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Energieverbrauch von Netzwerkkomponenten

Messbericht

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Contents

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Abstract

Measurements of electricity consumption of network components (router, switch, multiplexer, micro repeater, media converter) were carried out in two modern networks with 82 and 1200 users respectively. It was established that the recorded power was constant in terms of time and does not depend on the data-flow quantity or network topology. The measured power was approx. 30% of the specifications in the product descriptions, and this could give rise to an over-dimensioning of infrastructure systems such as air-conditioning plants and uninterruptible power supply (UPS) units.

1. Objectives

Goal

The goal of this project is to record the electricity consumption of active network components and list initial criteria for improving energy efficiency.
To achieve this, the electrical supply of major network components (switches, routers, multiplexers, micro-repeaters and media converters) was measured in an Ethernet and an ATM network.

Procedure

Measurements of the electrical power of network components were carried out during periods of high (daytime) and low (night-time) network system loads. The measurements were carried out on two networks: Basler & Hofmann (CISCO products) and Service Industriels de Genève (BAY products), in collaboration with Basler & Hofmann and Teleinform.

2. Description of networks

2.1 Topology of Rehalp / Esslingen network (B&H)

Description of topology

This description covers the application of the examined components in the B&H network:

- The topology of Rehalp corresponds to that of Esslingen. A switch (2901) is used in the backbone, to which the individual storey switches are connected. The individual segments have been set up according to 10Base2 standard and linked via media converters (transceivers) with the storey switch (2802).
- In the Esslingen topology, the storey switches (2802) are linked with the backbone switch (2901) via fibre. Since the CISCO switch does not possess any fibre ports, the individual uplinks opto-converters (transceivers) are pre-switched.

(See diagram in Appendix A)

Cabling, Rehalp

In Rehalp, the cabling has been carried out by means of ThinWire-Ethernet. The individual strands are fed to distributors which are connected to the central node in the server room by means of fibre.

Cabling, Esslingen

In Esslingen, universal cabling infrastruction was used for wiring the building. The central node point is located in the server room. The storeys are cabled using fibre, and the individual storeys are linked via copper (category 5) from the distributors located on each storey.

2.2 Topology of (SIG) network, Geneva

Description of topology

The ATM backbone of the SIG network consists of 8 Centillion 100 and a number of 5000DN models manufactured by Bay Networks.
For redundant reasons, two ATM C100 switches have been installed in the computer centre. The C100 switches in the basement and 3rd storey provide switched Ethernet connections to the 5000DN Bay model.
An ATM router (VNR) permits connection between the various virtual LANs. (See diagram in Appendix B).

3. Measurement concept

3.1 Structure of measurements / measured equipment in B&H network

Overview

The tested components are depicted in colour in the B&H Network Topology diagram in Appendix A.

Components

Measurement 1 (yellow)

Measurement 1 was carried out in the server room (SS) Rehalp:

- CISCO 2514 router (VAX link)
- CATALYST 2802 switch (storey switch)
- CATALYST 2901 switch (backbone switch)
- MR micro-repeater 122T transceiver

Media converter

Measurement 2 (green)

Measurement 2 was carried out in the PABX centre (basement), Rehalp:

- CISCO 2503 router (Esslingen link)
- CISCO 2503 router (Internet link)

IDNX Micro20 multiplexer (WAN link)

Measurement 3 (blue)

Measurement 3 was carried out in the server centre (basement), Esslingen:

- CISCO 2503 router (Rehalp link)
- CATALYST 2901 switch (storey switch)
- IDNX Micro20 multiplexer (WAN link)

Echo cancellor

Choice of components

Throughout the world, approximately 88% of Internet links use CISCO routers. Of these, some 60% concern the CISCO 2500 model (personal guess from M. Kistler). This indicates that the measurements were carried out on the most widely-used type of router.

Measuring devices

Each active component is connected to two measuring devices. This redundant method of measuring serves as a cross-comparison for precise measurement as well as helping to verify the measurement.

The evaluation of the measurements was mainly based on the readings at the electrical clamps.

Device 1

Connection of the clamps to the measuring wires, and link to a data logger.

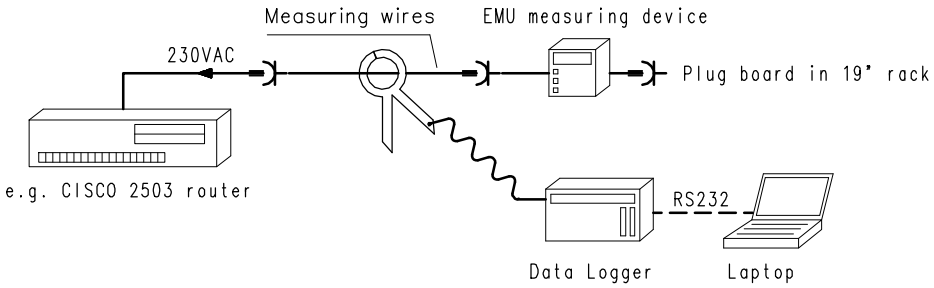
Device 2

Connection of EMU 1.x1M measuring device via direct wiring to the various components.

Both measuring arrangements were transferred to a laptop via an interface, and recorded and displayed in table form.

Diagram of measuring arrangement

Arrangement



Measurement cycle

Duration of measurement

The intention was to carry out two measurements:

Daily measurement:
Measurement was carried out in the smallest possible intervals of 1 second. The readings were averaged, stored and recorded every 30 seconds.

Weekly measurement:
Measurements were carried out in the smallest possible intervals of 1 second. The readings were averaged, stored and recorded every 5 minutes.

With both cycles, the maximum and minimum levels were also recorded for each active component.

Evaluation

For each of the three measurements an average was calculated using the integral. The course of the measurements was recorded graphically and the power was shown in watts [W].
Comparisons were made between the same components in the different topologies.

Measurement periods

Measurement 1 June 12 to 23, 1997
Measurement 2 July 24 June to 2, 1997
Measurement 3 July 2 to 11, 1997

Measured variable

Variable measured with the Chauvin Arnoux clamps: output 100 mV (=) / A (-). With EMU energy metres, the variable was measured in kWh.

3.2 Structure of measurements and examined SIG devices

Overview

The measurement is depicted in colour in the SIG Network Topology in Appendix B.

Components

Measurement 4 (red)

Measurement 4 was carried out in the computer centre of Service Industriels de Genève.

Measurement period

Measurement 4	June 23 to 30, 1997

4. Results

4.1 Weekly and daily measurements (B&H)

Explanations

Measurement capacity

It was possible to measure five devices simultaneously.

Measurement 1

It was only possible to use five channels for controlling the measurements obtained at the clamps. Only five EMU devices were available for carrying out measurements.

Measurement 3

It was not possible to feed the IDNX multiplexer via an EMU for carrying out measurements. Similar readings as for measurement 2.

Accuracy of EMU

These devices are capable of measuring currents up to 32 A. The EMU is classified in precision category 2, i.e. +/- 0.5% tolerance.

Accuracy of clamps

The clamps used are capable of measuring currents up to 150 A. Their tolerance is 3%, though clamps show a greater deviation tendency with very low current levels.

Results, B&H network

Power consumption

The results of the measurements were as follows

- The power consumption of the devices in permanent operation remains practically constant, regardless of the data-flow quantities, time of day or day of the week.
- It should also be noted that no significantly greater consumption fluctuations occur at weekends.
- The power consumption of the individual devices does not depend on the topology in which they are used.
- The readings obtained are approximately equivalent to 30% of the specifications indicated in the product descriptions.

Comparison, B&H

The table below shows the components used in the Basler & Hofmann network:

Model	Indicated power	Measured power
Micro-repeater		3W
Media converter		6W
Catalyst 2802 switch	110W	40W
Catalyst 2901 switch	264W	80W
CISCO 2503 router	40W	15W
CISCO 2514 router	40W	15W
IDNX multiplexer	400W	110W
Echo cancellor		12W

In connection with these comparisons it should be noted that the components are not completely installed, but the power supply is indicated for completion installation.

Comparison of power, Basler & Hofmann

Work-desk devices	30.0 kW, 10 hrs/day operation
Servers	1.5 kW, 24 hrs/day operation
Active components	2.3 kW (specified), 24 hrs/day operation
Active components	1.0 kW (measured)

Since work-desk devices are switched off at night, their operating time is reduced, and their energy consumption is correspondingly lower.

The proportion of the network components in the Basler & Hofmann network that was tested is equivalent to around 15% of the total annual consumption of the network.

Significance

Throughout Switzerland, operators of networks should be made increasingly aware of the annual energy consumption of network components. This means

that the application of energy management systems in networks should be more actively promoted.

4.2 Weekly measurement (SIG)

Explanations

Measurement 4

For cost reasons, Teleinform was unable to carry out daily measurements. No EMU devices were used in Geneva for cross-comparison purposes.

Comparison, SIG

The table below shows the components used in the Service Industriels de Genève network

Mode 1	Indicated power	Measured power
ATM switch	300/600W (redundant power supply)	130W
Bay model	950W	170W

Results, SIG network

Power consumption

The results of the measurements were as follows:

- The power consumption of the devices in permanent operation remains practically constant, regardless of the data-flow quantities, time of day or day of the week.
- It should also be noted that no significantly greater consumption fluctuations occur at weekends.
- The power consumption of the individual devices does not depend on the topology in which they are used.

The readings obtained are approximately equivalent to a quarter to a third of the specifications indicated in the product descriptions. With the Bay 5000 DN, the difference between specified and measured power is even more pronounced.

Measurement 1

Basler & Hofmann (Rehalp, EDP centre)

Measurement 2

Basler & Hofmann (Rehalp, PABX centre)

Measurement 3

Basler & Hofmann (Esslingen, EDP centre)

Measurement 4

Service industriels de Genève (computer centre)

5. Implementation

Data

The measurement data should be submitted to the two manufacturers (Cisco and Bay) for examination and evaluation purposes. In the same connection, the manufacturers should also be queried about possible developments. Should any relevant power variations exist between the manufacturers, a labelling procedure could be introduced in the same way as for end devices. Components which meet the criteria would be awarded a quality label, which would enhance transparency on the market.

6. Acknowledgements

Swiss Federal Office of Energy

At this juncture we wish to thank the Swiss Federal Office of Energy as principal for incorporating Basler & Hofmann into this project.

Teleinform

We would also like to thank Teleinform for its valuable assistance in connection with the various measurements carried out on the B&H network.

Support group

We received valuable tips and assistance from Messrs R. Bruniger and A. Huser.

Appendices

A **Diagram: Topology of B&H network**

B **Diagram: Topology of SIG network**