UOW MALAYSIA KDU PENANG UNIVERSITY COLLEGE

PART OF THE UNIVERSITY OF WOLLONGONG AUSTRALIA GLOBAL NETWORK

ASSIGNMENT COVER PAGE

Programme	**Course Code and Title**
Diploma in Computer Studies	DNS1244: Networking and Operating System
Student's name / student's id	**Lecturer's name**
• 0205096 THOR WEN ZHENG • 0204677 LIM ZHE YUAN • 0205430 TAN PENG HENG • 0205213 DESHIGAN A/L GANESAN	Ms. Ng Fong Chiu

Date issued	**Submission Deadline**	**Indicative Weighting**
Week 4 (8/10/2021)	Week 11 26-November-2021	15%
Assignment [2] title	**Assignment 2:** Report writing (Group work with individual component)	

This assessment assesses the following course learning outcomes

# as in Course Guide	**UOWM KDU Penang University College Learning Outcome**
CLO3	Explain the fundamental concepts underlying operating systems, their roles and services in computer systems.

Student's declaration

I certify that the work submitted for this assignment is my own and research sources are fully acknowledged.

Student's signature: Submission Date: 26/11/2021

Thor Wen Zheng (0205096) – *Wen Zheng*

Lim Zhe Yuan (0204677) – *Zhe Yuan*

Tan Peng Heng (0205430) – *Peng Heng*

Deshigan A/L Ganesan (0205213) – *Deshigan*

DNS1244_Assign2_Sept2021_(Thor Wen Zheng and Team)

ORIGINALITY REPORT

4%	0%	3%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	P.P. Ray. "A survey on Internet of Things architectures", Journal of King Saud University - Computer and Information Sciences, 2018 Publication	1%
2	Submitted to Ghana Technology University College Student Paper	1%
3	Submitted to Temple University Student Paper	1%
4	Juanjuan Yang, C. B. Sivaparthipan, BalaAnand Muthu. "Dynamic distributed iterative computational model for payment information management in shared logistics using blockchain-assisted Internet of Things approach", Soft Computing, 2021 Publication	1%
5	Submitted to ESCP-EAP Student Paper	<1%
6	Submitted to Kaplan University Student Paper	<1%

TABLE OF CONTENTS

MAIN REPORT

TASK 1: ARTICLE REVIEW

1. INTRODUCTION

The requirement of this assignment is to **review an article** titled “Internet of Things (IOT) Operating Systems Management: Opportunities, Challenges, and Solution” by Zikria and their team (2019) and to relate it with networking and operating systems. Upon reviewing the article, several key points were identified. Firstly, the article describes the current architecture of different IoT operating systems and the key features and characteristics that each IoT operating system possesses. Then, the article also introduces amazing opportunities that are within the capabilities of existing IoT technology, along with the current IoT challenges that are being faced by technical experts but could be solved in the foreseeable future.

Internet of Things (IoT) is a new concept that has transformed the traditional way of living by automating various aspects of our lifestyle using smart sensors. A lot of crucial, in-depth investigations have been conducted to also enhance current technologies through IoT (Kumar, Tiwari & Zymbler, 2019). By adopting more IoT technologies, industry processes and technology could see chances of transformation using sensors or nanotechnology. After all, data from IoT devices provide useful insights through comprehensive data analysis, such as surges or deflation of data values which reflect common trends or patterns that can aid people in proactively engaging with data to implement effective decision-making processes (Joseph, 2018). IoT in agriculture is an example of this usage; It monitors the crop field with the help of sensors by providing data about light, humidity, temperature, soil moisture, crop health, etc. and automates the irrigation system using information from the data (IOT Solutions World Congress, 2019). This example is just the tip of the IoT iceberg, there are many more inspiring IoT ideas out there, waiting to be found and acknowledged.

Of course, it is highly unlikely that the implementation of these new ideas would happen soon because numerous **challenges** caused by the infancy of IoT infrastructures are posing themselves to be a big hindrance. Even though it is said that hardware and network technologies have made great breakthroughs, the underlying computer environment makes the already complicated software design space become significantly sophisticated (Pan et al., 2018), which makes changing established hardware processes so much more confusing. Besides hardware capabilities, people still need to acquire a deep understanding of industrial characteristics and requirements based on factors such as cost, security, privacy, and risk, which ultimately decide the possibility of innovative ideas (Ray, 2016). Therefore, it is imperative to overcome these challenges to eliminate people’s hesitancy and doubts in adopting IoT technology before IoT can be widely accepted and deployed in all industries across the globe.

Fortunately, promising **solutions** to these imposing challenges are being suggested and studied by researchers. It goes without saying that finding these solutions is an obligatory mission for researchers who want to see the success of IoT. As Ray (2016) implies, IoT research are conducted to motivate the academics and industries to get more involved in seeking the possible way outs to capitalize on the potential of IoT. By leveraging manpower, more resources could be allocated in the study of IoT system vulnerabilities which in turn provides more insights on current IoT conditions and what can be improved. Whatever the case, it is important know that Albert Einstein once quoted: “We cannot solve our problems with the same level of thinking that created them” (GreatExpectations, 2018). Researchers have to expand their area of studies to search for possibilities beyond the existing realm of knowledge in order to develop an effective countermeasure.

2A. OPPORTUNITIES OF NETWORKING & OPERATING SYSTEMS

Opportunities in networking and operating systems come in a variety of shapes and sizes. One of which is the Smart **Home Energy Management System** (HEMS) based on Internet of Things (IoT) technology. It was built as a solution to decrease energy usage in households, and the model's applicability stems from the need for an effective and structured building energy management system based on ICT tech rises. The HEMS approach was designed to manage a variety of data utilizing body image sensors, ultrasonic sensors, environment monitor, detection sensors, and infrared sensors, which helps maintain the appropriate dwelling energy use ratio irrespective of time or location. The technique enables a mobile administrator or user to monitor, administrate, and control the system. To tackle global environmental impacts in the present time, other relevant disciplines such as decarbonization technology, energy efficiency technology, and alternative energy will be needed. As smart cities grow, there will be a great demand for this infrastructure (Kim, 2016).

Next, **blockchain**, which has been gaining popularity in recent years, is a decentralized technology that works in tandem with IoT technology to enable machine-to-machine interactions. It employs a series of operations that are stored in a database, double-checked by numerous sources, and recorded in a shared ledger that spans all nodes. Via the use of decentralized public blockchains, blockchain enforces high-level security by validating and authenticating encrypted device-generated data. Data computation and storage are shared over millions of devices in a distributed ledger (Deloitte, 2021). Consequently, the loss of a device, a server, or a network will not affect the whole IoT ecosystem. A blockchain network's robustness can fix any problems with ease, meaning the network will keep functioning even if nodes are taken down (Monica, 2021). IoT-blockchain technology is still in its initial stages, but several large IT firms already started looking for potential in this area.

Moreover, The Internet of Things (IoT) is allowing new opportunities for **intelligent transportation systems** (ITS) such as road, air, rail, and marine travel. These systems link automobiles, traffic lights, tolls, and other infrastructure to assist in decreasing road congestion, ensure safety, help the environment, and improve traffic efficiency. Intelligent traffic management, V2X communication, electric car recharging, automatic toll collection, and a variety of other transportation solutions are just some of the possibilities. It will offer useful data to a city's transportation control center for traffic control and will serve as a vital platform for the management of mixed traffic in just about any future smart city. Through this emerging IoT technology, this concept might benefit new upcoming smart cities (Intel, 2021). Each city's vehicular networks center may be linked to one or more similar various routing in other cities.

In **Information-Centric Networking (ICN)**, it has been proven to effectively satisfy modern computer network capacity expectations and bring more opportunities in the field, where users ingest network content rather than converse with specific hosts. The Internet of Things (IoT) apps and consumption habits frequently indicate information-centric use, in which users or devices receive IoT produced material from the network rather than connect with hosts or gadgets. Furthermore, the dispersed cache may result in lower energy usage owing to fewer wireless signals and greater duty cycle options, as well as lower data access delay. Additionally, decoupling between the network's publisher and consumers of data will result in enhanced performance in networks with either purposeful or unintentional communication interruptions (Lindgren et al., 2019). The IoT design might profit from either adopting an ICN or a host-centric network (HCN), depending on the circumstance. The best strategy is a complicated compromise that's also determined by the IoT network's applications and consumption.

2B. CHALLENGES FACED BY NETWORKING & OPERATING SYSTEMS

Networking and operating systems, specifically the Internet of Things (IoT), has grown exponentially in recent years. The number of network-enabled devices, the volume of internet traffic and data has risen to unprecedented amounts (Imran et al., 2020). Statista researcher, Holst (2021a; 2021b), estimates that by 2025 there will be around 16.44 billion IoT-connected devices and more than 180 zettabytes of data across the world in that same year. Naturally, such an exponential rise in usage and growth comes with a myriad of challenges and obstacles.

One major challenge is **energy efficiency**, which refers to using lesser energy to perform the same task (EESI, 2021). This is a major challenge because most IoT devices are usually in constant active use, thus requiring a constant supply of energy to perform their tasks. Furthermore, most IoT devices need to consume phantom energy, which is the power used even when they are inactive. They need this energy for the purpose of standing by and staying alert for any possible commands or instructions that may be given to them. Although power consumed in the form of phantom energy is miniscule, it can add up to a significant amount when used for long periods of time and if large amounts of these IoT devices are used (Matthews, 2019). With such high usages of energy, reliable and efficient sources of energy are necessary, especially in locations where energy sources are scarce.

Another challenge is **network connectivity**. In an IoT network, devices, applications, and servers must be able to effectively communicate and transfer data between one another (Gillis, 2021). For the whole system to operate effectively in real-time and for long durations, seamless network connectivity is essential, though it is difficult to achieve in many cases. One such case of connectivity issue is due to heterogeneous network communication standards, which causes IoT networks to have problems connecting various devices and systems or connecting with other networks that use different network protocols and standards (Chang et al., 2015). Additionally, limited bandwidth can also negatively affect connectivity due to the client-server model used in IoT. As significant numbers of devices are continuously added to IoT networks, servers may struggle to keep up with the overwhelming volumes of data and traffic (Began, 2020).

Security and safety also pose a major challenge. There are billions of IoT devices connected to the Internet, and data from every device typically travel long distances across several networks before reaching their destination (Patel, 2021). This leads to billions of potential points of cyberattack, providing a large “attack surface” for hackers to penetrate secure networks, planting malware and stealing data (Gillis, 2021). This security issue is further worsened by the fact that many IoT manufacturers and users often neglect IoT devices’ security as they do not see it as a potential point of attack, leading to various security flaws and vulnerabilities. For example, there was an interesting case in 2017 where hackers gained access to and stole data from a casino’s private network by hacking into an IoT thermostat in a fish tank, it was then found that the thermostat was poorly secured (Schiffer, 2017). However, it can be much more disastrous if security breaches occur in critical systems such as healthcare or smart home systems.

Lastly, another major challenge is **heterogeneous devices support**. The exponential growth of IoT has led to the emergence of countless types of devices from many different manufacturers and IoT OSes with different ranges of compatibility, all being used in diverse use cases (Zikria et al., 2019). Due to the lack of international standards, hardware and OS design by different manufacturers are not standardized and not cross-compatible (Gillis, 2021; BehrTech, 2021). This makes it challenging for IoT OSes to support a wide range of devices. This also leads to the grand challenge of heterogeneous devices interoperability, making it very difficult to seamlessly connect and integrate different IoT devices and systems together. Because of this, it is currently quite difficult to actually create complete, fully automated smart ecosystems.

2C. SOLUTIONS TO OVERCOME THE CHALLENGES

As previously mentioned, networking and operating systems faces many different challenges including energy efficiency, network connectivity, security and safety, and heterogeneous devices. Researchers must endeavor to seek out new solutions and work hard on in-progress solutions to such challenges as they will negatively affect consumers' experiences with IoT technology and ultimately hinder the progress of IoT technology advancement.

Firstly, to overcome the challenge of energy efficiency, **continuous improvement of batteries** is essential. Using batteries is the primary option for stable energy supply in wireless IoT deployment scenarios and locations where energy supply infrastructure is lacking, such as remote areas. However, batteries are a form of constrained energy supply (Zikria et al. 2019), so continuous research and development must be prioritized to produce higher capacity, energy-efficient batteries that last longer (Samuelsson, 2019). Additionally, **Radio Duty Cycling (RDC)** is another technique used to achieve energy efficiency. According to Dunkels (2011), RDC is a "wake-up" mechanism whose purpose is to reduce the consumption of phantom energy by IoT devices. It regulates the on and off cycles of devices by keeping their radio transceivers off for as long as possible, while also ensuring that they "wake up" often enough to perform their necessary tasks and communicate with other devices or servers. By doing that, RDC can help keep the devices' transceivers off for up to 99% of the times, reducing energy consumption by 10 to 80%.

Second, **multi-interface** can be used to tackle the network connectivity challenge caused by heterogeneous IoT network standards. A multi-interface IoT gateway allows networks with different protocol stacks to function in the same physical infrastructure. It facilitates the exchange of information between networks running on different protocols by virtualizing all the resources used, then allocating them to the networks involved (Serpanos & Wolf, 2011). **Continuous evolution** of heterogeneous industry standard protocols at different layers of communication stacks is also essential to ensure long-term compatibility of connectivity between different IoT networks (Zikria et al, 2019). Besides that, continuous evolution of server technologies and **bandwidth optimization** are also necessary to overcome the bandwidth limitations of IoT networks (i-Scoop, 2021).

Thirdly, to overcome the security and safety challenges, a security technique based on **blockchain** technology is one of the most promising solutions. Using the distributed database technology of blockchain, all data are stored in ledger records, which are then duplicated and distributed across all nodes in the chain, making it difficult to tamper with the integrity of data (Horwitz and Rosencrance, 2021). The complete decentralization of data storage, together with strong public-key cryptography and hashing techniques makes blockchain a very strong IoT security solution (Chattopadhyay, 2021). According to Zikria et al. (2019), **continuous review** and monitoring of deployed IoT networks should also be performed to ensure that no security flaws and threats are overlooked; and if there are any flaws, they should be fixed immediately. In addition, quick development, deployment, testing and adaptation to **latest security standards** is also essential to achieve the highest possible level of security. This is because keeping security protocols and software up to date helps to fix previously existing flaws and enables identification and detection of the latest security threats in the digital world.

Lastly, the best solution to overcome the challenge of heterogeneous devices support is to set and enforce open, **international standards** for all aspects of IoT development (Zikria et al., 2019), including development of IoT OSes, hardware, network protocols, etc. Open, international standards will encourage IoT vendors or manufacturers to adopt and adhere to globally accepted rules, regulations, and protocols when developing IoT products. This will help

eliminate inconsistent hardware or OS designs and lead to global consistency in IoT development, which will enable IoT devices interoperability and cross-vendor compatibility (BehrTech, 2021). Eventually, large-scale IoT systems comprising a variety of different devices and OSes from different IoT vendors would be possible, giving IoT consumers more flexibility over their options and their budget when setting up IoT systems as they are not bound to a single vendor for their whole system.

3. CONCLUSION & RECOMMENDATIONS

To summarize, there is definitely more room for IoT technologies to grow and improve in terms of networking and operating systems. By embracing newfound opportunities, major challenges that could present themselves when working with existing IoT infrastructures could be uncovered and solutions could be brainstormed way sooner to turn these opportunities into reality. However, it is not new that people may avert new ideas that contradicts with current technological standards, and it does not necessarily need to happen in the IT industry, as Thompson (2014) said in an article. People should be aware of this occurrence and prevent themselves from being blinded by their own knowledge and being complacent about the ability of existing technology, which can cause people to breed an innate bias against novelty. In short, people should think outside the box and be accepting to new, unfamiliar ideas. Although new ideas may seem odd or unconvincing, it has occurred many times throughout human history that ideas people once ridiculed eventually became revolutionary ideas.

The article is overall a good read, it organizes key points into subtopics and emphasizes them by using main elaboration points redundantly across many sections of the article. However, the article could use some improvements to provide a better reading experience. Not to be dissatisfied with the article, but for a professional document, the writers should be mindful of their level of grammar. Readers would have trouble understanding what the article is trying to articulate with the current English standard of the written contents and they would need to search for more resources online to do that. According to MacMillan (2017), grammar is important because it is the structure that conveys precise meaning from the writer to the audience. It essentially provides information that helps the reader’s comprehension.

Additionally, although it was mentioned previously that standardization helps in unifying different networking and operating system paradigms to pave the way towards interoperability of IoT components, the truth is often harsher. People think that the emergence of different standards for one particular domain would facilitate communication, however it might create more problematic effects that need to be taken care of. Take character code standardization alone for example, ASCII, EBCDIC, ANSI, ISO-8859-1 and UTF-8 are varying character sets that similarly defines character management and support (PCMag, 2021; W3schools, 2021). In most cases, it catalyses standards paralysis caused by competition of standards, religious wars over the comprehensiveness of standards, and version forking established standards that creates poorly specified standards. According to Cagle (2019), standards are essentially agreements that multiple parties will abide by, until it is no longer convenient or cost effective. It is recommended that pathways for standards expansion, evolution, and ultimately obsolescence should be laid down openly when establishing standards to create centralized, canonical ontologies that satisfy temporal demands.

All things considered, the article has provided much useful insight on the Internet of Things (IoT). The achievements, opportunities, and exponential growth of IoT and networking & operating systems technologies in general are very impressive. Hopefully, IoT will continue to grow and mature at a steady pace, ultimately turning its opportunities and promised benefits into reality.

TASK 2: INDIVIDUAL WORK

- **TAN PENG HENG (0205430)**

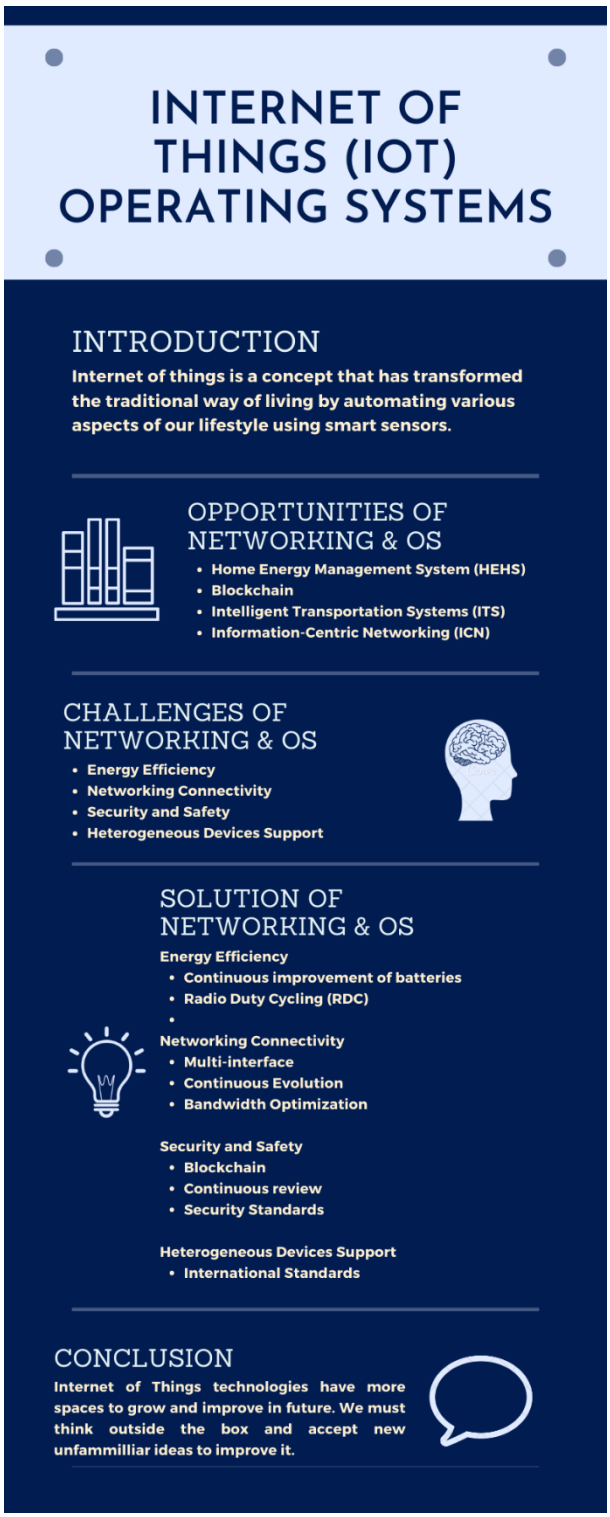

Figure 1: Tan Peng Heng's infographic on IoT

- **LIM ZHE YUAN (0204677)**

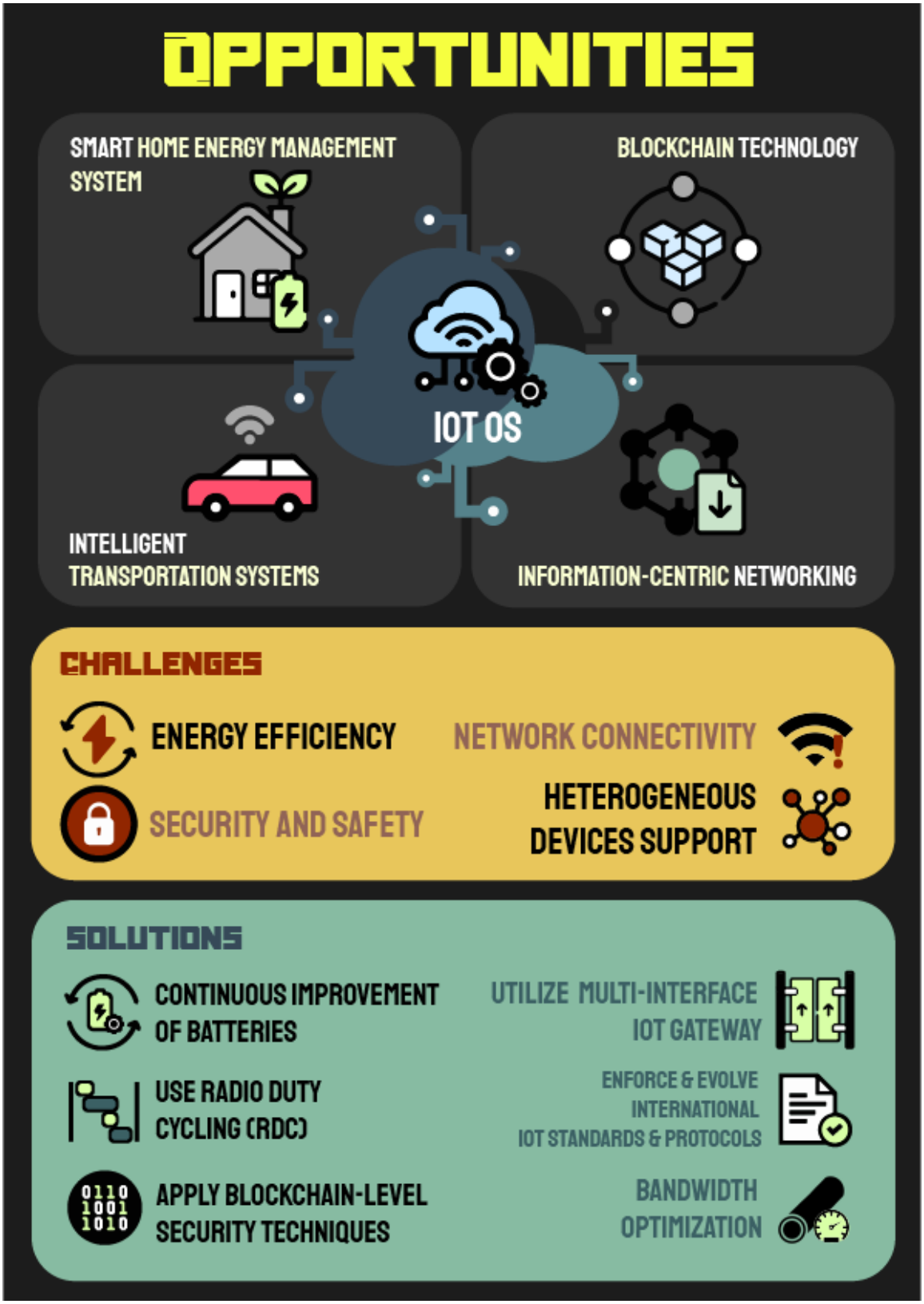

Figure 2: Lim Zhe Yuan's infographic on IoT

- **DESHIGAN A/L GANESAN (0205213)**

Figure 3: Deshigan's infographic on IoT

- **THOR WEN ZHENG (0205096)**

Figure 4: Thor Wen Zheng's infographic on IoT

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[DNS1244 Networking and Operating System]

MARKING RUBRIC
ASSIGNMENT [2]

Report Writing (15%)

REPORT COMPONENT (100%)							
LEARNING OUTCOME	**MARKING CRITERIA**	**SCALE**					
		Fail (0-49)	**3rd Class (50-59)**	**2nd Lower Class (60-69)**	**2nd Upper Class (70-79)**	**1st Class (80-100)**	**YOUR MARKS**
CLO3: Explain the fundamental concepts underlying operating systems, their roles and services in computer systems.	**Task 1 Introduction (10%)**	Weak or no introduction of the topic. Purpose of the writing is unclear or missing. Topics were not addressed properly.	Basic introduction that states topic but lacks interest. One or more topics were not addressed.	Adequate introduction and states the topic. All topics are addressed, and most questions answered with 1 sentence about each.	Proficient introduction that is interesting and states topic. All topics/questions are addressed, and most questions answered with at least 2 sentences about each.	Exceptional introduction that grabs interest of reader and states topic. All topics/questions are addressed, and all questions answered with at least 2 sentences about each.	
	Task 1 Quality of analysis on networking and operating systems' opportunities, challenges and solutions. (30%)	Failed to provide a level of information that answers the question. Statements are internally contradictory without explanation.	Statements are sometimes on target and sometimes off center. Segments of the writing hang together but other parts are unclear or contradictory with no good resolution.	Statements are on target and sometimes off center but with minimal explanation.	Most statements are at the best level of information that answers the question. Statements are usually mutually supporting and follow from one another.	Statements are at the best level of information that answer the question. Statements are mutually supporting and follow from one another.	
	Task 1 Style of Writing (20%)	The report writing does not meet the criteria for the assignment (too short or incomplete, too long, and/or completely off-topic). Reference section is missing.	Many ideas require clarification and/or are off-topic or have marginal relevance to the assignment. Many grammatical and/or spellings errors throughout the paper. The paper is very challenging to read due to poor writing flow. Improper reference section	Ideas are stated clearly and are related to the topic, with only adequate grammatical and/or spelling errors. Reference section with minor flaws	Most ideas are stated clearly and are related to the topic, with only minor grammatical and/or spelling errors. Reference section is in minimal	Writing is clear and relevant, with no grammatical and/or spelling errors – polished and professional. Reference section properly formatted.	

	Task 1 **Citation and references (10%)**	Missing or no citation and major flaws on the format. Reference section is missing.	Very minimal amount of cited works, with incorrect format. Improper reference section.	Adequate amount cited works, both text and visual, are done in the correct format. Inconsistencies evident. Reference section with minor flaws.	All, both text and visual, are done with minimal errors on the format or reference.	All cited works, both text and visual, are done in the correct format with no errors. Reference section properly formatted.	
	Task 2 **Info-graphic Presentation (Individual) (30%)**	Little or no info-graphic is offered. Inadequate info-graphic.	Some attempt of info-graphic, but the work is weak. The essence of content is missing or ill-considered.	The info-graphic is on balance acceptable. The effort is limited and do not show the necessary broader perspective. Not outstanding in any respect.	A sound info-graphic that covers a good range of context. The info-graphic is appropriate and may show a broader perspective. No section has serious weaknesses, and there may be excellent or outstanding features. On balance the work is good but not wholly excellent.	Outstanding info-graphic is stated clearly with distinctive context and are relevant to the topic.	
	Total (100%)						