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## EuP Preparatory Studies

### Lot 26: Networked Standby Losses

## Final Report Task 4

### Technical Analysis Existing Products

Contractor:

Fraunhofer Institute for Reliability and Microintegration, IZM

Department Environmental and Reliability Engineering

Dr.-Ing. Nils F. Nissen

Gustav-Meyer-Allee 25, 13355 Berlin, Germany

Contact:

Tel.: +49-30-46403-132

Fax: +49-30-46403-131

Email: [nils.nissen@izm.fraunhofer.de](mailto:nils.nissen@izm.fraunhofer.de)

Berlin, Paris

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Authors:

Dr. Nils F. Nissen, Fraunhofer IZM

Dr. Lutz Stobbe, Fraunhofer IZM

Kurt Muehmel, Bio Intelligence Service

Shailendra Mudgal, Bio Intelligence Service

Additional Contributions:

Karsten Schischke, Fraunhofer IZM

Sascha Scheiber, Fraunhofer IZM

Dr. Andreas Middendorf, Technische Universität Berlin and Fraunhofer IZM

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The findings presented in this document are results of the research conducted by the IZM consortium and are not to be perceived as the opinion of the European Commission.

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## 4 Task 4: Technical Analysis Existing Products

### 4.0 Introduction

#### 4.0.1 Objective

According to the given methodology (MEEuP), the objective of Task 4 is the technical analysis of products that are currently placed on the European market. The product selection should be characteristic of the product group which is under investigation in the particular study. The analysis has to determine relevant technical parameters that have an influence on the environmental life cycle performance of the products. This includes in general energy and material related product specifications. The Task 4 report provides the main input data for the later environmental product assessment and definition of the base cases in Task 5.

The ENER Lot 26 Study horizontally addresses the energy consumption of products in conjunction with networked standby. This specific objective makes it necessary to modify the technical analysis and the subsequent environmental assessment to some extent. The technical analysis will focus solely on the energy consumption of products in the use phase. That covers all aspects of the product's utilization from active modes to off modes.

Because networked standby is a functionality that could be provided out of different power modes, our investigation will address the issue of power management and the currently existing low power options for different network technologies. Despite power management the report will compile existing wake-over-network solutions and respective technical developments. In terms of products, the study needs to cover a broad spectrum of equipment and network technologies. The focus is clearly set on end-user information and communication technology equipment, consumer electronics and other electrical appliances that are typically employed in private households, business environments and offices as well as in the field of building automation. This technical analysis reflects networked standby issues with respect to the following, currently existing product groups:

- Personal computers (e.g. small servers, desktop, integrated computers, notebooks)
- Displays (e.g. computer monitors, information displays and digital picture frames)
- Networked storage (e.g. NAS, RAID, external HDD or SDD)
- Imaging equipment (e.g. printers, copiers, multifunctional devices)
- Consumer electronics (e.g. TV, AV receivers, media recorders, players and servers)
- TV customer premises equipment (e.g. complex set-top-boxes)
- Networking equipment (e.g. gateways, access points, telephones)

The production phase, distribution phase, and end-of-life phase of are not relevant for the study. We recognize however that the production of certain components – and production related cost factors – could be of interest in the later assessment of improvement potentials. Nevertheless, we will focus this particular analysis on technical and application related aspects that influence the energy consumption of products in the use phase.

#### **4.0.2 Terminology**

Throughout this task we are going to use the term “remote access and reactivation” synonymously for describing network standby. This term repeats the main functionality assigned to the networked standby condition. With “remote access and reactivation” we are recognizing the fact that networked standby provides certain functionality. The main functionality is the access of a particular “network service” that is provided by the networked product. That could include the upload of a file (e.g. video, music or document), the activation of a device or the transmission of a signal. The “resume time to application” is in that respect an important “quality-of-service” requirement. In Task 5 we will define certain quality-of-service levels with respect to the resume time to application. We will call these quality-of-service levels High, Medium, Low, and No “Network Availability”.

Networked standby not only represents remote access and reactivation, but also implies that this functionality is provided (or could be provided) with less energy, meaning in a lower power mode. But as a matter of fact, remote access and reactivation is not always possible at present with the current standby mode power requirement of 2 Watt and less. Certain product groups, particularly consumer electronics such as TVs, AV receiver, and Blu-Ray Player and HDD Recorder feature “active”, “high”, “hot”, “fast”, “quick” and other higher powered standby modes (both passive and networked) in support of this functionality. The power consumption for such fast reactivation can range from 8 watts for a media player/recorder to over 25 watts for a complex TV. Other products, such as networking products or so called customer premises equipment, do not feature a standby mode that allows remote access and reactivation. These products are always on in an active or idle mode. This current situation, however, does not necessarily reflect the future situation as technologies will tend to become more efficient, potentially as a result of regulation. The most advanced product group with respect to networked standby is personal computers. There are for a couple of years already technical solutions implemented in the market that correspond with networked standby mode such as Wake-on-LAN or more advanced technologies such as Intel’s proprietary AMT or technologies such as described by the Distributed Management Task Force (DMTF) Desktop and mobile Architecture for System hardware (DASH) standard. The DASH standard includes “Out of Band” access to servers independent of OS state and server power state.

In the following technical analysis we are going to examine the utilization parameters, product configurations, and existing technologies with respect to networked standby. The particular input data for the environmental assessment of the selected product groups will be provided and explained in Task 5.

### **4.0.3 Acknowledgement**

Note: In preparation of the Task 4 Report the authors provided a technical questionnaire to industry stakeholders and conducted about two dozen individual meetings and similar number of conference calls. The strongest input has been received from the computer industry, followed by consumer electronics and networking industry. Through this exchange of information we have gained a deeper understanding of technical aspects on the product level but even more on the system level.

The consortium would like to thank all active stakeholders for their support of this study.

## **4.1 Production Phase**

This subtask is not relevant for the purpose of the ENER Lot 26 Study.

## **4.2 Distribution Phase**

This subtask is not relevant for the purpose of the ENER Lot 26 Study.

## **4.3 Use Phase (Product)**

In this chapter we are going to analyze the utilization and technical solutions for remote access and reactivation of networked equipment on the example of the following product categories and application areas:

- Personal Computers
- Networking Equipment
- Multimedia Equipment
- Smart Home

With the investigation of these application areas and respective types of equipment we like to determine first of all the potential network services that the products offer in their particular use environment. We already assume that the general purposes for remote access of reactivation are related to:

- Monitoring and servicing of distributed client devices by a professional administrator
- Monitoring and servicing of customer premises equipment by a service provider
- Resuming an application or main function of a product within a local area network

- Retrieving content such as media files from a server-type device

These applications are only possible under certain technical conditions. Our analysis will cover the technical parameters of typical equipment and of the network technology that is employed. We address the following points:

- What are the performance features and network configurations of the products?
- What are the typical network services, applications, and utilization patterns?
- What are the modes and technical solutions for remote access and reactivation?

### 4.3.1 Example: Personal Computers

**Product description:** Personal computers are still a quickly developing product group. The market is basically divided into stationary devices (e.g. small server, desktops, thin clients, and integrated all-in-one) and battery powered portable devices (e.g. notebooks, subnotebooks, tablets). Battery powered products feature typically advanced power management. There is a range of computer peripheral devices that we consider in this study as well. They include e.g. network attached and plug-in storage devices, desktop monitors (displays), and imaging equipment such as printers or MFDs. The power consumption varies largely between different types of personal computers particularly due to the processor and storage performance of the system. The on-mode power demand ranges from a couple of ten watts<sup>1</sup> to a couple of hundred watts. New semiconductor generations and progress in system integration is balancing (if not constantly improving) the energy efficiency of PCs in general.

**Network configuration:** A general trend for all computer devices is the growing network capability in terms of bandwidth and network availability. Most computer products feature different versions of wired and wireless LAN (Ethernet) as well as USB. There are of course adapters for almost any kind of network interface available. PCs are configured with multiple wired and wireless interfaces (ports). An important aspect with respect to quality of service is the reliability and security of a network connection. With the introduction of more capable and secure network technologies the protocol overhead increases. The required network interface control (NIC) in close conjunction with the operation system (OS) determines the efficiency of the network utilization. The hardware and software elements are important instruments in optimizing power consumption of the utilized network.

**Network utilization:** The PC network connections are used for various purposes. With respect to this study we will focus on remote access and reactivation of the (sleeping) equipment over a network connection. This functionality is to some extent already a common practice in the field of personal computers. Our investigation indicates that remote access of devices is more common within the business environment. One example is servicing distributed office PCs by utilizing the Ethernet-based Wake-on-LAN (WOL) technologies or more advanced technical solutions such as Intel's AMT on Intel's vPro platform for business computers. Another established solution is provided by the Distributed Management Task Force (DMTF) DASH specification. They include platforms by HP, Compaq, Dell, and Lenovo among other platform vendors.

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<sup>1</sup> Or less, in the case of thin clients.

Administration of distributed PCs, imaging equipment, information displays, networking equipment and other IT can be done 24h/day (see Figure 1). In order to ensure full working capability, updates might be scheduled by the IT administration for the night.

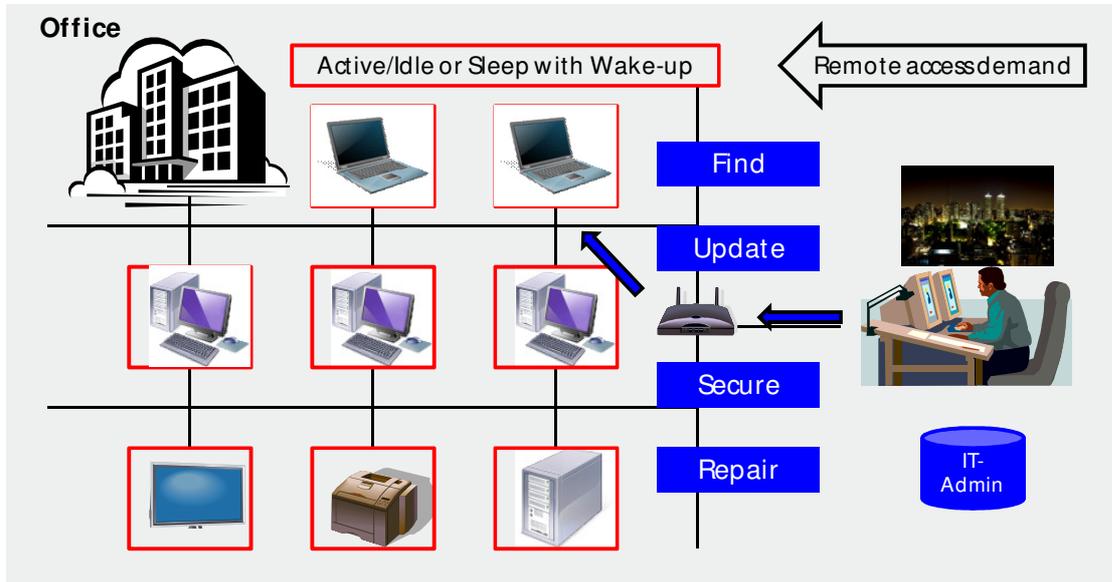


Figure 1: IT-Administration in business environments

As for the private use environment (home) it has been more difficult to assess the actual utilization of remote access and reactivation. As a matter of fact the long existing WOL is hardly utilized by private customers. Industry assumes that no more than 5% to 10% of private PCs are used in this way. External access of home PCs over WAN-LAN connection such as Virtual Private Networks (VPN) is not yet common in Europe (see Figure 2). Interoperability problems are an issue in that respect.

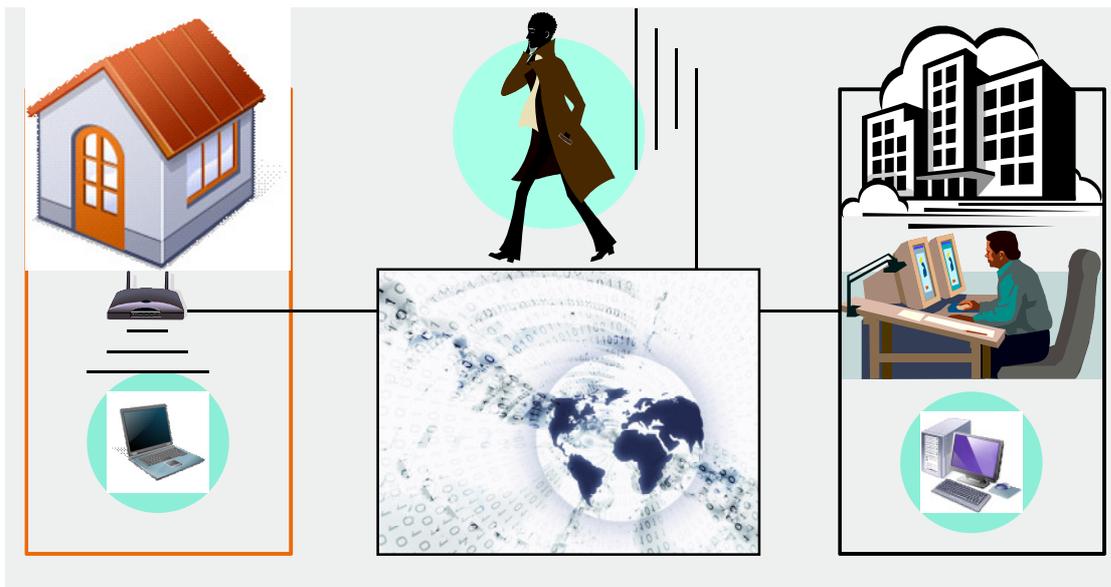


Figure 2: Virtual Private Network

Another reason for this situation is the still existing lack of appropriate bandwidth in the upstream, which reduces the upload and streaming capabilities (speed) from a server-type product at home. The currently existing asymmetrical bandwidth distribution – as is the case with most DSL standards – will eventually be solved when Fiber-to-the-Home (FTTH) is implemented. Many European Union member state governments are pushing this development. According to a recent publication of the Fiber-to-the-Home Council Europe (FTTHCE) a dynamic development is expected for the years to come. However, in 2010 only 1% of EU households are connected by FTTH.<sup>2</sup>

**Network availability:** Despite this situation we have to assume increasing network demand. File sharing, social networks, and other private network services are increasing the supply-side (service offers) and will result in increasing network demand with respective interfaces. Against that background it is reasonable to assume that PCs will more and more require the capability of remote access and reactivation (networked standby). A critical aspect in this respect is the resume time to application. This is the time necessary for a device to receive and process a wake-up signal, start (resume or boot) the operating system and support an application or service. Depending on the network service that is offered, the resume time to application could vary. In a virtual private network somewhat longer time delays might be acceptable whereas in a private-public application more instant reactivity is required. We expect that the utilization of remote access and reactivation will increase with higher network availability (faster resume time to application).

<sup>2</sup> FTTHCE (April 2010): [http://www.ftthcouncil.eu/documents/studies/FTTHCE\\_AnnualReport\\_2009-2010.pdf](http://www.ftthcouncil.eu/documents/studies/FTTHCE_AnnualReport_2009-2010.pdf) (downloaded 25.08.2010)

**Remote access and reactivation:** PC/LAN systems have some well established wake-up solutions (e.g. WOL, DASH). CE (AV) systems are also capable of wake-up over network by legacy SCART or digital HDMI CEC.

**Support of power management:** Power management of products that provide network services are related to ECMA393 (Proxying) and IEEE802.3az (Energy Efficient Ethernet).

### 4.3.2 Example: Networking Equipment

**Product description:** In the residential and office environment networking equipment are located at a subscriber's premises. They connect the local area network (LAN) of the private user or office with the service provider's wide area network (WAN). The main functionality of networking equipment is to provide high network availability for instant signal transmission. Networking equipment is a fast developing product group. They are driven historically from the telecommunication sector (telephone and internet service provider) on the one hand and the television sector (cable and satellite TV service provider) on the other hand. With increasing broadband capabilities of both telecommunication and television access technologies triple play services including telephone, internet and television are becoming a common business model. At the moment most households still have separated telephone and television access technologies. We assume that this situation will change over the next years leading to triple play capable home gateways based on wide area network technologies such as DSL or FTTH and headed complex set-top-boxes based on DOCSIS or SAT. Another access and local area network option is Femto cells. The access technologies would include 3D and 4G cellular such as UMTS, LTE and WiMAX.

**Network configuration:** Networking equipment, including both routers and set-top-boxes, increasingly support wired and wireless computer and multimedia networks in the home and office environment. They feature wired and wireless LAN (Ethernet) as well as USB and HDMI. The following groups of network interfaces are part of triple play gateways:

- Wide Area Network Interfaces (DSL, FTTH, DOCSIS, UMTS, LTE, WiMAX)
- Local Area Network Interfaces (Ethernet, WiFi, USB, PLC, MoCA)
- Broadcast Network Interfaces (DVB tuner and demodulation)
- Digital AV Network Interfaces (HDMI, DVI-D, DisplayPort)
- Analogue AV Network Interfaces (SCART)
- Analogue Telephone Network Interfaces (FXS)

The power consumption of networking equipment largely depends on the network configuration including the number of wired and wireless interfaces (ports), bandwidth capabilities, signal/data processing and storage performance. At the present time the on-mode power consumption is mainly <30W, averaging around 10W. Over the past years dedicated network System-on-Chip (SoC) and large scale system integration (LSI) improved power consumption despite increasing performance. With increasing integration of storage capacities and server-type applications this improved electricity consumption could however be offset – meaning power consumption could increase again.

**Network utilization:** Networking equipment is designed for high network availability (always online). The utilization in home and office environments is basically identical, though the utilization intensity varies. Again, the bandwidth availability in downstream and upstream is essential for the actual network demand and use. Due to the trend towards triple play supporting equipment it is feasible to assume that active utilization of networking equipment will further increase (more hours per day). Idle or possible standby periods, which occur during the night time, might decrease even further. We do not assume that customers switch off networking equipment. There are two types of network service demand (see Figure 3). The first is the CPE access demand of a service provider for codec and program updates or other security measures. The second demand comes from network services that the end user offers to the outside. This could be a file sharing application or utilization of a VPN.

With the already indicated shift towards new applications (e.g. media server, file sharing) the networking equipment becomes an essential part of the home multimedia infrastructure as well. This means that not only the WAN link needs to be maintained all the time, but also that the LAN/Multimedia links need to be capable of remote access and reactivation. Furthermore, our investigation also indicates that networking equipment (as a central node) will be used as a power supply source for smaller plug-in equipment that are powered over Ethernet or USB (or other technologies in the future).

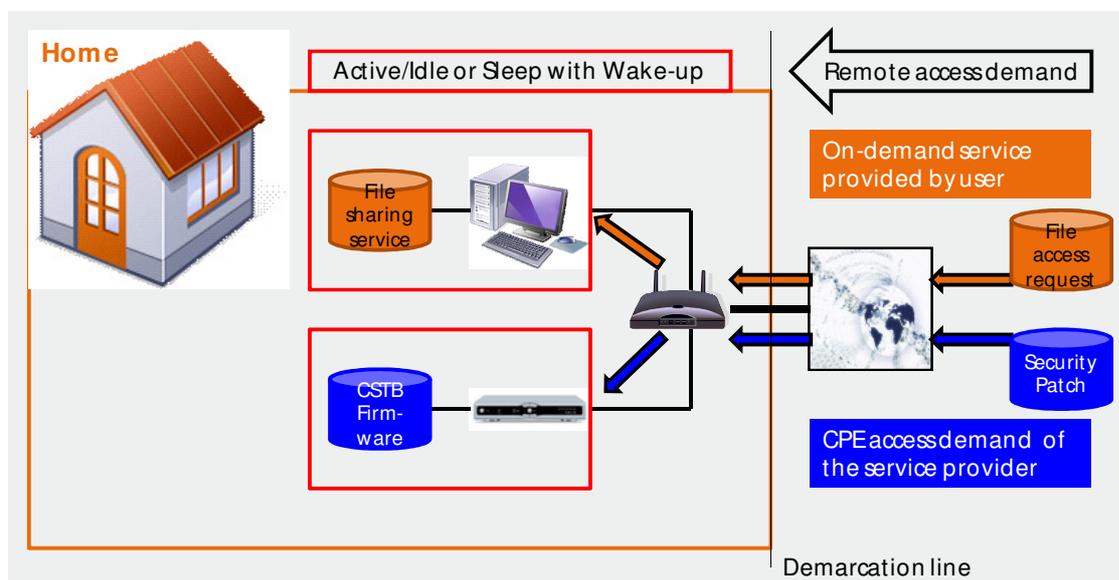


Figure 3: Remote access demand in the home environment

**Network availability:** Against that background we (not surprisingly) conclude that network availability has the highest priority for networking equipment. The reaction time is in the micro- and millisecond range. Nevertheless, due to obvious periods of no or less network

transmissions (active utilization) during night times, vacation or during the day (customer at work) we see a potential of reducing energy consumption though the implementation of a smart and reliable power management that provides still enough (fast) resume time to application. In Chapter 5, we will investigate the technical situation in that respect.

### 4.3.3 Example: Multimedia Equipment

**Product description:** TV and multimedia equipment describe a manifold set of products typically called audio/video or consumer electronics. The product spectrum is currently embedded into a dynamic market development. The driving forces behind this market are new television services and video media technologies in conjunction with changing triple play service provider infrastructure. TV and multimedia development is not only driven by changing form factors and display technologies, but also by digitalization of content platforms (media), high definition (HD), and three dimensional (3D) TV/video. This trend changes the media carrier systems and network requirements. It is expected that more than two Third of all CE products will be network enabled (HDMI LLC 2009). Despite regular TV programs, Pay-TV, Pay-per-View (PPV), Video-on-Demand (VoD) services, as well as Internet-TV (IPTV) are increasing the bandwidth demand in the access and local area networks. A second aspect is the development of media carriers systems such as Video Disks (DVD, BluRay), Hard Disk Drives (HDD), Redundant Array of Independent Disks (RAID), and Solid State Drives (SSD) for replaying, recoding, and storage of media content.

The product technical platforms originate from a highly diverse industry spectrum including (traditional) consumer electronics, game consoles, computers, and even networking equipment manufacturers. This diversity describes the functional spectrum of the products as well. In general we can observe the trend to higher functional integration (e.g. media centre) on the one hand and simultaneously also a further distribution of functionality into individual products. As a very rough trend we see a development from the STB/TV-Receiver side (integrating storage) and from the Disk-Player/Recorder side (integrating receiver). The power consumption mainly depends on the main functionality. In the case of a TV it is the display. Nevertheless, it is the data/signal processing and storage performance that defines more and more the complexity of the system (operation system) and indirectly the power consumption of the product. The power consumption of the basic (we exempt here the display in on-mode) system varies from a few watts to a few ten watts.

**Network configuration:** In order to support digital high definition media transmissions new network technologies and interoperability standards are entering the market. The dominant networking technology in the TV/AV area is High Definition Multimedia Interface (HDMI). Most products are support Digital Visual Interface (DVI) and older analogue network interfaces such as SCART for downward compatibility. WiFi is the main technology for

wireless connectivity. However, there is a range of other wireless technologies potentially available (see Table 1 below).

Avoiding cables is not only appreciated in an optical sense (pin the TV on the wall without a cable hanging around), but it additionally provides tremendous flexibility in the set-up of a home entertainment or office information system. Most of the wireless technologies provide necessary signal transmission performance in range of 3m to 30m. From an energy point of view, these technologies are better when the sender and receiver are as close together as possible.

There are plenty of limitations for wireless applications in conjunction with consumer electronics such as HDTV due to copy protection. As an example, transmitting digital media (Blu-ray, DVD, MP3, etc.) might be limited or not possible because they are tied to some form of Digital Rights Management (DRM).

Wireless Standard	Band	Data Rate
WiHD WirelessHD 1.0 [Next Generation]	60 GHz	4 Gbit/s [>10 Gbit/s]
WiGig Wireless Gigabit Alliances	60 GHz	7 Gbit/s
WHDI Wireless Home Digital Interface	5 GHz	3 Gbit/s
WiFi Alliance WiFi-Direct (P2P)	2.4 / 5 GHz	600 Mbit/s
WiDi Intel Wireless Display (My WiFi / MWT)	2.4 GHz	based on 802.11n
WUSB Wireless USB	3.1 - 10.6 GHz	480/110 Mbit/s

Table 1: Wireless standards for broadband and HD video signal transmission

At the present moment we are noticing that TV and multimedia equipment provide a multitude on network options. Interoperability is therefore a special issue. The problem is here again that new standards and proprietary interoperability solutions are continually evolving on the market. The equipment manufacturers generally join most of these “interoperability alliances” including the Digital Living Network Alliance (DLNA), Multimedia over Coax Alliance (MoCA), or Universal Plug and Play (UPnP) in order to have all options for their system architecture. This capability is important to provide the customer with the option to integrate the equipment seamlessly in existing or new networks. The interoperability alliances regulate license issues for the utilization and network support of different media formats including:

- audio (e.g. MP3, WMA)
- video (e.g. DivX, DivX HD, AVCHD, MPEG-4, VC-1, MKV)
- picture (e.g. JPEG, GIF, PNG)

**Network utilization:** Similar to personal computers the network utilization of TV and multimedia equipment will increase with new online services. If we make a distinction between active use (sitting in front of a TV or audio system to enjoy the content) and passive

use (the recording / download of content or servicing of the system) we notice that remote access and activation (networked standby) is somewhat different to computers or networking equipment. TVs and multimedia equipment are typically operated with remote control. That (traditional) feature makes the use of these devices very comfortable. However, it also means that the user has to be present in order to start (wake-up) the product. A typical line of events has been in the past (1) activating e.g. the STB, (2) then TV and (3) the DVD player. Nowadays the activation of the television or a peripheral device can be done automatically via HDMI/CEC-based network wake-up out of an active standby mode. An example would be a TV display in the bed room that is wireless connected to a main TV receiver in the living room. The receiver box would get a wake-up signal via a WiFi adapter/router. This type of solution requires more energy than regular standby as the TV/AV receiver provides such network wake-up typically only out of a higher power state. The so called "Fast Play" or "Quick Start" options that are provided by some manufacturers for media player/recorder or complex TVs consume from 8 watts to over 25 Watts in "hot" standby. In conclusion we could assume that a large group of products that are currently feature <1W standby may increase energy consumption for faster resume time to application.

**Network availability:** With the market shifting to more complex provider services (Pay-TV, Video-on-Demand, Interactive TV) the demand for network availability will increase in the downstream (towards the end-user) as well as upstream (from the end-user). The main demand is at the interface between service provider and end-user. The servicing of customer premises equipment such as complex set-top-boxes or headed gateways is already well established. These devices are regularly updated in order to ensure interoperability, copyright protection, or basic electronic program information. Depending on the individual system configuration (access technologies, device specific functionality) this network service demand could lead to increasing active/idle phases of related end-user equipment, if they do not provide low power options. The harmonization of technical solutions and service procedures are essential preconditions for energy efficiency. Service providers and equipment manufacturers need to collaborate on feasible solutions in the interest of the customer.

The network availability demand within end-user-controlled home multimedia networks is very difficult to judge. The user in most cases controls the distributed system within reach of the remote control or a few steps. There is however some network employments where convenience might require higher network availability. A common example is a central media receiver/server device that is hidden and not accessible with the remote control. In this case the system might be activated over a central node (WiFi router) or the distributed TV (monitor). Another example is the increasing number of small streaming clients such as displays or sound systems. These systems mostly use WiFi connectivity and are always on. Power management is not common. As for the downstream demand (media recording,

download) new media service platforms, security and copyright protection measures actually limit program recording to some extent. More commonly today are video streaming and in the case of Personal Video Recorder (PVR) time-shift viewing. The necessity for immediate resume time to application or high network availability is rather small.

**Remote access and reactivation:** In chapter 4.4 we investigate HDMI/CEC-based network wake-up and active standby modes.

#### 4.3.4 Example: Smart Home

The buzzword “smart home” is related to a number of network-based concepts with respect to the monitoring and control of:

- Objects (e.g. rooms, doors, windows),
- Equipment (e.g. large household appliances, HVAC equipment, surveillance systems)

One general concept is the automation and hopefully optimization of processes. The automatic adjustment of heating, ventilation and air conditioning (HVAC) as well as lighting based on sensors is a common praxis in building automation. Such system solutions have mostly a defined (programmed) network service which is limited to the home or building (local area network). The system also typically employs network technology (e.g. ZigBee, Powerline) that is less commonly used for end-user devices.

With the introduction of “Smart Metering” and “Networked Appliances” solutions, real-time status monitoring, assessment, and control units that are connected to service (utility) providers, the utilization of the network and respective network services become a new dimension.

**Networked appliances** defines large household appliances such as washing machines and dish washers that have a network interface connecting the appliance to a control box that functions as a network service interface. According to white goods manufacturer Miele and Bosch-Siemens-Hausgeräte (BSH), two of a handful of enterprises that presented networked appliances at the 2010 IFA household appliance and consumer electronics show in Berlin, there are currently only a few network services under investigation including smart grid applications and remote maintenance.

The most promoted network service is an energy-price-adaptive start of washing cycles in conjunction with the “Smart Grid” concept. With this network service the end-use benefits from low energy prices (in non-peak hours) while the utility provider would benefit from a load-adapted grid (reduce peak hours).

This concept brings together a couple of new players including the appliance manufacturer, utility provider and network provider. The main reason for this collaboration is the technical

realization of the network service interface. There are a few developments in that respect: First to mention is the harmonization of the network interfaces (outlet) on the appliance side. A number of brand-name manufactures are actively promoting quasi-industry-standards within the framework of CECED (Conseil Européen de la Construction d'appareils Domestiques or European Committee of Domestic Equipment Manufacturers). CHAIN is the acronym for Ceced Home Appliances Interoperating Network, a protocol standard for the interoperability of household appliances. As for the network technology no harmonization can be seen in the market. Current product concepts feature Powerline Communication (PLC) as well as wireless LAN (WiFi) and ZigBee (IEEE 802.15.4).

The second aspect is the necessary network service interface. This can be realized basically in three different ways:

- separate home appliance interface box, provided by the white good manufacturer<sup>3</sup>
- smart metering interface box, provided by the electricity supplier
- network access/home gateways, provided by network provider

In the first case an additional “box” would enter the home network. Smart metering interfaces are also new devices that only very slowly enter the market. The home gateway is more or less considered an existing product. Again, the end-user benefit of the network service is the all deciding aspect for the success – and therefore significant introduction – of networked appliances. At the moment the industry (CECED) assumes that no more than 5% of new products would utilize network services.

**Monitoring Systems** are another smart home application. These include variety of network services from smart meters to smart locks. The benefit of networked monitoring system is again distributed to the end-user and the external service provider (or homeowner). Smart Metering, Smart Living and other monitoring, assistance & control concepts are usually include benefits for both sides. There are quite a few ongoing projects for Ambient Assisted Living (AAL) focusing on medical support of seniors and people that need supervision. These professional systems include the monitoring of peoples (health condition), medical and safety equipment. Network technology reaches from Body Area, to Local Area and Wide Area Networks. With respect to this type of external monitoring systems the coding of sensor data and in general the secure data transmission is an essential requirement. Against that background we conclude that professionally administrated monitoring systems will be introduced in the private and assisted living environment in the next years. The technical complexity and respective cost factor of these solutions (e.g. medical equipment, security)

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<sup>3</sup> Miele showed an example at the IFA 2010 in Berlin

will however limited the dissemination to a few ten or hundred thousand applications in Europe. We could not detect cost efficient mass market solutions at the present.

There are examples for private end-user only applications as well. Such network applications are typically using VPNs to access sensor or video camera systems remotely from on the go. Most of such applications are self-made. We could not detect as mass market. It is feasible to assume that with growing symmetrical bandwidth supply such type of applications might increase. Users might like to know if there is regular mail in their mailbox, if their door locks and windows are closed, or if an appliance or other equipment is turned off (or on). With a multitude of networked sensors (e.g. optical, acceleration, thermal) and respective service interfaces (e.g. within a home server or network access device) these type of applications are technically possible. Commercial hardware and software solutions will drive this market. We assume that they will use existing platforms for this kind of applications.

### 4.3.5 Summary

With respect to network services we can mainly distinguish between professionally administrated (utilized) and privately utilized applications. Professional services include:

- Monitoring and servicing of customer premises equipment (CPE) such as complex set-top-boxes (CSTB) in conjunction with pay TV services
- Monitoring and servicing of distributed computers such as the administration of personal computers in business environments
- Monitoring and servicing of large household appliances such as dishwashers or washing machine (which could be a growing application in the future)
- Monitoring and servicing of sensors (building automation) and other building infrastructure equipment such as heating ventilation and air conditioning (HVAC)

Regarding private utilization we can currently recognize the following applications:

- Remote access and uploading of files (e.g. video, music, picture, documents) via a Virtual Private Network (VPN) over a wide area network (WAN)
- Remote access and reactivation of a TV or AV receiver (in house multimedia or so called video area network).
- Remote access and reactivation of a computer system (Wake-on-LAN) or computer peripheral devices (e.g. imaging equipment)

These are principle types of applications or network services that should be covered by a low power mode such as networked standby. At present, it is necessary for some types of products to cover such applications in active or idle mode. The introduction of power management and consequent reduction of power consumption is the assumed improvement potential of networked standby.

The power consumption level of the idle mode or (in terms of functionality) lower power mode (networked standby mode) that supports networked standby functionality varies in principle depending on the following factors:

- Processor performance,
- Memory or storage capacity,
- Complexity of the operation system (including software efficiency),
- Number and type of network interfaces
- Complexity of the supported network technologies,

- Type, size, and efficiency of the power supply unit (PSU)<sup>4</sup>

The utilization of a certain power mode (particularly low power modes) depends on the resume time to application. This requirement translates into quality-of-service levels or Network Availability as we like to call it. For example: networking-type products such as gateways or switches are designed for high network availability. This means that a link is maintained for instant transmission of signals without delay or link failure. We will develop networked standby scenarios based on this concept.

Networked standby is a product and system issue. We developed the understanding that a low power solution for networked standby requires not only a respective selection of electronic and network components, adequate circuitry design, and software efficiency. A good networked standby solution requires appropriate interoperability with the linked device (e.g. host). This aspect is reflected by the sophistication of the network technology and complexity of protocols.

Networked standby is also a standardization and collaboration issue. Technical standardization and the collaboration of different equipment manufacturers with service providers are important for efficient networks and interoperation of products. Take the particular example of customer premises equipment such as complex set-top-boxes. It is necessary that service providers (e.g. TV cable or pay TV provider) and consumer electronics manufacturers (e.g. CTSB, TV/Media Receiver) need to collaborate in an effort to facilitate low power solutions. An example is a time controlled servicing of CPEs.

**Note:** An important comment was received from Mr Edouard Toulouse, representative of the European Environmental Citizens Organisation for Standardisation (ECOS) which is useful to discuss directly. In his comment, Mr. Toulouse argues: “The preparatory study generally covers and analyses only one side of the story: networked standby modes considered as a solution (allowing to save some energy compared to leaving a product fully on or in idle state). The study describes several types of possible intermediate modes with network availability, and powering down to these modes is supposed to be the “principal improvement potential” (more important than the power level of these modes). We have a fundamental concern in that this approach mostly misses the other side of the story: networked standby viewed as a problem in itself, when it tends to replace unplugged, off and regular standby modes thus triggering an increase in energy consumption. The supposed need to maintain a constant network availability and fast reactivation 7x24 as a default state on an increasing range of products is hardly questioned.”

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<sup>4</sup> The PSU reflects the main functionality of a product. Large electro-photography imaging equipments (EP-Printers) require a few hundred watts in active mode. In comparison, a personal computer or notebook only requires a few tens of watts.

The authors of the study have recognized this duality – networked standby as a problem and as part of a solution – throughout the study. The user behavior and technical analysis has addressed both sides of the issue. However, by focusing on the likelihood that networked standby options are activated by default when the product is delivered to the customer, the study addresses the energy saving potential of an advanced power management – with networked standby as part of the solution – more strongly than hoping for fully aware customers who are willing to manually power down their devices. Furthermore, the improvement options provided in Task 7 report give customer interaction with the product very high priority (they are the first three options).

## 4.4 Network Technologies<sup>5</sup>

In this section we investigate the currently available network and system technologies for power management of network components, remote access and reactivation of networked products. The focus is placed on the identification of power management options and low power modes, their technical characteristics as well as software or system relevant aspects in conjunction to networked standby. This analysis generally includes:

- Existing power management and low power modes (wake-up options)
- Resume time to application (in conjunction with certain functionalities)
- Power demand per mode (averaged values considering product configurations)
- Maturity of the solution and future developments (technical potentials)

This analysis provides not only an information base on the current status of technology, but it also shows that power management and low power solutions with networked standby functionality exists in some markets more than in others. During this study we have developed the understanding that technical solutions for low power networked standby not only depend on individual circuitry designs and components. It is the technical facilitation of effective interoperability of both sides of a network connection (link) that needs consideration. Properly describing network functions and different aspects of network technology requires an analysis on the three basic layers<sup>6</sup> (a) the physical link, (b) the basic network functionality, and (c) the applications. Each of these layers has implications for power requirements and for behavior of the device as desired or required by the user.

### 4.4.1 Ethernet (IEEE 802.3)

#### 4.4.1.1 Ethernet support of networked standby

IEEE standard 802.3 (Ethernet) specifies the Physical (PHY) and Media Access Control (MAC) layers of today's main wired network technology in Local Area Networks (LAN) and to some extent with GEAPON in the access networks of Wide Area Networks (WAN). Ethernet is an established communication technology which will remain the most dominant network in the years to come. The standard specifies different transfer rates (speed) which range from 10 Mbps (Millions of bits per second) up to several Gbps (Giga bits per second).

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<sup>5</sup> The authors of this report received considerable support from various industry stakeholders. We like to thank Jim Kardach of INTEL Corporation for the detailed technical information.

<sup>6</sup> Based on the OSI Model which actually features seven layers.

With respect to networked standby, Ethernet supports following functions and power management:

- Wake-On-LAN (WOL)
- Adaptive Link Rate (link speed switching)
- Energy Efficient Ethernet (IEEE 802.3az)
- Network Proxying (ECMA 393)

#### 4.4.1.2 Wake-on-LAN (WOL)

Wake-on-LAN (WOL) is a technology standard for computer networks that allows a system to remotely wake-up from a sleep mode via an Ethernet connection (IEEE 802.3). The standard has been available since 1995. It is quite a simple technology solution. A specific wake-up packet, the so called **Magic Packet** containing the MAC address of the target system, is broadcast through Ethernet connection to the target system. If the MAC address in the magic packet matches the MAC address for the target system the wake-up process will start.<sup>7</sup>

With WOL it is possible to reactivate a computer operation system (OS) out of following power states:

- Sleep state (ACPI G1/S3): Resume time to application is typically in a range of 2 to 5 seconds (<10 sec.). In the G1/S3 state the hardware maintains memory context in DRAM. The TREN Lot 3 study on computers and monitors recommended that an idle computer should enter G1/S3 sleep state after 30 minutes with less than 5 seconds resume time. Power consumption levels for sleep mode (base) vary currently from about 1.5W to 4W depending on the type and configuration of the PC (notebooks even lower). G1/S3 sleep with WOL requires typically an additional 0.3W to 0.7W to the base value.
- Hibernate state (ACPI G1/S4): Resume time to application varies widely but is typically in a range from 25 to over 50 seconds (>>10 sec). This long reactivation time results from restoring the context of memory from non-volatile storage back to DRAM. Depending on the system and utilization this can take much longer than booting the OS. This state applies to notebooks and is typically not supported by desktop PCs. The TREN Lot 3 study suggested that after four hours of sleep the system should shift into a lower power state (e.g. G1/S4) which is less than 2.2W for desktop and 1.2W for notebooks as a base value. The power consumption level of G1/S4<sub>WOL</sub> is assumed to be an additional 0.3W to 0.7W to the base value.
- Soft off state (ACPI G2/S5): Booting time for the OS is about 25 seconds or more depending on the system configuration (>>10 sec.). There is no application context

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<sup>7</sup> This principle also applies to Wireless LAN (IEEE 802.11) and is called Wake-on-Wireless (WOW).

restored. This means that the reactivation is typically shorter than out of hibernate. This is the lowest power state for computers. The TREN Lot 3 study suggested that the lowest power state should be in the first step less than 1W and less than 0.5W by 2013. According to industry comments, current best power consumption in this state ranges from about 0.5W for notebooks and 0.9W to 1.2W for desktop PCs.

In conclusion we determine that WOL can be supported by different power states and provides the option to reactivate a sleeping or shutdown system via Ethernet link within a medium (<10 sec.) or longer (>>10 sec.) latency. Products are typically shipped with WOL. The employment and real life utilization of WOL is not well documented. Own experiences indicate difficulties with WOL over virtual personal networks (VPN). Nevertheless WOL is an existing solution for medium and low network availability.

The power “adder” for WOL is associated with the NIC device. According to industry sources it adds about 40 milli-watts at the device. Taking into account power supply and regulator inefficiency, at the wall the adder is about 4 or 5 times that or about 160 to 200 milli-watts.

#### **4.4.1.3 Out of Band remote management (OOB)**

Out of Band (OOB) access to network clients is a solution used for remotely managing computers that are independent of the operating system on the client computer. Ethernet and WiFi networked devices can be used.

**Intel’s Active Management Technology (AMT)** is a proprietary technology with WOL function that is implemented on Intel’s vPro platform for business PCs. Intel’s AMT is a hardware solution in conjunction with firmware used for remotely managing computers that are out-of-band (OOB). Intel AMT supports Ethernet and WiFi networked devices. This includes the feature of remote power-up similar to WOL but provides additional security and management options.<sup>8</sup> The energy consumption of an implemented AMT is an additional 0.3W to 0.8W more to the regular WOL resulting in an additional 1.5 Watt to the base value. However, the real life power consumption might vary largely and depends on the system type and configuration. Lights Out Management (LOM) is another out-of-band management technology by Intel for server computers and allows system administrators to monitor and manage servers remotely in active, low power sleep, soft-off states and even if the computer has crashed.

**DMTF’s Desktop and mobile Architecture for System Hardware (DASH)** Standard is a suite of specifications that takes full advantage of DMTF’s Web Services for Management (WS-Management) specification – delivering standards-based Web services management for

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<sup>8</sup> <http://www.intel.com/technology/platform-technology/intel-amt>. (downloaded on 25.08.2010)

desktop and mobile client systems. For example, AMD offers a number of client management tools for DMTF DASH enablement<sup>9</sup>

DASH builds on the power of WS-Management and CIM to deliver advanced desktop and mobile management features, including:

- Power Control,
- Boot Control,
- WS-Eventing Push Indications, Correlatable System ID,
- Firmware version information, Hardware information (including Chassis model/serial, CPU, Memory, Fan, Power Supply, and Sensor),
- Login and UserID credentials, as well as Roles and Privileges

Through DASH, DMTF provides the next generation of standards for secure out-of-band and remote management of desktop and mobile systems. Members include: Broadcom, Cisco, Citrix, Dell, EMC, Fujitsu, HP, Hitachi, IBM, Intel, AMD, Microsoft, Oracle, Symantec, VMware.

*Comment provided by AMD:* We believe that one best practice is the use of open standards-based client management tools and technology and that this is consistent with European standardization policy. Proprietary management solutions can overload systems with nonessential features, lock organizations into specific vendors, increase management costs, and eliminate flexibility. A number of vendors work directly with standards bodies like the Distributed Management Task Force (DMTF) to define standards that support interoperability among system management tools and managed computer systems. One such standard is the DMTF Desktop and mobile Architecture for System Hardware (DASH), which provides a standard for secure remote management, including out-of-band management, of desktop and mobile systems from multiple vendors.

#### **4.4.1.4 Adaptive Link Rate (Link Speed Switching)**

Link speed switching refers to the practice of reducing the link speed of the Ethernet connection between the client and its switch (the other end of the Ethernet cable) to the lowest link speed which saves power. For example the Ethernet PHY of a GbE link power can be in the Watts range, while the 10 BT link power can be in the 10s of Milliwatts range. As link speed is not very important while the system is in the sleep state, this turns out to be a very good technique to reduce overall platform power when the system is in the sleep state with the WOL technology enabled. One of the main issues with link speed switching was the

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<sup>9</sup> <http://developer.amd.com/cpu/manageability/Pages/default.aspx>

amount of time it took to exit the state (10ms range), which prevented the technology from being used in the active state.

This resulted in the development of the Energy Efficient Ethernet (IEEE 802.3az) technology.

#### **4.4.1.5 IEEE 802.3az (Energy Efficient Ethernet)**

IEEE 802.3az (Energy Efficient Ethernet) is a new standard that has been approved just recently. The 802.3az standard covers 100Base-TX, 1000Base-T, 10GBase-T, 1000Base-KX, 10GBase-KX4, 10GBase-KR, and also supports XGMII extension using the XGXS for 10Gbps PHYs. IEEE 802.3az (Energy Efficient Ethernet) covers most of the standard products in the office and home environments, such as laptop and desktop computers, servers, switches, routers, and home gateways.

The first idea for Energy Efficient Ethernet was an Adaptive Link Rate concept. According to this approach the power consumption of Ethernet transceivers (PHYs) would be to power down in periods when the data rate required was low. This first idea was however abandoned in favor of the Low Power Idle (LPI) concept. This second approach switches rapidly between the full operating speed and the LPI mode. Similar to the Wake-on-LAN concept that can remotely wake-up a system, the LPI concept is much faster on the order of 10 microseconds.

For 1000BASE-T and 10GBASE-T transceivers new LPI modes have been defined. Key features are:

- They allow powering down the transmitters and three of the four receivers in a link when there is no data to send.
- They include a refresh cycle that requires transmission of short training sequences in LPI mode so the PHY parameters (clock tracking at the slave, receiver equalizer coefficients, echo canceller coefficients, crosstalk canceller coefficients, etc.) can be updated and kept current.
- They include the definition of an alert signal that can be used to rapidly wake up a PHY from sleep in the LPI mode.
- They can be initiated either from the local system by signaling from the MAC or station management or from the remote system over the PHY link.

Because of these features, the LPI-to-active state transition can be made in less than 0.001% of the time it takes for the initial link-up of the PHY. During the sleep-to-wake transition, IEEE requires that data transmission be held off during the PHY wake time so no

data is lost.<sup>10</sup> The issue with Ethernet has been its lack of a good idle state, as a GbE PHY consumes about 1W of power while doing nothing. By including an optimized low power idle state allows the Ethernet link to have both transmitted efficiency and good idle power characteristics.

There are currently only few products on the market meeting this specification. However, feedback from component manufacturers, equipment manufacturers, and software indicate that a fast adaptation of this new standard is expected.

#### 4.4.1.6 Network Proxying (ECMA 393)<sup>11</sup>

ECMA-393 (ProxZzzy™) Standard was released in February 2010. Network Proxying is a technology that allows another network agent to act as a proxy for the computer that is providing network services. Through the proxy agent such services remain available to other network clients (wishing to find or use the services), while the computer providing the services can be in a low power sleep state. The proxy agent wakes the network service provider (computer) when needed.

The specification define mandatory proxy functions to support IPv4 ARP, IPv6 Neighbor Discover, and wake packets for both 802.3 (Ethernet) and 802.11 (Wi-Fi).

It also defines optional proxy functions to support DNS, DHCP, IGMP, MLD, Remote Access using SIP and IPv4, Remote Access using Teredo for IPv6, SNMP, mDNS (Device Discovery), and LLMNR (Device Discovery).

In detail ECMA 393 specifies maintenance of network connectivity and presence by proxies to extend the sleep duration of hosts:

- Capabilities that a proxy may expose to a host.
- Information that must be exchanged between a host and a proxy
- Proxy behavior for 802.3 (Ethernet) and 802.11 (WiFi)
- Required and optional behavior of a proxy while it is operating, including responding to packets, generating packets, ignoring packets, and waking the host.

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<sup>10</sup> PC world article by S. Katsuria (04.03.2010): Energy-efficient Ethernet: A greener choice for 2010; [http://www.pcworld.idg.com.au/article/338291/energy-efficient\\_ethernet\\_greener\\_choice\\_2010/](http://www.pcworld.idg.com.au/article/338291/energy-efficient_ethernet_greener_choice_2010/) (downloaded 30.06.2010)

<sup>11</sup>[www.ecma-international.org/publications/standards/Ecma-393.htm](http://www.ecma-international.org/publications/standards/Ecma-393.htm)

This standard does not:

- Specify communication mechanisms between hosts and proxies.
- Extend or modify the referenced specifications (and for any discrepancies those specifications are authoritative).
- Support security and communication protocols such as IPsec, MACSec, SSL, TLS, Mobile IP, etc.

#### **4.4.2 Wireless LAN (IEEE 802.11)**

IEEE standard 802.11 specifies the most common wireless network communication mechanisms commonly known as WLAN or WiFi. The technology provides a wireless link between a WAN access point (e.g. home gateway, router) and the LAN connected end-user device (desktop or notebook PC). The application of this mature technology is growing. Within the past two years the consumer electronics industry started to utilize WLAN for connecting TV, CSTB, Media Player; NAS or PCs wireless into Home Video Networks.

##### **4.4.2.1 Wake-on-Wireless (WOWLAN)**

Wake-on-Wireless (WOWLAN) is based on the WOL standard and is a feature which allows a WLAN-enabled client system to enter a low-power system state (G1/S3 or G1/S4) while still maintaining wireless LAN association with its current AP. WoW allows remote systems to wake up the sleeping client by sending a frame of a specific format (Magic Packet) which the client anticipates. The system also reacts to a changing link status. Wake-on-Wireless is very similar to Wake-on-LAN for Ethernet NICs in that no specialized support is required on any intervening devices in the network (e.g. switches, routers, APs, etc.).<sup>12</sup> The implementation and use of WOWLAN is not well documented.

Industry stakeholders indicate that at the present most computers under IT control are utilizing wired connections and use WOL. The market demand for platforms that implement wireless wake on LAN is at the present not considerable.

##### **4.4.2.2 WLAN power saving options**

Power Save Mode (PSM) or Power Save Poll (PSP) for WiFi is the original power-conservation technique defined in 802.11. The methodology is for the mobile device to suspend radio activity after a variable but pre-determined period of inactivity, and then wake up periodically (normally 100 ms) to see if the infrastructure has queued any traffic for it. This allows the client to be in a very low power state in both sleep and active states.

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<sup>12</sup> Linux wireless support: <http://wireless.kernel.org/en/users/Documentation/WoW> (downloaded 19.08.2010)

Unscheduled Automatic Power Save Delivery (U-APSD) is an asynchronous approach to power conservation defined in 802.11, and serves as the basis of WMM Power Save, allowing the client to request queued traffic at any time rather than waiting for the next beacon frame.

WMM Power Save (WMM-PS) is a product of the Wi-Fi Alliance and was introduced with the development of 802.11e and the corresponding Wireless Multimedia (WMM) specification. It is based on U-APSD, and is often implemented in Wi-Fi handsets.

Dynamic MIMO Power Save is a technology that allows MIMO-based (802.11n) radios to downshift to less-aggressive radio configurations (for example, from 2x2 to 1x1) when traffic loads are light.

#### **4.4.2.3 WLAN and Proxy**

Network Proxying (ECMA 393) uses the clients WoWLAN ability to lower system power even further by allowing the router/Access-point to act as a Proxy for the client computer who has turned on some sort of Network Service (like file sharing). Here the router/Access-point can then act as a proxy for the sleeping client, and respond to network requests for discovery or other protocols which require millisecond response. When a requests ask for something which actually requires the sleeping client (like access to a file), then the router/access-point sends the wake-request to the sleeping client to allow the request to be completed.

ECMA-393 (Proxying) specifies WLAN deployment considerations for proxy:

- Hosts often disconnect from an AP, and may re-connect to the same AP or another AP within the same SSID, or to an AP in a different SSID. This is based on the Connection Profiles configuration.
- A proxy may be unable to operate in public WiFi hotspots that require explicit user authorization, such as requiring a legal agreement (EULA).
- Some WLAN deployments require a DHCP Renew at association time.

#### **4.4.3 Universal Serial Bus (USB)**

USB is a very common interface in the personal computer, consumer electronics and mobile industries. The utilization of USB is growing constantly. The first versions of USB did not support active power management. The USB standards Version 2.0 and 3.0 provide some power saving options.

USB-devices that have sent the NRDY-status (not ready) have the option to shift into a power saving mode. If all attached devices are in power saving mode the host can now reduce the upstream-link to the USB clients.

There are the four following optional modes:

- U0 mode: Link active
- U1 mode: Link idle – fast exit
- U2 mode: Link idle – slower exit
- U3 mode: Link suspend

The resume time to active link is in a range of microseconds ( $\mu$ s) to milliseconds (ms).

Link State	Description	Characteristics	State Transition Initiator	Device Clock Gen On/Off	Typical Exit Latency Range
U0	Link active	Link operational state	N/A	On	N/A
U1	Link idle – fast exit	Rx and Tx circuitry quiesced	Hardware <sup>1</sup>	On or Off	$\mu$ s
U2	Link idle – slower exit	Clock generation circuitry may additionally be quiesced	Hardware <sup>1</sup>	On or Off <sup>2</sup>	$\mu$ s – ms
U3	Link suspend	Interface (e.g., Physical Layer) power may be removed	Entry: Software only Exit: Hardware or Software	Off	ms

Notes:

1. It is possible, under system test conditions, to instrument software initiated U1 and U2 state transitions.
2. From a power efficiency perspective it is desirable for devices to turn off their clock generation circuitry (e.g., their PLL) during the U2 link state.

Figure 4: Summary of USB link states (power modes)

It should be remembered that in terms of network standby a PC can have many roles:

- As a sleeping host, where it can receive wake-up messages from USB devices trying to wake-up the system (using a USB keyboard or mouse to wake the computer client from a sleep state)
- As an active host where it may have USB devices which are in a low power state and need to be awakened (A USB printer is connected to the computer, the USB printer is in a low power state and the user is printing a computer job)
- As a sleeping host, with a networked USB printer connected to it (a combination of the first two examples).

It takes a combination of active and sleeping USB power states to support these usages.

In general, the USB standard defines the following low power states which can apply to network standby situations:

- USB Global Suspend Mode
- USB Selective Suspend Mode
- USB Link Power Management State

#### **4.4.3.1 USB Global Suspend Mode**

USB Global suspend mode is used to put devices to sleep which still have the ability to wake-up the platform (which falls under the Lot 26 scope).

Suspend mode is mandatory on all devices. During suspend, additional constraints come into force. The maximum suspend current is proportional to the unit load. For a 1 unit load device (default) the maximum suspend current is 500uA (5V).

A USB device will enter suspend when there is no activity on the bus for greater than 3.0ms. It then has a further 7ms to shutdown the device and draw no more than the designated suspend current and thus must be only drawing the rated suspend current from the bus 10mS after bus activity stopped. In order to maintain connected to a suspended hub or host, the device must still provide power to its pull up speed selection resistors during suspend.

The term "Global Suspend" is used when the entire USB bus enters suspend mode collectively. However selected devices can be suspended by sending a command to the hub that the device is connected too. This is referred to as a "Selective Suspend."

#### **4.4.3.2 USB Selective Suspend**

USB Selective Suspend is very similar to the USB global suspend, but is used in an active mode where the device is put into a selective suspend state while idle. The issue with selective suspend mode is the exit latency is not very clearly defined and can take as long as half a second; which for many devices is an issue.

This mode is needed in active power management not because the USB interface itself consumes too much power, but because of the activity created by USB host controllers within the platform. USB is a polled interface, where a USB device is not capable of generating an interrupt or generating a bus cycle; and must be polled by the host to see if the device wishes to generate an interrupt or issue a bus cycle. This can result in a continuous stream of data between the USB host controller and main memory which creates consumes a large amount of system power (via memory, CPU and busses). Hence the selective suspend mode suspends that link, and removes the need for the host controller to constantly poll that device.

### 4.4.3.3 USB Link Power Management

USB link power management resolves the issues found with selective suspend by reducing the guaranteed exit latency of the selective suspend technology (at a high level) those allowing devices to quickly enter and exit these low power states which saves link power and the host controller polling power. This mode was added as an optional feature to USB 2.0 device (High speed and low speed) and as a mandatory feature of USB 3 high speed devices.

### 4.4.3.4 V Bus Power

The V-Bus is the USB bus that provides power to a device. The power of a USB bus powered device is limited by design. Table 2 shows the V-Bus power characteristics.

11.4.5 VBUS Electrical Characteristics					
Table 11-2. DC Electrical Characteristics					
Parameter	Symbol	Conditions	Min.	Max.	Units
<b>Supply Voltage:</b>					
Port (downstream connector)	VBUS		4.45	5.25	V
Port (upstream connector)	VBUS		4.0		V
<b>Supply Current:</b>					
High-power Hub Port (out)	ICCPRT		900		mA
Low-power Hub Port (out)	ICCUPT		150		mA
High-power Peripheral Device (in)	ICCHPF			900	mA
Low-power Peripheral Device (in)	ICCLPF			150	mA
Unconfigured Device (in)	ICCINIT			150	mA
Suspended High-power Device	ICCS			2.5	mA

Table 2: USB V Bus Power Characteristics

### Sleep and Charge USB ports

Some computers support charging of USB devices when the system is sleeping (ACPI G1/S3 or G1/S4 states) or off (G2/S5 state). USB provides a standard on how much power can be drawn from a host USB device for this purpose (USB charging specification 1.1: [http://www.usb.org/developers/devclass\\_docs](http://www.usb.org/developers/devclass_docs)). This should be considered when specifying sleep or off power for computers which host USB battery charging in the different low power modes.

If a device to be charged is plugged into a charging downstream port, then it is allowed to draw current up to IDEV\_CDP\_LFS (for low or full speed devices, max of 1.5A) or IDEV\_CDP\_HS (for high speed devices, max of 900mA) regardless of the system state of the host.

**Wireless USB** enables products from the PC, CE, and mobile industries to connect wirelessly at up to 480 Mbps at 3 meters and 110 Mbps at 10 meters.

Wireless USB is designed to deliver maximum power efficiency. Sleep, listen, wake and conserve modes ensure that devices use only the minimum power necessary.

#### 4.4.4 Digital Subscriber Line (ADSL and VDSL)

The ADSL (G.992.3) and ADSL2+ (G.992.5) as well as VDSL VDSL1 (G.993.1) and VDSL2 (G.993.2) recommendations define a power management feature to reduce the power consumption and the thermal dissipation of ADSL chip sets.

When there is no user traffic, the xDSL links can switch from a high power mode (L0) to a low power mode (L2). If there is no user data for a long period of time, the link can switch further to a very low power, idle state (L3).

TR-202 Low-Power Mode Guidelines (February 2010)

- L0 State Full power management state achieved after the initialization procedure has completed successfully (the ADSL link is fully functional)
- L2 State Low power management state (the ADSL link is active but a low power signal conveying background data is sent from the ATU-C to the ATU-R)
- L3 State Link state (Idle) at the start of the initialization procedure (there is no signal transmitting, the ATU may be powered or unpowered)

These features can be initiated on the central office (CO) or remote unit. Due to the several seconds transition time (L2) and the potential of losing data and connectivity (L3) most network provider are not using this power management feature. Their experience with unhappy VoIP (Voice over IP) customers cannot be denied. That does not mean however that the idea is wrong. The provider of the access network is influencing (with the technology, network topology, node configuration, and system setup) the energy consumption of the customer's equipment. If there is no traffic in the loop the system should support low power modes.

#### 4.4.5 Data Over Cable Service Interface Specification (DOCSIS)

DOCSIS is an international telecommunications standard that permits the addition of high-speed data transfer to an existing Cable TV (CATV) system. It is employed by many cable

television operators to provide Internet access (see cable internet) over their existing hybrid fiber coaxial (HFC) infrastructure. The specification was developed by Cable Labs and contributing companies including ARRIS, BigBand Networks, Broadcom, Cisco, Conexant, Correlant, Harmonic, Intel, Motorola, Netgear, Terayon, and Texas Instruments.

A DOCSIS architecture includes two primary components: a cable modem (CM) located at the customer premises, and a cable modem termination system (CMTS) located at the CATV head end. Of interest for this study is the modems power consumption on the CPE and the power management (interoperability) with the CMTS.

See current power consumption requirements below.

## 4.4.6 Multimedia Interoperability

### 4.4.6.1 High-Definition Multimedia Interface (HDMI)

HDMI is currently the most common audio/video interface for transmitting uncompressed digital data. It replaces consumer electronics analog standards including coaxial cable, composite video, S-Video, SCART, component video, D-Terminal, or VGA. HDMI is backwards compatible with DVI. HDMI is used to connect TVs, AV receivers, set-top-boxes, media player and recorder, camcorder, as well PCs, game consoles and displays. The HDMI 1.4a specification was released in 2010 and enables current and future IP-based applications, 3D support, 4Kx2k high resolution support, HDMI Ethernet channel, DLNA, UPnP, and MoCA over a single cable.

- Consolidation of HD video, audio, and data in a single cable
- Enables high speed bi-directional communication
- Enables IP-based applications over HDMI
- Transfer speeds up to 100Mbps (HDMI Ethernet Channel)
- Audio Return Channel

**Consumer Electronics Control (CEC)** is a one-wire bidirectional serial bus that uses the industry-standard AV.link protocol to perform remote control functions. CEC wiring is mandatory, although implementation of CEC in a product is optional. It was defined in HDMI Specification 1.0 and updated in HDMI 1.2, HDMI 1.2a, and HDMI 1.3a (which added timer and audio commands to the bus). The feature is designed to allow the user to command and control multiple CEC-enabled boxes with one remote control and for individual CEC-enabled devices to command and control each other without user intervention.

Products that are connected by way of the HDMI interface can interrogate the bus to determine what products are on the line while, at the same time, communicate with them, reducing IR remote functions with fewer key strokes. Like universal remotes, the system will identify each product when powered up and connect the system with the correct configuration for a true one-button solution. Based on a one-wire bidirectional system, the CEC line allows all parties (peripherals) to share on this one-wire communication channel. After Hot Plug detection takes place, all products route their data by way of switching, cables and video conversions to the root of the system.

Trade names for CEC are Anynet (Samsung); Aquos Link (Sharp); BRAVIA Sync (Sony); HDMI-CEC (Hitachi); Kuro Link (Pioneer); CE-Link and Regza Link (Toshiba); RIHD (Remote Interactive over HDMI) (Onkyo); SimpLink (LG); HDAVI Control, EZ-Sync, and VIERA Link (Panasonic); EasyLink (Philips); and NetCommand for HDMI (Mitsubishi).

#### **4.4.6.2 Digital Living Network Alliance (DLNA)**

The guidelines currently consist of three volumes covering Architecture & Protocols, Media Format Profiles, and Link Protection.<sup>13</sup>

DLNA was formed in 2003 to enable cross-industry convergence of multimedia content in home networks. At its core, its goal is to enable a wired and wireless interoperable home network where digital content in the form of images, music and video can be easily and seamlessly shared across personal computers, consumer electronics and mobile devices. DLNA achieves this by defining a platform of interoperability guidelines based on open and established industry standards. In addition to defining a manageable framework of standards and protocols, DLNA guidelines also outline several device classes, carefully constructed usage cases for networked homes, and additional functions which enhance the content sharing experience.

DLNA guidelines can be thought of as an umbrella standard that defines how the home network interoperates at all levels. DLNA guidelines define both mandatory and optional standards for each of the different networking layers.

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<sup>13</sup> <http://download.iomega.com/resources/whitepapers/media-dlna.pdf>

Matters of particular interest concerning network availability:

Discovery and Control: How devices discover and control each other (UPnP Device Architecture 1.0)

IP Netw. Connectivity: How wired and wireless devices physically connect and communicate (IPv4 Protocol Suite, Wired: Ethernet 802.3, MoCA etc.)

#### **4.4.6.3 Universal Plug and Play (UPnP):**

UPnP™ technology defines the architecture for pervasive peer-to-peer network connectivity of intelligent appliances, wireless devices, and PCs of all form factors. It is designed to bring easy-to-use, flexible, standards-based connectivity to ad-hoc or unmanaged networks whether in the home, in a small business, public spaces, or attached to the Internet. UPnP technology provides a distributed, open networking architecture that leverages TCP/IP and Web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices. The technologies leveraged in the UPnP architecture include Internet protocols such as IP, TCP, UDP, HTTP, and XML.

#### **4.4.6.4 Multimedia over Coax Alliance (MoCA)**

The primary goal of MoCA is to develop a high-performance, high-capacity home networking technology suitable for transporting multiple streams of high-definition multimedia content that leverages existing residential coaxial cabling and coexists with the services currently using the cable plant. To this end, the MoCA 1.0 standard supporting 135 Mb/s throughput was approved in December 2005. The MoCA 1.1 standard, which increased throughput to 175 Mb/s, was released in October 2007.<sup>14</sup>

### **4.5 End-of-Life Phase**

This subtask is not relevant for the purpose of the ENER Lot 26 Study. The influence of changed or potentially additional components on the end-of-life phase of the products is much less than that of ongoing technical development.

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<sup>14</sup> [http://www.mocalliance.org/industry/white\\_papers/Branded\\_Implication\\_Paper\\_MoCA.pdf](http://www.mocalliance.org/industry/white_papers/Branded_Implication_Paper_MoCA.pdf)