W I - F I E V E R Y W H E R E

Vivato

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Wi-Fi Switching: Next Generation Wi-Fi Infrastructure

Creating the New Wi-Fi Physics

Delivering the New Wi-Fi Economics

Vivato's Mission

> Wi-Fi Switch Manufacturer

- Industry standard Wi-Fi wireless network infrastructure for IEEE 802.11b/a/g …

> Scale Wi-Fi to the enterprise (and beyond)

- Support standard Wi-Fi client hardware and software
- Deliver high QoS client performance to 54 Mbps
- Floor/building/campus/metro coverage
  - > Outdoor service to 4 km
  - > Indoor service to 1 km
- Capacity scales to a gigabit
- Enterprise class security and management

> Lowest cost of deployment and ownership

- Universal deployment of Wi-Fi in client platforms

A Brief History

> Company founded 12/00
> Technology demo 9/01
> Launched company 11/02
> Received FCC certification for Wi-Fi Switch prototype 12/02
> Shipped beta units 2/03
> Vivato 2.4 GHz Indoor Wi-Fi Switch announced 2/03 at Demo 2003
> Intel investment/partnership 2/2003
> Vivato 2.4 GHz Outdoor W-Fi Switch announced at CTIA 3/2003
> GA Shipments – 5/2003

Wi-Fi Poised for Success

The New Ethernet

> 802.11b is a stealth success -> like 10BaseT
- Departmental networks like 10BaseT Ethernet
- Faster platform adoption than Ethernet
  - > 20% laptop penetration today
  - > Intel Centrino drives to >70% penetration

> 802.11a/g will catalyze the market -> 100BaseT
- Challenge of coverage vs. speed
- IT begins to centralize with 802.11b -> g/a

> Challenges of scale -> hubs/bridges not enough!
- Micro-cellular limitations
- Security, Manageability, Configuration, Coverage, Capacity, Cost

The Challenges of Scale

> Brute force micro-cellular tough to scale
- Like Enet hubs and bridges
- Lack of coverage
  > Higher speed often means shorter distance
- Lack of capacity
  > Interference, unpredictability of speed
- Lack of manageability
- Cost increasingly dominated by labor and infrastructure – not infrastructure electronics
- Reality check of radio – interference and range

> Time to reexamine assumptions
- Ethernet switching ubiquitous today
- Asymmetric infrastructure
  > Move labor cost to Moore's law cost
- Wi-Fi Switching needed!

Wi-Fi Switching

> Asymmetric Infrastructure
- Replace infrastructure labor cost with Moore's Law cost

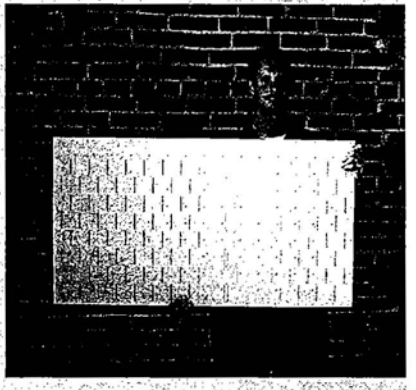
> Existing clients
- Backward compatible to current Wi-Fi clients
- Platform for future clients
  > Increased features: speed, QoS, management

> Increased coverage
- Decreased cost of deployment
- Allows increased speed
  > 802.11b->802.11a
- New markets: hot zone >>>> "first mile"

> Increased capacity
- Multiple simultaneous clients
- Space, frequency and time multiplexing

> Management and security
- Best of class

Creating the New Wi-Fi Physics



> Planar phased array antenna
- enables multiple shaped packet beams

> Narrow packet beams transmit and receive
- Narrow beams with high EIRP transmission
- Large aperture for increased sensitivity reception
- Power beamed only where it is needed

> Dramatically higher range
- Up to 4 kilometers outdoors with a conventional Wi-Fi client.
- Up to 1 kilometer to an indoor Wi-Fi client.

> Higher overall capacity
- Reduced interference
- Packet beams deliver capacity directly to clients rather than floor space
- Space, time and channel multiplexing to drive parallel capacity

> Standard IEEE 802.11 b/a/g client NIC h/w and s/w

> Integrated packaging
- "Plasma TV" with gigE and power
- Replaces a "Sea of APs, lots of wire, gigE switch, security controller and most of the labor - all rolled up"

Vivato Wi-Fi Switch

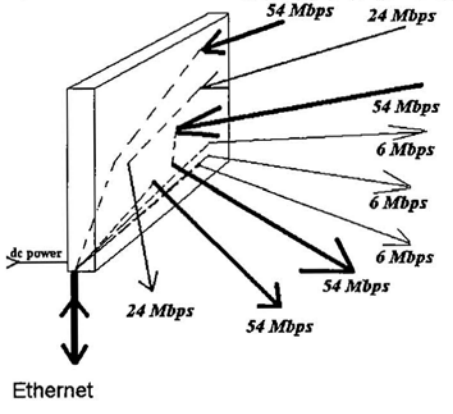
Enterprise Switch Functionality

> Fully integrated package
- Phased array antenna
- Layer 2 and 3 packet switch
  > IEEE 802.11 b/g/a
  > VLAN, VPN, QoS, security, mesh routing, roaming, authentication
  > Wireless or Ethernet backhaul

> Simultaneous packet beams
- High throughput
  > 33 Mb/s – 802.11b
  > 162 Mb/s – 802.11g
  > 270 Mb/s – 802.11a
- 2.4 GHz or 5 GHz
- 25 dBi gain

> Hundreds of simultaneous clients

> Integrated network management
- Support for legacy APs
- Rogue AP/client detection and mapping



> Packaging
  > Indoor, outdoor, building side, rooftop, tower
  > Switch has 100 degree FOV
  > Multiple panels per switch to scale reliability, capacity

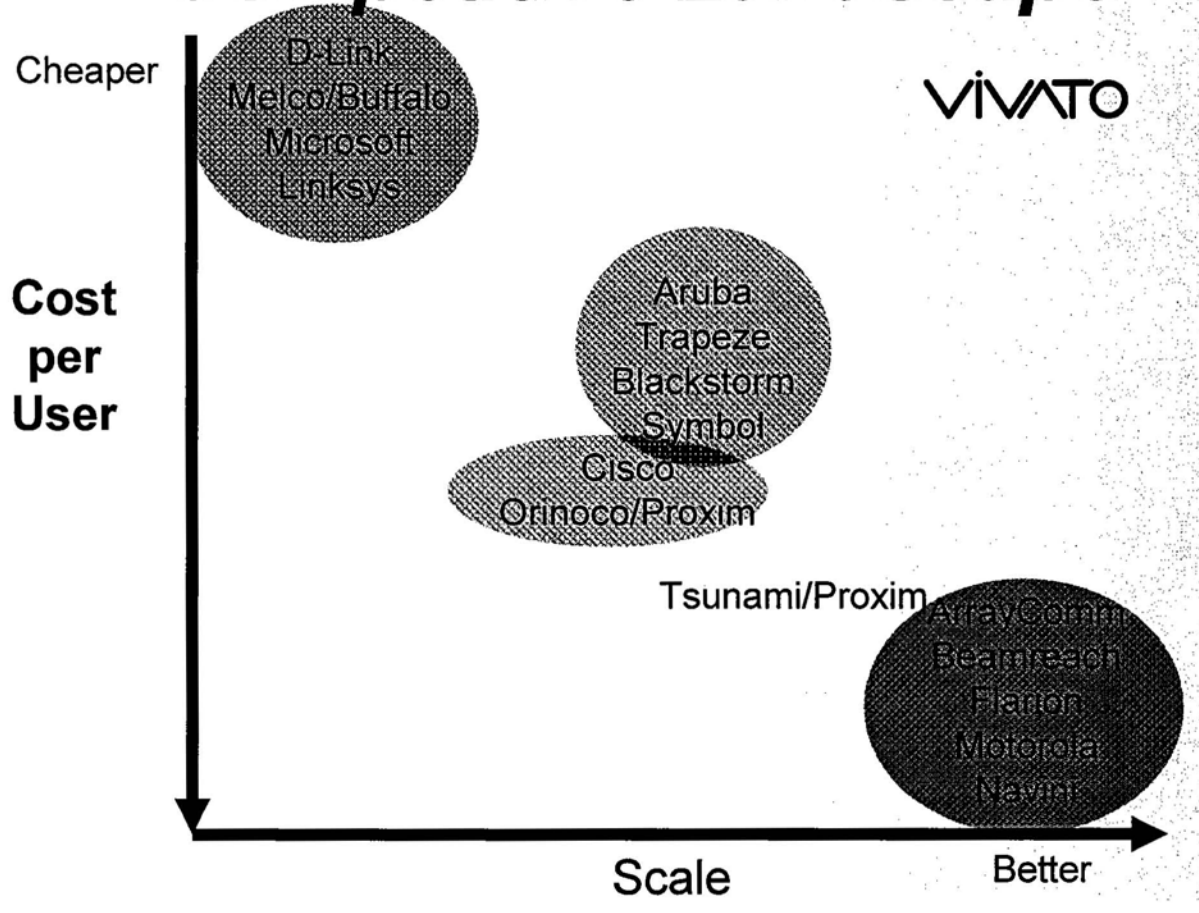
Target Customers

> Enterprises
- Lowest cost, highest performance Wi-Fi deployments
  - > Lowest cost of deployment and ownership
  - > Fewer, higher performance, greater range switches
  - > 802.11b -> 802.11a/g transition

> Service Providers
- Gb/s at the end of the fiber
  - > Low cost of incremental deployment
- Public Access Wi-Fi LANs
  - > airports, hotels, downtowns, business parks, residential neighborhoods

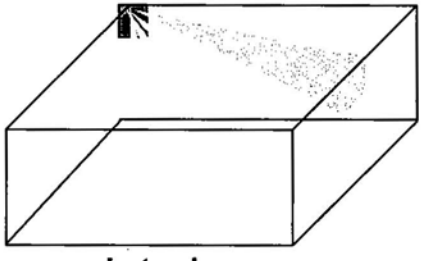
> Wi-Fi Carrier
- Wi-Fi Packet Tone everywhere
- Low cost ubiquitous broadband data service

New Wi-Fi Infrastructure Competitive Landscape

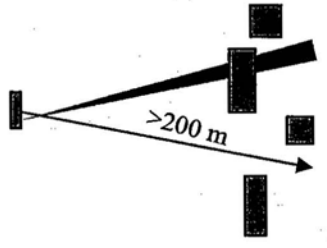


Vivato Wi-Fi Switch

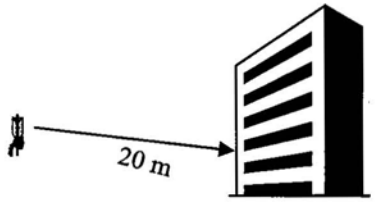
Scaled Deployment Options



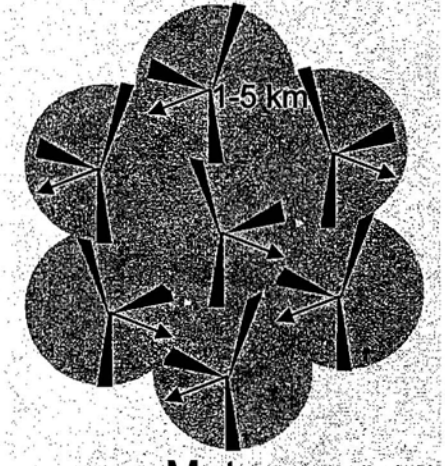
Interior Deployment
mounted on internal corner



Campus deployment



Entire building deployment

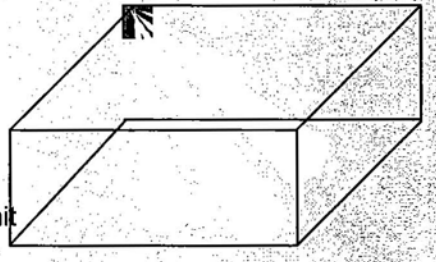


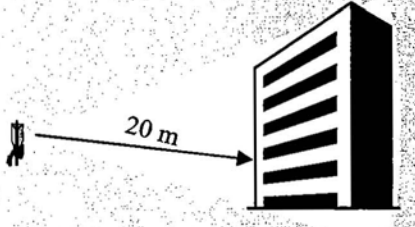
Metro deployment

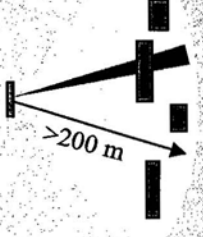
> Most cost effective Wi-Fi solution for single floors, entire buildings, the whole campus, and beyond

Vivato's New Wi-Fi Economics Enterprise Deployment

- > Lowest Cost of Coverage by a factor of 2 to 5
- > Scalable Capacity
  - Capacity dynamically follows users
    - > Bandwidth follows the clients
    - > Floor, building and campus coverage with a single, upgradeable unit
- > Manageability
  - Manage one network element instead of many
    - > Vivato Wi-Fi switch is the edge LAN switch, Access Gateway, Zone controller and many APs integrated into a single device
    - > Reduced System Complexity
    - > Want redundancy? Buy two.
  - Comprehensive, standards based management tools
  - Manage legacy APs for security and configuration
- > Security
  - CHAP,MS-CHAP V2, MS MPPE,IPSEC, 802.1x+EAP
  - Uses existing MS clients (XP, 2000, NT, etc.)
- > Maintainability
  - Single point for SW/FW upgrades, network configuration



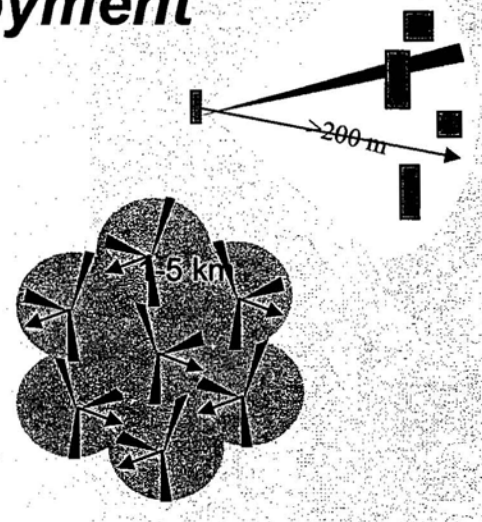




"If you were plowing a field, which would you rather use? Two strong oxen or 1024 chickens?"
-- Seymour Cray (1925-1996), father of supercomputing

Vivato's New Wi-Fi Economics

Campus and Wide-Area Deployment



> Lowest Cost of Coverage by a factor of 5

> Scalable Capacity
- Placed where it is needed
  - > Bandwidth follows the clients
  - > Floor, building and campus coverage with a single, upgradeable unit

> Manageability
- Manage one network element instead of many
- Comprehensive, standards based management tools
- Manage legacy APs for security and configuration

> Security
- CHAP,MS-CHAP V2, MS MPPE,IPSEC, 802.1x+EAP
- Uses existing MS clients (XP, 2000, NT, etc.)

> Maintainability
- Single point for SW/FW upgrades, network configuration

Vivato's Directed Focus

> Founder of a new category: Wi-Fi Switching
> Disruptive technology
- The New Wi-Fi Physics
- Low-cost Wi-Fi clients widely integrated into platforms
- High QoS client performance to 54 Mb/s
- Scale capacity to gigabit/s
- Scale coverage: Enterprise -> Campus -> Metro
- Integrated enterprise class management and security
- Distinctively valuable intellectual property

> Disruptive economics
- Up to 1/5 the CAPEX of alternatives
- Vastly improved OPEX through integrated function

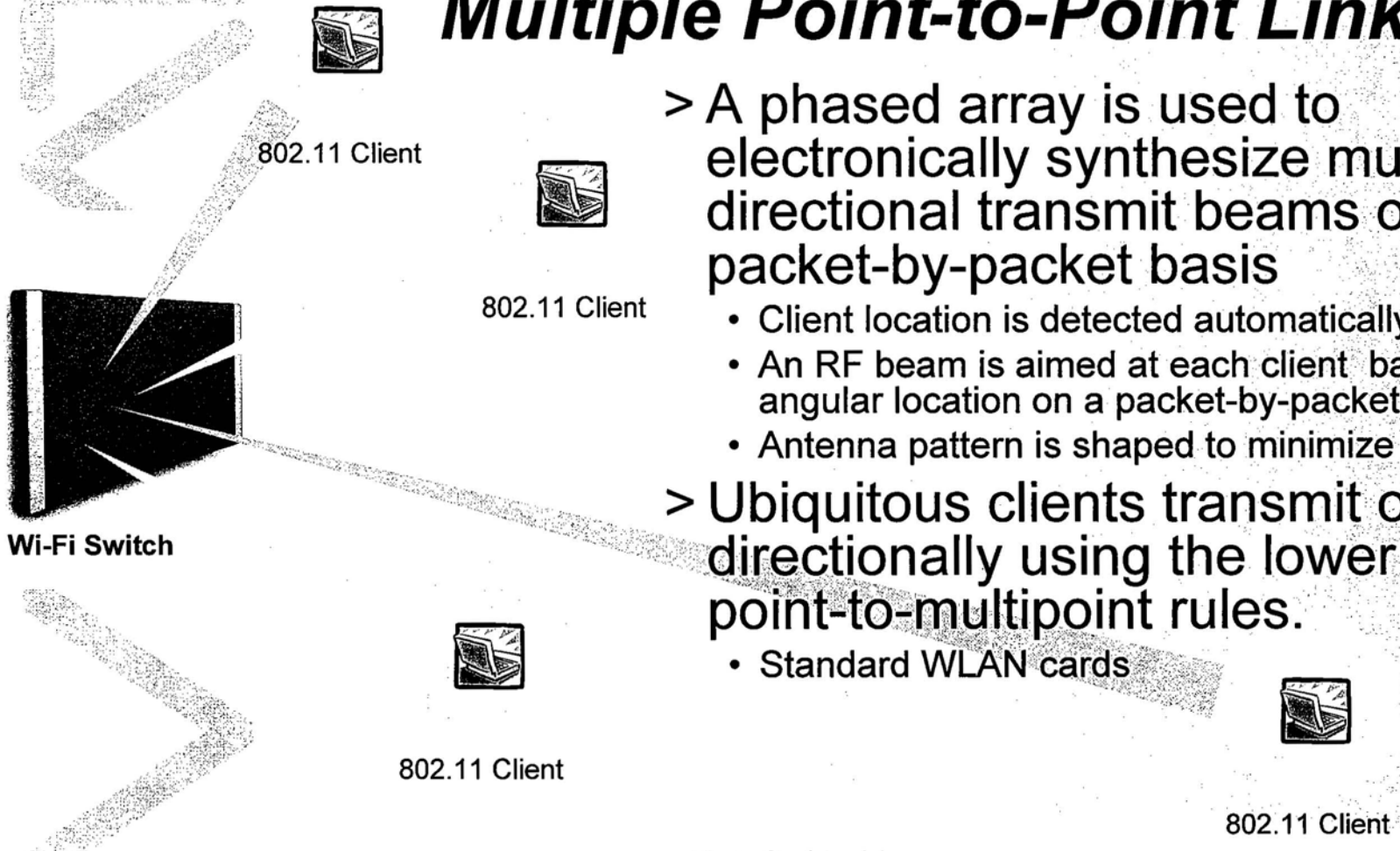
> Strong customer demand
- Large enterprise
- Public LAN

> Operational excellence
> Sound financing
> The team to deliver on the promise

Vivato Wi-Fi Switches

Vivato Wi-Fi Switches increase range and reduce interference.

The Vivato Wi-Fi Switch: Multiple Point-to-Point Links



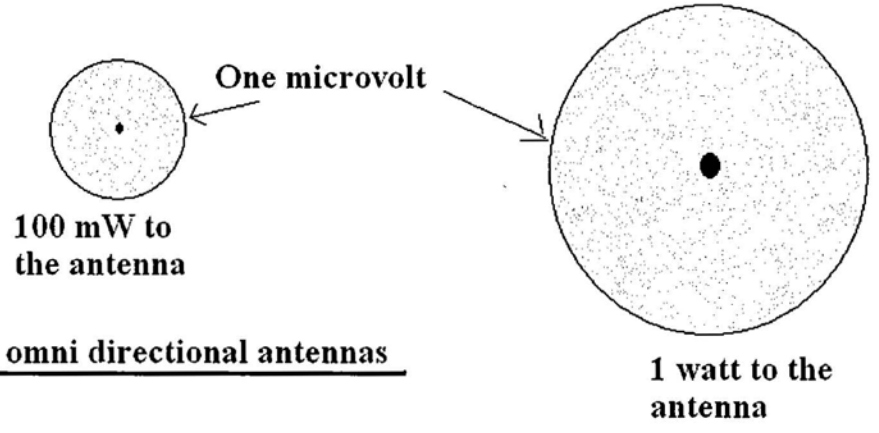
> A phased array is used to electronically synthesize multiple directional transmit beams on a packet-by-packet basis
- Client location is detected automatically
- An RF beam is aimed at each client based on its angular location on a packet-by-packet basis
- Antenna pattern is shaped to minimize interference

> Ubiquitous clients transmit omni-directionally using the lower power point-to-multipoint rules.
- Standard WLAN cards

EIRP and Omni Antennas

The Fundamental Issue: EIRP Affects Range

and interference levels at a distance

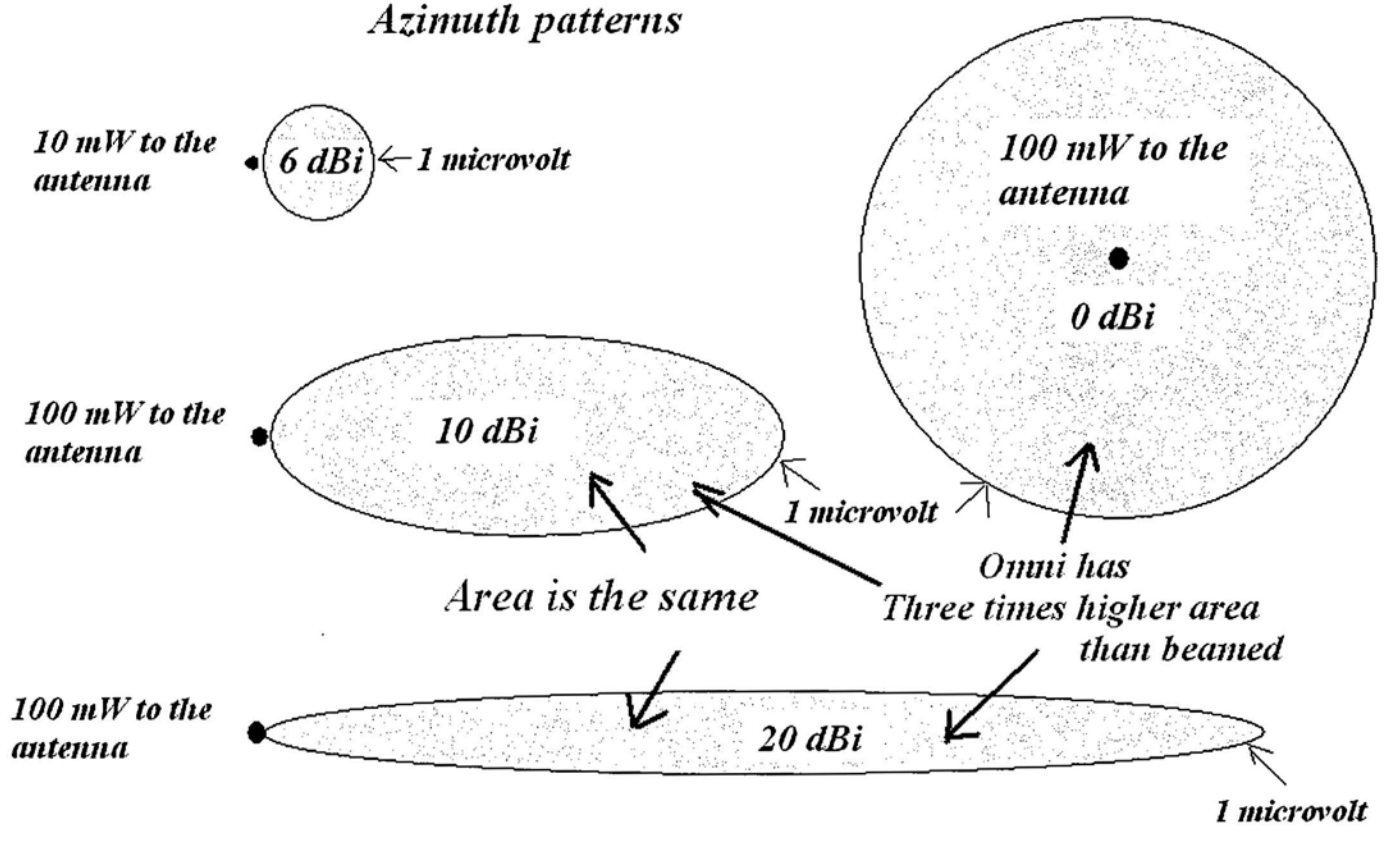


For omni directional antennas

For Directive Antennas?

EIRP Affects Range for Directive Antennas

Azimuth patterns



Area of Coverage is important

> An omni antenna covers an area approximately three times greater than a narrow beamwidth antenna, *for the same power to the antenna.*

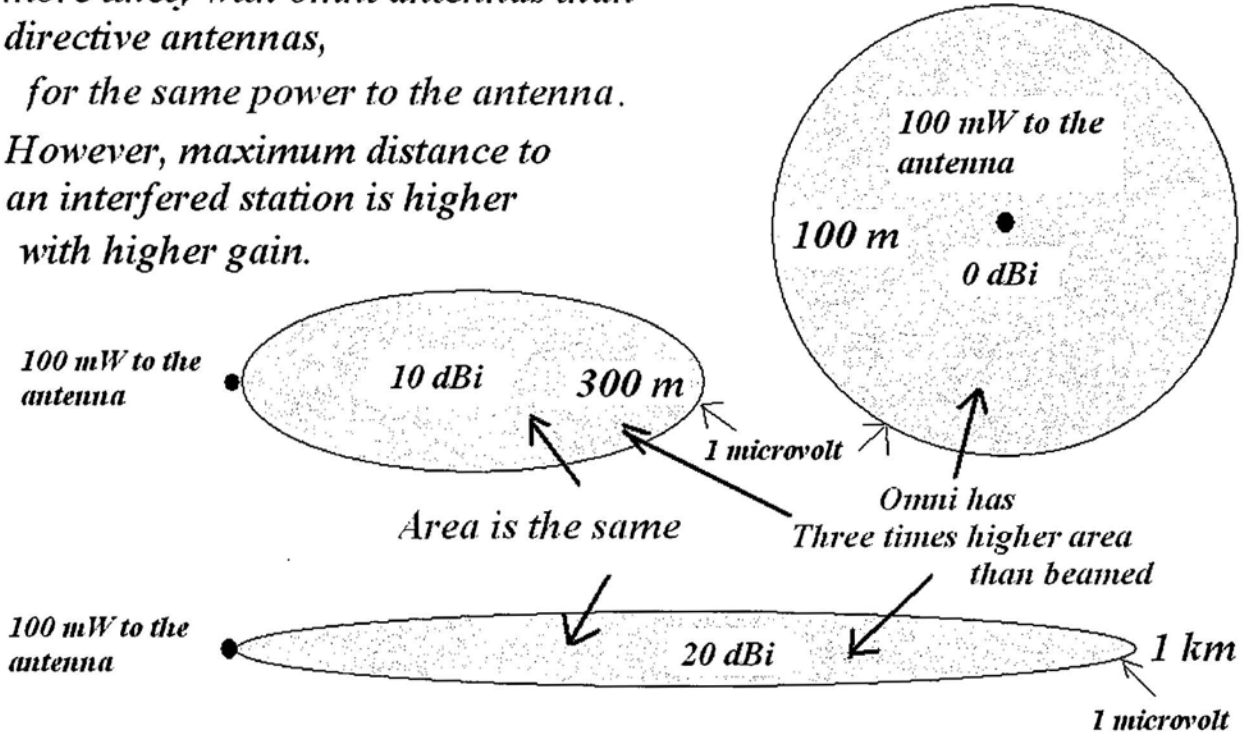
> With scattering, “fourth power propagation loss” reduces Switch (narrow beamwidth) coverage area further.

> Importantly, 1 W omnidirectional APs have much larger coverage area than 100 mW narrow beam Wi-Fi Switches with high gain antennas.

Therefore, interference is three times more likely with omni antennas than directive antennas,

for the same power to the antenna.

However, maximum distance to an interfered station is higher with higher gain.

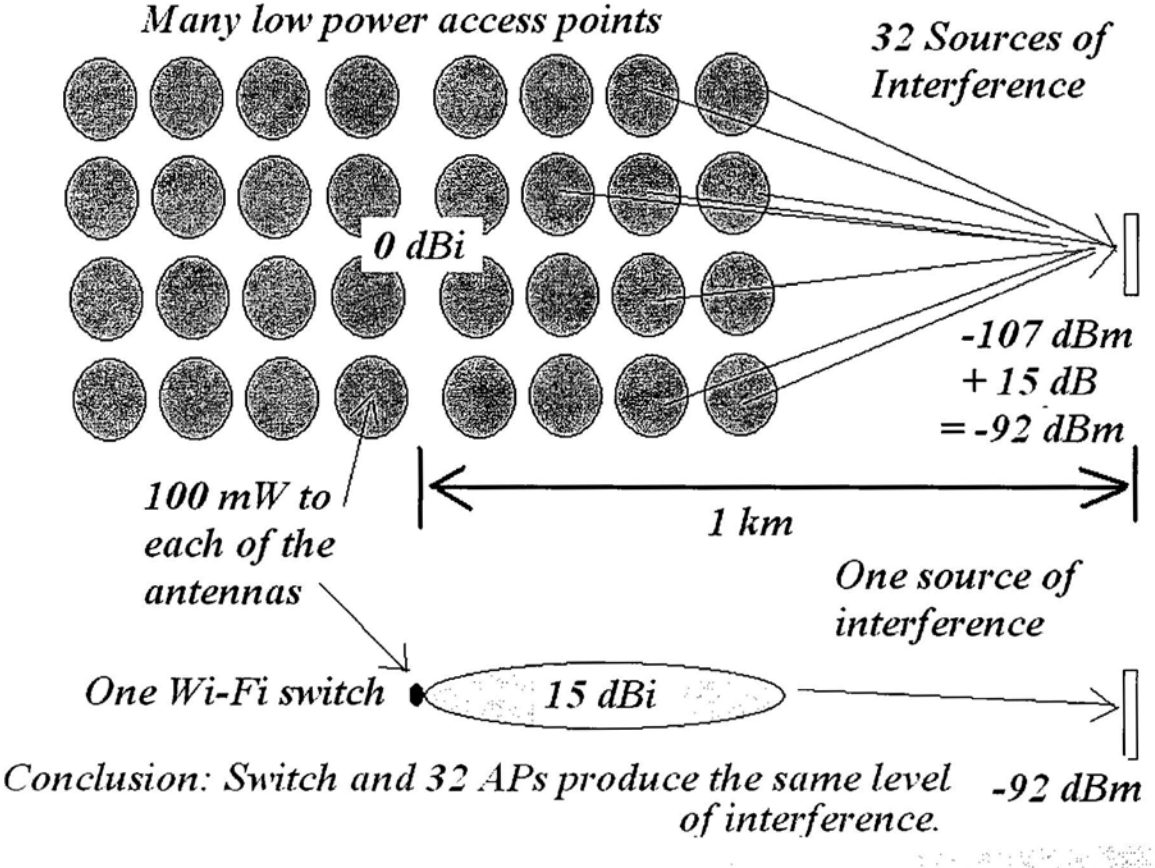


Maximum distance to interfered stations?

> For example, assume interference is measured 1 km away from the edge of coverage.

> How does a Wi-Fi Switch compare to a "Sea of Access points"?

32 APs Interfere Constantly



Conclusion: Switch and 32 APs produce the same level of interference.

A "Sea of APs" vs a Wi-Fi Switch

> Two scenarios for deployment:
  - A "Sea of Access Points"
  - One Wi-Fi Switch

> If interference is measured 1 km away from the edge of coverage, the sea of APs will add their power (always on, unless quiet due to interference, in 360°).

> The Wi-Fi Switch will direct energy with narrow beams and rarely interfere (energy would have to be directed along bearing to radar).

> The Wi-Fi Switch, with its higher directivity/gain will detect and avoid radar much farther away than any AP.

Advantages of Wi-Fi Switches

> Narrow beamwidth spatially filters energy.

> High Wi-Fi Switch gain allows distant RADARs to be detected.

> Dynamic Frequency Selection can be done *directionally.*

> Transmit Power Control can be done *directionally.*

> Switches continue to work gracefully without interfering. Omni systems may entirely stop.

> Total power to the Switch antenna is approximately equal to a client station's power (~ 150 mW), and can be controlled (tx power) to just include the zone of coverage.

In Summary

> Proliferation of omni radiators (APs) causes tremendous interference (not optimal).

> Remedy: Direct the energy only where (narrow beam) needed, and transmit only when needed using DFS and tx power control techniques.

> If there are clients, then there will be omni-directed energy. APs cause omni interference (more power = more interference).

> Thus, if high gain, narrow beamwidth antennas (Wi-Fi Switches) are foreclosed, the likelihood of the "sea of APs" is heightened; a sub-optimal scenario for interference mitigation, and debilitating to the future of Wi-Fi.

W I - F I E V E R Y W H E R E

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Wi-Fi Switches

Scaling Wi-Fi for Success