SIEMENS VDO
Automotive

PROMEXX
technical automation

Performance Engineering in Practice

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PROfessionele Mentaliteit en EXXpertise...

Performance Definitions

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Performance:

An indicator of how well a system meets its requirements for timeliness.

Timeliness:

An indicator of system response time and/or throughput.

"*Performance Solutions – A Practical Guide to Creating Responsive, Scalable Software*", 2002, C.U. Smith and L.G. Williams, Addison-Wesley.

Performance Troubles

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Many projects get in trouble with performance !

Performance Engineering

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Systematically plan for and predict performance.

- Performance requirements analysis
- Performance constraints analysis
- Performance modeling
  - Model system resource usage
  - Model system performance
  - Architecture based

Performance Requirements Examples

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- An Electronic News Gathering (ENG) video camera shall be fully operational within 2 seconds after switching it on.
- A digital photo camera shall shoot a picture within 50 ms after pressing the shutter release button.
- A printer shall print with a rate of at least 100 A4 pages per minute.
- A vehicle navigation system shall update its road map display at least 10 times per second.
- A vehicle navigation system shall provide guidance within 1 second after entering a destination.
- ...

Performance Constraints Examples

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- The main processor runs at 27 MHz.
- Task switching involves an overhead 15 µs.
- Grabbing a free semaphore takes 4 µs.
- Memory can be copied with a rate of 1 to 10 MB/s.
- Creating an application level object takes at least 35 µs.
- The communication channel bandwidth is 100 kB/s.
- The communication channel bandwidth is 1 ms.
- The Flash life time is limited to 10,000 program erase cycles.
- ...

Performance Engineering - System Resources

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- System resource planning
  - Resource usage budgets
- System resource tracking
  - Resource usage measurements
- System resource model
  - Requirements related
  - Constraints related

Performance Engineering - Deployment

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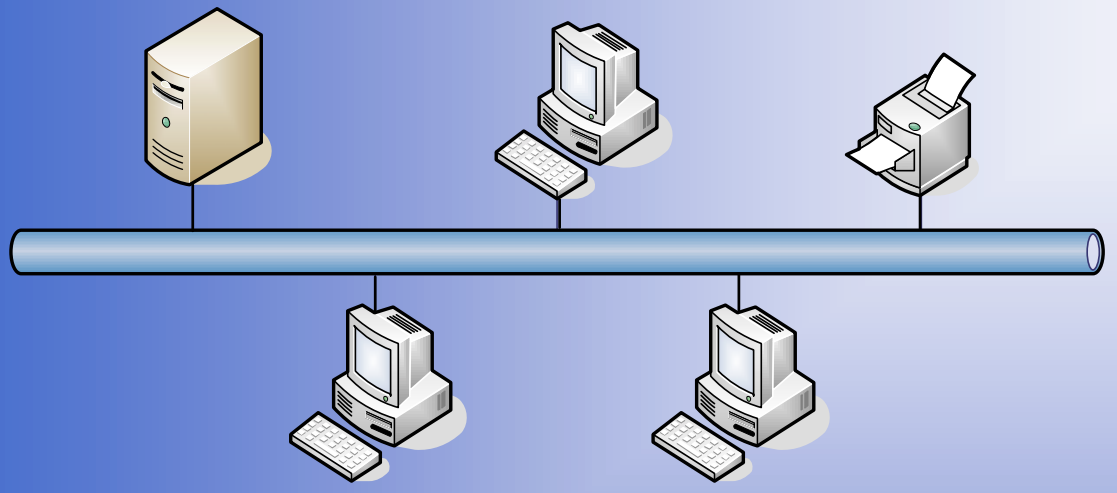
- Deployment involves
  - Project management
  - Requirements management
  - Product management & customers
  - Suppliers & purchasing
  - Architects & engineers
- Create awareness
  - Tradeoffs
- Clarify relationships
  - Price ⇔ performance
  - Architectural design decisions ⇔ performance
  - Detailed design & implementation decisions ⇔ performance

Performance Troubles Example



- Network utilization model promised good performance.
- Realized performance was however disappointing !

Performance Troubles Example

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- Considered candidate solutions
  - Faster network
  - Faster computers
  - Alternative architectures

  None of them resulted in better performance !!!

- Model validation
  - Measure network message traffic for several system performance use cases
  - Uncovered and fixed software bug

  Performance requirements were satisfied !!

Performance Modeling

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Performance models require validation !

Performance Engineering Example - Memory Access Performance

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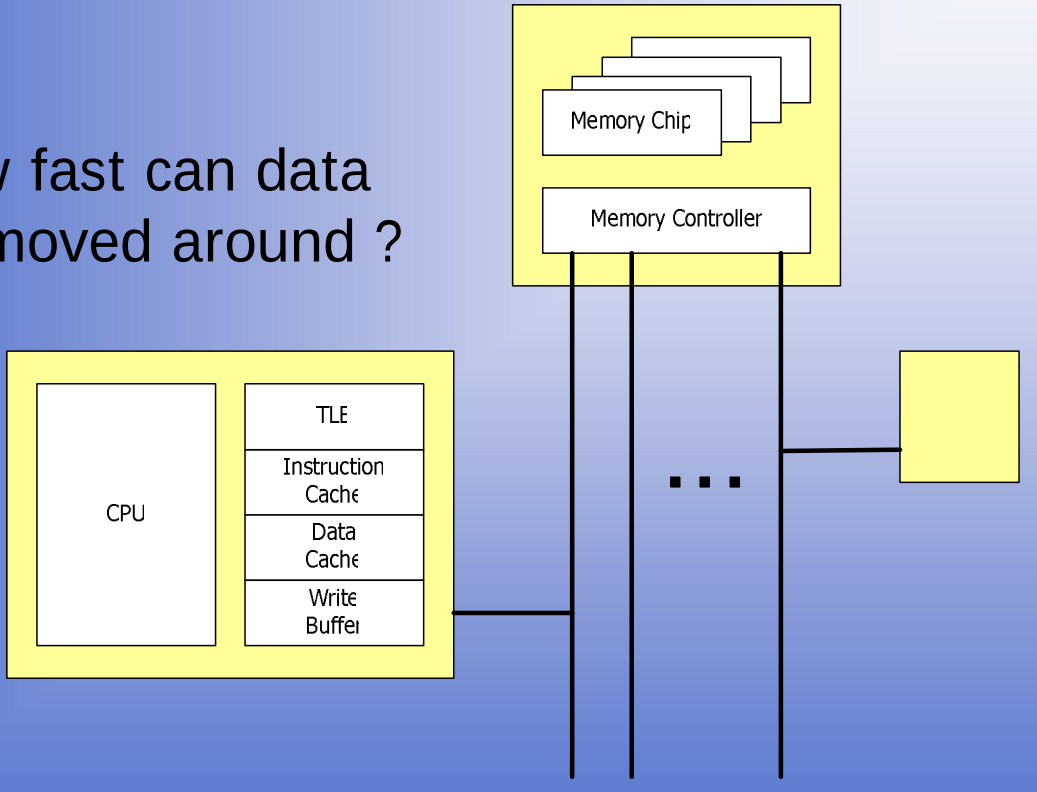
How fast can data be moved around ?



Memory Access Performance

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- Memory performance model supports
  - Making memory system design tradeoffs
  - Making memory device selection tradeoffs
  - Making software architecture design tradeoffs
- Memory performance model covers
  - Read & write access performance
  - Random & sequential access performance
  - Cached & uncached access performance
  - Relative & absolute access performance

Memory Access Performance

Memory access performance may be a key system performance constraint while it can be measured quite easily.

Performance Engineering Example - Computational Performance

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$$CPI = CPI_{cpu} + CPI_{memory.system}$$

Determining Factors

- Instruction set architecture
- Program dynamic instruction sequence
- Memory system characteristics
- Program memory reference behavior

"*Computer Architecture – A Quantitative Approach*", 2nd Edition, 1996, David A. Patterson and John L. Hennessey, Morgan Kaufmann Publishers, Inc.

Computational Performance

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Computational performance models provide essential information for making hardware architecture design tradeoffs including components selection (processor, memory, buses, etc.).

Performance Engineering Example – Execution Traces

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- Execution trace examples
  - Memory reference traces
  - I/O traces
  - Communication traces
- Execution trace applications
  - Execution visualization
  - Execution statistics gathering
  - Design simulations
- Execution trace based performance engineering is heavily used in the development of the Siemens VDO navigation systems

VDO Dayton Navigation Systems

Frankfurter Allgemeine Zeitung, November 2002 :

"Der schnellste Routenführer der Welt – VDO Dayton bietet mit dem MS 5500 Spitzentechnik und viel Tempo"

Auto Connect, November 2002 :

"VDO Dayton MS 5500 Im Temporausch"

EISA Award 2003 – 2004 :

"By comparison with conventional navigation systems, the VDO Dayton MS 5500 is extremely efficient "