D4.4 Final WP4 report on JEA4.1

Grant Agreement Number:	**257740**
Project Acronym:	**TREND**
Project Title:	**Towards Real Energy-efficient Network Design**
Funding Scheme:	Network of Excellence
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Due Date of Delivery:	M36 (30/11/2013)
Actual Date of Delivery:	22/12/2013
Workpackage:	WP4 : Instrumenting the network for power saving
Nature of the Deliverable	R
Dissemination level	PU
Editors:	Ivaylo Haratcherev

Abstract:

WP4 coordinates experimental activities, with implementation and testing of the technologies and procedures studied in the project. This report covers the progress made in JEA4.1 during the last (third) year of the project.

Keyword list: yearly, final, activities, experimental, joint experimental activity

Disclaimer

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Table of Contents

Executive Summary

This document presents the final yearly report for WP4 of TREND. TREND is a Network of Excellence (NoE) funded by the Seventh Framework Programme of the European Commission (FP7/2007-2013) under grant agreement n. 257740. The aim of the NoE is to assess and reduce the energy consumption of telecommunication networks.

This document contains the final progress report for JEA4.1 in WP4. It also contains a record of produced papers.

The first joint experimental activity of WP4 has been focused on creating an elaborate tool for measuring and collecting energy consumption and utilization data for various network devices. The tool, named TREND-Meter, also consolidates the data, and provides public web interface to access the measurements database.

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Task 4.1 and JEA4.1 (TD 4.1): Development of a tool for monitoring and controlling the power consumption of networking infrastructures

Partners: ALBLF, IHU, UTH, POLITO, TUB

Summary: During this activity, we have developed a tool, called TREND-meter [1], to measure power consumption and utilization of different networking devices. The tool description and a set of results is reported in the D4.3 Second WP4 yearly report. During the last year of this activity, we have increased the set of monitored devices, we have integrated the Trend-meter with two software tools used for network monitoring, and we have published a paper in an international journal.

Results:

The main goal of the Trend-Meter is to collect data of power consumption and utilization from a variety of devices connected to the Internet: a centralized server gets measurements from the devices hosted in different TREND partners' locations. As a second goal, the TREND-meter aims at consolidating these measurements to study whether there are similarities in the patterns of power and utilization of the devices. Additionally, collected data from the TREND-meter is made publicly available, with friendly graphical representation of the information. The architecture is composed of three main units: a device back-end for collecting the measurements, a server back-end collecting and storing the information from all the devices, and a server front-end to display the information on a web site.

During the last year of this activity we have added a femtocell to the set of monitored devices. The femtocell is located in the laboratory of Alcatel Lucent Bell Labs France. It is a modified variant of a commercially available 3G femtocell. The additional functionality of this enhanced version includes real-time power self-estimation and standby mode capabilities. It also supports remote power monitoring and control via different interfaces – one directly to the TREND-meter, and another one via the local web server. More information about the "green" femto can be found in Section 2.2 of deliverable D4.5

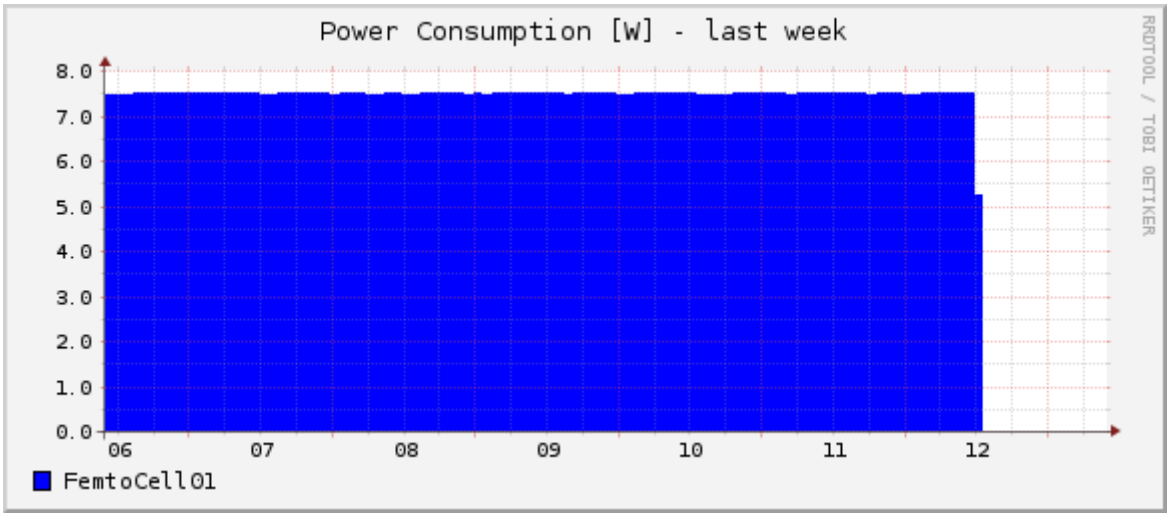

Fig.1: Power consumption variation of the femtocell. Days of the week are reported in the x axis.

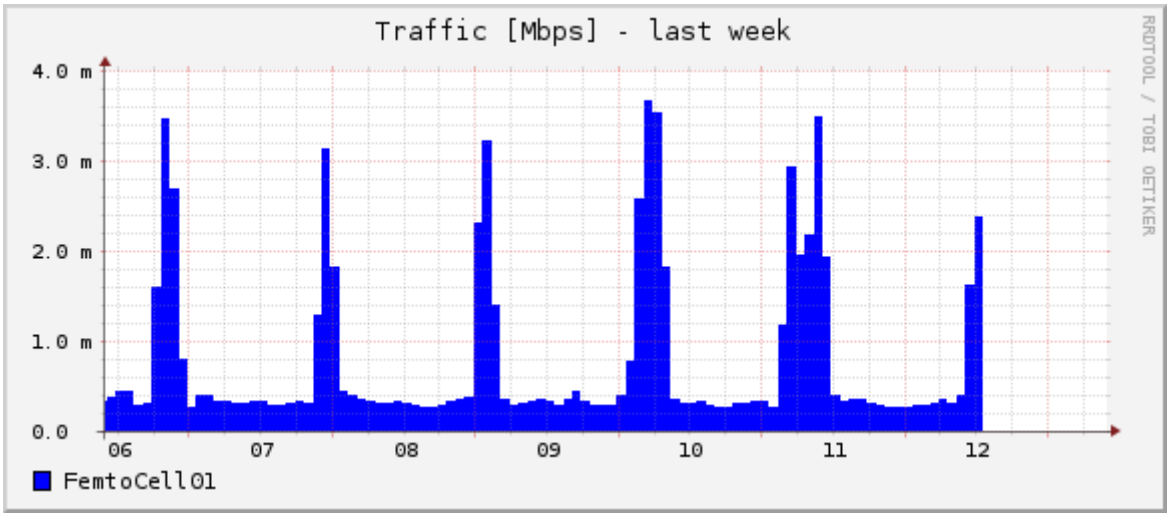

Fig.2: Traffic variation on the femtocell. Days of the week are reported on the x axis.

Fig.1 and Fig.2 report the results available on the TREND-meter web site (http://www.trend.polito.it). While traffic changes during the day, the power consumption is almost constant (in the case without dynamic power-control). This should trigger network manufacturers to deploy more energy proportional devices.

Integration of the TREND-Meter with Existing Monitoring Tools

Network monitoring is one of the main capabilities that need to be included in any network management platform. Existing network monitoring software tools control many features, such as traffic levels, hardware and applications states. However, little attention is paid to monitoring the power consumption of network devices. At the same time, the TREND-meter lacks detailed measurements on device utilization which are instead available in existing monitoring systems. The goal of this activity has been to integrate the TREND-meter software with existing monitoring tools. In particular, we have selected Nagios and Spiceworks due to their popularity as monitoring tool.

Integration with Nagios

We have divided the work into two main tasks:
a) implementation of the TREND-meter plugin to export data into the Nagios format; b) integration of the exported data inside Nagios.

Fig. 3 reports a schematic description of the architecture. Nagios runs the TREND-meter plugin whenever there is a need to check the status of one of the devices monitored by the TREND-meter. The TREND-meter plugin then interacts with the TREND-meter database to retrieve the information on the device status.

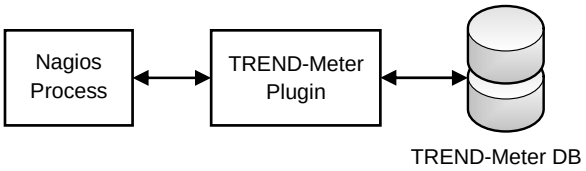

Fig.3 Block diagram of the architecture. The TREND-meter plugin exports the data from the TREND-meter DB to the Nagios process

Host	Service	Status	Last Check	Status Information
DataCenterIHU	Power Consumption [W]	OK	08-09-2013 16:33:45	11271.6620521173
	Utilization [Mbps]	OK	08-09-2013 16:34:34	0.10742468485342
Femtocell	Power Consumption [W]	WARNING	08-09-2013 16:32:23	0
	Utilization [Mbps]	WARNING	08-09-2013 16:33:58	0
PCPoli	Power Consumption [W]	OK	08-09-2013 16:32:47	26.8484848484848
	Utilization [Mbps]	OK	08-09-2013 16:34:36	0.00237066666666667
PolitoSubnet	Power Consumption [W]	OK	08-09-2013 16:34:12	3075
	Utilization	OK	08-09-2013 16:36:01	1.4734725
SWRouter	Power Consumption [W]	OK	08-09-2013 16:34:50	169.534125576765
	Utilization [Mbps]	OK	08-09-2013 16:36:26	0.563535235294118
routerRoma	Power Consumption [W]	WARNING	08-09-2013 16:32:45	0
	Utilization [Mbps]	WARNING	08-09-2013 16:34:20	0

Fig.4 Graphical interface inside Nagios showing the data from the Trend-meter

The data retrieved by the TREND-meter has been integrated inside Nagios. In particular, the information about power consumption and load is stored, together with the status of each device (on/off). This information is then processed inside Nagios in order to obtain consolidated results, like charts and alerts. An example of output is reported in Fig.4. In this case, Nagios displays warnings for the measurements that are not available. Additionally, the value of power consumption and utilization is stored in the status information.

In the following, we report the code of the script to export the data from the TREND-meter.

```
#!/bin/bash
PROGNAME=`basename $0`
PROGPATH=`echo $0 | sed -e 's,[\\/][^\\/][^\\/]*$,,'`
REVISION="1.0"
STATE_OK=0;
STATE_WARNING=1;
STATE_CRITICAL=2;
STATE_UNKNOWN=3;

print_usage() {
  echo "Usage:"
  echo "  $PROGNAME --help"
  echo "  $PROGNAME --version"
}
print_help() {
```

```
  print_revision
  echo ""
  print_usage
  echo "help for the command"
}
print_revision() {
  echo $PROGNAME $REVISION
}
#function to display the power
print_power() {
  case "$1" in
  router)
          ret_value=`cat /home/nagios/measurements/Nagios_RouterRoma.txt | cut -d ' ' -f1`;
          ;;
  pc)
          ret_value=`cat /home/nagios/measurements/Nagios_PCPoli.txt | cut -d ' ' -f1`;
          ;;
  swrouter)
          ret_value=`cat /home/nagios/measurements/Nagios_SWRouter.txt | cut -d ' ' -f1`;
          ;;
  datacenter)
          ret_value=`cat /home/nagios/measurements/Nagios_DataCenterUTH.txt | cut -d ' ' -f1`;
          ;;
  femtocell)
          ret_value=`cat /home/nagios/measurements/Nagios_FemtoCell01.txt | cut -d ' ' -f1`;
          ;;
  subnet)
          ret_value=`cat /home/nagios/measurements/Nagios_PoliToSubnet.txt | cut -d ' ' -f1`;
          ;;
  *)
          exit $STATE_CRITICAL
          ;;
  esac
  echo $ret_value
  if [ $ret_value == 0 ]
          then exit $STATE_WARNING
  fi

}

#function to display the traffic
print_traffic() {
  case "$1" in
  router)
          ret_value=`cat /home/nagios/measurements/Nagios_RouterRoma.txt | cut -d ' ' -f2`;
          ;;
  pc)
          ret_value=`cat /home/nagios/measurements/Nagios_PCPoli.txt | cut -d ' ' -f2`;
          ;;
  swrouter)
          ret_value=`cat /home/nagios/measurements/Nagios_SWRouter.txt | cut -d ' ' -f2`;
          ;;
```

```
  datacenter)
          ret_value=`cat /home/nagios/measurements/Nagios_DataCenterUTH.txt | cut -d ' ' -f2`;
          ;;
  femtocell)
          ret_value=`cat /home/nagios/measurements/Nagios_FemtoCell01.txt | cut -d ' ' -f2`;
          ;;
  subnet)
          ret_value=`cat /home/nagios/measurements/Nagios_PoliToSubnet.txt | cut -d ' ' -f2`;
          ;;
  *)
          exit $STATE_CRITICAL
          ;;
  esac
  echo $ret_value
  if [ $ret_value == 0 ]
          then exit $STATE_WARNING
  fi
}
# Information options
case "$1" in
--help)
                    print_help
    exit $STATE_OK
    ;;
-h)
                    print_help
    exit $STATE_OK
    ;;
--version)
                    print_revision
    exit $STATE_OK
    ;;
-V)
                    print_revision
    exit $STATE_OK
    ;;
--power)
                    print_power $2
    exit $STATE_OK
    ;;
-P)
                    print_power $2
    exit $STATE_OK
    ;;
--traffic)
                    print_traffic $2
    exit $STATE_OK
    ;;
-T)
                    print_traffic $2
    exit $STATE_OK
    ;;
```

```
esac

exit $STATE_CRITICAL
```

Finally, we report also the configuration file used inside Nagios to identify the devices.

```
##############################################################################

##############################################################################

#

# HOST DEFINITIONS

#

##############################################################################

##############################################################################


define command{

        command_name            check_trend_meter

        command_line            /usr/local/nagios/libexec/check_trend_meter '$ARG1$' '$ARG2$'

        }




# Define a host for the printer we'll be monitoring

# Change the host_name, alias, and address to fit your situation


define host{

        use generic-host                                ;

        host_name   routerRoma                          ;

        alias                   Router at UniRoma                ;

        hostgroups  TREND-meters                        ;

        max_check_attempts 1                            ;

        }


define host{

        use generic-host                                ;
```

```
        host_name   PCPoli                          ;
        alias               PC at Politecnico               ;
        hostgroups  TREND-meters                    ;
        max_check_attempts 1                        ;
        }


define host{
        use generic-host                            ;
        host_name   SWRouter                        ;
        alias               Software Router at Unigenova                ;
        hostgroups  TREND-meters                    ;
        max_check_attempts 1                        ;
        }
define host{
        use generic-host                            ;
        host_name   DataCenterIHU                           ;
        alias               Datacenter at IHU               ;
        hostgroups  TREND-meters                    ;
        max_check_attempts 1                        ;
        }
define host{
        use generic-host                            ;
        host_name   Femtocell                       ;
        alias               Femtocell at ALBLF              ;
        hostgroups  TREND-meters                    ;
        max_check_attempts 1                        ;
        }
define host{
        use generic-host                            ;
        host_name   PolitoSubnet                            ;
```

```
        alias                   Subnet at Politecnico           ;
        hostgroups  TREND-meters                        ;
        max_check_attempts 1                            ;
        }

################################################################################
################################################################################
#
# HOST GROUP DEFINITIONS
#
################################################################################
################################################################################


define hostgroup{
        hostgroup_name          TREND-meters                    ; The name of the hostgroup
        alias                   TREND-Meters Devices    ; Long name of the group
        }

################################################################################
################################################################################
#
# SERVICE DEFINITIONS
#
################################################################################
################################################################################



define service{
        use generic-service                                     ;
        host_name               routerRoma                      ; The name of the host the service is associated with
        service_description      Power Consumption  [W]         ; The service description
```

```
        check_command                   check_trend_meter!-P!router         ; The command used to monitor the service
        normal_check_interval   5       ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1       ; Re-check the service every minute until its final/hard state is determined
        }


define service{
        use generic-service                                 ;
        host_name               PCPoli                      ; The name of the host the service is associated with
        service_description      Power Consumption  [W]     ; The service description
        check_command                   check_trend_meter!-P!pc ; The command used to monitor the service
        normal_check_interval   5       ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1       ; Re-check the service every minute until its final/hard state is determined
        }
define service{
        use generic-service                                 ;
        host_name               SWRouter                    ; The name of the host the service is associated with
        service_description      Power Consumption  [W]     ; The service description
        check_command                   check_trend_meter!-P!swrouter       ; The command used to monitor the service
        normal_check_interval   5       ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1       ; Re-check the service every minute until its final/hard state is determined
        }
define service{
        use generic-service                                 ;
        host_name               DataCenterIHU                               ; The name of the host the service is associated with
        service_description      Power Consumption  [W]     ; The service description
        check_command                   check_trend_meter!-P!datacenter     ; The command used to monitor the service
        normal_check_interval   5       ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1       ; Re-check the service every minute until its final/hard state is determined
        }
define service{
```

```
        use generic-service                                     ;
        host_name               PolitoSubnet                                    ; The name of the host the service is associated with
        service_description      Power Consumption  [W]             ; The service description
        check_command                   check_trend_meter!-P!subnet         ; The command used to monitor the service
        normal_check_interval   5           ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1           ; Re-check the service every minute until its final/hard state is determined
        }
define service{
        use generic-service                                     ;
        host_name               Femtocell                       ; The name of the host the service is associated with
        service_description      Power Consumption [W]              ; The service description
        check_command                   check_trend_meter!-P!femtocell      ; The command used to monitor the service
        normal_check_interval   5           ; Check the service every 5 minutes under normal conditions
        retry_check_interval    1           ; Re-check the service every minute until its final/hard state is determined
        }

define service{
        use generic-service                                                     ;
        host_name               routerRoma                                      ;
        service_description      Utilization [Mbps]     ;
        check_command                   check_trend_meter!-T!router                     ;
        normal_check_interval   5                                               ;
        retry_check_interval    1                                               ;
      }
define service{
        use generic-service                                                     ;
        host_name               PCPoli                                          ;
        service_description      Utilization [Mbps]     ;
        check_command                   check_trend_meter!-T!pc             ;
        normal_check_interval   5                                               ;
```

```
        retry_check_interval    1                                               ;
    }
define service{
        use generic-service                                                     ;
        host_name               SWRouter                                        ;
        service_description      Utilization [Mbps]     ;
        check_command                   check_trend_meter!-T!swrouter           ;
        normal_check_interval   5                                               ;
        retry_check_interval    1                                               ;
    }
define service{
        use generic-service                                                     ;
        host_name               DataCenterIHU                                                   ;
        service_description      Utilization [Mbps]     ;
        check_command                   check_trend_meter!-T!datacenter         ;
        normal_check_interval   5                                               ;
        retry_check_interval    1                                               ;
    }
define service{
        use generic-service                                                     ;
        host_name               PolitoSubnet                                                    ;
        service_description      Utilization            ;
        check_command                   check_trend_meter!-T!subnet             ;
        normal_check_interval   5                                               ;
        retry_check_interval    1                                               ;
    }
define service{
        use generic-service                                                     ;
        host_name               Femtocell                                       ;
        service_description      Utilization [Mbps]     ;
```

```
        check_command                   check_trend_meter!-T!femtocell          ;
        normal_check_interval   5                                               ;
        retry_check_interval    1                                               ;
    }
```

Integration with Spiceworks

During this activity, we have integrated the measurements performed by Spiceworks in the TREND-meter tool. In particular, we have implemented a script which automatically exports the Spiceworks measurements inside the TREND-meter.

In particular, we have exploited the script run_report.rb available in Spiceworks to send the raw measurements to the TREND-meter server. The syntax is the following one:

..\bin\ruby run_report.rb -e <usernname spiceworks> -p <password spiceworks> -f csv 4

pscp -pw <password server trend-meter> report-4.csv trend@trend.polito.it: /home/trend/Data/UNIROMA-2/raw-data

In this way, a .csv file including all the measurements from Spiceworks is created and sent to the TREND-meter server. The script is automatically executed every 5 minutes in background.

Then, in the TREND-meter back-end, we have coded a script to parse the .csv file and to insert the data inside the database. Currently, Spiceworks is monitoring a printer inside the Department of the University of Rome. However, since neither power nor utilization are measured by Spiceworks, the only information available is the status of the printer (on, off or idle).

Papers

Published papers

Involved partners	Authors	Title	Conference/ Journal	Presentation/ publication date
CNIT, UTH, IHU	Luca Chiaraviglio, Roberto Bruschi, Antonio Cianfrani, Olga Maria Jaramillo Ortiz, George Koutitas	The TREND Meter: Monitoring the Energy Consumption of Networked Devices	International Journal of Business Data Communications and Networking (IJBDCN), IGI Global, special issue on "Green Networking and Computing	On press, 2013
ALBLF, POLITO, TUB, CNIT	Ivaylo Haratcherev, Michela Meo, Yi Zhang, Yige Hu, Alberto Conte, Filip Idzikowski, Lukasz Budzisz, Fatemeh Ganji, Raffaele Bolla, Olga Jaramillo, Roberto Bruschi, Antonio Cianfrani, Luca Chiaraviglio, Angelo Coiro, Roberto Gonzalez, Carmen Guerreo, Edion Tego, Francesco Matera, Stratos Keranidis, Giannis Kazdaridis,	*The TREND Experimental Activities on "green" Communication Networks*	The 24th Tyrrhenian International Workshop on Digital Communications, Genoa, Italy	September 2013.

	Thanasis Korakis			

Planned (or submitted) papers

Involved partners	Authors (if known)	Title / Topic	Conference/ Journal	Planned date
-	-	-	-	-

Mobility

Past mobility

Involved partners	Person	Topic	Period
-	-	-	-

References

[1] L. Chiaraviglio, R. Bruschi, A. Cianfrani, O. Jaramillo Ortiz, G. Koutitas, *The TREND Meter: Monitoring the Energy Consumption of Networked Devices*, International Journal of Business Data Communications and Networking (IJBDCN), IGI Global, special issue on "Green Networking and Computing," on press, 2013.