CONTENTS

I. Overview

As part of its Feasibility Study for a Fiber Optic Telecommunications System, Uptown Services proposed the identification of a portfolio of services, enabled by the implementation of a broadband network that would define the potential revenue stream for the County. The scope of this task includes the following key elements:

- Programming (Video)
- Packaging Structure (Video)
- Product Tiers (Internet)
- Price Levels and Comparison to Incumbents (All LOBs)
- Bundles

II. Lines of Business

As established within the scope of this project, the lines of business (LOBs) being considered are video entertainment, high-speed Internet access, and local and long distance telephone services. There will be other associated LOB opportunities facing the broadband venture, but they will not be "baked into" the financial analysis since the level of certainty surrounding their financial value and potential risks have not been established within this project or among Los Alamos's peers who have entered the broadband sector. These opportunities may present possibilities for additional revenues, reductions in operating expenses, or both. Examples of ancillary LOBs could be:

- Security Monitoring Service
- Automated Meter Reading
- WebTV applications

III. Sources of Differentiation and Value

As a later market entrant with the most advanced technology for delivering mass market broadband services, the two primary opportunities for Los Alamos to set itself apart from the incumbents are improved product performance and lower prices. The capacity and reliability characteristics of Fiber To The Premises (FTTP) versus incumbent network architecture will enable broadband services, especially Internet, to do more for the consumer. The fact that the County of Los Alamos does not share the same private sector financial performance expectations presents a pricing opportunity as well. Whereas incumbents must pay back the significant capital investments in their networks as well as continue earnings growth as expected by the financial markets, Los Alamos has a different standard for "profit" expectations. While there is a need to diversify revenue sources for the County and to manage the risk of a significant bond offering, there is less strain on price levels compared to incumbents measured against private market standards.

A. Product Functionality

The most visible advantage that the Los Alamos fiber network will offer to consumers and small businesses is the increased capacity to offer improved data and video entertainment services. The network architecture provides unique new product opportunities versus the incumbent network architectures. The "killer application" is increased speed that will be immediately available from the new Los Alamos FTTP network.

The FTTP architecture advantage lies in its ability to improve services that many of Los Alamos's residents are already using today. The realistic downstream throughput for HFC and DSL architectures is about 3Mbps at this time. With FTTP, Los Alamos will be able to have at least 10 Mbps available for each premise as a realistic and achievable attribute of its Internet product. Furthermore, the bandwidth advantage of FTTP can be extended to the upstream path (data sent from the home to the network) as well by providing Internet tiers (different classes of service each priced differently) with symmetric (same speed for both uplink and downlink data streams) bandwidth**.** Both DSL and cable modems limit their upstream capacities to about one-fourth of their downstream capacity. Especially within the commercial sector, a symmetrical design provides a significant advantage over the incumbents**,** where asymmetrical (limited upstream speeds) are the norm.

For video, there will be a capacity advantage as well, but it will not be as dramatic and immediate as the advantage for data services. The Los Alamos fiber system will have greater bandwidth capacity for video services than the 750MHz available on the Comcast system in Los Alamos. This will become increasingly important over time as the limited capacity of the Comcast network is exhausted. Even today, most urban market HFC networks are at or near capacity for the bandwidth allocated for video services. Although this seems odd given the massive cable upgrades in the last few years (usually from 400-450MHz to 750-860MHz), it has occurred because of the following:

- A tremendous expansion in the number of digital channels
- A likewise increase in the number of screens (multiplexes) offered by the premium channels
- The advent of Video On Demand (VOD) and an increase in the number of Pay Per View (PPV) channels
- The launch in the last 12 months of high definition channels and their 4 times greater consumption of bandwidth compared to a standard digital channel

For telephone, there are no specific product functionality benefits being derived from the FTTP network within the mass market. There will certainly be significant capacity to serve large commercial accounts, but this would not be a source of differentiation as there is fiber capacity from Qwest to serve this market today.

B. Pricing Strategy

1. Pricing Trends and Key Beliefs

The recommendations for the pricing strategies presented in this business plan are driven by a set of principles that Uptown has developed from its experience in the telecommunications and broadband sectors. It is largely shaped by the manner in which firms in this space compete and generate returns for shareholders or constituents. These beliefs are:

- Voice, video and data services offerings have ample opportunity to provide value to consumers across a number of dimensions beyond the price attribute alone. Long distance has been a painful exception to this rule for the industry, and serves as case study of the negative effects of commodity-like pricing.
- The most significant pricing tactic emerging within the telecommunications sector is bundling. The major service provider categories of cable operators and local exchange carriers are rapidly elevating bundling to a fundamental component of their marketing strategy. It is apparent that the telecommunications industry will be battling for market share with bundled offerings for the foreseeable future.

- The perceived need for greater bandwidth and data capacity has now gone beyond the early adopter consumer market as evidenced by accelerated growth in broadband Internet services compared to narrowband access. This translates into a substantial opportunity for Los Alamos to rely on the 'throughput' advantages of its fiber network as the primary source of value.
- At the same time, consumers are demanding a better deal from municipalities who enter this market. This is consistently heard in industry focus groups and was clearly articulated as a key service attribute from the quantitative survey.

2. Pricing Strategy

Given this set of beliefs and the need for the County to generate sufficient revenues to retire the up-front capital requirements of this project, Uptown recommends a conservative use of price discounting. This means the following:

- Reasonable, but not excessive, price discounts will be employed relative to incumbent operators. Uptown generally defines reasonable as a 10% discount for comparable services.
- Within lines of business, employ product package designs that encourage and reward subscription to optional services (e.g. premium channels with video or calling features with telephone). Use this strategy to increase average revenue per user (ARPU) and provide value for more product subscription versus offering the same product for less.
- Across lines of business, deliver price discounting via multi-product incentives (such as bundling) so that, in return for less revenue per product offering, the County can realize greater revenue per subscriber and the positive retention effects of bundling. Customer retention data from the cable industry indicates that the voluntary churn in three-product bundles is significantly lower than that of an analog-only subscriber.
- Limit reliance on price discounting by delivering value through other means, such as improved product performance and improved local support services.

IV. Product Strategy

A. Video

1. Sourcing Programming Content

In order to secure licensing rights to distribute video programming, the County should join the National Cable Television Cooperative (NCTC). The NCTC is an organization of independent cable television companies serving more than 14 million cable TV subscribers throughout the United States. It is a not-for-profit organization and is a purchasing cooperative for its members. The co-op negotiates and administers master affiliation agreements with cable television programming networks, cable hardware and equipment manufacturers and other service providers on behalf of its member companies.

Through joint purchasing and negotiation, the NCTC functions similarly to a multi-system operator (MSO), taking advantage of volume discounts offered by programming networks, hardware manufacturers, and other providers. NCTC member companies save an average of $4 to $12 per subscriber on programming costs alone. The County will qualify to join the NCTC as one of the many municipal utilities engaged in the business of providing television reception or

service to the public, primarily by means of a cable television system consistent with the definition of a "cable television system" in section 602 of the 1984 Cable Act.

Unfortunately, not all video channels that Los Alamos may want to provide are under NCTC contract. For example, the cooperative is currently attempting to re-negotiate its MTV license agreement, but cannot offer MTV-owned channels at this time. Those channels that can be licensed under NCTC terms are indicated with an asterisk below. For the remainder, the County may have to individually negotiate license agreements for all others. Between this and re-transmission agreements for broadcast channels, the County should anticipate taking 6 to 9 months to complete the process.

The current lineup of NCTC channels is presented below as Exhibit 1. The monthly cost per subscriber for this lineup is $19.75.

2. Channel Lineup

Within the video line of business, the most important aspect of product definition is the channel lineup. This determines which programs are available to customers and at what level of subscription (package or tier) they must be to receive a particular program. Given this aspect of the product, the selection and placement of programming is a key determinant of perceived product value. Video subscribers are very particular about specific programs and can have strong feelings and significant loyalty about their programming choices. Therefore, this part of the product definition is fundamentally important.

But also weighing into this decision is programming cost. The cost to carry a particular channel varies dramatically across the channel lineup. Some channels can cost in excess of $1 per subscriber per month, while others can be 5 cents. Furthermore, some video programming costs are rising at margin-eroding rates that far exceed inflation as well as the operator's ability to keep up via annual rate increases. For example, the major sports programming brands (ESPN and Fox, for example) have been raising their prices by 10 to 15% annually for the last several years. For this reason, some video service providers establish optional tiers of digital channels that are not included in the packages and must be purchased separately. Although the County would not know exactly which channels it may want to separate into a fully-optional tier of this nature until specific costs and customer interests are known, Uptown recommends that the County take this approach to control the cost of the overall video packages.

If Los Alamos moves forward and enters the video services sector, these two issues need to be addressed because they will impact customer perceptions of value and the ultimate operating margin that the County will be able to realize within this line of business. It's not an easy strategy question because these two 'realities' of this sector are in conflict with each other. But this fact will be a driving principal as Uptown presents its video product strategy recommendation below.

Exhibit 1 – NCTC Contracted Programming

ABC Family	Food Network	Ovation
AMC	Fox Movie Channel	Oxygen
Animal Planet	Fox News	PAX TV
Arts & Entertainment	Fox Sports Digital Nets	Product Information Network
BET	Fox Sports World	Recovery Network
BET on Jazz	Fox Sports World Espanol	RFD TV
Biography & History Int'l	Fuse	Royals Television Network
Bloomberg TV	FX	Sci-Fi Channel
Boomerang	G4TV	Shop at Home
Bravo	Game Show Network	Showtime
Cable in the Classroom	Golf Channel	Showtime Unlimited
Cartoon Network	GolfTV	SoapNet
Cinemax	Goodlife TV Network	Sorpresa
CNBC	Gospel Music Television	Speed Channel
CNN	Great American Country	STARZ!
CNN Espanol	Hallmark Channel	STARZ! Super Pak/
CNN International	HBO	Style
CNNfn	HDNET	Sundance Channel
Comedy Central	HDNET Movies	Trinity Broadcasting Network
Court TV	Headline News	TBS
CSPAN	History Channel	Tech TV
CSPAN2	HITS	Tennis Channel
Discovery Channel	HITS2HOME	The Erotic Networks
Discovery HD Theater	HITSQT	The Health Network
Discovery Health	Home & Garden TV	The Movie Channel
Disney Channel	Home Shopping Network	The Sportsman Channel
diy network	Horseracing TV	The Weather Channel
DMX	HTV	TLC
E! Entertainment TV	Independent Film Channel	TNT Plus
Encore Movie Pak	Infinito	Toon Disney
Encore Thematic Movie Plex	Inspiration Network	Travel Channel
Encore/STARZ!	Inspirational Life	TRIO
ESPN	International Ch. Foreign Nets	Turner Classic Movies
ESPN Classic	International Channel	Turner South
ESPN2	MBC	TV Land (in negotiation)
ESPNHD	MSNBC	Varsity TV
ESPNNEWS	MTV (in negotiation)	VH-1
EWTN	National Geographic Channel	Video Rola
Family Net	News World Int'l	WE (Women's Entertainment)
Familyland	Nickelodeon (in negotiation)	Wisdom Television
Fine Living	Outdoor Channel	Zap2It Express
Flix	Outdoor Life Network	

3. Packaging and Pricing

Uptown recommends that the County follow industry-standard packaging designs for its video service. There are two reasons for this. First, it is much easier for consumers to comprehend and evaluate the County's video offering compared to their current video service if the packaging structure is similar. Second, standard package designs can be used effectively to control programming costs and target certain programming to the specific households that are willing to pay for it. The packaging and pricing strategy being recommended can be summarized as follows for each of the video service categories:

- Limited Basic: Do not offer. Priced too low to recover variable capital costs.
- Expanded Basic: Compete on price and channel breadth.
- Digital Packages: Price to beat incumbent prices.
- Premium Channels: Price to market.
- High Definition: Price to match incumbent pricing.

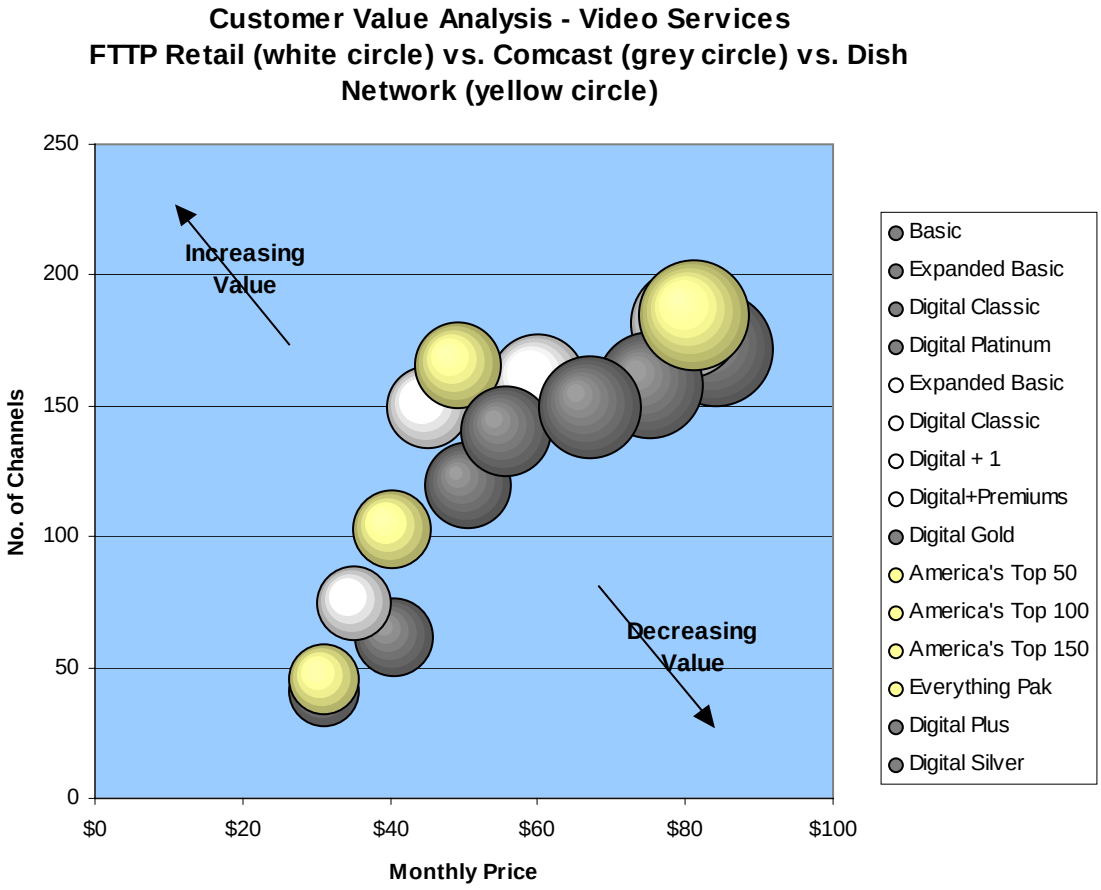
With the pricing guidelines in mind, Uptown recommends the following package structure and pricing for Los Alamos's video offering as summarized in Exhibit 2.

Exhibit 2 – Los Alamos Video Packages

	Monthly Price	Analog Channels	Digital Channels	Premium(s)	Digital Music	High Definition
Analog Basic	$34.95	75	-	-	-	
Digital Basic	$44.95	75	30	-	Included	$5.00 Extra
Digital + 2 Premium	$59.95	75	30	2	Included	$5.00 Extra
Digital + 4 Premiums	$79.95	75	30	4	Included	$5.00 Extra

As a confirmation of this strategy and to ensure that appropriate emphasis is being placed on delivering customer value, Uptown has plotted the monthly price of the County's and Comcast video packages against the number of channels received. This is presented in Exhibit 3. Although this can only approximate value as consumers place different levels of value on each channel, it provides a visual confirmation of how the packages are competitively positioned.

Exhibit 3 – Customer Value Analysis – Video



Source: Uptown Services Analysis, 2003

Uptown strongly recommends that the County's entry-level digital package be positioned as the 'Fighter Brand' among its video packages. The marketing strategy behind this approach would be to select the most competitive video package (the fighter brand) versus the incumbent and use that in Los Alamos's advertising and promotion. This package would establish the County's perceived value relative to the competition. Finally, and most importantly, these value perceptions should transfer across the County's entire product range and brand, thereby delivering upon the image and reputation that the County has already established in providing water and garbage collection service. This strategy has two tactical implications. First, that the County should not discount evenly across the entire video product line. Second, that the County should determine where it could best differentiate and compete there. Uptown believes that this is the digital basic package.

4. Los Alamos Versus Incumbent Price Comparison

The comparison between the County and Comcast's video products, and the amount of discount that the County would offer, is summarized in Exhibit 4.

Exhibit 4 – Incumbent Pricing Comparison

Video Services		Comcast	Dish	LAC FTTP	Discount
Analog Basic	Basic Service	$30.89	-	-	-
	Expanded Basic/America's Top 50	$40.51	$30.98	$34.95	14%
Digital Packages	Digital Classic/America's Top100	$50.46	$39.98	$44.95	11%
	Digital Plus	$55.46	-	-	-
	Digital Silver/America's Top150	$66.95	$48.98	$59.95	10%
	Digital Gold	$74.95	-	-	-
	Digital Platinum/Everything Pak	$83.95	$80.98	$79.95	5%
Premium Channels	HBO	$12.95	-	$12.95	-
	Cinemax	$12.95	-	$12.95	-
	Showtime/The Movie Channel	$12.95	-	$12.95	-
	Starz!/ Encore	$12.95	-	$12.95	-
Ala Carte Services	PPV Movie (non-adult)	$3.95	$3.99	$3.95	-
	High Definition	No	Yes	Yes	-

B. Internet

1. Packaging and Pricing

Uptown has based its Internet services recommendation (summarized in Exhibit 6) upon a fundamental belief that the marketplace will demand more and more bandwidth for data services and that the County will be uniquely positioned to deliver it to the mass market. Given this, the emphasis for customer value should be on increasing product speed and throughput. Accordingly, we believe the general strategy should be to use fiber technology to revolutionize broadband Internet service in Los Alamos:

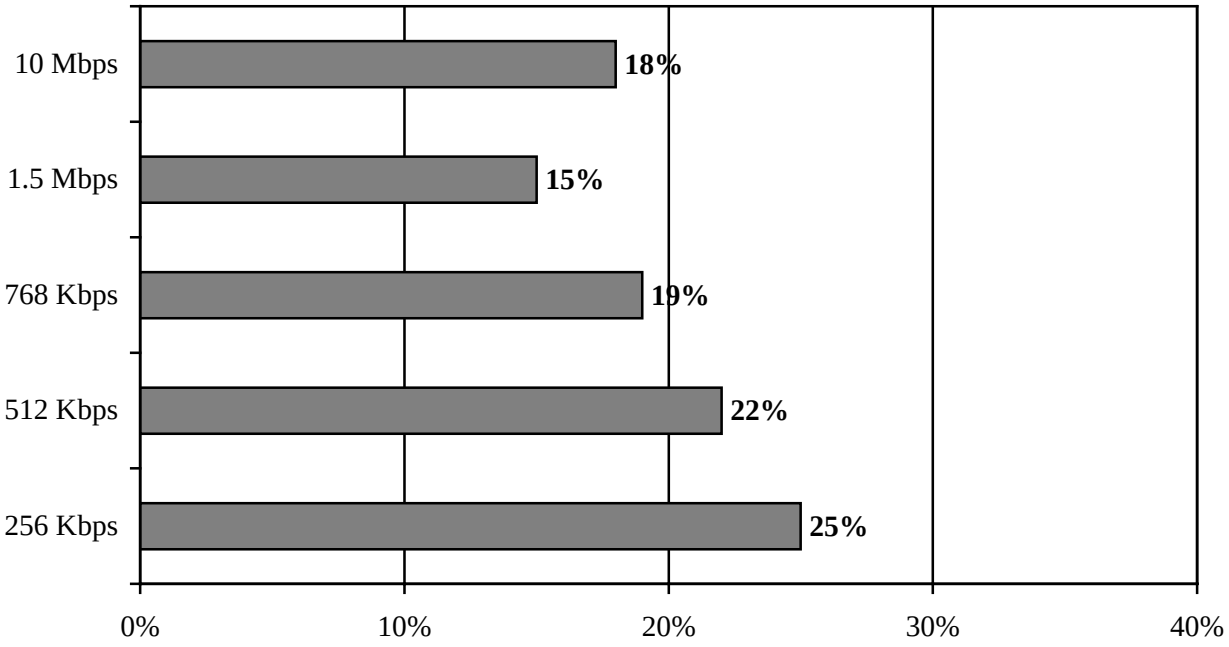
- Provide 100Mbps speeds to end users for "on network" data transfers over the Los Alamos Intranet, where capacity is abundant
- Manage cannibalization risk of the upper tiers by carefully setting maximum speeds for Internet traffic, where capacity has a variable cost structure[1]
- Provide symmetrical downstream and upstream data rates across all tiers, which is a major paradigm shift for mass-market Internet services.

Especially in the last 12 months, the need for increased speed and throughput has grown dramatically among residential and small business Internet users. As reflected by subscriber losses at the largest narrowband ISP (AOL), broadband Internet access has taken market share as

[1] Refers to the risk of unnecessarily moving subscribers from a higher revenue tier to a lower revenue tier by offering the lower priced tier at too low of a price.

users realize their need for greater performance in downloading and uploading data via the Internet. This need is reflected in the quantitative research, where small business respondents were asked to indicate the level of download speed they require (Exhibit 5). Even today, almost 1 in 5 require 10Mbps, and this demand will increase within the consumer and business markets as bandwidth-intensive applications expand.

Exhibit 5 – Los Alamos Small Business Internet Speed Requirements



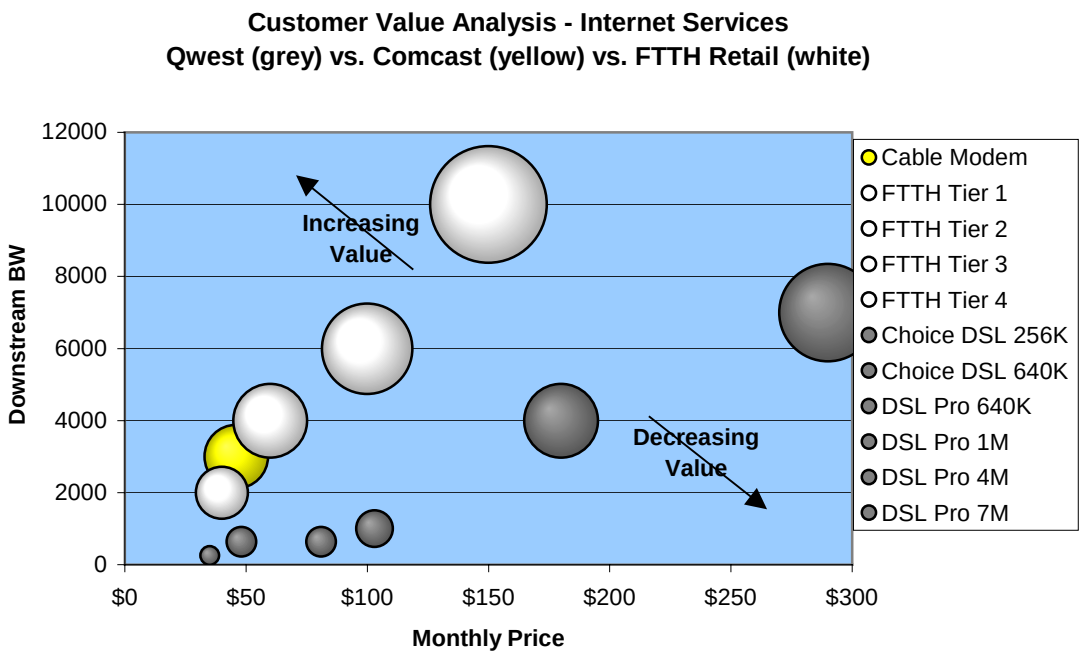
Source: Quantitative Research Report, Uptown Services. November 2003

Exhibit 6 – Los Alamos Broadband Internet Offerings

Tier	Monthly Price	Downstream Speed	Upstream Speed
2 Mbps	$39.95	2Mbps	2Mbps
4 Mbps	$59.95	4Mbps	4Mbps
6 Mbps	$99.95	6Mbps	6Mbps
10 Mbps	$149.95	10Mbps	10Mbps

Note: Indicated speeds are for Internet transfer rates. Transfer rates on the County's Intranet are expected to be 100Mbps.

Exhibit 7 – Customer Value Analysis – Internet



2. Los Alamos Versus Incumbent Price Comparison

The comparison between Los Alamos and Qwest's and Comcast's Internet products is summarized in Exhibit 8.

Exhibit 8 – Incumbent Pricing Comparison

Internet Services	Qwest	Comcast	LAC FTTP	Discount
Choice DSL 256Kbps	$34.99	-	-	-
Choice DSL 640Kbps Down/256 Up	$47.99	-		-
DSL Pro 640Kbps Symmetrical	$80.95	-	-	-
DSL Pro1Mbps Symmetrical	$102.95	-	-	-
Cable Modem/FTTP 2Mbps	-	$45.95	$39.95	13%
DSL Pro 4Mbps/FTTP 4Mbps	$179.95	-	$59.95	67%
DSL Pro 7Mbps/FTTP 6Mbps	$289.95	-	$99.95	66%
FTTP 10Mbps	-	-	$149.95	Exclusive

C. Telephone

1. Packaging and Pricing

The telephone services strategy is distinguished by its two market segments; the mass market (residential and small business) and the complex market (large business and institutions). These markets differ substantially, and warrant separate treatment from a product strategy perspective. For the purposes of this analysis, the complex services market can be described using the following characteristics:

- Services are consumed primarily by medium to very large sized businesses that require face-to-face sales and engineering support. Service arrangements typically require individual case basis design, pricing and contract terms.
- Customers have higher than average expectations for account services, service reliability and service availability.
- Customers don't purchase cable modem or DSL services for critical data services, nor do they purchase Plain Old Telephone Services (POTS) for telephone services. Instead, complex market customers use SONET, ATM and/or Ethernet based services for voice and data connectivity.

a) Mass Market Telecommunications Services

This feasibility study assumes that the County will retail telephone services by outsourcing network switching and interconnection to a third party partner. The third party would wholesale these network services to Los Alamos for $10 per port on its telephone switch and the County, in turn, would retail voice services to residential and business customers. Although negotiations will need to take place between the third party telephone retailer and County staff, Uptown believes that terms consisting of fees per port are realistic for a CLEC's wholesale pricing given its discussions with local service providers.

The proposed rate structure in Exhibit 9 shows the recommended Los Alamos retail rates compared to Qwest's pricing. In general, a 10% discount is targeted, but is not applied evenly across all services, as suggested in the pricing strategy section of this document. Uptown is targeting an ARPU of $21.50 for residential and small business customers with this pricing design, which is achievable given 1.3 lines per home and 2+ lines per small business along with typical penetrations of calling features and packages. This ARPU level will generate approximately a 60% gross margin for the service.

Exhibit 9 – Los Alamos Telephone Offerings & Incumbent Pricing Comparison

Telephone Services		Qwest	LAC FTTP	Discount
Access Lines	Basic Line (1FR)	$12.25	$9.95	19%
	Additional Line	$12.25	$9.95	19%
Switch-Based Calling Features	Call Waiting	$4.78	$4.95	+4%
	Caller ID	$6.25	$4.95	21%
	Voice Messaging	$6.95	$4.95	29%
	Three-Way Calling	$3.50	$4.95	+41%
	Custom Ringing	$5.00	$4.95	1%
Packages	Qwest Choice Home	$25.99	$19.95	23%
	Qwest Choice Home (2 lines)	$35.99	$29.95	17%
Maintenance Plans	Inside Wire Maintenance	$4.75	$4.75	-
	Equipment Maintenance	$4.50	$4.50	-
	Both	$5.95	$5.95	-

b) Complex Telecommunications Services

Uptown recommends that the County develop a telecommunications strategy to address the opportunities in the complex services markets on or near the fiber ring. The primary telecommunications need arising from the complex market is (1) The transport of data and voice traffic, and (2) The availability of voice circuits to a central office, where telephone calls can be completed to the greater public switched telephone network. The following sections describe the core offerings for Los Alamos's complex market.

(1) High Capacity Transport Services

Large businesses and carriers use transport services to send voice, data and video traffic from one point to another (locally, regionally, nationally or internationally). Large businesses use transport services to connect their PBX directly to a long distance company, thus eliminating the high cost of local switching. Large businesses also connect different office locations together for the purposes of creating a private network. Finally, these same businesses use transport services to connect directly to their ISP. Carriers use transport services in much the same way as large businesses, expect that they are usually connecting their network elements together. Like switch-to-switch or node to node interconnection. Switches could be theirs or another carrier's like the incumbent local exchange carrier (ILEC).

Transport services come in many varieties. Given the dominant position that the ILECs continue to hold in the high capacity transport services market, the market is typically defined in "Bell" terms. This means that T1s, DS-3s and SONET level interconnections are the norm. This is in stark contrast to the implementation of Gigabit Ethernet systems that offer much greater flexibility for the carrier, service provider and end user. Ethernet systems are used to carry voice

traffic using voice over Internet protocol (VOIP) standards. This will be the likely method of transport for the Los Alamos system.

The large business research report completed with this feasibility study determined that approximately 60 to 64 T1 equivalents should be expected as the County's market share of transport services. Uptown believes the local portion of these links can be priced at $135 each.

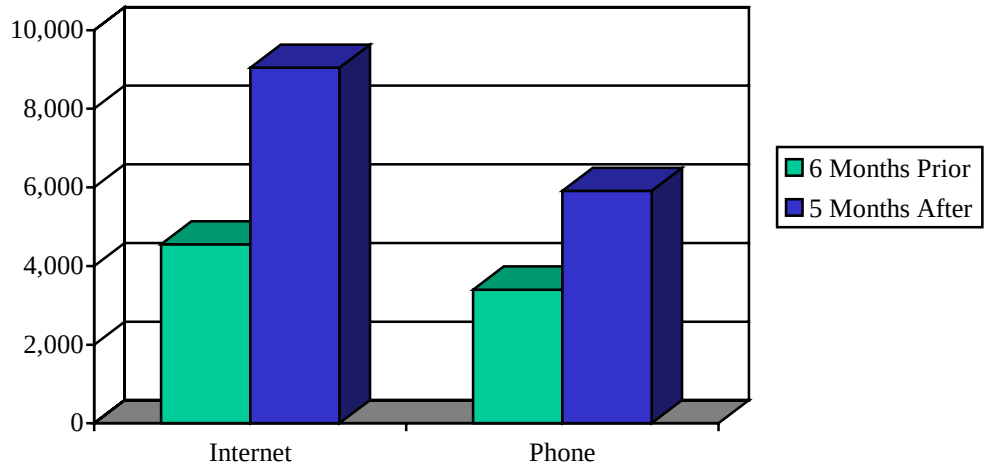
(2) Switched Services

The other telecommunications service opportunity to serve the complex market is switched service to the voice network via DS-O equivalents (usually served via a T1 transport link). Essentially, these serve as telephone lines that connect the business premises to a central office switch. From there the CLEC interconnects to the general Public Switched Telephone Network (PSTN) such that any and all local and local distance calls can be completed. Uptown forecasts 1,400 DS-O equivalents for the business sector at $18 monthly.

D. Bundles

As a final pricing strategy, Uptown recommends that the County bundle its FTTP products to maximize financial value. The broadband services industry is seeing an increase in the importance of services bundling as a marketing tactic to accelerate penetration of optional services (Internet and local telephone) and to entrench the current customer base from video competitors. It is being used effectively by a number of the major national incumbent brands, including Cox and SBC. Bundling can be very effective in accelerating the sell-in of Internet and local telephone services, as evidenced in a major urban market when a cable operator introduced a price point bundle design for video, telephone, and Internet (see Exhibit 10 below).

Exhibit 10 – Monthly Sales Impact of Bundling



Source: Data from a major urban market. Cable operator results during 2002.

The improvement in the financial health of the service provider is probably even more important than the sales impact realized from bundling. By reducing subscriber churn and improving revenue per subscriber (ARPU), bundling can improve profitability, even though it uses price

discounting to attract subscribers. In the same market, the following financial metrics realized from the subscriber base where bundling was being used are presented in Exhibit 11.

Exhibit 11 – Financial Impact of Bundling

	Average Revenue Per User (Monthly)	Monthly Churn (Voluntary)
3 Products	$119	0.3%
2 Products	$80	0.8%
Digital Video	$51	1.4%
Analog Video	$34	2.7%

Source: Data from a major urban market. Cable operator results during 2002.

Given the above strategic considerations, Uptown proposes that Los Alamos offer its three services as a bundle for $89.80, the sum of the individual prices for the following services:

- Video: Expanded Basic for $34.95
- Internet: 2Mbps tier for $39.95
- Telephone: $Single access line with 1 calling feature for $14.90
- Monthly Total is $89.80

This design prices the bundles at the sum of the rate card prices for each service, with no additional discount. Even without further discount, the County can offer bundles of services at better prices than the incumbents. Exhibit 12 compares the proposed bundle to the incumbent services if a customer combined multiple services to mimic a bundle offering. The Los Alamos bundle clearly presents a superior value in terms of cost and service performance, and would be the only single-stop solution for all three services.

Exhibit 12 – Los Alamos Bundle Offerings Compared to Incumbents

		Comcast 'Bundle'	Qwest 'Bundle'	Dish Network	LAC FTTP
Bundled Services	Video	Yes	No	Yes	Yes
	Internet	Yes	Yes	Yes	Yes
	Telephone	No	Yes	No	Yes
Service Prices	Video	$40.51	$40.51	$48.98	$34.95
	Internet	$45.95	$46.90	$40.00	$39.95
	Telephone	$18.50	$18.50	$18.50	$14.90
Total Price		**$104.96**	**$105.91**	**$107.48**	**$89.90**

V. Assessment of Wireless Services

As part of its project scope, the WCN Committee included the consideration of wireless services as a primary or supplemental technology for the broadband network being considered. This section presents Uptown's assessment of current wireless technology and its ability to support broadband applications in a reliable and robust fashion.

Wireless technology has continued to evolve over the past several years into a viable broadband alternative technology for certain applications. While FTTP is the superior architecture for delivering voice, data and video services, there are a number of wireless systems that still may pose limited threats to Los Alamos's FTTP endeavors. The following sections detail the capabilities of the main broadband wireless alternatives and their potential involvement in the proposed FTTP system.

A. Licensed Wireless Technologies

The FCC divides wireless services into two basic categories – licensed and unlicensed. Licensed technologies operate in bands that are assigned to specific owners of the given spectrum. These slices of spectrum are typically assigned for a given application like public safety or cellular telephone service. Broadband wireless systems that operate in these licensed bands are described next.

1. Multichannel Multipoint Distribution System

Multichannel Multipoint Distribution System (MMDS) was originally established for the transmission of television signals (wireless cable television service). Today's cable operators drove most wireless cable television companies out of business. Wireless Internet service providers now primarily use the spectrum. These providers offer services though roof-mounted antennas that must have a clear line-of-sight to a central transmission tower.

MMDS spectrum was originally granted as broadcast (one-way) only. But since the virtual elimination of the wireless cable operator and the advent of high-speed cable modem Internet services, the FCC now allows two-way services via this spectrum. They have limited the reverse path to just two out of the 33 channels available in the spectrum. Those operators seeking more reverse channel spectrum are required to file with the FCC for additional two-way frequencies.

MMDS-based services are typically deployed via a "macro-cell" network. Such a network is based on a single transmission tower at which all subscriber antennas are aimed. A single transmission tower will generally cover an area 35 miles in any direction. This saves start-up costs for an operator, but it typically requires more complex or powerful (expensive) equipment at each customer site. The alternative approach to macro-cell is "micro-cell." Micro-cell networks move the transmission sites closer to customers. Such an approach is more expensive up front, but can save money on customer equipment and may allow signals to penetrate structures. Building penetration capability would eliminate the need for roof-mounted antennas, thus simplifying the installation procedure considerably.

A properly configured MMDS network can offer high-speed Internet services with performance that is comparable to most cable modem services. The equipment at the central site and the subscriber location are actually very similar to their cable modem counterparts. The main difference is how the signal is transmitted to the home – over the air versus via fiber and coax.

Sprint is a leading provider of MMDS based Internet services throughout the country. They bought up large amounts of spectrum and began offering services in the late 1990s, but have since

stopped installing new subscribers. They announced that they were unhappy with the current generation of MMDS equipment and would not be expanding into new areas or installing any new subscribers until the vendor community made improvements. The following notice is currently posted the on the Sprint Broadband website:

> *"Sprint remains hopeful that the advantages of the next-generation of fixed wireless technology, which includes self installation, no line-of-sight limitations, increased capacity, and the ability to offer voice services will make fixed wireless a viable consumer broadband product. Sprint has taken a leadership role in next-generation development and will continue to monitor solutions."*

It is not clear when Sprint's issues will be resolved because the MMDS provider / supplier community appears to be locked in a stalemate over who commits to major changes first. While Sprint is not a provider in Los Alamos, their travails certainly shed light on the overall market. Based on the lack of any current provider and the issues being faced by the rest of the industry, MMDS-based offerings in Los Alamos will not pose a significant competitive threat for the foreseeable future.

2. Local Multipoint Distribution System

Local Multipoint Distribution System (LMDS) is a form of high-speed wireless telecommunications technology. The FCC set spectrum aside in the early 1990's for use by service providers wishing to provide fiber optic-like capabilities in urban and suburban areas of the U.S. Spectrum auctions were completed in the mid-1990s and re-auctions were completed in 1999-2000. Two bidders were dominant in the initial and subsequent auctions – Teligent and Winstar. Leading vendors of LMDS equipment at that time were Motorola and Nortel.

LMDS technology has the capability to provide very high capacity connections for voice, video and data within a three-mile range. Operating at 38 GHz, the system requires line-of-sight from building-mounted antennas to the serving tower. LMDS services were being targeted toward mid-sized and large businesses that needed highly reliable high capacity services, but didn't have access to a fiber ring. LMDS solutions will typically be more expensive to deploy and support than cable modem or DSL-based Internet services.

LMDS operators in the U.S. did not enjoy the success that they had hoped following the auctions. The industry was plagued by delays in equipment delivery and the massive capital costs incurred to construct the base infrastructure. Winstar and Teligent are both bankrupt. Their stocks are no longer traded in the NASDAQ system.

Uptown was unable to determine if any LMDS infrastructure has been built in Los Alamos, but it can be reasonably assumed that LMDS will not play a competitive role in Los Alamos for many years.

3. Broadband Satellite

a) Constellation Based Services

Much has been made of the crop of broadband satellite development ventures that seek a share of the cable modem and DSL markets. Companies like Teledesic and Astrolink are feverishly working on high capacity Internet satellite platforms that will serve the high-speed needs of consumers and businesses. Plans call for constellations of 60+ satellites orbiting the Earth and communicating with millions of subscribers via small roof-mounted dishes. Capacity per subscriber is expected to be over 1.5 Mbps at the time of launch in three to five years. There are a few broadband satellite providers that have launched service for the ISP and commercial

markets, but a truly affordable high-speed consumer service (Teledesic and Astrolink) will take longer to develop.

Analysts predict that the broadband satellite market may be strong for underdeveloped countries, but that the U.S. will have already been served with DSL and cable modem services by the time these networks are operational. Besides time-to-market problems, satellite signals will not be capable of penetrating building structures, thus the need for a roof-mounted dish. Finally, broadband satellite operators have given up on mobility, which takes away one of the greatest intrinsic benefits of any wireless Internet solution.

b) DBS Based Services

DirecTV was the first satellite provider to introduce a satellite based Internet access service – DirecPC (now called DirecWay). The original DirecWay service sent Internet downloads (downlink) to the subscriber via satellite and subscribers were required to use a dial-up connection to send information back (uplink) to the Internet. This limitation was due to the high cost of subscriber-based satellite uplinks, but these costs have since come down enough for DirecWay to offer two-way services over their own network. A telephone line is no longer required.

Customers must purchase separate data receivers, but DirecWay is offering a $69 start-up fee if the subscriber agrees to pay a monthly fee of $99 for the first twelve months. Regular monthly service runs $69 for unlimited usage. Downstream data rates for DirecWay appear to be in the 384 – 512 Kbps range.

StarBand service is a two-way satellite based Internet access system offered in partnership with Dish Network. Before StarBand, Dish did not have an Internet access service. They chose to wait for a two-way system rather than invest in a technologically inferior telephone return solution. StarBand is delivered to customer locations via a larger dish than the typical Dish Network antenna. This new dish is 24”x 36” compared to a standard 18” dish for DirecTV and Dish Network. A larger dish is required to generate enough power for the return path (uplink) to the satellite. Dish Network video services can also be received over the new StarBand dish. Download speeds are limited to 500 Kbps and upload speeds are limited to 150 Kbps.

4. 3G Wireless

Cellular telephone networks have been deployed ubiquitously across the U.S. Voice technology for wireless networks is now mature and the industry has turned its attention toward Internet services. With over 250 million cellular handsets in use throughout the world, equipment suppliers and standards groups are working hard to develop and introduce standardized high-speed Internet services that operate on cell phones and other hand held devices. Low to medium speed offerings are currently available that offer maximum bandwidths of 9.6 to 56 Kbps. Higher speed solutions will be deployed over the next several years in phases or “generations.” The ultimate high-speed Internet access solution for cellular telephone providers is called 3G or Third Generation Wireless.

3G wireless capabilities hold the promise of delivering speeds of 144 Kbps at high speeds, 384 Kbps at pedestrian speeds and 2 Mbps for fixed stations. Consumers are becoming more and more mobile every year as evidenced by the nonstop adoption of cell phones around the world. This dramatic mobility trend has intersected with the Internet economy. The market for high-speed mobile Internet services is expected to experience explosive growth over the next ten years. In fact, wireless operators expect that data service revenue will eventually be larger than voice service revenue.

3G wireless applications may offer a boon to wireless operators, but should not pose any significant threat to the FTTP system. First, 3G wireless will not have the capability that FTTP brings to the average residential and small business user. The technology will still be expensive to deploy, which will likely keep it in the premium category for most wireless operators. For example, the latest rage in the cell phone market is built-in digital cameras. However, wireless operators plan to implement pricing schemes that charge by the image (or message) sent to and from each device. This approach is not likely to drive the type of usage that a FTTP system could support.

B. Unlicensed Wireless Technologies

A number of wireless systems have been developed in recent years that exploit the advantages of the license-free bands set up by the FCC. Some of these systems have been developed based on standards that have been established by bodies like the Institute of Electrical and Electronic Engineers (IEEE), while others have been developed based on vendor-specific specifications. The top alternatives for each category are outlined in the following sections.

1. Standards Based Systems (Wi-Fi)

The top standardized wireless LAN system in the unlicensed category is Wi-Fi (Wireless Fidelity). Wi-Fi is the industry term given to the family of 802.11 (a, b and g) wireless LAN standards. The latest Wi-Fi standard (802.11g) offers the best of both earlier standards (a and b). It has the capability to transmit up to 54 Mbps of data and interoperates with systems running either 802.11a or 802.11b. While the stated throughput is 54 Mbps, 20 Mbps is usually the best most 802.11g systems are expected to produce. This is due to the high level of error correction (overhead) required in the license-free bands.

a) Benefits

Two primary benefits of a standardized system are interoperability and reduced cost. Both of these advantages stem from the ability to purchase hardware and software from multiple suppliers without fear of system failure. Access points (bridges and routers), end-user cards and antennas are all reasonably priced given the healthy competitive environment in the vendor market. Access points can be purchased for less than $600 and tri-mode PCMCIA cards are less than $150 each.

b) Drawbacks

While operating in a license free band may be free, it comes at a great cost to network operators and end users. Unlike licensed spectrum, the bands that Wi-Fi utilizes are open to any number of operators and sources of interference. For example, for low power household electronics like cordless telephones and microwave ovens, the FCC set aside 2.4 GHz for the primary Wi-Fi band. Wi-Fi standards have been carefully crafted to overcome these sources of constant interference, but they can still cause service interruptions or degradation without warning to the service provider or end user. Wi-Fi does not tolerate a multiple service provider model very well either. For example, if two service providers are offering service in the same geographical area, they are required to cooperate on channel assignments for their respective Wi-Fi networks. Even if they do cooperate, there is no guarantee that another rogue operator will not intentionally interfere with the “legitimate” networks.

The most troubling aspect of Wi-Fi systems today is the lack security. Wireless systems are inherently less secure than fiber systems by their very nature. Any technically adept person with

a laptop and directional antenna can drive down the street and view the various Wi-Fi networks broadcasting packets.

Recently, a Los Alamos Weekly reporter was able to access sensitive information from one of the Los Alamos Unified School District network servers simply by connecting her laptop via Wi-Fi to the server. She then reported her experiences in a series of newspaper articles, heightening community awareness of the security challenge facing Wi-Fi.

Should anyone be intelligent, sneaky and very persistent, they should be able to break the 128 bit wireless encryption protocol (WEP) that Wi-Fi uses to keep its traffic secure from hackers. Wi-Fi suppliers and service providers are scrambling to introduce more robust encryption approaches, but the issue remains a problem for any individual or enterprise that plans to use Wi-Fi.

2. Proprietary

Given the aforementioned limitations of the current Wi-Fi systems, some companies have chosen to implement their own systems using proprietary approaches. Two of the main solutions-providers are discussed next.

a) Wave Rider

Wave Rider offers a wireless Internet system that operates in the 900 MHz band. Wi-Fi elected to use the 2.4 GHz and 5.1 to 5.8 GHz bands due to the limited availability of usable spectrum in the 900 MHz band. However, the 900 MHz band is the only one that offers true non-line–of-sight capability from the transmit tower to the end user radio. Given the longer wavelength of a 900 MHz waveform, it is able to travel through trees and buildings over long distances. Wave Rider quotes a serving radius of 1.5 miles from a transmitter to an indoor end user radio. This enables Wave Rider subscribers to complete their own installations and skip the hassle of mounting an antenna on the roof or under an eave.

The primary drawbacks of the Wave Rider system are limited bandwidth and high cost. A Wave Rider transmitter has the capability to broadcast 2.5 Mbps to all radios within an 8-mile radius (outdoor antennas are required beyond 1.5 miles). This is compared to 54 Mbps for 802.11g. The ability to compete with cable modem and DSL speeds is clearly limited with a total shared bandwidth of only 2.5 Mbps. Cost is also high for this system. A “starter system” runs $6,500 and includes enough equipment to serve just six end users. At $1,000 per end user, this approach is likely to be the last resort for any ISP seeking broadband alternative to dial-up.

b) Motorola Canopy

Motorola has introduced a new wireless platform named Canopy. Motorola is infinitely qualified in the ways of wireless and determined that they could build a better system than Wi-Fi for providing broadband Internet access. The Canopy system operates in the 5.1 to 5.8 GHz band and provides up to 10 Mbps to subscribers within 10 miles of a central transmitter. The recommended configuration calls for a six-sector transmitter serving up to 1,200 subscribers. Subscribers would be required to install their antenna on the outside of their home or business such that clear line-of-sight could be attained to the transmitter location.

Canopy utilizes the precise timing of the Global Positioning System (GPS) to control all network traffic, which minimizes packet collisions and thus the need for repeated retransmission of lost or corrupt packets. This approach also results in low latency of transmission (< 20 ms). Latency refers to the time it takes for a packet to reach its specified destination.

C. Summary

Of all the technological threats to FTTP, wireless appears to garner the most attention and serious consideration. However, it is Uptown's opinion that wireless technologies will not be capable of delivering the kind of reliable bandwidth required to support a compelling voice, video and data bundle. Certainly there are applications for Wi-Fi as an alternative to wired LANs in homes, businesses and public meeting places ("hot spots"). But the technology has too many limitations:

1. Security: All signals are easily intercepted in the "open" air. This has been bothersome to many potential users.

2. Quality of Service: Service varies from location to location and by time of day. At any time competitors can compete in the same airspace, thus degrading the quality of all Wi-Fi services.

3. Limited Throughput: Just like cable modem technology, the system utilizes large blocks of shared bandwidth. This leads to lower throughput per user as more subscribers are added to the network.

4. Data Only: Wi-Fi was not designed to carry voice or video services in wide area configurations. This puts the technology at a disadvantage when bundling is a key element of any product strategy.