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Lot 26: Networked Standby Losses

Final Report Task 6

Technical Analysis BAT

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6 Task 6: Technical Analysis BAT

General objective: The subsequent analysis has been modified from the given methodology in order to serve the particular purpose of this horizontal study on networked standby. The objective of this task report however remains and is to identify and describe Best Available Technology (BAT), their technical and environmental performance parameters, as well as the state-of-the-art in technology and product implementation.[1]

Introduction: The results of the technical analysis (task report 4) and the environmental assessment (task report 5) support the conclusion that networked standby modes are very beneficial – and against the background of growing network capability of products – necessary instruments for saving energy. Networked standby only achieves an improvement of energy efficiency when implemented within an advanced and consequent power management. Technically, this includes a specific selection or development of hardware (e.g. System-on-Chip), circuitry design (e.g. power supply), and corresponding software (e.g. power policy of operating system in conjunction with firmware). The improvement is not only related to the single product's design. The computing and network infrastructure, in which the product is implemented, also have a considerable influence with respect to an effective power management. The following analysis of BAT will consider these product- and system-specific aspects.

Existing best practice: Power management is not a novelty for many product sectors although networked standby and dedicated networked standby modes are quite a new concept. The starting point is the existing best practice in the computer and mobile device industry. The technical assessment indicated that there are some driving and limiting factors for an advanced power management.

Driving factors:

- Battery-powered devices (limited energy budget, convenience of use)
- Form factor and noise (thermal limits of small devices, avoid active cooling/fans)
- Customer (user's energy / cost awareness in conjunction with convenience of use)

Limiting factors:

- Products with mostly passive utilization
  (Consumer electronics are basically used passively and with limited input/interaction

[1] While the MEEuP would tend to include an analysis of Best-Not-Available-Technology (BNAT) in this section, the technologies which are involved in the networked standby issue are developing so quickly that it is very difficult to determine what is BNAT or BAT at present, and only more difficult when looking to 2020. As such, this report focues primarily

options in comparison to a computer, which is more actively used and allows due to constant feedback from the user a simpler detection of application demand.)

- Cost of hardware and software options
  (Good power management and low power modes are mostly achieved through dedicated design of components. With respect to network interfaces, system large scale integration (system LSI or system-on-chip) provide advantages in terms of power consumption per function, but might limit the freedom of design (also with respect to software) and could have a considerable cost factor.)
- Missing standardization of interoperability and power mode schemes
  (The advantage of ACPI has been discussed already, but there are some limits. Suspend-to-RAM and suspend-to-disk are important concepts in the power management of computers. It is based on the availability of enough memory capacity and read/write speed. In the discussion with consumer electronics manufacturer the following argument was presented. Suspend-to-disk is not a feasible concept e.g. for TVs due to the limited technical lifetime, reliability, and noise associated to HDD. It is not simple to agree or disagree with such an argument, but the study will address these issues in the discussion of best available technology.)

Content of chapters: In the first chapter an overview on existing best practice in different product groups is provided. We start with a general assessment of the "state-of-the-art". Then we investigate the driving and limiting factors for the implementation of power management (see short discussion above). Finally, we are listing existing technology solutions. Again, this approach of investigating the driving and limiting factors for power management in individual product groups is designed to support the identification of general improvement options and the evaluation of the necessity for individual solutions.

The second chapter briefly takes up the standardization activities for energy efficient networks, as these are also considered best practice approaches.

In the third chapter best available products and their technical parameters are listed in order to provide examples and orientation for improvement options. We focus on power consumption in conjunction with certain levels of network availability and respective resume time to application (e.g. sleep modes with WOL).

6.1 Industry Best Practice

6.1.1 Personal Computers and Displays

General assessment:

- The personal computer, imaging equipment, and to some extent the mobiles industry, applying ACPI standardized technology platforms and operation systems have to be considered as best practice.
- With ACPI an open standard for device interoperability and power management exists that supports the equipment designer in the creation of energy saving solutions. The combined effort of the computing industry over the past 15 years warrants positive recognition.
- The industry is featuring capable and mature local area network standards including Ethernet (IEEE802.3), USB, and WiFi (IEEE802.11). Within these standards interoperability, recently energy efficiency and wake-up procedures have been addressed. With Energy Efficient Ethernet (IEEE802.3az) and Proxying (ECMA 393) two major efforts have been undertaken to improve the energy efficiency of networks and networked equipment.
- The draw-back is the relative openness (still not always full interoperability) and indirect limitation in design options (architectures) and technologies. With the digitalization of media new copyright issues occur as it becomes trivially inexpensive to reproduce content. Customer Premises Equipment, Complex STB/TVs and Media Player/Recorder currently feature firmware with the intention of limiting the user's option for downloading, copying and storing media content. This conflict is to some extent relevant in the context of network availability as providing such copy protection may require increased power levels or inhibits power management.

Driving factors and limitations:

- The Energy Star Program has addressed computers and computer peripheral devices for a long time. The industry supported this effort of the US EPA. With the introduction of TEC (typical energy consumption) test methodology the energy consumption under dynamic use conditions has been addressed. This type of product testing (and respective energy requirements for different products) resulted in an implementation of advanced power management featuring multiple sleep modes, and automatic power-down through preset default delay times.

- Battery-powered portable or mobile products (e.g. notebooks) require advanced low power components, circuitry and power supply design, and an ambitious system power management.
- Small form factor (flat, light) and thermal constraints (less active cooling) are considerable incentives to reduce power consumption in mobile, portable and all-in-one products.

Technology solutions:

- Display technology and setup:
  - Short default delay times for screen-off,
  - LED technology supporting adaptive brightness adjustment,[2]
  - Sensor-based user detection for screen-off (e.g. Philips Brilliance 225P1)
- Low power modes (ACPI):
  - Idle mode power reduction: Reducing functionality, clock speed adjustment, multi-core management, active cooling adjustment, adaptive network control
  - Multiple sleep modes: S3 Suspend-to-RAM (with WoL option) and utilization of fast read & write memory (Flash, SSD, HDD) for saving status of RAM and processor (S4 with WoL), fast and reliable reactivation possible (this increased user acceptance)
  - Manual and automatic activation of power management: Optional default delay times, application and device deactivation (e.g. WLAN), reliable power-down routines including user interaction (pop-ups for saving content etc.)
- Efficient power supply:
  - Conversion efficiency supporting feasible low power modes,
  - High efficiency external power supplies
  - Improved battery systems for longer use time and lifetime
- Energy efficient networks (see details in Task 4):
  - IEEE 802.3az (Energy Efficient Ethernet)

[2] In some cases, the energy-saving potential of adaptive brightness appears to be overstated. See the study by the UK Defra MTP: http://efficient-products.defra.gov.uk/spm/download/document/id/950

- ECMA 393 (Proxying)
- Wake-on-LAN (Magic packet)
- Wake-on-Wireless

6.1.2 Imaging Equipment

General assessment:

- The imaging equipment sector features two main and at least six other imaging technologies with different power requirements ranging from a few watts up to a few hundred watts and even kilowatts. Electro-photography (EP) is a main imaging technology, which requires high thermal energy for the printing process. Thermal and power management is an essential consideration in the design of these products.
- It was this high power EP-printer and EP-copier industry that introduced a multi-tiered power management. Functionality and through that power consumption is reduced step-by-step after a preset time duration. The reactivation capability (and resume time to application) has been a critical factor in all solutions.
- The energy saving efforts made by the industry have to be recognized in a positive way. In conjunction with energy efficiency the industry addressed the improvement of reliability with respect to the power-down routines, the development of fast reactivation technologies, as well as the improvement of the Digital Front End and respective network interface for controlled wake-up routines (avoid faulty wake-ups).
- There are many technical lessons learned. However, most important is the growing customer acceptance for power management settings and its utilization.
- This generally good assessment of best practice in the imaging equipment sector is limited by the fact that a considerable number of low priced inkjet products do not feature such advanced power management and consume significant energy in ready or sleep. The Energy Star's Functional Adder Approach for these products seems to be suboptimal and needs attention in future setting of requirements.

Driving factors and limitations:

- Similar to the computer industry and in conjunction with tightening energy consumption requirements under the Energy Star® Programme, the imaging equipment industry has been, for the past ten years, a best practice example for implementing functional power management schemes into a technically very heterogeneous market segment.

- The cascaded power-down concept has been developed deliberately in order to meet the resume-time-to-application demand of the customers as best as possible, while at the same time reducing overall energy consumption.
- Public awareness of the high power consumption (in ready) has been a strong incentive. The awareness raised by energy labeling and public information campaigns of governmental and non-governmental organizations.

Technology solutions (basically similar to computers):

- Fast fuser technologies for electro-photography imaging machines[3]
- Automatic device deactivation (e.g. scanner lamp)
- Adaptation of ACPI and respective component development
- Strict default delay time for power-down (typically only a few seconds or minutes, no long ready modes anymore)
- Power management options on the top-level of the menu (eco-menu)
- Manual power saving options (some products feature soft switches and hard offs)
- Detailed product information (power consumption per modes)

6.1.3 Networking and Customer Premises Equipment

General assessment:

- Telephones, home gateways (modem/router), LAN switches/routers, WLAN access points, and “headed” complex set-top-boxes (tuner/decoder with integrated modem) in home and office environment are products (small equipment) with an average power consumption of mostly under 20 Watt (Note: There are of course exceptions when the gateway becomes a home/media server-type product). This situation is the result of the business models related to customer premises equipment. The service provider (telecom, tv-cable, etc) is interested in providing price-oriented equipment to the customer. That means that the products are not “overloaded” with high performance functionality.
- The resulting design requirement for the product includes a small form factor and passive cooling. The product designer will focus on reliable performance (get all

[3] The energy-saving effectiveness of fast-fuser technologies requires additional support from a full duty-cycle analysis.

those new technologies and network options running) while at the same time demanding low power components and better power supply designs. The cost factor (low price) is limiting the availability of highly integrated (low power) devices.

- The semiconductor industry providing higher integrated components (system on chip) are becoming aware of the "energy efficiency" demand by the equipment manufacturers. However, component costs are still a considerable limitation to best practice.
- The power-down of networking equipment and CPEs is currently limited by network availability demand of the service providers. This demand results from frequent service downloads and updates of the CPEs including firmware, application, and electronic program guide updates. A particular concern is the updates by TV service providers. The problem in this case is the limited bandwidth capacity of digital video broadcast resulting in the active state of tuners and decoders over the long durations of the downloads.

Driving factors and limitations:

- The small form factor is supporting energy efficient product design (thermal management, low/no noise, this limits the integration of HDD).
- Customers are less aware of the power consumption (however, there are some nice blogs in the internet that prove otherwise). The situation might change in the near future.
- IPTV options and the utilization of more efficient network architectures (Ethernet) are potential drivers for new TV solutions or at least efficient program updates.

Technology solutions:

- System-on-Chip (highly integrated, energy efficient network interfaces in conjunction with e.g. IEEE 802.3az)
- Energy Efficient Ethernet (IEEE 802.3az) in conjunction with low-power design of the network protocols, e.g. energy efficient routing protocols)
- Support of Proxying (ECMA 393) solutions
- Support of ADSL/VDSL low power options (improved interoperability with network service provider, not limited to DSL but also passive optical networks, DOCSIS)
- Selected power management and deactivation of functionality (e.g. WLAN module, signal processor, adaptive link rate)

- Smart antenna technology (MIMO multiple-input and multiple-output in WiFi IEEE 802.11n, and cellular 4G wireless Long Term Evolution)
- Night switch off (timer, not only during the night)
- Broadband access network utilization (e.g. Fibre-to-the-home)

6.1.4 Consumer Electronics

General assessment:

- Similar to the PC, IE, and NE industry the audio/video (AV) and consumer electronics (CE) industry is featuring large product portfolios with the trend to hybrid equipment. Coming from long-time analogue technology the consumer electronic equipment is typically not based on computer architectures (there are exceptions). The resulting diversity of system designs, specifically designed hardware and software solutions including network technologies leads to a lack of interoperability.
- Power consumption has been a big issue in the past few years with respect to lowest power standby/off on the one hand, and the reduction of average active power consumption (e.g. large TVs) on the other hand. The power management was limited (mainly to the remote control standby) due to the more passive utilization of such equipment (you turn it on and it runs as long as you like to hear or see the content).
- With more complex, network, and storage capable devices active power management is a necessity. But at the present no standards comparable to ACPI are available. CE industry should focus on standardization of interoperability and power management.

Driving factors and limitations:

- Most CE products will be network-capable (wired or wireless). PC industry network standards (LAN, WLAN) and computing architectures are strong competitors. Power management could be a competition factor.
- Stakeholders from the TV industry indicated that the technical lifetime of non-volatile memory (HDD/SDD) to save RAM and processor states is not long enough (sufficient) for the more than 10 years expected lifetime of their products. This would presumably apply for constantly writing the system state into non-volatile storage. Nevertheless, HDD have been integrated in TV-sets already in order to facilitate program recording functionality such as Time Shift Viewing.

Technology solutions:

- Introduce or adapt power management when product architectures reach “booting required” complexity,
- Top-level eco-menu (dimmer settings, smart interface deactivation),
- Light sensors, display dimming, presence detection (where applicable)
- Sleep function (auto-off timer)
- HDMI network signalling which could power down connected equipment when the display is switched off

6.1.5 Mobile Communication

General assessment:

- The mobile phone and smart phone industry had to take extreme power saving approaches in order to extend functionality on a fixed energy budget. Even though the type of network connections and the wake-up behaviours differ from the non-mobile products, enough technical overlap exists to draw BAT conclusions.
- Apart from UMTS and GSM, which play a smaller role for the other product groups under investigation, many smart phones feature wireless LAN, Bluetooth and USB interfaces, which are also features of non-mobile products.
- Processor, memory and graphics capacity of smart phones are surpassing older PC equipment, while maintaining “few chip” system architectures with low power demand.

Driving factors and limitations:

- Limited battery storage capacity versus small form factor and maximum functionality all of the time. Recharge as seldom as possible.
- Interoperability with peripheral or host devices (mainly through Bluetooth and USB so far).
- Combining more expensive mobile network internet access with wireless LAN access, when available
- Using wireless LAN to realize universal remote control at home
- Cell phone and wireless LAN technologies are also incorporated into many ebook readers, so these are effectively part of the mobile phone architecture family.

Technology solutions:

- Smallest scale, smallest power integrated communication chips (or all-in-one)
- Interface modules to allow upgrades or market customization (usually for the manufacturer, not accessible for the user)
- All current wireless technologies adapt signal strength to save energy.

6.2 Standardization for Energy Efficiency

6.2.1 Energy Efficient Ethernet

IEEE standard 802.3az (Energy Efficient Ethernet) has been introduced in Task Report 4 (Chapter 4.4.1.4).

Energy Efficient Network Interface Controller by Broadcom[4]

According to a current white paper of Broadcom network equipment of all types can benefit from lower power consumption, which reduces energy costs and lowers overall operating costs for IT organizations. Broadcom® EEE-compliant products offer additional energy savings and provide customers with end-to-end silicon and software solutions that enable faster deployment of energy efficient networks.

As part of the EEN initiative, Broadcom has developed its proprietary AutoGrEEEn™ technology to facilitate the adoption of EEE and provide a faster migration path for legacy networking equipment. AutoGrEEEn technology implements the EEE standard directly into Broadcom PHYs and allows them to be in EEE mode when interfacing with non-EEE enabled MAC devices, without requiring changes to those devices. This innovation allows customers to make existing network equipment EEE-compliant by simply changing the PHY devices.

6.2.2 Network Proxying

ECMA-393 (ProxZzzy™) Standard has been introduced in the Task Report 4 (Chapter 4.4.1.5).

Implementation is already ongoing, as the growing support in mainstream operating systems shows. The two prominent examples are covered in short.

Apple's Wake-On-Demand (WOD) is a proprietary technology that supports ECMA-393 network proxying on the base of Apple's latest Operating System (OS X 10.6).[5]

[4] Broadcom white paper (October 2010): http://www.broadcom.com/collateral/wp/EEE-WP101-R.pdf

[5] Apple's website: Mac OS X v10.6: About Wake on Demand: http://support.apple.com/kb/HT3774 (downloaded 26.08.2010)

The WOD technology allows properly enabled and configured Macintosh computers to provide network services (like file, music or printer sharing) in low power sleep states with a WOL-type wakeup. This is done in conjunction with the Apple airport base station or time capsule, running the new "bonjour sleep proxy" (BSP) service, which then acts as a proxy for the sleeping Macintosh computer offering the network service.

The BSP handles requests for the Macintosh's network service (e.g. occasional synchs to the server) while it sleeps and then wakes it up when it is required e.g. access a file, stream song/movie or print a file to a network printer. When Wake on Demand is enabled, any Mac on your network running Snow Leopard will automatically register itself and its shared items with the Bonjour Sleep Proxy. This is in larger networks (with multiple routers) somehow problematic. When a request is made to access a shared item on a Mac running Snow Leopard, the Bonjour Sleep Proxy asks that Mac to wake and handle the request (that happens with all requests). Once that request is complete, the Mac will go back to sleep at its regularly-scheduled interval as set in the Computer Sleep section of the Energy Saver preferences pane.

This technology has some advantages but could lead in larger networks to false wake-ups.

Windows 7 incorporates ECMA-393 network proxying and adds support for Address Resolution Protocol (ARP) and Neighbour Solicitation (NS) offloads, which allows a proxy service to maintain a Windows 7 computer offering network services to sleep while a proxy server maintains its presence on the network.

6.3 Best Available Products

The selection of Best Available Products has been done according to the following criteria:

- The product examples feature power management options with low power modes similar to networked standby. Power consumption values are available and have been published (e.g. in test magazines).
- The low power consumption should not be related to an under-configured product. The product selection considers state-of-the art functional performance, including considerable computing power, storage capacity, latest (multiple) network configuration, and good display performance.
- The product selection also considers customer convenience. This includes time-shift functionality, internet access and media streaming capability (of non ICT products), sensors etc.

For the following study of best available products only a few products have been selected. There are a large number of products in different configurations available on the market. We do not attempt in this study a complete performance benchmark.

6.3.1 Computer Products

The active and idle power consumption of personal computers including desktop, all-in-one, notebook, tablets as well as thin and zero clients are varying largely in relation to its data processing, memory and network performance (display size if applicable). The complexity of the operating system as well as the application programs are influencing memory and processing and through that the power consumption as well. In terms of network availability (networked standby) the power consumption is mostly influenced by the type and number of network interfaces. The resume time, however, is determined by the individual configuration and the performance parameters of the equipment. Battery-powered devices feature already an advanced power management. In conjunction with a somewhat reduced performance the power consumption is in general much lower. Against that background it is difficult to provide uniform examples of best available products. A selection of examples highlighting differing aspects of available low power modes follows.

Acer Veriton N260G (Nettop):

- Configuration: Intel Atom N280 (1x1.6 GHz), Onboard VGA, 2 GB RAM, 160 GB HDD, GB-LAN, 6xUSB, VGA, HDMI

- Power: Active (max 22.8 W, Idle (max) 15.6 W, Sleep (WOL) 3.8 W, Standby (S5 with WOL) 1.4 W[6]

Lenovo Thinkpad X100e (Notebook):

- Configuration: AMD Athlon Neo MV-40 (1x1.6 GHz), Mobility Radeon HD 3200, 2GB RAM, 250 GB HDD, GB LAN, 3xUSB, WLAN, Bluetooth, UMTS, VGA
- Power: Active (max 35.4 W, Idle (max) 14.3 W Idle (min) 9.8 W, Standby (S5) 0.5 W[7]

INTEL Corporation provided the following test results for new products as input to the Lot 26 Study. Systems under test (partially identified by the internal platform names) and test results are listed below.

Desktop platform examples:

- Sugar Bay CRB (SandyBridge+CougarPoint, Mainstream)
- Dell OptiPlex960 (Penryn Core 2 Duo+EagleLake, Low cost VPro)

Notebook platform examples:

- Huron River CRB (SandyBridge+CougarPoint)
- HP EliteBook 2540p Notebook (Arrandale i5+IbexPeak, Business Notebook)

The results are summarized in table 1.

Table 1: Test results of desktop and notebook PC (provided by Intel)

System	Type	S3 PWR	S3 WOL Pwr	S3 WOL AMT Pwr	S4 Pwr	S4 WOL Pwr	S5 Pwr	S5 WOL Pwr	Idle (disp on)	Idle (dis off)	ARP S3 WOL Res time	ARP S3 AMT Res time	ARP S3 WOL Res Energy	ARP S AMT R Energ
	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[1][W]	[Sec]	[Sec]	[W*Sec]	[W*Se
SugarBay CRB	DT	1.28	1.4	1.65	0.87	1.08	0.87	1.08	28.77	28.31	8		342	
Dell Optiplex 960	DT	1.62	1.62	2.23	1.2	1.2	1.2	1.2	32.42	31.94	11	0.1	412	8.23
Huron River CRB	NB	0.84	1.06	1.3	0.57	0.78	0.57	0.78	8.32	11.42	9		230	
HP Elite 2540p	NB	0.66	0.978	1.25	0.5	0.84	0.5	0.84	8.47	12.67	10		170	

[6] Source: http://www.pcwelt.de/produkte/Acer-Veriton-N260G-Business-Nettop-Verbrauch-und-Lautstaerke-Idealer-Arbeitsplatz-PC-452884.html
Please notice: DEA suggests different values for these computers (Idle: 19.1 W – Sleep: 2.4 W – Standby/Off: 1.4 W with WOL enabled)

[7] Source: http://www.notebookcheck.com/Test-Lenovo-Thinkpad-X100e-Subnotebook.25522.0.html
DEA suggests different values for Idle: 11.4 W – Sleep: 1.5 W – Standby/Off: 0.9 W.

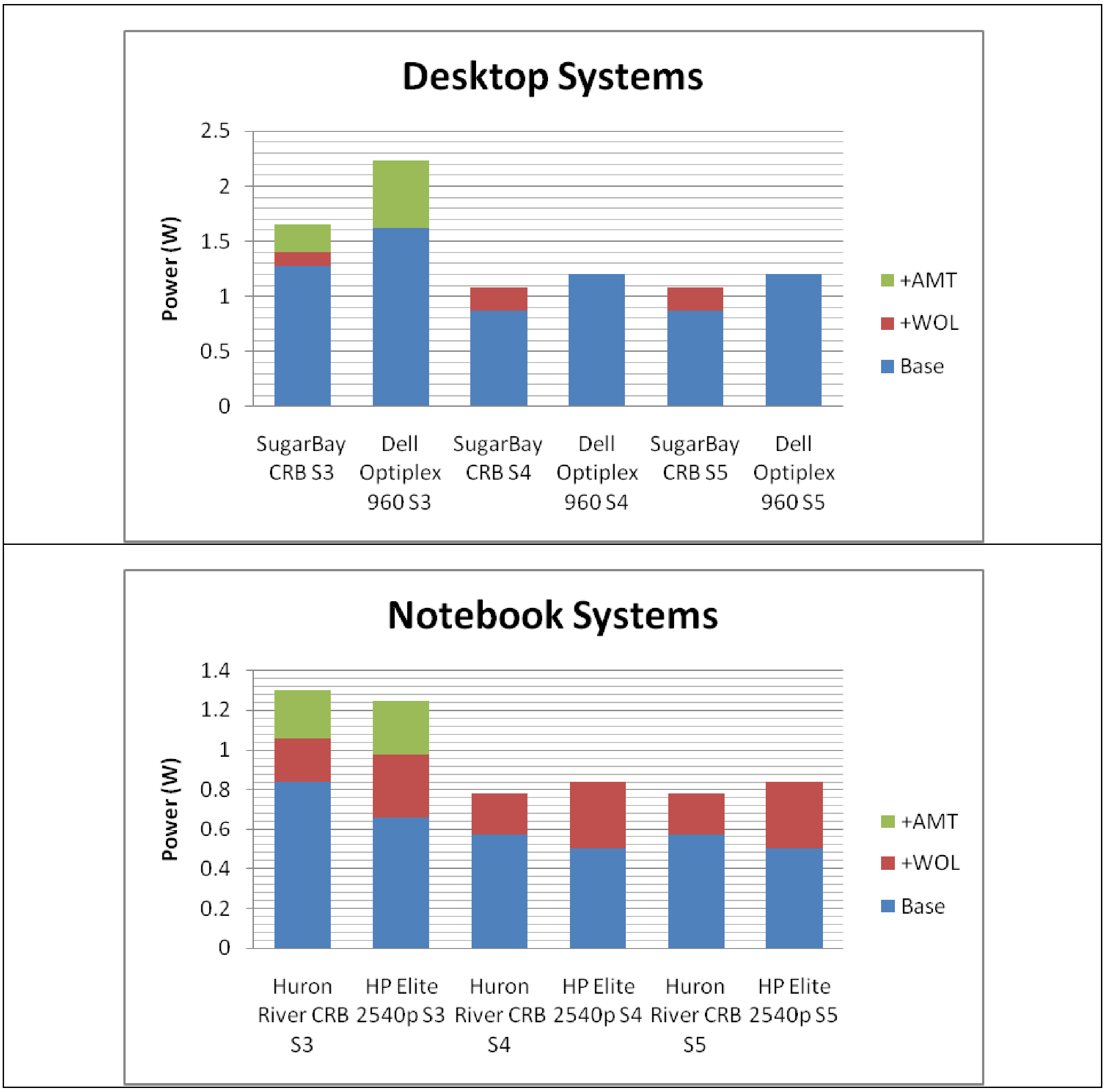

Figure 1: Comparison of test results for desktop and notebook PC (provided by Intel)

The results of these test measurements show the low power performance with medium network availability (S3 WOL).

The desktop PC power consumption in sleep S3 WOL (+Intel AMT) is below 2.5 Watts and in the best case 1.65 Watts.

The notebook PC power consumption in sleep S3 WOL (+Intel AMT) is below 1.5 Watts and in the best case 1.25 Watts. The lowest sleep (S4/S5 Base plus WOL) is under 1 Watt.

S4 and S5 states with WOL would be considered low network availability, and are shown with 1.2 and 1.08 W for the desktop PC examples and 0.78 and 0.84 W for the notebooks.[8]

6.3.2 Display

Display energy consumption including standby has been optimized in the past years due to new technologies (e.g. LED) and in conjunction with power saving measures (e.g. dimming, default delay time settings, user detection sensors).

LG W2286L:

- Configuration: 22 inch-Display with LED-Backlight, 2xHDMI, DVI-D, VGA
- Power: Active 19 W, Standby and Off <0.1 W

In standby the product will still reactivate, when signal changes are detected on the inputs, so this is a networked standby implementation at below 0.1 W.

6.3.3 Home NAS

This product group is again quite diverse. Power consumption is mainly influenced by the memory capacity, chip set family and types/number of network interfaces (interoperability). The products presented below are good examples (providing power consumption specification) but not necessarily best available products.

Buffalo LS-WSX500L/R1EU

- Configuration: 2x250 GB HDD, Raid 0/1/JBOD, DLNA-Server, i-Tunes-Server, Torrent-Client, LAN, USB
- Power: 8 W Active, 5.5 W Idle, 2.3 W Standby (with WOL)

LG N2R1

- Configuration: 2x1TB HDD, RAID, DLNA-Server, Gigabit LAN, eSATA, 3xUSB
- Power: 22 W Active, 19 W Idle, 9.3 W Standby (10 sec. reactivation), 2.3 W Hibernate (40 sec. reactivation)

[8] The UK MTP has suggested that in WOL enabled sleep mode 0.9W is possible for desktop PCs, and 0.7W for laptops.

6.3.4 Imaging Equipment (Printer)

Imaging equipment has been the focus for power management in the past years. There is a high diversity of products on the market.

Canon Pixma MG 6150

- Configuration: IJ-MFD, 9-12 ipm, USB, LAN, WLAN, Duplex, CD/DVD-Print
- Power: 25 W Active, 7.4 W Idle, 3.72 W Sleep (USB: Active, Wireless LAN: Active, Wired LAN: Inactive) 2.0 W Sleep (USB: Active; LAN (Wireless / Wired): Inactive), 0.5 W Off

Ricoh Aficio SP 3400SF

- Configuration: EP (laser) All-in-One: A4; black and white
- Power: Max. 850 W, Active 475 W, Idle 68.8 W, Standby 9.7 W (15 sec. reactivation)

  Although the standby value might seem high, the reactivation time is actually quite low for this type of equipment, showing once more the relation between the two parameters. Additionally, the UK MTP has evidence suggesting that for an inkjet printer, 0.6W is possible in sleep and 0.2W in off mode, and for a large format EP printer 4.6W is possible in sleep.

6.3.5 Home Gateway

Power consumption of home gateways are determined by the type(s) of modem, VoIP, LAN, WLAN and other network configuration. The product examples below are not the simplest products on the market.

Conceptronic C300GBRS4

- Configuration: 1xWAN, Router (4xLAN), W-LAN (n), WOL
- Power: with 1xWAN, 1xLAN and 1WLAN client registered, 4W Idle,

Sitecom WL-351

- Configuration: 1xWAN, Router (4xLAN), W-LAN (n), Multi-SSID
- Power: with 1WAN, 1xLAN and 1WLAN client registered, 3.3W Idle,

AVM FritzBox 7270

- Configuration: DSL Modem, Router (4xLAN FE), W-LAN (n), 3 Antenna, 1xUSB host, 2 TAE

- Power: Active 6.3 Watt, (Internet: Idle-timeout, auto reconnect), UPnP deactivation, Night timer)

AVM FritzBox Phone WLAN 7390

- Configuration: VDSL- und ADSL2+ Modem, Router (4xLAN), W-LAN (n), VoIP, ISDN, analogue Telephone (2), 2x USB
- Power: 9.3 W Active, 8.1 W Idle, WLAN-off-switch

6.3.6 Television

Most simple and complex TVs feature very low <<1W standby/off due to the EC1275/2008 regulation requirements. Complex TVs are just starting to enter the market. The problem is the considerable booting time. These products therefore increasingly feature idle modes (fast play, quick start), which can coincide with added network availability. The following products are not necessarily best available products in terms of networked standby power. They however show the current situation in the market.

Panasonic TX-L37GW20

- Configuration: 37-inch-Display, Full-HD, DVB-C, DVB-T, DVB-S2, analog, recording functionality (on USB), DLNA-Client, VIERA-CAST Web-Services, LAN, USB, HDMI, CI+
- Power: 98 W Active, 20 W (Recording), 0.25 W (Standby)

Sony KDL-52LX905

- Configuration: 52-inch-Display, Full-HD, DVB-C, DVB-T, DVB-S2, analog, DLNA-Client, LAN, W-LAN, USB, HDMI, 3D, presence-detector
- Power: 130 W Active, ca. 60-80W Eco-Mode, 20 W Fast-Reactivation-Mode, 0.2 W Standby

According to a comment from the Danish Energy Agency the following two TV's from Samsung have a very low consumption in standby mode with quick start. The information is based on results from the independent Danish consumer magazine TÆNK. http://www.taenk.dk/test/fladskaerm/testresultater/

Samsung UE40C7705:

- Configuration: 40-inch-Display, Full HD, 4 x HDMI 1.4, 2 x USB, Ethernet, Wi-Fi (via dongle), Internet@TV med Twitter, YouTube, Facebook, Skype, Google Maps.
- Standby with quick start 0.15 watt

Samsung LE40C775:

- Standby with quick start 0.30 watt

6.3.7 Complex Set-Top-Boxes and Player/Recorder

The differentiation of complex Set-Top-Box and Media Player/Recorders is difficult, as these product groups are merging regarding the functionality options. There are many hybrid products in the market featuring integrated TV-tuner/decoder (with and without pay-tv), media recording/storage (integrated HDD, or USB-connected), DVD, Blu-Ray, server-functionality (e.g. with PC hardware) and defined internet capability (mostly firmware solution).

Sat-Receiver SL HD-100 S

- Configuration: HD-DVB-S-Receiver without Pay-TV, HDMI, SCART, USB
- Power: 8.5 W Active, 3.2 W Standby with timer (networked), <0.2 W Standby

Sat-Receiver WISI Or 187 HDTV-CI plus

- Configuration: HD-DVB-S-Receiver with Pay-TV, CI+, HDMI, SCART, USB, Recording via USB
- Power: 11.5 W Active, 0.2 W Standby (incl. timer)

Samsung Blu-Ray Player BD-C5500

- Configuration: Blu-Ray-, DVD-, CD-Playback, HDMI, USB, LAN, Internet@TV, AllShare (DLNA)
- Power: 9.2 W Active (Blu-Ray), 7.8 W Active (DVD), 0.1 W Standby

AVM FRITZ!Media 8260 (Maxdome MediaCenter HD-TV)

- Configuration: HD-DVB-S2-Receiver with Pay-TV, CI, DLNA/UPnP-AV-Streaming, Video-On-Demand, Web-Services, LAN, USB, HDMI, external HDD (optional)
- Power: 14 W Active, 11 W Standby incl. streaming access, 1.7 W “Deep Standby”

Stakeholders from the CSTB industry have remarked that this list of products may not be entirely representative of the current CSTB market. That said, no better data on example cases was provided.

For reference, the following tables provide the limit values as specified in the Complex Set Top Box Voluntary Agreement (as discussed in Task 1).The VA specifies the maximum energy consumption for compliant devices (expressed in kWh/year) with two tiers, one effective from 2010 until 2013, the other from 2013 onwards. The limit values are calculated by taking a base value for the type of device (Tier 1 limits are given in Table 6-2, Tier 2 limits are given in Table 6-3), and adding a functional allowance for any additional functionalities present (Tier 1 limits are given in Table 6-4, Tier 2 limits are given in Table 6-5).

Table 6-2: Base Functionality Annual Energy Allowance for Tier 1 of the CSTB VA

Base Functionality	**Tier 1 Annual Energy Allowance (kWh/year)**
Cable	45
Satellite	45
IP	40
Terrestrial	40
Thin-Client/Remote	40

Table 6-3: Base Functionality Annual Energy Allowance for Tier 2 of the CSTB VA

Base Functionality	**Tier 2 Annual Energy Allowance (kWh/year)**
Cable	40
Satellite	40
IP	35
Terrestrial	35
Thin-Client/Remote	35

Table 6-4: Additional Functionalities Annual Energy Allowance for Tier 1 of the CSTB VA

Additional Functionalities	**Tier 1 Annual Energy Allowance (kWh/year)**
Advanced Video Processing	20
High Definition	20
Access to additional RF Channels	20
DVR	20
Return Path	60
Multi-Decode/Trans-code and Display	38
VDSL or DOCSIS 3.0	7

Table 6-5: Additional Functionalities Annual Energy Allowance for Tier 2 of the CSTB VA

Additional Functionalities	**Tier 2 Annual Energy Allowance (kWh/year)**
Advanced Video Processing	0
High Efficiency Video Processing	20
High Definition	0
Full High Definition	20
Ultra High Definition	30
3DTV	20
Access to Additional RF Channels	15
DVR	20
Return Path Functionality	2

6.3.8 Smart Phones

Smart phones exemplify the ability to stay connected to a network at low power levels. Although no direct power measurements are available, some aspects of the power consumption can be calculated from technical base data and use tests.

iPhone 4

- Configuration: 3.5-inch-display (LCD, multitouch), 16-32 GB memory, GSM/UMTS/HSDPA/W-LAN, 2x camera, photolight, different office-, internet- and entertainment-software
- Calculation input: Battery: 1600 mAh @ 3.7 V; Runtime: 6 h (internet via W-LAN), 300 h (standby with GSM/UMTS)
- Calculated power consumption:
  - Internet via W-LAN: approx. 1 W (average)
  - Standby GSM/UMTS: approx. 20 mW (average)

Samsung I9000 Galaxy S

- Configuration: 4-inch display (AMOLED, multitouch), 8-16 GB memory, GSM/UMTS/HSDPA/W-LAN, 2x camera, different office-, internet- and entertainment-software
- Calculation input: Battery: 1500 mAh @ 3.7 V; Runtime: 4.5 h (internet via W-LAN), 750 h (standby GSM)
- Calculated power consumption:
  - Internet via W-LAN: approx. 1.2 W (average)
  - Standby GSM: approx. 7.5 mW (average)

The GSM standby is possible with an averaged power consumption of just 7.5 mW. With wireless LAN the calculated value is not a minimum value for only keeping the connection, but rather for full internet operation. Hence W-LAN network availability is possible at below 1 W with smart phone architectures.

6.3.9 Summary

The following table shows a summary of the current product data.

Table 6: Summary of product data

Product	Network Types	Current (2010) Power Range (Watts) Idle (current), HiNA equiv.	LowP2/MeNA equiv.	LowP4/LoNA equiv.
Desktop PC	LAN, WLAN, local	10.0 - 85.0	1.4 - 4.7	1.1 - 3.2
Notebook PC		10.0 - 45.0	1.0 - 3.7	0.8 - 2.2
IJ Imaging Eqp.		6.0 - 20.0	1.5 - 4.0	0.4 (off)
EP Imaging Eqp.		40.0 - 140.0	6.0 - 9.7	0.4 (off)
Networked Storage		5.5 - 27.0	2.3 - 17.5	-
Game Console	HDMI, LAN + tbd	20.0 - 125.0	-	-
Complex Recorder		15.0 - 30.0	3.2 - 16.6	1.7 - 16.6
Complex TV		15.0 - 45.0	-	-
Complex STB	WAN, HDMI, local	8.0 - 14.5	2.5 - 14.5	-
Home Gateway	WAN, LAN, WLAN	6.0 - 15.0	1.9 - 13.0	-
Mobile Phone	GSM, UMTS, WLAN	7.5 - 20 mW (GSM standby); 1 - 1.2 W (web via WLAN)		

6.4 Conclusion

Should all products with network capabilities use mobile and PC technologies? That is one possible conclusion from looking at the possible low power states still allowing reactivation over a network. Without prescribing architecture, chip sets or interface components this is an available baseline for all further developments – making development time, and not the technical or cost issues, the main obstacle.

PC and mobile computing devices show, that low network availability can be delivered at about 1 W (slightly more for desktops and slightly less for notebooks). Medium network availability can be implemented at below 2 W – even including additional remote administration support (in this case AMT). The computing examples also show that the influence of the power supply size is not major or can technically be managed, since some of these products are in the 300-500 W power supply range. That is why these products serve as the exemplary case: strong functionality (even in the low power modes), large power supply size (hence applicable to other larger products), and stringent power management implementation (hence all players of the supply chain know how to contribute).

As an extension of that analysis low network availability at below 2 W should certainly be possible for many other products, which

- are smaller regarding active power and the power supply size
- have less computing and memory demands
- have leaner architectures (SoC) and fewer interfaces

Medium network availability has been shown to be possible at below 2 W as well, but this might be harder to transfer to all product types and configurations. Nevertheless, it is a clear BAT case for “fat” non-mobile devices with resume times below 10 seconds and still only 1.4 W power consumption (1.65 W with AMT enabled). Mobile architectures deliver the same functionality at 1 W (0.978 W in the data table) or 1.25 W (with AMT).

Some special cases deliver medium network availability at below 0.5 W, such as monitors still detecting signals even at 0.1 W, which is effectively the soft-off level of the product. In the monitor case the signal detection is much simpler, or even purely analogue in the VGA case, so this does not transfer to complex networks, where keeping network integrity is a must.

Mobile phone based architectures however show that even keeping an active network presence with wireless technology is possible at well below 1 W. For the growing section of wireless LAN capable smart phones and eBook readers reliable power measurements are hard to find, but calculating average power consumption from battery capacity and tested use times is possible. Keeping the connection to the mobile phone network during “standby” is certainly close to the lowest possible power consumption at 7.5 mW, yet near instantaneous reactivation is possible. Comparable values with wireless LAN enabled during standby are not available, but even with wireless LAN (and most of the phone) fully active during internet activity, only 1 W is consumed on average. The actual power consumption of the WLAN connection would therefore be a fraction of 1 W.

Thus, a relaxed upper BAT for keeping a wireless LAN connection open would be 1 W (with energy supplied from battery, so excluding power supply losses, which would arise when integrated in other products).

For high network availability the spread of product features and requirements is even less uniform, but BATs do exist. When summarizing “low idle”, “energy efficiency modes” or “active standby” for a generic “IT or CE box” with potentially more than one interface active, candidates are:

- 6.3 W for idle home gateway (fully available, and with many features active)
- 3.2 W for network availability of a complex set-top-box (usually also classified as high network availability)

We conclude that indeed PC and notebook examples serve as a kind of generic BAT for many other products. “If the PC can do it, why can’t the other products?” At the same time we acknowledge that the transfer of these accomplishments to other products and sectors can be lengthy, requiring a reorientation of the whole product value chain and – as one enabling path – further progress in standardization. The mobile phone examples show additionally, what power levels can be reached while keeping a two-way connection to the network open.