BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of the Review of:	**)**	
Unbundled Loop and Switching	**)**	
Rates; the Deaveraged Zone Rate	**)**	
Structure; and Unbundled Network	**)**	**DOCKET NO. UT-023003**
Elements, Transport, and	**)**	
Termination	**)**	
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DIRECT TESTIMONY OF

JOHN C. DONOVAN

on behalf of

AT&T COMMUNICATIONS OF THE PACIFIC NORTHWEST, INC.,

WORLDCOM, INC.,

and

XO WASHINGTON, INC.

JUNE 26, 2003

SUBJECT INDEX

I. IDENTIFICATION OF WITNESS

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND CURRENT POSITION.

A. My name is John C. Donovan. I am president of Telecom Visions, Inc., a telecommunications consulting company. My business address is 11 Osborne Road, Garden City, New York 11530. Currently, I am providing telecommunications consulting services to a number of firms concerning telecommunications infrastructure design, construction and the costing aspects of the local loop. I have also provided services to several manufacturers of telecommunications equipment, investment companies, insurance claims companies, patent attorneys, and others.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying on behalf of AT&T Communications of the Pacific Northwest, Inc. ("AT&T"), WorldCom, Inc. ("MCI"), and XO Washington, Inc. ("XO") (collectively "Joint CLECs").

Q. PLEASE DESCRIBE YOUR BACKGROUND.

A. I received a Bachelor of Science degree in Engineering from the United States Military Academy at West Point, an MBA from Purdue University, and completed the Executive Development Program at Penn State University. I have attended many outside plant training courses for engineering and construction at the Bell System and Bellcore (now known as Telcordia) Training Centers, along with private training available through various vendors and other sources. In addition, I have taught telecommunications as an Adjunct Professor at New York City Technical College.

I have 34 years of telecommunications experience. My last employment before forming Telecom Visions, Inc. was with the NYNEX Corporation, now known as Verizon. I retired from NYNEX after 24 years of experience in a variety of line and staff assignments, primarily in outside plant engineering and construction. That experience included everything from splicing fiber and copper cables, to heading an organization responsible for the procurement, warehousing, and distribution of approximately $1 million per day in telecommunications equipment. I have had detailed hands-on experience in rural, suburban, and high density urban environments. I spent a total of 7½ years on corporate staffs at NYNEX responsible for developing Methods and Procedures for Engineering and Construction throughout the New England states. To summarize, I have planned outside plant, I have designed outside plant, I have purchased telecommunications materials and contract labor, I have personally engineered and constructed outside plant, and I have designed methods for those who do such functions. I have also performed other functions, or have supervised those who do, in installing, connecting, repairing, and maintaining the various parts of the telecommunications network.

For the past seven years, I have submitted affidavits, written testimony, and appeared as an expert telecommunications witness in proceedings before state regulatory commissions in Alabama, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nevada, New Jersey, New York, Oklahoma, Pennsylvania, Texas, Washington, Washington DC, and before the Federal Communications Commission ("FCC").

I have participated extensively in costing and pricing proceedings involving the unbundled network elements ("UNEs") that incumbent local exchange carriers must provide to competitors. My curriculum vitae is attached hereto as Attachment JCD-1.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION?

A. Yes, I previously testified before this Commission in an Unbundled Network Element Workshop[1] on February 14, 1997; I submitted prefiled Reply Testimony

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1 Docket Nos. UT-960369, -70 and -71: Re: In the Matter of the Pricing Proceeding for Interconnection, Unbundled Elements, Transport and Termination, and Resale for US West Communications, Inc.; for GTE Northwest Incorporated; On behalf of AT&T Communications and MCI Telecommunications Corporation.

in Docket No. UT-003013 on behalf of Covad Communications Company on January 11, 2002, and testified in that matter on May 9, 2002.

II. PURPOSE

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. My purpose is to provide evidence and expert technical opinion to the Washington Utilities and Transportation Commission ("Commission") regarding outside plant. My experience spans several decades, and includes in-depth, hands-on experience in engineering, constructing, and procuring outside plant. My goal is to act as a resource to this Commission regarding generally accepted outside plant methods and procedures, and to give evidence about investment input values into any cost model or studies that this Commission may choose to use. I will also demonstrate for the Commission that it can rely on the engineering inputs and assumptions for outside plant in the HAI Model Release 5.3 ("HM 5.3" or "the Model") as representative of realistic forward-looking practices and values. HM 5.3 applies standard engineering guidelines, current equipment capabilities and prices to reasonably estimate loop costs.

Indeed, HM 5.3 includes important refinements over any previous cost model with which I am familiar in that it explicitly considers the current deployment of high capacity and broadband facilities, thereby allowing a more precise consideration of how those services affect total network costs than was heretofore possible.

Moreover, I have carefully reviewed and updated key loop cost inputs to the Washington-specific version of HM 5.3 that AT&T is filing today to ensure that the Model includes as current as possible inputs for key values such as copper and fiber cable and loop electronics systems. Throughout the remainder of this direct testimony, I will show that the outside plant values submitted by AT&T in this proceeding fairly represent current forward-looking costs for facilities and equipment that have been and are currently being deployed in the local loop.

In short, the HM 5.3 Model uses standard engineering guidelines and current prices for equipment and facilities to reasonably estimate loop costs. The results of HM 5.3 demonstrate that current loop prices in Washington are too high.

III. SUMMARY OF OUTSIDE PLANT ENGINEERING PRINCIPLES

Q. WHAT GENERAL METHOD DOES HM 5.3 USE TO MODEL OUTSIDE PLANT?

A. HM 5.3 models the network similar to the way an incumbent local exchange carrier ("ILEC") outside plant engineer, such as those at Qwest or Verizon, would do. Training courses in Outside Plant Long Range Planning teach an engineer to model the network in building blocks, starting at the customer premises and working back towards the central office. Each section of the outside plant network is sized according to the capacity requirements of the area being served. HM 5.3 follows a very similar methodology in modeling the forward-looking network.

Q. WHAT IS THE FIRST STEP THAT AN ENGINEER TAKES WHEN DEVELOPING AN OUTSIDE PLANT PLAN?

A. The initial step in developing an ILEC long-range forward-looking outside plant plan requires the gathering of information about all types of customer circuit demand (including POTS, special services, wideband, and broadband requirements), structure sharing opportunities with other utilities, interoffice facility requirements, wire center locations, and central office boundaries. Accumulating all of the facility requirements for all services is important because the engineer can then design the outside plant network in a cost -effective manner to achieve economies of scale and scope, and a telephone company can share costs among the various services.

Q. DOES AN ENGINEER NORMALLY CLUSTER CUSTOMER LOCATIONS?

A. Yes. The next step in the traditional planning process is to cluster customer locations into Distribution Areas ("DAs"). Each Distribution Area cluster has a single interface point to the feeder network, and contains what are typically copper distribution cables that connect subscribers' homes and businesses to the feeder network over what is commonly referred to as "the last mile."[2] Pictures of typical outside plant components, specifically Network Interface Devices ("NIDs"), Buried Pedestal Block Terminals, Aerial Strand Mounted Block Terminals, and Serving Area Interfaces ("SAIs"), are included as Attachment JCD-2 to this testimony.

Clustering customers into a Distribution Area allows engineers to input pockets of customer demand into a computerized feeder model. All copper cables within a Distribution Area cluster should have a uniform cable gauge makeup and transmission characteristics. This accepted engineering planning and design method, also known as "prescription design,"[3] has been used for decades because it makes it unnecessary for the engineer to do a manual loop qualification for each individual loop within the Distribution Area.

Q. HOW DOES AN ENGINEER PLAN THE CONNECTING OF DISTRIBUTION AREA CLUSTERS TO THE CENTRAL OFFICE?

[2] One exception to this general practice is when broadband facilities such as "DS-3" services are deployed. Services at that capacity require all fiber facilities. Where such fiber-based services share distribution routes with traditional copper facilities, the fiber-based service may consume facilities in a unique manner such as requiring a separate attachment on utility poles. ILECs are beginning to migrate more services, particularly for businesses, to a fully fiber-based design.

[3] *See* for example Telcordia, *Telcordia Notes on the Netw*orks, October 2000, page 12-2, which states: "Distribution plant design treats loops on an aggregate instead of an individual basis, so large composite cross-sections of facilities are designed with similar transmission characteristics. This simplifies distribution network design, especially when several gauges of cable are used."

A. The next step is to sectionalize the outside plant feeder structure and cable network. Each ILEC feeder section, called an Exchange Feeder Route Analysis Program ("EFRAP") section, should have one type of structure and may contain several cables. The purpose of this sectionalization is to allow the computer modeling of an outside plant feeder network.

Q. WHAT ROLE DOES LINE DEMAND PLAY IN PLANNING THE OUTSIDE PLANT NETWORK?

A. After the ILEC engineer sectionalizes the outside plant feeder structure and cable network, the next step is to connect the requirements of a Distribution Area cluster to the Feeder Cable network.

Q. HOW DOES AN OUTSIDE PLANT ENGINEER DETERMINE APPROPRIATE FEEDER CABLE SIZES?

A. The size of a copper feeder cable is based on several factors. First, it requires a forecast of demand from the Distribution Area cluster or areas that the EFRAP section will directly feed. The requirements of the feeder section are increased to accommodate an economical amount of growth. That normally consists of in-service requirements plus only two to five years of growth, and if done properly will result in reasonably high cable utilization rates (otherwise known as *Cable Fill* or *Fill Factors*). In addition, cables come in discrete sizes, so that the engineer may need to select a cable size that exceeds the exact number of pairs required for any particular section.

Q. HOW HAS THE DESIGN OF OUTSIDE PLANT CHANGED OVER TIME?

A. During the early 1960's until approximately 1972, outside plant design guidelines mandated the use of a Feeder Distribution Interface ("FDI"). The FDI provided a manual cross-connection point between feeder and distribution plant. Compared to "multipled plant" (originally designed for party-line service so that a single cable pair would appear for assignment in several locations; *i.e.*, multiple bridged taps), interfaced plant provides greater flexibility in the network.[4]

In the early 1970's, the Serving Area Concept ("SAC") design was introduced as a prescription-simplified engineering planning and design method. It was the first major attempt to modernize the network to care for growing and ubiquitous service to an ever-shifting customer base. Under SAC design, the distribution cable network is connected to the feeder network at a single interconnection point, the Serving Area Interface ("SAI") or FDI, with no multipled copper feeder cable facilities (*i.e.*, zero bridged tap).[5]

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[4] Telcordia, *Telcordia Notes on the Networks*, October 2000, page 12-3, states as follows: "Interfaced plant uses a manual cross-connect and demarcation point, the FDI, between the feeder plant and distribution plant. The cross-connect, or interface, allows any feeder pair to be connected to any distribution pair. This increases flexibility and reduces outside plant deployment and labor costs. Compared to both multiple and dedicated plant, interfaced plant provides greater flexibility in the network and represents the present conventional (metallic pair) distribution plant design philosophy."

[5] Bellcore (now known as Telcordia), *Telecommunications Transmission Engineering*, 1990, page 93.

In 1980, the SAC design concept was incorporated into the Carrier Serving Area concept ("CSA").6 Introduction of CSA design guidelines and utilization of digital loop carrier systems in the feeder portion of the local network changed the engineering planning process. This design change was implemented in 1980.7 A CSA is a planning entity consisting of a distinct geographic area that can be served by a single Digital Loop Carrier ("DLC") Remote Terminal ("RT") site. The geographic area could encompass a single DA cluster or multiple DAs. The maximum allowable bridged-tap within a DA was relaxed from no bridged tap under SAC guidelines to 2,500 feet, with no single bridged-tap longer than 2,000 feet. Also, all CSA loops must be unloaded.8

Q. WHAT HAS BEEN THE IMPACT OF THE USE OF DLC SYSTEMS IN THE NETWORK?

A. The use of DLC systems in the feeder route means that operations expenses can be significantly reduced (expenses related to fiber cable and self-monitoring and remotely provisionable DLC electronics equipment are an order of magnitude less than their copper feeder counterparts), and feeder plant can achieve much higher fill ratios. Higher and more economical feeder fill ratios can be achieved because an initial DLC installation involves a Remote Terminal ("RT") housing and common-control electronics. As time progresses, additional service requirements

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[6] Telcordia, *Telcordia Notes on the Networks*, October 2000, page 12-4.

[7] Telcordia, *Telcordia Notes on the Networks*, October 2000, page 12-3.

[8] Telcordia, *Telcordia Notes on the Networks*, October 2000, page 12-4.

can be very efficiently addressed by simply installing additional channel units at the RT site. On the other hand, copper feeder cable requires 1) the allocation of a small number of "administrative spares" to care for defective pairs that may accumulate over time; 2) providing sufficient spares to care for growth during the construction interval required for placing a new relief feeder cable; and 3) allowing for idle spare pairs caused by inward and outward churn of working lines. However, use of DLC systems 1) increases fill factors by eliminating the defective pair problem because line cards are electronically monitored for quality by the system, triggering a replacement of a defective card immediately; and 2) reduces growth spares because relief can be accomplished in a matter of minutes instead of requiring several months to reinforce copper feeder facilities by engineering and installing additional cables along a feeder route. The generally accepted engineering guideline for provisioning DLC systems has been to provide enough channel units (plug-ins), to meet the existing service requirements plus 6 to 12 months of anticipated growth, which allows for inward and outward churn.

Q. WHAT ASSUMPTIONS ARE MADE IN THE HAI MODEL REGARDING DLC COMMON EQUIPMENT AND LINE CARD UTILIZATION?

A. Although HM 5.3 could reasonably model a forward-looking network that operates at close to 100% less one year's growth rate, we have conservatively used a 90% utilization sizing factor for the line cards. Utilization of the common equipment and cabinets are much lower, typically less than 75% (which is equivalent to 3% growth per year for at least 10 years), due to large changes in going from one cabinet size to the next higher cabinet size. Such typically achieved lower fills for Next Generation Digital Loop Carrier ("NGDLC") common equipment and cabinets are incorporated into HM 5.3.

IV. TYPE OF STRUCTURE PERCENTAGES

Q. WHAT IS AERIAL, BURIED AND UNDERGROUND CABLE AND WHERE IN THE NETWORK ARE WE LIKELY TO OBSERVE THESE TYPES OF STRUCTURE?

A. Aerial outside plant consists of cables strung on poles; buried outside plant consists of cables placed in dirt trenches without any additional structure; and underground plant means that some sort of conduit has been placed underground with cables run through that conduit.

Feeder cables provide large amounts of capacity from the central office to the SAI. Distribution cables are small cables that run down local side streets. I believe, based on my experience, that it is reasonable to expect ***distribution*** cable to consist primarily of aerial and buried distribution cable; very little underground distribution cable exists, except for a small amount in higher density zones.[9] As

[9] Conduit and manholes are seldom built exclusively for the use of distribution cable. Where there is occasion to run distribution cable for a short distance in an underground conduit system, that system

will be discussed in more detail later, aerial, buried, and underground structure percentages for ***feeder*** cable will reflect a significantly different breakdown – for example, much more underground structure will prevail for feeder cable. Even for feeder cable, the use of expensive underground excavation, restoral, duct stabilization, and manholes is viewed by the industry as avoidable if possible.

Q. HOW WERE THE STRUCTURE FRACTION INPUTS DEVELOPED FOR DISTRIBUTION CABLE IN THE HAI MODEL?

A. Based on the data supplied by Qwest and Verizon to the FCC regarding its network, as reflected in its ARMIS reports[10], I developed HM 5.3 inputs for the percentage breakdown between aerial and buried distribution cable. The ARMIS data indicates a sheath-kilometer ratio of 27% aerial and 73% buried for Qwest and 43% aerial and 57% buried for Verizon, as shown below.

usually has already been built for feeder cable.

[10] The Automated Reporting Management Information System ("ARMIS") was initiated in 1987 for collecting financial and operational data from the largest carriers and is described at http://www.fcc.gov/wcb/armis/. ARMIS data are available on line at http://gullfoss2.fcc.gov/cgi-bin/websql/prod/ccb/armis1/forms/armis.hts.

FCC ARMIS Data for Qwest – Washington (sheath km)						
Year	Aerial	Intra-Bldg	Total Aerial		Buried	
1991	14,629	2,696	17,325	28.3%	43,919	71.7%
1992	14,479	2,681	17,160	27.6%	44,936	72.4%
1993	14,196	2,528	16,724	26.9%	45,482	73.1%
1994	14,196	2,560	16,756	26.5%	46,356	73.5%
1995	14,247	2,596	16,843	27.6%	44,248	72.4%
1996	14,077	2,597	16,674	28.0%	42,944	72.0%
1997	13,990	2,581	16,571	27.6%	43,440	72.4%
1998	13,922	2,583	16,505	27.3%	43,929	72.7%
1999	14,104	2,589	16,693	27.4%	44,330	72.6%
2000	14,117	2,594	16,711	27.2%	44,650	72.8%
2001	14,072	2,602	16,674	27.0%	45,046	73.0%
2002	14,041	2,602	16,643	26.9%	45,300	73.1%

FCC ARMIS Data for Verizon – Washington (sheath km)						
Year	Aerial	Intra-Bldg	Total Aerial		Buried	
1991	10,453	67	10,520	43.5%	13,653	56.5%
1992	10,118	63	10,181	42.7%	13,689	57.3%
1993	14,274	60	14,334	45.2%	17,371	54.8%
1994	14,050	55	14,105	44.3%	17,738	55.7%
1995	14,055	54	14,109	44.4%	17,634	55.6%
1996	14,207	53	14,260	43.7%	18,336	56.3%
1997	14,267	51	14,318	44.1%	18,118	55.9%
1998	14,946	51	14,997	43.8%	19,245	56.2%
1999	15,011	49	15,060	43.7%	19,411	56.3%
2000	15,097	48	15,145	43.6%	19,628	56.4%
2001	15,233	48	15,281	43.3%	20,000	56.7%
2002	15,147	46	15,193	43.1%	20,065	56.9%

Using that basis for the lower density zones, and reserving some underground cable structure for the higher density zones, the following structure percentages for copper distribution cable were used in HM 5.3. HM 5.3 includes costs for intra building cable, as well as block cable attached to the rear of buildings in its input for Block/Building Percent of Total Distance.[11]

Distribution Cable Structure Type - Qwest					
Density	Aerial			Buried	Underground
(lines/sq. mi.)	Pole line	Block/Building	Subtotal		
0-5	27%		27%	73%	
5-100	27%		27%	73%	
100-200	27%		27%	73%	
200-650	27%		27%	73%	
650-850	27%		27%	73%	
850-2,550	27%		27%	73%	
2,550-5,000	27%		27%	68%	5%
5,000-10,000	40%	10%	50%	35%	15%
10,000+	20%	30%	50%	15%	35%

Distribution Cable Structure Type – Verizon					
Density	Aerial			Buried	Underground
(lines/sq. mi.)	Pole line	Block/Building	Subtotal		
0-5	43%		43%	57%	
5-100	43%		43%	57%	
100-200	43%		43%	57%	
200-650	43%		43%	57%	
650-850	43%		43%	57%	
850-2,550	43%		43%	57%	
2,550-5,000	43%		43%	52%	5%
5,000-10,000	40%	10%	50%	35%	15%
10,000+	20%	30%	50%	15%	35%

[11] The HAI 5.3 Model Block/Building Fraction of Total Distance category includes cable inside buildings plus block cable attached to the rear walls of buildings. The distinction is that these cables do not require pole structure.

Q. HOW ARE THE BURIED PLACEMENT FRACTIONS DEVELOPED?

A. Since drop wires connect to distribution cable at the Block Terminal, it makes sense generally to have the same structure type for drop wires as for distribution cable (with the exception that there are no underground block terminals or underground drop wires). Therefore, I recommended the following HM 5.3 inputs for drop wire structure fractions:

Drop Structure Fractions - Qwest		
Density (lines/sq. mi.)	Aerial	Buried
0-5	27%	73%
5-100	27%	73%
100-200	27%	73%
200-650	27%	73%
650-850	27%	73%
850-2,550	27%	73%
2,550-5,000	32%	68%
5,000-10,000	65%	35%
10,000+	85%	15%

Drop Structure Fractions – Verizon		
Density (lines/sq. mi.)	Aerial	Buried
0-5	43%	57%
5-100	43%	57%
100-200	43%	57%
200-650	43%	57%
650-850	43%	57%
850-2,550	43%	57%
2,550-5,000	48%	52%
5,000-10,000	65%	35%
10,000+	85%	15%

Q. HOW WERE THE STRUCTURE FRACTION INPUTS DEVELOPED FOR FEEDER CABLE IN THE HAI MODEL?

A. Based on my experience, it is reasonable to expect a small amount of underground feeder cable in lower density zones and a very high percentage of underground feeder cable, and associated high-cost structures, in higher density zones. For example, in downtown Seattle, underground feeder cable would be placed between central offices and basements of buildings (distribution cable would consist of building riser cables). I performed a structure percentage analysis similar to that performed for distribution cable, using the data supplied by Qwest and Verizon to the FCC, as reflected in the ARMIS report.

FCC ARMIS Data for Qwest – Washington (metallic sheath km)						
Year	Aerial		Buried		Underground	
1991	14,629	21.72%	43,919	65.22%	8,795	13.06%
1992	14,479	21.17%	44,936	65.70%	8,983	13.13%
1993	14,196	20.60%	45,482	66.01%	9,228	13.39%
1994	14,196	20.26%	46,356	66.17%	9,505	13.57%
1995	14,247	20.85%	44,248	64.76%	9,833	14.39%
1996	14,077	20.95%	42,944	63.91%	10,176	15.14%
1997	13,990	20.60%	43,440	63.95%	10,493	15.45%
1998	13,922	20.30%	43,929	64.07%	10,718	15.63%
1999	14,104	20.29%	44,330	63.77%	11,080	15.94%
2000	14,117	20.12%	44,650	63.64%	11,394	16.24%
2001	14,072	19.86%	45,046	63.57%	11,746	16.58%
2002	14,041	19.69%	45,300	63.53%	11,965	16.78%

FCC ARMIS Data for Verizon – Washington (metallic sheath km)						
Year	Aerial		Buried		Underground	
1991	10,453	39.14%	13,653	51.12%	2,603	9.75%
1992	10,118	38.16%	13,689	51.62%	2,711	10.22%
1993	14,274	41.19%	17,371	50.13%	3,006	8.68%
1994	14,050	40.22%	17,738	50.78%	3,142	9.00%
1995	14,055	40.11%	17,634	50.33%	3,348	9.56%
1996	14,207	39.37%	18,336	50.81%	3,543	9.82%
1997	14,267	39.53%	18,118	50.20%	3,708	10.27%
1998	14,946	39.11%	19,245	50.36%	4,022	10.53%
1999	15,011	38.82%	19,411	50.20%	4,249	10.99%
2000	15,097	38.54%	19,628	50.10%	4,451	11.36%
2001	15,233	38.04%	20,000	49.94%	4,816	12.03%
2002	15,147	37.63%	20,065	49.85%	5,036	12.51%

After reviewing the ARMIS data and applying my experience, I recommended the following values for copper feeder cable structure percentages by density zone for HM 5.3.

Copper Feeder Cable Structure Type - Qwest			
Density	Aerial	Buried	Underground
0-5	20%	75%	5%
5-100	20%	75%	5%
100-200	20%	75%	5%
200-650	20%	60%	20%
650-850	20%	50%	30%
850-2,550	15%	35%	50%
2,550-5,000	10%	10%	80%
5,000-10,000	5%	5%	90%
10,000+	-	-	100%

Copper Feeder Cable Structure Type - Verizon			
Density	Aerial	Buried	Underground
0-5	37%	58%	5%
5-100	37%	58%	5%
100-200	37%	58%	5%
200-650	37%	43%	20%
650-850	37%	33%	30%
850-2,550	20%	30%	50%
2,550-5,000	10%	10%	80%
5,000-10,000	5%	5%	90%
10,000+	-	-	100%

A similar analysis for fiber cable is as follows:

FCC ARMIS Data for Qwest – Washington (fiber sheath km)						
Year	Aerial		Buried		Underground	
1991	82	3.07%	645	24.18%	1,941	72.75%
1992	84	2.60%	761	23.57%	2,383	73.82%
1993	135	3.54%	1,014	26.57%	2,667	69.89%
1994	158	3.72%	1,146	26.97%	2,945	69.31%
1995	175	3.68%	1,334	28.04%	3,249	68.28%
1996	241	4.77%	1,356	26.81%	3,460	68.42%
1997	267	5.09%	1,341	25.54%	3,642	69.37%
1998	301	5.58%	1,358	25.19%	3,732	69.23%
1999	327	5.81%	1,410	25.03%	3,896	69.16%
2000	369	6.31%	1,421	24.30%	4,057	69.39%
2001	481	7.52%	1,442	22.53%	4,477	69.95%
2002	557	8.29%	1,503	22.37%	4,659	69.34%

Fiber Feeder Cable Structure Type – Qwest			
Density	Aerial	Buried	Underground
0-5	8%	22%	70%
5-100	8%	22%	70%
100-200	8%	22%	70%
200-650	8%	22%	70%
650-850	8%	22%	70%
850-2,550	8%	12%	80%
2,550-5,000	8%	8%	86%
5,000-10,000	5%	5%	90%
10,000+	-	-	100%

FCC ARMIS Data for Verizon – Washington (fiber sheath km)						
Year	Aerial		Buried		Underground	
1991	94	16.21%	74	12.76%	412	71.03%
1992	160	17.90%	143	16.00%	591	66.11%
1993	326	23.92%	402	29.49%	635	46.59%
1994	395	25.14%	425	27.05%	751	47.80%
1995	428	24.09%	532	29.94%	817	45.98%
1996	475	23.51%	611	30.25%	934	46.24%
1997	492	22.99%	604	28.22%	1,044	48.79%
1998	567	24.19%	675	28.80%	1,102	47.01%
1999	607	24.05%	726	28.76%	1,191	47.19%
2000	668	23.98%	841	30.19%	1,277	45.84%
2001	915	27.60%	934	28.17%	1,466	44.22%
2002	1,047	29.15%	955	26.59%	1,590	44.27%

Fiber Feeder Cable Structure Type – Verizon			
Density	Aerial	Buried	Underground
0-5	29%	27%	44%
5-100	29%	27%	44%
100-200	29%	27%	44%
200-650	29%	27%	44%
650-850	29%	27%	44%
850-2,550	20%	20%	60%
2,550-5,000	10%	10%	80%
5,000-10,000	5%	5%	90%
10,000+	-	-	100%

In addition I recommend the following structure fractions for interoffice plant.

Interoffice Structure Percentages - Qwest		
Aerial	Buried	Underground
8%	22%	70%

Interoffice Structure Percentages - Verizon		
Aerial	Buried	Underground
29%	27%	44%

V. STRUCTURE SHARING

Q. WHAT ARE THE STRUCTURE SHARING FRACTIONS USED IN THE HAI MODEL AND WHY ARE THEY APPROPRIATE?

A. HM 5.3 assigns 33% of the structure cost to telephone for buried distribution plant and 40% in feeder plant. With the strong messages by state public utility commissions and from the general public at large to utilities requesting placement of out-of-sight plant, the percentages of buried plant structure shared among utilities will only increase in the future. It is also important that utilities continue to cooperate on joint placement of facilities to reduce costs and to prevent frequent disruptions that will occur as more competitors enter the telecommunications facilities market. Outside plant engineers should work diligently to coordinate excavation activities with other utilities and service providers to reduce cost and prevent the disruption of facilities and thoroughfares; they should be, in large part, measured by their achievement of high levels of structure sharing.

The Nevada Commission made the following statement in its Modified Final Order in Docket 98-6005, Para. 20, issued July 1, 1999:

> With regard to plant mix and structure sharing, the Commission is persuaded by the arguments offered by the Intervenors [AT&T, NextLink, and MGC] that Sprint's position on structure sharing for feeder plant is inconsistent, given Clark County's desire to minimize street cuts and Sprint's obligation to provide nondiscriminatory access to poles, ducts, conduit and rights of way, as mandated under Section 251 of the Telecommunications Act. The Commission also agrees with the Intervenors that it is unreasonable to assume, given these two directives, that there will be no sharing of underground ducts and conduit on a forward-looking basis, which is a reasonable assumption of how a business would respond to such a local ordinance. The Commission therefore adopts Staff's inputs for structure sharing and plant mix.

HM 5.3 varies the percentage of underground structure sharing cost depending upon the density zone and whether the structure is for feeder facilities or for distribution facilities. In feeder routes the percentages assigned to telephone range from 50% in the lowest density zone to 33% in the highest density zones. In distribution plant the percentages assigned to telephone range from 100% in the lowest density zone to 33% in the highest density zones. In large cities, it is well known that there are many occupants with facilities located in ILEC-owned conduit networks. As more service providers continue to enter the marketplace, the sharing of underground structure facilities will grow in most metropolitan areas of the country.

The HM 5.3 input value for aerial structure sharing for feeder and distribution plant is 50% in density zone 0-5, 33% in density zone 5-100, and 25% in the remaining higher density zones. These input values are very reasonable since pole structure is normally divided equally between high voltage users (electric companies) and low voltage users such as telephone and other communications companies (50% Electric – 25% Telco – 25% Others). In the lower density zones, there is less possibility of cable TV ("CATV") being available, and therefore fewer sharing opportunities. However as population densities increase, so do the opportunities for increased sharing of pole space.

Q. YOU MENTIONED PREVIOUSLY THAT DISTRIBUTION CABLE CAN SOMETIMES SHARE STRUCTURE WITH FEEDER CABLE. DOES THE HAI MODEL CONTAIN AN INPUT TO REFLECT THIS TYPE OF SHARING?

A. Yes, a new input to HM 5.3 reflects the percentage of feeder cable that can ride on structure already built to carry distribution cable. The default value of 55 percent is well supported by information publicly available. BellSouth's loop model in Florida and again in Louisiana reveal that such structure sharing occurs 74% of the time. The FCC's Synthesis Model indicates that the vast majority of feeder cable can share distribution structure. In a recent Universal Service Fund case in Kansas, the Kansas Corporation Commission's consultant, Dr. Ben Johnson, "examined the placement of feeder and distribution cable for 14 selected wire centers. In every case, **at least** 40 percent of the feeder routes also included distribution cable. In some wire centers, the percentage was much higher."[12] The Kansas Commission has found that study to be persuasive, and has adopted a 40%

[12] Kansas State Corporation Commission, Docket No. 99-GIMT-326-GIT, Order 16, at 52. The Kansas Commission opted to reduce feeder structure inputs because the model used in that case did not offer the option now presented in the HAI 5.3 Model.

reduction in total feeder structure and cable placement costs to reflect such sharing.[13] Whereas the Kansas Commission chose to reduce total feeder structure and cable placement cost directly, because it could not adjust only structure in that time, the logic applies equally to the issue of structure sharing percentages as it can be more accurately presented in HM 5.3. In fact, the Florida Commission found,

> witness Donovan's arguments that the value should be set at 75 percent most persuasive in view of apparent support for his rationale by the Kansas Commission. As such we adopt this figure for this input.[14]

The Florida Commission concluded that 56.35 percent of the total feeder distance would use the same structure as distribution facilities. All of this information provides ample support to the conservative input value of 55 percent.

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[13] Ibid. at 54.

[14] Final Order on Rates for Unbundled Network Elements Provided by BellSouth Telecommunications, Inc. (120-Day Filing In re: Investigation into pricing of unbundled network elements. (BellSouth Track), Docket No. 990649A-TP, Order No. PSC-02-1311-FOF-TP, September 27, 2002, page 43.

VI. SOURCES AND VALIDATION OF OUTSIDE PLANT COST INPUTS

Q. THERE ARE HUNDREDS OF OUTSIDE PLANT INPUTS IN THE HAI MODEL. HOW WERE THESE VALIDATED?

A. The principal outside plant assumptions and inputs utilized in HM 5.3 reflect years of cost modeling efforts and the participation of multiple subject matter experts developing model inputs. The subject matter experts, including myself, have extensive outside plant engineering and construction experience in the design, construction and maintenance of local loop networks. The Model's principal outside plant inputs are based on expert opinion, which has been validated with third-party data obtained from contractors, vendors and suppliers. The validation information that follows includes data from outside suppliers as well as input values approved by the FCC.[15]

The FCC considers comparisons of input costs from a number of sources to be valuable. For example, in the *Separate Statement of Commissioner Susan Ness* (FCC Massachusetts 271 Order FCC 01-130), Commissioner Ness expresses the opinion that:

[15] See, Federal-State Joint Board on Universal Service, CC Docket No. 96-45 and Forward-Looking Mechanism for High Cost Support for Non-Rural LECs, CC Docket No. 97-160, Tenth Report and Order: Adopted: October 21, 1999 and Released: November 2, 1999. Also see, Federal-State Joint Board on Universal Service, Fifth Report and Order, CC Docket Nos. 96-45, 97-160, Adopted: October 22, 1998 and Released: October 28, 1998 ("FCC Inputs Order").

> [P]ricing decisions in other states can serve as a benchmark by which a state commission can evaluate the appropriateness of its rates.

In addition, in that same 271 Order, the FCC clearly used input values from its own Universal Service Fund Synthesis Model for comparisons.[16] I will indicate several comparisons in the following sections of my testimony.

A. Pole Costs

Q. HOW DID THE FCC DETERMINE POLE COSTS AND HOW DO THESE VALUES COMPARE TO THE INPUTS USED IN THE HAI MODEL?

A. There is significant information available in the public record regarding the cost of poles. In mid-1997, the FCC requested information from large companies regarding the installed costs of 40 foot Class 4 poles.[17] The responses included material costs that ranged from $134.00 per pole (GTE) to $402 per pole (US West). Labor costs ranged from $100.00 per pole (Sprint) to $902 (Bell Atlantic-Massachusetts). In addition, the FCC relied on a review of Rural Utility System ("RUS") contract costs for thousands of items to help determine its cost inputs for poles.

Pole material costs should not vary significantly from one company or part of the country to another. Although there can be slight differences in transportation

[16] For example, see FCC 01-130 271 Order §22, §23, §25, §26, §39, and §40.

[17] See data available at http://www.fcc.gov/Bureaus/Common_Carrier/Comments/da971433_data_request/datareq.html

costs, aggressive purchasing techniques in a competitive marketplace, for a commodity item such as telephone poles, should level the playing field on pole material costs. Since poles are normally purchased in bulk, shipped to telephone company construction garages or work sites, and then placed by contractors or employees, competitive bidding can lower the cost of poles.

HM 5.3's input for poles is slightly higher than the input used by the FCC in its Synthesis Model. The FCC averages an input value of $396 per installed 40 foot Class 4 pole, compared to the HM 5.3 input of $417 per pole.

Q. HOW DO THE POLE SPACING VALUES COMPARE?

A. There has been little meaningful disagreement within the telecommunications industry on pole spacing values. HM 5.3 uses distances ranging from 250 feet between poles in the two density zones of less than 100 lines per square mile, to 150 feet between poles for the three density zones of 2,550 lines per square mile and greater. Members of the engineering team have personally engineered thousands of miles of outside plant facilities in various density zones. The pole spacing (spans) used in HM 5.3 are fully consistent with the experience of members of our engineering team.

The FCC has adopted pole spacing parameters that are identical to those used in HM 5.3, as shown in the following table:

Pole Spacing (feet between poles)		
Density (lines/sq. mi.)	HM 5.3 inputs	FCC
0-5	250	250
5-100	250	250
100-200	200	200
200-650	200	200
650-850	175	175
850-2,550	175	175
2,550-5,000	150	150
5,000-10,000	150	150
10,000+	150	150

B. Manhole Costs

Q. WHAT INFORMATION EXISTS FOR THE VALUES USED IN HM 5.3 FOR MANHOLE SPACING AND MANHOLE COSTS?

A. As is consistent with current engineering practices, HM 5.3 relies upon manhole spacing distances ranging from 800 feet between manholes in the four density zones of less than 650 lines per square mile, to 400 feet between manholes for the 2 density zones of more than 5,000 lines per square mile.

The following table shows that the FCC's manhole spacing parameters differ only slightly from the HM 5.3 inputs.

Copper Manhole Spacing (feet between manholes)		
Density (lines/sq. mi.)	HM 5.3 inputs	FCC
0-5	800	725
5-100	800	725
100-200	800	725
200-650	800	725
650-850	600	575
850-2,550	600	575
2,550-5,000	600	575
5,000-10,000	400	400
10,000+	400	400

For the most part, manholes have been built in the past to accommodate underground copper feeder cable splices.[18] Underground structure, by its nature, was created primarily to allow the periodic placement of additional copper feeder cables to accommodate growth over time.

> Because of the high number of [feeder route] cables involved, and the need for periodic addition of cables, most below-ground feeder plants are in underground conduit structures for ease of placement and replacement.[19]
>
> The length of a conduit section [between manholes] is based on several factors, including the locations of intersecting conduits and manholes for ancillary equipment such as repeaters or loading coils, the lengths of cable reels,[20] acceptable pulling tension, and physical obstructions. Pulling tension is determined by the weight

[18] "In more congested areas, cables are placed in conduits. Manholes are used for splicing … [and] for ancillary equipment such as repeaters or loading coils." Telcordia Technologies, *Telecommunications Transmission Engineering*, 1990, p. 120.

[19] Telcordia Technologies, *Telcordia Notes on the Networks*, Issue 4, October 2000, page 12-2.

[20] Maximum reel length for the thickest (4200-pair) copper cable on a standard No. 420 Reel is 810 feet, and fiber cable reel lengths on a No. 420 Reel are approximately 38,211 feet (7.2 miles) for 96-fiber cables and smaller, or 26,356 feet (5.0 miles) for 216-fiber cables and smaller. See Lucent Technologies, *AT&T Outside Plant Engineering Handbook*, August 1994, pages 14-10, 14-70 and 14-87.

> of the cable, the coefficient of friction, and the geometry of the duct run. Plastic conduit has a lower coefficient of friction than concrete or fiberglass conduit, and thus allows longer cable pulls. The ability to make long pulls [between manholes] is an important consideration in placing fiber cables because it allows the avoidance of splices. Fiber pulls of several thousand feet are routine.[21]

When HM 5.3 is set to allow copper feeder cable placements, an appropriate number of copper manholes will be placed at intervals specified by the copper manhole spacing parameters. Any manholes required for fiber cables will first use any available copper feeder manholes placed by the model. If no copper manholes exist for a portion of the route, the model utilizes fiber pullboxes, at an installed cost of $500.00, with a distance of 2,000 feet assumed between adjacent pullboxes.

Fiber manholes and pullboxes are essentially only required for slack cable storage, assumed to be at 2,000 foot intervals to allow slack to be pulled in case of a future fiber cable dig-up that severs the fiber.[22] Although fiber cable pulling distances are long enough to have splicing take place in central offices and DLC Remote Terminal cabinets, rather than in manholes, HM 5.3 assumes fiber splices every 6,000 feet.

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[21] Telcordia Technologies, Telecommunications Transmission Engineering, 1990, p. 120.

[22] "The number of [future contingency] maintenance splices allocated is generally a local decision based on a history of maintenance problems. If no local policy exists, then one maintenance splice per kilometer [3,280 feet] can be used." Lucent Technologies, *AT&T Outside Plant Engineering Handbook*, August 1994, p. 5-19.

Considering the significant amount of fiber feeder cable in a forward-looking construct, it is not surprising that few manholes are being built these days in practice, especially considering that one of the main reasons for underground copper feeder was the ability to augment cable capacities over time. This growth in a fiber environment is handled by simply putting higher bandwidth cards in the DLC Remote Terminal, rather than by placing more cable.

As for the size of manholes, the widespread use of fiber optic cables for significant numbers of lines eliminates the need for extremely large copper cable manholes. Even the smallest standard manhole, a Class A manhole, is 7 feet deep by 12 feet long and 6 feet wide. These dimensions are designed to accommodate at least 20 copper cables.[23]

The following chart compares the costs by density zone between HM 5.3 inputs and the FCC's inputs. As shown, the HM 5.3 inputs are uniformly higher than the FCC's inputs.

[23] See, for example, Lucent Technologies, *AT&T Outside Plant Engineering Handbook*, August 1994, pg. 8-43.

Copper Manhole Costs (per Class A manhole)		
Density (lines/sq. mi.)	HM 5.3 inputs	FCC
0-5	$5,140.00	$4,472.47
5-100	$5,140.00	$4,472.47
100-200	$5,140.00	$4,472.47
200-650	$5,140.00	$4,472.47
650-850	$5,540.00	$4,472.47
850-2,550	$5,840.00	$4,472.47
2,550-5,000	$5,840.00	$4,472.47
5,000-10,000	$7,340.00	$4,472.47
10,000+	$7,340.00	$4,472.47

As with other items, the FCC relied heavily on the NRRI analysis of thousands of lines of RUS contract data. In addition, the following represents information obtained from several small contractors and suppliers on installed, prefabricated manholes.

Copper Manhole Material Cost Obtained From Suppliers	
$1,350	
$1,700	
$2,340	HM 5.3
$3,100	Input = $2,800
$3,389	
$3,500	
$4,720	

Copper Manhole Excavation & Backfill Costs Obtained From Contractors		
Rural	Suburban	Urban
$850	$1,250	$1,700
$1,500	$1,830	$2,650
$1,600	$2,050	$3,140
$1,600	$2,100	$3,200
$1,614	$2,400	$3,500
$1,750	$2,400	$4,000
$2,800 HM 5.3	$2,800 HM 5.3	$4,000
$3,500 Input = $2,800	$4,200 Input = $3,200	$5,000 HM 5.3
$4,000	$4,500	$8,500 Input = $5,000

c. <u>Underground Excavation & Restoral</u>

Q. HOW DO THE COSTS FOR UNDERGROUND EXCAVATION AND RESTORAL COMPARE BETWEEN HM 5.3 AND THE FCC SYNTHESIS MODEL?

A. The following chart compares the HM 5.3 and FCC Synthesis Model inputs for underground excavation and restoration by density zone. The HM 5.3 inputs are uniformly ***higher*** than the FCC's input values (the FCC inputs vary from 18% to 75% of the HAI input values).

Underground Excavation & Restoration Costs (per foot)		
Density (lines/sq. mi.)	HM 5.3 inputs	FCC
0-5	$10.29	$1.86
5-100	$10.29	$1.86
100-200	$10.29	$7.63
200-650	$11.35	$8.16
650-850	$11.88	$8.90
850-2,550	$16.40	$10.23
2,550-5,000	$21.60	$14.15
5,000-10,000	$50.10	$27.79
10,000+	$75.00	$42.59

The following represents information obtained from several small contractors and suppliers on performing excavation and restoration. Placement and stabilization of conduit pipes would be additional. Consequently, these data would apply to the excavation and restoration functions that would be common to both underground conduit placement and buried trenching operations.

Normal Trenching Costs Obtained From Contractors					
Rural		Suburban		Urban	
$1.50		$2.00		$7.40	
$1.87		$2.46		$8.50	
$2.10		$2.50		$8.60	
$2.50		$3.10	HM 5.3	$8.80	
$2.75		$3.50	Inputs = $2.81-$3.88	$8.80	
$2.75	HM 5.3	$3.60		$9.10	
$3.00	Inputs = $2.81-$3.08	$3.90		$9.80	
$3.00		$4.00		$9.87	
$3.15		$4.10		$10.00	
$3.20		$4.25		$10.50	
$3.25		$4.25		$14.00	
$3.30		$4.50		$14.25	
$3.30		$4.50		$15.00	
$3.40		$4.50		$16.00	
$3.50		$4.50		$17.00	
$3.50		$4.75		$17.00	
$3.75		$4.90		$17.50	HM 5.3
$4.00		$6.00		$22.00	Inputs = $13.58 -$47.93
$4.50		$11.00		$42.00	
$4.93		$15.00		$63.00	
$6.00					

D. Buried Excavation & Restoral

Q. HOW DO THE COSTS FOR BURIED EXCAVATION AND RESTORAL COMPARE BETWEEN HM 5.3 AND THE FCC SYNTHESIS MODEL?

A. The following chart compares the HM 5.3 and FCC Synthesis Model inputs for buried excavation and restoration by density zone.

Buried Excavation & Restoration Costs (per foot)		
Density (lines/sq. mi.)	HM 5.3 inputs	FCC
0-5	$1.77	$0.77
5-100	$1.77	$1.54
100-200	$1.77	$3.24
200-650	$1.93	$4.26
650-850	$2.17	$5.20
850-2,550	$3.54	$5.51
2,550-5,000	$4.27	$7.34
5,000-10,000	$13.00	$9.02
10,000+	$45.00	$11.93

In my opinion, the FCC failed to give adequate weighting to the opportunity for plowing cables. This is a very cost-effective way to place multiple cables, with the least amount of disruption to the ground surface. Although this is impractical in higher density zones, it is the most often used method in rural and rural-suburban areas. The following represents information obtained from several small contractors and suppliers on performing plowing operations. Higher percentages of plowing lower average excavation and restoration costs.

Cable Plowing Costs Obtained From Contractors			
Rural		Suburban	
$0.50		$0.90	
$0.60	HM 5.3	$0.95	
$0.80	Input = $0.80	$1.05	HAI 5.3
$0.90		$1.20	Input = $1.20
$0.90		$1.25	
$0.90		$1.30	
$0.92		$1.30	
$0.95		$1.35	
$0.95		$1.35	
$1.15		$1.57	
$1.25		$1.65	
$1.35		$1.90	
$1.35		$2.00	
$1.75		$2.95	
$2.00		$4.00	

E. <u>Network Interface Device</u>

Q. WHAT IS A NID AND HOW DO THE INPUT VALUES COMPARE BETWEEN THE FCC SYNTHESIS MODEL AND HM 5.3?

A. The term NID refers to a Network Interface Device. It is the unit that marks the demarcation between the ILEC's network and the customer's own wiring. For example, a single family home will typically have a NID mounted on it. The ILEC's drop-wire (at the end of the distribution cabling) will lead to the NID from the outside; at the NID it will be connected to the customer's inside wiring.

By way of background, the FCC examined information and data submitted by large telephone companies and examined RUS contract data in determining inputs for its Synthesis Model. The FCC chose a single input for the NID. HM 5.3, in contrast, uses a more granular (and accurate) approach. Separate costs are input for the Residence 2-line NID housing, the Business 6-line NID housing, Installation Labor to install the NID, and a cost for each protector module inserted into either of the NID housings.

Our approach does not differ substantially from the FCC approach, but the HM 5.3 inputs are more accurate because they provide costs that vary with the number of lines terminated. The following table shows a comparison between the HM 5.3 inputs and the FCC's inputs. HM 5.3 uses reasonable values that appropriately vary by the number of lines installed.

NID Configuration	HM 5.3 Inputs	FCC
Residence w/ 1 line terminated	$29.00	$39.50
Residence w/ 2 lines terminated	$33.00	$39.50
Business w/1 line terminated	$44.00	$39.50
Business w/ 2 lines terminated	$48.00	$39.50
Business w/ 3 lines terminated	$52.00	$39.50
Business w/ 4 lines terminated	$56.00	$39.50

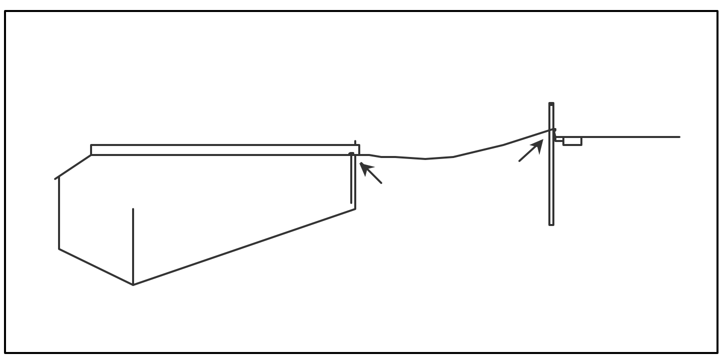
To validate HM 5.3's material cost inputs for NIDs and Protectors, we contacted several small suppliers and obtained the following costs:

NID and Protector Block Material Costs Obtained From Suppliers					
Residential 2-line NID w/o Protector		Business 6-line w/o Protector		NID Protector Block per Line	
$6.85	HM 5.3	$23.44	HM 5.3	$3.05	
$9.38	Input = $10.00	$28.65	Input = $25.00	$3.06	
$11.90				$3.07	HM 5.3
				$4.80	Input = $4.00

F. <u>Drop Wire</u>

Q. HOW DID THE FCC DEVELOP DROP WIRE COSTS AND HOW DO THESE COSTS COMPARE WITH THE INPUTS IN THE HAI MODEL?

A. For Drop Wire, the FCC examined information in the same manner as it did for NID inputs, and developed a flat rate drop cost of $0.56 per foot regardless of structure type. Once again, HM 5.3 provides better granularity. The HM 5.3 inputs are higher than the FCC's inputs for buried drops, and are lower for aerial drops. We believe that this is appropriate because, although the FCC's approach uses a uniform cost per foot, which would be appropriate in a buried environment, aerial drop placement does not require a labor cost per foot. Aerial drops are laid out along the ground and then simply pulled tight at the connection points (one at the pole, and one at the house) – *i.e.*, labor cost is not linear.



A comparison that eliminates the differences in approach is set forth in the chart below. As shown, in all but the very lowest Density Zone, the installed costs of drops assumed in HM 5.3 are conservatively equal to or higher than the FCC's inputs.

Equivalent Cost Comparison of Drop Wire Investment per foot						
Density Lines/sq. mi.	Equivalent HM 5.3 Aerial$ / ft	FCC % Aerial	HM 5.3 Buried $ / ft.	FCC % Buried and UG	HM 5.3 weighted average	FCC Input
0-5	$0.25	40%	$0.74	60%	$0.54	$0.56
5-100	$0.25	37%	$0.74	63%	$0.56	$0.56
100-200	$0.27	30%	$0.74	70%	$0.60	$0.56
200-650	$0.27	30%	$0.74	70%	$0.60	$0.56
650-850	$0.33	30%	$0.74	70%	$0.62	$0.56
850-2,550	$0.33	30%	$0.74	70%	$0.62	$0.56
2,550-5,000	$0.33	30%	$0.89	70%	$0.72	$0.56
5,000-10,000	$0.33	30%	$1.64	70%	$1.25	$0.56
10,000+	$0.33	10%	$5.14	90%	$4.66	$0.56

To validate HM 5.3's cost inputs for burying drop wires, we contacted several contractors and obtained the following costs for burying of drop wires:

Bury Drop Wire Costs Obtained From Contractors			
Rural		Suburban	
$0.55		$0.63	
$0.60		$0.70	
$0.60		$0.72	
$0.60	HM 5.3	$0.75	
$0.60	Input = $0.60	$0.75	
$0.70		$0.75	HAI 5.3
$0.74		$0.75	Input = $1.20
$0.75		$0.90	
$0.75		$1.00	
$0.75		$1.15	
$0.90		$1.15	
$0.90		$1.25	
$0.95		$1.50	
$1.00		$1.50	
$1.30		$1.90	
$1.75		$2.10	

In summary, the HM 5.3 inputs for aerial drops and buried drops provide a more realistic forward-looking economic cost investment than the FCC's single combined aerial-buried drop cost, and a combined weighting shows that for virtually all situations, the HM 5.3 input values are conservatively high.

G. Block Terminals

Q. HOW DID THE FCC DEVELOP INVESTMENTS FOR BLOCK TERMINALS AND HOW DO THESE VALUES COMPARE TO THOSE USED IN HM 5.3?

A. The FCC examined block terminal cost information in the same manner as it did for NID inputs. The FCC uses ***lower*** cost inputs than HM 5.3, reflecting the FCC's use of a smaller terminal than that used in HM 5.3. In addition, on May 8, 2001, Verizon filed public block terminal costs in Massachusetts Docket D.T.E. 01-20 that provide additional validation of the default inputs used in HM 5.3.

Block Terminal Installed Costs			
	HM 5.3 inputs	FCC*	Verizon Massachusetts
Buried	$170.00	$157.06	$112.22 - $145.82
Aerial	$128.00	$96.00	$118.00 - $140.00

*FCC value based on 6-pair terminal

To validate HM 5.3's material cost inputs for block terminals, we contacted several small suppliers and obtained the following costs for a large 25-pair terminal:

Block Terminal Material Costs Obtained From Suppliers			
Rural		Suburban	
$58.55	HM 5.3	$39.61	
$72.15	Input = $0.60	$54.20	
		$87.00	HAI 5.3
		$90.00	Input = $1.20
		$93.00	

H. **Copper Cable Costs**

Q. WHAT IS THE STRUCTURE OF THE COPPER CABLE COST INPUTS IN THE HAI MODEL?

A. Copper cable costs are a significant cost component within any appropriate cost model. Whereas previous versions of the HAI Model utilized a total installed cost per foot of copper cable, by size, HM 5.3 allows a much more granular approach.

This approach uses different material costs for each structure type (aerial, buried, and underground), and uses reasonable productivity inputs for engineering cable, placing cable, and splicing cable. Each of these components and my recommended input values are discussed in the following paragraphs.

HM 5.3 uses the same copper cable costs for feeder and distribution cable. The FCC agrees that it is reasonable to expect copper feeder cable and copper distribution cable costs to be the same.[24]

1. Copper Cable Material

Q. WHAT IS THE SOURCE OF THE COPPER CABLE MATERIAL COST USED IN HM 5.3?

A. The most significant component of copper cable costs is the cost of material. The copper cable material cost per foot is typically obtainable from ILEC cost accounting systems, where purchasing and logistics on a corporate basis achieve the benefits of bulk purchase discounts.

HM 5.3 utilizes BellSouth copper cable material costs that were placed in the public domain, as follows:

[24] FCC 99-304 §86.

Copper Cable, Material $/foot				
Cable		Material Cost/foot		
Size	Gauge	Aerial	Buried	Underground
4200	26	$15.14	$16.08	$14.05
3600	26	$12.97	$13.79	$12.13
3000	26	$10.81	$11.49	$10.23
2400	26	$8.23	$9.19	$8.28
1800	26	$6.63	$7.16	$6.33
1200	26	$4.48	$5.32	$4.41
900	26	$3.45	$3.56	$3.39
600	26	$2.47	$2.76	$2.27
400	26	$1.69	$1.75	$1.51
200	26	$1.31	$1.17	$1.05
100	24	$0.72	$0.62	$0.52
50	24	$0.45	$0.35	$0.26
25	24	$0.29	$0.21	$0.13
12	24	$0.29	$0.21	$0.13
6	24	$0.29	$0.21	$0.13

Source: Florida PSC Order No. PSC-99-0068-FOF, pages 149-155.

Although thicker 24-gauge wire is not required for transmission reasons, I recommend use of this more expensive cable for cable sizes of 200 pairs and smaller to prevent damage from craft handling wires in distribution terminals and pedestals. For cables of 400 pairs and larger, splices are normally enclosed in splice cases, and are not subject to wire handling problems.

2. Copper Cable Engineering Productivity

Q. WHAT INPUTS DOES THE HAI MODEL USE FOR ENGINEERING COPPER CABLE?

A. The engineering productivity inputs to HM 5.3 are as follows.

OSP Engineering Labor Rate & Productivity for Copper Cable		
Function	Parameter	
Length of OSP engineer's work day	8.0	hours per day
OSP engineering labor rate per hour	$60.00	per hour
OSP engineering cable layout productivity	10,000	feet per day
Minutes per splice engineered	30.0	minutes per splice
Minutes per 300 copper pairs engineered	15.0	minutes per 300 pairs

I have personally engineered hundreds of outside plant jobs, written methods and procedures for engineers to do so, have taught engineers to design such jobs, and have supervised hundreds of outside plant engineers in performing the required functions. The two key components of engineering productivity are the number of feet of cable engineered per day, and the costs to engineer copper cable splice points.

In my experience, it is not unreasonable to demand that engineers produce work prints that average approximately two miles of cable placed per day. For the HM 5.3 input, I conservatively recommend an input of 10,000 feet per 8 hour day.

Design of a splice consists of engineering the splice site location, and designating which wires should be joined. I recommend an input value of 30 minutes per splice. This is a conservative value for determining a splice location, and noting that information on a work print. Since wires joined in a splice are normally planned in groups of wire pairs, I recommend using a value of 15 minutes per 300 pairs. Both of these input values are based on my extensive hands-on experience in performing and teaching the outside plant engineering function.

3. Copper Cable Placing and Splicing Productivity

Q. WHAT IS THE BASIS FOR THE INPUTS RELATED TO PLACING AND SPLICING COPPER CABLE?

A. The engineering of copper cable provides instructions to technicians for placing the copper cable and for splicing that copper cable.

Although a single technician can place smaller cables, cable placing crews are generally made up of two technicians. That is the reasonable estimate incorporated into HM 5.3.

I have estimated, on a forward-looking basis, production placing techniques using state of the art placing machines and appropriate vehicles. The aerial placing rate of 5,000 feet per day represents average placement of 20 to 33 aerial sections per day per crew, depending on pole spacing intervals.

Although my experience has been that underground placing crews should average a minimum of one mile per day, we are recommending a conservative input of 3,600 feet per day, or a total of only 6 manhole-to-manhole sections per 8 hour day per crew.

My recommended buried placing rate of 8,000 feet per crew per day is very conservative. Frequently contract excavators include the cost of kicking the cable into the trench as part of the excavation and restoration cost. A plowing rate of 8,000 feet per day is very reasonable, based on my experience. Therefore, I believe this input is readily achieved by an efficient company.

Cable splicing crews normally consist of one technician for splicing cable in aerial and buried environments, and two technicians for splicing in an underground manhole environment.

Part of performing a copper cable splice consists of a fixed amount of time for setting up the splice and for closing the splice within a cable splice closure. Two hours for those operations is reasonable based on my experience, and is supported by the FCC as indicated in Appendix D2 to the FCC's *Inputs Order*[25] as shown in Attachment JCD-3.

The remaining work involved in a copper cable splice is the joining of wires. That activity involves taking a 25-pair binder group that is readily identified by a unique color-coded ribbon wrapped around each individual binder group at the factory, and placing each wire into a sorting comb. After all 25 pairs are sorted, a mechanical press seals the wires into a 25-pair module, and two modules are

[25] In the Matter of Federal-State Joint Board on Universal Service, CC Docket 96-45, and Forward Looking Mechanism for High Cost Support for Non-rural LECs, CC Docket 97-160, Tenth Report and Order, Released November 2, 1999.

quickly snapped together to create the splice. I can personally splice in excess of 500 pairs per hour, but recommend a conservative value of 300 pairs per hour. Additional support for this splicing rate is found in a letter advocating a rate of 300 pairs per hour from Amp Corporation, a manufacturer of such splicing devices, a Data Request response from BellSouth in which they indicated an expected splicing rate of 300 pairs per hour, and in the FCC *Inputs Order* which recognized the 300 pairs per hour rate as being feasible, although it selected a slightly lower input value of 250 pairs per hour. Copies of those documents are included as Attachment JCD-3.

An additional parameter needed to determine cost of splicing is the average distance between splices. I recommend a conservative value of 600 feet for underground cable, which would be a splice in every manhole (sometimes cables are pulled straight through a manhole without a splice), 2,000 feet between buried splices, and 1,000 feet between aerial splices. It should be noted that block terminals are spliced into distribution cables. The cost for those splices is included in the installed cost of the block terminals; therefore the distance between splices reflected in the copper distribution cable cost portion of HM 5.3 is only for straight splices and branch splices, not for terminal splices.

A summary of the copper cable placing and splicing parameters is contained in the table below.

OSP Technician Labor Rate & Productivity for Copper Cable		
Function	Parameter	
Length of OSP technician's work day	8.0	hours per day
OSP technician labor rate per hour	$60.00	per hour
Cable placing crew size	2.0	technicians per crew
Cable splicing crew size – aerial & buried	1.0	Technicians per splicing crew
Cable splicing crew size – underground	2.0	Technicians per splicing crew
Splicing set up and closure time (hours)	2.0	Hours
Splicing rate (pairs joined per hour)	300	pairs joined per hour

Function	Aerial	Buried	Underground
Copper Cable Placing Rates (ft. per day)	5,000	8,000	3,600
Average Distance between copper splices (ft.)	1,000	2,000	600

I. Fiber Cable Costs

1. Fiber Cable Material

Q. WHAT IS THE MOST SIGNIFICANT COMPONENT OF FIBER CABLE COSTS AND WHAT IS THE SOURCE OF THIS DATA FOR HM 5.3?

A. The most significant component of fiber cable costs is the cost of material. Fiber cable material cost per foot can usually be obtained from ILEC cost accounting systems. Just as with copper cable material purchases, ILECs perform their purchasing and logistics on a corporate basis to achieve the benefits of bulk purchase discounts.

HM 5.3 utilizes BellSouth fiber cable material costs that were placed in the public domain, as follows.

Fiber Feeder Cable, Material $/foot	
Cable Size	Material Cost/foot
288	$8.51
216	$6.42
144	$4.30
96	$2.97
72	$2.30
48	$1.60
36	$1.12
24	$0.89
12	$0.59
6	$0.36

Source: Florida PSC Order No. PSC-99-0068-FOF, pages 147-149.

2. <u>Fiber Cable Engineering Productivity</u>

Q. ARE THE FIBER CABLE ENGINEERING ACTIVITIES SIMILAR TO THOSE FOR COPPER CABLE?

A. Fiber cable is actually much easier to engineer, however we conservatively estimate the same engineering productivity per sheath foot as for copper cable in HM 5.3.

Designing splices consists of engineering the splice site location, and designating which fiber should be joined. I recommend an input value of 10 minutes per splice because fiber splices are much smaller, and there is considerably more leeway in where they are placed. Since fibers joined in a splice are frequently planned in groups of 12 fibers, I recommend using a value of three minutes per 12 fibers. Both of these input values are based on my extensive hands-on experience in performing and teaching this outside plant engineering function. The engineering productivity inputs to the HM 5.3 should be as follows.

OSP Engineering Labor Rate & Productivity for Fiber Cable		
Function	Parameter	
Length of OSP engineer's work day	8.0	hours per day
OSP engineering labor rate per hour	$60.00	per hour
OSP engineering cable layout productivity	10,000	feet per day
Minutes per splice engineered	10.0	Minutes per splice
Minutes per 12 fiber strands engineered	3.0	Minutes per 12 strands

3. Fiber Cable Placing and Splicing Productivity

Q. WHAT INPUTS DO YOU RECOMMEND FOR FIBER CABLE PLACING AND SPLICING PRODUCTIVITY?

A. Placing fiber cable is much more rapid than placing copper cable for two reasons. First, the cable reel lengths are extremely long – up to 38,211 feet on one reel, compared to, for example the maximum copper cable reel length for a 4200-pair copper cable of 810 feet.[26] Second, fiber cable is extremely lightweight, at approximately 100 pounds per 1,000 feet. I recommend a typical placing rate of 8,000 feet per day. I personally interviewed two contract fiber placing technicians

[26] See, for example Lucent, *AT&T Outside Plant Engineering Handbook*, August 1994, pp. 14-10, 14-70 and 14-87.

on June 27, 2002, who informed me that their crews typically place 8,000 to 10,000 feet of fiber cable per day.[27]

We conservatively assume the same technician productivity for splice setup and closure as we do for copper. The splicing rate in minutes per fiber joined should be 5.0 minutes per fiber, based on my personal experience and interviews with contract fiber splicing firms.

Average distance between splices is much greater for fiber cable than copper cable, because short reel lengths are never an issue. A fiber splice every 6,000 feet is typical.

A summary of the fiber cable placing and splicing parameters in HM 5.3 is contained in the table below.

OSP Technician Labor Rate & Productivity for Fiber Cable		
Function	Parameter	
Length of OSP technician's work day	8.0	hours per day
OSP technician labor rate per hour	$60.00	per hour
Cable placing crew size	2.0	technicians per crew
Cable splicing crew size – aerial & buried	1.0	technicians per splicing crew
Cable splicing crew size – underground	2.0	technicians per splicing crew
Splicing set up and closure time (hours)	2.0	hours
Splicing rate minutes per fiber strand joined	5.0	minutes per fiber strand joined

[27] Per Cablevision of Long Island cable placing contractor Rich Goss.

Function	Aerial	Buried	Underground
Fiber Cable Placing Rates (ft. per day)	8,000	8,000	8,000
Average Distance between fiber splices (ft.)	6,000	6,000	6,000

VII. CABLE SIZING AND "FILL" FACTORS

Q. WHAT ARE CABLE SIZING FACTORS AND HOW ARE THESE USED BY THE HAI MODEL?

A. HM 5.3 determines the efficient copper or fiber cable size to serve a particular distribution or feeder route. Cable sizing is closely related to the fill, or utilization, of the cables. The modeling algorithms in the HM 5.3 are designed to replicate efficient engineering of outside plant to meet all current and reasonably foreseeable demand. This is the amount of outside plant that an efficient firm would build if it started anew today, with no plant already in the ground, but with wire center locations and current customer locations already fixed and known.

Copper Cable Sizing. For copper distribution and feeder plant, HM 5.3 determines the minimum number of cable pairs necessary to meet current demand plus a "cushion" to satisfy the need for spare capacity. The size of this "cushion" is determined by dividing the pair requirement needed to meet current demand by the relevant Cable Sizing Factor (distribution or feeder). The Distribution Cable

Sizing Factor and the Feeder Cable Sizing Factor are user-adjustable inputs.[28] The default values for these factors are shown in the HM 5.3 Inputs Portfolio.

Copper cables only come in certain discrete sizes, such as the 25-pair or 100-pair cables often found in the distribution portion of the network and the much larger 1,200-pair or 2,400-pair cables that can be found in the feeder portion of the network. HM 5.3 chooses the smallest commercially available cable (from a list of cable sizes built into the model) that equals or exceeds the minimum required copper cable size for each area. Because of cable size modularity, which typically requires use of the next larger copper cable size, the achieved utilization of the cable (that is, the percentage of the cable pairs actually in use to provide revenue-generating services) is virtually always less than the cable sizing factor.

Fiber Cable Sizing. HM 5.3 assures that a full complement of four fibers is allocated to each fiber-fed remote DLC site (one fiber each for transmit, receive, redundant transmit, and redundant receive).[29] This redundancy is in addition to the Model's method of then choosing the next larger fiber cable size, starting with

[28] In prior releases of the HAI Model, these cable sizing factors were described as "fill factor" inputs. This created some confusion about their function in the model because the factors do *not* describe the "achieved" fill or utilization of the cables modeled. The current terminology more accurately reflects the function of these model inputs.

[29] HM 5.3 has inputs of 4 fibers per site, and then uses a 100% fiber cable sizing factor to ensure that every fiber pair has a fully redundant spare. Only 2 fibers are required for a 24-line DLC because, per vendor documentation, Wave Division Multiplexing can be used to derive the redundancy normally provided, if desired for such a small scale installation.

a minimum 6-fiber cable.[30] As a result, the effective utilization of the fiber strands is at or well below 50 percent, since redundant fibers are essentially spare and available for system rollovers to higher capacity fiber optic multiplexers.

In its *Inputs Order* in the federal universal service proceeding, the FCC agreed with this approach, determining that a forward-looking network should be modeled based on the same assumption of four fibers per DLC at our "100 percent" fill, producing an effective fill of no more than 50 percent.

> Fiber Fill Factors. Finally, we affirm our tentative conclusion that the input value for fiber fill in the federal mechanism should be 100 percent. The majority of commenters addressing this specific issue agree with our tentative conclusion. AT&T and MCI contend that fiber feeder fill factors of 100 percent are appropriate because the allocation of four fibers per integrated DLC site equates to an actual fill of 50 percent, since a redundant transmit and a redundant receive fiber are included in the four fibers per site. AT&T and MCI explain that, because fiber capacity can easily be upgraded, 100 percent fill factors applied to four fibers per site are sufficient to meet unexpected increases in demand, to accommodate customer churn, and, to handle maintenance issues. Similarly, SBC asserts that fiber fill factors of 100 percent can be obtained because they are not currently subject to daily service order volatility and are more easily administered. In contrast, BellSouth advocates that we employ projected fills estimated by BellSouth engineers. As noted above, these estimates are unsupported and we reject them accordingly. In sum, we find that the record demonstrates that it is appropriate to use 100 percent as the input value for fiber fill in the federal mechanism.

[30] A 6-fiber cable is synonymous with a 6-strand cable.

Q. CAN A USER OF THE HAI MODEL TARGET A LEVEL OF ACHIEVED FILL?

A. If one wishes to determine the forward-looking cost of loops given a particular level of achieved fill, this can be accomplished in HM 5.3 through a two-step iterative process.[31] First, from an engineering perspective, it is reasonable to use the same copper cable sizing factor for all density zones. Second, a default copper cable sizing factor is used that allows HM 5.3 to build a well-engineered outside plant network. As necessary, this factor can be adjusted so that the Model achieves an appropriate copper distribution cable utilization result and an appropriate copper feeder cable utilization result. HM 5.3 reports this achieved utilization.

Fill factors, especially as they relate to distribution cable, are a major concern in modeling forward-looking costs. Distribution cable is the portion of the loop that goes from the SAI to the NID. The lower the fill factor (or achieved utilization), the more excess capacity will be included in the cost study, and therefore distribution plant cost will be inflated.

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[31] It is not possible to directly input a desired fill factor into a bottom-up model such as HM 5.3 because models size outside plant using methods that relate to the engineering process, such as the HM 5.3 algorithms that I have just described. In other words, bottom-up models are not designed so that one can enter a desired copper feeder utilization, such as 70%, and have the model perform its calculations accordingly. Such a modeling function would require a reverse calculation starting at, for example, a desired 70% result, and then attempting through reiterative calculations to have the model fine-tune cable sizing factors until the desired result was nested into conformance. It is much simpler to run a bottom-up model such as HM 5.3 two or three times until the output of the model produces the desired achieved fill, and then lock in the engineering inputs that produce this result.

The generally accepted engineering practice is to design and build distribution plant so that it will have sufficient capacity to serve so-called "ultimate demand" at the end of its useful life. Generally, this translates into building approximately 1.5 to two lines per living unit when the plant is initially placed. This guideline implies cable utilization percentages in the range of 50-75 percent when the distribution plant is new, and approaching something closer to, but less than, 100 percent as the plant nears the end of its economic life. Also, because the outside plant network may migrate toward fiber and wireless solutions, it is important to avoid overbuilding copper distribution and run the long-term risk of stranded investment.

The following calculations illustrate that, based on an assumed 22 year economic life of distribution cable, even at a high level of initial utilization there will be sufficient cable pairs to serve initial demand plus the stated amount of annual demand growth without ever running out of spares for the duration of the economic plant life in the first example, or until the mid-point of the plant life in the second example.

INITIAL UTILIZATION SUFFICENT TO SERVE ALL DEMAND FOR ECONOMIC LIFE OF CABLE

Facilities Required	=	(1 + Additional Line Demand) $^{\text{(PLANT LIFE)}}$
Initial Fill Factor ("IFF")	=	1 ÷ Facilities Required
At 1% Growth: IFF	=	$1 \div (1.01)^{22}$ = **80.3%** Initial Utilization
At 2% Growth: IFF	=	$1 \div (1.02)^{22}$ = **64.7%** Initial Utilization
At 3% Growth: IFF	=	$1 \div (1.03)^{22}$ = **52.2%** Initial Utilization

INITIAL UTILIZATION SUFFICENT TO SERVE ALL DEMAND UNTIL MID-POINT OF ECONOMIC LIFE

At 1% Growth	=	**89.6%** Initial Utilization
At 2% Growth	=	**80.4%** Initial Utilization
At 3% Growth	=	**72.2%** Initial Utilization

To be conservative, AT&T and WorldCom have used cable sizing factors that **achieve** initial distribution cable utilization percentages of approximately 50%,[32] which provides ***more*** than enough spare facilities to last for the ***entire*** economic life of the plant.

The achieved utilization, or fill, levels in AT&T's HM 5.3 runs are highly conservative. Thus, the Commission should adopt cable sizing factors that produce at least a 50% initial achieved distribution fill and a 75% initial achieved feeder fill for copper cables.

[32] Achieved Fill may be observed in Columns AE and AF in the '*Investment Input*' Tab of the *Expense Module* output from the HAI 5.3 Model.

VIII. DIGITAL LOOP CARRIER ABOVE GROUND REMOTE TERMINALS

Q. ARE THE COSTS OF DIGITAL LOOP CARRIERS AN IMPORTANT INPUT IN THE HAI MODEL?

A. Yes, costs of Digital Loop Carrier ("DLC") are extremely important. They account for a significant percentage of UNE loop costs. In addition, costs for DLC equipment have been dropping significantly over the past several years for three reasons. First, the current and forward looking technology is called Next Generation Digital Loop Carrier ("NGDLC") – a phrase coined by manufacturers' marketing departments in 1991 as companies began to produce DLC systems that conform to technical specification GR-303. GR-303 was promulgated by the telecommunications industry to allow competition across a standard set of requirements. Second, as with electronic equipment generally, the prices for GR-303 have decreased steadily. Third, ILECs have recently begun rapid rollout of NGDLC systems in conjunction with xDSL systems for high-speed Internet access, such as SBC's Project Pronto – a $6 billion infrastructure improvement project that has allowed high-volume purchasing leverage of equipment costs. Other ILECs have similar projects underway.

Q. HOW ARE DLC COSTS USED IN THE HAI MODEL?

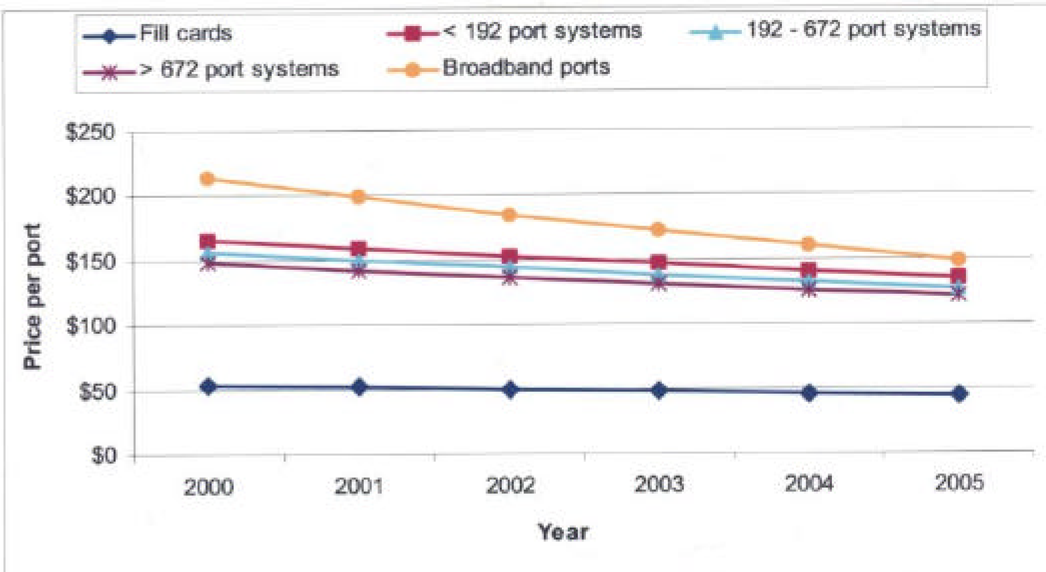
A. First it should be noted that my experience in product evaluation and purchasing has revealed to me that per line prices of telecommunications equipment continue to go down. I will discuss evidence that proves this to be true toward the end of this section on Digital Loop Carrier equipment costs. Industry analysts agree that year-over-year cost reductions of at least 4% per year are reasonable. Hence, it is likely that today's price will significantly overstate forward-looking costs, not the reverse. It is first important to note how HM 5.3 determines appropriate DLC investments.

HM 5.3 determines the investments required for DLC equipment in the following manner. Once demand at the SAI has been determined and the decision has been calculated between copper feeder and fiber-fed DLC in favor of DLC, HM 5.3 determines the investments required for DLC equipment in several steps. First, the number of lines, inflated by the *Channel Unit Sizing* [Fill] *Factor*, leads to choosing the next larger DLC Remote Terminal required. HM 5.3 offers a choice of 24-line, 120-line, 240-line, 672-line, 1,344-line, and 2,016-line DLC equipment housed in above-ground Remote Terminals ("RTs"). In the next section I describe DLC installations for more than 2,016 lines up to a maximum of 8,064 via the use of below-ground Controlled Environmental Vaults ("CEVs"). The investment required consists of *Common Equipment* in the central office, *Common Equipment* in the Remote Terminal (including the *Remote Terminal*

Cabinet, *Fiber Patch Panel* at the central office and RT, and the *Site Preparation* and *Mounting Pad*). To that investment in *Common Equipment* is added the appropriate number of *Line Cards* depending on the number of lines required as has been inflated by the *Channel Unit Sizing Factor*.

There is a separate model input for line cards, so that an appropriate cost can be considered depending on the number of feeder lines served by that remote terminal. HM 5.3 reflects line card cost inputs as reflected in the latest RHK market research study of December 2001 at $48 per line for year 2003 as indicated in the chart below that demonstrates the consistent downward trends in telecommunications electronics costs.

Figure 11: DLC per-port pricing (most likely)



	2000	2001	2002	2003	2004	2005
Fill cards	$54	$52	$50	$48	$46	$44
< 192 port systems	$166	$159	$153	$147	$141	$135
192 - 672 port systems	$156	$150	$144	$138	$132	$127
> 672 port systems	$148	$142	$136	$131	$126	$121
Broadband ports	$214	$199	$185	$172	$160	$149

Source: RHK

DLC Line Card Costs		
	Lines/Card	HM 5.3 inputs
24, 120, & 240 Line DLC Systems	6	$288.00
672-Line & larger DLC Systems	4	$192.00

Q. WHAT SUPPORT EXISTS FOR THE DLC INPUTS USED IN THE HAI MODEL?

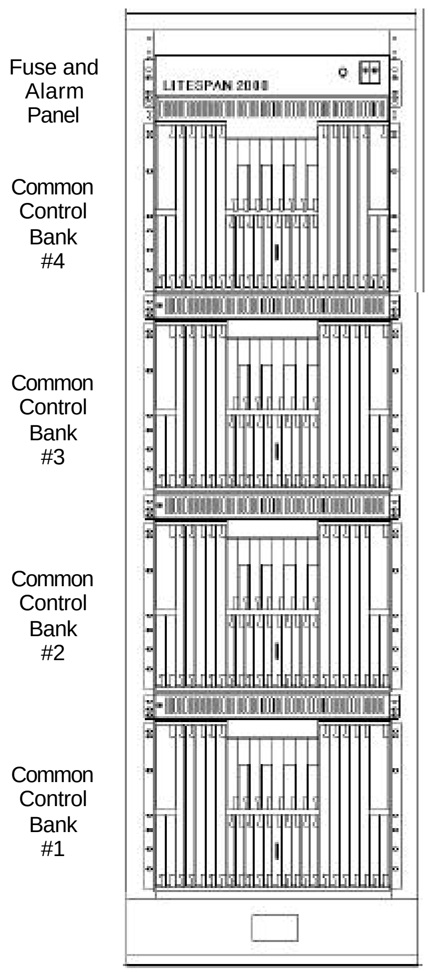
A. There is a tremendous amount of detail supporting the recommended input values for NGDLC Common Equipment costs. The $66,290 investment input for a 672-Line High Density GR-303 DLC Common Equipment (COT plus RT) system presumes that DLC equipment should be operated under GR-303 standards for integrated DLC systems. A detailed breakdown of costs follows. It is very important, when evaluating any proposed costs for DLC equipment, to review the labor costs involved. Many large telephone companies have relied in the past on simplistic Engineering, Furnish, and Install ("EF&I") percentage factors that are applied to equipment investment. Use of such factors can be very misleading. For example, good competitive procurement policies may determine that it is much more efficient to pay a bit more to have equipment pre-assembled in the factory by a manufacturer, rather than having that equipment installed piece by piece in the field. In such a case, use of an EF&I factor as a percent of equipment costs will double-count appropriate investments. Pre-assembled equipment is engineered up front, and installation labor in the field is significantly reduced. The installation factor method would make pre-assembled equipment more expensive to engineer and install under such a construct, which is illogical. It is therefore appropriate to base costs on disaggregated material costs, plus an estimate of engineering hours and an estimate of installation hours. The following table shows that detailed breakdown.

High Density GR-303 DLC			
Central Office Terminal Common Equipment		Central Office Terminal Labor	
SONET Firmware	$7,000	Engineering	$720 (12.0 hrs.)
SONET Transceivers	$2,200	Place Frames & Racks	$180 (3.0 hrs.)
Multiplexer Commons	$5,600	Splice DSX Metallic Cable	$60 (1.0 hr.)
Time Slot Interchanger	$2,200	Place DSX Cross Connections	$30 (0.5 hrs.)
DS-1 Shelf Commons	$500	Connect Alarms, CO Timing & Power	$60 (1.0 hr.)
DSX-1 & Cabling	$800	Place Common Plug Ins (21 ea.)	$30 (0.5 hrs.)
		Turn Up & Test System	$180 (3.0 hrs.)
Subtotal	$18,300	Subtotal	$1,260
Remote Terminal Common Equipment		Remote Terminal Labor	
Cabinet	$27,500	Engineering	$1,920 (32.0 hrs.)
SONET Transceivers	$4,500	Place Cabinet	$240 (4.0 hrs.)
Multiplexer Commons	$2,000	Copper Splicing (2 hrs. + 672 pairs @ 400/hr.)	$240 (4.0 hrs.)
Time Slot Interchanger	$3,500	Place Batteries & Turn Up Power	$120 (2 hrs.)
Channel Bank Assemblies	$4,000	Place Common Plug Ins (21 ea.)	$30 (0.5 hrs.)
Channel Bank Assembly Commons	$2,500	Turn Up & Test System	$180 (3.0 hrs.)
Subtotal	$44,000	Subtotal	$2,730
Total = $66,290			

A central office bay normally serves multiple remote terminal sites. The drawing below shows a typical central office DLC equipment bay layout containing four Common Control Bank Assembly Units. Although a single Common Control Bank Assembly Unit may serve multiple Remote Terminals, we have chosen a conservative approach of having one Common Control Bank Assembly Unit per Large DLC Remote Terminal that can serve up to 2,016 POTS lines.

DLC costs
Litespan 2000 Central Office Terminals

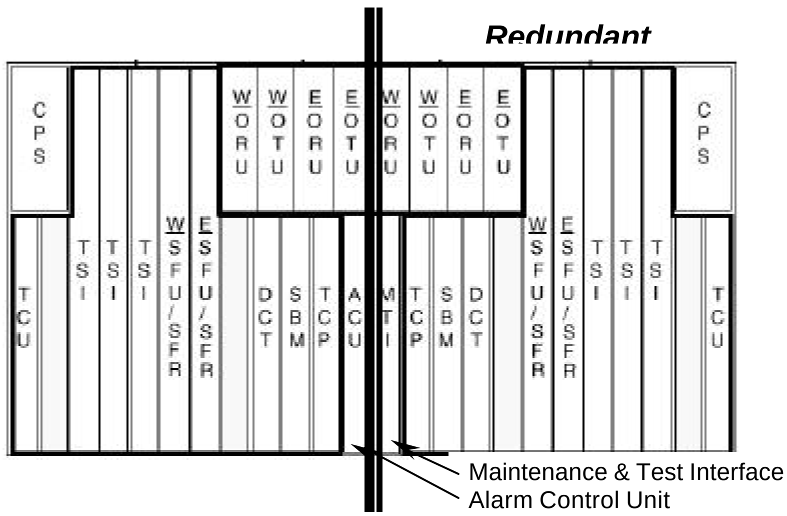
COMMON CONTROL BANKS THAT HOST REMOTE TERMINALS



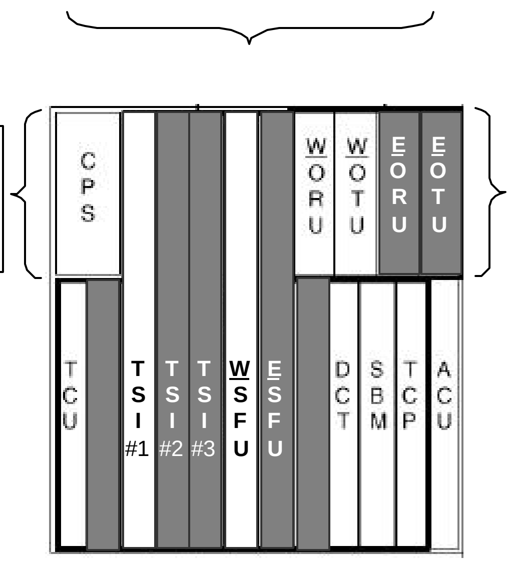
The following diagram shows appropriate equipment cards contained within a central office terminal, and how manufacturers price them as equipment packages.

Litespan 2000 Central Office Terminal
Common Control Bank with Full Redundancy
(except for ACU & MTI)

Typical Litespan 2000 Common Control Bank



<u>Common Support Group</u>
CPS = Common Control Power Supply
ACU = Alarm Control Unit
MTI = Maintenance & Test Interface

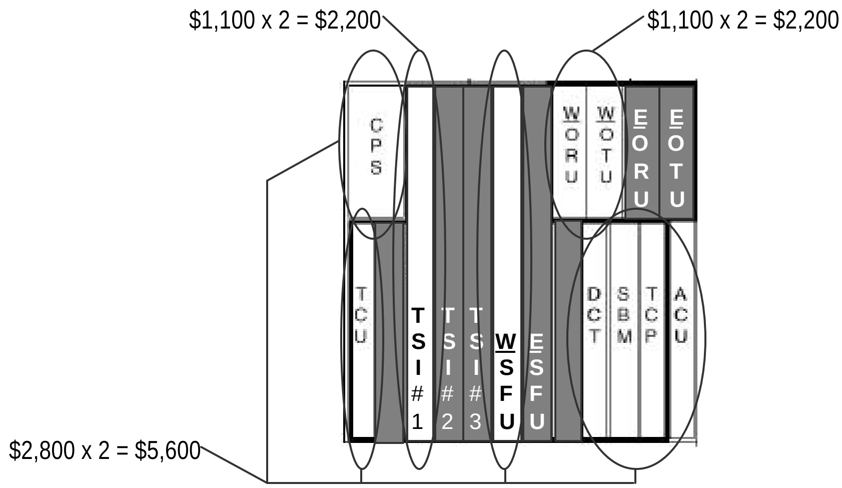


One Half of Common Control Bank

<u>Common Optical Group</u>
ORU = Optical Receiver Unit
OTU = Optical Transmitter Unit
W = West SONET direction
E = Optional East SONET direction
(for bi-directional rings – not modeled)

<u>Common Equipment Group</u>
TCU = Timing Control Unit
TSI #1 = Time Slot Interchanger (OC-1 #1: Initial 672 lines)
(W)SFU = (West direction) SONET Formatter Unit
<u>Optional</u>
TSI #2 = Time Slot Interchanger (OC-1 #2: Incremental Investment for 1344 lines)
TSI #3 = Time Slot Interchanger (OC1 #3): Incremental Investment for 2016 lines)
(E)SFU = (East direction) Optional SONET Formatter Unit (for bi-directional rings – not modeled)

Prices for this type of equipment are usually based on sets of cards. The diagram and information that follows is sufficient to support an initial increment of up to 672 lines.



Litespan 2000Common Control Bank Pricing

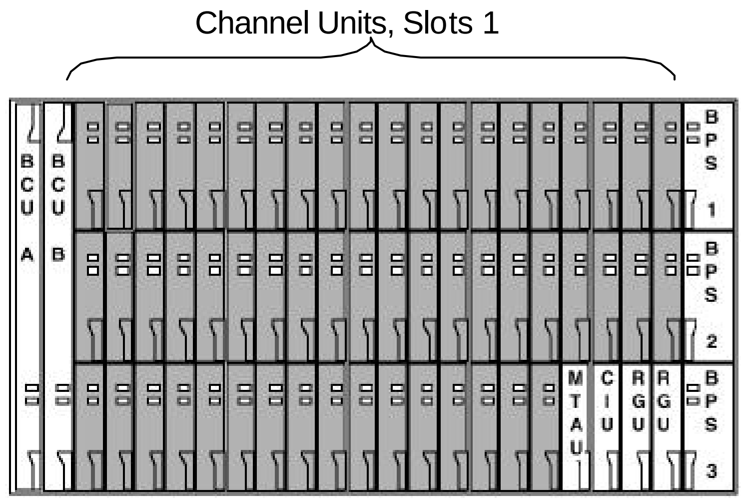
Common Control Bank [Fiber Optics Multiplexer] Pricing				
Item	Description	Quantity	Cost	Total Cost
ORU + OTU	SONET Transceivers (Receive + Transmit)	2 pr.	$1,100	$2,200
TSI	Time Slot Interchange (1 per 672 Lines)	2 ea.	$1,100	$2,200
2 ea. SFU 2 ea. TCU 2 ea. TCP 2 ea. SBM 2 ea. DCT 2 ea. CPS 1 ea. ACU 1 ea. MTI	2 ea. SONET [Ring] Formatter Unit 2 ea. Timing Control Unit 2 ea. Terminal Control Processor 2 ea. System Backup Memory 2 ea. Datalink Controller & Tone Generator 2 ea. Common Control Power Supply 1 ea. Alarm Control Unit 1 ea. Maintenance & Test Interface	1 set	$5,600	$5,600
			Total	$10,000

Central Office DLC Equipment				
Item	Description	Quantity	Cost	Total Cost
Matl	Common Control Bank	1 shelf	$10,000	$10,000
Matl	SONET Firmware (rack & multiplexer shelf)	1 shelf	$7,000	$7,000
Matl	Channel Bank Assembly w/ BCUs & BPSs	1 set	$500	$500
Matl	Digital Cross Connection Frame & Cabling	1 shelf	$800	$800
Matl	Fiber Splice Panel	1 shelf	$200	$200
Labor	Engineering hours	12.0 hrs	$60	$720
Labor	Place Frames & Racks	3.0 hrs.	$60	180
Labor	Connect Alarms, CO Timing & Power	1.0 hr.	$60	$60
Labor	Splice DSX Metallic Cable	1.0 hr.	$60	$60
Labor	Place DSX Cross Connections	0.8 hr.	$60	$48
Labor	Place Common Cards	0.5 hr.	$60	$30
Labor	Place Fiber Splice Panel & Splice Fibers	5.5 hrs.	$60	$330
Labor	Turn Up & Test System	3.0 hrs.	$60	$180
			Total	$20,108

Most of the same common equipment required in the central office is required in the field Remote Terminal. In addition, channel banks are needed at the RT to convert the digital signals to analog signals that can be routed to a SAI and out into the copper distribution cable network. The diagram and information that follows is sufficient to support an initial increment of up to 672 lines.

Litespan 2000 Remote Terminal

Channel Bank Assembly & Channel Bank Common Cards



<u>Channel Bank Commons</u> ***<u>$833</u>***

BCU = Bank Control Unit
BPS = Bank Power Supply
MTAU = Metallic Test Unit
RGU = Ringing Generator Unit
CIU = Communications Interface Unit

Remote Terminal DLC Equipment				
Item	Description	Quantity	Cost	Total Cost
Matl	Common Control Bank (same as C.O.)	1 shelf	$10,000	$10,000
Matl	Cabinet / Housing, equipped at factory	1 ea.	$27,500	$27,500
Matl	Channel Bank Assembly	3 shelves	$1,333	$4,000
Matl	Channel Bank Commons	3 sets	$833	$2,500
Matl	Power Pedestal	1 set	$500	$500
Matl	Fiber Splice Panel	1 shelf	$200	$200
Labor	Engineering	32 hrs.	$55	$1,760
Labor	Construct Pad & Site	1 site	$2,000	$2,000
Labor	Place Power Pedestal & Hook Up Power	1 site	$500	$500
Labor	Place Cabinet	4 hrs.	$60	$240
Labor	Install Batteries & Turn Up Power	2 hrs.	$60	$120
Labor	Place Fiber Patch Panel & Splice Fibers	5.5 hrs.	$60	$330
Labor	Copper Splicing	4 hrs.	$60	$240
Labor	Install Common Cards	0.5 hrs.	$60	$30
Labor	Turn Up & Test System	3 hrs.	$60	$180
			Total	$50,100

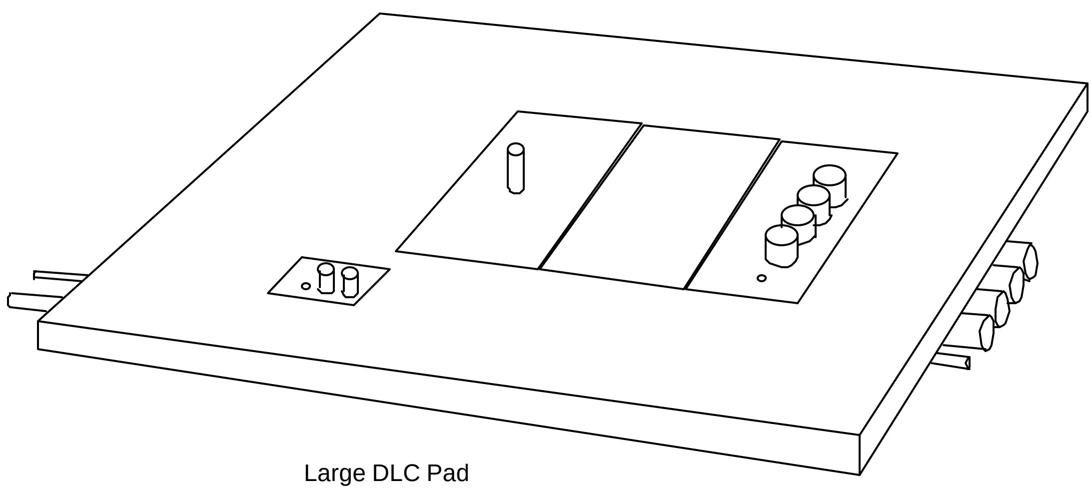
In the central office, incremental additions to increase a 672 line system to a capacity of 1,344 lines, or then again to 2,016 lines would require additional DSX-1 cross connect terminations, cabling, engineering labor, and installation labor in the central office to bring additional DS-1s to the switch. Most of the incremental investment required for this type of capacity expansion is in the Remote Terminal for a larger capacity cabinet, an additional Time Slot Interchanger, a Channel Bank Assembly, Channel Bank Assembly Commons, additional engineering, and additional installation labor. Each 672-line capacity increment requires costs detailed as follows:

High Density GR-303 DLC 672 Line Increment			
Central Office Terminal Common Equipment		Central Office Terminal Labor	
DSX-1 & Cabling	$800	Splice DSX Metallic Cable	$60 (1.0 hr.)
		Place DSX Cross Connections	$30 (0.5 hrs.)
		Turn Up & Test System	$120 (2.0 hrs.)
Subtotal	$800	Subtotal	$210
Remote Terminal Common Equipment		Remote Terminal Labor	
Cabinet	$7,300	Copper Splicing (2 hrs. + 672 pairs @ 400/hr.)	$120 (2.0 hrs.)
Time Slot Interchanger	$3,500	Turn Up & Test System	$120 (2.0 hrs.)
Channel Bank Assemblies	$4,000		
Channel Bank Assembly Commons	$2,500		
Subtotal	$17,300	Subtotal	$240
Total = $18,550			

Our common equipment investment inputs do not include the cost of line cards since the study separately includes line cards that provide the capacity for four POTS lines per card. As discussed previously, HM 5.3 includes a cost input of

$192 per installed line card ($48/line). If a large 672-line DLC system is loaded up to its full capacity, it requires 168 4-line plug-in cards at a cost of $192 each. That is an additional investment of $32,256 added to the recommended common equipment cost of $66,290 plus a fiber optic patch panels at $1,060 plus site preparation of $3,000, or a total of $102,606 for a fully loaded 672-line RT.

The concrete site pad for a large DLC above-ground Remote Terminal is not at all complicated. The largest 2,016-line DLC remote terminal site amounts to little more than a 15-foot by 19-foot concrete "patio" slab. This is a basic diagram of such a site.

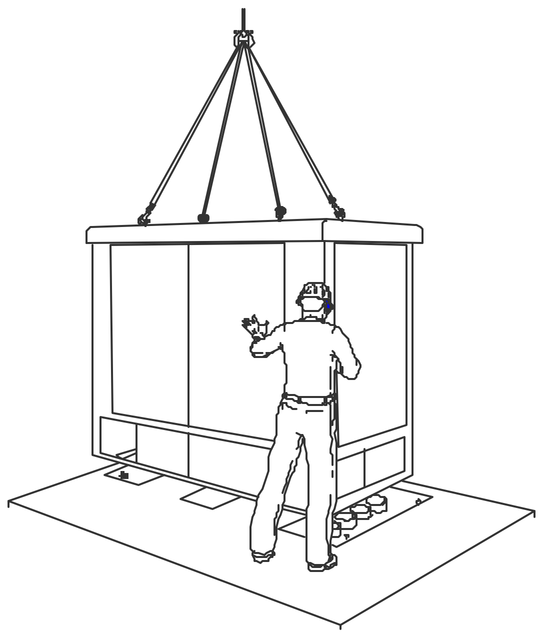


Large DLC Pad

The Remote Terminal equipment installation procedure is not at all difficult. This equipment is most efficiently assembled and tested in the factory by the manufacturer. This improves quality control, and avoids costly on-site assembly by highly paid technicians who should be utilized for tasks better suited to their skills. The information below includes excerpts from typical practices.

Litespan 2000 Remote Terminal Cabinet Installation

Installation of a large DLC Remote Terminal is greatly simplified because the cabinet and its components are preassembled and tested at the factory. In fact, Alcatel states in its documentation,



> "The Litespan ... cabinet is a fully self-contained remote terminal (RT) containing Litespan-2000 channel banks and auxiliary equipment to support up to 672 POTS lines, or up to 50 DS1 or T1 lines and an additional 472 POTS lines. It is completely assembled and tested at the factory. Once the equipment is on site and bolted to its mounting pad, the only assembly required consists of connecting local power, connecting drop facilities, connecting optical fiber facilities, installing the back-up batteries, and plugging the circuit packs into their assigned locations in the racks."

> "The cabinet is prewired at the factory for DC bulk power distribution, environmental alarm reporting, temperature control, and lightning protection. Ringing power is provided by Ring Generator Units (RGUs) installed in the Litespan channel banks [as opposed to a bulk ringing generator unit]. The cabinet is also provisioned for emergency battery backup and has connections for remote testing facilities."

Q. YOU DISCUSSED THE INPUTS FOR LARGE DLC SYSTEMS. WHAT INPUTS SHOULD BE USED FOR SMALLER SYSTEMS?

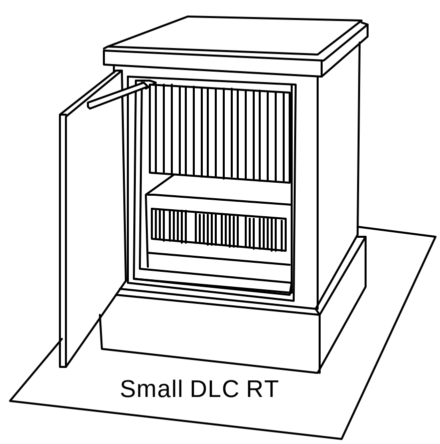
A. The following information is appropriate for a small 24-line and 120-line Integrated DLC ("IDLC") system without line cards. In the case of low density GR-303 IDLC systems, it is important to note that one central office Host Digital Terminal ("HDT") provides services for a number of small Remote Terminals. This is appropriate engineering design of such systems. The major difference between the 120-line DLC system and the 24-line system is that the 24-line system unit cost includes a pedestal for buried placement, or a pole mounting bracket and hookup to electric power.

Common Equipment Investment for 120-line DLC Equipment			
Central Office Terminal Common Equipment		Central Office Terminal Labor	
SONET Firmware	$3,000	Engineering	$720 (12.0 hrs.)
SONET Transceivers*	See Below*	Place Frames & Racks	$180 (3.0 hrs.)
Common COT Plug Ins	$1,200	Splice DSX Metallic Cable	$60 (1.0 hr.)
DSX-1 & Cabling	$800	Place DSX Cross Connections	$30 (0.5 hrs.)
		Connect Alarms, CO Timing & Power	$60 (1.0 hr.)
		Place Common Plug Ins (21 ea.)	$30 (0.5 hrs.)
		Turn Up & Test System	$180 (3.0 hrs.)
Subtotal	$5,000	Subtotal	$1,260
Allocation of COT Host Digital Terminal Investment per 120 RT 120 lines / 672 lines per COT HDT = 17.86% x 75% assumed HDT fill = 23.81%	.2381	Allocation of COT Host Digital Terminal Investment per 120 RT 120 lines / 672 lines per COT HDT = 17.86% x 75% assumed HDT fill = 23.81%	.2381
Subtotal	$1,200	Subtotal	$300
SONET Transceivers*	$2,000*		
Subtotal	$3,200	Subtotal	$300
Remote Terminal Common Equipment		Remote Terminal Labor	
Cabinet w/ Channel Bank Assembly	$5,500	Engineering	$1,080 (18.0 hrs.)
SONET Transceivers	$2,000	Place Cabinet	$180 (3.0 hrs.)
Multiplexer and Channel Bank Assembly Commons	$3,500	Copper Splicing (2 hrs. + 120 pairs @ 400/hr.)	$138 (2.3 hrs.)
		Place Batteries & Turn Up Power	$60 (1 hr.)
		Turn Up & Test System	$180 (3.0 hrs.)
Subtotal	$11,000	Subtotal	$1,638
Total = $16,198			

Common Equipment Investment for 24-line DLC Equipment			
Central Office Terminal Common Equipment		Central Office Terminal Labor	
SONET Firmware	$3,000	Engineering	$720 (12.0 hrs.)
SONET Transceivers*	See Below*	Place Frames & Racks	$180 (3.0 hrs.)
Common COT Plug Ins	$1,200	Splice DSX Metallic Cable	$60 (1.0 hr.)
DSX-1 & Cabling	$800	Place DSX Cross Connections	$30 (0.5 hrs.)
		Connect Alarms, CO Timing & Power	$60 (1.0 hr.)
		Place Common Plug Ins (21 ea.)	$30 (0.5 hrs.)
		Turn Up & Test System	$180 (3.0 hrs.)
Subtotal	$5,000	Subtotal	$1,260
Allocation of COT Host Digital Terminal Investment per 24-line RT 120 lines / 672 lines per COT HDT = 17.86% x 75% assumed HDT fill = 23.81%	.2381	Allocation of COT Host Digital Terminal Investment per 24-line RT 120 lines / 672 lines per COT HDT = 17.86% x 75% assumed HDT fill = 23.81%	.2381
Subtotal	$1,200	Subtotal	$300
SONET Transceivers*	$2,000*		
Subtotal	$3,200	Subtotal	$300
Remote Terminal Common Equipment		Remote Terminal Labor	
Cabinet w/ Channel Bank Assembly	$5,500	Engineering	$240 (4.0 hrs.)
SONET Transceivers	$2,000	Place Cabinet	$120 (2.0 hrs.)
Multiplexer and Channel Bank Assembly Commons	$3,500	Copper Splicing (2 hrs. + 120 pairs @ 400/hr.)	$60 (1 hr.)
		Place Batteries & Turn Up Power	$60 (1 hr.)
		Turn Up & Test System	$60 (1 hr.)
Subtotal	$11,000	Subtotal	$540
Total = $15,100			

Compared to the Large DLC line card investment of $192 per 4-line POTS card, the equivalent for the Small DLC line card investment is $288 for a 6-line POTS card ($48/line). We have assumed that extended range line cards are 150% the cost of a normal POTS card, based on experience in purchasing such cards in bulk. They are only needed for copper distribution loops longer than 16,000 feet from the RT (a user-adjustable input).

The site preparation for a small DLC cabinet is extremely simple. Whereas we have used the Alcatel Litespan 2000 IDLC system as typical of a cost effective large system, a popular small system, manufactured by Advanced Fibre Communications ("AFC") was used for our small IDLC model. This small cabinet is provided, as the manufacturer states, in "Pad, pole, H-frame, or wall mounting options."[33] Such a system has a very small footprint, or can even be mounted on a short "stub pole." The study relies upon a site preparation cost of $1,300 in addition to the $16,000 in common costs, $1,000 for fiber patch panels, and whatever number of line cards is needed to meet capacity at $288 per card.



[33] See AFC's website at http://www.fibre.com

Q. WHAT LEVEL OF UTILIZATION IS APPROPRIATE FOR DLC LINE CARDS?

A. DLC line card utilization should be extremely high for the following reasons. As noted above, an actual fiber fill of no more than 50 percent would ensure that all DLC remote terminals have two redundant fibers for their two in-service fibers[34]. Also, cables, especially copper cables, take months to reinforce by placing additional facilities. On the other hand, a DLC channel unit card weighs less than a pound, and can be installed any time a technician is in the feeder route, or on an annual routine maintenance visit basis. A DLC channel card can be used to expand facility capacity in minutes, not weeks, and at $192 to $288 per line card is a very expensive, highly portable part of the network – one that should not suffer from poor inventory management. This higher utilization rate is one of the advantages typically claimed by telephone companies in deploying fiber-fed DLC feeder rather than copper feeder cable. In addition, the typical guideline in telephone companies is that planned DLC line card deployment, even if done on a programmed basis, should provide for 6 to 12 months growth. Therefore a 90 percent utilization rate for DLC line cards is very reasonable.

[34] An exception is the 24-line DLC RT used in HM 5.3 that, according to the manufacturer, Advanced Fibre Communications, operates on a single fiber without redundancy or two fibers with redundancy through the standard use of wave division multiplexing.

IX. CONTROLLED ENVIRONMENTAL VAULTS ("CEVS")

Q. WHAT ARE CONTROLLED ENVIRONMENTAL VAULTS AND HOW ARE THEY APPLIED IN THE HAI MODEL?

A. CEVs are used to house large concentrations of Digital Loop Carrier equipment in a below-ground watertight structure. A CEV consists of a bottom half and a top half. The bottom half contains telecommunications equipment that is preinstalled and tested in a factory environment. Attachment JCD-4 contains pictures of a typical CEV installation. Disadvantages include the very high cost of the structure that precludes their use for small concentrations of subscriber lines. Advantages include the ability to reap the benefits of economies of concentrating a large number of loop services for transport back to the central office on fiber feeder cable, and the relatively unobtrusive above-ground hatch that belies the large amount of equipment maintained below the surface. The two sizes of CEV normally deployed are a 6-foot by 16-foot CEV that can house approximately 4,032 POTS lines, and a 10-foot by 24-foot CEV that can house up to 8,064 POTS lines.[35] CEVs are generally deployed where a requirement exists for more than 2,016 lines. HM 5.3 utilizes above-ground closures for DLC equipment in increments of 24, 120, 240, 672, 1,344, and 2,016 lines. HM 5.3 utilizes 6-foot by 16-foot CEVs in 672-line increments up to 4,032 lines (2,688, 3,360, and 4,032

[35] Line sizes continue to increase as equipment becomes more compact.

lines); 10-foot by 24-foot CEVs are used in 672-line increments up to 8,064 lines (4,704, 5,376, 6,048, 6,720, 7,392, and 8,064 lines).

Q. WHAT IS THE SOURCE OF THE COST INPUTS FOR CEVS?

A. A variety of sources were consulted, including personal experience of members of the engineering team, as well as costs obtained from a number of ILECs, in estimating appropriate default values for CEV structure and equipment costs. The following breakdown of costs has been deemed reasonable by engineering experts involved in estimating costs for AT&T. It is very important to note that very little telephone company labor is involved in the installation of a CEV and its equipment. This type of facility comes prepackaged and tested from the factory. It has already been assembled and has been working under test in the factory. Once a crane lowers the bottom segment into the pit, and cables are run into the vault and hooked up, the facility can be turned up and tested for immediate service. Because CEVs are pre-engineered and pre-packaged, Engineer, Furnish & Install ("EF&I") costs include some engineering, but primarily consist of site acquisition, coordination, permits, and contract excavation, placing and restoration costs.

6-ft. X 16-ft. Controlled Environmental Vault – CEV – Costs				
Component	**# Lines**	**2688**	**3360**	**4032**
Protector Frames (per 100 lines)	$900	$24,300	$30,600	$36,900
Protectors (per line)	$2.00	$5,400	$6,800	$8,200
Component	**# CBAs**	**12**	**15**	**18**
Channel Bank Assembly Pkg (per 224 DS-0s)	$1,333	$16,000	$20,000	$24,000
Component	**#DS3s**	**4**	**5**	**6**
Support Frames (per 672 DS-0s)	$300	$1,200	$1,500	$1,800
Time Slot Interchangers (per 672 DS-0s)	$1,750	$7,000	$8,750	$10,500
Component	**# OC3s**	**2**	**2**	**2**
CCA Getting Started Pkg (per OC3)	$6,000	$12,000	$12,000	$12,000
Component	**# Bays**	**4**	**5**	**5**
Bay Equipment Pkg (per 4 position Bay)	$6,200	$24,800	$31,000	$31,000
Component	**# Batt Strings**	**6**	**7**	**8**
Batteries (per 48 volt string)	$1,000	$6,000	$7,000	$8,000
CEV Structure				
Enclosure-Matl	$40,000	$40,000	$40,000	$40,000
Fiber Termination Shelf	$1,000	$1,000	$1,000	$1,000
Ladder Rack Kit	$500	$500	$500	$500
Span Termination Equipment	$300	$300	$300	$300
RT Power Bay	$9,300	$9,300	$9,300	$9,300
DC Power Distribution Panel	$350	$350	$350	$350
TOTAL	**# Lines**	**2688**	**3360**	**4032**
	Material	**$148,150**	**$169,100**	**$183,850**
	EF&I	**$15,000**	**$15,000**	**$15,000**
	Total	**$163,150**	**$184,100**	**$198,850**

10-ft. X 24-ft. Controlled Environmental Vault – CEV – Costs							
Component	**# Lines**	**4704**	**5376**	**6048**	**6720**	**7392**	**8064**
Protector Frames (per 100 lines)	$900	$43,200	$48,600	$54,900	$61,200	$66,600	$72,900
Protectors (per line)	$2.00	$9,600	$10,800	$12,200	$13,600	$14,800	$16,200
Component	**# CBAs**	**21**	**24**	**27**	**30**	**33**	**36**
CBA Pkg (per 224 DS-0s)	$1,333	$28,000	$32,000	$36,000	$40,000	$44,000	$48,000
Component	**#DS3s**	**7**	**8**	**9**	**10**	**11**	**12**
Support Frames (per 672 DS-0s)	$300	$2,100	$2,400	$2,700	$3,000	$3,300	$3,600
Time Slot Interchangers (per 672 DS-0s)	$1,750	$12,250	$14,000	$15,750	$17,500	$19,250	$21,000
Component	**# OC3s**	**3**	**3**	**3**	**4**	**4**	**4**
CCA Getting Started Pkg (per OC3)	$6,000	$18,000	$18,000	$18,000	$24,000	$24,000	$24,000
Component	**# Bays**	**6**	**7**	**8**	**9**	**10**	**10**
Bay Equipment Pkg (per 4 position Bay)	$6,200	$37,200	$43,400	$49,600	$55,800	$62,000	$62,000
Component	**# Batt Strings**	**9**	**10**	**11**	**12**	**13**	**14**
Batteries (per 48 volt string)	$1,000	$9,000	$10,000	$11,000	$12,000	$13,000	$14,000
CEV Structure							
Enclosure-Matl		$60,000	$60,000	$60,000	$60,000	$60,000	$60,000
Fiber Termination Shelf	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Ladder Rack Kit	$500	$500	$500	$500	$500	$500	$500
Span Termination Equipment	$300	$300	$300	$300	$300	$300	$300
RT Power Bay	$9,300	$9,300	$9,300	$9,300	$9,300	$9,300	$9,300
DC Power Distribution Panel	$350	$350	$350	$350	$350	$350	$350
TOTAL	**# Lines**	**4704**	**5376**	**6048**	**6720**	**7392**	**8064**
	Material	**$230,800**	**$250,650**	**$271,600**	**$298,550**	**$318,400**	**$333,150**
	EF&I	**$20,000**	**$20,000**	**$20,000**	**$20,000**	**$20,000**	**$20,000**
	Total	**$250,800**	**$270,650**	**$291,600**	**$318,550**	**$338,400**	**$353,150**

X. <u>UNBUNDLING INTEGRATED DIGITAL LOOP CARRIER</u>

Q. CAN LOOPS SERVED VIA INTEGRATED DIGITAL LOOP CARRIER BE UNBUNDLED?

A. ILECs frequently claim that it is impossible to unbundle loops on GR-303 compliant NGDLC, claiming instead that integrated digital loop carrier systems are connected directly into the digital switch. That is not the case. The Central Office Terminal ("COT") equipment associated with GR-303 compliant NGDLC does not simply stick fiber cable into a digital switch. An Integrated NGDLC system has a COT consisting of bay-mounted equipment; the systems are demultiplexed down to a DS-1 (1.544 Mb/s) signals, and sent to the digital switch over shielded twisted pair copper that is cross connected at the DSX-1 frame before being routed to either the ILEC's switch or to a CLEC's collocation arrangement.

The ability to unbundle local loops carried on IDLC is well known in the industry. It is quite illogical to believe that major NGDLC vendors have ignored the need to unbundle local loops to CLECs during the seven years since passage of the Telecommunications Act of 1996. Any claim to the contrary is simply incorrect. Operating a NGDLC system using an antiquated TR-008 Universal DLC system that takes a clean digital signal and demultiplexes it back to a copper analog circuit in the central office is costly, inappropriate, and not forward-looking. UNE rates should be based on Integrated NGDLC with GR-303 compliance.

Moreover, to the extent that much of the demand for unbundled loops is for loops combined with unbundled switching (*i.e.*, a "UNE-P" arrangement), the entire issue is moot. UNE-P arrangements remain on precisely the same facilities as did Qwest's and Verizon's retail service, be they NGDLC or any other configuration.

Attachment JCD-5 is a white paper, written in 1994 and presented at the National Fiber Optics Engineering Conference, that clearly indicates the viability of unbundling Integrated Digital Loop Carrier Systems operating under GR-303[36] international standards.

Attachment JCD-6 is an excerpt from Telcordia's *Notes on the Networks*, a 1,421-page industry source of telecommunications information. Telcordia is primarily funded by ILECs that normally incorporate its recommendations into engineering guidelines.

It is clear from both of these documents that unbundling Integrated DLC systems is a mature science utilizing the system's multi-hosting capabilities. Such systems come into the central office and are terminated on a Central Office Terminal ("COT"), where optical signals from the DLC Remote Terminal in the field are demultiplexed onto DS-1 electrical, digital, copper pair based facilities. The DS-1s are then routed from the COT to a DSX-1 cross-connect frame. Under UNE-P the DS-1s are cross-connected to run to the ILEC's switch. For stand-alone UNE loops, the DS-1s can be cross-connected to a tie cable that runs to the CLEC

[36] Although this document refers to TR-303, it is synonymous with GR-303 which became the international designation once approved by standards setting bodies in 1998.

collocation cage. The beauty of NGDLC, operating under GR-303, is that traffic can be pre-designated by incoming line at the DLC Remote Terminal, and directed onto a specific DS-1 circuit in the central office. This feature enables CLEC circuits to be groomed onto DS-1s going to the CLEC collocation cage. Appropriate costs for the DS-1 tie cable and cross connect terminations are included in collocation costs outside the realm of this docket. All investments and recurring costs required to unbundle IDLC are included in HM 5.3 because they are identical to the costs incurred to establish connectivity for circuits going from the COT to Qwest's or Verizon's central office switch. The only difference is whether the DS-1 from the COT is cross-connected to the ILEC's tie cable to its switch, or cross connected to a CLEC's tie cable to its collocation point.

XI. FIBER BASED SERVICES

Q. DOES THE HAI MODEL ESTIMATE COSTS FOR DS-3 LOOPS?

A. Yes, for the first time, HM 5.3 includes modeling of fiber-based services, such as DS-3 requirements. The *HAI Release 5.3 Model Description* is being provided as an Attachment to Dr. Bryant's testimony. Section 8.9, *Treatment of Services Provided over Fiber*, indicates that inputs to HM 5.3 are used to calculate the investments required. There is sufficient input data already in HM 5.3 for costs of individual fiber cables, now required in the Distribution Cable portion of the network from the DLC RT or SAI site to each identified DS-3 customer location, and for fiber feeder if there is no fiber feeder in the route from the DLC RT/SAI site back to the central office. Where fiber feeder exists in the route, the incremental fiber requirement of four fibers per OC-3/DS-3 multiplexer[37] is accumulated to upsize those fiber feeder cables. Additional investments required for the fiber-based connection are included in the fiber terminal cost input for these services. Those investments consist of 1) a four-fiber entrance cable 100 feet long; 2) a splice of the distribution fiber cable to the entrance cable; 3) a splice within the premises that transforms the outside plant cable to a pigtail cable that provides individual connectorized fibers that can be plugged into the optical multiplexer; 4) two duplex fiber pigtails (total of four fibers) on the premises; 5) an optical multiplexer at the customer premises; 6) an appropriate portion of a shared SONET (Synchronous Optical NETwork) multiplexer in the central office; and, 7) the coaxial cable for connecting the circuit termination to the customer's equipment.

Q. WHAT IS THE SOURCE OF THE INVESTMENT COSTS NECESSARY FOR DS-3 LOOPS?

A. The breakdown of investment costs that follows is based on estimated task times as supported previously in this testimony and in the *HAI 5.3 Inputs Portfolio* for

[37] Note that DS-3 is a 45 Mbps electrical bit rate that may easily be confused with OC-3, which is an optical bit rate of approximately 155 Mbps. The model assumes placement of an OC-3 multiplexer at the customer's location, which could then provide up to 3 DS-3s.

Engineering times, Technician times, and Material costs, with several exceptions. For the customer premises installation, those exceptions include engineering of the drop cable and multiplexer site, for which three hours is more than sufficient for the simple tasks involved; and, the placing, turn up & test of the multiplexer at the customer premises, which is based on expert opinion (Such multiplexers may be ordered for 110 volt wall outlet power, and are self-testing upon powering up the system.)

The estimated cost of $40 for the coaxial cable and terminal is based on readily obtainable prices for such items from a variety of public suppliers and manufacturers. Central office/wire center labor costs are based on information here, in the HIP, and on expert opinion. Such equipment may operate on a multi-node SONET ring, such that three OC-3 locations with one DS-3 service each may be readily homed on a single wire center mounted OC-3 multiplexer connected via four fibers. At least 12 OC-3 multiplexers can be mounted in a single wire center bay/rack, so costs are allocated to individual DS-3s on that basis.

Customer Premises Fixed Investment per DS-3

Customer Premises	Rate		Quantity	Cost
OSP engineering labor rate per hour	$60.00	/hr.		
OSP engineering of drop cable & mux site	3.0	hrs.	1	$180.00
Minutes per splice engineered	10.0	min.	2	$20.00
Minutes per 4 fiber strands engineered	3.0	min.	1	$3.00
		Engineering Labor		$203.00
OSP technician labor rate per hour	$60.00	/hr.		
Fiber drop cable placing time	0.5	hrs.	1	$30.00
Splicing set up and closure time (hours)	2.0	hrs.	2	$240.00
Splicing rate minutes per fiber strand joined	5.0	min.	8	$40.00
Place multiplexer, turn up & test system	1.5	hrs.	1	$90.00
		Technician Labor		$400.00
Multiplexer at Customer Site	$8,000	ea.	1	$8,000.00
Duplex pigtail	$60	ea.	2	$120.00
Coaxial cable cross connect & terminal	$40	ea.	1	$40.00
4-fiber entrance cable	$0.36	/ft.	100	$36.00
			Material	$8,196.00
Total Customer Premises Fixed Investment per DS-3				$8,799.00

Wire Center Fixed Investment per DS-3

Central Office 12 OC-3 Multiplex Bay			Quantity	Cost
Labor Rate	$60.00	/hr.		
Engineering	8.0	hrs.	1	$480
Place frame and racks	2.0	hrs.	1	$120
Install 12 multiplexers & cabling (40 min. ea.)	8.0	hrs.	1	$480
Turn up & test 12 multiplexers (10 min. ea.)	2.0	hrs.	1	$120
Install 48 fiber patch panel and splice	6.0	hrs.	1	$360
			Labor	$1,560
48-fiber patch panel	$1,340	ea.	1	$1,340
Frame and racks	$300	ea.	1	$300
OC-3 multiplexer	$8,000	ea.	12	$96,000
			Material	$97,640
Wire Center Fixed Investment per DS-3				$99,200
Number of DS-3s Served By Fixed Investment (12 OC-3s @ 3 DS-3s/OC-3)				36
Allocated Wire Center Cost per DS-3 with Fill				$2,755.56
Duplex Fiber Pigtails (2 ea. @ $60) per OC-3				$120
DS-3s per OC-3				3
Wire Center Variable Investment, per DS-3				$40.00

XII. SUMMARY OF RECOMMENDATIONS

Q. WHAT RECOMMENDATIONS DO YOU HAVE FOR THIS COMMISSION?

A. I recommend this Commission utilize the HAI Model for estimating the costs of unbundled loops for Qwest and Verizon in Washington. The HM 5.3 follows generally accepted outside plant engineering principles and has evolved to being able to model the costs for a complete network that ubiquitously handles all services carried over outside plant. HM 5.3 creates a network in the same manner as it would be designed by an outside plant engineer.

In addition, there is considerable evidence presented by AT&T that demonstrates for the Commission that it can rely on the engineering inputs and assumptions for HM 5.3 outside plant methods and inputs; they are representative of realistic forward-looking practices and values.