

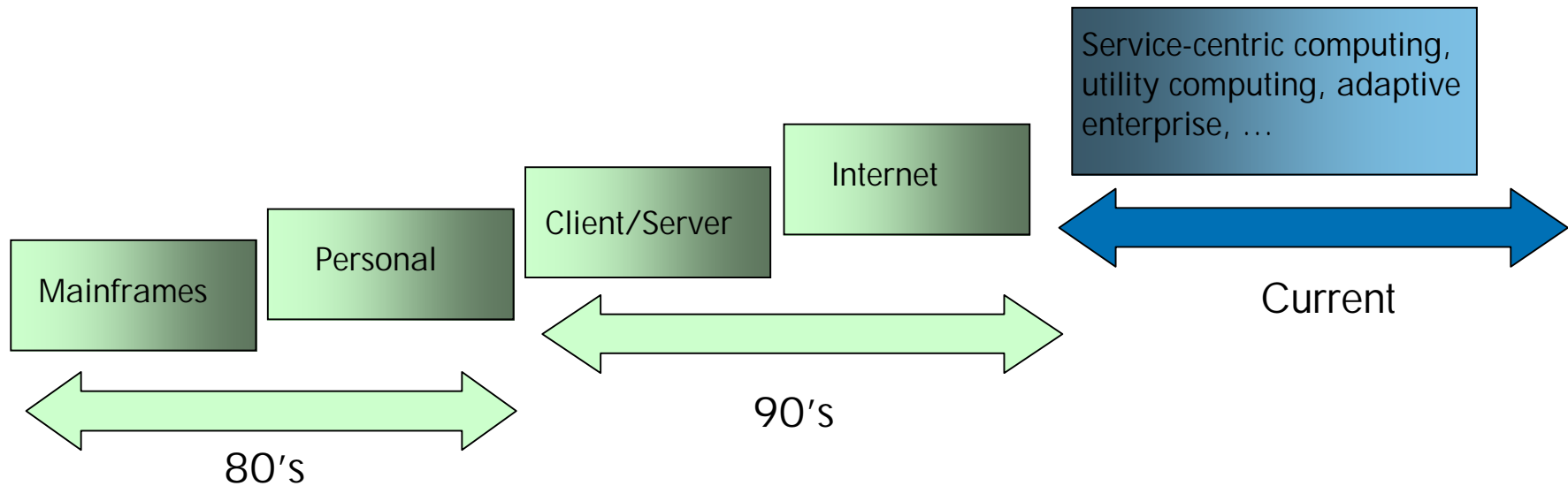


# Enterprise IT Trends and Implications on System Architecture

Partha Ranganathan and Norm Jouppi

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# Motivation



## Role of computing in enterprise changing

- IT infrastructure now closely tied to business process
  - E.g., e-commerce, supply-chain, customer-service
- Direct impact on top-line and bottom-line (sales, revenues)
- Driving changes in enterprise IT environments

# Specific Trends

Facilities

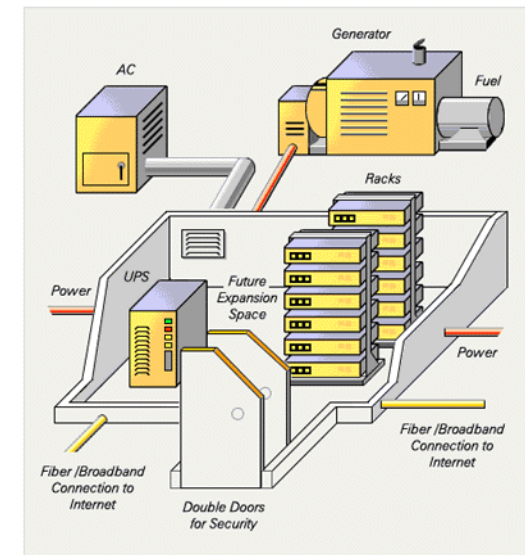
Hardware

Software

Metrics

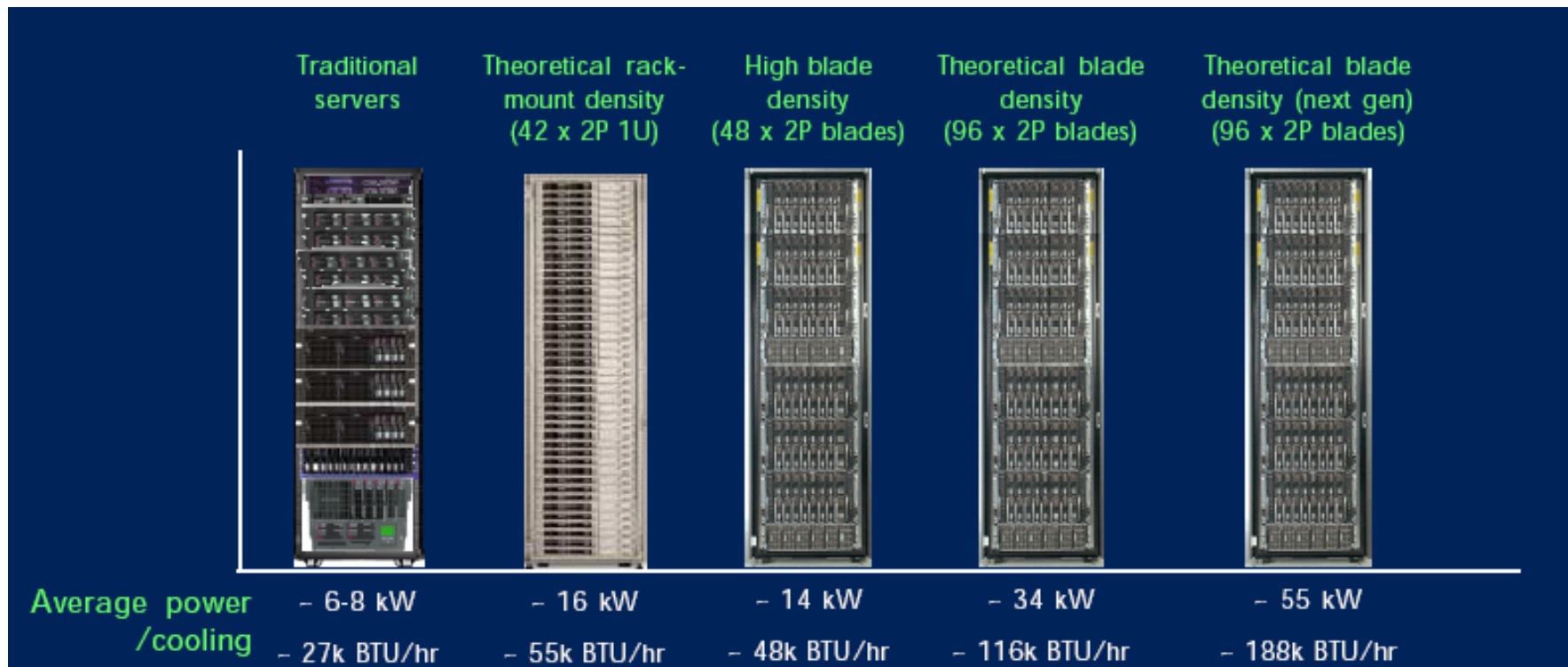
# Facilities Trends

- Consolidation of data centers
- Implications
  - Increased facilities challenges
    - Power delivery
    - Electricity consumption
    - Heat extraction
  - Operations and management for large-scale
    - People costs often largest fraction of IT costs



# Hardware Trends: Modularization

- Blade servers – miniaturization/modularization
- Implications
  - More modularity => “The enclosure is the computer”
  - More compaction => Power density, maintenance



# Commoditization & Virtualization

- **Commoditization**

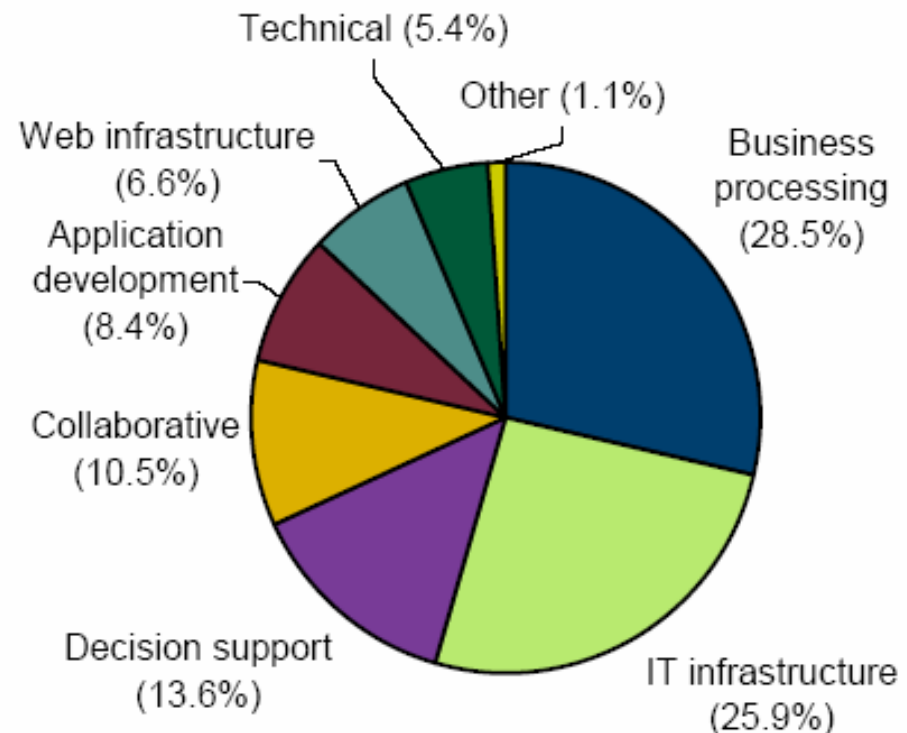
- Cheaper-cost systems: average server price falling [IDC]
- Implications
  - A few modular building blocks?
  - Focus beyond performance to usability

- **Virtualization**

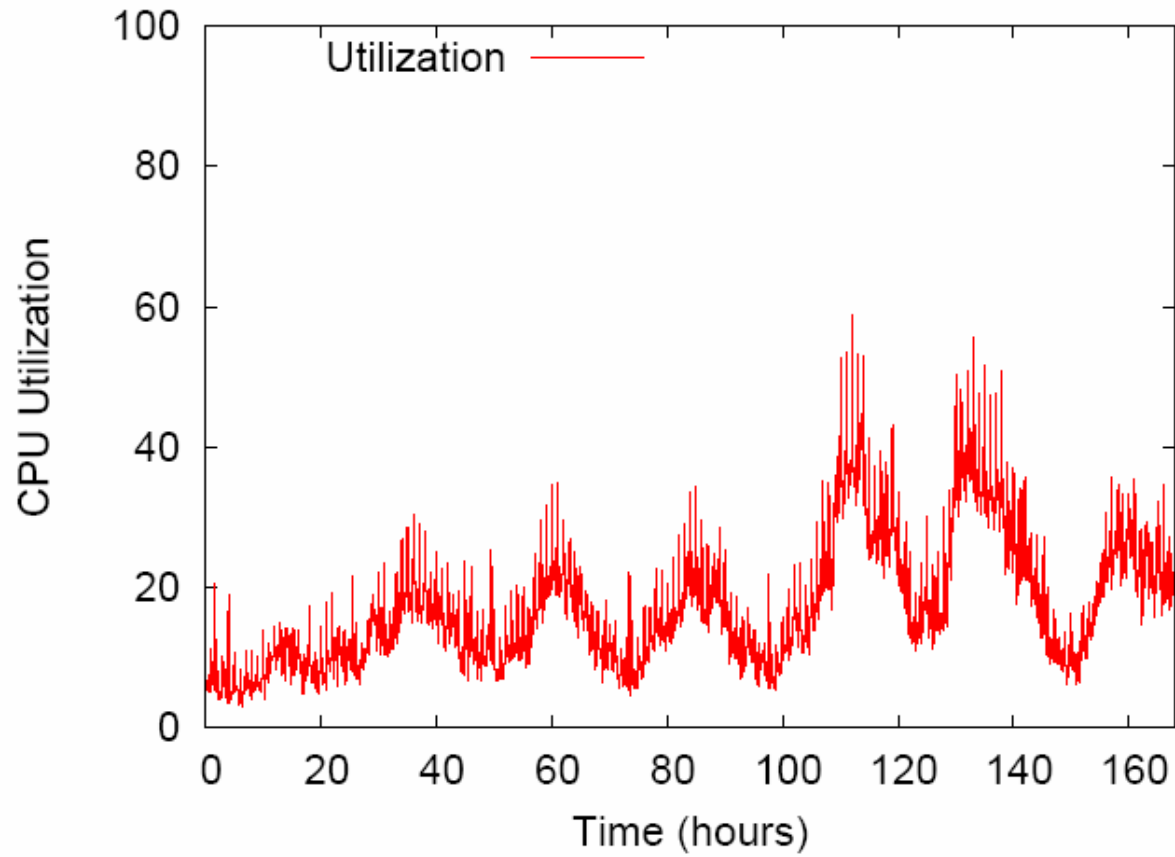
- Virtualized abstraction for hardware: at multiple levels
- Implications
  - Role of physical boundaries blurred => harder designs
  - Greater consolidation => more resource utilizations
  - Additional control point => opportunity for optimization

# Software trends: Workload Mix

- Business processing/IT
  - ERP, CRM, OLTP, file servers, sys mgmt, ...
- Implications
  - Increased complexity
  - Business-critical
  - Behavior trends

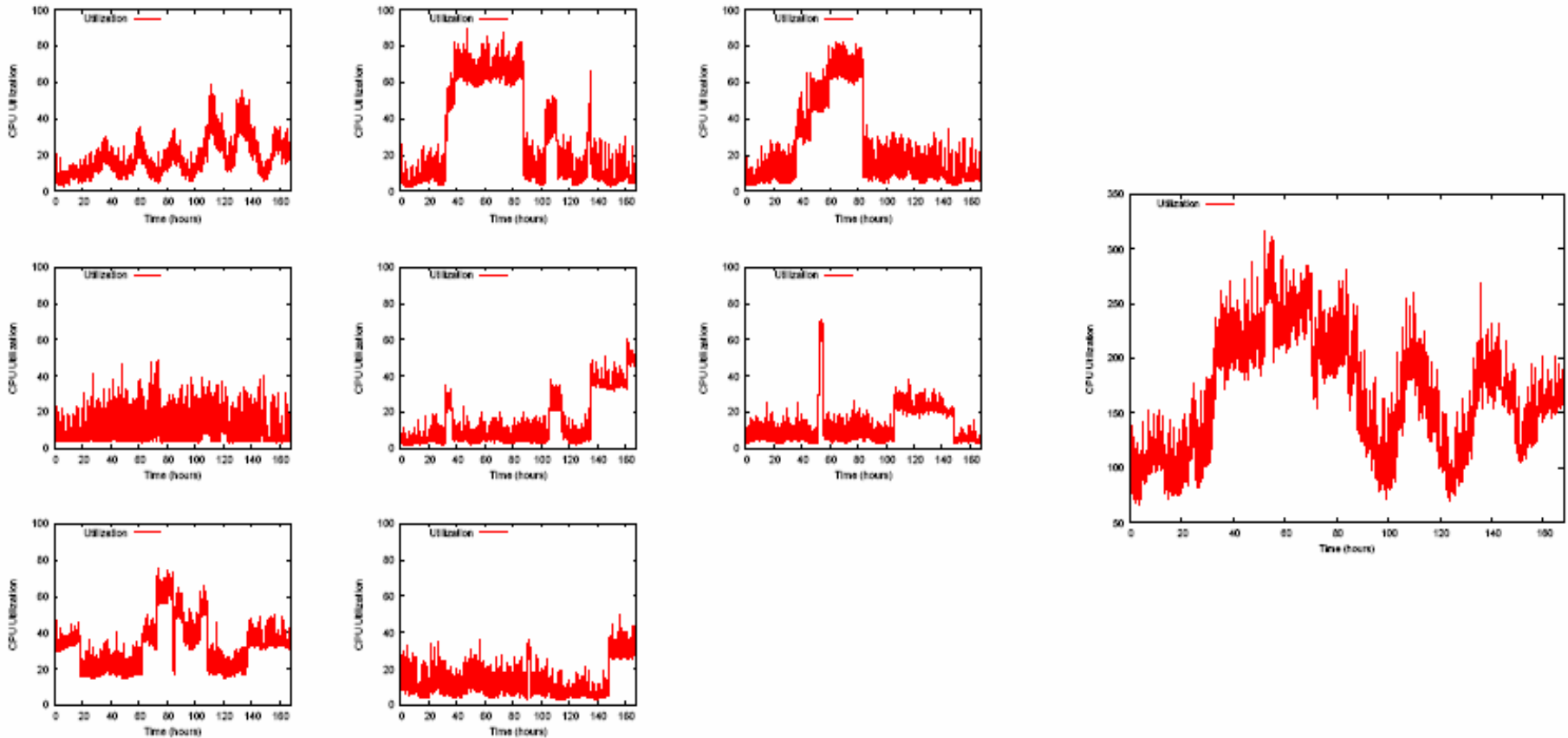


# Software trends: Workload Behavior



Nominal different from peak

# Software trends: Workload Behavior



Sum-of-peaks >>> peak-of-sums (system-of-system)

# Metrics' Trends

- Utility service-level agreements and cost functions
- Implications
  - Performance one aspect
  - Scalability, reliability, availability, manageability
  - Multi-service environments more complex

# Implications on Enterprise Architecture

How do we understand enterprise environments?

How do we improve enterprise environments?

# Benchmarks, metrics, tools, models...

- **What is the right benchmark?**
  - Current: SPEC, SPLASH, TPC -
  - Needed: ERP, CRM, file server, ...
- **What is the right objective function?**
  - Current: MIPS, EnergyDelay
  - Needed: SLA, risk, utility functions,
- **How do we measure/simulate/model?**
  - Current: vTune/SimpleScalar/Wattch, ...
  - Needed: full IT environments (e.g., splice)

# Architectural Design Implications

- How do we optimize for nominal instead of peak?
  - Understanding inflection points in efficiency curves
  - E.g., nominal-efficient power supplies
- How do we optimize for system-of-system?
  - Optimize outside the box
  - E.g., Enclosure-level, data-center level architecture designs

# Architectural Design Implications

- **How do we factor in facilities challenges?**
  - Power-optimized architectures, holistic designs
  - E.g., temperature-aware scheduling
- **How do we respond to changing metrics?**
  - Emphasis on reliability, availability, security, manageability, ...
  - E.g., DIVA, Intel Vanderpool/Silverveil
- **How do we deal with diversity (workload/service, SLA)?**
  - Adaptivity, heterogeneity
  - E.g., heterogeneous multi-core architectures
- **How do we deal with commoditization?**
  - Value over carefully-chosen modular building blocks
  - E.g., Federated array of bricks project for storage

# Summary

- **Interesting transformation in enterprise computing**
  - IT closely tied to business process
  - Dramatic changes in facilities, hardware, software, metrics
- **Corresponding new challenges for arch research**
  - **Open questions on benchmarks, metrics, tools, models**
    - Focus on long-term behavior of enterprise-level workloads
    - Need to scale tools/instrumentation to higher levels
  - **Interesting architectural directions to leverage trends**
    - Optimize at higher-levels (e.g., enclosure) for nominal behavior
    - Holistic solution for total cost of ownership (RAS, supply-chain)

# Questions?

Speaker email: [partha.ranganathan@hp.com](mailto:partha.ranganathan@hp.com)