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# Measuring ICT

To know your energy consumption you need to know

- How many units do you have?
- Which types are they ?
- How are they used ?

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- In large networks it can be hard to know how many units of different types there are
- But the hardest question is how they are used
- You need to measure !

- You can use software in computers
  But how to measure other types of equipment?
- You can probe the net with Ping
  But that is slow and have a negative impact on your network

# Address Resolution Protocol

- ARP is used by network switches on a low level (OSI level 2) to determine what machines are on the network and where they are
- Every network switch maintains an ARP-table containing addresses to all units attached to it
- The ARP table is updated frequently and contain only active units. Turned off units disappear
- Switches communicate ARP-tables between them
- In most networks there are one or a few switches that together has ARP-tables of all connected units

# Simple Network Management Protocol and Domain Name System

- SNMP is a way of controlling network equipment
- Using SNMP we can download ARP tables from switches with zero impact on network performance

  Meaning we can download ARP-tables from the entire network frequently without disturbing anyone
- DNS can resolve addresses in ARP-tables into names

# So we made an app

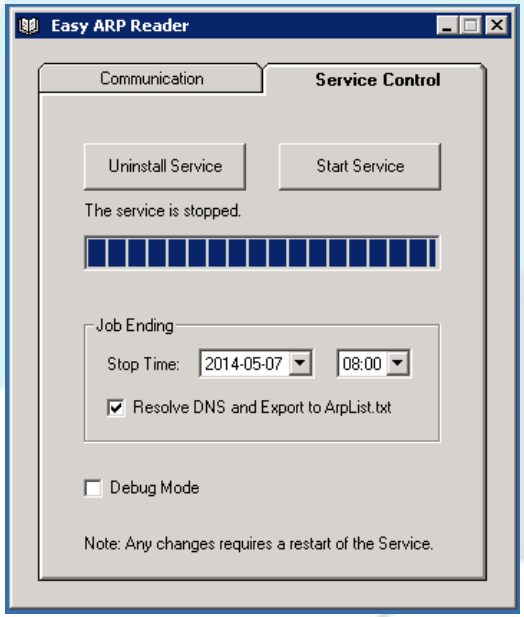
- Runs in a server, typically for 24 hours
- Downloads ARP-tables covering the entire network every half hour
- Stores everything into a database
- When the run ends the app counts how many “halfhours” each machine has been active
- Using DNS it resolves all addresses into names, and creates an output file

# Output file

In our network typically 14 000 units are found, meaning this file has 14 000 rows

Start: 2014-05-06 16:08
Stop: 2014-05-07 08:00

| IpAddress | MacAddress | SeenTimes | DnsName |
|---|---|---|---|
| 148.136.100.10 | 78 ac c0 9f eb 32 | 32 | e21886.adm.linkoping.se |
| 148.136.100.11 | 2c 41 38 9c c0 3d | 32 | e25791.adm.linkoping.se |
| 148.136.100.12 | 30 e4 db 45 4e 41 | 32 | rputlanhagby.adm.linkoping.se |
| 148.136.100.13 | 18 a9 05 33 80 d1 | 32 | e16453.adm.linkoping.se |
| 148.136.100.134 | 00 05 7c 00 18 fc | 32 | n/a |
| 148.136.100.14 | 78 e7 d1 c5 63 75 | 32 | e21226.adm.linkoping.se |
| 148.136.100.140 | 00 21 f7 fd cb 0c | 32 | n/a |
| 148.136.100.141 | 08 2e 5f 00 93 ad | 32 | e22292.adm.linkoping.se |
| 148.136.100.142 | 00 21 f7 fd cb 09 | 32 | n/a |
| 148.136.100.143 | 00 21 f7 fd cb 0d | 32 | n/a |
| 148.136.100.144 | 10 60 4b 6d 2d 7d | 32 | e28788.adm.linkoping.se |
| 148.136.100.145 | 00 21 f7 fd ca ae | 32 | n/a |
| 148.136.100.146 | 00 21 f7 fd ca cf | 32 | n/a |
| 148.136.100.147 | 00 21 f7 fd cb 0a | 32 | n/a |
| 148.136.100.148 | 00 14 c2 a0 ed 9b | 32 | n/a |
| 148.136.100.149 | 2c 41 38 b7 ad ae | 32 | e22285.adm.linkoping.se |
| 148.136.100.15 | d8 9d 67 96 8f eb | 32 | e29033.adm.linkoping.se |
| 148.136.100.150 | 00 21 f7 fd cb 00 | 32 | n/a |
| 148.136.100.151 | 2c 41 38 b6 bb a1 | 32 | e22289.adm.linkoping.se |
| 148.136.100.152 | 2c 27 d7 1c 12 25 | 32 | e23403.adm.linkoping.se |
| 148.136.100.153 | 00 21 f7 fd cb 14 | 32 | n/a |
| 148.136.100.154 | 18 a9 05 b8 53 71 | 32 | e19705.adm.linkoping.se |
| 148.136.100.155 | 2c 27 d7 1b cf 9b | 32 | e23336.adm.linkoping.se |
| 148.136.100.156 | 2c 41 38 b5 b1 07 | 32 | e22288.adm.linkoping.se |
| 148.136.100.157 | 10 60 4b 5d da 70 | 32 | e24962.adm.linkoping.se |
| 148.136.100.158 | e8 39 35 52 e6 5c | 32 | e24431.adm.linkoping.se |
| 148.136.100.159 | 2c 41 38 b5 b4 c9 | 32 | e22287.adm.linkoping.se |
| 148.136.100.16 | 78 e7 d1 c7 c9 c1 | 32 | e21231.adm.linkoping.se |
| 148.136.100.160 | 08 2e 5f 07 49 82 | 32 | e22290.adm.linkoping.se |
| 148.136.100.161 | 18 a9 05 35 28 23 | 32 | t4728.adm.linkoping.se |
| 148.136.100.162 | 18 a9 05 85 95 b6 | 32 | e19081.adm.linkoping.se |
| 148.136.100.163 | 2c 41 38 b4 64 11 | 32 | e22295.adm.linkoping.se |

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# The output file is imported to Excel

- Link
- Due to our naming conventions we now that names starting with
  - E….. is a PC
  - T….. is a thin client
  - NPI.. is a printer
  - ……and so on
- Using that we can do some counting in Excel
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# When count and usage is known, it's simple math

- Our PC with monitor consumes in average 85 Watt
- In this example we had 6351 PC's with an average usage of 7,3 hours per day
- 6351 x 7.3 x 85 = 3940795,5
- Gives:
  - Energy 3941 kWh per day
  - Cost 247 Euro per day
  - Emissions: 1,5 Kg Co2 emitted per day

# Accuracy Pro’s

- We get good values for usage and count
- With several runs at different seasons we get good average values
- Can measure all kinds of units with an IP-adress
  - Printers, IP-phones, battery operated units on Wireless LAN
- Equipment in sleep-mode are omitted, as they fall out of the ARP-tables
- We can measure at different seasons and see trends and variations

# Accuracy Con’s

- Can only distinguish units with clear name differences e.g. different kinds of PC get clumped together
- Portable PC’s that move between network segments during the measuring period will be partly missed
- Some equipment can’t be identified by name
- Some equipment in sleep mode are still active on the net, and therefore get registered as “in use” in ARP-tables

# Report

- We measured energy consumption for common types of equipment in our network using simple home market energy meters.
  Results was calculated into average numbers
- Co2 emissions by production of electrical power is calculated and published every second year by Swedish authorities
- We did several measurements of count and usage to get good averages
- We used the GDC reporting tool to summarize it all
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