March 28th, 2019

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC, V5A 1S6

RE: ENSC 405W/440 Project Proposal for the Distributed Computing Network by Oakion Systems

Dear Dr. Rawicz,

The attached document provides the project proposal for the Distributed Computing Network being implemented by Oakion Systems described previously in our Requirements[1]and Design Specification[2] documents . The definition of success for this project, will be to optimize the current Visual BACnet architecture at Optigo systems, a data analytics company for Building Automation, in a systematic method to help ease computational and bandwidth bottlenecks occuring on their current Visual BACnet SaaS product under high network traffic.

This document will outline a high level overview of the system architecture and design of our product. This will encompass a preface of our engineering prototype design, the risk and benefits of our product, a market analysis of the industries current climate and a brief look at our potential competitors, followed by a preliminary cost breakdown and tentative scheduling of our expected workflow.

Oakion Systems is comprised of 5 talented senior engineering students: Justin Singh, Tony Tan, Shawn Wang, Swimm Chan, and Aaron Nguyen. These individuals come from a strong background in software development, problem solving and systems design. Oakion is confident that the task at hand will be delivered with success and confidence to solve Optigo's request.

Thank you for reviewing our design specification. If you have any inquiries, please do not hesitate to contact myself, Justin Singh by phone: 250-961-3527 or email: jksingh@sfu.ca

Sincerely,

Justin Singh.
Chief Executive Officer
Oakion Systems

Enclosed: The Project Proposal for the **Distributed Computing Network**

PROJECT PROPOSAL

Distributed Computing Network

flexible scalable robust

Project Members:	Swimm Chan
	Aaron Nguyen
	Justin Singh
	Tony Tan
	Shawn Wang
Contact Person:	Justin Singh
	jksingh@sfu.ca
	250-961-3527
Submitted to:	Craig Scratchley (ENSC 405W)
	Dr. Andrew Rawicz (ENSC 440)
	School of Engineering Science
	Simon Fraser University
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Executive Summary

From their beginnings, all businesses seek to expand, potentially into new markets, ventures, or technologies. With this expansion comes challenges, as well as opportunities. Optigo Networks' is one said company whose continued growth has brought it to a point where it must adapt to the continuously changing ways of managing the ever increasing amount of data that flows through its systems. Oakion Systems is excited to have the chance to provide a solution for Optigo in this new juncture.

"every 100 ms delay costs 1% of sales" - Greg Linden [16]

Oakion Systems proposes a software solution that offers greater flexibility, scalability, cost efficiency, and ease of maintenance over a hardware solution. With Optigo currently approaching a rate of eight gigabytes of data processing per day, our system solution provided, will specifically target Optigo Networks for ease of integration. Oakion Systems will enable Optigo Networks to continue providing exceptional service through network health analysis on the smart buildings automation industry presently, and going forward as they grow as a company.

Oakion Systems' microservice software solution provides different levels of scalability to resolve computational and bandwidth bottlenecks that currently plague other architectural systems on the market. A series of modules, running in parallel, operate as a gatekeeper, processing data ensuring downstream networks receive only data pertinent to their operation. The final prototype will be fully integrated into Optigo's core software (Visual BACnet) with no requirement to change either the behaviour nor the business model of Optigo Networks.

The engineering team that make up Oakion Systems, will deliver a successful solution with their combined knowledge of engineering design, software development and organized communication. We are proposing an 8 month development cycle to design and implement a microservice prototype, delivered August 2019. Our estimated cost for the prototype will include a Version Control environment and a sample smart devices, all fully funded by Optigo Networks.

Table of Contents

List of Tables

List of Figures

Glossary

APM Application Performance Management monitors and manages performance and availability of software applications that strives to detect and diagnose complex application performance to maintain an expected level of service.[9]

AWS Amazon Web Service is a cloud computing platform built and hosted by Amazon.com to provide users with a pay-as-you-go scalable compute, storage and throughput computing model. [9]

BACnet Communications protocol for Building Automation and Control networks that leverage the ISO 16484-5 protocol.[1]

CAGR Compound Annual Growth Rate, is a useful measure of growth over multiple time periods.[28]

Grafana is an open source metric analytics & visualization suite. It is most commonly used for visualizing time series data for infrastructure and application analytics but many use it in other domains including industrial sensors, home automation, weather, and process control.[12]

GUI Graphical User Interface is an interface through which a user interacts with electronic devices such as computers, hand-held devices and other appliances. This interface uses icons, menus and other visual indicator (graphics) representations to display information and related user controls, unlike text-based interfaces, where data and commands are in text.[11]

Kafka is a software that takes in data and converts various kinds of data into a single storage container, or aggregates diverse data into a consistent resource, such as a database. [13]

LAN Local Area Network (LAN) is a computer network within a small geographical area such as a home, school, computer laboratory, office building or group of buildings.[30]

Microservice Architecture An Architectural style that structures an application as a collection of services that are highly maintainable and testable, loosely coupled, independently deployable, organized around business capabilities. [14]

Operational Technology Hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise.[26]

PCAP Data Packet Capture consists of an application programming interface for capturing network traffic.

WAN Wide area network (WAN) is a network that exists over a large-scale geographical area.[29]

Visual BACnet is an advanced visualization tool for Building Automation System Service Providers. The powerful analytics engine quickly identifies common problems and anomalous behavior in the BACnet infrastructure. [10]

1 Introduction

Over the past decade, tech enterprises have been gravitating from monolithic to microservice architectures, a transition that has played a key role in some of their rises, and for others, sustainability as tech giants in this period[5]. When Oakion Systems was approached with a complex computational and bandwidth data computing problem from Optigo Networks as their company continues to grow, we set forth to design and implement an optimal solution to their issue.

Through extensive research, Oakion Systems concluded that to deal with these data growth issues Optigo Networks is faced with, the optimal solution would be a primarily software solution, transitioning from the companies current monolithic software architecture to instead a microservice architecture that is predicted to become industry application default within the next five years [7]. The design would allow Optigo the ability to not only solve their current computational and bandwidth issues by scaling services independently, but also provide a feasible and affordable solution to manage the inundation of data as their company grows[6].

Oakion Systems will provide a product that will receive network data from deployed building automation devices on Optigo's client site and perform network analytics on this data, taking full advantage of our Microservice modular design to maximize performance through finding the optimal balance between CPU, memory and I/O usage. Finally, this analyzed network data will be stored and visualized using the same custom frontend established by Optigo Networks.

The purpose of this proposal document is to provide a high level overview of the Microservice middleware solution that will be developed by Oakion Systems for Optigo Networks. Oakion Systems' objective will be to provide a product that will optimize Optigo's current analytical monolithic architecture without incapacitating any core functionality of their deployed hardware, software, or visual frontend.

2 Project Overview

2.1 Background

Building IOT is becoming more and more prevalent as the industry trends toward automation and control to optimize their commercial systems. Energy costs and human error in smart buildings drive the need for real time network analytics for these systems and Optigo Networks are but one company that fulfills this need.

The amount of data that flows to Optigo exponentially increases as their client base grows. This growth will cause a computational and bandwidth bottleneck in the near future (~8GB/day currently). Without changing or improving their current architecture, Optigo will face issues with continuous analytics and performance.

Oakion Systems aims to provide a solution to the computation bottleneck issue as well as easing the bandwidth usage through a Microservice solution. To date, optimization for these purposes are typically done through hardware acceleration at the centralized server [1]. Oakion Systems' Distributed Network solution differs by focusing on a primarily software solution to this issue. This solution allows a much cheaper and scalable alternative to clients, and empowers them to maximize their software capabilities before justifying changes at the hardware level.

The model of Microservice solution that will be provided by Oakion Systems is an event based one[8]. This means that our system will not require a response to, or acknowledgement of, every communication that occurs. This allows the system to consist of modules that can be fully asynchronous allowing higher performance and faster computation. Our solution will be contain 5 main modules: a Producer, Splitter, Consumer, Reducer and a DSMS centralized queue that will each provide functionality toward the common goal of optimization.

2.2 Scope

The scope of this project encapsulates the software system architecture design, implementation, testing and optimization of a microservice solution to processing data across network infrastructure, specifically for Optigo Networks and their current BACnet visualization system. The Microservice Architecture, will encapsulate:

1. *Horizontal scalability* per module
2. *Versatility* of development process
3. *Easier* deployment

2.2.1 Proof of Concept System Overview

The product will consists mainly of five main modules:

Module 1: **Producer** - Collects original packets from smart devices
Module 2: **Kafka + Zookeeper (DSMS)** - Stores all data for centralized access
Module 3: **Consumer** - Processes related packet chunks
Module 4: **Reducer** - Combines the processed packet chunks through packet reducing
Module 5: **Grafana** - Monitors application metrics modularly for the entire system and visually displays these results

The PoC system overview of the Distributed Computing Network is shown in **Figure 2.1.**

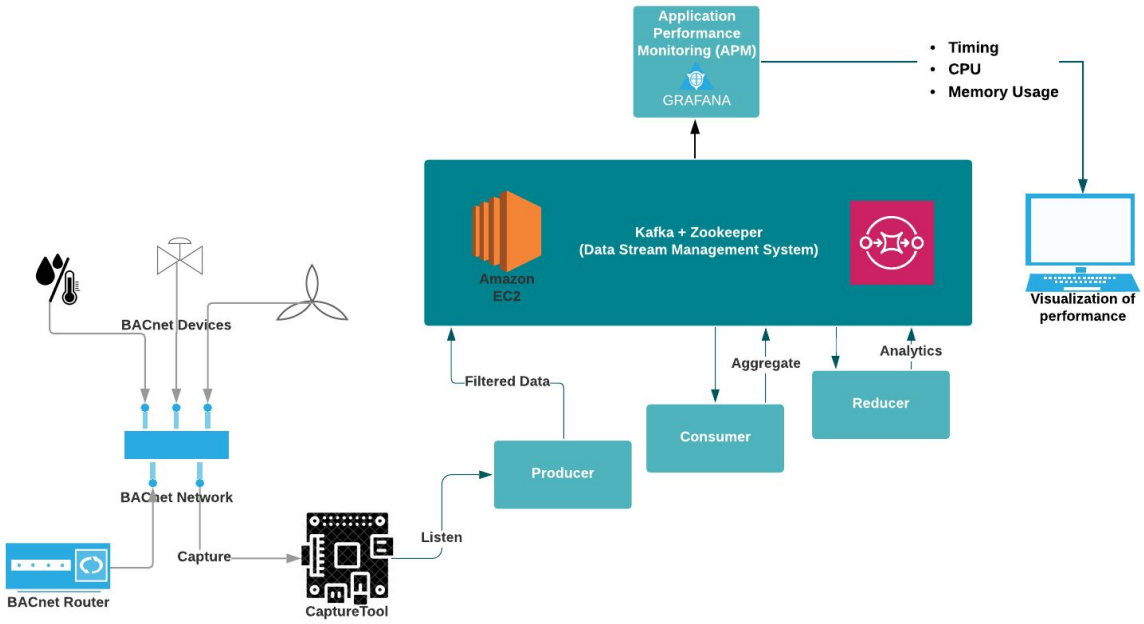


Figure 2.1 - PoC System Overview

2.2.2 Engineering Prototype System Overview

The Distributed Computing Network Engineering Prototype will add the following modules and functionality on top of the Proof of Concept prototype (**Section 2.1)**:

Module 6: **Splitter** - Integrated into the Producer module for symplicity, it strategically breaks up incoming packets through packet mapping to enable load balancing for the system
Module 7: **K2V Connector** - Inserts analytical data into Postgres database from Kafka and is integrated through REST API to allow Visual BACnet to pull this analytical data when ready
Module 8: **M2K Connector** - Notifies Visual BACnet when data for a certain PCAP is ready to be pulled
Module 9: **Kibana** - Monitors application logs for each module and visually displays this result

The Engineering Prototype system overview of the Distributed Computing Network is shown in **Figure 2.2**.

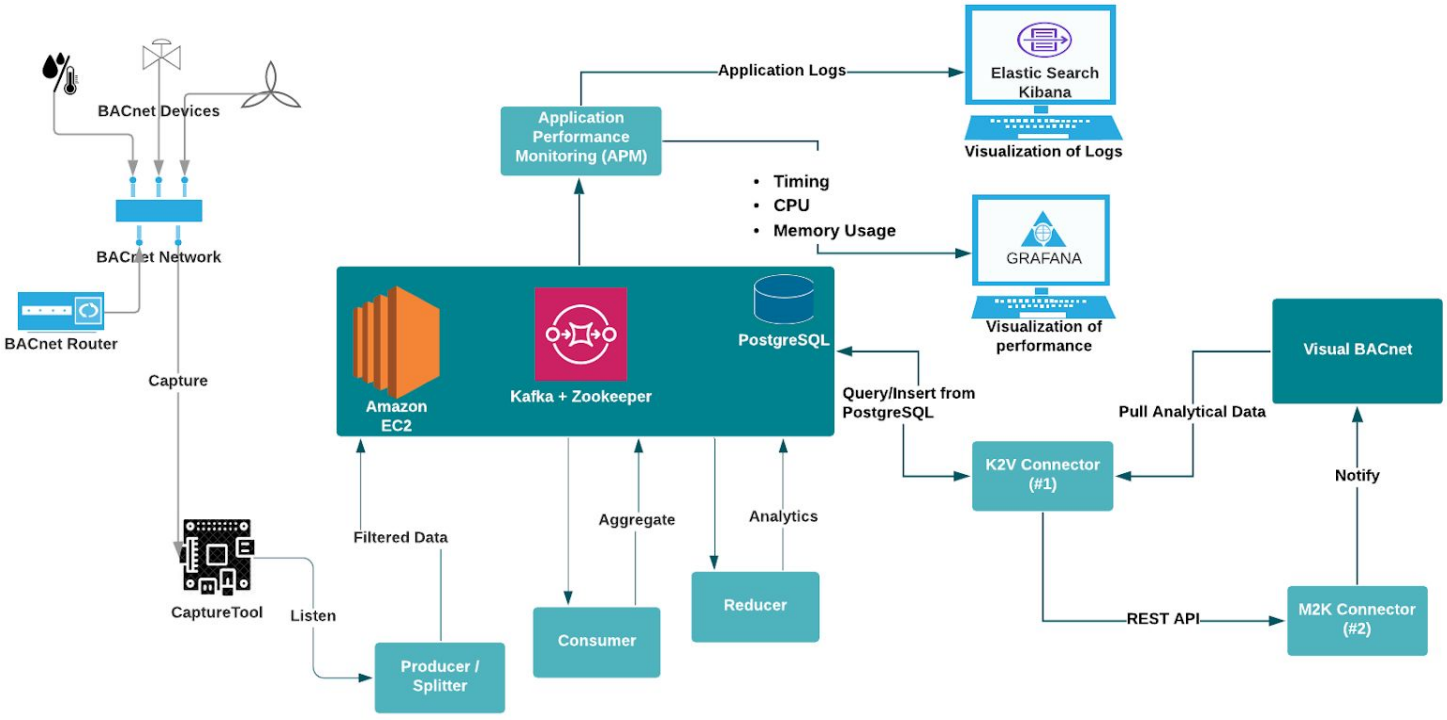


Figure 2.2 - Engineering Prototype System Overview

3 Project Justification

3.1 Risks

All Risks divulged and defined in this section and their likelihoods of occuring, pertain to the prototyping stages of Oakion Systems' design and are primarily aimed toward the company size and scope of Optigo Networks per our contractual agreement. Oakion Systems will use the following as a guideline to identify different severities of risks that exists within the project life cycle.

Risk Level	Description
4 High	A risk event with this rating will have a high impact on the project. One or more requirements will not be met.
3 Significant	A risk event with this rating will have a significant impact on the project. One or more requirements will fall under acceptance levels.
2 Moderate	A risk event with this rating will have a moderate impact on the project. One or more requirements will meet minimum acceptance levels.
1 Low	A risk event with this rating will have a minor impact on the project. There will be small or no impact on the requirements.

Table 3.1 - Risk Levels

3.1.1 Security Vulnerabilities and Malware

Oakion Systems' prototype's security will be dependant on the security of third party applications and third party software. If integrated into vital company systems in future use, these third party applications will need to be rewritten to comply with stricter security measures.

Third Party Software/GoLang Libraries

As mentioned above, Oakion systems will utilize third party software and libraries for cost efficiency and ease of development during the prototyping phases. These services, will be open-source with MIT licensing or similar for commercial use, modification, distribution, patent use, and private use. Since these third party applications are open-source, Oakion Systems will analyze security risks due to this fact.

Level	Risk	Risk Details	Likelihood of Occurrence
4	Third Party Software	The risk of poorly maintained third party software affecting the internal operations of Oakion Systems	5%
1	Disk Protection	The risk of unencrypted sensitive files on disk.	5%
1	Authentication	The risk of unauthorized access to the system resources	5%

Table 3.2 - Risk Analysis on Security

3.1.2 Resource consumption

Given the core goal of this product is to optimize the performance of a system, there are limitations on the amount of resources we have to work with. Each module will consume a certain amount of memory, a certain amount of CPU, and bandwidth. These risks must be analyzed to ensure the success of the project.

Level	Risk	Risk Details	Likelihood of Occurrence
1	Too much memory usage	The risk of memory usage being too high for the modules based on the minimum requirement	5%
2	Too much CPU usage	The risk of high CPU usage on the capture tool will affect modules and the original functionality of the capture tool.	5%
1	Too slow of processing	The risk of a machine that cannot achieve the desired speed for processing, which affects overall system performance.	5%

3	Bandwidth limitations	The risk of the system cannot process at a desired speed due to bandwidth limitations	10%

Table 3.3 - Risk Analysis on Resources

3.1.3 Human Intervention and Setup

Oakion Systems' Distributed Computing Network will minimize interaction for users given its functionality, but it does require human intervention for deployment, setup and monitoring. We will discuss the first two here and the third in **Section 3.1.5.** The environment the system is deployed on requires administration from a user. This allows users to control and deploy any modules within the system. In addition, the system itself is required to be installed manually. The risks of human intervention will be assessed in the following table:

Level	Risk	Risk Details	Likelihood of Occurrence
1	System setup	The risk of a user to install the system incorrectly can cause the system to not work.	5%
1	Environment setup	The risk of a user to set up the required environment incorrectly can cause the system to not work.	5%
1	Deployment failure	The risk that a user will fail the deployment of the newest version will cause the system to not work	5%
1	System update	The risk that a user cannot upgrade the system which leads to failure of the system.	5%

Table 3.4 - Risk Analysis on Human Intervention

3.1.4 Development slippage

Oakion Systems is under a time constraint where the PoC of our product will be delivered by April 2019 and the EP milestone delivered in August 2019. To meet these deadlines, project scheduling is required for the development stages of production. Potential slippage in this development schedule is taken seriously and thus contributes an internal potential risk to our product.

Level	Risk	Risk Details	Likelihood of Occurrence
4	Delay in sprint completion	The risk of the development team not completing the active sprint can cause failure in features.	25%
3	Poor internal communication	The risk of the development team not communicating through Slack or daily stand ups can cause delay in development.	50%

Table 3.5 - Risk Analysis on Development Slippage

3.1.5 Monitoring and Administration

The system will be monitored by two application performance monitoring softwares (Grafana & Kibana) integrated into our product. These softwares will log 2 types of events or errors:

1. Grafana will log performance metrics
2. Kibana will capture application logs

Monitoring our system will introduce risks to the system outlined as follows:

Level	Risk	Risk Details	Likelihood of Occurrence
3	Grafana responses too slow	The risk of Grafana responses too slow and the result will not be a real-time performance metrics.	5%
3	Kibana misses an application log	The risk of Kibana misses an application log that can be critical to a failure in the system.	5%
3	APM misrepresents the data	The risk of the APMs misrepresents the system data, which gives false results.	5%

Table 3.6 - Risk Analysis on Monitoring and Administration

3.2 Benefits

Given this project is an optimization project, the following benefits outline the core advantages of our product over the current system in place at Optigo Networks. For a more generalized view of how Oakion Systems' product compares with competition on the market, please see **Section 3.4**.

3.2.1 Cost Reduction

It doesn't take a business background to notice a correlation between cost and the quality of a product in a majority of industries today[19]. Oakion Systems' Distributed Computing Network aims to specifically deviate from this trend, offering a solution that leverages the existing hardware of the customer and maximizes these systems through optimization of software to allow for a cost efficient high performance solution for any company dealing with data inundation and scaling issues as they grow. Comparing costs with the current system in place at Optigo Networks, our solution demonstrates its cost efficiency through the mentioned adherence to maximization of software for prime performance without the need of upgrading existing hardware which would cost an absorbent amount that could prove hard to justify in the early stages of a company. See **Section 4** for a further breakdown of our products cost.

3.2.2 Design Flexibility

Oakion Systems' Distributed Computing Networks' choice of architecture design allows for our system to be integrated and modified over time given the changing operational requirements of a customer; functionality not present in the current monolithic architecture in place at Optigo Networks. Through load balancing and monitoring software (Grafana and Kibana, see **Section 2.2.2** for more details) integrated into our microservice solution, a customer has the ability to monitor processes and identify bottlenecks given the rate and size of data flowing through their system. With this information, the customer can further optimize their performance by enabling load balancing to target areas where a bottleneck has formed and disabling this functionality when it is not needed. With these integrations, Oakion Systems architecture design allows a customer to keep up with current trends that large platform industry leaders have internally been evolving their applications toward since 2015 without the fear of potential deprecation as their company grows[20].

3.2.3 Design Scalability

A Microservice architecture design was chosen for our solution as it represents a more scalable and robust design over the current centralized Monolithic architecture in place at Optigo Networks. Monolithic architectures, although simpler to develop and test, have issues with not

only reliability, but scalability when different modules draw dissimilar resource requirements [21]. As mentioned above in **Section 3.2.2**, our chosen architecture allows for load balancing that functions mainly to provide scalability to our product for further performance optimization. By definition, there are two types of system scalability in software design, horizontal and vertical; both of which are addressed in our product.

3.2.3.1 Horizontal Scalability

Scaling a system horizontally can be defined as the ability of the system to spread out its workload over multiple machines, ie: cluster computing. Software has the ability to be run on multiple machines, resulting in increased performance, but not with a linear correlation to the number of machines used (ie: ten seconds to perform a task on one machine, will become eight seconds on two machines and seven second on three machines). Oakion Systems Distributed Computing Network achieves horizontal scalability through load balancing on multiple modules allowing multiple instances to be processing data in parallel to alleviate any bottlenecks in our system.

3.2.3.2 Vertical Scalability

Scaling a system vertically can be defined as increasing a systems performance through additional resources being added to the system (ie: the CPU, memory and I/O resources of a bigger machine). Oakion Systems Distributed Computing Network achieves vertical scalability through multithreading functionality on the heavier processing modules of our system.

3.2.4 Design Robustness

As mentioned above in **Section 3.2.2**, a Microservice solution provides a much more robust architecture than the current Monolithic system in place at Optigo Networks. Through it's design alone. **See Section 2.2.2**, our solution guarantees data integrity and redundancy on services. All data is encrypted in transit and nothing is stored on a edge node. If a single module were to go down, it could always be replaced with another, providing robustness that cannot be matched with a Monolithic or P2P architecture given the problem at hand[22]. Our design also benefits from being incredibly lightweight, with a majority of it being deployed on the cloud while the rest can be integrated with the customers current architecture.

3.2.5 Performance Monitoring

As mentioned initially in the introduction and **Section 3.2.2**, to maximize a software's performance, one must find the optimal balance between CPU and memory usage in the given companies environment. Performance monitoring also increases the visibility of the system as well as event audits and trace backs. To increase the marketability of our product, each solution

will come deployed with APM software Grafana and application log monitoring software Kibana.

3.3 Market Analysis

3.3.1 Target Market

Oakion Systems target market is companies in the Operational Technology (OT) industry. In the age of Big Data for Operational Technology, the demand for data analytics has never been higher and it is here to stay as data-driven business models constantly take the industry by surprise.

In 2016, McKinsey Global Institution Analytics highlighted the range of applications in potential OT industries and how this market is continuing to grow, as well as factors hindering further growth in the sector. See below, **Figure 3.1**. Examining this figure, it is observed that the market value captured in each application highlighted was still quite minimal as of 2011, indicating a clear-cut potential for growth moving forward if market barriers can be overcome.

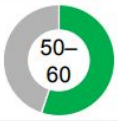
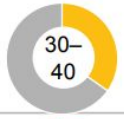
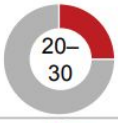
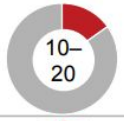
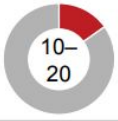
	Potential impact: 2011 research	Value captured %	Major barriers
Location-based data	▪ $100 billion+ revenues for service providers ▪ Up to $700 billion value to end users		▪ Penetration of GPS-enabled smartphones globally
US retail[1]	▪ 60%+ increase in net margin ▪ 0.5–1.0% annual productivity growth		▪ Lack of analytical talent ▪ Siloed data within companies
Manufacturing[2]	▪ Up to 50% lower product development cost ▪ Up to 25% lower operating cost ▪ Up to 30% gross margin increase		▪ Siloed data in legacy IT systems ▪ Leadership skeptical of impact
EU public sector[3]	▪ ~€250 billion value per year ▪ ~0.5% annual productivity growth		▪ Lack of analytical talent ▪ Siloed data within different agencies
US health care	▪ $300 billion value per year ▪ ~0.7% annual productivity growth		▪ Need to demonstrate clinical utility to gain acceptance ▪ Interoperability and data sharing

Figure 3.1 - Market Analysis on Data Analytics Driven Companies[23]

Efficient data processing is one of the major barriers in data-driven companies seen above, due to the increase in volume of data being collected and analyzed today. It is no secret that this is

especially challenging for small companies as they grow. Optigo Networks is a prime example of said company acquiring a solution to effectively perform analytics. For this reason, Oakion Systems provides a highly integrated solution to optimize their data processing flow in a cost effective manner in accordance with our contractual agreement. **Figure 3.2** visually represents how Oakion Systems will interact with the market of Operational Technology.

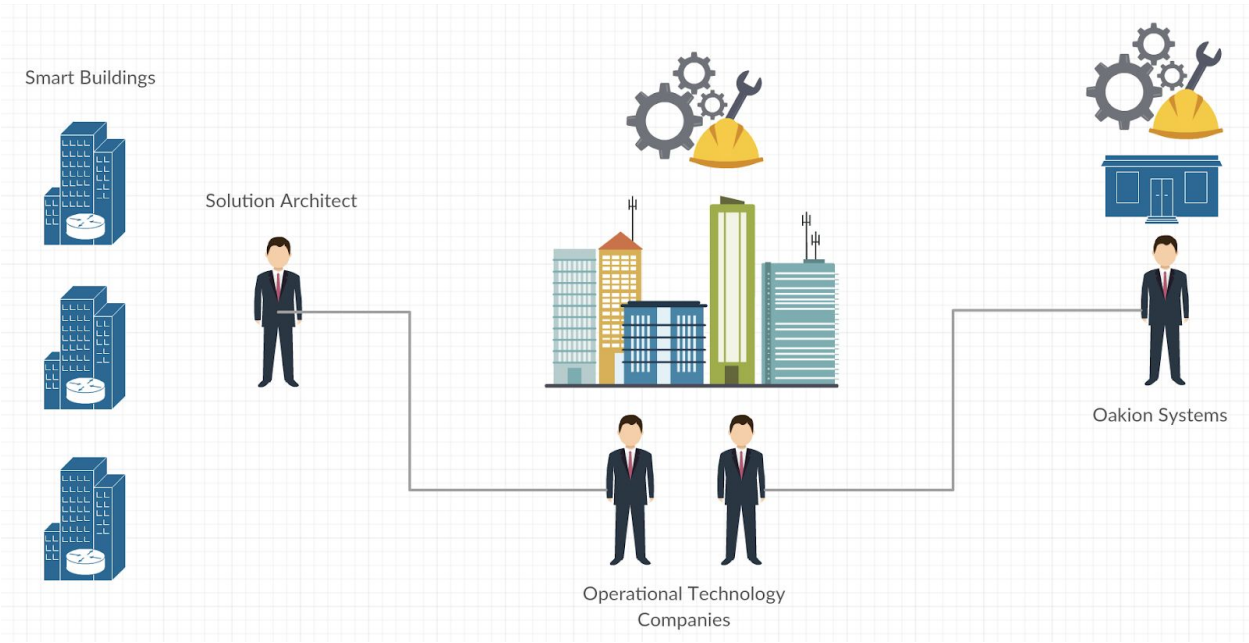


Figure 3.2 - Roadmap for Sales Operation

As the world of computing shifts between centralized and distributed, the global edge computing market size is projected to reach USD 3.24 billion by 2025, with a phenomenal CAGR of 41.0% during the forecast period[27]. What motivated this change is the exploding demand for data processing in the IoT sector. Business associates are finding it the best way to streamline IoT traffic and facilitate real-time data analysis. Some of the more popular applications include autonomous vehicles, analytics, and voice assistance.

Edge computing provides several advantages as follows:

1. *Security* compromises are localized and easy to contain before propagating to a catastrophic failure.
2. *Scalability* is horizontal instead of vertical, as discussed in **Section 3.2.3**.
3. *Speed* achieved in leveraging previously untapped computing power close to the source, to mitigate network traffic delays.

Another factor that fuels this market shift that is the continuous technology accumulation in Distributed Computing has matured. Distributed frameworks such as Kafka, Cassandra, and Storm were introduced not too long ago around 2010, and are all under open-source Apache License for the public use. These infrastructures are essential to supporting Edge Computing and coordinate an autonomous computing network. Middleware solutions also offering benefits in addition to safety. This includes redundancy for failure masking to achieve high availability, reliability, and maintainability.

These factors further propel the IoT industry to advance, resulting in a cycle in creating more demand in Edge Computing, and ultimately further tilting the market. The Distributed Middleware System that Oakion System offers is in line with market trends, and offers a multitude of competitive advantages to businesses currently adopting modern Cloud-based Solutions. These advantages include scaling, latency reduction, security, fault-tolerance, and most importantly for growing startups, cost-effectiveness.

3.4 Competition

Distributed Systems exists in many configurations. The particular solution that Oakion System provides does not observe direct competition based on our extensive research. This is possibly due to a cost/benefit analysis of integrating with businesses to achieve such a configuration, in which large tech companies that offer data analytics often choose to forgo. Thus we will analyze a few other common configurations currently on the market and showcase how Oakion Systems bridges the gap in these solutions.

3.4.1 Trackinno[25]

Many sensor data processing solutions have emerged in the past few years leveraging Cluster-Computing technologies to deliver their product through Cloud-Computing. Trackinno is a similar company to Oakion Systems founded in in 2015.

The key difference between Trackinno and Oakion Systems is that data processing is done entirely on Trackinno' IoT Cloud platform. This is a very common solution for businesses that do not have additional processing power on-site, or perhaps do not wish to leverage their embedded device processing powers, such as pervasive computing systems like smartwatches. Oakion Systems takes advantage of the excess processing resource on embedded hardware deployment to perform Edge Computing. This is results in reduced latency as well as cost reduction, as discussed in **Section 3.3**.

3.4.2 DIGIPEDE[3]

Digipede is another company similar to Oakion Systems, founded in 2003. The key main difference being Digipede makes no mention of wide-area network (WAN) functionality, leading us to believe their Distributed System solution is localized to a local-area network (LAN). While this ensures stability of operation through reliable and fast networking, this is often not the case in Smart-Building management. Sensors are often connected to large areas of a campus, not sharing the same LAN network.

Furthermore, Digipede is deeply invested in Microsoft's .NET framework. This means their architecture is not cross-platform like the solution of Oakion Systems and is restricted to x86 systems running a Windows operating system only. Thus, rendering it useless for Optigo's scenario in which Capture Tools run on ARM Linux embedded devices, as well as the majority of companies involved with sensor data analysis.

While Digipede also boasts cost-effective pricing, their breakdown for a company of Optigo's size is unappealing. For 100 agents (computing nodes), Digipede charges $4,700/year. In the case of large smart-building campuses, the Capture Tool count can easily exceeds this, in which the cost could increase to as large as $18,000/year.

3.4.3 APRIORIT [4]

Apriorit is a mature company that provides a wide range of services. Oakion is a competitor to Apriorit in terms of general distributed systems services as well as offering consulting services on software solutions.

A key difference between Apriorit and Oakion Systems is that Apriorit is generalized from C/C++ development to web development, while Oakin Systems specializes in OT networking and well experienced in network analytic for the OT industry.

3.4.4 COPPERLEAF[31]

Copperleaf is an established data collection and analytics company that specializes in infrastructure solutions. Smart-building data processing services is only a small subset of their operational scope, but their expertise in building automation and utilities makes them a popular choice for major building automation system manufacturers such as Delta Controls, as well as the government bodies. As a result, their focus is on large projects. Small smart-building analytics companies like Optigo will be overlooked by companies of Copperleaf's size, while Oakion Systems will thrive to provide the highly integrated and cost-effective solutions to meet small companies' demands.

4 Finances

4.1 Cost Analysis

Costs for Oakion Systems will be broken down into two sections: Development and Operations. Development will breakdown the costs associated with the implementation of the prototype (PoC and EP) stages of design. The operation section will then breakdown the costs associated with the deployment and maintenance of our product for the duration of its lifespan in a production environment. For transparency of pricing, costs presented in this document will be estimated for a company of middle tier size, complying with our outlined target audience of Optigo Networks, per our contractual agreement with them.

4.1.1 Development

The breakdown for the development cost for our Distributed Computing Network is summarized in **Table 4.1**.

Resources	Description	Quantity	Price per month ($)	Subtotal per month ($)
Atlassian JIRA	Issue & Project Tracking Software	5 (seats)	10	80.00
Atlassian Bitbucket	A web-based version control repository hosting service[15]	5 (seats)	0	0.00
Development Team	The man hours needed to develop and deploy the product to a customer	est: 640 hours	5333	5333
			Total	$5413 (CAD)

Table 4.1 - Monthly Development Costs

4.1.2 Operation Costs

Oakion Systems offers a microservice solution architecture for optimization. Given deployment on Optigo Network's system, the breakdown for our internal operation is summarized in **Table 4.2**. It is noted that the estimated monthly costs at Optigo with AWS is roughly $800,

understanding this, Oakion Systems will attempt to optimize their system to use about less than their current system in place.

Resources	**Description**	**Quantity**	**Price per month ($)**	**Subtotal per month ($)**
Amazon Web Service EC2 Instance	Instance Type: r5.xlarge	1	155.63	155.63
Amazon Web Service EC2 Instance	Instance Type: t2.xlarge	2	112.55	225.10
Amazon Web Service EC2 Instance	Instance Type: i3.xlarge	1	209.44	209.44
Amazon EBS Volumes (Storage)	Volume Type: Magnetic	5	17.16	85.80
PostgreSQL	An open-source relational database	1	0	0.00
InfluxDB	An open-source Time Series Database (TSDB)[2]	1	0	0.00
Kibana	Monitors application logs for each module and visually displays the results[2]	1	0	0.00
Grafana	Monitors application metrics modularly for the entire system[2[	1	0	0.00
Nomad	Deployment tool	1	0	0.00
Docker	Tool designed to make it easier to create, deploy, and run applications by using containers.	1	0	0.00
			Total:	$675.98 (CAD)

Table 4.2 - Monthly Operating Costs

4.2 Funding

The Proof of Concept (PoC) Prototype and Engineering Prototype (EP) are fully funded through contractual obligation with Optigo Networks. Per this agreement, Optigo Networks will fund the following if necessary for Oakion Systems' Distributed Computing Network:

1. Resources for development
2. Resources for integration
3. Resources for testing
4. Resources for deployment

In turn, research, design, the engineering prototype, and any accompanying surplus resources will become property of Optigo Networks following the conclusion of this agreement at the end of August 2019.

5 Project Scheduling

Oakion Systems will be incorporating a Agile Software Development Cycle for the full duration of the product. This means that issues and internal deadlines will be logged by sprint boards on JIRA, an issue tracker. If issues are not completed within the sprint duration, which may happen for many reason in development, they it will be ported over to the next appropriate sprint. **Figure 5.1** represents an example of how sprints are laid out for Oakion Systems.

JIRA Sprints will include the following:

1. Sprint duration (Start/End)
2. Task category
3. Swimlanes for current progress
4. Task assignment
    a. Who is assigned
    b. What is assigned
    c. Level of task

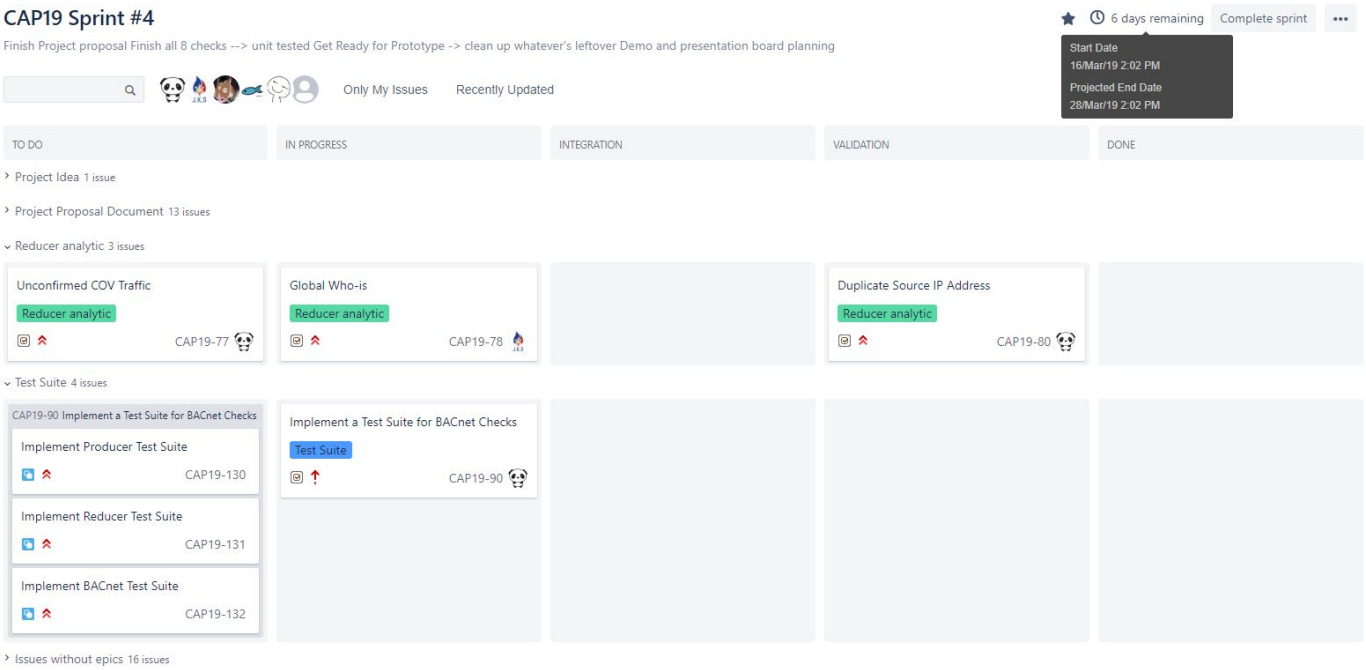


Figure 5.1 - Sprint #4 Example

5.1 Gantt Chart

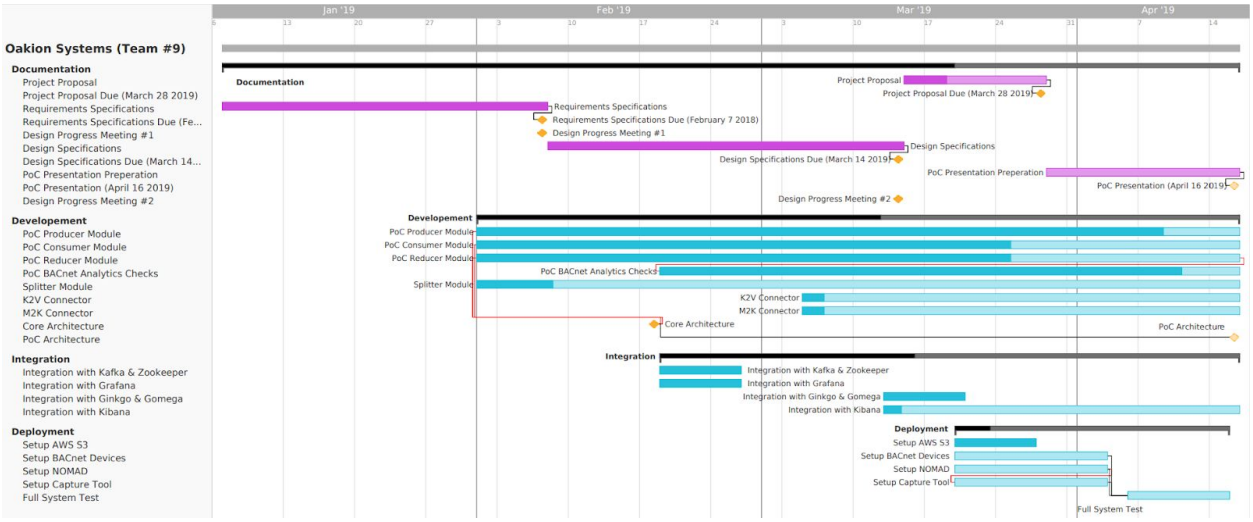


Figure 5.2 - Gantt Chart for ENSC 405W

Figure 5.2 displays the Gantt chart that Oakion Systems attempts to follow through the project life cycle for ENSC 405W (4 months). This includes milestones and durations for key tasks throughout the term. Note, that this Gantt Chart may change throughout the semester due to the fact that Oakion Systems will be following an Agile Software Development Cycle.

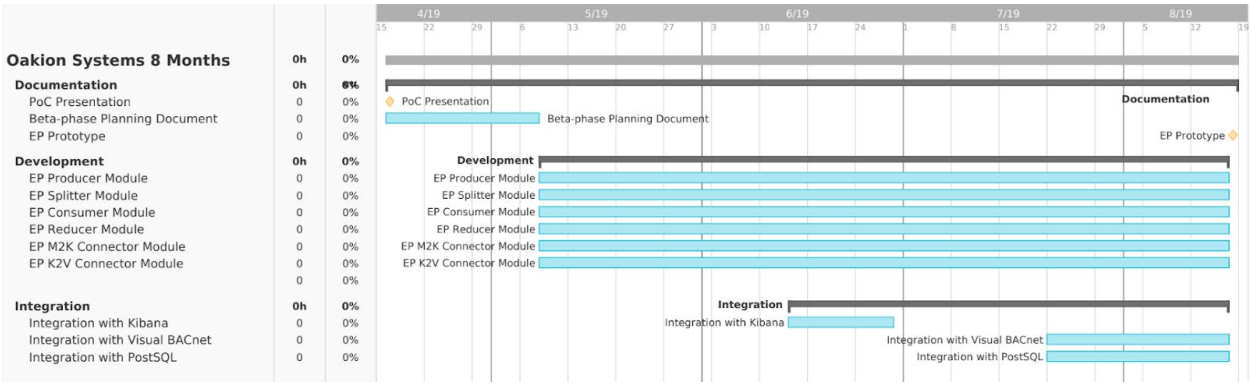


Figure 5.3 - Gantt Chart for ENSC 440

Figure 5.3 displays the Gantt chart Oakion Systems will attempt to follow through the project life cycle during ENSC 440. The current Gantt chart is a high level of expected tasks and subject to change. Note that this Gantt Chart may change throughout the semester as Oakion Systems will be following an Agile Software Development Cycle.

6 Company Overview

6.1 Who We Are

Since its inception in Burnaby, B.C in early 2019, Oakion Systems has been comprised of 5 talented engineering students from Simon Fraser University. Our company specializes in distributed computing solutions for the optimization of processing data across network infrastructure specializing in the OT industry. Our solution conforms to the latest trends of the industry and are custom to our clients needs. Oakion Systems strives to produce a scalable, flexible and robust systems to optimize any companies business needs; large or small.

6.2 The Team

CEO: Justin Singh

A 5th year Systems Engineering student, Justin is a very driven person with a passion for lifelong learning. He is fascinated with cutting edge technology and is always eager to learn and discuss trends, and opinions. Accomplished in both hardware and software systems, Justin is a tenacious problem solver either solo or collaboratively. He likes to break things and sometimes even put them back together!

CTO: Tony Tan

Also a 5th year Systems Engineering student, Tony has a strong passion for the design and development of both hardware and software systems and a strong belief in the value of continuous improvement. He has experience in team engineering competitions, tech industrial, as well as own personal projects.

CBO: Swimm Chan

Swimm is a 5th year Computer Engineering student who devotes her time to continuous learning and has discovered an interest in the software industry. Her experience in design and project management has created in her a drive to further her skills in these areas, with the goal of pursuing a career in project management.

CSA: Aaron Nguyen

As a 5th year Computer Engineering student, Aaron has a passion for developing and contributing to useful and sustainable solutions to everyday problems - whether they be small, quality of life problems or large issues that affect our shared future. He is also well balanced in the software cycle for any industry, where he has 8 months experience as a Software Developer and 8 months experience as a Quality Assurance Analyst. From the co-op terms, he also gained a solid understanding of the agile software development life cycle and knowledge of teamwork.

CLI: Shawn Wang (chief lead Intern)

Shawn is a 5th year Computer Engineering student that likes to solve problems in creative approaches. Years of education, industry experience, and Hackathons have honed his skills to work comfortably anywhere from beside the OS and upward. In his leisure, he enjoys tinkering with little projects and competitive strategy games like Starcraft and Chess.

7 Conclusion

The complexity and limitations of software systems is often one of the greatest limiting factors in the growth of a company[17]. Adaptation and scalability are among the most common problems faced by companies as they expand from startup to fully operational businesses. Oakion Systems eases this transition by optimizing data processing, thereby creating a greater opportunity for growth in data-driven companies.

Oakion Systems' Distributed Computing Network will provide a microservice middleware product, designed to the reduce bottleneck problems faced by many Operational Technology companies. Providing a microservice solution reduces cost by eliminating the need to upgrade hardware, and the robust security measures and cross-platform capabilities mean Oakian Systems can provide a lightweight product that stands apart from the competitors.

> *"Scalability isn't a 'bonus feature.' It's the quality that determines the lifetime value of software, and building with scalability in mind saves both time and money in the long run."* [18]

Oakion Systems enters the marketplace with optimism for the anticipated success of its microservice solutions. Optimizing the current Visual BACnet architecture at Optigo Network and easing computational bandwidth bottlenecks is the benchmark of success which Oakion Systems seeks to reach. Optigo Networks is not the first, nor will it be the last, company to face issues of this nature, as evolving monolithic system models is a difficulty many companies need to overcome. On the back of a successful implementation of Oakion Systems software solutions at Optigo Networks, we would look to find other opportunities to resolve this growing problem.

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