

3 File Management, Transfer Protocols, and Physical Connections

The transfer of program content can take place either as a continuous stream (as with existing analog playout) or in the form of a discontinuous file transfer in packetized form.

The transfer requires a number of operations, including the identification of the file or stream to be transferred, the destination for the transfer, establishment of a connection and the control of the transfer. In addition, file transfers require a logical connection, the identification of the file at its destination and notification to the user of the completion of the transfer.

These operations involve file management, transfer protocols and physical interfaces, and apply to both local-area and wide-area networks.

3.1 File Management and File Systems

It is necessary to specify components on which content management or other applications may be built. File systems for audio/video servers are similar in concept to normal computer file systems but they do have some unusual requirements in terms of file size, real-time access and reliability. Although some of these issues have been addressed in large-scale and real-time systems, the facilities are not available on a wide range of broadcast products. The primary requirement is to have a consistent feature set between broadcast file systems.

3.2 File System Attribute Requirements

The file system should support a hierarchical name space and have consistent file name syntax and semantics. The path and file naming must permit at least 256 characters.

The file system should support a read/write permission access mechanism, based on usernames, passwords and user groups. The chosen mechanism should also support default parameters for users that do not require access control. See Annex D section 3 for further details.

3.3 File System Commands

Commands are required in order to manipulate files and navigate the directory system. The local machine (the one the user is connected to) must respond to these commands. If remote machine access is provided then these same commands must be implemented on the remote machine.

The set of commands must at least permit:

listing of the contents of the current directory name space and sub-tree name space;

- display of the files and directory properties;
- copying, renaming and deletion of files;

- creation, rename and removal of directories.

3.4 Digital Data Transfers

At least two distinguishable types of data transfer are required:

- File Transfer. The File is any data wrapped with a known cover. See Annex D on Wrappers and Metadata.
- Streaming of raw data from a serving device to one or more receivers.

The two main methods to be supported are:

- Guaranteed-delivery "File Transfer".
- Bounded-quality streaming transfer. Data may be streamed from a serving device at user-selectable payload rates for real-time or slower/faster than real-time.

Note: The term "Bounded quality" is used for a transfer method that is designed to move the payload from source to destination(s) but without the absolute certainty of true guaranteed delivery. Traditional analogue video is moved with bounded quality in a "content playback" method today. Also, payload data that is moved over the ITU-R Rec. BT.656 serial digital interface is moved in a bounded-quality way. Usually, bounded-quality links are used to transport streamed, real-time content. On the other hand, "guaranteed delivery" indicates that the entire payload will reach the destination without bit errors, barring a failure of the physical link.

3.5 Transport mechanisms

The transport mechanism is used to build the link between the data to be transported (i.e. the file format) and the physical layer. Specifications are required on the following transport mechanism functions (for details see Annex E):

- **Transfer modes:**
In a mainstream television production environment three types of time relationship between the source data-clock and the received data-clock of a signal are necessary: synchronous, isochronous and asynchronous transmission in both bounded and guaranteed quality transmission.
- **Synchronization of associated data:**
The bonding of audio and video to certain types of metadata has been identified as a vital issue and requires further investigation.
- **Transfer initiation and transfer phase parameters:**
During the initiation or pre-roll phase of a transfer (independent from the transfer modes) certain parameters such as set-up-time of a process and the response time for a process need to be defined.

- **Quality of service (QoS) for the transfer:**
Once the a transfer has commenced, a defined transmission quality must be guaranteed. QoS-parameters for controlling such a transmission are: bit-rate, delay, Bit-Error-Rate (BER) and jitter.
- **Transfer interaction management and error reporting:**
The transfer interaction management such as establishment, maintenance and release of the data link, error and flow control usually runs in the background of the system and is not visible to the user. However all of these functions need to be specified to achieve interoperability and the system must report to the user non-recoverable exceptions and distortions if specified limits are exceeded.
- **Basic interworking protocols:**
Two families of transport mechanisms have been identified for the intra-studio transfer mechanism: transport mechanisms based on the serial digital interface (ITU-R BT.656) and network-based transport mechanisms. These need to fully specified.

- For data transfer via the serial digital interface (ITU-R BT.656) in packetized form, users require a single open transport mechanism. A standard for such a transport mechanism is currently under development in SMPTE and EBU.
- For transport mechanisms based on networks, users require at least one open standardized baseline protocol such as, for example, FTP/ IP. However these protocols have not been developed to meet the mainstream television production requirements and optimized protocols which better meet the user requirements defined above need to be developed and standardized.

Interworking between the serial digital and network based transport mechanisms is a strong user requirement and open, standardized gateways need to be defined.

3.6 Physical and Link Layer Considerations

The choice of physical and link layer implementations are restricted by the choice of network, and this choice is itself dependent on system and application requirements such as the required QoS and bit rate.

Network interfaces must be chosen from the existing industry-standard interfaces. At the present time these are considered to be:

- IEEE 802 Ethernet (see Note 1)
- Fibre Channel ANSI X3230-1994 and related standards (see Note 1)
- ATM (see Note 1)
- IEEE 1394 (see Note 1)
- SMPTE [XXX] (the SMPTE Serial Data Transport compatible with SMPTE 259M)

Note 1: Not all classes of service, particularly real-time full bit-rate video transfers, are available at the present time

It is desirable that equipment network interfaces be available in a variety of forms to suit the industry-standard networks listed above and that an equipment interface be capable of upgrading to take advantage of higher network bandwidths as these become available.

Gateways between the different interface implementations are required (e.g. between Fibre Channel and ATM) to enable networks to be interconnected and for local area networks to be connected to those serving the wider area. This report is currently limited in scope to operation within a local area network environment; the wide area network context requires further study.

3.7 High Level Management Functions

These are functions or principles which must permeate all parts of the system and be extended or contracted in their reach automatically or semi-automatically when the physical extent of the system is expanded or contracted. They must provide::

- **Data security:** backup/archiving must provide opportunity for restoration when any content element is lost or corrupted
- **Data shadowing:** redundant copy of data being accessed must allow real-time hot-switching to redundant copy in event of sudden non-availability of main copy
- **Automatic Backup:** must run in the background and not require human vigilance nor affect functionality or security of foreground operations
- **Localized recovery from local failure:** recovery must not affect remainder of system (e.g. Ctl-Alt-Del is not an option for the ABC network)
- **Robust operation:** no concentrations of failure points; extent of system failure caused by failure of a system element must be proportional to the fraction of the system represented by the failed element - there must be no propagation or escalation effect (e.g. no centralized bandwidth allocation manager or domain name server); this applies equally to hardware and to software elements.
- **Failure condition notification:** must trigger automatic system notification and logging of onset and end of failure (e.g. assist in localization of failed element, even across heterogeneous operating systems)
- **Distributed Resource Management:** automatic calculation and provisioning of system resources needed for transfers, across physically-separated but logically-bound system entities (e.g. file size notification & comparison with remote free storage capacity)
- **Dynamic resource detection (e.g. hot plugging):** user must

be able to add or remove system resources without rebooting entire system; when added, new resources must be fully functional and system must be fully aware of their presence (vice versa when removed) - e.g. switching a VTR in and out of a Remote

- Multi-operating system support: file names, properties, etc., must be interchangeable between different operating systems

3.8 Further work

To satisfy the requirement for interoperability between systems from different vendors, a number of open standards need to be defined:

- File formats for content transfer (see also Annex D)
- Link protocols for guaranteed and bounded-quality transfer over LAN and WAN applications

- Flow control
- Error control
- Networks and interfaces
- Payload and mapping documents (e.g. the mapping of content blocks into the packets of a transport mechanism)
- Gateways between networks, LAN and WAN and SDI-based transport mechanism
- Machine control interfaces (Note1)
- Platform independent file system management interfaces
- Timecode-based scheduling for file system actions such as browsing

Note 1: Machine control commands need to be openly defined: a central, external control system must be able to control all system elements without the need for multiple customized drivers or command translators; (e.g. would support ES-LAN Server dialect)