Technology White Paper

The Airport Wireless Plan

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There has been much talk and debate lately about whether Wireless Fidelity (WiFi) Internet access should be free in an airport or fee-based. Ross & Baruzzini has concluded that this is really just a subset of a bigger and probably more important issue: **"What is the Wireless Plan for your airport?"** It was not long ago that wireless communications was a curiosity, used by early adopters who were well steeped in technology. It has now become part of the mainstream and therefore warrants the same kind of attention given to a Master Telecommunications and Information Technology Plan. In fact, ideally, wireless would be a major section within that plan.

The purpose of this white paper is to explore the most vital facets of the **Airport Wireless Plan**. We will look at the current and forthcoming technical standards, the more salient elements of the business model, and delve into important trends in this technology that will impact you and your airport.

The 802.11 Family of Wireless Standards

Ross & Baruzzini will focus on the various standards that fall under the popular heading of WiFi. This focus is primarily because they are the ones an airport is able to deploy since WiFi standards do not require a license from the FCC. Licensed cellular standards will be addressed in this paper in the context of the convergence that is happening between the licensed and unlicensed services.

The prominent standard-setting agency in WiFi is the Institute of Electrical and Electronics Engineers (IEEE). The first two standards that emerged from the IEEE in the late 90's are known by the inelegant names of **802.11a** and **802.11b**. The former operates in the 5 gigahertz (Ghz) band with a total throughput of 54 megabits (Mbps), the latter runs in the 2.4Ghz band with a total throughput of 11 Mbps. For a variety of reasons, the marketplace chose 802.11b to be the dominant choice for building Wireless Local Area Networks (WLANs). 802.11a networks do exist but are not used to support public Internet access. Shortly after 802.11b networks were deployed another standard was ratified known as **802.11g**. It also operates in the 2.4Ghz band but has a total throughput of 54 Mbps. It is backwards compatible with 802.11b and therefore the two standards can operate together in the same environment. Later in 2007, yet another standard, **802.11n**, is expected to be ratified. It will also operate in the 2.4Ghz band but is expected to have total throughputs of well over 100 Mbps, perhaps as high as 600 Mbps. Pre-standard "n" hardware is available today but there is no assurance it will be compatible with the ratified standard. There are many other 802.11x standards that will not be addressed in this white paper. They typically deal with things like encryption, authentication, roaming, etc. Please refer to **Appendix A** for a complete listing of IEEE 802.11 standards.

Other wireless standards currently under discussion include the **802.15** family which deals with Wireless Personal Area Networks (WPANs) and the **802.16** family which deals with Wireless Wide Area Networks (WWANs). The often misunderstood **WiMAX (Worldwide Interoperability for Microwave Access)** technology is governed by the 802.16 standards. Both of these will be reviewed in this white paper as the important trends in wireless technology are addressed.

Finally, there are the various cellular standards and their evolutionary companions that all require licenses from the FCC and are therefore not available to many airports. However, they will have a significant impact on the wireless scene in an airport and must therefore be understood as part of the big picture. Please refer to **Figure 1** on page 6 for a better understanding of this complex array of standards and where they reside in the overall wireless domain.

The Business Model

After untangling the standards and the language, the second most pressing issue in wireless is a business issue: **"What are your business objectives for deploying a WiFi network in your airport?"**

The following is a partial list of possibilities:

- Use it as an **amenity** for customer satisfaction
- Create a new source of **non-airline revenues**
- Establish it to **enhance** the airport image as being leading-edge
- Make the airport a better place in which to run a business
- Create an **E-enabled** facility (including portions of the AOA) to support multiple applications for the airport and any of the tenants

The selection of one or more of these objectives has a significant effect on the major elements of the business case including costs (both initial and on-going), resource requirements, and make versus buy decisions. For example:

- Is there an existing telecommunications infrastructure that can be used to support a WiFi network?
- Are there other projects contemplated which could be leveraged to support a WiFi network (e.g. MUFIDS)?
- Is the IT organization robust enough to bear the burden of a WiFi deployment and operation or should you hire a wireless concessionaire?
- If one of the objectives is to make the network common-use to be shared across the concessionaire community, is there adequate business development staff to carry out the necessary account management function?

Single-Use and Common-Use Models

The simplest model is to build a network strictly to provide basic Internet access for airport customers. In making the decision as to whether to deploy a WiFi network solely for that purpose, it is essential to know the **Total Cost of Ownership,** so you can realistically plan to recover those costs. The purpose of this section of the paper is to promote a better understanding of where the most exposure lies and whether to go single-use or common-use.

In airports having greater than 5 million enplanements per year, the cost to build (design, furnish and install) a basic 802.11g network will range from **$300,000** to well over **$1 million** depending upon a number of factors. Annual operations costs typically run **10-15%** of the initial capital outlay. If you outsource technical support, a rule of thumb is that it would cost **$1/minute** for the service. If you have an existing Help Desk, then the issue becomes one of staffing levels. If you choose to not offer technical support, you have to consider whether or not this will lead to customer dissatisfaction when users are having connectivity problems.

An issue that is often overlooked is required technology updates/upgrades. Wireless technology is a fast-changing field with new standards coming along every 2-3 years. You need to be prepared to invest more capital to make sure you have the appropriately upgraded technology geared to delivering a positive customer experience. Broadband applications are starting to touch all aspects of our daily lives: at work, at home and on the road. Our culture has become conditioned to the broadband experience with expectations that it will be a good one. If the airport does not keep pace with the rate of change in the broader marketplace customer dissatisfaction will result.

A current example of emerging technology is the use of the WiFi network to make voice calls (known as **Voice over WiFi or VoWiFi**). This year, there will be many devices in the marketplace that support VoWiFi, either as WiFi handsets or dual-mode with cellular. Existing WirelessLANs **(WLANs)** treat these voice calls no differently than data sessions using what is known as “best effort” transmission. Since voice is very intolerant of any significant latency in the transmission, the quality of those calls will be subject to how much total traffic is on the network at any given time, and may produce unacceptable results. Changes must be made to the network to introduce **Quality of Service (QoS)** protocols which sense voice calls and give their bit streams priority over others to solve the latency problem. All elements of the WLAN must be upgraded to these new protocols, potentially a lengthy and expensive proposition. Other changes will also have to be implemented such as supporting fast handoffs to maintain a voice session. When the volume of VoWiFi calls increases in the ensuing years, the next issue will be capacity since VoWiFi can be fairly bandwidth intensive. If call quality is to be maintained, additional access points will have to be installed to increase capacity. Again, this can be a fairly expensive proposition unless VoWiFi is considered in the initial design of the WLAN.

Construction, upgrade and support are all costs that have to be recovered. The following are some of the ways you can recover those costs:

- Charge a fee for the use of the network by the end users
- Sell sponsorships to major corporations (naming rights)
- Sell advertising (being careful not to violate any existing advertising concession)
- Introduce value-added services to bring in new revenue streams (e.g., deliver rich media services to the users, offer network printing over the network, sell location-based advertising to your concessionaires, etc.)
- Make it a line item in your capital budget and annual operating budget
- And/or make it a **common-use** network basically offering shared tenant telecom services to your airport tenants.

Whatever path you choose to recover your costs, it is important that you establish reasonable expectations for the sources of revenue, how quickly they will develop, and how **sustainable** they are in the long run.

In the **common-use model** the WiFi network is used to provide the public hotspot service, and the network is also used to provide services to airport tenants such as concessionaires, security agencies, airlines and contractors. In this model, the WLAN is logically partitioned into what are called **Virtual LANs (VLANs)** so the traffic from different user communities can be handled and administered separately. Revenues from these private services can be used to help recover costs. Experience has shown that in the larger airports that aggressively pursue common-use applications, they can generate tens of thousands of dollars per year from basic wireless DSL-like services. Some of these airports include Detroit, Newark and Toronto. However, wireless use for private applications in airports is still in its infancy and requires market development since it does not benefit from the hype associated with public hotspots. If you are a proponent of the shared tenant service business, there is significant revenue potential with wireless. But it comes at a cost: **resources**. A question remains whether or not common-use net revenues can make a significant contribution to covering the initial and recurring costs of the WiFi deployment.

Looking Ahead At Next-Generation Wireless Technologies

The wireless field is in a constant state of flux and it is essential to look ahead to make sure your wireless business model is as future proof as possible. Next generation cellular services (3G and EV-DO) are starting to be widely deployed by all of the licensed carriers. These new services deliver useable data speeds that can equal those from WiFi networks. However, to achieve those results the cellular signal inside the airport must be strong, requiring excellent coverage and signal strength. In addition to WiFi networks, many airports have also installed cellular distributed antenna systems that assure excellent signal strengths and coverage. Under these circumstances, users have a choice between WiFi and cellular data. It is too early to say what impact 3G services will have on WiFi services in airports, but the potential to reduce revenues from WiFi certainly exists. Both technologies have their individual strengths and weaknesses, and the choice over which to use is governed by many factors than just useable data rate.

The next significant wireless technology that is just starting to be introduced is referred to as **WiMAX**. It is mentioned in the white paper not because it is anticipated to be a major factor at an airport, but rather to position it relative to WiFi and so airport operators can understand how it fits into your Wireless Plan or not. There are two versions of WiMAX. One is for fixed point-to-multipoint wide-area applications **(802.16d)**; the other is for mobile applications and is widely touted to become cellular's **4th generation technology** choice **(802.16e)**. The fixed version is becoming available today, as the standards have been recently ratified. It is seen primarily as an alternative to wired DSL service in remote areas or developing countries. It also could serve as the backhaul facility for cellular cell sites and/or nodes in a municipal WiFi mesh network. While it can be operated in unlicensed spectrum, the more likely scenario is that the service provider must purchase licensed spectrum. The same is true for the mobile version that is not expected to be widely deployed for a few more years. WiFi is a local area technology whereas WiMAX is wide-area.

One possible use for WiMAX is to create a backhaul ring tying together terminals that are not physically connected as a less costly alternative (or backup) to fiber. Remember, however, the airport would either have to own or rent WiMAX frequencies or purchase equipment that operates in the unlicensed spectrum. When mobile WiMAX is available it will probably be offered as an alternative to existing cellular service by licensed service providers. It is not viewed as a replacement for WiFi, but rather as a complement.

Another significant trend in wireless technology is the use of what is called **Mesh Networking** to build WiFi networks. The following is a common definition from *Wikipedia*:

> **Mesh networking** is a way to route data, voice and instructions between nodes. It allows for continuous connections and reconfiguration around broken or blocked paths by "hopping" from node to node until the destination is reached. Mesh networks are self-healing: the network can still operate even when a node breaks down or a connection goes bad. As a result, a very reliable network is formed. This concept is applicable to wireless networks, wired networks, and software interaction.
> A mesh network is a networking technique which allows inexpensive peer network nodes to supply back haul services to other nodes in the same network. It effectively extends a network by sharing access to higher cost network infrastructure.
>
> Mesh networks differ from other networks in that the component parts can all connect to each other via multiple hops, and they generally are not mobile.

The benefits of mesh networking are seen in outdoor installations where the opportunities for interference or line-of-sight blockage are much greater than indoors. Some airports are looking to create an "RF cloud" over large portions of the airfield to offer Internet and Intranet connectivity to airport operations, security and even the airlines. Such applications may lend themselves quite well to the use of mesh. If the layout of your airport is campus-like, you may also be a candidate for a mesh system should you decide to provide outdoor coverage.

Finally, as mentioned earlier, the next step for WiFi from today's 802.11g with a speed of 54Mbps is **802.11n** which is still a couple of years away from commercial reality (although pre-standard versions are already in the marketplace). It will offer speeds at least double that of today's systems, thus opening the potential for advanced broadband application delivery even wider.

Figure 1 shows the various wireless technologies and their domains of use. The far left portion of the chart refers to Wireless Personal Area Networks (WPANs) that are not a subject of this white paper. These are very short-range technologies aimed at desktop cable replacements.

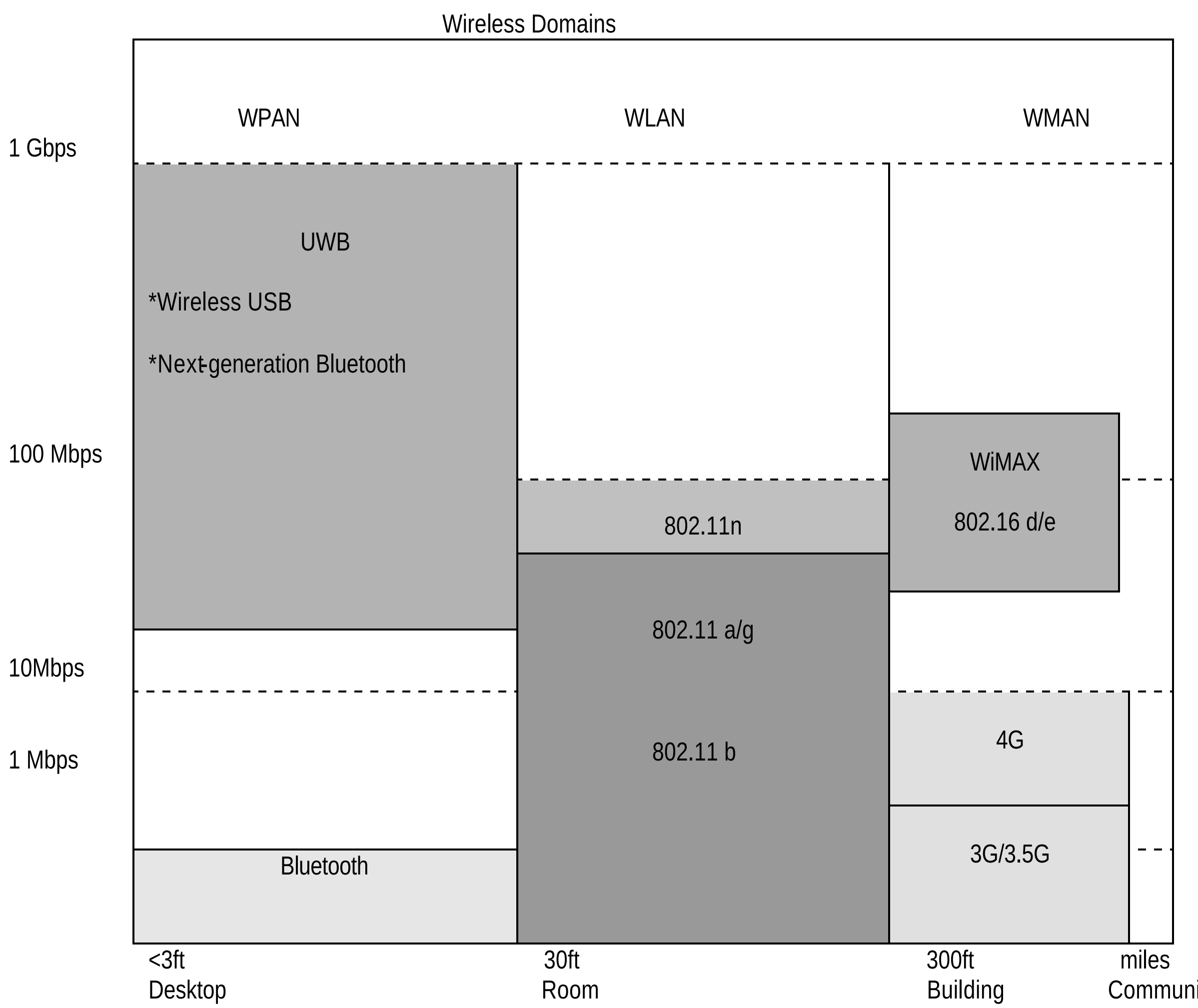

Figure 1

WiFi/Cellular Convergence

The next generation cellular technologies (3G) that are just being introduced can offer useable data rates that are comparable to today's 802.11g WiFi technology. End users will have a choice to either use WiFi for their access needs or 3G. It is apparent that device and handset manufacturers believe giving users the ability to use both is a good thing. Handsets are now in the marketplace that offer dual mode operation, i.e., both WiFi and cellular, and many more handsets are expected this year. There was a time when the licensed cellular carriers viewed WiFi as a competing technology, but it now appears that they see it as complementary and, in Europe, cellular companies are already offering both services to their customers (T-Mobile is expected to do so in the US). The choice of which to use is expected to be primarily based on coverage. However, the quality of the respective networks will also be important. This means that if the WiFi system deployed within an airport is not capable of supporting things like streaming audio and video and delivering high-quality voice transmission, then you are going to risk losing revenue to the cellular carriers. The nearly complete eradication of payphones by mobile phones could be repeated by cellular carriers offering services that eclipse WiFi. On the other hand, if the installed WiFi network, whether the airport or a third party runs it, is able to deliver a **high-quality broadband experience**, be it voice or data, then your ability to compete with the cellular carriers increases significantly.

Bringing It All Together

An airport is a microcosm of a small city with public hotspots, large and small enterprises, retail establishments, restaurants, security agencies, and licensed and unlicensed service providers. Therefore, all of the dynamics associated with the wireless technology and its industry come together in an airport. It has the potential to have a significant effect on the travel experience, the quality of the work life of the tenants, and opens the opportunity for the airport to view itself as much more than just a stop along the travel ribbon. This is why it is so important for an airport to consciously establish a **Wireless Plan**. The decision whether to offer free wireless Internet access or not is really a very small subset of bigger questions that you are encouraged to ask:

- Should we see wireless services as an important new source of non-airline revenues?
- Do we want to install and operate the wireless network or outsource it?
- Do we want to just offer basic Internet access to the public or introduce broadband value-added services?
- How do we recover the costs associated with the service?
- Do we want to make access available to all the tenants of the airport thereby e-enabling my facility?
- Do we want to be an active participant in the delivery of advanced functionality as the technology evolves or be a passive landlord?

This White Paper has presented information that should provoke thought about the bigger wireless picture at an airport. This technology offers the possibility to be a truly disruptive factor and should be a significant part of the **Telecommunications and Information Technology Master Plan** for your airport.

About the author

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About Ross & Baruzzini, Inc.

Founded in 1953, Ross & Baruzzini, Inc. provides professional consulting and engineering services to clients in the aviation, education, government, healthcare, and maritime industries. Ross & Baruzzini provides IT consulting, planning and design of security systems, systems engineering, wireless communications, mechanical engineering, electrical engineering, plumbing/fire protection, and architecture. Located in Missouri, Texas, Florida and Indiana, Ross & Baruzzini employs a staff of systems integration personnel, security specialists, mechanical engineers, electrical engineers, plumbing engineers, architects, and support personnel.

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Appendix A

IEEE 802.11 Standards

The following IEEE Standards and task groups exist within the IEEE 802.11 working group[2]:

- IEEE 802.11 - The original 1 Mbit/s and 2 Mbit/s, 2.4 GHz RF and IR standard (1997)
- IEEE 802.11a - 54 Mbit/s, 5 GHz standard (1999, shipping products in 2001)
- IEEE 802.11b - Enhancements to 802.11 to support 5.5 and 11 Mbit/s (1999)
- IEEE 802.11c - Bridge operation procedures; included in the IEEE 802.1D standard (2001)
- IEEE 802.11d - International (country-to-country) roaming extensions (2001)
- IEEE 802.11e - Enhancements: QoS, including packet bursting (2005)
- IEEE 802.11F - Inter-Access Point Protocol (2003) Withdrawn February 2006
- IEEE 802.11g - 54 Mbit/s, 2.4 GHz standard (backwards compatible with b) (2003)
- IEEE 802.11h - Spectrum Managed 802.11a (5 GHz) for European compatibility (2004)
- IEEE 802.11i - Enhanced security (2004)
- IEEE 802.11j - Extensions for Japan (2004)
- IEEE 802.11k - Radio resource measurement enhancements (proposed - 2007?)
- IEEE 802.11l - (reserved and will not be used)
- IEEE 802.11m - Maintenance of the standard; odds and ends. (ongoing)
- IEEE 802.11n - Higher throughput improvements using MIMO (multiple input, multiple output antennas) (pre-draft - 2007?)
- IEEE 802.11o - (reserved and will not be used)
- IEEE 802.11p - WAVE - Wireless Access for the Vehicular Environment (such as ambulances and passenger cars) (working - 2008?)
- IEEE 802.11q - (reserved and will not be used, can be confused with 802.1Q VLAN trunking)
- IEEE 802.11r - Fast roaming Working "Task Group r" - 2007?
- IEEE 802.11s - ESS Mesh Networking (working - 2008?)
- IEEE 802.11T - Wireless Performance Prediction (WPP) - test methods and metrics Recommendation (working - 2008?)
- IEEE 802.11u - Interworking with non-802 networks (for example, cellular) (proposal evaluation - ?)
- IEEE 802.11v - Wireless network management (early proposal stages - ?)
- IEEE 802.11w - Protected Management Frames (early proposal stages - 2008?)
- IEEE 802.11x - (reserved and will not be used, can be confused with the "x" wildcard referring to multi-compatibilty (eg "compatibile with 802.11x devices")
- IEEE 802.11y - 3650-3700 Operation in the U.S. (early proposal stages - ?)