

Request for Information on Hard-Wiring Bolinas-Stinson Schools

Introduction

This document reviews the implications and costs associated with the change from a wireless to hard-wired school district, as well as providing a comparison of the pros and cons of wireless vs. hard-wired network connectivity. Additional work is required to more accurately determine costs associated with hard-wiring and to better assess the educational aspects of learning in a wireless classroom. Study of the available science regarding the safety of RF radiation will be on-going.

Wiring Options

Every building in the district currently has Ethernet (wired) connectivity, but network port locations are not always located close to computer workspaces, nor are there sufficient network ports to provide access to every computer that is likely to be used in every space.

Table I. Networked Computers by Connection Type (as of 1/15/2008)

Workspace	Computers	
	Wired	Wireless ¹
Office	6	1 (1)
K		1 (1)
1-2		2 (1)
3-4	3	1 (1)
5-6	2	1 (1)
7-8	3	2~8 ² (2)
Library	1	
Tech Lab	up to 22	(1) ³
Learning Center	4	
Quesada/Kitchen		(1) ⁴
Art Shops	1	
Music Room	1	1 (0) ⁵
Language Room		1 (1)
Total	43	10~20⁶

Notes:

¹ Number of access points are listed parenthetically.

² Total number of wireless computers depends on how many students bring laptops from home. There are usually about 6.

³ Wireless access point not used every day, but provided for visitors to Learning Center and Tech Lab (e.g. vision specialist).

⁴ Wireless access point provided for school lunch program laptop, but not currently used.

⁵ Wireless access from Quesada or Language Room.

⁶ Largest range of total includes student and visitor laptops that may connect wirelessly.

As shown in Table I., most existing workspaces are currently hard-wired. The remaining workspaces can be hard-wired using one of the approaches in Table II.

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Table II. Hard-Wiring Solutions

Solution	Description	Application
A. Patch cable	If the workspace is within 6 to 10 feet from a network port and adjacent to a wall, or the teacher can relocate her or his workspace, an Ethernet patch cable can be used.	All administrators, K, 1-2 and 5-6 teacher workspaces that currently use wireless network connections
B. Wall surface wiring	If the room layout permits, Ethernet cable can be run along the interior wall of the classroom to provide network access.	Music Room, Art Room
C. Sub-floor wiring	Some teacher workspaces are located away from any walls from which a network cable can be routed unobtrusively, so the workspaces are not likely to be moved due to classroom layout. Student desks/tables are also located away from walls. In such cases, it would be advisable to provide in-floor network and power jacks.	3-4, 7-8 teacher workspaces, all classroom tables used by students

It is recommended in all cases that hard-wiring be provided via boxes containing power and Ethernet mounted directly to each desk, or that furniture be purchased with this connectivity built-in. This not only provides convenient access to required connections, but also enhances safety and reliability. Safety is enhanced by the elimination of trip hazards caused by cables draped across the room. Reliability is enhanced by the fact that cables will be less likely to be snagged, which damages jacks and cable clips.

Refer to Table III. for estimated labor and materials associated with each of these approaches.

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Time and Equipment Costs

The costs for time and equipment required to provide the solutions listed in Table II. are difficult to assess accurately, but will be addressed in Table III. The potential impact on student education and teaching will be addressed in the next section.

Table III. Hard-Wiring Costs

Solution	Description of Work	Estimated Cost
A. Patch cable	If necessary, move furniture. Measure and cut cable to suitable length, attach T568b end connectors or wall jack, run power conduit, if necessary, anchor connector to desk or assemble and connect new furniture with built-in power and Ethernet jacks.	Labor by school staff estimated at 4 hours per workstation. Add 1 hour per new piece of furniture. Electrician estimate required to assess cost of running power conduit \$? Parts: Cables and connectors \$? Connector box \$? Computer table with connectors \$?
B. Wall surface wiring	If necessary, move furniture. Measure and cut cable to suitable length, attach wall jack, run power conduit, if necessary, anchor connector to desk or assemble and connect new furniture with built-in power and Ethernet jacks.	Labor by school staff estimated at 6 hours per workstation. Add 1 hour per new piece of furniture. Electrician estimate required to assess cost of running power conduit \$? Parts: Cables and connectors \$? Connector box \$? Computer table with connectors \$?
C. Sub-floor wiring	Install power and network patch box in wall, pull carpet, use masonry saw to cut channels in floor leading from patch box to possible desk locations, install power and network conduit in floor, install in-floor patch panels, fill channels with concrete, replace carpet.	Commercial electrical contractor estimate required \$?

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Potential Impact on Teaching and Learning

Teachers do not require wireless access for the majority of their time in front of a computer. There are situations, however, when teachers may wish to connect their laptops to the school network and/or Internet wirelessly. Examples of these situations are during presentations - when laptops would be moved to the center of the room, connected to a projector, while assisting students - when the teacher would wish to refer to their laptop screen while sitting at a student's desk, or while grading - when teachers work in the office or in other locations away from students. Results from informal polls indicate that Bolinas-Stinson teachers generally support the use of wireless networks (i.e. much support and no opposition has been voiced).

The potential impact on the future of student learning, however, could be substantial. Teachers currently employ a diverse array of teaching strategies, supported by ad-hoc arrangements of classroom furniture/student seating according to desired student grouping for the lesson at hand. Hard-wired furniture would prevent this, or at least make it prohibitively difficult. Students currently bring laptops with them to school, using them for a variety of academic applications within the classroom, between multiple classrooms and the Learning Center and on the benches and tables outside their classrooms. Laptops are used with no more thought or planning than would be required for a student to use a textbook. Students and their families are increasingly using wireless technology in their homes and throughout the district using personal funds with no official endorsement by the school – an indication of the de-facto use of technology today.

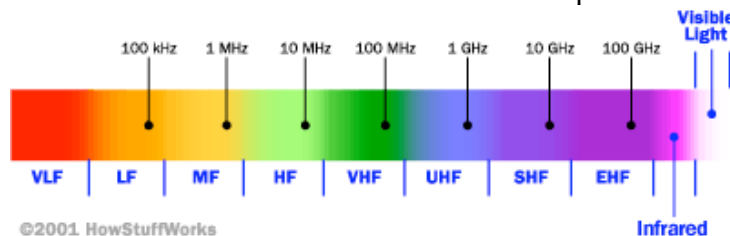
Many K-12 schools currently have wireless networks installed and the trend toward increased use of wireless networks to enhance education is undeniable. Many private high schools and private/public universities require laptops for incoming students, and wireless technology is in virtually every new laptop sold today. It is also widely used in cafés, hotels, airports and other public spaces, as well as being offered in equipment distributed widely by Internet service providers and sold in virtually any store that offers technology products for home and office use. A detailed study of how wireless technology enhances learning and productivity is beyond the scope of this document, but it is clear that it is being used to an increasing degree throughout business and academia, and that training our students to use wireless technology is advantageous in preparing them for the future.

What about Wi-Fi on-demand? In theory, the ability to activate and deactivate wireless networks on an as-needed basis sounds appealing. In practice, however, the level of technical expertise of end-users, the temperamental nature of the equipment and the lack of on/off switches on wireless access points makes it difficult, and the slightest bump in the road when it comes to classroom teaching can quickly turn a well-planned lesson into a wreck. Wireless equipment typically consumes very little power (3-7 Watts) and transmits radio signals at a low power (< 32mW), so from a manufacturer's perspective, a power switch adds little or no value to a product, but does increase the costs associated with providing technical support for wireless products. Wireless equipment broadcasts radio signals strongest when being used heavily, and signal saturation automatically drops when idle.

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Microwave Radiation - Background

The radio frequency (RF) network technology, known as Wi-Fi, works much like a cordless telephone, operates in the same frequency range and is regulated similarly by the Federal Communications Commission. Radio waves occur naturally from sources such as the sun, or background noise from the “big bang,” in addition to being produced by man-made antennas. The frequency of a radio wave affects its ability to cover long distances or to pass through materials such as human skin. Some well-known radio wave frequencies are shown below.



Common frequency bands include the following:¹

- **AM radio** - 535 kHz to 1.7 MHz
- **Baby monitors** - 49 MHz
- **Television stations** - 54 to 88 MHz, 174 to 220 MHz
- **FM radio** - 88 MHz to 108 MHz
- **Cell Phones** – 850MHz, 1.7-2.1GHz
- **Cordless Telephones** – Depending on the model of phone, several frequencies are approved by the FCC: 40-50MHz (old analog cordless phones), 900MHz (analog/digital), 2.4GHz (*most common* - digital), 5.8GHz (digital)
- **Wi-Fi** – 2.4GHz
- **Microwave Ovens** – 2.45GHz

As indicated above, the 2.4GHz frequency used by Wi-Fi and cordless telephones² is close to the 2.45GHz frequency microwave ovens use to cook our food. This is a notable concern for many people, who fear that microwave radios will “cook” human tissue. In brief, microwave ovens operate on the principal of resonance to cook our food, with the resonant frequency of water molecules being about 2.45GHz. The resulting resonance of a microwave oven doesn’t alter the chemical composition of our food, but merely warms it up as a result of the water molecules moving faster (heat is defined as the molecular motion of molecules; to put it simply, more motion equals more heat).³ Radio frequencies from 300MHz to 300GHz are classified as microwave radiation.⁴ Bear in mind, however, that microwave ovens operate at a power of 300-1600 Watts, while power levels of the Wi-Fi devices used in schools are limited to 0.032 Watts, about one ten-thousandth as powerful. Furthermore, the term “radiation” is broad, embodying everything from electromagnetic fields to nuclear radiation to visible light. In other words, not all radiation is equal.

¹ Illustration and information: <http://www.howstuffworks.com/radio-spectrum.htm>

² http://www.hpa.org.uk/radiation/understand/information_sheets/cordless_telephones.htm

³ http://www.ccohs.ca/oshanswers/phys_agents/microwave_ovens.html

⁴ <http://www.osha.gov/SLTC/radiofrequencyradiation/index.html>

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Microwave Radiation – Possible Adverse Health Effects

For several years the BSUSD Technology Committee has been collecting and reviewing data pertaining to possible adverse health effects due to exposure to RF radiation. To proactively address possible concerns of the Bolinas-Stinson community over exposure to Wi-Fi radiation, the stated objective of the Technology Committee is as follows:

“The Technology Committee continues to review information regarding the use of wireless connectivity. The committee agrees that review will be ongoing, and changes to the current program will be considered as necessary. With respect to the precautionary principle, the monitoring of the most current research will be ongoing. The committee affirms the pre-eminence of safety of students and staff.”

This statement was presented to the BSUSD Board of Trustees during their Regular Meeting in May, 2007.

After reviewing the most current data available as of their January 14, 2008 meeting, the BSUSD Technology Committee has concluded, *“There is no compelling evidence supporting the case that the radiation emitted by Wi-Fi devices is harmful.”* This conclusion has also been reached by organizations in the US such the FDA,⁵ FCC, OSHA⁶ and international organizations such as the WHO,⁷ the UK Health Protection Agency,⁸ among others. Note that most conclusions are based on cell phone microwave radiation, which is about 30 times more powerful than Wi-Fi (up to 1 Watt vs. 0.032 Watts, respectively).

In accordance with the Precautionary Principle, the BSUSD Technology Committee currently recommends implementation of the following policies:

- Wi-Fi and other RF technology only be used only when there is a compelling academic reason. At present, this excludes Kindergarten through second grades from the use of Wi-Fi.
- Guidelines be established for students and staff on the safe use of wireless technology, including cell phones (e.g. *“if your ear gets warm while using a cell phone, discontinue its use as soon as possible”*).
- On-going review of the literature be conducted and a report be presented to the Board of Trustees every trimester, or more often if deemed necessary due to scientific discoveries.

⁵ *“Many studies of low level RF exposures have not found any biological effects. Some studies have suggested that some biological effects may occur, but such findings have not been confirmed by additional research. In some cases, other researchers have had difficulty in reproducing those studies, or in determining the reasons for inconsistent results.”*

<http://www.fda.gov/cellphones/qa.html>

⁶ <http://www.osha.gov/SLTC/radiofrequencyradiation/index.html>

⁷ *“With more and more research data available, it has become increasingly unlikely that exposure to electromagnetic fields constitutes a serious health hazard, nevertheless, some uncertainty remains.”*
<http://www.who.int/peh-emf/about/WhatisEMF/en/index5.html>

⁸ *“... the overall evidence for adverse health effects of EMFs on health at levels of exposure normally experienced by the general public is weak.”*

http://www.hpa.org.uk/radiation/publications/documents_of_nrpbf/pdfs/doc_15_3.pdf