UAVs versus manned LRMP platforms

Dr Carlo Kopp

The US Navy's intended introduction of the turbofan P-8 Poseidon and MQ-4C (RQ-4N) BAMS Remotely Piloted Vehicle (RPV) represent the single greatest change to the basic technology used in the Long Range Maritime Patrol (LRMP) role since the 1940s. This fundamental shift in how LRMP is performed has in turn produced considerable argument.

While the Cold War era massed Soviet submarine threat has vanished, advanced submarines are now proliferating globally, and China is becoming a major operator of nuclear powered attack submarines and ballistic missile submarines. LRMP aircraft have also become important assets in the global Counter Insurgency (COIN) effort, used to provide ISR capabilities in littorals, and often also overland.

New Look LRMP CONOPS

The US Navy BAMS model is a major departure from an evolutionary path that remained largely linear for six decades, in that newer and more capable sensors and weapons have been progressively introduced into airframes, most of which had their origins in the 1950s.

Globally, LRMP fleets remain dominated by a small number of well established airframe types, although these are often fitted with ISR, ASW and AsuW systems, with weapons suites unique to specific operators.

US-aligned nations mostly operate variants of the P-3 Orion, based on the turboprop Electra airliner, with the RAF operating the Nimrod MR.2 based on the turbojet Comet airliner. Germany, France, Italy and Holland operate the purpose built Breguet Br.1180 Atlantique, with the latter frequently replaced by P-3 variants. Soviet aligned nations deployed the turboprop Tu-142 Bear F and Ilyushin Il-38 May, based on the Il-18 Coot airliner.

Turboprop airframes numerically dominate legacy LRMP fleets, the principal reason being that propeller driven airframes provide the best fuel burn for range and endurance at medium to low altitudes, which has been the dominant regime of operations for LRMP tasks.

Of these types, only the Bear F and Nimrod MR.2 are capable of fast dash speeds at altitude, reflecting the strategic bomber heritage of the Bear, and the jetliner heritage of the Nimrod.

In the legacy LRMP model, medium altitudes were preferred for area search profiles using radar to detect surface shipping and surfaced submarines or snorkelling masts. If a submarine contact was detected, the aircraft would descend to a lower altitude to use its MAD boom or deploy sonobuoys, in an effort to more precisely locate and identify the contact, and if necessary prosecute an attack using an air-dropped guided torpedo.

There is an inherent trade-off in LRMP operations when using radar: higher altitudes increase the immediate area coverage but decrease the detection probability for small targets like snorkels, as the radar's detection performance declines with distance following the inverse fourth power law. Passive detection of radio and radar emitters follows much the same pattern, but reflecting the inverse square law.

When prosecuting a subsurface target, low altitude flying becomes important due to the need to precisely drop both sonobuoys, but also torpedoes or depth charges. As LRMP aircraft are often also used for aerial delivery of naval mines, low altitude drops are also a requirement.

In COIN operations, LRMP aircraft must frequently identify surface contacts – especially smaller vessels used to smuggle insurgents, weapons or funds – and this frequently requires a low level pass for photographic intelligence or thermal imager recording collection.

If the LRMP aircraft is to perform AsuW using a sea-skimming cruise missile such as the Harpoon, Exocet, or any of the Russian supersonic sea skimmers, low altitude delivery permits the aircraft to stay below the radar horizon of the target and thus deny opportunities for defensive fire using long range surface to air missiles. The risk of

Above and top: MQ-4C RPV.

Boeing P-8A Poseidon prototypes in test.

SAMs should not be discounted, as area defence weapons like the Russian S-300F and Chinese HHQ-9 are Patriot class weapons with range performance comparable to many larger sea-skimming cruise missiles. An LRMP aircraft has poor survivability against such weapons.
The challenge in defining and choosing platforms for the LRMP role is thus not trivial. The needs are split between diametrically opposed demands for large area coverage footprint from high altitudes versus high endurance at low altitudes. Historically, the trade-off has nearly always been resolved in favour of low altitude operations, to meet the unavoidable needs of the critical ASW role.
The US Navy's shift toward a mixed LRMP force structure combining a large RPV and a more conventional manned LRMP aircraft is an attempt to reconcile the divergent needs with a mixed force, rather than attempt to construct an aircraft that can perform well in all of these diverse flight regimes.
The unmanned component will comprise a fleet of MQ-4C/RQ-4N BAMS RPVs, based on the US Air Force RQ-4B Global Hawk but equipped with a sensor package specifically optimised for LRMP operations.
The strong point of the RQ-4 airframe is its exceptional persistence, or range, which is considerably greater than that of any current manned LRMP aircraft. This permits the RQ-4 to fly a considerable distance, then orbit on station or perform an area search pattern – the cited maximum endurance is 30 hours at an unspecified range. As the RQ-4 airframe is designed to operate at station altitudes of 45,000 – 60,000 ft, the aircraft has a geometrical coverage footprint considerably larger than legacy LRMP aircraft, when using radar or passive radio-frequency sensors. This is by virtue of station altitude of the RQ-4.
The primary wide area sensors carried by the BAMS RPV are a Multi-Function Active Sensor Active Electronically Steered Array (MFAS AESA) Radar operating in the centimetre X-band, considered most suitable for surface searches, and the digital Merlin-MC Electronic Support Measures (ESM) system. These sensors are optimal for detection and tracking of surface shipping, whether it is silent or emitting. The radar has a high resolution ground-mapping capability but is not designed for volume search against aerial targets. These sensors are supplemented by an Automatic Identification System (AIS), which interrogates transponders on ships.
While the combination of sensors and airframe will be effective for traditional blue water area searches, it is especially useful for monitoring naval choke points, due to the large footprint and long endurance. This permits uninterrupted persistent coverage of the choke point by rotating RPVs through the station.
The AESA radar and ESM systems provide a robust identification capability from standoff ranges, but are supplemented by the MTS-B Multi-Spectral Targeting System, which is a turreted optical and thermal imaging sensor designed to produce still or live video imagery. The latter system will allow high quality imagery collection, weather and target defences permitting.

In a sense LRMP aircraft today must perform as Intelligence Surveillance Reconnaissance, Anti Submarine Warfare and Anti Surface Warfare assets, more than often all in the one sortie.

There is no intention at present to weaponise the MQ-4C. This makes sense, insofar as the strength of this platform is its high altitude capability, and it would be challenged to perform well at low altitudes. The fuel burn penalty of descent and climb back to station cycles would be costly in terms of time on station or operating radius.
The manned force structure capability will be provided by Boeing's P-8A Poseidon, which is a defacto replacement for the P-3 Orion series.
The P-8 was designed around a very different model to legacy LRMP aircraft. The intent with the P-8 was to provide much higher transit speeds to station, compared with its turboprop predecessors. The basic airframe is a modified commercial Boeing 737-800, with wings based on the 737-900, capable of providing four hours on station at 1,200 nautical miles radius, with an MTOW of 187,700 lb (~85 tonnes).
In most respects the P-8A is a conventional LRMP aircraft, with nine crew stations, an AN/APY-10 radar derived from the legacy APS-137 LRMP radar but with robust imaging capabilities, a Boeing USQ-78B acoustic processor capable of supporting 64 passive sonobuoys (twice the P-3C) or up to 32 active-passive buoys (fours times the P-3C), an Emitter Locating System based on the AN/ALQ-218(V)2 developed for the EA-18G Growler, an inertially stabilised L-3 Wescam MX-20HD electro-optical turret with HDTV and thermal imaging capabilities. US Navy P-8As will not be fitted with a MAD sensor, which will be available for export aircraft. Weapons capabilities include a heated aft fuselage internal bay with five hardpoints for torpedoes or mines, and four outboard wing hardpoints for AGM-84 family of missiles, bombs or mines.
The CONOPS (Concept of Operations) for the two tier LRMP model is to exploit the strengths of the mixed force structure, with the MQ-4C used for persistent surface surveillance tasks, and the P-8A to perform the more conventional prosecution of surface and subsurface contacts. For some years the BAMS CONOPS was argued at length, and a key idea was to exploit the RPV component for initial contacts, and then task the P-8A to localise the contact precisely, identify it, and then attack it (in wartime). The intent is to minimise the amount of time the manned component would be airborne, to maximise utilisation of the fleet.
How well this model will work will depend largely on the capabilities of the radar on the RPV component of the system to detect submarine snorkels, snorkel wakes, and subsurface wake disturbances. This is very difficult to assess accurately given how little has been published on the detailed design of the radar. Public disclosures indicate it is fusion of technologies employed in the APG-77/80/81 AESAs, and the APY-6 SAR/GMTI radar trialled on the NP-3C Hairy Buffalo testbed, this radar in turn derived from the exceptionally potent Ku-band APG-76.
The US Navy model of a mixed RPV and manned aircraft fleet has considerable potential but remains to be operationally proven in a real combat environment, especially involving a technologically sophisticated opponent. Operations against unsophisticated developing nations are not an issue.
Sophisticated opponents will invest effort in attacking the RPV component, and disrupting the datalinks employed to transfer target tracks between the RPVs and manned aircraft. Radars are also likely to be subjected to jamming.
Should the combined use of RPVs and manned aircraft not perform to expectations, the US Navy does have a fallback position, in procuring additional numbers of P-8A aircraft to replace the RPV capability in part, or wholly with a more conventional LRMP platform. It may well be that in theatres where the RPV component is at risk from long range SAMs or fighters the in-theatre force mix would be wholly conventional.

Evolution of LMRP CONOPS

The roles performed by LRMP aircraft under the generic label of LRMP are complex and diverse, and only partly reflect the stereotypical role of Anti-Submarine Warfare (ASW) alone. In a sense this should not be entirely surprising since aircraft tasked with LRMP have from the very beginning performed across a wide spectrum of roles.

The beginnings of the LRMP role proper lie in the intensive battle over the North Atlantic during which Germany tried to interdict resupply convoys carrying materiel to Britain, and Britain tried to blockade occupied ports on the European continent. Initially both sides deployed primarily large flying boats, and Germany some large seaplanes. These were used for visual reconnaissance initially, but very soon shifted to actively attacking contacts with gunfire. Both sides quickly learned that once a hostile contact was located, it could usually escape if the aircraft that located it could not remain in contact until better armed assets could arrive. This led to a rapid arms race to deploy increasingly better equipped and armed aircraft to locate and attack hostile shipping.

Germany adapted the four engine Focke-Wulf Condor airliner, while the RAF modified bombers for its purpose. Germany focussed on interdicting surface shipping, while the British had to diversify capabilities to locate and defeat German U-Boats as well as surface shipping. Most LRMP designs since then have been adaptations of bomber airframes or airliner airframes, the latter being numerically dominant. The imperative was always in endurance on station and range, and to a lesser extent payload carried be it sensors or weapons.

The first purpose built LRMP design was the US Navy's Convair PB4Y-2 Privateer, evolved from the mass production B-24 Liberator. Other than basic airframe changes, it incorporated additional large observation blisters for surface search using binoculars.

The 1940s LRMP arms race produced important developments in sensors and weapons, driven by the need to interdict U-boats and the limited opportunities to attack shipping. If bombs were expended without inflicting damage, there were no opportunities to reattack.

The British deployed ASV series radar to locate U-boats on the surface, and when the Kriegsmarine deployed snorkel-equipped boats the British moved to centimetre band radar to defeat that technology. To prosecute attacks at night, electrically powered Leigh Lights were employed.

The Germans deployed the rocket propelled Hs-293 glidebomb, and the US Navy trialled the active radar homing Bat glidebomb. The British introduced 2-inch aerial rockets, the Americans later a 3.5 inch rocket. In 1943 the US Navy deployed the air-dropped Mk.24 Fido acoustic homing torpedo and the air-dropped AN/CRT-1 sonobuoy. Magnetic Anomaly Detectors were also introduced during this period.

As the war progressed LRMP operations diversified, and a good case study were US Navy Pacific operations, when LRMP aircraft hunted submarines, blue water shipping, brown water shipping and, on occasion, attacked ground targets where these were not well defended. In the Atlantic, several engagements took place, during which German and British LRMP aircraft attempted to shoot each other down.

By the end of hostilities in 1945 the pattern for LRMP capabilities and operations had been set for the next six decades. LRMP aircraft would combine long range, long endurance, and would be equipped with a diverse suite of sensors and weapons to locate and attack surface and subsurface targets, day and night, under all weather conditions.

In a sense LRMP aircraft today must perform as ISR (Intelligence Surveillance Reconnaissance), ASW (Anti Submarine Warfare) and AsuW (Anti Surface Warfare) assets, more than often all in the one sortie.

The PB4Y-2 Privateer was the first purpose built LRMP aircraft, deployed in 1944.