

HPC Clusters Architecture

High-Performance Computing (HPC) clusters are designed for parallel processing, enabling complex computations across multiple nodes. An HPC cluster typically consists of the following key components:

1. Architecture Components

1.1 Head Node (Master Node):

- Manages the cluster.
- Handles scheduling, job submission, and monitoring.
- Examples: Slurm, PBS, or Torque for workload management.

1.2 Compute Nodes (Worker Nodes):

- Perform the actual computation.
- Connected through high-speed networks.

1.3 Storage:

- Centralized or distributed storage to share data across nodes.
- Examples: NFS, Lustre, GPFS.

1.4 Network:

- High-speed interconnects like InfiniBand or Ethernet for communication between nodes.

1.5 Management Interface:

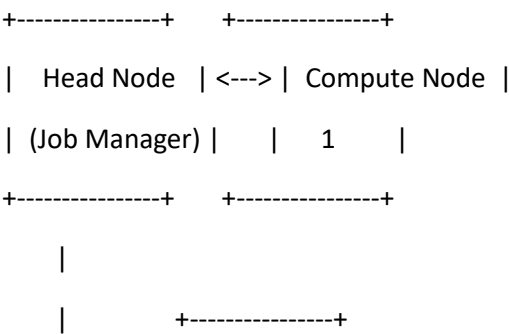
- Tools to configure, monitor, and maintain the cluster.
- Examples: Ganglia, Prometheus.

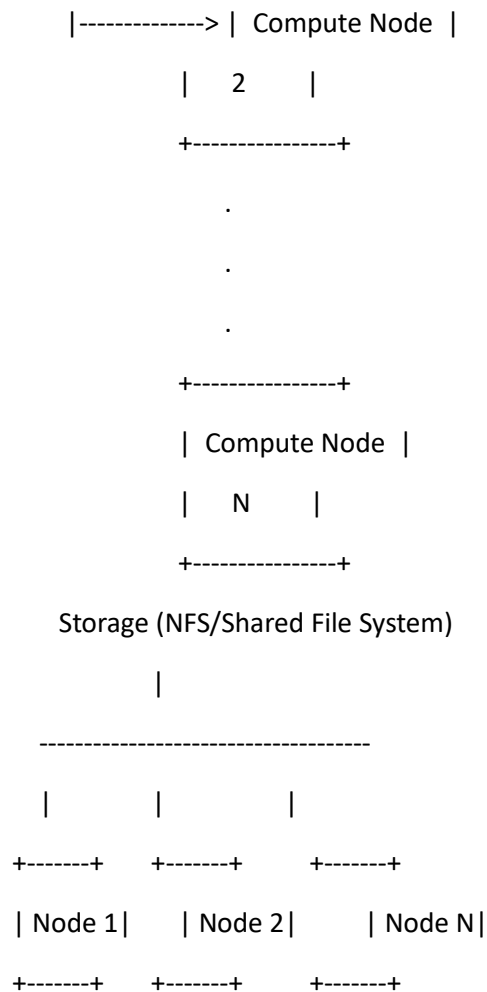
2. Logical Diagram

Here's a textual representation of the architecture:

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3. Example Commands for HPC Cluster Setup

Below is an example setup using **Slurm Workload Manager**.

Step 1: Install Required Software

On all nodes, install necessary packages.

bash

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```
sudo apt update && sudo apt install slurm-wlm munge nfs-common -y
```

Step 2: Configure Head Node

1. Install Slurm Controller:

bash

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```
sudo apt install slurmctld -y
```

2. Create Slurm Configuration (/etc/slurm/slurm.conf):

bash

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ControlMachine=headnode

NodeName=compute[1-4] CPUs=4 State=UNKNOWN

PartitionName=debug Nodes=ALL Default=YES MaxTime=INFINITE State=UP

3. Start Slurm Controller:

bash

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sudo systemctl start slurmctld

Step 3: Configure Compute Nodes

1. Install Slurm Daemon:

bash

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sudo apt install slurmd -y

2. Update Configuration (/etc/slurm/slurm.conf): Same as on the Head Node.

3. Start Slurm Daemon:

bash

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sudo systemctl start slurmd

Step 4: Shared Storage

1. Export Directory on Head Node:

bash

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sudo apt install nfs-kernel-server -y

sudo mkdir /shared

echo "/shared *(rw,sync,no_subtree_check)" | sudo tee -a /etc/exports

sudo exportfs -a

sudo systemctl restart nfs-server

2. Mount Shared Directory on Compute Nodes:

bash

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```
sudo apt install nfs-common -y
```

```
sudo mount headnode:/shared /shared
```

Step 5: Submit Jobs

Submit a test job to the cluster:

```
bash
```

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```
echo -e "#!/bin/bash\nnsrun hostname" > test_job.sh
```

```
chmod +x test_job.sh
```

```
sbatch test_job.sh
```

4. Diagram

Here is the diagram illustrating the HPC cluster architecture. Let me know if you'd like further explanation or modifications!