Terminology and Definitions Needs for Low Power Mode Energy Use with Network Connectivity

Bruce Nordman, Lawrence Berkeley National Laboratory
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Effective policy, technology, and products rely on clear communication of ideas, conveyed by terms with commonly understood definitions. The topic area of low-power mode energy use has a history of terms with conflicting or confusing meanings. This discussion[1] is an attempt to reduce this confusion and work towards more consistency in terminology in energy policy. Conclusions are those of the author alone.

Terminology is used for a wide variety of purposes, so that clarity on the intended scope of application is critical. Terms do not exist in isolation, but are created as needed. Within energy policy, terms can and do vary with the policy approach taken. The approaches taken to the topic of network connectivity and efficiency have varied across geography and product type, contributing to the profusion of terms.

The report begins with the terms in the title, the types of terms relevant to the topic, then reviews the contexts of terminology use, several approaches to crafting systems of terms, and finally makes a set of recommendations for near-term policy use.

The scope of this discussion is energy-using devices found in residential and commercial buildings. A common term for the topic area of this report is "network standby". However, since a definition of that term and its ultimate role in energy policy are still being determined, more generic and standard terms are used in the title to avoid ambiguity.

Low Power Modes

In general, policy in this area is concerned with energy use of devices when not performing their primary function, and the most general term for this is "low power mode energy use". This covers any non-active mode, including off and when disconnected from an external power source[2]. As a topic area, this also covers the net energy impact of low power modes, such as energy saved by shifting usage time from active modes to low-power modes (or from one low-power mode to a lower one), conventionally called "power management".

Since "low power mode" covers all non-active modes, it does not require more specific definition. Since it is a general term, it is not widely used in regulations.

Network

A communications network is a set of connections and technology that enables arbitrary exchange of information among a set of entities. Networks are inherently digital, and are built on data links between two directly-connected devices (whether wired or wireless).

[1] One exploration of this topic was prepared by Intertek and others in January, 2013 (Bellingham, 2013). Some of the content in that report was contributed by this author and is adapted and expanded on here. The collaboration with the Intertek team was an important part of moving this topic area forward.

[2] Devices with internal batteries may be active while disconnected from mains power, so that being disconnected has different meaning for these devices in that it does not determine a power mode in the way that it does for devices without internal batteries.

Many policies and discussions of energy use do not make clear whether the scope of network connectivity includes technologies that only provide data links, or excludes them. On a technical level, data links alone do not provide network connectivity so should be excluded, but on a more practical level, the issues at stake are largely the same and data links can be well-handled by a policy for network connectivity. Thus, it seems most useful to have 'network' as a topic area cover all communications and so include data links, and to always be clear on this point. While this term has been used with both meanings, the distinction has not been a particular source of controversy.

Energy Use

This discussion covers energy used by devices from external sources (that is, not self-generated), and while it could cover any form of energy, it is almost always solely concerned with electricity use, since that is what powers the communications, even if the device itself also uses other forms of energy.

Terms

Types

Policy for network connectivity does not include just a few entries in a list of terms of similar type. Instead, there is a diverse collection of types of terms, including topic areas (collections of ideas), named modes (with specific meanings), mode categories (with only general meaning), mode characteristics (i.e. functions), power levels, and test procedure results. Many of these are similar, but not identical, and the same term is often reused for multiple types of terms. This all increases the chances for mis-application or mis-interpretation of a term.

Context

Terms are created for use in a particular application context. These shape the types of terms needed, the specific terms used, and the audience intended to use them. Once created, the terms may be then used in other domains. Four major contexts of relevant terminology are:

- Energy Policy — mandatory standards, voluntary programs, and analyses of energy consumption patterns.
- Test Procedures — instructions for manufacturers or test laboratories on how to measure product energy use.
- Technology Standards — documents that specify how devices, components, or communication protocols operate.
- User Interfaces — terms printed on product hardware, rendered on displays, or present in user documentation.

Often a term will originate in one domain, and then be adapted and used in another. This can be done intentionally and carefully, or otherwise, and the original intention and scope may or may not be maintained. For example, terms developed for use in technology standards are sometimes imported into user interfaces or energy policy documents. Terms from test procedures often determine those used in energy policy. Terms from energy policy often appear in popular discussions of energy use. It is not required that different

contexts use the same terms, but when they do it is helpful, as are clear correspondences between terminology systems. Confusion can be created when the same term has different implied meanings in different contexts.

Terms are then used and experienced by people in a variety of professional and in non-professional contexts. A key is to anticipate such usage and do this with care or to not transfer terms when it would be problematic or not needed.

Systems of terms

Within energy policy, four major approaches to creating relevant terminology have been widely used. They are:

- Minimum Power Mode. The IEC 62301/Ed.1 definition.
- Standby as a Mode. Standby defined by the functions present.
- Standby as a Condition. From the EU "Lot 26" draft regulation.
- Sleep Paradigm. Three basic modes: on, sleep, off.

These are not four ways to do the same thing, but rather, each approach has different goals and outcomes, even while sometimes using the same terms. Each system creates a set of terms that work coherently together. The names above are for convenience only. Many existing definitions fit into one of these systems only; however some definitions can be used consistently in more than one approach.

The following discussion reviews the background and key principles of each major approach, then addresses advantages and disadvantages of each, for particular applications.

Minimum Power Mode

The first edition of IEC 62301 (IEC, 2005) defined "standby" as essentially the 'minimum power mode while connected to mains'. Specifically, it was defined as the:

> "lowest power consumption mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when an appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions"

While IEC 62301/Ed.1 has been used in policy and test procedures for a wide variety of product types, it was officially defined for household appliances. Appliances traditionally have had few non-active modes, often just one. The "minimum power" approach avoids having to define capabilities that a device's mode might have, be required to have, or be prohibited from having. It does not define a particular mode, but instead selects whatever mode has the 'minimum power' characteristic for that particular product.

Appliances often automatically switch to their lowest power mode at the end of an operational cycle. In addition, a user who wants to minimize energy use can (presumably) select the minimum power mode. Thus, this definition proved to be useful in the development of energy policy for appliances and some other products. An advantage of this approach is that the definition is unambiguous, universal, and relatively straightforward to explain. A disadvantage is that it often is not the mode of most interest

to policy makers, who are most interested in the low power mode the device spends the most time in.

While most devices contain a mode without network connectivity as their lowest power mode, there are products that do not (e.g. some printers and network equipment). Thus, this definition usually (but not always) does not cover network connectivity.

Standby as a Mode

The second edition of IEC 62301 (IEC, 2011) defines "standby mode(s)" as:

> "any product modes where the energy using product is connected to a mains power source and offers one or more of the following user oriented or protective functions which usually persist:
>
> - to facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including remote control), internal sensor, timer;
> - continuous function: information or status displays including clocks;
> - continuous function: sensor-based functions"

IEC 62301/Ed.2 has a series of definitions for function, mode, product mode, low power mode, off mode(s), standby mode(s), network mode(s), active mode(s), and disconnected mode. A mode is defined by the functions present. Measurement standards for particular products are expected to define modes for those products. Edition 2 further states:

> "NOTE: The issue of devising appropriate names for product modes is a matter for the relevant product committees. While a product mode name should generally reflect the functions that are activated, they need not contain the terms "standby" or "network" even where the product mode falls within these mode categories."

The standard identifies a category of mode of "network" that is distinct from the category of "standby", not a subset of it, and defines "network mode(s)" as:

> "...any product modes where the energy using product is connected to a mains power source and at least one network function is activated (such as reactivation via network command or network integrity communication) but where the primary function is not active"

A subsequent standard, IEC 62542 specifically excludes network connectivity from the definition of "partial on" (used in similar ways to "standby" is in this approach). IEC 62087, for several audio/video product types, divides Standby mode into types: Standby Passive; Standby Active, Low; and Standby Active, High. Some of these include communications (data or network).

An advantage of this approach is that it is more specific about what modes are or are not included in "standby". A disadvantage is that the distinctions made between off, standby, and network modes may not be relevant to other contexts.

Standby as a Condition

Within the EU regulatory framework an amendment proposed to the standby regulation (EC 1275/2008) creates maximum power limits for "networked standby". This would create a horizontal regulation of network-connected low-power modes across a wide range of products. The amendment defines "networked standby" as:

> "a condition in which the equipment is able to resume a function by way of a remotely initiated trigger from a network connection"

Networked Standby is a "condition" that a device has, rather than as a "mode" it is in. Condition seems to be the same as the terms 'function' and 'capability' used elsewhere. The "remotely initiated trigger" is defined as "a signal that comes from outside the equipment via a network".

While network-connected low-power modes have been addressed for many years in a "vertical" context — for a single product category — this is the first time that it will be addressed horizontally. The condition definition is derived from the IEC 62301/Ed.2 modal definition, with reference to "reactivation via the network". The EU guidance on the proposed amendment states (EU, 2013b):

> "Networked standby is presented as a condition, and not as a mode because it is assumed that this condition can be present in many modes. And it is the network standby condition (functionality) that is relevant and not the mode the product is in."

The condition approach avoids having to define a mode and the complications that brings. The definition was created to support a particular policy approach rather than being created for an individual product or mode. Being well-tailored to its policy purpose, it does not extend well to other domains. The proposed amendment includes a requirement for devices to have power management capabilities, though details are not specified.

The condition approach was necessary in the network context, but could also be applied to the general notion of "standby". The 'Standby as mode' approach could be changed to define it as a condition, not as a mode, and therefore avoid problems the mode approach creates.

Sleep Paradigm

Many technology standards, energy policies, and product user interfaces use the concept of a device (or component or other entity) being in a "sleep" mode, a distinct state between being fully on and being off. This establishes a third, basic power state. Generally, a power control command is required to take a device out of an off state, whereas it may wake from sleep from a variety of inputs or circumstances, often including from network activity. While waking from sleep is usually quick, turning on from the off state may take an extended time.

There are no horizontal policies or test procedures on sleep states, so there has been no need to create a rigorous, single definition of sleep. Rather, what constitutes sleep has been determined based on the nature of individual product types, and the expectations that human users bring to them.

IEEE 1621 (IEEE, 2004) standardizes user interface elements (terms, symbols, and indicators) for electronic devices. Its mode definitions are vague, only clarifying that sleep is intermediate between on and off in capability and power consumption[3]. The vagueness derives from the horizontal nature of the standard (horizontal within electronic devices).

[3] Products with internal batteries have power levels while charging higher than typical in the mode so that power level and mode lack the close correspondence they otherwise have.

As the sleep approach takes modal definitions on a product-by-product basis, network connectivity does not need to take on a consistent attribute. Some products have a sleep mode but have no network connectivity (e.g. a simple photocopier). PCs most commonly lack network connectivity in sleep (though they can have network connectivity in sleep and even in off). Other products (e.g. printers) always have network connectivity in sleep.

An advantage of the sleep paradigm is that it works well in user interfaces and in explanations to non-professionals. A disadvantage for this purpose is that it is not specifically tied to the presence of network connectivity.

Points of contention

There are several areas of discussion and disagreement in the policy community, even apart from the four different approaches. Some of these are discussed here.

Spectrum of modes

A common conception is that power modes exist, for individual products and in general, along a single linear scale, with capabilities and power consumption increasing incrementally as one moves from left to right. Diagrams of this form have been widely used, including recently in IEC 62542, commonly along with a goal to establish a unified system of power mode names and functions across all products. Such structures put low-power modes with network connectivity either within a broader category of "standby", or between standby and fully on.

There are many products for which this model holds, although for others it does not. For example, battery charging and devices running on battery power both upset the power association within this spectrum. Also, complex functions such as network connectivity can be added or dropped independently of the particular mode the device is in and so also violate the single linear scale. If such a scheme did always work, it would be useful to have, but since it does not, attempts to force one lead to problems.

Degree of horizontality

Regulation of low-power modes can be done in three basic ways, both in general, and to address network connectivity. First is the purely vertical approach, in which requirements are set on a product-by-product basis. Second is the widely horizontal approach, as is being established in the European Union. A third method could be called "clustered horizontality" or "sectoral horizontality" in which groupings of product types have a common regulatory framework, but that the framework is varied between these groups. The groups could be large, such as all kitchen appliances, all audio/video devices, all heating and cooling equipment, etc.

If a single horizontal approach is used, then a single, specific definition of core terms is needed. If regulations that reduce energy use attributable to network connectivity are more narrowly tailored, then the definitions can be similarly more narrowly applied. Thus, choices around terminology are inseparable from choices about policy.

What to do

The various purposes and contexts of terms will continue to exist, and past usages of terms are not likely to be dropped overnight, so that what is not needed is a few narrow definitions, but rather, a broad system of terms of different types that can co-exist with each other while creating a minimum of confusion. The following is a set of recommendations that, if adopted, could move the process forward.

Minimum power mode

The original 'standby' term was the "minimum power mode". This concept has some usefulness so that maintainingit is warranted. The most simple and direct way to express this is "minimum power mode".

Network standby

"Network standby" is widely used as the *topic area* of technologies, policies, etc., around energy use of low power modes with network connectivity. It seems appropriate to use this term for the general topic area, and to not assign it a more specific meaning. There appears to be no policy need for it to have a more specific meaning.

Networked standby

The EU widely-horizontal policy approach created the need for a "condition" of a device that is in a low power mode with network connectivity. "Networked standby" does not seem to have other usages and do can be safely used for that specific meaning. That this differs by only two letters from 'network standby' and can sound the same when spoken will likely lead to some confusion, but there may be no better alternative.

Standby

The IEC 62301/Ed.2 definition of "standby" will likely get significant use for the foreseeable future, but as there are many other definitions of the word, clarity can be accomplished by always referring to it as "IEC 62301 standby" when that meaning is intended. In addition, shifting to considering this a "condition" rather than a mode would be helpful. For the term "standby" unqualified, it is often used to refer to the topic area of **"**low power modes" generally, so that it should have that general meaning only.

Sleep

For product user interfaces, "sleep" is an unambiguous state between on and off for electronic devices, and should continue to have this meaning. While sleep often includes network connectivity, that is not required. For kitchen and laundry appliances, "sleep" does not well apply, so that we would expect such devices to have "ready" and possibly "off" modes, and either could have network connectivity.

In these recommendations, terms such as "network standby" and "standby" are quite general, whereas others such as "IEC 62301 standby" and "networked standby" have specific meanings. Both types of terms are needed.

For related terms, many devices have an "off" mode that (almost always) can only be exited via a power command. There is also "IEC 62301 off" which has a more limited definition, and should always be labeled as such to distinguish it from the more ordinary usage of off.

The only term that specifically refers to low-power modes with network connectivity is the "IEC 62301 network mode" term. This term has not gotten significant use since its creation so that for clarity it seems best to simply refer to "low power modes with network connectivity" or "sleep modes with network connectivity" to refer to this concept rather than creating a defined term. And as noted above, data link technologies should be covered by policies around networks.

Summary

Terminology around low-power modes has historically been diverse and often contradictory. This impedes making good policy and consumer use of such modes. Different approaches and contexts have been a major reason for the diversity of terms. This paper proposes a modest set of usage guidelines designed to accommodate existing usages and needs while laying out the beginnings of a system that can be unambiguous.

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