Visualizing Computer Systems Data Collection

Lecture #1 for CS348c

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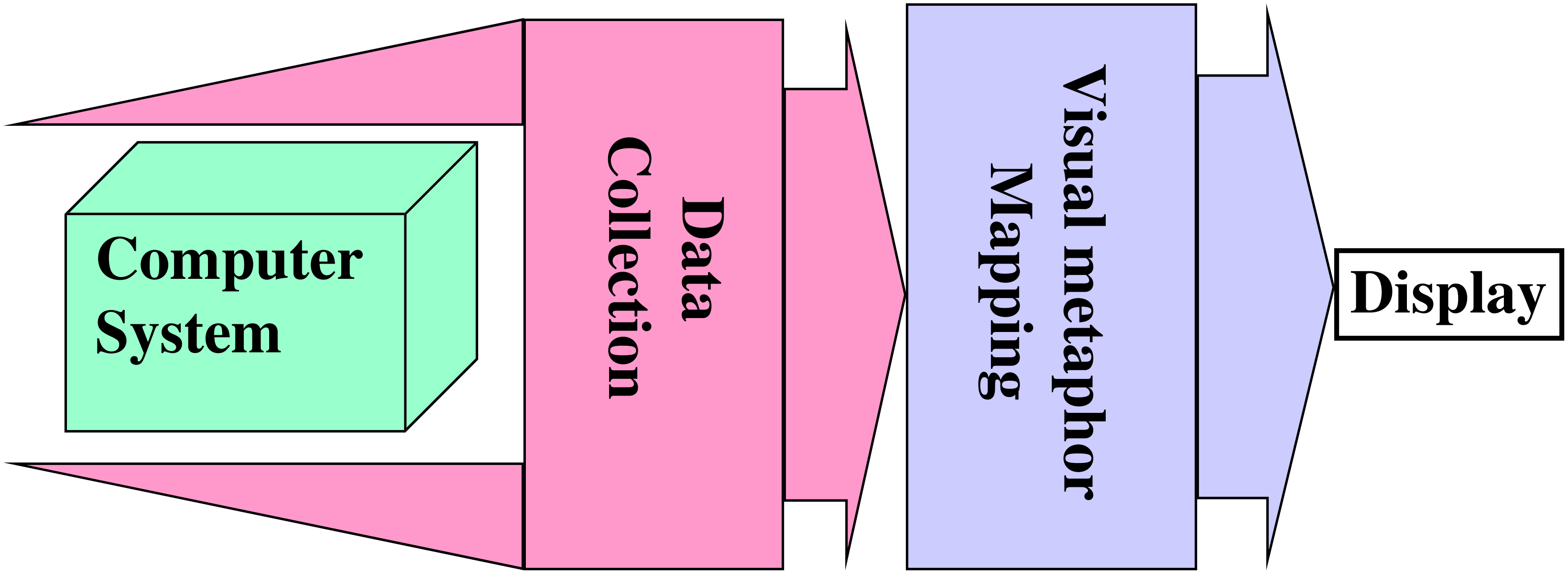
Outline

- Overview of computer system visualization
- Example computer systems
- Data collection
  - Measurement and instrumentation
  - Modelling and simulation
- Visual metaphor mapping

Computer system visualization



- Challenges:
  - Extract data from system
  - Determine good visual metaphors

Example computer systems

- Networks
  - Internet (Millions of hosts)
  - BARRnet
  - Stanford
    - 33K IP addresses, 660 subnets
  - Gates network
    - 21 CISCO routers, many hundreds of machines

Example computer systems #2

- Local area machine clusters
  - Sweet Hall
    - Hundred some machines
      - Various models of Sun, SGI, DEC
      - Uniprocessors and multiprocessors, file servers, etc.
  - TPC example
    - Thousands of machines
      - Front end, backend
      - Thousands of disks

Example computer systems #3

- Single machines
  - Flash machine example
    - Hundreds of boards each with CPUs, I/O and memory.
- Node boards
  - CPU pipeline, memory controller

Data collection

- Measurement and instrumentation
  - Observe and record system behavior
- Simulation
  - Model system behavior
  - Take data from model

Measurement

- Use existing data generated by system
  - Static configuration data
    - MBONE layout
    - Stanford network layout
  - Normally collected data
    - Billing or accounting data
    - Stats from gateways and routers
    - Operating system info:
      - Page faults, run-queue length, file I/Os, context switches
  - HW counters
    - Cache misses

Instrumentation

- Extend system to count or trace events
  - Networks
    - Modified software of hosts or gateways
    - Snoop on network to observe packets
  - Application:
    - Extend code to generate a trace

Instrumentation #2

- Hardware instrumentation
  - Firmware traces (ATUM, Flashpoint)
  - Bus monitor (Pablo, DASH)
- Software instrumentation
  - Static
    - Level: Source, assemble, object
  - Dynamic
    - Shade, Paradyn

Example: Pablo system

- Hardware & software instrumentation
  - Source annotation
  - Bus monitor
- Data collection
  - Self-describing trace format

Example: Paradyn system

- Dynamic instrumentation
- Run-time processing of information
- Performance consultant

Challenges for measurements & instrumentation

- Visibility
  - Example: bus monitors, memory stall
- Perturbation
  - Dilations
    - Space: Bandwidth consumed, disk I/Os, etc..
    - Time: System runs slower, user & I/O don’t.

Challenges for measurements & instrumentation #2

- Collection and storage
  - Consumes resources
    - Example: Build ATM network to study Ethernet network.
- Synchronization
  - Traces are taken with difficult clocks
- Mapping measurements to high-level levels
  - Example: what procedure is causing memory stall?

Trends for measurements and instrumentation

- High integration making more difficult
- Positive trends:
  - Designing realizing high complexity management requires info
  - Need for next generation design
  - Hardware/software support cheaper
- Example:
  - Network management
  - Counters/sampling of modern microprocessors

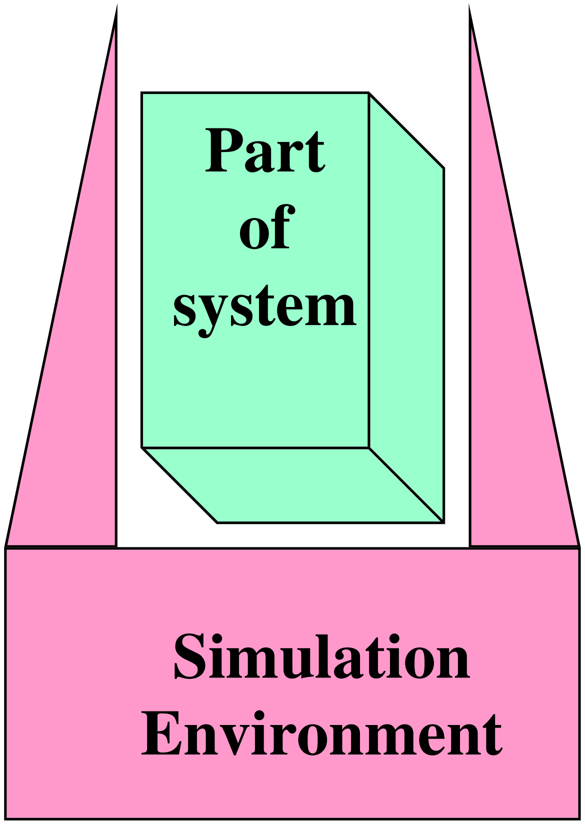
Modeling and simulation

- Simulation model of the computer system
  - Handles analytic intractable problems
- Key problem: workload to drive simulation
  - Synthetic
  - Driven from instrumentation

Modeling and Simulation #2

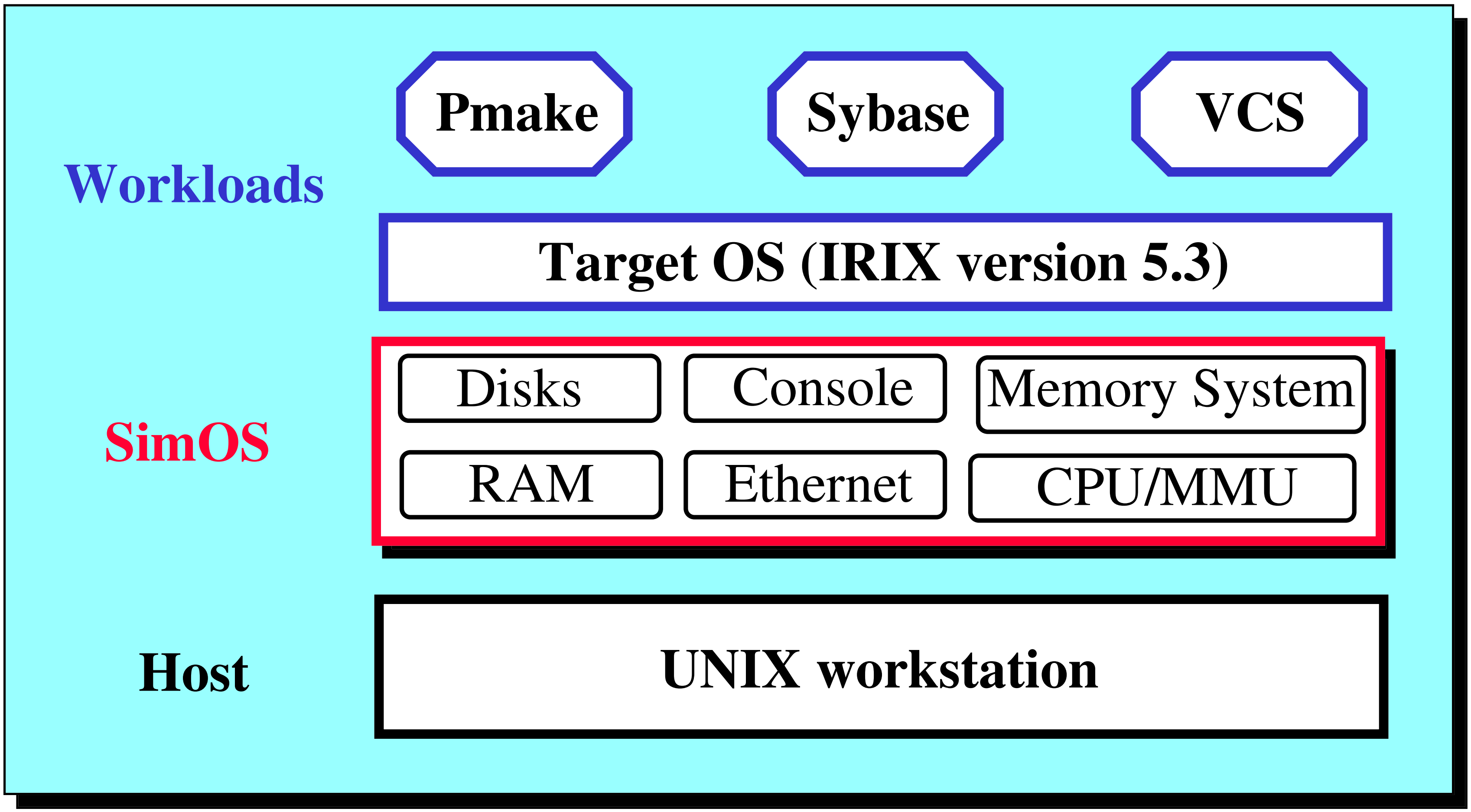
- Examples
  - Networks
    - Random packet arrival, model switches
    - Drive with packet traces
  - Computer systems
    - Trace of memory references for cache simulation

Modeling and Simulation #3



- Synthetic environment
  - Key advantage: visibility
- – Examples:
  - Single UNIX process
  - OS part: FS, VM, scheduler.
  - Processor cache, pipeline
  - Routing algorithm

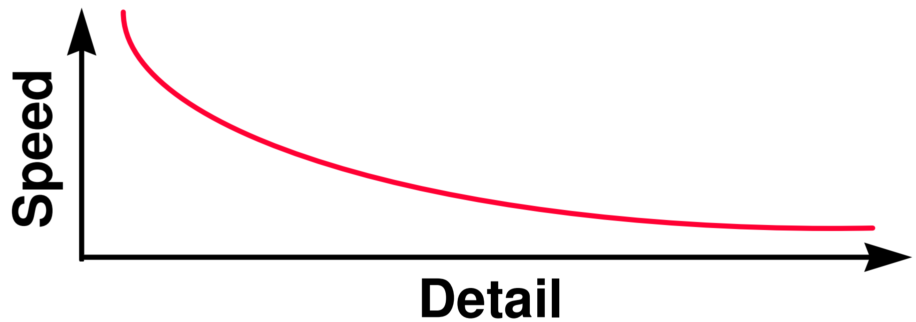
Example: the SimOS environment



Simulation Challenges

- Validation
  - How do we know simulation matches real system?
- Speed
  - Simulation not useful if it takes too long to get answer.

SimOS speed/detail trade-off



- **SimOS allows explicit control over the trade-off:**

Mode	Speed	Use
Emulation	Fast (<10X)	Booting/positioning workloads
Rough characterization	Medium (<50X)	Fast workload examination
Detailed	Slow (>100X)	Focused studies

- **Modes are dynamically selectable**
  – Use fast modes to setup detailed modes