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Audio and Video Standards for Internet Resources

FOREWORD

The National Aeronautics and Space Administration (NASA), was an early adopter of video on the Internet. Technology and public capabilities have grown and changed quickly over the years; it remains important for NASA to keep pace with the changes.

This standard has been developed by the NASA Web Video Working Group and is approved and published by NASA for use by NASA Headquarters, NASA Centers and their subsidiary locations as well as NASA contractors where applicable to NASA contractual agreements.

This standard provides a comprehensive guide for all audio and video resources produced by or for the agency, and also defines applicable requirements for accessibility as required by Federal law.

Requests for information, corrections, or additions to this standard should be submitted via “Feedback” in the NASA Technical Standards System at <https://standards.nasa.gov> .

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Audio and Video Standards for Internet Resources

1. Scope

1.1 Purpose

This standard establishes requirements and responsibilities related to NASA audio and video resources for Internet Protocol (IP) delivery. It contains requirements for audio and video codecs, bitrates and accessibility.

1.2 Applicability

1.2.1 Compliance with this standard is mandatory for all newly published NASA audio and video resources for Internet Protocol delivery, both internal and external. The individual NASA Centers are responsible for implementation and enforcement.

1.2.2 This NASA standard is applicable to all audio and video content created for use on NASA controlled websites.

1.2.3 Any decision to waive or vary from the requirements in this NASA-STD requires the concurrence of the NASA Web Video Working Group, Configuration Control Board.

1.2.4 Within this NASA standard, the word “shall” indicates a mandatory requirement, the word “should” indicates that a statement is strongly recommended for implementation but not required, and the word “may” indicates an optional implementation.

1.3 General Guidance

1.3.1 This document establishes at minimum, the necessary parameters for internet audio and video delivery and is intended to be the foundation for content delivered through current industry practices. Further consideration shall be given to include appropriate metadata as appropriate for the specific media type, or at minimum, compliant with the Dublin Core Metadata Element Set and [*NASA Standard 2822, Still and Motion Imagery Metadata Standard*](#). Due to the constant evolution of internet technologies these requirements are subject to change. These requirements shall apply to all NASA audio and video produced for the internet. All NASA Centers and facilities are responsible for keeping up to date with applicable Federal accessibility requirements.

2. Applicable and Reference Documents

2.1 Applicable and Reference Documents

The documents listed in this section are accessible via the World Wide Web, or directly from the Standards Developing Organizations (SDO) or other document distributors.

Federal Regulations:

- Rehabilitation Act of 1973 (29 U.S.C. 794d) as amended by the Workforce Investment Act of 1998 (P.L. 105 - 220), August 7, 1998.
<https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards>
 - -§ 1194.22 Web-based intranet and internet information and applications.
<https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards#22>
 - -§ 1194.24 Video and audio and video resources products.
<https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards - 24>
- Final Rule Updating the Information and Communications Technology (ICT) Standards and Guidelines
<https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-ict-refresh/final-rule/iii-major-issues-6>
- Federal Information Processing Standards (FIPS) 140-2 *Cryptographic Module Validation Program*
<https://csrc.nist.gov/Projects/Cryptographic-Module-Validation-Program/Standards>

NASA Publications:

- Electronic and Information Technology Accessibility
 - NASA Procedural Requirements NPR:2800.2 – Electronic and Information Technology Accessibility
https://nodis3.gsfc.nasa.gov/npg_img/N_PR_2800_0002_/N_PR_2800_0002_.pdf
 - Section 508 and Web Video White Paper
<https://sharepoint.msfc.nasa.gov/msfc/nieg/Shared%20Documents/Section%20508%20and%20Web%20Video.docx?Web=1>

Reference Documents:

- W3C HTML5
 - <https://dev.w3.org/html5/spec/Overview.html>
- Web Content Accessibility Guidelines (WCAG) 2.0
 - <https://www.w3.org/WAI/intro/wcag>
 - <https://www.w3.org/TR/WCAG20/>
- Dublin Core Metadata Element Set (ISO Standard 15836:2009)
 - <https://www.dublincore.org/specifications/dublin-core/dces/2010-10-11/>
- The Audio Description Project
 - <http://www.acb.org/adp/>

- Apple Corporation iOS Developer Library
 - [HTTP Live Streaming](https://developer.apple.com/documentation/http_live_streaming)
https://developer.apple.com/documentation/http_live_streaming
 - Podcasts Connect Help: Podcast best practices
https://help.apple.com/itc/podcasts_connect/#/itc2b3780e76

3. Acronyms and Definitions

3.1 Acronyms

AAC	Advanced Audio Codec
FIPS	Federal Information Processing Standard
HTML	Hypertext Markup Language
ISO	International Organization for Standardization
IEC	International Electrotechnical Commission
MPEG	Moving Picture Experts Group
VOD	Video on Demand
SDO	Standards Developing Organizations
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WHATWG	Web Hypertext Application Technology Working Group

3.2 Definitions

Advanced Audio Coding: A standardized, lossy compression and encoding scheme for digital audio. Designed to be the successor of the MP3 format, AAC generally achieves better sound quality than MP3 at similar bit rates. AAC has been standardized by ISO and IEC, as part of the MPEG-2 and MPEG-4 specifications.

Aspect ratio: Generally refers to the ratio between the width and height of an object.

Audio codec: There are two schemas for audio codecs; software and hardware. A software codec is a computer application that utilizes algorithms to either compress or decompress digital audio data according to a specific audio or streaming format. Compressing audio data reduces the bandwidth necessary to deliver the data over the internet and retain as much of the original file clarity as possible. A hardware codec is a device that converts analog audio into digital data or subsequently can convert a digital audio file to an analog format.

Audio Description: An additional narration track added to a video's soundtrack that vocally describes what is being seen in the video. Its intension is to aid visually impaired individuals when accessing video content.

Bitrate: Audio and video resources bitrate refers to the number of bits encoded/decoded per second necessary to produce/reproduce a continuous audio or video experience.

Codec: a device or software that enables compression and/or decompression of digital media

Closed Captioning: Allows individuals with hearing disabilities to access visual media by displaying the audio portion of a program textually on the screen. Closed Captioning can be turned on or off by the end user and is required by law to be included in all federally produced audio and video resources content.

Flash Media: Usually referred to simply as "Flash" this is a proprietary video format developed by Adobe Systems Inc. for encoding and delivery of audio and video resources over the internet.

Frame Size: Width and height of a frame measured in pixels.

Format: A particular way that information is encoded for storage in a computer file.

H.264: H.264/MPEG-4 Part 10 or AVC (Advanced Video Coding) is a standard for video compression, and is currently one of the most commonly used formats for the recording, compression, and distribution of high definition video. The final drafting work on the first version of the standard was completed in May 2003.

H.265/HEVC: The heir apparent to H.264's throne, H.265/MPEG-H Part 2, or High Efficiency Video Codec (HEVC) is about twice as efficient as H.264 at the same bandwidth, but takes about an order of magnitude more computing power to decode, and significantly more than that to encode.

HTML5: The next major revision of HTML (Hypertext Markup Language) currently under development by the Web Hypertext Application Technology Working Group (WHATWG) and the World Wide Web Consortium (W3C). It is a language for structuring and presenting content for the World Wide Web, a core technology of the Internet. Its core aims have been to improve the language with support for the latest audio and video resources while keeping it easily readable by humans and consistently understood by computers and devices (web browsers, parsers etc.).

International Electrotechnical Commission: The IEC is a non-profit, non-governmental international standards organization that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electrotechnology". The IEC charter embraces all electrotechnologies including energy production and distribution, electronics, magnetics and electromagnetics, electroacoustics, audio and video resources and telecommunication, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility (by its Advisory Committee on Electromagnetic Compatibility, ACEC), measurement and performance, dependability, design and development, safety and the environment.

Letterboxing: The practice of transferring film shot in a widescreen aspect ratio to standard-width video formats while preserving the film's original aspect ratio. The resulting videographic image has mattes (black bars) above and below it; these mattes are part of the image (i.e., of each frame of the video signal).

Live Webcast: A media file distributed live (rather than "on demand") over the Internet using streaming media technology to distribute a single content source to many simultaneous listeners/viewers

Lossy compression: A data encoding method which compresses data by discarding (losing) some of it. The procedure aims to minimize the amount of data that need to be held, handled, and/or transmitted by a computer.

Metadata: Metadata simply means "data about data". Metadata articulates a context for objects of interest. The modern "metadata" field that gave rise to Dublin Core and other recent standards emerged with the Web revolution of the mid-1990s. Metadata is particularly useful in video, where information about its contents is not directly understandable by a computer.

MP3: MP3 is an audio-specific format that was designed by the Moving Picture Experts Group as part of its MPEG-1 standard and later extended in MPEG-2 standard.

MPEG: Refers to the Moving Picture Experts Group, a working group of experts that was formed by ISO and IEC to set standards for audio and video compression and transmission.

MIME type: An Internet media type, originally called a MIME type after MIME (Multipurpose Internet Mail Extensions) used as a standard way of exchanging information over the Internet. Many e-mail clients now support MIME, which enables them to send and receive graphics, audio, and video files via the Internet mail system.

Audio and video resources: Media and content that uses a combination of different content forms

On-demand Webcast: Often synonymous with Video on Demand (VOD) that allows a viewer to watch a webcast anytime they want on their own schedule.

Pillarboxing: Occurs in widescreen video displays when black bars (mattes or masking) are placed on the sides of the image. It becomes necessary when film or video that was not originally designed for widescreen is shown on a widescreen display, or a narrower widescreen image is displayed within a wider aspect ratio, such as a 1.85:1 image in a 2.35:1 frame. The original material is shrunk and placed in the middle of the widescreen frame.

Podcast: A non-streamed webcast which broadcasts a series of digital media files (either audio or video) that are released episodically and often downloaded through web syndication. The word replaced webcast in common vernacular due to the fame of the iPod and its role in the rising popularity and innovation of web feeds.

Progressive Download: The transfer of digital media files from a server to a client, typically using the HTTP protocol when initiated from a computer. The consumer may begin playback of the media before the download is complete. A media player that is capable of progressive download playback relies on metadata located in the header of the file to be intact and a local buffer of the digital media file as it is downloaded from a web server. At the point in which a specified amount of data becomes available to the local playback device, the media will begin to play. This specified amount of buffer is embedded into the file by the producer of the content in the encoder settings and is reinforced by additional buffer settings imposed by the media player.

Streaming Video: Video that is constantly received by and presented to an end-user while being delivered by a streaming provider. The name refers to the delivery method of the medium rather than to the medium itself. The distinction is usually applied to video that is distributed over telecommunications networks, as most other delivery systems are either inherently streaming (e.g., radio, television) or inherently non-streaming (e.g., books, video cassettes, audio CDs). The verb 'to stream' is also derived from this term, meaning to deliver media in this manner. Internet television is a commonly streamed medium.

Video codec: There are two schemas for video codecs; software and hardware. A software codec is a computer application that utilizes algorithms to either compress or decompress digital video data according to a specific video or streaming format. Compressing video data reduces the bandwidth necessary to deliver the data over the Internet and maintain the clarity of the original file as much as possible. A hardware codec is a device that converts analog video into digital data or subsequently can convert a digital video file to an analog format.

VOD: Video On Demand (see On Demand Webcast)

W3C: The World Wide Web Consortium (W3C) is an international community that develops standards to ensure the long-term growth of the Web.

Windowboxing: The effect seen as a black border all around the video image. It occurs when the aspect ratio of the media is such that the in the display of film or video occurs letterbox effect and pillarbox effect occur simultaneously. Sometimes, by accident or design, a standard ratio image is presented in the central portion of a letterbox picture (or vice versa). It is also called the "postage stamp effect", "gutterboxing", or "matchboxing"

Wrapper: A container or wrapper format is a meta-file format whose specification describes how different data elements and metadata coexist in a computer file.

4. Audio

NASA has a wealth of new and historic recordings that are of great interest to our stakeholders and there is an increasing desire to make this content available online. This standard establishes the guidelines and criteria to meet this demand for audio streaming, podcasts and downloading. This standard supports the use of MPEG Audio Layer-III (MP3) and Advanced Audio Coding (AAC) where applicable. The MP3 audio codec was once the most widely used audio file format and is supported by all of the major media players. AAC is a newer, more efficient codec that is also widely supported. AAC is the audio codec of choice for our video standard. Either is acceptable for dissemination of audio content, with a preference given to AAC because of the higher efficiency.

4.1 MP3 Codec Usage

Publication of MP3 file-based audio, including podcasts, progressive download, or direct download files, shall conform to the ISO/IEC 13818-3:1995 standard and at a minimum use:

4.1.1 MPEG Audio Layer-3 (MP3)

4.1.2 Filename extension: .mp3

4.1.3 MIME type: audio/mpeg, audio/MPA, or audio/mpa-robust

4.1.4 Minimum recommended encoding bitrate: 64 kbps, 44 kHz, 16 bit stereo

4.1.5 Maximum recommended encoding bitrate: 320 kbps, 44 kHz, 16 bit stereo

4.2 AAC Codec Usage

Publication of AAC file-based audio, including podcasts, progressive download, or direct download files, shall conform to the ISO/IEC 13818-7:1997 standard (MPEG-2 Part 7) and at a minimum use:

4.2.1 MPEG-2 Advanced Audio Coding (AAC)

4.2.2 Filename extension: .MP4

4.2.3 MIME type: audio/x-aac video/mp4 .mp4 .m4a

4.2.4 Minimum recommended encoding bitrate: AAC-LC 128 kbps, 48 kHz, stereo

4.2.5 Maximum recommended encoding bitrate: AAC-LC 160 kbps, 48 kHz, stereo

5. Video

Video on the web is one of the most popular means of communication and has become the fastest growing media source. Not only is it engaging, it is easily accessible and a popular way to deliver an effective message. This standard establishes the guidelines for producers who shall use the following criteria by adopting the H.264 video codec and AAC audio codec for Video Podcasts, Live and On-demand Webcasts as well as Progressive downloading. The producer shall use the H.264 video codec at the highest frame/bitrate possible as established in figure 1 or at minimum retain the source attributes. The use of the Moving Picture Experts Group's (MPEG) MPEG-4 (.mp4) wrapper is preferred. The standard is not intended to limit the use of other codecs, but requires all new publications be available in the H.264 format.

The newer H.265 format is starting to gain some momentum, especially for extremely high-bitrate content such as UHD-TV video. However, even in this case having versions available in H.264 format is advisable.

5.1 Video Codec Usage

5.1.1 H.264 video codec H.264/MPEG-4 Part 10

5.1.3 AAC Audio codec ISO/IEC 14496

6. Content Delivery

Content delivery is the fundamental core of any web video solution. When developing such a solution, great consideration must be given to current technologies and protocols to ensure that the target audience has preeminent access with as few obstacles as possible. This standard groups delivery into four categories: Download and Progressive Download, On Demand Streaming, Live Streaming, and IPTV Delivery. All considerations for appropriate legal concerns, established and future NASA IT protocols, policies and security shall be adopted.

6.1 Download and Progressive Download

Whether an audio or video file is primarily intended to be downloaded for later use or played as it downloads, the end result is that the user has access to a copy of the file. **Files available to the end user shall, at a minimum, be available in the formats defined in this standard.**

6.1.1 Video shall use, at minimum, H.264 video codec with AAC audio codec

6.1.2 Audio only content shall use AAC or MP3 codec

6.1.3 Video files shall use the .MP4 wrapper (ISO/IEC 14496)

6.1.4 Captions shall be available in a format that supports synchronized playback compatible with the requirements above. A listing of methods, in order of preference, are:

- Embedded in the MP4 file using MPEG-4 Timed Text (MPEG-4 Part 17) or WebVTT (MPEG-4 Part 30). Embedding is preferred, since the captions will always be available if the file is copied or shared.
- A separate sidecar file, in WebVTT, MPEG-4 Timed Text, or SRT format. A best practice for sidecar files is that they have the same name as the video file, with the appropriate extension indicating the format (e.g. nasa-sample.mp4 file with nasa-sample.vtt as the accompanying WebVTT-format caption file).
- Open Captioned, either for all users, or as an equally-available alternative to an uncaptioned version.

Providing both sidecar and embedded captions for download is the ideal user case, since that allows both easy use of video and captions in various standalone players, which typically can use

the embedded captions, or share using via HTML 5 web sharing, which usually requires a sidecar.

6.2 On Demand

On-demand content is typically delivered through unicast streaming of files from a streaming server. However, in some cases the same effect can be achieved through progressive download with a custom player that prevents reuse of the resulting file.

6.2.1 Video shall use, at minimum, H.264 video codec with AAC audio codec

6.2.2 Audio-only content shall use AAC or MP3 codecs

6.2.3 Embedded web delivery of audio-only content shall support HTML 5 <audio> tag delivery

6.2.4 Embedded web delivery of video content shall support HTML 5 <video> and <caption> tag delivery

6.3 Live Streaming

Live streaming requires a live (or simulated live) audio or video stream, typically sent to a streaming server for distribution.

6.3.1 Video shall use, at minimum, H.264 video codec with AAC audio codec

6.3.2 Audio-only content shall use AAC or MP3 codecs

6.3.3 Embedded web delivery of audio-only content shall support HTML 5 <audio> tag delivery

6.3.4 Embedded web delivery of video content shall support HTML 5 <video> and <caption> tag delivery

6.4 Internet Protocol Television (IPTV)/Multicast Video Delivery

Multicast streaming of video content can be radically more efficient than multiple unicast streams of identical content, as long as the underlying networks support the necessary protocols.

NASA is in the process of moving to an agency-wide multicast zone structure on the NASA network, which will enable easy sharing of video content while limiting its dissemination to Center, Agency, or the world based on the address space chosen.

6.4.1 Video shall use H.264 video codec with AAC audio codec

6.4.2 Audio-only content shall use AAC or MP3 codecs

6.4.3 Content shall use multicast addressing as assigned by the NASA Office of the CIO's DNS, DHCP, and IP Address Management (**DDI**) group.

6.4.4 Content shall use MPEG2 Transport Stream (TS)

6.4.5 Encryption, when used, shall conform to FIPS 140-2 requirements. AES-128 or AES-256 are recommended for best compatibility.

6.5 Recommended Encoding Specifications

Due to the vast number of video devices, variants in bandwidth and different access protocols it has become necessary to consider the complete range of video available on the Internet.

6.4.1 It is recommended that the aspect ratio of the original source be maintained as much as possible. If necessary, the use of Letterboxing, Pillarboxing and Windowboxing are acceptable industry practices and may be freely used where applicable.

6.4.2 Specific encoder settings, including bitrates, vary by service and intended audience. See [NASA Streaming Best Practices Guide](#) for current recommendations.

7. Accessibility

Section 508 of the Rehabilitation Act was enacted to assure that all Federal employees and individuals from the public with disabilities have equal access to electronic information. There are no exemptions for audio and video resources and therefore every Federal Agency, as mandated by law, shall require that all electronic materials produced are compliant. All video content must be compliant per the “*Rehabilitation Act of 1973 (29 U.S.C. 794d) as amended by the Workforce Investment Act of 1998 (P.L. 105 - 220), August 7, 1998*” and NASA Procedural Requirements “*NPR:2800.2; Electronic and Information Technology Accessibility*”

7.1 Captioning

All Web-hosted videos must be captioned so their information is accessible. This standard makes no distinction between Open and Closed captioning, though greater emphasis is placed on the latter.

7.1.1 Application of the HTML5 <track> element may be utilized where appropriate for captioning

video for over-the-air broadcast, webcast and/or CD distribution

7.1.2 Compatible text tracks shall be enabled for downloadable MP4 videos.

7.1.3 Compliance is necessary for both internal and external audiences.

7.2 Video Description

Video description is a means of providing access for people who are visually impaired; a description of what is being shown, enabling them to appreciate and to share in the presentation as fully as a sighted person. There are three principle elements to be considered when incorporating video descriptions: What needs to be described to your audience, how best to describe the visual proceedings and how to prepare. Video producers must bear in mind that adding video descriptions to a video can force changes in the material itself. For example, a video clip may take longer to describe than the clip itself was planned to run in the video. Producers should consider whether adding video description may necessitate creating a second version of the video so users can get the full benefit of the description. Producers should also plan for incorporating video description at the beginning of their production process. Trying to add video descriptions to video already produced and digitized for the web is unnecessarily laborious and time consuming.

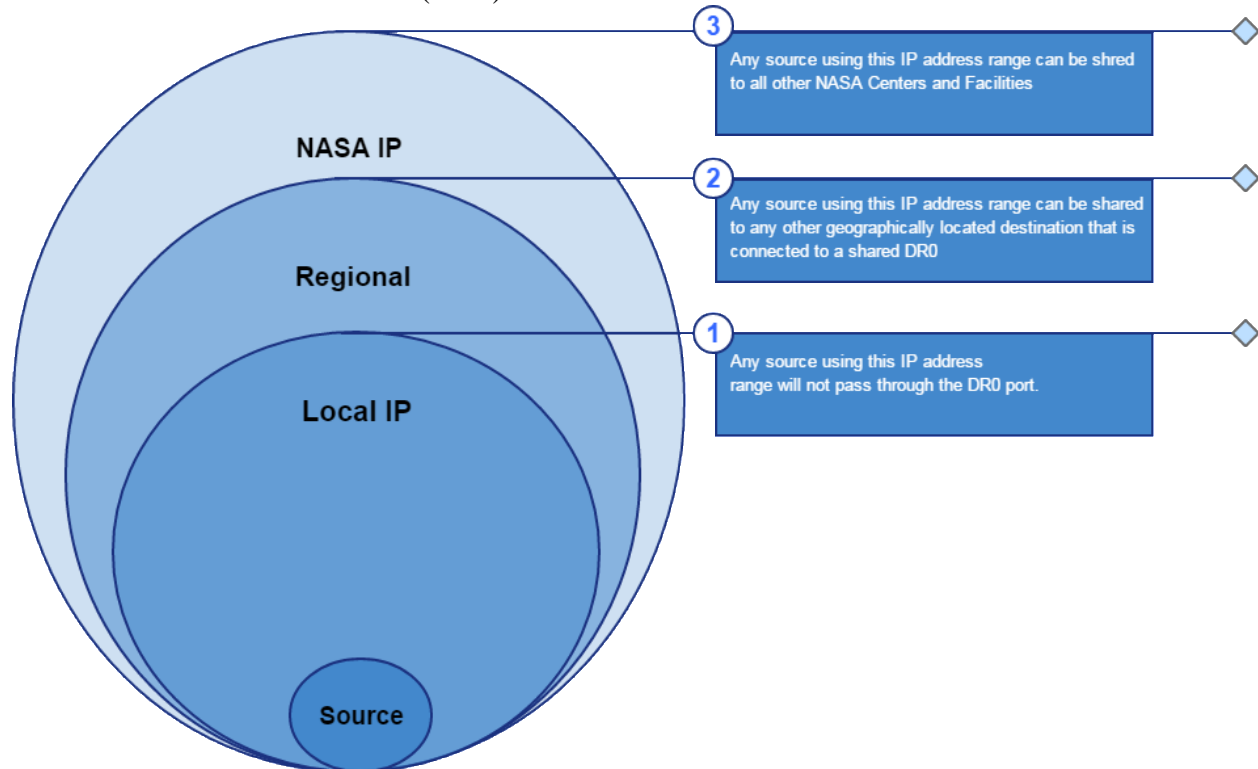
7.2.1 Compliance necessitates that all video content produced shall provide alternative media streams and/or to embed video description tracks into their media streams unless all pertinent video content is described in the primary soundtrack.

7.3 NASA Video on Third-Party Sites and Social Media Channels

Section 508 makes no distinction between video posted by the government or a contractor to other sites.

APPENDIX: NASA Multicast Addressing for Video

NASA's target architecture for multicast management is to go to one large zone for the whole agency. Specifically for video, each Center has been assigned blocks of addresses in the "non-routable" multicast space, with a block for Local, Regional, and NASA-wide delivery. For content allowed to propagate outside of the NASA network, Center's may use GLOP space associated with their Autonomous System number (AS). For more information, or to request one or more multicast addresses from your Center's range, contact the DNS, DHCP, and IP Address Management (DDI) group of NASA's Office of the Chief Information Officer, in the Communication Service Office (CSO).



Requests can be made through the ESD Service Request system.

IPTV Center Multicast Designations			
Center	Local IP	Regional IP	NASA IP
ARC	239.0.1.0/24	239.192.1.0/24	239.1.0.0/24
MSFC	239.0.2.0/24	239.192.2.0/24	239.2.0.0/24
GSFC	239.0.3.0/24	239.192.3.0/24	239.3.0.0/24
JPL	239.0.4.0/24	239.192.4.0/24	239.4.0.0/24
VAFB	239.0.5.0/24	239.192.5.0/24	239.5.0.0/24
DFRC	239.0.6.0/24	239.192.6.0/24	239.6.0.0/24
WSC	239.0.7.0/24	239.192.7.0/24	239.7.0.0/24
WSTF	239.0.8.0/24	239.192.8.0/24	239.8.0.0/24
JSC	239.0.9.0/24	239.192.9.0/24	239.9.0.0/24
SSC	239.0.10.0/24	239.192.10.0/24	239.10.0.0/24
GRC	239.0.11.0/24	239.192.11.0/24	239.11.0.0/24
KSC	239.0.12.0/24	239.192.12.0/24	239.12.0.0/24
IVVF	239.0.13.0/24	239.192.13.0/24	239.13.0.0/24
HQ	239.0.14.0/24	239.192.14.0/24	239.14.0.0/24
LaRC	239.0.15.0/24	239.192.15.0/24	239.15.0.0/24
MAF	239.0.16.0/24	239.192.16.0/24	239.16.0.0/24
WFF	239.0.17.0/24	239.192.17.0/24	239.17.0.0/24
NSSC	239.0.19.0/24	239.192.19.0/24	239.19.0.0/24