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HEALTH EFFECTS of human spaceflight

Asia-Pacific: The new space race
Military helicopters: The wave crests

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Asia-Pacific

The new space

Countries in the Far East, Pacific Rim, and Southwest Asia are competing to increase their technical expertise in order to develop new launchers and satellites to navigate, communicate, and spy on their neighbors for economic and military intelligence.

A surging Asian space race is under way, with more than a dozen Asia-Pacific nations trying to settle old scores, earn global recognition, and achieve technological and military space dominance over each other, especially China.

In addition to China, the nations most engaged in this 21st century space race are Australia, India, Indonesia, Iran, Japan, North Korea, South Korea, Malaysia, Pakistan, Singapore, Thailand, and Vietnam. They are vying to increase the technical expertise they will need to develop new launchers and satellites. Their new efforts will improve their ability not only to communicate and navigate but also to spy on their neighbors for economic and military intelligence.

The U.S. recognizes the importance of what is happening. Part of the Obama administration's 'pivot to Asia' is greater military space cooperation with Australia. Such programs are vital to enabling Australia, the U.S., and their allies to monitor Asian nations that are rarely in agreement.

"It is important that Australia take action to address current and emerging space-related vulnerabilities and threats," the Australian government said in commenting on its new cooperation with the U.S.

"Asia's space powers are largely isolated from one another, do not share infor-

mation, and display a tremendous divergence of perspectives," says James Clay Moltz, a professor at the Naval Postgraduate School in Monterey, California, in his book *Asia's Space Race*.

"Such hostile dyads as India-China, China-Japan, India-Pakistan, Japan-South Korea, and North Korea-South Korea indicate that Asian countries see space largely as an extension of other competitive realms, and are carefully watching regional rivalries, attempting to match or at least to check their capabilities, influence, and power," Moltz wrote.

China: Picking up the pace

Ian Easton, research fellow with the Project 2049 Institute, tells *Aerospace America* that "China's ground-to-space ASAT [antisatellite] weapon tests in 2007 and 2010, and its continued progress in a wide range of other ASAT and military space capabilities, have generated a tremendous amount of attention in the Asia-Pacific region, finally putting space on the broader Asian agenda in a way that it was not before." The 2049 Institute is a Washington-area think tank focused on China.

Between 2005 and 2009 China launched just three to five military spacecraft a year. In 2010, however, it more than doubled that rate: Of the 15 missions it launched that year, 12 were military satellites.

by Craig Covault
Contributing writer

RACE

The country has maintained this aggressive pace by launching about a dozen military or dual-use spacecraft a year out of 19 missions for both 2011 and 2012. And this year China says it expects to launch 16 missions carrying 20 satellites, then build the launch rate to 30 missions a year toward 2020. U.S. intelligence analysts have determined that up to 70% of the satellites China has launched are military related.

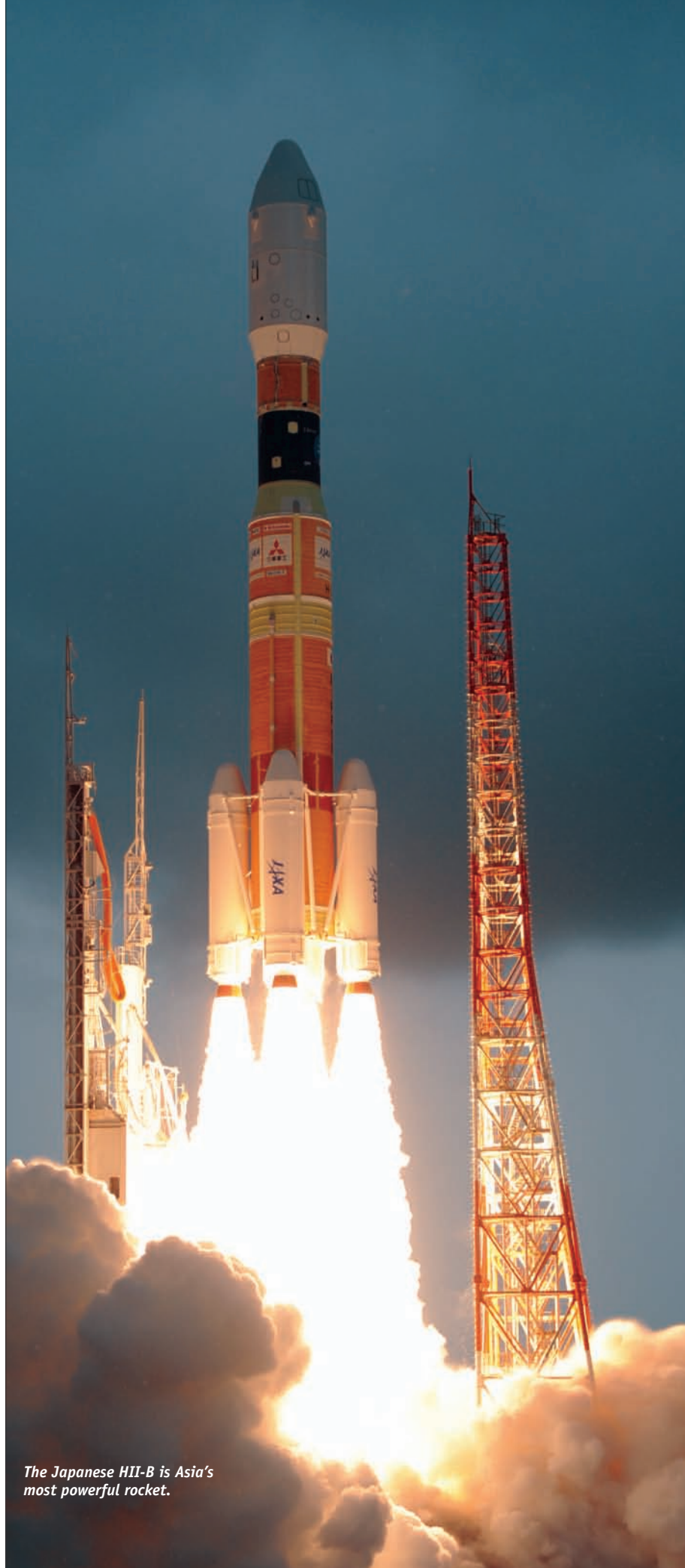
By contrast, Japan and India have each been launching only two to three missions a year. But their launch rates are increasing, especially for military reconnaissance, communications, and navigation spacecraft to counter China and watch North Korea.

Breakout point?

China believes that it is nearing a space breakout point that can lure more Asian countries under its umbrella while also advancing its competitive space posture against the U.S.

To achieve this it will continue launching crews to small Tiangong outposts before assembling a larger modular station by about 2020. Like the June Shenzhou 10 rendezvous mission, these Tiangong longer duration flights will provide the People's Liberation Army, which runs the manned program, with a foothold in space.

China will move toward human lunar missions, according to Liang Xiaohong, af-



The Japanese HII-B is Asia's most powerful rocket.

Shenzhou 10 returned its three-person crew to Earth after a series of successful docking exercises with the Tiangong-1 space laboratory.



ter it gains experience with robotic missions to the Moon and Mars. Liang is the deputy director of the China Academy of Launch Vehicle Technology, the country's largest rocket manufacturer.

In a March 4 Beijing announcement that drew virtually no U.S. media interest, Liang said China is starting formal development of a Saturn-V-class Moon rocket, the Long March 9. The giant three-stage all-liquid-propellant booster is needed "to meet long-term space goals" and "will be able to send men to the Moon," said Liang. The behemoth will be designed to place about 287,000 lb in Earth orbit. By comparison, the U.S. Saturn V could launch up to 308,700 lb, as it did in the April 1972 launch of Apollo 16.

The Chinese Moon rocket will be 323 ft tall with 11 million lb of thrust at liftoff, says Charles P. Vick, an analyst at GlobalSecurity.org. These numbers indicate that the vehicle would have 3.5 million lb more thrust than the 7.5-million-lb-thrust Saturn. China's super rocket missions could start by 2030 from its new launch center on Hainan Island, just south of the mainland.

Competition from India and Japan

The nexus of the Asian space race, however, is the fierce space competition under way between India and China. This rivalry is every bit as serious as the 1960s race to

The Vietnam National Satellite Center received substantial financial backing from Japan, and will develop imaging satellites for that country.



the Moon between the Soviet Union and the U.S., but with the added dimension of antisatellite weapons.

"China plus India plus Japan equals opportunity, tension, and danger," says author Bill Emmott, former editor of *The Economist*, in his book *Rivals*.

All three countries have begun the development of robotic missions to the Moon and Mars, not only for exploration and technology, but because the others are doing it too. All have completed lunar orbit missions, and China plans in December to launch a nuclear-powered robotic lunar lander with a surface life of one Earth year carrying a 200-lb solar-array-powered rover with a lifetime of three months.

India has delayed its lunar rover and will now try to beat China to Mars with an orbiter launched late this year. Japan is developing a second, more ambitious asteroid sample return mission while studying its own future Mars missions.

One rare cooperative project between Vietnam and Japan illustrates how Asian geopolitical and military objectives are being achieved in space by an unlikely team united to counter China.

Vietnam, invaded by the Chinese most recently in 1979, remains angry over such incursions, which date back 2,500 years. West-oriented Japan and communist China, both far more powerful than Vietnam, have opposing ideologies and are vying for advantage in the same area of the Pacific.

Forty years after the bitter U.S.-Vietnam conflict, a more pragmatic communist Vietnam has emerged. Its growing space program is largely supported by Japan, also its prior adversary. Their joint strategy is to reduce China's regional influence while increasing their own reconnaissance of the country, according to a top U.S. analyst of Chinese issues, speaking on background.

In a not-so-subtle message to China, the Japanese government donated close to \$1 billion in aid to Vietnam for a \$600-million Vietnamese National Satellite Center outside Hanoi. Japan is paying the center to develop two Japanese-designed imaging radar satellites that the two countries will use to monitor China. The funds built an attractive campus that has lured a bright young staff of more than 60 people, including 23 engineers who are more like the young geniuses at JPL than revolutionaries.

The first radar spacecraft will be a Japanese-flagged satellite to be launched from Russia or Japan by about 2017. Viet-

Indian responses to China in the Asian space race

•**Military space cell:** India's Ministry of Defence has combined army, navy, and air force officers into a formal Indian Integrated Space Cell. Its purpose is to outline future Indian military space organizational and procurement moves, establish military satellite development, and create an Indian Space Command in coming years.

•**Space agency role:** India's government has ordered ISRO, a civilian agency, to provide each of the country's armed services with initial military spacecraft and with rockets to launch them.

•**Israeli teamwork:** India teamed with Israel for acquisition of an Israeli Air Force TecSar imaging radar satellite with 3-ft resolution to perform military reconnaissance of Pakistan and China. The spacecraft was launched by India as Risat-2 in 2009. India launched an identical radar satellite for Israeli use; both have all-weather, day/night, and foliage penetration capability.

•**Humans in space:** India is beginning development of a manned orbital spacecraft for launching Indian astronauts on its own booster, perhaps as soon as 2018, to blunt China's human spaceflight advancements.

•**Russian help:** Russia agreed to provide India with some manned space technology after the U.S. was forced to decline because of technology transfer regulations. This may include some Russian ground system technology for reconnaissance satellite operations.

•**Planetary exploration:** India accelerated development of its Mars orbiter ahead of a lunar rover originally scheduled for launch in 2014. The Mars mission will now launch this November instead of waiting for the 2018-2020 launch window. This should enable India to beat China to Mars, since China's initial Mars orbiter was lost with the Russian Mars Phobos spacecraft after launch. India hopes to launch its own lunar rover mission later in the decade.



The Israeli-built TecSar day/night all-weather imaging radar satellite, which can also see through foliage, is being used by India to monitor Pakistan and China, especially the deployment of aircraft and armor. India launched a similar satellite for Israel. Credit: Israel Aircraft Industries.

nam will then use the Japanese design to develop its own radar imaging satellite by 2020. Both will be controlled from the Vietnamese National Satellite Center.

For land and ocean remote sensing of their territories and coastlines, the two spacecraft will also use their own night/all-weather and foliage-penetrating radars to image China and share the data.

Worry and change in Japan

Japan has been so worried about China and North Korea that it abolished a ban on Japanese military space activities and since 2003 has launched seven H-IIA boosters carrying military payloads. Six of these flights have been successful, placing six optical and four radar high-resolution military reconnaissance spacecraft in orbit. Even with tight budgets, Japan is funding 10 more reconnaissance satellites for launch over the next five years.

Japan is a key member of the international space station, having provided several Japanese astronauts and the impressive Kibo laboratory module, the largest on the ISS. The country is also continuing to build the 36,000-lb HTV (H-IIB-launched transfer vehicle) to deliver cargo to the station.

The 186-ft-tall Japanese H-IIB is Asia's largest, most powerful rocket, with 2.57 million lb of thrust. The second-largest is China's Long March 3B, which can launch 26,000 lb to LEO. The third-largest, which can place 11,000 lb in LEO, is India's Geosynchronous Satellite Launch Vehicle.

Toward 2020 Japan could lose its edge

to the Chinese as they bring on line their new Long March 5 series, capable of lifting up to 55,000 lb to LEO. Although currently outpowered by Japan, China's rocket fleet is more diverse. It also serves Pakistan, which increases India's space fears.

There are basically two Asian space camps: a limited number of countries aligning with China outright, and a larger number aligning behind Japan, or both. China formed the Asia Pacific Space Cooperation Organization to bring as many Asian nations as it could, including Iran, under its influence. So far Bangladesh, Indonesia, Mongolia, Pakistan, Peru, and Thailand are also part of the group.



India's powerful GSLV is Asia's third-largest rocket.

Pakistan

Pakistan has sided with the Chinese, who developed and launched its new Packsat-1R spacecraft in 2011 to replace an older model. Packsat-1R has 30 transponders, 12 in C-band and 18 in Ku-band.

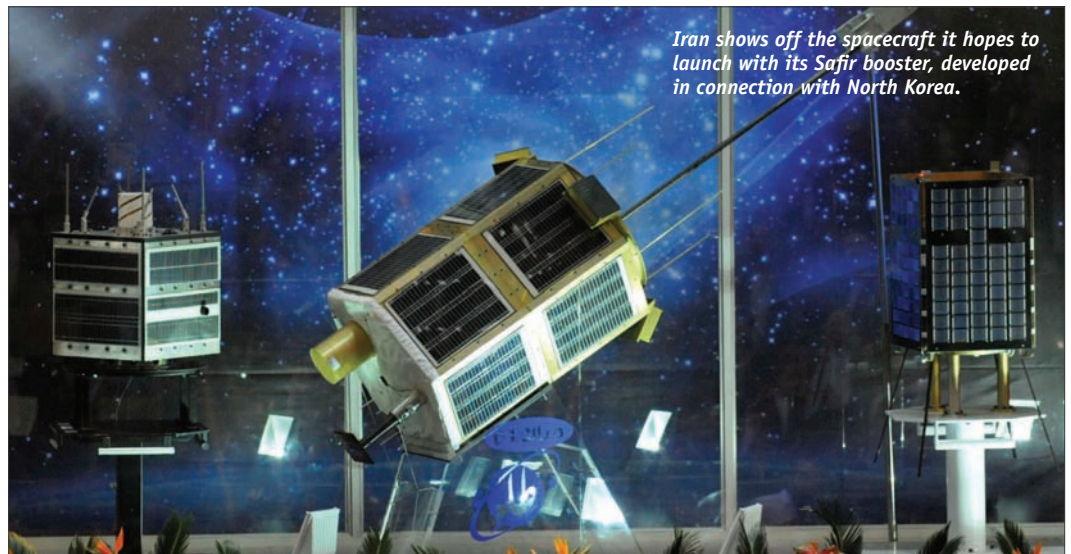
Although the craft serves commercial customers, it also provides Pakistan's military with major new communications capabilities. These include operations in rugged border terrain, says Bharath Gopalaswamy, deputy director of South Asia programs for the Atlantic Council.

Pakistan is also moving to develop a high-resolution optical imaging spacecraft for launch in the coming years. This is another worry to India, which has dominated Pakistan for years with its mature imaging and radar satellite program, partly in collaboration with Israel.

to develop its booster and satellite capabilities, which analysts see as a front for nuclear-armed ICBM development.

In fact Iran says it has a manned space program, with the objective of launching an Iranian astronaut (simply for prestige) on a suborbital space mission. That would not occur until nearly 60 years after U.S. astronaut Alan Shepard's first flight, and by then it would be easier and cheaper for Iran to buy its astronaut a ticket on Virgin Galactic.

But Iran is also affecting the Asian region by exchanging rocket and nuclear hardware with North Korea. For example, the upper stage on the North Korean Unha 3 ICBM-type rocket that launched the country's first crude satellite on December 5, 2012, was Iranian. The North Korean 'remote sensing' spacecraft tumbled out of control shortly after launch.



Iran

Iran has its own 72-ft-tall Safir space booster and has launched up to two small satellites with the vehicle. But it continues

Taiwan

In China, the People's Liberation Army (PLA) is rapidly accelerating its military space operations. Although most military analysts focus on China's ASAT development as a threat to U.S. space assets, the real threat may actually be against Taiwan's increasingly advanced spacecraft, said Mark Stokes, executive director of the Project 2049 Institute, speaking in February before a Chinese ASAT forum at the Marshall Institute in Washington, D.C.

Over mainland China's objections, Taiwan and Matra-Marconi Space in France developed the Formosat/ROCSAT-2 spacecraft having 5-6-ft panchromatic/color



This 5-ft-resolution image of Taipei Airport taken from 553 mi. high by the Formosat spacecraft shows that the satellite has the basic ability to monitor aircraft, large vehicles, and tactical missile deployments. Credit: Taiwan National Space Program Office.

resolution and 26-ft multispectral resolution. It was launched in 2004 from Vandenberg AFB, California, on a Taurus rocket into an orbit that specifically enables daily change detection from space.

That orbit is 553 mi. high, essentially the same altitude where the ASAT attack against the Fengyun-1C polar orbit weather satellite took place. China opposed the satellite on the grounds that it could monitor the PLA. The Taiwanese never admit to spying on China but are of course greatly interested in the several thousand missiles that China has aimed at them.

Although ostensibly a civilian satellite, Formosat-2's resolution is good enough to distinguish facilities such as China's missile batteries and aircraft types and basing. Taiwan's next spacecraft, Formosat/ROCSAT-5, will also have a panchromatic/color resolution of 5-6 ft and improved multispectral resolution (15 ft). Set for launch in 2014 on a SpaceX Falcon 9 rocket from Vandenberg, it will be the first spacecraft totally designed and developed in Taiwan.

Thailand

While Vietnam is countering China by leaning more to the West, Thailand, which used to favor the U.S., is now teaming more with China for spaceflight participation. This is significant, because Thailand operates top-of-the-line U.S. satellites, among them the Space Systems/Loral iPSat-1—at 14,770 lb the largest GEO communications spacecraft ever launched.

Thailand used a Russian Dnepr rocket to launch its 3-ft-resolution EADS/Astrium-built Theos imaging spacecraft in 2008, then a Falcon 9 to launch the Razaksat high-resolution satellite in 2009. Razaksat suffered a serious malfunction and was abandoned.

South Korea: Watching the North

To keep watch on North Korea and China, South Korea also is developing both optical and radar imaging spacecraft. These will serve as dual resource-monitoring/military reconnaissance satellites.

The country bought a Russian launch for its 3.2-ft-resolution Kompsat-2 in 2006, and a Japanese H-IIA to launch its 2.3-ft-resolution Kompsat-3 into a Sun-synchronous orbit in 2012. The pair provide high-resolution resource surveys as well as images of North Korean weapons emplacements, aircraft, and troop movements.

Kompsat-5, a new radar imaging satellite capable of seeing through clouds and



Formosat's large electrooptical imager can simultaneously capture four panchromatic, multispectrum images and then transmit the data to government agencies, private sector companies, and research organizations. Credit: Matra-Marconi/Taiwan National Space Program Office.

foliage with 10-ft resolution, is set for a Dnepr launch late this year.

Although China is a major adversary of both Japan and South Korea, the latter two do not share intelligence, said Dean Cheng, speaking at the Marshall Institute forum. Cheng, a research fellow at the Asian Studies Center of the Heritage Foundation, noted that the lack of cooperation between Asian space nations is one factor that emboldens China.

In January of this year, South Korea finally succeeded in launching its own small research spacecraft on its Naro-1 rocket, developed with a Russian Angara first stage and a South Korean solid-propellant second stage. The program had suffered two previous launch failures, in 2008 and 2009.

U.S. intelligence agencies provide Seoul with images or data about North Korea from National Reconnaissance Office satellites. But now Kompsat spacecraft and Naro-1 should enable South Korea to keep more of its own watch on the North.

(Continued on page 47)



Korean Space Launch Vehicle 1, also called Naro, launches into orbit from South Korea's Naro Space Center, successfully carrying a science satellite into orbit. Credit: Korea Aerospace Research Institute.

Asia-Pacific

(Continued from page 37)

It is noteworthy that North Korean Unha 3 launch attempts—the December 5 success and an earlier failure—took place from a North Korean pad and gantry designed for a much larger rocket. The service tower dwarfed the Unha 3 and could handle a rocket nearly twice as big. North Korea will eventually develop reconnaissance satellites, analysts believe, but for now it is concentrating far more on developing rockets as long-range ballistic missiles.

Indonesia, Malaysia, and Singapore

Like North Korea and Iran, Indonesia wants to broaden into launch operations. For 30 years the country has had communications spacecraft programs, including shuttle-launched Palapa Hughes HS-376 satellites like the one rescued for relaunch by Discovery astronauts in 1984. In fact two Indonesian astronauts trained as shuttle payload specialists affiliated with the Palapa program, but were never able to fly.

Today Indonesia plans to lure commercial vehicles to its territory (or even build one of its own) to launch toward geostationary orbit from its energy-efficient equatorial location.

While South Korea and Taiwan monitor China with nearly 1,500-lb satellites, Malaysia is “the mouse that roared,” says Moltz. He refers to the country’s participation in a host of Asian space forums and its aspirations for using space activities to benefit its population. It has formed a major commercial communications spacecraft capability using U.S.-developed satellites launched by Ariane boosters. A Malaysian astronaut also spent 10 days on board the ISS.

Even the tiny but wealthy city-state of Singapore is laying the groundwork for a serious space program. This will take the country beyond the glitzy marketing that surrounds space-themed hotels and proposed suborbital rides for wealthy space tourists.

“Singapore has recently begun sending large numbers of scientists, engineers, and military officers abroad for space training, and promising big salaries to attract aerospace faculty to its own universities,” Moltz said in the *Boston Globe*. “In 2011, it paid India to put the first domestically produced Singaporean satellite into orbit. The tiny nation seems well poised to develop a niche capability in maritime operations and reconnaissance,” he noted.



Responses from India

At around the time Singapore began reaching for greater space development, India’s government specifically ordered the Indian Space Research Organization (ISRO) to develop Indian military satellites in response to China and Pakistan.

“Evidence shows that China and India are watching each other’s activities in space very carefully and keeping score as to who is gaining and losing influence,” said Moltz in a *Space Quarterly* interview.

China’s ASAT test “highlighted the long-term global threats to India’s considerable space assets,” said Gopaldaswamy in a Carnegie Endowment report. India is now deciding how to handle any future Chinese ASAT tests, he said. If one occurs, India will be prepared to test an ASAT weapon of its own, comprising Indian antiballistic missile hardware.

China’s 2007 and 2010 lunar orbit missions have also blunted India’s prestige. The missions have prompted India to increase its own space budget sharply, by 38%, and to shift from crop monitoring and hydrology to military space efforts as well as higher visibility exploration missions.

Indian and other Asian space experts have told *Aerospace America* that India is set on winning its space race with China and Pakistan, having resolved to spend the money and make the project decisions necessary to make that happen.

But the broader Asian space race is just getting started, on many different levels in many different countries, and the outcome will take years, if not decades, to sort out. ▲

The new North Korean launch pad and service tower are much larger than required for the white Unha-3 rocket being serviced at the site. This indicates North Korea plans to launch larger rockets from the same facility. Credit: KCNA