The Educational Broadband Gap: A White Paper on Utilizing ATSC 3.0/NextGenTV to Address Remote Learning Needs

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INTRODUCTION

Significant gaps in Internet (broadband) access remain in the United States. Never has this problem been more evident than in its effect on K-12 education during the COVID-19 pandemic. Inequities in internet availability and costs have disrupted the education process.

K-12 educational institutions and governmental partners scrambled to address the need for internet connectivity with the mass purchase and deployment of cellular hotspots. Some Public Television networks stepped in to provide limited data delivery over a 20-year-old broadcast television technology that soon will become obsolete. These efforts are to be commended, but will not provide a long-term solution.

This paper explores a sustainable solution to the national broadband concern as it relates to education, utilizing emerging broadcast television transmission technology to address access, security and user experience. It will focus on utilizing the software teachers and students currently use, adapted for this new broadcast technology, providing disconnected students with an “internet-like” experience to vastly improve their remote learning environment, and heighten their chances for success.

PRE-COVID REMOTE LEARNING EFFORTS

K-12 educational institutions have used software-based educational applications for years. Often these are tied to "Learning Management Systems" (LMS), which most schools use to manage and distribute curriculum, as well as track student progress. Students fortunate to have internet access and a compatible device can connect and communicate with their school and teacher for remote instruction.

Necessary tools for in-class and remote work are often provided by schools to students. Laptops, tablets, mobile devices and dedicated internet-connected devices, which operate Windows, iOS, and Android operating systems, are commonly used. Utilizing Wi-Fi connections within the school, or via the internet at home, students interact with educators, perform assignments, do research and communicate with fellow classmates. An excellent reference for the types of software and systems used in remote learning is available at: https://www.accreditedschoolsonline.org/resources/educational-technology/ [1]

COVID-ERA REMOTE LEARNING CHALLENGES AND RESPONSES

In a report to Congress in October 2019, (https://crsreports.congress.gov/product/pdf/RL/RL30719) (page 6)[2] the Congressional Research Service reported that 6.5%, or approximately 21 million Americans do not have access to the Internet. A different study from Connected Nation (https://connectednation.org/blog/2020/09/24/new-census-data-shows-broadband-adoption-rates-inching-up-mobile-connectivity-growing-in-importance/)[3] reported in September 2020 that nearly 15% of American households have no internet service at all. Although the data from the two studies differ, there is no argument that millions of households with school-age children lack internet connectivity.

The broadband gap in the United States remains a significant problem, one that has become an urgent matter during the COVID-19 pandemic. Students are not in classrooms, schools continue to struggle to create meaningful engagement and parents must grapple with their children's studies.

Listening to the education community, the Catalyst "Focus Group Report on Remote Teaching"[4] (www.thecatalystdifference.com/s/Catalyst-equity-access.pdf) noted that *"teachers were deeply concerned about the ways that remote teaching platforms hindered their ability to build relationships with students and grow a classroom community, both of which are essential for effective instruction." (page 3)* And *"teachers were concerned about students' differential access to resources and technology… [and] teachers also pointed out other remote tools, features, and resources that are critical for instructional equity for all children and families" (page 3).* Additionally - "*Teachers, students, and families need a platform that does not reinforce or exacerbate existing opportunity gaps for children. Therefore, future platform roll-outs need to bring commonly used tools and apps into an integrated*

[1] Community for Accredited ONLINE Schools, Ron Sabo, author
[2] Congressional Research Service RL30719 October 25, 2019
[3] Connected Nation blog September 24, 2020
[4] Brasel, J. and Curren-Preis, M. (2020) Equity, Access, and Instruction: A Focus Group Report on Remote Teaching. Accessed at: www.thecatalystdifference.com/s/Catalyst-equity-access.pdf

environment that is easy and intuitive to use and is accessible by all students and families, including those with limited reading proficiency" (page 17).

With the onset of COVID-19, several efforts have been made to provide students without internet access the means to connect to their schools. Large-scale efforts have been made to distribute mobile "hot-spots" but, sadly, cellular service is limited in many locations or school districts cannot afford hotspots. As a result, students and parents have resorted to driving to libraries, restaurants, or even school-district-provided Wi-Fi zones, so they may connect to the school, download lessons and interact with their teachers.

Adding to the challenge has been the many reports of "bad actors" interrupting the remote learning experience. In North Carolina *The News & Observer* noted in an August 19, 2020 posting (https://www.newsobserver.com/news/state/north-carolina/article245091235.html) *"Students at two high schools in Wake County and Lee County, as well as one middle school in Forsyth County, were exposed to profanities, "inappropriate gestures," and insults when their virtual classrooms were infiltrated by unwelcome participants—some of them fellow students in the school district, officials said."* [5] Hacks into remote classroom meetings utilizing video conferencing communications software and other interruptions raise concerns about how secure remote learning will evolve.

The cellular hotspot effort is to be commended; it has been a quick solution to address the immediate needs of many students. However, there is concern about the long-term costs. Will school districts continue to cover the cost of the data plans for these services, or will the burden move to the families?

Public broadcasters have stepped in to try and address this issue by using "datacasting" technology, a means of taking a portion of the television broadcast signal and delivering educational content as data files to households without internet, but within the receiving range. A pilot project is in deployment in South Carolina (https://www.scetv.org/datacasting) and other states. Educational content in the form of data files is added to the television broadcast and delivered to devices at the home. These gateway devices utilize a specialized data receiver, a means of data storage, and a Wi-Fi emitter to reach the students' devices in the home. The gateway has educational material preloaded, and can also receive new and updated content. There are means for teachers to contact individual students via this connection, but initially it is a one-way link, a "push" of data to the gateway.

THE STATE OF TELEVISION BROADCASTING

Broadcast television began in earnest utilizing analog technologies in the 1940s. Color TV came along in the 1950s. The TV set was the centerpiece in most American homes for decades. During the early years, Public Broadcast System members provided live classroom television instruction and now, in 2020, the television has again become a learning tool and many Public Broadcasters are offering coursework from various sources. With students' resurgent educational needs comes a hard, necessary look at how broadcast has advanced since its origination.

[5] *The News & Observer*, August 29, 2020, Haley Fowler, writer

The television broadcast signal falls into the Radio Frequency Spectrum. The spectrum used for television is broken up into 35 separate 6 Megahertz channels. For analog TV, one video and audio stream was broadcast over a single channel.

Digital Television (DTV) made its appearance in the 1990s. The DTV broadcast standard was developed by a large group of industry experts under the leadership of the Advanced Television Systems Committee (ATSC). The first DTV standard, ATSC 1.0, provided improved video and audio quality, including High Definition Video and multi-channel audio. It also allowed broadcasters to add multiple program streams, within the same channel, previously used for a single-stream analog broadcast.

The 6 Megahertz channel used for ATSC 1.0 has a capacity of 19.3 million bits of data per second (19.3 Mbits/sec). Those 19.3 Mbits/sec carry the multiple video and audio streams, and excess data is often used for other purposes. Called “datacasting,” several pilot efforts were developed to serve the public safety communications community and other applications.

The quality improvements in ATSC 1.0 were created by using video and audio compression technology, a means of reducing the amount of digital information needed for each program stream, through complex software applications. This compression system was developed by the “Motion Pictures Experts Group” (MPEG) and the version utilized for ATSC 1.0 is identified as MPEG 2.

But ATSC 1.0 has its limitations. For time reference, it was developed well before the era of internet enabled smart phones. It is a “locked” system, meaning that no significant improvements to the standard have been made. The means of transmission modulation used (called “8VSB”) suffers from reception issues related to the broadcast signal reflecting off structures, terrain (including trees), and manmade interference. Early TV sets would struggle with providing stable reception in environments that analog television broadcasts did not. Although, over time, improvements in television sets improved reception quality, many viewers found alternate means to receive their local TV stations (via Cable-TV, Satellite). ATSC 1.0 has proven to be unreliable for mobile reception (vehicles, vessels, even pedestrian movement). Attempts were made to develop enhancements for mobile reception, however, they were not widely adopted.

ATSC 3.0/NextGenTV

Understanding the limitations of ATSC 1.0, the Advanced Televisions System Committee in 2013 announced a call for proposals (https://www.atsc.org/news/atsc-invites-physical-layer-proposals-for-atsc-3-0/)[6] to develop a new television broadcast system. From this effort, ATSC 3.0 was developed. In 2017 the FCC allowed for the deployment of this new technology with a defined path and timetables for the transition from ATSC 1.0 to 3.0. This voluntary standard (meaning broadcasters do not have to adopt it) is gaining traction with several large U.S. Markets deploying the new technology.

ATSC 3.0, now often referred to as “NextGenTV,” provides the consumer with a more rich, robust, and reliable viewing experience. It is a digital system, but it is based on Internet Protocol (IP), meaning that it operates like any mobile/app-based product. Viewers are delivered their favorite programs via broadcast, as they have always been. However, there will be a number of improvements, including

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[6] Advanced Television System Committee call for proposal April 4, 2013

picture and audio quality, interactivity when a TV is connected to the internet, content suggestions based on viewers' preferences, mobile applications for vehicles, and, eventually, smart phones and overall better reception.

The new ATSC 3.0/NextGenTV system is not compatible with current TVs. However, leading consumer electronics manufacturers are quickly releasing new NextGenTV models and set-top converters are being developed and becoming more readily available.

At its core, ATSC 3.0/NextGenTV utilizes a different modulation scheme, which overcomes many of the challenges that ATSC 1.0 has regarding reception. The data carrying capacity of ATSC 3.0/NextGenTV is higher than ATSC 1.0, likely around 25 Mbits/sec vs 19.3 Mbits/sec. And, the broadcast data streams can be customized to serve multiple reception scenarios simultaneously, to serve differing reception environments. Some broadcasters will look to the additional capabilities of a Single Frequency Network (SFN) to both improve reception and data capacity.

The video and audio compression technology used by ATSC 3.0/NextGenTV, High Efficiency Video Coding, is far advanced from what is used in ATSC 1.0. This efficiency, coupled with the increased data carrying capacity of ATSC 3.0/NextGenTV, leaves a large portion for other purposes. Commercial broadcasters are looking to monetize this added capacity and Public Broadcasters now have an opportunity to find innovative ways to use it and serve the greater good in education, public safety and other areas.

ATSC 3.0/NextGenTV and Education

ATSC 3.0/NextGenTV, with its expanded data carrying capacity, Internet Protocol backbone and robust reception capability is a logical candidate for the next generation of educational communication, one that will demonstrate its capabilities well past COVID-19.

Television broadcasting is a one-to-many distribution system. It is a highly efficient means of delivering data over a large area. Emanating from very tall towers by high-power transmitters, broadcasters can cover 10,000 square miles with their signals. Adding a SFN with its additional transmission facilities surrounding the central transmission point will improve reception quality.

Remote learning is often described as "synchronous," wherein two-way communication between teacher and students is available, and "asynchronous" wherein information is pushed directly to the student, allowing work without any real-time interaction with teachers or other students.

As mentioned, television broadcasting is a one-to-many transmission of information. There is no "back-channel" to reconnect to the school, so it would lend itself to "asynchronous" learning. Later in this paper there will be a discussion of methods to achieve "back channel" communications to create a synchronous learning experience.

The technology products and services needed to deliver a robust remote educational experience over ATSC 3.0 consists of the following components:

- Aggregation and customization of commonly used software applications for teachers/students

- Student Information System customization to identify and direct content to non-internet connected students
- Interface to Television Broadcast System
- Reception and interface products needed at the home

Software Applications

Educators do not need a new suite of software packages designed specifically for ATSC 3.0/NextGenTV. The software they currently use must be adapted to multiple delivery platforms and should support both synchronous and asynchronous learning, wherever applicable.

Learning Management Systems (LMS) are the central hub for remote classroom work. They interface to other educational software, provide a platform for tests and quizzes, and track the progress of students. The LMS dashboard experience for students on an ATSC 3.0/NextGenTV connected device must be as similar to internet connected students as possible.

Student Information System

The Student Information System (SIS) software applications is the repository for information, often confidential, about students and managed by the school. A means of identifying whether a student is internet-connected at home or not, would need to be made and flagged in this system. The goal would be that, when remote learning assignments are made by the teacher, there would be no need to determine whether a student has an internet or ATSC 3.0/NextGenTV capability at home. The SIS would pass that information on to the software from which assignments are generated.

Television Broadcast Interface

The IP based ATSC 3.0/NextGenTV transmission system is very capable of accepting and transmitting IP data streams from the school to the home. Any broadcaster transitioning will have the basic building blocks necessary for this. Work continues on exploring the appropriate means for input data into the broadcast stream and how it will be formatted. For instance, development work on Public Safety Communications over ATSC 3.0/NextGenTV, currently in progress in North Carolina, uses means for data transmission that would be similar for educational delivery.

The key area of necessary discovery to is to understand the data payload needed for educational data delivery, as well as the robustness of delivery over the ATSC 3.0/NextGenTV broadcast.

Technology Needed at Home

As this is television broadcast, there is a need for a receiving antenna. There are two "bands" of television broadcasts, Very High Frequency (VHF) and Ultra High Frequency (UHF). An antenna will be needed at the home to receive broadcasts, either from a VHF or UHF transmission facility. VHF antennas are larger than UHF antennas and they can range from those installed on a roof, in an attic, on an outside wall or, if the receive signal is strong enough, a simple window "stick on" antenna.

Next is the receiver, which is connected to the antenna. It is anticipated that the receiver will be integrated into a "gateway" device. In addition to the receiver, the gateway will have data storage capability, as well as wired and wireless (Wi-Fi) connection availability.

The gateway is in essence a small computer. The gateway tunes the receiver and finds the ATSC 3.0/NextGenTV broadcast and stores data sent from the schools. It would be the repository for pre-positioned content (e-textbooks, encyclopedias, and other reference materials) and assignments and updates of pre-positioned content would be routed to the gateway and then to the student device.

One of the concerns with a one-way transmission system (such as ATSC 3.0/NextGenTV) is the lack of the return path. Innovators are looking at using low-cost cellular products to address this issue. The cellular path would provide a low-bandwidth connection path back to the school to send assignments and establish a means of synchronous communications.

Summary

With the ongoing COVID-19 crisis affecting education, creative ways of dealing with this disruption and future disruptions is critical for our children. Many efforts are underway to address the immediate concerns for remote learning, but there are concerns about their long-term viability.

Utilizing an existing network of Public Broadcast transmission facilities transitioned to the new broadcast technology, ATSC 3.0/NextGenTV, creates the possibility of developing a solution for the broadband/internet gap for remote learning. A highly efficient and extremely secure educational data delivery system can be developed, one combined with our television broadcast streams, all in the same delivery channel, all at the same delivery cost.

Educational leaders, educators, educational software providers and broadcasters must work together to research the potential of this technology and, hopefully in the coming year, we will see them develop a pilot project to validate this solution.

Public Broadcasters have a unique opportunity to assume a critical role in the education of our nation's most precious resource; this effort could very well become the primary delivery method of educational content to students' homes.

References

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4- Catalyst "Focus Group Report on Remote Teaching" August 28, 2020
5- *The News & Observer*, August 29, 2020, Haley Fowler, writer
6- ATSC call for proposals April 4, 2013