Emirates Mars Mission – Hope Probe Factsheet

The Emirates Mars Mission – Hope Probe (EMM) is a strategic initiative that was announced by UAE's President His Highness Sheikh Khalifa Bin Zayed Al Nahyan and UAE's Vice President and Prime Minister His Highness Sheikh Mohammed Bin Rashid Al Maktoum on 16 July 2014. EMM was initiated to disrupt and accelerate the development of the UAE's space, education, science and technologies sectors. The Hope Probe will reach Mars' orbit on 9 February 2021 and aims to build the first full picture of Mars' climate throughout the Martian year.

EMM is the culmination of a knowledge transfer and development effort started in 2006 by the the Mohammed bin Rashed Space Center (MBRSC), which has seen Emirati engineers and experts working with partners around the world to develop the UAE's space mission design and engineering capabilities.

The Mohammed bin Rashid Space Center was assigned by the UAE government to manage, develop, and execute all phases of the program, while the UAE Space Agency is charged with the general supervision of the mission.

Background - MBRSC and satellite development

- The Mohammed bin Rashid Space Centre (MBRSC) in Dubai, UAE, has been working on developing earth-sensing satellites since 2006.
- MBRSC embarked on a technology transfer program with Satrec Initiative of South Korea for to develop remote sensing spacecraft and missions.
- DubaiSat-1, developed with 30% contribution from Emirati engineers, launched successfully in 2009 from Kazakhstan.
- DubaiSat-2 was a joint development project with 50% contribution from Emirati engineers and launched successfully in 2013 from Russia.
- UAE first CubeSat and University satellite, Nayif-1, launched from India in February 2017. CubeSat developed by MBRSC with students from the American University of Sharjah.
- Khalifasat was the first satellite to be wholly designed and developed in the UAE. It was launched from Tanegashima, Japan, in October 2018.
- Over 200 employees now work at MBRSC, the staff are 100% Emirati.

Project Goals:

The main goals set by UAE's federal government for the program are the following:

- Get a probe to Mars by the UAE's 50th anniversary in 2021.
- Develop the Science and Technology Sector in the UAE.
- Develop UAE Scientific Capabilities.
- Increase UAE's Contribution to the Global Science Community.

Objectives:

The following objectives were derived from the main goals set by the government:

- Train and prepare UAE scientists to do significant science work in the field of space exploration.
- Train and prepare UAE engineers to develop outer space exploration systems and instruments in UAE.
- Build the necessary infrastructure to create a sustainable outer space exploration program in UAE.
- Establish partnership with international entities in the field of outer space exploration.
- Establish, improve and further develop the engineering and scientific programs in the academic sector.
- Transfer knowledge to the different sectors in UAE. (Spin-offs and spillover effects)

Project Requirments

The following requirements were set to develop the EMM mission conceptualization:

- The mission should be unique, and should aim for novel and significant discoveries.
- The mission should have significant contributions to the ongoing work of the global space science community, and should be of great value to humanity.
- The mission should help build a sustainable outer space exploration program in UAE.
- The mission should include valuable contribution from UAE engineers and scientists.
- Some of the system development activities should take place in the UAE.

Team's Outlook toward EMM

The Emirates Mars Mission (EMM) and its Hope spacecraft, represent the UAE's vision for the future. A post oil future, where the knowledge and capabilities of those in the UAE are the wealth of the nation. In addition to, being the source of stability and readiness of tomorrow's challenges and opportunities. With that in mind, the mission's ownership lays at the UAE's cabinet, thus trickling down to the citizenry of the UAE. Finally, a recurring theme within the mission is that EMM is not about sending a probe to Mars; but it represents a greater hope for the region, that in empowering the youth in the fields of science and technology and having overarching goals; nations today, just like our ancestors, can aspire to reach for the stars, contribute on a global scale and creating impactful policies that will influence generations to come.

Science Objective:

- Hope's mission is focused on atmospheric dynamics. It will explore the atmosphere of Mars globally while sampling both diurnal (daily) and seasonal timescales. (Never been done by any previous Mars mission). Understanding atmospheres of other planets, allows us to better understand our planet (since there is another sample to compare with) and better understand other planets in the universe.

Science Questions:

1. How does the Martian lower atmosphere respond globally, diurnally (daily), and seasonally to solar forcing (radiated energy from the sun)?

2. How do conditions throughout the Martian atmosphere affect rates of atmospheric escape (escape of Hydrogen and Oxygen, building blocks of life from the Martian atmosphere)?
3. How does the Martian exosphere (Upper atmosphere) behave temporally (At different times during the day) and spatially (At different distances relative to Mars)?

Science Instruments

- Mars Hope carries three instruments:

  EXI – The Emirates eXploration Imager is a digital camera that will capture high resolution images of Mars along with measuring water ice and ozone in the lower atmosphere through the UV bands.

  EMIRS – The Emirates Mars InfraRed Spectrometer will to measure global distribution of dust, ice cloud, and water vapor in the Martian lower atmosphere.

  EMUS – The Emirates Mars Ultraviolet Spectrometer will measure oxygen and carbon monoxide in the thermoshphere and the variability of hydrogen and oxygen in the upper atmosphere.

Journey to Mars

- EMM launches in July 2020 to reach Mars Orbital Insertion (MOI) in February 2021. It will launch from Tanegashima, Japan using an MHI H2A launcher.
- The launcher will travel at a speed of 34,000 km/h to a 'parking orbit', before a second stage will launch it towards Mars.
- The average speed of the Hope Probe during its 7 months journey to Mars is 121,000 km/h
- The 493,500,000 km journey to Mars, will take 7 months.
- Star trackers will help position the highly autonomous spacecraft.
- It takes radio signals 11 to 22 minutes to travel from Hope around Mars to the ground network on Earth, hence the need for autonomy.
- The Capture Orbit will take the Hope Probe as close as 1,000 km above Mars' surface and as far as 49,380 km away from it.
- EMM has a 20,000 – 43,000 km elliptical science orbit. The probe will complete one orbit of the planet every 55 hours.
- Hope will use the DSN – Deep Space Network – for communications.
- Contact period with the Command & Control Center in UAE is limited to 6-8 hours, twice a week.
- Hope is a 1,350 kg mass spacecraft – about the size of an SUV.

Partners

- The Hope Probe was designed and developed by the EMM team at MBRSC, and its Knowledge Transfer partners at the University of Colorado, Boulder; Arizona State University and the University of California, Berkley.
- The Laboratory for Atmospheric and Space Physics (LASP) at University of Colorado, Boulder is the primary knowledge transfer partner for mission design, spacecraft, and EXI/EMUS instrument development, testing, science team/apprenticeship, and operations
- Arizona State University is the knowledge transfer partner for EMIRS instrument development and science team/apprenticeship

- The University of California, Berkeley Space Sciences Lab (SSL) is the knowledge transfer partner for Science team/apprenticeship & EMUS detectors

EMM in Numbers

- 60,000 young people and teachers engaged in outreach programs
- 200 new technical designs
- 100% Emirati, 34% female (science team is 80% female) team
- 66 components made in the UAE
- 87 scientific presentations published in international conferences
- On time, on budget in a 6 year program as opposed to usual 10-year development time.