Running Head: NETWORKING WITH DYNAMIC WORKFLOWS

Networking with Dynamic Workflows

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Abstract

This document is a quick research on why and how our recent and traditional schemas are evolving into Dynamic Workflows, while adjusting to new market demands and maintaining their conformity to standards.

Networking with Dynamic Workflows

Now that information systems are shifting from a data centric to a process centric approach, workflow systems are the leading technology to control and coordinate these processes (Meng et al., 2002). The information overload that clutters hardware space and overflows our memory and time limitations, creates the need to automate the identification and appropriate use of valuable resources, and the disposal of obsolete or marginal components, within an acceptable time-frame.

Understanding first the benefits of workflows and how flexibility is defined, we will explore how the dynamic paradigm has improved internal workflows, inter-organizational workflows and network routing.

Summary of the theory

Workflow Flexibility Concept and Benefits

Flexibility of a workflow process is defined by (Mangan & Sadiq, 2002) as its ability to execute on a partially defined model; they proposed a dynamic workflow model for a tertiary educational institute, as an example of a non-traditional domain for workflow systems, where the full specification must be made at runtime and may be unique to each instance, because of the countless number of possible combinations.

The key benefits of workflows, as explained in the workflow portal (WfMC & WARIA, 2003) include:

- Improvement of efficiency through the automation of business processes that eliminate unnecessary steps,
- Better process control through the standardization of working methods and audit trails.
- Improved service through consistency and predictability.
- Flexible software control that enables re-design as needed.
- Process streamlining and simplification.

Dynamic Internal Workflows

A parallel server-based production workflow working as an automated control system to schedule software notifications and monitor resources, was the result of re-examining the entire BBC News workflow process, under project Jupiter for the integration of their resources (Dwyer, C., 2003); using an open-architecture and industry standards, Journalists have the tools they need on the desktop, to maximize their achieving and editing production processes.

On a broader development, (Casati et al., 1999) integrated workflow specifications with expected exceptions through Chimera-Exc, a language to specify exceptions in workflows, based on detached active rules; unlike workflow conditions, the exception handler is activated either periodically or at the time of special events, executing rules in parallel, so rules with different priorities can be executed concurrently; each Chimera-Exc data manipulation event is stored into an appropriate database trigger.

To support diverse workflows for global software production projects at Fujitsu, (Gao et al., 1999) built and deployed a web-based Problem Information Management System (PIMS) where ad-hoc problem management processes can be converted into systematic workflow; a data-driven method is used on a configurable state-based workflow model, to automatically control, track and monitor problem status.

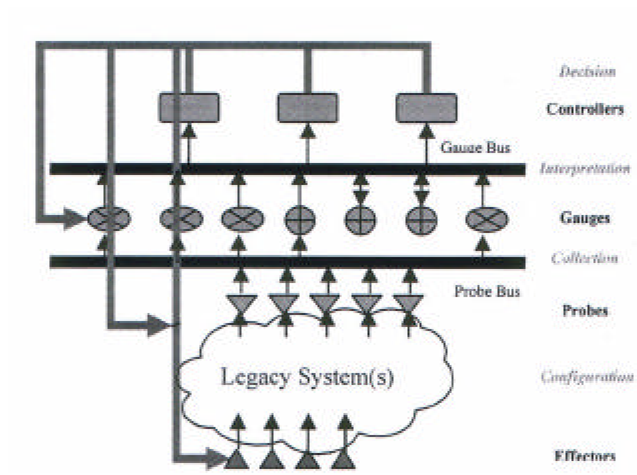

Figure 1. Externalized Dynamic Adaptation Infrastructure

(Valetto & Kaiser, 2002) provided an external dynamic adaptation of the Kinesthetics eXtreme (KX) model to a real-world mass-market Internet service, and reported the merits and limitations found; KX enables continuous and remote monitoring of pre-existing software service parameters, to provide feedback with its minimally invasive external probes, gauges, controllers and effectors (see Figure 1). Legacy

System(s) is conceptualized as any pre-existing software, not only old or ancient software.

Inter-Organizational Workflows

While building an inter-organizational Workflow Management System (WfMS) called SALSA, (Kang et al., 2001) realized that the specifications of each inter-organizational workflow needs to be insulated from the possible changes at its organization level, to ensure continuous operation; SALSA was the result of implementing new design-time tools and extending the existing distributed and CORBA-compliant workflow runtime engine, to facilitate the communication between workflow domains via specific cooperation contracts.

Complementing the Workflow based Internet SErvice (WISE) project, the European Union research project CrossFlow, and the University of Florida research on advanced technologies to support Internet-based Scalable E-business Enterprises (ISEE) shown on Figure 2, (Meng et al., 2002) presented the Dynamic Workflow Model (DWM) which enhanced the architecture with Application Programming Interfaces (APIs) to modify the process model at run-time.

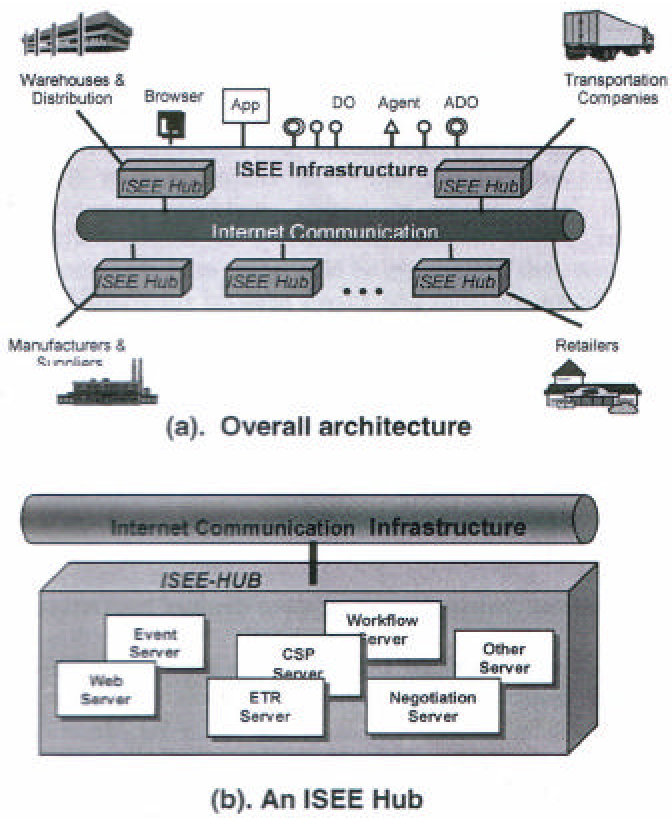

Figure 1. ISEE infrastructure

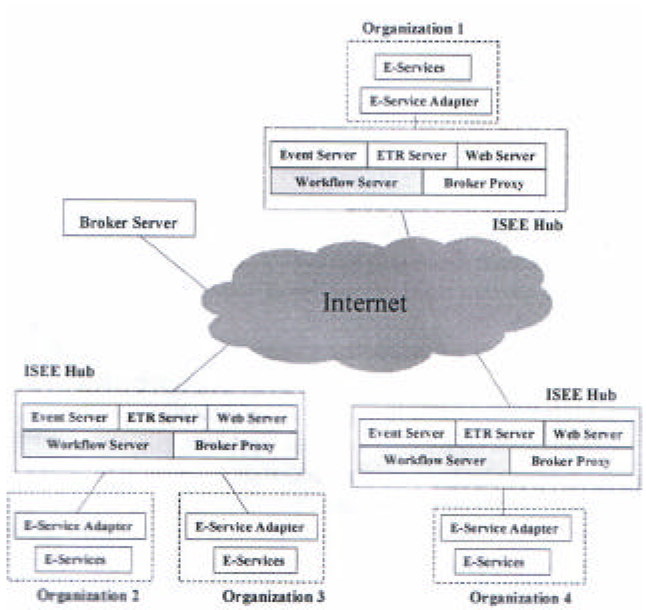

Figure 2. Global architecture of the dynamic workflow management system

As you can see on Figure 3, a centralized Broker Server is to be used by service providers through their Broker Proxy, to register their e-services with their specific constraints, instead of the previous Negotiation Server.

On another proposal to extend and expand the work done in interface simplification, to build easily reconfigurable web-based workflows, (Baldridge & Elbert, 2002) use web services to access remote computational chemistry components integrated into a grid workflow environment. A grid workflow management service is used for job instantiation and management through a portal interface, using a network of workflow management web services. The complexities of High Performance Computing (HPC) resources and the difficulty to anticipate where the highest performance can be achieved, force users to learn the nuances of each new system, distracting them from their own problems.

To leverage web services with business object components technology (BOCT) and Distributed Artificial Intelligence (DAI), object-oriented Intelligent Web Services (IWSs) are proposed by (Van Den Heuvel & Maamar, 2003) to facilitate short-term and fluid relationships between customers and suppliers, based in the negotiation of Trading Partner Agreements (TPAs) and their ability to find each other and collaborate. The proposed framework four layers above the physical network are...

- Business Workflow Layer, where IWSs work, moving from task to task
- Business Task Layer, where short interrelated activities produces a task
- Business Entity Layer, to store the state of each task and its workflow
- Distributed Object Layer, for load balancing, message brokering, security and life-cycle management

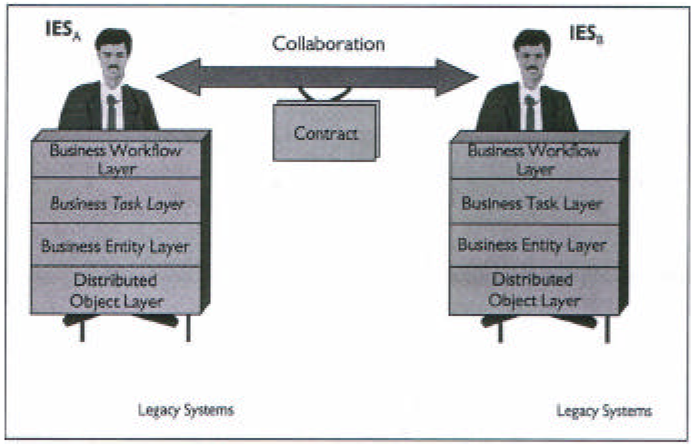

Figure 4. The intelligent Web service framework

The objects on each layer (see Figure 4) follow the TPAs specific or default technical parameters, like encryption or communication protocols, visibility of entities or tasks, middleware technology, network address, etc.; nevertheless, IWS technology is still in its infancy.

Routers's Workflows

An Adaptive Routing Control (ARC) algorithm was proposed and demonstrated by (Yang, Sh., 2003) to improve the performance obtained from conventional routing approaches. ARC uses a central routing server to decide the most efficient path for a workflow task, using the queue information of all subordinate nodes, requested and obtained from local servers (see figure 5)

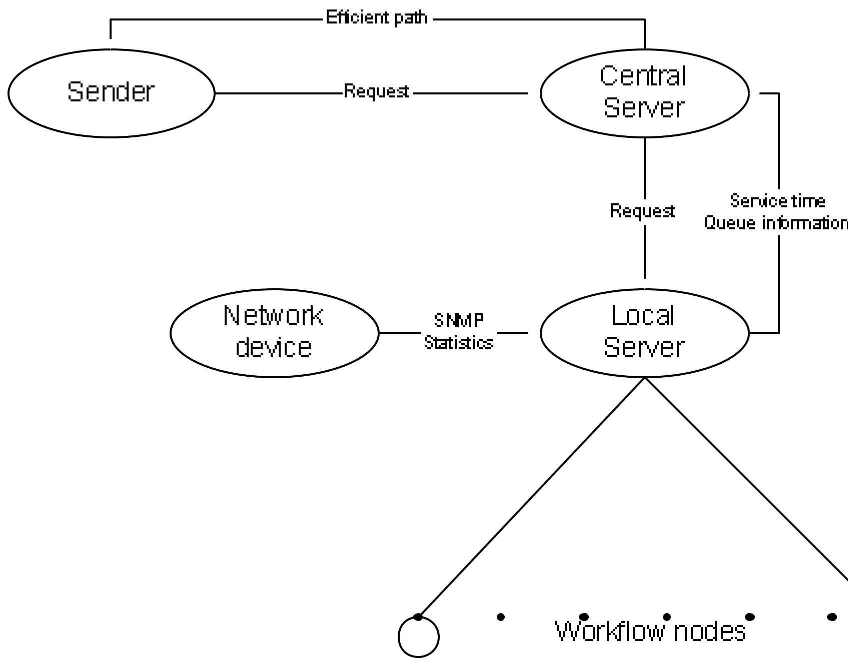

Figure 5. The central server and the local server

Unlike conventional routing algorithms, ARC uses the current available bandwidth instead of the total fixed bandwidth of each link (see table 1) to identify congested routes and support the complex policies governing each path.

Algorithm Item	Conventional (Static)	Conventional (Dynamic)	ARC (Adaptive)
Routing strategy	Static	Dynamic	Adaptive
Link cost (LC)	Number of hops	Total bandwidth	Available bandwidth and Link utilization
Node cost (NC)	Ignore	Ignore	Required
Priority handling	Fixed	Classification or notification	Priority queue with multilevel feedback
Adjustability	None	LC is partially adjustable	Both LC and NC are adjustable
Performance	Poor	Medium	Good

Table 1. Features comparison of Routing algorithms (Yang, Sh., 2003)

After saving one-third of routing requirements at News 12 in Long Island NY, simply by moving from tape-based to server-based play-out, (Moote et al., 2003) present router-servers as a scalable and cost-effective hybrid solution that eliminates the need for hard-wiring or pre-allocating router resources, while enabling central services and content to coexist with local services and content, when combined with the distributed nature of a Storage Area Network (SAN) architecture. To ensure compliance, Media Object Server (MOS) interface protocol, Simple Network Management Protocol (SNMP), Advanced Authoring Format (AAF), and Material eXchange Format (MXF) are utilized.

In the wireless evolution we can find the Bluetooth specification (Halsall, 2000) designed with extremely dynamic routing in mind, to connect to and use any network it may find, and without reconfiguration. The Bluetooth wireless specification is a royalty-free standard with its specification documents available at https://www.bluetooth.org/

Most influential papers

For improving internal workflows, the continuous and remote monitoring of pre-existing software service parameters, presented by (Valetto & Kaiser, 2002) when evaluating the application of the Kinesthetics eXtreme (KS) model from a real-world mass-market Internet service experience, with minimally invasive external facilities, shows a modular approach to incrementally update or upgrade aging but productive systems, while considering their replacement.

On inter-organizational workflows, (Van Den Heuvel & Maamar, 2003) proposed object-oriented Intelligent Web Services (IWSs) with specific details of how to design this layered framework that supports the principles of loose coupling and dynamic binding, certainly promotes future reuse and the dynamic improvement of its components. Maybe the most influential paper of all, it concludes with the possibility of integrating IWSs with wrapped legacy systems, like the one evaluated in the previous paper.

Considering Routers' Workflows, the Adaptive Routing Control (ARC) algorithm proposed by (Yang, Sh., 2003) is a very appealing option to improve internal routing workflows, as long as its required central server can be bypassed when over-loaded or timing-out.

Review of the Literature

Changing from traditional fixed and reliable settings to a dynamic workflow paradigm is an event taking place in different arenas, here explored first with the benefits of flexible workflows, followed by how some businesses are Improving Internal Workflows, starting Inter-Organizational Workflows, which inspired the most recent Router's Workflow initiatives.

Benefits of Flexible Workflows

On e-workflow, the workflow portal (WfMC & WARIA, 2003), the benefits of workflows are explained.

Contrary to traditionally fixed workflows, (Mangan & Sadiq, 2002) proposed a framework to model the logic of non-traditional and highly flexible processes, maintaining simple standard modeling constructs, to obtain the full specification at runtime, which could be unique to each instance from an open range of possibilities. Their example, modeling degree programs in tertiary educational institutes, explore workflow systems as the current leading technology for supporting business processes, as new categories of workflow technology are emerging to automate the coordination of diverse processes. Flexibility is defined as the ability of a workflow process to execute on a partially defined model, which may be increased through extensions to the Workflow Definition Language (WDL) to handle exceptions or instances that cannot be anticipated at design time.

Improving Internal Workflows

Analyzing Project Jupiter, the BBC News re-examination of their entire workflow process to integrate the resources of their newsrooms into a cohesive production center, (Dwyer, C., 2003) explained how they solved their need for a parallel workflow supported by assets management, with an open-architecture server-based production workflow using industry-standard high-speed IT networks.

Part of the WIDE project, funded by one of the programs at the European Union, to develop an advanced commercial workflow management system called FORO, a team at Politecnico di Milano was in charge of the design and implementation of FORO Active Rule (FAR) component for exception management; the team (Casati et al., 1999) documented the specification and implementation of expected but unpredictable exceptions in workflow management systems, based on detached active rules, forming the language Chimera-Exc. Expected exceptions are unpredictable because they cannot be represented in a specific location of the process or with a frequency; they are asynchronous and highly influenced by external factors, so each Chimera-Exc exception handler is activated either periodically or at specified events.

When (Gao et al., 1999) reported their experiences and lessons on managing problems for global software production, after building and deploying a web-based Problem Information Management System (PIMS) to support diverse workflows for global software production projects at Fujitsu, they mentioned the importance of designing for user scalability, data scalability and existing system resources; it is also recommended to setup up the application servers on different machines to share the system load. Three types of workflow-enabled applications were identified:

- workflow-initiating applications
- workflow-participating applications
- workflow management applications

To convert ad-hoc problem management processes into a systematic workflow, an automatic problem tracking and monitoring system was based on a data-driven method, a configurable state-based workflow model with two parts:

- workflow administration
- workflow tracking

This classifications are useful to obtain a well-defined conceptual model, considered essential for collaborative development processes.

(Valetto & Kaiser, 2002) evaluate the merits and limitations of the Kinesthetics eXtreme (KX) model from a real-world mass-market Internet service experience; KX enables continuous and remote monitoring of pre-existing software service parameters, providing dynamic feedback with its minimally invasive external facilities.

Inter-Organizational Workflows

Access control requirements for inter-organizational workflow were investigated by (Kang et al., 2001) to provide solutions for data sharing and work coordination at the global level, while constructing an inter-organizational Workflow Management System (WfMS) called SALSA, by implementing new design-time tools and extending the existing distributed and CORBA-compliant workflow runtime engine called OrbWork. The communication between workflow domains should honor the autonomy of each independent workflow or organization, with detailed cooperation contracts to specify the type of requests or data or timing allowed.

A Dynamic Workflow Model (DWM), an extension to the Workflow Management Coalition's (WfMC) Workflow Process Definition Language (WPDL) was presented by (Meng et al., 2002) to model and control inter-organizational business processes, with an Event-Trigger-Rule (ETR) server that specify triggers as the relationship between business events and rules, to provide timely and automated responses; synchronous events are the access points where organizations can attach their business rules to adapt to changes at run-time. This DWM have also extended the Universal Description Discovery and Integration of Web Services (UDDI) e-service specification, to manage standardized e-service templates with a central Broker Server, that service providers can use to register e-services with their specific constraints. Following the Workflow based Internet SErvices (WISE) Swiss federal project and the European Union research project CrossFlow initiatives, the research on advanced technologies to support Internet-based Scalable E-business Enterprises (ISEE) at the University of Florida is the architecture to be enhanced by this DWM, which provides Application Programming Interfaces (APIs) to modify the process model at run-time.

(Baldridge & Elbert, 2002) described the integration of various computational chemistry components into a grid workflow environment, using web services to access remote resources; their interface simplification strategy, building re-configurable web-based workflows, let the users choose from massive parallel platforms, a network of PCs, or shared memory platforms. They noticed that the difficulty to achieve the highest performance on different systems, force users to learn the nuances of new systems, distracting them from their intended problems; likewise, new grid technologies lack an architecture to integrate various tools into an interface to shield users and application programmers from the complexities of the High Performance Computing (HPC) resources available.

To leverage web services with business object components technology (BOCT) and Distributed Artificial Intelligence (DAI), object-oriented Intelligent Web Services (IWSs) are proposed by (Van Den Heuvel & Maamar, 2003) to facilitate short-term and fluid relationships between customers and suppliers, based in the negotiation of Trading Partner Agreements (TPAs) and their ability to find each other and collaborate. The proposed a framework with four layers above the physical network.

Routers' Workflows

To improve performance on the Internet workflow, (Yang, Sh., 2003) proposed an Adaptive Routing Control (ARC) algorithm, which uses the updated available bandwidth instead of the total fixed bandwidth of a link, identifying congested routes and supporting the complex policies governing each path; this algorithm requires local servers to collect and report to a central routing server, the queue information of all its subordinate nodes; the central routing server decides the best path for each workflow task upon request.

On the broadcastengineering.com article 'Trends in Connectivity', (Moote et al., 2003) explain that new cost-effective hybrid router-servers eliminate the need for pre-allocating hard-wired router resources; at the same time, because of the distributed nature of the Storage Area Network (SAN), hybrid router-servers are scalable systems that enable central services and content to coexist with local services and content, which can improve the Return On Investment (ROI) and workflow.

Three years ago, an article published by (Halsall, 2000) mentioned available off-the-shell products implementing a standard called IEEE 802.11 with wireless communication speeds as high as 11 Mbit/second through walls and floors, while anticipating a new specification known as Bluetooth, designed with extremely dynamic routing in mind, to connect to and use any network it may find, and without reconfiguration.

Consequently with 'Extremely dynamic routing', one of the four research topics to be surveyed by the Routing Research Group, part of the Internet Research Task Force (IRTF-r), the description of the IRTF RRG Ad hoc Network Scaling Research Subgroup (IRTF, 2003) conceptualizes an Ad hoc Network as an autonomous system of routers, free to move randomly and organize themselves arbitrarily.

Conclusion

Wired or wireless, the need for dynamic functionality is being recognized from the internal to the inter-organizational workflows, as well as in hardware and software connectivity improvement plans.

Reference List

Baldridge, K. & Elbert, S. (2002). *QMView and GAMESS: Integration into the World Wide Computational Grid*. San Diego, CA: San Diego Supercomputer Center and Entropia, Inc. (IEEE 0-7695-1524-X/02)

Casati, F., Ceri, S., Paraboschi, S., & Pozzi, G. (1999). *Specification and Implementation of Exceptions in Workflow Management Systems*. Dipartimento di Elettronica e Informazione, Politecnica di Milano (ACM 0362-5915/99/0900-0405)

Dwyer, C. (2003). *Newsroom Automation*. Broadcast Eng (World Ed) 45 no6 Je 2003. broadcastengineering.com (WN: 0315207571006)

Gao, J., Itaru, F., & Toyoshima, Y. (1999). *Managing Problems for Global Software Production - Experience and Lessons*. San Jose State University.

Gilmer, B. (2003). *Storage Area Networking. Broadcast Eng 45 no4 Ap 2003*. broadcastengineering.com (WN: 0309107354008)

Halsall, Ch. (2000). *Networking Alternatives, without wires!*. Retrieved November 15, 2003 from http://www.wabbit.com/busex/20000710.html

Internet Research Task Force (IRTF). (2003). *IRTF RRG Ad hog Network Scaling Research Subgroup*. Retrieved November 15, 2003 from http://www.flarion.com/ans-research/

Internet Research Task Force (IRTF-r). (n.d.). *IRTF Home Page - Routing Research Group Charter*. Retrieved November 15, 2003 from http://www.irtf.org/charters/routing.html

Kang, M., Park, J., & Froscher J. (2001). *Access Control Mechanisms for Inter-Organizational Workflow*. Information Technology Division, Naval Research Laboratory.

Mangan, P. & Sadiq, Sh. (2002). *On Building Workflow Models for Flexible Processes*. School of Computer Science and Electrical Engineering, The University of Queensland QLD 4072 Australia.

Meng, J., Su, S., Lam, H., & Helal, A. (2002). *Achieving Dynamic Inter-Organizational Workflow Management by Integrating Business Processes, Events and Rules*. Database Systems R&D Center, University of Florida. (IEEE 0-7695-1435-9/02).

Moote, S., Roth, T., & Sulte, S. (2003). *Trends in Connectivity.* Broadcast Eng 45 no5 My 2003. broadcastengineering.com (WN: 0312107354011). Retrieved December 1, 2003 from http://broadcastengineering.com/ar/broadcasting_trends_connectivity/

Valetto, G., Kaiser, G. (2002). *A Case Study in Software Adaptation*. WOSS '02, Nov 18-19, 2002, Charleston, SC, USA. (ACM 1-58113-609-9/02/0011)

Van Den Heuvel, W., & Maamar, Z. (2003). *Moving Toward a Framework to Compose Intelligent Web Services*. Communications of the ACM October 2003/Vol. 46. No. 10. (ACM 0002-0782/03/1000)

Yang, Sh. (2003). *Design issues and performance improvements in routing strategy on the Internet workflow*. Department of Computer and Information Science, Soochow University, Taipei, Taiwan. (John Wiley & Sons, Ltd.)

Workflow Management Coalition and the Workflow And Reengineering International Association (WfMC & WARIA). (2003). *e-workflow - the workflow portal*. Retrieved November 15, 2003 from http://www.e-workflow.org/

Workflow Management Coalition (WfMC). (2003). *WfMC Published Documents*. Retrieved November 15, 2003 from http://www.wfmc.org/standards/docs.htm