Code Optimization

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Roadmap

- **Introduction**
- **gprof**
- **Timer calls**
- **Understanding Performance**

Introduction

- Scientific Performance Method:
  - Measure (don’t assume!)
    - Find the bottlenecks in the code
      - They aren’t where you expect!
    - Fix the worst problems first
    - Consider stopping-- is it good enough?
  - Fix
    - Improve algorithms first
    - Improve implementations second
  - Repeat (indefinitely)

gprof– UNIX performance tool

- Compile and link with “-pg” flag
  - Adds instrumentation to code
- Run serial program normally
  - Instrumentation runs automatically
- Run gprof to analyze trace
  - `gprof pgm gmon.out`
- Shows a function-level view of execution time
- Heisenberg measurement error!

Timer Calls

- CPU time (virtual time)
  - Time spent running your code
  - CmiCpuTimer()– 10ms resolution

- Wall clock time (real time)
  - Includes OS interference, network delays, context-switching overhead
  - CmiWallTimer()– to 1ns resolution
  - This is what really counts

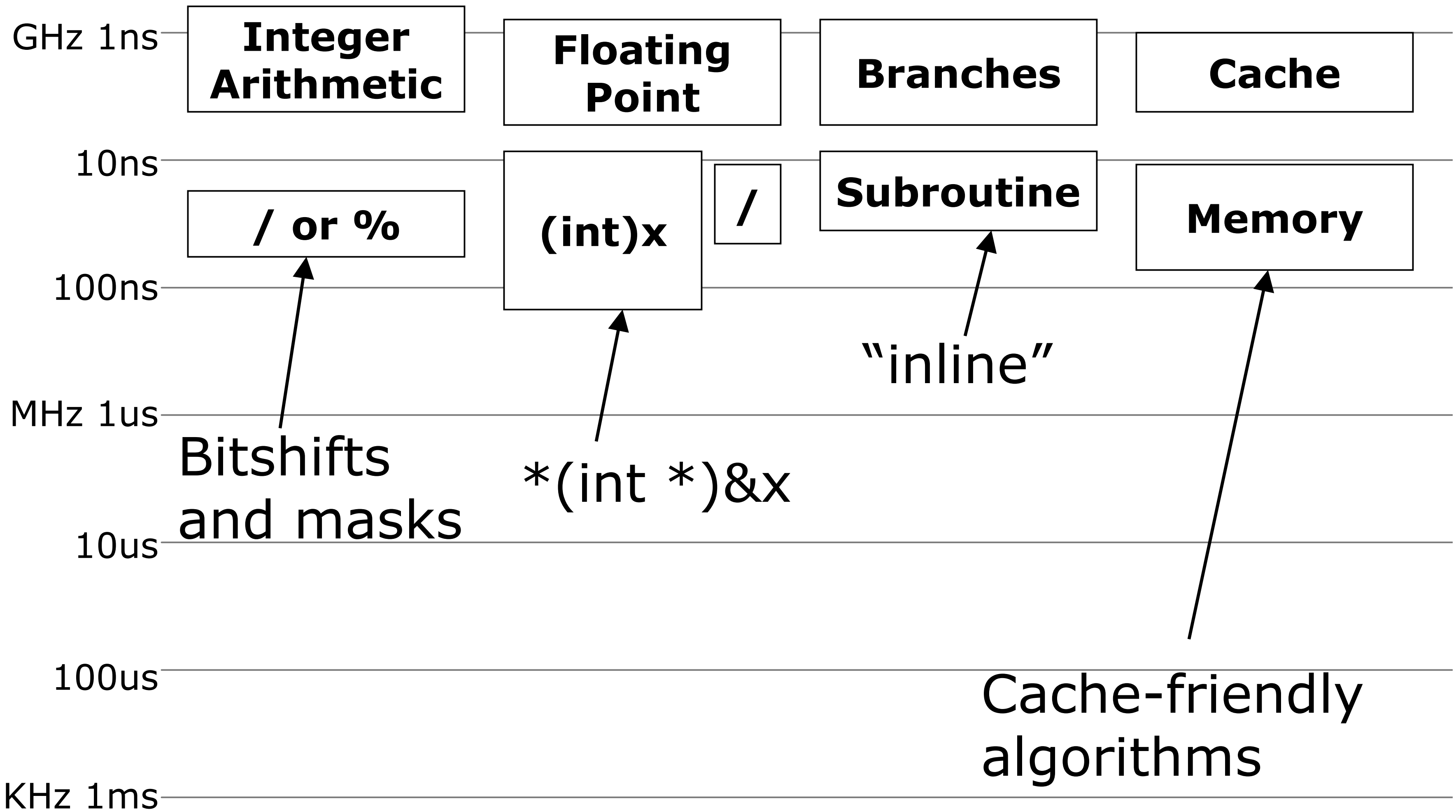
How to call the timer: one time

- What's wrong with this?
  - double s=CmiWallTimer();
  - foo();
  - double e=CmiWallTimer()-s;
  - CkPrintf("foo took %fs\n",e);
- If CmiWallTimer takes 100ns, and foo takes 50ns, this may print 150ns!
  - Only a problem for very fast functions (or slow timers!)

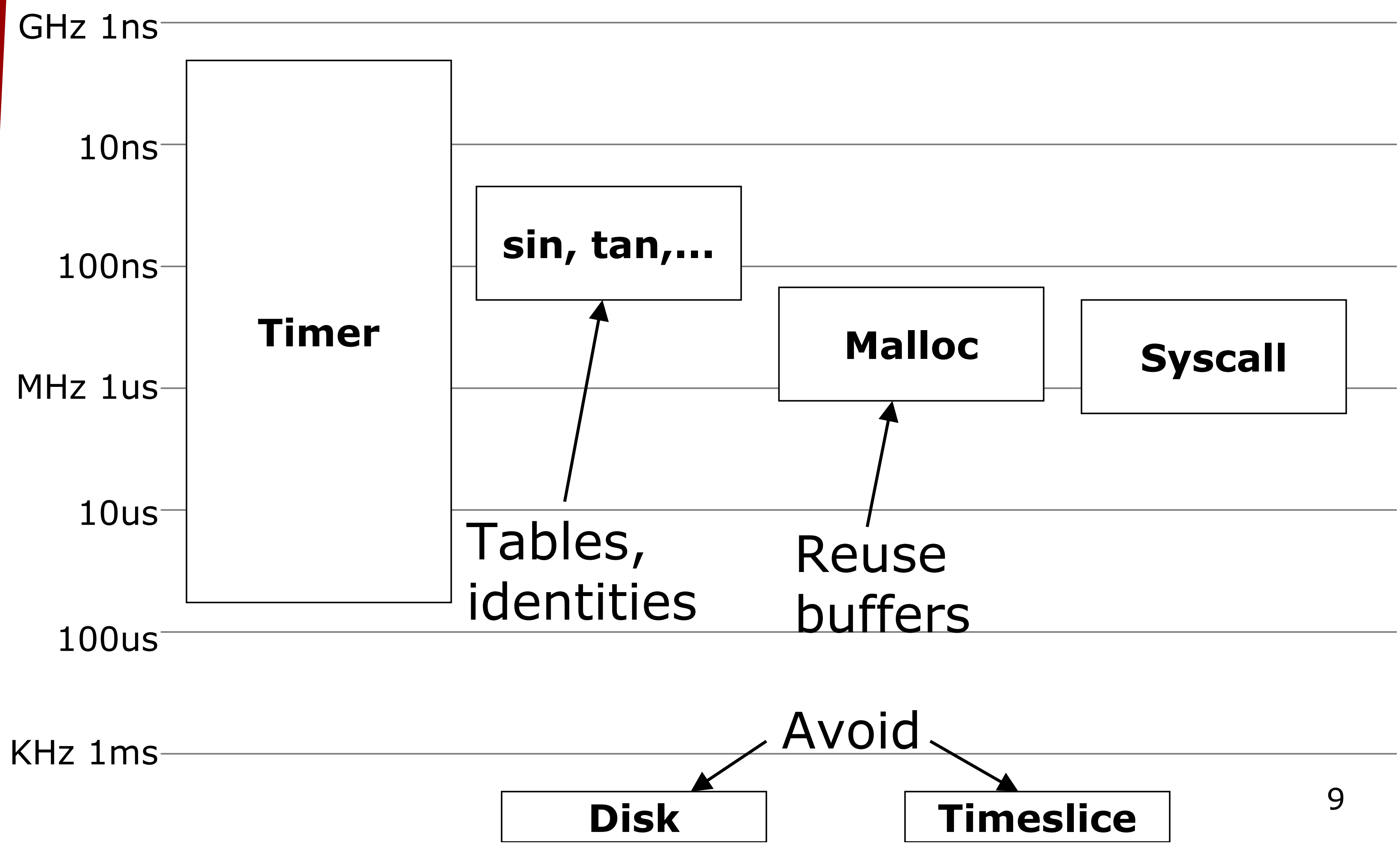
How to call the timer: repeat

- **Repetition can decrease apparent timer overhead and increase resolution:**
  - **const int n=1000;**
  - **double s=CmiWallTimer();**
  - **for (i=0;i<n;i++) foo();**
  - **double e=(CmiWallTimer()-s)/n;**
  - **CkPrintf("foo took %fs\n",e);**
- **Problem: what if foo's performance is cache-sensitive?**

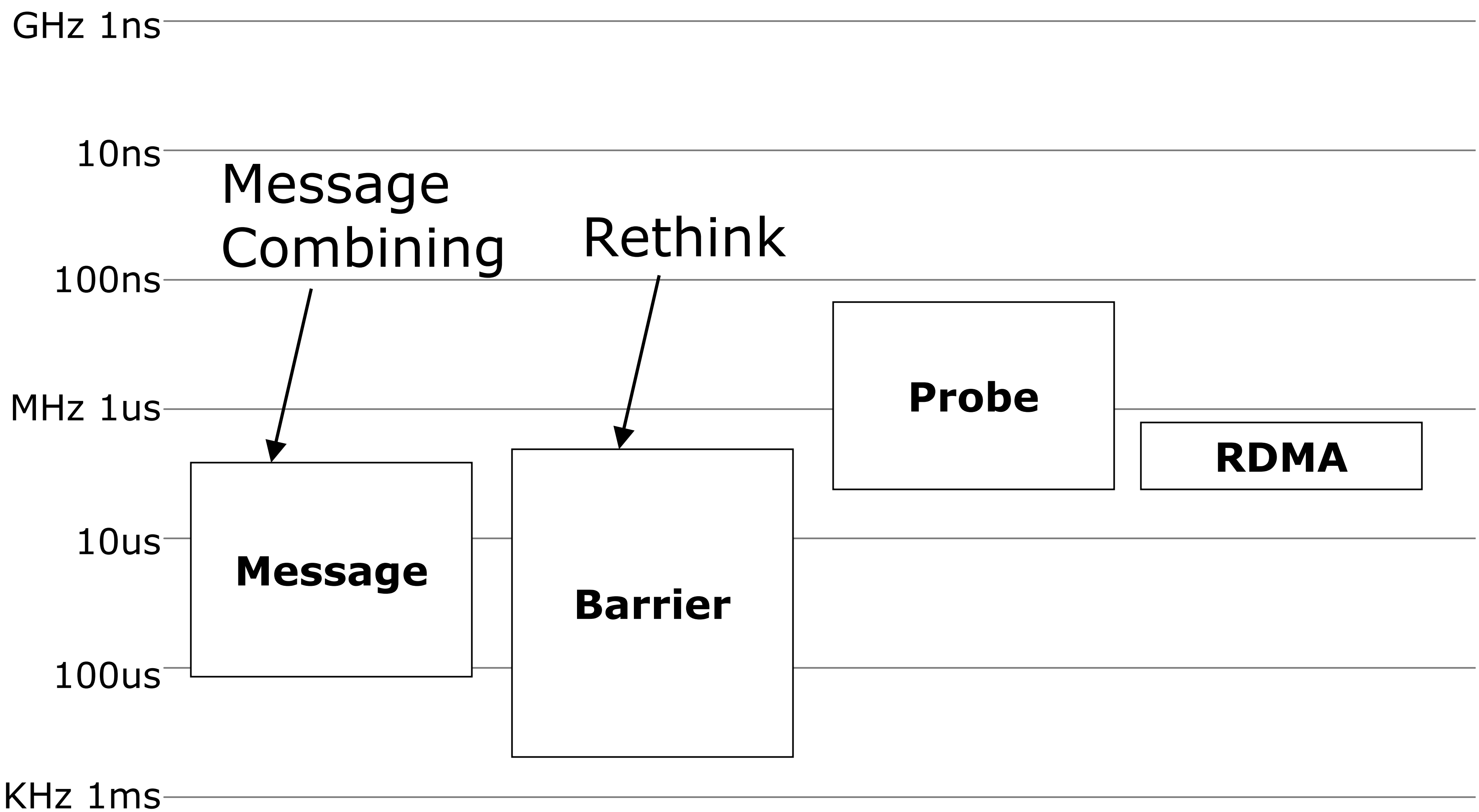
Understanding Performance: CPU



Understanding Performance: OS



Understanding Performance: Net



Conclusions

- **Performance is the whole point of parallel programming**
  - **painful but necessary**
- **Asymptotics matter– find O(n)**
- **Constants matter– count mallocs**
- **Scientific Performance Method:**
  - **Measure**
  - **Fix**
  - **Repeat**