Disaggregation of Telecommunications[1]

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Abstract

This paper develops the concepts of disaggregation in the area of telecommunications. Specifically we demonstrate that there are certain technological trends that have enabled the development of telecommunications networks in a fully disaggregated fashion. These trends are specifically distributed processing, the loss of scale in telecommunications networks, and the ability to disaggregate elements into the hands of providers whose function it is to maximize the value content of their own network services.

1. Overview

The development of complex information networks has been accelerated by many factors; technical, operational, institutional, and sociological. It is goal of this paper to address certain elements of these factors that have the most significant influence on these changes. These observations will be based upon two observations that frequently occur in such change mechanisms; namely, changes that we believe will occur in the short term frequently take much longer or never occur, and changes that we expect will take many years have the habit of occurring all too quickly. The example of the first is electronic banking, which every bank thought would be a reality in two years in the 1982 time frame, and the example of the latter is the Web on Internet, which is the embodiment of the electronic marketing and distribution channel.[2]

The author in 1990 discussed the changing structure of networks, and in particular the influence of this change on the flow of content and transactions on these networks.[3]In that presentation was a discussion of how network structures were changing and that the old paradigms of networks were breaking down. The author argued that the centrally controlled networks of the RBOCs would no longer be the viable option and that open networks with software defined interfaces would be the viable alternative.

The terms "cyber communications" has been used in the Columbia CITI project to reflect the concept of ***communications in environments where layers of applications and platforms are used to overlay the existing physical network***. We argue in this paper that, whereas cyrebcommunications as a concept relates to the disaggragation of elements, the overall concept of disaggregation also includes functions, processes and operations. It is this concept of disaggregation in that large that we develop on this paper.

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[1]Presented at Columbia University CITI Conference on The Impact of Cybercommunications on Telecommunications, March 8, 1996.

[2]The author owes this observation of change to Bob Kahn. He made this observation, now called ***Kahn's Rule of Technology Expectation,*** at a conference the author sponsored at NYNEX in June of 1987 at which time Bob told the NYNEX officers all about the Internet opportunities. At that time the author was told by the head of MIS for the company that Bob was "totally un-realistic" and that "distributed networks" and the Internet had "no place in reality" in her lifetime. So much for having "keen insight into the obvious". As usual Bob was correct and his observation concerning the timing of the expected was right on target.

[3]See McGarty, Alternative Networking Architectures, JF Kennedy School, Harvard University, November, 1990.

Disaggregation as a network concept is defined as the breaking apart of functions in such a manner that they are easily reintegrated in an open network form but at the same time each separate function may be performed in the most cost effective manner. The essence of disaggrations is openness and value maximization. Openness is viewed from a physical and logical perspective of the cybernetwork.

Value maximization is the concept that certain element may be done more effectively by one or a few players and that these players may aggregate elements to be able to price at the margin. It means further that each disaggregated element may be done in such a fashion to maximize the economic value to the provider. Simply stated, it eschews the old Bell System concept and construct of vertical integration.

2. Key Technological Trends

There are two major trends in the process of allowing and enhancing disaggregation of networks. They are the development of a distributed processing environment and the loss of scale in infrastructure. We shall discuss each of these in some detail since they will be at the heart of our understanding of the new disaggregated networks.

2.1 Distributed Processing

Distributed processing is used in a most general fashion. We define ***Distributed Processing to mean the ability to place different processes (applications programs and other software elements) and processors (hardware computer units and the like) in different physical locations and that via the ability to intercommunication physically and via the ability of having either standard protocol interfaces or through protocol conversion processes, we can effect and virtual single entity from this distributed and physically and logically disconnected system***.

The Internet is the paradigm of the distributed system. The antithesis of this is the current voice based telephone network. We argue that having an open and distributed system, both being synonymous, that we create a Petri dish for the rapid evolution of new services and opportunities. All one has to do is to look at the evolution of the Internet over the last three years.

In terms of a distributed system, the concept of “interconnection” used in its broadest sense has significant merit. An open of fully distributed system is one that allows for ultimate flexibility. In the 1990 Harvard paper the author stated three views, and these views are even more important today;

“There are three general views of interconnection that are valid today; the Telcom, the Computer Scientist, and the User. The Telcom view is based on the assumption of voice based transport with universal service and the assumption of the inseparability of interconnect and control. The Computer Scientist view is based upon the assumption that the network, as transport, is totally unreliable, and that computer hardware and software must be used in extremes to handle each data packet. Furthermore the Computer Scientist's view of the network is one where timeliness is secondary to control. The Computer Scientists view has been epitomized in the quote, "Every Packet is an Adventure". This is said with glee, in that each data packet is set out across the network and it is through the best of hacking that the Computer Scientist saves the packet from the perils of Scylla and Charybdis. The third view is that of the user, who is interested in developing an interconnect capability that meets the needs and minimizes cost. This is minimization of both obsolescence and cost strategy.”

The author has also argued in early 1993 reference that the Internet would be open and distributed and that it was this characteristic that would make it a public thoroughfare. The term Low End User or New User was initially coined for this phenomenon.[4]

[4]See McGarty, From High End User to “New user”, Harvard Kennedy School, May, 1993.

2.2 Loss of Scale

Technology has had a dramatic influence on the cost of entry into a market. More importantly, there is the concept that "silicon is almost free". Namely that we can now construct systems that have low fixed costs and that the capital per subscriber, whether is be average or marginal are almost equal. This means that technological changes have driven scale economies out of the business.

There are three examples of loss of scale. The first is the advent of the ATM (voice packet) or Frame Relay (Long Packet) switches. Unlike the old Central Office switches which are priced at a fixed entry costs of $5,000,000, one can enter a switched voice or data market with an ATM at $50,000, and reach loss of scale at 50 to 100 lines or even less. Fundamentally, ATM fabrics present a level playing field to all entrants.

The second example is wireless, namely CDMA. It has been shown by the author that unlike analog or even TDMA, CDMA cellular reached a capital per subscriber of $200 or less at 30,000 subscribers or less.[5] In the analog world scale was not lost until the subscriber base was ten times that number. Thus PCS using CDMA is almost one tenth the capital per subscriber as the current wire based telecommunications business of the RBOCs.

The third example is the concept of outsourcing. This is the "virtual" loss of scale. One can use service bureaus for billing or customer services that allow for pricing at the margin. The provider of network services no longer is required to provides for all software, computers, personnel, training and infrastructure.

This loss of scale has several dramatic consequences;

Barriers to entry are removed: This means any new entrant may get into some part of the business. Combined with the distributed element, the new entrant may do so at little costs.

Economic and Regulatory Rationale for monopolies are eliminated: There is no longer the justification that one large entity, to who consumers are paying monopoly rents, is the best entity due to scale economies. One must re-look at the regulation.

Change can be Effected More Swiftly: Loss of scale allow for rapid changes in service offerings by eliminating the concept of sunk costs. Albeit sunk costs are not to be considered in economic decisions they are frequently a significant factor in delaying change. The elimination of theses virtual burdens should allow for more rapid change.

3. The Disaggregated Network

We briefly show what the structure of the disaggregated network will look like and do so in the context of several specific examples.

3.1 Disaggregation Elements

Disaggregation falls into three dimensions; technical, operational, and relational. We define each as follows:

Technical: Technical disaggregation is what we have used as the term a cybernetwork. It is the ability to overlay applications and platforms a disparate backbone of transport facilities and create a whole. An example of technical disaggregation is the client server architectures and the LAN networks in common use.

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[5]See McGarty, TPRC, September, 1993.

Operational: Operational desegregation is the breaking apart of re-assembling in any fashion the operational or business elements to effect the successful provision of service. Namely we can separate billing, transport, sales, service, and network control into different pots and create a virtual corporate entity. We no longer have to do all. We only have to do that part that we do well. An example of operational disaggregation is the outsourcing business whereby a company such as a Bell Operating Company would use an outsourced customer service center to provide this function, or in another context of a bank who outsources all of its telecommunications network.

Relational: This will be the issue of who does what to whom in such entities as electronic marketing and distribution channels in a telecommunications cybernetwork. This is the most recent example of building cybernetworks via relationships. Unfortunately many of the current examples are examples of failure; Prodigy with IBM, CBS and Sears, or MCI and News Corp on the Internet side.

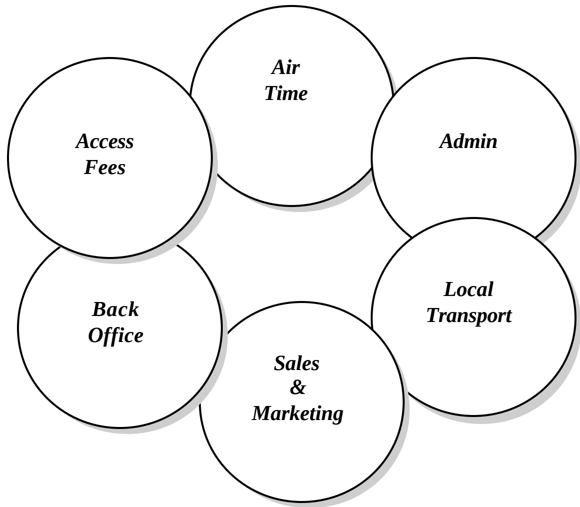
In this paper we attempt to focus on the latter two elements. The first has been treated elsewhere.

3.2 Disaggregators

This entity is a key differentiation in the market. The Disaggregator is one who may use the existing license holders access facilities as one of several means to provide service to a fixed customer base. In FCC Docket WT 96-6 the Commission raises the issue of allowing the CMRS to provide fixed services. Namely this allows the CMRS, as defined by the Commission, to be a purveyor of what is normally termed "LEC services" and for the purpose of WT 96-6 is called wireless local loop, "WLL". It is argued that the Disaggregator is a different entity altogether and more importantly it is argued that the disaggregator is the most likely evolutionary entity to change as full competition is presented in the wireless market.

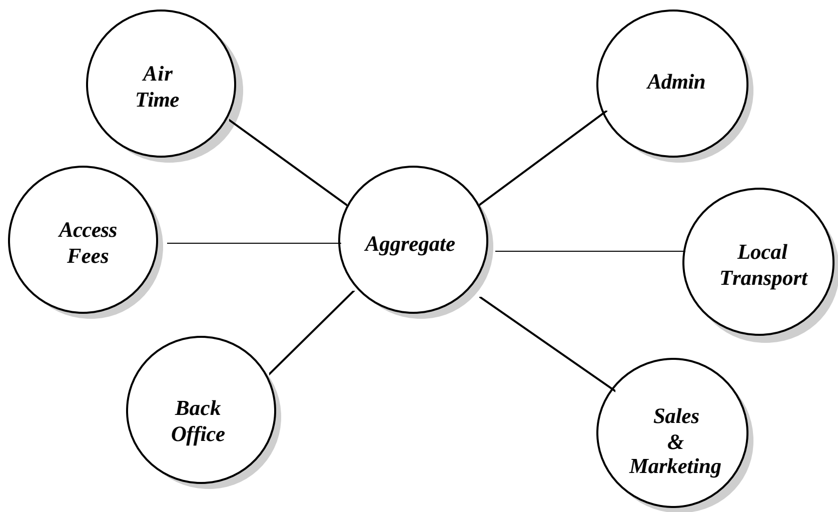
The author believes that by acting as a "Disaggregator" it can effect this competitive position. The Disaggregator works on the following principles. The provision of wireless services is based upon the integration of the service elements shown in the following Figure. This integration may be performed as an aggregation or as a desegregation approach. The Aggregation is the way most of the CMRS entities now work, having control over all of the elements of "production". The Disaggregator as control of certain strategic elements but will "outsource" other.

This following Figure shows the parts of the telecommunications business from a functional perspective that must be provided.



The approach of the author to this market is a full disaggregation strategy for deployment of the business. Specifically the company may outsource services, buy Airtime, contract sales, and would hold minor administrative duties unto itself. This means that a company can get into the business of providing local exchange services as well as mobile like services without holding a license. In fact it further can do so through the acquisition of intermediary transport via wireless and terrestrial based suppliers. It is argued that this reseller business paradigm has been at the heart of the inter-exchange business during its first ten years of deregulation, and it was this strategy that gave rise to the maximum amount of competitive pricing and services development.

The following Figure depicts the ability of the company to sell a service based upon the purchase of all of the elements. It also demonstrates what is actually happening to the industry. The key issue will be disaggragation of Airtime.



4. Information Networks

Information networks have seen significant evolution over the last fifteen years. The author divides them into three segments, all of which have converged in the past fifteen years. The segments are the ARPA Net, Proprietary Corporate Networks, and Proprietary Consumer Networks. We shall begin at the end and move forward.

As noted, information services are naturally a valued added benefit to commercial users and the consumer is generally interested in entertainment or at most a limited transaction capacity. Transactions are also purchases and to obtain the purchase the seller must not only have access to the buyer but also must promote and persuade. The video medium that currently exists is a promotional medium and creates awareness.

The vision of Videotex has been significantly blemished over the past ten years in the United States. We all too frequently look to the success of Minitel in France, but we all too often have no knowledge of the French Telephone System. Telephone Information Operators in France are almost non existent and when available have been known to hang up on customers in less than the most polite fashion. In addition, the French Telephone company, in conjunction with the French Newspapers, developed a way to ensure a noncompetitive advertising market in an electronic fashion. The classic yellow pages were abandoned, the terminals were underwritten by the government as a social action move to develop a technology base, and the public turned to their favorite pastime, now in digital form.

Minitel is not the harbinger of things to come in the area of home information systems. The regional Phone companies have all introduced videotex gateways for use of information services. These have been of little success. It is still to be determined what the consumer wants from electronic information services. However, the use of the World Wide Web, using a Web browser such as Netscape, which is nothing more than an FTP front end, albeit an ingenious one, is a major breakthrough in empowerment of content and transaction providers.

As indicated, the use of the communications channel through the end user interface allows for a distribution or sales channel for products or services. Promotion and persuasion are critical and these require high quality, personalized, self segmented, full motion video. The impacts on the network are significant and it is possible to perform this task only with the extended network that we have developed. The architecture of user empowerment is essential and existing networks cannot meet the needs.

4.1 Proprietary Consumer Networks

In December 1977 Gustave M. Hauser, then CEO of Warner Cable, initiated the first two way fully interactive Cable TV network called QUBE. It allowed users to purchase pay-per-view services, bank at home, shop at home, play games, and all the things that could be done using a high speed two way channel. The data rate was 256,000 bps! Pioneer corporation provided the terminals in the home and Data General did the computer system. What is important to note is this was almost twenty years ago!

Remember ***Kahn's Rule of Technology Expectation***. At the same time the author was interconnecting ARPA from Eatom, WV to Goonhill in the UK. There we were trying to get 56 Kbps by satellite. At the same time you were lucky if AT&T allowed you the use of 300 bps on the telephone lines. The past is prologue to the future.

The next step was in 1982 when the author, then at Warner working for Hauser initiated the first two way video-on-demand system in the world. It worked in Pittsburgh, using 100 Pioneer video disk players, and included content providers such as Spiegels, American Express, and Bank of America. The joint venture partners were Bell of Pennsylvania, then with Ray Smith as COO, Bank of America, Digital, and GTE.

The Warner TIES (for Transaction, Information, Entertainment System) system was functionally successful using a two way integrated cable-telco system to allow it to work in systems not having two way activated cable.[6] The way the system worked was simple:

- *It used a return telco path for low speed data to the head end. The path on the CATV link to the home used a bank of video channels that passed the homes. The number of video banks was selected as six passing each home.*

- *From the headend the system used a bank of videodisk players, 100 in all in the first system. The videodisks were prepared by and sequenced with videotex that was separately provided on a stand alone system.*

- *A request for a full motion video segment was sent to the headend from a subscriber.*

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[6]See the following references by McGarty at that time:

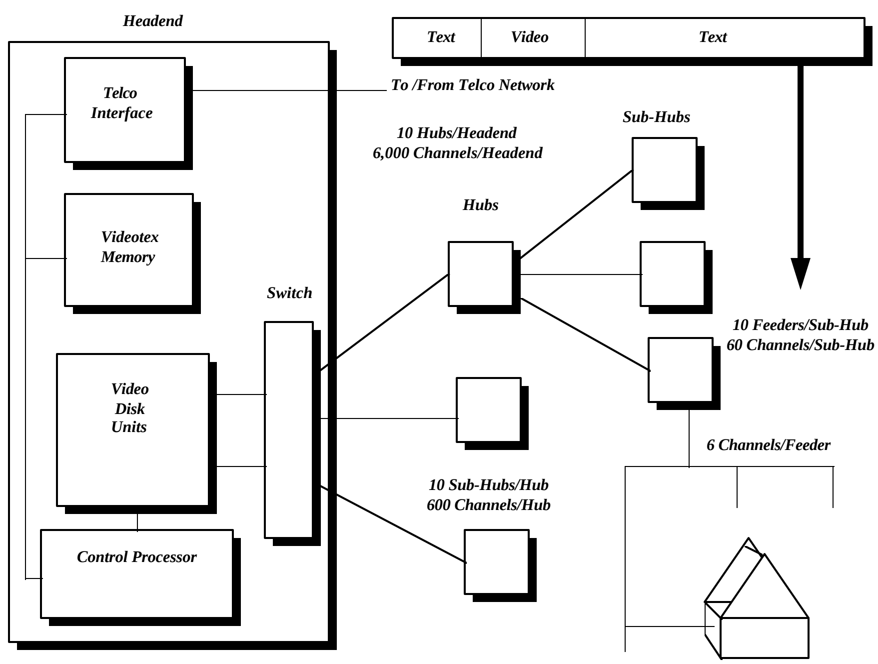
i. Financial Data Networking and Technological Impacts, INTELECOM, 80', Los Angeles, CA, 1980.
ii. EFT Networks and Systems, CASHFLOW Magazine, November, 1981.
iii. Local Area Wideband Data Communications Networks, IEEE EASCON, Washington, DC, 1981.
iv. CATV for Computer Communications Networks, IEEE Computer Conference, Washington, DC, 1982.
v. QUBE: The Medium of Interactive Direct Response, Direct Marketers Compendium, Direct Marketing Association (New York), pp 162-165, 1982.
vi. Impacts of Consumer Demands on CATV Local Loop Communications, International Communications Conference, Boston, MA, 1983.
vii. Hybrid Cable and Telephone Computer Communications, Computer Conference, Washington, DC, 1983.
viii. Cable Based Metro Area Networks, IEEE, JSAC-1, November, 1983.

- *The system then responded with a frame formatted signal that changed from text to short video segments, the segments being on demand. The segment lengths were 30 to 90 seconds, and were obtained from the VDU.*

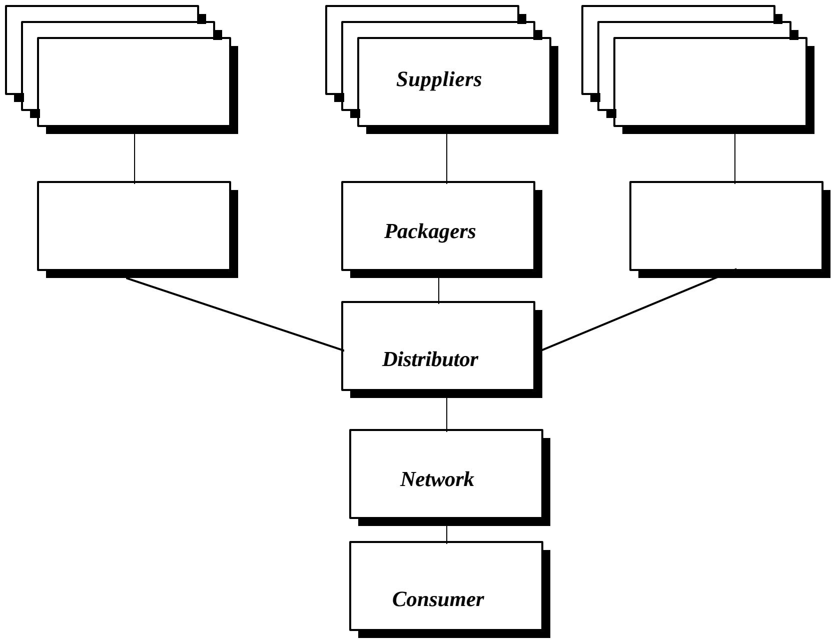
- *The system used a space division multiple access system (SDMA) wherein there were six video channels for burst video per home, there were ten of those per sub-hub, or 60 per sub-hub, there were ten sub-hubs per hub, or 600 video channels per hub, and ten hubs per headend, or 6,000 effective video channels for the system. There were generally 100 homes per local feeder. Thus is there were a 6% Erlang load per home, each home could have full time full motion video!*

- *The back-haul networks were all fiber, single mode, with the Pittsburgh system being the main site of operations.*

Figure: The Warner TIES System



In 1982 Cox introduced the Indax System which was a step above QUBE in using specific Videotex standards. All of these systems had the following non-distribute paradigm for their architecture:



The functions of this hierarchical paradigm is as follows:

Entity	Function	Example
Supplier	*Primary provider of the product or service. May be a game company, may be a clothing manufacture, a local bank, a tour agency or some other entity.*	*Clothing Manufacturer (Levi's)*
Packager	*Aggregates industry specific suppliers and provides a common interface for them to reach the customer. For example, American Express could have developed.*	*Lands End, Spiegel, American Express, Sears*
Distributor	*The entity that collects the "customers" It looks towards the customer an not the supplier. In this case it would have been Warner, Cox or others. In the late 1980s it was America on Line and Prodigy. Compuserve was somewhere in between.*	*Warner, Cox, AT&T, Prodigy, AOL*
Network	*The provider of the "physical" connection. It may include or bifurcate the transport and terminal. It may integrate several networks.*	*CATV, RBOC, Atari, IBM, etc.*
Consumer	*The ultimate decision maker.*	*You and me!*

We now have to ask why did this not work. The answers are that technology changed, terminals entered the home, and the Internet.

4.2 Corporate Networks

The networks were generally proprietary. Some open example were the Dialog system, now Knight Ridder Information system. This was a high end information rich environment. Another was Lotus Notes. This is a closed system. We can make two observations. Knight Ridder allegedly has Dialog up for sale having not made a smashing success of its acquisition and AT&T just dropped the Notes concept in favor of Internet. The former example is that of a high value sustainable niche business that should be run that way and the latter is an example of the tail end of closed non-cybernetwork environments.

4.3 Internet Structures

The current architectural structure of the Internet has been described elsewhere at length.[7] We review it briefly here to establish a basis for a detailed description of the system. Before doing so it is important to view the evolution of the INTERNET concept in the context of several Phases. These phases are:

Phase 1, The Simple Internet (1968-1974): Beginning as an experiment in networking, "the ultimate petri dish", in this period the Internet, as ARPANET was a simple interconnection of at most 56 Kbps circuits interconnected by Intermediate Message Processors, IMPs. The user community was a collection of large scale computer processing facilities, called Hosts, with end users who were uniquely identified with their host computers. The concept of time sharing in an operational context was not present.

Phase 2, INTERNET Goes Global (1973-1981): In this period the TCP/IP protocol is developed and added on top of the existing datagram network. Although originally aimed at remote login and file transfer (FTP), the afterthought, Email, became 95% or more of the total network traffic.

Phase 3, Military and Non Military Split (1982-1986): During this phase the non-military INTERNET evolves. DoD separates its network and the residual is spun off into a larger user community. Unauthorized accesses are found and user scares from hacking are observed. The user community expands, allowing access to new user communities. The backbone grows to T1 rate, namely 1.544 Mbps.

Phase 4, The Mitotic Period (1986-1992): "Cell" division of the network occurs. DS3 or 45 Mbps circuits are added and local and regional networks are adopted. The proliferation of access closer to the end user is generated and hosts grow explosively. Networks seen by the INTERNET grow from about 100 in 1988 to over 5,000 in 1992. Personal computers proliferate, and access to the end user is now growing. Identity is still with the host.

Phase 5, New User Access Era (1993-1996)[8]: This era is the era of New User access and the proliferation of commercial user hosts and networks. The user community is expanding from the computer literate and comfortable to the infrequent user community, and those whose expertise is frequently exceeded by their enthusiasm and expectations.

Phase 6, The Distributed Open Network (1996-) : The network moves into a Giga bit per second backbone allowing for the first time real-time access to such applications as multimedia processing, video, and supercomputer networking. The protocols for access allow expansive addressing and accessibility. End user access costs are reduced by access costs enablement/control policies and the introduction of 64 Kbps

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[7]This section is a paraphrase of the McGarty Internet Paper, Harvard, May, 1993.

[8]It should be noted in the 1993 paper by the author this was the "Present" and not 1996!

end user transport access to all terminals. Host identity is now made consistent with user identity. Specifically, in this phase, the end user may have sufficient processing power and memory capability, as well as communications access capabilities, to be a host.

The essence of Internet facilitation and accessibility is the set of protocols accepted by the community to allow access by a wide variety of hosts in a complex and fully distributed fashion. The protocols are at the heart of Internet success. They are the "software and system agreements" that allow disparate machines and software to talk across equally disparate networks. The current protocols focus on data transactions, with some innovation allowing images and limited multimedia; namely voice and video. The future challenge will be the development of new and innovative protocols to allow New User access to grow while enriching the capability of the information transferred.

The current Internet Architecture thus has two main elements. The first is the semi hierarchical structure of Backbone, Regional, Campus and Host, and the second is the agreement on a single protocol to talk across the Internet, currently embodied in the TCP/IP suite. These elements reflect a great deal about how the Internet is managed and its growth potential. INTERNET Transmits with a High disaggregation of data: The network assumes a high degree of disaggregation of the data from one location to another. Namely, it packetizes data extensively assuming that it can do so because communications is between computers.

4.4 The Electronic Distribution Channel

The concept of the evolution of the Internet was to create an open inter-exchange of information and ideas. It also becomes an open electronic marketing and distribution channel. Namely it creates the version of an electronic “bazaar”. This is a flowing open air market of many purveyors of information, products, ideas, services, etc. This is the way we as humans sold our wares for thousands of years. We only had shopping malls for the past fifty. In may ways Internet today is the sales stalls inside the gates of Paris in 1270. We enter, scan what is there, wander around seeing many vendors, select our products, carry them about with us in a generally clumsy fashion. There are no organized billboards, stores, restaurants and the like. It is not even the eighteenth century in Boston with small niche oriented stores. There is a dissonance but it seems to work.

The question is what is its future direction and how does the cybernetwork effect this change. It is argued that this change will occur and the structure will evolve into the original paradigm that we discussed in the early networks. However, for the to occur, the economic value of each function must be understood and its relationship to others defined by convention and experience.

4.5 Architectural Evolution

The New User community has a different set of requirements for both the use of and access to the Internet facilities. The emerging demand for multimedia services and the potential mobility of the New User present several challenges to the architecture which may change its elements in an evolutionary sense. In this section we develop some of the key new dimensions in the expansion of the Internet architecture. These dimensions reflect not only the needs of the New User but also those of the remaining established user base. The main catalyst is the New User , however, because the expansion of applications, the reduction in costs of access and the redefinition and commoditization of the host concept are fundamentally driven by the expanded nature of the New User applications.[9] The two major dimensions along the INTERNET change

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[9]The Host has been defined as the computer and communications complex that represents the end users access point to the Internet or the point at which the end user may have access to another end user. The principle of redefinition and commoditization is based upon the two factors described earlier, namely increased end user processing capability and reduced high speed communications access. The host redefinition results from identifying multiple hosts per user rather than multiple users per host, as well as the concept of a portable or mobile host. The commditization concept is based on the dramatically lowered costs

axes are lowered costs and higher capabilities of communications and processing. The new paradigm against which the new architecture will be determined is multiple hosts per users rather than multiple users per host.

The first major issue is that of access to communications. In this dimension dramatic changes are occurring. Local exchange access, also know as the “last mile” problem, is one key issue. ISDN was and still is an option, yet it always has been too little and too late. Alternative access mechanisms such as wireless PCS and CATV may lead to the elimination of ISDN. ATM (Asynchronous Transfer Mode, or packetized high speed networks integrating voice and data) switching is another technology change element that has a great deal of potential for expanding local access as well as the long distance access

A future communications and processing issue that will define the architecture is whether dark fiber, providing bandwidth capability coupled with intelligent hosts handling the switching in a highly distributed fashion, will become a viable commercial option. Dark fiber, or simply the provision of access from a host to any fiber with no telephone company intermediary switching, could allow for highly intelligent hosts to control the communications processing at the periphery via intelligent high layer protocols. This is the concept of intelligence at the periphery of the network, namely at the host.

This concept states that communications should be minimalist in form, namely that the communications providers should do nothing that delimits the creativity of the processing hosts intelligence and capabilities. Intelligence in the network results frequently in what has been termed the hierarchical network paradigm, a design that has been at the heart of telecommunications for over 100 years. Intelligence at the periphery is a paradigm that enables distributed processing and enables the end user maximum flexibility in design and in the provision of services. Until dark fiber becomes an available commodity, switching will remain a centrally provided host service. Host processing capability or intelligence and not the communications network intelligence will, in any case, be the driver that will enable and promote new and innovative services to the New User community.

Specifically, we believe that there are three main technological changes which will impact New User migration as well as the existing base. These are;

- Multimedia Communications: This area of multimedia communications is generally the least understood and most discussed area in both computers and communications. The challenge of multimedia communications is to create what we have called "displaced conversationality". This means the provision of all sensory inputs and outputs to any human user, at any time and place, required for the transmission of information in order to transact a series of events, leading ultimately to an agreed consensus amongst the parties involved in the transaction. Simply put, it means that I can talk in simple terms with anybody else, using whatever displays, video, data, voice or other annotations I desire, either simultaneously or at a delayed period of time.

- Access Expansion: Access implies any and all physical communications means that a user may have to access the Internet, either through the Campus system, the Regional or even the Backbone. Today, we view the access to be achieved via a telephone line or possibly a LAN. In this paper we extend the access in two dimensions; CATV and wireless. CATV access means broadband access, even with the systems in place today.

- Host Migration: Historically, an Internet user was identified with a Host. The user had access via the host and the user was merely an extension of this host. This made sense when the user requires access

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for both computer power and communications. Thus the multiple hosts per users is initiated by the lower costs of both processing and communications.

to the host for the host shared resources. With the increased power, capabilities, and ubiquity of personal computers, migration of identity from the host to the user is more likely.

We have developed each of these areas elsewhere. The issue is not what these changes are, but what are the implications of these changes on the Internet and the User community. Will these changes be feasible with the evolving Internet, will they be more likely to occur in other networks, and if they are Internet compatible, how can they be implemented. However, what cannot be denied is the fact that the User community, as well as the established user base, will demand the capabilities that are being discussed, and that the confluence of market demand and technological innovation will make this a reality.

4.6 Access Expansion

Access is defined as the physical connection between a local host or network entity and the body of the Internet. It is the last mile or the last 1,000 feet connection to the Internet. It also is generally the most costly. It may be the local telephone company and a dedicated access line, or it may be the campus local area network. We shall focus on the User exclusively, and shall consider access as a full time and real time connection to the Internet from a single User location to the remainder of the network. As a point of reference, PSI may charge a user almost $1,000 per month for such a connection, the costs dominated by the local telephone company. Such charges are the primary barrier to entry to the User.

Access fees must be changed if the User is to be more than a sporadic user of the service This section discusses two alternatives that are currently being developed. We shall focus on two of the most dramatic areas of change and discuss their architectural implications. Specifically CATV and wireless access. The existing CATV entities have argued that they have an infrastructure that is highly suitable to use for local access and broadband access.[10]

To demonstrate the potential of Cable for local access we review some of the Cable architectures and directions. The current CATV systems have a tree and branch architecture that is one way. CATV systems have two major plant elements; the residential cable that services all homes and the institutional cable or loop which was required for the Cable franchises but never put to use.

The institutional loops present significant access alternatives. The institutional loop passes many homes and commercial locations and is designed for two way high speed data as well as video. Thus, institutional cable is not a typical one way video distribution system. It can be used for data applications and can readily be used as an element in INTERNET access. CATV companies have also been adding additional backbone elements and have been using these as CAP, Competitive Access Providers, in the commercial areas.

CATV was initially two way capable and some systems such as the Warner QUBE systems were two way activated. However, this requires the use of two way repeaters which are inactive in almost all plants. There is 50 MHz of bandwidth available in all CATV systems for residential use and 150 MHz for all institutional use. The question is how to take a one way system and make it two way.

This two way capability is achieved by creating a 50 Mbps or even 100 Mbps bus comparable to that provided in FDDI.[11] This is achieved by looping the local feeder cables back to a bus fiber via a bridge. Thus

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[10]The author notes that in May, 1993, there were no CATV access alternatives. In August of 1993, Continental Cable of Boston and PSI of Reston Virginia signed a joint agreement to allow access to the Continental Cambridge customer base to Internet at a proposed rate of $100 per month. This was a factor of 10 less than the telephone rates. As of this writing of this version of the paper there are no known customers on the proposed network.

[11]Cable systems are generally split with a 50 MHz band on the return path, the path from the home to the headend. All of the other bandwidth is from the headend to the home, see McGarty and McGarty, [4] 1983.

the system looks like a broadband system allowing any home or location with up to 100 Mbps service with minimal capital change in the CATV plant.[12] The question then is, what are the user requirements for such a system. Simply put, we can assume that a single user is accessing the system and that when accessing it transfers 4 Mbit of files per hour. This is approximately 1 Kbps average rate, and on average if there are 8,000 users, we need about 24 Mbps to handle all of them.[13] Thus a cable system can theoretically handle a reasonable community of users.

In a CATV environment, there are several reasons for lack of CATV two-way broadband digital infrastructure at the present time. Specifically they are:[14]

(1)

(1) Interconnect: In a reasonable radius from any large metropolitan area there are one to several dozen CATV entities. The issue of interface and interconnect has never been adequately addressed and there are no standards that allow for this. In addition, CATV switch access uses the same dated architecture as does cellular and thus is highly reliant upon the existing LEC. This will merely drive up the costs of goods for the carrier.

(2) Availability: CATV systems have a system availability, or the percent of the time that the system works for all users, that is less than 90%, whereas communications networks have availability numbers in excess of 99.5%, namely outages occur less than 0.5% of the time. The inherent structure, operations and management of the two networks are currently incompatible. Specifically CATV, as currently operated cannot provide toll grade quality service.

(3) Bandwidth: Bandwidth in a CATV system is limited, except on Institutional loops. Local bandwidth is structured for video and the two way systems have limited return path. When we begin the multimedia applications, the bandwidth need is even greater.[15]

(4) Performance: Data transmission performance on coaxial or fiber/co-ax has been shown to have significant problems due to an excessively noisy environment resulting from many open cable access termination in homes of current or prior subscribers. Admittedly this may be ameliorated by real time noise supression systems or interactive devices in the homes, but it will require significant rebuilds as well as management and administration of the subscriber loop.

(5) Inactivated Two Way Returns: Two way cable almost ceased to exist as an operating entity with the demise of the famous QUBE system.[16] Currently there are less than 0.1% of the CATV systems with

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[12]In fact, it can be argued that the CATV plant is left unchanged. A third party may find it appropriate to build the backward flowing bus, and thus require no capital change to the CATV operators plant. This may be a way to do this given the new regulation imposed on cable companies.

[13]See McGarty, Access Policy, Telecommunications Policy Research Conference, October, 1993, Solomon's, Island.

[14] McGarty, T.P., R. Veith, Hybrid Cable and Telephone Networks, IEEE Comp Con, 1983. and, McGarty, T.P., S.J. McGarty, Impacts of Consumer Demands on CATV Local Loop Communications, IEEE ICC, 1983.

[15]McGarty and Clancy, [5]. The authors develop the model for integrated video, voice, text and data on an integrated cable-telco system. This paper, although for proprietary reasons not describing the full motion video on demand system, does present the detailed technical analysis.

[16] See: McGarty, T.P., G.J. Clancy, Cable Based Metro Area Networks, IEEE Jour on Sel Areas in Comm, Vol 1, No 5, pp 816-831, Nov 1983. , and McGarty, T.P., Local Area Wideband Data Communications Networks, EASCON, 1982.

active and operational cable return paths and supported bi-directional amplifiers.[17] For the CATV system to function this must be addressed.

However, we argue that these limitations can be eliminated from the current designs, and thus allow significant Internet access. Specifically,

(1) Interconnect: CATV companies are being pressured to establish interconnect amongst themselves at the head ends as well as entering into the CAP, or Competitive Access Provider, business. This will ensure system to system access. Internet access can be achieved directly via a CAP point of presence, or PoP.

(2) Availability: Trunk CATV transport is being upgraded to fiber which is much more reliable. By establishing a bus network on top of that, alternative routing is possible and the system availability improved.

(3) Bandwidth: Using Institutional loops, 150 MHz is available and with high signal to noise and controlled interference it is possible to achieve 300 Mbps on such loops. Thus a bus of 300 Mbps or more is achievable in today's architecture.

(4) Performance: This is a major problem area generally due to open taps on the cable. This may require better maintenance and control, which is a methods and procedures problem for the CATV operators.

(5) Two Way: This is achieved via the bus proposal.

Therefore, CATV provides Internet with a viable and current option for the expansion into high data rates and multimedia capability.

5. Wireless Networks

Wireless communications services introduce new sets of technologies that will create a new local loop access paradigm. The current view of the local loop is that of a bundled set of services that possess significant economies of scale and thus justify permitting the Local Exchange Carriers (LECs) to have a total monopoly in the local exchange. The new technologies allow dramatically lower capital costs per subscriber and also eliminate the scale and scope economies in local access.

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. 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.

What does wireless do for the Cybernetwork? There are several things that it does immediately:

(1) Access Expansion: Providing access to places not readily served. This is, for example, school class rooms and other locations not now served by wire based telephone.

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[17]For example, the author has been told by Continental that Cambridge was the only system with two way activated feed in their entire network.

(2) Expanded Bandwidth: Using wireless, it may be possible to take 20 to 40 MHz of bandwidth, and create a 40 to 80 Mbps bus to allow PDA users access to a wide variety of services including multimedia.

(3) Terminal Identification: Wireless has an infrastructure that will enable the "Find Me!" paradigm to be effected. It has more than the cellular roaming capabilities that we have seen evolve in the older analog cellular architecture.

It is clear that wireless will introduce many new dimensions to access. Most especially, wireless is a direct competitor to the local exchange carrier. It can provide voice and data, and a limited amount of video. We show in the next section how disaggregation works in the world of wireless.

5.1 Disaggregation of Wireless

Voice is a product offering that has two major characteristic; it is commodicizable and it is price elastic. The concept of commodicizable implies that voice service from one carrier is the same as voice service from another, if the underlying quality is the same. The only determinant in a commodicizable product will therefore be price. Data bits transmitted across fiber in an Inter Exchange Carrier, IEC, network are commodicizable at the transport level. Voice grade residential service is also commodicizable. This clearly has been the case in the Inter Exchange area with movement from AT&T to MCI driven by price.

Price will determine the rate of adoption. Simply put, if the product is commodicized, and the consumer has no other product differential other than price, the consumer will determine the product solely on price, and given a strong price differential, the consumer will shift.

There is a four point disaggregation strategy to expense reduction and the proper execution of the Service business. It is as follows:

Reduce Access Fees to Zero: Access fees are those charges the Local Exchange Carrier charges anyone to interconnect with them. Charges of $0.11 per minute are common. At 600 minutes per month, typical the Service usage, this will be an access fee of $66 per customer per month. There is significant action directed at eliminating access fees. Some companies have bee successful in some states in achieving this goal.[18] In other states, the RBOCs, through their LEC are reconsidering their positions.

Obtain AirTime at Wholesale Rates: This will be the three Phase strategy of requesting DS1 or equivalent circuits from the Cellular or wireless provider and reselling bulk rates. This has also been termed the "Dark Hertz" strategy as compared to the "Dark Fiber" strategy tried in long distance and in some cases in the local exchange market.

Minimize Operating Costs on a Marginal Cost Basis: The operating costs of a system, namely the back room operations, are significant factors in the overall cost performance. the Service operators forget the need for such services as network management, customer service, billing, roaming, IEC interfaces, and operator services. To build these de novo is quite expensive and prone to risk. To build these also results in considerable difference between average and marginal costs.

Low Cost to Acquire Customer and Minimize Churn: The acquisition of a new customer is the most important element in success. Customers generate revenue. Customers also have inherent

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[18]Telmarc Telecommunications had filed a tariff in Massachusetts for its the Service offering at $30 per month for unlimited local usage, within a thirty-five mile radius of Boston. The Massachusetts Department of Public Utilities awarded Telmarc Telecommunications the first the Service Common Carrier Certification in the United States for that effort.

costs. The cellular model is an expensive model. It has two elements that must be avoided; the use of dealers and resellers and the resultant churn of the customer base. The attempt to sell a commodicized service, with a bundled product, namely the portable, will allow direct marketing techniques to be applied to the Service.

Let us take this a step further. Let us assume the following:

Access: Assume that the current FCC Docket CC 95-185 allows "Bill and Keep" or zero access fees. Thus we can obtain interconnection at now costs.

Air Time: Let us assume that we can obtain air time from an incumbent carrier in an unbundled fashion as required by the 1996 Act.

Operations: Let us assume that we can "out-source" our billing, customer services, and other elements on a per subscriber basis as can be done with such companies as NPC.

Sales: let us assume we use network marketing, as per the Mary Kay or Tupperware school, and pay our sales agents a percent of gross revenue per month per actual customer.

What has been accomplished. First, this is disaggregation. Second, for every dollar of revenue we have a commensurate dollar of expenses. There are no FIXED costs. This means anyone smart enough can get into this network business. We now expand this a step further.

5.2 Airtime Disaggregation Options

Let us begin with a discussion of airtime first. This is important since it addresses the Noam Hypothesis of airtime as a public assets and not as a private good. This will be the basis of a critically important policy element. Let us assume that there exists a Disaggregator. The Diasaggregator may approach the market in several ways as the disaggregation of airtime. This can be done in four ways:

- ***Type 1 "Buy Fully Integrated Minutes" :*** This is what is available to the current resellers. The CMRS, generally the duopolistic cellular company sells minutes of connect time from the customer to the RBOC LEC.

- ***Type 2 "Disaggregated Minutes" :*** This is the sale of cellular minutes from the customer to the trunk side of the CMRS switch.

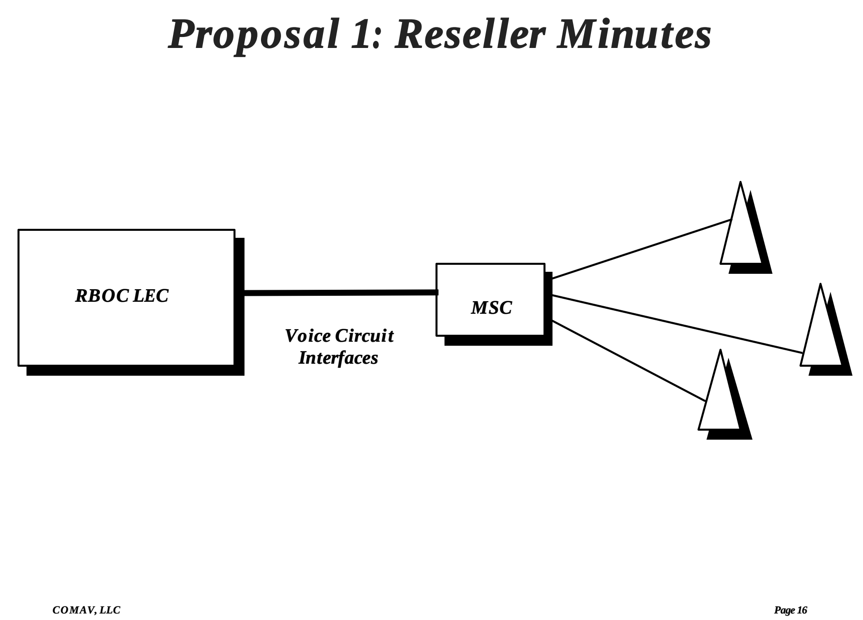
- ***Type 3 "DS1 Buys" :*** This is the purchase of DS1 or 24 voice channels from the cellular purveyor from the users to the trunk side of the CMRS switch.

- ***Type 4 "Spectrum Access" :*** This form of air time disaggregation is the most extreme. It allows, depending upon availability of spectrum, the purchaser to buy from the license holder, IF Bandwidth.

The following subsections discusses each of these requests in some detail.

5.2.1 Type 1: Airtime Interconnection at LEC Interface

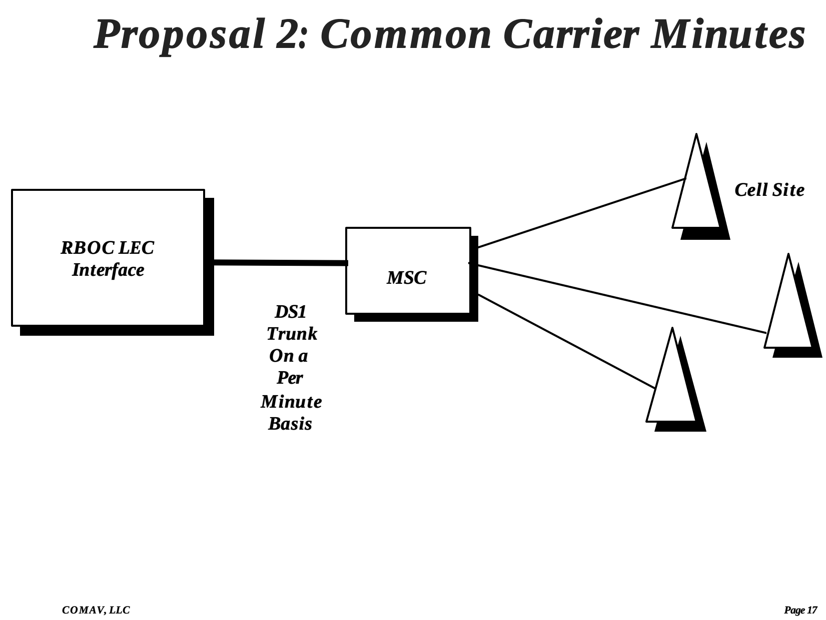
This approach or proposal is to purchase or buy straight Airtime at the standard reseller rates. These are generally at the range of $0.20 per minute. This is as shown in the following Figure. This has already been discussed with the major cellular companies.



5.2.2 Type 2: Airtime Connection at Trunk Termination

In this proposal the company is to terminate on the MSC with a DS1 circuit and to have the connection from the CMRS carrier to the LEC be a competitor connection. It allows the competing LEC to sell service from that point on and allows the competing carrier to become a Local Exchange Carrier in its own right and seek appropriate interconnect and access pricing agreement from the monopoly local exchange carrier, the RBOC.

This has been proposed to the Cellular companies and has yet to be accepted. It would reduce the rates to approximately $0.18 to $0.15 per minute. This is shown in the following Figure



5.2.3 Type 3: Bulk Voice Channel Buys with Trunk Termination

This is the critical step that allows for success in local market competition and has been proposed under several other state dockets. What is being requested in this Phase is the purchase of a DS1 bank of voice channels. This is not a per minute rate, rather it is a buy of air time at risk.

The new carrier takes the risk of loading these circuits up and then sell them. This is what is done today in the LEC market. It is mandated to LECs that are not CMRS by the 1996 Act but is not done so yet in this area of the CMRS. ***The author sees that the Commission has the ability to join this issue and so mandate that the existing CMRS must unbundle the DS1 circuits and sell them to competing LECs.***

The competing carrier would take the risk of filing the channels with traffic. The following simple calculation how such an approach could be priced:

- *Cell Capital at about $750,00 fully loaded per cell.*
- *In an analog system, 30 KHz per voice channel, 15 MHz per band, reuse of 7, yields (15000/(30*7)) or 72 instantaneous trunks per cell, or three DS1.*
- *The capital per DS1 is $250,000.*
- *The lease rate for seven years at 18% annual interest is 2% per month or $5,000 per DS1 per month.*
- *A uses is busy 1% of the time at 100 minutes per month. Thus a DS1 can handle 2,400 users. That is $2 per user per month.*
- *At 100 minutes per user this is $0.02 per minute, a factor of 10 less than the Phase 1 Rates!*
- *If we further assume that there is a less than 100% loading and that the usage is less than 100%, and we use 50% in both cases, the effective rate per minute is $0.08. It is this strategy that shows how one can achieve the result of expanding competition and in un-bundling.*

The author further notes the following facts:

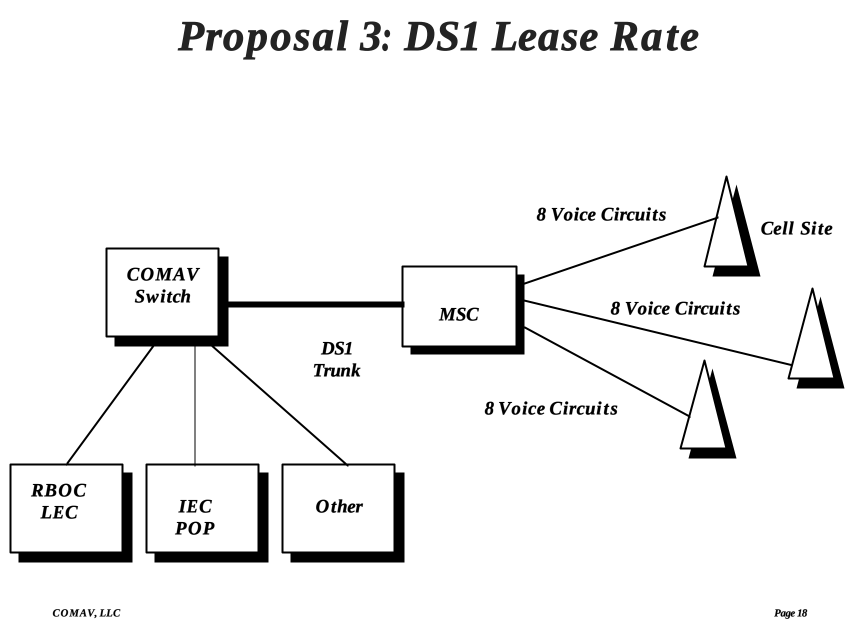
- Under the most conservative calculations, the above pricing scheme for analog voice provides Air Time at almost one-third of what the current providers are selling it at. This is comparable to building a DS1 from 24 DS0 circuits because the LEC refuses to sell a DS1.

- The above calculation assumes a very costly cell capital structure. Most analog cells may be half to one third of this, even with full capital allocation and cost allocation.

- Digital cells have five to twenty times the capacity as analog and thus for the same of similar capital the capacity is five to twenty times as much per unit capital. Thus digital introduction should drive down the costs by a similar amount.

- Other overhead factors can and should be appropriately allocated but the disaggregation approach requires appropriate location of costs. The CMRS should not allocate costs on a basis that disadvantages the new entrant. Specifically, the author will use its rights under Section 252 of the 1996 Act hereto.

The following Figure depicts the architecture for the Type 3 air time access.



The new entity is a desegregated entity and this entity can only be developed if the Commission utilizes its powers under the 1996 Act to treat the CMRS as any LEC and to apply the un-bundling requirements thereto.

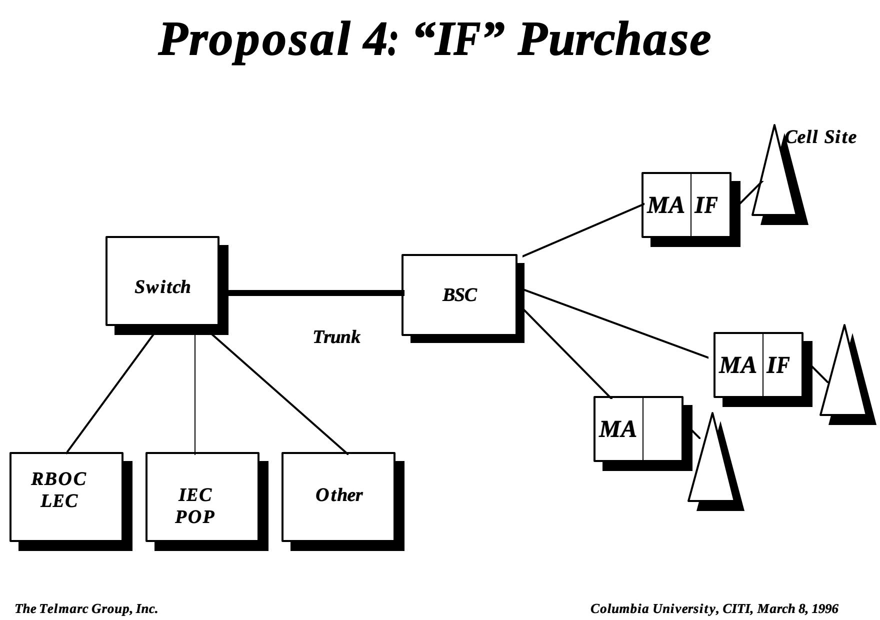
The question then posed is the one that asks if this new disaggregated entity is itself a CMRS. The author has argued that the law is clear in that a CMRS must hold a license from the Commission and that this "bright line" test is all that suffices. Further, what is asked and addressed to and by the Commission is the issue of whether this new disaggregated entity can effectively compete with the Incumbent LEC and its agents, affiliates, and associated entities on the basis of a "Bill and Keep" or more preferably a "Zero Access" interconnect interface. Is there an "equal protection" issue here that states that the Disaggregator has rights that are pari passu with those of the CMRS or are that separate. We argue that the rights to access on a free and open basis convey without the position as LEC competitor and not merely as a CMRS. The Commission in CC 95-185 and in WT 96-6 has joined these questions.

5.2.4 Type 4: "Dark Hertz" Access; "IF" Access with Trunk Termination[19]

The following depicts the fourth option, type or proposal. This is the proposal that requests that the CMRS provide only IF interfaces at intermediate frequencies, "IF", to a disaggregator.

Namely, the license holder will provide the transmitters and receivers at the sites but the buyer will provide all signaling behind this. This form has been advocated by several people in various forms before. The author has commented on the Gilder Conjectures and this type of Airtime is a way, under the 1996 Act, to begin implementation of this approach.[20] This will especially be important in the context of the proliferation of spectrum with the completion of the PCS auctions.

This approach is depicted in the following Figure,



The author hereby request that the Commission intervene under it jurisdiction under the 1996 Act and support the author requests from the CMRS in question, in view of their refusal to negotiate.

5.3 Impacts of Wireless Disaggregation

The overall business strategy is one that contains the four elements of airtime, access, outsourcing, and the ability to market more efficiently than any other competitor. The following Table depicts the current costs of service as presented by the existing duopoly cellular player. It contains all of their costs elements and profit and also reflects their strategy as product positioning. The key assumptions are the ability to buy bulk DS1

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[19]This is the Noam structure for airtime or spectrum access.

[20]See McGarty, TPRC September, 1994.

circuits and the ability to eliminate access fees. The following shows the current costs that a typical cellular company faces.

5.3.1.1 Current Costs of Service

Costs for Service

Local Infrastructure		***$0.05***
Local Interconnect		***$0.01***
Local Access		***$0.06***
Back Office	***$18/mo***	***$0.18***
Sales & Marketing	***$600/new sub 5 years, 100 min***	***$0.10***
Admin	***10%***	***$0.04***
Profit	***10%***	***$0.04***
Total		***$0.48***

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Give the four point strategy, the following Figure depicts what the author believes that can be achieved in the long run. These are goals and are not operation numbers. These goals, however, reflect that success is based on achieving all four goals, and especially the ability to address a larger market more efficiently than the existing carriers. The following shows the ability that a company will have if its strategy is successful in attaining a dramatic reduction in price.

5.3.1.2 Proposed Cost/Price Point Strategies

Costs for Disaggregated Service

Local Infrastructure		***$0.05***
Local Interconnect		***$0.01***
Local Access		***$0.00***
Back Office	***$9/mo; 300 min***	***$0.03***
Sales & Marketing	***$600/new sub 5 years, 100 min***	***$0.00***
Admin	***10%***	***$0.02***
Profit	***10%***	***$0.02***
Total		***$ 0.13***

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What this states is that the product being sold is plain old telephone service at a price point that is lower than any other provider. It is a reincarnation of the strategy used by the long distance resellers who were most successful. It is also reminiscent of the “Kluge Strategy” that led to Metromedia and then LDDS. Furthermore, what this states is that one can now bundle long distance in this at $0.05 per minute and have a $0.20 per minute “anywhere to anywhere” service that is comparable to the proposed AT&T offering that is priced at $0.25 per minute!

6. Conclusions

There are many policy considerations that will evolve out of this concept of disaggregation. We focus here on a few that are currently under consideration as part of the new Telecommunications “Re-Regulation” Act.

The 1996 Act defines a Local Exchange Carrier (“LEC”) as[21]; *“local exchange carrier” means any person that is engaged in the provision of telephone exchange service or exchange access. Such term does not include a person insofar as such person is engaged in the provision of a commercial mobile service under section 332(c), except to the extent that the Commission finds that such service should be included in the definition of such term.”*

The 1996 Act does not preclude a wireless carrier, namely a Commercial Mobile Radio Service, CMRS, provider, from being a LEC, however it leaves to the Commission the ability to so define. In fact the Commission in FCC Docket WT 96-6 suggest that such is the case and that being a LEC is in common law determined by how one presents oneself to the market rather that the “bright line” test of whether one owns

[21]See 1996 Act, Sec. 2, Sec 3., Definitions.

a license, even if such ownership of the license is not put to use.[22] The author recognizes the concern for the inter-state transport portended by the availability of spectrum but this is a use by a customer and will undoubtedly be more difficult to manage by regulation.

The Act defines "Telephone Exchange Services" as follows; *''Telephone exchange service'' means service within a telephone exchange, or within a connected system of telephone exchanges within the same exchange area operated to furnish to subscribers intercommunicating service of the character ordinarily furnished by a single exchange, and which is covered by the exchange service charge."*

The Telephone Exchange service is merely the ability to interconnect one user with another. The 1996 Act does not delimit this to wire or wireless applications. The definition includes the terms "same exchange area" and "connected system of telephone exchanges". As a term of art, the author seeks to bring to the attention of the Commission the fact that with the current wireless technology the exchange function is performed in the BTS or cell site and not only in the separate MSC or mobile switching Center. The author has addressed this issue in its presentation to the Commission in WT 96-6.

The author then further argues that there is no distinction between a CMRS and a LEC in its ability to perform the exchange function or the exchange access function.

The 1996 Act, Section 251, defines the Incumbent Local Exchange Carrier as an RBOC or one who materially acts as one.[23]

This states that any entity such as NYNEX or Bell Atlantic is a per se Incumbent Carrier. The author then argues that Bell Atlantic and NYNEX hold themselves out, using the same name, representations, technical support, and through interlocking Boards and Directorates exhibit control over the cellular subsidiaries so as to be one and the same entity. Thus, the author argues, that for the sake of the 1996 Act, BANM is an entity of the Incumbent Carrier and thus is itself, being indistinguishable from the Incumbent Carriers in name and essential operational functionality, covered under this clause. Furthermore, the author argues that (h)(2) allows for the Commission to readily extend the definition of Incumbent to the Incumbent's CMRS. In fact, the petitioner argues that it is essential that the Commission do so in a timely fashion.

The author has argued elsewhere that BANM is pari passu an Incumbent LEC. The 1996 Act, Section 251, further requires that for any Incumbent LEC that there is a duty to unbundle, amongst other duties attending thereto, and that unbundling be provided as per the following from the 1996 Act[24]. This argument then opens up a whirlwind of issues with regard to the overall disaggregation of the telephone network.

[22]See COMAV and Telmarc Response to WT 96-6. The Respondents argue that the CMRS is in effect also a LEC and that such a distinction may be valid on as regards to the management and administrative control of RF regulations and that the LEC actions are market driven and not regulatory driven.

[23]See 1996 Act, Title I, Part II, Section 251, (h)(1)-(2).

[24]See 1996 Act, Title I, Part II, Sec. 251 (c).