



ET International

# HPC Runtime Software

SC'11

# Agenda

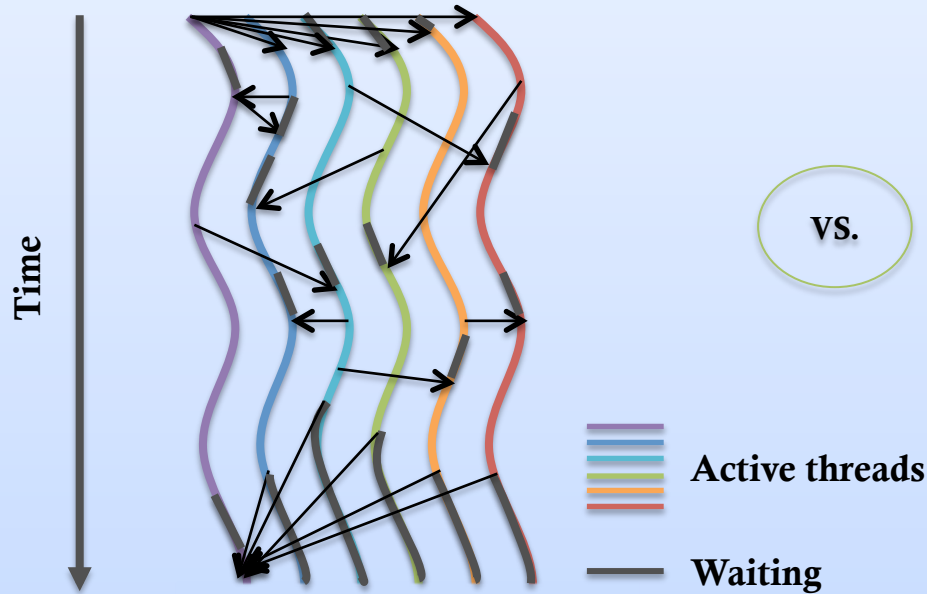
- Intro (10 minutes)
- Runtime System Experiences
  - ▶ 10-12 minutes: Charm++ (Dr. Kale)
  - ▶ 10-12 minutes: ParalleX/HPX (Dr. Sterling)
  - ▶ 10-12 minutes: SWARM (Dr. Khan)
  - ▶ 10-12 minutes: OCR (Dr. Sarkar)
- Questions to the audience (20 minutes)
- Comments from the audience (10 minutes)

# Future Challenges

- Many-core is coming
  - ▶ Single-threaded programs with OpenMP acceleration will no longer fully exploit hardware
  - ▶ **New programming paradigms are necessary**
- Hardware is getting more heterogeneous
  - ▶ Irregular mix of Architecture, Processor Speeds, Memory Layout, etc.
  - ▶ **Current hybrid programming techniques (MPI+ OpenMP + OpenCL) are not maintainable with growing complexity**
- Application Computation Irregularity
  - ▶ Elastic RTM
  - ▶ Full Wave Inversion
  - ▶ **Static scheduling can no longer properly load balance**

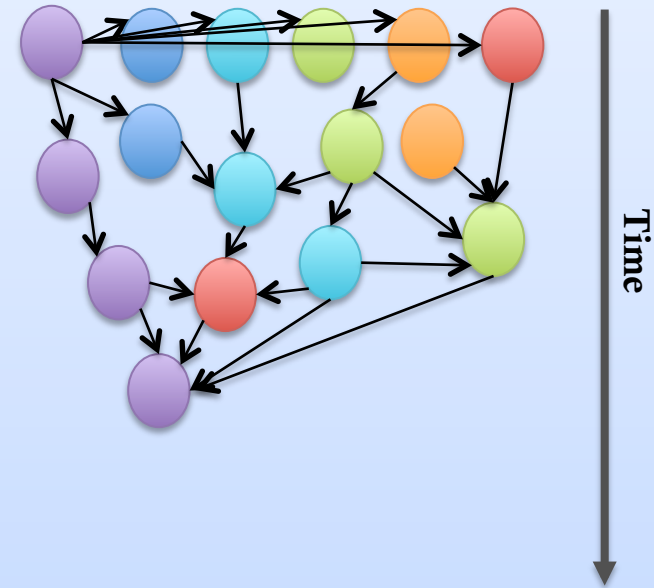
# Runtime System Comparisons

## MPI, OpenMP, OpenCL



- Communicating Turing Machines
- Bulk Synchronous
- Message Passing

## New Runtime Systems



- Asynchronous Event-Driven Tasks
- Dependencies
- Constraints
- Resources
- Active Messages



# Properties of Future Runtime Systems

- Expose and exploit concurrency of application
  - ▶ Hide latency
  - ▶ Prioritize critical path
  - ▶ ... but don't expose too much concurrency!
- Expose and exploit data locality
  - ▶ Minimize data movement between memory hierarchies
  - ▶ Maximize data reuse
- Low overhead object oriented type system for runtime introspection
- High performance lock-free data structures
- Abstraction and unification of user/runtime interactions for productive heterogeneous programming
- Dynamic mapping of application needs and available resources

# Questions

- In what contexts does your runtime improve performance over existing mainstream HPC runtimes (OpenMP/MPI)?
- What are the benefits of your runtime?
- What are the key runtime concepts you would like the audience to walk away with?