Project Planning Report for Renewal of the St. George Campus Data Centre

Campus and Facilities Planning

November 2, 2010

Table of Contents

Table of Figures

Appendices

I. EXECUTIVE SUMMARY

The University's main data centre moved to the McLennan Physics building after the initial data centre was destroyed by a fire in the Sanford Fleming building in 1977. Built to house a mainframe computing platform and supporting peripheral equipment of the day, and now well beyond its useful life, its design exposes the University's current information assets to greater risks than those ever conceived of in 1977.

Thirty-three years later, computing has become essential for the University to function. Most faculty, students and staff use computers on a daily basis for instructional activity, research, administrative work or communication.

These information technologies provide a host of new marketing and communication methods and, through the web, provide the primary showcase of the University to the world.

The Data Centre houses all of the University's central, business critical systems such as:

- ROSI student information system
- BlackBoard Learning Management System
- UTOR Info (UofT's main web page)
- AMS/SAP
- DUA systems
- Internet & Research network connectivity for St George, UTSC & UTM
- All fibre optic network connections for the St George Campus, connecting all departmental networks
- Campus Wireless Network
- Server Virtualization Service
- MROL (My Research Online)
- Procurement Services UShop
- UTOR ID & UTOR Authentication
- UTOR Exchange (staff & faculty e-mail & calendaring)
- Blackberry Enterprise Server
- OCTEL voicemail system
- UTOR Mail (student, faculty and staff e-mail)
- UTOR Recover (central backup service)
- UTOR CSI (managed desktops & storage for Simcoe Hall et al)
- Police network & terminal server for squad cars
- Enterprise data storage & archiving

As computers have evolved over the past 30 years, consequently power and cooling demands have increased dramatically. The power-density of rack-optimized and "blade" servers continue to increase. Racks once containing a single computer can now hold 40 or more. As a consequence, and due to the lack of a structured cabling system to deal with this added complexity, the existing raised floor air conditioning plenum is clogged with network and power cabling. This prevents proper cooling of the IT loads and greatly reduces efficiency. Mechanical support systems that were adequate for a single mainframe are now inadequate, prone to failure[1], and have already caused campus-wide IT service outages.

There have been leaks[2] from overhead roof drains and other sources that have resulted in service outages and damaged equipment. Facility-wide environmental monitoring alerting operations staff to leaks, thermal problems, or other factors that could endanger the equipment and/or cause a service outage is necessary.

The facility lacks emergency backup power generation capability in the event of a prolonged (i.e. longer than 10 minutes) power outage. It has already been shown,

[1] AC Compressor failure on June 24th, 2010
Critical cooling tower failure on August 29th, 2010

[2] Flood in MP367 from Mechanical Penthouse on June 17th 2009
Flood in MP367 on June 24th 2009 due to plugged AC drain

through the extensive analysis conducted while preparing the I+TS Incident Response Plan[3] for water in the Data Centre, that the time to restore services following a planned, graceful shutdown is between 2 and 10 hours. Following an *unplanned* shutdown, which would occur after the 10 minutes of UPS battery backup is depleted, the time to restore only the most critical services would increase to between 5 hours and 2 days, assuming that the data was not corrupted by the shutdown and/or the equipment damaged.

A service outage of these proportions – ROSI, BlackBoard, E-mail etc unavailable for hours or days - would result in significant challenges for the University.

Recommendations:

The University requires a modern data centre that can accommodate necessary power and cooling densities. The University also needs to address the many single points of failure in the supporting infrastructure as well as building envelope deficiencies that pose a serious risk to the University's substantial investment in IT infrastructure and irreplaceable information assets.

Furthermore, to make a compelling case for divisions to host their servers centrally, either virtually or physically in the McLennan Data Centre, a data centre is required that instils confidence, eliminates the risks identified in the external audit[4] and provides access to better infrastructure (power, cooling, fire suppression, emergency power) than the divisions could afford on their own.

It is recognized that the University faces unprecedented financial pressures and that there are many competing demands for funding. Nonetheless, it is an inescapable fact that the University is more heavily dependent than ever before on a stable network and highly-available central services operating 7 days a week, 24 hours a day.

This proposal divides the renovation into two phases, Risk Mitigation and Capacity Growth. Phase 1 addresses Risk Mitigation issues while Phase 2 allows for additional Capacity Growth.

The report seeks approval in principle for both phases and approval to implement Phase 1 of the Renewal of the St. George Data Centre.

The proposed project will not require any additional building area and the move into renovated space will actually liberate space, approximately 167 NASM, for reassignment by the Provost's office, a 25% increase in space efficiency. An expanded use by Physics and Canadian Institute for Theoretical Astrophysics would be a possible outcome given that their research computers are in currently in this space.

The engineering and construction team selection process for the Data Centre will begin immediately following project approval, with an anticipated construction start in April, 2011, and occupancy by August, 2011.

---

[3] IRP Best Case: https://files.me.com/phopewell/hd3ebm
IRP Worst Case: https://files.me.com/phopewell/mavyj4

[4] MP367 DC External Audit Report: https://files.me.com/phopewell/q9065k

Current operating costs in the McLennan Building are charged at a rate equivalent to $119.23/GSM or $85,488 for the existing space (717 GSM), thus for the reduced area to be allocated to the Data Centre (450 GSM) an annual cost of $53,654 would be expected. However because data centre power and cooling requirements are extraordinary, this method of calculation of operating costs is inadequate. It is recommended that power use for the IT load and mechanical load be separately metered to apportion expenses to the Faculty of Arts and Science and separately to the Data Centre. For information, current average power costs for 2009-10 have been $0.11118/kWh.

The estimated Total Project Cost for Phase 1, of the project, which addresses risk mitigation and provides an emergency generator, is $5,160,100.

Phase 2, addressing capacity growth, is estimated to cost $945,000. This report is seeking approval for the implementation of Phase1 only.

Funding sources for Phase 1 of the project will be $2,835,000 from the Information and Technology Services and $2,325,100 from central funding.

II. PROJECT BACKGROUND

a. Membership

Patrick Hopewell	- Director, Enterprise Infrastructure Solutions
John Calvin	- Manager, Data Centres
Bruce Wildfong	- Supervisor, Network Operations
Ron Swail	- Assistant Vice-President, Facilities & Services
Bruce Dodds	- Director, Utilities & Building Operations, Facilities & Services
Julian Binks	- Director, Planning & Estimating, Capital Projects, Real Estate Operations
Alan Webb	- Planner, Campus & Facilities Planning
Olivier Sorin	- Graduate Student, Humanities, French

b. Terms of Reference

1. Propose a plan that will address the current and future requirements for the University of Toronto St. George Campus Primary Data Centre.

2. Review options for the location of the Data Centre and recommend a preferred location that will best serve the University.

3. Identify the capital cost of the Data Centre and all other resource implications, including projected increases to the annual operating cost as a result of the plan.

4. Identify any costs associated with staging during implementation of the project.

5. Identify a funding plan for the project.

6. Report by November, 2010.

c. Background Information

A Two Phase Data Centre Renewal Plan
The primary purpose of any data centre is to provide a protected and stable operating environment for the critical information systems and assets on which an institution relies. The University's Data Centre is no different in that respect. Were one to design a new data centre without regard for cost, complete redundancy would be designed.

In banking and brokerage, that would be two data centres, each having two separate utility feeds, two uninterruptible power supplies, two generators, two cooling towers, two chilling and air-handling systems. This complete redundancy affords one the ability to maintain one mechanical system, while the other supports the continued operation of the data centre.

In higher education, complete redundancy in all systems is typically financially unfeasible. Thus, every design decision, short of total redundancy, is necessarily a trade-off between cost and risk. To make an informed decision, these risks must be understood and accepted by the University. What must be prevented above all else is the complete and prolonged loss of service affecting the information systems supporting the academic, research, and administrative functions of the University.

Computers cannot operate without both electricity and cooling in roughly equal proportions. Even with an Uninterruptable Power Supply (UPS), a loss of power to the building (or a tripped main breaker) will ultimately result in an uncontrolled total shutdown of the facility 10 minutes later, when the UPS batteries eventually run down. A loss of cooling will have a similar effect when the temperature in the Data Centre rises above a critical threshold. What this means in practical terms is that for any electrical and most cooling failures, if the issue cannot be resolved quickly, the result is likely a complete shutdown of all services.

Enterprise Infrastructure Solutions (EIS) requested Ehvert Engineering to design a data centre for the University that would be located in the McLennan building reusing part of the existing facility, according to industry best practice and without discussion of costs. This design informed the discussion of how best to build a 280 m^2 data centre having 350kW IT load. The result was a $10M design incorporating all of the redundant elements that a proper data centre should have.

EIS then removed from that design those redundancy features that were appropriate to the University's mission but cost prohibitive (a second UPS, a second generator, a redundant electrical supply and distribution system). In short, the ability to grow the Data Centre beyond 350kW IT load, without a total shutdown to install a new building electrical service, is sacrificed. A designed valued at $6M remained, appropriate to the needs and resources of the University over the long term, but perhaps too large to accommodate in any single budget year. Working with Ehvert Engineering, that $6M design has been broken into two phases, which when completed will provide an appropriate level of redundancy in both power and cooling as well as additional capacity.

Thus, few of the operational risks associated with the current machine room, other than fire and flooding, are mitigated until after Phase 1 has been completed. Until such time as there is a generator that powers both the IT and mechanical loads, and a redundant cooling plant that can be powered by that generator, the risk of a prolonged service outage due to scheduled and unscheduled power outages remain. The last scheduled building electrical maintenance lasting 12 hours was March 2007 and the next is to be scheduled before the end of this fiscal year. However, the two phases of the plan have been designed with the goal of continuous Data Centre operation from the completion of Phase 1 through to the completion of Phase 2. Keeping the Day-1 load of 125kW (16 cabinets only) operational through the implementation of Phase-2 was integral to the Phase 1 requirements.

Phase 1 provides the ability to grow beyond 16 cabinets and/or 125kW IT by adding more cooling that will also serve as redundant cooling.

d. Statement of Academic Plan

The Data Centre plays a vital role in fulfilling the University's academic mission, allowing for the reliable and seamless storage and communication of information to many thousands of users daily. The Data Centre is also a critical piece of infrastructure to the administration of the institution, housing the AMS financial and payroll systems, ROSI Student Information System among many other key services.

Students, faculty and staff rely on the Data Centre for network connectivity to reach administrative and academic resources of the University as well as the Internet, wireless, and other data resources and services. Maintaining reliable information and network services is critical to the University's operation as a whole.

e. Space Requirements

Overview of Existing Space

The Data Centre is operated by the Enterprise Infrastructure Solutions unit of the University's Information and Technology Services administrative department and is located on the third floor of the McLennan Physics Building's North Wing. Including support space such as the Network Operations Centre, the entire Data Centre is currently approximately 618 NASM in area. The main server space, room 367, is also shared with the department of Physics and the Canadian Centre for Theoretical Astrophysics (CITA), which currently occupy approximately 63 NASM of the room's available floor area.

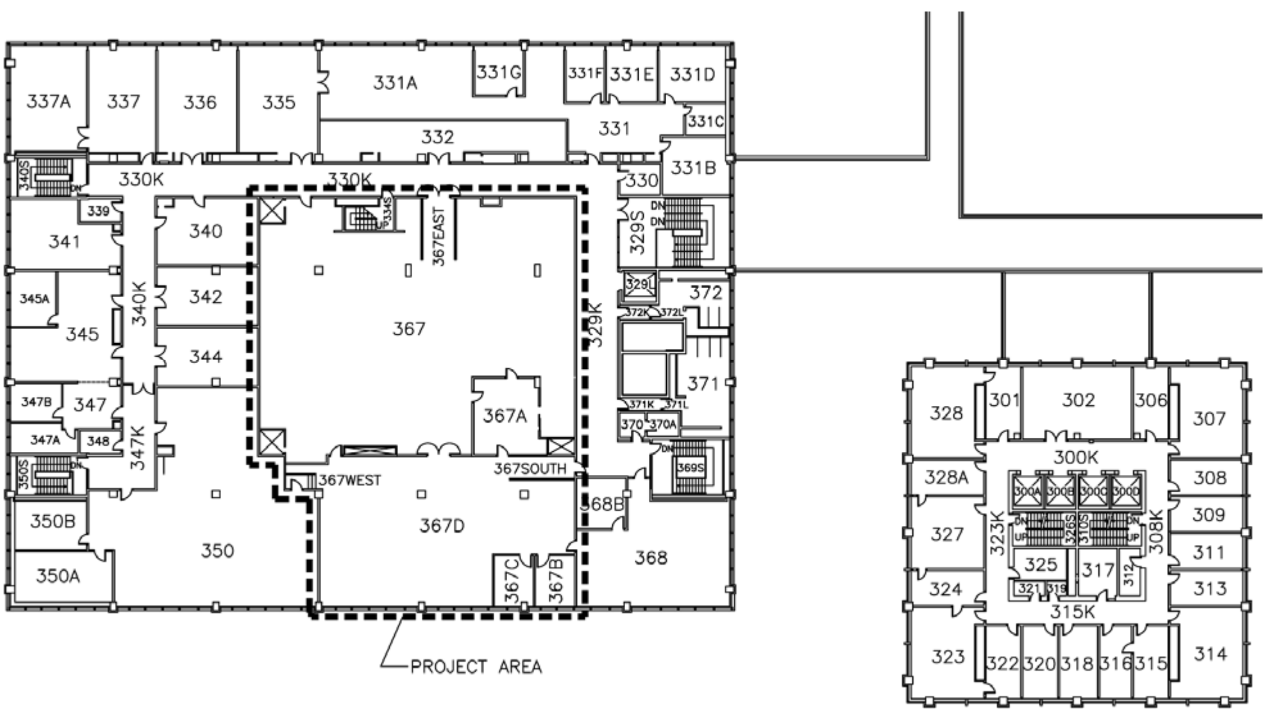

Figure 1 - McLennan Physics Building, Existing Third Floor Plan

Room 367D, commonly referred to as the Print and Test Area, has recently been vacated in anticipation of accommodating the renewed Data Centre.

The Enterprise Infrastructure Solutions unit of Information and Technology Services occupies a total of 1,302 NASM of space across three locations: the Bancroft Building, 246 Bloor Street and the McLennan Physics Building. The proposed project will not require any additional building area.

Equipment Profile

The I+TS component of the existing McLennan Data Centre currently comprises a total of 66 server racks and a variety of peripheral equipment (e.g. tape backup libraries, UPS, fibre optic patch panels, etc). There are no staff in rooms 367 or 367D however the Network Operations Centre in room 367A accommodates four staff members whose workstations will be relocated to existing Information and Technology Services space in room 368. A staff member in room 367C will also be relocated to room 368.

The Existing Equipment Inventory is included in Appendix 2 (available on request).

III. PROJECT DESCRIPTION

a. Site Options Considered

A comprehensive analysis of the existing Data Centre was conducted in September 2009 by consultants at Bell Canada/Cesmic Group Ltd. The options for addressing the risks and deficiencies contained in the report included renovating the existing space or moving the data centre to a collocation facility. Professional collocation was eliminated early on because of the prohibitive annual costs, however a costing analysis was conducted by I+TS, in conjunction with the Real Estate Operations, to evaluate the relative costs of renovating the current space versus moving to leased space. The table in Appendix 4 shows the comparative OTO and annual costs applicable to portions of the Phase 1 project for the various locations considered.

	Advantages	Disadvantages
Renovate Existing DC	Building owned by The University	Single power feed to building
	No additional inter-networking costs	Higher capital cost to renovate
	Lower migration costs	
	Fewer and shorter service disruptions during migration	
	Proximate to existing support staff offices	
Professional DC Co-location	24x7 Security Guard and Monitoring	High annual operating costs
	Low upfront capital costs	No dedicated support staff office space available
		High moving costs
		High inter-networking costs
		Significant disruption/outages during migration
		Year-to-year space commitment
Off-Campus Leased DC Space	Frees up MP367 for other uses	High inter-networking costs
	Fibre optic connection diversity (905 King)	Higher moving costs
	A & B utility power feeds (905 King)	Significant disruption/outages during migration
		Lease costs could escalate after initial 1-5 year term (905 King) Renovation required at all sites visited to accommodate planned power density and to bring site up-to-date
		Generator is shared among all building tenants (905 King)
		Dedicated staff office space not included in occupancy costs.

For a cost comparison of the specific sites considered, please refer to Appendix 4

It has been demonstrated that locating the Data Centre at the McLennan Building represents a significant annual savings in operating costs and significantly less risk and downtime than relocation to leased space. For example, the leased alternatives would provide a 5-year lease arrangement after which new lease costs would have to be negotiated and the co-location options are on a year-to-year basis.

Relocation of the Data Centre to an off-site facility will require downtime in order to move the existing hardware. The costs of relocating the hardware and the replacement of portions that cannot be easily relocated without damage have not been included in the estimate. Alternatively, to eliminate downtime for the transition to an off-site location, new hardware would have to be purchased (valued in excess of $10 million) to allow for server migration.

Due to the advanced age of many of the production servers, and the fact that the servers are not being replaced as part of this project, there is a very high risk that the vibration and impact to which they would be subjected in the course of external relocation would result in about 30% being inoperable at the destination site. This is in addition to the length of downtime that would result from having to dismantle, move and setup the servers at the new location. Downtime and risk could be reduced significantly with new hardware and the ability to migrate services over the network to a new location.

b. Space Program and Functional Plan

The proposed phased renewal strategy calls for renovating the west section of the Data Centre, room 367D, and demolishing rooms 367B and 367C in order to create an open area of approximately 231 NASM. All central I+TS production servers and related data storage equipment would be able to move into this reduced footprint. The consolidation would be through a combination of server virtualization and optimized server rack layout.

The vacated side of the Data Centre, room 367, could then be divided into two sections by cage walls with a shared aisle in the middle. One side, measuring approximately 177 NASM, would be used by I+TS as Data Centre support space for optical fibre plant infrastructure, network racks, staging, setup and storage, as well as mechanical infrastructure serving the Data Centre. The other half of room 367, approximately 167 NASM would become available for reassignment by the Provost's office. An expanded use by Physics & CITA would be a possible outcome given that the research computers are in currently in this space.

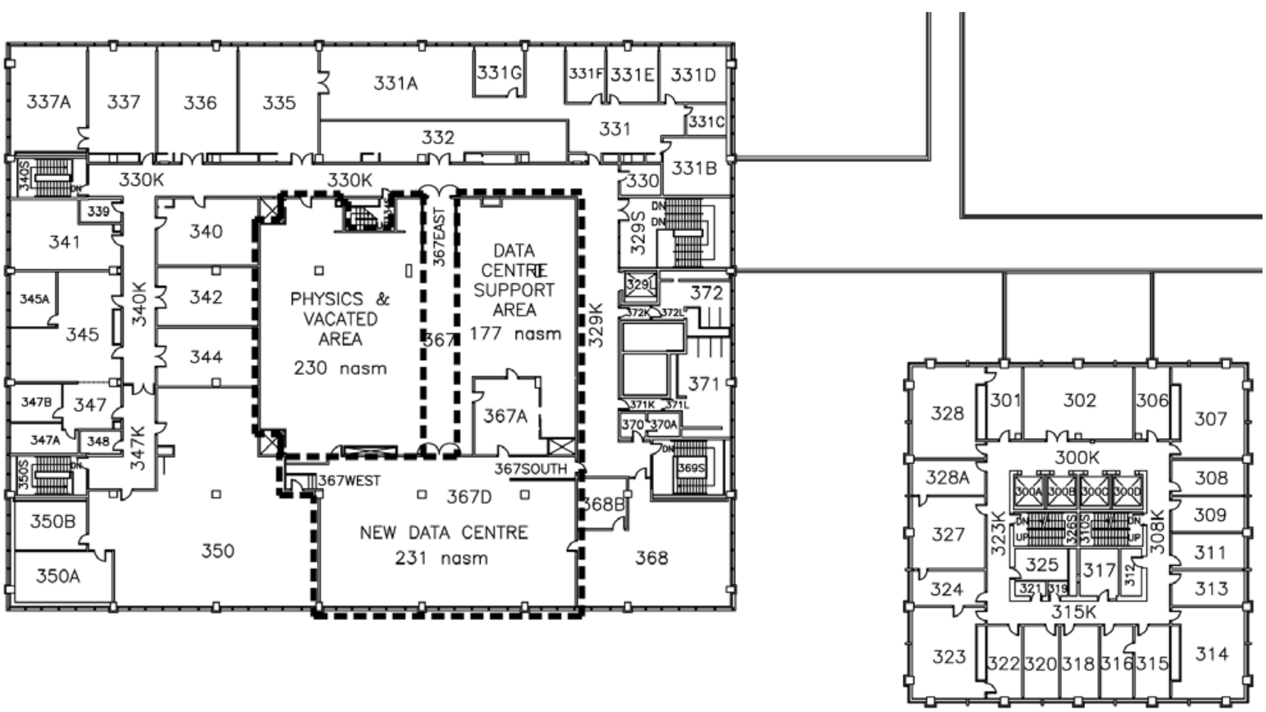

Figure 2 - McLennan Physics Building, Proposed Third Floor Plan

Figure 3 (following page) shows one possible layout for the renovated data centre and was suggested as part of the Ehvert Engineering study conducted in June, 2010. It should be noted that rack layout, rack orientation, and the final number of racks containing server equipment, will depend on the method of cooling selected as a result of a comprehensive engineering study and design. The final layout may differ from what is shown below, however, the concept of rows with overhead cable management is the likely end product regardless of cooling and electrical distribution method selected.

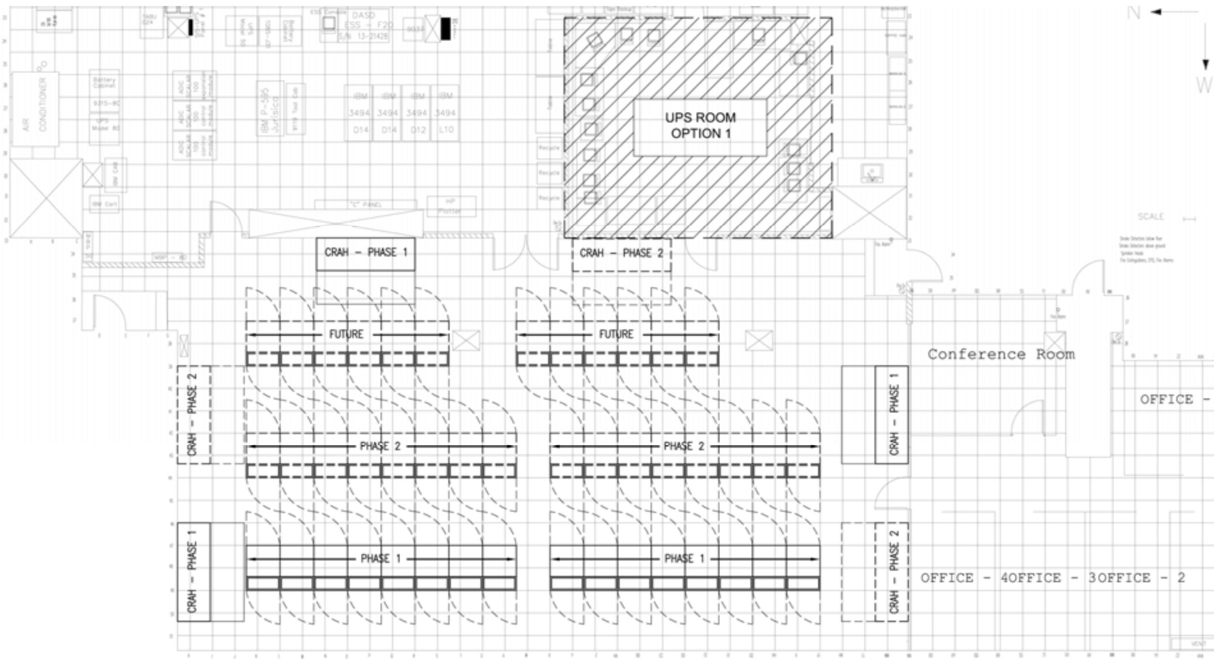

Figure 3 - Potential rack layout, new Data Centre, room 367D

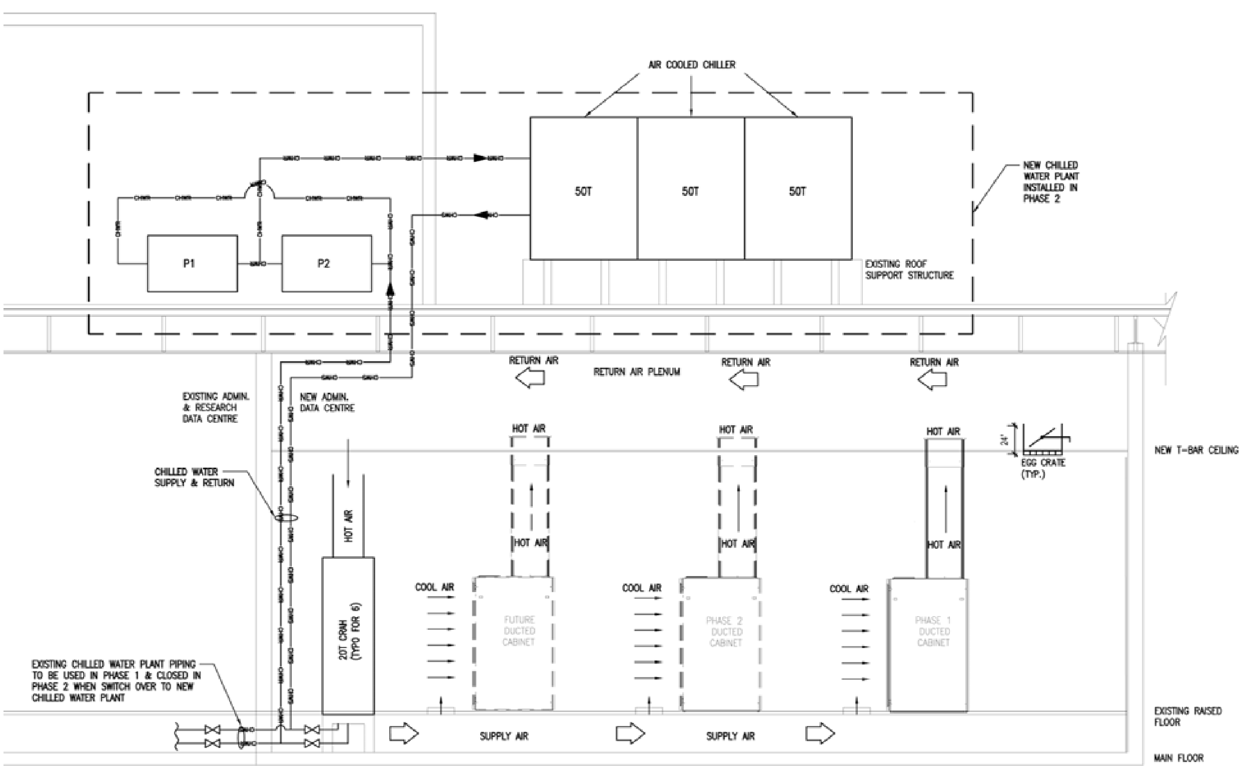

Figure 4 - Potential mechanical schematic elevation, room 367D

A detailed space program (to be read in conjunction with the functional plans) is listed as follows:

<u>Data Centre (Main Room)</u>

This room must be a secure and protected, scalable, high-availability, high-density computing environment to house only the rack-mounted servers and associated peripheral equipment of the Data Centre.

<u>Data Centre (Support Area)</u>

This area will act as support space for the Data Centre's main room and could include: a networking room to house existing MAN and WAN connections, a testing/staging area, and a secure storage area.

Please see Space Program below for additional information.

Space Program for the Data Centre Renewal

	NASM
Data Centre - Main Room	
Server/Rack Area	231.0
Data Centre - Support Space	
Network Area	59.0
Testing/Staging Area	59.0
Secure Storage Area	59.0
Grand Total	**408.0**

c. Design Objectives

To develop and deliver professionally managed, central facilities to accommodate and support core IT and computing services in a cost-effective manner to meet the academic and administrative needs of the University.

In achieving this goal, the guiding values and principles are:

- **Predictability**, **reliability** and **resilience**
- **Cost effectiveness** and **efficiency**
- **Managing risk** to meet business continuity and disaster recovery requirements
- **Energy efficiency** to minimize carbon emissions
- **Flexibility and scalability** to meet the changing needs of the University

A detailed description of the design objectives, operational criteria and of the phased approach can be found in Appendix 6.

f. Building Considerations

The new Data Centre should be created in line with industry best practices for redundancy and security and must be able to support the next generation of high density computing equipment.

The existing Data Centre contains a high number of risk factors including but not limited to an old and temperamental power distribution network, inadequate cooling distribution, and faulty drainage from the floors above, insufficient physical security and lack of proper rack level documentation.

In order to significantly reduce the risk level within the Data Centre, multiple systems should be addressed. These systems include: the cold air distribution system as well as the hot air return system; Electrical Distribution and UPS systems; Physical Security and Auditing controls; and the raised floor system, which should be replaced.

In order to prepare room 367D to house the new Data Centre, a program must be designed to remove and replace the existing raised floor system, after thoroughly cleaning the area, patching the concrete, and addressing any structural deficiencies. Roof and floor drains above must be repaired where required, moved to a location outside the Data Centre foot print where possible, and fitted with a secondary containment system that would direct water away from the Data Centre in the event of a leak.

Standardized server racks should be used; overhead network and power distribution cabling; and rack mounted PDU's that are metered and managed should be used in every rack. New racks should have pre-terminated ports for copper and fibre backbone connections to the existing network so as to contain each system and enable manageability to the rack level. These changes will allow for higher density server technologies and the migration away from older systems over time.

Mechanical

Heating, Ventilation and Air Conditioning
The area is currently served by 4 reciprocating chillers that produce chilled water at the rate of 250 Tons. The majority of this equipment dates from the late 1970's. Heat is expelled via a closed metal cooling tower which has recently failed, forcing an emergency shutdown of the facility to be commenced. The chilled water is used by the computer room air handlers that date from about 1978. About 25-30 Tons of the cooling capacity is used for the laser labs in the basement.

The chillers currently in place use R-22 refrigerant (an HCFC) which is gradually being phased out over the next few years. While we would still be able to operate them, replacement of the compressors in the event of a failure or refilling of the system will start to get more and more difficult, and historically we have had to replace compressors on these units.

Air handler #7 serving the area should be upgraded or replaced as this unit is required to perform a major role in the sensible cooling, humidification/dehumidification and ventilation of the support areas.

In general a key design principle should be the use of equipment cabinets that are integrated into the overall facility heat load management to further increase the cooling efficiencies.

The goals of the mechanical design are:
- Lower annual maintenance cost
- Improve performance and efficiency
- Improve access to equipment
- Provide for free cooling and partial free cooling capabilities
- N+1 redundancy in all active equipment components

Electrical

The 750kW feed that previously serviced the CRAY computer can be used for the IT Loads (up to 350kW); and the mechanical load. Without having a second utility power feed for the Data Centre, a generator, capable of supporting both the IT and mechanical loads, is required.

Back-up power

The Bell/Cesmic report suggested automatic switching of the loop feeder in the event of a failure on a segment of the loop. This is not acceptable because such a failure requires investigation of the cause of the incident before such switching can occur – hence, the potential for up to 4 hours before restoration of the power. A back up diesel generator set with automatic transfer switches would be a better solution to this problem.

When a diesel generator is be added, it should be sized to include the mechanical support equipment as well. The rooftop may not be a viable place for the generator because of the proximity to air intakes. A new generator could be located in the parking garage (unfortunately, at the expense of two parking spots). A location for the diesel tank and filling equipment would also have to be identified.

The electrical distribution for the new data centre is based on a 750 kVA distribution feed to service both the Data Centre IT and mechanical loads.

The first phase of upgrades should include the implementation of a modular UPS. The power distribution infrastructure feeding the UPS would be sized to accommodate the end-state configuration and load, in order to facilitate a seamless implementation of the additional capacity. The design should not preclude the addition of an optional second and fully redundant UPS of equal capacity (not included in the two-phase plan) at a later date.

As part of the distribution upgrades for the first phase, an Automatic Transfer Switch should be implemented. A mobile generator connection can be installed to provide emergency power in the event of a planned outage. This distribution will also be sized for the combined end-state loading of 750kVA (IT and mechanical loads).

It is envisaged that a future fixed generator will be a diesel based unit. Diesel is the preferred fuel source for emergency generators due to the technology’s inherent ability to withstand “block loading” and long history of reliability in standby applications. It is preferred over natural gas because a gas-main shut-off, ordered by the fire department, very is likely in the event of fire in an adjacent or neighboring building.

Fire Protection
The existing combined Administration and Research Data Centre has a recently installed pre-action dry type sprinkler system. This pre-action system provides the life safety component of fire protection. A separate system, providing equipment fire protection, should be implemented. A Very Early Smoke Detection Apparatus (VESDA), which detects the presence of smoke in advance of a standard smoke detection system would pin point the source of the warning allowing for immediate response prior to ignition and open flame.

The standard fire protection system should be paired with a gas fire-suppression system. In the event of a fire the gas suppressant is released to extinguish the fire prior to the wet sprinklers discharging. The gas suppressant system can be designed to minimize damage to the electronic equipment, and limiting equipment replacement costs and downtime.

The above fire protection systems should be installed and implemented in Phase-1, beyond providing a high level of fire protection and detection as soon as possible this would also allow the installation to take place before any equipment is in installed in the room, preventing the introduction of dust and debris to the equipment.

Communications and Network Infrastructure
The proposed communications and network infrastructure includes new fibre optic cable distribution, internetworking equipment, network core switches, cabinets and pathways. In addition, redundant cabling should be removed and new cable management at the existing central fibre termination should be installed.

The new fibre cable infrastructure could be routed from the central termination to all new server cabinets.

The fibre cable infrastructure should be supported by a new overhead cable tray system in order to separate the new installation from the legacy fibre and copper in the raised floor. All fibre cables should be terminated in fibre patch panels, complete with connector panels, sleeves, labeling, and cable management. All fibre and connectivity products should be laser optimized and rated to support speeds of 10 Gigabits.

The new cabinets should support all standard networking and server equipment and be equipped with devices/ducting for heat extraction, to prevent the mixing of hot return air with the cooler supply air. This approach would not only provide better cooling inside the cabinet for the equipment but would also provide higher efficiencies and tangible cost savings on the mechanical systems. All cabinets should include standard components such as mounting rails, steel mesh front doors, solid rear doors, and integrated cable management.

Hazardous Materials
Appendix 5 includes an overview of the presence of asbestos-containing materials within the building. Detailed information can be obtained from the University's asbestos inventory system upon request.

Prior to planning any renovation or demolition project a pre-construction survey must be carried out.

Disclaimer
The information provided has been collected from consultants' audit reports as well as the experience and knowledge of Facilities & Services staff. No detailed engineering has been done – this is left to the design team during the implementation of the project.

g. Site Considerations

Electrical Infrastructure
The anticipated electrical load for the IT equipment is 350kW. According to the Bell/Cesmic report the existing capacity is enough for the loads anticipated at the data centre. However, the loads anticipated over the next few years for the adjoining Physics/CITA space must be investigated and considered as well.

It should be noted that the existing facility does not have a single feed, but several. In order to facilitate the addition of back-up power, this should be changed to a single feed from one transformer. There should also be sub-metering for the loads for the facility so that true costs, separate from the rest of the building can be measured for the facility. Metering shall be compatible with the University's campus metering initiative.

h. Campus Infrastructure Considerations

Roof
The flat roof above the Data Centre was replaced in 2006.

Drains
All cast iron drains including any asbestos coverings within the facility need replacement.

Risk Containment
Flood alarms in the mechanical room (above) and within the raised flooring below are recommended. A structural assessment of the concrete floor slab is required prior to moving additional equipment into the space.

Fire Suppression – A gas suppression system is recommended and would enhance protection of assets within the facility. Very Early Smoke Detection Apparatus (VESDA) should also be installed.

Non-assigned space
No additional caretaking lunchrooms or closets need be provided assuming that the existing ones remains. The only new non-assignable space required would be an extension to the penthouse on the roof, should the chillers or other equipment be located outside of the penthouse.

i. Secondary Effects

Temporary effects (during construction)

While it should be possible to construct hoarding for the renovation that will segregate dust and other construction debris from the rest of the McLennan Building spaces, there will be construction noise to varying degrees of amplitude throughout the course of the project. The floor below houses 22 Physics scheduled class laboratories with 1 laboratory directly below the area of work. Arrangements should be made, where feasible and within budget, to schedule the most disruptive aspects of the work outside of normal teaching laboratory hours.

Long term effects

Approximately 167 NASM of room 367 will become available for reassignment by the Provost's office. An expanded use by Physics & CITA would be a possible outcome given that their research computers are in currently in this space.

IV. RESOURCE IMPLICATIONS

a. Total Project Cost Estimate

The Total Project Cost for Phase 1, including all taxes, contingencies, secondary effects, permits and professional fees, installed equipment, and miscellaneous costs, but not including any furnishings, is estimated to be $5,160,100.

Phase 2 which addresses capacity growth will be an additional $945,000.

Approval in principle is being sought for both phases. Phase 2, capacity growth, will be implemented when funding becomes available in accordance with the Policy on Capital Planning and Capital Projects.

See Appendix 3 for Total Project Cost estimate (available on request).

b. Schedule

• •Planning and Budget approval	November, 2010
• Business Board Approval	December, 2010
• Governing Council	December 2010
• Team selection & appointment	January, 2011
• Construction start	April, 2011
• Occupancy	August, 2011

c. Operating Costs

The total cost of the Physics building pro-rated over the total gross area is $119.23/GSM including utilities based on the new budget model using 2010-11 budget estimates. It is strongly recommended that both the power use for the data centre and its cooling be separately metered so that Arts and Science can determine if they should be credited for extraordinary power use by this facility. For information, current average power costs for 2009-10 have been $0.11118/kWh.

Using an assumption of 408 NASM (450 GSM) and 16 rack servers, Facilities & Services predict the following outcomes:

Utilities

No additional costs are foreseen for heating and the cost to cool the heat generated by the IT load (125kW) will remain at $44,000 per annum, and will increase to approximately $63,300 once the end-state IT load of 350kW is reached.

Electricity costs to supply the IT load will remain at $122,000 per annum for the Day-1 IT load and will increase to $341,000 per annum for the end-state IT load of 350 KW.

Operation and Maintenance

In the McLennan Building these costs are charged at a rate equivalent to $60.20/GSM or $27,090 for this space. This would include cleaning, waste management, police, fire prevention, mail services, as well as building fabric, mechanical, electrical and elevator maintenance. As there is no new space there is no increase in operation and maintenance costs.

d. Funding Sources

Funding sources for Phase 1 of the project will be $2,835,000 from Information & Technology Services and central funding of $2,325,100.

V. RECOMMENDATIONS

It is recommended that the Planning and Budget Committee recommend to the Academic Board:

1. That the Project Planning Report for the Renewal of the St. George Data Centre in its present location in the McLennan Physical Laboratories Building be approved in principle.

2. That the project scope for Phase 1, as identified in the Project Planning Report, be approved at a total project cost of $5,160,100 with sources of funding as follows:

Information & Technology Services	$ 2,835,000
Central funding	$ 2,325,100
Total	$ 5,160,100

3. That, pending available funding, Phase 2 forward to implementation through the Accommodation and Facilities Directorate in accordance with the Policy on Capital Planning and Capital Projects.

Appendix 1	Existing Space Inventory
Appendix 2	Existing Equipment Inventory (available on request)
Appendix 3	Total Project Cost Estimate (available on request)
Appendix 4	Location Comparison Table
Appendix 5	Summary of Asbestos Containing Materials
Appendix 6	Design Objectives, Operational Criteria and Phased Approach

Appendix 1 Existing Space Inventory

McLennan Building (area of work)

Flr	Rm #	Sul	Dept Short Nam	Categ	Category	Short I	Prorati	%	Stns	Room Alloc Comments	Area
M02	367		I+TS-Infrastruc	12.1	Cent Computing	Space		85	0	Computer Room	358.86
M02	367		Physics	3.2	Res Lab Support			15	0	Computer Serves/Racks	63.33
M02	367	A	I+TS-Infrastruc	10.1	Central Admin				4	Professional Office Multi (Sh	29.76
M02	367	B	I+TS-Infrastruc	19.5	Inactive/Assign				1	Vacant	11.97
M02	367	C	I+TS-Infrastruc	10.1	Central Admin				1	Professional Office Single	11.79
M02	367	D	I+TS-Infrastruc	12.1	Cent Computing				0	Computer Room	204.98
											680.69

Appendix 2 Existing Equipment Inventory (available on request)

Appendix 3 Total Project Cost Estimate (available on request)

APPENDIX 4

Data Centre Cost Comparision Table - 3000 sq.ft., 125kW IT Load, 16 Racks - Phase 1 Renovation

	McLennan Physics 255 Huron St. Renovate Existing Space	905 King W. Leased Space	Parkway Place 245 Consumers Rd. Leased Space	Bell Canada Canniff Street DC Co-locate	Data Centers Canada Toronto North DC Co-locate	Momentum Colocation Banigan Dr. Co-locate
Space	$33,201 $119/NASM	$150,000 $50/sq.ft./month	$90,000 $30/sq.ft./month	$1,320,000 $4400/rack/month	$307,968 $1604/rack/month	$391,680 $2040/rack/month
Utilities	$244,842	$219,307	$219,307	included in co-location cost **MAX 5000VA/rack	$219,307	$186,150 $0.0850/kWh + 15% admin
Networking	$0	$216,000 10Gb circuit @ $18,000/mo.	$216,000 10Gb circuit @ $18,000/mo.	$216,000 10Gb circuit @ $18,000/mo.	$216,000 10Gb circuit @ $18,000/mo.	$216,000 10Gb circuit @ $18,000/mo.
Moving	$0	$250,000	$250,000	$250,000	$250,000	$250,000
OTO	$2,700,000 renovation est.	$1,360,000 renovation est.	$2,360,000 renovation est.	$24,000 $1500 setup/rack	$180,000 $100k setup fee $5k/rack for racks & power	$400,000 OTO costs to be confirmed once detailed engineering study conducted. Est.: $400k
Downtime & Disruption	Low	Very High	Very High	Very High	Very High	Very High
Notes	Applicable portion of Phase 1 for comparison purposes. Day- 1 IT load	does not include office space	OTO costs to bring Power & Cooling up-to-date were not explored in detail because site was not ideal, however it would not be unreasonable to expect the OTO cost to be between the 905 King and 255 Huron estimates.	Includes security monitoring, fire detection & suppression, UPS, diesel generator backup. Does not include dedicated office space.	Includes security monitoring, fire detection & suppression, UPS, diesel generator backup. Does not include dedicated office space.	Includes security monitoring, fire detection & suppression, UPS, diesel generator backup. Does not include dedicated office space.
OTO Total	$3,335,000	$1,610,000	$2,610,000	$274,000	$430,000	$650,000
Amortized OTO	$474,439	$229,040	$371,300	$38,979	$61,172	$92,469
Annual Costs	$278,043	$585,307	$525,307	$1,320,000	$743,275	$793,830
Total per Annum Cost	$752,482	$814,346	$896,607	$1,358,979	$804,447	$886,299

IT Load	125	kW
Mech Load	125	kW
# of Racks	16	Racks
Power Cost	0.11180	per kWh UofT
Power Cost	0.10014	per kWh non-UofT
Space	3000	Sq. Ft.
NASM to sq.ft.	10.7527	sq.ft./NASM
Amortization Rate	5.25%	
Amortization Period	9	years
PUE	2.0	Ratio
Rack Density	7.81	kW per Rack

**** To accommodate the IT Load, 25 cabinets are needed!!**

N.B. Due to the advanced age of many of the servers we are running, and the fact that we are not replacing the servers as part of this project, there is a very high risk that the jostling they will be subjected to as a result of a physical move will result in about 30% not being bootable when they reach their destination. This is in addition to the length of downtime that will result from having to dismantle, move and setup the servers at the new location. Downtime and risk could be reduced significantly if we had new hardware to

Cost of Power: ~10.22 cents per kWh unless otherwise specified

Moving Cost Detail: Moving cost estimates are based on Ehvert Engineering's estimates and have been used as a guide-price for all locations. Ehvert mentioned that these estimates are probably on the low side, and do not include the cost of moving out of the space at the end of the lease.

Appendix 5 Summary of Asbestos Containing Materials

SUMMARY OF ASBESTOS-CONTAINING MATERIALS - McLENNAN PHYSICAL LABS - BUILDING # 078

Level	BUILDING MATERIAL							
	Texture Coat	Drywall Joint Compound	Thermal Mechanical Insulation	Vinyl Floor Tile/Sheeting	Ceiling Tile	Transite	Plaster	Fireproofing
16	Not Present	Not Present	Not Present	C**	Not Present	Not Present	Not Present	Not Present
15	Not Present	S*	C** S**	C**	Not Present	C**	S**	C** (Encapsulated)
14	Not Present	Not Present	C** S**	S* N	N	Not Present	Not Present	Not Present
13	Not Present	N	C** S**	N	N	Not Present	Not Present	Not Present
12	Not Present	S**	C* S*	S* N	N	Not Present	S*	Not Present
11	Not Present	S**	C* S*	S* N	N	Not Present	Not Present	Not Present
10	Not Present	S*	C** S**	N	N	Not Present	Not Present	Not Present
9	Not Present	S**	C** S**	S* N	N	Not Present	S*	Not Present
8	Not Present	S* N	C** S**	C* S* N	S*	Not Present	S*	Not Present
7	Not Present	S**	C* S*	N	N	Not Present	Not Present	Not Present
6	Not Present	Not Present	C** S**	N	N	Not Present	Not Present	Not Present
5	Not Present	Not Present	C** S**	S* N	N	C*	Not Present	Not Present
4	Not Present	S*	C** S**	C* S* N	N	C*	S*	Not Present
3	Not Present	S**	C** S**	C** S** N	S** N	C*	S*	Not Present
2	Not Present	S** N	C** S** N	C* S* N	S* N	Not Present	S**	Not Present
1	N	S** N	C** S**	C* S*	S* N	Not Present	S**	C*
B	Not Present	S** N	C** S** N	C** S** N	S* N	C*	S**	Not Present
SB	Not Present	N	C** S** N	C** S**	N	C*	S**	Not Present

C - Confirmed Asbestos-containing *** Minor Quantity**
S - Suspected to Contain Asbestos **** Major Quantity**
N - Non-Asbestos

This summary provides an elementary information of presence/absence of asbestos-containing materials within the building. Prior to planning any renovation or demolition project a pre-construction survey should be carried out.

Bldg. # 078

Appendix 6 Design Objectives, Operational Criteria and Phased Approach

Design Objectives

To develop and deliver professionally managed, central facilities to accommodate and support core IT and computing services in a cost-effective manner to meet the academic and administrative needs of the University.

In achieving this goal, the guiding values and principles are:

- **Predictability**, **reliability** and **resilience**
- **Cost effectiveness** and **efficiency**
- **Managing risk** to meet business continuity and disaster recovery requirements
- **Energy efficiency** to minimize carbon emissions
- **Flexibility and scalability** to meet the changing needs of the University

The electrical power demands of the renewed Data Centre are anticipated as an IT Load of 125 KW on Day 1 and 350 KW at end-state. In order to support a staged approach to capital spending, existing infrastructure should be re-used where possible. There is limited mechanical infrastructure that can be re-used beyond the Day-1 load of 125kW. However, there is an opportunity to re-use some existing electrical infrastructure.

Given the current power and cooling distribution configuration in the existing McLennan Data Centre, it's difficult to empirically measure the existing Power Usage Effectiveness (PUE) of the facility. Based on similar type data centres, without a clogged plenum, our current average PUE is likely worse than 2.0. Upon completion of Phase-2, the proposed Data Centre should have an average PUE of 1.5. This represents an estimated increase in efficiency of over 25% from the current situation. At the end-state 350 kW IT load, that represents a savings of up to $65,000 in annual operating cost. Over ten years, that savings would cover the capital cost of the emergency power generator.

Operational Criteria

- A Day 1 (Phase-1) IT load to match the existing load of the Administration equipment, this is projected to be at 125 kW.
- An end-state IT load of up to 350kW, maximizing the existing electrical distribution.
- Phase-1 cabinet count of 16 cabinets
- Phase-2 cabinet count of 32 cabinets (an additional 16 cabinets)
- End-state cabinet count of 44 cabinets total
- Phase-1 to include the installation of a new redundant chilled water plant dedicated to the new Administration Data Centre
- Phase-1 to include the installation of a new generator to provide backup power for the equipment in and supporting the new Administration Data Centre.
- An increasing need for greater service availability for administrative applications due to increasing dependency on technology and applications for service delivery to classrooms and off site users
- N+1 redundancy in certain key elements of the physical infrastructure to ensure service continuity and scalability

- Mobile generator tie-point to permit annual scheduled building electrical maintenance without forcing a complete shutdown

Phased Approach

Phase-1 of the project seeks to accomplish the following

1) Deliver a scalable data centre with Day-1 capacity of 125kW IT load.
    a. Limit the number of cabinets Day-1 to 16
    b. Outfit only the first of three rows of cabinets
    c. Install only three of six air-handlers
    d. Use the existing chiller infrastructure

2) Reduce the number of planned electrical shutdowns
    a. Size the critical electrical components for 750kW on Day-1
    b. Size the modular electrical to scale to 350kW of IT load from 125kW
    c. Pre-wire from UPS to all planned electrical panels
    d. Permit optional secondary UPS
    e. Provide a mobile generator tie-point with ATS.

3) Protect the critical load from dust, debris, and damage
    a. Replace raised floor
    b. Perform all “dirty work” for later phases in Phase-1
    c. Pre-install mechanical systems support for second and third rows
    d. Keep serviceable mechanical components outside the data centre

4) Eliminate the risk of flooding that exists in the current facility.
    a. Replace existing roof drain piping
    b. Install a fluid containment barrier outside the data centre
    c. Use a gas fire suppression system before the pre-action system

5) Reduce the cost of cooling as compared with the existing facility.
    a. Use over-head power and network cable management.
    b. Use the raised-floor plenum for cold-air supply only.
    c. Use rear-door heat extraction into a ceiling plenum for hot-air return.

6) Reduce the risk of fire as compared with the existing facility.
    a. Add VESDA for each cabinet (in hot-air return duct)
    b. Isolate UPS in a “battery room”

7) Consolidate the existing computing infrastructure to 16 cabinets.
    a. Create a shared data centre network infrastructure
    b. Increase rack power density to 7.5kW per rack.
    c. Provide redundant power circuits to each rack.

8) Add emergency generator to power both IT and mechanical loads up to 750k

9) Add a new and separate cooling plant
    a. Use N+1 redundancy with active/active or automatic configuration
    b. Add final three of six air handlers and migrate to new loop.

10) Do it all without a shutdown of the critical load

Phase-2 of the project seeks to accomplish the following goals:

1) Add second and third rows (16 – 28 more cabinets)
    a. Provide dual power circuits
    b. Vent hot-air to ceiling plenum
    c. Add VESDA
    d. Per cabinet networking and runs to the core

2) Increase UPS capacity to 350kW IT load
    a. Purchase new modules as IT load increases

3) Do it all without a shutdown of the critical load