DND photo by Corporal David Veldman

A CP-140 *Aurora* overflies HMCS *Glace Bay* during Operation *Nanook 2020*, 21 August 2020.

The Lockheed CP-140M *Aurora*, Canada's Current Long Range Patrol Fleet

by Bernie Thorne

Lieutenant-Colonel Bernie Thorne, MSc, MPA, CD, *is an Air Combat Systems Officer (ACSO) with over 32 years of Regular Force service, and is now a reservist helping to field the newest updates to the CP-140M* Aurora *as the Director of Block 4 Implementation. He has attained just short of 4000 flying hours in the* Aurora*, has witnessed the breadth of* Aurora *operations over 30 years, and has seen the aircraft updated through all Blocks of the modernization program. He has also commanded twice within the CP-140M fleet, and has also 'done time' in Ottawa at the national headquarters – lastly as the head Career Manager for the Air Force. Bernie also now keeps a small vineyard in the Annapolis Valley of Nova Scotia.*

The CP-140M Block 4 *Aurora* – Sharing Future Secrets

Winnipeg, April 7, 2024. The Regional Joint Task Force (RJTF) liaison to the On Scene Command (OSC) of the flood catches up to the situation at the watch brief to the incoming OSC. "Generally, with the amount of snow accumulated this past year, and the rapidity of the spring melt with the warm, heavy rain, we saw a rapid rise that may surpass the levels from 1997. We believe that the peak water is at the floodway now and expect to see water going down inside the city within the next 2 days. We have a CP-140M doing overwatch of the flood, and our responders on the ground seem to be catching their breath. Several items of note in the past few hours: a pumping station in Osbourne Village had its dike fail, we expect the water pressure to go down in the area, and we have started testing water quality hourly – no boil water order required yet. It seems one of the families on Turnbull Avenue did not evacuate as ordered, and they were found sitting on their garage roof after their dike failed. The local Fire Hall is responding. The city is in tough shape, but we seem to be at the peak now, and are just watching for dike failures. Ten minutes ago, we had a report that Highway 204 near the Selkirk Bridge is flooded. We are not expecting the crest to reach Selkirk for another 2 days, and asked the military to take a look right away."

Introduction

The CP-140M *Aurora* operates from two Main Operating Bases, 14 Wing in Greenwood Nova Scotia and 19 Wing in Comox British Columbia. Each Wing is supported by an Air Maintenance Squadron (14 and 19 AMS) who deal with maintenance beyond the daily flying, and also by an Operational Support Squadron (14 and 19 OSS) who provide airfield services and mission preparation (Intelligence, Meteorology, Mission Data Loads, and so on).

Three CP-140M Squadrons operate from 14 Wing Greenwood. 405 Squadron is the operational Squadron and takes the bulk of east coast Force Employment (FE) missions, although the other 14 Wing Squadrons also conduct operations to maintain proficiency or to balance task levels. 405 Squadron maintenance handles the flight line for all Greenwood CP-140Ms. 404 Squadron is the training or Force Generation (FG) Squadron, operates most simulators, and delivers initial qualification of both aircrew and maintainers on the fleet. 415 Squadron leads Force Development (FD) for the fleet, from identifying future requirements to developing tactics.

One CP-140M Squadron operates from 19 Wing Comox. 407 Squadron is the second operational Squadron in the fleet, and it carries the bulk of FE missions from the west coast.

CP-140 *Aurora* Aircraft Origins

In the early-1970s, the Long Range Patrol Aircraft (LRPA) project was activated to replace the venerable (24 years at retirement) Canadair *Argus*. The Lockheed CP-140 bid won the contract, and the CP-140 *Aurora* derived from a number of Lockheed aircraft, most notably the P-3 *Orion* airframe and the S-3 *Viking* computer and sub-hunting suite. Although not known at the time, the CP-140 also effectively replaced the CP-121 *Tracker*, with the Coastal Patrol Aircraft (CPA) replacement project being terminated in the mid-1990s.

The first CP-140 *Aurora* flew out of the Lockheed factory in 1979, and delivery of the 18 aircraft contract commitment sped along between 1980 and 1981. Each of these aircraft were rated originally for a service life of 25,000 flight hours. A minor side note pertaining to the CP-140 fleet was the delivery of three CP-140A *Arcturus* in 1992 and 1993 to take some of the non-ASW roles away from the overworked fleet CP-140s. These *Arcturus*, while fundamentally a CP-140 airframe but lacking many of the *Aurora*'s detection systems, were retired from operational service in the mid-2000s after heavy use, although one remains in the fleet as a maintenance trainer at 404 Squadron.[1]

"In the early-1970s, the Long Range Patrol Aircraft (LRPA) project was activated to replace the venerable (24 years at retirement) Canadair *Argus*."

CP-140 Updates

Expected to have a service life similar to the *Argus*, a single *Aurora* mid-life Upgrade was pursued beginning in the early-1990s. However, the mid-1990s proved to be a challenging period to seek large capital military funding. After several years of effort, the project staff changed strategy to advance an *Aurora* Incremental Modernization Program (AIMP), with three planned Blocks and one optional fourth Block. This approach caused significantly increased change costs within the project staff, but the fleet did obtain funding for the planned upgrades. Block 1 addressed immediate sustainability issues, such as an HF radio for which parts were no longer available and the removal of obsolescent systems that had not been turned on in years. Block 2 updated navigation and communication equipment communicating over a 1553 databus. Block 3 updated most sensors, provided a capable mission computer allowing work to be done flexibly at different crew workstations, and installed several networks inside the aircraft to exchange the massive amounts of sensor and mission data. The AIMP project was paused for a period during Block 2 production, but then resumed. Only 14 of the 18 CP-140 *Auroras* were upgraded to Block 3, and gained the moniker CP-140M (M for modernized). One Block 2 CP-140 remains flying today, serving to take propulsion and flight deck prototyping work from the small CP-140M fleet.

Several notable (and many smaller) projects have occurred over the same period as AIMP. As the service life of the CP-140 has vastly surpassed what had been expected, significant study and effort went into ensuring the aircraft remained safe to fly. Studies in what airframe parts could fail led to an *Aurora* Service Life Extension Program (ASLEP) that replaced the wings and vertical stabilizer. Leading up to this project, the aircrew were limited in manoeuvres and speed to reduce airframe strain, and extra maintenance steps were taken to keep the aircraft safe to fly. ASLEP reset/reduced the service life to 15,000 hours per airframe. Due to the rising importance of overland operations, and stand-off visual identification in the maritime domain, the fleet installed the WESCAM MX-20 EO/IR turret, Tactical Common Data Link (TCDL), and an interim laptop computer network with moving map display called the Overland Equipment Mission Suite (OEMS) before Block 3 upgrades commenced. Eventually, in order to send CP-140M surveillance data back Beyond Line Of Sight (BLOS) during Operation *Impact,* an interim BLOS (iBLOS) satellite communication system was very rapidly installed on a small number of Block 3 aircraft.

The original plan for Block 4 was an update to obsolescent systems, and perhaps, a precision stand-off weapon, such as SLAM-ER, to expand beyond the purely Anti-Submarine Warfare (ASW) weapons carried today. Operational imperatives change, and the need to share situational awareness with other war-fighters and other partners not sharing the 'eyes' of the CP-140M became more important. The Block 4 project includes three major new capability elements. First, a BLOS communication system that uses the Worldwide Global Satellite communication (WGS) system delivered by the Mercury Global project. In a generic sense, the aircraft will be certified to join the Consolidated Secure Network Infrastructure (CSNI) domain over WGS via the Mission Support Centre (MSC) CNET enclave. Second, a Link-16 terminal that operates on both Line Of Sight (LOS) and BLOS. Third, a Directed Infra-Red Counter Measures (DIRCM) self-protection system was approved to provide limited protection for a number of aircraft. Block 4 also delivers more and cleaner electrical power, and refreshes servers, networks and interoperability standards for both sensor and mission computers.

DND photo by LS Louis-Phillipe Dubé, 14 Wing Imaging

Arrival of first Block 4 CP-140M in Greenwood, 21 February 2020.

It should be evident that the number of sensor, navigation, communication, network and mission computer equipment on-board the CP-140M is very sensitive to changes in technology. If a supported war-fighter changes from a LINK-11 to a LINK-22 system, the CP-140M must keep pace, or we no longer communicate. If the world's civilian air control upgrades navigation and communication requirements to make airspace denser and/or safer, the CP-140M must update or lose access to other nations' airspace. The latest defence policy, *Strong Secure and Engaged,* has identified that the CP-140M will eventually be replaced, and estimates identify that replacement to occur around 2035; but we military folk always plan for contingencies. To ensure there is no gap in capability, the Weapon System Manager (WSM) is studying what work will need to be done to keep the CP-140M operational until the 2035-2040 period. There will clearly be some major updates and many minor refreshes required to keep the CP-140M operational over this period.

A number of significant projects post-Block 4 are already in various stages of planning or approval, supporting the mandate of keeping the CP-140M operationally viable until the arrival of its successor. International airspace regulation updates require new navigation equipment to allow safe flight, and a number of omnibus and fleet-specific projects are running within the WSM to ensure continued ability to deploy. Crypto modernization requires new communication equipment and a new military Identify Friend or Foe (IFF) system. The old engines on the CP-140M (common with the old H Model C-130 *Hercules*) are becoming costly to maintain, and an update to the same power plant as the newer J Model *Hercules* is being considered. A single kit 'buy-and-try' update for the MX-20 camera is also being considered. Minor software and hardware updates are always 'in the works,' and the CP-140M aggregates changes in an 18-month update cycle that balances speed with the fleet ability to adapt to the changes. Updates to simulators, labs and support equipment must stay in lockstep with the aircraft.

It could be viewed that these significant updates are required due solely to the age of the aircraft, but this is only partially correct. Needing to replace wings and engines do indeed result from long service. Technical updates, however, whether from a changing world or from changing operational requirements, will occur with any fleet routinely, sometimes even before initial delivery. The more advanced equipment is procured and the more operational roles are assigned, the more sensitive the aircraft is to change - and the more energy that must be dedicated to keeping up with change. Perhaps no other aircraft in the world is thus as sensitive to change as the Canadian CP-140M LRP fleet. Little wonder the fleet has a Force Development (FD) Squadron dedicated to managing change.

"The radar has two planer array antennas mounted back-to-back, and they can do autonomous roles or be used in synchronization to double the data provided to a single role."

Some CP-140M Capabilities

The long-range/endurance aircraft, varied and capable sensors, communications suite, mission support elements and the crews trained to many different roles and missions result in a flexible capability. Few outside the operational fleet understand what operational effects it can deliver to the mission, and this has sometimes limited its employment, and the benefits gained when it is employed. Describing all technical capabilities would be both classified and a long dry read. For those professionally interested, a classified capability brief is being worked for the CJOC that describes the capabilities as well as suggested employment in expected operations. A few capabilities must be introduced here in a simplified manner to both give a sense of the total capability, but also to provide understanding of an unclassified operational vignette, which will be addressed later.

The radar has two planer array antennas mounted back-to-back, and they can do autonomous roles or be used in synchronization to double the data provided to a single role. It has an auto-detect and auto-track system, which is used for building the Recognized Maritime Picture (RMP), and a Ground Moving Target Indicator

(GMTI) mode that tracks moving targets overland. It can be employed in several imaging modes, including a Side-Looking Aperture Radar (SLAR) mode that delivers high resolution radar strip maps that look like monochrome imagery. Radar analysis tools allow automatic change recognition that highlights changed areas such as moved vehicles, flooded areas, landslides, blast areas, digs, removed walls/buildings, etc. The positional accuracy of radar is quite precise and can be used to cross cue to other sensors, such as the EO/IR video camera or to pass to other assets.

The EO/IR camera was arguably the most capable analog long-range surveillance camera ever built. Is has an EO-wide, an EO-narrow with very long range, and IR mode. It has been updated with a laser rangefinder to improve the sensor's positional accuracy. Most everyone will have seen this camera in use as it has been widely employed by police, news and sport/movie shoots. If it was an overhead shot from a decade-or-two ago – it was likely a version similar to this. State-of-the-art cameras are now digital with higher resolution, better sensitivity, and so on, but with suitable parts remaining broadly available, this one has lost none of its original capability. As previously mentioned, a 'buy-and-try' of a modern camera is being considered by the CP-140 WSM.

To share this information, the CP-140M uses the communication standards of our closest allies to ensure interoperability. In operations where there is not an asset with which we share broad interoperability, the CP-140M fleet has Deployable Mission Support Centres (DMSCs) that can be pre-positioned to give access to all information and to provide communications to enable Command and Control. The notable systems shared by the Block 4 CP140M and the DMSC are; Line-Of-Sight (LOS) radios, an Iridium satellite phone, HF radios, TCDL network (K-band), LINK-11, LINK -16, WGS satellite with common services on the CSNI network (Chat, email, VOIP, Sensor Databases, and so on). The DMSC also has CP-140M experts who can act as Liaison Officers (LO) to explain capabilities and recommend employment. The MSCs at 14 and 19 Wing offer the same capabilities as the MOBs.

Without going into detail, the CP-140M also has a robust suite of sensors for Anti-Submarine Warfare (ASW), and will be updated to the new Mk.54 ASW torpedo. It has an Electronic Surveillance Measures (ESM) system that includes auto-classification, auto-fixing and Specific Emitter Identification (SEI) for emitters pre-programmed in the mission data load. It carries a variety of hand-held sensors (video and still cameras, night-vision goggles, and so on). Its communication suite can provide radio relay for units out of range of each other. TCDL-equipped units could use the CP-140M to act as a post-box to send and receive data.

This very quick introduction should give the appreciation that the CP-140M is a very capable and flexible weapon system. It *can* and *does* perform a wide variety of missions around the world.

Operations Overview

The flexible CP-140M capability *has been* and *continues to be* employed across a very broad range of missions, and to support a very comprehensive list of Military Commanders and Other Government Departments (OGDs). The original focus of the CP-140 was almost exclusively a Maritime asset; Cold War ASW and direct support to naval task groups were the prime roles, while surveillance of the domestic maritime approaches and Search and Rescue (SAR) were among important secondary roles. In a perhaps unfortunate[2] circumstance, the primary roles of the CP-140 were classified missions, flown from home or allied MOBs, sometimes armed, often remote and dangerous, but unknown and unacknowledged by either the military or the public at large.[3]

DND photo by Sgt Shilo Adamson, CFB Borden

(From left), Master-Corporal Kevin Hardy, lead Airborne Electronic Sensor Operator (AESOP), Patricia DeMille, Fishery Officer for the Department of Fisheries and Oceans (DFO), and Corporal Brett Galliford, AESOP and the Non-Acoustic Sensor Operator (NASO) for the CP-140 *Aurora* work together to identify possible vessels of interest engaged in illegal fishing during Operation *Driftnet*, 18 July 2017.

The employment of the CP-40/140M slowly grew beyond these initial roles. However, OGDs and civilian agencies developed some *enduring,* as well as a number of *one-off* support requests. The domestic maritime surveillance capabilities gained the attention of the Department of Fisheries and Oceans (DFO), who began requesting flying their specialists on the CP-140 for fisheries patrols around Canada and supporting international fisheries agreements on the high seas (i.e. Drift Net). The CP-140 predominance over water allowed it to catch polluters inside the Canadian EEZ, and the CP-140/140M became Environment Canada's (Now Environment and Climate Change) largest source of prosecutions. Similarly, the RCMP began requesting the CP-140 to locate and track vessels of interest – shadowing them and any accomplices until they could be taken. Natural disasters needing swift situational awareness to plan rescue and recovery began using the CP-140 for such as floods in Winnipeg under Operation *Lentus*, or for assessing the Hydro Quebec power lines following the Ice Storm. Some air-dropped geo-buoys were used to record seismic data, supporting Canada's claim to the Arctic. The CP-140M continues to be requested to support a 14-nation coalition to counter illicit narcotic trafficking on Operation *Caribbe*. The CP-140/140M sensors and eyes have been used to record seals, whales, icebergs, ice cover, temperature levels in the oceans, and others.[4]

Military roles also began to proliferate. The long range and ability to self-deploy made the CP-140 the best choice to conduct sovereignty patrols in the north, seeking activity and taking imagery to assess the condition of remote sites. Primary Search-and-Rescue (SAR) assets that were better at low-level visual search began to leverage the CP-140 instead to coordinate and control the air search when many assets were on-scene, such as the eight helicopters and one CC-130 *Hercules* that responded to the SwissAir 111 Search and Rescue mission. A now-obsolete *Applanix* camera from the DND Mapping and Charting Establishment (MCE) was temporarily installed on the CP-140 to record high resolution mapping imagery in Afghanistan. Fighter aircraft that cross oceans often request escort, a *Duck Butt*, from a CP-140/140M carrying deployable life rafts. International agreements resulted in a number of Maritime Interdiction Operations (MIO) to counter piracy, such as Operation *Artemis,*[5] or support UN sanctions, such as during Operation *Sharp Guard*.[6] A significant additional area of operations really 'kicked into high gear' just over a decade ago. Commencing with the EO/IR, TCDL and overland equipment mission suite updates, the CP-140 began to be requested to support traditional land forces and Special Operations.

These paragraphs are not exhaustive, but are intended to show the flexibility of the platform and the many agencies supported across a multitude of roles. The CP-140 *has* and *does* work for OGDs during both normal days and disasters over Canadian waters, land and ice. The military roles have gone far beyond the original maritime Cold War roles. Of significant historical note, recent operations have focused CP-140M efforts overland, and perhaps at cost to the traditional roles.

DND photo by LS Dan Bard, Formation Imaging Services, Halifax

Arabian Sea, 9 October 2013. Boarding party members from HMCS *Toronto* board a suspect dhow during Operation *Artemis.*

DND photo by Corporal Mathieu St-Amour

Captain Barrie Ransome, Task Force *Libeccio* CP-140 *Aurora* pilot, looks out his cockpit window during a patrol off the coast of Libya, 30 September 2011, as part of Operation *Mobile*.

Recent Named Operations

Although the CP-140 had taken minor[7] forays into military overland operations, and the CP-140/140M has always been capable of operations in the littoral (coastal) environment, the first significant overland military operation was Operation *Mobile*.[8] The standard deployment for a CP-140 to expect a high serviceability rate is a two-plane detachment, and the 2-plane 2011 detachment to Sigonella attained 99% mission attainment over 179 missions. A significant shortage of Long Range Patrol (LRP) assets, as well as the CP-140's inherent flexibility marked them as a tightly-contested asset that conducted a range of roles in the months of the operation. Maritime surveillance was required to enable an embargo. Information Operation radio broadcasts were transmitted deep into Libya. The CP-140 was initially operated 21 miles or more from the coast, but this was later dropped to only 4 miles, then fully overland, where they provided overland surveillance and supported Strike Coordination And Reconnaissance (SCAR). Although the CP-140 crews were not trained to this latter role, the CP-140's sensor, situational awareness and communication capabilities were greatly appreciated by the qualified Joint Terminal Attack Controllers (JTACs) who flew on-board directing these missions.[9] As the CP-140 had no self-protection, Intelligence assessments on Libyan anti-air capabilities and intents would certainly have been of deep interest to the crews.

DND photo/Operation *Impact*

An aircraft technician from Air Task Force – Iraq marshals a CP-140 *Aurora* long range patrol aircraft during Operation *Impact*, 8 April 2017.

The CP-140M's most significant operation overland began when a global coalition of 79 members formed in September 2014 to support Iraqi security forces in countering Daesh (otherwise known as ISIS or ISIL). To support Operation *Impact*, the CP-140M again deployed a 2-plane detachment flying out of Kuwait. The *Aurora* then flew in support of *Impact* from October 2014 until December 2017.[10] The basic mission was to provide support to the ISR Commander who directed about thirty UAVs and the CP-140M; the tasks were predictably UAV-like, coming from a common target deck that focused upon visual sensors. Although a valuable contribution to the coalition, these tasks did not well employ the many advanced capabilities of the CP-140M. Obtaining better value from the CP-140M in future complex roles may require national Command of ISR planning and analysis, with results fed out to allies (i.e. similar to various satellite capabilities or other advanced air breathing platforms). Unbelievably, the 3+ year Operation *Impact* deployment continuously took two- and-a-half operational crews, when the entire fleet's operational capacity comprised just five-to-six crews. With work-ups and leave following, many crewmembers were essentially deployed for years, with only short breaks at home.

"As should be expected with this level of operational commitment, the operational squadrons soon required relief from the school and force development squadrons."

As should be expected with this level of operational commitment, the operational squadrons soon required relief from the school and force development squadrons. Both *training upon* and *advancing* the new CP-140M capabilities in other missions/roles was nearly impossible throughout this period and, with the fleet *near* (some think *past*) collapse, a significant effort called the CP-140M Get Well Program was initiated to rebuild the production of newly-qualified crew members and to regain experience and capability outside of Operation *Impact*. Nevertheless, a return to maritime operations *generally* and ASW *specifically* was profoundly required.

Not all CP-140M overland missions are related to war-fighting. During Operation *Impact*, and following the 2017 'double hits' of Hurricanes *Irma* and *Maria* in the Caribbean, 407 Squadron from 19 Wing Comox was tasked to provide rapid ISR support to the disaster recovery effort (although closer, 14 Wing Greenwood was in rotation with Operation *Impact*). Great Britain no longer had long-range ISR assets (having earlier disposed of their Hawker Siddeley *Nimrods*), and requested Canadian support in advance of their naval vessels arriving to assist their overseas territory of Turks and Caicos. CP-140M imagery was used by partner nations to assess and plan the response before arrival of the ships. The long patrol range allows basing outside the disaster area and limits demands upon strained logistics and infrastructure. Although ISR aircraft cannot assess the structural integrity of piers, bridges and buildings – they can see when critical infrastructure is seriously damaged, can tell if infrastructure such as airports and seaports are in use, can tell if roads are in use, see where displaced people are setting up camp (and thus need support), and so on. Quickly obtained, this form of information allows planners to develop a more rapid and effective response.[11,12]

The CP-140M also continues operations in the maritime and littoral (coastal) environments. ASW has seen a resurgence in importance and requests for Canadian participation. In addition to being continuously on call for the many roles previously listed (such as SAR and ASW) the CP-140M also regularly deploys for operations, such as Operation *Neon*, Operation *Caribbe* and Operation *Artemis*. Crews

DND photo/Operation *Impact*.

Air Combat System Officers onboard a CP-140M *Aurora* patrol aircraft log in their observations during a reconnaissance mission conducted as part of Operation *Impact*, 1 January 2017.

DND photo Corporal Gary Calvé

Members of the Royal Canadian Air Force and the British Royal Air Force conduct operations out of Operation *Renaissance Irma-Maria* Task Force Headquarters at Grantley-Adams International Airport, Barbados, 17 September 2017.

also exercise internationally on joint warfighting exercises such as *Joint Warrior* and *Rim of the Pacific* (*Rimpac*). The results of the CP-140M Get Well Plan are bearing fruit with more trained operational crews each year, and all of whom have a much broader base of expertise.

Block 4

The Block 4 updates are not expected to change the broad mission sets of the CP-140M. Neither are these updates significantly changing sensor capabilities. What Block 4 will deliver is the ability to process and share information that until now used to be downloaded only after the aircraft landed. To provide a sense of what these updates mean in an operation, we will consider the CP-140M providing ISR oversight to a domestic flood (a contingency plan under Operation *Lentus*), such as the futuristic fictional account provided at the Introduction.

When the CP-140M has been called upon in the past, it has served to 'give eyes in the sky' to the Regional Joint Task Force (RJTF) Commander and whatever emergency measure organization which was being supported. The MX-20 EO/IR camera would be tasked to look at anything considered important and at risk by Command on the ground. When given no specific task, they looked up and down the flood zone seeking anyone needing help, or to identify unreported issues with infrastructure. As long as the support equipment was pre-positioned with Deployed Mission Support Center (DMSC) personnel, the video could be down-linked using Tactical Common Data Link (TCDL).

Block 4 provides two aspects of capability that enhances performance of this mission. The EO/IR and radar remain unchanged. However, the new computers provided with the Block 4 upgrade allow change recognition between radar strip maps. If the crew imaged the flood area every hour or two and run change recognition, they can see what areas have become flooded in that short period. The crew could immediately see if an area of interest has become flooded between radar images and shift video there. If there are no critical areas recently flooded, the crews could then look at non-critical areas recently flooded to see if anyone is stranded on a road or on a roof. While EO/IR imagery is being gathered, or if the weather is too poor for EO/IR, radar can still be used to

DND photo Corporal Trevor Matheson

Corporal Mitchell Scott, an Airborne Electronic Sensors Operator (AESOP) on a CP-140 *Aurora* aircraft, launches a 53 D Sonobouy as part of a submarine hunting scenario during Exercise *Rimpac*, 24 July 2018.

DND photo Corporal Matthieu Racette

Members from the 2nd Battalion, The Royal Canadian Regiment (2 RCR) conduct evacuations of local residents during Operation *Lentus* in Grand Bay-Westfield, New Brunswick, 25 April 2019.

track the progress of the flood waters, to see if traffic is still moving on at-risk roads, and so on. The high-speed satellite communication with Block 4 allows sharing of gathered information to end-users without the need to pre-position TCDL. Planners and analysts at any location could be reviewing this data and adjusting plans. It may be interesting to some that these same capabilities could be equally applied to other operations over land.

The aircraft itself has a specific capability without the associated support to provide advice on CP-140M employment, plan more effective operations, provide a conduit for Command and Control, do further analysis of collected data, and so on. The DMSC includes the components that allows mission data to be prepared and loaded onto a/the weapon system, systems to allow data replay and analysis, communications and computers (networks), and the personnel to do these associated activities. With this level of importance to the effectiveness of the weapons system, the DMSC should be pre-positioned when possible.

In this Operation *Lentus* flood scenario, (Introduction), the DMSC elements have significant roles. Network administrators ensure that required networks and satellite access is in place. Intelligence elements would liaise via the RJTF to determine what the local emergency measures sees as critical infrastructure within the flood zone. This listing of at-risk infrastructure would be provided to the crew to set priority for imaging, but crew performance will be faster if mission support enters these locations on a map overlay. Post mission reports and deeper analysis as required by the supported command may begin while the crew is still flying and continue 'round the clock'. Intelligence is usually named in the CJOC's Air Task Force (ATF) orders as the Release and Disclosure Office, giving them the mandate to recommend what can be forwarded to the supported emergency measures organization, and how to declassify information for news release. Radar and EO/IR imagery from previous events and previous years' floods can be used to compare against the current operation. This information must be properly archived and curated for the present crews, and the database uploaded prior to their mission. The mission briefer must remain aware of what happens on the flood, and what are the changing Commander's objectives as the crews rest so they can be briefed before the next flight. This partial list begins to explain the role of CP-140M mission support in operations, but there are supports equally required beyond the fleet itself.

Block 4 and Beyond

Just as the CP-140M information may be used to enhance performance of the supported operation, data from other sources, such as satellite (i.e., Radar Sat Constellation and AIS Sats) can greatly enhance CP-140M effectiveness in some roles. In providing maritime surveillance for example, with Block 4 networking, the LRP crews may see the already-known national inputs derived from all other sources and focus upon filling in the blanks; potentially much more effective than repeating what is already known. More focused databases allow greater automation, more rapid identification/situational awareness and results in higher crew performance. The use of Coalition Shared Databases (CSDs) that allow metadata tagged searches between allies must be maintained for each operation and area. Proper analysis, archival, querying and rapid transmission of data in national and allied databases has become a significant enabler.

We have already discussed an example of a growing role for Intelligence in mission preparation in the flood scenario in liaising with other agencies to identify potential mission priorities (or requirements). There are other areas equally important and growing. As information may be sent to almost anyone in a networked world, two broad concepts must be well-understood. First, at times information must be provided rapidly to the supported force for operational reasons, and this type of information can be referred as time-sensitive and must be routed in the shortest possible method (i.e. the crew 'sending direct,' as with TCDL downlink, or a 'voice report today'). At other times, there is no immediate need, and deeper analysis should be conducted to ensure the correct picture is provided and this is context-sensitive information that should be well-considered before release (i.e. post-flight analysis to whatever degree required). Second, an understanding of the aspects of security (technical security, operational security, controlled goods concerns, and sometimes surveillance of Canadians concerns) must be very clearly communicated to the Operational Commander and to the Tactical Crew Commander. The ability to declassify products so they may be shared with supported allies and agencies can be a critical role to release both time-sensitive and context-sensitive data.

"There are other areas equally important and growing. As information may be sent to almost anyone in a networked world, two broad concepts must be well-understood."

We already see the need for intelligence to gather and situate information to prepare the crew for operations, and this will continue. Additionally, in future, crews may request context or analysis during flight. Post mission, today we see intelligence conducting analysis on mission data and archival in national and allied databases. This deeper analysis includes tools at the MSC/DMSC, but also specialist facilities at the Acoustic Data Analysis Centre (ADAC), Electronic Warfare Operational Support (EWOS) and the Canadian Forces Electronic Warfare Centre (CFEWC). With networked capabilities, critical aspects of analysis on high value targets could be completed even before the aircraft lands and is provided to allies. The need to grow analysis capabilities to new sensors is worthwhile to note. While specialists have long been established for acoustic and electronic warfare, our intelligence analysts were largely trained with respect to still imagery and Full-Motion Video (FMV) analysis through operations, including those in Afghanistan and Iraq. New sensors, such as those provided from space and advanced sensors on aircraft, such as the radar on the CP-140M, or hyper-spectral cameras, can see things impossible to routine imagery and must be better understood to be well-employed.

Associated with understanding how to analyze advanced capabilities is the need to properly task and employ them. As seen in Operation *Impact,* employing an advanced capability (with an older EO/IR turret), largely as a UAV, offers operational effect, but very limited when compared against alternative methods of employment. Looking for a vehicle with an EO/IR tool that can see a 100m x 100m square (or 0.01 square km) cannot compare with modes of radar that (employed in the right environment) can look at 10,000 square kilometres at a time. If Canada finds it difficult to effectively task complex capabilities, it is extremely unlikely that a coalition will do so. Depending upon the operation and theatre, it may be significantly more effective to maintain advanced capabilities (such as the CP-140M) under national Command and to execute the entire Tasking, Collection, Processing, Exploitation and Dissemination (TCPED) cycle.

DND photo

A CP-140 *Aurora* returns from its 100th combat mission over Iraq during Operation *Impact*, 23 February 2015.

The communication and computers folks, the "sixers,"[13] likewise have a growing role in the new world. None of the information we have described flowing back and forth moves without the network infrastructure. Classified networks are tightly controlled in terms of network design, physical security, user access, and etcetera. The networks on the aircraft are more restricted than normal networks, due to the fact that the aircraft and systems are also subject to aviation safety laws. The software systems are also antiquated, and many would have to be updated to still work after changes to associated systems. The aircraft can theoretically change its network architecture, but this would take significant time, cost and effort.

When the CP-140M architecture design was selected several years ago, the national network that had penetration to the many potential domestic Commanding and supporting agencies was (and is) the Consolidated Secret Network Infrastructure (CSNI). CSNI also offers many services and links (limited as they are) to the other most common networks. As with any large system that tries to do *everything* for *everybody*, it does have issues, such as responsiveness regarding establishing new connections, enabling new services, and support in an operational context. There is significant interest at the highest levels to establish a coherent and workable way ahead for the operational networks. These networks must allow flexibility for different operations at home and around the world, and for sharing information with allies and supported agencies. In a very broad sense, these networks will have to enable Command and Control (VOIP phones, internet chat, orders, and so on), passing of tactical data (Link-16, Link-11, and others) and passing of sensor data (FMV, radar imagery, still photos, metadata for some, and so on). This for every Canadian military capability. Whatever the architecture is eventually articulated, in the interim, the environmental Commanders, the bases and military capabilities address operational deficiencies as they arise.

In a large sense, the MSC/DMSC is the CP-140M's connection to the network world (barring line-of-sight radios and links). It is also the facility that allows mission data to be loaded on and off of proprietary aircraft systems (militarized drives, configuration files, and so on). Rapidly deployable, the DMSC can be 'fully up and running' within one day of the equipment and personnel arrival. Contracting for network access intra-theatre and back-haul to Canada can take some time unless theatre infrastructure is already in place. As back-up, the DMSC has its own satellite terminal, although busy theatres of operations may be so congested as to limit access to any network - whether satellite or terrestrial. In addition, some military scenarios see loss of network access. As a result, the DMSC must be able to operate autonomously and retain the flexibility to support the CP-140M on its own, or to establish network links in-theatre. Once the back-haul link is in place, CSNI, or a potential follow-on, may be able to deliver some of the required services (if connected to the theatre network in use).

At delivery, a Block 4 aircraft is connected directly to the MSC or DMSC local network (or enclave). The MSC and DMSC enclaves have a primary connection to the CSNI domain widely used for Canadian operations and which provides some basic access to allied networks. They also allow a separate connection with respect to another local network to a second domain - as when working with allies. This second domain does not touch the primary CNSI domain and to get information from the aircraft to the crew requires human intervention at the MSC/DMSC. Today, this could mean an extra operator on the ground reading command chat rooms and new mission orders and reports, and manually moving this information to the primary domain to send to the crew (for example, retyping chat messages, or burning files to a CD to move), and vice versa.

A repeated topic is the need to transfer information from the aircraft to the supported Commander and vice-versa. Full connections between even the closest allied national networks is not expected, for many compelling reasons. Rather, a new domain is established for a specific purpose, and the chosen allies would be allowed inside. Another option is to have a form of information gateway that allows only permitted information to leave or come into the separate networks. Both of these options are commonly employed. For the CP-140M, due to the conjunction of both aviation and network rules and the difficulty to change the aircraft weapon system, the aircraft is not expected to be able to join a new domain for each exercise and operation.[14] Some ability to have information to bridge the network is required. Therefore, I will refer to this capability generically as a gateway. Today CSNI offers gateways for some data to some allied nets (usually chat, email, web browsing). As already discussed, a network link back to Ottawa cannot be guaranteed, and if the required gateway is not in place, a person sits and types messages back and forth.

Perhaps the most interesting project today related to the CP-140M is within ADM(IM). The group that delivered the CAF the Next Gen Data Centres has another project at the pilot phase. The new CDIE project is looking to simplify Base (including MSC and DMSC) infrastructure to work on multiple nets of the same level of classification. These would all operate in virtual machines in one server, and be accessed within virtual machines on one client. One terminal with a window for each network. An option for the subsequent phase is to enable cross-domain data. If chosen as the next goal and implemented considering the need of the CP-140M, it would enable the DMSC to set up a gateway between the aircraft network and the supported Command. It would also enable CP-140M participation in exercises on BICES or CFXNET, and let us rapidly migrate data and operations to any newly-selected national network. I expect this would equally be lauded by any often deployed military capability.

"Full connections between even the closest allied national networks is not expected, for many compelling reasons."

To conduct operational testing on the CP-140M, educate on what it can do, and how it needs to do it, gather attention and support to important projects, such as the CDIE and Joint ISR Battle Lab; the CP-140M is planned to participate in *Bold Quest* '21 as a network exercise with the MSC, and subsequently, for the aircraft to participate in *Bold Quest* '22. If operational exigencies require a change in plans, the fleet may participate in the Unified Vision event, or the *Coalition Warrior* Interoperability Exercise. A capability brief will be provided to CJOC and updated with suggested employment in different Operation and Contingency plans.

Conclusion

The Lockheed CP-140 *Aurora* has proved to be a noble and very versatile warrior in Canadian service. Furthermore, by virtue of astute anticipation and planning, Canada's venerable maritime patrol aircraft, focused initially upon anti-submarine warfare, has successfully morphed into a formidable asset in myriad ancillary roles. By virtue of a timely change in operational employments, astute and viable modernization updates, Canada's venerable aerial warrior has been assured of a viable and contributive operational life for many years to come.

DND photo by S2 Jeremy W. Morris, 14 Wing Imaging

CP-140M Block 4 Tactical Station occupants Major Tardif, Major Fugger, Master-Corporal Fournier, and Master-Corporal Shepherd on duty, 7 December 2021.

NOTES

1 Wikipedia. (2020). Lockheed CP-140 Aurora. Retrieved from https://en.wikipedia.org/wiki/Lockheed_CP-140_Aurora

2 Perhaps unfortunate as the fleet was almost cancelled in the mid-2000s, in the middle of the Block 2 upgrades. The fleet was preserved but cut to 10 from 18 (later boosted to 14). Many credit the preservation of the fleet with the shift overland. Had the cut come through, this would have mirrored the long-rued loss of the U.K. Nimrod aircraft, with the U.K. only now re-gaining a similar capability with the P-8.

3 Canada: Department of National Defence. (2020). Current operations list. Retrieved from https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/list.html

4 Ibid.

5 Canada: Department of National Defence. (2018). Operation ARTEMIS. Retrieved from https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/operation-artemis.html

6 Canada: Department of National Defence. (2018). Operation MARITIME GUARD. Retrieved from https://www.canada.ca/en/department-national-defence/services/military-history/history-heritage/past-operations/europe/maritime-guard.html

7 Examples of early overland operations include SAR, various domestic security tasks, photo mapping, demonstrations to CA and SOF at different venues, Vancouver Olympics, etc.

8 Canada: Department of National Defence. (2014). Operation MOBILE. Retrieved from https://www.canada.ca/en/department-national-defence/services/operations/military-operations/recently-completed/operation-mobile.html

9 Mayne, R. O. (2015). The Canadian experience: Op MOBILE. In K. P. Mueller (Ed.), Precision and purpose: Airpower in the libyan civil war (pp. 239-266). JSTOR: RAND Corporation. Retrieved from https://www.jstor.org/stable/10.7249/j.ctt16f-8d7x.15?seq=5#metadata_info_tab_contents

10 Canada: Department of National Defence. (2018). Operation IMPACT. Retrieved from https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/operation-impact.html

11 Canada: Department of National Defence. (2017). Operation RENAISSANCE IRMA MARIA. Retrieved fromhttps://www.canada.ca/en/department-national-defence/services/operations/military-operations/recently-completed/operation-renaissance-irma-maria.html

12 Bregg, C. D. (2017). CAF's aurora aircraft gathers aerial imagery in the caribbean to support hurricane relief. Retrieved from https://ml-fd.caf-fac.ca/en/2017/09/6683

13 "Sixers" from the continental staff system with 6 being communications. The group includes the military trades such as CELE and ATIS Tech as well as DND civilians and sometimes contractors.

14 There is a caveat to this statement in that the aircraft and MSC/DMSC each have the capability for a second domain that is separate from the primary domain. The important thing to note in this is that the crew could see this network, see orders, chat rooms, email, etc. But would be unable to get tactical data such as Link-16 or sensor data across.