Production Data Capture and Messaging Architecture in Media Production Networks

Simo Karttunen

Keywords: Workflow, production, data management, messaging, connectivity, media, printing, networks

Abstract: To create contents, documents and their components for various digital media is a complex network of three basic resources: interactive human work at design workstations, networked communication between the stages of production and, finally, the control of powerful output devices, printing systems and network delivery tools. There are very few vendor-neutral tools to configure and control the work flow. The basic level is to capture the production data from the subsystems. Another layer is needed to connect the subsystems to transport the captured data for analysis, monitoring and database reporting. There are some early examples of global production management databases and workflow software which are briefly reviewed. The risk of configuring a monolithic and unique solution for production management is obvious. Recommendations and policies are made to guide the system approaches for scaleable workflow and production control.

Introduction

Several research groups and projects [1, 2, 3, 4, 5, 6, 7, 8, 9, 11] have begun to define the basic concepts of production management and its key issues, such as the production chain, work flow, data capture, tracking of events, messaging, intersystem control and scheduling. This relates to the trend towards completely digital production systems and to a more liquid flow of data, files, information and media elements into various media.

Today, it is better to refer not only to digital media production but also to new structures in the business information and data processing in general. Davenport [10] mentioned **tracking** as one of the key factors in the "Impact of Information Technology on Process Innovation". He understands by tracking, as he says, "closely monitoring process status and objects" which is a somewhat wider interpretation than the common definition of tracking in the production.

* **Simo Karttunen, Professor DTech,** VTT Information Technology, Finland
Phone/fax : +3580 456 5230 /455 2839. E-mail: Simo.Karttunen@vtt.fi

In the system evolution and penetration, tracking, messaging and control between the processes and their subsystems are logical steps from **isles** of systems to **networked** systems. At the same time we can separate at least three integration trends:

• Linking between the subsystems of the **production chain** for tracking, messaging and intersystem control or other functions useful in production management or data management [2]. In the media production, formatted files or job components need a local area network or a virtual LAN (VLAN) for the work flow and for digital data management. Now, this media work flow and the respective large data stores and servers must be managed.

• Linking between the **archipelagos** (LAN or VLAN connected systems) of the business, marketing and administration systems [2, 4] and the systems of the production chain. The production is often an expensive set of resources and requires reporting to the business management.

• General **departmental** data processing, normally client/server systems, integrated into the companywide or intercompany solutions with joint business rules, software distribution, data warehousing, data security, directory and management services [17].

It is important to remember that a companywide infrastructure, e.g. a VLAN and some shared services, such as e-mail or file delivery, do not imply any real messaging tools dedicated to production management. Production management, i.e. the PMS , is a wide spectrum of modular systems [1, 2, 3, 4, 8, 31] with many **links** ans **interfaces** between departments or companies.

The interface between publishers and printers - the **Press Frontend** [2] - and in general the servers and file archives in the media production are typical key nodes, often bottlenecks, in the processes and networks. The PMS also includes many functions to improve the work flow and timing of the processes [1, 2, 3].

Another important trend is towards branching and parallel structures in the media. Publishers have to design products from the same basic information material for several distribution media (e.g. print, CD-ROM, WWW). The production network must support this kind of branching which in fact takes place in early product stages, i.e. before the editorial packaging processes.

Alternative outputs are also possible in the **press frontend systems**. For the print media we may use film recording, direct platemaking (CTP), various proofing alternatives (e.g. before and after the imposition) and digital printing [2, 9, 31]. To do this in a single company with specific products needs well controlled and complex work flow, i.e. the production management.

This paper is a review of the data capture and messaging architectures to be developed for data management and media production. The messaging of production data is considered as a primary function for any PMS [1]. The production data, e.g. the events in the process states, have to be captured from the subsystems and this can be done **automatically** rather than manually, by the keyboard or click commands of the production staff.

It is easy to see that there are analog problems with the PMS for the different media [16]. There may be some primitive log functions in the systems but total workflow management is a more ambitious and difficult goal. There are only few commercial systems for prepress, printing and web media and no major markets since the users - professional media producers - are only beginning to feel the pressure and the expense of not having an adequate workflow, resource and data management [12, 16, 17, 18, 21, 22, 23, 31, 32].

Management and Data Management

Production management and PMS are a part of the business management [1]. They tend to become key factors in system integration since they are one of the first concrete needs for interconnection and messaging of the systems. We shall discuss the levels and types of messaging in the system environment in the subsequent chapters. Let us first look at the question: **What must we manage?** In Fig.1 we have four categories or ares to be managed in a media company.

Data	**Information**
• Databases • Spreadsheet applications • Spreadsheets, Tables • Servers, Client/servers • Data sources, sensors	• Mail, telephone, fax and e-mail • News, professional news, press releases • Commercial and market information • Web info: Browsers, search engines, information filters, agents and services
Contents for media	**Processes and production**
• Text, image, media files • Structured documents • Portable documents • Media-specific products	• Production resources and costs • Projects, batches, products and jobs • Transactions, states and events • Schedules, deadlines, routing and changes

Fig.1 Categories of data, information, contents and processes to be managed.

In the case of **media,** both the raw materials and the product are information. Data management is here a tool for managing input, processes and output. We have to expand our views from the conventional concepts of data management to understand also the information/data, process/data and content/data relations. This will gradually lead to **object-oriented systems**, aimed at defining and modelling complex systems [20] such as large media production systems.

Like in many other areas, the **amount of data** to be managed increases rapidly. A system environment commonly lacks disk, server, database or network capacity. Due to some fundamentals in the structure of many **basic formats,** the files are large, or they expand in certain processes when their data compression

is decoded or their links are opened. This is typical, for example, of the PostScript files, the most common code for pages, and of more covering codes of the **larger-than-page elements** (LPEs). We do not define this LPE concept here but take as an example large, post-imposition **signatures** correrponding to large press sheets, e.g. in size B1. They may contain numerous pages and in all four process colours.

As pointed out [1, 2, 4], **data management** has to be applied very efficiently in an environment like the backend of the publisher and in the Press Frontend [2] where many jobs are processed and LPEs dominate. There is a new market for systems in the commercial printers´ frontends. This market includes job servers and databases as well as imposition and output file preparation software such as trapping, proofers, file checkers, and naturally OPI servers and RIPs [1, 9, 16].

The next question is: **How must we manage?** Most data, files, jobs and objects must be held, at least on **servers**. Holding and deleting routines must exist. Some data need **databases**. Filtering and conversions from one format to another are common operations. Packaging, linking and combining are also usual [13, 15, 16, 22]. Delivery and transmission are automated in some cases. Finally there is also a real need for production management, the PMS.

We have to know **what** the media elements are (identity, structures), **where** they are (location, logistics), in which process **state** they are on a certain moment and how high the **direct costs** are. Then we compare how these observed or **tracked facts** relate to our budgets, schedules and deadlines. If we do not manage all this, we may plan and execute our production in a less precise manner and achieve good results only by chance and with much confusion. The following chapters deal with potential data management and messaging architectures for production management.

Middleware, Data Access and DB Connectivity

In the production, we have to use a large variety [16] of applications, ranging from shrink-wrap packages for DTP to larger, more integrated/complicated and dedicated software for editorial or printing departments. Many PMS software components, and subsystems are **embedded** in the hardware and many are deeply integrated both vertically and horizontally [14, 15, 16, 24, 31].

We do not show here a complete topology of the various production systems. Instead, we view the various levels of the systems in the media production from the angle of production control and automation.

In **Fig. 2** we approach the problem from the tracking angle. The basic timing of production and process events must be **captured** from the applications, i.e. from each process and subsystem throughout the production chain [1, 2, 3]. Besides, messaging, PMS databases, analysis and reporting [1] must be included in the different forms of the PMS modules. **Fig. 2** does not give any detailed architecture for thew way these systems are connected or share their data and reports. It shows roughly the categories observed and inevitably needed in the PMS, i.e. production management.

High-end Media & Prepress Systems [16, 24]: Dedicated but application and DB compliant (e.g. Word+ QuarkXpress + SQL based publishing systems) which include PMS and time control and which may contain some essential parts of the lower levels. Typical of large media companies.

Production management systems, PMS, as separate global systems [16], e.g. Covalent, Print Flow [22] and Grafi-Data

---

Messaging and delivery

File delivery and workflow messaging applications such as First Class, Adobe Virtual Network or Lotus Notes, or larger enterprise middleware [17] packages, e.g. the Connection/Open Horizon or DCE/Transarc Co [21].

Data capture and identification

Modules for creating, formatting and exporting production and tracking data, e.g. the IFRAtrack and its IMF [18] or the CIP3 [19]

Process data sources

All production systems and control systems in the media production chains including DTP Systems such as PageMaker, PhotoShop, FrameMaker+SGML, Multimedia Authoring and Web Site management systems and portable documents such as Acrobat [32] and their Plug-ins, or portable colour tools

Fig 2. The categories of systems for the PMS, tracking and production data messaging showing data source, capture and middleware layers and the highest more global layers, high-end integration and embedded PMS and their DBs.

It is not easy to integrate the PMS on all the levels mentioned in Fig. 2 . This "management burden" was stressed by e.g Leinfuss [17]. It should be pointed out that the companywide computing is taking its first steps and very few examples and references [17] can be shown of such a advanced activities as companywide data warehousing, business rules management, marketing and distribution data control [10, 21, 31]. It is clear that database access and security issues will become more important, and DCE middleware [17, 29] and Internet technologies [26, 27, 28, 31] are set up to solve these problems.

Layers of Networks and Messaging

It is useful to separate the upper layers of data messaging from the more basic ones as shown in Fig. 3 , e.g. by using the Open Systems Interconnection, OSI layers. The local area network (LAN) has its physical, link and router layers (OSI layers 1, 2, and 3). With these we need network protocol layers, e.g. the TCP/IP (OSI layers 3 and 4), a de facto industrial standard today.

OSI Layers	Task	Medium or Protocol
7	Applications	SMTP, file delivery , browsers, middleware
6	Presentation	File **formats** , e.g. Word, HTML, PDF, EPS
5	Connections	FTP or WWW
3-4	Transfer	TCP/IP
3-5	Network services, e.g. leased lines, Internet or ISDN	
1-2	Physical and link layers	LAN segments, modems, links, optical fibre, cables, radiowaves

Fig. 3 The OSI layers of communication and the media

Using a defined file exhange infrastructure (layer 1-5) the network services create and maintain connections like the FTP or WWW. Above these (presentation, layer 7) we use identified, i.e. **formatted** data files such as Word (or other text file formats), PostScript, EPS, HTML, PDF (the Portable Document Format related to the Adobe Acrobat™) or the image format TIFF/IT. Some of these are official standards, some belong to the MIMEs (Multipurpose Internet Mail Extensions), while all are common.

All the above listed **formats** are content-related graphic or web formats. For the PMS, data capture and formatting must be automatic. This requires **special formats** for e.g. tracking or production control , such as the new IFRA Message Format (IMF) defined by the IFRAtrack Group [18] and the CIP3 format [19].

Weshall analyse the use and integration of the tracking and PMS formats in the chapter "Production Data Messaging".

Data access is a problem at both ends of the **tracking function**. In the workstation and application, in which the job to be tracked is processed, we must create these formats. This is described in detail in the basic IFRA Specification [18]. We have to **identify** the event which is the change of the process state, stamp its time and **form an identification** and an envelope before this formatted message - in this case **an object** - can be sent to the production database or to other PMS modules [18]. There it is parsed and used for constructing events/timetables of the **observed** process events and for comparisons with the planned or scheduled data.

In the mid 1990s, the Internet software category of easy-to-use freeware was invented. The **browsers** were introduced and the World Wide Web service (WWW) begun to explode. While this explosion continues, we can record another fairly natural use of the network service www. These applications are called **intranets** [25, 26, 31] which means using the Internet www service as it is, as a network service, but redefining and separating it further to **form specific and private networks,** e.g. for data and file distribution, for marketing, or for component and job delivery.

Specific, Secured and Private Networking

Intranet applications are secured and separated applications on the existing, robust and cheap www infrastructure which the companies need for the Internet communications anyhow. This solves many common data management problems, such as multiplatform support, data distribution, and certain basic levels of the PMS, i.e. the connectivity, addressing, file delivery, DB access and partner links [26, 27, 30, 31].

The intranet software will deploy **HTML**, browsers and form-based transactions with the users, or automatic data capture and multi DB access in various combinations with the existing group or middleware [26, 29]. A large company certainly needs to define **several intranets** for their marketing, partnerships, distribution, production tracking and control. Browser-level integration of various applications, e.g. Java applets, makes it possible to interact with the users in a number of new ways [26, 27, 28, 30, 31].

Browsers include many groupware and transaction functions [26, 28]. It is not only the Internet but also the internet **technologies** (browsers, Java, web servers, intranets, APIs, ODBC and JDBC, MIME, forms, HTML, Acrobat, PDF, web site builders, NNTP, IMAP) that are under development. The browser is a familiar and cheap interface and its position as the www client is unique.

There are examples of how to combine shrink-wrapped **DCE middleware** [17] including multi DB access, security, directory and application services [29, 30], with the **Java applets,** and to define the client/server roles so that the client gets a more functionality without any too heavy server roles.

It is self-evident that **media producers** - i.e. both print publishers and web publishers - are interested in systems which are open and scaleable. Standards have been adopted relatively late and therefore the web publishers have a big advantage: they get integrated products where the integration has been accomplished by deploying international standards (i.e. formats and OSI layers) on the application, presentation and network levels, as pointed out above.

The socalled **Internet technologies** listed above combine standards and new integrator software. Print media have their peculiarities and companies still use many dedicated systems. This was pointed out by Tribute and coauthors [24] in his analysis of the state of the art in editorial systems in Europe where only a few vendors based their systems on common Word and Quark Xpress, e.g. the Table on page 3 of ref. [24].

To use and promote **openness** remains a users´ problem but the direction is clear. Print media system users and vendors must adapt to the same data architectures as those used in the production of web media (Fig.3 and Fig.4).

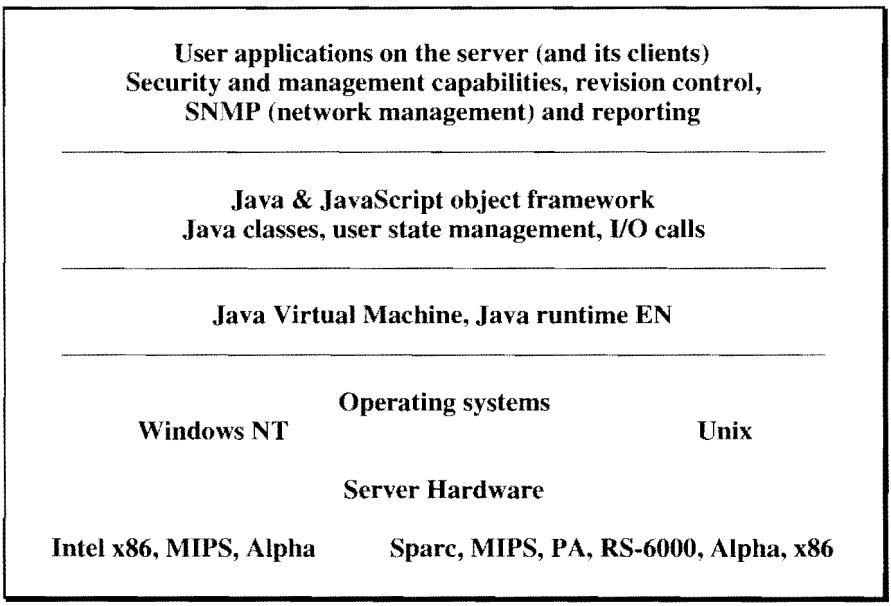

Fig. 4 The Netscape Enterprise Server™ is one of the servers of the SuiteSpot family planned [30] to integrate flexible Internet technology into the enterprise and web publishing environment, to improve scaleability and to deploy the concept of open servers.

A good example of how the leading browser vendor Netscape addresses the corporate messaging and server problem is the new Enterprise Server, referred to in Fig. 4. Running on Windows NT or on any Unix server it adds on many rather advanced www server and corporate functions based on the socalled "Java virtual machine and Java object framework" [30].

Production Data Messaging

In the previous chapter we reviewed potential tools for production data and file messaging, and mentioned some important vendors and approaches. This was done with references to both print and web media production. Now we may go back to the basics of the data messaging, i.e. **automatic data capture** from the processes using vendor-neutral and identified formats.

For any practical integration work, we have to get the data on the process events from DTP applications or from the other control systems [33] of the production chain. The IFRAtrack approach uses a vendor-neutral format, the IMF, to be transmitted by sender modules and parsed for a database analysis and reporting. This approach requires software development for the modules and application of the DB parsers [18].

There are a number of **projects** which apply the IMF in real production conditions [12, 31] but it is too early to state whether the tracking will be adequate and useful when using the IFRA approach. The experts participating in these projects and the members of the IFRAtrack Developers´ Group will report on the system development later. The IFRAtrack Developers´ Group can be contacted on <http://www.gt.kth.se>.

It has been possible to track events and timing in the **simulators** of newspaper production [3, 11, 12]. Many dedicated systems already include tracking and workflow features [3, 14, 15, 16, 20, 22, 23, 32, 33]. The next step is to broaden the scope of data capture. The quality parameters, waste control and colour management have been mentioned [1, 2, 3, 7]. The embedded solutions are common in the press and postpress control systems and in the plant-wide systems [14, 33]. Even in those cases the systems may be developed to use tracking formats and interchange production data.

The openness is often very limited in the control systems. It is based on the lowest layers of the OSI model. The Allen Bradley and Honeywell process control systems have been built on the CAN [33] specification which is a fieldbus corresponding to the same OSI layers than those of the LANs, e.g. Token Ring and Ethernet. The higher layers of industrial control systems have more open interfaces and subsystems, such as SQL-compliant databases or common Windows PCs. Connecting such layes for tracking is much easier.

Finally we have to propose an architecture for a modular and open tracking and PMS system in the media production. **Fig. 5 and 6** show no exact infrastructural features of the fundamental data management components such as the LAN, VLAN, ATM backbone or the DB applications. Neither are any precise system-to-system interfaces shown. The **categories** listed in Fig. 2 and the **OSI layers** of Fig. 3 are useful to show the interfaces and the compliancy.

In real projects of this nature the existing systems have to be mapped and the final approach must be tailored to support and link the existing solutions and applications [31]. In **Fig. 7** we show some principles of data capture, formatting and messaging from the data sources to the PMS databases.

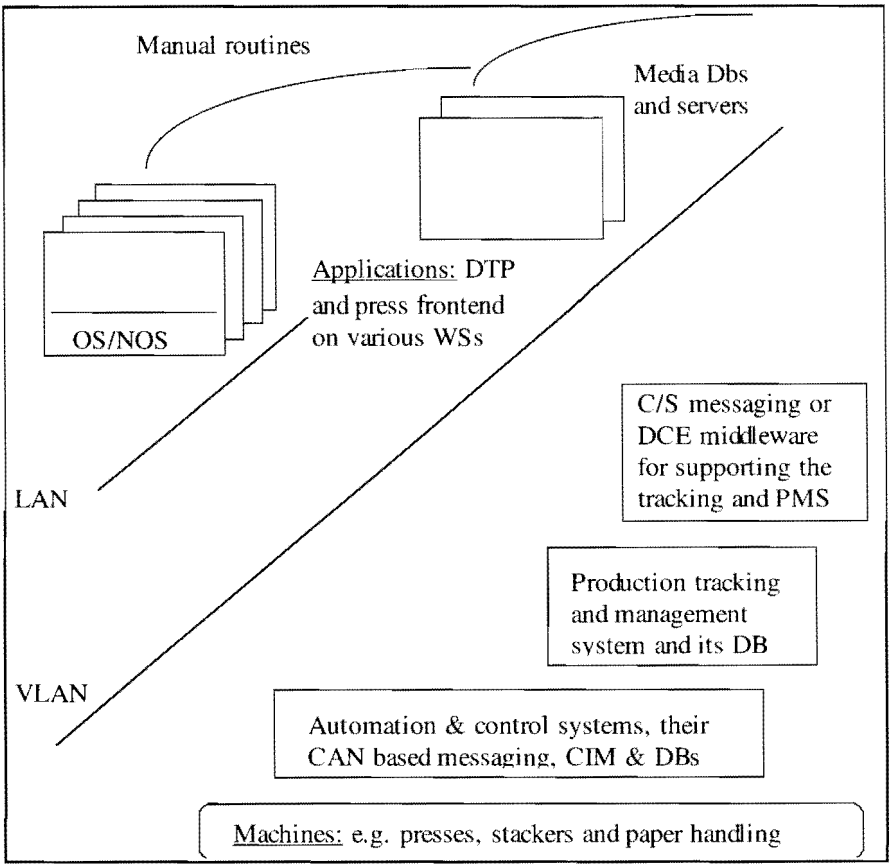

Fig. 5 Tracking and production control are based on object formats [18, 19] and respective parsing, DB analysis and reporting. Client/server groupware and messaging [32] or more powerful DCE middleware [17, 29] are useful to support connectivity and DB access in the numerous subsystems which are the **production data sources**, e.g. DTP, press frontend, press and postpress control systems. A similar system structure could be based on **intranets**, a private network between separate companies. Unlike in the web site production (cf. **Fig. 6**) the printing plants use CAN based [33] or similar fieldbus + CIM applications in which tracking is possible on the DBs through the SQL compliancy. The IMF format senders [18] are distributed in the subsystems or over the clients of the middleware [17, 30, 31].

The production is basically similar in the **print media** and the **web media** as long as the latter is not yet using many time-based components such as sound and video clips. The distribution of video based products will require very high capacities. **Fig. 6** shows system types necessary for the tracking and production control of web sites. Storing and serving reusable components and jointly print/web compatible formats, such as PDF [32], are typical needs, at least for a publisher who offers services on both print and web basis. In web media, partnerships are more fundamental because of hyperlinking.

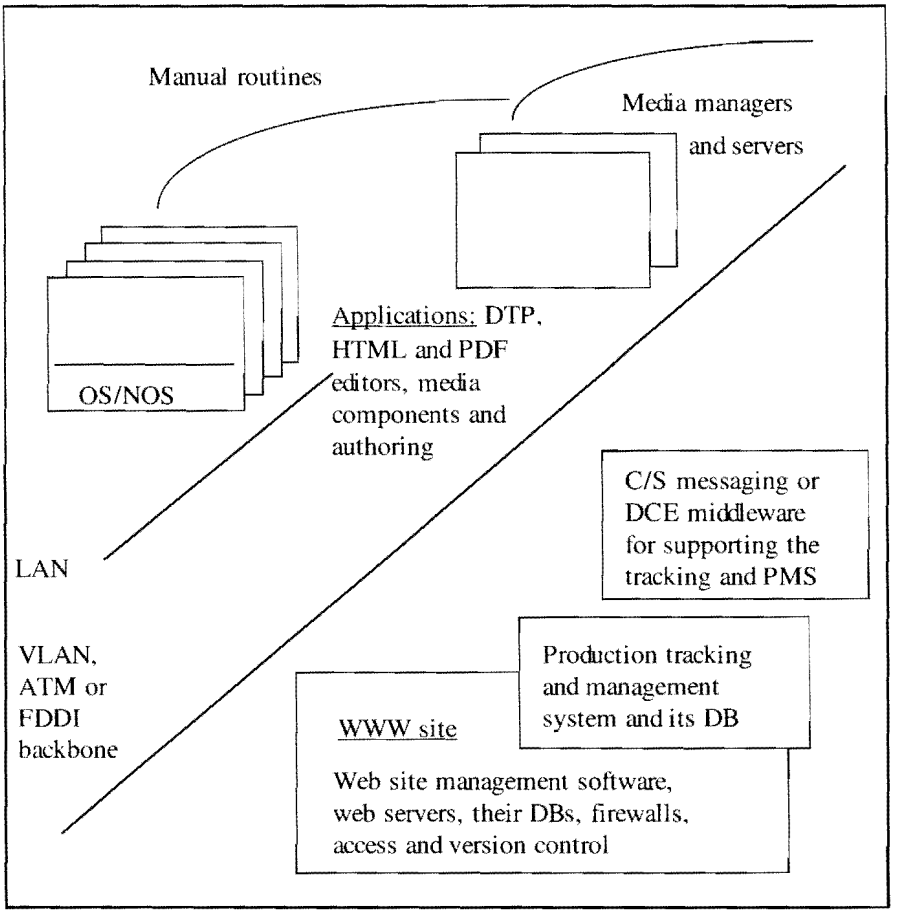

Fig. 6 Web publishing uses manual routines, DTP, web format editor software and multimedia authoring to offer and distribute services on the web sites which need management since the web documents are linked dynamically. Production tracking can be to a certain degree similar to print media production (Fig. 5) at least at the beginning of the production chain (editing and design). Intranets and other Internet technologies will make web publishing more flexible.

The tracking requirements and control principles of web sites differ from print media in many respects, e.g. the hyperlinks, real-time processes, and version and updating mechanisms. Web publishing is still new and experimental. Since the regular income is rather limited, the systems have to be built up gradually.

In **Fig. 7** we point out that there are numerous alternatives [17, 18, 19, 29] of constructing messaging and PMS applications in a scaleable and flexible manner. The PMS modules and functions should not cause any problems when frequent changes have to be made in the basic networking and data management of the enterprise. A large project called VIRTU (Web Publishing and Virtual Production), involving several print publisher companies and VTT Information Technology, will study the formatting, messaging, networking and data management problems in the media production [31].

Application	Middleware	PMS and DB
A. IFRA modules (18) • IMF generators as SQL clients in all subsystems	e.g. TMC/IP or other network service	• SQL database
B. DTP + IMF Press frontend •AVN client* •IMF generator	• AVN* on e.g. TCP/IP	• SQL database
C. DCE supported middleware (17): • ODBC links • IMF generator	• TCP/IP with "enterprise C/S" + secured services	• Multiple Dbs with business logic & COBRA
D. DTP + Adobe (32) press frontend (Open) •AVN client	• Adobe: Virtual Network (server)	• Adobe Open with a PMS/DB

Fig. 7 Examples of production data messaging : As IFRA has pointed out [18] there are several alternatives to send e.g. the IMF (IFRA Message Format) from subsystems and applications over the LAN or VLAN to the database of the PMS software. Middleware, such as AVN* (Adobe Virtual Network),or heavier DCE middleware (17, 29, 32) may be useful, as shown in cases B, C and D. Adobe plug-ins could make the **press frontend** (in case D the Open™) a proper and adequate site for PMS and database linking to other systems or DBs.

This paper does not make a direct reference to the software solutions of the development projects [12, 31]. We have pointed out the needs for proper data formatting, messaging and databases. The role of object oriented methods will be obvious in most future media production systems. The **LPEs** (larger than page elements) are often formed relatively late - i.e. in the press frontend and imposition. This makes the **imposition** very central production stage in the print media production control. Signatures must wait for pages, and on the other hand they are formed just before the output on film or on plates.

Conclusion

There are several techno-economical reasons for using tracking in the media production processes and for constructing database and messaging applications for the production management, the PMS. The production data (events and

parameters) has to be captured from the subsystems, which are e.g. the key workstations of the publishing processes, the press frontend and the control and automation systems of the web sites or those of the printing plants.

The data may be simple log tables of the file transfer traffic, or preferably structured messaging formats, e.g. the IFRA Message Format (IMF). The structure of the trackable objects must be identified from the product/production environment.

There are numerous middleware and messaging tools for data access, security, connectivity and database linking in a more standard manner. The layers of the Open Systems Interconnection , OSI framework, help us to understand on which level of the communication protocols the numerous tools and standards are.

More and more production communications and messaging are available as integrated OSI stacks up to the **network services** such as the www or higher. The integrated features of the application layer software, such as web browsers or middleware, are very useful. **Intranets** will be used widely in production management. The scaleability and flexibility of these product or customer specific (secured and private) networking tools offer great benefits.

Web publishing may use similar static material (text, image, database) as the print media. Time based multimedia products and components, such as video and sound, are still under development. Linking them in web services is possible but it will require capacities not quite available on every desktop. Web media production has its information sources and partners in similar businesses as the print media namely publishing and advertising.

Acknowledgement

The author thanks Mr Heikki Nikulin for many fruitful discussions on our joint research topics: data formats, messaging, middleware, Internet, web media and communications, at VTT Information Technology. Warm thanks also to Dr Tapio Lehtonen, the Project Manager of the VIRTU Project, and to the industrial experts of this project consortium.

References

1. Simo Karttunen "On the Quality of Data Management of Publishers and Printers" TAGA/IARIGAI '95 Conference, in Paris, France, 17-20 September 1995, 14 pages.

2. Simo Karttunen "On Systematic Production Data Messaging between Publishers and Commercial Printers: The Press Frontend" TAGA '95 Conference, Orlando, Florida, 2-5 April 1995.

3. Stig Nordqvist and Nils Enlund "Control and Management Methods for Prepress Production in Multichannel Newspapers" TAGA '95 Conference, Orlando, Florida, 2-5 April 1995.

4. Simo Karttunen "Integrating Production Management Systems into the Printing Production" Graphic Arts in Finland, Vol. 23 (1994) No. 3, pp 3-15.

5. Johan Stenberg "Printing and Distribution of Newspapers - the Process and Its Logistics" (in Swedish) Thesis for the Degree of Lic. Tech, The Royal Institute of Technology (KTH), Stockholm, December 1994, 147 pages + Apps.

6. Johan Stenberg and Simo Karttunen "Dynamic Control of the Printing, Postpress and Distribution Operations in Newspaper Publishing", TAGA '95 Conference, Orlando, Florida, USA, 2-5 April 1995.

7. Johan Stenberg and Simo Karttunen "Systems Integration in Newspaper Printing: The Goals and the Tools", 22nd IARIGAI Conference, Munich, Germany, September 1993, 20 p.

8. Tapio Lehtonen, Helene Juhola, Asta Bäck and Timo Siivonen "The Production Chain and Networks of Electronic Printing" , Paper for the 1st TAGA/IARIGAI '95 Conference, Paris, France, 17-20 September 1995.

9. Ron Straayer* "Workflow and Dataflow Issues When Implementing Computer-to-Plate", The 1st TAGA/IARIGAI Conference, Paris, France, 17-20th September 1995. * Gerber Systems Corporation.

10. Thomas H. Davenport "Process Innovation: Reengineering Work Through Information Technology" The Harvard Business School Press. © 1993 by Ernst&Young, Center for Information Technology and Strategy. Boston Massachusetts.

11. Stig Nordqvist, Johan Stenberg and Simo Karttunen "Modelling of Production Management Solutions: TidSim Newspaper Production Simulator", TAGA '94 Conference, Baltimore, USA, 2-5 May 1994.

12. Stig Nordqvist "Simulation of Newspaper Production Processes - Decision and Management Support Tools" Paper for the TAGA '96 Conference, Dallas, Texas, 28 April - 1 May 1996.

13. Simo Karttunen and Heikki Nikulin "Network Publishing: The Internet and the Publishers" (in Finnish). GT Report No. 3/1995. July 1995. 37 pages

14. Honeywell and ABB: System information about the press automation and factory management system products of two automation vendors. The systems reach the machine element control (actuators) in depth and combine laterally other than strictly press-control functions, e.g. plates, paper handling data, and mailroom systems. Many PMS features have been integrated into the software.

15. Peter Leu "Putting It All Together: How To Make Real Workflows" Linotype-Hell Users' Group Meeting, Dallas, Texas, 9 March 1995. Linotype-Hell has much experience in integrating Press Frontends, i.e. prepress and output systems. Large system networks can be configured from the image and text file capture to output file preparation, proofing and film/plate recording.

Similar system knowhow is apparent in the product families of Adobe, Agfa, Crosfield, Dainippon Screen, Kodak and Scitex.

16. Drupa Report (in Finnish) on the GT-Service. GT-Report No 2/1995, May 1995. VTT Information Technology, Espoo, Finland. 52 pages. It became evident in the Drupa 1995 that there is a market for the PMS. Several vendors showed production management software. In some more integrated systems the PMS is often embedded in other workflow and control functions.

17. Emily Leinfuss "Caught in the Middle" An analysis of advanced DCE middleware tools including the **enterprise services** based on remote procedure calls (RPCs), database gateways, file transfer, object request brokers and transaction monitors. **Infoworld,** 25 Dec 1995 - 1 Jan 1996, pp. 1, +45-46. WWW links for **seven** commercial tools by vendors such as Open Horizon, Transarc Corp., IBM, Information Builders, Gradient Technology, Peer Logic and Intersolv are listed.

18. Nils Enlund and Philippe Maeght (IFRA) "A Recommendation for the Interconnection of Production Tracking Systems in Newspaper Production" TAGA/IARIGAI '95 Conference, Paris, France, 17-20 September 1995. Also the original IFRAtrack Recommendation Document by **Bruno Thoyer** : Special Report 6.19. IFRA, Darmstadt, July 1995. <http://www.gt.kth>.

19. Stefan Daun, Georg Lucas and Jürgen Schönhut "Specification of the **CIP3** Print Production Format" Version 1.0. Fraunhofer IGD, Document Imaging Dep. Darmstadt, Germany. IGD's WWW site <http://www.igd.fhg.de> Mentioned in the paper by **Michael Seydel** at the TAGA '96 Conf. , in Dallas.

20. Anon "XSoft Astoria Handles Document Objects", The Seybold Report on Publishing Systems Vol. 24 , No.14, 27 March 1995, p. 8. Using the ObjectStore, an object database system from Object Design, **Astoria** works with the XSoft's other products: **InConcert** a workflow system and InContext, an SGML editor. Another object DB (also ObjectStore) workflow system, called RACE from Contex is included in the same Report, p. 10. A more detailed presentation of the Astoria and InConcert systems of XSoft is in the IEPRC USA West Coast Study Tour Report (member-classified), April 1995, Leatherhead, Surrey, UK, p. 227-261 (37 pages).

21. Web sites: The DCE middleware vendors [17], e.g. IBM/Somers, Transarc Corp, Gradient Technologies Inc and Open Horizon Corp. and enterprise or document management vendors e.g. Saros: On sites http://www. transarc.com, www.gradient.com, www.openhorizon.com and www.saros.com. all include examples of leading solutions to enterprise service and assets management problems.

22. Setanta Technology (Cambridge , UK) Print • Flow - a workflow and production tracking system for prepress. Product Documents 1995. Closely connected to the development of the IFRAtrack and IMF [18].

23. Covalent Coorporation. Product Overview. A complete Informix DB and Unix-based system family with scheduling, data collection and job tracking supported by cost estimation and inventory management.

24. Andrew Tribute, Rosanne Rosello and Urban Jönér "Editorial and Advertising Systems, Output Devices: IFRA '95, Part II " Seybold Report on Publishing Systems Vol. 25, Nov 1995, No. 6, pp. 1, 3-31.

25. Jim Carr "Intranets Deliver" Infoworld, 19 February, 1996, p.61-63.

26. Web presentations of the INTRAnet Jazz™ software of the JSB (UK), the INTRAnet Company at the site http://www.intranet.co.uk

27. Erica Liederman "Java in the Real World", http://www.javaworld.com

28. Anon "Navigator 2.0 meets with user approval" Infoworld, 26 February 1996, p.51 , and the Netscape web site http://home.netscape.com announcing now (mid-March1996) the **intranet server** architectureNetscapeSuiteSpot™.

29. Anon "Open Horizon looks to Java links" a box of the JDBC article in Infoworld, 12 Feb, 1996, pp.1 and 20. The Open Horizon Corp.'s web site <http://www.openhorizon.com> gives more information on the **Connection** DCE middleware and their other three-tier systems with enterprise services, DCE (Distributed Computer Environment) and COBRA.

30. Netscape Communication Corporation. Server Central and SuiteSpot™ presentations on the site http://home.netscape.com.

31. Simo Karttunen. "Web Publishing and Virtual Production", The Project VIRTU (1996) at VTT Information Technology. Private discussions and inside information on several projects applying IMF to real production, in Swedish and Finnish companies. Process and product development of the PMS goes on to make the IMF and the IFRAtrack concept an industrial standard.

32. Adobe middleware and press frontend products Adobe Acrobat™, Adobe Virtual Network™ and Adobe Open™ represent an **inside-out approach** to guide the work flow from the entering page files to various output preparation and control functions. Virtual Network and Open include log features and could be glue systems for applying IMF or other track modules in large DTP systems and press frontends where lots of cheap software form the production chain.

33. Olaf Pfeiffer "Controller Area Networking" an article on the www site CAN: The Controller Area Network, <http://www.docs.uu.se>. The computer integrated manufacturing (CIM) frameworks like MMS and MiTS for car manufacturing and maritime networking are CAN-based tools. The scale of the ocean vessels is closer to publishing than that of the large car factories. The problems, however, are very similar: How to capture data from a cluster of heterogeneous production systems.
