BALLISTIC AND CRUISE MISSILE THREAT

Obtained by the Federation of American Scientists from the National Air and Space Intelligence Center (NASIC)

DEFENSE INTELLIGENCE BALLISTIC MISSILE ANALYSIS COMMITTEE

Key Findings

India Agni IV IRBM

Many countries view ballistic and cruise missile systems as cost-effective weapons and symbols of national power. These weapons present an asymmetric threat to US forces. Many ballistic and cruise missiles are armed with weapons of mass destruction. However, numerous types of ballistic and cruise missiles have achieved dramatic improvements in accuracy that allow them to be used effectively with conventional warheads. These highly accurate weapons can be used in anti-access/area denial (A2/AD) missions. The term A2/AD refers to capabilities designed to deter or counter adversary forces from deploying to or operating within a defined space.

North Korea has been developing the road-mobile Hwasong-13 intercontinental ballistic missile (ICBM) for several years and in October 2015 unveiled the Hwasong-14, a new road-mobile ICBM. The Taepo Dong-2 (TD-2), which placed a satellite in orbit for the first time in December 2012, placed a second satellite in orbit in February 2016. Flight testing of the Hwasong-10 (Musudan) intermediate-range ballistic missile (IRBM) began in April 2016 with multiple failures. Several new solid-propellant missiles including a short-range ballistic missile (SRBM), a submarine-launched ballistic missile (SLBM) and a medium-range ballistic missile (MRBM) are also being developed. In April 2017, North Korea also commenced flight testing of a new liquid-propellant IRBM, the Hwasong-12.

Tehran's desire to have a strategic counter to the United States could drive it to field an ICBM. Progress in Iran's space program could shorten a pathway to an ICBM because space launch vehicles (SLV) use inherently similar technologies. Since 2008, Iran has conducted multiple successful launches of the two-stage Safir SLV and has also revealed the larger two-stage Simorgh SLV, which could serve as a test bed for developing ICBM technologies. Iran has developed the Qiam-1 SRBM, the fourth-generation Fateh-110 SRBM, and claims to be mass-producing ballistic missiles capable of striking ships. Iran has modified its Shahab 3 MRBM to extend its range and effectiveness and also claims to have deployed the two-stage, solid-propellant Sejjil MRBM. In 2015, Iran publicized the launch of the Emad-1, which officials claim is Iran's first long-range missile that is guided throughout flight and capable of hitting its targets with high-precision. Iranian officials have also announced plans for an Emad-2 with greater precision as well as a new Sejjil which can also be guided all the way to the target.

China continues to have the most active and diverse ballistic missile development program in the world. It is developing and testing offensive missiles, forming additional missile units, qualitatively upgrading missile systems, and developing methods to counter ballistic missile defenses. China's deployed ballistic missile force, operated by the People's Liberation Army (PLA) Navy and PLA Rocket Force after being renamed - from the Second Artillery late last year as part of the PLA's reorganization - is expanding in both size and types of missiles. China continues to field conventionally armed SRBMs such as the CSS-6 (DF-15) and the CSS-7 (DF-11) opposite Taiwan, and has developed a number of mobile, conventionally-armed MRBMs and IRBMs. Missiles such as the CSS-11 (DF-16), CSS-5 Mod 4 (DF-21C) and Mod 5 (DF-21D) and DF-26 are key components of the Chinese military modernization program, specifically designed to prevent adversary military forces' access to regional conflicts. The CSS-5 Mod 5 and a variant of the DF-26 have anti-ship missions.

China's nuclear-armed missile force is also expanding. China is adding the CSS-10 Mod 2 (DF-31A) and CSS-4 Mod 3 (DF-5B) to the ICBM force; the DF-5B is China's first ICBM with multiple independently-targetable reentry vehicles (MIRVs). The number of Chinese ICBM nuclear warheads capable of reaching the United States could expand to well over 100 within the next 5 years. The CSS-N-14 SLBM gives China its first long-range, sea-based nuclear capability. China is also developing a new road-mobile ICBM, the CSS-X-20 (DF-41), possibly capable of carrying MIRVs. China attributed both nuclear and conventional missions to the DF-26 displayed for the first time during the Victory Day Parade in September 2015.

Hypersonic Glide Vehicles (HGVs),

a new class of weapon propelled to hypersonic velocity by ballistic missile boosters, are an emerging threat.

In September 2014, Russia surpassed the US in deployed nuclear warheads with over 1,500 deployed on ballistic missiles capable of reaching the United States. Despite arms control limitations and resource constraints, development of new ICBM and SLBM systems is proceeding, and Russia is expected to retain the largest force of strategic ballistic missiles outside the United States. According to official statements, a new missile called the Rubezh, which is smaller than the SS-27 Mod 2 ICBM, will be deployed. The Bulava SLBM has been deployed on the new DOLGORUKIY-class SSBNs. Officials have stated that Russia is set to begin flight-testing a new heavy, liquid-propellant ICBM called the Sarmat. Additionally, Russian industry officials have indicated deployment of a new rail-mobile ICBM is being considered.

Pakistan RA'AD Cruise Missile

Land-attack cruise missiles (LACMs) are highly effective weapon systems that can present a major threat to military operations. The majority of LACMs fly at subsonic speeds, but there are a few which fly at supersonic speeds, and, in the future, some will be able to reach hypersonic speeds. Subsonic missiles are able to fly at low altitude and attack a target from multiple directions. Aircraft, ground and naval platforms can all launch LACMs. Russia has various LACMs which can be launched from all three types of platforms. China has ground and air-launched LACMs and Iran is developing a ground launched LACM. According to open press reports, Russia has used air- and naval-launched LACMs several times in Syria.

Some weapon systems have characteristics of both ballistic and cruise missiles. For example, ballistic missile-launched hypersonic glide vehicles (HGVs), are essentially unpowered cruise missiles. Future supersonic/hypersonic powered cruise missiles may be launched by large rocket boosters that have traditionally been associated with ballistic missiles.

The Threat

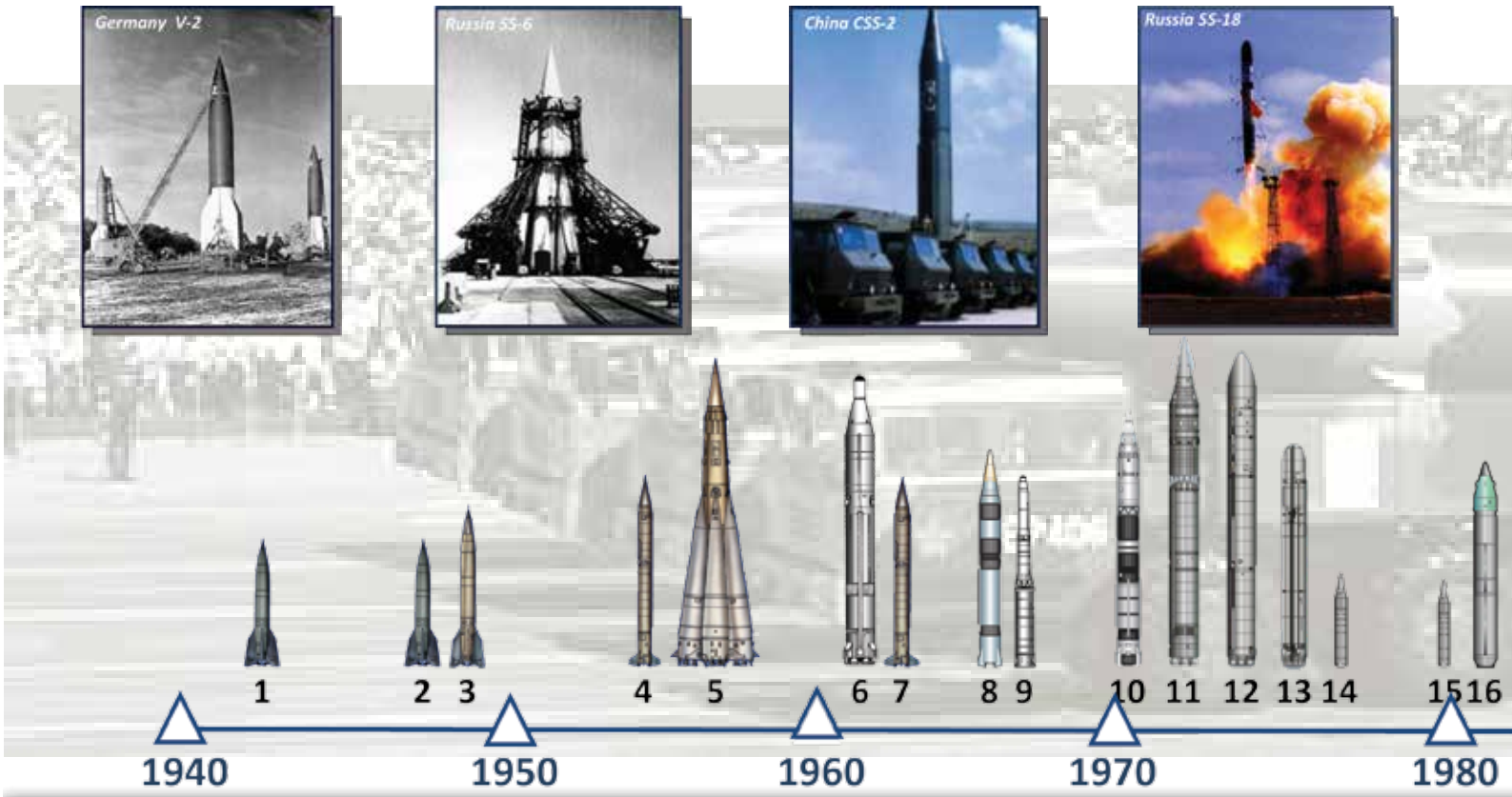
Guided cruise and ballistic missiles were first used when Germany attacked targets in England and Northern Europe with V-1 cruise missiles and V-2 ballistic missiles during World War II. Although these missiles were inaccurate, their use resulted in tens of thousands of Allied casualties.

Ballistic and cruise missiles present a significant threat to US and Allied forces overseas, and to the United States and its territories. Missiles are attractive to many nations because they can be used effectively against an adversary with a formidable air defense system, where an attack with manned aircraft would be impractical or too costly. In addition, missiles can be used as a deterrent or an instrument of coercion. Missiles also have the advantage of fewer maintenance, training, and logistic requirements than manned aircraft. Even limited use of these weapons could have devastating consequences if armed with chemical, biological, or nuclear warheads.

The ballistic and cruise missile threat continues to increase with the proliferation of missile technology. Over 20 countries have ballistic missile systems, and missiles likely will be a threat in future conflicts involving US forces. Ballistic missiles have been used in several conflicts over the last 30 years, including the Iran-Iraq war, the Afghan civil war, the war in Yemen, the 1991 and 2003 Persian Gulf conflicts, the Russian military actions in Chechnya and Georgia, and most recently in the conflicts in Syria and the Ukraine. Russia used cruise missiles for the first time during the conflict in Syria.

The US Armed Forces are responsible for countering the ballistic and cruise missile threat through deterrence and, if necessary, active suppression. Threat suppression may include attacks on missile systems, both before launch and in flight, and attacks on their supporting infrastructure. This document includes information on some of the major current and projected foreign ballistic and cruise missile systems.

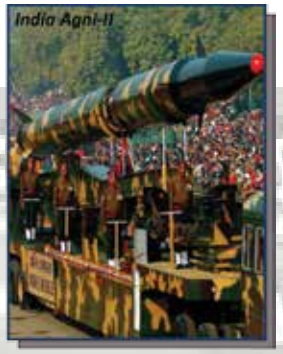
The table and timeline depict selected ballistic missiles to highlight first flight tests, notable systems, and significant development achievements for various countries.

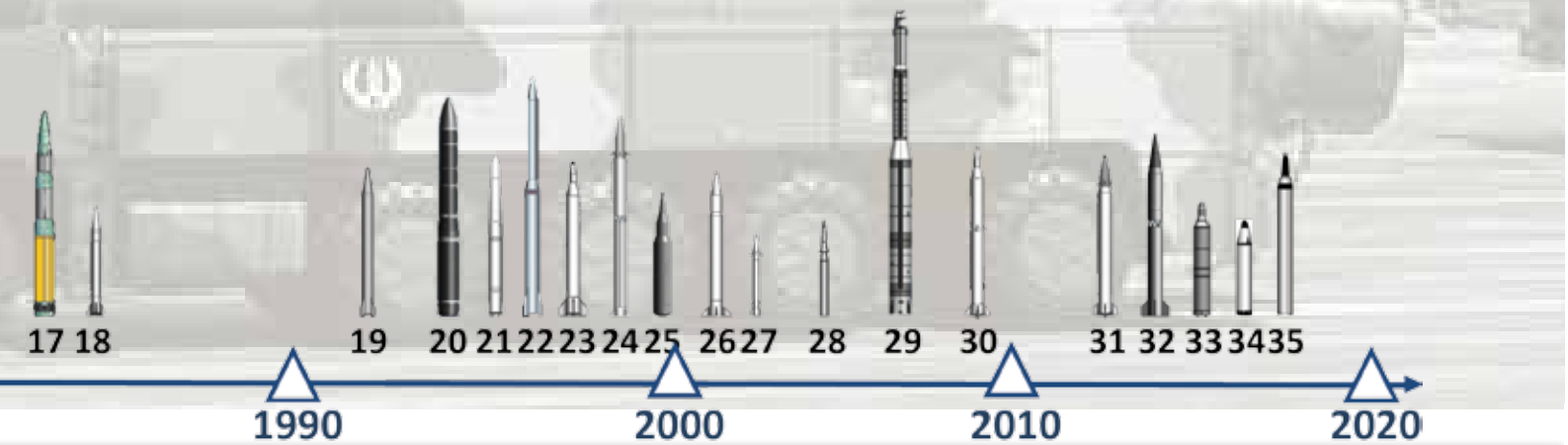


Ballistic Missile System Development

#	System	Country	Year	Range (km)
1	V-2 SRBM	Germany	1942	320
2	SS-1 SRBM	Soviet Union	1948	270
3	SS-2 SRBM	Soviet Union	1949	1,200
4	SS-3 MRBM	Soviet Union	1955	1,200
5	SS-6 ICBM	Soviet Union	1957	8,000+
6	SS-9 ICBM	Soviet Union	1963	10,200+
7	CSS-1 MRBM	China	1964	1,250
8	CSS-2 MRBM	China	1966	2,500
9	SS-13 ICBM	Soviet Union	1966	9,500
10	CSS-3 ICBM	China	1970	5,500+
11	CSS-4 ICBM	China	1971	12,000+
12	SS-18 ICBM	Russia	1973	10,000+
13	SS-19 ICBM	Russia	1973	9,000+
14	CSS-5 MRBM	China	Late 1970s	1,750+
15	JL-1 SLBM	China	1981	1,700
16	SS-24 ICBM	Russia	1982	10,100+
17	SS-25 ICBM	Russia	1983	11,000+
18	SCUD-B SRBM	North Korea	1984	300
19	No Dong MRBM	North Korea	1993	1,200+

#	System	Country	Year	Range (km)
20	SS-27 ICBM	Russia	1994	11,000+
21	SS-26 SRBM	Russia	1996	350
22	TD-1 MRBM	North Korea	1998	2,000+
23	Shahab 3 MRBM	Iran	1998	Up to 2,000
24	Agni-II MRBM	India	1999	2,000+
25	CSS-10 ICBM	China	1999	7,000+
26	Agni-I SRBM	India	2002	700
27	Fateh-110 SRBM	Iran	2002	300
28	CSS-5 Mod 5 MRBM	China	Mid-2000s	1,500+
29	TD-2 ICBM/SLV	North Korea	2006	12,000+
30	Sejjil MRBM	Iran	2009	2,000
31	Emad MRBM	Iran	2015	Up to 2,000
32	Shaheen-3 MRBM	Pakistan	2015	2,750
33	Hwasong-10 (Musudan) IRBM	North Korea	2016	3,000+
34	Bukkeukseong-2 MRBM	North Korea	2017	1,000+
35	Hwasong-12 IRBM	North Korea	2017	3,000+





Warheads and Targets

Ballistic and cruise missiles can be armed with conventional or nonconventional warheads. Conventional warheads rely on the detonation of an explosive and can be designed for various effects. Nonconventional warheads include weapons of mass destruction (nuclear, biological, and chemical weapons) and nonlethal warheads designed to disable equipment rather than harm personnel. Conventional, biological, and chemical weapons can be packaged in unitary (single) warheads and in submunitions (multiple small bomblets that are released at altitude to disperse over a wide area).

India Dhanush Ship Launched Ballistic Missile (ShLBM)

Conventional warheads can be optimized for specific types of targets. For example, submunitions can be used to create craters in an airfield runway or destroy armored vehicles. A penetrator warhead, which uses a relatively small amount of explosive surrounded by a heavy metal casing, can pass through a hardened structure, such as a bunker, to destroy its contents.

Many ballistic missiles and several types of LACMs carry nuclear warheads. Most of these warheads have an explosive force that is tens to hundreds of times more powerful than the atomic bombs used in World War II.

Chemical and biological weapons are attractive to some countries because they are much easier to produce than nuclear weapons. Accuracy is not very important for these weapons when used against urban areas or large concentrations of military forces. Chemical and biological weapons can be packaged in submunitions to be dispersed over a wide area. They are capable of producing massive casualties, inducing panic and chaos in civilian populations, and severely degrading military operations.

North Korea Hwasong-12 IRBM

Taiwan Wan Chien LACM

China CSS-6 Mod 3 SRBM

Iran Emad-1 MRBM

India Prithvi-I CRBM

North Korea Hwasong-10 (Musudan) IRBM

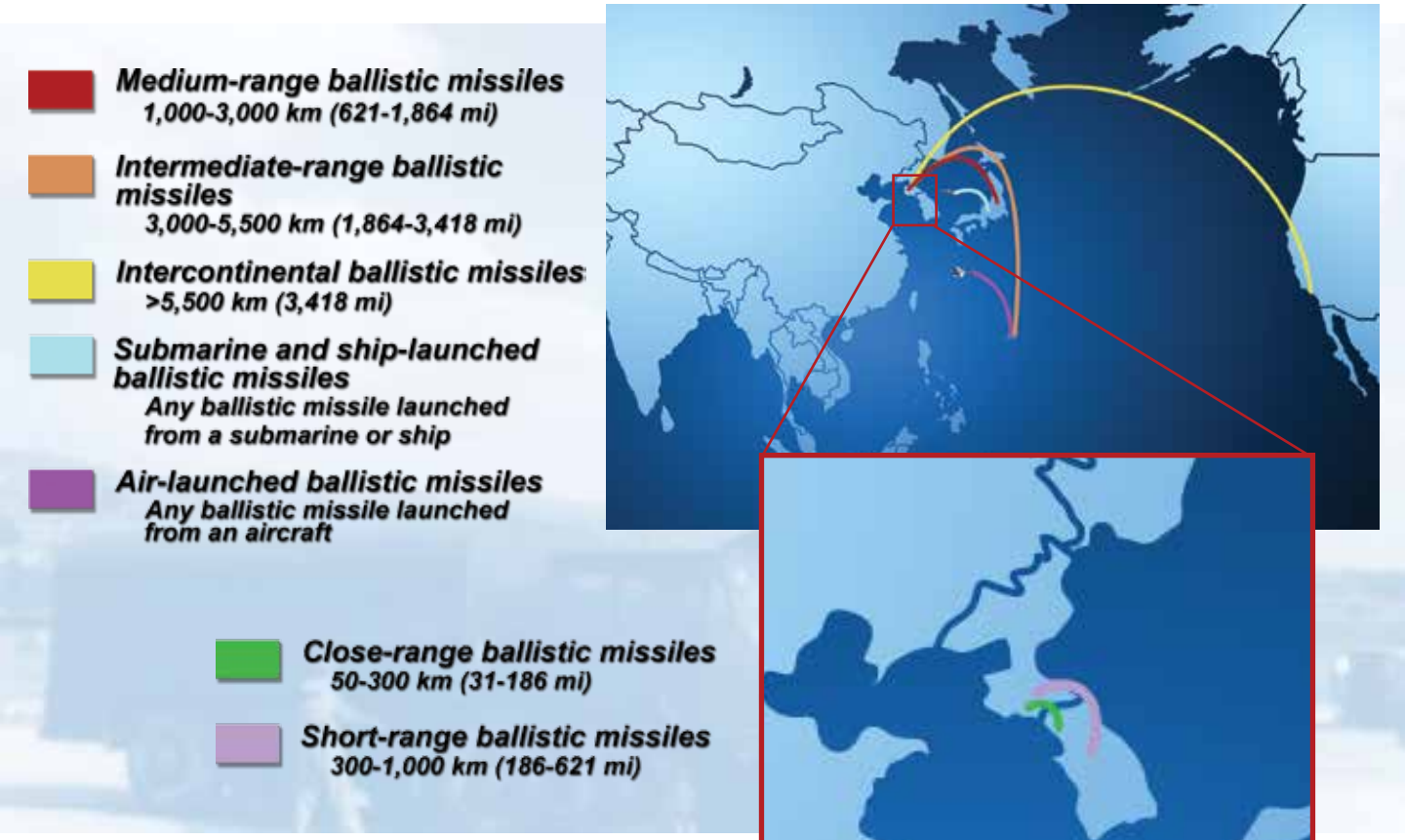
Ballistic Missiles

Ballistic missiles can be deployed in silos, on submarines, surface ships, road- and rail-mobile launchers, and aircraft. Mobile missiles can provide greater pre-launch survivability. The last decade has seen a dramatic increase in ballistic missile capabilities to include accuracy, post-boost maneuverability, and combat effectiveness.

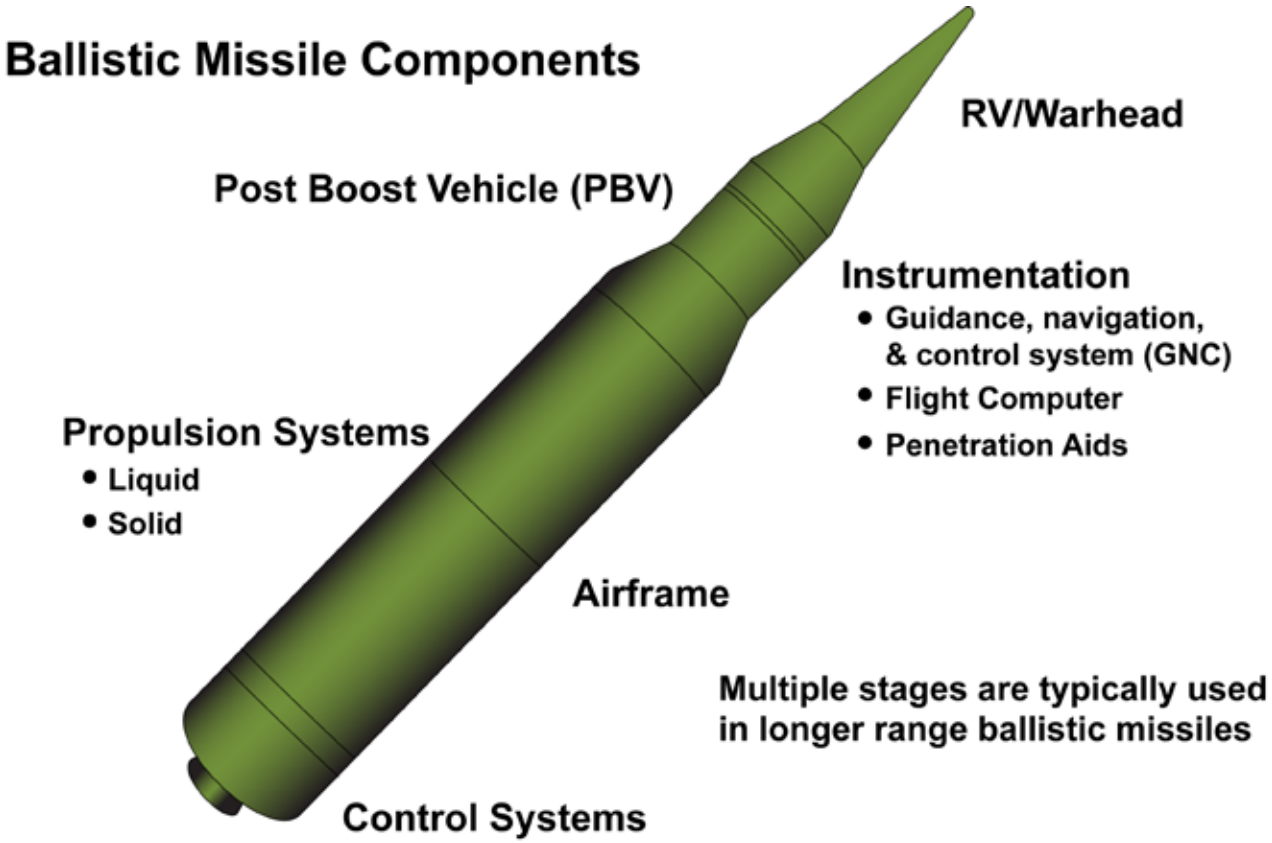
Some shorter range missiles remain intact until the warhead detonates; however, others have a warhead in a reentry vehicle (RV) that separates from the booster. In most long-range ballistic missiles, warheads are contained in separating RVs. Some long-range ballistic missiles carry MIRVs, with up to 10 RVs per missile. RVs reenter the Earth's atmosphere at very high velocities, on the order of 6-8 kilometers per second at ICBM ranges. Some types of reentry vehicles have the capability to maneuver to avoid defenses and/or increase accuracy. Hypersonic glide vehicles (HGVs) are being developed as a new type of ballistic missile payload. HGVs are maneuverable vehicles that travel at hypersonic (greater than Mach 5) speed and spend most of their flight at much lower altitudes than a typical ballistic missile. The combination of high speed, maneuverability, and relatively low altitude makes them challenging targets for missile defense systems. HGVs are currently in development in Russia and China.

Ballistic missiles can use solid- or liquid-propellant rocket propulsion systems. The trend in modern missile systems has been toward the use of solid propellants because of their reduced logistical requirements and simplicity of operation. However, some nations have greater access to liquid-propellant technology and continue to develop new liquid-propellant missiles. In addition, liquid-propellant missiles can be more efficient for very heavy payloads than solid-propellant missiles. The missiles with the world's heaviest payloads, the Russian SS-18 and Chinese CSS-4, are liquid-propellant ICBMs, and Russia is developing a new heavy-lift, liquid-propellant ICBM called the Sarmat.

Missile Range



Trajectories are for illustration purposes only.



Multiple-stage missiles, with each stage having its own independent propulsion system, are more efficient for longer range missions. ICBMs typically have two or three stages, with powerful liquid-propellant engines or solid-propellant motors to propel the payload toward its target, and a postboost vehicle (PBV) with a much smaller propulsion system. A PBV can be used to improve the RV deployment accuracy for a single-RV missile. For a missile with a MIRV payload, the PBV is used to release RVs so that they follow different trajectories, allowing them to hit separate targets. Some MIRV missiles can hit targets separated by over 1,500 kilometers with a single missile.

Many ballistic missiles carry penetration aids to improve the chances of an RV penetrating a ballistic missile defense system. Penetration aids are devices intended to deceive, obscure, or jam sensors used to detect and track missiles and RVs. They are of increasing importance to countries developing and operating ballistic missiles. Other techniques that complicate missile defense operations include separating payloads, multiple RVs, depressed trajectories, and boost-phase, midcourse, or terminal maneuvers.

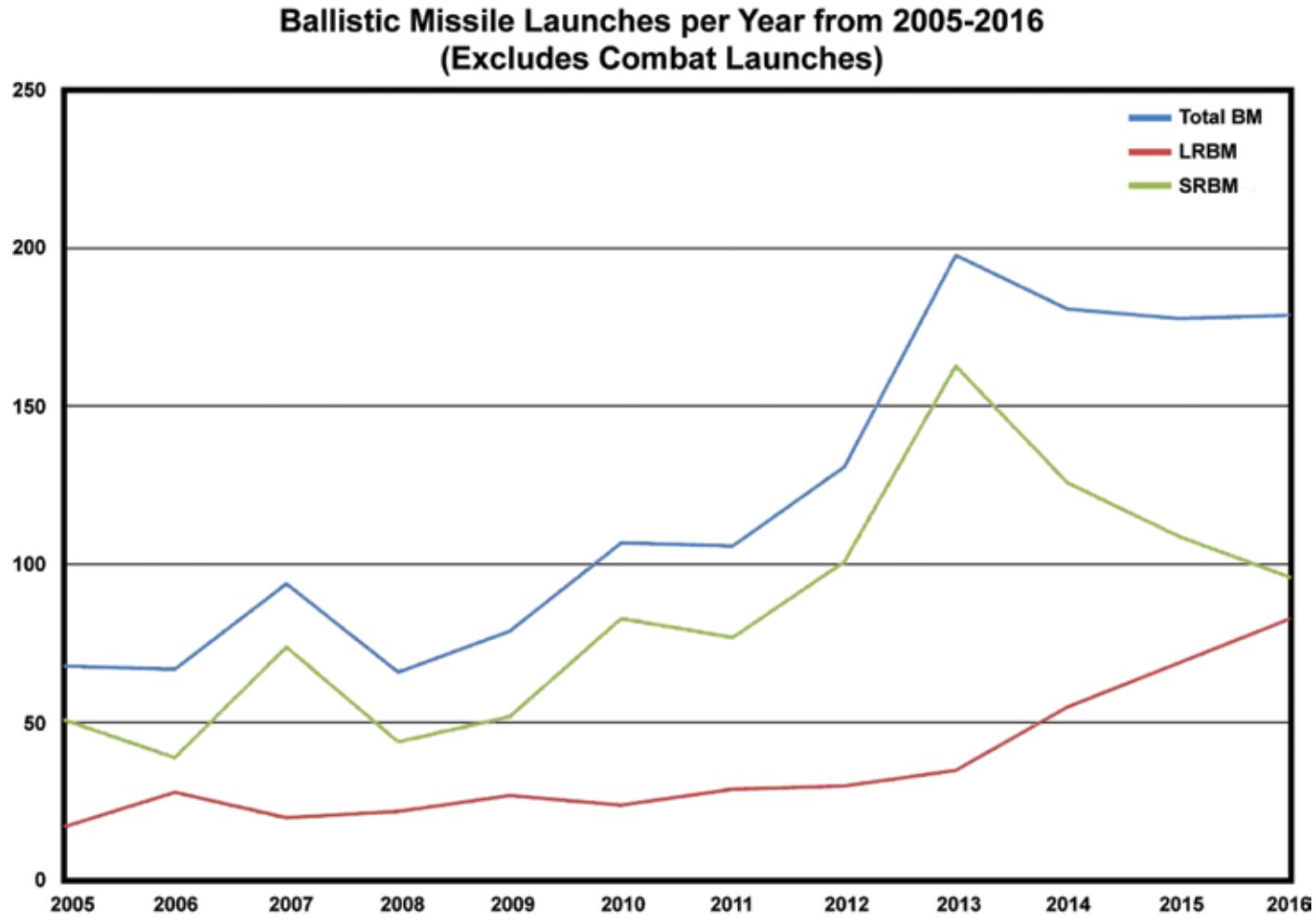
An ICBM with a high-quality inertial guidance system is capable of delivering an RV within a few hundred meters of the target after a flight of 10,000 kilometers. For many missiles, accuracy can be greatly improved by utilizing satellite-aided navigation. Missiles also can use maneuvering RVs with terminal sensors to attain very high accuracy. The use of improved guidance techniques and a maneuver capability can allow conventionally armed ballistic missiles to be used effectively against many fixed targets as well as moving targets such as ships at sea.

As more modern guidance technology is proliferated, countries will be able to improve the accuracy and lethality of their missile forces. However, even a missile with a guidance system only accurate enough to hit a large city is capable of inflicting massive casualties when armed with a weapon of mass destruction.

Launch Trends

Over the last decade there has been a significant increase in worldwide ballistic missile testing. The emphasis on ballistic missile development around the world is noted by Chinese scholars who have stated, “ballistic missiles have become an important factor that influences the world political setup, controls the battlefield posture, and even decides the outcome of war”and “it is appropriate to say that ballistic missiles have become an important sign of national defense strength and symbol of national status.”

The graphic below depicts the approximate number of ballistic missiles launched per year from 2005 to 2016. In the graphic, all ballistic missiles are categorized by range, regardless of launch platform; all missiles with a range of 1,000 km or greater are classified as long-range ballistic missiles (LRBM) and all missiles with a range from 300 km – 1,000 km are classified as short-range ballistic missiles (SRBM). This graphic does not include close-range ballistic missiles (CRBM - missiles with a range less than 300 km) or ballistic missiles launched in combat.



Iran Qiam-1 SRBM

Russia SS-25 ICBM

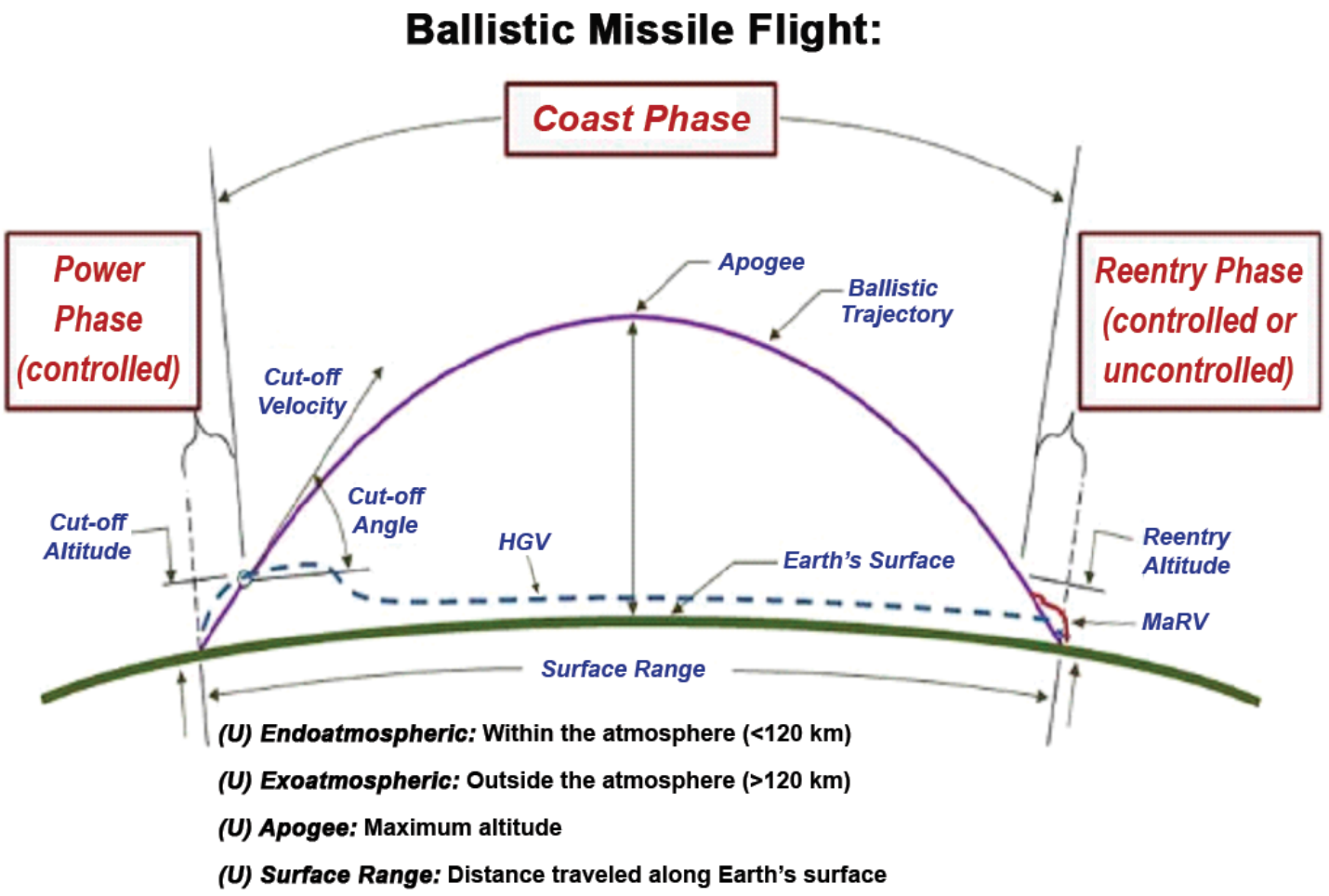
India Agni V IRBM

China CSS-N-14 SLBM

In-Flight Maneuverability, Accuracy, and Defense Penetration

Webster's Dictionary defines a ballistic missile as, "A projectile that assumes a free-falling trajectory after an internally-guided, self-powered ascent." Some newer "ballistic" missiles are stretching this definition as they move beyond "internally-guided" and purely ballistic trajectories to include maneuvers during flight and various means to achieve accuracy. Some missiles today have characteristics of both ballistic and cruise missiles. Modern ballistic missiles can include maneuvers during boost, midcourse, and/or terminal phases of flight. Some ballistic missiles remain in the atmosphere for large portions of their flight with control provided by aerodynamic surfaces. In-flight maneuverability can act as a missile defense countermeasure and/or improve accuracy. In-flight maneuvers, combined with guidance updates, can allow ballistic missiles to be precision-strike weapons.

Nearly all of our adversaries are concerned with US missile defenses and have devised various means to complicate missile defense operations. Traditional countermeasures include penaids such as balloons, chaff, decoys, and jammers. Multiple RVs are also employed to increase the probability that at least one RV arrives on target.



Russia SS-18 Mod 5 ICBM Launch Canister

Pakistan Shaheen-2 MRBM

TD-2 ICBM/SLV

Russia SS-27 Mod 2 ICBM

Close-Range Ballistic Missiles (CRBM)

States including Russia, China, North Korea, Pakistan, India, and Iran are likely pursuing increased accuracy, range and lethality for their close-range ballistic missile systems. China is likely marketing and/or producing various CRBM variants with a maximum range of just under 300 km and marketing the B611MR, a CRBM with an anti-radiation homing seeker. CRBM variants currently in research and development (R&D) or in production worldwide are included in the chart on page 15.

China and Russia are marketing and/or producing CRBMs with various warhead types. These warhead variants likely include dual-purpose improved conventional munition (DPICM)

China CSS-14 Mod-X-1

India Prithvi II

Iran CSS-8

warheads, thermobaric and high explosive (HE) warheads. CRBMs with DPICM, thermobaric and HE warheads are more effective than similar unguided rocket rounds against stationary or moving targets including armor, mechanized artillery and personnel. The improved accuracy of CRBMs (compared to unguided artillery rockets) reduces the miss distance from the intended target and increases the probability that the CRBM warhead blast wave or the warhead's fragments will reach the intended target and neutralize it.

Iran and North Korea are likely progressing towards producing the Fadj-5 Aero CRBM and KN-SS-X-9, respectively. If the Iranians and North Koreans use satellite navigation systems (such as GPS) onboard their CRBMs, then the miss distance of these CRBMs could be reduced to tens of meters. High accuracy of CRBMs would be a force multiplier for both the Iranian and North Korean artillery forces by giving them precision strike capability against high priority targets.

Russia SS-21 Mod 3

Russia SS-21 Mod 2

Pakistan Hatf-9

China BRE7

China A100-111

Close-Range Ballistic Missiles

COUNTRY / SYSTEMS	MAXIMUM RANGE (km)
BRAZIL	
SS-150	150
CHINA	
WS-22	40
BRE7	40
GR1	70
BRC-3 (300-mm PHL-03/AR2/AR1/AR1A/AR3)	70
A100-111	80
A100-311	120
WM-120	120
BRC-4 (300-mm PHL-03/AR2/AR1/AR1A/AR3)	130
BRE-2 (300-mm PHL-03/AR2/AR1/AR1A/AR3)	150
BRE-3 / Fire Dragon 140 (300-mm PHL-03/AR2/AR1/AR1A/AR3)	150
CSS-14 Mod-X-1	150
CSS-9 Mod 1	150
CSS-X-16	200
WS-2 (HE, TBX, DPICM)	200
WS-3	200
BRE-6 (370-mm AR3)	220
CSS-9 Mod-X-2	260
CSS-14 Mod-X-2	280
BRE-8 / Fire Dragon 280 (370-mm AR3)	280
INDIA	
Pinaka-II Guided	65
Prithvi I	150
Prahar	150
Prithvi II	250
IRAN	
Fadjr-5 Aero	>75
CSS-8	150

COUNTRY / SYSTEMS	MAXIMUM RANGE (km)
ISRAEL	
Romach ("Magic Spear")	35
STRIKES	40
ACCULAR	40
MLRS-TCS	45
JUMPER	50
ExTRA (HE, Cluster, Penetrator, MIMS)	150
Predator Hawk	250
LORA	300
NORTH KOREA	
Toksa	120
KN-SS-X-9	190
PAKISTAN	
Hatf-1	50
NASR (Hatf-9)	60
Abdali (Hatf-2)	200
RUSSIA	
122-mm Guided	40
SS-21 Mod 2	70
9M55 (F, K, K1, K3, K4, K5, K6, K7, S)	70
9M5 (25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 36, 37)	90
SS-21 Mod 3	120
9M542	120
SERBIA	
Guided 128mm	21
R-400 Guided	143
SOUTH KOREA	
130MM CRBM	36
Chunmoo 239-mm CRBM	80
THAILAND	
DTI-1G	150
TURKEY	
TRG-122 CRBM	35
“Tiger” 300-mm CRBM	120

Note: All ranges are approximate.

Short-Range Ballistic Missiles (SRBM)

Several countries are now producing and/or developing SRBM systems, while many other countries have purchased SRBMs or SRBM technologies.

The Russian SS-1C Mod 1, also called the SCUD B, has been exported to more countries than any other type of guided ballistic missile, and has proven to be a versatile and adaptable weapon. For example, the Iraqi SCUD missiles used during the 1991 Persian Gulf War had been modified to double their range. North Korea has produced its own version of the SCUD B and the SCUD C, which is an extended-range version of the SCUD B as well as extended range variants of the SCUD C - the SCUD D and the SCUD ER.

New SRBM systems are in development in several countries. China has deployed a very large force of modern solid-propellant SRBMs in the vicinity of Taiwan. In August 2010, Iranian officials hailed the successful test firing of the liquid-fuel Qiam-1 SRBM. Around the same time, the Iranian Minister of Defense told reporters that the third-generation of the Fateh-110 missile had been successfully test fired and that the system was officially delivered to the missile force in September

China CSS-7 Mod 2

Iran Shahab 1

North Korea SCUD C

2010. In 2012, Iran claimed to have also successfully flight tested a fourth-generation Fateh-110. Iran has also flight tested an anti-ship-capable variant of its Fateh-110 missile. A seeker has likely been added to the missile to improve the system's accuracy against sea-based targets.

Recent conflicts have highlighted missile defense capabilities, motivating ballistic missile developers to pursue missile defense countermeasures. Some SRBM developers have already begun to develop countermeasures such as maneuverable RVs (MaRVs), and are expected to continue countermeasure development.

Iran Fateh-110

China CSS-6 Mod 3

Multi-Country SCUD C

Russia SS-26 Iskander

Pakistan Ghaznavi

New North Korea SCUD Variant on Tracked TEL

Short-Range Ballistic Missiles

COUNTRY / SYSTEMS	PROPELLANT	DEPLOYMENT MODE	MAXIMUM RANGE (km)	NUMBER OF LAUNCHERS*
CHINA				
CSS-6 Mod 1	Solid	Road-mobile	600	
CSS-6 Mod 2	Solid	Road-mobile	850+	
CSS-6 Mod 3	Solid	Road-mobile	725+	
CSS-7 Mod 1	Solid	Road-mobile	300	More than 200
CSS-7 Mod 2	Solid	Road-mobile	600	
CSS-11 Mod 1	Solid	Road-mobile	700+	
CSS-11 Mod 2	Solid	Road-mobile	700+	
INDIA				
Agni I	Solid	Road-mobile	700	Fewer than 75
IRAN				
Fateh-110	Solid	Road-mobile	300	
Shahab 1	Liquid	Road-mobile	300	Fewer than 100
Shahab 2	Liquid	Road-mobile	500	
Qiam-1	Liquid	Road-mobile	800	
NORTH KOREA				
SCUD B	Liquid	Road-mobile	300	Fewer than 100
SCUD C	Liquid	Road-mobile	500	
PAKISTAN				
Ghaznavi	Solid	Road-mobile	300	Fewer than 50
Shaheen I	Solid	Road-mobile	750	
RUSSIA				
SCUD B (SS-1c Mod 1)	Liquid	Road-mobile	300	Fewer than 200
SS-26 (Iskander-M/E)	Solid	Road-mobile	350	
SYRIA				
Fateh-110	Solid	Road-mobile	300	Fewer than 100
SCUD D	Liquid	Road-mobile	700	

Note: All ranges are approximate.
* The missile inventory may be larger than the number of launchers; launchers can be reused to fire additional missiles.

Medium-Range (MRBM) & Intermediate-Range Ballistic Missiles (IRBM)

New MRBM and/or IRBM systems are in development in China, North Korea, Iran, India, and Pakistan, and many will be armed with nonconventional warheads. All of these countries except Iran have tested nuclear weapons.

China continues to deploy nuclear-armed MRBMs to maintain regional nuclear deterrence, and its long-term, comprehensive military modernization is improving the capability of its conventionally-armed ballistic missile force to conduct high-intensity, regional military operations, including “anti-access and area denial” (A2/AD) operations. Currently, China deploys the CSS-5 Mod 2 for regional nuclear deterrence. China has the conventionally armed CSS-5 Mod 4 and Mod 5 MRBMs to conduct precision strikes. The CSS-5 Mod 4 (DF-21C) is intended to hold at-risk or strike logistics and communication nodes, regional military bases including airfields and ports. China has also deployed the CSS-5 Mod 5 (DF-21D), an anti-ship ballistic missile (ASBM) that gives the PLA the capability to attack aircraft carriers in the western Pacific Ocean. According to a Chinese CCTV report, the DF-21D brigades are capable of quickly reloading in the field and launching multiple salvo strikes within a few hours.

Iran Emad-1 MRBM

Pakistan Shaheen-2 MRBM

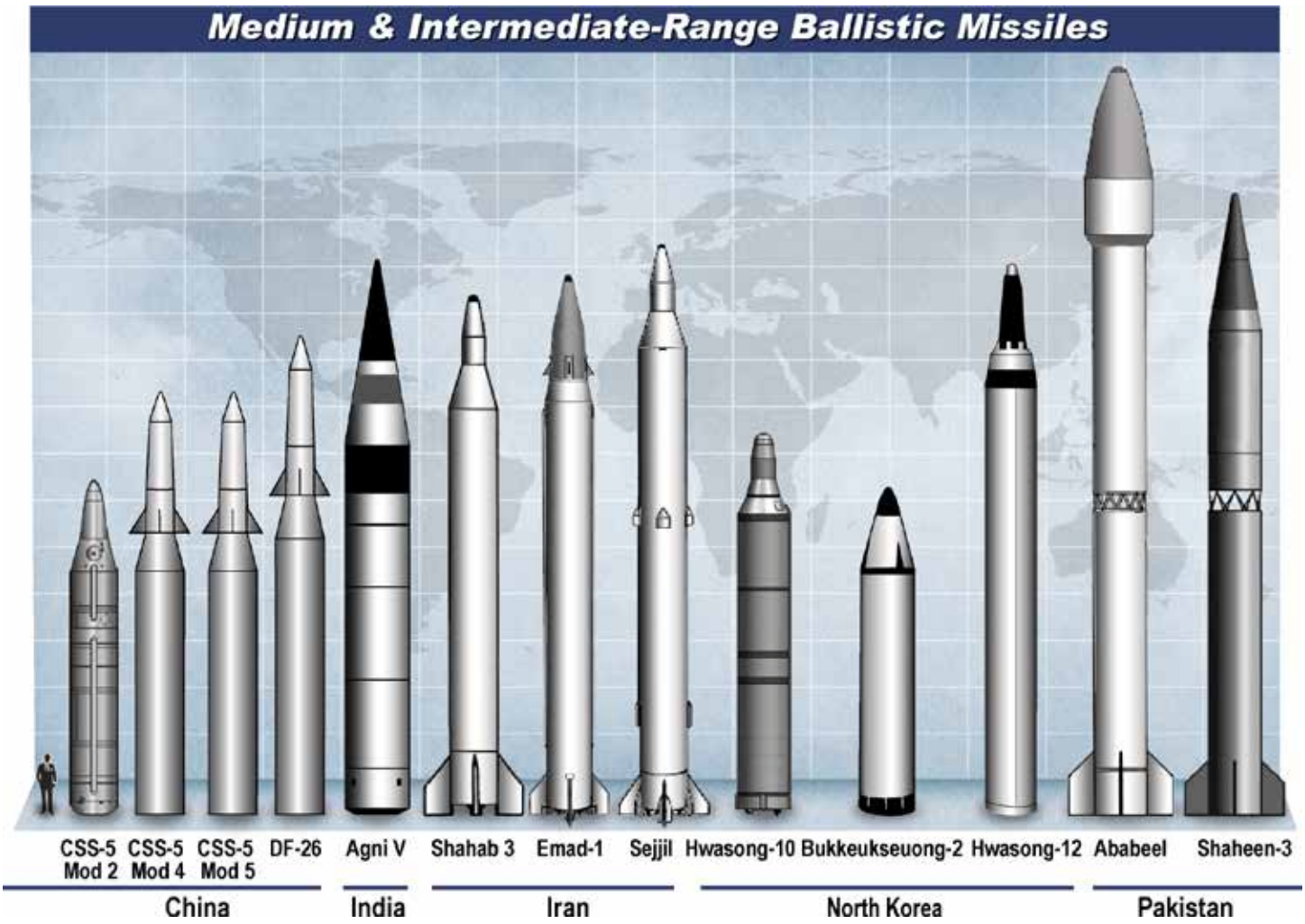
North Korea Hwasong-12 IRBM

China debuted the new DF-26 IRBM during the 3 September 2015 Victory Day Parade. Official Chinese media commentary described the system as “one carrier, many warheads.” Other media reports revealed it was capable of nuclear and conventional missions and its design enabled strikes against many kinds of targets, including large ships. It also requires little support equipment and has fast reaction times, according to descriptions in official Chinese media outlets.

North Korea has an ambitious ballistic missile development program and has exported missiles and missile technology to other countries, including Iran and Pakistan. North Korea has also tested nuclear weapons and claims its missiles are capable of carrying nuclear warheads. Initial flight testing of the Hwasong-10 (Musudan) IRBM in 2016 resulted in several failures. Beginning in February 2017, North Korea began flight-testing the solid-propellant Bukkeukseong-2 MRBM, which is a land-based variant of the solid-propellant Bukkeukseong-1 SLBM. Initial flight testing of the liquid-propellant Hwasong-12 IRBM commenced in April 2017.

Iran has an extensive missile development program. The Iranian Shahab 3 MRBM is based on the North Korean No Dong missile. Iran has modified the Shahab 3 to extend its range and effectiveness, with the longest range variant reportedly being able to reach targets at a distance of about 2,000 km. Iran also claims to have mass-produced Shahab 3 missiles. Iranian solid-propellant programs are also progressing. Iran has conducted multiple launches of the Sejjil, a solid-propellant MRBM with a claimed range of 2,000 km. In 2015, Iran publicized the launch of the Emad-1 missile, which officials claim is Iran’s first long-range missile that is guided throughout flight and capable of hitting targets with high-precision. Iran also announced plans for an Emad-2 with greater precision than the Emad-1.

India continues to develop and improve its ballistic missiles. All of India’s long-range missiles use solid propellants. The Agni II MRBM and Agni III IRBM are deployed. The Agni IV IRBM has been successfully flight tested six times since the 2010 failure, but Indian officials still say further testing is required before deployment.



The Agni V has been flight tested four times. In the two most recent launches, the missile was launched from a sealed canister aboard a road-mobile launcher. More flight testing is required before deployment.

Pakistan continues to improve the readiness and capabilities of its Army Strategic Force Command and individual strategic missile groups through training exercises that include live missile firings. Pakistan has tested its solid-propellant Shaheen-2 MRBM seven times since 2004. In 2015, Pakistan began testing a longer range Shaheen-3 MRBM and, in January 2017, began testing the MIRVed Ababeel MRBM.

Iran Shahab-3 MRBM

North Korea Bukkeukseong-2 MRBM

China CSS-5 Mod 5 MRBM

China DF-26 IRBM

North Korea Hwasong-10 (Musudan) IRBM

Medium- and Intermediate-Range Ballistic Missiles

COUNTRY / SYSTEMS	NUMBER OF STAGES	PROPELLANT	DEPLOYMENT MODE	MAXIMUM RANGE (km)	NUMBER OF LAUNCHERS*
CHINA					
CSS-5 Mod 2 (MRBM)	2	Solid	Road-Mobile	1,750+	Fewer Than 50
CSS-5 Mod 4 (MRBM)	2	Solid	Road-Mobile	1,500+	16+
CSS-5 Mod 5 (MRBM)	2	Solid	Road-Mobile	1,500+	16+
DF-26 (IRBM)	2	Solid	Road-Mobile	3,000+	16+
INDIA					
Agni II (MRBM)	2	Solid	Rail-Mobile	2,000+	Fewer Than 10
Agni III (IRBM)	2	Solid	Rail-Mobile	3,200+	Fewer Than 10
Agni IV (IRBM)	2	Solid	Road & Rail-Mobile	3,500+	Not Yet Deployed
Agni V (IRBM)	3	Solid	Road-Mobile	5,000+	Not Yet Deployed
IRAN					
Shahab 3 (MRBM)	1	Liquid	Silo & Road-Mobile	Up to 2,000	Fewer Than 50
Emad-1 (MRBM)	1	Liquid	Road-Mobile	Up to 2,000	Undetermined
Sejjil (Ashura) (MRBM)	2	Solid	Road-Mobile	2,000	Undetermined
NORTH KOREA					
Bukkeukseong-2 (MRBM)	2	Solid	Road-Mobile	1,000+	Not Yet Deployed
ER SCUD (MRBM)	1	Liquid	Road-Mobile	1,000	Undetermined
No Dong Mod 1/2 (MRBM)	1	Liquid	Road-Mobile	1,200+	Fewer Than 100
Hwasong-12 (IRBM)	1	Liquid	Road-Mobile	3,000+	Undetermined
Hwasong-10 (Musudan) IRBM	1	Liquid	Road-Mobile	3,000+	Fewer Than 50
PAKISTAN					
Ghauri (MRBM)	1	Liquid	Road-Mobile	1,250	Fewer Than 50
Shaheen-2 (MRBM)	2	Solid	Road-Mobile	2,000	Fewer Than 50
Shaheen-3 (MRBM)	2	Solid	Road-Mobile	2,750	Not Yet Deployed
Ababeel (MRBM)	3	Solid	Unknown	2,200	Not Yet Deployed
SAUDI ARABIA					
CSS-2 (MRBM) (Chinese-produced)	1	Liquid	Transportable	3,000	Fewer Than 50

Note: All ranges are approximate.
* The missile inventory may be much larger than the number of launchers; launchers can be reused to fire additional missiles.

Pakistan Ababeel MRBM

India Agni V IRBM

Intercontinental Ballistic Missiles (ICBM)

Russia SS-25

Both China and Russia currently deploy multiple types of ICBMs and are modernizing their ICBM forces. North Korea has demonstrated ICBM technology with the launch of the TD-2 space launch vehicle (SLV) and has displayed two types of road-mobile ICBMs. India is developing an ICBM, and Iran may also develop an ICBM.

On 5 February 2011, the New Strategic Arms Reduction Treaty entered into force. This treaty limits the United States and Russia to no more than 1,550 warheads each (including warheads on ICBMs and SLBMs, and counting each heavy bomber as one warhead) seven years after entry into force. Russia retains over 1,000 nuclear warheads on ICBMs. Most of these missiles are maintained on alert, capable of being launched within minutes of receiving a launch order. Although the number of missiles in the Russian ICBM force will continue to decrease because of arms control agreements, aging missiles, and resource constraints, Russia probably will retain the largest ICBM force outside the United States. Efforts to maintain and modernize the force are underway. According to official statements, the new RS-26 Rubezh is smaller than the SS-27 Mod 2. The Russian SS-27 Mod 1 ICBM, a missile designed with countermeasures to ballistic missile defense systems, is now deployed in silos in six regiments. Russia began deployment of the road-mobile version of the SS-27 Mod 1 in 2006. A MIRV version of the SS-27, the SS-27 Mod 2 (RS-24), was first deployed in 2010, and continues to be deployed in at least five road-mobile missile divisions according to Russian press reports. In addition, Russian officials claim a new class of hypersonic vehicle, probably called “object 4202,” is being developed to allow Russian strategic missiles to penetrate missile defense systems, and the Russian press has indicated deployment of a new rail-mobile ICBM is being

North Korea TD-2

considered. Russia has stated that it will soon begin testing a developmental, heavy, liquid-propellant ICBM called the Sarmat to replace the aging SS-18. Russia's goal is to begin Sarmat deployment in the 2020 timeframe.

China is strengthening its strategic nuclear deterrent force with the development and deployment of new ICBMs. China retains a relatively small number of nuclear armed, liquid-propellant CSS-3 (DF-4) limited range ICBMs and CSS-4 (DF-5) ICBMs capable of reaching the United States. China first displayed the CSS-4 Mod 3 (DF-5B) ICBM, with a claimed MIRV payload in 2015. It is also modernizing its nuclear forces by adding more survivable, road-mobile delivery systems. Both the road-mobile, solid-propellant CSS-10 Mod 1 and the longer range CSS-10 Mod 2 ICBMs have been deployed to units within the PLA Rocket Force. The CSS-10 Mod 1 is capable of reaching targets throughout Europe, Asia, and parts of Canada and the northwestern United States. The longer range CSS-10 Mod 2 will allow targeting of most of the continental United States. China is developing the CSS-X-20 (DF-41), a new road-mobile ICBM possibly capable of carrying a MIRV payload. The number of warheads on Chinese ICBMs capable of threatening the United States is expected to grow to well over 100 in the next 5 years.

The North Korean TD-2 has been launched as a space launch vehicle (SLV). If configured as an ICBM, it could reach the United States. TD-2 SLV launches in July 2006, April 2009, and April 2012 ended in failure, but December 2012 and February 2016 launches successfully placed a satellite in orbit. In an April 2012 military parade, North Korea unveiled the new Hwasong-13 road-mobile ICBM and in an October 2015 parade displayed the new Hwasong-14 road-mobile ICBM. Neither missile has been flight tested. Any of these systems could be exported to other countries in the future. During an April 2017 parade, North Korea showcased a modified Hwasong-13 ICBM launcher with a launch canister, as well as a new mobile-erector-launcher with a launch canister. Road-mobile launch canisters are typically associated with solid-propellant missiles. Actual missiles for the launch canisters were not displayed.

Tehran's desire to have a strategic counter to the United States could drive it to field an ICBM. Progress in Iran's space program could shorten a pathway to an ICBM because space launch vehicles use inherently similar technologies. Since 2008, Iran has conducted multiple successful launches of the two-stage Safir SLV. In early 2010, Iran unveiled the larger Simorgh SLV.

India's Agni VI ICBM is reportedly in the design phase with a range of 6,000 km.

Russia SS-27

Russia SS-27 TEL

North Korea Modified Hwasong-13 TEL with Launch Canister

North Korea Hwasong-13 on TEL

China CSS-10 Launch Canister on MEL

Intercontinental Ballistic Missiles

COUNTRY / SYSTEMS	NUMBER OF STAGES	WARHEADS PER MISSILE	PROPELLANT	DEPLOYMENT MODE	MAXIMUM RANGE (km)	NUMBER OF LAUNCHERS*
CHINA						
CSS-3	2	1	Liquid	Transportable	5,500+	10 to 15
CSS-4 Mod 2	2	1	Liquid	Silo	12,000+	About 20
CSS-4 Mod 3	2 + PBV	Multiple	Liquid	Silo	12,000+	
CSS-10 Mod 1	3	1	Solid	Road-Mobile	7,000+	5 to 10
CSS-10 Mod 2	3	1	Solid	Road-Mobile	11,000+	More than 15
CSS-X-20	3 + PBV	Multiple	Solid	Road-Mobile	UNK	In Development
NORTH KOREA						
Taepo Dong 2	3	1	Liquid	Fixed	12,000+	Undetermined**
Hwasong-13	3	1	Liquid	Road-Mobile	5,500+	Undetermined
Hwasong-14	2	Unknown	Liquid	Road-Mobile	5,500+	Undetermined
RUSSIA						
SS-18 Mod 5	2 + PBV	10	Liquid	Silo	10,000+	About 50
SS-19 Mod 3	2 + PBV	6	Liquid	Silo	9,000+	About 50
SS-25	3 + PBV	1	Solid	Road-Mobile	11,000	About 100
SS-27 Mod 1	3 + PBV	1	Solid	Silo & Road-Mobile	11,000	About 80
SS-27 Mod 2	3 + PBV	Multiple	Solid	Silo & Road-Mobile	11,000	More than 50
SS-X-28***	At least 2	Multiple	Solid	Road-Mobile	5,500+	In Development
Sarmat	2 + PBV	Multiple	Liquid	Silo	10,000+	In Development

Note: All ranges are approximate.
* The missile inventory may be much larger than the number of launchers; launchers can be reused to fire additional missiles.
** We have observed launches of the TD-2 space launch vehicle from both east (2006 and 2009) and west (2012) coast facilities.
*** The Russian press indicated the missile was initially tested to ICBM range. Russian officials quoted in the press have claimed the missile is "lighter and, consequently, has a shorter range" than the SS-27 Mod 2 ICBM on which it is based.

Russia SS-27 Mod 2

North Korea Hwasong-14

Submarine-Launched (SLBM) & Ship-Launched Ballistic Missiles (ShLBM)

Russia maintains a substantial force of nuclear powered ballistic missile submarines (SSBNs) with intercontinental-range missiles. Upgraded SS-N-23s are intended to replace older SS-N-23s on DELTA IV Class SSBNs. The SS-N-32/BULAVA is a new solid-propellant SLBM deployed on the new DOLGORUKIY class SSBNs. Russian SLBMs are capable of launch from surfaced and submerged SSBNs from a variety of launch locations.

China has deployed the new CSS-N-14 SLBM on new 12-tube JIN Class SSBNs. This missile will, for the first time, allow Chinese SSBNs to target portions of the United States from operating areas located near the Chinese coast.

North Korea is developing an SLBM, possibly designated the Bukkeukseong-1 or Polaris-1. According to North Korean press statements, the SLBM will be cold-launched, solid-fueled, will carry a nuclear warhead, and is intended for launch from the Sinpo-class submarine. North Korea conducted multiple flight tests of the developmental SLBM in 2016.

India is developing a new ballistic missile-capable submarine, the INS ARIHANT. The INS ARIHANT will carry either 12 SRBM-range K-15s or four IRBM-range K-4 SLBMs. The Dhanush, a liquid-fueled, ship-launched ballistic missile (ShLBM), is a naval variant of India's Prithvi II CRBM.

China CSS-N-14

Russia SS-N-18

India K-15

Russia Bulava Launch Canister

North Korea Bukkeukseong-1 Launch

India Dhanush

Russia SS-N-18 Payload Section

Submarine and Ship-Launched Ballistic Missiles

COUNTRY / SYSTEMS	NUMBER OF STAGES	WARHEADS PER MISSILE	PROPELLANT	DEPLOYMENT MODE	MAXIMUM RANGE (km)	NUMBER OF LAUNCHERS*
CHINA						
CSS-N-14	3	1	Solid	JIN Sub	7,000+	48
INDIA						
K-15	2	1	Solid	ARIHANT Sub	700	12
K-4	2	1	Solid	ARIHANT Sub	3,500	4; Not Yet Deployed
Dhanush	1	1	Liquid	Sukyana-class Patrol Boat	400	2
NORTH KOREA						
Bukkeukseong-1	2	1	Solid	SINPO Sub	UNK	1; Not Yet Deployed
RUSSIA						
SS-N-18	2 + PBV	3	Liquid	DELTA III Sub	5,500+	96
SS-N-23 Sineva	3 + PBV	4	Liquid	DELTA IV Sub	8,000+	96
SS-N-32 Bulava	3 + PBV	6	Solid	DOLGORUKIY (BOREY) Sub	8,000+	48
SS-N-32 Bulava	3 + PBV	6	Solid	TYPHOON Sub	8,000+	20; Not Yet Deployed

Note: All ranges are approximate.

North Korea Bukkeukseong-1

Land-Attack Cruise Missiles (LACM)

Cruise missiles are typically categorized by their intended mission; either a land attack cruise missile (LACM) or as an anti-ship cruise missile (ASCM). Cruise missiles can further be categorized by launch platform: aircraft, ship, submarine, or ground-based launcher.

A LACM is an unmanned, armed, aerial vehicle designed to attack a fixed or relocatable target. It spends the majority of its mission in level flight, as it follows a preprogrammed path to the predetermined target. LACMs typically use a small gas turbine engine for propulsion.

France SCALP-EG

Russia Kh-101

India Brahmos

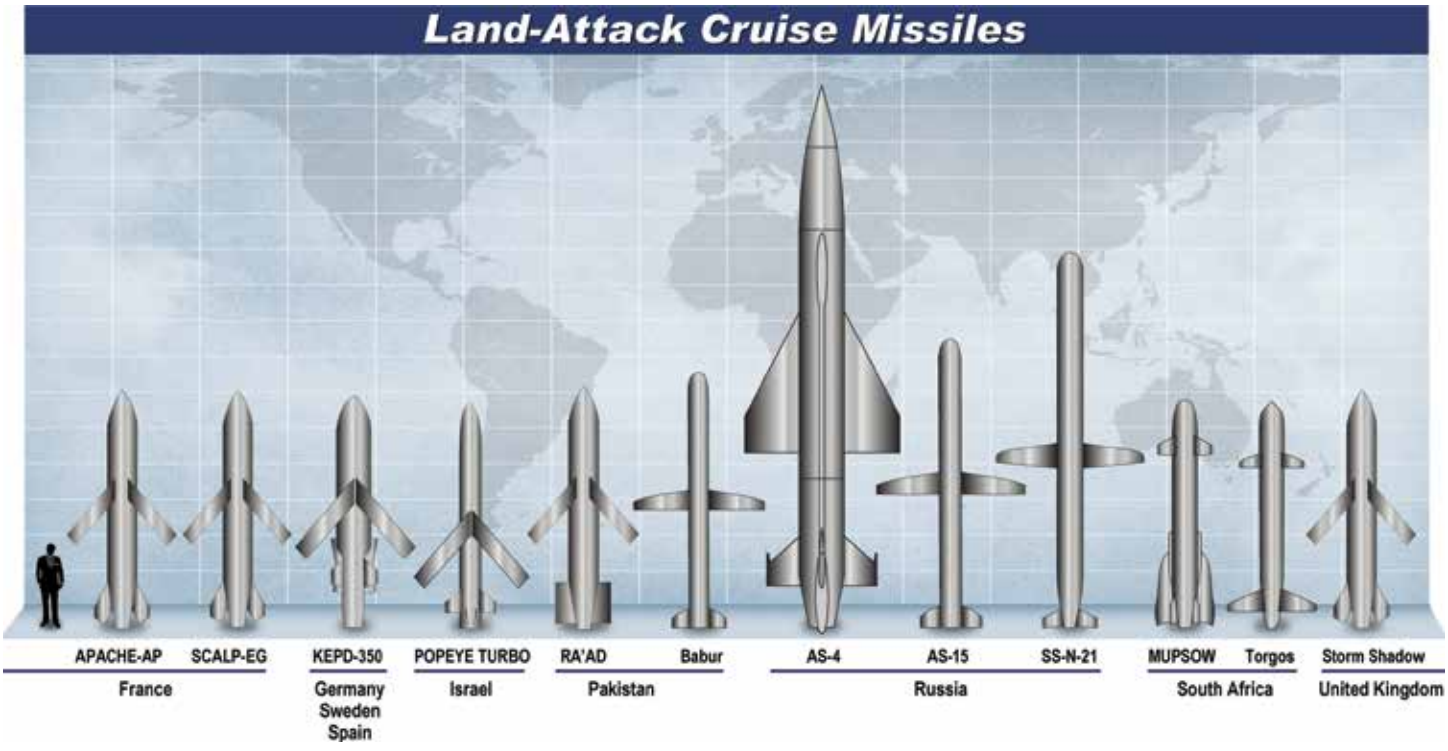
LACM guidance usually occurs in three phases: launch, midcourse, and terminal. During the launch phase, a missile is guided using only the inertial navigation system (INS). During the midcourse phase, the missile's INS is updated by one or more of the following systems: a satellite navigation system (such as the US Global Positioning System (GPS) or the Russian Global Navigation Satellite System (GLONASS)), a terrain contour matching (TERCOM) system, or a radar or optical scene matching system. The terminal guidance phase begins when a missile enters the target area and uses either a more accurate scene matching system or a terminal seeker (usually an optical or radar-based sensor). Some advanced LACMs have the potential to have highly accurate guidance systems that can place the missile within a few feet of the intended target.

LACMs can be challenging targets for air defense systems. Cruise missiles can fly at low altitudes to stay below a radar's line of sight. Depending on a country's ability to do mission planning, the missile can use terrain features, such as mountains/valleys, to hide from radars. Furthermore, LACMs may fly circuitous routes to the target, avoiding radar and air defense installations. A salvo of missiles can be launched to approach a target simultaneously from different directions, potentially overwhelming air defenses. Some missiles have incorporated stealth features to make them less visible to radars and infrared detectors. Some developmental systems may incorporate chaff or decoys as an added layer of protection, though concealment will remain a cruise missile's main defense. The cruise missile threat to US forces is increasing in the number of countries possessing LACMs, the number of LACMs, and the number of LACMs possessing advanced capabilities.

The CJ-10 (DH-10) is the first of the Chinese Changjian series of long-range missiles and LACMs. It made its public debut during a military parade in 2009 and is currently deployed with the PLA Rocket Force.

In March 2015, Iran displayed the Soumar LACM. The Soumar is a ground-launched LACM that appears to be based on the Russian air-launched AS-15. Iran claims the Soumar has a 2000 km range. In 2012, Iran announced development of a similar missile called "Meshkat". The Soumar could be a new name for the Meshkat or a variant of the Meshkat. Iran could develop alternate launch modes, aircraft or naval, for the Meshkat/Soumar.

The Club-K cruise missile "container launcher" weapon system, produced and marketed by a Russian firm, looks like a standard shipping container. The company claims the system can launch cruise missiles from cargo ships, trains, or commercial trucks. Beginning in fall 2015, Russia fired LACMs from surface ships, submarines and aircraft in support of ongoing military operations in Syria.



China Cruise Missile Launchers

Iran Soumar

Russia KH-555M

Israel Popeye Turbo

Russia R-500

Land-Attack Cruise Missiles

COUNTRY / SYSTEMS	LAUNCH MODE	WARHEAD TYPE	MAXIMUM RANGE (km)	IOC
CHINA				
YJ-63	Air	Conventional	Undetermined	Operational
CJ-10	Ground	Conventional	Undetermined	Operational
CJ-20	Air	Conventional	Undetermined	Operational
FRANCE				
APACHE-AP	Air	Submunitions	100+	2002
SCALP-EG	Air and ship	Penetrator	250+	2003
Naval SCALP	Sub and Surface Ship	Penetrator	250+	2013+
GERMANY/SWEDEN/SPAIN/SOUTH KOREA				
KEPD-350	Air	Penetrator	350+	2004
INDIA/RUSSIA				
Brahmos 1	Air, ground, ship, & sub	Conventional	less than 300	2010+
Brahmos 2	Air, ground, ship, & sub	Conventional	300+	2020+
IRAN				
Meshkat/Soumar	Air, ground, & ship	Conventional	Undetermined	Undetermined
ISRAEL				
Popeye Turbo	Air	Conventional	300+	2002
PAKISTAN				
RA'AD	Air	Conventional or Nuclear	350	Undetermined
Babur	Ground	Conventional or Nuclear	350	Undetermined
RUSSIA				
AS-4	Air	Conventional or nuclear	300+	Operational
AS-15	Air	Nuclear	2,800+	Operational
SS-N-21	Submarine	Nuclear	2400	Operational
Kh-555	Air	Conventional	Undetermined	Operational
Kh-101	Air	Conventional	Undetermined	Operational
3M-14	Ground, ship, & sub	Conventional, Nuclear Possible	2500	Operational
3M-55	Ground, ship, & sub	Nuclear Possible	400+	Operational
TAIWAN				
Wan Chen	Air	Conventional	150	2006
HF-2E	Ground	Conventional	300	Undetermined
UNITED ARAB EMIRATES				
BLACK SHAHEEN*	Air	Penetrator	250+	2006
UNITED KINGDOM				
Storm Shadow	Air	Penetrator	250+	2003

Note: All ranges are approximate and represent the range of the missile only. The effective system range may be greatly increased by the range of the launch platform.
*The BLACK SHAHEEN is an export version of the SCALP-EG.

Summary

Overall, the threats posed by ballistic missile delivery systems are likely to continue to increase and grow more complex. Adversary ballistic missile systems are becoming more mobile, survivable, reliable, and accurate while also achieving longer ranges. Hypersonic glide vehicles delivered by ballistic missile boosters are an emerging threat that will pose new challenges to missile defense systems. Prelaunch survivability is likely to increase as potential adversaries strengthen their denial and deception measures and increasingly base missiles on mobile platforms. Countries are adopting technical and operational ballistic missile defense countermeasures in their ballistic missiles.

Russia probably will retain the largest force of strategic ballistic missiles outside the United States. The development of new ballistic missile systems is a high priority for Russia. Russian officials have claimed that a new class of hypersonic vehicle is being developed to allow Russian strategic missiles to penetrate missile defense systems. Russia claims it will deploy the RS-26 Rubezh for shorter-range targets and has stated it will soon begin flight testing a new heavy liquid-propellant ICBM, called the Sarmat, to replace the aging SS-18. Russia is also offering the advanced Iskander-E SRBM for export.

North Korea Hwasong-10 (Musudan) IRBM

Iran Fateh-110 SRBM

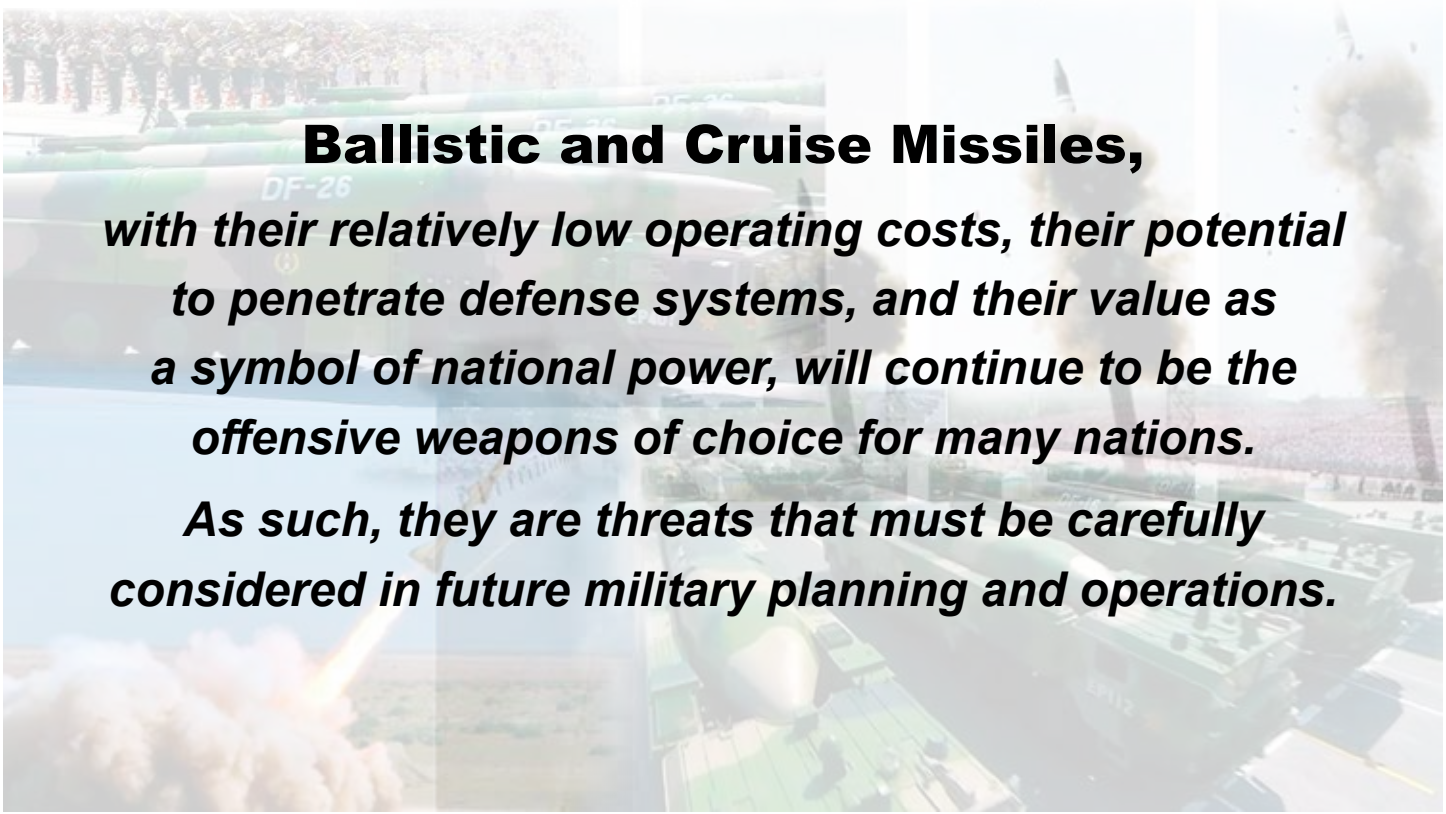
North Korea Bukkeukseong-1 SLBM

China is producing technologically advanced ballistic missiles, has sold ballistic missile technology to other countries, has deployed a large force of ballistic missiles in the vicinity of Taiwan, and is expanding the reach of its ballistic missiles to attempt to prevent foreign powers from becoming involved in any future regional conflict. China can already target the United States with a relatively small force of ICBMs, and its ICBM force is growing quantitatively and qualitatively.

North Korea has had two successful flights of the TD-2 SLV, has unveiled road-mobile ICBMs, has IRBMs in development, has tested a new solid-propellant SLBM and MRBM, and maintains a large SRBM inventory. The pace of North Korea's ballistic missile flight tests has increased dramatically in recent years

Iran has ambitious ballistic missile and space launch development programs and continues to attempt to increase the lethality of its ballistic missile force. Iranian ballistic missile forces continue to train extensively in highly publicized exercises. These exercises enable Iranian ballistic missile forces to hone wartime operational skills and evolve new tactics. Iran is fielding increased numbers of theater ballistic missiles, improving its existing inventory, and is developing technical capabilities to produce an ICBM through its ballistic missile and SLV programs.

The cruise missile threat to US forces is increasing. The majority of LACMs will still be subsonic, but supersonic and hypersonic missile will be deployed in the future. LACMs will also have increased survivability by minimizing radar signature and/or the use of chaff and decoys.



Ballistic and Cruise Missiles,

with their relatively low operating costs, their potential to penetrate defense systems, and their value as a symbol of national power, will continue to be the offensive weapons of choice for many nations.

As such, they are threats that must be carefully considered in future military planning and operations.

NASIC Public Affairs Office
4180 Watson Way
Wright-Patterson AFB, OH 45433-5625
(937) 522-6600

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DEFENSE INTELLIGENCE BALLISTIC MISSILE ANALYSIS COMMITTEE