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Analysis of Data Centre Cabling and Recommendations

PricewaterhouseCoopers LLP

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12 May 2008

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12 May 2008

Dr. Sujeet Chaudhuri, chair
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Dear Sir:

This report, entitled "Analysis of Data Centre Cabling and Recommendations", was prepared as my 1A Work Report for PricewaterhouseCoopers LLP (PwC Canada). This report is in fulfillment of the course WKRPT 100. The purpose of this report is to analyze the current state of the network cabling in PwC Canada's data centre and to offer several recommendations to help improve the overall operation of the data centre with regards to said cabling.

I was employed as a Junior Technologist within the Production Services Team, managed by [name removed] and Cynthia Beernink. My primary responsibilities included assisting the rest of the team in ensuring that all necessary functions within the data centre were carried out appropriately, including monitoring backups, installing and configuring various devices, etc.; I was also involved in some programming.

I would like to thank Mr. [name removed] for providing me with valuable ideas, information, and feedback which helped me in finalizing this report. I also wish to thank Mr. Leonardo Soares, ing. for proofreading my report. I hereby confirm that I have received no further help other than what is mentioned above in writing this report. I also confirm this report has not been previously submitted for academic credit at this or any other academic institution.

Sincerely,

Michael A. Soares
ID [removed]

Contributions

For the past four months, I was employed at PricewaterhouseCoopers LLP (PwC Canada) in Toronto, Ontario as a Junior Technologist. I was part of a small team which consisted of eleven members: one senior manager, one manager, three Junior Technologists, and six Senior Technologists.

The Production Services Team (PS Team) is responsible for providing different levels of support to PwC Canada's infrastructure services. The PS Team's main goal is to ensure that all service disruptions affecting the firm are always kept to a minimum. This is done by working collaboratively with other information technology personnel within the Canadian division of the firm to ensure that any and all changes are implemented in an orderly fashion. Other responsibilities include, but are not limited to:

- Ensuring that all server, storage, security, and network services meet the firm's current and future requirements,
- Monitoring and providing operational and management support for the aforementioned, complete with managing changes within the firm's development, management, staging, and production environments, and
- Conducting regular backups of the firm's data on daily and weekly bases.

While at PwC Canada, my primary responsibilities involved assisting the PS Team in ensuring that all operational, maintenance, and support functions were carried out as per the requirements of the firm and more specifically encompassed:

- Monitoring data and e-mail backups,
- Building and configuring servers using varying pieces of software,
- Physically installing servers into cabinets,
- Updating documentation,
- Providing support for other IT personnel, and
- Maintaining and supporting servers and other networking devices.

For the majority of the term, I was diligent in leading a project which required moving over certain networking devices over to a centralized network switch to free up valuable network ports on the firm's main network switches. I was also involved in revising a program for internal use and performed several server audits and server decommissions.

The data that was collected in the project I led was somewhat insufficient in scope to be suitable for a work term report. As a result, I decided to challenge this information from a different angle and only then was I able to identify a specific problem within the firm's networking environment which continues to exist. I took it upon myself to provide a series of possible solutions that could be implemented to rectify the problem in the present and near future. This is the main relationship between this report, the knowledge I gained, and the tasks I performed while working at the firm. The information collected and the analysis performed in this work term report is beneficial to me in many different ways, primarily because it has given me the opportunity to learn as well as work with various resources available from the firm. This project has also provided me with the ability to identify, analyze, and evaluate other problems that the firm can address and repair in the future, including the one discussed in this report.

In the broader scheme of things, my research on this report topic should prove to be beneficial for PwC Canada. Since the PS Team is constantly adding and removing servers and other networking devices to and from the firm's network, there is always a possibility of there being problems when adding and removing cables. In this report, I provide the PS Team with several recommendations that will reduce the risk of servers or other networking device becoming inaccessible due to two areas in the firm's data centre that can cause delays.

Executive Summary

The main purpose and scope of this report is to analyze and identify the factors contributing to the overall cabling complexity of the vital cross-cabinets located in PwC Canada's data centre. This report will allow PwC Canada's PS Team to gain a clearer understanding of the present state of the cabling in the cross-connect cabinets and the risk liability they provoke onto the firm's operations. I have identified several recommendations in this report that will eliminate much unneeded cabling in the cross-connect cabinets and the rest of the data centre and which in turn will reduce the risk of a networking device becoming inaccessible, causing delays throughout the rest of the firm's operations.

The major points in this report are that each of the major sections in this report identify and summarize the use of both the patch panels and the cross-connect cabinets. The first section describes the data centre and the problem being analyzed. The second section includes an analysis of the cross-connect cabinets and offers solutions on minimizing or completely eliminating unneeded cabling. The third section does the same for the patch panels. The final sections provide conclusions and recommendations based on the analyses in the preceding sections.

The major conclusion of this report will confirm that the present state of cabling in the cross-connect cabinets is one that most definitely creates a major point of failure in the firm's networking environment and, if not corrected, will cause various delays to the firm's operations which in turn can affect revenues. In addition, it will also show that there are two distinct discrepancies between the number of ports in use in the cross-connect cabinets and on the patch panels.

Major recommendations in this report are also identified in that PwC Canada should re-cable and re-organize the cross-connect cabinets to eliminate as much clutter as possible and to install network switches into many of its server cabinets to further reduce the amount of cabling currently in the cross-connect cabinets. A complete and detailed

review and audit of the network ports in the data centre should also be conducted to achieve and record the most up-to-date documentation of the existing systems which will then facilitate streamlining future cabling processes.

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1 Introduction

PricewaterhouseCoopers LLP, Canada, is a sister company of one of the four largest accounting firms in the world, PricewaterhouseCoopers International Limited. The data centre, in which most of the firm's vital information is stored, allows the firm to provide a broad selection of assurance, advisory, and tax services for a wide variety of clientele [1]. Due to the importance and confidential nature of information that PwC Canada's data centre handles on a daily basis, all staff nation-wide must be able to access this information immediately, without delay, and there can never be any system downtime.

Currently, there exist two areas within the firm's data centre that evidently cause delays to some operation of the data centre requiring special attention. If not, server and device downtime will definitely increase operational and maintenance costs. This report will identify and analyze the existing problems in these particular areas. In addition, it will recommend possible solutions that will reduce labour costs and time required to work in these areas to minimize downtime so that the firm can conduct normal business without interruption.

In this section, the purpose and scope of the report are both set out, and essential background information is presented on the topic.

1.1 Data Centre and Cabling

PwC Canada's data centre comprises of servers and other networking devices vital to the overall operation and management of the firm. These servers and other devices within cabinets are connected to a series of network port panels (patch panels). Each of the ports on the patch panels connect to ports within cross-connect cabinets which finally connect to the firm's main networking equipment. All servers connect through the patch panels and cross-connect cabinets use Category 6 (CAT6) cabling. This type of cabling can currently support speeds of up to 1 Gigabit per second (Gbps), equivalent to 1000

Megabits per second (Mbps), and has been rated to support speeds of up to 10 Gbps over short distances in the near future [2].

1.2 Purpose

Because the cross-connect cabinets are composed of several hundred cables, the accumulation of cables makes it extremely difficult and time consuming to work within such cabinets, specifically when having to trace, remove, or add cables. In addition, the complexity of the cabinets makes it difficult to accurately record and document the various connections within the cabinets. This report will identify factors contributing to the overall complexity of the cross-connect cabinets and suggest ways of minimizing or eliminating the clutter through solutions that can be implemented in the server cabinets, on the patch panels, and in the cross-connect cabinets.

1.3 Scope

This report will include qualitative and quantitative analysis of both the patch panels and the cross-connect cabinets. It will also outline the costs and benefits of implementing the recommended solutions.

1.4 Outline

The sections in this report identify and summarize the use of both the patch panels and the cross-connect cabinets. This report also provides a qualitative and a quantitative analysis on both the patch panels and the cross-connect cabinets as well as solutions on minimizing or eliminating unneeded cabling. A glossary has also been included for easy reference of technical terms used in this report. The first section analyzes the cross-connect cabinets, offering solutions on minimizing or eliminating unneeded cabling. The second section does the same for the patch panels. Finally, conclusions and recommendations are outlined at the end of the report.

2 Cross-Connect Cabinets

2.1 Introduction

The cross-connect cabinets currently used by PwC Canada offer an intermediate connection between the firm's servers and the firm's main network switches within the data centre. Within the cross-connect cabinets are numerous network ports, each of which connects back to a network port connection within another cabinet or a network switch's port over CAT6 cabling. Cross-connect cabinets allow for much flexibility in the data centre; network ports terminating in different cabinets can be connected to any of the various network switches or other cabinets simply by interchanging cables. Figure 1 shows a simplified version of how the cross-connect cabinets currently fit within the network.

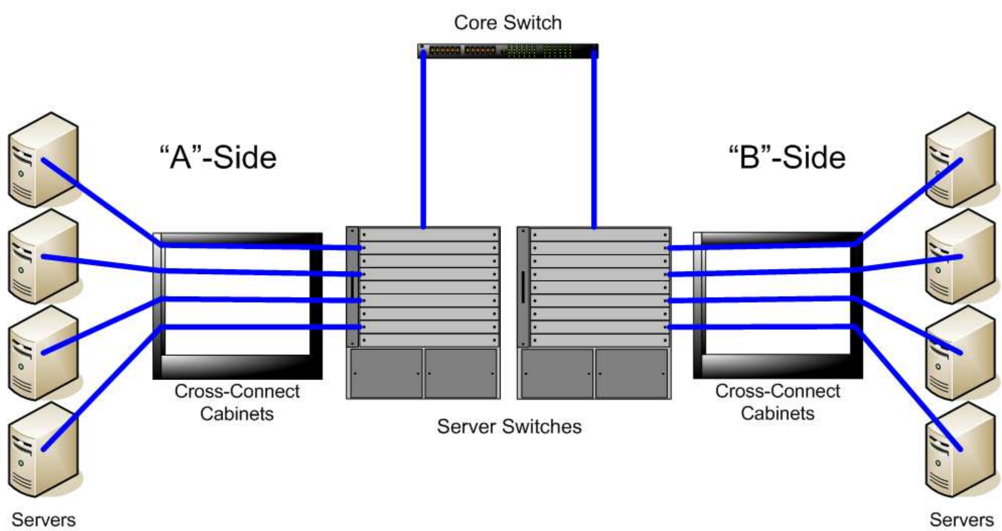

Figure 1. Arrangement of the cross-connect cabinets within the network.

As noted in Figure 1, two separate cross-connect cabinet sides are being used; this facilitates an equal distribution of the servers' network connections to the various network switches.

2.2 Point of Failure

Despite the flexibility provided by the cross-connect cabinets, cables in the cross-connect cabinets have either been ignored or forgotten, especially where servers have been removed from the firm's internal network, leading to an accumulation of unneeded cabling. These existing cross-connect cabinets have become increasingly complex due to the accumulation of these cables and due to the lack of a proper cable design or layout. As a result, there is presently no room within the existing cross-connect cabinets for any additional cabling, as can be seen in Figure 2, requiring the removal of redundant and unused cables.

Figure 2. Existing cabling in a cross-connect cabinet in the data centre.

The complexity and the intertwining of cabling of the cross-connect cabinets as shown in Figure 2 is representative of a disaster ready to happen and manifests itself as a major point of failure within the network. If a single cable needs to be traced from one point to another, it is must be pulled upon. By pulling on any one cable, it is possible for surrounding cables to be inadvertently disconnected or possibly damaged. This can cause a server or other networking device to lose its connectivity to the network and, in turn, can also cause major repercussions for members of the firm and the firm itself, including:

- Inaccessibility to internal and external data,
- Reduced productivity,
- Client frustration,
- Reduced client base, and
- Loss of profits.

A recent project included the task of removing approximately 250 patch cables from the cross-connect cabinets; some of the cables were left untouched in order to minimize the possibility of accidentally damaging or disconnecting other cables. Fortunately, during the removal, only one non-critical server momentarily lost its connection to the network due to a damaged connector having been accidentally pulled out. The removal of these cables took approximately 12 hours to complete, averaging about three minutes per cable; the most time it took to remove a single cable was approximately 15 minutes. The removal of the related patch cables connected to the patch panels in the server cabinets, however, took under a minute per cable.

2.3 Re-Cabling of the Cross-Connect Cabinets

It is important to note that the PS Team must completely re-cable the entire cross-connect cabinets in order to eliminate the points of failure as well as to eliminate the clutter of the cross-connect cabinets. In doing so, all necessary cables should be tagged or somehow identified and accounted for. Steps involved in incorporating this recommendation would include the following:

1) Label all of the connected ends of the cables with their respective port numbers.
2) Disconnect and remove all cables.
3) Discard all cables whose ends are not labeled.
4) Group all cabinet-related cables together.
5) Reconnect opposite ends of all cables to their respective network ports, ensuring that the cables used are of the proper lengths.

This method of clearing and cleaning the cross-connect cabinets will need to be done in two different steps. The labeling of the cables can be done at any time prior to any removal of cables. However, the removal and reconnection of any cables will have to take place when work at the firm is reduced to a minimum, during a non-work day, or on a weekend. This will mean that PwC Canada will have one to two days of complete downtime. As a result in the future, the time and effort being expensed to add or remove cabling to and from the cross-connect cabinets will be minimized as cables will be better organized and more manageable than before. Without the clutter of unused wiring, more room will be available to see promptly and immediately detect any problematic areas that may exist in the cross-connect cabinets. It will also allow certain members of the PS Team working at the data centre to maneuver with ease in adding or removing cables, thus reducing the time required verifying the network connections between devices. Finally and most importantly and despite the firm's network being offline during the implementation of this recommendation, the proposed solution offers the firm a future cost-benefit while reducing downtime for all users reducing risk to the firm.

Costs involved in implementing this solution would only include labour and are specific to the PS Team member who will be implementing the recommendation. Based on personal experience, should a single co-op student be given this task, it is estimated that it will take the student approximately five to ten hours to label all cables on a single side of the cross-connect cabinets. In addition, it is estimated that it will take him or her an additional fifteen to twenty hours extending over a weekend to completely re-cable the same side, for a total of twenty to thirty hours of labour. At a net base salary of $17 per hour for a co-op student, this solution is estimated to cost the firm at least $340 to $510 per cross-connect cabinet side to implement, plus all additional overhead costs (e.g., employee benefits, insurance, etc.) associated with the co-op student, if any. The monetary expense of not implementing this solution, however, is dependent upon several factors, including whether a server goes down, how long the server is down for, what period the server goes down for, and the purpose of the server. For example, should a tax server be inaccessible for an entire day during tax season, the potential lost revenue for this period can be as much as one million dollars (see Appendix B). Considering how low the cost of implementing this solution is versus the amount that can be potentially lost, this solution is definitely a viable one.

2.4 Further Analysis

A further review was performed on all of the ports within the cross-connect cabinets and their associated ports on the patch panels. Overall, 17 additional ports were in use on the “A”-side of the cross-connect cabinets while 71 additional ports were in use on the “B”-side of the cross-connect cabinets than on the respective sides of the patch panels; refer to Appendix A for the complete datasheet. This data indicates that there is indeed a surplus of unnecessary cables which contribute to the complexity of the cross-connect cabinets at the present moment within data centre, already identified in section 2.2.

In order to determine the exact ports in which cables are currently connected to in the cross-connect cabinets but not on the patch panels, a more detailed and in-depth review and audit of the network ports within the data centre will have to be conducted. The data and information collected must include whether or not a port is in use both in the cross-connect cabinets and on the patch panels. After the audit is complete, all cables found to be unneeded are to be removed to free up space within the cross-connect cabinets. This review, audit, and removal of any unneeded cables should take no more than five hours to complete.

3 Cabinet Patch Panels

3.1 Introduction

The server cabinets used by PwC Canada are arranged row-by-row throughout the data centre. Each cabinet contains different sets of servers: management, development, and production. One commonality between the various cabinets is the patch panel in each: the set of network ports which connect to the cross-connect cabinets. Much like the cross-connect cabinets, the patch panels are also separated into two separate “A”- and “B”-sides, each side of which connects to its respective cross-connect side. Most cabinets contain a total of 24 ports on each side of the patch panels; others contain varying amounts, such as the one in Figure 3. Appendix A includes the exact number of ports for all server cabinets.

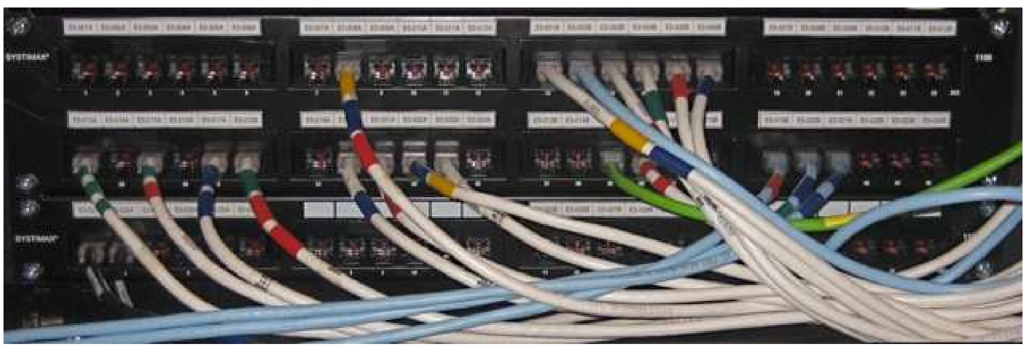

Figure 3. A 72-port patch panel with 60 ports terminating in the cross-connect cabinets.

Patch panels, such as the one in Figure 3, allow for flexible network environments. Cables between the patch panels and the network devices connected to the panels can be added, removed, or replaced when needed; they are not permanent.

3.2 Impact on Cross-Connect Cabinets and Documentation

When servers are added to cabinets, they are normally connected to ports on the patch panels using CAT6 patch cables which in turn, connects them to the network via the cross-connect cabinets. Similarly, when servers are removed from the networking environment, all associated cables must also be removed. Depending on the purpose and importance of the servers, multiple ports on the panels may need to be used, leading to a decrease in the number of available ports on the patch panels and an increase in the number of cables in the cross-connect cabinets.

The firm currently uses a spreadsheet to keep track of all of the connections being made between the patch panels, the cross-connect cabinets, and the main network switches in the data centre. This document is particularly useful when having to troubleshoot various connectivity problems. Unfortunately, there have been times when it has not been updated appropriately. From personal experience, not having proper and updated documentation also leads to an increase in time when troubleshooting and decommissioning old servers.

3.3 Further Analysis

After having analyzed all of the patch panels in the server cabinets and their associated ports in the cross-connect cabinets, a discrepancy was found. It was found that there were a total of 53 additional ports in use on the "A"-side patch panels and three additional ports in use on the "B"-side patch panels which were not connected in the cross-connect cabinets; the full datasheet for this analysis can be found in Appendix A. This discrepancy indicates that there may be leftover patch cables or networking devices that have inadvertently been left connected to the patch panels or that have been purposely left in the cabinets for future use by the firm.

In order to determine if, in fact, there are any patch cables or networking devices that have legitimate uses in the server cabinets in which they are located, a review or an audit of the patch panels and the devices connected to them will need to be conducted in conjunction with the cross-connect cabinet audit mentioned in section 2.4. In addition to the information collected from the audit proposed in section 2.4, other information that will need to be collected will most likely include a description of the device connected to the patch panel, if not a lone cable. If, after the audit, it is determined that the cables or devices identified have no use, then they can removed from the patch panels to make room for other devices or cables.

By conducting an audit of this sort, the PS Team will be able to maintain up-to-date documentation, such as the spreadsheet mentioned in the previous section. By keeping its documentation up-to-date, the PS Team will be able to quickly identify unused patch panel and cross-connect cabinet ports for connecting new devices to the network, thus eliminating the need to repetitively examine the patch panels.

3.4 Cabling Reduction Using Cabinet-Specific Switches

In order to further reduce the amount of cabling within the cross-connect cabinets, the firm should consolidate all of the cables currently connected to patch panels onto cabinet-specific Gigabit switches. Figure 4 shows an example of how a cabinet-specific network switch could be incorporated into the existing network.

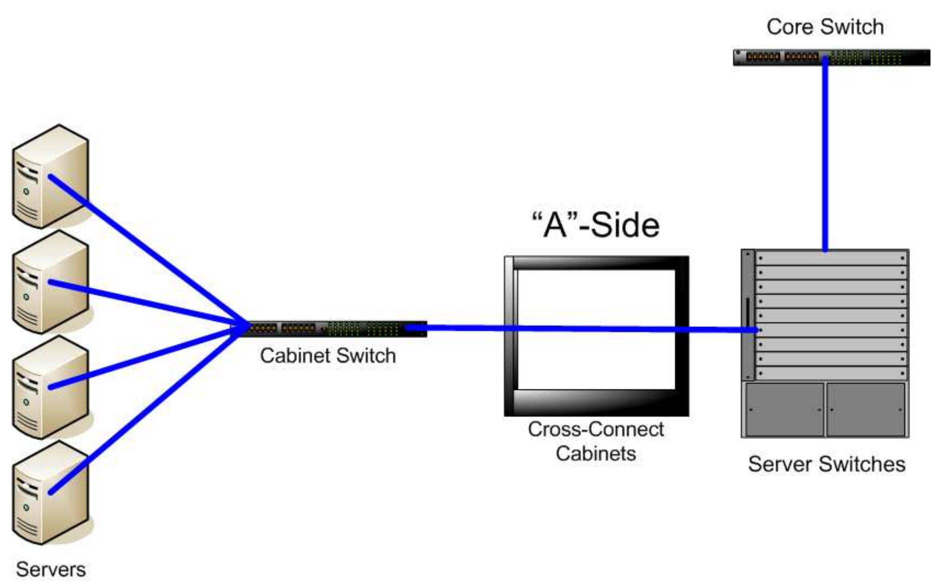

Figure 4. Example of how a cabinet-specific switch would fit in the network.

A cabinet-specific Gigabit network switch, as shown in Figure 4, would have one end of a cable connected to its uplink port and the other end to a network port on the "A"-side of a patch panel. If redundancy is a concern, then an additional uplink port would have to be properly configured and cabled. This will result in a major reduction of cabling on both sides of the cross-connect cabinets. The total number of cables would be reduced to approximately the same number of server cabinets or twice that amount for redundancy, excluding cables interconnecting cabinets.

Overall, this method of reducing the cabling in the cross-connect cabinets will be costly in regards to the switches that will need to be purchased. Gigabit switches similar to the ones currently used by PwC Canada can cost approximately $6000 each (see Appendix B). Installing, configuring, and rewiring each of them can take up to two hours; this can be done by a future co-op student, knowledgeable in the field of networking, and will cost the firm an additional $17 per hour, based on the firm's current co-op student salary. Assuming switches are installed in the thirty-seven cabinets where power (i.e., electrical outlets) is currently available (see Appendix A), the total purchase of the switches alone will cost approximately $222,000; the installation and configuration of the switches by A co-op student will cost an estimated $1258, excluding overhead costs such as those mentioned in section 2.3. Assuming PwC Canada's e-mail system is inaccessible for a certain period, the firm could be severely impacted through lost business. One such example in Appendix B mentions the possibility of losing a potential contract of ten million dollars which translates into lost revenues resulting from inaccessibility to the e-mail system. To prevent a disaster like this from happening, this recommendation, like the one mentioned in section 2.3, is definitely one the firm should look into. In fact, there is absolutely no question when one compares having to expense monies to correct the problem now versus leaving its status quo.

An area that may have to be further analyzed in order to determine whether or not a switch should be installed into a particular cabinet would be the overall bandwidth usage specific to servers in cabinets. If, for example, too many high-traffic servers (i.e., servers constantly attempting to share data at a full 1 Gbps) are connected to a single Gigabit switch, the network performance of those servers may be significantly reduced. This may not be an issue, however, if future Ethernet switches using CAT6 cabling can support up to 10 Gbps [2]. Alternatively, the firm may wish to use switches with multimode fiber optic uplink ports which can currently support speeds of up to 10 Gbps [3], where possible.

This solution can be implemented over time when operations in the data centre are at a minimum; it does not have to be implemented at one specific time. It will definitely benefit the overall operations of the data centre and those of the firm as it will further eliminate the amount of cabling within the data centre and, in turn, further prevent server inaccessibility and disaster which can lead to delays and losses in other parts of the firm. However, it should be implemented prior to implementing the recommendation made in section 2.3, should the firm choose to do so. This will maximize the number of cables being removed from the cross-connect cabinets.

As a result, cabling processes will be streamlined; there will be less time and less effort being spent on the cabling of all new servers and the removal of cables for decommissioned servers. In addition, the documentation mentioned in section 3.2 will be further reduced as there will be fewer connections to take note of in the cross-connect cabinets. This will allow the PS Team to spend more time working on more important and more valuable projects vital to the firm's operations. This solution will also allow the firm to further expand its network, should it choose to do so, through the use of the newly available ports in the patch panels. Members of the PS Team currently working from remote locations may also be more inclined to work at the data centre due to there being fewer obstructions to work with in the cross-connect cabinets.

4 Conclusions

From the analysis in the report body, it is concluded that the complexity of the cross-connect cabinets creates a major point of failure in PwC Canada's network, a definite risk. If cables are not removed from the cabinets slowly and carefully, critical servers may lose their connectivity to the network and cause delays for different departments, resulting in significant lost revenues for the firm.

In addition, there is a discrepancy in the cross-connect cabinets; they contain a number of network ports with patch cables connected to them that are not being used. This unneeded cabling contributes towards the point of failure and causes an increased risk to the firm's daily operations.

Lastly, there is a similar discrepancy in the patch panels in server cabinets. Unused networking devices or patch cables alone are connected to the patch panels, but not connected to anything else via the cross-connect cabinets. These devices or patch cables are using up valuable ports on the patch panels and are using up cabinet space which can be used for other devices or cables.

5 Recommendations

Based on the analysis and conclusions put forth in this report, it is recommended that PwC Canada implement the following recommendations:

1) Re-cable the cross-connect cabinets in order to minimize or eliminate the overburden of useless and unneeded wiring that currently exists within the cabinets.
2) Install Gigabit switches, using either CAT6 cables or fiber optic cables for uplink ports, into server cabinets. It is suggested to implement this prior to re-cabling the cross-connect cabinets in order to further eliminate unnecessary cabling.
3) Conduct a detailed audit of all patch panel and cross-connect cabinet ports to document, certify, and remove all unnecessary cables.

By implementing one or more of the above recommendations, the firm will benefit in increasing their overall bottom line as far as revenues are concerned. In general, the firm will be able to accomplish the following:

1) Reduce the failure rate caused by the cross-connect cabinets that currently impose a high risk on the firm's overall operations.
2) Reduce the time and effort expensed on cabling servers, when troubleshooting cable-related problems, and when adding, removing, and tracing all other cables.
3) Facilitate PS Team members in identifying and removing old cables during the implementation process.
4) Reduce the firm's operational costs.
5) Reduce the documentation required when installing and decommissioning servers.

The implementation of these recommendations will allow PwC Canada to attain more accurate identification of unused ports and will streamline cabling processes when connecting new devices to the network. This will allow the PS Team to fully manage and oversee a department with a clean and complete record of the most up-to-date documentation surrounding the cabling process and the interconnected networking devices. Working with proper documentation allows the troubleshooter to fast-track and immediately find the problem. Failures between devices should not be sensitive to clutter of cables nor to any end connections. The aforementioned recommendations make it clear that these failure points should be reduced and, if possible, totally eliminated.

Glossary

Bandwidth – The amount of data that can be transferred between networking devices at any given moment of time.

Category 6 (CAT6) – A type of cabling media used in more modern networking environments. This type of cabling is used commonly for Internet Protocol telephony, servers, and switches [2].

Downtime – The amount of time for which a device is offline or inaccessible.

Fiber Optics – Strands of silica which allow light to be transmitted from end-to-end [3].

Gbps – Gigabit(s) per second. A transfer rate, also abbreviated as Gb/s, measured in the number of Gigabits that can be transferred between networking devices in one second.

Gigabit – In data transfer rates, one Gigabit is equivalent to one billion Bits and is abbreviated as Gb.

Mbps – Megabit(s) per second. A transfer rate, also abbreviated as Mb/s, measured in the number of Megabits that can be transferred between networking devices in one second.

Megabit – In data transfer rates, one Megabit is equivalent to one million Bits and is abbreviated as Mb.

Multimode Fiber – Type of optical fiber which allows light to travel in multiple paths, allowing data to be transferred at higher transfer rates [3].

Network Switch – Networking device capable of connecting multiple network segments and various other networking devices together.

Patch Cable – Cables of various short lengths used to interconnect networking devices and/or ports within cabinets.

Uplink Port – Special port on a network hub or switch that is capable of expanding the network port density on that particular switch by connecting to an additional network hub or switch.

References

[1] PricewaterhouseCoopers LLP, “Our Organization -- PricewaterhouseCoopers Canada,” 2008; http://www.pwc.com/extweb/aboutus.nsf/docid/87C4DD10053035C2852570CA00175245.

[2] “Facility Considerations for the Data Center: Version 2.1,” white paper, Panduit Corp., Cisco Systems, Inc., and American Power Conversion Corp., Oct. 2005

[3] Telecommunications Industry Association - Fiber Optics LAN Section, “Fiber Optics LAN Section (FOLS): Technology - Fiber Information,” 2008; http://www.fols.org/technology/.

Appendix A – Patch Panel and Cross-Connect Cabinet Analyses

Patch Panels

		"A"-Side Ports			"B"-Side Ports		
Cabinet	**Power Available?**	**Used**	**Free**	**Total**	**Used**	**Free**	**Total**
#1	Yes	1	23	24	1	23	24
#2	Yes	3	21	24	1	23	24
#3	Yes	0	24	24	10	14	24
#4	Yes	0	24	24	5	19	24
#5	Yes	18	6	24	5	19	24
#6	Yes	3	21	24	4	20	24
#7	Yes	12	12	24	10	14	24
#8	Yes	10	14	24	12	12	24
#9	Yes	12	12	24	6	18	24
#10	Yes	6	18	24	2	22	24
#11	Yes	14	10	24	23	1	24
#12	Yes	4	20	24	1	23	24
#13	Yes	18	6	24	11	13	24
#14	Yes	0	24	24	1	23	24
#15	No	16	8	24	6	18	24
#16	Yes	2	22	24	4	20	24
#17	Yes	5	25	30	11	19	30
#18	Yes	15	15	30	4	26	30
#19	Yes	8	22	30	8	22	30
#20	Yes	3	21	24	3	21	24
#21	Yes	9	15	24	4	20	24
#22	Yes	8	16	24	10	14	24
#23	Yes	8	16	24	5	19	24
#24	Yes	15	9	24	6	18	24
#25	No	13	11	24	10	14	24
#26	Yes	14	10	24	13	11	24
#27	No	10	14	24	4	20	24
#28	Yes	9	21	30	11	19	30
#29	Yes	11	19	30	11	19	30
#30	No	14	10	24	8	16	24
#31	Yes	12	12	24	3	21	24
#32	Yes	3	21	24	9	15	24
#33	Yes	15	9	24	10	14	24
#34	Yes	15	9	24	6	18	24
#35	Yes	10	14	24	5	19	24
#36	Yes	12	12	24	18	6	24
#37	Yes	12	12	24	13	11	24
#38	Yes	23	1	24	11	13	24
#39	Yes	13	11	24	5	19	24

#40	Yes	0	24	24	0	24	24
#41	Yes	7	17	24	5	19	24
#42	No	15	9	24	2	22	24
#43	No	0	24	24	0	24	24
	Total	**398**	**664**	**1062**	**297**	**765**	**1062**

Cross-Connect Cabinets

	"A"-Side Ports			**"B"-Side Ports**		
Cabinet (Section)	**Used**	**Free**	**Total**	**Used**	**Free**	**Total**
#1	1	23	24	2	22	24
#2	3	21	24	2	22	24
#3	1	23	24	10	14	24
#4	0	24	24	4	20	24
#5	20	4	24	5	19	24
#6	3	21	24	5	19	24
#7	12	12	24	11	13	24
#8	12	12	24	18	6	24
#9	12	12	24	15	9	24
#10	7	17	24	2	22	24
#11	14	10	24	23	1	24
#12	4	20	24	1	23	24
#13	11	13	24	11	13	24
#14	0	24	24	2	22	24
#15	12	12	24	7	17	24
#16	2	22	24	4	20	24
#17	5	25	30	11	19	30
#18	16	14	30	4	26	30
#19	7	23	30	9	21	30
#20	4	20	24	9	15	24
#21	10	14	24	3	21	24
#22	5	19	24	11	13	24
#23	7	17	24	8	16	24
#24	14	10	24	10	14	24
#25	9	15	24	16	8	24
#26	11	13	24	18	6	24
#27	9	15	24	4	20	24
#28	7	23	30	11	19	30
#29	4	26	30	12	18	30
#30	9	15	24	10	14	24
#31	8	16	24	4	20	24
#32	7	17	24	19	5	24
#33	11	13	24	15	9	24
#34	13	11	24	8	16	24
#35	9	15	24	5	19	24
#36	10	14	24	17	7	24

#37	15	9	24	15	9	24
#38	23	1	24	11	13	24
#39	13	11	24	5	19	24
#40	0	24	24	0	24	24
#41	7	17	24	6	18	24
#42	14	10	24	2	22	24
#43	1	23	24	0	24	24
Total	**362**	**700**	**1062**	**365**	**697**	**1062**

Comparison – Difference in Used Ports

Cabinet	Used Ports – "A"-Side	Used Ports – "B"-Side
#1	0	1
#2	0	1
#3	1	0
#4	0	-1
#5	2	0
#6	0	1
#7	0	1
#8	2	6
#9	0	9
#10	1	0
#11	0	0
#12	0	0
#13	-7	0
#14	0	1
#15	-4	1
#16	0	0
#17	0	0
#18	1	0
#19	-1	1
#20	1	6
#21	1	-1
#22	-3	1
#23	-1	3
#24	-1	4
#25	-4	6
#26	-3	5
#27	-1	0
#28	-2	0
#29	-7	1
#30	-5	2
#31	-4	1
#32	4	10
#33	-4	5

#34	-2	2
#35	-1	0
#36	-2	-1
#37	3	2
#38	0	0
#39	0	0
#40	0	0
#41	0	1
#42	-1	0
#43	1	0

All negative values above and on the previous page relate to ports in use on the patch panels, but not in the cross-connect cabinets (missing cabling). Similarly, all positive values relate to ports in use in the cross-connect cabinets, but not on the patch panels (surplus cabling). This being the case, both sets of values were added separately to obtain the totals listed below.

	Used Ports – "A"-Side	**Used Ports – "B"-Side**
Total Surplus Cabling	17	71
Total Missing Cabling	53	3

Appendix B – E-mail Correspondence with [name removed] (Supervisor)

From: [name removed]
To: Michael Soares
Date: 5/9/2008 1:49 PM
Subject: Re: Some Information

Hi Michael,

Interesting questions.

Loss of productivity is a tough one to place a $$ number on, however I will give it a try with 2 examples.

Assume our TAX LoS lost access to their systems (Delta) - based on past experience we could expect to be informed by the business the potential lost revenue for a day would be upwards of 1 million, especially if it is anytime during tax season.

Assume our email system was unable to send emails to external clients. Depending upon the business activity at the time we could be severely impacted financially through lost business. One example from a few years ago - we were doing some major work on the infrastructure and at the last minute one of the LoS contacted us and told us we could not move ahead because they were working on a 10 million dollar proposal that had to be out by midnight.

So the potential for lost revenue is difficult to articulate, however these are two true examples of which I am aware in recent years.

On the other side, if we lost the Hoteling servers we may not loose as much money, however we would have a lot of very unhappy clients. The Hoteling system enables us to have fewer physical seats that actual staff. Several physical seats on each floor would be designated as Hoteling for use by those individuals who do not have permanent seats. The AOS systems allows them to reserve a seat, similar to a regular Hotel. If they are unable to do that then we have to perform the work manually. This means lost time and extra effort on behalf of the AOS admins to ensure all services are available when someone needs to hotel.

If we lost one of our Fax servers there would be not capability for staff to send faxes as we have a very limited number of manual fax machines. Again, depending upon the nature of work in the business at the time this could have a similar impact as if we lost the ability to send external email.

As for the cost of a 48 port gig switch, ~$6,000 each.

[excerpt removed]

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Senior Manager - IT Operations

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