The Case for Energy-Oriented Partial Desktop Migration

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Problem

- Offices & homes crowded with desktop PCs
- PCs idle on average 12 hours a day (Nedevschi09)
- 60% of desktops remain powered overnight (Webber06)
- Why do we care?

Dell Optiplex 745 Desktop
Peak power: 280W
Idle power: 102.1W
Sleep power: 1.2W

Why Idle Desktops Stay On?

- Always-on semantics
- Background Applications: IM, E-mail, VoIP
- Remote Access: files, remote admin

Full VM Migration

- Encapsulate user session in VM
- When idle, migrate VM to consolidation server and power down PC.
- When busy, migrate back to user's PC

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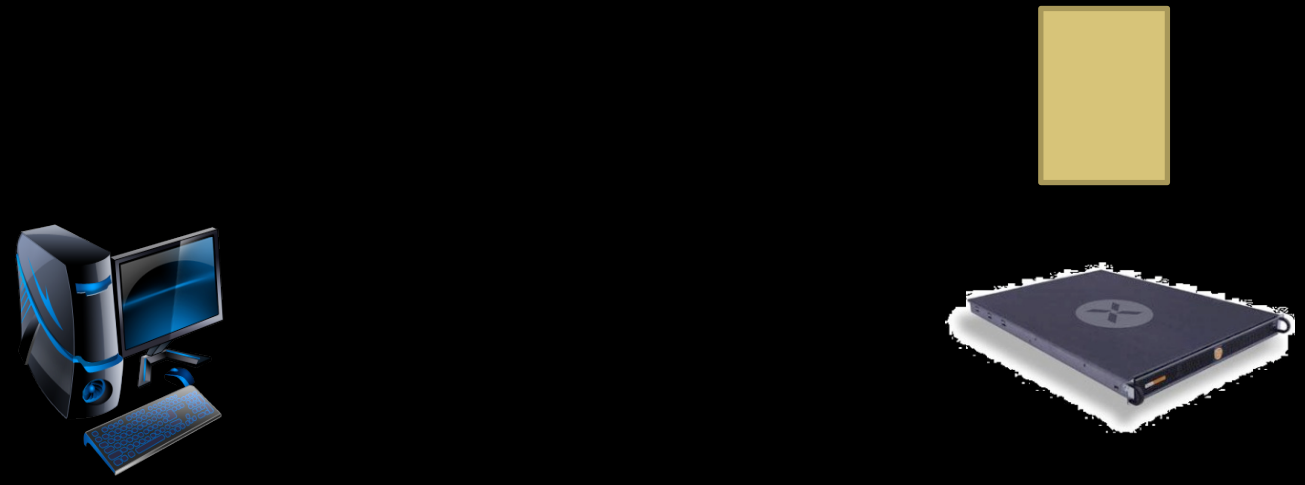
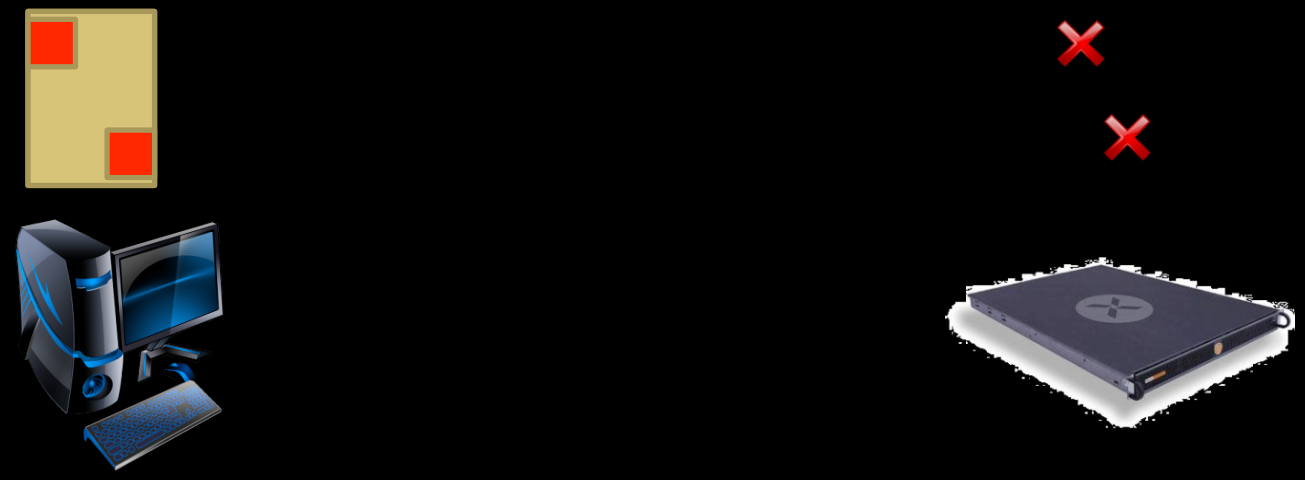


- Downside: VMs are large

Partial VM Migration

- Insight: Idle VM access only a small fraction of their memory and disk state
- Migrate just the working set



Advantages

- Small migration footprint
- Client
  - Fast migration
  - Low energy cost
- Network
  - Gentle on network resources
- Server
  - High consolidation ratios

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- Small migration footprint
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  - Fast migration — over 3G or WiFi
  - Low energy cost — mobile devices
- Network
  - Gentle on network resources — wide area (IaaS)
- Server
  - High consolidation ratios

Research Questions

- Length of sleep times?
- Size of the memory footprint?
- Prototyped simple on-demand migration approach with SnowFlock
  - Monitor memory and disk page migration to clone VM

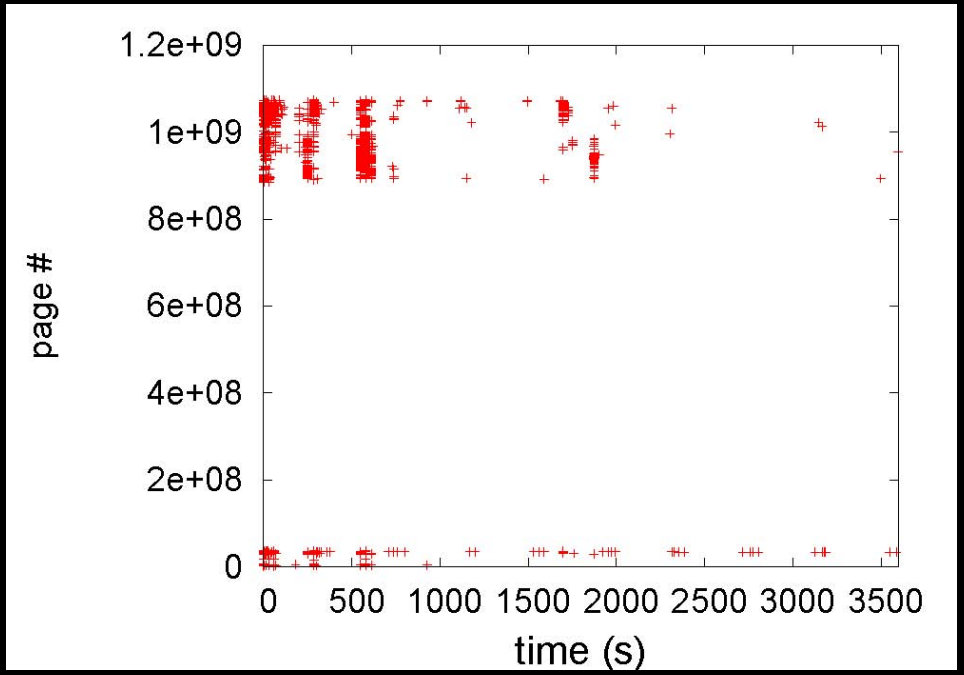
Setup

- Dell Optiplex 745 Desktop
  - 4GB RAM, 2.66GHz Intel C2D
  - Peak power: 280W
  - Idle power: 102.1W
  - Sleep power: 1.2W
- VM Image:
  - Debian Linux 5
  - 1GB RAM
  - 12 GB disk

Workloads

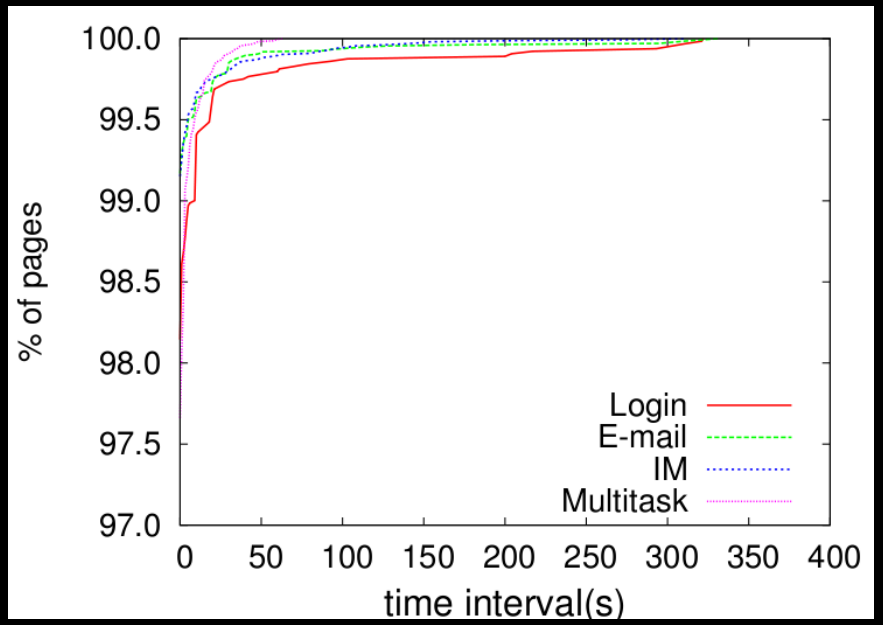
Workload	Description
Login	The login screen of a Linux desktop system (GDM).
E-mail	Mozilla thunderbird connected to an IMAP e-mail server. The client polls the server every 10 minutes.
IM	The Pidgin multi-protocol IM client connected to an IRC room with more than 100 users.
Multitask	A Gnome Desktop session with the E-mail client, IM client, Spreadsheet (OpenOffice Calc), PDF Reader (Evince) and file browser (Nautilus)

Memory Request Pattern



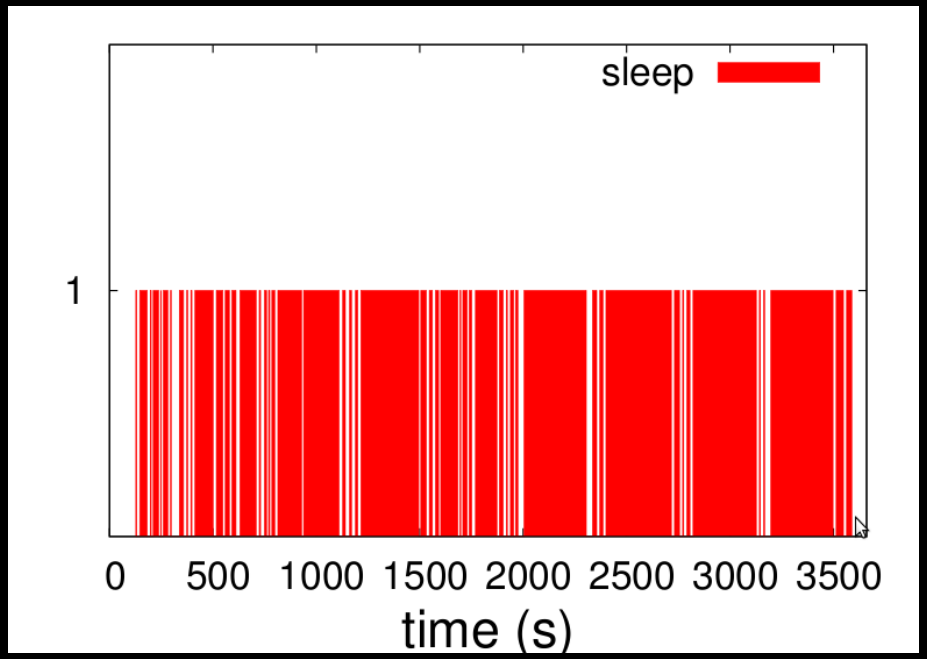
- Spatial locality
  - Potential benefits for pre-fetching

Page Request Interval

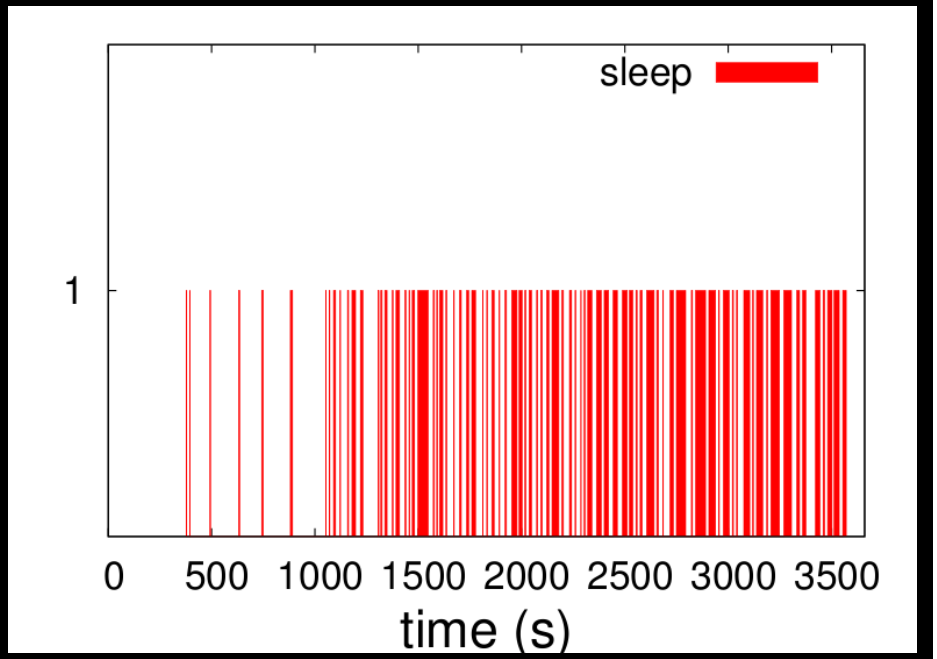


- 98% of request arrive in close succession

Sleep Potential



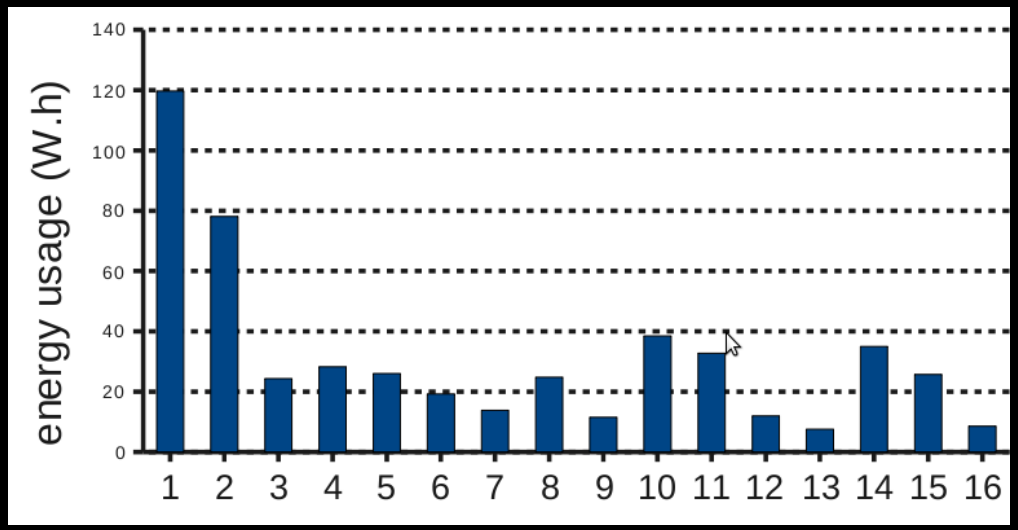
Email



Multitask

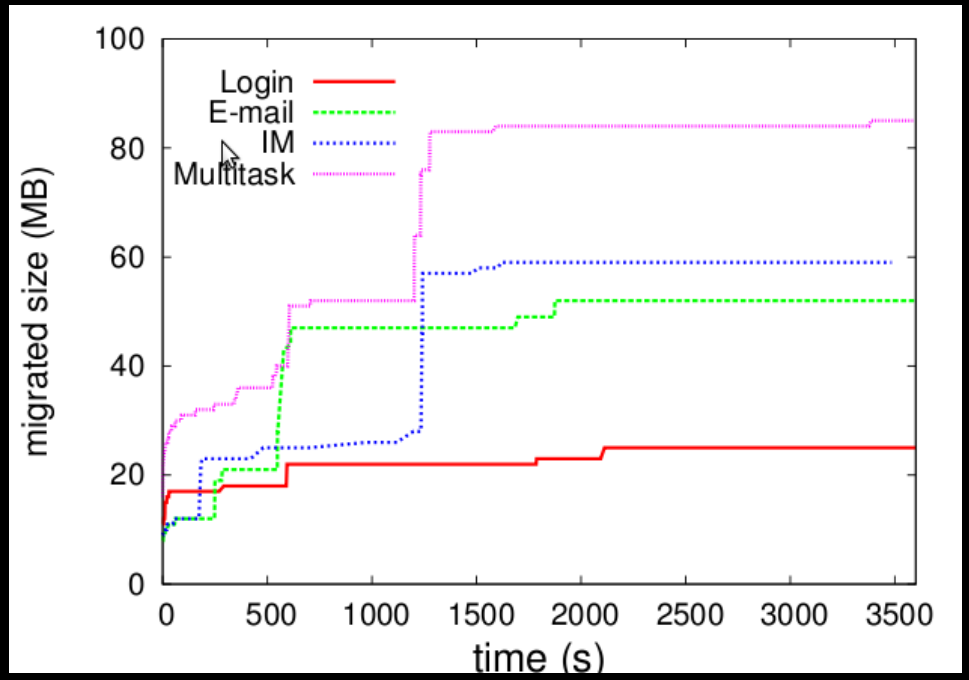
- Total sleep of 17 to 46 minutes out of 1hour
- Energy savings of 50% to 0.
- Sleep opportunities increase over time

Energy Savings: Overnight



- Inefficient in 1st hour
- 69% energy savings overall

Memory Footprint



Workload	Working Set (KB)
Login	43,012(3,851)
E-mail	71,376(424)
IM	80,351(1,147)
Multitask	119,896(10,802)

- A cloud node with 4GB of RAM can run ~30 VMs

Open Challenges

- Frequent power cycling reduces hw life expectancy and limits power savings
  - Reduce number of sleep cycles and increase sleep duration
  - Predict page access patterns and prefetch
  - Leverage content addressable memory
- Fast reintegration
- Policies
  - When to migrate/re-integrate?
  - When does the desktop go to sleep?
  - On re-integration, should state be maintained in the cloud? For how long?

Related Work

- Remote wake up: Wake-on-LAN, Wake-on-Wireless
  - No support for always-on applications
  - Short sleep times
- Protocol proxy: Nedevschi'09, Reich'10
  - Limited flexibility
- Application proxy: Somniloquy, Turducken, SleepServer
  - Applications must be modified
  - Management of applications may be complex
- Full VM Migration: LiteGreen
  - Low consolidation ratios
  - Bandwidth intensive

Conclusion

- Proposed partial VM migration
- Even naïve partial VM migration can reduce energy use of idle desktop
  - 32 – 50% over an hour-long idle interval
  - 69% overnight
- Idle desktop sessions have a memory footprint an order of magnitude smaller than their RAM allocation.
- Partial VM migration can save medium to large size organizations tens to hundreds of thousands of dollars

Thanks!

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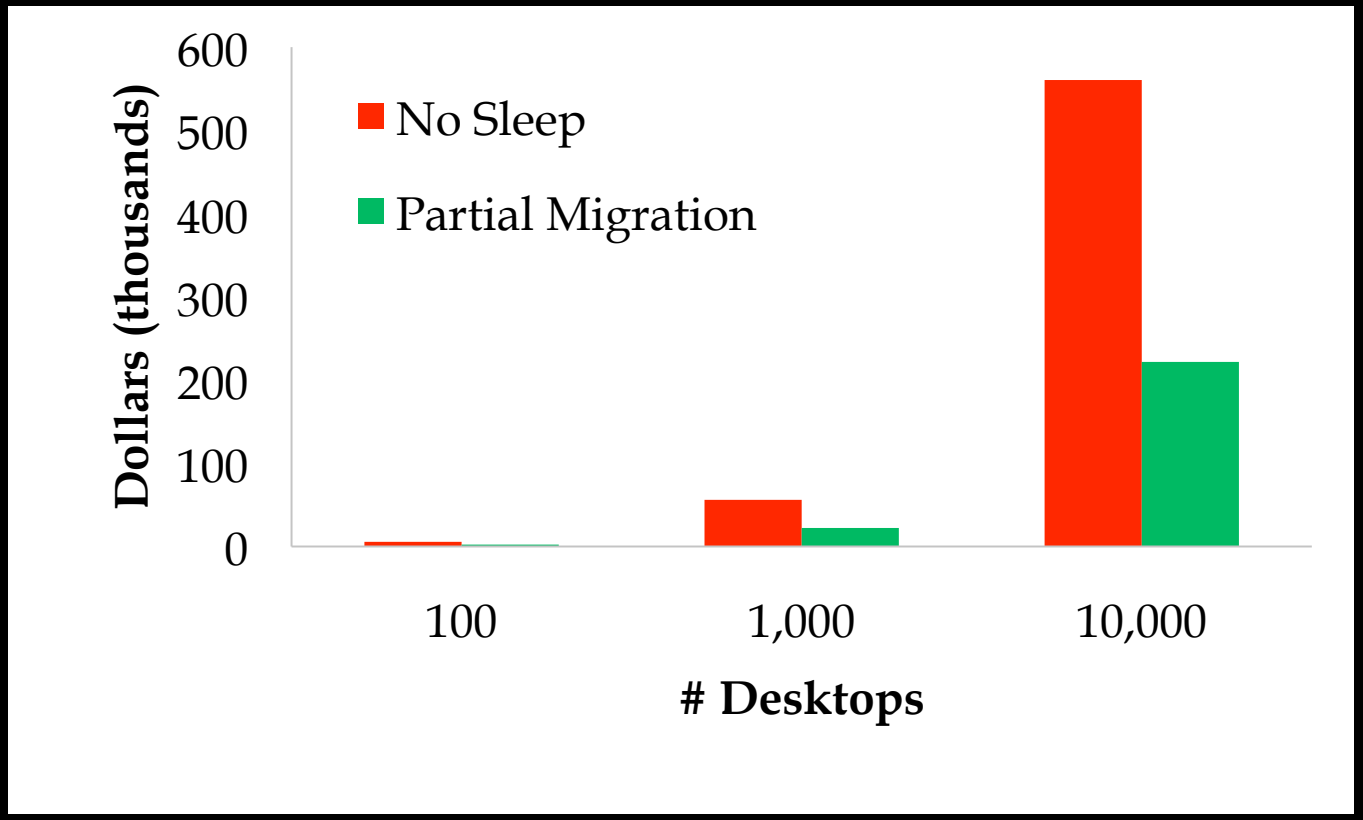
Questions?

Annual Overnight Energy Costs



- 44% to 60% reduction in energy costs