

Composition
Graph Ruled

Rich Reece
c Stadium Design Notebook

8/26/2010

First Team Meeting

- talked about the VIP program & eStadium

15

8/27/2010

First Sub-Team Meeting

WR160NL (Router Model)

Chris & Pepe gave an intro ppt that covered some of the work that has already been done and highlighted work that needs to be done.

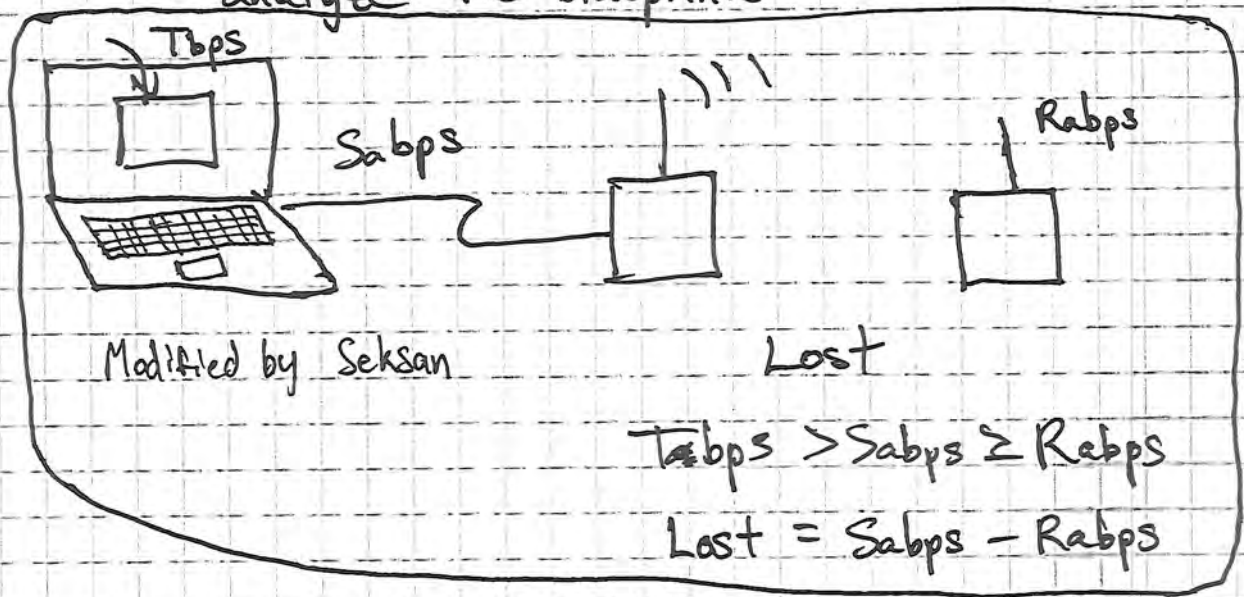
9/02/2010

Do the reading that will be e-mailed out

Discussed the goals for the semester & began to break it up into manageable tasks.

Group To Do!

- 1) Terminators (Aquire)
- 2) Understanding Antenna Config
- 3) APs in stadium
- analyze the blueprints



11/1/11

02/2018

Proposal notes:

- Primary goal of the wireless subteam is to provide Bobby Dodd Stadium with wireless connectivity for smart phone users.
- USA has 11 wifi channels other countries have 14 channels 1,6,11; 2,7,12; 3,8,13; 4,9,14; 5,10 are non-overlapping
- 802.11 has a 22 MHz bandwidth for each non-overlapping channel
- ZIGBEE operates at the same frequencies as wifi
- The technical stuff about antennas and propagating EM waves reminds me of emag too much.
- there are concerns about interference from existing wireless networks within the stadium
- there was only a 4.23 dB attenuation caused by people I thought it might be more as we are big bags of water
- Interesting proposal. Karson expressed some concern about the number of users that the APs can actually support and I think this might be a legitimate concern when I think back to how wireless signals are "keyed" so that they can be processed and superimpose on each other

Fundamentals of Patch Antenna Design and Performance notes:

- you can feed the antenna patch from the side with a typical microstrip line or from the underside with a feedline
- it sounds like the feed line from the back is a superior method but costs more to manufacture
- patch antennas provide good gain while having a low volume and are lightweight
- I am even more convinced that emag is voodoo

Microstrip Patch Antenna CH 3 notes:

- Emag is hard and can only be done by hand for simple geometries. Complex geometries require computer assisted numerical analysis
- There are both pros and cons to microstrip patch antennas. pg. 33 list some of these pros/cons
- Microstrip line feed (from the side), coaxial feed (from the back)
- pg. 38 has a table listing the qualities of the different feeding techniques
- There is a T-Line model and Cavity model of patch antennas in the notes if you want to attempt to understand the magic of electronics

9/03/2010

3

- Talked about microcell measurement plan for tomorrow's football game.
- Try moving around the stadium and seeing if the "tower" id changes.
- Talked about concerns w/ making measurements.
- Lab assignments were discussed. (On T-square)
- Discussed how labs will be done.



Complete Lab 1



Complete Lab 2



~~Complete Lab 3~~

There was some difficulty completing the labs due to poor hardware support with the new MacBook hardware under Ubuntu.

Lab 1: PCs need to be on the same channel w/ the same SSID to communicate.

Lab 2: the iperf tool seems pretty cool. I wonder how different it is from the TCPGEN & UDPGEN that we wrote in EEE 411B.

(Seshat-L)

9/10/2010

5

To-do (Update from Chris by phone)

12/2010



Flash remaining routers (by next week) (9/17)



Terminators (9/12)



Antenna Config (9/12)



Analyze Network Layout in Auto-Cad (9/11)
- Install Auto-Cad (convert CAD → PDF)



New Guy Labs (today)

- Pepe went over the AT&T data that we collected at the game last week.

- We decided to let Pepe take all of the notes since Karson & I had the phones of interest on game day.

The numerical results of the Game 1 measurement can be found in the binder that accompanies this notebook.

9/17/2010

7

I had an idea of putting the C code from the ECE 4118 lab on a iPhone application. Run the server side code on the eStadium server, wrap a simple GUI around the C code.

What should be in a design notebook

Each page should be:

- numbered, DATED, Signed, and possibly cosigned
witnessed

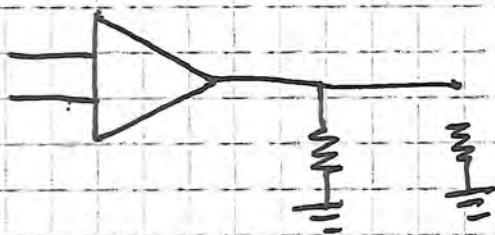
- Front Cover: Name, Project Name, Contact Info, Team Member contact info.

- Technical Notes: Design notes, design decisions, copies or pointers to code, important websites.

* check boxes next to items to be done, check when done

- Meeting notes: detailed meeting notes including items you are responsible + deadlines for ~~sub team~~ sub team + overall team

- Usability: legibility, intelligible technical & meeting notes



From: Pepe on why the routers need an antenna connected.

" Transistor outputs a specific current.

If the antenna is not attached, all the

9/17/2010

I flashed one of the APs today with the 9 DD-WRT firmware.

- The flashing process was fairly simple
- 1) firmware was downloaded (optionally verified by hash)
 - 2) Router was logged into and ROMM was loaded.
 - 3) Once the router came back up a 30-30-30 reset was done to clear the NVRAM
 - 4) the final firmware was flashed
 - 5) AP setup w/ user name & password.

9/24/2010

This week I loaned my iPhone to Pepe and crew so they could do some additional AT&T throughput measurements in the stadium.

Pepe informed me that the AT&T system that was installed in the stadium was not activated during the testing that was done. I suppose that this means the system is off except during games or it was temporarily down at the testing time.

I just read an e-mail from Prof. Coyle saying that the AT&T system installed in the stadium is not a collection of femtocells as previously thought but rather a DAS (Distributed Antenna System).

According to the article that was linked to in the e-mail Prof. Coyle sent out the DAS antenna output relatively "low power" as compared to the normal cell towers due to close proximity.

The article was a good overview of DASs. I printed it out for later reference.

09/24/2010

DAS Article

DAS article from the
e-mail EJC sent out.

09/24/2010

DAS Article

There's been a lot of hype recently proposing femtocells as a low cost means of rolling out mobile network capacity (specifically for LTE, the new 4th Generation radio standard). Femtocells could be a low cost way of providing hotspot capacity in public areas. But in some situations, it will compete with existing techniques. Here we compare and contrast femtocells with DAS.

What is DAS

Distributed Antenna Systems (DAS) are a commonly used technique to provide excellent coverage and capacity throughout large buildings or campus areas. They are commonly deployed in large office buildings, shopping centres and conference centres. Radio power levels are much reduced for both transmitters and mobile devices, because an antenna is usually within line of sight and only a short distance away. This benefits call quality, data rates/response and battery life.

The formal definition of DAS?

Like every good new invention, the technology has its own not-for-profit organisation – the DAS Forum, although this seems to be very US centric and not very active. Their official definition of DAS is “a network of spatially separated antenna nodes connected to a common source via a transport medium that provides wireless service within a geographic area or structure. DAS antenna elevations are generally at or below the clutter level and node installations are compact”.

How does DAS work in Plain English?

What this means in plain English is that the RF signals to and from the mobile operators cellsite basestation are piped through a system of multiple antennas. There are a number of different types of DAS each with their own characteristics :

- Passive DAS – where RF signals are combined using passive components such as filters, splitters and couplers. Great for multiple bands and small to medium size locations
 - Active DAS – RF signals are converted and distributed over fibre. Great for larger installations but more costly and have to be dedicated to bands e.g. GSM900, GSM1800, UMTS2100.
 - Hybrid – combination of the above techniques
- DAS can be employed purely within a large building (In-building DAS) or across a large urban area (Street Level DAS). Street Level DAS can provide a very efficient solution for large urban regeneration projects which require dense coverage. They can also be provided in other busy areas such as Metros, Airports or Railway Stations.

Pros and Cons

The benefits of this approach include:

- Operator equipment is located in one place – simpler maintenance and upgrade procedures
 - Supports multiple network operators, allowing sharing of costs and resources
 - RF coverage can be tailored to meet the needs of specific buildings and use cases
 - Easily upgraded to handle new frequencies, transmission technologies, capacity
 - Allows capacity uplift by offloading in-building traffic from Macro layer
 - Supports rollout of bandwidth hungry, low latency applications
- But the downsides include:
- High capital investment – only justified for large airports, businesses, campuses, centres
 - Complexity - Needs specialist RF expertise to design and maintain

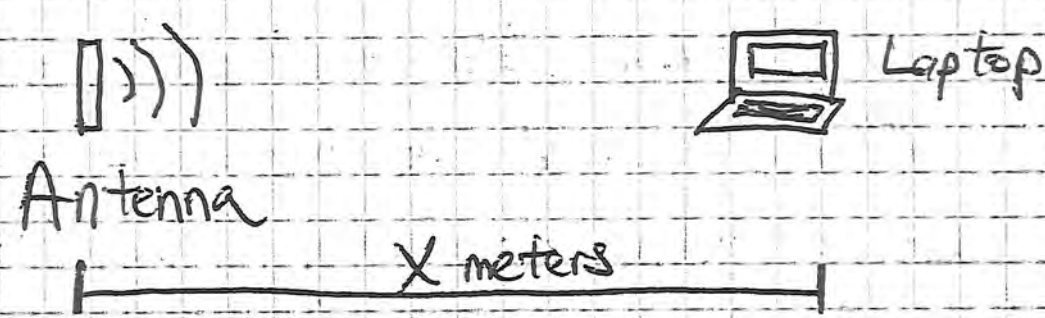
Large Business Premises

DAS is commonly used today by operators for equipping large business premises. Where a business signs up exclusively with one operator, large amounts of capacity and good coverage are required and the investment to provide this is justified. It's cheaper than trying to penetrate the building from several high capacity outdoor

2/24/2019

Today the wireless sub team divided into two smaller groups to develop new labs. The group I was in was tasked with recreating the radiation pattern of the patch antenna.

Seksan, Pepe, Mohamed, and I worked on developing a new lab that shows how to create the radiation pattern that the patch antenna has. I came up with a testing method that allows the antenna and receiver (computer) to stay stationary.



The procedure is simple, Make a measurement and then rotate the antenna and make another measurement. Repeat this process keeping track of the power readings and the angle of the antenna. With this data a radiation pattern can be drawn.

09/24/2010

Antenna Radiation Pattern Results

Angle (in deg)	Distance (in meters)							
	1	2	3	4	6	8	10	12
0	-33	-37	-37	-39	-44	-40	-45	-50
45	-41	-40	-40	-45	-47	-46	-51	-51
90	-48	-46	-46	-49	-44	-45	-48	-49
135	-48	-46	-46	-40	-44	-44	-50	-50
180	-37	-40	-40	-43	-54	-41	-50	-49
225	-36	-43	-43	-49	-49	-53	-48	-52
270	-44	-48	-48	-46	-46	-50	-52	-48
315	-40	-37	-37	-41	-48	-43	-48	-49

Tx Power = 3dB

Preliminary conclusions about the test/procedure.

Looking at the data it seems like the conditions (Klaus VIP room) were far from ideal and we had significant shewing of measurements. It also is apparent that we should have taken measurements at more angles, maybe 15° or 10° would be better as a delta.

Seksan is looking into finding a way to create the plots that this data represents. We know that excel is not very good with polar plots. Matlab is our current best guess as a way to process the data since Matlab does nearly everything.

1/25/2019

Game Day

13

Today Pepe, a student from Morehouse, and I will be making some more game day measurements of the AT&T DAS that was installed over the summer.

So far Pepe says that the measurements look similar to the ones that were taken earlier this week.

This would indicate that either the system is turned off (which I think is unlikely) or AT&T has fixed some of the issues that we uncovered with our previous round of measurements. Specifically, the ping times we are seeing today are far lower than ~~than~~ the previous ones were.

Boo, we lost!!

1/2010
✓

- Look @ SUN repo; make sure you can do it!
- shift focus from new guy labs to pushing the project efforts forward.
- Do labs individually
- Look into PoE for APs
- Where to setup test network (Auto(ad))
- meeting w/OIT

- ✓ - Wednesday, tentative locations in Stadium to provide wireless coverage
- should have form of network infrastructure, if not we could get OIT's help

group ✓

- ✓ - Look at PoE by Wednesday (10/6)
 - extractor / injector solution.
 - pepe & mike will take point on this.
 - switches need to support PoE

- ✓ - Lab 9 Patch Antenna Config (recommended to due during the day in middle of week)
 - me & Karson will do this.

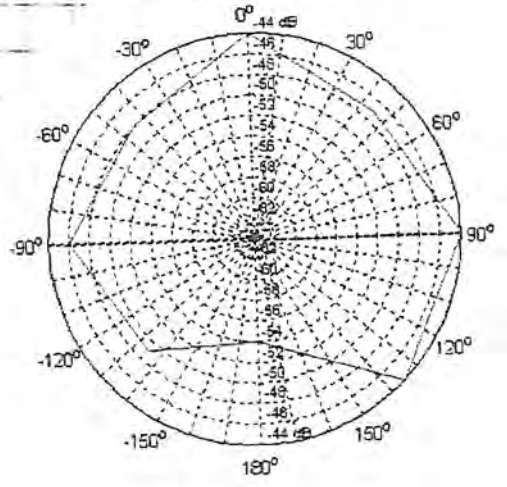
- 4 ✓ - E-mail Ghaith about wireless SUN repo.
 - Ghaith replied back pointing me to the documents he posted on T-Square about SUN. I have no problems getting to the Sensor Nets' Repo but I still don't know what/where the wireless team's repo is.

16
10/04/2010

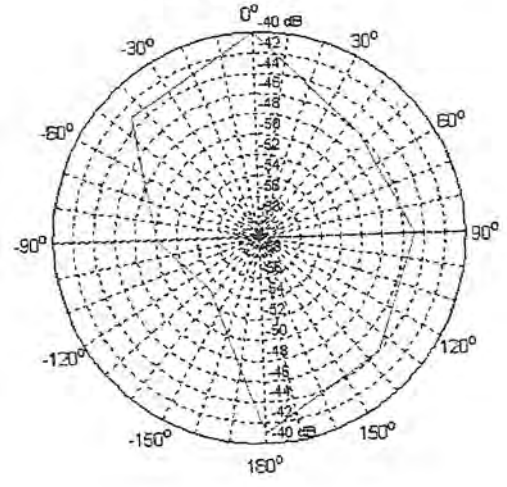
Plots from Seksan of Antenna Radiation Patterns

We definitely need more data points around ~~the~~ in terms of angle. It really looks like the classroom messed up the measurements.

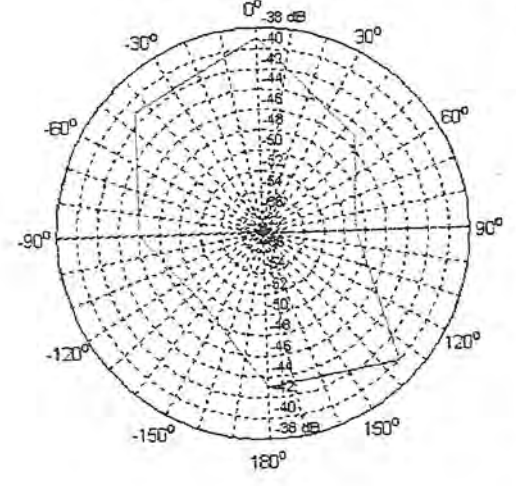
Measured at 6 feet away



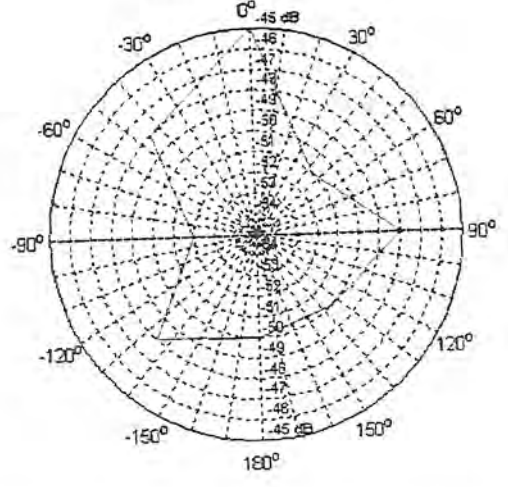
Measured at 8 feet away



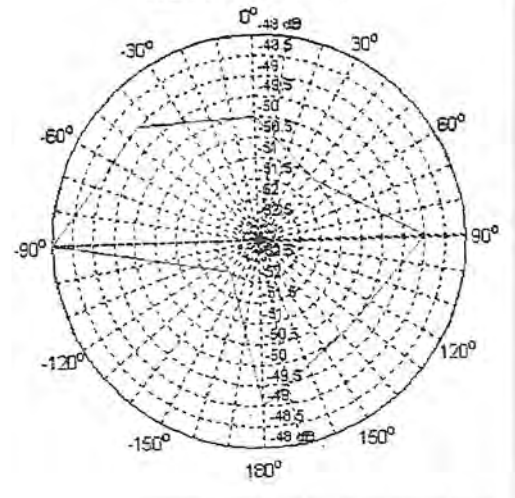
Measured at 4 feet away



Measured at 10 feet away



Measured at 12 feet away



10/08/2010

Look @ SUN repo

ex. ssh jfundora@vpprod.vop.gatech.edu

home → estad → wireless

~~Plan~~ To-do

Research Estadium Competitors

- Purdue
- Clemson iTiger
- OSU iShoe
- Pittsburgh Penguins
- Carnegie Mellon
- Giants / Jets Stadium
- Dallas Cowboys

Clemson iTiger : uses Cisco staff

OSU : based on Purdue "Living Lab"

Pitt. Peng. : GonzCam, private company, live video feeds.

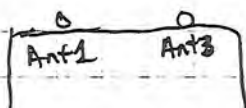
10/11/2010

Pepe sent out an email about PoE injectors / extractors. He expressed some concerns with the amount of power that our Routers require. It looks like we're going to have to come back to this.

10/15/2010

Pepe walked us through some photos he took while he was doing a walkthrough of the data closets in the stadium.

Router Antennas



15/2010
17

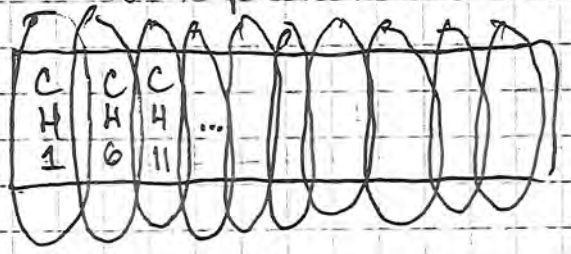
- Antenna cable length leads to loss
- Place antenna(s) to cover a specific area, similar to AT&T's implementation
 - If this isn't done then users will oversaturate the system / APs
- Manual control of each routers, no centralized controller for our linksys routers
 - Cisco Systems implemented across campus centralized

Water Tight boxes?



To-do

- prep for OIT
 - 1 antenna/AP due to lead
 - weather proof boxes



22/2010

- Constraint for APs for test network, how & where we can access.
- Bill & Matt are available Tuesday 10/26 + meeting @ 3PM in YL 465. (Cannot Attend)
- Mohamed has taken point on the weatherproof boxes and will research them and get in contact w/ Prof. Coyle.
- How do we test things out w/out interfering with the existing ticketing wifi.

29/2010

Cisco 3550 switches
- don't have PoE

To-Do



patch antenna measurement



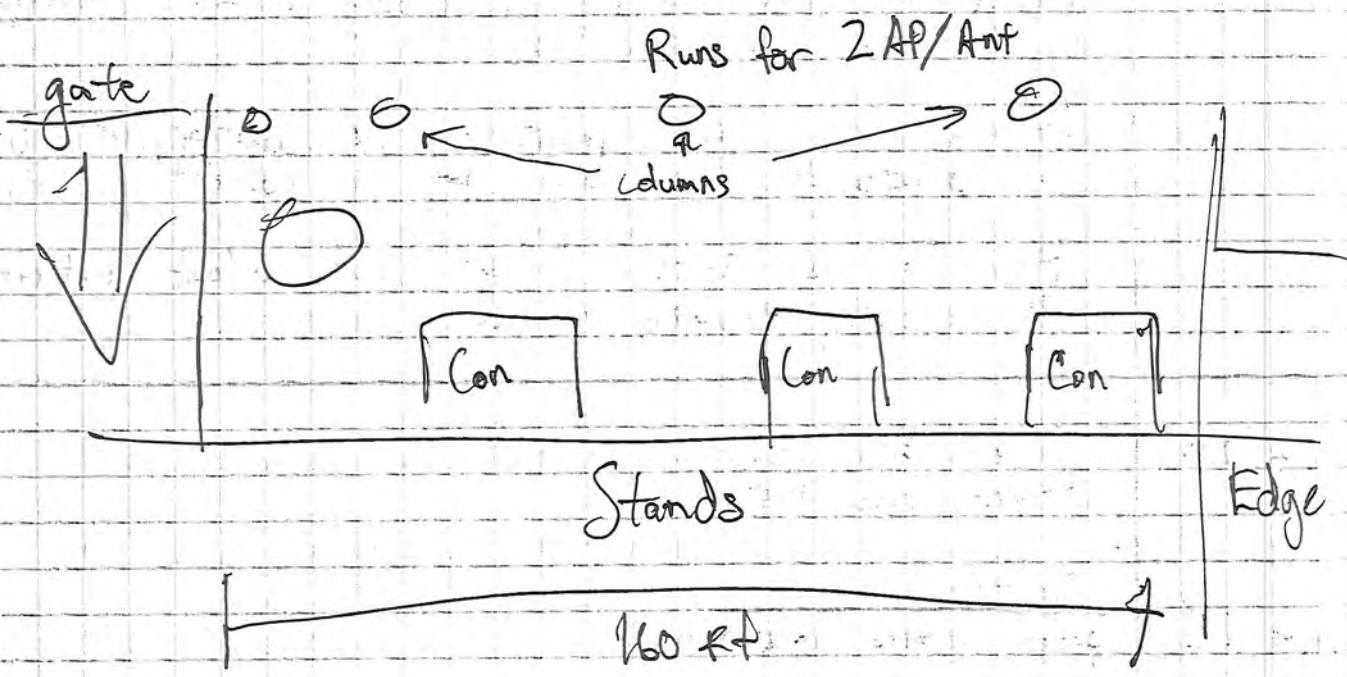
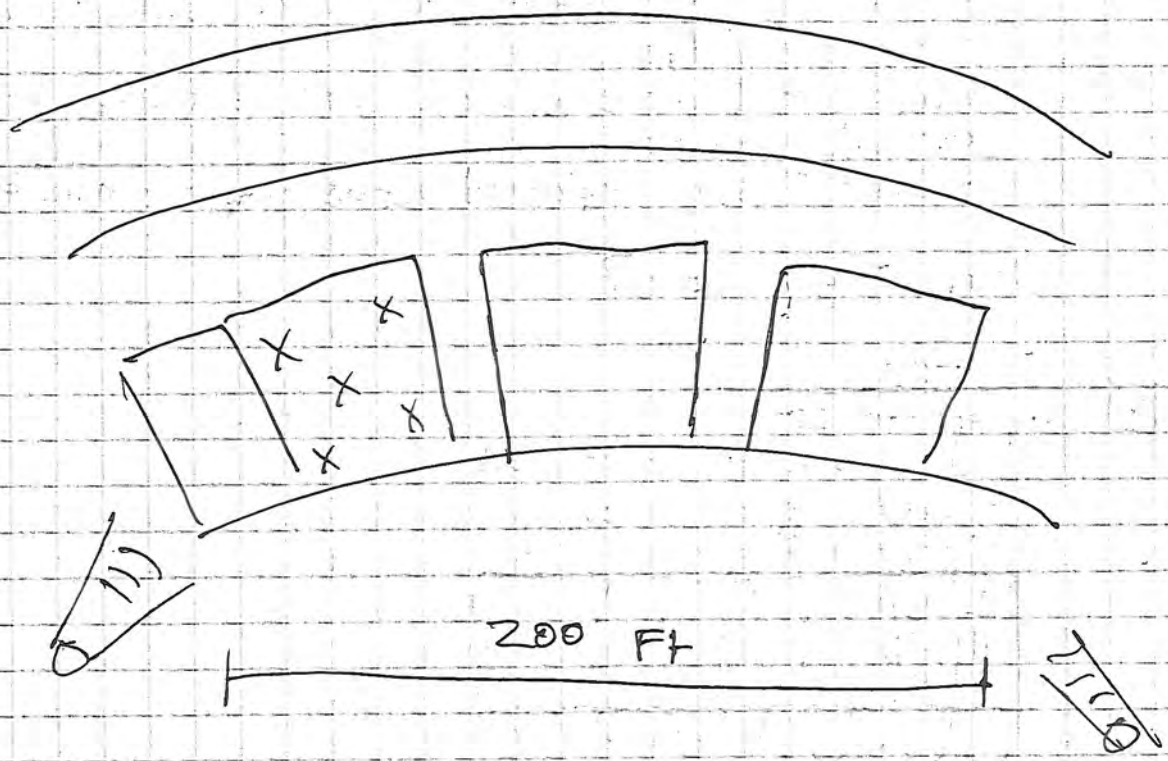
9AM Tuesday @ Stadium → patch Antenna



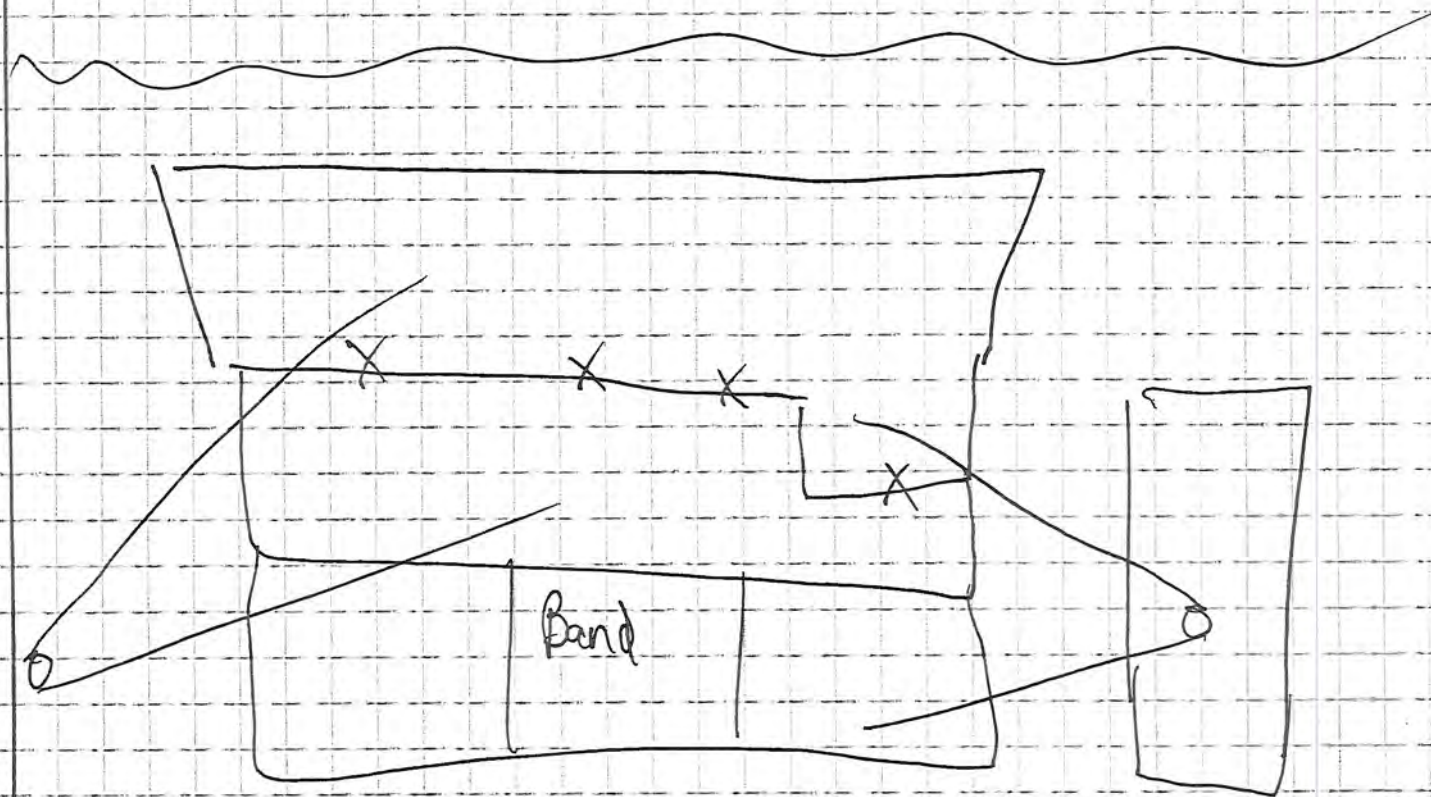
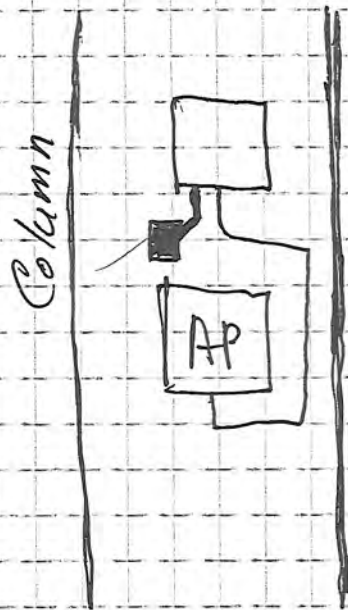
~~Write up proposals~~

• 1 AP

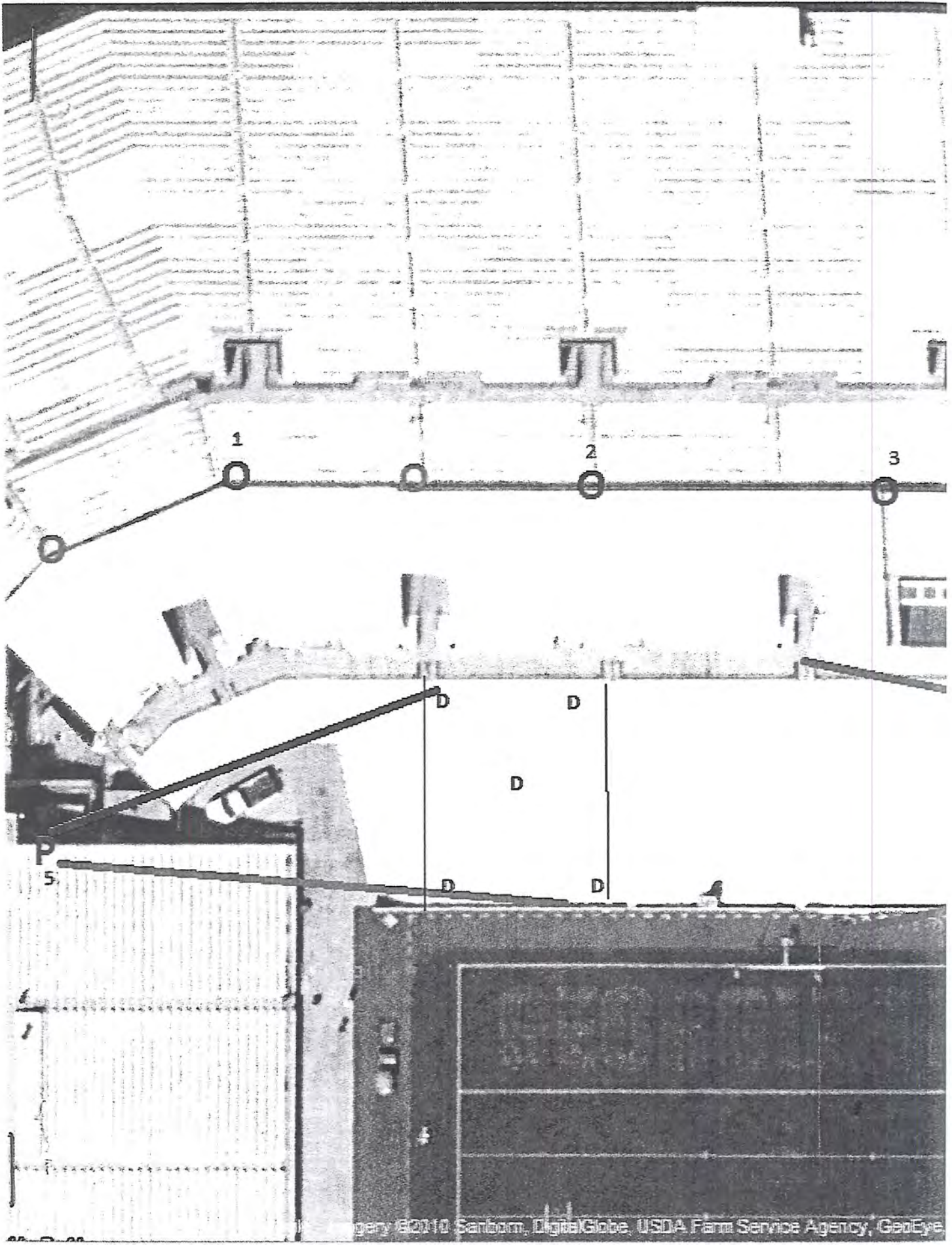
1/29/2010
anti.



29/2010
ent.



Possible Patch Locations

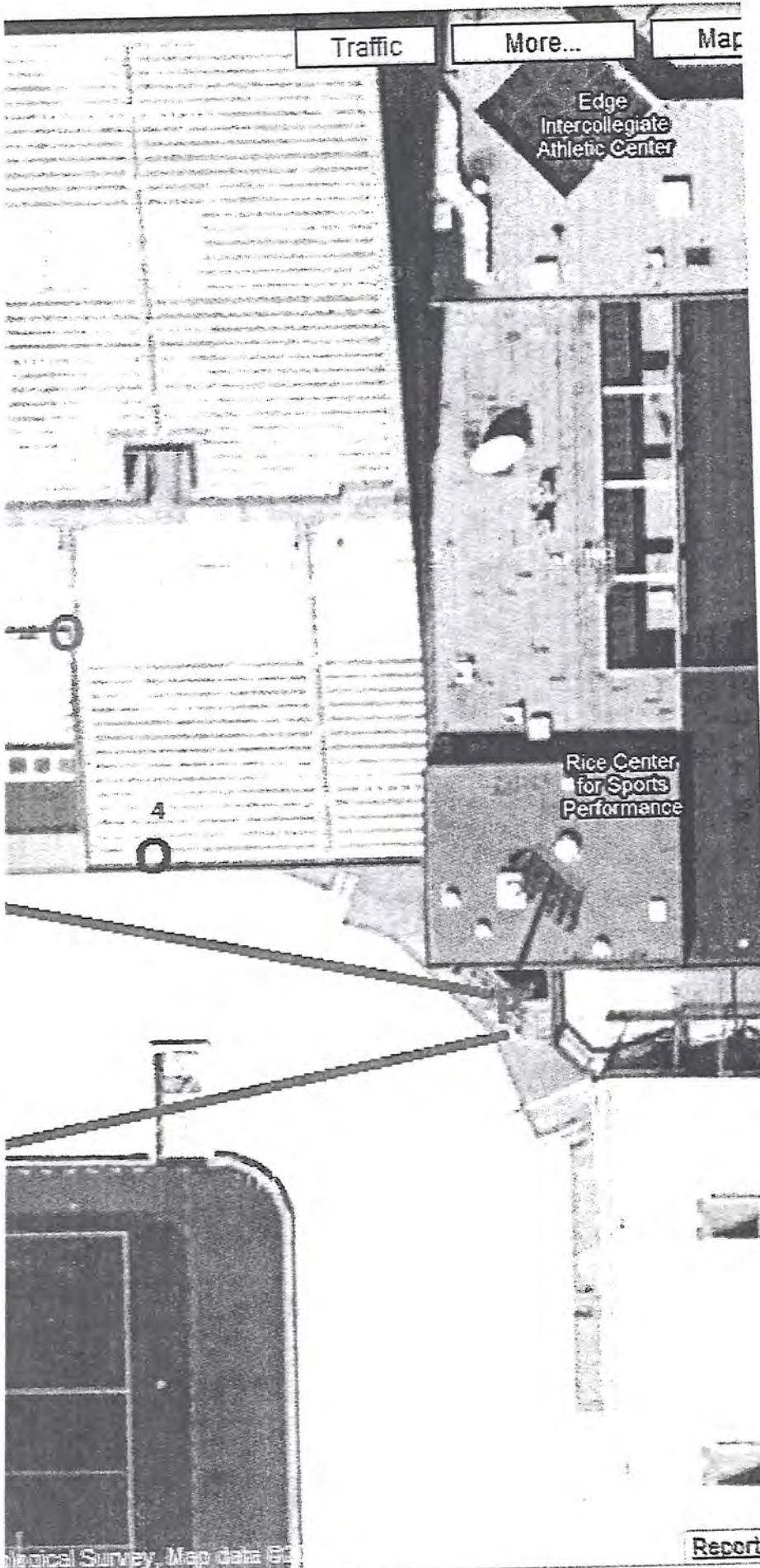


2/2/10
t.

Antenna 1

0°

23



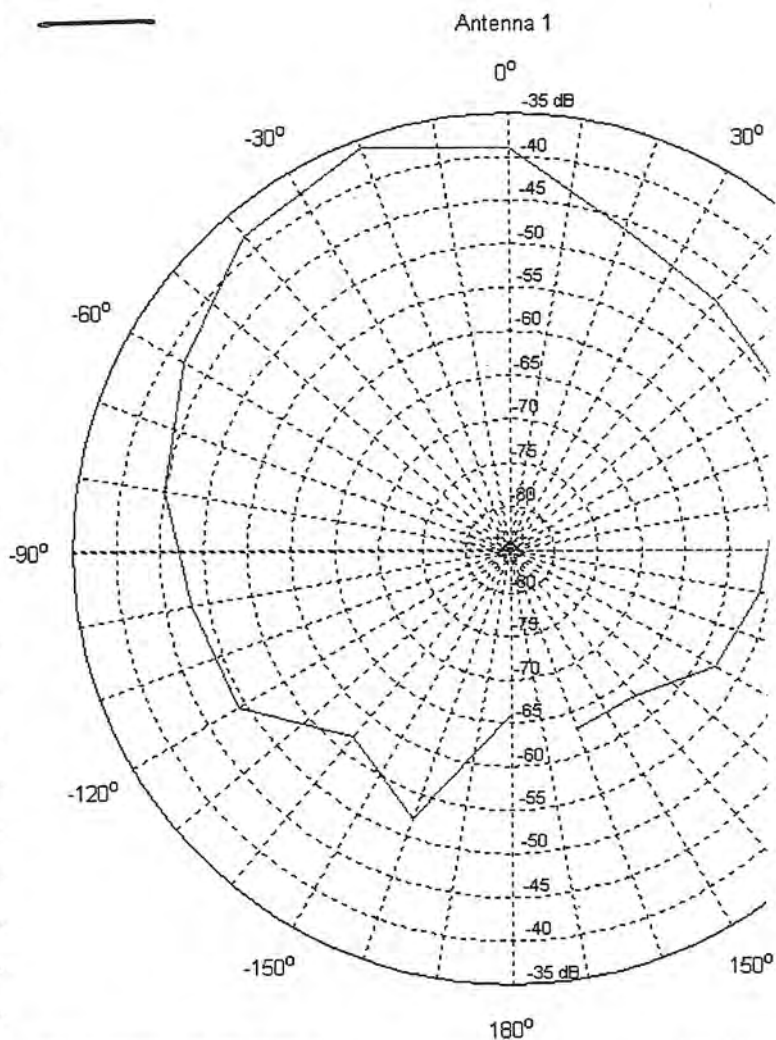
Antenna	Power (dBm)	
1		
Angle		
0	-39	
20	-46	
40	-48	
60	-49	
80	-54	
100	-56	
120	-58	
140	-63	
160	-63	
180	-66	
200	-52	
220	-57	
240	-49	
260	-48	
280	-45	
300	-42	
320	-38	
340	-36	

that Chris & I
 using the Patch Antenna
 Radiation pattern that
 see that are data
 (a points) you can see that
 um and took some
 and our mobile devices
 On Next Page

Report a

1/2/10

23



Antenna	Angle	Power (dBm)
1	0	-39
1	20	-46
1	40	-48
1	60	-49
1	80	-54
1	100	-56
1	120	-58
1	140	-63
1	160	-63
1	180	-66
1	200	-52
1	220	-57
1	240	-49
1	260	-48
1	280	-45
1	300	-42
1	320	-38
1	340	-36

- These are the numbers that Chris & I collected in Piedmont Park using the Patch Antenna
- When looking at the Cisco Radiation pattern that is on T-square you can see that are data is similar.
- Due to limited resolution (# of data points) you can see that there is some difference.

02/2010

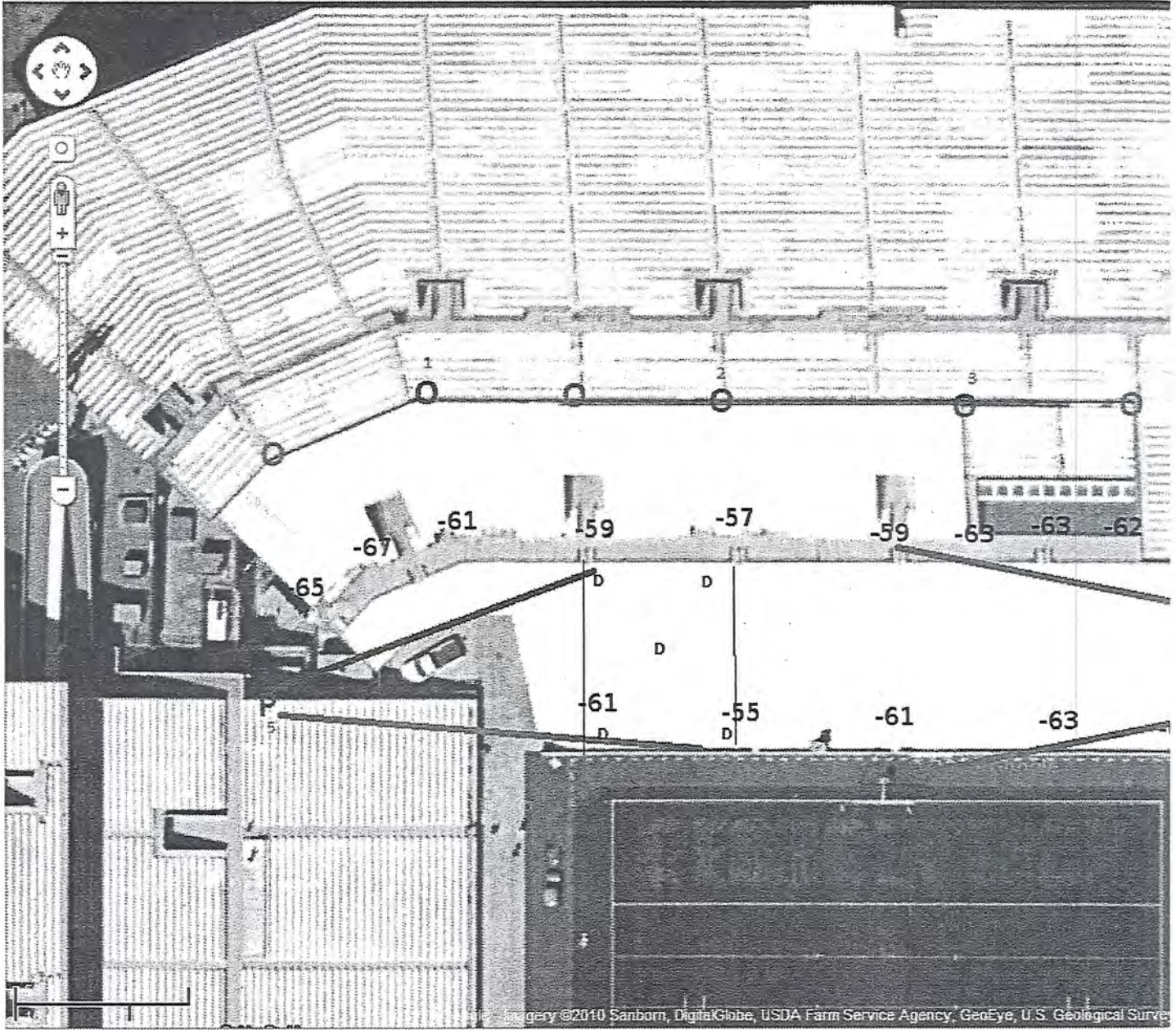
We went into the stadium and took some measurements using an AP and our mobile devices (iPhone, iPod Touch)

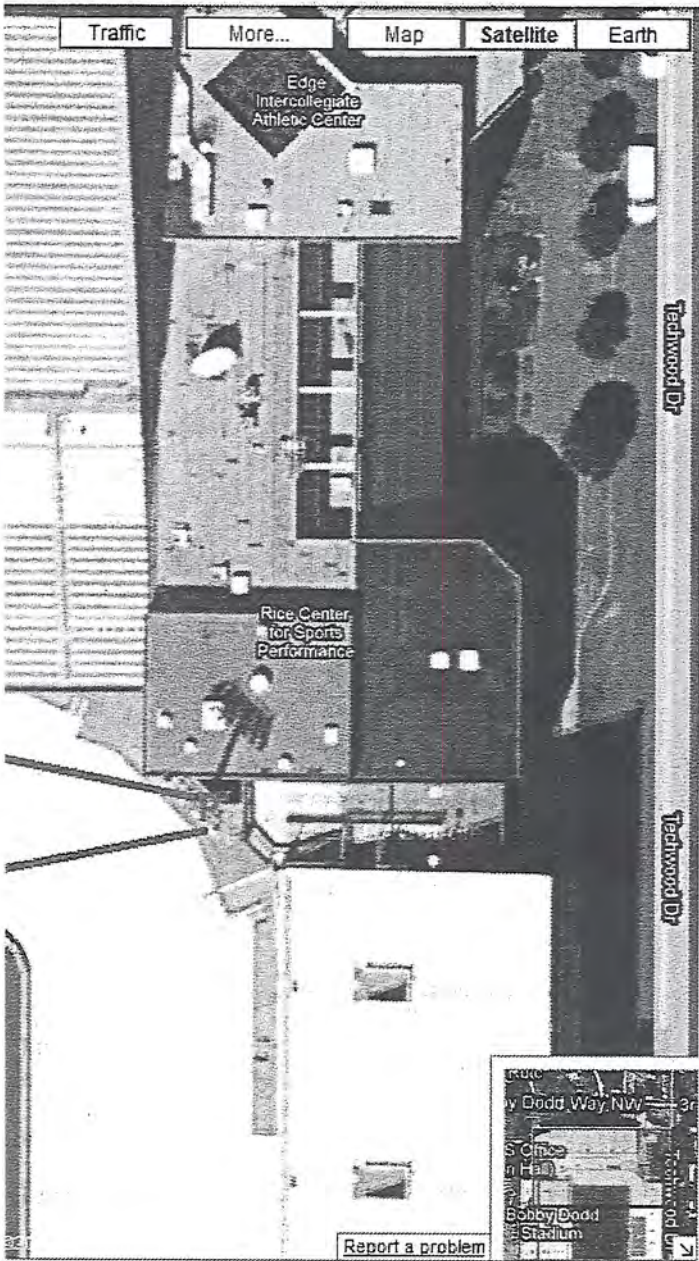
Numerical Results On Next Page

24

11/02/2010

11/02/2010





sub-team meeting

11/2/2010

acadically an
abler lecture.

11/2/10	11/2/10	11/2/10	11/2/10
11/2/10	11/2/10	11/2/10	11/2/10
11/2/10	11/2/10	11/2/10	11/2/10
11/2/10	11/2/10	11/2/10	11/2/10

Notes

15/2010

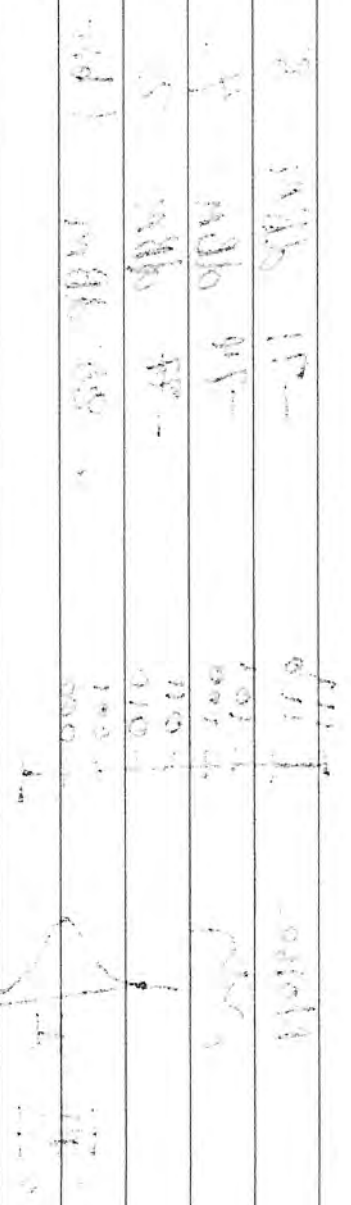
Sub-team Meeting

01/21/11

Basically an Abler lecture.

use of language that speak - 3
(single person) answer situation
Ab 2:2

keep notes down

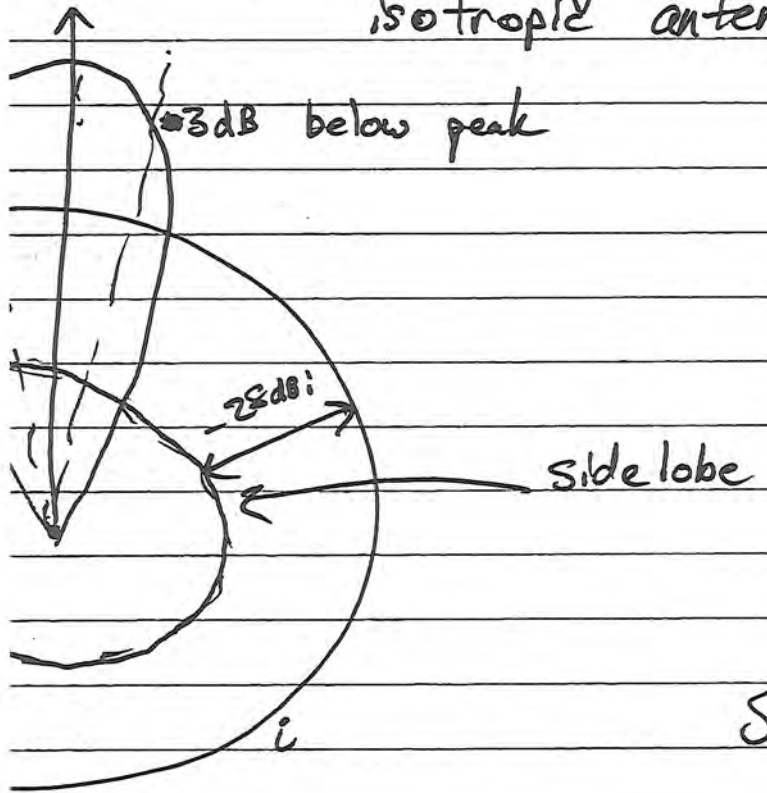


M/02/2010

11/5/2010

e	111	-71 dBm	8
	110		
	101	-74 dBm	4
	100		
	011	-77 dBm	2
	010		
	001	-80 dBm	1 bit
	000		

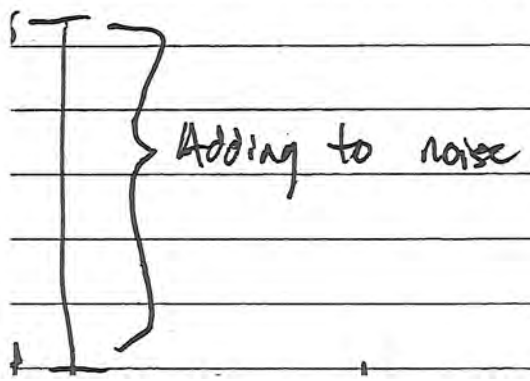
G_i i - means gain compared to an isotropic antenna (perfect sphere)



M/05/2010

Shannon - Hartley Theorem

No contribute to noise



1

12/2010

Look @ VLANs (on APs)

Poster Locations

- Klaus
- VL
- SC
- Skiles

To-do

✓ look into splash page (~~Mike~~ ^{Pepe} & Mike)

1/15/10 ✓ Router/AP configurations (by 11/16 w/ seksan)

1/15/2010

Router/AP configs

- No NAT
- No DHCP
- Static Public IP
- VLAN Tagging
- DNS?
- Power Levels

Thoughts

- Limit access to the Web configuration page
- No wireless configs

Wireless

- Channel 6
- B & Mixed
- 20 MHz

1/20/2010

Last Home Game vs. Duke (A Win!)

Jobs didn't see entry on other page

Channel	# of networks/APs detected
1	12
6	9
11	13

1/2/10 Data Closet in West Stands? Access Available? [27]

3/2/10 Verizon contact with ~~be~~ meeting on Thurs (12/09/2010)

- Contact UGA & Clemson about installing slingboxes so we can get video feeds.
 - not a huge deal as these games are at home next season.

- Reminder of Semester:
 - task list for future semesters

- Question:

- how many APs can a single AP handle??

- Is GTRI interested in "in house" advertisements?

- Can we get WREK radio audio stream?

- Is it live?

- Suite of the Future

- services specifically targeted to the Suites.
- merchandise purchasing.

To-Do

1/6/10 Peer Evaluations

3/10 Design Notebook

1/6/2010 Sub-team meeting to work on Powerpoint presentation in preparation for Thursday. Got a solid base ready.

3/8/2010 Finished the Power Point presentation.