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New Combinations: Changing Technologies and Infrastructures and the Business Organizations That Will Deal with Them.

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I. Alexander Skirpan, Jr.
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{1} This tale is somewhat unique. It is probably one of the few panels, or the only panel in which there is a certain level of agreement. In fact, every one in this room probably has the basic agreement with this panel, that changes in regulation and changes in policy that we are struggling with are driven by changes in technology. This panel has been put together to look at changes in technology. It has three overall goals. The first is, as you heard one of the panels this morning talk about, to talk about technology itself to try to gain some type of understanding. As regulators or practitioners of law in the area, it is hard to be effective without some type of understanding of just what the technology is that we are supposed to be regulating or trying to give people advice concerning. The second area that this panel will hopefully inform us on is how technology continues to change. Many times we look back and see how technological changes have occurred, and how they have forced us to change. However, there is little consideration for the fact that these technologies continue to change and there will be other challenges or maybe even solutions to current problems that will result from that change in technology. And the final area we hope to provide information on is, as technology changes and as it causes regulators to address new issues, how the utilities, are themselves very different, and have been changed and shaped by this changing technology. This group, I think, can demonstrate very well how the conversion of the different technologies have shaped most of the companies and people who are on the panel.

{2} The first speaker will be Alex Best, who is Senior Vice-President of Engineering with Cox Communication, speaking on the emergence of the cable and telecommunications industry. The second speaker will be Pat Bennett, who is the Manager of Network Planning/Network Services of Williams Communications Group. His is a marriage of communications for a transmission pipeline. Next, we have Douglas Taylor, who is going to be providing information from PJM Interconnections, which gets us more into the energy area of how things have changed. Finally, Steven J. Rosenstock, who is Manager of Electro-Technology Policy with the Edison Electric Institute. He will go over further changes in technology and take more of a look at the specifics. With that, I turn it over to the panel members and I appreciate them all coming.

II. Alex Best

Senior Vice President-Engineering, Cox Communications, Inc.

{3} Thank you. If I may, I am going to stand over here. I believe I talk loud enough for everyone in the back to hear okay. I am an engineer by trade, the Vice President for Engineering for Cox Communications, headquartered in Atlanta, Georgia. We are considered the fifth largest cable operator in the country; fifth largest MSO (multi -system operator). A week ago, we were the sixth largest. That changes on a daily basis depending on the trades that are taking place. Our acquisition of the cable properties in Las Vegas from Prime Cable last week made us fifth largest. As a result, we now serve about 3.7 million customers scattered across the country.

{4} Basically, up until a year or so ago, we were what I would classify a plain old cable operator. We provided thirty to seventy channels of plain old cable to the customers that we served. However, due to technology changes, and also due to the rewrite of the telecommunication laws, we now consider ourselves a telecommunications company, not just a plain old cable operator. As you will see in a moment, as a result of the telecommunications rewrite and a result of the technology changes, not only do we provide cable television service, but we also provide high speed Internet service and cable phone service over the same network.

{5} I like to call what we put in our customers' homes a winning network. It might be a little presumptuous and you will have to bear with me because I make this presentation to a lot of Wall Street analysts, trying to convince them that we in fact have the winning network. We went public about 3 years ago at $18 a share. A year later we had skyrocketed to $20 a share and were not doing too well. Lo and behold, a gentlemen who resides on the West Coast named Bill Gates, took note of what we were doing, especially the fact that we were providing Internet service over our network at multi-megabit speeds. As a result, he met with some of the cable industry CEO's and subsequently invested $1 billion in another cable operator called Comcast Communications. Six months after that $1 billion investment, we went from $20 a share to $40 a share. Obviously, Bill Gates had ulterior motives. Those of you who follow the cable industry closely know that he was the keynote speaker at the National Cable Television Convention in Atlanta last week. Of course, what he really wants to do is get his software on the computer devices that we are about to put in place on top of your television set. Those set type converters, those dumb old boxes where you tune the channels, are about to get very, very intelligent. He wants to control the software that goes in those boxes, because he who controls the software that goes in those boxes controls the gateway into your television set. Soon, not only will you be watching plain old cable on that television set, if you get bored, then with a flick of a button on your remote, you will be surfing the web on your TV set. If you surf the web on your TV set, you can purchase things and do transactions through your TV set, and Bill Gates knows that and he wants a piece of that pie.

{6} We do think we have the winning network. Now another way to look at the winning network is with the

deregulation of the television industry, someone went out and did a survey of the average consumer in this country and said, "Look, if someone knocked on your door and said they could provide your video service, a voice service, and data service all packaged together, would you take it from them?" And in general the consumer said, "Yes I would do that. A single bill? Yes, I would do that." Therefore, as a result of that survey, every single telecommunication provider in this country has been doing everything in their power to put together all the pieces to do video, voice, and data. Why do you think AT&T several years ago took the 5 % investment in Direct TV? It was because they needed the video piece. The Bell companies, as I look individually at what they are doing, tend to be all over the map in terms of how they intend to provide video, but they certainly do intend to provide video. Some of these companies are what we call classical over-builders, meaning that they duplicate the same kind of network that we have in place. Ameritech has been doing that throughout their region. Some have done it by building wireless cable systems, wireless MMDS-that is what Bell South is doing-some have tried both. Tactel built a hybrid fiber collection network like what we have, then shut it down and went wireless. Now that is for sale. And last week, U.S. West announced yet another architecture that would provide video, voice and data service over a fiber into homes in Phoenix before the end of the year. That is what they call a switch digital network. The point is: this winning network should be the network that can provide all those services - video, voice and data.

{7}Why do we think we can do that? We think we can do that because we have the capacity to do that. The network we are putting in place from our head-end facility, our central office, is a fiber network down to a point in your neighborhood, what we call fiber to the node, and then from the node, we have conventional coaxial cable. The small yellow lines represent coaxial cable running down your street. As these signals transverse down these cables and we cap some off to go into homes, the signals get weaker and weaker, therefore every half mile they go to booster amplifiers. Those amplifiers work in two different directions. They allow lots of capacity to go from the head-end down to your home, and they allow additional capacity back to the head-end. The capacity of that cable system is determined by the capability of that green amplifier. We buy those amplifiers from companies like Scientific Atlanta, General Instruments and Magnavox. The state of the art of those amplifiers today allows 750 megahertz (MHz) capacity. That is a lot of capacity. One analog television channel takes six MHz, today. One voice circuit would take such a small amount, a sliver of this spectrum, that it would not even be noted. When we put that kind of capacity in place in our cable properties, we want to provide plain old cable the way we always have, up to 550 MHz. We can provide 78 channels of analog television. From 550 MHz to 650 MHz, using a new technology, called digital compression technology, we can actually now put one channel per MHz, or another 100 digital channels. So these 100 digital channels plus those 78 analog channels represent about 180 channels of television. This is what we are doing on many of our systems across the country. In order to get access to those digital television channels, you have to have access to a digital set-top converter that Bill Gates wants to put his software on. We have installed over 15,000 digital sets in Orange County and Omaha, and they are coming also to Hampton Roads. In addition, we take one television channel, put 27 megabits of data and send it downstream, and that 27 megabits of data are shared by the number of Internet users in that 1,000 home node.

{8} On average, where we have launched that service, we get about 2% penetration, so 2% of 1,000 is 20 people sharing 27 megabits. The effective throughput on your computer is 3 to 4 megabits per second for Internet service. That speed is limited by the capability of your PC, not by the capability of this network. Let me tell you, that is lightning fast. That is enough data to do full motion video over the Internet, not just still images. That of course is also what Bill Gates is interested in. That is delivering video on demand over the Internet - streaming video we call it, and if you went to the cable show last week, every single modem vendor is demonstrating streaming video over the Internet. Honestly, to provide all these services (television, digital TV, and data), our head-end, or hub, is interconnected into several other networks. Obviously, motion video programming comes in by satellite, therefore, you see the large satellite dishes at our head-end facility, receiving the Discovery Channel etc. In order to provide Internet service, our head-end facility is tied into an ISP, an Internet service provider. In Cox's case, we are part owner of our own Internet provider. Our provider is a start up company that did a very successful IPO (initial public offering) about a year ago called "At

Home." It has essentially built a huge fiber optic network across the country. When you access a website, your request goes up by cable system through the ISP's fiber network where it is interconnected into the Internet at various places around the country. Very popular web sites become cached locally at our head-end, so when you access a very popular website, you do not have to go across the country to get that information. That also relieves some of the capacity problems of the backbone system of the Internet. In addition, we want to provide plain old phone service over our cable network. We can do that by allocating 6 MHz of downstream spectrum and 6 MHz of our upstream spectrum to do plain old telephone service.

{9}In addition to that, we have some reserve capacity. I suspect that reserve capacity will be used probably by digital television transmitted by the broadcasters. If you follow that scenario, you know that every broadcaster in this country, in addition to their analog 6 MHz, has been given a second 6 MHz to transmit digital television. Initially, it was to be high definition television. In the end, those in the computer industry did not like the standards the FCC came up with because the standards did not suit their needs. They knew they would be sending stuff to PCs to be viewed like television. The computer industry got the FCC in Washington not to adopt a single HDTV (high definition television) standard. In fact the FCC adopted 18 digital standards, all the way from standard definition to high definition.

{10}One of the biggest issues facing my industry is when the broadcaster lights up that second 6 MHz channel with digital television--does that second channel become a "must-carry" for me? I can tell you that ten to fifteen of these analog channels are already "must-carry", by government regulation. When the local broadcaster lights up the digital channel, will that digital channel become a "must-carry" for me? If it does become a "must-carry" for me, suppose I have not upgraded my system and all my channels are full, will the government tell me which analog channel to take off? Who is to say that I should take off the Discovery Channel and put on a digital channel when the broadcast starts up? A major battle will be looming in Washington over digital "must-carry" by the broadcaster.

{11}Obviously, the kind of customer we are looking for is one I show in this picture here. We are looking for the customer who takes all three services from us. We are looking for the customer who wants access to those 180 channels of television, and we want to put a digital set up on their television set. We are looking for the customer who wants to take multi-megabit Internet service from us; therefore, we go to a home and put in a cable modem. And, by the way, as an example, cable modem service from us today is $44.95 a month, and that includes the lease of this modem. If you buy that modem from me, the price is $39.95 a month. Now with respect to the Hampton Roads system, it varies slightly by market, so do not hold me to the letter of the law for those prices. But the point I want to make is that these cable modems are now being standardized by the cable industry. Sometimes you hear the cable industry talking about a DOCSIS- (Data Over Cable Systems Interface Specification). A DOCSIS modem is a standard base modem and will be for sale in Circuit City within the year. You can go buy that modem, hook it up yourself, so to speak, probably with some help from us, but you can own that modem in which case the service will be $39.95. In addition, technology now allows us access through a box that we mount on the side of the home. The box is powered by the drop cable going into your house. That drop cable now carries 90 volts if, in fact, you take phone service from me, so do not be out there connecting it. That network is delivered by the cable operator and powers your telephone, so you dial no differently than you do today to make phone calls.

{12} We have launched telephone service in three markets. In the areas where we have had telephone service for at least three months, we are getting twenty percent of the homes taking telephone service from us as opposed to the Bell Company. There are many people in this country who said, "no way in hell will I ever take telephone service from my cable operator." But I can tell you that Cox is a good cable operator, a very reliable operator. What we now know is if you offer a compelling package of services, the consumer will take those from you. So there are many cable operators in this country that are gearing up to provide video, voice, and data. I am going to stop with that.

{13} With all the major regulatory issues facing the cable industry, and believe me there are many, the biggest is whether or not we will be deregulated next year as promised by the FCC during the telecommunications rewrite of 1996. It is scheduled to sunset in March of next year. There are rumors now, as I am sure you know. Some say they will not deregulate us, and that the cable industry has continued to raise their rates and gouge the consumers, even though we cannot raise our rates more than what the law allows. One issue is that when I upgrade my cable system, I can add more channels, and as a result of adding more channels, I can raise my rates. That is allowed by law. The problem is that you may not want those channels. But technology does not allow me to sell just those packages of channels on an a la carte basis. The government would like me to offer 200 channels and sell them one at the time. Even though it is possible to do this, I would have to put a set- top box in every home in my service area. Some cable operators have tried that, scrambled all the channels and made everybody have a set-top converter. There was such an upheaval by the consumers, that they had to undo it all. Many people just want our plain package of services. They buy a new cable-ready set with a lot of "whiz bang" features so they do not need a box. Then, I come in as a cable operator and say, "that is a great set, put it on channel 3, put this box on top of it, and take my remote." They get very upset, and I don't blame them. So the problem is, if we did have the technology, it would mean a box in every home and consumers do not want that. We are stuck with offering packages of new services and essentially charging everyone for all of them, and that is why we get a bad rap. It remains to be seen whether we will truly be deregulated next year.

{14} As part of that Telecommunication Act, the government said, "cable operators, you have to sell that box, you can no longer lease it," even though what we lease it for is also regulated. Circuit City put that bug in their ear, and they said, "good idea, cable industries sell that box." We said, "fine, we'd love to sell that box and get it off our books," with one caveat--that everything associated with the security of that box remains under the ownership of the cable operator. The biggest problem we have here as everyone knows is that those boxes are easily pirated. If you own it and it is pirated, I have no recourse to fix it. As long as I own it, there are games we play, so-called "silver bullets" to try to maintain the security of the box. So if we sell that thing at Circuit City, there would be a removable POP, a point of performance module. We have asked the FCC to allow us to continue to retain ownership of the POP and Cable Lab is doing their best to try to design the box with this purpose in mind.

{15} Finally, I cannot be in the telephone business if I do not have two things provided by my competitor, the Bell Company. One is interconnection rights, because if I hook up a telephone customer, I guarantee you they will want to call someone who is a Bell customer. Therefore, I have to have a link into their switch. Now the government requires me to have that. However, we buy it in chunks of capacity. In California, where we were having lots of success, when we went to buy more capacity, guess what? The Bell Company just happened to be out of capacity. When we got lawyers in the room, somehow Bell found some additional capacity. Well, those are the kinds of games competitors play, and those are the kinds of issues with which we have to deal. The second requirement is final number portability. I cannot convince telephone customers to come to me if they also have to change their telephone numbers. Right now we only have interim number portability, and I pay two to five dollars per month, per telephone number to the phone company for nothing more than call forwarding. I need final number portability. So, if you truly want competition with the local phone systems, you have got to make the Bell Companies provide interconnection agreements, and work on final number portability because they surely can be a cable operator. I do not have a guaranteed monopoly. Anybody can come in and overbill me if they want. U.S. Western has done that in Omaha.

{16} So, if we truly want competition, we have got to level the playing field on both sides in order to make this happen. Technology has gotten to the point where the Bell Companies, through AVSL and VGSL, are trying to provide video and high-speed data over their network, and we are trying to provide video, voice and data over our network. It is clear that the technology enables us to compete. We need the laws changed to insure that it can happen.

III. Patrick Bennett

Manager-Network Planning, Williams Communications Group

{17} Good afternoon, I am Pat Bennett, manager of the Network Planning Department at Williams Network in Tulsa, Oklahoma. Today, I will be discussing technology advances and how our businesses are changing and reforming as a result of these technology advances.

{18} My background is primarily on the long distance side of the telecommunications industry. Thus, my comments today will be from a long distance perspective. I will begin my discussions by showing some industry trends, followed by the significant advances that have allowed these trends to come about. Then, I plan to discuss the Internet and the technology that is making the Internet the explosive network that it is. Finally, I will discuss a technology that is on the horizon, voice over IP. Mixed in all these discussions will be the effect these technologies have on businesses.

{19} This graph shows the trend of the total U.S. telecommunications market in terms of revenue. The projected compound annual growth rate between 1996 and 2003 is seven percent. Although total revenue for data does not overcome the total long distance revenue shown on this chart, it is a considerably higher annual compound rate of seventeen percent compared to the seven percent of voice. It is also important to note that due to technology advances, the growth rate of data usage is higher than the seventeen percent revenue growth rate shown here. In fact, some studies predict that data bandwidth usage will surpass the voice bandwidth usage this year. The reasons data revenue is growing at a slower rate than bandwidth usage is because users are migrating from expensive private line services to less expensive, efficient frame relay and ATM (Asynchronous Transfer Mode) bandwidth services.

{20} What are some of the technologies that are driving these trends? I would like to spend a few minutes discussing some advances in transport systems, such as fiber, as well as frame relay and ATM. Here is a brief history of transport deployment since the early 1980s. I list DS-3s (an ultra high speed digital subscriber line), for those who do not know what a DS-3 is or the capacity available in it. A DS-3 will basically handle 672 simultaneous voice conversations at one time; it is a large amount of bandwidth. We have made significant advances in technology in terms of capacity in the last ten to fifteen years. This is important because fiber is not a commodity, and companies have had to employ transport systems with increased bandwidth capabilities to keep up with bandwidth demand. As the number of DS-3 systems increase, the DS-3 cost decreases. This graphically depicts the significant bandwidth increases that have been developed and deployed over the last ten to fifteen years. Early this next century, we expect a huge increase in bandwidth capacity systems. Initial cable multi-mode fiber users liked to use this fiber early in the deployment of interoffice fiber plant. Once divestiture happened, and long distance companies started building their long distance networks, single mode fiber proved to be a better solution. In the 1990s, the true wave in lambda shifted fiber technologies, allowed access to the efficient wave lengths of light used to transmit light through the fiber. These are the predominant fiber types installed today. Farbwire technology has advanced over the past few years as well. This fiber was used the same as the same lambda shifted fiber, but is packaged amount of high tension electrical lines. It provides an economic alternative for right-of-way to the long distance carriers. It also provides the electrical utility companies an avenue to enter the telecommunications industry.

{21} Wave division multiplexing allows multiple light signals to be transmitted on a fiber at the same time. Early generation WDM (wave-length division multiplexing) devices were used on single modem fibers to double and sometimes quadruple the bandwidth capabilities of the fiber. This was significant at the time because Sonet technology (synchronous optical network) deployment was delayed and the ICs (inter-exchange carrier) were running out of fiber. These WDM devices allowed the ICs to increase their bandwidth on their networks without installing more fiber in the ground, while waiting for the higher bandwidth Sonet

technology to be commercially available. The latest generation of WDM devices, or DWDM (dense wavelength division multiplexing), based on ITU (international telecommunications union) standards, are up to forty distinct wavelengths and can effectively be used on the latest fiber. Optical amplifiers were developed to perform WDM and DWDM functionality. In addition, optical amplifiers perform another equally important function -- they amplify the light signals. This allows the signal on a transport system to travel greater distances before requiring signal regeneration. This design greatly reduces the capital to install a transport system, particularly with long distance networks.

{22} As you can see from this chart, the bandwidth capabilities are growing astronomically. Comparing this to the previous graph showing DS-3 per system, this graph is even more impressive. This shows that the combination of transport technology and WDM technology is not additive, but has a geometric effect on bandwidth capabilities. There are two camps in the industry concerning the direction technology is likely to take. One is advocating higher speeds of transmission as the best way to increase bandwidths; the other says that the DWDM technology is the most effective way to increase the bandwidth. My opinion is that higher speed transmission systems are preferable to minimize the number of boxes that are put out on the network. I suspect the sum combination of the two will provide a bandwidth requirement that are needed as we head into the new millennium. A new service is being developed among the IC carriers as a result of this WDM technology. Carriers are now willing to lease light waves on our fiber. This is similar to dark fiber releases in the past, but the carriers do not have to give up the total use of the entire top fiber, only waves at a time.

{23} You are all familiar with the legacy players I have listed. They all have fiber networks of which a significant portion was developed back in the 1980s. Thus they have older generation fiber and transport systems on their network. The old fiber cannot support the higher bandwidth or WDM technologies efficiently; and often not at all. This inability to expand bandwidth economically by the legacy players has allowed a new set of companies to enter the long distance business. These new companies are deploying the latest technology that provides considerably more bandwidth per dollar than the old networks. Thus, much of the supply and demand to meet future growth will be provided by the new companies.

{24} An interesting environment has developed with this new wave of fiber bills. In the 1980s, when the first wave of long distance fiber networks were built, every company did its own thing, and for the most part did not enter into fiber agreements with their competitors. Today, however, we are seeing companies enter into joint ventures, fiber swaps and fiber sells with their competition. Many of the new companies have strategies to install excess fiber when they are laying fiber on the ground with the intention of selling these excess fibers. This, in effect, lowers or eliminates the cost of construction of the fiber. Although it is difficult to verify, it has been estimated that the fiber and transport costs for the new companies is forty percent to sixty percent less than that of the legacy players. This is not to say that the legacy players are not deploying new technology, but they do carry a financial anchor with their legacy networks. Examples of electrical utility companies entering telecommunications industry using their right of way synergies are troublesome to the legacy players as well.

{25} Well, who is using all this band width? For one, frame relay and ATM networks are being deployed all over the country and are taking up a considerable portion of the bandwidth consumption. Frame relay exploded commercially in the early-to-mid 1990s. It has proven to be a very cost efficient alternative to x.25 networks and other private line services. Frame relay networks are built in the form of clouds. These cloud networks are viable systems, thus the network can route around a problem, like a fiber cut, automatically. This provides a higher level service which cannot be offered with traditional private line services. This has been essential for mission critical data networks for businesses throughout the world. Also, frame relay is especially suited for transport of diversity type data transmission; companies do not have to buy bandwidth merely to support a cable and file transfer. ATM operates and performs much the same as frame relay but at higher speeds. Forks on the ATM network range from a T-1 up to an OC-12. OC-48 interfaces are not too far in the future. Although ATM technology has been here for a few years, applications of ATM are just now

beginning to emerge in the industry. The ability of ATM to carry any kind of traffic is appealing, because now end users can migrate all their traffic to one survivable network and operate in a more efficient, economic manner than the current segmented networks employed today. ATM, with its high bandwidth capabilities, is also an excellent source to transport multi-media applications. The Internet is migrating to an ATM network to provide survivability and network efficiencies.

{26} A second large user of bandwidth is the Internet. The Internet has become a viable form of communication in all segments of the economy. The original developers of the Internet envisioned a non-hierarchal structure. This produces the highest survivable network with the least interruptions when a problem occurs. The backbone networks are controlled by the companies listed in the materials. The network access points are connected by the backbone networks. The Nets, as they are abbreviated, are the locations where companies providing Internet services connect to the Internet. With the pending merger of MCI and WorldCom, the combined company will control over fifty percent of the Internet backbone network. This could potentially create a noncompetitive situation. GTE filed suit to stop the merger partially because of this.

{27} Peering used to be free for all those connected to the network. Now due to the inequities and the sizing of the network, small ISPs are charged for Net access whereas the large ISPs are not. Internet Protocol, or IP, is a protocol that defines the format of the data signal. There are several common IPs; the most prevalent is transmission control protocol, or TCP-IP. Another popular IP is the hypertext transfer protocol, HTTP. This is the one that allows Web brackets to work on the Internet. HTTP, along with the introduction of browser technology, is the most critical technical development in the commercialization of the Internet.

{28} ISPs such as Unet, Netcom and PSInet are some of the larger and more well-known ISPs. Over 3,000 ISPs have emerged with the commercialization of the Internet. Typically, ISPs focus solely on Internet services. OSPs such as America Online, Prodigy and Compuserve offer Internet access to the public via their proprietary networks. It has been estimated that in 1996 there were twenty million users of the Internet, and 87 million projected by the year 2000. It is easy to imagine why there is a lot of interest in providing Internet services.

{29} Some carriers are in the process of developing voice-over IP. I would like to describe what voice-over IP is, the technologies that are used, who is considering using voice-over IP, and the applications of this technology. Well, what is voice-over IP? To help explain voice-over IP, we must compare the process of providing voice-over IP to traditional voice calling. With the traditional voice calls, when someone dials a telephone number, the local and long distance phone companies create a physical temporary circuit in the public switch network for the duration of the call. When the parties hang up, the circuit is torn down to be used by subsequent telephone calls. With a voice-over IP call, the voice signal is converted to data packets provided by an IP gateway located at the customer premises. These packets are inserted into an IP network cloud, routed to the terminating address and converted back to the analog signal. A vertical path in the IP cloud network is established during the call between the originating and terminating sites.

{30} The additional service signal processor is the technology that changes the analog signal to a digital signal. Although this is not a new technology, the application is new. The gateway box that performs this function is to be located on the customer's premises, instead of at the local exchange central office as with traditional voice networking. The key technology problem that has to be solved is the real time bandwidth requirements that voice requires. Our key networks have the tendency to introduce delay, especially when the networks are loaded down. With voice, transmission delays result in unsatisfactory call quality. This bandwidth management issue must be resolved before widespread use and acceptance of voice-over IP occurs. The bandwidth management is easier on private IP networks, but creates a challenge on the public IP networks. This is what has made voice-over on the Internet difficult. The Internet has inherent blockages and bottlenecks that voice cannot tolerate. A number of companies are trying to resolve this issue as we speak.

{31} Here are some ISPs, which have been providing IP networks for the past few years, that have the potential to provide voice-over IP. Of course, this is just a few; there are many out there. Some companies that have been offering voice-over the Internet for international calling. This has been attractive in calling countries that are still very expensive on the traditional system. Because of the huge cost savings, people are willing to tolerate sub-par service. However, many of the government-controlled telephone companies overseas have put a stop to voice-over the Internet because it is eroding their revenue stream. The biggest domestic application of voice-over IP will be for private businesses to put their voice as well as their data and multimedia over the same IP network. This will make their networks more efficient and cost effective. A company that recently installed a voice-over IP network lowered its telephone bill from $25,000 to $4,000 per month. This is a significant savings to the end user and potentially large business for the carrier. Someday, voice-over IP could also be expanded to the home, once the fiber to the curve is common and the bandwidth management issue is resolved on the public network.

{32} In conclusion, I have talked about how the evolution of bandwidth technology has provided the telecommunications industry with huge quantities of bandwidth, and the potential for even greater quantities at lower costs. I have given some examples of how this bandwidth is used and consumed by data networks, frame relay, ATM, the Internet and voice-over will begin to be routed over the data networks in the not too distant future. All these applications use the bandwidth more efficiently and cost effectively, thus allowing more services to be sold on the bandwidth at a lower cost to the consumer. The carriers can sell more, the customers can receive services at lower costs, everybody is a winner. Thank you for your attention and enjoy the rest of your conference.

IV. Douglas Taylor

PJM Interconnection, L.L.C.

{33} Actually, Stan Kijewski, who is my boss, was supposed to be here today, but he got called away. The way I look at it, you end up with the graduate student rather than the professor, and given our setting, I guess that is appropriate. The other point is, we can have fun, since Stan is not here. I just want to give a quick presentation here, and give you some information on PJMs, who they are, the power system functions, the exponential changes going on in the electric utility industry, the exponential change that is going on in technology, some key technologies for the electric utility industry, and the exponential growth and opportunities because of all these other things going on.

{34} PJM is a power pool. I do not know how many of you know what power pool is, but it is our function to reliably and economically operate the transmission system for Pennsylvania, New Jersey, Maryland, Delaware, a small piece of Virginia, and the District of Columbia. We basically have six jurisdictions, and we operate the resources of those utilities. There are eight transmission providers in that group, and there are also 90 other members who either sell energy into, buy energy out of, or pass energy through PJM. We take all of that and operate it as a single source. That is what the power pool function is. It is actually operated as a control area. We are the largest control area in North America. If you take a look at our service area statistics, we actually cover 48,000 square miles; we have 540 generating units. We have nuclear, we have coal, we have oil, we have hydro, and we have pump hydro generation plants. We also have 8,000 miles of EHB transmissions systems. We serve 22 million customers. In terms of the United States, we serve actually 8.6 percent of the population and eight percent of the total peak load in the U.S.; we serve roughly eight percent of the energy and eight percent of the actual capacity of the United States. Taking that on a global scale, we compare ourselves to countries for the most part. We are the third largest centrally dispatched entity in the world, and if you look who our peers are, we are talking France, which has a peak load of 61,000; Tokyo, 57,000; and there is us, PJM; and England, 49,000. California is new to this because they just started their ISO (Independent System Operator) April 1, but they are now on the board as well. They are the fifth largest

overall.

{35} We are the hub of the operation for the generation and transmission of load. We are nothing more. We take data in, turn it into information, and we use that information to reliably and economically operate the system. So, if you take a look at it, we have massive amounts of information coming into us every four seconds. We have roughly 5300 telemetered points. What am I talking about? Well, relative to generation is megawatt and megabore outputs of the units- relative to transmissions, it is the flow of the megawatts and megabores of the transmissions facilities. There is also bus foliages and at the load end, megawatts and megabores. We also provide the ninety-eight members in the pool information back as to how much available transmission capacity is out there for them to actually use. We take that data and turn it into information using computationally intensive applications. We have some really large computers in our facility. Their purpose is to source this information, and reliably and economically operate the system. Every 3.5 seconds we send our signals to our generators. If the load is increasing, we tell them to put out more megawatts. If the load is decreasing, we tell them to reduce the megawatt output. That goes on every 3.5 seconds. We monitor the transmission facilities to allow these transactions to occur. We take a look at the thermal profile of the system and say whether you can or cannot do this deal based on the fact that we have constraints on our system thermally. Then, there is a reactive component which most people do not know: you can collapse the voltage on your system to the point that the whole system will go down. We also protect against such crashes. Those two algorithms take a lot of horsepower to do correctly and provide the feedback in a timely manner such that the system is reliable.

{36} Now, what causes us to change our framework or move from one paradigm to another? Realistically, some of the major drivers are the regulatory agencies. What they desire is to create an efficient marketplace for energy by competition. It was only a few years ago that the Federal Energy Regulatory Commission (FERC) put out Orders 888 and 889, dealing with open access to the transmission system. They intended to let the people use the transmission system and pay a tariff back to the transmission providers so that they got revenue for the use of their resources. Now, that is on the transmission end.

{37} You all deal with the distribution end, that is what we call the retail end. Pennsylvania and New Jersey have gone a long way towards providing retail access and providing a mechanism by which that can be done. I have heard similar things in your conversations today that I heard in Pennsylvania and New Jersey when they were going through the same things -- trying to determine how we could actually make this work. I will get into that in a little bit, but that is the regulatory component. The agencies desired to create this efficient market, to break up or make the monolithic utilities let other people play in their territories.

{38} What created this market? The players in this market were not conservative electric utility people. What we had coming on board when this market was established was large financial institutions, figuring they could make money transacting energy, and also the gas industry. In fact, we had a lot of people in the gas industry wanting to play in this marketplace. Their mind-set was almost completely opposite of the more conservative electric utility people. They were very creative and very insistent on customer choice because that was how they were going to gain market share. They felt they could provide service cheaper than the electric utilities could. They were very insistent on consumer choice. They were also aggressive competitively, not only among themselves but among the electric utilities. In order for them to determine what their opportunities were, they demanded information. They wanted to reduce their risks by getting that information. That is why information systems were, and continue to be, vital and important to them. In order to solve the needs of the market, you have to bring technology into place. Some of the things about the Internet, or Asynchronous Transfer Mode (ATM), that you have heard today are the types of leading edge technologies they want so they can make timely and informed decisions about how to reduce their own overall risk in this marketplace.

{39} The other thing I want to address is the unbundling of energy products. The electric utilities were given

an order to unbundle their services and allow other people to come in and play in their market. When I first got my bill with all these line items, I really was not certain why they tried to complicate things. Realistically, all they were trying to do was make a line-item breakdown so that if someone else wanted to supply the energy component of your bill (rather than the operation and maintenance component), they could do it. So they put it all down on your bill now as a bunch of line items, but that is going to allow for competition to occur even under the retail choice or open access schemes. That was the whole idea behind the unbundling of the products -- the vertical disaggregation. The monolithic utilities, the horizontal or big companies, decided they had to disaggregate in order to compete in this new world. All they did was form business units. Most of the utilities up in the Pennsylvania area have a transmission unit, they have a generation unit, they have someone taking generation down to fossil fuel and nuclear power, etc. Basically that is their way of making themselves more efficient to compete in these marketplaces.

{40} We talked about open access a little bit. Open access makes it possible for anyone to play in the game. The transmission they need to serve people inside host utilities is now accessible. Since these utilities now have disaggregated into these business units, many at the generation end of these businesses are not only looking into our country for opportunities, but are looking abroad as well. Some of these people are looking to provide other countries with the capability to form independent system operators (ISOs). This aggregation of the vertical utilities has other ramifications in the U.S. and abroad. We will see a lot of utilities actually using these business units to make a profit abroad.

{41} Last year at PJM, we were an organization run by eight electric utilities, with a management committee. Those eight people decided which way to go. Now, because of open access, retail choice, and the ability of other members to join our organization, we went from eight decision-making members to ninety-eight. This was accomplished by creating sectors: a generation sector, a transition sector and other supply sector, a regulatory sector, and a user sector. If a decision needed to be made within a sector, the members of that sector made the decision. On top of that, we have a board of managers who have a fiduciary responsibility to our organization to make certain that what we are doing is in line with our core business and services. They also ensure that what we supply in the future follows the direction of the organization.

{42} Accomplishments in retail choice and open access in our organization have been similar to what is happening technologically world-wide. If you take a look at these technologies, you will discover that these materials did not exist twenty years ago. Which one of us can live without a fax now? You talk about microchips and the microchip industry. Microchips are now being put into consumer products. I think we all know what's happening with Internet usage. PC megahertz -- the power behind it, the speed of it -- is increasing exponentially. There are two key components that play into these technologies. One of these technologies is this "computer component cost," and you can see computer component costs are going down. It is the competitive nature of the marketplace that drives prices down. Look at the three minute phone call, where it was to where it is going. Again, the competitive nature of the industry drives prices down. I believe that the purpose behind open access and retail choice causes the same result to the end user consumer of electricity. Now, we do not see this reduction in prices yet. I think it will be some time until this comes about. But, I think this is what the federal and state people had in mind: increased competition drives prices down.

{43} As far as PJM is concerned, there are a number of enabling technologies we use to get over a number of hurdles. First, if you think about what we said originally, about the large size of PJM, you will find there is a lot of technology employed to ensure that systems run reliably. This has been done for years. We have a good track record and know how to do it. We keep those systems up to date.

{44} Electricity is an instantaneous commodity. You create it; it gets used. That is the end result. There is pump storage hydro-electric power out there, that is really not as cost efficient as you would like to believe, but people make money on it. That is a key point about electricity- instantaneous commodity. Because of these characteristics of electricity, the gas people had a lot of trouble when they came into the electric utility

marketplace.

{45} Another key point is the requisite volume. At the retail level, right now we assume we are going to have 100 - 200 members in the pool for the next year. At the retail level, there are large industrial customers saying that they do not want to belong to their host utilities. This will probably increase the number of members in our pool. At the consumer end, there are load aggregators for customers who join and become members of our pool. We will experience exponential growth because of these factors. To solve the problems surrounding the extensibility and stability of our systems, we will use computing, telecommunications, network, metering, information access, and delivery in order to meet the demands of the market. These are our key technologies.

{46} Of paramount consideration in all of this is the computer. We all use them. They are a part of our daily lives. What is nice about the computer is that in 1975 somebody discovered Moore's Law. According to Moore's Law, every eighteen months the number of transistors you put on a computer doubles. So what does that mean?

{47} A year ago we started to upgrade our computers at PJM. At that time, we bought personal computers (PCs) with the best processors then available, 166 MHz. One year later, we were purchasing PCs with 300MHz processors. That was in accordance with Moore's Law.

{48} From another standpoint, a calculation that takes a day to do today will take less than ten seconds to complete twenty years from now. Raw computing power will solve a lot of problems. A lot of people in this business know Moore's Law and design their systems to take advantage of what does not exist yet. This is what all the applications developers do. We count on Moore's Law to hold true when creating new systems. Do the names "Gordon Moore" and "Bob Noyce" sound familiar to any of you? These individuals started ITO. Sometimes, I wonder if Gordon is keeping Moore's Law alive by only letting out certain chips at certain times.

{49} Another principle used at PJM that is very critical to our information network, metering and infrastructure is redundancy. We have private line, Voice X, voice dispatch circuits, for which we have "backups." We also have our management system -- our large application which monitors the system. It is with this system that we do our unit commitment, dispatch, and our reliability assessments and analysis. We also have hail log metering circuits, and another "backup" system (which can be employed whenever our digital network goes down). Although this may result in reduced operability, we can keep the system running. We have corporate computer links and an integral computer network. We are one power pool. We deal with the surrounding utilities: New York, Virginia Power, and Allegheny Power. We exchange information with the surrounding utilities to ensure regional viability.

{50} Bandwidth is also a key factor for us. We have had many discussions on why bandwidth is key. Alex Best gave you some reasons. Pat Bennett gave you some reasons. When the Internet got started, we were in this narrow band mode. It took a relatively long time to upload and download information. Because of the Internet's narrow band mode, Bill Gates did not want to develop Internet technologies. Gates basically believed that people did not have the patience required to wait for information to upload and download. Gates also believed people would soon lose interest in the Internet. Gates quickly realized that he had made a mistake and opted to "jump into this with both feet."

{51} Today, we are in the mid-band era of Internet access. As Alex Best alluded to, cable modems are now becoming available. At our company, all of our managers and vice-presidents have an ISDN line to our computer systems that works great. We can even dial in from home. But as the bandwidth increases, new technologies (such as the ATM) become available. A funny thing is that when I first heard about the automatic teller machine, I thought that the banking industry had this great network that everybody wanted to use. No, it is called Asynchronous Transfer Mode and there is a noticeable difference between asynchronous

transfer mode and cable modem, a difference where one mode is measured in bits per second. I tend to agree with Pat Bennett, ATM is the future relative to throughput. You can download a video in seconds! You want to use this technology to get the maximum amount of data out as soon as possible to decision makers.

{52} PJM has latched on to the Internet as a key to our doing business. Why is that? When we were an eight member group at PJM we were all geographically clustered and limited by distance in doing things. The Internet provides the capability to reach people in California, Florida, anywhere, quickly. "http://www.pjm.com" is our PJM home page. If you really want to know what we are about, things we are doing, technologies we are employing, take a look at our home page. We have posted our filings, business processes, retail choices that are implemented, accounting-- all these processes are available.

{53} Another system we have is our PJM Oasis. This is where people who need transmission service request reservations and receive transmission service. That was mandated by FERC, and this is our implementation node.

{54} We also have an e-document system. This lets our participants communicate with themselves. They can look at meeting agendas and notes and correspond with one another. Also, we have e-schedules, a Pennsylvania choice, a retail pilot project. Load aggregators input their interchange daily using this software. Five percent of all utility customers had the option to get involved with them. What happens is thirty-five load aggregators went out soliciting the host utilities people, and grouped them together under their umbrella.

{55} Overall, it is not very difficult to implement a system the way we have done. There are other issues. We still have not discussed the Obligation-To-Serve load issue, starting January 1. Right now the obligation-to-serve resides with the host utilities. This obligation will reside with the load aggregators once full retail choice is implemented. Just to echo what everybody else has been saying, Internet usage is doubling worldwide every 100 days. The Internet is a key technology to everyone. There are many opportunities provided by open access, retail choice, and technology itself. At some point in the not too distant future, there will be an appliance that basically is going to go out to the Net, figure out what the prices of energy are at any given moment in time, determine whether it should remain on or turn itself off. Not impractical, not impossible. That same device, having the information, might be able to state, "Provider A is costing too much right now, I want to switch to Provider B." If you take it full bore, full spectrum, this is where it could end up.

{56} I think this is a very worthwhile statement for what is going on right now. Keep open access and retail choice. There is a lot of conflict surrounding this issue. I've been to a number of these types of discussions. I hear issues raised and a lot of turmoil. We at PJM believe that if you bring the proper technologies and resources together, you can solve the issues to the satisfaction of all people involved.

V. Steven J. Rosenstock
Manager-Technology Policy, Edison Electric Institute

{57} I wanted to talk about the way that technologies are converging, for example your television set converging with your telephone, video-conferencing. All kinds of things will be happening. The only thing I predict, that is for certain, is that everything will change, and at a faster pace. Obviously, at a commission level, there might be some people who say that there should be some state regulations or that somehow that there should be some rules and regulations on the Internet, For example, the consumer use tax in Virginia.

{58} If you go through deliberations and take testimony, six to nine months pass. According to computer professionals, an Internet year is actually 3 months. So by the time a decision is made, you may have missed six or seven light years. That's the case of market technology.

{59} I would like to go over a few things concerning the electric industry. Edison Electric Institute (EEI) is an association of electric utilities in the United States. But they are planning on modifying that since EEI members now control the pipeline for over half of the natural gas in the United States. So it is a trade association of electric companies that happen to have natural gas components as well. But as I remember from the last panel, in terms of opportunities, many companies have varied interests - natural gas, electric, long distance, telecommunications, cable television, home security, appliance repairs, facilities management, Internet services, lighting systems, etc. So basically, the companies I am representing put a lot of stuff into your house. But that is the way the market works - there are a lot of opportunities.

{60} If you ask why they are doing this, when you look at a lot of the federal policies in terms of energy, you have the National Appliance Energy Conservation Act and the Energy Policy Act. There has been a federal policy to use less energy - less electricity, less natural gas. As a result, the maximum growth we have ever seen, except in areas like Las Vegas, especially in electricity and natural gas is about 1% per year. Compound annual growth rate for the telephone is 7%. Wireless is 17% per year. That is across the United States. Now where are the opportunities?

{61} One thing that is part of the revolution in terms of the supply side is the generation increment. Also, here is a little bit of my background. I was with the power company in Maryland and I was a commercial governmental institutional representative working on their anti-management program. Between 1990 and 1997, they spent $180 million on anti-management for residential, commercial and institutional customers. As a result, Potomac Electric Power Company (PEPCO) last hit a summer peak demand, an actual annual peak demand, of 5,711 megawatts in 1991. Since then, they have not exceeded that peak demand. Those energy scales have basically been pretty flat for the last several years. As a result, which is what anti-management was supposed to do, utilities did not have build new power plants. And it worked. The reserve market increased because the last plants that went online, went online in the early 1990s. So the reserve market increase and the peak load stayed the same.

{62} But there is the law of unintended consequences though. Research and development at the Department of Energy and natural gas companies, new technologies, renewable management technologies -- they all went down. As a utility, they said, we do not need new technology. All of a sudden some of these new technologies did not want these power plants. These new technologists said, "Wait a minute, I have a new way to do these things. All I need is get it to market." There are other similarities in other industries. Some people, upset with their own cable companies, are saying, "Wait a minute, I saw that ad at Radio Shack. I can put a dish on the side of the house for a couple hundred dollars installed, and instead of being charged $30 per month I will be charged $20 per month. The same stations, more of the stations that I want. Maybe I have only got 50 instead of 100 but so what, I am getting it for less money and it's good service." So a million dishes have been sold. They are going around cable systems. A similar problem is happening with telephone service. A lot of people out there are using wireless networks for their phone calls. More and more hard-wire service customers are using wireless communications. New ways of doing things -- new technologies.

{63} The first thing I want to show (which is the first part of the hand out) is what I call my power plant comparison table. If you take a look at it the old way, fifty-six percent of the power in the U.S. is generated by coal power plants. I am going to put up some of the latest statistics about these power plants. A lot of them are central stations, especially these old power plants, and have relatively good efficiency (32 to 37 percent): installed costs, maintenance costs, and emission factors. With new research and development there are new advanced power plants with a little bit higher efficiency, (with higher installed costs, unfortunately) and lower maintenance and emissions. However, the thing is that under an old regulatory environment, those plants might want in. Under the new environment, though, with something called merchant plants (gas-turbine combined cycle). They are almost as large, look at the efficiency of it because better turbines. Look at the installed costs, however -- less than one-half of a full fired powered plant.

{64} Now in California and New England, merchant plants "crop up" where they are not going to into a special regulatory environments. They will be treated like any other manufacturing plant that the environment permits, however they do not go through an integrated resource plant, and they do not go through a regulatory emission. They are not regulated facilities. They are not regulated utilities. They are independent power producers. They do not guarantee anything whatsoever. Whether they are getting a loan from the bank, or issuing shares to raise their capital, they are building a plant. They are hoping that once the plant is built, they can get customers to buy power at their facility. The installed cost is so low that they realize a huge cost advantage. They are looking to the future. Especially when you look at maintenance and emissions as well. If you are building that size of a power plant, this looks like the way to go. That is why many of the new power plants plan to either buy regulated utilities, or, especially, non-utility generators. Independent power resources, such as gas service. Basically, with the number of power plants you can be pretty that as we start to go along there will be no need for regulated entities on power plants.

{65} There is another revolution that is happening. The prices on renewables, like solar link power, are coming down because of research and development, the Department of Energy, and especially wind-powered turbines. Some of them are going in and the power is being sold at four cents per kilowatt hour. With combined cycle gas turbines, they are running from one and one-half to two cents per kilowatt hour. This is a premium price, but is within the ballpark. What is happening is that a lot of utilities and municipalities are eliminating having what green power programs that utilities or other entities are building, such as wind turbines, and the customers are paying a premium for that power. There is a market for this and as the market opened up, it actually increased the market for renewables. A lot of people were saying renewables will never go through; but this is not happening. There are a lot of these throughout the U.S. We are discovering that people do value these plants. Even in our market economy, people are willing to pay more for a product. Other people see it as, if this consumer is paying more for power, maybe I should get in. This also happens at a smaller level.

{66} Then there are some of the things, especially on fuel cell and micro turbine technology, that are basically portable plants -- on site power plants that are small, yet so efficient that owners and developers have the option of not connecting. Some are thinking "maybe I can do it cheaper on site. When looking at the capital costs and the installed costs, maybe I'll do it on my own." There is a utility plant, Unicom, which is the parent company of Consolidated Edison, they are a distributor of micro turbines. They are trying to sell it in areas with higher electric prices. They believe that if you can put it on your site, and it costs less than it would to buy it off the grid, why not do it? This is doing something better, cheaper, and more efficiently.

{67} This is a snapshot for 1997-1998. In 1999, I guarantee that a lot of these numbers will change. Why? You are taking all these people that are coming into the market. But again let me emphasize why there are changes in the electric markets and why generational specialists will help open the market to industry.

{68} Let's highlight the cost efficiencies. This is for all the people who built the power plant. If you really want to get into the business, natural gas shows a lot of the advantages.

{69} Now I am going to jump over into metering technologies. It was partially addressed in some of the other items discussed, but what I think you have to remember is that the basic meter on most residential customers' houses and small commercial houses is between 30 and 60 years old. Think of them as a rotary telephone. They performed the basic functions, performed them well, were reliable, and could last for a long time. Your monthly electric bill has one piece of information that it determines from customers' meters: how much electricity a customer uses in a month. For a commercial customer, this number could be how much is used and the peak grade. That is two pieces of information. It would be very simple to get that information. Look at these marketplaces that Douglas Taylor is talking about at PJM. They are going to be the spot market for hourly-priced electricity. That is twenty-four data points, 720 a month, the old meters cannot do that. There are some instances in which fifteen minutes of data are needed to make an energy decision; that is 2,880 per

month. The old meters just cannot do it.

{70} There is a revolution in meters that is continuing right now. Many of them are being rated as to how the data is transferred and many of the meters are having data recorders put on them so that, perhaps, as you collect the information you decide what you might like turned on, or shut off, or which lights dimmed, etc. Meters are going to be asked to do a lot more. The basic meter will not exist ten years from now. The old meters will have to be replaced because, just like the rotary phones, they do not perform the functions that are needed in the marketplace. So there will be a change in the meters. There will be many companies going to that market and trying to decide what kind of features the new meters should have. The meter will be like a computer. What features should it have in the consumers' markets? There will be changes because of the new market.

{71} The interesting thing is that they said everyone in California has access to the California market. However, most people do not have hourly meters. So the electric companies decided to use load profiles. They took information that the utilities had gathered on the load user. They determined customer hourly usage. Typically either on an annualized or monthly basis, they assigned that load profile, and assigned how much energy and cost of electricity were assigned during the day and the corresponding rate charged for the usage. This is a way to estimate before they get advanced meters.

{72} They are also being allowed to aggregate and combine like they were talking about in Pennsylvania. They combine profiles and then aggregate the loads in the power pool. Then, the aggregators are responsible for some of the billing. And the company can get into some billing issues too. These are some of the issues you get into: who supplies the meter, what kind of meter do we use, and what will it have to do? Some people are concerned that if you restructure, that electricity is going to hurt the environment, in terms of consumption. As I have shown on that chart, if anything, potential environmental damage will go down with the implementation of new technology. The environment will be assisted by this restructuring. On the end user side, I do not believe people will go "hog wild" in their consumption. A refrigerator-freezer manufactured today uses less than one-half the electricity used by a refrigerator-freezer twelve years ago. If someone buys a new refrigerator and it has the same features and is same size as the older refrigerator, that customer will save 50 percent on their electric bill.

{73} The following is another example of modern technology -- heat pump, an advanced system for heating and cooling people's homes. Basically, a heat pump is using the ground as a heat source and a heat sink -- a heat source in the winter and heat sink in the summer. Heat pumps are very efficient, much more efficient than any other heating system out there. The system is combined and there are roots, basically, underground to circulate the antifreeze. If you put one of these in your house and there is restructuring and you lower your costs, how many of us are going to tear that system out and put in a 1970s system that uses more energy? Raise your hands? How many people? I didn't think so. People will not go "hog wild" for the 1970s model because the new one will result in greater efficiency.

{74} The EPA put out a report in 1993 comparing future space heating and cooling systems. In this report, the EPA said it was their decision to use simulation in six different areas of the U.S. According to the results of these simulations, the geothermal machine systems have the lowest cost and least impact on the environment. In fact the Department of Energy reported that over 150,000 geothermal machine systems had been installed by consumers all over the U.S. The Department hopes this number increases to 400,000 by 2001.

{75} Again, once you install a new system, such as a refrigerator or heating/cooling system, the customer will not remove it. You will say to use more of them. Use more money for these new technologies and consumers will not go crazy on consumption.

{76} Here are a more statistics on new technologies. Maytag has a new washing machine. Maytag has

conducted tests comparing it to the old machine. The tests concluded that washing time was reduced by 38 percent. Energy usage by the washing machine, dryer, and hot water heater was reduced by 56%. This new machine was introduced last year and is available in department stores. The new washing machine retails for $1,099; there is currently a $100 rebate. The new Maytag machines have the reputation for performing much better on clothes and much better with cleaning products than the old machines. Pacific Northwest has a regular washing machine which costs approximately $400 after a $100 manufacturer's rebate, but only has a 10% market share. The new machines now have 90 percent of the market share in washing machines. Customers prefer the side benefits, such as lower energy usage.

{77} Another example of an application of emerging technologies is the Otis electric lawn mower. You replace the old gas powered lawn mower engine with an electric mower, reducing emission by over 80 percent. Overall, customers are moving from oil to electricity, a move that could result in a 90 percent reduction in emissions. So again, new technologies are developed every week. There are other technologies in the commercial and industrial sector there but, in conclusion, everything is going to change, its going to be fun and will result in competition from all sorts of companies. Thank you very much.

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Alexander Skirpan, Jr., Alex Best, Patrick Bennett, Douglas Taylor & Steven J. Rosenstock, *New Combinations: Changing Technologies and Infrastructures and the Business Organizations That Will Deal With Them*, 5 RICH. J. L. & TECH. 3 (Fall 1998), *at* http://www.richmond.edu/~jolt/v5i1/speech4.html.