WHAT IS INTERNET2 AND HOW CAN MUSIC EDUCATION PROGRAMS USE IT?

Christine Senavsky

Arts Management & Technology Laboratory

Carnegie Mellon University

As online connoisseurs we are familiar with the public face of the Internet, a digital space we frequent often in both our personal and professional lives. We think less about the back end of the network, the underbelly where the data is accessed—unless we're involved in infrastructure support. Now imagine a network like the Internet, except exclusive in access, meaning no commercialization. That's Internet2, which exists to streamline network access for entities with a commitment to research and education. It turns out that this network offers a myriad of practical applications beyond its academic use. For years, orchestras across the U.S. have been building their community engagement, youth orchestra, and education programs to provide equal opportunity for underrepresented students. This paper will examine this technology and its various uses to music organizations in both education and performance contexts.

First, it will discuss the nature of Internet2 technology and detail how low latency audio and videoconferencing facilitates musicians connecting across vast distances. Then, it will present different cases in which music organizations are leveraging the technology for masterclasses as well as rehearsals and performances. The opportunity is huge for music organizations across the country to acquire access to Internet2 technology and utilize it to develop more robust education programs.[1]

What is Internet2?

Developed in 1996 and incorporated as a nonprofit the following year, Internet2 was created by university researchers to ensure that they could continue to conduct research on a secure platform at lightning speed after the original Internet platform became commercialized. Internet2 provides IP-based hybrid optical network services to its members for the sole purpose of research and education. The network routes to major city hubs as seen in the organization's network map.[2] Internet2 also provides resources for network performance, security, and identity management, maintaining that its members should be focusing on "the research itself, rather than the provision of infrastructure."[3]

Who are its members?

Internet2's philosophy is that its members contribute to creating and maintaining a collaborative, dynamic environment that facilitates cutting-edge research in addition to pursuing their own independent research advancements. Internet2 classifies membership in five categories: higher education, affiliate, industry, research and education networks, and federal affiliate.[4] The majority of its members, as can be seen below, are universities, but also include other groups such as non-profits and education networks. In order to broaden access, Internet2's state-funded Community Anchor Program allows non-member institutions such as public libraries, schools, and

---

[1] Due to the length constraints of this paper, use of Internet2 outside of the U.S. is not discussed, although the technology is internationally utilized.
[2] "Internet2 Network Infrastructure Topology." *Internet2*. July 2018. https://www.internet2.edu/media/medialibrary/201

8/07/16/Internet2-Network-Infrastructure-Topology-All-legendtitle.pdf.
[3] "Research Solutions." *Internet2*. https://www.internet2.edu/research-solutions/. [4] "Membership." *Internet2*. https://www.internet2.edu/about-us/membership/.

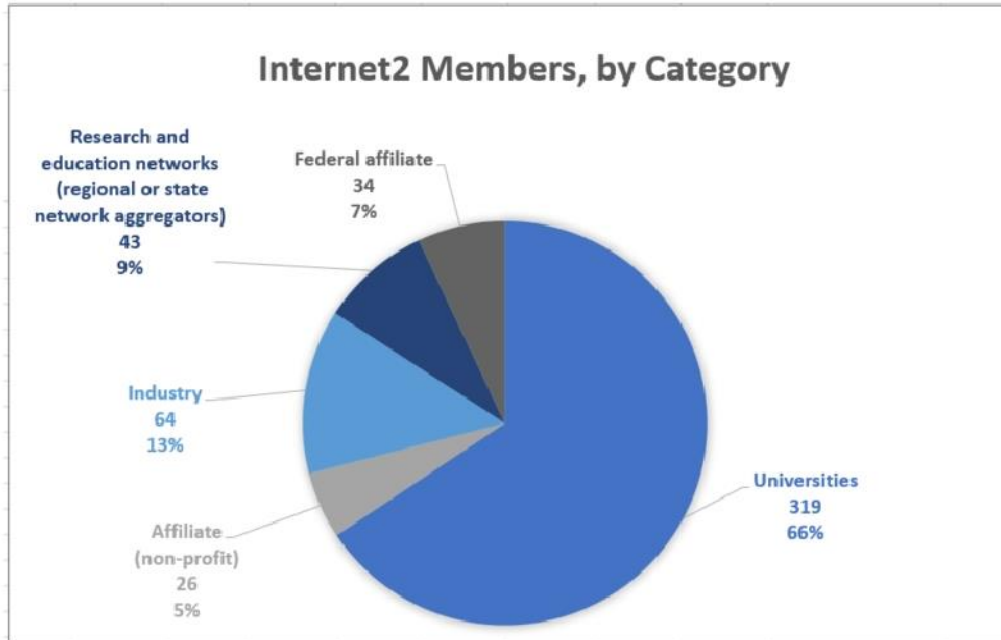institutions to access Internet2 services through Internet2 members.[5]

Figure 1 Internet2 Members By Category, author created chart

What is the cost?

Members must pay an annual fee to Internet2 for use of the network. For universities, this fee is called a Sustaining Contribution and is calculated according to a scale model influenced by, most notably, research and development and annual expenses. This year this figure is set at a minimum of $11,800 not to exceed $97,500.[6] Affiliate members pay according to level of membership, the lowest being $4,456 and the highest fee set at $26,570.[7] Research and education networks pay a base fee of $13,765 each year to participate. Partnerships with member institutions can both eliminate the financial burden of registering

with Internet2 as a member and spark collaborations that extend far beyond the act of sharing access to the technology.

But how does Internet2 really work?

Internet2 has its own network. Does that mean that specific research-designated computers at a university are connected privately to the network? In fact, Internet2's physical infrastructure is no different than the commercial Internet's; the network is built of fiber wires installed in pipes underground.[8] These wires are co-mingled with other wires, such as the ones facilitating the commodity Internet. The main difference is that Internet2's

---

[5] "Internet2 Community Anchor Program." *Internet2*. https://www.internet2.edu/vision-initiatives/initiatives/internet2-community-anchor-program/.

[6] "Scale-based Fee Model for Internet2 Higher Education Members." *Internet2*. September 19, 2018.

https://www.internet2.edu/media/medialibrary/2018/09/21/New-fee-model-general-description-19Sep18.pdf.

[7] "Network Fees." *Internet2*. https://www.internet2.edu/products-services/advanced-networking/network-fees/. [8] Interview with CMU Network team.

network is less geographically extensive. Because it provides a more direct connection and an extremely high bandwidth over long distances, Internet2 is best at sending large quantities of data.

The Internet is a collection of service providers which utilize routers to connect different parts of the physical infrastructure to others.[9] This all happens automatically depending on the pages a user visits. Sometimes these gatekeepers are commercial, like Google, and sometimes they are regional network providers.

One could easily be using Internet2 if they are on a campus with Internet2 access.[10] When one visits a website like Youtube, they may be routing via Google's network since the company is an industry member of Internet2. And if sending a large data set to an institution with Internet2, it's definitely traveling along the Internet2 network.

Carnegie Mellon University gets its Internet2 access through a Pennsylvania-based research and education network called KINBER. Dark fiber providers, or service providers, provide the actual access to Internet2's network. But an Internet2 connection alone is not the complete answer. Musicians can facilitate long distance sessions via the technology with low latency audio and videoconferencing technology (LOLA), a layer of software which is the most

effective platform for the nature of playing music over vast distances.

What is the LOLA streaming platform and how does it work?

Through application management, Internet2's Arts and Humanities Initiative serves to facilitate the effective functioning of streaming for live performances, master classes, and auditions. The Initiative utilizes low latency audio and videoconferencing technology (LOLA) through Internet2's 100 gigabit Innovation Platform, which facilitates more effective network services for members.[11] LOLA allows musicians to connect across vast distances in real time. Internet2 is fast, stable, and accurate enough a network to support LOLA.[12] Configured via Internet2's Innovation platform, it can facilitate lightning-speed streaming of master classes and performances.

Low latency is an absolute requirement for LOLA because the delay, from source to destination, must have a latency of 30 milliseconds (ms) or less to synchronize playing between musicians.[13] Latency is a network term that refers to the time delay caused by transmitting packet from host to client processors. LOLA's latency currently stands at five ms, which was not the case back in 2004 when the technology was first developed and was at a processing time of 100 ms.[14]

[9] Ibid.

[10] Ibid.

[11] "Innovation Platform. *Internet2*. https://www.internet2.edu/vision-initiatives/initiatives/innovation-platform/.

[12] "LOLA: LOw LAtency Audio Visual Streaming System." Powerpoint, Conservatoria di musica Guiseppe Tartini and Consortium GARR. https://www.internet2.edu/presentations/fall11/20111004-ALLOCCHIO-LOLA.pdf.

[13] Farrell, Lance. "Making music across the miles: LoLa broadens access and breaks down barriers." *Science Node*. June 10, 2015. https://sciencenode.org/feature/making-music-across-miles-lola-broadens-access-and-breaks-down-barriers.php.

[14] Fernandez, Enrique. "Virtually Classic: New World Symphony's Cutting Edge Technology." *The Miami Herald*. Accessed October 5, 2018. https://www.internet2.edu/news/detail/2037/.

LOLA's audio is undeniably enhanced because the stream is uncompressed, making it deliverable at the destination without further processing and hence without gaps in delivery, producing "raw, recording-studio quality."[15] Under these circumstances there is virtually no loss of audio quality. This is especially key when LOLA is used to facilitate any type of feedback session. For instance, if a teacher or coach cannot accurately hear the sound the student is producing, it will be nearly impossible to go about improving performance.

While LOLA in addition supports a video standard of 90 frames per second, which is important in correctly discerning how musicians visually execute the sound they create, LOLA's biggest strength lies in its audio abilities.[16] Musicians can rely on its high definition audio and low latency to make long-distance collaborations potentially as productive as they would be in person.

For what purposes can classical musicians use LOLA?

Although the majority of network bandwidth on Internet2 is dedicated to scientific research, there is sufficient bandwidth for music organizations to live stream performances, master classes, and online auditions. While it should be noted that union contracts will likely limit the ability of orchestras to broadcast public concerts via Internet2 technology, in 2007 Philadelphia Orchestra became the first orchestra to use Internet2 to livestream a performance to large screen venues.[17]

More widespread, New World Symphony and conservatories across the country have been using its one gigabit per second and faster streaming to conduct master classes with acclaimed musicians who are thousands of miles away—with no lag time. New World Symphony has even used the technology to bring in guest conductors from different countries. The result is unrivalled professional development for musicians at participating institutions, who are seamlessly connected to some of the best musicians in the world for the benefit of their career development and education. Of the 319 university members of Internet2, over three-quarters of them offer music performance degrees or majors and have Internet2 capabilities, which can supplement their students' music curriculum. Symphonies and other musical performing organizations may be eligible to access Internet2 and stream via LOLA without being registered members by partnering with regional institutions through the Community Anchor Program.

Internet2's affiliate and university members are using Internet2 and low latency audio and videoconferencing technology for both music education and performance purposes. Given that a long-distance collaboration will benefit the musical entities connecting via the platform, the technology can be used to teach masterclasses or lessons or to rehearse and perform. This versatility, enabled by the technology's ability to connect musicians across vast distances as if they were in the same room, allows organizations to tailor the technology to meet their individual needs. The following

---

[15] Farrell.

[16] Ibid.

[17] "Philadelphia Orchestra's Global Concert Series continues on February 22." *The Philadelphia*

Orchestra. February 15, 2008. https://www.philorch.org/pdfs/newsreleases/Global%20Concert%20Series%20February%2022%202008.pdf.

section of this paper will highlight the primary uses of LOLA by music organizations at the current time.

Purpose 1: Music Education through classes or lessons

LOLA, paired with Internet2, can facilitate effective streaming of both private lessons and group master classes, which can be excellent learning opportunities for students. Fundamental to music education is a student's ability to get experts' perspectives on both their technical and musical approach. This becomes even more essential at the pre-professional level, when students are preparing for competitive auditions or a big recital. In these spaces one-on-one feedback from or master class participation with a trusted professional in the field can make the difference between winning an audition or not. Mentoring from these musicians can be an indispensable opportunity when students have already received comprehensive feedback from faculty at their conservatory or university. Logistically, LOLA allows professional musicians and university professors hundreds or thousands of miles away to listen and provide help to these music students. The technology in turn allows for students to have access to the best teachers at any time without a compromise in instructional quality, as LOLA operates with the highest audio and visual streaming capabilities.

Private lessons bring a music professor and a music student together who are separated by vast distances in day-to-day life. The culture at the Northern Illinois University (NIU) School of Music has developed to recognize private lessons over LOLA as an expected activity.[18] This may not come as a surprise considering that NIU was the first university in the U.S. to join the Internet2 community. Regardless, the School of Music has grown to facilitate a seamless relationship with the school's IT department, and music students can use the technology as a resource as needed in the context of their development as professional musicians.

Master classes provide the same support to musicians except in a group setting. Via LOLA the technology allows the students to receive instruction from a professional who cannot be present in person. LOLA, with its high streaming precision, can even be utilized to facilitate a guest conductor leading a small or large ensemble. Master classes of this type are common for New World Symphony musicians. Even back in spring of 2004 it was just another routine class when the symphony cello section gathered on the stage of its resident Lincoln Theater in Miami to receive guidance from Carter Brey of the New York Philharmonic and Stephen Geber of the Cleveland Institute of Music via projection.[19] The quality of the interface is such that workshops of this endeavor provide great benefit to the students of various institutions that participate in Internet2. Notably the previous case studies have centered around higher education institutions, as universities are more often Internet2 members and can use the technology frequently once it is set up. However, as

---

[18] "Music students continue to maximize Internet2." Northern Illinois University. February 29, 2012. https://www.niutoday.info/2012/02/29/music-students-continue-to-maximize-internet2/.

[19] Midgette, Anne. "MUSIC; Classical Finally Cracks the Internet." The New York Times. May 23, 2004. https://www.nytimes.com/2004/05/23/arts/music-classical-finally-cracks-the-internet.html.

discussed later, other organizations can partner with higher education institutions to gain network access, although they must be on the campus with the Internet2 connection to do so. As one of LOLA's features is the extreme end of low latency streaming, musicians can play together across the country as if they were sitting feet away from each other in the same room. A lucky consequence of this is that the technology is more than equipped for not only educational environments, but for world-class musical collaborations as well, which can be encapsulated in the form of rehearsals and performances.

Purpose 2: Music Rehearsals

In anticipation of performances, Internet2 can be used for chamber performances or for soloists rehearsing with orchestras at any time before the day before the performance date. In these cases musicians cannot physically meet and play repertoire together in the time they should be rehearsing to prep for the performance. LOLA is the perfect substitute for these instances as quality is not sacrificed; the technology facilitates the virtual rehearsal and manifests the original intent when parties cannot meet in the same physical space. The alternative of course requires musicians to become familiar with various facets of the interface. However, when it is logistically impossible for musicians to meet a longer period of time before a substantial performance, LOLA can be a highly productive option.

An example of New World Symphony's early and substantive use of the technology was in February 2004, in which the orchestra received feedback on Steve Reich's Three Movements from the composer himself from Columbia University in preparation for the upcoming performance of the piece.[20] As can be seen, the line between education and performance here becomes hazy, as NWS is an educational institution and the nature of the activity is just as well classified as a master class for the benefit of the orchestra. However, it just as well falls under the category of performance preparation, as the technology is being utilized to rehearse for an upcoming event when it would otherwise be logistically impossible. While categorical distinctions can often become ambiguous, this purpose is nonetheless indispensable. As Curtis's CEO Roberto Díaz intimated in an Internet2 meeting in the fall of 2012:[21]

> Artists' schedules become more and more crowded...so rehearsal time becomes a real issue. You can picture a conductor and a singer that are about to embark in some opera productions could get together from different parts of the world and go through some arias and discuss the timing of works they are about to rehearse. In other words, when they get out in front of the orchestra, a lot of the pre-rehearsals that have to have happened could have happened without people having to be in the same place. For us at Curtis this is an amazing opportunity. Our students will benefit greatly from the fact that they will have access to artists from around the world.

---

[20] Midgette, Anne. "MUSIC; Classical Finally Cracks the Internet." The New York Times. May 23, 2004. https://www.nytimes.com/2004/05/23/arts/music-classical-finally-cracks-the-internet.html.

[21] "Tuesday General Session - NSF, LOLA and Internet2 NET+: Fall 2012 Internet2 Member

Meeting." Internet2. October 2, 2012. https://meetings.internet2.edu/2012-fall-mm/detail/10002623/.

Given more widespread collaboration with universities or educational institutions that have Internet2 access, ensemble coordination for, at the very least, concertos with featured soloist, could be revolutionized.[22]

Purpose 3: Music Performances
The technology can also be utilized for the

demonstration of technological capability. An illustration of the medium's infallibility comes in the aforementioned tech demonstration conducted at an Internet2 member meeting in 2012. In this instance, two university music professors, Marjorie Bagley, violin, from University of North Carolina, and Cheng-Hou Lee, cello, from the music school at Northern

Image 1. Image: Michael Tilson Thomas leads an Atlanta Symphony Youth Orchestra rehearsal over Internet2's LOLA from the New World Symphony campus in Miami Beach, FL. Photo used with permission from the New World Symphony.

performance itself, which in the modern art world can either mean any sort of multi-media live performance collaboration or a

Illinois University, performed Handel/Halvorsen's Passacaglia for violin and cello via LOLA and Internet2.[23] The recording of the event is a testament as to the quality of the

---

[22] While rehearsals via LOLA could be a great asset to professional orchestras, union contracts might prohibit the financial viability of such an endeavor, although it is certainly an option that could be explored further. As soloists have their own contracts, Diaz's earlier example regarding the

conductor and singer meeting before the rehearsal could likely be conducted effectively over LOLA.
[23] ReteGARR. "LOLA - Internet2 FALL 2012 - Concert." Youtube. January 15, 2013. https://www.youtube.com/watch?v=GuVVWuXXMwc.

interface. Internet2 members sat stunned at the practical application of the theory they already knew; the performance was immaculately precise, as if Cheng-Hou was actually on stage in Philadelphia with Bagley, breathing in sync. If desired, the technology can work for putting on shows of a more extensive scope. The pinnacle of LOLA could perhaps be seen in Michael Tilson Thomas remotely conducting the Atlanta Symphony Youth Orchestra for a side-by-side concert in 2015.[24] In truth, the practical applications of LOLA are limitless. This might leave an institution's leaders curious.

Should my institution be using Internet2 as a resource and if so, what are the steps I need to take to implement this technology?

1. First you need to answer: Do musicians in my institution need to be connected with other musicians hundreds or thousands of miles away?

> *If Yes*: Proceed to step 2.
> *If No:* The institution would benefit more from allocating resources to other areas of need.

2. Does my institution have access to Internet2?

> *If Yes:* Talk to in-house network provider about installation of LOLA.
> *If No:* Find out which other music organizations or local universities have access to the network and collaborate with them, or reach out to a community or regional research network which has access. Check that the network exists in your location, as its scope is limited to larger metropolitan areas.

---

[24] Gonzalez, Fernando. "A Musical Collaboration, Across the Miles." John S. and James L. Knight Foundation. February 9, 2015. https://knightfoundation.org/articles/musical-collaboration-across-miles.

What LOLA specs should I be using?

New World Symphony recommends H.323 technology via a Polycom HDX or Group Series room system which require a network capacity of at least two to five megabits per second along with specific TCP/UDP ports open to run properly. These requirements are explained in more detail here: https://community.polycom.com/t5/Video-Endpoints/FAQ-Ports-in-a-firewall-that-need-to-be-open-in-order-to-utilize/td-p/75172[25]

Lessons Learned

Internet2, the private internet created exclusively for research and education, can be a vital resource to music organizations. With member or partnership-acquired access and the installation of low latency audio and videoconferencing technology (LOLA), musicians can play across vast distances as if they were in the same room. With a low latency of five milliseconds, an uncompressed studio-quality audio stream, and a 90 frame per second video standard, LOLA is the technology substitute when in-person meetings are not possible. Internet2's LOLA technology can be leveraged especially by arts organizations and conservatories with education programs. The most popular uses of the technology in the arts field are for providing musical instruction via masterclass and private lesson, rehearsing remotely before an upcoming performance, and performing a contemporary concert. If your organization' musicians could benefit from long-distance collaborations with experts or

---

[25] Justin Trieger, Director of New Media and Distance Education, New World Symphony

colleagues in the industry, determine whether your organization has Internet2 and if it does not, consider determining how to acquire access. Local universities and regional research networks are often great candidates. LOLA's utility can be a great asset for any music organization, but especially for ones which want to expand, deepen, or diversify their education programs. Internet2 can help us immensely with the work we are striving to undertake in our youth orchestras and music organizations in improving access to music education for all young people regardless of their circumstances—we must know how we can use the technology when it is time.

Bibliography

"A Music Center for the 21st Century: Miami's New World Symphony." *Feast of Music*.
https://www.feastofmusic.com/feast_of_music/2018/05/a-music-center-for-the-21st-century-
miamis-new-world-symphony.html.

DiMaria, Frank. "The 20-Year History Behind Internet2." *Campus Technology*. September 22, 2016.
https://campustechnology.com/Articles/2016/09/22/The-20-Year-History-Behind-
Internet2.aspx?Page=2.

"Distant melodies from Internet2." *Science Node*. June 13, 2016.
https://sciencenode.org/feature/distant-melodies-from-internet2.php.

Doyle, Anne (moderator.) "A Bright Future for the Arts." Powerpoint, Internet2 TNC 2017. May 30, 2017.
https://tnc17.geant.org/getfile/3166.

Farrell, Lance. "Making music across the miles: LoLa broadens access and breaks down barriers." *Science
Node.* June 10, 2015. https://sciencenode.org/feature/making-music-across-miles-lola-
broadens-access-and-breaks-down-barriers.php.

Fernandez, Enrique. "Virtually Classic: New World Symphony's Cutting Edge Technology." *The Miami
Herald*. Accessed October 5, 2018. https://www.internet2.edu/news/detail/2037/.

Gonzalez, Fernando. "A Musical Collaboration, Across the Miles." *John S. and James L. Knight
Foundation*. February 9, 2015. https://knightfoundation.org/articles/musical-collaboration-
across-miles.

Hafner, Katie. "Internet2; An Incubator For Technology." *The New York Times*. January 10, 2002.
https://www.nytimes.com/2002/01/10/technology/internet2-an-incubator-for-
technology.html?rref=collection%2Fsectioncollection%2Ftechnology&action=click&contentColle
ction=technology&region=stream&module=stream_unit&version=search&contentPlacement=1
&pgtype=sectionfront.

"Innovation Platform. Internet2. https://www.internet2.edu/vision-initiatives/initiatives/innovation-
platform/.

"Internet2 Community Anchor Program." Internet2. https://www.internet2.edu/vision-
initiatives/initiatives/internet2-community-anchor-program/.

"Internet2 Community Timeline." Internet2.

https://www.internet2.edu/about-us/internet2-community-timeline/.

"Internet2 Network Infrastructure Topology." Internet2. July 2018.
https://www.internet2.edu/media/medialibrary/2018/07/16/Internet2-Network-Infrastructure-
Topology-All-legendtitle.pdf.

"Internet2 Services." Eastman School of Music. https://www.esm.rochester.edu/esmtmp/internet2/.

"Internet2 Will Bring Philadelphia Orchestra Performance To CU Boulder's ATLAS Building Oct.12." *CU
        Boulder Today*. October 3, 2007.
        https://www.colorado.edu/today/2007/10/03/internet2willbringphiladelphiaorchestraperforma
        ncecubouldersatlas-building-oct-12.

Kasprzak, Don. "Philadelphia Orchestra: Live via Internet2." Wordpress. February 25, 2008.
http://donkasprzak.com/philadelphia-orchestra-live-via-internet2/.

"Membership." Internet2. https://www.internet2.edu/about-us/membership/.

Midgette, Anne. "MUSIC; Classical Finally Cracks the Internet." *The New York Times*. May 23, 2004.
        https://www.nytimes.com/2004/05/23/arts/music-classical-finally-cracks-the-internet.html.

"Music students continue to maximize Internet2." Northern Illinois University. February 29, 2012.
        https://www.niutoday.info/2012/02/29/music-students-continue-to-maximize-internet2/.

"Network Fees." Internet2. https://www.internet2.edu/products-services/advanced-
networking/network-fees/.

"New World Symphony, America's Orchestral Academy Hosts Network PerformingArts Production
        Workshop in Conjunction with Internet2 and Trans-European Research and Education Networking
        Association." *PR Newswire Association LLC*. April 7, 2014.
        https://www.prnewswire.com/news-releases/new-world-symphony-americas-orchestral-
        academy-hosts-network-performing-arts-production-workshop-in-conjunction-with-internet2- and-
        trans-european-research-and-education-networking-association-254221351.html.

"New World Symphony in Collaboration with Internet2 and Géant to Host 13th Annual Network
        Performing Arts Production Workshop (Npapw)." *Criticaclassica*. February 26, 2016.
        https://criticaclassica.wordpress.com/2016/02/25/new-world-symphony-in-collaboration-with-
        internet2-and-geant-to-host-13th-annual-network-performing-arts-production-workshop-
        npapw-%e2%80%95a-technology-conference-exploring-long-distance-artistic-a/

"NPAPW18 Programme." *GEANT Association*. April 24, 2018.

https://npapws.org/npapw18-programme/.

Orto, Christianne. "Video Conferencing for Music Performance Education at the Manhattan School,
        Exclusively Online." Syllabus.com. January 5, 2004.
        https://www.internet2.edu/news/detail/1962/.

Pascu, C., D. Osimo, M.Ulbrich, G. Turlea and J.C. Burgelman. "The potential disruptive impact of
        Internet 2 based technologies." *First Monday*, volume 12, number 3. March 2007.
        http://journals.uic.edu/ojs/index.php/fm/article/view/1630/1545.

Patrizio, Andy. "Internet2 Pumps Streaming Media." *Wired*. November 8, 2002.
        https://www.wired.com/2002/11/internet2-pumps-streaming-media/.

"Philadelphia Orchestra's Global Concert Series continues on February 22." *The Philadelphia Orchestra*. February 15, 2008.
https://www.philorch.org/pdfs/newsreleases/Global%20Concert%20Series%20February%2022%202008 .pdf.

Rabimov, Stephan. "The New World Symphony Brings Classical Music Into The Digital Future." *Forbes*.
        Accessed October 5, 2018. https://www.forbes.com/sites/stephanrabimov/2018/04/25/the-
        new-world-symphony-brings-classical-music-into-the-digital-future/.

"Research and Education Network Member Details." Internet2.
        https://www.internet2.edu/about-us/membership/research-education-network-member-
        details/.

"Research Solutions." Internet2. https://www.internet2.edu/research-solutions/.

ReteGARR. "LOLA - Internet2 FALL 2012 - Concert." Youtube. January 15, 2013.
        https://www.youtube.com/watch?v=GuVVWuXXMwc.

Russo, Alexander. "Internet2: The better, faster internet you can't use." *Slate*. June 7, 2005.
        https://slate.com/technology/2005/06/the-better-faster-internet-you-can-t-use.html.

Sartain, JD. "Internet2 turns 15. Has it delivered on its promise?" *Network World*. April 11, 2011.
        https://www.networkworld.com/article/2201817/lan-wan/internet2-turns-15--has-it-delivered- on-its-
        promise-.html.

"Scale-based Fee Model for Internet2 Higher Education Members." Internet2. September 19, 2018.
https://www.internet2.edu/media/medialibrary/2018/09/21/New-fee-model-general-description-
19Sep18.pdf.

"Securing a Bright Future for the Arts and Advanced Networking." Internet2. 2017.
https://tnc17.geant.org/getfile/3166.

Smith, Marianne, Ray Ford, Heather Martinson, Renee Frost, and Ann Doyle. "Internet2 Overview:
Engagement, Network and Services." PowerPoint, Internet2 Spring 2008 Membership Meeting.
April 21, 2008. https://www.internet2.edu/presentations/spring08/2008SMM-
OverviewFinal.pdf.

Summerhill, Rick. "The New Internet2 Network." Powerpoint, Internet2 GLIF Meeting. September 11,
2006. https://www.glif.is/meetings/2006/plenary/summerhill-internet2.pdf.

"The Philadelphia Orchestra: A Historical Timeline." Philorch.org. January 2009.
https://www.philorch.org/pdfs/Timeline_Philadelphia_Orchestra_2009_Jan.pdf.

"Tuesday General Session - NSF, LOLA and Internet2 NET+: Fall 2012 Internet2 Member Meeting."
Internet2. October 2, 2012. https://meetings.internet2.edu/2012-fall-mm/detail/10002623/.

Werle, James and Louis Fox. "Internet2 and Libraries: Serving Your Communities at the Speed of Light."
http://www.infotoday.com/cilmag/nov07/werle_fox.shtml.