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Design of a robot to control agricultural soil conditions using ESP-NOW protocol

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Design of a Robot to Control Agricultural Soil Conditions using ESP-NOW Protocol

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***Abstract*—Internet of Things (IoT) is a concept that utilizes an internet network that is always connected among some devices. Internet of Things requires a protocol to get the information quickly and in real-time to exchange the data needed, one of them is ESP-NOW. ESP-NOW protocol is a communication protocol that is able to send data over long distances, with relatively fast transfer speeds. In addition, the technology that is developing rapidly at this time is the development of robots. A robot is a tool or technology used to facilitate human work. In this research, an IoT-based robot was developed to perform maintenance on various types of soil in accordance with optimal parameters. The robot can monitor the soil conditions and water the plant automatically. The robot monitors the temperature and humidity of the air, as well as the humidity of the agricultural soil. The desired crop condition is 70% for the minimum air humidity threshold and 60% for the minimum soil moisture threshold. The robot is also equipped with a GPS module to store the initial location of the robot. The test was conducted at 6 points, where all points were in the desired condition after 3 times of testing. The robot also uses ESP-NOW as the communication protocol to send necessary information in real-time such as agricultural soil data. The success rate of messages received by the ESP-NOW gateway at a distance of 0.5 up to 3 meters from the sender is 100%.**

Keywords—internet of things, ESP-NOW protocol, robot, air humidity, soil moisture

I. Introduction

Agriculture is one of the fundamental fields in human life. Since the beginning of its development, agriculture has been conducted using tools such as sickles, hoes, and similar devices. Humans are required to devote time and energy to carry out agricultural activities. Many jobs have used mobile technology, especially in the agricultural sector. The agricultural sector is very helpful in the economy and food needs in Indonesia. In the period 2012-2016 agricultural land area in Indonesia experienced fluctuations [1].

The problem that may arise in the dry season is the limited availability of water resources, so it is not always available in both quantity and quality in location or time when it is needed [2]. Due to global warming, unpredictable weather also affects harvests and farmers face huge losses so the IoT Smart Agriculture application will allow farmers to take quick action to prevent that from happening [3]. Therefore, innovation is needed so that agriculture can be carried out more effectively, where maintenance can be carried out with a standardized process, with the best parameters previously set.

The purpose of the research is to develop a robot that can perform plant maintenance that can be directly used without having to require a complicated installation process. The Robot that is made can also maintain the crop plants in accordance with the conditions of existing agricultural soil without increasing the number of human resources.

II. Literature Review

A. Internet of Things

Internet of Things (IoT) is a concept in utilizing internet connectivity that is always connected at all times [4]. The benefit of the Internet of Things (IoT) is to connect one electronic device with other devices through internet media with the purpose of making the system easier for humans to perform some tasks or jobs.

B. ESP-NOW

In its implementation, the Internet of Things (IoT) requires a protocol for data communication so that it can be accessed quickly and easily [5]. ESP-NOW is a wireless communication protocol developed by Espressif, which allows many devices to communicate with each other without using Wi-Fi [6]. On the ESP-NOW network, all devices can communicate through three methods, i.e., broadcast, unicast, and multicast with data rates of 1Mbps or more [7].

C. Robot with Internet of Things

The development of IoT is increasingly rapid, comparable to the increasingly widespread use of robots in everyday life [8]. This makes robotic technology combined with the IoT a new innovation at this time. Automatic robots are able to move, measure as well as run commands autonomously because of the sensors that are used as input parameters which will be processed in accordance with the program that has been previously defined into the robot system. In general, to process the program, the robot uses a microcontroller that matches the system requirements criteria.

D. Previous Research Studies

Several studies have been carried out by previous researchers related to the research conducted. Maulidiyah *et al.* proposed a robot namely ROBUN (abbreviated from

Comparison of Migration Approaches of ICN/NDN on IP Networks

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***Abstract*—Named-based Internet architecture such as the Named Data Networking (NDN) and the Information-Centric Networking (ICN) have been developed rapidly. The current Internet architecture, TCP/IP, will be replaced by ICN/NDN in the next decades. However, it seems unrealistic to replace all the IP routers to ICN/NDN routers at the same time, so the migration process of the ICN/NDN routers over the Internet is unavoidable. Therefore, we should discuss the migration mechanism to realize the name-based Internet architecture. This paper depicts several mechanisms and approaches that have been written and reported in recent years. The advantages and disadvantages of each approach are also deeply discussed and explained. Finally, this paper gives a big picture and recommendation about the efficient way of migrating ICN/NDN routers on the Internet.**

***Index Terms*—Named Data Networking, Future Internet Architecture, Translation, Migration**

I. Introduction

Current Internet architecture such as TCP/IP was found in the late 1960s by US military projects, and it connects millions of computers around the world now. Many technologies have been implemented to improve the current Internet architecture. The TCP/IP has been evolved from IP version 4 to IP version 6 solving the lack of IP address. In the future, there will be billions of hosts that will be connected to the global network. The TCP/IP uses a host-centric mechanism for sending and receiving a packet. In the packet frame, source and destination addresses are stated to establish a connection between client and server. This kind of communication scheme is called as host-centric communication. Routers forward the packets based on the destination IP addresses indicating the receiving hosts until reaching the destination hosts.

The information-centric networking (ICN) [9] or its promising candidate, named data networking (NDN), was proposed as a future Internet architecture in around 2009. The ICN/NDN replaces the host-centric networking protocol like TCP/IP by the data-centric networking, and the ICN/NDN refines the drawbacks of TCP/IP and enables routers to cache packets for better performance and latency. Two types of packet primitives are introduced namely interest and data packets. In order to make data transactions, the node (consumer) should emit an interest packet in advance with a prefix name to retrieve the content. Every node (producer) that has the content with a designated prefix name will reply to the interest and send the data to the consumer. Since the packet has a prefix name, this type of communication is called an information-centric network protocol.

NDN routers have three components to forward and process the interest and data packet [7], Pending Interest Table (PIT), Forwarding Information Based (FIB), and Content Store (CS). The PIT is used to register prefix names of missed interests and corresponding incoming interfaces if the interest prefix name is not found in the CS. The FIB is used to forward the missed interest packets to other interfaces listed in the table. And finally, the CS is used to store and cache the data of incoming data packets. The migration from host-centric routers to name-centric routers is unavoidable in the future as seen in Figure 1. Smooth and economical transition and migration are indispensable for the success of the future network.

This paper discusses several migrations and transition approaches that have been proposed recently by many researchers. Furthermore, this paper also categorizes the methods and gives some recommendations for future works. This paper is organized into four sections, namely introduction, migration approach, discussion, and conclusions.

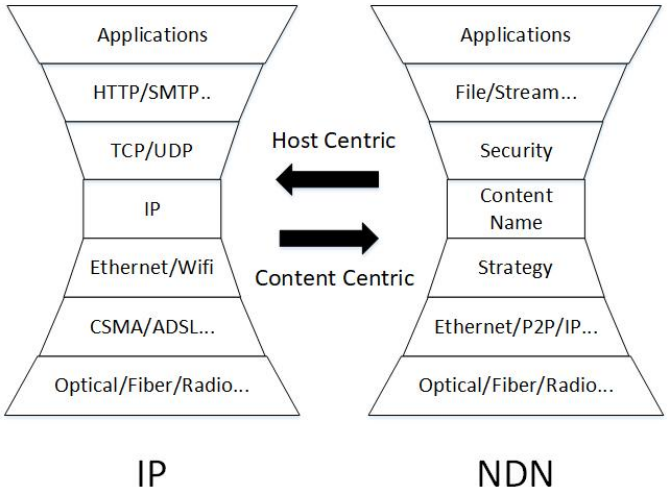

Fig. 1. NDN vs IP stack

II. Migration Approach

In this section, several approaches that have been published to migrate from host-centric to name-centric networking are explained. Some approaches use the translation mechanism for

Drivers and Barriers to IT Service Management Adoption in Indonesian Start-up Based on the Diffusion of Innovation Theory

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***Abstract*—Along with the emergence and trend of startup worldwide, Indonesia, as a developing country, has been supporting startup as a platform for the digital economy. Indonesia has been stated as one of the countries with the most extensive digital industry power. Indonesia has a strong determination in startup development by declaring the vision "Indonesia The Digital Energy of Asia." As a company, a startup relies on information technology (IT) to provide services to customers. Therefore, it is pivotal for the startup to implement IT service management (ITSM) to align IT and business goals. ITSM is not fully implemented yet in a startup because initially, ITSM is designed for large companies only. In other words, it indicates several factors that influence adoption. Therefore, this study aims to fill the gap in this phenomenon by identifying the drivers and barriers to the adoption of ITSM using the Diffusion of Innovation Theory. To sum up, the result of this study reveals that most of the reported drivers for adopting ITSM in Indonesian startups fall under the theme of the effort of change agent and nature of the system, while barriers fall under attributes of innovation and also nature of the system.**

Keywords—information technology service management, startup, adoption, driver, barrier

I. INTRODUCTION

In today's digital era, all organizations depend on information technology (IT) to organize and operate their businesses. One of the biggest challenges in organizations is aligning business needs and the use of IT to achieve organizational goals [1]. Therefore, planning, management, and integration of IT with organization goals are essential. The aligning process of IT services to business goals refers to IT service management. IT services can be in the form of software, hardware, or infrastructure used by organizations that are used for organizing and delivering service or products to customers [2]. Over the last few years, organizations are increasingly aware of the importance of implementing IT service management. In 2014, there were at least 50 countries joined as a member of the IT Service Management Forum (itSMF) with a total membership of 6000 companies and more than 40000 people scattered all over the world [3].

Thus far, IT service management has several frameworks in the form of best practice or standard, such as the Information Technology Infrastructure Library (ITIL), COBIT, ISO/IEC 20000. According to the International Business Machine (IBM), ITIL is the most popular framework for IT service management [4] and the earliest released framework compared to other frameworks. Based on ITIL, IT service management consist of five main processes, namely service strategy, service design, service transition, service operation, and continuous service improvement [4]. Initially, IT service management was intended to be implemented in large-scale companies [5]. This is supported by the assumption that large companies need IT management because they have a large number of IT services to handle. In addition, implementing ITSM requires large and stable resources [6]. Several kinds of research revealed that ITSM was implemented in various types of organizations, such as government institutions [7][8][9], industry [10][11], universities [12], and banking [13]. On the other hand, several studies explained that ITSM adoption is influenced by several factors that could be drivers or barriers. Identifying drivers and barriers was considered one step in designing appropriate policies to increase ITSM adoption [14].

Along with business development, ITSM then began to be implemented in small-scale companies. The adoption of ITSM in small-scale organizations is driven by the belief that ITSM can provide benefits, such as job transparency, workload reduction, and business competition [15]. In small organizations, ITSM is only applied to critical areas. The essential areas refer to the areas that provide the most benefits to organizations such as incident, problem, change, and configuration management [16]. As a developing country, Indonesia certainly realizes the positive impact of ITSM adoption on the organization. Therefore, several companies in Indonesia have implemented the ITSM framework. Lismanto et al. stated that ITIL had been used in several companies in Indonesia that are engaged in various fields, such as marketing, telecommunications, aviation, and education [17]. The companies mentioned in the study were classified as large