STANDARDS AND INFORMATION DOCUMENTS

AES-R20-2021

STANDARDS

Standards Report - AES67 beyond the LAN

AUDIO ENGINEERING SOCIETY, INC.
132 East 43rd St., Suite 405, New York, NY 10017, US.

STANDARDS

The AES Standards Committee is the organization responsible for the standards program of the Audio Engineering Society. It publishes technical standards, information documents and technical reports. Working groups and task groups with a fully international membership are engaged in writing standards covering fields that include topics of specific relevance to professional audio. Membership of any AES standards working group is open to all individuals who are materially and directly affected by the documents that may be issued under the scope of that working group.

Complete information, including working group scopes and project status is available at http://www.aes.org/standards. Enquiries may be addressed to standards@aes.org

The AES Standards Committee is supported in part by those listed below who, as Standards Sustainers, make significant financial contribution to its operation.

Standards Sustainer Gold

NETFLIX

Focusrite

DOLBY

Standards Sustainer Silver

LECTROSONICS

21ST CENTURY FOX

Audio precision

WAVES

SHURE

fulcrum ACOUSTIC

ROSS LIVING LIVE!

Eventide

PreSonus

ADAMSON

THE TELOS ALLIANCE

SENNHEISER

MUSIC TRIBE

Standards Sustainer

NHK

NTi AUDIO

MQA

audio-technica

CLAIR

WEISS

LAWO

HEA

U SOUND

THAT Corporation

NBCUniversal

Control 4

WorldCast Systems

Fraunhofer IIS

PRO AUDIO TECHNOLOGY

AMERGING AUDIO FOR THE NETWORKING AGE

RAVENNA

steinberg

XPERI

HARMAN A SAMSUNG COMPANY

KLIPPEL

NEUTRIK

dbx-tv

This list is current as of 2020/7/30

AES Standards Report - AES67 beyond the LAN

Published by
Audio Engineering Society, Inc.

Abstract

AES67 has made low-latency, synchronized, and uncompressed audio delivery commonplace on local area networks (LANs). As the need to provide two-way interaction between multiple sites rises, there is a desire to extend AES67 solutions into Wide Area Networks (WAN) and datacenters. This report examines the requirements and challenges when AES67 is extended beyond LAN environments. After describing the operational environments and associated constraints in detail, this report will address timing, transport and data reliability in the context of WAN and cloud. The report shows that none of the discussed environments is associated with a specific single problem, but instead, there are a number of smaller technical factors that interact and need to be addressed. While this study indicates that bit-precise transmission, synchronization and timing alignment is reasonably achievable, very low latencies, use of multicast, and 100% reliable reception remain challenging or impossible. Field experience annexes included in this report correlate well with the theoretical expectations based on this study. Robustness of AES67 is confirmed by its success on WAN production facilities and long-distance deployments. It brings generally better audio quality, latency performance and routing flexibility, compared to point-to-point transport based on lossy compression.

Audio Engineering Society Inc. 132 East 43rd Street, New York, NY., 10017 US.
www.aes.org/standards standards@aes.org

2021-09-25 printing

Contents

Foreword

This foreword is not part of the *AES-R20 AES Standards Report - AES67 beyond the LAN*.

This document was developed in the SC-02-12-M task group on AES67 development under the leadership of Nicolas Sturmel.

The members of the writing group that developed this document in draft are: C. Becker-Foss, P. Brightwell, R. Bugg, O. Chambin, M. Danielson, N.N. Dong, J. Fletcher, J. Freyberger, M. Gilbert, J. Grant, K. Gross, W. Hatano, S. Heinzmann, E. Heurtel, A. Hildebrand, T. Holton, L. Howard, I. Kostiukevych, A, Kuzub, L. Lamarre, S. Langhans, S. Ledergeber, G. Linis, F. Poulin, A. Santos, S. Scott, G. Shay, M. Smaak, P. Stevens, P. Stoikoff, N. Sturmel, P. Treleaven, A. Vulic.

Morten Lave

Chair, working group SC-02-12

2021-09-16

Standards project report - AES67 beyond the LAN

0 Introduction

0.1 General

AES67 [1] has made low-latency, synchronized, and uncompressed audio delivery commonplace on local area networks (LANs). As the use of both the Internet and dedicated wide-area links to deliver content from remote sites increases and the need to provide two-way interaction between multiple sites rises, there is a desire to extend AES67 solutions into Wide Area Networks (WAN) and datacenters. This report examines the requirements and challenges when AES67 is extended beyond LAN environments.

While wide-area network capabilities continue to improve, there are still a number of constraints that make it challenging to transport AES67 across WANs. Geographical distance and the speed of light will add a delay of about 5 ms per 1000 km as data moves through fiber optic cables. Network topology and the number of hops will also add delay. The move to cloud-based applications and services presents new timing challenges that are not always obvious.

There have been a number of attempts to address these issues which have resulted in several alternative protocol solutions for audio over WAN. This report examines how users and manufacturers can extend AES67 beyond the LAN and in doing so, achieve a solution with familiar design rules and established performance. Although not originally designed for the WAN, it has been demonstrated that implementations based on AES67 can be successfully deployed across WANs, when proper care is taken over the entire path. Descriptions of some successful deployments are included in annexes attached to this report.

This report is a collection of recommendations to aid in proper device and system design from the start, and to achieve the best possible results under the existing conditions. Readers who are designing or managing multi-site systems and manufacturers who want to make their AES67 devices easier to use in a WAN environment, will find example solutions as well as references to further resources.

After describing the operational environments and associated constraints in detail, this report will address timing, transport and data reliability in the context of WAN and cloud. From this discussion a list of possible tools and techniques will be put in perspective against the different WAN situations, providing guidelines to the required steps towards the successful AES67 transmission over long distances.

This report is the result of a series of web conferences within the SC-02-12-M task group of the AESSC, started in 2020. It is based on the sharing of experience and observations of task group members reflecting real-world experiences.

0.2 Document Conventions

In this report, a Courier typeface may be used to identify computer code expressions to distinguish them from regular text.

Numerical values are decimal unless otherwise stated.

1. Scope

The target application for AES67 is audio streaming between devices interconnected via LAN and implemented on purpose-built or specially conditioned hardware and software platforms.

This report discusses possibilities to extend AES67 applications beyond dedicated platforms and LAN to more diverse environments, which may include the following elements:

- Wide area network (WAN) connections
- Data center (DC) infrastructure
- Virtual machines (VM)

Within the scope of this report, the aforementioned elements may be combined arbitrarily, to constitute AES67 solutions. For example:

- Purpose-built AES67 devices interconnected via WAN
- AES67 endpoint software running on private VMs, interconnected via LAN
- AES67 endpoint software running in data centers, interconnected via WAN

WAN, VMs, and DCs are often discussed together as the basis for cloud computing. WAN, VMs, and DCs represent specific sets of technologies and physical conditions, and as such, they can directly contribute to challenges for AES67. On the contrary, cloud computing is a framework concept representing a number of service models attached to an abstract global network. Although DCs providing cloud computing services typically are accessed using WAN connections, and cloud computing services themselves heavily rely on VMs, cloud computing in itself does not introduce additional technical difficulties compared to virtual machines and data centers owned by the end user, located in user's premises and accessed through a WAN connection. However, security policies imposed by third-party service providers could be generally more restrictive, compared to those implemented in DCs owned by the end user.

This report only considers media transport and synchronization aspects of operating AES67 implementations over WAN and in DC and VM environments. Other important aspects, which are outside the scope of this report, include audio processing and the related audio and control latency budget, which may have significant impact on the feasibility of performing such functionality in environments discussed here.

2. Definitions and abbreviations

For the purposes of this document, the following terms, definitions, and abbreviations apply.

2.1
Access Control List (ACL)
An access control list (ACL) contains rules that grant or deny access to certain digital environments. Filesystem ACLs filter access to files and/or directories. Networking ACLs filter access to the network.

2.2
Data center (DC)
A building, a dedicated space within a building, or a group of buildings used to house computer systems and associated components, such as telecommunications and storage systems.

2.3
Hypervisor
A hypervisor (or virtual machine monitor, VMM, virtualizer) is a kind of emulator; it is computer software, firmware or hardware that creates and runs virtual machines.

2.4
Local area network (LAN)
A local area network (LAN) is a computer network that interconnects computers within a limited area such as a residence, school, laboratory, university campus or office building.

2.5
Packet Delay Variation (PDV)
Difference in the one-way delay of received packets