

# An Introduction to NDI<sup>®</sup>



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# 1 Preface – Introducing NDI® 4.5

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## The Next Leap for NDI

NDI version 4.5 constitutes the most significant release update since NDI was introduced in 2015. Advancements in NDI's already unmatched capabilities for transferring video, audio and metadata in real time across standard and wireless Ethernet networks include breakthroughs in mobile phone connectivity, wireless networking, augmented and virtual reality environments and more. Fortuitously, these advancements come at a time when making video accessible over IP matters more than ever. As social distancing is being widely practiced around the globe, the only way content creators can work together is through IP networks and using software – the mission that has always driven NDI. And NDI has the widest support of any IP video technology with thousands of companies implementing the NDI SDK, putting the technology in the hands of millions of users globally.

### *Mobile Support*

As growth in esports accelerates and more than 50% of online gamers are now using mobile devices, the ability to bring the game from a smart phone into streaming software favored by gamers is crucial. NDI 4.5 adds support in iOS for real-time, full frame-rate, and resolution capture of the display on wireless. In addition, the NDI Camera for iOS app turns any iPhone into a full 4K wireless camera, giving it the same capabilities as a high-end video camera. No other IP technology for video production can translate to mobile phones because NDI is software-defined, not hardware-constrained. The NDI|HX mode for high-efficiency low bandwidth data transfer gives anyone with an iOS phone the ability to screen capture games and deliver it to any NDI-enabled multi camera live production system

### *Internet and Wireless*

Built into NDI 4.5 are extended capabilities for use on the Internet and wireless networks. This version shows massive improvements to NDI|HX, with lower latency, full support for (multi) GPU decoding acceleration, and support for the most advanced compression formats available today.

### *Augmented and Virtual Reality*

Working with Epic Games, the NDI SDK for Unreal Engine adds full support for video inputs and outputs over IP enabling a new generation of augmented reality (AR) and virtual reality (VR) video products for integration into games and more. The NDI SDK for Unreal Engine is free to download and the source code is available so that developers can customize their content creations.

### *Unlimited IP Recording*

NDI 4.5 offers unlimited IP recording, with Adobe Premiere plugins both for real-time NDI and working with time-locked ISO recording across multiple streams. This takes NDI streams from the network and stores them on disk with no CPU usage, allowing users to record any number of streams to disk and extend this to multiple machines for almost infinite recording capabilities.

### *Embedded Decoding and Encoding*

For use in embedded systems, NDI 4.5 now includes the latest version of the embedded NDI SDK that offers full FPGA support for both NDI encoding and decoding. In addition there is support across almost all platforms for access to the compressed data streams, instant routing and more. For advanced development, embedded platforms and custom hardware needs, NDI fully provides the ability for developers to create amazing products.

*We're very proud of NDI. It's what results when experienced video software developers design an IP protocol.* NDI checks all the important boxes for production. And yet it doesn't paint you into a corner: Interop with various IP protocols of is already possible, and we anticipate this will continue to be true for upcoming formats from both software and hardware-focused companies.

With version 4.5, NDI has gotten dramatically better in almost every way while maintaining the same bitrate. Massively improved video quality, significantly faster decoding, faster discovery of sources, support for many more streams on a single PC than ever before, better discovery server, and new example code are some highlights of the many new improvements.

*We want to sincerely thank the community for making NDI the world's most successful IP standard for video production.* Without the enthusiasm of thousands of companies who joined hands with us more than ten million people would still be chained to HDMI and SDI. Version 4.5 continues the tradition of providing a feature-packed upgrade to the NDI toolset, delivering massive benefits to developers and customers alike.

## NDI Scan Converter



The new version of NDI Scan Converter provides vastly improved image quality and much, much more. The GPU is now used for screen capture, and handles the lion's share of color conversion, processing and transmission. Capture all of your system's desktops in real-time, at full 60Hz or even games at 120Hz or above and with almost no CPU usage.

Note: This version of Scan Converter relies on the latest DirectX 11 API, thus requires Windows 8 or better.

Choose an audio source for your screen capture. Now you can play a computer game or Power Point presentation with sound (with no impact on frame-rate) and supply it as an NDI source. Scan Converter now fully supports

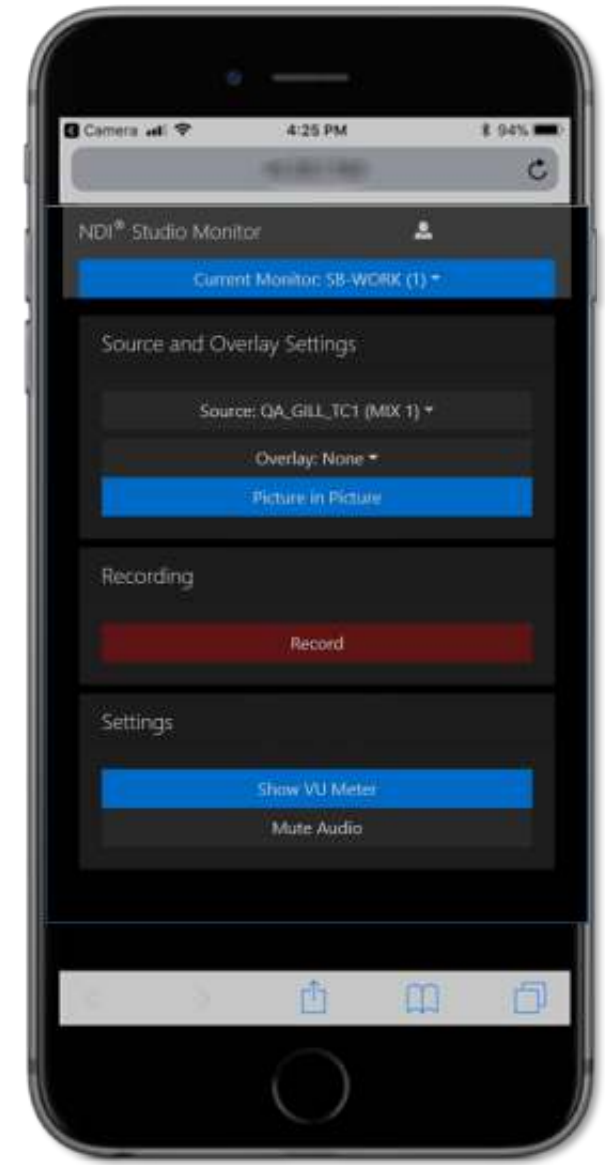
webcams, too.

Stream games with audio, and overlay a webcam on the stream while supplying voice-over. Send PowerPoint to Hangouts, Zoom Media, Skype, or GotoMeeting (see NDI Virtual Input), and use your webcam to talk to them. 'Region of interest' support lets you can capture video directly from a YouTube page. And in this new version, NDI Scan Converter provides KVM support that – in concert with NDI Studio Monitor – lets you interact with Windows computers on your network remotely.

## NDI Studio Monitor

It would be hard to overstate the importance of this 'little giant'. Signage is an extensive and important video field, and Studio Monitor has it covered. The set for virtually every video production now includes multiple screens; lobbies, building façades and billboards display giant screens, and so on. Supplying these sources over analog cabling was always impractical; SDI hardware costs are prohibitive, and HDMI's distance limitations prevent it from serving as a reliable alternative. IP is, of course, the perfect solution – ubiquitous, reliable, and inexpensive.

Need to update the display on a remote screen? NDI Studio Monitor now provides an integrated web server; just scan a QR code on the display to turn your mobile device into a (password-protected) remote control.



What's more, multiple instances of Studio Monitor running on the same machine can be independently controlled. Even when you have lots of different computers running Studio Monitor, they all 'see' each other over P2P, giving you complete control from any point on your network! Add to this joysticks and keyboard shortcuts for PTZ control, and you've got a tiny little production powerhouse at your fingertips/

An equally valuable feature of Studio Monitor lets you overlay titles and graphics (even full motion video) on the display. Assign a unique overlay to appear over video in your lobby and apply something different for your showroom. Or use the Overlay feature to provide picture in picture output.

Too, each Studio Monitor instance can choose which sound device to use for playback, and which video monitor its output should appear on (or which *monitors* it should span). You can even set Studio Monitor to launch on computer startup so that multiple instances, all correctly configured, launch automatically. Buy a NUC or two to easily and inexpensively create multiple, remotely controllable 4K outputs.

In NDI 4 and later, local recording (on the NDI Studio Monitor host) with remote web control has been added. Further, you can actually enable NDI output from an instance of Studio Monitor, allowing it to operate as a server for downstream NDI applications (you could think of this as Studio Monitor serving as a NDI router, and use it to control multiple outboard displays).

## NDI Virtual Input

Assign NDI video sources as inputs to anything that supports webcams (including GotoMeeting, Skype, Hangouts, Zoom Media, and much more!) NDI Virtual Input fully supports 1080p60 or even 4K at full frame-rate, and even allows you to modify audio levels for different application requirements.

## Adobe CC drivers

The new driver supports the latest version of Adobe CC, at the same time as delivering higher quality, floating point color support, and more.

## NDI HX Drivers

Some NDI devices (such as cameras or converters) output NDI signals designated as "NDI|HX". This format could be described as a 'transport stream' variant of NDI, ideal for use when network bandwidth is limited (trading lower bitrates for slightly higher latency). For your convenience, the NDI Tools bundle includes integrated NDI HX drivers.

## Changes to the SDK

As you'd expect, we've also extended the entire SDK (and naturally, the SDK is fully backwards compatible). The SDK Getting Started Guide accelerates the learning process for those who are new to the NDI ecosystem.



## Changes to the Protocol

Really, NDI itself continues to be completely transformed ‘under the hood’, including supporting UDP data transfer, with Forwards Error Correction (for both Unicast and Multicast), and Multipath-TCP.

What is more, NDI now automatically detects NICs, and all the possible paths between a source and a destination, in order to spread the bandwidth out across all the possible paths. This delivers much better performance in almost every case, even on high latency networks. What is more, very sophisticated internal congestion control reduces packet loss, and helps everything run on real-world networks which often employ ‘less than ideal’ routers or switches.

## More reliable discovery

Numerous discovery and connection enhancements in prior versions improved reliability when network topologies change, across multiple NICs (or networks) and much more. NDI discovery on the local machine was improved, along with detection of NDI sources on virtual networks.

In NDI 4, system administrators and developers will welcome the ability to enable an NDI discovery server to overcome challenges in complex network scenarios.

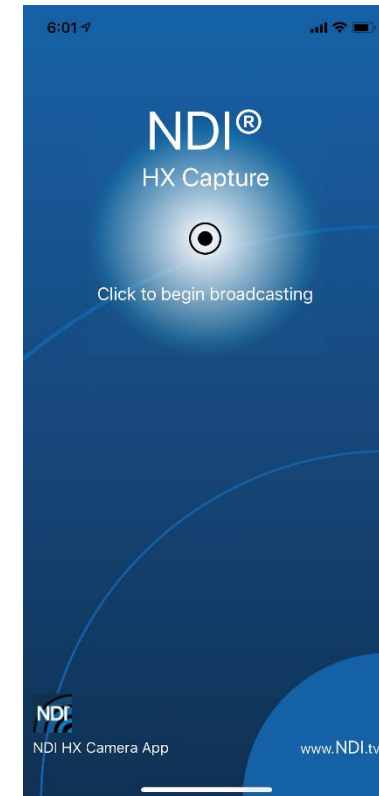
## NDI Hardware

The NDI Embedded SDK includes a reference FPGA project that hardware developers can examine for free. If you want to make a commercial project, we’ll even work with you to help make it successful.

# NDI®

## 2 More Great NDI Apps!

### NDI® HX Capture for iOS (NEW!)



Outrageous – bring your iPhone® screen into the pro a/v, broadcast and streaming realms with the new NDI® HX Capture app. It's so easy – just “Click to begin broadcasting”, and share your game live with the room or the world (using any of the countless video software and systems with native NDI support). Please note that this new app requires iOS 13.1 or better, and is not supported on the iPad®.

## NDI® HX Camera for iOS

Several NDI camera applications have been prepared for mobile devices. We'd like to mention the newest entry to this field, NDI® HX Camera for iOS. This lightweight NDI 4 based app is long on features and performance, and can be found in Apple's App Store (see also <http://ndi.tv/tools>) Perfect for an iPhone® or iPad® connected by wifi, the handy camera app provides high-quality video (up to 4K format) and audio output without extravagant resource or \*bandwidth demands.

(Note that we recommend using a 5GHz network connection when possible. Also, be aware that this application is not compatible with software or systems that have not been updated to use NDI 4.)

## Features and Controls

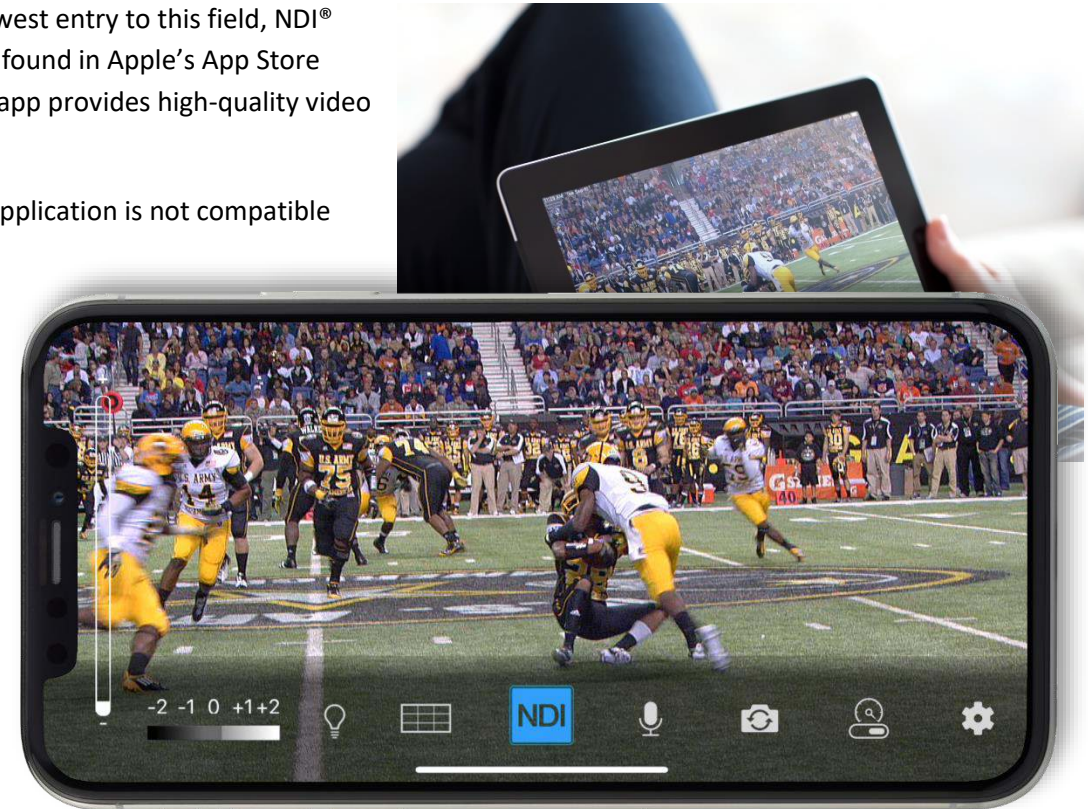
Tapping the *Settings* button (gear) reveals the following controls from left to right:

- *Zoom* slider
- *Exposure compensation*
- *Light* – toggle the device's light
- *Grid overlay* – toggles a grid overlay dividing the screen into thirds
- *NDI (Send)* – tap to send your video to output
- *Mic* – toggle audio output
- *Front/Rear Camera* selection
- *Format/Bandwidth* options: Max (up to 4K); 720p; 640x480

In addition, note that the app shows red or green tally borders as appropriate when used with supporting systems.

## NDI® Listen for iOS

Sometimes you just need to hear an NDI source, rather than view it, and NDI® Listen for iOS is just right for those occasions. Select the NDI source device you want to hear, and the specific channel you're interested in, and you're all set. This free app is also available in Apple's App Store (see also <http://ndi.tv/tools>)



### 3 Why NDI®?

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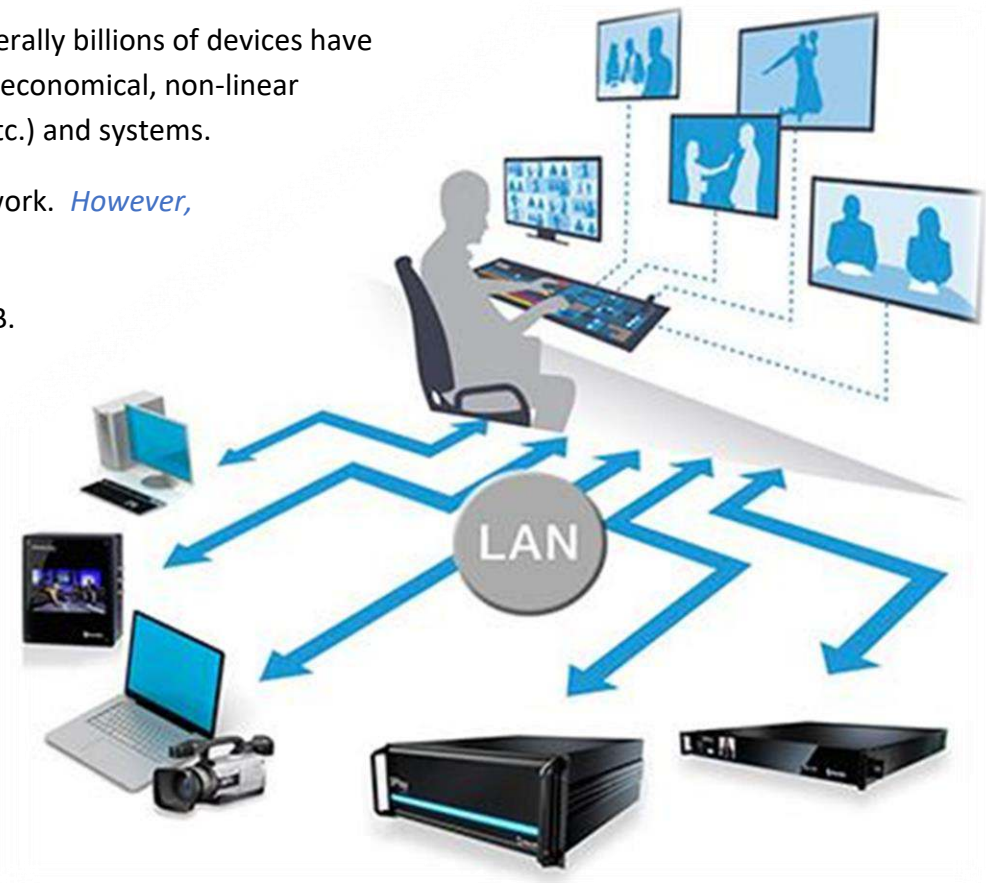
*Every few decades, the video production industry goes through a revolution that forever changes the way we work, and what we can achieve. It is thrilling to know that one is happening right now (and you can be part of it).*

For example, the industry abandoned analog cameras, video and transmission in favor of digital systems over a decade ago, paving the way for vastly more efficient non-linear workflows. Similarly, the explosion of the Internet and widespread adoption of high speed networking set the stage for the next revolution. We confidently predict that twenty years hence it will be clear that this shift was far more important than matters like resolution, frame-rate, and the like.

Today, virtually every computer system in the world is potentially connected to every other one. Literally billions of devices have high quality screens, fast processors and cameras. In this environment, it is inevitable that efficient, economical, non-linear video transfer in IP space will ultimately supersede linear connection methods (such as SDI, HDMI, etc.) and systems.

NDI® (Network Device Interface) makes it easy to share high-quality video over a local Ethernet network. *However, the NDI vision is vastly more exciting and important than any mere 'cable upgrade'.*

Consider how the Internet is much more than an improved way to move data from point A to point B. At home, the office, and everywhere in between, you, and your associates use many different devices – tablets, smart phones, laptops, workstations, and more. You might work independently, or perhaps you share files while communicating by video chat with someone in the next office, or on another continent.



The 'net' enabled countless innovators to truly change how the world works, lives and plays in fundamental ways, by creating tools and workflows that use data in ways that no-one had ever imagined. *NDI constitutes a similar quantum leap for video production.*

From the outset of personal computing, NDI's developers foresaw that video production would inevitably leverage the exponential progress of general computing.

In turn, that vision also embraced the commensurate advances in general purpose networking and the Internet. Production systems using IP to integrate data, video, and audio are transforming live video production yet again – in ways that would have seemed miraculous just a few years ago.

NDI springs from this understanding, coupled with a passion for bringing advanced video storytelling tools to people everywhere. We are providing NDI to the world for free to make it easy to connect video products over IP, in turn greatly expanding creative options for video producers – providing them with greater power, increased efficiency, and economy.

## THINK OF NDI AS YOUR OWN 'VIDEO INTERNET'.

Like a webpage, each NDI source is instantly available to many viewers and devices. Wherever your network extends – throughout your office, broadcast studio, hospital, campus (etc.) – NDI is ready for immediate display, capture, replay, production, and more.

NDI operates bi-directionally over a local area network, and supports many ultra-low latency, ultra-high quality video streams on shared connections. It is resolution and frame-rate independent, supports 4K (and beyond) along with 16 channels (and more) of floating-point audio. Alpha channel, command channels, tally data, bi-directional metadata, and things like access rights and grouping are natively supported.

NDI's superb performance over standard 1Gbit/s networks makes it possible to transition facilities to an incredibly versatile IP video production pipeline without negating existing investments in SDI infrastructure, or costly new high-speed network installations (though 10Gbit and beyond can provide even more simultaneous channels of video).

We expect you to find all of this hard to believe. That's why we want you to try NDI out for yourself.

## 4 How Do I Start Using NDI®?

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The NDI® concept is simple:

You supply an NDI video source to your network. At that point, anyone else on that network can see it and work with it (unless you deliberately restrict access) just as if it was a locally connected to their system.

In this brave new world of IP video, you do not need to think about capture cards, SDI, HDMI, etc. (although you can use these methods to connect to legacy sources, as we will discuss a bit later). You might also enjoy freedom from dependency on distribution amps, video matrix routers, and the like.

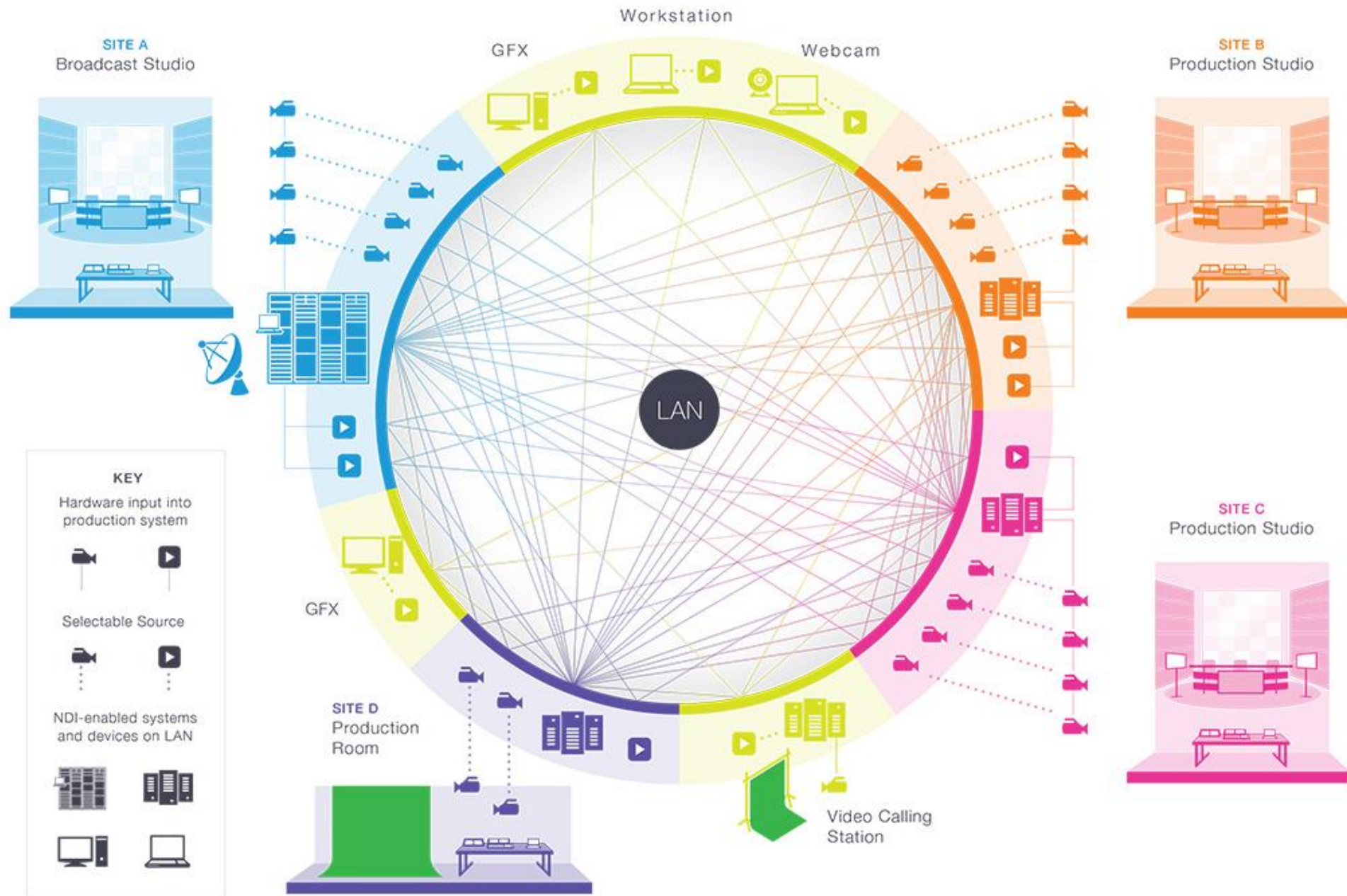
Let's begin our adventure by creating an NDI source.

For more than 40 years, the need to physically connect cameras, graphics systems, video switchers and routers has dictated studio design, architecture and workflows. ***This is no longer true.***

- Production operations, including video mixing, can be performed wherever it is convenient (and quiet), rather than being shoe-horned into the actual production space.

So – you might producing a video in your office; someone in the next office can also view it, and so can still others down the corridor, elsewhere on your campus, or on the other side of the world – all at once.

- Your graphics systems need no longer be in your control room (with bi-directional communication they can be controlled from somewhere else as well).
- Naturally, the reverse is also true. If someone takes your source and inserts it into their program, you can connect to their NDI output and see the result.
- You can even use other NDI channels to video chat to collaborate on the production.

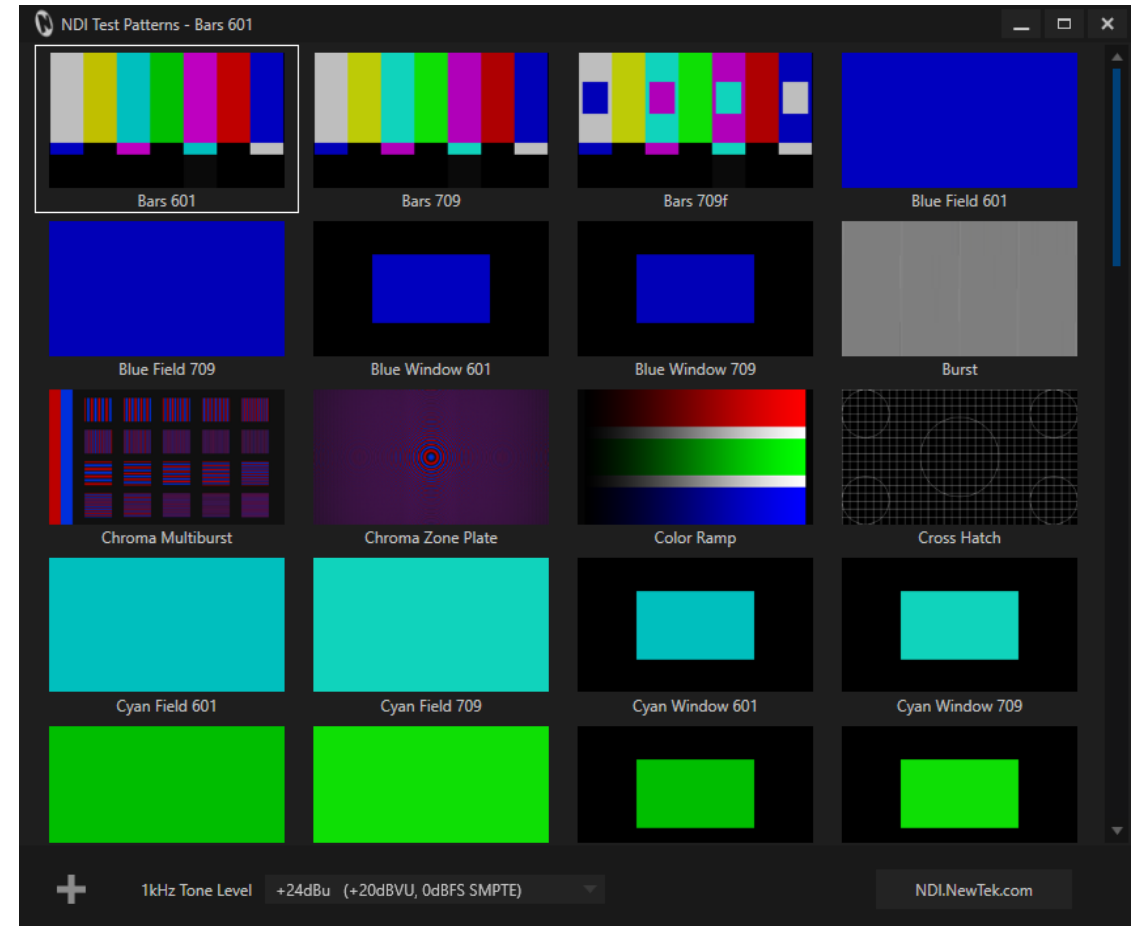


## 5 Sending Video over NDI®

Our first exercise will generate an NDI® test pattern and 1 kHz audio signal.

- Download and install NewTek NDI Tools from <https://ndi.tv>.
- Launch *NewTek > NDI Test Patterns* (Fig. 1) from the Windows® *Start menu*.

*Congratulations - you're already making NDI video and audio visible on your network!* Of course you can't see it without a suitable video monitor, though, so let's add one.





## 6 Viewing NDI®

We now have an NDI® video source – the test pattern you configured in the previous section – and since your computer almost certainly has an IP connection already, it is already visible to any other system on that network.

The next step is to open a video monitor that can see it.

*Since we're dealing with an NDI source, client systems do not require a special, add-on hardware card with SDI or HDMI connectors.* Nor must you run any heavy cabling, or add an external video monitor to view your NDI source.)

Launch *NewTek > Studio Monitor* from the Windows® Start menu.

- Right-click and select the “*Test Pattern*” source from the menu (the first part of the source menu entry is your computer’s name on the network).

*NewTek NDI Studio Monitor* is now showing the content from the NDI channel output by the *NDI Test Patterns* generator. (Double click the image to toggle full screen display.)

*Note: This document details NDI Studio Monitor for Microsoft Windows. For OS X users, NewTek provides a similar application, called NDI Video Monitor. The feature set and interface of the latter differs somewhat from NDI Studio Monitor. In particular, it presents controls and settings in the application menu at the top of the desktop.*



Video Source & Settings Menu



Full-Screen Toggle

To satisfy yourself that this high-quality, low latency video source is really available network-wide, install *Studio Monitor* on a second networked system, too. Then display the same NDI source on that second system.

You are already broadcasting NDI video across your local Ethernet network, and each NDI-enabled application and system has real-time access to it.

In many ways your NDI-enabled network is operating like a powerful video matrix router connecting everything to everything, with NDI maintaining complete visibility, identification, bandwidth management, and so on.

Even if there are hundreds of NDI channels available, and lots of machines viewing them, they are all managed correctly, automatically.

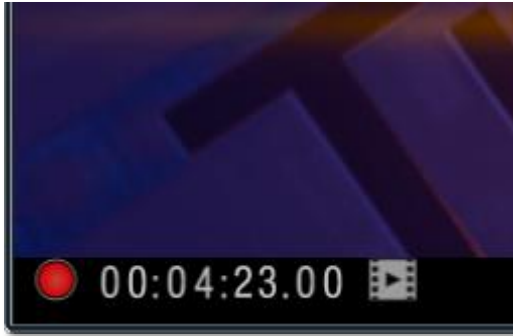
*NDI is so efficient that a single machine can receive and send an amazing number of video and audio sources. Bandwidth consumption is limited to those sources that are actually being used.*

Compare this with the traditional production pipeline world based around capture cards, distribution amps and routers; A computer system able to support scores of SDI sources is, for all practical purposes, a pipedream – but not so with NDI. For many purposes, an existing gigabit network may supply all the bandwidth you need.



## 7 Capturing NDI®

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Obviously you will often want to capture video sources to media files. The previous generation of video production methods, although digital, required specialized cabling and systems for video transmission; in turn this meant that specialized devices were needed to record it. In the IP realm, that is no longer the case. The ability to record *any* media to storage *anywhere* is part of the IP-based revolution.

From version 4, NDI Studio Monitor, included free of charge in the NDI Tools bundle, provides broadcast quality QuickTime recording (see the Advanced Topics section for full details). Need another recorder? Fire up another instance of Studio Monitor!

(For more complex requirements, NewTek NDI IsoCorder Pro™ offers powerful functionality and features. In addition, hardware NDI recording solutions are available from NewTek and other firms.)

### NDI 4 and Frame Sync

One huge advantage of NDI 4 capture is that all files recorded on a local system use its internal clock to provide frame sync. This means that you can capture multiple sources, even starting their recorders at different intervals, and easily sync them up for post-production using their embedded timecode.

Better still, since the system clocks of multiple systems in different locations can easily be slaved to an online NTP (Network Time Protocol) server, numerous NDI recordings can be matched up with precision in non-linear editing systems for multi-cam workflows – even when these are captured at different venues!

## 8 Sending Video via NDI®

While test signals are handy, let's now create an NDI® source with moving video in it. For this demonstration, we'll use the Scan Converter application included with NDI Tools to capture video from a desktop application in real time, making it visible on the network.

- Open your web browser, and navigate to your favorite streaming video site, and choose a video to play.
- Launch NDI Scan Converter from the Windows® Start menu (a small NDI notification icon is added to the Windows Taskbar).

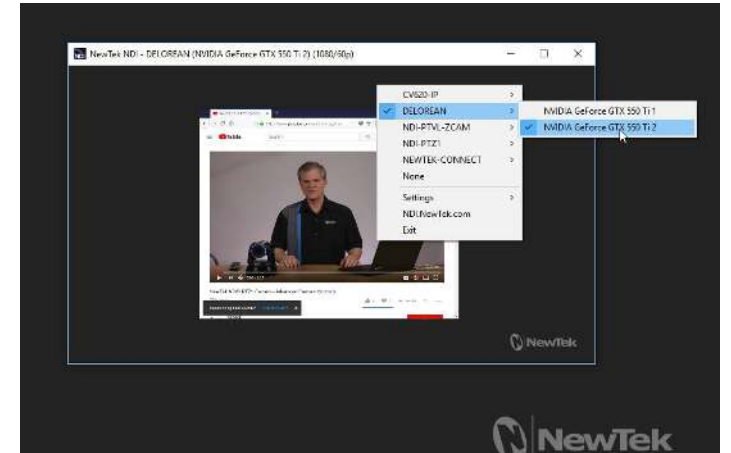


Scan Converter System Tray icon

*Believe it or not, that's all there is to it!* Your system desktop(s), including any video playing on it, is already being sent to the network as one or more high quality NDI video streams. To confirm this, use the *NDI Studio Monitor* application (installed earlier and launched in the previous section) to confirm that the Desktop and the video player window are available.

- Simply use Studio Monitor to select the correct graphics card entry from your local host system to do so.
- To finish up, try playing your video in full-screen mode!

[SCAN CONVERTER'S MANY OTHER FEATURES ARE FULLY DESCRIBED AFTER THIS INTRODUCTORY TOUR IN SECTION 15, UNDER THE HEADING SCAN CONVERTER IN DEPTH.](#)



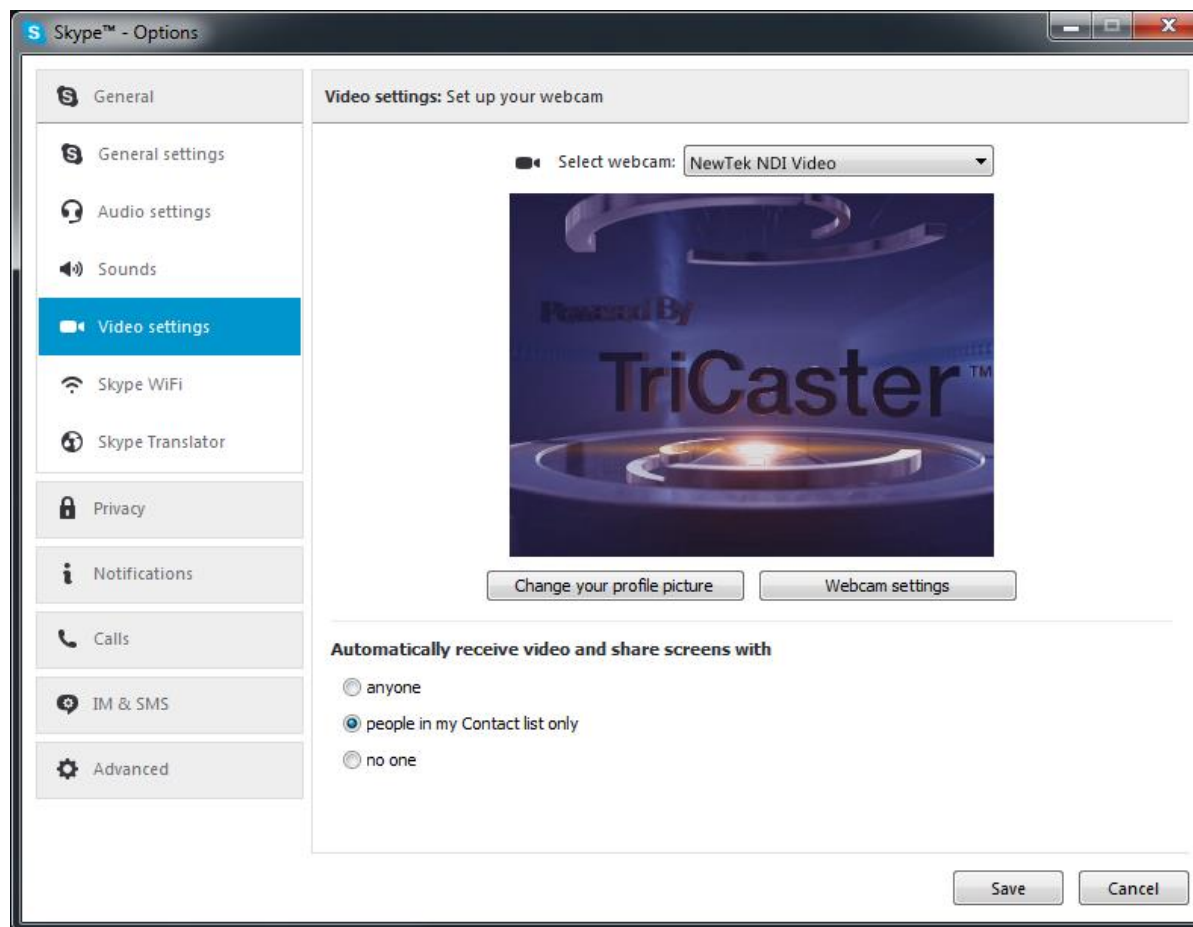
## 9 Send NDI® Video to Skype

More than 300 million people use Skype. *Wouldn't it be wonderful to supply a truly high-quality video source to your Skype connections?* You could, for instance, do a company meeting using a group Skype video conference, and present pristine quality video to them.

Assuming you already have Skype installed, proceed as follows:

- Launch NDI Tool's Virtual Input application from the Windows® Start menu.
- Right-click the NDI® icon that it adds to the Windows® *Task Tray*, and select one of the NDI sources you have previously added to your network, and which are now listed in the popup menu.
- Launch Skype and select *Options* from its *Tools* menu.
- Click *Video settings* in the column at left. Use the *Select webcam* menu to choose *NewTek Video Source* (you can do the same thing in the *Audio settings* pane if you wish the remote Skype viewer to hear audio from the NDI source).

Skype is now ready to send your high-quality NDI source out to contacts in the usual manner.



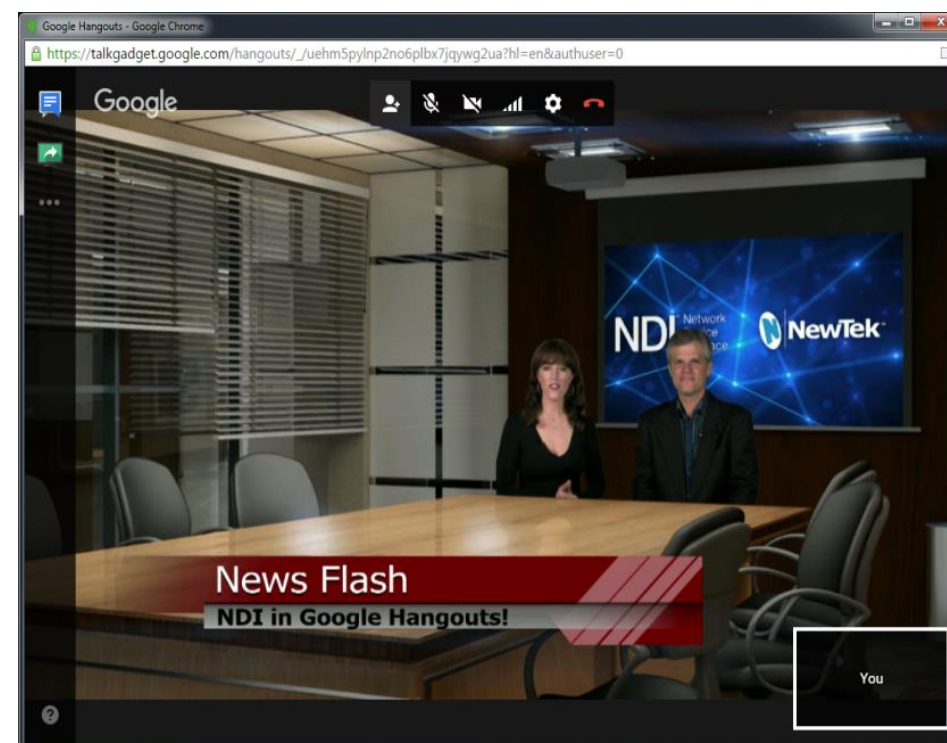
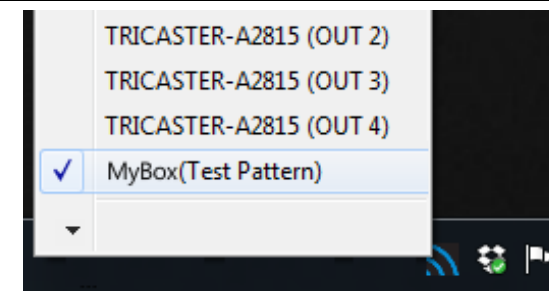
## 10 Send NDI® Video to Hangouts, YouTube, and More ...

Likewise, the output from Virtual Input can be sent detected and by such applications as Google+ Hangouts (and Hangouts On Air), YouTube Live, Adobe Flash Media Live Encoder, VLC media player, and many others.

- Configure a suitable NDI® source in the *Virtual Input* menu.
- Select the output from *Virtual input* in your desired application, in the same manner as you might previously have selected a webcam.

The gorgeous video quality NDI supplies to your viewers will make you and your message look great\*.

\* Note that, by default, Hangouts shows your video source as a mirror image on your local display (only).



# 11 NDI® and the Adobe® Creative Cloud

NDI version 4 gives special attention to supporting these important, industry standard applications. In particular, media files captured in applications or systems using the latest SDK can be imported directly into Adobe® applications by means of the NDI Adobe CC File I/O plugin. In addition, the NDI® Adobe CC Frame-Buffer plugin supports real time playout from selected Adobe® applications to outboard NDI-enabled devices and systems on your network.

## File Import

Traditionally, various and competing file formats pose challenges for video production pipelines. Most NewTek systems support flexible transcoding to alleviate this issue, but no – courtesy of the NDI Adobe CC File I/O plugin – video applications in the Adobe® Creative Cloud suite can now directly import high quality QuickTime® files from native NDI capture applications.

## Growing Files

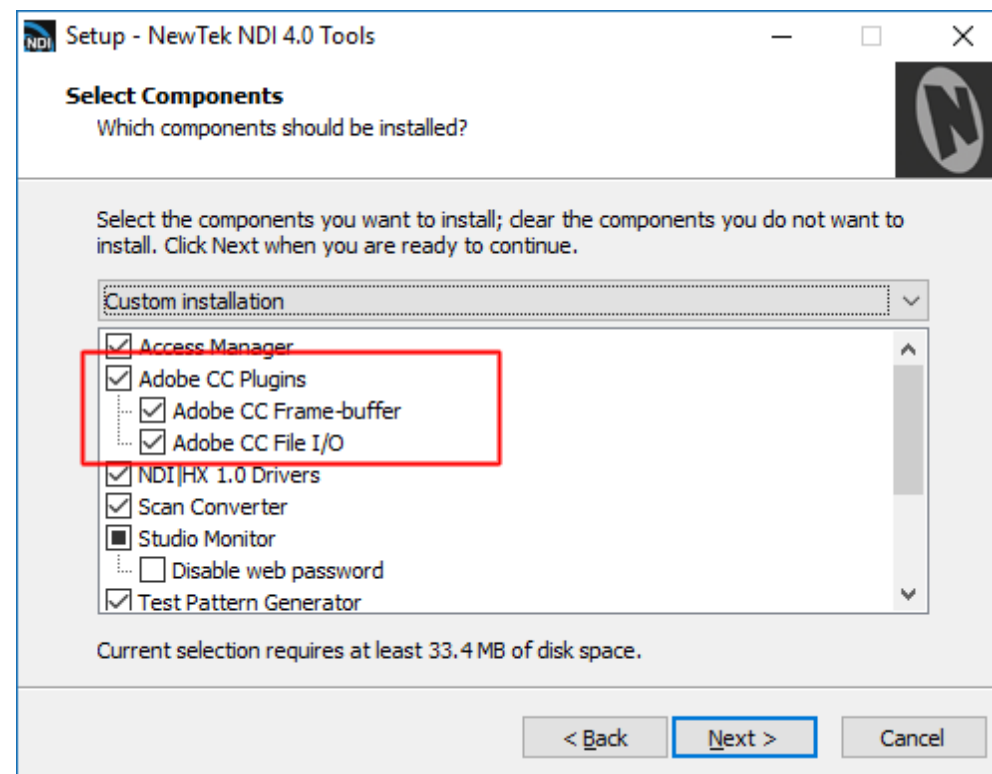
And it doesn't stop there: While it has generally been necessary to wait until recording has stopped – i.e., the recorder is no longer 'writing' data, and the file has been 'closed' – before the file can be imported into (for example) non-linear video editing software, both NDI files and the Adobe® Creative Cloud suite support 'growing files'.

This means that you can start editing a video project (such as a concert, seminar, or meeting) as soon as you press the Record button! Having added the file to your project, its duration is automatically updated periodically without any effort on your part. You can simply extend the clip's out point on your timeline to access the fresh material. Imagine having your finished, polished edit ready for upload to social media as soon as, or even before the event ends!

## Frame Sync and Multicam Editing

As mentioned earlier, files captured by NDI 4 on a local system use its internal clock to provide frame sync. This means that you can capture multiple sources, even starting their recorders at different intervals, and easily sync them up for post-production using their embedded timecode.

Better still, since the system clocks of multiple systems in different locations can easily be slaved to an online NTP (Network Time Protocol) server, numerous NDI recordings can be matched up with precision in non-linear editing systems for multi-cam workflows – even when these are captured at different venues!



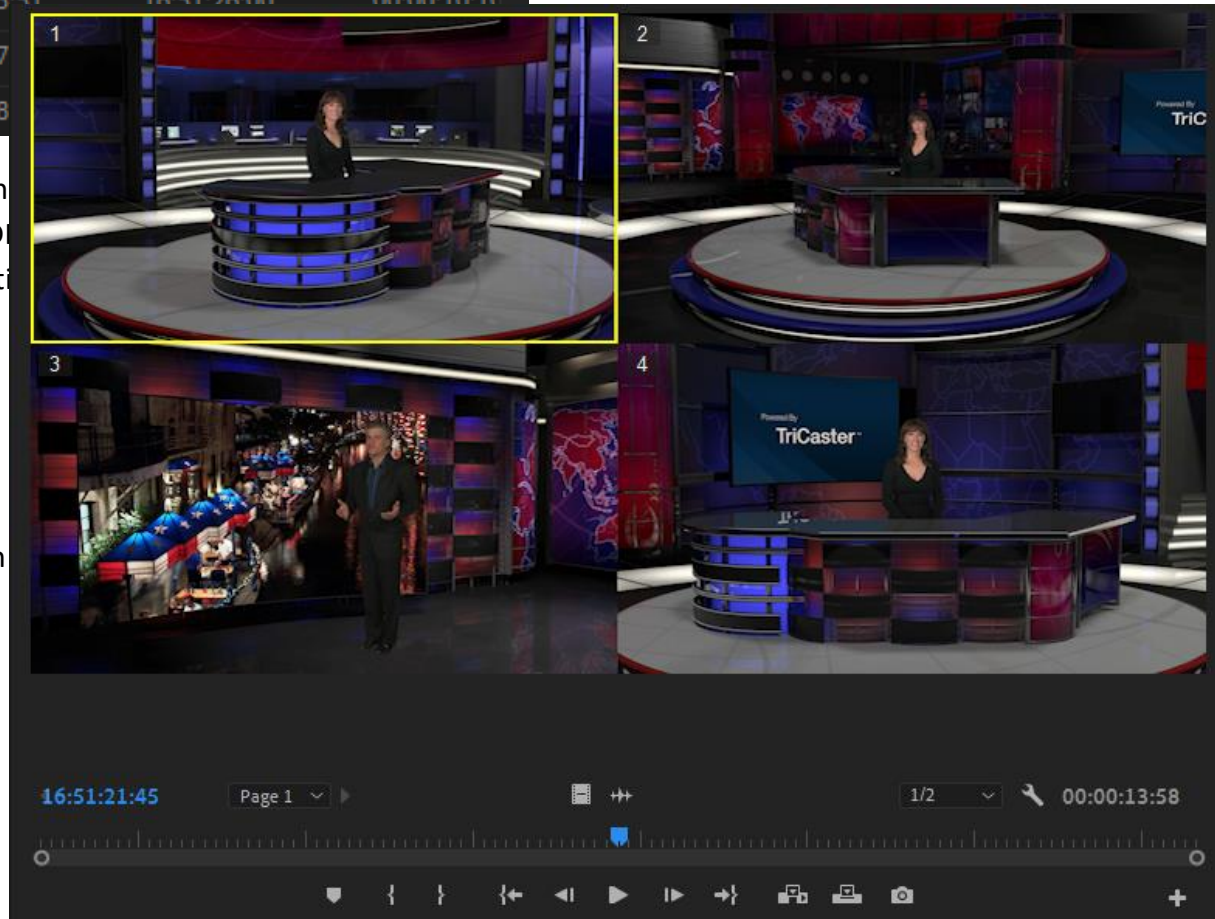
For example, Adobe Premiere, part of the Adobe® Creative Cloud suite, provides an extensive set of multicam features, including the ability to sync multiple clips in a sequence based on their embedded timecode.

■	📺	Cam 1.movMulticam	59.94 fps	16:51:14:42	16:51:28:39	00:00:13:58
■	📺	Cam 2.mov	59.94 fps	16:51:15:51	16:51:26:00	00:00:10:10
■	📺	Cam 3.mov	59.94 fps	16:51:17:00		
■	📺	Cam 4.mov	59.94 fps	16:51:18:00		

Better still, since the system clocks of multiple systems in different locations can easily be slaved to an online NTP (Network Time Protocol) server, numerous ND recordings can be matched up with precision in non-linear editing systems for multicam workflows – even when these are captured at different venues!

This means that you can produce frame matched video projects using footage captured from multiple events scattered across different locations with a minimum of fuss.

Hint: In our experience, Premiere's multicam support works most reliably when all clips in the matched sequence conform to a single video format (such as 1080p60).





## Video Output

In production, each graphic, animation, and video is reviewed many times; and it is often necessary to render the project to a media file for various stakeholders for review each time. With NDI® for Adobe Creative Cloud, when you play a project in a supported Adobe application anyone on the network can view it locally in real time (using NDI Studio Monitor). NDI for Adobe CC can really accelerate the creative process.

## Live To Air/Drive/The World

Consider a few more examples:

- Send After Effects® output live-to-air, directly injecting it into your broadcast pipeline.
- Use NDI® IsoCorder™ to capture output from CC applications to file anywhere your network runs.
- Use NDI Virtual Input with this plugin to use almost any application accepting webcam input (Skype™, Google+ Hangouts Live™, etc.) to collaborate across the globe.

These are just a few of the ways you can combine the large and growing number of free and commercial NDI tools to enhance your workflow, and show off your creativity.

## 12 Control Access to NDI® Channels

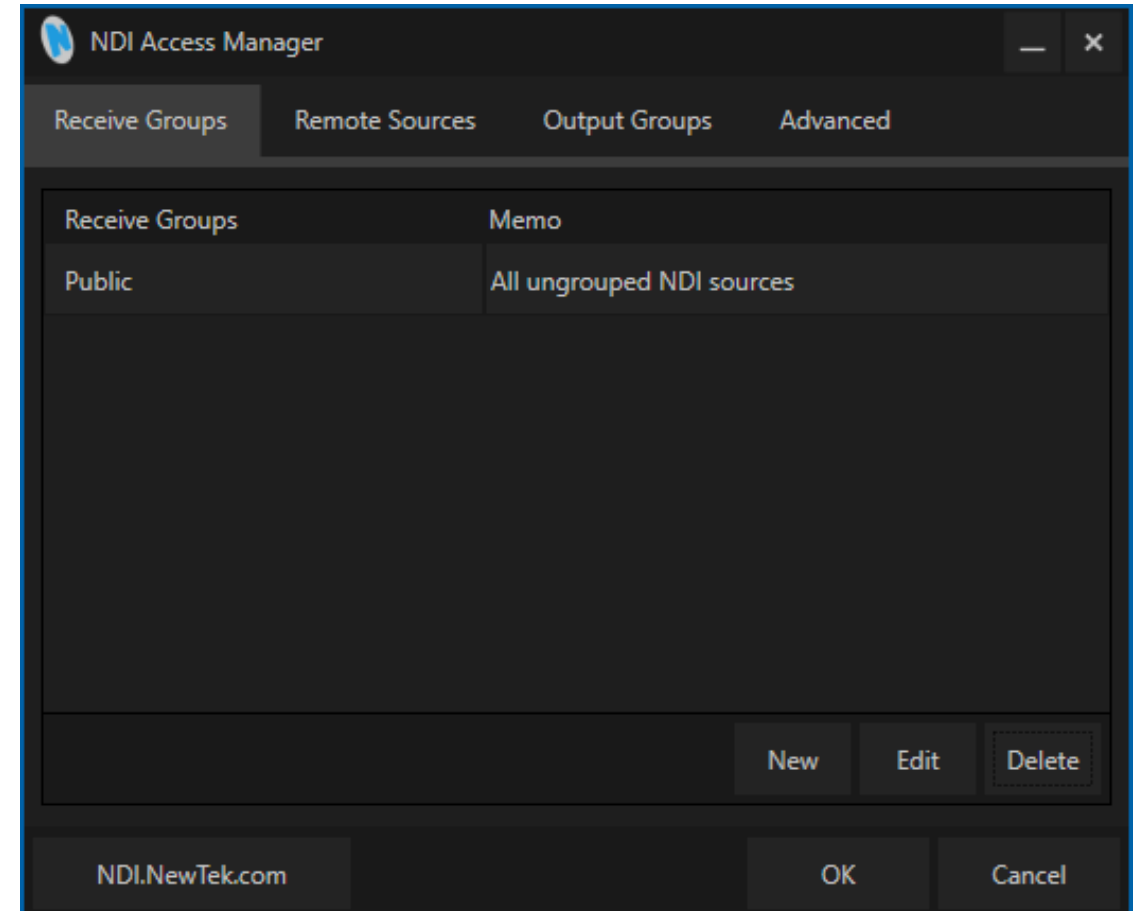
As you come to appreciate the power of NDI®, you'll doubtless want more and more of such convenient video sources. You could easily wind up having hundreds of video sources available (clearly, this was impossible before NDI).

Often, though, you will want to limit visibility of NDI channels to specific systems. Or you may need access to NDI channels from another subnet. The *NDI Access Manager* lets you assign sources to groups, and choose which of these various systems receive. You can also access NDI sources from other subnets.

The NDI Access Manager lets you assign sources on individual host systems to groups, and choose which of these group that you receive. You can also access NDI sources from other subnets or even other networks.

*Note: This document details NDI Access Manager for Microsoft Windows, but NewTek provides a similar application for OS X users. The interface and functionality of the latter may differs slightly from the Windows version as illustrated in this discussion.*

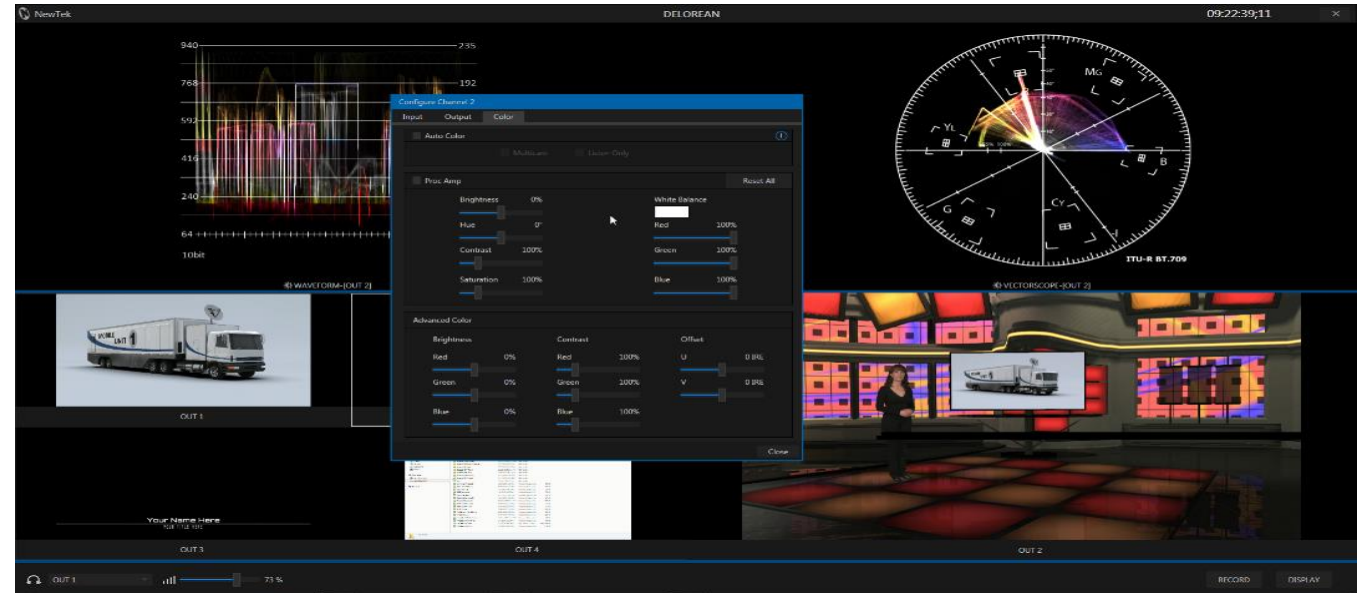
More detail on this application's features is provided in the Advanced Topics section of this document.



# 13 Connect to Hardware

We've used computer sources to this point, but input from other sources is obviously important, too. You may want to send NDI® video across the network to devices and displays connected to video output cards at the far end of the building. Thankfully, NDI provides full connectivity to and from traditional production devices.

Perhaps you already rely on hardware audio-video I/O cards, such as the fine products from Bluefish444, TeraDek, AJA Video systems, Blackmagic Design, Matrox, or DELTACAST, using these for capture or display of audio and video. Imagine how useful it would be if sources you connect to those cards were immediately available as NDI channels for use anywhere on your network or, conversely, if NDI sources could be sent to the card's video outputs.



You could then connect a high-quality camera to the input the card and (with the help of *NewTek NDI Virtual Input*) stream to YouTube Live or Google+ Hangouts, etc. Alternatively, you might display remote NDI sources on local monitors connected to a card's outputs located anywhere in your studio, office building or campus that the network runs. The free *NewTek NDI Connect* software does all of this and more and is available at <https://ndi.tv>. Here's a partial feature list for the extra cost NewTek NDI Connect Pro application:

- 4 NDI output channels; accepts NDI channels as sources, but also supports Bluefish444, Blackmagic, DELTACAST, AJA, Matrox, Teradek devices and others, along with webcams and custom sound cards for professional connectivity (including XLR).
- Separate Key/Fill Input and Output (convert key and fill supplied to a card to a single 32bit NDI channel on your network, and vice versa).
- Supports 8-channel audio I/O, with per-channel level control
- Supplementary NDI Viewer (e.g., for program return), and versatile display configurations, including dual monitor workspaces
- Media file playback (with *Autoplay* for systems supporting NDI tally)
- Integrated Waveform/Vectorscope and Color Correction, including White Balance and Auto-color
- Overlays (VUs, Title Safe, 4:3, Checkerboard, Center Cross)

## 14 The NDI® SDKs

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As the foundation technology of the NewTek Advanced IP Workflow, NDI® employs refined encoding and communication protocols to efficiently package and send information over a standard LAN. NewTek's NDI Software Development Kit (SDK) supplies all of the information, tools and examples needed to build applications and products with native NDI support. Both inputs and outputs of devices and applications (including switchers, graphics engines, laptops, etc.) you prepare using this SDK can serve as video sources exposed to other NDI-enabled devices on a shared network. Interested parties are encouraged to visit <https://ndi.tv> for further details.

The specific goal of the NDI SDK is to make it as quick and easy for you to create software and hardware applications that allow you to create and use video over IP as is physically possible. Indeed, if you have the ability to render video frames, we believe that NDI sending functionality can be added in less than 10 lines of code.

### [NDI Embedded SDK](#)

The supplemental NDI Embedded SDK is designed for device manufacturers who wish to provide hardware assisted encoding or decoding. It provides access to the video data in compressed form allowing for the use of hardware codecs. The Embedded SDK includes example software and FPGA hardware source code, along with bootable uSD images for several commercially available development boards to help get you started.

# 15 Advanced Topics

## Scan Converter in Depth

Scan conversion is frequently a necessity in today's video production, e-sports, and presentation environments. Hardware solutions run from a few hundred dollars per video stream to several thousand dollars for professional systems.

Connecting a hardware scan converter typically requires one or more unused computer graphics card ports, and cumbersome connections comprising VGA or HDMI video cabling on one end, and the hassles of HDMI or expense and bulk of SDI on the other.

In this light, the inclusion of our powerful Scan Converter in the free NewTek NDI Tools bundle can save you thousands of dollars in both gear and setup time.

Even better, Scan Converter provides features that exceed what 'mere' hardware adapters typically provide, as discussed next

### High Quality Desktop Capture

Supply 'desktop quality' video output to your downstream, NDI-enabled production systems and software at frame rates up to 60Hz with virtually no visible latency, and almost not CPU processing burden.

Simply launch Scan Converter, and it will immediately begin to supply an NDI video stream to your network for each monitor output your graphics card provides.

### DESKTOP AUDIO OPTIONS

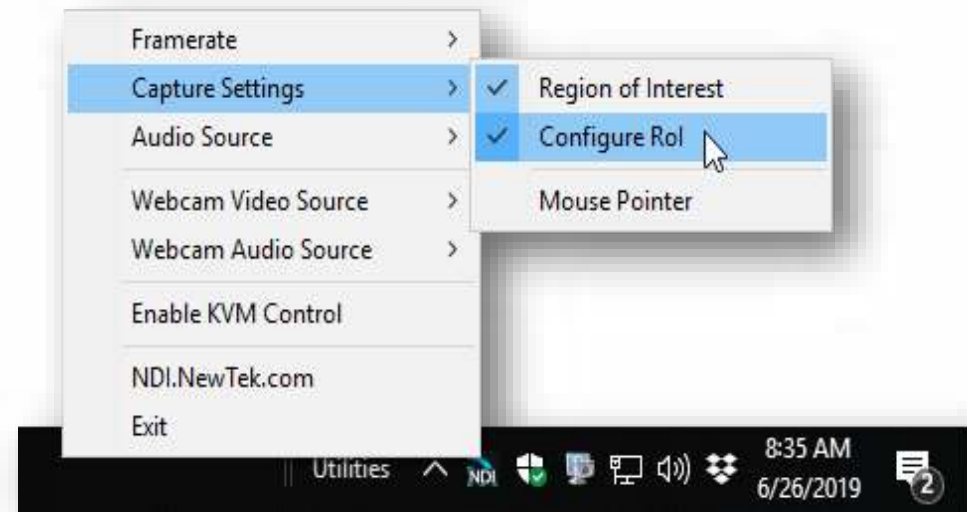
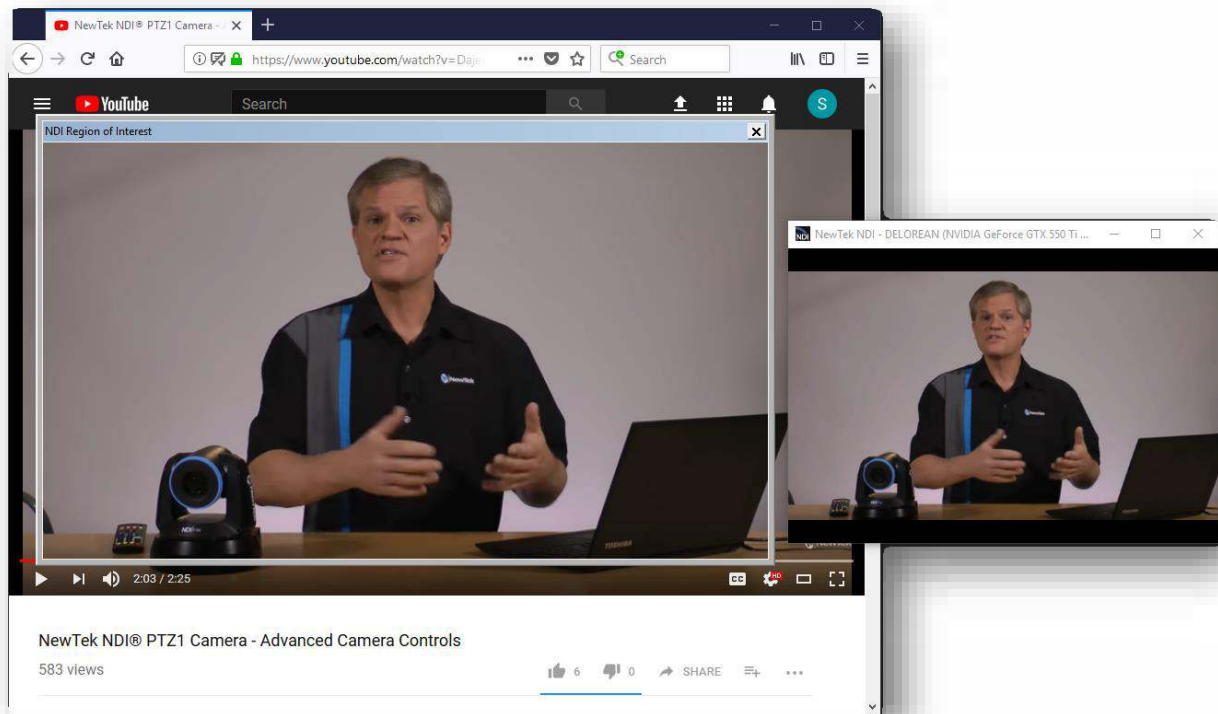
Choose which audio source accompanies your screen capture, including system audio, connected headsets, and the like. You can even take advantage of virtual sound cards, such as Audinate's Dante Virtual Soundcard, or AES67 solutions. Now you can play a computer game or Power Point presentation with audio (with no impact on frame-rate) and supply it as an NDI source.



## Region of Interest

Choose Capture Settings > Configure RoI from the Settings menu to pop the Region of Interest frame onto your display. Adjust the window borders to taste, and the video desktop content within this frame is transmitted to the associated NDI output.

You can use Region of Interest to isolate and send high quality, high frame rate video from computer game windows, websites and video streaming servers and applications, or desktop software to your NDI-enabled video systems and software.



Or use the Virtual Input application included in NDI Tools to send a selected part of your screen to video over IP services.

For example, show PowerPoint presentations to your audience anywhere in the world using popular online services like Skype, Hangouts, GotoMeeting, Zoom, etc. (really pretty much anything that supports webcam input).

## Webcam to NDI Video

Speaking of webcams, Scan Converter now also supports webcam input.

Connect an inexpensive webcam to your Windows system, select Webcam Video Source from the settings menu, then choose your camera and, if you wish, specify its video format too.

Immediately, you have a new video source for your presentations.

Consider, too, that your webcam can now be assigned as a Picture in Picture overlay on the output of a game or other application courtesy of Studio Monitor.

### WEBCAM AUDIO OPTIONS

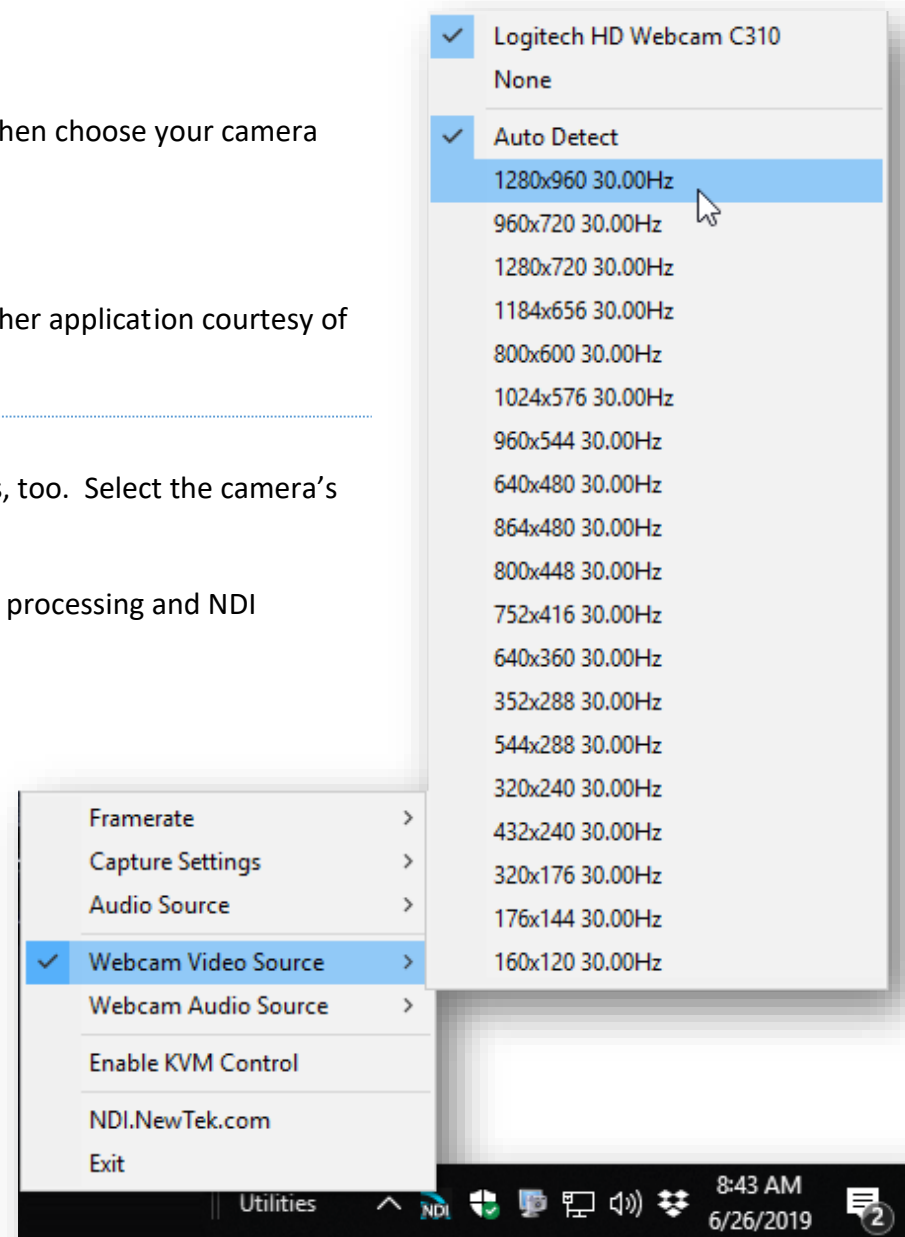
The webcam NDI output independently enjoys all the same audio options as Scan Converter's NDI desktop outputs, too. Select the camera's own mic, your headset or another high quality mic, or the output from any audio source recognized by the system.

Scan Converter Note: The GPU is now used to capture the screen, and handles the lion's share of color conversion, processing and NDI transmission. This version uses the DirectX 11 API, thus requires Windows 8 or better.

## KVM over NDI

According to a popular online source, "A KVM switch (KVM being an abbreviation for "keyboard, video and mouse") is a hardware device that allows a user to control multiple computers from one or more sets of keyboards, video monitors, and mice. *Now, with KVM over NDI, feel free to erase the "hardware device" portion of that sentence.*

Previously, selected NewTek live production systems gained KVM over the network via NDI. This represents huge value; and in this version of NDI Tools KVM features have been added to NDI Scan Converter too. Simply checkmark Enable KVM Control in the Settings menu on the local host, then open a Studio Monitor window on the system you wish to use to remotely it.



## Studio Monitor in Depth

As we learned in 6 (Viewing NDI®), *Studio Monitor* allows you to view NDI® sources from anywhere on your network. However, it does much, much more too!

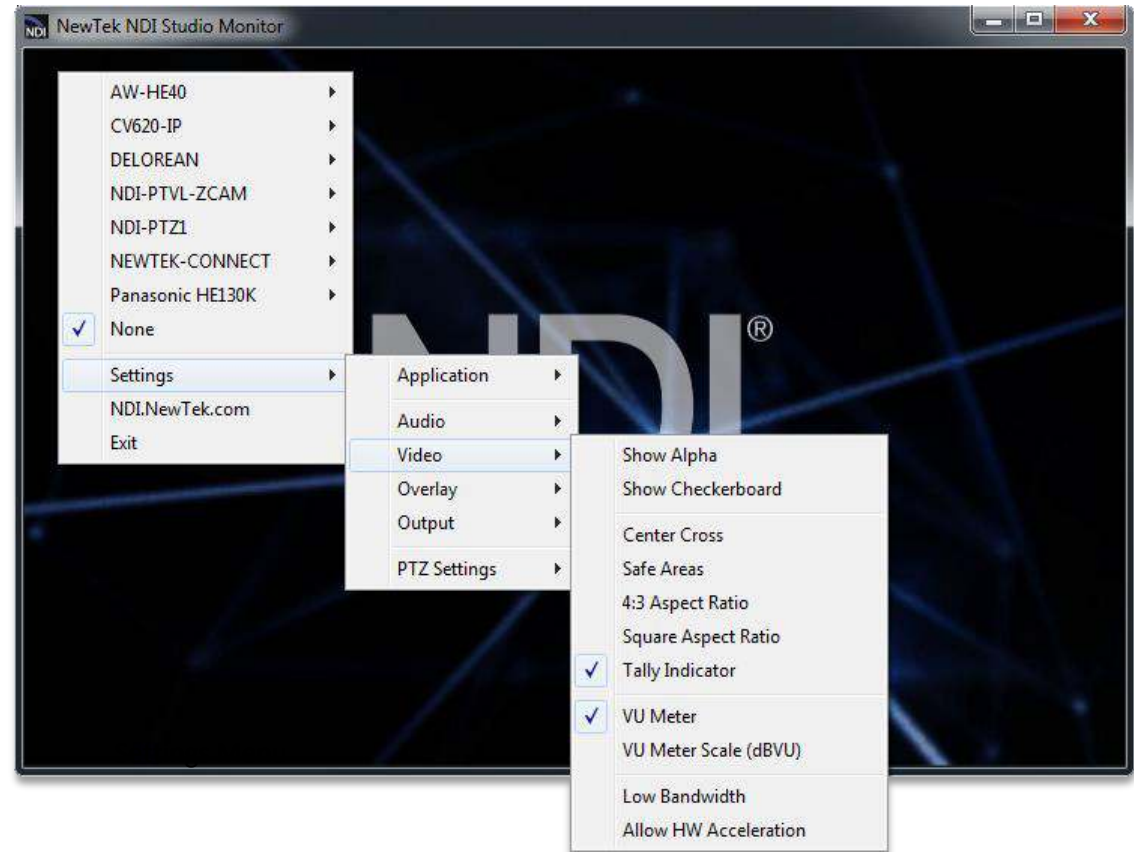
*Nearly endless features are provided by the Studio Monitor's Settings menu* (opened by clicking the 'hamburger' icon shown at upper-left on rolling the mouse over the video window, or by right-clicking anywhere on the window). These, and a few other features supported in the interface are detailed below.

### Video Features

- Display NDI or NDI|HX sources (requires NDI|HX driver)
- Display NDI video sources in custom windows, full-screen, on selected monitors, or even across multiple screens.
- Open multiple instances of Studio Monitor to display an array of video sources, creating custom multiview displays or even video walls with a few clicks.
- Repeat the connected source onto the network as a new NDI source
- Auto-run Studio Monitor to show complex multiview setups on boot-up without any user intervention.
- Optionally show a checkerboard pattern behind video sources with an embedded alpha (transparency) channel.
- Toggle full color or alpha matte output for video sources with an embedded alpha (transparency) channel.
- Enable tally to display red/green notification when a source is being utilized on systems supporting NDI tally signaling.
- Optionally show various safe area and alignment guides.
- Use Hardware video acceleration when available to minimize CPU processing demands.

### Audio Features

- Mute or transmit audio output, and adjust it to respect regional audio standards such as EBU or SMPTE audio levels.





- Optionally overlay VU meters (with or without a scale) on your Studio Monitor's video output.
- Send output to system playback devices, including third-party hardware outputs and virtual soundcards (such as Audinate's Dante Virtual Soundcard).

## Overlay Features

- *Add a secondary NDI video source – whether a static title or graphic, or full motion video – over your NDI video source.*
  - Use Scan Converter to supply both your webcam and a Power Point presentation, game display, or other desktop source, and compose it as a Picture in Picture element.
  - Or add a full-frame overlay with embedded transparency in front of your primary video source.

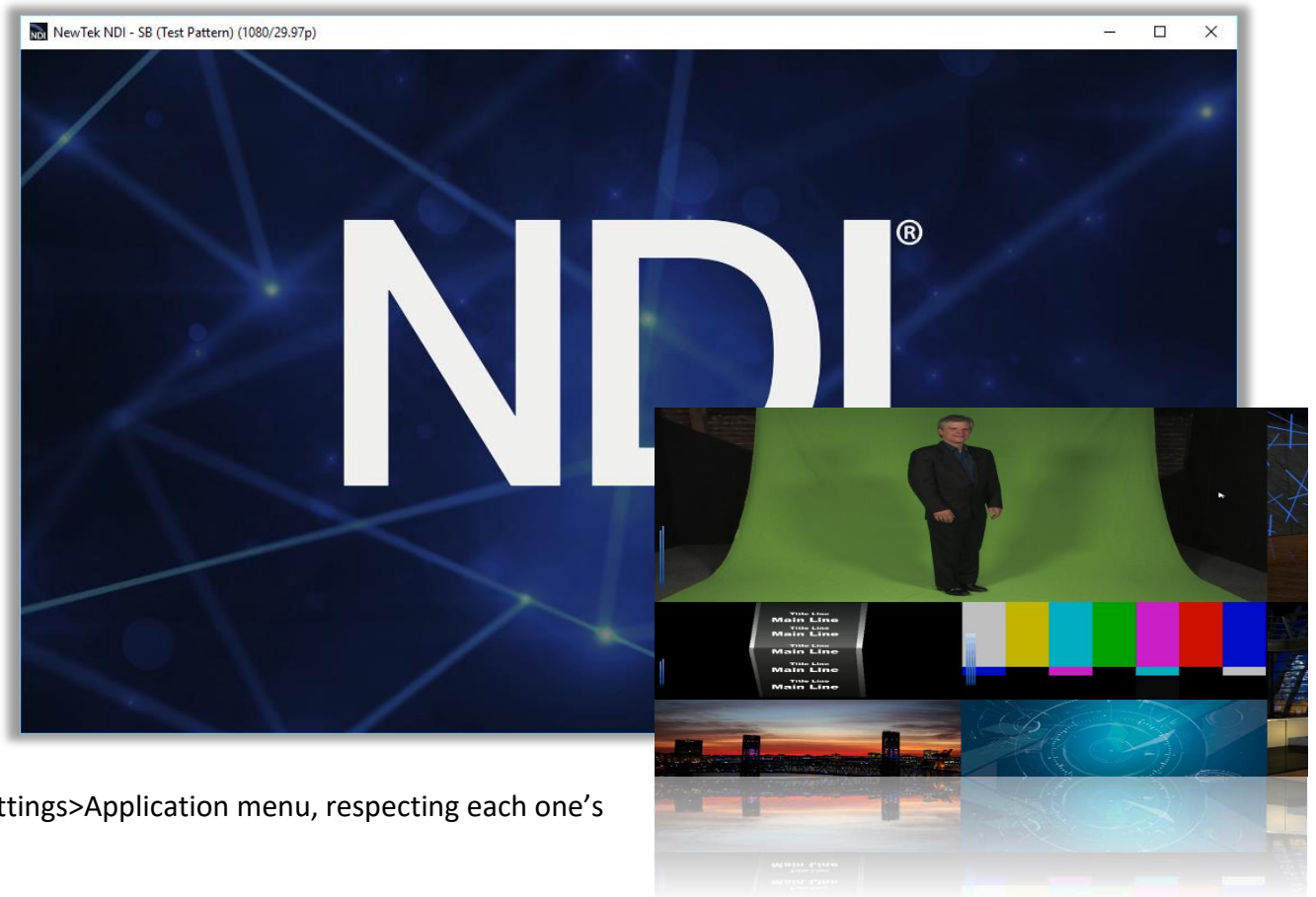
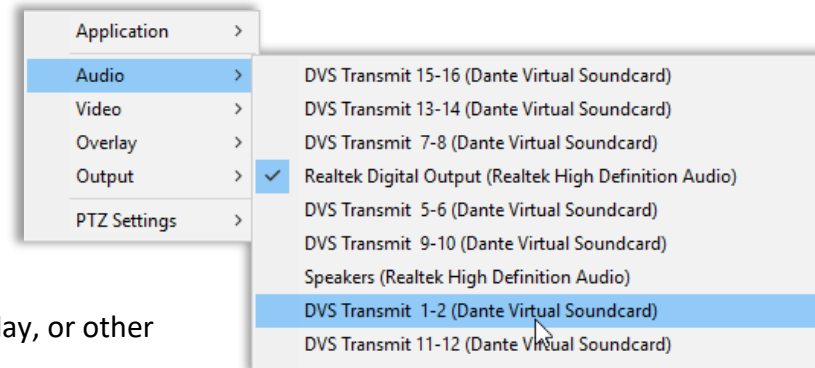
You might use a simple logo graphic loaded into the NDI Test Pattern application as a 'bug', animated graphics from one of the many professional CG applications supporting NDI output or Adobe® After Effects (using the Adobe CC NDI driver), or even chromakeyed video played from NewTek Connect Pro™.

## Output and Multiviewers

- Display Studio Monitor in its own application window, or full-screen.
- Optionally display Studio Monitor in front of all other desktop applications
- Hide the window borders and arrange multiple instances of Studio Monitor to create multiviews and custom video-wall arrangements.

*Hint: Shift Double-click the monitor to automatically fit it to a screen quadrant.*

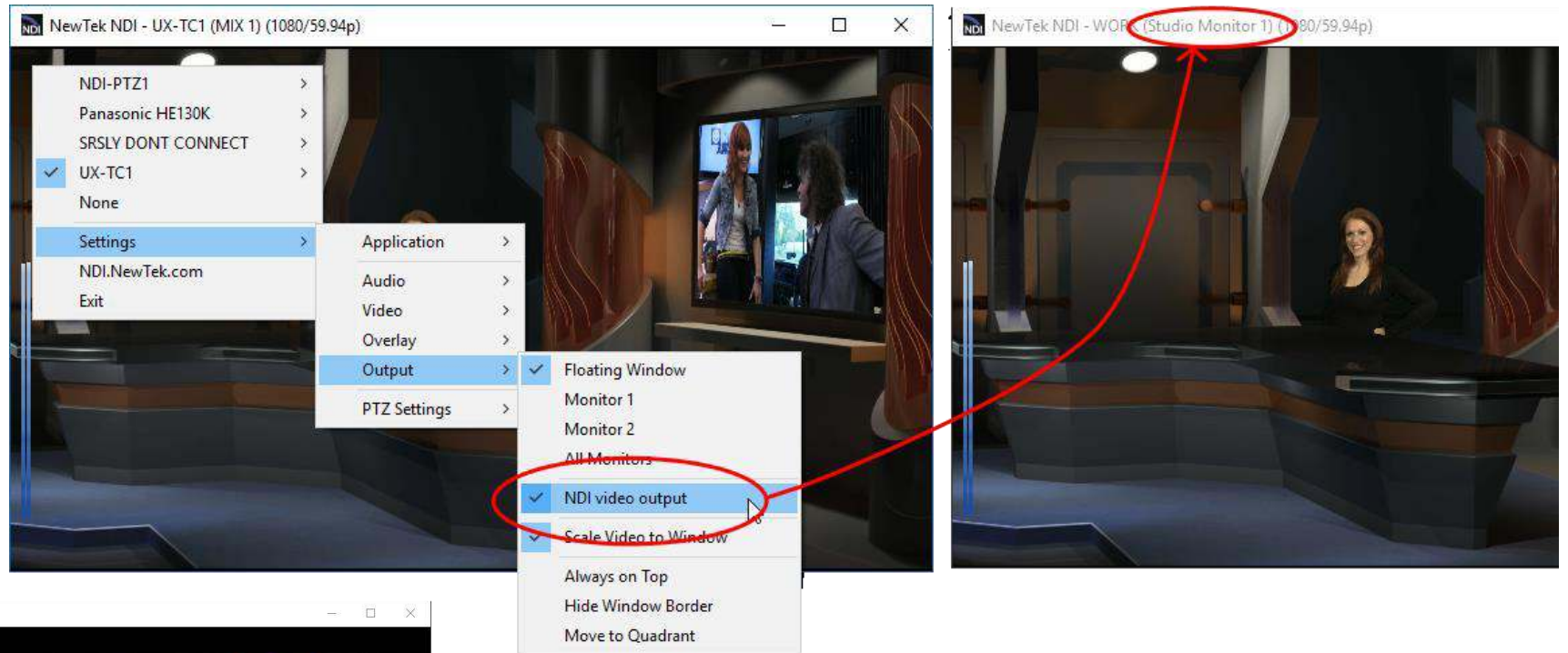
- Assign multiple Studio Monitors to auto-run at system startup in the Settings>Application menu, respecting each one's individual source settings and other configuration options.



## NDI Output

Enable the NDI video output option in Studio Monitor's Settings menu to repeat the current source onto the network. Among other applications, this lets you use Studio Monitor as a virtual video router.

For example, one or more Studio Monitor instances in your control room can be used as master controls for numerous Studio Monitor instances or other NDI receivers anywhere on your network.



## KVM over NDI

As discussed in the Scan Converter section of this document, Studio Monitor for Microsoft Windows provides complete support for KVM ('keyboard, video, mouse') over an NDI connection.

Simply enable NDI KVM on the remote target you intend to control (whether a NewTek live production system or one running NDI Scan Converter), then launch Studio Monitor on the local host and click its KVM switch, which turns blue when active.

With KVM enabled, you've got complete control over the remote system, with low latency and high quality (it's so good you can sometimes you're not controlling the local system).

Hint: You can freely drag the KVM switch's 'tag' to another position on the window.

## PTZ Control (and Virtual PTZ)

- Take direct control of NDI-enabled PTZ cameras from NewTek and other manufacturers right from Studio Monitor.
- Pop-up PTZ controls let you adjust Zoom, Pan, Tilt, Focus and Iris settings manually, or store and recall presets with the mouse.
- Or punch keyboard number keys to recall PTZ presets (hold down ALT while doing so to store a preset).

*Actually, you don't really even need a PTZ camera to use these features!* Studio Monitor supports virtual PTZ operations for NDI output from NewTek's Connect Spark series NDI converters and the free media player VLC from Videolan.

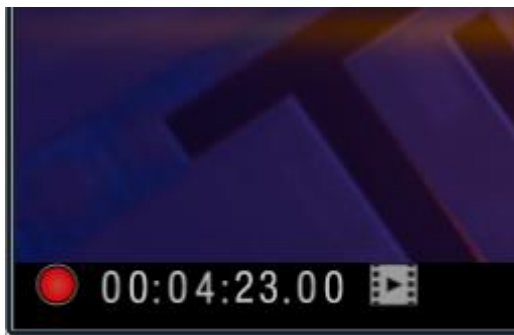
## Hardware Joystick Support



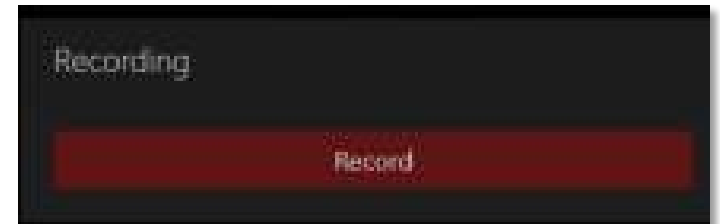
Assign a Windows hardware joystick connected to the Studio Monitor host to control a PTZ camera (or the virtual PTZ feature supported by selected NDI|HX sources). Pan and tilt using the left thumbstick, zoom and focus with the right, and toggle autofocus mode using the controller's buttons.



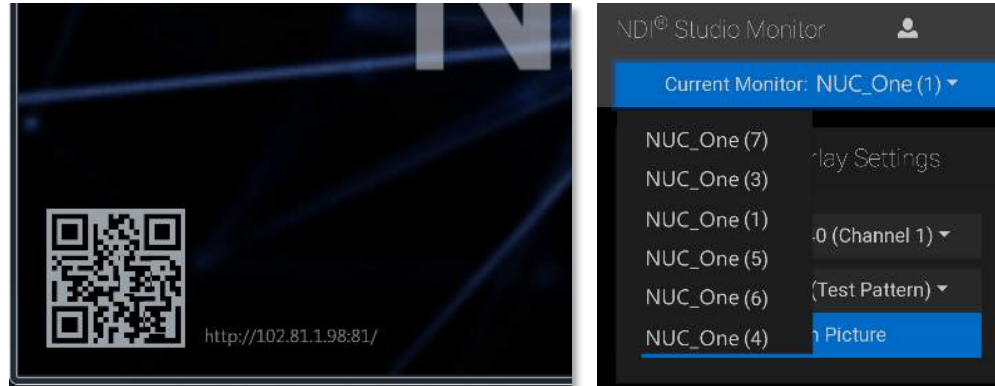
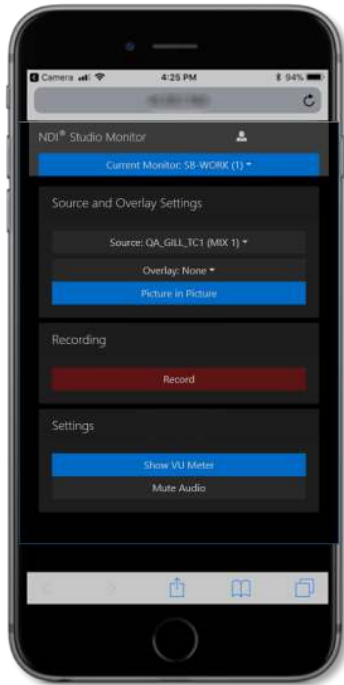
## Recording



- From version 4, Studio Monitor always displays a red record icon in the lower-left corner. Click this to toggle recording.
- Regardless of the NDI source type, Studio Monitor captures high-quality QuickTime files to the path specified with the Settings>Application>Set Record Path menu option.
- A timecode display runs during recording, and the nearby filmstrip icon provides quick access to captured files.
- Studio Monitor's web page, discussed next, likewise features a convenient Record button for full remote control over capture from a browser.



## Web Interface



- Scan the QR code on a mobile device to open Studio Monitor's web app.
- Select any Studio Monitor instance from among all those discovered on any system on your network.
- Take advantage of optional password protection to prevent tampering.
- Update the source, audio and overlay settings of every Studio Monitor display remotely – perfect for signage or remote display applications!
- Enable or disable recording by any connected Studio Monitor instance.

## NDI Source Device Web Access

If the selected NDI video source supports web configuration (e.g. NDI Connect™ Spark or your NDI-enabled PTZ camera), a configuration button (gear) is shown at lower right when the mouse is over Studio Monitor. Clicking this gadget opens a web browser to the corresponding configuration page, allowing you to modify source settings without any need to identifying its IP address.

*Note: This document details NDI Studio Monitor for Microsoft Windows. For OS X users, NewTek provides a similar application, called NDI Video Monitor. The feature set and interface of the latter differs somewhat from NDI Studio Monitor. In particular, it presents controls and settings in the application menu at the top of the desktop.*

## Access Manager in Depth

We touched on the NDI Access Manager earlier under the heading Control Access to NDI® Channels. It's pretty easy to use, but some environments are more challenging, so we'll offer a few helpful points here.

### Receive and Output Groups

The *Receive Groups* tab lists all NDI groups from remote systems visible to the local host. By default, all NDI sources contribute to the "Public" group, visible to all NDI clients on the same subnet whose host systems include a matching "Public" entry in their own *Output* tab.

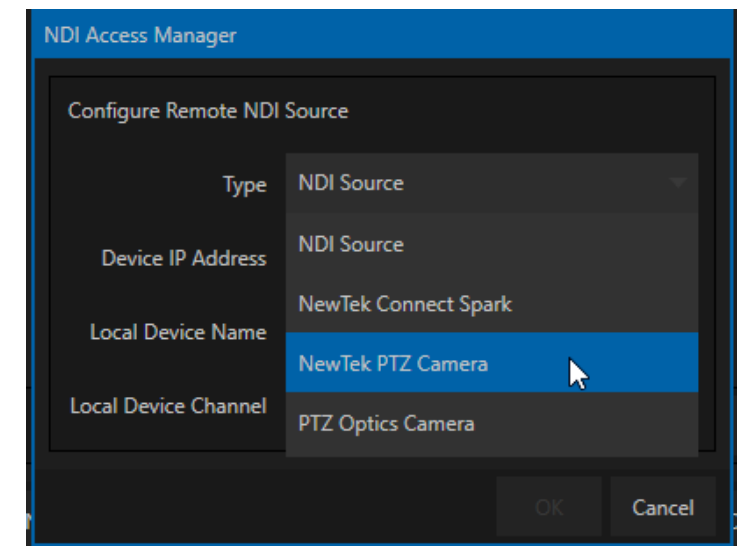
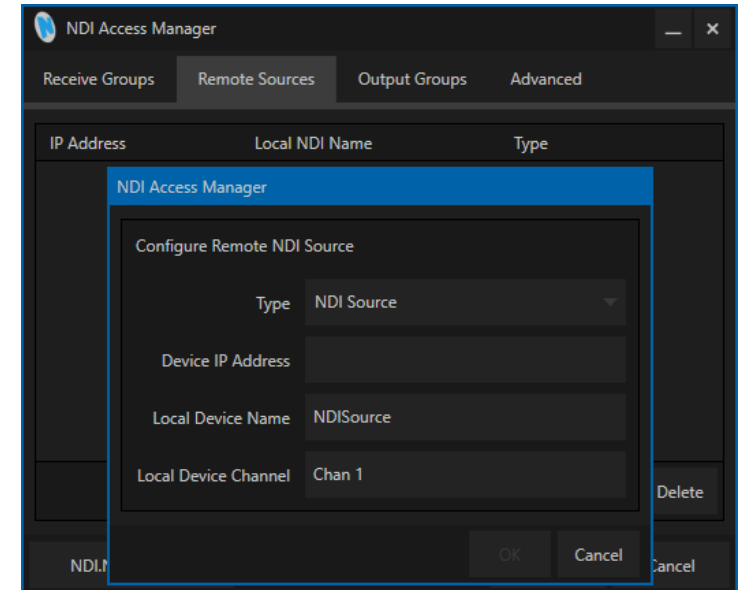
Conversely, custom groups in the *Output* tab let others with matching entries in their *Receive* group access your NDI output. If you remove "Public" from your *Output* groups, only systems listing your custom groups will see your NDI output. Similarly, from your *Receive* entries groups tells your local system to ignore channels that aren't supplied by a *Receive* groups. To add a custom group to either the *Receive* or *Output* tab, click the *New* button in the footer of the panel.

### Remote Sources

The *Remote Sources* tab is similar to *Receive*, in that its entries add sources to the list of those visible to NDI enabled applications on the local host. The difference is that that entries in the *Remote Sources* list do not identify NDI groups, but rather individual remote NDI and NDI|HX sources (including Panasonic cameras supporting NDI|HX). Remote sources are identified in this panel by their IP address, rather than their NDI device or channel name.

Note that sources listed in this panel can traverse subnets on the local network, and even connect across different networks when specific criteria are met. This may require your IT team to open specific ports for this traffic.

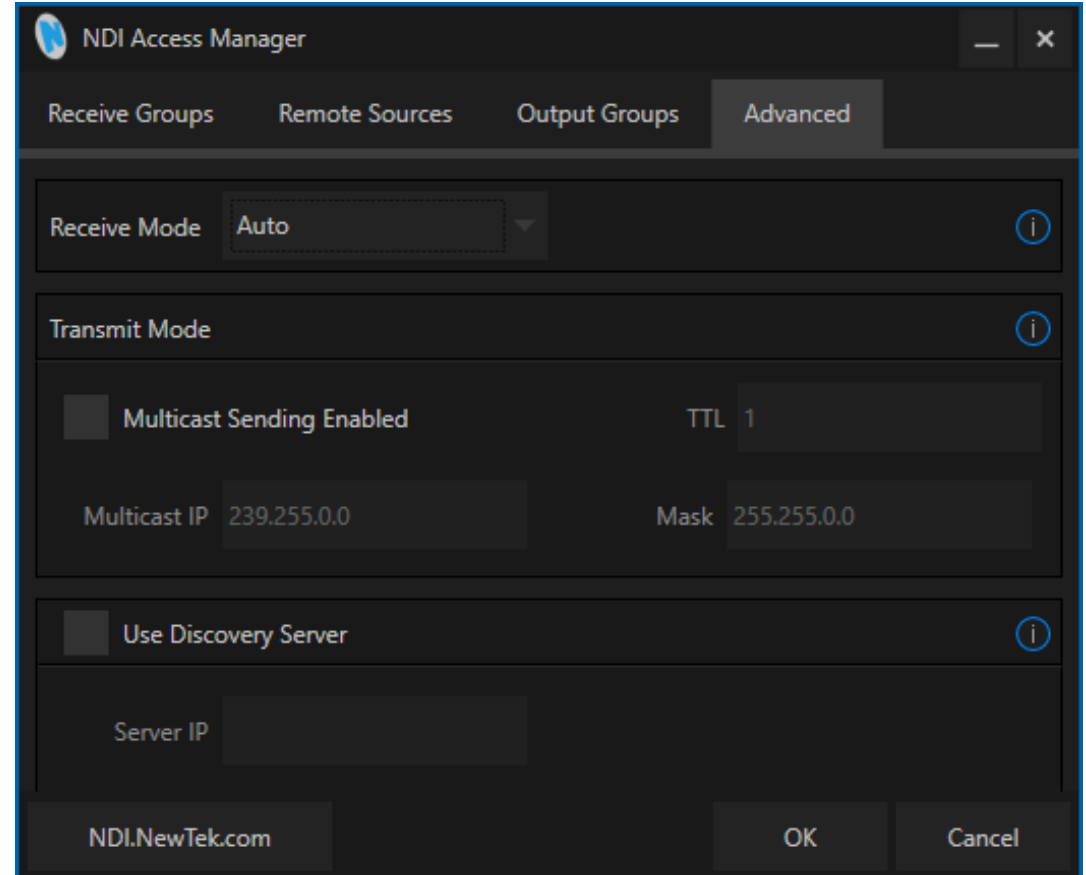
Since an IP Address can serve multiple NDI channels (e.g., *NDI Scan Converter* can supply 1 channel or many more), the channel count matters. When crossing network boundaries, you must ensure that – starting from port 5960 – enough network ports are available for the maximum supplied NDI sources *plus one*, for NDI server messaging. For example, adding an IP Address for a system supplying one NDI channel to the *Receive from IP* list means ports 5960 and 5961 must be available. A source serving eight NDI channels would need ports 5960 – 5968 to be free, etc.



## Advanced

NDI Access Manager's *Advanced* tab is home to features designed to delight Information Technology specialists, including the following:

- Receive mode options – This allows you to bias NDI protocol negotiations, and includes “Prefer UDP” and “Prefer Multi-TCP” options, in addition to the default (Auto).
- Multicast – on well-configured networks, this option can greatly reduce bandwidth demands (conversely, multicast can actually *cause* extremely heavy traffic in sub-optimal environments)
- Support for NDI discovery servers – leap over complex hurdles impeding NDI channel discovery in a single bound (details on implementing NDI discovery servers is available separately in the NDI SDK)



# Frequently Asked Questions

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It all seems too good to be true, doesn't it? No doubt you have many questions. We want to comment on a few of the more common ones here, in order that you can come to the conclusion that there's really nothing preventing you from trying NDI® out for yourself right away.

We're confident you'll be happy you did.

## IS IT COMPLICATED?

Nope. NDI is no harder to use than the worldwide web (maybe easier).

## WHAT IF OUR PIPELINE IS ALL SDI?

NDI is fully compatible with SDI and can easily be implemented alongside your existing infrastructure without disruption. You can augment and extend your existing systems without expensive investment or downtime.

## IS LATENCY AN ISSUE?

Forget about it. NDI transmission speed typically requires considerably less than one video frame.

## WHAT ARE THE SYSTEM REQUIREMENTS FOR CAPTURE?

On most Windows®-based systems with a gigabit network connection and reasonably fast hard drive (i.e., write speeds >20 Mb/Sec per HD NDI channel recorded), the NewTek NDI IsoCorder application can capture two different HD NDI channels to disk at once.

## WILL IT COST ME A FORTUNE?

NewTek NDI is available without cost. While a number of providers offer NDI-enabled products for sale (and more are on the way), a variety of NDI solutions with powerful capabilities are being offered to you without charge.

## WON'T ALL THAT VIDEO OVERLOAD MY NETWORK?

Only if you try really, really, hard. NDI's extremely efficient encoder supplies broadcast quality audio video that is shockingly 'small'. Data demands are from 50-100 Mbps per channel.

## WHAT ABOUT UHD?

Got it covered. NDI supports any and all resolutions, frame rates, audio sample rate and channel count, from HD to 4K and beyond.

## IS IT COMPATIBLE WITH SMPTE 2022, ETC.?

NewTek strongly believes in interoperability, and in making NDI work with other popular IP infrastructures wherever possible. For example, it is our goal for NDI enabled-applications to automatically support SMPTE 2022/6, too.

We expect to extend this standard-agnostic philosophy further, as hardware supporting other IP video transport methods advance from the planning phase to real world availability.

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