

## Large-scale Computing and Visualization Systems at the Cybermedia Center



### Overview of high-performance computing environment at the CMC

Large-scale computing systems (SX-ACE, VCC, and OCTOPUS), and large-scale visualization systems are deployed on CMC-Supercomputer network, a.k.a CMC-SCinet, a low-latency and wide-bandwidth network. This architectural design allows users to access to large-scale storage systems, perform large-scale high-performance computation and analysis on our large-scale computing systems, and then visualize its computation and analysis results without losing any important information on our large-scale visualization systems.

### Large-scale Computing System

The large-scale computing systems at the CMC are classified into (1) Vector-typed Supercomputer and (2) Scalar-typed Supercomputer.

#### SX-ACE



Type: Vector  
OS: Super UX  
# of nodes: 1536  
# of cores: 6144  
Peak performance: 423 TFlops

**SX-ACE** is a "clusterized" vector-typed supercomputer, composed of 3 cluster, each of which is composed of 512 nodes. Each node equips 4-core multi-core CPU and a 64 GB main memory. These 512 nodes are interconnected on a dedicated and specialized network switch, called IXS (Internode Crossbar Switch) and form a cluster. Note that IXS interconnects 512 nodes with a single lane of 2-layer fat-tree structure and as a result exhibits 4 GB/s for each direction of input and output between nodes.

#### Library

MathKeisan(BLAS, LAPACK, etc)
ASL, ASLSTAT, ASLQUAD
MPI/SX
HPF/SX
XMP

#### Application

AVS/Express	TensorFlow	OpenFOAM
NICE DCV	Torch	GAMESS
VisIt	Caffe	ABINIT-MP
Gaussian09	Theano	Octave
IDL	Chainer	Relion
LAMMPS	Quantum Espresso	GROMACS

#### OCTOPUS



Type: Scalar  
OS: Linux  
# of nodes: 319  
Peak performance: 1,463 Pflops  
Interconnect: InfiniBand EDR

**OCTOPUS** means Osaka university Cybermedia cenTer Over-Petascale Universal Super-computer. OCTOPUS is a new cluster system supposed to start its operation in December 2017, this system is composed of different types of 4 cluster, General purpose CPU nodes, Xeon Phi nodes, GPU nodes and Large-scale shared-memory nodes, total 319 nodes. These nodes and large-scale storage "EXAScaler" are interconnected on InfiniBand EDR and form a cluster.

#### Library

Intel MKL(BLAS, LAPACK, etc)	IntelMPI, OpenMPI, MVAPICH2
ASL, ASLSTAT, ASLQUAD	XMP

#### General purpose CPU node × 236

CPU: Intel Xeon Gold 6126 × 2 (2.6 GHz, 12 cores)  
Memory: 192 GB  
Performance: 1,996 TFlops

#### Xeon Phi node × 44

CPU: Intel Xeon Phi 7210 (1.3 GHz, 64 cores)  
Memory: 192 GB  
Performance: 2,662 TFlops

#### GPU node × 37

CPU: Intel Xeon Gold 6126 × 2 (2.6 GHz, 12 cores)  
Memory: 192 GB  
Accelerator: NVIDIA Tesla P100×4  
Performance: 23.196 TFlops

#### Large-scale shared-memory node × 2

CPU: Intel Xeon Platinum 8153 × 8 (2.0 GHz, 16 cores)  
Memory: 6 TB  
Performance: 8,192 TFlops

#### Sstorage

File system: DDN EXAScaler (Lustre)  
capacity: 3.1PB

#### VCC (PC Cluster for large-scale visualization)



Type: Scalar  
OS: Linux  
# of nodes: 69  
Peak performance: 31,104 TFlops  
Accelerator: NVIDIA Tesla K20×59

#### Library

Intel MKL(BLAS, LAPACK, etc)
Intel MPI, Open MPI

**VCC** is a cluster system composed of 69 nodes. These nodes are interconnected on InfiniBand FDR and form a cluster. Also, this system has introduced ExpEther, a system hardware virtualization technology. Each node can be connected with extension I/O nodes with which GPU resource, and SSD on 20Gbps ExpEther network. A major characteristic is that this cluster system is reconfigured based on user's usage and purpose by changing the combination of node and extension I/O node.

### Large-scale Visualization System



The large-scale visualization systems at the CMC are set up on Campus and on CMC's Ume-kita Office. Large-scale and interactive visualization processing becomes possible through the dedicated use of PC cluster for large-scale visualization (VCC) on these systems. The visualization system in Campus is composed of 24 50-inch Full HD (1920x1080) stereo projection module (Barco OLS-521). Also, OptiTrackFlex13, a motion capturing system has been introduced in this visualization system. By making use of the software corresponding to the motion capturing system, interactive visualization leveraging Virtual Reality (VR) becomes possible.