



**CONNECTIVITY IN THE SCHOOL SECTOR:
NRENS SURVEY'S RESULTS FOR ACCESS AND CONNECTIVITY OF SCHOOLS IN
EUROPE**



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EXECUTIVE SUMMARY

With 50 million more children enrolled in schools worldwide today, more funding, and resources are required. According to UNESCO, \$22 billion will be needed to ensure basic education by 2030

Information and communications (ICT's) have become more affordable and have embedded themselves so effectively into daily activity. However, universal access to Internet has not yet been achieved, nor has universal access to broadband. In an increasingly connected world, those who fall behind on the technology adoption curve are at a great disadvantage. This sentiment is echoed most noticeably within the education sector.

Since 2003 World Summit on the Information Society (WSIS) acknowledged the importance of schools connectivity and adopted Plan of action calling governments "to connect universities, colleges, secondary schools and primary schools with ICTs." This change was driven by the move towards greater availability of devices for students, and the emergence of cloud computing for supporting online educational content and schools administration software.

This report reviews the ICT in education, main challenges, and the undertaking of Géant partners in primary and secondary schools with access to the internet and focus in internet connectivity. These are the key findings:

Access: there are major issues related to gaining high quality access to broadband and technology infrastructure in schools. The issue is more profound in primary schools, and rural areas. Many schools struggles to provide and maintain high quality access to schools compared to commercial organisation.

Funding: many government in Europe recognised the importance of ICT in schools, and has committed a portion of education to modernise schools technology. However, the complexity of schools funding makes it difficult as there are various level of administration involved in transfers of funds depending on the resource in question (school staff, operation, services, and capital goods). In addition there are no harmonised funding mechanism in Europe.

SURVEY KEY FINDINGS

Upward trends in number of schools connected to NREN network + 124% increase to 26,982 schools, the highest growth since 2012

NRENs connecting more than 62% of schools in their country.

70% of NRENs have peak traffic load of 1Gbps and above.

83% of NRENs expect traffic to grow over 11% for the next 3 years

63% of NRENs provide services beyond connectivity

Commented [SM1]: Might probably add another slide on the schools survey result to complement the general overview



INTRODUCTION

Background

RedIRIS are involved in a national project to improve connectivity to schools (primary and secondary education). The aim of the project is to ensure that 18 000 schools will have connections of at least 100 Mbps.

The project, with an estimated total budget of more than 300 M€, includes:

1. Funds for the deployment of WiFi and LAN networks in schools,
2. Plus funds for access links provided by operators or regional research and education networks,
3. Plus additional funds to upgrade existing RedIRIS equipment, as the traffic of each of the 17 Spanish regions would be aggregated by the operators or regional RENs, and then passed to them at RedIRIS, which would provide them the global IP service.

In response to RedIRIS, Géant conducted a survey, the focus of this survey is gathering and analysing data on schools (Primary and Secondary schools). The main areas of investigation were:

- How many schools are connected to NREN's network
- Capacity and traffic load
- Connectivity services to schools

Methodology

An invitation to take part in the survey was sent to sig-msp@lists.geant.org mailing list. The list was sent to 39 Géant partners.

The survey was built and developed using SurveyMonkey an online survey tool [School Survey](#)

The survey was open for 4 months, and closed on 11th of August 2017.

Survey Response Rate

As per the Compendium data for 2016 23 of NRENs provide connectivity to schools. **70%** response rate (16 respondents)

RESOURCES ON EDUCATION- EUROPE TRENDS

Total expenditure on education jumped by 7.9% to Euro 895 billion, their highest level since 2012

The surge on prioritising education and training from the European member's states, was the major factor behind the rebound.

Figure 1, shows the relative expenditure on education, from the three main sources of expenditure, government, non-educational private source and international organisation. In 2014, the contribution of government expenditure on education posted 82% to €730 billion. The spending in UK and Portugal ranged from just less than 72%, and up to more than 95% in Romania and Sweden.

The non-educational sources posted €158 billion (17%) across 33 countries in Europe, and international organisation was much lower. Italy, Spain, Portugal, and Cyprus had the highest contribution from private organisation than the rest of Europe.

The highest growth was noticeable in Northern Europe, the total expenditure rose by 15% in 2014 to €428 billion, mainly driven by the United Kingdom. Followed by Western and Eastern Europe, (2%), and lowest was recorded in Southern Europe 1%

Generally, the smallest share of educational expenditure in 2014 was recorded for pre-primary education, with shares ranging from 5.7% in UK 5.7 %, and 5.9 % in Cyprus. Pre-primary education did not account for the lowest share of education expenditure, as the proportion of spending, post-secondary non tertiary education was less 8%

Expenditure on tertiary education in 2014 was generally higher 37% share. On the other hand upper secondary and post-secondary non-tertiary education typically accounted largest of total educational expenditure, with lower shares recorded in Lithuania and Sweden, while higher shares were registered in Belgium and Italy.

FIGURE 1. DISTRIBUTION OF EXPENDITURE ON EDUCATION BY SOURCE, 2014 (EXCLUDING EARLY CHILDHOOD EDUCATIONAL DEVELOPMENT)

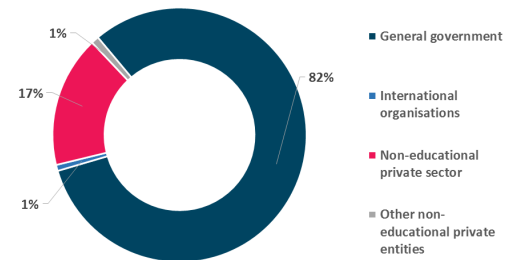
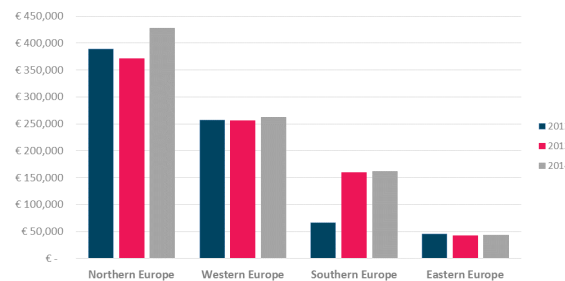


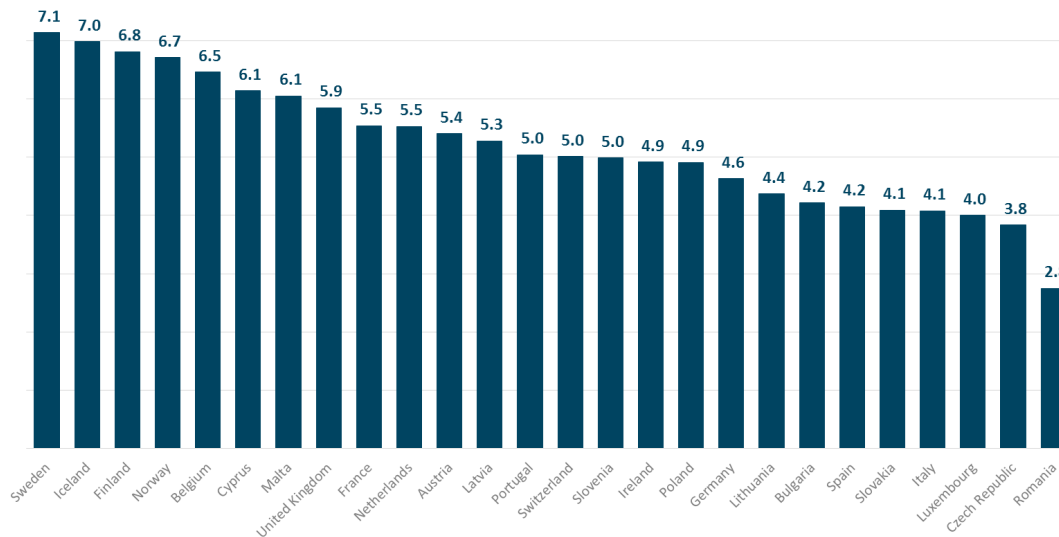
FIGURE 2. TOTAL EXPENDITURE ON EDUCATION BY REGION, Euro million (EXCLUDING EARLY CHILDHOOD DEVELOPMENT CHILDHOOD)



Public expenditure (Government expenditure)

Public expenditure as share of GDP are often used to assess government commitment to education (Figure3). The highest public spending on education relative to GDP was observed in Sweden (7.1 %), followed by Finland (6.8 %), while relatively high ratios were also recorded among the northern EFTA members of Iceland (7.0 %) and Norway (6.7 %). Aside from Sweden and Finland, most countries reported ratios of public expenditure on education relative to GDP that were between 3.5 % and 6.0 %, with only Romania below this range.

**FIGURE 3. PUBLIC EXPENDITURE ON EDUCATION AS % OF GDP, 2014
(EXCLUDING EARLY CHILDHOOD EDUCATIONAL DEVELOPMENT)**



NO DATA AVAILABLE FOR CROATIA, DENMARK, ESTONIA, HUNGARY, MACEDONIA, SERBIA, AND UK
DATA SOURCE: EUROSTAT

Capital Expenditure (CAPEX) on educational institutions

Capital expenditure in Europe exceeded 10.0 % of total capital and current expenditure on educational institutions, peaking at 19% in Latvia, followed by Estonia and Lithuania (15.2 %; 14.3%). Whereas United Kingdom posted the lowest capital expenditure in Europe 3.3 %. Nearly 50% of current expenditure in Europe is spent on teachers' pay

TABLE 2. CAPITAL EXPENDITURE ON EDUCATIONAL INSTITUTION
All ISCED 2011 levels excluding early childhood educational development
€ Million

GEO	Capital expenditure	Current expenditure
Austria	834	16,955
Belgium	955	24,991
Bulgaria	180	1,577
Croatia	73	1,875
Cyprus	43	1,218
Czech Republic	-	-
Denmark	-	-
Estonia	-	-
Finland	822	12,703
Macedonia	-	-
France	10,464	118,606
Germany	10,631	131,307
Hungary	-	-
Iceland	-	860
Ireland	581	8,976
Italy	3,627	69,367
Latvia	251	1,066
Liechtenstein	-	-
Lithuania	251	1,506
Luxembourg	234	1,856
Malta	30	489
Netherlands	4,320	33,808
Norway	2,213	19,378
Poland	1,941	20,802
Portugal	375	9,265
Romania	192	4,008
Serbia	-	-
Slovakia	206	3,149
Slovenia	254	1,867
Spain	2,834	47,227
Sweden	1,500	27,242
Switzerland	-	-
United Kingdom	5,236	152,456

TABLE 1. MAIN INDICATOR FOR PUBLIC EXPENDITURE ON EDUCATION- 2014
All ISCED 2011 levels excluding early childhood educational development

GEO	Public Expenditure (million Euro)	Expenditure as share of GDP	Expenditure as share of GNI
Austria	17,836	5.4	5.4
Belgium	25,878	6.5	6.4
Bulgaria	1,804	4.2	4.2
Croatia	-	-	-
Cyprus	1,078	6.1	6.4
Czech Republic	6,008	3.8	4.1
Denmark	-	-	-
Estonia	-	-	-
Finland	13,991	6.8	-
France	118,496	5.5	5.5
Germany	135,393	4.6	4.5
Hungary	-	-	-
Iceland	904	7.0	7.1
Ireland	9,510	4.9	5.8
Italy	66,094	4.1	4.1
Latvia	1,248	5.3	5.3
Liechtenstein	-	-	-
Lithuania	1,597	4.4	4.4
Luxembourg	1,997	4.0	6.0
Macedonia	-	-	-
Malta	510	6.1	6.4
Netherlands	36,660	5.5	5.5
Norway	25,241	6.7	6.5
Poland	20,190	4.9	5.1
Portugal	8,715	5.0	5.1
Romania	4,137	2.8	2.8
Serbia	-	-	-
Slovakia	3,106	4.1	4.2
Slovenia	1,861	5.0	5.0
Spain	43,011	4.2	4.2
Sweden	30,893	7.1	7.0
Switzerland	26,549	5.0	5.0
Turkey	-	-	-
United Kingdom	127,667	-	5.9

SCHOOLS FUNDING

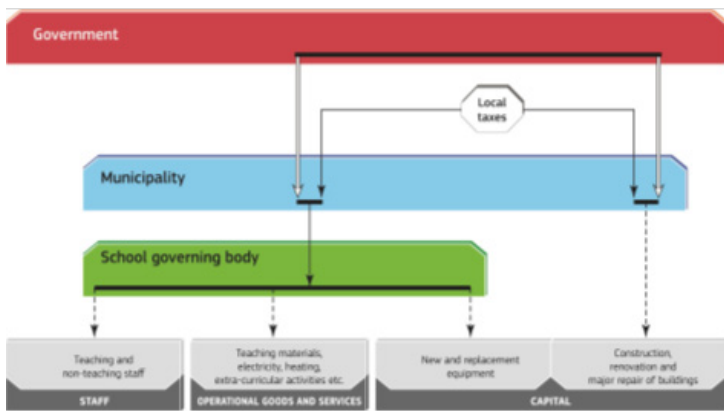
Schools funding mechanism is not harmonised and very complex from a country to another, there are various level of administration involved in transfers of funds depending on the resource in question (school staff, operation, services, and capital goods). The contrasting diagrams from Poland and Sweden below demonstrate well, that there are more authorities involved in school funding in Poland than Sweden

For funding school connectivity, the most direct and transparent model are ICT expenditures from the budget of the ministry responsible for education. However, education ministries sometimes lack the funding to absorb the full cost of ICT equipment purchases and service charges. In that case, the education budget could be increased or an allocation made from the central government. Another option is a universal service fund. Alternatively, instead of imposing a universal service charge, operators could agree to provide Internet access in schools as a universal service obligation.

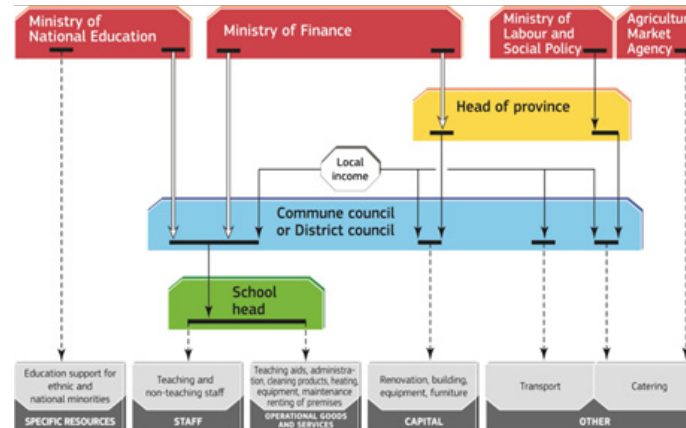
Commented [SM2]: Might need to ask One big NREN and one small NREN how their funding for schools work.

From Compendium we do have the general source of income for NREN's but would be good if we included the specific one to schools

Financial flows for Public schools -Sweden



Financial flows for Public schools -Poland



Source: Eurydice Study "Financing Schools in Europe: Mechanisms, Methods and Criteria in Public Funding"



SCHOOLS CONNECTIVITY

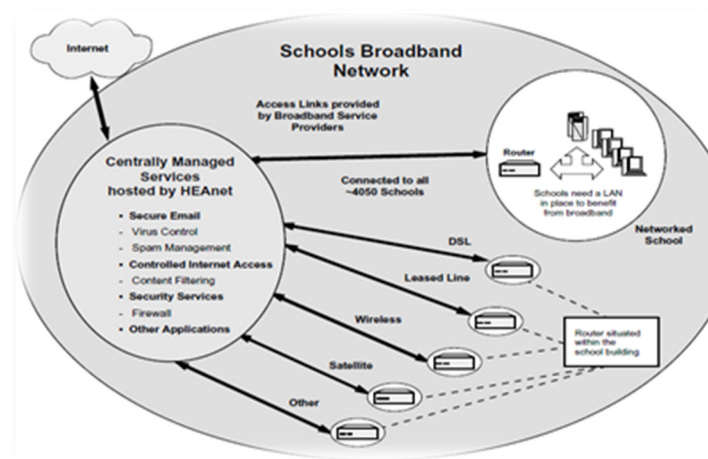
Connectivity Options

Connectivity option for schools has a lots requirements, this includes the bandwidth required, the physical link to the Internet the upstream service provider and downstream distribution throughout the school. The amount of bandwidth required per school will vary depending on its size (number of students, teachers), the number of connected devices and the location of the school. Hence, it is not realistic to propose a common broadband speed for schools. An example from Ireland below used to illustrate the schools broadband network

Internet Connectivity Options

There are a number of technologies exist that facilitate connection to the Internet. Preferably, schools will want a connection that matches bandwidth requirements based on the number of students. However, the location of the school is also a factor since the choice of technologies and/or speeds becomes more restricted the further the school is from urban areas. Wireless is often used in remote areas due to the unavailability of cabled technology.

Ireland schools broadband network



Source: National Centre for Technology in Education (NCTE), 20114. "The Schools Broadband Programme.

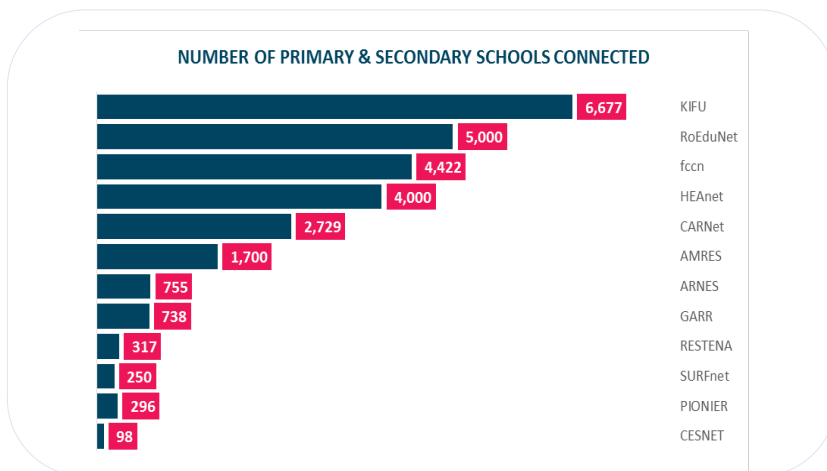
SCHOOLS CONNECTIVITY

NRENs user landscape

Over the last years NRENS user landscape expanded considerably. Many NRENs go beyond connecting to universities and research institution. There is an upward trend of connected schools, the latest Compendium data for 2016 indicated that primary and secondary schools represent the largest segment (65%), followed by research institute 17%

Figure 4. Illustrate the results from the latest “School Survey”, **81%** of NRENs responded they connect both primary and secondary schools. The number of schools connected doubled from 12 060 in 2015 to 26 982. The growth is driven mainly by AMRES, RoEduNet, CARNET, and KIFU NIIF Program (Hungary). due the recent government funding’s.

The share of primary is considerably higher 69% in comparison to secondary schools 31%.

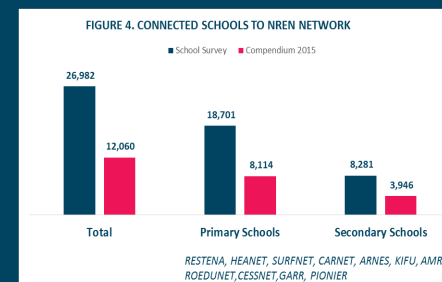


SURVEY RESULTS

*The number of schools connected jumped by **124%** to **26,982** schools, the highest growth since 2012. The surge on prioritising ICT use in education from many governments in Europe was the major factor behind the rebound*

*Primary schools posted an increase of **130%** to **10 587** more schools connected*

*Secondary schools posted increase of **110 %** to **4 335** more schools connected*

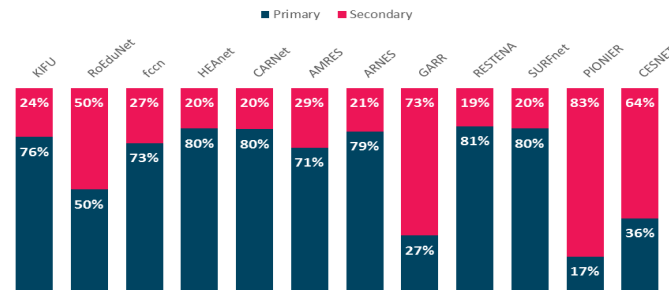


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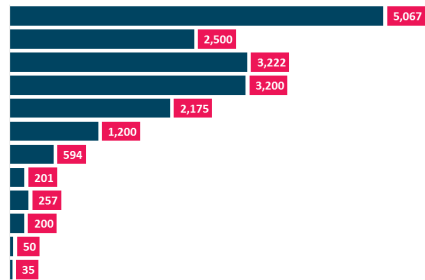
How many primary and secondary schools are connected?

81%
response
rate

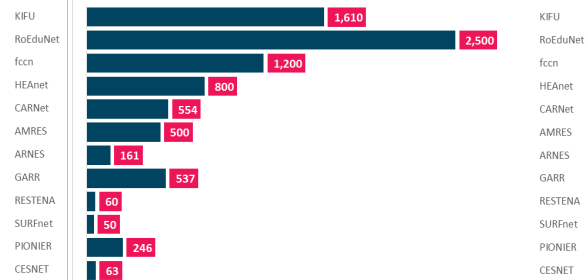
PERCENTAGE OF SCHOOLS CONNECTED BY NREN



NUMBER OF PRIMARY SCHOOLS CONNECTED



NUMBER OF SECONDARY SCHOOLS CONNECTED





SCHOOLS CONNECTIVITY

NRENS Market Share

The table shows the estimated market share for both primary and secondary schools. The overall market share distribution is comparable to the latest data from Compendium 2016.

69%
response
rate

SURVEY RESULTS

The data showing a rising trend in number of schools connected to NREN Network

NRENs are connecting on average more than 62% of schools in their country

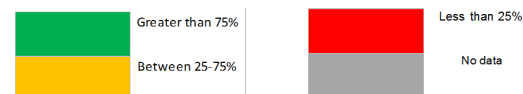
GARR posted the highest growth for secondary schools the coverage increase from 5% to 80-90%

45% increase on RoEduNet market share for secondary schools

RESTENA market share for primary schools increased from 80% to 100% coverage

What is the percentage of primary and secondary schools?

	Primary Schools	Secondary Schools
RESTENA	100%	100%
HEAnet	98%	100%
ARNES	90%	90%
GARR	10-20%	80-90%
ACOnet	90%	
CARNet	75%	25%
FCCN	73%	27%
RoEduNet	25%	75%
SURFnet	8%	
CESNET	1%	5%





SCHOOLS CONNECTIVITY

Average connection speed and traffic load

Overall, the average connectivity speed to schools vary, ranging from 1 Mbps up to 1Gbps, nearly half of NRENs who responded indicates that 1Gbps and above is typical capacity for connected primary and secondary schools

The graph below shows the peak traffic load from schools to GÉANT network/ From Géant to schools, and includes data from both primary and secondary schools. The largest source of traffic comes from Portugal, Ireland, & and Croatia where peak traffic are 2.5Gbps, 5Gbps, and 20Gbps respectively.

We also asked NRENs about how the traffic is carried. Is NREN who provides the local loops; is traffic carried to the backbone by regional RENs; traffic carried to the backbone by commercial providers? 42% of NRENs responded they have mix of how traffic is carried.

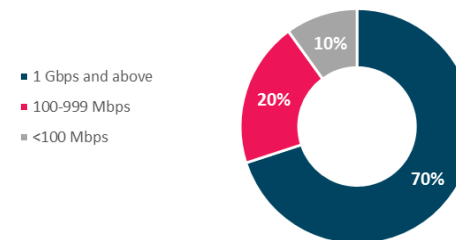
- **GARR:** NREN's provides the local loops" and "Traffic carried to the backbone by regional RENs or local Universities.
- **KIFU NIIF Program (Hungary),** mostly commercial providers carry traffic to NREN backbone but there are some cases where NREN has local loop.
- **Surfnet** provides upstream IP only to commercial or public provider(s) that delivers ISP-service to schools.
- **CARNET,** provide local loops where possible (city where they have their own fiber) or they use lease line from providers.

SURVEY RESULTS

70% of NRENs have peak traffic load of 1Gbps and above from schools to Géant–from Géant to schools

83% of NRENs expect traffic to grow over 11% for the next 3 years with the exception of GARR (50%)

PEAK TRAFFIC LOAD FROM SCHOOLS TO NETWORK & TO SCHOOLS FROM NETWORK





SCHOOLS NETWORK SERVICES

NRENs provide a broad portfolio of services to meet user need, from videoconferencing, virtual dedicated networks, web filtering, cloud services, security services Eduroam, virtual hosting, and many other services. The table below illustrate the type of services that NREN's provides beyond connectivity.



Eduroam

eduroam (education roaming) is the secure, worldwide roaming federated access service developed for the international research and education community, it allows students, researchers and staff from participating institutions to connect to the Internet when they are at their own campus or institutions, as well as when visiting other participating institutions. We asked NRENS if they provide eduroam to schools and what is their coverage, 11 from 16 responded they provide Eduroam, however the coverage in schools is very small in contrast to the number of schools they already connect to.



CASE STUDIES – NATIONAL PROGRAMS



NIFU NIF Program (Hungary) /Sulinet + project

In the past 2 years the Hungarian school network complexly renewed (bandwidth, services etc.). As part of the development project NIF/ Hungarnet introduced eduroam on more than 1700 primary or secondary schools. The Goal of Sulinet+ (School Network +) - Renewal of the 10+ years old infrastructure of the school network:

- ✚ Development of network infrastructure
 - Development of the end-point CPE
 - Increase capacity and reliability of the backbone
 - Build access network capacity in rural area where there is no other alternatives
- ✚ New services with Integrated Service management systems for schools
- ✚ T&I pilot to schools with Wifi
- ✚ Mul7media infrastructure pilot to schools
- ✚ Increase the available bandwidth by 10 folds - “Schools at 100 Mbps”

- Contract with the institution
- Up to date user database
- Physical take-care of Wifi Aps
- Local support person

- ✚ **NIF responsibility**
 - Running the APs
 - Running Radius infrastructure
 - Running the user database
 - Provide easy to use user interface for local administrator

Methods for Schoolnetwork

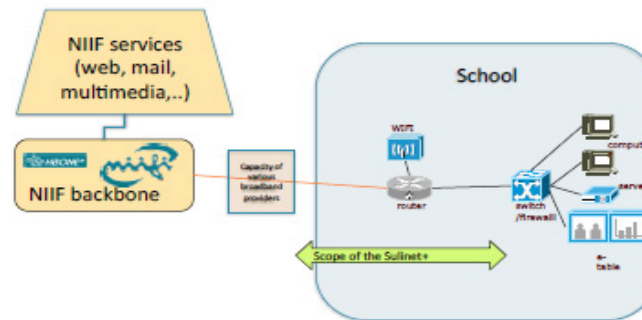
- SDN for CPE and WiFi APs-Programmability/Automation
- End point router development ~5500 high performance CPE with similar configura7on
 - Abstract service interface in database
 - Automa7cally generated configura7on and provisioned systems (CICI, DROPS tools) for routers and APs
 - Initial eduroam pilot in 87 locations – huge success

Methods for FedaaS

Integrated T&I and eduroam for schools – FedaaS

- ✚ **Federated SSO authentication**
 - Institution identity: pupil/student, teacher, other educa7onal staff

Scheme of schools in the NIF/Hungarnet Schoolnetwork



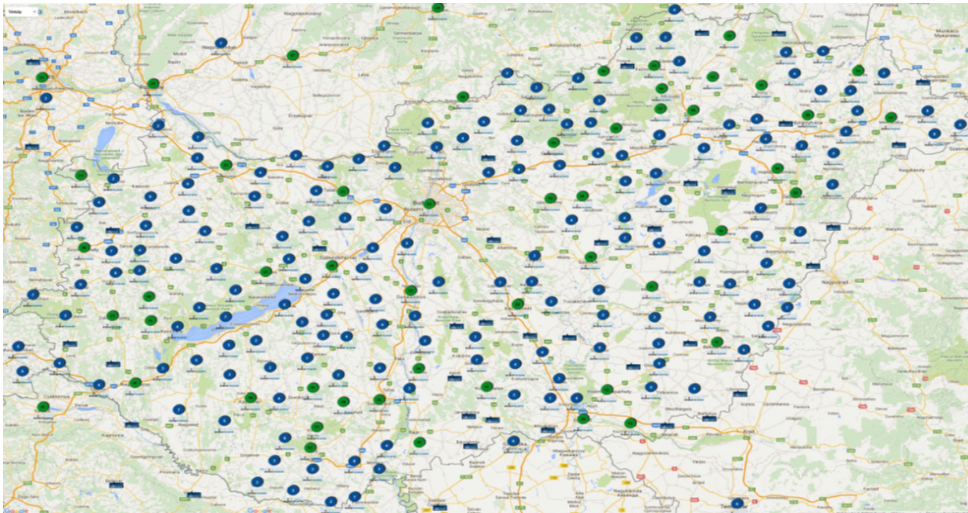
Key findings:

- Eduroam CAT is a must for all the used plaworms – including Windows Phone
- Intuitive user interface is important
- Mass management of users is required

Results

- eduroam at 1700+ service locations in Hungary
- Federated Identity for schools
- Automated provisioning system for routers and WiFi

Eduroam service locations in Hungary (mostly at schools)





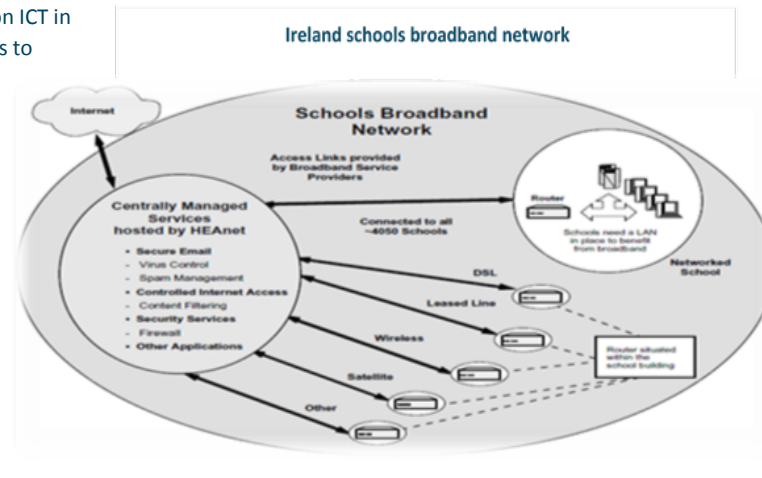
Ireland HEAnet: 100 Mbps Broadband Program

Schools connectivity in Ireland gone through several phases since 1997, the first policy on ICT in education led to the technology integration in schools and grant was provided to schools to purchase computers and establish internet connections. The program resulted in all schools having an Internet connection by 2001. However, the connection speed to schools were slow and there were challenges with maintenance and technical support.

In 2005 the Schools Broadband Programs was launched to overcome and address these issues. Under this initiative, all primary and secondary schools would have an Internet connection of at least 512 kbps. **HEAnet** was appointed as a network managers of centralised Schools Network under the Department of Education Skills Broadband for Schools programme. The program was a joint project between the government and the Telecommunications and Internet Federation of the Irish Business and Employers' Confederation. The total costs of the project, including the fixed and recurring costs through June 2008 were estimated to amount to around €30 million

Arising from the government's 2009 Next Generation Broadband report, the **100 Mbps Post Primary Schools Project** marked the next stage for Ireland's vision of developing its schools as world leading centres of digital education:

The project called for the some 700 post-primary schools in Ireland to be provided with broadband at speeds of at least 100 Mbps. The project commenced in 2010 with a pilot that drew participation from 78 schools with each county in the country represented by at least one school. Following a positive evaluation of the first pilot, the remaining schools were connected from 2012 to 2014



Source: National Centre for Technology in Education (NCTE). 20114. "The Schools Broadband Programme."

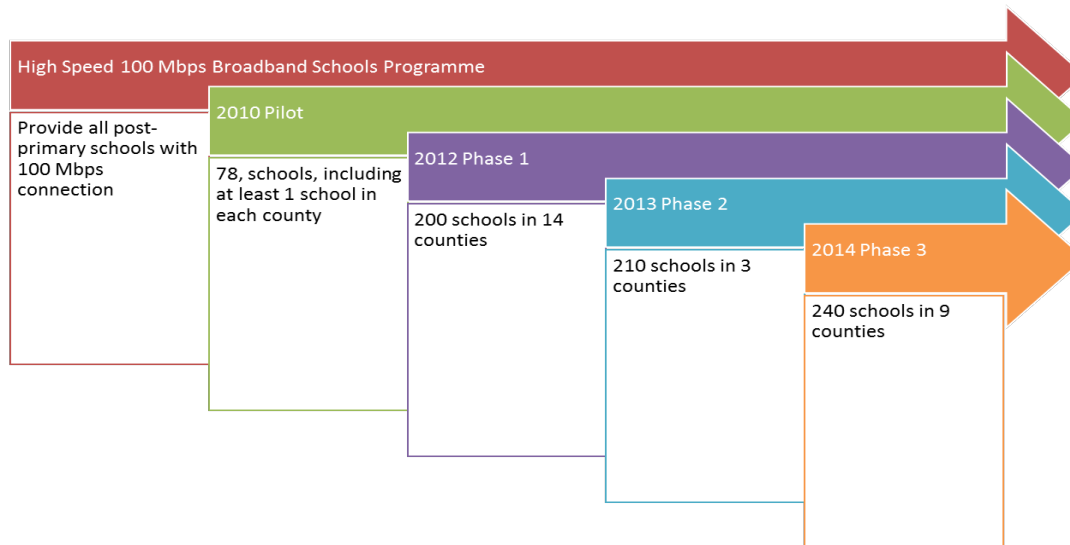
Level	Schools connected	Market Share
Primary	3200	98%
Secondary	800	100%



Following the successful completion of the third and final phase of the project in 2014, **HEAnet** was designated by the Government to oversee maintenance of the new network, supported by ESB Telecoms, which will continue to provide backhaul from regional locations to Dublin. As of September 2014, almost 750 post-primary schools were covered by the Schools 100 Mbit/s High-Speed Programme; those schools that have not yet secured the benefits of 100 Mbps connections will do so gradually as they are transitioned off of the Broadband for Schools Programme

A team consisting of the Department of Education and Skills (DES), the Department of Communications, Energy and Natural Resources (DCENR), HEAnet and PDST Technology in Education manages both the Schools Broadband Program and the 100 Mbps Post Primary Schools Project. The latter has been funded primarily by DCENR (capital costs of around €11 million and €11 million for current costs for the years 2012-2015), with additional backing from the European Regional Development Fund (ERDF) and DES (remaining current costs estimated to be some €16 million up to 2015 and responsible for ongoing annual costs into the future)

Ireland 100 Mbps Broadband Schools Deployment





AMRES

Commented [SM4]: This will be done by Silvie