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ALARM INDICATOR ANALYSIS ON CORE SUBSYSTEM FOR ENHANCES RELIABILITY AND AVAILABILITY IN AERONAUTICAL MESSAGE HANDLING SYSTEM

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Abstract

Perum LPPNPI Palembang uses the AMHS Comsoft brand, which has a Core Subsystem (CSS), a module used to connect with external communication partners, handle different protocols, and receive store and forward messages. This research aims to analyze the alarm indicators on CSS A by performing corrective maintenance, which consists of inspection, equipment troubleshooting, and problem-solving. This research uses a descriptive qualitative method by collecting data from observation and document analysis to explore the relationship in each context. The inspection results found a way to restore the alarm using corrective maintenance such as checking the condition or inspecting the equipment, troubleshooting by conducting connectivity checking and performing problem-solving by routing the address. By conducting this research, AMHS equipment can operate using 2 CSS modules (CSS A and CSS B) so that CSS can operate redundantly. One CSS is in operational mode, and the second CSS waits in a hot standby mode, so it impacts optimal performance, reduces downtime, and enhances operational reliability and availability for aviation communication systems to enhance aviation safety standards.

Keywords: *analysis, core subsystem, reliability, availability, amhs*

Introduction

In aviation, well communication is crucial in ensuring safety and operational efficiency. Effective communication between pilots, air traffic controllers, and ground telecommunication personnel is essential for exchanging information accurately and promptly to ensure smooth traffic flow and flight safety (Kim, 2023; Schnell et al., 2014). Various advanced equipment and technologies are continually developed and implemented to meet this critical communication need.

Aeronautical communication services are provided by dedicated and secure infrastructures to meet high aviation safety requirements (Zeng et al., 2019). Flight communication equipment encompasses not only conventional radio communication but also satellite technology, air navigation systems, and complex data communication networks. Each piece of equipment has specific functions and roles in supporting communication throughout various flight phases, from pre-departure preparation to landing.

One commonly used piece of aeronautical communication equipment for receiving, processing, and distributing flight news is the Aeronautical Message Handling System (AMHS). AMHS is a computer system that manages the distribution of flight messages, operating on a store and forward basis. The function of AMHS is to receive, process, distribute, and respond to flight messages. The Aeronautical Message Handling System (AMHS) is a critical aviation communication tool used for receiving, processing, and distributing flight-related messages. In Perum LPPNPI Palembang, the AMHS system utilized is the Comsoft brand. A key component of this system is the Core Subsystem (CSS), responsible for connecting with external communication partners, handling different communication protocols, and managing the receipt, storage, and forwarding of messages. Messages received by AMHS are stored and then distributed according to the Aeronautical Fixed Telecommunication Network (AFTN) format. AMHS is combined with AFTN Teleprinter to create and display messages (Fatonah et al., 2020).

AFTN is a data communication network for aviation that connects airports worldwide and is used to transmit flight schedules, weather data, and other flight-related news using VSAT and AMHS facilities (Vandosyen & Hariyanto, 2023). This network has the same characteristics and compatibility, enabling efficient exchange of information between them. The AFTN addressing route or flight information region (FIR) (Naufal et al., 2023) in Indonesia is divided into two major regions: Jakarta Air Traffic Service Center (JATSC) (Imandoko et al., 2023) and Makassar Air Traffic Service Center (MATSC) (Tridiandini et al., 2022). The Jakarta region is connected to the international network, covering the western part of Indonesia. The Makassar region covers the eastern part of Indonesia. The AFTN network system in Indonesia can be seen in Figure 1.

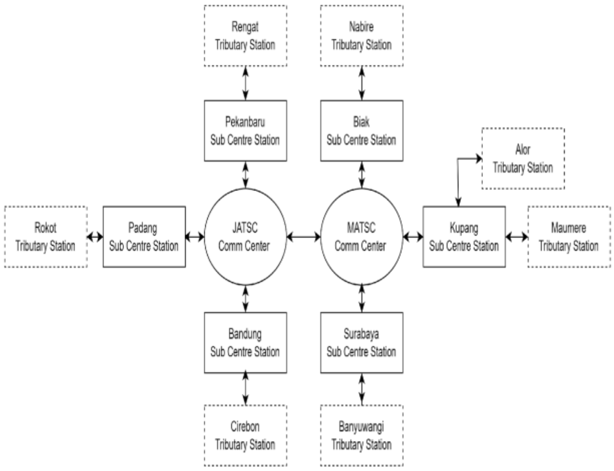

Figure 1. AFTN Network System in Indonesia

The AFTN network in Indonesia is divided into three types: 1) Communication Centre (CC) is a station in the AFTN network that serves to relay or retransmit news transmissions from or to several other stations directly connected to the communication center, 2) Sub-center Station (SCS) is a station in the AFTN network that serves to relay or retransmit news transmissions from or to some other stations that are directly related to the Sub Center Station, and 3) Tributary Station (TS) is a station in the AFTN network that receives or sends news but cannot relay message.

The AFTN message format consists of: 1) heading (start of message, circuit identification, channel sequence number, and time of transmission), 2) address (address indicator and priority indicator, 3) origin (origin indicator and filling time), 4) text/message content, and 5) ending. The layout of the AFTN message format is shown in Figure 2.

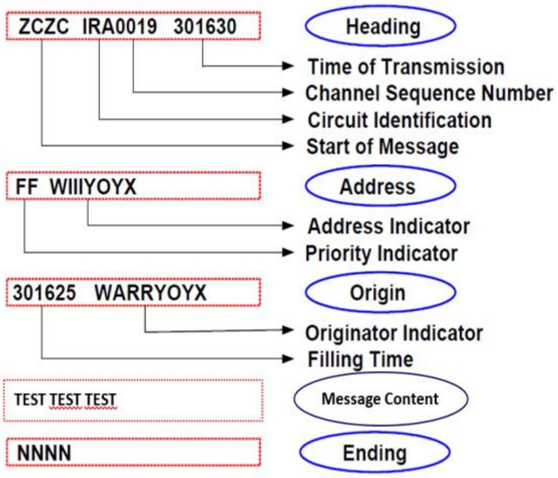

Figure 2. AFTN Message Format

In recent times, there has been an increase in the frequency of alarm indicators on CSS A AMHS server 1, indicating operational issues requiring immediate attention. One prominent issue is the occurrence of congested messages and locks on the AFTN server. These locked messages can cause delays in delivering crucial information, negatively impacting flight safety and operational efficiency.

This research aims to analyze the alarm indicators on CSS A by performing corrective maintenance (Fatonah et al., 2023) which consists of inspection, equipment troubleshooting, and providing problems. This is done based on the Directorate General of Civil Aviation Regulation Number: KP 35 of 2019 regarding the Technical Operational Guidelines for Civil Aviation Safety Regulations Article 11, which states that corrective maintenance activities aim to restore facilities experiencing disturbances or damage to normal conditions, including fault analysis, module replacement, module repair, facility modification, reconditioning or overhaul, and alignment.

Reliability (Zarei et al., 2021) refers to the ability of aviation communication equipment to perform consistently without failure over a specified time under normal operating conditions. Preventive maintenance involves scheduled inspections, servicing, and repairs aimed at preventing equipment failures and ensuring continuous operation. In aviation communication systems, preventive maintenance is critical to maintaining high availability (Melo et al., 2020) and reliability (Mohammed et al., 2020). Implementing a comprehensive preventive maintenance program is essential for aviation communication systems, ensuring their optimal performance, reliability, and long-term serviceability.

In other research, Analysis of Corrective Maintenance Monitors CCA Tool Doppler VHF Omni-Directional Range (DVOR) Selex Type-1150A (Abrar et al., 2024), aimed to analyze the care and maintenance system for DVOR and identify several potential problems that have arisen during the operation of DVOR equipment at Perum LPPNPI Pekanbaru. This research evaluated Corrective Maintenance Monitor (CMM) analysis on DVOR Selex Type-1150A equipment at Perum LPPNPI Pekanbaru. The method used in the research is procedural analysis of equipment maintenance and performance analysis to improve maintenance efficiency. The research adopted a qualitative research method with a descriptive approach because the data collected is textual. This research method involved CMM system inspection, equipment maintenance analysis, and interviews with engineering. The research results provide insights for improving corrective maintenance procedures and increasing the availability and reliability of the DVOR system.

This research impacts to aviation communication systems, availability and reliability of critical performance metrics that ensure continuous and accurate communication between aircraft and ground control, supporting flight safety and operational efficiency. Availability refers to the readiness of aviation communication equipment to perform its intended function when required.

Methods

This research uses a descriptive qualitative method (Atmaja et al., 2024) by collecting data from observation and documents. The research focuses on gaining an in-depth understanding of a phenomenon or issue (Fadli, 2021; Stewart, 2022) and describing an event in AMHS (Gupta et al., 2023). The descriptive qualitative research method is used as an approach to understand and describe phenomena in how to overcome the alarm indicator in CSS AMHS (Grecu, 2023) to explore the meanings, patterns, and relationships that arise in a particular context (Amelia et al., 2023; Farid et al., 2023). The data obtained is processed and analyzed narratively without using statistical analysis so that the research results emphasize a deep understanding.

This research was conducted to overcome the causes of the alarm indicators on CSS A AMHS server one at the Perum LPPNPI Palembang. After identifying the causes, the researcher took several steps to repair the equipment, as shown in Figure 3.

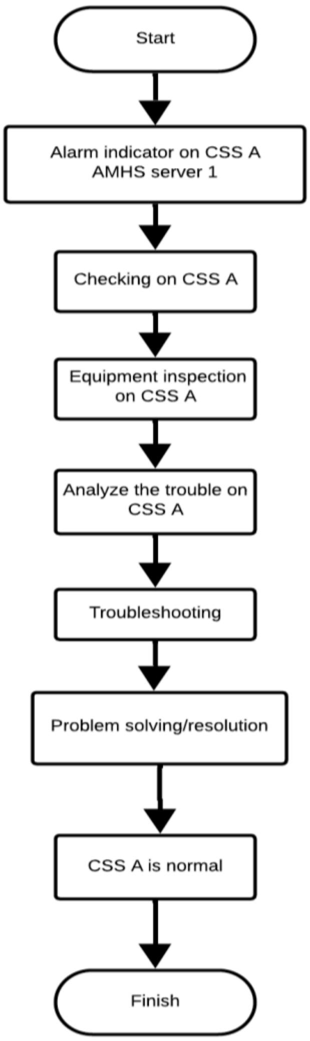

Figure 3. Research Flowchart

The research taken are as follows: 1) Equipment inspection to ensure that the equipment is in good condition (Chen et al., 2020) and free from damage; 2) Troubleshooting equipment damage to identify which part is damaged and the cause of the damage, then 3) Problem resolution by replacing or repairing the damaged part.

Results And Discussions

Based on inspection, the Indonesian Aviation Navigation Service Provider Palembang (Perum LLPNPI) of Palembang, use Comsoft CADAS PB made in Germany. This device uses an IP address system, allowing access from the internet. The components of Comsoft CADAS include: 1) One server unit consisting of main and standby; this server displays incoming and rejected messages, and 2) Clients that function as operators in the BO unit, Tower, APP, Com-Cent, R-Dara, meteo, and PIA units. The Comsoft flight data access system is a web-based flight information and messaging system. This system includes various flight applications and services that can be customized to users' needs. Comsoft provides two products for AFTN/AMHS. The major components of the Comsoft brand AMHS using Internal/External Local Area Network (ILAN/ELAN) are shown in Figure 4.

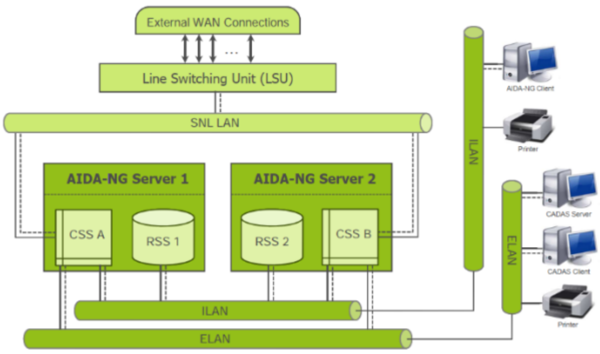

Figure 4. Major Components of AMHS Comsoft Block Diagram

The Internal/External LAN (ILAN/ELAN) major components of AMHS are external wide area network (WAN) connections, Line Switching Unit (LSU), Serial Network Link (SNL) local area network (LAN), Aeronautical Integrated Data Exchange Agent-Next Generation (AIDA-NG) server, Internal/External LAN (ILAN/ELAN), client. IADA-NG server consists of a Core Subsystem (CSS) and a Recording Subsystem

(RSS). There are two AIDA-NG servers, server one and server 2. AIDA-NG server 1 consists of CSS A and RSS 1, while AIDA-NG server 2 consists of RSS 2 and CSS B. ILAN connects the AIDA-NG server with the AIDA-NG client and printer, while ELAN connects CSS A and CSS B with the CADAS server, CADAS client, and printer.

The main components of AMHS Comsoft consist of a Core Subsystem (CSS), a Redundant Communication System (RCS), and a Central Monitoring Controller (CMC). CSS is the core system routing incoming flight messages/data to the server. CSS also receives stores, and forwards messages. Under normal conditions, CSS operates with two identical core subsystems (CSS A/B). CSS A is in operational mode, while CSS B is in hot standby mode (Saini et al., 2022). In situations or conditions of trouble, CSS will switch automatically (Yong et al., 2021). All WAN serial interfaces (Zhang et al., 2021) are mechanically switched between the two CSS units via the LSU with CMC. The CSS server interface can be seen in Figure 5.

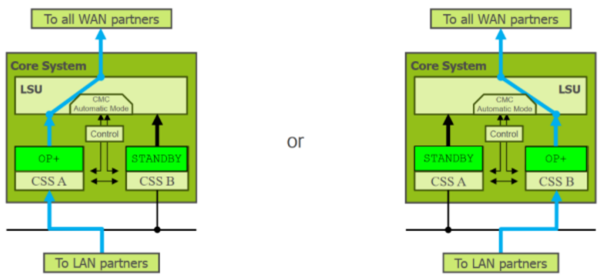

Figure 5. CSS Server Interface

The Redundant Communication System (RCS) is a part of the core system that ensures the availability of flight data communication services. RCS connects CSS to the Line Switching Unit (LSU) through the SNL network switch. LSU and CMC are responsible for routing all serial interfaces to the operational CSS. SNL is an autonomous Input/Output module that relieves the core CPU from handling low-level protocol. An overview of the RCS rack can be seen in Figure 6 below.

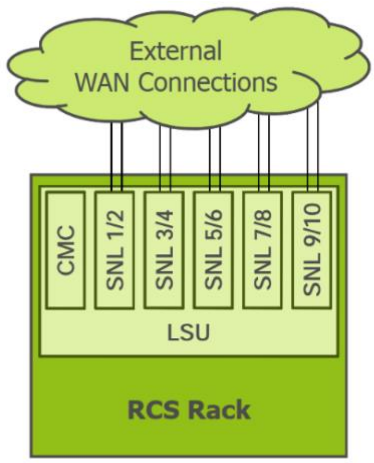

Figure 6. RCS Rack

In the redundant system, CMC is a status monitoring unit for functional units A and B, system Power Supply Units in the rack, switching status, system environment, and RCS. It manages automatic/manual operation mode settings with CMC switching when the operational unit fails and the standby unit is activated. In case of problems or issues, the CSS will automatically switch (Gyongyosi & Imre, 2020). All WAN serial interfaces (Zhang et al., 2021) are mechanically redirected between two CSS units via the LSU with CMC.

On November 17, 2022, at 08:30 AM local time, the technician got the report from EREP that AMHS server 1 was alarmed and marked by the congested message indicator piling up to around 19,000 messages. This finding was reported and recorded in the digital logbook or EREP. Following this, the researcher conducted an inspection regarding the cause of the equipment damage.

After receiving reports of AMHS getting in trouble, the researcher immediately conducted a physical inspection of the AMHS server. The inspection began with observing the indicators on the equipment. Technicians found alarm indicators on CSS A and piled-up messages were causing the server to go down. This caused AMHS server 1 to be down and server 2 took over temporary operations so it means the AMHS operated in single mode operation. The occurrence of alarm display on server 1 of the AMHS equipment can be seen in Figure 7.

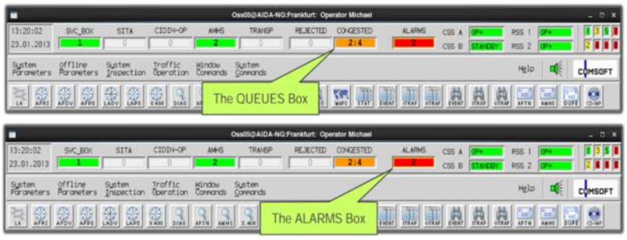

Figure 7. Display Alarm AMHS

Figure 7 shows the alarm indicator on AMHS server 1. This was caused by congested messages that occur when processed messages exceed the system's capacity, causing a build-up (queue) that interferes with sending and receiving messages. The results of the inspection stated that the causes of the congested message include network failure (Gyongyosi & Imre, 2020), incorrect configuration such as improper routing address or protocol configuration (Bhosale & Patil, 2023), and software or hardware failure (Wang et al., 2019). In this case, this research will perform troubleshooting by checking the hardware and software as well as the network configuration. Subsequently, the researcher checked the hardware by conducting a connectivity check on AMHS server 1. The results of the cable connection test using an avometer can be seen in Table 1.

Table 1. Data of AMHS Server 1 Connection Examination

No.	Inspection	Media	Result
1.	Equipment supply testing	Avometer	Normal 221 Volt AC
2.	Server 1 cable to CMC module	Avometer	Connected
3.	SNL 1 module with SNL 1 switch on RCS rack	Network Ping	Connected
4.	Server 2 cable to CMC module	Avometer	Connected
5.	SNL 2 module with SNL 2switch on RCS rack	Network Ping	Connected

The results showed that there were no issues with the modules and cabling of the AMHS server 1. Then, the researcher proceeded to plug and unplug all SNL AMHS server 1 modules and cleaned the modules with a contact cleaner. Following this, the researcher reinstalled all the cleaned modules and restarted the AMHS server 1. The result showed that the CSS A AMHS server 1 no longer had an alarm, but there were locked, congested messages.

By identifying the root cause, the problem-solving is to reset the routing from address WIPPAWOS to WIPPYFYX by selecting the system parameter menu, then selecting routing, selecting the AFTN menu, and selecting routing indicator parameters. After resetting the routing, we observed the system for 60 minutes and found no increase in the message queue, but there were still locked messages that could not be deleted. Therefore, we discarded the messages by changing the message profile type to Prot System_Profile. The message status will change to queued, allowing them to be deleted. Once the congested messages are deleted, the CSS AMHS server A returns to normal.

Based on the result, we can conclude that the problem is caused by the improper routing address, so it is necessary to find a correct routing path since routing is an important challenge for the network. This is similar to the research result by (Ryu & Kim, 2023). This is important since reliability impacts the entire lifetime of the equipment as said in (Zio et al., 2019) as we know that aviation systems conduct critical operation conditions (Zhou et al., 2023), high-standard reliability demands (Glowacki et al., 2020), and high-cost through-life maintenance services are the most important in preventive maintenance (Alomar & Jackiva, 2023; Schreiber et al., 2023; Xiong & Wang, 2022). By conducting inspection, troubleshooting, and problem-solving means we maintain availability and reliability and support safety standard in aviation communication systems (Abrar et al., 2024), especially in AMHS.

Conclusion

The inspection and troubleshooting process conducted at Perum LPPNPI Palembang demonstrated the effectiveness of structured problem-solving approaches for AMHS system maintenance. The root cause of the server failure was identified as message congestion on CSS A, triggered by accumulated messages due to system processing delays. A comprehensive inspection, including hardware and software diagnostics, confirmed that physical components and cable connections function normally. Corrective actions involved resetting routing parameters, clearing congested messages, and restarting system modules. This process successfully restored normal operations on AMHS Server 1. The research underscores the importance of proactive system monitoring, routine maintenance, and immediate corrective actions when alarms occur. This research implies to availability of AMHS, which now can operate using 2 CSS modules (CSS A and CSS B) so that CSS can operate redundantly, one CSS is in operational mode, and the second CSS waits in a hot standby mode so it ensures optimal performance, reduces downtime, and enhances operational reliability for aviation communication systems.

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