CHAPTER 1

Networked Media in an IT Environment

CONTENTS

1.0 INTRODUCTION

Among his many great accomplishments, Sir Isaac Newton discovered three fundamental laws of physics. Law number one is often called the *law of inertia* and is stated as *Every object in a state of uniform motion remains in that state unless an external force is applied to it.*

By analogy, this law may be applied to the recent state of A/V system technology. The traditional methods *(state of uniform motion)* of moving video [serial digital interface (SDI), composite…] and storing video (tape, VTRs) assets are accepted and comfortable to the engineering and production staff, fit existing workflows, and are proven to work. Some facility managers feel, "If it's not broken don't fix it." Ah, but the second part of the law states "… *unless an external force is applied to it."* So, what force is moving A/V systems today into a new direction—the direction of networked media? Well, it is the force of information technology (IT)[1] and all that is associated with it. Is this a benign force? Will its muscle be beneficial for the broadcast and professional A/V production businesses? What are the advantages and trade-offs of this new direction? These issues and many more are investigated in the course of this book. First, what is networked media?

1.1 WHAT IS NETWORKED MEDIA?

The term *network* in the context of our discussions is limited to a system of digital interconnections that communicate, move, or transfer information. This primarily includes traditional IT-based LAN (Ethernet in all forms), WAN (Telco-provided links), and Fibre Channel network technologies. Some secondary linkages such as IEEE-1394, USB, and SCSI are used for very short haul connectivity. The secondary links have limited geographical reach and are not as fully routable and extensible as the primary links.

In contrast to traditional A/V equipment,[2] networked media relies on technology and components supplied by IT equipment vendors to move, store, and manipulate A/V assets. With all respect to the stalwart SDI router, it is woefully lacking in terms of true networkability. Only by Herculean feats can SDI links be networked in similar ways to what Ethernet and Internet Protocol (IP) routing can offer.

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[1] IT storage and networking concepts are used universally in business systems worldwide. See the Introduction for background on IT.

[2] If you are not familiar with traditional A/V techniques, consider reviewing Chapter 11 for a general overview.

The following fundamental methods and concepts are examples of networked media.

- Direct-to-storage media ingest, edit, playout, process, and so on
- 100 percent reliable file transfer methods
- A/V streaming over IT networks
- Media/data routing and distribution using Ethernet LAN connectivity, Fibre Channel, WAN, and other links with appropriate switching
- Networkable A/V components (media clients): ingest ports, edit stations, data servers, caches, playout ports, proxy stations, controllers, A/V process stations, and so on
- A/V-as-data archive; not traditional videotape archive

For the most part, file-based technology and workflows (so-called tapeless) use networked media techniques. So, file-based technology is implemented using elements of AV + IT systems and is contrasted to stream-based throughout this book. Also, the AV/IT systems domain is a superset of the file-based concepts domain. Figure 1.1 illustrates the relationships between the various actors in the AV/IT systems domain.

The world of networked media spans from a simple home video network to large broadcast and postproduction facilities. There are countless applications of the concepts in the list just given, and many are described in the course of the book. We will concentrate on the subset that is the realm of the professional/enterprise (and prosumer) media producer/creator. Figure 1.2 illustrates the domain of the general professional video system, whether digital or not.

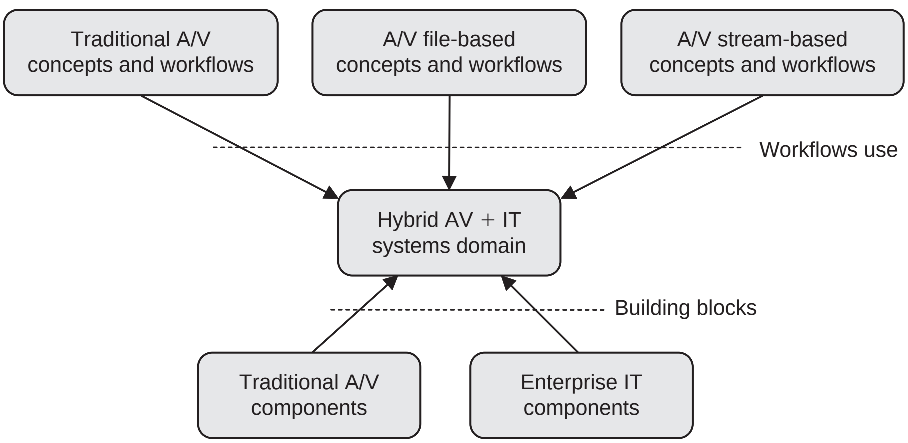

FIGURE 1.1 *Professional video system components.*

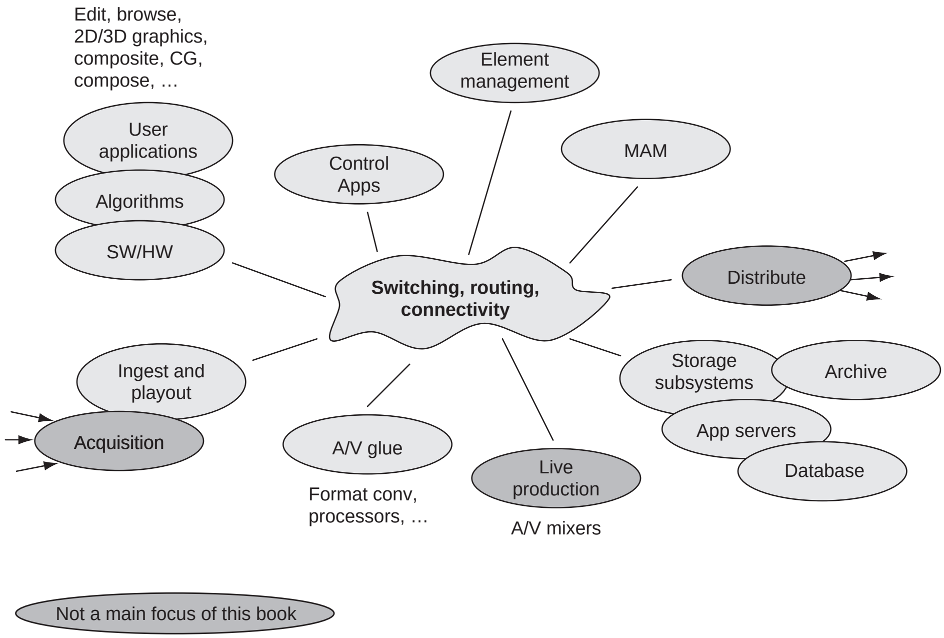

FIGURE 1.2 *Switching, routing, connectivity.*

The components are connected via the routing domain to create an unlimited variety of systems to perform almost any desired workflow. Examples of these systems include the following:

1. Analog based (analog tape + A/V processing + analog connectivity)
2. Digitally based (digital tape + A/V processing + digital connectivity)
3. Networked based (data servers + A/V processing + networked connectivity)
4. Hybrid combinations of all the above

The distinction between digitally based and networked based may seem inconsequential, as networks are digital in nature. Think of it this way: all networks are digital, but not all digital interconnectivity is net-workable. The ubiquitous SDI link is certainly digital, but it is not easily networkable. Over the course of discussions, our focus highlights item #3 as primary, with the others taking on supporting roles. Items #1 and #2 are defined for our discussions as "traditional A/V" compared to item #3, which is referred to as "AV/IT or IT-based AV" throughout this book.

Again, looking at Figure 1.1, most of the components may be combined in various ways to make up an IT-based professional video system. However, three elements have extended applications beyond our consideration. The world of media acquisition and distribution is enormous and will not be considered in all its glory. Also, media distribution methods using terrestrial RF broadcast, cable TV networks, the Web, and satellite are beyond our scope. Additionally, live (sporting events, news, etc.) production methods (field cameras, vision mixers) fall into a gray area in terms of the application of IT. However, most new field cameras don't use videotape; instead, they use use file-based optical disc or flash memory for storage. These offer nonlinear access and network ports.

1.2 MOTIVATION TOWARD NETWORKED MEDIA

Over the past few years, there has been a gradual increase in new A/V products that steal pages from the playbook of IT methods. Figure 1.3 shows the changing nature of video systems. At the core are untimed, asynchronous IT networks, data servers, and storage subsystems. At the edges are traditional timed (in the horizontal and vertical raster-scanning sense) A/V circuits and links that interface to the core. The core is expanding rapidly and consuming many of the functionalities that were once performed solely by A/V-specific devices. This picture likely raises many questions in your mind. How can not-designed-for-video equipment replace carefully designed video gear? How far can this trend continue before all notion of timed video has disappeared? What is fueling the expansion? Will the trend reverse itself after poor experiences have accumulated? Our discussions will answer these questions.

There is no single motivational force responsible for the shift to IT media. There are at least two levels of motivational factors: business related and technology related. At the business level there is what may be called the prime directive. Simply put, owners and managers of video and broadcast facilities are demanding, "*I want more and better but with less*." That is a tall order, but this directive is driving many purchasing decisions every day. More what? More compelling content, more distribution channels, more throughput. Better what? Better quality (HD, for example), more compelling imagery, better production

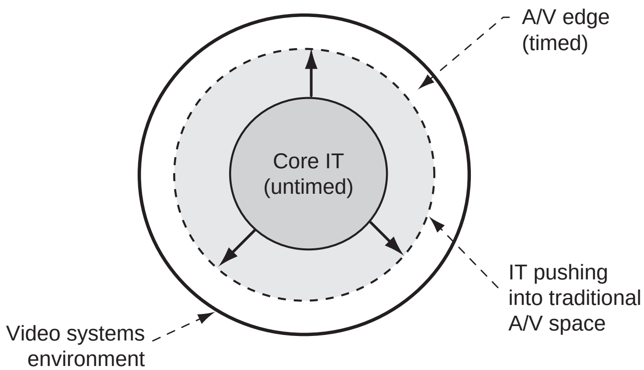

FIGURE 1.3 *The expansion of the IT universe into A/V space.*

value, better branding. Less what? Less capital spending, less ongoing operational cost, fewer maintenance headaches. All these combine to create value and the real business driver—more profit. Of course, there are many aspects to more/better/less, but let us focus our attention on the technical side of the operations. If we want to achieve more/better/less, the technology selection is key. The following sections examine this aspect.

Of course, there are issues with the transition to the AV/IT environment from the comfortable world of traditional A/V video. All is not peaches and cream. The so-called move to IT has lots of baggage. The following sections focus on the positive workflow-related benefits of the move to IT. However, in Chapter 10, several case studies examine real-world examples of those who took the bold step to create hybrid IT and A/V environments. In that chapter you will feel the pains and joys of the implementers on the bleeding edge. In that consideration we examine the cultural, organizational, operational, and technical implications of the move to IT.

At least eight *technical* forces are combining to create a resulting vector that is moving media systems in the direction of IT. Let us call the area enclosed by the boundary contour of Figure 1.4 the *system IQ*. This metric is synthetic, but consider the area (bigger is better) as a measure of a system's "goodness" to meet or exceed a user's requirements. Each of the eight axes is labeled with one of the forces. Let us devote some time to each force and add insight into their individual significance. Also, for each force, a measure of workflow improvement

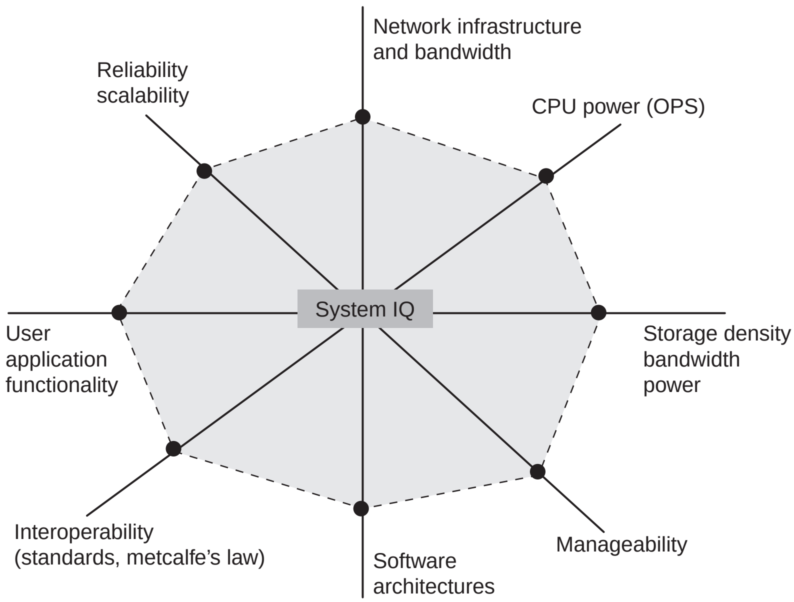

FIGURE 1.4 *Eight forces enabling the new AV/IT infrastructure.*

due to the force is described. After all, without an improvement in cost savings, quality, production value, resource utilization, or process delay, a force would be rather feeble. Although the forces are numbered, this is not meant to imply a priority to their importance.

1.2.1 Force #1: Network Infrastructure and Bandwidth

The glue of any IT system is its routing and connectivity network. The faster and wider the interconnectivity, the more access any node has to another node. But of what benefit is this to a media producer? What are the workflow improvements? Networks break the barrier of geography and allow for distributed workflows that are impossible using legacy A/V equipment. For example, imagine a joint production project with collaborating editors in Tokyo, New York City, and London (or among different editors in a campus environment). Over a WAN they can share a common pool of A/V content, access the same archive, and creatively develop a project using a coordinated workflow management system. File transfer is also enabled by LANs and WANs. Does file transfer improve workflow efficiency? Consider the following steps for a typical videotape-based copy and transfer cycle:

1. Create a tape dub of material—delay and cost.
   a. Check quality of dub—delay and cost.
   b. Separately package any closed caption files, audio descriptive narration files (SAP channel), and ratings information.
2. Deliver to recipient using land-based courier—delay and cost.
3. Receive package, log it, and distribute to end user—delay mainly.
   a. Integrate the closed caption and descriptive notation ready for playout.

THE PERFECT VIDEO SYSTEM

Snapshot

The late itinerant Hungarian mathematician Paul Erdos developed the idea of "The Book of Mathematical Proofs" written by God. In his spare time, God filled it with perfect mathematical proofs. For every imaginable mathematical problem or puzzle that one can posit, the book contains a correspondingly elegant and beautifully simple proof that cannot be improved upon. Erdos imagined that all the proofs developed by mere mortal mathematicians could only hope to equal those in the "Book." We too can imagine a similar book filled with perfectly ideal video systems designed to match all the requirements of their users. Of the many architectural choices, of the many equipment preferences, and of the many design decisions, our book would contain a video system that could not be improved upon for a given set of user workflow requirements. True, such a book is a dream. However, many of the principles discussed in these chapters would make up the fabric and backbone of our book.

4. Ingest into archive or video server system (and enter any metadata)—delay and cost.
   a. QA ingested material—delay and cost.

5. Archive videotape—cost to manage and store it, format obsolescence worries.

It is obvious that the steps are prone to error, are costly, and add delay. Let us look at the corresponding file transfer workflow:

1. Locate target file(s) to transfer.
2. Initiate and transfer file(s) to end station—minimum delay for transfer (seconds to hours, depending on desired transfer speed).

Additionally, file-associated metadata are included in the transfer, thereby eliminating another cause or error—manual metadata logging. The transferred file integrity is 100 percent guaranteed accurate.

What are the advantages? No QA process steps—or very short ones—delay cut from days to minutes and guaranteed delivery (not lost or stuck in shipment) to the end user. All in all, file transfer improves the workflow of making a copy and distribution of a program in meaningful ways. The walls of the traditional video facility are crumbling, and the new virtual facility is an anywhere-anytime operation. So what are the technology trends for LANs and WANs?

Not all that long ago, Ethernet seemed stuck indefinitely at 100 Mbps Fortunately, there is a continual press forward to higher bandwidths and reach of networks. Today it is not uncommon to see 10-Gbps Ethernet links and routers in high-end data centers.

Let us take a tangent for a moment and investigate the very high end of connectivity. Using wavelength division multiplexing on optical fiber, researchers at Alcatel-Lucent Bell Labs (4/07) have proven that a WDM optical system is capable of delivering ~50,000 Gbps of data on one strand of fiber. Using 320 different wavelengths, each carrying a 156.25-Gbps payload, they postulate that the astronomical rate of ~50 Tbps is achievable per strand of fiber (see Appendix F).

Let us assume that we have encoded an immense collection of MPEG movies and programs each at 5 Mbps. At this rate, one could transmit *10 million* different programs simultaneously on one single fiber. Since most fiber cables carry 200+ strands, one properly snaked cable could serve *2 billion* homes, each accessing a unique program. Ah, so many channels, so few people. Amazing? Yes, but tomorrow promises even greater bandwidths. What is the point of this hyperbolic illustration? Video distribution and production workflows will be impacted greatly by these major advances in connectivity. Fasten your seat belt and hold on for a wild ride.