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Sleepy, the Smart Activity Monitoring and Energy Saving Solution for Personal Computers

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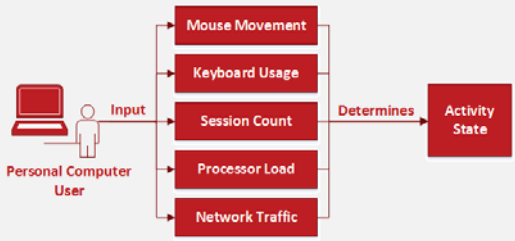
Introduction

Sleepy is part of the Green Mind award winning project of 2012, Sustainable Buildings. The Green Mind Award was an initiative of the Sustainability Steering Group of the University of Groningen. The Sustainable Buildings project is an initiative of Faris Nizamic and Tuan Anh Nguyen, both are PhD students at the University of Groningen. The Sustainable Buildings project strives to make the buildings of the University of Groningen more sustainable.

During the initial phase of the project it was concluded that personal computers are responsible for a large amount of energy being consumed throughout the day. This is especially true in environments where there are thousands of personal computers. The University of Groningen is an example of such an environment: it is not uncommon to see personal computers still running after workings hours. Thus there was a need to monitor when personal computers are on, and to monitor whether they are in use or not.

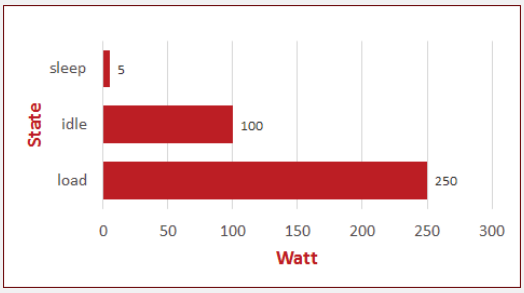
The goal of Sleepy is to prevent personal computers from being left running while they are not in use. Sleepy does this by putting personal computers to sleep when it determines that it is the right moment to do so. The right moment is determined by monitoring the activity of the personal computer and looking at the historical data to find the optimal time to put the personal computer to sleep.

Activity

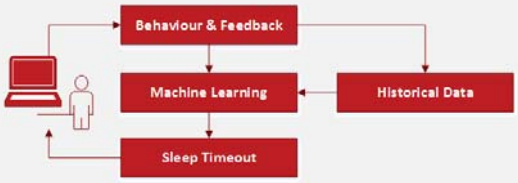


The **activity state** of a personal computer is determined by a variety of inputs. The following values can be assumed by activity state AS $= \{active, idle\}$. $P(x)$ is given as "x shows activity" and x is an input that is being monitored to determine the activity state. $AS = active$ when $\exists x : P(x)$ holds true for a given personal computer. $AS = idle$ when $\forall x : \neg P(x)$ holds true for a given personal computer.

Power Consumption



Machine Learning



Sleepy is able to learn from user behaviour and feedback by applying **machine learning** to the data that is gathered, this is done in order to find the right balance between energy saving and end user convenience. The goal is to find the optimal setting for each individual user, optimal settings do not hinder the user by letting their personal computer enter sleep mode too soon.

Web Dashboard

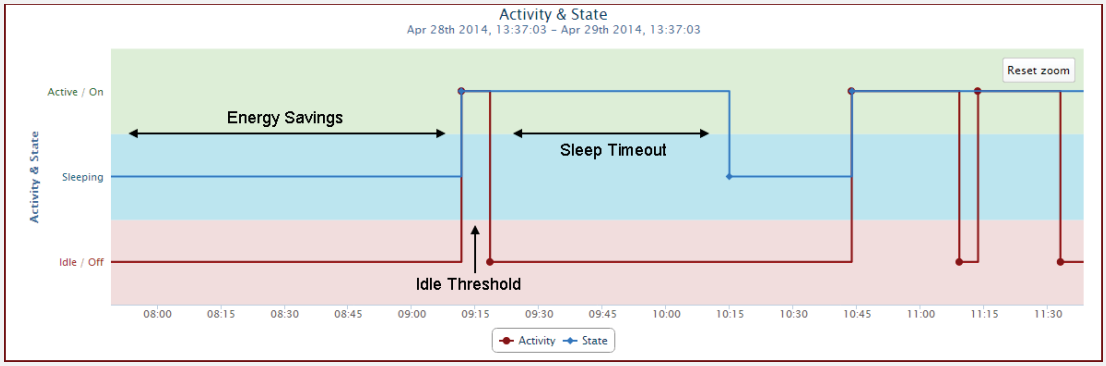
Select	MAC Address	IP Address	Sleep Timeout	Idle Threshold	Status	Activity	Enabled	History	Version	Last Seen
☐	000FFEDDC705	[redacted].51.143	60 minute(s)	240 second(s)	On	Idle	Yes	Historical Data	2.2.5227.33047	79 seconds ago
☐	F4CE46314AF6	[redacted].51.21	60 minute(s)	240 second(s)	On	Idle	Yes	Historical Data	2.2.5227.33047	50 minutes ago

Sleep | Wake Up | Turn Off

Change Sleep Timeout | Timeout in minutes

Change Idle Threshold | Threshold in seconds

The **Sleep Management Dashboard** provides means for administrators to monitor Sleepy. On the dashboard there is an overview of all personal computers using Sleepy, for each personal computer the parameters are given. Changing these parameters changes the behaviour of Sleepy, for example the sleep timeout determines for how long a personal computer has to be idle before it is put to sleep automatically. Administrators can also manually put the personal computer to sleep, wake it up, or turn it off completely. The web dashboard also gives administrator the option to view the historical data for each personal computer, this can be used to easily verify that Sleepy is indeed saving energy by putting the personal computer to sleep.



Sleepy, the Smart Activity Monitoring and Energy Saving Solution for Personal Computers

B. Setz, F. Nizamic, T.A. Nguyen, A. Lazovik, M. Aiello

Abstract—Sleepy is a smart activity monitoring and energy saving solution for personal computers. By monitoring user activity and applying machine learning techniques the solution is able to determine the earliest possible moment when a personal computer can be put in sleep mode. Resulting in energy savings up to 95 percent.

Subject Area—Low cost, low effort energy saving in buildings.

Keywords—Personal computers, energy saving, energy efficiency, sustainability, machine learning.

1 Summary

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During the initial phase of the project it was concluded that personal computers are responsible for a large amount of energy being consumed throughout the day. This is especially true in environments where there are thousands of personal computers. The University of Groningen is an example of such an environment: it is not uncommon to see personal computers still running after workings hours. Thus there was a need to gain insight into how often personal computers are turned on while not in use and to act accordingly using this information, Sleepy's raison d'être.

When Sleepy is running on a personal computer it collects information in order to determine whether the personal computer is in use or not. Information that is useful to determine activity includes keyboard and mouse activity, number of sessions logged in, processor load and network traffic. After analysing the data collected over a one week period it was discovered that there were many moments on which energy could have been saved because the personal computers were not in use. These moments were often around lunch time and after work, but also throughout the rest of the day there were times were the personal computer could have been put to sleep in order to save energy.

A web based management dashboard was developed in order to visualize the collected information. The dashboard made it possible to view activity information of each individual personal computer: a quick glance at the graphs can verify whether the personal computer is operating in an energy efficient fashion or if more energy savings are possible. The dashboard also provides means to remotely put personal computers to sleep, wake them up or turn them off.

Energy savings are achieved by putting the personal computer into sleep mode whenever it is not being used. This in itself may seem trivial, but as it turns out sleep mode is often disabled by the end user or never turned on in the first place. One might think a possible solution would be to enforce a policy to always have sleep mode enabled, but this works counter-productive as different end users have different needs. One end user may want a longer time before their personal computer enters sleep mode, whereas another end user might not need this much time. This is where Sleepy shines as a mediator.

Power consumption of personal computers in sleep mode drops to around 5 watts. This is a huge difference compared to leaving the personal computer running idle, which on average consumes around 100 watts. The result is an energy saving of around 95 percent when the personal computer is sleeping instead of idling. Also, this only takes into account the personal computer, not the monitors that are attached to it. If the monitors that are connected to the personal computer are also taken into account the savings are even more significant.

The key to Sleepy becoming successful is transparency, the end user should be completely unaware and unhindered by the actions which Sleepy performs in the background. This means there has to be a balance between the amount of energy that is saved and end user convenience. The goal is to find the optimal settings for each individual user, allowing for the maximum amount of energy savings with the minimum amount of discomfort.

To help find these optimal settings for each user machine learning techniques will be applied. Sleepy is able to learn from user behaviour and feedback, using the data that is gathered to find the right balance between energy saving and end user convenience. This is a continuous process, the solution will keep learning from the user while striving to be as transparent as possible.

Of course there might always be scenarios in which the end user wants to disable sleep mode on their personal computer, for example when there is a task running that should not be interrupted or when the current sleep timeout is too short and causing hindrance to the end user. Sleepy provides the end user means to disable sleep mode.The machine learning algorithm will use this information to learn from in order to prevent end users having to disable the solution again.

One of the biggest advantages of Sleepy is that it is a low cost and low effort method to save energy. No special hardware is needed to deploy Sleepy and it can be deployed to existing as well as new environments.Sleepy will work on a wide range of personal computers. Currently Microsoft Windows versions from Windows XP and onwards are fully supported. Linux has not been forgotten, there have been tests with Debian-based Linux distributions. These tests showed that it is also possible to implement the Sleepy solution for Linux. However currently the main focus is on Microsoft Windows as it is more widely used on personal computers at the University of Groningen.

The development of Sleepy is still ongoing, it is currently being tested with success on a smaller scale at the Bernoulliborg building of the University of Groningen. Expectations are that the Sleepy solution for smart activity and energy savings will be deployed at the University of Groningen by the end of May 2014.

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