Scientific Report

First name / Family name	Luca Chiaraviglio
Nationality	Italian
Name of the *Host Organisation*	INRIA
First Name / family name of the *Scientific Coordinator*	David Coudert
Period of the fellowship	03/09/2012 to 02/03/2013

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The research activities were focused on the reduction of the overall power consumption of the Internet architecture. We have first focused on the definition of analytical models to precisely characterize the impact of sleep modes in backbone networks [3]. The main outcome of this work is that sleep modes are effective in current and even in future networks, when more energy proportional devices will be deployed. We have then moved our attention to two case studies provided by telecom operators to compute the savings with a simple power aware algorithm with traffic and networks forecasts for 2020 [1]. Results show that huge energy savings will still be possible. Moreover, we have defined the technological issues for applying energy efficient policies in optical networks, and we have derived a global picture in this scenario [2]. In the following, we have then moved our attention to a realistic application of sleep modes to specific networks. In particular, we have assumed that the network can be reconfigured only few times per day, i.e. the set of devices in sleep mode might not consistently vary. We have then proved that at most three configurations per day are sufficient to achieve high energy savings, considering cellular networks [4] and core networks [5]. Finally, we have then proposed a new approach for the energy-efficient design of content distribution infrastructures managed by a telecom operator. In particular, we have designed a new algorithm to decide where to place content caches inside the network [6]. Results show that the savings obtained by caching the content inside the network can be huge, saving more than one million euro per year for a national operator.

The main achievements can be summarized as follows:
- 6 papers (2 accepted, 3 submitted and 1 in submission) with target top level conferences and journals in networking;
- interaction with the European project FP7 TREND. The link between INRIA and TREND has been established and enforced. In particular, Luca Chiaraviglio has performed 3 mobilities to other institutions of the project. Moreover, Luca Chiaraviglio and Frederic Giroire (an INRIA researcher) have attended two plenary meetings ot the project;
- plan for future cooperation. Thanks to the links established with the other partners, INRIA has submitted a proposal for a national French project in the field of energy-efficient networking, together with Orange – France Telecom.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. F. Idzikowski, L. Chiaraviglio, R. Duque, F. Jimenez, E. Le Rouzic, *Green Horizon: Looking at Backbone Networks in 2020 from the Perspective of Network Operators* , IEEE International Conference on Communications (ICC'13), Budapest, Hungary, June 2013.

2. E. Le Rouzic, E. Bonetto, L. Chiaraviglio, F. Giroire, F. Idzikowski, F. Jimenez, C. Lange, J. Montalvo, F. Musumeci, I. Tahiri, A. Valenti, W. Van Heddeghem, Y. Ye, A. Bianco, A. Pattavina, *TREND towards more energy-efficient optical networks*, The 17th International Conference on Optical Network Design and Modeling (ONDM 2013), Brest, France, April 2013.

3. L. Chiaraviglio, D. Ciullo, M. Mellia, M. Meo, *Modeling Sleep Mode Gains in Energy-Aware Networks*, submitted to Computer Networks.

4. M. Ajmone Marsan, L. Chiaraviglio, D. Ciullo, M. Meo, *On the Effectiveness of Base Station Sleep Modes in Cellular etworks*, submitted to Computer Networks.

5. L. Chiaraviglio, A. Cianfrani, E. Le Rouzic, M. Polverini, *Sleep Modes Effectiveness in Backbone*

Networks with Limited Configurations, submitted to Computer Networks.

6. L. Chiaraviglio, R. Modrzejewski, I. Tahiri, F. Giroire, E. Le Rouzic, E. Bonetto, F. Musumeci, R. Gonzales, C. Guerrero, *Energy Efficient Content Distribution in an Operator's Network*, in submission to IEEE Globecom 2013.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

Participation to the seminar organized by ERCIM. The seminar has been a good occasion to link with other fellows (even with different background) and to attend interesting talks.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Nothing to be added.