

Wake-on-LAN Explained

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Overview

Wake-on-LAN (WoL) is a technique used to remotely power-on or resume computer equipment. WoL is platform independent and supported by most modern computers including both IBM compatible PCs and Apple Mac based systems. WoL is implemented using a special type of network message or packet. There are practical and security considerations when implementing WoL in larger enterprise networks.

This document explains the operation of WoL and the practical issues involved in WoL implementation. Data Synergy provides the free WoLMAN command-line tool for investigating and debugging WoL. Data Synergy supplies the commercial DMCMOS32 utility for configuring BIOS features, such as WoL, on large numbers of similar computers.

This document assumes the reader is familiar with common network terminology and system configuration.

What is Wake-on-LAN?

Wake-on-LAN is a computer industry standard for remotely powering-on or waking an otherwise unavailable computer from a remote location. WoL was originally developed by AMD/HP¹ and uses a special network broadcast or 'magic' packet. When WoL is enabled the computer maintains power to the network interface card (NIC) and this continues to process network packets. When a valid WoL packet is detected the NIC powers-on or resumes the computer.

Wake-on-LAN requires the following to function:

- **A compatible motherboard and BIOS** - most modern ACPI boards support WoL
- **A compatible network card** - This is often integrated into modern motherboards
- **Correct operating system configuration** - The OS must configure the NIC to remain powered whilst the computer is suspended.

WoL is a versatile technique that allows otherwise active computers to be deactivated when not required. Effective use of WoL allows system administrators or users to turn computers on remotely. This is commonly used for patch management, remote support and remote access. WoL has the

potential to greatly increase the use of low-power modes and energy saving techniques.

WoL has a number of practical, technical and security considerations that can sometimes prevent effective implementation in larger networks. This document explains these issues and how they may be successfully overcome.

It is important to remember that WoL is not the only technique available for resuming a computer. Modern PCs include a built-in timer circuit that can resume the PC from sleep or hibernate at a specific time. This is ideal for planned system resumption and avoids the implementation issues associated with WoL. The Data Synergy PowerMAN suite supports both WoL and the PC timer method.

Limitations of Wake-on-LAN Magic Packets?

A basic WoL packet consists of a trivial header followed by the network media-access-control (MAC) address repeated 16 times. The packet can be sent by using any network or transport layer protocol. The most common technique used is a UDP broadcast.

A WoL packet has the following basic limitations:

- a. **Specific to each computer and can only wake a single machine.** This is because the packet is designed to be very simple and quickly processed by the circuitry present on the network interface card (NIC) with minimal power requirement.
- b. **Requires the hardware MAC address.** This is because WoL operates below the protocol layer. At this layer IP addresses or DNS names are not relevant.
- c. **Does not provide a delivery confirmation.** This is because WoL operates below the protocol layer. UDP packets are not guaranteed to arrive. There is therefore no way to determine if the WoL packet was delivered successfully.
- d. **May not work outside of the local network.** This is because WoL is typically implemented using broadcast packets. Such packets are generally not routed and are therefore stopped at the local network boundary. In large routed networks, with multiple network segments, this prevents a WoL request from one broadcast domain reaching another.

Wake-on-LAN using Subnet Directed Broadcasts

A principal limitation of WoL is that broadcast packets are generally not routable. This prevents WoL being used in larger networks or over the internet. Subnet Directed Broadcasts (SDB) may be used to overcome this limitation. SDB may require changes to intermediate router configuration.

Subnet directed broadcasts are treated as normal network packets until processed by the final (local) router. This router converts the packet into a true broadcast packet. This technique allows a broadcast to be initiated on a remote network but requires all intervening routers to forward the SDB.

SDB is often disabled for security reasons. The most common reason for this is to prevent so-called 'Smurf' attacks. In such an attack an aggressor sends a large number of ICMP echo requests (Pings) to a broadcast address using a spoofed source IP address. Unless disabled each network host replies to this request sending the resulting echo to the spoofed address. This can inundate that address with traffic resulting in a denial of service. SDB may however be safely enabled for WoL using a combination of the following techniques:

- **Use a non-standard UDP port** - WoL typically uses port 7 or 9
- **Use ingress filtering to ensure SDB packets are only accepted from approved sources**
- **Use packet inspection to eliminate ICMP requests**

Despite these potential limitations SDB is the industry standard technique for WoL in larger networks. For instance, Microsoft's System Center Configuration Manager 2007 product uses the SDB technique. This is explained in the following Microsoft document:

<http://technet.microsoft.com/en-us/library/bb632807.aspx>

Wake-on-LAN using Unicast (Standard) network packets

WoL may also be implemented using a standard, unicast, network packet. This technique has a number of potential advantages but is limited by the following disadvantages:

- **Target computer address must be known**
- **Will fail if the address has changed**
- **Not supported by all network cards or may be inconsistent with resume from some low-power states on some systems**
- **Will fail if the local router ARP cache has expired**

These limitations prevent unicast WoL being used in most practical scenarios.

Microsoft's System Center Configuration Manager 2007 product supports the unicast technique. The following table explains the differences between the SDB and unicast methods:

<http://technet.microsoft.com/en-us/library/bb632911.aspx>

Windows/PC: Wake-on-LAN Configuration

Wake-on-LAN requires correct configuration of the system BIOS and operating system to function. There are sometimes several interlinked settings and it may require several combinations to be tested to achieve successful WoL. This section explains the common BIOS and Windows Device Manager settings required.

BIOS configuration is usually straightforward but may be complicated by the different terminology used by each BIOS vendor. The setting is often located in either the **Power** or **Boot** sections of the BIOS configuration and may be described as **Wake-on-LAN**, **PME**, **PM Wake-up Events**, **Wake-up Control**, **Remote Wake** or similar. A typical BIOS setting is shown below:

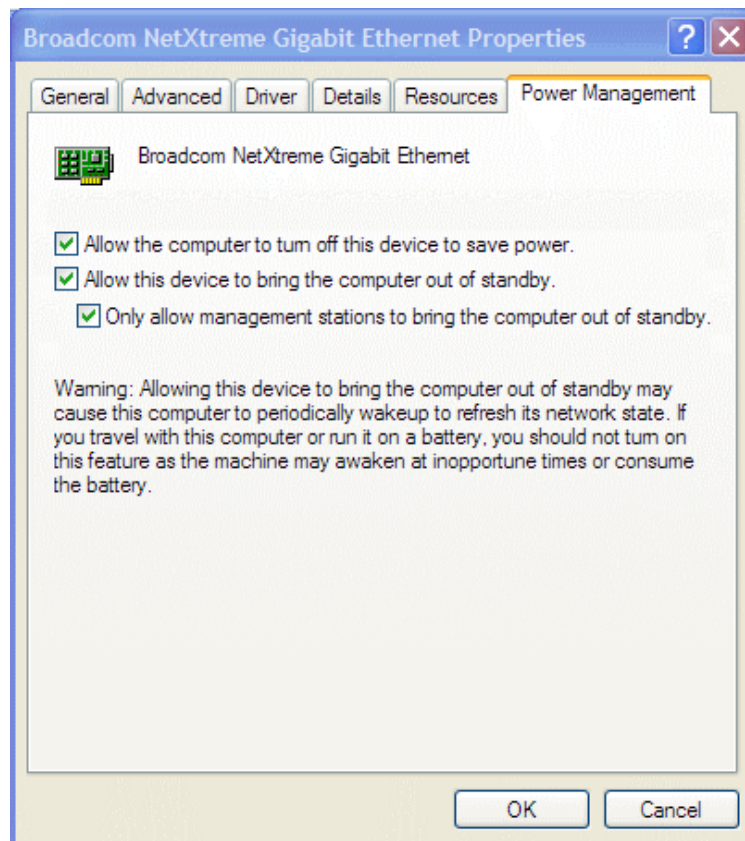
Soft-Off by PWR-Button	Delay 4 Sec.
Wake On PCI Card	By OS
Wake On Modem	Disabled
Wake On LAN	Enabled
Wake On RTC	By OS

Data Synergy TechNote: Wake-On-LAN Explained

WoL also requires operating system participation to function whilst the system is suspended. This is because the network interface card must be configured to remain active and thus able to process WoL packets.

The following options must be selected (ticked) for the network card in Device Manager:

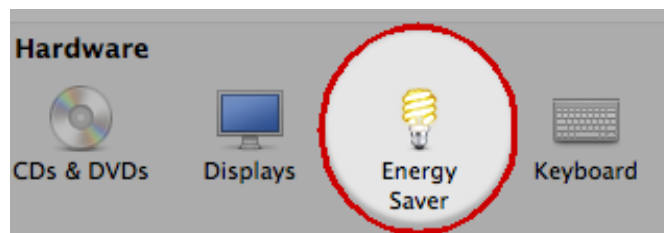
- Allow the computer to turn off this device to save power
- Allow this device to bring the computer out of standby / wake the computer
- Only allow management stations to bring the computer out of standby



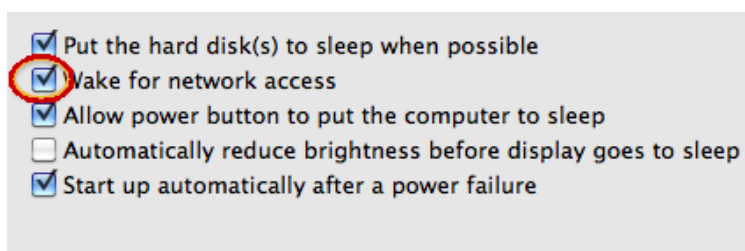
Apple Mac / OS X: Wake-on-LAN Configuration

To enable Wake-on-LAN support in Apple OS X proceed as follows:

1. Open **System Preferences**
2. Select **Energy Saver**



3. Select **Wake for network access**



Data Synergy Wake-on-LAN and Power Management Tools

Data Synergy produces several related Wake-on-LAN and power management products. Each product is independent and may be used in isolation. In some cases features are complementary and may be used together.

Wake-on-LAN can be troublesome and time consuming to configure. For this reason we recommend that WoL is not used unless absolutely necessary. Our PowerMAN product is capable of reliably waking workstations from sleep and hibernate at scheduled times. This feature uses the internal PC 'alarm clock' and does not require any external support or network changes. In most cases this is sufficient for workstation updates or maintenance and will avoid the complications associated with Wake-on-LAN. Further details on the wake-up features available in PowerMAN are available here:

<http://www.datasynergy.co.uk/products/powerman/PowerManagerFAQ.aspx#WOL>

Remember: Wake-on-LAN is used to wake-up or turn-on computers. It plays no part achieving low-power modes such as sleep, hibernate or shutdown. WoL is sometimes a useful addition to a power management strategy but is not essential.

The main reasons that Wake-on-LAN may be necessary are:

- Ad-hoc wake-up by remote users
- Wake-up from full shutdown state

Data Synergy supplies several Wake-on-LAN related tools:

WoIMAN is a free command line tool for system administrator use. It can be used to test Wake-on-LAN and resolve network problems. It does not allow standard users to wake-up workstations from a remote location (unless they are running the tool and understand how to use it). Every wake-up requires entry of the workstation technical details (MAC address, IP address etc.)

WakeMyPC Lite Server is a basic web-based product providing manual workstation wake-up using known technical details. The product does not include any persistent data storage (database) and therefore workstation technical details must be manually entered and then either stored in an Internet browser bookmark or re-entered on a subsequent occasion. This product is ideal for small scale deployments.

WakeMyPC Enterprise Server is a fully featured enterprise-class product providing:

- Ad-hoc workstation wake-up based upon computer name, recent user name
- Ad-hoc workstation wake-up by workstation group
- Scheduled workstation wake-up compatible with the Windows Task Scheduler
- Persistent workstation information storage database – avoiding manual re-input
- Optional integration with Data Synergy PowerMAN and PowerMAN Enterprise Server
- Optional workstation agent to automatically gather and update workstation information

Each WoL product builds upon the functionality of the previous one. WoIMAN and WakeMyPC Lite are both free of charge but also both require some degree of technical knowledge to use. WakeMyPC Enterprise Server is a fully featured enterprise software product that is suitable for wide deployment and use by end-users.

About Data Synergy



Data Synergy is a British company based in Sheffield. We have over 10 years' experience developing and supporting software solutions for enterprise PC deployment and management. We do not resell other vendors' products and do all of our development, sales and support from our UK base.

Our products have evolved through listening to customer ideas and applying our unrivalled knowledge of PC internals. If you have a suggestion for a new product or feature we would love to talk to you.

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