# AUDITOR GENERAL'S REPORT

## IT Infrastructure and IT Asset Management Review:

## Phase 1: Establishing an Information Technology Roadmap to Guide the Way Forward for Infrastructure and Asset Management

## January 30, 2018

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**Auditor General**

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# EXECUTIVE SUMMARY

**Auditor General's strategy is to evaluate IT risks**

As part of the strategy to evaluate the City's Information Technology (IT) risks, the Auditor General has conducted a series of audits of the security and management of the City's IT infrastructure and IT assets.

**The Auditor General tested vulnerabilities in the City's IT networks, systems and applications in 2015 and 2016**

The Auditor General initially focused on assessing the security of the City's information and systems. The Auditor General's Office performed a vulnerability assessment and penetration testing of the City's IT networks, systems and applications in 2015 and 2016. The results are available at:

**Three reports with confidential attachments submitted to Council**

- Audit of Information Technology Vulnerability and Penetration Testing – Phase I: External Penetration Testing, February 16, 2016
  http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.AU5.10

- Audit of Information Technology Vulnerability and Penetration Testing – Phase II: Internal Penetration Testing, Part 1 – Accessibility of Network and Servers – October 24, 2016
  http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.AU7.13

- Information Technology Vulnerability Assessment and Penetration Testing – Wrap-up Phase I and Phase II– March 10, 2017
  http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2017.AU8.6

**Need for a City-wide approach and baseline standards for managing IT**

The main theme of these previous reports was the importance of having a single corporate view of cybersecurity within the City. The Auditor General recommended a unified City-wide approach to manage cyber threats.

The Auditor General also recommended that the Information & Technology (I&T) Division develop baseline security standards for all of the City's IT systems and infrastructure, regardless of which division, agency or corporation manages them. This single corporate view theme resonates throughout our current audit.

**Audit of IT infrastructure and IT asset management is currently underway**

In 2017, the Auditor General initiated an audit of the City's IT infrastructure and IT asset management.

**I&T Division's mission**

The strategic direction of the Corporate I&T Division is based on its stated mission:

> "*To drive innovative Information Technology solutions that enhance the delivery of City Services.*"

**Staff reported on City's IT Strategy in 2014**

A staff report on the City's Information Technology Strategy was considered by Executive Committee in August 2014.

http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.EX44.23

The staff report highlights that the implementation of the IT Strategy will be done in consideration of:

- the ongoing management of the City's large and complex IT infrastructure that includes applications, networks, and computers; and

- the need to manage emerging technologies, change, and the workforce's skills and knowledge.

**Strategic Technology Roadmap is needed**

To be effective, the Strategy must be taken a step further. It is missing a Strategic Technology Roadmap that would coordinate the planning, acquisition and deployment of technology into the IT environment.

**Three key actions to create and execute on the Technology Roadmap in order to achieve IT's strategic vision are:**

1. **Define the gap** – It is important to have a clear picture of the City's current and future state of IT infrastructure and assets so that the IT team can strategically identify, acquire and deploy information technology to achieve the City's vision.

2. **Establish a coordinated plan (technology roadmap) to close the gap** – Identifying the people, processes, and technology that will be needed to achieve the vision, and the milestones that will be used to assess progress.

3. **Execute the plan** – Taking the actions necessary to deploy the strategic technology roadmap so that the strategic vision is achieved with costs and efficiencies in mind.

**The issues identified in this report are not new**

Some of the key themes identified in this report are not new. The Auditor General highlighted similar issues in previous audits, summarized in Exhibit 2. Key themes include:

- Having a centralized IT governance structure that extends to agencies and corporations

- Having a City-wide coordinated plan for IT initiatives to promote strategic alignment and reduce decentralized IT services

- Having an accurate IT assets inventory, both hardware and software

The fact that these issues have been noted several times signifies a clear need for a culture shift.

We recognize that information technology is an industry with continuous change, risks and emerging threats, and managing these in the largest City in Canada presents its own unique challenges. However, it is precisely because of these specific challenges that the findings in this report are so crucial.

### Relevance to Agencies and Corporations

**Findings and recommendations are also relevant to agencies and corporations**

Although agencies and corporations were not included within the scope of our audit, this report contains a number of findings and recommendations that are relevant to them.

Based on our review, it is evident that strategic IT decision-making can be improved and savings are possible through improved collaboration and coordination across the entire organization. The Chief Information Officer, through the City Manager, should share relevant audit recommendations and any resulting IT strategy, roadmap, policies, procedures, and standards with all City agencies and corporations. Further engagement on these matters will help ensure effective coordination to support strategic procurement and technology deployment.

### Conclusion

**This interim report highlights issues that require timely action**

This interim report highlights overarching issues that require the Information & Technology Division and the City to make timely progress on the key actions to create and execute the Strategic Technology Roadmap for the IT environment. Additional findings related to this audit will be reported in a subsequent report expected to be issued by mid-2018.

**Any cost savings will be included in final report**

Although this audit has identified some potential for cost savings and cost avoidance, any quantifications will be included in the final report.

We express our appreciation for the co-operation and assistance we received from the management and staff of the Information & Technology Division and other City divisions.

# BACKGROUND

**Corporate Information & Technology Division's role is to provide leadership**

The Corporate Information & Technology (I&T) Division's role is to provide city-wide leadership in modernizing City services through the strategic investment, development, and management of the City's Information Technology (IT) systems.

**Financial Highlights**

The I&T Division's 2017 Operating Budget was $127.8 million, and its 10-year Capital Plan is $437.7 million.

**City Information Technology Strategy reported to Executive Committee in August 2014**

A staff report on the City's IT Strategy was considered by the Executive Committee in August 2014.

http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.EX44.23

This report identified (emphasis added):

- *"One key common denominator that supports the effective delivery of all City Programs and Services and the overarching success of the City is the **effectiveness of the underpinning digital infrastructure"***

- *"Successful cities are **investing in digital infrastructure, the integrated solutions and underpinning connectivity and networks** to attract, create and enable easy knowledge sharing, collaboration, and innovation"*

- *"It is recognized that the world of **technology continues to evolve at a very rapid pace"***

- *"The City's IT Strategy is a framework that fully aligns to and supports the City's Strategic Plan. The IT Strategy consists of (a) eCity Strategy, (b) the IT Portfolio Integrated Plan and (c) the IT Environment. This is supported through the IT Governance Model."*

**eCity Strategy**

The eCity Strategy, established in 2012, is a vision of "our local government, anytime, anywhere." It was established by the City's senior business leaders to drive strategic decision-making in setting an IT strategy. The strategy's four overarching business goals are to:

- Improve access to government services
- Improve decision making support
- Improve workforce capabilities
- Improve business processes

**IT Portfolio Integrated Plan**

According to management, the IT Portfolio Integrated Plan for achieving the eCity goals focuses on twelve Key Programs. These are summarized in Figure 1.

**Figure 1: Key Programs in the IT Portfolio Integrated Plan**



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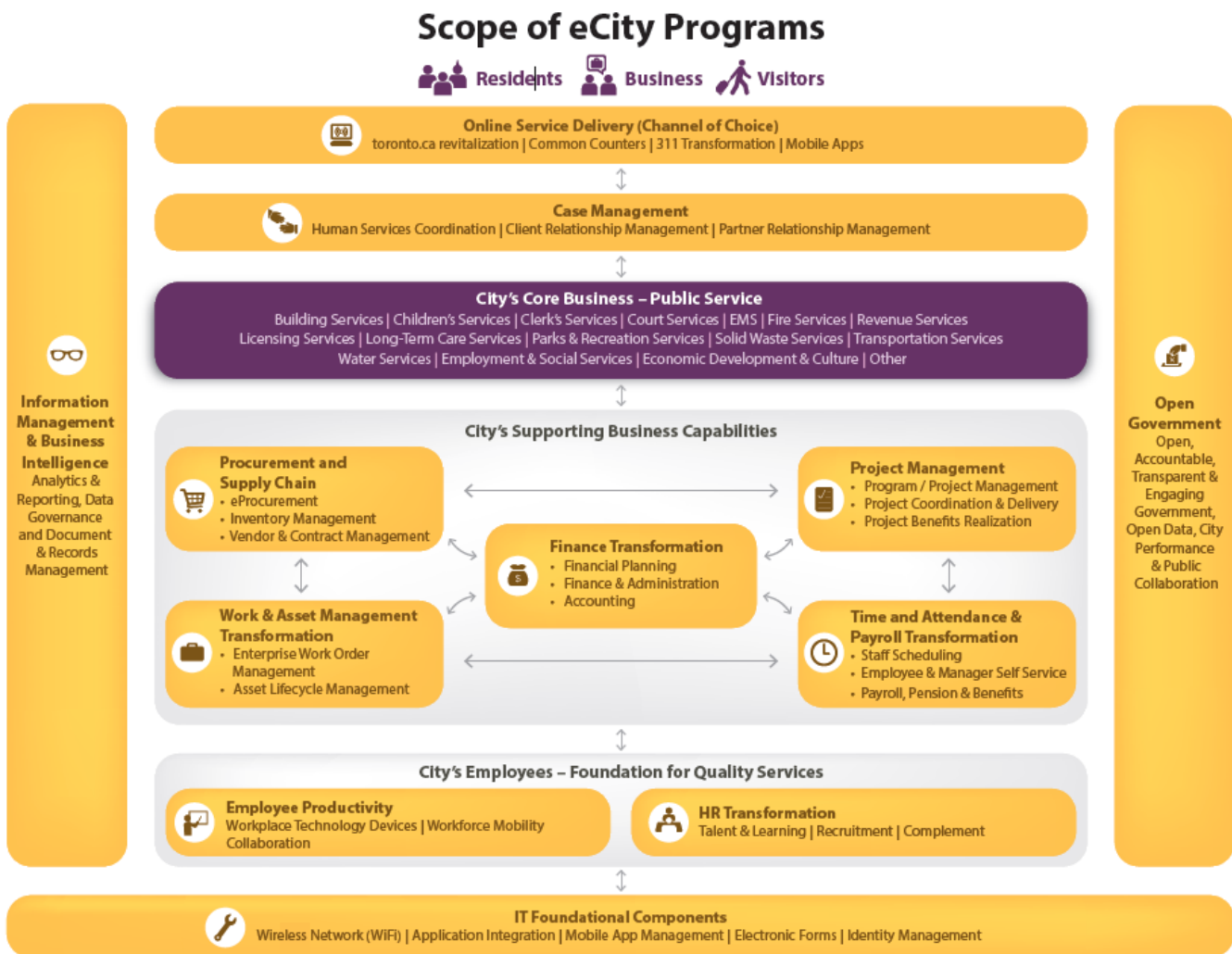
| **City has a large and complex IT environment** | The City's IT Environment is comprised of a complex infrastructure of applications, networks, and computers spread over 700 locations, servicing more than 50 City divisions and as well as the millions of citizens who call Toronto home. |
| :--- | :--- |
| | The on-premise IT infrastructure includes 2,700 servers that host over 850 systems. Members of the public also use certain City applications, such as the community recreation registration system, the permit system, the 311 system, and various payment systems. |
| | To achieve the eCity Strategy, the I&T Division needs to be clear on which technologies are needed, and how it will deploy them into this complex IT environment. |
| | A glossary of terminology is included in Exhibit 1 to facilitate the understanding of certain technical terms used in this report. |

# AUDIT RESULTS

This section of the report contains the findings from our audit-in-progress followed by specific recommendations.

## A.   DEFINING THE GAP

| **Need for an understanding of the current state of IT infrastructure** | The first critical step in moving forward is for the Corporate I&T Division to understand the current state of the City's IT infrastructure in its entirety. With this information, the Division can then identify the infrastructure needs that must be addressed in order for the City to achieve its IT vision. |
| :--- | :--- |
| | To do this, the City should: |

1. Strengthen the Chief Information Officer's role across divisional boundaries.

2. Maintain an accurate and up-to-date view of IT infrastructure and assets.

3. Reassess the decentralized approach to managing IT systems, assets and security.

## A.1. Strengthen Chief Information Officer's Role Across Divisional Boundaries

**Responsibility for IT is not fully centralized**

Responsibility, control and accountability for IT infrastructure and assets are not fully centralized at the City:

- The Corporate I&T Division provides leadership and is responsible for overseeing and developing the overall information strategy for the City.

- Certain divisions operate on a somewhat independent basis and develop their own priorities, as well as short-term and long-term planning for managing information technology assets.

- Agencies and corporations are independent and autonomous, yet there are advantages and economies to be gained through the closer coordination of information technology functions.

**2006 audit identified that the CIO should have the appropriate authority to implement IT management across divisional boundaries**

Our Office's 2006 audit of the Management of City Information Technology Assets identified the need to ensure that the Chief Information Officer had the appropriate authority to implement information technology management across divisional boundaries. The 2006 audit highlighted that failure to provide the Chief Information Officer with the "clout" to compel line managers to adhere to City-wide policies and standards and to the City's priorities would unduly compromise the effectiveness of the position.

**Consequences of the decentralized model**

The 2006 audit identified that the potential consequences of the decentralized model for managing information technology assets include:

- *"lack of coordinated planning and priority setting for information technology initiatives;*
- *lack of City-wide support to complete Corporate information technology initiatives;*
- *no assurance of compliance with information technology standards;*
- *lack of effective monitoring and control of information technology assets; and*
- *lack of coordinated hardware and software inventory management."*

https://www.toronto.ca/legdocs/2006/agendas/council/cc060425/au1rpt/cl002.pdf

In addition, our more recent Information Technology Vulnerability Assessment and Penetration Testing audits identified the need to centralize governance of IT security city-wide.

**Issues related to decentralized management of IT assets continue to persist**

Although there have been some improvements to coordination and collaboration over time, similar issues related to the decentralized model persist more than 10 years after our 2006 report was issued.

**Appropriate governance and accountabilities are needed**

To address these ongoing issues, there needs to be a culture shift so that the CIO is clearly in charge of information technology City-wide. Wherever there is an operational need to continue with a decentralized approach, appropriate governance and accountabilities should be established to ensure these divisions adhere to corporate policies and procedures.

> **Recommendation:**
>
> 1. **City Council request the City Manager, in consultation with the Chief Information Officer, to establish appropriate governance and accountabilities to ensure that divisions with IT services operating independently from the Information &Technology Division follow Corporate IT policies, procedures, and standards in acquiring and managing IT services.**

## A.2.  Maintain an Accurate and Up-to-date View of IT Infrastructure and Assets

**Inventory of IT assets is incomplete and not accurate**

The I&T Division's existing IT assets inventory is not accurate, complete, or up-to-date. The current status of existing assets, including those directly managed by the I&T Division, as well as those managed on a decentralized basis by other City divisions, is not updated regularly within the corporate IT assets management system.

| | |
|---|---|
| **Use asset management data to improve technology decision making** | Procedurally, the I&T Division is required to check that asset data in the system matches hardware assets that are actually deployed, but this check is not done regularly.<br><br>It is important to have reliable data to improve asset planning, enable strategic procurement, ensure security, and effectively manage upgrades and maintenance.<br><br>Corporate I&T Division should review asset data periodically to ensure information is accurate and current. |
| **Implementation of the Corporate IT asset management system should be expedited** | Although the corporate IT asset management system was acquired five years ago, certain tools and reports meant to support ongoing asset monitoring have not yet been implemented.<br><br>Additional findings relating to IT asset management will be detailed in a separate audit report expected to be issued by mid-2018. |
| **Network mapping tools should be used for infrastructure planning** | In addition to the IT asset management system, the I&T Division also has a variety of network performance and monitoring tools available to visualize or map the network and assets. While the Division uses these tools to support day-to-day operations, these network maps, visualization tools, or other network data collected should be leveraged to inform infrastructure planning and strategic decision-making. |

**Recommendations:**

2. **City Council request the Chief Information Officer to:**

   a. **Ensure that the inventory in the corporate IT asset management system is updated (including assets directly managed by the Information &Technology Division, as well as assets managed by other City divisions).**

   b. **Perform periodic reviews and reconciliations of data captured within the corporate IT asset management system to ensure the system is accurate and complete.**

   c. **Implement available tools and reporting functionality within the corporate IT asset management system to support ongoing asset monitoring.**

   d. **Use the data available within the corporate asset management system to inform strategic technology planning, including maximizing the use of assets and managing the costs to maintain them throughout their lifecycle.**

3. **City Council request the Chief Information Officer to leverage data obtained through various network tools to inform the City's network and strategic planning teams.**

### A.3. Reassess the Decentralized Approach to Managing IT Systems, Assets and Security

**The City maintains a variety of systems and applications with similar functionalities**

City divisions have, on occasion, taken a decentralized and siloed, rather than coordinated, approach to information technology planning, acquiring, and managing IT solutions. This approach has resulted in the City implementing and maintaining systems and applications with similar functionalities. Some examples of potentially duplicative systems include:

- multiple incident and service management applications
- multiple time management, scheduling, and dispatch systems
- multiple work order and project management applications

**Identify applications that can be consolidated**

A comprehensive organization-wide applications inventory would help efforts to identify applications serving similar functions that can be consolidated. This, in turn, can inform IT strategic planning and lead to improved operational efficiencies and reduced costs when procuring, implementing, and maintaining any modernized or replaced systems.

**A number of IT services are managed independently by City divisions**

There are also a number of IT services managed by City divisions independently from the I&T Division. These include network infrastructure, IT service desks, data centres and other services. Some divisions may need segregated IT infrastructure and services, but the I&T Division should revisit this need and consolidate where possible. Doing so may be more effective and efficient and could result in cost savings.

**Recommendation:**

**4.    City Council request the Chief Information Officer, in consultation with all relevant divisions, to:**

**a.    Develop a comprehensive list of applications and identify those applications and systems that have the potential to be consolidated and modernized, eliminating the need to procure, implement, and maintain duplicative systems in the future.**

**b.    Review existing decentralized IT services and, where possible, consolidate these services with the Information &Technology Division.**

## B.    ESTABLISHING A STRATEGIC TECHNOLOGY ROADMAP

**Strategic Technology Roadmap is needed**

Once the Corporate I&T Division is able to understand the current state of the City's IT infrastructure in its entirety, the second critical step in moving forward is to establish its strategic technology roadmap. The ability to deliver on this roadmap will depend on the Division's ability to:

1. Establish a coordinated plan to address the identified gaps and infrastructure needs in order to achieve its vision for the future of the City's IT environment.

2. Transform the City's IT Infrastructure by harmonizing, consolidating, integrating, and modernizing technologies.

3. Mature the City's readiness for cloud-based solutions.

### B.1.    Establish a Coordinated Plan

**Plan should provide direction for specific technology solutions to meet long-term goals**

The City needs a clearly defined and coordinated plan to achieve short-term and long-term goals to modernize and transform the City's IT environment. This Strategic Technology Roadmap should provide direction for the specific technology solutions needed to meet those goals.

The Strategic Technology Roadmap should orient all of the I&T Division's infrastructure planning and procurement decisions, as well as the decisions of all other divisions that are independently managing IT infrastructure, assets, and services.

**Clarify roles, responsibilities, milestones and performance measures for modernizing and transforming IT**

To establish the plan, within the I&T Division itself, there should be clarity and consensus about:

- who is responsible for creating, maintaining, and refreshing the roadmap

- the short-term and long-term goals and the technologies needed to achieve those goals

- the milestones and performance measures to assess progress in moving forward with modernizing and transforming the City's IT environment

**Recommendations:**

5. **City Council request the Chief Information Officer to establish a strategic technology roadmap to modernize and transform the IT environment. The roadmap should clearly set out milestones and performance measures to assess progress in meeting the City's short-term and long-term IT goals.**

6. **City Council request the Chief Information Officer to develop and implement procedures to promote clarity in roles and responsibilities for creating, maintaining, and refreshing the IT infrastructure roadmap.**

### B.2. Transform the City's IT Infrastructure by Harmonizing and Modernizing Technologies

**IT asset replacement is based on lifecycle management**

Currently, the I&T Division replaces existing IT infrastructure and assets at their end of life. A Strategic Technology Roadmap will help the I&T Division to consider the bigger picture and to factor in the technologies needed to realize the City's future IT vision.

The City procures, implements, and maintains different brands or models of similar technology, all at different points in their lifecycle. For example, the City acquired six different brands of servers with 23 unique models during a period of three years from 2015 to 2017.

**Standardizing infrastructure can reduce acquisition and maintenance costs and improve operational efficiency**

While we understand that, on occasion, divisions need non-standard technology, reducing the number of brands and standardizing the models and specifications can improve the operational efficiency and reduce costs to acquire and maintain the infrastructure and assets. This also enables better category management and strategic sourcing.

The City currently uses a variety of security tools to protect against internal and external threats. When developing and executing the Strategic Technology Roadmap, the I&T Division should regularly review the security architecture in order to strengthen security, eliminate redundancies, and identify opportunities to modernize the IT environment.

**Recommendations:**

**7. City Council request the Chief Information Officer to ensure that the Strategic Technology Roadmap identifies opportunities for harmonizing lifecycle management and standardizing technologies in IT infrastructure in order to achieve operational efficiencies, reduce costs, and source assets strategically.**

**8. City Council request the Chief Information Officer to conduct periodic architecture reviews to strengthen security, eliminate redundancies, and identify opportunities to modernize the IT environment.**

## B.3. Mature the City's Readiness for Cloud-Based Solutions

**Technology evolves at a very rapid pace**

The 2014 staff report on the City's Information Technology Strategy recognized that technology continues to evolve at a very rapid pace and that an effective and well-aligned IT strategy would help to support the City's ability to respond.

**One key opportunity is cloud computing**

One of the key trends identified in the report was that cloud computing presented "*Opportunities to source and deliver integrated solutions from service providers in new delivery models that can provide agile and scalable solutions but that need to ensure integrated outcomes.*"

However, the report also highlighted that "*In introducing new technologies, the City needs to respect and recognize the level of planning and readiness within the complexity of the City's IT environment (e.g. existing technology infrastructure and application systems) and the necessary skills and knowledge of the City workforce.*"

https://www.toronto.ca/wp-content/uploads/2017/08/963d-city-information-technology-strategy.pdf

**Cloud computing decision framework developed in 2016**

The I&T Division developed a Cloud Computing Framework in 2016 to provide guidance on the evaluation, acquisition, implementation and management of Cloud Computing services for the City. However, the design of this decision framework leans towards selection of on-premise solutions.

The Cloud Computing Framework states:

**Cloud computing offers a number of benefits**

"*The Cloud delivery model has the potential to offer a number of benefits such as financial incentives for only paying for what you need, agility to roll out IT solutions faster, and innovative solutions where mobility, social connections and analytics is built into the design.*

**Cloud computing also bears risk**

*However, Cloud also bears risk. When data is managed by a third party service provider in a foreign jurisdiction, there are a number of risks ranging from protecting information privacy, managing City records, and ensuring continued operations of the City services.*

**The City's Cloud decision framework leans towards selection of on-premise solutions**

*As a result of the benefit and risk tradeoffs, Cloud Computing needs to be assessed on a case-by-case basis when evaluating IT solutions. The City has an established process for delivering IT solutions on the City's infrastructure, so there needs to be a justifiable business case to adopt third party Cloud services."*

**City should advance its ability to adopt new technologies**

At the time the Framework was created, the I&T Division identified areas where the City was not yet mature enough to support Cloud services. These areas are shown in Figure 2.

**Figure 2: Maturity of Cloud Planning Considerations**
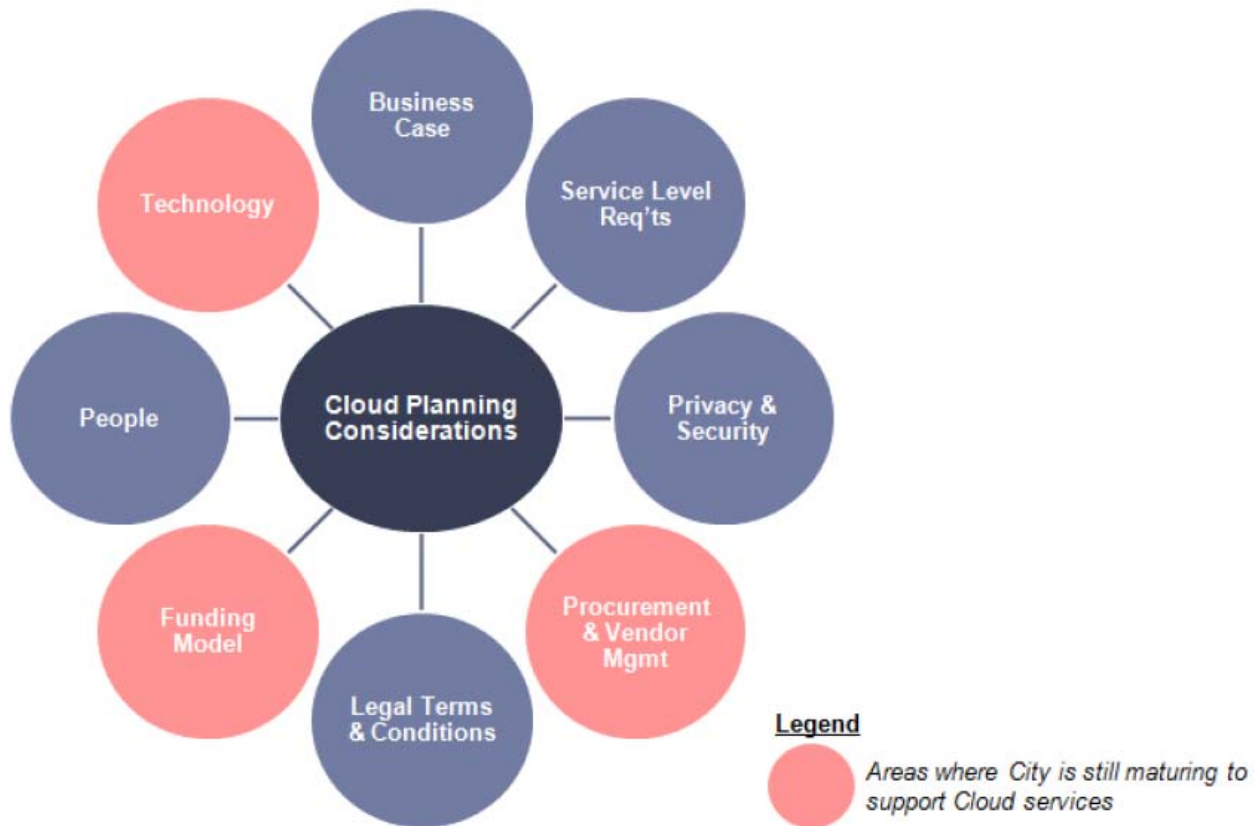


Source: 2016 Cloud Computing Framework - Figure 1: Cloud Planning Considerations

For example, the City needs to mature its funding model and approach to budgeting for cloud-based services.

**Net savings for cloud solutions are based on increases in Opex offset by decreases in Capex over time**

Unlike traditional on-premise IT projects where the cost of owning infrastructure and assets is mostly funded through capital expenditures (Capex), cloud solutions require a one-time investment for initial set-up and an ongoing rental fee (pay-per-use service) for required services that are funded mostly through operating expenditures (Opex).

Cloud-based IT solutions will likely result in increased operating expenditures. However, these costs may be more than offset by decreases in capital expenditures to purchase and sustain systems, as well as savings from decommissioning systems and/or repurposing staff, infrastructure, and data centre real estate.

Where divisions face significant pressures to reduce operating budgets, there is a risk that decisions about IT solutions will be made based on a desire to limit operating expenditures rather than the total overall cost (Opex and Capex) of the IT solution.

The I&T Division should expedite its continued efforts to mature its processes and capabilities to support cloud services.

**Recommendations:**

9.     **City Council request the Chief Information Officer to expedite efforts to mature its processes and capabilities to support Cloud services.**

10.    **City Council request the Chief Information Officer to ensure that all IT business cases describe how the new IT project or lifecycle management refresh aligns with the strategic technology roadmap; and include an evaluation of cloud versus on-premise solution.**

11.    **City Council request the Chief Financial Officer, in consultation with the Chief Information Officer, to develop a tool to communicate the total cost impacts (operating and capital) of IT projects to provide clarity wherever increased operating budget pressures from cloud services are offset by savings in capital costs.**

# C.    EXECUTING THE PLAN AND TAKING ACTION

**Deploy the Technology Roadmap**

Once a Strategic Technology Roadmap has been established, the I&T Division should take action to deploy it. Key actions to support this deployment include:

1. Leveraging ongoing procurement transformation initiatives when executing the technology roadmap.

2. Establishing procedures for lifecycle management of data.

3. Updating corporate IT policies, procedures and standards.

Regular performance reporting can help City Council assess the I&T Division's progress in modernizing and transforming the City's IT environment.

## C.1.    Leverage Ongoing Procurement Transformation Initiatives when Executing the Technology Roadmap

**Category management is being incorporated into the City's procurement methodology**

Purchasing and Materials Management (PMMD) advised that the Division has launched a transformational project to bring category management and strategic sourcing into the City's procurement methodology. Introducing category management is expected to change the City's current, primarily transactional, approach to procurement to an approach that adds a strategic element.

**Ensure strategies to lower total cost of ownership are used when deploying the Strategic Technology Roadmap**

This transformation initiative aims to improve how the City manages key spend categories strategically across the organization to lower total cost of ownership.

Successful category management for IT requires close collaboration between PMMD, the I&T Division, and all other City divisions, agencies, and corporations that manage IT.

In developing Technology Roadmap, the Chief Information Officer needs to gather the information to:

- aggregate demand (e.g. consolidating requirements across all City divisions as well as agencies and corporations that manage IT); and

- establish the right specifications (e.g. harmonizing, consolidating, standardizing technologies in IT infrastructure).

This information forms the foundation for successful strategic procurement.

The CIO can then work with PMMD to move forward strategic procurement by:

- understanding the suppliers in the marketplace (e.g. understanding innovative solutions suppliers can bring to solve the City's problems, some of which may only be available through cloud service providers);
- understanding key cost drivers of the good or service;
- timing the strategic sourcing events to take advantage of market conditions;
- negotiating;
- managing contract spend; and
- managing supplier relationships and performance.

**Recommendation:**

12. **City Council request the Chief Information Officer, to coordinate with the Chief Purchasing Officer on implementing category management for the procurement of IT equipment, services and solutions, utilizing the strategic technology roadmap to lower the total cost of IT.**

## C.2. Establish Procedures for Lifecycle Management of Data

**Data storage requirements are growing**

The volume of digitally stored data has increased by over 300 per cent from 2012 to 2016.

Data storage costs are not increasing as quickly, but the City can avoid costs by being more rigorous about the data it stores.

There are no formal guidelines for data lifecycle management. The Toronto Municipal Code Chapter 217 outlines record retention requirements. However, digital data practices are not aligned with these requirements. Without clear digital data policies, the City is retaining more than it needs to.

**Developing a City-wide data strategy can help to reduce or avoid costs**

The City should develop and implement digital data lifecycle management guidelines. Doing so can reduce the demand for data storage assets and save or avoid costs.

**Recommendation:**

13. **City Council request the Chief Information Officer, in consultation with the City Clerk, the City Solicitor, and where needed, the City's Accountability Officers, to include in the data governance model:**

    a. **Guidance on the City's enterprise-wide data strategy to provide direction for lifecycle management and classification of data in alignment with the Municipal Code.**

    b. **A special case data retention policy and procedure to address scenarios where archiving specific data required, such as litigation needs.**

### C.3. Update Corporate IT Policies, Procedures and Standards

**Corporate IT policies, procedures and standards need to be kept current**

We found Corporate IT policies, procedures and standards are not current. Policies, procedures, and standards provide a roadmap for day-to-day operations, uniformity, and guidance for decision-making. Table 1 provides a list of policies and standards that have not been revised for five or more years.

**Policies should be updated regularly to reflect the rapidly evolving nature of technology**

The policies, procedures, and standards need to be updated and refreshed to coincide with the IT vision and roadmap.

**Table 1: Policies and Standards Not Revised for Five or More Years, December 31, 2017**

| Policy/Standard | Current Version | Date of Current Version |
|---|---|---|
| Corporate Information Security Policy | 1.2 | July 2005 |
| Mobile End Point Device Security Standard | 1.1 | Dec 14, 2012 |
| Acceptable Use Policy | 2.1 | Feb 06, 2009 |
| Information Technology Asset Management Policy | 1.8 | Dec 15, 2011 |
| Minimum Standard to Connect IT Assets to the City's Network | 1.3 | Dec 14, 2012 |
| Standard for Core Workstation Software | 2.0 | Dec 14, 2012 |
| Standard for Print Output Devices | 1.0 | May 20, 2011 |

**Recommendation:**

**14.    City Council request the Chief Information Officer to enhance the existing process to monitor and update IT policies, procedures and standards on a periodic basis.**

# D. RELEVANCE TO AGENCIES AND CORPORATIONS

**Share relevant audit findings with agencies and corporations**

Although agencies and corporations were not within the scope of our audit, this report contains a number of findings and recommendations that are also relevant to them to leverage economy of scale, improve efficiency and cost savings.

The CIO, through the City Manager, should share relevant audit recommendations with all City agencies and corporations. Any resulting IT strategy, policies, procedures, and standards should be provided to agencies and corporations for consideration.

Management staff in each of these organizations should review the issues and recommendations in this report, consider the relevance to their respective organizations, and provide any necessary reports to their governing body.

> **Recommendation:**
>
> **15. City Council request:**
>
>     **a. The City Manager forward this report to the major agencies and corporations for review.**
>
>     **b. The heads of agencies and corporations review the issues and recommendations included in this report and consider the relevance to their respective organizations for implementation.**

# CONCLUSION

This interim report highlights the critical need to create a Strategic Technology Roadmap.

We have made 15 recommendations that will enable the Information & Technology Division and the City to make timely progress on the key actions needed to create and execute a Strategic Technology Roadmap for the IT environment.

To address these ongoing issues, there needs to be a culture shift to support the Chief Information Officer's role in leading the City's Information Technology Strategy.

Additional findings related to this audit will be reported in a subsequent report expected to be issued by mid-2018.

# AUDIT OBJECTIVES, SCOPE AND METHODOLOGY

**Audit objective**

The Auditor General's 2017 Audit Work Plan included a review of information technology infrastructure and assets managed by the Corporate I&T Division.

The objectives of this review were to identify potential opportunities to optimize costs and enhance the operational efficiency of the IT infrastructure and IT assets.

**Methodology**

Our audit methodology included the following:

- Meetings with the external consultant, the staff of various City divisions and the Corporate Information & Technology Division
- Identification of in-scope IT networks, servers, systems and applications
- Understanding of the City of Toronto network infrastructure through the review of documented material and interviews with key staff
- Review of the IT network design, topologies and security.
- Review of asset management policies and procedures.
- Analysis of data obtained from IT asset management system and other IT systems

**Compliance with generally accepted government auditing standards**

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

**Exhibit 1: Glossary of Terms**

| | |
|---|---|
| **Cloud Computing** | An information technology model that enables access to shared pool of IT systems and resources  that can be acquired through services providers and often adopted over the internet. |
| | Cloud computing can be compared to public utilities used to deliver commodities such as gas, water or electricity. Instead of acquiring and operating IT systems and applications, computing infrastructure, such as storage and servers, computing power is purchased from the utility (Service) provider. |
| | Additional information is available on Government of Canada website: https://www.canada.ca/en/treasury-board-secretariat/services/information-technology/cloud-computing/government-canada-cloud-adoption-strategy.html |
| **Computer network** commonly referred as "network" | A collection of IT assets connected together either through physical wiring or wirelessly. |
| **Corporate Network** | A group of IT assets connected together, which are part of a company's IT infrastructure, and abide by the same corporate policies, standards and procedures. |
| **Data Centre** | A dedicated facility used to house computer systems and associated components, such as processors, storage, network devices and telecommunications. |
| **Firewall** | A security system that monitors and controls incoming and outgoing internet/data traffic based on specified security rules, such as unauthorized access to/from a specific network. |
| **Hardware** | Refers to the physical aspect of computers, networks, telecommunications, and other devices, such as, a computer, a hard disk, a monitor or a telephone. |
| **Intrusion Detection System** | A physical device or a computer program that monitors a network or systems for malicious or unauthorized activity. |
| **IT Asset** | The units or individual elements of information, software and hardware that are used in the course of business activities, which in conjunction are the foundation of the IT infrastructure. |
| **IT Asset Management System** | Refers to the software application that enacts a set of business practices that join financial, contractual and inventory functions to support lifecycle management of IT assets and strategic decision making for the IT environment. |
| **IT Environment** | The specific conditions of an entity's IT infrastructure, software, people, procedures, and data necessary to perform a function or provide a service. |

| IT Infrastructure | Refers to the physical structures, IT software and other hardware, for example, computers, equipment, mobile devices, network and telecommunications devices that are required for the existence, operation and management of an enterprise IT environment. |
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| IT Network map | A visualization (in the form of flow chart or suitable diagram) of the logical representation of all traditional network switches, routers, and firewalls connected. |
| Network Switch | A network device used to connect multiple devices on the same computer network. |
| Next Generation Firewall | Refer to the definition provided for Firewall. A next generation firewall provides additional security features, such as, complete visibility into all network traffic, prevents advanced and unknown security threats, and helps enhance the entity's security posture, for example, by disseminating protections from previously unknown threats globally in near-real time and correlating a series of related threat events to indicate a likely attack on the network. |
| Operating Environment | Refers to the IT environment supported by an IT infrastructure in which services can be provided and application software can be run. |
| Penetration Testing | An authorized manual or computer-generated attack, performed to evaluate the security of the system. Penetration testing could be based on vulnerabilities found during the vulnerability assessment on a computer system. |
| Router | A network device that forwards data between computer networks. Routers can perform traffic directing functions over the internet and corporate networks until data reaches the intended destination. |
| Security Architecture | The design of security controls in an IT environment to address the potential risks involved in a certain scenario or environment. It describes how the security controls are positioned and how they are related to the IT environment to maintain the confidentiality, integrity and availability of systems and data. |
| Server | A computer, usually more powerful and advanced in comparison to regular user computers, that provides services to other computers. |
| Software | A computer program that consist of specific instructions to perform intended functions in a computer environment. |
| Technology Lifecycle Management (LCM) | An approach that encompasses the planning, design, acquisition implementation, decommission and management of all the elements of the IT infrastructure, including data, applications, and corporate devices. |

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| **Technology Roadmap** | A technology roadmap is a plan developed to achieve short-term and long-term goals. It usually considers specific technology solutions to help meet those goals.<br><br>Developing a roadmap has three major uses. It helps reach a consensus about a set of needs and the technologies required to satisfy those needs, it provides a mechanism to help forecast technology developments, and it provides a framework to help plan and coordinate technology developments. |
| **Vulnerability Assessment** | A vulnerability is a weakness which allows an attacker to reduce a system's reliability. A vulnerability assessment is the process of identifying, quantifying, and prioritizing the vulnerabilities in a system. |

**Exhibit 2:  Common Themes Identified in Previous IT Audits**

**2006 Audit of the Management of City Information Technology Assets**

- The need for an information technology governance structure, which is inclusive of the Agencies, Boards and Commissions
- Many operational decisions are made on a divisional, as opposed to a corporate basis
- There is a need to ensure that all divisional asset inventories are complete, up to date and accurate
- A complete and consolidated inventory of City owned software does not exist

**2007 Audit of the Management of Information Technology Projects – Opportunities for Improvement – Toronto Transit Commission**

- The need for closer cooperation and coordination in the area of information technology between the City and its local boards, particularly the TTC and the Toronto Police Service

**2011 Governance and Management of City Computer Software Needs Improvement**

- Steps need to be taken to develop closer co-operation in terms of software sharing and software management standards and practices across the City divisions, Agencies, Boards, Commissions, and Corporations
- Software information contained in the Information Technology Asset Management System was incomplete, outdated and unreliable for making management decisions

**2012 eCity Initiative – Improvements Needed in Governance, Management, and Accountability**

- Assessment of the IT governance process identified that there was no clear ownership and accountability for the eCity governance structure

**2015 Software Licenses – Managing the Asset and Related Risks**

- Software license reconciliations, comparing software purchased to software installed, are not performed on a regular basis

**2016 & 2017 Information Technology Vulnerability Assessment and Penetration Testing audits**

- The need to have a single corporate view of IT security within the City. The decentralized approach to information technology systems and security results in differing perspectives, risk tolerances, and levels of maturity when identifying and responding to cyber risks

The above reports are available at: https://www.toronto.ca/city-government/accountability-operations-customer-service/accountability-officers/auditor-general/reports/auditor-generals-reports/

**APPENDIX 1:  Management's Response to the Auditor General's Report Entitled: "IT Infrastructure and IT Asset Management Review: Phase 1: Establishing an Information Technology Roadmap to Guide the Way Forward for Infrastructure and Asset Management"**

**Recommendation 1:**  City Council request the City Manager, in consultation with the Chief Information Officer, to establish appropriate governance and accountabilities to ensure that divisions with IT services operating independently from the Information &Technology Division follow Corporate IT policies, procedures, and standards in acquiring and managing IT services.

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| **Management Response:** ☒ Agree      ☐ Disagree |
| **Comments/Action Plan/Time Frame:**<br><br>The City Manager and Chief Information Officer will determine how to best enforce divisional compliance with Corporate IT policies, procedures and standards.  A process will be developed to guide City divisions towards adherence to Corporate IT policies, procedures and standards. Estimated completion of required documentation Q2, 2019, with implementation following the publication of documentation. |

**Recommendation 2:**  City Council request the Chief Information Officer to:

a.    Ensure that the inventory in the corporate IT asset management system is updated (including assets directly managed by the Information &Technology Division, as well as assets managed by other City divisions).

b.    Perform periodic reviews and reconciliations of data captured within the corporate IT asset management system to ensure the system is accurate and complete.

c.    Implement available tools and reporting functionality within the corporate IT asset management system to support ongoing asset monitoring.

d.    Use the data available within the corporate asset management system to inform strategic technology planning, including maximizing the use of assets and managing the costs to maintain them throughout their lifecycle.

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| **Management Response:** ☒ Agree      ☐ Disagree |
| **Comments/Action Plan/Time Frame:**<br><br>The Chief Information Officer will determine how to best expedite the implementation of the current corporate IT asset management system in existence and leverage processes to update IT assets belonging to divisions with decentralized IT services.<br><br>The Chief Information Officer has set up a task force within Corporate I&T focused on specific and measured outcomes on improving data within the Corporate IT asset management system, building sustainable processes to track IT assets and ensure IT asset management system is technically enhanced to build on the new improved product features from the IT asset management vendor. Phase 1 of the IT asset system improvements concentrates on Corporate I&T assets improvements, following strong foundation and processes the best practice approach will be extended as Phase 2 to Divisional IT assets.<br><br>Estimated implementation is 2019. |

**Recommendation 3:** City Council request the Chief Information Officer to leverage data obtained through various network tools to inform the City's network and strategic planning teams.

| Management Response:  ☒ Agree     ☐ Disagree |
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| **Comments/Action Plan/Time Frame:**<br><br>The Chief Information Officer will leverage the data obtained through various network tools to inform the City's network and strategic infrastructure planning.  An estimated completion of Q3, 2019. |

**Recommendation 4:** City Council request the Chief Information Officer, in consultation with all relevant divisions, to:

a.   Develop a comprehensive list of applications and identify those applications and systems that have the potential to be consolidated and modernized, eliminating the need to procure, implement, and maintain duplicative systems in the future.

b.   Review existing decentralized IT services and, where possible, consolidate these services with the Information &Technology Division.

| Management Response:  ☒ Agree     ☐ Disagree |
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| **Comments/Action Plan/Time Frame:**<br><br>The Chief Information Officer will:<br><br>a)  Review the Project Review Team (PRT) gating process to ensure the effectiveness of coordination and controls that mitigate the risk of recommending projects that introduce duplicate IT solutions.  The application rationalization assessment will be expanded to include business applications and systems supported by divisions with decentralized IT services.  Development of criteria for review and a 3-year strategic systems portfolio roadmap for investments.  Estimated timeline is Q1, 2019.<br><br>b)  Determine how to best review and evaluate existing decentralized IT services in alignment with the Strategic Action Plan of the City.  The Information and Technology Division will develop an appropriate evaluation process to effectively determine if consolidation of decentralized IT services is merited, based on the City's strategic direction.  Estimated completion is Q2, 2019. |

**Recommendation 5:**  City Council request the Chief Information Officer to establish a strategic technology roadmap to modernize and transform the IT environment. The roadmap should clearly set out milestones and performance measures to assess progress in meeting the City's short-term and long-term IT goals.

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| **Management Response:**  ☒  Agree  ☐  Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The City has already adopted an eCity Strategy, and IT Portfolio Integrated Plan cognizant of a formal governance process including City business divisional representation.  This strategy is aligned with the City's Strategic Actions and is underpinned by 12 strategic programs and supporting IT projects across all City divisions.  The City also has established an IT Share Services Enterprise Partnership model with major city agencies and corporations. <br><br> A strategic technology roadmap will enable the City's Digital Footprint, expected in Q2, 2019. The Technology Strategy will set the strategic direction and a roadmap for key technology capabilities based on service delivery and business.  Development of this strategy will involve broad stakeholder engagement and will be comprised of a 3 to 5-Year Plan. |

**Recommendation 6:**  City Council request the Chief Information Officer to develop and implement procedures to promote clarity in roles and responsibilities for creating, maintaining, and refreshing the IT infrastructure roadmap.

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| **Management Response:**  ☒  Agree  ☐  Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will ensure there is clarity in roles and responsibilities for creating, maintaining, and refreshing the IT infrastructure roadmap.  Estimated completion is Q2, 2019. |

**Recommendation 7:**  City Council request that the Chief Information Officer to ensure that the Strategic Technology Roadmap identifies opportunities for harmonizing lifecycle management and standardizing technologies in IT infrastructure in order to achieve operational efficiencies, reduce costs, and source assets strategically.

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| **Management Response:**  ☒  Agree  ☐  Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will determine how to best assess the current state of the City's IT infrastructure and will identify gaps in the strategic vision and roadmap.  As per recommendation #5, a Technology Strategy and roadmap will be available in Q2, 2019. <br><br> The Chief Information Officer will determine how to best optimize cost and efficiencies through harmonizing life cycle replacements. |

**Recommendation 8:** City Council request the Chief Information Officer to conduct periodic architecture reviews in order to strengthen security, eliminate redundancies, and identify opportunities to modernize the IT environment.

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| **Management Response:** ☒ Agree ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will utilize best practices to perform the security architecture review, with the intent to enhance security technologies and increase cost-effectiveness, strengthen security and effectively eliminates redundancies. <br><br> Estimated completion in Q4, 2019 |

**Recommendation 9:** City Council request the Chief Information Officer to expedite efforts to mature its processes and capabilities to support Cloud services.

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| **Management Response:** ☒ Agree ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer is currently developing a cloud strategy to help align the Cloud computing framework and establish cloud governance processes to support Cloud services. Estimated completion in Q2, 2019. |

**Recommendation 10:** City Council request the Chief Information Officer to ensure that all IT business cases describe how the new IT project or lifecycle management refresh aligns with the strategic technology roadmap; and include an evaluation of cloud versus on-premise solution.

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| **Management Response:** ☒ Agree ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will determine how to establish formal procedures and guidelines based on the above recommendation that aligns with the strategic vision and roadmap. As per recommendation #5, a Technology Strategy and roadmap will be available in Q2, 2019. Based on the assessment of key criteria (legislative compliance, privacy protection, risk mitigation, etc.), an on-premise deployment model was identified as a key requirement for the City of Toronto. <br><br> The Chief Information Officer will concurrently develop a formal evaluation procedure to determine if a cloud solution is an option, and embed within the internal business case development process by Q4, 2019. |

**Recommendation 11:** City Council request that the Chief Financial Officer, in consultation with the Chief Information Officer, to develop a tool to communicate the total cost impacts (operating and capital) of IT projects to provide clarity wherever increased operating budget pressures from cloud services are offset by savings in capital costs.

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| **Management Response:** ☒ Agree    ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Financial Officer in consultation with the Chief Information Officer will determine how to best develop a City-wide methodology for IT budgeting and planning to identify and report total costs and savings – by Q4, 2019. This will build upon work underway to develop a cloud-funding model to ensure a sustainable approach to IT investments for the City. |

**Recommendation 12:** City Council request the Chief Information Officer, to coordinate with the Chief Purchasing Officer on implementing category management for the procurement of IT equipment, services and solutions, utilizing the strategic technology roadmap to lower the total cost of IT.

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| **Management Response:** ☒ Agree    ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will work with the Chief Purchasing Officer and the Supply Chain Transformation over the course of the implementation of category management that utilizes the strategic technology roadmap.  I&T is already part of this Transformation and has representation on the Executive Steering Committee.  Estimated completion, Q4, 2020. |

**Recommendation 13:** City Council request the Chief Information Officer, in consultation with the City Clerk, the City Solicitor, and where needed, the City's Accountability Officers, to include in the data governance model:

a.    Guidance on the City's enterprise-wide data strategy to provide direction for lifecycle management and classification of data in alignment with the Municipal Code.

b.    A special case data retention policy and procedure to address scenarios where archiving specific data is required, such as litigation needs.

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| **Management Response:** ☒ Agree    ☐ Disagree |
| **Comments/Action Plan/Time Frame:** <br><br> The Chief Information Officer will consult the City Clerk, City Solicitor and where needed the Accountability Officers, and develop a data governance model that includes (1) guidance to the City's enterprise-wide data strategy to provide direction for lifecycle management of data; and, (2) retention policy and procedure to address scenarios where archiving specific data are required, such as litigation needs.  A timeline to be validated, estimated timeline Q4, 2019 |

**Recommendation 14:** City Council request the Chief Information Officer to enhance the existing process to monitor and update IT policies, procedures and standards on a periodic basis.

| **Management Response:** ☒ Agree ☐ Disagree |
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| **Comments/Action Plan/Time Frame:**<br><br>The Chief Information Officer will enhance the existing process to monitor and update IT policies, procedures and standards on a periodic basis by Q2, 2019. |

**Recommendation 15:** City Council request:

a.   The City Manager forward this report to the major agencies and corporations for review.

b.   The heads of agencies and corporations review the issues and recommendations included in this report and consider the relevance to their respective organizations for implementation.

| **Management Response:** ☒ Agree ☐ Disagree |
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| **Comments/Action Plan/Time Frame:**<br><br>The City Manager will forward the report to the identified agencies and corporations for review by Q2, 2018. |