



Wyoming Department of Education

PRESS RELEASE

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Report on Technological Requirements for Wyoming Students

Cheyenne – Cheyenne, WY. Superintendent of Public Instruction, Cindy Hill, announced today that the Wyoming Department of Education had completed its study on the bandwidth requirements for the next generation of the Wyoming Equality Network (WEN v3). The report was the culmination of information gathered from students, parents, educators, administrators and experts in the Kindergarten through Grade 12 (K-12) schools and from community colleges across Wyoming. It is expected that the report will become a component of the process by which the next WEN contract is bid and under which the services will be provided. That contract is expected to take effect July 1, 2014.

The report recommends that as the next contract for bandwidth is negotiated, each student be supplied with One Megabit per second (1 Mb) of connectivity. Small remote schools are recommended to receive a minimum of Ten Megabits. It further recommends that additional bandwidth be available by local districts as requested and that the use and requirements of schools be continuously reviewed.

The current WEN service, when measured in May, produced an average of slightly higher than Nine Kilobits (9Kb) per second of service per student and thus the new level, if adopted, would increase student connectivity by over 100-fold.

Superintendent Hill noted that connectivity within schools and beyond to the enormous resources of the internet is an essential component of preparing Wyoming students for the 21st century. She further noted that she expects the growth in connectivity to continue stating: “This is another essential service, much like heat and electricity, that we must provide to our schools if we are to continue to produce the best students for a world economy. For too long many of our schools have struggled on the wrong-side of the digital divide and now it is time for all of us to move forward.”

Hill went on to note that she expects the increase in bandwidth will have ancillary benefits to other members of the community and for many other state agencies operating in locations where adequate connectivity has been previously unavailable. “I join with Governor Mead in a desire to help Wyoming lead in technological growth. High-speed connectivity to the internet will drive changes in our educational methods, the tools available to our committed teachers, and the opportunities to engage and enrich the lives of each of our students.”

Superintendent Hill went on to thank her staff and the many persons from around the state who collaborated in evaluating the requirements found in the report. These included:

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Bart Kunz, Lincoln County School District #2
Andy Corbin, Wyoming Community College Commission
Brady Fackrell, Sheridan Community College
Bruce Thoren, Fremont County School District #24
Greg Lundvall, H-D LLC, consultants
Jim Petty, Governor's Task Force for Video Teleconferencing
Chuck Mitchell, Wyoming Department of Education
Greg Hansen, Wyoming Department of Education
Joe Ahern, Consultant, Office of the Chief Information Officer
Kevin Lewis, Wyoming Department of Education
Liz Simpson, Governor's Task Force on Distance Education
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Shane Ogden, Carbon County School District #1
Stoney Gaddy, Sheridan Community College
Teri Wigert, Wyoming Department of Education
John Masters, Wyoming Department of Education

A copy of the report is attached and may be located at the Department Website: <http://edu.wyoming.gov/> on December 1, 2011.

CH:jz

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WEN v3
*A Tool in the Modern Classroom and
An Investment in Wyoming's Future*
Report on the Technological Requirements of Wyoming Students
Submitted by the Wyoming Department of Education
November 30, 2011

1. Executive Summary:

After lengthy study, the Wyoming Department of Education (WDE) recommends the existing Wyoming Equality Network (WEN) be improved to provide a minimum of 1 megabit (1Mb) of bandwidth per student across the state. This represents a 110 fold increase in existing service (presently averaging about 9.23Kb per student) but remains moderate in relationship to average bandwidth presently supplied to private and commercial customers within the state of nearly 5Mb per consumer. It is further recommended that this level of service be delivered by phasing in increases over the first three years of the next contract, starting at 384kb in year one, growing to 768kb in year two and reaching 1Mb in year three. Lastly, it is recommended that to support minimum services in every school, a minimum of 10Mb be provided to each building regardless of the school census.

The services should be guaranteed not only to the central office of each district and community college but also to remote schools and extension campuses where bandwidth shortage is felt the most and the need often is the greatest. This initial increase in bandwidth brings each classroom closer to the anticipated growth and demand ratio. Succinctly, the ongoing technology investment by districts and community colleges coupled with innovative integration of technologies into the classroom requires an exponential increase in bandwidth. Access to adequate bandwidth has become as essential as access to other utilities such as heat, electricity, and telephone.

2. Purpose of the Report:

The current extended contract for the provision of Wyoming Equality Network services will conclude on June 30, 2013. The intention of this report is to create a tool by which the Wyoming Department of Education, on behalf of Kindergarten through 12th grade schools (K-12) and in conjunction with the Community Colleges within the state can: (1) identify the requirements of the WEN in the next contract cycle; and (2) provide information supporting the conclusion. It is anticipated that this report and supporting information will be used by the State of Wyoming as it prepares its next Request for Proposal (RFP) related to the third WEN contract cycle (WEN v3).

Although the WDE is aware that the state's next RFP may also encompass other applications of technology for other agencies in a unified state-wide solution, and while the WDE anticipates cooperating in delivering technology into communities across the state, the scope of this report addresses only educational needs. It is our intention, however, that as educational needs are fulfilled, the entire community will directly or indirectly benefit from the delivery of technology through WEN v3.

3. Observations:

In preparing this report, the WDE made several observations from the experience of the first two WEN agreements.

- a. Technology outpaces the ability of the contract document to anticipate change and therefore the next contract document must provide a certain degree of flexibility allowing the parties to react to technological developments during the term of the agreement.
- b. Unless otherwise required by contract, a provider may have little or no incentive to introduce new technological solutions into the contract fulfillment until the provider is faced with either renewal or rebid of the contract. The Network (WEN v3) should incorporate a “strategy” advocating and perpetuating new solutions as part of the “cost of doing business”. Otherwise the contract may become a vehicle stifling growth of students and of teaching methods and practices.
- c. A longer term contract allows the vendor to recoup fixed costs over that term thus lowering prices but simultaneously it may hamper future growth in services under the contract.
- d. The Network (WEN v3) must permit synchronous communication for certain applications such as Voice of Internet Protocol telephone service (VOIP) and video conferencing all the while providing asynchronous communication for known and future applications.
- e. It is expected that substantial challenges are encountered in delivering adequate technological service to more remote locations and until vendors create economically viable solutions, it is incumbent upon the State encourage partnering solutions with local service providers creating appropriate incentives for the private sector to provide service and absent such partnerships for the State to directly provide such service.
- f. Certain services require establishing a network through a single or small number of aggregation points (such as currently experienced at the Emerson Building in Cheyenne) while other services need quick access and multiple channels of access to the Internet (the “Cloud”). Security for the WEN will be enhanced by limiting the number of cloud access points.
- g. Current compliance for e-Rate reimbursement from the Universal Service Administrative Company (USAC) requires content filtering of K-12 access to the Internet but similar filtering is not required of community college use.
- h. Exponential growth in both technology integration and supporting bandwidth is essential to the network’s (WEN v3) topography. Supporting infrastructure must include completing the ‘last mile’ of connectivity into each school and administration building as a responsibility of the state.
- i. Management or oversight of the network (WEN v3) must include a single point-of-contact as the responsible administration authority ensuring a flawless and uninterrupted signal handoff between schools, local providers and the state. This measure must include interoperability protocols between local networks, state-wide infrastructure and agency servicing personnel.
- j. Flexibility allowing each educational agency to use local providers, after approval from a unified service oversight/architecture committee, as a means of supplementing connectivity based on specific or unique demands particular to their learning environment is conducive to building a cohesive and viable network.
- k. Multiple avenues for redundancy via an “on-boarding” strategy for all future fiber runs must be included in future deliverables from the providers to each school or administration building.

- l. Open and frequent communications with the provider(s), education agencies and the State must include dialog about future trends in connectivity as well as educational technology development and usage. Periodic reviews and reporting to the Legislatures remains the responsibility of the educational agencies; however, with ongoing support from the network administrator(s) and provider(s).
- m. Uniformity of equipment, software and protocols within the system will vastly improve purchasing at economical cost and servicing and maintaining systems with fewer technical support positions.
- n. The WDE recognizes and understands the importance of pedagogical changes influenced by the advent of technology into the daily curriculum; therefore, in partnership with the districts, community college commission, community colleges and UW's College of Education, WDE plans to institute a statewide professional development program conducive to the advancements deployed through technology and connectivity.
- o. Standards for access and usage need to be developed to enable proper evaluation of all requests for future expansion of service.

4. Methodology employed in information gathering:

To develop this report, the WDE created a WEN RFP task force. Participation in the work of the task force was fluid with many parties being invited but with some participating only in small portions of the task force's work. Substantial credit must be given to the Technology Directors of the school districts and of the colleges for leading the technological discussions, but important work and input was received also from Curriculum Directors, School Administrators, Educators, Parents, the Office of the Chief Information Officer (OCIO), other experts, and, of course, the ultimate consumer and beneficiaries of this exercise, Wyoming Students, many of whom participated in the 2011 Technology Summit at the WDE Summer Camp in Casper, Wyoming. The expertise assembled and shared in this effort was substantial and the Department gratefully acknowledges the contributions of all those who worked on this project

The goal of this work was to develop a reasonable recommendation of the WEN resources required to continuously move Wyoming students into a modern classroom, to gain and refine skills needed in the 21st century marketplace, and to gather the information supporting the recommendations within this report. As seen below in developing this recommendation, the WDE continues to identify various additional tasks that the WDE believes it must complete in order to facilitate the employment of modern technology and related teaching pedagogies; therefore, preparing Wyoming students for success in the technology-rich future.

5. Basic Assumptions:

Technology at its basic understanding is the application of a tool in the completion of a task. It can be as simple as pencil on paper or as complex as multi-tiered computing systems applied to exploring enormous data banks. However, just as cellular phones and home computers revolutionized life 25 years ago, and as hand-held devices and social networking are changing the experience of our children today, we can state with certainty only that technology will continue to evolve.

Nevertheless, it remains the statutory duty of the Superintendent of Public Instruction to anticipate and provide adequate tools for our children and to prepare students for a future of continued technological innovation.¹ This is a duty shared with the Wyoming State Legislature.² The Wyoming Equality Network is, in part, a response to these duties.

6. Data Considerations.

a. Bandwidth usage.

Collaborative Learning Environment. Collaborative learning³ occurs when students are encouraged to work with others in experiencing new concepts. This may be as simple as working together to produce a report or project with one or more classmates, or it may require the student to explore information obtained from others in distant locations. Even when working locally, adequate bandwidth permits application of so-called “social media” tools to share information and experiences. The explosive growth in sharing YouTube™ video files is a simple example of how youth share information in a collaborative setting. Similarly, such tools are often used to deliver information in the form of instruction, virtual field trips, and collaboration with students in distant districts and colleges or even foreign lands.

Collaborative learning is not limited to students but can and does become the bases by which professional learning communities develop and transact the sharing of experiences essential to furthering individual skills and techniques of instructors⁴.

Educational Enrichment. Student educational enrichment results in benefits beyond simply a better educated individual such as improved attendance, higher graduation rates and fewer disciplinary actions. Enriching the educational opportunities of students, including those located in remote areas, or without access to specialized instruction facilitates enrichment and provides instruction that is not available for other reasons.

¹ **21-2-202. Duties of the state superintendent.**

(a) In addition to any other duties assigned by law, the state superintendent shall:

* * * *

(xx) In cooperation with the state board, the Wyoming community college commission, University of Wyoming, state telecommunications council, public service commission, department of transportation, department of administration and information, public libraries, school district boards of trustees, classroom teachers and other appropriate groups identified by the superintendent, **develop and implement a statewide education technology plan which shall address staff training, curriculum integration and network connectivity in and between schools, communities and between the state and the world, and which shall have as its goal the provision of equal access to educational instruction and information.** . . .

² “The state financed basket of quality educational goods and services available to all school-age youth must be nearly identical from district to district. If a local district then wants to enhance the content of that basket, the legislature can provide a mechanism by which it can be done. But first, before all else, the constitutional basket must be filled.” *Campbell County School District v. State*, 1995 WY 184, 907 P.2d 1238 at ¶147.

³ See: <http://www.iste.org/standards/nets-for-students.aspx>

⁴ For further discuss, see: <http://www.iste.org/standards/nets-for-teachers.aspx>
<http://www.iste.org/standards/nets-for-administrators.aspx> and
<http://loticonnection.com/index.php/resources/publications/20-loti-framework>

Content enrichment comes in many forms. It may be a standardized calculus curriculum taught by a superior instructor on a distance learning platform. This might take the form of an interactive, real-time experience or it may be through participating in an established series of lectures followed by interactive group work. It may even involve students participating in a lecture then followed by exercises evaluated by a computer in real time with additional instruction on basic concepts then being offered to the student so that she can recover a concept and be permitted to build on a firm understanding of the subject matter. It may also take the form of instructional content on-line followed up with face to face refinement by the local instructor⁵.

Regardless of the form, the goal will be to broaden the student's educational opportunities beyond those locally available. Connectivity delivers enrichment enabling every Wyoming student to receive a superior education at an efficient rate and economical cost. This has a positive side-effect, in turn, by increasing the Hathaway Scholarship opportunities for Wyoming students.

Research. One of the more common uses of bandwidth is for research. The days of resorting to texts within the school library or to learning through the study of encyclopedia topics, are being replaced by "real time" research. Instead students are relying on access to topics in venues such as Wikipedia™ or seeking answers to questions formulated within Google™ or similar search engines. Students now are challenged to determine whether the information they gather is consistent with their training, education and experience and thus worthy of assimilation.

The internet is becoming the repository of nearly all human experience. Most new scientific papers and research studies can now be found online. Surveys and opinions are gathered in specialized sites related to content areas. A significant challenge in the current workplace is learning how to distinguish valuable information from irrelevant or misleading information. This is a critical thinking skill⁶ which is essential to valuable research and a component of a good educational experience.

Assessment. Within educational pedagogy is well established the process of establishing standards and measures followed by assessment⁷ to determine the success in infusing learning into each student. While we often think of this in the sense of the state-wide summative assessment, in fact assessment is occurring whenever a student and teacher interact around learning. A skilled educator understands how to respond to a hole in the student's learning revealed by the periodic assessment. This formative type of assessment allows the instructor to revisit concepts with the student thus allowing the student to quickly return to relevant material.

Online assessment can be developed for educational formation as well as to measure the summative learning of the student. Online tools permit a quick and efficient evaluation of the student's progress within the subject matter thus facilitating the educator's ability to timely respond to the student's special need. Thus online platforms will grow in importance as a means by which formative assessment

⁵ See, blended learning discussed at: http://kpk12.com/cms/wp-content/uploads/EEG_KeepingPace2011-1r.pdf and the Innosight white paper located at: <http://www.innosightinstitute.org/media-room/publications/education-publications/the-rise-of-k-12-blended-learning/>

⁶ Performance indicators are more thoroughly discussed at: <http://www.iste.org/standards/nets-for-students/nets-student-standards-2007.aspx>

⁷ Assessment applications are more thoroughly discussed at: <http://www.iste.org/standards/nets-for-teachers/nets-for-teachers-2008.aspx>

occurs. As online resources grow and as online formative assessment becomes more common, we can expect the student's growth to be monitored on nearly a real-time basis. Thus, disruptions to growth can be more quickly identified by parents, teachers and administrators allowing for timely intervention and less need for remediation or recovery of skills. Such systems will, however, require considerable bandwidth.

As to statewide summative assessment, the trend continues away from paper-pencil and towards online systems. This trend will demand connectivity between each student and the testing contractor, something which could be considered more than problematic under the existing WEN network. Such statewide systems place an overwhelming burden on networks unless the network has sufficient capacity to deliver the testing instrument to the student and the student's response to the vendor.

Other Data Applications. Storing and retrieval of all forms of data continues to grow. These might include student educational progress records, student created content, school performance information, financial transactional records, and public meetings documents. Retention and retrieval of these items is becoming the norm rather than the exception, all the while remaining within the Family Educational Rights Protection Act (FERPA) guidelines. Administrative uses of data for longitudinal data systems, interactivity with parents, and tracking individual educational plans for students will continue to develop.

All data ultimately is stored and once stored is at risk of loss or damage unless stored in an off-site location from which it can be recovered. Off-site storage and recovery consumes enormous amounts of bandwidth but is normally positioned to occur automatically during low bandwidth demand times (late night and early morning).

Data Warehousing Solutions. Each user develops data that for security and data protection reasons should be periodically transferred to an off-site location. As bandwidth capacity increases opportunities will exist for districts and colleges to act as the back-up location for data from other districts and colleges in an efficient and economical manner. Present WEN limitations seriously hamper the ability to transfer large data files even during low usage periods.

Communications. Telephone communication by voice-over-internet-protocol (VoIP) remains an efficient tool for lowering communication costs and reaching individuals via their computer or hand-held device rather than merely by a stationary phone. Much as with streaming video, to function best VoIP requires substantial bandwidth or adequate synchronous circuits.

b. Technical considerations.

Static Internet address. A Static IP permits a device to maintain a permanent location on the Internet. Some features work well only if a static IP is maintained. For example, a local network fileserver, a website, or a video conferencing device will likely function more effectively if identified by a Static IP. . Currently the Wyoming Equality Network (WEN) utilizes public IP addresses registered with Wyoming Community College Commission WYEN (NET-137-84-0-0-1) 137.84.0.0 - 137.90.255.255. Numerous services, DNS, and firewall settings are configured utilizing these addresses. Proposed network solutions need to consider the implications, routing, and utilization of the mentioned addresses.

Synchronous and Asynchronous applications. Similarly, certain applications require approximately the same upload and download capacity (synchronous) while others work well if upload speed is far less

than download speed. Thus, a steaming video conference or a VoIP based telephone conversation each requires both parties enjoy approximately the same upload and download capacity. Such devices are best served on synchronous systems while pure data transfer might operate effectively in an asynchronous environment.

Quality of Service (QoS). An important consideration involving a unified network is the interoperability between systems. Agreed upon settings allows data, audio and video to flow between systems at the same priority levels. Level of Service (LoS) on the other hand establishes the customer service obligations between systems, support staff and agencies.

Data transfer, recovery and related security. As with the preservation and care of any valuable asset, security of the information and the speed by which it can be recovered (even if damaged) are functions best served on high capacity bandwidth connections. Often data is encrypted to protect it while in transit. Encryption prepares hardware and software for sensitive and valuable forms of data to be transmitted via the internet.

Child Internet Protection Act (CIPA). To qualify for E-Rate participation, K-12 schools must be able to demonstrate compliance with CIPA. CIPA is designed to protect children from harmful and inappropriate content found often on the internet. Conversely, content to college-aged students is normally not filtered.

“Edge” connections. Currently, when a school or college has found its WEN connection to be inadequate some have turned to other providers in their marketplace to acquire additional bandwidth. These circuits have acquired the general name “edge” connections and are often available at much lower cost than similar capacity under the existing WEN circuits. However, not every school served by the WEN can gain access to edge connections and this ultimately leads to inequality among the services available at schools. The need for incentivize edge solution providers must be part of any future contract(s). The WEN also utilizes BGP routing to most of the entities that have edge connections. The BGP routing has been configured to ensure correct traffic routing for the local entity and so that providers may not utilize redundant or edge connections as a failover connection.

Domain Name Service (DNS). The Wyoming Department of Education currently administers DNS for all educational entities that wish to utilize the service. These servers are located within the network where ample bandwidth is available and should be considered in the proposed solution.

Firewall Services. The WEN currently uses a multi-tiered approach to firewall services that mitigates most of the outside “Hacker” traffic at the edge of the network, limiting the impact of unnecessary traffic on already burdened circuits.

c. Other Considerations:

Contract management. The future WEN v3 contract or contracts will require continued service and enforcement, probably by a unified statewide network team. Nevertheless the WDE recognizes that several terms should be incorporated within the contract(s) to garner the greatest benefit to the WEN. These would include most-favored-nation pricing over the life of the contract, most-favored-nation technology over the life the contract, and local option to acquire additional capacity on these terms. The contract(s) should also anticipate scaling of the service as demands increase as might be determined

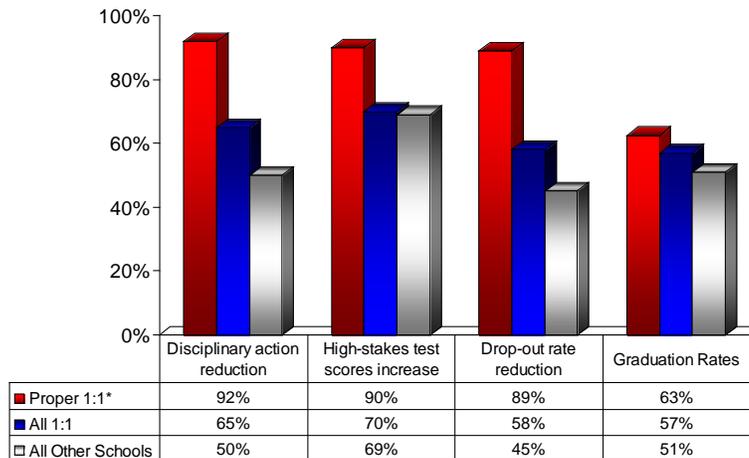
from time to time during the contract life. This can be accomplished via “on-boarding” agreements in the upcoming contract(s).

Off-site access by students. A substantial challenge for some Wyoming students is to have continued access to bandwidth as an educational tool after leaving the school campus. Some common examples are: the student traveling to a school approved activity who could benefit by participating in his class’s activity through a real-time connection; the homebound student who might need instruction delivered for a substantial period of time while recuperating from an illness; or the student who has been institutionalized in a non-educational environment who nevertheless is able to continue to participate in classes. But perhaps the most common is the student who does not have access to bandwidth at home either due to economic circumstances or remoteness of the home. The WDE, the community colleges, and the districts will be challenged to provide solutions to these and similar circumstances as access to broadband becomes an increasing component of education in Wyoming.

Increased educational outcomes. While it seems intuitive that students will perform better if provided with better tools, it is empirically difficult to prove this proposition. Nevertheless research suggests:

Key Implementation Factors Linked to Education Improvement

Pct. of Respondents Reporting Improvement by Students/Computer Ratio



* Proper 1:1: Those schools practicing the top 4 Key Implementation Factors: Intervention Classes Every Class Period, Principal Leads Change management, Online collaboration Daily, Core Curriculum weekly

Source: Project Red (Revolutionizing Education), Properly Implemented Technology Improves Learning and Saves Money for Beleaguered Schools, Press Release of October 10, 2010

The chart suggests that properly implemented technology seems to reduce disciplinary problems, increase test scoring and improve graduation rates. In this sense, bandwidth supports the technology-rich pedagogy with corresponding increased student educational availability and outcomes.

Delivery to district central office or to all schools in district. Districts and community colleges typically operate a local-area network (LAN) connecting all or most buildings within the district or the college campus. However, for remote schools and college extension sites the connectivity is limited to that

provided by WEN. A challenge exists in supplying broadband to remote locations in sufficient capacity and without latency so as to permit the students in those locations to fully participate in the full array of the educational experience. Further, such systems are often subject to unacceptable latency and consideration should be given to finding stable or redundant means by which to deliver bandwidth.

What should be provided. The next generation of the WEN should provide adequate bandwidth permitting connectivity (on-boarding) not only within a school or college campus but to the internet, with a capacity to expand as needed. It needs to use standardized routers and switches with standardized software systems permitting prompt repair and maintenance and efficient management of the system. It will continue to provide CIPA compliant filtering devices for school districts.

Rural access. Wyoming's primary and secondary schools are found in nearly every remote location within the state. Even long established towns such as Encampment and Farson struggle to find connectivity to the internet. Large districts have small, remote schools (e.g., Natrona County SD#1 with schools at Alcova, Powder River, Red Creek and Willow Creek; and Sweetwater SD#2 with schools at McKinnon and Granger). Bundling these small or remote schools with large district-wide contracts for service will create the economic incentive to deliver adequate bandwidth to remote locations, benefiting not only the schools but residents in the immediate area. Identifying connection solutions by the provider(s) is a WEN v3 required element.

Continued and future requirements of Department of Education. To make best advantage of WEN v3 the WDE should be tasked and resourced to provide: instructional training of educators in current and developing strategies for the use of technology in the classroom; continued evaluation and recommendation of content and tools available for student success; continued development of systems to further formative assessment of students and educational improvement; technological services in support of state-wide and local WEN systems; continuous monitoring of technology development and adequacy of the WEN in support of best pedagogical systems; and on-going instructive support within districts and in conjunction with the community colleges.

Current state of Wyoming bandwidth. Attached is Schedule 1 demonstrating the WEN bandwidth supplied to each district as of May 2011. Also attached is Schedule 2, a chart from the Akamai Technologies "State of the Internet" report, reflecting how Wyoming compares with the nation and the nearby states of Colorado and Utah in terms of average bandwidth available. Wyoming does not substantially lag its neighbors notwithstanding the paltry level of our current WEN service. However, with the ubiquitous appearance of handheld and personal computing devices, it becomes increasingly important that we increase our average bandwidth to each of our schools and colleges.

7. Recommendation for Business Plan

a. Pricing to make economic incentive for remote service.

Most small communities in Wyoming are on the short side of the digital divide. To adequately serve these communities and many of the rural schools, contracts should be awarded which include larger communities giving the vendor adequate incentive to build out the infrastructure needed to reach these remote areas. Earlier efforts to accomplish this through WEN vendors has met with marginal success at best through the reliance on satellite based, high latency connections. Such connections are inadequate for many of the new technologies and until the disparity is resolved, it will be difficult for the people of Wyoming to claim that the "state financed basket of quality educational goods and services available to

all school-age youth must be nearly identical from district to district.” The alternative is to continue with slow, inadequate levels of service to all districts and the community colleges, a concept rejected by the authors of this report. “Equality” needs to address bandwidth and services for the remote locations for this to become a reality.

b. Alternative state partnering model.

Just as occasions have arisen where roads or utilities were extended into remote regions where economic conditions did not justify a private enterprise solution, it may be incumbent upon the State of Wyoming to develop partnerships with private vendors under any of a variety of relationships for the operation or subsidization of service.

c. Projecting bandwidth requirements.

The review panel discussed conducting a test but rejected it as impractical. The reasoning was thus: If we were to increase the bandwidth provided to a school, district, or college to the level of 1 Mb/student, then how long would it take for the pedagogy to adjust to the new tool, especially if we suggested to the users that it is only test of limited duration. We concluded it might take a substantial length of time for teachers to adjust their teaching style and, even then, only a few would be willing to put in the effort to do so if they believed the bandwidth was only temporarily available.

Other tools, such as on-line assessment and interaction with a student-achievement based longitudinal data system would not necessarily come on-line during the test phase.

Some applications, such as VoIP telephony, would require a transition from existing systems that would not likely be encouraged for a short-term test period. The same would likely be true for parent interface tools, and new data recovery and data transfer protocols and systems.

Students would not necessarily transition from existing (private) collaborative and social interaction tools to school-based tools until the test school supplies the necessary means for connection, which again, a district or college might be reluctant to do until it could be assured the students would have long-term value from the connection points.

Equally important, however, is that a test would delay the process and that a substantial advantage of getting out well in advance of the next contract would be lost. A significant reason for moving forward with a new contract RFP is to give everyone - vendors and schools alike - the opportunity to plan and prepare for a transition. A delay in order to conduct the suggested type of testing would close this window of opportunity, thus delaying a new RFP and subsequent contract.

d. Transition to 21st Century tools and skills

Online learning has the potential to be a disruptive force that will transform the factory-like, monolithic structure that has dominated America’s schools into a new model that is student-centric, highly personalized for each learner, and more productive, as it delivers dramatically better results at the same or lower cost.

Michael B. Horn and Heather Staker, *The Rise of K-12 Blended Learning* (Innosight Institute, January 2011, pg 2).

Preparing Wyoming's youth for competition on a world stage requires bold and dramatic change in the way we provide educational resources. Providing students with access to the informational riches of the internet is a first step towards the educational revolution that must inevitably occur. By providing adequate and "on-board" bandwidth and associated tools to reform the pedagogy, Wyoming can position itself to give our students the best possible launch into the future.

e. Recommended bandwidth.

- After reviewing resources available to students in other states and nations; considering the cost of bandwidth most household consumers enjoy in the state; looking at expected changes in pedagogy; anticipating new assessment tools and demands for data at every level of the educational system; and the recommendations of experts within and beyond the state, the WEN v3 advisory group concluded that one megabit (1Mb) per student should be provided to each of our students in K-12 and on the college campuses as soon as possible. However, in recognition that it is unlikely this increased could be fully consumed and put effectively to use, the group further recommends it be phased in starting at 384kb in year one, growing to 768kb in year two and reaching 1Mb in year three. If the contract extends beyond three years, then bandwidth requirements should continue to be evaluated and increased as appropriate.
- The WEN v3 services can be provided under a master single-provider contract or a series of contracts for different districts or regions. In either event adequate performance standards backed by liquidated damages are essential.
- The contract should be scalable over its life to increase service as demanded and local districts and colleges should have the option of increasing the bandwidth at favorable pricing available under the state contract.
- Districts and community colleges must be allowed to operate private networks among all schools and extension sites within the district or college.
- It is recommended that to support minimum services in every school, a minimum of 10Mb be provided regardless of the school census.
- It is recommended that service be provided to every school in every district and district but that vendors are encouraged to use existing LANs within district or college, where available.
- It is recommended that each district and each college have a single aggregation point for connection to the WEN v3 unless that district or college elects not to maintain a single aggregation point.
- Delivery of bandwidth will likely be made through fiber optical network connections but other solutions should be considered provide that latency of signal by such means should not exceed 5 milliseconds.
- All new fiber deployments will have "on-board" capacity for expansion and "as needed" capacity.
- A centralized aggregation point is not essential for WEN v3 but monitoring quality of service will be a challenge for network administrators, especially for VoIP and teleconferencing applications.
- Regularly scheduled planning sessions between the vendor(s) and the stakeholders to cover future enterprises, expansions and pedagogical advancements are relevant to the impact of a statewide network's bandwidth consumption.

8. Conclusion

Our students and teachers now engaged are in a global communication “transformation” which requires the current service to be increased in size and quality on a continuous basis.

A key ingredient toward providing a successful learning environment for all Wyoming students incorporates the equitable access to services in spite a student’s demographic or physical location within Wyoming’s borders.

Wyoming is uniquely positioned on the cusp of the information divide. We can continue with a moderately successful, expensive network or we can demand more of our vendors, driving home the message that the current service is not sufficient; that Wyoming taxpayers have paid for a premium service and now our students deserve to receive the tools needed to succeed, including adequate bandwidth as determined by each educational entity.

Glossary of Terms

Aggregation Point: A location or point of presence where more than one entity or service converges to form a single entity or service unit. An example would be multiple buildings connected to a single building hosting an Internet gateway. The hosting building would be the aggregation point.

Asynchronous: Of, used in, or being digital communication (as between computers) in which there is no timing requirement for transmission and in which the start of each character is individually signaled by the transmitting device

Bandwidth: Is a bit rate measure of available or consumed data communication resources expressed in bits/second or multiples of it (kilobits/s, megabits/s etc.).

Broadband: The term *broadband* refers to a telecommunications signal or device of greater bandwidth, in some sense, than another standard or usual signal or device (and the broader the band, the greater the capacity for traffic). Different criteria for "broad" have been applied in different contexts and at different times. Its origin is in physics, acoustics and radio systems engineering, where it had been used with a meaning similar to wideband. However, the term became popularized through the 1990s as a vague marketing term for Internet access.

Children Internet Protection Act (CIPA): Requires that K-12 schools and libraries in the United States use Internet filters and implement other measures to protect children from harmful online content as a condition for the receipt of certain federal funding. It was signed into law on December 21, 2000 and was found to be constitutional by the United States Supreme Court on June 23, 2003.

Cloud (computing): Is the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet).

Collaborative Learning: Is a situation in which two or more people learn or attempt to learn something together. Unlike individual learning, people engaged in collaborative learning capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.). More specifically, collaborative learning is based on the model that knowledge can be created within a population where members actively interact by sharing experiences and take on asymmetry roles. Put differently, collaborative learning refers to methodologies and environments in which learners engage in a common task where each individual depends on and is accountable to each other. These include both face-to-face conversations and computer discussions (online forums, chat rooms, etc.).

Courseware: Is a term that combines the words 'course' with 'software'. Its meaning originally was used to describe additional educational material intended as kits for teachers or trainers or as tutorials for students, usually packaged for use with a computer. The term's meaning and usage has expanded and can refer to the entire course and any additional material when used in reference an online or 'computer formatted' classroom. Many companies are using the term to describe the entire "package" consisting of one 'class' or 'course' bundled together with the various lessons, tests, and other material needed. The courseware itself can be in different formats, some are only available online such as html pages, while others can be downloaded in .pdf files or other types of document files. Many forms of e-

learning are now being blended with term courseware. Most leading educational companies solicit or include courseware with their training packages.

Distance Education: Distance education instruction occurs whenever the teacher and student are (1) physically separated by time or space, and (2) connected by means of a communications source used to provide synchronous or asynchronous instruction.

E-Rate: The program provides discounts to assist most schools and libraries in the United States (and U.S. territories) to obtain affordable telecommunications and Internet access. It is one of four support programs funded through a Universal Service fee charged to companies that provide interstate and/or international telecommunications services.

End User: Is someone who operates the tool, such as a computer, video conferencing unit or hand held device, as opposed to the developer of the system who creates new functions for end users; a consumer of network services.

Family Educational Rights and Privacy Act (FERPA): It allows students with access to their education records, an opportunity to seek to have the records amended, and some control over the disclosure of information from the records. With several exceptions, schools must have a student's consent prior to the disclosure of education records. It only applies to educational agencies and institutions that receive funding under a program administered by the U.S. Department of Education.

Fiber (optic): An optical fiber is a flexible, transparent fiber made of very pure glass (silica) not much wider than a human hair that acts as a waveguide, or "light pipe", to transmit light between the two ends of the fiber. The field of applied science and engineering concerned with the design and application of optical fibers is known as fiber optics. Optical fibers are widely used in fiber-optic communications, which permits transmission over longer distances and at higher bandwidths (data rates) than other forms of communication. Fibers are used instead of metal wires because signals travel along them with less loss and are also immune to electromagnetic interference. Fibers are also used for illumination, and are wrapped in bundles so they can be used to carry images, thus allowing viewing in tight spaces. Specially designed fibers are used for a variety of other applications, including sensors and fiber lasers.

Firewall: Is a device or set of devices designed to permit or deny network transmissions based upon a set of rules and is frequently used to protect networks from unauthorized access while permitting legitimate communications to pass.

Internet Protocol: Is the principal communications protocol used for relaying datagrams (packets) across an internetwork using the Internet Protocol Suite. Responsible for routing packets across network boundaries, it is the primary protocol that establishes the Internet.

- **Dynamic IP:** Are used because it avoids the administrative burden of assigning specific static addresses to each device on a network. It also allows many devices to share limited address space on a network if only some of them will be online at a particular time.
- **Static IP:** An Internet Protocol address (IP address) is a numerical label manually assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing.
- **Public:** Routable Internet Protocol addresses used in the public Internet space.

- Private: Non routed IP addresses used behind routers for private networks. These IP address ranges are not routed in the public Internet space.

Last Mile: Is the final leg of delivering connectivity from a communications provider to a customer. The phrase is therefore often used by the telecommunications and cable television industries. The actual distance of this leg may be considerably more than a mile, especially in rural areas. It is typically seen as an expensive challenge because "fanning out" wires and cables is a considerable physical undertaking. Because the last mile of a network to the user is also the first mile from the user to the world in regards to sending data (such as uploading), the term "*first mile*" is sometimes used.

Latency: Latency in a packet-switched network is measured either *one-way* (the time from the source sending a packet to the destination receiving it), or *round-trip* (the one-way latency from source to destination plus the one-way latency from the destination back to the source).

Local Area Network (LAN): Is a computer network that interconnects computers in a limited area such as home, school, computer laboratory or office building. The defining characteristics of LANs, in contrast to wide area networks (WANs), include their usually higher data-transfer rates, smaller geographic area, and lack of a need for leased telecommunication lines.

Mobility (extending the classroom; school without walls): Providing educational resources in locations beyond traditional schools.

Network: Is a collection of hardware components and computers interconnected by communication channels that allow sharing of resources and information. Networks may be classified according to a wide variety of characteristics such as the medium used to transport the data, communications protocol used, scale, topology, and organizational scope.

Network Security (categories and minimum standards): Consists of the provisions and policies adopted by the network administrator to prevent and monitor unauthorized access, misuse, modification, or denial of the computer network and network-accessible resources. Network security involves the authorization of access to data in a network, which is controlled by the network administrator.

Pedagogy: The art and science of teaching or being a teacher.

Personal Learning Devices: Refers to any electronic device used to store or retrieve educational content, including access to the internet. A more comprehensive list is found above under "Wireless."

Point of Presence (POP): Is an artificial demarcation point or interface point between communications entities.

Professional Development: Skills and knowledge obtained via training to improve or enhance an individual's skill-set.

Quality of Service (QOS): Refers to several related aspects of telephony and computer networks that allow the transport of traffic with special requirements. In particular, much technology has been developed to allow computer networks to become as useful as telephone network for audio conversations, as well as supporting new applications with even more strict service demands.

Redundancy: Synonym for Fault Tolerance. **Fault Tolerance** - The ability of an IT Service\e of Configuration Item to continue to Operate correctly after Failure of a Component part; opposite of Single Point Failure.

Response to Intervention (RTI): Is a method of academic intervention used in the United States which is designed to provide early, effective assistance to children who are having difficulty learning. Response to intervention was also designed to function as one part of a data-based process of identifying learning disabilities. This method can be used at the group and individual level. The RTI method has been developed by proponents as an alternative to identifying learning disabilities with the ability-achievement discrepancy model, which requires children to exhibit a discrepancy between their ability, often measured by Intelligence Quotient (IQ) testing and academic achievement as measured by their grades and standardized testing.

Service Level Agreement: An agreement between an IT Service Provider and a Customer. The SLA describes the IT Service, documents Server Level Targets, and specifies the responsibilities of the IT Service Provider and the Customer. A single SLA may cover multiple IT Services or multiple Customers.

Statewide Longitudinal Data Systems (SLDS): A system for gathering basic information and sharing it among agencies in the form of a searchable data base, the purpose of which is normally to make better informed decisions concerning education and other data-intensive systems.

Student Centered Learning: Is an approach to education focusing on the needs of the students, rather than those of others involved in the educational process, such as teachers and administrators. This approach has many implications for the design of curriculum, course content, and interactivity of courses. Student-centered learning, that is, putting students first, is in contrast to teacher-centre learning. Student-centered learning is focused on the student's needs, abilities, interests, and learning styles with the teacher as a facilitator of learning. This classroom teaching method acknowledges student voice as central to the learning experience for every learner.

Synchronous: Happening, existing, or arising at precisely the same time; recurring or operating at exactly the same periods.

Videoconferencing: Is the conduct of a videoconference (also known as a video conference or video teleconference) by a set of telecommunication technologies which allow two or more locations to interact via two-way video and audio transmissions simultaneously.

Voice over Internet Protocol (VoIP): Is a family of technologies, methodologies, communication protocols, and transmission techniques for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.

Web Conferencing: Refers to a service that allows conferencing events to be shared with remote locations.

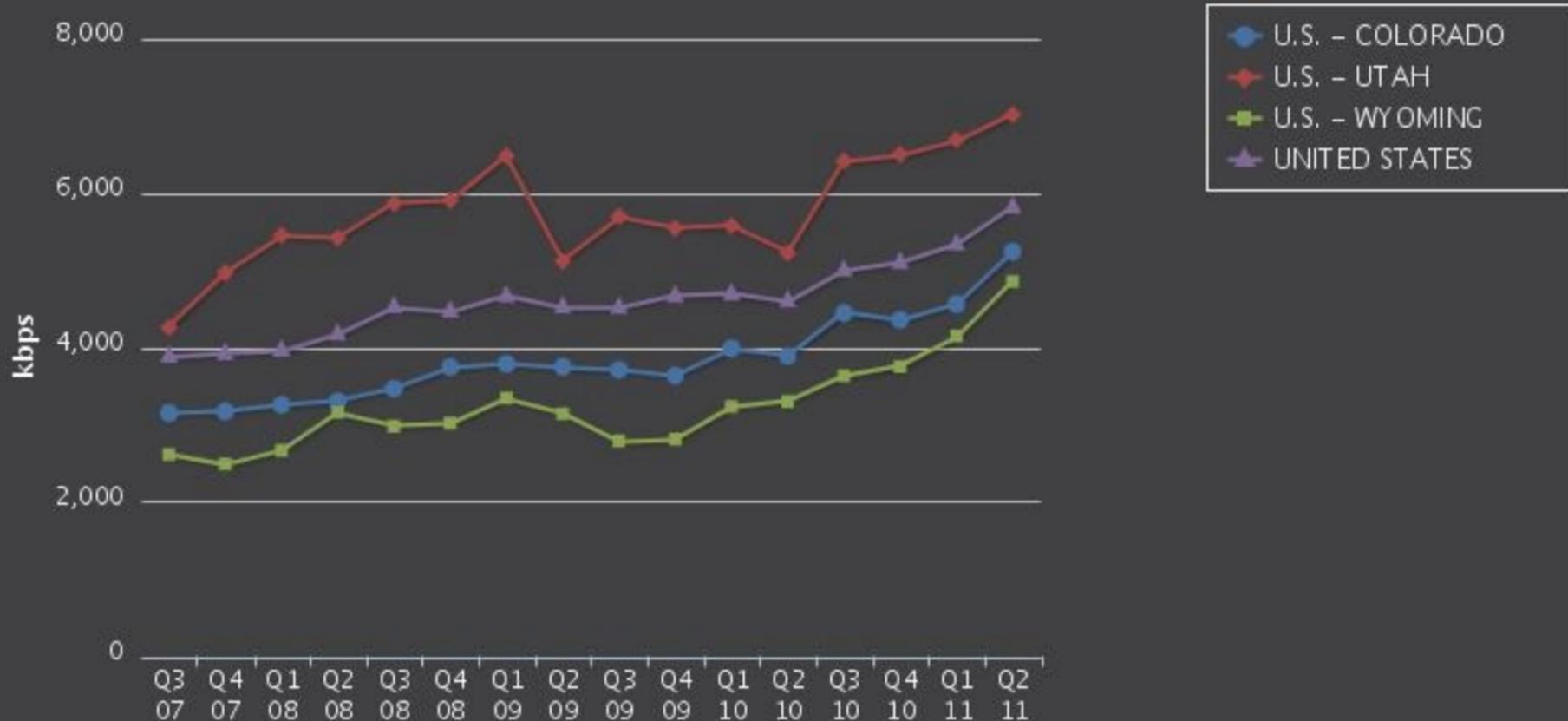
Wide Area Network (WAN): Is a telecommunication network that covers a broad area (i.e., any network that links across metropolitan, regional, or national boundaries). Business and government entities utilize WANs to relay data among employees, clients, buyers, and suppliers from various geographical locations. In essence this mode of telecommunication allows a business to effectively carry out its daily function regardless of location.

WiFi: Is a mechanism for wirelessly connecting electronic devices. A device enabled with Wi-Fi, such as a personal computer, video game console, smartphone, or digital audio player, can connect to the Internet via a wireless network access point. An access point (or hotspot) has a range of about 20 meters (65 ft) indoors and a greater range outdoors. Multiple overlapping access points can cover large areas.

Wireless: Is the transfer of information between two or more points that are physically not connected. Distances can be short, as a few meters as in television remote control; or long ranging from thousands to millions of kilometers for deep-space radio communications. It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking.

Wyoming Equality Network (WEN): The existing network connecting each school district and community college to a central aggregation point in the Emerson Building in Cheyenne from which a hand off is made of internet traffic to the CenturyLink central office.

Average Connection Speed



District	2009 Enrollment	Bandwidth to Emerson (Mbps)	Bandwidth in Kbps	Kbps per student	WSBA Kbps Recommendation	WSBA Mbps Recommendation
Crook #1	104	6	6000	57.69231	41600	40.625
Sheridan #3	101	3	3000	29.70297	40400	39.45313
Sweetwater #1	5033	149	149000	29.60461	2013200	1966.016
Washakie #2	112	3	3000	26.78571	44800	43.75
Park #6	2156	44	44000	20.40816	862400	842.1875
Fremont #2	178	3	3000	16.85393	71200	69.53125
Johnson #1	1232	20	20000	16.23377	492800	481.25
Platte #2	193	3	3000	15.54404	77200	75.39063
Fremont #6	396	6	6000	15.15152	158400	154.6875
Carbon #1	1803	24	24000	13.31115	721200	704.2969
Park #16	119	1.5	1500	12.60504	47600	46.48438
Fremont #1	1670	20	20000	11.97605	668000	652.3438
Park #1	1695	20	20000	11.79941	678000	662.1094
Weston #7	277	3	3000	10.83032	110800	108.2031
Big Horn #4	297	3	3000	10.10101	118800	116.0156
Sheridan #1	923	9	9000	9.750813	369200	360.5469
Fremont #24	316	3	3000	9.493671	126400	123.4375
Platte #1	1062	10	10000	9.416196	424800	414.8438
Carbon #2	648	6	6000	9.259259	259200	253.125
Fremont #21	489	4.5	4500	9.202454	195600	191.0156
Fremont #38	331	3	3000	9.063444	132400	129.2969
Sublette #9	675	6	6000	8.888889	270000	263.6719
Converse #2	688	6	6000	8.72093	275200	268.75
Fremont #25	2465	20	20000	8.11359	986000	962.8906
Teton #1	2317	18	18000	7.768666	926800	905.0781
Laramie #1	13195	100	100000	7.578628	5278000	5154.297
Lincoln #1	602	4.5	4500	7.475083	240800	235.1563
Natrona #1	12134	90	90000	7.417175	4853600	4739.844
Weston #1	814	6	6000	7.371007	325600	317.9688
Big Horn #1	650	4.5	4500	6.923077	260000	253.9063
Hot Springs #1	652	4.5	4500	6.90184	260800	254.6875
Albany #1	3636	25	25000	6.875688	1454400	1420.313
Lincoln #2	2640	18	18000	6.818182	1056000	1031.25
Uinta #1	2962	20	20000	6.752194	1184800	1157.031
Uinta #6	690	4.5	4500	6.521739	276000	269.5313
Uinta #4	742	4.5	4500	6.06469	296800	289.8438
Big Horn #3	498	3	3000	6.024096	199200	194.5313
Fremont #14	535	3	3000	5.607477	214000	208.9844
Sheridan #2	3165	17	17000	5.371248	1266000	1236.328
Goshen #1	1807	9	9000	4.980631	722800	705.8594
Campbell #1	8214	40	40000	4.869735	3285600	3208.594
Niobrara #1	617	3	3000	4.862237	246800	241.0156
Converse #1	1690	8	8000	4.733728	676000	660.1563
Sublette #1	978	4.5	4500	4.601227	391200	382.0313
Big Horn #2	660	3	3000	4.545455	264000	257.8125
Washakie #1	1325	6	6000	4.528302	530000	517.5781
Sweetwater #2	2601	9	9000	3.460208	1040400	1016.016
Laramie #2	872	3	3000	3.440367	348800	340.625
WY Boys School		1.5				
WY Girls School		6				
Casper College		25				
Casper College Guest		10				
Central Wy College		40				
Eastern WY College		45				
Laramie County Community College		20				
Northwest College		40				
Sheridan College		44				
Western WY College		20				
Dept of Ed Laramie		1.5				
Dept of Ed Riverton		1.5				