

Skyhawk's Game Changing Portable Remote IoT(PRIoT) Connectivity Platform Services

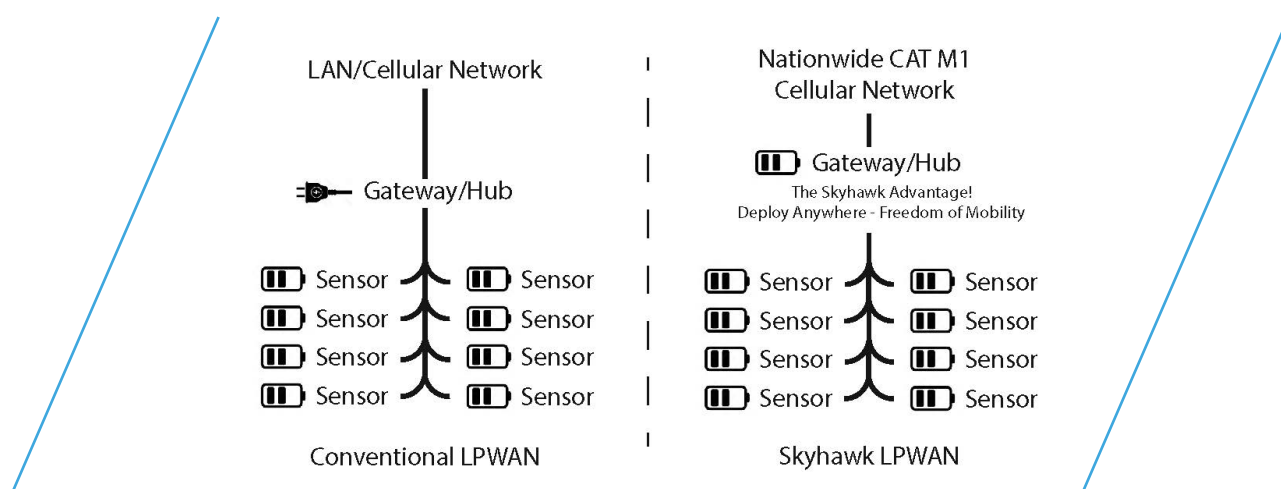
The Skyhawk PRIoT Platform enables reliable sensor monitoring using a local sub-GHz connection to battery operated gateways that are backhauled to the cloud via a specialized cellular based IoT(CBloT) connection. The system uniquely operates with no reliance on local power or other infrastructure. As we say, "No Power, No WiFi, No Problem." It lends itself to reliable portable, mobile, and remote IoT monitoring. It facilitates both an expanded set of IoT monitoring applications and simplifies deployment of existing applications.

Developing the Skyhawk PRIoT platform required tight integration of multiple design skills and a custom OS bridging sensors, gateways, servers and applications. The Skyhawk PRIoT platform will be uniquely useful for various consumer, commercial, industrial and transportation applications.

/ Long Battery Life, Technology Overview /

The platform leverages advanced CBloT connectivity technology launched by the major mobile network operators (MNOs) starting in 2017. It is technically considered an early subset of 5G but with ubiquitous coverage in North America and most worldwide locations. It is a separate development branch from the wideband, highspeed 5G familiar to most people. Due to its lower bandwidth requirements, CBloT signals have enhanced range and coverage as compared to conventional cellular signals. It has two primary subsets, Cat M1 and NB IoT. Each of these can be deployed in various modes and optimized for various applications. Cat M1 is better suited for mobile applications.

Long battery life is achieved by optimizing various design features, the most challenging being minimizing both receiving and transmitting RF duty cycles. In a typical LPWAN IoT sensor deployment, minimizing receiver on-time is a requirement for the sensors only, which are the end nodes of the network that initiate RF transactions. With conventional IoT platforms, the gateways are AC-powered with always on receivers. However, the Skyhawk system supports battery-operated gateways using our proprietary “Flocksense” technology.



The system is inherently portable and easy to deploy, being independent of local infrastructure. It requires no hardware pairing or security codes like Bluetooth or WiFi-based systems. All Skyhawk sensors can connect to all Skyhawk gateways and will self-learn and optimize connections in a process we refer to as “Reactive Pairing.” Skyhawk servers handle the proper processing and forwarding of messages to subscribed users and seamlessly coordinate message routing and deduplication if multiple gateways forward a sensor signal.

The Skyhawk system can support sensor-to-gateway ranges measured in kilometers under ideal circumstances but benefits greatly from the ability to economically place one or more gateways in locations that are optimized for local RF coverage. The untethered freedom of deployment for gateways offers significant RF coverage advantages. Local RF coverage is highly dependent upon local conditions and notorious for “nooks and crannies” that are devoid of longer-range sub-GHz signals. The flexibility to simply drop in low-cost, battery-operated gateways can readily improve coverage.

A typical gateway will operate on 3 AA batteries for 1-2 years and is readily scalable with additional batteries. Alternative power solutions permit indefinite deployments with the battery serving as a long-term backup. With certain limitations on signal counts, there is no practical limit on the number of sensors a gateway can monitor.

Gateways provide various levels of location accuracy with the simplest and coarsest location based on cell tower positioning. More precise, power-intensive location information is available on demand. This includes very precise outdoor GPS location or indoor WiFi-based positioning.

Various types of sensors can be deployed and monitored with the Skyhawk platform. Due to low communication energy requirements, sensor battery life is typically 5-10 years if coupled with low-power or low-duty cycle sensing. Skyhawk's communication protocol can be deployed in virtually any type of sensor that has limited data transfer requirements. Based on its 2-way communication protocol, remotely deployed sensors can be controlled.

Sensor signal types fit into three different categories. Alerts, Polls and Heartbeats.

- **Alerts** signals are processed and sent immediately. These are sent based on sensor thresholds being reached, such as low or high temperature limits or high magnitude accelerometer measurements.
- **Polling data** signals that are batch downloaded to generate an historical record of conditions, such as a temperature graph or vibration profile. This data is typically batched stored at the sensor level, then further batched at the gateway after which it is downloaded to the application software.

Signal schedules are developed based upon the needs of the application with RF transmissions being limited, both at the cellular and sub-GHz levels, to ensure long battery operation. The tradeoff is that routine historical data has latency, which typically averages a few hours. This contrasts with critical alert signals that are forwarded immediately.

- **Heartbeat** signals are used by the system to self-monitor. Users are notified if the signals are not received at a predetermined time interval.

/ Applications /

Application categories include:

- 1. High reliability and cost-effective monitoring of multiple sensors routed through one cellular IoT connection.**
- 2. Monitoring of mobile assets.**
- 3. Monitoring at remote locations without power or WiFi.**
- 4. Service provider, portable drop-in monitoring solutions that can be readily deployed and re-deployed.**

Skyhawk provides ultra reliable monitoring starting with the backhaul to a cellular network and no reliance on local power. MNO cellular provides the most dependable, commercially available connections available. They are proven and hardened to resist various natural disasters such as hurricanes and ice storms. The Skyhawk platform expands on that using a local sub-GHz RF connection with 2-way communication to confirm signal receipts and highly developed OS logic to ensure that sensor signals are reliably received.

Mobile assets are an ideal deployment for the Skyhawk platform. Various sensors can be deployed on vehicles such as tractor-trailers, train cars, shipping containers, or other assets to monitor for multiple events or conditions. Skyhawk's open sensor-to-hub RF connectivity standard permits cargo owners to deploy very low-cost sensor tags that would forward cargo information via the carrier's deployed Skyhawk gateway. There is no need for individual box cellular connections. Sensor signals also include coarse gateway-derived location information.

Marine centric applications are another focus of the Skyhawk platform. Like commercial transportation applications, these fit into two categories. First, a commercial operator at a marina, storage facility, or similar location can provide gateway connectivity, enabling customers to deploy marine application sensors on their private assets to monitor for various conditions or events. The second category is a complete on-board deployment, including the cellular backhauled gateway, by individual boat owners. This ensures connectivity and adds boat-level location technology enabling the boat to be precisely located on demand. The Skyhawk platform offers the unique advantage of not requiring the boat's battery as a power source thus avoiding what is commonly referred to as a "vampire drain".

The Skyhawk PRIoT platform was developed with multiple vertical uses in mind. It was first commercialized and proven in a particularly well-suited vertical application: the monitoring of rodent and live animal capture traps by pest control and nuisance wildlife control operators. This custom application of the Skyhawk platform reduces the need for often daily customer site visits in the case of live animal trapping or the labor-intensive activity of checking individual rodent traps, sometimes hundreds, at a given location. Experience with this application has proven out the local RF coverage advantages of an untethered battery-operated gateway, the system's reliability, and ease of deployment.

Backed by the PICA Group of companies the Skyhawk PRIoT platform is being commercially deployed into various applications, generally in partnerships with application focused companies. Customized software applications, API integrations, and custom hardware can be quickly and cost effectively developed by our multidiscipline team. Our global manufacturing resources enable the cost-effective production of both standard and custom hardware to support the requirements of various applications.