

Financial Impact of Magnolia's Mobile Transmit Diversity Technology in WCDMA Networks

Abstract

In this document presents the financial impact of introducing user terminals (UE) with Magnolia Broadband's Mobile Transmit Diversity technology (DiversityPlus) in a WCDMA based network. In this case study, the Greater New York BTA was considered and a Greenfield (an incumbent new network deployment) was analyzed. For the financial impact results, a spreadsheet was developed in order to calculate network demand, capacity, CAPEX, OPEX and User Terminal costs. Financial viability is presented in terms of investment outcome per user terminal, as well as other additional financial gains.

Introduction

In WCDMA systems the reverse link capacity is limited by the interference caused by other users sharing the same frequencies. Magnolia Broadband has developed a Mobile Transmit Diversity ("MTD") technology that allows the user terminal to transmit at lower power than conventional user terminals leading to an increase in the system capacity and reverse link footprint enhancement.

The deployment of user terminals using this technology involves additional cost to the network operators. In order to assess the financial value of Magnolia's MTD technology to a network operator, an analysis tool was developed by Marconi in conjunction with Magnolia Broadband.

The spreadsheet was designed to simulate a particular network scenario in which the user may define a study timeline, area to be covered, operation frequency, population, penetration level (initial and final), grade of service, site hardware setup, site hardware upgrade capabilities, site load level that would trigger a site hardware upgrade, among other settings.

The analysis considered a typical site hardware upgrade path that included site additions in order to overcome increasing capacity. These site hardware upgrades are associated to certain costs to the operator based on a survey conducted by Marconi. Costs are considered in terms of capital expenditure (CAPEX or hardware cost), operational expenditure (OPEX or cost to operate a network) and user terminal cost.

The analysis considers a new incumbent network (Greenfield) deployment. It assumes that all the new customer additions would have user terminals equipped with Magnolia Broadband transmit diversity technology. The case study considers a large urban network of the New York BTA, approximately 9877 square miles (about 25,000 square km). It considers two independent networks operating at 1900 MHz and 2100 MHz respectively with the same level

of penetration. Both networks are analyzed during a deployment timeline of 5 years. The market penetration over the 5 years reaches approximately 2.4 Million customers.

Methods of Analysis

The analysis is to provide a financial viability outcome, within a user definable timeline, in terms of potential savings, or cost, to the network operator that is considering, introducing Magnolia user equipment in their network. Costs are represented in terms of CAPEX (includes cell site hardware, implementation, regulation costs, RF related costs etc), OPEX (includes personnel, facilities, services, leases costs, etc) and user terminal costs (includes typical mid-level conventional and Magnolia Broadband user terminals costs).

The analysis was developed around user definable scenarios such as: timeline analysis, area to be covered, population, initial and final penetration, grade of service, initial hardware per site, target sector load (beyond specified load hardware upgrade will be triggered), among other inputs.

As a result of the customer base (and traffic) increase, hardware upgrades and even new sites needed to be consider in order to accommodate capacity and system load demand. The analysis considered following a typical hardware upgrade path that is illustrated in figure 1.

Additionally, certain assumptions and limitations were taken in consideration:

- Link budget was defined for urban environment with stationary users.
- Only voice service is considered.
- Under the aforementioned conditions, the Magnolia technology user equipments are able to provide a 4dB in transmit diversity gain and a 35% in capacity gain.
- System load and traffic are uniform across the network
- User and traffic growth are linear.
- Replacement, migration and renewal of user equipments are linear within the specified timeline.

The capacity calculations start determining the sector pole capacity for a network using conventional and Magnolia user equipments. Based on a user definable network load upgrade threshold and the calculated pole capacity, the limits for sector capacity and required channel elements are calculated. These limits will be the trigger points for sites expansion following the path illustrated in figure 1.

A standard reverse link budget for urban environments with stationary users accessing voice services is used in the analysis. Based on this input, the number of sites needed during the first month of the deployment timeline is calculated. The link budget calculates simultaneously the number of sites needed to provide service within the user

specified area and frequency, considering the capabilities of the MTD enhanced mobile terminals and conventional terminals.

Once the initial number of sites are calculated and the site limit capacity and trigger points have been established, the spreadsheet considers the user definable market penetration, traffic per subscriber and GOS values. With these inputs, initial (first month of the deployment timeline), final (last month of the deployment timeline) and monthly average are calculated for user equipments (customers), traffic, capacity and site load.

Initial and maximum site equipment setup, in terms of number of CE cards, carriers, and cabinet (frames) are also user definable. Using the initial traffic, the monthly growth rate, user equipment distribution and site load, the required site capacity is estimated. Once the network capacity reaches hardware or the network upgrade threshold load limits, site hardware will be automatically upgraded following the path shown in figure 1. If the site reached the maximum hardware setup, sufficient number of sites will be added (with the same equipment setup) in order to accommodate the demand.

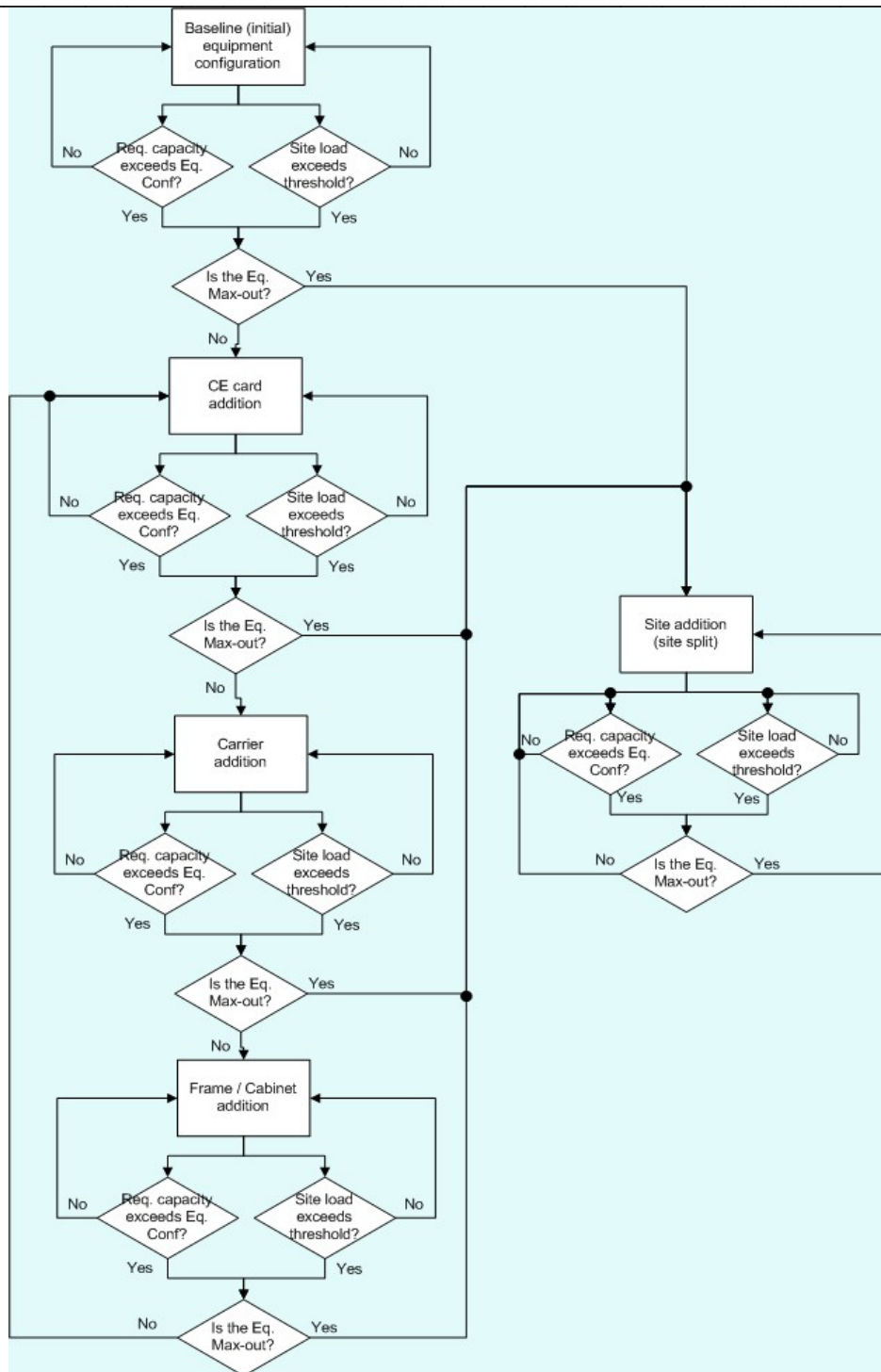


Figure 1: Site Hardware Upgrade Path

Study Market

For this case study, New York BTA, a large urban network with the following characteristics and network settings was considered:

- Market area: Approximately 9877 square miles
 - Study length: 5 years (60 months)
 - Greenfield deployment to reach more than 2.4 million customers in 5 years
 - Two networks operating at 1900 and 2100 MHz with 5MHz spectrum.
 - Traffic per subscriber set to 50 mE
 - Grade of Service (GOS): 2%
 - Network upgrade threshold load: 50%
 - Site initial hardware equipment set to 1 frame (cabinet), 1 carrier and 2 64CE cards.
 - Maximum equipment configuration for 5 MHz would be: 1 frame (cabinet), 4 carriers and 8, 64CE cards. (Maximum 2 CE cards per carrier).
 - Once the network reaches hardware or the network upgrade threshold load, the site hardware will be automatically upgraded following, the upgrade path illustrated on [Figure 1](#). If no additional upgrades are available enough number of sites will be added (with the same equipment setup) in order to accommodate demand.
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Summary of Results

Based on the assumptions the following are the results:

Network Stats

Network stats illustrate the initial and final customer base and traffic. Additionally it offers traffic, users growth rates and area covered.

Network Data	Market Penetration	Users	Users Growth /Month	Total Traffic (E)	Traffic Growth /Month (E)	Area Covered			
						1900		2100	
Initial	0	0	0	0	0	Sq. Mile	Sq. Km	Sq. Mile	Sq. Km
Final (5 Years)	25%	2452613	40877	122630	2258	2470	6400	2470	6400

Table 1: Network Data Statistics for the Greenfield Deployment

The Greenfield deployment considers addition of over 2.4 million customers within the 5 years study timeline leading to over 40,000 new monthly additions generating an average traffic of 2258 Erlangs/Month.

Site Stats

Site stats established the initial and final number of sites needed per frequency band. The area to be covered defined the initial numbers of sites while the final number of sites account for the capacity demand.

	Magnolia UE		Conventional UE	
	1900 MHz	2100 MHz	1900 MHz	2100 MHz
Cell Area (Km)	2.51	2.06	1.48	1.22
# of Sites (Initial)	2551	3100	4331	5264
# of Sites (Final)	2551	3100	4331	5264
Additional Sites Required	0	0	0	0

Table 2: Site Statistics for a Greenfield Deployment

The results shown on Table 2 indicates that designing a Greenfield network using exclusively user equipments equipped with Magnolia Broadband dual transmit diversity technology, could potentially save to the network operator 41% in initial number of sites.

As an example, in the 1900 MHz case the increase in capacity over the 5 years study demands no additional sites for a network designed with Magnolia UE. However, the same network would require 1800 additional sites (41% more sites) if designed with conventional UE.

Financial Viability

Financial viability statistics establish the initial and final costs and investments a network operator incurs in order to build and operate a wireless network.

(in 000's)

Operating Frequency	CAPEX		OPEX		UE Cost	Total	
	1900 MHz	2100 MHz	1900 MHz	2100 MHz	1900/2100	1900	2100
Greenfield Network w/ Magnolia UE	\$ 807,154	\$ 980,862	\$ 545,171	\$ 622,498	\$ 787,942	\$2,140,269	\$2,431,302
Greenfield Network w/ Conventional UE	\$1,370,359	\$1,665,567	\$ 925,573	\$1,124,964	\$ 748,046	\$3,043,980	\$3,538,578
Savings (\$)	\$ 563,204	\$ 684,705	\$ 380,402	\$ 462,466	\$ (39,895)	\$ 903,710	\$1,107,275
Savings (%)	41%	41%	41%	41%	-5%	30%	31%
Savings per Subscriber						\$ 368.47	\$ 451.47

Table 3: Summary of Capex and Opex Savings for Greenfield Deployment

The results illustrated on the Table 3 indicates that if the network operator in the 1900 MHz decides to design its network with Magnolia UE performance gains in the handset, they would save more than \$680 million (41%) in CAPEX and \$380 million (41%) in OPEX. Costs. The network operator also would need to invest an additional \$40 million (5%) in user equipments equipped with Magnolia Broadband transmit diversity compared with conventional UE.

Overall, the network operator would save \$900 million (30%) over 5 years in the 1900 MHz band and over \$1.1 billion (31%) in the 2100 MHz. Calculated per user terminal, the operator would save more than \$368 per user in the 1900 MHz band and \$451 per subscriber in the 2100 MHz band

In addition to the savings associated with capital equipment and operation costs, the wireless carrier will benefit financially from reduced spectrum costs, as well as increase in quality of service (share of decision from the subscriber) and reduced churn.

Spectrum Savings:

In the most recent transaction of spectrum in the NYC BTA, Verizon Wireless purchased a spectrum license auctioned by Nextwave Telecom in the 1900 MHz band. Verizon purchased the 10 MHz license for \$930 million. Using a basic calculation method of spectrum savings (35% used in this analysis) gained by the carrier using Magnolia's mobile transmit diversity technology in the UE, a carrier will realize savings of more than \$325 million.

Share of Decision and Reduced Churn:

As a Magnolia enhanced terminal will provide service quality improvements in improved coverage, voice quality and reverse link data rates, a carrier will realize significant improvement in customer perception of the carrier service. This will enhance the carrier's position with higher penetration and reduce customer churn.

Assuming an additional 3% penetration over the five years due to improved quality of service and reduced churn, a carrier will be able to realize more than \$400 million in revenues (assuming an average ARPU of \$60/month for 24 months).

Conclusion:

By introducing Mobile Transmit Diversity from Magnolia, a carrier will financially benefit in the following areas:

1. Capital Equipment Reduction
2. Operation Cost Reduction
3. Spectrum Cost Reduction
4. Share of Decision Increase
5. Churn Reduction

The potential financial gains realized by a carrier operating in the New York BTA at 1900 MHz over 5 years by deploying Magnolia’s MTD in the User Equipment (mobile terminal) from a Greenfield deployment are significant.

Capital Equipment Savings	\$563,204,000	41%
Operational Cost Savings	\$380,402,000	41%
Spectrum Savings	\$325,000,000	35%
Additional Cost to UE due to MTD	\$38,895,000	5%
Additional Revenues from Higher Market Penetration	\$400,000,000	3%