PowerNap your Data Center

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What is PowerNap?

- Like a **screen saver**, but for **servers**

- Detects **inactivity**

  − rather than disabling a display, puts underutilized servers

    into **lower power states**

- Monitors for new **activity**

  − raises servers back to **full power** as necessary

- Initially integrated into the **Ubuntu Enterprise Cloud**

- Now, it's a full project/project/solution for **Ubuntu Servers**

    (and even Ubuntu Desktops!)

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Some PowerNap Numbers

System	No PowerNap		PowerNap		
	Busy	Idle	PowerSave / TTR	Suspend / TTR	Hibernate / TTR
Thinkpad x201	49W	26W	*19W / 0s*	6W / ~3s	0W / ~30s
HP 8xCPU 1u Server	430W	300W	*280W / 0s*	N/A	0W / ~180s

On a laptop, PowerNap means longer battery
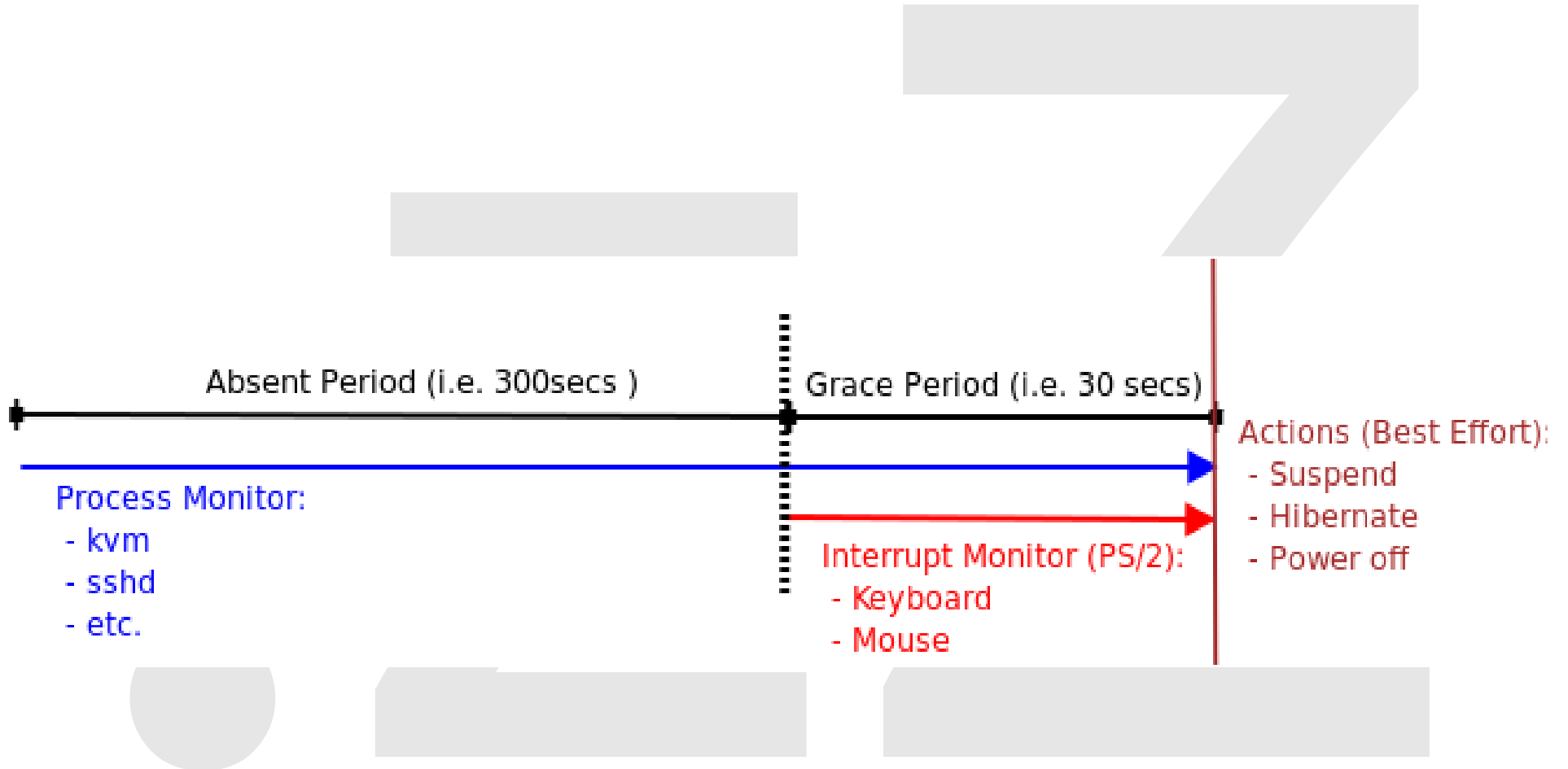- My normal 6 hour battery lasts over 7.5 hours with PowerNap

In a data center, PowerNap means lower energy bills
- Average 20W/hour saved, and a rate $0.10/KWh, that's $17.52 saved per year, per machine
- Not impressed? What about 1,000 machines x $17.52 = $17,520

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The Original PowerNap1 Approach

- **MONITORED** PROCESSES
  - Watch the system process table looking for absent processes

- **INTERVAL** SECONDS (e.g. 1 sec)
  - Interval for which to check for the MONITORED PROCESS

- **ABSENT** PERIOD (e.g. 300 secs)
  - Time for which the process has not been seen

- **GRACE** PERIOD (e.g. 30 secs)
  - Time before performing and ACTION

- **ACTION** METHOD
  - Custom script, Suspend, Hibernate, or Power-off

PowerNap1 Monitor/Action Timeline

Absent Period (i.e. 300secs)

Grace Period (i.e. 30 secs)

Actions (Best Effort):
- Suspend
- Hibernate
- Power off

Process Monitor:
- kvm
- sshd
- etc.

Interrupt Monitor (PS/2):
- Keyboard
- Mouse

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Motivation: Cloud Integration

- **Eucalyptus**

  - SCHEDPOLICY=[ROUNDROBIN,GREEDY,POWERSAVE] as a configuration option

  - INACTIVITY was tracked by Eucalyptus

  - **powernap-now** when a node is running no cloud instances

  - **powerwake** nodes when requests exceed capacity of online nodes

The PowerNap2 Approach

- Make PowerNap **generally applicable** to any Linux data center or server workloads

- Andres Rodriguez's graduate project at FIU
  - Support widely available ways to save power, **without bringing the server entirely offline**
  - Monitor **many different types of activity**
  - In a **highly configurable** manner
  - Fix the **ABSENT/GRACE** period ambiguity

PowerNap2: PowerSave Action

- Problem

  - **Few servers actually support S3**/Suspend-to-RAM

  - **Hibernate/Poweroff takes a long time** to sleep/wake

  - Server is **essentially offline** while in these modes

- Solution

  - **Add a PowerSave state**, to save power while still running

  - **Resume** from PowerSave, and cleanly undo actions

- How

  - **Extend pm-utils** power save scripts in /etc/pm/power.d/

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PowerNap2: PowerSave Scripts

- **Original**, from pm-utils:
  - disable_wol
  - hal-cd-polling
  - sched-powersave
  - intel-audio-powersave
  - journal-commit
  - sata_alpm
  - wireless

- **New**, from PowerNap:
  - cpu_frequency
    - ondemand governor not configurable
  - cpu_online
    - huge savings!
  - eth_speed
    - 100mbps saves power
  - usb_autosuspend

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PowerNap2: New Monitors

- Problem
  - **Monitoring the process table** was not enough

- Solution
  - Extend the ability to **determine a busy or idled system**

- How:
  - **Input** devices
  - **Output** devices
  - **Network** activity
  - **Application** activity

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PowerNap2: Configurable Monitors

- **Input Activity**
  - InputMonitor
  - ConsoleMonitor

- **Output Activity**
  - DiskMonitor

- **Application Activity**
  - IOMonitor
  - LoadMonitor
  - ProcessMonitor

- **Network Activity**
  - TCPMonitor
  - UDPMonitor
  - WoLMonitor

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PowerNap2: /etc/powernap/config

[powernap]
ACTION_METHOD = 0
ABSENT_SECONDS = 300
GRACE_SECONDS = 60
INTERVAL_SECONDS = 1
WARN = y
DEBUG = 0
STAGE2_ABSENT_SECONDS = 0
STAGE2_ACTION_METHOD = 4

[WoLMonitor]
wol7 = 7
Wol9 = 9

[ConsoleMonitor]
ptmx = y

[ProcessMonitor]
mplayer = "mplayer "
sshd = "sshd: .*\[priv\]$"
kvm = "kvm "

[LoadMonitor]
Threshold = 2

[TCPMonitor]
ssh = 22
http = 80
https = 443
other = 64500-65000

[UDPMonitor]
udp = 1025

[IOMonitor]
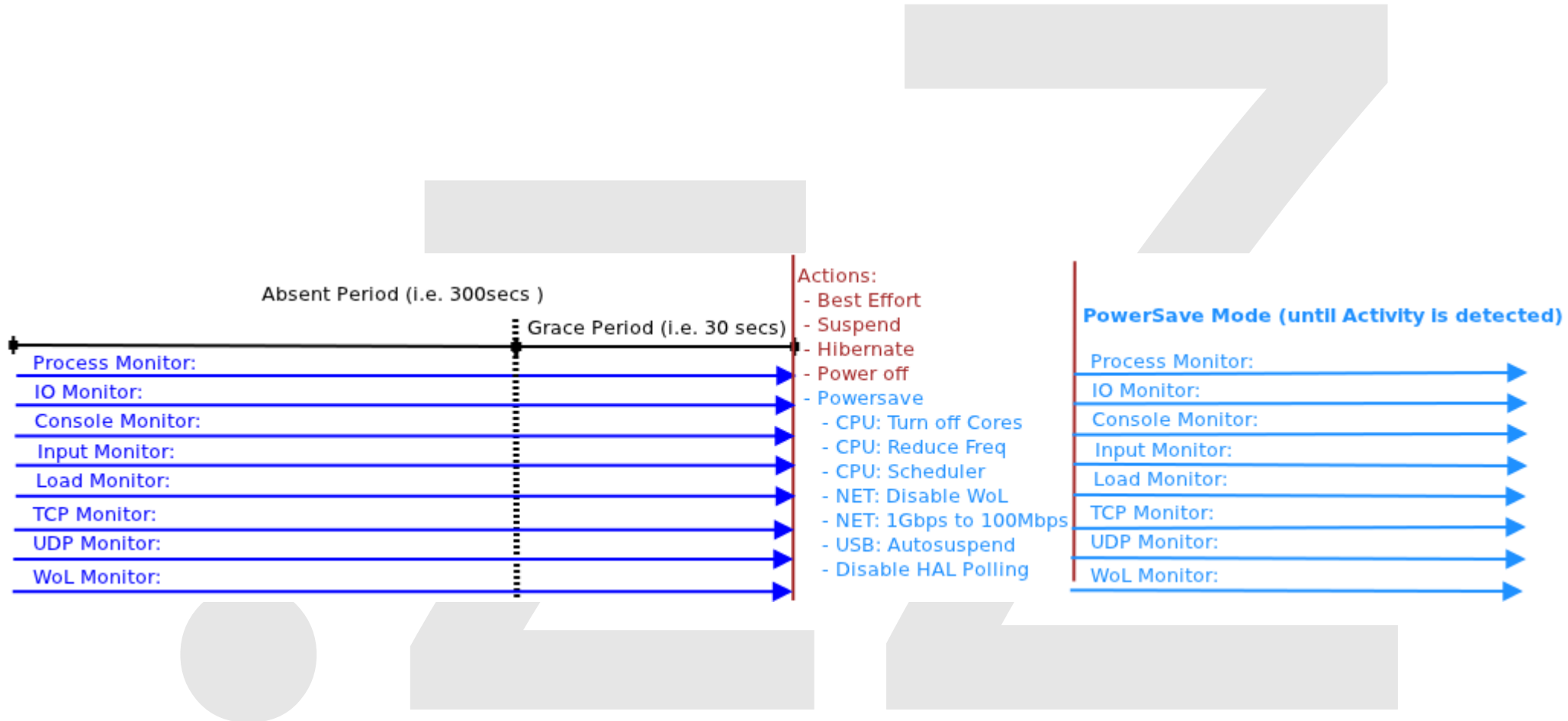kvm-io = "kvm"
mysqld-io = "mysql"

[InputMonitor]
keyboard = y
mouse = y

[DiskMonitor]
sda = y

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PowerNap 2.0 Monitor/Action Timeline

Absent Period (i.e. 300secs)

Grace Period (i.e. 30 secs)

Process Monitor:

IO Monitor:

Console Monitor:

Input Monitor:

Load Monitor:

TCP Monitor:

UDP Monitor:

WoL Monitor:

Actions:
- Best Effort
- Suspend
- Hibernate
- Power off
- Powersave
  - CPU: Turn off Cores
  - CPU: Reduce Freq
  - CPU: Scheduler
  - NET: Disable WoL
  - NET: 1Gbps to 100Mbps
  - USB: Autosuspend
- Disable HAL Polling

PowerSave Mode (until Activity is detected)

Process Monitor:

IO Monitor:

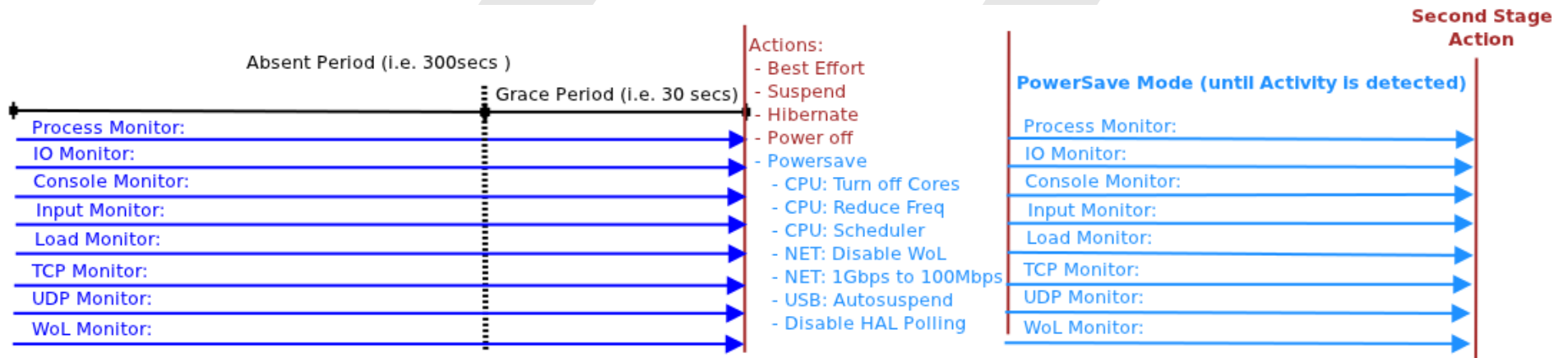Console Monitor:

Input Monitor:

Load Monitor:

TCP Monitor:

UDP Monitor:

WoL Monitor:

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PowerNap2: Second Stage Action

- Optionally take a **second-stage action**, after an extended period in PowerSave state
  - Suspend, Hibernate, or Power-off idled machine
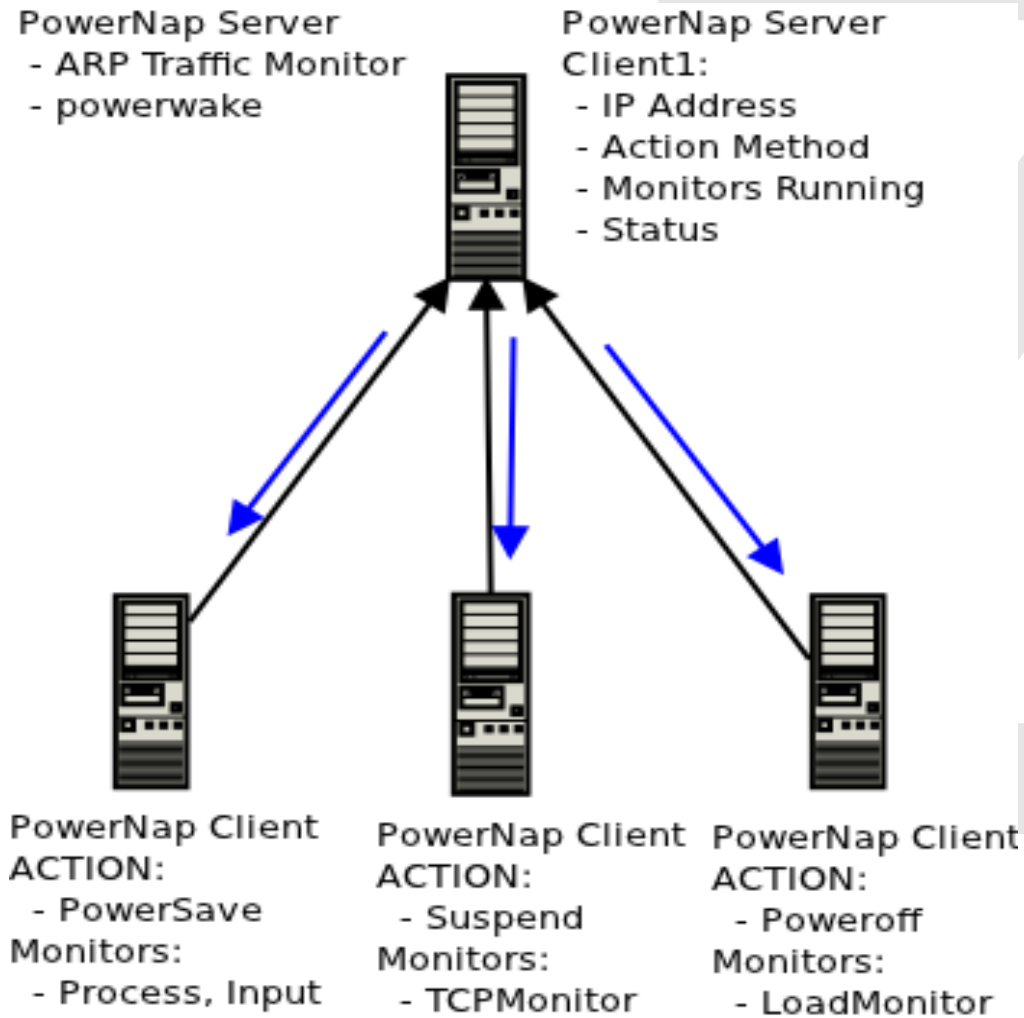
PowerNap2: Helper Tools

- **powerwake**:
  - Sends WoL packet to IP/MAC address
  - Caches host names, ip addresses, mac addresses
- **powernap-action**
  - Enable/disable action methods for PowerSave
- **powernap-now**
  - Sends a signal to local daemon to execute ACTION
- **powerwake-now**
  - Sends signal to local daemon to recover from ACTION (PowerSave)

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What's Next?

PowerNap3: PowerNap Client/Server coming soon!

- Objective:
  - **Manage** machines running PowerNap

- Operations:
  - **Schedule** wake-ups, sleeps
  - **Track** status of machines
  - **Expose** an API
  - **Auto-register** new systems

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Coming Soon: Client/Server Model

PowerNap Server
- ARP Traffic Monitor
- powerwake

PowerNap Server
Client1:
- IP Address
- Action Method
- Monitors Running
- Status

PowerNap Client
ACTION:
- PowerSave
Monitors:
- Process, Input

PowerNap Client
ACTION:
- Suspend
Monitors:
- TCPMonitor

PowerNap Client
ACTION:
- Poweroff
Monitors:
- LoadMonitor

Need More Information?

- Website, project, source code, questions, bugs:
    - **http://launchpad.net/powernap**

- **Dustin Kirkland** (original author of PowerNap)
    - kirkland@canonical.com

- **Andres Rodriguez** (current maintainer of PowerNap)
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Questions? Comments? Suggestions?

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