

INTERNSHIP REPORT

*A report submitted in partial fulfilment of the requirements for the
award of Degree of*

**BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE & ENGINEERING**

by

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Under Supervision of

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CERTIFICATE

This is to certify that the **Digital Bill of Materials** submitted by **Gaurav V – 1MS18CS046** is work done by him at Unisys India Private Limited and submitted during 2021 – 2022 academic year, in partial fulfilment of the requirements for the award of the degree of **BACHELOR OF ENGINEERING IN COMPUTER SCIENCE & ENGINEERING**.

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TO WHOMSOEVER IT MAY CONCERN

*Certified that the project work entitled **Digital Bill of Materials** carried out by **Gaurav V, USN: 1MS18CS046** a bonafide student of **M. S. Ramaiah Institute of Technology, Bangalore** in partial fulfillment for the award of **B.E in Computer Science of the M. S. Ramaiah Institute of Technology, Bangalore** under **VTU** during the year **09th August, 2021 to 15th November, 2021**.*

It is certified that, he has completed the Internship satisfactorily.

For Unisys India Private Limited,

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I am extremely grateful to my department staff members and friends who helped me in the successful completion of this internship.

Gaurav V

EXECUTIVE SUMMARY

The Company

Unisys Corporation is an American multinational information technology (IT) services and consulting company headquartered in Blue Bell, Pennsylvania. It is the legacy proprietor of the Burroughs and UNIVAC line of computers, formed when the former bought the latter.

It is built on over 145 years of game-changing innovation. Along the way, they have made the world a better place by bringing technological innovation to businesses and governments around the world. The company has evolved and adapted over time, but their passion for innovation and for helping our clients succeed has remained constant.

They consider their mission is to deliver advanced IT solutions to businesses and governments around the world. Also, their solutions consistently deliver the significant, measurable results that matter most to the clients. And they focus on building security into the solutions themselves.

It offers outsourcing and managed services, systems integration and consulting services, high end server technology, cybersecurity and cloud management software, and maintenance and support services.

They also organize Cloud 20/20, which is an annual technical paper contest for tertiary students from India, and is one of their flagship events in India, providing the great platform for students to showcase our talents.

The problem and methodology

With the lack of any standard software that establishes establish a secure network for sharing any kind of data the vision of The Digital Bill of Materials (DBoM) from this. It basically enables companies to easily establish a secure network for sharing software, hardware and manufacturing bill of materials. Organizations will be able to automate attestation sharing and validation for stablishing trust and transparency while reducing the cost of operation. This can be more clearly understood by relating it with SBOM

(Software Bill of Materials). An SBOM is a complete inventory of a codebase including the open-source components, the license and version information for those open source components, and whether there are any known vulnerabilities in those components.

The diversity of the supply chain is a double-edged sword: The flexibility that makes supply chain critical to modern operations also makes it critical to have a trustworthy and secure network for companies to share and receive bill of materials and attestations regarding the composition and the origin of the content of their products.

The Digital Bill of Materials (DBoM) enables companies to easily establish a secure network for sharing software, hardware and manufacturing bill of materials. Organizations will be able to automate attestation sharing and validation for establishing trust and transparency while reducing the cost of operation.

Key findings and benefits to the company

The report consists of the different endpoints that were developed for DBOM, the purpose for that, the functionality it can perform and the inputs and outputs that can be expected. Also, the configurations to integrate role-based access control to DBOM and other applications.

A complete detailed guide with a working demo was presented to the team in midweeks and at the end of the internship period discussing the various findings from the research, the applications developed, and interaction between services of mongo and application in role-based authentication, DBOM added functionality, etc. The company will be able to use this evaluation report to integrate the role-based access control for DBOM and their future applications if and when needed, also the brief up of the endpoints and their functionality.

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INTERNSHIP OBJECTIVES

Learning Objectives:

- Building frontend applications with AngularJS
- Building backend applications with Golang
- Deploying nodes in a virtual environment
- Working with REST APIs
- Working with authentication and authorization
- Understand key features of DBOM

Expected Results:

- Develop dynamic microservices
- Dockerize the microservices
- Deploy the containers
- Design multiple UI mock-ups
- Contribute to the Open source community
- Secure and sustainable software
- Develop responsive webpages
- Enable logging and tracing for backend microservices
- Implementing traffic management
- Demonstrate the idea as a Proof of Concept

WEEKLY OVERVIEW OF INTERNSHIP ACTIVITIES

WEEK 1	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	09/08/21	Monday	Initial introduction to the team. Mandatory onboarding with fellow interns.
	10/08/21	Tuesday	Formal introduction to the project to be worked on over the duration of the internship. Discussions about the project.
	11/08/21	Wednesday	Identify the tools and techniques required to carry out the project. Listing the components of the solution stack.
	12/08/21	Thursday	Discuss and design the basic flow to be realized for the fruition of the project.
	13/08/21	Friday	Attend local onboarding with fellow interns. Finish all mandatory trainings pertaining to company policies and guidelines.

WEEK 2	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	16/08/21	Monday	Payroll and company policy induction.
	17/08/21	Tuesday	Introductory meet with global team members, general discussion about the project.
	18/08/21	Wednesday	Training related to project workflow and understanding software engineering processes.
	19/08/21	Thursday	Deeper dive into the specifics of the problem statement.
	20/08/21	Friday	Trainings related to company policies.

WEEK 3	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	23/08/21	Monday	Learn basic concepts of NodeJS, express, and other associated libraries
	24/08/21	Tuesday	Learn basic concepts of AngularJS a frontend JavaScript framework.
	25/08/21	Wednesday	Learn basic concepts of AngularJS a frontend JavaScript framework.
	26/08/21	Thursday	Learn basic concepts of AngularJS a frontend JavaScript framework.
	27/08/21	Friday	Learn basic concepts of Golang a backend framework.

WEEK 4	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	30/08/21	Monday	Learn basic concepts of REST APIs
	31/08/21	Tuesday	Learn basic concepts of Figma, a vector graphics editor and prototyping tool.
	01/09/21	Wednesday	Learn basic concepts of Figma, a vector graphics editor and prototyping tool.
	02/09/21	Thursday	Learn basic concepts of Swagger, a suite of API developer tools from SmartBear Software and a former specification upon which the OpenAPI Specification is based.
	03/09/21	Friday	Interact with a virtual machine with provided authentication keys.

WEEK 5	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	06/09/21	Monday	Design user login screen using Figma.
	07/09/21	Tuesday	Design users sign up screen using Figma.
	08/09/21	Wednesday	Design account setup using Figma.
	09/09/21	Thursday	Design DBOM node provisioning screens using Figma.
	10/09/21	Friday	Design a custom menu and notification bar for users using Figma.

WEEK 6	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	13/09/21	Monday	Develop user login and sign-up page using AngularJS.
	14/09/21	Tuesday	Develop account setup page using AngularJS.
	15/09/21	Wednesday	Develop DBOM node provisioning screens using AngularJS.
	16/09/21	Thursday	Develop a custom menu and notification bar for users using AngularJS.
	17/09/21	Friday	Integrate backend APIs with the developed pages.

WEEK 7	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	20/09/21	Monday	Discussion on the endpoints which has already been present in Swagger and the APIs / endpoints which are required to develop the backend as given and suggested in the swagger specification.
	21/09/21	Tuesday	Understand the format, style and the standard of the backend code that must be followed for the writing and developing the new APIs
	22/09/21	Wednesday	Develop the endpoint / API as per defined in the Swagger and discussed to be developed
	23/09/21	Thursday	Develop the endpoint / API as per defined in the Swagger and discussed to be developed
	24/09/21	Friday	Test of the Code developed through the postman by hitting the endpoint / APIs with the provided dummy input and verifying against the expected output

WEEK 8	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	27/09/21	Monday	Review of the work and the changes suggested incorporation
	28/09/21	Tuesday	Demonstration and presentation of the work to the whole team
	29/09/21	Wednesday	Discussion on what new endpoints is required and to be created and what are already present in Swagger and, to be developed for backend.
	30/09/21	Thursday	Develop the endpoint on the Swagger for the documentation and maintaining the API endpoint references.
	01/10/21	Friday	Add some examples of dummy inputs and expected out from each newly developed endpoint on the Swagger.

WEEK 9	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	04/10/21	Monday	Review of the swagger endpoints that has been created and incorporating the suggested changes.
	05/10/21	Tuesday	Develop the endpoint / API as per defined in the Swagger and discussed to be developed
	06/10/21	Wednesday	Develop the endpoint / API as per defined in the Swagger and discussed to be developed
	07/10/21	Thursday	Test of the Code developed through the postman by hitting the endpoint / APIs with the provided dummy input and verifying against the expected output
	08/10/21	Friday	Review of the work and the changes suggested incorporation

WEEK 10	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	11/10/21	Monday	Demonstration and presentation of the work to the whole team.
	12/10/21	Tuesday	Brainstorming for the role-based database access control in the DBOM software with the help of mongo DB.
	13/10/21	Wednesday	Understanding and going through the docs of mongo
	14/10/21	Thursday	Understanding and going through the docs of mongo
	15/10/21	Friday	Initial setup of the role-based database access control

WEEK 11	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	18/10/21	Monday	Sample commands testing for the role-based database access control in mongo console
	19/10/21	Tuesday	Initial development of the JavaScript file for the role-based database access control in mongo console
	20/10/21	Wednesday	Development of node application for the role-based database access control in mongo console
	21/10/21	Thursday	Development of node application for the role-based database access control in mongo console
	22/10/21	Friday	Testing of the endpoints/ API through postman.

WEEK 12	DATE	DAY	NAME OF THE TOPIC/MODULE COMPLETED
	25/10/21	Monday	Review of the work and the changes suggested incorporation
	26/10/21	Tuesday	Demonstration and presentation of the work to the whole team.
	27/10/21	Wednesday	Handover of the work
	28/10/21	Thursday	Handover of the work
	29/10/21	Friday	Farewell and thanksgiving

INTRODUCTION

The Internship

My internship started on the 9th of August 2021. Once the onboarding formalities were complete, I was introduced to my manager and team mates. The project description and requirements were explained to me and I was assigned with trainings and tasks to complete for the same.

The training courses assigned to me were the ones that would come handy when I worked on my project. Apart from the project specific trainings, I also attended the generic training track where topics like Payroll, Conversion procedures, and mandatory web content based courses were explained in much detail. The trainings were delivered by fellow Unisys India Private Limited employees who were experienced and experts in these fields respectively. The training program continued for about 2 weeks alongside the project work that I was assigned.

The Project

The diversity of the global supply chain that makes it critical to modern society also makes it very difficult to know where all of the components of a device came from. Who designed each part, who made it, who put it into a device, who sold it, and who bought it? Inside the sheet metal or plastic shells of our personal and business equipment is a fractal maze of assemblies and subassemblies reaching down to the nanometer scale and beyond into the virtual world.

The modern supply chain is a tempting target for attackers driven by financial, political or other motives. A solution to this problem must be found to propagate the benefits of modern supply chains – benefits that underlie the living standards and economies of the world. A Digital Bill of Materials (DBoM), a small but significant addition to the processes used in the supply chain already, may be the solution.

A Bill of Materials (BoM) is a list of everything on a pallet or box or unit of transport that moves from one set of hands to another. A Digital Bill of Materials is a list of every component inside any type of product as each moves from one set of hands to another.

Creating a Digital BoM for a product is simply the act of signing a shared ledger at each step of production and consumption. With digital certificates establishing identity and a distributed ledger run by a consortium of large industry producers providing scale as well as nonrepudiation and forensic record keeping, each step of each physical and virtual product component can be documented with a high degree of surety.

Vendors will be able to maintain appropriate visibility of the “who, what, where, and when” as their products and services are developed, purchased and used. Enterprises will be able to have full visibility into the sources of their technology and purposes they are applied to. With this vital information, vendors and enterprises can better maintain systems, prevent, detect and remediate compromises, demonstrate compliance, and cooperate to build efficient and competitive processes.

Transparency and accountability are the purpose of distributed ledger technologies. The forensic foundation provided by shared visibility into all pertinent events allows vendors and consumers to build the trust necessary to support rapid digital innovation. This shared visibility establishes a virtually inexhaustible resource for valuable analytics, enabling cost and efficiency savings across all business functions.

This DBoM process is managed under the auspices of a consortium of organizations (the DBoM Consortium) which will begin operating the DBoM shared ledger in 2020. The DBoM Consortium will define the standards and common interfaces that can be used by external sources to record data to the Consortium’s distributed ledger. Consortium members will be able to provide additional services such as Advanced Analytics or technical plugins to add value to the ecosystem.

INTERNSHIP DISCUSSION

Project Vision:

Provide a common platform for managing supply chain information

Project Value Proposition:

There is various value proposition for the Digital Bill of Materials. Firstly, it Address need for reliable, transparent, and protected supply chain information. Furthermore, it reduces the cost of sharing and using supply chain information as the offering price of the software isn't much expensive and the cost of developing and setting up stack and the resources will cost way higher. Last but not least, it also provides the maximizes flexibility to accommodate all use cases.

Digital Bill of Materials Architecture:

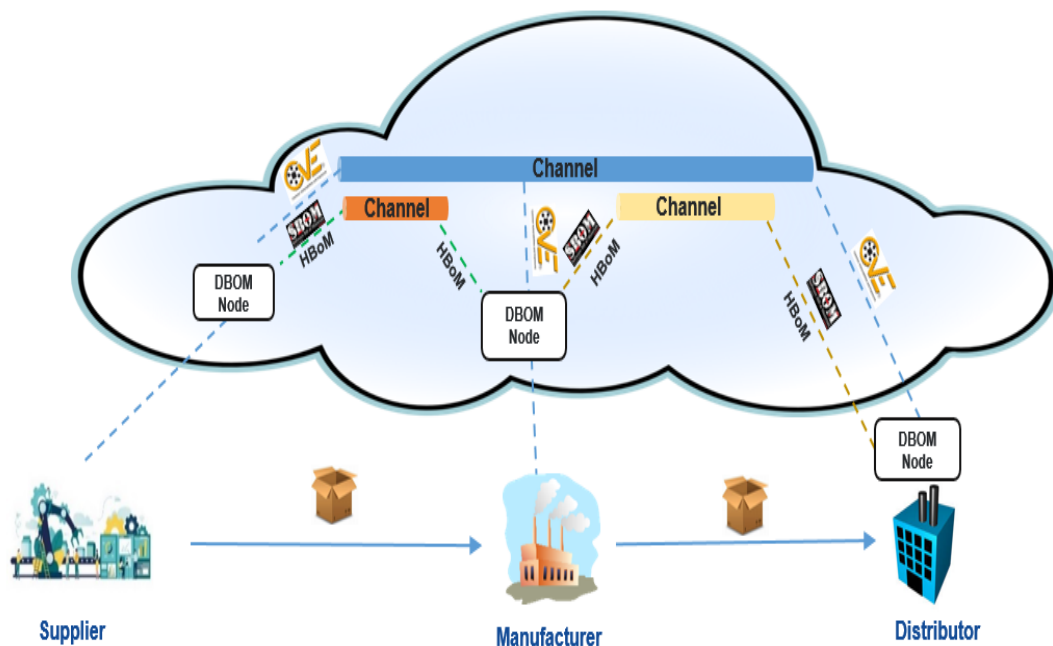


Fig 1 : DBOM Architecture

Nodes are interfaces to process and store data in a standardized manner on Channels.

Channels allow organizations to implement controls on their value chain of shared data, in compliance with policy.

Challenges with adopting Software Bills of Materials

Sharing

- Sharing SBOM data across organizational boundaries in a manageable manner is difficult.

Automation

- SBOMs must be updated and published constantly with every software change to ensure best value.

Interoperability

- SBOMs have a variety of formats. The transport must support conversion on-the-fly for seamless integration.

Policy Control

- SBOMs have the potential to expose organizational intellectual property; hence, policy-controlled distribution is essential.

Use Cases of DBOM:

It is more than just sharing Bill Of Materials, as it can be used in various other use cases like :

- **Manufacturing** : Products with many components rely on complex supply chains in which the manufacturer of each component is responsible to follow

stringent QA processes. There are currently no effective frameworks for sharing this data in a uniform, secure and permissioned manner. DBOM provides a network by which the manufacturers and their suppliers can have a common mechanism to share, access and aggregate their data in order to perform root-cause analysis of defects and subsequently develop corrective actions.

- **Threat Intelligence** : Real-time sharing of threat intelligence in the supply chain is a critical requirement in today's threat landscape, especially with the recent covert attacks on software supply chains like SolarWinds and Colonial Pipeline. DBoM can transport STIX and other related IoC metadata right to the organizations that need them.
- **Compliance and regulatory requirements** : OEMs and other participants in industries like critical infrastructure are required to have certifications to demonstrate compliance and traceability for many years of service. DBoM enables organizations to streamline certification-related data sharing with regulatory agencies in an organized and uniform manner in order to reduce operational cost, disputes and liabilities.
- **Internal information Sharing** : DBoM enables organizations to bring uniformity and automation in the way of organizing and sharing product related data, internally between business units or externally with their customers. This enables organizations to develop end-to-end provenance for their product metadata, all the way from development to deployment.

Backend Endpoints

Endpoints were developed for the channels, it consists of various endpoints some of them were

- create/channel – This endpoint is to create the channel, and required some specific data for the executing the creation of the channel. One of the primary and important thing it required was the name, which shall be unique. Which was again crosschecked with another api/endpoint

- verify/channel - This endpoint verifies if the given name is unique and no similar name exist for any existing channel
- edit/channel - This endpoint is to edit some editable features of the channel like resources assigned or policies change

Endpoints that were developed for the nodes, it consists of various endpoints some of them were

- create/node - This endpoint is to create the node, and required some specific data for the executing the creation of the node. One of the primary and important thing it required was the name, which shall be unique. Which was again crosschecked with another api/endpoint\
- verify/channel - This endpoint verifies if the given name is unique and no similar name exist for any existing node
- subscribe/node – This endpoint is takes the data consisting of the channel name it needs to subscribe to and some other details. After getting all the data verified it then subscribe the calling node to the given channel.

Deployment

For deployment, the team used the Jenkins for the automated and smooth transition of the code to the production. Jenkins is an open-source automation server. It helps automate the parts of software development related to building, testing, and deploying, facilitating continuous integration and continuous delivery. It is a server-based system that runs in servlet containers such as Apache Tomcat. It supports version control tools, including AccuRev, CVS, Subversion, Git, Mercurial, Perforce, ClearCase and RTC.

The build was triggered when there was a merge in the master branch from any feature branch. Though there are many other various ways through which the build can be

triggered like for example a webhook that gets triggered upon pushed commits in a version control system, or scheduling via a cron-like mechanism or after the other builds in the queue have completed, or invoked by other builds, etc.

Plugins was used for the Jenkins in our project as it was in JavaScript. Plugins, in general are available for integrating Jenkins with most version control systems and bug databases. Many build tools are supported via their respective plugins. It can also change the way Jenkins looks or add new functionality. Builds can generate test reports in various formats supported by plugins and Jenkins can display the reports and generate trends and render them in the GUI.

Completion of objectives:

The completion of the initial objectives for the project happened in 3 phases.

Ideation and Discovery

- Identify the pain points for a few industries that will benefit from the solution
- Define the use cases with the early adopters
- Build the business case for funding POCs and promotions
- Customer pre-commitment to POCs

Nurturing and Customer Validation

- Support the PoCs & collect feedback
- Define the Minimum Viable Product (MVP) based on the input from early adopters
- Enrich the open-source
- Roadmap for productization
- Business case to raise funding for the MVP

Productization

- SaaS offering on Azure with additional features and capabilities
- Enterprise version for private clouds

DBOM Offerings to customers:

Feature	Open Source	SaaS	Enterprise
Repository Agents	MongoDB, IOTA	MongoDB, IOTA, Cosmos, HL-Fabric, Trillian Repository cost sharing	MongoDB, IOTA, Cosmos, HL-Fabric, Trillian
Channel Configuration	Through APIs R/W only policies	Through UI, Enhanced policies	Through UI, Enhanced policies
Data Repositories		MongoDB, Cosmos, HL-Fabric, IOTA	MongoDB, HL-Fabric, IOTA

Challenges Faced:

- The transition from a student to an intern in a professional environment can be stressful at times but the team I had worked with at Unisys India Private Limited were very welcoming and that made me feel comfortable in a very short duration.
- The learning curve is quite steep when transitioning into a work place and I had to start quite slowly in the initial weeks but as time passed by, I was able to pick up pace and finish all assignments in the stipulated time frame.
- The cultural differences between colleges and professional work environments are quite different. It sure takes time to understand the office culture. Since every organizational culture varies from office to office. Some have a rigid structure while others are flexible.
- As digital bill of materials is a new concept it took meticulous effort to understand and develop the proof of concept.
- Integrating role based access control required the understanding of the configuration of DBOM and mongo setup.
- Replicating Figma mock-ups to actual webpages took some time initially as AngularJS was a new web framework for me.

Skills gained:

Throughout the duration of the internship, I've had the pleasure to cultivate various professional and technical skills. To list a few soft skills adopted from this project are:

- Communication skills by conversing with various professionals over the duration of 3 months in various contexts of the project and the organization.
- Work experience that can be essential when transitioning into the technology industry.
- Understood the essence and importance of teamwork in any professional setup and the major role it plays in the success of a project.
- Software education in the subtext of how companies create software and sustain the development cycle.
- Necessary critical thinking and problem solving skills were gained throughout the design and implementation phases.

In addition to this, several technical skills were also picked upon in the timespan the internship lasted for. To mention some of them, NodeJS and Golang based microservice development, frontend development with the help of AngularJS with typescript and PrimeNG components, version control through GitLab and GitHub, database deployments and management through MongoDB.

CONCLUSION

Working in the capacity of an intern Unisys India Private Limited gave me the opportunity to learn real-life applications of the various technologies that I had come across. I was able to develop the tasks and project assigned to me and fulfil the required features of the same. The training sessions provided by the firm helped me to gain deeper knowledge of the industry application of the technologies and concepts being taught. Unisys India Private Limited's core value of giving back gave me an opportunity to be a part of such noble causes and contribute my share towards the betterment of society. I gained knowledge about development environments, deployment scenarios and landscapes, etc.,. I understood the importance of design patterns and farsightedness while developing code structure. This internship has also shaped me to be a better professional and taught me communication skills, work ethic and professional etiquette. I look forward to utilizing the knowledge and experience I gained here in the years to come to provide better engineering solutions for society and to be able to thrive in a professional capacity.

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