



Leo LaPorte - TWIT.TV @ SXSW 2011

## How to Stream Live Video

Easily reach your audience on any device

# Getting Started

People are always asking us at NewTek what's involved in streaming live video. And with good reason. Not long ago, only broadcasters and other professionals had the money, skill, equipment and infrastructure needed to create and distribute video content. And all that content showed up on a single device – your television set.

Today, anyone with a smartphone and a streaming account can stream content for free. Of course, that doesn't necessarily mean a video will capture and hold audience attention. The challenge is to create professional-looking video that makes an impact. And to do that your content has to have the polished look viewers are accustomed to seeing on network television, or they'll stop watching.

It's all now within reach. Even beginners can create sophisticated video content, because of recent advancements in video technology:

- Readily available and high-quality camera equipment.
- Services that can send your content across the Internet to any Web-connected device.
- Desktop streaming production systems, like NewTek TriCaster 40, that allow you to mix multiple camera and video feeds, create a complete television program and stream it live to the Web.

To produce a streaming program that you can confidently show to audiences anywhere, start by reading this article. It contains the basic tips you need to think through the production process, avoid most technical problems, maximize value to your target audience—and rival the clean look of a television network.

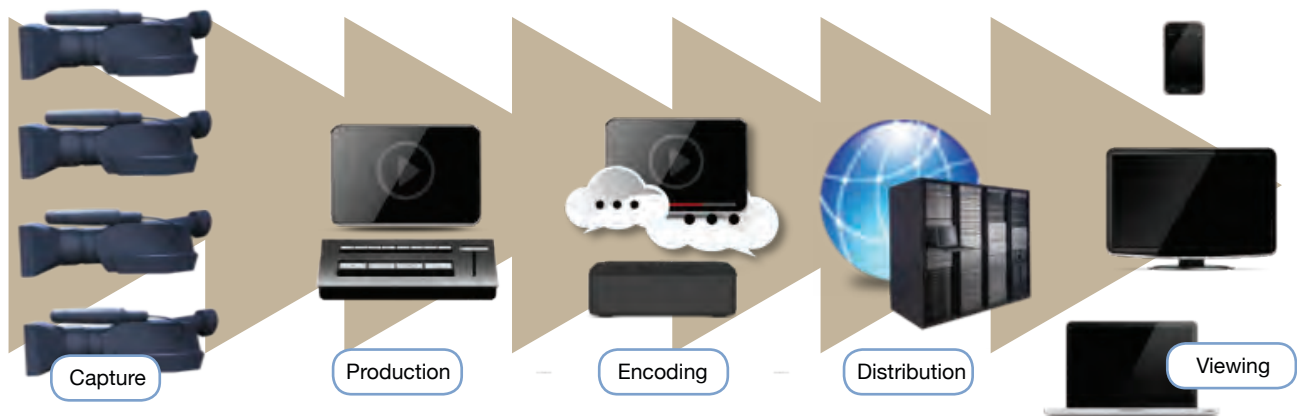
Let's start with an Overview and then look at each step more closely.

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# Process Overview: From Cameras to Consumers

All video content follows the same basic process to get from camera to consumer. Whether you use a smartphone and a free Ustream account or a 20-camera HD facility built for large productions, the five steps in creating your streaming Web program are the same: Capture, Production, Encoding, Distribution, and Viewing. Let's look at them one at a time.



## Capture

Capturing is using one or more cameras to record live action. The capture process doesn't include any enhancement to the footage. Instead, it simply transforms the images of the live action into a digital format that you can work with in real time.

## Production

Here's where you shape that live action into a polished product with the look and feel you want. It involves making shot selections and switching between cameras so your audience always sees the best angle. It may involve mixing video feeds from multiple cameras with prerecorded video or other media. You might add special effects, narration, still images and music. In production, you transform your camera angles and live action into a finished, polished video that will hold the attention of a video-savvy audience.

## Encoding

In order to deliver a stream over the Web, the finished output of your live event must be converted from a video signal into a file format that is easier to distribute. You will likely use a robust online server system in the form of a Content Delivery Network (CDN) or Streaming Service Provider (SSP).

# Distribution

Instead of the satellites, radio towers, and cable networks used to distribute broadcast content, video streams are transmitted over the Internet in formats that can be viewed on a wide variety of devices like computer screens, mobile phones, tablets, and set-top boxes.

# Viewing

Here's where you actually connect to your target audience. To optimize the viewing experience, you need your content to be accessible on whatever device each individual viewer chooses.

# Capture

## Cameras

First, let's dispel a HUGE myth. You don't need network TV cameras for web streaming. There are many camera choices to fit both your production needs and budget. It's simply a matter of considering the trade-offs you'll have to make balancing budget, picture quality, and maneuverability.

For example, with a larger camera, you may sacrifice access to small spaces and have greater difficulty being unobtrusive. Or, if you need the stability of a fixed camera, then you likely sacrifice quick movement and easy portability.

Camera Mount	Ideal For	Cost	Picture Quality	Avoid When
Static or Lipstick	Well-lit areas where the lighting and framing is fixed or predictable. Camera can be clipped to scenery	\$100s	Fair, due to small sensors and wide lenses	You need to be certain of lighting or framing
Consumer/Prosumer	Handheld use; events that require camera to follow action in frame	\$500-\$5000	Fair to Excellent	Production requires professional specs or industry-standard signal/connectivity
Robotic	Confined areas too small for a crew or productions with no crew.	From \$5000	Good	Budget can't accommodate costs of extra cabling and additional labor
ENG/Shoulder Mounted	When you need high quality pictures; action is dynamic and requires quick adjustments to framing, and exposure, budget can accommodate required crew	\$10,000 and up	Best	Budget is limited and access is tight

Table 1: Types of Cameras Common in Live Web Production

# Multi-camera Shoot

When trying to emulate the look and feel of a professional video, shooting with multiple cameras adds much more visual interest to your program. For programs shown in real time, mixing multiple camera angles enhances pacing, helps your audience better see what's happening, makes your content more compelling and helps to hold viewer interest.

Even for live events that are not streamed or aired until later, capturing and mixing multiple camera shots in real-time often increases production efficiency by reducing the time required to edit raw footage and eliminating the need to re-light and re-shoot the same activity at a different angle.

Getting everything you need on camera is a great start – but a lot more technology happens between shooting an event and live streaming it, to create content that actually engages an audience.

# Production

## Your Creative Mark

Production is the general term used for all the creative decisions, visual enhancements, and editing changes that go into polishing a program. People who make professional-looking video productions use an array of specialized video techniques to create a program with higher production value. Elements like transitions, titles, graphics, and pre-recorded video add professional quality and greatly improve the viewer experience compared to the home-video style commonly uploaded to consumer video-sharing sites.

To create a more professional look, you'll first need to consider the look you want to achieve and what type of equipment will help you accomplish your goals. Some of these decisions will naturally depend on your budget and level of expertise.

## Production Value

Once you've determined the style you want, you need to select the production techniques and tools to help achieve that style. For example, cutting from one camera angle to another is pretty basic and easy. But even in the most straightforward program, such as a company CEO addressing employees at a quarterly meeting, there are any number of visual changes you can make, as part of producing a live show, that will make it more compelling and memorable.

Technique	Value
Dissolves	Dissolving between camera shots softens a transition that might otherwise seem jarring. For example, moving from one location to what is obviously a very different one. Timing also makes a difference; a half second dissolve sets a different pace and mood from that of a 2-second dissolve.
Dramatic Transitions	Animating the transitions between different camera angles adds more dramatic visual variety and can support or complement the action.
Titles, Text, and Text Graphics	Inserting text titles gives viewers additional information like a person's name, location, or job title. On-screen text can show lyrics to a song being sung or a scoreboard. Using more sophisticated CG techniques you'll be able to insert an image "over the shoulder" of a presenter or incorporate a news, stock, or sports ticker.
Pre-recorded Video	Integrating pre-produced video played from digital media players during a production elevates production value. With a pre-produced package you're able to invest the time needed to perfect a related story, in a way that simply isn't possible in the midst of a live event.
Computer Displays	Tapping into a Skype interview, PowerPoint presentations or images from a wireless iPad add variety.
Virtual Backgrounds	Adding pre-produced graphical or moving backgrounds and virtual props (like a news desk) can transform a multi-purpose room into a broadcast studio.

Table 2: Production Technique Examples

Elements like these change a local-access quality program into a production equal to the appearance of a network program. They help you add information, make the viewing experience more engaging and to satisfy the sophisticated visual demands of your audience.

In the past, broadcasters and other professionals needed to purchase separate components to accomplish each step in the production process – video switcher, effects box, character generator, scan converter to display computer screens, chroma-key system, and virtual studio product. But technology innovations have advanced to the point that all these components can be integrated into one affordable, PC-sized unit with a common interface. With NewTek’s TriCaster 40, for example, achieving the visual quality of a network show during live production is not only feasible on a web production budget, but also easy to use, even with a volunteer crew of just one or two people.

## Output

The production output is commonly referred to as the “Program Out” feed. This feed includes all of the camera angles, video and audio sources, and graphic components that you’ve brought together. Essentially, it is the single, final video signal that you want your viewers to watch.

Ideally, the Program Output video signal from whatever system you’re using meets every industry standard necessary to broadcast over a television signal or project on an image magnification (IMAG) display. But if your target audience is viewing on a web-connected device, the signal also needs to be encoded to another resolution that will let your video look good over the internet.

# Encoding

## Achieving Your Goals

The choices you make when encoding content and selecting your distribution model are interrelated, and each has an impact on the three typical production goals of Professional Appearance, Audience Maximization, and Production Expenses:

Professional Appearance	<ul style="list-style-type: none"><li>• Picture and sound quality</li><li>• Smoothness of streaming</li><li>• Reliability of stream</li><li>• Transparency of encoding</li></ul>
Audience Maximization	<ul style="list-style-type: none"><li>• Different bandwidths for different users</li><li>• Different device types</li><li>• Repurpose/re-use</li></ul>
Production Expenses	<ul style="list-style-type: none"><li>• Cost of bandwidth (ISP charge)</li><li>• Cost of content distribution (CDN or SSP charges)</li></ul>

Table 3: Considerations for Stream Encoding



# Bit rates and Bandwidth

Professional Appearance is maximized when the picture looks great, the stream doesn't stall due to buffering, and the viewer isn't distracted by sudden changes in picture quality.

You can meet all these criteria for all your viewers by choosing multi bit-rate streaming. This is where your program is encoded at different bit rates, and the consumer's viewing device chooses the best stream for its bandwidth connection.

What bit rates should you use to ensure viewers can watch the stream? It depends on the uplink bandwidth available, and the network conditions that your viewers will experience. As a good rule of thumb, you should always assume approximately 20% of the bandwidth available is used up by non-content server communication. So target the remaining 80% for your video stream.

Next, consider different viewing conditions for viewers on mobile and fixed Internet connections. Many households with high-speed connections still only have DSL connections, so their downlink bandwidth will be limited to 512kb/s or 768kb/s. Applying the 20% rule above, this means they'll be best served by profiles at 400kb/s and 600 kb/s respectively.

Address mobile users with a second stream that keeps the resolution at or below that of smartphones, and offering a range of bitrates that serves users on slower 3G networks (video bandwidth limited to around 768 kb/s) as well as on WiFi in the office or home.

Be sure you consider viewers on all the devices they'll be using. Multi-bitrate streaming is widely recommended by technology manufacturers, service providers, and video streaming experts in order to achieve maximum device support.

## Device Choices

Probably your most important choice is what device to use as a stream encoder. There are three primary encoder types:

1. An external streaming appliance that sits outside your production gear and is connected to the program-out feed by a cable.
2. Third-party software that generates the video signal on your computer workstation or laptop.
3. An on-board encoder built in to your production workstation, as with the TriCaster 40.

Each has its own advantages and trade-offs:

Choice	Advantage	Trade-Offs
External encoding device	<ul style="list-style-type: none"><li>• Offers potential for purchase of gear with multi-format streaming.</li><li>• May offer more support for multiple bit-rates.</li></ul>	<ul style="list-style-type: none"><li>• Adds to physical setup time and space.</li><li>• Significantly higher system costs.</li><li>• Limited ability to affect program attributes (audio level, contrast, interlace) depending on encoder.</li></ul>
Third-party encoding software	<ul style="list-style-type: none"><li>• Can eliminate trade-offs required to use an external encoder, while preserving some advantages of on-board native encoder.</li></ul>	<ul style="list-style-type: none"><li>• Some of these only designed to work with one SSP.</li><li>• May cause computer performance conflicts.</li></ul>
Encoder built-in to production workstation	<ul style="list-style-type: none"><li>• Lower overall system cost</li><li>• Less complexity to setup, connect, manage.</li><li>• One-click streaming.</li><li>• Can be set up by the same person operating live production</li><li>• Automatically improves picture quality and compression.</li><li>• Only one interface to learn</li><li>• Ability to set different audio levels for stream vs. main output.</li><li>• Ability to adjust color, brightness and contrast of streamed video separate to main output.</li><li>• Presets to directly connect to CDNs/SSPs.</li></ul>	<ul style="list-style-type: none"><li>• Flash and Windows Media stream formats only.</li><li>• Only one program streamed at any one time.</li><li>• Multi-rate streaming limited to 2 streams.</li></ul>

Table 4: Encoding Choices



# Distribution

The choices for distributing content over a streaming channel involve a variety of trade-offs to consider and lead to another decision—whether to stream all the versions from where you’re producing the program, or to stream just one “master” version, from which your SSP can then create copies to target multiple different device types at multiple bit rates.

Choice	Advantage	Trade-Offs
Create multiple versions at your venue	<ul style="list-style-type: none"><li>• Closer control over encoding parameters.</li><li>• Ability to adjust parameters mid-stream at the source, if integrated.</li><li>• Only native signal is processed.</li></ul>	<ul style="list-style-type: none"><li>• If external encoders are used, significantly higher equipment costs.</li><li>• Uplink bandwidth is split among multiple streams. (a problem when bandwidth is limited).</li></ul>
Master to SSP	<ul style="list-style-type: none"><li>• Minimizes equipment at venue.</li><li>• Faster set-up time.</li><li>• Best use of limited uplink bandwidth.</li><li>• Potentially lower ISP costs because less uplink bandwidth is needed.</li><li>• Only pay for services actually used.</li></ul>	<ul style="list-style-type: none"><li>• Must talk to CDN or SSP to determine which device types they support.</li><li>• SSP needs to use already-compressed first stream to create second stream.</li></ul>

Table 5: Multi-bitrate, Multi-device Streams

## Streaming Choices

Although it is possible to arrange your own streaming infrastructure, it’s crucial to remember that you have a separate TCP/IP connection for each viewer. To reach a large or geographically distributed audience, you need a scale of server power that’s not practical for most content creators to maintain.

## CDNs

An easier option for those without an in-house technology infrastructure or expertise is to use a Content Delivery Network or CDN. With data centers around the world connected to the Internet backbone, and content mirrored across them, they can deliver your content quickly to consumers. Be aware that CDNs deliver many types of Internet traffic – not just video – so they’re not necessarily optimized for streaming services.

## SSPs

Streaming Service Providers or SSPs, however, are optimized for streaming video, and some even specialize in certain genres, such as music or sports. They often use CDNs themselves for actual delivery, but provide value-added services such as taking a single stream from your live venue and creating the multi-bitrate versions required to serve all your different viewer profiles.

Additionally, SSPs will let the content creator or rights holders choose among several options such as ad supported, subscriptions, and pay-per-view to turn content views into revenue.

# Dry Run

After you've made your streaming decisions, and when you really need to guarantee success, best practice requires doing a dry run of your production the day before going live. For events that draw big crowds, or in situations where other media producers will likely stress available bandwidth, be aware that ISPs hosting the event may become strained and you may not get the same performance out of them as during the dry run. For this reason, always plan enough time to reconfigure your streaming profiles and verify that they work well before the start of the event.

The best way to test the bandwidth from your ISP is to time the transfer of a very large file—one that mimics the load of your full-resolution video and audio signal. You could, for example, use a previously recorded program, rehearsal, or placeholder video with similar action. If budget permits, you may try to privately stream and view the test video on a password-protected channel, so you're confident in your streaming workflow and pre-set profiles.

# Viewing

The audience's ability to tune in is the most important component of a successful live stream. And today, audiences are watching on practically every device that has a screen. To make sure your program is effective on all viewing devices, by this point you've already done what you need to do. You've planned, enhanced, and considered each option along the way and even completed a dry run. Your program should stream smoothly, be viewable on any device, and have maximum production value to hold your audience's attention.

You'll want to keep your target audience in mind all along the way. Are they students, church members, high-school sports spectators, voters, or employees? What types of programs do they choose to watch? Public television talking-heads debates are different from live concerts, and viewers of each have an expectation for the pacing, sophistication, and visual effects that complement the experience. The more you know about your audience the more wisely you will be able to make production decisions that maximize their attention.

# It's All in Your Hands

Creating content and streaming it live over the Internet involve many considerations. But you should now have a better understanding of how to deliver content that is:

- Professional Quality – allowing viewers to concentrate on your content without being distracted by pixel breakup and buffering delays.
- Audience-maximized – making it viewable on the variety of devices used by your audience.
- Budget-friendly – using readily available, industry standard technology that adds value to your productions.

Technology now puts all three at your fingertips. With budget-friendly, desktop streaming production systems like TriCaster 40 that mix multiple camera and video feeds and incorporate all the necessary production components in one system, even people without extensive video expertise or piles of money can create a complete, professional-quality television program and stream it to all the devices their audiences demand.





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