Local Area Network Access And It's Impact On The Environment

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1 Introduction

In this paper I want to give a brief overview about what a LAN is, what different types of LANs exist and what devices are used to build a typical LAN. Further I want to take a look on the environmental burden of access to wired and wireless LANs and to introduce a method how this can be measured. Last I want to apply the results on the situation at my own place and give a possible solution to lessen the effect of LAN access to the environment.

2 What is a Local Area Network?

A Local Area Network (LAN) is a data network used to transmit data between computers and other devices (hosts) within certain geographical boundaries with distances between the hosts of meters up to kilometers [4]. A LAN can be wired or wireless. Wired means the hosts are connected with a cable made out of copper or fiberglass with possible bandwidths in the range from 10 Mbit/s to 10 Gbit/s [3]. Wireless means that radio waves are used as transmission media with possible bandwidths of 11 Mbit/s, 54 Mbit/s or greater 54 Mbit/s [3]. Ethernet is the most used technology for wired LANs [3] to render communication between hosts and other devices possible, which was standardized by the Institute of Electrical and Electronics Engineers (IEEE) as 802.3 standard [1]. For wireless LANs (WLAN), WLAN technology based on the IEEE 802.11 [2] standard is used.

3 What Components are used to build a LAN?

A LAN consists generally of multiple nodes, for instance desktop computers, laptops, mobile phones, tablets, etc., and each node needs an interface to access the network. A node is usually not connected directly to another node but most of the time to a hub, switch and/or router. A hub has ports where the nodes can connect to and all it does is sending incoming data to all other ports. A switch has ports like a hub but incoming data is send to selected ports. Hubs and switches connect all devices that want to participate in this LAN-fragment, so building the actual LAN [5]. A router can do the same but additionally a router can be used to connect one LAN-fragment with another LAN-fragment or with the Internet. In the latter case the router is then called edge router. In a wireless scenario the nodes are connected to an Access Point, which often functions too as a router.

4 Case Example: My own LAN

As an example of a LAN, I want to describe the network I have in my own place – as illustrated in Figure 1. The LAN consist of a cable-modem which is connected to the Internet, a router with switch functionality and access point functionality, a desktop computer, a laptop, a smart phone and a tablet. The cable-modem, the router and the desktop computer are connected by cable. The notebook, the smart phone and the tablet connect to the router's access point functionality by the use of WLAN technology.

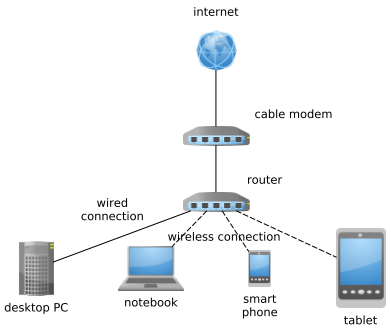

Figure 1: My own LAN at place.

5 How can we measure the Environmental Impact of LAN Access?

We can evaluate the environmental impact of LAN access by using the methodology of Life Cycle Assessment, as described in the paper "A Study of the Environmental Impact of Wired and Wireless Local Area Network Access" by Dr. Biplap Sikdar [6].

5.1 What is Life Cycle Assessment?

The author describes in his paper the methodology of Life Cycle Assessment (LCA) to give a quantification of the environmental impact of two concrete products, an ethernet-switch and a WiFi access point. [6] He describes this method as follows:

"Life cycle assessment is a well-established tool for the study and quantification of the environmental impact of process, products, and activities. As the name suggests, the analysis covers the entire life cycle of a product, starting from the extraction of raw materials, manufacturing, transport, use (including re-use and maintenance), and final disposal (including recycling). The methodology followed by LCA of a product involves four stages: Goal and Scope Definition, Inventory Analysis, Impact Assessment, and Interpretation [14]. [...]" [6]

As output of this method we get values for energy consumption and CO_2 emission during manufacturing phase and usage phase of the two chosen products.

5.2 What is the Energy and Emission during Manufacture and Usage?

For the manufacturing phase of the WiFi access point 39572.41 Wh were consumed and a CO_2 emission of 9.11 kg was calculated. For the Ethernet switch 71080.72 Wh were consumed and a CO_2 emission of 10.45 kg was calculated. [6]

For the usage phase the energy consumption and CO_2 emission were calculated for the periods of 1 day, 1 year, 2 years and 3 years. The values for the Wifi access point can be seen in Table 1 and for the Ethernet switch in Table 2.

period	1 day	1 year	2 years	3 years
power intensity	66.62 Wh	24316.30 Wh	48632.60 Wh	72948.90 Wh
CO_2 emission	40.64 g	14.83 kg	29.67 kg	44.50 kg

Table 1: Power intensity and CO_2 emission for different periods of a WiFi access point. Numbers taken from [6]

period	1 day	1 year	2 years	3 years
power intensity	48.51 Wh	17706.15 Wh	35412.30 Wh	53118.45 Wh
CO_2 emission	29.59 g	10.80 kg	21.60 kg	32.40 kg

Table 2: Power intensity and CO_2 emission for different periods of an Ethernet Switch. Numbers taken from [6]

It is worthy to note that the energy use of both systems was constant under different traffic loads and a 24/7 usage was assumed for the calculation. While the manufacturing phase of both devices have a large influence on the overall energy consumption, the CO_2 emission during the usage phase are higher. [6]

The author concludes from his findings, that an Ethernet switch needs less power during usage phase than a WiFi access point and that an extended lifetime and the use of clean energy sources are key to lessen the environmental burden of LAN access.

6 Own Observations and Thoughts

When searching for reachable access points at my place, I can find about 15-20 running WLANs (including my own), which corresponds to 15-20 networks and also running devices. Taking the value from 4.2 and calculating with the maximum number of available networks would give us a daily energy consumption of 1332.4 Wh with CO_2 emissions of 809.20 g. If the networks were cable bound, we would have a daily energy consumption of 970.20 Wh and CO_2 emission of 591.80 g.

If we assume a normal usage of the Internet like checking emails, being on facebook, twitter and alike, watching videos on youtube and playing online games, we could probably reduce the number of needed access points to 5, which would lead to a daily energy consumption of 333.10 Wh and

CO_2 emission of 202.3 g. This would come with the loss of direct control over the network and it's configuration and last but not least a possible reduction in available bandwidth.

7 Conclusion

From the points above we can conclude that access to a LAN, be it wired or wireless, has an impact on the environment which gets lower the longer we use devices like Ethernet switches and WiFi access points. While a WiFi access point uses more energy compared to an Ethernet switch, the use of more participants per access point would reduce the amount of needed networks and so decrease the energy consumption, leading to an overall lower burden during the usage phase of the devices.

References

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