Enabling Worldwide Package Delivery with M2M

A Whitepaper on the Technical Considerations of Autonomous, Flight-enabled Wireless M2M Devices for End-to-End Air Cargo Tracking and Chain of Custody Applications

Introduction

In 2010, the air cargo industry will reach a record age of 100 years in the making since the first air cargo shipment made by the Wright brothers in 1910. Today, according to the International Air Trade Association (IATA), the global air cargo industry has grown to more than $40 billion and has become a major statistic to evaluate global economic trends[1]. Whether shipping consumer packaged goods or high-value, environmentally sensitive products like medications, harvested organs, or expensive art work, air travel has become a widely used method across the globe for fast delivery of critical assets. The question now is how to ensure that packages with valuable contents maintain their condition from departure to destination while in the air.

The machine-to-machine (M2M) communications industry has worked for more than a decade to provide shippers with devices capable of wirelessly tracking assets and monitoring their condition in order to improve chain of custody, service quality, claims management, and brand protection. So far, the majority of these devices are deployed for use on the ground, leaving shippers with chain of custody issues and lack of visibility regarding conditions that may occur in the air or at the airport. To solve this problem and make possible complete chain of custody and in-air visibility, the missing link is an M2M device capable of operating in a mode that is designed for autonomous air travel. In-air visibility provides shippers the confidence needed to know their cargo is in good condition across the entire supply chain.

This paper will explore the challenges that air travel presents as well as discuss the benefits of flight-enabled monitoring devices. Specific attention will be paid to overcoming technical challenges posed by the following factors:

- Battery drain in the air
- Lack of human intervention
- Unique aircrafts, flight patterns, and flight profiles
- Need for guaranteed operations

The solution to solving each of these technical challenges is embodied in the OnAsset SENTRY FlightSafe™ device. This patent-pending technology has been specifically designed to enable the first, redundant, multi-mode device with guaranteed operations for all forms of supply chain transit including air cargo transportation.

The benefit of flight-enabled M2M devices allows customers to have 24x7 visibility into the condition of their packages throughout the entire chain of custody. In addition, shippers and carriers are able to deploy a single M2M solution for operation across all modes of travel including land, sea, and air, making the logistics of managing hundreds of thousands of dynamic assets considerably easier and more cost effective.

[1] IATA (International Air Trade Association) www.iata.org

The following discussion of technical challenges for a flight-enabled M2M device is by no means exhaustive. The discussions here are designed to provide a high-level view of major considerations that impacted the design and development of the SENTRY FlightSafe unit. FlightSafe is a patent-pending, proprietary technology developed and manufactured by OnAsset Intelligence, Inc.

Challenges of In-Air Visibility

Imagine briefly the job of an individual responsible for assigning M2M devices to temperature sensitive medicines that are shipped daily, all over the world, to populated and remote areas, in packages designed to support refrigerated product viability for a limited amount of time. The individual must consider that the device will travel with the pharmaceutical package from start to finish, even during air travel, in order to provide their customer with a guarantee that the product fully maintained the required handling and environmental characteristics at all times from point of packing to point of delivery. There are currently thousands of different aircrafts and flight patterns that support the world-wide package delivery system, especially when considering travel to the most remote areas of the planet. This landscape, in addition to the fact that previous devices were not intelligent enough to adapt their behavior based on the mode of transport, has posed great challenges to flight-enabled M2M devices until the introduction of SENTRY FlightSafe™ technology.

SENTRY FlightSafe is the M2M industry's first wireless telemetry device with fully redundant, multi-mode aircraft detection that enables safe, guaranteed air cargo tracking. The development of the device was designed specifically to achieve the following operational benefits:

- Minimal power drain during flight
- No human intervention required to turn off transmitters
- Multiple, redundant modes of detection
- Standardized unit across all flight situations and airframes
- Complete chain of custody visibility and data logging while in flight

Power Drain in the Air

Power drain is a critical application requirement that must be fully understood to successfully enable the deployment and longevity of an M2M application. The frequency with which data is reported from the field and the duration of time the radio remains in receive mode as well as many other factors, directly correlate to how long an autonomously battery powered device can remain active without additional charging. Power drain factors occur even more rapidly for devices in the air due to the lack of available networks and the high power burn condition exhibited by units continuously attempting to connect to networks that are not present at 30-40,000 feet. If the wide-area radio transmitter remains on during the flight, the power drains by the time it lands because of consistent retries by the radio to connect to the towers below the plane. This makes it extremely difficult to monitor a temperature sensitive package throughout a trip if the device cannot sustain power. Thus, when the device is finally on the ground and in range to safely connect to a cellular network to transmit data collected during the flight, not enough battery power exists to do so. The unique ability of the SENTRY to autonomously turn on and off its radio transmitters directly contributes to its power saving capabilities, ensuring that the unit retains the battery power necessary for the duration of the trip.

No Human Intervention

To fully enable a flight-ready system, the SENTRY device needed to have autonomous power in addition to the intelligence to turn off its wide-area wireless transmitter so that cellular communication is suspended during flight. This means no human intervention could be relied upon to turn the unit off as most people do with their cell phones prior to take-off on commercial airlines. To meet this specification, the SENTRY is equipped with a complete sensory and proprietary firmware package that detects specific conditions that trigger an automatic shut down of the cellular radio, thus not requiring a human being to manually shut it off.

Multiple, Redundant Modes of Aircraft Detection

At first look, single sensor detection appears to be a viable solution for detecting flight conditions. However, during thousands of man hours of testing and data collection it has proven to be inadequate to support a detection scheme that is robust enough to deploy on various types of aircraft throughout a highly dynamic supply chain. There is no single sensor solution that can account for the myriad of different types of aircraft or flight profiles that occur on the various types of cargo or passenger aircraft utilized by commercial shippers. Moreover, each individual pilot also has control over how he or she lands creating a massive number of unique flight profiles. For example, if a device is placed on a small propeller-driven cargo aircraft with short take-off or landing (STOL) capabilities and flown from a long landing strip gracefully, an accelerometer alone generates too shallow of a profile to differentiate this from a ground vehicle that is being driven robustly. In order to account for as many flight variations as possible and distinguish transportation from normal ground activities, the SENTRY unit uses multiple sensors and proprietary logic for fail-safe aircraft detection.

Standardized Unit Across All Flight Situations

As stated earlier, there are currently thousands of different aircrafts and flight patterns that support the world-wide package delivery system. Aircrafts range in size from small "bush" style aircraft that fly into the most remote areas to large commercial-sized airliners. Each aircraft presents unique sensor conditions that flight-enabled M2M devices must address, because there is no way for the device to know where the package is headed only that it operates while it's headed there. For this reason, a single device that accommodates thousands of aircraft bodies, flight profiles that differentiate between take-off and landing conditions across airports, and the most unique variable, individual pilot flying styles, is critical for the success of the unit in the marketplace. Shippers should not have to determine which packages can fly with M2M devices based on the travel conditions and aircraft used. They should simply use a standardized device and place it in the package, and have the peace of mind that the M2M device will be monitoring the shipment conditions from that point forward.

Complete Chain of Custody Between Aircraft

Ultimately, technology development must be done with a business solution in mind, and in the case of FlightSafe, the focus is to enable chain of custody management across the supply chain for high-value air cargo. This means that not only does the M2M device need to comply with FAA safety requirements regarding no cellular communications during flight, but the unit must also be able to recognize when the aircraft lands in order to power on and achieve immediate visibility once on the ground. Using the same proprietary hardware and software combination the device uses to power down, the SENTRY unit also powers up after a given safe interval on the ground. This ensures that the chain of custody, environmental conditions, and GPS locations are available as quickly as possible following the flight.

How SENTRY FlightSafe Works

SENTRY FlightSafe autonomously senses and intelligently disables its wide area network connections (WAN) when the device enters FlightSafe mode. The SENTRY is capable of detecting its presence in the vicinity of operable aircraft. The device distinctly detects and adjusts its operation based on specific conditions associated with pre-flight ground operations, take-off events, in-flight conditions, and landing events. During the flight, onboard sensors continue to operate by taking real-time readings of environmental conditions and handling events, while storing that information in internal memory. When the aircraft lands, the SENTRY unit powers up the WAN connections and transmits its current location along with the data collected during the flight to include any alarm conditions that may have occurred.

SENTRY FlightSafe is easily placed inside any type of cargo solution for air transportation. Below are some examples of commonly used packing materials used with SENTRY air cargo shipments. See how easily the SENTRY unit slips into the package for continuous monitoring on the ground and in the air.

SENTRY FlightSafe Features

With SENTRY FlightSafe, reliable air cargo tracking for high-value goods is now a reality. Finally, a solution exists that provides the richness of features with multiple redundant modes to offer guaranteed aircraft detection. Key features of SENTRY FlightSafe include:

- Multiple sensor event triggers for aircraft detection
- Proprietary, smart algorithms for intelligent decision-making
- Redundant detection and release
- Autonomous operations with no human intervention required
- Support for dynamic flight scenarios and consistent operation across multiple airframes
- Does not require any change in work-flow for air cargo personnel

For more information on FlightSafe aircraft detection for M2M devices, please contact *www.onasset.com*.

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