Accelerating Connectivity in the 21st Century Classroom
Education today is nothing like it was yesterday. New innovative classroom technologies based in digital content and mobile trends are creating a learning revolution where school administrators, educators and policymakers are being challenged to rethink modern education.

As schools integrate new technology into the classrooms the focus has shifted to keeping education relevant, while implementing new tech-based education models and investing in a network infrastructure that can support their growing wireless needs.

The deployment of wireless and mobile technologies in K-12 schools is growing exponentially. Preparing students for the digital reality of the real world while creating innovative ways to engage and improve classroom performance is the new goal of education. However, schools are often handicapped by tight budgets, insufficient infrastructure and little or no IT staff. Without a doubt, the right technology must address each schools’ unique requirements of today and tomorrow for capacity, speed and coverage as well as security, control and cost-efficiency.

This whitepaper describes the key drivers behind the learning transformation schools are experiencing today, the role that the Fifth Generation of Wi-Fi plays, the unique challenges of student-centric learning environments and five key considerations for your wireless network strategy.
Shift to Super Innovative Learning Experiences

The traditional educational approach is quickly being tossed aside as personalized learning is emerging as an important methodology, not only in K-12, but in higher education classrooms as well. Personalized learning uses technology to meet the different learning needs of students, allowing teachers to become more of a facilitator, encouraging and empowering students to develop 21st century skills.

According to the New Media Consortium, there are six key technologies that are going to have an important impact in education in the next five years.

In one year or less:
- **Bring Your Own Device (BYOD)** – The practice of allowing students to bring their own laptops, tablets, smartphones with them to use for educational purposes.
- **Makerspaces** – Community-oriented workshops where technology-savvy students can meet and share electronic hardware, mechanical tools and programming techniques and tricks.

In two to three years:
- **3D Printing** – Technology that can construct physical objects from three-dimensional digital content.
- **Adaptive Learning Technologies** – Software that adjusts to individual students’ needs as they learn and progress.

In four to five years:
- **Digital Badges** – Similar to when Boy or Girl Scouts earn merit badges, digital badges help track, capture and visualize learning in an incentive-based environment.
- **Wearable Technology** – Computer-based devices that can be worn by students and can integrate tools to track, movement and location.

These new technologies are resulting in more hybrid classrooms where teachers mix traditional lessons with technology for enhanced learning opportunities. Students are able to actively collaborate on group assignments and/or project-based activities, while using the network for their 1:1 learning to accessing readings, videos and other materials on their own, leveraging both environments. Most of the benefits of this personalized learning approach highly depend on fast and reliable connectivity to handle multiple devices streaming videos, running “big” applications and downloading other online resources and data.

**Bandwidth Intensive Applications**

More than 80% of American schools are using some form of digital content in their classrooms.

The use of eBooks, audiobooks and digital textbooks, as well as learning apps such as Edmodo, Think Through Math, Study Island and other education management solutions like Samsung School, have empowered and enabled teachers to maintain their students’ attention, while encouraging their imagination and creativity.

**Education in the U.S.**

The exponential growth of mobile devices, momentum of technology advancements and demand for real-time connectivity to multimedia and cloud services are just some of the many challenges facing education today. While education and technology are working and advancing in tandem, most school systems in the U.S. don’t have the sufficient capacity, bandwidth or internal connections (wired and wireless) to keep up with the technology.

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In fact, as of 2014, only 39% of schools had adequate bandwidth for their data-intensive curriculum.3

And while some schools have deployed a Wi-Fi infrastructure, the truth is that their equipment is outdated and limited in speed and coverage.

Because of this prominent digital divide, the U.S. announced the ConnectED initiative in 2013, designed to enrich the educational experience for all students, grades K-12. Under the program, 99% of U.S. schools will be equipped with next-generation broadband and high-speed wireless by 2018.

3http://elearningindustry.com/bandwidth-schools-bandwidth-need
As data usage demands have continued to increase, Wi-Fi has continued to evolve. The Fifth Generation of Wi-Fi, the 802.11ac, was designed specifically to keep up with ever-growing mobility trends and to operate in crowded data-rich environments where it can support a wide range of devices. These devices are usually engaged in multiple and concurrent demanding applications that are bandwidth intensive, such as multimedia streaming and rapid file transfers.

Key features of the 802.11ac are:

- Increased channel bandwidth: 80 MHz (mandatory) and 160 MHz (optional) channels
- More capacity due to its 5 GHz only RF band, a definitely much less crowded environment than the 2.4 GHz
- More efficient modulation (256-QAM) adding additional speed at short ranges where RF interference is low
- Up to 8 spatial streams and more.

The following table shows the different speeds and throughput by standard and the significant performance advancements for this technology:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Frequency (GHz) RF Bands</th>
<th>Channel Size</th>
<th>Max Data Rate (throughput)</th>
<th>Max Spatial Streams</th>
<th>Max Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>802.11b</td>
<td>2.4 GHz</td>
<td>25 MHz</td>
<td>11 Mbps</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>802.11g</td>
<td>2.4 GHz</td>
<td>20 MHz</td>
<td>54 Mbps</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>802.11a</td>
<td>5GHz</td>
<td>20 MHz</td>
<td>54 Mbps</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>802.11n</td>
<td>2.4 GHz – 5GHz</td>
<td>20-40 MHz</td>
<td>450 -600 Mbps</td>
<td>3</td>
<td>64-QAM</td>
</tr>
<tr>
<td>802.11ac (Wave 1)</td>
<td>5GHz</td>
<td>20-40-80 MHz</td>
<td>1.3 Gbps</td>
<td>4</td>
<td>256-QAM</td>
</tr>
<tr>
<td>802.11ac (Wave 2)</td>
<td>5GHz</td>
<td>20-40-80-160 MHz</td>
<td>6.9 Gbps</td>
<td>8</td>
<td>256-QAM</td>
</tr>
</tbody>
</table>

http://elearningindustry.com/bandwidth-schools-bandwidth-need
https://www.whitehouse.gov/issues/educationK-12/connected
When the older 802.11n was first introduced, the maximum speed was increased with a single standard (between 72 Mbps to 600 Mbps) as a consequence of the support of multiple antennas and data streams enabled by MIMO technology. Yet, most Wi-Fi networks provide just a fraction of the wired network capacity, which delivers close to 100Mbps of bandwidth to users. Meanwhile, the average Wi-Fi connection (802.11n) delivers about 5Mbps or less per user.

Today, products available in the 802.11ac market theoretically deliver 1.3 Gbps – nearly double the typical 802.11n – but with overhead and other environmental interference, its actual throughput is about 433 Mbps or 15 Mbps or less per user, assuming an average of 25-30 students per classroom.

The second wave of 802.11ac doubles the maximum rate to speeds of 6.9 Gbps, making the conventional 802.11n somewhat inadequate for some school locations. Samsung’s 802.11ac Wave 2 Access point will be available beginning Fall 2016, and will offer up to 8 spatial streams with multiuser (MU), multiple input, multiple output (MIMO).
One of the most important keys to ensuring the quality of education for both today and tomorrow is identifying the connectivity needs of each school and choosing a WLAN infrastructure that will support it. Every school strives to meet the education goals proposed by policy makers and school administrators and an inefficient network can limit teachers’ abilities to meet those objectives.

Samsung Wireless Enterprise recognizes the potential benefit that a reliable and seamless wireless infrastructure can offer both teachers and students in an educational environment. A dependable and efficient Wi-Fi network can deliver a secure connection while enabling smoother and more engaging digital experiences in class.

Samsung Wi-Fi Solutions for Schools address the following key areas:

- Inspiring students with new learning experiences through a world of possibilities leveraging on technology, student-centric resources and education programs aiming to improve local communities and build a better tomorrow.
- Empowering teachers to create more meaningful lessons in a 21st century context and motivate students to exceed their goals and expectations. Smart solutions like Samsung School, coupled with reliable Wi-Fi connectivity allow teachers to share content more efficiently and improve teacher interaction with students.
- Providing IT administrators with an infrastructure that simplifies deployment, installation and management of WLAN equipment to reduce costs while creating more efficient, undisrupted digital interactions between teachers and students, as well as productive collaboration and participation in the classroom.
- More secure internet access to parents and school guests by allowing IT administrators to implement security policies where students, visitors and staff have their proper authentication access levels. Thus, avoiding unwanted access to the school’s intranet and protecting their networks from viruses, hackers, spam, spyware and other dangers.
Class Room
- BYOD/1:1 Digital Learning Initiatives
- Class Room Management and Smart Solutions
- Automated Time and Attendance Policies Improve Classroom Efficiency
- Emergency Procedure and Notification
- Support for Non-Emergency Events and Notifications Methods
- Multimedia content streaming
- Flipped Classroom

Library
- Student Online Research
- Study Groups (High dense pockets of students)
- Multimedia Streaming

Common Areas
- Management/control of Social Media use to specific areas
- Student Events

Teacher’s Lounge
- Online Research to Facilitate Content to their Lesson Plans
- Space for Web and Email Access
- Web Parent/Teacher Consultation

Dormitory
- Access to Files and Print services offered by the school
- Entertainment: Netflix can be a great way for students to relax from the rigors of campus life
- Game Consoles such as PlayStation and Xbox
- Use of Services such as Skype to communicate with family members, friends and other students

1. Focus on a phased approach to deploy 802.11ac APs in high density areas or where
video streaming, video conferences and similar applications will be used. Consider controllers that
are able to support your network for the next 5 years, while you gradually decrease the resources
dedicated to serving 2.4GHz devices.

2. Look for maximum connectivity flexibility where
dual-band APs can connect to older 802.11b/g/n devices, which use the 2.4 GHz band, and
also switch to the much faster 5 GHz band when available. This way, older Wi-Fi devices
can connect to the network while your newer 11ac devices connect to the 5GHz network for
maximum speed and capacity.

3. RF spectrum is important to consider when
determining the conditions of the environment
and the best deployment that fit the school needs.
Network performance depends on which channel
width you will be using for each RF band 2.4 GHz
and 5GHz. Typically, 20-MHz channels are used in
2.4 GHz, and 40- and 80-MHz channels are used
in the 5-GHz band. In dense deployments, speed
may be traded for capacity in the 5-GHz band by
reducing to a 20- or 40-MHz channel.

4. Even though maximum data rate speeds don’t
happen in the real world, throughput still serves
as a great benchmark of what you can expect
for any given Wi-Fi speed claim. Remember that
external factors often decreases data rates, i.e.:
when users move away from the AP, topology of
the area, number of users, type of devices, type of
applications, etc.

5. Always consider school network vulnerabilities
while deploying different mechanisms for Wi-Fi
network protection that are able to detect, locate
and prevent intrusions and protect the network
against potential threats such as Denial of Service
(DoS) attacks, MAC spoofing, misconfigured AP,
eavesdropping, hijacking and rogue AP, among
others.
With a fully integrated 1:1 learning platform that empowers teachers to deliver an extraordinary learning environment, Samsung’s infrastructure is the best option to support mobile learning devices inside schools. Samsung LTE leadership, paired with Samsung’s Wireless Enterprise offerings allows us to bring our core, trusted LTE technology indoors to support school’s wireless infrastructure.

Samsung’s Wi-Fi solutions support student-centric learning environment by providing the following benefits:

**Peace of Mind through Reliability and Scalability**

The Samsung’s Wi-Fi solution provides a highly integrated and scalable WLAN infrastructure with a management capacity that fits your needs. Samsung AP controllers are 802.11ac ready with two 10G and eight 1G ports for network interface optimization to ensure a reliable and scalable wireless network.

Intelligent Beam Selectable Antennas (IBSA) enable smart devices to receive a strong, reliable signal over long distances. The IBSA's optimal RF pattern minimizes dead zones for a greater coverage area by following a device through its intelligent algorithm and multiple number of antennas.

Also, Samsung’s Wi-Fi's centralized management and Self-Organizing Network (SON) technology make it easy to configure, maintain and troubleshoot issues.
Maximum Engagement with Undisrupted Connectivity

In classrooms and other high density areas, an optimized wireless network is required to provide equal airtime to multiple devices simultaneously. Samsung AirEqualizer technology guarantees throughput fairness when various devices connect to an AP at the same time even when different devices and traffic types are in use.

Similarly, Samsung AirMove uses LTE technology to allow AP controllers to determine the best timing and target AP for handovers. This gives you seamless service during calls and videos streaming and provides double the throughput of any other legacy handover.

Real-Time Interactive Collaboration through High Capacity and Speed

To improve concurrent call capacity and transmit voice frames to multiple devices more efficiently, Samsung created the Voice-aware Traffic Scheduling (VaTS), a patented technology that uses mobile communications scheduling technology. Using VaTS, schools can reduce their investment costs for additional equipment necessary to support high-density environments without risk of losing voice call quality.
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About Samsung Wireless Enterprise

Samsung Wireless Enterprise™ offers communication solutions specially designed to help businesses transform their traditional fixed communications infrastructure into a mobile-ready wireless network. From optimized Wi-Fi infrastructure, enterprise-grade applications, and robust phone systems to full-featured IP phones, Samsung Wireless Enterprise™ portfolio provides a dynamic system architecture that scales to accommodate growth and meets a variety of business communications needs. Samsung Wireless Enterprise™ enables businesses to provide efficient work environments anywhere, anytime with optimized, secure and seamless mobile voice and data experience. For more information on how Samsung can help you ensure the best possible wireless experience for your students visit www.Samsung.com/wlan