



Proposal for

# Market Driven Strategy for Canada's First 10 Gig Smart City

March 2019



Submitted to **City of Clarence-Rockland**

Submitted by



in association with **JACOBS** **NOKIA**



1565 Carling Avenue, Suite 200  
Ottawa, Ontario K1Z 8R1  
T 613.723.8700  
F 613.723.7489  
[www.jacobs.com](http://www.jacobs.com)

245 Consumers Road, Suite 400  
Toronto, ON M2J 1R3 Canada  
T 416.499.9000  
T 416.499.4687  
[www.jacobs.com](http://www.jacobs.com)



March 26, 2019

Helen Collier, Chief Administrative Officer  
Corporation of the City of Clarence-Rockland  
1560 Laurier Street  
Rockland, Ontario K4K 1P7

**Subject: City of Clarence-Rockland, Market Driven Strategy for Canada's First 10 Gig Smart City**

Dear Ms. Collier:

By entering the Infrastructure Canada's Smart Cities Challenge in April 2018, the City of Clarence-Rockland has demonstrated its intent and commitment to becoming a Smart City. Congratulations are for this type of innovative thinking! Furthermore, it is admirable that Clarence-Rockland is working toward a complete active transportation network which will enable pedestrian and biking access to key community destinations; thereby accelerating progress toward becoming a connected, healthy city.

CH2M HILL Canada Limited has been a trusted advisor for the past 18 years on municipal engineering assignments such as phases 1 and 2 of the Regional Water Supply project, the Sanitary Sewer Master Plan, various sewer replacements, and the Rockland Pumping Station standby power project. On December 18, 2017 Jacobs announced that they completed the acquisition of CH2M, creating a \$15 Billion professional services global leader focused on delivering innovative solutions for a more connected, sustainable world. Now that CH2M is part of Jacobs, we have something special to offer you. Our consortium (Smart City Capital, Nokia, and Jacobs) is excited to present to the City of Clarence-Rockland a Market Driven Strategy to become Canada's First 10 Gig Smart City. As a valued long-term Jacobs client, we are making this offer to you first within Canada.

You may be aware of what a Smart City is – but you might be wondering: What is a 10 Gig Smart City?

*"Today, we are celebrating a new Jacobs, a company like no other. Combined, we bring unequaled talent and innovation to deliver more for our clients and the world."*

**Steve Demetriou,  
Jacobs Chairman and  
CEO, December 2017**

**What is the 10 Gig offering all about?**

Our unique market offering will establish infrastructure capable of delivering internet access speeds up to 10 Gbps (ultra-high speed internet connection) to all residents, businesses, and municipal entities. This infrastructure will provide an opportunity for new internet service providers to compete within Clarence-Rockland to deliver new and innovative services to the community (see Appendix B for technology solutions from by Nokia for Clarence-Rockland). Per your [Smart Cities Challenge Application](#) to Infrastructure Canada it is obvious that Clarence-Rockland has the desire to become a more connected community which is an important step to becoming a Smart City. The following Nokia [case study video](#), of the City of Chattanooga, TN, best describes the positive economic impacts that we believe can be realized by Clarence-Rockland by implementing our offering.



Scan the QR code above to view the Chattanooga, TN case study video...

## What is the Smart City offering about?

Smart City solutions are shaping cities and changing lives faster than any other social, cultural, or market force today. Cities of every size and in every corner of the world are looking to leverage Smart City Solutions to manage resources efficiently, be responsive to the needs of all citizens, and be more fiscally progressive. As an example of why it is important to be striving to be fiscally progressive your [2018 Budget Summary](#) shows that your transit network costs of \$447,000 exceed the associated revenues while serving limited ridership. For example - why not use a Smart Cities platform to operate your transit (Bus) network with an on-demand smart methodology? Overall, we believe that a Smart City platform can be leveraged by Clarence-Rockland to optimize operating costs and even generate new revenue streams to strive to achieve a near cost neutral, fiscally progressive, service to its residents.

As a key market differentiator, we strongly believe that our consortium's partnership with the City of Clarence-Rockland will be able to generate new smart revenue streams and create smart cost savings for your municipal operating budgets – see attached proposal, Section 4.1, for examples that are for further discussion.

Please note that this Market Driven Strategy proposal is being presented for discussion and collaboration and when you are ready to discuss it further, please contact us: [Michael.Bidwell@jacobs.com](mailto:Michael.Bidwell@jacobs.com) or via phone at 416.499.9000.

Yours sincerely

CH2M HILL Canada Limited



Michael Bidwell, P.Eng.  
Regional Smart Cities Director



# Contents

Section	Page
<b>1 Executive Summary .....</b>	<b>1-1</b>
<b>2 Introduction .....</b>	<b>2-1</b>
<b>3 The Consortium.....</b>	<b>3-2</b>
3.1 Smart City Capital .....	3-2
3.2 Nokia .....	3-3
3.3 Jacobs.....	3-3
<b>4 Foundational Smart City Initiatives.....</b>	<b>4-3</b>
4.1 Smart Revenue Generation and Smart Cost Savings .....	4-3
4.2 Proposed Solution and Execution.....	4-4
4.2.1 Phase I – Implementation .....	4-5
4.2.2 Phase II – Implementation .....	4-6
4.2.3 Phase III – Ongoing Operations and Smart City Expansion.....	4-7
4.2.4 Overall Proposed Schedule .....	4-8
4.2.5 Summary of Illustrative Value Creation .....	4-8
4.3 Proposed Financial Model Overview .....	4-9
4.3.1 Revenue Sharing Goal.....	4-9
<b>5 Smart City Capital Advisory Methodology .....</b>	<b>5-10</b>
5.1 Overview .....	5-10
5.2 Scoping New Initiatives .....	5-12
<b>6 Conclusion and Next Steps .....</b>	<b>6-1</b>

## Appendices

- A Jacobs: Smart and Connected Places
- B The Nokia Solution: Clarence-Rockland, 10G/Wi-Fi Technical Presentation







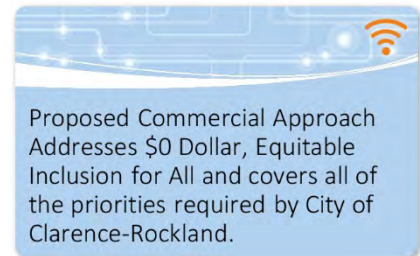
# 1 Executive Summary

The Smart City Capital (SCC) comprehensive financial and commercialization proposal will support all required initiatives using a phased approach. It will be fully integrated into overall program management so that the final product is a true Build, Operate, Finance/Monetize and Transfer (BOF/MT) facility. The overarching goal is to provide a structure that is self-sustaining and self-funding, requires no capital outlay from the City of Clarence-Rockland (the City), and covers both the served and underserved so that the digital divide is reduced or eliminated.

The model relies on a public-private partnership (P3) structure with the City that will be transparent and provide a compelling and responsive financial platform. We will also develop the right portfolio mix, yield attainment, and downside protection to achieve maximum success for the City.

As described in the financial experience and capabilities section, the SCC consortium is an industry leader in terms of Smart City outcome-based funding models, creating an ecosystem of top tier institutions and investors with billions of dollars in capacity, and several billions of prior funding and assets under management.

Our team's comprehensive solution covers the planning and development of a smart city strategy plan aligned to the City's strategic objectives. SCC's model will achieve zero dollar capital requirements and drive the highest value and efficiencies for the City using our portfolio bundle approach (with recommended phases).



This three-phase proposal addresses the foundational bundle of services necessary to underpin infrastructure and baseline quick-win Smart City initiatives that align with the City's known objectives (both needs and wants). Phase 1 focuses on getting the Clarence-Rockland Smart City enabled and onboarding the first bundle of Smart City elements. This phase includes establishing a neutral host carrier environment that allows residents, municipal entities, and businesses to access internet services that deliver data transfer speeds of up to 10 Gigabits per second (Gbps). An anchor tenant internet service provider (ISP) will be engaged to launch services in Phase 1; Phase 2 will interconnect the outlying hamlets with the core Clarence-Rockland network. Once connected, the network will be built out to provide the same level of service to hamlet residents, municipalities, and businesses. Phase 3 is an ongoing effort to identify additional Smart City initiatives, establish additional services bundles, determine the financial model, and execute new projects to onboard services.

SCC's bundling approach allows cities to embark on material Smart City and infrastructure projects in a manner that not only supports overall project requirements but maximizes revenue generation. Using this new concept and asset class creation, our team's approach will allow projects to be launched and completed sooner in a truly inclusive manner.

## 2 Introduction

Smart City Capital Advisory, LLC (SCCA)(with its investor consortium ecosystem) in collaboration with partners Jacobs Engineering and Nokia, is proposing a truly cost-neutral, self-funding approach by combining energy and cost savings with net new revenue creation (from Smart City big data analytics) in order to generate revenue that covers the project and beyond. Self-funding can be achieved through various financing and business model options that offer a wide-ranging portfolio of financial solutions to the City. The SSC team will work with the City to determine the values for each Smart City initiative and potential associated revenues (or cost savings) in order to provide a customized financial vehicle.





## 3 The Consortium

### 3.1 Smart City Capital

On April 17, 2018, Nokia and Smart City Capital, LLC launched a joint program to help Canadian cities fund and reduce the risks associated with smart city initiatives. With available project funding from Smart City Capital exceeding \$2 billion CAD, this program complements the Smart Cities Challenge program launched by Infrastructure Canada earlier this year. Source - <https://www.nokia.com/about-us/news/releases/2018/04/17/nokia-and-smart-city-capital-join-forces-to-foster-smart-city-projects-in-canada/>

Smart City Capital provides vendor agnostic outcome based IOT & smart city solutions. The two most significant barriers to Smart City/IOT adoption is “know how” and matched / monetized funding that can enable both short-term and long-term outcome-based models, reducing the risk and funding requirement up to 100%. Smart City Capital has developed a disruptive Outcome Based Model / Solutions, which is manufacture agnostic, availing the respective City or Service Provider of all available options, without the typical limitations when linked to one specific OEM. The Smart City Capital Eco-system is also delivering industry leading “know-how” via its highly experienced, partner eco-system (including Jacobs and Nokia).

The importance of becoming a smart city is now clearly appreciated by cities of all sizes around the globe. The common reality faced by all cities, even those with multi-billion dollar annual budgets is that Smart City Projects Require Smart City Capital, budget creating, solutions. For smaller cities, the budget challenge is even greater. Know-how is the second most significant challenge as traditional infrastructure project is no longer enough when considering that Smart City Projects will require in many cases for the solutions that deliver a blended outcome inclusive of both the technical and revenue generating / budget creating components. The learning curve can be significant.

SCC's portfolio of available financing options includes project financing/leasing; third party Financial Institution (FI); Energy Savings Structures (ESS); and Energy Savings Company – Energy Performance Contracts (ESCO-EPC). In addition, financial or funding options that can be combined with recommended value-added assets (for example, sensors, cameras, Wi-Fi access points, applications) will facilitate comprehensive monetization, net new revenue creation, and revenue sharing opportunities for the City. These can be combined with Environmental Monitoring and Energy Efficiency (EE) options, resulting in an outcome-based financial structure that could cover a substantial portion of the City's obligations.

The last scenario of combining financial solutions would use the ESCO model to cover smart light pole and luminaire control costs. SCC's variable- and outcome-based investor led model could fund all value-added assets (for example, sensors, cameras, controls, access points), as well as material portions of payment responsibility (that would otherwise be the City's responsibility). In short, SCC's effective and end-to-end financial solution could potentially reduce the overall risk and funding required by the City, depending on the final solution, assets, and actual data (pre-determined in cooperation with the City).

SCC develops tailored solutions for each city package, leveraging a portfolio or bundling approach that aligns monetizable use cases (for example, big data, savings share) with non-monetizable use cases (for example, safety and security, command centres), so that the City's overall objectives can be met as the monetizable component covers both the monetizable/non-monetizable portions in a single project. Once all required project or concession information, terms, and conditions have been defined, we can provide the Smart City solutions and financing and funding options.



## 3.2 Nokia

NOKIA creates the technology that connects the world. Founded in 1865, NOKIA is a multinational Information & Communication Technology company with a global workforce of over 100,000 employees. Powered by the research and innovation of NOKIA Bell Labs, NOKIA is driving innovation and the future of technology to power the digital age and transform how people live, work and communicate. NOKIA is a strategic global partner with a true end-to-end industry leading portfolio spanning Mobile Networks, Fixed Networks, IP/Optical Networks, Software, and Global Services. Leveraging this position, NOKIA powers Communication Services Providers, Transportation, Energy, and Public Sector networks including Smart City networks.

## 3.3 Jacobs

Partner Jacobs brings to the team 100 years of leadership in urban infrastructure planning, design, construction, and operations management for all core city systems—water, wastewater, transportation, energy, waste management, environment, information technology, industry, and security. An award-winning systems integrator, the firm offers the City expertise in linking citywide assets using real-time data collection, analytics, and visualization (including geospatial analytics), telecommunications services, cloud technologies, and automation. This experience results in a holistic view of a Smart City's needs and challenges and allows us to build best practice solutions into each project phase, as well as long-term asset management and citywide operations.

For more details about Jacobs please see **Appendix A – Jacobs, Smart and Connected Places.**

# 4 Foundational Smart City Initiatives

## 4.1 Smart Revenue Generation and Smart Cost Savings

In addition to establishing a neutral host carrier environment that allows access to internet services that deliver data transfer speeds of up to 10 Gbps, our consortium's partnership with the City of Clarence-Rockland will be able to generate new smart revenue streams and create smart cost savings to your municipal operating budget. Some of the examples include:

### Smart Revenue Generation

1. Neutral Host Carrier – in near future the cost for internet service will increase due to more Video Applications, Virtual Reality and Conference Calls, Augmented Reality. With the increased populations, there is more revenue to provide bundled services.
  - a. Currently established internet service providers (ISP) in Canada have historically underserved large populations within Canada. For example, the 2019 Federal Budget, the demonstrates the Federal Governments commitment to set a national target, in which 95 per cent of Canadian homes and businesses will have access to internet speeds of at least 50/10 Mbps by 2026 and 100 per cent by 2030, no matter where they are in Canada. This is in keeping with the broadband internet speed objective set by the Canadian Radio-television and Telecommunications Commission (CRTC) for Canadian households and businesses across Canada. As such, our neutral host carrier environment solution will unlock the current roadblocks that Clarence-Rockland has experienced with the current ISPs and bring new ISP options for residents.
2. Smart Transit - Real-time tracking and in-bus services improve travel experience, which helps increase ridership and revenue
  - a. Your 2019 Budget shows that your 2018 actual transit network costs exceed the associated revenues by \$328,268 or almost 900% (\$371,875 costs - \$43,607 revenues) while likely serving limited ridership. As one example of what our consortium's solution





could yield – why not operate your transit (Bus) network with on-demand smart methodology? This would allow your expenses to much closer to the actual revenues and provide improved service that would likely increase the ridership.

3. Smart City Wi-Fi - Based on travel avoidance, time saved by people, increased people engagement, increased economic growth (Starbucks Model).
4. Smart Citizen Services - Provides convenient access through smartphones to City and Council information and services, reduces cost to serve citizens, improves citizen engagement, simplifies interaction with government, helps in information-driven decisions
5. Underground infrastructure mapping services using IoT and then providing this as service to developers and construction firms. Firms would pay monthly fees to access data as they will get quicker permits due to availability of data thus reducing wait time to begin construction.
6. Recovering costs from parking using parking cameras and sensors, since parking enforcement officers cannot be at all parking spaces at all time to issue tickets when necessary. Using consumption-based parking rates thus increasing revenue.
7. Using real time mobility solutions to collect and analyze data and monetize this data with Insurance providers and also will help in Vision Zero (i.e. Zero Accidents and Zero Fatalities). This results in less costs to levels of government.
8. Advertising revenue from Kiosks.
9. Revenue from advertising in Buses by providing Broadband services.

#### Smart Cost Savings:

10. Energy savings from LED conversion to street lighting
11. Real Time asset management thus reduce operating cost of infrastructure as you are operating the system using an approach of predictive operations and maintenance for Water, Wastewater, Energy, Transportation, Buildings etc.
12. Smart waste management, reducing fleet and fuel costs
13. Smart winter maintenance management, reducing fleet and fuel costs

## 4.2 Proposed Solution and Execution

The following table outlines our phased approach at a high level. Our program management approach covers both strategy and planning and project execution, with each component taking a different form in various phases.

**Exhibit 1: Smart City Initiatives**

	Phase 1	Phase 2	Phase 3
Strategy and Planning	<ul style="list-style-type: none"> <li>Initial stand-up of program management office (PMO) and overall Smart City strategy development</li> <li>Rapid scale-up, including defining an integrated roadmap, project specifications, and financing</li> <li>Focus on initial quick wins and outlined long term initiatives</li> </ul>	<ul style="list-style-type: none"> <li>Ongoing PMO functions, including periodic strategy refresh</li> <li>Project-specific management</li> <li>Additional road mapping and project specification</li> <li>Focus on Phase 2 initiative execution</li> </ul>	<ul style="list-style-type: none"> <li>Smart City assessment and advisory to determine potential additional projects</li> <li>Establish new potential projects</li> <li>Create proposals for additional initiatives</li> <li>Project planning</li> </ul>
Project Execution	<ul style="list-style-type: none"> <li>Quick Wins Projects</li> </ul>	<ul style="list-style-type: none"> <li>Launch Phase 2 project execution (approximately</li> </ul>	<ul style="list-style-type: none"> <li>Ongoing operations and maintenance (O&amp;M)</li> </ul>







<ul style="list-style-type: none"> <li>○ Network backbone coverage for Clarence-Rockland</li> <li>○ Facility buildout of core hub sites (2) in municipal buildings</li> <li>○ Establish neutral host carrier environment on network and establish anchor tenant</li> <li>○ High-speed internet for strategic business and municipal entities</li> <li>○ Wi-Fi deployment in key strategic municipal areas</li> <li>○ CityIQ Nodes deployment begins</li> <li>● Commencement of initial phase, (approximately half) of the overall project initiatives as outlined or agreed to in the Strategy Development Plan, developed with the City</li> </ul>	<ul style="list-style-type: none"> <li>○ Network backbone coverage for remaining hamlet areas</li> <li>○ Facility buildout of secondary hub site in a municipal building</li> <li>○ High-speed internet for residential homes</li> <li>○ Expanded Wi-fi Deployment</li> <li>○ CityIQ Nodes deployment continues</li> <li>● Establish O&amp;M for network and Smart City elements</li> </ul>	<ul style="list-style-type: none"> <li>● Onboarding of additional projects</li> </ul>
---	---	---

For full technical details of the proposed solution and the underpinning technology that will drive this Smart City initiative see **Appendix B – The Nokia Solution: Clarence-Rockland, 10G/Wi-Fi Technical Presentation.**

## 4.2.1 Phase I – Implementation

### 4.2.1.1 Sub-Phase 1a - Strategy and Execution Plan Development

**Estimated Time Required:** 5 months

**Key Actions in this sub-phase:**

- Stand up the PMO function
- Project financial modelling
- Develop agreed to Smart City/data policy
- Privacy assessment
- Develop overall strategic Smart City Plan for:
  - Overall network design and facility design for primary hub sites (2) in municipal building
  - Establish neutral host carrier environment on network and establish anchor tenant
  - Facility design for secondary hub site in municipal building
  - Planning to service strategic business and municipal entities with high-speed internet in conjunction with core network build
  - Planning for overall Wi-Fi deployment
  - Planning for overall CityIQ Nodes deployment
- Develop detailed project plans to execute Phase 1 initiatives
- Engagement with all key departments
- Establish governance and overall operational model
- Citizen/media communication and/or education plan



#### 4.2.1.2 Sub-Phase 1b – Plan Execution

**Estimated Time Required:** 10 months

**Key Actions in this sub-phase:**

- Continued overall network design
- Core network buildout for Clarence-Rockland
- Service build to strategic business and municipal entities for high-speed internet
- Facility buildout of primary hub sites (2) in municipal building
- Wi-Fi deployment for Clarence-Rockland
- CityIQ Nodes deployments for Clarence-Rockland
- Establishing O&M

#### 4.2.1.3 Phase I Financials

**Solution value\*:** To be determined based on agreed to use cases.

**Funding sources:** SCC; energy efficiency shared savings, Wi-Fi access, data monetization (details of each will be provided upon successful down select presentation)

**Capital Outlay for City of Clarence-Rockland:** \$0

**City of Clarence-Rockland Phase I Revenue Creation\*\*:** Actual will be based on final structure, terms, conditions and agreed to use cases.

*\* Excluding P3, travel, risk adjusted funding, etc. and other related expenses, all be covered by the SCC model.*

*\*\* Beyond project cost and over the 20-year life of the concession.*

### 4.2.2 Phase II – Implementation

#### 4.2.2.1 Plan Execution

**Estimated Time Required:** 12 months

**Key Actions in this Phase:**

- Core network buildout for remaining hamlets
- Facility buildout of secondary hub site in municipal building
- Service build to strategic business and municipal entities for high-speed internet
- Wi-Fi deployment for remaining hamlets
- CityIQ Nodes deployments for remaining hamlet

#### 4.2.2.2 Phase II Financials

**Solution value\*:** To be determined based on agreed to use cases.

**Funding sources:** SCC; energy efficiency shared savings, Wi-Fi access, data monetization (details of each will be provided upon successful down select presentation)

**Capital Outlay for City of Clarence-Rockland:** \$0

**City of Clarence-Rockland Phase II Revenue Creation\*\*:** Actual will be based on final structure, terms, conditions and agreed to use cases.

*\* Excluding P3, travel, risk adjusted funding, etc. and other related expenses, all be covered by the SCC model.*

*\*\* Beyond project cost and over the 20-year life of the concession.*



## 4.2.3 Phase III – Ongoing Operations and Smart City Expansion

### 4.2.3.1 Ongoing Discovery, Planning and Execution

Time: 18 years (Month 25 through Year 20, total term)

#### **Key Actions in this Phase:**

- Ongoing operational support, maintenance and technology refresh expenses (through end of 20-year concession)
- Discovery and assessment of additional Smart City services using SCC's advisory services as outlined in Section 5
- Costing and evaluation of additional Smart City services under the same financial model
- Creation of project proposal to add additional vetted services
- Execution of approved projects
- Continued search for operating efficiency savings and new revenue realization

### 4.2.3.2 Phase III Financials

**Additional Solution value\*:** To be determined based on agreed to additional use cases on a case-by-case basis.

**Funding source:** SCC; Energy Efficiency Shared Savings, Wi-Fi access, advertising shared revenue, data monetization (details of each will be provided upon City approval)

**Capital Outlay for City of Clarence-Rockland:** Expected to be \$0 but depending on how strategic the opportunity is to the municipality and what the potential revenue model some costs may need to be covered by the City.

**City of Clarence-Rockland Phase III Revenue Creation\*\*:** Actual will be based on final structure, terms, conditions and agreed to use cases.

*\* Excluding P3, travel, risk adjusted funding, etc. and other related expenses, all be covered by the SCC model.*

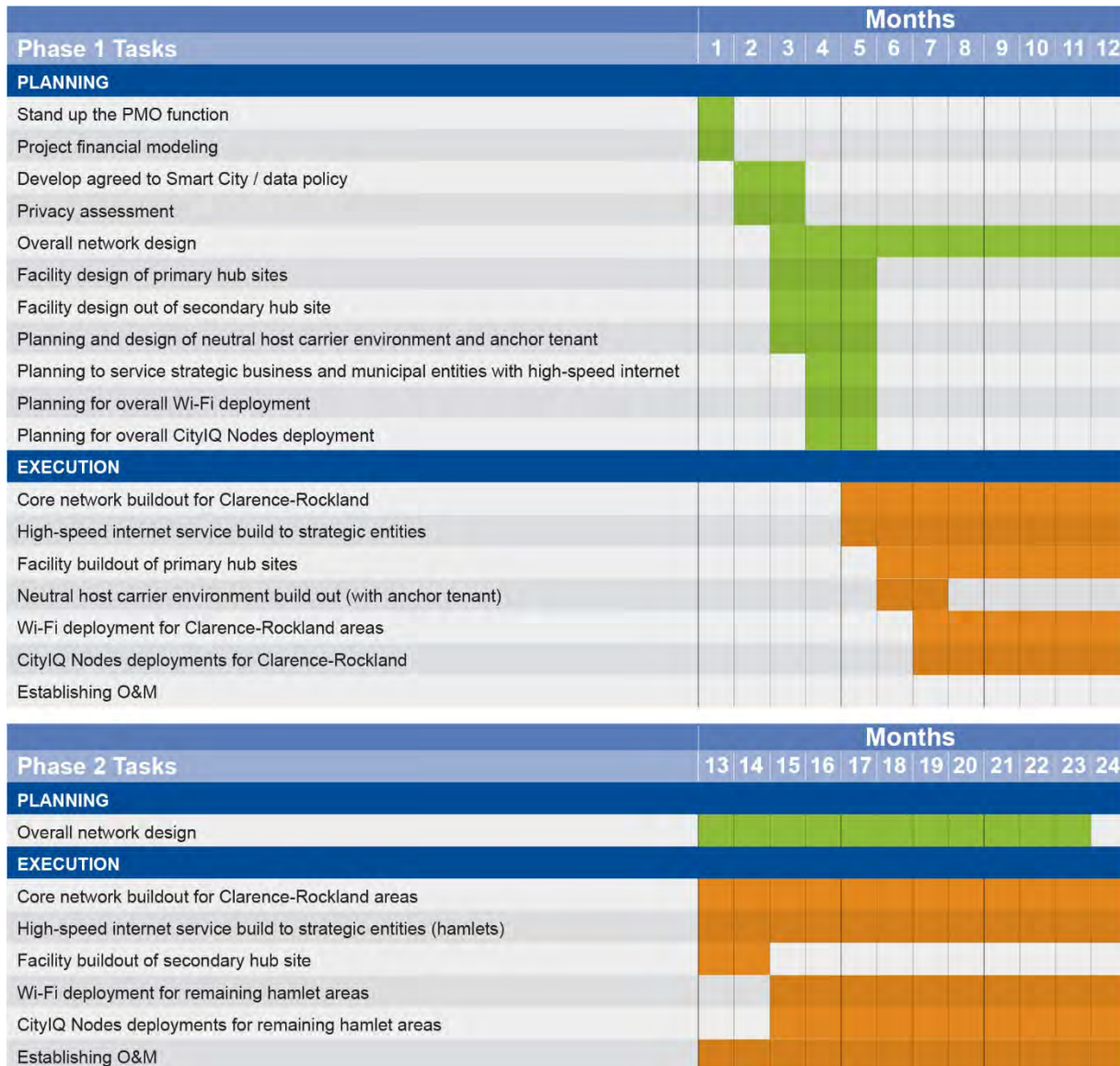
*\*\* Beyond project cost and over the 20-year life of the concession.*





#### 4.2.4 Overall Proposed Schedule

Though many project aspects can vary between inception and actual execution (especially when coordinating multiple entities), the proposed schedule provides a framework for understanding the actions, dependencies, and durations needed to successfully complete the project. It is expected that a more detailed and mutually agreed upon schedule will be established within the first few weeks.



Phase 3 will be an ongoing cycle over the course of the remaining duration of the overall engagement, specifically running from month 25 to the end of the 20-year term.

#### 4.2.5 Summary of Illustrative Value Creation

Given our team's industry-leading experience and distinctive Smart City BOF/MT model, there is the potential for multi-million dollar value creation for the City over the 20-year life of the concession. The actual value is subject to final terms, conditions, and agreed to use-case, beyond proving backbone network for high-speed Internet access and Smart City/IOT data and smart lighting.





It is important to note that our portfolio approach not only realizes the highest potential value proposition for the City from a fiscal perspective (by leveraging big data monetization and realized savings share) but supports all citizens by reducing or eliminating the digital divide. In the past this was not possible, but this team has the knowledge and experience to effectively execute these Smart City solutions. The data collected by the City will help monitor community engagement, develop urbanism strategies, and link real-time information to emergency vehicles. Geospatial data analysis will help the City to identify network connectivity weaknesses and plan non-motorized routes for a more active and healthier city.

## 4.3 Proposed Financial Model Overview

### 4.3.1 Revenue Sharing Goal

With respect to estimated revenue sharing, the SCC model provides typical revenue sharing levels, in the following step-up fashion:

- Year 1-5: 2-3% (depends on initial/actual capital expenditure [CAPEX] required)
- Year 5-10: 4-6% (doubles from initial 5-year term)
- Year 11-15: 6-8%
- Year 16-20: 8-10%
- Every 5-year extension (beyond year 20): Increase of 2-3% with every 5-year extension period

#### High Level Condition Precedent Summary:

Given the material capital investment and risk required to fully deploy all proposed Smart City initiatives/use cases, the base level concession features should include, but are not limited to:

- Contracted and awarded initiatives or area to include all areas of the City and Smart City use cases
- No competing or similar concessions in same right of way (ROW)/assets (for example, smart lights, poles, corridors, building, ROW)
- City to own data; however, winning proposer receives intelligent big data use priority, with carve outs for City use
- Establishing a savings share program with the City, supporting maintenance expense reduction (for example, fleet, spaces) and SCC sharing with the City on savings as part of the overall model.

#### Financial Model Governance

- Provides the City with a seat at the P3 table without triggering financial or performance responsibility
- Ensures that key City objectives are achieved, and that there is no inappropriate content or violation of any applicable data privacy or regulation overall
- Monthly Status Report: SCC to report all agreed to key performance indicators (KPIs) to the City, based on a reporting template to be jointly developed with the City.

#### Key Takeaway:

The anticipated value creation and respective revenue sharing with the City will be based on a materially higher baseline revenue base and maximizing budget creation for the City over the project/concession life. This permits the successful de-risking of the project in its entirety for the City, while also generating budget creation (over and above the project CAPEX and operational expenditure [OPEX] coverage) using the step-up revenue/savings share levels previously illustrated.

- The initial audit is critical as it will serve as the basis for the long-term monitoring and verification (M&V) of project savings. Given the importance of the M&V process to the overall success of any ESCO-EPC project, our team has the necessary experience to provide the highest level of accuracy, management, and collaboration, which should avoid typical errors and omissions or inaccuracy.





- Specific audit results, values, and terms and conditions will be finalized during the subsequent rounds of the due diligence process.
- Rapid and agile engagement, execution, and deployment will be achieved as a result of the team's experience; from a capital structure perspective, approval times will be accelerated (compared to the industry standard) and overall agility maximized.

#### Revenue Creation/Monetization:

- SCC, in collaboration with the overall team, will recommend value-added assets (for example, sensors, cameras, controls, Wi-Fi access points, small-cells) including the type, number, and location of assets which have the greatest potential to maximize revenue generation. In turn, this should result in a revenue sharing relationship with the City. Value-added assets (as described above) could also potentially benefit the City and its citizens' quality of life, safety, and security by use cases such as environmental, road/path condition reporting, community engagement, and other enhancements chosen by the City.
- For value-added assets (subject to final terms and conditions), SCC would fund and provide the value-added assets, thereby maintaining a cost-neutral or zero dollar cost to the City, eliminating funds which the City would otherwise use for procuring these assets. Interactive kiosks (small structures in a public area used for providing information or displaying advertisements, often incorporating an interactive display screen or screens) may also be included as part of the smart light-emitting diode (LED) lighting option, based on City approval. Kiosks could also be covered within our bundled funding model, with additional revenue sharing being generated by the Interactive City.
- Advertising, targeted data stakeholder, and big data analytics could be used to create net new revenue to seek to recover the City's funding of various projects.
- Revenue sharing will commence upon achieving minimum yield targets, with step-up. Incremental sharing percentages could potentially be realized in the City's favour at the time of each contract extension period.
- Generated revenue from this focused LED lighting project/value-added services use case may exceed the specific use case requirements. If that is the case, the City could use the revenue sharing to support other projects/use cases such as those that may lack monetizability or are beyond the scope of this project.
- Revenue sharing levels will be based on the final awarded project, funded capital levels, risk adjusted pricing, yield targets, and final terms and conditions. Typical ranges are included in this proposal.

## 5 Smart City Capital Advisory Methodology

### 5.1 Overview

The changing nature of local consumer economies, coupled with the continuing impact of technological advancement and the increasing importance of innovation and entrepreneurship as a platform for growth, means a heightened level of national and international competition to attract financial capital, workforce talent, and business investment. Compounding this competition is the maturity and commoditization of Smart Technologies and the growing effect they are having on economic impact, revenues, and profits.

The implications of this shifting landscape (often referred to as the Fourth Industrial Revolution) are challenging the old economic development models and tactics deployed by public and private sector entities to attract and sustain business investment and growth. Where historically economic development was driven by the availability of land, buildings, and an educated workforce, today the industry must look beyond the traditional approaches to investment attraction, leveraging outcome-based business models and asset classes to facilitate their success in the new digital economy. The industry must work more effectively with post-secondary institutions to devise strategies that invest in (and develop) the necessary assets and solutions to unlock value and generate profitable revenue in this transforming economy.



Our understanding is that the City has a vision to become an early Smart City adopter and potentially Canada's first P3 Smart City initiative. To achieve this vision, the intent is to leverage best-in-class market proven technology solutions to offer experiences to people who live, work, visit, and operate across the City and broader community. We further understand the material undertaking the overall project scope represents, along with the accelerated phased time schedule, demands firms with the following expertise:

- Significant experience in Smart Cities and P3 delivery
- Strong understanding of the various emerging technologies
- Previous experience integrating turnkey solutions
- Knowledge of matched outcome-based funding models (equity, junior and senior debt including tax-free bonds, muni-leasing and customized structures).

Currently SCC and its partners are the only source that can not only provide strategic advisory and development services but can also execute the strategy with accountability and the highest level of customer satisfaction. This is a material difference from traditional consultancy firms.

The use of new innovative, outcome-based business models and cutting-edge technologies are critical to economic growth. Assessing new innovations using previously established economic development frameworks, policies, and perspectives will inhibit progress in the short term and stifle broad economic growth potential. As an industry, we must be aware that as technology evolves, evaluating and making decisions based on old frameworks will not yield growth and development. We must shift our focus and sharpen our perspectives to truly understand how best to transform the planning and decision-making process to mitigate material risk and maximize yield targets and revenue generation.

SCC and its partners understand how important it is to help clients like the City recognize opportunities to leverage smart, digital, connected, and outcome-based solutions to enhance economic growth and operations. We have assisted clients in the private and public sectors, government port authorities, and point solution provider original equipment manufacturers (OEMs) understand, evaluate, and execute on successful Smart Infrastructure and real estate development projects.

We believe that using smart, digital, and connected solutions across the City can be best understood from the user perspective. This approach helps create transparency and enhances the potential of delivering a successful project. It is important to develop a sustainable outcome business strategy that uses the latest Smart Infrastructure and understands which domains the technology will optimize. These domains include digital and personalized location based services; smart lighting and energy; smart parking and intelligent transportation; 5G communications and neutral host broadband and small cell; safety and security; and other key use cases. SCC has domain, project execution, business, and revenue model expertise in all these areas.

The City, working with SCC, Jacobs, and Nokia Inc. can delivering the City's vision of establishing Smart Infrastructure development projects as Canada's first P3 Smart City initiative. The partnership can take advantage of, and benefit from derivative assets enabled by Smart Infrastructure solutions (the valuable asset class, called the "data rights"). The principles defining this asset class are similar to those of "mineral rights"; essentially, the owner of the underlying Smart Infrastructure can realize significant additional revenue through various branches of data analysis, cost savings share, and data monetization.

Beyond the Smart City, technology components, and knowledge of (and experience with) P3, our team's differentiated value extends to other critical components including compliant automated competitive Smart City procurement; request for proposal (RFP) development and process management; minority business process management; data centre, cloud, and any technology delivered and/or integrated in an International Financial Reporting Standard (IFRS)(OPEX)-compliant solution; as well as P3 financial special purpose vehicle (SPV) operation, reporting, and compliance.

The following proposed Scope of Work (SOW) includes the capabilities and list of services SCC will deliver to the City to help establish it as one of the first truly smart cities in Canada.



## 5.2 Scoping New Initiatives

### Deliverable 1: Build project specific Smart Solutions Performance Metrics for Business

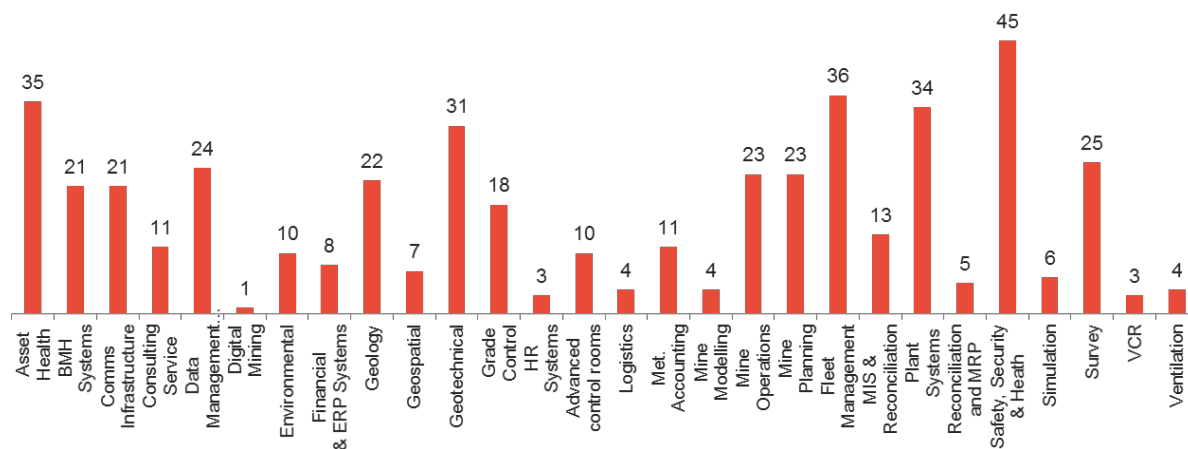
#### Modelling

The following elements must be understood and evaluated as part of the technology strategy to create a practical, value-added, customized solution for the City.

The convergence of external market pressures, digital technology maturity, and widespread social acceptance of technology is driving transformation in real estate development and infrastructure projects. Owners perceive digitalization as a game changing solution, creating step changes in safety, productivity, cost efficiency, and overall performance. Selecting the best blend of technologies is a challenging task; it involves a systematic approach to synthesize an organization's digitalization and technology strategy programs and projects spanning near, mid-, and long-term time horizons. Beyond program development, it is critical to identify the critical success factors for rollout. Applying a customized digitalization and technology roadmap while addressing these success factors allows the industry to move the digitalization and technology conversation from concepts to sustainable value creation.

Today, the wide range of digital technology solutions on offer make selecting the best blend of technologies a challenging task, with many vendors, service providers, and consultants all putting forward their version of the future "Smart City" or "smart digital infrastructure". In 2017, SCC conducted a scan of technology-related solutions across various industries and identified over 450 solutions from 220 vendors and service providers spanning software, instrumentation and sensors, services, and consulting (see Exhibit 2).

#### Exhibit 2: Technology-related Solutions for Infrastructure Across Various Vendors and Solution Categories



No municipality should be locked into technologies and solutions based on existing vendor relationships. Following the path that simply continues to focus on easy and seamless integration with the vendor's existing technologies does not guarantee true value creation. The perceived value in upgrades by following a particular vendor's upgrade path must be measured in terms of Return on Investment (ROI), Return on Time (ROT), and Total Cost of Use (TCU) versus traditional total cost of ownership (TCO). This will determine the creation of true value to the municipality.

SCC offers proven experience and value creation for our client from these logical metrics. Point solutions create pockets of value that are not integrated; SCC adopts a portfolio approach and evaluates from broader, ecosystem-based business case perspective.





Our fundamental philosophy is that, after analysis and due diligence, our investment committee and investor group do not find the project worthy of investment, our advisory clients and partners should not invest. We evaluate each project and investment decision as investors first and base our decisions upon creating project investment prospectuses. We aim to assess and unlock the following key values through implementing smart technologies using a portfolio approach. The analysis behind the metrics is proven and thorough.

**Please note these are basic metrics or high level “rules of thumb” that can help determine the inevitability of a development project.**

**Target Performance Metrics through Smart Solutions**

- 12–18% in cost reductions through application of asset management techniques, focusing on real time conditional monitoring and predictive maintenance
- 10–15% in throughput improvement by enhancing autonomous execution through automation
- 14–21% in revenue increase by applying transformative digital technologies, including internet of things (IoT) platforms and sensors; big data and advanced analytics; virtual and augmented reality; and mobile devices
- 25% in throughput improvement by integrating operations across the value chain by focusing on collaborative environments and enabling platforms including integrated operations and performance centres.

To build project-specific *Performance Metrics through Smart Solutions* the following elements must be evaluated as part of the technology strategy to create a practical, value adding and customized solution:

- *Global digitization and technology scan:* A keen understanding of how peers use digital technologies is an excellent starting point to gauge applicability of technologies. However, this limits the view. Expanding the review to adjacent industries offers a more complete picture and allows municipalities to think creatively about technology while still being grounded by practicality. Ultimately, the goal is to create benchmarks that are applicable to the municipality's specific needs.
- *Grounding in operations:* Looking inward to craft a clear operational view of challenges, opportunities, and value drivers is key to assessing the opportunity for technology and understanding which areas are not ready to accept a digital solution.
- *Synchronizing strategic and economic objectives:* Understanding that today's challenges and opportunities may not speak to tomorrow's economic intent drives the need to facilitate longer-term relevance to the developed transformation strategy.
- *Focus on value add:* Developing upfront value measurement mechanisms for objectively assessing digitalization and technology opportunities and initiatives ensures that the organization is not digitalizing for the sake of digitalizing.
- *Change upfront:* Making sure that change is part of the process effectively takes personnel along the technology journey. The intent is to complement the more technical and business focused elements with sufficient behavioural capability.



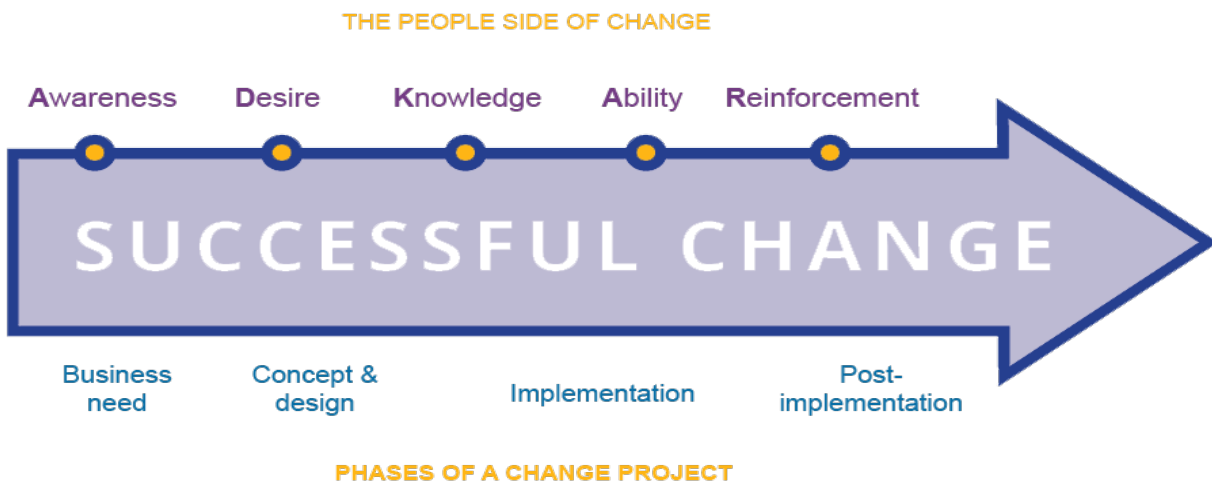
## Deliverable 2: Create Digital Execution Strategy and Business Case Analysis

Solidifying the digital execution strategy into specific outputs makes the digital transformation more tangible and avoids strategies that have unclear boundaries and impractical outcomes. The strategy development benefits from upfront direction from a mission and objective statement, which articulates the municipality's vision, what will be done, for who, and why.

Strategy outcomes include the road map/project rollout program, CAPEX and benefit estimates, and infrastructure requirements. The intent is to plan sufficiently far ahead, make sure that "far" is far enough, confirm that unique ideas have been generated, and that the difference these ideas make is well understood.

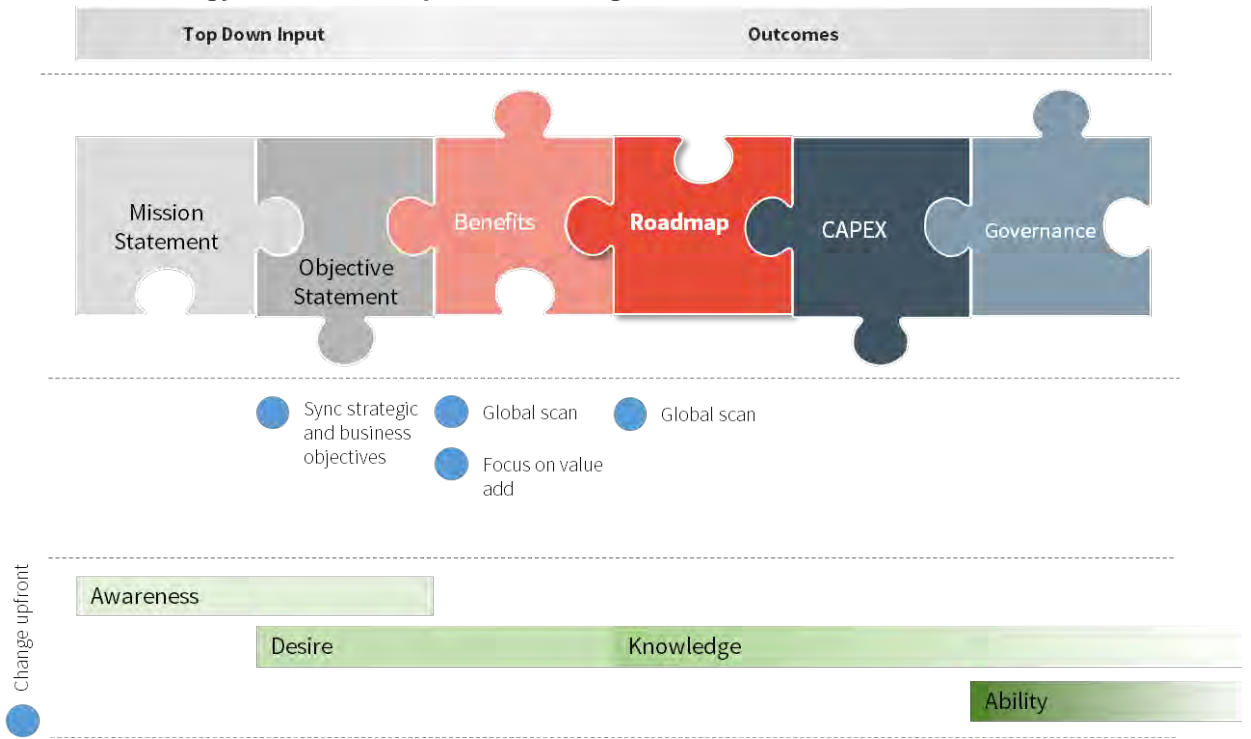
In addition to making sure that the strategy is properly bounded by these deliverables, it is critical to apply a robust change management process to develop the program and implementations. The well-established Awareness, Desire, Knowledge, Ability and Reinforcement model (ADKAR), developed by Prosci, is a three-phase change management process throughout the lifecycle of initiatives that cause change.

**Figure 3: Summary of the ADKAR Process Against Typical Project Phases**



**Exhibit 4** brings the core digital strategy elements, identified outputs, and change management process together to illustrate how they interact with each other. The mission statement articulates the municipality’s vision around technology and digitalization, clearly identifying core priorities or areas of technological advancement.

**Exhibit 4: Strategy Elements, Outputs and Change Interaction Model**



Organizational awareness is created through the mission statement, but it is the objective statement that creates the desire to undertake the change. The primary driver of this willingness is clear and quantifiable targets that the technology and digital strategy must achieve through its various programs and projects.

The desire is cemented through the global digitalization and technology scan, which adds references for developing benefits arising from the strategy. This demonstrates to stakeholders that the strategy is achievable and practical through the real experiences of others. Looking at the targets and the potential benefits from reference sites and projects brings a keen focus on value added.

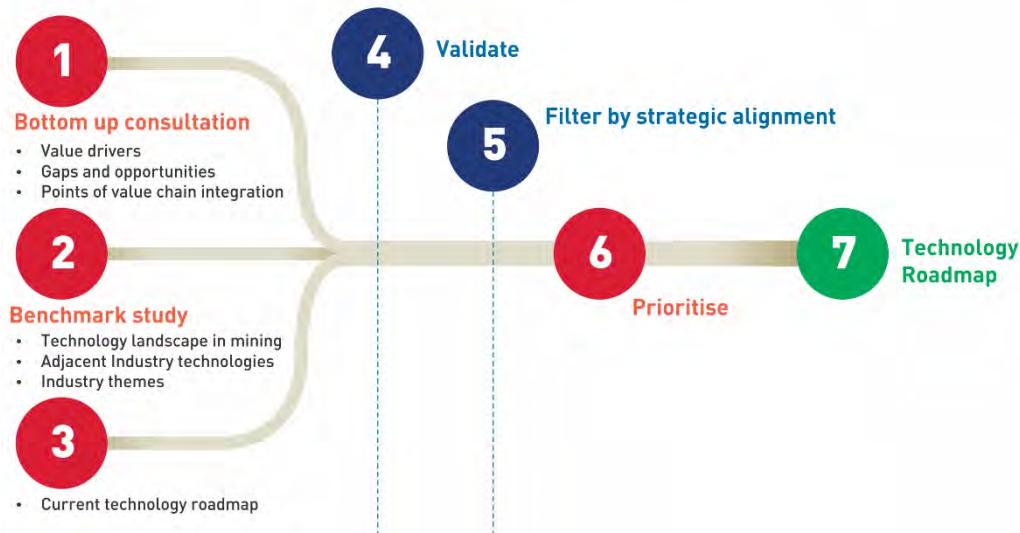
The roadmap articulates the actual portion of projects that make the strategy executable. This is meant to define projects, dependencies between projects, and timelines for study, scoping, and execution. A high-level CAPEX estimate is developed and overlaid on the roadmap to assist with budgeting processes. This is the start of the knowledge journey that will continue after implementation of the respective projects.

The strategy development also seeks to address critical issues within the municipality’s governance structures covering the implementation of digitalization and technology. Examples include managing the digital technology pipeline from concept to implementation; digital project governance including value measurement, funding applications, and progress measurement (especially given non-traditional project approaches - agile, incremental fast value, or fail fast); and identifying role and skills changes. The exercise seeks to enhance the organization’s abilities, which will continue after project implementation.



**Exhibit 5** describes the digital program development process to generate the roadmap, benefits, CAPEX, and governance outcomes.

#### Exhibit 5: Digital and Technology Program Development Process



The bottom-up consultations ground the program development in operations; they seek to understand gaps, opportunities, and challenges in the municipality's key value drivers and its individual initiatives.

For each initiative, stakeholders across various departments (such as development, construction, process management, engineering, and logistics) participate in workshop sessions to identify opportunities for digitalization and technology. The process takes into consideration what is available, what ideal scenarios look like, and what quick wins are possible among core value drivers (including labour, safety, and resource optimization).

The benchmark study results in an understanding of the broad themes that could be relevant to a municipal operation and provides the coarse opportunity sizing necessary to understand the possible benefits. This sizing can be expressed in a variety of operational and business metrics including cost, revenue, availability, utilization, or even injury frequency rates. Regardless of metric, this effort seeks to provide early quantification of benefit size. Further analyses are performed to create an organization-specific benchmark guideline that calibrates the list of possible initiatives from the global scan for local and operational context.

The bottom-up consultations and global digital scan come together through the organization's strategic and business objectives. The resulting initiatives are synthesized into a practical and time-based roadmap by focusing on areas of key value added.

A robust digital and technology road mapping process tailors these themes and underlying concepts with a view to maximizing operational performance. This is at the heart of the validation, filtering, and prioritization components. The prioritization step ranks individual projects against criteria agreed with key stakeholders (for example, heads of department and site general managers). Such criteria could include quantifiable metrics like net present value (NPV) benefit and CAPEX, and unquantifiable metrics like ease of implementation. In formulating the roadmap, a final (but core) step is to check whether project and infrastructure dependencies are sound.

Successful application of this approach hinges on flexible application. Being adaptable through the strategy development process helps alleviate some of the common road mapping challenges so that critical success factors are met.

The digital transformation goes beyond technology. Digital and technology must be viewed as an enabler to achieve full performance; for this reason, the full technology, people, and process system must be





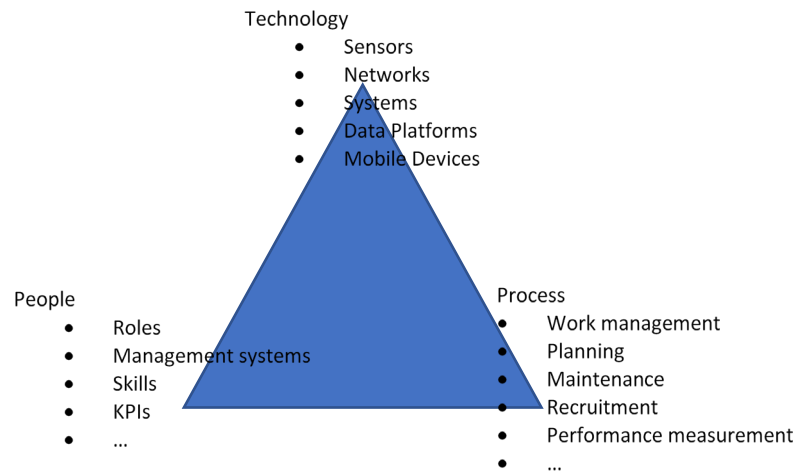
considered in any digitalization program. The system triangle (**Exhibit 6**) is an often-used visualization of the components to consider.

While the system triangle from **Exhibit 6** has become the consultant's cliché, a more telling view of the need to consider the people and process aspects of digital transformation can be derived from it.

The following outlines SCC's customized framework for evaluating and building Smart Infrastructure investment prospectuses:

- **Model uncertainty and modelling benefits:** Quantifying the improvement or benefits from digitalization is difficult without a robust business and operational model at the appropriate level of detail.
- **Scheduling and time constraints:** The effort required to formulate a strong, customized digital program is often underestimated. The strategy development process relies heavily on the expertise and experience of the functional teams, so competition for individuals' time must be managed.
- **Benchmark and reference data availability:** Accessing applicable and relevant benchmark data may be impossible given the confidentiality around the organization's initiatives. Compounding the data availability issue is the lack of site-specific reference information.
- **Stakeholder engagement:** Related to the change management topic, individual stakeholders may not understand the technologies or digital thinking, particularly when a mature workforce is in place and used to undertaking activities and tasks in more conventional ways.
- **Complex existing systems landscape:** In a more mature environment, existing processes and procedures, reporting requirements, and measures may have developed over many decades, resulting in pushback on new technologies. The overall software, IT, and process control environments may also be fragmented.
- **Functional versus value chain focus:** Individual stakeholders are often focused only on getting what is best for their function group or department and not look at the entity as a whole. Realigning the thinking to a more holistic base is often challenging in environments with competing KPIs.
- **Deliver a business and technical memorandum:** The memorandum summarizes design risks; project phasing; implementation schedule; policy issues; operational benefits; opportunities for monetization; risk management strategies; and a comprehensive, variable risk financial model and prospectus.

**Exhibit 6: People, Technology, Process System Analysis**



### Deliverable 3: Success Target, Business and Revenue Model

SCC understands the City's need to explore all possible equity funding options as it is in the owner's best interest to mitigate risk and maximize risk free return. We will provide the most exclusive funding model in the industry for the City's evaluation and consideration. This is the final output created through SCC and includes the full Smart Infrastructure business and revenue model. This is the formal process and output SCC uses for their private equity funds and investor group.



**Financial Modelling and Risk Management Methodology:**

- SCC Advisory Financial Management – Risk Management Review
- SCC Advisory Financial Management – Investment and Yield Targets
- Smart Solutions Use Case Bundling Strategy – Illustrative Smart Solutions Bundle (**Exhibit 7**)
- Expected Portfolio and Individual project ROI
- Financial Modelling per Project
- Financial Modelling on a Portfolio Basis Across Smart Assets
- Monetization solution execution
- Data Monetization structured contracts and back to back agreements for each data bundle
- Financial Governance and reporting
- Advising on appropriate technology and data-sharing platforms for IoT capabilities that are compliant with open systems standards and optimal for implementation
- The City's Smart City initiatives reprioritization due to various possible scenarios (such as change in administration, personnel, mindset), negatively affecting forward progress past the development phase when substantial investment has been undertaken by the City, our funding partner, SCC, and its ecosystem. This risk is around termination for convenience and excludes appropriation or performance-related risk matters.
- Regulatory requirements and support, if needed, contract/agreement development is subject to a lengthy/protracted process or complexity.
- For monetization components which are relying on long term concessions (that is, out of home advertising, savings share) is materially changed by the City after project launch.
- Revenue and savings assumptions are not achieved, negatively affecting expected ROI, sharing, and project viability.
- Material Adverse Change (MAC) event is realized by the City project, negatively impacting the City's risk rating for any portion it is participating in said risk/commitment.
- Model Risk/All Funding Requirements will be SCC's responsibility through its equity, junior, and senior debt financial partners. SCC's funding consortium, all of whom are highly successful, respected, and experienced institutions will include, but not be limited to:
  - Scenario Analysis where Smart City Capital LLC. to serve as Funding Model/Vehicle Administrator
  - Scenario Analysis for SCC Consortium Equity and Mezzanine/Junior Debt Funding
  - Scenario Analysis for SCC Consortium Senior Debt and Project Financing (including Tax Free Bonds)
  - Scenario Analysis for SCC Consortium Muni Leases and Project Financing (Traditional and Tax Free)
  - Scenario Analysis for SCC Consortium Delivered Data Center or Any Technology As A Service (XaaS)
- Include language that provide an appropriate level of support for such changes including the reality that a 10 to 20 plus year contract tenant will need to survive multiple administrations and City personnel changes. Said language to also cover termination for convenience, thereby providing a foundational support to potential funding sources, yielding the most competitive structures for the City.
- Given that many aspects of Smart City agreements are relatively new and require a flexible yet efficient approach, all efforts should be made for an agreement development process that is comprehensive, protects the City, yet it is efficient, without avoidable material delays.
- Concession agreements may include language that protects stakeholders so that the maximum de-risking/monetization levels are achieved in executing the City's Smart City initiative.



- Revenue assumptions and business model risk will be 100 percent on SCC and so for this point, just providing all available data points, allowing for the most accurate forecast possible, would be valuable. Any failure in this point would not be a City risk.
- MAC or appropriation risk occurrence is not expected; they are noted simply as a common risk.
- SCC Market Place Procurement platform providing compliant purchasing/sourcing as well as MWBE/DBE process and administration.
- Design, build, and operation of neutral host broadband, small cell and data center solutions
- P3 NewCo or SPV administration

**Exhibit 7** below is illustrative of a *Smart Solutions Bundle* investment approach. It breaks down the elements that make up the approach including proposed project portfolio/bundling, estimated value of overall bundle, City funding (if any), high level terms and condition and structure.

**Exhibit 7: Proposed Investment Summary**

Proposed Project Bundling/Title	Estimated Value and Funding Required	High Level Terms and Conditions and Structure
<p><b><u>Portfolio/Bundle Solution</u></b></p> <ul style="list-style-type: none"> <li>• Intelligent transportation/ traffic (key intersections and to major venues)</li> <li>• Safe City solutions <ul style="list-style-type: none"> <li>◦ Cameras, sensors, smart clothing, and video platform</li> </ul> </li> <li>• Dynamic data centre to be provided and covered as part of the bundle (material CAPEX and OPEX savings)</li> </ul>	<ul style="list-style-type: none"> <li>• \$TBD (Bundle Value)</li> <li>• Little to NO City funding to be required, fully funded by SCC</li> <li>• Portfolio approach, supporting, revenue and savings share covering entire project</li> <li>• Potential City revenue of \$TBD over and above project CAPEX and OPEX, throughout the concession time line</li> </ul>	<ul style="list-style-type: none"> <li>• 10+ year concession, with two, 5 year extension options</li> </ul> <p><b><u>P3 Structure</u></b></p> <ul style="list-style-type: none"> <li>• Blended equity and debt stakeholders</li> </ul> <p><b><u>Requirement(s)</u></b></p> <ul style="list-style-type: none"> <li>• Assets attachments (City utility assets)</li> <li>• ROW</li> <li>• Intelligent big data rights, use, and policy</li> <li>• Efficient licensing approval process</li> </ul>

**The financial model and outcome-based business plan would consist of the following components:**

- Work with the City to establish approved priorities (across a portfolio of “Smart Solutions”)
- Establish estimated value of aggregate projects,
- Categorize financial model broken out by:
  - Projects that result in net new City revenue through monetization
  - Projects yielding savings for the City and can be structured through a savings share
  - Projects which are budget neutral
  - Projects that require budget commitment
- Recommend to the City potential project re-prioritization so that projects that can be monetized will not only cover the entirety of that specific project but also cover a portion of other priorities that cannot be monetized or at same percentage levels.
- SCC internal overall project funding requirements to be established based on final priority list, along with individual project timelines, phasing, interlock, and revenue generating forecast made available to the City’s management team
- Secured funding, if requested, for the City’s prioritized Smart City project list, inclusive of the amounts that will be de-risked for the City project, thereby requiring little to no actual funds from the City



balance sheet or City commitment, based on achieving the required term, condition, documentation, and concession.

- Variable risk components would not be an exposure to the City; however, revenue sharing of fully de-risked portions would be realized for the City. Revenue sharing levels, terms, and conditions would be agreed to upfront with the City in a transparent fashion.
- Flexible contracting options possible.

Funding any Smart Infrastructure project today requires out-of-the-box thinking. Smart City Capital Advisory's disruptive outcome-based model will allow the City of Clarence-Rockland to explore every option for the City of Clarence-Rockland project without the typical limitations when linked to one specific OEM or financial partner. Smart City Capital Advisory can not only provide equity to finance an end-to-end solution, it will have a truly differentiated outcome-based business model that will enable the monetization of qualifying use cases as well as structured financing of key portions of the infrastructure for all the Smart Infrastructure initiatives prioritized by the City of Clarence-Rockland.

### **SCC Advisory Services**

SCC looks forward to opportunity to collaborating and working with Jacobs Engineering and Nokia in executing and establishing the City as Canada's first Smart City. The above detailed SOW outlines the key deliverables SCC will provide to the City over a proposed 6-month term.

### **Summary of Deliverables:**

#### **1) Build project specific Smart Solutions Performance Metrics for Business Modelling**

- i. Target Performance Metrics
- ii. Global digitization and technology scan
- iii. Grounding in operations
- iv. Synchronizing strategic and business objectives
- v. Focus on value added
- vi. Change upfront

#### **2) Create Digital Execution Strategy and Business Case Analysis**

- i. Strategy elements, outputs, and change interaction model
- ii. Digital and technology program development process
- iii. People, technology, process system analysis
- iv. Model uncertainty and modelling benefits
- v. Scheduling and time constraints

#### **3) Success Target, Business and Revenue Model**

- i. Benchmark and reference data availability
- ii. Stakeholder engagement
- iii. Complex existing systems landscape
- iv. Functional versus value chain focus
- v. Deliver a business and technical memorandum

#### **4) Smart City Capital Advisory Committed Resources:**

- i. 1 Smart City Capital Advisory Dedicated Technical Analyst
- ii. 1 Smart City Capital Advisory Project Manager
- iii. 1 Smart City Capital Financial Engineer
- iv. SCC analyst team



## 6 Conclusion and Next Steps

SCC is confident that this proposal offers significant value to the City and will have a significant impact on the quality of life for the people living in the City's communities. The resulting infrastructure will move the City to the forefront of Canada's smart and connected communities, allowing the City to become more efficient and effective, as well as meeting future challenges. The proposal's funding structure requires little to no upfront City capital but will generate new revenues previously not possible for the municipality. We strongly believe this proposal is a "win-win" for the people and businesses and look forward to discussing it in more detail with you.

In terms of next steps, SCC would like to sign a letter of intent with the City to engage in negotiations of the detailed terms and conditions need to support this unique initiative to allow Clarence-Rockland to become Canada's First 10 Gig Smart City.





Appendix A

## Jacobs: Smart and Connected Places





**JACOBS®**  
**SMART AND CONNECTED PLACES**





# Improving Quality of Life and Empowering Economic Growth

Digital solutions are shaping cities and changing lives faster than any other social, cultural, or market force today. Cities of every size and in every corner of the world are looking to leverage digital solutions to manage resources efficiently, be responsive to the needs of all citizens, and be economically competitive. While much of the discussion about being smart and connected is happening at the scale of the City, there are often implementation challenges due to size, magnitude, and complexity. Today, digital solutions are being applied at the scale of the district, the corridor, the campus, the building, military installation, neighborhood, and in some cases the entire city.

It is our belief that being smart is about more than sensors, Wi-Fi hotspots, and the Internet of Things (IoT). Smart means taking a triple bottom line based systems approach and developing comprehensive and connected solutions that are focused on improving the quality of life. Infrastructure networks – utilities, communications, transportation, public safety, and operations – must be integrated and considered in context with important physical attributes such as land use, mobility, and walkability.

Working across scales, infrastructure systems and technologies allow us to create Smart and Connected Places that function more effectively, are more resilient and sustainable, and are more responsive to the needs of the citizens. At Jacobs, we are working with our clients, our partner network, and our global platform of technologists, specialists, engineers, planners, and urban designers to create these smart and connected places. We provide integrated services including: planning, design, systems integration, networking, delivery, financing, and complete city and asset management operations services. We address pressing challenges faced by places across the globe relating to:

- **Governance:** Which department leads the change process?
- **Cross-Departmental Coordination:** How are projects prioritized and implemented?
- **Policy Frameworks:** Do existing policies support new technologies and business models?
- **Funding and Technology:** How do leaders monetize various services to generate funds? How can smart and connected places leverage Public Private Partnerships for technology refresh?
- **Community Engagement:** What is needed to integrate social value, quantify community benefits, and elicit strong support?

With an understanding and passion for evolving technology, Jacobs is dedicated to creating and implementing places that are smart, connected, inclusive, competitive, safe, and resourceful.



### **Becoming Connected**

Becoming Connected entails having networks that drive day-to-day activities. Networks are the foundation for communicating data from all objects embedded in Smart and Connected Places, like parking sensors, safety and security cameras, and pressure monitoring sensors in distribution systems. In order to be smart and connected, the network foundation and design, for any digital solution, such as autonomous vehicles or smart lighting, must align.



### **Becoming Inclusive**

Places are home to citizens from all walks of life. Promoting a diverse culture with equitable access to resources is critical to creating an inclusive place. An equity based environment is where all have access to the necessary amenities and services including: clean water, efficient energy, education, transportation, waste management, and connectivity, among others.



### **Becoming Competitive**

Places once competed based on their access to raw goods and markets. Today, modern societies compete by offering competitive jobs for residents, a high quality of life, and a range of amenities such as water, multi-modal transportation, power, and other services. Successful competitive places alleviate poverty, attract investors, and improve quality of life for all citizens.



### **Becoming Safe**

Public safety and cyber security are critical elements of Smart and Connected Places, assisting first responders, in locating, mitigating, and preventing safety issues. The network and sensors embedded across a Smart and Connected Place have a proven track record of increasing security and resiliency against cyber threats, thus protecting our assets and valuable digital information.



### **Becoming Resourceful**

The natural resources available to support humans and earth's other living systems are finite. As a result of rapid development, places face a loss of wetlands, tree canopy, and agricultural land. Smart and Connected Places help create resource-efficient and self-sustaining neighborhoods. Resourceful places accentuate what is unique about each place and build upon its assets to bolster its strengths. Technical solutions help conserve resources, improving services, and saving taxpayers' money.

## FULL LIFE-CYCLE DELIVERY

Joining you at any step along your project life-cycle, we custom build solutions to address your unique needs and immediate strategic areas of concern – creating solutions that fully support your Smart and Connected Places transformation.

Whether serving as your master planner, design engineer, delivery partner, program manager and/or city operations manager, we provide our services on a scalable basis, so you can efficiently and effectively adapt to fluctuating economic cycles. We use proven technologies; implement best practices and solutions; employ a highly talented and engaged workforce; and, most importantly, cultivate a close relationship with our clients.

Our approach for Smart and Connected Places starts with our implementation roadmap.

**THE IMPLEMENTATION ROADMAP ALIGNS YOUR VISION, GOALS, AND OBJECTIVES TO OUR REPRESENTATIVE CONNECTED PLACES SOLUTIONS. THIS PROCESS IDENTIFIES CRITICAL SUCCESS FACTORS AND TECHNOLOGY, EVALUATES REVENUE GENERATING PLATFORMS USING ANALYTICS, AND MITIGATES RISK. THE PROCESS RESULTS IN AN OPTIMIZED PROJECT FUNDING STRATEGY AND IMPLEMENTABLE SCHEDULE THAT ACCELERATES YOUR MOST IMPORTANT PROJECTS.**

**1**

Identify and Prioritize  
Vision, Goals, Mission  
and Objectives

**2**

Identify Critical  
Success Factors  
and Technologies

**3**

Evaluate Revenue  
Generating Platforms  
Using Analytics

**4**

Identify Projects and  
Embedded Digital  
Solutions





## BRINGING YOUR CONNECTED PLACE TO LIFE

Smart and Connected Places that seek to harness the benefits of digital technologies are often faced with organizational and technological challenges. Our four-step implementation roadmap assists in developing a prioritized list of projects, optimizes implementation schedules, and tailors a financing strategy for overcoming funding gaps, for each unique place.

Combining our decision analysis and comparative modeling tools, we work across various client departments to compare hundreds of projects and funding scenarios against a range of constraints and risks. This cross-departmental collaboration facilitates consensus-built investment decisions and execution strategies – securing the broad support needed to drive success.





# SMART AND CONNECTED PLACES REPRESENTATIVE SOLUTIONS



## ADVANCE PLANNING

Planning is first step in developing Smart and Connected Places. Jacobs advance planning services includes land planning, site planning, urban design, regulatory control, landscape architecture, pre-design business strategies, and services for a range of public and private sector clients globally. Our systems-based approach integrates complex natural and man-made systems to achieve social, environmental, and economic sustainability. We are sensitive to the unique cultural and environmental needs of a site and formulate place-based responses. We leverage technology such as GIS, BIM, and VR to create, evaluate, and visualize master plans that are implementable.



## NETWORK AND CONNECTIVITY

Network and connectivity are key requirements in the successful implementation of Smart and Connected Places. Network technologies are no longer limited to fixed-line telephones, mobile communications, and the internet, but now leverage the Internet of Things (IoT) – the connection of everyday objects to the internet that creates smart devices capable of exchanging information. The IoT harnesses massive amounts of real time data about traffic, crime, weather, energy consumption, and more, to improve quality of life. At Jacobs, we provide complete network solutions for today and the future.



## P3 ADVISORY SERVICES

The development and implementation of Smart and Connected Places projects requires considerable investments that are difficult to fund with traditional public finance. Due to the technological advancements and associated inherent risks in the Internet of Things, funding for connected places projects is often limited. In this context, Public-Private-Partnerships (P3) is a suitable solution to overcome the shortage of public financing and cuts on public spending. Our expertise in structuring and managing P3 projects is recognized by clients in both the public and private sectors. Successfully acting as sell-side, buy-side, lender's advisors, and special studies consultants from project conception to completion, operation, and decommissioning.



## URBAN MOBILITY

Smart and Connected Places will share a single characteristic: the ability to effectively move people and goods in harmony within the urban fabric and through all modes of transportation. Mobility solutions improve traffic flow, reduce roadside incidents and traffic congestion, improve response time to traffic events, optimize public transit, and enable centralized highway operations. Our mobility team provides forward-looking solutions and policies for connectivity for intelligent transportation systems, autonomous vehicles, signal timing and management, and traffic operations centers.



## UTILITIES

Smart utilities reduce delivery and replacement costs of aging infrastructure, promote efficient allocation of resources, protect the water supply from internal system problems or tampering, and increase the safety of continuous power transmission and delivery. Digital utilities solutions now provide the ability for real time monitoring and evaluation of large amounts of operational data which assists in reducing operating costs of energy, chemicals, and other system components. Data collected and analyzed is used in avoiding system failure by using predictive analytics of system components.







## INTEGRATED INFRASTRUCTURE

Jacobs integrated infrastructure solutions deliver a convergence of physical and digital infrastructure, leveraging data analytics, cyber security, among other digital solutions to develop Smart and Connected Places that are rich in character, community, and livability. Our approach is systems-based and evaluates all infrastructure solutions and their associated linkages to provide efficiency and cost savings. From developing a water treatment plant, to building bridges, and other infrastructure, we cultivate solutions that provide operational efficiency in all aspects of the built environment, ultimately delivering reduced energy costs, minimizing water losses in distribution systems, and providing multi-modal transportation solutions to name a few.



## RESILIENCE

Resilience is the ability of any place to adapt to changing conditions and rebound from disasters. Before an event, our resiliency services offer business continuity planning, vulnerability assessments, and all-hazard mitigations, as well as advanced IT, data center, and cyber security solutions. When disasters occur, we assess damages and provide rapid response for all integrated infrastructure overtaken by events. We facilitate recovery planning and supports all aspects of design, engineering, and construction to help cities rebuild stronger.



## SAFETY AND CYBER SECURITY

Even with the advantage, convenience, and efficiency provided through Smart and Connected Places, security will always be critical. Through the implementation of a layered, "Defence-in-Depth" approach, utilizing strategic technologies and practices, we work with clients to develop an action plan to secure their organization's networks. A unified command center keeps facilities, assets, citizens, and public spaces safe and promotes more rapid, accurate, and cost-effective emergency response.



## OPERATIONS AND ASSET MANAGEMENT

Managing operations and assets in Smart and Connected Places is important for all organizations. Asset management helps clients make the right cost, risk, and performance decisions to optimize and sustain the performance and value of physical assets throughout their life cycle. Our asset management framework utilizes digital solutions to establish a database of assets that effectively logs the condition of each asset and predicts the timeline for future maintenance and repair using real time operation data analytics and statistics.



## DESIGN

After planning, design provides the details necessary for implementation of various integrated infrastructure solutions for Smart and Connected Places. Our team develops detailed design and design guidelines specific to each unique solution area as required by the project. Our integrated design process is interactive and incorporates value engineering and optimizes total cost of ownership throughout the project life-cycle and beyond. At the foundation of our design services are cost and schedule savings, reduced risk, and innovative and optimized designs.





## ADVANCE PLANNING

### **Australian Education City Master Plan Melbourne, Australia**

Jacobs is working alongside a developer client to create a long-range master plan for a new suburban town on the outskirts of Melbourne. The 412-hectare project will be home to a new university with over 40,000 students and a vibrant walkable central business district with commercial, residential, and community support facilities. The city is envisioned to be a world-class example of sustainability. It will have a direct connection to Melbourne's extensive transit system; a network of trails, parks, and accessible open space; and aggressive targets for energy use, water recycling, and building performance, establishing a fully connected place. The master plan incorporates a robust digital network supporting the development's education campus assets and global connectivity capabilities. Through this project, Jacobs is able to leverage its global reach to provide in house capability across the full range of planning, urban design, architecture, and engineering disciplines. The team has developed a flexible planning framework that will support a long-term implementation horizon in response to market demand. The initial phase of development is planned for 2023.



### **Technopole Fom El Qued Master Plan Laayoune, Morocco**

Already a prime region for phosphate exports, southern Morocco is poised for a new phase of growth and development. Working with the Office Cherifien des Phosphates (OCP), the world's largest exporter of phosphates and derivatives, Jacobs created a detailed master plan for a new Technopole City. The new city will serve as OCP's southern Morocco headquarters and will fill the void for a regional technology and education center. The 125-hectare site on the Atlantic coast will integrate research and development, university, housing, infrastructure, commercial, and social services facilities, and provide an improved quality of life for the region's residents. Our design strengthens the region's existing mangrove and ecological community through the integration of sea rise and tidal monitoring technologies, wastewater reuse and monitoring technologies, and portable wastewater management solutions. Street grids, pedestrian networks, blocks, and buildings are oriented and positioned based on environmental factors. Extreme arid conditions, intense sun, and prevalent year-round winds impact the city's long term functionality. The city's master plan responds to these severe environmental factors to ensure successful strategies for increased livability and mobility.







## NETWORK AND CONNECTIVITY



### **Small Cell Design: Nationwide Small Cell Design Services Confidential Client Confidential Location**

National wireless carriers are preparing to offload their macro networks in order to ready themselves for the future of 5G networks. This strategy will increase the number of existing wireless transmission locations by four times the current amount. Carriers are focused on implementing this strategy in large metropolitan areas. Jacobs is involved in field surveys, site selection, and utility coordination for construction of these small cell locations. Our work has primarily been focused on the eastern United States. Our scope includes full construction drawings for installation of these multi-tenant small cells. Over the past 18 months, Jacobs provided over 15,000 site selection and field surveys that have produced over 11,000 small cell designs for our clients.



### **Fiber Fronthaul: Laying the Foundation for the 5G Network Great Chicago Metropolitan Area, Chicago, Illinois, USA**



Our team provided program management and engineering services for design and installation for 375 miles of front haul fiber for transport of the future 5G networks. Fiber is the solution for data transmission of the many small cells that are required to make a Connected Place. This project is currently underway in the Greater Chicago area and consists of 375 miles of aerial and underground fiber optic cables within the metro area that will carry all data and transport thousands of small cell nodes across the city. Jacobs has evaluated the routing of the fiber and maximized the design for cost efficiency. We engineered all splicing and termination of the fiber at node locations to maximize cable efficiency. Along with this scope, Jacobs selected and engineered small cell (node locations) for coverage and future data collection. As carriers begin to prepare for 5G, they will offload their macro networks to densify their coverage and allow for faster data transmission over the fiber front-haul network.





## P3 ADVISORY SERVICES

### **FasTracks Denver, Colorado** **Denver Regional Transport District** **Denver, Colorado, USA**

As the first transit P3 in the US, Jacobs serves as the program support consultant, providing 50 percent of a fully integrated program team with Denver's Regional Transport District (RTD) staff. We have been fundamental in securing \$2 billion USD of federal funding; 29 percent of the overall \$7 billion USD project value, making it one of the largest transit projects ever undertaken in the United States. As a client agent and advisory for technical, finance, and design aspects of the program, we have managed preliminary designs and environmental analyses of ten projects, supporting procurements and the securing of funding from the Federal Transit Administration. Jacobs has exceeded the expectations of RTD and lenders by delivering the first FasTracks light-rail corridor eight months ahead of program and under budget. This allowed the RTD to widen the scope to include two future rail corridors, and retain the original budget; further improving the scheme and the services to the community.



### **Luis Muñoz Marín International Airport Privatization** **Puerto Rico Ports Authority** **Puerto Rico**

Under the Federal Aviation Administration's Airport Privatization Pilot Program, the Puerto Rico Ports Authority completed the first privatization of a large commercial airport in the United States in 2013. The competitive bidding process attracted world-class operators with histories of enhancing air service and contributing to the local economy. With our assistance, the Authority entered into a 40-year lease with Aerostar Airport Holdings, LLC, a joint venture of Aeropuertos del Sureste (ASUR) and Highstar Capital, for the development and operation of Luis Muñoz Marín International Airport. In order to secure funding and partnership, our team provided services that analyzed air traffic and revenue projections, included airline negotiations, assessment of capital projects, passenger facility charges analysis, and FAA coordination.





## URBAN MOBILITY



### **City of Philadelphia, Department of Street Traffic Operations Center Philadelphia, Pennsylvania, USA**

The Streets Department/Traffic Division of the City of Philadelphia is responsible for almost 3,000 traffic signals that vary considerably in terms of operation, from being controlled by a centralized signal software via a fiber optic communications network, to isolated electromechanical controllers. Through city signal system projects and the PennDOT reconstruction efforts on I-95, the ability to actively manage the traffic signals has been growing. Jacobs is helping the City of Philadelphia achieve major milestones through our Connected Places solutions that envelope systems engineering processes across subsystems and with stakeholders, to produce a continuous design and development process. The development of a Traffic Operations Centre (TOC) is a necessity given that the City will fundamentally change the way it manages the arterial street system through the expansion of the signal system and deployment of Intelligent Transportation Systems devices. The TOC serves as a nerve center for the City's street network that provides the ability to actively manage traffic signals, provide situational awareness, enhance incident management, promote corridor management, and improve interagency coordination.



### **Nevada Connected Vehicle and Autonomous Vehicle Program Nevada Department of Transportation Statewide, Nevada, USA**



Jacobs is working with the Nevada Department of Transportation (NDOT) to develop and implement policies and programs for accelerating the progress of Connected Vehicles (CV) and Autonomous Vehicles (AV) throughout Nevada and the United States. Our team is collaborating with a joint coalition consisting of NDOT, the Nevada Governor's Office of Economic Development, the Department of Motor Vehicles, Nevada Business and Industry, and the Department of Public Safety. Our team has developed a series of key policy deliverables including a summary of national and international CV/AV activities, a SWOT analysis, goals and objectives, and technical and engineering assessments for CV/AV projects. We have also identified a number of future projects, including a multimodal CV/AV test facility, autonomous snow plows, and automated transit along key business and tourist corridors.







## UTILITIES

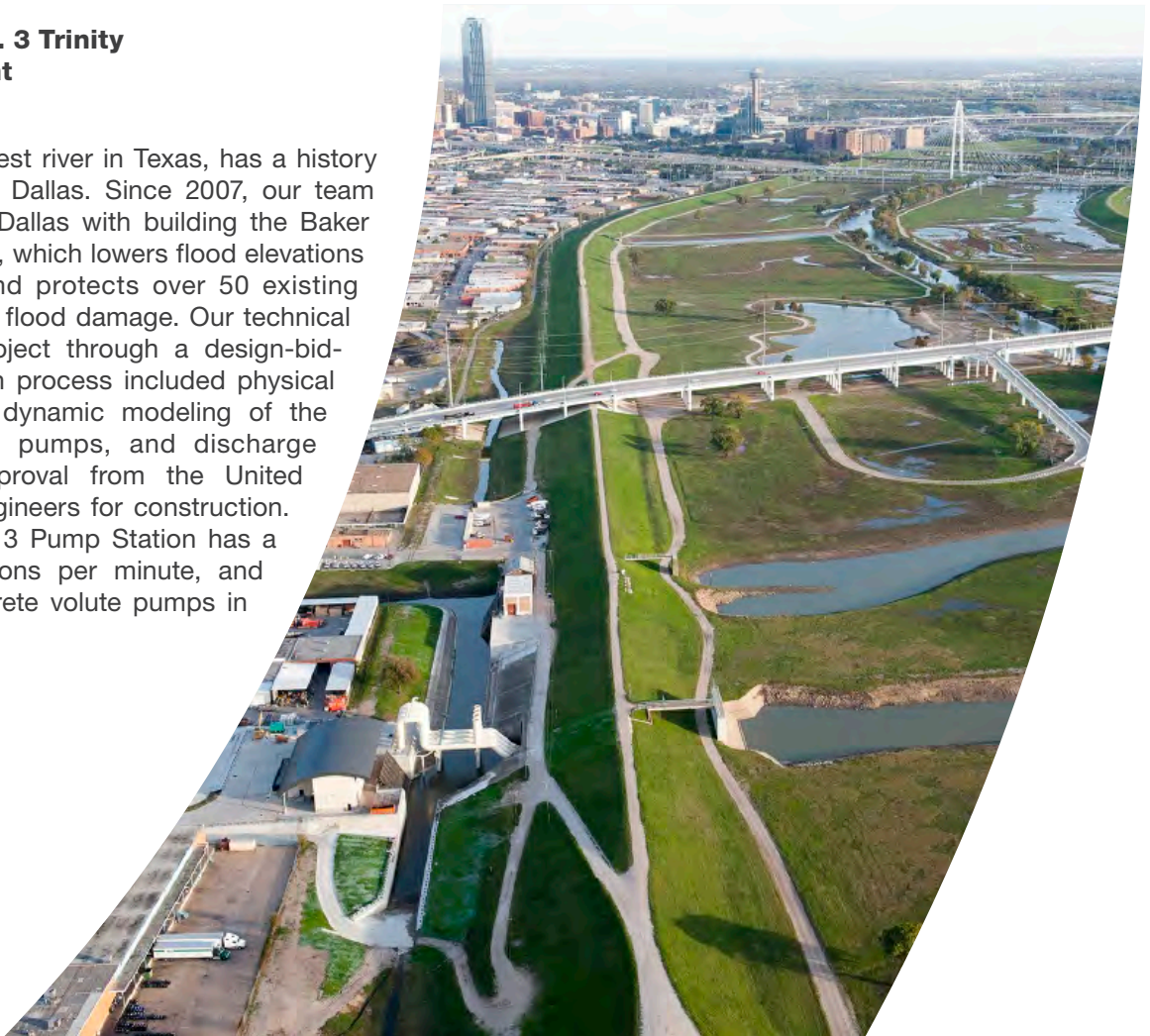
### **Cairns Cleaner Seas Northern and Southern Wastewater Treatment Upgrades *Cairns, Australia***

Australia's Great Barrier Reef is one of the seven natural wonders of the world, and the only living thing on earth visible from space. However, this irreplaceable natural resource is threatened by continued urban growth along Australia's coast. The Cleaner Seas Project is a multi-billion dollar effort to upgrade wastewater treatment facilities in the Cairns region. To date, it has achieved an 80 percent reduction in nutrient loading. Our team upgraded the Southern Wastewater Treatment Plant (SWWTP) and Northern Wastewater Treatment Plant (NWWTP) through conversions to membrane bioreactors. The SWWTP now produces 19.5 million liters of Class A recycled water daily, and the NWWTP innovatively maximizes its brownfield site, which is constrained by height limits from the nearby Cairns International Airport.



### **Baker Pump Station No. 3 Trinity Watershed Management *Dallas, Texas, USA***

The Trinity River, the longest river in Texas, has a history of destructive flooding in Dallas. Since 2007, our team has assisted the City of Dallas with building the Baker No. 3 Water Pump Station, which lowers flood elevations in parts of downtown and protects over 50 existing businesses from potential flood damage. Our technical experts delivered the project through a design-bid-build process. The design process included physical and computational fluid dynamic modeling of the collection sump, intake, pumps, and discharge piping and required approval from the United States Army Corps of Engineers for construction. Now built, the Baker No. 3 Pump Station has a capacity of 700,000 gallons per minute, and features the largest concrete volute pumps in the United States.








## **INTEGRATED INFRASTRUCTURE**



### **Aurangabad Industrial City (AURIC) Program Management Aurangabad, India**

CH2M, now Jacobs, is the Program Manager for Aurangabad Industrial Township Limited, a partnership between DMICDC (agency of Government of India) and MIDC (agency of Government of Maharashtra), that introduces AURIC, one of the first smart industrial cities in India. AURIC takes pride in developing the first underground cabling system in India for industrial use, ensuring reliability of power with an efficient supervisory control and data acquisition SCADA system. Deployment of Information and Communication Technologies (ICT) will promote effective urban management, thus streamlining city functions. A centralized command and control facility will maintain and monitor citywide utilities to help achieve operational efficiencies across resources use and workforce. Business residents and visitors alike will benefit from an integrated ICT platform that provides smart traffic management, smart grid, and smart housing that will connect smart communities to the rest of the world through high-speed communications, transmission, and digital information systems.



### **National Geospatial-Intelligence Agency Campus East Fort Belvoir, Virginia, USA**



In 2011, the National Geospatial-Intelligence Agency (NGA) was challenged to consolidate six Washington, DC area sites into a single facility that could accommodate 8,500 professionals in an innovative, technology-right workplace. The agency and United States Army Core of Engineers hired Jacobs experts for full service programming, master planning, architectural and engineering design, construction documentation, and construction administration of the campus. The final design was driven by a cultural transformation mandate to meet future mission goals along with significant requirements for reliability, flexibility, sustainability, and expandability in compliance with national security criteria. Its emphasis on sustainability earned the NGA campus LEED Gold certification.





## RESILIENCY

### **MTA New York City Transit Flood Mitigation Study and Preventive Measure Concepts *New York, New York, USA***

Superstorm Sandy caused tremendous damage to New York City Transit (NYCT) structures and facilities. The storm surge caused flooding of transit structures, tracks, and facilities in low lying areas resulting in significant damage to electrical, mechanical, signal, and communication systems. To make the low lying areas more resilient to flooding, Jacobs technical experts performed mitigation studies and provided preventive measure concepts to harden the electrical distribution systems for seven below-river MTA tubes in Lower Manhattan. After assessing each tube, our team developed reports on existing conditions and proposed hardening concepts that will enable each tube to withstand similar stresses in the future.



### **Hong Kong Preventive Landslip Works *Hong Kong, China***

Despite a population of over seven million, Hong Kong is a 60 percent natural area and characterized by steep, rugged terrain. As the City continues to grow, increasing pressure is put on these slopes, resulting in dangerous landslide conditions. Jacobs technical experts have been involved in Hong Kong's Preventive Landslip Works to address slope stability since the 1990s. Over this period, we have assessed slope stability, ranked grades, performed ground investigations, and designed and supervised construction of retaining wall infrastructure. The high number of slopes requiring stabilization has necessitated cost-efficient responses—our experts have been at the forefront of innovation to assist Hong Kong with cost efficiencies, including looking at soil nail design methods to minimize construction materials without sacrificing slope stability.







## SAFETY AND CYBER SECURITY



### **Massport Data Centre Consolidation Statewide, Massachusetts, USA**

The Massachusetts Port Authority (Massport) develops, promotes, and manages State of Massachusetts airports, seaports, and transportation infrastructure, including Logan International Airport. In 2008, Massport officials began working with Jacobs experts to reduce Information Technology (IT) costs. Our team led Massport in increasing its efficiency through data center optimization and consolidation, data server design, and improved network security. Through the innovative use of technology, our team has increased Massport's server utilization by up to 80 percent, reduced hardware requirements by a ratio of 10:1, increased IT operational agility, and has reduced carbon emissions to the atmosphere equivalent to the planting of 2,100 trees. Also, by implementing VMWare technology and a storage area network, Massport can now secure server images in a central location for rapid operations recovery in the event of a disaster.



### **Amtrak Advance Controls System Network Pennsylvania Station New York, New York, USA**



Technology has enabled incredible advancements in infrastructure, but has also made our cities more vulnerable to cyber-attacks. In conjunction with our partner, Advanced Control Systems (ACS), our experts work to protect Amtrak's network security at Pennsylvania Station in New York City, a major data hub for the company. The project involves an assessment of the existing supervisory control and data acquisition (SCADA) network, and identifying potential cyber-security threats. Specifically, our team is performing port and vulnerability scans, network device configuration reviews, testing, reviewing server system vulnerabilities, black box testing from various locations throughout the city, and identifying single points of communication failures between various sites. The goal is to provide recommendations that will help Amtrak create an efficient and encrypted SCADA network that would be impenetrable to malicious hacking.





## OPERATIONS AND ASSET MANAGEMENT

### **Stanford Health Care Enterprise Asset Management System Palo Alto, California, USA**

Jacobs partnered with Stanford Health Care (SHC) to develop a strategic asset management program and launched a series of initiatives to develop an optimal service delivery framework to support on-campus facilities, as well as the growing number of facilities within SHC's expanding geographical region. Jacobs developed a long-term comprehensive asset management strategy combining existing building management technology and new intelligent building systems to provide a life-cycle asset management implementation roadmap across the entire multi-state portfolio. Our team configured and implemented an enterprise level asset management technology solution as the portfolio management and data analytics framework. The Integrated Asset Management Program included real-time performance monitoring, hand-held technology capability, autonomous vehicle integration, and portfolio-wide performance management, which reduced risk using Reliability Centered Maintenance analysis for critical systems. The Integrated Asset Management Plan resulted in a 20% initial portfolio cost savings achieved through efficiencies in material management tracking over a five-year period.



### **Citywide Operations Management City of Centennial, Colorado, USA**

Striving to increase the level of focus and service for the citizens of Centennial, city leaders selected CH2M, now Jacobs, as their partner for delivering comprehensive public works services. The City of Centennial is the seventh-largest city in the Denver metro area with approximately 100,000 residents. Our team launched Centennial's Public Works Department — a new city-managed organization, that delivers a complete range of services including traffic engineering and operations, permit processing, inspections, administrative services, and street and roadside maintenance. At the time, this partnership was thought to be among the largest outsourcing of public works services to a private contractor in the country. Our team created a consolidated customer service center serving as a single point-of-contact for all citizens' concerns, including public works. Most recently, we developed and are employing a concept of operations and implementation plan to enhance and expand Centennial's existing traffic signal control system and other arterial Intelligent Transportation System (ITS) components.







### **Light Rail Transit, Tri-County Metropolitan Transportation District (TriMet)**

**Portland, Oregon, USA**

Jacobs provided preliminary and final design for a one-mile extension to TriMet's Light Rail Transit (LRT) service in downtown Portland – creating a major new downtown entry for the city. Services included traffic evaluation, urban design, station architecture, landscaping, street lighting, trackway and drainage design, and geotechnical and structural engineering. Innovative design resolved complex right-of-way and grading challenges, reduced vibration in structures along the line, creatively repurposed contaminated soils as fill behind retaining walls, and successfully navigated high-volume intersections and LRT compatibility with existing structure restrictions. Simple wayfinding for active modes focused on the site's gateway function. Art, landscape elements, and structures celebrate and accentuate the experience. Our early focus on identifying and mitigating high-cost risk items helped TriMet plan a strategy to meet federal funding requirements and supported a laser focus on key risk areas throughout delivery.



### **Elgin O'Hare Western Access Project**

**Illinois State Tollway Authority, Illinois, USA**



As Design Corridor Manager of the Elgin O'Hare Western Access Project in metropolitan Chicago, we're helping the Illinois Tollway meet the area's diverse travel needs – improving travel efficiency, providing western access to O'Hare International Airport, creating opportunities for jobs and economic development, enhancing multi-modal connections and reducing congestion. The \$3.4B Project is currently under contract to Illinois State Tollway Authority's (ISTHA) for its largest-ever, and the state's first-ever freeway-to-toll road conversion. Our team is advancing the design for the ITS and toll systems throughout the project corridor. The scope of work includes the design of all electronic "open road" toll plazas on both mainline segments and selected ramps; full video surveillance of the entire corridor; electronic monitoring of traffic conditions; road weather monitoring; and a traveler information system, including electronic message signs. The project includes 17 miles of new roads with 15 new or improved interchanges as part of a new, all-electronic toll (AET) road. The 15 miles of toll roads and 124 miles of local road improvements feature mainline lanes instrumented with AET gantries and various ITS devices.











An aerial night view of a city, likely New York City, with a glowing blue network overlay. The network consists of numerous white lines connecting various points across the city, creating a complex web that suggests connectivity and infrastructure. The city lights are visible in the background, and the overall color scheme is dominated by blue and white.

Jacobs leads the global professional services sector delivering solutions for a more connected, sustainable world. With \$15 billion in fiscal 2017 revenue when combined with full-year CH2M revenues and a talent force of more than 77,000, Jacobs provides a full spectrum of services including scientific, technical, professional, and construction- and program-management for business, industrial, commercial, government and infrastructure sectors. For more information, visit [www.jacobs.com](http://www.jacobs.com), and connect with Jacobs on LinkedIn, Twitter, Facebook and Instagram.

**JACOBS**

Avinash S. Patwardhan, PhD, BCEEM  
Managing Director - Smart Cities  
Buildings, Infrastructure and Advanced Facilities  
Mobile: + 1.954.415.5484  
[avi.patwardhan@jacobs.com](mailto:avi.patwardhan@jacobs.com) | [www.jacobs.com](http://www.jacobs.com)



Appendix B

## **The Nokia Solution: Clarence-Rockland, 10G/WiFi Technical Presentation**



# Clarence-Rockland – 10G/WiFi Nokia/Jacobs/Smart City Capital

18.CA.843706 - Architecture

Clarence-Rockland

February 2019

# Clarence-Rockland

## Project objectives

Clarence-Rockland wants to be first Canadian 10G city – achieve something comparable to Chattanooga.

Priorities :

- 1 ) Provide 10 GPON to all residences in Rockland, hamlets of Clarence, Bourget, Clarence Creek and Hammond. Position architecture for neutral host approach.
- 2 ) Provide community WiFi on all streets in Rockland and hamlets of Clarence, Bourget, Clarence Creek and Hammond. Will be connected by 1G GPON using GPON SFP.
- 3 ) Provide Current by GE CityIQ systems at major intersections in Rockland and Clarence. Will be connected by 1G GPON using GPON SFP.
- 4 ) Out of current scope – future – provide private LTE to supply fixed wireless access to remote residences

Nokia scope :

Provide install and integrate all core components to support initiatives 1, 2 and 3 above.

Supply all GPON equipment up to and including ONT.

Supply all AP and WOAA power module.

Supply Current by GE CityIQ systems

Associated services

Out of scope :

All outside plant, fiber, splitters, over the top services...internet, etc.





## Clarence-Rockland Assumptions

Streetlights are 45 M apart and available everywhere we need WiFi AP

Power for WOAA taken from streetlight pole

WOAA will provide power to AP and connectivity to both AP and CityIQ

WOAA will be connected to 1G GPON ONT SFP

On intersections where we install CityIQ nodes there will be one on each corner

Municipal employees will perform AP/CityIQ installations

Jacobs or other will perform ONT installation inside homes.

Jacobs will install outdoor cabinet in Clarence Creek and provide standby generator

Two indoor data centers will be provided with full AC and power backup by Jacobs

Assume 100 CityIQ nodes

## Clarence-Rockland GPON BOM

Network Component	Product	QTY
OLT	ISAM FX 16	2
OLT	ISAM FX 8	2
ONT	XS-0250X-A	3452 (incl. 132 spares)
Residential Gateway	WiFi Gateway G240W-E	3452 (incl. 132 spares)
Core Router	7750 SR-7	2
Switch	7210-SASx	2
Rack	Indoor rack for hosting ISAM and 7750	2 (or 4)
Outdoor Cabinet	Outdoor cabinet for hosting ISAM FX 8 (in Clarence Creek)	1
CityIQ	Current by GE CityIQ nodes	100
DC Rectifiers	Rectifiers for ISAM	2 locations
NFM-P	7750 Network Management (geo-redundant)	1
AMS	GPON Network management (geo-redundant)	1
Server	Server to host AMS	2
Server	Server to host NFM-P	2

## Clarence-Rockland WiFi BOM

Network Component	Product	QTY
WLAN Controller Software	Nokia AirScale Wi-Fi Virtual Controller (HA)	2
Server+OS for WLAN Controller	Dell R640	4
AP - Access Point	AC400 (with integrated omni antenna)	42 (inc. 2 spares)
AP - Access Point	AC220 (with integrated omni antenna)	610 (inc. 24 spares)
Fiber-PoE converter	WOAA	651 + 100 (GE) (inc. 25 spares)
GPON SFP	Nokia G-010S-P GPON SFP	651 + 100 (GE) (inc. 25 spares)
Captive Portal/AAA	WaveSpot (HA)	2
Server+OS for Captive Portal/AAA	Dell R640	4
Firewall/DNS/DHCP	Fortinet FortiGate E500	2
Operator console	Windows PC	2



## Clarence-Rockland

### Nokia Services

Nokia Services:

- Installation, Design, Integration, Configuration of core elements: WLC, NPM VitalSuite, Fortinet Fortigate, NFM-P, AMS
- Assume city staff will install WiFi APs and CityIQ nodes on existing city street light poles, but Nokia will price the following support services:
  - Installation training (assume 8 staff)
  - custom set of deployment drawings/documentation (for city staff to use during installation)
- Product training for all network elements provided by Nokia including 3<sup>rd</sup> party (Fortinet, CityIQ, etc)
  - 4 network operators
  - 4 field maintenance
- Care services for 5 years
  - 60 days Repair & return
  - 8x5 emergency tech support
  - SSP
  - 3<sup>rd</sup> party maintenance (servers, PC, Fortinet Firewall, GE CityIQ, WaveSpot)

WiFi Specific :

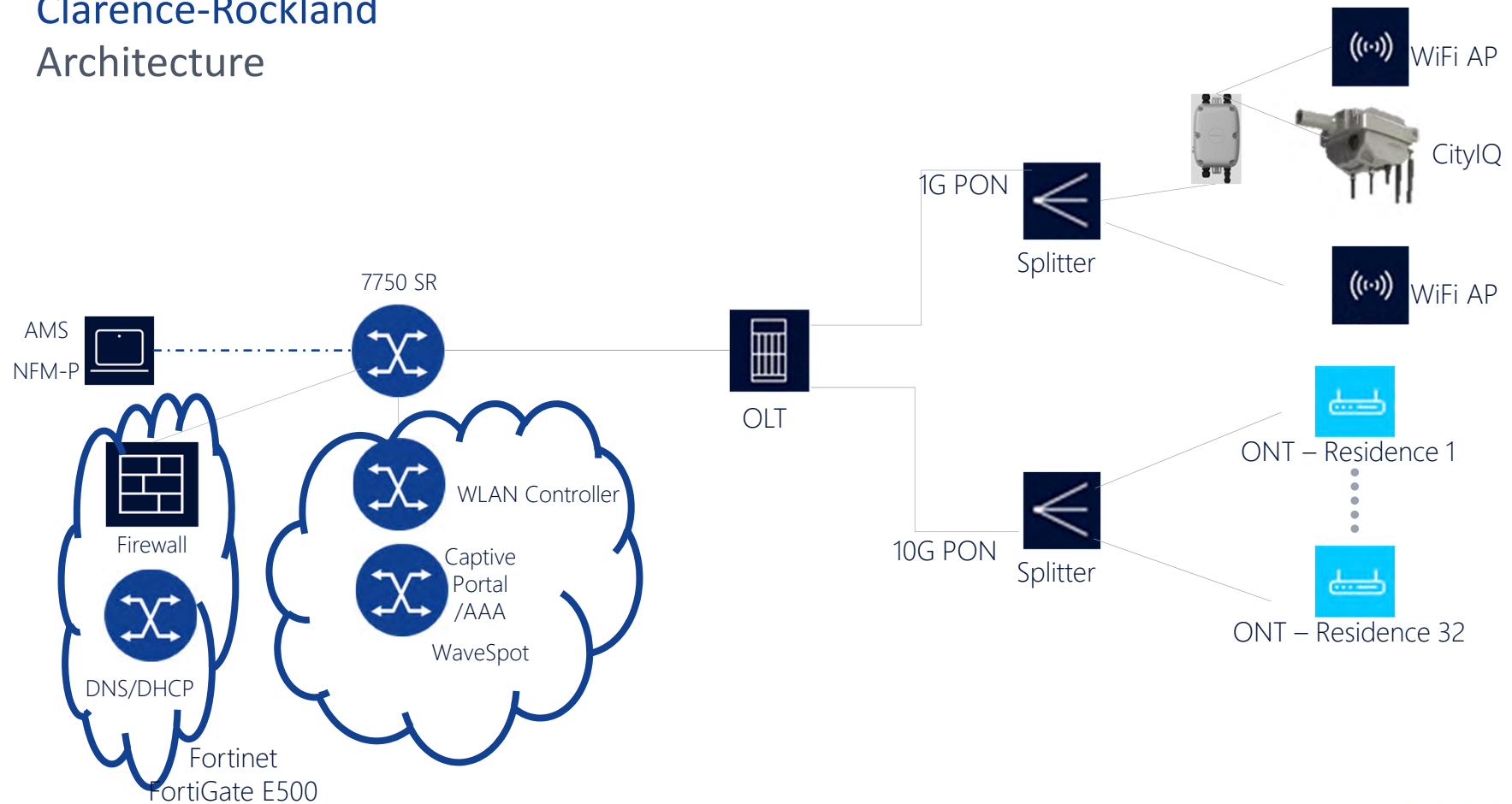
- WiFi RF Design
- WiFi coverage testing for pilot area



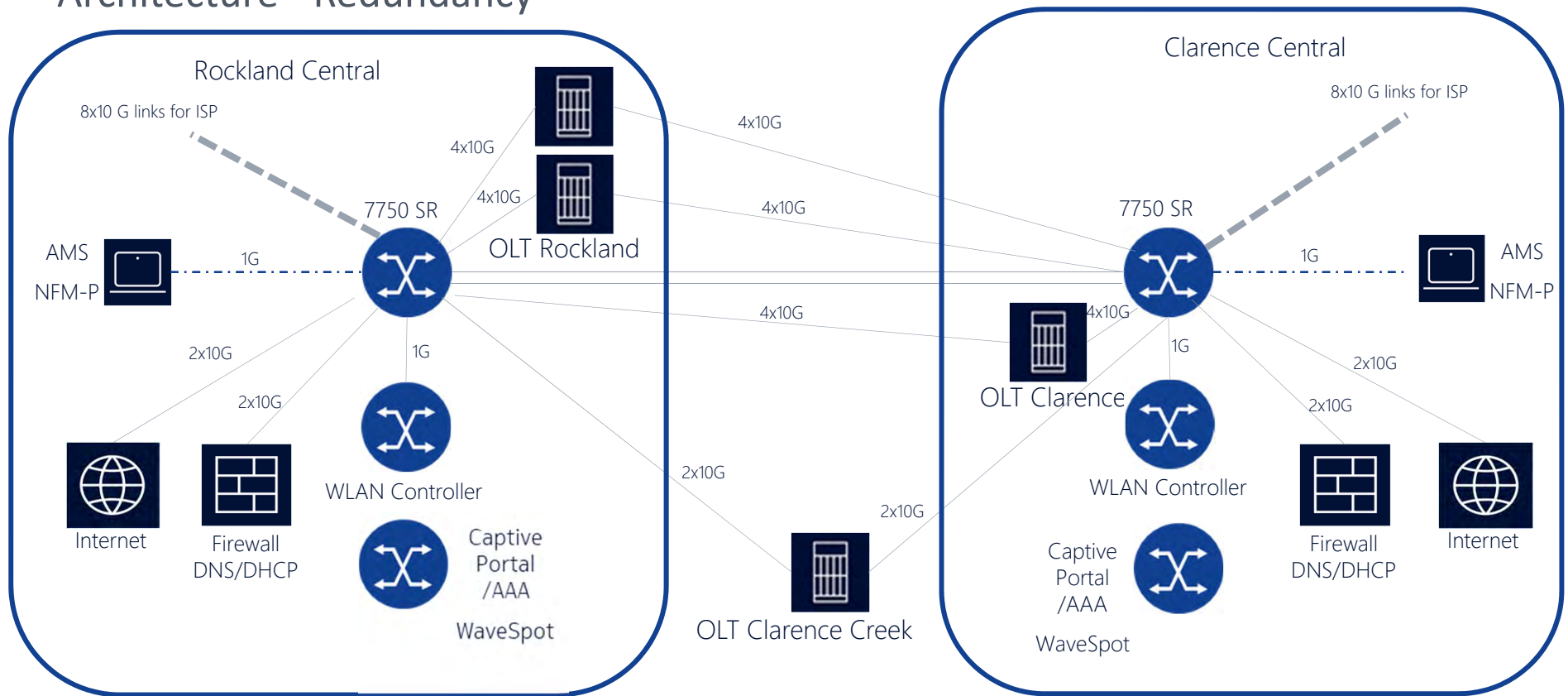
## Architecture



# Clarence-Rockland Architecture



## Clarence-Rockland Architecture - Redundancy







## Core / GPON

## Clarence-Rockland

### Core Sites:

2 core sites to provide redundancy (likely 1 in Rockland other in Clarence)

Each core site shall include:

1 AMS geo-redundant

1 NFM-P geo-redundant

1 7750 + 1 7210

OLT FX 16

Wireless LAN Controller

Firewall/DNS/DHCP

Captive Portal/AAA

Administrative console (PC)

1 additional OLT site in Clarence Creek (because distance Rockland to Bourget is 25 km)

## Clarence-Rockland GPON Residential

### Rockland

10GPON to 5000 residences in Rockland

1G GPON to light poles with WiFi APs :440

1G GPON to light poles with City IQ Current by GE : 100

### Clarence

10GPON to 2500 (approx.) residences

1G GPON to light poles with WiFi APs :56

### Bourget + Clarence Creek + Hammond

10GPON to 800 (approx.) residences

1G GPON to light poles with WiFi APs : 130

Number of 10 ONT : assume 40% take rate on 8300 residences

For AP and GE nodes 1G SFP ONT will be used



## Clarence-Rockland GPON Estimates

Rockland :

$5000/32/8 = 20$  10GPON OLT cards

$440 + 100 \text{ (GE)} / 32 / 16 = 2$  GPON OLT card

Clarence :

$2500/32/8 = 10$  10GPON OLT cards

$56 / 32 / 16 = 1$  GPON OLT card

Clarence Creek :

$800 / 32 / 8 = 4$  10 GPON OLT cards

$130 / 32 / 16 = 1$  GPON OLT card

ONTs :

8300 @ 40% take rate = 3320



WiFi

## Clarence-Rockland – Community WiFi

### Rockland, Clarence + hamlets

For WiFi assume mixed suburban/rural coverage: 180m, no inbuilding penetration...outdoor public areas only

AC400 4x4 MIMO AP in urban areas (Laurier St, Hwy 17 by Canadian Tire – est. 7 km of roadways)

AC220 2x2 MIMO AP in remaining areas

Rockland: 79km of roads -> 40x AC400, 400x AC220

Clarence: 10km of roads -> 56x AC220

Clarence Creek: 5km of roads -> 28x AC220

Bourget: 14km of roads -> 80x AC220

Hammond: 4km of roads -> 22x AC220

Total: 626 WiFi APs (40x AC400, 586x AC220)

2x WiFi LAN controllers at redundant CO/datacenter sites (one in Rockland, one in Clarence)

2x WaveSpot to provide Captive Portal and WiFi analytics

2x Fortinet Fortigate 500E at redundant CO/datacenter suites

2x operator console computers, one per CO/datacenter





## Details about location

## BUSINESS CASE: Rockland Market (Phase 1)

Dense Areas – 60 Private Dwellings / km (Estimate)



Population and dwellings	
Population, 2016 <sup>1</sup>	12,302
Population, 2011 <sup>1</sup>	10,980 <sup>1</sup>
Population percentage change, 2011 to 2016	12.0
Total private dwellings <sup>2</sup>	4,964
Private dwellings occupied by usual residents <sup>3</sup>	4,873
Population density per square kilometre	1,785.4
Land area in square kilometres	6.89

<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=POPC&Code1=0719&Geo2=PR&Code2=35&Data=Count&SearchText=Rockland&SearchType=Begin&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=0719&TABID=1>

## BUSINESS CASE: Clarence-Rockland (Phase 2 – Hybrid Option)

26 Private Dwellings / km (Estimate)



Population and dwellings	
Population, 2016 <sup>1</sup>	24,512
Population, 2011 <sup>1</sup>	23,185
Population percentage change, 2011 to 2016	5.7
Total private dwellings <sup>2</sup>	9,537
Private dwellings occupied by usual residents <sup>3</sup>	9,329
Population density per square kilometre	82.3
Land area in square kilometres	297.71

**KMs of Selected Road = 250KM (~6,500 Dwellings)**

<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?lang=E&Geo1=CSD&Code1=3502036&Geo2=PR&Code2=35&Data=Count&SearchText=Clarence-Rockland&SearchType=Begin&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3502036&TABID=1>



## BUSINESS CASE: Bourget



### Population and dwellings

Population, 2016 <sup>1</sup>	1,169
Population, 2011 <sup>1</sup>	1,080
Population percentage change, 2011 to 2016	8.2
Total private dwellings <sup>2</sup>	440
Private dwellings occupied by usual residents <sup>3</sup>	428
Population density per square kilometre	525.1
Land area in square kilometres	2.23

**KMs of Selected Road = 14 KM**

<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?lang=E&Geo1=CSD&Code1=3502036&Geo2=PR&Code2=35&Data=Count&SearchText=Clarence-Rockland&SearchType=Begin&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3502036&TABID=1>



## Products



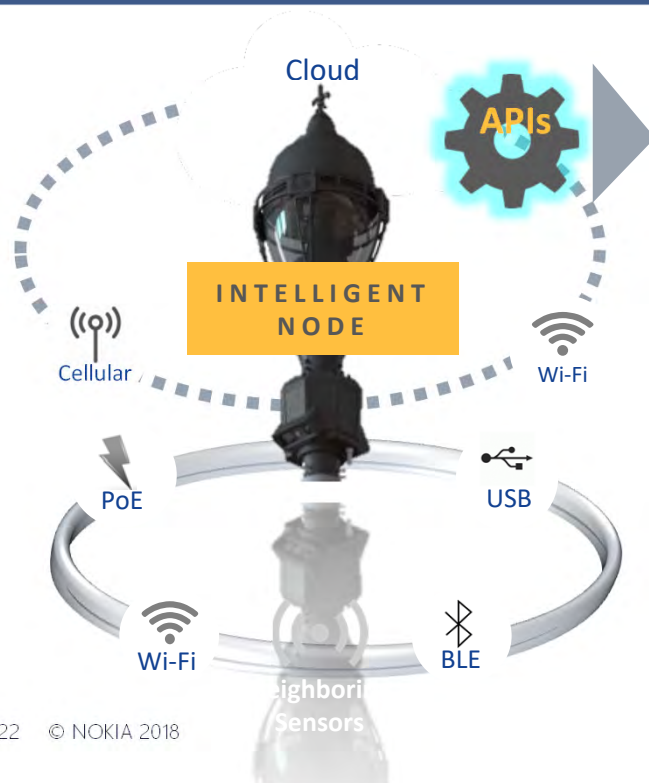
CityIQ



ENABLING DIGITAL INFRASTRUCTURE WITH

# CityIQ™ IoT Platform

Designed with Future-proofed City in Mind



## REAL-TIME & HISTORICAL

Traffic  
Parking  
Pedestrian  
Media  
Environmental  
Other

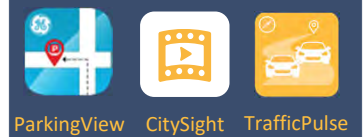
## DEVELOPERS

Partners  
SIs  
Entrepreneurs  
Incubators  
High School  
College  
Hackathons  
Etc.

## APPLICATIONS



## REFERENCE APPS



**NOKIA**

STARTING WITH

# Universal Intelligent Nodes for All Street Lights.

Multi-sensor Hub | Extensible thru OTA Upgrade | Sensor Fusion for Neighboring Devices



# CityIQ™ Transforms Lighting Network into Ubiquitous Digital Infrastructure

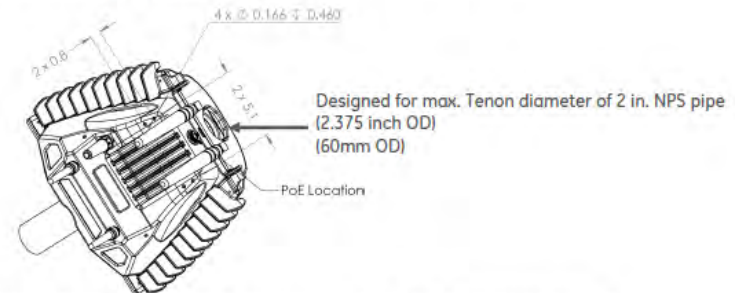
## Universal Intelligent Node Specifications – Horizontal Node for Area or Roadway Light Poles



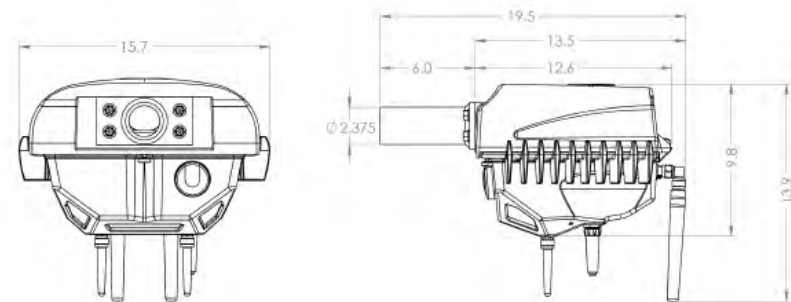
### Mechanical

- CityIQ Node Weight: 30 lbs..
- Ingress Protection: IP65 lower housing compartment made in cast aluminum (includes all electronics and sensors)
- Vibration Rating\*: Meets 3G vibration per ANSI C136.31-2010
- Max Weight of the Luminaire: 30 lbs.
- Luminaire Mounting: 2" slipfitter arm
- EPA: 1.00 ft<sup>2</sup> (0.093 m<sup>2</sup>)

\*Tested at 2 in. NPS pipe



Standard Mounting Holes for Accessories (i.e. Wi-Fi access point)



Dimensional Drawing (all dimensions are in inches)





## WiFi AP and Controller

## High performance Outdoor AP (4x4 MIMO, Wave-2)

### AC400 - High performance Outdoor AP (4x4 MIMO, 802.11ac Wave-2)\*

Specification	Details
Wi-Fi Access	802.11a/b/g/n/ac dual-band 4x4
Band Frequency	2.4GHz and 5GHz Operating in concurrent mode 2.4GHz: 2.4000GHz~2.4835GHz 5GHz: 5.150~5.250GHz, 5.250~5.350GHz, 5.470~5.725GHz, 5.725~5.850GHz; 4.9425GHz~4.9825GHz
Output Power per chain	2.4GHz: 23dBm; 5GHz: 23dBm
PoE	PoE++
Physical Size	Dimensions: 49/55/25cm x 24 cm x 6 cm; ≤3.5kg
Concurrent Clients	255 per radio
Backhaul	2x1 GigE port
Antenna	Configuration: 4 Tx / 4 Rx MIMO Internal dual-band integrated antenna or External antennas connected to 4 RP-SMA connectors
Operating temperature	-40°C to +65°C
Mounting	Wall & Pole mounting
USB	1x USB 3.0

Product Codes: WO4C



\*Includes support for all 4 variants – external antenna, integrated omni antenna, integrated directional antenna and integrated small omni antenna (last one with Wi-Fi 17)

## High performance Outdoor AP (2x2 MIMO, Wave-2)

### AC220 - High performance Outdoor AP (2x2 MIMO, 802.11ac Wave-2)

Specification	Details
Wi-Fi Access	802.11a/b/g/n/ac dual-band 2x2
Band Frequency	2.4GHz and 5GHz Operating in concurrent mode 2.4GHz: 2.4000GHz~2.4835GHz 5GHz: 5.150~5.250, 5.250~5.350, 5.470~5.725, 5.725~5.850 GHz
Output Power per chain	2.4GHz: 23dBm;5GHz: 23dBm
PoE	802.3af PoE
Physical Size	Dimensions: 260(L)x140(W)x71mm(H)
Concurrent Clients	512 per AP
Backhaul	1x1 GigE port
Antenna	Configuration: 2 Tx / 2 Rx MIMO Internal dual-band integrated antenna or External antennas connected to 2 RP-SMA connectors
Operating temperature	-45°C to +65°C
Mounting	Wall & Pole mounting
USB	1x USB 2.0 (reserved)

Product Codes: WO2B\WO2C\WO2D

Rear view WO2B\WO2D



Rear view WO2C



Front view  
WO2B\WO2C\WO2D



\*Includes support for 3 variants – external antenna, integrated directional antenna and integrated small omni antenna



## Nokia AirScale Wi-Fi Virtual Controller

### Feature highlights

- Entry level, Cost effective, Distributed, Wi-Fi Virtual controller VNF deployable on any x86 (VT Enabled) based COTS HW
- Supports VMware ESXi based platform
- Flexible deployment options with Optimized resource footprint
- Single highly available virtual controller instance supports up to 10,000 Nokia AirScale APs from Wi-Fi 18A
- Flexible scaling as per expansion plan –
  - Option 1 – provisioning of [0-500] AP's supported.
  - Option 2 – provisioning of [500-2000] AP's supported.
  - Option 3 – provisioning of [2000 – 10,000] AP's supported.



## Nokia AirScale Wi-Fi Power and backhaul Options

### Auxiliary Power Module \*

Power & Backhaul options



- Power options:
  - AC,
  - DC,
  - power over Cable or Fiber
- Backhaul options:
  - 1000Base-BX-D,
  - 1000Base-BX-U,
  - 1000Base-LX,
  - Nokia G-010S-P GPON SFP, SFP+
- 1 x GE with PoE++
- Opt: 1 x GE with PoE+

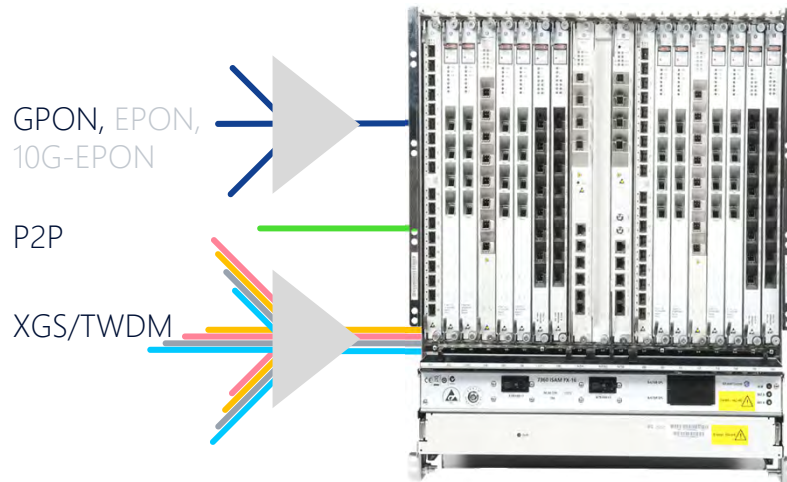


## GPON OLT / ONT / Gateway



# Nokia's universal next generation PON platform

7360 ISAM FX-16



7360 ISAM FX-8



7360 ISAM FX-4



7362 ISAM SF-8



7362 ISAM DF-16



From **GPON** to **10G PON** without fork-lift

Universal approach for the right service at the right cost

10Gb/s Symmetrical services

TWDM wavelengths mobility

Market leading **capacity**:  
10 Tb/s total  
2.5Tb/s switching  
360 Gb/s uplink

Different form factors for deployment flexibility and **cost-efficiency**

## ALP-117 FX-8 Equipped Cabinets

- Houses 7360 FX-8 shelf
- 1,450W Heat Exchangers
- 53" Tall, 42" Wide, 25" Deep
- 67" Tall with battery riser
- Estimated weight 315 lbs
- Pad Mount or pole mount



## 10 G ONT XS-250-X

The Nokia Intelligent Services Access Manager (ISAM) Optical Network Terminal (ONT) XS-250X-A with one 1/10 Gigabit Ethernet (GigE), four GigE, and two plain old telephone service (POTS) ports is part of the industry-leading Nokia 7368 ISAM ONT product family and is compatible with the Nokia 7360 ISAM fiber to the x (FTTx) product line. It is designed to deliver triple play services in a fiber to the home (FTTH) environment to single family units (SFUs) where multiple Ethernet and voice ports are required. The Nokia ONT terminates the 10 G symmetrical Passive Optical Network (XGS PON) fiber interface that is compliant with a Full Service Access Network (FSAN).

The Nokia 7368 ISAM ONT XS-250X-A is designed for small businesses and residential customers. This ONT offers data, voice and video services to the subscriber through FTTH or fiber to the premises (FTTP) applications. The XS-250X-A is a temperature-hardened ONT for outdoor and indoor deployments. For outdoor deployment, the XS-250X-A should be mounted in a Nokia universal SFU ONT enclosure.

The ONT XS-250X-A is compliant with ITU-T G.9807.1, supporting a line rate of 10 Gb/s downstream and 10 Gb/s upstream. With XGS PON as the uplink interface, the ONT XS-250X-A supports standard triple play services: voice, video and high-speed internet access to support home networking. Compliant with the standard optical



network unit (ONU) management and control interface (OMCI) definition, the ONT XS-250X-A can be managed from a remote site using application management services (AMS) and supports the full range of fault, configuration, accounting, performance, and security (FCAPS) functions.



## Nokia WiFi premium gateway and beacon



# Residential Gateway



## WiFi Gateway G240W-E

### GPON

Line rate: 2.488 Gb/s downstream, 1.244 Gb/s upstream

- GPON Encapsulation Method (GEM) mode support for IP/Ethernet service traffic support
- ITU-T G.984.3-compliant dynamic bandwidth report (DBR)
- ITU-T G.984.3-compliant Advanced Encryption Standard (AES) in downstream
- ITU-T G.984.3-compliant forward error correction (FEC)
- ITU-T G.988 Appendix 1 and Appendix 2 OMCI

### Ethernet interfaces

- Four 10/100/1000Base-T interfaces with RJ-45 connectors for LAN side

### WLAN interfaces

- Supports 3x3 802.11b/g/n 2.4 GHz wireless LAN (WLAN) interface
- Supports 4x4 802.11ac 5 GHz WLAN interface with multi-user multiple input, multiple output (MU-MIMO)
- Maximum effective isotropic radiated power (EIRP) on 2.4 GHz up to 500 mW and 5 GHz up to 1 W
- 64-bit and 128-bit Wired Equivalent Privacy (WEP) support
- Wi-Fi Protected Access (WPA) support including Pre-Shared Key (WPA-PSK) and WPA2
- Media access control (MAC) filters

### Router mode

- IPv4 and IPv6 connectivity: Dual stack and DS Lite, stateless and stateful auto-configuration, DHCPv6 prefix delegation
- Point-to-Point Protocol over Ethernet (PPPoE) and IP over Ethernet (IPoE)
- Network Address Translation (NAT), port forwarding, demilitarized zone (DMZ) and firewall
- Dynamic Host Configuration Protocol (DHCP), domain name system (DNS) proxy and dynamic domain name system (DDNS)
- Internet Group Management Protocol (IGMP) v2/ v3 proxy/Multicast Listener Discovery (MLD) proxy
- Virtual private network (VPN) pass-through for Point-to-Point Tunneling Protocol (PPTP), Layer 2 Tunneling Protocol (L2TP) and IPSec
- Flexible video delivery options over Ethernet or wireless
- TR-069 for remote management

### POTS

- Two FXS ports for voice over IP (VoIP) service with RJ-11 connectors
- Multiple codecs: ITU-T G.711, ITU-T G.729 (A and B)
- Session Initiation Protocol (SIP) (RFC 3261)
- ITU-T G.168 echo cancellation
- Services: caller ID, call waiting, call hold, 3-way call, call transfer, message waiting indication
- Maximum 5 ringer equivalency numbers (RENs) per line

\*Partial list full list of features in datasheet.

**NOKIA**



## Network Management - GPON



# 5520 Access Management System Overview

## Adapting to your organization

- Same management for GPON, DSL and Ethernet access
- Scalability, from small to large network deployments
- Support for new network-element releases with hot-pluggable modules
- Ability to host GUIs on individual PCs or centralized "presentation" servers
- Extendable with value added applications
- Authenticating using local or corporate DB (RADIUS/LDAP)
- Full set of high availability solutions (act-stby, act-act, hot stby, geo redundancy)
- Full Virtualization support

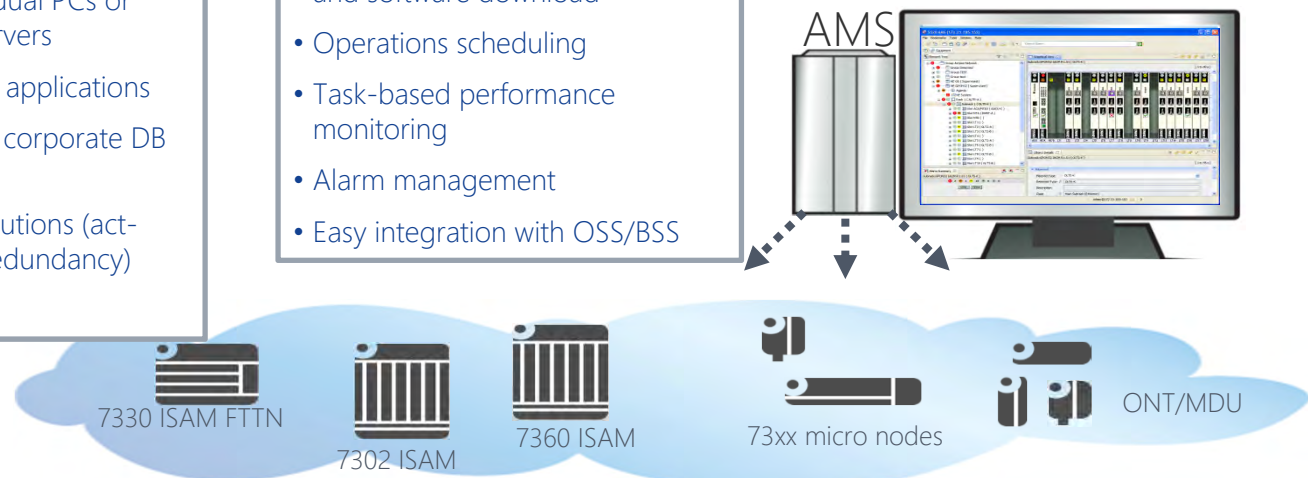
## Optimizing your operations

- Rich set of functionality simplifies operations and increases efficiency
- Equipment profile and configuration templates
- Network-element backup, restore and software download
- Operations scheduling
- Task-based performance monitoring
- Alarm management
- Easy integration with OSS/BSS

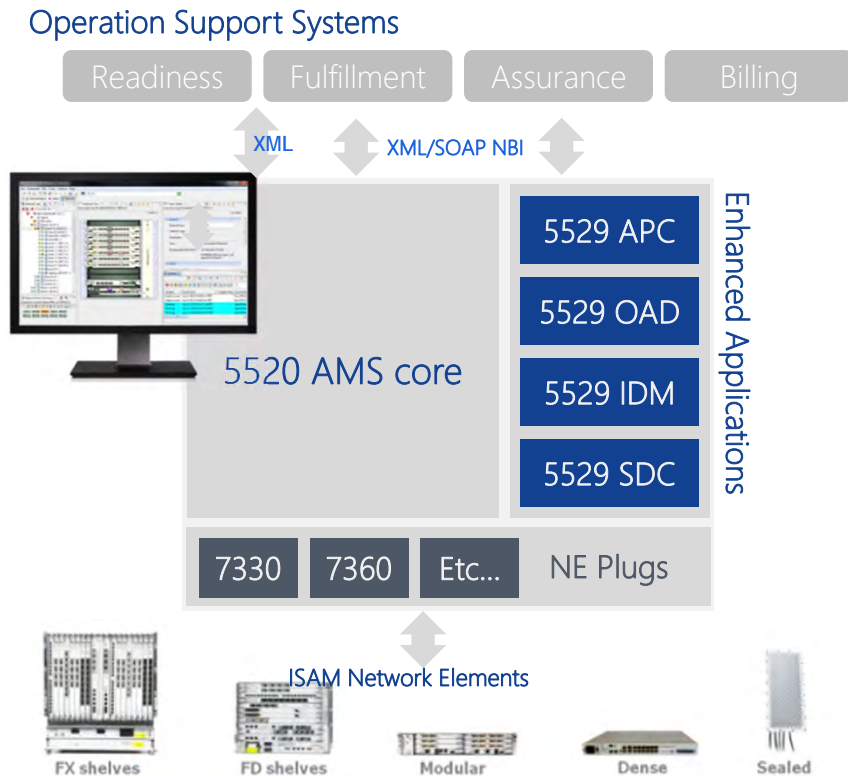
Nokia 5520 AMS is based on Java™ technology

Runs on standard x86 based hardware

Integrated management of all new-generation access network elements



## 5520 Access Management System (AMS)



### Element Management for the ISAM portfolio

Configuration, inventory, alarm, performance and software management

Intuitive GUI reduces learning curve

Plug-and-play XML/SOAP-based OSS interfaces

Scalability, from very small to very large networks

5529 enhanced applications

- Access Provisioning Center (APC)

- Use service templates to accurately provision new services

- OSS Alarm Dispatcher (OAD)

- Manage all alarms in your access network

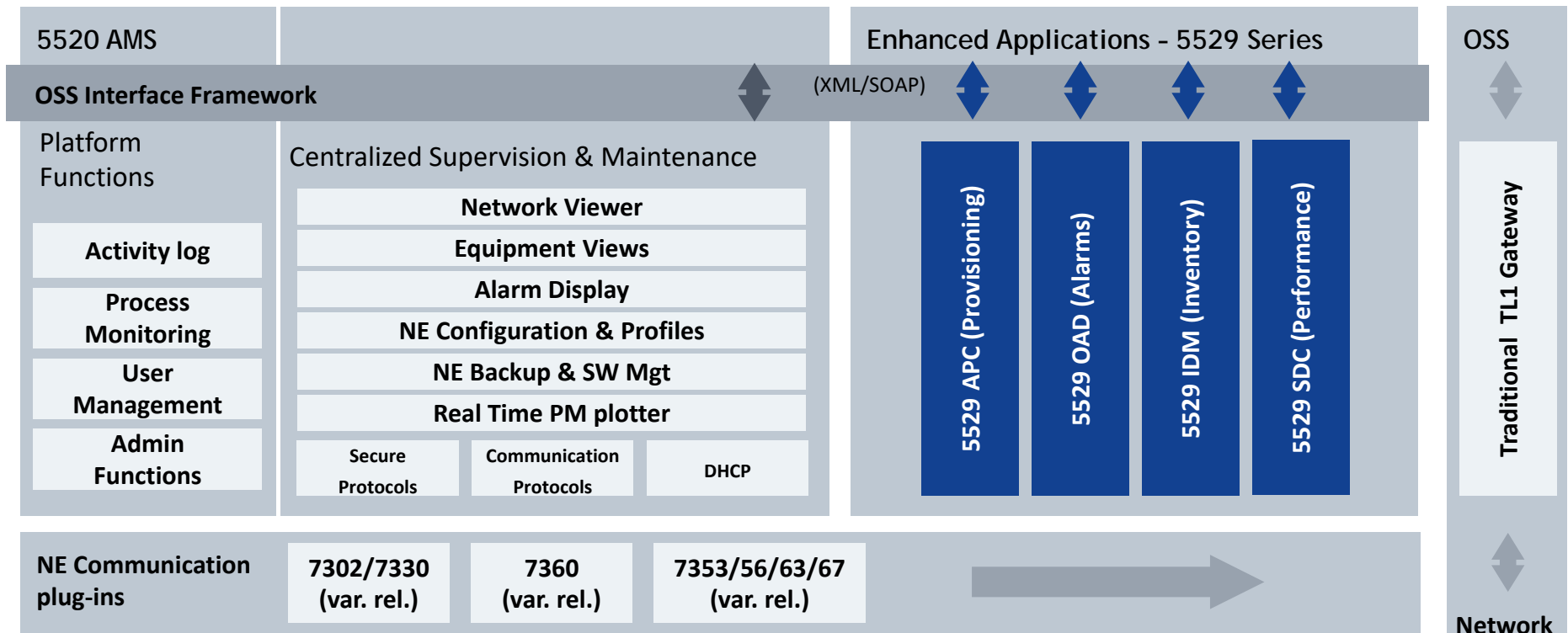
- Inventory Data Manager (IDM)

- Maintain an up to date data base of all NEs, line cards etc..

- Statistics and Data Collector (SDC)

- Efficiently collect data from all access NEs

# 5520 Access Management System Architecture





## 5520 Access Management System Redundancy

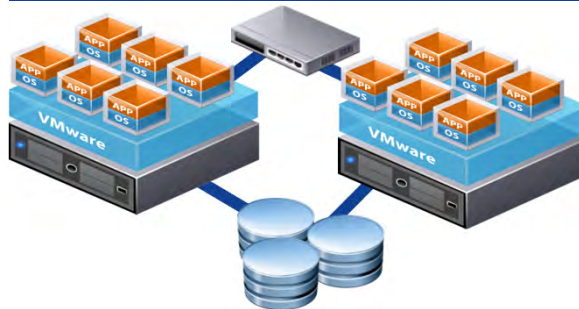
### Local Redundancy

- High availability through local redundancy (clustering), load balancing, distribution of functionality across multiple server nodes
- Allows performance improvements and scalability up to 300 concurrent users, 8M ports, 50 000 NEs per cluster

### Geographical Redundancy

- Redundancy across a wide-area network supports disaster recovery
- Warm-standby capability (applications are not running concurrently at both sites)
- Continuous synchronization of data between geographical sites

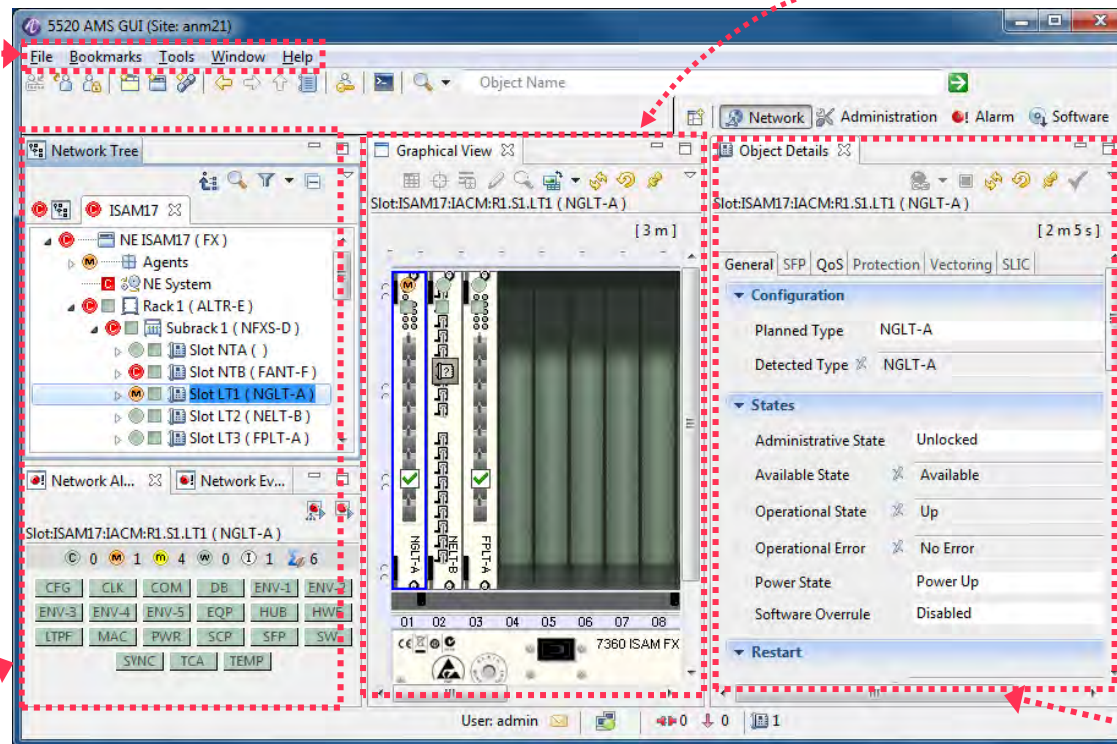
### Virtualization



## 5520 AMS GUI Overview

Simple, short menu list to avoid losing a user's patience by hunting through big menus

Comprehensive object tree allowing navigation to the deepest levels of the network while providing simultaneous access to alarm status



Clear graphical visualization of all elements of Access Network, displaying key status information – easily switchable to tabular format

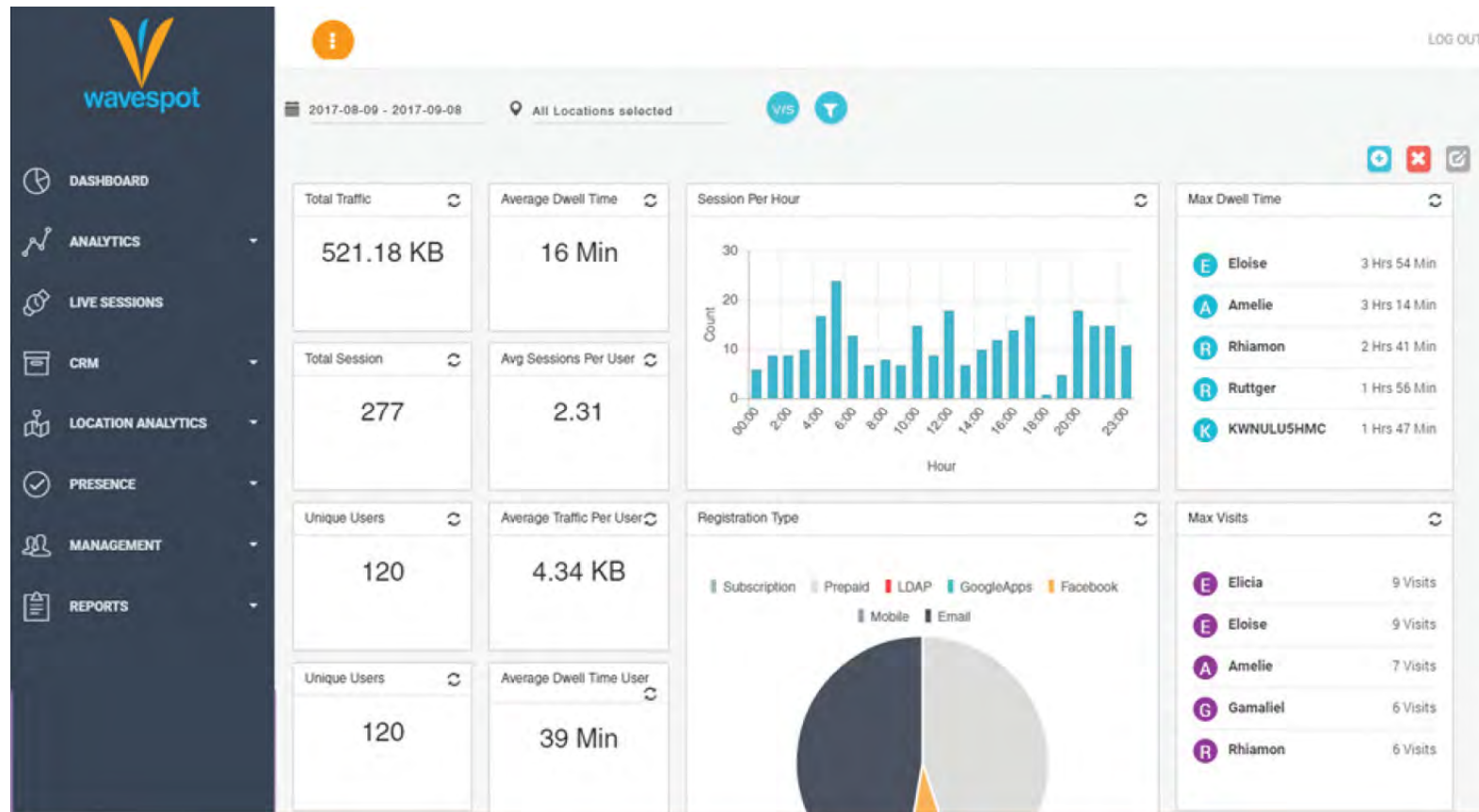
Object details window enables viewing and editing from the same window with no need to access complex menu structures



## Captive Portal / AAA



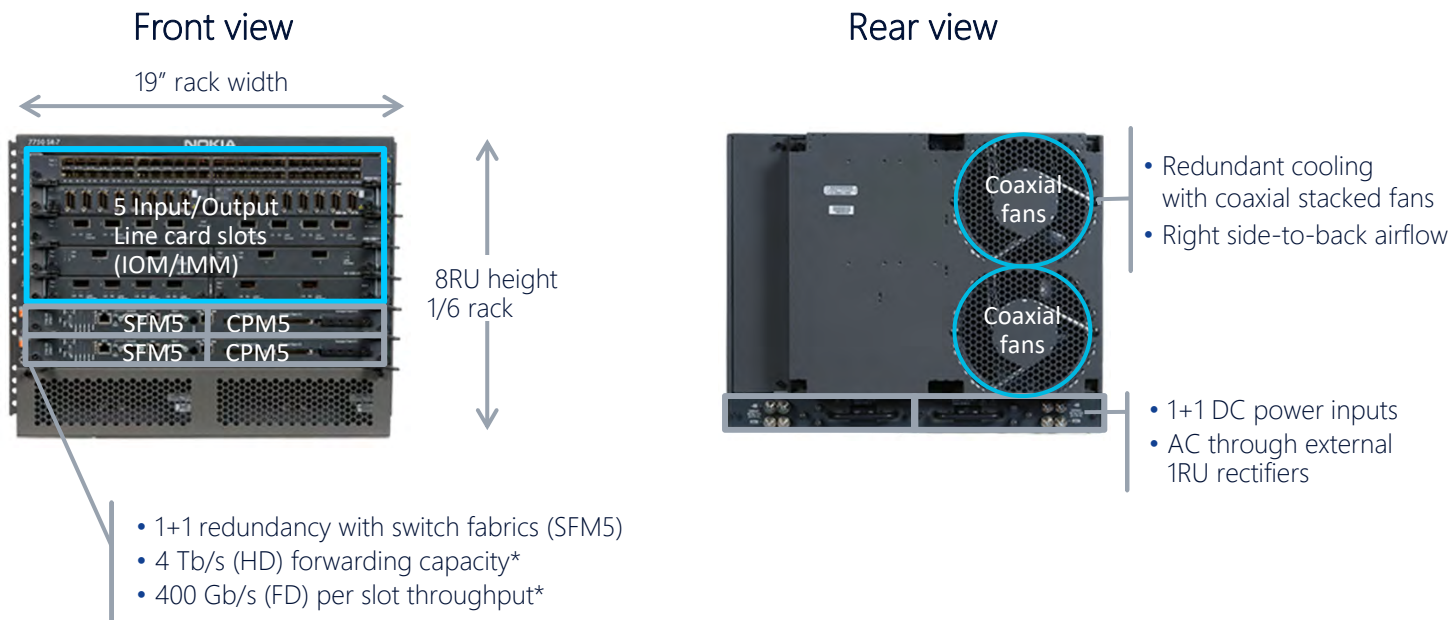
## WaveSpot Captive Portal/AAA





## 7750 Service Router and 7210 SAS

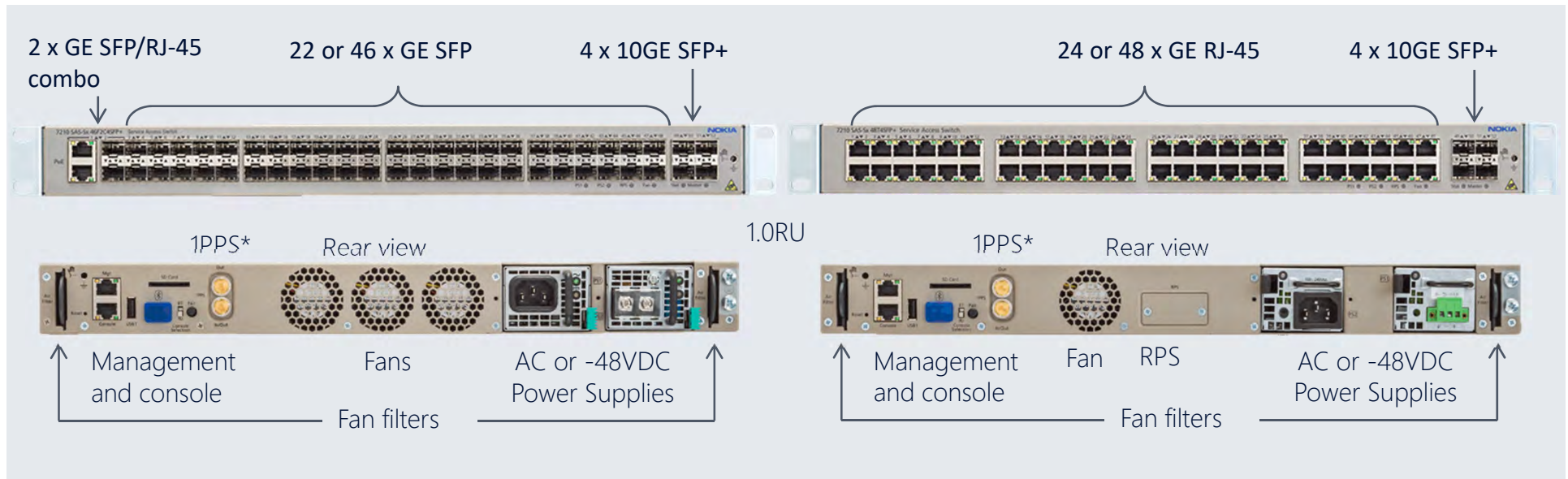
## 7750 SR-7: Chassis overview



Note: \* For availability and timelines, contact Nokia



## 7210 SAS-Sx 1/10GE



- Side-to-back airflow with fixed fans & replaceable fan filters
- Two modular rear power supplies with RPS connector

- 0 to 50°C operation
- ITU-T Sync-E today, IEEE1588 future
- Fully NEBS compliant

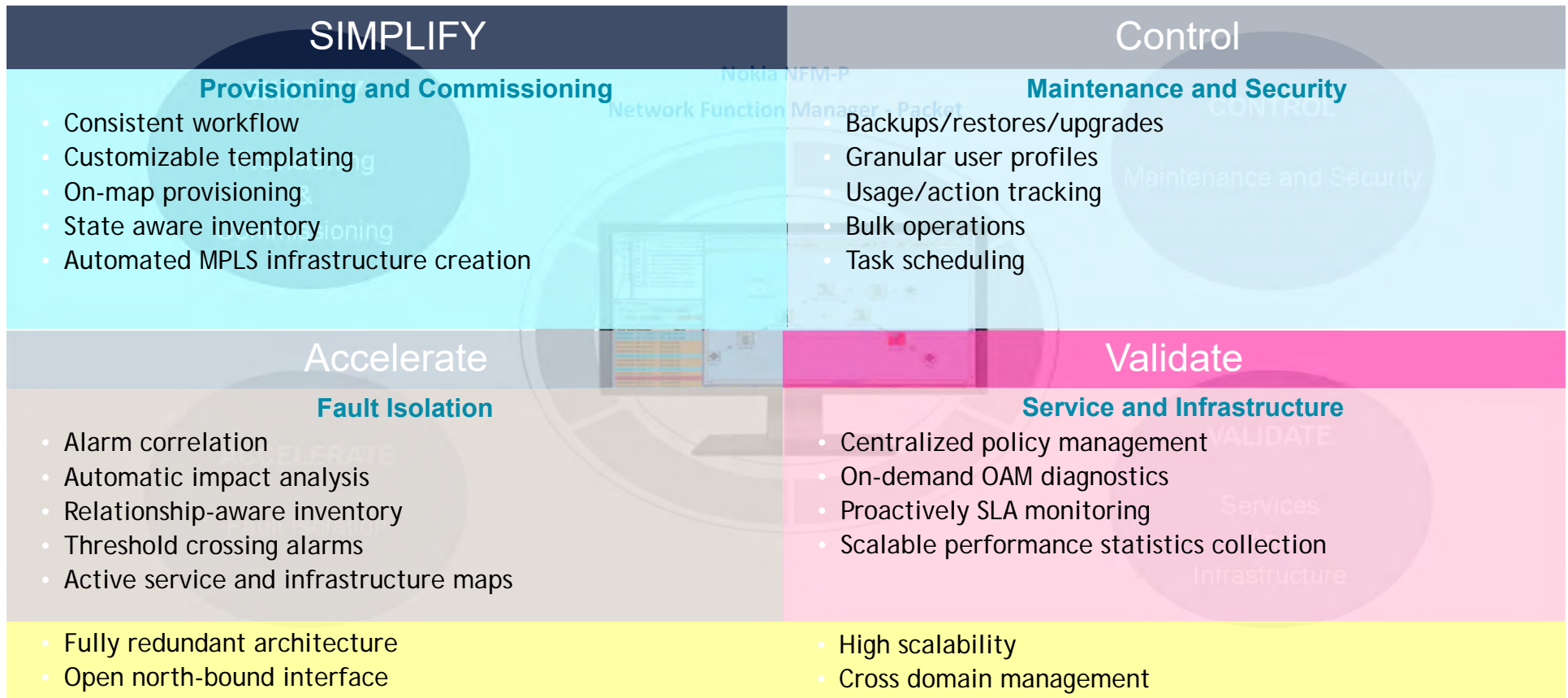
\*future software deliverable



## NFM-P Network Management

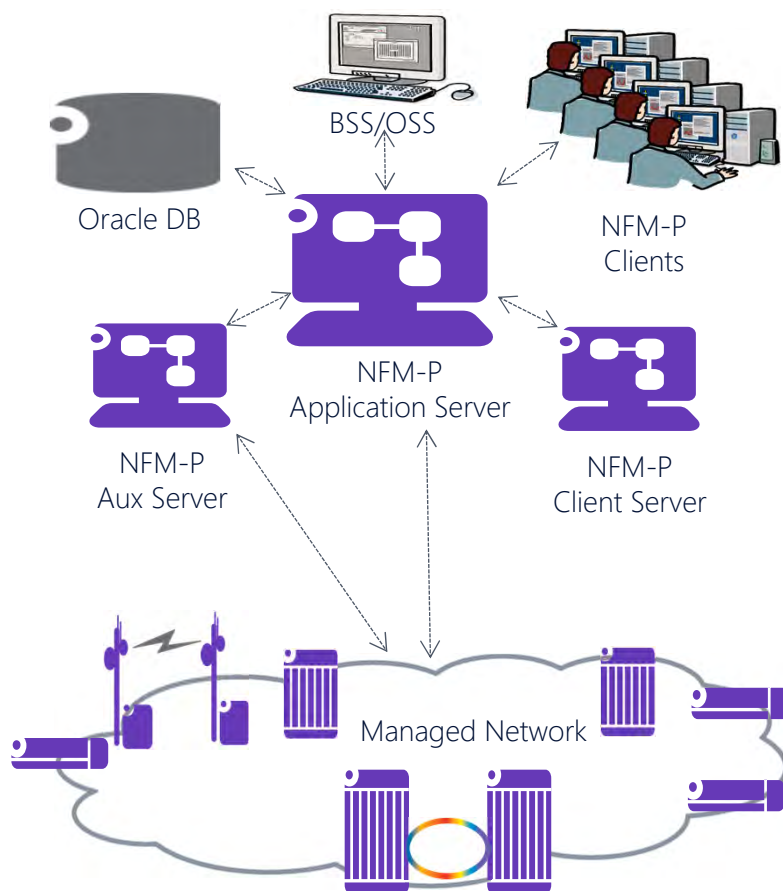
# Network Function Manager - Packet (NFM-P)

## INTEGRATED ELEMENT + NETWORK + SERVICE MANAGEMENT IN ONE PLATFORM





## NFM-P Architecture



### Platform

- Red Hat Enterprise Linux 7
- Embedded Oracle 11 db
- Approved for HP x86 based workstations
- Virtualization supported using both VMware vSphere ESXi and RHEL KVM

### Fully Integrated Components

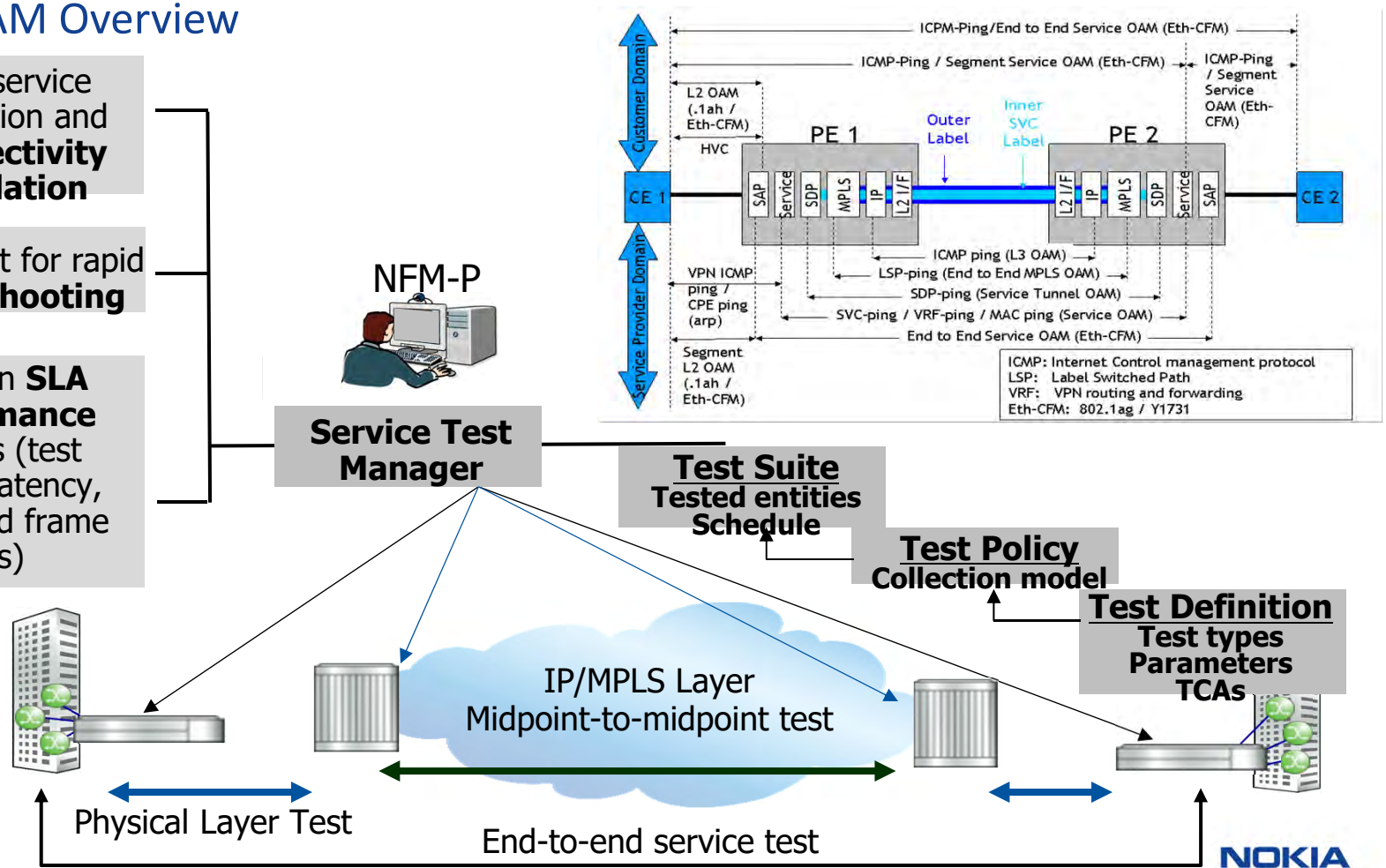
- NFM-P Server
  - Collocated application and database
  - Optional Distributed application and database on 2 servers
- NFM-P OSS Interface
  - XML/JMS connections to service provider OSSes
- NFM-P Client
  - Java thin client on operator PCs/Solaris workstations
- Optional NFM-P Delegate Client Server
  - Citrix host for NFM-P Client (30 clients per server)
- Optional NFM-P Auxiliary Server
  - Increased Statistics Collection Capacity

### Redundancy

- Optional Full Redundancy
  - NFM-P Server
  - NFM-P DB Server for Distributed Deployments
  - NFM-P Auxiliary Server

## NFM-P OAM Overview

- 1 Fast service activation and **connectivity validation**
- 2 OAM toolkit for rapid **troubleshooting**
- 3 Maintain **SLA performance** metrics (test service latency, jitter, and frame loss)



**NOKIA**



## Copyright and confidentiality

The contents of this document are proprietary and confidential property of Nokia. This document is provided subject to confidentiality obligations of the applicable agreement(s).

This document is intended for use of Nokia's customers and collaborators only for the purpose for which this document is submitted by Nokia. No part of this document may be reproduced or made available to the public or to any third party in any form or means without the prior written permission of Nokia. This document is to be used by properly trained professional personnel. Any use of the contents in this document is limited strictly to the use(s) specifically created in the applicable agreement(s) under which the document is submitted. The user of this document may voluntarily provide suggestions, comments or other feedback to Nokia in respect of the contents of this document ("Feedback"). Such Feedback may be used in Nokia products and

related specifications or other documentation. Accordingly, if the user of this document gives Nokia Feedback on the contents of this document, Nokia may freely use, disclose, reproduce, license, distribute and otherwise commercialize the feedback in any Nokia product, technology, service, specification or other documentation.

Nokia operates a policy of ongoing development. Nokia reserves the right to make changes and improvements to any of the products and/or services described in this document or withdraw this document at any time without prior notice.

The contents of this document are provided "as is". Except as required by applicable law, no warranties of any kind, either express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose, are made in relation to the accuracy, reliability or contents of this document.

NOKIA SHALL NOT BE RESPONSIBLE IN ANY EVENT FOR ERRORS IN THIS DOCUMENT or for any loss of data or income or any special, incidental, consequential, indirect or direct damages howsoever caused, that might arise from the use of this document or any contents of this document.

This document and the product(s) it describes are protected by copyright according to the applicable laws.

Nokia is a registered trademark of Nokia Corporation. Other product and company names mentioned herein may be trademarks or trade names of their respective owners.