



Digital Metrology Transformation in the Time and Frequency Laboratory of SNSU-BSN

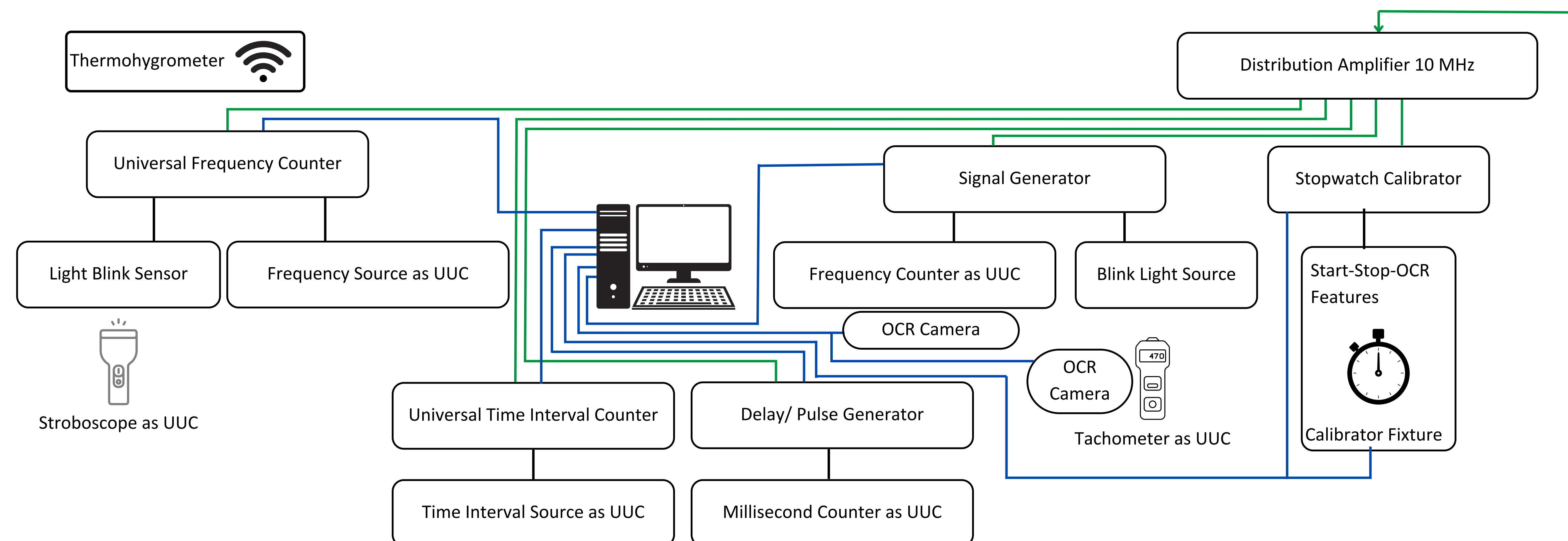
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Introduction

As part of implementing the second resolution of the General Conference on Weights and Measures (CGPM), the SNSU-BSN Time and Frequency Laboratory has initiated a comprehensive digital transformation project. This project aims to automate routine laboratory tasks, from monitoring and maintaining the national time standard UTC(IDN) to disseminating unit values through domestic calibration services. This automation is expected to accelerate and optimize the development of time and frequency metrology in Indonesia.

Time and Frequency Calibration Automation Systems



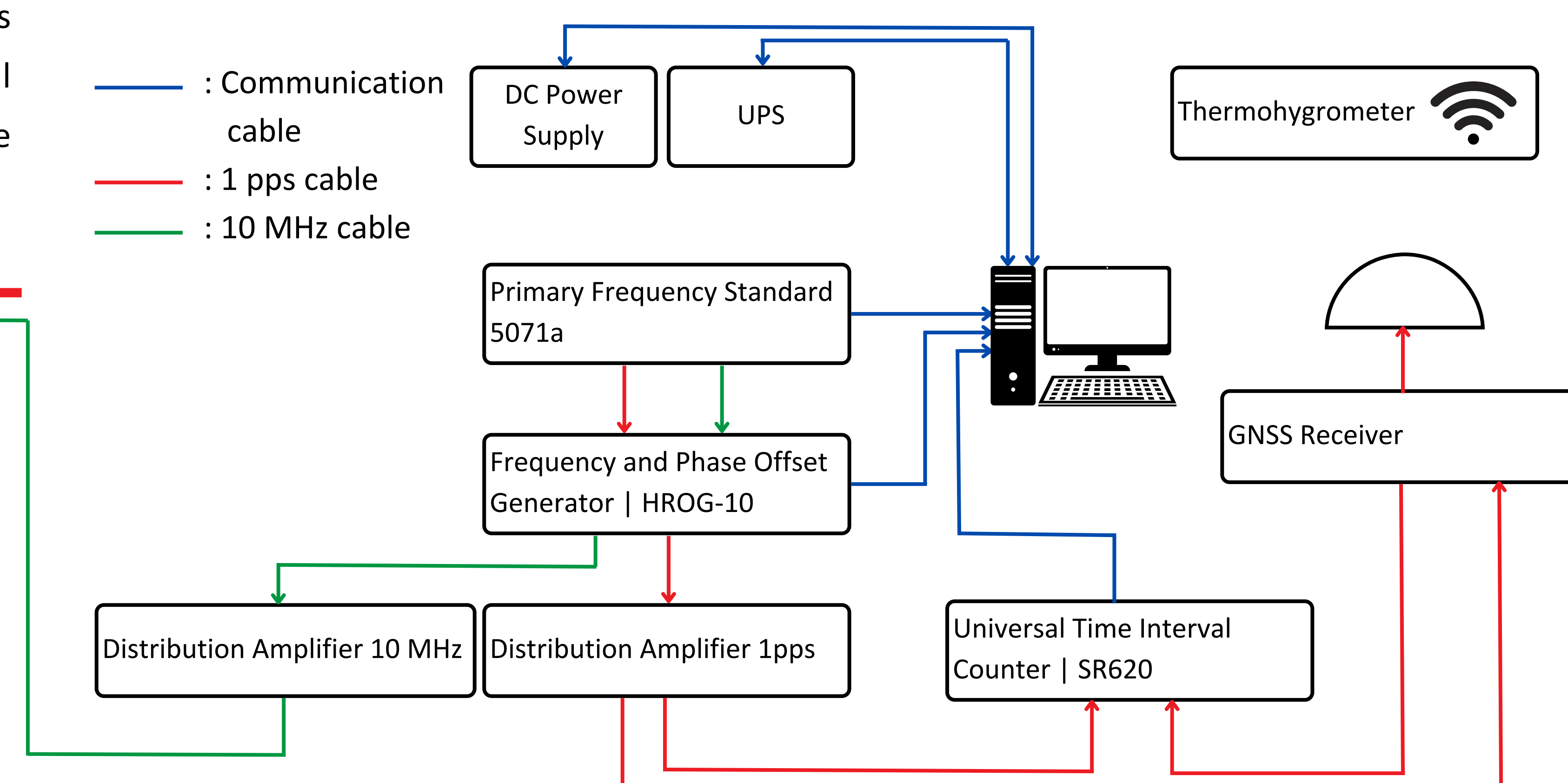
System Overview Block Diagram

System Overview | The development of an automated calibration system in the field of time and frequency primarily involves controlling standard systems and recording calibration results to enable the calibration process to operate independently while minimizing the intervention of calibration personnel. Automation of frequency source calibration, such as signal generators and stroboscopes, is achieved by controlling frequency counters and automatically recording measurement results. This approach is also applied to the calibration of time interval sources. The utilization of Optical Character Recognition (OCR) for recording calibration results will be implemented for frequency meters, tachometers, millisecond counters, and stopwatches. Specifically, for stopwatch calibration systems, a mechanical system for starting, stopping, and resetting will be required in addition to OCR implementation. **Recent Progress** | The automation of frequency source calibration systems has been developed through the creation of software capable of controlling frequency counters and automatically storing measurement results on a computer. **Future Development** | The automation system for time interval source calibration will be developed using a framework similar to that of frequency source calibration automation. Additionally, the OCR system will be enhanced to support multiple calibration systems by implementing machine learning-based OCR, allowing its application across various calibration processes.

Conclusion

The digital metrology transformation in the Time and Frequency Laboratory of the National Measurement Standards - National Standardization Agency of Indonesia (SNSU-BSN) has commenced. In the area of maintaining primary time and frequency standards, a monitoring system has been developed, alongside the ongoing development of the UTC(IDN) steering system. In calibration, the automation of frequency source calibration has been implemented. The development of an OCR camera-based calibration automation system will significantly impact the calibration process within the time and frequency metrology field. Other applications of digital transformation to be developed include systems for wavelength measurement and RF power measurement, which will begin once the systems are ready. Additionally, the implementation of DCC will also be developed to support a more comprehensive digital transformation effort.

Primary Time and Frequency Standard Control and Monitoring System



System Overview Block Diagram

System Overview | The monitoring system for UTC(IDN) as the primary time and frequency standard in Indonesia encompasses the internal operational parameters of cesium atomic clocks, the current status of cesium atomic clocks, and the environmental conditions of the standard room. The control system for UTC(IDN) aims to maintain the accuracy of UTC(IDN) output and ensure a more stable correction relative to UTC. This system involves analyzing the relationship between UTC(IDN) and GNSS Time to observe the characteristics of UTC(IDN) and validating these characteristics using data from Circular-T. These two data sets serve as the basis for controlling the UTC(IDN) values. **Recent Progress** | The monitoring system has been fully developed as an internet-based real-time monitoring system. The control system for UTC(IDN) has been initiated by collecting GNSS Time vs UTC(IDN) data and implementing an automated data retrieval system for Circular-T using the BIPM Time Department API Web Service. This retrieval system has been enhanced to calculate drift values, which serve as the basis for steering UTC(IDN) values. **Future Development** | The development of the UTC(IDN) control system will continue with the automation of GNSS Time vs. UTC(IDN) data collection and the development of a machine learning model. This model will determine the appropriate steering values at the right time, enabling automated control of the frequency and offset generator.

Related References

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