COSMOGRID

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CosmoGrid
Details at: http://wiki.2048x2048x2048.org

- A cosmological N-body simulation with 10 billion particles
- Higher resolution, higher accuracy and better performance
CosmoGrid:
A large scale cosmological simulation of a limited volume
Composition of the Universe

- 73% Dark Energy
- 23% Dark Matter
- 3.6% Intergalactic Gas
- 0.4% Stars, etc.
The CosmoGrid project

- **Motivation:** previous simulations found >100 times more substructure than is observed

- Simulate large structure formation in the Universe
  - Dark Energy (cosmological constant)
  - Dark Matter (particles)

- **Method:** Cosmological $N$-body code

- **Computer:** Intercontinental supercomputer grid
Too much substructure in simulations
The hardware setup

- 2 supercomputers:
  - 1 in Amsterdam (60Tflops Power6 @ SARA)
  - 1 in Tokyo (30Tflops Cray XD0-4 @ CFCA)
- Both computers are connected via an intercontinental optical 10Gbit/s network
Z=0 result of test calculation
(N=128³)

30Mpc on the side
32nodes Amsterdam
32nodes Tokyo
Regular network
CosmoGrid network

Network Topology for Cosmo Grid experiment
- Round Trip Performance Test -

VLAN 3780: 10.0.0.0/24
VLAN 3781: 10.0.1.0/24

10G STM-64/10GE WAN-PHY
10GE LAN-PHY

Mitaka, Tokyo
Cray TX4
10.0.0.2/24
10.0.1.2/24

Foundry RX3
10.0.0.1/24
10.0.1.1/24

Foundry MLX

NAOJ

SINET3 Laser 2 Net
Foundry N140G
T-LEX
NTT-com Otemachi, Tokyo

JGN2plus
Hitachi GS4K
KDDI Otemachi, Tokyo

JGN2plus
Hitachi GS4K
B26 Wilshire, L.A.

JGN2plus
Hitachi GS4K

NorthWestern Univ.
710 Lakeshore Chicago

JGN2plus
Force10 E2600

SARA (NetherLight)
Huygens
Amsterdam

StarLIGHT
Nortel HDX
Force10 E1200

IRNC circuit

10.0.0.254/24
10.0.1.254/24

10G STM-64/10GE WAN-PHY
10GE LAN-PHY

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Network and parallelization strategy
Performance Power5+ on Huygens

Huygens Power5+ measurements

\[ t \text{ [s/step]} \] vs. \[ \log_{10} N_p \]

- N=128
- N=256
- N=512
- N=1024
- N=2048
Questions ?