The Greatest Gig in the Sky;
Iran's Ballistic Missile Capabilities

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“Our production lines are running very smoothly and we are capable of producing an endless number of ballistic missiles,” announced Brigadier General Hossein Salami, deputy commander of Iran’s Islamic Revolution Guards Corps (IRGC) in a recent interview with Iranian national news agency, *Fars*.

We have made phenomenal progress in air defence capabilities and a current slew of sanctions mean nothing more than a soft encouragement for us to acquire ‘self-sufficiency’ added Salami.

The top commander’s comments clearly resonate with President Mahmoud Ahmedinejad’s earlier claims made in February, that Iran’s enemies still remained at a loss to devise any kind of interception system capable of breaching its ‘impenetrable’ missile shield.

Iranian political and military top brass is known to have gone on record, time and again, claiming flamboyant military accomplishments and technological advancements, only to maintain a hush-hush silence later on.

In the beginning of 2010, Iran’s defence minister Ahmad Vahidi had boasted how Iran’s *Qaem* missiles were completely out of reach of its enemy’s electronic warfare and tracking systems. *Qaem* being a semi-heavy laser-guided missile with an ability to destroy targets flying only at low speeds and altitudes. If one goes by the defence minister, this incredible stealth ability had been acquired due to Qaem’s super advanced laser-guidance systems.

So are most of Iran’s military and ballistic claims a part of well-choreographed histrionics? Is it just plain baloney to accentuate a power-play? Or is there some truth lurking in Iran’s dangerous claims?

While it is well known that Iran has made serious efforts to expand its nuclear abilities and develop ballistic missiles, with an aim of acquiring an ability to deliver nuclear warheads beyond its borders, not much is spoken on the utility and efficacy of its current missile arsenal.

Iran has consistently denied any interest in nuclear weapons and historically claimed its missiles were strictly defensive in nature, while Western powers have unwaveringly accused it of harbouring nuclear warfare ambitions. In February 2010, the *International Atomic Energy Agency*, IAEA, declared that ‘Iran’s activities are related to the development of a nuclear payload for a missile’.

Missiles in Iran’s inventory are now believed to be inherently nuclear capable, if it could develop sufficiently compact warheads. It is now known that Iran’s longest range missiles are capable of reaching Israel, Turkey, the neighbouring Arab Gulf States, Southern Russia and South-Eastern Europe.

It was in 2003-04 that concerns about Iran’s nuclear intentions and its designs for a missile re-entry vehicle, capable of carrying a nuclear payload, were fanned for the first time. Since then Iran has achieved considerable progress in the domain of fissile-material production capabilities (enriched uranium and plutonium) and ballistic missiles.

In November 2008, Iran test-fired a solid-fuelled *Sajjil* missile, capable of delivering a 750 kilogram nuclear weapon over approximately 2500 kilometres. Subsequent tests of *Sajjil* in May, September and December 2009 were also reported to be successful by Iranian authorities.

February 2009 witnessed Iran deploying a satellite in space, the *Omed*, by employing a two-stage rocket and thus becoming the first Muslim nation in the world to put an indigenously built satellite in orbit. By this time, Iran had successfully exhibited its prowess in developing liquid-filled missiles such as *Shahab-3* and *Ghadr-1*.

All this served as an indicator that Iran had indeed established the industrial infrastructure and technological foundations to begin indigenous development of a larger, more powerful rocket propulsion mechanism.

The last 10 years has seen the US and other nations deploy silo-based missile interceptors in Poland, tracking radar mechanisms in Czech Republic, and a national missile defence system in Alaska and California to supposedly ward off potential Iranian Intercontinental ballistic missiles (ICBMs).

America's threat perception from Iran has accentuated manifold over the years. In 2007, President George Bush cited US intelligence agencies that 'with continued foreign assistance', Iran could develop an ICBM capable of targeting the United States and entire Europe before 2015.

However, this seems to be an old story re-packaged again. As early as 1998, the Rumsfeld Commission, also known as the *Commission to Asess Ballistic Missile Threat to the United States*, concluded that Iran 'had the technical capability and resources to demonstrate an ICBM-range ballistic missile, with a range greater than 5,500 kilometres.

Ten years later, the story remained the same yet none of the worst-case scenarios projected by the US had played out.

Based on an 'updated new intelligence assessment', in September 2009, President Barack Obama decided to reconfigure the European missile shield into Morag, South-Eastern Europe. A White-House fact sheet issued in support of the defence plan said: "the intelligence community now assesses that the threat from Iran's short-and medium-range ballistic missiles is developing more rapidly than projected, while the threat of potential Iranian ICBM capabilities has been slower to develop, than previously estimated."

This was a volte face from the line of approach adopted by the previous Bush administration, which strongly believed Iran could unleash a flurry of ICBM's by 2015.

While the world witnessed a concentrated momentum among Western nations to restrain Iran's missile capabilities, the stark truth was that there was not a single international treaty banning ballistic missile development or acquisitions. The most successful initiative till date was established in 1987 by Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

Known as the *Missile Technology Control Regime(MTCR)*, the initiative had a mere 34 member states by the end of 2001. It sought specifically to limit the spread of missiles, rockets, cruise missiles and unmanned aircraft capable of delivering a 500kg payload to a distance of not more than 300km. Understandably, Iran became a prime target for MTCR member nations and in 2003 the latter restricted export of items believed to be used for missile proliferation programmes, such as that at the Iranian facility involved in the production of *Shahab-3* missiles. However, countries such as China, North Korea and Libya, with whom Iran has supposedly had more than favourable military alliances, did not sign the MTCR.

In 2004, the Chinese government's application for MTCR membership was rejected on the grounds that it had not ceased exporting missile technologies to Iran and carried on surreptitiously.

Further obstacles to Iran's ballistic programmes were put in place in 2002 and 2003 in the form of the *International Code of Conduct against Ballistic Missile Proliferation (ICOC) or The Hague Code of Conduct* and the *Proliferation Security Initiative (PSI)*.

As of 2010, 130 countries subscribed to the ICOC yet Iran was not amongst them. It was also the only country to have voted against the UN General Assembly resolutions in 2005 and 2008 that endorsed this code. On December 23, 2006, the UN Security Council adopted *Resolution 1737* that directed states to prohibit the transit of missile technology to Iran from their territory or by their nationals.

The Journey, so far

Iran's acquisition of ballistic-missile technologies began in the mid-1980s when it purchased Soviet-made, liquid-fuelled, *Scud-B* missiles from Libya, North Korea and Syria to satisfy an immediate wartime need during the Iran-Iraq war. On March 12, 1985, Iran executed its first *Scud-B* missile attack against Iraq from a base in Kermanshah. Over the following three weeks, Tehran fired seven more missiles at Baghdad and one at Kirkuk.

Following the success of the *Scud-B* missile attacks, Iran purchased additional 300-km range *Scud-Bs* and 500-km range *Scud-Cs* from Libya, Syria and North Korea, which it later fielded as *Shahab-1* and *Shahab-2*, respectively.

Akbar Hashemi Rafsanjani, the then Speaker of the *Majlis*(Iranian parliament), led diplomatic missions to the above countries in pursuit of the additional missiles.

The acquisition of this second batch of missiles allowed Iran to launch eight more *Scud-Bs* against Baghdad and other Iraqi cities in the second half of 1986.

In November 1987, IRGC Minister Mohsen Rafiqdust claimed that Iran had successfully begun copying *Scud-B* missiles. With the help of North Korean engineers, Tehran embarked on a new journey of assembling and maintaining missiles.

North Korea emerged as Iran's chosen military partner as it easily reverse-engineered the *Scud-B* missiles in the early 1980s and was perhaps one of the first countries outside the *Warsaw Pact* to produce these missiles indigenously.

In the mid-1990s, Tehran also purchased the *No-dong* medium-range missile from North Korea. It quickly put an infrastructure together to assemble a domestic version of the *No-dong* and rechristened it as the *Shahab-3*. Today, the actual production of *Shahab-3* is still believed to be dependent on critical components imported from North Korea, Russia and possibly China as well.

By 2004, Iran modified the *Shahab-3* by increasing its range, lengthening the propellant tanks, reducing the warhead mass, reconfiguring the re-entry vehicle and most importantly, replacing the heavy steel airframe with a lighter-weight, high-strength aluminium alloy. They called this new missile as the *Ghadr-1*.

As if to demonstrate their improving ballistic advancement to the world, Iran added a second-stage to a modified *Ghadr-1* platform to deploy a satellite into low-Earth orbit with the help of the *Safir* space launcher.

It is estimated that Iran, today, has approximately 200-300 *Shahab-1* and *Shahab-2* missiles, each capable of easily reaching targets in neighbouring countries. Using the *Shahab-3*, which has a payload of 1000kg, Iran can also hit as far as 900 km from its border. The *Shahab-3* has been successfully commissioned in the Iranian army since 2003.

In 2004, Iran began flight tests of modified versions of *Shahab-3/Ghadr-1*, which had an extended range of 1600km, albeit, with a smaller 750kg warhead. It is now believed by Western intelligence agencies that Iran has six *Shahab3/Ghadr-1* transporter-erector-launcher (TEL) vehicles and between 12 and 18 *Shahab-1/2* TELs.

Despite Iran's growing ballistic prowess, its liquid propellant missile programme remained ever dependent on foreign supply of key components, including antiquated Soviet-era engines. These missiles were also turning out to be cumbersome, immobile and vulnerable to pre-emption. The solution for Iran rested in a high-growth potential, indigenously designed and produced, solid-propellant missile industry.

What could easily be considered as a turning point in Iran's ballistic history, Tehran indigenously designed, developed and produced, a solid-propellant missile, *Sajjil*, for the first time. After two decades of secretive efforts and substantial technical and material support from China, *Sajjil* boosted Iran to a completely new level.

It had better acceleration, shorter motor-burn time that reduced any chances of boost-phase interception by potential adversaries and could be launched faster than any other missile.

Iran's path of progress from liquid-fuelled missiles, *Ghadr* and *Shahab*, to solid propellant missiles such as *Sajjil*, has profound strategic implications. As Iran masters solid-propellant production technologies, it inches closer to its goal of manufacturing long-range missiles designed to meet specific strategic objectives.

It is now developing an operational system of a new medium-range solid propellant missile, the *Sajjil-2*, potentially capable of delivering a 750kg warhead to a range of about 2,200km.The *Sajjil-2* has been successfully flight-tested and is barely two to three years away from being commissioned in the military units. However, *Sajjil-2*'s consistency and reliability under a variety of operational conditions is yet to be proven.

Iran is the only country in the world to have developed a missile of this range without first having developed its nuclear warhead or nuclear weapon.

Despite all brouhaha and advancements in ballistic missile development, Iran is not known to have developed appropriate nuclear warheads that can be delivered by an ICBM or MRBM. It is widely believed that China and North Korea are now helping Iran to achieve this ability.

While most missile design and development activities can be hidden from public view or initially concealed with a commercial, space-launcher development programme, flight tests, which must be undertaken to verify and document a missile's performance and reliability, cannot be kept hidden.

Factors such as gyro-stabilization, down-range dispersion, range and payload thresholds, aerodynamic stability, strike and flight accuracy, combustion/propulsion efficacy with and without the warhead, can only be studied when the missile is in flight.

With current satellite tracking systems, it is impossible for Iran or any country to conceal flight-tests, that are an absolute must to verify and document a missile's performance and reliability, uncover design and construction flaw and validate system performance under a variety of operational conditions.

On an average, at least one dozen flights have to be performed before any missile system capable of delivering nuclear warhead is deployed or commissioned. Additional tests are at times required to fix any flight failures during the test programme Therefore; there is no chance that Iran can avoid detection of its missile testing activities.

In 1998, when Iran secretly test-fired a missile from a barge in the Caspian Sea, US Secretary of Defense, Donald Rumsfeld confirmed that a missile was launched from a cargo vessel in the Persian Gulf.

"They took a Scud, put it on a transporter-erector-launcher, lowered it in, took the vessel out into the water, peeled back the top, erected it, fired it, lowered it and tried to cover it up," said Rumsfeld then.

Helping Hand

Much of Iran's advancements and military prowess is known to have been acquired with the help of considerable foreign assistance it received in 1990s. In the case of North Korea, its missile cooperation with Iran is well-documented. Besides providing the bulk of Iran's missile imports, it is believed to have tutored Iran in the reverse-engineering process of developing and producing missiles and rockets from existing operational systems.

Russia's role in providing technical assistance to Iran is amply substantiated by reports of Russia's *Central Aerohydrodynamic Institute* tying up with Iran's *Defence Industries Organization* and the *Shahid Hemmat Industrial Group* in developing specialised wind-tunnels, data collection systems and scale models for testing aerodynamic properties for shorter-range missiles.

In fact, according to a dossier released by the *International Institute of Strategic Studies(IISS)*, London, *Roosvoorouzhenie*, the official Russian military equipment export agency, *Nikolia Kuznetsov Engines*-a former manufacturer of liquid-fuel engines and the *Bauman National Technical University*-one of Russia's leading research centres, have all played a crucial role in developing the propulsion, guidance and control systems of Iranian missiles. Iranian students have also been known to be studying rocket engineering courses at the *Baltic State University* in St.Petersburg.

China is also alleged to have provided equipment, technology and expertise to Iran in developing their long-range solid propellant missiles. In the recently released dossier on Iran's ballistic and missile abilities, IISS London mentions Chinese institutions such as *China Precision Engineering Institute* and *Great Wall Industries* as having helped Iran develop more accurate and reliable missiles.

Deployment Options

With an arsenal of such lethal missiles, how does Iran intend to maximize their benefits? All of Tehran's ballistic missiles are assigned to the air-force units of *Iranian Revolutionary Guards Corps(IRGC)*. In 2003, IRGC chief commander, Yahya Rahim Safavi, revealed that Iran had organized five ballistic-missile groups, while in 2004, the exiled *National Council of Resistance of Iran(NCRI)* claimed that Iran was fielding two brigades for the *Shahab-3* missile; the *5th Raad Brigade* stationed at the *Sajjad Base* near Karaj and the *15th Qaem Brigade*.

It is also widely believed that Iran has built underground silos in *Tabriz* and *Khoraramabad* areas, from where Iran's *Shahab* and *Ghadr-1* range of missiles would put Iraq, Israel, Turkey, Qatar and other countries in the Persian Gulf at easy strike range. Presumably, once the *Sajjil-2* is fully developed and ready for operation, it too could be deployed to the silos near *Tabriz*, putting parts of south-eastern Europe within reach.

Utility of its deadly missile arsenal

Iran could use its ballistic missile programme as a political weapon to wage a terror campaign against adversary countries or cities. While the attacks could trigger a wave of fear, the casualties caused would be lower than imagined.

One of the principal reasons being, Iran's ballistic missiles are severely limited due of their poor accuracy, despite Iran's tall claims.

Iran could probably conduct harassment attacks aimed at disrupting operations or causing damage at fuel-storage depots, airfields and seaports but it would be incapable of shutting down critical military activities or bases.

The distance from Western Iran to Israel is about 1000 km. And it is this distance that plays a critical role in determining Iranian military might.Operational security and pre-launch survivability prevent Iran from deploying missiles near its border with Iraq, extending the minimum required missile range by another 300km, the approximate surveillance distance of the American E-3 Advanced Warning and Control Systems (AWACS) airplane patrolling in the Persian Gulf or along Iran's international border with Iraq.

The maximum range for an operational Shahb-2 missile is 500 km, less than half the distance to Israel. Its range could be increased to 700 or 800km by extending the fuel tanks and lightening the payload. However, this would diminish the military utility of the missile by reducing the warhead mass to inconsequential levels. A poor warhead mass means the impact is not as powerful.

The range of a missile is, therefore, inversely proportional to the mass of its warhead. The greater the range, the lesser the warhead mass on board. As of now, Iran does not seem to have figured out a solution that mixes the perfect match of the two parameters.

When Iran tested the Shahb-3/Ghadr-1 in July 2000, the missile impacted some 800km short of its maximum range attributed. Failures such as these suggest that its missiles do not provide a stable flight path or strike accuracy.

Another important parameter that acts an indicator of a missile's control and accuracy is the CEP- *Circular Error Probable*. The CEP calculates a weapon's accuracy most

precisely. It is defined as a radius of a circle into which a missile, projectile or bomb will land at least half the time. For short-range tactical rockets, an accuracy error of 1-2% of the total flight range is permissible but for longer ranges strategic systems, even if they are armed with a nuclear warhead, this kind of margin of error is too large.

A 1% percent error for a 2000km range missile would result in a warhead missing the target by as much as 20km. Therefore, to be strategically effective, medium and long-range missiles require more precision. The Sajjil-2, has many shortcomings to overcome before Iran even dares to field it against Israel.

An accurate delivery of the warhead also requires the missile's propulsion system to shut down precisely at the right moment. Iran is still struggling with that problem in its existing liquid-fuelled missiles.

Turning one's attention back to the CEP or the accuracy factor of a missile, the CEP also denotes the kill probability for a missile. For a missile to have a better than one-in-ten chance of destroying a hardened building, or let's say a kill probability of 0.1%, the CEP must be less than 200 metres. But the CEP for Iran's Shahab and Ghadr missiles ranges between 500 to 1500 metres. Therefore, the military utility of these missiles is very poor. The probability that Ghadr-1 could destroy a soft target such as exposed military or civilian personnel and equipment stationed near the 'aim' point is extremely low, ranging between 0.01 and 0.001 % kill probability.

Assuming, each of these missiles carry one-tonne, high-explosive warheads and Iranian target planners demand a destruction level of only 50 %, it would require 800 Shahab-1 to fulfil the mission. If the Ghadr-1 was used, it would require more than 3000 missiles. In a hypothetical situation, if Iran wanted to damage Israel's nuclear reactor at Dimona in Tel Aviv, and achieve only 50% success, it would require more than 3500 Ghadr-1 missiles. To achieve 90% success, more than 10,000Ghadr-1 missiles would be required. Therefore, as of now, Iran's ballistic abilities are not much of an imminent threat to Israel.

When it comes to 'casualties', the strategic value of ballistic missile attacks rely more on fear than realistic assessment of risks. Consider the 1115 German A-4 missile attacks on Britain during the Second World War, 2754 civilian deaths were caused. That averages to two people per missile.

In the 1991 Gulf War, Iraq launched 88 Al-Hussein missiles against Israel and Saudi Arabia killing 31 people. Hizbollah rocket attacks of more than 4000 in number, during the summer of 2006, resulted in 53 Israeli deaths. That's one casualty for every 100 rockets.

There have been one-off tragedies as well where the kill-rate was more than 200 people, for instance in Antwerp and London in World War II. Similarly in Feb'1991, an Iraqi Al-Hussein missile attack at a US military barrack in Dhahran, Saudi Arabia, killed over 28 and injured nearly 100 soldiers.

The matter of fact is that more harm is inflicted by the panic and terror than the actual number of casualties caused. Extrapolating the above numbers, if Iran had to use its entire arsenal of Shahab, Sajjil and Ghadr missiles, the attacks would result a death of 100-500 people, though the population density of most gulf cities is lower in number than London or Antwerp, where the highest per missile death rates were experienced during World War II.

Moreover, theatre missile defence systems deployed by USA and launcher interdiction efforts are bound to reduce the number of missiles actually striking population centres. Consequently, casualty figures expected would be much lower than historically suggested.

Therefore, in all probability, the threat perception that the West projects from the Persian nation is exaggerated. While, on the other hand, the heroic tales of its ballistic might that Iran keeps churning, can surely be taken with a pinch of salt. All in all, it has reduced down to a ridiculous game of 'who blinks first' and proving one's supremacy over the other.

While, the author of this paper has based his observations on independent research and the recently released dossier on Iran's missile and ballistic abilities by the International Institute for Strategic Studies, London, a series interviews with Mr Mark Fitzpatrick, Senior Fellow for Non Proliferation, IISS london, have contributed significantly in forming the mainstay of this report.

Mark Fitzpatrick's interesting observations and views on Iran's ballistic abilities, that he shared with the Al Jazeera Centre for Studies, can be found on the following video links:

http://www.youtube.com/watch?v=0VL9u_fN9Os
http://www.youtube.com/watch?v=Il_g6s4QrLM
http://www.youtube.com/watch?v=sO5iQpoz_W8

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