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INTRODUCTION

Cross-discipline research requires researchers to understand many concepts outside their own discipline. Computer networks are becoming pervasive throughout all disciplines. Researchers have to account for the effects of network-based information systems or delimit their studies so that the effects of the information system are outside the boundaries of their studies. Researchers outside of computer network-related disciplines are interested in studying the effects of network-based information systems on different aspects of their disciplines. This paper presents a model to aid researchers with the tasks of properly identifying the elements of a network-based information system within their studies. Proper identification will reduce confusing the sources of effects from a network-based information system within their studies. Proper identification can also help delimit their studies to minimize the effects of networks and network technology, or aid in assessing the effects of particular elements of the system with respect to the researchers' functional areas.

The complexity associated with network-based information systems may be seen by considering a study involving the effectiveness of an ERP for a mid-sized company. Such a study can become muddled by not recognizing the difference between the ERP application, the company's data, the company's procedures, the performance of the database underlying the ERP, the authentication procedures of the network, and the other myriad of people, procedures, data, software, and hardware involved in the development, implementation, security, use, and support of an ERP system. A researcher who confuses a network security issue of limitations on user's accounts with ERP configuration limitations obscures two important points. One point is that a network must be secured in such a way that authorized users have access to data for which they have rights. The other point concerns what limits are imposed by an ERP when configuring its accounts and their relationships. Both points relate to the availability of data, but their implementations are independent of each other. The two points should not be addressed as if both are attributable to the same source. Confusing network-based information system elements reflects negatively upon the legitimacy of an entire study.

PURPOSE

The purpose of this paper is to provide a model to aid researchers in dealing with the complexity introduced by computing technologies. The model may be used to categorize network-based information systems elements of their studies, to delimit their studies' computer network related elements, or to attribute events that occur during the study.

BACKGROUND

Management information systems, applications systems development, and data communications each have contributed models that may be useful in categorizing network-based information system elements of a study. Kroenke (1981) offered the five component model for planning business computer systems. Willis et al. (1999) presented three-tier client/server architecture for network-based applications. The Technical Committee 97, Subcommittee 16 of the International Organization for Standardization (ISO) created the Open Systems Interconnection (OSI, 1979) Model for network communications (Stallings, 1998).

Kroenke's five components are: people, procedures, data, software, and hardware. Many people are involved in a network-based information system. The people most researchers outside of information technology are interested in studying are the people who use the network-based information system or the people who benefit from the use of the network-based information system. Procedures refer to the tasks that the people perform. Data includes a wide range of data from users' data to the data necessary for configuring the network. Data forms the bridge between procedures and software. Software is the programs, scripts, or applications that provide the ordered lists of instructions that direct the operation of the hardware. The hardware is the equipment used by the users, applications, and in the network.

The three-tiered model presented by Willis et al. views a network-based application as consisting of a "client" tier, a middleware tier, and a "server" tier. The client tier contains applications that present processed data to the user and receives the user's data entries. The middleware processes data using business logic, and the server tier provides the database services. Another variation on the three-tiered model is found in Dean (2002). Dean's three-tiered model refers to client computers in networks. Her model consists of the "client" tier, the middleware, and the "server" tier. In Dean's model, the client is a workstation on a network. The middleware provides access to applications on the servers. The server tier contains servers attached to a network.

The ISO's OSI is a seven-layer model used to separate the tasks of data communication used in a network. The seven layers are physical, data link, network, transport, session, presentation, and application. The model describes a message traveling through the layers and the responsibilities of each layer. The OSI relates to both hardware and software standards. It allows many vendors to provide products that work together in a network.

Each of these models provides part of the puzzle for classifying the elements of a network-based information system. However, one must be familiar with the different types of personnel, procedures, data, software, and hardware to understand which are client, which are middleware, and which are server. If one delves further into the network's function, then the OSI model becomes important in understanding how a message is passed from a sender to a receiver. None of these models were intended to aid researchers outside of the computing technologies areas to understand the relationships among the elements of a network-based information system.

MODEL

To help in understanding the different types of personnel, procedures, data, software, and hardware and how they work together, the following model is proposed.

Basic Network-based Information System Model

Let us begin with a three-tiered model. The top tier will represent the people who use the system or the people who benefit from the system's use. These people have procedures to follow in order to use the system or to receive the benefits. Also, the data representing information of interest to the users and beneficiaries would be in this top tier. For ease of reference this tier needs a name. Let us refer to the top tier as the Use Tier.

Next, let us have a middle tier that represents the applications that do the work the people represented in the use tier want performed. The middle tier we will call the Application Tier. In the application-tier we would find a vast assortment of useful programs, such as Notepad, Word, Excel, StarOffice, SAP, Citrix, MAS 90, POSTman, SAS, RATS, Oracle, and countless others.

The bottom tier of our three-tiers will represent the workstations, operating systems, networking protocols, network devices, cabling, and all of the other hardware, people, procedures, data, and software necessary to make the network operate satisfactorily. Let us call this the Infrastructure Tier.

The model at this point appears as shown in Figure 1. For some studies, this will provide a sufficient amount of detail.

Figure 1: Overview of Network-based Information System

Use Tier People, procedures, and data used to do work
Applications Tier Software used to do work. People, procedures, and data used to create, implement, and maintain software.
Infrastructure Tier People, procedures, system data, system software, and hardware necessary for the applications and network to operate satisfactorily.

Refined Network-based Information System Model

The model in Figure 1 is very simplistic. It does not include organizational structures, inter-organizational connections, or customer-organization relationships that can exist in the use tier. Figure 1 does not show the tiers of a network-based application, and it does not show the layers of communication in the network. Therefore, some studies may need a more detailed model that better defines the content of each tier.

When considering the details of the use tier, we will defer to the functional area specialists doing the studies. Each study will organize the people, procedures, and data in the use tier as best fits the functional area being studied. For accounting and finance, generally accepted accounting principles, Security and Exchange Commission regulations, and other standards and theories define the data. In management, organizational theory gives guidance as to structures in which people work. Operations management provides definitions of procedures used to produce goods and services. Marketing has definitions for procurement procedures, data about goods and services, and relationships among people. Each functional area has its own rich resources for categorizing the elements represented by the use tier.

The three-tiered model of Willis et al. provides a meaningful classification scheme for the application-tier. Thus, we can further classify applications within the application-tier as to their place in three-tier architecture of presentation, functional logic, and data support.

Presentation applications are those that run on the local workstation and present data that has been processed. Examples of presentation applications are browsers, html pages, and client-side scripts. Another example of a presentation application would be the SAP client that runs on the local workstation. Most of the standalone applications, such as NotePad, Word, PowerPoint, and StarOffice, are often considered presentation applications.

Functional logic processes data from the data support tier according to some functional area or communications rules. The functional logic then hands the data it generates to the presentation sub-tier. Examples of functional logic applications or middleware are Java server pages (jsp), Active Server Pages (asp), and Common Gateway Interface (cgi) scripts. Enterprise resource planning (ERP) applications are also examples of functional logic applications. ERPs process the data from a database and then hand the processed data to the client software on the workstation for display.

The data support applications manage the data. Databases are the most common example. However, applications that manage flat files containing data may be data support applications. Batch files that add, modify, or delete data of data sets would belong to the data support sub-tier.

The OSI model refines much of the infrastructure layer. The OSI model describes communications of messages, but it does not include operating systems, systems utilities, personnel, system data above its applications layer, and procedures necessary for installing, configuring, securing, and maintaining the devices and applications represented by the infrastructure tier. If a study involves significant detail in the infrastructure tier, then the research team should include an individual familiar with network technology and management.

Figure 2 summarizes the refined model for categorizing elements of a network-based information system.

Figure 2: Refined View of Network-based Information System

Use Tier

Refinement of this tier should be based on models, standards, or theories being investigated in the study

Applications Tier

- Presentation applications run on a workstation and present processed data
- Functional logic applications may run on either a workstation or a server, but preferably on a server. Functional logic applications process the data according to functional area rules. These are usually the applications of interest in a study.
- Data support applications manage underlying data

Infrastructure Tier

- People, procedures, and data necessary to install, configure, secure, and maintain devices, applications, and services in the system
- System applications outside the OSI model
- OSI model
    - Applications layer: communications applications, such as http, ftp, and telnet
    - Presentation layer: data preparation, such as encryption
    - Session layer: protocols relating to connecting sender and receiver
    - Transport layer: Initial subdividing of data into packets, error checking, and sequencing packets
    - Network layer: Packaging packets with logical addressing and routing packets
    - Data link layer: Packaging of packets for specific types of networks and physical addressing
    - Physical layer: Signal representing the packets, media and devices carrying the signal

USING THE MODEL

Let us consider some examples of research using this model. Let us first imagine that researchers are interested in investigating the effects of using an ERP's accounting features upon the financial performance of mid-size firms. For the use tier, the accountants decide upon classifications for users' procedures, data structures, and the classification of the users. In the applications tier would be several products related to the ERP. In the presentation sub-tier would be the ERP's client that runs on the workstations used by the participants in the study. The ERP business rules modules would be in the functional logic sub-tier. The database used by the ERP would be in the data support sub-tier. In the infrastructure tier, we would find the hardware and system software necessary to implement and support the network, ERP, and the database.

Now let us look at a few events that might occur during the study. A user may not be able to log into the network. This event should be attributed to the infrastructure tier, and not presented as a deficiency of the ERP. On the other hand, if the accountants found that the calculation of a ratio was incorrect, this problem belongs to the applications tier, in particular the functional logic. Another problem that might arise is users entering incorrect data. The entering of incorrect data by users would be a use tier problem. By properly classifying the elements in the study related to the network-based information system, the researchers may find a conflict between the use tier definition of data and the application-tier definition of data. Since the elements of the system are properly defined, the data definition conflict will be more obvious and more easily substantiated.

Now let us consider another possible study. Suppose researchers in the area of marketing are investigating the effectiveness of Web pages in selling XYZ product. The marketing researchers would decide on the classifications of the people involved in the use of the Web site, the procedures used by the people, and the structure of data involved in the use of the Website. The browser used to display the Web pages would be in the presentation sub-tier of the applications tier. The server-side script used to produce the Web pages and apply business rules would be in the functional logic sub-tier of the applications tier. The database management system used to manage data used by the Web site would be in the data support sub-tier of the applications tier. The Web server executing the server-side scripts and serving the Web pages would be in the infrastructure tier.

By properly classifying the elements of the study, the marketing researchers will be able to better assess the functional area-specific effects, such as events that might occur during the study. A few events that might have occurred during the study include failure of the user to read the Web page, an error in computing quantity discount, and an aborted ending of a session due to a faulty connection. The failure of the user to read the Web page would be a use error. The incorrect computation of the quantity discount would be an application error in the functional logic. The aborted session would be an infrastructure error. If the researchers are primarily interested in the user's reaction to the Web pages, they may have delimited the study so that they could ignore the infrastructure error.

Differentiating between the tiers can be problematic. For example, Access can be seen as encompassing all three application sub-tiers. The forms, reports, and Web pages generated by Access are usually considered to belong to the presentation sub-tier. Modules written by functional area developers belong to the functional logic sub-tier. The tables, queries, and system modules are in the data support sub-tier. However, in the marketing study about selling XYZ product on the Web, the researchers may need to distinguish a query that gets catalog items stored in an Access database, from an ASP page that applies customer specific preferences, from a Web page that displays the resulting customer-specific catalog selections. In this case, Access would be in the data support sub-tier, the ASP page would be in the functional logic sub-tier, and the Web page would be in the presentation sub-tier.

In some studies, even applications that we normally think of as presentation sub-tier applications may have elements spread across the three tiers of the model. For example, a business communications study may be interested in formatting errors, grammar errors, file corruption, and typographical errors. In this study, typographical errors could be due to user error or infrastructure problems. If the user makes a mistake typing a character on a familiar QWERTY keyboard, then the error would be attributed to the use tier. On the other hand, if the user were given an unfamiliar DVORAK keyboard, then the error could be attributed to the infrastructure tier. In neither case should the errors be attributed to the application-tier. Within the application, Word incorrectly reformatting may be classified as a presentation feature's error. Grammar errors undetected by the grammar checker could be attributed to the functional sub-tier, and the corruption of a file by the save operation would be a data support error.

As just shown, classifying the elements and events may vary according to each study's purpose. However, the classification should reflect appropriate network-based information system relationships. In differentiating the application-tier elements, a helpful tactic is to identify which elements present the data, which elements perform functional area-specific processing, and which elements manage the underlying data. Once the elements are identified, then the events associated with the elements are more easily attributed. Properly classifying information system elements and ascribing the events make a study more reliable.

CONCLUSIONS

In this paper, we have seen that the elements and events of a study involving a network-based information system may be classified to reduce confusion. The appropriate classification of information system elements and attribution of events within a study should lead to more reliable results.

WORKS CITED

Dean, T. (2002) *Network+ Guide to Networks*, 2nd ed. Boston, Massachusetts: Course Technology.

International Organization for Standardization (ISO) (1979 to present) "*Open Systems Interconnection*," 35.100. http://www.iso.ch/iso/en/CatalogueListPage.CatalogueList .

Kroenke, D. (1981) *Business Computer Systems, An Introduction* Santa Cruz, California: Mitchell Publishing Inc.

Stallings, W. (1998) "*The Origins of OSI*." http://williamstallings.com/Extras/OSI.html.

Willis, T.; Wilton, P.; Brown, M.; Reynolds, M; Lane Thomas, M.; Carison, C.; Hasan, J.; Barnaby,T.; Boutquin,P.; Ablan,J.; Harrison,R.; Shlosberg, D. & Waters, T. (1999) *Professional VB6 Web Programming*. West Sussex, England: Wrox Press Ltd.