Violating Wi-Fi Best Practices

Customizing SMB Wi-Fi for Unique Applications

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IT Professional Wi-Fi Trek 2016

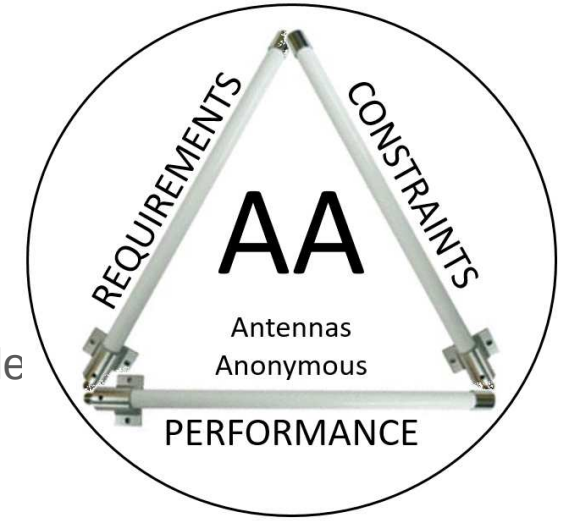
State of the Wi-Fi Industry

Wi-Fi: It's Not Just the Spectrum That's Unlicensed

- "Firms should treat Wi-Fi like other utilities." @KeithRParsons, 8/24/16
- Other utility trades require training, apprenticeships, and professional licenses
  - Electricians (high voltage)
  - Plumbers
  - Architects
  - Engineers (Mechanical / Structural)
  - HVAC
- Only regulatory requirements are from FCC
  - Applies only to AP radio hardware
  - Does not apply to managed systems for controlling and monitoring APs
  - Does not apply to deployment of Wi-Fi (installation, or maintenance)
- Most customers (installers and MSPs) have never even heard of CWNP, let alone have any certifications themselves

Deploying Wi-Fi does not require any formal education, certification, or licensing.

Wi-Fi: An Industry of “Enablers”



- For 17 years, the industry has touted how “easy” Wi-Fi is
  - DIY: Just go to your local electronics retailer, buy whatever is on sale and plug it in
  - “Put the APs wherever you want, we’ll make it work in firmware”
  - Marketing “ease of use” discourages customers from becoming educated about Wi-Fi
- As Wi-Fi Gets Harder, Vendors Add More Complexity to “Keep it Simple”
  - Invest in ludicrously complicated radio resource management (RRM) algorithms to tune channel and transmit power. We know these cannot work in a generic sense!
  - New startups (e.g. Eero) “making it easy” with cloud management, auto configuration, mesh…

“I think I'm just going to build my own WAPs. Can't be that hard. Who wants to invest?” – @BadAtWiFi, 2/25/2016

Wi-Fi: An Industry Obsessed with Speed

- Market Wi-Fi based on idealized MCS rates, not throughput
  - MCS rates are not related to achievable throughput
  - Under ideal laboratory conditions, measured throughput is 45% of MCS
- Advertise features for speed… that are not actually usable
  - 40 MHz bonded channels at 2.4 GHz, & 160 MHz bonded channels at 5 GHz
  - 3 spatial stream 802.11n/ac APs, when most clients are single stream or dual stream
  - 256 QAM requires an SNR of >37 dB @ 80 MHz (< 15 feet from AP) @RevolutionWiFi
- Can't go faster, go parallel: 802.11ac wave 2, 802.11ax, MegaMIMO @MIT
  - Will this extra complexity really have any meaningful impact in real-world scenarios?
  - "802.11ac wave 2 is dead!" – misattributed to @DevinAkin

"The box says the AP can go up to 300 Mbps. How do I push 300 Mbps through this PTP link?" – actual customer quote, 9/2015 ***#WhyIDrink***

Wi-Fi: An Industry Out of Control

http://successify.net/wp-content/uploads/2013/07/attitude-and-effort.jpg

- Wi-Fi Alliance struggling to maintain relevance
  - "Wi-Fi Certified" has no meaning: interoperability is (mistakenly) assumed
- "2.4 GHz is dead!" @DevinAkin
  - Medical and IoT still deploy 2.4 GHz only devices
  - Installers still follow design rules relevant to 2.4 GHz, not 5 GHz
  - Like IPv4, 2.4 GHz will not die anytime soon
- LTE-U and LAA-LTE: 5 GHz is no longer "sacred space"
  - Technical studies indicate that these technologies will compromise Wi-Fi performance
- You get what you measure
  - Every client device tells you signal strength. No client device tells you signal interference.

"The fault, dear Brutus, is not in our stars, but in ourselves, that we have Bad-Fi." – William Shakespeare [misquoted]

Wi-Fi: Damn, This is Fun!

- As Certified Wireless Professionals, it is our job to…
  - Understand and address the requirements and constraints of our customers
  - Sell the **right** equipment, not just **more** equipment
  - Improve the level of professionalism in our organizations and the industry
  - Acknowledge our mistakes, fix them, and learn from them
  - Educate our customers
  - Mentor our successors
  - Refine our own craft

http://www.thecoastercritic.com/wp-content/uploads/2015/05/Carowinds-Closes-Thunder-Road-Roller-Coaster.jpg

"Sometimes it's HUGE enterprises, sometimes SMB. Still Wi-Fi and I love it all! #WiFiForever !" – @grcate, 9/16/2016

Wi-Fi in the SMB Market

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What is the SMB Wi-Fi Market?

- Not Enterprise, but…
  - Many enterprise vendors try to sell into this space with downscaled products
  - Many of the same requirements (coverage, capacity, reliability, etc.)
- Not Consumer, but…
  - Many consumer vendors try to sell into this space with upscaled products
  - Many SMB installations try to get away with consumer gear
- Small-to-Medium Business (SMB) is…
  - Fastest growing Wi-Fi market segment

"Wherever there's a deep human need, there's money to be made!"
- Brian Hope, Nuns on the Run (1990)

Challenges of Doing Business in SMB Wi-Fi

- Budget
  - Less expensive equipment
  - Economize on the quantity of equipment
  - Do not want to pay for any professional services (predictive modeling, site surveys, troubleshooting, consulting)

https://encrypted-tbn2.gstatic.com/images?q=tbn:ANd9GcTqNLYu3ajlI3rDoj5wO4lrEw8_oDDXoE3ZnImISwdRa6bZFc4E5g

- Increasing Expectations
  - >5 year expected lifetime
  - Requires design for tomorrow, not today
  - Even “coverage only” designs require capacity considerations
- Highly Fragmented Market
  - Service Providers (low voltage electricians, IT technicians, part-time consultants)
- Lack of knowledge and lack of proper tools
- Last minute

The SMB Wi-Fi Market Spans Diverse Verticals

- Large private homes
- Apartment complexes
- Condominiums
- RV parks
- Student housing
- Assisted living
- Hotels
- Cafés / Restaurants
- Professional offices (doctor, dentist, lawyer)
- Retail
- Houses of Worship
- Small private schools
- Parks
- Warehouses / Factories

All of these verticals have different requirements and constraints!

How to be Successful at SMB Wi-Fi

- Build a large customer-base across many different verticals
  - Establish relationships
  - Build trust
- Need to proactively educate the customer
  - Most customers don't understand RF
  - Many customers don't understand basic networking
  - Provide guidance on specific customer applications
- Make the equipment "easy" to use
  - Choosing "intelligent defaults" to guide customers into doing the right things
  - Tradeoff between features and nerd-knobs
- Mass Customization
  - Repeat the use of the same equipment and configurations over and over again
  - Tradeoff between variety of products and limiting the options
  - Some problems require out-of-the-box solutions

Establish Best Practices… But Don't be Constrained by Them.

Field Application Engineering (a.k.a. My Day Job)

- Product Engineers make hardware
- Field Application Engineers (FAEs) make the hardware work in real applications
  - System Engineers (SEs)
  - Pre-Sales Engineers
- Understand the product from the customer's perspective (i.e. how is it **used** to create a system)

- Pre-Sales Engineering
  - Work with sales and customers to understand requirements and constraints
  - Develop Bill of Materials (BoM) and recommended settings (location, channel, transmit power)
  - Establish Best Practices
  - Provide online and hands-on education
- Post-Sales Support (Level 3)
  - Fixing bad implementations (as much as possible)
  - Detect and resolve "undocumented features"

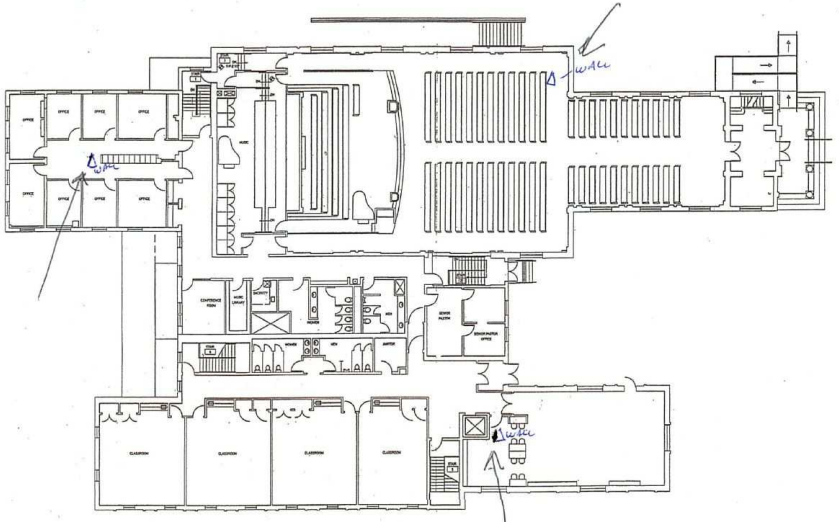
Limitations of Field Application Engineering in SMB

- Limited amount of time “in the field”
  - SMB customers won’t pay for site visits, surveys, or field troubleshooting
  - Sales calls: bulk of visits for establishing relationships with distributors / large customers
  - High volume: Don’t have the money or personnel to visit every job site
- Last minute
  - Every job is a rush job
  - In new construction, Wi-Fi is still often an “afterthought” left to the very end of the project

Designing Networks Like It's 1999 (or 20**0**6)

- Church
- Two levels
- Sanctuary holds 500 people
- Fellowship / social hall holds 500 people
- Classrooms and offices on both levels
- Our design: 23 APs

WPC Upper Level (Sanctuary & Chapel)

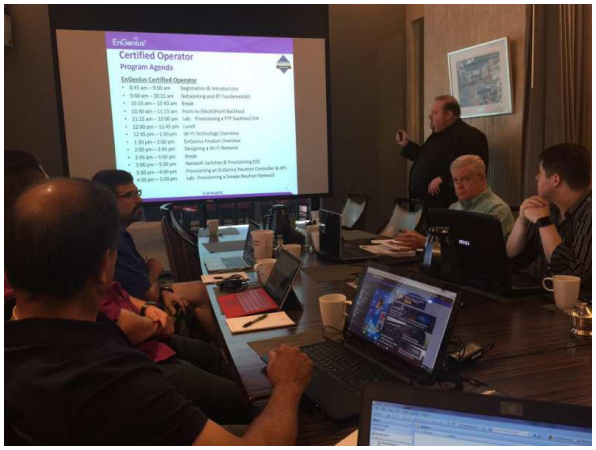


"Attached is the floor plan. The arrows point to where I think we would plan the access points. Because of the block walls, I let them know we may need to add 1-2 access points, past the initial 7." ***#WhyIDrink***

Making FAE Successful

Educating the Customer

- Online Certification
  - Minimal Level of Knowledge that all customers should have
  - Basic Best Practices
- Monthly Hands-on Two Day Course
  - Certified Operator: Networking and Wi-Fi Fundamentals, Wi-Fi Industry Overview, Antenna Technology, Point-to-Multipoint, Wi-Fi Design
  - Certified System Engineer: Client Isolation, VLANs, Subnet Masks, Switches, Security, MCS Rates, Troubleshooting
  - Multiple hands-on lab exercises

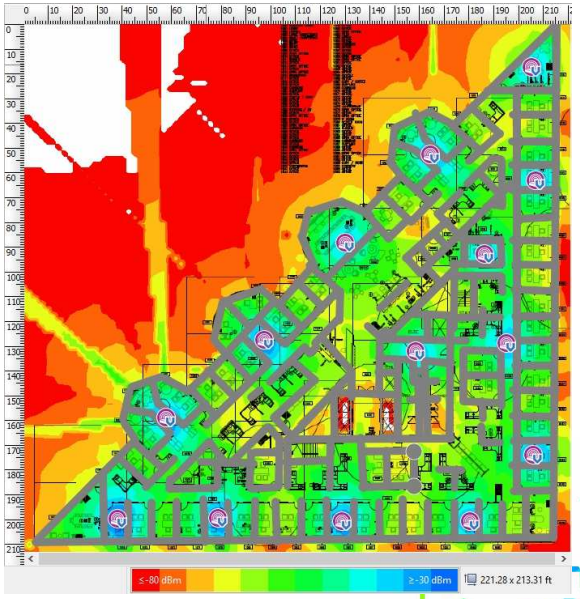


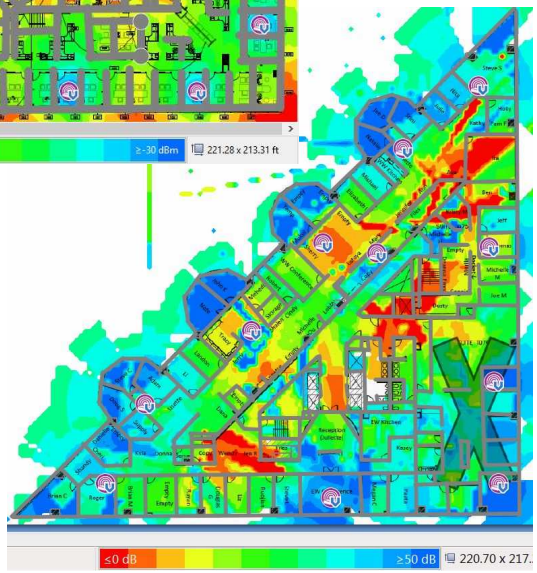
EnGenius Certified Operator and System Engineer training course.
- Los Angeles, CA 9/2015

Making FAE Successful

Predictive Designs as a Sales Tool

- Offer free predictive design modeling for larger opportunities
  - Bill of Materials
  - AP Locations
  - Channel and Transmit Power settings
  - Best Practices guidelines
- Rely upon the customer to perform site surveys
- Most customers don’t, because they lack both the knowledge and the necessary tools





Optimizing the Predictive Design

- Truth of any mathematical model: ***Garbage In, Garbage Out***
- The designer requires intuition
  - First look at a project to estimate the quantity and placement of without ANY modeling
  - Skill that is honed with experience
- The predictive model therefore refines the initial engineering estimate
- If there is a large discrepancy between estimate and model:
  - Option 1: Mistake in your assumptions
  - Option 2: Mistake in the model

So Why Even Bother Doing Site Surveys?

a.k.a. Why @EmperorWiFi is not guilty of blasphemy…

- Rule 1: Customers lie (or at least are “in error” where facts are concerned)
- Rule 2: The floor plans never tell the whole story
- Site survey is intended to refine your predictive model, and catch things you didn’t know up front
- Site survey still requires an up-front estimate of how AP signals will propagate
- Large discrepancies with the predictive model:
  - Option 1: Mistake in your estimate (bad assumptions in predictive model)
  - Option 2: Mistake in your site survey procedure

More Unusual SMB Wi-Fi Applications

RV Parks / Campgrounds / Marinas

Application Requirements

- Seasonal
- Portable devices
- “Low density” usage
- Ruggedized equipment
- Coverage & backhaul challenges
  - Trees (heavily wooded)
  - Large distances
  - Limited mounting options (existing poles)
  - Point-to-(Multi)point Backhaul

Source: http://www.mtrv.com/images/RVParkSitesNorth.jpg

RV Parks / Campgrounds / Marinas

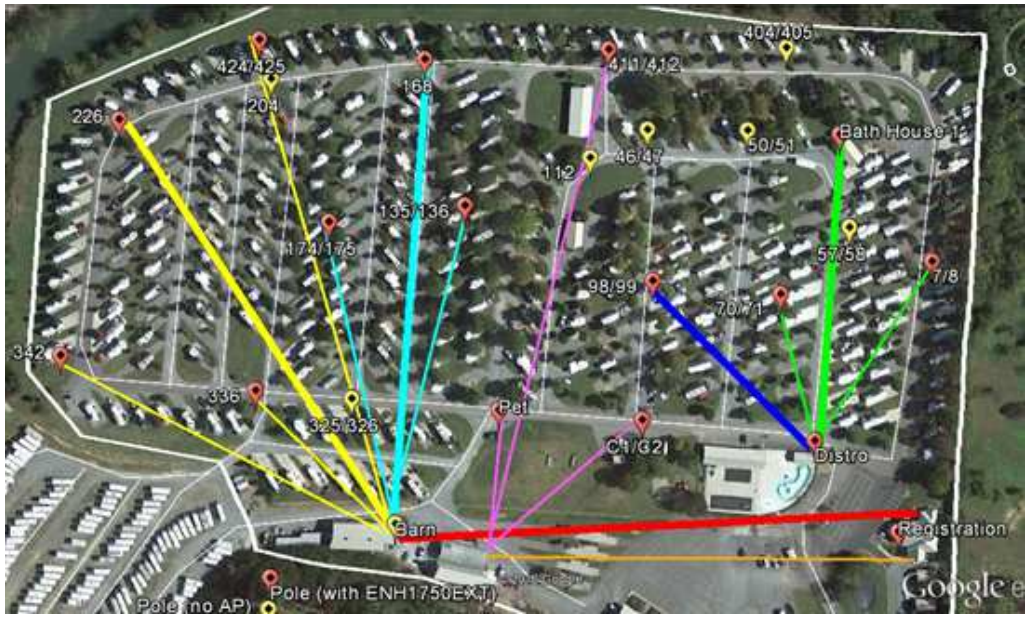
RV Park Design Example: Knoxville, TN

- 18 dual-band managed outdoor APs mounted on poles and buildings
- No central wiring for backhaul
- Wi-Fi on 2.4 GHz, Mesh on 5 GHz (20% with PTP backhaul links)
- Original Design: Capacity Issues
  - 40+ clients per AP (10-15 per AP assumed)
  - Backhaul could not sustain traffic load

RV Parks / Campgrounds / Marinas

RV Park Design Example: Knoxville, TN

- New Design
  - Provide Wi-Fi service on both bands (UNII-1 and UNII-3 on 5 GHz)
  - PTP links to every access point
  - Additional PTP links to MDF (lower right corner) – UNII-2 and UNII-2e on all PTP links



Remote Surveillance Point-to-Multipoint

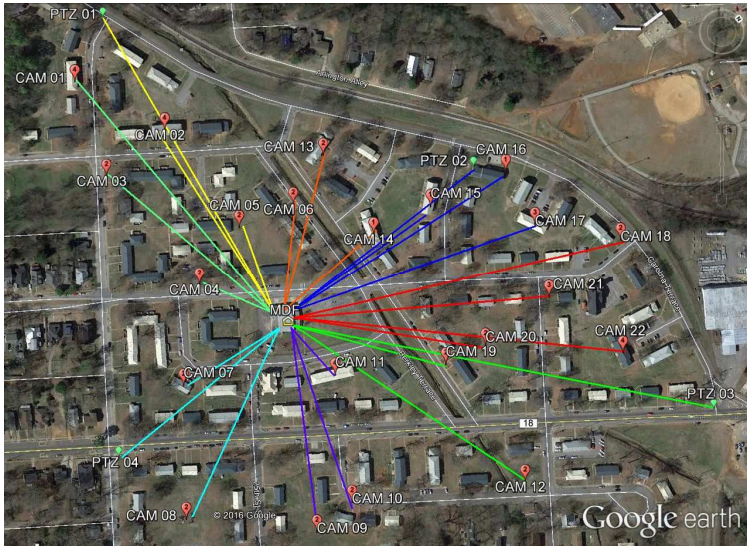
Surveillance Design Example: Brooklyn NY

- 59 buildings built in 1940s
- 16 cameras + NVR per building, security NOC
- No central wiring, each rooftop had line of sight
- 15 PTP radios on rooftop, shielded tower allowed for channel reuse

Remote Surveillance Point-to-Multipoint

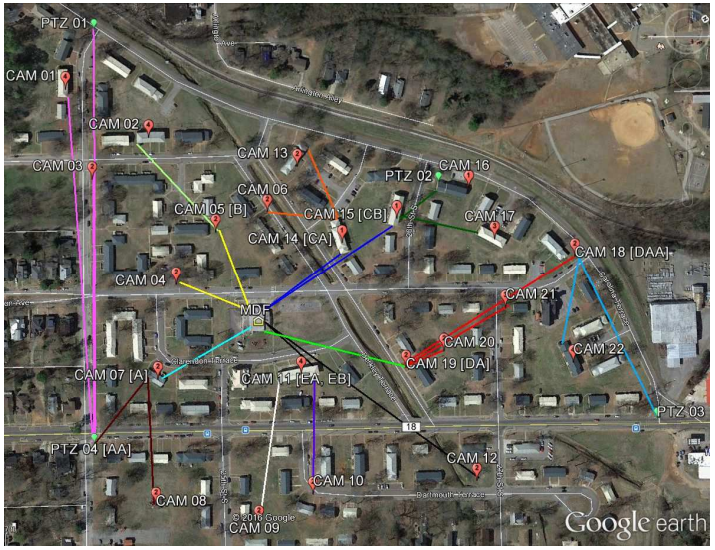
Surveillance Design Example: Bessemer, AL

Ideal Line of Sight



- 32 directional APs in WDS bridge mode
- Assumes RF line of sight to all locations

Actual Line of Sight

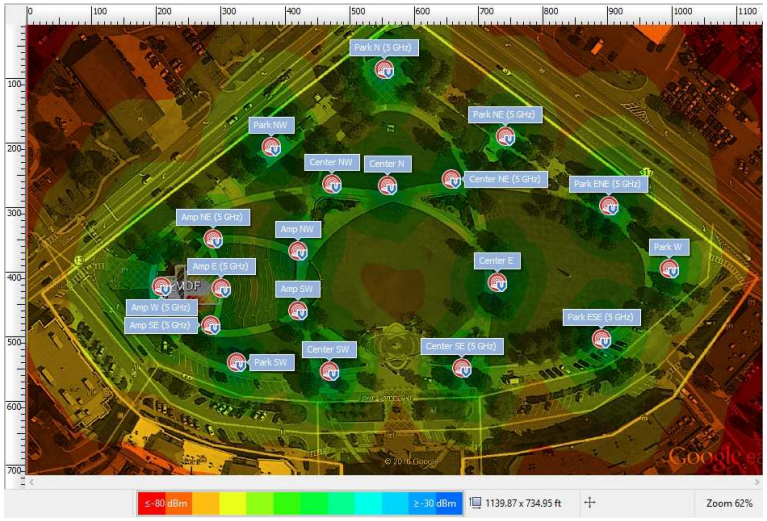


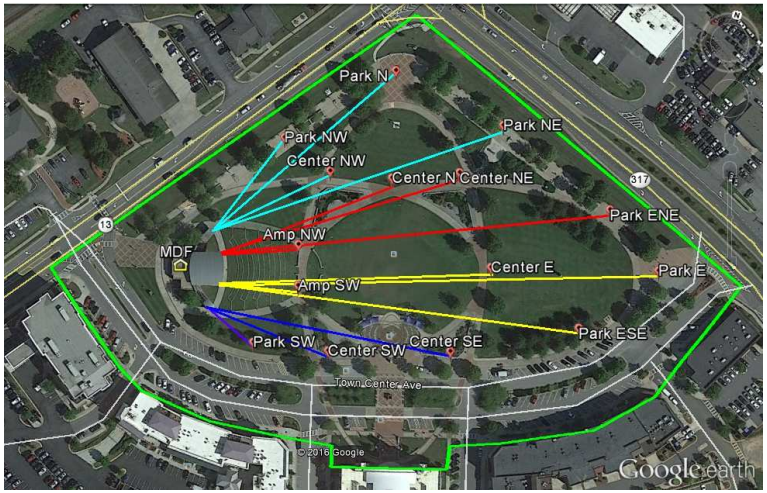
- 38 directional APs in WDS bridge mode
- Accommodates actual environment by avoiding building and trees

Public Parks

Design Example: Suwanee, GA

- Concert / event venue (west side)
  - High capacity
- Vendors with credit card readers along edge of the park (south side)
  - PCI-DSS compliance
- Limited budget
- Point-to-multi-point backhaul to each AP
- 19 802.11ac outdoor APs (7 on 5 GHz only)

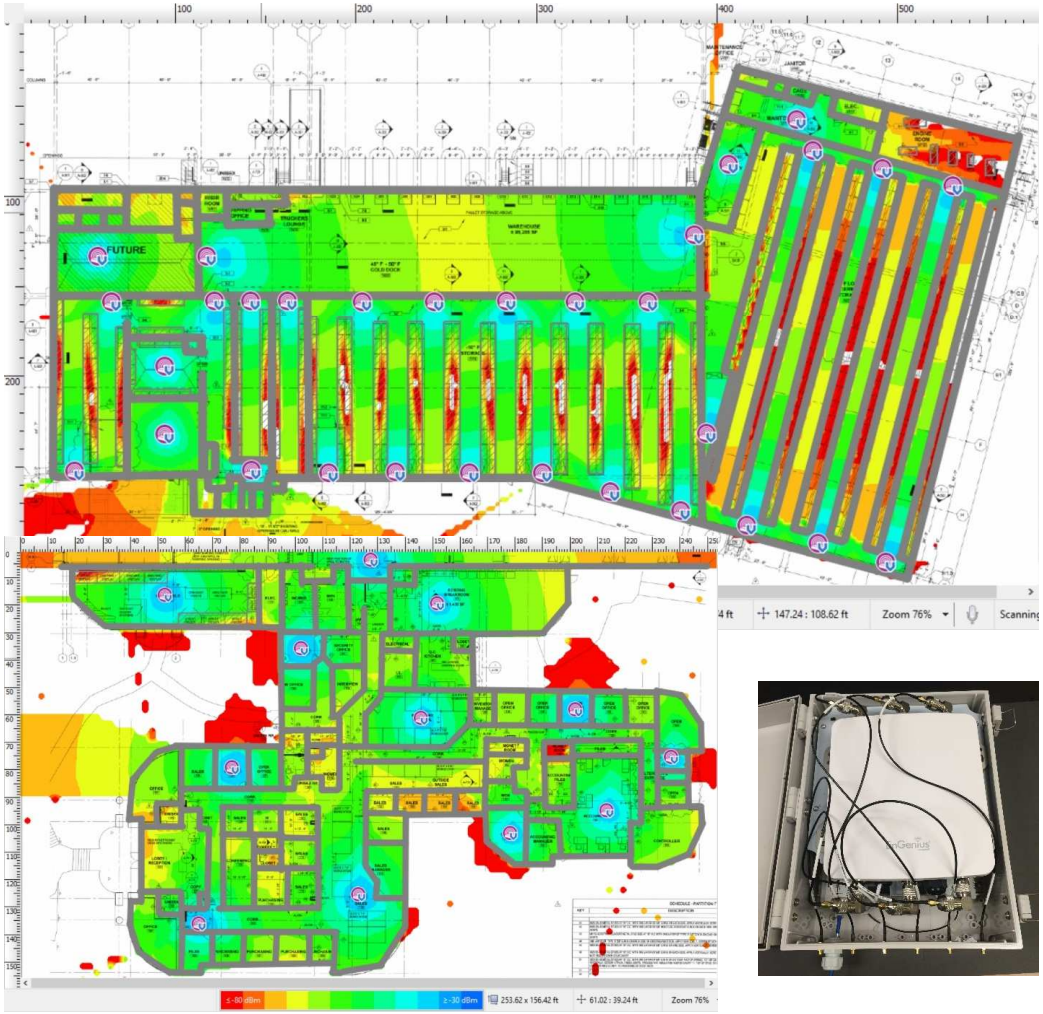




Cold Storage

Seafood Warehouse, Atlanta, GA

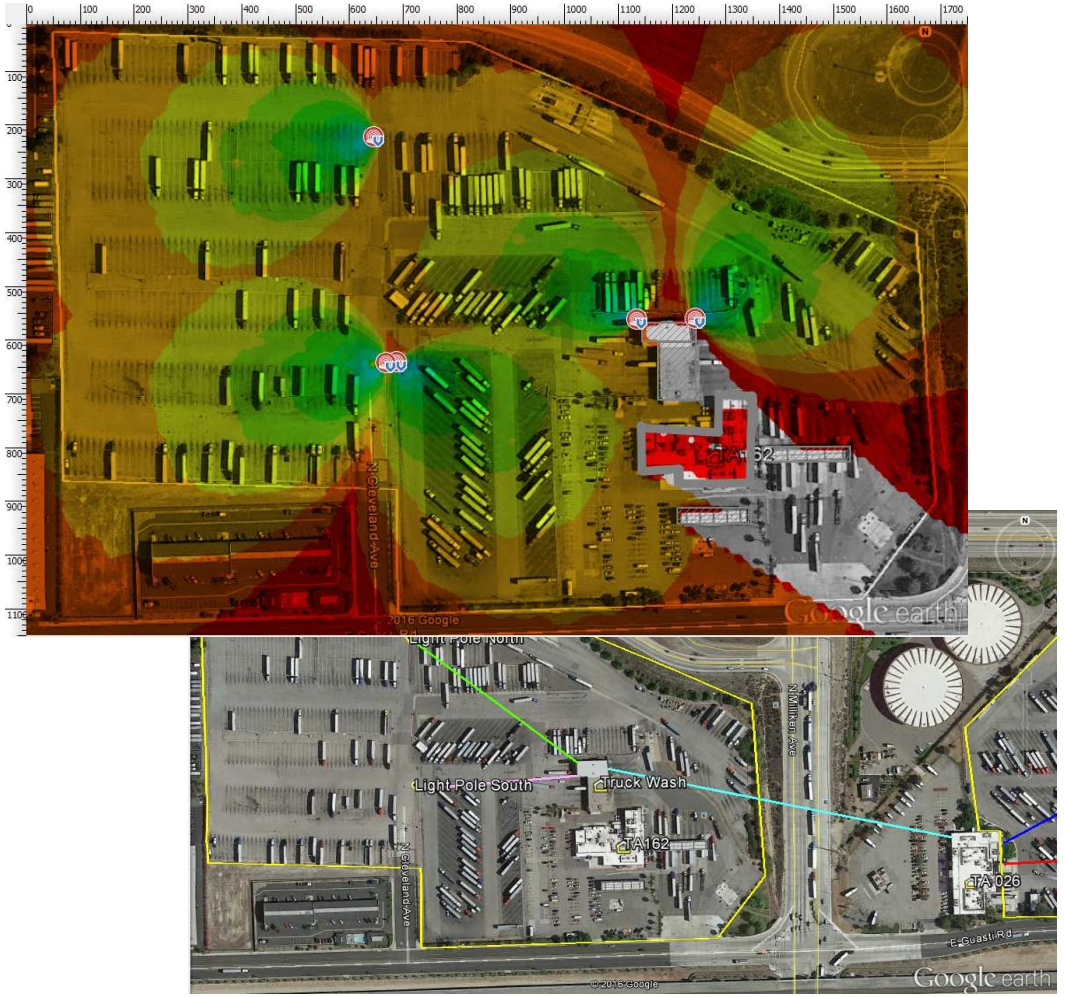
- Corporate offices
  - Omni-directional ceiling APs
- Regular warehouse
  - Directional antennas for each aisle
- Cold storage warehouse -30ºF
  - Directional antennas with heated NEMA enclosures
  - Partnered with antenna / NEMA enclosure manufacturer for full solution



Truck Stops

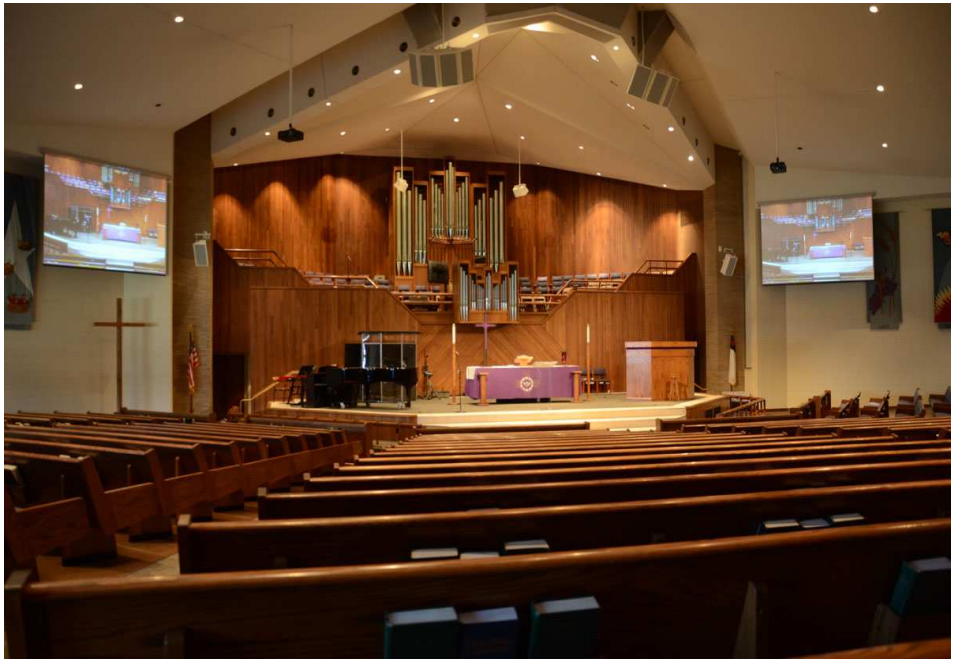
Various Locations around USA

- Wi-Fi access for truckers when spending time at a truck stop along the highway
- Wi-Fi router inside cab, with 5 GHz omni antenna for backhaul outside
- Sector antennas for large area coverage
- PTP links for backhaul



Houses of Worship

- Mixed capacity & coverage requirements
  - High capacity areas (main sanctuary)
  - Moderate capacity areas (classrooms, offices, community facilities)
- Not just for boring sermons
  - Doing away with prayer books
  - Have parishioners call up bible and service on tablets and smartphones with custom apps

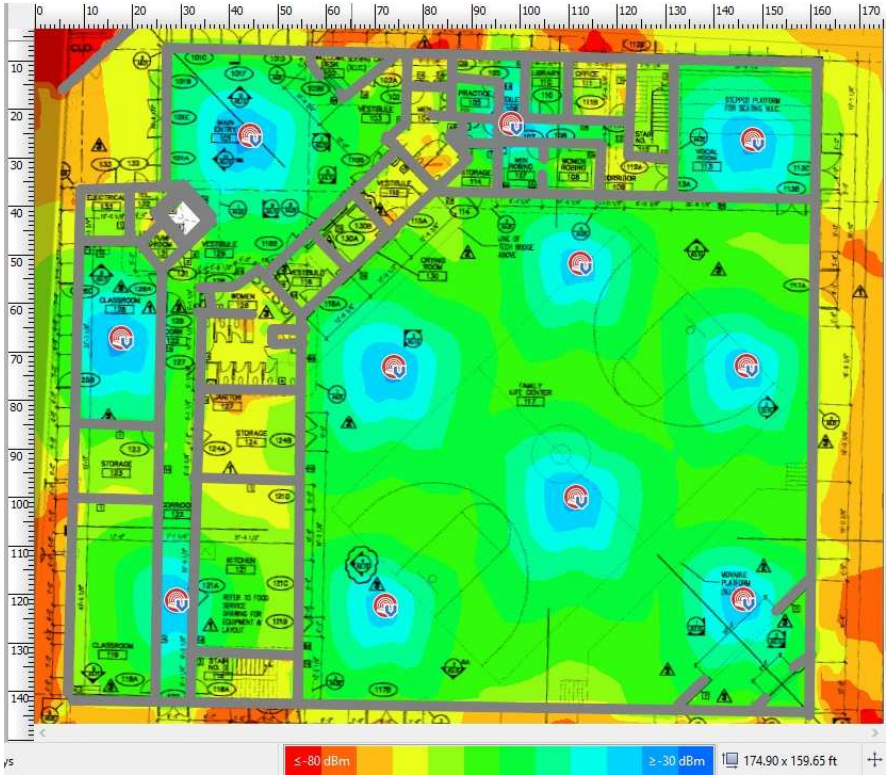


Source: http://audioengineeringgroup.com/site/uploads/house.jpg

Houses of Worship

Design Example: Church with Multi-Use Space

- Two levels
- 1000 seat sanctuary including balcony
- Classrooms and choir rehearsal space
- 6 APs (802.11ac wave 1) in main sanctuary (3 set for 5 GHz only)
- 10 APs (802.11ac wave 1) for coverage in classrooms & offices



Houses of Worship

Design Example: Mini Mega Church

- 800 seat sanctuary w/ 20’ vaulted ceiling
- Offices, café classrooms, locker rooms, gymnasium
- 8 APs (802.11ac wave 2) on walls of sanctuary
- 21 APs (802.11ac wave 1) elsewhere

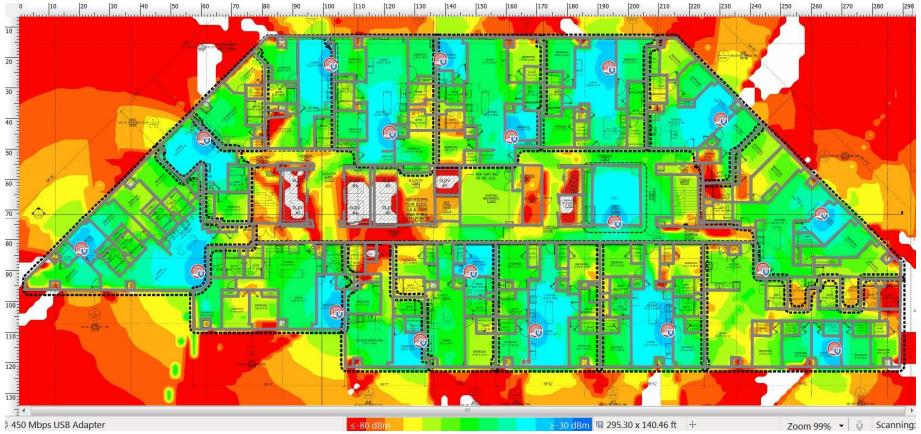
Student Housing

- High bandwidth consumption
- High number of devices per user
- Pervasive abusers (e.g. BitTorrent)
- Entitlement-minded
- Wired and wireless
  - Co-channel interference from students setting up their own consumer wireless routers

Student Housing

Design & Troubleshooting Site Survey Example: Charleston, SC

- 22 floor high-rise (19 residential floors)
  - Common area floor + outdoor pool
  - Two IDF closets per floor, wired & wireless
  - 260 apartments, 851 residents
- 166 access points (roughly 17 per floor)
- Site Survey results
  - Cheap construction, especially between floors: too many APs
  - Vendor put all 5 GHz radios on UNII-1 and UNII-3 only, 80 MHz channels
  - Massive numbers of third party access points (seen in several student rooms per floor)

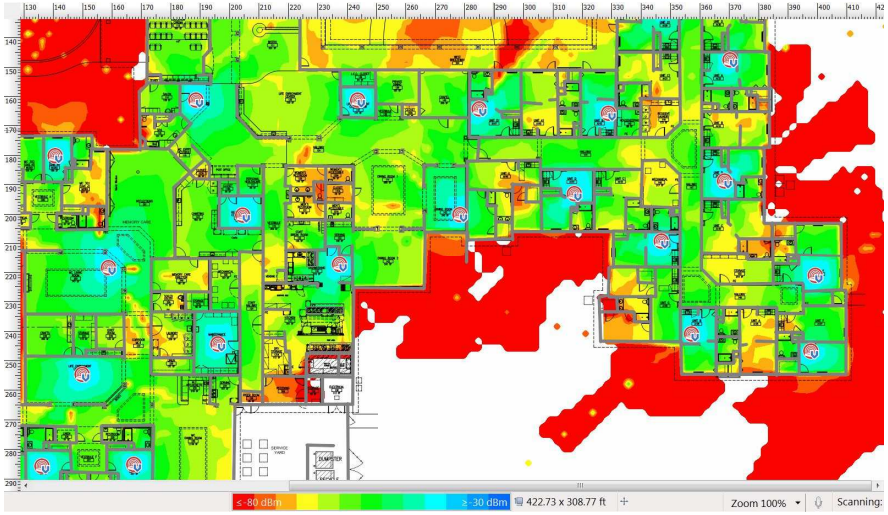


Assisted Living

- Medical records integration / HIPAA compliance
- Ultra-high availability / redundancy –
  - No tolerance for downtime
- Primary focus: Operations
  - Real-time location services (RTLS) for resident and inventory tracking
  - Real-time patient vitals monitoring / sensors
- Secondary focus: Resident Internet

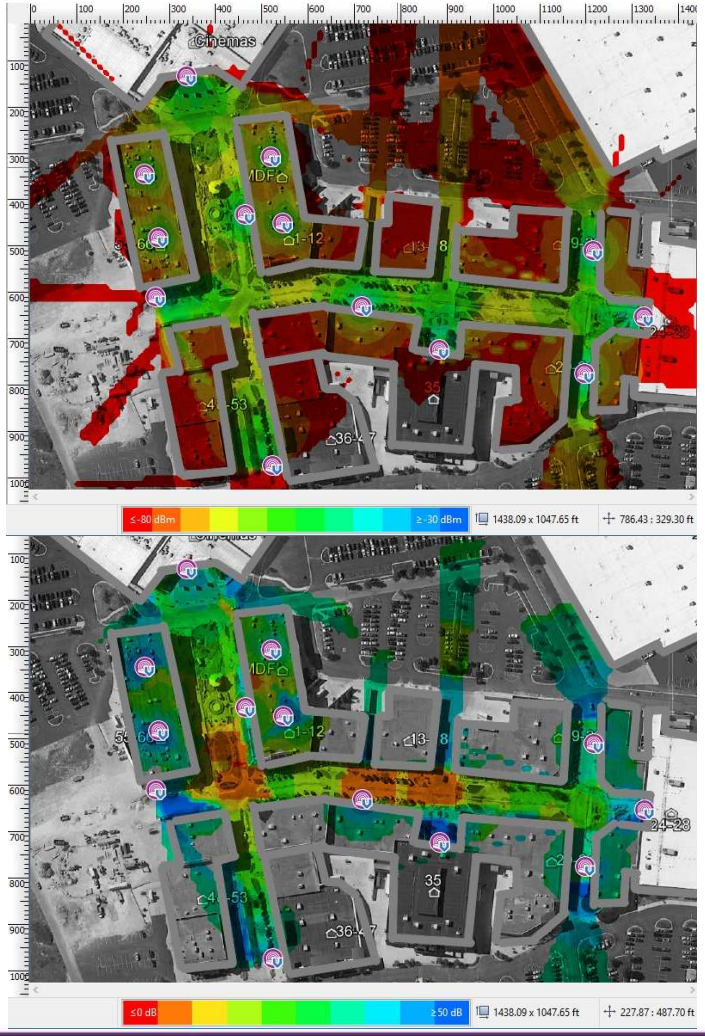
Assisted Living
Design Example

- ~350 resident capacity, two main sections
- Resident and staff networks
- Future expansion: IoT / patient monitoring
- 45 APs (802.11ac wave 1)
  - Approximately one AP per 3-4 patient rooms
- Often a good application for wall-plate APs



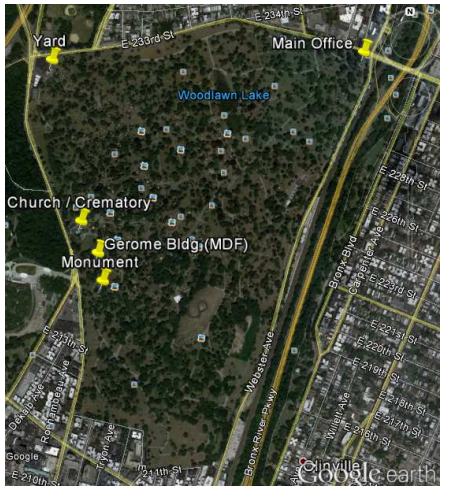
Shopping Malls
Design Example

- Outdoor coverage for mall patrons
- >400 simultaneous users during peak events (e.g. Christmas pageants, fairs, etc.)
- Office / Staff network for maintenance
- Future expansion:
  - Surveillance
  - Wi-Fi for tenants
- 19 APs (802.11ac wave 1)
  - 5 802.11ac wave 1 APs with sector antennas
  - 14 indoor and outdoor 802.11ac wave 2 APs



Other Interesting Applications

- Hazardous Waste Treatment
  - Barcode scanners
  - Explosion-Proof Electronics
- Mine Shafts
  - 5 GHz does not propagate well underground
  - FCC regulations don't apply, so long as they don't penetrate the surface
- Cemeteries
  - National historical landmark
  - Multiple Internet feeds at different sections of the property
  - Initial: Event spaces (e.g. concerts)
  - Long-term: Full property Wi-Fi, surveillance



"I am many things. No one thing defines me."
– Keeping the Faith, 2000

Conclusions

- Diverse set of verticals
- Requires both breadth of knowledge and depth of understanding
- Don’t have the luxury of doing it “by the book” – so ***re-write*** the book
  - Lack of customer knowledge and expensive “tools”
  - Lack of on-site surveys
  - Lack of money
- It needs to “just work”. It doesn’t need to be “perfect”.

“Perfectionism is a form of procrastination.”
– David A. Fields, 9/14/2016