
WHITE PAPER

# IMPROVING PATIENT OUTCOMES THROUGH **IN-FLIGHT INTELLIGENT CONNECTIVITY**

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# FOREWORD BY DR. LEONARD WEISS

We have entered an era where we depend upon robust communication streams and connectivity to accomplish even menial tasks in our day-to-day work and personal lives. Embracing such technology is essential to performing mission-critical duties in transporting acutely ill and injured patients.

In the modern air medical industry, our mission is to bring the referral center directly to the patient at the point of illness or injury or shortly after that with rendezvous at a critical access facility. In addition to providing a full intensive care suite of advanced practitioners with specialized skills and equipment, we need to lead the way in transmitting essential multi-sourced data to provide enhanced visualization of patient diagnostics and treatments beyond what is currently achievable by voice-only description.

Whether initiating care on a ground scene, hospital inpatient location, or during en-route care in flight, we shall consistently strive to connect our crews and patients directly to medical oversight infrastructure consistently and dependably. This will allow for real-time interventional support while appropriately preparing specialty teams for patient arrival. Importantly, we will pave the way for future data-dependent technologies augmenting care through artificial intelligence and predictive modeling.

As we journey deep into 21st-century air medical care, our vision and culture should ultimately be driven by and contribute to improving our patients' outcomes and survival, a rigorous aviation standard, and imparting safety for both our patients and air medical crews.

Leonard Weiss, MD, FACEP, FAEMS
Assistant Professor of Emergency Medicine, University of Pittsburgh
Assistant Medical Director, STAT MedEvac

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# ABOUT DR. LEONARD WEISS

Dr. Weiss is an Assistant Professor in the Department of Emergency Medicine at the University of Pittsburgh School of Medicine. In the Division of Emergency Medical Services, he specializes in out of hospital care & medical transport. His passion for medicine started in Bloomington, IN, at IU where he trained & worked as an EMT earning cherished experience, friends and mentors. Dr. Weiss completed his residency & fellowship training at the University of Pittsburgh.

He is an attending emergency physician at Mercy Hospital, and serves as a flight physician and Assistant Medical Director for STAT MedEvac and medical command physician for UPMC Communications Center and Airline Consultation Service, STAT-MD. He serves as the Medical Director of City of Pittsburgh Police-SWAT, as well as Medical Director of Carnegie Mellon University EMS. His career is focused on EMS and combining technology, invention, public health and medicine.

# 1.0 A HISTORY OF AIR MEDICAL TRANSPORT

## The long-running 1970s TV show M*A*S*H helped the general public understand the value of helicopters in medicine.


**Figure 1.** M*A*S*H* opening credits scene.

The show's opening credits depicts a small helicopter, with injured soldiers strapped in baskets crudely fastened on each side, flying to a Mobile Army Surgical Hospital (MASH) located in close proximity to the battle zone.

These MASH units were a key innovation during the Korean War (1950-1953) which proved that fast treatment of severely injured soldiers could drastically decrease a war's death rate. Contrary to popular belief, however, the Korean War medevac helicopters were not the first to demonstrate the value of helicopter air ambulances.

**The first organized air ambulance was established in the rugged, remote territory of Saskatchewan, Canada by the provincial government in 1947.**

In the same year, the Schaefer Ambulance Company in Los Angeles added a helicopter to its fleet of medical transports. In the early couple of decades, air ambulances proved their value simply by getting a patient to medical facilities faster than ground-based ambulances, especially in crowded urban areas or from remote regions. In the 1980s, a military trauma surgeon Dr. R. Adams Crowley wrote extensively about the urgency of getting an injured person proper care, coining the timeframe as the Golden Hour. This concept has underpinned the rationale for helicopter air ambulances ever since. But in addition to the simple speed of transport, the inclusion of medical specialists and life support equipment in those helicopters has further improved patient survival rates.

Beyond merely transporting critically ill and injured to care facilities, air medical aircraft have evolved to rival intensive care units to provide complex life support using state-of-the-art medical equipment including onboard ventilators, defibrillators, medication pumps, and echocardiograms. Dedicated to childrens' hospitals, some air ambulances are specially outfitted with neonatal incubators, ventilators, and other critical equipment needed to safely transport infants. Providing such care requires skilled medical professionals to provide immediate treatment to the patient starting either at an emergency scene or critical access hospital, through to arrival at an advanced medical or trauma center.

## Why are air ambulances important?

**Today, 45% of the world's population still lives in rural regions where access to critical treatment via a ground ambulance during a case of an emergency would take hours.**

This means that 3.4 billion people globally would have a better chance of surviving with air medical services in the case of a health emergency. Air ambulances teams are often trained to a higher level and carry more advanced equipment than traditional ground units which can improve patient survivability. However, the transfer of critically ill patients is still one of the riskiest phases of care. Air ambulance services require innovations to improve their operations to ultimately provide more effective patient care and outcomes.

# 2.0 CHALLENGES TO IN-FLIGHT PATIENT CARE

An air medical aircraft usually has one or two medical crew and a pilot (in many European countries two pilots are mandatory for air ambulances). Studies reflect that trauma patients transported by an air ambulance are more likely to survive when the air medical crew has advanced critical care training than standard paramedic crews. Some providers support the crew with a transport physician present either physically or virtually to ensure that the crew has any immediate supplemental expertise.

## What is a transport physican, and why are they important?

When the call for help is received, a transport physician often determines the type of care the patient needs, the time-sensitivity of their injury or illness, and the capabilities and capacity of the receiving hospital.

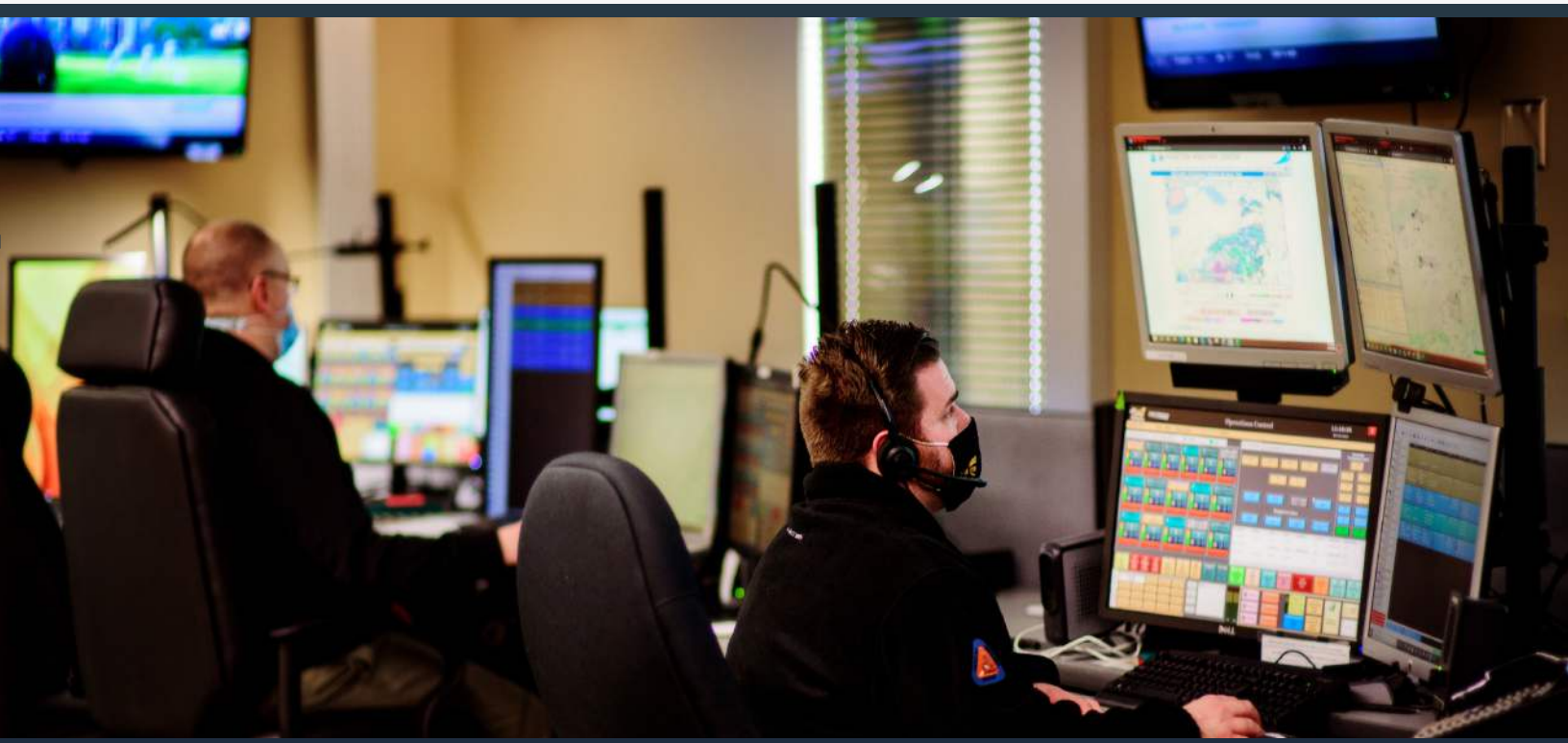
Transport physicians provide consultation to local health centers and Emergency Medical Services (EMS) to stabilize patients for transport to an appropriate referral facility. Transport physicians support the air medical crew's patient care by phone or radio. Depending on circumstances, the transport physician may travel with the patient, providing an even higher level of medical support during the flight.

However, it is not possible to have the transport physician onboard for all missions, so communication via radio or phone is utilized so guidance can be provided to the on-board medical crew.

The quality of help the transport physician can provide is mediated by several factors such as the crew's communication abilities during a high-stress situation, potential human error, dynamic patient status and vitals, and lastly, depending on the location of the mission, lack of connectivity to carry out radio or phone communication.

Air ambulances are often used in these remote regions as no other means of transport can quickly arrive at the scene. In addition to traditionally rural locations, outlying areas may include industrial sites, forestry operations, First Nation communities, and marine environments.
Ultimately, patient care during times with no onboard connectivity can be detrimentally impacted without the potential life-saving expertise of transport physicians or the preparation of advanced medical centers to receive the patient.

"To address these significant challenges of critical medical and trauma care in remote or austere locations, air ambulance operators can implement intelligent connectivity solutions to remain in contact with the transport physician."




# 3.0 HOW CONNECTIVITY CAN SAVE LIVES

Traditionally, transport physicians and receiving hospitals can only be present via phone or radio, limiting their impact on patient care. SKYTRAC's intelligent connectivity solutions enable in-flight, real-time telemedicine which transmits medical data to physicians at a destination hospital to address the limitation of verbally communicating patient metrics.

## What is Medical Data Transfer?

Air medical crews monitor patient vitals such as oxygen saturation, carbon dioxide output, heart rate, ECG, and blood pressure data with onboard medical devices. Rather than verbally communicating this data to the remote transport physician or receiving hospitals, medical data transfer capability enables patient vitals to be directly transmitted.

Patient data is transmitted through satellite, cellular, or Wi-Fi radios in real-time, enabling remote transport physicians and receiving care teams to see the latest patient data. With this capability, the air medical crew are relieved of the task to communicate patient vitals, freeing them to focus on patient care and comfort. At the same time, transport physicians receiving objective and accurate patient data can make better inferences in relation to changing patient conditions. This real-time data transmission enables transport physicians to analyze a patient's status and make recommendations quickly during critical situations where every second is crucial.

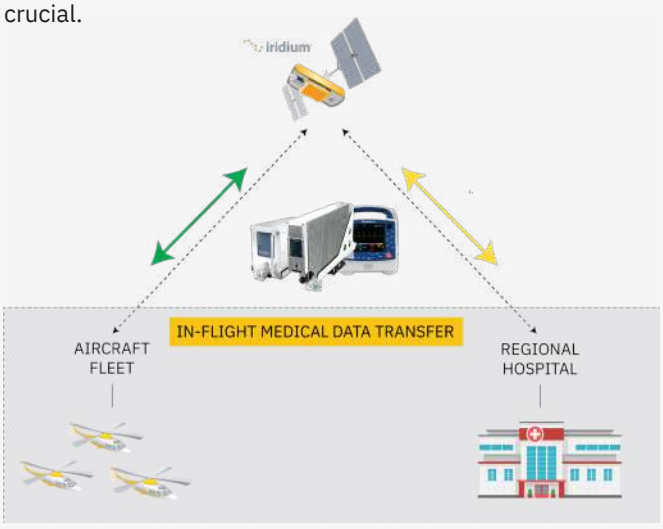



**Figure 2.** Transmission of medical data through LEO (Iridium) network.


SKYTRAC's medical data transfer capability is dynamic, which means it utilizes a unique mix of satellite, cellular, and Wi-Fi connectivity. Having multiple pipelines for offloading data provides redundancy to ensure that even during very remote operations, air medical crew remain connected to transport physicians.

## How does Medical Data Transfer Work?

SKYTRAC's medical data transfer capability requires two critical pieces of onboard hardware –SKYTRAC's Dynamic Air Link 200 (DAL-200) and SKYTRAC's ISAT-200A. First, the onboard monitors capture patient vitals such as oxygen saturation, carbon dioxide output, pulse rate, and blood pressure. This device is configured to connect to an onboard Wi-Fi network enabled by SKYTRAC's DAL-200.

The DAL-200 allows the monitor and other equipment to transmit data when cellular connectivity is available. When cellular connectivity is not available, the DAL-200 dynamically switches from cellular connectivity to satellite. At this point, SKYTRAC's ISAT-200A encrypts and transmits medical data securely to transport physicians and receiving facilities.

By meeting HL7 and DICOM standards, SKYTRAC's intelligent connectivity solution ensures that patient data meets the standard for transporting electronic health information. SKYTRAC also leverages 256-bit encryption and cybersecurity best practices to ensure patient data security. By utilizing Iridium's global satellite network, SKYTRAC ensures the air ambulance is connected to the transport physician and receiving hospitals anywhere on the globe.


**Figure 3.** Critical components to enable onboard medical data transfer.


# 4.0 SKYTRAC INTELLIGENT CONNECTIVITY

**SKYTRAC's suite of satellite, cellular, and Wi-Fi connectivity solutions provides assured communications for remote and urban operators alike.**

Remote operators will likely need to rely on satellite communications where cellular isn't available, whereas operators in urban centers will rely more heavily on robust cellular networks, all being managed by SKYTRAC's intelligent connectivity.

## SKYTRAC Low Earth Orbit (LEO) Satellite Connectivity

SKYTRAC is aviation's platform of choice for intelligent connectivity solutions, which includes the world's only truly pole-to-pole satellite network, Iridium. With the Iridium Certus service, operators can leverage up to 704 Kbps of efficient low latency bandwidth.

SKYTRAC offers a variety of solutions that can leverage the Iridium network, including the narrowband ISAT-200A, the midband DLS-100, and the broadband SDL-350 and IMS-350.

## SKYTRAC Narrowband Connectivity

SKYTRAC's ISAT-200A is a unique, all-in-one platform designed for fixed-wing and rotor-wing aircraft. Operating on the Iridium satellite network, the ISAT-200A supports **2.4 Kbps** of bidirectional bandwidth.

Its flight data acquisition capabilities enable operators to satisfy flight following and FOQA/MOQA requirements cost-effectively, as well as voice, text, and Satellite PTT communications.

## SKYTRAC Midband Connectivity

SKYTRAC's compact DLS-100 is the smallest midband Satcom transceiver enabling command and control, telemetry streaming, and GPS connectivity for both manned and unmanned aviation.

It's lightweight, slim profile make it ideal for smaller airframes and UAVs seeking global connectivity. The ruggedized, IP67 compliant modem ensures worry-free connectivity under any weather conditions and supports up to **88 Kbps** of bandwidth.

## SKYTRAC Broadband Connectivity

SKYTRAC's flagship SDL-350 satellite transceiver with on-board server harnesses the world's only true pole-to-pole satellite network, allowing operators 99.9% global uptime.

This reliability allows mission-critical operations in EMS, SAR, offshore oil and gas, business aviation, scientific exploration, military, and airline industries to perform when the mission gets tough. The SDL-350 meets all current requirements, provides advanced capabilities, and **352/704 Kbps** to and from the aircraft.

# Globally Available Cellular

Besides providing global satellite connectivity as an Iridium partner, SKYTRAC also offers global, roaming-free 4G/LTE cellular coverage in over 190 countries. In 2019, SKYTRAC partnered with GigSky to provide the aviation industry with mission-critical data through high-speed cellular connectivity.

SKYTRAC cellular connectivity provides up to 50 Mbps download and up to 10 Mbps upload speeds with cost-effective data plans for their entire enterprise. Beyond medical data transfers, users can expect to leverage downloading for FDM/FOQA and HUMS data, automatic updates to Electronic Flight Bags (EFB) with flight plans and charts, weather to the cockpit services, VIP cabin connectivity, and much more.

SKYTRAC cellular connectivity capability offers users secure, convenient access to data, protecting users from unnecessary threats with public Wi-Fi and secure, customizable VPN connectivity to enterprise services for strict cybersecurity policies.

### Enabling Systems

To enable onboard cellular connectivity, operators can extend the ISAT-200A's capabilities with SKYTRAC's DAL-200 which can link up to 8 Wi-Fi or Bluetooth-enabled devices to ground-based cellular networks. The SKYTRAC cellular data solution is available as a built-in capability on the SDL-350 and does not require the DAL-200.

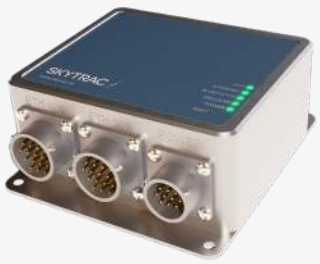



**Figure 4.** SKYTRAC's wireless Dynamic Air Link (DAL-200).

# In-Flight Wi-Fi and Postflight Data Offloading

In addition to enabling in-flight 4G LTE cellular connectivity, SKYTRAC also provides wireless in-flight and post-flight connectivity. SKYTRAC's wireless communication and a data download solution allows for multiple network types besides 4G/LTE, including Bluetooth, Ethernet, Wi-Fi, and optional POTS connectivity with an external cellular/Wi-Fi antenna.

Leveraging post-flight automated data offloading capacity, operators can digitize paper-based reporting, speed up processing times, and improve the accuracy of essential reporting processes. With post-flight automated data offloading capacity, fixed-wing and rotary aircraft operators can reduce costs and AOG times.

**Enabling Systems**

The ISAT-200A coupled with the DAL-200 supports up to eight simultaneous Wi-Fi connections and links any Wi-Fi device to ground-based WiFi networks for the cockpit, cabin crew, and passengers. SKYTRAC's SDl-350 also enables inflight Wi-Fi and postflight data offloading without the need for the DAL-200.

SKYTRAC's all-in-one solution for cellular, Wi-Fi, and satellite connectivity simplifies the sourcing and integration of various vendors' multiple connectivity, hardware, and software solutions. Operators can eliminate multiple invoices, overages, policies, and more, to enable enterprise-wide connectivity.


**Figure 5.** SKYTRAC pipelines for data offloading.

# Additional Capabilities

SKYTRAC is a global leader in intelligent connectivity and truly global satellite communications. We are the leading provider of satellite communications for the air medical industry, enabling powerful mission-critical capabilities on fixed-wing and rotorcraft airframe types. Our satellite communications terminals empower air medical operators to allow various services to boost operational efficiencies from the operational control center to onboard crews and pilots.

With our all-in-one satellite communications terminals, we can enable other capabilities for air medical operators beyond medical data transfer with no additional hardware required. These include:

## AUTOMATED FLIGHT FOLLOWING (AFF) AND MISSION MONITORING

SKYTRAC's Flight Following and Mission Monitoring platform, TrooTrax Mission, combines flight planning, flight following, and mission monitoring with weather assessment. The platform enables operators to chart real-time flight paths for an unlimited number of aircraft, set flight corridors, add custom geo-references, monitor flight plan deviations, and more. With over a hundred user adjustable viewing options, operators can customize TrooTrax Mission to suit their requirements.

**Figure 6.** SKYTRAC's TrooTrax flight following and mission monitoring platform.

Offering 63 current and forecast FAA-NOAA and Barn Aviation Weather layers with near real-time weather insights en route, TrooTrax Mission increases dispatch teams situational awareness and ability to safely reroute aircraft through weather events. With the Mission mobile app, TrooTrax enables notifications on iPads, iPhones, or Android devices for operators to act on critical events with full app to aircraft messaging. Coupled with the operator's choice of tracking device, TrooTrax fulfils the flight following requirements of Part 135.

## FLIGHT DATA MONITORING

SKYTRAC's leading FDM program, SAFR, is a web-based platform providing complete insight into flight operations. While the SAFR FDM Essentials is built for organizations with in-house flight data analysts, providing everything required to run an effective FDM program with no IT configuration, SAFR FDM Plus provides dedicated analyst services and a program manager. Implementing either provides operators with a 360 and real-time view of all flights, flight paths, and flight operations.

Operators can also review and replay all 2D and 3D playback flights with live instrument controls. Users can configure parameters to identify high-risk events and categorize exceedances to view the most relevant data.

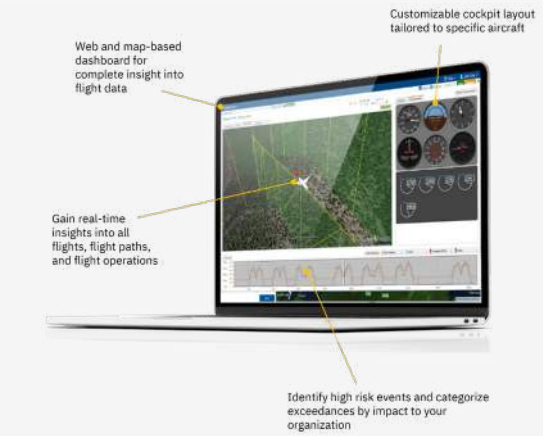



**Figure 7.** SKYTRAC's SAFR flight data monitoring platform.

SKYTRAC's FDM program provides users with deep data insights with interactive reporting. SAFR FDM also enables operators to reduce costs on aircraft maintenance, insurance, and manual offloading of data.

## VOICE, TEXT, AND SATELLITE PUSH-T0-TALK COMMUNICATIONS

SKYTRAC's Iridium Push-to-Talk solution combines fast, simple, and secure group communications with the power of trusted voice-talk hardware. SKYTRAC can connect air and ground assets globally and under all conditions with voice, text, and satellite PTT. Utilizing Iridium's satellite network, operators can gain crystal clear sounds with less than 2 seconds of latency and ensure communications are immune to natural disasters.

Operators can enable global group communications at a mere push of a button without the need for land-based radio towers. Communications are secure with military-grade AES 256-bit encryption. Pilots can call and message in-air using a mobile phone or tablet with this capability. Pilots can also leverage quick message and speed dial capabilities with cockpit display panels and dispatch voice interface for seamless, easy-to-use functionality. Push-to-Talk is ideal for EMS, SAR, Military, Humanitarian, and Oil and Gas operators.

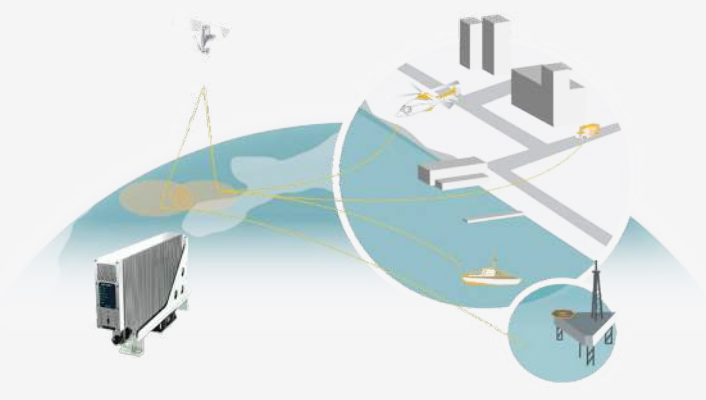


**Figure 8.** Real-time talk group with Push-To-Talk solution.


## REAL-TIME HEALTH AND USAGE MONITORING (HUMS) ALERTING

SKYRAC's real-time HUMS alerting capability provides early warning notifications when in-flight exceedances are detected. This capability allows operators to monitor HUMS parameters in real-time and alert ground crews automatically with critical details such as exceedance type, location, time, and severity of the detected exceedance.

Real-time HUMS data can also be wirelessly transferred to ground stations through Wi-Fi or cellular networks. Insight in HUMS data allows operators to plan for parts and repairs to reduce costly and unnecessary turnaround and unscheduled maintenance downtimes.

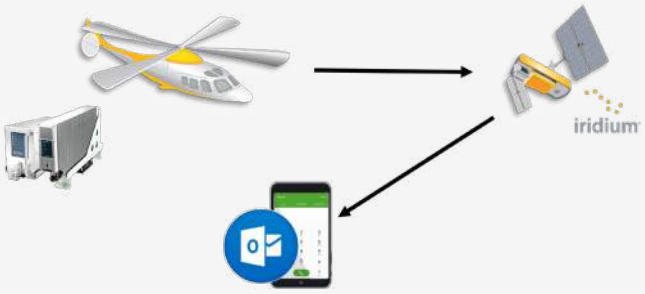



**Figure 9.** Real-time in-flight exceedance detecting and alerting.

## ELECTRONIC FLIGHT BAG (EFB) AUTOMATION

With EFB Automation, operators can automate essential reporting processes in the air and on the ground. The automation allows digitized reporting of the paper-based reporting processes, speeds up processing times, and improves data accuracy.

SKYTRAC offers the only EFB solution that auto-populates existing document management systems with objective data from the aircraft, such as fuel burn rates, takeoff, landing, and engine times. SKYTRAC Satcom terminals feature robust data acquisition capabilities for digital and analog interfaces to auto-populate engine data. The reports are customizable based on flight operations and allow for digital signing and submission of information back to headquarters.


**Figure 10.** EFB automation digitizing reports and journey logs.


## LIVE VIDEO AND DATA STREAMING

SKYTRAC broadband Satcom connectivity provides up to 704 Kbps of broadband data throughput, enabling the transfer of large data files and streaming compressed, optimized video in real-time. Operators can save on costs by compressing and optimizing video and data files. Operators can leverage this capability globally and with 99.9% uptime reliability even during natural disasters and severe weather events.

**SKYTRAC Video Streaming with Iridium Certus**

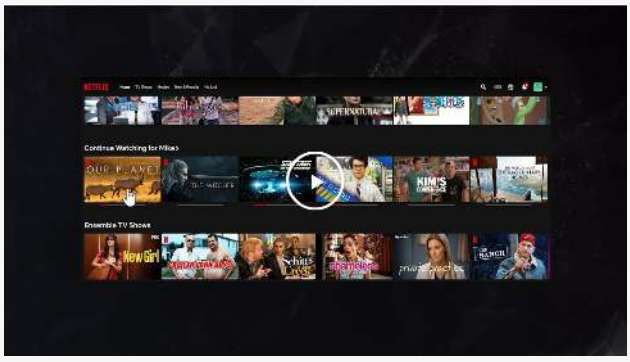


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**Table 1.** SKYTRAC Satcom solutions for broadband, midband, and narrowband LEO Satcom.

| **BROADBAND SATCOM** (capable of up to 704 Kbps of truly global connectivity) | | |
|---|---|---|
| **SDL-350** | **Capabilities** | **Interfaces** |
|  | Live HD Video and Data Streaming<br>Server with VM and AI-based Application Support<br>Safety Services (FANS 1/A)<br>Satellite Push-to-Talk (PTT)<br>Real-Time Alerting, Monitoring, and Weather<br>Aircraft Tracking and Monitoring<br>Electronic Flight Bag Automation<br>Wi-Fi and Cellular Connectivity | GPS/GNSS<br>Audio Interfaces<br>Ethernet Interfaces<br>ARINC 429 Tx/Rx Interfaces<br>RS-232/485 Serial Interfaces<br>Discrete I/O Interfaces |
| **IMS-350** | | |
|  | Live HD Video and Data Streaming<br>Beyond Line of Sight Communications (BLOS)<br>Real-Time Command and Control (C2)<br>Unmanned Traffic Management and Remote ID<br>Server with VM and AI-based Application Support<br>Real-Time Alerting, Monitoring, and Weather<br>Aircraft Tracking and Monitoring<br>Wi-Fi and Cellular Connectivity | GPS/GNSS<br>Ethernet Interfaces<br>ARINC 429 Tx/Rx<br>ARINC 717 Rx<br>RS-232/485 |
| **MIDBAND SATCOM** (capable of up to 88 Kbps of truly global connectivity) | | |
| **DLS-100** | | |
|  | Live Photo and Data Streaming<br>Beyond Line of Sight Communications (BLOS)<br>Real-Time Command and Control (C2)<br>UAS and Payload Health Monitoring<br>Unmanned Traffic Management and Remote ID<br>Aircraft Tracking and Monitoring<br>Wi-Fi Connectivity | DB25 Custom Pin-Out<br>100BASE-T Ethernet<br>RS-232<br>SMA for Wi-Fi and GPS<br>TNC for Iridium |
| **NARROWBAND SATCOM** (capable of up to 2.4 Kbps of truly global connectivity) | | |
| **ISAT-200A-07** | | |
|  | Live Data Streaming<br>Server with VM<br>Satellite Push-to-Talk (PTT)<br>Real-Time Alerting, Monitoring, and Weather<br>Aircraft Tracking and Monitoring<br>Electronic Flight Bag Automation<br>Optional Wi-Fi and Cellular Connectivity | GPS/GNSS<br>Audio Interfaces<br>Ethernet Interfaces<br>ARINC 429 Tx/Rx Interfaces<br>ARINC-717 Rx Interfaces<br>RS-232/485/422 Serial Interfaces<br>Discrete I/O Interfaces |

# 5.0 CONCLUSION

## Air medical operators require expertise and technology to provide the best possible care.

For transport physicians to support air medical crews, operators are encouraged to equip their air ambulances with SKYTRAC's intelligent connectivity solutions. By utilizing SKYTRAC's intelligent connectivity solutions, patient data can be transmitted to the transport physician so they can provide suggestions based on accurate data. SKYTRAC's intelligent connectivity offers air medical operators a solution to support their air medical crews by enabling real-time support from physicians and medical teams on the ground.

Besides remaining connected with the transport physicians, utilizing SKYTRAC's medical data transfer capability sends real-time patient data to receiving hospital centers. With the visibility of patient data, receiving hospital centers are equipped with the information they need to prepare for each patient's unique condition and needs, reducing life-saving minutes for critical conditions. Equipped with the unique mix of satellite, cellular, and Wi-Fi connectivity, air medical crews, can fly in remote and rugged terrain, remaining connected with the operational control center, transport physicians, and the receiving hospital.

Whether it is leveraging the virtual presence of the transport physician, ensuring receiving hospitals remain up to date on the patient's condition, or connectivity in remote regions, SKYTRAC's intelligent connectivity solution ultimately enables air medical operators to improve patient care.

Beyond medical data transfer, air medical operators can enable several other capabilities to enhance their operations by improving operational efficiencies and cost and better serving their communities.

**To learn more about how SKYTRAC's medical data transfer capability and connectivity solutions can improve your air medical operation, please contract a SKYTRAC Technical Expert at sales@skytrac.ca.**


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