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Why are Wireless Services Important to State and Education Leaders?

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Wireless services are revolutionizing communication and can benefit both schools and students in significant ways.

Overview of wireless services and education

Wireless services have introduced a new era in communication for the education community, and this new concept of mobility within the educator's daily environment is having a major impact on student learning. Personal digital assistants (also called hand-held computers or PDAs), tablet computers, notebook (laptop) computers, wireless networking and the cellular telephone are liberating faculty, staff and students from the time and space constraints of the traditional classroom.

The emergence of wireless technology is already evident in many ways: as an important delivery format for off-site access to campus learning resources and services, such as online student registration; in course management systems used to facilitate online courses; in the skyrocketing use of e-mail and online communications among and between teachers and students; and in the rapid growth of distance learning via the Web, video conferencing and satellite television. In order to benefit from these changes and the potential for even greater educational opportunities, education leaders and state policy-makers should understand these trends and prepare to incorporate and benefit from them.

Mobility boosts interactivity, reduces problems

Wireless technology brings the primary benefit of mobility to traditional class activities. For example, wireless connections to a classroom eliminate the need to run wires through thick, fire-retardant walls. Students' and teachers' laptop computers with wireless cards can be moved wherever needed in the local area and still access educational materials on the school's server. Classroom sets of laptops or hand-helds allow students to practice skills and complete writing tasks; many applications track each student's

progress for grading and collect data to be analyzed for school reports. In addition, mobile sets of computers give students one-to-one access. Students can continue to collaborate on a class project with other students while outside the classroom, school or campus and can send the results to their instructors from anywhere they find a “hot spot” (wireless public access, increasingly offered by businesses, libraries and other facilities).

There are also situations in which wireless connections are more economical than traditional wired connections, especially where wired connections would be prohibitively difficult. Many schools have no space for computer labs, or they anticipate future renovations that would require wiring in classrooms to be redone. To accommodate rapid expansion, some schools use mobile classrooms that can make wiring very challenging, and the number and placement of these mobile buildings change yearly to meet the changing needs of the schools. Science labs, in particular, provide logistical complications that prevent fixed computers near water and chemicals. Wireless devices eliminate these barriers.

Learning activities are more flexible

Of more significance, however, is the potential of using the unique advantages of advanced wireless technology to do things very *differently* and to do *different things* to improve and expand educational activities. A phrase that is often used to capture this vision is “anytime, anywhere learning.” With reliable, high-capacity, secure wireless connectivity to online educational resources and services, many types of learning activities can be supported whenever and wherever they are needed. Scientific data can be collected, stored and transmitted to the appropriate researcher from remote locations. Instructors can use wireless devices to question students, and students can send their responses back to the teacher — thus engaging all students and providing an instant check of student learning or miscues. **Many time and location constraints of traditional educational structures can be overcome.**

With the increased flexibility and mobility of advanced wireless services, students are able to access educational courses, teachers and faculty are able to design different and more tailored experiences, and there is more free-flowing collaboration among students, teachers and other sources. For example, wireless devices let students transfer their homework assignments to the teacher’s server for grading, even from remote locations. Teachers can discuss the work directly with each student online (with an interactive whiteboard, for example), and each receives a corrected example for review. Teachers who have tried this technique report that their students are more engaged in learning and more willing to extend the activity past class time to talk about the topic or ask questions, resulting in a deeper understanding and a more effective match with their learning styles.

Above all, wireless services are now very common among consumers, with cell phones becoming as prevalent as traditional phones and wireless local-area networks (WLANs) proliferating. A survey by The Campus Computing Project¹ reveals that more than 81 percent of U.S. college and university campuses surveyed now make Wi-Fi available, up dramatically from just 4 percent in 2000. (Wi-Fi or “wireless fidelity” is a widely used term for certain types of local-area networks.) **College campuses have had to move toward the use of wireless technology to respond to the demands of students, faculty and staff.** Increasing incorporation of wireless services into the infrastructure and curricula of all educational institutions is now inevitable.

Community relationships can improve

In addition to opening up new avenues for education, the growing ubiquity of wireless services offers a special opportunity to build a relationship with the local community. For example, in many areas collaboration between a school, college or university and the surrounding community may be necessary to establish the initial wireless infrastructure, because of cost or technical considerations. The resulting wireless connections can then be used by the school or college to expand its educational services to the region, and all segments of the local education community may find ways to operate together in a more seamless manner. Some universities and school districts already are deploying — or plan to deploy — wireless services to nearby government offices, homes and businesses. Many schools already offer the use of their computer access to community members, and some offer after-school classes to the public to improve work force skills and increase community access to the Internet.

Future use will differ among educational levels

Both the mobility and the flexibility of wireless technology will be employed differently and will have different impacts on the various segments of K-20 in the future. The impact on administrative and certain teacher activities across all segments may not differ very much, however. Instructional and independent student use will vary significantly depending upon the importance of close teacher proximity and the students’ capabilities for independent work.

Use in primary and intermediate grades will probably involve teachers using Wi-Fi devices for individual activities as well as for access to administrative systems, digital resources and the Internet. Student use will likely be more limited and take place primarily in public areas such as the library, music rooms and gymnasium, or off campus on field trips with groups of students. Some young students may use a wireless

¹ Kenneth Green, *The 2004 Campus Computing Survey* — (www.campuscomputing.net/).

listening center to practice reading skills. Linking parents to teachers and providing teachers with student information when outside the classroom are other strong possibilities.

Grades eight through 12 will probably see significant increase in the use of the Internet by both students and teachers. Mobility will become more important as student age increases and will be required by many more user groups. More students will use hand-helds for more personal organization uses (such as calendars and listing assignments) and will likely record more science lab readings from probes and sensors attached to hand-helds, for example.

Middle grades and high school teachers may use course management systems to facilitate their lessons or to teach classes online. Administrators will utilize mobile access to up-to-date student information on hand-held computers to respond to emergency situations and handle disciplinary incidents, security enforcement and parent communications. Some systems already use student photographs for identity confirmation. More parents will request online access to teachers' schedules, grade books and any online, digital library resources as well. More parents will provide students with PDAs and cellular phones, and more students will expect their schools to provide Internet access for their mobile devices. The growing philosophy may be: **More homes are now equipped for wireless mobility, so the school or university should be able to install similar equipment.** In some cases, this could create a division between the "haves" and "have-nots."

Higher education also will see similarly varied and high-level use, except for the extent and type of parent use. College students can more readily and easily take advantage of wireless mobility, so a higher level of integration into the future college curriculum is anticipated. Anytime, anywhere learning and access to services will become the standard.

Change drives policy decisions regarding wireless use

With the increasing use of wireless services, teachers, administrators, other education leaders and policy-makers will need to make additional policy decisions in the same areas already affected by computers and the Internet, such as curriculum, funding, cost control, security, planning and collaborative infrastructure development.

However, the mobility enabled by wireless technology also will introduce new, somewhat different policy issues from those associated with earlier technologies. For example, wireless devices will bring new opportunities to collect data at an off-campus location by students conducting research, and they will allow students to complete

assignments and access lectures and other resources 24 hours a day, seven days a week. This will enable better tracking of the location of buses and equipment throughout the campus as well as off campus. Because the constraints of the physical classroom will no longer be an issue, more groups of students will be formed around a project or question to be answered, regrouped for whole-class instruction and then reconfigured for publishing and presenting individual or group projects. This will cause potentially disruptive changes to the organization and the logistics of learning. Instructors increasingly will compete with the Internet, e-mail and instant messaging for the attention of students.

New policies must be in place to track equipment, determine liabilities and outline the responsibilities of the institution and the student for repair or replacement of equipment. New policies also must be put in place for students' and parents' access to the instructor, as well as how to deal with issues surrounding the privacy of student information, etc.

Furthermore, wireless has been introduced in the educational environment in a manner somewhat different from other technologies. Historically a school, college or university introduced a technology when it determined that the timing was appropriate and the necessary funding was available. With wireless, however, individuals are purchasing the technology and expect it to be available in the workplace and in learning activities also. Most college students now bring a computer and a cell phone with them. They don't see these technologies as a luxury but as a necessity that should be seamlessly integrated into their everyday environment. **Organizations without strategies to address these expectations and opportunities will experience an increase in problems in the areas of technical support, security and management.**

Important features and advantages of wireless technologies

Wireless obviously implies the absence of a wire or tether, allowing a higher degree of movement or choice in location. Associated with modern wireless services are multiple types of small, lightweight devices — often consumer products (e.g., handheld computers and cellular phones), which are reasonably economical. If the appropriate network infrastructure is in place, clearly wireless technology can add mobility, interactivity and flexibility to an individual's or group's learning activities, reducing or eliminating the constraints of a fixed location or schedule. **Wireless technology is the critical factor in establishing the real potential of information-supported educational activities occurring anytime and almost anywhere.**

Wireless services also are advancing very rapidly and have reached a point where they can be an integral part of an educational organization's networking and technology infrastructure. Cell phones are adding capabilities that take them toward

becoming hand-held computers or personal digital assistants (PDAs). Wireless local-area networks (WLANs) are increasing in information-carrying capacity and distance — and are adding standards, hardware and software that provide greater security, access control and quality-of-service features. Traditional microwave educational television (Instructional Television-Fixed Service) systems are adding standards and capabilities for additional uses of that spectrum, including Internet access, two-way, mobile service and wide-area networks. And all of these systems are increasingly able to operate among each other so that comprehensive and seamless services are provided to users. Many of these capabilities and features are currently in various stages of development and maturity, so **careful investigation and planning are needed when putting advanced systems together.**

Cost can be another specific advantage when considering the use of wireless services in education. The availability of a core infrastructure is an important factor. The incremental cost of bringing wireless services to a particular classroom may be easily justified if it can be connected to a wireless local-area network (WLAN) that already exists. Where physical barriers are a problem (such as concrete or fire-retardant walls), wireless connections may be significantly less costly than wire. In fact, the cost of establishing a wireless LAN infrastructure is not likely to be more — and probably will be less — than a wired LAN.

The cost of newer end-user wireless devices, such as cell phones and hand-held computers, also will typically be less than that of more traditional devices, such as laptop and desktop computers. Because many of these new wireless devices are popular consumer items, consumer pricing pressure has made them more affordable. In sum, **wireless services are relatively economical.**

In addition to cost, security has been considered a major concern with the use of wireless communications for serious organizational or business purposes. After all, the signals are sent through the air, where they might be picked up by unintended listeners. **While security continues to be a concern, with the newer technologies, adequate security can usually be provided with good planning, design, technology selection and management practices — and at reasonable cost.**

Management and planning: First steps

Often the early installation of wireless technology is a grass-roots effort by faculty and staff, sometimes for individual rather than organizational uses. In such cases, the installation may ignore issues such as security, reliability and overall organizational benefits. **Today, IT (Information Technology) departments must assume leadership and develop wireless strategies that meet the needs of the organization in concert with organizational management.** Developing and implementing a successful wireless strategy involves making many critical choices and top-level decisions.

Wireless is a new technology in the educational environment that offers tremendous potential for change and improvement. **The first requirement for taking advantage of this potential is better understanding of several key questions among education leaders:**

How does wireless work with other technologies, what is required, and how can one facilitate its implementation?

Technology planning*

Should wireless networking replace wired networks?

First of all, it should be noted that wireless networking generally is not replacing wired networks, although it does make networks available where wired networks are difficult, impractical or otherwise impossible to install.

How do new cellular services affect wireless decisions?

Developments in cellular phone technology suggest a totally different future. Consider the devices that are merging telephone services, Personal Digital Assistant (PDA) services and even television services into a single device. Today, many corporations are providing leadership in deploying this technology, primarily because they must offer their employees guaranteed access anywhere, at any time. As the cost for cellular services decreases to a reasonable and fixed monthly rate, many schools and colleges will adapt the use of cellular technology for various academic applications. However, until cellular services become readily available at this lower cost, most schools and colleges will probably deploy Wi-Fi technology (wireless local-area networks, or WLANs) for data transmission.

* For some additional discussion of these strategic considerations, see the appendix.

So the best choice is Wi-Fi vs. cellular?

Not always. The best type of wireless technology is an early strategic decision that should be weighed for each individual institution. A typical K-12 public school may focus primarily on Wi-Fi technology, since its users are generally confined to its own facilities. However, the choice may not be as straightforward for colleges and universities. Many faculty and students already are using cellular technology, both personal and organizational. Their locations are more varied, often remote, and may be better served by cellular since it covers greater distances. Larger institutions may sometimes have to form partnerships with local cellular companies to ensure that adequate coverage is achieved. Wi-Fi, however, also will find common use in local buildings and on campus, and at this time, it probably is more widely used than cellular in colleges and universities.

What considerations should be made in choosing Wi-Fi technologies?

Institutions will be offered a choice of “flavors” (industry jargon for “specifications”) of Wi-Fi among the three current technology standards for sending and receiving data in what is called the 802.11 family: a, b and g. A decision should not be made on which is the newest, fastest or cheapest technology. It should be made on what the end-users and the organization need, along with several other considerations.

For example, many (if not most) public locations currently are 802.11b. It is the least costly and most widely deployed standard and may be the standard of choice for some time. Because there are differences in the ranges within which the technologies work well, however, many consultants suggest deploying access points with dual technologies, providing both 802.11a and 802.11g. This strategy gives the IT staff more options in developing security practices and offers the most speed. However, it doubles the equipment cost. All options should be considered carefully before a standard is selected.

What are the implications of Wi-Max?

Wi-Max is a more recent and powerful variant of Wi-Fi and has a range of up to 30 miles. Because it is relatively low in cost and doesn't require the sizable infrastructure development of wired systems, it has the potential of providing greatly improved services to rural and hard-to-reach areas and alleviating their current “last mile” range problem. Recent changes in regulations by the FCC for the use of the licensed spectrum previously used exclusively for Instructional Television-Fixed Service (ITFS) make Wi-Max even more promising, since Wi-Max can operate in this spectrum, which is still reserved for education. This is an emerging technology and application area that should be monitored by education technology planners.

Funding

How can wireless funding become a competitive enterprise and a resourceful endeavor?

Most public schools, colleges and universities will be expected to fund emerging technologies from the same budgets available today. This means that the need for a wireless network must compete with the needs for new buildings, additional teachers, new textbooks — and other technologies. **Each institution must decide the extent to which investments in wireless services are worthwhile versus other needs.** Once a decision is made to develop a wireless network, an institution often purchases its equipment from a local supplier and its cellular services from a network provider. Typically, this process is replicated at each school, college or university.

A modified approach is to **collaborate with the local community, other education institutions, government agencies, providers and/or businesses — or any practical subset of these.** With creative funding and charge methods, comprehensive and robust networks might be developed at much lower cost. This approach could allow the development of a network consisting of **multiple virtual wireless networks.** Each virtual network could be managed in a manner to suit the organization(s) that it serves. For example, those available to the educational community could be free (or funded from educational budgets), those available to offer public services could be paid with tax dollars, and those used by the business sector could be outsourced to nationwide providers of wireless Internet access. This is possible today with the right technology and could be an excellent choice for many organizations.

Further, **this approach might be the only way of providing rural areas with broadband services and solving their “last mile” problem with high-speed Internet access.** Today, telephone and cable companies are hesitant to make an investment in broadband technologies in rural areas. Even when they do, the price is often prohibitive for education. Collaboration may be the answer.

Security

Can wireless technology be made secure?

Another important decision the organization will have to make is how well it wants to secure wireless services. A good answer would be “very secure.” For example, the IT staff may want to build a network that will allow strong protection for the classroom learning environment, while allowing more freedom for some others. This type of deployment is possible with the proper equipment. It is not possible without planning and with the use of the cheapest equipment in the marketplace. IT staff, with consultation if needed, can develop a network that is secure. This is the same technology that is being deployed in hospitals and that meets the rigid standards of the Health Insurance Portability & Accountability Act of 1996.

The availability of cheap and unsecured Wi-Fi gear means that employees can easily plug in their own rogue access points, resulting in the worst possible scenario — a network that's open to outsiders yet fails to provide legitimate users with the freedom of mobility. **Developing a successful Wi-Fi security strategy means making critical choices about both network design and the role of Wi-Fi.**

It is important to prepare for appropriate wireless security within the organization's overall security plan. The problem many schools and institutions will have is the failure to develop an explicit plan for network security. The ad hoc installations of many wireless networks will frustrate efforts to create networks that work well together.

Once the wireless network is secure, the IT department can deploy laptops and PDAs with Wi-Fi capabilities. This will open up many new and innovative learning opportunities for educators and students.

Changes in educational activities

Will wireless technology really improve teaching and learning?

Wireless does bring the possibility of many new, improved uses and benefits for education, as described above. But realizing these benefits will require changes in how things are done by the organization — and sometimes changes in *what* is done. It is well-known that such organizational changes are usually very challenging, no matter what the change. A lot also is known about the requirements of change processes under various circumstances. Effectively using wireless to improve both education and the operation of schools, colleges and universities will require five key elements: leadership, clear goals, funding for planned cost/benefits, people support and ongoing evaluation.

Obviously, many beneficial changes first occur when an individual or small group achieves success by doing something differently — and this is even more often the case with wireless technology. But accomplishing true, effective change within a larger group for core functions carries the normal requirements of any organizational change process, which must not be ignored.

What are the benefits of collaborative wireless efforts?

As mentioned previously, wireless technology can offer schools, colleges and universities the opportunity to change and expand their relationships with their local communities while sharing costs. This occurs in at least two ways. First is the possibility of collaborating on infrastructure. For example, a college, university and/or school system might join with the community in establishing Wi-Fi hot spots or other wireless infrastructure. Second is the opportunity for a college, university and/or school system to increase the access of the community to its educational offerings and also to develop new offerings for the community that could be supported by the increased access.

In summary, what should state and education leaders know and do about wireless service?

- Become familiar with the potential, requirements and policy implications of the use of wireless technology in education and support the challenging change process that is necessary for truly effective use.
- Champion the broader-scope goals that may be achieved by wireless services, such as providing rural areas with broadband; solving the “last mile” problem with Internet access; and collaborating on costs and infrastructure with the local community, other educational institutions, government agencies, providers and/or businesses — or any practical subset of these.
- Ensure that wireless strategies are incorporated into the organization’s technology plan in an integrated fashion, reflecting the goals and capabilities of the specific organization.
- Ensure that appropriate wireless security is a component of the overall organizational security plan
- When considering funding for wireless technology and services, keep three concepts in mind:
 - Wireless technology generally does not *replace* wires but typically is used to do things that cannot be done reasonably by wires.
 - Wireless services are relatively economical.
 - When wireless services require a large-scale infrastructure that covers a wide geographical area, collaboration with the community, other schools and colleges, etc., may make them feasible and more cost-effective.

Appendix — Strategic technology considerations

A serious commitment to the use of wireless technology in education requires making sound decisions to determine the key elements of the technology strategy. Among those are: standards, alternative wireless technologies, designing the system, security and access control, licensing and technology integration. Further discussion to supplement the earlier information in this report is provided below.

WLAN (also referred to as Wi-Fi)

Wireless local-area networks (WLANs, or Wi-Fi) are becoming very common in metropolitan areas, on campuses and in schools. Several Wi-Fi standards exist, with some more mature than others. Selecting the standard to be implemented is a strategic decision that depends upon what needs to be accomplished.

802.11b

The three basic standards for how wireless devices send and receive data are 802.11a, 802.11b and 802.11g. The first widely popular and still most common standard is 802.11b, which operates at up to 11Mbps (million bits per second) and can communicate with 15 to 25 computers up to 1,500 feet away outside and 500 feet inside. It is an unlicensed frequency band and is prone to interference.

802.11a

The 802.11a standard followed 802.11b, operates faster at up to 54Mbps and offers greater capabilities, such as downloading large files and more advanced multimedia. It also is unlicensed, but it operates in a frequency band that is not as conducive to interference. The range is not as great as that of 802.11b, but it generally works well within a range of 100 feet. It will support significantly more users per access point. It is more costly to implement, not as commonly used and is incompatible with 802.11b.

802.11g

The most recent wireless network standard (and one that is still evolving) is 802.11g, which operates at up to 54 Mbps and is fully backward compatible with 802.11b and all Wi-Fi devices. Its range (the same as 802.11b) and its ability to travel through walls and other obstructions are greater than 802.11a. Its frequency band is more popular, and it is more susceptible to interference. It will handle high-bandwidth multimedia. Migrations from the other two standards to 802.11g should be seamless. Pricing of products may be lower than 802.11a, which should make it a cost-effective decision in many situations.

WANs

Wireless wide-area networks (WANs) also are proliferating with campuses and schools. For example, line-of-sight antennas and 802.11b technology are being used to connect several buildings on a campus. Also, LANs in buildings up to 20 to 25 miles away are connected with wireless network bridges. These techniques can be much less costly than leased data lines.

2.5 – 2.7GHz and IEEE 802.16

For a number of years, a specific licensed spectrum (2.5 - 2.7 GHz) has been given priority for educational use for Instructional Television-Fixed Service (ITFS), or educational television. The allocation of this spectrum recently came under challenge, but that has now been resolved by the FCC in favor of education, which also broadened the licensed uses of the spectrum and now refers to it as Educational Broadband Service (EBS).

In addition to broadcast, the spectrum can now be used for cellular and wireless networking. The new IEEE 802.16 (Wi-Max) for broadband wireless networking, which operates in both licensed and unlicensed space, can be used here. This new technology has a range of up to 30 miles but currently may be considered expensive for some applications, and it has security issues similar to Wi-Fi. As the technology and the market continue to develop, Wi-Max could offer significant potential for addressing difficult “last mile” Internet access problems for remote areas and for other applications.

Cellular phones

Another wireless technology that is now very commonly seen in schools, colleges and universities — at least in personal use — is the cell phone. Coverage by cell towers is generally good in most areas, although there are still gaps, especially in remote areas. Usage charges by the minute and low data rates of 40-60 Kbps do not make basic cellular service advantageous for data communications. However, third-generation (3G) technologies, including data rates of up to 3 Mbps and browser software for Web services, offer expanded capabilities for cellular and hand-held devices. 3G will support Internet services to hand-held devices (including cell phones) and notebook (laptop) computers.

At this time, inconsistent reception for cellular devices (for example, inside buildings and in remote areas) may limit the use of this technology for serious, large-scale use as an alternative to wireless LANs or WANs.

802.11i and 802.1x for added security

Wireless technology transmits information through the air, which introduces significant security vulnerabilities. Although many measures are available to provide various levels of security, they generally introduce additional cost, complexity, effort/difficulty for users and restricted access. Wired equivalent privacy (WEP) is an encryption security scheme for Wi-Fi, but it is not very effective. 802.11i is an evolving standard that supposedly overcomes the problems with WEP. 802.1x is another emerging standard that provides authentication of users from access points. This standard also has problems. Work continues on better standards and solutions.

These wireless security technologies can be augmented by the implementing organization through such methods as developing authentication and encryption measures in virtual private networks (VPNs). Using such methods, a firewall can be established between the wired network and the LAN.

What it takes — systems design and technical skills

A good systems-design approach is needed to make the right choice of wireless technology, standards, security levels, cost levels and integration with other components of an overall IT and communications system. Another important element of design for wireless systems is potential interference among the components or from outside systems. For example, as mentioned previously, Wi-Fi uses an unlicensed spectrum and, therefore, does not have the same protections against interference as those of a licensed spectrum. Technical expertise is needed to put together a reliable and effective integrated system. Please consult IT and other industry professionals for detailed assistance and best results.

This publication was prepared by J. B. Mathews, senior technology policy advisor, SREB, as part of the work of the Educational Technology Cooperative. Substantial use was made of an internal white paper entitled “Why wireless in the K-20 world?” by Doyle Friskney, associate vice president, Information Technology, University of Kentucky, January 2004. For more information, e-mail jbmathews@sreb.org.

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