WiFi networking for GMS

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Sept 21, 2013

For more info, see: **http://gms.pejaver.com/Overview.htm**

WiFi configuration guide http://gms.pejaver.com/WiFiConfig.htm

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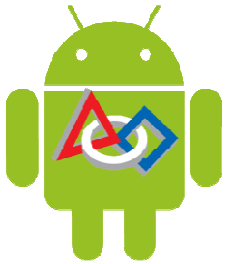
Role of WiFi



- GMS uses WiFi for communications
  - Tablets communicate only with laptops
  - Tablets do not talk to each other
- 2.4 Gig 802.11g is used, 5 GHz is also OK
- FRC, FTC & FLL robots are *not* affected
  - Different bands and channels are used
  - FRC FMS uses 5 GHz, FTC/FLL use 2.4 GHz
- Communications are secure & protected
- Traffic volume is low and load resistant

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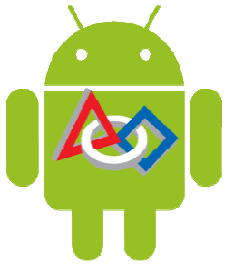
Preexisting Event Site WiFi



- Schools often have WiFis installed
  - Open access may be available for guests
  - Separate private SSIDs for staff
- Advantages:
  - no WiFi set up is necessary (major win)
  - the coverage is usually good (major win)
  - Internet access is usually available (major win)
- Disadvantages:
  - Testing will be required to determine its suitability (see next page)
  - SSL encryption must be used (minor hassle)
  - wired access may not be available for the laptop (no big deal)

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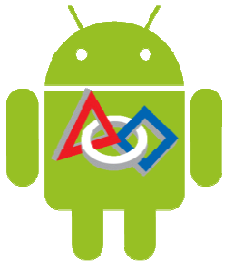
Event Site WiFi: Testing



- Planning days before the event will minimize surprises on the day of the event.
  - Discuss requirements with the site's network administrator
  - Test with multiple tablets and laptop
  - Test from many locations: corridors, cafeteria, rest rooms, …
  - Perform Stress Test to see network behavior under load
- Sometimes routing will be blocked between WiFi clients for security reasons, thereby preventing tablets' access to the GMS laptop. This does not affect Cloud Mode.
- Sometimes a WiFi system will be configured to support multiple 255.255.255.0 /24 segments and routing may be blocked between segments.

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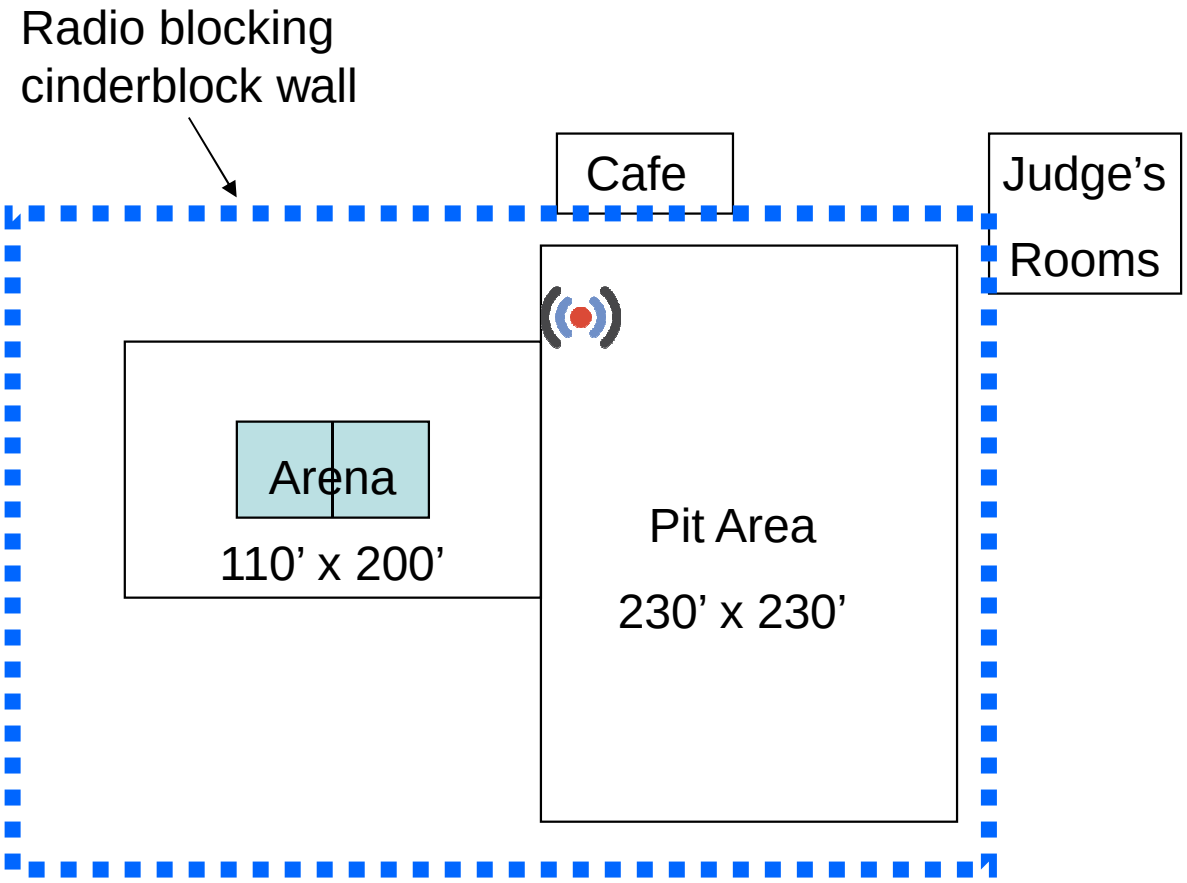
Typical site layout



- Many events are in high school gyms
- Arena and pit areas are in the same 'line of sight' area
- Judge's room & cafeteria may be adjacent
- One WiFi AP will typically cover all areas quite well.

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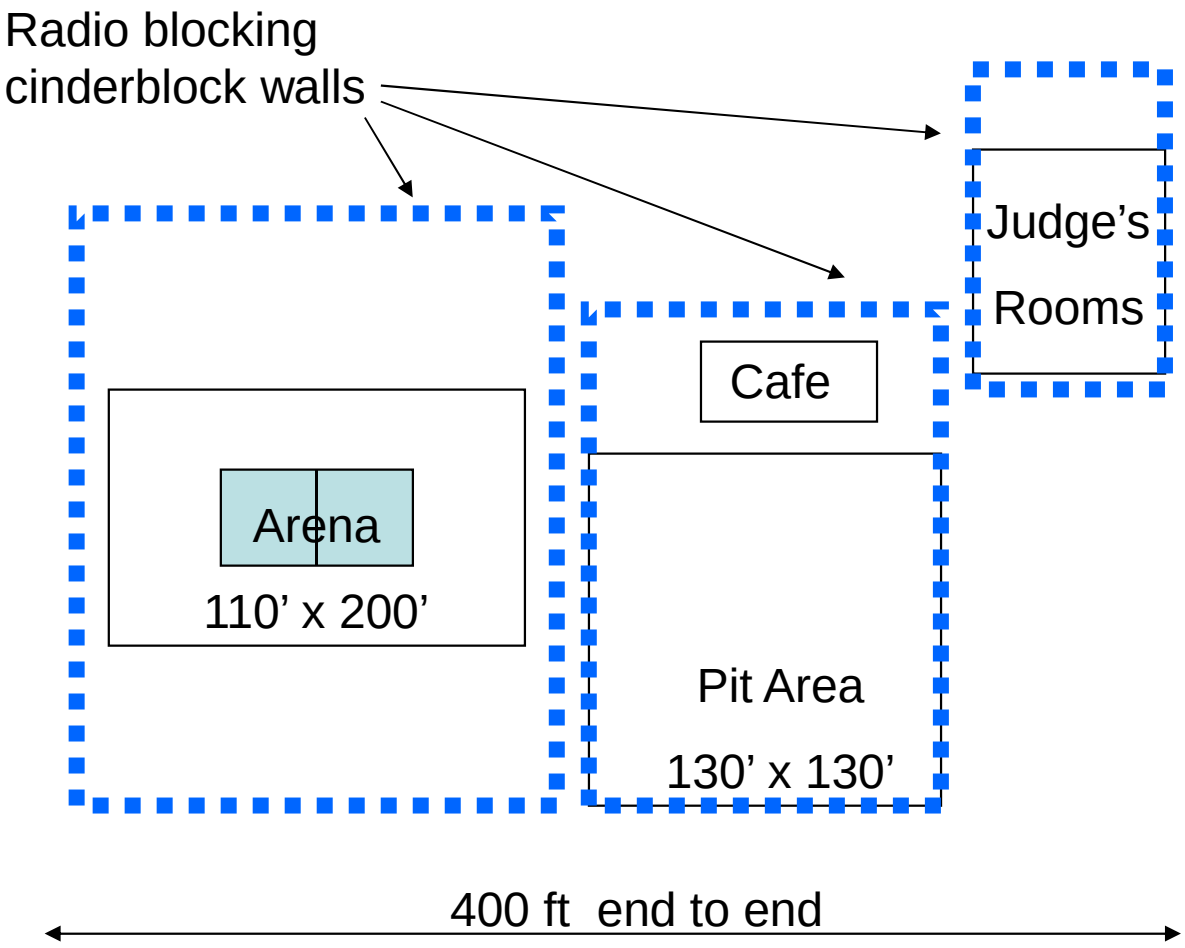
More complex site layout



- Sometimes there are walls between important areas
- We need to have WiFi coverage in all areas
- Judge's rooms may be on a different floor
- Cafeterias need to be covered. Staff expect GMS to work there.

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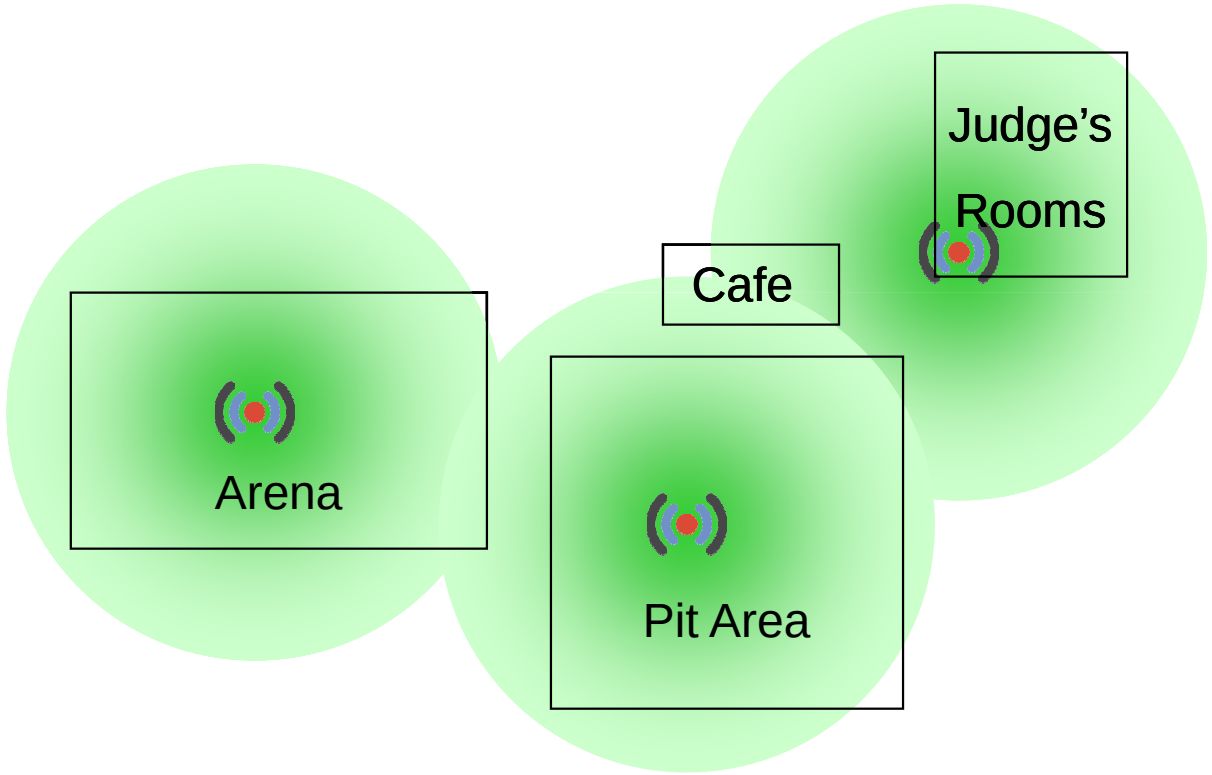
WiFi Access Point locations



- Three access points will provide sufficient coverage at most events
- Walls & floors can block or reflect signals.

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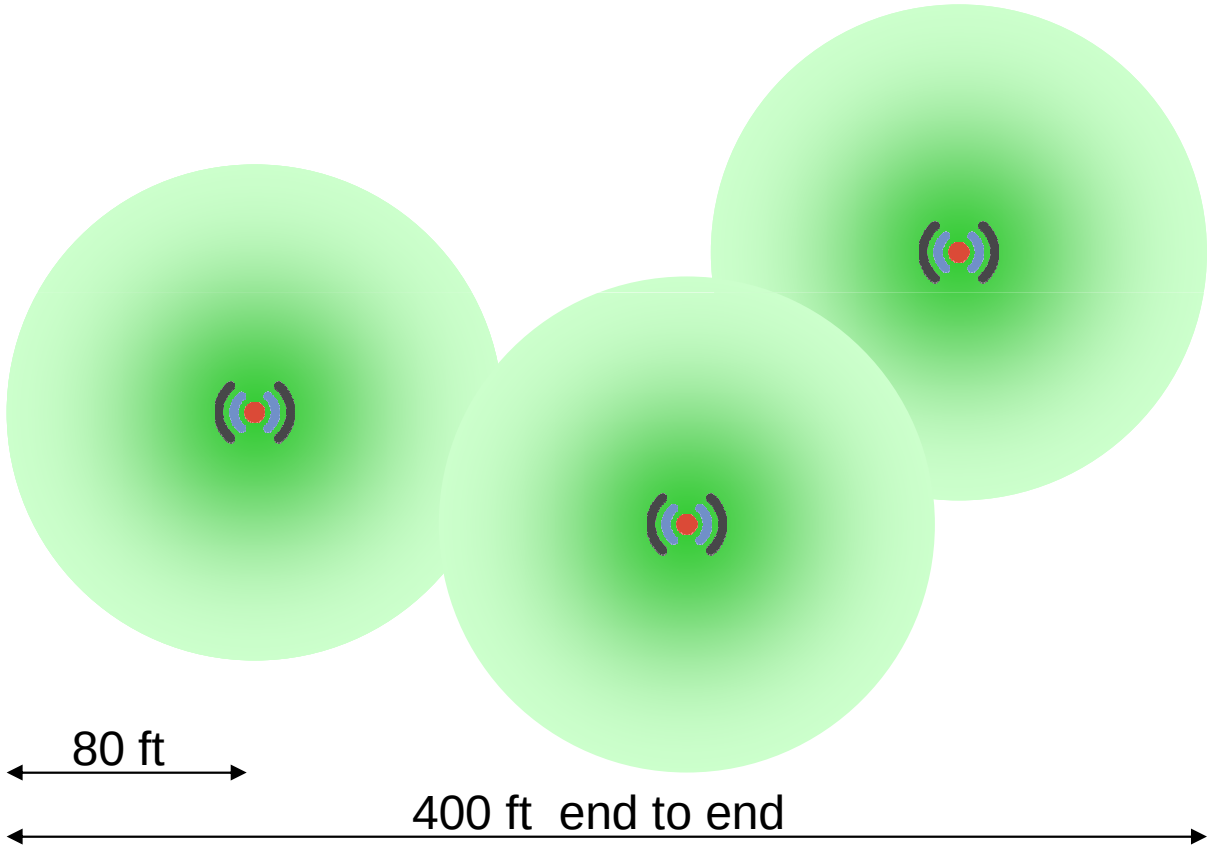
Transmission range



- Typical Wifi range indoors is about 80’-150’.
- A mobile device has to transmit only 80’ to the nearest AP.
- Try to place APs to optimize coverage
- Place AP as high up as possible

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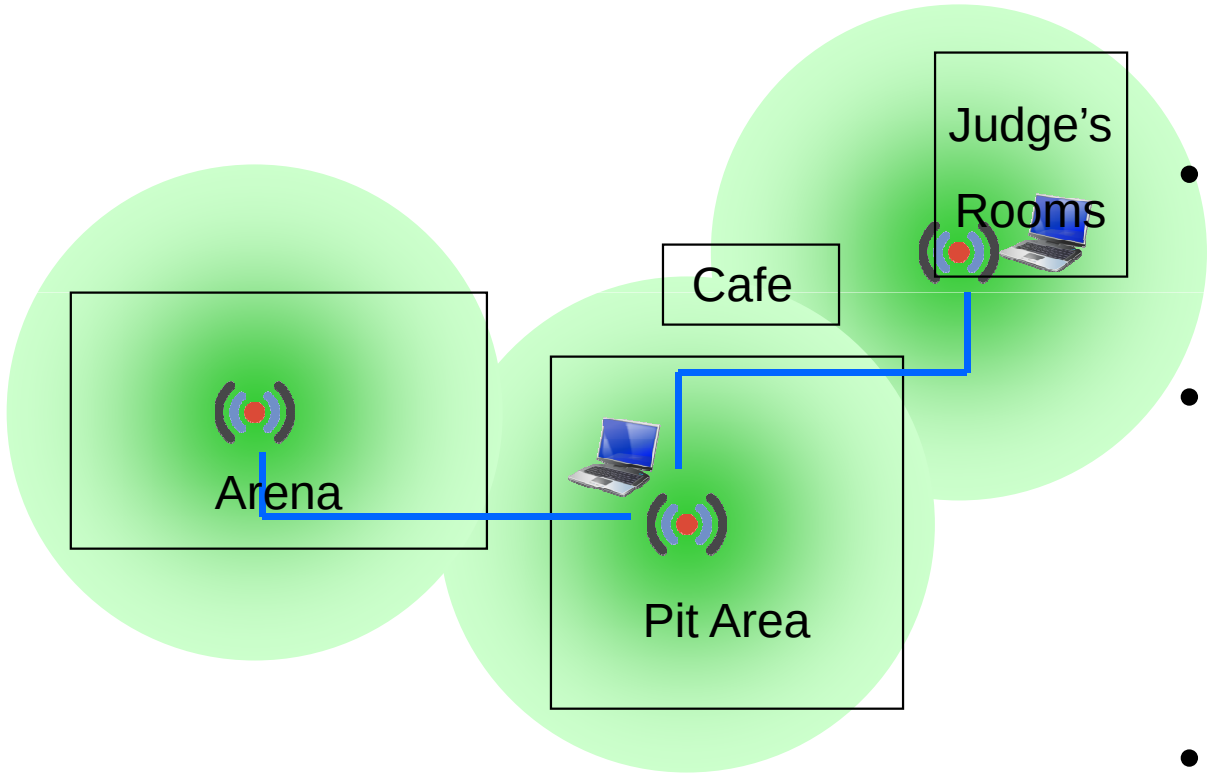
Wired backbone network



- 802.11 LAN cables connect access points
- Use 200' CAT 5 cables, run along corridors
- Connect laptops to APs using a Ethernet cable in Judge's room and at LRI station
- Wired laptops reduce WiFi traffic by 50%

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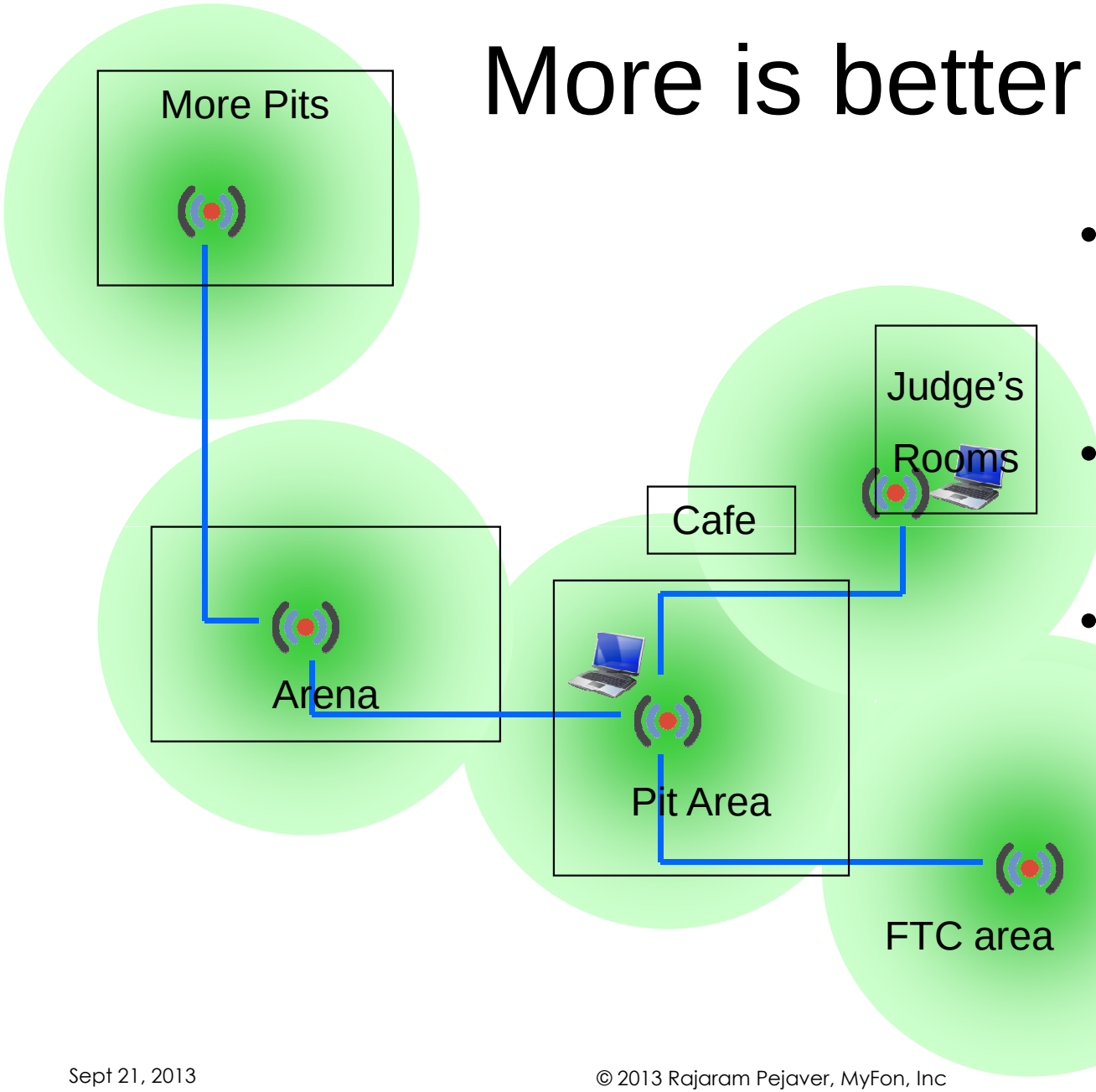
More is better



- Can easily extend to more than 3 Access Points if needed.
- Multiple hops on the wired network are OK.
- A star configuration is simple but not necessary.

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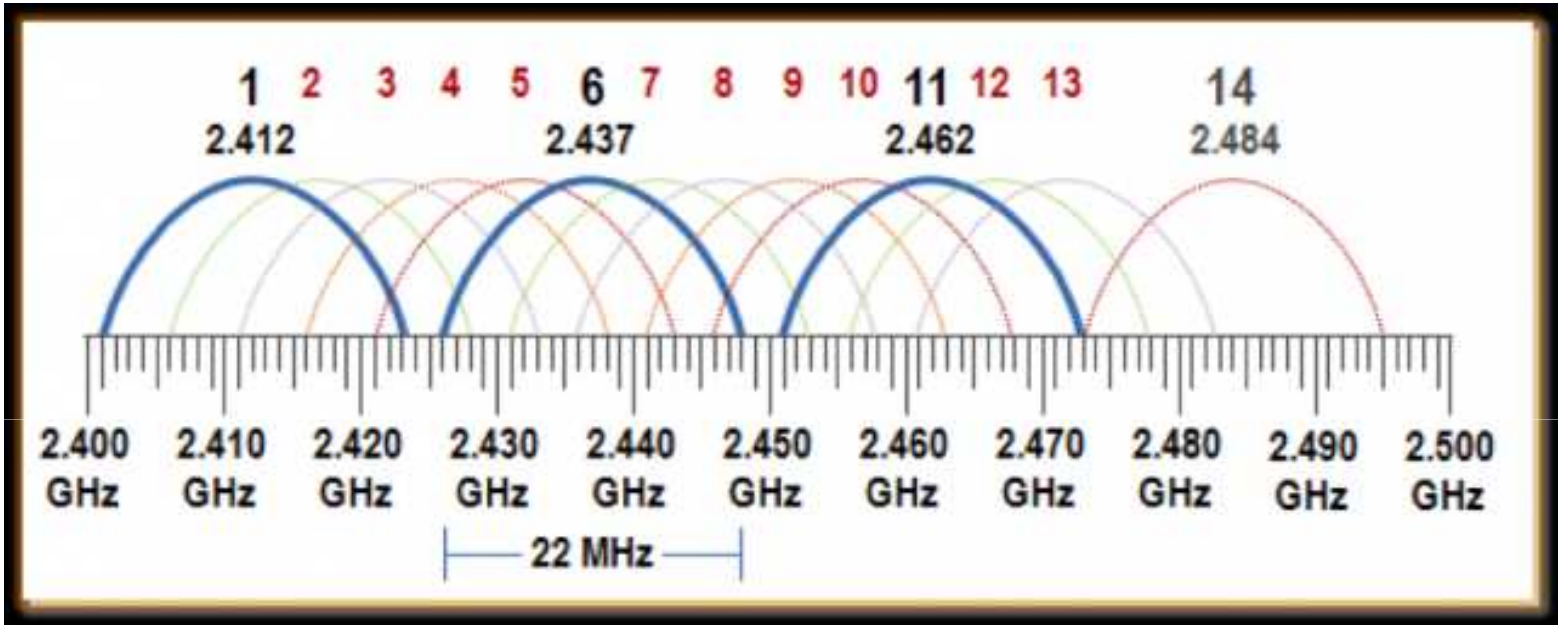
WiFi G Channels



- WiFi G (2.4 GHz) has 3 good non-interfering channels
  - Shown in blue above: Channels 1, 6 and 11
  - Avoid other channels, shown in red
- Configure APs to use these channels for FRC events
- 5 GHz channels work fine too, use them for FTC/FLL events
  - They are not yet approved by *FIRST* for FRC

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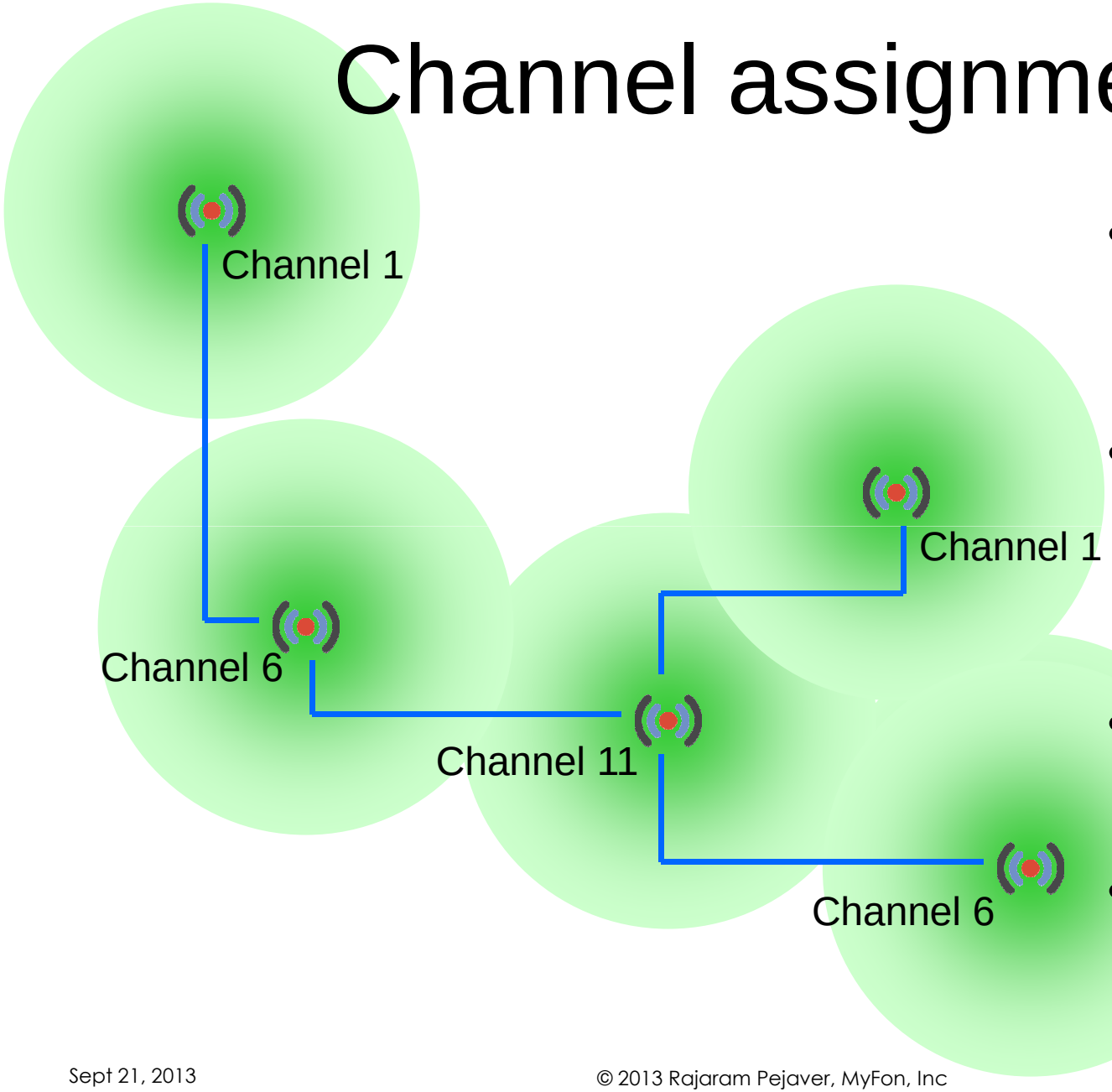
Channel assignment



- Assign channels to APs so that channels do not interfere.
- Scan for signals from other WiFi APs and avoid using the same channels
- Or simply use Auto Channel Scan
- *5GHz WiFi N supports 24 non-overlapping channels*

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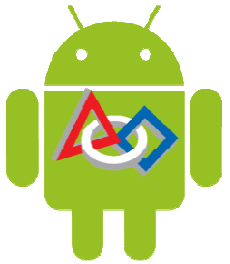
AP configuration concepts



- One AP will act as the Router:
  - It allocates DHCP IP addresses for all devices
  - It connects to the Internet (if available)
- All other APs function as Bridges
  - They extend the WiFi range

- All APs will have the same SSID and Password
  - Allows mobile devices to ‘roam’ between APs
    - Automatically connect to closest AP
  - SSID should not be broadcast
    - But they are not a big secret
    - They can be seen by anyone who has a GMS tablet

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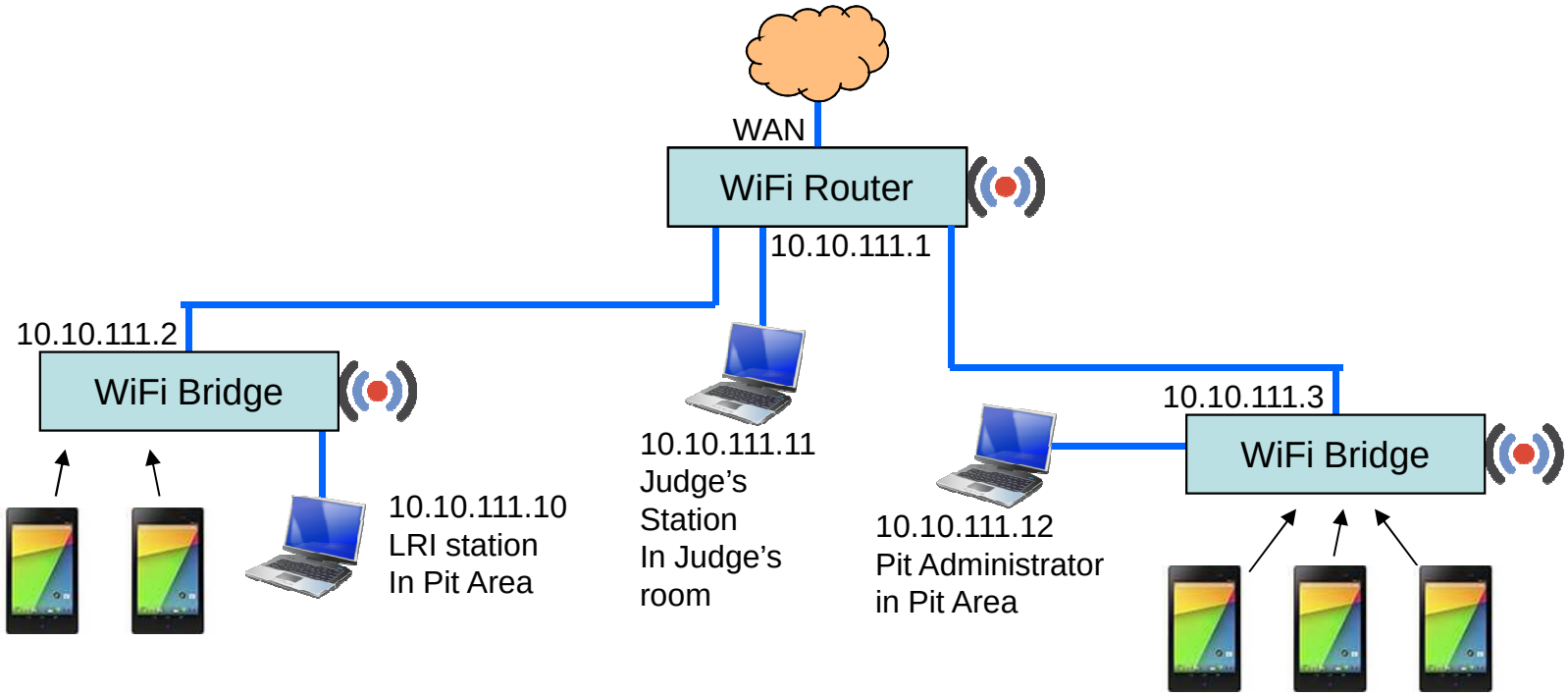
AP Routing Example



- DD-WRT is really nice, but DAP 1522 can be used too.
- Configured as AP Router and as AP Bridges.
- All devices (wired and wireless) are on 10.10.111.0/24.
- Results in a flat LAN.
- Allows UDP broadcasts to devices.

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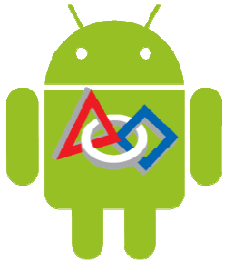
Configuring a DAP 1522



- Either Hardware Version A (old) or Version B (current) can be used
- Configure one AP as the Router and rest as Bridges
- Common Settings for both Router and Bridges:
  - Set sliding switch (on back) to AP Mode (not Bridge, not Auto)
  - Reset the DAP 1522 (if necessary) by poking a pin into Reset hole
    - A DAP 1522 User Manual is available at: http://s3.amazonaws.com/szmanuals/a316344a9c846a97592f5794f041cc0c
  - Use an Ethernet cable to connect a PC to a DAP 1522 port
    - Set PC's IP address to static : 192.168.0.10 (use SetStaticIP.bat in GMS directory)
  - Login to the DAP 1522 using a browser
    - URL: 192.168.0.50, User Name: Admin, Password: <blank>
  - Set new password
    - Maintenance → Admin → Password: <yourPassword> <press Save>
  - Configure DAP 1522 to get its WAN IP address via DHCP
    - Setup → Network Settings → LAN Connection Type: DHCP

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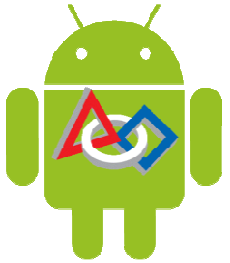
Configuring a DAP 1522…



- Common WiFi settings for both Router and Bridge, continued:
  - Setup → Wireless Settings → Manual Wireless Setup → Wireless Network Settings:
    - Enable Wireless: Checked
    - Wireless Network Name (SSID): Staff1
    - 802.11 Band: 2.4GHz (Use 5GHz for FTC/FLL events)
    - 802.11 Mode: Mixed 802.11n, 802.11g
    - Enable Auto Channel Scan: Checked
      - Uncheck to manually select Wireless Channel, if you know what you are doing
    - Channel Width: Auto 20/40 MHz
    - Visibility Status: Invisible
  - Setup → Wireless Settings → Manual Wireless Setup → Wireless Security Mode:
    - Security Mode: WPA-Personal
    - WPA Mode: WPA2 Only
    - Cipher Type: TKIP
    - Passphrase: <xxxxxxxx> (at least 8 chars) <Press Save Settings>

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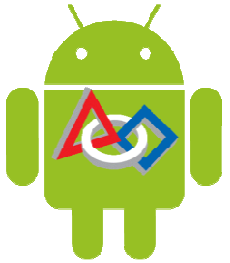
Configuring a DAP 1522…



- Configure one DAP as a Router:
  - Advanced → DHCP Server → DHCP Server Settings
    - Enable DHCP Server: Checked
    - IP Assigned From: 10.10.111.15 (for mobile devices)
    - Default Subnet Mask: 255.255.255.0
    - Default Gateway: 10.10.111.1 (Press Save Settings)
    - Reset PC's IP address to DHCP (use RestoreDHCP.bat in GMS directory)
  - Optionally, assign static IP addresses for laptops as follows:

    Advanced → DHCP Server → DHCP Reservation
    - Enter MAC address as 12:23:34:45:56:67 (your PC MAC address)
    - Enter IP address as 10.10.111.11 (or .12, .13) (Press Save Settings)
  - Connect WAN Ethernet port to the Internet (if available)
- Configure other DAPs as Bridges:
  - Advanced → DHCP Server → DHCP Server Settings
    - Enable DHCP Server: Unchecked (Press Save Settings)
  - Connect a Bridge Ethernet port to Router

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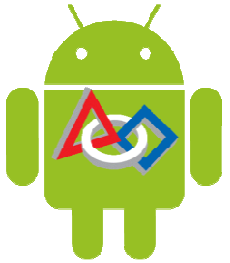
Connecting Devices to AP



- Windows PC stations
  - If possible, connect via wired Ethernet to a AP.
    - Set PC to “Obtain an IP address automatically” (DHCP)
    - Disable WiFi on PC. Don’t allow multiple routes to tablets.
  - Otherwise, connect PC to WiFi network
- Android
  - Settings → WiFi: set to ON
  - Settings → WiFi → Click SSID if it is visible in the list
  - Otherwise, touch the + icon to add a network
    - Type in the SSID
    - Select security: WPA/WPA2
    - Click Save
  - Enter WiFi Password, and click Connect

<Need to test WiFi Protected Setup on DAP 1522 before recommending it>

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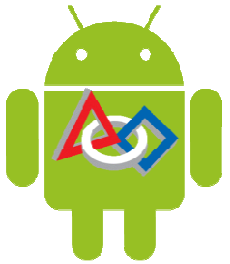
AP Device Selection



Low end routers lack some useful features:

- DNS (or DNSMasq)
  - Allows names to be used for LRI Station
  - SSL security certificates can use name, not IP
- Disabling NAT (router mode vs. gateway)
  - Allows UDP notifications to be sent to clients
- Predictable routing
- Suggest re-flashing an inexpensive router to DD-WRT

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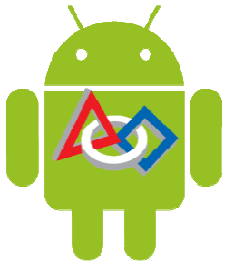
Capacity & Security



- GMS bandwidth usage is low and bursty
- There are only about 50 users on the GMS WiFi net
- If a transmission fails, GMS queues and re-transmits it
- Contention is mainly from other APs on the same channel.

- We do not reveal the WiFi shared-key ‘password’.
  - All tablets are pre-configured with the key and given to users
  - WiFi key cannot be extracted from configured tablets
- Using MAC Address filtering can help sometimes
- Security details: http://gms.pejaver.com/Security.htm

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