Mohammed bin Rashid Space Centre Magazine

Majarat

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Inspired by Space Science and Technology

MARS PROBE

Sheikh Khalifa bin Zayed announces the historic UAE Space Probe project

25 YEARS OF THE HUBBLE TELESCOPE

Stunning imagery captured during its extended orbit

FAROUK EL-BAZ

Memories of Sheikh Zayed and the Hope Probe

Sheikh Mohammed bin Rashid confirms the scientific goals for UAE's Mars Probe

"This probe represents hope for millions of young Arabs looking for a better future. There is no future, no achievement, no life without hope. The Emirates Mars Mission will be a great contribution to human knowledge, a milestone for Arab civilisation, and a real investment for future generations."

H H Sheikh Mohammed bin Rashid Al Maktoum

UAE Vice-President, Prime Minister, Ruler of Dubai

Khalifa bin Zayed Announces the Historic UAE Hope Space Probe Project

The President of the UAE announces to a global audience that work is to begin on sending a probe to Mars by 2021.

The UAE entered the global race to explore outer space in mid-July 2014, when The President, His Highness Sheikh Khalifa bin Zayed Al Nahyan, unveiled the formulation of the UAE Space Agency. HH Sheikh Khalifa also announced plans to start working on sending the first Arabic-Islamic probe to Mars, under the supervision of a national team, on a scientific voyage of discovery by 2021.

HH Sheikh Khalifa, President of the UAE, emphasised that the goal of the UAE is to enter the space industry, to benefit from space technology in a way that enhances the country's development plans, and to build Emirati technical and intellectual capabilities in the fields of aerospace and space exploration. He added "We aim for the UAE to be among the top countries in the field of aerospace by 2021. We have a great belief in Allah and in the talents of our young people. We have the strongest determination, the greatest ambitions and a clear plan to reach our goals."

> *"We aim for the UAE to be among the top countries in the field of aerospace by 2021."*

Echoing the President's sentiment, His Highness Sheikh Mohammed bin Rashid Al Maktoum, UAE Vice President, Prime Minister and Ruler of Dubai, said: "We chose the epic challenge of reaching Mars because epic challenges inspire us and motivate us. The moment we stop taking on such challenges is the moment we stop moving forward."

He added that the UAE Space Agency would be responsible for supervising and organising all such activities, developing the sector, ensuring knowledge transfer, enhancing the UAE's position as a global player in aerospace and maximising the contribution of space industries to the national economy.

His Highness explained: "Despite all the tensions and the conflicts across the Middle East, we have proved today how positive a contribution the Arab people can make to humanity through great achievements, given the right circumstances and ingredients. Our region is a region of civilisation. Our destiny is, once again, to explore, to create, to build and to civilise."

Taking Practical Steps Towards Exploring Mars

Sheikh Mohammed bin Rashid confirms the scientific goals behind the UAE's Mars Probe, and announces the name is to be "Hope".

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, has revealed the scientific goals of the UAE's Mars probe mission, named Hope. HH said, during a press conference held at Qasr El Bahr in Dubai, that the project is a strategic investment in human capital, in science and in knowledge, and that future generations will reap the rewards of this investment.

He added that this project will send three important messages; "The first message is for the world: that Arab civilisation once played a great role in contributing to human knowledge, and will play that role again. The second message is to our Arab brethren: that nothing is impossible, and that we can compete with the greatest of nations in the race for knowledge. The third message is for those who strive to reach the highest of peaks: set no limits to your ambitions, and you can reach even to space."

Speaking of the development miracle that took place in the UAE, HH pointed out that "in a small tent 43 years ago, the late Sheikh Zayed and Sheikh Rashid worked day and night to build the UAE; and today, under the leadership of His Highness Sheikh Khalifa bin Zayed Al Nahyan, President of the UAE – may God protect him - we have a team capable of competing with major nations in reaching Mars."

Addressing the probe team, His Highness Sheikh Mohammed bin Rashid Al Maktoum said: "If the late Sheikh Zayed could have seen your work today, he would have tears in his eyes, as your work is the fruit of his work and the culmination of his march.

HH Hamdan bin Mohammed Al Maktoum and HH Sheikh Saif bin Zayed were present at the Hope announcement

UAE Space Agency President Khalifa Mohammed Al Rumaithi addresses the audience

"We thank everyone who participated and wanted to be part of this great historic project to send the first Arab probe to Mars. Everyone who took part is a partner in this mission. I would like to announce that the probe is to be called "Hope", because Zayed was the hope of the UAE and today the UAE is the hope of the Arab world. This probe represents hope for millions of young Arabs looking for a better future; there's always hope for a better future for all, God willing.

"The UAE Mars probe mission is the hope of our young Arabs; and there is no future, no achievement, no life without hope," HH added.

"We have now introduced the scientific and logistical details of the first Arab mission to Mars. This project will address new questions, including why the planet's atmosphere has been decaying into space to the point that it is too thin for water to exist on the surface." His Highness the Ruler of Dubai tweeted.

HH also explained that Hope is to be the first probe to study dynamic changes in the Martian climate and atmosphere throughout its daily and seasonal cycles.

The practical steps to start designing, building and launching the UAE Mars probe were commissioned to the Mohammed bin Rashid Space Centre under an agreement with the UAE Space Agency, which was signed in the presence of His Highness Sheikh Mohammed bin Rashid.

Under the agreement, the implementation of all stages of the UAE Mars probe mission and its launch will be carried out under the supervision and with direct funding from the UAE Space Agency for a period of seven years. The agreement stipulates the financial and legal framework, as well as the timeframe for beginning the Mars probe project, which will be carried out by a team of Emirati engineers.

> *"If the late Sheikh Zayed could have seen your work today, he would have tears in his eyes, as your work is the fruit of his work and the culmination of his march."*

In addition, the agreement emphasises the importance of building a national base of research and developing specialised national organisations in the next few years. An integral part of the mission also depends upon the commitment of international partners. They will share their knowledge with the national work team who will, in turn, contribute to building a solid scientific base for developing the UAE space sector.

Furthermore, the agreement stipulates that the benefits of scientific and technical know-how created by the Mars team engineers will also be shared with other sectors under the supervision of the UAE Space Agency, such as the telecommunications, aerospace and the satellite industries.

His Highness Sheikh Mohammed bin Rashid said during the agreement signing ceremony which took place on 20th October 2014, at the Mohammed bin Rashid Innovation Centre, located in Emirates Towers in Dubai, that "Great challenges require the strongest teams; and travelling into space requires people with

MRBSC Team Members brief the gathered assembly

ambitions that reach and embrace the sky."

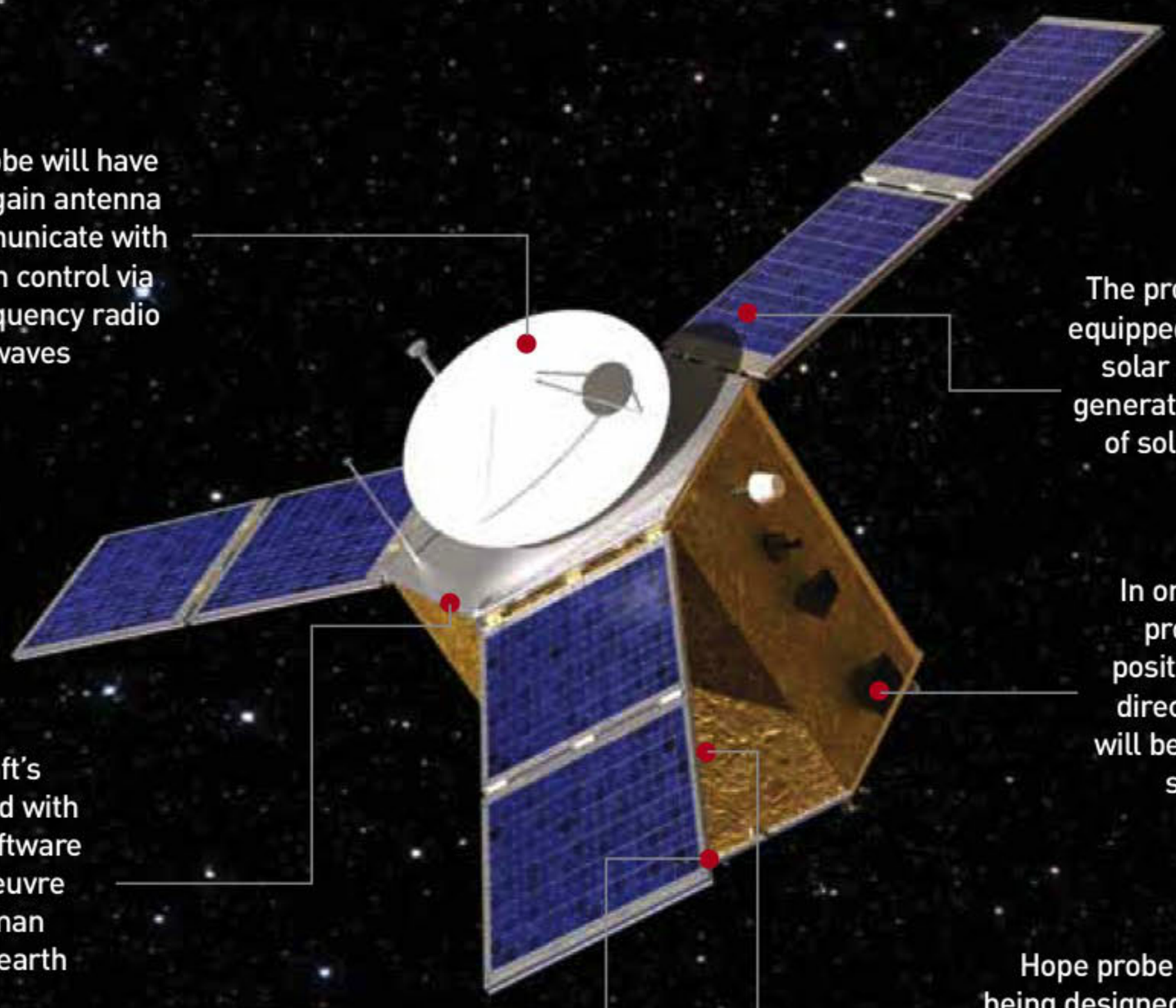
Addressing the probe team, HH said that "An historic Arab and national mission lies ahead of us; the UAE Mars probe mission is one of a great source of national pride, a great Arab achievement and a valuable contribution to science and humanity. The UAE people and leadership will keenly follow the project's progress. We have seven years to build our knowledge, develop our organisations and set up an infrastructure to reach the Red Planet."

Hope Probe: What You Need to Know

- The spacecraft will be launched in the nose cone of a rocket. The rocket must exceed 40,000 km/hour to break out of the Earth's atmosphere.
- The first rockets will detach a minute after the launch. After that, three rocket-propelled platforms will be operated sequentially to break out of the Earth's atmosphere and release the probe into space to navigate its journey towards Mars through the Solar System.
- This will be a tense time at mission control in the EMM command and control room as the probe is still in a concussion stage until it adjusts its position, stabilises, and mission control receives signals of its initial stability.
- The spacecraft will unfold its solar panels and direct them towards the Sun to charge the batteries that operate the computers, transmission etc... that are onboard.
- Once the probe hits its maximum speed limit, it will not need any extra energy to reach outer space where there's no gravity, atmosphere or anything that may slow it down.
- In 2021, the probe reaches the closest point to Mars and uses its impulse as a "brake" to slow itself down in preparation to enter Mars orbit.
- The probe enters a wide oval-shaped orbit around Mars before relocating to its determined scientific orbit (the closest point to the red planet) with a speed ranging from between 3600 km/hr and 14000 km/hr in order to operate its trackers, start collecting data and send it back to Earth.
- Once the probe enters Mars orbit it will automatically operate its engines for 30 minutes to maintain its new path in Mars orbit.
- At this point no control can be taken over the probe instantly from mission control because the signals take around 13-20 minutes to reach Earth.
- It will travel more than 600 million km in a journey that will last around 7-9 months (200 days).

> *"The Hope Probe... A strategic investment in human capital, in knowledge and in the future."*

The probe's shape, size and devices



- Hope probe is being designed in a compressed hexagonal form that looks like a beehive. It will be made of lightweight aluminum metal (1500kg) with dimensions of 2.37 metres in width and 2.90 metres in height.
- The probe will be equipped with three solar panels to generate 600 watts of solar power. The panels will be fastened to the probe during the launch and unfastened automatically once the probe detatches the space rocket.•

  The probe will have a high-gain antenna to communicate with mission control via low frequency radio waves, precisely directed at mission control, plus star trackers to locate its position in space, as well as the Earth's position, during its mission.
- In order to enable the probe to adjust its position and control its direction and speed, it will be equipped with two sets of rockets; the first rocket contains 4-6 120-Newton Delta V thrusters, to accelerate/decelerate its speed. The second one contains 8-12 of the 5-Newton RCS Thrusters to adjust the position and the direction of the probe precisely.
- Because the probe needs to change its self-direction from time to time, direct power generation panels toward the sun, direct Wireless Antenna toward the ground and channel scientific equipment to Mars, it will use a set of internal reaction flywheels that are spun to create momentum that rotates the probe precisely around any axis.
- The spacecraft's brain is a computer equipped with sophisticated software that can manoeuvre it into Mars orbit autonomously.

An artist's impression of the Hope Space Probe

An Emirati Team of 150 Engineers and Scientists will Build and Manage the Hope Probe

Majarat introduces you to some of the key members of the Hope Mars Probe team, and the task that lays ahead for them.

The Mohammed bin Rashid Space Centre has announced that the probe is to be built and managed by a team primarily made up by Emiratis. The team will depend on the implementation of engineering expertise and technological knowledge that entered the space science and technology sector over 10 years ago. Also, scientific partnerships with space and specialised global research agencies will contribute to the transfer of knowledge, and enrich Emirati scientific capabilities working on this project.

Omran Sharaf, Director of the Program Management Department and the Emirates Mars Mission Project Manager said that he, along with his team, will be working hard to complete the project within the specified deadline, a deadline which sits just five years away. They will be working on developing and reviewing the designs, building the probe and testing it before the designated launch window in 2020.

"There is no second chance. It's a race against time", warns Sharaf. "Earth and Mars align their orbits once every 2 years, but we can't be ready by 2016 and 2018, that's why we chose year 2020."

Sharaf explained that the team consisting of specialists in electronic, electrical and mechanical engineering, space systems, imaging technologies, space research and satellites, is divided into mini-teams operating according to flexible schedules. Two of the most important teams are:

Product Assurance Team: Managing and implementing quality standards across all phases of the project in line with the UAE vision, and in accordance with the international standards related to this field.

Risk Management Team: Ensuring that the probe tests and the probe launch have been successfully carried out, as well as the implementation of the project within the specified timeframe.

Omran Sharaf: Emirates Mars Mission Project Manager "The UAE plans to develop scientists in space science and technology."

Omran Sharaf

Since he joined the Mohammed bin Rashid Space Centre, Omran Sharaf, who holds a B.S. degree in electrical engineering from the University of Virginia, USA, has contributed to the development of the two satellites DubaiSat 1 and DubaiSat 2, and represented the UAE in many international meetings.

He explained that the UAE plans to form a generation of scientists in the field of space science and technology: "The UAE project gives us a promising opportunity to scientifically apply what we have learned, to gain a lot of knowledge and to achieve valuable scientific discoveries that will enrich human knowledge."

Suhail Al Muhairi: Deputy Project Manager-Spacecraft Development "We are designing a spacecraft that adapts to climatic conditions."

Suhail Al Muhairi, EMM Deputy Project Manager/Spacecraft Development, said that his team's mission is to develop designs and build a spacecraft capable of withstanding and operating under the climate changes in outer space until it reaches Mars orbit, as well as to ensure its readiness to work on time.

Suhail Al Muhairi

Zakareyya Al Shamsi: Deputy Project Manager-Mission Operations "We will be managing the communications with the probe."

Zakareyya Al Shamsi, EMM Deputy Project Manager/Mission Operations, said his team are to be responsible for software management, ensuring they meet the tasks assigned to the probe. In addition, the team will be directing the probe after its launch, controlling its movement until it enters the specified path, determining its location in its orbit and providing the ground station with the required information to be transferred to the probe devices. Prior to all that, the team will design an antenna to locate the probe during its journey to avoid any costly mistakes. He also pointed out that any mistake made in directing the probe could lead to losing it in outer space.

Zakareyya Al Shamsi

Mohammed Wali: EMM-Launch Segment Lead "Our mission is to choose the best rocket."

Mohammed Wali

Mohammed Wali, EMM Launch Segment Lead, explained that his team's tasks include the selection of the best rocket in terms of performance, speed and endurance to be used in carrying the probe into space during the launch phase. "We are studying a number of options based on the success rates in all previous operations. We will be studying their readiness and compatibility with the final design for the Hope Probe. After completing the construction of the probe, we will be able to determine the best rocket to carry it into space." he added.

Adnan Al Rais: Deputy Project Manager-Ground Station "It is 600 million km away from the Earth's surface."

Adnan Al Rais, EMM Deputy Project Manager/ Ground Station, is responsible for monitoring the probe after taking its position in its orbit around Mars. The probe will be located 600 million kilometres away from the Earth's surface, and constant monitoring will be a very complicated and challenging task for the ground station team. "We have multiple choices, and we will study the structure and equipment of the ground monitoring stations

Adnan Al Rais

in countries that have previously launched projects to explore Mars, in order to make an informed decision and develop equipment that meets the requirements of the Hope Probe." he explained.

Ibrahim Hamza, Deputy Project Manager - Strategic Planning Officer

Ibrahim Hamza

Ibrahim is responsible for the "Education program" and "Media and Communications" at the Mohammad Bin Rashid Space Centre (MBRSC). He also works on improving research initiatives in the field of space for Schools and Universities. Some of which are the "Kan Sat" program for Schools, and "Naief 1" which is designed in collaboration with the American University of Sharjah.

Ibrahim joined the space program management in MBRSC as the first employee with a non-engineering background. After that, he moved to the Project Management Office and was appointed the Director of the Satellite initiatives project "Kan Sat" for high school students.

Five Female Engineers in the Scientific Team

Sarah Amiri

Space exploration is far from a male-dominated sector. Some of the most integral members of the Mohammed bin Rashid Space Centre are bright young Emirati women, whose influence and contributions are immeasurable in terms of importance.

Sarah Amiri, Deputy Project Manager-Science Lead: "Emirati women are active and dynamic members of the community."

Sarah Amiri, who graduated with a Bachelor's degree in computer science from the American University of Sharjah, said that the scientific team has the capabilities and skills to work and excel in achieving the scientific objectives of the UAE's mission to explore Mars.

Nour Al Teneiji, EMM- Liaison Officer.

Nour manages all contractual and financial aspects of the project management. "We are committed to the implementation of the project according to international standards during the specified timeframe. We will be working on the development of periodic

Nour Al Teneiji

reports to measure the percentage of completion in accordance with the time plans, as well as ensuring a perfect coordination of all teams involved in the project."

Khulood Al Harmoodi

Khulood Al Harmoodi, Deputy Project Manager-Product Assurance and Logistics.

Khulood heads the Project Management Department/Knowledge Management departments at the Mohammed bin Rashid Space Centre.

Scientific Goals: Studying the Climate on the Red Planet

The Hope Probe will unlock some of the questions that remain unanswered about Mars.

The UAE Mars probe mission "Hope" aims to enrich human knowledge, unlocking the mysteries surrounding the atmosphere and climate of the Red Planet. Mars is unable to sustain water except in the form of ice or steam, and this is due to the erosion of the planet's surface. The probe will reveal the reasons behind the surface erosion, as well as the effect of the Martian climate on the loss of hydrogen and oxygen in the upper layers of the planet's atmosphere (the two key components of water, and life itself).

By understanding the atmosphere changes on Mars, we are able to simultaneously reach a far greater level of understanding relating to our own atmosphere, and any changes that could occur further down the line. The information gathered from the Hope Space Probe will also aid scientists as they assess hundreds of other planets that could potentially support life based on their atmosphere and composition.

The Mars probe mission will be one of the UAE's greatest achievements and our most prominent scientific contribution to human knowledge. The probe will collect and send over 1,000 gigabytes of new Mars data back to Earth. This will then be catalogued and analysed in the UAE by the Mars probe mission science team, before being shared with worldwide institutions for the benefit of thousands of space specialists. This is the UAE's contribution to the global scientific community.

Engineers at work in the Space Centre

Taking on the challenge

The probe will be designed, built and effectively managed by a team primarily made up of Emiratis, in coordination with the global scientific and research community. It would of course have been far easier to outsource aspects of the project, but the Mohammed bin Rashid Space Centre team decided to take up this challenge, and take upon itself the development of satellite systems that are fully owned by the UAE.

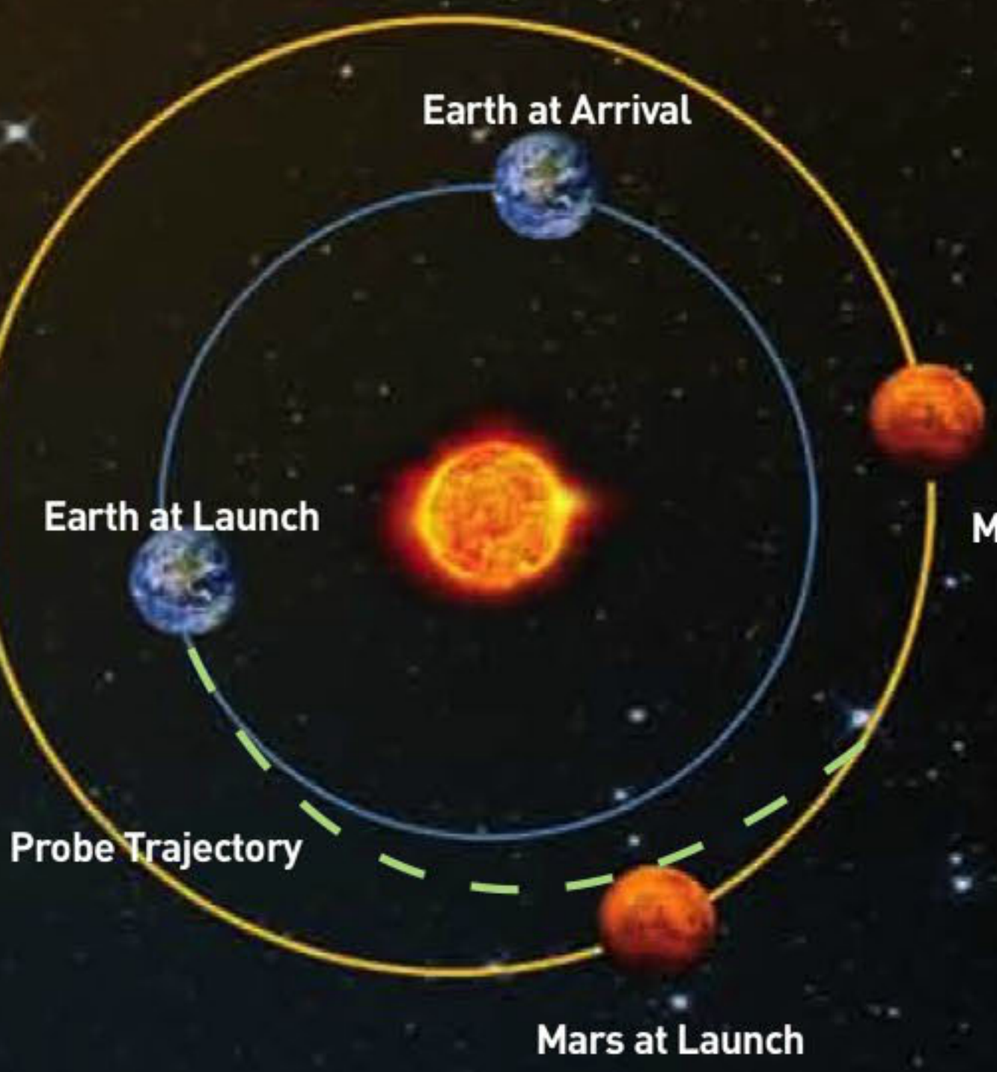
This approach ensures that the mission will leave behind a valuable and enduring legacy in the form of human capital: a generation of experienced scientists and engineers trained and inspired by the Mars mission. Globally, space technologies are becoming increasingly important to the security and economy of nations. The sector is integral to many aspects of life from telecommunications and navigation to broadcasting and the monitoring of weather and natural disasters.

The industry is estimated to be worth around $300 billion globally and is growing by around 8% annually. The Mars mission will be an anchor project for a new space technology industry in the UAE.

The UAE's investment in space technology is already substantial, exceeding 20 billion AED ($5,444,918,400). This includes satellite communications company Yahsat, a satellite data and television broadcast company, mobile satellite communication company, Thuraya Satellite Telecommunications, who provide uninterrupted coverage across two thirds of the world, and the observation satellite system DubaiSat.

HOPE PROBE
Mars Mission Journey

The probe will travel more than 600 million km in a journey that will last around 7-9 months (200 days)



200Days

Crusing distance from Earth to Mars 600m Kilometres

Launch Speed
39600 km/hr

Orbit Period
55 hrs

13-20 mins
Signal delay

Altitude of science orbit
22,000-44000 km
elliptical

Mars orbit insertion

Probe decelerates to
14,000km/h

Crusing speed
126,000 Km/h

Probe uses star trackers to navigate

Unfolding panels to recharge