REAL TIME MONITORING FOR TANK LEVEL BASED ON ISA100.11A
USING STAR TOPOLOGY

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ABSTRACT

The use of wireless for data transmission and control system is a method that better and easier, especially for the oil and gas industry. Wireless methods generally have few protocols so that the data sent is not affected. If the data submitted is incorrect, it will affect the system to be controlled. By using the ISA100.11a, wireless security protocol can send data and control safely. The focus of this project is focused on a different network topologies, namely STAR protocol to be used by ISA100.11a. These networks are used to gain a faster response time within a range of less than 100M. The response time is obtained for both the network topology can be used to control digital logic control system uses data to ensure that it really is implemented in line with the process.

ABSTRAK

Penggunaan tanpa wayar untuk penghantaran data dan kawalan sistem adalah satu kaedah yang lebih baik dan mudah terutama bagi industri minyak dan gas. Kaedah tanpa wayar umumnya mempunyai beberapa protokol supaya data yang dihantar tidak terjejas. Jika data yang dihantar tidak tepat, ia akan memberi kesan kepada sistem yang hendak dikawal. Dengan menggunakan ISA100.11a, jaminan protokol tanpa wayar ini dapat menghantar data dan kawalan dengan selamat. Fokus projek ini tertumpu pada jaringan topologi yang berbeza iaitu STAR yang akan digunakan berdasarkan protokol ISA100.11a. Jaringan ini digunakan dan untuk mendapatkan sambutan masa yang lebih cepat dalam jarak lingkungan kurang daripada 100M. Sambutan masa yang diperolehi bagi jaringan topologi dapat digunakan pada kawalan menggunakan sistem kawalan logik digital data bagi memastikan ia benar-benar selari dengan proses yang dilaksanakan.

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LIST OF SYMBOLS AND ABBREVIATIONS

AGA	-	American Gas Association
ASME	-	American Society of Mechanical Engineers
ANSI	-	American National Standards Institute
API	-	American Petroleum Institute
ASCI	-	Automation Standards Compliance Institute
ASM	-	Abnormal Situation Management Consortium
BCS	-	British Computer Society
BS	-	British Standards
BSC	-	British Computer Society
CEN	-	European Committee for Standardization
CFR	-	Code of Federal Regulations (US)
CRE API	-	Committee for Refining Equipment
CSA	-	Canadian Standards Association
DIN	-	German Institute for Standardization
EC	-	European Commission
EIA	-	Electronics Industries Association
EMC	-	Electromagnetic compatibility
EN	-	European Norm
FCI	-	Fluid Controls Institute (US)
FDT	-	Field Device Type
HCF HART	-	Communication Foundation
IAS	-	IEEE Industry Applications Society
IEC	-	International Electrotechnical Commission
IEE	-	Institution of Electrical Engineers (UK)
IEEE	-	Institute of Electrical and Electronics Engineers (US)
IFE	-	Institute for Energy Technology (Norway)
IMO	-	International Maritime Organization

IMS	-	IEEE Instrumentation & Measurement Society
ISA	-	International Society of Automation (US)
ISO	-	International Organization for Standardization
LAN	-	Local area network
MOA	-	Memorandum of Agreement
MODU	-	Mobile Offshore Drilling Units Code (IMO)
NACE	-	National Association of Corrosion Engineers (US)
NAMUR	-	Automation Systems Interest Group of the Process Industry
NFC	-	National Fire Code
OGP	-	International Association of Oil & Gas Producers
OLF	-	Norwegian Oil Industry Association
OSHA	-	Occupational Safety and Health Administration (US)
PAS	-	Publicly Available Specification (ISO)
PSA	-	Petroleum Safety Authority (Norway)
SCD	-	System Control Diagram
SIL	-	Safety Integrity Levels

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CHAPTER 1

INTRODUCTION

1.1 Project overview

The innovation of wireless technology increases the use of wireless communication in the industry. The introduction of wireless communication to plants, however, requires strict features such as robustness, real-time responsiveness, and low power consumption. This has restricted the use of wireless communication to limited applications such as data logging and device status monitoring that does not require strict real-time responsiveness and data arrival reliability in communication. However, ISA100.11a, a wireless communication standard for industrial automation, which could realize such strict features was published in September 2009. In response to that, in June 2010 Yokogawa released the world's first two wireless field instruments and a device for field wireless systems based on the ISA100.11a. This project introduces the features and capabilities of these wireless instruments using STAR topology and a wireless device for field wireless systems response based on ISA100.11a for level system.

1.2 Problem statement

Use of the wireless technology is still not widely used because it is still new and the trust industry to which data will be acquired may not be real time. Because of these problems, many studies have been and are being made to ensure wireless capabilities similar to the use of cable. In 2009, a wireless communication standard for industrial automation has been removed and is named as ISA100.11a. With the wireless communication standard, the producers are racing to produce their products but how do we know which one is the suitable topology will used during installation is the main topic. STAR and Mesh Topology has been commonly used in networking connectivity in wireless connectivity but it is still in the preliminary stages. Here the idea is to study response time using STAR topology and impact to the controller.

1.3 Project objective

The aim of this project is to testing the wireless transmitter using STAR topology and the specific objectives are:

i. To construct wiring hardware mini desterilize tank system with wireless transmitter.
ii. To develop wireless connection from field to controller using STAR topology.
iii. To evaluate the performance of the propose system technically and physically.

1.4 Project scope

Mini desterilize Tank System, wireless transmitter and gateway (manufactured by Yokogawa) are used for this study involving lab scaled. This lab scale mini desterilize tank system consists of 3 subsystems namely cooling tower, desterilize and vessel. The scope proposed for this project are:-

i. Use level wireless transmitter as the water level sensor.
ii. FieldMate software, Field Wireless Monitor and Field Wireless Configurator as software development tools.
iii. Limited to the STAR topology connection and wireless performance less than 50M.

1.5 Project significant

Real time monitoring is needed as it is very helpful especially in a complex system. In oil and gas industry, usage of wireless technology is very limited. Thus, by investigating one of the product available in wireless technology will motivate the usage of the technology.

1.6 Chapter summary

This chapter had described in general the focus of this project. They are include project's overview, problem statement, objective and scope. This chapter will be used as a basis for the next chapters.

1.7 Project report layout

This project report is organized as follows:

i) Chapter 1 briefs the overall background of the study. A quick glimpse of study touched in first sub-topic. The heart of study such as problem statement and project's objective, scope and report layout are presented in this chapter.

ii) Chapter 2 covers the literature review of previous case study based on ISA100.11a protocol and network topology. Besides, general information about wireless transmitter, gateway and data management system also described in this chapter.

iii) Chapter 3 presents the methodology used to design the network topology and applied to the mini desterilized tank system. All the components that have been used in mini desterilized tank system are described well in this chapter.

iv) Chapter 4 reports and discuss on the results obtained based on the problem statements as mentioned in the first chapter. The results from network topology testing using FieldMate software and FieldWireless Monitor software will be analyzed and recorded. The difference time response using 2 difference network topology will be discuss in this chapter.

v) Chapter 5 will go through about the conclusion and recommendation for future study. References and supporting appendices are given at the end of this project report.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter covers the literature related to this research. Topics discussed are to support the research made in real time monitoring, especially in network topology. Besides that strategies taken by researchers in coping with real time monitoring using ISA100.11a protocol are elaborated. The background and specification of the protocol also will be discussed. Next, the methods used to configure the protocol will be explained. Finally, ISA100.11a the topology will be compared to other available wireless protocol.

2.2 Basic of topologies

The physical topology of a network refers to the configuration of cables, computers, and other peripherals. Physical topology should not be confused with logical topology which is the method used to pass information between workstations. In networking, the term "topology" refers to the layout of connected devices on a network. Network topologies are categorized into the following basic types:

2.2.1 Star topology

Many home networks use the star topology. A star network features a central connection point called a "hub" that may be a hub, switch or router. Devices typically connect to the hub with Unshielded Twisted Pair (UTP) Ethernet. Compared to the bus topology, a star network generally requires more cable, but a failure in any star network cable will only take down one computer's network access and not the entire LAN. (If the hub fails, however, the entire network also fails.).

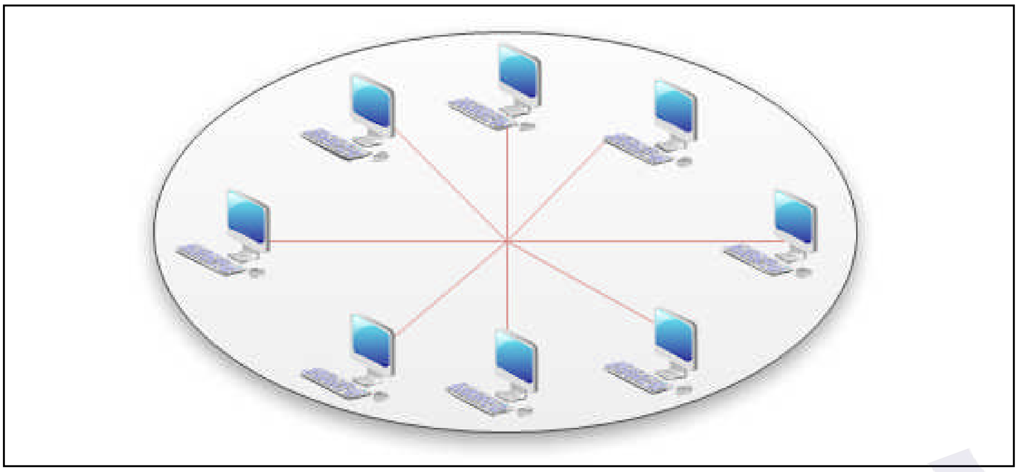

Figure 2.1: Star Topology

2.2.2 Ring topology

In a ring network, every device has exactly two neighbors for communication purposes. All messages travel through a ring in the same direction. A failure in any cable or device breaks the loop and can take down the entire network. To implement a ring network, one typically uses FDDI, SONET, or Token Ring technology. Ring topologies are found in some office buildings or school campuses.

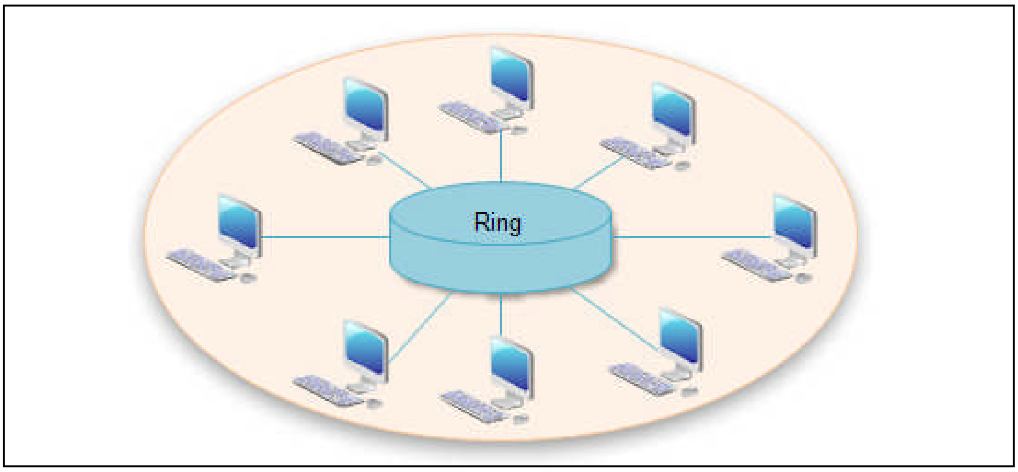

Figure 2.2: Ring Topology

2.2.3 Bus topology

Bus networks use a common backbone to connect all devices. A single cable, the backbone functions as a shared communication medium that devices attach or tap into with an interface connector. A device wanting to communicate with another device on the network sends a broadcast message onto the wire that all other devices see, but only the intended recipient actually accepts and processes the message. Ethernet bus topologies are relatively easy to install and don't require much cabling compared to the alternatives. If the backbone cable fails, the entire network effectively becomes unusable.

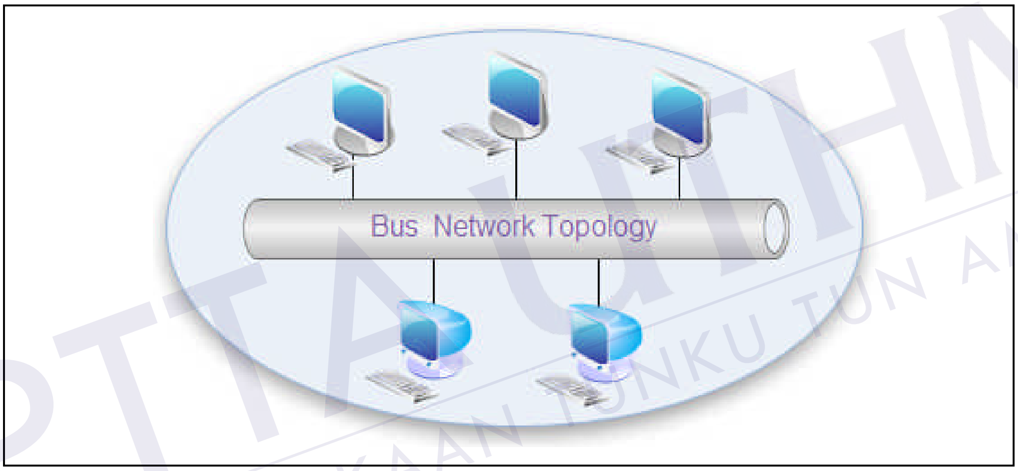

Figure 2.3: Bus Topology

2.2.4 Tree topology

Tree topologies integrate multiple star topologies together onto a bus. In its simplest form, only hub devices connect directly to the tree bus, and each hub functions as the "root" of a tree of devices. This bus/star hybrid approach supports future expandability of the network much better than a bus or a star.

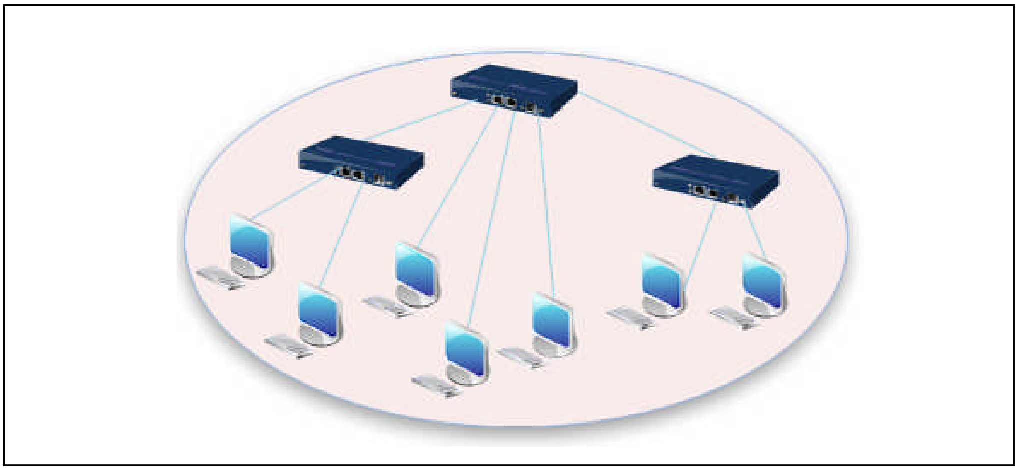

Figure 2.4: Tree Topology

2.2.5 Mesh topology

Mesh topologies involve the concept of routes. Unlike each of the previous topologies, messages sent on a mesh network can take any of several possible paths from source to destination. A mesh network in which every device connects to every other is called a full mesh. Figure 2.5 shown in the illustration, partial mesh networks also exist in which some devices connect only indirectly to others.

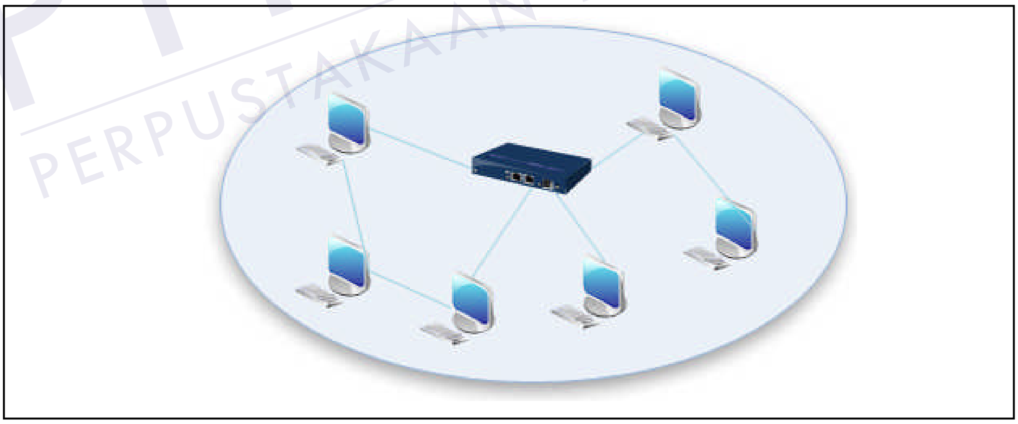

Figure 2.5: Mesh Topology

2.3 Previous case study

Since wireless protocol ISA100.11A introduced in the oil and gas industry, many wireless research conducted to obtain data and control method. Most of the research carried out over the monitoring, wireless sensor network, application of wireless sensor and wireless topology.

Pan Yi, Xiao Lizhi, Zhang Yuanzhong (2010) proposed a monitoring system for production well based on WSN design where the sensors can be used as the downhole permanent sensor to measure temperature and pressure analog signals. The analog signals are modulated digital signals by data acquisition system. The digital signals are transmitted to database server of monitoring center. Meanwhile the data can be browsed on internet or by mobile telephone, and the consumer receive alarm message when the data are overflow. The system offered manager and technician credible gist to make decision timely.

Shamneesh Sharma1 , Dinesh Kumar2 and Keshav Kishore (2013) focuses on the existing topologies that are used in the wireless sensor networks and second part emphasis on the architecture of the node. As we all know that wireless sensor network technology is the application oriented technology so topology and architecture of the network will always vary from application to application i.e. dynamic in nature. The development and deployment of the nodes always differ from traditional technologies; no doubt initially the traditional technology has been used but the excessive use of traditional technology changed the scenario.

Akhondi, Talevski, Carlsen and Petersen (2010) study on the use of Wireless Sensor Networks (WSNs) in refineries, petrochemicals, underwater development facilities, and oil and gas platforms. The work focuses on networks that monitor the production process, to either prevent or detect health and safety issues or to enhance production. WSN applications offer great opportunities for production optimization where the use of wired counterparts may prove to be prohibitive. They can be used to remotely monitor pipelines, natural gas leaks, corrosion, H_2S, equipment condition, and real-time reservoir status. Data gathered by such devices enables new insights into plant operation and innovative solutions that aids the oil, gas and resources industries in improving platform safety, optimizing operations, preventing problems, tolerating errors, and reducing operating costs.

Stefano Savazzi, Sergio Guardiano, Umberto Spagnolinil (2012) proposed a critical process control in industrial plants and oil/gas refineries. In contrast to wireline communication, wireless links are inherently unreliable. This unreliability depends critically on the propagation environment of the radio-links as the layout of scattering objects (pipes and metallic structures) influences the strength and the fluctuations of the received signal power. The development of next generation critical process control systems using the wireless technology calls for the design of advanced network architectures. By following the guidelines introduced by recent standardization, this paper proposes a novel architecture based on the most recent technological advances to enable wireless advanced process control for tight closed loop applications. Cooperative network paradigm is indicated as the key technology to provide link reliability even in critical environments.

Based on those related work, the researchers make a great efforts to propose the good application in wireless monitoring in industrial oil and gas. Their applications of each method differ and still, the wireless communication is very conveniences compared to wired communication.

The approach of this study is similar to Pan Yi, Xiao Lizhi, Zhang Yuanzhong (2010) in monitoring using wireless and Shamneesh Sharma1 , Dinesh Kumar2 and Keshav Kishore (2013) focuses on the existing topologies that are used in the wireless sensor networks. In this research, the control element will be studied using topology have selected to control heater.

2.4 Wireless network ISA100.11a

A field wireless network refers to a network in factories and plants based on field devices and system devices with a wireless communication function. A wireless communication of a field wireless system is interactive full-digital network communication. This digital communication provides many information communication functions involving device status monitoring, status diagnostic monitoring, and device parameter adjustment, in addition to process values.

Yokogawa's field wireless communication system is based on the industrial automation wireless communication standard ISA100.11a of the International Society of Automation (ISA). ISA100.11a is approved as an International Standards by International Electrotechnical Commission (IEC).

A field wireless system consists of field wireless system devices such as an access point and a gateway, its lower-level wirelessly connected field wireless devices, and its upper-level PC connected by Ethernet. The upper-level field wireless management PC is used to perform settings and management of a field wireless network.

Technology advancements in measurement instruments and final control elements provide greater process insight, reduce engineering costs and contribute to improving the overall operational performance of the plant. These instruments are often collectively referred to as smart devices. Getting this technology to the field has often been hampered by the high costs of installation as well as other factors. To address these needs what has emerged is a whole new line of devices using wireless technology. Although some of these devices contain the same technology as their wired counterparts, newer devices are emerging with innovative low-powered sensors and mobile sensors. The most prominent wireless technology to date uses is IEEE 802.15.4-compatible DSSS radios and operates in the 2.4GHz ISM radio band. Two standards using the IEEE 802.15.4 radio technology are WirelessHART and ISA100.11a. Both specifications also use similar graph routing, source routing, security and centralized network management functions. Although both standards contain many similarities, they also contain differences.

WirelessHART is based on the HART communication protocol and user layer. The HART application layer has been in existence since the late 80s. The WirelessHART design criteria included integrated security, high availability, centralized network management and support for upward and downward interoperability with previous and future releases of the HART protocol. In addition to traditional measurements, WirelessHART also targets rotating equipment such as kiln dryers, environmental health and safety applications, such as safety showers, condition monitoring and flexible manufacturing in which a portion of the plant can be reconfigured for specific products. The latest release of the HART protocol includes a new specification for discrete devices.

ISA100.11a was developed through the International Society of Automation (ISA). ISA100.11a is intended to be part of a family of standards designed to support a wide range of wireless industrial plant needs, including process automation, factory automation and RFID. Key design criteria for ISA100.11a include flexibility, support for multiple applications, high reliability and integrated security. ISA100.11a defines the protocol stack, system management and security functions for use over low-power, low-rate wireless networks. ISA100.11a does not specify a process automation protocol application layer or an interface to an existing protocol.

Architecturally the standards have many differences. Whereas WirelessHART extends HART by introducing device types, ISA100.11a introduces the concept of roles and allows these roles to be applied in various combinations. ISA100.11a includes backbone routers for bridging subnets vs. WirelessHART which uses Access Points. Backbone routers limit the throughput into and out of a single subnet to the throughput of one radio. Backbone routers can be used in parallel to create a very large wireless network. WirelessHART Access Points can be used in parallel to create a mesh of thousands of devices. A single WirelessHART network is limited by address space to about 30,000 devices. In both ISA100.11a and WirelessHART can connect too many gateways.

Other differences include support for fragmentation and reassembly at the network layer ISA100.11a and WirelessHART's is support at the application layer, configurable time slots which only specifies a 10-ms time slot and configurable channel hopping mechanisms which specifies only one channel-hopping mechanism and options to enable or disable security settings which dictates that security must always be on. Devices in ISA100.11a do not have to support routing compared with WirelessHART devices, must support routing.

2.5 Methods configuration wireless field

2.5.1 Field wireless management station

The field wireless management station is a field wireless system device for large-scale and a High reliability plants. The field wireless management station builds flexible large-scale field wireless systems by communication to multiple field wireless subnets, and builds high reliability field wireless systems by redundant configuration. The field wireless management station has a gateway function to connect field wireless devices to a host system via field wireless access points, a system configuration function and a management function of a field wireless network. System configuration and management of a field wireless network are performed using the field wireless management console software included in the field wireless management station. The field wireless management PC on which this software program installed is connected with a field wireless management station by Ethernet.

2.5.2 Field wireless access point

The field wireless access point has a function to connect field wireless devices and a field wireless management station. The field wireless access point connects with field wireless devices by wireless communications, and connects with a field wireless management station by Ethernet or Wireless LAN. The field wireless access point is set up by the field wireless access point configuration software included in the field wireless access point. The field wireless setup PC on which this software program installed is connected with a field wireless access point via infrared communication.

2.5.3 Field wireless media convertor

The field wireless media convertor has a function to convert 100BASE-TX Twisted pair cable into 100BASE-FX Optical fiber cable. The field wireless media convertor is used when connecting a field wireless management station and a field wireless access point with the outdoors or a long distance.

2.5.4 Field wireless integrated gateway

The field wireless integrated gateway is a field wireless system device for middle-scale and middle scale plants. The field wireless integrated gateway has a gateway function to connect field wireless devices and a host system, and a field wireless network setting and a management function. A field wireless network setting and management are performed using the field wireless configurator and the field wireless management tool software included in the field wireless integrated gateway. The field wireless management PC on which these software programs are installed is connected by Ethernet. These project focus on method field wireless integrated gateway.

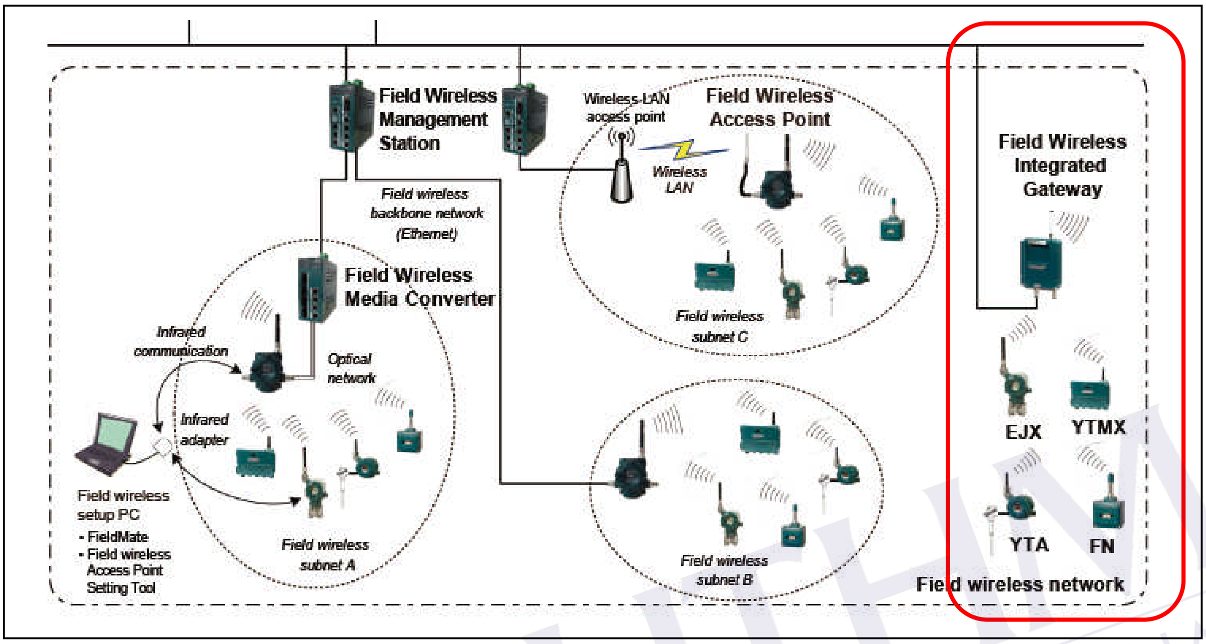

Figure 2.6: Method System Wireless Configuration

2.6 Comparison of Wireless Hart and ISA100.11a

Protocols such as Foundation Fieldbus, Profibus, and HART are well-established in the industrial process control space. Although the cost of installing and maintaining the wiring for these networks is often quite significant, they continue to dominate installations. Many years of experience with wired technologies and well-established procedures for using them are important to plants. As such, the willingness to replace these networks with something completely new is relatively low. There is also a continued need to improve productivity and safety while at the same time reducing costs. In general, this means more measurements. In many cases, the most effective way to add these measurements is with wireless instruments that use an existing process control application language.

Wireless devices are suitable for both large and small plants. In both cases the RF environment may be complicated by interference and obstructions. The establishment and maintenance of the RF network is complicated, and it is therefore important that the network manager be sophisticated enough to hide the complexity from the end user. In the case of a large network, multiple wireless networks may be deployed within the same location with overlapping RF communications where they will be distinct and separate networks with no need for internetwork communication. Since most plant personnel have limited RF background, setting up and maintaining these networks must be easy. It should always be assumed that the wireless environment is always changing and that site surveys have limited value and cannot be relied on for long-term operation. This means that the wireless sensor network must be able to operate and automatically adapt in the presence of interference from other networks, self-interference, radio shadows, multi-path interference and limited single hop range. Although both WirelessHART and ISA100.11a contain capabilities to support coexistence strategies, users need to be aware of limitations that may be implemented by specific suppliers.

2.6.1 WirelessHART

WirelessHART is based on the HART Communication protocol. The HART application layer has been in existence since the late 80s. In its initial release, the HART Field Communications Protocol was superimposed on a 4-20mA signal providing two-way communications with field instruments without compromising the integrity of the analog output. The HART protocol has evolved from a simple 4-20mA-based signal to the current wired and wireless-based technology with extensive features supporting security, unsolicited data transfers, event notifications, block mode transfers, and advanced diagnostics. Diagnostics now include information about the device, the equipment the device is attached to and, in some cases, the actual process being monitored.

WirelessHART targets sensors and actuators, rotating equipment, such as kiln dryers, and environmental health and safety applications, such as safety showers, condition monitoring and flexible manufacturing in which a portion of the plant can be reconfigured for specific products. WirelessHART also drove extensions to the core HART protocol, ensuring that newer devices, such as vibration monitors, would be fully supported. The standard architecture usually depicted for WirelessHART is shown in Figure 2.7.

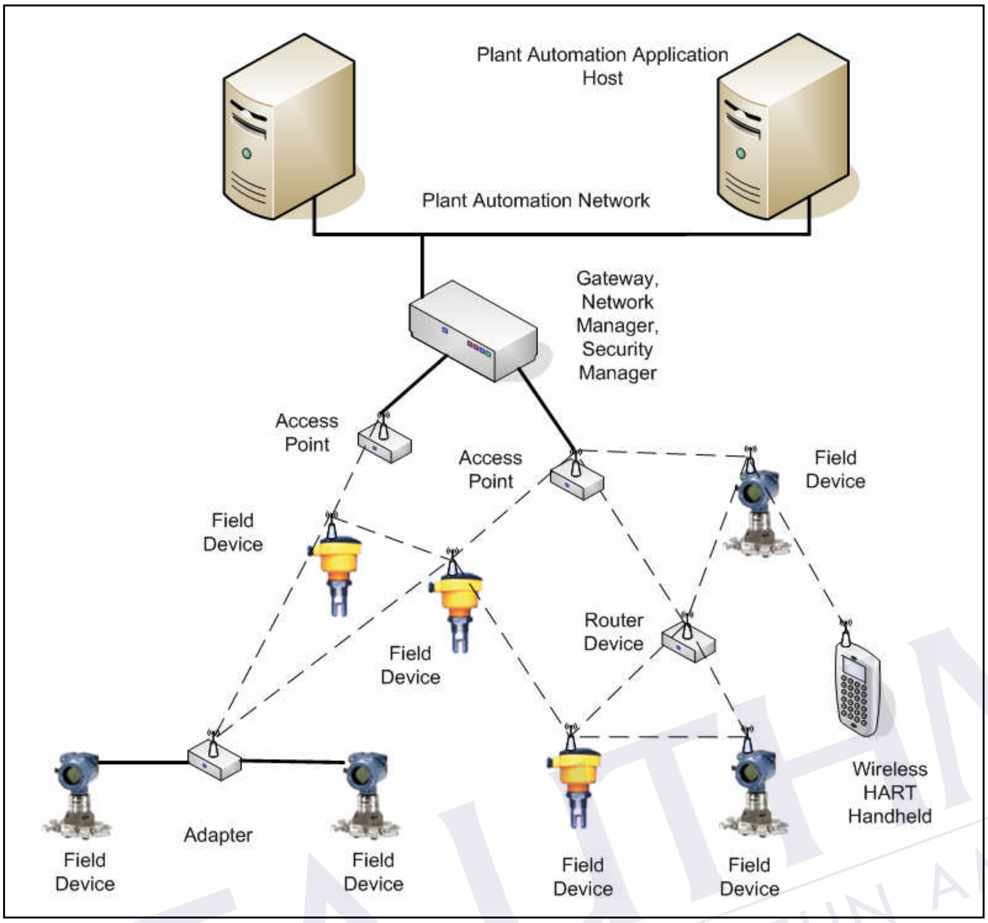

Figure 2.7: WirelessHART Architecture

Figure 2.8 illustrates the architecture of the WirelessHART protocol stack according to the OSI 7- layer communication model. As shown in this figure, the WirelessHART protocol stack includes five layers: the physical layer, the data link layer, the network layer, the transport layer and the application layer. In addition, a central network manager is responsible for overall network routing communication scheduling.

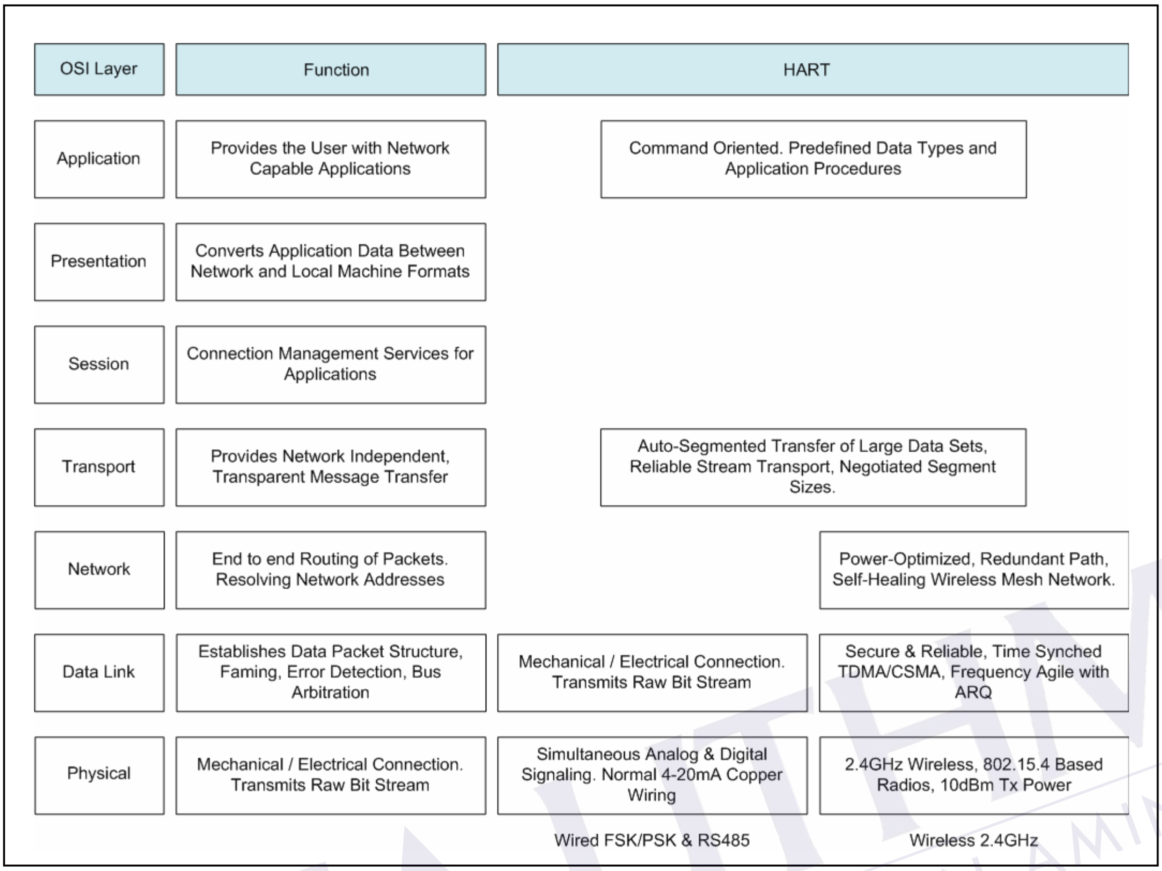

Figure 2.8: WirelessHART layers

The WirelessHART physical layer is based on the IEEE 802.15.4 2.4GHz DSSS physical layer. WirelessHART fully conforms to IEEE 802.15.4. Additional physical layers can be easily added in the future as radio technology evolves.

WirelessHART employs two architectural patterns: a service-oriented pattern and a message bus pattern. A message bus supports message-oriented communications. With message-oriented communications, all communication between application layers is based on messages that use well-known descriptions. With this style, it is not necessary for applications to know specific details about each other. Interaction between applications is accomplished by passing messages over a common bus. A service-oriented approach allows application functionality to be provided as a set of services. The network services that a specific device supports are summarized in the device's EDDL description. Services are accessed through interfaces that are defined as part of the WirelessHART standards. Since services are invoked through message-based interactions, the locations of the service requester and service provider can be separated.

Combining the two approaches provide several benefits. First, applications can be run in different environments. Second, not all devices need to support all services. Third, services allow higher level applications to be implemented independently of the actual bus protocol. And fourth, the commands exchanged as part of the message bus can be highly compressed and very efficient. This interaction is illustrated in Figure 2.9.

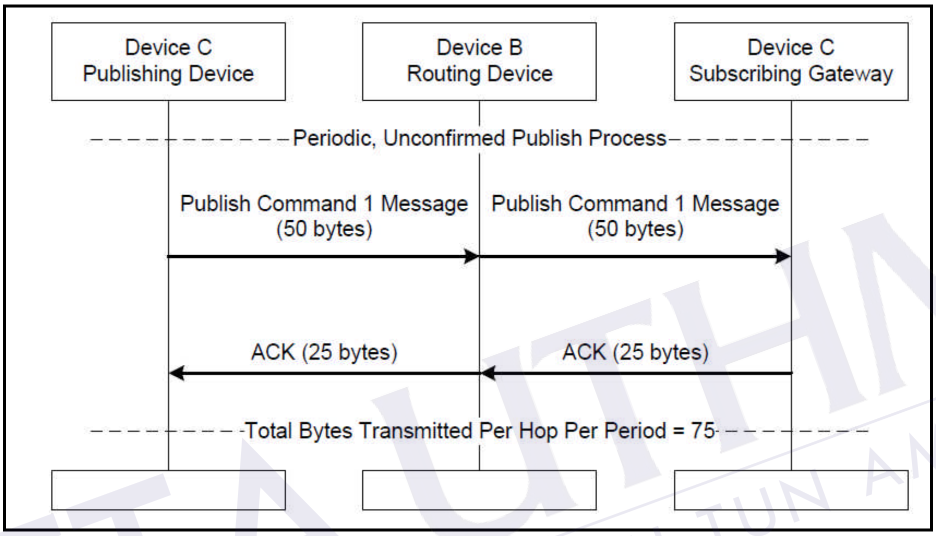

Figure 2.9: WirelessHart packets

As shown in Figure 2.9 the total size of a packet for Command 1 is 50 bytes for transmission and 25 bytes for the acknowledgement.

2.6.2 ISA100.11A

ISA100.11a was developed through the International Society of Automation (ISA). ISA is a U.S.-based, non-profit organization made up of about 20,000 automation professionals. ISA100.11a is intended to be part of a family of standards designed to support a wide range of wireless industrial plant needs, including process automation, factory automation and RFID. The only standard approved thus far is ISA100.11a. The design criteria for ISA100.11a include:

- flexibility,
- support for multiple protocols,

- use of open standards,
- support for multiple applications,
- reliability (error detection, channel-hopping),
- determinism (TDMA, QOS support),
- security.

ISA100.11a defines the protocol stack, system management and security functions for use over low-power, low-rate wireless networks. ISA100.11a does not specify a process automation protocol application layer or an interface to an existing protocol. It only specifies tools for constructing an interface. The architecture for the ISA100.11a network is shown in Figure 2.10.

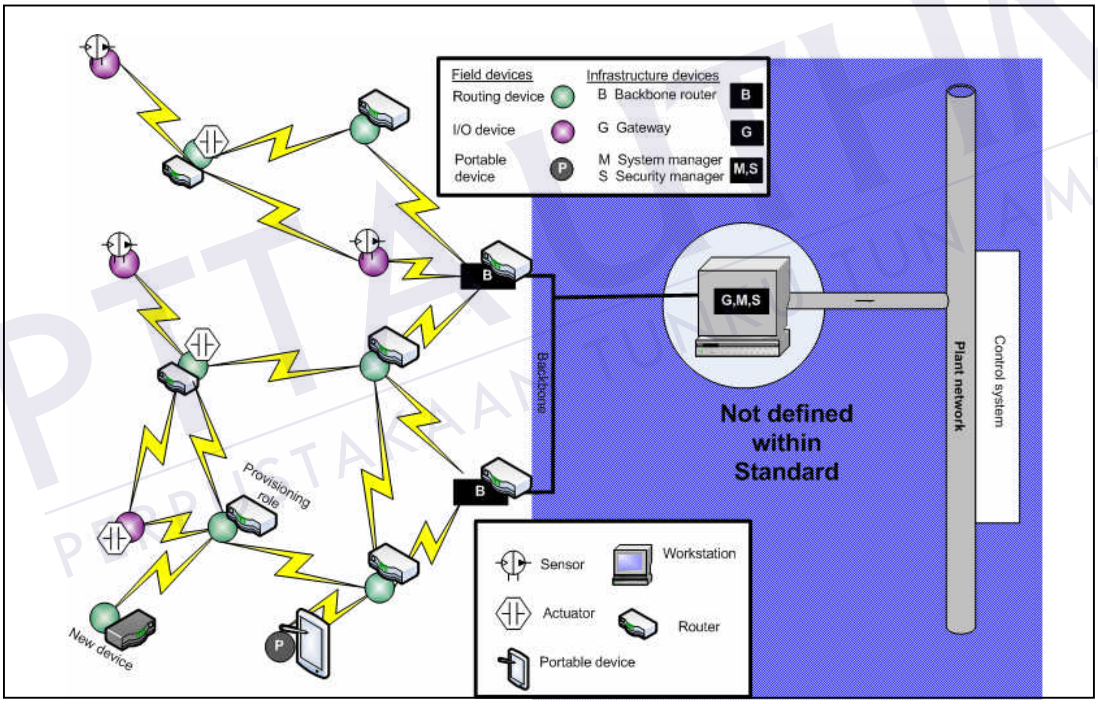

Figure 2.10: Architecture ISA100.11A

ISA100.11a leverages IPv6 protocols and addressing for routing-over. All of the nodes connected within a single star or mesh are collectively called a DL subnet (data link subnet). Until a packet reaches either the destination node within the DL subnet or the border router, it does not get interpreted by the LoWPAN adaptation and IP layers. Messages are forwarded within the DL subnet transparently to the upper layers. As a result, the ISA100.11a data link layer provides an abstraction of a broadcast-type network to the higher layers. The ISA100.11a network support:

- STAR, MESH and Star-Mesh topologies (Note: ISA100.11a is limited in the number of hops that can be supported; backbone routers are always required)
- non-routing sensor nodes
- connection to a plant network via a gateway
- device interoperability
- data integrity, privacy, authenticity, replay and delay protection
- coexistence with other wireless networks
- robustness in the presence of interference

ISA100.11a employs an object-index mechanism for referencing and transferring data. The advantage of this approach is that it is largely self-describing while at the same time is relatively efficient. This same technique has been successfully used by Foundation fieldbus for many years. The packet exchange and byte counts are shown in Figure 2.11.

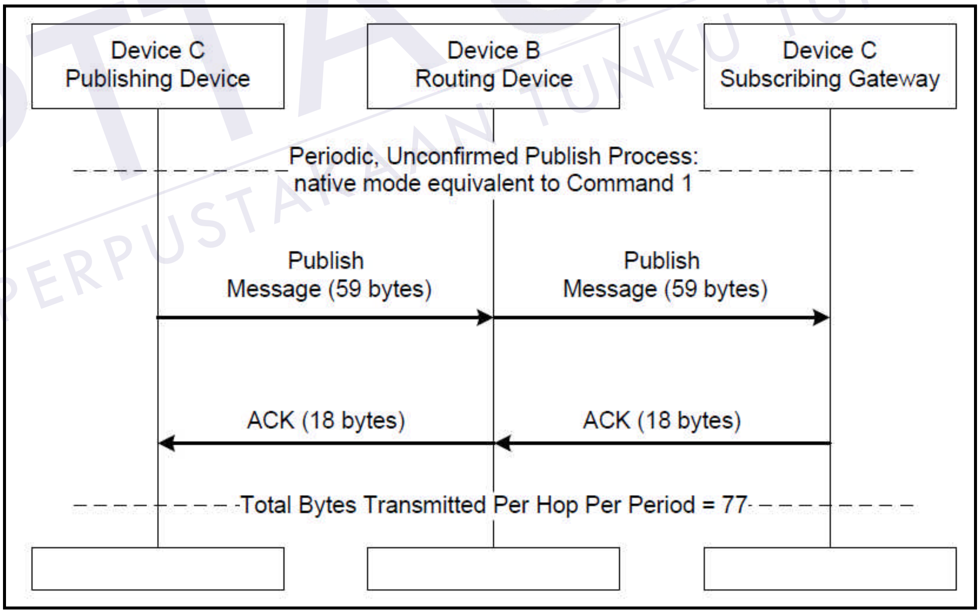

Figure 2.11: ISA100.11a packets

As shown in Figure 2.11, the total size of a packet for communicating a single parameter (equivalent of Command 1) is 59 bytes for the transmit and 17 bytes for the acknowledgement.

2.6.3 Difference WirelessHart and ISA100.11a

The major differences between WirelessHART and ISA100.11a can be directly traced to the differences in the goals of each standard. Whereas WirelessHART is designed to address key end-user concerns, ISA100.11a is designed to provide flexibility. ISA100.11a devices implementing non-compatible options will not interoperate. This flexibility can be a source of confusion for end users. The differences between WirelessHART and ISA100.11a are listed in Table

Table 2.1: Difference between WirelessHart and ISA100.11a

Layer	**IEC 62591 (WirelessHART)**	**ANSI/ISA100.11a**
Physical (PHY)	IEEE 802.15.4 2.4GHz DSSS radio	IEEE 802.15.4 2.4GHz DSSS radio
Media Access Layer (MAC)	Complies with the 802.15.4-2006 MAC and MAC services	Based on a modified, non-ompliant version of the IEEE 802.15.4-2006 MAC
Data Link Layer (DLL)	Time-slotted Channel-hopping Secure acknowledgements Clock propagation Security: hop-by-hop data integrity	Time-slotted Channel-hopping Secure acknowledgements Clock propagation Security: hop-by-hop data integrity and encryption Graph and source routing Joining Options* for: Slow hopping and hybrid slow/fast hopping Dual acknowledgement Configuration based time slot sizes Explicit congestion notification
Network Layer	Graph and source routing. Graph routes include the “1 through n access points,” allowing redundant / multiple connections to the backbone networks. This enables a single network to support very high throughput. Joining Security: end-to-	IETF IPv6 and 6LoWPAN Fragmentation and reassembly at backbone router. Note: If fragmentation and reassembly is used, then graph route must terminate and reassemble messages at a single backbone router, introducing a single point of failure.
Transport Layer	Connectionless service Reliable delivery with an acknowledgement service	Connectionless UDP service Security: end-to-end encryption and data integrity

Table 2.1 (continued)

Layer	IEC 62591 (WirelessHART)	ANSI/ISA100.11a
Device Types and Roles	WirelessHART defines device which includes field device, access point, gateway, network manager, security manager, adapter and handheld	ISA100.11a defines roles which I/O, router, provisioning, backbone router, gateway, system manager, security manager and system time source
Address space	WirelessHART is limited to about 30K devices per WirelessHART network	ISA100.11a uses IPv6 and, as such, has much larger address space.
Redundancy	WirelessHART is a mesh network; by design all paths should be defined to be redundant. At the backbone, multiple access points can be used.	ISA100.11a is defined to optionally support mesh technology. Backbone routers may be designed to support DUO-CAST.
Data-link layer	WirelessHART uses a 10-ms slot time. A single algorithm for channel-hopping is defined. MIC codes are always 4 bytes. Networks are coordinated by their absolute slot time (AST).	ISA100.11a supports a configurable time slot size. 10 is just one slot size that may be supported. The System Manager configures the slot time when a device joins the network. Three channel-hopping sequences and five hopping patterns are defined. The channel hopping patterns are provided to the system manager when the device joins the network. MIC codes may be 4 to 16 bytes. Networks are coordinated by TAI time. ISA100.11a also supports routing at the DLL.
Network Layer	WirelessHART supports routing, joining and encryption/decryption at the network layer.	ISA100.11a supports IETF IPv6 and 6LoWPAN at the network layer.
Backbone routing	WirelessHART does not mandate a backbone technology. HART-Over-IP can be used for the backbone.	ISA100.11a uses IPv6 for the backbone to route packets between subnets
Transport Layer	WirelessHART supports both acknowledged and unacknowledged services. The acknowledged service allows devices to send packets and get a confirmation upon delivery, while the unacknowledged services allows devices to send packets without the requirement of end to-end acknowledgment, thus without any guarantee of successful packet transmission.	ISA100.11a TL provides connectionless services through User Datagram Protocol (UDP) over IPv6 with optional compression as defined by the IETF 6LoWPAN specification. The extension includes better data integrity checks than is available using the UDP checksum and additional authentication and encryption mechanisms. ISA100.11a TL does not support acknowledged transactions.

Table 2.1 (continued)

Layer	**IEC 62591 (WirelessHART)**	**ANSI/ISA100.11a**
Security	WirelessHART supports join keys, network keys and session keys. Session keys are allocated for device-to-device communications. All devices must use a join key. All communications must be encrypted using session keys. Join keys are provisioned using a hand-held device. Symmetric AES-128 keys are supported. Keys may be rotated.	ISA100.11a supports join keys, network keys and ession keys. Session keys are allocated for device-todevice communications. Join keys are optional, as are session keys. Join keys are provisioned using over the air provisioning. Symmetric AES-128 keys are supported. ISA100.11a also optionally defines asymmetric keys for the join process. Keys may be rotated.
Network/System Manager	WirelessHART contains an extensive description and set of commands for the Network Manager.	ISA100.11a contains an extensive description and set of services for the System Manager.
International Standard	IEC 62591-1 as of March 2010 HART7 as of 2007	ANSI/ISA100.11a-2011

2.7 Chapter summary

This chapter had discussed all the concepts that will be used throughout this project. They are include the information on network topology, method configuration and comparison between current wireless topology used in oil and gas industry. The next chapter will explain the methodology of this project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the explanation will be roughly about how to setup the project. It will be start with the approach that will be used. Then followed by development phases, tools and techniques, the topography of a wireless and the way network components are arranged. It describes the physical layout of devices and gateways, as well as the data flow paths between them. Topology STAR will be used in this project to connect with transmitter, gateway and computer. The process flow and design requirement for this project will be explain in this chapter. The constraint on this methodology are that it must support the sub-disciplines of software data management, wireless host system, gateway, wireless device and panel wiring. While the basic device system must support ISA100.11a protocol and configuration setting with star topology.

3.2 Experimental phase

In this experiment I have develop a configuration setting to wireless transmitter so that experiments can be carried out in accordance with the above topology. Field wireless software monitor will show 'received signal strength indication (RSSI) and' packet error rate (PER). This data will affect the response time to be received from each wireless transmitter using STAR topology. FieldMate software will ensure wireless transmitter is configured in advance with accordance to the topology. As a

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