

Wireless: From the Desktop to the Rooftop

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Wireless Technology

Wireless is not a “nice to have”: it’s expected by everyone and used everywhere.

The trick is selecting the most efficient and cost-effective technology for the application given the project’s often conflicting financial, technology, operational, organizational and administrative objectives.



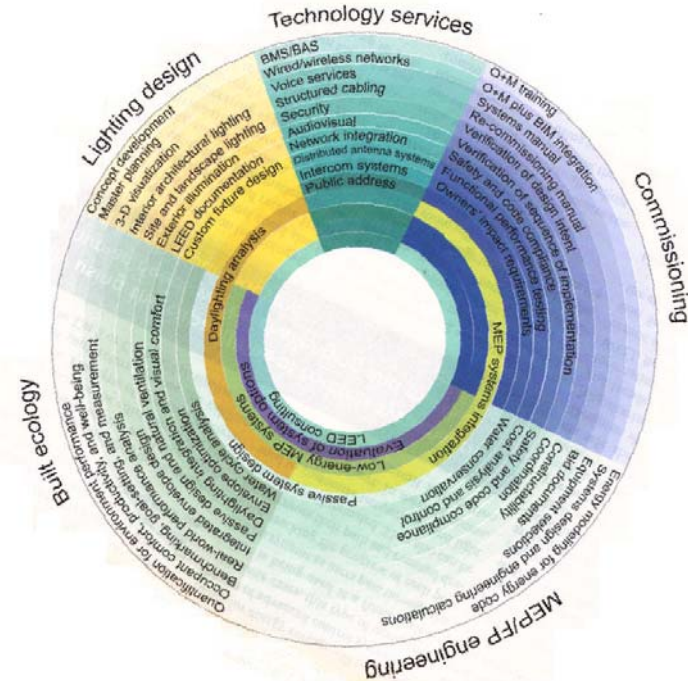
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Wireless Technology

Cabling + Wireless Technology = Opportunity



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Wireless Technology: Applications

- **Voice:** Telephony, radio, cellular
- **Data:** Wireless LANs, cellular
- **Connectivity:** Internet of Things **IoT** Industrial IoT **IIoT** Machine-to-Machine **M2M**
- **Security:** cameras, detectors, door sensors, latch bolt sensors
- **Buildings:** control, automation, management
- **Telemetry:** sensors
- **Tracking:** GPS, RFID, asset control and tracking, inventory control

Wireless Technology: Whatever Works

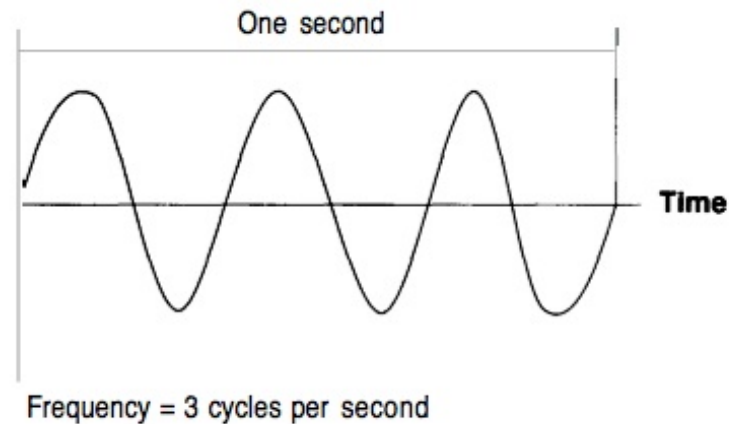


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Wireless Technology: Terminology

Frequency: The number of times per second a signal repeats. In 1960 ISO replaced “Cycles Per Second” (CPS) with “Hertz” (Hz) in honor of the German scientist, Gustav Hertz.



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Wireless Technology: Terminology

Prefix	Symbol	1000 ^m	10 ⁿ	Decimal	Short scale	Long scale	Since ^[n 1]
yotta	Y	1000 ⁸	10 ²⁴	1 000 000 000 000 000 000 000 000	Septillion	Quadrillion	1991
zetta	Z	1000 ⁷	10 ²¹	1 000 000 000 000 000 000 000	Sextillion	Trilliard	1991
exa	E	1000 ⁶	10 ¹⁸	1 000 000 000 000 000 000	Quintillion	Trillion	1975
peta	P	1000 ⁵	10 ¹⁵	1 000 000 000 000 000	Quadrillion	Billiard	1975
tera	T	1000 ⁴	10 ¹²	1 000 000 000 000	Trillion	Billion	1960
giga	G	1000 ³	10 ⁹	1 000 000 000	Billion	Milliard	1960
mega	M	1000 ²	10 ⁶	1 000 000		Million	1960
kilo	k	1000 ¹	10 ³	1 000		Thousand	1795
hecto	h	1000 ^{2/3}	10 ²	100		Hundred	1795
deca	da	1000 ^{1/3}	10 ¹	10		Ten	1795
		1000 ⁰	10 ⁰	1		One	–
deci	d	1000 ^{-1/3}	10 ⁻¹	0.1		Tenth	1795
centi	c	1000 ^{-2/3}	10 ⁻²	0.01		Hundredth	1795
milli	m	1000 ⁻¹	10 ⁻³	0.001		Thousandth	1795
micro	μ	1000 ⁻²	10 ⁻⁶	0.000 001		Millionth	1960
nano	n	1000 ⁻³	10 ⁻⁹	0.000 000 001	Billionth	Milliardth	1960
pico	p	1000 ⁻⁴	10 ⁻¹²	0.000 000 000 001	Trillionth	Billionth	1960
femto	f	1000 ⁻⁵	10 ⁻¹⁵	0.000 000 000 000 001	Quadrillionth	Billiardth	1964
atto	a	1000 ⁻⁶	10 ⁻¹⁸	0.000 000 000 000 000 001	Quintillionth	Trillionth	1964
zepto	z	1000 ⁻⁷	10 ⁻²¹	0.000 000 000 000 000 000 001	Sextillionth	Trilliardth	1991
yocto	y	1000 ⁻⁸	10 ⁻²⁴	0.000 000 000 000 000 000 000 001	Septillionth	Quadrillionth	1991

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Wireless Technology: Frequency Allocations

- AM Radio: 580 to 1610 KHz
- Public safety (fire, police) 25 to 50 MHz
- Former low-band VHF TV channels 2 to 6 54 - 88 MHz Channel 1?
- FM Radio 88 to 108 MHz
- Aviation communications and navigation 108 to 136 MHz
- Various agencies and usage 136 to 150 MHz
- Public safety (fire, police) 150 to 174 MHz
- Former high-band VHF TV channels 7 to 13 174 to 216 MHz



Wireless Technology: Frequency Allocations

AERONAUTICAL MOBILE (R)				136.0
AERONAUTICAL MOBILE (R)				137.0
MOB. SAT. (S-E)	SPACE RES. (S-E)	SPACE OPN. (S-E)	MET. SAT. (S-E)	137.025
Mob. Sat. (S-E)	SPACE RES. (S-E)	SPACE OPN. (S-E)	MET. SAT. (S-E)	137.175
MOB. SAT. (S-E)	SPACE RES. (S-E)	SPACE OPN. (S-E)	MET. SAT. (S-E)	137.825
Mob. Sat. (S-E)	SPACE RES. (S-E)	SPACE OPN. (S-E)	MET. SAT. (S-E)	138.0
FIXED		MOBILE		144.0
AMATEUR		AMATEUR SATELLITE		146.0
AMATEUR				148.0
MOBILE SATELLITE (E-S)	FIXED	MOBILE		149.9
RADIONAV-SATELLITE		MOBILE SATELLITE (E-S)		150.05
FIXED		MOBILE		150.8
FIXED		LAND MOBILE		



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Wireless Technology: Licensed Operations

Licensed Radio Operations: A frequency or radio service that requires coordination with other users, the approval of the Federal Communications Commission and the issuing of a radio license.

Examples:

- Commercial AM/FM and TV stations
- Cellular radio base stations
- Fire, police and EMS radios
- Some microwave systems
- Amateur Radio Service (ham radio)



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Wireless Technology: Unlicensed Operations

Unlicensed Radio Operations: A frequency or radio service that does not require a license from the Federal Communications Commission.

Examples:

- Wireless Local Area Networks
- Microwave ovens
- Cordless phones
- Citizen band and Family Radio Service
- Remote control cars and planes
- Garage door openers



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Wireless Technology: Licensed & Unlicensed

Some radio systems are a combination of licensed and unlicensed services.

- Companies that operate cell phone networks must have an FCC license, but the end-user buys a phone and starts using it.
- Within the United States, a pilot doesn't need a radio operator's license, but must obtain an aviation radio operator's license when flying into a foreign country.



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Wireless Technology: Interference

Unlicensed radio frequencies are subject to FCC technical standards and specifications. However, assuming the equipment is operating correctly and complies with FCC specifications, there is no protection from interference when using unlicensed frequencies.

The main subject of this presentation are the unlicensed 2.4 GHz and 5.0 Industrial, Scientific, & Medical (ISM) bands of frequencies. As the name ISM implies, many different types of equipment are designed to use the same frequencies. The result may be interference and poor communications.



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Wireless Technology: Frequency Allocations

Primary Unlicensed Industrial, Medical, Scientific (ISM) Frequencies

- 902 - 928 MHz (cordless phones, wireless microphones)
- 2.400-2.483 GHz (Allocated worldwide for unlicensed operations)
- 5.150-5.350 GHz (US)
- 5.725-5.825 GHz (Canada)



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Wireless Technology: By Mission Profile

- **Ultra short-range:** Near-Field Magnetic Communications
- **Very short-range:** Zigbee
- **Short-range:** Bluetooth, Low Power Bluetooth, Ultra-Wide Band
- **Local Area Networking:** Wi-Fi
- **Metro or Campus:** WiMAX
- **Point-to-Point:** Wi-Fi, microwave, laser



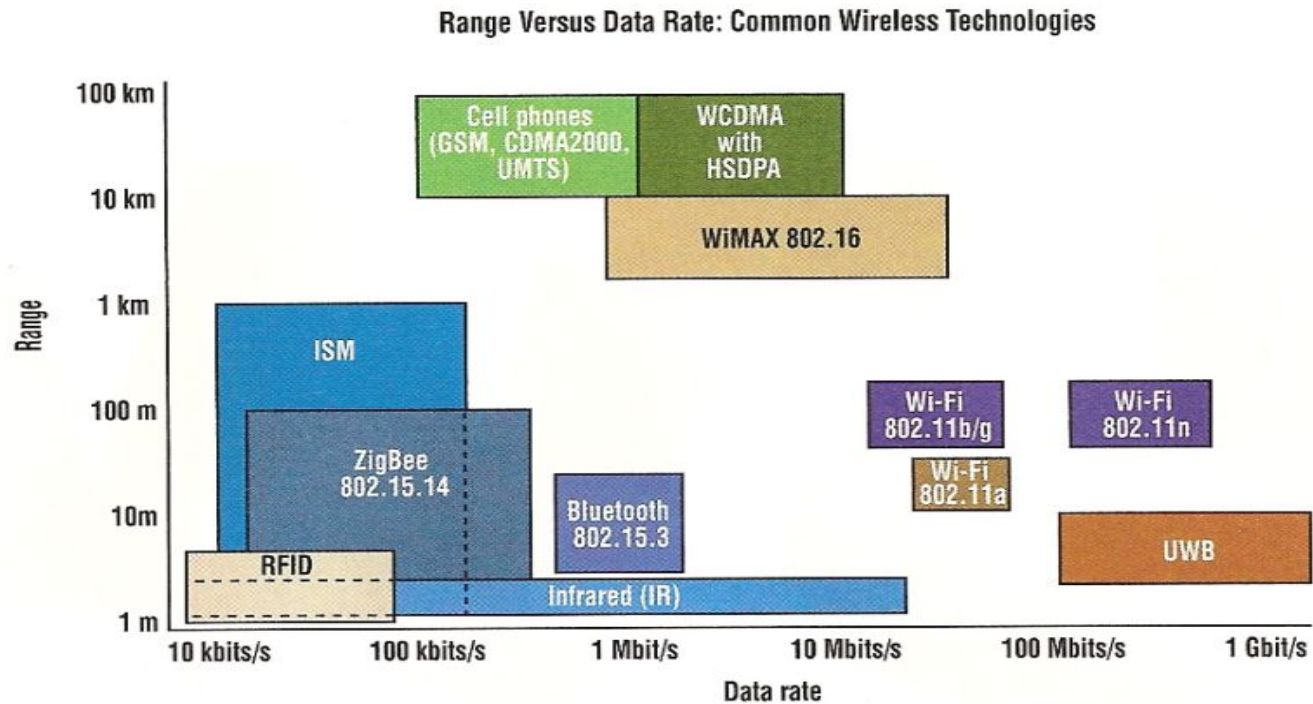
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Wireless Technology: By Mission Profile

“Your actual mileage may vary.”



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Wireless Technology: Standards

- 802.1x Extensible Authorization Protocol.
- 802.11a Wi-Fi 54 Mbps at 5 GHz
- 802.11b Wi-Fi 11 Mbps at 2.4 GHz
- 802.11d International frequency coordination
- 802.11e Quality of Service
- 802.11f Access Point Interoperability
- 802.11g Wi-Fi 54 Mbps at 2.4 GHz.



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Wireless Technology: Standards

- 802.11h Adds frequency and power control to 802.11a.
- 802.11i Enhanced security and encryption.
- 802.11k Advanced radio resource management.
- **802.11n Wi-Fi 108+ Mbps at 2.4 and 5 GHz**
 - Multiple input/Multiple output (MiMo) (Wi-Fi)
- 802.11p Automotive 5.9 GHz band for direct short-range communications.



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Wireless Technology: Standards

- **802.11r** Fast roaming between APs
- **802.11s** Extended Service Set (Mesh)
- **802.11u** Internetworking (e.g. Wi-Fi to cellular)
- **802.11v** Wireless network management
- **802.11w** Protected management frames
- **802.11x** User-authentication



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Wireless Technology: Standards

- **802.11ac Wave 1 Wi-Fi 1.3 Gbps at 5 GHz**
- **802.11ac Wave 2 Wi-Fi 3.47 Gbps at 5 GHz band**
- **802.11ax Wi-Fi 10 Gbps at 2.4 and 5 GHz (December 2018)**
- **802.11ay Wi-Fi 20 Gbps at 60 GHz (December 2019)**



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Wireless Technology: Standards

- 802.15 Personal Area Networks (e.g., Bluetooth)
- 802.16 Broadband wireless local access (“Last mile” access in competition with telephone and cable service providers.
- 802.20 Mobil Broadband Wireless Access **V2V**
 - Low latency (< 20 ms).
 - Real-time data rates up to 1 Mbps at 150 MPH (241 km/hr)
 - **Porsche has done field trials of 1 Mbps at 206 MPH (331 km/hr)**



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Wireless Technology: NFC

Ultra Short-range: Near (Magnetic) Field Communications

- Standard: ISO/IEC 18000-3 (data exchange)
- Range: 1.6 inches (4 cm) (typical)
- Data Rate: 384 kbps (typical)
- Frequency: 13.56 MHz band (worldwide allocation)
- Relatively unaffected by conductive (metal) objects or people.
- The strength of the magnetic field decreases as the 3rd power (cube law) with distance compared to radiated electric fields which decrease at the 2nd power (square law).



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Wireless Technology: PAN

Very Short-range: Zigbee Personal Area Network (PAN)

- Standard: IEEE 802.15.4
- Range: 30 to 300 feet (9 to 91 meters)
- Data Rate: 20 kbps (868 MHz)
- Data Rate: 40 kbps (915 MHz)
- Data Rate: 250 kbps (2.4 GHz)
- Power: <10 microamps (sleep mode)



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Wireless Technology: PAN

Very Short-range: Zigbee Personal Area Network (PAN)

- Up to 255 nodes per network.
- Very low-cost electronics (<\$2).
- Security was not part of original specification.
- Latest specification includes three levels of security.
- Minimal hardware requirements.



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Wireless Technology: PAN

Short-range: Bluetooth Personal Area Networks (PAN)

- Standard: IEEE 802.15.1
- Range: 30 to 300 feet (9 to 91 meters)
- Data Rate: 723 kbps
- Data Rate: 3 Mbps (peak).
- Power: <math><100\ \mu\text{A}</math> (sleep mode).
- 79 1 MHz channels.
- Up to 7 clients form a piconet. Multiple piconets can link to form scatternets.



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Wireless Technology: PAN

Short-range: Ultra-Wideband

Standard: None* (based on IEEE 802.15.3a)

Range: 6 to 30 feet (1.8 to 9 meters)

Data Rate: 480 Mbps at 6 feet (1.8 meters)

Data Rate: 110 Mbps at 30 feet (9 meters)

*IEEE UWB committee voted to disband at its January 19, 2006 meeting in **Hawaii** after failure to agree on an implementation technology.



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Wireless Technology: IOT

Verizon announces Cellular Network to support IoT

Network World Net Optimization Alert Apr 04, 2017



Verizon to launch wireless Cat M1 network nationwide to juice IoT

Verizon will launch a nationwide wireless network designed to help developers, businesses, utilities and municipalities deploy secure internet-of-things devices at lower cost. [Read More](#)

- 2+ million square miles of coverage
- Competes with LoRa*, Sigfox*, Narrowband IoT (*unlicensed services)
- 300 – 400 Kbps
- \$8 chipset – projected to be \$3 in high volume
- \$2/month or less service charge

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Wireless Technology

We Take A Deep Dive Into Wi-Fi



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Wireless Technology: Wi-Fi

Standard	Frequency	Typical Data Rate	Bit Rate
802.11a	5 GHz	25 Mbps	54 Mbps
802.11b	2.4 GHz	6.5 Mbps	11 Mbps
802.11g	2.4 GHz	25 Mbps	54 Mbps
802.11n	2.4 & 5 GHz	200 Mbps	540 Mbps
802.11ac Wave 1	5 GHz	433 Mbps*	1.3 Gbps
802.11ac Wave 2	5 GHz	867 Mbps*	13 Gbps

*Single stream

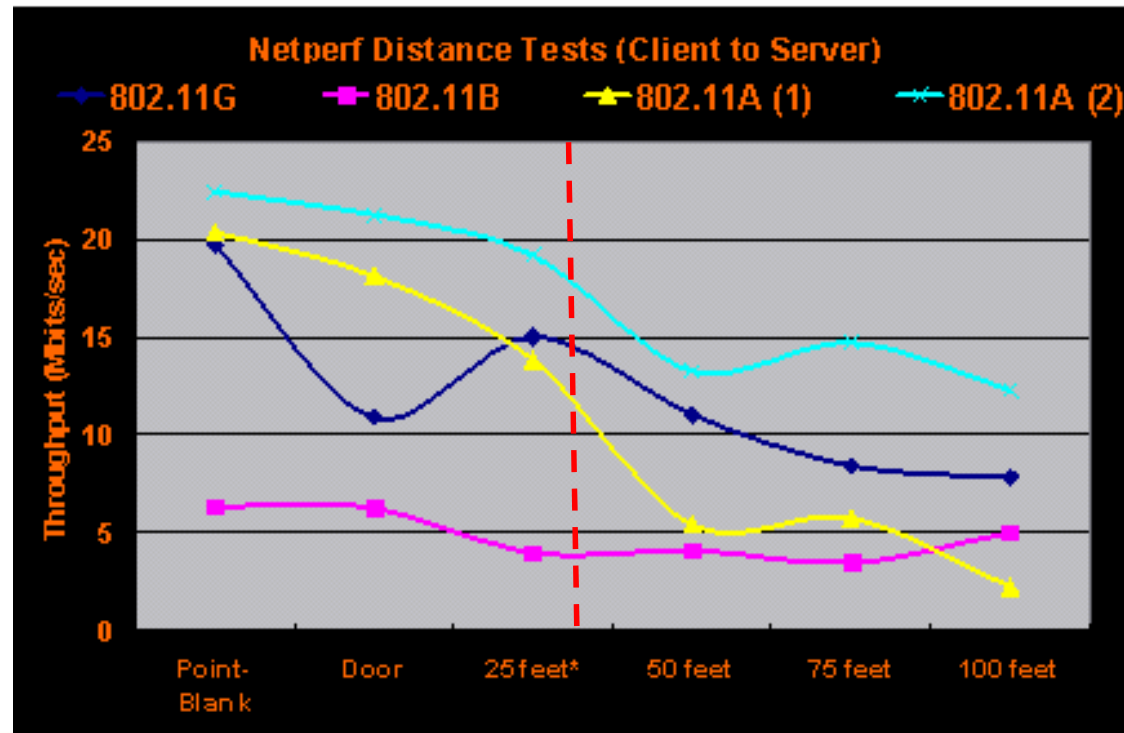


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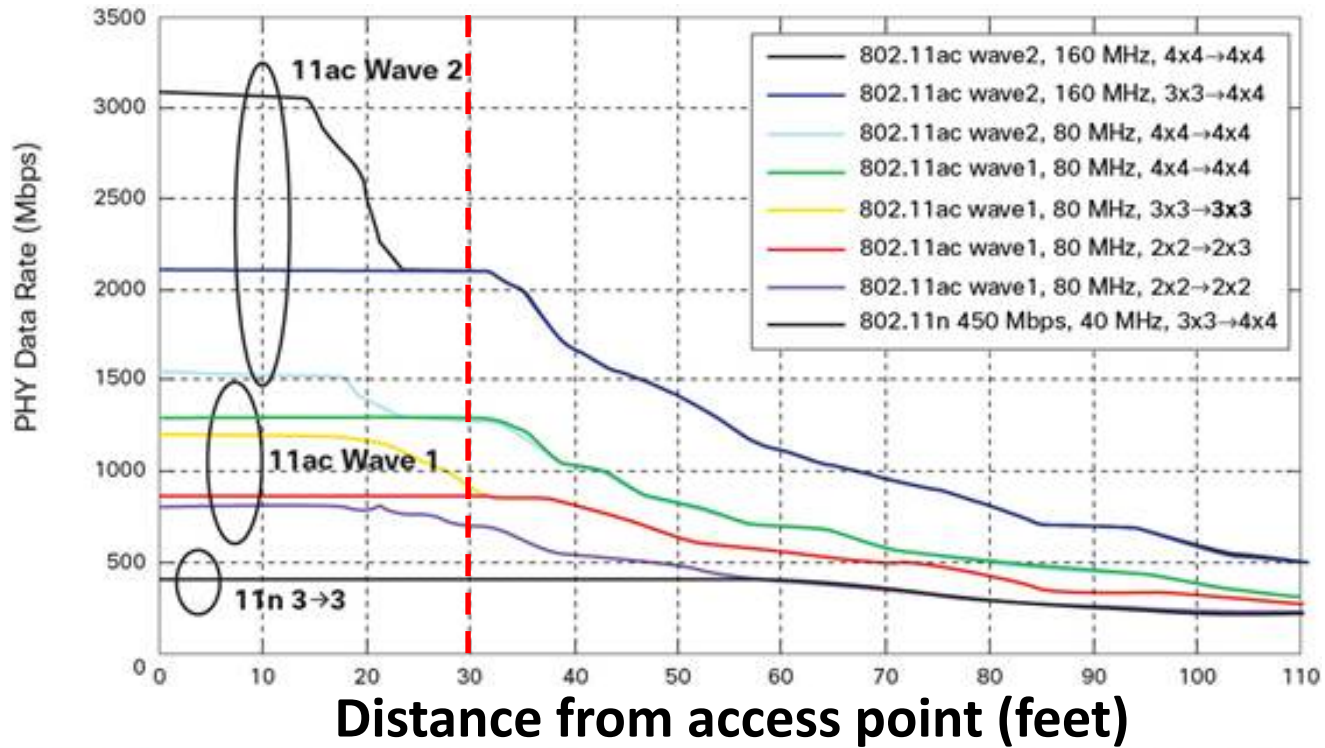
Wireless Technology: Wi-Fi Range



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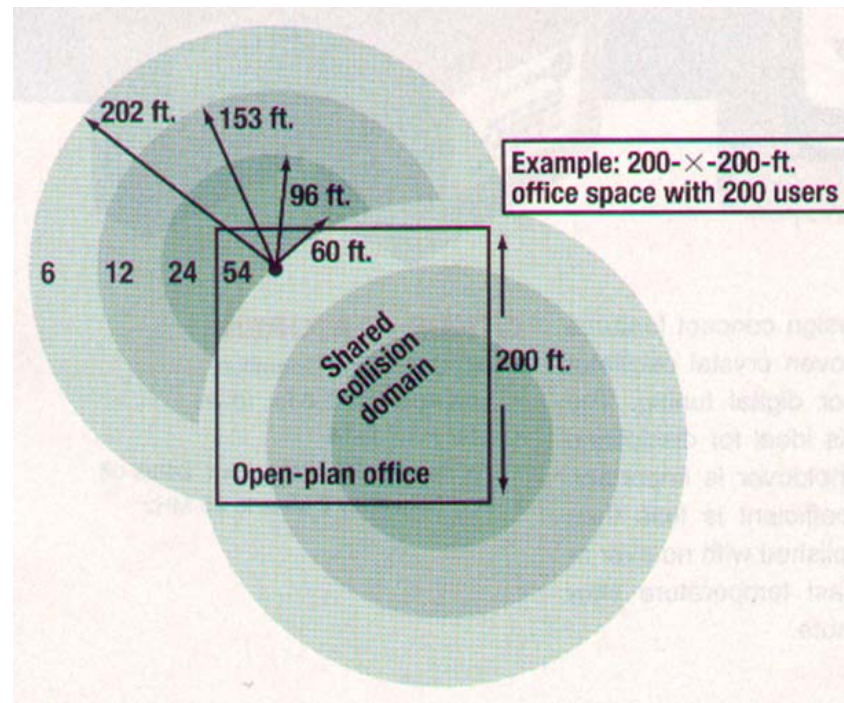
Wireless Technology: Wi-Fi Range



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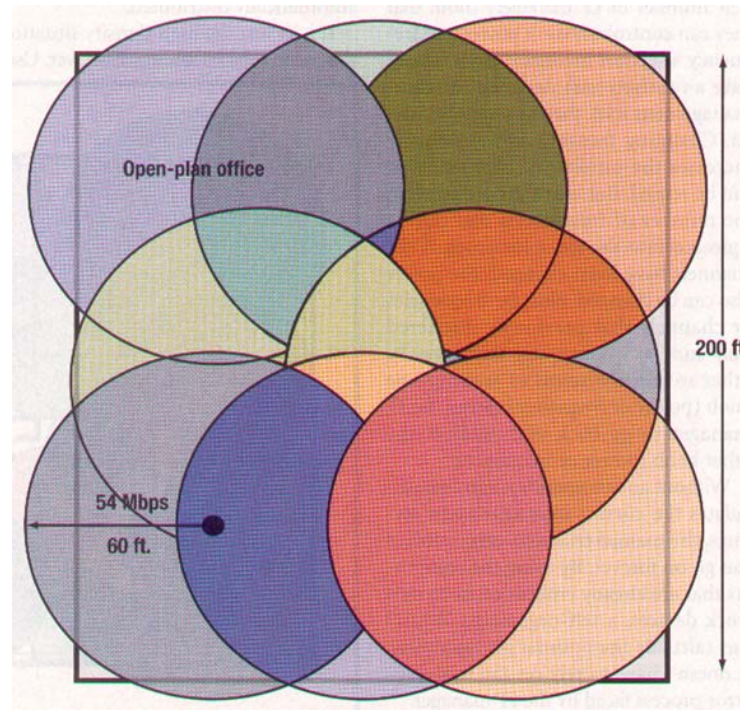
Wireless Technology: Wi-Fi Coverage



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Wireless Technology: Wi-Fi Capacity

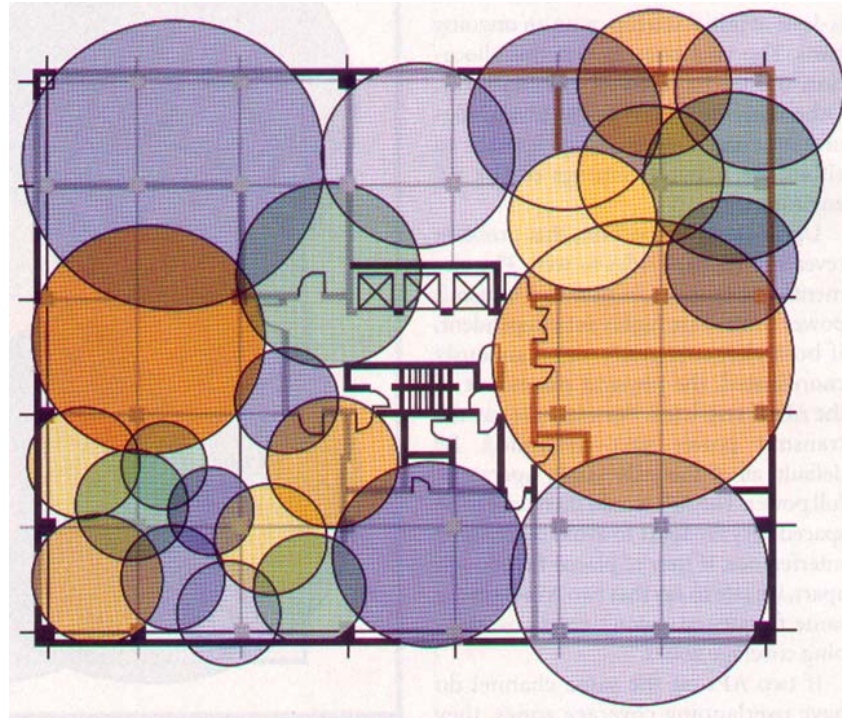


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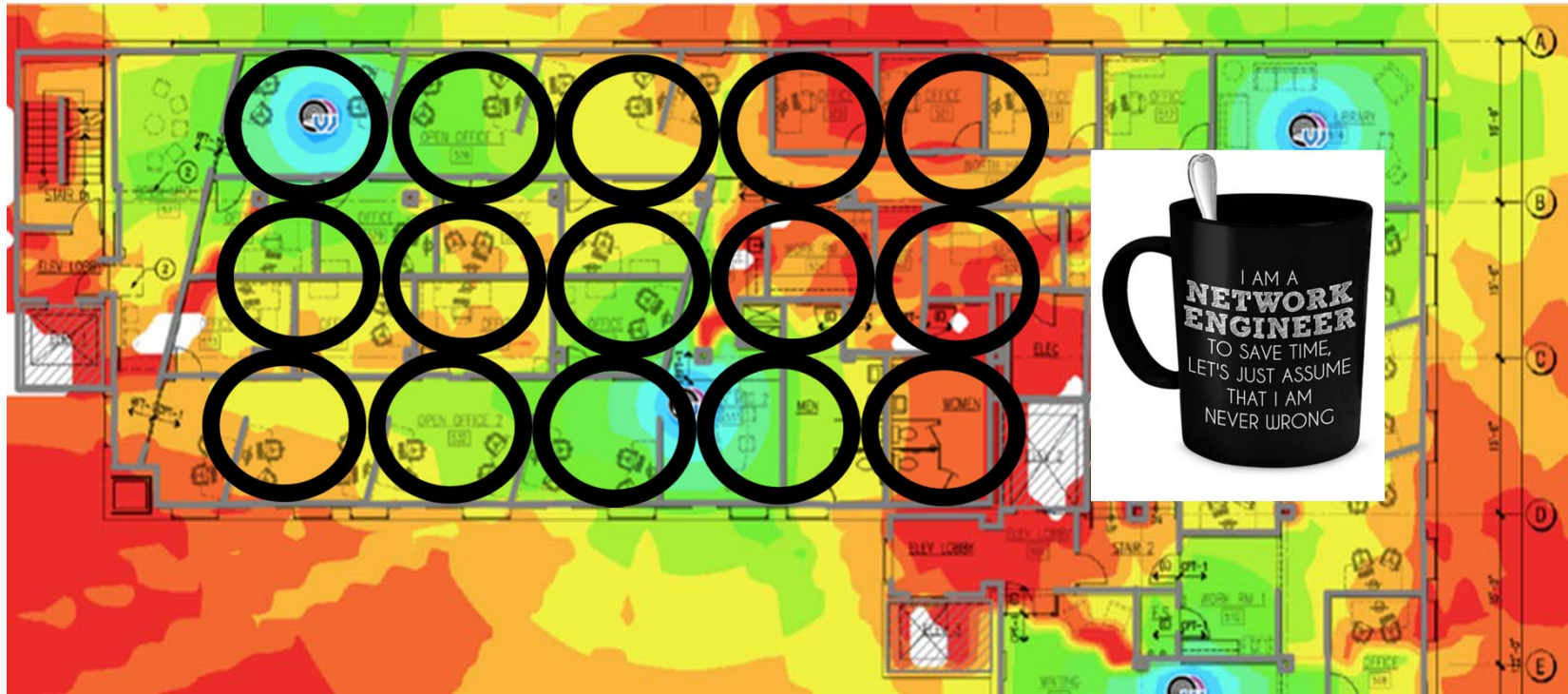
Wireless Technology: Wi-Fi Density



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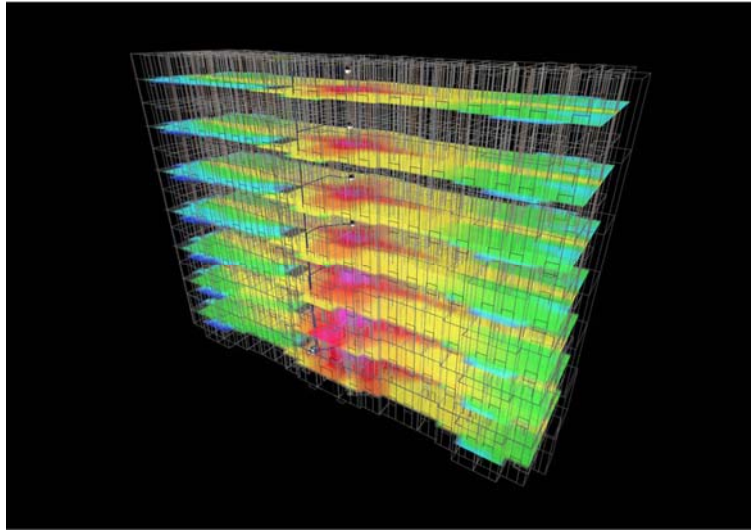
Wireless Technology: Heat Map vs. Coffee Cup



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Wireless Technology: Planning Tools



Partial listing:

Aerohive

AirMagnet Netscout

Extreme

Fortinet

Huawei

iBwave

NetSpotApp

Xirrus



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Wireless Technology

And Now Back to Our Survey of Wireless Technologies



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Wireless Technology: WiMAX

- Standard: 802.16 (point-to-point)
- Standard: 802.16a (omnidirectional)
- Range: ~30 miles (48 km)
- Data Rate: 70 Mbps
- Frequency: 10 – 60 GHz (802.16)
- Frequency: 2 – 11 GHz (802.16a)
- Power: 20 watts average power (typical)
- Can support mobile connectivity at speeds >60 mph (96 km/hr)



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Wireless Technology: Microwave

- **Line-Of-Sight (LOS) required**
- **Range: 2 miles (3 km) at 30 GHz - 30 miles (48 km) at 2 GHz**
- **Bandwidth**
 - **Depends on carrier frequency (400 Mbps for 18 GHz link)**
- **Multiple channels.**
 - **Modular systems add bandwidth as needed.**
- **License required**
 - **Can exceed the cost of the equipment in some countries.**
 - **Frequency coordination required.**
 - **Frequencies may be difficult to get in urban areas.**



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Wireless Technology: Microwave

- About \$40,000 per link (single carrier) for 18 GHz or 80 GHz.
- No preventive maintenance.
- Subject to signal fade, ice, rain, etc.
- Antenna requires heaters to control condensation and melt snow and ice.



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Wireless Technology: Laser (Free Space Optics)

- Highest theoretical bit rate available.
- Uses infrared lasers (LED for short distances).
- 10 Gbps over 2 to 3 miles (3 – 5 km)
 - Practical issues limit distance to about 1 600 feet (500 meters) to get acceptable bit error rates (e.g., fog, heat distortion, vibration, “blinded” by sunlight, etc.).
- No license required.
- About \$20,000 per link.



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Wireless Technology

Wireless Systems Design Considerations



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Wireless Technology: Design Considerations

Things We Can Control

- Most suitable frequency or service
- Coverage (area)
- Capacity (simultaneous users)
- Bandwidth (applications)
- Transmitting power (may be regulated)
- Channel selection
- Cabling
- Electric power
- Signal security
- Physical security

Wireless Technology: Design Considerations

Things We Can't Control

- Other users (same service or frequency)
- Building construction
- Signal reflection, deflection, refraction, etc.
- Rouge users (if no or weak security)
- Rouge WLAN access points (if access control not used)



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Wireless Technology: Power

Decibel: Increase or decrease in power expressed as a ratio compared to a reference value. The ratio is expressed mathematically as:

$$\text{dB} = 10 \log_{10} (P_1/P_2)$$

Example: If $P_1 = 100\text{mw}$ and $P_2 = 1\text{mw}$ (the reference value)

$$P_1/P_2 = 100$$

$$\log_{10} 100 = 2$$

$$10 \times 2 = 20 \text{ dB}$$



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Wireless Technology: Power

Common (power) dB values to remember are:

- 3 dB = times 2 increase or 1/2 decrease
- 6 dB = times 4 increase or 1/4 decrease
- 10 dB = times 10 increase or 1/10 decrease
- 20 dB = times 100 increase or 1/100 decrease
- 30 dB = times 1 000 increase or 1/1 000 decrease



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Wireless Technology: Terminology

Attenuation: Signal loss caused by transmission through a wire, the air, or objects located between the transmitter and the receiver.

Radio waves traveling through free space are attenuated according to a “square law” formula.

$$\text{Signal strength} = q/r^2$$

That is, if the distance between the transmitter and receiver is doubled, the strength of the signal is reduced by a factor of 4 (1/4 of its value).



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Wireless Technology: Attenuation Values

Common Building Materials (2.4 GHz) (all values are approximate)

- Glass (non-tinted) -2 to -3 dB
- Wood door -3 dB
- Systems furniture -3 to -5 dB
- Dry wall (sheetrock) -3 to -4 dB
- Marble -5 dB
- Brick -8 dB to -10 dB
- Concrete (floor/wall) -10 to -15 dB



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Wireless Technology: Signal to Noise Ratio

Signal strength determines if the receiver can detect the signal.

The signal-to-noise ratio determines the data rate and associated error bit rate.

Claude Shannon's formulae for maximum channel capacity, C (bits/second)

$$C = B \log_2 \left(1 + \frac{S}{N} \right)$$

B = Channel bandwidth in Hertz, S/N = signal-to-noise ratio in watts



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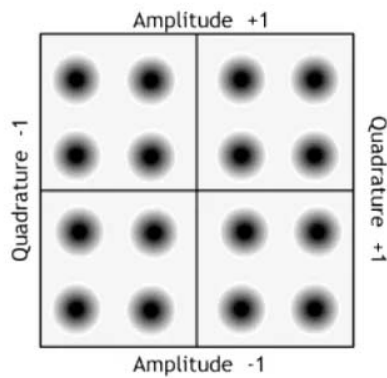


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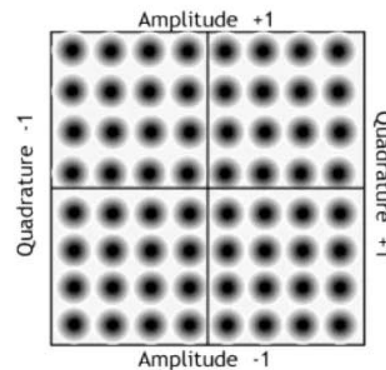
Wireless Technology: Signal to Noise Ratio

For example, 802.11ac requires approximately a signal strength +10 dB stronger than former 802.11 types and a 6 dB better S/N ratio to recover the signal encoding with minimal error.

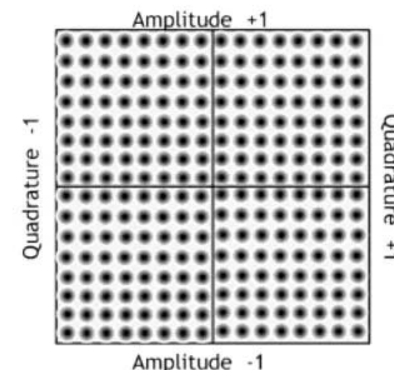
CONSTELLATION DIAGRAMS FOR 16-, 64-, 256-QAM



16-QAM constellation



64-QAM constellation



256-QAM constellation



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Wireless Technology: (Rough) Rules of Thumb

- Doubling the height of an antenna has approximately the same affect as increasing transmitter power by a factor of 10 (usually not an option).
- BUT doubling the height of an antenna or increasing transmitting power by a factor of ten does not double the coverage area. As a rule of thumb, reliable operating range increases by approximately 30%.

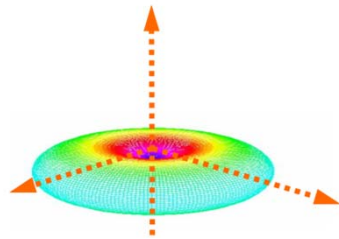


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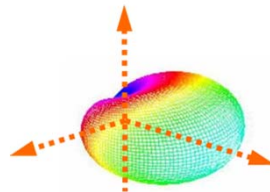


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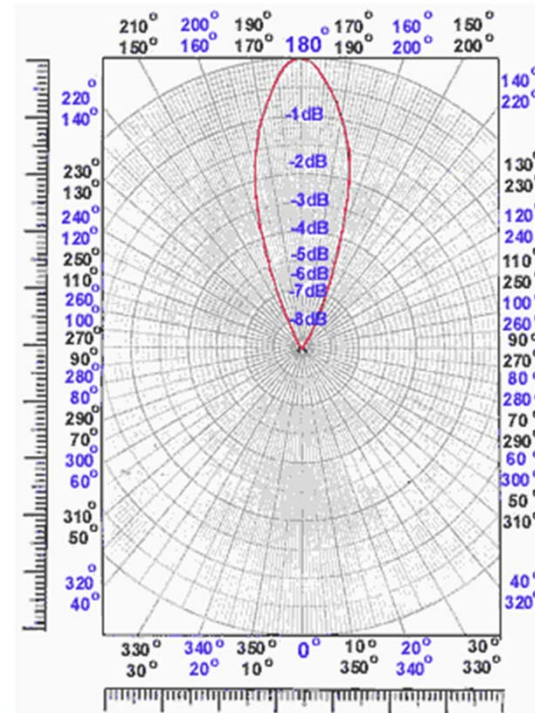
Wireless Technology: Directional Antennae



Non-directional antenna



Directional antenna

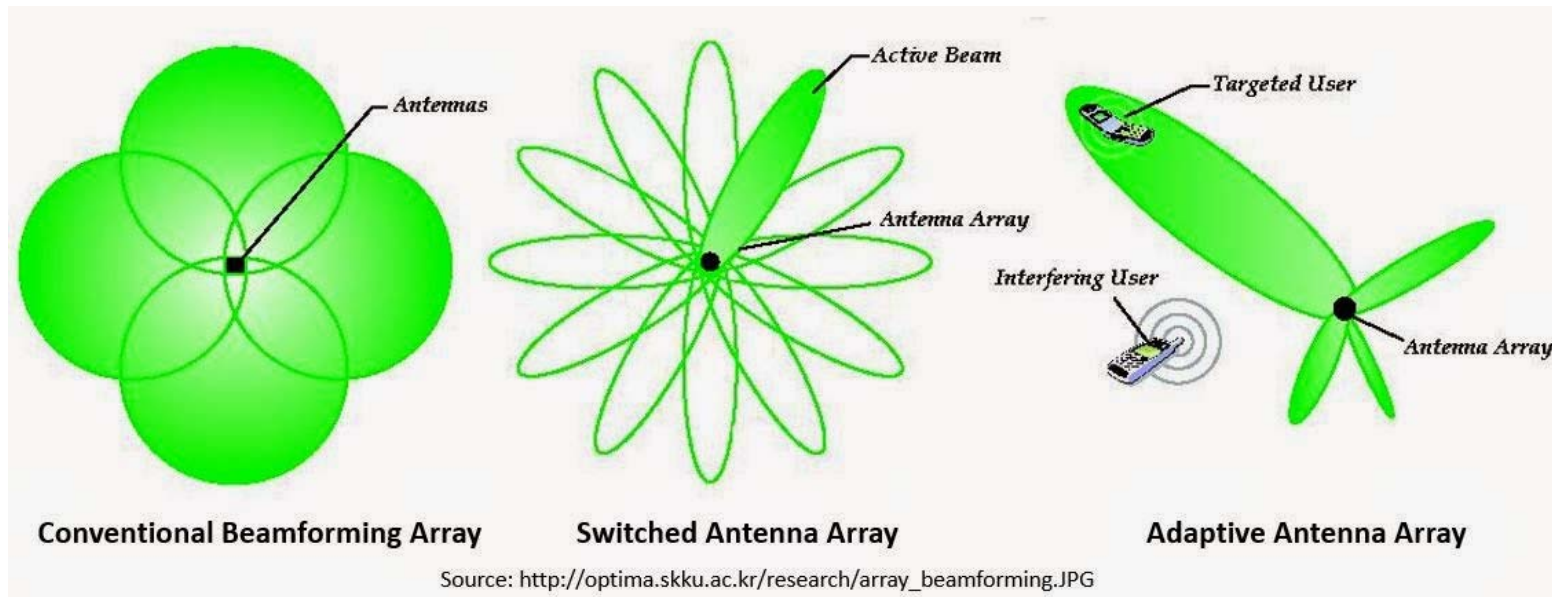


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Wireless Technology: Beam Forming



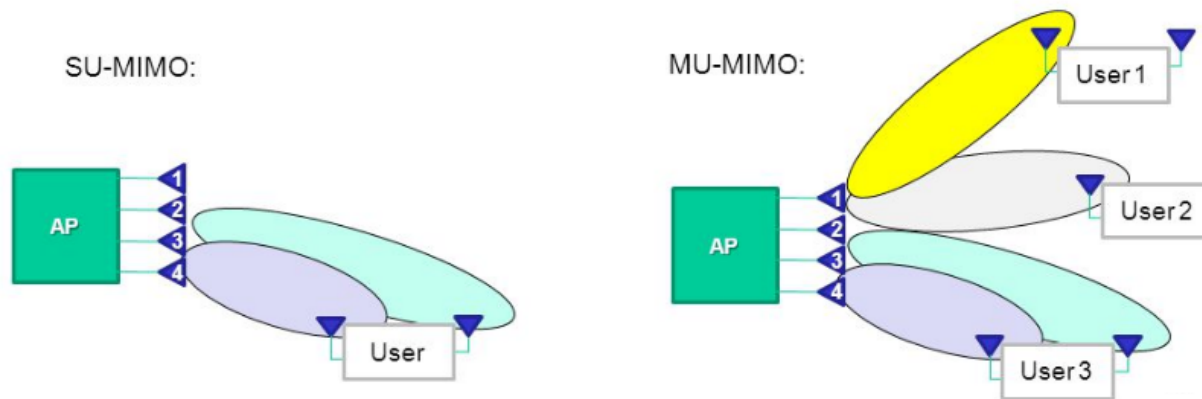
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Wireless Technology: MIMO

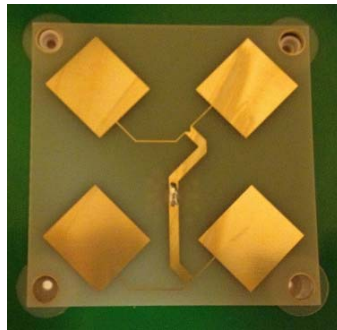
SU-MIMO: Single-user MIMO: exploits the presence of multiple transmit and receive antennas to improve both the capacity and the reliability of a transmission

MU-MIMO: Multi-user MIMO: stations having multiple antennas can simultaneously transmit or receive multiple information flows



Wireless Technology: Specialized Antennae

“Rubber Ducky”™ flexible antenna



Patch Antenna



Faceplate Antenna



Directional YAGI Antenna



Slotted Coaxial Cable

Wireless Technology: Specialized Antennae

Armstrong iCeiling Product Line: Multi-band cellular + 2.4 GHz Wi-Fi
Marketed 2004 - 2007 (Not a current product)



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Wireless Technology: Specialized Antennae



Wireless Technology: Specialized Access Point

- 8 radios
- 45 degree coverage per radio
- 1 920 associated users
- 27.7 Gbps aggregate bandwidth
- 16 SSIDs
- 64 VLANs
- Two 1 GB Ethernet ports



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Wireless Technology

A Quick Diversion



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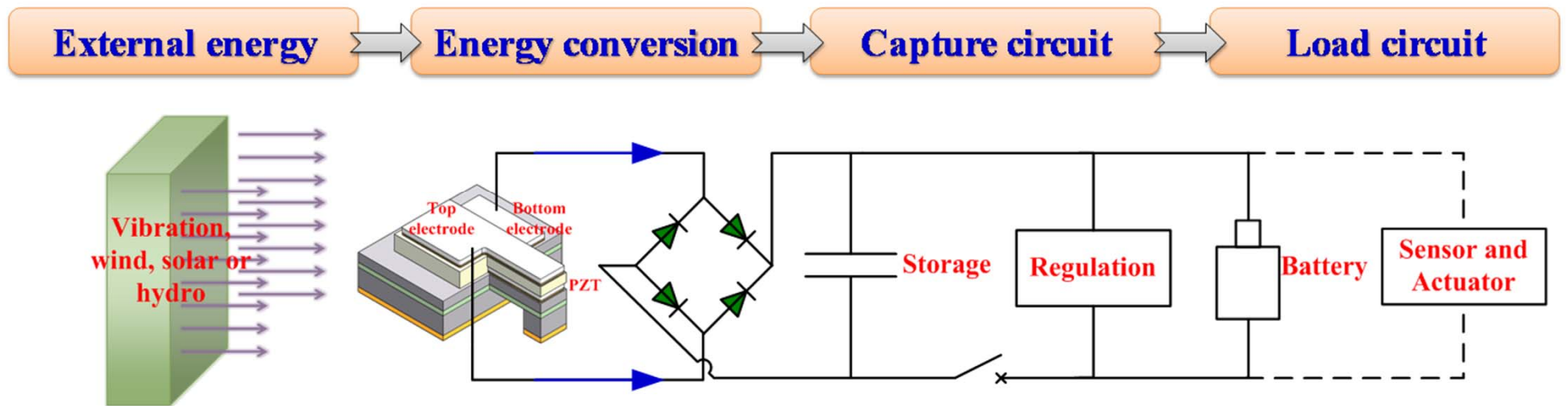


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Wireless Technology Sidebar: Free Power

- **Energy Harvesting**
 - The conversion of very low-level energy sources into sufficient electrical energy to power circuits (e.g., a Low Energy Bluetooth radio).
 - Coverts picowatts/nanowatts/microwatts of power into milliwatts of electrical power over time.
 - Energy sources can be thermal, kinetic (mechanical vibration), light or radio.
 - Commercial products readily available.
 - Very useful for powering Industrial Internet of Things (IIoT) remote sensors – no batteries to replace.

Wireless Technology Sidebar: Free Power



Wireless Technology Sidebar: Free Power

VIBRATIONAL PARASITES

The typical building never stops shaking. Air conditioners, heaters and even computer fans vibrate the walls, floors and ceilings. University of California, Berkeley, researchers are working on tiny wireless devices that scavenge this continual buzz as a source of power. The devices attach to surfaces throughout a building to monitor conditions such as airflow and temperature, and contain transceivers that send data to a central computer that can adjust the climate.

Better than batteries because it doesn't run down, and more practical than wall wiring, the device's power scavenger uses a piezoelectric material and a weight attached to a springy cantilever (*photo*) to convert mechanical pressure into electricity. Berkeley mechanical engineering graduate student Shad Roundy has built quarter-sized scavengers that generate 70 to 80 microwatts—enough to run a sensor and transceiver—and aims to demonstrate more powerful devices by year-end.

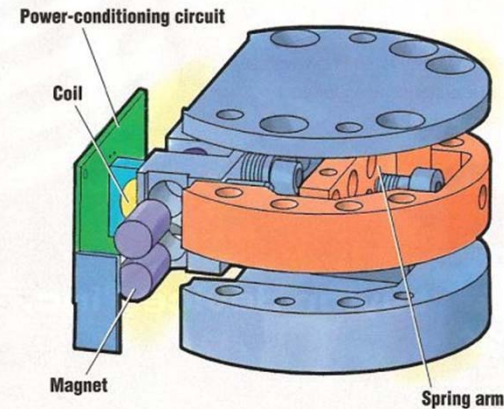


IN THE NEWS Scanning for ideas

Pulling energy from vibrations

Engineers at Perpetuum Ltd. in Britain (www.perpetuum.com) designed the PMG7, an energy-harvesting generator, with wireless, battery-free sensors in mind. The small generators convert kinetic energy from equipment vibrating at 50 or 60 Hz into electricity. One such device generates up to 5 mW, enough to power a wireless transmitter sending 6 kbytes of data every few minutes. It could also power a temperature sensor sending smaller amounts of data but several times per second. The generator will work in most industrial settings and needs minimal vibration levels of 25 mg. (A mg is a thousandth of a g.) The device can be screwed in place or held by magnets. The manufacturer says the unit needs no maintenance.

Circle 403



MACHINE DESIGN

22 • SEPTEMBER 14, 2006

www.machinedesign.com

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Wireless Technology Sidebar: Free Power



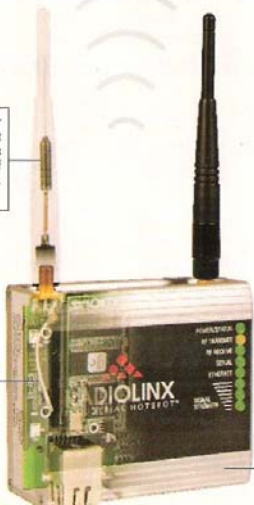
Engineers at the University of Utah have discovered a new material aimed at shaking up the power industry. This discover could lead to wearable generators and turn household items into charging stations, such as using a kitchen pot to power up a nearby smartphone in only an hours' time.

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Wireless Technology: Make York Own

It takes guts to go wireless.



Antennas get your data to the hardest to reach places inside and outside of factory walls.

Secure wireless circuitry gets data moving at high speeds to wherever you need it to go.

Industrial-built outer shell protects radio guts from the harshest of environments.

Get the strength of industrial wireless from the inside-out.

RadioLinx Industrial Hotspot™

- 20+ mile, 11 Mbps wireless link to Ethernet devices
- 802.11b Industrial Hotspot for moving devices and user laptops/PDAs
- A repeater/bridge for wide area wireless coverage

Frequency Hopping Series

- "Hopping" signal hard to detect
- Proprietary radio protocol
- 128 bit hardware based encryption

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Know Your Wireless History: A Quiz



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Wireless Technology: Trivia Question

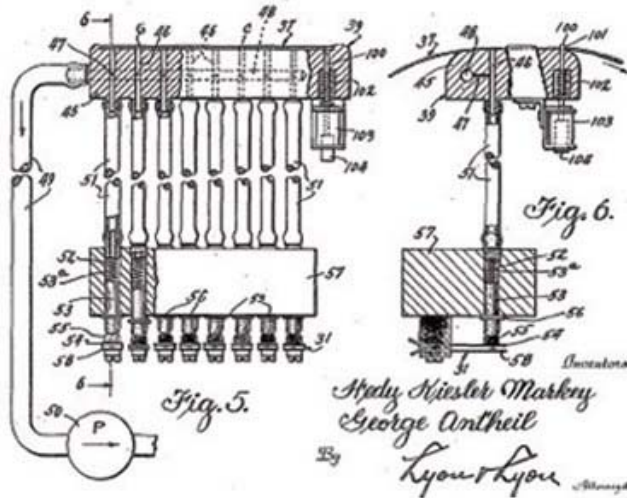
Which female Hollywood star invented spread spectrum technology and received patent #2,292,387 on Aug. 11, 1942?

(Technology first put into use during the 1962 Cuban missile crisis)

-  Born in Austria
-  Wife of a German officer in WWII
-  Dropped out of school
-  Married six times
-  Worked with George Antheil
-  Ms. Hedwig Eva Maria Kiesler

Wireless Technology: Trivia Answer

Hedy Lamarr, inventor of Frequency Hopping Technology



WESTERN EUROPE EDITION
THE STARS AND STRIPES
Official Newspaper of U.S. Forces
Vol. 2—No. 128 1 Fr. Monday, Nov. 19, 1945

Hedy Adds New Twist to War

Actress Invents Control Device While Toying With Torpedo Idea, Has Patent to Prove It

HOLLYWOOD, Nov. 18 (AP).—It could not have been a press agent's stunt, because the timing was too perfect, but the report from London that film actress Hedy Lamarr had patented a radio steering device for torpedoes at least had a patent to back it up.

In an interview, Hedy modestly admitted she did only "creative work on the invention," while the composer and author, George Antheil, "did the really important chemical part."

Hedy was not too clear about how the device worked, but she remembered that she and Antheil sat down on her living room rug and were using a silver match box with the matches simulating the wiring of the invented "thing."

She said that at the start of the war "British fliers were over hostile territory as soon as they crossed the channel, but German aviators were over friendly territory most of the way to England... I got the idea for my invention when I tried to think of some way to even the balance for the British. A radio controlled torpedo, I thought would do it."

Hedy asserted that the "control" device works on aerial as well as submarine torpedoes.

She said it works on anything and added that it was "lots of fun planning the invention and watching them pick, sort and put together all the little thingamabobs that went into the device." She said it was lots more fun being scientific than going to the movies.

She coyly dodged a query as to whether any company was interested in producing the device but did admit that as far as she knew nobody has ever used it yet for any practical purpose.

Hedy Lamarr

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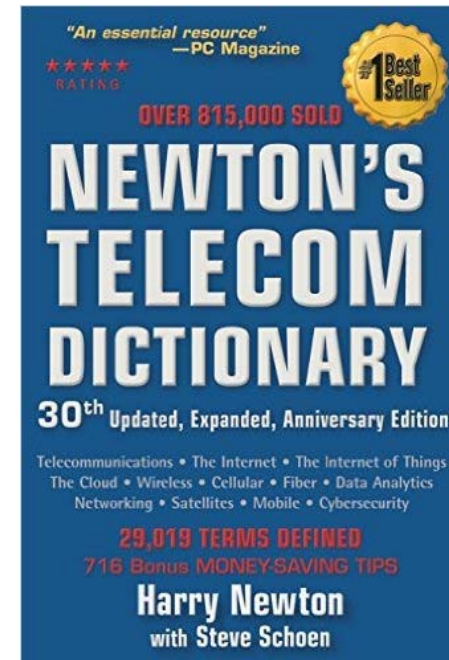
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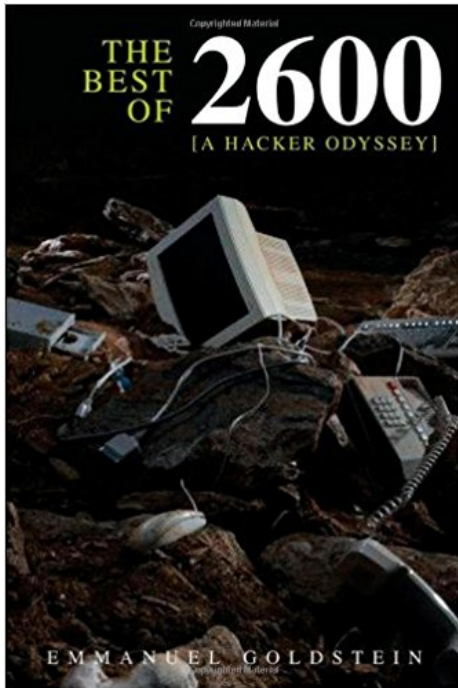
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2600 The Hackers Quarterly
<https://www.2600.com>

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<http://www.arrl.org/home>

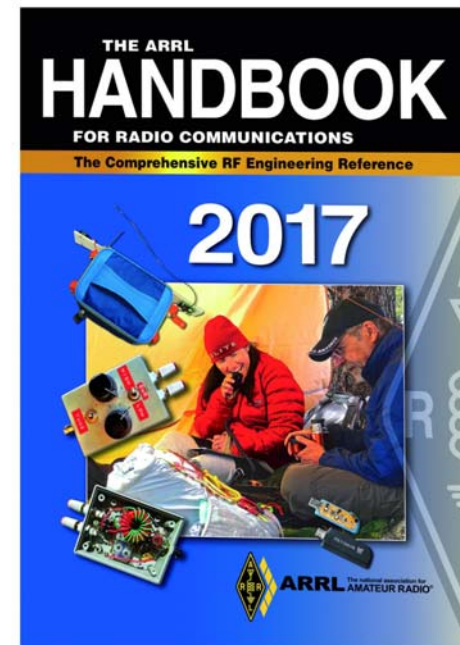
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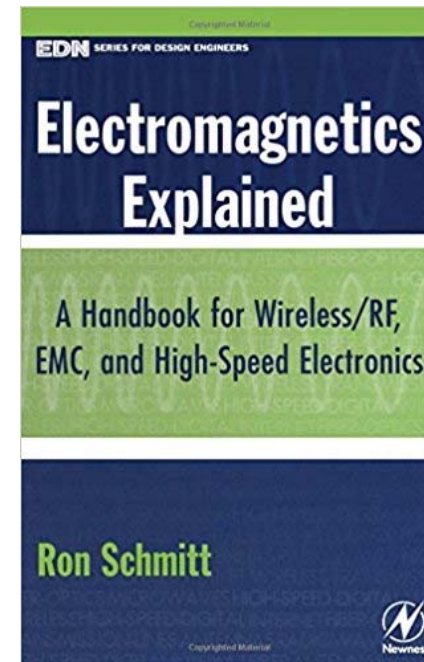


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