Access Policy
and
The Changing Telecommunications Environment[1]

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Abstract

Access policy has evolved over the past ten years in an environment pressured by competitive carriers and now with innovative technologies. A third dimension driven by new and innovative services will also effect the change in access. This paper reviews the issues of access and uses specific case studies to demonstrate the effects that access can have on the development of new and innovative telecommunications infrastructures. The primary focus is on the developments in Personal Communications Services, PCS, a new wireless service offering in the 1.8 to 2.0 GHz bands. The paper develops a set of detailed Microeconomic models for the new infrastructure and shows that access can have a dominant role to play on its rapid acceptance. The paper demonstrates that the infrastructure has limited scale and scope in its economies and that access fees and policy present potential bottlenecks to competing service providers. The paper concludes with a set of policy options that are a natural result of the detailed economic analysis of the new service.

1.0 Introduction

The major objective of this paper is to examine the basic structure of and justification for an access fee and from that structure develop several policy alternatives that must be considered as the Government and State Agencies work through the elements of new and innovative access structures. In preparing this paper, the author has attempted to revisit many of the inherent assumptions that are the basis of access fees and ultimately the current economic and regulator structures of telecommunications. In addition the author was forced to reevaluate the basic economic tenets that are used in determining such things as sunk costs when such costs are not irrelevant in an environment that is rate base dominated. In such environments, the system has memory, and it is that memory that changes the basic economic tenets that we all accept so readily.

This paper further relies on developing the theory into policy by focusing on the current examples prevalent in wireless Personal Communications Services, PCS. In addition, the author expends this into alternative access and INTERNET applications, although the focus is on PCS. The PCS focus is critical in that it is a technology that dramatically shifts the well understood paradigms that have shaped the world view of telecommunications. PCS allows for the delivery of telecommunications in an environment where there is limited economies of scale and scope. To do this PCS takes advantage of technology, existing infrastructure and equity in access fees. It is the combination of these three elements that has allowed PCS to have a dramatic impact in the telecommunications competitive environment.

2.0 Access Fee Structures

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[2]The opinions presented in this paper are those of the author, personally, and do not necessarily reflect those of Telmarc Telecommunications, of which he is Chairman, of National PCS Consortium, G.P., of which he is Chairman of the Executive Committee, nor of the National PCS Consortium, Inc., of which he is President.

Current access fee structures are undergoing significant change. In this section, we shall present a few of the current structures and present some possible changes that may be in the offing. We shall focus on the wireless access tariffs that are in place. It is important to note that many of these tariffs are not the end product of access fees but are elements thereto. For example, in the cellular world, there are agreements, specifically contracts, that have tariffs embedded in them. The Agreements go beyond or delimit the tariff. We shall reference in this paper several such tariffs between RBOCs and cellular carriers. In addition, these referenced tariffs further reference of the tariffs that have been in place in other areas of application. Thus it is not as simple as is first surmised.

2.1 Local Access: Type 1 and Type 2 Connections

The local access fees of type 1 and type 2 are developed for special use customers. The following table depicts the details of a typical Type 2 tariff.[3]

General	Specific	One Time	Fixed	Variable (per unit)[4]
Trunk Group		$371.95		
	Multifrequency Outpulsing		$78.82	
	Dial Pulsing		$118.33	
Trunk Interconnect		$371.95	$83.06	
Trunks		$36.24/trunk		
Overflow Option		$36.24		
IntraLATA				
	1-8 Miles			$0.0291
	16-25 Miles			$0.0322
	50-100 Miles			$0.051

The tariff can then be described in terms of the cost per unit access in the following expression. Specifically;

$$A = \sum_{j=1}^{J} \frac{F_j}{T} + \sum_{k=1}^{K} V_k + \sum_{l=1}^{L} M_l m_l$$

where;

F is the fixed amount , T its lifetime ,

V the variable amount , and M the unit

amount and m the number of units .

In the New York tariff, if we were to allocate all of the costs, the effective rate per minute approaches $0.10.

2.2 IEC Access: Tarriffed Access

A more recent tariff for wireless has been issued in a transitional filing in the Massachusetts DPU.[5] The filing is summarized in the following tables.

[3]This tariff is from a New York Telephone PSC No. 900 Tariff effective January 1, 1991.

[4]The variable rates are in per minute or per mile, unless otherwise specified.

Type 1

Present		Proposed	
Contract	**Charges**	**Tariff**	**Charges**
Type 1 Digital Facility	$1,163[6]	Flexpath	$941

Type 2A

Present		Proposed	
Contract	**Charges**	**Tariff**	**Charges**
Land to Mobile Originating	NA	Originating Switch Access Eastern LATA Western LATA	Reference[7] $0.020947 $0.005328
Mobile to Land Terminating Per Minute ARPM	 $0.07985	Terminating SW Access Eastern LATA Western LATA	Reference $0.035773 $0.033974

Type 3A

Present		Proposed	
Contract	**Charges**	**Tariff**	**Charges**
Eastern LATA Per Minute Per Message Western LATA Per Minute Per Message	 $0.020000 $0.060000 $0.020000 $0.060000	Originating SW Access Eastern LATA Per Minute Western LATA Per Minute	Reference $0.020947 $0.005328

Type 3B

Present		Proposed	
Contract	**Charges**	**Tariff**	**Charges**
100 Number Group	$13.00	100 Number Group	$1.00
Per Trunk Equipped	$9.00	DID Trunk	$31.52
Trunk	$49.00	Business Exchange Line	$13.00

[5]Massachusetts DPU, Transitional Filing, DPU-1-13, Attachment II

[6]Average Monthly Charge per Digital Facility

[7]ARPMS are weighted for time of day.

Total	$71.00	Total	$45.52

What is seen in these most recent rates are two trends. First is the trend to tariff the access fee and not have it under contract. The second trend is an almost halving of the access fee. This was pressured by the Recent awarding of Common Carrier Status to the first PCS company in the Commonwealth of Massachusetts.[8] What is also seen is the apparent reduction from $0.08 per minute to about $0.04.

2.3 The Access Impact

The access fee was established to reimburse the provider of service with the imputed expenses of providing the service. In principle it is a cost based reimbursement scheme wherein the user of the service reimburses the provider on the basis of the cost of providing the service.

Consider the case of an IEC. The IEC charges a rate R per minute that is based upon competitive factors. It costs the IEC a rate R_{IEC} to provide the service and it pays the LEC the amount $T_{IEC,LEC}R_{LEC}$, where T is the percent of the costs of the LEC allocated to provide the service. Thus the total IEC rate is;

$$R = R_{IEC} + T_{IEC,LEC}R_{LEC}$$

The IEC then carries the LEC costs through the access fee. Now consider the case of two competing LECs using the same formula. Let the rates be defined as follows:

$$R_{LEC,1} = A_{LEC,1}C_{LEC,1} + T_{LEC1,LEC2}C_{LEC,2}$$
$$and;$$
$$R_{LEC,2} = A_{LEC,2}C_{LEC,2} + T_{LEC2,LEC1}C_{LEC,1}$$

If LEC,1 is the less expensive, then the subscriber to LEC 1 will be paying a lower rate for the more efficient LEC based on its internal costs, but paying a premium for accessing the less efficient LEC through the access fee mechanism. In contrast the subscriber to LEC,2 will be paying a higher cost of LEC,2 operations but a lower cost of access to LEC,1 based on its efficiency. In effect, LEC,1, the efficient provider, is being "taxed" by the inefficient provider and this tax is becoming a subsidy to that provider.[9]

From an economic perspective, LEC 1 should always have the lower rates since it is the more efficient carrier. It is possible from the above series of equations to see that if LEC 2 is very inefficient, then at high rates for LEC 2 and high LEC 2 costs, it can drive LEC 1 process higher. This process is economically inefficient, since it does not clear the market of an inefficient player. This is the problem with access fees in general.

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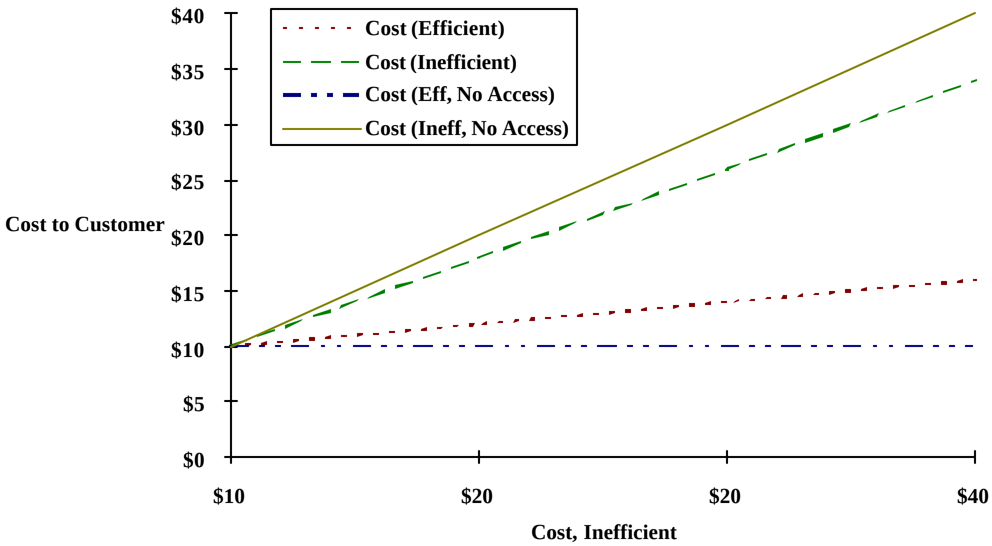
[8]Press Release from the Commonwealth of Massachusetts by the Secretary of State of the Commonwealth announcing the issuance of the first PCS Common Carrier status to telmarc Telecommunications of Boston. New England Telephone was moot on the filing but there was extensive intervention from Southwest Bell. It was assumed that the SW Bell intervention in attempting to stop a nascent industry in the Commonwealth was a driving factor in the DPUs move forward. Telmar Telecommunications was the founder of the PCS Consortium called the National PCS Consortium, a Group in existence since June of 1992, and formally announced in April of 1993. Unlike any of the other consortia, NPC has been focusing on access from the start. The reader is referred to the Appendix on the Hausman Conjectures to see what Pacific Telesis tried to do through the FCC process.

[9]Appendix A discusses the Hausman Conjectures. This discussion is the basis of refuting the 16th Hausman Conjecture.

Let us consider a simple example. Assume that the A factors are equal and are 0.8. Assume that Bs are equal are 0.2. Let us assume that cost of the efficient producer is $10 and that the inefficient producer is greater than that. We can then plot the costs to the customers of the efficient and inefficient producers, as shown below.



We now observe two facts. First, the Cost to the subscriber of the inefficient user is being subsidized by the efficient user. Second, the efficient user is being taxed by the inefficient user. This is not economically efficient. The reciprocity can still result in economic efficiencies. The solution is elimination of such fees altogether.

3.0 PCS Systems, Elements, Costs and Capital

In this section we build the model for the PCS business construct and provide support for each element of that model. Further, we develop and demonstrate the technology changes that make this a clear paradigm shift from the existing wire based telecommunications systems and services.

3.1 Costs; Short Term and Long Term

We review the short term and long term costs arguments that are found in both economic and regulatory theory. It is necessary to review these in the context of the access fee since it will be a convoluted argument in comparing the sunk costs of the monopolists with the opportunity costs of the entrepreneur.[10]

Definition: Let q be any product, and let $x = \left[x_1, \ldots, x_n\right]$ be the set of inputs necessary to produce q. Let;

$$q = f\left(x_1, \ldots x_n\right)$$

we call q the production function based on the resources provided.

[10]We shall also be using these definitions as part of refuting the Hausman Conjectures presented in the Appendix.

Definition: The ***unit market price*** of x_k is p_k, and this prices is based on obtaining the unit input from a totally competitive market where such an input is generally provided.

Definition: The ***cost of the product*** obtaining the unit inputs from a competitive market is given by:

$$C(q) = \left(x_1, \dots x_n ; p_1, \dots p_n ; b_1, \dots b_n\right)$$

where x is the unit input, p the competitive market price, and b the fixed costs associated with each unit input.

Definition: A provider of services is said to deliver those service in a *profit maximized* fashion if;

$$\text{Profit} = \Pi = pq - C$$

is maximized by the choice of x.

Theorem: Let f, a production function be dependent on a set of inputs, x, and let the cost of the quantity produced be a linear sum of the inputs priced independently at prices p which are obtained in a competitive fashion on the open market, and let the cost function be minimized constrained by the production function, specifically, let;

$$C(q) = \left(x_1, \dots x_n ; p_1, \dots p_n ; b_1, \dots b_n\right)$$

and,

$$C = \sum_{k=1}^{n} p_k q_k + b$$

and choose x to minimize;

$$\left(x_1^*, \dots x_n^*\right) = \left\{\left(x_1, \dots x_n\right) : \_\min(V = \sum_{k=1}^{n} p_k q_k + b + l(q - f(x_1, \dots, x_n))\right\}$$

then,

there exist an expansion path;

$$g(x_1, \dots, x_n) = 0$$

such that the set of production functions, and cost function, can yield the relationship for cost;

$$C_{ShortTerm}(q) = f(q) + b$$

which is the short term cost function.

Proof: See Henderson and Quandt.

Definition: For a system of production, producing a quantity q, at unit prices, p, and at **fixed inputs**, x, define the cost function C as[11];

$$C_{ShortTerm}(q) = f(q) + b$$

Then C is called the *short term cost function*.

The next set of issues relate to long run costs. These are the costs associated with the ability to vary the size of the plant and other inputs. Note in the above discussion, we have assumed that there was some fixed production capacity that allowed the delivery of the product. In this analysis we allow that to be augmented.

Let us extend the cost to long term costs wherein the size of the plant can be parameterized on a factor k. Let us assume that k is fixed for the short-term and is variable for the long term. Namely, the producer can change the capital base.

Definition: The *long run cost* is defined as the costs generated by the system as follows:

$$q = f(x, \ldots, x; k)$$
$$C = \sum_{k=1}^{n} p_k x_k + j(k)$$
$$0 = g(x_1, \ldots, x_n; k)$$

where we have defined the variable long run factor k. Reduced the long run cost is:

$$C = f(q, k) + j(k)$$

Definition: The *long run cost curve* is the envelope of the short run cost curves.

3.2 PCS System Design: The Capital Equation

The capital in the system will be divided into two major categories; local service infrastructure (LSI) and national service infrastructure (NSI). The LSI portion consists of all elements of the system up to and including the switch. The NSI portion is all elements from the switch on back. The NSI will also include elements that comprise the databases and computer support.

A generic architecture has been developed in several fora that is comprised of elements that is shown in the next Figure. The intent of the architecture is to demonstrate that the elements can have a minimal set of functionality and that the interfaces can be open interfaces that can be established as standards.

Six independent elements have been identified in the architecture. They are as follows;

o **Portable**: Provides the end user access to the network for voice and or data services.

o **Local Service Infrastructure (LSI)**: The LSI provides three elements. The first is the establishment of a virtual circuit between the portable and the LSI. The second is the interconnection within the LSI covered areas between portables. The third is access to the other network interfaces to allow off net connections to

[11] We assume that there also exists an expansion path function, g(...), as developed by Samuelson and as shown in Henderson and Quandt, that implicitly shows the movement of resources, x, constrained to producing quantity q in an optimal fashion, see Henderson and Quandt, p. 83.

LECs and IECs. It is important to note that the LSI has a sense of switching but that the implementation of the LSI switching can be implemented in many ways. The LSI service functions can be described as follows:

- Call Set Up
- Call Administration
- Virtual Circuit Establishment
- Call Hand Off-Intra LSI
- Call Hand Off-Inter LSI
- Monitoring and Control
- Call Identification
- Call Information Transfer

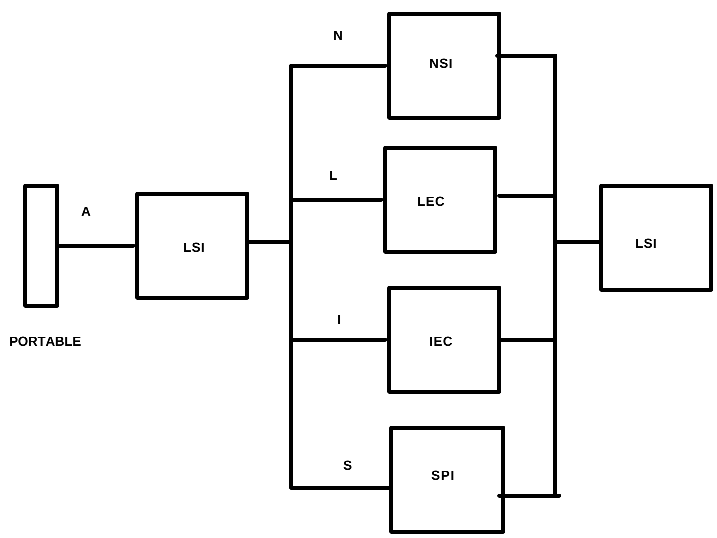
o National Service Infrastructure: The NSI provides for the overall national amendment functions of the PCS network, including network management, customer service, billing, operator services and other elements.

o **Service Provider Infrastructure (SPI)**: The SPI is a third party service node that can provide such services to the PCS users as may be found in Intelligent Network Services. These may be the services such as messaging, voice mail etc.

o **Local Exchange Carriers (LEC)**: This is the access to the LEC and the LECs customer base. It allows LEC customer access to the LSI and the PCS customer access to the LEC customer.

o **Interexchange Carriers (IEC)**: The IEC provides access to other inter LATA LEC customers and other PCS customers in different regions.

The architecture is shown below.



3.2.1 LSI Capital Elements

Let us first focus on the LSI elements. These elements of the capital side focus on providing the service up to and including the switching functions for the local network.[12] Let us assume that we have a given coverage area, A, and that the system has a customer base, B. Let us assume that;

$$A(t) = f_A(t, B(t))$$

$$and$$

$$B(T) = f_B(t, A(t))$$

That is the area and the base of customers are interdependent and time dependent. We define the population density as;

$$r_A(t) = \frac{B(t)}{A(t)}$$

Let us take the market numbers that we developed earlier and assume that B is the actual using customer base. Let us assume that each customer uses the phone T minutes per month, and that each call is L minutes in duration. We now define the average system load and the peak system load. Note that we will design for the peak load. The average load is:

$$E_{Average} = a\left(B(t)\frac{T}{30*24*60}\right) + b\ \_or;$$

$$E_{Average} = a\left(B(t)\frac{T}{k}\right) + b\ ;$$

$$\text{where\_ } k = 30*24*60\text{\_ (minutes\_ per\_ month), and: } a \geq 1, b \geq 0.$$

This yields the average number of instantaneously active channels. Clearly, this does not take into account limited time usage, nor does it take into account peak to average ratios. The peak traffic can then be written as;

$$E_{Peak} = p d E_{Average} \text{where};$$

$$p = \text{Peak\_ to\_ Average\_ Ratio};$$

$$\text{and; } d = \frac{k}{DHM}\text{; where;}$$

$$\text{D = max days per month , H = max hours per day ,}$$

$$\text{M = max minutes per hour .}$$

For example:

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[12]It should be noted that the local switch may be a physical reality such as a DMS 100 or 250, or it may be a virtual reality by having the Class 5 functions distributed in the cell controller elements. The author has proposed and designed systems that meet both implementation goals. Architecturally, the segmentation of the LSI into a switch begs the question of a physical switch. The reason that we have left it absent is that technology today allows for a distributed functionality. This distributed functionality makes for a dramatically different architecture.

- Assume 100,000 users, each with 600 minutes of usage per month per user. The total time per month is 30 days, times 24 hours, times 60 minutes, or 43,200 minutes. If we divide 600 minutes by 43,200 we obtain, 0.0139 trunks per customer, on average. With 100,000 customers, we have 1388.9 trunks, of active circuits at any instant of time.

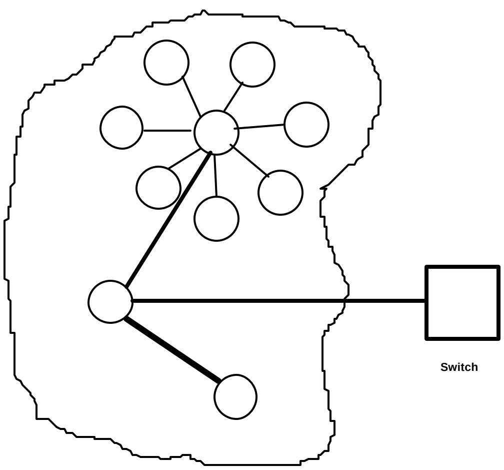
- Now assume that a customer is active only 5 days a week or twenty days a month, and only 12 hours per day, but all 60 minutes in an hour. The we have for δ, 43,200/(14,400), or 3. That is to handle this traffic we need three times the trunks, or 4166.7 trunks.

- Finally, if there is a peak too average factor that says that on any one day, we must have two times the capacity to deal with the peak loading for reasons that are related to customer call clustering, we have a need for 8,333.4 trunks for 100,000 users, using it 600 minutes per user per month.

- Using this logic all other scale numbers follow.

There are two factors that drive the design of the LSI elements; capacity and coverage. We have just described the capacity factor. It is driven by the number of customers and their usage characteristics, primarily minutes of usage per month per user. The coverage factor is generally the factor that drives the need for capital during the early stage. It is driven by the area covered, independent of the number of users covered. In PCS this will be the major factor in rapid expansion.

Consider the coverage area in the following Figure. Each cell has an effective radius R and the total area is A.



The number of cells needed to cover this area are:

$$N_{Effective} = \frac{A}{pR^2} e; \text{where};$$

$$e = \text{the cell coverage efficiency factor} \quad ; \text{ and } 0 \le e \le 1.$$

For example;

- Assume that the coverage area is 1,000 square miles.

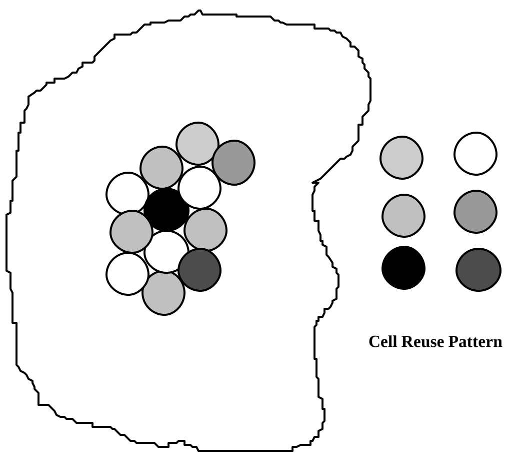
- Assume that a cell can cover approximately 3 mi. radius.

- The area per cell is approximately 30 sq. mi. (actually 28.3).

- Assume the cell covering efficiency is 70%. This means that a cell can cover approximately 20 square miles.

- The number of cells needed for coverage is 50 cells.[13]

Let us now take one further step and overlay frequency. Let us assume the standard cellular bands of 1.25 MHz of bandwidth per frequency band. One band for transmit and one for receive. Let us assume that we use analog, with 30 KHz FM voice, yielding approximately 40 voice channels in this band. Let us assume that TDMA can provide for 5 times this number, namely 200 voice channels, and further assume that CDMA can do ten times, or 400. Now we must lay out the cells for coverage to ensure that the frequency is appropriately used. This is shown in the following figure.



Cell Reuse Pattern

What this says is that if we have 12.5 MHz, or ten 1.25 MHz slots, we need a pattern where there are anywhere from three to seven separate and distinct frequencies, because no two adjacent circles can have the same frequency assignment. This is the reuse of N problem.[14] However, this is not required for CDMA, only for TDMA.

Let us begin to build the capital model. Let us assume that the area is A, the customer base B, and that cells have radii of coverage of R. Let us further assume that cells are equal in coverage but come in two types, one a low capacity type and another a high capacity type. Let us define the following capital model:

$$C_{LSI} = C_{Cells} + C_{CellInterconnect} + C_{Switch} + C_{SwitchInterconnect}; \text{ where;}$$
$$C_{Cells} = N_{Type1} C_{Type1} + N_{Type2} C_{Type2}; with;$$
$$C_{Type\_n} = \text{capital per cell of type n.}$$

Now we can define;

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[13]This assumes that a cell radiates with an effective radius as stated. The definition of what is a cell will be further developed. A cell may not be what we normally expect a cell to be in the cellular context. It may be nothing more than a re-radiator of RF energy, see TTI Quarterly Report to the FCC, July 1, 1993.

[14]Lee, Cellular Communications.

$$N = N_{Type\_1} + N_{Type\_2}; \text{where}; N = \frac{A}{pR^2}$$

We shall not focus on the interconnect in detail and shall defer it to a reference to the detailed model. Suffice it to say that the interconnect may be telco wire, fiber (lease or build), microwave, or any other choice available such as coax.

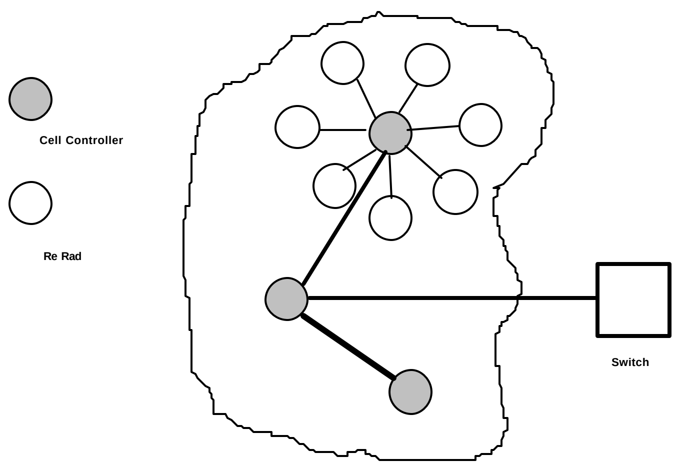
Let us no define the capital per subscriber:

$$c_{LSI} = \frac{C_{LSI}}{B}; \text{or};$$

$$c_{LSI} = \frac{C_{Cells} + C_{CellInterconnect} + C_{Switch} + C_{SwitchInterconnect}}{B} : \text{yields};$$

$$c_{LSI} = \frac{N_{Type1}C_{Type1} + N_{Type2}C_{Type2}}{B} + \frac{C_{CellInterconnect} + C_{Switch} + C_{SwitchInterconnect}}{B}$$

Let us take this set of capital requirements and apply them to a specific case. In the Figure below, we have detailed the typical architecture for a cell system layout. It includes the following elements; cell controllers, re-radiators, cell-controller and rerad interconnects, switches, switch to cell controller interconnect. The input is from a portable that connects to a rerad or cell controller. The output is a toll tandem trunk with appropriate signaling to connect to another telephone carriers.



We shall use the example of CDMA technology to demonstrate how this new technological infrastructure can enable the new market. We shall briefly describe the CDMA system and then proceed to the financial implications of using this new technology. The CDMA system described is that of QUALCOMM [15].

[15] See the works by Gilhousen for the QUALCOMM approach. Also see the paper by Pickholtz et al for a differing approach to CDMA. The latter approach is Broad band CDMA compared to mid-band.

A simple calculation will show how this new technology dramatically reduces the capital per subscriber.

o Assume that there are 1,000 square miles of coverage and 48,000 subscribers.

o Assume that a cell controller or a re-rad handles a 3 mi. radius or about a 30 mi. cell coverage area. This implies that 3 cell controllers and 30 re-rads will cover the area.[16]

o Assume that the cell-controller is equipped to handle 800 trunks per cell controller. Assume that the peak usage ratio is 5%. Thus each cell controller can handle 16,000 subscribers, 800 instantaneously active in the busy hour.

o Assume that the cell controller are about $1 million each and that the re-rads, with microwave back haul are at $50 thousand each. The total capital is $4.5 million. This the is about $100 of capital per subscriber.

Now this can be compared to the capital per subscriber in the LEC and cellular environments. In the LEC world the capital per subscriber is almost $1,800. This is split between switch and transport as follows; $400 for the switch and $1,400 for transport. Namely, the LEC is outside plant dominated. Moreover, under rate of return regulation, the LEC makes most of its profit off of its outside plant. In the cellular world the capital per subscriber is $750. This includes the cells and the MTSO, Mobile Telephone Switching Office. It does not include access to the LEC Class 5 switch.

3.2.2 NSI Capital Elements

The NSI capital elements are generally computers, workstations, memory units and other MIS type systems. The capital is composed of initial fixed capital and then incremental growth capital. These have been sized and are part of the overall model. We will show their impact when we develop the design of the system.

3.3 PCS Expenses: The Allocation of Resources

The operations of a PCS system, or any telecommunications system, for that matter, has intrinsically several costs to be included. We divide these costs into the following categories;

Cost of Goods: The costs associated with the provision of materials that may find themselves inventory. We shall consider in this case that provision of the terminal, namely the portable, as a cost of goods.

Cost of Service: This will be the costs associated with the access costs.

Cost of Sales: This is the cost of all of the elements of acquiring and maintaining the customer. It includes:

- Advertising
- Telemarketing
- Marketing

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[16]This is only possible with CDMA. If it were TDMA you could not use the Re Rads. Each coverage cell must be a TDMA cell site. This accounts for the difference between TDMA and CDMA. CDMA is the ONLY technology that allows the use of ReRads in the K=1 reuse pattern that we have been discussing. In a recent discussion with Gilhousen of QUALCOMM, on August 23, 1993, the author questioned why this was not generally understood. Neither the author or QUALCOMM staff knew why. In a recent paper by Lusiginan at Stamford, the author totally neglected the reuse of 1 for CDMA and thus fell short by almost a factor of ten in his calculation. QUALCOMM has already demonstrated a reuse of 12 or greater for the past two years.

- Product Development
- Billing
- Customer Service
- Promotion

Cost of Operations: This includes the LSI Operations as well as the NSI Operations. Specifically:

o **Local Service Infrastructure (LSI):** The operations functions of the LSI are as follows:

- Installation
- Local Operations
- Local Engineering
- Carrier Support

o **National Service Infrastructure (NSI)**: The NSI provides a set of comprehensive functions. These are:

- Network Management
- Customer Service
- Billing
- Network Management
- Telemarketing
- Roaming
- Inventory Management
- Operator Services

The cost model for the above elements can be developed as follows. We have developed and used a three part model. It consists of a revenue driver, a productivity factor and a unit cost approach. In this model we assume that all costs are revenue driven, name market driven. That is the entrepreneur will not invest until such time that there is a clear and simple market opportunity. It assumes further hat the entrepreneur will allocate costs on the basis of a know risk, and that risk is general the appearance of a new customer. It further assumes that Long Run costs can be achieved by the near real time optimization of costs in the system rollout.

We define the three element as follows:

Revenue Driver, R: The revenue drive may be as simple as the number of customers or the number of new customers. Clearly the customer service and billing functions are driven by the number of customers. The sales effort is driven by the number of new customers. The cell maintenance function is driven by the number of cell sites which in turn is driven by the number of customers.

Productivity Factor, P: The productivity factor reflects how the operations reflects revenue drivers into human resources. For example in customer service it is in terms of the calls per customer per day, the holding time per call, the hours per day per customer service representative. This results in the number of customer service representatives per unit revenue driver.

Unit Costs; U: The unit costs are the costs associated with the labor and other units of production used in the operations model. This then yields a cost for unit k as:

$$C_k = RD_k PF_k UC_k$$

Then the total operations costs are;

$$C = \sum_{k=1}^{K} RD_k PF_k UC_k$$

Then we have for the total cost function the following, where we have parameterized it on time units, k, and have further included all cost element;

$$C(q) = C_{Capital} + C_{Cost\_of\_Goods} + C_{Service} + C_{Sales} + C_{Operation}$$

We can simplify this as:

$$C = \sum_{n=1}^{N} \sum_{k=1}^{K} RD_k^n PF_k^n UC_k^n ; where;$$
$$n = 1 = Capital, \ldots, n = N = Operations.$$

which can be placed in the general cost form as;

$$C(q) = C(q; x_1, \ldots x_{NK}; b_1, \ldots b_{NK})$$

which is the general cost equation for LRC.

4.0 PCS Case Studies

This section presents the results of analyzing the costs from the model developed in the last section. We have considered two cases; CDMA and TDMA. In both cases we have developed a detailed model of the service and the system and have used the technology that is described in the previous sections.

4.1 Several CDMA Cases

The following are the results of the CDMA case analysis. We have assumed that CDMA is implemented as we have shown before. We have determined the average and marginal costs and expenses, respectively, for the case of no access and for the case of access. We have assumed 600 minutes of usage per customer per month, an area of coverage of 2,000 square miles and a population of 4 million in that density. We have included the following elements in the deployment strategy:

- Assume that the set is part of the sales, namely a cost of goods. There is no separate buy of the set.
- Assume that the sales channel is a direct advertising sales channel that takes inbound telemarketing calls and directly ships the set.
- Assume that the access fee are averaged at $0.05 per minute.

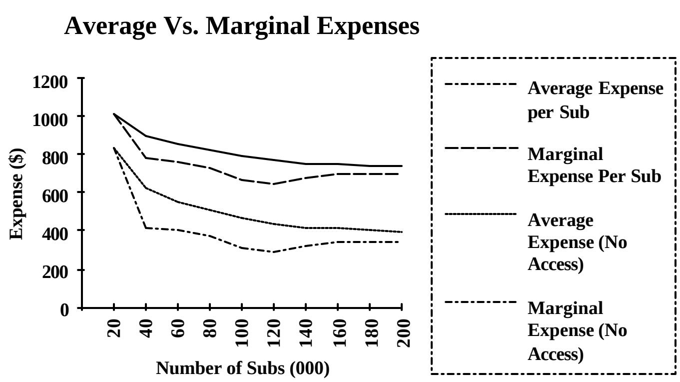
The following figures shown the results of this analysis. The first is the cost per subscriber.

Figure: CDMA Costs Per Sub

Note in the above figure that the average and marginal costs are approximating each other in a fairly short time period.[17] The costs include capital averaging. Note also that there is a wide gap due to access fees that offset the two numbers by more than $400 per sub per year. This offset is significant, and as reflected in the costs will cause a barrier to entry.

The next figure shows the expense numbers. This reflects depreciation rather than capital. Note that with the assumption of giving the set away, with establishing a new infrastructure, with acquiring the new customers, that the access free case shown a cost base that can compete very well with the LEC in cost based elements. In addition, note that the marginal and average costs approach each other very rapidly thus eliminating scale.

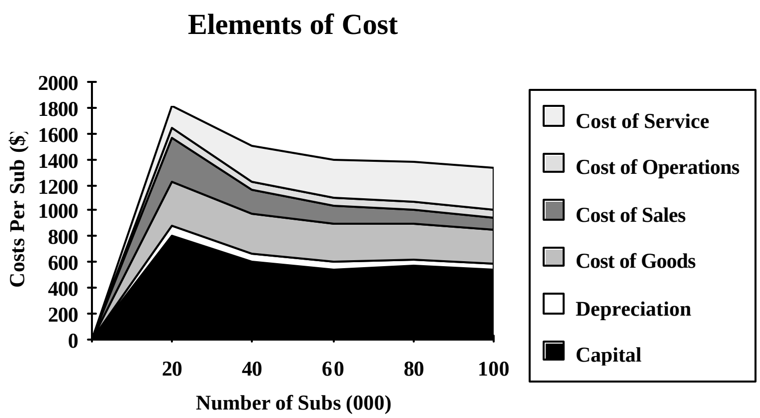
Figure: CDMA Expenses Per Sub



The next figure shows the flow of costs and expenses as we progress in the development of the system.

[17]It should be noted in these figures that the marginal costs are not smoothed and show significant "noise" due to the resolution of the model. This can be improved upon by a more complex analysis of the marginal analysis.

Figure: CDMA Cost Breakout



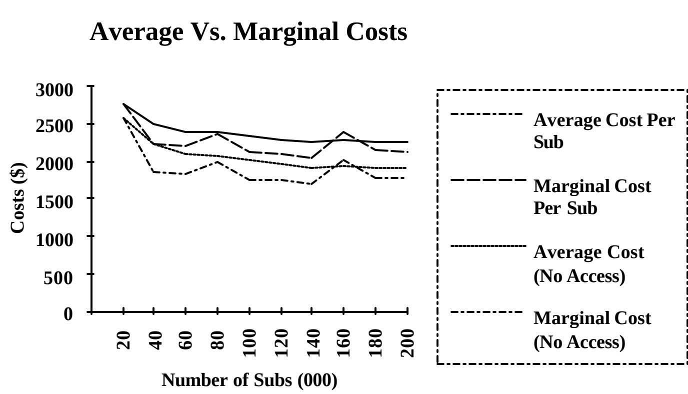
The three largest elements are capital, cost of goods and cost of service. The cost of the service, namely access is the second largest cost element. We have assumed that the set is bundled with the costs of the product offering, and thus is the third largest costs element. Sales, Operations, and Depreciation are nominal in comparison to this cost structure.

There are several conclusions regarding CDMA. As we have argued, CDMA optimizes the issues of capacity and coverage. It minimizes the costs as we shall see when looking at TDMA. CDMA is most likely the optimal solution in providing maximum net present value at minimal peak cumulative negative cash flow.

4.2 Several TDMA Cases

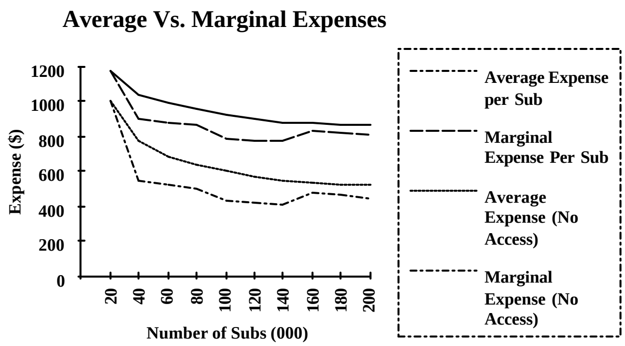
We now present several TDMA cases. Unlike CDMA, the TDMA design needs cells at all locations, and cannot function with Re Rads. This will dramatically increase the capital requirement. All other costs should be comparable, with the minor exception of Operations and Maintenance which are increased by the increased cell count. The first figure depicts the cost elements.

Figure: TDMA Cost Structure



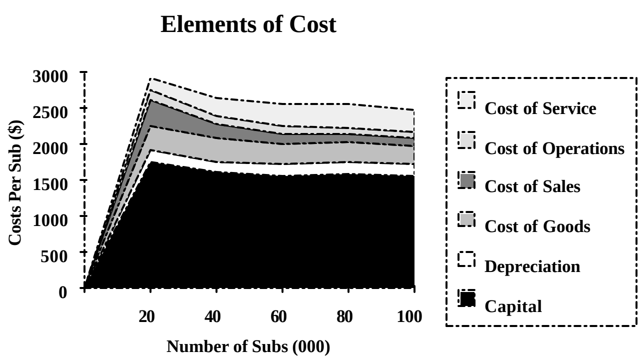
As we can see, the TDMA cost elements reflect similar structure with the major exception of the capital base. The TDMA design needs almost $1,000 in capital per subscriber more that CDMA. This is a combination of coverage and capacity inefficiencies. This is not inconsequential. It is interesting that Bellcore has been forcefully pressing TDMA in its standards efforts. This approach will add additional burdens on any potential LEC competitor and make the capital structures of the wireline and the wireless carrier comparable. The following figure looks at the expense structure for TDMA.

Figure: TDMA Expense Structure



The above figure shows the increase in TDMA expense base reflected in depreciation. The following figure depicts the detailed costs elements.

Figure: TDMA Cost Elements



The conclusions drawn in this figure also reflect the same result as with CDMA. The only significant difference is the capital element.

4.3 The Existence of Scale

In this section we develop a definition of scale that attaches a more rigorous set of strictures than is normally found in the accepted definitions. This will allow us to expand further upon the issues with the systems developed above.

Definition: An **economic entity**, $\aleph$, has **economies of scale**, if for any ε, there exists a δ, such that, [18]

[18]The use of the Long Run costs for scale is obvious and follows from the works of Kahn, Spulber and others.

$$C_{LongRun}(q+d) \leq C_{LongRun}(q) + e$$

Theorem: If the Cost Function, $C_{LongRun}(q)$, is concave, namely:

$$if\_\forall q_k, k=1,\ldots,n, and\_\forall q, such\_that; \_0<q<1;$$
$$qf(q_a)+(1-q)f(q_b) \geq f(qq_a+(1-q)q_b)$$

where:

$$q_a\_andq_b\_belong\_to:$$

$$\Re = \{q_1,\ldots q_n\}$$

Proof: The proof of this follows directly from the continuity of functions.[19]

Corollary: An economic entity, $\aleph$, has economies of scale, if;

$$\frac{¶C(q_a)}{¶q} \leq 0\_\forall q_a \in \Im\_where; \Im = set\_of\_all\_appropriate\_q.$$

Proof: This follows directly from convexity arguments.

Applying this to the above discussion, demonstrates that scale is minimal in the PCS system so described.

4.4 The Impact of the Access Fee

We now develop the analysis that allows us to determine the impact of access fees and other similar barriers to entry in this PCS market. We do so by developing a set of examples based on the two extremes of RBOC and Non-RBOC competition.

Case 1: LEC Wire Based

The LEC currently has invested about $1,800 of capital per subscriber with 20% of that in inside plant and 80% in outside plant. The LEC currently uses cost based rate based pricing for their services. Thus, the LEC has a expense plus depreciation supply model that does not reflect any market or technology economies. More importantly, the LEC has a profit defined as:[20]

Profit = RoR (Accumulated Capital - Accumulated Depreciation)

where RoR is the PUC accepted rate of return. To maximize their profit, therefore, it is prima facie required to maximize the capital plant. Thus there are de minimis needs to reduce capital through capital innovation.

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[19]Rudin, p.88.

[20]Brenner or Spulber. Both references describe the rate of return regulation.

Case 2: PCS Wireless

Technology has changed dramatically in the past five years. The two current ways of providing voice service are via wireline twisted pair telephone service and through cellular voice service.[21] New technological innovations have allowed the wireless PCS services to be provided by another form of technology. This technology takes advantage of a distributed telecommunications architecture and places as much "silicon" in the field as possible. It also performs as much processing as possible so as to minimize the functions required by the LEC interconnect.

Let us now take these two models and determine what the value is for each of these business. This is at the heart of the dynamics of and allocation process based upon a bidding or auction mechanism. Let us create a NPV, net present value function that uses revenue, expenses and depreciation. [22] If m is the cost of capital or the effective discount rate at the defined risk level, than the NPV can be defined as;[23]

$$V(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n)}{(1+m)^n}$$

We can define this NPV on a per customer basis. We further use a time horizon of N years for the measurement of the NPV. We shall use the life of a PCS license, assuming fifteen years.

Now we can expand this concept one step if we assume that there is some form of tax, foe example an auction fee or a franchise fee. Let us assume that there is a "tax" due to some form of U.S. Government allocation process. Call that tax, T. This then reduces the NPV as shown in the following.

$$V^*(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n) - T(n)}{(1+m)^n}$$

Now we can further add to the tax, the access fee. Let A be the access fee. Then the PCS carrier faces the following NPV function;

$$V_{PCS}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n) - T(n) - A(n)}{(1+m)^n}$$

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[21]See the works by Lee. The author has provided several key bodies of analysis that provide insight into the history and current status of cellular.

[22]It should be noted that this should be revenue, expenses and capital. We shall assume that we can use depreciation since there may be a leasing function available. This is truly an inaccurate method for NPV but it allows a first order comparison of LEC and PCS on a per subscriber basis. A more detailed model has been developed by the author and presented elsewhere, see McGarty, CMU, 1992.

[23]McGarty, Business Plans. See the details on the definition of NPV and its evaluation. In the proper sense it does not include depreciation but capital.

In Contrast the LEC has the value;

$$V_{LEC}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n)}{(1+m)^n}$$

It should be immediately clear that the LEC, even if it is more economically efficient can reduce the net present value per customer of the PCS company by four means;

(i) **Access Fees:** The LEC can burden the PCS company with and access fee, such as the $55 per month number in New York, that makes the PCS company, in any circumstance non-competitive.[24]

(ii) **Auction "Tax"**; The "Tax" can be structured in such a fashion, as is currently being lobbied by the RBOCs in Congress, as a large up front payment,, that increases the risk and further reduces the NPV for the PCS company.[25]

(iii) **Increased Risk**: The cost of capital, m, can be different for the two companies. Specifically, if m_{LEC} is the LEC cost of capital, generally a very low cost due to its existence and capital raising capacity, and if m_{PCS} is the cost of capital for the PCS entrant, then we find;[26]

$$m_{PCS} >> m_{LEC}$$

Specifically:

$$V_{PCS}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n) - T(n) - A(n)}{(1+m_{PCS})^n}$$

for the PCS entity, and;

$$V_{LEC}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n)}{(1+m_{LEC})^n}$$

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[24]McGarty, Wireless (MIT, 1993). The author details the impact of access fees on PCS and details the potential for violation under Robinson Patman. It is not clear if there is any violation per se but the issue of internal transfer pricing of switch access at possible rates less than long term average costs and having the IECs and other CAPs effectively underwrite these costs are in question. Another factor that delimits access indirectly is that of number availability through the North American Numbering Plan (NAM), see Brenner, p. 19. The NANP can also be an access barrier to entry to any potential competitor. It is controlled by Bellcore, the R&D arm of the RBOCs. Bellcore is generally difficult to deal with and as has been seen in the cellular world the ability of Bellcore to manipulate the numbering plan can add additional costs and market delays. It is an issue that the Commission must address if it truly seeks competitive options.

[25]Clearly this is a Fiscal Policy element that impacts the Industrial Policy element. The author suggest a balanced of risk sharing. This approach is a modification of the policies developed by Solow in the area of Growth Theory and have been positioned in a similar fashion by Arrow.

[26]See the reference by Kolbe where he develops the details on rates of return and the cost of Capital for utilities.

for the LEC.

Thus, the LEC, can through its entrenched position, increase the risk level and, in turn, reduce the NPV, indirectly, through the cost of capital.

(iv) **Monopoly Rents**: The LEC, as a monopoly, has what is termed monopoly rents resulting from its monopolistic control over the property. This rent, as we shall discuss in the next section, acts in a bidding process, as a price escalator. Namely the LEC, if in the bidding process, can bid an amount that is consistent with its NPV, plus the amount equal to its existing monopoly rent. Namely; if MR_{LEC} is the LEC monopoly rent, as defined in the next section, then the NPV_{LEC} is;

$$\_V_{LEC}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n)}{(1 + m_{LEC})^n} + MR_{LEC}$$
$$>> V_{PCS}(N) = \sum_{n=0}^{N} \frac{R(n) - E(n) - C(n) - T(n) - A(n)}{(1 + m_{PCS})^n}$$

Note, that the LEC now has four factors that increase its value for bidding for a wireless property. The LEC has such strong market power that it could, in a collusive fashion, between and amongst themselves, dominate the new PCS market. All one has to do is look at the current Cellular markets and see that they dominate by almost 70% all current cellular properties and if one adds AT&T, it is almost 90% of the major markets.

We provide a brief overview of the microeconomic models in order to show the impact of the results presented in the last section. The following Figure depicts the market for this type of telecommunications services. We define P(q) as the demand curve, and define MD as the marginal demand. We define MR as the marginal revenue, where MR is given by;

$$MR(q) = \frac{\P R}{\P q} = \frac{\P (pq)}{\P q} = q\frac{\P p}{\P q} + p = p - qP'$$

That is the marginal revenue is always the demand curve less the factor associated with price and prices sensitivity. Therefore, the MR, marginal revenue always lies below the demand curve.. The marginal cost curve, MC, is the supply oriented curve. It is as shown. Recall from the last section, we have developed a simplistic model of the marginal cost curve for both LEC and PCS businesses.

Recall, also, that the profit maximization stable points for a competitive market and a monopolistic market are as follows:

Competitive:

MC(q)=p(q); defines the q_m point on the demand curve.

Monopoly:

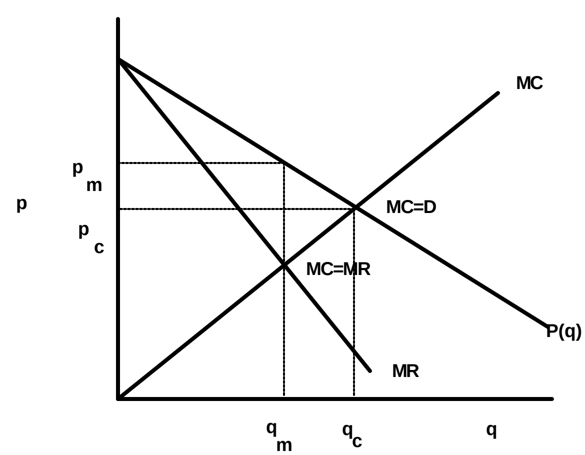
MC(q)=MR(q); defines the q_m point on the demand curve.

Therefore, the monopoly player can charge a higher price, p_M, as compared to a competitive play, charging, p_C. We show this in the following Figure. Note also that the monopoly player has a greater profit. Specifically, it can be shown that the price of a monopoly player is $P_{\mathbf{MONOPOLY}}$ as compared to the price of a competitive player, $P_{\mathbf{COMPETITIVE}}$, and that they are related as:[27]

$$P_{MONOPOLY} = \frac{P_{COMPETITIVE}}{1 + \frac{1}{\frac{\partial D}{\partial q}}}$$

Since the elasticity of demand is negative, the price of the monopolist is greater. Moreover, in the PCS and LEC environment, the LEC if it retains its monopoly position can retain the excess monopoly rates and thus retain monopoly profits, which are competitive profits plus the monopoly rent. In the following Figure, we first note that the monopoly demand point, q_m is where MC=MR. The price depends on where this demand quantity intersects with the demand curve, p(q). However, in the competitive case, the market equilibrium is where the demand curve equals the MC curve.

Figure: Microeconomic Analysis of Monopoly vs. Competitive Markets



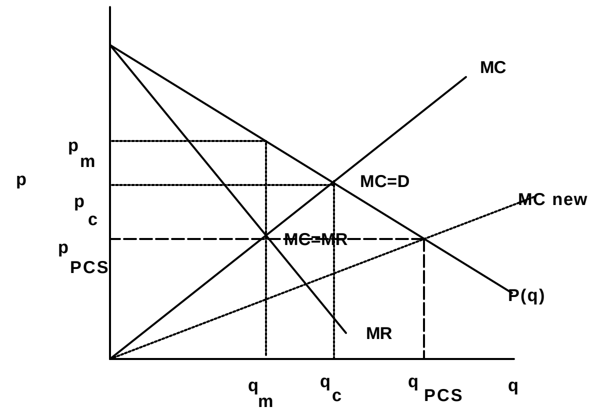
Monopoly rents are the excess profits that accrue to a monopoly player, such as an RBOC acting as a LEC, in the absence of competition. This "rent" is a premium resulting from their single market dominance, and results in an increase in the NPV of the property if this rent can be retained through continuing monopoly control. In the following Figure we depict the microeconomic situation with a monopoly and a competitive environment,. Here we show the competitive price at p_C and the monopoly price as shown before.

Moreover, in the Figure we show that the competitor now has a marginal costs curve below that of the monopolist as shown for PCS. The effect is dramatically increased demand at a dramatically lowered cost to

[27]Pindyck and Rubinfeld, p. 343. This shows the added monopoly power in pricing of the LEC in a potentially competitive market.

the consumer. This is a Pareto efficient case.[28] However, this assumes that the Taxes and Access fees were not present. If these fees and taxes are added, then the new marginal costs may, as we have shown, exceed the marginal costs of the monopoly. This is and artificial cost increase, driven by Government fiat and not market forces. It is an artificial manipulation of the market mechanism that further entrenches the monopolist.

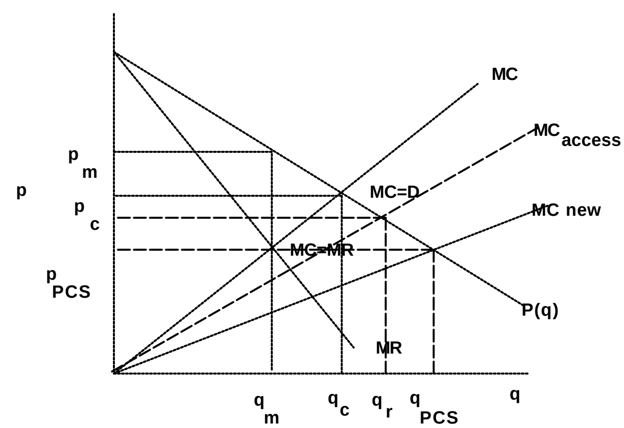
Figure: Competitive Environment with New Technology



The deadweight loss is defined as the value of the dotted triangle that appears between the p and MC curve.[29] It is in effect the monopoly rent.

We can now determine the effects on competition with the addition of access fees. The same argument will hold with regard to the addition of the "Tax" fees. The next Figure depicts the results with access added. Specifically, we show the case of the access fee added. This reduces demand, increases costs, and further puts the new entrant in a non-competitive position with respect to the entrenched monopolist.

Figure: Competitive Environment with New Technology and Access Fees



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[28]Henderson and Quandt, p. 286. Also termed Pareto Optimal, this implies, "if production or distribution cannot be reorganized to increase the utility to one or more individuals without decreasing the utility to others. "

[29]See Tirole or Pindyck and Rubinfeld.

Innovation in technology can be supported or destroyed by Government actions as we have just demonstrated. It can be shown that if a new technology is introduced that will reduce the MC, marginal cost, from c_{old} to c_{new}, where $c_{old} >> c_{new}$, then the value to the monopolist in not allowing this change to occur can be shown to be:[30]

$$V_m = (1/r) \int_{c_{new}}^{c_{old}} D(p_m(c))\, dc$$

where D is the demand function, and r is the cost of money. The valuation is made at the price point of optimization. Thus there is a further incentive by the LECs to hinder new technologies. This has been shown to be the case in two specific recent examples. Consider first the attempt by Bellcore to position PCS as nothing more than a slight extension of the wireless phone.[31] The Bellcore position is that all wireless users should use older technology and use the existing telephone network to act as a backbone in support of the telecommunications infrastructure.[32] What this does is drive up the costs and further entrench the monopolist. It also reduces the chances for technology innovation. The second example was in the RBOC battles over a new generation access technology for cellular. This was and still is the CDMA versus the TDMA battle. It is in essence an attempt to maintain the high costs of infrastructure and in order to maintain the high barrier to entry despite the ability of technology to reduce it.

5.0 Additional Infrastructure Elements

One of the issues in building a PCS system is that os NSI costs and how they are best handled. This begs the question of scope in this business. As we define scope, it implies that a business entity that provides a portion of an infrastructure element, such as billing, and that since it may do so in another part of its business, it is a fungible assets that can be leveraged in multiple business elements. We shall argue that this reasoning has open questions that need answering, and that the scope that may exist in PCS is questionable.

5.1 Displaceable Costs and Economies of Scope

In the preceding section we have developed a model for the delivery of PCS services that combines capital, cost of goods, cost of service and cost of expenses (sales & service, and operations and maintenance). We can generally group these into the following form:

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[30]Tirole, p. 391. The author develops this relationship in the context of the "Social Planner" model. It also represents the bidders excess prices that an LEC may bid to keep the competition out of a market.

[31]Cox. This paper summarizes the attempts by Bellcore to delimit technology innovation. There is a blatant attack on CDMA technology because it frees the wireless provider from the LEC network.

[32]In a recent FCC report, see Reed, the Commission Staff indicated that in its analysis there was limited scale economies but significant scope economies. The scope was based on cable and LECs having infrastructure. In McGarty, Wireless, the author demonstrated why the argument is specious in the context of the CATV entities. As regards to the LECs, that argument is also invalid because it assumes a technological solution consistent with the Bellcore approach of many microcells, being nothing more than extensions of wireless phones in the home, the cordless phone. This is a specious argument since it is based upon the Bellcore technology which begs the answer of continued reliance and support of the monopoly LEC.

$$C(q) = C_{Capital} + C_{CostofGoods} + C_{CostofService} + C_{Sales\&Service} + C_{O\&M}$$

Let us consider a more specific case. Let us focus on the issue of billing. A firm has several product entities that all require a billing function. The firm has the choice of building the billing function and then leveraging it across it different business units. In so doing, it arguable may have economies of scope, and thus the costs of billing in unit 1 may be lower than the costs of billing in unit 2. This arguable is a result of common software, common infrastructure, common experiences, or otherwise. This is the essence of scope. Spulber details this in a general form. The definition according to Spulber is as follows:

Definition: A firm has a technology that is described by a cost function as follows;

$$C(Q;w) \text{ is the cost function; } Q = \left(Q_1, \ldots, Q_n\right) \text{ is the vector of outputs, and;}$$
$$w = \left(w_1, \ldots, w_k\right) \text{ is a vector of input prices.}$$

The cost element is continuous, twice continuously differentiable and non-decreasing.

Definition: A firm with the above structure has a *stand alone cost* defined as;

$$C(0, \ldots, Q_I, \ldots 0) = \text{ stand alone cost of Good I }.$$

Then we can define a special structure of such a good.

Definition[33]: The firms *technology is nonjoint* if and only if the cost function can be written as the sum of the stand alone costs, specifically;

$$C(Q;w) = \sum_{l=1}^{m} C(0, \ldots, Q_l, \ldots, 0) \text{ for all Q and w }.$$

The implication is that if technology is nonjoint that production may be organized efficiently into single product firms. For multiproduct firms to yield cost efficiencies, Spulber notes, there must be returns to common or joint production of outputs, as we have discussed in the billing example.

Definition: Let M be a product set and let S be some subset of M. Let Q_S represent the output vector Q with outputs Q_l not in the set S equal to zero. Then; the cost function,

C(...), exhibits economies of scope if for any nonempty set S, T of M, with the intersection of S and T being non-empty,

$$C(Q_S) + C(Q_T) > C(Q_{S \cup T})$$

This again goes back to the issue of billing. Scope exists in a LEC if billing for LEC wire based customers plus wireless customers is less than billing for both separately. This is not the case. There are two billing

[33] Spulber, p. 114.

infrastructures, and those companies that have attempted this have found that there are minimal commonalties between the two.[34]

Let us consider several of the NSI functions. Specifically;

- Billing
- Customer Service
- Network Management
- Telemarketing

Each of these functions are today provided by outsourcing service bureaus. Such companies as EDS, IBM, CSC and others provide these functions. There is clearly scale in these functions, and there may be limited scope. For example, a cellular billing service bureau, such as EDS, which bought Apex, can provide many cellular companies with lower costs per bill than if the company did it itself. This is more scale than scope. Specifically, if the billing requested from the service bureau is the same for all purchasers then the cost per using per purchaser will be lower than the cost of the purchaser doing it for themselves. However, the costs for doing a different billing service will be more expensive. All one has to do is ask the vendors for quotes on such services.

The conclusion is twofold:

· ***Scope does not exits in PCS between the LEC side and the new business side. The difference is function is too dramatic to allow the capture and amortization of common costs.***

· ***Displacement of service acquisition and provision by service bureaus or outsourcing can leverage on scale and provide common services at lower unit costs. Scope is not the facto, scale, is.***

5.2 Lease versus Buy: Is Financing Important?

The next issue is one of economic and practical importance. It is the issue of what are the costs that are used in determining the economic structure of a business. It has been argued that depreciation is an accounting factor and that true capital costs are required. Further, it is argued that the financial structure of a business in terms of debt structure, or otherwise must be neglected in determining the rate of return and net present value on investment cash flows.

The net present value analysis of a venture does not include the financing structure of the capital plant. This distorts the NPV of the investment. The NPV is calculated on the basis of an all equity investment. It is only after that, that the effects of financing on the venture are determined. Economic costs are those costs incurred by the firm in providing the business services. These costs are generally independent of financing also. However, there is an issue of lease versus buy.

Consider the issue of billing again. There are three ways a firm may do billing:

1. Design and build from the ground up a billing system, including developing the software and buying the hardware.

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[34]The author, while an officer at NYNEX, and while responsible for billing, among other Operations items, developed a separate cellular billing system. This was necessary from an operational perspective since there was no way the existing software could accommodate the bills used in cellular. Furthermore, it would have been more efficient to buy the billing services from a cellular service bureau rather that build that system. We shall discuss this issue latter in this section.

2. Lease a computer system and buy an already developed software package.

3. Buy the service from a third party service bureau at a cost per sub per month.

Now the issue of scale and scope must reflect the structure of the firm under these three scenarios. These are more than simply financing scenarios. They reflect strategic alternatives to the operations of the business. Scenario 1 will clearly show significant scale. By definition, the capital will be significant and will requires dramatic increases in the costs per sub at low sub numbers. Scenario 3 is a viable strategy if there are well defined billing constructs that have common acceptance in a large user base. The truth of the matter is that Scenario 3 is the optimal strategy for most applications, due to scale and not scope. It is the analog of lease versus buy.

6.0 Policy Implications

This section develops policy perspectives from several different angles. We look first at the issues associated with co-carriers status and then address the issues relating to auctions. We then focus on antitrust issues and the basic Constitutional concerns the build both from the issue of antitrust and the broader issues that relate to access. We conclude with a brief discussion of the current PCS contenders and their respective strategies.

6.1 Common Carrier and Co-Carrier Status

PCS can become a common carrier. All this implies is that PCS is open to any subscriber and that the provider cannot discriminate on the sale of the service. Common Carriage does not imply tarrifing. It is anticipated that all PCS providers will be common carriers.[35]

The evolving policy directions that handle these factors are the development of a co-carrier concept and the resulting elimination of the settlements process. Consider first the cocarrier status. A co-carrier is any local exchange service provider whose customers have common carrier access to their local exchange provider and desire access to other common carrier providers in a competitive environment. A common carrier can become a co-carrier by acclamation and by operation. The net result of co-carrier status is that the originating carrier pays the terminating carrier an access fee. The net amount paid between the carriers is termed the settlement. This process was common prior to divestiture.

The payments of settlements and the agreement between co-carriers to pay access to terminating carriers begs the question of access equality and fairness. As we have shown in an earlier section, a more efficient provider is taxed by the less inefficient, and in turn the inefficient is subsidized by the more efficient. In addition, if a carrier decides to offer service at a fixed fee, unlimited local usage, its costs of billing are de minimis. Thus its costs of settlement are significant.

Consider an example of a competitive PCS company and an existing BOC. Let us assume the following:

- *A user has 500 minute of usage per month.*
- *The PCS company has fixed fee, unlimited local usage, and the cost per customer per month per bill is zero.*
- *Assume that the BOC bills as they do currently and assume that the BOC cost per bill is $1.75.*

[35] The Commonwealth of Massachusetts issued the first PCS Common Carrier Certification, without restriction, to Telmarc Telecommunications on August 23, 1993. This is the first of its kind. TTI subsequently filed for co-carrier status as argued in this paper.

- *Assume that the traffic from the PCS company is 275 minutes to the BOC and 225 minutes from the BOC. Thus there are 50 minutes per month to be settled. This is a 10% difference in traffic flow.*

- *Assume that the access fee is $0.02 cents per minute, or a settlement of $1.00 per month.*

- *Assume, further, that the PCS company must now install a billing system at the cost of $1.75 per customer per month to establish settlements.*

- *Then, the PCS customer will be further taxed by the addition of the $1.00 plus the $1.75 to measure the $1.00 settlement.*

- *Therefore, it is argued that from a pubic policy perspective, settlements should be abandoned.*

The co-carrier status can work most effectively if and only if settlements, and thus access fees are eliminated. To summarize, this is because the fees are subsidies to the inefficient, and the imposition of the fees will create additional costs that the consumer must bear to clear the fee structure. Thus it is clear that the economically most efficient method is to eliminate access fees totally.

6.2 Auctions and the Constitutional Implications

Auctions are processes and procedures developed and conducted by the federal Government under the premises of establishing a market value for spectrum and returning that value to the tax payer. Such a procedure has not been achieved in the spectrum area to date but has been achieved in oil and gas and in lumber and other natural resource areas. Thus the Federal Government has a set of precedents that it can legally build upon in this area. However, there is a dramatic difference in PCS and similar areas with the presence of he RBOCs and other Government "sponsored" monopolists in the market which, as we have argued have a significant advantage accruing them from this monopoly position.

Congress and the Administration have before them a set of policy and legal options which will determine the future of telecommunications in the United States for the next decades. The issue is the allocation of spectrum for the purpose of providing innovative telecommunications services, such as Personal Communications Services, PCS. The key public policy objectives are:

Service Objective: *The service should be, at a minimum, of toll grade quality, supporting both voice and data, and provided in a national seamless interoperable network, on the most cost effective basis.*

Valuation Objective: *The bandwidth should be valued on a fair market basis, assuming that all bidders can bid on a fair and equitable basis, with their reservation prices reflecting their individual abilities to meet the Service Objective through innovative technologies.*

Equity Objective: *The entitlement to participate should be based in equity and should consider the following factors: the ability to deliver the service, the early commitment to innovation, the entrepreneurial contribution to the development of a national service and infrastructure, and the ability of the entity to create value for the nation through jobs, technology, or infrastructure.*

The service objective is a public policy objective and supports the industrial policy of creating innovative infrastructures in a highly competitive fashion. The valuation objective is a fiscal objective that attempts to validate new entrants into the market, while returning value to the public. The equity objective acknowledges the contributions made by pioneers in this new area and confers Preference as a result of their efforts to date.

The overriding concern is for the Government to be compensated for spectrum without destroying competition and innovation. The market is still uncertain and the risks are high. The major impediment to true competition is the existing player, the RBOCs, as both Local Exchange Carriers (LEC) and as cellular carriers.

The RBOCs can use their monopolistic power in four ways to drive the bid price high:. (i) ***Access fees***, having bottleneck control over access from and to the user, (ii) ***Auction "Tax"***; having a new entrant pay a cost of spectrum usage that they did not and will not have to pay, (iii) ***Cost of Capital***, paying a greater cost of capital because of the greater risk associated with a new entrant, and, (iv) ***Monopoly Rent***, having an existing monopoly rent advantage that allows them to bid excessively above free market value.

The need to value the spectrum should be based on the payout from the provision of the service rather that a single up front payment. The bid for the service then can be risk averaged over the life of the bid amount.

It is critical that provision of a seamless interoperable national service and revenue for the Federal Government be balanced in order to ensure the Global competitiveness of US. technology. There is a fundamental technological change occurring in telecommunications and this change will significantly alter the way the services are provided to the consumer. Furthermore, the benefits to the consumer of this change are directly linked to the manner in which the Government will allocate the spectrum.

There are two Amendments to the Constitution that give rise to concern; the fourteenth and the ninth. The fourteen amendment states:

" ... nor deny to any person within its jurisdiction the equal protection of the laws."

The equal protection clause has two restrictions that have typically delimited its use. One is that it applies to the states, and second that it generally applies to individuals in a discriminatory setting. However, as noted by Peltason, [36]

> *"There is no equal protection clause limiting the national government; however, just as the due process clause of the Fourteenth Amendment has been used to apply the provisions of the Bill of Rights to the States, so has the due process clause of the Fifth Amendment been used to prevent national discriminator legislation."*

Likewise, the ninth Amendment states;

"The enumeration in the Constitution, of certain rights, shall not be construed to deny or disparage others retained by the people."

As is well known, it was through this that the right to privacy and the justification to Roe v Wade was secured. In deed, the Ninth Amendment extends the protections under the Fourteenth.

Kahn has shown that the Fourteenth Amendment, under due process, was the original basis to sustaining the rights to regulate.[37] It will be argued that the same Amendment, under the equal protection clause, will provide a basis for protection from the predatory practices of an existing and dominant monopolist, sustained in its position by Federal regulation.[38]

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[36]Peltason, p. 167.

[37]Kahn, p. I, 37-40. The issue was the Smythe v. Ames case of 1898.

[38]Weinhaus and Oettinger, p. 9. This discusses the 1913 Kingsbury decision. The Department of Justice filed an antitrust suit against the AT&T companies and this was forestalled by the December 19, 1913

In Slaughter-House v. Strauder, 1873, the Court, in that ruling, stated that the Fourteenth Amendment related to persons not companies. This was latter followed by Munn v. Illinois regulating grain elevators. [39]However, in Powell v. Pennsylvania, the Court did hear this against upholding the restrictions on oleomargarine sale, thus again opening the application of equal protection to businesses as well as individuals. It is thus argued, that as a policy issue, it is necessary to carefully understand the dynamics of auctions and allocations of resources to ensure that equal protection is afforded all of the contenders.

The policy implication here is quite clear. Can an existing competitor, whose monopolistic control over the market, which was granted explicitly by the Government, be in a position perforce of its monopolistic rents and financial structures, bid in an auction, in a full and unencumbered fashion, and deny other bidders, without advantage of such Government granted benefits, equal protection? This issue is more than an academic consideration. It is the basis of the future of the evolution of competitiveness in telecommunications in the twenty first century.

6.4 PCS Player Strategies

The following table presents a list of the activities of the current players in the PCS area. Each player has developed a slightly different strategy and as a result has differing policy implications. This paper has developed a framework to evaluate those implications and to demonstrate how they will effect the evolution of telecommunications. At the heart of each of these issues is the access fee. Each of these players has taken a different position on access. Each, if successful, will alter telecommunications in the next century as a result of that position.

There are several groups of PCS entrants that have been aggressively trying to enter the market. The following table presents a summary of these players and also presents a summary of their strategies. In almost all cases, with the exception of the RBOC players, the contenders for PCS license are arguing for the elimination of access.

Kingsbury letter to Justice, proposing to dispose of the Western Union stock. Arguably, the U.S. Government thus grated AT&T and through the MFJ, the BOCs special and monopolistic consideration that allows them to continue to reap the advantages of this position as an entrenched competitor. It is therefore argued that under equal protection, that the BOCs have a disproportionate protective capacity, dating from the 1913 decisions, and supported by action thereafter. It is further argued that this could potential be the basis of an equal protection issue un this Amendment.

[39]Currie, p. 390-392.

Player	Strategy	Policy Implication
MCI	National License, single dominate control via its National Manager, and single network infrastructure. Maximize the number of participants.	The establishment of an significant AT&T and RBOC competitor in the short term.
AT&T	Single player, no other players, dominant control and full vertical integrate	Reinstitute the Bell System.
RBOCs	Protection of existing assets, Bellcore fronting, dominate the process through fragmentation of spectrum, namely 5 license at 20 MHz of occupied spectrum. Maximize the barrier to entry to any and all competitors.	Minimize competition via market and political strength. Obfuscate the obvious by reducing the value of PCS through fragmentation. Establish a maintenance policy access.
NPC	"States Rights" approach of having the power at the operator level. The Manager serves the operators, not the other way around. Democratic structure f a all general partnership, generate a national Manager on a contractual basis.	Maximizes opportunity to play in the market. Establishes a seamless interoperable nation network in the INTERNET paradigm.
Time Warner	Single dominant player, building from its base and extending into other markets by buyout.	Build from leading edge cable base. Establish a cable versus Telco compromise by US West buying to Time Warner.
TCI	Strong alliances with major competitors. Build off of key financial strengths and linkages through relationships. Be flexible without stating a specific strategy.	Co-opt the Markets with AT&T with TCI acting as a front.

7.0 Conclusions

This paper has approached the issue of access from a broad perspective. The premise of the paper is that access fees are constructs that are essential inherent taxes from one operation to another. Further the paper argues that the taxes were instituted for a specific purpose at a specific time. That purpose and time have gone by. The issue of access, however, is still with us. Thus as the 1980s were a decade of change in the IEC business, the 1990s will be a change period for the LEC and the initial element of change will be the access issue.

We have attempted to demonstrate that the PCS business, from an economic as well as accounting perspective, have little if any scale and scope. Scale depends on the technology used in local access. Thus the use of CDMA versus TDMA can and will have a significant impact on the evolution of the business. However, we have shown that PCS as a business is more dominated in growth potential by access fee structure more than anything else.

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3. NPRM COMMENTS, NOVEMBER 8, 1993
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5. EX PARTE, DECEMBER 21, 1992
6. NPRM JOINT COMMENTS, JANUARY 12, 1993
7. EX PARTE, FEBRUARY 17, 1993
8. EX PARTE, MARCH 29, 1993
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10. LICENSE AMENDMENT, OCTOBER 15, 1992
11. LICENSE FILINGS, APRIL 19, 1993
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