TEKNILLINEN KORKEAKOULU

S-72.333 Postgraduate course on radio communications

802.11 Network Deployment

Teemu Karhima 27.4.2004

TEKNILLINEN KORKEAKOULU

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  - Mobility and roaming
  - Security considerations
  - Project planning
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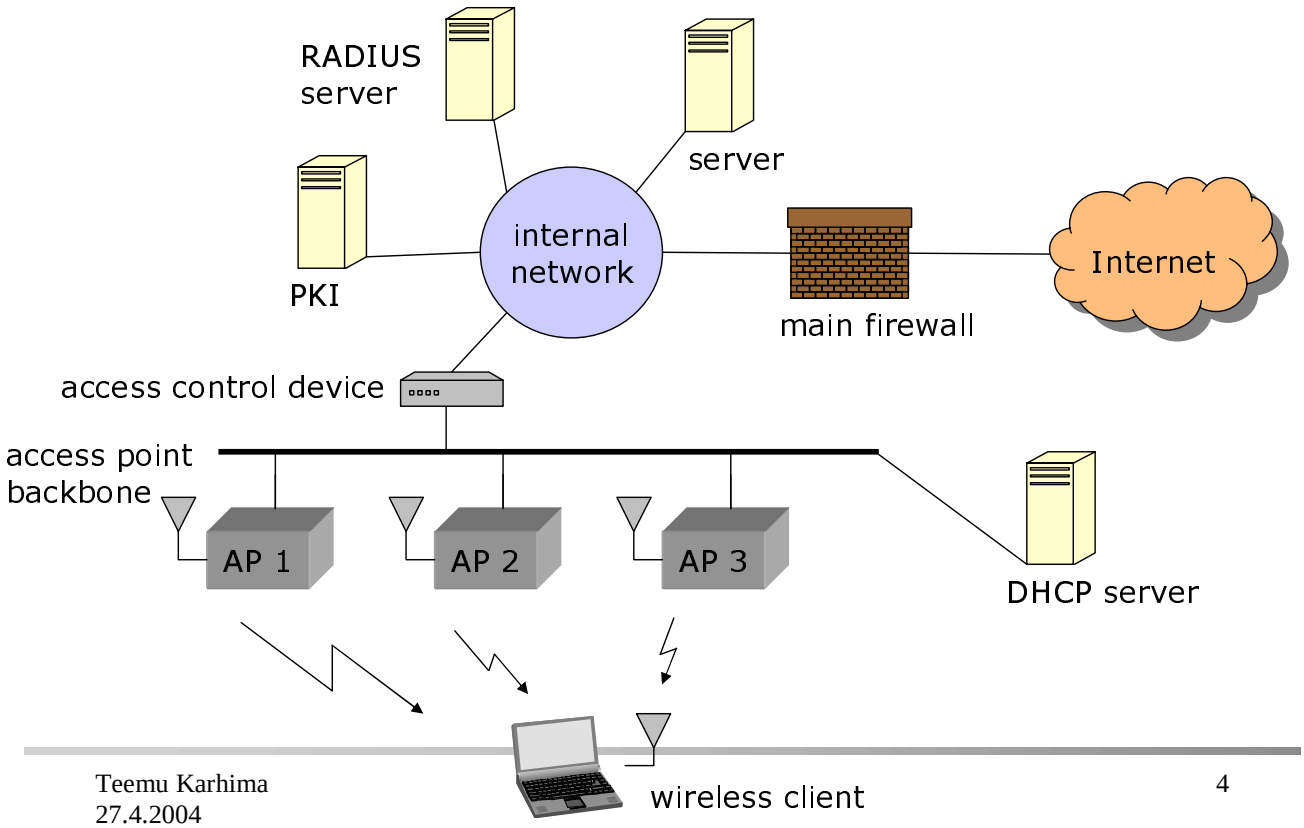
Network Deployment

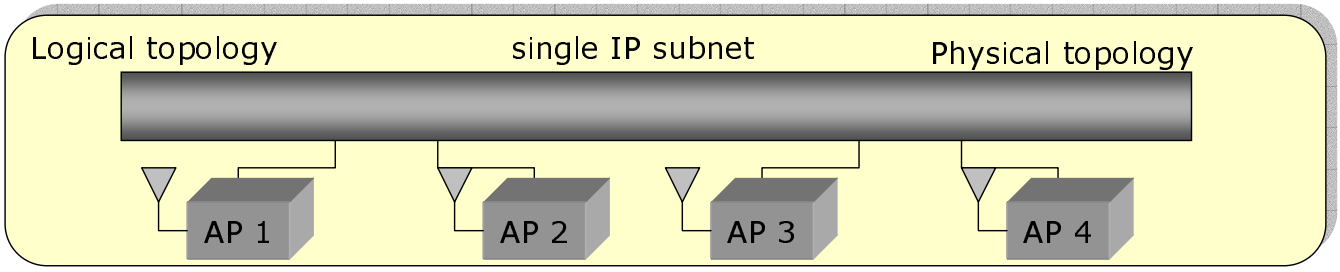
- WLAN network planning have to compensate with coverage and security issues.
- Each building has its own characteristics (radio propagation environment, interference…) which requires unique planning and site surveying.
- Wireless network is dependent on wired network.
- In large networks (several buildings) planning must consider tasks inside and between buildings.

Network Topology



Roaming and Mobility 1/3

- Mobility is supported between access points that are connected to the access point backbone, which is a single IP subnet.
- 802.11 provides link level mobility, which means that connection is managed if client changes access point inside a single IP subnet.
- Same IP address, SSID and WEP are also required for mobility.
- Virtual LANs (VLANs) can be employed to connect multiple physical locations on the same IP subnet.

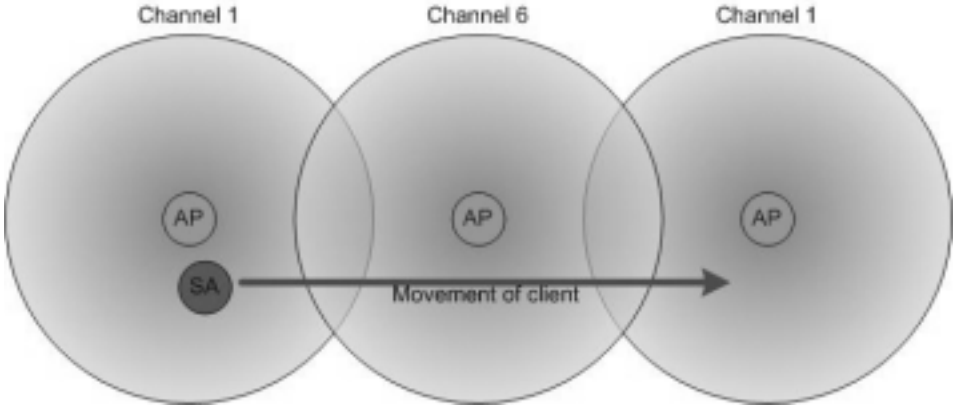


Roaming and Mobility 2/3

- Common strategy is to establish mobility within individual buildings, but not provide roaming between buildings.
- ESS (same SSID) can be extended across subnet boundaries to provide roaming, but network connection will be interrupted when moving between different subnets.
- DHCP (Dynamic Host Configuration Protocol) service provides the easiest way the user to configure to the wireless network. Static addressing is also acceptable.
- Access points include DHCP server almost without exception, but the best way is to use single DHCP server to support wireless clients and thus database problems can be avoided.
- In organization where centralized address assignment with DHCP is used, DHCP relay might be the best way to address wireless clients.

Roaming and Mobility 3/3

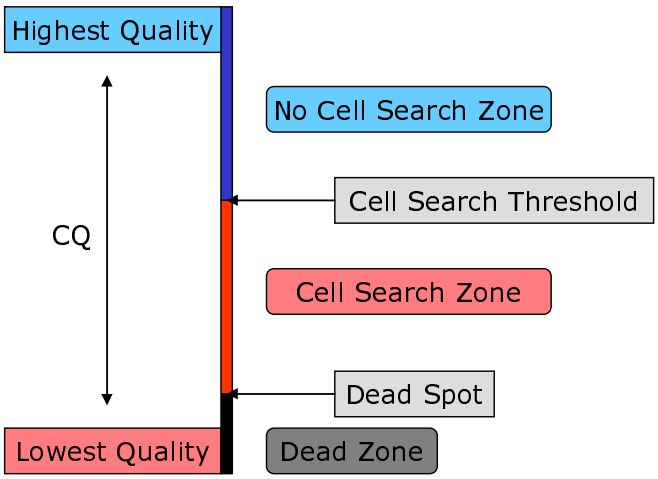
- Roaming does not require physical movement, it could also happen as the result of load sharing and balancing between access points.
- IAAP (Inter-Access Point Protocol) ensures roaming between access points from different vendors. Handoff delay ~ 400 ms
- Mobile-IP will compensate for these mobility limitations.



CQ and ARF

CQ (Communication Quality) indicator is one possible solution for roaming establishment.

Station can search better AP when its CQ is in the *Cell Search Zone* by sending a probe request message. If station finds an AP that has sufficiently good CQ, it will arrive to the handover state and re-associate to this second AP.



ARF (Automatic Rate Fallback) is not given in the standard but it's required to ensure usage of the highest practical data rate.

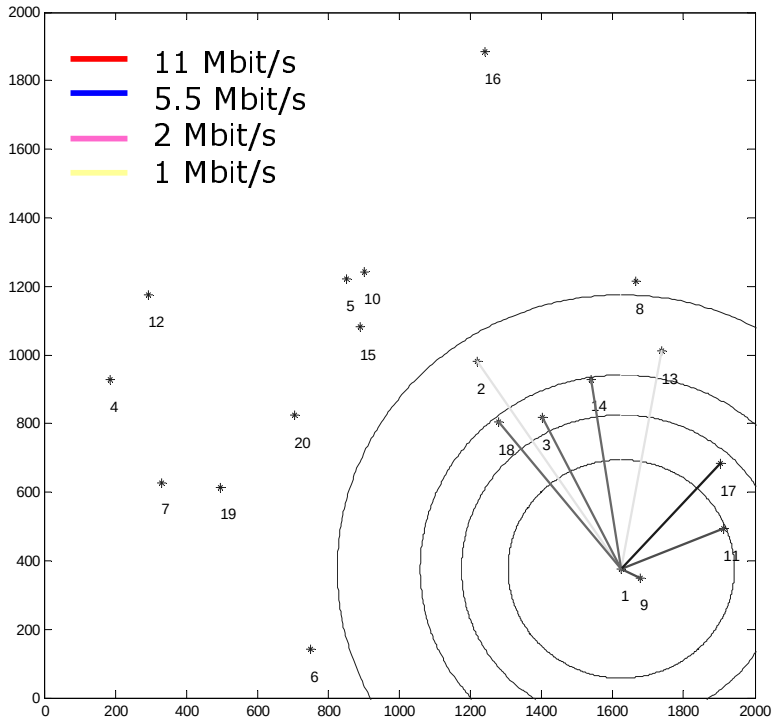
ARF is executed after few (6 is optimum) successive retry a fallback to prevent "ping-pong" effect.

Communication range

WLAN communication range depends on environment and data speeds:

Theoretical ranges:

Speed	Outdoor	Indoor
54 Mbit/s	50 m	20 m
18 Mbit/s	150 m	75 m
11 Mbit/s	180 m	125 m
1 Mbit/s	570 m	125 m

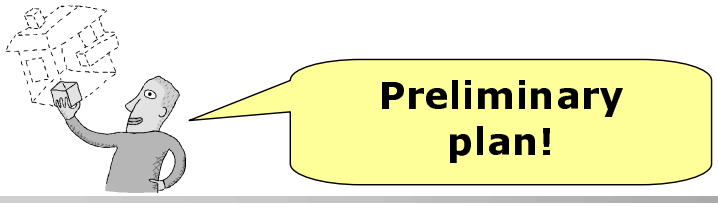


Security Considerations in Network Deployment

- Access control devise (router, firewall, VPN etc.) should be used between wireless network and internal network to protect networks against the threat of unauthorized access.
- PKI (Public-key infrastructure) is used to support remote access.
- RADIUS (Remote Authentication Dial-In User Service) enables remote access servers communicate with the central user database and thus increases the network security.

Project Planning

- Throughput
- Coverage area
- Mobility
- User population
- Physical network planning
- Logical network planning
- Application characteristics
- Security requirements
- Site environmental considerations
- Purchasing hardware and software
- Project management



The Site Survey

Purpose of site surveying:

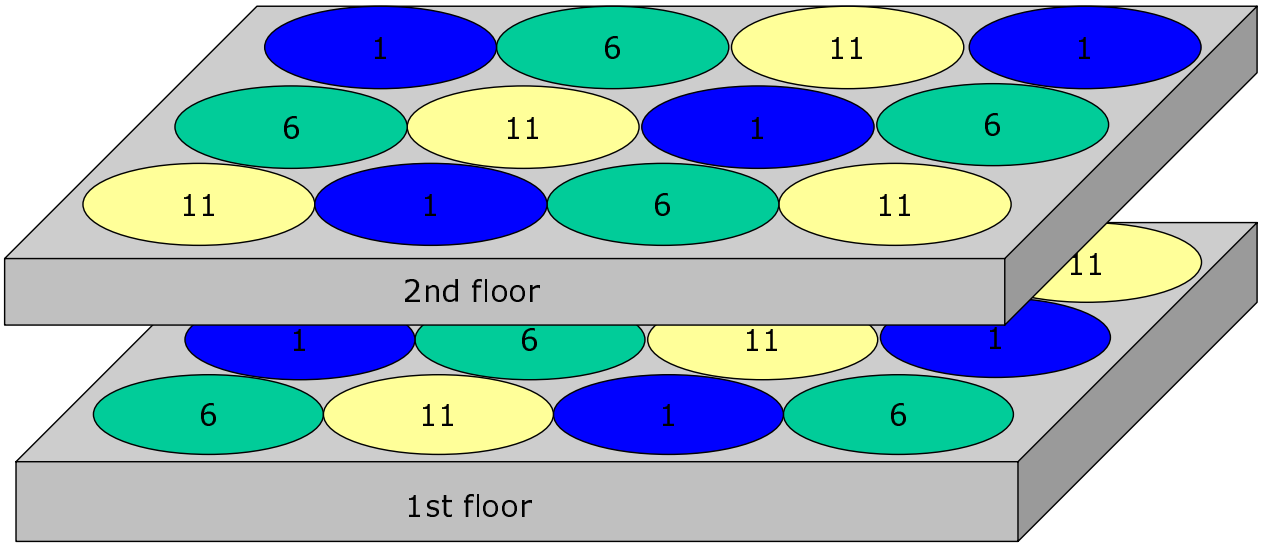
- Check coverage area of each access point
- Check bit rates and error rates in different locations
- Check that the number of access points is sufficient
- Check the performance of applications
- Check possible interfering devices

Measurement parameters:

- Packet Error Rate (PER)
- Received Signal Strength Indicator (RSSI)
- Multipath time dispersion

Frequency Planning

3 non-overlapping channels (ch 1, ch 6 and ch 11)



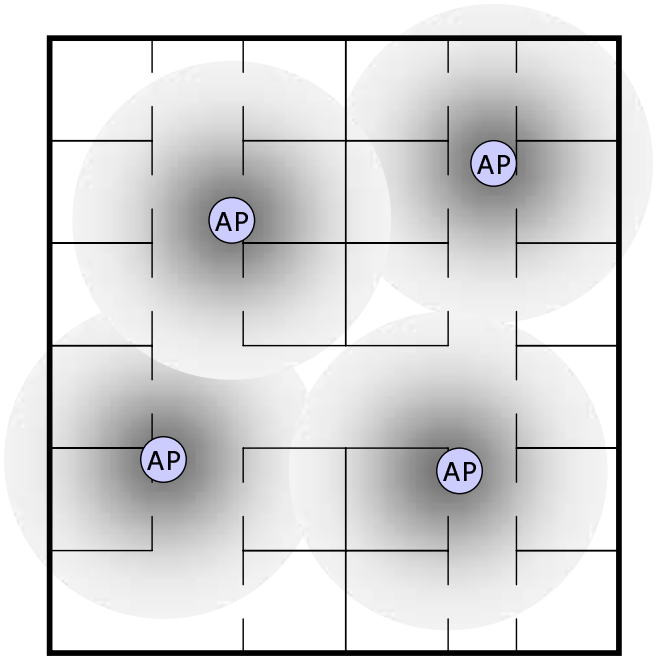
Final Steps

Site survey report:

- A summary of requirements
- Estimated coverage areas
- Locations of access points
- Antenna types
- Estimation of installation work

Installation procedures:

- Record keeping
- Naming
- Security



Network Analyzers

Why?

- Statistic on RF signal strength (more access points needed?)
- Throughput measurements (too many users/access point?)
- Interference analyses (microwave oven, bluetooth device?)
- Packet analyses (network or application problem)
- Security monitoring (illegal users, WEP in use)

What kind of?

- Software
- Hardware
- Commercial
- Freeware

Commercial analyzers

AiroPeek NX™

- Software
- Site surveys
- Security assessments
- Client troubleshooting
- WLAN monitoring
- Remote WLAN analysis
- Application layer protocol analysis
- Enhanced VoIP Analysis

Commercial Analyzers

Beetle

- **Beetle**™ is a handheld, low-cost wireless receiver designed specifically for installing and maintaining Local Area Networks.
- The instrument measures coverage of IEEE 802.11b networks.
- Measures and displays signal strength of all APs on all 14 DSSS channels as well as PERs (Packet Error Rates) and WEP encryption detection.
- Detects and differentiates from narrow-band interferences such as microwave ovens and frequency hopping systems.

Freeware Analyzers

Ethereal

- Ethereal is open source network protocol analyzer.

KISMET

- Kismet is an 802.11 layer2 wireless network detector, sniffer, and intrusion detection system.

NETSTUMBLER.COM

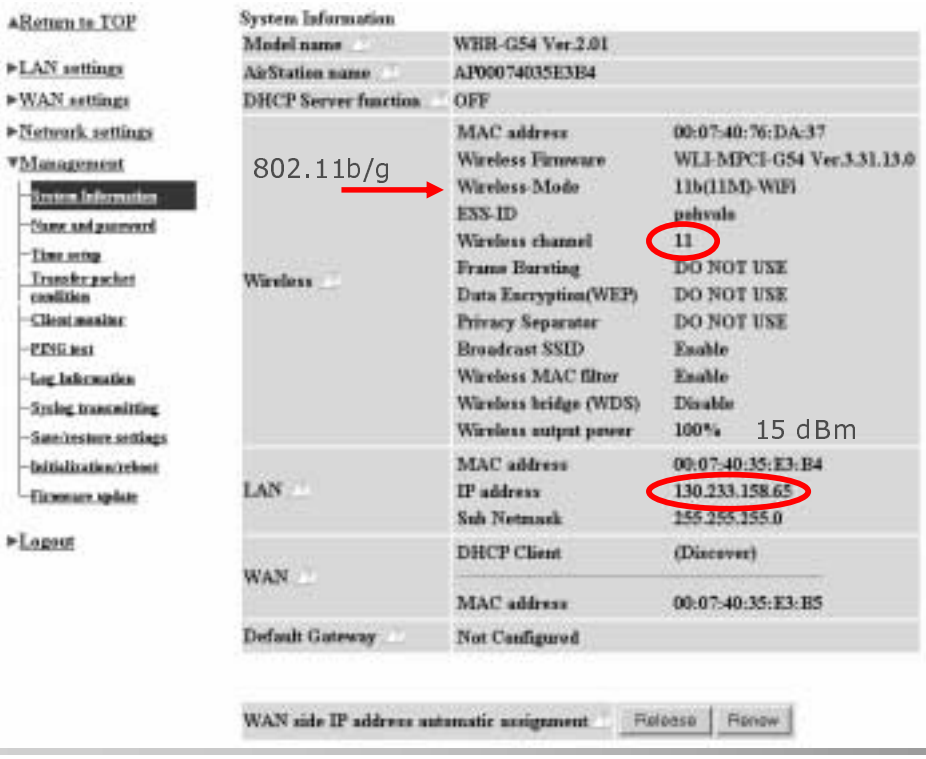
- Netstumbler is a wireless network scanning tool (RSSI, ESSID, channel, MAC address).

Network Configuration

- Network configuration can be used to improve the performance of wireless network by tuning administrative parameters.
- Beacon interval can be decreased to enable more effective mobility.
- Shorter RTS/CTS threshold will combat against "hidden node" problem.
- Under heavy interference, fragmentation threshold reduction can increase throughput.
- Retry limit determines the number of retransmission. It can effect on maximum throughput and required buffer space.
- Power control management parameters: Listen interval (broadcast, multicast), DTIM period (unicast), ATIM window (ad-hoc network).
- Timing operations: scan timing, authentication timeout.
- Transmit power level

Configuration example:

AirStation WBR-G54



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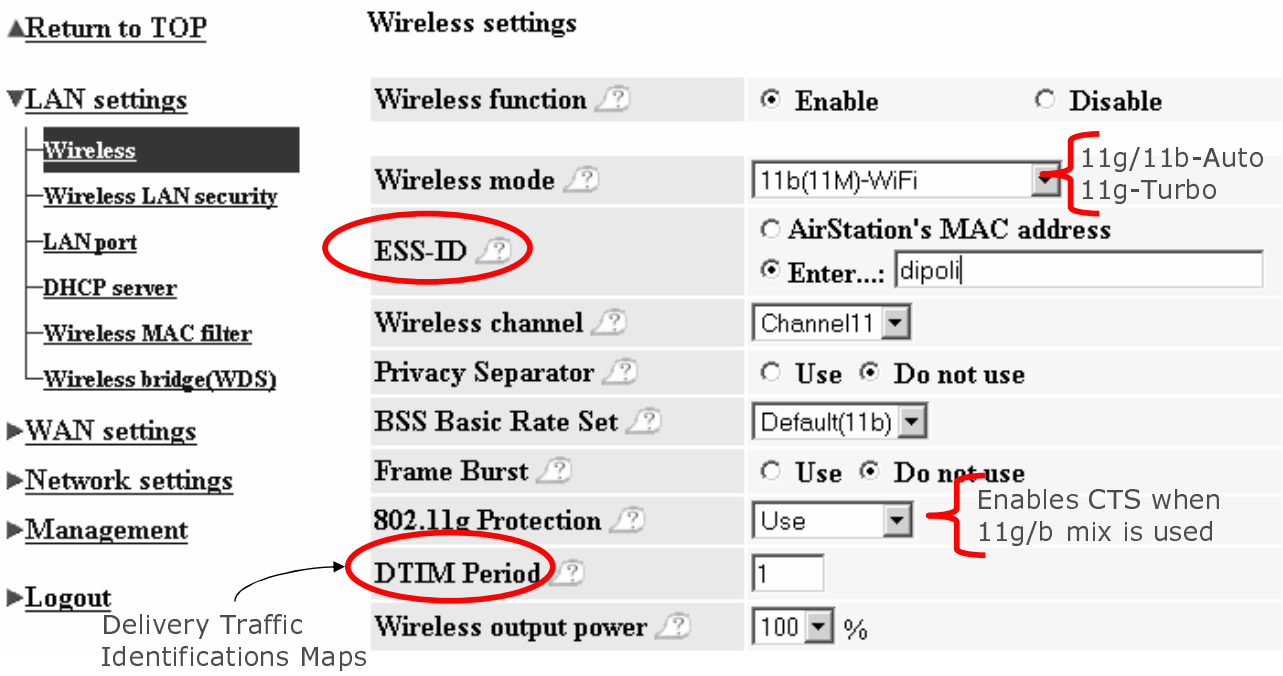
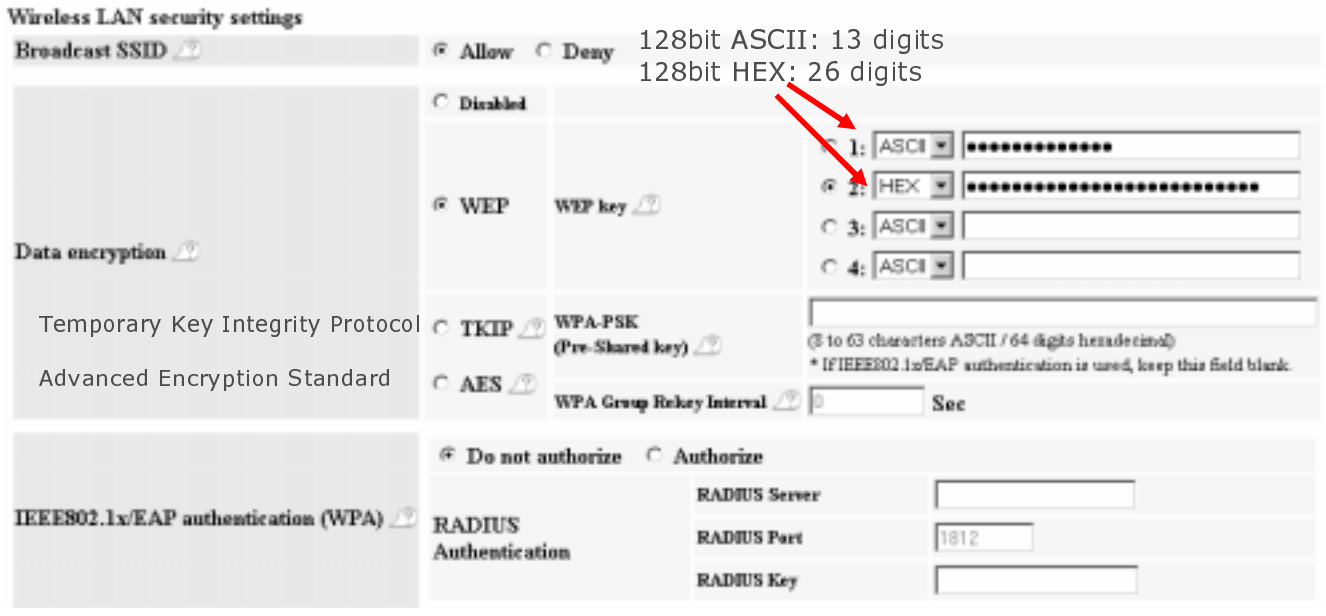


Configuration example:



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[3] http://www.commsdesign.com/printableArticle/?articleID=16500977

[4] A. R. Prasad, N. R. Prasad, A. Kamerman, H. Moelard, A. Eikelenboom, "Performance Evaluation, System Design and Network Deployment of IEEE 802.11", Kluwer Academic Publishers, Wireless Personal Communications, pp. 57-79, 2001.

[5] http://www.ethereal.com/

[6] http://www.kismetwireless.net/

[7] http://www.netstumbler.com/

Homework

What is the maximum square area that you can cover if you can afford to buy 4 access points (AP) using 802.11b standard? The required bit error probability for 1 Mbit/s data rate is 0.001. It can be calculated by BER = 0.5exp(-E/N*Gp), where E is the signal energy, N is the noise energy (assumed to be -80 dBm) and Gp is the processing gain (10*log11 = 10.41 dB). The transmission power of AP is 15 dBm and only the free space loss is considered L = 32.45 + 20log(f[MHz]) + 20log(r[km]). Even the APs should use different frequencies, you can use single frequency (2.45 GHz) in these calculations. The optimum locations of APs are shown in the figure below.