Filesystems and I/O Balance on the NERSC T3E

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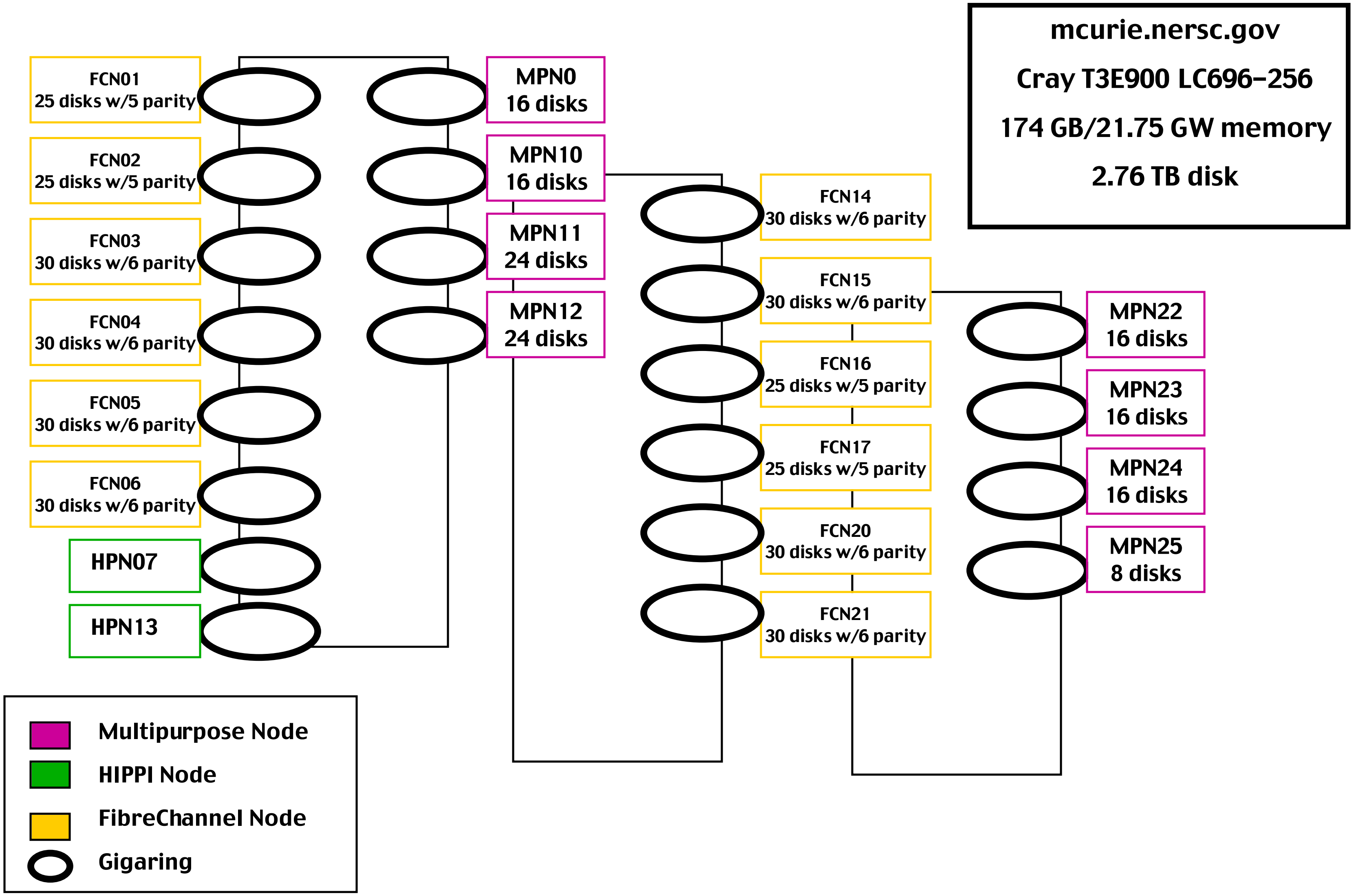
What is NERSC?

- National Energy Research Scientific Computing Center
  - Funded by DOE Office of Science
  - Located at Lawrence Berkeley National Lab
  - Provides Computational Resources to the following programs
    - Fusion Energy
    - High Energy and Nuclear Sciences
    - Basic Energy Sciences
    - Biology and Environmental Research
    - Computational and Environmental Research
  - Approximately 2500 Users from Major Universities and Government Labs
  - Hardware: 696 PE T3E-900, 1 J90 SE system (32 CPUs) & 3 SV1 (64 processors)

Mcurie – The NERSC T3E

- T3E 900 with 696 PEs running UNICOS/MK 2.0.4.67
- 644 APP PEs
- 256 MB per PE
- 22 Gigarings
- 12 FCNs
- 8 MPNs
- 2 HPNs



mcurie.nersc.gov

Cray T3E900 LC696-256

174 GB/21.75 GW memory

2.76 TB disk

FCN01 25 disks w/5 parity

FCN02 25 disks w/5 parity

FCN03 30 disks w/6 parity

FCN04 30 disks w/6 parity

FCN05 30 disks w/6 parity

FCN06 30 disks w/6 parity

HPN07

HPN13

MPN0 16 disks

MPN10 16 disks

MPN11 24 disks

MPN12 24 disks

FCN14 30 disks w/6 parity

FCN15 30 disks w/6 parity

FCN16 25 disks w/5 parity

FCN17 25 disks w/5 parity

FCN20 30 disks w/6 parity

FCN21 30 disks w/6 parity

MPN22 16 disks

MPN23 16 disks

MPN24 16 disks

MPN25 8 disks

🟪	Multipurpose Node
🟩	HIPPI Node
🟨	FibreChannel Node
○	Gigaring

NERSC Job Mix – Application Mix

- Applications from the fields of
  - Chemistry
  - Materials Science
  - Fusion Energy
  - Geophysics
  - Biology
  - High Energy Nuclear Physics
  - Climate Modeling
  - Astrophysics
  - Computational Fluid Dynamics
- Mostly user-written codes

NERSC Job Mix – Diverse and Dynamic

App Size (PEs)	% of all Apps	% of PE Hours
2 - 16	56	6
17 - 64	38	56
65 - 128	5	29
129 - 512	1	9

App Run Time	% of all Apps	% of PE Hours
0 – 10 min	56	1
10 – 30 min	23	10
0.5 – 3.5 hr	17	49
3.5 – 12.0 hr	4	40

Mix of Development, Capacity and Capability computing

Mcurie Filesystems – performance

- 68 Fibre Channel disk arrays
- Striping of swap and checkpoint
- pcache for metadata optimization on root, usr, opt
- primary/secondary partitions
- remote mount file servers

Mcurie Filesystems – resiliency

- Mirroring of primary partitions for homes and usrtmp
- Alternate path for all arrays
- Sized for feasible dump/restore

Mcurie Filesystems – swap and checkpoint

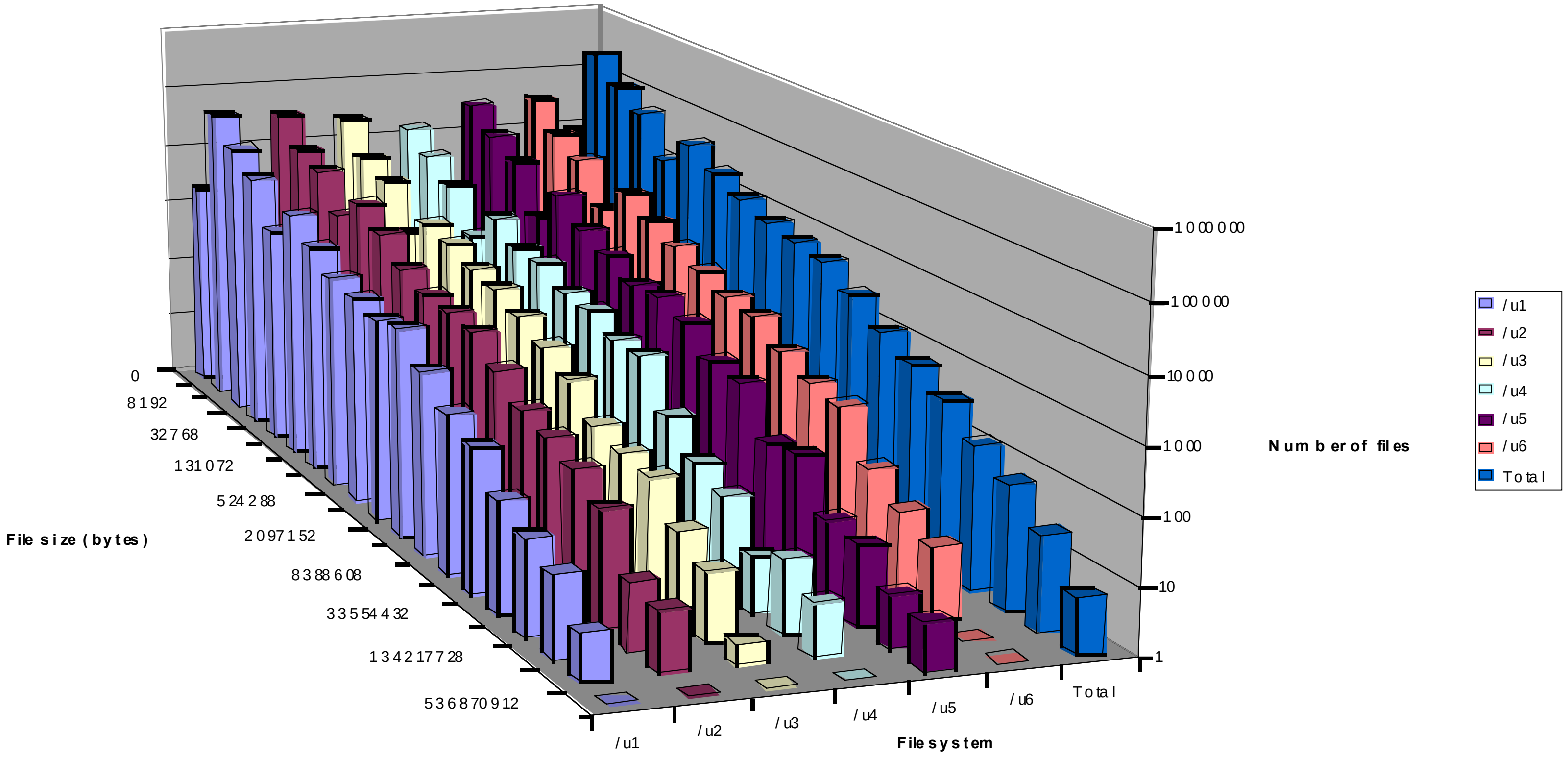
- NERSC uses both checkpointing and gang scheduling for system scheduling
- Swap – 383 Gigabytes – 2.4 times APP memory
- Checkpoint – 582 Gigabytes – 3.6 times APP memory
- Filesystems have 5 logical partitions that are 5 or 6-way striped on FCN disk
- 800 MB/sec observed on checkpoint
- Full machine checkpoint regularly under 5 minutes

Mcurie Filesystems – homes

- Multiple filesystems to distribute user load and risk
- Configured for full mirroring
- Six filesystems – 25 GB on MPN disks
- Approximately 150 users per filesystem

Mcurie Filesystems – homes

File distribution on mcurie homes



Mcurie Filesystems – /usr/tmp

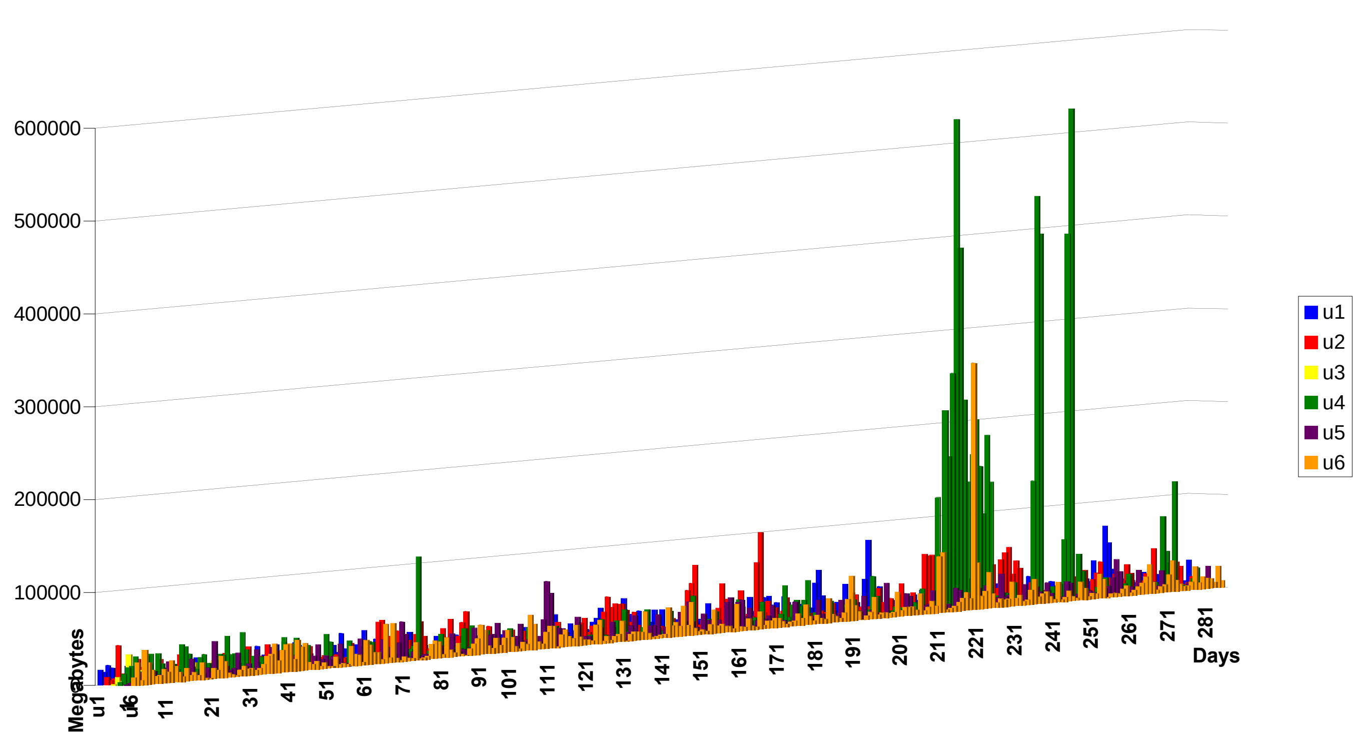
- Main area for user data files
- 1.5 TB of FCN disk arrays
- Primary/secondary partition configuration to allow mirroring of metadata

Mcurie filesystems – space management

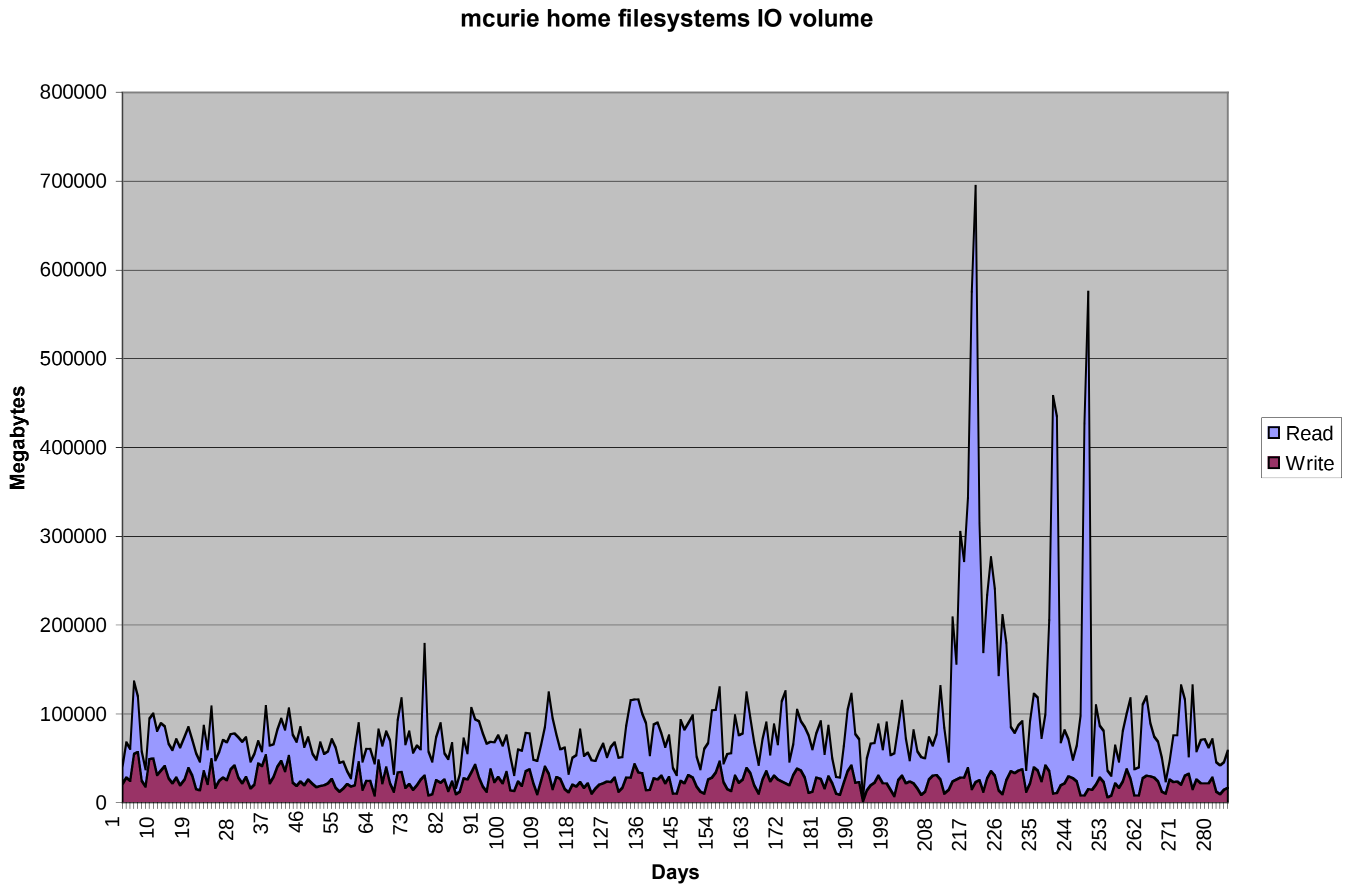
- Hard quotas on user-writable filesystems
- Home filesystems – 4 GB and 3500 inodes
- /usr/tmp filesystem – 70 GB and 6000 inodes
- Homes migrated to HPSS under Cray DMF control
- /usr/tmp – purging of files inactive for 14 days

Mcurie Filesystems – homes

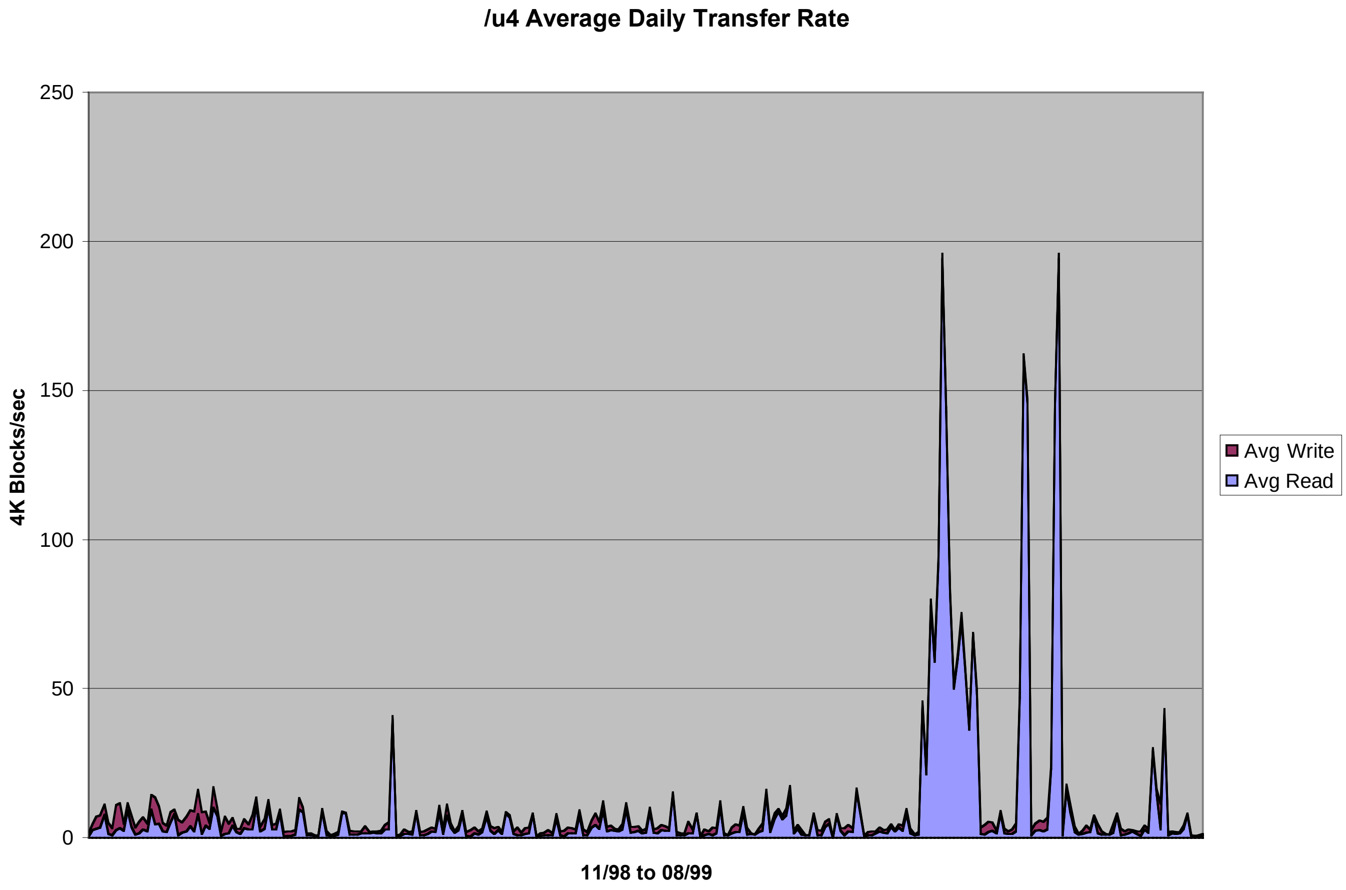
mcurie home IO volume - combined



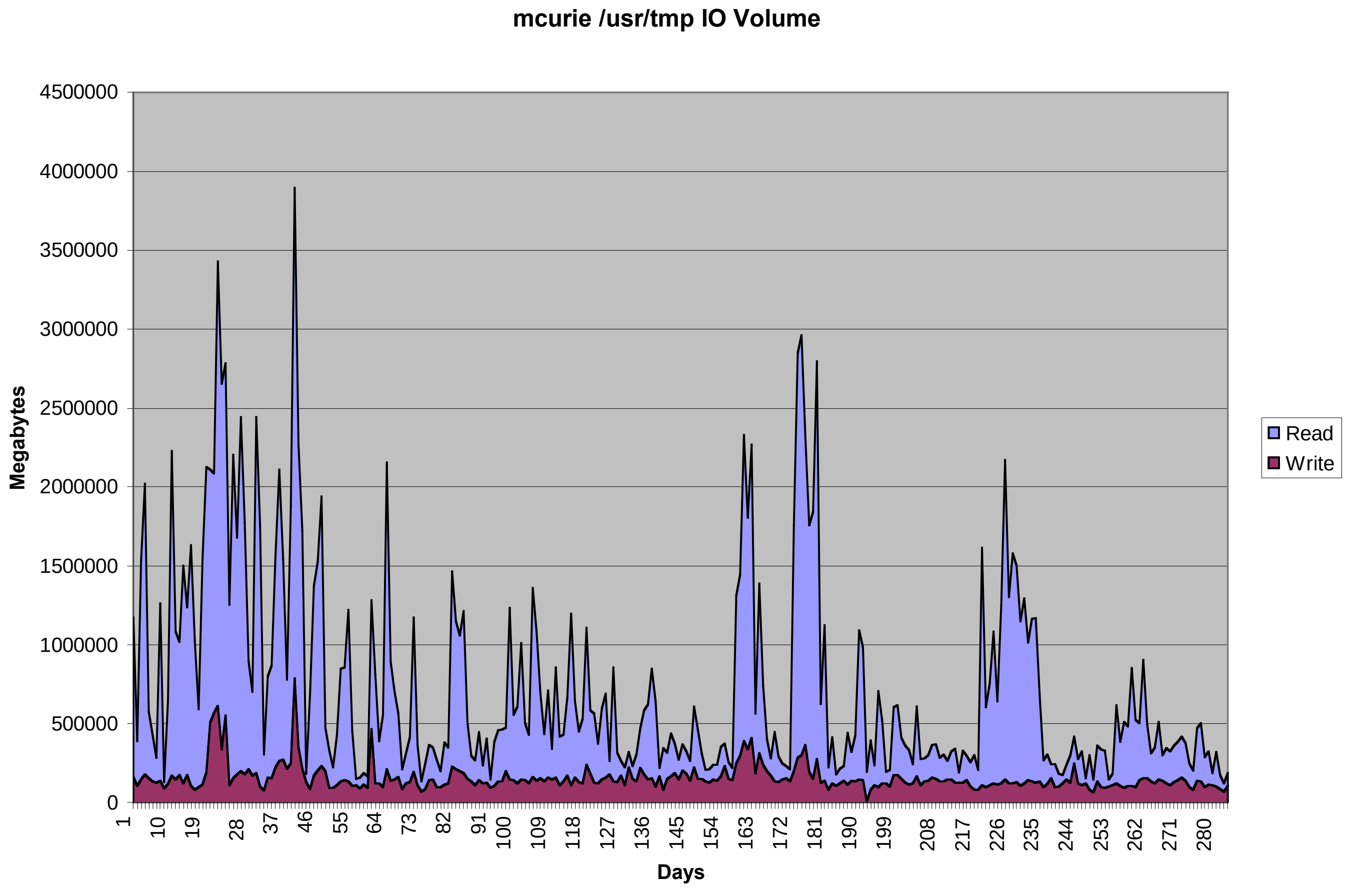
Mcurie Filesystems – homes



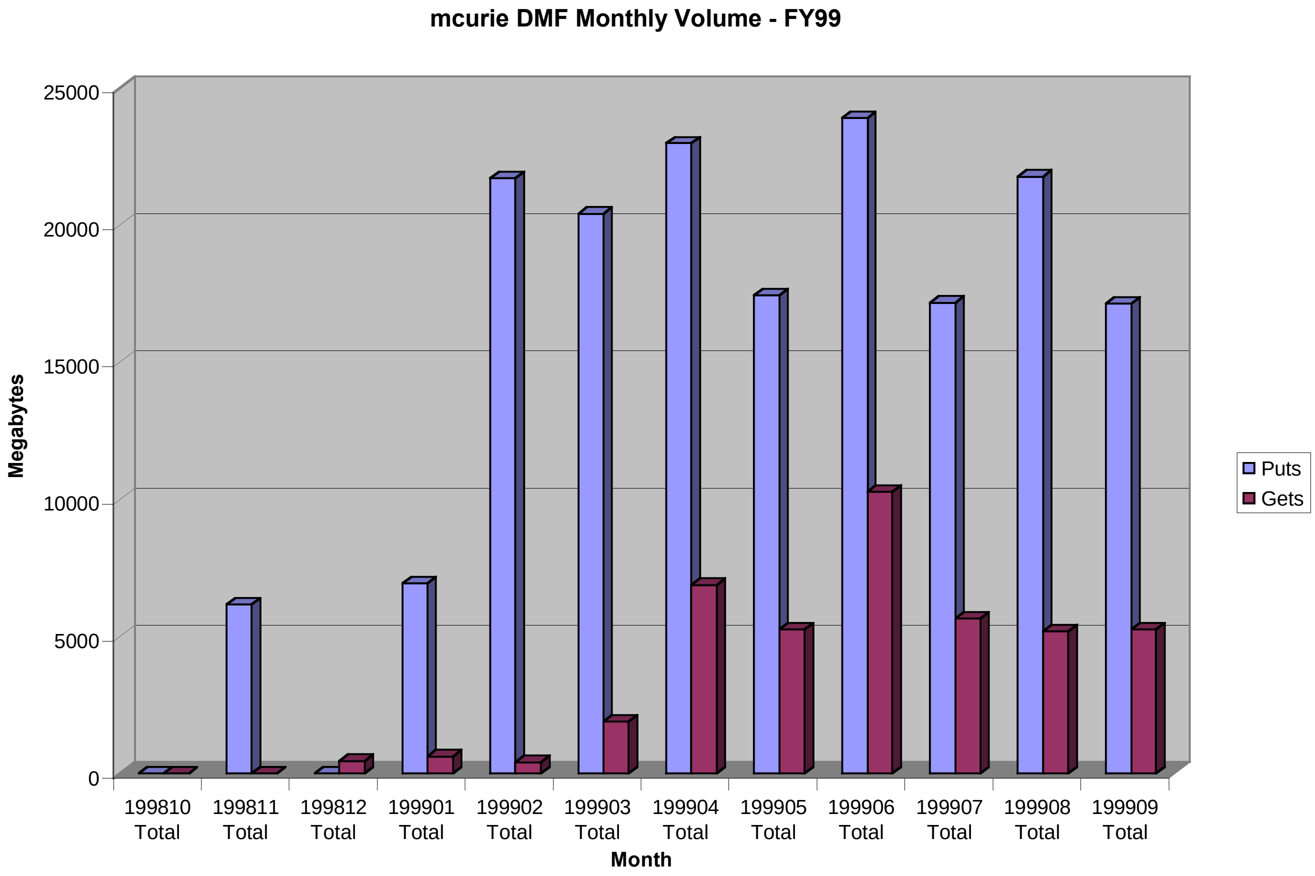
Mcurie Filesystems – home



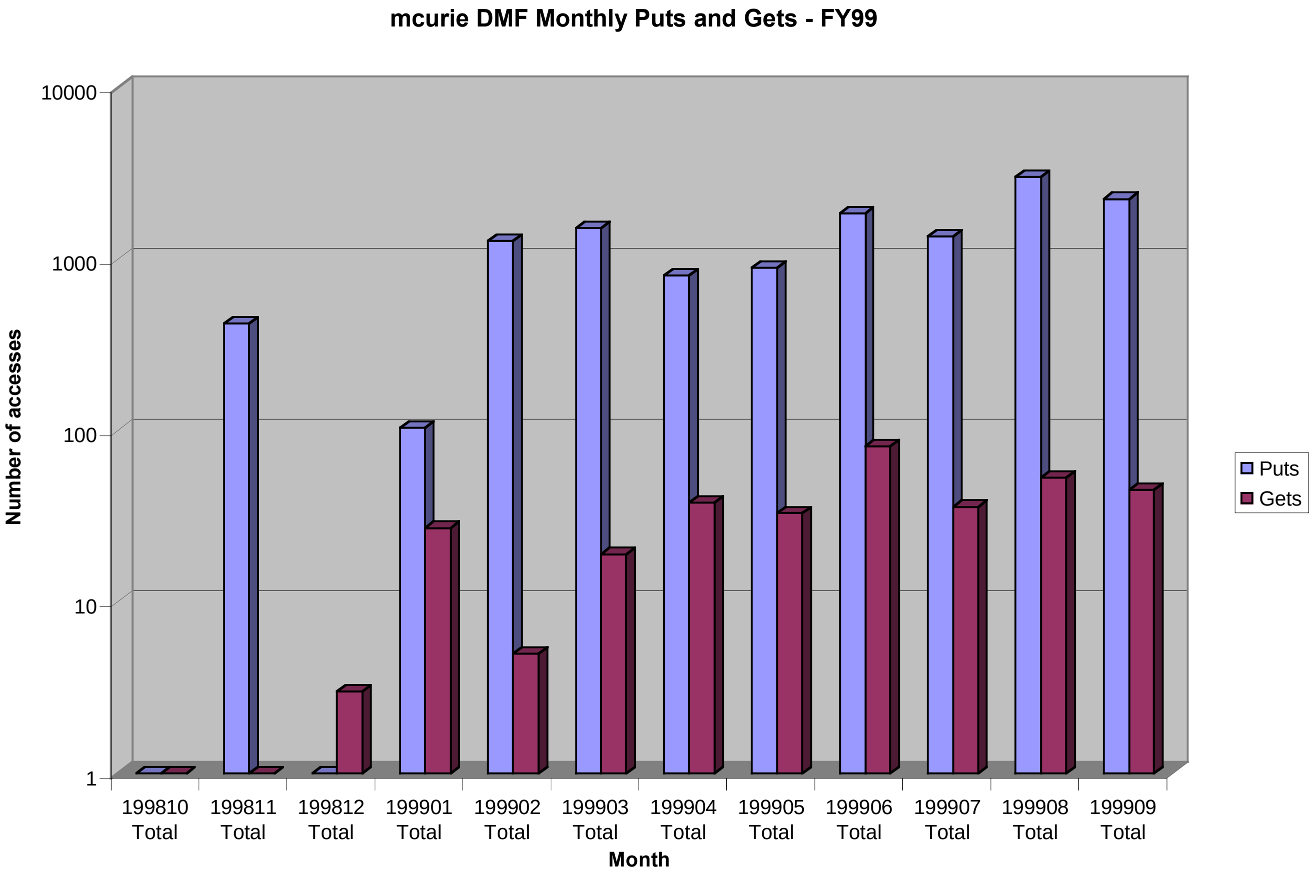
Mcurie filesystems – /usr/tmp



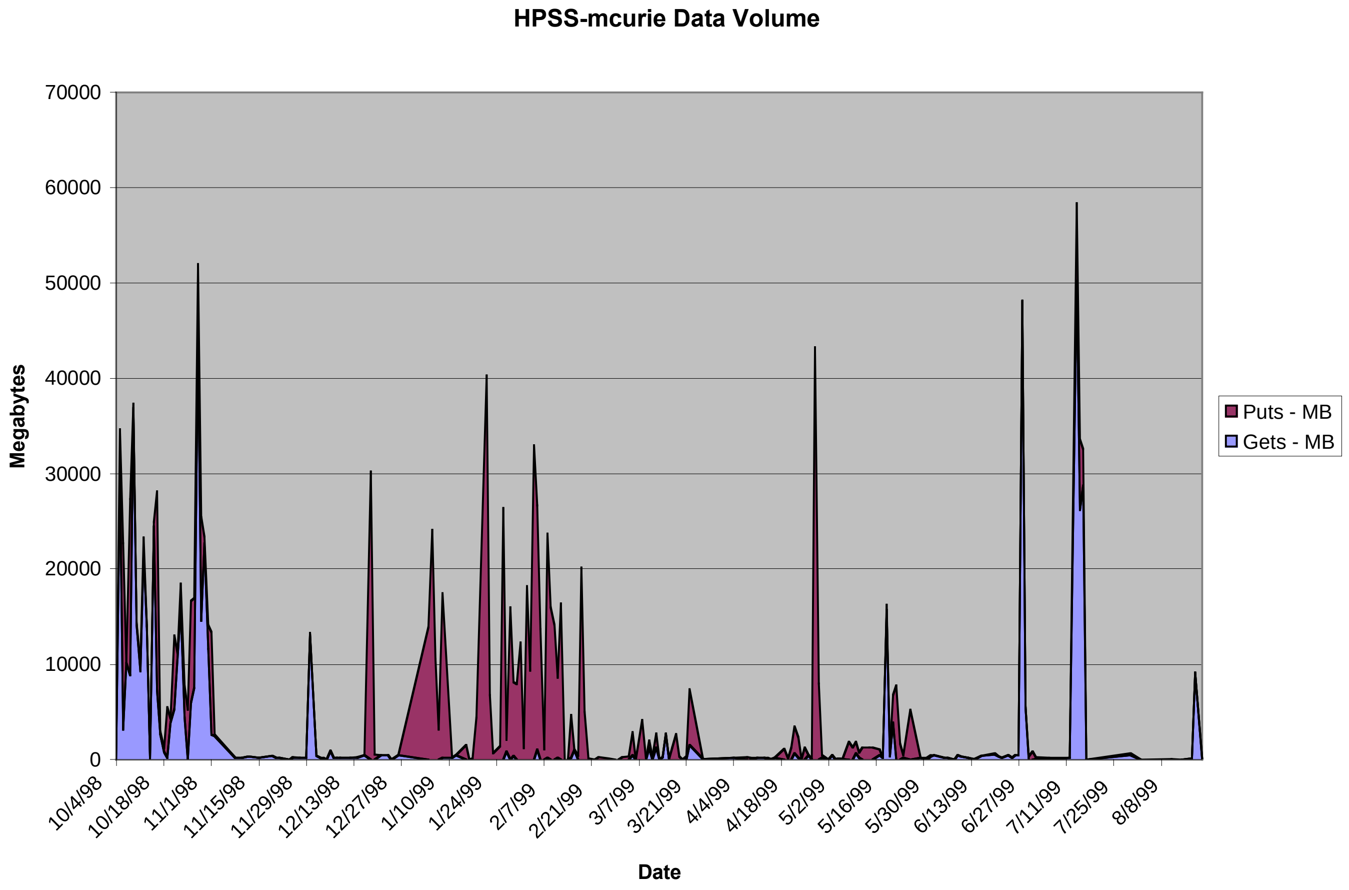
Mcurie Filesystems – DMF traffic



Mcurie Filesystems – DMF traffic



Mcurie Filesystems – HPSS traffic



Mcurie Filesystems – Conclusions

- User home filesystems are well balanced in file distribution and transfer load
- Data migration is a relief valve for homes, but not a critical resource yet
- /usr/tmp filesystem buffers user intermediate data
- HPSS is being used as a long-term archive resource for user data
- NERSC's T3E storage resources are successful in supporting the growing utilization of the system