Journal of Public Transportation Community
Vol.6 No. 2, October 2026, pp. 120-130
Online: https://ejournal.poltekbangsby.ac.id/index.php/jptc/about
e-ISSN :2808-3393

Handling Of A Hard Disk Failure On Radio Control Monitoring System (RCMS) A Of A Voice Communication Control System (VCCS) At An Air Navigation Service Provider Branch

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Abstract

The Voice Communication Control System (VCCS) integrates VHF Ground-to-Air radio and Direct Speech communication for Air Traffic Controllers through a Voice Communication Unit (VCU), whose configuration and database are managed by a Radio Control Monitoring System (RCMS). At a branch of Indonesia's air navigation service provider, the VCCS uses two redundant RCMS units: RCMS A (Main) and RCMS B (Standby). RCMS A once exhibited a loudly running cooling fan and a blue-screen display, attributed to a hard disk failure that rendered the configuration data unreadable. This article documents the handling process; the root cause of the disk failure was not established. A descriptive case study was conducted through direct observation and fault tracing on the RCMS A hardware. As a temporary solution, RCMS application data were copied from RCMS B to a laptop via a LAN cross cable to maintain VCCS service while a new hard disk was procured. The hard disk was then replaced, the BIOS boot device priority reconfigured, and RCMS A reinstalled with its IP address reconfigured, restoring normal operation. This single case suggests the value of RCMS redundancy for ATC communication continuity and of preventive maintenance for early detection of hard disk failure.

Keywords: VCCS, RCMS, hard disk failure, system redundancy, ATC communication

Article History:
Received: 27 June 2026 ; Reviewed : 12 July 2026; Accepted: 7 August 2026; Published : 1 October 2026
DOI: 10.46491/jptc.v6i2.2856

How to cite : Wildan, M., Yudha, R. P. S., & Saidala, R. K. (2026). Handling of a Hard Disk Failure on Radio Control Monitoring System (RCMS) A of a Voice Communication Control System (VCCS) at an Air Navigation Service Provider Branch. ***Journal of Public Transportation Community*****, 6(2), 120–130.**
https://doi.org/10.46491/jptc.v6i2.2856

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Introduction

Air transportation plays a vital role for Indonesia as an archipelagic nation, so flight safety and orderliness depend heavily on the readiness of the air navigation facilities managed by Indonesia's air navigation service provider. One of the communication facilities that forms the backbone of interaction between

Air Traffic Controllers (ATC) and pilots is the Voice Communication Control System (VCCS), a system that integrates VHF Ground-to-Air radio and Direct Speech communication through a Voice Communication Unit (VCU) at every ATC working position, such as Aerodrome Control (ADC) and Approach Control (APP). Modern voice communication systems for ATC are increasingly moving toward IP-based voice transport, which offers greater flexibility than conventional circuit-switched systems but also imposes strict requirements on delay and reliability (Borković et al., 2006; Haindl, 2009).

The configuration and database of the VCCS are managed by a Radio Control Monitoring System (RCMS), a server computer that stores all frequency settings, communication channels, and VCU operational parameters. Because the role of the RCMS is highly critical to the continuity of ATC communication service, a hardware failure on the RCMS has the potential to disrupt air traffic service operations if not supported by an adequate redundancy architecture. In critical communication systems of this kind, the application of cross-domain redundancy management with dual priority has proven effective in maintaining communication-service resiliency without sacrificing operational continuity, as shown in a study that specifically uses an air traffic control system as a case study for the application of such a redundancy algorithm (Kabashkin, 2024). The reliability of voice communication channels on the ground segment of an embedded-cloud-technology-based air traffic management system has also been analyzed mathematically through channel reliability modeling, which underscores the importance of a redundant architecture for critical communication systems such as the VCCS (Kabashkin, 2016). In ATC practice, ground-to-air voice service is generally supported by main and standby equipment, so the availability of the communication network depends strongly on its redundancy design (Kabashkin & Philippov, 2020). Availability and reliability are core attributes of dependable systems, in which fault tolerance is typically achieved through redundancy (Avižienis et al., 2004).

Beyond the aspect of system redundancy, failure of a data storage medium such as a hard disk is one of the common causes of disturbances in server-computer-based equipment, so early detection of hard-disk-failure indications through operational-parameter monitoring is an important part of a preventive-maintenance strategy to prevent data loss and service downtime (Shen et al., 2018). Field studies of large disk populations show that actual annual disk replacement rates typically exceed those implied by datasheet MTTF values and tend to increase with age (Schroeder & Gibson, 2007), while SMART-based warning methods have long been developed to improve the detection of impending disk failures (Hughes et al., 2002). The availability of large volumes of Self-Monitoring, Analysis, and Reporting Technology (SMART) parameter data from enterprise environments also supports the development of more

accurate hard-disk-failure prediction models, so early indications such as performance anomalies or mechanical noise can be acted upon before total failure occurs (Wei et al., 2025).

At the Aviation Communication Engineering Unit of a branch of the service provider, the VCCS is configured with two RCMS units working redundantly, namely RCMS A in the Main condition and RCMS B in Standby. At one point, RCMS A experienced a disturbance in the form of a loudly running server cooling fan accompanied by a blue-screen display, which upon investigation was found to be caused by a failure of the RCMS A CPU's hard disk, requiring immediate handling so that ATC communication service could continue without significant disruption. Unawareness of or slowness in responding to early indications of hardware failure is one of the human-error factors that can increase the risk of service disruption (Olaganathan, 2024), making technicians' competence in recognizing early symptoms of failure and performing systematic troubleshooting critically important (Lubis, 2021; Darni et al., 2025).

This article aims to (1) analyze the cause of the hard disk failure on the VCCS's RCMS A, (2) document the handling steps taken until RCMS A returned to normal operation, and (3) review the role of the RCMS A and RCMS B redundancy architecture in maintaining the continuity of ATC communication service, so that it may serve as a technical reference for other Aviation Communication units facing similar cases.

Research Method

This study uses a descriptive qualitative method with a case study approach, as put forward by Baxter and Jack (2008) and Crowe et al. (2011), which is suitable for systematically describing the process of identifying and analyzing a technical problem in a single unit of study based on field data, without aiming for statistical generalization.

Data were collected directly at the work site, at the Aviation Communication Engineering Unit of the service provider's branch, during the period of 4 April 2022-31 August 2022. The object of this study is the Radio Control Monitoring System (RCMS) A device within the VCCS configuration, based on the condition that RCMS A experienced a loud server-fan disturbance accompanied by a blue-screen display on 6 July 2022 while in the Main condition.

The tools and references used in the analysis process included: the RCMS A CPU monitor to observe the system display; a LAN cross cable and a laptop running Windows 10 as a temporary-solution medium; a hard disk component and new SATA cable as replacement parts; AMI BIOS settings on the RCMS A CPU for boot device priority configuration; and Transmission Control

Protocol/Internet Protocol version 4 (TCP/IPv4) settings in the Windows operating system for reconfiguring the RCMS IP address.

The analysis stages carried out were as follows: (1) identifying an early indication of disturbance in the form of loud server-fan noise on RCMS A while in the Main condition; (2) checking the RCMS A CPU monitor and finding a blue-screen display as an indication of hard disk failure; (3) restarting the RCMS A CPU to confirm whether the disturbance was temporary; (4) applying a temporary solution in the form of copying RCMS application data from RCMS B to a laptop via LAN cross cable to keep VCCS service running; (5) procuring and replacing the hard disk together with a new SATA cable on the RCMS A CPU; (6) configuring the boot device priority in the AMI BIOS if the new hard disk was not yet detected; and (7) reinstalling the RCMS A CPU in the rack together with reconfiguring the IP address, followed by verifying the function of the RCMS A application.

Results and Discussion

Object Profile and Scope of the Study

The object of this study is the Radio Control Monitoring System (RCMS) A within the Voice Communication Control System (VCCS) configuration, Aviation Communication Engineering Unit, the service provider's branch, which supports air-to-ground communication at the Aerodrome Control (ADC) and Approach Control (APP) working positions at the airport. The VCCS in this unit is configured with two redundant RCMS units, namely RCMS A in the Main condition and RCMS B in Standby, so that if one unit experiences a disturbance, the other unit can take over its role to maintain the continuity of communication service.

VCCS Working Principle and the Role of the RCMS

The VCCS works by integrating all VHF Ground-to-Air and Direct Speech radio communication channels into a single working interface through the Voice Communication Unit (VCU), allowing an Air Traffic Controller to select and operate the required communication channel efficiently from a single working position. All frequency, channel, and VCU operational-parameter configurations are stored and controlled by the RCMS, a server computer that functions as the system's central database and configuration interface. Because the role of the RCMS is critical to the continuity of communication service, applying a redundancy architecture with dual priority between the Main and Standby units is an important strategy for maintaining the resiliency of a critical communication system, as shown in a study of a cross-domain redundancy management

algorithm that explicitly uses an air traffic control system as a case study of its application (Kabashkin, 2024).

Problem Identification

On 6 July 2022, during a daily equipment check, it was found that the cooling fan on the RCMS A server was running louder than normal while RCMS A was in the Main condition. Further checking on the RCMS A CPU monitor showed a blue-screen display, which upon investigation was interpreted as an indication of failure in the RCMS A CPU's hard disk, causing the VCCS configuration data to become unreadable by the system. The relationship between the fan noise and the disk failure is not established here, since the noise may also reflect a separate thermal or cooling problem, and disk error messages, SMART logs, disk age, and the cause of the failure are not documented.

Handling and Verification Stages

Handling was carried out in stages to ensure that VCCS service continued to run during the RCMS A repair process. Table 1 presents a summary of the handling stages together with the results at each stage.

Table 1 Hard Disk Failure Handling Stages on RCMS A VCCS

No.	Handling Stage	Result / Action
1	Identifying the early indication: RCMS A server fan running loudly while in the Main condition	RCMS A CPU monitor checked
2	Checking the RCMS A CPU monitor	Blue-screen display found, indicating hard disk failure
3	Restarting the RCMS A CPU	Fan returns to normal, but RCMS A data remains unreadable
4	Temporary solution: copying RCMS application data from RCMS B to a laptop via LAN cross cable	VCCS service continues to run via RCMS B and the laptop while awaiting the new hard disk
5	Procuring and installing a new hard disk together with a new SATA cable	RCMS A CPU cleaned and fitted with new components
6	Checking new-hard-disk detection in the BIOS	Hard disk not yet detected by the system
7	Configuring boot device priority in the AMI BIOS	New hard disk detected and usable
8	Reinstalling the RCMS A CPU in the rack and reconfiguring the IP address	RCMS A application operating normally again

Table 1 shows that handling was carried out through two main stages: a temporary solution in the form of copying RCMS application data from RCMS B to a laptop to maintain the continuity of VCCS service while awaiting procurement of a new hard disk, and a permanent solution in the form of replacing the hard disk together with reconfiguring the BIOS and IP address on RCMS A. The BIOS configuration step was needed because the new hard disk was initially not detected by the system. This staged approach illustrates the value of acting on early symptoms such as abnormal fan noise, although the link

between this symptom and the disk failure was not established in this case; early detection of hard-disk-failure indications is a recognized part of a preventive-maintenance strategy (Shen et al., 2018).

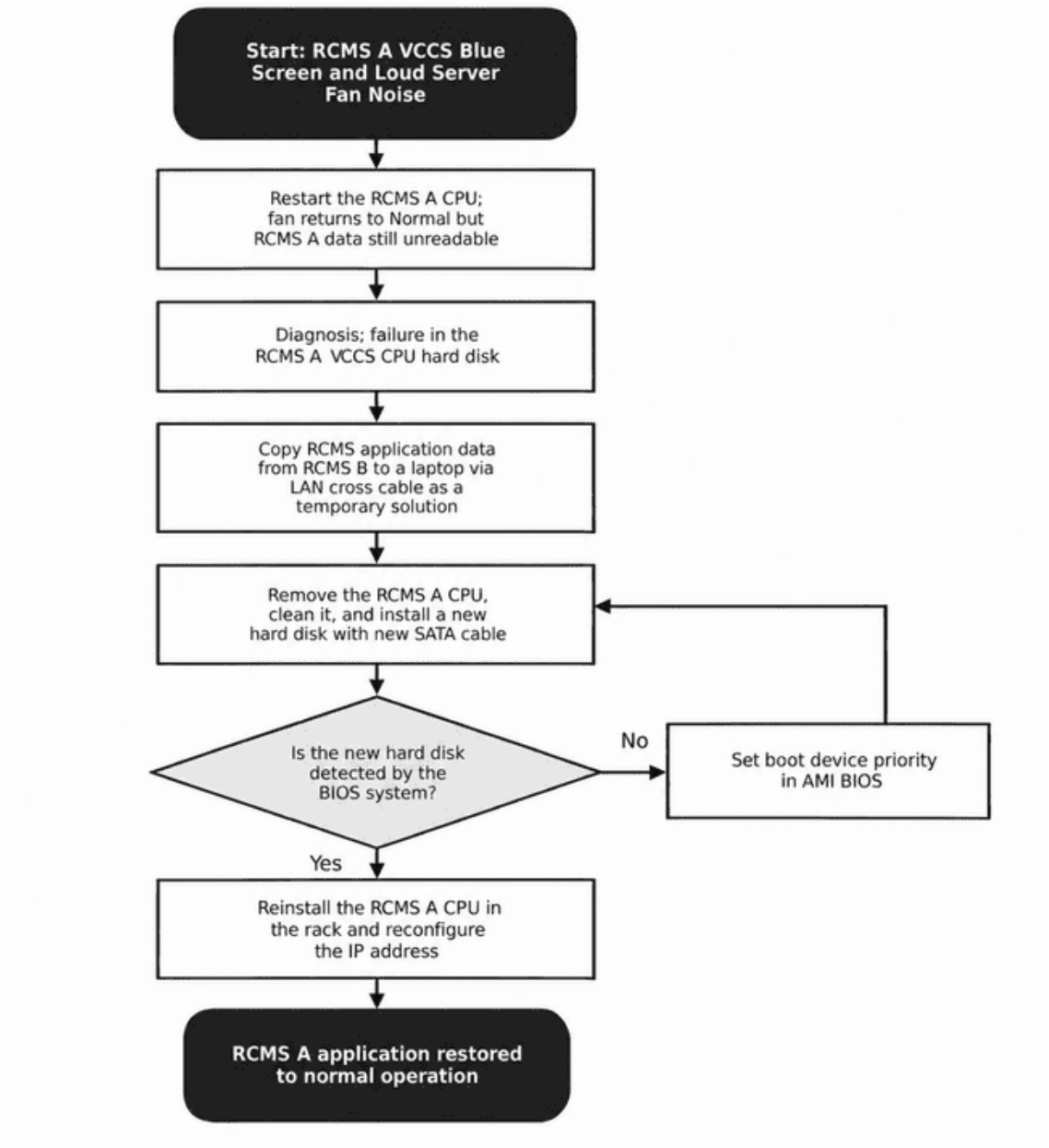

Figure 1 Flowchart of the RCMS A VCCS Hard Disk Failure Handling Process at the service provider's branch (Source: Authors' analysis of the 2022 case records)

Figure 1 presents a flowchart of the handling process carried out, starting from restarting the RCMS A CPU, diagnosing the hard disk failure, temporarily copying data from RCMS B to a laptop, replacing the hard disk, the decision regarding new-hard-disk detection in the BIOS, through to reinstalling and reconfiguring RCMS A until the application operates normally.

System Redundancy and ATC Communication Reliability

The success in maintaining the continuity of VCCS service while RCMS A was under repair cannot be separated from the role of the RCMS A and RCMS B redundancy architecture. Table 2 summarizes a comparison of the two RCMS units' roles during the disturbance.

Table 2 Comparison of RCMS A and RCMS B Roles During the Disturbance

Aspect	RCMS A (Main Condition)	RCMS B (Standby Condition)
Function	Controls VCU configuration and stores the communication system's active database	Redundant backup capable of taking over RCMS A's role if a disturbance occurs
Status during the disturbance	Experienced a hard disk failure, so configuration data could not be read	Continued functioning normally as the backup data source
Role in recovery	Repaired through hard disk replacement and BIOS/IP address reconfiguration	Data was temporarily copied to a laptop to maintain the continuity of VCCS service

Table 2 shows that although RCMS A experienced a hard disk failure, ATC communication service could still be maintained because RCMS B continued to function normally as the backup data source, whose data was then temporarily copied to a laptop. This handling pattern is consistent with the principle of cross-domain redundancy management in a dual-priority critical communication system, in which the backup unit can be activated quickly to maintain service continuity without having to wait for permanent repair of the main unit to be completed first (Kabashkin, 2024). The Main-and-Standby configuration pattern of RCMS A and RCMS B is conceptually a simple form of a k-out-of-n redundant system with a warm-standby component, whose reliability and availability models have been widely studied to optimize maintenance and recovery strategies for communication systems with similar backup mechanisms (Hsieh et al., 2026). This principle may be relevant for other RCMS equipment within the service provider's environment to minimize the risk of ATC communication-service disruption due to a single hardware failure.

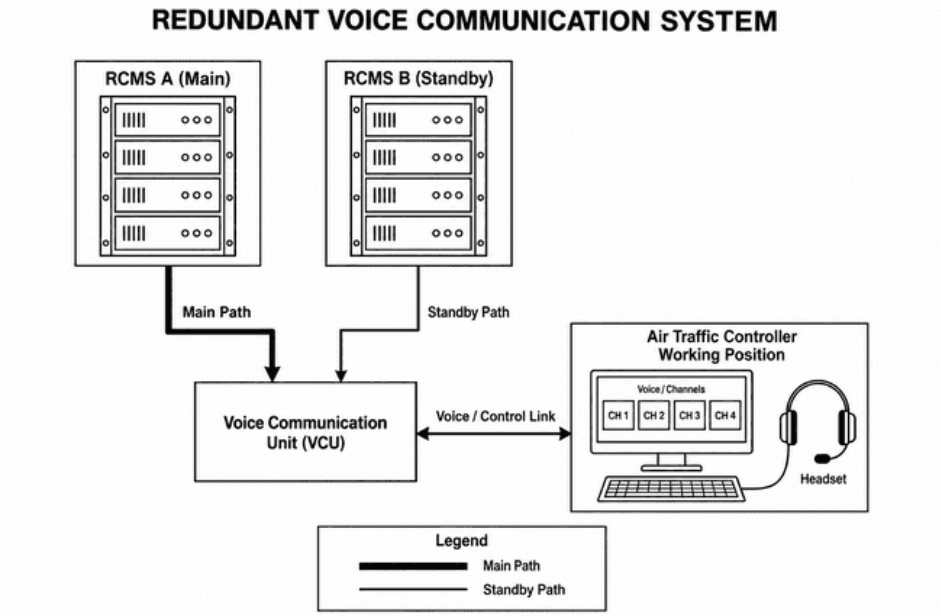

Figure 2 Conceptual Illustration of the VCCS RCMS A and RCMS B Redundancy Architecture in the ATC Communication System (Source: Authors' conceptual illustration)

Figure 2 presents a conceptual illustration of the redundancy architecture between RCMS A and RCMS B within the VCCS system, depicting the relationship between the two RCMS units and the Voice Communication Unit (VCU) and the Air Traffic Controller working position, as a visual complement to the explanation of the system's working principle and redundancy described in the previous section.

Importance of Technician Competence and Preventive Maintenance

This case study confirms that early detection of initial symptoms of hardware failure, such as abnormal server-fan noise, is an important step in preventive maintenance to prevent a more significant ATC communication-service disturbance. Slowness or unawareness on the part of technicians in recognizing early symptoms of hardware failure is one of the human-error factors that can increase the risk of service disruption (Latorella & Prabhu, 2000; Olaganathan, 2024). Technicians' competence in systematically troubleshooting RCMS equipment is also shaped through direct involvement in handling problems in the field, which has been shown to contribute to the work readiness of aviation vocational technicians (Lubis, 2021) and to the alignment of technical understanding with industry work systems (Darni et al., 2025). Applying an optimal preventive-maintenance schedule also contributes to reducing unexpected downtime while sustainably improving the operational reliability of server-computer equipment (Al-Duais et al., 2022), while a historical review of preventive and corrective maintenance models for complex systems confirms that scheduled maintenance strategies remain relevant to apply even though routine inspection does not always yield perfect results (Ulansky & Raza, 2024).

In addition, condition-based maintenance, which acts on monitored indicators of equipment condition rather than fixed time intervals alone, can complement time-based schedules for detecting degradation before failure (Jardine et al., 2006; Ahmad & Kamaruddin, 2012).

Discussion

This case suggests that a hardware failure on a single RCMS unit does not necessarily disrupt ATC communication service as a whole, so long as the redundancy architecture between RCMS A and RCMS B can be utilized quickly and appropriately through a suitable temporary solution. The staged approach, from early detection of failure symptoms and a redundancy-based temporary solution through to permanent repair by component replacement, appeared effective in maintaining the continuity of VCCS service in this case and may serve as a reference pattern for similar RCMS hardware failures at other Aviation Communication units. Early detection, system redundancy, and technician competence together appear to be the main supports for the reliability of aviation communication service in this case. Measures suggested for further evaluation, but not tested in this study, include SMART-based monitoring of disk health, scheduled configuration backups of RCMS A and RCMS B, and periodic restoration tests.

Limitations. This is a single case, and its data date from 2022 (4 April–31 August 2022), so the findings cannot be generalized. The root cause of the disk failure was not analysed because disk age, error messages, and SMART logs are not documented, and the link between the loud fan and the disk failure is not established. The records do not specify how the laptop supported VCCS service, whether RCMS B took over automatically or manually, the operational risk and approval procedure for the temporary solution, the duration of RCMS A downtime, the hard disk procurement time, or the effect on ATC communication. The recovery method (restoration from a backup or fresh installation) and the post-recovery tests, such as synchronization with RCMS B and VCU function, are likewise not documented beyond the application operating normally again.

Conclusion

The disturbance on RCMS A of the VCCS, in the form of a loud server fan accompanied by a blue-screen display, was attributed to a failure of the RCMS A CPU's hard disk that left the configuration data unreadable; the underlying cause of the disk failure was not established. Handling proceeded in stages: a temporary solution of copying RCMS application data from RCMS B to a laptop via a LAN cross cable, followed by a permanent solution of hard disk replacement, boot device priority configuration in the BIOS, and reinstallation and IP address reconfiguration of RCMS A. This restored the RCMS A application to normal operation without a documented disruption to ATC

communication service, although the downtime and service impact were not recorded. The case suggests that the RCMS A and RCMS B redundancy architecture, early attention to failure symptoms, and technician competence in systematic troubleshooting support the reliability of aviation communication service, and monitoring of disk health and scheduled backups are suggested for further evaluation.

Acknowledgements

The author expresses gratitude to the agencies, companies, and institutions that have offered support in conducting research and/or writing publications

AI Declaration

The author acknowledges the use of artificial intelligence (AI) tools in supporting the preparation of this manuscript. The author remains fully responsible for the accuracy, originality, and integrity of the research and its findings.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

No funding was received for this work.

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