Notes

- **OpenMP assignment due Monday**: don't compile for profiling (with `–xpg`) and for OpenMP at same time
  - use `omp_get_wtime()` to time parts of your OpenMP code – OK to call from different threads
  - other questions?
- Need more volunteers for paper/questions
- Sample topics for group project posted soon
- Talk to me about GRA positions

Ethernet

- One of the first, and definitely the most successful, local area network (LAN) protocol and implementation
- Notice that also targeted at multiprocessing, not just distributed computing
- CSMA/CD wire protocol – carrier sense multiple access, with collision detection
  - a shared physical medium, even with repeaters
  - randomized exponential backoff after a collision
  - error detection using checksums on medium, still need end-to-end error detection since whole packets can be lost
- Modern Ethernet protocols are different – for a switched physical medium to scale better
  - original at 3Mb/s (shared), 1Gb/sec (switched) common now, with 10Gb/sec and soon 100Gb/sec in HPC environments

Quadrics Network

- Elan network interface
  - connects host computer to the switch
  - implements message passing protocols, including MPI, to minimize host CPU load
  - data moved through DMA engine
  - provides memory that can be mapped into host address space (virtual memory mapping), to minimize copies
  - multiple threads to deal with different activities (like an early multicore processor)
- Elite switch
  - connect in a fat tree, to build larger networks from 8x8 component switches
  - source routed from Elan network interface, with a series of link tags
    - wormhole routing - virtual circuit to send packet as sequence of flits
  - supports broadcast packets too – multiple destinations
Quadrics Network (cont.)

- **Elan supports global VM space**
  - can map memory on other nodes Elans into local space
  - requires synchronizing MMU in Elan (page tables, TLB, etc.)
    - with host MMU, so VM mappings are the same
  - then can do DMAs to move data between Elans

- **Programming models**
  - Elan3lib – lowest level, hardware specific, highest performance
    - memory mapping, event notification, remote DMAs
  - Elanlib/Tports – middle level, machine independent, lower performance
    - point to point message passing, with tags, both blocking and non-blocking
  - MPI/Shmem – top level protocols, worst performance, from software overhead