In 1997, the then U.S. Secretary of Transportation, Federico Pena, famously stated, “Most people don’t know what GPS is. Five years from now, Americans won’t know how we lived without it.”

Today, seventeen years after that statement, the Global Positioning System (GPS) is used for a multitude of tasks from navigating your car to tracking your lost phone or pet, to improving your workout. Thousands of smartphone applications allow you use GPS to find out when the next bus is coming or the location of the nearest public washroom.

The impact of GPS on aviation has been no less dramatic. Although aviation makes up only three per cent of the total users of the GPS system, aircraft navigation and surveillance increasingly use the GPS network.

At NAV CANADA, an important focus in recent years has been the expansion of surveillance using ground-based Automatic Dependant Surveillance-Broadcast (ADS-B) and soon space-based ADS-B.

ADS-B is a cooperative surveillance system in which aircraft determine their own position via the Global Navigation Satellite System (GNSS) and broadcast that position to receivers which then transmit the data to air traffic control facilities. This gives highly precise data at a high update rate at a fraction of the cost of new radars.

With most aircraft operating today equipped for GNSS operations, the expanded availability of lateral navigation (LNAV) instrument procedures at airports across Canada has greatly improved airport accessibility. It is a significant advancement from a time when the only airports that could have IFR operations were those with ground-based

---

**SPRING/SUMMER 2014**

1. Navigating the Future
2. Pushing the boundaries
3. President’s Point of View
4. Working towards an adaptable framework for UAS operations
5. Multilateration at Fredericton Airport to increase safety, improve service
6. Pilot’s Corner: GNSS overlay approaches
7. NOTAM modernization

Continued on Page 2 →
Navigating the Future (cont. from pg. 1)

Today, the combined volumes of the Canada Air Pilot are a total of over 3,300 pages, whereas in 2000 they were under 1,700 pages.

navigational aids. Today, improved IFR approaches can be designed to most runways, even at remote airports where traditional ground-based services are unavailable.

Across most of Canada, GPS performance is augmented by the Wide Area Augmentation System (WAAS), making possible even greater precision localizer performance with vertical guidance (LPV) approaches.

The improved airport accessibility as a result of GNSS has provided many benefits, but has also greatly increased the workload related to the design, maintenance and flight check of instrument procedures.

Today, the combined volumes of the Canada Air Pilot are a total of over 3,300 pages, whereas in 2000 they were under 1,700 pages. Every 56-day cycle, new approaches - most of them GPS based - are added.

Canada’s navaid network

The reliance on GNSS operations and the availability of GNSS Instrument Procedures has increased to the point that the use of ground-based navigation aids has been largely eliminated for most international and domestic IFR flights. However, the size and scope of the ground-based navaid network has not significantly changed.

Today, NAV CANADA’s navaid network consists of 104 instrument landing systems (ILS), 17 localizers, 164 distance measuring equipment (DMEs), 115 very high frequency omnidirectional range (VORs) and 330 non-directional beacons (NDBs) which create aircraft routings, arrival and departure paths throughout Canada.

Steve Bellingham, Manager, Navigation Systems Engineering, explains what NAV CANADA has been doing to replace older navaids with newer, more reliable models. “We are nearing the end of a 14-year program that began in 2003 to replace all our Instrument Landing Systems and Localizers. We have 22 left to complete and are on track to wrap up in 2016. We have also replaced more than 80 per cent of DMEs in the past eight years.”

But the remainder of the network is aging as well,” he adds. “Almost all of the NDB’s are 30 to 40 years old and the VOR network is between 20 and 35 years old. That puts us in the difficult position of maintaining an aging network of equipment, much of it at remote locations, that is being used less and less by our customers.”

Establishing requirements

With the implementation of GNSS across the country and the costs of maintaining and replacing the existing navaid network, it is understandable that many countries are trying to determine what the future ground-based navaid network requirements might look like. The advanced state of GNSS use in aviation and the reliability of the GNSS network are important factors in this analysis.

Says Bellingham: “The emerging international consensus is that, eventually, what will be required is a ground-based navaid network that is sufficient to enable aircraft to land at a suitable airport or continue as directed by air traffic control in the event of a catastrophic outage of the satellite-based navigation system. The resulting network will not need to replicate the operational capability of the current system, but only be sufficient to ensure the safe operation of aircraft until satellite navigation can be restored.”

But, ‘how far away is eventually?’ and ‘how do we get there?’ are questions that will need to be answered.

“NAV CANADA is undertaking the work now that will be required to answer those important questions,” says Jeff Cochrane, Manager, CNS Service Design. “We are actively undertaking analysis to define what combination of navaids will be required and how best to make the transition. When that work is complete we will be consulting with customers on the way forward.”

“One important factor is the CARs requirement regarding the need for a ground-based navaid at either the flight planned destination or alternative airport. That limits how far we can rationalize the existing network. We don’t want to impact the economics of certain flights by causing operators to have to carry additional fuel,” says Cochrane.

“Factors such as radar coverage and the accessibility needs of northern airports are also being considered and will be major influencers of the final result,” he adds.

“The work being done to determine the future need for ground-based navigational aids is critical to avoiding unnecessary costs now,” stresses Bellingham. “Once we know what we will need, we can make rational decisions about what existing infrastructure needs to be replaced.”

But before moving away from ground-based navaids, there is more to be done to ensure the air navigation system is ready for the transition without losing key capabilities that exist today. “We recognize that the full implementation of GNSS is a vital prerequisite. We are working closely with our customers to determine priorities and have allocated additional resources to getting us where we want to be,” says Chuck Montgomery, Director, AIS and Flight Operations. ✨
President’s Point of View

In March, I was pleased to have the opportunity to be in Madrid to attend World ATM Congress. While the daily demands of the job often conspire to keep one close to the office, getting away to these types of international forums can be worthwhile.

Colleagues and partners came together in Madrid to discuss problems and experiences, share lessons learned and, in some cases, agree on the best way forward. The event, sponsored by the Civil Air Navigation Organization (CANSO) and the Air Traffic Control Association (ATCA), had over 6,000 attendees from 128 countries.

While each Air Navigation Service Provider (ANSP) has very different reality, we all share common challenges; these forums are great opportunities to compare notes and discuss ways we can collaborate to our mutual benefit, and for the benefit of our airline customers.

The trade show associated with the Congress displayed the latest in ATM technology. There was a constant buzz from suppliers and ANSPs alike. We were actively showcasing our own NAVCANatm technologies at the trade show, along with Searidge and other partners.

There was also significant interest in Aireon, our joint venture with Iridium Communications Inc. for space-based ADS-B. In fact, in the days leading up to the conference, three of our colleague ANSPs joined us as investors in Aireon. ENAV of Italy, the Irish Aviation Authority and Naviair of Denmark have all taken an ownership stake in the company, while NATS of the UK has signed a 12-year agreement to be a customer of the Aireon service.

NAV CANADA is working with the Irish Aviation Authority, Naviair, NATS and NAV Portugal to define together how space-based surveillance service can best be used for improving air traffic management over the North Atlantic.

In my continuing role as President and CEO of NAV CANADA, I have seen significant improvements in the commitment to global collaboration. There is broad recognition that in supporting a global aviation industry, service providers like ANSPs cannot develop independently of each other.

Initiatives like the ICAO Aviation System Block Upgrade (ASBU) framework further that objective by providing a common roadmap for system enhancements and facilitate dialogue between avionics manufacturers, airlines, airports, air navigation service providers, regulators and others on where we are going and how and when we are getting there.

This edition of Direct Route includes stories on several topics on which domestic and international collaboration is actively ongoing.

As always we appreciate your feedback on any of the stories here, or on stories you would like to see covered in future editions. Input can be sent to directroute@navcanada.ca.

The Gander Oceanic Transition Area (shaded).
Pushing the boundaries (cont. from pg. 3) of flying time under surveillance as aircraft transit the North Atlantic.”

Since air traffic controllers will be able to space aircraft closer together, there will be more opportunities for flights at lower altitudes to access higher, more fuel-efficient altitudes.

“Aircraft can change altitude much quicker, because spacing standards will drop from 80 nautical miles to 10 nautical miles,” says Lachance. “Eastbound aircraft will not have to transition as early to procedural, oceanic flight tracks, and westbound aircraft will start transitioning earlier to more economical flight profiles.”

For instance, westbound aircraft will exit North Atlantic tracks earlier, giving controllers more flexibility to route flights south toward cities located on the U.S. east coast. This will be particularly useful when the track system is aligned farther north than usual due to variations in the jet stream.

Making the Fix
To enable the creation of the Gander Oceanic Transition Area, NAV CANADA will be implementing additional fixes near the new domestic and oceanic boundaries over a two year period, with a first set of 23 fixes being implemented as of May 29, 2014.

Customers transiting the GOTA will need to take these new fixes into consideration in their flight planning activities, with details on how to do so available in AIC 14/14.

In addition to ensuring customers are ready for the change, the Company has been readying its staff and systems.

“Since the GOTA represents an expansion of services similar to those offered in domestic airspace, neighbouring domestic specialties will be adjusted to include the transition area,” says Lachance.

From a technological perspective, customers in the transition area will benefit from many of the recent safety features deployed in the Canadian Automated Air Traffic System (CAATS) and the Gander Automated Air Traffic System (GAATS), such as Medium Term Conflict Detection (MTCD) – which notifies controllers of a potential conflict situation with a look-ahead window of up to 20 minutes – and RADAR/ADS-B Confirmation (RADCON) – which continuously compares surveillance information against the data in ATS systems, flagging any discrepancies.

“These features help enhance safety in higher capacity airspace and, from the customer’s perspective, it all happens seamlessly in the background,” says Lachance.

Moving towards reduced lateral separation
The new fixes are being planned in a manner to accommodate track spacing associated with Reduced Lateral Separation Minima (RLatSM) for eastbound aircraft exiting the GOTA.

The reduced spacing will be implemented in 2015, and will reduce lateral spacing of aircraft in the North Atlantic from one degree to half a degree, or by approximately 30 nautical miles.

“This will significantly increase capacity at more desirable altitudes in airspace that does not currently benefit from surveillance,” says Lachance. “And it means more westbound aircraft will be able access the jetstream, which in turn leads to a reduction in fuel burn.”

To benefit from RLatSM, aircraft need to be equipped with a combination Automatic Dependent Surveillance-Contract (ADS-C) for position reporting and Controller Pilot Data Link Communications (CPDLC).

Looking further into the future, further changes to the separation standard and improvements in service in oceanic airspace will be realized when space-based ADS-B – being deployed by Aireon – is launched.

Quick Fact: The Gander Oceanic Transition Area (GOTA) will cover an area of approximately 175,000 square miles, or 280,000 square kilometres, in size.

GOFLI... and climb higher
In addition to the development of the Gander Oceanic Transition Area, NAV CANADA has implemented a service initiative to provide more aircraft with opportunities to climb to preferred altitudes.

Known as the Gander Oceanic Flight Level Initiative (GOFLI), air traffic controllers responsible for the North Atlantic airspace are now proactively contacting pilots to let them know when higher altitudes become available.

When a previously unavailable flight level opens up, the Gander Automated Air Traffic System alerts the responsible controller who can actively offer it to a lower flying aircraft.

“This reduces the need for pilots to actively request higher, more fuel-efficient altitudes from air traffic control,” says Larry Lachance, Vice President, Operations.

“Where pilots would sometimes hold back from requesting higher altitudes as a result of having those requests previously denied, the Company is taking ownership of proactively flagging opportunities as they happen.”

Between December 8, 2013 and January 11, 2014, NAV CANADA air traffic controllers made more than 5,100 active climb offers (ACOs) to pilots with more than 1,200 pilots accepting the opportunity to move to a higher altitude. This number is expected to grow as more pilots become aware of the initiative.

“It’s a bit of a culture shift, whereby we are actively looking for ways to assist customers to reduce their fuel burn on a flight-by-flight, tactical level,” says Lachance. “But it certainly fits with our philosophy of providing the best possible service to our customers, and finding new ways of doing things in a cost-effective manner.”

Customers transiting the GOTA...
The civil use of Unmanned Aircraft Vehicles (UAV) is growing rapidly. Increasing applications in law enforcement, agriculture, research and development, power and gas line monitoring are just a few areas that are pushing industry to work together to build a regulatory and operational framework that will help unlock the potential of unmanned systems.

Despite a number of challenges inherent in Unmanned Air Systems (UAS) operations – from a lack of sense & avoid capability, to aircraft control latency and lack of type certification – there are two key approaches being used and adapted to support the safe operation of UAVs in Canadian airspace.

**Special Flight Operations Certificate**

The majority of operations in Canada are small UAVs, less than 25 kilograms, operating within the visual line of sight of the operator and associated observers in Class G airspace. Operators currently require a Transport Canada-issued Special Flight Operations Certificate (SFOC) and must coordinate their activities with NAV CANADA if operating within controlled airspace. SFOCs are issued on an individual basis to a specific operator for a specific operation.

Transport Canada’s policy requires these UAVs operators to demonstrate their ability to meet equivalent levels of safety as manned aircraft through an application process detailed in section 623.65 (d) of the Canadian Aviation Regulations (CARs). While Transport Canada remains the approval authority, NAV CANADA air traffic services units are responsible for reviewing the proposed concept of operation and providing guidance to UAV operators on how to safely integrate their operation in their respective areas with controlled airspace.

---

**Multilateration at Fredericton Airport to increase safety, improve service**

Six new Wide Area Multilateration (WAM) sensors have been installed at Fredericton to provide additional surveillance coverage, enhancing situational awareness for controllers and improving service for customers.

The WAM installation, which went operational this spring, provides surveillance coverage below 1,500 feet, which is the lower coverage limit currently available via the Moncton radar site.

“This represents a significant safety enhancement for customers, many which are student pilots, operating in and out of Fredericton,” says Jeff Vey, Manager, Fredericton control tower. “Situational awareness will be greatly improved with the ability to acquire targets and integrate them into controller displays.”

---

Photo courtesy of Fredericton International Airport Authority.
In conversations I have regularly with pilots across the country I often encounter questions about GNSS overlay approaches. I wanted to take the opportunity in this column to address some of the common ones.

Most importantly, a GNSS overlay approach is not an RNAV approach. An overlay approach is an NDB or VOR non-precision approach that has been adapted to allow a standalone GPS receiver or a GPS sensor to provide approach navigation guidance to the FMS. While overlay approaches have GNSS in the approach title, at their core they are still conventional approach procedures because they were designed as conventional procedures. As conventional procedures they are coded using ARINC 424 rules for conventional leg types, which for most NDB and VOR approaches require the use of CF legs, or COURSE TO FIX legs.

An RNAV procedure is coded using ARINC 424 rules for RNAV leg types which would be a TF leg, or TRACK TO FIX legs. TF legs are anchored at both ends by the latitude/longitude of the waypoints starting and ending the leg.

In contrast, CF legs are anchored on the ending fix only. This results in CF legs being very sensitive to magnetic variation discrepancies while TF legs are not affected by magnetic variation at all.

In addition, TF legs will always tie together while CF legs can be disconnected. The magnitude of the disconnection is driven by the amount of magnetic variation difference between aircraft systems, navigation aids and the airport magnetic variation of record.

During the latest review of instrument approach procedures in Canada, NAV CANADA Flight Inspection found issues with excessive roll steering at each transition point of the approach on overlay approaches.

In one case, a pilot was complaining about the performance of his autopilot on approach to his home airport. In actual fact, the autopilot was just chasing the disconnected CF legs on the approach; the autopilot was just following the guidance provided by the FMS.

Here is an example of what was found on the VOR DME (GNSS) RWY 16 CYAM in the fall of 2013.

As you can see on the multi-function display (MFD), the flight path legs between XUBER, PURUS and SSM are all disconnected. The reaction of the aircraft was to overshoot the transition from the ARC to XUBER, then at PURUS the aircraft initiated a 15° bank turn to the right to regain the track from PURUS to SSM and the same thing happened from SSM to the runway.

Each FMS/GPS handles differences in magnetic variation differently between the onboard aircraft sources when using GPS as the navigator. When the approach is flown with reference to the VOR RADIAL as the primary navigation source, the aircraft is stable. However when it is flown with reference to the GPS as the primary navigator, the aircraft becomes unstable in roll while trying to make good the flight path between disconnected legs.

In Northern domestic airspace (NDA), where navigation aids and airports are referenced to TRUE NORTH, the magnetic variation issue is not a problem because for...
all intents and purposes the magnetic variation is 0. The issue with overlay approaches in NDA however still relates to conventional leg path terminators and the ARINC 424 rules around them.

For many conventional leg path terminators to be used, a reference VHF navigation aid must be within 45 nm of the approach procedure. For that reason, many of the NDB overlay approaches in NDA do not have the entire procedure coded; only the final approach segment is coded in the FMS. The procedure turn, approach transitions and the missed approach segment may be missing.

In one case, NAV CANADA flight inspection found that the NDB missed approach called for an immediate left turn but the conventional coding used in the overlay had the aircraft track climbing straight ahead until 400’ and then turning. This caused the track to be too close to terrain and as a result the overlay was NOTAM’d as “Not Authorized”. The basic conventional procedure was OK but the overlay coding did not match the approach designer’s intention.

As more RNAV approaches are designed and published, GNSS Overlay Approaches will be discontinued. In the meantime, when NAV CANADA Flight Inspection finds issues with final approach coding during flight check of current GNSS overlay approaches, the GNSS overlay approach must be NOTAM’d out of service.

"We are essentially building the system alongside work that is being done to transition our internal systems to process ICAO NOTAM format," says Meier. "And by keeping the focus on data, we can easily shape the output to match the data package requests we receive from larger airlines to feed their dispatch systems."

**Phased approach**

While the cutover to the ICAO format is expected to occur on a fixed date, the deployment of NOTAMWiz will take a phased approach, building up to that target date.

Development of the application, as well as testing and training of NAV CANADA employees, will happen through to the Fall of 2015.

Following this, the Company plans to issue a limited release to a pre-selected group of airports for user acceptance testing. “At this stage, we’re looking at how the human-machine interface and machine-machine interface works in the field, taking the opportunity to implement enhancements before the full launch, planned for 2016.”

**Appetite for change is there**

If the launch of SNOWiz – the Company’s web-based interface for the submission of runway surface condition reports – is any indication, reporting bodies have a shown a strong preference for self-serve, web-based solutions.

“More than 150 airports are participating, with more than 87 per cent of runway surface condition reports now being submitted through SNOWiz and compatible external interfaces – a number that doubled between January 2013 and January 2014,” says Meier. “As such, we think that having 80 per cent of all NOTAMs coming through NOTAMWiz within two years of launch is a realistic target.”
In doing so, discussions usually center around:

› establishing the vertical and horizontal boundaries of the areas of operation and the route to be taken to access the area of operation,
› the ability of the UAV operator to maintain visual contact and remain within the boundaries agreed upon,
› the means by which two-way communication can be maintained between the ATS unit and the operator, and
› various contingencies.

The growth in UAV use is very apparent when measured by the number of SFOCs issued across Canada. Between 2011 and 2013, the annual volume of SFOCs granted grew by more than 600 per cent, from just 155 in 2011 to 945 in 2013.

Beyond Visual Line of Sight: Segregating Airspace

Operations that go beyond visual line-of-sight are predominantly restricted to Class F restricted airspace, as the technology does not yet exist to address conventional see-and-be-seen requirements.

In this case, the operation is typically the subject of a NOTAM to notify conventional flights of the UAV activities. These operations are considered and approved only when the SFOC applicant is able to propose a means of mitigating collision risks that is acceptable to the Minister of Transport.

The Department of National Defence have a number of small tactical UAVs supporting Army and Navy operations which only operate in Class F (or otherwise) restricted airspace in Canada. These operations are not subject to the CARs, however they always consult and coordinate with both Transport Canada and NAV CANADA. A number of projects are on the books for the acquisition of larger UAVs which are intended to operate outside of restricted airspace, but delivery of these systems is not expected for several years.

Supporting research

Currently, the technological solutions do not exist to enable the safe integration of UAS beyond visual line-of-sight in controlled airspace. This is a major obstacle to advancing this technology for commercial applications.

In response to this, UAV industry groups are working with Transport Canada and NAV CANADA to establish restricted areas that would permit the use and testing of UAVs beyond visual line-of-sight.

At Alma, QC, Le Centre d’excellence sur les drones/Unmanned Aerial System Center of Excellence (CED/UASCE) has been established to facilitate and support flight testing research and development activities and provide facilities for maintenance of civilian UAV operations.

In the West, the Canadian Centre for Unmanned Vehicle Systems (CCUVS) has asked that an area close to Foremost, AB be designated as special use (Class F) airspace (CYR) for the development, testing and evaluation of civil UAVs.

Both groups have submitted proposals to create CYRs for UAV flight testing in their respective areas and aeronautical studies are well underway.

The development of an area of Class F airspace for UAV testing and development would allow for wide-spread participation from companies that are in need of safe, managed and segregated airspace, providing a focused area of development for the UAV industry.

Working with industry

One thing is certain: as the aviation industry moves towards more flexible frameworks for UAV integration, working with stakeholders in establishing objectives, standards and best practices will be key.

That is why NAV CANADA is participating on the Transport Canada-led Canadian Aviation Regulation Advisory Council (CARAC) UAV Systems Program Design Working Group to help develop the required regulations, standards and procedures within Canada.

In addition, the Company regularly attends Unmanned Systems Canada’s annual conference to stay abreast of emerging issues and discuss upcoming initiatives.

While there is still a lot of work to do, it is clear that a more flexible framework – that takes into account the infrastructure and process requirement of the commercial UAV industry – will need to be a part of the aviation landscape in the not-too-distant future.

“Multilateration at Fredericton Airport to increase safety, improve service (cont. from pg. 5)

“For our controllers that means better planning, less time spent manually updating flight information and more time focused on their primary tasks of managing traffic.”

WAM, which works with existing transponder technology, has been approved by Transport Canada to be used in the same way as Secondary Surveillance Radar.

Flight information associated with an aircraft – such as flight ident, altitude, routing as well as any flight plans that have been submitted – will automatically be fed through NAV CANADA processors and displayed on appropriate controller displays such as NAVCANstrips, the Company’s electronic flight strip system, as well as radar displays.

In addition to being displayed to tower controllers, information is available to terminal controllers at the Moncton Area Control Centre and flight service specialists at the Saint John FSS, who are responsible for delivering Remote Airport Advisory Services in the overnight hours.

“This all comes together to provide a better picture of the operation for air traffic services personnel, resulting in better service for our customers,” says Vey.

The control zone has been changed to transponder mandatory airspace following an aeronautical study.”