Hardware Scorecard

Overall Rating

Overall Health Check Rating is based on the rolled-up score of all areas defined within Operations: IT Governance, IT Service Management, and Business Continuity Management.

IT Infrastructure Health Check: Hardware (Datacenters)

May 16th, 2017

Last Year	150 Fredrick – 250 Strasburgh – 100 Maple	Health Check Rating
N/A		**2.9**

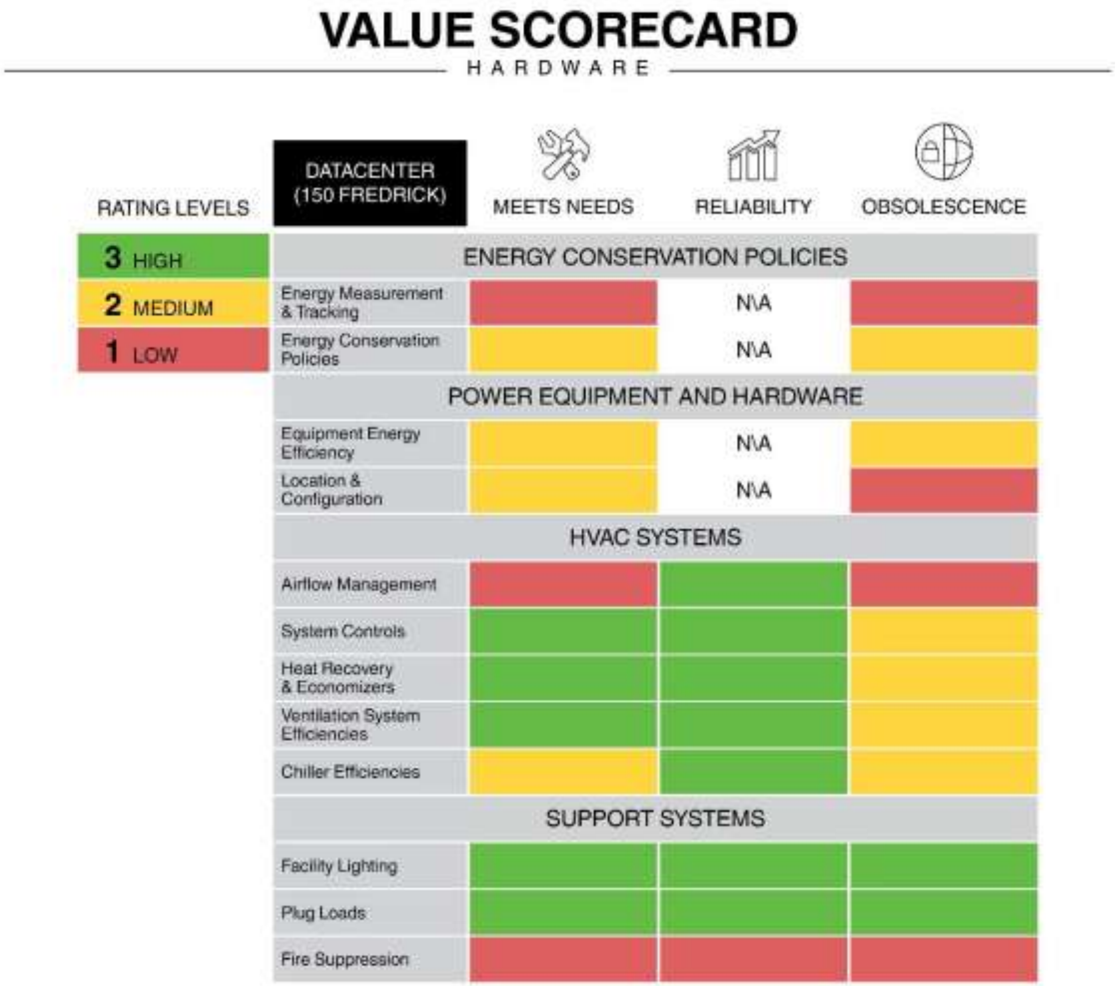
IT Infrastructure Health Check: Hardware (Servers,Storage,Network Devices)

May 16th, 2017

Last Year	Servers – Storage - Network Devices	Health Check Rating
N/A		**3.3**

DATACENTER - 150 FREDRICK (PRIMARY)

ITEM	CURRENT RATING	PREVIOUS RATING
DATACENTER (150 FREDRICK)	3.2	N/A



Synopsis

As the primary datacenter, a walk-through audit was performed on May 8th, 2017 in which our energy consultant, accompanied by Region staff, reviewed the space and equipment. A building operations person was not available for this review.

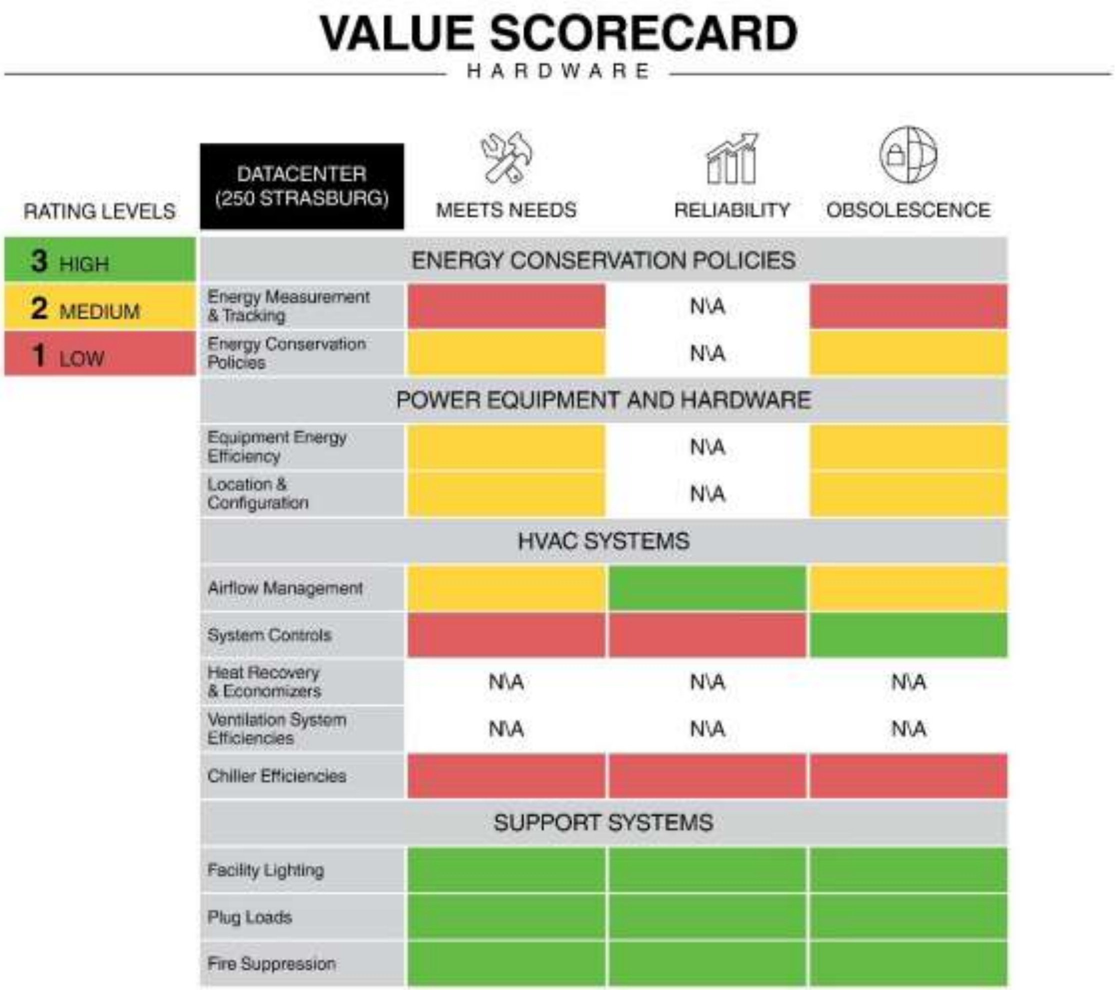
Departments across organizations are increasingly being asked to reduce their energy footprint to help meet conservation goals. Without adequate measurement and monitoring, optimization project can not be verified nor results maintained. Energy monitoring can also track and define savings when process and efficiency improvements are delivered within the department, making it a powerful communication and project justification tool.

The energy consumption and demand from the data centre is not currently monitored. This data, coupled with server utilization can provide a baseline for continuous improvement and troubleshooting.

It was also noted that the fire suppression system is water – not inert gas. Multiple floods over the past 1-2 years from a water leak two floors up has created concerns.

Please refer to the Datacenter section for the complete review and recommendations

DATACENTER – 250 STRASBURG (GRT)



ITEM	CURRENT RATING	PREVIOUS RATING
DATACENTER (250 STRASBURG)	2.8	N/A

Synopsis

The IT room, houses approximately 20 servers, including telecom switches and several UPSs. The recommendations within this report will be added, with ratings, to an overall Data Infrastructure assessment software portal provided to the Region.

The energy consumption and demand from the data centre is not currently monitored. This data, coupled with server utilization can provide a baseline for continuous improvement and troubleshooting.

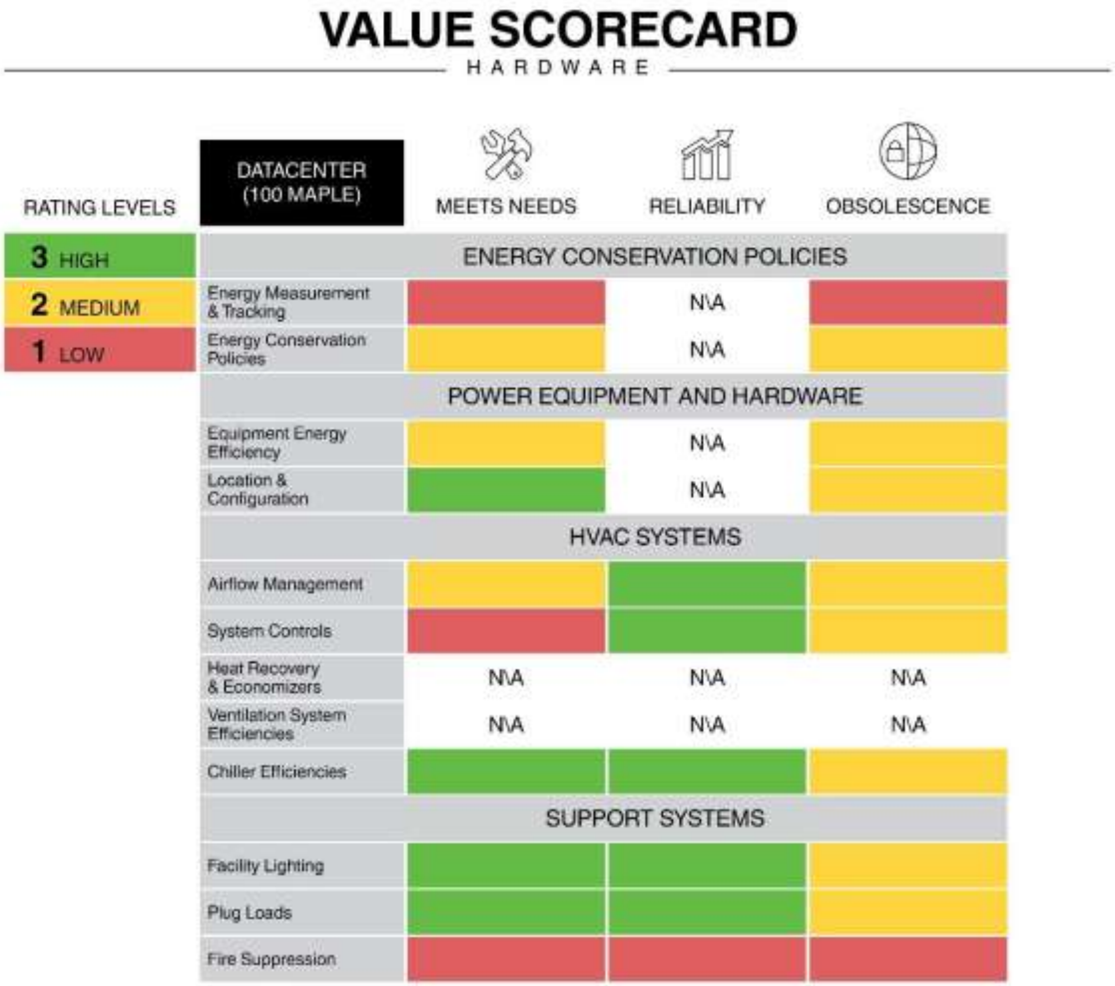
The main UPS in the data centre is an EATON model 9E for 3 phase power sources.

A portion of all the power supplied to the UPS to operate the data centre equipment is always lost to inefficiencies in the system. The first step to minimizing this loss is to identify and remove any equipment that does not require a UPS system.

This facility has a proper inert gas fire suppression system in place.

Please refer to the Datacenter section for the complete review and recommendations

DATACENTER – 100 MAPLE (OPS)



ITEM	CURRENT RATING	PREVIOUS RATING
100 MAPLE	2.9	N/A

Synopsis

The room, located in the basement, houses approximately 20 servers, including telecom switches and several UPSs.

Energy policies and goals have been set for the Region of Waterloo as set out by the Green Energy Act and the re regulation 397/11. In addition, the Region of Waterloo has included energy conservation in the purchasing policy which includes energy conservation and life cycle costing in the criteria for purchasing.

ITS does not currently have department energy targets or goals.

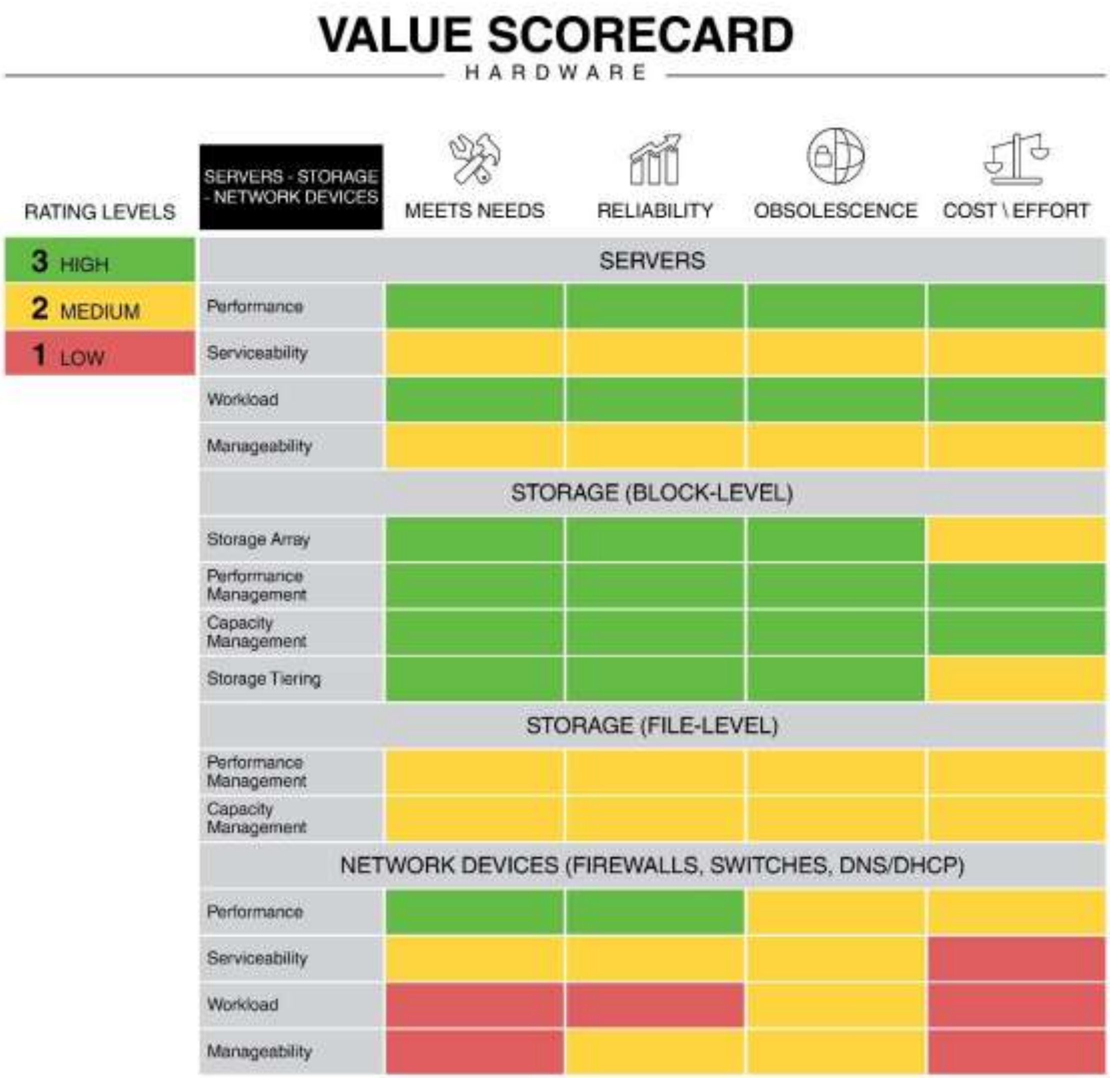
It was noted that this facility lacks a proper gas fire suppression system.

There is no centralized air handling system to feed conditioned fresh supply air to the space. Fresh air is provided only by a vent located in the bottom half of the door.

Cable congestion at the back of each server rack is an issue in this computer room.

Please refer to the Datacenter section for the complete review and recommendations

Servers, Storage, Network Devices



Item	Current Rating	Previous Rating
Servers, Storage, Network Devices	3.3	N/A

Synopsis

Both servers and storage are currently well equipped for growth, resulting in the bulk of the high ratings within this area.

31% of the server hardware is obsolete due to either legacy application or vendor based servicing.

Storage Arrays are running on newer generation Compellent SAN hardware storage arrays with 8GBit FC.

Storage Array containers are configured from Raid 5, 6 and 10 - almost 75% of data (KB/s) is read, but only 40% by IOPS. This would suggest fewer, larger reads, with more frequent but smaller writes.

With respect to the network devices/services, there are an abundance of multi-vendor products adding a layer of complexity.

The knowledge/management of these systems is also centralized to a limited number of resources. There appears to be a high MTTR (Mean Time To Repair) and extra work effort required to support these devices/services.

Please refer to the Hardware section for the complete review and recommendations

Findings and Recommendations

HARDWARE

[6]150 FREDERICK DATACENTER

The following report outlines recommendations to improve the energy efficiency of the Region of Waterloo's (the Region's) largest data centre equipment and support systems. This data centre is located on the 5th floor of the Region's headquarter building at 150 Fredrick Street, Kitchener, ON. A walk-through audit was performed on May 8th, 2017 in which Andrea Dwight, the energy consultant, accompanied Rhonda Wadel and Marco Chao from the Region, reviewed the space and equipment.

The room houses over 50 servers, vendor equipment including telecom switches, several UPSs and provides some general storage space. The recommendations will be added with ratings to an overall Data Infrastructure assessment software portal provided to the Region.

The first step in improving energy efficiency in any facility is the elimination of waste. In data centres, this means looking at the performance of the servers and process equipment and includes server consolidation, improving utilization and taking advantage of virtualization opportunities. These opportunities are being developed by others in the project team.

After this is completed, the overall layout of the room can be reviewed along with optimization of the support systems such as backup power, air conditioning, airflow management, lighting and controls. Finally, ensuring the waste heat produced by the equipment is evaluated for capture and use in other building spaces.

Cost of Electricity:

The following is a summary of energy cost data from Kitchener Wilmot Hydro bills provided by client. Energy costs vary month to month because of the Global Adjustment and the Hourly Ontario Energy Price (HOEP). Two electricity bills are summarized in Table 2.0 below.

Table 2.0 – Electricity Costs Summary

Description	Comments	October 2016	November 2016
Energy Cost			
Commodity Charge	Variable:Hourly Ontario Energy Price (HOEP)	¢1.22 / kWh (average)	¢1.58 / kWh (average)

[6] Based on a review of the new facility at 518 Dutton Drive the recommendation in this report will be the exploration of a migration of primary datacenter services from 150 Frederick to Dutton Drive. Region ITS will work with Region Facilities to plan/budget future requirements of ITS space on the 5th floor of 150 Frederick Street and return any unused/no longer require space to be repurposed accordingly.

Global Adjustment	Varies Monthly	¢9.72 / kWh	¢12.271 / kWh
Wholesale Market Services		¢0.60 / kWh	¢0.60 / kWh
	Total Energy Cost =	¢11.54 / kWh	¢14.45 / kWh
Peak Monthly Demand Cost			
Distribution		$4.7019 / kW	$4.7019 / kW
Transmission Network		$3.2265 / kW	$3.2265 / kW
Transmission Connection		$0.7836 / kW	$0.7836 / kW
	Total Peak Demand Cost =	$8.712 / kW	$8.712 / kW

In addition to the variable charges, the Region is also charged a monthly $175.83 customer charge for this facility.

For a point of reference, for every kilowatt (kW) of electrical demand this data centre continuously reduces, approximately $1,240 in direct electricity and demand costs will be saved annually (assuming the pricing shown in Table 1 above). In addition, savings will be achieved through reduction in cooling requirements due to lower heat loads.

Energy Conservation Policies

Energy Measurement & Tracking

Departments across organizations are increasingly being asked to reduce their energy footprint to help meet conservation goals. Without adequate measurement and monitoring, optimization project can not be verified nor results maintained. Energy monitoring can also track and define savings when process and efficiency improvements are delivered within the department, making it a powerful communication and project justification tool.

The energy consumption and demand from the data centre is not currently monitored. This data, coupled with server utilization can provide a baseline for continuous improvement and troubleshooting. A software package called Solarwinds has been installed for network monitoring, but has yet to be configured to easily track or monitor energy use.

Recommendations

- Consider installing permanent electrical sub-meters on data centre power sources to track the energy used by both the IT related equipment, and the support systems such as cooling and lighting. It is recommended that the Region install the meters before improvements are made to the department, in order to create a current energy baseline and to track savings.
- Set up Solarwinds to track energy usage over time by rack for the existing servers and equipment. Power density per rack or power/ft^2 can be a helpful measurement to evaluate the efficiency of the room. Automatic reports should be set up for weekly updates to flag issues and to ensure energy performance is maintained.

Energy Conservation Policies

Energy policies and goals have been set for the Region of Waterloo as set out by the Green Energy Act and the re regulation 397/11. In addition, the Region of Waterloo has included energy conservation in the purchasing policy which includes energy conservation and life cycle costing in the criteria for purchasing.

ITS does not currently have department energy targets or goals.

Recommendations

- Determine the energy consumption baseline and set energy targets for the ITS department to illustrate acceptable energy consumption rates, (and conservation goals if applicable). Consider including energy conservation and management measures to the Key Performance Measures (KPIs) for the department with well defined baselines and targets.

Power Equipment and Hardware

Equipment Energy Efficiency

The main data centre UPS is an EATON 9355 model 30 for 3 phase power sources. It is believed that this electrical demand represents half of the energy drawn by the server load as the load is split at the racks and is diverted through separate rack mounted UPS units. For a seven-day measurement period, the output load was measured between 56-57%. The input voltage and amps are tracked through Solarwinds allowing the calculation of input power over time. Figure 5 below, illustrates the electrical demand through the UPS over a week period (May 5th – 12th, 2017) in 5 minute increments.

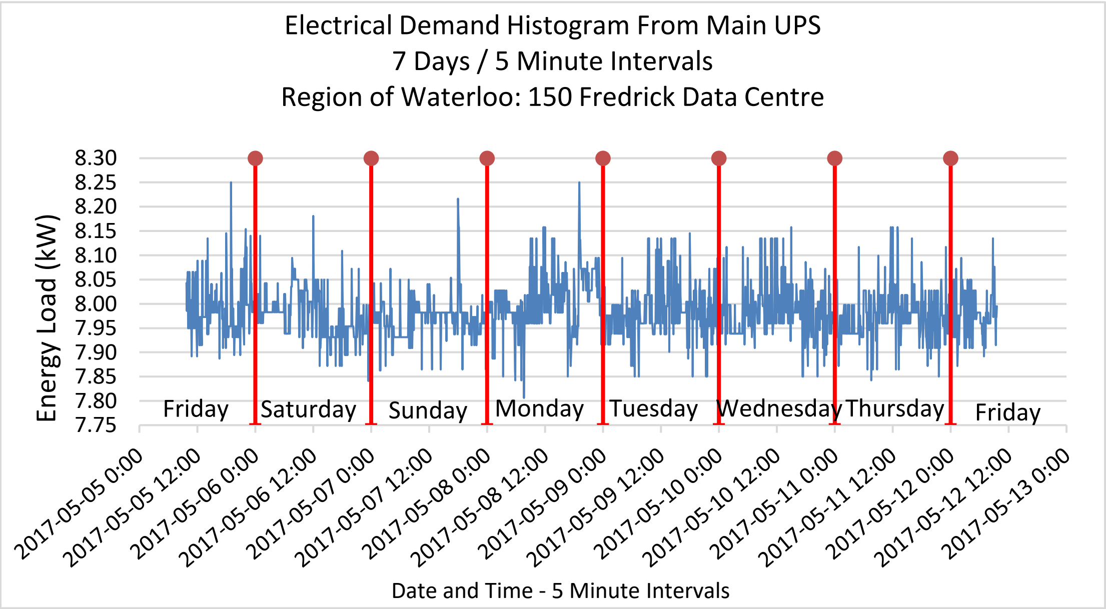


Figure 5.0 Main UPS Power Usage Data Over a Week's Period.

The demand drops, as expected, on Saturday and Sunday and weeknights by a little over 1% however this drop is slight, and highlights potential off hours energy savings opportunities.

A portion of all the power supplied through a UPS is lost to inefficiencies in the equipment. The first step to minimizing this loss is to review, identify and remove any equipment that does not require a UPS.

The efficiency of the UPS is also critical to energy conservation as any improvements will result in direct, 24 hour a day energy savings both from within the unit and from the resulting reduction of heat loads in the space. Mechanical specifications for the Eaton 9355 UPS indicate an approximate efficiency of 91% at the current 56-57% load ratio.

The newer servers in the data centre will all be equipped with energy management software. This is not currently used.

Recommendations

- Review energy efficiency options for the Eaton UPS including the Eaton Energy Saver System (ESS), or other similar controls on the market. The efficiency of the large Eaton 9355 UPS is approximately 91% according to vendor literature, at the current load ratio of 56-57%. Mechanical specifications state that energy efficiency of the UPS could increase to 99% by using the ESS, resulting in a significant energy savings for the department.
- Consider running the energy management software for non-critical servers.

Location and Configuration

This data centre is currently larger than is required for the current equipment, evident in part because of the free space and storage items in the room.

As discussed in the airflow management section, the placement of racking to create cold and hot deck airflow management strategy, is key to optimizing energy consumed for cooling.

Recommendations

- It is suggested that the room be reduced in size if it is found that the square footage is not needed. The additional room area only increases the complexity of air flow (mixing of hot and cold air) and therefore the energy cost to maintain set point temperatures.
- As a result of the overall data centre infrastructure review, the number and location of servers may be adjusted. At this time a new layout, to optimize cooling based on the new racking requirements, should be developed.

HVAC Systems

Airflow Management

As part of thermal management in a data centre, the placement of data centre racking and the design and flow of cooling air through the room can have a significant effect on cooling performance and energy efficiency. In this data centre, the middle isle (in the middle of the room) has been set up as the hot zone or hot deck. In this manner, the hot air can rise towards the return air ducts located in ceiling above the middle isle and be removed from the room.

The server racks in this room should therefore be positioned such that the front of the racks face the walls and the 'hot', back of the servers are facing the middle isle. It was observed that one row of racking was not set up in this manner, with the back of the server units facing the back wall.

Airflow within the data centre should be designed such that the hot and cold air mix minimally. Cooling is not as effective if the cool air is warmed first through mixing. The cooling units operate more efficiently when the return air temperature is higher. Newer data centres use closed racking to improve airflow and/or flexible curtains to better define hot and cool zones. Air from the room cooling units is currently delivered through ceiling mounted ducting along the outside of each racking isle and is not separated from the hot air which is pulled from the plenum below the raised floor.

Supply air from the central air handling system is delivered through several diffusers in the ceiling. Return air is pulled through square vents also located in the ceiling, and through slats in the edges of some lighting fixtures along the centre isle. One of the return air vents was blocked by insulation – please see Figure 6 below. When this is done by local staff, it may indicate an issue with the return air flow (size of plenum or location).

Figure 6.0 Partially Blocked Ceiling Return Air Duct – 150 Fredrick Data Centre

There are numerous openings in the floor for cable runs. This can create an imbalance in air flow as the air is short circuited and therefore reduces the volume of air pulled from racking located farthest away from the cooling units. In addition, under-floor obstructions such as cable congestion can negatively affect return of hot air to the air handlers and can significantly reduce the airflow.

Recommendations

- After the number of servers/racks has been assessed, complete a full air balance of the room to optimize the air flow patterns. This would include an assessment of the cooling air flows from the room chilling units to ensure a proper 'hot deck' and 'cold deck' design strategy is employed. The assessment would also review the impact of the fresh supply air from the central floor air handling unit through the variable air volume (VAV) boxes.

- Create a cable management strategy to minimize air flow obstructions caused by cables and wiring. This strategy should target the entire cooling air flow path, including the rack-level IT equipment air intake and discharge areas, as well as under-floor areas. Ensure any old cable is removed. Use structured cabling wherever possible to avoid restricting air flow to servers.

- Review the size and number of cable openings in the floor to assess impact on return air flow through the room. Install grommets to seal areas where cables enter and exit plenums (such as the raised floor).

- When the data centre A/C units are replaced (they are currently approximately 13 years old and would generally be up for replacement after 15 years of service), consider using different air flow strategy. Consider delivering the cool air through the floor instead of through the ceiling ducting. This strategy would take advantage of passive airflow conditions (when heated air rises) when hot air is removed at the ceiling through the ceiling mounted ducting and reduces mixing. Consider installing curtains to separate the cold deck and hot deck areas or fully closed racking units.

System Controls

When optimizing cooling and air management systems in a data centre it is recommended to look at the standardized operating parameters set out by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in their publication, *Thermal Guidelines for Data Processing Environments, 2nd Edition*. In the most recent 2009 ASHRAE Guidelines, the recommended and allowable inlet air conditions for Class 1 and 2 data centers have been modified to include a wider range of temperature setpoints. Referring to the 2009 ASHRAE guidelines, the recommended range for Class 1 and Class 2 data centres is between 64.4 – 80.6F (18-27C).

The temperature setpoints for both the room air conditioning units, and the central air handling system, are controlled by the central BAS. The temperature setting was noted as 22C for the room A/C units and 21.1C for the central air handling unit. Two of the three room A/C units are run as primary cooling in the space. The third cooling unit is on standby if one of the first two units fail and although the cooling is shut off, the main fan is run continuously.

The power supply for the A/C units and servers is wired into the emergency backup power system. Backup power for the emergency system is provided by an onsite diesel generator.

Recommendations

- Consider raising the room set point temperature, staying within the reference temperatures outlined in the 2009 ASHRAE guidelines. Please note that minor adjustments can make a large difference in energy use. For every degree celsius the room set point is increased, a 3-4% reduction in cooling and conditioning energy will result.

Heat Recovery and Economizers

The facility has a heat exchanger to capture/recover the heat produced in the data centre for use in other parts of the building during the heating season. The main air handling unit for fresh air is fitted with an economizer.

There are no recommendations at this time.

Ventilation System Efficiencies

The main air handling system provides fresh air and cooling to the 5th floor of the building and to the data centre through three variable air volume (VAV) boxes. The main fans are equipped with variable frequency drives (VFD) which efficiently manage the needs of the spaces. Humidification is also mainly controlled through this unit which is more effective and efficient than relying on the air conditioning units located in the data centre.

The system is controlled by the BAS and is on a setback schedule to take advantage of building occupancy periods.

There are no recommendations at this time.

CRAC Efficiencies

The room is cooled by three A/C units as described in the HVAC Systems Control section. The units are 13 years old. The consulting team was not able to determine the energy efficiency of these units (EER) as literature and field data was incomplete. Energy efficiency improves substantially as technology improves and a newer unit will therefore have a higher EER rating.

Recommendations

- Consider replacing units if the cost of maintaining increases significantly or if reliability becomes an issue. Replacement with currently available higher efficiency models is typically considered after the units are over 15 years in service.
- Review and optimize the controls, set-points and sequencing after the number and placement of servers is reviewed. If the data centre heat load changes significantly (if the number of servers/equipment increases or decreases) the setpoints for the A/C may not be operating in the most energy efficient manner and should be reviewed.
- If not already part of a regular maintenance program, ensure that the systems are maintained regularly. The filters on these units should be checked quarterly and cleaned or replaced as necessary. Increased pressure drop over plugged filters increases fan energy use substantially.

Support Systems

Facility Lighting

This data centre is equipped with energy efficient LED lighting. Staff at the data centre remarked that the lighting is left on at night.

Recommendations

- Review lighting controls and install motion sensors with timer to turn off lighting when room is not in use.

Plug Loads

No improvements identified for general plug loads.

250 STRASBURG DATACENTER

The following report outlines recommendations to improve the energy efficiency of the Region of Waterloo's (the Region's) data centre located in the GRT Building at 250 Strasburg Ave., Kitchener, ON. A walk-through audit was performed on May 8th, 2017 in which Andrea Dwight, the energy consultant, accompanied Rhonda Wadel, and an IT staff person, reviewed the space and equipment. A building operations person was not available for this review.

The IT room, houses approximately 20 servers, including telecom switches and several UPSs. The recommendations within this report will be added, with ratings, to an overall Data Infrastructure assessment software portal provided to the Region.

The first step in improving energy efficiency in any facility is the elimination of waste. In data centres, this means looking at the performance of the servers and process equipment and includes server consolidation, improving utilization and taking advantage of virtualization opportunities. These opportunities are being developed by others in the project team.

After this is completed, the overall layout of the room can be reviewed along with optimization of the support systems such as backup power, air conditioning, airflow management, lighting and controls. Finally, ensuring the waste heat produced by the equipment is evaluated for capture and use in other building spaces.

Cost of Electricity:

The following is a summary of energy cost data from Kitchener-Wilmot Hydro Inc. bill provided by the client. Energy costs vary month to month because of the Global Adjustment and the Hourly Ontario Energy Price (HOEP). The electricity bill is summarized in Table 4.0 below.

Table 4.0 – Electricity Costs Summary

Description	Comments	February 2017
Energy Cost		
Commodity Charge	Variable: Hourly Ontario Energy Price (HOEP)	¢2.10 / kWh (average)
Global Adjustment	Varies Monthly	¢10.559 / kWh
Wholesale Market Services		¢0.68 / kWh
	Total Energy Cost =	¢13.34 / kWh
Peak Monthly Demand Cost		

Distribution	$4.6515 / kW
Transmission Network	$2.9295 / kW
Transmission Connection	$0.7818 / kW
Total Peak Demand Cost =	$8.3628 / kW

No heat or water is provided to the space so only electrical charges apply.

For a point of reference, for every kilowatt (kW) of electrical demand this data centre continuously reduces, approximately $1,270 in direct electricity and demand costs would be saved annually (assuming the pricing shown in Table 1 above). In addition, savings would be achieved through reduction in cooling requirements due to lower heat loads.

Energy Conservation Policies

Energy Measurement & Tracking

Departments across organizations are increasingly being asked to reduce their energy footprint to help meet conservation goals. Without adequate measurement and monitoring, optimization project can not be verified nor results maintained. Energy monitoring can also track and define savings when process and efficiency improvements are delivered within the department, making it a powerful communication and project justification tool.

The energy consumption and demand from the data centre is not currently monitored. This data, coupled with server utilization can provide a baseline for continuous improvement and troubleshooting.

Recommendations

- Consider installing permanent electrical sub-meters on data centre power sources to track the energy used by both the IT related equipment, and the support systems such as cooling and lighting. It is recommended that the Region install the meters before improvements are made to the room, in order to create an energy baseline and to track savings.

- Set up the servers to be managed on Solarwinds, a package used to manage servers at the 150 Frederick data centre. The program can be configured to track energy usage over time by rack for the existing servers and equipment. Total power with power density per rack or power/ft^2 is a recommended measurement to evaluate the efficiency of the room. Automatic reports should be set up for weekly updates to flag issues and to ensure energy performance is maintained.

Energy Conservation Policies

Energy policies and goals have been set for the Region of Waterloo as set out by the Green Energy Act and the regulation 397/11. In addition, the Region of Waterloo has included energy conservation in the purchasing policy which includes energy conservation and life cycle costing in the criteria for purchasing.

ITS does not currently have department energy targets or goals.

Recommendations

- Determine the energy consumption baseline and set energy targets for the ITS department to illustrate acceptable energy consumption rates, (and conservation goals if applicable). Consider including energy conservation and management measures to the Key Performance Measures (KPIs) for the department with well defined baselines and targets.

Power Equipment and Hardware

Equipment Energy Efficiency

The main UPS in the data centre is an EATON model 9E for 3 phase power sources.

A portion of all the power supplied to the UPS to operate the data centre equipment is always lost to inefficiencies in the system. The first step to minimizing this loss is to identify and remove any equipment that does not require a UPS system.

The next step is to look at the efficiency of the UPS unit itself as any improvements will result in direct, 24 hour a day energy savings both from within the unit and from the resulting reduction of heat loads in the space. Mechanical specifications for the Eaton 9E show that it has been discontinued, and although it is listed to have a high efficiency, it most likely is less efficient than current models. Information has not been provided by the client on the UPS age or technical specs therefore a specific recommendation can not be suggested.

Newer servers in the data centre will be equipped with energy management software but currently this feature is not being utilized.

Recommendations

- Consider running the energy management software for non-critical servers.

HVAC Systems

Airflow Management

As part of thermal management in a data centre, the placement of data centre racking and the design as well as the flow of cooling air through the room can have a significant effect on cooling performance and energy efficiency.

Airflow within the data centre should be designed such that the hot and cold air mix minimally. Cooling is not as effective if the cool air is warmed first through mixing and the A/C units operate more efficiently when the return air temperature is higher. Newer data centres use closed racking to improve airflow or installing flexible curtains to better define hot and cool zones.

The layout of this room has not been set to optimize cooling and airflow. The room is large and holds only five racks spread out on the floor facing different directions. Two large new empty racks are being stored in the middle of this space.

Cable congestion at the back of each server rack is an issue in this computer room. Cable obstructions can significantly reduce airflow and therefore reduce the ability for heat to flow back to the air handlers.

Air ducts were evident in the ceiling of this data centre but it is not known what central air system is handling this air or how it is controlled. Review and full recommendations to optimize airflow in this data centre can not be made until information on the control, sizing and technology of the existing air handling and air conditioning system is provided.

Recommendations

- Create a cable management strategy to minimize air flow obstructions caused by cables and wiring.
- This strategy should target the entire cooling air flow path, including the rack-level IT equipment air intake and discharge areas.
- Ensure any old cable is removed. Use structured cabling wherever possible to avoid restricting air flow to servers.

- Review the layout of the existing server racking and adjust in relation to the local A/C units to create a cold and hot areas to improve airflow. A suggestion regarding the best location for the racking can not be determined without information on both the A/C unit controls and the central air handling system.

System Controls

Review and full recommendations regarding system controls can not be made until information on the control, sizing and technology of the existing air handling and air conditioning system is provided.

Heat Recovery and Economizers

Review and full recommendations regarding heat recovery and economizers can not be made until information on the control, sizing and technology of the existing air handling and air conditioning system is provided.

Ventilation System Efficiencies

Review and full recommendations regarding heat recovery and economizers can not be made until information on the control, sizing and technology of the existing air handling and air conditioning system is provided.

CRAC Efficiencies

Review and full recommendations regarding the computer room A/C units (CRAC) can not be made until information on the control, sizing and technology of the existing air handling and air conditioning system is provided.

Support Systems

Facility Lighting

This data centre is equipped with energy efficient LED lighting.

No improvements identified for lighting.

Plug Loads

No improvements identified for general plug loads.

100 Maple Datacenter

The following report outlines recommendations to improve the energy efficiency of the Region of Waterloo's (the Region's) data centre located in the Operations Building at 100 Maple St., Kitchener, ON. A walk-through audit was performed on May 8th, 2017 in which Andrea Dwight, the energy consultant, accompanied Rhonda Wadel and the building operations manager from the Region, reviewed the space and equipment.

The room, located in the basement, houses approximately 20 servers, including telecom switches and several UPSs.

The recommendations within this report will be added, with ratings, to an overall Data Infrastructure assessment software portal provided to the Region.

The first step in improving energy efficiency in any facility is the elimination of waste. In data centres, this means looking at the performance of the servers and process equipment and includes server consolidation, improving utilization and taking advantage of virtualization opportunities. These opportunities are being developed by others in the project team.

After this is completed, the overall layout of the room can be reviewed along with optimization of the support systems such as backup power, air conditioning, airflow management, lighting and controls. Finally, ensuring the waste heat produced by the equipment is evaluated for capture and use in other building spaces.

Cost of Electricity:

The following is a summary of energy cost data from Energy+ Inc. bill provided by client. Energy costs vary month to month because of the Global Adjustment and the Hourly Ontario Energy Price (HOEP). The electricity bill is summarized in Table 3 below.

Description	Comments	January 2017
Energy Cost		
Commodity Charge	Variable: Hourly Ontario Energy Price (HOEP)	¢1.98 / kWh (average)
Global Adjustment	Varies Monthly	¢10.594 / kWh
Regulatory Charge	Can Vary	¢0.62 / kWh
Debt Retirement Charge	Can Vary	¢0.70 / kWh

Table 3.0 – Electricity Costs Summary

Total Energy Cost =	¢13.89 / kWh
Peak Monthly Demand Cost	
Delivery	$10.720 / kW
Total Peak Demand Cost =	$10.720 / kW

No heat or water is provided to the space so only electrical charges apply.

For a point of reference, for every kilowatt (kW) of electrical demand this data centre continuously reduces, approximately $1,340 in direct electricity and demand costs would be saved annually (assuming the pricing shown in Table 3 above). In addition, savings would be achieved through reduction in cooling requirements due to lower heat loads.

Energy Conservation Policies

Energy Measurement & Tracking

Departments across organizations are increasingly being asked to reduce their energy footprint to help meet conservation goals. Without adequate measurement and monitoring, optimization project can not be verified nor results maintained. Energy monitoring can also track and define savings when process and efficiency improvements are delivered within the department, making it a powerful communication and project justification tool.

The energy consumption and demand from the data centre is not currently monitored. This data, coupled with server utilization can provide a baseline for continuous improvement and troubleshooting.

Recommendations

- Consider installing permanent electrical sub-meters on data centre power sources to track the energy used by both the IT related equipment, and the support systems such as cooling and lighting. It is recommended that the Region install the meters before improvements are made to the room, in order to create an energy baseline and to track savings.
- Set up the servers to be managed on Solarwinds, a package used to manage servers at the 150 Fredrick data centre. The program can be configured to track energy usage over time by rack for the existing servers and equipment. Total power with

power density per rack or power/ft^2 is a recommended measurement to evaluate the efficiency of the room. Automatic reports should be set up for weekly updates to flag issues and to ensure energy performance is maintained.

Energy Conservation Policies

Energy policies and goals have been set for the Region of Waterloo as set out by the Green Energy Act and the re regulation 397/11. In addition, the Region of Waterloo has included energy conservation in the purchasing policy which includes energy conservation and life cycle costing in the criteria for purchasing.

ITS does not currently have department energy targets or goals.

Recommendations

- Determine the energy consumption baseline and set energy targets for the ITS department to illustrate acceptable energy consumption rates, (and conservation goals if applicable). Consider including energy conservation and management measures to the Key Performance Measures (KPIs) for the department with well defined baselines and targets.

Power Equipment and Hardware

Equipment Energy Efficiency

The main UPS in the data centre is an EATON 9355 model 15 for 3 phase power sources. It is believed that this electrical demand represents half of the energy drawn by the server load as the load was observed to be split at the racks – half seems to be diverted through separate rack mounted UPS units with a separate power line.

A portion of all the power supplied to the UPS to operate the data centre equipment is always lost to inefficiencies in the system. The first step to minimizing this loss is to identify and remove any equipment that does not require a UPS system.

The next step is to look at the efficiency of the UPS unit itself as any improvements will result in direct, 24 hour a day energy savings both from within the unit and from the resulting reduction of heat loads in the space. Mechanical specifications for the Eaton 9355-15 UPS indicate that the unit runs at over 90% efficiency at half load. This means that 10% of all electricity sent through the UPS will be lost to inefficiencies and directly result in increased heat load in the room.

Newer servers in the data centre will be equipped with energy management software but currently this feature is not being utilized.

Recommendations

- Review energy efficiency options for the UPS including the Eaton Energy Saver System (ESS), or other similar controls on the market. The efficiency of the large Eaton 9355-15 UPS is approximately 90% according to vendor literature at half load range. Mechanical specifications state that energy efficiency of the UPS would increase to 99% by using the ESS, resulting in an energy savings from both reduced consumption and reduced heat load.

- Consider running the energy management software for non-critical servers.

HVAC SYSTEMS

Airflow Management

As part of thermal management in a data centre, the placement of data centre racking and the design as well as the flow of cooling air through the room can have a significant effect on cooling performance and energy efficiency. The servers in the racking has been positioned such that the front is facing the cool air plenum creating the 'cold isle' with the back of the servers 'hot isle' at the rear.

Airflow within the data centre should be designed such that the hot and cold air mix minimally. Cooling is not as effective if the cool air is warmed first through mixing and the A/C units operate more efficiently when the return air temperature is higher. Newer data centres use closed racking to improve airflow or installing flexible curtains to better define hot and cool zones.

Air from the A/C units in this room is currently delivered through ceiling mounted ducting along one side of the room. The units are elevated – return air is pulled from the bottom of the units located one side of the room. Some efficiency is lost because the hot return air to the A/C unit can mix with the cool supply air, however the room is quite small and the units work effectively.

There is no centralized air handling system to feed conditioned fresh supply air to the space. Fresh air is provided only by a vent located in the bottom half of the door.

Cable congestion at the back of each server rack is an issue in this computer room. Cable obstructions can significantly reduce airflow and therefore the reduce the ability for heat to flow back to the air handlers.

Recommendations

- Create a cable management strategy to minimize air flow obstructions caused by cables and wiring. This strategy should target the entire cooling air flow path, including the rack-level IT equipment air intake and discharge areas. Ensure any old cable is removed. Use structured cabling wherever possible to avoid restricting air flow to servers.

System Controls

When optimizing cooling and air management systems in a data centre it is recommended to look at the standardized operating parameters set out by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in their publication, *Thermal Guidelines for Data Processing Environments, 2nd Edition*. In the most recent 2009 ASHRAE Guidelines, the recommended and allowable inlet air conditions for Class 1 and 2 data centers have been modified to include a wider range of temperature setpoints. Referring to the 2009 ASHRAE guidelines, the recommended range for Class 1 and Class 2 data centres is between 64.4 – 80.6F (18-27C).

Regional staff indicated that temperature setpoints for the room air conditioning units are controlled locally however a room control thermostat was not found during the site tour (only temperature measurement was found indicating the room was currently 21C). Regional staff also indicated that there were no room temperature alarms in the facility BAS system. This is a concern because a failure of the two Carrier fan coil A/C units would only be recognized when the servers began overheating.

The power supply for the A/C units and servers is wired into the emergency backup power system. Backup power for the emergency system is provided by an onsite diesel generator.

Recommendations

- Add a control point to the BAS systems which monitors the data centre room temperature and Carrier Fan Coil units, and alarms if the temperature rises above a level which would impact the performance of the servers. A Siemens temperature sensor is already in installed in the room and if this is already programed to indicate and alarm in the BAS, provide training to the building operator or utility person.
- Consider raising the room set point temperature, staying within the reference temperatures outlined in the 2009 ASHRAE guidelines. Please note that minor adjustments can make a large difference in energy use. For every degree celcius the room set point is increased, a 3-4% reduction in cooling and conditioning energy will result.

Heat Recovery and Economizers

This facility does not have a heat recovery unit to capture and utilize waste heat created by the servers and equipment. A heat recovery unit would not be cost effective to add to this system as the waste heat stream would not be large enough to offset the capital cost.

There is no supply air provided to this space from a central building air handing unit. Fresh air is supplied only through a vent in the door. The use of an economizer is therefore not applicable for this space.

There are no recommendations at this time.

Ventilation System Efficiencies

There is no supply air provided to this space from a central building air handling unit. Fresh air is supplied only through a vent in the door. This category is therefore not applicable.

CRAC Efficiencies

The room is cooled by two Carrier fan coil units which are approximately 8 years old and have not experienced any significant maintenance or reliability issues. It was noted by regional staff that the filters on these units have never been changed. A typical maintenance program would change them quarterly or when the measured pressure drop rises above manufacturer's recommendations.

Recommendations

- If not already part of a regular maintenance program, ensure that the filters on these units are cleaned, and the system is maintained properly. The increased pressure drop over plugged filters increases fan energy consumption substantially. General maintenance of the fan coils should also be reviewed.

Support Systems

Facility Lighting

This data centre is equipped with seven T8 Fluorescent fixtures (2x4'-T8) controlled by a manual light switch.

Recommendations

- Manual switches can be left on accidentally. Install motion sensors with timer to turn off lighting when room is not in use. The cost in sensors range in price from approximately $25 to $120 each depending on the technology (passive infrared technology (PIR), ultrasonic technology (US) or a combination of the two). PIR sensors are the cheapest and work well in small rooms without any obstructions and could work for this space. A total installed cost would therefore be estimated at $70/each.

Plug Loads

No improvements identified for general plug loads.

SERVERS/STORAGE/NETWORK DEVICES

SERVERS & STORAGE

The assessment of the server and storage hardware was based on all three data center locations. Factors analyzed included compute power and storage accessibility for virtualized environments.

Key findings:

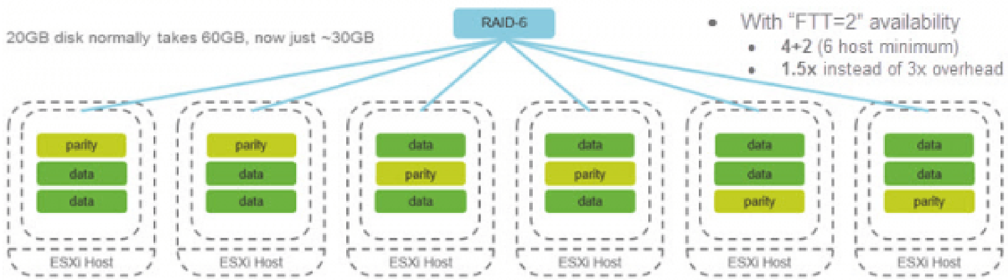
- 42% of the server hardware are within 2 years running the latest generation Dell Servers as well as last generations Dell Servers.
    - This covers the Intel Xeon E5 class CPUs for high density compute power.
- 26% of the server hardware were 2 generations behind using the Intel 5600 series which provided adequate compute power for less demanding applications and testing environment
- The remaining 31% of server hardware are considered obsolete (either due to legacy application or vendor based servicing)
- There is 1% of server hardware that is critical and beyond replacement (located at GRT – old 286 PC)
- Storage Arrays are running on newer generation Compellent SAN hardware storage arrays with 8GBit FC
- Storage Arrays containers are configured from Raid 5, 6 and 10 with almost 75% of data (KB/s) is read, but only 40% by IOPS is read. This would suggest fewer, larger reads, with more frequent but smaller writes.
- Replacing 1950 + 2xMD1000: **$42,000**
    - Limit: 2 + 15 +15 = 32x3.5" disks (max 2TB/ea, 64TB total) in 5U.
    - Options: Low cost R510 and stuff it full of 12x8TB drives for 96TB in 2U.
    - Note: ITS staff feel they need to keep the same number of disks to maintain performance, not taking into account how much faster modern drives are.
    - Mostly purchasing 2.5" servers now.
        - Should consider 3.5" for things like backup - 2-6x more density with 3.5".
- Some 2850's and 2550s in the racks.
    - "sentimental value." **These are EOL**.
- 2950 with RAID5 array. One disk failed, one predicted failure. Drives are EOL, can't find replacements. Already replaced at an application level, but still around for "sentimental value."
    - ITS seems unsure as to why it's still there and turned on.
- GRT refuses to plan for EOL. They buy servers with 5 year warranty, can be extended to 7. At 5 year, they have 2 years to plan replacement, but never do. See: OptiPlex GX1. Response is always "we'll consider it." – They cannot be forced to buy new hardware.[7]

[7] The past approach for GRT was to procure servers based on application specific needs – the new model within the Region is based on compute/capacity

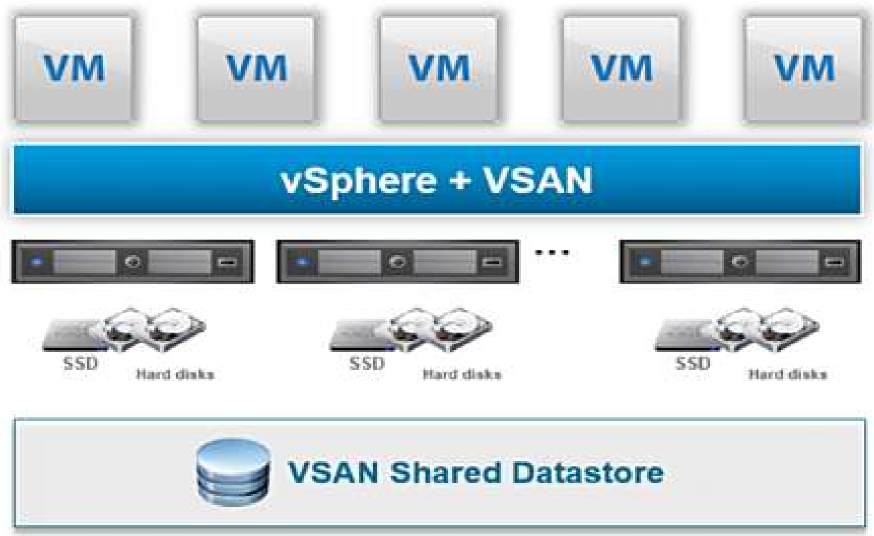
Recommendations

In combinations of server hardware, storage and virtualization, we recommend the following:

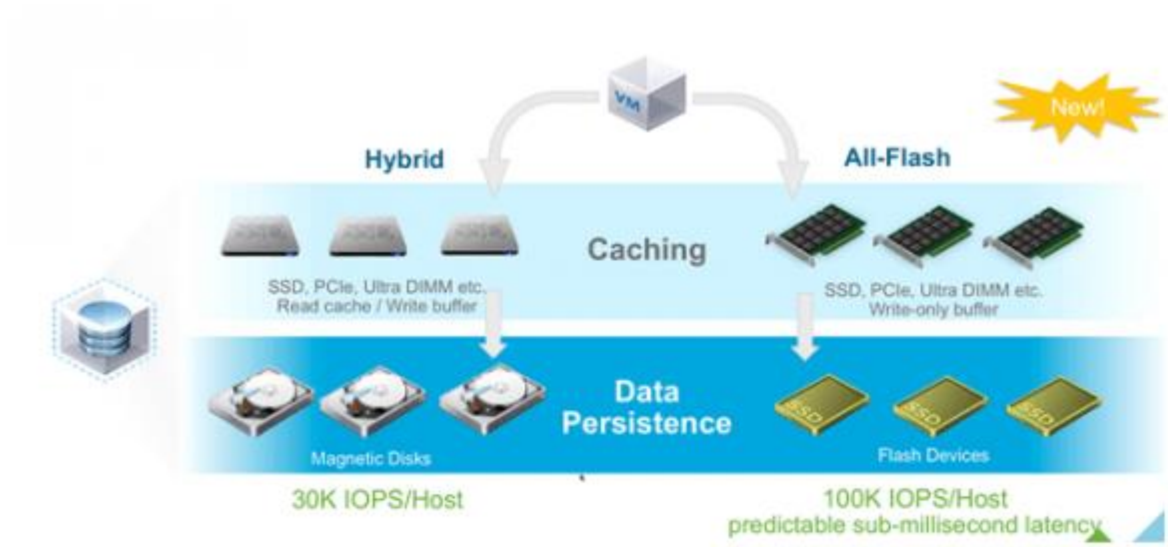
- vSphere & vSAN in a Raid 6 node hyper-converge configuration allowing fault tolerance up to 2 nodes failure



- vSAN will provide centralized shared datastore for easier manageability
- current hardware can be recycled / reconfigured to use vSAN
- recommend 10GB Ethernet and teamed for redundancy



- Multi-tier storage (SSD + Spinning media or PCIe/NVMe SSD + SAS/SATA SSDs) under a single datastore that spans across the cluster
- vSAN will determine which VMs will get priority between the storage tiers to give you optimal performance
- optionally administrators can pin the VMs to SSD tier if required manually



Network Devices

Key Discoveries:

- Several key components of the network are provisioned as a single device, including the main ('core') network switches (Core switch 5406).
- As robust these HP switches may be, as well as their life-time warranty and support, this does not mean they don't fail. The same applies to the WREPNET 3800 switch/router.

- A large number of “multi-vendor” devices has added a layer of complexity
- Knowledge of platforms (manageability) is too centralized
- Extra work effort needed every time there is a fix required on one of the devices
- There is a risk of an increase in MTTR (Mean Time To Recover).
- Majority of expertise on network devices is with a minority of the team.

Recommendations:

- Set reasonable vendor standards
- Cross-train resources on technology platforms to avoid having single resources supporting core platforms
- Document processes and procedures