

Why WiMAX*?

Educators are becoming increasingly aware of the benefits of properly implemented online digital materials and tools. Not only are these more current and engaging than their print and paper-and-pencil counterparts, they are more cost-effective at both the district and state level.

However, to maximize their effectiveness, digital materials and tools must be available to students wherever and whenever they are needed.

WiMAX* provides this capability, allowing students and families access to all the required educational resources anytime, anywhere, and contributing to a truly transformed learning system. "Always-on" Internet access is likely to introduce a powerful new paradigm into our education system, just as the cell phone paradigm changed our society at large.

Learning is no longer limited to the school and home, but can take place in the park, on the bus, or while waiting for a sibling at the soccer field. As WiMAX becomes more widespread, even more applications will appear that take advantage of the new opportunities for learning.

In addition, WiMAX streamlines and simplifies school-to-home communications—another major objective of school systems.

WiMAX is faster than WiFi, and, most importantly, WiMAX has a much greater range. This allows WiMAX to behave somewhat like cellular phone and data networks, with wide coverage that depends on careful placement of tall outdoor antennas.

	WiFi	WiMAX
Frequency	2.4 Ghz	2.5 Ghz or 3.65 Ghz
Coverage area¹	30 feet to 300 feet	2,000 feet to 30 miles
Line of sight <i>Applies to outdoor use only</i>	Yes	Can accommodate partial blockages, referred to as <i>near-line-of-sight</i> , or NLOS
Speed	11 or 54 Mb/sec	70 Mb/sec/sector
Mobility	Fixed or Nomadic	Fixed, Nomadic, or Mobile
Base station cost²	\$50-1,500	\$5,000-25,000

1. WiFi range typically depends on the number and type of walls the signal must penetrate. WiMAX will go much further than WiFi, but walls, trees, and other non-line-of-sight conditions will restrict the range. Better antennas and more powerful transmitters will increase the range of either technology.

2. This cost is for the transmitters only. The total cost per fully installed tower can exceed \$200,000, depending on many factors.

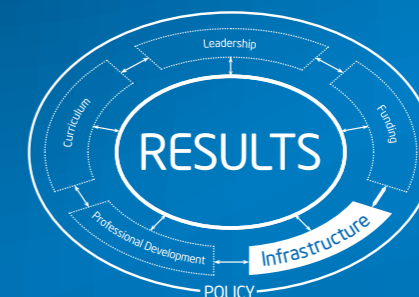
Frequently Asked Questions

- Q:** How do districts make sure they have coverage everywhere?
- A:** In general, coverage is not an issue if there is line-of-sight access to a tower. Just as in cell phone networks, dead spots occur unless antennas are placed correctly and in sufficient quantity. In rugged terrain or dense urban areas, this may not always be economically feasible.
- Q:** How do districts ensure sufficient network capacity?
- A:** Capacity is related to coverage. Just as cell phone networks have dropped calls, if too many units try to access a single antenna there will be negative consequences. Additional towers, antenna segments, and Internet backhaul capacity can remedy this situation.
- Q:** Which spectrum should districts use?
- A:** Districts that have an EBS licensee with available spectrum should consider using this first. Other districts should consider licensing 2.5 Ghz spectrum from a spectrum owner or agent. WiMAX installation providers can assist in this process. Districts that cannot obtain 2.5 Ghz spectrum should consider using 3.65 Ghz spectrum, which is easily licensed from the FCC. However, 3.65 Ghz is more appropriate for connecting homes to the Internet, due to power restrictions.
- Q:** Who are the major WiMAX ecosystem providers?
- A:** Many types of providers make up the WiMAX ecosystem, and new companies enter this market on an ongoing basis.
- All WiMAX equipment is certified by the WiMAX Forum*. A list of certified equipment is available at www.wimaxforum.org. This includes base stations and all types of customer premises equipment.
 - Many local and regional tower and construction providers are available.
 - There are a few national and many local and regional providers of network design assistance and consulting services.

Resources

- K12Blueprint.com
- K12WiMAX.com
- Wimaxforum.org
- WCAI.com
- 4GWorld.com
- ntia.doc.gov/broadbandgrants

School districts interested in WiMAX installations should contact local or national WiMAX service and equipment providers. If additional assistance is needed, please contact your local Intel account executive.



WiMAX* for Education
A Powerful New Broadband Solution

Commercial WiMAX Coverage

Commercial WiMAX providers are providing coverage in a number of cities across the country. For example:

- Clearwire, serving Baltimore; Washington; D.C.; Portland; and Atlanta, with more cities planned
- Digital Bridge, serving 14 communities in Idaho, Indiana, Virginia, Montana, and South Dakota, with more planned
- Xanadoo, serving Texas and Oklahoma, with seven more states planned
- Main Street Broadband, serving southern Georgia and northern Florida
- Mobile Citizen, serving nonprofit organizations in several large cities
- Some local ISPs and telecommunications companies—check to see if yours has WiMAX plans

Districts in a current WiMAX subscriber area need only purchase the WiMAX equipment and sign a subscriber agreement. Contact the provider to discuss specific requirements. See the Resources section for contact information.

District WiMAX Networks

Many school districts are considering building out their own WiMAX networks, sometimes in partnership with community groups. A major source of funding for these plans could be the upcoming \$7.2B ARRA Broadband Technology Opportunity Program (BTOP).

To be successful in this effort, districts will likely need commercial partners. Some initial steps and decision points are outlined to the right.



SPECTRUM

In contrast to WiFi, which operates on the unlicensed 2.4 Ghz spectrum, WiMAX requires an FCC license. Of the two common WiMAX frequencies in the U.S., 2.5 Ghz, and 3.65 Ghz, 2.5 Ghz is generally preferable because the signal goes farther and because it is used by Clearwire and other commercial providers.

Educational Broadcast TV (EBS) also uses the 2.5 Ghz spectrum. Districts with an EBS license should be able to use it for WiMAX also.

INFRASTRUCTURE

Community-wide WiMAX networks require significant infrastructure, including:

- Towers. Antenna towers are generally 100 feet tall or higher. The number and placement is determined by a site survey conducted by the installation company.
- WiMAX transmitters and receivers. These devices send and receive the signals.
- Power. The transmitters need 110V power. Typically power is required for transmitters close to the towers.
- Antennas. WiMAX antennas are mounted on the towers, with multiple antennas to cover different directions.
- Internet backhaul. The transmitter and receiver must be connected to the Internet. Remote towers far from school buildings with Internet connectivity can be connected back via a separate WiMAX network or microwave system.
- Management server. This server manages billing, roaming, and support requirements.

OPERATION AND SUPPORT

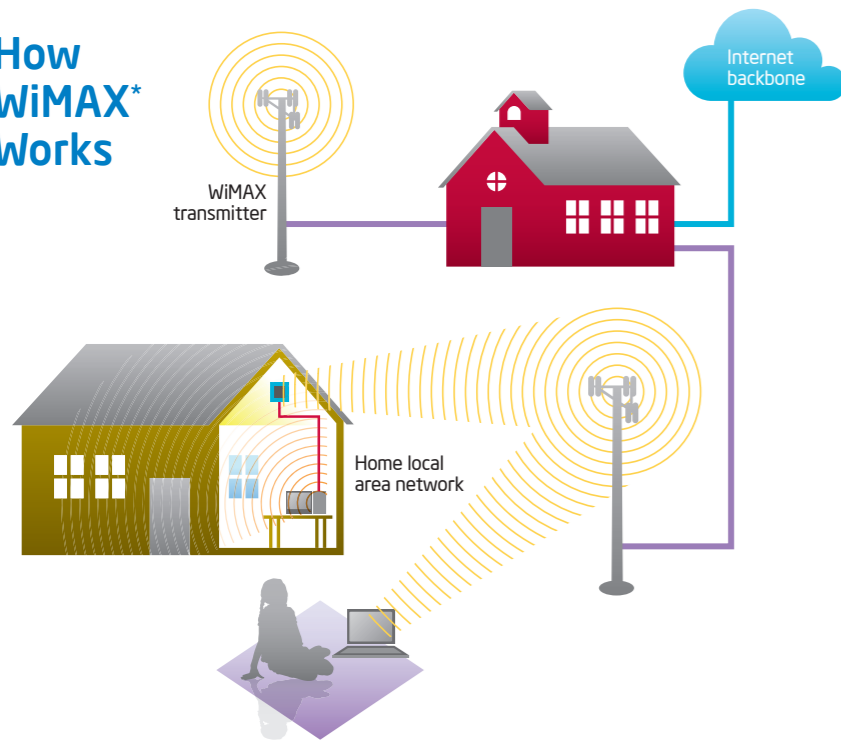
All networks require some level of support. Districts need to compare their internal support capabilities with those of an outside network operation company.

EQUIPMENT

Frequently known as customer premises equipment (CPE), the equipment list includes:

- WiMAX laptops. Some new Intel® processors already have WiMAX support built into the main CPU. Otherwise, this functionality can be provided using a mini-PCI card.
- External WiMAX connectivity. When built-in WiMAX is not available, USB WiMAX dongles and WiMAX PC Express cards can be used to connect laptop or desktop computers to a WiMAX network.
- WiMAX cell phones. These are expected to become more common, along with multiband phones that can interoperate with major carriers when not in a WiMAX coverage area.
- WiMAX-WiFi converters. WiMAX is a great way to provide broadband connectivity to homes. These converter boxes support both WiFi and WiMAX. They sit in a window, or they have an external roof-mounted antenna that substantially increases the range. They convert the WiMAX signal to WiFi, providing connectivity to WiFi devices inside the home.
- New WiMAX devices under development. WiMAX-enabled cameras, science probes, equipment trackers, and a variety of other types of computer-to-computer communications devices are on the drawing boards of many companies around the world.

How WiMAX* Works



ARRA Broadband Technology Opportunity Program

The American Recovery and Reinvestment Act (ARRA) Broadband Technology Opportunity Program (BTOP) has allocated \$4.7B for rural broadband coverage. An additional \$2.5B is available from the Department of Agriculture Rural Utilities Service (RUS), for a total of \$7.2B.

While the complete grant rules are not available as of this writing, it is expected that preference will be given to proposals that address educational needs, serve the widest number of community members, include the community as well as the school district, and involve a strong team with a broad consortium of players.



Cost Implications for a Sample School District

WiMAX infrastructure is a capital expense that can be amortized over many years. The typical infrastructure costs \$5–20 per student per month, over a five-year period, depending on factors such as population density, terrain, and the size of the area to be covered.

Our sample district is in a rural location, has 4,000 students, and 95% of people live in the town or within two miles of a school or tower. There is 99% coverage in town to laptops located in rooms with an exterior wall, without using WiMAX-WiFi converters.

The maximum distance to all remaining students, all in line of sight to an antenna, is 10 miles, and all remaining clients are covered with WiMAX-WiFi converters.

Total throughput averages 40 kilobits/second per student or 160 megabits/second system capacity, with peak bandwidth per student as high as 3 megabits/second.

There are eight existing towers, and there is access to land for all other required towers.

The total cost is \$1.6M, or \$7 per student per month, amortized over a five-year period, with networking maintenance costing approximately \$100K per year. The costs of CPE (laptops, window boxes, and so on) and Internet backhaul are incremental.

If schools have sufficient Internet capacity during the school day, they may require no additional capacity after school hours since in many cases school capacity can be redirected to the WiMAX network.