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Electricity consumption of telecommunication equipment to achieve a telemeeting

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HIGHLIGHTS

- We determine electricity consumption in use to perform one remote meeting.
- The service uses phones, computers, access and Internet networks, and servers.
- Each requires some power to perform hours of use or bit/s of traffic.
- The consumption is related to service needs and device efficiency and utilization rate.
- It is 50 times as low as for train travels over 2500 km for three participants to meet.

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ABSTRACT

The article assesses the electricity consumption in use of telecommunication equipment to achieve one remote multi-user work meeting, an existing service proposed by Orange group. It also examines the electric gains of substitution for a meeting requiring physical transport. Equipment comprises participant computers PC and phones, access to core networks and servers to permit audio link and the share of documents on PC display between users. Each device requires power to perform hours of activity or transfer nominal bit/s of throughput.

A generic and modular method is suggested to determine from this information, which is not directly related to services processed by the devices, the consumption of the service under study. The method thus provides a quantitative relation of service consumption to its characteristics – duration, number of users and access throughput – but also to device consumption efficiency and utilization rate. The relation of dependance permits to assess potential energy saving by substituting devices for more efficiency ones and/or by increasing their utilization rate at same provided service.

With some utilization rates at around 10%, as observed for the servers, a telemeeting between three users and lasting 2.3 h requires 9 MJ of electricity. Using better equipment and higher rates it can be decreased to 1.5 MJ. By comparison transport of two of the users by train over a total distance of 2500 km requires 500 MJ.

The method can be applied to any service provided its characteristics are known.

1. Introduction

The last three decades have witnessed an impressive expansion of the digital information and communication technology (ICT) dubbed the third industrial revolution, as observed with the evolution of the number of personal computers (PCs) in the US (Fig. 1(a)). It resulted from a long process of accumulation of knowledge on algorithms and physics of electronic [1], as well as from industrial processes to manufacture at a large scale components of the technology.

However, public agencies are increasingly worried about electrical energy required by the ICT devices for their use [2] as well as for their manufacture [3], in spite of efficiency gains [4].

On the other hand, organizations like the International Telecommunication Union of the United Nations (ITU) point to gains from the substitution of ICT services, such as teleworking

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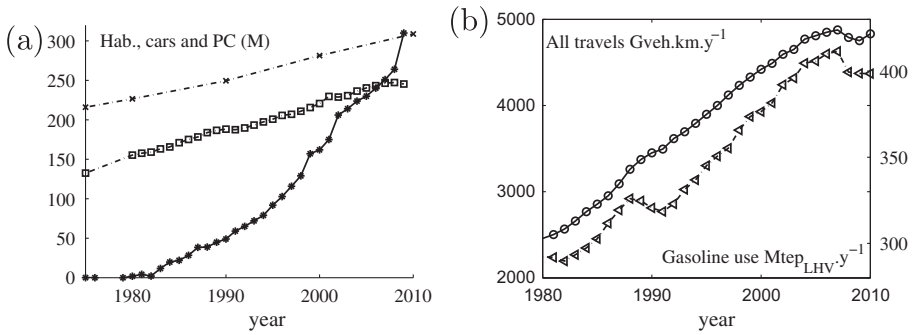

Fig. 1. (a) Evolution of population (dashed line), and numbers of cars (□, dashed line) and PCs (• with continuous line) in millions in the US per year. (b) Evolution of cumulated distance traveled in US roads (○ continuous line, left axis) and gasoline consumption (◁ dashed line, right axis) per year. Influence of population and numbers of cars and personal computers (PCs) on total travels and gasoline consumption in the US from 1980 to 2010. Sources: US census bureau 2011, Polk company, Federal Highway Administration and Computer Industry Almanach Inc. press news.

and videoconference, for meetings requiring physical travels. So far the growth of computer number has not prevented the rise of travel distance and gasoline consumption in the US. Only spikes of gasoline price in 2007/2008 and 2011 have had a result (Fig. 1(b)).

Nevertheless, with the development of the broadband access to the Internet (with a throughput of at least 1 Mbit/s at home [5]), telecommunication services become widespread. ICT could thus have a more important effect on the number of physical travels and so their impacts, provided the teleservices themselves do not require too much energy, chiefly electricity.

This assessment in the case of a specific teleservice, as well as the gain relative to its physical counterpart, is the aim of this article. Energy consumption to manufacture ICT equipment is excluded from the present study; it can be determined separately using the method suggested in the article. Likewise, we limit the scope to electricity consumption from a national grid, as overall energy demand to produce electricity and the environmental impacts of such production (contaminant emission...) can be worked out separately knowing the electricity requirement. Electricity consumption also permits to deduce its monetary cost for a telecom company or a country.

Consumption efficiency for teleservices, that is their energy requirement per unit of service provided, has already been examined with various approaches.

A first method is based on an equipment inventory at a specific date in the various ICT networks – from fixed or mobile access to edge and core ones – of a telecommunication group like Orange (formerly France Télécom) or an area like North America [6,4]. From the power requirement of each type of equipment in a network one can assess its electricity consumption. Knowing the number of subscribers or users for the network like for mobile phone, its efficiency is measured thanks to the power per user. In addition, when network traffics in bits are available, powers per unit of actual throughput are derived [4].

Another approach relies on the specifications of each type of equipment [4,7]. For access networks the equipment power can be reported per unit of user or port. The specific consumption depends on the technology (either optical line, copper wire or radio link) [5]. For all networks the efficiency of a device can be expressed in power per unit of throughput capacity [8]. From an estimation of their utilization factor, taking into account the redundancy for protection and expected growth, it is converted into power per unit of actual throughput. By combining the different networks required to perform a type of teleservice (video on demand, mobile data or voice...) for one user, the electricity consumption per user is derived and its variation with the specific access technology and the per user access rate. This rate presents a range depending on the type of service and future demand.

The approach adopted by this article is to assess the electrical consumption to achieve one specific ICT service, as well as its dependence.

Like in other approaches a part of data are provided by equipment specifications such as power requirement, number of ports and/or processing capacity. One of the difficulties to use them in our approach comes from the fact that devices in networks and data centers process simultaneously very different teleservices.

The work of establishing a relation between equipment specifications and the consumption efficiency of the teleservice is performed thanks to a generic and modular method, which is not restricted to the service under study.

The method intends to make explicit the dependence of the efficiency on parameters of the service such as its average throughput, duration and number of participants, and requirements in terms of processing and memory in servers, along with ICT devices characteristics like their utilization factors. The relation is important to assess potential energy saving for one service.

It also facilitates the identification of potential errors due to insufficient raw data and implicit assumptions. Realistic models are suggested to compensate for this deficiency. The method also assesses data uncertainties and their propagation to the final results.

Section 2 of this article exposes the principle of the method. It also presents the different parts of the ICT system along the chain of data transfer and processing required to perform the teleservice. For a more complete impact of the service consumption, equipment of the system includes not only networks but also dedicated servers in data centers and user terminals (PC and phone) at home or office.

Table 1 provides a glossary of the method terminology and its symbols used in the text.

Section 3 presents data for each part of the system and details the calculations to deduce their contribution to the consumption of one telemeeting.

To show the influence of the choice of equipment and/or their settings two cases with different configurations are examined.

In Section 4 is analyzed the consumption dependence on variables identified in previous sections, in particular by comparing the consumptions of each part of the systems between the two cases.

Lastly, in order to verify ITU claims, the consumption of the teleservice is compared to the transport requirements to achieve equivalent service with travels.

1.1. Notes about energy unit and other ones

Because a unit of energy such as J or W h gives no indication about the form of the energy, which may be a source of confusion,