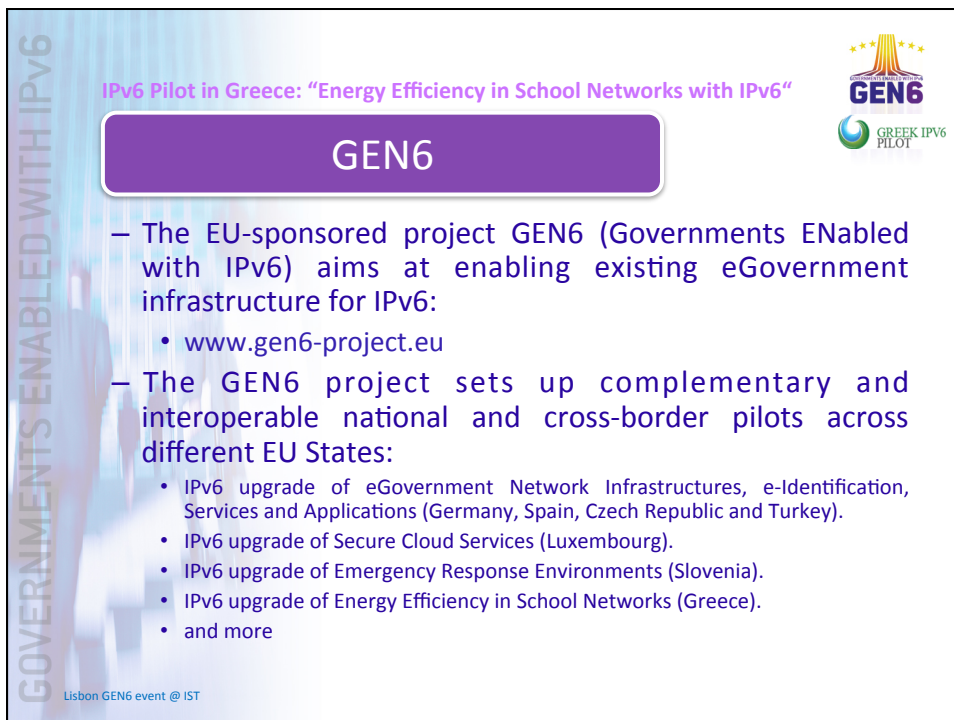




IPv6 upgrade for Energy Efficiency in School Networks



Vassilis Nikolopoulos, PhD
Intelen

Lisbon, GEN6 IST Event



IPv6 Pilot in Greece: "Energy Efficiency in School Networks with IPv6"

GEN6



- The EU-sponsored project GEN6 (Governments Enabled with IPv6) aims at enabling existing eGovernment infrastructure for IPv6:
 - www.gen6-project.eu
- The GEN6 project sets up complementary and interoperable national and cross-border pilots across different EU States:
 - IPv6 upgrade of eGovernment Network Infrastructures, e-Identification, Services and Applications (Germany, Spain, Czech Republic and Turkey).
 - IPv6 upgrade of Secure Cloud Services (Luxembourg).
 - IPv6 upgrade of Emergency Response Environments (Slovenia).
 - IPv6 upgrade of Energy Efficiency in School Networks (Greece).
 - and more

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IPv6 Pilot in Greece: "Energy Efficiency in School Networks with IPv6"

GEN6
GREEK IPv6 PILOT

Objectives of Greek Pilot

- **Prove IPv6** as a service enabler
- **Raise energy awareness**
- **Engage school communities**

IPv6



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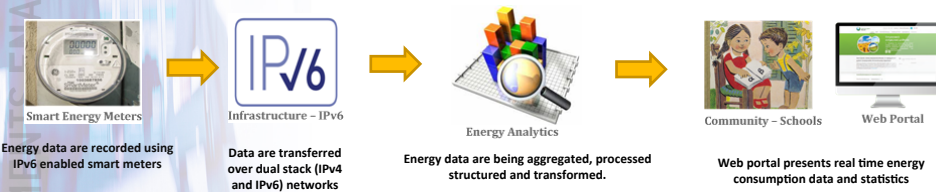
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GEN6
GREEK IPv6 PILOT

Pilot

The pilot provides real-time energy efficiency services over IPv6-enabled networks to the local educational community



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graph LR; A[Smart Energy Meters] --> B[Infrastructure - IPv6]; B --> C[Energy Analytics]; C --> D[Community - Schools / Web Portal];
```

Smart Energy Meters
Energy data are recorded using IPv6 enabled smart meters

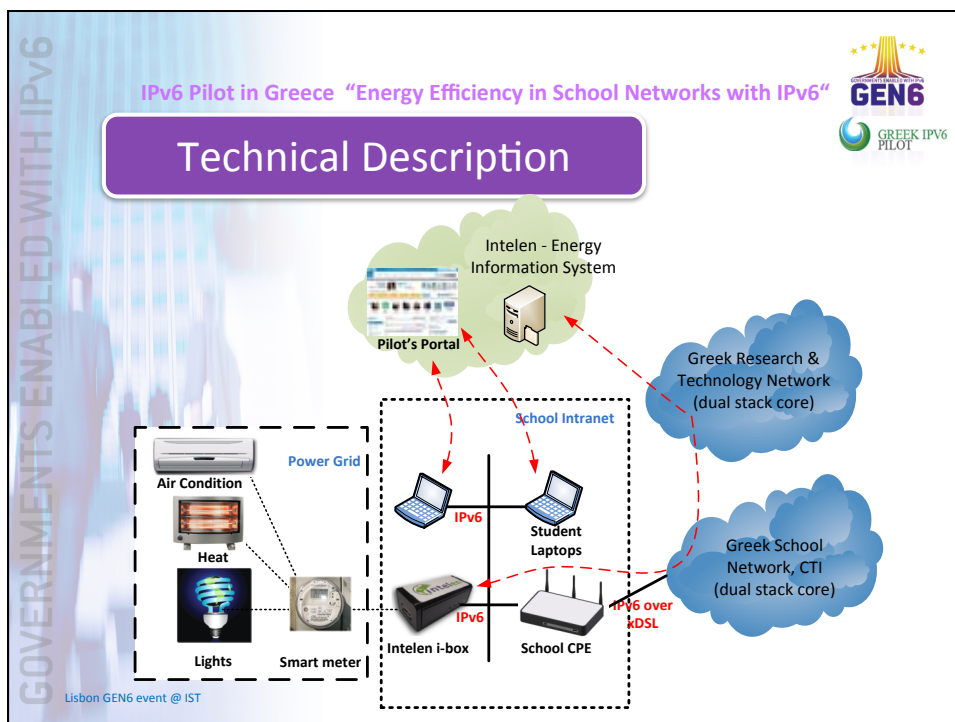
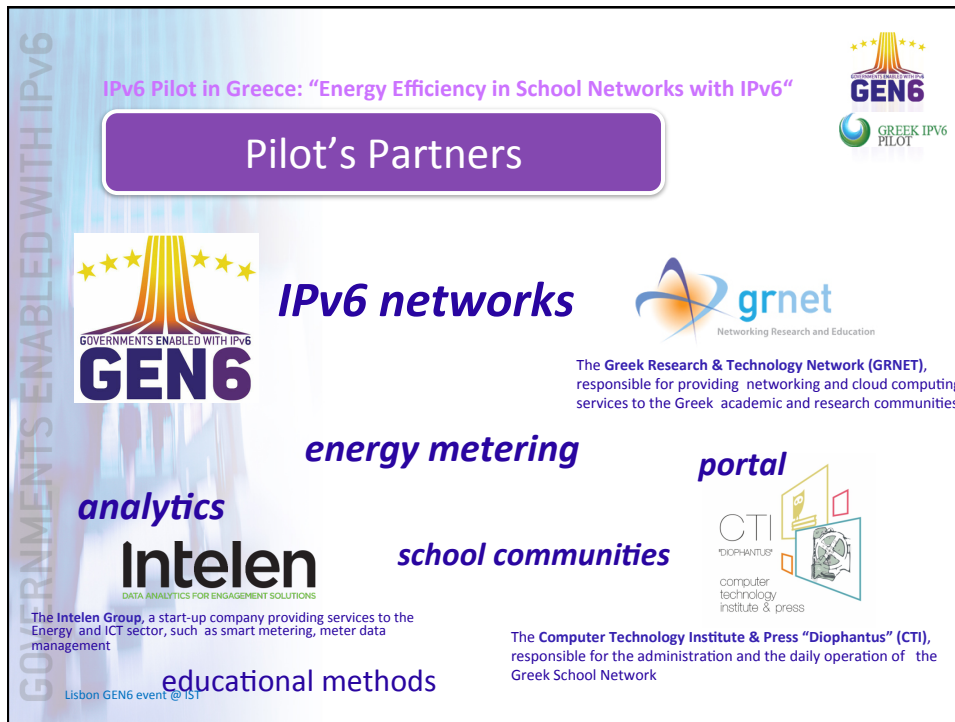
Infrastructure - IPv6
Data are transferred over dual stack (IPv4 and IPv6) networks

Energy Analytics
Energy data are being aggregated, processed structured and transformed.


Community - Schools
Web Portal
Web portal presents real time energy consumption data and statistics


50 schools , 11500 students

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IPv6 Pilot in Greece “Energy Efficiency in School Networks with IPv6”

Energy Metering

- The smart metering infrastructure consists of a consumption metering device and the i-box
- The i-box is a network device that acts as a data bridge between the power meter and the school’s router
- Both i-box and school router have IPv6 global address





Ποιοι δημόσιοι σχολείο Αθηνών
Ημερ. Έγκριτ: 09/10/2013
Εγκατάσταση: Λουκάς Ντράνης



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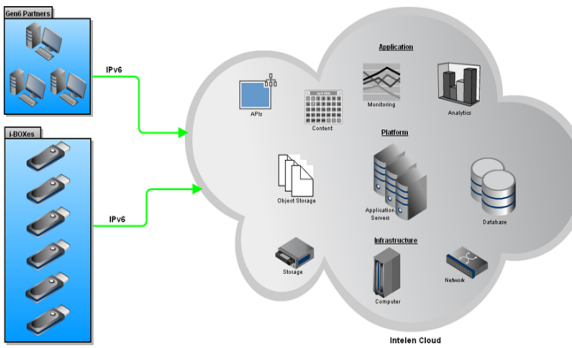


IPv6 Pilot in Greece “Energy Efficiency in School Networks with IPv6”

Energy Analytics



- Energy data are being aggregated, structured and transformed
- Energy data are also correlated with other data (other schools, school area, student count, etc.)
- Calculations and data mining algorithms are performed

Energy Information System in the cloud



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Networking Infrastructure

Backbone:
Based on 8 PoPs of GRNET

Distribution Network:
51 nodes
(8 main, 43 secondary)

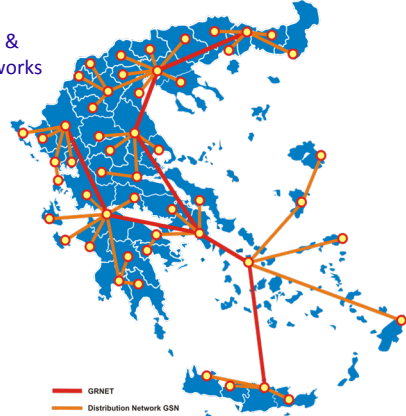
Access Network technology:

- ADSL
- Dialup (ISDN, PSTN)
- Leased Lines (SDSL, VDSL),
- Wireless
- Optical

Number of connected schools:

- 6k primary education
- 4k secondary education
- 0.5k administration offices



The GRNET backbone & GSN distribution networks are dual stack i.e. supporting both IPv4 and IPv6



www.sch.gr

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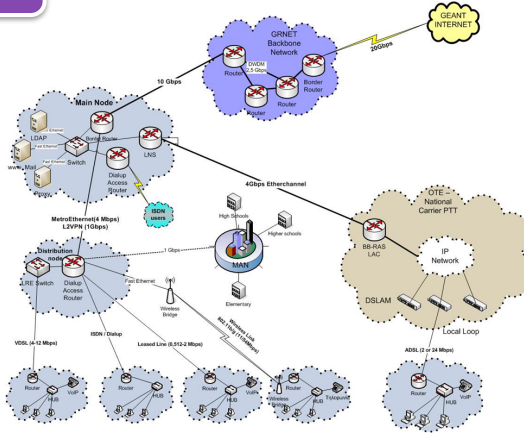
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Networking Infrastructure

- The GRNET backbone & GSN distribution networks are dual stack i.e. supporting both IPv4 and IPv6
- On the access network, IPv6 has also been enabled for 95% of GSN users



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Web Portal – gen6.cti.gr

GEN6 GREEK IPv6 PILOT

Home GEN6 Energy Consumption Educational Material Activities Contact

Energy consumption in schools

The purpose of the proposed action is the pilot installation of a recording system (smart energy meter) of 50 schools energy consumption in real time.

Real-time Monitoring of Energy Consumption into 50 Schools

In this context, the Greek pilot in GEN6, a European Commission funded project, aims to influence the behaviour of the local school communities by raising their energy awareness. As discussed herein, the pilot will provide real-time energy efficiency services over IPv6-enabled grids to the local educational community, providing students with information on their consumption patterns and raising awareness among them on the energy savings that behavioural changes may bring [More»](#)

“Energy and persistence conquer all things.” Benjamin Franklin

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IPv6 Pilot in Greece “Energy Efficiency in School Networks with IPv6”


Networking Infrastructure

Benefits of IPv6 / problems with IPv4

- IPv6 removes the limitations imposed by the IPv4 address shortage
 - Every school has a NAT / PAT gateway due to address shortage
 - Difficult to debug interconnection problems
 - IPv6: Enough address space for every school and pupil!
- P2P applications do not work with servers behind PAT
 - Multimedia e-learning and peer-to-peer virtual collaboration applications
 - IPv6: Easier P2P application development

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IPv6 Pilot in Greece “Energy Efficiency in School Networks with IPv6”


Networking Infrastructure

Benefits of IPv6 / problems with IPv4

- Management and security issues
 - Deployment procedures in large numbers (auto-configuration of CPE routers and PCs)
 - Address fragmentation resolved
 - Easier aggregation of classes of users
 - Security (based on ACLs) simplified using the IPv6 addressing schema
- Innovation – Expose to new technologies
 - Today’s school pupils are the future engineers
 - IPv6 allows the development of new advanced services that exploit features unique to IPv6 environments, such as enhanced security, multicast or mobility, QoS, etc
 - Multiply the impact of other IPv6-enabled networks in Greece

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IPv6 Pilot in Greece “Energy Efficiency in School Networks with IPv6”

Web Portal – gen6.cti.gr

Real Time Energy Consumption Monitoring

Select Consumption Period: Daily Energy Consumption

Energy Consumption (kWh)

School Name	Consumption (kWh)
1. [GEN6] 41η Δημοτική Σχολή Πατριάρχου Πρωτόκλη	81.030
2. [GEN6] 13η Δημοτική Σχολή Καρανίου	80.368
3. [GEN6] 152η Δημοτική Σχολή Αθηνών	79.257
4. [GEN6] 16η Δημοτική Σχολή Αθηνών	72.333

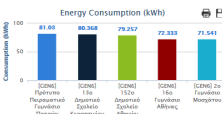
Compared to Previous Date Interval (%)

School Name	Comparison (%)
1. [GEN6] 41η Δημοτική Σχολή Πατριάρχου Πρωτόκλη	34.83
2. [GEN6] 2η Δημοτική Σχολή Αχαΐας	0
3. [GEN6] 46η Δημοτική Σχολή Πατρών	0
4. [GEN6] 10η Δημοτική Σχολή Αθηνών	0
5. [GEN6] 1η Δημοτική Σχολή Παναγίας	0


Energy Consumption/Student (kWh/Student)

School Name	kWh/Student
1. [GEN6] 24η Δημοτική Σχολή Αθηνών	0.029
2. [GEN6] 7η Δημοτική Σχολή Πατρών	0.041
3. [GEN6] 3η Δημοτική Σχολή Νέας Πύργου	0.009
4. [GEN6] Γραβιάς Διακονιστός	0.102
5. [GEN6] 41η Δημοτική Σχολή Πατριάρχου Πρωτόκλη	0.119


Energy Consumption (kWh)



Energy Saving (%)



Energy Consumption/Student



- Categorize schools based on their energy efficiency using KPIs
 - Energy consumption (KWh)
 - Energy consumption comparison to the previous day (%)
 - Energy consumption / student / square meters (Kwh/student/m2)
- Consumption Period:
 - Daily
 - Weekly
 - Monthly
 - Yearly

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WITH IPv6

IPv6 Pilot in Greece "Energy Efficiency in School Networks with IPv6"

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GREEK IPv6 PILOT

Web Portal – gen6.cti.gr

Period: Daily Energy Consumption

Search Schools

Name:

Address:

Type: All

Prefecture: All

Search Clear

Summary Table For Daily Energy Consumption

School Name	Number of Students	Energy Consumption / Student / m ²	Comparison to Previous Day %	CO ₂ Emissions
Αιγάλεω	10	0	-2.374	50.043
[GEN6] 49ο Γυμνάσιο Αθηνών	10	0	-6.422	65.359
[GEN6] 41ο Δημοτικό Σχολείο Περιστερίου	10	0	0.000	0.000
[GEN6] 23ο Γυμνάσιο Αθηνών	10	0	38.044	32.576
[GEN6] 27ο Δημοτικό Σχολείο Παιονίας	10	0	-4.555	57.133
Ασπροπύργου	10	0	-0.792	130.453
[GEN6] 1ο Δημοτικό Σχολείο Παιονίας	242	0	7.233	142.107
[GEN6] 1ο Γυμνάσιο Ραφήνας	10	0	0.000	0.000
[GEN6] 13ο Δημοτικό Σχολείο Κερατσινίου	10	0	-5.336	132.459

1 - 29 of 29 items 10 | 25 | All

Search schools with various criteria

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GREEK IPv6 PILOT

Web Portal – gen6.cti.gr

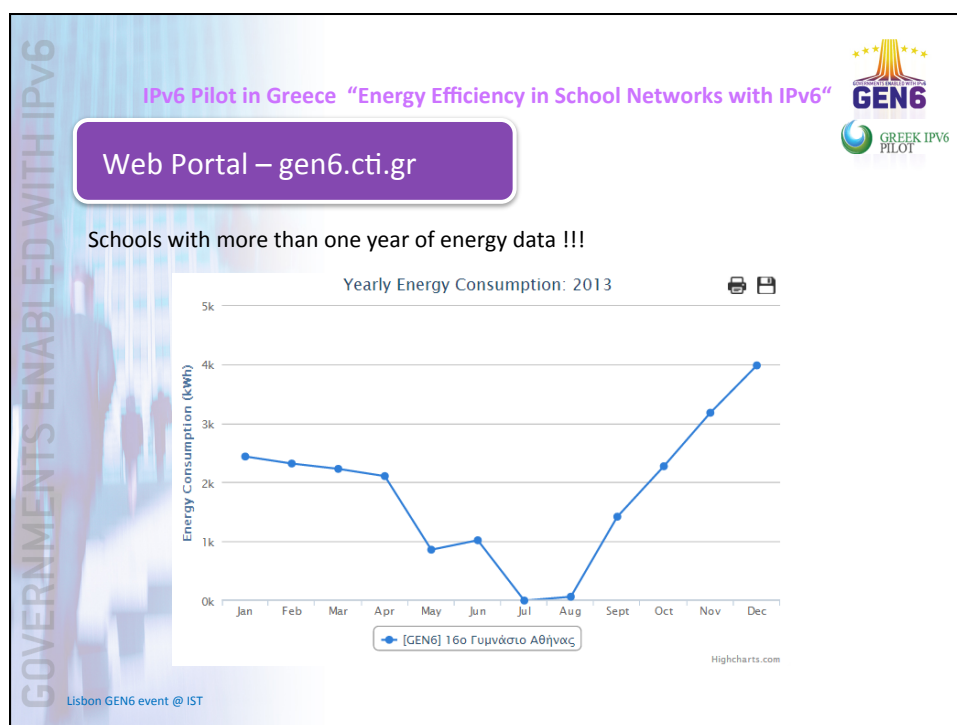
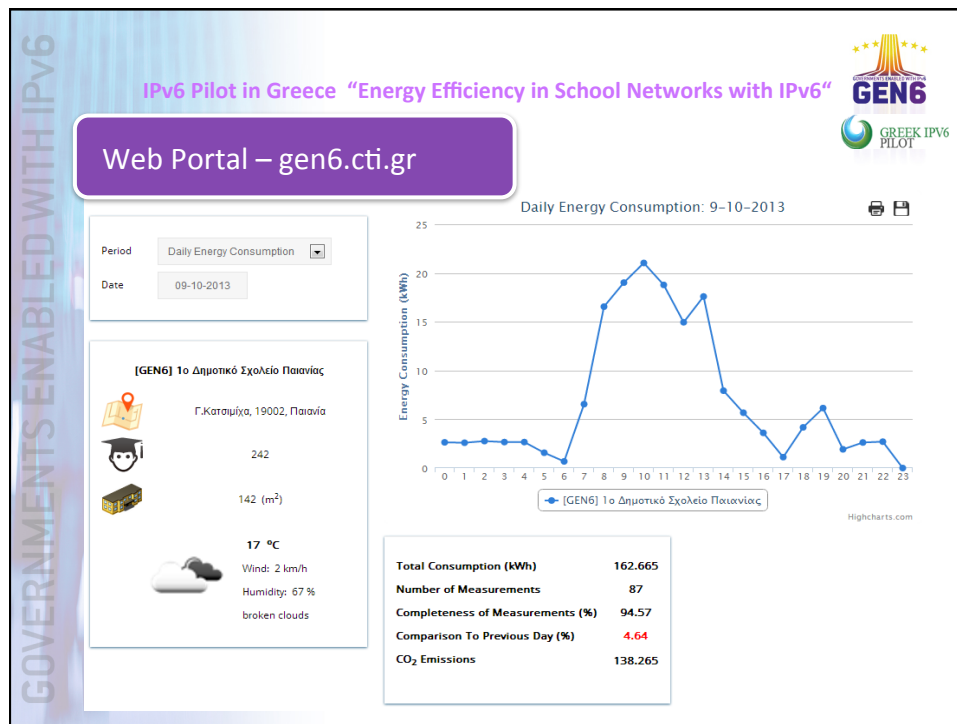
You are here: Home » Energy Consumption » School Map

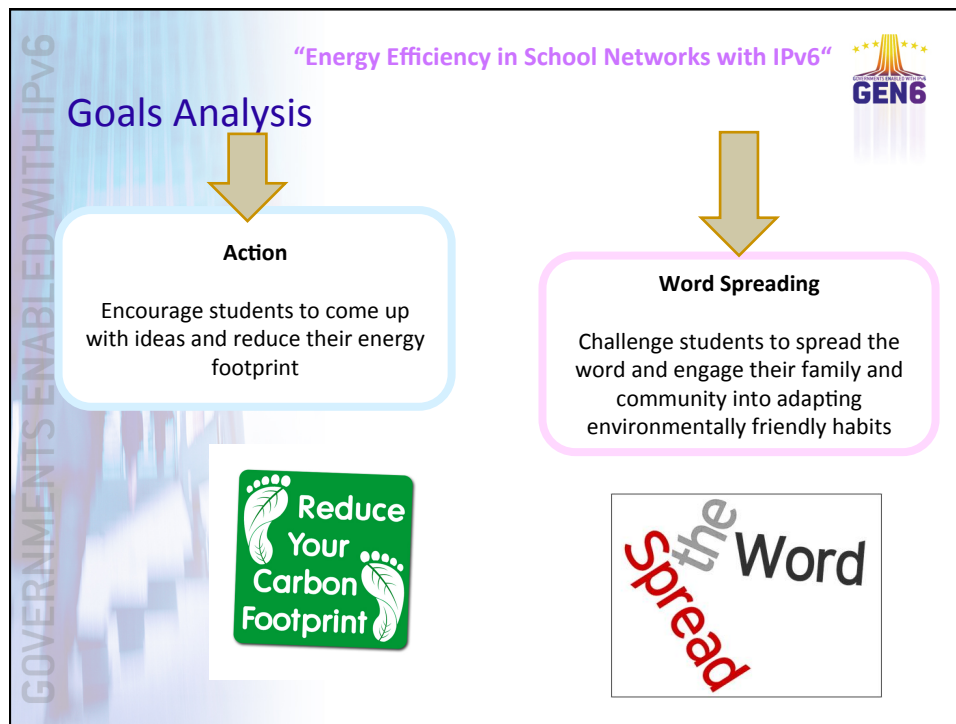
Select Schools: All Schools, All Schools, Schools in Attica, Schools in Achaia, Schools in Corinthia

Primary School




Secondary School

Map data ©2013 Google






GOVERNMENTS ENABLED WITH IPV6

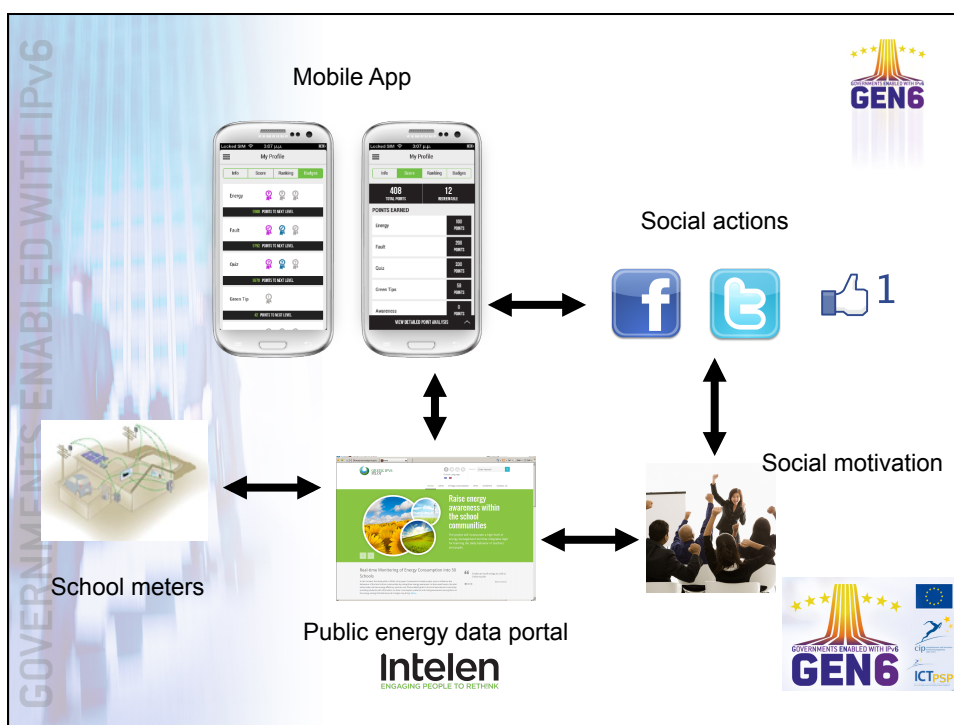




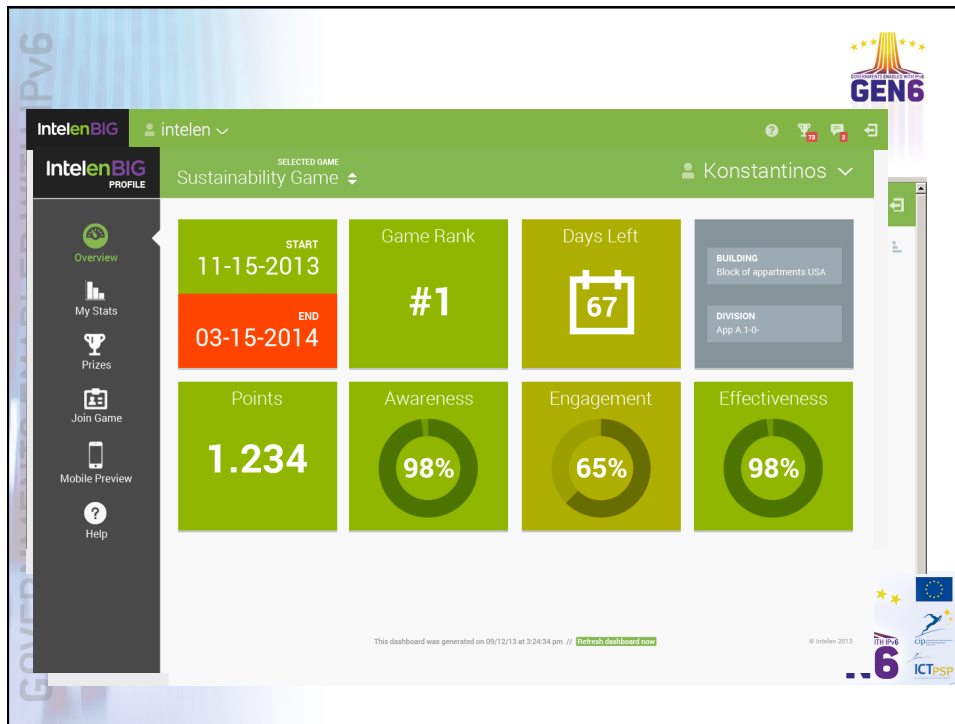
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Current status

- Completion of installations in 50 schools in Attica, Achaia, Corinthia
- Collection of energy consumption data over IPv6 from the existing systems
- Dissemination activities in schools
- Install other kind of sensors (e.g., weather related) to schools







IPv6 Pilot in Greece "Energy Efficiency in School Networks with IPv6"

Conclusions

- **IPv6 can become an enabling technology**
- **IPv6 in support of Sensor grids**
 - Higher Security
 - Easier interoperability and fast installation
 - Bi-directional communication
- **IPv6 in support of IoT**
 - Bigger address space, everything connected
 - Point-to-point control and access tunneling to real time data
- **Energy Efficiency in Schools pilot has a huge impact**
 - 50 Greek Schools, with about **11500 students !!!**
- **Inform the student communities in real time**
 - how much energy is consumed by their actions
- **Change students' behavior** towards environmental protection
- **Reduce energy consumption**

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 **GEN6**

 GREEK IPV6
PILOT

Thank you!

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