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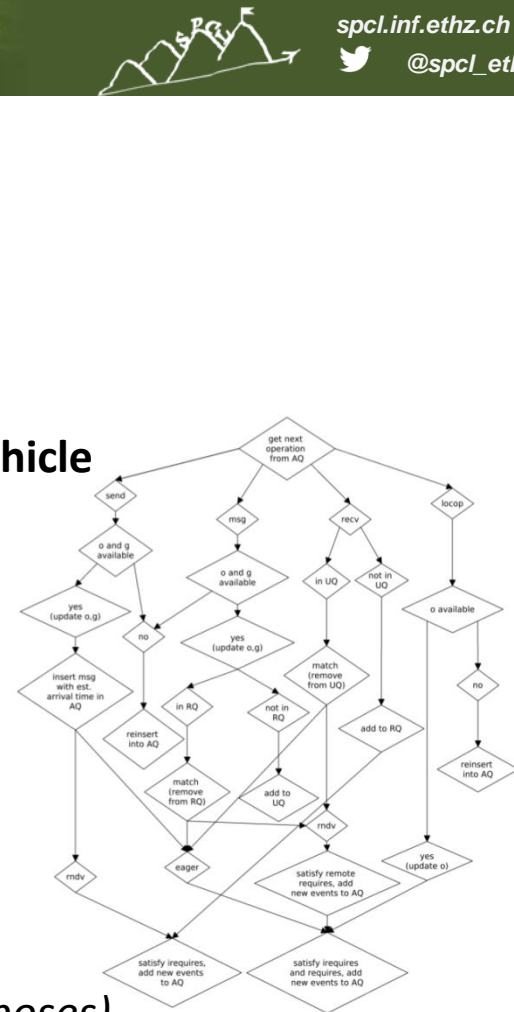# LogGOPSim – Simple and Fast Large-Scale Simulations

LogGOPSim: Type of analysis

- **Purpose: Performance Model for Extrapolation**
  - Large-scale algorithm development (millions of nodes) [1]
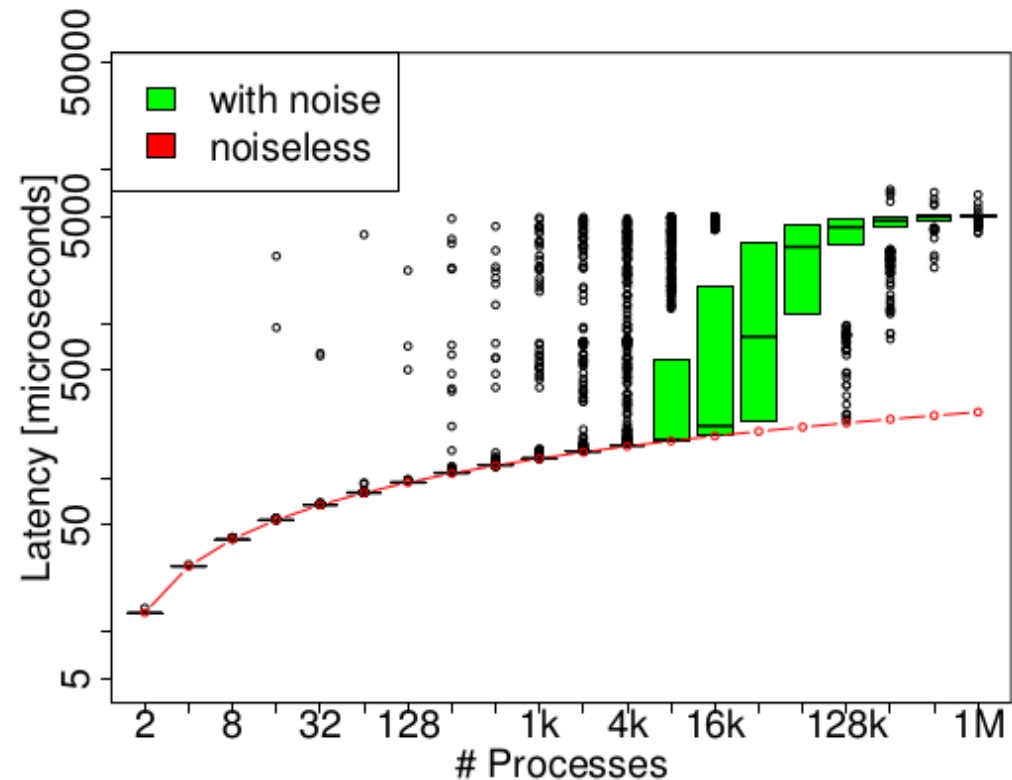 - Application verification, noise injection, **simple research vehicle**

- **Features:**
  - Input languages:
    GOAL, MPI, Portals IV (beta)
  - Network Models:
    LogGOPS, LogGOPS+offload, Packet-level (slow)
  - Special features (what's different from simulator XYZ?):
    ***Simplicity** (essentially a single C file, modular, research purposes)*
    ***Scalability** (Millions of processes, >100k events per second)*
    ***Noise injection** (from real traces, can simulate resilience overheads)*

    ***Accuracy** (verified on several systems --- not special, I know)*

[1]: TH, Schneider, Lumsdaine: *Characterizing the Influence of System Noise on Large-Scale Applications by Simulation* , SC10
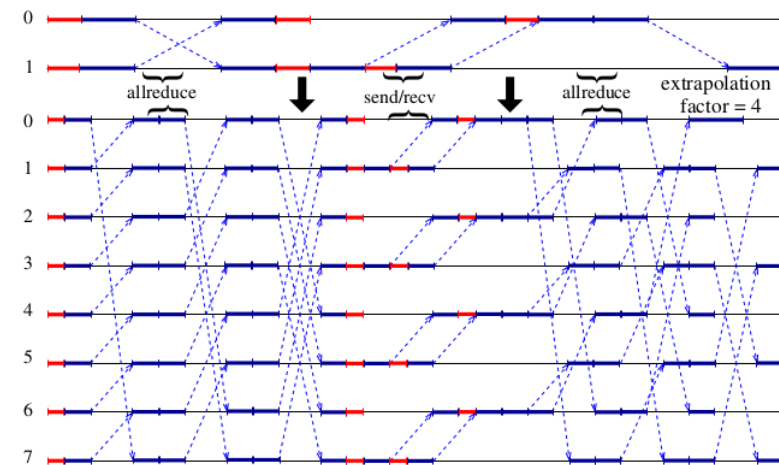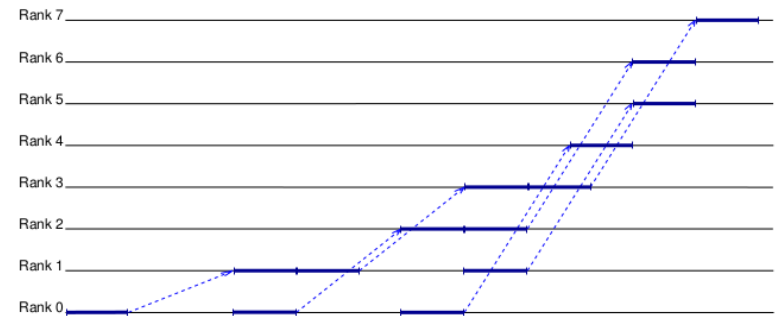
LogGOPSim: Typical Workload

- **Typical target code:**
  - MPI (or Portals IV) applications

    Trace-driven (incl. automatic trace extrapolation features)

- **Typical machine:**
  - LogGOPSim model [2]
  - Portals IV triggered operations
  - Packet-level simple congestion

- **Typical resource of interest:**
  - Network, nothing else ☺

- **Typical scale:**
  - 10's (classroom use)
  - 100's (small design studies)
  - 1000000's (research work)

[2]: TH, Schneider, Lumsdaine: *LogGOPSim - Simulating Large-Scale Applications in the LogGOPS Model*, LSAP/HPDC'10
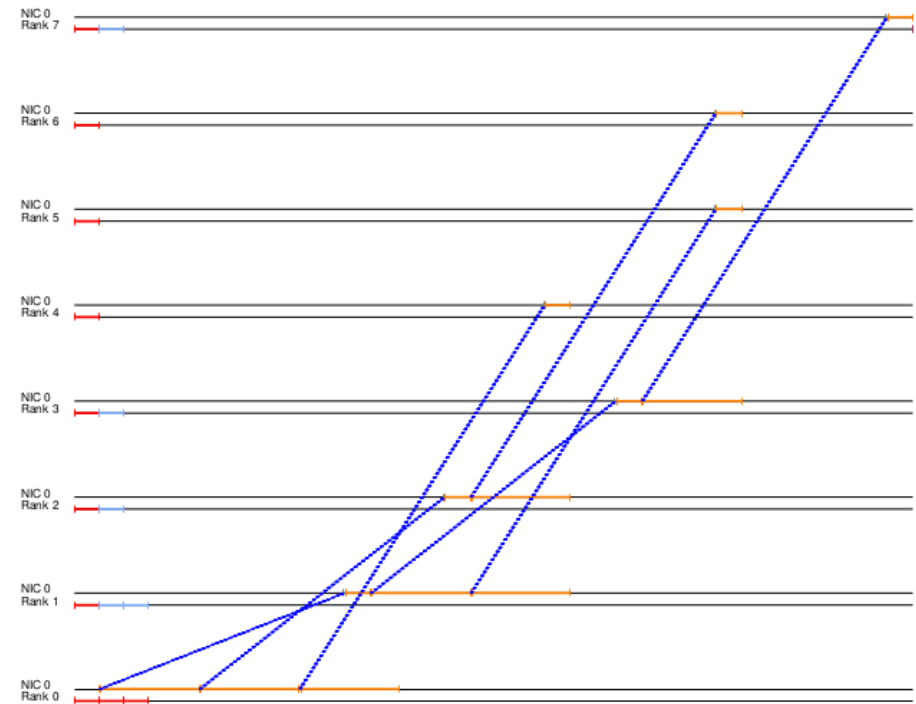
LogGOPSim: Ecosystem and Integration

- **Our hope:**
  - It's simple enough that we don't need an ecosystem

- **We have:**
  - MPI tracing library (adaptors to others are simple but work-intensive)
  - Schedule generator
  - Single-threaded simulator
  - Very simple visualization (eps output)

- **Unix Philosophy: If you need a tool, add it**
  - Highly modular design
  - New network module: 2 API calls
    ~ 1 hour for boiler plate
  - New interface: change parser + single C file
    ~ 1 week of work

[2]: TH, Schneider, Lumsdaine: *LogGOPSim - Simulating Large-Scale Applications in the LogGOPS Model*, LSAP/HPDC'10

LogGOPSim: Self assessment

- **Strengths:**
    - Simple, modular, easy to get student started
    - Very fast
    - Scalability (in-memory trace expansion) [3]

- **Weaknesses:**
    - Doesn't simulate computation at all
    - It's a trace-driven simulation
      (big traces can be horrible)

- **Features planned:**
    - Full Portals IV support
    - Offload architectures
    - Better topology simulations

[3]: Levy, Topp, Ferreira, Arnold, TH, Widener: *Using Simulation to Evaluate the Performance of Resilience Strategies at Scale*, PMBS'13

LogGOPSim: Success Stories

- **Collaboration with Sandia on Resilience Overheads at Scale**
  - Last year's PMBS paper on scalable checkpoint/restart simulation [3]
  - This year's SC paper on C/R overheads in practice [4]
  - … much more to come in the area of FT.

- **Used in several research groups (without us knowing)**
  - E.g., KTH in the EU FP7 project "Exascale ProGRAmming Models" (EPiGRAM)
    Very cool parameter sensitivity studies

- **We even used it in class**
  - Students started to extend it immediately
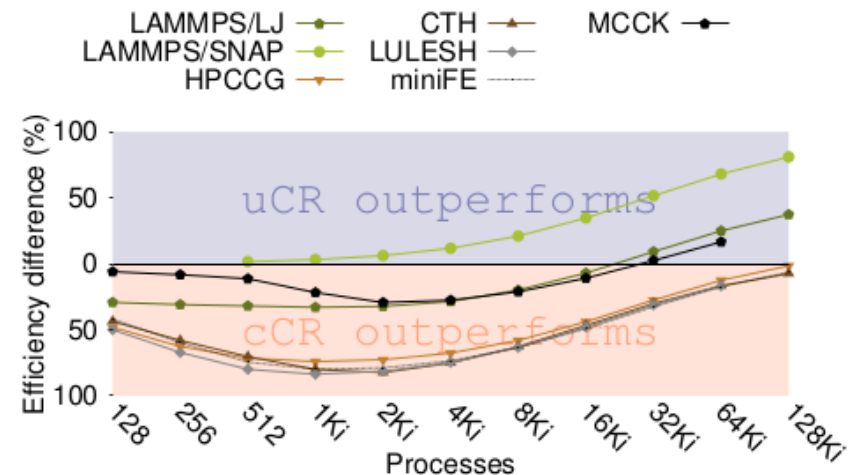
[3]: Levy, Topp, Ferreira, Arnold, TH, Widener: *Using Simulation to Evaluate the Performance of Resilience Strategies at Scale*, PMBS'13
[4]: Ferreira, Widener, Levy, Arnold, TH: *Understanding the Effects of Communication and Coordination on Checkpointing at Scale*, SC14