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The Arab Gulf and the U.S. Strategic Partnership in Ballistic Missile Defense

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Missile Proliferation Risk is driven by two factors:

Political Motivation: Threat Perception and Security Concerns
Technical Capability: Ballistic Missiles Design, Development, and Deployment

Iran's Threat Perception and Security Concerns:

Sees itself as a dominant Gulf power, its aim is to keep the waters free from any foreign military presence, and to prevent outside countries from shaping the political & security future of the Gulf.

Sees itself as a regional power in the Middle East therefore has a say in the internal affairs of regional countries and in the M.E. Peace Process.

The presence of the U.S. 5th fleet in the waters of the Gulf as a direct threat to its National Security, and sees the U.S. building bases in the Gulf as launching pads for a strike against it.

Israel views Iran as an Existential Threat and Iran must be dealt through a Military Strike, within the immediate future.

The U.S., Israel, and the Arab States are working to destabilize Iran politically and economically, and to deny it a Nuclear Energy Program.

Countries in the region and adjacent are politically unstable, with internal violence.

There are three types of systems which Iran can use to deliver Conventional and Non-Conventional weapons over a considerable distance

Aircraft

Mig-29 Fulcrum
Su - 24 Sukhoi
Su-25 Sukhoi
F-14 Tomcat
F-4E Phantom

Cruise Missile

Kh-55
SS-N-22
SS-N-26
C=801/802
SSC-3
HY-4 Silkworm

Ballistic Missile

Shahab - 1 (SCUD B)
Shahab - 2 (SCUD C)
Shahab - 3
Shahab - 3M
Sejjil (under-development)
Safir SLV (under

Iran: Force Level Total Sortie Generation - 2014

Tactical Fighter	Order of Battle	Operational Readiness (%)	Force Available	Sorties per Aircraft per day	Total Force Sorties per day	Postulated Employment
MiG-29	36	60	22	2	44	AD,Escort,FS,BAS
Su-23	13	60	8	2	16	CAS,BI,Deep Strike
Su-24	30	60	18	2	36	CAS,BI,Deep Strike
F-14	43	50	22	2	44	AD,FS
F-4E	65	55	36	2	72	AD,Strike,SEAD
Total	187		106		212	

FS:Fighter Sweep BAS: Battlefield Air Superiority AD: Air Defense CAS: Close Air Support BI: Battlefield Interdiction SEAD: Suppression of Enemy Air Defense

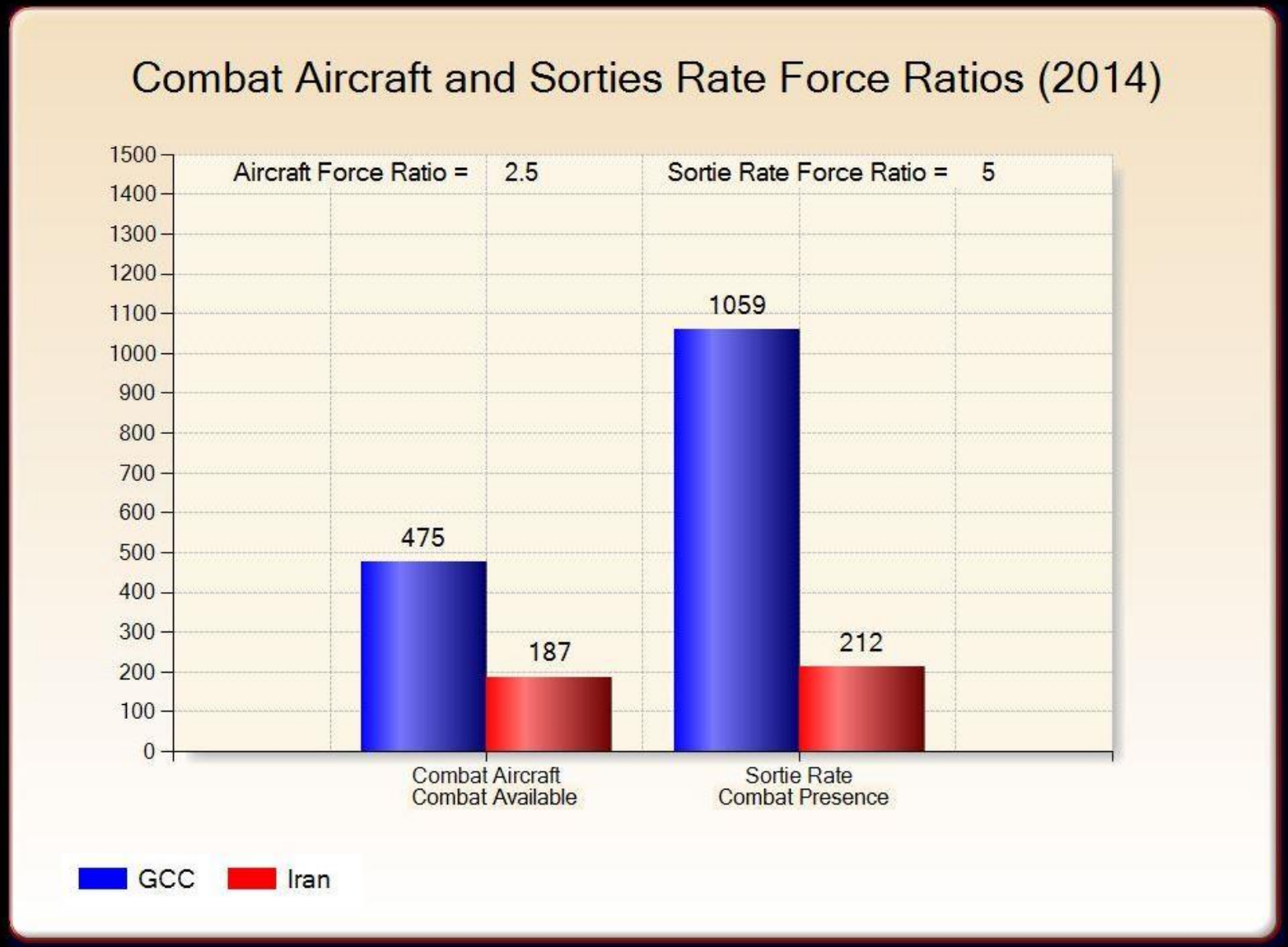
GCC: Force Level Total Sortie Generation - 2014

Tactical Fighter	Country	Order of Battle	Operational Readiness (%)	Force Available	Sorties per Aircraft per day	Total Sorties per day	Postulated Employment
Tornado IDS	Saudi Arabia	69	65	45	3	135	Deep Strike
Typhoon-2	Saudi Arabia	32	75	24	3	72	FS,BAS,AD,Escort
Mirage 2000	UAE	60	75	45	3	135	FS,BAS,AD,Escort
	Qatar	12	75	9	3	27	
F-18L	Kuwait	39	70	27	3	81	FS,BAS,AD,Escort,CAS,BI,SEAD
F-16C/D	Bahrain	21	80	17	3	51	FS,BAS,AD,Escort,CAS,BI
	Oman	12	80	10	3	30	
	UAE	78	80	62	3	186	
F-15C/D	Saudi Arabia	81	75	61	3	183	FS,BAS,AD,Escort,CAS,BI
F-15S	Saudi Arabia	71	75	53	3	159	Deep Strike,FS,AD,Escort,CAS,BI
Total		475		353		1059	

FS:Fighter Sweep BAS: Battlefield Air Superiority AD: Air Defense CAS: Close Air Support BI: Battlefield Interdiction SEAD: Suppression of Enemy Air Defense

In addition to the Sorties Rate Force Ratio the following is taken into consideration in the overall analysis:

1) Combat Aircraft Performance: Range and Survivability;
2) Number and type of weapons carried;
3) Weapons Effectiveness and Accuracy (CEP).



Combat aircraft are slow when compared to Ballistic Missiles and vulnerable to conventional air defense systems. They can be detected at a very early stage in the mission flight path to the target.

The aging Iranian airforce will definitely be no match against the U.S. and even the GCC airforces. Iran's weaknesses in air-to-air combat, and its weaknesses in surface-to-air missile defense leave it highly vulnerable to any US/GCC attack.

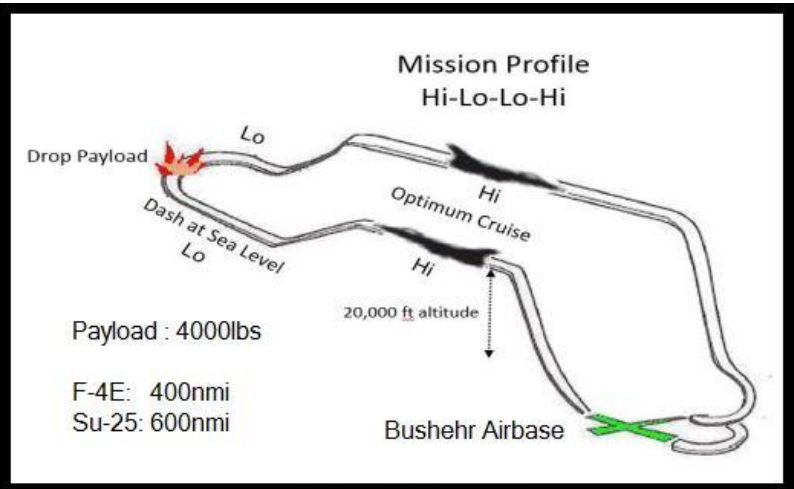
Iranian Airforce does not have the capability to reach major cities and high value targets over 1000 km away carrying one or two 1000 kg bombs when flying a Lo-Lo-Lo-Lo mission profile

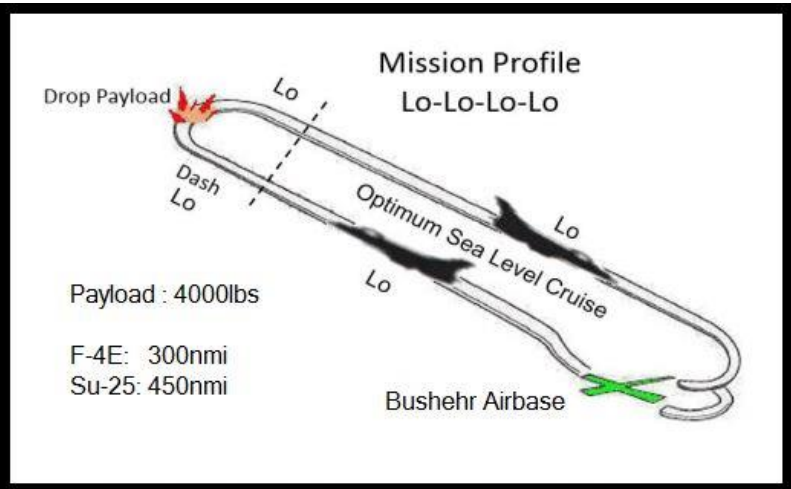
Iran's Current Air/Missile Defenses:

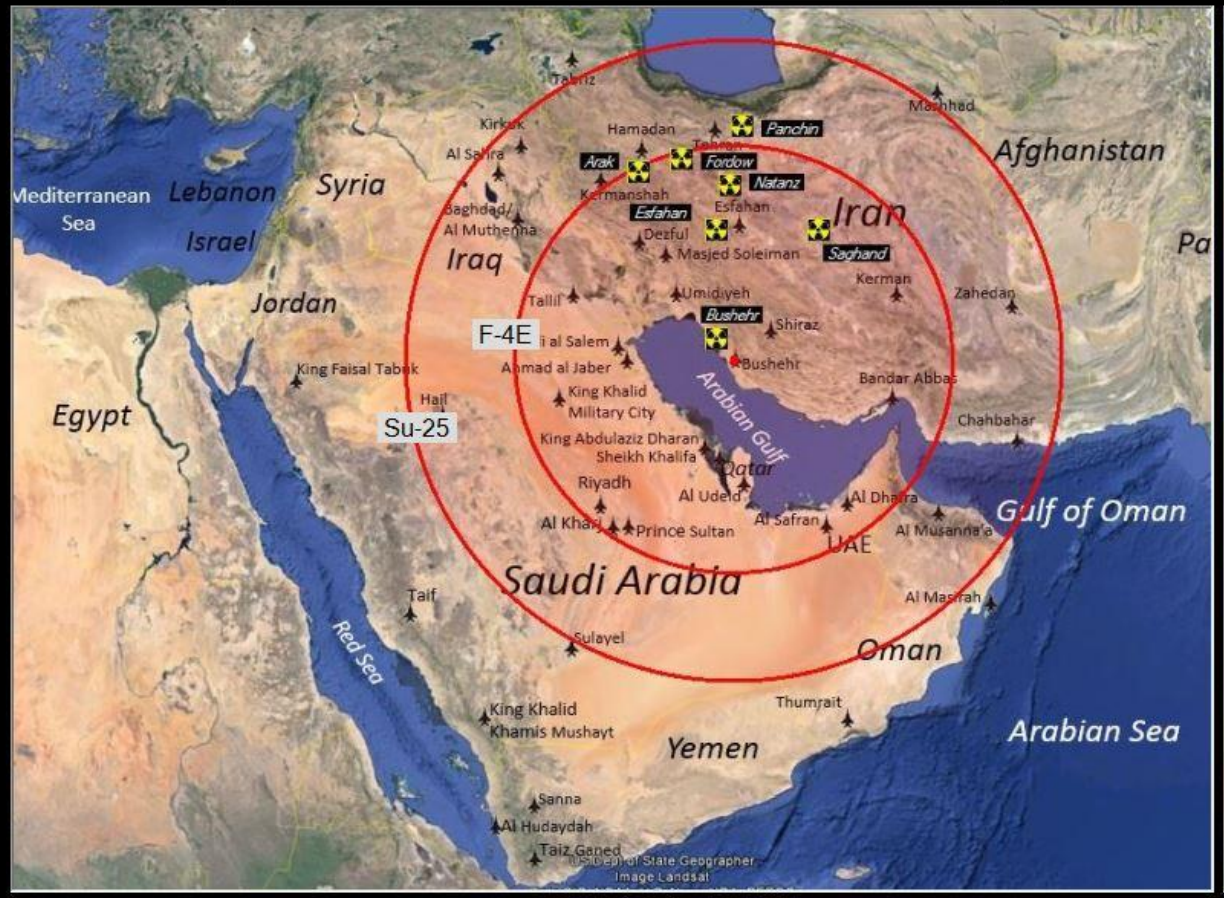
- U.S. never delivered integrated system before fall of Shah.
- Only modern short-range point defense system is TOR-M.
- Other short-range systems mix of older Russian system, SHORADs, and aging – possible inactive British and French systems.
- Medium to long-range systems are low capability or obsolescent.
- HAWKS and IHAWKs do not have capable ECM. Date back to 1960s and 1970s.
- Various versions of SA-2 and SA-5 are obsolete in spite of Iran's claims of modifting SA-5 into S-300.
- Radar sensor and battle management/C4I systems have major limitations. No satellite targeting capability, and they have serious Intelligence, Surveillance, and Reconnaissance (ISR) limits.

Iran Airforce

Interdiction Mission Radius

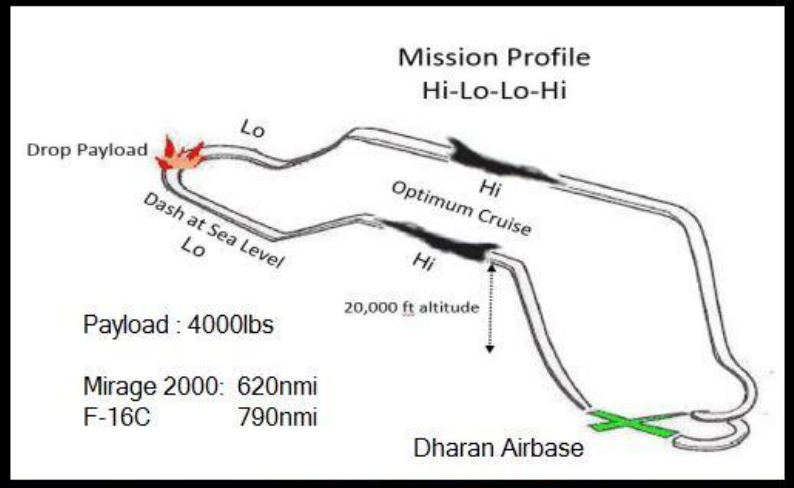


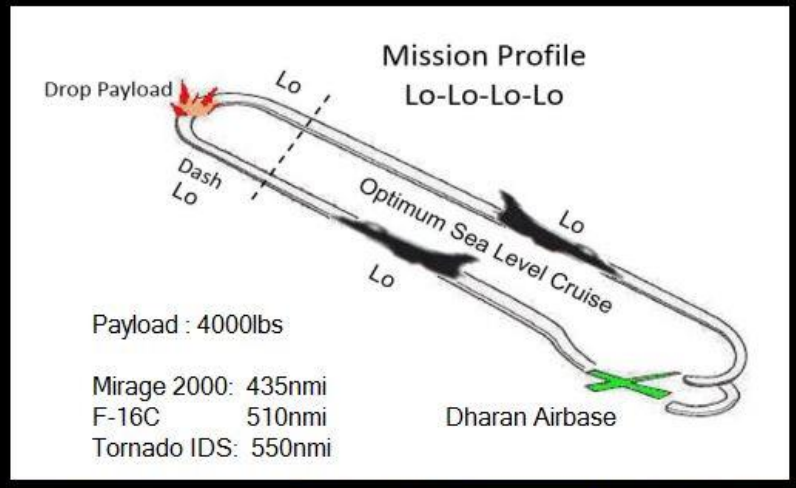


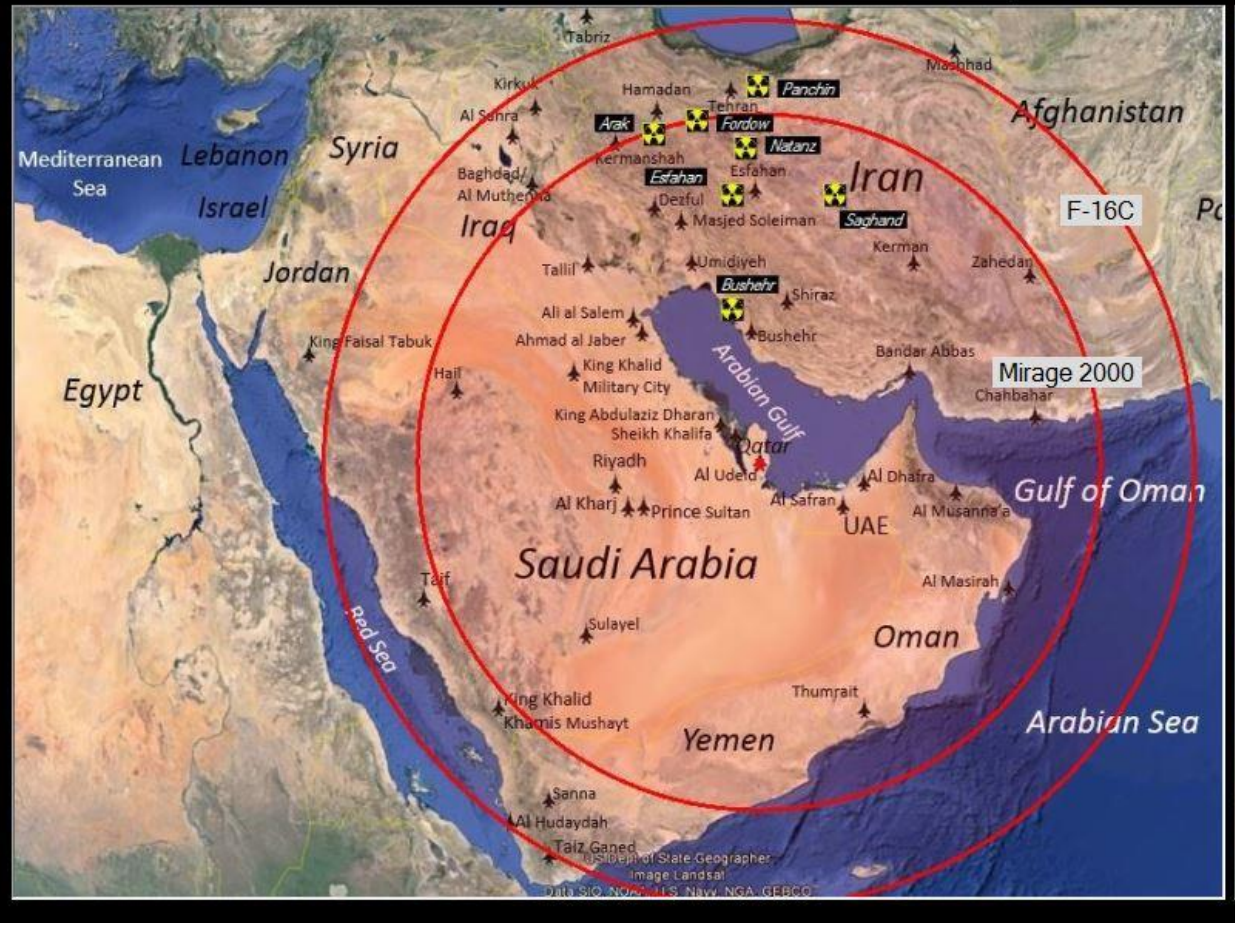


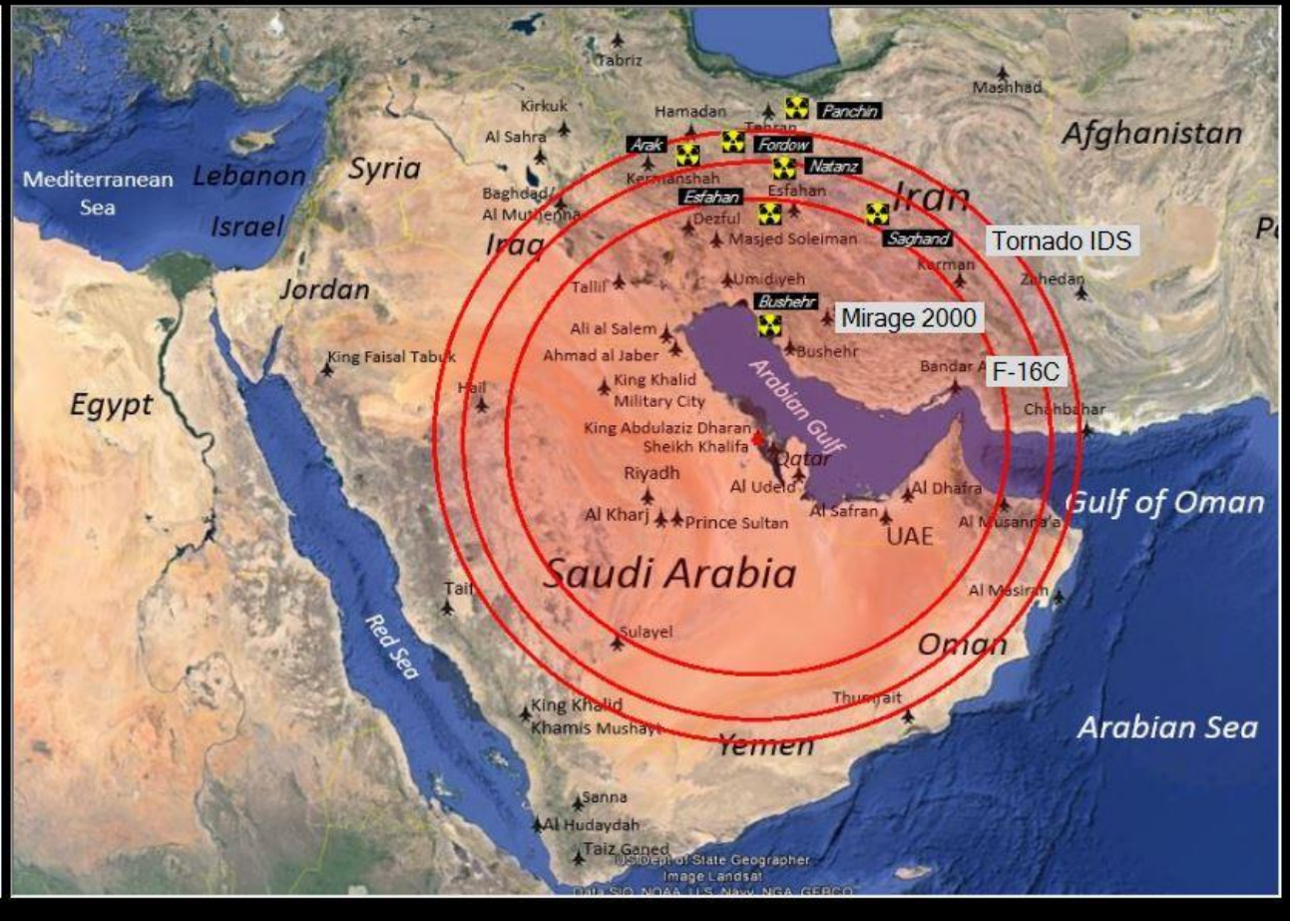
GCC Airforce

Interdiction Mission Radius





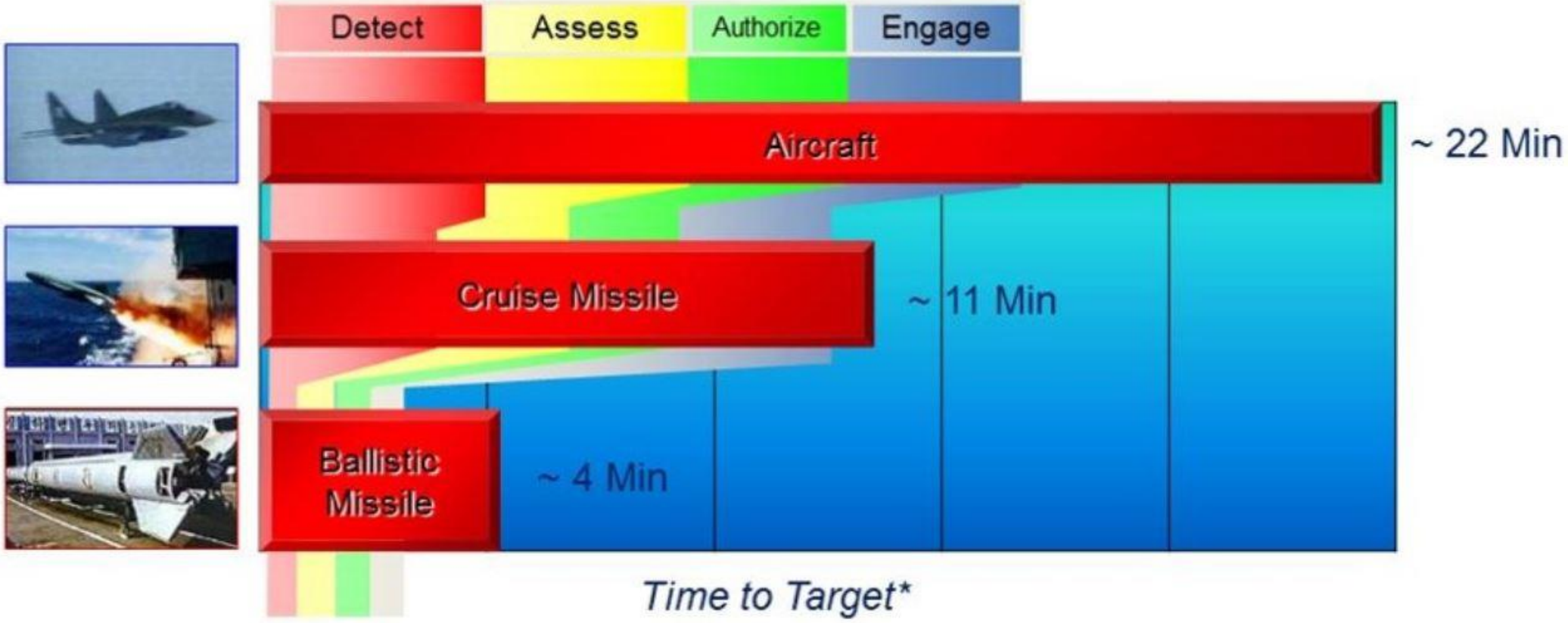




Possible Iran Cruise Missiles

System	Payload (kg)	Max Speed (Mach)	Range (km)	Notes
Kh-55	410 Nuclear/Conventional	0.8	2500	Designed as ALCM, with a CEP of 25m, is slower but more accurate than any of Iran's missiles. Vulnerable to anti-missile weapons which degrades its effectiveness in hitting hardened and defended targets. Not operational in Iran, maybe used as engineering testbed.
SS-N-22	300 - 320	2.1 (low altitude) 2.5 (high altitude)	150	Heavier than the Kh-55. Not operational in Iran, maybe used as engineering testbed.
SS-N-26	250	-	300	Lighter version than the SS-N-22. Launched from submarines, surface ships, aircraft and land batteries.
C-801	165	0.85	50	Chinese. The C-801 is carried on missile speedboats, submarines, escort boats, and destroyers, and is used to attack destroyers or escort boats
C-802	165	0.85	120	Chinese. land attack and anti-ship cruise missile
SSC-3	513	0.9	80	Soviet Cruise Missile launched from submarines
HY-4 Silkworm	513	0.8	130 - 150	Chinese. The HY-4 development of the C-201 is a mid-range ground-, air-, and ship-launched cruise missile.

Missile Defense Challenge



* Based on Approximate Range of 320 Km

Responsive Missile Defense System is Crucial

(Dennis Cavin, "Counterforce Capabilities Against Cruise and Ballistic Missiles". MEMAD 14 & 15 December, 2008)

Iran's Ballistic Missiles, in service and under development, cover the range from 150km up to 5,500km; Short, Medium, and Intercontinental Ranges.

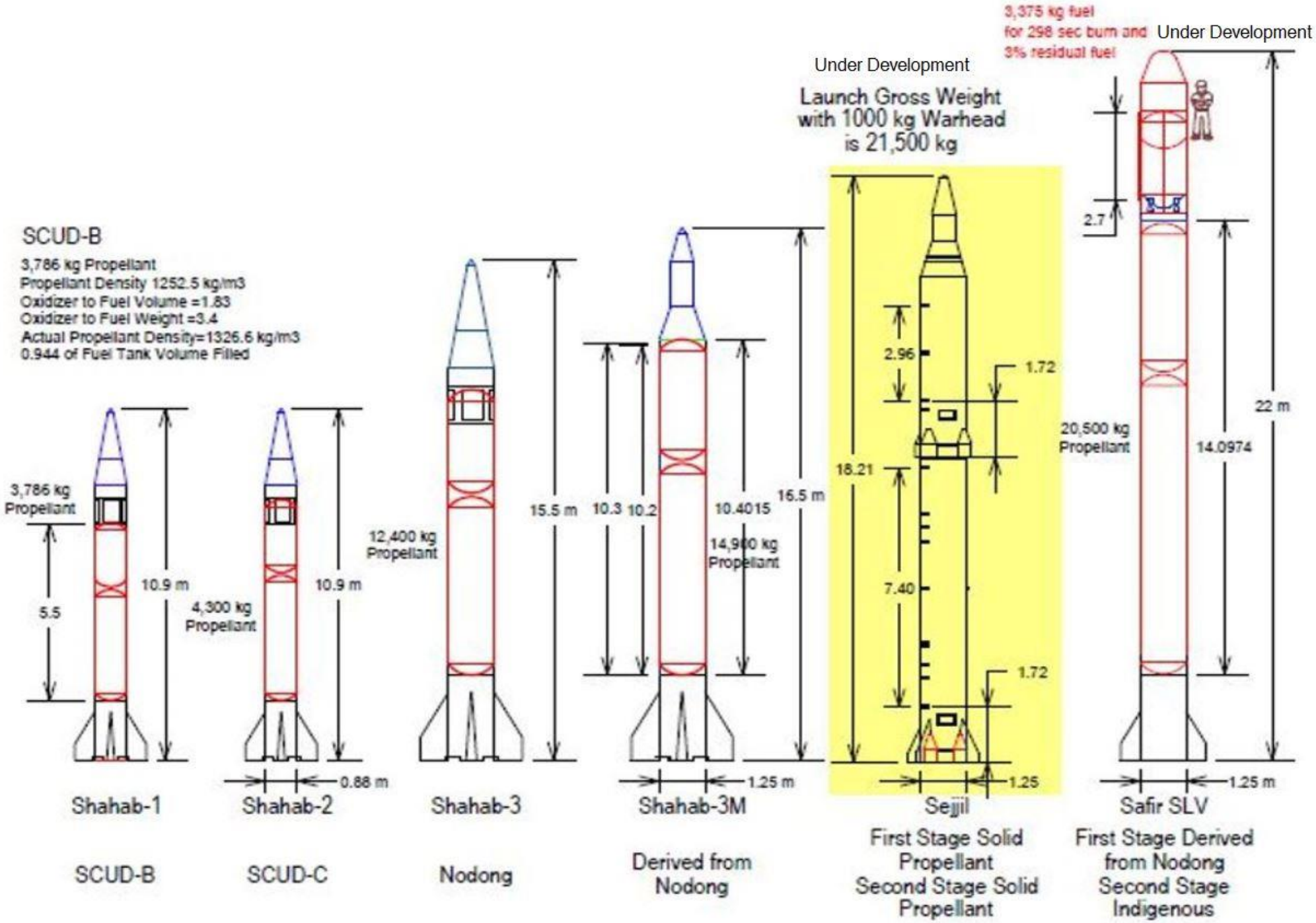
Iran is currently developing Ballistic Missiles as a means to:

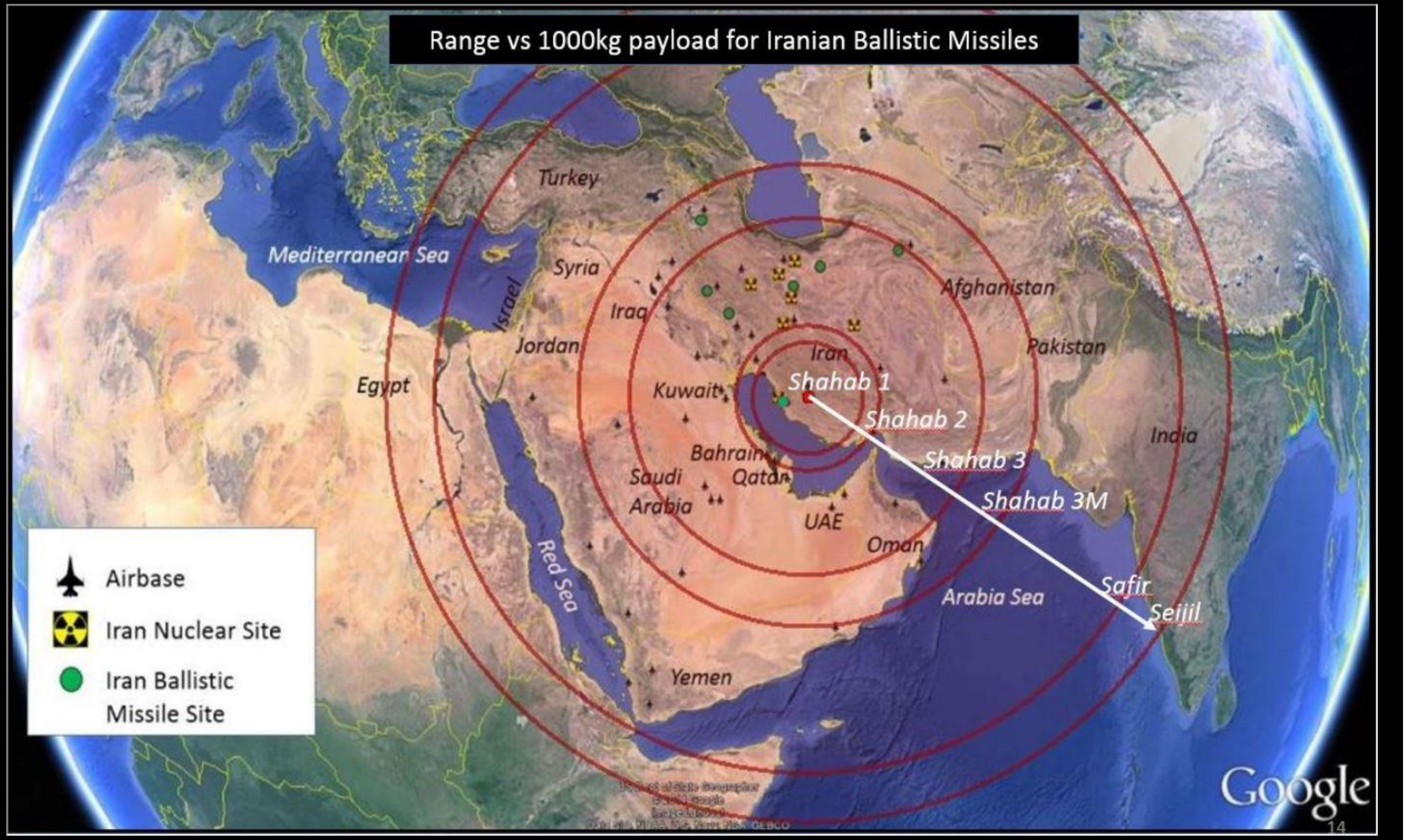
Project Power
A capability for in-depth defense by launching an attack from deep within its own territory

Iran seeks to use Ballistic Missiles to compensate for any deficiencies in its Conventional Forces Capabilities and Air Power

The only effective strike capability Iran has other than asymmetric warfare in the Gulf, and the use of proxies like Hezbollah, is their Ballistic Missile Force. A massive strike could cause quite a considerable damage to critical infrastructure centers, inthe GCC states.

U.S. is partnering with GCC states to develop the capability to defeat the threat Iran poses to the Gulf, and to the flow of trade and energy exports that, during a crisis, Iran could try to prevent their ships from traversing the Strait of Hormuz and cutting off their oil export business.


SCUD-B
3,786 kg Propellant
Propellant Density 1252.5 kg/m3
Oxidizer to Fuel Volume =1.83
Oxidizer to Fuel Weight =3.4
Actual Propellant Density=1326.6 kg/m3
0.944 of Fuel Tank Volume Filled
3,786 kg Propellant
5.5
10.9 m
4,300 kg Propellant
10.9 m
0.88 m
12,400 kg Propellant
15.5 m
10.3
10.2
10.4015
14,900 kg Propellant
16.5 m
1.25 m
Under Development
Launch Gross Weight with 1000 kg Warhead is 21,500 kg
18.21
2.96
7.40
1.72
1.72
1.25
3,375 kg fuel for 298 sec burn and 3% residual fuel
Under Development
2.7
20,500 kg Propellant
14.0974
22 m
1.25 m
Shahab-1
SCUD-B
Shahab-2
SCUD-C
Shahab-3
Nodong
Shahab-3M
Derived from Nodong
Sejjil
First Stage Solid Propellant Second Stage Solid Propellant
Safir SLV
First Stage Derived from Nodong Second Stage Indigenous


Range vs 1000kg payload for Iranian Ballistic Missiles
Turkey
Mediterranean Sea
Syria
Israel
Iraq
Jordan
Egypt
Kuwait
Iran
Shahab 1
Shahab 2
Shahab 3
Shahab 3M
Safir
Seijil
Afghanistan
Pakistan
India
Bahrain
Qatar
Saudi Arabia
UAE
Oman
Red Sea
Arabia Sea
Yemen
Airbase
Iran Nuclear Site
Iran Ballistic Missile Site
Google

The maximum distance from the periphery of the target at which weapon detonation will inflict the necessary damage for a kill is termed the lethal blast distance for that weapon – target combination

	Over Pressure	Lethal Distance MK84 2000 lb bomb with 634 kg of TNT explosives	Lethal Distance 1000 kg TNT explosive warhead
Target	psi	LMD (m)	LMD (m)
Radar Antenna destroyed	8	38	47
Commercial building destroyed plus 50% population fatalities	10	34	40
Light houses destroyed, 5% population fatalities and 45% injuries	5	50	58
Reinforced concrete, structures destroyed	20	24	28.5
Parked Aircraft destroyed	25	22	25
Command Centers destroyed	40	18	21

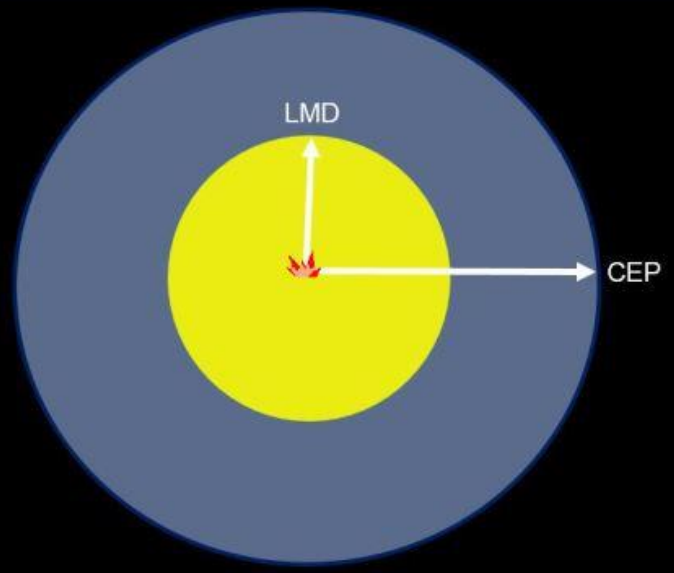
Importance of improving missile accuracy (CEP)

Directly affecting number of missiles required to achieve the desired probability of damage.

Input warhead explosive weight (kg) :	1000
Input warhead lethal radius (m) :	25
Input weapon CEP (m) :	50
Input probability of damage required PD :	0.75

Run

Blast Overpressure (psi) :	26.98
Warhead lethal radius/weapon CEP :	0.5
Probability of target destruction :	0.159
No of missiles/sorties required for PD :	8



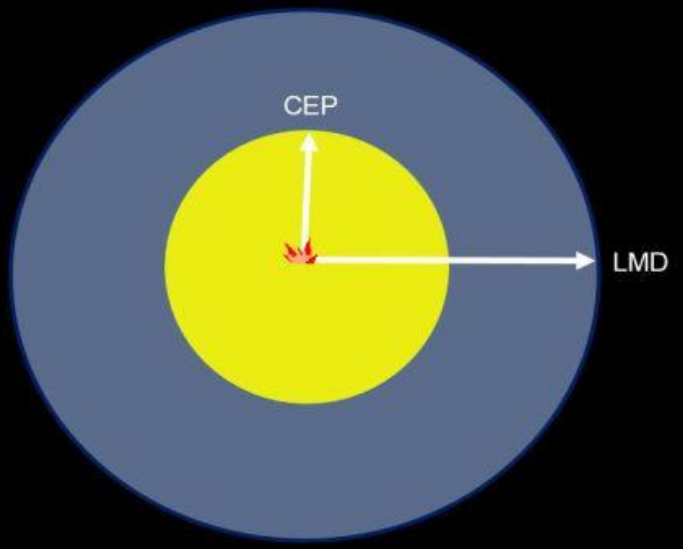
Importance of improving missile accuracy (CEP)

Directly affecting number of missiles required to achieve the desired probability of damage.

Input warhead explosive weight (kg) :	1000
Input warhead lethal radius (m) :	25
Input weapon CEP (m) :	20
Input probability of damage required PD :	0.75

Run

Blast Overpressure (psi) :	26.98
Warhead lethal radius/weapon CEP :	1.25
Probability of target destruction :	0.661
No of missiles/sorties required for PD :	1



Missile Accuracy (CEP)	No of Missiles needed to damage/destroy the target	Number of targets that can be attacked
Large, missile accuracy is small	More missies needed to damage/destroy target	Fewer targets are attacked, since more missiles are allocated per target damage/destruction
Small, missile accuracy is high	Fewer missiles are needed to damage/destroy target	More targets are attacked, since fewer missiles are allocated per target damage/destruction

- Ballistic Missiles can also be used with success against Soft Targets, in open areas and cities to inflict maximum human casualties and create terror.
- In essence what is considered as a major component in Asymmetric Warfare in the form of high civilian casualties.

Click on Yield (kt)

Yield KT
5
10
20
30
40
50
60
70
80
90
100
110
120
130

Yield (kt)	20
Blast Range (km) 50% Lethality	0.4
Ionization (km) 50% Lethality (X rays, gamma rays, and neutrons)	1.58
Thermal Radiation (km) 50% Lethality 3rd degree burns	1.9
Range of Maximum EMP (km)	5

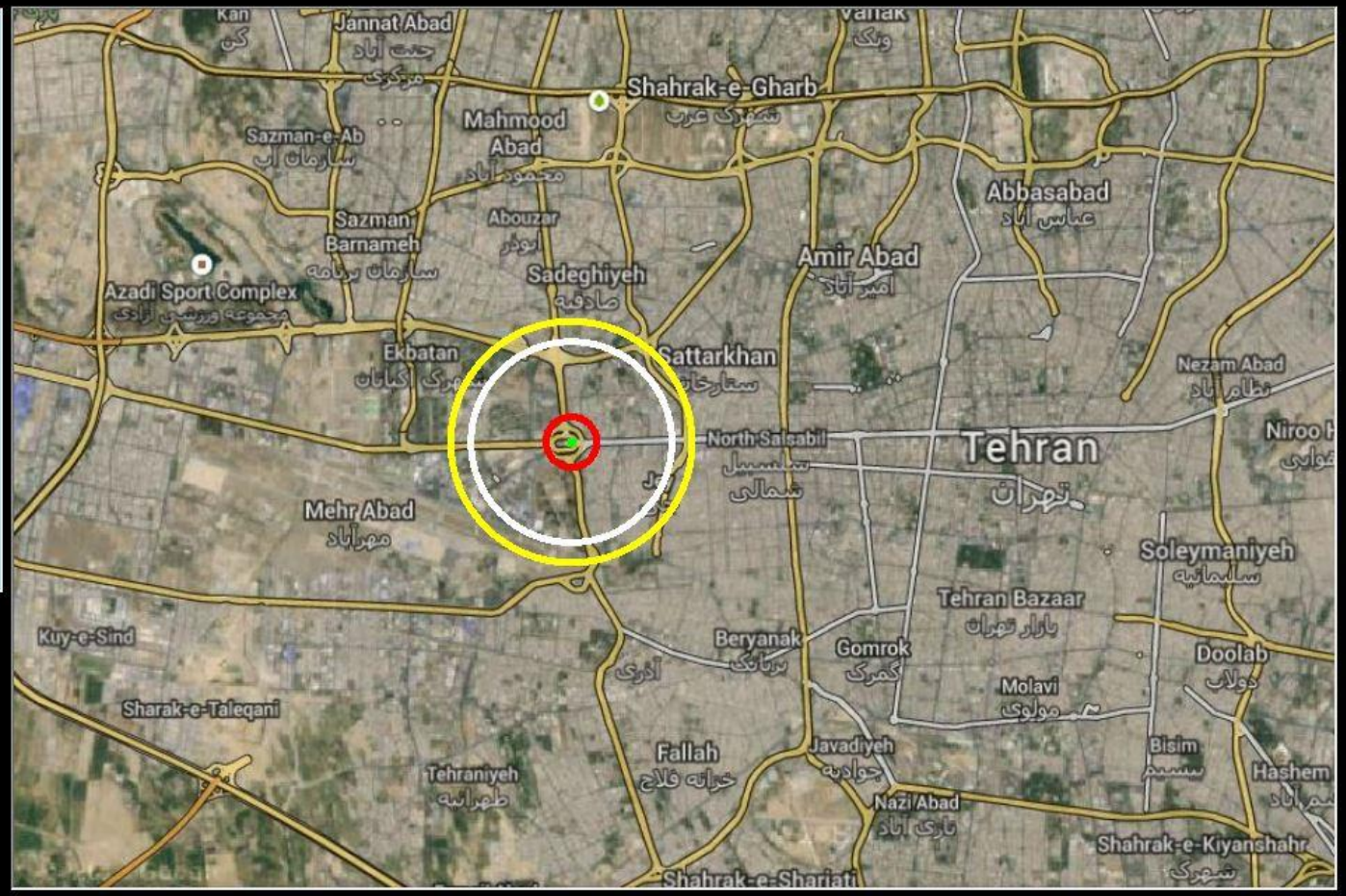
50% Lethality:

Blast

Ionizing Radiation

Thermal Radiation

Clear



Nuclear Missile Delivery Capability for a 1,000 kg Warhead Weight

Iran Ballistic Missiles	Status	Missile warhead radius (cm)	Max weight of a nuclear device that could fit the missile (kg)	Max warhead deliverable range (km)	Missile range required to reach main targets (km)	Nuclear missile delivery capability (Iran very uncertain)
Shahab 1	In Service	44	750 - 1,310	285	>350	No
Shahab 2	In Service	44	750 - 1,310	370	>350	Marginal
Shahab 3	In Service	62.5	2,030 - 3,200	910	>500	Yes
Shahab 3M	In Service	62.5	2,030 - 3,200	1,150	>500	Yes
Safir	Under Development	62.5	2,030 - 3,200	1,910	>1,000	Yes
Seijil	Under Development	62.5	2,030 - 3,200	2,160	>1,000	Yes

A "nuclear capable" missile is defined by the MTCR as one with a payload capability in excess of 500 kg combined with a range in excess of 300 km. This definition is based on an assumption that an emerging nuclear state will be unable to build nuclear warheads weighing less than 500 kg.

Iran has received Soviet designed Scud-B missiles and it has adapted the design into two independently-built versions; the Shahab 1 and Shahab 2, both of which have the same diameter of 88 cm and their ranges, for 750 kg warhead, are 340 and 440 km respectively. For a 1000 kg warhead the ranges become 285 and 370 km.Even though the Shahab-1 could fit a 1000 kg warhead but it cannot reach deep into GCC territory. Whereas the Shahab 2 nuclear capability is marginal to deliver nuclear warhead in excess of 350 km.

Iran's Shahab 3 & 3M missiles which have a diameter of 125 cm and a range in excess of 900 km with a payload of 1,000 kg would be able to deliver a nuclear warheads to many of the Middle East capitals and targets.

Iran Ballistic Missile as a Conventional and Nuclear Weapon Capable Delivery System

Missile Technical Design & Engineering sites:

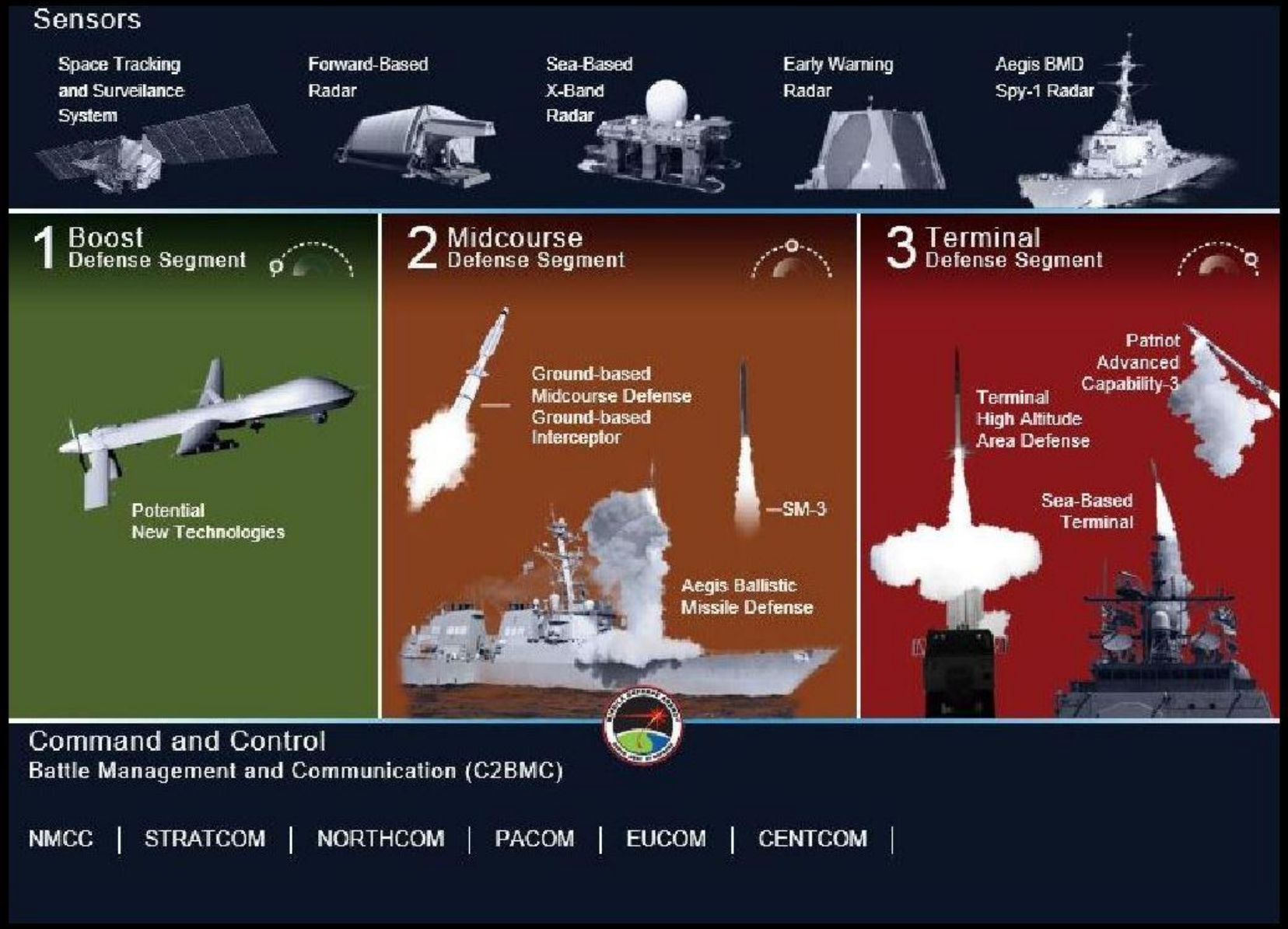
- Aerospace Industries Organization (AIO) Location: Tehran
- Defense Industries Organization (DIO) Location: Tehran
- Garmsar Missile Test Range Location: Garmsar, Tehran province
- Gostaresh Scientific Research Center Location: Hamadan
- Imam Hussein University (IHU) Location: Tehran
- Imam Khomeini Space Center Location: Semnan, Iran
- Iran Aircraft Manufacturing Industries Location: Isfahan
- Isfahan Missile Complex Location: Isfahan
- Karaj Missile Development Complex Location: Karaj
- Kuhestak Missile Battery Location: Kuhestak
- Lavizan Technical and Engineering Complex Location: Tehran, Lavizan district
- Parchin Military Complex. Location: Parchin
- Qods Aeronautics Industries Location: Tehran
- Sanam College Location: Tehran, Lavizan district
- Semnan Missile Complex Location: Semnan
- Shahid Bakeri Industrial Group Location: Tehran
- Shahid Hemmat Industrial Group Location: Tehran
- Shahroud Missile Test Site Location: Shahroud, Tehran province
- Shiraz Missile Plant Location: Shiraz, Fars
- Sirjan Missile Plant Location: Sirjan, Kerman
- Tabas Location: Tabas, Khorasan province
- Tabriz Missile Base Location: Tabriz

Main Missile Launch Sites

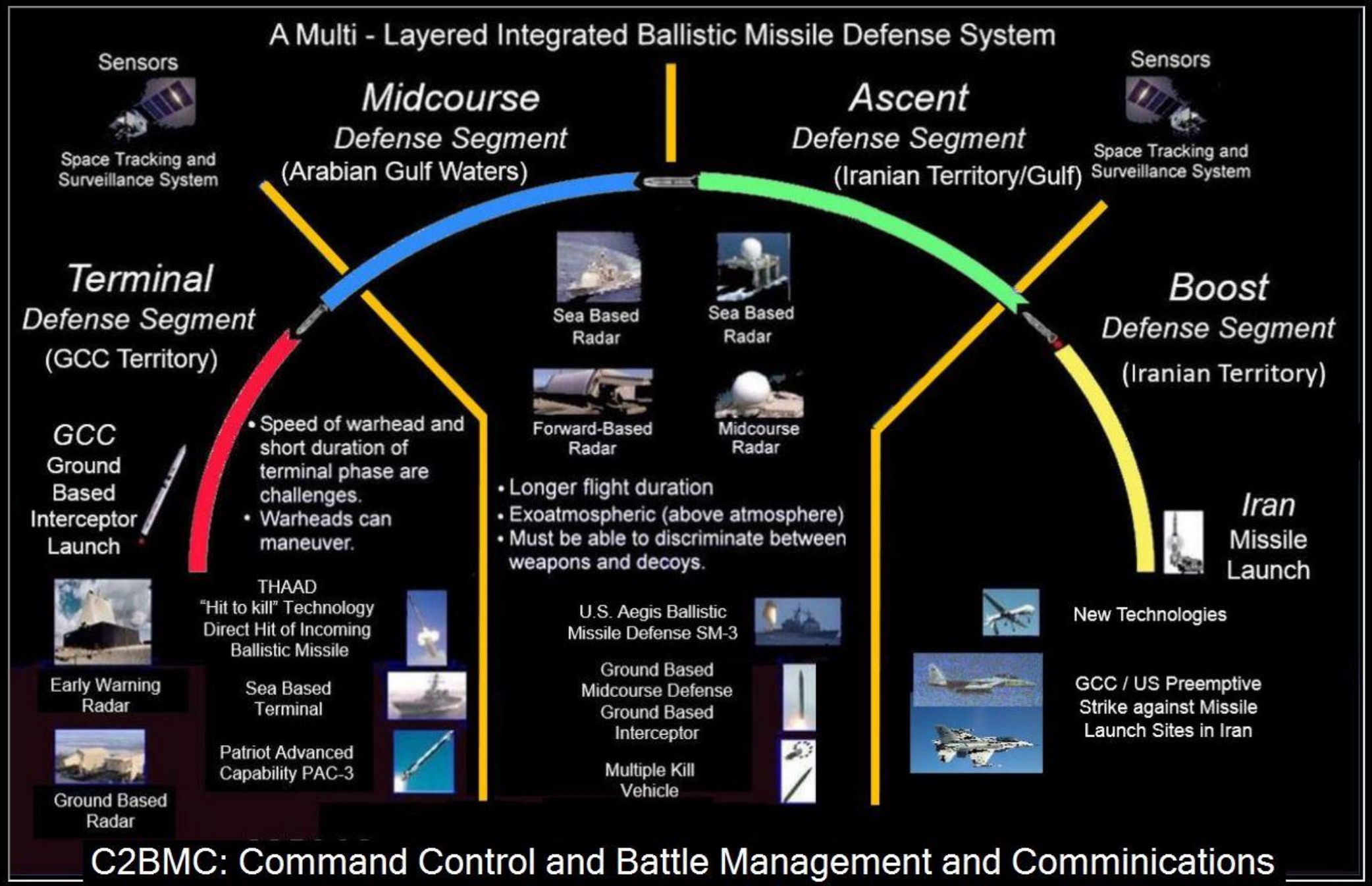
- Abu Musa Island Location: Abu Musa Island
- Bakhtaran Missile Base Location: Kermanshah
- Bandar Abbas Location: Bandar Abbas, Hormozgan
- Imam Ali Missile Base Location: Khorramabad, Lorestan
- Tabriz Missile Base Location: Tabriz
- Mashad Airbase Location: Mashad, Khorasan

Source: www.nti.org

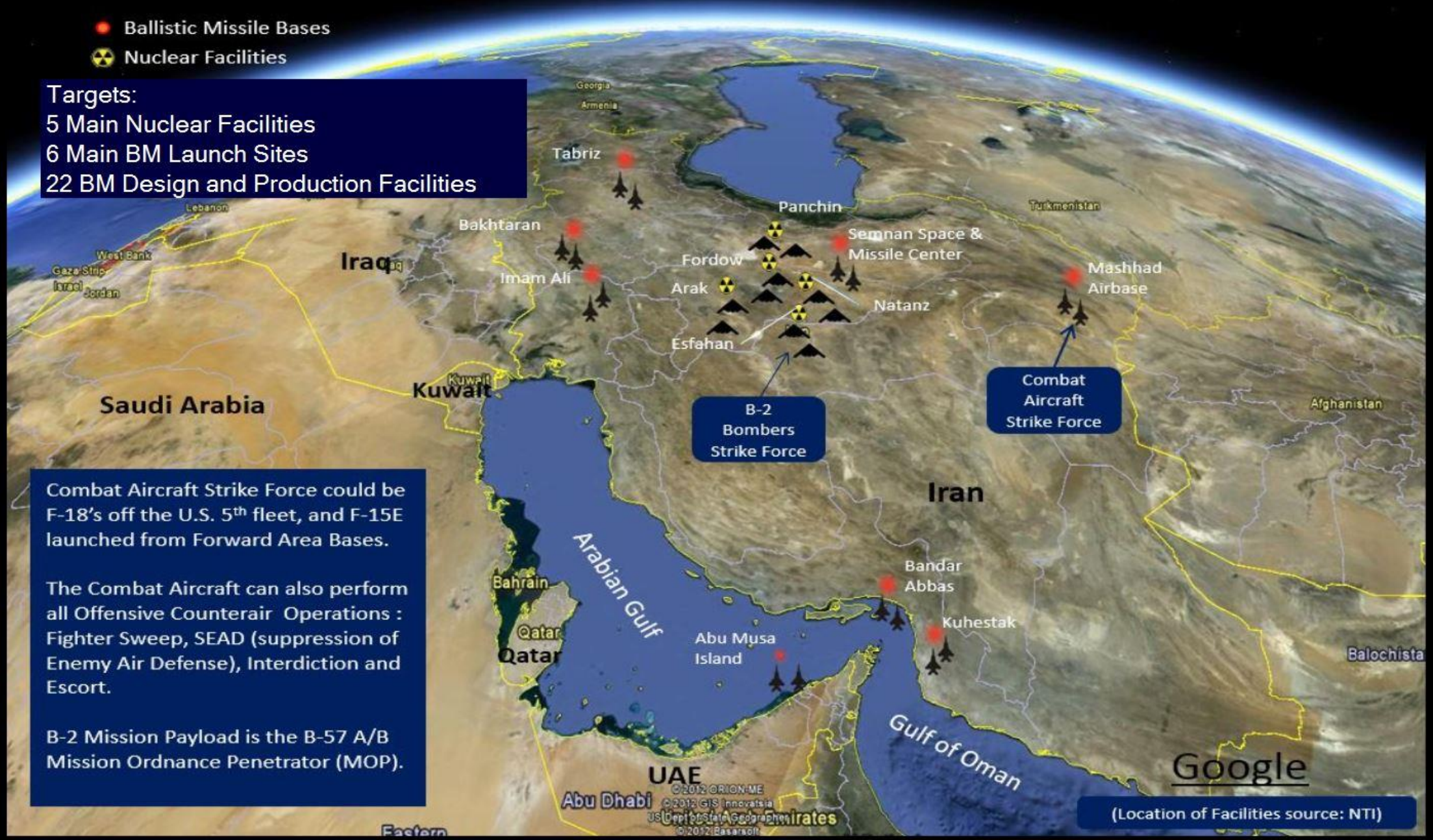
The Ballistic Missile Defense System (BMDS)



(Source: Missile Defense Agency)


A Multi - Layered Integrated Ballistic Missile Defense System
Sensors
Space Tracking and Surveillance System
Midcourse
Defense Segment
(Arabian Gulf Waters)
Ascent
Defense Segment
(Iranian Territory/Gulf)
Sensors
Space Tracking and Surveillance System
Terminal
Defense Segment
(GCC Territory)
Sea Based Radar
Sea Based Radar
Forward-Based Radar
Midcourse Radar
Boost
Defense Segment
(Iranian Territory)
GCC
Ground Based Interceptor Launch
• Speed of warhead and short duration of terminal phase are challenges.
• Warheads can maneuver.
• Longer flight duration
• Exoatmospheric (above atmosphere)
• Must be able to discriminate between weapons and decoys.
Iran
Missile Launch
Early Warning Radar
Ground Based Radar
THAAD
"Hit to kill" Technology
Direct Hit of Incoming Ballistic Missile
Sea Based Terminal
Patriot Advanced Capability PAC-3
U.S. Aegis Ballistic Missile Defense SM-3
Ground Based Midcourse Defense Ground Based Interceptor
Multiple Kill Vehicle
New Technologies
GCC / US Preemptive Strike against Missile Launch Sites in Iran
C2BMC: Command Control and Battle Management and Comminications

US - GCC Preventive Military Strike against Iranian Nuclear Facilities and Ballistic Missile Bases



Probability of Detection, Track, and Firing Reliability :	0.99
Probability of Defense Effectiveness:	0.85
Single Shot Kill Probability (SSKP) :	0.75
Number of Warheads in the Attack :	5
Number of Shots that must be fired at each incoming warhead to achieve a given level of effectiveness :	2

Run Reset

Ballistic Missiles Volley Launch

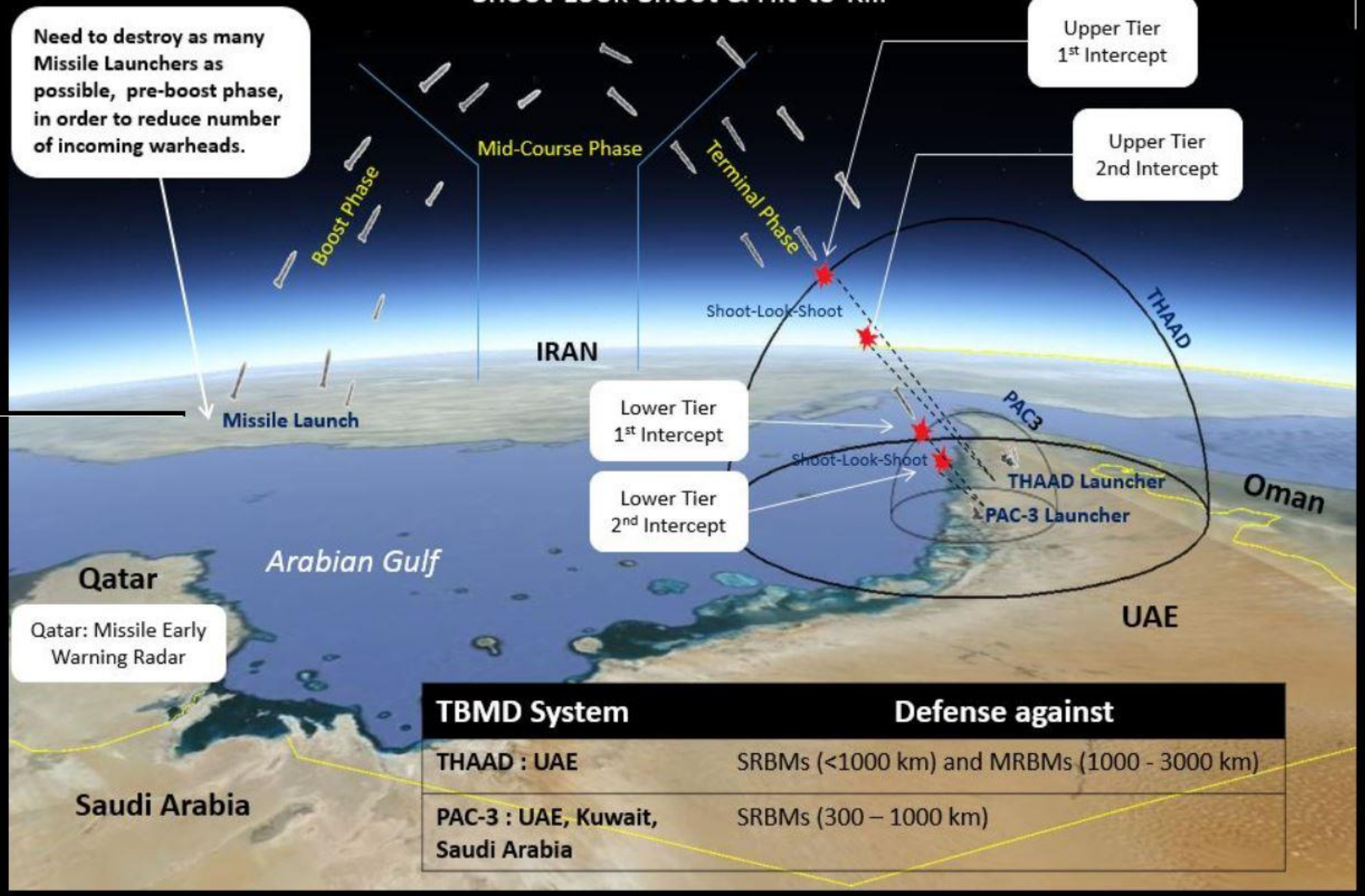
Destroying as many Ballistic Missile Launchers during boost (boost phase) or before launch:

1. Reduces the number of incoming missiles (warheads)
2. Reduces the number of shots defense needs to take at each incoming missile (warhead)

PAC-3

Maximum Range for Destruction of BM target (km):	40
Upper limit of Destruction Zone (km):	30
Maximum Speed of destroyed target (m/sec):	3000

Two Tier Theater Ballistic Missile Defense (TBMD) – THAAD & PAC 3 Endo and Exo-Atmospheric Engagements using Shoot-Look-Shoot & Hit-to-Kill



TBMD System	Defense against
THAAD : UAE	SRBMs (<1000 km) and MRBMs (1000 - 3000 km)
PAC-3 : UAE, Kuwait, Saudi Arabia	SRBMs (300 – 1000 km)

Two Tier Theater Ballistic Missile Defense (TBMD) – THAAD & PAC 3
Endo and Exo-Atmospheric Engagements using Shoot-Look-Shoot & Hit-to-Kill

Probability of Detection, Track, and Firing Reliability :	0.99
Probability of Defense Effectiveness:	0.85
Single Shot Kill Probability (SSKP) :	0.75
Number of Warheads in the Attack :	20
Number of Shots that must be fired at each incoming warhead to achieve a given level of effectiveness :	4

Run Reset

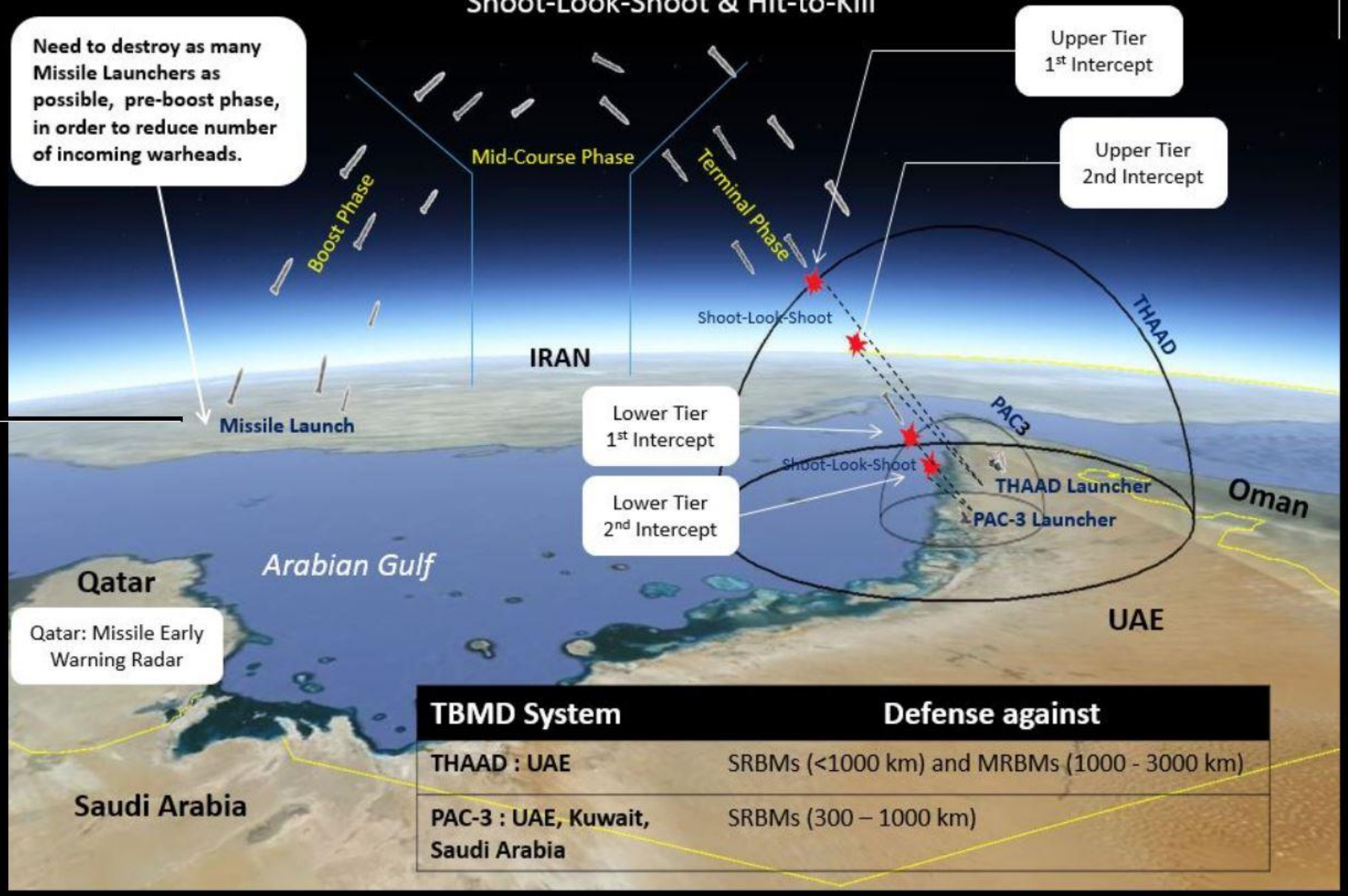
Ballistic Missiles Volley Launch

Destroying as many Ballistic Missile Launchers during boost (boost phase) or before launch:

1. Reduces the number of incoming missiles (warheads)
2. Reduces the number of shots defense needs to take at each incoming missile (warhead)

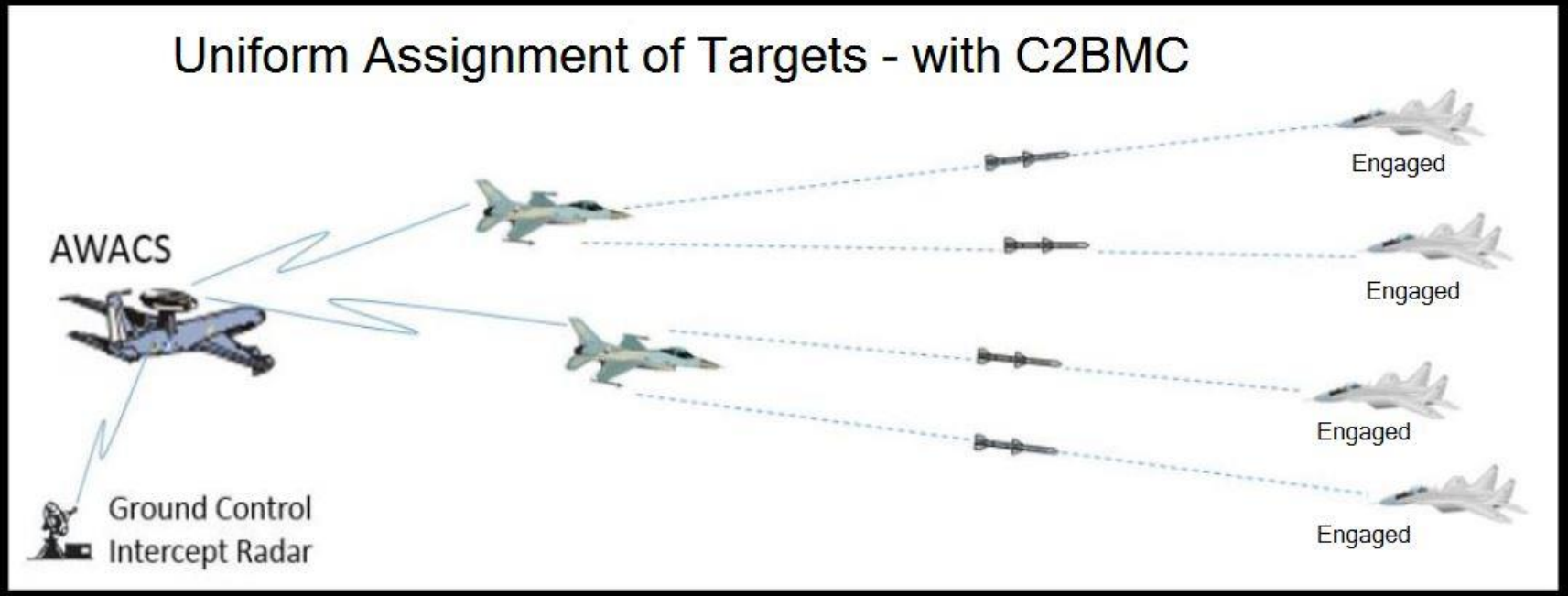
PAC-3

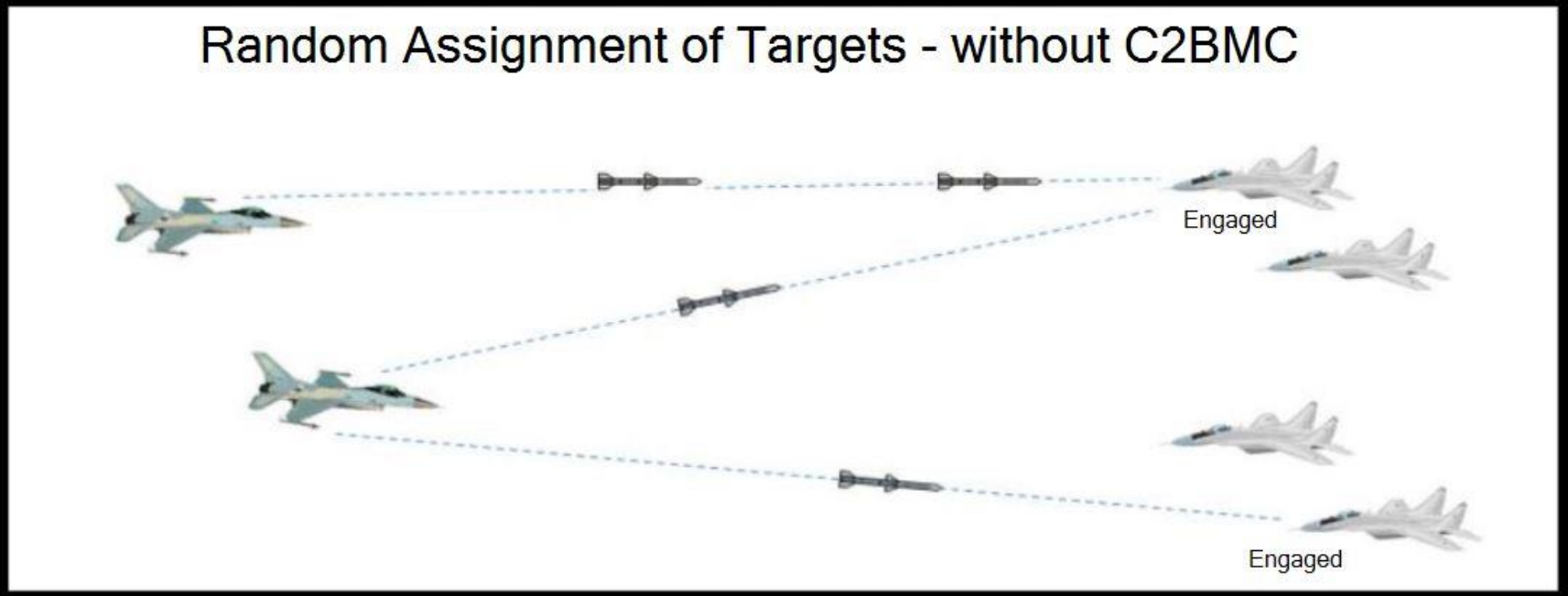
Maximum Range for Destruction of BM target (km):	40
Upper limit of Destruction Zone (km):	30
Maximum Speed of destroyed target (m/sec):	3000

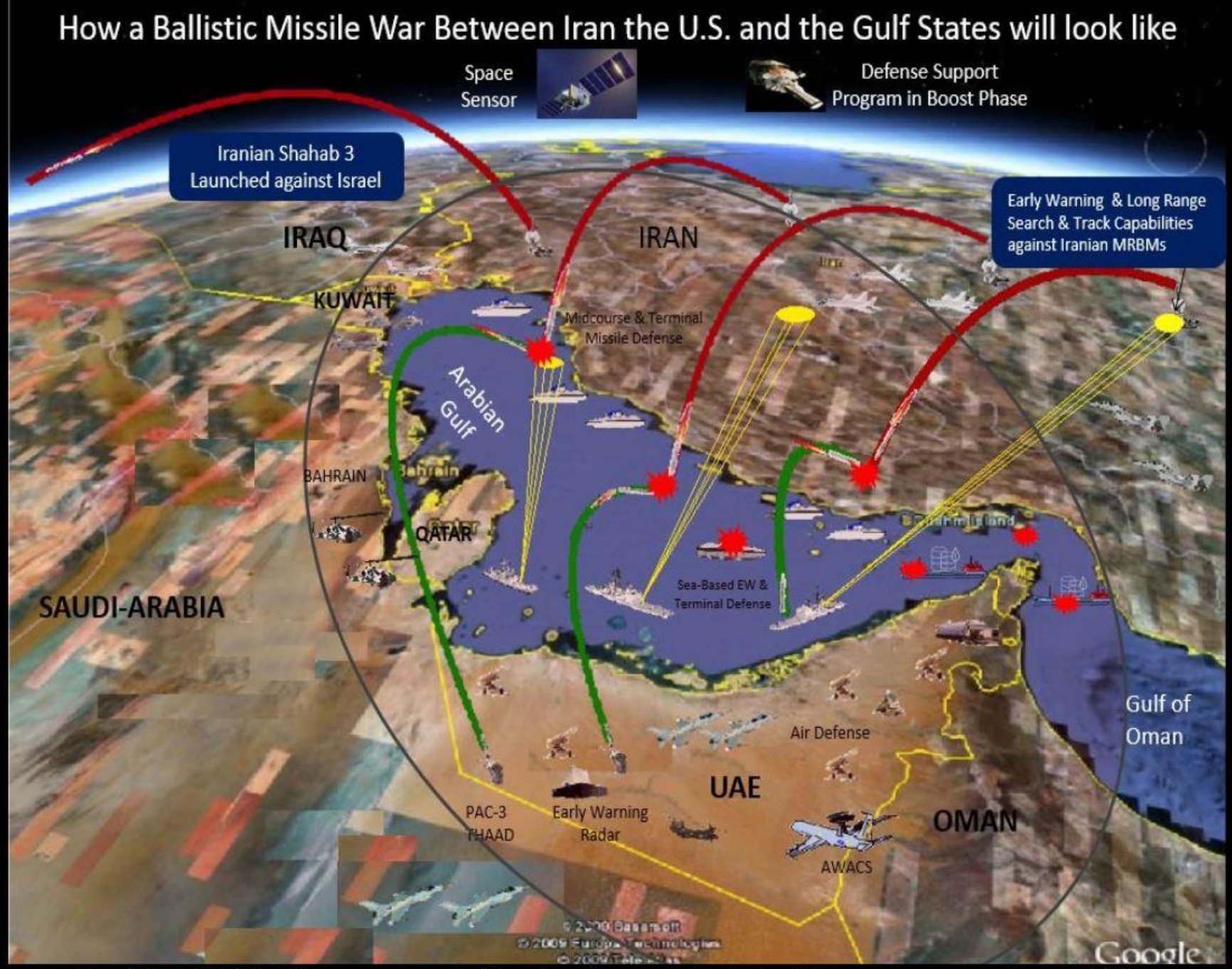


TBMD System	Defense against
THAAD : UAE	SRBMs (<1000 km) and MRBMs (1000 - 3000 km)
PAC-3 : UAE, Kuwait, Saudi Arabia	SRBMs (300 – 1000 km)

Importance of a C2BMC: Command Control and Battle Management and Comminications







Importance of a C2BMC: Command Control and Battle Management and Comminications

The Arab Gulf and the U.S. Strategic Partnership in Ballistic Missile Defense

Country	BMD System
UAE	• The UAE is so far the first GCC country to buy the Terminal High Altitude Air Defense (THAAD) missile system. • On Dec 31, 2011 Pentagon announced that the UAE will be buying 2 full THAAD batteries, 96 missiles, 2 Raytheon AN/TPY-2 radars, and 30 years of spare parts. Total Value $3.34 billion. • In 2008 the UAE ordered Patriot PAC-3: 10 fire units, 172 missiles, First delivery 2009.
Kuwait	• July 2012, Pentagon informed Congress of a plan to sell Kuwait $4.2 billion in weapon systems, including 60 PAC-3 missiles, 20 launching platforms and 4 radars. This will be in addition to the 350 Patriot missiles bought between 2007 and 2010. In 1992, Kuwait bought 210 of the earlier generation Patriots and 25 launchers. Kuwait bought a further 140 more in 2007.
Saudi Arabia	• In 2011 Saudi Arabia signed a $1.7 billion US contract to upgrade it's Patriot anti-missile system. • U.S. is planning a $1.75 billion Patriot Missile sale to Saudi Arabia. The Saudi government had requested the purchase of 202 Patriot Advanced Capability (PAC)-3 missiles — the most sophisticated version of the Patriot anti-missile weapons — as well as a flight test target, telemetry kits and other related equipment, the Defense Security Cooperation Agency said in a statement. (www.businessinsider.com October 1, 2014).
Qatar	• The U.S. is building a Missile Warning Facility in Qatar that would utilize an AN/TPY-2-X Band Radar. • Qatar has selected the Lockheed Martin's PAC-3 Missile. The initial contract is for missile and command launch system production. (PRNewswire: October 15, 2014)
Oman	• Oman set to buy a $2.1 billion missile system (PAC-3) built by Lockheed Martin as part of a U.S. drive to install a coordinated air-defense system linking the GCC states. (UPI May 21, 2013)

Thank You

End