INNOVATIVE COMPUTING LABORATORY

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CIRC: ENS: Monitoring Infrastructure for Network and Computing Environment Research (MINCER)

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ABSTRACT

The MINCER project aims to provide **comprehensive insights into distributed heterogeneous computing environments,** advancing research and education in platform reliability, efficiency, and security, through three main thrusts:

1. **Enhanced Performance and Power Monitoring Capabilities for AI Architectures:**
   - Support research aimed at improving AI system performance and utilization.
   - Enables informed decisions on optimization and system configurations.

2. **Unique Network-Related Measurements:**
   - Facilitates research in network anomaly detection, resilience, and energy efficiency.

3. **Integration of the MINCER Monitoring Infrastructure with Leading Research Platforms:**
   - Chameleon: Enhance the understanding of cloud and edge computing dynamics.
   - Open Science Grid: Explore the relationship between data transfer and computation in large-scale distributed computing.

MONITORING CAPABILITIES FOR AI CHIPS

→ **Development** of **Unique Performance and Power Monitoring Capabilities** for **Specialized AI Chips,** including:

- Habana Gaudi2 processor
- SambaNova Reconfigurable Dataflow Unit (RDU)
- Cerebras' Wafer-Scale Engine

→ **Identify AI-Specific Hardware Events & Bottlenecks:**

- Goes beyond execution time to pinpoint performance issues.
- Helps optimize system configurations.

→ **Support AI Training & Machine Learning Research:**

- Aims to improve performance and efficiency of AI architectures.

→ **Key hardware-specific monitoring capabilities we seek to explore:**

- **Compute Utilization**
- **Memory Access Patterns and Bandwidth**
- **Instruction-level Parallelism**
- **Tensor Operations**
- **Power Consumption and Efficiency**
- **Interconnect Utilization**
- **Thermal Monitoring**
- **Branch and Control Flow**
- **Error and Fault Monitoring**

MONITORING CAPABILITIES FOR NETWORKS

→ **Development** of **Network-Specific Monitoring Capabilities** for various **Network Systems:**

- Provide insights into network-centric events and hardware details for better performance analysis and optimization.
- Identify bottlenecks and make informed decisions on network optimization and system configurations

→ **Network Monitoring for Anomaly Detection:**

- **AI-Driven Anomaly Detection:** Leverages fine-grained network data and semi-supervised learning to detect anomalies, including faulty situations and cyber incidents
- **Reliable Data Collection:** continuous network data gathering with provenance assurance to ensure integrity and trustworthiness.

→ **Key network-specific monitoring capabilities we seek to explore:**

- **Packet Drops**
- **Bandwidth Utilization**
- **Latency Metrics**
- **Error Rates**
- **Queue Depths & Buffer Utilization**
- **Switch & Router Performance Metrics**
- **Port Utilization**
- **NIC (Network Interface Controller) Metrics**
- **Topology Mapping**
- **Throughput**
- **Temperature & Hardware Health**

INTEGRATION WITH LEADING RESEARCH PLATFORMS

Integration of the MINCER monitoring infrastructure with research platforms like **Chameleon** and **Open Science Grid** will significantly enhance the utility of these platforms for advancing systems and network research and associated educational programs for a growing user community.

Open Science Grid

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