Trade Study Web Visualisation

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Table of Contents

Paragraph **Page No.**

List of Tables

Definitions

UAV	Unmanned Aerial Vehicle
QUT	Queensland University of Technology
GCS	Ground Control Station
WVI	Web Visualisation Interface
LAN	Local Area Network
HLO	High Level Objective
MEAN	MongoDB, Express, Angular, NodeJS
LAMP	Linux, Apache, MySQL, PHP
WISA	Windows, Internet Information Services, SQL Server, ASP.NET
ROS	Robot Operating System
UAVTAQ	Unmanned Aerial Vehicle: Target Air Quality Monitoring
HTML	Hypertext Mark-up Language
PHP	Hypertext Pre-processor

1 Introduction

The purpose of this document is to investigate possible solutions for a suitable Web Visualisation Interface (WVI) that meet system requirements. A list of industry standard web development stacks will be weighted based on a set of criteria to determine an optimal solution. The role of this subsystem is to convey technical data taken from various other subsystems on board an unmanned aircraft system (UAS). The information will then be displayed in an easy to visualise manner through dynamic html forms. The content will be hosted locally within a local area network (LAN) simulating the experience of a web site hosted from an external web server.

1.2 Scope

This document addresses trade studies for all system and subsystem requirements of the Web Visualisation Interface (WVI). All requirement information is referenced from the "System Requirements" documentation where higher-level objectives (HLO's) have been traced and detailed into lists of sub requirements to be tracked and satisfied.

1.3 Background

Queensland University of Technology Airborne Sensing Systems are a world-leading research team based in Brisbane, Australia. Focusing on the innovation of autonomous UAV flight using on board sensing equipment they strive to turn cutting edge technology along with leading edge concepts from paper into flight tested reality. As a part of the team they have commissioned students EGB349 to design and build a UAVTAQ multi rotor based UAV to take targeted air samples within a simulated mine. The idea is that there are potentially deadly C02 leaks occurring down within a mine which otherwise cannot be physically inspected due to the potential risks involved. This is where the UAVTAQ is required. The UAV will fly in using sensor navigation the known locations and take air samples to confirm the leaks. This information can then be delivered safely to teams outside the mine.

2 Reference Documents

2.1 QUT Avionics Documents

RD/1	UAVTAQ - Customer Requirements	UAVTAQ Customer Requirements 2017
RD/2	PMP of UAVTAQ	The PMP for UAVTAQ Group 1
RD/3	TAG16GM2-NAV-TS-02	Navigation Subsystem Trade Study

2.2 Non-QUT Documents

RD/4 "How to install a MEAN.JS stack on an Ubuntu 14.04 Server", *digitalocean.com*, 2016. [Online]. Available: https://www.digitalocean.com/community/tutorials/how-to-install-a-mean-js-stack-on-an-ubuntu-14-04-server [Accessed: 29- Mar- 2017].

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https://www.microsoftstore.com/store/msusa/en_US/cat/All-additional-software/categoryID.69407400?icid=en_US_Store_UH_software_addlsoft. [Accessed: 26- Mar- 2017].

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RD/11 "MEAN logo", *3.bp.blogspot.com,* 2017. [Online]. Available: https://3.bp.blogspot.com/-E6x2j1X4agw/VuyRNMI7VEI/AAAAAAAAeio/zbwi-b60qKQpDGetZVtY6l14ecVsaPtGA/s1600/MEAN.png. [Accessed:30-Mar-2017].

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RD/13 "Windows Server Logo", *rimdesk.com,* 2017. [Online]. Available: https://www.rimdesk.com/wp-content/uploads/2016/10/Windows-Server.png. [Accessed: 30- Mar- 2017].

RD/14 "LAMP stack logo", *cyberswipe.org,* 2017. [Online]. Available: http://cyberscribe.org/wp-content/uploads/2014/12/NewLAMP.png. [Accessed: 30- Mar- 2017].

3 Review of System Requirements

Listed below is all the WVI subsystem requirements to satisfy customer needs. These are derived directly from the commissioned high level objectives. These can consist of two main categories'. Firstly, mandatory requirements which derive directly from the HLO's (RD/1) and are strict requirements in place for the project to be successful, whilst also meeting the direct needs of the customer. Secondly, Desired requirements which do not derive from anything and are not required for the completeness of the project; however, they can be used to improve the performance and ability of the system.

Due to the large number of System Requirements within the project, a logical ordering system has been put in place. This helps with the flow of documentation and ensures key requirements are easily identified and can be tracked effectively within a large project team.

REQ-M-7-1

Description: Web interface built on web server, server may be hosted locally.

Rationale: Web interface platform hosted on server for dynamic interfacing with html and database

Traced from: HLO-M-7

Verification: Inspection

REQ-M-7-2

Description: Web interface built to serve dynamic content.

Rationale: The web interface data is live updated from ground control station data.

Traced from: HLO-M-7-1

Verification: Demonstration

REQ-M-7-3

Description: Web page can be accessed by third party machines on the local area network (LAN).

Rationale: Multiple computers from different locations within the local network will have access to the web interface

Traced from: HLO-M-7-2

Verification: Demonstration

3.1 Criteria

The trade study will be looking at possible web development stacks suitable for the project. Each option will be weighted on different options to determine a most suitable result. The key considerations been the cost, ease of use, performance, and availability.

3.2 Price

QUT has commissioned the project to go ahead with a total budget of $1000, this must be spread across all the subsystems required to complete the task. This makes cost an important factor where minimisation should be prioritized heavily. This will receive a weighting of 40 %.

3.3 Ease of Use

Every programming language uses different syntax and style some which may be deemed more difficult than others. The gap in difficulty is usually related to how good the language documentation is. Other factors include how recent the language was developed, where for example most modern languages come with features such as garbage collection alleviating the user of having to allocate/deallocate memory. For the WVI there is additional factors as a program

stack is required, multiple languages will be involved and how well they work together is important. Primarily the last point will be of primary importance when evaluating the ease of use. Seeing as if a system is not easy to use then it automatically becomes undesirable this section will be weighted 30 %.

3.4 Performance

The performance of most solutions will be relatively on par due to the nature of the size and complexity of the web interface. Certain stacks may out perform in some areas but have less performance in other areas. Most of the performance issues will be related to relaying information throughout the nodes within the ROS distributed network into a chosen database. Overall performance has a weighting of 20 %.

3.5 Availability

Availability of possible solution stacks ties in with cost as it falls into two major categories. Either you opt to pick an open source solution which is free, or go with a closed source solution distrusted by an organisation for a cost. A weighting of 10 % has been allocated.

3.6 Criteria table

Table 1 - Criteria Table

Price	Free	<$200	>$200	>$350	>$500

· Last updated by Daniel Huffer on 12 April 2017

Weighting: 0.40					
Difficulty Weighting: 0.30	Very Easy	Easy	Moderate	Difficult	Extremely Difficult
Performance Weighting: 0.20	Very Fast	Fast	Average	Below Average	Terrible
Availability Weighting: 0.10	Open Source	-	-	-	Closed Source
					Total →

4 Possible Solutions

4.1 MEAN Stack

Figure 1 - Mean Stack Picture [RD/11]

The MEAN stack consists of MongoDB, ExpressJS, AngularJS and NodeJS, together they are a full stack solution that pulls together some of the best JavaScript technologies. Building with the MEAN stack can get applications into production quickly and easily [RD/5]. The stack is

based off the Node.js runtime environment which is an open source cross-platform. Express is the web application framework for Node.js which is written in JavaScript and hosted in the Node.js runtime environment. Many developers have described express to be a fast, minimalist and un-opinionated framework with a robust set of features [RD/4]. While express and the node framework handle the back end of the web development stack, Angular the core front end component is said to achieve maximum speed and performance possible on today's web platforms [RD/6]. There also appears to be a ROS package rosnodejs, which is a pure Node.js implementation of ROS which comes equipped with a client library enabling Node.js developers to quickly interface with ROS. The only pitfall of the MEAN stack is that it's a lot more recent than older solutions for web development platforms which could lead to less support from project members making ease of use a lot more difficult.

4.1.1 Price

All the MEAN stack components are open source software and free to use on any platform by the public; Therefore, the score for the price criteria is a 5.

4.1.2 Difficulty

Potentially difficult due to the lack of pre-requisite knowledge within the project team. As this could cause issues due to the time sensitivity of the project, difficulty has been scored a 2.

4.1.3 Performance

The MEAN stack performance is at the top of industry standards, MongoDB offers a document structure that is much more flexible than MySQL, Benchmark test results show node.js is flat out faster than other popular web servers like apache. In summary put together all the components of the MEAN stack and you have a clean coherent mechanism for moving data from user to disk farm and back again [RD/12]. Been the

most recent development in the Web development industry it's no surprise the MEAN stack delivers top level performance and a score of 5 for the criteria table.

4.1.4 Availability

As the MEAN stack is comprised entirely of open source software it is currently available to anyone on all platforms with an active internet connection for electronic delivery; Availability is scored a maximum score of 5.

Table 2 - MEAN Stack

	5	4	3	2	1	Weighted Score
Price Weighting: 0.40	Free	<$200	>$200	>$350	>$500	2
Difficulty Weighting: 0.30	Very Easy	Easy	Moderate	Difficult	Extremely Difficult	0.6
Performance Weighting: 0.20	Very Fast	Fast	Average	Below Average	Terrible	1
Availability Weighting: 0.10	Open Source	-	-	-	Closed Source	0.5
					Total →	4.1

4.2 WISA Stack

Figure 2 - Microsoft Windows Server [RD/13]

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The WISA stack consists of Windows server, Internet Information Services (IIS), SQL Server, ASP.NET. Together they form Microsoft's web development stack which runs off the Microsoft server operating system. The IIS is an extensible web server made by Microsoft for use with their operating systems and comes included with windows server. Windows server can either be deployed on site or using cloud computing services such as Amazon Web Services or Microsoft azure where costs are involved. Everything is constructed using windows powerful .NET framework where performance is of a high quality [RD/8]. Integrating ROS with windows can be difficult and it is unclear if it there is support for windows server and SQL server. The WISA .NET framework stack does come with good performance but is targeted for large enterprise commercial purposes, Windows Server and SQL Server both have costs associated with licencing.

4.2.1 Cost

The cost associated with purchasing Windows Server 2016 standard from the Microsoft website is $1209.00 and SQL Server is $1250.00 [RD/9]. Earlier editions of the software at available at cheaper prices but are still far out of the range of the projects budget. As these price ranges are completely out of the budget cost for the WISA stack is scored a 1.

4.2.2 Difficulty

The WISA stack is of the highest standard when it comes to ease of use and difficulty. [RD/8] Everything is managed through Graphical User Interfaces (GUI's) in relation to traditional methods of having to remember many obscure terminal line inputs to deal with database management. Not to mention immediate support is always available at the hand of Microsoft employees; Difficulty of the WISA stack receives a score of 4.

4.2.3 Performance

Been produced by the tech giant Microsoft and used by many large enterprises

performance is certainly not an issue with the WISA stack. Performance for the WISA stack is very fast and therefore receives a score of 5.

4.2.4 Availability

All the software is available for download, for the bigger components within the stack such as the Windows Server operating system electronic and hard copies are available. Upon obtaining everything though there are initial overheads as windows server must be installed as an operating system either on the host PC or in the cloud. Due to the initial overheads and the fact the software is closed source availability has been scored as a 1.

Table 3 - WISA Stack

	5	4	3	2	1	Weighted Score
Price Weighting: 0.40	Free	<$200	>$200	>$350	>$500	0.4
Difficulty Weighting: 0.30	Very Easy	Easy	Moderate	Difficult	Extremely Difficult	1.2
Performance Weighting: 0.20	Very Fast	Fast	Average	Below Average	Terrible	1
Availability Weighting: 0.10	Open Source	-	-	-	Closed Source	0.1
					Total →	2.7

4.3 LAMP Stack

Figure 3 - LAMP stack [RD/14]

The LAMP stack consists of Apache web server MySQL database and PHP a hypertext pre-processor all running on the Linux Operating system [RD/10]. The LAMP stack is a very popular among web developers as it's an open source choice for running dynamic web sites

and servers. For many developers, this stack is a prime choice as it has been around for over forty years where plenty of support and packages for integration into other systems are supported. LAMP stack was one of the earliest stacks to gain momentum and has been going ever since where it has only recently been rivalled by the MEAN stack.

4.3.1 Price

For the lamp stack, each and all the individual components are open source, resulting in a completely free development option. This is perfect for the project as there is limited funding and many subsystems requiring purchased components; The price criteria for the LAMP stack receives a score of 5.

4.3.2 Difficulty

The LAMP stack has been a part of the web development industry for over 40 years where support from the web development community is readily available. Additionally, members of the project team have experience in working with the LAMP stack. It is for these reasons the LAMP stack is scored a 4 for difficulty.

4.3.3 Performance

LAMP is the most popular and most used architecture in the internet. The default settings don't result in the most optimal performance, although there are optimisations that can be done to increase performance; LAMP stack for performance has been scored a 4.

4.3.4 Availability

As the LAMP stack is comprised entirely of open source software it is currently available to anyone with an active internet connection for electronic download; LAMP stack receives a score of 5 for availability.

Table 4 - LAMP Stack

	5	4	3	2	1	Weighted Score
Price Weighting: 0.40	Free	<$200	>$200	>$350	>$500	2
Difficulty Weighting: 0.30	Very Easy	Easy	Moderate	Difficult	Extremely Difficult	1.2
Performance Weighting: 0.20	Very Fast	Fast	Average	Below Average	Terrible	0.8
Availability Weighting: 0.10	Open Source	-	-	-	Closed Source	0.5

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Total →	4.5

5 Conclusion

The following trade study compared three popular web development stacks evaluating a given criteria to determine a best suited option for the Visual Web Interface subsystem. The criteria selection was based on desired requirements and their importance weighted. Through the analysis of the different criteria for each possible solution an optimal solution meeting requirements will be found.

5.1 Summary of Scores

The results of the possible solutions and their analysis are as follows:

Table 5 - Results

Web Development Stacks	**Criteria**				**Total Score**
	Price Weighting: 0.4	**Difficulty** Weighting: 0.3	**Performance** Weighting: 0.2	**Availability** Weighting: 0.1	
MEAN	2	0.6	1	0.5	4.1
WISA	0.4	1.2	1	0.1	2.7
LAMP	2	1.2	0.8	0.5	4.5

6 Recommendations

Results conclude that the LAMP stack is over all the best solution for the Visual Web Interface subsystem. Closely followed by the MEAN stack which comes equipped with a little more performance however it will be slightly more difficult to configure which could cause issues for this project due to time sensitivity. Windows stack has great performance and plenty of support and ease of use however is completely out of the budget for the scale of the project. The apache web server satisfies system requirement REQ-M-7-1, PHP the server side scripting component of LAMP can be embedded into HTML to serve dynamic content satisfying REQ-M-7-2. Also, it should be noted that REQ-M-7-3 is not relevant to the selection of the web development application stack. With all system requirements satisfied it is confirmed LAMP is the best solution for the VWI subsystem.