO Class 7). The trolley will need to meet the stringent cleanliness and planetary protection requirements of the clean room whilst providing an element of mobility over the clean room floor. The trolley will need to be able to support the full mass of the Rover Module (350kg).

**Models:** (Quantity 3) to support STM, GTM & FM.

**Main Reviews:** PDR, CDR, DR, MRR, TRR, TRB, DRB

**Notes:**
## ETM/ATB Benches and Harnesses

<table>
<thead>
<tr>
<th>Item: ETM/ATB Benches and Harnesses</th>
<th>Procuring Company: Astrium Limited</th>
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<tr>
<td>ITT issue: Jan 14</td>
<td>K/O: May 14</td>
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</table>

**Short description:** The ETM and ATB test benches and harnesses will form part of the Rover Vehicle Test and Verification Environment and are required to be used in a Precision Clean Room (ISO Class 8) Test Environment. The items will be interfacing with Test Hardware and as such will be required to meet applicable requirements for cleanliness.

**Main requirements:**
- The ETM is a non-redundant, non-flight build Flatsat that is electrically and functionally flight representative. The Flatsat will consist of a mix of simulated equipment and Development Model (DM), Engineering Model (EM) and Engineering Qualification Model (EQM) hardware (all CFI from Astrium).
- The ATB is a hybrid hardware/simulated Test Bench.
- Test benches and harnesses are required for both the ETM and ATB.
- Both Test Benches will require containers which will be required to accommodate the precision cleanliness standards required of the ExoMars project during transport.

**Models:** ATB, ETM

**Main Reviews:** PDR, CDR, DR, MRR, TRR, TRB, DRB

**Notes:**
**RF/UHF SCOE**

<table>
<thead>
<tr>
<th>Item: RF/UHF SCOE</th>
<th>Procuring Company: Astrium Limited</th>
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<tbody>
<tr>
<td>ITT issue: Dec 13</td>
<td>K/O: Jul 14</td>
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<td>Contract duration: Complete Nov 15</td>
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**Short description:** UHF RF SCOE for the Rover Vehicle Electrical Ground Support Equipment (EGSE) required to test the ExoMars Rover Vehicle. The UHF SCOE represents the UHF (Forward and Return Link) interface to the Rover Vehicle UHF Proximity 1 Transceiver, and provides all elements for RF reception, demodulation, modulation and transmission.

**Main requirements:** The SCOE will consist of the following main elements:-
- UHF Forward Link Transmitter
- UHF Return Link Receiver
- RF Switching and Matching Unit
- RF Measurement Equipment
- Configurable Baseband Proximity 1 signal processor

**Models:** ETM, GTM, PFM

**Main Reviews:** PDR, CDR, DR, MRR, TRR, TRB, DRB

**Notes:**
## CCS

<table>
<thead>
<tr>
<th>Item: CCS</th>
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<tr>
<td>ITT issue: Jan 14</td>
<td>K/O: Jul 14</td>
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### Short description:
The Rover Vehicle CCS is a primary element of the Spacecraft electrical ground support equipment (EGSE) required to test the Rover Vehicle. The CCS forms the central hub of the Rover Vehicle test environments, from which the majority of the on-board equipment and software testing is performed.

### Main requirements:
The CCS application will be based on the Astrium Ltd Open Center (OC) software product, hosted on a number of Linux servers and workstations. The OC software will be provided to the contractor by Astrium SAS, via Astrium Ltd, as CFI.

The CCS allows automatic testing to be performed in real time, by utilising OC specific Automatic Test Procedures, (ATP) which allow automated control of the associated EGSE as well as full monitoring and control of the on-board systems, via the TC and TM interfaces.

The CCS also provides offline activities. These include ATP generation and editing, synoptic generation and editing and offline analysis of test results and events (logbook).

### Models:
Quantity 14 configured sets

### Main Reviews:
PDR, CDR, DR, MRR, TRR, TRB, DRB

### Notes: