

# Intra-Query Parallelism for a Scalable and Responsive Web-Based Digital Pathology Viewer

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**Abstract.** Computational systems are successfully used in distinct areas of health. However, the use of digital imaging in pathology is taking its first steps when compared with the radiology sector. For instance, inter-institutional web platforms interoperable with various scanners through standard communications are very rare. This is due to the fact that the technology is only now being mature enough to meet the major challenges of this sector in terms of data storage and data access for efficient visualization of images with several gigabytes. The remote access to those images proves to be a challenge in an open and heterogeneous environment. This paper proposes a scalable and efficient architecture for storing and dynamic data retrieval on distributed large-scale systems. The adopted methodology relies on intra-query parallelism to retrieve a large number of image segments in a scalable distributed environment.

**Keywords.** WSI, Digital Pathology, PACS, Intra-Query Parallelism, Distributed systems

## 1. Introduction

The presence of digital technologies in the healthcare industry has become more prevalent due to the advantages that it brings over traditional ones. Improvements in workflow speed and ergonomics [1], quality of the diagnosis, access to diagnostic support tools, collaborative sessions and management of the medical data were made possible by storing the medical exams, and scans in a digital format [2].

Despite the advantages digital pathology brings, these systems are still relatively new, and their adoption has been slow. The implementation of a digital pathology system in a large-scale clinical center poses several challenges. It needs to provide significant advantages in both operation costs and logistics and most importantly, it needs to improve diagnose efficiency and quality to justify the migration efforts [3]. This is a considerable challenge for web-based systems in digital pathology due to the giga-pixel resolution of the digital slites.

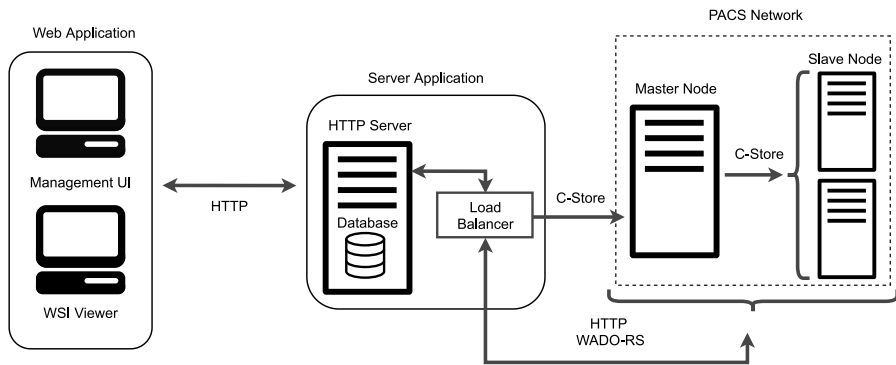
This paper proposes a distributed architecture that takes advantage of the data organization in a Whole Slide Image (WSI) to increase system performance and reliability in large-scale scenarios.

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## 2. Architecture Overview

The goal of this architecture (Figure 1) is to reduce response times to user's queries when the system is under heavy load but also to singular query requests. The user navigates the WSI images through the WSI Viewer component. These images can be seen as layers of a pyramid split in tiles. A slide scanned at 40x magnification can have upwards of 30000 tiles hence the challenge that they pose. When the user navigates the image, several tiles will be requested at once to update the application viewport. Each frame is individually requested through a HTTP request. This allows the architecture to split the workload through the node network employing an intra-query strategy. The Server Application splits the requests equally amongst all nodes using load balancing strategies. All nodes can answer image requests but only the master node is allowed to receive data. This node propagates the data it receives to the remaining nodes in the network.



**Figure 1.** Overview of the proposed system architecture

## 3. Conclusion

The architecture presented in this work tries to address the concerns of a digital pathology system being used on a massive scale over the Web. It was proposed an architecture to facilitate access to the tiles of a WSI in a parallelized format, using an intra-query strategy. The results show that by splitting the work through several archive nodes response times can be improved with the proposed architecture.

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## References

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