Personnel

Arizona State University (ASU) is served by both the central University Technology Office (UTO) and the Research Technology Office (RTO). UTO is the central IT organization with over 540 FTEs across multiple service areas including desktop support, wired and wireless networking, public and private cloud, identity management, information security, and web application development. UTO oversees core campus IT services such as payroll, email, instant messaging, user file storage, and document creation/collaboration. UTO also handles ASU policies regarding IT services, data governance, and information security. RTO focuses on IT services directly supporting research and researchers. Specifically, RTO comprises 65 FTEs covering Research Computing, Scientific Software Engineering, Research Data Management, Business Intelligence, and Web Services. RTO is overseen by the Chief Research Information Officer who reports to the University's Executive Vice President of Research. The Research Computing staff consists of computational scientists, programmers, engineers, and database administrators with expertise in all areas of computing, including scientific and parallel computing, big data analytics (in memory), custom software development, database engineering, and scientific visualization.

Advanced Computing

Research Computing is an academic supercomputing facility providing high performance computing (HPC) environments, a data intensive ecosystem, connectivity to the Internet2 research and education network, and large-scale data storage with elastic capacity to the public cloud. Research Computing provides a variety of HPC (both physical and virtual), cloud, storage, development, implementation, and consulting services. Research Computing consulting services and support for computational investigations, including data analysis, simulation, modeling, visualization and other high-performance approaches include:

- Identifying optimal systems and software platforms
- Training in computational and/or graphics algorithms, tools and packages
- Implementing parallel algorithms and programs
- Developing custom post-processing graphics tools
- Creating virtual environments for scientific research and fine arts
- Tuning applications for peak performance
- Purchase consultation for server, HPC, and storage acquisitions
- Virtual server provisioning (local, cloud)
- Physical and virtual server management
- Recharge of non-preemptable computing time and data storage solutions
- Accessing extensive external, government-funded compute resources (XSEDE, OSG)

ASU Research Computing
ARIZONA STATE UNIVERSITY

Advanced Computing Systems

System Name	CPU	CPU Speed (GHz)	CPU Cores	CPU Sockets	Single precision TFLOPS*	Double precision TFLOPS*
Agave	Intel Xeon E5-2680v4	2.4	14 per socket; 8,680 total	608	654	327
Agave Phi	Intel Xeon PHI 7210	1.3	64 per socket; 1,280 total	20	106	53
Ocotillo	Intel Xeon E5-2683v3	2	14 per socket; 1,344 total	96	86	43
Saguaro	Intel E5 (various)	*Varies*	8 per socket; 2,056 total	278	249	124

**Computing capacity is given for each system in theoretical Tera-FLOPS (that is, trillions of floating point operations per second) for both single- and double-precision floating point operations.*

The Agave supercomputer is ASU's flagship high performance computing cluster. Agave is composed of solid-state drives, DDR4-2400 memory scaling from 128GB and 256GB of DDR4 2400, as well as a 1.5TB of DDR4 2666 node. The Agave cluster includes 8,680 CPU cores across over 360 Intel Xeon E5-2680v4 "Broadwell" 2.4GHz systems, and 1,280 cores of Intel Xeon Phi 7210 "Knights Landing" processors (denoted separately as "Agave Phi" above). GPU computing capabilities include access to over 290 NVIDIA Tesla V100, NVIDIA Tesla K80, GeForce GTX 1080/1080Ti and RTX 2080 GPU processors.

The Ocotillo and Saguaro systems are legacy HPC systems that provide additional capacity for moderate computing needs. While Ocotillo has a homogenous CPU layout, Saguaro is a heterogeneous system divided into separate homogeneous CPU pools.

The computational environment is supported by dual 100Gbps interconnected communication fabrics (Intel Omni-Path and Mellanox InfiniBand) and is interlinked to the campus Science DMZ, Internet2, and Data Transfer Nodes (DTN) by a 100/40GE core network to support both high performance computing and high throughput computing.

A dedicated pool of 1.2PB high performance BeeGFS fast scratch storage is presented to the Agave cluster via dual interconnected networks (InfiniBand and Omni-path). A primary working multi-tier storage of 3PB+ supports current computation, with plans to incorporate an additional 2 PB of primary storage within the year. Secondary cloud storage options are also available.

Dell Center of Excellence for HPC and Artificial Intelligence

ASU was recently designated a Dell Center of Excellence for HPC and Artificial Intelligence, the third such center in the United States, and the ninth globally. This distinction has grown out of a close collaboration with Dell HPC experts on system architecture, design, and innovation. Through this new partnership ASU will deploy a new high performance computing system in Q4 2020 to replace the current Agave system. Anticipated characteristics are a mixed CPU/GPU environment of approximately 20,000 CPU cores and 16PB of high performance scratch storage.

Open Science Grid

Research Computing runs a 20-node Open Science Grid (OSG) site for the research community at large and is investigating using spare cycles on idle lab workstations to significantly augment this OSG infrastructure.

Data Center

Interdisciplinary Science and Technology Building 1 (ISTB1), in the center of the ASU Tempe campus, was built in 2012. In addition to housing ASU's primary data center, ISTB1 provides laboratories with adjoining workspaces for bioengineering research. The ISTB1 facility consists of a 5,000 square foot primary data center for critical systems, networking, and computational resources as well as a 3,000 square foot secondary data center for non-critical systems, development, and individual research development equipment. Both data centers employ a standard "hot and cool aisle" layout cooled with computer room air conditioning units totaling 200 tons, supported by campus chilled water systems. Room-dedicated FM-200 fire suppression systems protect the facility. Power for the facility is from on-campus natural gas turbines fed by Utility natural gas. Data center power supports dual power feeds, protected by two uninterruptible power supply units totaling 1MW, with an onsite diesel generator providing 2MW of power and a 500-ton emergency chiller in the event of a loss of utility power. Access to the data center requires a keycard and PIN, and the facility is monitored 24x7 from a dedicated operations center, and physical access is controlled and maintained by the UTO operations center.

Network

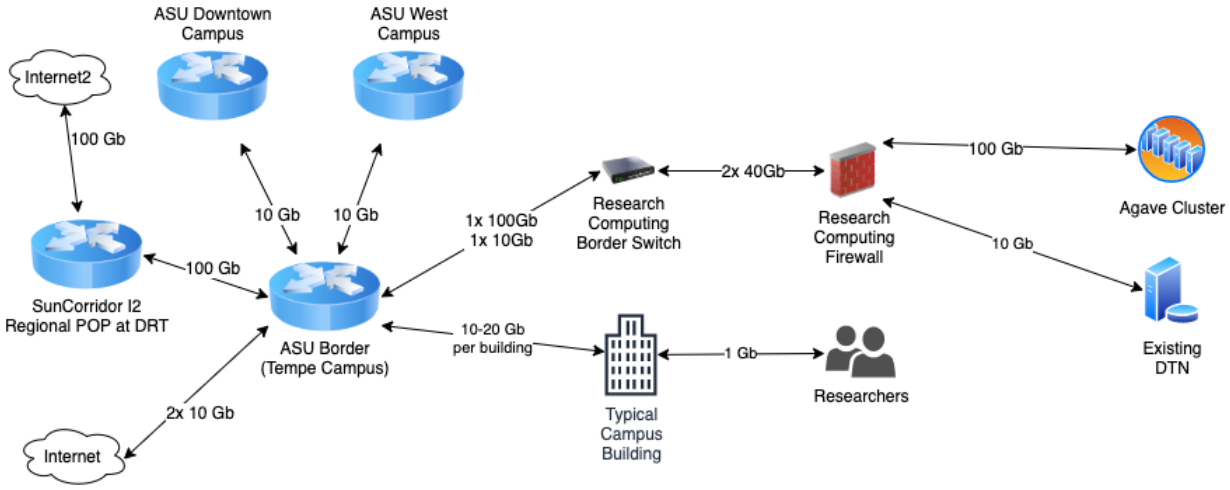

Figure 1: Existing ASU Border, Research Computing, and Researcher Access

Figure 1 illustrates the current ASU network border topology. Primary network access is via a 100 Gb Internet2 circuit to the Tempe campus. Secondary 10 Gb commodity Internet circuits provide additional and partially redundant network access directly from the Tempe campus. The ASU Polytechnic campus (25 miles southeast of Tempe), the ASU West campus (25 miles northwest of Tempe), and the ASU Downtown campus (10 miles west of Tempe) connect to the Tempe campus via redundant 10Gb circuits on a commodity fiber ring. The ASU network is monitored 24x7x365 by a commercial network provider as well as by the University Technology Office. Buildings on all ASU campuses are connected in a hub-and-spoke model, with most buildings served by redundant 10Gb links and 1Gb to end users. The campus network employs an advanced security complex consisting of a layered defense-in-depth deployment of security controls that include DDoS and IP reputation, a variety of specialized network firewalls, and anti-phishing protections. The ASU cybersecurity program also includes mandatory security education and awareness training, and the UTO Governance, Risk, and Compliance Team conducts continuous assessments evaluating risk and vulnerabilities.

Science DMZ

The ASU Science DMZ is a network enclave that bypasses the network security complex. The Science DMZ is explicitly designed for high-throughput data movement, incorporating 100/40 Gigabit Ethernet, virtual circuits, and software-defined networking capabilities as well as dedicated systems for large data movement requiring a friction-free path, with security policies and enforcement mechanisms tailored for high performance science environments.

Data Storage

ASU supports a variety of commercial cloud storage offerings, including Dropbox (up to 1TB for staff and faculty), Microsoft OneDrive (up to 1TB for staff, faculty, and students), and Google Drive (unlimited for all staff, faculty, and students). UTO provides network storage to individual business units via on-premise network storage appliances. Research Computing provides 100GB of home directory storage for users of the Agave Cluster, as well as access to the high-speed short-duration scratch environment for cluster jobs. The Globus data movement platform provides resilient high-speed access to data stored on Research Computing systems.