Office of the Auditor General of Ontario

Value-for-Money Audit:

5G Network Technology and 5G Pre-commercial Program

December 2021

Ministry of Economic Development, Job Creation and Trade
Ministry of Government and Consumer Services
Ontario Centre of Innovation

5G Network Technology and Related Pre-commercial 5G Program

1.0 Summary

Communication technology has evolved rapidly over the last few decades – from the invention of mobile phones in the 1970s to the launch of the first smartphone in 2007, it continues to improve the lives of people through fast and easy access to information. Mobile technology is now an integral part of everyone's lives and plays a crucial role in connecting people across the province, the country, and the world. In Canada, so-called 5G or fifth generation network technology is not fully commercially available, although it has launched in other places such as South Korea, Australia and the United States.

Mobile phones and a mobile network go hand in hand to deliver digital content such as government services, banking, and social media. 5G is the newest standard in mobile technology, with a network speed supposedly 50 times faster than the 4G mobile network Ontarians are using currently. The 5G network is poised to be a game-changer, with the power to fuel innovation and transform the way people live, work, and play. Besides being able to connect a much larger number of devices, this network enables new services and technology that rely on real-time (instantaneous) data-sharing, such as driverless cars, smart energy products, and smart health-care services.

To ensure that the commercial implementation of 5G incorporates fundamental principles of data security and privacy, and that citizens' personal information is safeguarded, all levels of government, along with private stakeholders such as telecommunication companies, will need to work together. A clear accountability structure that defines roles and responsibilities, deliverables and measurable outcomes is required. The federal department Innovation, Science and Economic Development Canada is responsible for developing a national mandate and policies for 5G mobile technology, as well as for regulating 5G mobile networks. In Ontario, current legislation does not yet address emerging technology, including 5G; however, the government is in the process of updating its privacy legislation, the *Freedom of Information and Protection of Privacy Act*.

In September 2016, the multi-national technology companies Ericsson, Ciena and Thales jointly submitted a proposal to Canada's federal government and the governments of Ontario and Quebec, to build and operate several 5G test platforms. The purpose of building these test platforms was to provide entrepreneurs and researchers with access to a small-scale 5G network where they could try out and develop 5G-related concepts, projects, and prototypes before

the 5G network is available commercially. The technology vendors that constructed the platforms sought to benefit from collaborating with these small- and medium-sized enterprises (SMEs) to create innovative and potentially patentable products. Likewise, the technology vendors presented SMEs with the opportunity to show their prototypes and concepts related to 5G technology. The Ontario government's stated objective in supporting the technology vendors was to generate long-term economic benefits to the Province of Ontario through investment or job opportunities.

In Ontario, the funding proposal was submitted to the Ministry of Economic Development, Job Creation and Trade (the Ministry) under the Ministry's Jobs and Prosperity Fund. The proposal was approved by the Ontario government, and ultimately became the ENCQOR 5G Program (Evolution of Networked Services through a Corridor in Québec and Ontario for Research and Innovation). The technology companies Ericsson, Ciena and Thales, in partnership with the three governments, collectively contributed a total of $400 million to the ENCQOR 5G Program, of which $200 million in public money was contributed equally by the three participating governments, making the Government of Ontario's contribution $66.7 million. Of the $200 million contributed by the three technology companies, approximately $88.8 million was invested in Ontario. The provincial Ministry is responsible for the overall governance and oversight of this five-year program. It appointed the Ontario Centre of Innovation (OCI) as program administrator to manage and deliver the program in Ontario.

Of note, the ENCQOR 5G Program is entirely independent of the commercial implementation of 5G in the province, a widespread rollout that is unlikely to begin for over a year. The test platforms, housed at so-called innovation hubs (office locations dedicated to technological incubation and innovation) provide participants with 5G test conditions. They were built solely for the ENCQOR 5G Program, and have been accessible to selected program participants for a limited time. It is uncertain whether the platforms will be used after the program has ended. Once the commercial 5G network is launched in Canada, anyone who is interested in developing or using a 5G-enabled device or application could simply make use of the commercially available network.

The majority of Ontario's ENCQOR 5G Program funding, $56.9 million (86% of total Ontario funds), was paid to Ericsson and Ciena, to research, design, build and operate the three test platforms. The remainder ($9.8 million) was earmarked for program participants. The ENCQOR 5G Program is broken into five program streams. In four of the streams, participants receive funding to support the projects they propose upon applying. In the fifth stream, participants are allowed access to the test platform but do not receive funding. As of June 2021, the ENCQOR 5G Program had hosted 401 projects in total, with 282 of these receiving funding. There is a total of 330 program participants (some participants applied for more than one project).

Our audit found that the Ministry is unable to measure the overall effectiveness of the program, because the Agreement between the Ministry and OCI did not establish targets for five of its nine performance metrics. Although the other four metrics with targets are being reported on by OCI to the Ministry, we noted that OCI does not always verify the performance metrics' outcome data as reported by program participants. The Transfer Payment Agreement between the Ministry and OCI lacks clarity for key performance metrics such as job creation or retention and usage of test platforms.

We also found that OCI's budgeting and fund management process needs improvement, as the program was only able to enrol half the number of targeted projects within its two highest-funded program streams. Almost 92% of the funding for these streams was essentially allocated to match the amounts requested by SMEs, without a formal assessment of what the SMEs needed.

Further, we noted that OCI did not formally review SMEs' proposed budgets before allocating funds, resulting in ineligible expenses being approved. For example, the funding SMEs proposed

for employee salaries varied widely, even for people doing similar jobs. Almost 90% of the funds were allocated for salaries and wages, and whatever budget amount was requested by an SME ended up being approved by OCI. Although OCI set a compensation limit on the amount that could be claimed as executive salary compensation, we discovered that participants often misidentified themselves as non-executives to circumvent the limit, and received higher amounts.

The majority of Ontario's program funding, $56.9 million (86% of total Ontario funds), went to research, design, build and operate the test platforms. We noted that SMEs were not required to use the test platforms for all program streams, resulting in the test platforms being significantly underutilized by program participants. Also, the Agreement is unclear whether all projects as part of the ENCQOR 5G Program are required to use the test platforms. As a result, OCI did not require program participants to use the test platforms for the two highest Ontario-funded program streams.

Further, we determined that out of a total of 306 projects that were required to use the test platforms under the iPaaS Access and Demonstration Program Streams, more than one-third (114) had not used the test platforms at all, as of August 2021. Without monitoring the utilization of the test platforms, the Ministry is unable to assess its effectiveness. A factor for low utilization is attributed to the six-month closure of the test platforms when the COVID-19 pandemic hit Ontario in March 2020, which temporarily restricted SMEs' physical access to the test platforms.

The following are some of our significant audit findings:

- **Legislation currently in place in Ontario to protect privacy and ensure data security predates emerging technologies such as 5G.** Provincial policies and legislation concerning security and data privacy that specifically contemplate emerging technology such as 5G in Ontario are not yet in place. However, we noted that as of June 2021, the province has commenced preliminary work, including public consultations, for the purpose of updating relevant legislation such as the *Freedom of Information and Protection of Privacy Act*. This is an opportunity to specifically contemplate emerging technology such as 5G when considering the privacy rights of Ontarians. In addition, the province has established an intellectual property action plan with the purpose of implementing a governance framework and providing guidance to organizations that create intellectual property (IP) using Ontario government funds.
- **The Ministry is unable to determine whether the ENCQOR 5G Program has met its overall objective since half of its performance metrics do not have associated targets.** The Ministry did not establish performance targets to measure the effectiveness of the program within its Transfer Payment Agreement (Agreement) with OCI. Five of the nine performance metrics defined in the Agreement—such as the incremental sales revenues generated, follow-on investment generated, or the number of 5G products launched—did not have measurable targets associated with them. Without targets, it will remain unknown whether the objective of securing long-term economic benefits to the province was achieved.
- **The Transfer Payment Agreement between the Ministry and OCI lacks clarity.** Two critical intended outcomes of the program, related to creation of jobs by program participants and the requirements for SMEs to utilize the 5G test platforms did not have clear expectations and targets established in the Agreement. The Agreement text implied that program participants across all program streams were required to use the test platforms, built at a cost of $56.9 million dollars. By virtue of the Agreement's imprecise wording, not all streams were required to use the test platforms. However, the Agreement did specify for one funded program stream to use the test platforms.
- **OCI's existing fund and budget allocation process requires improvement**

to ensure ineligible expenses are not approved. As ENCQOR 5G Program participants, SMEs submitted project proposals to OCI with associated requests for funding. We found that OCI did not have a formal assessment or criteria-based evaluation to assess requested funding. Upon our review of all applications, we noted that in almost all cases, the amount that was requested by an SME participant was approved by OCI. This meant that participants were allocated very different amounts of funding for similar roles. We noted that 89% of funding was budgeted as salaries and wages, whereas only 11% was allocated for other project costs. Some SMEs allocated Ontario funds towards their daily operational expenses such as Internet service, office rental and medical insurance.

- **Only about half of the expected number of SMEs were enrolled in two of the four funded program streams.** As of March 2021, OCI had enrolled 39 SME projects as compared to the approximately 80 projects it had targeted within the SME and Academia Technology Development program streams. OCI is unable to enrol and fund any additional projects in these streams because it has already allocated 92% ($3.2 million of the $3.5 million) of the available Ontario funding. As a result, program participants applying to the above two funded streams were directed to enrol in the non-funded program stream.
- **As of August 2021, test platforms were significantly underused.** We found many instances where participants were allocated funding to develop a project on the 5G test platforms yet spent no time on the test platforms at all. For the two program streams where test platform use was being tracked, we noted that utilization was low. In one stream, 42% of projects (78 out of a total of 187 projects) have yet to use the test platforms. In the other stream, 30% (36 out of 119) of SMEs have not currently used the test platforms. OCI does not regularly monitor whether or not SMEs are using the platforms.
- **Cybersecurity of the ENCQOR 5G test platforms should be strengthened.** As part of our audit work we performed a penetration test of the ENCQOR 5G network and identified cybersecurity observations that were remediated immediately upon communication to the technology vendors. In addition, we also identified improvements needed for recordkeeping and tracking of IT incidents and deletion of program participants' data.
- **Weak cybersecurity practices at OCI put SMEs' proprietary data at risk of inappropriate disclosure.** Our audit found that OCI's vendors, which manage critical IT systems on behalf of OCI as well as its day-to-day operations, do not regularly perform security tests such as penetration testing to identify network vulnerabilities. Confidential SME data such as company profiles, employee qualifications, and pay stubs with Social Insurance Numbers are stored within these IT systems and remain vulnerable up until the completion of the program, should there be a security breach. We noted that OCI does not obtain service level reports from its IT vendors to assess if IT incidents are being resolved in line with industry best practices. Further, OCI does not have a penalty clause in its vendor contracts by which to hold vendors accountable for poor performance.

This report contains 10 recommendations, with 23 action items, to address our audit findings.

Overall Conclusion

One purpose of the ENCQOR 5G Program was to provide Ontario small- and medium-sized enterprises (SMEs) an early competitive advantage when innovating with 5G technology by providing the SMEs with access to the 5G test platforms to develop and test their products. COVID-19 has had a noteworthy impact on use of the 5G platforms. The access to the test platforms was restricted for approximately six months, and has experienced access restraints to date. As a result, the test platforms experienced a period of underutilization.

We found that the Transfer Payment Agreement between the Ministry and the Ontario Centre for Innovation (OCI), which administered the program and distributed funds to selected SMEs, lacked clarity about two expected outcomes: job creation and retention by program participants, and specific requirements for those that received funds to actually use the 5G test platform.

It was anticipated that the 5G Program funding would help to create or retain about 3,000 jobs. However, the Transfer Payment Agreement was unclear whether these jobs would be created by the technology vendors that built the 5G platforms or by the SMEs. Based on our discussions with the Ministry and OCI, we were informed that the intent of the program was to create or retain approximately 3,000 jobs exclusively by SMEs. As of December 2020 (most recent data available), OCI had reported to the Ministry a total of 320 jobs created or retained by SMEs, who were budgeted approximately $4.2 million from the overall program budget of $66.7 million. Upon our review, we noted that this number was incorrectly reported to the Ministry and only about 130 jobs had been created or retained by the SMEs.

Nevertheless, the technology vendors that received $56.9 million of the overall program budget to research, design, build and operate the ENCQOR test platforms had created or retained about 1,900 jobs in addition to the ones created by SMEs. The remaining $5.6 million was allocated to OCI for delivery of the program and to the office locations where the test platforms are housed.

The Transfer Payment Agreement was also unclear on whether SMEs were required to use the 5G test platforms for all program streams. Our audit found the test platforms were significantly underused and that, in many instances, participants received funding yet, as of August 2021, spent no time on the test platforms at all. The lack of clarity in the Transfer Payment Agreement, including the absence of established targets for all performance metrics, makes it unclear at this point in time what the longer-term economic benefit for the province will be once the program has concluded in March 2022.

As well, OCI did not perform a comprehensive review of budgets submitted by program participants to ensure that only eligible expenditures were budgeted and approved, which ultimately limited the number of participants that qualified for funding.

We conducted cybersecurity testing of the ENCQOR 5G network and identified cybersecurity weakness that were remediated immediately upon communication of our findings to the technology vendors. Due to the nature of cybersecurity, and so as to minimize the risk of exposure for ENCQOR participants, we provided relevant details of our findings and recommendations directly to the technology vendors. The technology vendors agreed to address our other IT-operational recommendations.

Finally, we noted that in order for the Government of Ontario to effectively update its existing privacy legislation to address the risks associated with emerging technology such as 5G, it will need to collaborate with all levels of governments to create a legislative framework that protects and secures data for Ontarians.

OVERALL MINISTRY OF ECONOMIC DEVELOPMENT, JOB CREATION AND TRADE RESPONSE

The ENCQOR 5G Program is a collaborative partnership among industry leaders, federal and provincial governments, innovation organizations and researchers. The first of its kind, ENCQOR built the world's largest pre-commercial 5G testbed accessible to any Ontario company and researcher, providing a head start in the global race to commercialize innovative 5G technologies. This program provides Ontario companies access to technology required to be industry leaders – launching new products like components for driverless cars, warehousing robots, or vaccine-transporting drones.

ENCQOR's industry partners' commercial R&D (research and development) investments

signal the value these multi-nationals provide to Ontario's high-tech workforce and mature innovation ecosystem.

ENCQOR was launched in 2017 when 5G awareness was in its early stages. It presented many complexities like the development, installation, and small- and medium-sized enterprise (SME) onboarding of the test platforms requiring a high degree of co-ordination. The uniqueness of the project contributed to difficulties predicting several performance targets and SME participation rates. The platforms first became available in 2019. By March 2020, the world was hit by COVID-19 which restricted access to the sites. Despite the pandemic's challenges, project targets will be met upon the completion of the program in March 2022.

Advancing Ontario's 5G and network capacity is critical to developing and retaining a highly skilled, in-demand workforce – foundational ingredients in advanced industrial applications laying the groundwork for new products and services necessary to Ontario's economic recovery and enhanced prosperity.

With the program agreement ending March 2022, the Ministry of Economic Development, Job Creation and Trade (Ministry) and the Ontario Centre of Innovation continue to work closely with partners to manage operational challenges. Upon completion, the Ontario Centre of Innovation will undertake a third-party economic impact study to assess the program's effectiveness. The Ministry acknowledges the Auditor General's recommendations and, consistent with its commitment to continuous program improvement, will act on all recommendations to provide meaningful improvements to governance and performance monitoring in future 5G programs.

OVERALL RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) thanks the Auditor General and her team for their work and commits to take all necessary steps to use this report's recommendations to strengthen our operations. OCI believes continuous improvement in its operations, processes, and program delivery is core to its innovation mandate.

The ENCQOR 5G Program is a critical catalyst in the Canadian 5G ecosystem, bringing together the entrepreneurial strengths of SMEs, the world-class research and development expertise of the anchor partners Ericsson, Ciena, and Thales, and the impressive knowledge and talent base of our postsecondary institutions, with the objectives of driving job increasing revenue generation, and positioning Ontario as leader in 5G application development on the global stage.

The usage of the platforms was severely impacted by the COVID-19 pandemic resulting in the shutdown of the platforms for many months and small- and medium-sized enterprises (SMEs) refocusing on survival and business continuity. As Ontario begins to ease lockdown measures, OCI is seeing a sustained return of SMEs to the platforms. We are confident the program will meet the target of creating and/or retaining 3,000 jobs in Ontario, and interim reporting is pointing in the right direction.

OCI takes the recommendations to better protect confidential SME data very seriously. OCI agrees with the Auditor General that there are opportunities to improve protection. Actions have been already undertaken to enhance the security of all sensitive data.

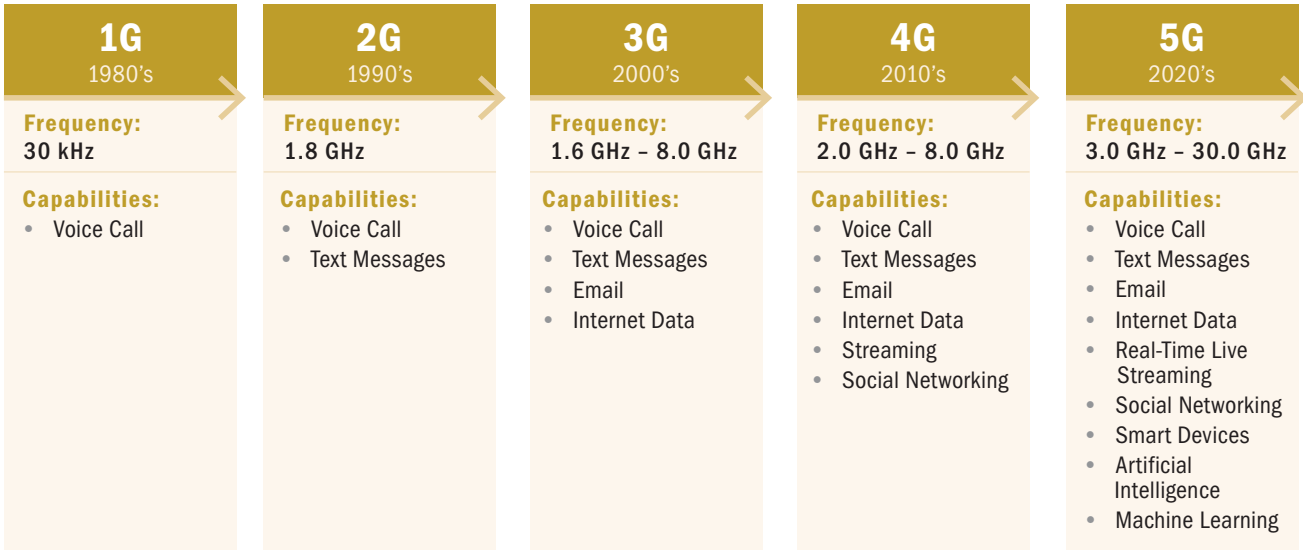
2.0 Background

2.1 Evolution of Mobile Network Technologies (1G – 5G)

The first generation (1G) of mobile network technology was introduced in Canada in the early 1980s. Early cell phones allowed customers to communicate via voice calls but did not have the capability to transmit data through Internet

Figure 1: Evolution of Mobile Network Technologies, First to Fifth Generation

Prepared by the Office of the Auditor General of Ontario



communication or text messaging. The second generation (2G) was launched in the early 1990s, and that introduced services such as mobile pagers. 3G technology was built with higher speed transmissions, which allowed mobile phone users to browse the Internet and send emails. Canada's current platform, 4G, introduced new services and better connectivity compared to 3G, allowing customers to play videos, listen to music, and connect via social media communication. **Figure 1** depicts the evolution of mobile network technologies.

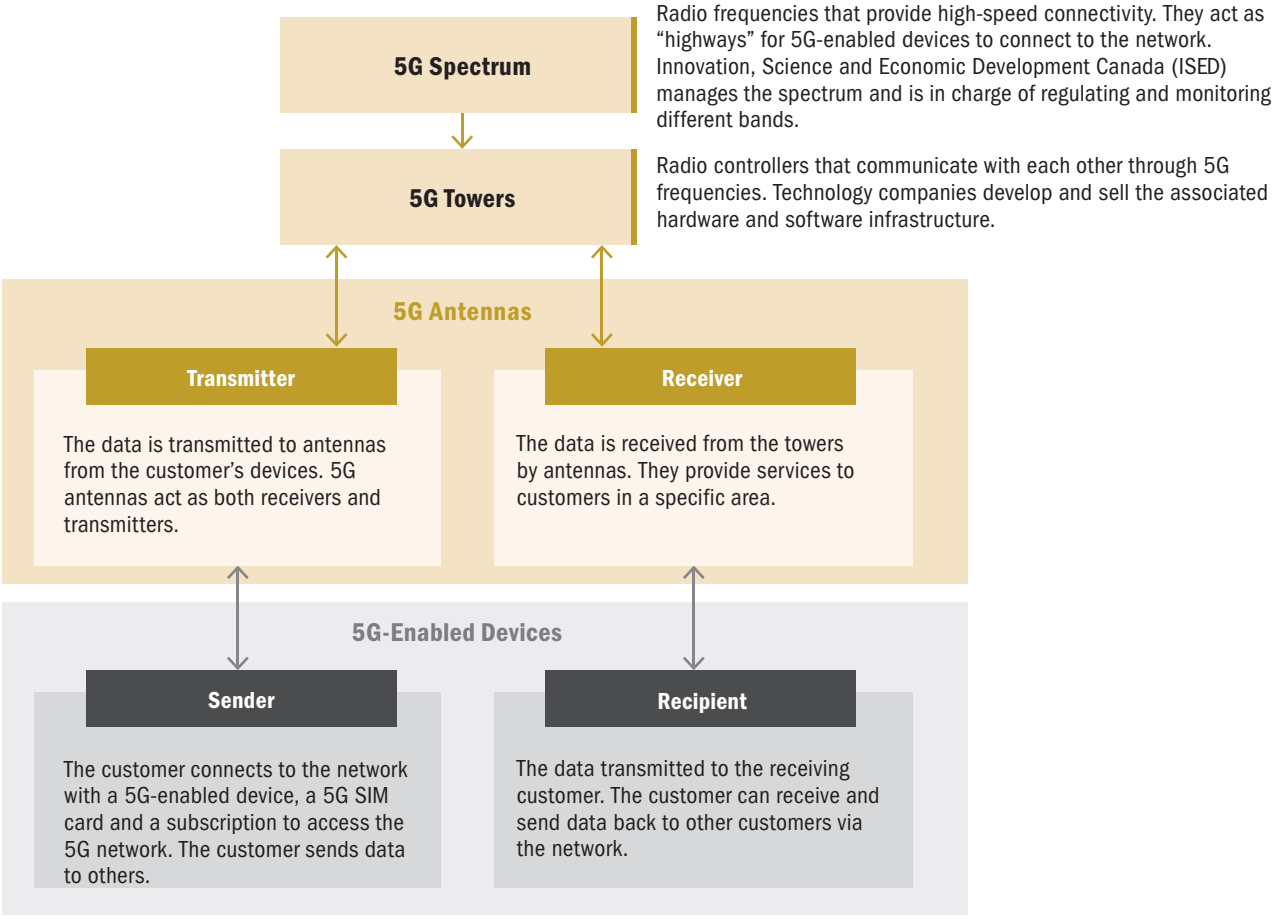
In Canada, the 5G network infrastructure is not yet fully operational. 5G, which stands for fifth generation network technology, is the latest mobile technology standard, with the ability to connect a large number of advanced devices and services in real-time. The 5G network can transfer large volumes of data over the Internet, enabling such things as streaming of live sports games, video calling, and operating smart devices. To be able to use the 5G network, customers must have a compatible 5G-enabled device, for example, an iPhone version 12.

Figure 2 provides an overview of a 5G mobile network ecosystem. When customers with mobile devices connect to a 5G network, their data is sent from the devices to a mobile tower (antenna) equipped with 5G-specific hardware, such as radio controllers, capable of accessing the 5G spectrum for data transmission. The spectrum refers to a specific range of radio frequencies measured in megahertz (MHz) and gigahertz (GHz). The spectrum has frequency ranges, such as low-band, mid-band and high-band. Through an auction, 5G radio frequencies are licensed to telecommunication companies such as BCE Inc., Rogers Communications Inc. and TELUS Communications Inc. by the federal department, Innovation, Science and Economic Development Canada (ISED). The ISED develops national goals and policies for spectrum utilization.

The auction for one of the 5G frequency spectrums (3,500 MHz) occurred from June 2021 through July 2021. About 1,500 5G licences were awarded to 15 telecommunication providers. These companies will be responsible for the commercial implementation of 5G in Canada based on mandates and policies established by the federal ISED. The issuance of 5G spectrum licences is the first step toward full commercialization of a 5G mobile network in Canada. Next, telecommunication companies

Figure 2: 5G Network Technology Ecosystem

Prepared by the Office of the Auditor General of Ontario



Note: 4G devices cannot access the 5G spectrum. 4G devices have their own allocated spectrum and network.

work with different stakeholders on a phased rollout, building the infrastructure for the new network. The federal government is still in the process of auctioning other 5G spectrums, which it expects to complete by 2025.

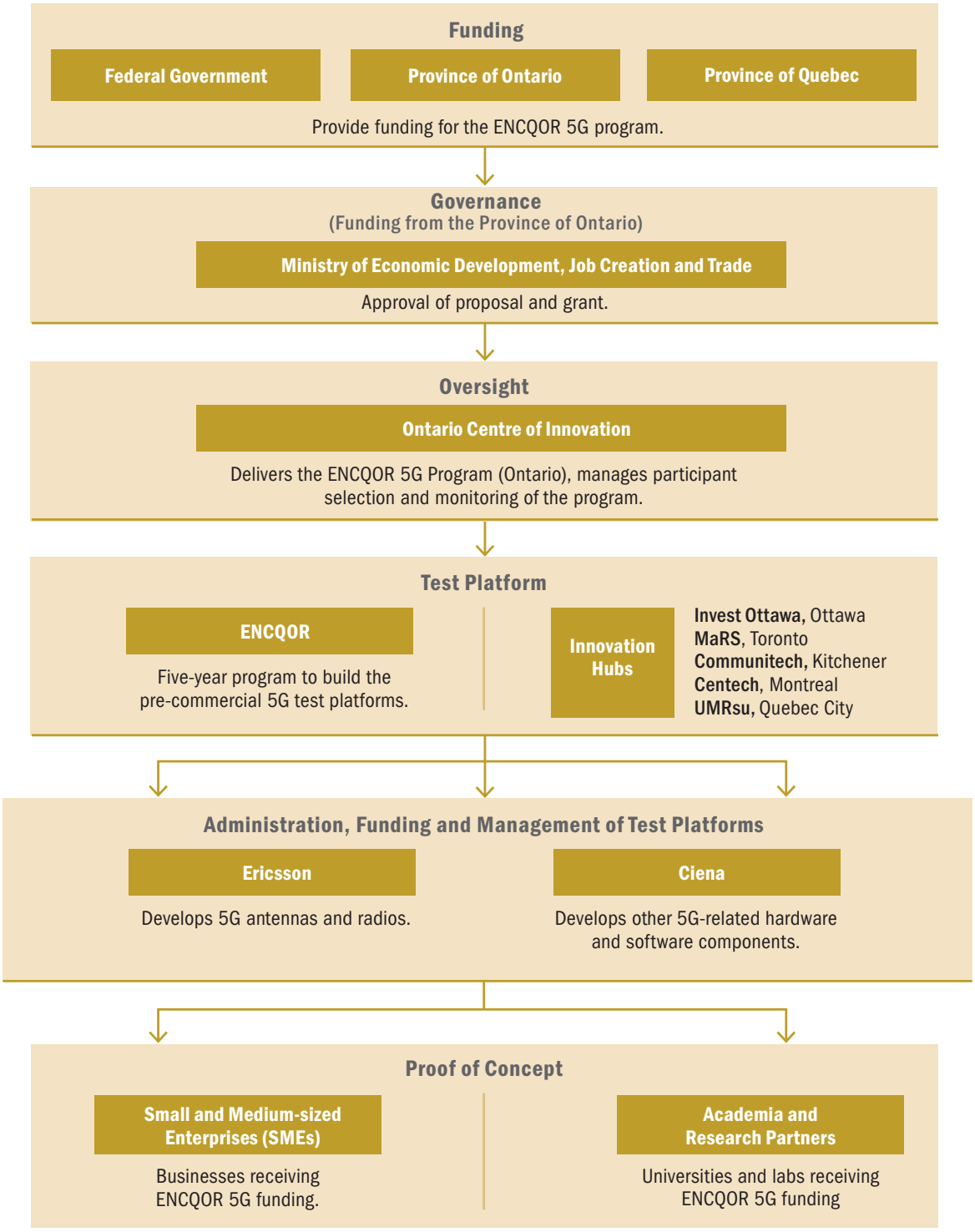
2.2 Overview of Pre-Commercial 5G Program (ENCQOR 5G)

The ENCQOR 5G Program (Evolution of Networked Services through a Corridor in Québec and Ontario for Research and Innovation) was intended to have participants develop and test their potential 5G products before the commercial launch of 5G occurs. The program is a collaboration of the Government of Canada, the Province of Ontario, the Province of Quebec, and three technology companies: Ericsson, Ciena, and Thales. In Ontario, program participants, which are small- and medium-sized enterprises (SMEs) as well as academic research teams, can develop and test their projects and technologies at one of three innovation hubs that host a 5G test platform. **Figure 3** shows the key stakeholders involved in this program.

In March 2017, the federal and provincial governments, technology vendors, and the appointed administrator, the Ontario Centre of Innovation (OCI), began building the test platforms. Test platforms became available to SMEs in April 2019. As of June 2021, approximately 330 SMEs with over

Figure 3: ENCQOR 5G Program Key Stakeholders

Prepared by the Office of the Auditor General of Ontario



400 projects have participated in the program. The program is scheduled to end in March 2022.

2.2.1 Key Players and their Roles and Responsibilities

There are several key players in the ENCQOR 5G Program:

Ministry of Economic Development, Job Creation and Trade
The Ministry of Economic Development, Job Creation and Trade (the Ministry) funds the ENCQOR 5G Program in Ontario. The Ministry has appointed the Ontario Centre of Innovation (OCI) to administer and co-ordinate the program deliverables, in partnership with designated technology vendors (Ericsson, Ciena, and Thales) and innovation hubs, the office locations that host the platforms. Through a Transfer Payment Agreement (Agreement) with OCI, the Ministry is to oversee OCI's delivery of the ENCQOR 5G Program. The Agreement includes a payment schedule along with program deliverables that OCI is required to report on for disbursement of the total fund amount, $66.7 million.

Ontario Centre of Innovation (OCI)
Ontario Centre of Innovation (OCI) is a not-for-profit organization funded by the Government of Ontario. It is governed by a Board of Directors and is overseen by the Deputy Minister and an Assistant Deputy Minister of the Ministry. As per the Agreement, OCI is responsible for managing the Ontario portion of the ENCQOR 5G Program.

Technology Vendors and Innovation Hubs
The hardware and software that make up the ENCQOR 5G test platform infrastructure is technology developed by the companies Ericsson and Ciena. These technology vendors are also responsible for the day-to-day running of the test platforms, including operations, security, maintenance and technical support to SMEs. The test platforms are physically located at so-called innovation hubs across Ontario—MaRS in Toronto, Invest Ottawa in Ottawa, and Communitech in Kitchener.

The two technology companies, Ericsson and Ciena, are also receiving grant funding from the Quebec government and the federal government in order to build and manage another test platform located in Montreal. Only the Ontario portion of program funding is administered by OCI.

Small and Medium-sized Enterprises (SMEs)
Ontario-based businesses with fewer than 500 employees are the overwhelming majority of participants in the ENCQOR 5G Program. SMEs apply online through OCI's website, where they provide details about their organization, business model, relevance to 5G technology, and specific ideas for their project, or proof of concept. **Section 2.3** discusses the program application and selection process.

2.2.2 ENCQOR 5G Program Streams

The ENCOQR 5G Program has five program streams geared towards different industries and participants. They are:

1. **SME Technology Development** enables an SME to collaborate with technology vendors, Ericsson and Ciena on 5G-related projects. Maximum funding for any given project within this program stream is $500,000.
2. **Academia Technology Development** is designed for academic researchers to partner with technology vendors. Maximum funding available under this stream is $150,000.
3. **Demonstration** provides SMEs with access to the test platforms to develop new technologies, products, processes and services that leverage 5G connectivity but the SMEs work independently rather than in collaboration with the technology vendors. The maximum funding available under this stream is $50,000 per project.
4. **Talent Edge Internship** is reserved for college and university students to work on industry-driven research and development projects within an SME. Maximum funding for this program stream is $60,000.
5. **iPaaS Access,** short for Innovation Platform as a Service Access, provides Ontario-based SMEs

and researchers who are not seeking funding for a project access to the test platforms to test a 5G technology.

Program streams have a maximum duration of 24 months, meaning that participants can access the test platform within this timeframe. **Appendix 1** provides further details about each program stream, such as the typical project duration, funding, and the number of applicants enrolled.

2.2.3 Eligibility Criteria to Apply for the ENCQOR 5G Program

Following is the list of eligibility criteria for the ENCQOR 5G Program:

- The applicant's project ideas or proof of concept must be relevant or demonstrate the need for a 5G network.
- Applicants must be Ontario-based SMEs with less than 500 employees, or researchers at an Ontario publicly funded postsecondary institution.
- Applicants must use the results of their project to economically benefit Ontario. Economic benefit is measured by number of jobs created, product sales, and patents registered, among other outcomes.
- Applicants must have the necessary expertise and resources to perform the project within the appropriate time frame.

2.3 ENCQOR 5G Program Application Process

2.3.1 Outreach and Marketing - Identification of SMEs

At OCI, Business Development Managers are responsible for marketing the different program streams to the public. Managers attend information sessions and events such as technology conferences, innovation workshops, and start-up launches, to inform SMEs about the ENCQOR 5G Program. Their focus is to connect with and educate eligible SMEs about the benefits of applying.

2.3.2 Application Submission Process

Managers also assist SMEs with the application submission process, based on an SME's eligibility and fit for a program stream. For the iPaaS Access, Demonstration and Talent Edge Internship streams, SMEs apply directly on OCI's website using login credentials provided by OCI staff.

For the Technology Development programs (SME and Academia), a challenge statement is posted by technology vendors on OCI's website and SMEs are required to respond with an expression of interest document. This document is reviewed by OCI and the technology vendors for approval. If approved, the SME is invited to submit a full application. OCI program managers screen these applications for eligibility, such as ensuring the SME is Ontario-based.

See **Appendix 2** for the process flow of onboarding SMEs via the iPaaS Access, Demonstration and Talent Edge Internship program streams and **Appendix 3** for the onboarding process in the Technology Development (SME & Academia) program streams.

2.3.3 Application Review Process

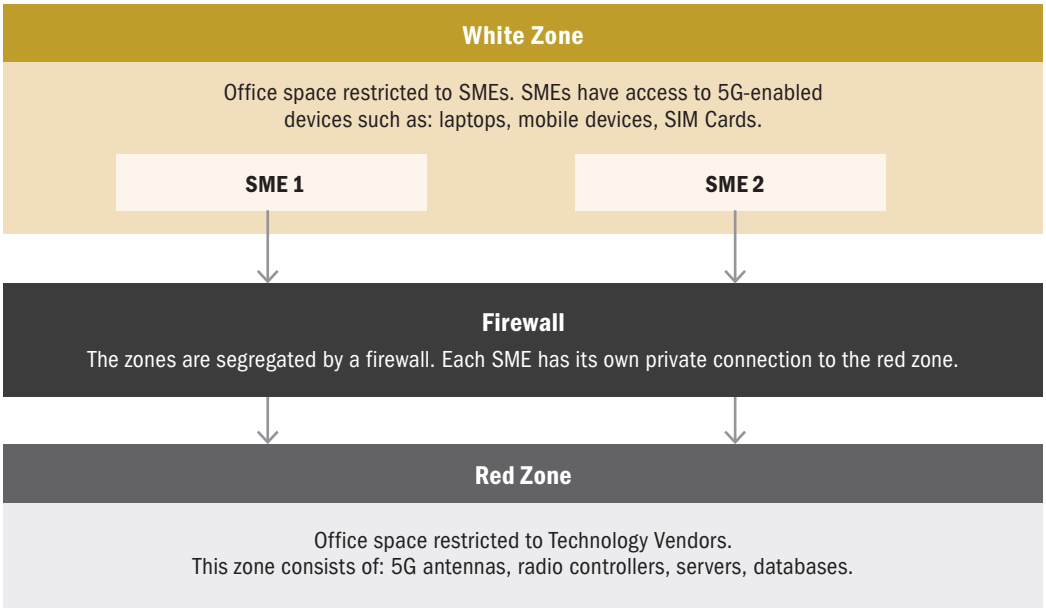
All OCI-screened applications are reviewed by ENCQOR technology vendors, who perform an initial assessment of whether the proposed project is technically feasible on the 5G test platform.

OCI-screened applications to the Demonstration and Talent Edge Internship streams are reviewed by an independent panel of reviewers called the College of Reviewers (Reviewers). The Reviewers evaluate the application based on fit to the program, return on investment, market commercialization and benefit to Ontario. Each application is reviewed by three Reviewers that score it on a scale of 1 to 100, with 75 being the threshold score for approval.

Applications for the Technology Development programs (SME and Academia) are reviewed by OCI's internal review panel. If the application is approved, an SME enters into an agreement with the technology vendors and OCI that outlines the terms and conditions for using the test platform.

Figure 4: ENCQOR 5G Test Platform Zones

Prepared by the Office of the Auditor General of Ontario using OCI data



Program funding is disbursed using a claims and reimbursement model. Periodically, reimbursement claims and progress reports are submitted to OCI based on a project funding agreement and program requirements. At the end of a project, a final report on economic benefit and the final reimbursement claim are submitted. The last reimbursement claim is released upon project completion and receipt of a participant's final report.

2.4 ENCQOR 5G Test Platform Technical Design

The ENCQOR 5G test platforms are located in three cities in Ontario (Toronto, Ottawa and Kitchener) and two in Quebec (Montreal and Quebec City). The platforms are physical facilities equipped with 5G software and hardware such as radio controllers and antennas to provide 5G connectivity. These hardware devices are installed and supported by employees of Ericsson and Ciena. The test platforms are designed to provide 5G connectivity internally within the facility, or innovation hub, plus up to a one-kilometre range of external access.

2.4.1 Security of ENCQOR 5G Test Platforms

SMEs are assigned their own individual private connection to the 5G test platform through a dedicated Internet Protocol address. In addition, access to SMEs' data and intellectual property stored within the ENCQOR 5G platform is designed to restrict access to authorized individuals only.

Test platforms are segregated into different security zones called a red zone and a white zone, as depicted in **Figure 4.**

- **The white zone** is restricted to SMEs. It consists of an office space that has 5G connection along with 5G-enabled mobile phones that SMEs can use to test their projects. It is also possible for SMEs to bring their own computer hardware such as laptops and mobile devices to connect to the test platform. SMEs have to pre-book the test platform with a co-ordinator who also facilitates the onboarding process. As part of the onboarding process, SMEs are assigned unique credentials and an individual private connection to the network.
- **The red zone** is restricted to the technology vendors that are responsible for managing 5G-related software and hardware components such as

security software, radio controllers, and antennas. Technology vendors are responsible for data security and privacy within the test platforms, including protection of intellectual property.

In addition to the above access controls, the test platforms are implemented with the following cybersecurity controls:

- **Vulnerability Scanning:** the 5G infrastructure at the test platforms is scanned for security vulnerabilities, and identified gaps are remediated.
- **Closed Network Protocol:** the test platforms are not open to the general public or private organizations. They are closed private networks, with access restricted to participants approved to enter the ENCQOR 5G Program.
- **Data Deletion:** SMEs that do not have their own 5G devices, such as smart phones, SIM cards or servers, can borrow 5G devices at the test platforms. Between borrowers, any data that is stored on these devices is deleted by an employee of the innovation hub.

2.5 Legislation and Regulations in Relation to Technology

With faster Internet speed and fewer communication delays in connecting a large number of devices, 5G provides new opportunities for innovative products and services that can benefit customers and the economy. However, there are risks and concerns with this emerging technology.

The 5G network will be used to connect numerous online devices and process a large volume of personal data in real-time. This creates many more entry points to access data which hackers can exploit to steal sensitive personal and financial information. As such, policies and legislation surrounding data privacy, security and the ownership of intellectual property are critical to protect Ontarians in the context of commercial 5G implementation.

The following existing legislation, federal and provincial, is relevant in this regard:

Freedom of Information and Protection of Privacy Act 1990

This act applies to Ontario's provincial public sector institutions. Its purposes are to provide a right of access to information under the control of government organizations, and to protect personal information that is held by government organizations.

***Personal Information Protection and Electronic Documents Act* (PIPEDA)**

The Office of the Privacy Commissioner of Canada is responsible for this act. PIPEDA establishes rules for how private-sector organizations are entitled to collect, use and disclose personal information in relation to for-profit, commercial activities across Canada. It also applies to personal information of employees at federally regulated businesses such as banks, airlines, and telecommunication companies. Currently, private-sector organizations operating in Ontario must follow the rules set out by PIPEDA.

Municipal Freedom of Information and Protection of Privacy Act

This act applies to Ontario's municipal institutions and largely mirrors the provisions of the *Freedom of Information and Protection of Privacy Act,* appropriately varied for the municipal sector.

Personal Health Information Protection Act, 2004

This act sets out specific protections for personal health information in Ontario in order to ensure the privacy of individuals with respect to that information, while facilitating the effective provision of health care.

3.0 Audit Objective and Scope

Our audit objective was to assess whether:

- the Province of Ontario has put into place relevant and current governing policies, procedures, security and legislation, where applicable, for data ownership and privacy and ownership of intellectual

property in preparation for the future commercial implementation of the 5G network in Ontario;

- the Ministry of Economic Development, Job Creation and Trade (the Ministry) has effective oversight over the Ontario Centre of Innovation (OCI) to ensure it is operating in accordance with the spirit and intent of the memorandum of understanding (MOU) and Transfer Payment Agreement associated with 5G technology; and
- the Ontario Centre of Innovation is administering the 5G pre-commercial programs under the terms of the MOU and Transfer Payment Agreement; monitoring the programs to ensure economic benefit is achieved via innovation and job creation; and to ensure that security is in place in the use of the pre-commercial 5G network to protect access to pilot users' data and information.

We conducted our audit between April 2021 and September 2021. We obtained written representation from Ministry management that, effective November 24, 2021, they had provided us with all the information they were aware of that could significantly affect the findings or the conclusion of this report.

Before starting our work, we identified the audit criteria we would use to address our audit objective. These criteria were established based on a review of applicable legislation, agreements and best practices. Senior management at the Ministry of Government and Consumer Services, the Ministry of Economic Development, Job Creation and Trade, and OCI reviewed and agreed with the suitability of our audit objective and related criteria, as listed in **Appendix 4.**

As part of our audit, we initially interviewed senior management at the Ministry of Government and Consumer Services to discern their roles and responsibilities as they relate to applicable governing policies and legislation for the commercial implementation of a 5G network. We interviewed the Chief Privacy Officer of the Information, Privacy and Archives Division of this Ministry to assess if policies and legislation are in place for the security and privacy of data. In addition, we interviewed senior management at OCI and at the technology vendors, Ericsson and Ciena.

We evaluated controls related to governance – roles and responsibilities, funding disbursement, management reporting, cybersecurity, data privacy and the intended outcomes of the ENCQOR 5G Program.

We also visited the ENCQOR 5G test platform located at MaRS District, Toronto, to do a walkthrough of the different security zones used by SMEs to test their projects. We also observed 5G-enabled devices such as antennas, mobile phones, and routers to obtain a high-level understanding of the operating model of 5G network technology and performed data analysis work on the program applications received by OCI.

4.0 Detailed Audit Observations

4.1 Existing Government Policies and Privacy Legislation Are Outdated and Do Not Contemplate Emerging Technologies Such as 5G

The Ontario government has not yet updated relevant and appropriate legislation and policies that aim to ensure privacy, security and ownership of data is protected in the upcoming 5G era. Although the province is working on updating the *Freedom of Information and Protection of Privacy Act*, we noted this undertaking does not specifically contemplate the future commercial 5G implementation in Ontario.

The risk associated with 5G is with the enormous volume of data that can be shared and with the relatively larger number devices and users that will be on a 5G network in real-time. The much greater size of the network means there are more entry points that could be exploited to silently obtain sensitive personal, proprietary, and/or financial information. Therefore, the development of policies and legislation surrounding data privacy, data security and the ownership of intellectual property is critical to protect Ontarians participating in the 5G network.

Just as the commercial implementation of the 5G network requires input from all levels of government

and various stakeholders, such as telecommunications sector companies, achieving and maintaining digital data security and data management requires the co-ordinated effort of all levels of government. A key role the Ontario government plays is in updating the applicable provincial legislation to take into account new and emerging technology such as 5G.

In Ontario, the Ministry of Government and Consumer Services (the Ministry) provides advice to ministries and other institutions with respect to the collection, use and disclosure of personal information that is obtained by publicly funded bodies in the course of their operations. The Information, Privacy and Archives division of the Ministry oversees the *Freedom of Information and Protection of Privacy Act*.

We noted that the Ministry is currently updating Ontario's privacy framework to include comprehensive and up-to-date requirements to protect privacy rights. In order to do so, the Ministry launched a public consultation in June 2021 to obtain feedback from members of the public, private sector organizations and other relevant stakeholders on critical privacy elements such as a rights-based approach to privacy, consent and lawful uses of personal data, data transparency and the regulatory system. The public consultation ended in September 2021.

With respect to intellectual property (IP), in April 2019 the Ontario government created an expert panel with expertise in IP law, IP education, and the commercialization of ideas to provide advice and recommendations in relation to IP policy in Ontario. In July 2020, the Ontario government announced the Intellectual Property Action Plan based on the recommendations made by the Expert Panel on Intellectual Property.

Ontario's Intellectual Property Action Plan will:

- work with postsecondary institutions and research institutes to strengthen mandates related to commercialization entities within their organizations;
- strengthen Ontario's IP literacy by developing standardized, web-based basic and advanced IP education curriculums;
- create a centralized provincial resource entity that will increase access to sophisticated IP expertise; and
- develop a governance framework for organizations supporting entrepreneurial and innovation activities, which incorporates IP considerations.

For the ENCQOR 5G program, we noted as of December 2020 there were 35 projects that had been completed. However, these projects were part of the Demonstration, iPaaS Access and Talent Edge Internship program streams, which do not require collaboration with a technology vendor. As a result, no intellectual property was generated.

RECOMMENDATION 1

To support the future commercial implementation of the 5G network in Ontario, and reduce the risks to privacy, data security and intellectual property that will increase with this implementation, we recommend that the Ministry of Government and Consumer Services and the Ministry of Economic Development, Job Creation and Trade:

- update relevant and appropriate provincial policies and legislation regarding the security and privacy of data to be able to address and respond to emerging technologies, including 5G;
- work with the federal government and key stakeholders to develop clear roles and responsibilities within an overall provincial strategy that encompasses privacy, security and ownership of data and intellectual property;
- update the existing standardized governance framework to explicitly include requirements for the protection of intellectual property generated by entities receiving public funds; and
- for all future Ontario Centre of Innovation programs, ensure ownership and protection of intellectual property clearly demonstrate how the province will benefit by partnering with third party vendors.

RESPONSE FROM MINISTRY OF GOVERNMENT AND CONSUMER SERVICES

The Ministry of Government and Consumer Services (Ministry) agrees with this recommendation. The Ministry recognizes the importance of privacy and data security for public confidence. The Ministry will continue to work with the federal government and other key stakeholders to ensure Ontarians enjoy robust privacy protection. In doing so we will draw on the numerous submissions provided on the recent white paper. While existing privacy laws are based on a principle of technology neutrality, the Ministry is committed to ensuring provincial privacy policy remains well-suited to emerging technologies such as 5G and changing societal contexts.

The Ministry further notes:

- Federal law is, and will likely continue to be, the foundation for privacy protection in respect of commercial activity. Any provincial law will need to be acknowledged as "substantially similar" to apply in place of the *Personal Information Protection and Electronic Documents Act*.
- Should Ontario legislate in this way, federal privacy law will continue to be the applicable statute in federally regulated industries, such as telecommunications.

The Ministry will also continue to provide guidance to public sector institutions on the protection of privacy when using emerging technologies.

RESPONSE FROM MINISTRY OF ECONOMIC DEVELOPMENT, JOB CREATION AND TRADE

The Ministry of Economic Development, Job Creation and Trade (Ministry) agrees with this recommendation. Through the Intellectual Property Action Plan, the Ministry has been working with funding recipients to establish and implement an intellectual property governance framework in its transfer payment agreements. For the Ontario Centre of Innovation (OCI), this was established in its base funding agreement for 2021-22. OCI and the Ministry will review OCI's existing intellectual property policy for the organization and all programs delivered by OCI to ensure consistency and alignment with the IP governance framework. Modifications will be made and implemented as necessary.

4.2 Ineffective Monitoring of the Program by OCI and the Ministry

From 2016/17 to 2020/21, the Ministry transferred $65.9 million to OCI, which represents 98.8% of the total Ontario grant for the ENCQOR 5G Program. (A holdback of $800,000 will go to OCI upon completion of the program.) As of June 2021, OCI had distributed $53.8 million of the $65.9 million in grants to technology vendors, innovations hubs, and SMEs. Refer to **Figure 5** for a detailed breakdown of the funding disbursed.

4.2.1 Not All Ministry Performance Metrics for OCI Have Measurable Targets

OCI has a payment schedule subject to the terms and conditions of the Agreement between the Ministry and OCI. Program milestones and deliverables are required to be achieved for the Ministry to continue disbursing funds to OCI. This includes reporting on interim program outcomes and targets. The Ministry is accountable for ensuring the terms and conditions of the Agreement are met, and relied on OCI to provide regular performance reports. Refer to **Figure 6** for an elaboration of the nine performance metrics and targets that OCI is required to report on.

We noted, however, that the Ministry did not establish performance targets for five of the nine metrics included in the Agreement. They are: 1) incremental sales revenues generated by program participants, 2) new products or services launched, 3) environmental or social impacts, 4) public awareness of the program and 5) mentions of the program in the media. Without establishing targets for these

Figure 5: Ontario Grants to Key Stakeholders, March 2017 – June 2021

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation data

Stakeholder	Budget Ontario Fund ($ millions)	Actual Ontario Fund Disbursed ($millions)	Portion of Budget Disbursed (%)
Ciena Canada Inc.	27.1	23.5	87
Ericsson Canada Inc.	23.2	18.7	81
Thales Canada Inc.	4.9	4.3	86
Program Participants (SMEs)	4.2	1.7	41
Innovation Hubs, IT Infrastructure Provider	5.8	4.4	77
Ontario Centre of Innovation	1.5	1.2	80
Total	**66.7**	**53.8**	**81**

Figure 6: ENCQOR 5G Program Performance Metrics with Targets and OCI Results, as of December 2020

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation data

	Performance Metrics	Measurement Method	Ministry Target	OCI Results
1.	Directly attributable SME results for all projects and internships:	Outcome reports completed by SMEs	None defined	
	a) Jobs created or retained			a) 320
	b) Incremental sales revenues generated			b) $1,598,505
	c) Follow-on investment generated			c) $2,005,000
	d) New prototypes developed/launched			d) 44
	e) New products and services developed/launched			e) 63
	f) Qualified Personnel Trained			f) 109
2.	SME partnerships developed with Technology Vendors	Technology Vendors' reporting	30 partnerships	1
3.	New products or services launched by the Technology Vendors as a result of the Project	Technology Vendors' reporting	None defined	5
4.	Number of test platform users	Applications received	200 funded SMEs	268 SMEs
5.	Number of hours of technical support provided	Technology Vendors' reporting	Up to five hours per SME	1.1 hours
6.	Number of jobs at each of the Technology Vendors: Active 5G Employees (primarily working on ENCQOR 5G program)	Technology Vendors' Reporting	Ericsson: 300 Ciena: 640 Thales: 15	Ericsson: 1,050 Ciena: 847 Thales: 15
7.	Environmental or social impacts of the projects (e.g. greenhouse gas reductions, air quality improvements, and energy reductions, health impacts)	Outcome reports completed by SMEs	None defined	7
8.	Number of visits to ENCQOR website	Website tracking	None defined	33,300 unique page views
9.	Number of mentions in the media	Media tracking	None defined	113 news articles; 900 social media mentions

outcomes, the Ministry has been unable to assess whether the outcomes reported by OCI have met any targeted program objectives to provide economic benefits via job creation and innovation (that is, 5G products or services) in Ontario.

For instance, OCI reported to the Ministry that the ENCQOR 5G Program resulted in 63 new products and services developed or launched by SMEs as of December 2020, (as seen in **Figure 6**). OCI also reported that SMEs generated incremental sales revenues of $1.6 million due to the ENCQOR 5G program funding. But because the Agreement did not specify measurable targets, the Ministry is unable to assess whether these are sufficient outcomes to demonstrate that OCI has been successfully and effectively administering the program.

The Ministry originally consulted with the Treasury Board Secretariat to develop the ENCQOR 5G Program performance metrics. It subsequently did not revisit these metrics in the last four years, (since the program began), to confirm that the original nine performance metrics are suitable and have measurable targets for economic benefits to Ontario.

We noted other possible metrics that would be beneficial to include in gauging the overall effectiveness of the ENCQOR 5G Program. For example:

- track job creation and job retention separately, in order to measure jobs that are created as a direct result of the Ontario funding; and
- establish the number of hours that SMEs that receive funding should use the test platforms.

4.2.2 Program Outcomes Not Verified for Accuracy Before Reporting Them to the Ministry

Four out of nine performance metrics have defined targets and are reported to the Ministry on an annual basis by OCI. As part of this annual reporting process, OCI prepares and consolidates the performance reports using the data it collects from technology vendors, innovation hubs and SMEs. In addition, OCI reports on detailed project costs and status to the Ministry on a semi-annual basis. However, we noted that OCI does not always verify the project outcome data reported by the program participants. As a result, the Ministry may not have complete and accurate data as required for effective monitoring of overall ENCQOR 5G program progress.

We also found that SMEs' economic outcome reports to OCI and the Ministry, as of December 2020, provided limited outcome data. For example, OCI's annual outcome report to the Ministry for the period May 2019 to December 2020 is based on 35 completed projects even though there was a total of 62 projects completed as of December 2020. (Refer to **Figure 7** for a breakdown of the results of these 35 completed projects.) As per program guidelines, SMEs are required to submit their project outcome reports to OCI within 30 days of their project completion date. Only 35 SMEs submitted final outcome reports. OCI is responsible for following up on reports that are past due for more than 30 days. However, OCI did not follow

Figure 7: ENCQOR 5G Program Stream Completion Status as of December 2020

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation data

	Number of Projects			
Program Streams	In Progress	Closed – Outcome Reports Provided Within 30 days	Closed – Outcome Reports Not Provided	Total
SME Technology Development	15	–	–	15
Academia Technology Development	22	–	–	22
Demonstration	79	6	23	108
Talent Edge Internship	34	4	4	42
iPaaS Access to Test Platform	94	25	–	119
Total	**244**	**35**	**27**	**306**

up and obtain the outstanding reports for 44% of the 62 completed projects. The outcome results for performance metrics therefore do not include these 27 projects. **Figure 7** shows the status of projects, by program stream. We inquired directly with three program participants who told us that they opted to cancel their projects and not participate in the program. However, OCI had identified these SMEs as part of the completed projects awaiting final outcome reports.

Effective project oversight practices suggest that initial performance measures and targets should be established, reviewed and revisited periodically, to provide insights for decision-making and to avoid project failures. The Ministry indicated that an assessment to evaluate the overall effectiveness of the program will be performed after the program ends in March 2022.

4.2.3 Transfer Payment Agreement Lacks Clarity for Key Program Outcomes

One of the key intended outcomes of the program is to provide economic benefits to Ontario via job creation, retention and innovation. We found the Agreement between the Ministry and OCI is unclear with respect to jobs to be created or retained by program participants. The agreement established that the program would create or retain approximately 3,000 jobs; however, the agreement does not clarify whether these jobs were to come from the SMEs or the technology vendors that built the test platform. As of December 2020, the three technology vendors that received a total of $56.9 million from the overall program budget of $66.7 million to research, design, build and operate the test platform reported that 1,912 jobs were established or maintained. In addition, SMEs that were allocated $4.2 million from the overall program budget of $66.7 million to develop 5G products, secure funding and create new jobs reported 320 jobs had been created or retained by program participants, based on reports received from 35 completed projects. The remaining $5.6 million was allocated towards OCI for program delivery and physical locations where the test platforms are housed.

Of the 320 jobs reported by SMEs, we found that OCI relied on self-reported information from SMEs without performing its own check or verification. Our review of the 320 reported jobs that were created or retained found that 188 jobs were created or retained at a single SME (SME A). This SME reported 188 jobs created or retained in an outcome report provided to OCI upon its project completion. However, the same SME also reported to OCI, in its final project report, that zero jobs had been created or retained. OCI did not identify any discrepancy between these two reports and did not verify whether either total was correct.

In addition to the above-noted reporting discrepancy, we also inquired directly with a number of the SMEs that completed their projects, and one informed us that it had not created any new jobs. However, OCI had incorrectly reported to the Ministry that this SME had created two new jobs as a direct result of the program participation. We also noted the Ministry does not require OCI to report job creation and job retention separately, a metric approved by the Treasury Board Secretariat and used widely throughout government. Consequently, the Ministry is unable to assess the number of jobs that were actually created as a direct result of the funding, versus whether the funding went to sustain existing jobs. It is unclear whether such funding would have been needed to retain jobs.

4.2.4 Future of ENCQOR 5G Program is Uncertain

The ENCQOR 5G Program is set to end in March 2022. In October 2021, we inquired about the future of the program and received no definitive information regarding a possible extension of the program or how the program will wind down in the event that it is not renewed. The Ministry told us it has not yet reached a decision.

In addition, the Ministry does not have a strategy or a plan for how to decommission the test platforms

and to determine who is accountable for any decommissioning costs and ownership of the intellectual property. The cost of decommissioning has not been assessed yet. Furthermore, we noted that the Transfer Payment Agreement is silent on this matter and does not clearly stipulate a decommissioning/sunset process for the program.

RECOMMENDATION 2

To improve the oversight of future funded programs that could bring economic benefits to Ontario, we recommend that the Ministry of Economic Development, Job Creation and Trade (Ministry):

- establish measurable project performance metrics and targets in Transfer Agreements to use to conduct monitoring for economic benefits to Ontario throughout a project lifecycle;
- ensure the Ontario Centre of Innovation performs a comprehensive due-diligence on outcome data before it reports the information to the Ministry; and
- develop and implement an exit strategy that includes decommissioning of the test platforms, along with the associated cost and ownership of the intellectual property.

RESPONSE FROM MINISTRY OF ECONOMIC DEVELOPMENT, JOB CREATION AND TRADE

The Ministry of Economic Development, Job Creation and Trade (Ministry) agrees with this recommendation and is committed to continuing to make improvements to its programs and funding agreements to ensure that oversight is strengthened and that maximum economic benefits in Ontario can be achieved.

The Ministry also acknowledges requirements and best practices for oversight set forth in the Transfer Payment Operational Policy established under the Transfer Payment Accountability Directive.

The Ministry specifically notes the Auditor General's recommendations to be incorporated into future funded programs where applicable to:

- establish measurable project performance metrics and targets where feasible;
- ensure appropriate due diligence is performed on outcome data; and
- develop and implement an exit strategy that ensures the responsible decommissioning of any associated infrastructure, programming or intellectual property ownership, and supports the programs' delivery partners and end users through to contract termination.

RECOMMENDATION 3

In the event that the existing ENCQOR 5G program is extended after March 2022, we recommend that the Ministry of Economic Development, Job Creation and Trade (Ministry) update the existing Transfer Payment Agreement between the Ministry and the Ontario Centre of Innovation to include clear and concise measurable targets for all performance metrics.

RESPONSE FROM MINISTRY OF ECONOMIC DEVELPOMENT, JOB CREATION AND TRADE

The Ministry of Economic Development, Job Creation and Trade (Ministry) agrees with this recommendation. As of November 2021, there is no decision on the extension or continuation of a 5G-access program beyond the current March 2022 program end date. Following the approval of Treasury Board / Management Board of Cabinet, the program would require a new Transfer Payment Agreement. Given the advanced nature of the industry and the technologies involved, it is possible that any new program or extension could be redesigned with a redefined mandate, scope of funding, governance structure, objectives, partners and technologies, in order to best meet the needs of funding recipients and advance the initiative.

Potential program changes in future would impact the Ministry's ability to implement these explicit recommendations based on an assessment of the current state program that is still in progress.

In establishing a new Transfer Payment Agreement, the Ministry would address the Auditor General's recommendations on performance metrics in line with future program objectives by:

- including measurable targets for established performance metrics;
- considering additional performance metrics;
- performing reviews throughout the life of the project, including at interim and final stages; and
- regularly monitoring program outcomes against established metrics and targets.

4.3 OCI's Budgeting and Fund Allocation Process Requires Improvement to Efficiently Allocate Program Funds and Ensure Only Eligible Expenses are Approved

As per the Agreement between the Ministry and OCI, $4.2 million (6% of the total Ontario funding) is allocated for SMEs to cover eligible project costs incurred while participating in the ENCQOR 5G Program. Eligible project costs include direct labour, sub-contractors, direct materials, IT equipment, travel, and other direct costs. See **Appendix 5** for a detailed list of eligible and ineligible project costs.

We noted that OCI's existing fund and budgeting process for the allocation of program funds requires improvement to ensure it meets the enrolment targets defined in the Agreement and so that ineligible expenses that are already allocated are not approved and reimbursed.

4.3.1 ENCQOR 5G Program Design Did Not Enrol Targeted Ontario Small- and Medium-sized Enterprises (SMEs) as Intended by The Ministry

From the Agreement, we noted that the majority of the funding, 86% of the total grant ($56.9 million), went to the two technology vendors, Ericsson and Ciena, to research, design, build and implement the test platforms, as shown in the **Figure 8.** Only 14% of the total grant ($9.8 million) was allocated to support program streams for SMEs and academia to make use of the test platforms, with technical and business supports. However, OCI did not allocate the funds to participants according to a comprehensive rationale.

The ENCQOR 5G Program remains unable to enrol more SMEs and meet its intended target for participants because OCI has already allocated all available funds. Instead, at that time of the audit, any new program participants were enrolled into the non-funded program stream. Refer to **Figure 9** and **Figure 10** for the Ontario budget along with the Ministry's project target and OCI outcome for each program stream. Under the Academia and SME

Figure 8: Ontario Funds Allocation by ENCQOR 5G Program Activity, March 2017

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data

5G Program Activity	Budget Grant Contribution ($ million)	Portion of Total Grant Disbursed (%)
Research, design, develop and operate ENCQOR 5G test platforms by Technology Vendors (Ericsson and Ciena)	56.9	86
ENCQOR 5G Program Streams	4.2	6
Host test platforms and provide business services by Innovation Hubs	4.1	6
OCI operating cost, management and administration	1.5	2
Total	**66.7**	**100**

Figure 9: ENCQOR 5G Program Ontario Budget Allocation, June 2021

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data

5G Project Stream	Ministry Budget ($ millions)	Allocation by OCI ($ millions)	% of Budget Allocated
SME Technology Development	2.5	2.17	87
Academia Technology Development	1.0	1.04	104
Demonstration[1]	–	–	–
Talent Edge Program[2]	1.75	1.75	100
Total	**5.25**	**4.96**	**94**

1. Supported by the federal government funding ($10 million).
2. Combination of Ontario Grant ($0.7 million) and Technology Vendors' contribution ($1.05 million).

Figure 10: ENCQOR 5G Programs, Projected and Actual, as of June 2021

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data

5G Project Stream	Target Projects by the Ministry (as per Transfer Payment Agreement)	Actual Projects Approved by OCI	% of Target	Weighted Avg # of SMEs[3]
Funded Program Streams				
SME Technology Development	30	16	53	11
Academia Technology Development	50	23	46	19
Demonstration	200	187	94	162
Talent Edge Program	58[1]	56	97	30
Sub-total	**338**	**282**	**83**	**222**
Unfunded Program Stream				
iPaaS Access to Test Platform	n/a[2]	119	n/a	105
Total	**n/a**	**401**	**n/a**	**327**

1. Internship units (175 units per Transfer Payment Agreement) converted to number of projects using an average internship unit (3 units) per project. Does not require use of test platform.
2. The Ministry did not define a target for the iPaaS Access Program Stream.
3. Since an SME can apply to more than one program stream, we took the weighted average number of applications per stream. For example, if an SME was applying to both Demonstration and Talent Edge program streams, they were counted as 0.5 SME for each program stream.

Technology Development program streams, OCI allocated 92% of the available funds ($3.2 million out of the $3.5 million Ontario budget) to the 39 project applications, even though it had a goal to enrol approximately 80 projects.

Moreover, OCI funded the initial applicants heavily. We calculated that program participants in the SME Technology Development program stream were approved for an average of $133,000 per project, near the maximum per project funding of $167,000. From a total of 16 projects within this program stream, we noted that 13 projects were allocated funds near the maximum amount possible. If the budget had been allocated more evenly, more SMEs could have been enrolled.

Sometimes additional funds were provided to the same SMEs under the same or different program streams, rather than providing the funding opportunity to a new eligible participant. For example, of the 16 approved projects in the SME Technology Development stream, two approved projects (funded with $332,000 of Ontario funding; $996,000 overall) belonged to the same SME.

4.3.2 OCI Did Not Establish a Compensation Limit for All Salary Cost Reimbursement, Resulting in Inconsistent Allocation of Funds

Based on the funding agreement entered into between OCI and SME participants, the maximum salary that can be claimed by SME executives is $5,000 per month, for roles such as a founder or Chief Executive Officer. Our audit found that there were 14 SME executives who applied to the program as regular employees instead of identifying themselves as executives and requested more money than the maximum limit for executives. These 14 executives were allocated a total of $180,000 of excess pay above the maximum allowed. For example, SME B was approved for a total budget of $467,000 under the SME Technology Development program stream. As part of the application process, the founder of the company identified themselves as an "IT architect," and was approved for a monthly compensation of $6,800, for a total of $68,000 over 10 months.

In another example, SME C was approved for a total budget of $235,000 under the SME Technology Development program stream. In this case, the founder of the company identified themselves as a "Senior Technical SME" on the application and was approved for a monthly compensation of $15,000, which is three times the program limit for executives. The SME was approved for excess payments of $60,000 over six months.

Also, OCI does not set a cap on the salary amount that can be claimed for non-executive SME employees who apply for funding. Employees performing similar job roles were approved for very different salary amounts. For example, we noted one software developer employed with SME D has a monthly salary allocation of $10,000 whereas another software developer employed with SME E was allocated approximately $5,600 per month for the same job function and duration. In another case, we observed that a data scientist at SME F working on two separate projects over the same time period was approved different monthly wages for each ($8,400 and $2,800).

4.3.3 Majority of ENCQOR 5G SME Funds Were Allocated for Salaries and Wages, Sometimes Without SMEs Even Using the Test Platform

As noted in **Section 4.3.1**, OCI is unable to enrol more SMEs to the ENCQOR 5G Program since it has allocated nearly all available funds. OCI established an expense policy that outlines project costs such as salaries, IT equipment, and other project-related costs. However, OCI did not establish a budget threshold for each of the project expense categories. We obtained a list of all approved projects along with their associated project costs across all program streams funded by both Ontario and the federal government. We noted that SMEs had requested a large majority of their project costs to cover salaries and wages. From a total of 226 projects, 89% of project costs reimbursed were for salaries and wages, 6% was for the purchase of 5G-related hardware equipment and 5% was proposed for other costs such as travel and utility expenses.

We further noted that 139 (representing 62% of completed projects) of the 226 projects budgeted 100% of their funding for salaries and wages; 137 of these projects are in the Demonstration program stream. We reviewed these 137 projects to assess the amount of time they spent using the test platform. Since they began last year, 25 of them have never used the test platform. For the remaining 52 of 137 projects that were started before 2021, SMEs had spent an average of 11 hours on the test platform. For further details about low platform usage, please refer to **Section 4.4.**

4.3.4 5G-related IT Equipment Is Not Being Competitively Procured by SMEs

OCI is subject to the Broader Public Sector (BPS) procurement directive which recommends that entities competitively procure contracts by publicly advertising for services required and by obtaining at least three quotes from independent vendors. We noted that OCI does not ensure that the ENCQOR 5G SMEs that are recipients of Ontario funds procure IT-related

equipment such as software or hardware using a competitive procurement process.

We reviewed the funding agreement between the SMEs and OCI meant to outline project costs and an itemized list of IT equipment that an SME intends to purchase as part of its project. We noted seven projects had each budgeted for a total of $261,000 to procure hardware and software equipment. In one case, SME G submitted a claim of $30,000 to purchase hardware equipment related to a battery-energy storage system without multiple quotes to purchase the equipment at a competitive price.

In another example, we noted that OCI approved funding to SME F for $61,000 to procure a cloud-based software that was not competitively procured. We noted the same software could have been obtained for free through the ENCQOR 5G Program.

4.3.5 Ineligible Expenses Are Being Approved by OCI

OCI did not review the budgets submitted by SMEs as part of their applications to assess whether they included ineligible expenses. We noted that OCI had allocated ineligible expenses that were budgeted by SMEs, such as medical insurance, Employment Insurance and contributions to the Canada Pension Plan. SMEs had also incorporated their office operational costs, such as office rent, Internet connection, and software licences (not related to 5G projects) within their budgets, something that is disallowed for the Ontario portion of the program funds but was approved by OCI.

We reviewed the program applications and the related budgets that were allocated by OCI for all approved applications. From our sample, we noted the following situations where ineligible expenses had been allocated by OCI:

- SMEs had allocated funds for project costs such as office space rental, Internet access and travel to non-ENCQOR 5G locations, all of which is not covered under the ENCQOR 5G expense policy for Ontario funds;
- SME H under the Academia Technology Program Stream had budgeted about 25% or $22,000 of its total project cost to attend conferences;
- SME I and SME J had budgeted a total of $10,000 to attending conferences to present to private audiences, not explicitly related to their 5G projects;
- eight projects that were allocated funding by OCI included a total of $23,000 to publish research papers, something that is not covered under the ENCQOR 5G expense policy;
- SME K recorded $107,000 in salaries and wages in the “other direct costs” category instead of the “direct labour” category, as required under the expense policy, resulting in incorrect classification of project funds; and
- SME F budgeted expenses such as benefits, Employment Insurance, Canadian Pension Plan and medical insurance that were paid out as part of the $25,000 as of March 2021.

4.3.6 Some Approved and Funded Projects Did Not Require 5G Technology

A key criterion for eligibility in the ENCQOR 5G Program is that an applicant’s project ideas or proof of concept must demonstrate the need for a 5G network. From 187 projects in the Demonstration program stream, we reviewed a sample of 20 projects to determine how they would benefit from 5G technology. Of the 20 Demonstration stream projects reviewed, we noted that three projects would not benefit from the use of the 5G test platform.

For example, SME L was approved funding of $50,000 to develop an automated student enrolment and tuition payment system for schools and daycare providers. This project is similar to any website that is used to submit online application forms and collect payments, such as the Service Ontario website. The program application stated that the SME wanted to use a 5G test platform to test its project on a high-speed network. However, commercial websites offering similar features currently perform well on 4G networks. Thus, this applicant did not justify why access to the test platform was required. In

addition, despite requesting to use the test platform for 15 hours, it ended up using the test platform for only four hours. As of September 2021, this SME had nonetheless received the full payment of $50,000 as requested.

In another example, SME M submitted an application to use the test platform to develop a product that remotely monitors grids such as oil fields and power plants, similar to a smart thermostat commonly used in homes. The application did not indicate how the attributes of the 5G network, such as faster response time, would apply to this project. Furthermore, the project description lacked clear criteria for its intended use of the test platform. Such testing can, in fact, be performed outside of a 5G network. As of August 2021, this project had not accessed the test platform at all, yet was approved $50,000.

In a third example, we identified SME N, which is developing a new form of lithium battery that was said could power a 5G cellular network. The SME planned to test its new battery by attempting to power up 5G equipment at the test platform. It is unclear why this test would be required to be conducted on a 5G test platform, compared to bench testing the battery at its local office. As of August 2021, this project did not access the test platform at all, yet was approved for $50,000.

4.3.7 ENCQOR 5G Program Lacks Conflict of Interest Policy

As discussed in **Section 2.3**, SME applications for Demonstration and Talent Edge Internship streams are reviewed by reviewers on an independent panel known as the College of Reviewers. The College of Reviewers is a group of 26 industry and academia professionals who are experts in 5G and related technologies. Reviewers were selected by OCI via an open application process and a review of their professional and technical credentials.

We noted that OCI does not have a formal policy or a process to identify potential conflicts of interest among reviewers and SME applicants to the ENCQOR 5G Program. One individual, who had been working as a reviewer for the program, subsequently also applied for funding from two ENCQOR 5G Program streams and was approved for a total of $80,000. The individual's application was reviewed by someone other than themselves. However, as the program has no conflict of interest policy, this individual was able to apply with insider knowledge of how applicants are scored. This individual used the test platform for only 4.5 hours over the course of 13 months (April 2020 – May 2021).

RECOMMENDATION 4

In order for the Ontario Centre of Innovation (OCI) to effectively ensure the proper management of funds allocations to small- and medium-sized enterprises (SMEs) for existing and future Ontario government-funded programs, we recommend that OCI:

- update the existing process for the allocation of funds that includes consistent salary allocation and compensation limits for all employees at SMEs that receive government funds;
- establish consistent criteria for the allocation of program funds between different expense categories;
- extend the procurement guidelines to SMEs that are using Ontario funds to procure equipment;
- establish a comprehensive verification process to ensure SMEs enrolled in the program and are allocating funds towards eligible project costs only; and
- implement and enforce a conflict of interest policy so that OCI is able to effectively oversee and monitor compliance and perceived conflicts and obtain declarations of independence where applicable.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with the recommendation that improvements will

be made in the initial project budget allocation of expenses to ensure there are no opportunity costs associated with allocating an SME a budget that will ultimately not be paid in the future. OCI will undertake a review of its processes, keeping in mind that the benefits of implementing a robust upfront review should outweigh the cost of implementation. In addition, OCI will examine the benefits of conducting a process similar to the current one when reviewing claims

OCI will reinforce the procurement guidelines to program participants to procure equipment competitively. OCI will undertake a review of its conflict of interest policy for reviewers and endeavour to ensure the policy covers both direct and perceived conflicts of interest. In addition, OCI will review its process to ensure there is clear attention from all relevant parties that there is no conflict of interest.

4.4 Low Usage of the ENCQOR 5G Test Platforms

The technology vendors that are responsible for managing the day-to-day operations of the test platforms track their overall utilization by SMEs. The tracking attaches to project identification numbers that are assigned to each project and provides information about the amount of time an SME is spending on the test platform, along with the project details, date of use, and which test platform is used. The majority of the ENCQOR 5G Program funding, $56.9 million (86% of total Ontario funds), was paid to Ericsson and Ciena to research, design, build and operate the three test platforms. The remainder ($9.8 million) was earmarked for program participants.

The design of the five ENCQOR 5G program streams required technology vendors to track test platform utilization for only two of the streams, iPaaS Access and the Demonstration program stream. We noted that the technology vendors do not track utilization for Academia and SME Technology Development program streams and the Agreement is unclear about whether this is required.

For the program streams where utilization was tracked, we reviewed utilization reports for the period of April 2019 to August 2021 and found that the time spent by SMEs on the test platforms was significantly low.

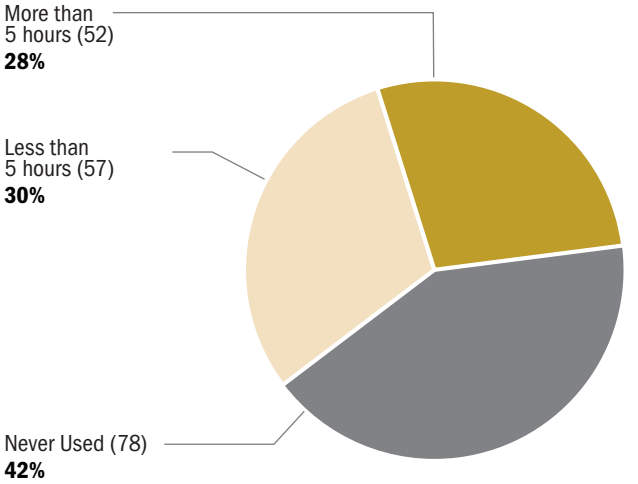
4.4.1 Low Test Platform Use by Demonstration and iPaaS Program Stream Participants

Demonstration Program Stream

As of August 2021, we found that 78 of the 187 projects (42%) in the Demonstration program stream never used the test platform. Of the other 109 projects that did use it, 57 (30%) used it for less than five hours, as of August 2021, for an average of 2.1 hours per project. The remaining 52 (28%) spent an average of 15 hours on the platform. These 187 projects were allocated approximately $10 million in federal funds to design and test their technologies on the 5G platforms. Refer to **Figure 11** for a breakdown of hours spent by SMEs for the program streams where platform usage was tracked.

Figure 11: Number of Hours Spent by SMEs on the 5G Test Platform under the Demonstration Program Stream, as of August 2021

Prepared by the Office of the Auditor General of Ontario using OCI data



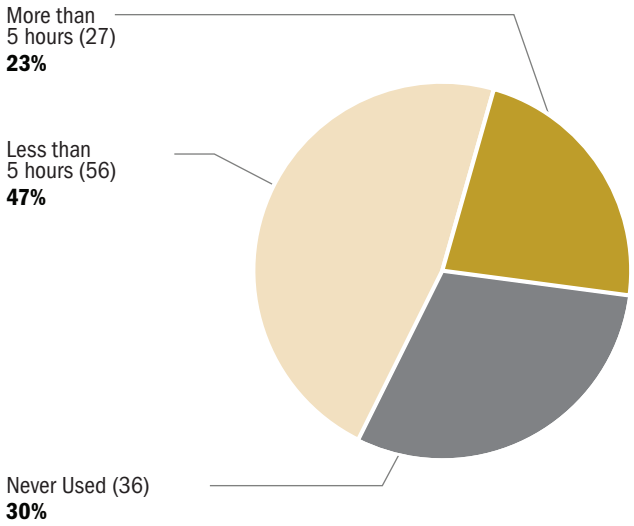
iPaaS Program Stream

For the iPaaS program stream, we determined that 36 of the 119 projects (30%) never used the test platform as of August 2021. Fifty-six projects (47%) used the test platform for less than five hours, at an average of 2.2 hours each. The average use for the remaining 27 projects (23% of 119) was 20 hours per project between April 2019 and August 2021. Refer to **Figure 12** for a breakdown of hours spent by SMEs where the utilization was being tracked.

We noted that OCI did not regularly monitor the platform utilization reports to assess the extent to which SMEs were or were not using the test platforms. Furthermore, as a result of public health measures enacted to stop the COVID-19 pandemic, test platforms were closed for six months. During this time, SMEs', physical access to the test platforms was restricted. As well, the pandemic affected some SMEs' ability to engage or continue with the program, resulting in delays to, or abandonment of, their projects.

Figure 12: Number of Hours Spent by SMEs on the 5G Test Platform under the iPaaS Access Program Stream, as of August 2021

Prepared by the Office of the Auditor General of Ontario using OCI data



4.4.2 Unclear Requirement for Program Participants to Use the Test Platform

While the Agreement between the Ministry and OCI states that SMEs are to develop and test 5G-related technology at a test platform, it however is silent on explicit requirements for usage of the platforms by SMEs. OCI does not set a benchmark for the number of hours an SME could or should use the 5G test platforms, or even that they have to use it all.

Of the five program streams, the Agreement does not explicitly require the two highest Ontario-funded program streams to utilize the test platforms. Neither the Ministry nor OCI requires program participants to use the test platform within the Academia and SME Technology Development program streams, which provide funding of up to $150,000 and $500,000 respectively. OCI only required the technology vendors to track test platform utilization for two of the streams, iPaaS Access and the Demonstration program stream.

4.4.3 Delays in Opening Test Platforms Contributed to Reduced Usage

In March 2017, the ENCQOR 5G Program launched and work began to construct three pre-commercial 5G test platforms. As per agreed-upon timelines between OCI and the technology vendors, the test platforms were located at innovation hubs in Toronto (MaRS District), Ottawa (Invest Ottawa) and Kitchener (Communitech).

Implementation was supposed to have been completed by September 2018, allowing the ENCQOR 5G Program to be operational for another four years. However, the opening of each of the test platforms was delayed up to six months due to contract negotiations between technology vendors and innovation hubs. OCI and the technology vendors were unable to provide us with evidence on the cause of the delays incurred in launching the test platforms. The Ottawa test platform was completed in December 2018, the Kitchener test platform in February 2019, and the Toronto test platform in April 2019.

RECOMMENDATION 5

In order for the Ontario Centre of Innovation (OCI) to ensure the test platforms are being effectively utilized by small- and medium-sized enterprises (SMEs) for innovation and meet the intended economic outcome of the 5G ENCQOR Program, we recommend that OCI:

- establish and quantify the requirement to utilize the test platform by SMEs; and
- implement a periodic monitoring process to identify SMEs with low usage and encourage them to utilize the ENCQOR 5G test platform.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with the recommendation that tracking and utilization of the test platform can be improved. The program is expected to end in March 2022. OCI will perform an analysis to establish and quantify requirements to utilize the test platform for the existing small- and medium-sized enterprises.

RECOMMENDATION 6

In the event that existing ENCQOR 5G Program is extended after the end date of March 2022, we recommend that the Ontario Centre of Innovation and the Ministry update the existing Transfer Payment Agreement to clearly establish requirements to utilize the test platform across all program streams.

RESPONSE FROM THE MINISTRY OF ECONOMIC DEVELOPMENT, JOB CREATION AND TRADE

The Ministry of Economic Development, Job Creation and Trade (Ministry) agrees with this recommendation. As of November 2021, there are no decisions regarding the extension or continuation of a 5G-access program, or its associated test platform infrastructure at this time, but the Ministry is committed to making continuous improvements to future programs.

Should the Ministry have continued oversight of the 5G-access program for small- and medium-sized enterprises (SMEs), it would:

- work with the Ontario Centre of Innovation and other delivery partners to determine requirements based on the needs and expectations of the platform's users (SMEs, academic research community, and industry technology partners);
- review final program metrics and SME utilization data on program completion; and
- leverage insight from the impact study to be carried out at program completion.

Any revisions to program guidelines, eligibility, project milestones and targets would be set based on these assessments, and then tracked on an ongoing basis.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with the recommendation. OCI recognizes the importance of clear language within the Transfer Payment Agreement. OCI will work with the Ministry to ensure there are clear requirements for each program stream to use the test platform, if required by program design.

4.5 The ENCQOR 5G Program Did Not Include Participation From All Industry Sectors

There are 10 main categories under which ENCQOR 5G Program applicants can identify their projects. These 10 categories were developed based on categories used by the Canadian Foundation for Innovation and were adapted for use by OCI.

We obtained a list of all applications across the four funded ENCQOR 5G Program streams and noted that not all industry sectors were represented. Furthermore, we noted that OCI does not

Figure 13: Breakdown of Approved Applications Across the ENCQOR 5G Program Streams

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of InnovationI data

Industry Sector Classification	Demonstration	Talent Edge Internship	Academia Technology Development	SME Technology Development	Total
Industrial Production and Technology	11	78	30	9	128
Health	0	16	8	0	24
Production, Distribution and Rational Utilization of Energy	0	6	2	0	8
Infrastructure and General Planning of Land-use	0	5	2	0	7
Renewable Resource Production and Technology	0	5	0	0	5
Social Structures and Relationships	0	1	2	0	3
Pollution and Protection of the Environment	0	2	0	0	2
Exploration and Exploitation of Space	0	1	0	0	1
Exploration and Exploitation of the Earth	0	1	0	0	1
Other Research*	11	22	10	6	49
Total	**22**	**137**	**54**	**15**	**228**

* Refers to any research that does not belong to one of the 10 categories.

have a review process in place to ensure that there is equal representation, or if not equal, at least reasonable representation, from different industry sectors.

As seen in **Figure 13,** 56% (128 out of 228) of the Demonstration and Talent Edge applications came under the category of "Industrial Production and Technology." The next biggest pool of projects at 21% (49 out of 228) comprised the generic "Other Research" category. The remaining eight categories were represented by 23% (51 out of 228) of the applications.

Within the Academia and SME Technology Development program streams, the two most heavily funded in the program, there is no representation at all in eight of the 10 sector categories. For example, there was no representation for research areas such as infrastructure, renewable energy, or exploration of the earth or space. For the Demonstration and Talent Edge program streams, we found there is representation in all 10 categories, however 73% of projects were concentrated in two categories.

Since the primary goal of the ENCQOR 5G Program is to encourage long-term economic growth in Ontario across the technological ecosystem, sufficient representation from a diversity of industries and sectors would best support this goal.

RECOMMENDATION 7

In order to promote innovation and support technological advancement related to 5G across all industry sectors, we recommend that, should the program be extended, the Ontario Centre of Innovation accept and enrol ENCQOR 5G Program applicants from a diverse range of industry sectors especially from those sectors not well represented in the current pool of participants.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with this recommendation for future program design. The ENCQOR 5G Program was designed to be sector agnostic and did not specify sector representation and/or distribution, given the emerging nature of 5G application areas at the pre-commercial stages

of 5G deployment. Additionally, the primary objective of this program, which was funded under Ontario's Jobs and Prosperity Fund, was job creation and economic growth. If the program is extended, a sector strategy, including setting priority sectors and/or specifying sector representation, will be considered.

4.6 Cybersecurity of the 5G Test Platforms Needs to be Strengthened

Penetration testing is a cybersecurity exercise whereby information technology security experts pretend to be hackers and purposely identify and exploit vulnerabilities within a network. This exercise allows organizations to identify any existing security weaknesses. Vulnerabilities can allow a severe cyberattack where hackers could run malicious code, install viruses, or steal sensitive or confidential data, including information that compromises intellectual property. According to industry best practices, penetration tests should be performed at least annually, and whenever there is a major change to IT systems. By having an ongoing process to detect any vulnerabilities to their IT systems, organizations can remediate those system vulnerabilities before hackers can exploit them.

5G Test Platforms

We reviewed cybersecurity controls, such as vulnerability scans and penetration tests, the protection of data using encryption, access controls and the disposal of program participants, intellectual proprietary data, to ensure cybersecurity vulnerabilities are being identified on an ongoing basis and remediated.

As well, we performed our own penetration test of the ENCQOR 5G network and identified cybersecurity weaknesses that were remediated immediately upon communication of our findings to the technology vendors. In addition, we identified opportunities for improvement related to better recordkeeping and tracking of IT incidents and the deletion of program participants' data.

Due to the nature of cybersecurity, and so as to minimize the risk of exposure for ENCQOR participants, we provided relevant details of our findings and recommendations directly to the technology vendors for immediate remediation. The technology vendors were in agreement with the recommendations and have provided a management response to us and OCI.

RECOMMENDATION 8

We have provided relevant details of our cybersecurity findings on the 5G test platform to the technology vendors, who have agreed with our observations and recommendations.

RESPONSE FROM TECHNOLOGY VENDORS

As technology partners in this program, we would like to thank the Auditor General for reviewing the vitally important cybersecurity aspects and controls we have put in place in this experimental testbed. The collaboration and exchange of information are appreciated. Furthermore, we agree with the specific observations shared with our teams and have since acted upon the recommendations.

4.7 OCI Management of IT Vendors Requires Improvement

OCI outsources the management of its own IT environment—including hardware and software support services, helpdesk support, cybersecurity defence—to the vendor Nuvollo. Likewise, OCI relies on another vendor, SmartSimple, for management of a critical IT system for SMEs to submit their ENCQOR 5G Program applications. This system stores confidential SME data such as company profile, employee qualifications and pay stubs with Social Insurance Numbers. Our audit found that OCI's oversight of its critical IT providers needs improvement.

Cybersecurity of IT Systems

Our audit found that both Nuvollo and SmartSimple have not performed penetration testing of OCI's IT environment and systems to identify cybersecurity weaknesses since they were procured by OCI in 2019 and 2005 respectively.

IT Service Level Agreements

OCI has established Service Level Agreements (SLAs) with its vendors Nuvollo and SmartSimple, outlining the expected level of service for day-to-day operations. However, it does not obtain the SLA reports to assess whether these vendors are providing IT services as per the established agreements. We noted that OCI has paid Nuvollo approximately $450,000 since it began procuring the company's services (April 2018 – December 2020). SmartSimple has been in use by OCI since 2005, and in the period from January 2016 – December 2020 (most recent data available), OCI paid SmartSimple approximately $200,000.

Procurement of IT Vendors

We also noted that for both of these IT vendors, the procurement process lacked adequate oversight since the decisions and related approvals were not obtained from OCI's senior management and its Board of Directors or any other subcommittee. Upon review of the Service Level Agreements, we found that OCI has not incorporated a "right to audit" or penalty clauses, thereby limiting its oversight of the services being provided and limiting its ability to hold these vendors accountable for missed performance targets.

OCI's Review of Vendor Audit Reports

OCI has not reviewed the vendor audit reports that are issued by its vendors' external auditors and that identify any system weaknesses or risks to IT operations. We obtained these reports and discovered that they do identify weaknesses such as vulnerability scans not being performed, inappropriate access to privileged accounts, user access review, weak password controls, inadequate firewall review and data encryption for key IT systems. Without reviewing or acting on this information, OCI does not have sufficient assurance over the data security operations of its critical IT systems.

RECOMMENDATION 9

To better protect confidential data and minimize the risks from cyberattacks, we recommend that the agreements with the Ontario Centre of Innovation's (OCI's) IT vendors be amended to incorporate the requirement to perform penetration testing of OCI's IT systems according to industry best practices.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with the recommendation that OCI's IT system needs improvement. OCI, on a cost-benefit basis, will embark on a review of the existing IT infrastructure and ensure that it meets best practices where applicable and justifiable. OCI will amend the agreement with IT vendors to incorporate requirements to perform penetration testing of OCI's IT systems.

RECOMMENDATION 10

To improve the effectiveness of IT contracts and the oversight of IT operations at the Ontario Centre of Innovation (OCI), we recommend that OCI:

- review performance metrics such as incident resolution time within the service level agreements for OCI's IT vendors;
- have adequate oversight over the procurement process that impacts critical business operations such as outsourcing of the IT function by obtaining approvals from the relevant stakeholders such as OCI's Board of Directors;
- amend existing contracts with OCI's IT vendors to include a "right to audit" and penalty

clauses, and periodically review the performance metrics established in the Service Level Agreement; and

- establish a process to obtain and review external audit reports to identify IT security risks, and to confirm that corrective action has been taken.

RESPONSE FROM THE ONTARIO CENTRE OF INNOVATION

The Ontario Centre of Innovation (OCI) agrees with the recommendation. OCI, on renewal of existing IT provider agreements, will implement a "right to audit" and penalty clause. OCI will ensure that there is a greater emphasis on the review and documentation of the performance of these vendors including a review of performance metrics in the Service Level Agreement. Furthermore, OCI will implement a policy to review audit reports of our IT vendors and take corrective action as needed to safeguard our IT systems.

OCI agrees with the recommendation to update its procurement policy. During the audit, OCI modified and updated the procurement policy. Our board has reviewed and approved our revised policy.

Appendix 1: Overview of ENCQOR 5G Program Streams

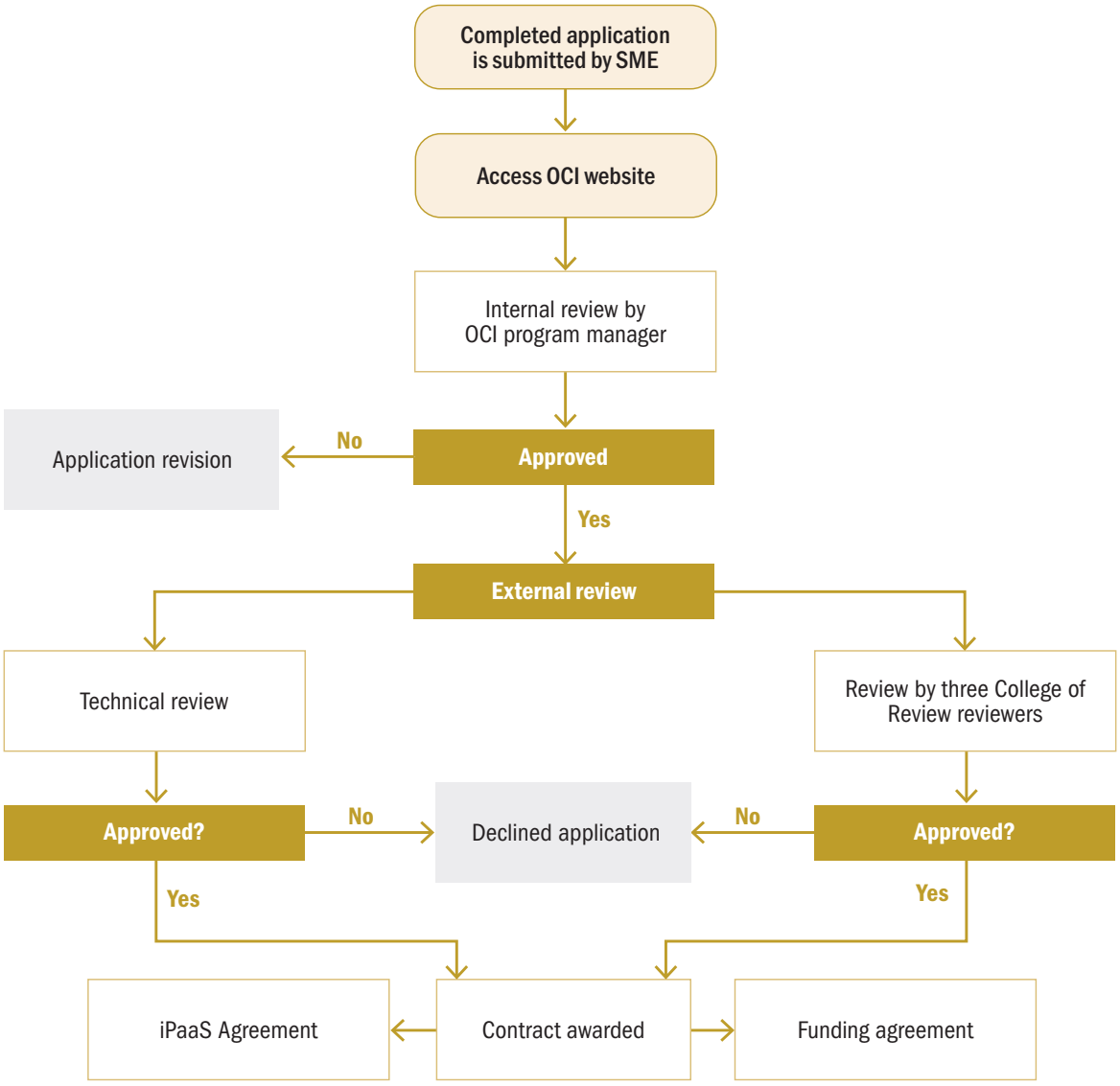
Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data

Program Stream	SME Technology Development	Academia Technology Development	Demonstration Program (only federal funding)	Talent Edge Internship	iPaaS Access
Duration (months)	12-24	12-24	Up to 12	4, 8 or 12	Up to 12
Target SMEs (# of projects)	30	50	200	58	No Limit
SMEs Enrolled (# of projects)*	16	23	187	56	119
Funding for eligible project expenditures ($)	50,000 to 500,000	50,000 to 150,000	50,000	10,000 to 60,000	No funding provided
Technology Vendors Approval	Yes	Yes	Yes	Yes	Yes
College of Reviewers	No	No	Yes	Yes	No
OCI Internal Review Panel	Yes	Yes	No	No	No
Challenge Statements	Yes	Yes	No	No	No
Reporting timelines (at specific month)	3, 6, 12, 18, project end	3, 6, 12, 18, project end	3, 6, 12 or project end	Project end	Project end
Types of reports	• Interim • Progress • Claim • Final • Project Metrics • Retrospective Survey • Project Changes	• Interim • Progress • Claim • Final • Project Metrics • Retrospective Survey • Project Changes	• Interim • Progress • Claim • Final • Project Metrics • Retrospective Survey • Project Changes	• Final • Retrospective Survey • Project Changes	• Retrospective Survey

* Number as of June 2021.

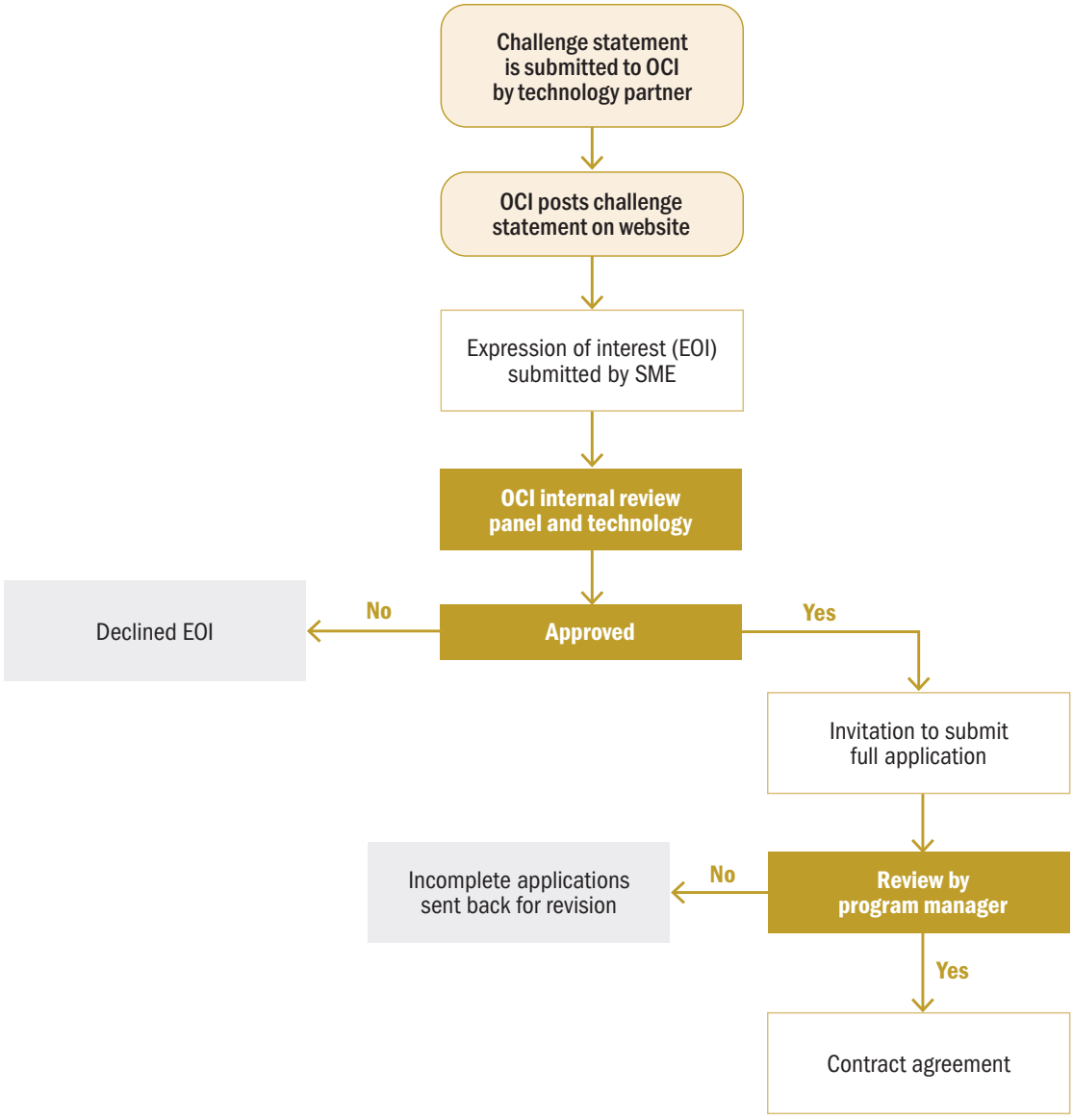
Appendix 2: ENCQOR 5G Program Stream Onboarding Process Flow – iPaaS Access, Demonstration and Talent Edge Internship Program Streams

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data



Appendix 3: ENCQOR 5G Program Stream Onboarding Process Flow – SME and Academia Technology Development Program Streams

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data



Appendix 4: Audit Criteria

Prepared by the Office of the Auditor General of Ontario

Ministry of Government and Consumer Services
1. Effective governance, transparency and accountability with clear roles and responsibilities at all levels of government are in place to oversee preparedness of 5G deployment with an overall strategy that encompasses privacy, security and ownership of data and intellectual property.
2. Appropriate legislation, regulations and policies are in place to secure the privacy of data, personal information and intellectual property.
Ministry of Economic Development, Job Creation and Trade (Ministry)
1. Effective governance, transparency and accountability is in place for the Ministry to oversee the Ontario Centre of Innovation in its 5G-related pre-commercial initiatives.
2. Regular monitoring is in place that ensures the Memorandum of Understanding and Transfer Payment Agreements are being adhered to and evaluated against appropriate performance metrics.
Ontario Centre of Innovation
1. Effective governance, transparency and accountability is in place for the Ontario Centre of Innovation to oversee the 5G-related pre-commercial initiatives.
2. Effective processes and procedures are in place for the Ontario Centre of Innovation to oversee SMEs of pre-commercial 5G programs based on an evaluation criterion and monitor them in accordance with applicable legislation, directives and agreements.
3. Privacy and security controls are in place to safeguard data and to preserve personal control on data subjects relating to use and disclosure of personal information, intellectual property, proof of concept against accidental disclosure and cybersecurity threats.

Appendix 5: ENCQOR 5G Program – OCI's Eligible Expenses Guidelines

Prepared by the Office of the Auditor General of Ontario using Ontario Centre of Innovation (OCI) data

Eligible Expenses	Ineligible Expenses
Direct Labour	
• The costs of the portion of gross wages or salaries incurred for work that can be specifically identified and measured as having been incurred in the performance of the Project to a maximum specified in the funding agreement with OCI (specify position and employment status). **Additional Limits & Conditions:** • Direct Labour must only be claimed in proportion to the amount of time spent working directly on Project activities. • The Applicant shall be required to maintain timesheets or appropriate records for all employees working directly on the project.	• Costs related to proposal development (including staff); • Indirect labour; • Fringe benefits; and • General and administrative expenses including, but not limited to, the remuneration of executive and corporate officers, general office wages and salaries, clerical expenses related to the administration and management of the Project, such as processing claims and reporting, and expenses such as stationery, office supplies, postage and other necessary administration and management expenses.
Sub-Contractors	
• The costs of subcontracts or consultants incurred for work or services which can be specifically identified and measured as having been incurred in the performance of the Project. • Sub-contractor and consultant fees must be approved by OCI management prior to the start of the project and if procured in accordance with the BPSAA Procurement Directive.	• Item included in "Overhead." • See Ineligible Expenses under "Other Direct Costs."
Direct Materials	
• Materials purchased solely for the performance of the Project and processed by the Applicant, or obtained from sub-contractors, any materials issued from the general stocks of the Applicant solely for the performance of the Project; • Materials purchased solely for the performance of the Project must be charged to the Project at the net laid down cost to the Applicant; and • Materials issued from the general stocks of the Applicant must be charged to the Project in accordance with the method as used consistently by the Recipient in pricing its material inventories.	• Item included in "Overhead." • See Ineligible Expenses under "Other Direct Costs."
Regular Equipment	
• The costs of equipment, including, but not limited to, ancillary systems, instrumentation, or special test equipment that is purchased, leased, manufactured or otherwise acquired for the purposes of the Project. **Regular Equipment includes:** • Cost of usage of equipment (up to maximum 20% of the project cost); • Project-related computer hardware and software, including specialized hardware and software.	• Full purchase price of equipment with a useful life longer than the length of the Project, and; • Federal and provincial goods and services taxes.

Eligible Expenses	Ineligible Expenses
Travel	
• Travel expenses are explicitly project-related, represent the most economical option (economy fare, and standard hotel room).	• Meals and incidental expenses; • Reimbursement for airfare purchased with personal frequent-flyer points programs; • Commuting costs between residence and place of employment, and; • Passport and immigration fees.
Travel	
• Costs not falling within the definitions of Direct Labour Costs or Direct Materials Costs, but which can be specifically identified and measured as having been incurred in the performance of Project Activities.	• Costs not directly associated with meeting the deliverables and milestones as specified in the funding agreement with OCI; • Expenses of a personal nature; • Costs related to staff awards and recognition; • Monthly parking fees; • Costs of moving; • Expenses associated with lobbying or government relations activities; • Allowance for interest on invested capital, bonds, debentures, bank or other loans together with related bond discounts and finance charges; • Legal, accounting and consulting fees in connection with financial reorganization, security issues, capital stock issues, obtaining of licences and prosecution of claims; • Losses on investments, bad debts and expenses for the collection charges; • Losses on other projects or contracts; • Federal and provincial income taxes, goods and services taxes, excess profit taxes or surtaxes and/or special expenses in connection with those taxes; • Provisions for contingencies; • Premiums for life insurance on the lives of officers and/or directors where proceeds accrue to the Recipient; • Amortization of unrealized appreciation of assets; • Fines and penalties; • Unreasonable compensation for officers and employees; • Product development or improvement expenses not associated with the work being performed under the Project; • Advertising, except reasonable advertising of an industrial or institutional character placed in trade, technical or professional journals for the dissemination of information for the industry or institution; • Meals and entertainment expenses, gifts and alcoholic beverages; • Donations; • Dues and other memberships other than regular trade and professional associations; • Extraordinary or abnormal fees for professional advice regarding technical, administrative, or accounting matters; and • Selling and marketing expenses associated with the products or services or both being developed.

Eligible Expenses	Ineligible Expenses
Overhead (Applicable to Federal Funding Only)	
• Indirect materials and supplies (including but not limited to, supplies of low-value, high-usage items that meet the definition of Direct Material Costs but for which it is commercially unreasonable, in the context of the Project, to account for their costs in the manner prescribed for Direct Costs); • Indirect labour; • Fringe benefits; • Public utilities expenses of a general nature including, but not limited to, power, HVAC, lighting, and the operation and maintenance of general assets and facilities; • Expenses such as property taxes, facilities and office rentals and depreciation costs; • General and administrative expenses including, but not limited to, the remuneration of executive and corporate officers, general office wages and salaries, clerical; and • Expenses related to the administration and management of the project, such as processing claims and reporting, and expenses such as stationery, office supplies, postage and other necessary administration and management expenses.	

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ISSN 1911-7078 (Online)
ISBN 978-1-4868-5658-9
(PDF, 2021 ed.)