Business Brief

AI-Enabled Digital Pathology

Empowering AI-Enabled Digital Pathology with Easy-to-Deploy Solutions

Intel® technology streamlines AI-enabled Digital Pathology workflows and delivers key optimization toolsets for high-performance implementations.

"[Digital Pathology] is an innovation committed to the reduction of laboratory expenses, an improvement of operational efficiency, enhanced productivity, and improving treatment decisions and patient care."

—The Digital Pathology Association

Pathology services, including biopsies and blood work used to diagnose illnesses, are a foundation of modern medical care. Drug discovery relies on pathology to simulate drug mechanisms and to establish biomarkers—molecules in body fluids or tissues that indicate abnormality or signs of disease. Clinical trials also rely on pathology to manage chronic diseases and to measure the efficacy of new pharmaceuticals. Traditionally, pathologists analyze a patient's tissue or fluid sample by staining cellular structures on a glass slide and using a microscope to identify biomarkers in the sample. If needed, the pathologist requests a second opinion or interpretation of the sample by physically shipping the slide to another pathologist.

Digital Pathology: A much-needed overhaul to traditional processes

Digital Pathology is the process of converting physical glass slides into digitized whole slide images for fast transmission and examination by pathologists and specialists. Pathologists no longer need to examine physical slides through a microscope but instead examine digitized whole slide images at their workstations. When a second opinion is needed, pathologists can send digitized whole slide images to other experts—either on- or off-site—forgoing the hassle of manual handling. Because hospitals can accrue hundreds of thousands or even millions of glass slides per year, digitization also helps reduce the burden of physical slide storage, shipment to other locations, and preanalytical variables. These variables can include cutting the slides too thick, using improper barcoding, and making sure the dyes stay the same over time in addition to potential biohazard dangers from breakage during transport.

AI helps focus efforts and save time

The adoption of AI in Digital Pathology further enhances operational efficiency by deploying AI models for such use cases as improving image resolution, classification, and segmentation. AI models classify biological structures in a whole slide image and highlight areas of interest to help focus the pathologist's attention. These AI-assisted workflows can augment a pathologist's expertise in identifying biomarkers, making diagnoses, or measuring the efficacy of drug treatments, potentially resulting in faster and more accurate interpretations.[1] Additionally, AI can be used to triage the importance of images and future-facing tasks such as prognosis.[2]

AI models help standardize the practice of classifying biological structures in a sample, helping to mitigate potential bias from pathologists of different expertise levels or training. AI-enabled Digital Pathology can help mitigate caseloads by empowering pathologists to examine more samples in less time, fostering easy collaboration between healthcare professionals and scientists all over the world and allowing a vast repository of privacy-respecting historical data to fuel research efforts—all without the hassle of manual slide handling.

The need to do more with less

↑49%
Forecasted increase in US cancer rates by 2050.[3]

1 in 3
Adults with multiple chronic conditions.[4]

15M
Predicted healthcare worker shortage by 2030.[5]

80%
Hospitals with legacy systems still in place.[6]

Challenges to adoption for Digital Pathology and AI

Healthcare and life sciences will face increasingly difficult challenges in the future: rising cancer rates, aging populations, tighter budgets, and worker shortages. However, hospitals, labs, universities, and pharmaceutical companies face technological hurdles while deploying AI-enabled Digital Pathology largely because of complexity and high performance demands, alongside the lack of interoperability with legacy systems. Hospital IT infrastructure requires an integrated solution that abstracts complexities related to underlying hardware, network topology, storage, and AI frameworks—without requiring deep expertise.

Hospitals, laboratories, and enterprises serving healthcare and life sciences customers can help solve these problems with technology stacks built on Intel® hardware—as well as toolkits for optimization and reference architecture for platform scalability across multiple locations.

Digital Pathology Opportunities	Challenges to Overcome	Intel® Solutions and Benefits
Second opinions fast: Hospitals can quickly move digitized slide samples to practitioners and specialists both on- and off-site, without delays for shipping and handling.	**Data volume:** Whole slide images can produce files as large as 80 GB, uncompressed. Storing and transferring data over slow or disparate networks can take time.	**Data portability:** Intel-enabled storage, networking, 5G, and hybrid cloud solutions help empower hospital networks to store and move high volumes of data fast.
More patients covered: AI-assisted Digital Pathology can help highlight areas of interest in slide samples, saving the pathologists time and enabling them to serve more patients.	**AI complexity:** Hospital IT infrastructure consists of various underlying architectures, host operating systems, and network capabilities that can make it difficult or costly to integrate new AI solutions.	**AI simplicity:** Toolkits help optimize and accelerate AI workflows with lower performance requirements on Intel® hardware, integrating more easily with legacy systems while supporting hardware convergence on consolidated networks.
Accelerated discovery: Anonymized patient data can be aggregated to support multitenant AI analysis for pharmaceutical research, clinical trials, genome mapping, and vaccine development.	**Scalability:** Maintaining consistent AI models across numerous devices, clouds, or compute nodes incurs high administrative overhead.	**Easy management:** Reference architecture helps orchestrate multiple edge platforms to keep AI models consistent and updated across multiple hospitals and locations.

AI in Digital Pathology use cases


Patient care in hospitals and clinics


Research and discovery in laboratories


Learning in universities and academic settings

Drug research and testing for pharmaceuticals

Driving image quality and AI efficiency

The Intel® technology stack that supports AI-enabled Digital Pathology consists of multiple toolkits and platforms that deliver optimized performance on Intel® processors, accelerators, VPUs, and GPUs. AI optimization facilitates flexible deployments with less-stringent performance requirements while maintaining high-resolution image quality and visualization. These toolkits can help make AI Digital Pathology more accessible for single-location hospitals and labs.

Overview: Intel® toolsets for image quality and AI efficiency

oneAPI

Intel® oneAPI Rendering Toolkit

Optimized frameworks for high-fidelity rendering and visualization of digitized whole slide images.

OpenVINO™

Intel® Distribution of OpenVINO™ toolkit

Fast inference with write-once, deploy-anywhere flexibility for models trained on frameworks such as TensorFlow and PyTorch.

Optimized for performance on Intel-based systems

intel. CORE · intel. ATOM · intel. XEON · intel. iRIS Xe MAX GRAPHICS · Intel. AGILEX · intel. MOVIDIUS

The Intel® oneAPI Rendering Toolkit enhances whole slide image visualization

The Intel oneAPI Rendering Toolkit provides powerful rendering libraries that enable high-fidelity scientific visualization. As the number of whole slide images increases, the toolkit helps process image data fast and at extreme resolution. Pathologists benefit from more detail in each whole slide image and support for greater degrees of magnification, and pharmaceutical researchers can render or animate their biological simulations quickly.

The Intel® Distribution of OpenVINO™ toolkit optimizes AI model inference

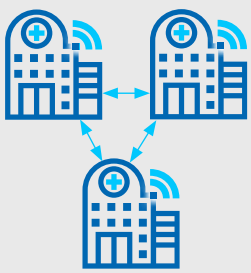
AI-enabled Digital Pathology workflows become more feasible to implement with AI model optimization that supports high performance across multiple Intel-enabled configurations. The Intel Distribution of OpenVINO toolkit allows developers to convert their AI models trained on familiar frameworks such as TensorFlow and PyTorch to an intermediate representation (IR) that executes efficiently across multiple processor architectures, accelerators, and future GPUs.

The Intel Distribution of OpenVINO toolkit can help simplify the move from traditional to Digital Pathology for clinics and research facilities as developers can start with pretrained models for inferencing on general-purpose Intel processors. The solution also supports multidevice inferencing using industry-standard APIs, giving solution providers more flexibility in setting up their configurations.

Addressing manageability and orchestration hurdles when scaling up

Health and life science applications have unique requirements such as large data sets, regulated workloads, and the need for heightened cybersecurity to protect company intellectual property (IP) and patient privacy. Edge computing platforms and servers allow hospital IT professionals to keep data on-site and within the network perimeter. However, heterogenous and distributed hospital infrastructure makes it difficult to deploy and scale new technologies with cloud-like agility. These challenges compound as hospitals and laboratories attempt to scale the Digital Pathology solution stack to more than one hospital or location. When combined with toolsets for AI efficiency and image quality, Intel® platforms for AI management can help ease scaling up a Digital Pathology solution across multiple locations.

Overview: Intel® platforms for AI management and orchestration



OpenVINO™ MODEL SERVER

A platform that centralizes AI model management across numerous edge devices within a hospital environment.

intel. SMART edge

Reference architectures to build and scale edge platforms across any number of hospitals and laboratories.

Connect separate locations over high-bandwidth, low-latency 4G, 5G, private LTE, or Wi-Fi networks

OpenVINO™ Model Server centralizes AI model management

Digital Pathology ecosystems generate and rely on multiple AI models to recognize biomarkers, abnormalities, and disease indicators. Managing multiple AI models and applying them consistently across multiple instruments or edge devices can be challenging, especially on constrained budgets. OpenVINO Model Server is a scalable, high-performance solution that serves AI models optimized for Intel® architecture and takes advantage of inference engine libraries from the OpenVINO toolkit.

In a typical configuration, pathologists submit whole slide images for analysis to the OpenVINO Model Server, which applies AI models consistently to samples and returns the results to the pathologist for further diagnosis. OpenVINO Model Server also supports easy integration between training and deployment systems and a standard client interface to deploy new algorithms and AI experiments that are trained in a framework supported by the OpenVINO toolkit.

Intel® Smart Edge Open accelerates deployments at scale

Intel Smart Edge Open is an open source edge computing platform that makes it easy to manage multiple edge devices and onboard new applications seamlessly. Built on a microservice-based architecture, Intel Smart Edge Open uses Kubernetes to orchestrate containerized applications and workloads in a modular, cloud-like manner. Hospital IT staff or service providers benefit from centralized management of assets, enabling them to keep workstations, instrumentation, and edge servers up to date without impeding pathologists' workflows.

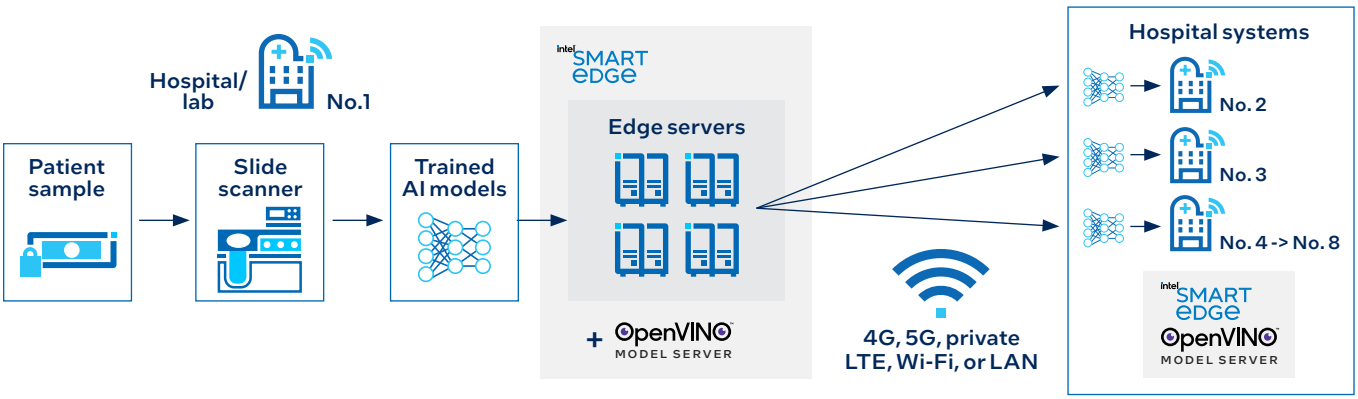


Figure 1: Intel® Smart Edge Open can be used to manage and help secure the distribution of consistent and updated AI models across multiple hospitals or laboratories using a 4G, 5G, private LTE, or Wi-Fi connection.

With this platform, IT managers can orchestrate multiple OpenVINO Model Server solutions at multiple locations and transmit trained AI models over fast 4G, 5G, private LTE, or Wi-Fi connections to disparate hospital or laboratory networks. The platform also integrates data plane, telemetry, and resource management tools to support further optimization efforts. Within the Intel Smart Edge Open platform, Intel offers a reference implementation to expedite planning and deployment for AI-enabled Digital Pathology.

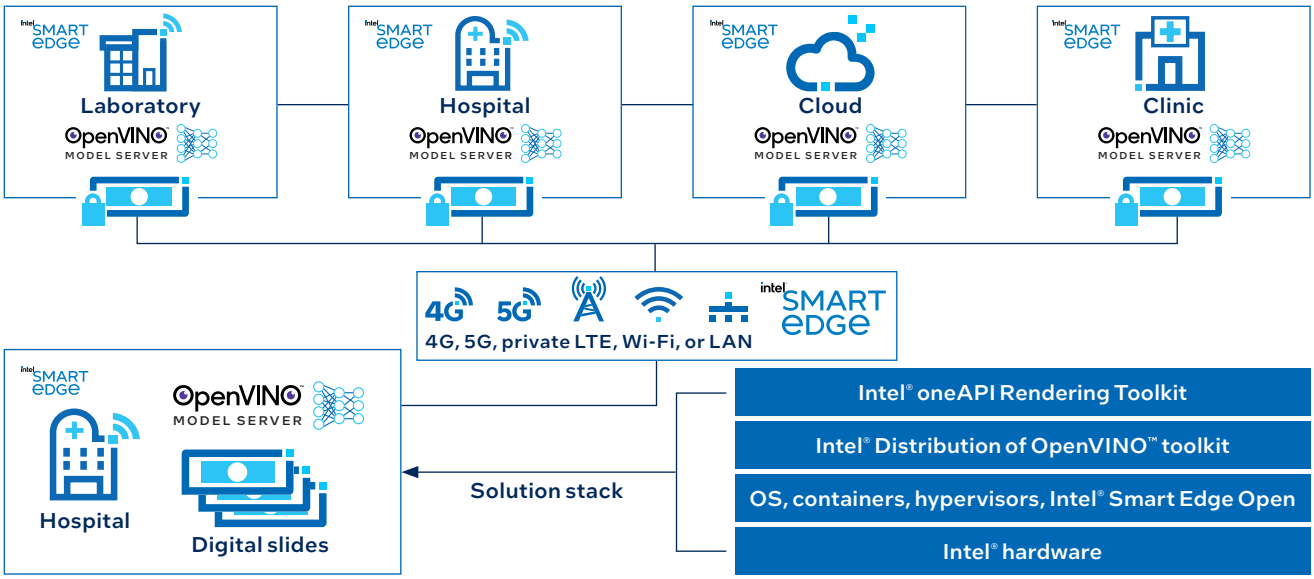


Figure 2: Solution overview for AI-enabled Digital Pathology. Pathologists can analyze and share digital slides and inference models through an integrated solution using the Intel® oneAPI Rendering Toolkit, OpenVINO™ toolkit, Intel® Smart Edge Open, and Intel® hardware.

Intel powers the platform with an extensive portfolio and life cycle commitment

Backed by a vast ecosystem of technology partners, only Intel provides a full edge-to-cloud portfolio of processors, accelerators, storage, and networking to empower Digital Pathology solutions at scale. Solution providers and hospital IT staff and can find high-performance Intel architecture in IoT sensors, instrumentation, edge computing platforms and servers, HPC clusters, and the cloud. With long life availability on select SKUs, healthcare organizations can maximize the value from equipment certification cycles and depend on support, service, and parts for longer durations between refresh cycles.

Conclusion: Integrated deployments on high-performance hardware

The full stack of Intel® toolsets and platforms for Digital Pathology is purpose-built to help solution providers plan and deploy their implementations with ease and accelerate time to value for hospitals and laboratories. Scalable architecture allows for the ongoing refinement and integration of new AI models, increasing the usefulness of technology investments over time. With these offerings, hospitals worldwide have a more accessible path to integrate AI-enabled Digital Pathology into their workflows.

Learn more

Explore toolkits and platforms:

Intel® oneAPI Rendering Toolkit

Intel® Distribution of OpenVINO™ toolkit

OpenVINO™ Model Server

Intel® Smart Edge Open

Digital Pathology:

Reference implementation: Network optimization and AI inferencing management

Blog post: Network optimization and AI inferencing management

Partner solutions:

Wistron white paper: Bringing AI-Enabled Digital Pathology to Hospitals

Solution brief: KFBIO Accelerates Cancer Detection Workloads with Intel® AI Technology

Additional resources:

Intel® Developer Catalog for Edge Software

Intel® software development tools

Reference implementation demo explores a scalable, end-to-end solution

On the Intel® Developer Catalog for Edge Software, AI developers can access a nuclei segmentation demo that shows how an accessible, integrated, end-to-end solution is within reach for health and life sciences organizations. This demo integrates solutions including Intel® Smart Edge Open and OpenVINO™ Model Server (see Figure 2) to serve AI models at scale from a remote location such as the cloud. As the basis for this implementation, Intel engineers took an open source Digital Pathology toolkit named QuPath, converted it to the OpenVINO toolkit, and then implemented it through OpenVINO Model Server and Intel Smart Edge Open.

1. "Artificial intelligence as the next step towards precision pathology," pubmed.gov, July 2020. https://pubmed.ncbi.nlm.nih.gov/32128929/
2. "Bring To Light More Than The Eye Can See—The Future Of Pathology With The Tribun Health Platform," Tribun Health, date of access: March 2022. gw-resources.genomeweb.com/free/w_defa1813/prgm.cgi
3. Hannah K. Weir et al., "Cancer Incidence Projections in the United States Between 2015 and 2050," June 2021. https://www.cdc.gov/pcd/issues/2021/21_0006.htm
4. "This is the biggest challenge to our health," World Economic Forum, December 2017. https://www.weforum.org/agenda/2017/12/healthcare-future-multiple-chronic-disease-ncd/
5. "Global Health Workforce Labor Market Projections for 2030," Human Resources for Health, February 2017. https://human-resources-health.biomedcentral.com/articles/10.1186/s12960-017-0187-2
6. 2020 HIMSS Cybersecurity Survey, himss.org, 2020. https://www.himss.org/sites/hde/files/media/file/2020/11/16/2020_himss_cybersecurity_survey_final.pdf

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