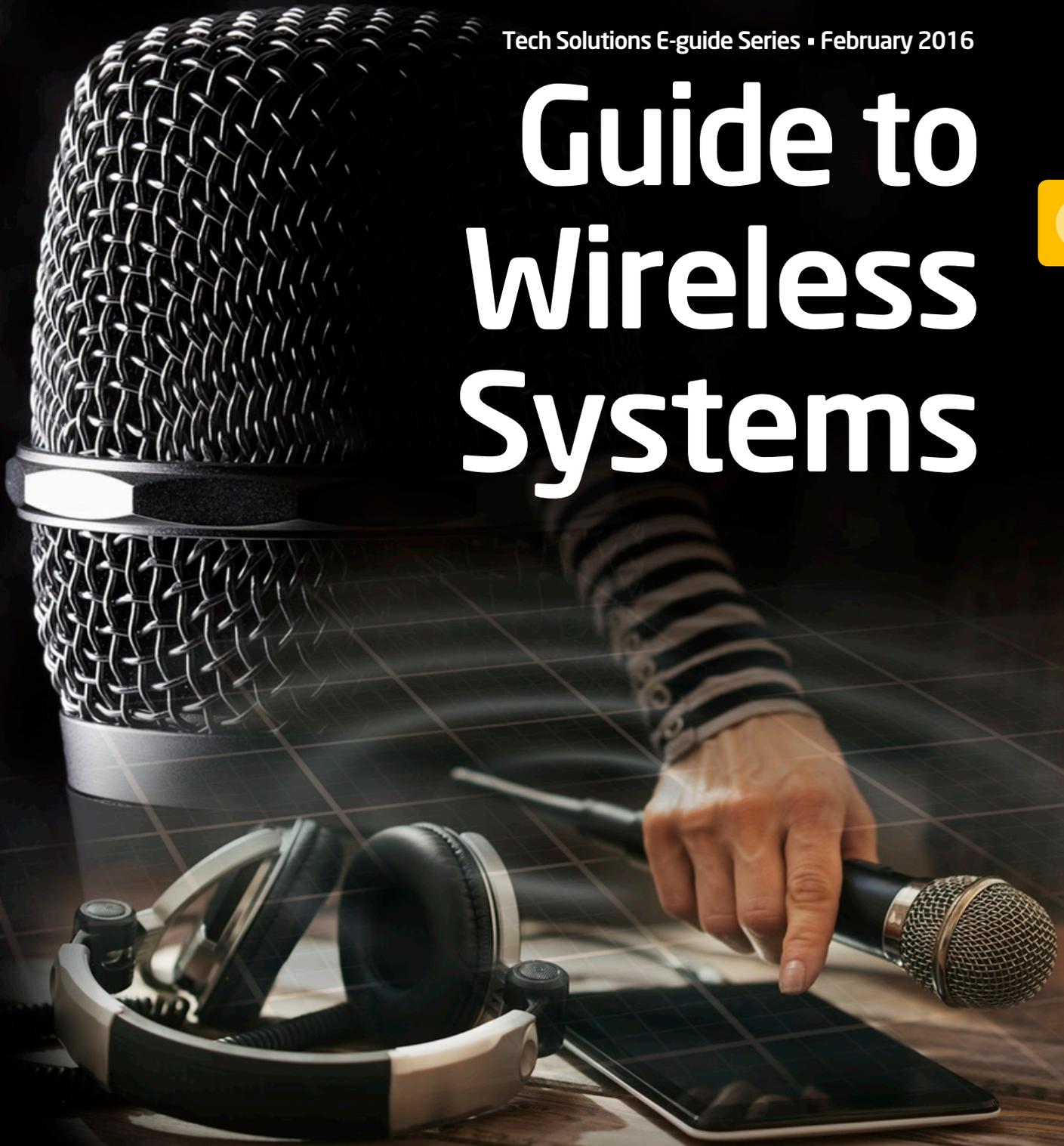


Tech Solutions E-guide Series • February 2016

Guide to Wireless Systems



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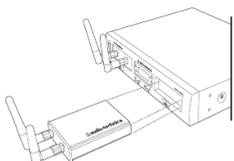


ANYWHERE WIRELESS



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Remote-Mountable
Receiver Units

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Wireless Options for Churches

Changes by the FCC are causing concern for churches about making long-term investments in wireless infrastructures. Here are the latest solutions for maximizing the available spectrum.

By Ben Coleman

Money is finally available in the church budget, so the resident tech director anxiously jumps at the chance, adding to the small but growing wireless system. In an aim to get the most bang for the buck, the TD purchases three new wireless microphones and two used IEM units for the worship leader. A quick frequency scan and setup takes place for midweek practice and all seems calm. Sunday morning rolls

around; the auditorium fills up and chaos ensues. Blips and cutouts are plaguing the new wireless systems. The worship leader is visibly frustrated as his IEM mix keeps dropping. What seemed right is now wrong.

Vast improvements in product features, audio quality and price points have made wireless solutions increasingly popular, especially for churches. While the availability of high quality wireless systems grows,



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Audio-Technica System 10 Pro Wireless System

The System 10 Pro from Audio-Technica offers a simple user interface backed by a powerful suite of features. For improved performance, receivers can be mounted in the half-rack chassis or located closer to the transmitter via a RJ45 connection.



the FCC is auctioning off portions of the frequency spectrum, causing concern for churches about making long-term investments in wireless infrastructures and worries about relying on wireless systems for critical audio situations.

Staying relevant on the current issues facing wireless systems and applications is becoming a necessary and urgent assignment for every church technical director. Through an overview of new technologies, updated frequency allocation, and application insights from several industry professionals, this white paper will provide the foundation for improved knowledge and wiser decision making about upcoming purchases.

CROWDED SPACES

As cellular technology, digital television, and advances in wireless communication continue to expand, it has placed a premium on available space within the frequency spectrum. Major wireless carriers are purchasing auctioned frequency spectrums for integrated

personal devices such as cell phones, tablets, and laptops; any mobile data device that can communicate in some form or fashion.

In an effort to accommodate increasing demands by major communication providers, the FCC cleared significant space in the 700 MHz band several years ago, and in the spring of 2016, a majority of the 600 MHz band is set to be auctioned off as well. Restrictions to these bands are having a profound effect on the consumer wireless industry as users in the house of worship, theatrical, sports, and touring worlds need to discontinue operating equipment assigned to these frequencies just as they did with the 700 MHz range a few years ago.

In his August 2015 article for *Church Production*, "FCC Clears the Way for Wireless Mics," Gary Parks offered a clear explanation regarding the upcoming 600 MHz auction and allocation:

"As has already been ruled, after the auctions and the reassignment of channels to the new owners and services are complete,



Continuing changes to frequency allocation is a complex issue. For any tech director, **knowledge of the potential ramifications and trouble spots is becoming essential.**

users of wireless mics operating in the 600 MHz band will have 39 months during which they can still use their equipment under certain rules and conditions. After that, they cannot be legally used in most of that band. On an ongoing basis, it appears that uncensored wireless mics will have shared access with medical telemetry and radio astronomy devices within channel 37, from 608 to 614 MHz. Wireless mics will also be allowed in the 600 MHz ‘guard bands’ and the ‘duplex gap,’ which will offer a few MHz of spectrum.”

As you can see, continuing changes to frequency allocation is a complex issue. For any tech director, knowledge of the potential ramifications and trouble spots is becoming essential.

A SPECTRUM PRIMER

Before tackling the current landscape of wireless options, it’s beneficial to review the various operating spectrums available for use in wireless microphone, in-ear monitors and intercoms:

VHF—Wireless systems in this narrow band, 174 to 216 MHz, are not as common as they were a few decades ago due to the limited operating space and the relatively few channels that can be successfully used together using standard analog technology. Other systems in the VHF spectrum include FM radio, Air Traffic Control, and TV stations.

UHF—Currently the most popular frequency band in use for wireless microphone, in-ear monitors and wireless in-

tercom, these operate in the 470 to 698 MHz band and are offered in analog or digital configurations. Digital TV stations have a heavy presence as well.

ISM—Operating in the 900 MHz and 2.4 GHz bands, these are the Industrial, Scientific, and Medical frequencies previously unregulated but gaining more control each year while becoming a new destination for consumer wireless gear. WiFi systems are a large user of these bands and will also potentially operate in the 900 MHz band using new “HaLow” technology.

Worth noting is that while each of the mentioned spectrum bands have their own advantages and disadvantages, none of them are inherently better than others. Understanding specific considerations, application for use, and your unique environment will be the best indicator for making informed decisions.

THE DIGITAL WORLD

As available frequency bands become further compressed, the introduction of digital systems has brought a new wave of technology aimed to alleviate this strain. There are several key factors that differentiate the operation of digital and analog wireless systems.

Although audio quality is a subjective topic depending on the listener, digital systems tend to sound better due to their higher dynamic range and frequency response. Analog systems use companding circuitry to properly transmit wide dynamic audio sources—circuitry not needed in the digital



realm. You will also find a much cleaner signal with digital systems at the end of their range. While high-end analog units employ more advanced components, leading to comparable audio quality and performance, noticeable differences between analog and digital will usually be heard in the lower to mid-tier systems.

Tim Vear, senior applications engineer at Shure Inc., says that digital systems do offer big advantages when it comes to RF response. “Digital wireless systems are much more spectrally efficient than analog.

Typically four or five analog systems can be used within a single TV spectrum channel, which has a 6 MHz bandwidth. While the best analog systems available can fit upwards of eight to ten systems, one can fit 14 or 15 digital systems in the same space. And you can stack multiple systems in adjacent TV channels with no intermodulation.”

Keep in mind that RF interference remains possible regardless of a chosen system. Comparable quality can be found in the digital or analog realms, but the application and environment will always dictate the performance.

NEW TECHNOLOGIES

Digital wireless systems have taken an increasingly larger foothold in the consumer and professional wireless market. While analog systems are still applicable and acceptable solutions for many applications, it helps to stay current with recent offerings in the digital world. This list is sure to keep expanding quickly.

Budget-Minded Digital Systems

Audio Technica System 10

2.4 GHz spectrum

Line 6 XD-V35, V55

2.4 GHz spectrum

Sennheiser XLS 35

548-865 MHz spectrum

Shure PGX-D

900 MHz spectrum

Shure GLX-D

2.4 GHz spectrum

Mid- and Upper-Tier Digital Systems

AKG DMS800

548-697 MHz

Audio-Technica System 10 Pro

2.4 GHz spectrum

Mi-Pro 909 - In-Ear Monitor System

470-960 MHz spectrum

Lectrosonics IS400 - Instrument System

470-691 MHz spectrum

Line 6 XD-V75

2.4 GHz spectrum

Shure ULX-D

470-636 MHz spectrum

Shure QLX-D

470-636 MHz spectrum

Sennheiser Evolution D1

2.4 GHz spectrum

Sony DWZ-M50

2.4 GHz spectrum

High-End Professional Digital Systems

Shure Axient

470-952 MHz

Sennheiser Digital 9000

470-798 MHz



In recent years, wireless systems in the 900 MHz and 2.4 GHz ranges have been developed and are now available for consumer purchase. One should be aware of the variables these systems pose, as they are not necessarily operating in the same manner as those in the VHF and UHF bands. One of the biggest differences resides in the minimum bandwidth needed to operate, as mandated by the FCC. While a few channels can successfully operate together in the 900 MHz band, and even more in 2.4 GHz, that other applications use this space, including WiFi and Bluetooth. While systems in these newer spectrums are a great fit for more modest applications and adding several additional channels, many would advise against employing them in a large-scale application at this point.

Brad Van Voorst is an installation manager for Reach Communications, a Minneapolis-based event production and installation company with a strong emphasis in houses of worship. He reports that while the new frequency offerings can seem attractive, they do come with reservations. “Most houses of worship have multiple wireless WiFi Networks that are also operating in the same bandwidth as these digital systems and are jumping channels all over the place causing a very unpredictable space. So what works one day may be significantly different the next.”

Van Voorst continues, “Digital, in the UHF bands, is definitely the way to go if you need to use larger amounts of wireless due to the frequency density—you can fit a lot more in the same bandwidth. If you are only using a couple of channels at a time



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If you are only using a couple of channels at a time and are on a budget, **there are some great options that aren't digital.** Analog systems are still applicable.”

and are on a budget, there are some great options that aren't digital. Analog systems are still applicable.”

INTERCOM AND IEM

Wireless microphones are not the only area of use for digital technology. Manufacturers including Clear-Com, Eartec, RTS, and Riedel are long-time suppliers of intercom systems. They each currently offer wireless systems in the 2.4 GHz band, with Clear-Com and Eartec also offering units in the UHF band. Additionally, RadioActive Technology offers a narrow-band wireless intercom that operates on a combination of VHF and UHF frequencies. While potential issues as described above could come into play, the company recommends thorough testing to determine antenna placement and coverage area, especially when other 2.4 GHz equipment is nearby.

In-ear monitor systems (IEM) are another major user in the wireless world. The big question many are asking is when will we see digital IEM systems? The short answer is:

not in the near future. Digital systems of any kind introduce latency. With microphones, you are looking at anywhere from 2.5 to 3.5 ms of latency. This is not necessarily enough where a human ear can detect the delay. But once you run signal through a digital console and then a digital IEM pack, that latency can be pushed towards 8 to 10 ms. At that stage, the human ear will notice the delay. Comb filtering, because of the way we hear our voice in our head and ear bones, comes into play and can wreak havoc on singers and horn players when it comes to tone and pitch. So at this stage, analog is still the best solution when wireless IEM systems are needed.

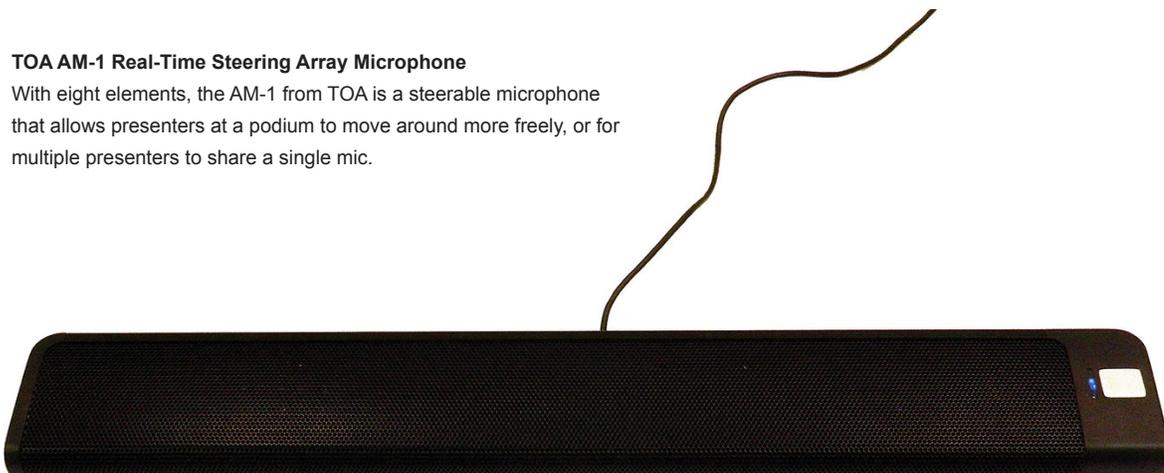
KNOW YOUR NEEDS AND PRIORITIZE

Being equipped for your needs but prepared for the future is the first and most vital step in tackling your wireless systems plan. The diminishing UHF band means that people need to be more conscious than ever about deployment and choice.

Breaking down the various usage areas for wireless equipment in a house of worship

TOA AM-1 Real-Time Steering Array Microphone

With eight elements, the AM-1 from TOA is a steerable microphone that allows presenters at a podium to move around more freely, or for multiple presenters to share a single mic.



There are a lot of great tools from multiple manufacturers that allow you to do frequency coordination. They aren't normally free, but **in the end can save you a lot of time and frustration.**

could look something like this: main auditorium, secondary auditorium or worship space, youth rooms, elementary rooms, and additional meeting rooms. And with each room, several questions are worth asking from the outset:

- **What is the size and space of the room?**
- **Where will the transmitters and receivers be located?**
- **How much range (distance between transmitter and receiver) is needed?**
- **What is the application (voice, instrument, etc.) needed for this space?**
- **What is the RF environment of the church and area? Where are the problems?**

While this only touches the surface, it's far too often we jump head first into buying equipment without fully understanding our needs, space, and application. "The biggest purchasing mistakes we typically see are people buying things uninformed. They see something inexpensive online and buy it up without doing their research. There is normally a reason that it is inexpensive," says Van Voorst.

Although purchasing the right equipment is the first step, integrating it into your existing environment is equally, if not more important. Van Voorst goes on to explain the critical aspect of frequency coordination.

"Many of the application mistakes we see are mainly the fact that places are just 'guessing' when it comes to channel use. There are a lot of great tools from multiple manufacturers that allow you to do fre-

quency coordination. They aren't normally free, but in the end can save you a lot of time and frustration. Using the scan feature that most wireless systems have built in is very limited and doesn't give you a total picture of what is going on. The frequency coordination software, and hardware in some cases, will allow you to input your systems and frequency ranges and show where the intermodulation is happening between them all. Most will allow for putting in your zip code and show TV stations in the area as well. Working with an integrator that uses these tools vs. simply picking something out online can normally save you money and steer you in the right direction from the beginning."

Note that many systems, especially the digital ones, can transmit at various RF levels. A lower setting can be used when longer distances are not necessary, thus significantly lessening the chance of systems in use in different areas affecting each other.

Blips, cracks, dropouts, fuzz, and any other combination of audio disruptors sabotage both the quality and effectiveness of any weekend service or event. Not only is it distracting for the audience but equally frustrating for the person on stage. If there's one place where getting the best you can afford is critical, or even holding off to save up a few more months, your lead pastor's wireless system should be that place.

Think of this as your insurance policy. Having peace of mind that mission-critical gear is going to be rock solid week in and week out is worth every penny spent. Urgent now, more than ever, is buying gear that will be usable



The RF landscape changes with time, so don't assume the frequency coordination that worked last Easter will work again this year.

for a long time. This means wireless equipment with the widest tuning range and highest spectral efficiency you can afford.

THE FUTURE LANDSCAPE

James Stoffo, founder of Professional Wireless Systems in Lincoln, Neb., says all wireless users need to prioritize wireless preparation in the near future.

“Severe decrease in availability of UHF radio spectrum, over-congestion of the remaining spectrum, and introduction of white space devices will require wireless microphone operators to play every trick and implement the best practices possible even to get a few wireless microphones to function properly. In addition, it is not as easy for a church to obtain the required

Part 74 FCC license, which enables priority over these consumer digital radio devices. Churches should be prepared to rely on RF expertise to maximize their chances for successful wireless audio operations.”

Although each individual situation will present its own circumstances and approach, all of the industry experts above agree on several points for any house of worship:

- **Stay away from purchasing any wireless gear in the 600 MHz range.**
- **Buy the best equipment you can afford.**
- **Work with a qualified integrator for system and frequency coordination.**
- **Develop and pursue a wireless equipment plan rather than waiting before it's too late.**



Sennheiser evolution D1 Wireless System

Designed for small- and medium-sized applications, the Sennheiser D1 system is designed for ease-of-use, high sound quality and extended operating range.





Develop and pursue a wireless equipment plan rather than waiting before it's too late.

While the wireless landscape for 2016 and beyond can spark confusion and a sense of complexity, by taking proactive steps forward, employing the use of wireless integration professionals, and seeking continual education, we can confidently position ourselves on solid footing.

BEN COLEMAN *has been a sound engineer and production manager since 2006 for a variety of Christian and mainstream artists, as well as several churches. From 2010-2014 he was a percussion instructor at the University of Nebraska Lincoln and continues to teach and write for various high school percussion programs. He is currently a freelance audio engineer based out of Lincoln, Neb.*

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