Improving Energy Efficiency in Greek Schools with IPv6-enabled Smart Meters

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Authors:	E. Varvarigos (CTI), K. Koumoutsos (CTI), M. Oikonomakos (CTI), V. Nikolopoulos (Intelen), E. Gioxi (Intelen), A. Zafeiropoulos (GRNET), V. Giannikopoulou (GRNET)

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Introduction

The Greek IPv6 pilot in schools aims to demonstrate that IPv6 could become the leveraging technology for enhancing existing services or providing new services to the end users. In the context of GEN6, this pilot investigates the benefits of establishing an advanced metering infrastructure over IPv4 and IPv6, and provides insights about the benefits of building IPv6 services.

This initial case study regards work in progress regarding the implementation of the Greek pilot within the framework of the GEN6 project (number 261584 – http://www.gen6.eu/home) that is co-funded by the European Commission under the ICT Policy Support Programme (PSP) as part of the Competitiveness and Innovation framework Programme (CIP).

GEN6 shares the view that a democratic European society, with a strong and productive economy, requires service-oriented, secure, reliable and innovative government at all levels. Such a government should not be based on population, should be location-independent, and used by all citizens (including the old, the young, those with disabilities and immigrants). Successful implementation of eGovernment can improve services, strengthen our societies, increase productivity and welfare, and reinforce democracy. This success will only be achieved by pursuing a long-term vision, with clear and sustainable objectives, constancy and persistence, and with participation of all stakeholders, including government, citizens and industry. GEN6 will contribute to these objectives in the area of communication and how to transition to IPv6 in the government area.

The Greek IPv6 pilot in Schools has been supported by the following public authorities, research organisations and commercial companies:

- The Computer Technology Institute & Press “Diophantus” (CTI Diophantus), under the supervision of the Minister of Education and Religious Affairs (www.minedu.gov.gr/), responsible for the administration and the daily operation of the Greek School Network, which provides advanced IT services to primary and secondary schools in Greece.

- The Greek Research & Technology Network (http://www.grnet.gr/, http://green.grnet.gr/), under the supervision of the Minister of Education and Religious Affairs (www.minedu.gov.gr/), responsible for providing networking and cloud computing services to the Greek academic and research communities.

- The Intelen Group (http://www.intelen.com/), a start-up company providing services to the energy and ICT sector, such as smart metering, meter data management, etc.

This pilot has been conducted as a response to recent statistics that indicate great potential for energy saving in Greece, in public infrastructures. Initial results from the pilot suggest a reduction of carbon footprint of more than 30%. Through the implementation of the Greek IPv6 pilot, the deployed infrastructure will be extended and many problems related with the use of IPv4 for access to the smart energy meters will be overcome. This extension will provide a signal to European stakeholders that IPv6 technology can be a “green” enabler.

This case study is of great relevance to the activities of the Green GÉANT Team (http://www.geant.net/Network/Environmental_Impact/Pages/home.aspx) and the efforts of the team members for the dissemination and the adoption of ‘green’ best practices from the National Research and Education Networks (NRENs). The technology applied in the case study and the conclusions that will be extracted from the final results may constitute a guide for the replication of the case study to a wider scale in the research and academic community in Europe.

School and Administrative Requirements

The selection of participating schools has been based on school geographical location and its characteristics (such as size, existing network connectivity). The selected schools are located across three adjacent prefectures (namely, Achaia, Korinthia and Attiki) within the Greek territory. Information registering schools' interest in pilot participation, as well as information regarding the number of students, the type of the school, IT infrastructure, as well as any related environmental activities has been collected through a detailed questionnaire.

Network Infrastructure Requirements

The basic architecture of the GSN Network operated by CTI is shown in Figure 1, below. The majority of schools in Greece (close to 95%), are connected to GSN (and thus to the Internet) using ADSL technology. There has also been significant growth in the number of schools connected to the Greek School Network (GSN) by using Ethernet technologies, mostly because GSN is currently trying to utilise as much of the optical Metropolitan Area Networks as possible, deployed by several municipalities across Greece in the previous years.

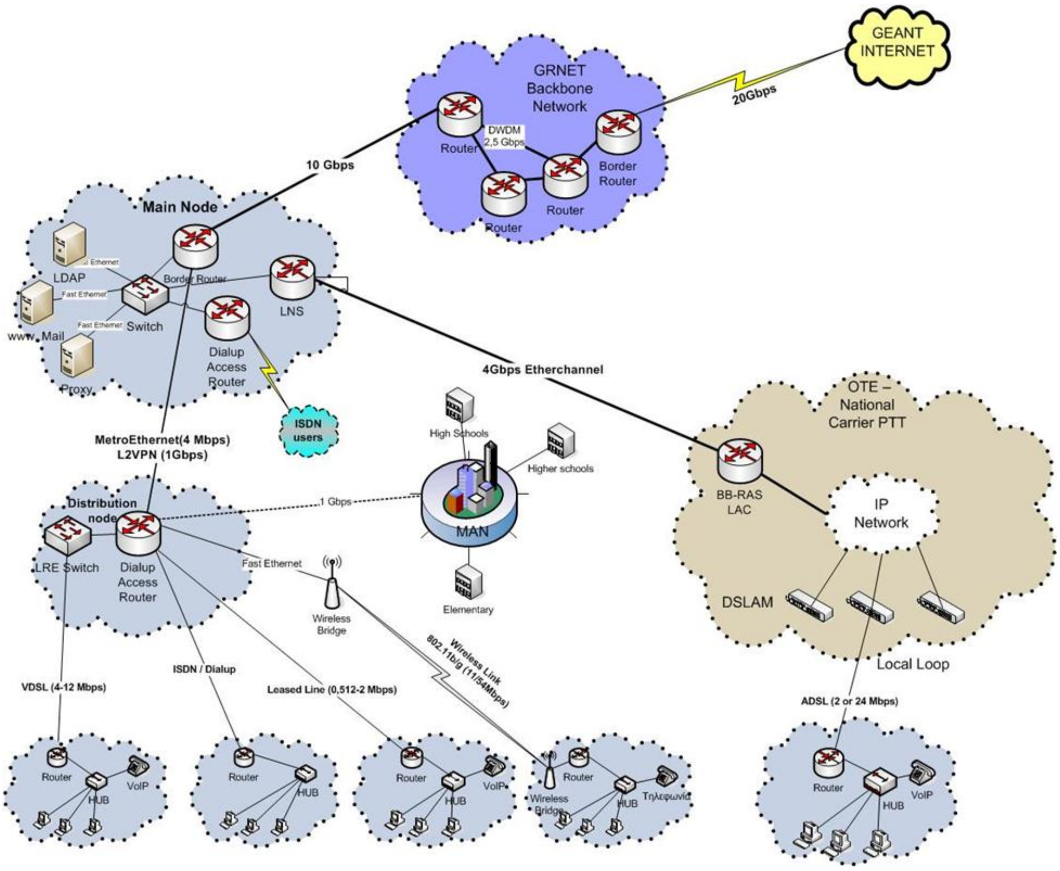

Figure 1: GSN Architecture

GSN has acquired one /47 and one /48 IPv6 address spaces from RIPE. The initial IPv6 addressing schema (subject to change in the near future) made by the GSN's NOC within CTI is: 2001:db8::1300/47 assigned to access network and 2001:db8::1302/48 assigned to backbone network.

The GSN backbone network is fully IPv6-enabled, and includes IPv6 support on all point-to-point (p2p) links of the primary and secondary nodes of GSN. Peering with GSN's ISP (GRNET) and the access network is also IPv6-enabled. On the access network, IPv6 has also been enabled for 95% of GSN users.

System and Data Management Requirements

Smart metering generally involves the installation of an intelligent meter, the regular reading and processing of energy-consumption data, and the provision of feedback on consumption data to the customer. A smart meter will track real-time or near real-time electricity use, local and remote access to the meter (on demand), remote limitation of the throughput through the meter, and interconnection to premise-based networks and devices.

The 'intelligence' of the meter is incorporated in the electricity meter. It has three basic functions: measuring the electricity used (or generated), remotely switching the customer offer and remotely controlling the maximum electricity consumption. The smart metering infrastructure in each building at the Greek IPv6 pilot consists of a consumption metering device (CMD) along with its current transformer (CT), a transmitter and the i-box. The i-box is a smart device that acts as a data bridge between the meter and the Internet, which is capable of supporting data analytics services [1].

Technical Details and Primary Results

The pilot includes the installation of IPv6-enabled smart energy meters to 50 schools in Greece, with the parallel upgrade of the existing networking infrastructure aiming to fully support the installation of IPv6-enabled smart meters, and the provision of IPv6 services to the GSN's end users. The installed smart energy meters within each school will clearly -in real time- illustrate to the students the correlation between their actions and energy consumption/CO_2 emissions of their schools, providing significant motivation for behavioural change. The main goal is to reduce the schools' energy bills and carbon footprint by at least 10% and to offer real-time energy efficiency services, over IPv6. Furthermore, the pilot focuses on positively affecting the students' behaviour and raising awareness of the potential of IPv6, as well as environmental issues.

The pilot provides an IPv6-only service, targeting end-users and stimulating the use of IPv6 as an easy way to support smart meters. In parallel to increased energy awareness of the school communities, IPv6 awareness will also increase, based on the proper dissemination of the selected technologies for the implementation of the pilot and the provision of direct access to the students for viewing real-time energy consumption data from the smart meters. The energy power meters installed in schools forward energy consumption data (over IPv6) to Intelen's cloud infrastructure. The cloud infrastructure integrates near-real-time stream analysis, while an interactive web platform allows secure access to energy consumption data (Figure 2).

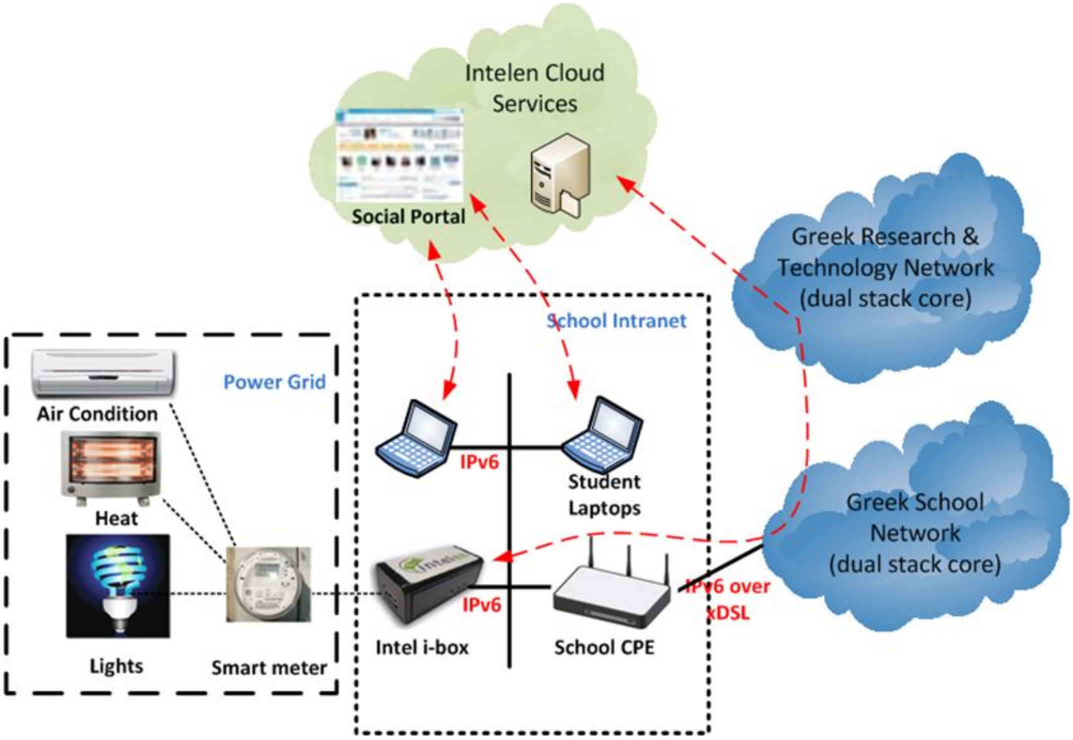

Figure 2: GSN Architecture

Based on the first-round of results from the initial deployment of smart meters to 10 (out of a total of 50) schools, the total energy power savings for these 10 school units over a period of 10 weeks was 12.234 KWh. The calculated monetary benefit is 3500€, when the electricity school price for energy unit is 12 cents per KWh. The extrapolated power saving per school year (40 weeks) is 48,936 KWh. The energy-saving (KWh) results from ten schools after ten weeks are presented in Table 1. Furthermore, Figure 3 and 4 provide indicative screenshots from the real-time energy consumption data collected through the developed cloud-based monitoring infrastructure, which will be displayed via a web portal: http://gen6.cti.gr/.

Real-time energy consumption data from all the participating pilot schools will be publicly available, while the full pilot deployment is going to be extended in order to cover all 50 schools. Upon finalisation of the installation phase of the pilot, analytical data for daily energy consumption, as well as energy consumption trends during different time periods will be presented (at present, data is only available for the summer period).

School Name	Power Saving
1st High School Haidariou	16,38%
8th Primary School Vyrona	18,51%
70th Primary School Athens	29,93%
10th Primary School Haidari	25,68%
7th High School Haidari	27,77%
152th Primary School Athens	29,43%
7th High School Peristeri	29,70%
8th Primary School Dafni	25,68%
1/7th Primary School Athens	24,02%
59th High School Peristeri	28,92%

Table 1: Power saving results from ten schools in the Athens area

Figure 3: Real-time energy consumption data from a smart meter

Figure 4: Interactive maps providing an overview of the installed smart meters

Conclusions

In this use case, an analysis regarding IPv6 as a “green” enabler in GSN, based on the initial installation of IPv6 power meters in ten schools spanning among three prefectures of Greece is made. The basic architecture of the deployment, as well as the main technologies used are described, focusing on the exploitation of IPv6 characteristics for the real-time management of the smart meters and the proper presentation of the collected data. Based on the initial results, it is shown that reduction in energy consumption up to 30% may be achieved in public schools in Greece. It is important to note that in addition to the installation and the management of the infrastructure, proper dissemination actions targeting at increasing the environmental awareness of the Greek school community are also considered crucial. In the upcoming period, the pilot implementation will be extended to 50 schools, and real-time energy consumption monitoring data will be collected for a longer time period. As a result, a follow-up study will be prepared in about 6 months presenting data regarding the achieved reduction in the energy consumption in public schools in Greece, as well as experiences from the engagement of the students in the entire process.

The successful implementation and dissemination of the results of the pilot may constitute a point of reference for wider implementation, targeting the reduction of energy consumption, based on the provision of IPv6-only services. In addition, such a solution could easily be repackaged to work in other locations, as the only hardware requirement is an IPv6-enabled smart energy meter, The basic steps that have to be followed in such a case include the design and implementation of a proper IPv6 address allocation scheme, the enablement of IPv6 support in the networking infrastructure, the selection and installation of IPv6-enabled smart meters and the development of the data management platform for dissemination purposes. Based on the achieved reductions in the energy consumption, environmentally-oriented advantages may be also combined with significant financial savings.

References

[1] GEN6 Project, D3.2: Requirements Analysis for "Power of 10", Available Online: http://www.gen6.eu/docs/deliverables/GEN6_PU_D3_2_v1_6.pdf