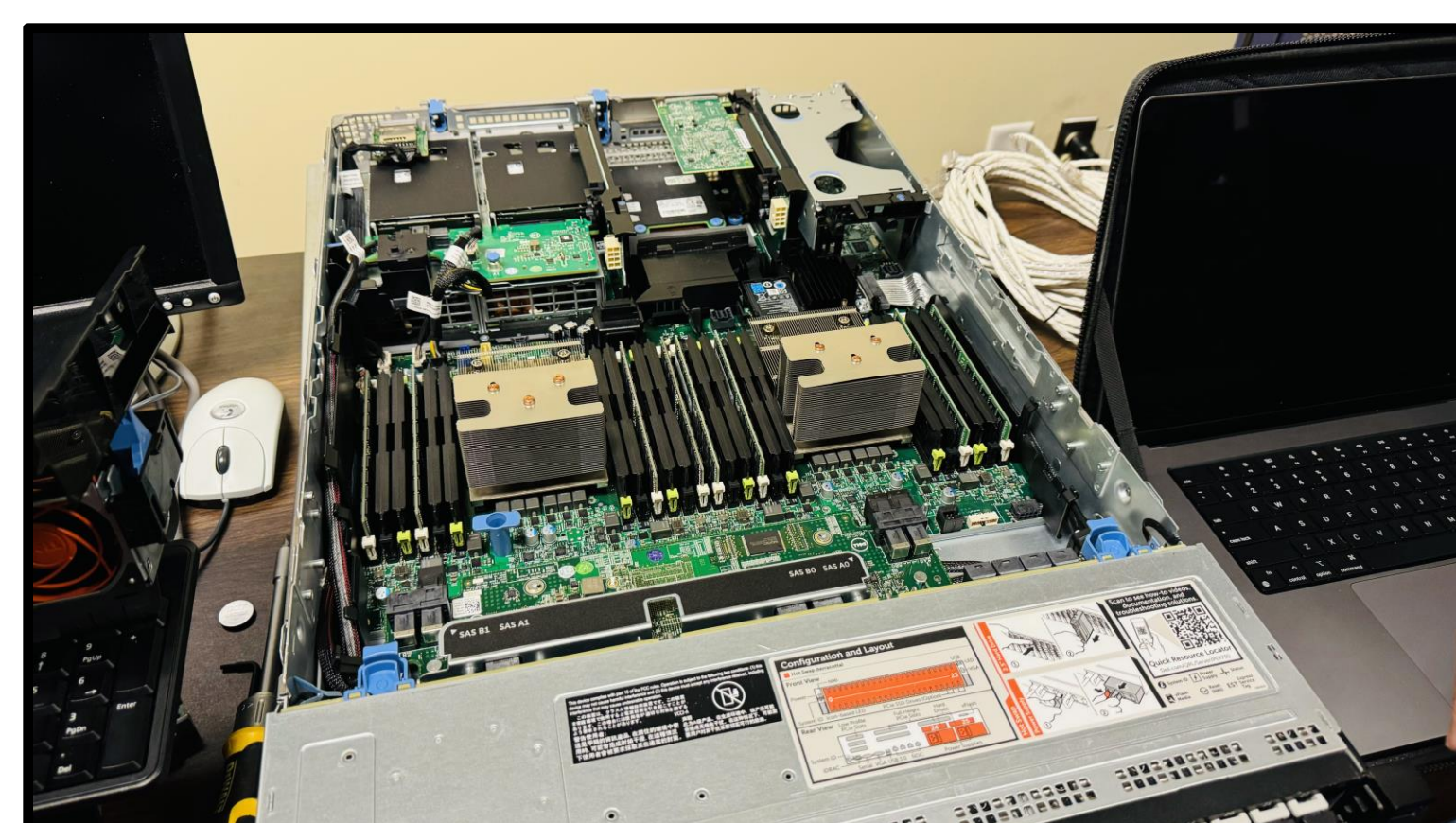# Advancing HPRC at VCU

Team members: Yunus Bidav, Steven Holcombe, James Jenkins, Amaka Odidika | **Faculty adviser:** Alberto Cano, Ph.D., Kostadin Damevski Ph.D. | **Sponsor:** VCU HPRC Core Lab | **Mentor:** Carlisle Childress

Overview

The **High Performance Research Computing (HPRC)** core laboratory at Virginia Commonwealth University (VCU) has been supporting researchers since **2006**. HPRC provides access to advanced computational resources, including:

- High performance **computer clusters.**
- Large **CPU, RAM, and storage resources.**
- **Specialized tools** for scientific computation.

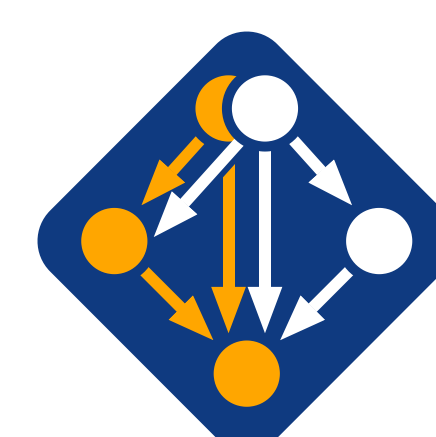## Key Technologies Utilized

Base Operating System
Rocky Linux 9.5

HPC Framework
OpenHPC

Application Build Systems
Spack *(also Anaconda, EasyBuild)*

MPI Libraries
Openmpi *(also mpich)*

Web Interface
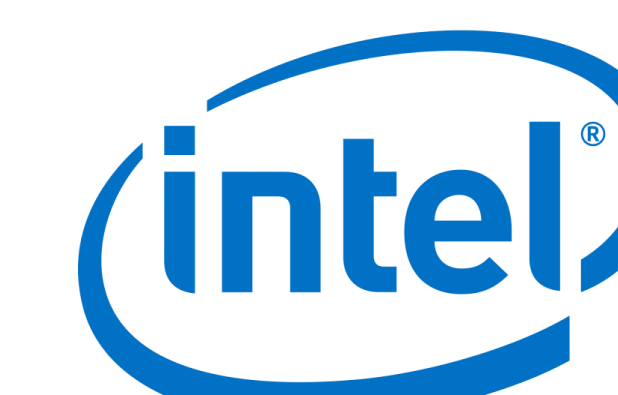Open OnDemand

Provisioning
Warewulf

Workload Manager
Slurm

Compilers
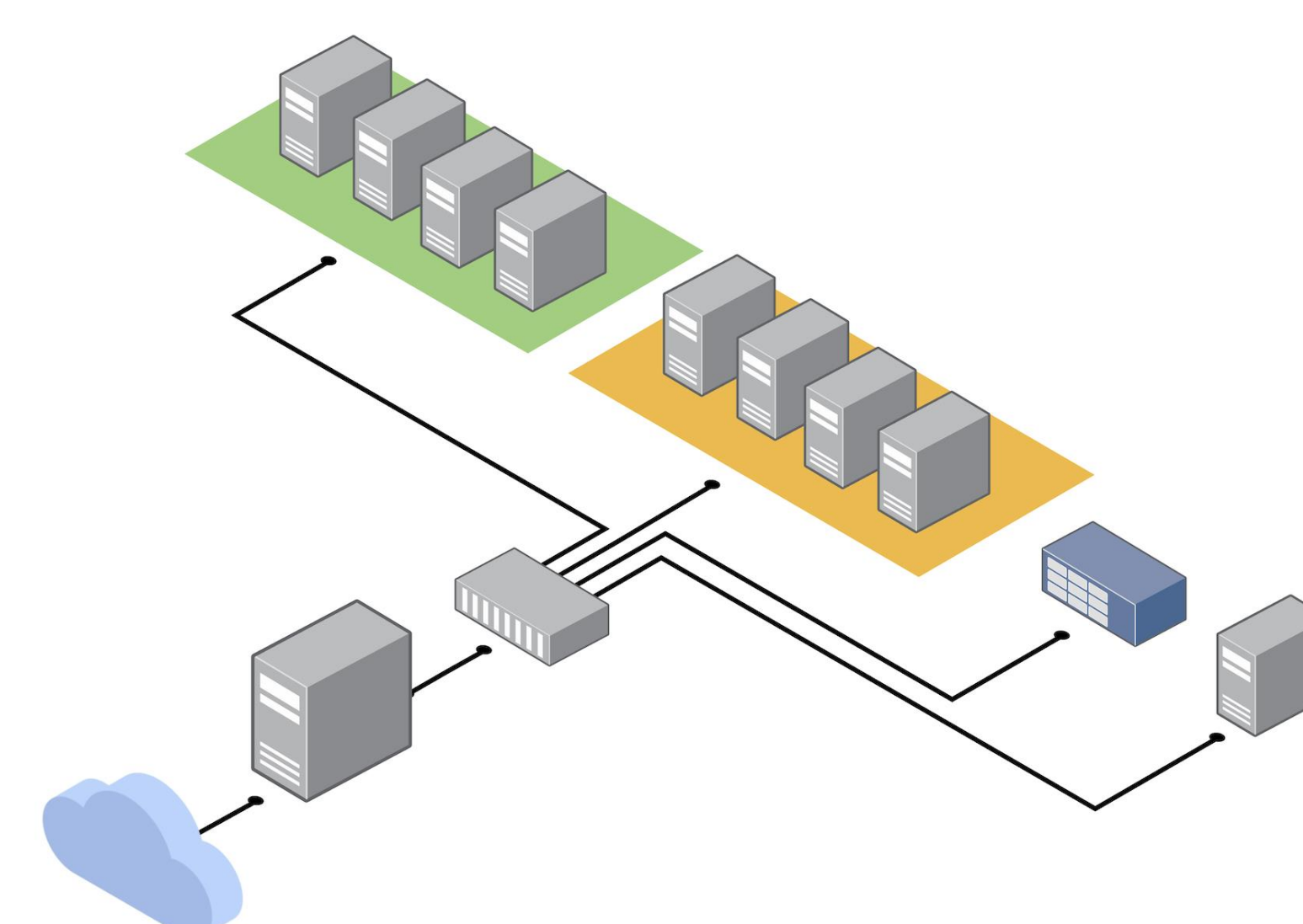Intel ICC *(also GCC)*

Implemented Solution

Our team evaluated the **OpenHPC +Warewulf 4** toolchain, focusing on automating provisioning and integrating diverse hardware.
Key implementation steps include:

- **OpenHPC** core components installed.
- **Warewulf** configured for PXE booting.
  - Custom containers built for specialized hardware.
- **Hybrid provisioning** for **non-standard hardware.**
- Application **build toolchains** installed.
- **Slurm** exercises validated HPRC software compatibility.
- **Open OnDemand** installed for easier access.
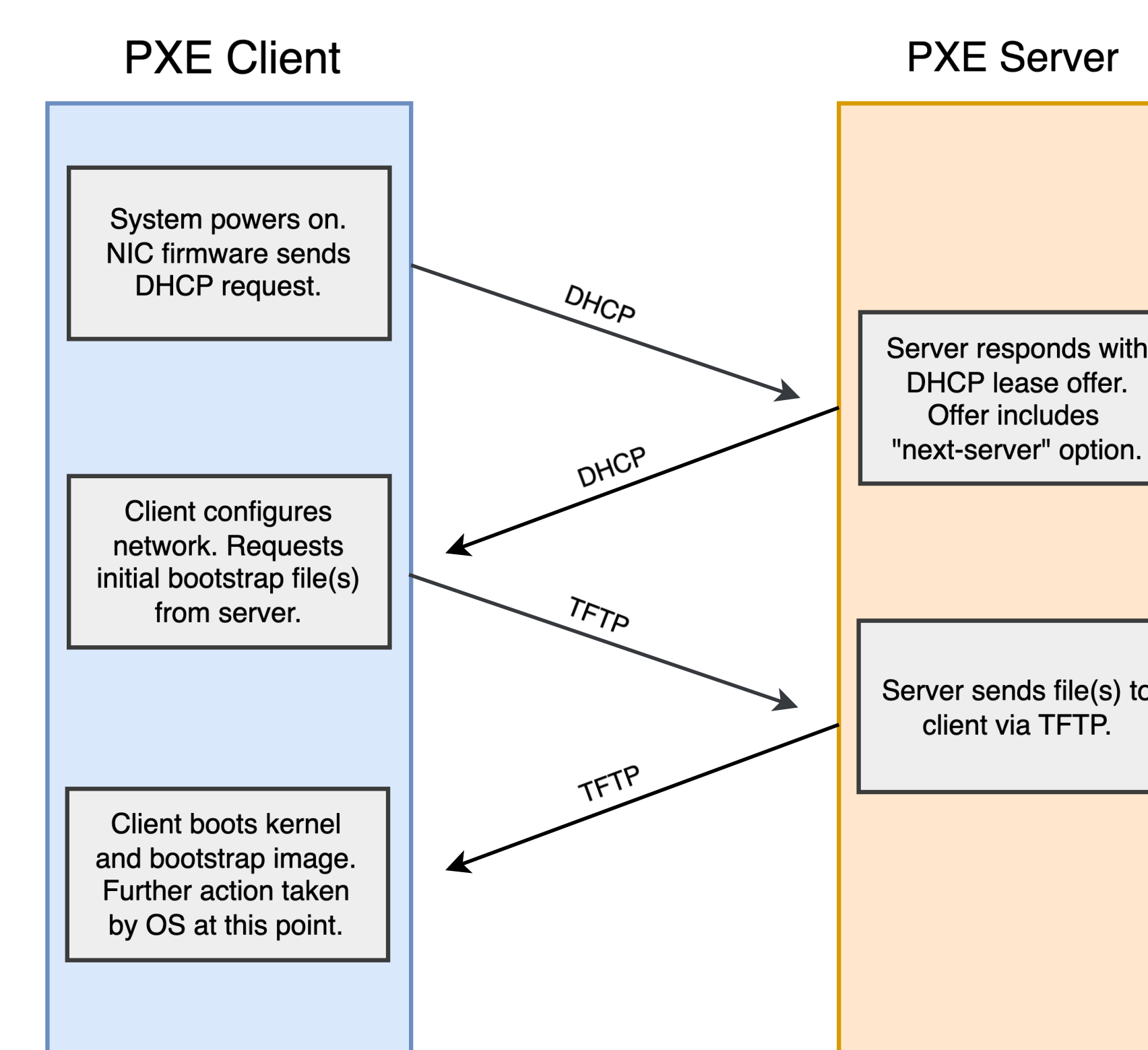- **High-Performance Linpack** deployed for benchmarking.

Why Change is Needed

- **High-performance computing evolves,** new technologies add **instability**, requiring **thorough testing**.

- **Outdated or incomplete documentation** hinders integration and troubleshooting.

- **Manual compute node configuration** causes **technical debt and errors**. Fixing these issues is key to **stability and uptime.**

Network Diagram

PXE Boot Diagram

PXE Client

PXE Server

System powers on. NIC firmware sends DHCP request.

DHCP

Server responds with DHCP lease offer. Offer includes "next-server" option.

DHCP

Client configures network. Requests initial bootstrap file(s) from server.

TFTP

Server sends file(s) to client via TFTP.

Client boots kernel and bootstrap image. Further action taken by OS at this point.

TFTP

Scylla Specifications

The Scylla cluster features high-performance hardware:

- **15 Nodes**
- **>300 CPUs**
- **2.5 TiB Ram**
- **4 Nvidia GPUs**

Acknowledgments

VCU College of Engineering