MPICH-GX: Message Passing Interface CHameleon-Grid eXensible

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Agenda

- Motivation
- What is MPICH-GX ?
  - Private IP Support
  - Fault Tolerance Support
- Experiment
- Conclusion

The Problems (1/2)

- Running on a Grid presents the following problems:
  - Standard MPI implementations require that all compute nodes are visible to each other, making it necessary to have them on public IP addresses
    - Public IP addresses for assigning to all compute nodes aren't always readily available
    - There are security issues when exposing all compute nodes with public IP addresses
    - At developing countries, the majority of government and research institutions only have public IP addresses

The Problems (2/2)

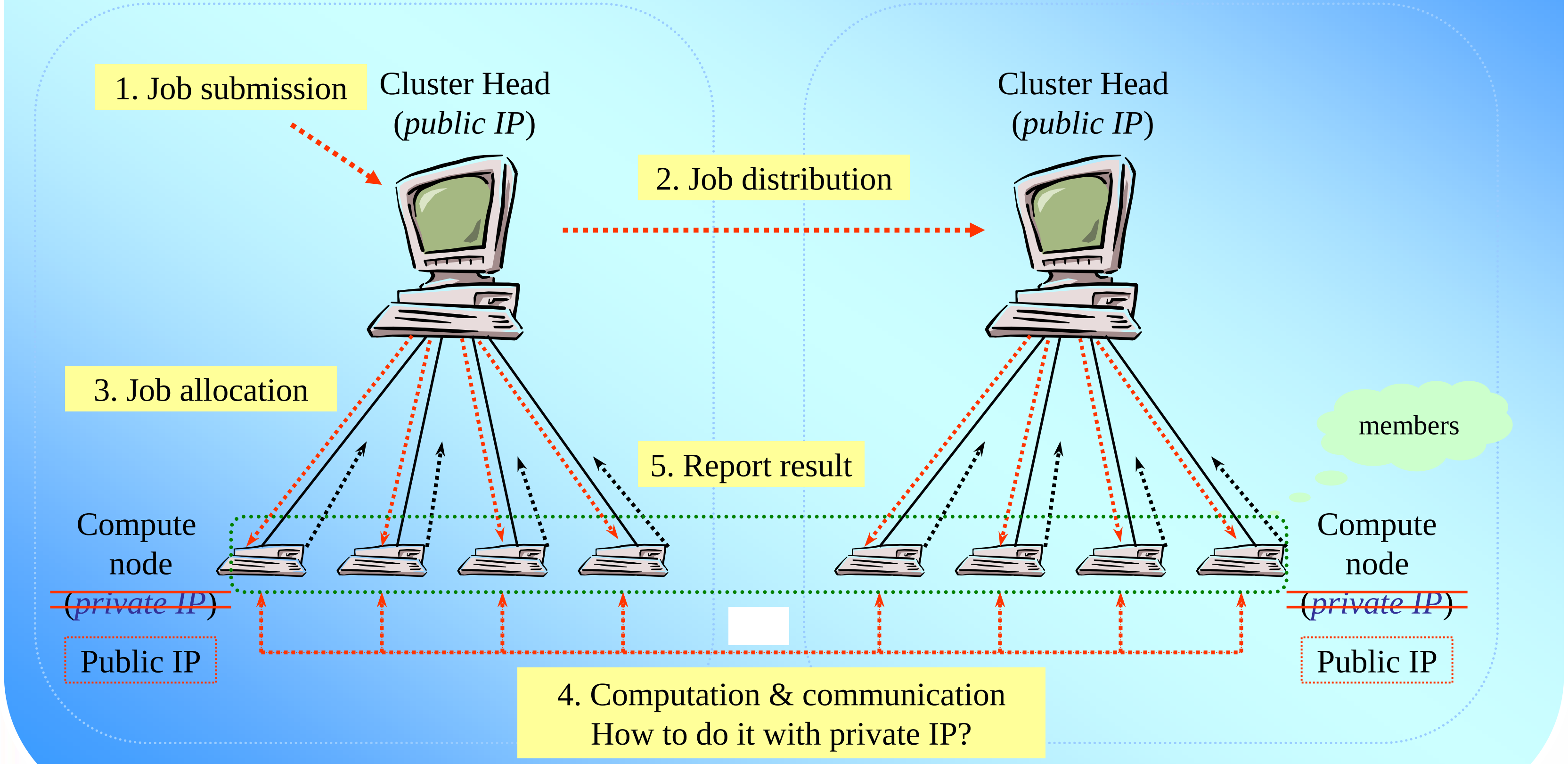
- Running on a Grid presents the following problems: (cont.)
  - What if a node is broken or a running process is die in geographically distributed Grid environments?
    - Difficult to manually find the broken node and the failure process among many compute nodes

What is MPICH-GX?

- MPICH-GX is a patch of MPICH-G2 to extend following functionalities required in the Grid.
  - Private IP Support
  - Fault Tolerant Support

Private IP Support

- MPICH-G2 does not support private IP clusters



1. Job submission

2. Job distribution

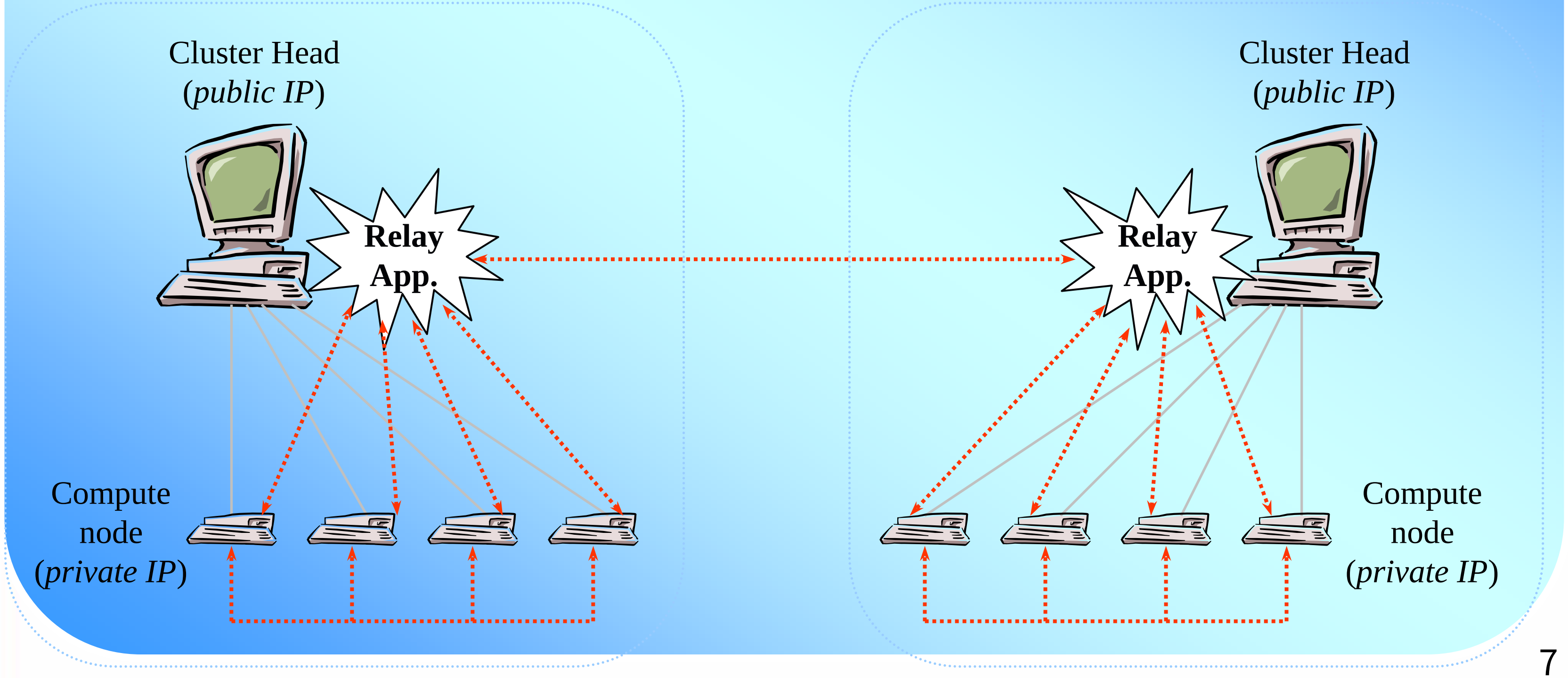
3. Job allocation

4. Computation & communication
How to do it with private IP?

5. Report result

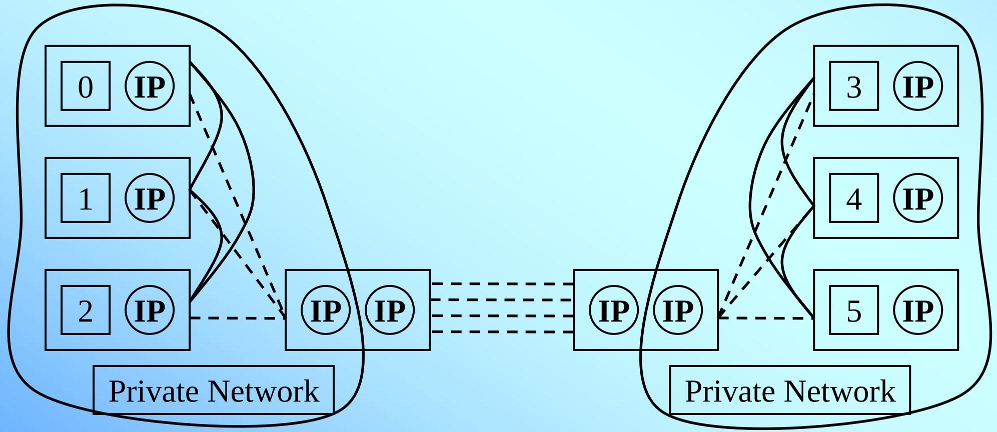
How To Penetrate Firewalls (1/2)

- User-level proxy
  - Use separate application
  - It is easy to implement and portable
  - But it causes performance degradation due to additional user-kernel level switching



How To Penetrate Firewalls (2/2)

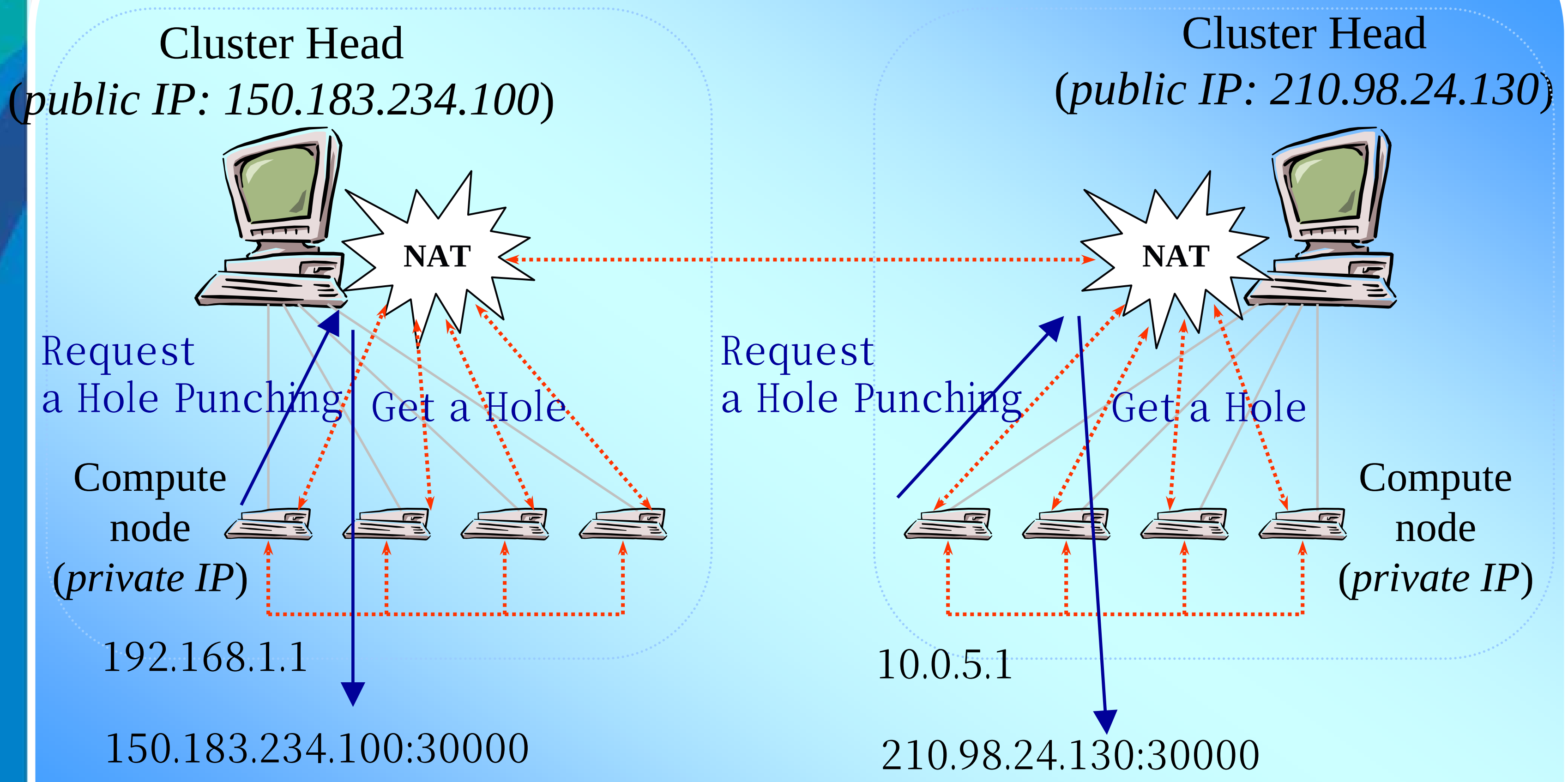
- Kernel-level proxy
  - Generally, it is neither easy to implement nor portable
  - But it can minimize communication overhead due to firewall
  - NAT (Network Address Translation)
    - Main mechanisms of Linux masquerading



NAT Hole Punching (1/2)

- Easily applicable kernel-level solution
  - It is a way to reach otherwise unreachable hosts with a minimal additional effort
  - All you need is a server that coordinates the connections
  - When a client registers with server, it records two endpoints for that client

NAT Hole Punching (2/2)



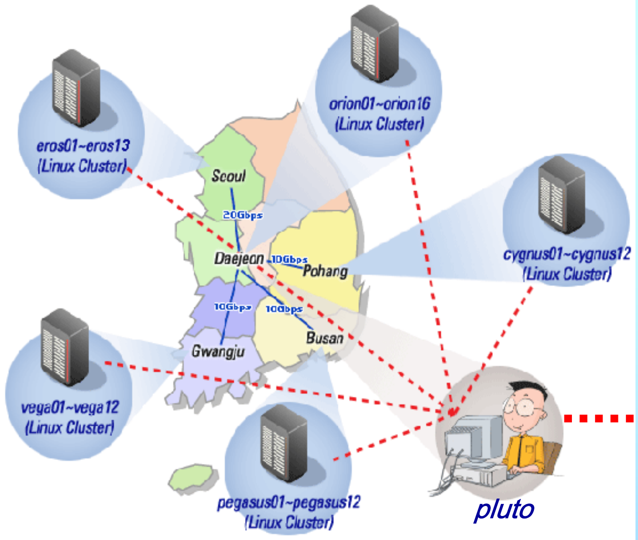
Fault Tolerant Support

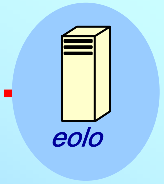
- We provide a checkpointing-recovery system for Grid.
- Our library requires no modifications of application source codes.
  - ➔ affects the MPICH communication characteristics as less as possible.
- All of the implementation have been done at the low level, that is, the abstract device level of MPICH

Experiment (1/2)

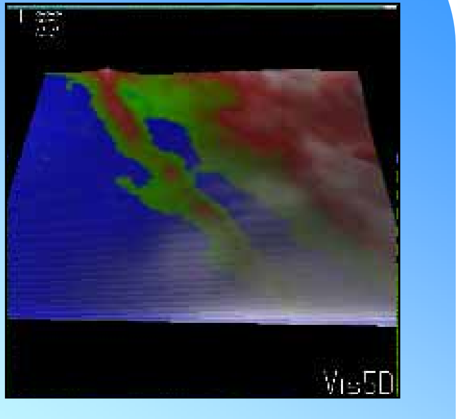
- Experiment of MPICH-GX using Atmospheric application (MM5/WRF)
- Collaboration efforts with PRAGMA people (CICESE in Mexico, SDSC)
- Testbed
  - Geographically distributed 5 Linux Clusters: Daejeon, Seoul, Busan, Gwangju, Pohang
  - Network bandwidth between nodes is 1Gbps

Experiment (2/2)

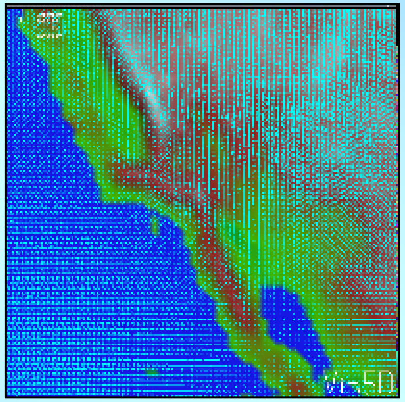




HHurricane Marty Simulation



SSantana Winds Simulation



Analyze the output

- 12 nodes on single cluster (orion cluster): 17.55min
- 12 nodes on cross-site
  - 6 nodes on orion + 6 nodes on eros, where all nodes have public IP: 21min
  - 6 nodes on orion + 6 nodes on eros, where where the nodes on orion have private IP and the nodes on eros have public IP: 24min
- 16 nodes on cross-site
  - 8 nodes on orion + 8 nodes on eros, where all nodes have public IP: 18min
  - 8 nodes on orion + 8 nodes on eros, where where the nodes on orion have private IP and the nodes on eros have public IP: 20min

Conclusion

- MPICH-GX is a patch of MPICH-G2 to provide useful functionalities for supporting the private IP and fault tolerance
- The application of WRF model work well with MPICH-GX at geographically distributed Grid environments.
- The functionality of the private IP could be usable practically, and the performance of the private IP is reasonable.

Q&A

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Thank you

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