Engineering Management
Field Project

The Laws of Documentation - Engineering Document Control for Telecommunication Systems

By

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Executive Summary

The purpose of this field project is to create a documentation system that allows co-workers at a telecommunication company to store files on a shared LAN and retrieve that information quickly, easily and confidently when needed. A dictionary provides a good illustration of the laws of documentation that must be applied to a working documentation system. A solution for storing project-specific, site-specific, product-specific information as well as inter-company documents such as request for proposals, quotes and scopes of work is developed.

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1.   Introduction

Documentation is a critical component of a well-functioning company or organization. "Intellectual capital and the management of the intellectual capital is becoming more important in terms of potential investment and the future of a company" (Sainter 3). "The effective and efficient communication of information internally within an organization and externally between organizations is a strategically important competence for almost all organizations" (Harris 385). A proper documentation system allows employees to locate, use, update and store information without losing or writing over someone else's work. Whether it is labeled data management, information management, knowledge management, configuration management or document control, all companies need to be able to store "something" in a way that they can retrieve that "something" at a later date. Knowledge management is a key success factor of a business' strategy.

Taming document clutter needs to be a high priority in today's businesses. Clutter is the twisted mess that piles up in everyone's living space. It wastes money and energy by occupying time to search through the chaos. It even creates anxiety and frustration. Try finding car keys when it is time to go to work. The effects of clutter in the workplace are lost and misplaced documents which result in wasted time, low worker productivity and decreased profit. Clutter also leads to poor morale among employees and poor communication among teams. "Frustration caused by poor documentation can lead to ill will among workers. The emotional and psychological effect to these workers is decreased employee morale" (Millman 2).

Surprisingly, de-cluttering this document mess is not a hot topic and very little has been written about it. Bergman stated that a UC Berkley study found that each year in the United States there are more than four billion pages of internal office documents produced with archival value (Bergman 6). However, only three large document studies have been produced since 1995 with regard to the importance of documents and the manner in which companies use them (Bergman 5). Most companies ignore the documentation clutter problem. This can be a huge problem since 85 percent of corporate data is contained in documents (Bergman 32). In today's knowledge economy, companies cannot afford to neglect or mismanage the valuable resources locked in their documents.

In a quality-minded environment, documentation control is essential. "Global marketing today requires ISO9000 certification. Part of the certification process requires that a company quickly locate documents and provide good document controls" (Ehrlich 92). However, ISO does not tell you how to do it. Dr. Deming's ninth point in his fourteen points for the transformation of management states that management should "break down barriers between departments" so different groups can work as one team to foresee problems (Aguayo 124). By creating a documentation system that helps different team members locate and use up-to-date information, this ninth point is put into practice. Instead of a throw-it-over-the-wall mentality where one group does not know what the others are doing, a centralized document system allows everyone to see document changes the same way at the same time, thereby reducing errors. NASA determined that users of documentation look for information for a few minutes, but become frustrated when they are not able to find it quickly. This frustration leads users not to follow

documentation procedures, which "can lead to serious non-conformance issues" for many companies (Olson 59). Knowledge workers need guidelines to be able to access information quickly, easily and confidently so that they have the right information. According to Bergman, an A.T. Kearney study "estimated that knowledge workers waste between 15% to 25% of their time in non-productive document activities" (Bergman 3).

This author's frustration caused by the inability to locate information at multiple telecommunication companies led to the creation of the FOUR LAWS OF DOCUMENTATION presented in this field project. Two companies were essential in developing understanding for this field project. One was an internal projects telecommunication company with the engineers focused on building microwave systems for the company itself. The other was an external projects telecommunication company with the engineers selling microwave products and helping other companies build their microwave networks. At each company, engineers created most of the project information in the form of Microsoft Office products such as Word, Excel, PowerPoint, and Visio. Quite frequently, new projects needed this information to upgrade existing systems or sites. Both companies used a shared network LAN to store the project information, and all engineers, project managers and sales people had complete access to the LAN.

Companies with documentation problems have similar symptoms. In the two companies cited, engineers, project managers, sales representatives and technicians had the same problems. Engineers generally manage their knowledge on a "personal rather than a company basis." Their management is usually "in an ad hoc and sometimes incomplete manner" which leads to knowledge loss (Sainter 2). First, engineers, project

managers and sales people wasted time searching for documents that should have been readily available. When documents could not be found, they had to be recreated. This duplication wasted more time. Classic symptoms of documentation problems include space problems and misfilings (Lawinski 43). Second, documents that were finally located may not have been the correct revision; therefore, engineers may have been working with outdated information. Document management problems include (1) "finding the right version of the right document at the right time" and (2) "using inconsistent documents" when the holders of multiple copies make changes to a document without the other users' knowledge (Harris 387).

For example, consider the consequences of using revision C of a floor plan when revision D had already installed more equipment. Revision D equipment may already occupy equipment space that engineers plan to use for new equipment. This duplicated use of the same space requires moving the new equipment, which makes all of the connecting cables too short or long. Inappropriate cable lengths require ordering more cables. These cascading problems lead to a delay in the project just because the team did not use the correct version of the floor plan. Third, different groups working at the same sites usually kept their own documentation. This isolation meant the teams were not talking as they were planning changes to the same site at the same time. This lack of communication could lead to different groups planning to use the same floor space and not finding out until the time of installation.

Finally, poor documentation became a problem with customers who demanded quicker responses. Engineers and sales people became embarrassed in front of customers when they could not locate the work of others in the company. Problems with finding

documents resulted in spending "several hours weekly just locating files" and having to open the file to find the correct one (Ehrlich 92). Wrong information caused missed deadlines. Employee morale suffered. All these reasons resulted in frustration, low productivity, wasted profit and errors that should have been avoidable. Previously created file information was difficult to locate and at times impossible to find because it was stored inconsistently. The problem was not with the engineers, sales people, technicians or customers. The problem existed with the way the companies had chosen to handle their documentation process.

What if information was stored correctly? What if a company could locate information within seconds instead of hours? What if a company could find the final revisions with confidence? Two companies did give permission to implement a system for controlling documents. At the internal projects company, the focus was to locate internal documents for use on projects such as project definitions, budgets, site information, and product information. At the external projects company, because it was dealing with many customers, the goal was to control the documents that flowed between companies such as request for proposals (RFP) and quotes along with statements of work (SOW) and installation manuals. It was also important to manage the project, site and product information as well.

While there may be several ways to control documents such as relational databases or third party solutions, this field project solution uses designed directory structures and "smart" filenames to store information on a shared network at a telecommunication company. It uses Windows Explorer to view the documents which means that any company can implement this solution today at very low cost. This

solution facilitates the efficient retrieval of documents which saves time, increases productivity, and increases employee morale. "The reuse of knowledge saves work, reduces communications costs, and allows a company to take on more projects" (Hansen 106). The engineers can spend their time working on the project instead of looking for the information so that they can start working on the project.

If a documentation system can be taught to employees that is low cost and enables them to store and retrieve correct information quickly, easily, and confidently, how much is that worth? Most companies have the ability to implement a document sharing system with just a little training to its employees. According to Microsoft, "good documentation management and retention decreases risk and liability while boosting productivity and efficiency" (How Better Document Control Cuts Your Risk, Boosts Your Efficiency). A protocol for good documentation management and retention is exactly what this field project accomplishes for an engineering group at a telecommunication company. This document defines procedures for documentation that will allow electronic file information to be stored on a shared network and easily retrieved when needed. When it comes to documentation storage, the time is now for the corporate spring-cleaning of clutter.

2. Literature Review

Locating previously written literature related to designing filenames and directory structures to control documentation was difficult. A University of Kansas librarian was unable to locate useful information either. In 1997, S. Harris stated that a "general understanding about document management strategies is very variable and is not itself well documented" (Harris 385). In 2006, Pitman and Payne noticed that researchers in

the study of early human-computer interaction (HCI) deemed the choice and use of lexical filenames as an important topic; however, it has "recently become unfashionable" (Pitman 489).

This lack of recent study has left some "unexplored connections between naming and the use of computers by teams" (489). Pitman and Payne also state that when teams share files, there continues to be a problem when team members try to retrieve that information (489). To investigate whether team members could alter their filename technique to make it easier for others to use, they performed two experiments. These experiments examined the retrieval effectiveness between a group creating filenames for its own use and a group designing filenames that others would use. While individuals may be able to recognize their own filenames better for self-use, the two studies indicate that a designed filename is better when other people are trying to retrieve that information.

This conclusion confirms the earlier studies they referenced. This study is important for companies that use shared networks to store information that multiple people will use. A major difficulty for designing filenames for later retrieval by other people is being able to predict the way those other people think, reason, and remember things. These difficulties are caused by the complexities of natural language and the myriad ways to refer to a subject. Pitman and Payne's study gives credence to this field project that uses the "smart" filename concept of designed filenames that makes retrieving information on shared networks easier for multiple users.

Because people hardly ever agree on filenames, a "smart" filename formula that follows a predetermined design can guide a team to name files consistently. One author

who researched filename usage is John M. Carroll. In the early 1980's, Carroll studied how people name files and commands and how the filename's characteristics affect the way in which people use and learn them. He stated that naming paradigms follow a form which "suggests properties of the files and commands to which they refer" (Carroll 330). When a name does not follow a paradigm, "people experience difficulty and confusion" (330). Because people name files for later retrieval and use, a bad filename can cause trouble in locating those files. Therefore, Carroll states, "the filenamer's task seems to be one of constraining or collapsing a description of a file into a name that can evoke the description during retrieval" (330). He collected and examined 2500 real filenames from 22 staff members from the Watson Research Center in Yorktown, New York. Carroll classified the filenames into two groups, filename paradigms and non-paradigmatic filenames.

Paradigms were of more interest because "overall, 85 percent of the filenames were organized into paradigms" (332). These paradigms follow a structural schema of some sort. The example Carroll provides is GETP, GETPNA, GETUCB, and GETUIC that follow the <getx> schema. Each <getx> filename makes it clear that they "get" something. He further broke the paradigms into 'literal paradigms" and "non-literal" paradigms (333). Like the "get" example, literal paradigms repeat certain common characters. Non-literal paradigms do not have the repetitive characters but still follow a schema. An example Carroll gives is the pair of commands "BRIGHT" which makes a line on a computer brighter and "DIM" which makes the line dimmer (333).

Carroll proceeds to study command paradigms to infer the links between paradigmatic structure and behavioral usability. These experiments used a computerized

toy robot system that utilized command names to control the robot to perform certain tasks. Commands are grouped in pairs such as up/down or right/left. In these experiments, subjects go through a battery of tests using the robot (335).

Carroll developed two terms of congruence and hierarchicalness. Congruence relates to non-literal filename paradigms and occurs when commands with contrary functions are assigned names that are semantic contraries in English such as bright and dim (335). Hierarchicalness relates to literal filename paradigms and occurs when "lexical elements of a command are repeated and form a basis for organizing the command language" (336). In his conclusion, Carroll states that command customization should not be unstructured. Also, when people are allowed to customize commands, they should be prompted in some way. Finally, he suggests that "all names be organized into paradigms and be congruent and hierarchically consistent" (345).

Carroll did state that "rendering a file content description is not really analogous to the sorts of things people design filenames for anyway" (334). That is why he progressed to command names. On the contrary, rendering a description of file content is very important. When a company creates documents using Microsoft Office and not merely commands of instructions, the file description is very important when communicating the type of document to coworkers. The "smart" filenames in this field project are designed to communicate their placement, the type of file, and the revision of the document to communicate clearly with coworkers as they view the filename. It relies heavily on the idea of using a naming paradigm with a hierarchical syntax to organize the filenames. Microsoft Explorer sorts the hierarchical filenames automatically when viewed in the Details View.

Knowing which documents to store is also important. In his book The Practical Guide to Project Management Documentation, John Rakos and his team of MBA students at the University of Ottawa define project documentation and provide detailed templates for use. Most management books refer to project documentation but do not show useful examples. However, because most project deliverables are documents, it is crucial to produce them correctly and consistently (Rakos ix). Rakos and his team follow the major phases of the Project Management Book of Knowledge Guide (PMBOK) and present examples of documentation that the PMBOK does not include. Defining the names of these documents is crucial in order to develop a standard naming filename so that they can be stored on a shared network.

Having a finite number of documents and naming them consistently mitigates the problem of natural language and the complexities of not knowing what to call a document. Realizing that different companies may call these documents different names is important. For example, instead of using the term preliminary plan, other companies may call this a project definition or workbook. Rakos provides an excellent explanation of project-specific documentation, but this is where he stops (ix). In a company, more documents exist related to a project such as site-specific or product-specific documents that need to be defined and controlled as well. This field project addresses these other documents along with project-specific documents to provide a complete picture of the documents needed.

In his book, Engineering Documentation Control Handbook, Second Edition, Frank B. Watts discusses how documentation control is a key business strategy (v). Using clear, fast, accurate and simple documentation, companies can achieve outstanding

configuration management (CM) processes. With outstanding CM processes, quality will improve. Watts says, "Good CM alone will not achieve world class Total Quality Manufacturing (TQM); however, world class TQM cannot be achieved without world class Configuration Management" (ix). Some of the benefits of CM he lists are that products will get to market faster, that customers will be happier, that costs due to rework will decrease, and that lead times will shorten (3).

Watts is critical of the reliance of companies on ISO certification because ISO does not care how efficient the processes are. On a scale of A through E with an "A" being a "World Class" system and an "E" being an incapable system with no CM process, Watts rates a system that just passes ISO requirements as a "D" (8). Watts describes in detail the product documentation based on an example of a front end loader which is used throughout the book. Four areas he discusses are product and document release including drawings and identification number, bill of materials, change requests and change control. Watts hopes that, in the future, CM will be viewed not just as a way to meet ISO requirements but that it is seen as a "first step in constant improvement and a necessity for management" (354).

Blair and Maron stated that finding documents which contain useful information is everyone's problem (Blair 1). One way to search for documents is to use a full text retrieval system known as a search engine. In their working paper, "An Evaluation of Retrieval Effectiveness for a Full-Text Document Retrieval System," they examine automatic full-text retrieval as a solution for finding all and only the relevant items during a search. Blair is highly critical of full text retrieval systems because of the difficulty with recall and precision. "Recall measures how well a system retrieves all of the

relevant documents, and precision measures how well the system retrieves only the relevant documents" (3). In their study in 1984, they statistically examined how IBM's STAIRS/LTS (Storage And Information Retrieval System/Thesaurus Linguistic System) software accomplished the task of retrieving relevant documents in a law firm (4). Even though the lawyers believed they were receiving at least 75 percent of relevant documents, they were actually retrieving only 20 percent (12).

Blair stated that "it is impossibly difficult to predict the exact words, word combinations, and phrases which are 1. used by all relevant documents and 2. used only (or primarily) by those documents" (Blair 13). This difficulty is due to the complexities of natural language. Increasing the number of keywords in a search increases precision but decreases recall because "there is a probability that some relevant documents will be excluded by that reformulated query" (19). Blair and Maron conclude, "there are reasons why full-text retrieval systems are unlikely to perform well in any retrieval system" (25).

Even with a plan for documentation control in place, employees' fears and lack of trust can still be a hurdle for information sharing. Birgit Renzl examined the importance of knowledge sharing between teams and the links between trust in management and knowledge sharing. She discusses the characteristics and meaning of trust. Emphasizing how the employee's trust in management affects the employee's behavior in relation to knowledge sharing, she examines reasons why an employee is willing to engage in the process of knowledge sharing. Renzl reasons that two effects of this trust are: (1) it has a negative impact on the fear of losing one's unique value to the company and (2) it has a positive impact on the documentation of knowledge (207). These two effects positively influence both the knowledge sharing within teams and the knowledge sharing among

teams. She points out that knowledge documentation is not just a "technical problem that can easily be solved by information technology (IT)" but is also largely dependent on the "willingness of the parties involved" (216).

A trusting atmosphere contributes to that willingness. This trust leads to increased knowledge sharing which leads to an increase in the rate of new product ideas, which then contributes to the overall performance of the company. While trust is not the focus of this field project, thinking about it is important when presenting these new ideas. When discussing these new documentation ideas, this author has had to answer questions such as "Why are you messing with our jobs?" and "Aren't you making it easier for us to be replaced?" (Sullivan 2007).

As stated by Sainter, without a workforce educated to the importance of knowledge sharing, "a negative culture can exist, and employees may feel that 'giving away' their information will make them vulnerable to redundancy or resent being told what to do" (Sainter 4). The fact is that an employee who does not know how to document is more vulnerable to being replaced than the one who learns how to document correctly. A company can hire anyone who does not know how to document, but an employee's value rises when he/she knows how to store and retrieve documents correctly because that knowledge helps the whole team become more productive. In addition, there is the added benefit to the employee of getting work done on time and incurring less frustration, thereby making his/her job more enjoyable.

3.   Procedure and Methodology

Only one reason exists to store information, and that reason is to retrieve that information later, whether it is one day, one week, one year or more. However, retrieving

information is not enough. If a needle were lost in a haystack, it would be possible to retrieve that needle by moving one piece of hay at a time. That type of retrieval is not acceptable in telecommunication companies because it takes too much time. Not only do users need to retrieve information, they need to find the correct information quickly, easily, and confidently. The question is "How?" By applying the correct rules, a documentation system can be created that is easy and reliable to use for everyone in the company.

It is beneficial to examine working documentation systems with comparable qualities as required in the workplace. Many good examples of documentation systems that everyone uses already exist. For example, the dictionary, the phone book, and the encyclopedia are easy to use data repositories that make it easy to find detailed, correct information quickly. Think about all the books in all the libraries in all the cities of the world. The Dewey Decimal System organizes many libraries so that the visitors can find information. Interestingly enough, all of these trusted documentation systems follow the same laws of documentation that allow quick retrieval of information. In each of these systems, users are able to locate information easily, even though there is a lot of unneeded data to sort through. Yet, the unneeded information never interferes.

Now compare those easy to use documentation systems to the way a business stores electronic files. Businesses usually store information poorly with individuals doing their own thing. Also, compare those organized systems to using a search engine on the internet. Even with the power of sophisticated search engines, there is frequently too much information provided to be useful, or there is a lot of irrelevant information mixed in with the results. Users are never sure if they obtain the correct or best

information. What allows one type of documentation system to retrieve information precisely while the others cannot? All good documentation systems follow the same laws in order to locate information easily. The goal is to make locating information and files on a company's shared LAN as easy as looking up a word in the dictionary.

3.1   THE LAWS OF DOCUMENTATION - DICTIONARY EXAMPLE

This field project proposes that all systems which allow the user to find information efficiently must follow certain laws that make the retrieval of stored information possible. The laws are (1) the items must be stored in one place only, (2) the items must be uniquely named, (3) the items must be in a defined order, and (4) the defined order must match the users' search criteria. The dictionary is an excellent example of these laws. This example also provides a way for large groups of people to visualize the laws clearly at the same time.

3.1.1   Store Items in One Place Only

The first rule of good documentation is to store information in one place only (Sullivan). Imagine trying to find a word in the pages of 50 books. That word may be found one time, many times, or none at all. It would be impossible to know where to start looking for it, and it would take a long time to locate it. If the word was not found, it may not be there at all, or it may have been overlooked. There would be no way to know. A dictionary breaks words out of their sentence structures and stores the words in one single book. In addition, each word is in the dictionary one time. This way the user knows that there is just one occurrence of the word to look for. Once he finds it, he knows that he can stop his search. Multiple places cause uncertainty. Dictionary users

do not have multiple locations to search and do not have this uncertainty. Because the word is in one place, it is easier to find.

3.1.2 Uniquely Name Items

The second law of good documentation is to name items uniquely (Sullivan). Try looking up the word "cabinet" in the dictionary if all the words were spelled "cabinet." There would be no way to know which "cabinet" was the correct one. Once all the words are in one place, there must be a way to tell the words apart from one another. The unique naming allows differentiation between the words. Otherwise, it would be impossible to find the word among all the others. A unique name is essential to confidently finding accurate information.

3.1.3 Defined Order

The third law of good documentation is that the items must be in a defined order (Sullivan). This order can be alphabetical, numerical, chronological, or whatever makes sense to the documentation schema. The hierarchical structure of an order sorts the word which makes it easier to find. Imagine a dictionary where all the words were in one place and where they were all named uniquely, but they were not in alphabetical order. Instead, the dictionary contained randomly placed words. Without the hierarchical structure of the alphabetical order that sorts the words, there is no way to locate the word quickly. The user would have to start at the beginning and search every word until he found the one for which he was searching. This system is the "needle in the haystack" problem. A defined order is necessary when trying to find information quickly.

3.1.4   Order Must Match Searcher's Criteria

The fourth law of good documentation is that the order must match the criteria for which the searcher is looking (Sullivan). Consider if the dictionary randomly numbered each word as 1) penguin, 2) bear, 3) zebra, and so on. For a user looking for the word "cabinet," it would be very difficult to find. Again, this is the "needle in the haystack problem." The user would have to start at the beginning and search each word until he/she found it. Even if the first three laws are followed, the word is hard to find if the way the user is trying to use the information does not agree with the order in which it is sorted. In reality, the dictionary sorts alphabetically by word and the user is looking for a word; therefore, the order and criteria match. This match makes quickly locating the information easy.

3.2   HOW THE LAWS WORK TOGETHER

Ask people if they know where the word "skyscraper" is in the dictionary, and most of them will say "yes." However, nobody knows where any word is in the dictionary. What they know is where it is not. When a system follows all four laws of documentation, these laws allow users to throw away large chunks of information where they know the desired information is not located without even reading it. For example, when looking for the word "skyscraper," users quickly discard the "A" section, then the "B" section and continue deleting until all that is left is the "S" section. Notice that users still do not know where the word is located, but they have been able to throw away most of the dictionary because the laws assure them that the desired information is not in those sections. Because all the words now start with "S," users move on to the next letter and discard the "SA-SJ" sections and the "SL-SZ" sections until they are left with just the "SK" section. Users still do not know the location of the word. This process continues.

Once users whittle down the information where they know it is not, the information that is remaining is the information for which they are looking. These laws work together to enable users to discard unneeded information in order to locate the correct, needed information quickly, easily and confidently.

3.3   PROBLEM WITH THE DICTIONARY

The one drawback of the dictionary example is that, if a word is unknown, then it is impossible to find. This lack of relevant information can also be a problem for project documents stored on a shared LAN. This problem occurs when one employee gives a file an arbitrary filename, but the other employees have no way to decipher the filename. That important information will usually be misplaced and never found. Fortunately, telecommunication projects have a finite number of clearly defined documents that are usually repeated which makes them easily learned. A form of a controlled vocabulary can be enforced to define which terms to use for each document. A controlled vocabulary helps mitigate the effect of natural language by taking out the uncertainty that comes from personalized naming. Therefore, this problem is not major when applied to a project documentation scheme.

3.4   DOCUMENTATION DIAGRAM

Understanding where information belongs one time only is the first step in designing a documentation system that works. In her book, <u>Organizing from the Inside Out</u>, Julie Morgenstern says that people would like to put things away but that they do not know where to put them. Her solution is first to evaluate what needs to be stored and then to "assign each item a single, consistent home" (Morgenstern 16). As with a dictionary, each word has a single consistent home because the four laws of

documentation are used. It is important to group like items together and understand how to determine whether documents are really being stored one place only. A documentation diagram is useful to keep this idea straight and to ensure coworkers use the same system.

3.5   UNDERSTANDING SMART FILENAMES

      In this documentation system, a smart filename ensures that electronic files have unique names, are in an order, and match the user's criteria where they belong only one time. Without knowledge of Carroll's studies, the smart filenames were designed with a hierarchical form to help organize the filenames. A smart filename uses a hierarchical syntax schema to help organize the filenames when viewed in the Details View in Windows Explorer. The filename is configured in four sections that make up the filename, plus an underscore and a notes section just for added information. These four sections tell the user where the file belongs, what type of document the file is, clarifies the type of document, and includes a revision. After the revision, an underscore clues the user that the remaining part of the filename is just notes. The four sections work together to create a unique filename. The smart filename is designed to sort itself by all four sections. This sorting enables the user to discard unneeded information and locate the desired document. All co-workers can create consistent filenames by using this filename formula. The benefits of a unique smart filename are that it saves time, it lowers frustration, and it enables the user to find the latest revision easily. If misplaced on the LAN, smart filenames can be easily located with a search because the files are identified uniquely. A filename that is not unique will not be easily located. The typical smart filename formula is:

(Where it belongs) (Type of document) (Clarifier) (Revision)_notes

(Sullivan)

Figure 1 shows an example of all four laws of documentation working together for site-specific filenames at the Henderson site. The first section that the filename sorts on is the unique name of the site "Henderson." Because this first section of the filename tells where it belongs, misplaced files such as Baton Rouge and New Orleans will sort above and below the files that belong in the directory making errors easy to spot. When the first section is identical, then the second section sorts on the type of documents at the site. Each type of document will sort together, sorting like with like. For instance, all of the floor plans (FP) sort together just as all of the "sk" words sort together in the dictionary.

Figure 1 – Smart Filename Example – All smart filenames contain four sections that tell 1) where the file belongs, 2) the type of document, 3) a clarifier and 4) a revision. When viewed in the Detail View of Windows Explorer, the filename automatically sorts itself on all four parts of the filename. This sorting creates a hierarchical structure. Misplaced files are recognizable because they sort above and below the group of files that belong in the directory (Sullivan).

After the first two sections sort, the third section to sort is the "X-letter clarifier." This subjective field is necessary in case there are different aspects of the document type. As shown, the floor plans group by "floor 1" and "floor 2." The "X-letter clarifier" runs the risk of natural language complexities. However, because the first two sections narrow the filenames to just a few remaining, this risk is manageable. The fourth section to sort is the revision. When the first three sections of the filename are identical, the revision will sort in order with the most recent revision at the bottom making it easy to recognize. The revision can be a letter, number or date, but they must be consistent. If a date is used, then the order must be "YYYY-MM-DD" in order to sort in proper chronological order.

4.   Results (How Methodology is Applied to Telecommunications)

Now that the basic rules of documentation have been identified, the rules can be applied to the telecommunications industry. First, an examination of an internal company will reveal the internal documentation structure. Secondly, the documentation scheme will be expanded to include the external projects company and the interactions between separate companies.

The Laws of Documentation are:

1. Information must be stored in one place and one place only.
2. The information must be uniquely named.
3. The information must be stored in a defined order (alphabetical, numerical, chronological, or whatever makes sense).
4. The order must match the information that the user is trying to find

(Sullivan).

The rest of this document shows how a company's documentation system based on these Laws of Documentation allows employees to locate and use information. It also describes how to understand the proper "one place" to store information and describes the smart unique filenames to keep the information in order.

4.1   INTERNAL COMPANY

At the internal company, the focus was to organize information to help build microwave networks across the United States. Each project created new microwave links or upgraded existing links and sites with new equipment to add capacity. The problem that engineers faced was the inability to find site information when managers assigned new projects. Obscurely named project folders hid site documents. Many project managers were using their personal names as a directory to control the projects for which they were responsible.

4.2   DOCUMENTATION CLOUDS

The first step in organizing documents is to identify the types of documents being used and to understand where those documents belong one time only. Documentation clouds are the different directories in which to store information so that the search can be narrowed easily. Determining which cloud is the one place to store the document is a critical key to store information correctly.

By recognizing that many different projects may be performed that will affect one site, it is easy to see that the site-specific information should not be stored in the project folders. The site information would be too hard to find stored in multiple places. For instance, a site locator map would only be useful for one site; but many projects may take place at that site. Therefore, the site locator map should be stored in the site cloud and

not the project cloud. Likewise, since a single project may affect multiple sites, it is easy to see that project specific information should not be stored with site-specific information. A project definition will be useful for only one project, but it may cover multiple sites. Therefore, the project definition should be stored in the project cloud and not in the site cloud. Two different places, one for project information and one for site information, need to be created.   Other types of documents were product-related documents such as manuals and data sheets.   Because multiple projects commonly installed a single product at multiple sites, a third product-related storage place needed to be created.

4.3   PROJECT-SPECIFIC DOCUMENTATION

This section explains the theory of project-specific documentation, the filename convention for project-specific documents, and exactly what types of documents are considered project-specific.

4.3.1   Explanation for Project Documentation

At the beginning of a project, an engineer writes a project definition that describes the work to be performed, the planned path and all sites included in the project. This engineer wants to document work properly and store it in the correct place so that others may find and use it. But where should the project information be stored?

The first cloud in the documentation process is the project-specific cloud that stores project-specific information. Each project will have an individual folder to store the project-specific documents such as project definitions, project books, budgets, schedules, supply lists, and whatever else is needed for the project. All project-specific

information should have the project-specific "P######" code in the filename/document name to identify it with that project.

Figure 2 – Project Specific Cloud - The project-specific cloud is a directory on a shared network that contains directories for each project. Each project requires a unique identifier such as a project number (Sullivan).

4.3.2   Project-Specific Directories

Project-specific documents should be stored so that anyone in the company can find all the documents and the revisions for each project without wasting time searching. The documentation process should assure that the latest documents along with the previous revisions can be accessed quickly. In order to access documents that are specific to a single project, the document must be named with a project-specific identifier. This project-specific identifier has to be unique to the project, such as the project number "P#####."

The project documentation is located in the Project-Specific Documents directory. In this directory, each project has a directory to store its project-specific documents. As shown in Figure 3, the project directories have the format of (P#####)(Project Name). The project number must be at the beginning of the directory name because it is the only project-specific identifier that is consistent and unique. Also, the project number will sort easily in Windows Explorer; so anyone in the company can locate his/her project folder immediately and without hassle. The Project-Specific Directory is setup like a "Project Dictionary" with the project folders stored in numerical order.
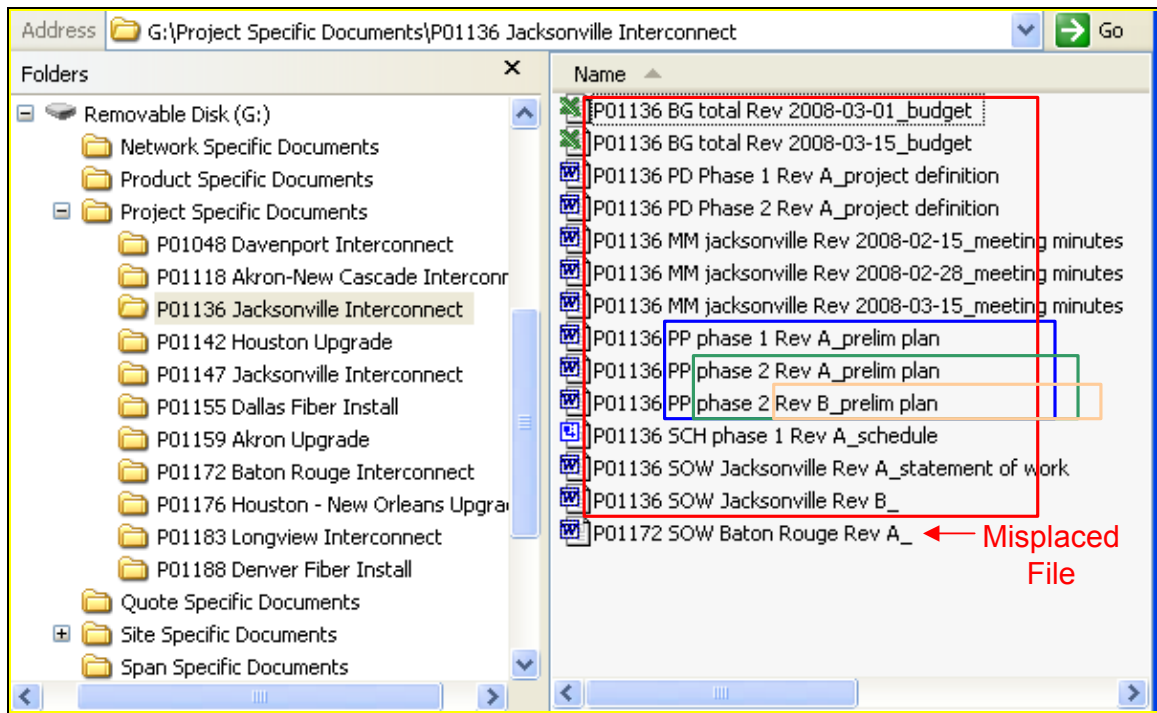
Figure 3 - Project Specific Documents – In the project specific directory the project folders sort numerically because each project has a unique project number. Inside each project folder, the documents sort on the four parts of the smart filename. Misplaced files are easy to spot because they sort above or below the group of files that belong in the directory (Sullivan).

4.3.3 Project-Specific Filename

As shown in Figure 3, the project-specific filename format is well defined to provide consistency when searching for documents. This format prevents subjective, hard-to-find filenames. The filename format consists of the six digit project-specific number (P#####), the two or three letter document type identifier, an X-letter clarifying field for clarity and differentiation, and a revision letter or date. The revision letter starts with "A" for initial releases and then continues with "B-Z" for the revisions. After the revision number, an optional underscore (_) and notes can be added for clarity. The filename format is as follows:

(6 digit project #) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes) (Sullivan)

4.3.4 Project-Specific Documents

Some examples of project-specific documents, along with the two or three letter document type identifiers that will be used in the filename are shown in Table 1. As more documents are needed, this list can be extended.

Drawings Description	2 or 3 letter Document Type Identifier
Project Definition	PD
Budget	BG
Schedule	SCH
Equipment List	EQL
Project Book	PB
Installation Plan for Full Project	IP
Project Description Summary	PDS
Purchase Order / Invoice Tracking	POI
Statement of Work	SOW
Test Plan for Project	TP
Test Report for Project	TR

Table 1. Project-Specific Document Type Identifiers. The two or three letter document type identifiers are the abbreviations that will be used in the smart filename for the type of drawings. More can be added if needed.

4.4 SITE-SPECIFIC DOCUMENTATION

This section explains the theory of site-specific documentation, the filename convention for site-specific documents, and exactly what types of documents are considered site-specific.

4.4.1   Explanation of Site-Documentation

When a project is started, an engineer determines which sites are involved and looks for the most updated (latest and greatest) documents for those sites, such as site locator maps, rack elevations, block diagrams, equipment layouts, site plans and detail drawings for those specific sites. If these documents are stored in project folders, there is no easy way to find all of the documents that pertain to a site because what is required does not match the order in which it is stored. If the engineer is successful in extracting the site documents from project folders, he/she cannot be certain that another project did not occur after this one with further changes located in yet another project folder.

An engineer needs to find the latest site information without tedious searching. This site information needs to be stored in one place so that everyone can use and easily locate it. Therefore, a site-specific location must be formed to store the information for each site as shown in Figure 4. This location can be a site-specific file cabinet for hard copies or a site-specific public drive on a LAN for soft copies. The soft copies would be the official copies of the documentation because these will be the ones changed when revisions are needed. Thus, a company's second documentation group, or "cloud," is a site-specific cloud that stores all site-specific information in individual site folders listed by site name and unique site code. All site-specific information requires the site-specific code in the filename/document name to identify it to that site.
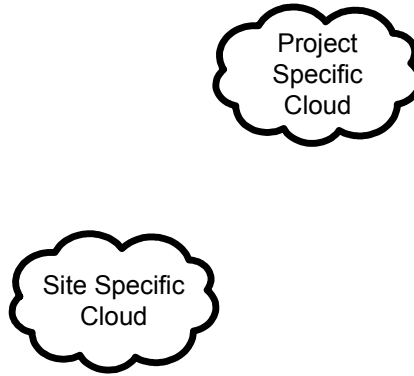
Figure 4 – Site Specific Cloud - The site specific cloud is a directory on a shared network that contains directories for each site. Each site requires a unique identifier such as a site name or site code (Sullivan).

4.4.2   Site-Specific Directories

Site-specific documents should be stored so that anyone in the company can find all the documents and the revisions for each site without wasting time searching. The documentation process should assure that the latest documents along with the previous revisions can be accessed quickly. In order to access documents that are specific to a single site, the document must be named with a site-specific identifier. This site-specific identifier must be unique to the site, such as a unique name, a site code or a CLLI (Common Language Location Identifier) code.

The site documentation is located in the Site-Specific Documents directory. In the Site-Specific Documents directory, each site has a directory to store its site-specific documents. These site directories have the format of (City name)(descriptive Term i.e., Collo, Microwave, or Fiber)(site code). The site directories are named this way because most people think in terms of the site name when thinking about a site. The name of a city is consistent and is not subjective to what different people will name it. Also, the name of a site is usually known before the site or CLLI code. Therefore, the directory can be started, and the CLLI code added when available.

4.4.3   Site-Specific Filenames

The document filename format below is well defined to provide consistency when searching for documents. This format prevents subjective, hard-to-find filenames. The filename format consists of the site-specific identifier (unique site name or code), the two or three letter document type identifier, an X-letter clarifying field for clarity and differentiation, and a revision letter or date. The revision letter starts with an "A" for initial releases and then continues with B-Z for the revisions. After the revision number, an optional underscore (_) and notes can be added for clarity. The site-specific filename format is as follows:

(Site Code) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _ (add notes)
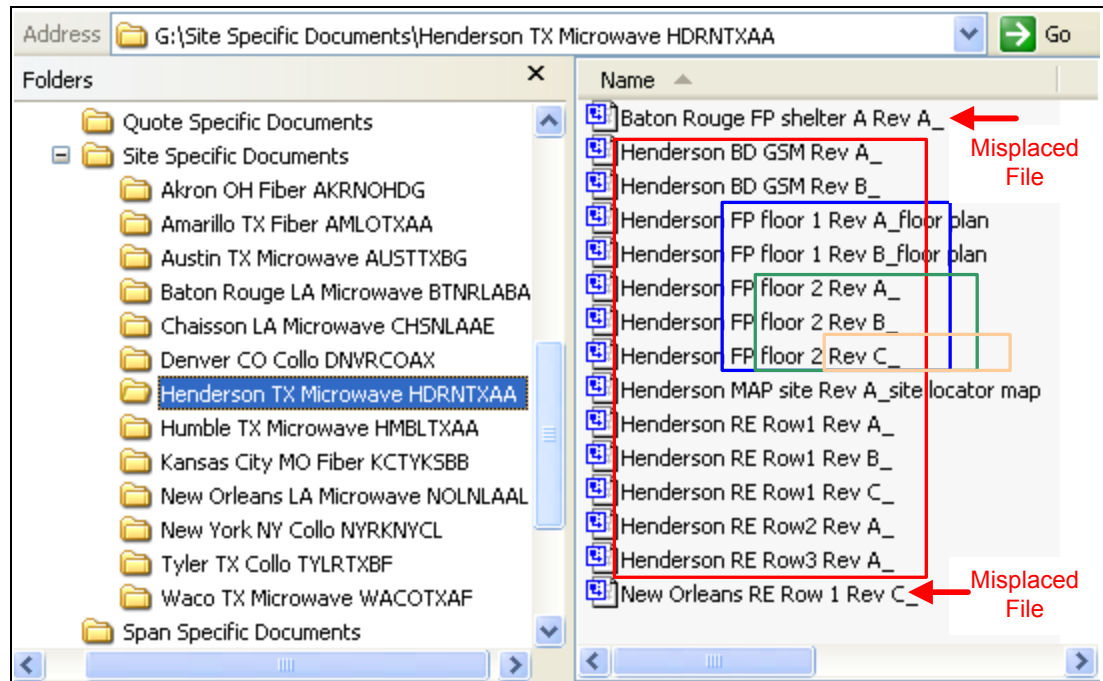

Figure 5 – Site-Specific Documents - In the site-specific directory, the site folders sort alphabetically by the name of the town. Inside each site folder, the documents sort on the four parts of the smart filename. Misplaced files are easy to spot because they sort above or below the group of files that belong in the directory (Sullivan).

4.4.4   Site-Dictionary Example

This analogy compares a network of sites to the structure of a sentence. As shown in Figure 6, a network of sites is like a sentence because the sites of the network are connected in a certain order just as the words of a sentence are connected in a certain order. The information describing the word "dingo" is easy to locate in a dictionary.
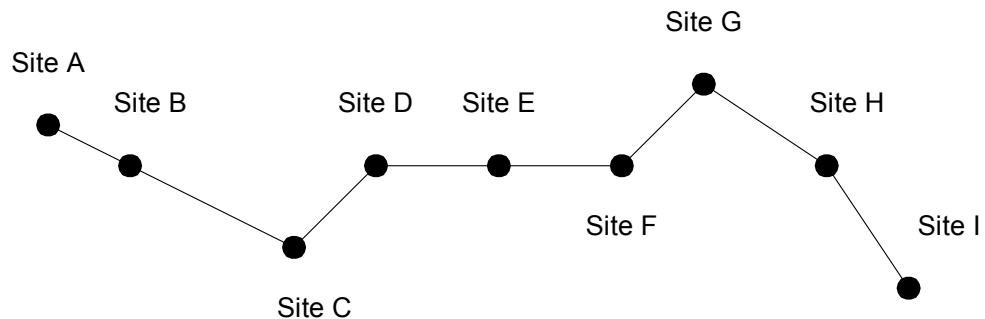
The dingo likes to run in the desert.

Figure 6 - Site Dictionary Example – Compares the structure of a sentence to the architecture of a telecommunication system. Just as words are removed from sentences and stored in the dictionary, sites are removed from the network's architecture and stored one by one in a site-specific folder (Sullivan).

A company should use the same logic as a dictionary when storing site information. Site information is not stored by project or by network, but it is stored by site. Just as words are pulled out of a sentence and stored by word in a dictionary, site information is pulled out of the network structure and stored by site in alphabetical order. Using this system, engineers, program managers, the network operation center (NOC) and all other employees can quickly look up the information about a site. This system also prevents duplications when a site is part of two networks or multiple projects. In this "site dictionary," there is still only one location for that site information. The smart filename is the order in which the document is stored.

4.4.5   Site-Specific Documents

Some examples of site-specific documents along with the two or three letter document type identifiers that will be used in the filename are shown in Table 2. As more documents are needed, this list will be extended (Sullivan).

Drawing Description	2 or 3 Letter Document Type Identifier
Map – Site Locator (Among Others)	MAP
Site Plan	SP
Floor Plan	FP
Rack Elevation	RE
Block Diagram	BD
Detail/Assembly Drawing	AD
Power Calculations	PWR
Network Management System and Alarms	NMS

Table 2. Site-Specific Document Type Identifiers. The two or three letter document type identifiers are the abbreviations that will be used in the smart filename for the type of drawings. More can be added if needed.

4.5   PRODUCT-SPECIFIC DOCUMENTATION

4.5.1   Explanation of Product Documentation

For all of the products that are used in a project or at a site, information about that product should be available. This statement is true whether a company purchases a part or produces the part itself. This information can be in the form of a specification sheet, manuals, or catalogs. Also, it can be in hard or soft copy. What should be done with product documentation?

Product documentation is not site-specific because it can be used at multiple sites. It is not project-specific because it can be used on multiple projects. Thus, the third cloud

in the documentation procedure is the product-specific cloud, which stores product-specific information by manufacturer name and part number. For products, information is first stored by the manufacturer's name and then by the part number (part identifier). There are two reasons for this sequence. First, two companies may have identical part numbers so that the manufacturer's name is important in identifying the part. Second, the information available may be in a catalog with many parts included. The only way to store information by part number would be to tear out every page of the catalog and store them in a part number folder. This process is impractical. Therefore, product data is sorted by manufacturer name and then by part number. The actual name of the document is important since a company cannot control the naming convention of other companies.
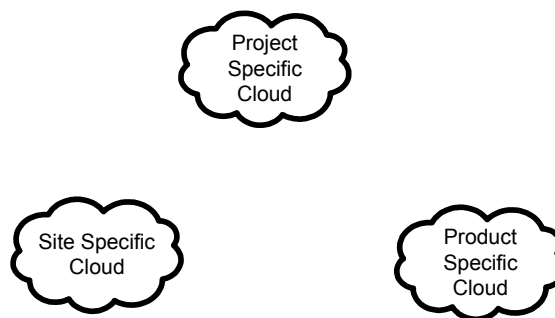
Figure 7 - Documentation Clouds – The first three documentation clouds are project specific, site-specific, and product-specific. Project-specific, site-specific, and product-specific information should not be stored together in order to obey the first law of documentation which is to store information in its own specific place (Sullivan).

4.5.2 Product-Specific Directory and Filenames

Product-specific documents should be stored so that anyone in the company can find all the documents and the revisions for each product without wasting time searching. In order to access documents that are specific to a single product, the document must be named with a product-specific identifier. One way to do this is by the manufacturer's

name and part number or part name. However, since other companies control the name of their documents, it is difficult to create a solid standard. The engineers will know which manufacturer makes the product with which they are working. Therefore, the manufacturer's name is a good way to group and narrow down product documents. Subsequently, the search can be narrowed further by using the part number or name of the part.

Product documentation is located in the Product-Specific Documents directory as shown in Figure 8. The manufacturer determines the filename of the document. The product directory format is as follows:

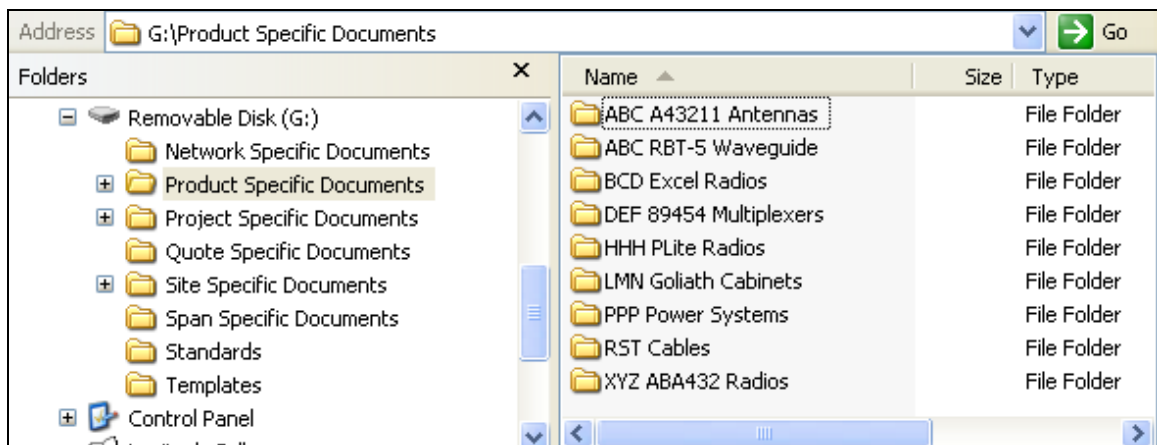(Mfg Name) (1space) (Part Number/Name) (1space) (descriptive Text)

Figure 8 – Product-Specific Directory – The folders are arranged by manufacturer's name and part number or description (Sullivan).

4.5.3   Product-Specific Documents

Some examples of product-specific drawings along with the two or three letter document type identifiers that will be used in the filename are shown in Table 3.   As more documents are needed, this list will be extended.

Drawings Description	2 or 3 letter Document Type Identifier
Product Catalog	PC
Spec Sheet - Technical Description of Product	SS
Bill of Materials for Product	BOM
Assembly Plan for Product	AP
Test Plan for Product	TP
Factory Acceptance Test (FAT) Report for Product	FAT

Table 3. Product-Specific Document Type Identifiers.   The two or three letter document type identifiers are the abbreviations that will be used in the smart filename for the type of drawings.   More can be added if needed.

4.6   LINKING DOCUMENTATION CLOUDS

The document procedure now has three specific clouds: site-specific, project-specific, and product-specific.   The reason people put all of the information in one folder is to link documents on which they are working.   For instance, if an engineer is working on project "P#####," he needs to know what site documentation that involves. When an engineer talks about a site, he needs to know what products are there and how they work.   As Figure 9 shows, part of documentation is linking the clouds so that this engineer can start in one cloud and find relevant information in other clouds without searching through a lot of irrelevant files.   Linking, however, does not refer to creating shortcuts in all directories.
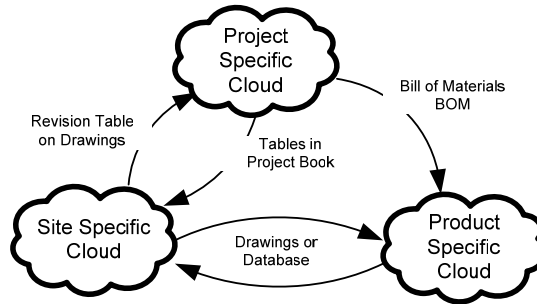
Figure 9 - Linking Clouds – Documents in different directories are linked by information within the documents that specify the other directories. For instance, a project definition will contain a bill of materials that tell which parts to use. Also, the project definition will contain a list of sites that are affected by the project (Sullivan).

4.6.1   Linking Projects and Sites

In the project definition, there should be a table that lists the site-specific drawings that are included in the project. This table includes the drawing type, name of drawings, and filename with revision number. There should be a table for each site included in the project. When the project definition document is printed, these tables are used to identify which site-specific drawings should be printed and inserted into the document.

On the site drawings, there is a revision table, shown in Figure 10, that should be filled in every time the drawing is revised. When looking at the drawing, one sees the revision table that identifies which projects affected this particular site drawing.

Figure 10 - Revision History – Example of linked information from the site-specific documents to the projects specific documents. The revision history contains a project number that identifies the project that changed the drawing. This information can be used to locate the project specific documents (Sullivan).

4.6.2   Linking Sites and Parts

On any site drawing, enough information should be available to identify the manufacturer and part numbers of the equipment used to locate the manuals. If enough information is not available on the drawing, the revision history on the drawing can be used to locate the project numbers that installed the equipment. The Bill of Materials (BOM) in the project engineering package can be used to identify the equipment.

A database solves the problem of tracking which parts are located at which site. For instance, if an engineer wants to know which sites are equipped with external timing sources, he would have to search through all drawings and projects to make sure he located them all. Using a database, the part number can be queried, and the sites can be located more quickly and efficiently. This database is more valuable for companies that must track product information and less valuable for the vendor companies that do not track the location of the equipment over a period of time.

4.6.3   Linking Projects and Parts

In a project definition, there is a section for a Bill of Materials (BOM) that is used to identify which parts were used during that particular project. This BOM can be used to find product specific manuals, data sheets and catalogs.

4.6.4   Specific Kernels of Information

When trying to locate data, people must supply a kernel of information that aids in the search. For instance, to ask the question, "Can you find the floor plan?" does not help. The obvious reply is "Which floor plan?" On the other hand, the question, "Can you find the floor plan for the Henderson site?" provides a specific kernel of information

that aids the search process. If a documentation system is designed correctly, these kernels of information will direct the user where to search (Sullivan).

The specific clouds provide the user multiple access points into the information. An engineer may need the rack elevation for the Henderson site. A project manager may need the budget for project P01148. An installation technician may need the manual for an 89454 multiplexer. The user can enter the documents using the specific kernel they know and then link to other clouds.

4.7   SPAN-SPECIFIC CLOUD

4.7.1   Explanation of Span-Specific Documentation

There are now three specific clouds and links defined and explained. However, there are documents that do not necessarily fit into one of these clouds. As the documentation structure developed, additional documents needed additional clouds that did not fit into the site-specific, project-specific, or product-specific clouds. For instance, documents that related to two sites required a span-specific cloud. A span is a link, path or hop between two contiguous site codes. Span-specific documents do not refer to full network views. An example of a span-specific document is a microwave path profile, as shown in Figure 11. Another example is a map that shows the route of a fiber optic cable under the streets between two specific site codes.
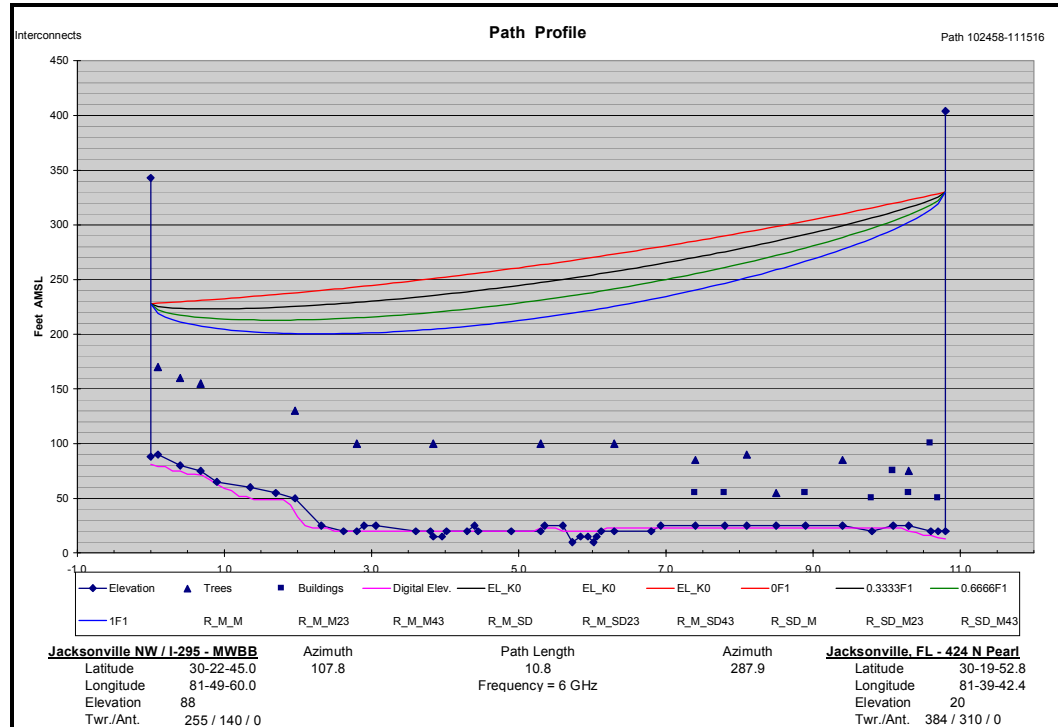
Figure 11 – Span-Specific Example – A microwave path profile shows the microwave path between two sites and any obstacles that may block communication (Sullivan).

In order to find this information in the future, it cannot be hidden away in one of the project folders. There is no way to extract this information easily from the project folders. Span-specific information could be stored at one of the site locations. By storing it at one of the site locations by site code with which the SPAN is associated, it can be found. However, this technique is still too difficult to find span-specific information because it would be stored in multiple places. An engineer wants to find all of the spans that enter a site quickly.

The only easy way to locate information that is span-specific is to have BOTH of the site codes in the span-specific identifier. When using both site codes in the identifier, the site codes should be sorted alphabetically. For example, the span-specific identifier for a span between Chaisson (CHBYLA01) and Belle Rose (BLRSLAZQ) is

BLRSLAZQ-CHBYLA01. Another example is a span-specific identifier between Chaisson (CHBYLA01) and Paradis (PRDSLA02) is CHBYLA01-PRDSLA02.

By creating a separate cloud for SPANs and including both site codes in alphabetic order in the identifier, an engineer can search in Windows Explorer and quickly find all the links that go into a specific site. The engineer can find all links that are associated to a site by searching on the single site code. This engineer can also find only the applicable links between two sites by searching on both site codes in alphabetical order.

The reason for putting the site codes in alphabetical order is to prevent one person calling it CHBYLA01-PRDSLA02 and another person calling it PRDSLA02-CHBYLA01. Storing information in two different places would break the first law of documentation. With the site codes in alphabetical order, the links between two sites will group together making it possible to spot errors.

4.7.2   Span-Specific Filename Convention

Span-specific documentation is located on the Span-Specific Documents directory. Because of the filename convention, the documents for the links will group together and make them easy to find. The filename format for span-specific documents is as follows:

(Site Code A) (dash) (Site Code B) (1space) (2or 3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes) (Sullivan)

4.8 NETWORK-SPECIFIC CLOUD

4.8.1 Explanation of Network-Specific Drawings

Engineers use network documents to view the big picture of the network. For instance, drawings that show the overall architecture and show which parts of the network are being overbuilt contain important information. Especially when two projects are happening on the same network at the same time, network drawings provide a good view of how the projects affect each other and the overall architecture of the network. These network drawings make potential problems easy to identify. These drawings do not belong in individual site folders, individual project folders, product folders, or span folders. There is a need for a network-specific cloud as shown in Figure 12.
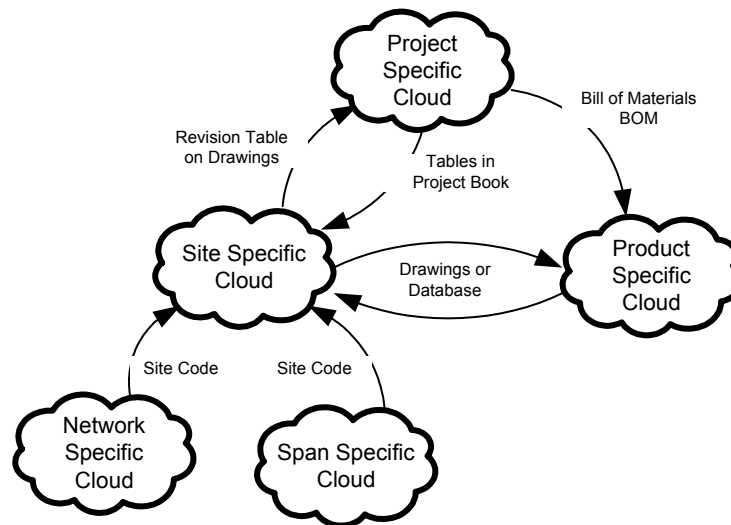

Figure 12 - Expanded Documentation Clouds – Documentation Clouds expanded to include the Network-Specific documents and the Span-Specific Documents (Sullivan).

4.8.2 Network-Specific Filenames

Network-Specific documentation is located on the Network-Specific Documents directory. The filename format for span-specific documents is as follows:

(Network Name) (1space) (2 space Document Type =BD) (1space) (X space Identifier) (1space) (Revision) _(add notes) (Sullivan)

4.9   TEMPLATES CLOUD

4.9.1   Explanation of Templates

A template is the shell of a document used to create other documents that will be filled with important information and stored in the appropriate directory. Templates are used to keep the formatting consistent and to save time when creating a new document. After a template is created, it is normally not revised often. However, it can be. Remember that templates are used to create new drawings which are usually the "A" revision of that document. Therefore, the revision on a template is an "A" so the new documents already have the revision correct.

4.9.2   Template Filename Convention

The filename format for company templates is as follows:

(CompanyTemplate) (1space) (2-3 letter Document Type) (1space) (X letter clarifier) (1space) (Rev "A") _(add notes) (Sullivan)

i.e. ABCTemplate RE radio Rev A_ rack elevation

4.10   STANDARDS CLOUD

4.10.1 Explanation of Standards Documents

Standards are written documents explaining the process and procedures to accomplish repetitive work that does not change at many sites or on many projects. For instance, the procedure to change a terminal multiplexer to an add-drop multiplexer is information that could be used at multiple sites and on multiple projects. It is different from a Template because the engineer would not add anything or create a new document,

but the standard is a written reference of learned information from past experiences to be used again.

If the standard was written by the manufacturer, it would be stored in the Product-Specific Cloud with the name of the company and the part number as the specific identifier. If the company wrote the standard, the company name is used as the specific identifier.

4.10.2 Company Standards Filename Convention
The filename format for company templates is as follows:

(Company) (1space) (2-3 letter Document Type) (1space) (X letter clarifier) (1space) (Revision) _(add notes) (Sullivan)

4.11 EXTERNAL COMPANY
At the external projects telecommunications company, engineers sold microwave products and helped other companies build their microwave networks. The company can play the role of either Customer or Vendor. During a project, the company may play both roles, but the exchange of documents is similar. The exchange of documents follows this timeline as shown in Figure 13**Error! Reference source not found.**.

a) The Customer learns of the Vendor's product through a salesperson, product catalog or website.
b) Customer sends an RFP to the Vendor.
c) Vendor sends a quote to the Customer.
d) If the quote is accepted, the Customer sends a purchase order to the Vendor.
e) Vendor sends the equipment and an invoice to the Customer.
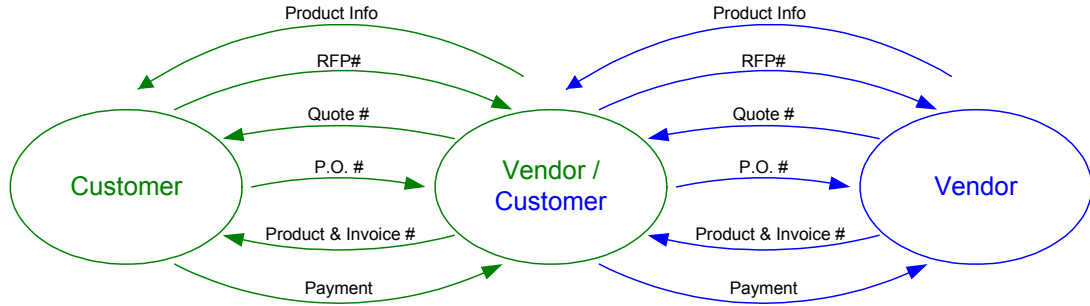f) Customer sends Payment to the Vendor.

Figure 13 - Company Interaction Diagram – Shows the flow of exchange between companies. All companies act as vendor and customer at some point. Each interaction should be easy to locate by specific unique identifiers (Sullivan).

The fact that multiple customers had to be tracked and each had its own set of sites, span and networks prompted a slight change in the document diagram as shown in Figure 14. Instead of having a product-specific directory with different vendors listed in that directory, a company-specific directory was created.
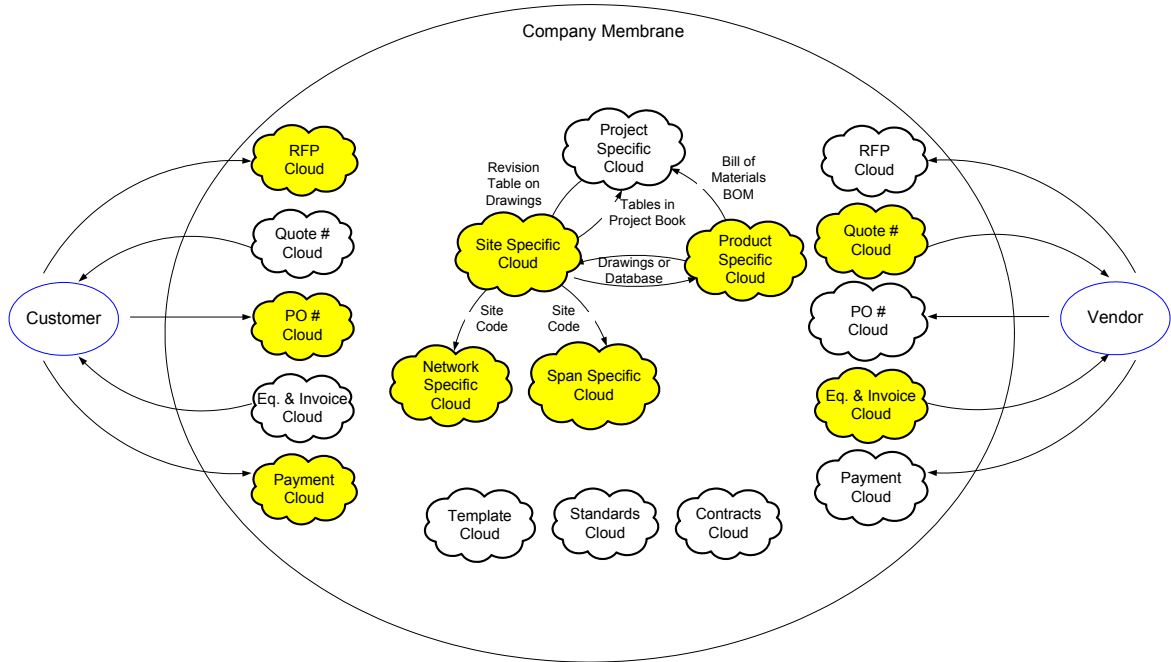

Figure 14 – Documents To Track – When working with multiple external companies, many documents (in yellow) will be associated with each external company; therefore, they will need to be grouped with the external companies name (Sullivan).

The company-specific directory listed each company whether it was customer or vendor. Then inside each individual company directory, each type of document that the company provided had its own directory. For instance, inside the customer ABC's directory, there was an ABC site-specific directory, an ABC span-specific directory, and an ABC network-specific directory. If they delivered products, then there would also be a product-specific directory.

Another important cloud seen at the external company that was not seen at the internal company was the Quote cloud. A quote was sent to each customer after its request for a proposal detailing product and services. Each of these quotes needed to be tracked and found whether or not that specific quote number was referred to by the customer.

4.12   QUOTE CLOUD

4.12.1 Explanation of Quotes

A company must be able to find specific quotes quickly. Therefore, these quotes must have unique identifiers which are the specific quote numbers. Potential customers will refer to this unique identifier when they have questions. These quotes must be stored by the specific quote identifier in a specific order. Quotes cannot be stored in project folders because many quotes will never turn into projects, and there will not be project folders available.

Anything that leaves the company should have the company name as the beginning of the unique identifier. With the company name at the beginning, all information will sort properly and group together on the customer or vendors' drives.

4.12.2 Quote Filename Convention

(Company and Quote Number) (1space) (2-3 letter Document Type) (1space) (X letter clarifier)

(1space) (Revision) _(add notes) (Sullivan)

i.e. ABC Q05-10030A PRC CompanyXYZ Rev A_

4.13   DOCUMENTATION FOR "OTHER CLOUDS"

Additional specific clouds may be added in the future as needed. This system can be expanded as necessary, but the first documents that a company must control are in the eight major clouds that are the focus of this field project.

5.   Conclusion

The tidal wave of search engine technology may be too large to avoid. In addition, getting every web user to follow naming conventions is unrealistic but not impossible. Consider the millions of people who have been taught to obey the same traffic laws each day with relatively few problems. Thus, it is possible that a team of engineers can utilize the four Laws of Documentation to build a document management scheme to increase productivity, to increase accuracy, to improve employee morale, and to improve customer satisfaction while at the same time lowering costs, reducing frustration, and saving time spent on unrelated tasks.

This field project provides a solution for a telecommunications company to store electronic files on a shared network in order to save time, save money and reduce frustration. By applying the four Laws of Documentation, a company can ensure that its employees can find information. Putting information in only one place, uniquely identifying the filenames, organizing them in some order, and making sure that order is relevant to what is being searched for ensures that the correct information can be

confidently located quickly and easily. The literature review supports the idea of designing filenames and directory structures instead of using search engines because both recall and precision are important.

Finding the correct information fosters better communication between teams and breaks down the walls among groups. Even though telecommunication companies are the focus of this field project, the four Laws of Documentation are universal and can be applied to all companies or for personal use. Each company, no matter the industry, should manage its information closely and ensure that employees can find it. As Harris said, "companies need to consider the value of their documents and data, and give them the same management attention as other company assets" (Harris 394).

6.   Suggestions for Additional Work

In this current system, documents are stored with all revisions in the same directory. The smart filename will automatically group and sort the revisions so that all the history of that document is readily available. However, according to Harris, a key aspect of managing documents is knowing when their useful life is over (Harris 391). Therefore, a rule needs to be developed which governs how many past documents are kept or how they are archived once no longer needed.

Digital photography is an excellent field in which to apply smart filenames. If cameras automatically created smart filenames instead of sequential numeric filenames, then pictures would be easier to locate. The smart filename field could include location, subject, date taken, and sequential number. Another use is for giving high school and college students a way to store their electronic files for class while being able to retrieve them when needed. Other fields that can benefit from keeping information in order are

education, healthcare, and law. Even the documents on the internet would be easier to find if they were better organized. In fact, many companies have already figured out that a company-specific website is the best place to store company information.

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8.   Appendices

This field project defines procedures for documentation in a company because documentation should be as easy to find as words in a dictionary. The author of a document must first decide in which specific directory the file belongs. Then, based on the filename conventions discussed in this guideline and summarized below in 8.1 to 8.8, the author must save the document with the correct filename and revision letter and in the correct directory.

To determine in which cloud the document belongs, determine in which cloud the document will be used only once. For instance, a rack elevation will be used at one site only, but multiple projects can revise the rack elevation. It is a site-specific document. Another example is a project definition. The project definition covers multiple sites. However, it makes sense to associate a project definition with only one "P#####" number. Therefore, a project definition is project-specific. Finally, a product manual can be associated with multiple projects and multiple sites; but, it is specific to only one product. Obviously, a product manual is product specific.

8.1   SITE-SPECIFIC FILENAME CONVENTION
The filename format for site-specific documents is as follows:
(Site Code) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)
i.e., BTRGLAMAH01 RE 01.01.01 Rev - _Baton Rouge Rack Elevation
i.e., Henderson RE 02.12 Rev B_ Henderson Rack Elevation

8.2   PROJECT-SPECIFIC FILENAME CONVENTION
The filename format for product specific documents is as follows:
(6 digit project #) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)
i.e., P01149 PD Baton Rouge - _Project Definition for Baton Rouge Interconnect Rev –
i.e., P022345 SOW Dallas Rev A_ Statement of Work

8.3 PRODUCT-SPECIFIC DIRECTORY NAME CONVENTION

The directory name format for product-specific documents is as follows. The filename is decided by the document author.

(Mfg Name) (1space) (Part Number/Name) (1space) (descriptive text)

i.e., ABC Express Mux

8.4 SPAN-SPECIFIC FILENAME CONVENTION

The filename format for span-specific documents is as follows:

(Site Code) (dash) (Site Code) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)

i.e., CHBYLA01xxx-PRDSLA02xxx PR Microwave Rev - _Microwave Terrain Profile

i.e., Hillsboro-Waco MAP Fiber01 Rev A _Map of Fiber route under streets between CLLIs

8.5 NETWORK-SPECIFIC FILENAME CONVENTION

The filename format for network-specific documents is as follows:

(Network Name) (1space) (2-3 letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)

i.e., ABC ND Microwave Rev A _ABC Microwave Backbone Network Block Diagram

i.e., Chicago-Denver ND Fiber Rev B – Fiber Backbone Network Block Diagram

8.6 COMPANY TEMPLATE FILENAME CONVENTION

The filename form for a company's templates is as follows:

(CompanyTemplate) (1space) (2-3 Letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)

i.e., ABCTemplate PD Microwave Rev A_project definition for Microwave

i.e., ABCTemplate SOW Fiber Rev A_Statement of Work for Fiber

8.7 STANDARDS FILENAME CONVENTION

The filename format for Company templates is as follows:

(Company) (1space) (2-3 Letter Document Type) (1space) (X letter Clarifier) (1space) (Revision) _(add notes)

8.8 QUOTES FILENAME CONVENTION

The filename format for NEC Quotes is as follows:

(Company and quote number) (1space) (2-3 Letter Document Type) (1space) (X letter clarifier) (1space) (Revision) _(add notes)

ABC-Q08-001 PRC Radio Type A Rev A_pricing (Sullivan)