2002
ADVANCED ENGINEERING TASKFORCE REPORT AND STAFF COMMENTS

ILLINOIS CENTURY NETWORK

Advanced Engineering Taskforce Report and Staff Comments

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CONTENTS

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Staff

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Neil Matkin, Illinois Century Network
Kristy Morelock, Illinois Century Network
Karlin Sink, Illinois Century Network
Frank Walters, Illinois Century Network

State Agency liaison

John Anderson, Central Management Services

INTRODUCTION

This is the second year in which the Advanced Engineering Taskforce has operated. Since last year, a number of new members have been appointed, primarily from the constituencies that were lightly represented in the initial group. Libraries, museums, and municipalities now have better representation. This has increased the interest from organizations that provide information services as well as the organizations receiving information. One of the first tasks was to catalog the benefits in which each type of client was most interested. The results of this discussion are presented later in this report.

Significant progress has been made on the recommendations from the 2001 report, and in general, the AET members concur with the priority ordering of the items identified in the report. Of special note, is the progress on procurement, network capacity, and Internet egress. ICN clients are well served in both reliability and performance of the network, with performance in particular being well above the usual levels of the commercial providers.

Progress in procurement has made it possible to obtain a better selection of products, to obtain them faster, and to initiate what will be favorable relationships with key providers. This has been true of both networking hardware and to a lesser degree with circuits. The AET encourages more progress on the circuit acquisition process.

The one recommendation identified as extremely important and on which there has been embarrassingly little progress has been in the use of state controlled and other directly acquired dark fiber. This is essential if the ICN is to be able to achieve the needed capacity within the funds likely to be available. It is essential that the ICN have direct control of dark fiber and that the ICN set the specifications for implementation. The failure to use state-controlled fiber to implement the I-Wire project further demonstrates the need to remove control of this valuable asset from unnecessary bureaucratic processes.

Staff Comments: The ICN has released an RFP for procurement of dark fiber. The vendor conference was held on June 26, 2002 with the bids due on August 6, 2002. The RFP was issued by the ICN with grading and management being a joint ICN/CMS project. The ICN agrees that this project has taken too long and is moving forward as quickly as possible. The ICN is also initiating a dark fiber equipment RFP that will be released this summer. The ICN also released and awarded a circuit RFP that provides circuits in Collinsville where additional bandwidth was not available through the current CMS contract. For additional information please reference the June 12, 2002 Policy Committee Agenda, Item 5, Dark Fiber Partnership on the ICN web site (www.illinois.net/calendar/policy.htm).

The ICN got a unique opportunity to demonstrate the competence and commitment of its technical and business staff when a significant provider of Internet services to education

withdrew from offering services near Chicago. Over a very short period, ICN moved hundreds of clients from Avenew to the ICN network with minimal disruption of service.

In general, the AET feels that the network and the organization are maturing very well, thus providing the opportunity to focus on the future rather than on addressing major current problems. The future depends as much on increasing client knowledge of how to use the network as well as on the technical implementation. It is very important that either the ICN organization or its educational management sponsors begin to provide much more extensive training to educators about the educational advantages facilitated by the ICN. Teachers, librarians, and local technical staff need much more training and an opportunity to talk with experienced peers if Illinois is to gain the maximum benefit from this investment. It is essential that the ICN establish an effective user organization to provide guidance on issues and policies.

One area of broad interest to clients is security and network management of local networks. Sponsoring tutorials and other information sharing should be a priority for either the staff or the user groups.

During the course of this year, there have been increasing concerns about the financial support that has made the ICN so effective, and allowed the management to concentrate on building the network and connecting constituents. Cost recovery has gone from a long-term issue to one that has become a major part of the financial model within the next two years. Any such transition needs to be orderly and allow time for client organizations to adjust, as well as allowing the ICN management to gain more control over its costs. The current financial climate has also accelerated the need to complete cleaning up the procurement and dark fiber issues, as this represents the primary means of controlling future costs without sharply curtailing services.

Many of the issues the AET addressed this year were a mix of technical and policy matters. As a user group becomes more active, certain issues will fall more clearly on one agenda or the other.

REVISED RECOMMENDATIONS FROM THE 2001 REPORT

Several of last year's recommendations have been slightly revised in this year's deliberations.

PROTOCOL UPGRADES

In the 2001 report, there was significant discussion about the need to improve the flexibility of the ICN by introducing multicast, mirroring and caching, and taking the initial steps towards the types of priority schemes that allow bandwidth to be assigned to the most critical applications. The AET concluded at that time that priority schemes could be improved sufficiently without the move to a major new generation of TCP/IP protocols known as version 6. This recommendation has been revised and the ICN should move fairly aggressively to this new generation, not only on the backbone, but also in the connections to the initial set of users who stand to benefit from the new protocols. This will be particularly important to ICN constituents who want to take advantage of the new interconnection with Internet2 and those who want to guarantee performance levels for critical applications such as telemedicine using video or remote instrumentation.

The staff has followed through very effectively on last year's recommendation, but new requirements and opportunities indicate this is the time to move ahead. Significant efforts in this direction have already begun on the core backbone segments.

Staff Comments: The ICN has done IPv6 testing both on routers and on client software. Today the ICN runs the IPv6 TCP/IP stack on some workstations. The ICN would like to continue testing with IPv6 and when Cisco supports IPv6 on all of the router models and stability improves, the ICN will move aggressively toward IPv6. The ICN has most of the backbone multicast enabled and has had some successful multicast tests in Chicago for the largest convention in the nation, the Radiologists Association.

MEASUREMENT

There was concern last year that ICN did little to measure and characterize traffic. The staff has been cautious about collecting and retaining information that violates the intended privacy of users. The AET concurs that ICN staff should not be recording who looks at what, either as individuals or in summary for a school. The ICN has been taking seriously its ability to help protect children through providing filtering. However, the AET still feels it is necessary to increase the measurement activities in ways that illustrate the value being received from the state investment. Traffic between Illinois educational institutions, particularly educational content, represents a significant value to the state. Some of this measurement should be occurring at the level of school districts or colleges, but given the technical staff available at many of these organizations, it will require that ICN provide much of the technical means or consultation.

The AET endorses measurement which helps in the planning and engineering of the network and that which provides evidence of meeting the ICN mission.

Staff Comments: The ICN implemented Clairvoyant last year - a monitoring product that provides bandwidth utilization graphs for the ICN egress and backbone circuits. It also has a predictive capability that allows the ICN management team to determine when to upgrade circuits. This feature was limited this year due to the one year lead time required to get good baseline numbers. Clairvoyant will be exceptionally valuable this year as the ICN uses it to more accurately forecast needs and growth areas of the network. The ICN is also using software called Multi Router Traffic Grapher (MRTG) to measure utilization of public servers such as domain name service (DNS) servers. This tool provides monitoring of DNS queries in 15-minute intervals and tracks the amount of memory in use on these servers. This allows the ICN to predict when upgrades to servers are required. The ICN agrees that knowing the amount of intranet traffic would be good information, however, this would require substantial overhead on both the routers and staff time. Using current tools, the ICN can compare the amount of traffic on backbone links to the traffic on egress links to provide an indication of the amount of intranet traffic.

2002 ISSUES AND RECOMMENDATIONS

CLIENT PRIORITIES

The AET has spent some time determining what different clients value in the network and where their priorities lie. These priorities should be verified through user groups, discussions with aggregations of clients, and perhaps through statewide or regional surveys. What stands out as the first priority is clearly the provision of a highly reliable network with sufficient capacity to assure good performance to all users. The current assessment is that this goal is being very well met and that the plans for upgrading the backbone will continue to ensure meeting this goal, although the ability to continue to do so is dependent on both budget stability and the rapid deployment of dark fiber. The network performance is presently sufficient to encourage new applications, but the ICN should be prepared for the impact of success in encouraging educational uses.

Different constituent types have somewhat different needs beyond basic connectivity to a reliable network. For the K-12 community, there is an increasing interest in content services and informing potential users about the availability of useful materials. Training programs are one aspect of this, including training about how to find and use the emerging materials in both traditional and video forms. There is an expectation that video is within one to two years of being important to the K-12 audience, including both accessing prerecorded material and using live video for remote teaching and personal conferencing. It is clear that while the backbone will probably be able to keep up with this load, the connections to individual school buildings will be a severe problem.

Staff Comments: ICN staff agrees that video is of increasing importance to K-12 constituents and has implemented video multicast on the network (discussed later in the response). In addition, the ICN is working toward implementation of central support for the H.323 protocol for distance learning and meeting services via ICN sponsored gatekeeper, gateway, and MCU hardware and software. The ICN will continue to work to lower constituent connectivity costs while increasing bandwidth through the negotiation of special tariffs and by placing the network connection point closer to the constituent through the funding of extended channelized DS3s, distribution POPs, and fiscally prudent community networks. Recent results include discounted DS1 and DS3 access agreements with SBC/Ameritech, discounted DS3 and OCn access agreements with AT&T Broadband Network Systems, the continued sponsorship of extended aggregation points and community networks, and negotiation with Charter Cable for discounted 10Mbps aggregation circuits and multi-megabit constituent access circuits in some of the least served areas of the state. These efforts will continue to be a high priority for the ICN.

Another content related issue for the K-12 community is providing a means to meet the requirements for filtering material deemed inappropriate for minors. Many of the K-12 organizations have very little local technical staff and therefore desire more assistance from the RTC program and more services such as server hosting.

Staff Comments: The ICN agrees that available content will need to be advertised as it is added to the network. In addition, as new applications are added to the network, especially video, the size of the constituent connections will need to be increased. The ICN has released and awarded a caching and filtering RFP. The caching portion did not make economic sense given the rapid changes in the telecommunications market, however, the filtering portion was awarded and will be pursued accordingly. This gives the ICN the ability to host filtering servers at ICN POP sites. The servers will be maintained by the ICN, but individual schools or districts will maintain the filtering rules. The other awards were to four vendors that will be able to make filtering products available at discounted prices to all ICN constituents. In structuring the RFP and subsequent award in this manner, a low cost centralized filtering solution is possible for schools and institutions with limited technical staff and discounts are made available on site-based filtering and caching equipment for larger institutions.

The community colleges are considerably further along on their use of some video services, and expect this to be a major factor for the future. They have close ties to both high schools and to local employer sites for the delivery of instruction, and need both the capacity and the policy freedom to meet these needs.

Staff Comments: The ICN appreciates the important role community colleges play and sees their role as one of promoting the use of video and lowering the cost of video instruction. The ICN funded implementation of ATM circuit emulation services and a central video switch provided for the transport of Illinois Video Education Network (IVEN) inter-consortia curriculum at no cost to members in FY 2002 and will do so at minimal cost to IVEN members through FY 2003. The implementation of H.323 video components in the network this year will support IVEN's efforts to migrate to lower cost IP video solutions as well as open doors to lower cost video to all education sectors. This migration will allow ICN support for video over "right-sized" network access circuits, which will in turn reduce institutional expenditures.

In many cases, the community colleges are serving clients on the other side of the digital divide and will depend on improved telecommunications services to rural locations becoming available. The community colleges were given high capacity links and in most cases are not yet fully utilizing them, although their use is far above the levels to which their previous connections limited them. Note that in many cases there was an upgrade from 1.5 Mbs to 45Mbs, a factor of 30, due to these being the available options for circuits. With the early advent of cost recovery that makes it quite expensive to continue these service levels, some may cut back and see a disincentive to expand their usage to more remote instruction, or to at least move from dedicated T1 circuits to ICN for video distribution. Most of the community colleges have more self-sufficient technical staff than the K-12 institutions, and need far less help with issues like server operation.

Many senior institutions are already major users of networking services and want rapidly increasing capacity at the lowest possible costs. In some cases they want to use the ICN as a provider of a private intranet between their locations, as do a few of the community colleges. This constituent group is also the first demanding QoS (quality of service) and other protocol upgrades.

Staff Comments: The ICN currently has the ability to provide intranet bandwidth to universities. There has been little interest in this to date. QoS was first requested by hospitals for a remote teleburn project. In a pilot demonstration, the implementation of QoS was successful. The ICN is completing hardware upgrades that are needed to be able to provide QoS on a statewide basis. A staff-developed white paper on QoS has been forwarded to various large bandwidth constituents for comment and feedback.

No one group among these has the corner on the market of innovative and demanding applications. There are examples of advanced applications within every constituency, and the ICN needs to recognize this in allocating subsidies and attention. Similarly, the level of self-sufficiency of technical support varies widely within each type of constituent, and needs to be reflected in the services offered.

The largest users, typically the largest four-year institutions, represent an important challenge for the ICN as they are the most likely to have sufficient scale to individually gain price advantages that are at least competitive with those offered through the ICN. The ICN needs to consider how far to go to attract these connections and what advantages can be offered.

Staff Comments: The ICN has offered lower pricing for large bandwidth requests. These prices are competitive with commercial prices although due to the competition provided by ICN pricing some commercial providers are countering with even lower offers to some of the ICN's largest customers. Some offers from ISPs have been documented as below actual cost in an effort to maintain volume and scale.

Libraries and museums are a large and diverse grouping of clients. Some have well-developed capabilities, but this is an area where sharing of experience can be very valuable. Servers, licensing of materials, and informing potential clients of available materials are particularly needed. Supporting affinity activities such as the statewide library sharing system, and extending access beyond the present group will enhance an already successful activity. Because of the diversity of this group the ICN will need to present several options on matters such as hosting servers vs. providing better connectivity to institutionally hosted material.

Staff Comments: The ICN is in the process of creating collocation facilities across the state. As part of this activity, the ICN is looking at providing either space for constituent servers that provide content or hosting servers for constituent content.

Municipalities are currently not a very active membership group within the ICN, but they represent an enormous opportunity. Larger cities and counties, like larger universities, are primarily interested in the advantages of increased buying power and information sharing. For the vast number of smaller units of government there is more of a need for sharing experience regarding network initiation, connectivity for many areas beyond the digital divide, and assistance with community networks. It is important that the ICN develop its policies around the role it can play in assisting economic development in these lesser-served areas, so that the ICN can work with units of government as well as organizations such as Chambers of Commerce. To achieve true connectivity throughout the state it will be necessary to work with organizations outside the primary ICN mission in order to serve those the ICN is legislated to serve.

Staff Comments: The ICN staff sent a mailing to all municipalities in June 2002 in order to increase participation by municipalities. The ICN is also working with the Illinois Municipal League to create templates and other information that will assist municipalities with best practices for installing and maintaining municipal networks. These materials will include checklists and step-by-step considerations to assist municipalities in reaching their goals.

As long as the primary service is basic connectivity, the ICN is operating in an environment that will eventually be well served by whatever emerges from the networking industry, particularly in those areas with sufficient business to justify investment. The ICN would then be left with only the most expensive clients to support. The ICN needs to create comparative advantages beyond group purchasing power, and keep its services ahead of commercial offerings in both price and innovation. In order to do this, the ICN will have to encourage the most innovative users to remain engaged.

Within each constituent type there are individual organizations that provide, as well as receive, information services. Examples include museums, libraries, and originators of educational content. Some of these institutions have made significant materials available, but there is a need to inform Illinois users about their availability and protect those making material freely available from increased costs. In certain cases, there may be large amounts of traffic, but the primary benefit is realized by the recipient. For these organizations, ICN capacity is very important, as is the option to locate servers on the backbone and favorable terms in the cost recovery policies.

Across all constituent groups there are perceived benefits in collaborating on technology issues and in fostering collaboration among users.

PROPOSED STRUCTURE AND ROLE OF REGIONAL USER GROUPS

During the past few months ICN management has been reworking the program of Regional Technology Centers and User Groups. New contracts have been awarded to continue locating staff in the regions, but the role of the user group remains to be resolved. The AET has several recommendations and observations in these areas. It is essential to incorporate a strong user representation in the policy and priority setting process. This includes areas that are outside the scope of the more technical AET.

First, the AET believes that it is important to keep staff distributed throughout the state to provide localized contact with constituents. However, the AET expects that the workload in the next two years will change fairly dramatically from the initial period. From the outset, and indeed through the earlier LincOn program, the workload of regional staff has focused largely on establishing the initial connection for constituents to the backbone. This has involved a large amount of consultation, ordering circuits and equipment, and installing equipment. Most of the potential constituents now have basic connectivity, and this activity is likely to slow down. To some degree it will be directly replaced by similar activities related to upgrading circuits and equipment, increasing the number of constituents directly connected vs. those with connections via local services, and looking at

local network designs. It seems very likely that some staff time will become available for other activities in support of the constituents, and that the current mix of staff has most of the skills for some of the most needed services. On average, the AET feels that one FTE of staff per RTC can be reassigned to new services.

Staff Comments: The number of eligible constituents who are not yet connected remains high, although the focus is indeed changing. Current and future growth is expected from municipalities, government agencies, social service agencies, hospitals and other non-primary constituents. A large number of private K-12 schools and private colleges and universities remain unconnected. Connecting these entities along with the added workload required to support cost recovery, improved monitoring, and other services that are already planned will keep staff very busy in the next year to eighteen months. Staff is developing models and reviewing best practices in other states and in industry to assist in predicting staffing levels necessary to accomplish the specified mission.

Second, the AET believes that the role of the host institution in the user group activity should only be maintained where the host has an interest and has proven able to make a real contribution. Recommendations on structure, staffing and charge for the user group program are presented below.

Third, the AET feels that certain services are likely to be needed in the very near future and should be considered for assignment to the RTC staff. Included among these are consultation and promotion of both advanced applications and the associated capacity enhancements these services will require. Primary among these are several types of video, local server strategy, and security services. As part of the user group program, the RTC Coordinator and the RTC office staff should play a large role in establishing the program.

Staff Comments: Staff desires to offer expanded services to meet demand in many regions. This can only be done when core functions are not impacted adversely. Priority must be given to core functions necessary to ensure network reliability and bandwidth availability. For these reasons, additional services will be added to RTC operations with great care, review, and consideration.

The user group portion of the original RTC grants had a varied degree of success. There are many reasons for this including the lack of dedicated staffing, the lack of central leadership, and ambiguity in the mission. It was also clearly a secondary priority compared to establishing the backbone and client connections. The program also has lacked a means of coordination across the state. The AET has recommendations in three areas: structure, staffing, and charge.

Users of ICN are very diverse both in location and in interests. All community colleges are likely to share certain interests, regardless of location. Similarly, all libraries, all museums, and all healthcare providers have interests in common. On the other hand, all organizations in an area share common interests such as telecommunication providers, local educational delivery, and local network infrastructure design. To address this diversity, the AET recommends a mixed hierarchical model with much of the activity occurring at the local level, but with some central guidance. The central guidance, which may take one or two FTE, should help with integrating the results of local and affinity interests into a statewide program. With affinity groups such as museums or libraries, the central staff will need to provide much of the organization and logistical support so that people of similar interests can have a forum and an agenda for expressing their needs. This central management could be provided by ICN staff, but could also be contracted out to some organization already dealing with a diverse statewide clientele such as the Illinois Libraries Computer Systems Organization (ILCSO) or Cooperative Extension. An outside contractor would encourage more independent advice and feedback.

There are a number of statewide affinity organizations that should be drawn upon for leadership, membership, and agendas. Example areas include library services, museums, IVEN, and rural medicine. Another model of organization that could be drawn on is the "special interest group" structure found in many large associations.

For the more geographically oriented part of the user group activity, it is appropriate to approximate the RTC regions, although it may be possible to combine more than one region under the same leadership. Here the leadership should come from those who have already stepped forward in the earlier user group structure or be found in the local community. It is important to identify leaders who recognize the diversity of the constituents in the region and who are aggressive in bringing people together. One barrier to previous success has been the staffing to assist in this activity, and that should come from the local RTC whenever possible. Support for the user group should be treated as a high priority among the RTC duties. It is important that the leadership come from outside the staff since the objective is to get advice directly from users, rather than just those within the organization. In all cases where there has been success with local user activities, some local leadership has applied considerable effort to the task.

To bring the regional priorities together, and to enable affinity groups to consolidate their opinions, ICN should provide staffing centrally. Whoever does this should periodically bring together a representative from each region and from each affinity group to establish statewide priorities and recommendations. A summary report to ICN management should be produced at least annually.

Staff Comments: The ICN management team is currently reviewing the structure and role of ICN user groups. The recommendations put forward by the AET will be considered carefully by the management team and will be incorporated into a plan for maximizing the user group function that will be presented to the Policy Committee for approval and funding.

The charge to the user group must be primarily focused on getting ICN management sound advice on the needs of the clientele, and to provide a forum for working through critical policy development. Several specific policy areas are already identified in AET discussions and should be included in the initial charge to the user group program:

1. Prioritize new services or improvements that should be offered by ICN or the RTCs, and make the services more visible to local organizations,

2. Advise ICN management on critical policies such as cost recovery and service subsidy allocations,

3. Identify regional or affinity group opportunities for grants, partnerships or self-financing and build ties to them,

4. Provide clients with information about ICN activities of benefit to them,

5. Assure all present and potential clients that there is a forum for user input into the management of ICN,

6. Compliment the AET technical recommendations with input about user expectations of the evolution of network use, and

7. Assist ICN with knowledge of local opportunities and resources.

Both the AET and the staff have looked at some of the potential services that could be offered via the RTC and the user group, and several have attracted the most attention:

1. Provision of server hosting or content serving
2. Filtering of content to meet federal requirements
3. Consultation of various kinds:
    a. Assistance in planning, particularly for smaller municipalities
    b. Technical education and organizing sharing of experience
    c. Security services and consultation

In general, the AET believes the effort, and any subsidy, should go to those areas with broad impact on many clients and on the smooth operation of the network.

Staff Comments: The regional technology supervisors have done significant work in developing a list of services requested by ICN constituents and, with regional input from constituents, are in the process of putting these in priority order and identifying costs associated with providing these services. Recognizing the need to maintain core services, additional services will be introduced gradually in order to determine impact and constituent response.

THE DIGITAL DIVIDE

The most difficult continuing issue the ICN will face is coping with the digital divide, particularly where areas of low population density and low wealth characterize that divide. Much of the geographic area of the state has these characteristics and does not represent an attractive market for investment by communications services companies. These areas also suffer from historically low investment in communications infrastructure. When communications was largely an issue of having telephones everywhere, a national universal service policy was implemented by charging some customers a premium to allow subsidizing others. Today the market is not nearly so well defined, with cable, telephone, broadcast, and other utilities offering overlapping services. Each is regulated with a different discipline and there is little hope that such cross subsidies can work.

The problem is aggravated by the fact that Illinois has so many small local utilities, many with outdated plants and without interconnections beyond those required for basic telephone services. Many areas do not have the capability to provide the next upgrade in capacity required by ICN clients (e.g. upgrading high schools to 10mbs) and even if they can make local connections to some central point they have no facilities to reach the ICN backbone or any other Internet service.

Unfortunately, the areas with digital divide problems are often the same areas that suffer from poorer schools, smaller libraries, and a lack of other information services. If the ICN fails to help solve the problems of access in these areas, it will simply perpetuate the difficulties of education and economic development.

The AET has been searching for solutions and offers some conclusions. First, the evolution of wireless services that avoid some of the cost of extensive fiber construction does not look promising in the near future. The alternatives currently available suffer from relatively high costs per customer in low population areas, as well as facing the problem of making the connection to the wired backbone infrastructure. Wireless will play some role

in ICN's future, but it will not solve the general problem unless there is some dramatic breakthrough such as the "low earth orbiting satellite". Nevertheless the AET feels that there is enough promise for wireless to address part of the problem and the ICN should be encouraged to pursue it selectively, possibly in partnerships with rural medicine and other critical services that are difficult to provide.

Staff Comments: As part of the MSA by MSA study, " Telecommunications Analysis: Availability and Pricing of Services for Illinois Education", and as a matter of course, ICN staff has researched the use of wireless services for constituent access and to a lesser degree backbone/aggregation circuits. Three general categories of wireless connectivity were considered: satellite, digital microwave, and fixed wireless. The report will be released in Fall 2002.

Second, there seems likely to be a decrease in federal funding methods aimed at the weak demand areas. Both programmatic grants such as those that have come from the Department of Commerce and the e-rate subsidy based on low income are in real danger of cancellation At present, ICN and Illinois institutions get several million dollars from e-rate. Some sectors, including agriculture and medicine, are likely to have more targeted initiatives in which the ICN can serve as a focal organization in establishing partnerships and seeking grants. This is one of the supporting reasons for the local organization of much of the user group activity.

Our third conclusion is the most critical. Because of all the factors in the communications services market, there is unlikely to be any reasonable solution for these underserved areas without substantial public incentives or investment. This is coupled with the fact that the currently defined public sector clientele of ICN is not sufficient to justify public investment in the magnitude needed. The AET recommends that the state look at the alternative of expanding its investment to provide some infrastructure both for public sector activities and to allow economic development that requires advanced communications services. Without such a bold initiative, the AET is concerned that the poorest and most rural areas will not have access to the new economy, telemedicine, or the new educational services. It is very likely that a program could be created, which would attract both commercial partner investment and investment by local communities resulting in a strong partnership for attracting federal and foundation funds.

ICN staff and the AET have spent a good deal of effort looking for alternatives, but an honest assessment is that little has been accomplished on the digital divide issue beyond making smaller bandwidth connections to schools. For the emerging generation of applications there is simply no universal availability, even at relatively high prices. If it were simply a matter of price, the state could subsidize a program to equalize costs across the state. Every state has had to face these problems, and the ICN management team

should look for examples of approaches that have worked. While the AET is certain that there are not fully satisfactory solutions in any state, Illinois may be able to find partial solutions that make progress towards a general solution. One issue to look at is what incentives other states have used to influence public and private investment in solutions to the divide.

Staff Comments: Through contacts made at the State Networks conference, and other State technology organizations, the ICN has and will identify programs that have worked in other states and duplicate them where feasible. Illinois also operates two public agency programs aimed at eliminating the "Digital Divide". The Digital Divide Elimination Fund provides money for community technology centers, public hospitals, libraries and park districts through technology grants. The Eliminate the Digital Divide Infrastructure Fund will award grants to promote the development of infrastructure in underserved inner city and rural areas of the state. Many ICN eligible constituents will be able to take advantage of these programs.

The ICN was funded with the express purpose of making Internet education and information services available to the whole population of Illinois, and the AET recommends that the state funding be applied in such a way as to more fully equalize access to services in all communities.

Subsidization of constituent connections may become possible when ICN efforts to lower backbone costs via dark fiber procurements bear fruit.

Staff Comments: Currently, even with the newly implemented cost recovery policy, 99% of primary constituents pay for only the local access circuit while paying nothing to the ICN - in other words, 99% of primary constituents fall within the allocated baseline bandwidth provided by the state appropriation and, at this time, need no additional bandwidth to meet institutional priorities. In addition, 87% of primary education constituents connect to the ICN through aggregate local loops partially subsidized by the ICN appropriation. With ICN initiatives such as extended aggregation points and special tariffs and with federal e-rate dollars going directly to schools, the average cost of connectivity at the standard DS1 rate is within a surprisingly narrow price range throughout the state ranging from $336 to $521 per month for recurring customers (before e-rate discounts) compared to $800 - $1,200 for the commercial equivalent. As T1 circuits have become a commodity, the ICN believes that price points should fall further and staff is working with the Illinois Commerce Commission to address this issue.

The last statement regarding subsidization of constituent connections misstates the point of acquiring dark fiber. Dark fiber acquisition is aimed squarely at increasing capacity at the same or near the same funding levels in order to facilitate current

growth trends in out years. ICN staff does not anticipate a substantial windfall other than being able to meet growing constituent needs that have historically increased exponentially. It should be noted that the ICN currently provides substantial funding of $8-10 million per year to reduce the cost of last mile circuits throughout the state. No commercial Internet Service Provider subsidizes the last mile, however, the ICN does so to better facilitate the lowest speed connections and provide incentive to connect. Whether there will be a substantial windfall remains to be seen and is dependent largely on how quickly dark fiber routes can be implemented, the start up costs of doing so, growth trends, and other factors. It is entirely possible that dark fiber will cost about the same amount, but provide greater elasticity. On the down side, it is also possible, dependent upon the same factors, that a gradual reduction in the current local loop subsidies may occur in order to ensure that backbone traffic and services keeps pace with constituent needs.

In the last year, sophisticated forecasting software (Clairvoyant) was added to the network. The first year of operation established a baseline. In the next year, the ICN will gain substantial capacity at projecting future bandwidth needs. As this data becomes available, more accurate estimations of future costs and capacity will be possible.

VIDEO AND ICN

Video was identified in last year's report as both an emerging source of traffic growth and an important opportunity for the ICN. Video services are highly varied and include factors ranging from small pictures with few frames per second up to high definition with very large pictures, many frames per second, and requirements for performance levels in the hundreds of megabits per second. The most important areas of emphasis for the ICN are in the low to medium range for remote instruction, person-to-person communication, and relatively short segments of higher resolution material that can be viewed at a desktop. Much of the education is available from Illinois institutions, and a number of ICN clients have developed excellent video materials. For example, The Art Institute of Chicago has produced forty videos (15-30 minutes) over the last ten years. Almost all are directed at some segment of K-12, students or teachers. This material can be converted for network distribution and be made available to anyone with a high-speed connection.

The ICN has moved ahead on one of the most important issues, multicast, which allows a single stream of video to be broadcast to multiple simultaneous users. The next step in making this capability more available is to get more of the client connections upgraded to also support this capability. This must be coupled with increased capacity in the client connections to ensure that the early users of video do not spoil the service for all other users. This is an issue involving both the acquisition of increased service and some consulting help on making the local changes necessary.

Staff Comments: The ICN will be making multicast available to all constituents by early 2003. The RTCs will be working with constituents on requirements to implement multicast both in bandwidth demands and hardware and software upgrades that may be necessary.

The ICN has also begun to provide "quality of service" (QoS) options that will give preferred performance to client-selected traffic. Before this goes into wide use, clients need to understand that such a priority scheme favors one activity over another within their own bandwidth, and can have the side effect of poor service to the less preferred applications. Remembering that the top client priority is sufficient and reliable capacity at a reasonable cost, ICN should be prepared for a substantial demand for higher speed connections at a low cost.

Technical protocols for video and other streaming services do continue to evolve, and the ICN needs to monitor the market and plan accordingly. On the other hand, the ICN cannot wait for this to be fully resolved, and needs to move ahead with opening up connections between the extensive base of traditional video services built around IVEN and newer IP needs for both desktop and constituent school facilities. There are a large number of circuits currently dedicated to occasional video use and economic pressure this year will add encouragement for those who want to spend more efficiently.

Staff Comments: In the area of the low to medium range video for remote instruction and person-to-person communication, the ICN has budgeted funds and developed a comprehensive plan to implement support for IP video and assist in conversion from the older H.320 standards. Staff is currently evaluating H.323 video products for inclusion on the network.

ICN support for H.323 video will foster the migration from H.320 to H.323 video for both IVEN consortia and their affiliates and other ICN constituents not affiliated with IVEN. Both constituent groups will benefit from lowered costs and connectivity to other IP video networks. The initial implementation would include the deployment of a central ICN Gatekeeper; a central gateway integrated with existing consortia H.320 and H.323 equipment, a QoS policy, and an MCU (Multi-point Control Unit). This initial implementation allows users to try the technology prior to making a commitment to full deployment of their own. Initial phase implementation is planned for Fall 2002. A complete disclosure of the ramifications of implementing QoS will be part of the implementation process.

Much of the video use will be live, but there will also be an increasing amount of stored material developed. This stored material can be stored on servers near the backbone, avoiding use of the circuit to the supplier. The ICN should put this service in place immediately. Similarly, there will be increasing amounts of purchased video material for which the ICN can provide purchasing and serving efficiency.

Like many issues, there is an interaction between the acceptance of video materials and the cost structure to users. It is important that the ICN keep the backbone costs as low as possible and find a means to reduce the cost of local connections. Selected video material, specifically for purposes such as educational delivery, should be protected and encouraged in any cost recovery policies. Cost is a major disincentive given the funding problems of education. The dark fiber initiative helps with the backbone costs, while group purchasing and partnerships help with the local access costs.

ICN should monitor the level of video traffic on its network to help plan capacity upgrades. It is not likely that this added capacity could be provided without some cost recovery from all clients.

Staff Comments: The ICN is currently working with RealNetworks and Microsoft to plan for video servers that can store educational video materials on servers located on the backbone. The ICN is investigating hosting servers that can provide multimedia content. This strategy would allow faster access to the material for constituents and institutions without technical expertise to serve curriculum will be able to do so without requiring additional technical staff or additional bandwidth to end sites. A report will be forthcoming to the Policy Committee and AET after a design and pricing are available. Staff estimates that video traffic will increase exponentially for the foreseeable future. As such, cost sharing among constituents will likely be required to fund the video expansion.

COST RECOVERY AND THE ICN FINANCIAL MODEL

The AET had a fairly extensive discussion of the emerging cost recovery policy of ICN. Not surprisingly, it has attracted as much interest as any topic on the AET agenda. The impressions of the initiative to date can be divided into three categories.

First, it needs to be made clear to the constituents that while ICN may eventually recover a substantial amount through this mechanism, in its early phases the income will be a small component compared to the subsidy being provided to all primary constituents. How long this will remain a minor issue will be determined in part by how the ICN is treated in the state budgeting process, and this vulnerability needs to be made clear to the constituents.

Second, the details of the plan are very important, and many were not clear from the initial materials. For example, it is not clear how an organization's entitlement is determined. It appears that the entitlement goes with physical connections to individual buildings or networks, putting a premium on maximizing the number of direct connections rather than

on connecting client intranets. The extreme case would be the Chicago schools that would have entitlement to 900mb if they connect 600 T1 lines, but only 12mb based on enrollment if they do an organization wide network and one connection to the ICN. In a case like CPS, a good intranet is critical because it is expected that they would have a great deal of internal traffic as well as traffic to the ICN and egress. This impact on the engineering of the local network is important and the policy approach should not have incentives to game the system. The impact on multi-institution intranets is a concern to some large institutions.

Staff Comments: The ICN provided a matrix that listed baseline bandwidth by student enrollment for K-12 institutions and full time equivalent enrollment for higher education entities. The policy does not promote direct connects over intranets. Some institutions are well served by creating a WAN with one connection to the ICN. Some entities do not have the internal expertise to manage a private WAN and therefore would be better served connecting individually.

The third and greatest area of concern is that the incentives perceived to flow from the policy are to discourage growth and innovation because they introduce high marginal costs. The zero recovery over a fairly broad range of traffic, and then a "substantial and sudden" marginal cost to go beyond that level were seen as a problem. A smoother cost structure with more gradations is suggested. The incentives are seen as particular problems for organizations that want to be suppliers of content, since they will be penalized for success in having users. The Art Institute is an example where "their" traffic is really a mix of what their internal users do and what use is made of resources they make available on the network. This also relates to the issue of whether servers remain local or placed on the backbone at an ICN POP.

Staff Comments: The ICN will look into a smoother cost structure when it sets the pricing for next year. Currently most institutions use less than their baseline bandwidth and therefore have plenty of bandwidth available for new services.

These concerns would have been less pronounced if there were enough details to make realistic assessments of likely impact on organizational budgets and on organizational intranet engineering. In the future development of this policy area, both the user group and the AET can help assess alternatives.

There was no concern expressed that ICN should not move ahead with a cost recovery system as part of its financing. The AET is primarily concerned with clarity in the policy and a careful evaluation of how alternative policies impact the goals of the network.

A couple of other details were lesser concerns. One is the problem of counting heads in community colleges. Another is that the policy has no differentiation for less served areas,

although that should be one of the places that any income is directed. Finally, there will be issues of how the backbone topology, server location, and POPs are impacted.

Staff Comments: The ICN will be working on the fiscal year 2004 pricing model this fall. The ICN intends to have public meetings with constituents to help set the new policy and pricing structure. Constituent needs and feedback will be incorporated into the cost recovery model for fiscal year 2004. Regarding service to least served areas, while the federal e-rate funds continue to be distributed, least served areas receive considerable discounts for circuits and equipment (relating to K-12 schools, libraries, and rural hospitals).

The AET suggests the following guidelines that should be included in the ongoing development of the cost recovery policy. Some of these are conflicting objectives which must be balanced. *(Staff Comments are included after each item.)*

1. Constituents should be given as much warning as possible of any change in cost.

   Staff agrees and has put a schedule in place that should operate in advance of budget planning periods for most institutions.

2. Constituents should be informed of the guidelines that will be used over several years to determine charge back shares.

   Staff is working to publish a standard annual schedule of public meetings that will provide sufficient opportunity for input and provide a clear methodology to adopt change.

3. The ICN should build a small reserve fund to avoid last minute changes in cost recovery because of changes in appropriations that usually occur in May/June.

   Staff agrees and will advance this suggestion to the Policy Committee in preparation for the fiscal year 2004 budget plan.

4. Entitlements to a subsidy that are based on headcount should be expanded to cover the actual size of large institutions.

   This suggestion may operate from a false premise that providing greater granularity (e.g. additional head count ranges for larger institutions) would automatically be accompanied by additional bandwidth. The staff agrees that a broader allocation scale is appropriate but it may not be accompanied by larger amounts of state-paid bandwidth dependent upon availability of funding.

5. Organizations providing valuable materials to Illinois clients should not be charged for the traffic generated so long as they are willing to move servers onto the backbone.

   Staff agrees and will make co-location facilities available at the lowest possible cost to constituents wishing to provide educational content to ICN constituents.

6. All educational constituents should be charged the same as others of the same size and traffic.

   Staff agrees wholeheartedly that constituents should be charged equitably across the system.

7. All constituents should be charged something.

   Staff points out that all constituents are charged for bandwidth above the allocated baseline. The cost recovery model was put into place to ensure the long-term viability of the network. Although the current usage and allocation translate to less than 1% of primary constituents paying currently, as growth occurs this will not be the case. All primary constituents currently pay for access circuits and institutional equipment to connect as well as for bandwidth above the baseline. Non-educational constituents pay for the bandwidth as well.

8. Intranet traffic should not be included in measurements, or should be counted at a lower level because Internet egress is a major identifiable cost and many priority applications are within the intranet.

   Staff agrees partially with this recommendation. As costs for backbone circuits decrease, this may be possible. With current pricing of circuits, however, some intranet connections are more expensive than commercial Internet egress.

9. The ICN should balance explicit subsidy to schools on the far side of the digital divide, the principle that everyone's cost of a comparable connection being equal, and it's goal of being attractive to all of its intended constituents.

   As long as federal e-rate subsidies continue, there is already a substantial discount (40-90% off of circuits and equipment) in place for the K-12 and library sectors in the most economically disadvantaged regions of the state. In addition to this, the ICN has achieved deep educational discounts for education con-

stituents for circuits, equipment, and maintenance contracts. Many constituents, as a direct result of e-rate dollars, have not experienced cost barriers. In some cases, however, institutions have encountered some lack of facilities issues in underserved areas of the state - areas where desired facilities are not immediately available or where build out is projected in to be a year or longer.

While the ICN can and does work to promote lower costs and greater investment in regional infrastructure, it is not possible for the ICN to subsidize one region of the state over another as this recommendation potentially suggests. Why? The AET report mentions earlier that Illinois has many small local utilities, many with outdated plant and without interconnections beyond those required for basic telephone services. This "patchwork quilt" of telecommunications providers clearly makes a comprehensive solution more difficult.

The areas of the state with more population have greater competition and therefore greater selection and lower rates. The ICN budget is insufficient to balance the pricing inequities that result from population-based services. Nonetheless, staff continues to work with the Illinois Commerce Commission in order to actively and aggressively promote price equalization throughout the state for like services. The staff continues to pursue Individual Case Basis tariffs with Illinois Local Exchange Carriers to create special discounts for educational constituents and continues dialog with the Illinois Telecommunications Association to this end.

Staff has prepared an analysis that clearly illustrates why this recommendation, a type of "postalization of rates[1] ," simply does not work due to the pricing structure inherent to the telecommunications industry in Illinois. This report was referenced previously as the "MSA by MSA Analysis" and discussed at the June 12, 2002 Policy Committee meeting in agenda item seven. The official title of the draft report is "Illinois Century Network Telecommunications Analysis: Availability and Pricing of Services for Illinois Education." This analysis includes a comprehensive examination of the federal e-rate subsidies that attempt to accomplish the task of addressing the digital divide and includes amounts of federal dollars spent through this program throughout Illinois. Unfortunately, rather than achieve the intended purpose in all cases, as a direct result of unfortunate business practices currently under investigation, the application of some federal e-rate dollars has resulted in artificially high pricing by some telecommunications vendors.

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[1] Postalization is a reference to the method used by the United State Post Office to price postage. The concept is that there is one price for a service regardless of the actual cost and other factors such as geographical location. Postalization works well when organizations are required to use a specific service or when there is no competition. When imposed in a system where there is broad competition it ultimately results in a loss of the larger clients and higher operating expenses for remaining clients.

10. The cost recovery policy should minimize the incentives to game the system or make irrational local decisions.

    Staff agrees and will examine this issue on an ongoing basis.

11. The resulting policy should be clear and simple to administer.

    Staff is committed to make cost recovery policies as clear and simple to administer as humanly possible.

SUMMARY NOTES

The ICN has made excellent progress both technically and as an organization. The service is excellent and the staff is responsible and responsive.

The key barriers to greater success are:

1. Local personnel and equipment capabilities at constituents organizations are not sufficient to sustain rapid growth,

2. There has not been enough training and support of teachers so that the technology is being exploited well,

3. The lack of an upgrade path for the last mile in many areas will limit the ability to cope with success,

4. The crazy quilt of telcos, other utilities, and regulations present uncertainties that make it difficult to make long term commitments,

5. The difficulty of economical procurement generally and especially for circuits and fiber has limited progress, but solutions do seem to be moving ahead,

Overall, this project has been a very successful investment by the State of Illinois.

120 West Jefferson, Suite B, Springfield, IL 62702-5172
Telephone: 217.557.6555 or 877.844.2724 Facsimile: 217.557.6550 TTY: 800.526.0844
www.Illinois.net