SyTech | White Paper

Establishing Beyond-Visual-Line-of-Sight Radio Communications for Uncrewed Flight Operations

Challenges and solutions for connecting the remote pilot to the air, ground, and beyond.

CONTACT:

Aaron@SyTechCorp.com

VERSION:

Fall 2026

Systems Engineering Technologies Corporation

6121 LINCOLNIA ROAD, SUITE 200 | ALEXANDRIA, VA 22312 | 703.941.7887 | www.SyTechCorp.com

The Operational Communications Gap in BVLOS Flight

During conventional flight operations, a pilot communicates directly with air traffic control and other aircraft through the aviation-band radio installed in the aircraft. The pilot can hear radio traffic, transmit as needed, and change frequencies while moving between controlled airspace, airports, and operating areas.

Beyond-visual-line-of-sight operations separate the remote pilot from that radio. Once the uncrewed aircraft travels beyond the effective range of a local ground-based radio, the pilot can no longer rely on a direct VHF connection. A separate communications path is required to carry radio audio and control information between the aircraft and the remote pilot.

Many uncrewed aircraft already maintain an IP connection for command and control, telemetry, payload data, or situational awareness. Depending on the mission, that connection may use satellite, cellular, terrestrial radio, or a combination of available networks. However, transporting aviation-radio communications over the same connection introduces additional requirements. The system must carry intelligible two-way audio with minimal delay, operate within the aircraft's available bandwidth, recover from interruptions in the IP link, and allow the remote pilot to control the airborne radio.

Remote frequency control is particularly important. As the aircraft moves through different airspace, the pilot may be directed to contact another air traffic control facility or change to a different operating frequency. A BVLOS communications system must therefore do more than relay audio. It must allow the remote pilot to view the radio's current status, enter and select frequencies, adjust available radio functions, and transmit through the onboard radio as though operating from the aircraft.

The aircraft installation must also meet practical size, weight, and power constraints. It cannot depend on a large communications payload or require the aircraft operator to replace an otherwise suitable aviation radio and IP network. The most useful approach is to extend the aircraft's existing radio through its existing network connection.

The SyTech RADIUS nPoint system provides that extension. It connects the onboard aviation radio to the remote pilot over an IP network, preserving two-way voice communications and remote radio control beyond line of sight.

The RADIUS nPoint BVLOS System

The RADIUS nPoint system extends an aircraft's onboard aviation radio to a remote pilot over a suitable IP connection. The system carries radio audio and control information between the aircraft and the operator, allowing the pilot to communicate through the airborne radio from a ground control station located beyond direct radio range.

The complete system consists of four primary elements:

1. **The RADIUS nPoint and onboard aviation radio**

   Installed on the aircraft, the nPoint connects directly to the aviation radio. It receives analog radio audio, converts it into IP data, and sends it across the aircraft's network connection. In the opposite direction, it converts audio received from the remote pilot into the analog signals required by the radio. The nPoint also exchanges control data with compatible radios, allowing supported radio functions to be operated remotely.

2. **The aircraft's IP connection**

   The aircraft provides the network path between the nPoint and the ground-based system. This connection may use satellite, cellular, terrestrial radio, or another IP transport appropriate for the aircraft and mission. The nPoint operates independently of the underlying transport and can therefore be integrated with an aircraft's existing communications architecture.

3. **The RADIUS Distribution Service**

   The Distribution Service manages the connections between the aircraft and authorized ground operators. It routes audio and control data, monitors connection status, and applies the user permissions and system configuration established for the operation. The Distribution Service can be hosted by SyTech or deployed within the operator's own network environment.

4. **The RADIUS Client and Virtual Control Head**

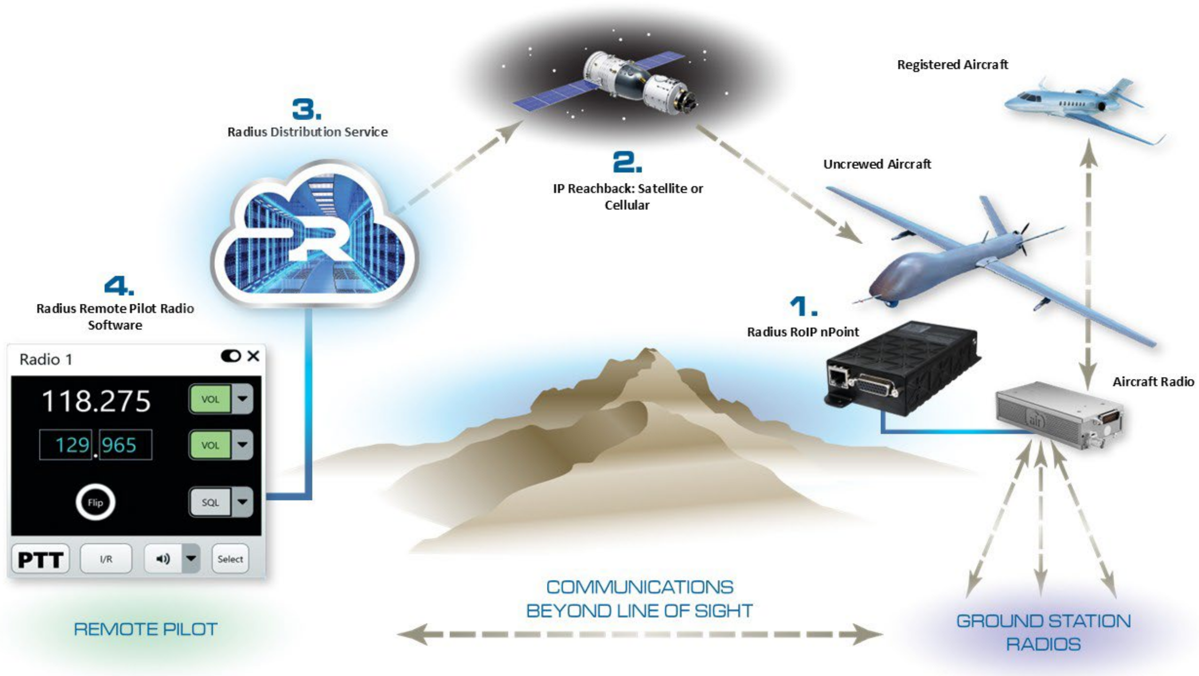
   At the ground control station, the remote pilot accesses the airborne radio through the RADIUS Client. The software provides push-to-talk, received audio, radio status, and a Virtual Control Head for supported radio functions. Depending on the connected radio, the pilot can enter and change frequencies, switch between primary and secondary channels, adjust volume and squelch, and review recent radio traffic.

When the aircraft receives a transmission, the onboard radio passes the audio to the nPoint. The nPoint digitizes and compresses the audio, then sends it through the aircraft's IP connection to the Distribution Service. The Distribution Service routes the audio to the remote pilot's RADIUS Client.

The return path operates in the same manner. When the remote pilot activates push-to-talk, the RADIUS Client sends the pilot's audio through the Distribution Service and across the aircraft's IP connection. The nPoint converts the received data back into audio for transmission through the onboard aviation radio.

- The result is a continuous operational link between the remote pilot and the aircraft's radio. To air traffic control and other aircraft, the communication is transmitted and received by the airborne radio in the same manner as a conventional piloted aircraft.

  The image below illustrates the four primary subsystems of the SyTech RADIUS nPoint BVLOS system.



End-to-End System Architecture

The RADIUS nPoint architecture connects the aircraft's aviation radio to one or more authorized operators without requiring a direct radio-frequency link between the aircraft and the ground control station. The aircraft and operator communicate through the RADIUS Distribution Service, which provides a common connection point for audio, radio control, and system status.

On the aircraft, the nPoint connects to the aviation radio through a radio-specific interface. This connection carries transmit and receive audio, push-to-talk signaling, and supported radio-control data. The nPoint also connects to the aircraft's onboard IP network, allowing it to use the network transport already available to the aircraft.

When powered, the nPoint establishes a secure, TLS 1.3 encrypted connection with the configured Distribution Service. The system uses keep-alive messages to monitor the connection and report whether the airborne equipment is available. Because the nPoint initiates the connection, it can operate across most conventional IP networks without requiring the aircraft to maintain a publicly accessible IP address.

The remote pilot's RADIUS Client establishes a separate connection with the same Distribution Service. After the user signs in, the Distribution Service applies the appropriate permissions and makes the assigned airborne radio available through the Client. The pilot can then monitor received audio, activate push-to-talk, and operate the supported functions presented through the Virtual Control Head.

The architecture carries three related types of information:

- Radio audio: Voice communications transmitted between the remote pilot and the onboard aviation radio.
- Radio control: Commands used to operate supported functions such as frequency selection, channel changes, volume, and squelch.
- System status: Information used to indicate network connectivity, radio state, and the availability of the airborne equipment.

Separating the operator, aircraft equipment, and network transport allows each part of the system to be deployed according to the mission. The remote pilot may operate from a fixed ground control station, a mobile command location, or another authorized site with network access. The Distribution Service may be hosted by SyTech or deployed within the operator's own infrastructure, while the aircraft may use whichever suitable IP transport is available for the flight.

Operation Across IP Networks

The RADIUS nPoint does not depend on a specific satellite provider, cellular carrier, or terrestrial network. It transports audio and radio-control data over a suitable IP connection, allowing the aircraft operator to select the network technology that best supports the aircraft, operating area, and mission.

Common transport options include:

- Satellite communications: Provides wide-area coverage for operations over remote regions, oceans, and other locations beyond terrestrial network coverage. Available options include low-Earth-orbit broadband services such as Starlink and lower-bandwidth satellite services such as Iridium.

- Cellular communications: Provides a relatively low-cost, low-latency connection where reliable cellular coverage is available. Cellular service may be appropriate for testing, populated operating areas, and missions conducted within established coverage zones.
- Terrestrial radio networks: Private mesh radios and other IP-capable data links can connect the aircraft directly to a ground network without relying on public cellular or satellite infrastructure.
- Combined network architectures: Aircraft may carry multiple communications systems to support different phases of flight, operating areas, or levels of redundancy.

Because the nPoint operates at the IP layer, the same airborne radio interface and ground-control software can be used as the underlying network changes. The aircraft may communicate through Starlink during one mission, an Iridium terminal during another, or a terrestrial data radio when operating within range of the ground network. This allows the operator to select the transport independently of the aviation-radio system.

The selected network directly affects communication performance. Available bandwidth, latency, jitter, packet loss, coverage, and interruptions in service can influence how quickly audio arrives and how naturally it is heard by the operator. A broadband connection may provide low latency and substantial capacity, while a narrowband satellite link may require tighter control over bandwidth and additional buffering to maintain intelligible audio.

The RADIUS nPoint system is designed to minimize the amount of network capacity required for voice communications. This allows radio audio and control data to share the aircraft's IP connection with command-and-control, telemetry, or payload traffic without requiring a dedicated broadband link solely for aviation communications.

Network selection remains an aircraft and mission-level decision. The RADIUS architecture allows the communications system to operate across the chosen transport while preserving a consistent radio interface for the remote pilot.

SyTech nPoint – Power Selection and Input

Remote Radio Control and Frequency Management

Relaying radio audio is only part of the requirement for BVLOS aviation communications. The remote pilot must also be able to operate the radio as the aircraft moves between frequencies, air traffic control sectors, airports, and mission areas.

The RADIUS nPoint exchanges control data with compatible aviation radios through the radio's supported control interface. This connection allows the current radio state to be transmitted to the RADIUS Client and allows commands from the remote pilot to be applied to the airborne radio.

The RADIUS Virtual Control Head presents the supported radio functions through the pilot's ground-control workstation. Depending on the connected radio, these functions may include:

- Viewing the active and standby frequencies
- Entering a new frequency
- Switching the standby frequency to active
- Monitoring two channels
- Adjusting volume and squelch
- Activating push-to-talk
- Reviewing recently received radio traffic

Virtual Control Head for Air Avionics AC-1

During flight, the pilot can enter a new frequency into the standby position while continuing to monitor and communicate on the active frequency. When directed by air traffic control, the pilot promotes the standby frequency to active through the Virtual Control Head. The command is sent through the Distribution Service to the nPoint, which applies the change to the airborne radio. The updated radio state is then returned to the Client and displayed to the pilot.

For radios that support dual-watch operation, the pilot can monitor traffic on both the active and standby frequencies. The system can identify which frequency is receiving audio and provide the pilot with control over how the available channels are monitored and selected.

The Virtual Control Head remains synchronized with the radio. Changes applied through the RADIUS Client are reflected at the airborne radio, while changes made through an attached physical control head can be reported back to the Client when supported by the radio interface.

This remote-control capability allows the aircraft's aviation radio to remain operationally useful throughout a BVLOS flight. The remote pilot is not limited to a frequency selected before takeoff and can respond to changing airspace and communication requirements while the aircraft is airborne.

Latency, Buffering, and Link Interruption

Aviation communications are time-sensitive. Excessive delay can disrupt the natural exchange between the remote pilot, air traffic control, and other aircraft. At the same time, an IP network rarely delivers every packet at perfectly uniform intervals. Satellite, cellular, and terrestrial links can introduce changes in latency, packet arrival time, and available bandwidth throughout a flight.

The RADIUS nPoint system balances these conditions by buffering a limited amount of received audio before playback. This buffer compensates for normal variations in packet arrival time and helps prevent speech from becoming broken or unintelligible. Increasing the buffer can improve audio continuity over an inconsistent network, but it also introduces additional delay. Reducing the buffer minimizes delay but leaves less protection against network jitter and temporary congestion.

SyTech nPoint – Ethernet and Radio Interface

The appropriate configuration therefore depends on the selected IP transport and its performance characteristics. A stable, low-latency broadband connection may require very little buffering. A narrowband or variable satellite connection may benefit from additional buffering to preserve intelligible audio. Buffer settings can be adjusted to balance responsiveness and continuity for the aircraft's operating environment.

The system also uses connection monitoring and keep-alive messages to determine whether the airborne nPoint, Distribution Service, and remote Client remain connected. Changes in connection status are reported to the operator so the availability of the radio path can be monitored during flight.

During a complete interruption of the IP link, live radio audio and control commands cannot pass between the aircraft and the remote pilot. The onboard aviation radio remains powered and tuned to its last commanded settings, while the nPoint continues attempting to restore its connection to the Distribution Service. Once the IP path becomes available again, the system reestablishes the session and resumes the exchange of audio, control, and status information without requiring the airborne equipment to be manually restarted.

No radio-over-IP system can eliminate delay or compensate indefinitely for the loss of its underlying network. Reliable BVLOS communications therefore depend on both the nPoint system and an IP architecture appropriate for the mission. By minimizing bandwidth requirements, providing configurable buffering, and automatically recovering its network connection, the RADIUS nPoint helps preserve usable aviation-radio communications across the variable conditions encountered during BVLOS flight.

Size, Weight, Power, and Aircraft Integration

Uncrewed aircraft have limited capacity for additional communications equipment. Any BVLOS radio solution must fit within the aircraft's available payload space, remain within its weight and power budgets, and integrate without unnecessarily disrupting the existing avionics architecture.

The RADIUS nPoint measures 28 mm high, 63 mm wide, and 133 mm long and weighs 185 grams. It can be powered through a 5 V USB-C connection or an 11–30 VDC aircraft power source. The nPoint consumes approximately 3 watts during normal operation, with a peak consumption of 7.5 watts.

When paired with the AIRCOM AC-1 aviation radio, the complete airborne radio package remains compact and lightweight. The AC-1 measures 60 mm high, 63 mm wide, and 160 mm long and weighs 365 grams. Together, the nPoint and AC-1 weigh approximately 550 grams, or 1.21 pounds, excluding cables, antenna, and the aircraft's IP-network equipment. The combined configuration operates from 11–30 VDC and consumes approximately 5 watts nominally and 24 watts during radio transmission.

The nPoint connects to three primary aircraft resources:

Power: The unit operates from the aircraft's available DC electrical system using an appropriate regulated power connection.

Network: An Ethernet connection links the nPoint to the aircraft's satellite terminal, cellular modem, terrestrial data radio, network switch, or other IP equipment.

Aviation radio: A radio-specific interface carries transmit and receive audio, push-to-talk signaling, and supported radio-control data between the nPoint and the onboard radio.

The nPoint can be integrated with the AC-1 or with another supported radio selected for the aircraft and mission. This allows the operator to choose an aviation radio based on factors such as frequency coverage, transmit power, certification requirements, environmental specifications, and available installation space.

Air Avionics AC-1 VHF Radio

Antenna selection and placement remain important parts of the aircraft installation. The aviation radio requires a suitable VHF antenna with adequate separation from other transmitters and electronic equipment. The installer must also account for cable routing, grounding, electromagnetic compatibility, cooling, and access for inspection or maintenance.

Because the nPoint uses the aircraft's existing IP connection, it does not require a separate communications network solely for radio audio. This reduces the amount of additional airborne equipment and allows the aviation-radio capability to be incorporated into the aircraft's broader command, control, and communications architecture.

Final integration requirements depend on the aircraft, aviation radio, network transport, and intended operation. SyTech can work with the aircraft manufacturer or system integrator to define the required interfaces, cable assemblies, power configuration, network settings, and ground-test procedures before flight testing.

Operational Use and Applications

Deployed by the U.S. Navy in 2022, the RADIUS nPoint extends radio communications and control over IP networks for several long-range UAS configurations conducting intelligence, surveillance, and reconnaissance (ISR). This operational use demonstrates the system's ability to connect geographically separated operators with remote radio equipment through a deployable, network-based architecture.

The Platform Aero Vanilla: U.S. Navy Long-Range UAS

The RADIUS nPoint flew in 2023 under an FAA BVLOS waiver, demonstrating the system's ability to support authorized long-range uncrewed operations under current BVLOS requirements.

For uncrewed aircraft operations, the same architecture places the radio aboard the aircraft while allowing the remote pilot to operate it from the ground. The pilot communicates through the airborne radio rather than relying on a separate ground-based VHF station or chase aircraft located within radio range of the operating area.

This capability can support a range of BVLOS missions, including:

Cargo and logistics operations: Maintaining aviation-band communications as uncrewed cargo aircraft travel between airports or through controlled airspace.

Military operations: Extending airborne radio access to pilots and mission personnel operating from remote command locations.

Public-safety missions: Supporting uncrewed aircraft used for emergency response, disaster assessment, search and rescue, and operations over large or inaccessible areas.

Infrastructure and environmental monitoring: Providing radio communications during long-range inspection, mapping, surveillance, and research flights.

Remote and maritime operations: Supporting aircraft operating over oceans, Arctic regions, islands, and other areas where terrestrial communications infrastructure is limited.

Flight testing and aircraft development: Allowing manufacturers and integrators to incorporate remotely controlled aviation communications into experimental and production uncrewed aircraft.

The nPoint may also be used outside an aircraft. The same radio-to-IP architecture can extend a radio located at a tower, command post, vehicle, ship, or remote operating site to authorized users elsewhere on the network. This allows aircraft operators to use a common RADIUS environment for both airborne and ground-based radio assets.

Each deployment is configured around the aircraft, radio, IP transport, operating environment, and mission requirements. The modular architecture allows operators to begin with a single aircraft and ground-control station, then add additional aircraft, radios, pilots, or operating locations as the program expands.

Deployment Options and Next Steps

The RADIUS nPoint system can be deployed through a SyTech-hosted Distribution Service or within the operator’s own network environment. The appropriate configuration depends on the program’s security requirements, network architecture, number of aircraft, operating locations, and long-term support model.

A SyTech-hosted deployment provides access to the RADIUS Distribution Service through SyTech’s cloud environment. This approach can simplify initial evaluation and deployment by reducing the amount of server infrastructure the operator must install and maintain.

For programs that require direct control of the supporting infrastructure, the Distribution Service can be installed on premises or within a customer-managed cloud environment. This allows the operator to manage network access, user accounts, security certificates, system configuration, and connections to other operational systems.

A typical integration effort progresses through several stages:

Requirements review: Identify the aircraft, aviation radio, IP transport, antenna configuration, ground-control environment, and required radio functions.

Bench evaluation: Connect the nPoint, radio, Distribution Service, and RADIUS Client in a controlled environment to verify audio, push-to-talk, remote frequency control, and network performance.

Aircraft integration: Install the airborne equipment and complete the required power, network, radio, antenna, and mechanical connections.

Ground testing: Verify radio operation, audio quality, control functions, network recovery, and compatibility with the aircraft's other systems.

Radius nPoint (top) with AC-1 Radio (bottom)

Flight testing: Evaluate performance under representative operating conditions before progressing to longer-range or operational BVLOS flights.

Operational deployment: Establish the final user permissions, system configuration, support procedures, and network architecture for routine operations.

An evaluation system can be used to demonstrate the end-to-end capability and collect performance data over the operator's intended IP network before a permanent aircraft installation is finalized. SyTech can support the evaluation remotely or work with the aircraft manufacturer, integrator, and operator during bench testing and aircraft integration.

By extending the aircraft's existing aviation radio through its existing IP connection, the RADIUS nPoint provides remote pilots with two-way voice communications and radio control beyond direct radio range. Its transport-independent architecture allows the system to support different aircraft, networks, and missions while preserving a consistent operating interface for the remote pilot.

The Operational Communications Gap in BVLOS Flight

During conventional flight operations, a pilot communicates directly with air traffic control and other aircraft through the aviation-band radio installed in the aircraft. The pilot can hear radio traffic, transmit as needed, and change frequencies while moving between controlled airspace, airports, and operating areas.

Beyond-visual-line-of-sight operations separate the remote pilot from that radio. Once the uncrewed aircraft travels beyond the effective range of a local ground-based radio, the pilot can no longer rely on a direct VHF connection. A separate communications path is required to carry radio audio and control information between the aircraft and the remote pilot.

Many uncrewed aircraft already maintain an IP connection for command and control, telemetry, payload data, or situational awareness. Depending on the mission, that connection may use satellite, cellular, terrestrial radio, or a combination of available networks. However, transporting aviation-radio communications over the same connection introduces additional requirements. The system must carry intelligible two-way audio with minimal delay, operate within the aircraft's available bandwidth, recover from interruptions in the IP link, and allow the remote pilot to control the airborne radio.

Remote frequency control is particularly important. As the aircraft moves through different airspace, the pilot may be directed to contact another air traffic control facility or change to a different operating frequency. A BVLOS communications system must therefore do more than relay audio. It must allow the remote pilot to view the radio's current status, enter and select frequencies, adjust available radio functions, and transmit through the onboard radio as though operating from the aircraft.

The aircraft installation must also meet practical size, weight, and power constraints. It cannot depend on a large communications payload or require the aircraft operator to replace an otherwise suitable aviation radio and IP network. The most useful approach is to extend the aircraft's existing radio through its existing network connection.

The SyTech RADIUS nPoint system provides that extension. It connects the onboard aviation radio to the remote pilot over an IP network, preserving two-way voice communications and remote radio control beyond line of sight.

The RADIUS nPoint BVLOS System

The RADIUS nPoint system extends an aircraft's onboard aviation radio to a remote pilot over a suitable IP connection. The system carries radio audio and control information between the aircraft and the operator, allowing the pilot to communicate through the airborne radio from a ground control station located beyond direct radio range.

The complete system consists of four primary elements:

1. **The RADIUS nPoint and onboard aviation radio**

   Installed on the aircraft, the nPoint connects directly to the aviation radio. It receives analog radio audio, converts it into IP data, and sends it across the aircraft's network connection. In the opposite direction, it converts audio received from the remote pilot into the analog signals required by the radio. The nPoint also exchanges control data with compatible radios, allowing supported radio functions to be operated remotely.

2. **The aircraft's IP connection**

   The aircraft provides the network path between the nPoint and the ground-based system. This connection may use satellite, cellular, terrestrial radio, or another IP transport appropriate for the aircraft and mission. The nPoint operates independently of the underlying transport and can therefore be integrated with an aircraft's existing communications architecture.

3. **The RADIUS Distribution Service**

   The Distribution Service manages the connections between the aircraft and authorized ground operators. It routes audio and control data, monitors connection status, and applies the user permissions and system configuration established for the operation. The Distribution Service can be hosted by SyTech or deployed within the operator's own network environment.

4. **The RADIUS Client and Virtual Control Head**

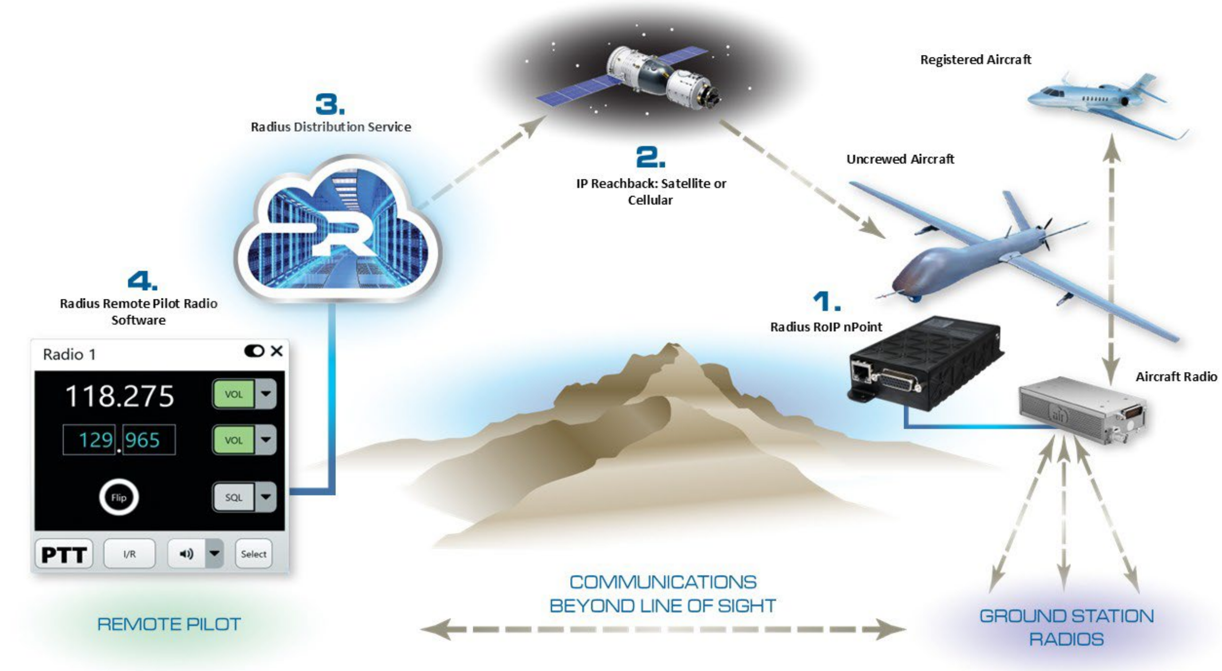
   At the ground control station, the remote pilot accesses the airborne radio through the RADIUS Client. The software provides push-to-talk, received audio, radio status, and a Virtual Control Head for supported radio functions. Depending on the connected radio, the pilot can enter and change frequencies, switch between primary and secondary channels, adjust volume and squelch, and review recent radio traffic.

When the aircraft receives a transmission, the onboard radio passes the audio to the nPoint. The nPoint digitizes and compresses the audio, then sends it through the aircraft's IP connection to the Distribution Service. The Distribution Service routes the audio to the remote pilot's RADIUS Client.

The return path operates in the same manner. When the remote pilot activates push-to-talk, the RADIUS Client sends the pilot's audio through the Distribution Service and across the aircraft's IP connection. The nPoint converts the received data back into audio for transmission through the onboard aviation radio.

- The result is a continuous operational link between the remote pilot and the aircraft's radio. To air traffic control and other aircraft, the communication is transmitted and received by the airborne radio in the same manner as a conventional piloted aircraft.

  The image below illustrates the four primary subsystems of the SyTech RADIUS nPoint BVLOS system.



End-to-End System Architecture

The RADIUS nPoint architecture connects the aircraft's aviation radio to one or more authorized operators without requiring a direct radio-frequency link between the aircraft and the ground control station. The aircraft and operator communicate through the RADIUS Distribution Service, which provides a common connection point for audio, radio control, and system status.

On the aircraft, the nPoint connects to the aviation radio through a radio-specific interface. This connection carries transmit and receive audio, push-to-talk signaling, and supported radio-control data. The nPoint also connects to the aircraft's onboard IP network, allowing it to use the network transport already available to the aircraft.

When powered, the nPoint establishes a secure, TLS 1.3 encrypted connection with the configured Distribution Service. The system uses keep-alive messages to monitor the connection and report whether the airborne equipment is available. Because the nPoint initiates the connection, it can operate across most conventional IP networks without requiring the aircraft to maintain a publicly accessible IP address.

The remote pilot's RADIUS Client establishes a separate connection with the same Distribution Service. After the user signs in, the Distribution Service applies the appropriate permissions and makes the assigned airborne radio available through the Client. The pilot can then monitor received audio, activate push-to-talk, and operate the supported functions presented through the Virtual Control Head.

The architecture carries three related types of information:

- Radio audio: Voice communications transmitted between the remote pilot and the onboard aviation radio.
- Radio control: Commands used to operate supported functions such as frequency selection, channel changes, volume, and squelch.
- System status: Information used to indicate network connectivity, radio state, and the availability of the airborne equipment.

Separating the operator, aircraft equipment, and network transport allows each part of the system to be deployed according to the mission. The remote pilot may operate from a fixed ground control station, a mobile command location, or another authorized site with network access. The Distribution Service may be hosted by SyTech or deployed within the operator's own infrastructure, while the aircraft may use whichever suitable IP transport is available for the flight.

Operation Across IP Networks

The RADIUS nPoint does not depend on a specific satellite provider, cellular carrier, or terrestrial network. It transports audio and radio-control data over a suitable IP connection, allowing the aircraft operator to select the network technology that best supports the aircraft, operating area, and mission.

Common transport options include:

- Satellite communications: Provides wide-area coverage for operations over remote regions, oceans, and other locations beyond terrestrial network coverage. Available options include low-Earth-orbit broadband services such as Starlink and lower-bandwidth satellite services such as Iridium.

- Cellular communications: Provides a relatively low-cost, low-latency connection where reliable cellular coverage is available. Cellular service may be appropriate for testing, populated operating areas, and missions conducted within established coverage zones.
- Terrestrial radio networks: Private mesh radios and other IP-capable data links can connect the aircraft directly to a ground network without relying on public cellular or satellite infrastructure.
- Combined network architectures: Aircraft may carry multiple communications systems to support different phases of flight, operating areas, or levels of redundancy.

Because the nPoint operates at the IP layer, the same airborne radio interface and ground-control software can be used as the underlying network changes. The aircraft may communicate through Starlink during one mission, an Iridium terminal during another, or a terrestrial data radio when operating within range of the ground network. This allows the operator to select the transport independently of the aviation-radio system.

The selected network directly affects communication performance. Available bandwidth, latency, jitter, packet loss, coverage, and interruptions in service can influence how quickly audio arrives and how naturally it is heard by the operator. A broadband connection may provide low latency and substantial capacity, while a narrowband satellite link may require tighter control over bandwidth and additional buffering to maintain intelligible audio.

The RADIUS nPoint system is designed to minimize the amount of network capacity required for voice communications. This allows radio audio and control data to share the aircraft's IP connection with command-and-control, telemetry, or payload traffic without requiring a dedicated broadband link solely for aviation communications.

SyTech nPoint – Power Selection and Input

Network selection remains an aircraft and mission-level decision. The RADIUS architecture allows the communications system to operate across the chosen transport while preserving a consistent radio interface for the remote pilot.

Remote Radio Control and Frequency Management

Relaying radio audio is only part of the requirement for BVLOS aviation communications. The remote pilot must also be able to operate the radio as the aircraft moves between frequencies, air traffic control sectors, airports, and mission areas.

The RADIUS nPoint exchanges control data with compatible aviation radios through the radio's supported control interface. This connection allows the current radio state to be transmitted to the RADIUS Client and allows commands from the remote pilot to be applied to the airborne radio.

The RADIUS Virtual Control Head presents the supported radio functions through the pilot's ground-control workstation. Depending on the connected radio, these functions may include:

- Viewing the active and standby frequencies
- Entering a new frequency
- Switching the standby frequency to active
- Monitoring two channels
- Adjusting volume and squelch
- Activating push-to-talk
- Reviewing recently received radio traffic

Virtual Control Head for Air Avionics AC-1

During flight, the pilot can enter a new frequency into the standby position while continuing to monitor and communicate on the active frequency. When directed by air traffic control, the pilot promotes the standby frequency to active through the Virtual Control Head. The command is sent through the Distribution Service to the nPoint, which applies the change to the airborne radio. The updated radio state is then returned to the Client and displayed to the pilot.

For radios that support dual-watch operation, the pilot can monitor traffic on both the active and standby frequencies. The system can identify which frequency is receiving audio and provide the pilot with control over how the available channels are monitored and selected.

The Virtual Control Head remains synchronized with the radio. Changes applied through the RADIUS Client are reflected at the airborne radio, while changes made through an attached physical control head can be reported back to the Client when supported by the radio interface.

This remote-control capability allows the aircraft's aviation radio to remain operationally useful throughout a BVLOS flight. The remote pilot is not limited to a frequency selected before takeoff and can respond to changing airspace and communication requirements while the aircraft is airborne.

Latency, Buffering, and Link Interruption

Aviation communications are time-sensitive. Excessive delay can disrupt the natural exchange between the remote pilot, air traffic control, and other aircraft. At the same time, an IP network rarely delivers every packet at perfectly uniform intervals. Satellite, cellular, and terrestrial links can introduce changes in latency, packet arrival time, and available bandwidth throughout a flight.

The RADIUS nPoint system balances these conditions by buffering a limited amount of received audio before playback. This buffer compensates for normal variations in packet arrival time and helps prevent speech from becoming broken or unintelligible. Increasing the buffer can improve audio continuity over an inconsistent network, but it also introduces additional delay. Reducing the buffer minimizes delay but leaves less protection against network jitter and temporary congestion.

SyTech nPoint – Ethernet and Radio Interface

The appropriate configuration therefore depends on the selected IP transport and its performance characteristics. A stable, low-latency broadband connection may require very little buffering. A narrowband or variable satellite connection may benefit from additional buffering to preserve intelligible audio. Buffer settings can be adjusted to balance responsiveness and continuity for the aircraft's operating environment.

The system also uses connection monitoring and keep-alive messages to determine whether the airborne nPoint, Distribution Service, and remote Client remain connected. Changes in connection status are reported to the operator so the availability of the radio path can be monitored during flight.

During a complete interruption of the IP link, live radio audio and control commands cannot pass between the aircraft and the remote pilot. The onboard aviation radio remains powered and tuned to its last commanded settings, while the nPoint continues attempting to restore its connection to the Distribution Service. Once the IP path becomes available again, the system reestablishes the session and resumes the exchange of audio, control, and status information without requiring the airborne equipment to be manually restarted.

No radio-over-IP system can eliminate delay or compensate indefinitely for the loss of its underlying network. Reliable BVLOS communications therefore depend on both the nPoint system and an IP architecture appropriate for the mission. By minimizing bandwidth requirements, providing configurable buffering, and automatically recovering its network connection, the RADIUS nPoint helps preserve usable aviation-radio communications across the variable conditions encountered during BVLOS flight.

Size, Weight, Power, and Aircraft Integration

Uncrewed aircraft have limited capacity for additional communications equipment. Any BVLOS radio solution must fit within the aircraft's available payload space, remain within its weight and power budgets, and integrate without unnecessarily disrupting the existing avionics architecture.

The RADIUS nPoint measures 28 mm high, 63 mm wide, and 133 mm long and weighs 185 grams. It can be powered through a 5 V USB-C connection or an 11–30 VDC aircraft power source. The nPoint consumes approximately 3 watts during normal operation, with a peak consumption of 7.5 watts.

When paired with the AIR AVIONICS AC-1 aviation radio, the complete airborne radio package remains compact and lightweight. The AC-1 measures 60 mm high, 63 mm wide, and 160 mm long and weighs 365 grams. Together, the nPoint and AC-1 weigh approximately 427 grams, excluding cables, antenna, and the aircraft's IP-network equipment. The combined configuration operates from 11–30 VDC and consumes approximately 5 watts nominally and 24 watts during radio transmission.

The nPoint connects to three primary aircraft resources:

Power: The unit operates from the aircraft's available DC electrical system using an appropriate regulated power connection.

Network: An Ethernet connection links the nPoint to the aircraft's satellite terminal, cellular modem, terrestrial data radio, network switch, or other IP equipment.

Aviation radio: A radio-specific interface carries transmit and receive audio, push-to-talk signaling, and supported radio-control data between the nPoint and the onboard radio.

The nPoint can be integrated with the AC-1 or with another supported radio selected for the aircraft and mission. This allows the operator to choose an aviation radio based on factors such as frequency coverage, transmit power, certification requirements, environmental specifications, and available installation space.

Air Avionics AC-1 VHF Radio

Antenna selection and placement remain important parts of the aircraft installation. The aviation radio requires a suitable VHF antenna with adequate separation from other transmitters and electronic equipment. The installer must also account for cable routing, grounding, electromagnetic compatibility, cooling, and access for inspection or maintenance.

Because the nPoint uses the aircraft's existing IP connection, it does not require a separate communications network solely for radio audio. This reduces the amount of additional airborne equipment and allows the aviation-radio capability to be incorporated into the aircraft's broader command, control, and communications architecture.

Final integration requirements depend on the aircraft, aviation radio, network transport, and intended operation. SyTech can work with the aircraft manufacturer or system integrator to define the required interfaces, cable assemblies, power configuration, network settings, and ground-test procedures before flight testing.

Operational Use and Applications

Deployed by the U.S. Navy in 2022, the RADIUS nPoint extends radio communications and control over IP networks for several long-range UAS configurations conducting intelligence, surveillance, and reconnaissance (ISR). This operational use demonstrates the system's ability to connect geographically separated operators with remote radio equipment through a deployable, network-based architecture.

The Platform Aero Vanilla: U.S. Navy Long-Range UAS

The RADIUS nPoint flew in 2023 under an FAA BVLOS waiver, demonstrating the system's ability to support authorized long-range uncrewed operations under current BVLOS requirements.

For uncrewed aircraft operations, the same architecture places the radio aboard the aircraft while allowing the remote pilot to operate it from the ground. The pilot communicates through the airborne radio rather than relying on a separate ground-based VHF station or chase aircraft located within radio range of the operating area.

This capability can support a range of BVLOS missions, including:

Cargo and logistics operations: Maintaining aviation-band communications as uncrewed cargo aircraft travel between airports or through controlled airspace.

Military operations: Extending airborne radio access to pilots and mission personnel operating from remote command locations.

Public-safety missions: Supporting uncrewed aircraft used for emergency response, disaster assessment, search and rescue, and operations over large or inaccessible areas.

Infrastructure and environmental monitoring: Providing radio communications during long-range inspection, mapping, surveillance, and research flights.

Remote and maritime operations: Supporting aircraft operating over oceans, Arctic regions, islands, and other areas where terrestrial communications infrastructure is limited.

Flight testing and aircraft development: Allowing manufacturers and integrators to incorporate remotely controlled aviation communications into experimental and production uncrewed aircraft.

The nPoint may also be used outside an aircraft. The same radio-to-IP architecture can extend a radio located at a tower, command post, vehicle, ship, or remote operating site to authorized users elsewhere on the network. This allows aircraft operators to use a common RADIUS environment for both airborne and ground-based radio assets.

Each deployment is configured around the aircraft, radio, IP transport, operating environment, and mission requirements. The modular architecture allows operators to begin with a single aircraft and ground-control station, then add additional aircraft, radios, pilots, or operating locations as the program expands.

Deployment Options and Next Steps

The RADIUS nPoint system can be deployed through a SyTech-hosted Distribution Service or within the operator's own network environment. The appropriate configuration depends on the program's security requirements, network architecture, number of aircraft, operating locations, and long-term support model.

A SyTech-hosted deployment provides access to the RADIUS Distribution Service through SyTech's cloud environment. This approach can simplify initial evaluation and deployment by reducing the amount of server infrastructure the operator must install and maintain.

For programs that require direct control of the supporting infrastructure, the Distribution Service can be installed on premises or within a customer-managed cloud environment. This allows the operator to manage network access, user accounts, security certificates, system configuration, and connections to other operational systems.

A typical integration effort progresses through several stages:

Requirements review: Identify the aircraft, aviation radio, IP transport, antenna configuration, ground-control environment, and required radio functions.

Bench evaluation: Connect the nPoint, radio, Distribution Service, and RADIUS Client in a controlled environment to verify audio, push-to-talk, remote frequency control, and network performance.

Aircraft integration: Install the airborne equipment and complete the required power, network, radio, antenna, and mechanical connections.

Ground testing: Verify radio operation, audio quality, control functions, network recovery, and compatibility with the aircraft's other systems.

Radius nPoint (top) with AC-1 Radio (bottom)

Flight testing: Evaluate performance under representative operating conditions before progressing to longer-range or operational BVLOS flights.

Operational deployment: Establish the final user permissions, system configuration, support procedures, and network architecture for routine operations.

An evaluation system can be used to demonstrate the end-to-end capability and collect performance data over the operator's intended IP network before a permanent aircraft installation is finalized. SyTech can support the evaluation remotely or work with the aircraft manufacturer, integrator, and operator during bench testing and aircraft integration.

By extending the aircraft's existing aviation radio through its existing IP connection, the RADIUS nPoint provides remote pilots with two-way voice communications and radio control beyond direct radio range. Its transport-independent architecture allows the system to support different aircraft, networks, and missions while preserving a consistent operating interface for the remote pilot.