China to deploy anti-ship ballistic missile

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No images have been released showing the DF-21C MARV or DF-21D ASBM MARV.

When leading American China analyst Richard D Fisher reported the development of China's DF-21D Anti-Ship Ballistic Missile (ASBM) in 2005, his work was greeted with disbelief, and mostly ignored in Washington. The Rumsfeld and later Gates-led Office of the Secretary of Defense had no interest in any developments outside of the Islamist insurgency, and in line with this myopic perspective, much of the US think tank community and media sought to avoid the subject matter.

However, much has changed since then, with growing acceptance that the DF-21D ASBM will become a major 'game changer' in maritime warfare. The Chinese 'carrier killer' ASBM has produced more media attention than any other new PLA weapon system, including the arguably much more important J-20 stealth fighter.

Any analysis of maritime warfare strategy needs to take into account the potential deployment of advanced ASBM capability to non-Western states.

ASBMs are a specialised class of ballistic missile with a Manoeuvring Re-entry Vehicle (MaRV/MARV), equipped with a terminal seeker to provide precision or accurate terminal guidance in the final phase of weapon flight. While MARVs in general are often provided with terminal manoeuvre capability to frustrate interception by Anti-Ballistic Missiles (ABM), an ASBM is provided with this capability to become accurate enough to hit a large warship, transport, tanker or amphibious vessel.

The Chinese DF-21 is not the first terminally guided Intermediate Range Ballistic Missile (IRBM), nor is it the first ASBM to be developed, but it is expected to be built in large numbers; and it is intended to be an 'anti-access' capability, to deny US Navy carriers battle groups access to operating areas from which US Navy aircraft could attack China's eastern seaboard. As such, this ASBM is only part of a comprehensive PLA effort to develop force structure components asymmetric to Western capabilities in the Western Pacific (WestPAC) region, and would be used concurrently with other anti-access capabilities. These include highly mobile CJ-10 and YJ-62 Ground Launched Cruise Missiles (GLCM) and air launched variants delivered by the new production turbofan powered H-6K Badger 'theatre bomber'. These anti-access systems will be provided with targeting support by a new constellation of PLA RORSATs (Radar Ocean Reconnaissance Satellites) modelled on the late Cold War period Soviet anti-shipping strike architecture. The indigenous weapons have been supplemented by imported Russian Novator 3M54 Club or SS-N-27 Sizzler Anti-Shipping Cruise Missiles (ASCM), it is not known whether these include the Mach 2.9 sea-skimming variant.

The outer ring or 'blue water' component of the PLA's maritime 'anti-access' architecture is supplemented by an inner ring or 'brown water' component comprising JH-7 Flounder, H-6M Badger and imported Russian built Su-30MK2 Flanker G aircraft armed with a range of indigenous and Russian ASCMs, as well as ASCM armed Type 22 or Houbei class fast catamaran missile boats. The latter are claimed to have been built using Australian catamaran technology. Targeting for the 'brown water' capabilities is to be provided by aircraft, RORSATs when available, and a new generation of recently introduced Surface-Wave Over The Horizon Backscatter (SW OTHB) radar systems, the latter developed by the 724 Institute of the China Shipbuilding Heavy Industry corporation.

The technological strategy underpinning this multilayered 'anti-access' architecture is sound, and carefully crafted to exploit weaknesses in the current US Navy force structure. By putting USN CVBGs at risk at 1000+ NMI from the Chinese coastline, carrier based aircraft are denied access to the 'brown water' coastal seas, where PLA strike aircraft and GLCM batteries can operate unhindered and saturate approaching surface fleet defences with ASCMs. The parallel force structure development has been the deployment of terminally guided DF-21C IRBMs and CJ-10 GLCMs to close down proximate Western airfields that could be used to deploy aircraft against PLA airfields, almost 40 of which are equipped with deep underground hangars, tunnelled into hillsides. While many of the latter date to the Cold War period, the PLANAF Foluo Northeast AB site on Hainan Island was redeveloped since 2005, and an underground hangar sized for around twenty Badgers was constructed.

As a technological strategy measure, the DF-21D ASBM significantly complicates life for the US Navy and Allied navies operating in the WestPAC theatre.

DF-21D ASBM Technology and CONOPS

Open sources and the US DoD agree that the Chinese DF-21D ASBM is a terminally guided variant of the DF-21C / CSS-5C, which is a 1,000 nautical mile range class IRBM derived from the JL-1 series solid rocket propelled SLBM carried by PLA-N SLBMs.

The early DF-21A/B is carried by a towed TEL and is highly mobile. The newer DF-21C is carried on a large 10 x 10 Transporter Erector Launcher (TEL) vehicle, modelled on the Soviet RSD-10 Pionier / SS-20 Saber MAZ-543 12 x 12 TEL, to provide high off road mobility absent in a towed road mobile TEL. The DF-21D ASBM variant would likely be deployed in exactly the same fashion, as dispersed mobile TELs are extremely difficult to locate and target prior to missile launch, and off-road mobile TELs even more difficult to defeat. The TEL is equipped with a gas turbine APU to permit fully autonomous operation with the main engine shut down. PLA Second Artillery IRBM units have been observed codeployed with the TS-504 troposcatter OTH communication system, which would permit multiple Megabit/s battery wide area networking at distances in excess of 100 NMI from any fixed C3 infrastructure, and further if multiple TS-504 stations are chained into a relay system. In practice targeting data would be sent via fixed optical fibre links from SW-OTHB and RORSAT downlink sites to prepared relay sites with TS-504 stations, or directly to batteries via satcom relay links. The latter would typically be at much lower data rates.

In any contingency the Second Artillery would disperse its DF-21 batteries from fixed garrison bases to prepared tunnel hides, of which several thousand kilometres worth have been constructed since the 1960s. This would prevent early targeting of battery launch sites, as the TELs would only deploy to these from a prepared hide before a planned launch. With polar orbit satellite revisit cycles of hours, battery movements between garrisons and hides, and hides and launch sites, can be easily scheduled during blind periods.

Once the battery is in situ, the TELs can erect the missiles, for which prelaunch preparation largely amounts to power-up via the umbilical, spinning up the IMUs, and performing automated Built In Test (BIT), upon which the missile is in standby waiting to be loaded with target coordinates and launched. The PLA have not disclosed the times involved, but given the design of the TEL, these will be minutes. Once the ASBMs (or IRBMs) have been launched, the TELs can stow the launch tubes and ‘scoot’ to a hide or garrison to be reloaded.

The launched ASBM will burn out its two sequential solid rocket stages, under inertial control via gimballed rocket nozzles. At that point the kill vehicle is coasting upward and then arcing over in a ballistic arc. As it flies through the apogee of the trajectory, it noses over into its dive toward the target area. With no imagery as yet of the re-entry vehicle RV,it can only be assumed that it follows the convention of a blunt nosed conical shape with an ablative coating, and four or more tail mounted fins, in the manner of the Pershing II. There are no reports that the RV is equipped with thrusters, so if it is relying on aerodynamic controls, it will be unable to effect trajectory changes until it penetrates into the stratosphere.

Once the air is dense enough for the controls to work, the RV will effect a course correction to remove any drift it experienced during uncontrolled flight, adjusting the trajectory to hit the aimpoint programmed at launch. The RV will be travelling at some speed between Mach 5 and 7 at this point.

Once low enough, the protective ablative nosecone will be jettisoned to expose the optical window for the terminal seeker, which may have to be cooled from an internal gas bottle. The stabilised gimballed seeker will be pointed at the intended point of impact and take a snapshot of the area, large enough to capture any course changes by a CVBG steaming at 30+ knots. Software in the seeker will identify ship wakes, select the CVN in the CVBG likely by size, and compute a trajectory correction, resulting in another trajectory change. The latter will be repeated until the RV hits the target or the ocean very near, if the design is deficient. The impact velocity is apt to be in the vicinity of Mach 4 to 5.

From a lethality perspective, even an ASBM armed with an inert concrete warhead presents as a highly lethal projectile, given the exceptional terminal velocity at impact. The kinetic energy at impact of a single ASBM MARV is roughly 10 to 20 times greater than that of a concrete piercing guided bomb. Hitting any portion of the flight deck of a carrier, the RV is likely to penetrate deep into the structure before the warhead initiates.

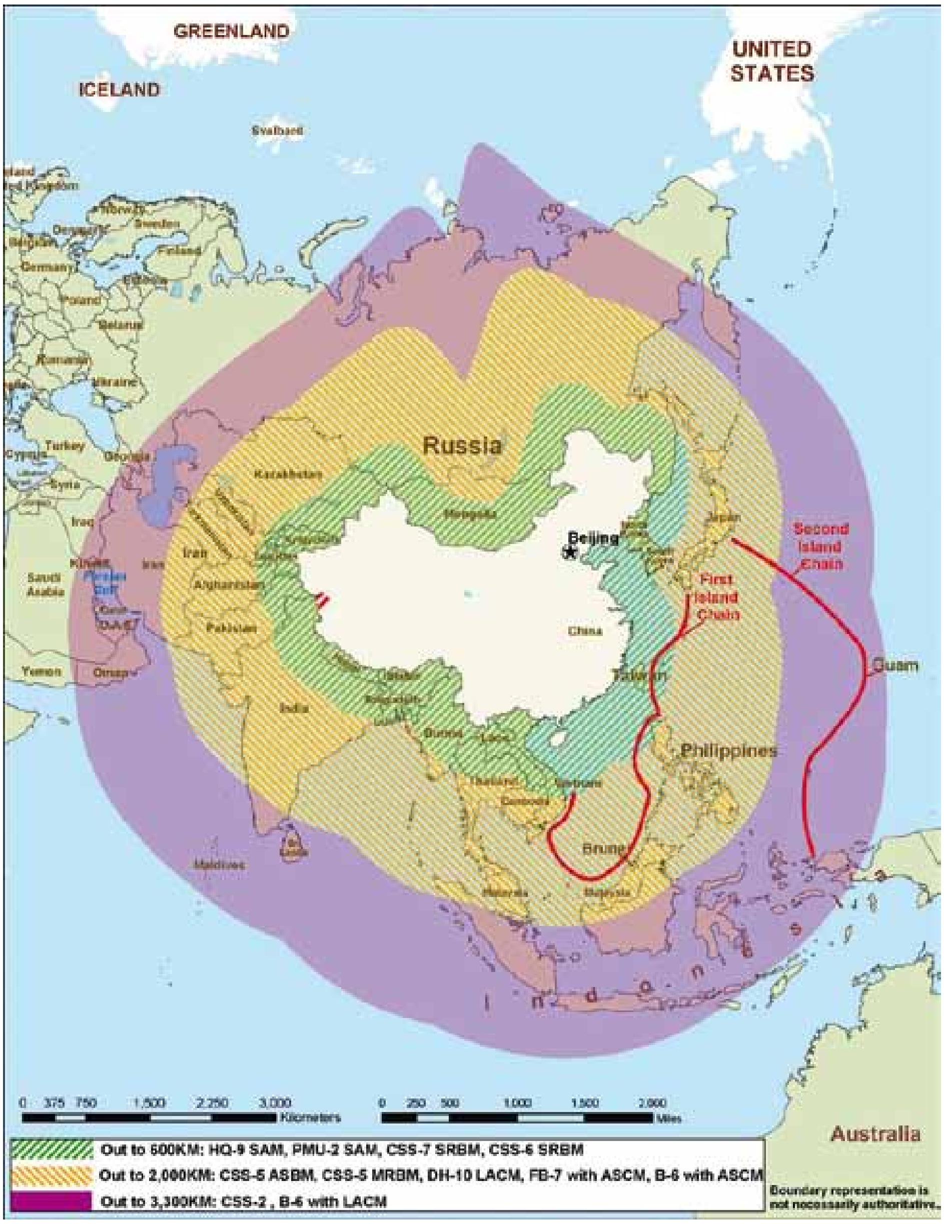
JY-62 GLCM.

CJ-10 GLCM TEL.

A H-6M Badger armed with two KD-63 ASCMs.

A JH-7A Flounder armed the KD-88 ASCM.

Type 22 fast catamaran missile boat.



PLA anti-access capabilities.

DF-21C WS-2400 TEL.

TS-504 troposcatter system.

The main limitation of optical correlator based seekers is that dense cloud will 'blind' them. Indeed, a dense low undercast would deny target acquisition early enough to correct the flight of the missile. Accuracy of a well designed seeker of this type is very high, the US Navy DAMASK seeker for the GBU-32 JDAM consistently hit inside of 1 - 2 metres of the aimpoint. In an ASBM RV the principal problem will be the rate at which the guidance loop can perform trajectory corrections. If we assume a starting point for final RV manoeuvres at 60,000 ft AMSL, the time to impact is ~8 - 10 seconds. At 30 knots a CVN travels a distance of ~120 metres in this time, or less than half the length of the ship.

A RADAC seeker modelled on the Pershing II design would permit earlier acquisition, but also result in vulnerability to electronic countermeasures. While good opportunities will exist to jam a RADAC style seeker, the propensity to combine passive anti-radiation homing seeker technology into existing ASCM active radar seekers make this a marginally viable strategy in the long term. The cost of an ASBM and its targets make the installation of sophisticated multi-mode terminal seekers entirely justifiable.

The DF-21D ASBM is a difficult missile to stop using a tactical or theatre ABM system due to its high re-entry velocity, as it sits at the outer performance envelope of contemporary ATBM systems, compounded by its manoeuvre during the terminal dive – MARVs are considered the most challenging ABM targets.

A no lesser concern is that DF-21D ASBMs could be salvoed to produce multiple round saturation attacks against naval task forces. There will be practical limits to how many concurrent engagements against ASBMs can be handled by a single ABM system such as the SPY-1 Aegis.

The high re-entry velocity of the DF-21D demands a high update rate during tracking, and this in turn consumes per target some share of the total tracking time available from each Aegis system. There will be, as with supersonic ASCMs, some hard limit beyond which these systems are overwhelmed.

The current US Navy ABM capability is based on the RIM-161A/B/C/D Standard Missile 3 (SM-3) which is an exo-atmospheric interceptor, using a thruster propelled Lightweight Exo-Atmospheric Projectile (LEAP) kinetic kill vehicle. This is a very different approach to the endo-atmospheric ABMs most widely used. It would engage the DF-21D before it re-enters. While existing warship defensive systems with ABM capability will have no difficulty in engaging small numbers of such weapons, saturation attacks change the whole strategic dynamic.

Compared to ASCM attacks, ASBM attacks offer more warning time as the ASBM can be tracked during the exo-atmospheric phase, and later the ionization trail of the MARV is readily detected by radar.

On the other hand, ASBMs are significantly faster making them more challenging targets to intercept. While ASCMs can still be engaged by close-in gun systems or lasers once inside the minimal engagement distance of defensive missiles, ASBMs are much too difficult a target for such terminal defences – their speed alone requires exceptionally high tracking rate performance for an effective intercept. The US Navy does not operate any specialised endo-atmospheric ABM as the second layer defence to stop ASBMs that have escaped interception by the SM-3.

Existing ABMs in the required performance class, such as the Russian 9M82/SA-12B Giant and 9M82M/SA-23B, the US THAAD, or Israeli Arrow II, are large two stage missiles.

The DF-21D ASBM is a major advance for the PLA, and will be very expensive to counter reliably. It is but one of many capabilities China is deploying to make the Western Pacific unsafe for Western naval surface fleets.