Preventing Black Hole Traffic in MANETs Using Machine Learning

Group Project Plan

Version	1.0
Responsible Officers	u3201908 (Curtis), u3215948 (Daniel), u3225675 (Ellie)
Date	01/09/2023
Project ID	2023-S1-03
Tutor	Jeanette Cotterill
Tutorial Time	Monday 7:30pm-8:30pm
Group ID	9785-23-07

Version History

Version	Modifications made	Date
1.0	Initial document/proposal submission	01/09/2023

Endorsement

Position	Name	Signature	Date
Project Mentor	Maryam Sousani		01/09/2023
Project Sponsor	Dr Yibe Alem		01/09/2023

Proposal Areas of Responsibility

Group Member	Proposal Assignment Task
U3201908, Curtis Richardson	Project Management Methodology; Code of Ethics; Project Governance Structure; Timeframes; Cost Breakdown; CPM and Dependencies, Annexure B (Microsoft Azure Cost Estimate)
U3215948, Daniel Davaris	Key Stakeholders; Requirements; Options for Delivery; Assumptions; Challenges (incl. Risks); KPIs/CSFs; Annexure C (Gantt Chart)
U3225675, (Ellie) Minjeong Kim	Value; MOV/QA; Communication; Scope; WBS; Annexure C (Gantt Chart)
All Members	Executive Summary; Annexure A (Risk Matrix); Additions to each section, where appropriate or necessary

Contents

Executive Summary of Project Proposal

Group 9875-23-07 has been successful with our Expression Of Interest (EOI) to undertake Project (ID) “2023-S1-03", titled *Preventing Black Hole Traffic in MANETs Using Machine Learning*. Conceptually, a Black Hole node is a malicious network node that advertises itself as the best neighbour for its’ peers to route traffic to, then subsequently (silently) refuses to route that traffic to the correct destination/path. The body of work our Group is undertaking to address this malicious behaviour is to utilise Machine Learning (ML) to train a Model that can be applied to production environments, that would enable the identification and mitigation of the effects of Black Hole nodes on surrounding legitimate nodes. Our focus on the benefits gained via implementation of the Model, is greater security and accuracy of the network traffic, and an energy savings from minimising time wastage from communication with malicious nodes.

Our Group will endeavour to progress this Project in a professional manner, utilising skills gained both through academia, and employment in industry. The documentation and governance structure of our project will follow a traditional Project Management methodology, while the operational undertaking of the Project will follow a more modern Agile methodology.

As indicated in the Project ID, our body of work was originally intended to be completed by a group in UC Semester 1 2023. This provided some opportunities for utilising effort that had already been spent on the project tasks, but also introduced some limitations, in the form of requiring to understand the method and reason behind the actions of the previous group. To ensure the feasibility of the Project, the Sponsor identified a powerful simulation platform named Network Simulator 3 (NS3) which can be modified to incorporate the protocol behaviours we would expect to see from both a production AODV network, as well as a malicious ‘Black Hole’ node operating within. The majority of risks the Project team face in delivery of the Model is process-based, either in terms of conflict within the Project team, or as the similarity of the project parameters to another academic endeavour means no unique insight has been studied and expressed for the greater IT and academic industries. In order to provide a single, centrally-available environment, the decision to utilise Microsoft Azure VM infrastructure (under University of Canberra licencing arrangements) was taken – access to which is controlled by the Project Sponsor.

A majority of the stakeholders in this Project are involved heavily in the academic industry (specifically, with the University of Canberra), including the Sponsor for the Project. Due to an inherent lack of adherence to responding to emails during business hours in the Educational Industry as a whole, communication with both internal and external stakeholders is highly available. Centralised platforms (such as MS Teams file and Github repositories) enable “source of truth” document tracking and availability.

The desired outcome of this Project is to create a Model that enables an operator managing an AODV-based network to mitigate issues relating to malicious “Black Hole” type nodes – particularly for the security and power consumption benefits that mitigation would provide. The period for delivery is to be kept within the bounds of the Capstone unit semester, though the conservative estimate for completion describes a roughly three month implementation. Total Costs for the Project estimate a total of $1,728.18, though the vast majority of that is costs incurred by the University of Canberra; there is no concern of going over the allocated $350 budget for the Project.

The major deliverables for this Project are the technical building of a plugin Model for AODV networks to detect malicious nodes, and communicating progress with the Project Governance team. As the structure

of work items is fairly linear, each technical task iterates on its predecessor, culminating in the final delivered product (with documentation to match).

Project Management Methodology

In order to provide a holistic documentation for both the administration and operation of this project, Group 9785-23-07 will follow the Project Management Body of Knowledge (PMBoK) framework. The PMBoK structure will assist the Group in defining and explaining the tasks involved with the project – particularly regarding the management of the project, in a more comprehensive manner that may be directly beneficial to the Project Governance team (and oversight of the project progress, in general).

As the current Group for this Project aren't the first to attempt an undertaking of this body of work, following a PMBoK methodology for the documentation will add additional benefit of greater consolidation of documentation, should our Group be unsuccessful for implementation of the project output, and a future Group are required to continue the work.

For ongoing administration of the project, however, a more Agile-like methodology will be utilised (through the GitHub Project toolset available via the Github.com website). The technical nature of the assignment coordinates well with the Agile structure, and the familiarity some Group members have with this particular methodology enables greater acceptance and comfort for those Group members to undertake their respective tasks.

Code of Ethics

Group 9785-23-07 will:

1. Competence
   Always undertake and complete research and coursework objectives to the best of our abilities
2. Honest
   Consistently operate with honesty and integrity being core to all aspects of our Group
3. Legal
   Comply with all laws and regulations of the Australian Government, and any terms required by University of Canberra
4. Compassion
   Always provide a positive working environment and a Duty of Care to all internal and external stakeholders to coursework being undertaken
5. Diligent
   Familiarise and adhere to all university organisational policies and procedures (including Academic Integrity Module and Consent Matters)
6. Professional
   As we are all working towards the same objective, each Group member shall conduct themselves in a professional manner.
7. Appropriate
   Use University resources in an appropriate manner to conduct research tasks and coursework
8. Diverse
   Always endeavour for effective communication and collaboration, regardless of the backgrounds of the team members and other stakeholders
9. Reliable

Strive for reliability in all aspects of undertaking project work towards unit goals

10. Accountable

    Group members must respect the interests of stakeholders and take ownership and accountability for the work produced in the pursuit of their duties/tasks

Project Governance Structure

Governance for this project will be provided by a purely academic team, consisting of:

- Project Sponsorship, via Dr Yibe Alem
- Project Mentorship, via Miss Maryam Sousani

The nature of the project being an academic endeavour, and the governance team for the project being primarily involved with the contribution this Project would make to wider academia, facilitates a closer working relationship between Group members and the Project sponsor than may be expected in a more traditional industry-based Project.

Meetings with the Project sponsor will occur semi-frequently; likely on a weekly basis. These meetings (described in the Stakeholder Communication Matrix) will enable the Sponsor to stay abreast of progress, as well as provide guidance, where they deem relevant.

Requirements

1. New project must incorporate previous projects work
2. The project must be a novel improvement of the previous project
3. The project must incorporate black hole nodes into the problem area and solution
4. A machine learning solution should be implemented to solve the chosen problem
5. All assets, code and procedures should be thoroughly documented for future readability
6. The machine learning solution should include an intermediate to advanced level of data science methodology to demonstrate learnt ML concepts
7. A unique approach to block hole nodes should be implemented
8. The solution should be deployable on NS-3

Options for delivery

Option 1) Simple ETL:

The most basic implementation would focus on the minimum viable product and concentrate on creating a working model without focusing on live deployment. This would include manual data extracts to train and evaluate the model.

Option 2) Deploy on running network:

The target state is a running deployable model which would be uploaded to the NS-3 software configuration to operate alongside the network. This is the preferred delivery option and allows a complete implementation to take place. With this configuration, the model would evaluate real time data after being trained on manual extracts.

Option 3) Deploy on running network with live reporting/notifications:

The third deployment option adds optional but desirable functionality to option 2, to allow for reporting and notifications in the event of true positive classification results. This would help develop the project into a product and assist in the utility of the model.

Assumptions

1. A novel solution to the black hole nodes problem can be found
2. The existing project research is relevant and can be applied to the new project
3. Students/Group members will not receive pay/salary (associated with the Project) while undertaking the Project
4. Total funds available to students for the purpose of Capstone Project is $350.00
5. Costs above the $350 threshold will be absorbed by the University of Canberra (UC), only so long as the source of that overhead is Azure Infrastructure associated with the licencing acquired by UC
6. In order to mitigate runaway costs with Azure/cloud infrastructure:
    a. Azure management will be controlled solely by UC staff / Project Sponsor; and
    b. A defined session timeout will be configured for Azure instances, so an instance cannot be accidentally left active (or otherwise counting towards the billable minutes of cloud infrastructure)
7. All interactions with Azure throughout this Project will be utilising UC-managed objects (student accounts)
8. Sponsor for UC is classified Academic Level C, Step 4: annual salary, cut to include time spent assisting with project (likely counted in hours); (University of Canberra, 2023), Schedule 1 – Staff Salaries
    a. UC standard hours = 7;
    b. ALcS4 salary = 141218;
    c. work days = ~250;
    d. hourly = $80.70
9. Mentors receive casual rate of Rate N ($51.49/h) (University of Canberra, 2023)
10. Salary costs are not covered by the funds allocated to the Project for product delivery – rather, UC provides these as matter of course for enabling Capstone Unit function
11. Endorsement from the project governance team is provided
    a. i.e. due to inherent buy-in, it is assumed the Project Governance team (Sponsor and Mentor) would have signed off on the Proposal
12. Risk Matrix follows standard workplace risk identification processes (link to coloured risk matrix)
13. Azure pricing follows the standard timing of one month = 730 hour allotment
14. Costs for IT Infrastructure are calculated according to the Annexure B – Microsoft Azure Infrastructure Procurement Costs Estimate

Challenges

1. The previous group was not able to successfully deploy the machine learning models or interface successfully with the NS3 software. This may indicate a inherit challenge for our project.
2. The complexity of the project is a challenge the team will need to overcome, having also to define a unique solution beyond simple detection will be a challenging endeavour.
3. Domain expertise and contextual understanding may also prove difficult as fine tuning such a model will require in dept knowledge into the network simulation software.
4. Live deployment may also be a challenge and will involve heavy modifications to low level code.

Project Risks

The majority of the Project Management Risks posed to the running of our Project occur at the earlier stages of the Project. Primarily, the planning stage, where we may not be fully across all the intricacies of implementing such a technically challenging product. The Project Delivery Risks, meanwhile, are predominantly situated at the Executing Phase of the Project.

Project Risk Register

Please see Annex A – Risk Matrix for guidance on the Likelihood and Impact fields in the below table.

Risk	Description	Likelihood	Impact	Mitigation Strategy
Delays in NS3 Environment Establishment	Delays in having an appropriate environment to test and improve ML modelling	High	Medium	Work on ML models ahead of time and in parallel before NS3 is finalized.
Existing ML Model Inaccuracy	Inaccuracy of existing ML models on live dataset and delays to redevelop models	Low	High	Develop good understanding of literature to be able to develop new successful models.
Complexity of Deploying ML Models	Increased complexity in deploying models on NS3	Medium	Medium	Switch to ETL deployment.
Complexity of Creating ML Models	Increased complexity in creating new ML models	Medium	Medium	Simply models to achieve a more timely outcome.
Illness	Project member becomes ill	Medium	Low	Group members maintain socially acceptable level of hygiene and cleanliness
Team breakdown	Member wants to go out of the team	Low	High	Group members commit to providing advanced notice to rest of team and Project Governance team of any desired movements
Team conflict	Members argue each other	Low	Medium	Group members commit to articulate ideas and feelings in respectful manner
Simulation Error	Simulation has errors on, I.e., code, algorithm, data set, and ETC.	High	High	Reproduce executed simulations to produce averaged dataset
Project Similarity	The degree of resemblance between the current project and the past project.	Medium	High	Team conducts comprehensive analysis to mine the unique aspects of the current project and involves stakeholders for the brief direction

Inadequate Planning	Lack of planning in the project and to the delivery of the network model and how it will function.	Low	High	Develop clear project documentation and planning early and check back in regularly.
Poor Scope Management	Lack of control over the scope and size of the project opposed to a defined set of requirements.	Medium	High	Established MVP and set the requirements early on, checking back to confirm original scope.
Undefined Roles and Responsibilities	Lack of clarify around defined roles and tasks required for each team member.	Low	High	Setup and adhere to regular communication cadence. Define role and responsibilities document.
Ineffective Communication	Lack of effectiveness of communication practices to coordinate project objectives.	Medium	High	Establish team communication channel, cadence and technology early, be disciplined in the approach to regular communication with structured meetings.
Inadequate Management	Insufficient project management and coordination.	Low	Medium	Establish formal project governance and processes. Implement PMBOK practices.
Insufficient Resource Allocation	Inadequate level of resources to complete project.	Low	Low	Present business case early and plan project around outcome.

Subsequent/Arising Opportunities

With this Project having been proposed and attempted by a previous group in Semester 1 at the University of Canberra, some work had already been done on possible avenues for model generation. Our group will be able to utilise this previous attempt and refocus towards a novel approach, with a goal to output a model that can be added to a running production AODV-based network.

Key Stakeholders

Stakeholder	Role	Responsibility
Yibe Alem	Project Sponsor	Overall direction and strategy of the project implementation; final decision maker for project outcome.
Maryam Sousani	Project mentor	Operational direction, ensuring deliverables are on track to be delivered and communication is clear.

Jeanette Cotterill	Tutor	Adviser for project management, project consultation and industry experience.
University of Canberra	Project institution	Responsible entity for undertaking project. Provide access to resources
Project Group Members	Creators, operators and researchers	Undertaking all base tasking to create, test, and implement ML Models in NS3
AODV Network Operators	Modelling end user	Application of tested Candidate Model within Production AODV network

Communication

Plan communication management

Communication is a vital aspect of any kind of undertaking, whether business, academic, or otherwise. A significant factor in the chance of success for this Project is the facilitation of clear and concise communication – especially between the internal Project member stakeholders, and the Project Sponsor.

The methodology we utilise is to identify the key Project stakeholders, define the communication types/mediums that will be used, and the flow of communication that will take place through the Project. By following this process, we anticipate we will:

1. The prevention of issues
    - By minimising the misunderstandings caused by unclear communication
2. Enhance consistency
    - By standardising the way we share and collect information, to ensure “single source of truth” and other knowledge sharing methodologies, where appropriate
3. Be accountable and responsible
    - By defining the roles for communication tasks, and following up with the relevant stakeholders
4. Improve decision making
    - By taking feedback from interested parties on board, and constructively engaging stakeholders to ensure we don’t repeat basic errors
5. Build trust
    - By ensuring all communication parties are cognisant of the status and progress of the Project, and records of formal communication keeping everyone informed (regardless of attendance)
6. Continuously improve
    - By using the meetings with the Project stakeholders, and the documentation we build as we progress through the Project to consistently review what avenues are working, and adjust (if necessary) the paths we take ahead

Project Communication

Communication Plan:

Topic	Methods	Frequency	Goal	Owner	Audience
Virtual meet-up	MS Teams	Weekly	- Synchronous meeting with no regulation on place - Open communication between members to share progress, difficulties, and issues on the project	Curtis Minjeong Daniel	None
Scheduling & informing	Email	Up to topic	- Scheduling any meet-up between the team and the stakeholders - Informing any announcement or request of the stakeholders for the team can be on the same page.	Curtis Minjeong Daniel	Yibe Maryam
Kanban board	Github	Daily	- Transparency of work and contribution - Efficiency of task management and time management	Curtis Minjeong Daniel	Yibe Maryam

Stakeholder Communication Matrix

Stakeholder	Reason for Communications	Communication Method	Frequency	Responsible Stakeholder
Project Sponsor	Check-up progress and issues of the project Guide the direction of the project	Teleconference, email and face-to-face meeting	Weekly	Project Sponsor
Project Mentor	Check-up any issues in the team	Email and face-to-face meeting	Fortnightly	Project Mentor
Project Team	Check project status and member schedules	Teleconference, email, and face-to-face meeting	Weekly	Group Members
Project Team	Chase up tasking and provide attendance updates	Instant Messaging	Ad-hoc	Group Members

Value

- Plugin Model for Black Hole malicious node mitigation
- Less DOS vectors in their networks
- Minimisation of energy wastage by network-participating device

Measurable Organisational Value (MOV) / Quality Assurance

Area of Impact

Operational. Black Hole nodes within ad-hoc networks adversely affect the ongoing operation of each wholesale network they have infiltrated

Desired Value

Neutralisation of effect of Black Hole node on surrounding network traffic

Metric

90% of simulated Black Hole nodes are identified and flagged for avoidance

Timeframe

Value should be visible upon delivery of this project, dependant on interested parties utilising the trained model in their own AODV networks

Verification

The MOV statement and verification plan are apt by addressing Black Hole nodes in ad-hoc networks with a practical 90% identification goal, presenting a comprehensive approach that aligns with organizational objectives

MOV Summary / Statement

The Project will be successful if a simulation output Predictive Model that has tested to show 80% mitigation of Black Hole nodes can be inserted into currently operating AODV network

Scope

Project Scope / Key Deliverables

1. Project Documentation – including Project Proposal, Report, Poster, and Presentation
2. Organisation and utilisation of cloud-based infrastructure for simulation of candidate behaviour models
3. Individual tasks undertaken for the Project are enumerated within the Work Breakdown Structure (WBS) and Annexure C of this Proposal

Product Scope

1. A behavioural model that facilitates some mitigation of Black Hole node vulnerabilities for AODV networks
2. Prevention of security issues with avoiding Black Hole node
3. Energy Efficiency improvements through reduction of meaningless messages to Black Hole node
4. Greater confidence in accuracy and performance of AODV networks when utilising our model

Timeframe

Implementation and delivery of this project would take roughly 3 months time. As there are tasks allocated to three primary group members, as well as some tasks allocated to the Project Sponsor, the effort is approximately split between 3.5 (equivalent) personnel.

Phase	Effort Duration/Timeframe
Initiating Phase	6.75 days
Planning Phase	22 days
Executing Phase	206.33 days
Monitoring and Controlling Phase	63.66 days
Closing Phase	6.67 days

Total time: **305.41 days (personnel-days/effort); 87.26 days (chronological)**

Project Evaluation and Review Technique (PERT) Analysis

Activity	Description	Predecessor	Optimistic Estimates (Days)	Most likely Estimates (Days)	Pessimistic Estimates (Days)	Expected Duration (Days)
1.1	Write and justify Business Case	None	1	2	4	3.17
1.2	Obtain authorisation from sponsor	1.1	0.5	1	5	3.58
2.1	Develop Project Plan	1.1,1.2	10	18	26	22
3.1	Identify General Project Novelty Direction	2.1	15	27	37	31.67
3.2	Develop Base Algorithm for Model	3.1	10	18	28	23.33
3.3	Procure Infrastructure Resources	2.1	2	3	12	8.83
3.4	Configure Simulation Environment	3.3	10	22	36	29.33
3.5	Developed Trained Model	3.4	17	24	31	27.5
3.6	Select Trained Model Candidate	3.5	4	8	12	8.67
3.7	Engage Stakeholders	2.1,3.1,3.5	70	72	80	77
4.1	Implement Selected Candidate Behaviour Model	3.6,3.7	10	12	16	14.33
4.2	Investigate Meta Behaviours	4.1	15	19	26	23
4.3	Review Peer Academic Papers	4.2	17	21	30	26.33

5.1	Review of project and lessons learned	4.3	2	3	4	3.5
5.2	Final closure / authorisation of closure by project sponsor	5.1	1	2	4	3.17

Cost Breakdown

Each Capstone unit Group is allocated a funding budget of $350 towards the implementation/delivery of their respective Projects. There is no concern for this Project exceeding the budget limit, as described in the assumptions list, points 4 and 5.

WBS Items	Unit hours	Cost/unit/hour	Subtotals	WBS Level 1 Totals	% of Total
1. Project Operations				$0.00	
Group Members	300	$0.00*	$0.00		
2. Project Governance				$1,438.74***	83.25%
Sponsor	14	$80.70	$1,129.80		
Mentor	6	$51.49	$308.94		
3. Infrastructure				$289.44	16.75%
Cloud Compute	804**	$0.36	$289.44		
Total Project Cost Estimate			$1,728.18***		100%

*: Please see assumptions list, point 3 for reason for given value

**: WBS items requiring direct involvement (and activation) of IT infrastructure are: *3.2*, *3.4*, *3.5*, *4.1*, *4.2*.

***: Please see assumptions list, point 10 for reasons this doesn't push out Group 9785-23-7's budget

Key Performance Indicators / Critical Success Factors

1. Build and deploy a model with an accuracy of at least 80%
2. Complete the project on time and within the budget
3. Establish a working model on the NS3 software
4. Address improvements from previous groups work
5. Implement a novel solution around black hole nodes
6. Understand the problem domain to be able to critically evaluate the models features

Work Breakdown Structure (WBS)

1. Initiating Phase
    1.1. Write and justify Business Case
    1.2. Obtain authorisation from Project Sponsor
    1.3. *Initiating Phase Complete*
2. Planning Phase
    2.1. Develop Project Plan
        2.1.1. Define the project goals
        2.1.2. Understand the previous project
        2.1.3. Populate and assign specific tasks
        2.1.4. Set the deadline for each task
        2.1.5. *Project Plan Complete*
    2.2. *Planning Phase Complete*
3. Executing Phase
    3.1. Identify General Project Novelty Direction
        3.1.1. Find Peer Academic papers
        3.1.2. Summarise the description of the academic papers
        3.1.3. *Identify General Project Novelty Direction Completion*
    3.2. Develop Base Algorithm for Model
        3.2.1. Evaluate performance of previous ML models
        3.2.2. Test and revise models
        3.2.3. *Develop Base Algorithm for Model Complete*
    3.3. Procure Infrastructure Resources
        3.3.1. Project Sponsor allocate VM resource for Project
        3.3.2. Project Sponsor provision resource access to Project members
        3.3.3. Procure Infrastructure Resources Complete
    3.4. Configure Simulation Environment
        3.4.1. Clone Network Simulator 3 “all-in-one” repository
        3.4.2. Build NS3 tool via binaries available
        3.4.3. Build NetAnim tool via binaries available
        3.4.4. Configure RDP capability for Project members
        3.4.5. Define method for running simulation application
        3.4.6. Configure Simulation Environment Complete
    3.5. Develop Trained Model
        3.5.1. Incorporate new data
        3.5.2. Develop and test model on ns3
        3.5.3. Tune hyperparameters
        3.5.4. Develop Trained Model Complete
    3.6. Select Trained Behaviour Model Candidate
        3.6.1. Compare models to evaluate overall performance
        3.6.2. Select Trained Behaviour Model Candidate Complete
    3.7. Engage Stakeholders
        3.7.1. Request Project in EOI process
        3.7.2. Introduce Project members to Project governance team
        3.7.3. Conduct milestone meetings with Project governance team

3.7.4. Engage Stakeholders Complete

3.8. *Executing Phase Complete*

4. Monitoring and Controlling Phase
   4.1. Implement Selected Candidate Behaviour Model
      4.1.1. Revise model to work with NS-3
      4.1.2. Execute simulation software using final candidate model choice
      4.1.3. Implement Selected Candidate Behaviour Model Complete
   4.2. Investigate Meta Behaviours
      4.2.1. Record metrics while simulations occur
      4.2.2. Parse metrics against normalised dataset to highlight consumption
      4.2.3. Reiterate tests to find averaged consumption data
      4.2.4. Investigate Meta Behaviours Complete
   4.3. Review Peer Academic Papers
      4.3.1. Compare Project performance against expected outcomes
      4.3.2. Express viability of Project outcome for wider adoption
      4.3.3. Detail possible avenues for continued study/experimentation
      4.3.4. Review Peer Academic Papers Complete
   4.4. *Monitoring and Controlling Phase Complete*
5. Closing Phase
   5.1. Review of project and lessons learned
   5.2. Final closure / authorisation of closure by project sponsor
   5.3. *Closing Phase Complete*

Critical Path Method (CPM) and Dependencies

Activity Analysis

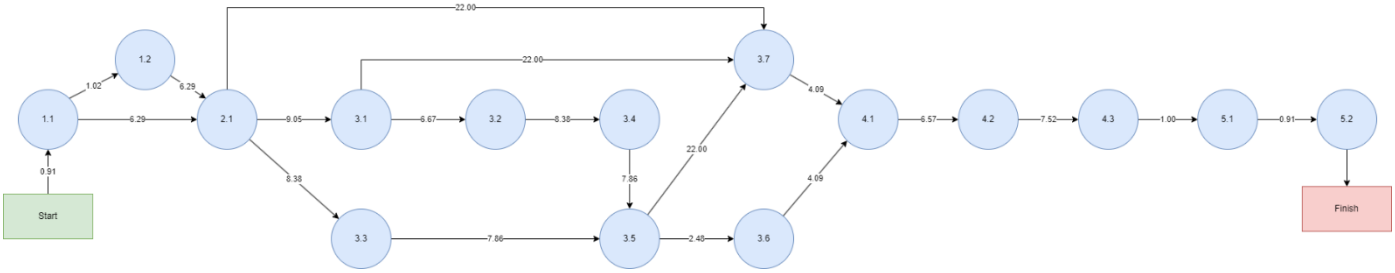
Activity	Description	predecessor	Expected Duration (Chronological Days) from PERT Analysis
1.1	Write and justify Business Case	None	0.91
1.2	Obtain authorisation from sponsor	1.1	1.02
2.1	Develop Project Plan	1.1,1.2	6.29
3.1	Identify General Project Novelty Direction	2.1	9.05
3.2	Develop Base Algorithm for Model	3.1	6.67
3.3	Procure Infrastructure Resources	2.1	2.52
3.4	Configure Simulation Environment	3.3	8.38
3.5	Developed Trained Model	3.2, 3.4	7.86
3.6	Select Trained Model Candidate	3.5	2.48
3.7	Engage Stakeholders	2.1,3.1,3.5	22
4.1	Implement Selected Candidate Behaviour Model	3.6,3.7	4.09
4.2	Investigate Meta Behaviours	4.1	6.57
4.3	Review Peer Academic Papers	4.2	7.52
5.1	Review of project and lessons learned	4.3	1
5.2	Final closure / authorisation of closure by project sponsor	5.1	0.91

Possible Paths for Project Completion

Path Number	Path	Total time (Chronological Days)
Path 1 Days	1.1 + 2.1 + 3.1 + 3.2 + 3.4 + 3.5 + 3.6 + 3.7 + 4.1 + 4.2 + 4.3 + 5.1 + 5.2	83.73
	0.91 + 6.29 + 9.05 + 6.67 + 8.38 + 7.86 + 2.48 + 22 + 4.09 + 6.57 + 7.52 + 1 + 0.91	
Path 2 Days	1.1 + 1.2 + 2.1 + 3.1 + 3.2 + 3.3 + 3.4 + 3.5 + 3.6 + 3.7 + 4.1 + 4.2 + 4.3 + 5.1 + 5.2	87.27
	0.91 + 1.02 + 6.29 + 9.05 + 6.67 + 2.52 + 8.38 + 7.86 + 2.48 + 22 + 4.09 + 6.57 + 7.52 + 1 + 0.91	
Path 3 Days	1.1 + 2.1 + 3.1 + 3.2 + 3.4 + 3.5 + 3.6 + 4.1 + 4.2 + 4.3 + 5.1 + 5.2	61.73
	0.91 + 6.29 + 9.05 + 6.67 + 8.38 + 7.86 + 2.48 + 4.09 + 6.57 + 7.52 + 1 + 0.91	
Path 4 Days	1.1 + 1.2 + 2.1 + 3.1 + 3.2 + 3.4 + 3.6 + 3.7 + 4.1 + 4.2 + 4.3 + 5.1 + 5.2	76.89
	0.91 + 1.02 + 6.29 + 9.05 + 6.67 + 8.38 + 2.48 + 22 + 4.09 + 6.57 + 7.52 + 1 + 0.91	

The critical path is path **2**.

CPM Graph



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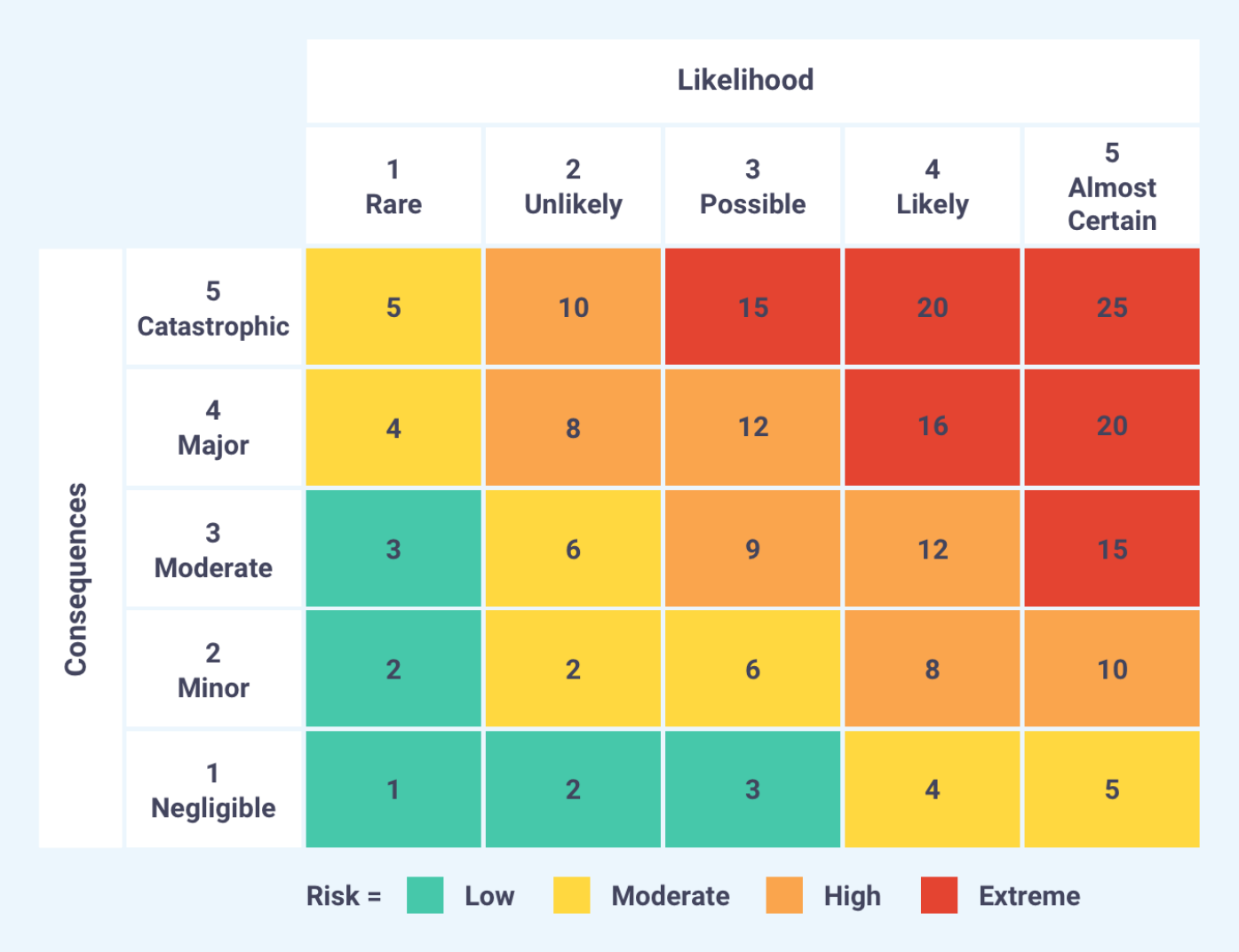
[Accessed 26 August 2023].

Annexure A – Risk Matrix Model



(Safran Software Solutions, 2019)

Annexure B – Microsoft Azure Infrastructure Procurement Cost Estimate

Microsoft Azure Estimate

Your Estimate

Service category	Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Compute	Virtual Machines		Australia East	1 A4 v2 (4 Cores, 8 GB RAM) x 730 Hours (Pay as you go), Linux, (Pay as you go); 1 managed disk – E10; Inter Region transfer type, 5 GB outbound data transfer from Australia East to East Asia	$260.30	$0.00
Support			**Support**		$0.00	$0.00
			Licensing Program	**Microsoft Customer Agreement (MCA)**		
			Billing Account			
			Billing Profile			
			Total		**$260.30**	**$0.00**

Disclaimer

All prices shown are in Australia – Dollar ($) AUD. This is a summary estimate, not a quote. For up to date pricing information please visit https://azure.microsoft.com/pricing/calculator/
This estimate was created at 9/1/2023 12:24:04 AM UTC.

(Microsoft, 2023)

Annexure C – Preventing Black Hole Traffic in MANETs Using Machine Learning Project Gantt Chart

Please continue scrolling for Gantt Chart

Preventing Black Hole Traffic in MANETs Using ML

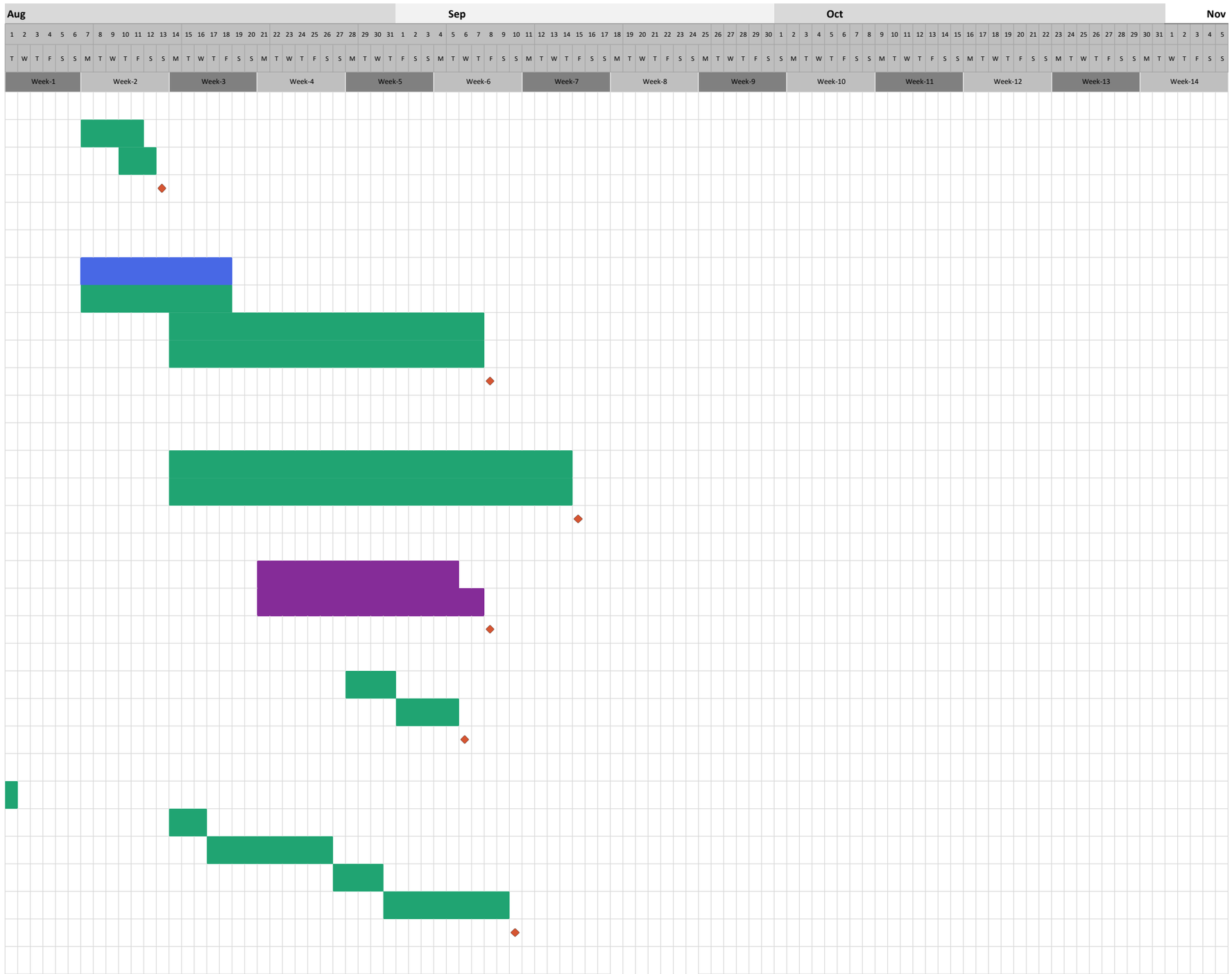
9785-23-7 Sponsor: Yib Mentor: Mriyam Category:

Team u3201908_Curt u3215948_Daniel u3225675_Ellie

Project Start Date 1/08/2023

In Progress | Low Priority | Medium Priority | High Priority | No allocation

Tasks	Category	Responsibility	Progress	Start date	Days
1.Initiating Phase	Important	Ellie + Curtis + Daniel	100%		
1.1.Write and justify Business Case	In Progress	Ellie + Curtis + Daniel	100%	7/08/2023	5
1.2.Obtain authorisation from Project Sponsor	In Progress	Ellie + Curtis + Daniel	100%	10/08/2023	3
1.3.Initiating Phase Complete	Goal	Ellie + Curtis + Daniel	100%	13/08/2023	1
2.Planning Phase					
2.1. Develop Project Plan	Important				
2.1.1 Define the project goals	Medium Priority	Ellie + Curtis + Daniel	100%	7/08/2023	12
2.1.2.Understand the previous project	In Progress	Ellie + Curtis + Daniel	100%	7/08/2023	12
2.1.3.Populate and assign specific tasks	In Progress	Ellie + Curtis + Daniel	50%	14/08/2023	25
2.1.4.Set the deadline for each task	In Progress	Ellie + Curtis + Daniel	50%	14/08/2023	25
2.1.5. Project Plan Complete	Goal	Ellie + Curtis + Daniel	0%	8/09/2023	1
3. Executing Phase					
3.1. Identify General Project Novelty Direction	Important				
3.1.1.Find Peer Academic papers	In Progress	Ellie	50%	14/08/2023	32
3.1.2.Summarise the description of the academic papers	In Progress	Ellie	50%	14/08/2023	32
3.1.3. Identify General Project Novelty Direction Completion	Goal	Ellie	0%	15/09/2023	1
3.2.Develop Base Algorithm for Model	Important				
3.2.1.Evaluate performance of previous ML models	High Priority	Daniel	100%	21/08/2023	16
3.2.2.Test and revise models	High Priority	Daniel	0%	21/08/2023	18
3.2.3.Develop Base Algorithm for Model Complete	Goal	Daniel	0%	8/09/2023	1
3.3.Procure Infrastructure Resources	Important				
3.3.1.Project Sponsor allocate VM resource for Project	In Progress	Project sponsor	50%	28/08/2023	4
3.3.2.Project Sponsor provision resource access to Project members	In Progress	Project sponsor	50%	1/09/2023	5
3.3.3.Procure Infrastructure Resources Complete	Goal	Project sponsor	50%	6/09/2023	1
3.4.Configure Simulation Environment	Important				
3.4.1.Clone Network Simulator 3 “all-in-one” repository	In Progress	Curtis	100%	1/08/2023	1
3.4.2.Build NS3 tool via binaries available	In Progress	Curtis	100%	14/08/2023	3
3.4.3.Build NetAnim tool via binaries available	In Progress	Curtis	50%	17/08/2023	10
3.4.4.Configure RDP capability for Project members	In Progress	Curtis	50%	27/08/2023	4
3.4.5.Define method for running simulation application	In Progress	Curtis	50%	31/08/2023	10
3.4.6.Configure Simulation Environment Complete	Goal	Curtis	50%	10/09/2023	1
3.5.Develop Trained Model	Important				



Project Start Date 1/08/2023

Tasks	Category	Responsibility	Progress	Start date	Days
3.5.1.Incorporate new data	High Priority	Daniel	0%	18/09/2023	7
3.5.2.Develop and test model on ns3	High Priority	Daniel	0%	25/09/2023	7
3.5.3.Tune hyperparameters	Medium Priority	Daniel	0%	2/10/2023	7
3.5.4.Develop Trained Model Complete	Goal	Daniel	0%	9/10/2023	1
3.6.Select Trained Behaviour Model Candidate	Important				
3.6.1.Compare models to evaluate overall performance	High Priority	Daniel	0%	9/10/2023	7
3.6.2.Select Trained Behaviour Model Candidate Complete	Goal	Daniel	0%	16/10/2023	1
3.7.Engage Stakeholders	Important				
3.7.1.Request Project in EOI process	High Priority	Ellie + Curtis + Daniel	100%	3/08/2023	2
3.7.2.Introduce Project members to Project governance team	Medium Priority	Ellie + Curtis + Daniel	100%	7/08/2023	2
3.7.3.Conduct milestone meetings with Project governance team	In Progress	Ellie + Curtis + Daniel	15%	21/08/2023	68
3.7.4.Engage Stakeholders Complete	Goal	Ellie + Curtis + Daniel	0%	28/10/2023	1
3.8.Executing Phase Complete	Goal	Ellie + Curtis + Daniel			
4.Monitoring and Controlling Phase					
4.1.Implement Selected Candidate Behaviour Model	Important	Ellie + Curtis + Daniel			
4.1.1.Revise model to work with NS-3	In Progress	Ellie + Curtis + Daniel	0%	12/10/2023	5
4.1.2.Execute simulation software using final candidate model choice	In Progress	Ellie + Curtis + Daniel	0%	13/10/2023	5
4.1.3.Implement Selected Candidate Behaviour Model Complete	Goal	Ellie + Curtis + Daniel	0%	18/10/2023	1
4.2.Investigate Meta Behaviours	Important				
4.2.1.Record metrics while simulations occur	Low Priority	Ellie + Curtis + Daniel	0%	15/10/2023	5
4.2.2.Parse metrics against normalised dataset to highlight consumotion	Low Priority	Ellie + Curtis + Daniel	0%	15/10/2023	5
4.2.3.Reiterate tests to find averaged consumption data	Low Priority	Ellie + Curtis + Daniel	0%	15/10/2023	5
4.2.4.Investigate Meta Behaviours Complete	Goal	Ellie + Curtis + Daniel	0%	20/10/2023	1
4.3.Review Peer Academic Papers	Important				
4.3.1.Compare Project performance against expected outcomes	Low Priority	Ellie + Curtis + Daniel	0%	20/10/2023	5
4.3.2.Express viability of Project outcome for wider adoption	Medium Priority	Ellie + Curtis + Daniel	0%	20/10/2023	5
4.3.3.Detail possible avenues for continued study/experimentation	Low Priority	Ellie + Curtis + Daniel	0%	20/10/2023	5
4.3.4.Review Peer Academic Papers Complete	Goal	Ellie + Curtis + Daniel	0%	25/10/2023	1
4.4.Monitoring and Controlling Phase Complete	Goal	Ellie + Curtis + Daniel	0%	25/10/2023	1
5.Closing Phase					
5.1.Review of project and lessons learned	High Priority	Ellie + Curtis + Daniel	0%	25/10/2023	4
5.2.Final closure / authorisation of closure by project sponsor	High Priority	Ellie + Curtis + Daniel	0%	25/10/2023	4
5.3.Closing Phase Complete	Goal	Ellie + Curtis + Daniel	0%	29/10/2023	1