Strategic Implications for Future Content Management Systems

By John D. Litke

The broadcasting industry is facing massive investment requirements for digital production and distribution technology. At the same time, industry competitive relationships are changing, business models being challenged, delivery mechanisms changing, and content formats proliferating. Asset and media management systems pose particularly difficult investment decisions because of their central role in the production infrastructure and their cost. After reviewing the business issues, the paper suggests that content management systems should expect to work in distributed, federated, and collaborative contexts. This implies specific requirements on content management systems for content location and identification, for version and configuration management, and for project and task control systems.

The broadcasting industry faces massive investment requirements to make the transition from analog to digital production and distribution technology. At the same time, competitive industry relationships are changing, business models are being challenged, delivery mechanisms redesigned, and content formats proliferating. In this dynamic and diverse transition, it is difficult to confidently anticipate strategic innovations in business, technology, and personnel for maintaining competitive leadership.

Broadcasting has unique properties that affect these choices. The industry is capital intensive both in production equipment and transmission/reception equipment. Most important, the industry has expected and required that the infrastructure be universally able to process all content. If this remains constant, it suggests that the technology that gains market dominance wins and becomes a suitable target for new investments. On the other hand, new production and reception technology, based on general purpose computational equipment, is very flexible and inexpensively adaptable. Historically, this encourages innovation, specialization, and rapid evolution rather than universal uniformity. Many other markets have already benefited from the ability to customize or specialize an otherwise mass-market product. If this is the result for broadcasting, the conventional strategy of investing in expectation of stability and long-term productivity may fail.

The challenge for strategic management is to determine an investment strategy that remains flexible enough to react to rapid market changes, yet is sufficiently productive and efficient to maintain competitiveness and cash flow. It is critical that new investments in storage and archive systems avoid premature obsolescence, both because of the high cost and their crucial role in the connected infrastructure. This paper suggests critical properties of asset management systems that will most likely maximize the benefit of cost ratio recapitalization and retain critical flexibility in uncertain times.

While envisioning the future to inform the present, it is important not to define the future and thereby become blind to its surprises. Thus the major emphasis in this paper is the process of analysis and the identification of critical issues, not a specific list of issues that result.

Changes in the Marketplace

Changes in any industry are not solely the result of technical and business possibilities, but are also conditioned by social, political, and economic history and common perceptions based on that history. Relevant changes in product customization and availability pioneered by other industries may now influence the public's expectations of the broadcasting industry.

It is not news that the principal characteristic of the economy is no longer mass production of uniform product to provide the lowest cost functionality. Past practice meant massive investment in hard tooling, resulting in long lead times for new products and long production runs to amortize investment. Now, rapid product innovation of adaptive services and products, delivered in short intervals, dominates the consumer culture.

What appears to have happened is that the investment in specialized tooling remains at the small component level, producing efficiency for items with slow market change rates. Major advances in automation, transportation, and coordination and communication permit the rapid design and assembly of major products from mass produced parts, with substantial product differentiation provided by systems and software.

Stated another way, efficiency-focused investment and automation at the small-part level has been coupled with flexibility-based investment and automation at the system design and assembly level. This provides

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unprecedented adaptivity and reduced time to market while retaining cost efficiencies. The whole process depends upon fast, efficient, and effective collaboration of diverse independent specialists to adaptively produce an economical product. Similar changes are ahead for the broadcast industry, and the author believes that anticipating those changes will guide a wise investment in media and asset management.

Changes in Digital Television Technology

Television broadcasting today is a highly collaborative effort, particularly for the production and integration processes. What will change will not be the collaborative nature of the industry, but the means, mechanisms, and efficacy of collaboration as facilitated by digital media representation and digital processing.

Digital television production provides new important capabilities. Although all are not equally mature in current equipment, they include:

• Lossless processing, so multiple sequential composition steps no longer degrade content quality.

• Automated storage, naming, and locating, so content components can be rapidly located and retrieved into multiple production suites.

• Scriptable, reversible composition to provide greater flexibility to explore new effects within inflexible program development deadlines.

• Software-based automation, providing efficiency and reduced errors for routine tasks.

The new digital communication infrastructure also provides new capabilities, including:

• Lossless transmission to point of consumption, providing better quality at all resolutions to the consumer.

• Multiple paths for delivery, including not only broadcast paths but also the potential for coherent, integrated use of unicast and multicast and even bidirectional paths to diversify the transport of content to consumer.

• Multiple formats for delivery and consumption, permitting the nature of the content to be adapted to its purpose and the intended audience.

• Adaptive receiving equipment permitting customization or user adaptation at the point of consumption rather than at the point of production or distribution.

Given the general expectations of the marketplace for innovation and adaptation, and the technical ability of the production and transport infrastructure to support more extensive production and composition options, it is reasonable to anticipate a radical increase in innovation to provide diversity, specialization, and customization of product. If the recent history of the electronics, software, and computer industries are any guide, it is unwise to expect that the innovative ferment will be short lived. Instead the author projects a long period of innovation and adaptation while the new capabilities of digital technology are explored. If this is so, what will the strategic properties of the technical production infrastructure be, and what does that imply about the key technical attributes of longer duration investments such as media and asset management?

Key Production Infrastructure Properties

Analogous with the past experience of U.S. industry, it is anticipated that the most important properties of future production and delivery infrastructures will be those that provide faster development at lower labor cost, or customization of content for individuals and market segments, or faster response to market changes.

Notably missing from this list are conventional attributes such as highest near-term return on investment, or highest discounted cash flow, or greatest labor savings. Despite the unconventional list of goals noted above, could one not just proceed to choose investments accordingly?

Unfortunately, the answer is no. Previous experience with massive business shifts teaches that the fruits of a major change in business practice come from many synergistic changes, not any single one. This is an important lesson first taught by the quality movement of the 1960s through the 1980s. The language of the quality movement would elaborate on the previous assertion as follows: One may have to remove 80% of the defect causes before seeing any substantial change in final product quality, and more than 90% before a substantial net benefit is realized. However, the benefits of achieving very high quality are so large that the investment is still justified.

As another illustration, the computerization of U.S. industry was expensive and took many years. Many industry analysts condemned these investments for not producing expected productivity increases. However, in the last few years, as business systems (in some companies) begin to work together to provide timely coordination of activities, mass market leverage is much more apparent. This also illustrates the well-known system effect where benefits are provided by the synergy of many changes, not by any one change.

This circumstance is particularly vexing for media asset management infrastructure investments because asset management is foundational and will constrain what the infrastructure can do. An investment is usually made early on, so the payoffs from synergistic changes elsewhere in the organization and its processes are well into the future. Finally, equipment is expensive and so is changed very rarely.

These factors mean that any nonessential investment in media asset management must be motivated by the expected synergy with concomitant changes, both present and future, in the production infrastructure and processes. What might these be and how will they affect media asset management investment planning?

Future Production Infrastructure

It is expected that the critical properties of future production infrastructure will be fully connected content storage, processing, editing, viewing, management, and transmission systems; fully digital content representation and manipulation; and largely automated and lossless content conversion, transport, and composition.

These properties are already possible on a small scale, and there are few technical obstacles toward ubiquity. However, technical changes alone yield few benefits; work processes must also change in response to the new capabilities.

Most analog production currently requires a sequence of steps through a sequence of specialists, each working on specialized suites of equipment.

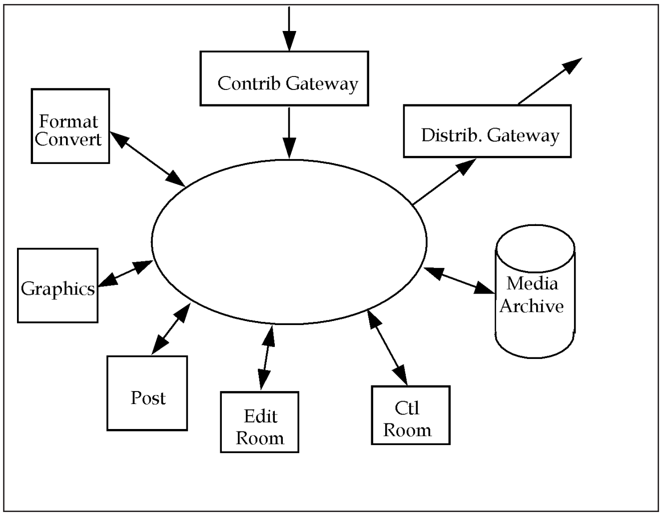

Figure 1. Logical structure of collaborative production.

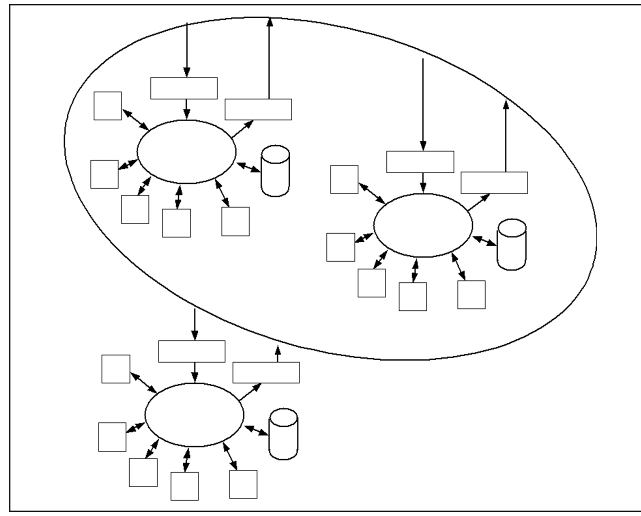

Figure 2. Larger system of federated domains.

Coordination is largely sequential, and availability of resources and control of the process is managed by physical transport of tapes and work orders. Further, the artistic and business requirements for control encourage local ownership of production equipment, so most steps are done in-house or with near-captive suppliers. In this respect, the broadcast industry is similar to the vertically integrated automobile industry of yesterday.

Consider the implications of a fully connected digital production system. Figure 1 shows a logical diagram of this pattern of collaborative work by specialists. The labels on this figure reflect current custom only for familiarity. More realistically, the boxes represent specialist work groups, sharing some media archive facility, connected by some automated electronic network, and bounded or distinguished from the rest of the collaborative universe by administrative logical or physical gateways. The network is represented as a ring, not to symbolize topology, but rather, a single-level administrative domain. The gateways symbolize administrative boundaries in the system.

The implications of this simple figure are that any worker can access any work item at any time, subject to appropriate administrative constraints. One no longer must wait for the tape to be provided or uploaded. This implies that the current overhead of coordination and transport vanishes, subject only to good process discipline.

Now consider the implications of a digital production infrastructure that permits substantial task automation coupled with the ability to access material at any time from anywhere. One can imagine a script to automatically compose individual clips into a coherent program, complete with whatever transition effects, masks, etc., are required. The director could invoke this script at any time to see the current effect of ongoing, parallel work. This could not only help "tune" the feel of highly composed shows, particularly magazine shows and news, but also provide a good indication of the progress of work as a deadline approaches. This capability also means that many current sequence dependencies can be removed, providing substantial new flexibility to work scheduling.

Consider the implications of such a content development environment in a larger organization (Fig. 2). The model represents a large organization as a confederation of smaller administrative units. The author does not expect that a solution with a large administrative domain or a large centralized media archive is wise. This is because large centralized systems increase the risks from component failure and are very expensive, thereby reducing the ability to respond to rapid change in a dynamic business climate. In addition, broadcast production is naturally organized into separate administrative domains (e.g., news, sports, drama) that are unlikely to relinquish administrative freedom, and smaller systems permit better specialization for more efficient operations.

Naturally this basic structural expectation has implications for media archive design, which is noted later. More important, it implies that comprehensive management of assets and work processes must function in a federated environment of diverse group systems. Indeed, asset management must be supported by effective, flexible automated support, as manual coordination becomes ineffective for fast-paced processes. Such comprehensive management of assets and work processes will become essential if interwork group collaboration is to be effective and efficient. This also has substantial implications on media asset management systems.

Future Distribution Infrastructure

As semi-automated work processes improve, building on the inherent flexibility of fully connected systems, it will become clear that scheduling flexibility will no longer require ownership of resources. Thus the development network can evolve as depicted in Fig. 3, where the cloud represents a public or shared infrastructure to connect two separate organizations.

Note here that the administrative controls (symbolized by the oblong boxes) between what is outside an organization and what is inside would surely be more stringent than interwork group administrative controls. Naturally, this does not preclude automated access to material from crossing such a boundary, but it does demand more elaborate monitoring and control

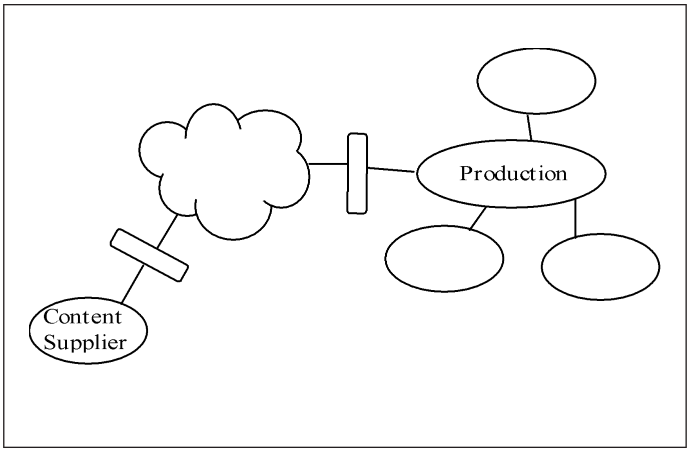

Figure 3. Collaboration between organizations.

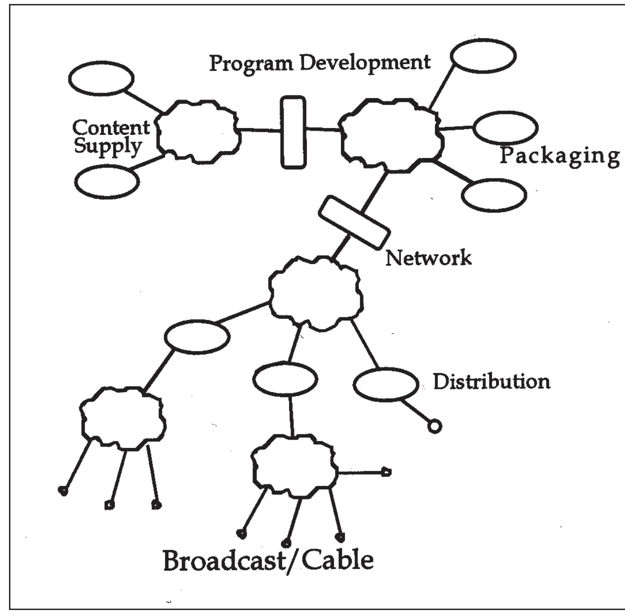

Figure 4. Fully evolved content production and distribution infrastructure.

of such traffic.

The traffic between outside and inside is just a digital stream of bits, much like the digital transport to the user. Remember that the future market will probably be characterized by diverse and rapid specialization and customization of product. Consider that the content is digitally represented and, hence, susceptible of automated digital manipulation; the digital transport infrastructure can include wired networks, as well as free air or satellite broadcast; and a connection to a wired network is usually bidirectional, not receive-only.

Suppose then, that content is deliberately designed to be customizable on the way to the consumer. For example, one might include the dialogue of a program in textual form, with the express intent that a transformative service along the path to the consumer will, for a fee, automatically translate English dialogue to Spanish. One can imagine a large industry of small service companies providing content enhancements. The technology and transport is there; what is missing are appropriate business models and content intellectual property administration mechanisms.

Now the production system looks like the diagram in Fig. 4. The ovals labeled Distribution represent not only the path from the network origination point to the ultimate emission location, but also opportunities for small business to adapt the content to special audience needs. Conventional roles are schematically placed on the diagram as well: note the topological uniformity of this view. The entire process now is topologically similar at large and at small scales, reinforcing the notion that the production process is now distributed over the entire reach of the communication and process infrastructure, including the possibility of customized transformations in the receiver itself.

Naturally, such a system is not designed, nor installed in a methodical way. It will grow in response to the gradual accretion of administrative domains and maturation of entrepreneurial ventures. The first interdomain commerce will require substantial legal and administrative effort to develop and maintain, but it should gradually become more automated and facilitated. Such a system will contain boundaries with substantial legal and commercial constraints, as well as others designed to be more flexible.

Implications for Asset Management Systems

This vision of a radically altered production process and infrastructure will make major demands upon asset management and archive systems. It is important to anticipate these challenges because asset systems are capital intensive and vital to the efficient workflow process. To review, the key properties of future production and distribution systems are:

- Distributed, due to economy of installation and process evolution.
- Federated, due to administrative and business boundaries.
- Collaborative, to best take advantage of specialization.

To ensure that these attributes have a positive effect on the production process, that is, increased efficiency, reduced development times, and increased product customizability, production organizations must make substantial improvements in management, coordination, and tracking of the many pieces and compositions. Given these architectural constraints, and the requirement for greatly enhanced automated support for management and asset tracking, new archive systems should be designed with the following properties in mind to reduce their vulnerability to obsolescence:

1. Avoid unnecessary coupling of names, locations, and relational information for managed content.

This will help ensure that an item has the same identity no matter where it is located or in which program it is used. The property is essential to managing cached copies, determine traceability in support of intellectual property claims, support accurate configuration management, etc.

Today it is almost universally true that an item name is actually a name for a storage location. Breaking this dependence means that each access to an item must translate from a name to a possibly dynamic location or to a cached version of an item. Further, the requirement means never encoding information in an attribute value that is not meaningful for that value; for example, a name must only be an opaque identifier and cannot encode version information by the stylization of the name. The version information, which is really derivation information, would be encoded separately.

The full implication is that each item in the system is supported by a collection of metadata and a translation mechanism to deduce the relevant attributes, rather than relying on ad hoc means of encoding information.

2. Content identification must be verifiable by automated means.

This is a defensive requirement, assuming that information will not always be managed accurately in a federated system. It is therefore essential that isolated content is always unambiguously identifiable even in the absence of the proper metadata collection. It represents the equivalent of a global, unique id that cannot be removed from the item. The requirement itself does not inherently require defense against fraud via, for example, fingerprints, although some business relationships may impose this means of achieving the desired goal.

3. Version and configuration management must include at least parallel derivation tree capability.

Classic project and task management presumes that a managed unit of work has a controllable start and end and an identifiable input and output. This is no longer true for parallel evolution of related items, and the core identifying and relating systems must accommodate such richness.

4. Project and task control systems must be usable with federated content management systems.

Work groups will have administrative boundaries enforcing a sense of management and control. If they are to work collaboratively, the overall management system must be able to decouple administration from control, task management from task assignment, product evaluation from process control, etc. A classic control system ensures some attributes of the process or product by enforcing specific sequencing, inspections (e.g., sign-offs), etc. In a federated context, one must be able to substitute milestone evaluation techniques for process control techniques and vice versa to accommodate the administrative boundaries in the federated system.

5. Metadata schemas and semantics must be discoverable rather than statically defined.

One of the essential binding agents for a federated system is the means to exchange metadata about the content being managed and exchanged. Because it is unrealistic for all organizations to completely agree on the metadata and its integrity properties for all content items, the common practice is to provide a transform from one metadata schema to another, including some information that is passed uninterpreted through some systems for the sake of others. As the infrastructure evolves into a rich structure, this means that a change in any system implies at least the evaluation of all neighboring systems for the implications of change. In a large, rich web of relationships this is costly and difficult; thus we must find a way for the schemas themselves to be interpretable and evaluable at least to the extent that disjuncts caused by one system's revisions are not propagated into another system without due analysis. This is a very difficult problem with no ready solution. One measure we can take at present is to require that all schemas and related information be formally accessible by appropriate means and never just defined by documents and programming interfaces.

Conclusion

To wisely invest in a critical asset management infrastructure in times of turbulent change, it is essential that decisions be guided by strategic considerations. These must include a holistic system view of market dynamics and expectations, technology strengths and weaknesses, and business models and relationships. Such a view is always informed by the strategic stance of the company toward risk and reward.

When a strategic framework is agreed, the strategic plan for technology evolution must ensure that plans are made for the co-evolution of people skills and equipment and process changes. Such plans must recognize that full return on investment depends upon the effective adjustment of all the components of the production activity; no change in any one component is sufficient. Further, in a competitive environment of rapid innovation and change, production activities designed to cope with change will provide a substantial competitive advantage.

Plans for improving media asset management infrastructure must avoid the mistake of planning for a uniform, tightly integrated, stable production infrastructure. Vendor blandishments to the contrary, this is simply not achievable given the practical investment rates and the pace of technical change. Instead, investments must favor solutions that support efficient and effective collaboration between administratively separate groups using diverse equipment and techniques. Wise choices of equipment for efficient production and production flexibility will be difficult but important.

In a future where the work processes include tight collaboration between different work groups within and without a company, the processes to control, manage, and diagnose them are critical. This is a challenge not primarily to equipment and software vendors, but most critically to the management processes within production and distribution companies.

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John D. Litke has 34 years of experience in strategic technology analysis and development. He worked for Bell Laboratories on distributed database systems; directed the design and development of CAD/CAM and process engineering systems for Kollmorgen Corp.; and was director of research on software, systems, and controls for Northrop Grumman.

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