Sharing the space

Globalsys' paired headsets will automatically connect with a helicopter's private voice network once in range. Image: Globalsys

Already a buzzword around the airlines and among business aviation operators, connectivity is rapidly changing the way helicopters are used. It is also a key technology for a future in which helicopters and a new generation of potentially autonomous aircraft share dense urban airspace. Paul Eden finds out more.

Miniaturisation, new air-to-ground and satcom options, and digital avionics for cockpit and cabin are driving an ongoing revolution in fixed-wing aircraft connectivity.

The same could be true for helicopters, but their typically shorter missions and limited airframe "real estate", plus the complex physics associated with passing satcom signals through main rotor discs, mean that connectivity for rotary-wing aircraft is evolving along different channels.

Connectivity within a helicopter, between aircraft and between a helicopter and the ground promises advances in mission capability, aircraft health monitoring, maintenance, operational efficiency, safety and passenger experience.

The options for data and voice transmission have expanded, and while proven radio technologies remain key, cellular networks, air-to-ground, satellite communications, Wi-Fi and Bluetooth are all increasingly relevant to rotary-wing aircraft.

Casey Bakula, Communication, Navigation Surveillance Systems test team lead for the Air Mobility Pathfinders project at NASA, is well placed to provide an overview of helicopter connectivity technology.

A 15-year NASA veteran, Bakula initially joined the space programme, investigating requirements for establishing communication networks on the moon, then moving on to suit radio systems for extravehicular activity, before examining how astronauts would communicate on the International Space Station, among other things.

A subsequent interest in unmanned aircraft drew him to aeronautics, where he has remined for the past eight years.

Data loss

Today, Bakula takes communications lead on several of the advanced air mobility (AAM) projects NASA supports.

While eVTOL craft and their obvious relationship with helicopters fall under his jurisdiction, so too do eSTOL and other platforms, all operating at relatively low speeds and altitudes in what might be considered the helicopter's natural environment.

Bakula therefore appreciates the challenges of helicopter connectivity in the contemporary market and in an aviation ecosystem evolving to potentially integrate conventional rotorcraft with eVTOL and other low-

flying “slow movers”. Considering the cornerstone of bizjet connectivity, he says: “Main rotor blades pose a real challenge to satcom. Each blade periodically blocks the signal and induces Doppler effects as RF (radio frequency) energy reflects off it, shifting frequencies around.

“It makes radio synchronisation a challenge, as well causing data loss. We’ve understood all this for a while, though, and know that the higher the frequency the more pronounced the effects become.

“Most of the prototype eVTOLs don’t have a large overhead rotor, and their configuration mitigates the challenge somewhat, although not entirely.”

Operating in the L-band frequency range, GPS avoids some of the problem associated with data transmission through main rotors, with other negative effects being mitigated through software – facts that also enable satcom providers to connect helicopters via L-band satellite, albeit at lower data transmission rates.

Among them, Thuraya Aero offers a line-fit satcom option for H135 and H145 helicopters.

Promising real-time connectivity via Thuraya’s own L-band satellite network, the system will stream video, making it attractive for search-and-rescue and similar applications, but will not deliver the experience familiar to business jet travellers from much higher frequency Ku- or Ka-band satcom.

Airframe size is another challenge for helicopters, with space to mount satcom antennas and install associated avionics at a premium.

Bakula sees this as a burgeoning challenge for AAM vehicles.

He says: “Lots of them are very small and as a comms guy, walking up to one of these aircraft the first thing I think about is where I’d put my comms equipment.”

Cellular connection

Helicopter operations seldom reach high altitudes, leaving terrestrial cellular networks frequently within reach, but as anyone who has attempted to use their mobile phone on a helicopter will likely attest, connection is limited or non-existent.

The physics of cell networks militates against phones attempting to connect from altitude, since the device might attempt to connect to a tower in a distant cell rather than the closest tower, thereby “confusing” the network and causing service failure.

However, airborne equipment optimised for cellular connection, and exemplified by Astronautics’ AeroSync Wireless Airborne Communication System (WACS), offers significant potential for broadband connectivity, including real-time transmission of mission data, streaming video, and maintenance and operational data.

Combined with an aircraft Wi-Fi system, it also enables crew and passenger devices to connect, facilitating pilot interaction with iPad applications, for example, and passenger communications and entertainment.

It also has significant potential as a datalink, transmitting detailed patient information to hospital ahead of an EMS helicopter arriving on the pad, for example.

Similar connectivity could be achieved via Gogo Business Aviation’s dedicated air-to-ground network, albeit only for customers in North America.

Primarily providing connectivity to fixed-wing business aircraft though its own tower network, Gogo requires a small under-fuselage antenna and onboard server, for a minimal aircraft footprint.

The Astronautics system is available as line-fit for the H145, H125 and H130, with additional features including its ability to turn the helicopter into a

> *“Most of the prototype eVTOLs don’t have a large overhead rotor, and their configuration mitigates the challenge somewhat, although not entirely.”*
>
> Casey Bakula, Communication, Navigation Surveillance Systems test team lead for the Air Mobility Pathfinders project at NASA

Datalinking has a significant role to play in HEMS-to-hospital communication, transferring critical patient data. Image: Bell

Sikorsky's S-76B SARA and H-60 OPV depart for a NASA trial in 2023. Image: NASA/Steve Freeman

"wireless hub", capable of wirelessly connecting as many as 10 devices within a 400 ft radius to the internet.

It also offers automatic, secure download of maintenance data on landing, via cellular or local Wi-Fi network.

Maintained advantage

Alan Love is Manager IVHM (integrated vehicle health management) at Bell, a position that increasingly involves connectivity.

He says: "I lead a team of engineers traditionally involved in health monitoring within the commercial business.

"As technology has progressed, we've seen more and more monitoring systems, whether HUMS (helicopter and usage monitoring system), vibration monitoring, flight data recorder, or digital avionics going on the aircraft and recording more and more data, making them increasingly capable from an IoT standpoint. We have devices that go on primarily as recorders, but now you can Bluetooth into them and that wasn't possible 15 years ago.

"Looking at the latest and greatest aircraft off the production line, it's possible to stream data from the aircraft as soon as it is within range of a Wi-Fi network and via cellular as soon as it lands, and all of that is still changing very quickly. I would say the latest development is the potential for offloading data in the air via cellular, which is traditionally something that, at least here in the US, was previously unheard of."

Love adds a caveat generally ignored by connectivity providers. He agrees that connectivity has the potential to deliver huge operational benefits, but adds: "What you're able to move while you're in the air, whatever the connection, is always going to be limited. Physical media transfer is almost always going to be the fastest way to move data from point A to point B, but new technology adoption allows the operator to get ahead of the data in a more meaningful way. Flagging a problem before the aircraft comes back to base is invaluable for the maintainer and helps turn the aircraft around faster."

It is worth noting that Bell was the first helicopter OEM to offer SiriusXM Aviation Weather and Audio. The satellite-based service is available on Bell 407GX and 429 helicopters equipped with Garmin GDL69 avionics and, according to the 2020 press release, will also be available as a Bell 525 option.

Future connection

In October 2023, NASA tested autonomous flight software in the S-76B SARA (Sikorsky Autonomy Research Aircraft) and OPV (Optionally Piloted Vehicle) UH-60 Black Hawk.

The helicopters played the roles of eVTOLs or similar AAM craft, primarily investigating how such aircraft might safely operate without pilots in busy urban airspace. Connectivity, in several forms, was critical to the trials.

Referencing those trials and NASA's wider connectivity remit,

Globalsys technology is designed for voice transmission but also has the potential to act as a limited datalink. Image: Globalsys

Bakula describes "the problem of figuring out how everything works together in this new ecosystem", adding: "From a communications standpoint there are two driving characteristics. The big one is the inclusion of remotely piloted aircraft, which necessitates all kinds of air-to-ground connectivity between the aircraft and the remote pilots operating them.

"Initially these links support command and control [C2], but as we talk with industry, the FAA and international community, we're trying to understand the needs beyond C2. For example, real-time weather and air traffic data must be sent to the aircraft, while ADS-B data needs to pass from the aircraft to the remote pilot.

"In a recent workshop we brought several stakeholders together and performed an air taxi 'walk-through', trying to understand the communication needs. We talked lots about the additional communications systems required when a passenger wants to speak with the pilot – should it be over voice, or a video link and should it be emergency only? Should the remote pilot be able to see what's happening inside the cabin? And are additional communications channels required should an emergency arise?"

> *"The big one is the inclusion of remotely piloted aircraft, which necessitates all kinds of air-to-ground connectivity between the aircraft and the remote pilots operating them."*
>
> Casey Bakula, Communication, Navigation Surveillance Systems test team lead for the Air Mobility Pathfinders project at NASA

Bakula says the second driver of evolving connectivity is aircraft-to-aircraft communication in dense airspace.

"We're considering links between aircraft for tactical deconfliction and collision avoidance, functions beyond the capability of ADS-B and TCAS (terrain collision avoidance system)."

Adding an additional layer of challenge, Bakula acknowledges that to ensure resilience, critical command and control channels require back-ups should a primary link fail.

If the aircraft is carrying a payload that also requires connectivity, and that could be a specific cargo, or a sensor delivering

Helicopters including the Bell 429 are popular choices for shore to vessel transfers. Image: Bell

streaming video, for example, then at least one more link is required.

"It's difficult to achieve one link for each of these services, but there must also be dissimilar redundancy," he says. "In the workshop we investigated the scenario of a lost link with a primary service provider, which led us to consider if local links with vertiports ought to be available. But then who would operate them and what information would be transmitted?"

It's still good to talk

Amid the possibilities of Bluetooth, cellular, radio datalink, satcom and Wi-Fi connectivity, it is easy to lose sight of perhaps the most fundamental aircraft communication of all – voice.

An internet connection enables secure voice chat through VoIP, while traditional radios remain critical operational equipment. But even here, new technologies are enabling connectivity beyond traditional means.

Known for its wireless pilot and groundcrew headset portfolio, Globalsys offers the possibility for operators to establish private, stand-alone voice networks centred around an aircraft-mounted base station.

Remi Doutriaux, Globalsys's CEO, says: "The base station establishes a link with the aircraft intercom, creates a wireless communication hub for eight users and mixes their audio content.

"It can be battery powered and removable, or fully integrated and drawing its power from the aircraft. It uses the DECT (digital enhanced cordless telecommunication) protocol, which is licence-free and offers full duplex communication, high-quality wideband audio, very low latency and audio conferencing capabilities.

"The protocol is free from interference because each box is allocated an available frequency channel from 120 available channels operating around 1.8 GHz."

Significantly, Globalsys offers a unique function that enables a ground operator to remotely connect to an incoming aircraft via a paired headset. This has obvious utility for off-airfield landing sites, plus mountain rescue teams, yacht crews and even rescue divers.

Doutriaux says: "We use the same product architecture and design to support a variety of clients. Designed to operate in harsh environments, the system employs electronic de-noising to remove background sound and we have waterproof designs suitable for at-sea rescue and even rescue divers. Maximum range is 300 metres line-of-sight, but an optional half-duplex radio extends this to between four and five kilometres."

Globalsys designed its technology for voice transmission, but it also has the potential to act as a limited datalink for aircraft data.

Doutriaux adds: "The DECT protocol supports data transmission but not high bandwidth, restricting it to small data volumes – it will not support large files or video stream. However, it can transmit critical data needed for processes including geolocation."

Connectivity is already changing how helicopters operate, although in subtly different ways to fixed-wing aviation.

Helicopter passengers, VIP or otherwise, are less likely to yearn for an internet connection or wireless entertainment on a 40-minute helicopter trip than they are during a 10-hour bizjet flight, but the possibilities from datalinking key aircraft and operational data are now being realised.

Perhaps most significantly, the helicopter is closer in operating model than any other aircraft type to the emerging AAM technologies.

It is naive to believe that eVTOLs will replace helicopters – more realistic to imagine a nascent ecosystem in which AAM platforms and helicopters operate side by side.

In that case, the critical enabling technologies relate to connectivity – within aircraft, between them, and between the vehicle and the ground. ■