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Service Drive 2020 - Fine Design

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Service Drive 2020

Fine Design

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Executive Summary

This report explores a cloud network solution for the automotive industry. The project scope was defined with a problem statement. Robust connectivity solutions offered by the OEM manufacturers provide data communication between the customer and the connected car, but lack data communication from the customer to the private franchise dealers. This antiquated business model creates variation in operation from one dealer to the other and creates a challenge to apply a standardized solution. One fundamental requirement is to provide a network solution that can seamlessly integrate into existing hardware, software and process infrastructure.

The project group conducted interviews with two Atlanta dealerships, RBM Mercedes-Benz and Krause Family Ford, considered to be the most progressive and successful private franchise dealers. They provided the system requirements, while the technical requirements were gathered by interviewing a KSU alumni Information Technology professional.

The project strategy was developed by assigning duties for the group members and a master schedule was drafted to estimate the effort required. The project manager would assign research material for the group by interpreting requirements from interviewing the advisors. The design would undergo iterations until a final verification was completed by the project advisors.

The functionality of Amazon Web Services (AWS) provides the data streaming and real-time processing required to deploy this solution and is robust enough for this enterprise application. A test case was created to narrow the scope so that the group could verify the solution. The Systems Engineering V-model provides the methods of verification for the report. For the particular test case, AWS services are charged per data processed, accruing a monthly charge of roughly $11. Increasing the scale of the test case to more instances would not linearly increase this cost.

The System's V-Model dictates the designs progression. The proposed solution is verified by a last-mile delivery network model for expedited lead times. Quality metrics are defined to measure the proposed solution when it is deployed. Ultimately, the final design was verified by the key players that were interviewed throughout the project. Their feedback throughout the project dictated the final solution which meets the fundamental requirements.

Index

List of Figures

Abbreviations

OEM	Original Equipment Manufacturer
API	Application Program Interface
AWS	Amazon Web Services
CAN-bus	Controller Area Network-bus
CDC	Central Distribution Center
KPI	Key Performance Indicator

Chapter 1: Introduction

1.1 Objective

The purpose of this report is to provide an approach for serverless network deployment. The network will automate administrative tasks at the dealership level, automate spare parts ordering, and provide an encompassing-seamless mobile solution for customers. The solution must integrate with little to no disruption in hardware, software and supply chain infrastructure. The aim is to gather system, hardware and software requirements using systems engineering principles to guide the effort.

1.2 Justification

The key point in justifying this solution is a customer satisfaction approach. The system provides an encompassing ownership experience through the customer's mobile device. It empowers the customer in making decisions at their convenience and solidifies customer loyalty to the dealership that is fulfilling service requests. On average, over half of a dealership's profit comes from the service department yet only 30% of the customers return for service outside of the vehicle warranty (Truett, 2017). Customers ultimately value their time and the ability to make decisions entirely at their convenience. Digitization is rapidly shaping new business models outside of the automotive industry. A far departure from the antiquated approach seen in private franchise dealerships.

1.3 Project Background/ Problem Statement

David Sirotinsky, Project Manager of this report shares the following message from his 1 year working experience at a Mercedes-Benz dealership in 2017.

The root cause of failure in a dealer's service department is the medium of communication between departments (parts, service advisors, technicians) and their silo database structure, as well as the excess administrative tasks performed by employees. The OEM mobile phone application for customers offers *robust solutions linking the vehicle to the customer but not the dealership to the customer. Customer retention and loyalty to the service department is decreasing due to the increased convenience of the aftermarket. The age old private franchise dealership model has proven to limit innovation for both the automobile and the service process. A level of standardization must be met in order to provide a competitive product and service.*

The increasing complexity of the automotive industry is forcing OEMs to explore cutting edge network systems to connect key players. Instant data sharing and analysis from the connected car, the customer, the dealership and the manufacturer is critical for OEMs to remain competitive in mobility solutions. The enabler in linking these players is the computing potential offered by a server-less network model, namely Amazon Web Services (AWS).

Chapter 2: Literature Review

1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.868.2116&rep=rep1&type=pdf

This dissertation is on Forecasting dealer inventory and supply chain analysis between distribution centers and dealers. The format served as a template for our report. It also provided holistic insight of the distribution network for spare parts in the automotive industry.

2. https://arxiv.org/ftp/arxiv/papers/1309/1309.1921.pdf

This report gives insight on the benefits of condition based maintenance over preventative maintenance.

3. http://www.diva-portal.se/smash/get/diva2:1155761/FULLTEXT01.pdf

This report gives insight on a Lean approach in RD at Daimler for the seat department. It analyzes the procedure for quality control reports called KEMs sent to the management department for reviewing. Outsourcing to India has limited communication and many of the KEMs are not read. Lean thinking can be implemented in OEM dealership processes. Namely, AGILE and SCRUM development with proper documentation after each iteration.

4. https://www.accenture.com/t20170411T120057Z__w__/us-en/_acnmedia/Accenture/Conversion-Assets/WEF/PDF/Accenture-Automotive-Industry.pdf

This report gives further insight on how the automotive industry is digitizing at a global scale. Details on collaboration between technology companies and OEMs offering new value for customers. It also describes business initiatives to advance autonomous and electric mobility. It is not a technical document because it is directed towards legislative progress and realization.

5. http://www.autonews.com/article/20170619/RETAIL05/170619929/why-customers-stray-and-what-your-dealerships-service-department-can

Statistical information on customer retention and loyalty outside of the vehicle warranty is provided. It is a holistic figure for all OEM dealerships claiming a total $99 billion is spent at auto servicing centers outside of the OEM dealership. The goal is to increase customer loyalty to OEM dealerships by offering value beyond price.

6. *https://www.linkedin.com/pulse/why-dealer-franchise-model-go-extinct-cliff-banks*
   This online article highlights why a private dealer model is necessary. To come at vehicle ownership as a cost analysis exercise ignores the human dynamic of how we as Americans behave and what drives our consumerism. Much of it is based on convenience, not cost

7. *https://www.youtube.com/watch?v=1nOZ0zj7ILA&t=1536s*
   @ 7:30, Mark Fields, CEO of Ford mentions how to introduce "disruptive concepts into the automotive industry."

8. *AWS Kinesis: https://aws.amazon.com/kinesis/*
   AWS Lambda: https://aws.amazon.com/lambda/
   AWS S3 Bucket: https://aws.amazon.com/s3/
   The AWS homepage provides surface level knowledge on the operational functions.

9. *https://www.mulesoft.com/resources/api/what-is-rest-api-design*
   This website gives insight on API development for dealer management software.

Chapter 3: Problem Solving Approach

3.1 Fundamental Requirements

The primary requirement of the proposed system is that it must integrate into existing hardware and software infrastructure with little disruption and must improve on the following fronts:

- Customer retention and dealer loyalty throughout the vehicle lifecycle and beyond the warranty
- Automate or eliminate repetitive administrative tasks performed by dealer employees
- Customer and connected car data sharing between departments real-time

These requirements where stated in the initial design report and served as a backbone to guide the progress of this report.

3.2 Research Methods and Project Strategy

The project took on three design changes throughout the semester.

Design 1: Operations Research with ARENA

The initial approach to meeting these requirements was to revisit the text book *Introduction to Operations Research 10th Edition*, the primary curriculum for ISYE students.

- Demand Forecasting: to appropriately stock parts inventory and maximize service rate

- Moving Average/Exponential Smoothing: to forecast demand based on historical data

- Queuing Theory: to employ the optimal number call center employees to handle service appointments

- System Modeling and Simulation with ARENA

The application of these techniques would then yield enough data and analytics to slightly improve the current process. This approach proved to be unambitious by "solving a 30 year old problem with a 30 year old solution."

Design 2: Private Blockchain with HyperLedger

The second design approach to meet the fundamental requirements was far more radical. A private blockchain developed using HyperLedger Fabric would handle transactions autonomously. Event driven code would process transactions between the key players, the connected car, the customer's mobile device, and the dealership then publish these events to a tamper proof blockchain available for authorized users to see. All research was done through their website and their open forum for discussions. Advancements in blockchain technology would enable secure data transfers between key players but large scale deployment of this use case proved it to be underdeveloped. The verification process in the automotive industry requires strenuous testing before launching said network solutions. This approach was provable but far too ambitious to deploy.

The key take away from design 2 was that event driven programs could automate redundancy in employee tasks, but most importantly, analyze day to day operations in real time. The program would then instantiate age old ISYE principles mentioned in design 1. Another key take away from this research was that a very elementary use case blockchain could be used to document vehicle service history and notary with instant authorization, essentially the vehicle “CARFAX”.

Design 3: Amazon Web Services

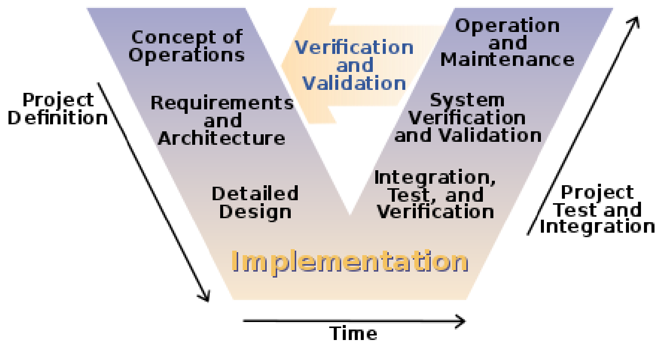
INCOSE defines Systems Engineering as the **interdisciplinary** approach to enable the realization of successful systems. The modern interpretation of this definition requires extensive knowledge in state of the art technologies, whether it be rocket science or neurology. Any true advancement in legacy systems as per the automotive industry would require extensive knowledge in concepts beyond those taught in ISYE curriculum.

The ultimate focus is to develop a software program that would provide true innovation for the outdated system. This requires a holistic understanding of the technical functions available in cloud network solutions. With this in consideration, interviews were held with a KSU alumni Information Technology consultant for a best fit network provider. After extensive online research and verification from the consultant, Amazon Web Services (AWS) proved to be a robust solution that could be tested and deployed. An ambitious attempt to develop a test model was made in AWS but was remitted due to time constraints. It was advised, the time spent to deploy this would be 10% programming and 90% gaining developer rights (APIs and requirements) for the network.

Project Strategy

The main strategy for the project is gathering both functional requirements from service managers and technical requirements from the Information Technology consultant, elicited by frequent interviews. Designing the solution would abide by the System Engineering V model illustrated below.

Figure 1: V-Model



Progression of the report will follow these steps. After requirements are gathered, a test case would be provided and verified. Key Performance Indicators (KPI's) will be defined to gauge quality and maintain the system.

3.3 Project Enablers

To set the stage it is important to realize the current technology and infrastructure offered for the key players in the automotive industry.

- Connected Car: 4G internet transmitting CAN-bus data to the OEM and dealership for remote diagnostics and Over-the-Air updates
- Customer Mobile Phone App (OEM): allowing customers to monitor vehicle health, set preferred dealers, and schedule service appointments
- Last-Mile Transportation Networks: allowing faster lead times and less spare parts inventory holdings at dealerships. A dealer-to-dealer spare parts trading platform to retain high service levels. This enables a just-in-time delivery network model.

The missing piece in this ecosystem is the ability for the dealer to analyze the vehicle health of every vehicle they sold in real-time, essentially connecting the car and mobile app to the private dealers. Dealer operations would be far more predictable if they knew exactly when a customer will arrive and for what purpose. The goal then, would be to provide an encompassing vehicle lifecycle on the mobile app where “events” triggered would be fulfilled by a favorited dealer, all autonomously. Events are defined as upcoming service intervals or requests made by the customer. The primary reason this has not been accomplished in the automotive industry is because of the private franchise business model mentioned in section 1.3 Problem Statement, namely the variation in Dealer Management Software (DMS) amongst dealers. A light weight network solution like AWS would be an effective way to integrate these functions into the OEM mobile app.

Application Programming Interface – A key enabler in adding functions to a software system is an API. Developers can use an API over any protocol to add functionality from any permitted software. In this case, the DMS, the OEM parts catalog, and the mobile app each require development permissions to access their API (MuleSoft).

3.4 Project Management

A. Responsibilities

David Sirotinsky - Project Manager

The main duty for the project manager will be to conduct field interviews with dealer managers once a week and I.T. professors to gather functional and technical requirements. Other duties include:

- Assign research curriculum during the design phase of the project
- Ensure the project meets the initial requirements throughout the report
- Conduct ROI or cost analysis during the design phase
- Manage project scope to ensure a deliverable solution

Ling Marshall - Administration Manager

The main duty for the administration manager is to organize the report and presentations throughout the project. Other duties include:

- Establish team schedules and milestones
- Organize the written or verbal requirements gathered at interviews
- Ensure the report meets academic formatting

B. Schedule

The master schedule is displayed in Appendix D: Supporting Links and Schedule Gantt chart.

The table below displays total hours contributed and the distribution of effort.

Task Type	David's Hours	Ling's Hours
researching	18	5
writing	11	7
interviewing	11	0
admininstrative	2	13
TOTAL	41	25
Estimated	46	20

65 total estimated hours were projected before beginning the project. 66 total Allocated hours were performed. David performed more hours because of his defined job duties. For Ling, actual hours exceeded the estimated hours because of the design changes made and the administrative duties assigned with them.

C. Budget

Developing the architecture for the proposed cloud network will not require any cost to the team. Test cases within AWS would warrant pay-per-use data transfers. This report only proposes a test case without deploying one so there will be no expenses.

Test Case Budget:

AWS Kinesis ≈ $11 /month

Figure 2: Kinesis Stream Cost

Kinesis Streams:

	Description	Records per Second	Record Size	Number of Kinesis Streams	Extended Retention	Details	Monthly Cost
	1 failure detectio	10	1 KB	1	No	1 shard 26.36 million PUT Payload Units per month	$ 11.35
	Add New Row						

AWS Lambda ≈ Free for 1M transaction per month.

AWS Bucket = Free /12 months

Student Programmer = Free for the duration of her attention span

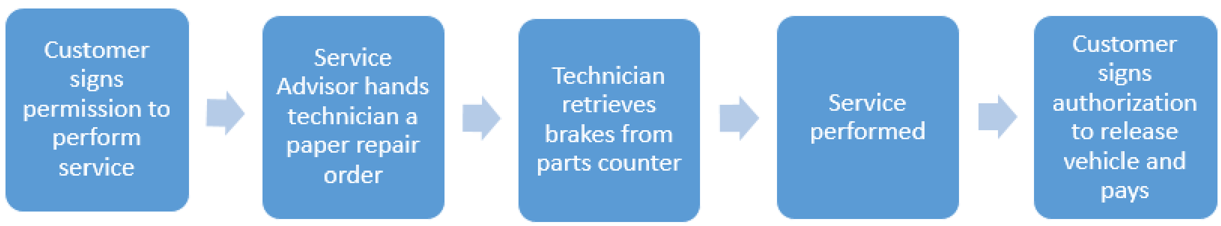
Chapter 4: Test Case Design

4.1 Concept of Operations: Determining Scope

Due to the wide scope of this problem, a particular test case was drafted. This will eliminate "scope creep" when approaching the project and better illustrate the value derived from the proposed solution.

The test case is a customer requesting their first brake pad replacement on a car still under factory warranty and a prepaid maintenance plan. This process is illustrated in Figure 3 below:

Figure 3: Current Process Flow



The problems with this process are stated in these questions:

> *If the customer services the car where it was purchased, why do some departments still ask for their personal or vehicle information?*
>
> *If a scheduled service interval is premeditated, why does a service advisor fill out the same repair order as though it were a walk in customers' with a damaged vehicle?*
>
> *Why does the technician hand the Parts department a paper repair order, who then enters the VIN manually into the parts catalog?*
>
> *Some brake pads are special order and are not inventoried. How can this process be streamlined even with the one day lead time?*
>
> *Why does the customer hand sign authorization of release when the customer approved of the dealership's prepaid maintenance policy when purchasing the car new?*

4.2 Requirements and Design

The questions asked in opposition to Figure 3:

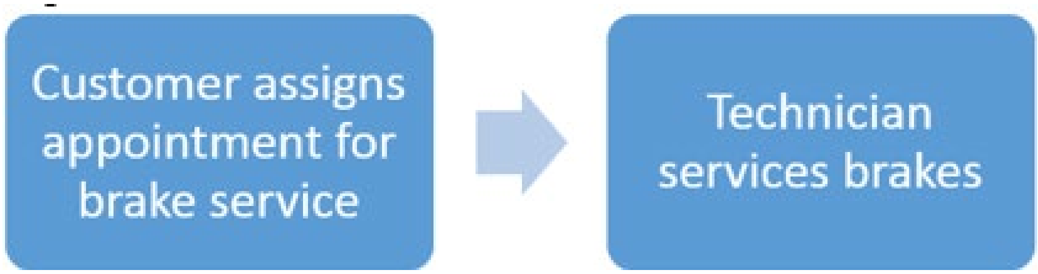
Can the administrative tasks be categorized and automated using event triggered programs?

Can a customer schedule an appointment, receive an invoice with parts ordered/service performed, and pay for their service simultaneously from a mobile device?

How can all departments share the vehicle and customer data simultaneously?

The requirements of the test case are to optimize the process flow as shown in Figure 4 below.

Figure 4: Optimized Process Flow



Design: Amazon Web Services

The key take away from this section is to note the functionality provided by AWS.

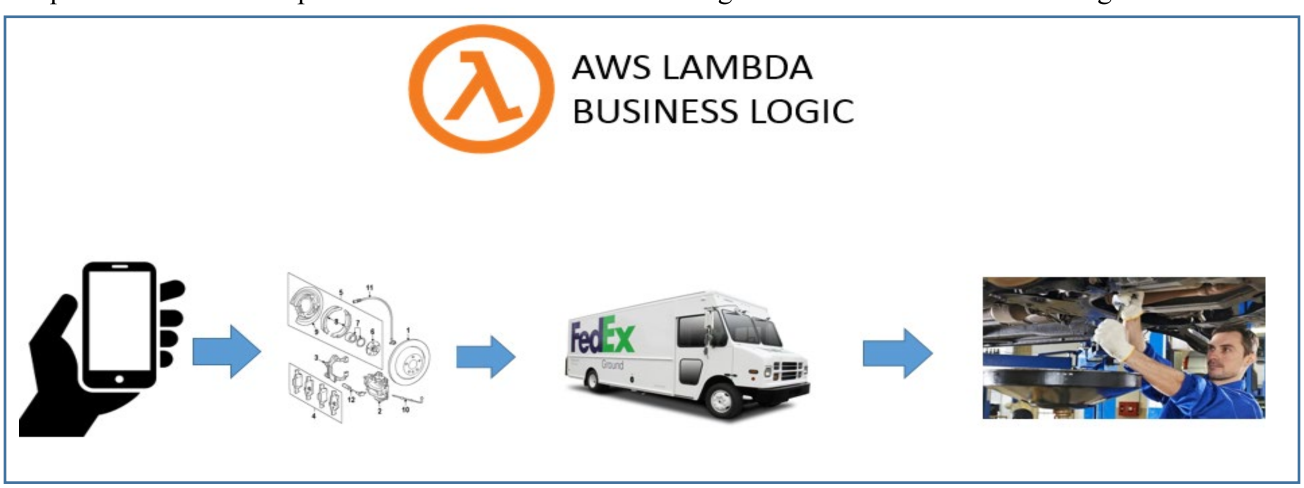
Illustrated below is how AWS eliminates the administrative tasks in the test case.

Figure 5: AWS Functions

Figure 5 explained:

- The vehicle CAN bus transfers data via 4G network
- The data is streamed into Kinesis.
- When an anomaly occurs, business logic programmed into the Lambda is triggered and an "event" is created
- The event is stored in DynamoDB where it takes its form in a relational SQL format for future reference.

Ultimately, the business logic programmed into AWS Lambda is the enabler to meet the system requirements. For this particular test case the business logic in Lambda is defined in Figure 6 below:



An error message for worn brake pads is detected by AWS Lambda!

Figure 6 explained:

- The program shall notify the customer of the anomaly streamed from the vehicle CAN bus
- The user shall initiate authorization of repairs by scheduling an appointment
- The parts catalog is referenced and a service invoice is displayed.
- The part is automatically shipped from the distribution center to the dealership
- A technician is assigned for that time slot.

4.3 System Verification

This section proves the validity of the proposed solution in context of the system and requirements.

Supply Chain System Verification:

In order to verify the automated ordering system proposed in this report, the current supply chain for spare parts must be analyzed.

The key players in the supply chain are the manufacturers, the central distribution center (CDC) and the dealers. Dealership inventory levels are managed by allocating criticality of the parts. High criticality would be parts directly associated with the quick-lane service for walk-in customers. For example, oil, filters and tires must be stocked to satisfy demand. Medium criticality is an intermediate level of lead time permitted in stocking the part (24 hours). Low criticality are parts are permitted to have lead times of several days and are never stocked at a dealership. Assigning parts criticality is described in further detail in this cited case study with the Volvo Group and most notably, dealers inventory parts because demand is unknown (Bjarnadóttir and Halldórsdóttir, 2015).

In the proposed system, demand is known. Transparency in the exact number of vehicles needing service and parts will provide new forecasting strategies in the supply chain. The system is verified through the current transportation infrastructure.

Last Mile Delivery Network

The Milk-Run supply chain network for last mile deliveries and flow of inventory amongst the key players is illustrated in Figures 7 and 8.

Figure 7: CDC Supply Chain

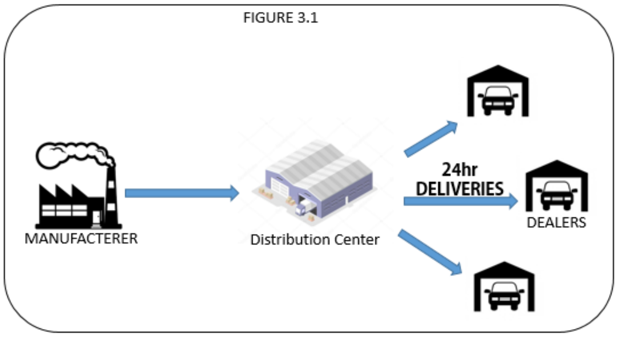


Figure 8: Milk-Run Supply Chain

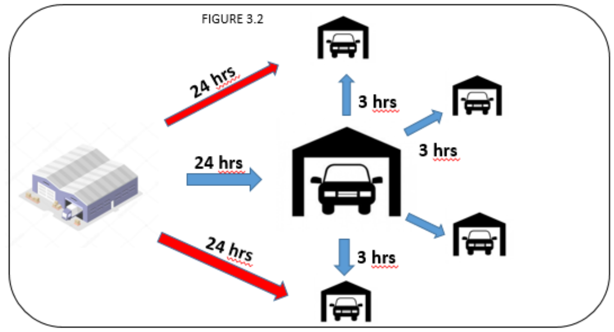


FIGURE 7:

The manufacturer hold low criticality parts with lead times of several days. High and Medium criticality parts are held at the CDC with a 24 hour lead time. High criticality parts are inventoried along with safety stock at the dealership.

FIGURE 8:

In the milk-run supply chain network the CDC ships high/medium criticality parts to a dealership with large storage infrastructure who will wholesale inventory to the smaller dealerships within an optimized radius. The CDC provides inventory for all dealers but certain level criticality are stored at the large dealership which can be dispersed in under 3 hours lead time. The CDC ships only high criticality parts to the small dealerships.

Key Take Away: Given the current milk-run network model, delivery trucks arrive three times a day, every three hours. In the proposed system, automated parts ordering can be sustained with no change in infrastructure.

COST ANALYSIS TEST CASE:

A rudimentary cost analysis in inventory holding was conducted at one **small** dealership.

- Total capital held in inventory: ≈ $200,000 (at any given time)
- ≈ 65% ($135,000) of the inventory is regular maintenance parts for new cars under factory warranty (Brake pads, rotors, gaskets, spark plugs, etc.)
- An additional $70,000 in tires. (High stock levels due to OEM discounts)
- Dead stock is audited annually with a return rate of 5% to the manufacturer at full refund.

The proposed system can entirely eliminate "medium or low" criticality inventory at the dealership. High criticality parts are inventoried to provide adequate service levels.

60% of the regular maintenance parts for new cars under factory warranty are categorized as medium or low criticality and 70% of the tire inventory fall into that category as well.

A grand total of $136,750 in dealership capitol is freed. Conversely, the distribution centers operated by the OEM's will absorb the storage costs and potentially require a more robust fulfilment processor. Decreased inventory equals increased transportation cost. This dichotomy would need to be further analyzed with proprietary methods provided by the OEM.

4.4 Operation and Maintenance: Measuring Quality

This section deploys performance metrics to measure the success of the system after it is deployed.

The Key Performance Indicators (KPIs) for the system are shown in Table 1.1:

STOCK TURN RATE KPI	$\frac{Inventory\ drawdown\ (consumption)(\sum 12\ months)}{Average\ inventory\ (\frac{\sum 12\ months)}{12\ months})}$
SERVICE LEVEL KPI	$\frac{Number\ of\ parts\ immediately\ available}{Number\ of\ parts\ requested}\ x\ 100 = \%$
PRIORITY ORDERING RATE KPI	$\frac{Number\ of\ priority\ items\ ordered\ \ from\ Distribution\ Center}{Number\ of\ all\ items\ ordered\ from\ Distribution\ Center}\ x\ 100 = \%$
RATIO OF DIRECT TO INDIRECT WORKERS	$\frac{Productive\ Work\ hours\ (technitians)}{Total\ worker\ hours}\ x\ 100 = \%$

KPIs allow dealers to audit their operations accordingly. The proposed system would undergo these four quality metrics in reference to the existing system in place.

Service Level KPI: A high service indicates high levels of inventory which means more tied cash. Low service level indicates inventory is too low and a lost sale. The proposed system would provide a near 100% service level.

Stock Turn Rate KPI: A higher turn rate is the goal in the current system. It means the inventory levels are at the optimal level and are reordered with a safety level of about 10%. The proposed system would further maximize turn rate.

Priority Ordering Rate KPI: This is a negative occurrence for the current system. A dealer aims to have parts in stock to avoid priority ordering and transportation costs. The proposed system relies on this to minimize inventory and the proven milk-run network can support these transportation costs.

Ratio of Direct to Indirect Workers:

Total workers = productive (technicians) + unproductive (service + parts). The aim is to minimize administrative work. Of course the proposed system eliminates the need for these types of tasks but only for a specific type of customer. It is not suggesting to eliminate these job positions.

Chapter 5: Results and Conclusions

The purpose of this report was to explore a digital solution for an analog process, given the recent technological advancement in enterprise ready cloud computing.

Integrating event triggered programming with AWS meets the fundamental requirements stated in the introduction. However, deploying an enterprise solution requires permissions to develop using API's from three key players which will be explored outside of this academic report.

1. The dealer management software(DMS)
2. The OEM parts catalog
3. A standardized payment processor for every dealer.

The other deployment initiative is to standardize the I.T. infrastructure at dealerships. Some operate on twenty year old computers. The solution would be to issue a standard Windows operating system for all dealers using a virtual machine.

The initiative to deploy the solution at an enterprise scale would be to select one OEM dealer region and gather requirements from each individual dealer. A team of field engineers would document variation in operations for each private franchise. Once a standard solution is met, installing Windows 10 virtual machines for example, the proposed solution would be deployed. The customer demographic would be limited to new car customers with a prepaid maintenance plan for a narrowed sample size to conduct quality metrics. The proposed system would coincide with standard operations.

The benefits of the proposed solution is far greater reaching but the scope was narrowed to illustrate key points. Further developments in OEM operations will be conducted with proprietary information outside this report.

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Appendix A: Acknowledgements

Special thanks to Doug Dubuc, Fixed Operations Director at RBM Atlanta Mercedes-Benz, for the wealth of knowledge during interviews and positive feedback for the project.

Thank you, Zack Thackston, Service Manager at Krause Ford, for providing valuable information on dealer operations.

Thank you, Gavin Smith, Senior Network Administrator, for guiding the technical progress of the project.

We are grateful for the educational journey provided by the Industrial and Systems Engineering faculty at Kennesaw State University. We proudly claim that efforts outside of academia will reflect the knowledge gained in this curriculum.

This reports was supervised by Dr. Adeel Khalid. We are especially grateful for his dedication and efforts to further higher education at Kennesaw State University.

Appendix B: Contact Information

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Appendix C: Reflections

David Sirotinsky

I would like to begin by thanking everyone involved in this project. This final year at KSU was particularly challenging and completing this project has enriched my academic experience.

The beginning of January, I quit my Sales position a Mercedes-Benz to work on my Senior Design. It was particularly challenging because I knew what problem I wanted to solve but I did not have the group to do it with. The other students partnered with Siemens while I had to quickly match with the students who did not have a project idea. We were left with two in our group after the other dropped the course due to health.

In terms of my role for this project, I found it difficult to write this report in collaboration with my partner. Mainly because of the lean approach I took in developing a solution, I was moving too quickly to stop and think what my partner could add to the project design. I learned that creating a report is not just an idea and proof that it works. The format requires time and effort to create the final report, so assigning administrative roles to my partner seemed best fit. Also the advisor interviewing was done by me because of how limited the service managers are with time. They are considered to be the busiest, most stressed employees at the dealership, and to sit with me for an hour at a time was a real testament to their interest in such solution.

Referring to the design phases in Chapter 3, when I interviewed the dealership managers with design 1, they were unimpressed. Design 2, a blockchain solution, was very entertaining to research because at the time, anything blockchain was marketable. My brother showed me his crypto-currency trading account with $60,000, an increase ten times from his initial investment in just three weeks. I began to research blockchain development and Initial Coin Offerings, particularly one called UService in Russia that raised $24 million in 2017 attempting to digitize the vehicle “CarFax”. I noticed how little progression the actually accomplished by reading their whitepaper and monitoring their progress through forum chatrooms. Blockchain development is far too undeveloped to serve as an enabler in network development, especially for someone without a computer science degree. Then I spent a few weeks researching AWS and all the technical requirements to develop. After the countless hours spent research cloud network solutions, calling every dealer software provider, reading every masters dissertation, and reviewing every network patent on google, I assumed this problem had not been solved. If there is any attempt to do so by the OEM, it is being done in the near future, as they are just now recruiting AWS developers to explore these options.

I think the dialog found on the internet about the connected car, autonomous driving, or artificial intelligence is far detached from the actual business and there needs to be a middle ground. Incremental progression will eventually lead to a new infrastructure for the automotive industry. It is just a matter of discerning what that next step should be. This requires a broader understanding of technology and how we can connect the dots to make better products. I am particularly eager to propose this solution for further development with an OEM.

Appendix D: Supporting Links and Schedule Gantt chart

1 .These are links to view the OEM mobile application functions offered by MercedesMe and Ford SYNC.

https://www.mbusa.com/mercedesme/index

https://www.ford.com/technology/sync/

2. This link is to the Dealer Management Software provider, CDK Global.

https://www.cdkglobal.com/#sm.000017hnt8vftfktw9t1y1aiy9y62

3. This website gives insight on API development for dealer management software.

https://www.mulesoft.com/resources/api/what-is-rest-api-design

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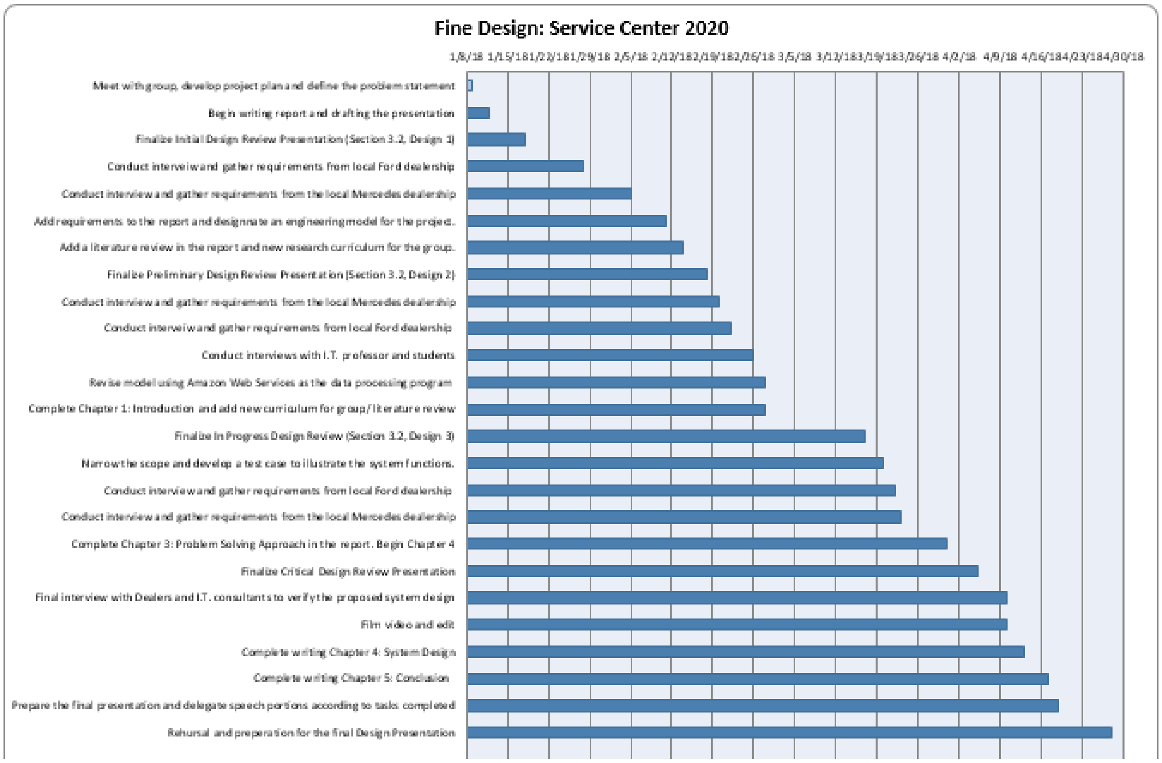
Schedule

	Task Type	Task Name	Start Date	End Date	Duration in Days	Estimated Hours	Actual Time Spent in hours
5	Researching	Meet with group, develop project plan and define the problem statement	1/8/2018	1/17/2018	9	3	5
6	Writing	Begin writing report and drafting the presentation	1/12/2018	1/17/2018	5	4	2
7	Administrative	Finalize Initial Design Review Presentation (Section 3.2, Design 1)	1/18/2018	1/22/2018	4	2	2
8	Interviewing	Conduct interveiw and gather requirements from local Ford dealership	1/28/2018	2/4/2018	7	1	1
9	Interviewing	Conduct interview and gather requirements from the local Mercedes dealership	2/5/2018	2/10/2018	5	1	1
10	Researching	Add requirements to the report and designnate an engineering model for the project.	2/11/2018	2/14/2018	3	3	2
11	Researching	Add a literature review in the report and new research curriculum for the group.	2/14/2018	2/17/2018	3	1	1
12	Administrative	Finalize Preliminary Design Review Presentation (Section 3.2, Design 2)	2/18/2018	2/19/2018	1	1	2
13	Interviewing	Conduct interview and gather requirements from the local Mercedes dealership	2/20/2018	2/22/2018	2	1	1
14	Interviewing	Conduct interveiw and gather requirements from local Ford dealership	2/22/2018	2/24/2018	2	1	1
15	Interviewing	Conduct interviews with I.T. professor and students	2/26/2018	2/27/2018	2	1	1
16	Researching	Revise model using Amazon Web Services as the data processing program	2/28/2018	3/13/2018	13	12	12
13	Interviewing	Conduct interview and gather requirements from the local Mercedes dealership	2/20/2018	2/22/2018	2	1	1
14	Interviewing	Conduct interveiw and gather requirements from local Ford dealership	2/22/2018	2/24/2018	2	1	1
15	Interviewing	Conduct interviews with I.T. professor and students	2/26/2018	2/27/2018	2	1	1
16	Researching	Revise model using Amazon Web Services as the data processing program	2/28/2018	3/13/2018	13	12	12
17	Writing	Complete Chapter 1: Introduction and add new curriculum for group/ literature review	2/28/2018	3/18/2018	18	4	5
18	Administrative	Finalize In Progress Design Review (Section 3.2, Design 3)	3/17/2018	3/19/2018	2	1	2
19	Researching	Narrow the scope and develop a test case to illustrate the system functions.	3/20/2018	3/23/2018	3	4	3
20	Interviewing	Conduct interview and gather requirements from local Ford dealership	3/22/2018	3/23/2018	1	1	1
21	Interviewing	Conduct interview and gather requirements from the local Mercedes dealership	3/23/2018	3/24/2018	1	1	1
22	Writing	Complete Chapter 3: Problem Solving Approach in the report. Begin Chapter 4	3/31/2018	4/6/2018	6	4	5
23	Administrative	Finalize Critical Design Review Presentation	4/5/2018	4/9/2018	4	1	2
24	Interviewing	Final interview with Dealers and I.T. consultants to verify the proposed system design	4/10/2018	4/12/2018	2	3	3
25	Administrative	Film video and edit	4/10/2018	4/12/2018	2	2	2
26	Writing	Complete writing Chapter 4: System Design	4/13/2018	4/16/2018	3	5	5
27	Writing	Complete writing Chapter 5: Conclusion	4/17/2018	4/18/2018	1	2	1
28	Administrative	Prepare the final presentation and delegate speech portions according to tasks comple	4/19/2018	4/27/2018	8	4	3
29	Administrative	Rehursal and preperation for the final Design Presentation	4/28/2018	4/30/2018	2	2	2


Fine Design: Service Center 2020
1/8/18 1/15/18 1/22/18 1/29/18 2/5/18 2/12/18 2/19/18 2/26/18 3/5/18 3/12/18 3/19/18 3/26/18 4/2/18 4/9/18 4/16/18 4/23/18 4/30/18
Meet with group, develop project plan and define the problem statement
Begin writing report and drafting the presentation
Finalize Initial Design Review Presentation (Section 3.2, Design 1)
Conduct interveiw and gather requirements from local Ford dealership
Conduct interview and gather requirements from the local Mercedes dealership
Add requirements to the report and designnate an engineering model for the project.
Add a literature review in the report and new research curriculum for the group.
Finalize Preliminary Design Review Presentation (Section 3.2, Design 2)
Conduct interview and gather requirements from the local Mercedes dealership
Conduct interveiw and gather requirements from local Ford dealership
Conduct interviews with I.T. professor and students
Revise model using Amazon Web Services as the data processing program
Complete Chapter 1: Introduction and add new curriculum for group/literature review
Finalize In Progress Design Review (Section 3.2, Design 3)
Narrow the scope and develop a test case to illustrate the system functions.
Conduct interview and gather requirements from local Ford dealership
Conduct interview and gather requirements from the local Mercedes dealership
Complete Chapter 3: Problem Solving Approach in the report. Begin Chapter 4
Finalize Critical Design Review Presentation
Final interview with Dealers and I.T. consultants to verify the proposed system design
Film video and edit
Complete writing Chapter 4: System Design
Complete writing Chapter 5: Conclusion
Prepare the final presentation and delegate speech portions according to tasks completed
Rehursal and preperation for the final Design Presentation