» Whitepaper «

Optimizing Airborne Platforms To Support Wireless-In-The-Sky Applications

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An Overview of the Opportunities, Challenges & Solutions for Deploying Web Access, Multicast In-flight Entertainment and Other Wi-Fi Services On-Board Commercial Aircraft.

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Overview

Over the past few years, the deployment of broadband Internet access and other wireless services aboard commercial aircraft has moved from just a "pie in the sky" idea to a very real "wireless in the sky" market opportunity. A recent Airline Business/SITA study indicated that some 68% of airlines plan to invest in IP broadband connectivity both to and from aircraft over the next three years.

As some of the early experiments have progressed and validated the market opportunity, the scope of potential services has also broadened; from an initial focus on Web browsing and email access to now also encompassing multicast wireless video entertainment and wireless delivery of on-demand video/audio content throughout the passenger cabin. This expanded set of services holds great opportunity for airlines to both differentiate their offerings and to generate additional revenue streams. However, it also presents significant challenges with regard to deploying robust hardware/software platforms that can handle the bandwidth and mix-of-services requirements.

The wireless servers and access points need to fit seamlessly into the physical constraints of a variety of existing aircraft and must be able to scale up support for various user-load scenarios, while reliably delivering standards-based Wi-Fi services for a full range of user devices. All of the hardware must also conform to deployment requirements for rugged airborne operating environments as well as providing the modularity needed for cost-effective maintainability. In addition, the on-board equipment should include the flexibility to support a number of different "backhaul" connectivity scenarios, ranging from ground-based transponder towers to satellite-based communications.

This paper addresses the above issues in greater detail and describes a comprehensive set of highly adaptable and maintainable solutions, using ruggedized servers and modular wireless access points to deliver 802.11n wireless services.

Market Drivers and Requirements

In recent years, commercial airlines have been faced with the two-headed dilemma of rising costs of operation and heightened competition for passengers. On one hand, most airlines are turning to the creation of "ancillary revenue" streams, which often entail charging fees for previously free services, such as checking baggage, in-flight beverages, preferred seating, agent booking fees, etc. In a 2007 survey of airline executives by the Ideaworks market research firm, 63 percent of the respondents indicated plans for the unbundling of various services to create such ancillary revenue streams.

On another front, airlines also are looking to differentiate themselves by offering new services, which can be leveraged for generating lucrative ancillary revenue streams; but without the stigma that they are simply charging for something that was previously free. This is where in-flight Wi-Fi service offerings can play a major role by giving passengers something that they've become used to having at their fingertips virtually everywhere, by extending the familiar Wi-Fi service that they're already used to paying fees to receive.

Applications: The Sky is the Limit

Making Wi-Fi available on board commercial aircraft in theory is similar to the already ubiquitous offering of wireless hot-spots in coffee shops, hotels, restaurants, and virtually every type of public gathering place imaginable. However, there are some important differences that can work to the advantage of the airlines' revenue generation objectives.

One factor is the pent-up demand. Most of us have become used to being in touch (checking/responding to email or getting a quick status update) almost anywhere we go; except between takeoff and landing on a commercial airliner. Another factor is the ready-to-go potential user base. Over 65% of business travelers and one third of all leisure travelers in the United States already carry laptops onboard when they fly and more than 30% carry Wi-Fi enabled phones and PDAs, such as Blackberrys and iPhones.

In addition, there are very significant opportunities for "up-selling" passengers with premium content offerings over the same Wi-Fi infrastructure. In the early days of public Wi-Fi hotspots, many in the industry talked about the concept of "walled-gardens" in which the Wi-Fi provider could offer premium content that was only available for a fee to users within their hotspot. While this walled-garden concept has seen spotty success in specific situations, most users have come to view their Internet connectivity has being essentially "wall-less" and the local premium content really has to be compelling to capture their attention for the brief periods that they spend in the hotspot. This is not the case with a commercial airliner full of passengers, who stay on-board for a finite period of time. In effect, there is not a more captive-audience anywhere else in the world.

Over the years, airline passengers have become accustomed to in-flight entertainment such as movies on longer duration flights and in recent years have also gotten used to paying a fee for such entertainment. On-board Wi-Fi systems with multi-cast capabilities and media server features can offer a very flexible and cost-effective delivery system for a wide range of in-flight entertainment. In addition, to the "free" web-based content that comes as part of their pay-for-access Wi-Fi connection, passengers can be offered a wide range of additional "on-demand" content for various fees. Such premium offerings can include feature movies, television, and other on-demand video/audio content, as well as special-interest services such as interactive gaming, voice-over-IP telephony, etc.

In addition to opening up new revenue streams, the shifting to standards-based Wi-Fi for disseminating in-flight entertainment also holds the opportunity for cost benefits to the airlines. Instead of having to outfit the aircraft with drop-down video monitors at various points in the passenger cabin or individual seat-back screens, Wi-Fi enables airlines to leverage virtually any of the Wi-Fi enabled devices (laptops, netbooks, PDAs, etc.) that passengers are already bringing on board with them. Of course, airlines also have the option to provide wireless units (for a fee) to those passengers who want the service but don't have their own device with them.

Deployment & Usage Scenarios

A number of large scale implementation efforts by major airlines are already underway and the market for wireless-in-the-sky is rapidly evolving as a highly-desired feature for frequent flyer airline passengers – especially business travelers.

One of the issues in deploying Internet connectivity for commercial airline passengers is deciding on how to connect the "backhaul pipeline" from the aircraft to the Internet. Basically, there are two fundamental approaches. The first uses terrestrial radio towers with transponders that hand-off the connection to the aircraft as it travels, much as cell-towers hand-off mobile phone connections for people on the move. The second approach uses satellite-based radio connections to the aircraft. Both of these approaches have proven merits and are being used in the deployments by airlines.

For example, in December 2008, Delta Airlines launched Internet service on a handful of planes, using the Aircell air-to-ground service, and has plans to expand its offering to its full fleet of 330 aircraft later this year. Southwest Airlines is also proceeding with plans to roll-out Wi-Fi using the Row 44 satellite-based solution. Beginning this fall, Southwest will be moving to the next step of certifying their full fleet and then to begin fleet wide roll-out of the Row 44 satellite service in Q1 2010. The airline has been testing the service on four aircraft since February, with customers using the service for anything from e-mail to streaming video.

Regardless of whether the Internet backhaul methodology is air-to-ground or via satellite, a similar set of challenges must be addressed with regard to implementing the Wi-Fi and media services throughout the aircraft passenger cabin. As a matter of fact, Kontron, formerly AP Avionx, has worked closely with both Aircell and Row 44 to provide ruggedized airborne platforms for implementing the on-board Wi-Fi portion of their services.

As these deployments move forward, with a growing number of airlines offering in-flight Wi-Fi services and large numbers of passengers taking advantage of them, some of the most important factors for market success will be 1) reliability, 2) performance, 3) cost, 4) maintainability, 5) scalability and 6) SWaP (Size, Weight and Power).

Airlines cannot afford to be faced with conducting forklift change-out of platforms and/or sub-standard performance levels if passenger usage patterns and bandwidth demands exceed expectations. Having to replace inadequate systems would unnecessarily drive up costs or nagging service problems could do irreparable harm to the airline's reputation, which is a very difficult thing to recover in such a highly competitive market.

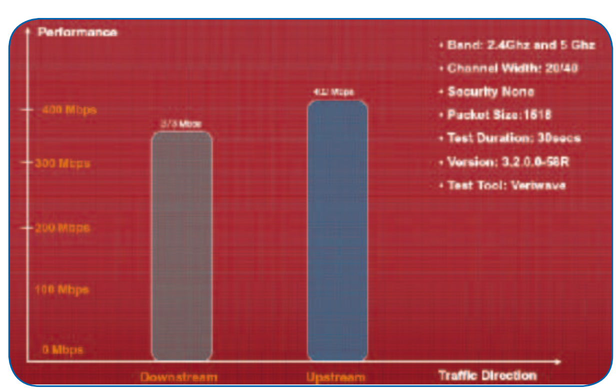
The following sections address the key implementation issues for selecting both the wireless connectivity standard and the underlying hardware platforms, in order to deploy an on-board Wi-Fi capability that can deliver the required performance from the outset, as well as the sustainability and scalability to grow with escalating usage patterns and to support new bandwidth-hungry applications.

The Optimal Wireless Standard: 802.11n

As the usage of Wi-Fi services has skyrocketed over the past decade, the underlying standards defined in IEEE 802.11 have gone through a series of iterations to support both an expanding range of applications/devices and a constant growth in the demands for more bandwidth. These iterations have included 802.11a, 802.11b, and 802.11g, which have been sometimes but not always compatible with each other. Differing feature sets, distance capabilities and frequency bands (2.4GHz vs. 5.0GHz) have been some of the key incompatibility issues.

High Capacity, Multi-Channel Flexibility, Backward Compatibility

Fortunately for implementers of wireless-in-the-sky services, the newest Wi-Fi standard, 802.11n, provides a solid basis for implementing robust, high performance wireless capabilities with full backward compatibility for any Wi-Fi device. Through the use of simultaneous dual-radio operation, 802.11n supports both 2.4GHz and 5.0GHz communications (providing compatibility with 802.11 b/g/n and 802.11a/n). The Multiple Input/Multiple Output (MIMO) system uses channel widths of 20 or 40 MHz and can deliver data rates of over 300 Mbps per radio as compared to the 11 or 54 Mbps capacity limits of previous standards.



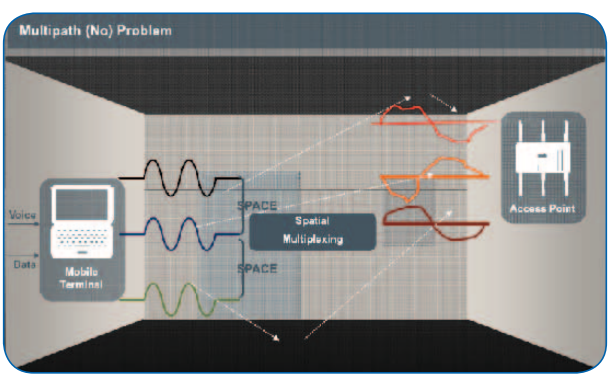
Optimized Support for Multicast and Video-on-Demand

In addition, the 802.11n standard is optimized for supporting Multicast video-streaming operations, as well as Unicast AVOD (Audio-Video-On-Demand). A multicast packet includes a group address that simultaneously delivers the same packet to more than one destination on the network. The use of multicasting greatly reduces overall bandwidth consumption on the network because only the transmission of a single packet is necessary rather than sending packets individually addressed to each node.

For instance, multicasting is the ideal data transmission methodology for video streaming of in-flight entertainment with many passengers watching the same movie. The use of unicast packets to send the stream to each recipient individually would require many separate video streams, resulting in major performance impacts to the wireless network. With multicasting, only one stream is necessary and upstream packet acknowledgements are not required.

MIMO Multipath Radio Transmission: Ideal for Airborne Wi-Fi

Another key advantage of 802.11n is the built-in standard support for multiple radio paths to support the MIMO multiple transmit and receive channels with dual frequencies. Unlike previous 802.11 standards, which could experience performance degradation from having to sort out reflected signals, 802.11n is inherently geared for spatial multiplexing.



When implementing Wi-Fi services within the passenger cabin of a variety of different airframes (which are essentially metal tubes in the sky), it is very helpful to start with a wireless standard that is already designed to gracefully handle reflected signals. Plus, as will be detailed in the following sections, it also helps to select multi-radio wireless access point hardware that is optimized for performance within such very demanding airborne environments.

Designing the Optimal Rugged Platform

Creating an optimized platform for implementing wireless-in-the-sky is a multi-faceted challenge, which requires deep expertise in wireless networking, radio transmission, hardware design and ruggedization for airborne operations. Engineers from Kontron and Motorola have collaborated closely together in ruggedizing and adapting Motorola's industry-leading 802.11n wireless solutions into an efficient, high-performance, scalable and highly-maintainable platform for wireless-in-the-sky.

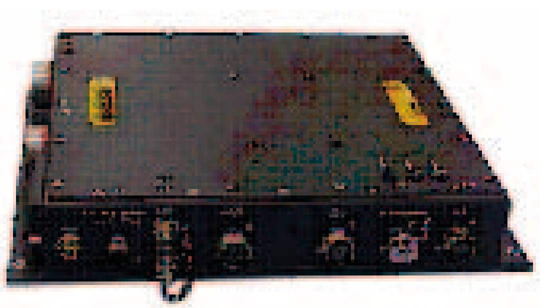
The Cab-n-Connect™ Cabin Wireless Access Point (CWAP) supports flexible deployment of multiple Wi-Fi access points virtually anywhere within the commercial aircraft. Depending on the size and configuration of the particular airframe, and the specific types of applications being supported, there could be from two to eight CWAP modules distributed at various locations throughout the plane.

Cab-n-Connect™

Using a robust 3x3 MIMO radio configuration, the CWAP supports dual-band (TX/RX) communications with any type of Wi-Fi device in the on-board network mesh, using either 2.4GHz (11b/g/n) or 5.0GHZ (11a/n). A third radio connection can be dedicated to network management and communications with the on-board wireless server.

The individual CWAP units throughout the passenger cabin communicate with centralized airborne server units via Gigabit Ethernet. Depending on the specific requirements, one or more server units provide network management, load-balancing, media server functions and handling of the backhaul communications (via satellite or air-to-ground). Robust security layers ensure integrity and privacy of all communications over the local wireless network and the backhaul communication links.

CWAP units



Key Factors for Success

Successfully deploying commercial wireless-in-the-sky service presents a number of difficult challenges regarding the special physical demands of an airborne operating environment. Many of these issues are similar to those encountered in harsh airborne military deployments and some are unique to the commercial airline industry.

Optimizing Size, Weight, Power and Cost

Designing the specified functionality and performance to meet stringent size, weight and cost requirements is an always-present challenge with any airborne application. With the steadily rising cost of fuel, which is the single largest expense category for most airlines, the weight factor in fuel-efficiency has become an area of constant concern and scrutiny. At the same time that airlines are already eliminating any unnecessary weight from their aircraft, it is critical that wireless-in-the-sky deployments deliver the highest possible weight-to-revenue return.

Through a close collaboration, Motorola and Kontron have designed the modular CWAP unit to weigh about four pounds, while minimizing both size and cost. The bottom line for airlines is a fully ruggedized wireless access point that is only two-thirds of the weight, size and cost of the available alternatives.

Motorola's integrated over-the-air software upgradeability features also offer significant benefits for airlines by stream-lining the process of system maintenance and updates, thereby helping to minimize on-going operational costs.

Fitting into Tight Space Constraints

Leveraging years of experience in designing airborne, shipboard, UAV, and aerospace units to meet ultra-demanding deployment scenarios, Kontron engineers have become very adept at accommodating a wide range of mounting scenarios. We also frequently need to optimize the packaging approach to allow for quick access, such as changing out storage modules or downloading data.

Similar requirements have been addressed in the design of all the wireless-in-the-sky CWAP modules and server units. The CWAP modules are designed for easy mounting in a wide range of accessible but out-of-the-way bulkhead locations, enabling the airline engineers to place them virtually anywhere within existing aircraft to provide optimal coverage. Likewise, the server units are designed so that they can be efficiently mounted within existing space configurations, while also providing easy access for maintenance, data updates, storage uploads/change-outs, etc.

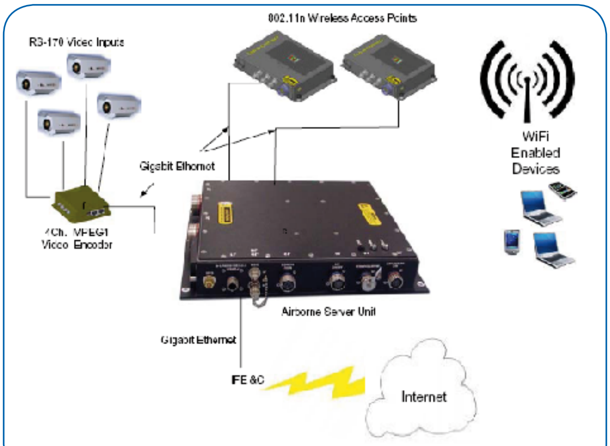
Compliance with Standards & Interoperability (DO-160E, ARINC)

All of the Kontron servers and CWAP units are compliant with appropriate standards for airborne deployment and operation. Key among these is RTCA/DO-160E, which defines a full spectrum of environmental specifications and test criteria to assure the safety and reliability of all airborne electronics. In addition, the units are designed to meet ARINC mounting, interoperability and connectivity standards to provide for easy integration with other systems and efficient maintainability.

Real-world Configuration Example

In addition to the real-world deployed systems that are already serving airline passengers through our partnerships with pioneering wireless-in-the-sky service providers, Kontron has also developed a comprehensive simulation environment to demonstrate the relationships and interaction of the various elements within the overall architecture.
As can be seen in the block diagram, this demonstration architecture also allows various usage scenarios and system loading to be modeled, for example by increasing the video streaming inputs, changing the number and location of CWAP modules and/or increasing or changing the mix of end-user Wi-Fi enabled devices and applications.

Rigorous empirical testing of the system within real-world operating environments has shown excellent performance results and scalability. For example, a controlled test using a single CWAP access point mounted within a wide-body commercial aircraft showed the capability to simultaneously stream real-time video content at 1Mbs to over 120 wireless client systems. This constitutes a more than 5x performance advantage over competing systems that show measureable degradation of performance at 20+ wireless clients.



The Bottom Line

Now that the long-held predictions about wireless-in-the-sky services and the real-world market opportunities have finally come together, many airlines are moving very quickly to implement their own services. Lured by the lucrative ancillary revenue opportunities and driven by competitive pressures, airlines are looking for proven solutions that can support both rapid-rollout and scalable, sustainable growth over the long run.

Many of them have already found that a standards-based blending of robust 802.11n wireless and ruggedized modular CWAP/server networks combine to provide the solid architectural foundation needed to finally get wireless-in-the-sky off the ground.

About Kontron

Kontron is a global leader in embedded computing technology. With more than 30% of its employees in Research and Development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators. Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchange under the symbol "KBC".
For more information, please visit: **www.kontron.com**

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