A New Building in the Hospital – What IT infrastructure should we recommend?

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Abstract— **The Hospital for Sick Children in Toronto, Ontario is embarking in the renovation of the old buildings under the auspices of Project Horizon. The first phase of the project, consist in the development of a 22 story building to house all Patient Support personnel (PSC building). The second phase of the project is to demolish the old parts of the building and build a new Inpatient Care Centre (PCC). A Technology Group was formed to advice the Project Horizon team on the IT infrastructure for the new PSC building. The challenge is to ensure that the IT infrastructure shall meet the needs of PSC's tenants five year from now. In addition it needs to be flexible to support the needs over the next ten to twenty years. The Technology Group did a thorough research on the pros and cons for Structured Cable and GPON infrastructure. The paper describes the steps the team took to arrive to the final recommendation.**

Keywords— **IT infrastructure, structured cabling, GPON, Integrated network.**

I. Introduction

The Hospital for Sick Children in Toronto, Ontario is embarking in a very exciting project of renovating the old building infrastructure under a campaign called Project Horizon. The project, will see the re-construction of the old part of the Hospital into a new Patient Care Centre (PCC) that will host a new Emergency Department, Operating Rooms, Critical Care units (Paediatric and Neonatal) and a blood and bone marrow Transplant Unit. The new facility "will enhance SickKids' ability to deliver high-quality specialized care by investing in new, sustainable facilities and technology"[1]. The first component of Project Horizon is the construction of a new Patient Support Centre (PSC). As the name implies, the new PSC will host the support services, which will allow the creation of on-campus space to "move" departments to allow the demolition of the old parts of the building for the new PCC. Project Horizon is a 10 to 15 year project that projects the opening of the PSC in 2022 and the PCC in 2030. The PSC will not only host the Patient Support departments (IS, Finance, HR, etc.), but also will have a state of the art Conference Centre and a Simulation Laboratory.

The PSC is envisioned to be a 22 floor office type building. To start the construction of the PSC, the demolition of an existing building is required to create the space for the PSC. The design of the PSC and PCC was initiated few years ago, but now that the project launched the official kickoff, the design stage of the PSC has begun. As the PSC is being designed from scratch, an IT specific Technology Stream was formed to help determine the IT infrastructure requirements that will be able to serve the tenants IT needs five years from now and for the next twenty years. This paper will describe the process that has been followed to come up with the ideal IT infrastructure that will allow the future tenants be able to use the technology seamlessly.

II. IT Infrastructure Requirements

Recommending an IT infrastructure for the new building might seem like an easy task. One can always look at the current IT infrastructure of the Hospital and repeat it in the new building. The new building, however, will not open until 2022, therefore the IT infrastructure needs to be able to serve the user's needs five plus years from now. Furthermore, the IT infrastructure will have to be flexible to support any technological needs that might come up five or more years from now. This requires a thorough understanding of where technology is going and what the potential implications on the IT infrastructure it might bring. To ensure a good understanding of the possible demands on the IT infrastructure, the Technology Stream committee reviewed the following:

- Tenants projections on technology use;
- Current and future technology trends in office, conference environments and network infrastructure solutions;
- Building requirements from the IT point of view

The following paragraphs will describe some of the committee's findings.

A. Tenant Requirements

The PSC will be home for most of the support services and administrative offices. In addition, the PSC will have a state of the art Simulation laboratory and a conference centre. The guiding principles established for the construction of the new PSC indicate a high dependency on Technology for the new PSC. In particular the following[3]:

- Optimize utilization and workflow efficiency while fostering collaboration and integration between services;
- Have the capability to be adaptable to new innovation / processes and emerging technologies
- Improve service quality while lowering operating costs and leveraging technology
- Leverage automation where appropriate.

The above guiding principles, highlight the importance technology will play in the new building.

Discussions with the potential users of the PSC expressed the following needs[2]:

- Robust Wired/Wireless network, should be void of any Wi-Fi “Dead Zones” so staff can be as flexible and as mobile as possible
- Immediate connectivity to existing systems, either financial, medical or other departmental systems;
- Support the exchange of information from medical systems in real time, e.g., PACS or HIS;
- Support for Tele-med videoconferencing from either the desktop or dedicated systems;
- Support for desktop/meeting room video conferencing;
- Support for wayfinding, RTLS services;
- Robust and a wide-scale Virtual Desktop Infrastructure (VDI);
- Support transfer of big data whether it is within the hospital walls, inter-hospitals or through the Cloud;
- High network reliability network with sufficient redundancy to avoid network downtimes;
- Support of a DAS infrastructure;
- Support for occupancy sensors (both for meeting rooms and for general spaces);
- Support for a Building Automation System/Building Management System;

B. Office and Conference Environment Requirements

The requirements for the meeting rooms and conference centre were to be wired and equipped for the following:

- Video-conferencing and Tele-Medicine conferencing;
- Room availability/booking system with occupancy sensors to make rooms available should they not be occupied;
- Content sharing and collaboration for use in-room and via video-conference system;
- White-boarding/process mapping;
- Meeting room to Meeting room communication;
- Video input/distribution from and to other conference rooms and procedure rooms;
- Wireless connection to presentation displays;
- Ultra-thin and light screens for ease of space reconfiguration;
- HD video camera for online meetings;
- High-sensitivity microphones for online meetings;
- Recording capability with the ability to live broadcast or save video for future consumption;
- Sound reduction system;
- Secure Physical Storage solutions;

C. Building requirements from the IT perspective

The Hospital for Sick Children is committed to Environmental sustainability. As such, one of the design principles for the PSC is to have a buildings with a sustainable design with a performance initiative, targeting a minimum of LEED Gold Certification[1]. Therefore, it is envisioned that the building will have a smart Building Automation System that will utilize technology to efficiently manage and monitor the use of energy resources. As such, some of the building requirements are as follows:

- Computerized air and environment control;
- Energy efficient LED lighting systems;
- Microprocessor Dali (Digital Addressable Lighting Interface) based lighting control system;
- Complete building network for integration systems;
- Complete security access control, monitoring and CCTV system
- Digital Signage;
- Electronic metering

III. IT Infrastructure Choices

Selection of the proper IT infrastructure is one of the most important decisions the Technology Group will have to make, as it will serve the needs of the users for the next 10 to 20 years. To this end, the technology Group did the following research/reviews:

- Thorough review of the literature on IT infrastructures;
- Arranged conference calls with Gartner leading experts on WiFi, IoT, DAS and other IT infrastructure related fields;

- Talked to leading IT infrastructure vendors to explore the various possible options;
- Performed site visit with a vendor to talk to their experts on the future of IT infrastructures;
- Reviewed with the Hospital's Project Horizon's consultants the pros and cons of two possible IT infrastructures for the new PSC buildings.

From the research, the group found out that the two main possible IT infrastructures were Traditional Ethernet Structured Cable and GPON (Gigabit Passive Optical Networks).

A. Traditional Ethernet Structured Cable

Structured Ethernet Cable is the predominant industry standard for buildings and facilities. There are numerous standards that regulate the performance and characteristics of a Structured Cable system. Structure Cable infrastructure, offers a highly flexible network with highly resilient traffic flows based on endpoint connectivity requirements. In the typical Layer 3 based 3-Tier network design, traffic flows allow the Ethernet switches to forward and route packets to their destination at any layer affording a meshed traffic flow determined by endpoint connectivity requirements. Both peer-to-peer and device to core traffic flows are supported[4]. Structured Cable utilizes a structured cabling platform of copper and fiber. It has dedicated cable runs to each device offering dedicated bandwidth to end devices[4]. With the new 10Gb/s network switches and Cat 6A cabling, it is possible to offer dedicated 10Gb/s to end devices. One of the major requirements with IoT is the ability to provide Power over the Ethernet (POE). Structured Cable configuration is more flexible to offer POE. A typical Ethernet Structured Cable network is depicted below:

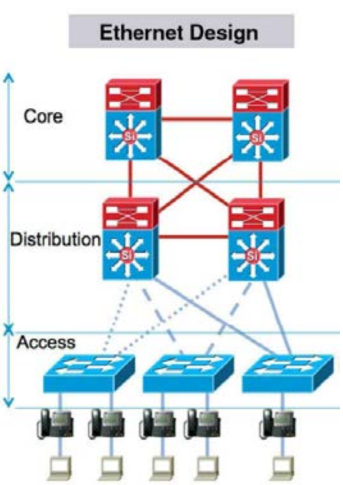

Fig. 1 Structured Ethernet Structured Cable

B. Gigabit Passive Optical Networks

Another form of communication that is highly used in the Cable/Telephony industry is Passive Optical Network (PON). In a PON configuration, a single Fiber Optic strand carries the information to an optical splitter that divides/splits the signal to multiple users. A typical PON configuration is shown in figure 2 below.

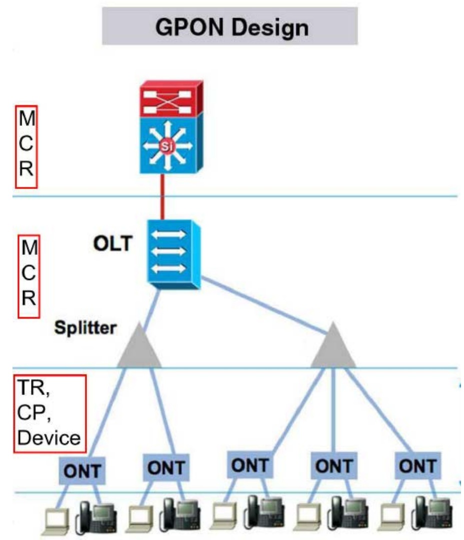

Fig. 2 GPON Structure

The single Fiber Strand is connected to the Optical Line Terminal (OLT). The Fiber is then sent to an Optical Splitter. As the name implies, the Optical splitter divides the signal to multiple lines that are taken to the Optical Network Terminal (ONT). From the ONT the signal is routed to the end user. One of the advantages is that the Single Fiber is divided to multiple end points. PON Bandwidth is traditional 2.5 Gb/s downstream and 1.25 Gb/s upstream. However, in a typical GPON deployment this capacity is shared between 16, 32 or 64 users depending on the splitters used. The resulting per device bandwidth is approximately 100 Mb/s at the lowest splitter ration and is reduced further at higher splitter ratios[4]. To achieve POE over a GPON configuration, a copper cable will have to be deployed from the ONT to the end device. This will require power at the ONT level. One advantage of the GPON configuration is the reduction/elimination of telecommunication rooms at each floor. Most of the "end" connections are done at the end point (terminal, PC, etc.).

IV. Final Recommendation For IT Network Infrastructure

As mentioned before, the Technology Group tackled this problem by conducting thorough research and review of the two configurations. The group listed pros and cons of each configuration and we had long discussions among the group. At the end, we are recommending to implement a Structured Cable infrastructure. It will consist of single strand fiber optic as the main backbone on the risers. Fiber optic to telecommunication closets (switches) on the floors and CAT 6A cabling to the end points. The Technology Group feels confident that this configuration offers the capacity and flexibility to serve the IT needs for the next five to 10 years. As transmission speeds increase, the only possible upgrades that might be needed would be to the copper cabling (to the successor of CAT-6A, today's industry standard) and the switches in the communication closets when higher speeds/bandwidths are supportable. While the GPON configuration had some positive advantages, it is not prevalent in the healthcare environment. There are not many vendors who can fully support such an infrastructure in healthcare. GPON equipment is not 100% interchangeable, hence there will be dependency on a single vendor. In contrast, Structured Cable configurations are a proven technology with various vendors capable of supporting the infrastructure locally. There is also equipment inter-operability between various vendors which will not limit us to a specific vendor when repairing or replacing our infrastructure.

V. Conclusions

While it is not a typical role for a Clinical Engineer to be involved in the selection of an IT infrastructure for a new building, participating in the Technology Group offered a great opportunity for learning. The challenge of selecting an infrastructure that will serve the needs for the future gave us the opportunity to explore and seek information on the possible future. We had to explore where technology is moving and how healthcare providers will be, potentially, using such technology. Areas such as Artificial Intelligence, Virtual/Augmented Reality, Internet of Things as it relates to health care and wearable technology are just few of the areas that we need to be aware and ready to tackle in the very near future. Many of these technologies are already being used in some advanced institutions and present an interesting challenge to both disciplines, IT and Clinical Engineering. The collaboration on the Technology Group, offered also a great vehicle for developing a great working relationship between the two groups, as we both had to explain and understand the client's needs from both the IT perspective and the medical perspective. The work done during the design for the IT infrastructure for the PSC will now serve as the foundations for the infrastructure to the future Patient Care Centre (PCC) which will start construction in five to six years. Overall, this project shows the great results that can be achieved, when Clinical Engineering and IT work together to provide the tools and technology for health care providers!

Acknowledgment

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Conflict of Interest

The authors declare that they have no conflict of interest.

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