Applied Research on NDI Technology in Mobile Video Reporting (Postprint)

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Abstract

The future trend of the video industry is the seamless and efficient transmission of video within IP space, a vision that will largely supersede the industry' s traditional baseband transmission paradigm. NDI' s flexible distributed access methodology eliminates the challenges associated with extensive cabling, thereby enabling greater and more convenient scalability of signal capacity. This paper examines the application of NDI technology in video reporting, with particular attention to its characteristics and engineering requirements.

Full Text

NDI Technology in Video Mobile Reporting Applications

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Abstract: The future trend of the video industry is the effortless and efficient transmission of video within IP space, a vision that will largely replace traditional baseband transmission models. NDI' s flexible distributed access approach eliminates the hassle of extensive cabling, enabling greater and more convenient expansion of signal capacity. This paper explores the application of NDI technology in video reporting, focusing on its characteristics and engineering requirements.

Keywords: NewTek; NDI; digital media; 4K; video mobile reporting

1. NDI Technology Overview

NDI is a royalty-free standard developed by NewTek to support real-time transmission of production-grade video over local area networks between video-compatible products. NDI enables multiple video systems to identify

and communicate with each other via IP, while simultaneously encoding, transmitting, and receiving numerous high-quality, low-latency, frame-accurate video and audio streams. NDI can operate bi-directionally on LANs through many video streams on shared connections. Its encoding algorithm is resolution and frame-rate independent, supporting 4K (and higher) video along with 16 channels (or more) of floating-point audio. Its superior performance on standard GigE networks enables the transformation of equipment into versatile IP video production pipelines without compromising existing SDI camera and infrastructure investments or requiring costly new high-speed network infrastructure.

Unlike traditional baseband signal transmission methods, digital media transmission technology operates on network architecture, connecting all elements within a simplified network infrastructure. IP streams serve as carriers for audio and video signals, leveraging advanced media processing capabilities of networking and computing technologies to achieve unrestricted distributed production that transcends traditional workflows. Software-driven digital media transmission production systems combine production methods with functionality, efficiency, and flexibility to create all types of digital media programs.

1.1 Network Layout

NDI video streams are extremely demanding data flows that immediately expose weaknesses in a network. Networks must reliably and synchronously support multiple video, audio, and data streams without interruption. When latency, packet loss, and jitter exceed the threshold where video is visibly affected, the video' s utility drops to zero. Understanding the complexities of video in IP data networks is therefore critical.

Networks designed for NDI video transmission should be considered video-primary. When designing networks, employ basic linear cascade structures rather than pyramid or tree arrangements to ensure video travels the fastest path between devices. Network topology and configuration must maximize available bandwidth. When selecting network switches, verify throughput capacity, and maintain sufficient bandwidth between switches to eliminate potential bottlenecks. It is preferable to use switches from the same manufacturer within the same subnet, or ideally the same model switches. This simplifies configuration and reduces the likelihood of compatibility and configuration issues. Ensure each port operates in full-duplex mode (bidirectional communication) with upstream and downstream data speeds of at least 1 Gbps per port.

1.2 Bandwidth

A single 1080i HD video NDI stream can generate data rates up to 100 Mbps per stream. A single UHDp60 4K video NDI stream can generate data rates up to 250 Mbps per stream. This extremely efficient data stream design features very low latency and allows multiple data streams to be stacked together on a

single Gigabit or 10-Gigabit network. Depending on the types and quantities of NDI video streams present simultaneously in a specific workflow, the production environment may require additional capacity.

1.3 Encoding/Decoding

NDI employs compression technology to enable transmission of multiple video streams across existing infrastructure. Supporting all resolutions, frame rates, and video streams, it is one of the most efficient codecs currently available, achieving better compression than many codecs already used in professional broadcasting. For typical video content, NDI codec peak signal-to-noise ratio (PSNR) exceeds 70 dB. NDI provides multi-generational stability, meaning once video signals are compressed, there is no further quality loss.

Latency is a factor present in both network connections and endpoint devices. NDI video streams have a technical latency of 16 video scan lines, but in practice, most implementation tools exhibit minimal latency. Hardware implementations can control complete end-to-end latency within 8 scan lines.

2. Simplified Video Transmission Production System

Based on NDI technology, ultra-low latency (50 ms) and high-quality video transmission (4K) can be achieved. This breaks the physical distance limitations on signal transmission and is suitable for building highly flexible, scalable multi-point workflows and distributed deployment projects. Software-driven digital media production systems significantly improve operational deployment flexibility and efficiency compared to hardware equipment, substantially reducing production costs.

2.1 Codec

The Magewell Pro Convert HDMI 4K Plus encoder and Pro Convert for NDI® to HDMI 4K decoder were applied for 4Kp60 audio-video signal encoding/decoding transmission between venues during the 2020 National Two Sessions press conference network video interaction. The encoder connects HDMI or 12G-SDI signals to output up to 8 audio channels. Each audio input features configurable audio delay settings to address external synchronization issues between input audio and video sources. The NDI video signal transmission solution can replace traditional SDI optical transceiver solutions, particularly for 4K video. Compared with traditional 12G-SDI optical transceivers, NDI encoders offer lightweight portability, convenient deployment, and POE power support, greatly reducing on-site cabling burdens. Local video sources are converted to NDI and output to the network for use by studios, program production equipment, or other NDI-compatible devices in the production pipeline.

2.2 Digital Media Production System

NewTek' s TriCaster 2 Elite simplifies all elements in the network infrastructure through NDI connectivity, enabling broadcast-grade production in distributed environments. It processes video and images at native resolution while maintaining signal quality throughout. Seamlessly integrating with traditional systems without requiring abandonment of existing equipment, TriCaster 2 Elite connects to existing network infrastructure and interconnects with compatible technologies through software and IP transmission. NDI-based workflows also enable coverage of any compatible systems, devices, and applications available on the network, exchanging between SDI and IP while solving interoperability issues between IP video standards, particularly NDI and SMPTE ST 2110, as well as streaming formats like SRT, RTSP, and RTMP.

2.2.1 4K Production All external inputs and main program mix outputs natively support 2160p video at frame rates up to 60 fps, enabling true 4K UHD production. Full-process 4K UHD video workflows are supported for switching, streaming, recording, and transmission, including file playback, graphic packaging, and mixed effects. Multiple 4K video streams can be transmitted to multiple locations simultaneously.

2.2.2 Signal Source Access The system simultaneously supports 32 external video inputs with compatible signal sources in any combination, with resolutions up to Ultra HD and frame rates up to 60 fps (2160p 59.94). Eight 3G/HD/SD-SDI interfaces support video inputs in any combination of standard formats, resolutions, and frame rates. All signal sources feature internal frame synchronizers to handle various video sources while eliminating signal timing issues. The Live Call Connect feature for teleconferencing supports integration of multiple video call inputs from Microsoft Skype, Microsoft Teams, Zoom Meetings, Slack, Discord, and Tencent Meeting.

2.2.3 Audio Processing An intuitive software-based audio mixer provides 16-channel audio passthrough, supporting comprehensive integration of system audio with external mixers. Each input source or output can output up to 8 audio channels. Configurable audio delay settings for each input address external synchronization issues between input audio and video sources.

2.2.4 Real-Time Streaming Push Two built-in streaming encoders can be configured to push real-time streaming video to the network, supporting multiple connection types, resolutions, and streaming providers. Simultaneous streaming recording is supported, including SRT streaming format. Users can utilize any number of preset default streaming providers including Facebook Live, Microsoft® Azure®, Periscope, Twitch, Ustream, YouTube™ Live, etc., or configure custom links and designate them as presets.

2.2.5 Recording Multiple NDI signal sources can be recorded, with ongoing recording projects present as signal sources in the live production system interface for quick and easy instant replay from each input. New recording features allow users to designate any channel for recording, including each input source, mixed effects, output signals, etc. Depending on the production environment, recorded program materials can be stored locally or uploaded to any network storage and workstation, greatly facilitating post-production staff and connecting pre-production and post-production channels. From main clip content for archive library purposes to unprocessed footage for post-production, additional production and program materials for on-demand use, and real-time footage for instant replay, all needs are covered.

2.3 Signal Processing Platform

NewTek NDI BOX enables signals to be sent and received across hundreds of compatible devices or systems. It can function as both input and output, supporting RTMP, RTSP, SRT, and HTTP streaming. Any audio-video files can be added for playback and converted to NDI signals, supporting multiple signal formats. NDIBOX can effectively convert camera SDI signals, subtitle machine SDI signals, video matrix SDI signals, and non-linear editing workstation SDI signals into NDI protocol IP signals, or convert IP signals within the network into SDI signals for acquisition and use by other video workstations on the network, solving traditional cabling hassles and enabling more efficient and rapid deployment. NDIBOX can also convert mobile terminal mirroring signals from devices such as iPads, iPhones, and Android phones into SDI video signals, offering extremely strong signal access flexibility.

3. Summary and Outlook

The IP-based video environment of the NDI protocol makes video mobile reporting more convenient.

Note: Figure translations are in progress. See original paper for figures.