COURSE:	**INTRODUCTION TO WIRELESS COMMUNICATIONS.**
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SUBJECT:	**PROJECT REPORT.**
TITLE:	**CDMA 1900 MHz RF DESIGN.**
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ABSTRACT

The project involves simulation of a real-time CDMA wireless system for providing cell service to a particular area. The project starts with a Link Budget in which the customer precisely tells what all he wants. Once all the data is obtained simulation is being done using the Planet RF simulation tool. The entire area under consideration is divided into cells. Models for Urban, Sub-urban and rural cell sites are being created. Once we are done with loading all the database and creating good models, cell sites have been created. Later predictions have been run over the entire area of coverage. Finally we have simulated the entire network. Plots that tell about the entire coverage, the best server and signal level at each corner have been obtained. Ultimately taking all these factors into consideration a mobile system has been designed that does call processing, mobility management and billing and will be handed over to the customer.

INTRODUCTION

In the current project a preliminary RF design for BTA 50 Boise, Idaho has been done using the Planet RF simulation tool. The intention of this design is to provide the cell counts required to support coverage and a 5- year capacity design for a customer and a fixed CDMA operation. The design requirements and engineering parameters in this design are assumed to be given by the customer (local cell network provider) in any wireless project. The CDMA network standards that have been followed throughout the project are taken from Nortel Networks.

BACKGROUND

What is CDMA: CDMA is a "spread spectrum" technology, which means that it spreads the information contained in a particular signal of interest over a much greater bandwidth than the original signal. When implemented in a cellular telephone system, CDMA technology offers numerous benefits to the cellular operators and their subscribers. It has the following advantages.

Capacity increases of 8 to 10 times than that of an AMPS analog system and 4 to 5 times than that of a GSM system. Improved call quality, with better and more consistent sound as compared to AMPS system. Simplified system planning through the use of the same frequency in every sector of every cell.

The knowledge of the following terms and their application is imperative in understanding the technicality of the project.

Link Budget: This is the spreadsheet proposed by the customer. Link Budget gives us the various parameters about the project undertaken. It gives the factors like Antenna

Gain, Diversity Gain, Duplexor loss, TX cable loss, Maximum TX power, Total Transmitter EIRP, Max allowable isotropic path loss, Mean Penetration Loss, Total minimum required margin and the various signal levels in various kind of morphologies (i.e. urban, sub-urban and rural etc) and the radius of coverage in various morphologies. In the current project we have assumed that the link budget has been given by the customer.

BTA and MTA: MTA is Metropolitan Trading Area and BTA is Basic Trading Area. First of all we will have to decide the BTA and MTA of the area for which we want to provide the coverage. Once if we decide in which BTA and MTA we are in, we need to load those standard BTAs and MTAs into PLANET.

Cellsite Management: The entire area under consideration for providing coverage is divided into cells. Each cell has a base station, where the antenna is installed. The type of Antenna is decided based on the Link Budget. A group of cells (usually 7) are defined as Cluster. A group of voice channels are distributed among the cluster. These are the channels we are given by bandwidth considerations for the entire network we are going to cover. Each cluster has the same set of voice channels. The cellsites are sectored so as to increase the Capacity of the system.

Creating Models: We are supposed to create models for each urban, sub-urban and rural Cellsite we are going to have. We have to tune the models in such a way that they give us good coverage in respective morphologies. We can tune the models by changing the clutter factors.

Creating Cellsite: Once we are done with the loading all database and creating good models we can start creating cellsites based on our technical background. We have to

create cellsites keeping various parameters in mind. First of all Link Budget parameters are of foremost importance. These are basic proposal data and not the final Cellsite position. So in future we can move around these cellsites to get a better coverage.

DESIGN REQUIREMENTS

Coverage Requirements: The main coverage area is the interstate highway I-84 and the state highway in BTA 50 and the following towns along the highway: Boise, Baker, Payette, Elmore, Gem. We have designed the Suburban, Residential, Highway areas in the town to be covered with the following levels.

Morphology/Area	Pilot Signal Level (dB)
Dense Urban	-87
Urban	-90
Suburban/Rural	-93(indoor)
Highway	-96
Rural	-105(outdoor)

Capacity Requirements: We had assumed that the customer has provided us with the following capacity requirements.

- 13K Vocoder.

- Ratio of mobile users: fixed users = 60% : 40%.

- Erlangs/mobile user = 20 mE/user.

- Erlangs/fixed user = 100 mE/user.

- 2% RF blocking.

- Penetration rate = 1% for year 1, 2% for year 2, … up to 5% year 5.

ASSUMPTIONS

Link Budget and Design Assumptions: The design assumptions in the coverage link budget are as follows.

Coverage: The requirement for the mobility network is more stringent than for the fixed network, hence the coverage design is done for the mobility network. And since CDMA is reverse link limited in the mobile environment, the reverse link budget is used to determine the maximum allowable path loss. In turn, the maximum allowable path loss determines the down link signal levels..

- A 4-dB BTS noise figure is used in accordance with the measurements obtained from Nortel's 1900 MHz BTS, IS-97 testing.

- The mobility Eb/No of 7.0 dB.

- There are two antenna types used: 718207.MSI(Mobile system international) and DB980H65. 718207.MSI with 90-degree horizontal beamwidth and 18-dBi gain is used mostly for the 3-sector suburban sites. DB980H65 with 65-degree horizontal beamwidth and 18.6-dBi gain is used mostly for the 2-sector highway sites.

- Antenna heights used in the design are 46 m (150 ft) for suburban sites, and 76 m (250 ft) for highway sites.

- For cable and connector losses, Nortel has assumed a 3-dB loss for the 46-m (150-ft) antenna height, and a 4-dB loss for the 76-m antenna height.

- A 75% cell edge reliability that corresponds to a 90% cell area coverage availability. From Nortel's experience, 75% represents a good compromise between cell coverage and desired drop call rate.

- In-building standard deviation of 10 dB, and in-car and outdoor standard deviation of 8 dB.

- Suburban/residential building penetration loss of 12 dB, and car penetration loss of 7 dB.

- Body loss of 3 dB. (Loss of the energy attenuated by the user's body during a call. This loss will vary depending on the location of handset position by the user).

- Loading factor of 50% for the mobility network, and 60% for the fixed network. Using the mobile users: fixed users ratio of 60%: 40%, the average loading factor is then = (60% x 50%) + (40% + 60%) = 54%. This yields the interference margin due to traffic loading to be = 10 x log (1/(1-54%)) = 3.4 dB. This margin reflects the interference-based cell-breathing phenomenon that is unique to the CDMA system.

  Taking all of these factors into account, the link budget shows the maximum allowable path loss of 137.6 dB, 144.0 dB, and 151.0 dB.

  Capacity: The design assumptions in the capacity calculation are as follows:

  The advantages of using the 1900MHz antenna are maximum capacity and minimum loss.

- For the frequency reuse efficiency, voice activity factor, and sectorization factor, the standard values of 0.65, 0.40, and 0.85 are used.

- For the mobility network: Eb/No of 7.0 dB and loading factor of 50%. This yields about 12 users/sector.

- For the fixed network: Eb/No of 4.5 dB and loading factor of 60%. This yields about 27 users/sector.

Using the mobile users: fixed users ratio of 60%: 40%, the composite (average) number of users/sectors is 18. With 2% blocking rate, this equals to 11.5 Erlangs/sector.

IMPLEMENTATION

Planet: This is software for simulating the entire network of wireless coverage we are providing. To start with PLANET we created a definition file for PLANET. We created a particular folder for the area we are considering for the coverage. In that folder all the databases have been loaded. The databases that are loaded are antenna database, vector database (i.e. which tells the primary and secondary roads and all the other roads going through that area), clutters (i.e. residential, commercial, openlands, forest areas etc). Once we are done with loading PLANET we started running simulations with that.

Creating Arrays: The array facility enables planet to support the design and development of the best and the second best server coverage. With the help of the array facility we calculated the number of servers within defined contour thresholds. Planet creates arrays, which combines different types of cells and provides predictions at any resolution in the array.

Predictions: After we have created model cellsites and created models for each kind of cellsite we ran predictions over the entire area of coverage. The 'prediction' option in the Planet simulation tool calculates the path loss for all the cellsites. . Once the predictions are made and the array is created there is an 'composite coverage' option in Planet with which we can see how the coverage looks like. Once we ran the predictions for all the cellsites we observed the coverage of all the cellsites and the signal level in all the places over the area in which we are providing the coverage.

RESULTS

Finally we have simulated the entire network. We can see the plots, which tell about the entire coverage and their respective signal levels. In order to cover the BTA (Boise) along the interstate highway I-84 and state highway 95 and the counties along the highway our design suggested the customer to install 68 bisector highway cell sites, 203 trisector cell sites to cover all the urban and suburban area in that BTA.We also came with plots which shows the composite coverage area in the entire area. Plots (E-size) which will give a clear idea of what the final coverage looks like have been also attached.

CONCLUSIONS AND SCOPE FOR FURTHER IMPROVEMENT

Any modification that results in the reduction of the number of cell sites that can be designed, will be an ideal improvement. That can only be done by the efficient usage of the Planet RF simulation tool.

REFERENCES

1.PLANET V2.8, "A Technical Reference Guide". MSI (Mobile System International).

2.Theodore S Rappaport, " Wireless Communications, An Introduction" pp. 405-407