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Satellite broadband for schools: Feasibility study

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2thePoint Consulting

Authors:

Acreo: *Marco Forzati, Håkan Cavenius*

Airbus: *Agnès Salvatori*

Eutelsat: *Stefano Agnelli*

2thePoint Consulting: *Luisella Ciani*

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Executive summary

In 2016 many schools in the EU still lack *broadband* access (especially in primary schools, where 25% lack broadband). The main reason behind this situation is **poor awareness** among schools and local authorities of the available options for broadband services as well as a **limited number of dedicated, large national institutional support programmes,** and the lack of knowledge of possible **funding options, including voucher schemes** and how to implement these.

In order to close the gap more rapidly, this report identifies *satellite-based broadband services* as an efficient option for unconnected or poorly connected schools.

Even though satellite-based broadband may have – as any wireless technology using shared media (spectrum) – some limitations with respect to fibre-based broadband on the maximum speed and on data allowance, it has some inherent **advantages**, relevant for schools that have difficulty connecting to the internet by terrestrial means:

- **Ubiquity and Quality:** Satellite communications offer a predictable and stable quality of service everywhere, regardless of geographic location.
- **Quick and immediate access:** Deployment of satellite broadband at the customer premises is simple and quick, installation of the equipment and activation of the broadband service typically takes a couple of hours.
- **Cost-effectiveness:** The deployment cost is independent of terrain characteristics, population density or right-of-way regulation, etc. hence the cost per user is fixed.
- **High reliability and security:** Satellites have very limited downtimes.

Vouchers are defined as public grants provided by a Public Authority to an eligible end-user (e.g. a school) to stimulate demand for priority services among specific underserved groups and could be used as a tool to close the broadband gap for schools. A **basic voucher scheme for satellite-based broadband should cover a) fixed fee for terminal equipment and installation and b) recurring monthly fee for a limited period (e.g. 24 months) in order to kick off the actual use.** Satellite voucher schemes can provide a simpler, quicker and more competitive process (in fact, they are often based on the selection of multiple competing providers) compared to traditional purchasing. Case studies show that a voucher scheme should be programmed for a limited period of time and be renewed several times: a short window of subsidy creates an incentive for schools to really use the voucher. Voucher schemes should, if possible, cover **more than just pure broadband access**, i.e. also include support, training, customised solutions, IT tools etc. in order to be a really effective part of a true digital learning program.

Several **EU sources can finance satellite broadband voucher schemes**: ERDF (European Regional Development Fund) and EAFRD (European Agricultural Fund for Rural Development) are available to finance the purchase of **broadband** infrastructure (and initial

service period), while ESF (European Social Fund) could be used to finance the distribution of **educational content** (to local digital libraries) and other **digital learning** tools. These three specific funds are part of the European Union's main investment policy tool, the European Structural and Investment Funds (ESIFs). Please note that the combination of ESF, ERDF and EAFRD in multi-fund operational programmes should be more efficient in school connectivity voucher scheme projects if it **combines support packages** for broadband access and other online-based curriculum materials and tools.

For a **Public Authority** to launch a broadband voucher scheme, there are some **fundamental steps** to be implemented for the success of the initiative:

1. Identify **what** the voucher scheme should finance: A voucher should cover the customer premises equipment but also a service subscription (for a limited period) and other tools related to education.

2. Identify the **target group**: Potential beneficiaries are primary and/or secondary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions.

3. Specify the **total budget** allocated for the voucher scheme and the **single maximum grant.**

4. Identify the **implementing authority** that delivers the voucher scheme.

5. Set up an effective and comprehensive **communication campaign** by the involved authorities (e.g. Ministries of Education and/or Telecommunications) to widely expose and advertise the benefits and rules for the voucher scheme and reach all the final beneficiaries.

6. Decide on Internet Service Provider (ISP) **selection procedure,** either by a) Call for tender for a single provider or by b) Call-off procedure (multitude of providers) – where alternative b) is recommended in most situations.

7. Decide the **duration** of the voucher and consequently the timing of the service provided.

8. Set up a **web site** to allow both schools and ISP(s) to apply online.

Résumé

En 2016, il reste encore de nombreuses écoles en Europe qui n'ont pas accès au haut-débit (en particulier, 25% des écoles primaires). La raison principale en est une méconnaissance des solutions haut-débit disponibles et une quantité limitée de programmes de soutien public spécifique, un manque de connaissance desoptions de financement associées (par exemple bons d'achat) par les écoles et les autorités locales et sur comme les mettre en œuvre.

Ce rapport identifies les services haut-débit par satellite comme une solution efficace pour connecter les écoles en zones blanches ou mal desservies.

Si la connectivité par satellite peut présenter, en comparaison de la fibre, les limitations en terme de débit et de volume de données inhérente à toute technologie sans-fil qui partage la bande passante, elle présente aussi des avantages très pertinents pour les écoles non ou mal desservies:

- **Une couverture globale et de grande qualité :** les communications par satellite permettent une qualité de service constante et prédictible, indépendamment de la localisation géographique
- **Une connexion rapide et un service disponible immédiatement** : le déploiement d'une connexion par satellite sur site est simple et rapide, l'installation des équipements et l'activation du service étant une question de quelques heures.
- **Un excellent rapport qualité-prix**: le cout des équipements et de l'installation est indépendant des caractéristiques du terrain, de la densité de la population ou des réglementations locales ; le cout est le même quel que et où que soit l'utilisateur.
- **Un service très fiable et très sûr :** il y a très peu d'interruption des communications satellitaires.

Les **Bons d'Achat** sont des subventions publiques fournies par des autorités publiques à des utilisateurs éligibles afin de stimuler la demande et l'adoption de services prioritaires pour des groupes d'utilisateurs ciblés; ils pourraient être utilisés pour connecter toutes les écoles encore non ou mal dessservies.

A système de **bons d'achat basique** pour subventionner la connectivité satellitaire pourrait couvrir a) un montant fixe pour l'achat et l'installation des équipements b) un montant mensuel pour couvrir l'abonnement sur une période limitée (par exemple 24 mois) afin de motiver l'utilisateur. Ce système de bons d'achat est simple et rapide et permet de plus un processus compétitif (pré-sélection compétitive de fournisseurs d'accès), en comparaison avec un achat traditionnel. Les études de cas montrent qu'il vaut mieux que les bons d'achat soit proposés pour une période limitée et renouvelée plusieurs fois: il semble que limiter la durée pour postuler motive les écoles à y faire appel.

Afin de maximiser l'impact d'un tel programme d'e-éducation, les bons d'achats doivent, si possible aller au-delà du simple accès haut-débit et inclure du support technique, de la formation, des solutions spécifiques, des outils informatiques etc.

Plusieurs financements européens peuvent soutenir ces bons d'achat pour de la connectivité satellitaire haut-débit: le FEDER (Fond Européen de Développement Economique régional) et le FEADER (Fond Européen Agricole pour le Développement Economique Rural) peuvent financer l'achat des équipements (voire d'une période initiale d'abonnement), alors que le FSE (Fond Social Européen) peut financer la distribution de contenu éducatif (vers des bibliothèques locales) et autres outils d'éducation digitale. Ces trois fonds spécifiques font partie du plus important instrument financier de l'Europe, le FESI (Fonds Européens Structurels et d'Investissement). Notez que la combinaison de FSE, FEDER et FEADER est plus efficace si le programme de bons d'achats pour des écoles combine le soutien pour l'accès à très haut débit avec et des service d'enseignement en ligne.

Pour qu'une autorité publique lance avec succès un tel système de bons d'achat, il y a quelques étapes fondamentales à respecter:

1. **Identifier ce que le bon d'achat va financer:** Un bon d'achat doit couvrir les équipements de l'utilisateur mais aussi un abonnement pour une durée limitée voire d'autres outils éducatifs.

2. **Identifier les bénéficiaires cible**: Les bénéficiaires potentiels sont les écoles primaires, les collèges et les lycées situés dans des zones non ou mal desservies par la connectivité terrestre ou mobile.

3. **Spécifier le budget total** alloué au programme de bons d'achat, ainsi que le montant maximum de la subvention individuelle (c'est-à-dire accordée à une école).

4. Identifier **quelle autorité publique** va délivrer les bons d'achat.

5. Mettre en place **une campagne de communication** efficace déroulée par les autorités publiques concernés (par exemple les Ministères de l'éducation ou des télécommunications) afin d'atteindre le bénéficiaire final et lui faire connaitre les bénéfices de ce système et les règles associées.

6. Décider de la **procédure de sélection** des fournisseurs d'accès internet, c'est-à-dire la sélection d'un seul fournisseur ou de plusieurs fournisseurs (cette dernière solution étant recommandée).

7. Décider de la **durée** du bon d'achat et par conséquent, de combien de temps doit durer le service.

8. Mettre en place un **site web** pour permettre aux écoles et aux fournisseurs d'accès de postuler en ligne.

1. INTRODUCTION

Broadband roll-out in Europe has been accelerating in recent years and at present broadband access in some form – fixed or wireless – is an infrastructure that is expected to be available in schools, even in the most rural areas. However, one in ten students in 2010 was still in schools with no internet connection and there is yet a lack of adequate broadband in some schools, especially primary schools in some European countries.

In 2011 in general, secondary schools were better connected to the internet (around 95% of students in the EU had some kind of internet access at school) compared to students in primary schools (92%)[1]. The figures vary widely across member states, e.g. only 66% of primary school students were in connected schools in 2011 in Italy, to be compared with 100% in Finland. Although fixed terrestrial access is the most common type, connection by satellite is also used in some schools (generally less than 5% of students are in schools connected by satellite). The need for higher access speeds increases, so that new tools and more demanding applications can be fully utilised in the education by both students and teachers.

This study analyses the gaps (current and forecasted) of broadband availability for European schools as well as identifying possible funding support mechanisms through voucher schemes and satellite-based broadband solutions. Different cases studies (European and non-European) are presented with a set of suggested recommendations and a *short guide* for relevant authorities willing to embark on such a scheme is provided (see Annex G).

For schools with the possibility to purchase affordable broadband services but that currently are not connected, we have also identified the main barriers to adoption.

This current project is targeting four objectives*:*

1. **Current situation and forecast:** Classify and quantify unserved schools in EU28 and identify main barriers to adoption.

2. **Case studies:** Analysis of different relevant cases and identification of good practices.

3. **Funding options:** Identify regulatory and financing options for implementing e.g. voucher schemes.

4. **Guidelines and considerations:** Aiming at public authorities and schools, built on lessons learnt from the case studies.

[1] Survey of Schools: ICT in Education - SMART-Nr 2010/0039

2. SITUATION OF BROADBAND ACCESS TO EU SCHOOLS

2.1. Classification of unserved schools

In recent years the bridging of the *digital divide* for schools has accelerated and today internet access is now almost ubiquitous in European schools[2]. Fixed and mobile access technologies have been dominating but also satellite-based broadband is used in some schools (generally less than 5% of students are in schools connected by satellite) and can be a faster way of connecting a school to broadband.

The first step of the study aimed at classifying schools that were currently not connected to broadband according to the suitable categories. Initially, before the research started, we identified the following preliminary school categories, with a focus on primary (ISCED 1) and secondary schools (ISCED 2-3):

1) Primary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions with unaffordable satellite offerings
2) Secondary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions with unaffordable satellite offerings
3) Primary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions with affordable satellite offering but currently not connected
4) Secondary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions with affordable satellite offering but currently not connected.
5) Primary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions and currently connected by satellite broadband
6) Secondary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions and currently connected by satellite broadband

The “affordability” aspect has shown to be complex to elaborate and calculate and, depends on a different number of factors: school size, satellite service prices (as proportion of average income), financial autonomy of schools etc. It was finally decided to use the broadband affordability index, provided by the EC Digital Scoreboard, for this purpose.

For schools with affordable satellite offerings but currently not connected, the study has identified the main barriers to adoption, such as lack of awareness, high prices etc. Schools in above mentioned categories 5 and 6 have been described in a number of case studies identified and analysed (see section 3).

[2] Survey of Schools: ICT in Education - SMART-Nr 2010/0039

The study has also tried to quantify the amount of schools (served and unserved by broadband access) in each member state, using data, input and estimations/calculations from the following sources:

- Previous EU survey (2011-12)[3]
- Questionnaires to EU28 member states and selected interviews (see Annex E)
- EU Country Reports[4]
- Specific school reports from different countries and sources
- Multitude of reports covering facts and insights of the case studies
- Open sources and articles

2.2. Methodology used in estimating broadband availability

Since no EU-wide survey has been conducted after 2011-12, no direct data from schools is available. In order to be able to estimate the current situation regarding schools' availability to broadband (estimate for year 2015 as well as a forecast for 2020) the following methodology has been used:

1. **Extrapolation of broadband availability figures** from 2011-12 (Schoolnet survey[5]) have been used to estimate 2015 and forecast 2020, based on proxies (using uptake logistic s-curves, see below) from the general market development of broadband deployment and uptake in each respective EU member state. Per definition, these calculations do not take into account any additional supporting or funding initiatives or programmes by each member state's government, but are purely based on "business-as-usual" build-out progress of broadband and does not take into account extraordinary means from dedicated funding and build-out programmes.

Logistic S-curve forecasting has been used extensively in the widest range of applications. It fits the 'natural growth' process of a "species" under competition with the ability to multiply inside finite 'niche capacity' through a given time period.

The main strength of logistic S-curve forecasting is: 1) properly established logistic growth reflects the action of a natural law. It works everywhere, independently from scale, for example, from nano-level (molecule clustering), micro-level (yeast growth), macro-level (economy of country), and up to mega-levels (stars and galactic growth); 2) relatively easy to apply with clear concept and working mechanism.

[3] Survey of Schools: ICT in Education - SMART 2010/0039

[4] EURYDICE: https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Countries

[5] Ibid.

On the other hand, the weakness of this method includes: 1) Forecasting biases towards low or high ceilings; 2) Question whether the raw or the cumulative data are to be used. This question has no easy answer and it depends on the essential mechanism of system growing under competition and how this mechanism is perceived. Hence, forecasting based on logistic S-curve can be very illustrative. It should be taken into account that that the trends forecast by logistic S-curve are also based on certain assumptions, e.g. how big will be the value of limit of growth (i.e. the ceiling level), hence one may perceive the forecast trends as essentially ideas on how the trends would be.

Projecting the broadband coverage roll-out and service subscription evolutions, the weakness of this method is not obvious in that the coverage and subscription rates are essentially accumulated parameters with a maximum (ceiling) value of 100%. The uncertainty does exist as to how accurate and different the ceiling, or the saturated, coverage or subscription value would be.

For socio-technical systems the three-parameter S-shaped logistic growth model is applied to describe a continuous "trajectories" of system's growth or decline through time. More specifically, in this exercise work, the following formula has been used:

$$f(x) = \frac{L}{1 + e^{-k(x - x_0)}}$$

to model the projection, with the parameters of

L: maximum coverage or service subscription rate (i.e., ≤100%)

k: steepness of the S-curve

x_0: the time when 50% of the maximum coverage or service subscription is reached.

For the projection of the broadband coverage the maximum ceiling level has been set to 100%, while for the maximum broadband service subscription the ceiling level can be significantly less than 100%. Hence the S-curve fitting consists in finding the *k* and x_0 parameters which minimise the “error” between the predicted curve and the observed values for the past years.

2. Updated research and details on **each member state’s initiatives** (if available) and **reported actual government figures and estimates** (see details per member state in Table 1 and in Annex A). Beside the extrapolated figures, there are figures and estimates (but not from all member states) that have been added.[6]

[6] Note: All EU member states have been invited to provide the project with updated figures. Not all EU member states have responded. See Annex E for the questionnaires used.

3. Finally, three **overview** summary tables of all EU member states estimated number of schools lacking broadband have been compiled (see section 2.3 below, Table 1, 2 and 3), including the presence of a **dedicated** national school broadband programme (through direct questionnaire and/or country reports)[7].

2.3. Schools' availability to broadband access

In a survey conducted in 2006, 65% of EU primary schools were connected to internet, and 74% of secondary schools[8] - but not necessarily to real broadband access. In the Schoolnet survey undertaken in 2011-12[9] between 5% and 8% of students in Europe on average, depending on level, were in schools with no internet access at all. If we look at schools that 2011 lacked internet access with a speed of less than 5 Mbps the figures increase to 40% for primary schools. At this time (2011-12) the most common access technologies used were fixed (ADSL mainly, followed by fibre and cable), see below figure:

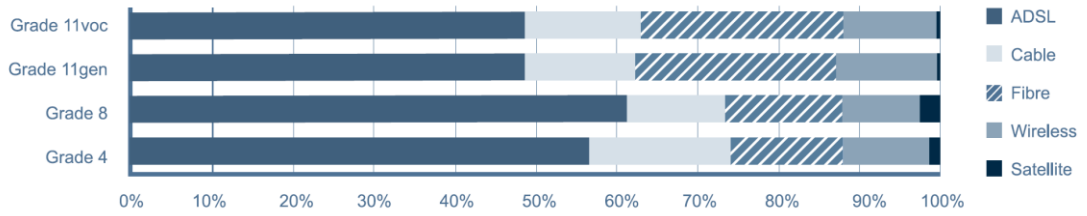

Figure 1: Access type per school level (percentage of students in schools, divided into 4 levels: Grade 4 = Primary schools (ISCED 1) and Grades 8 and 11 = Secondary schools (ISCED 2-3))[10].

Today, in 2016, in general most EU secondary schools are connected to broadband (with at least 5 Mbps), while there are still several countries where primary schools are lagging behind, so this category of schools should be prioritized when addressing the digital divide. The progress is to a large extent the effect of dedicated national support programmes (for schools) in place in more than half of the EU member states.

The current need for fully closing the gap and speeding up the support to ensuring the availability of broadband to schools should mainly take place in Germany, Poland, UK, Austria, Italy and Spain. There are also some member states that have connected most schools (or at least 100% of all secondary schools) to high-speed broadband already today, or are

[7] In Annex F these tables are expanded.

[8] Survey of Schools: ICT in Education - SMART-Nr 2010/0039

[9] Ibid.

[10] Ibid.

expecting that to happen latest by year 2020 and therefore are in principle in no need of additional support.

Annex A provides information on each member state's reported situation regarding schools' availability to broadband and if there are specific support programmes dedicated to connecting schools. Given this information some member states have already reached their objectives, often by the full implementation of these government-driven programmes.

Table 1 below is a summary of estimated (calculated by trend extrapolation[11], see section 2.2 and officially estimated by some member states) **number of schools that lack broadband** (or have an internet connection with less than 5 Mbps of downlink bandwidth/speed) in year 2015 and 2020 respectively. Besides the extrapolated trend figures and the estimates directly from member states there is also stated if the member state has a dedicated broadband for schools programme.

When comparing the extrapolated figures with the government estimates, those for year 2015 the differences are not that large and there are some schools (especially primary schools) that still lack broadband. When looking at the 2020 forecast figures (extrapolated vs government estimated), the numbers decrease significantly (even for primary schools).

When analysing the extrapolated total figure for 2020, there are approximately 12% of the schools throughout EU that lack broadband – if an *ordinary build-out pace* of broadband would continue as before – but if we look at the "limited" government estimates the figure for 2020 is getting close to 0%. An interpretation of the low figure government estimates for 2020 is that due to the dedicated school broadband programmes there is a large likelihood of reaching those targets. Another interpretation is that these figures are somewhat optimistic, regarding the short time frame to reach them.

As the table shows, member states are addressing the issue of school connectivity and working to progress on the DAE goals. By 2020, very few schools are expected to be without broadband connection (with at least 5 Mbps), unless the plans and forecasts of the national governments are not met. However, **the problem today remains acute, with around 48 000 schools in the EU not fully connected.**

We therefore believe there is a case for a quick, well-functioning and pragmatic solution to bridge over to 2020 (and possibly beyond in some cases) by using satellite broadband.

[11] Trend extrapolation from SMART 2010/0039 and EC Digital Scoreboard historic data

	Total # of schools	# Schools lacking broadband 2015 (<5 Mbps)		# Schools lacking broadband 2020 (<5 Mbps)		Dedicated school broadband build-out program in place (or done)
Country	Primary and Secondary, ISCED 1-3	Trend extrapolation estimate	Government estimate	Trend extrapolation estimate	Government estimate	
Austria	5 881	1 675		1 396	Low	No
Belgium	2 290	635	229*	346	Low	Yes
Bulgaria	2 500	150		73		N/A
Croatia	1 674	326		220		N/A
Cyprus	532	164		41	Low	Yes
Czech Republic	5 416	996	134*	484		No
Denmark	2 885	283	Low	134	0	Yes
Estonia	588	83		60	0	Yes
Finland	3 256	463	Low	380	0	Yes
France	48 764	2 316		48		Yes
Germany	38 217	8 358	*	5 692		No
Greece	8 683	1 969		425	0	Yes
Hungary	4 214	1 087	540*	675		Yes
Ireland	3 873	794	*	375	Low	Yes
Italy	27 939	9 494	4700*	8 094	0	Yes
Latvia	898	296		206		Yes
Lithuania	1 028	134		82		Yes
Luxembourg	197	26		17	0	N/A
Malta	186	2		0	0	No
Netherlands	8 982	522	629*	67	Low	Yes
Poland	30 045	8 939		8 143		No
Portugal	8 273	462		125		No
Romania	6 275	961	1945*	541	Low	Yes
Slovakia	2 823	1 121		759		N/A
Slovenia	782	77	*	38	0	Yes
Spain	18 682	2 559		1 395	0*	Yes
Sweden	6 233	1 156	*	991	0	No
United Kingdom	25 053	3 182		1 188		No
TOTAL	**266 169**	**48 230**		**31 997**		
Share	*100%*	*18%*		*12%*		

Table 1: Overview of broadband availability to Schools in Europe (based on extrapolation of Schoolnet figures and Government estimates from additional questionnaires/country reports). All * marks are comments that can be found in Annex F.

The below table shows the number of *primary schools* that are estimated by **trend extrapolation** of 2011-12 survey figures (see section 2.2) to lack broadband access in 2015 (approximately 27%) and in 2020 (approximately 19%).

	#Primary schools (ISCED 1)	Share (%) of Primary Schools that lack broadband access (< 5 Mbps; extrapolated)		Extrapolated # Primary Schools lacking broadband (<5 Mbps)	
Country	**2015**	**2015**	**2020**	**2015**	**2020**
Austria	3 066	53%	45%	1 613	1 393
Belgium	1 750	36%	20%	625	346
Bulgaria	1 474	9%	5%	135	73
Croatia	1 245	25%	18%	314	219
Cyprus	364	43%	11%	156	41
Czech Republic	4 112	24%	12%	972	484
Denmark	2 306	12%	6%	281	134
Estonia	345	22%	17%	76	60
Finland	2 644	17%	14%	459	379
France	37 379	5%	0%	1 874	31
Germany	16 588	45%	34%	7 480	5 658
Greece	5 005	32%	8%	1 626	411
Hungary	2 294	44%	29%	1 003	672
Ireland	3 165	24%	12%	773	374
Italy	15 281	57%	53%	8 724	8 063
Latvia	832	35%	25%	293	206
Lithuania	502	24%	16%	120	82
Luxembourg	154	17%	11%	25	17
Malta	115	0%	0%	1	0
Netherlands	6 703	7%	1%	449	64
Poland	13 446	61%	60%	8 249	8 117
Portugal	5 846	8%	2%	440	124
Romania	3 136	28%	17%	879	538
Slovakia	2 133	51%	36%	1 084	758
Slovenia	391	17%	10%	68	38
Spain	10 350	23%	13%	2 397	1 389
Sweden	4 897	23%	20%	1 148	991
United Kingdom	21 008	15%	6%	3 149	1 187
TOTAL	**166 531**			**44 413**	**31 849**
Share	*100%*			*27%*	*19%*

Table 2: European Primary Schools lacking high-speed broadband (trend extrapolation only).

Compared to the figures for *secondary schools*, see below, the numbers are significantly higher and we can conclude that the **lack of broadband to primary schools is much higher** while for secondary schools this is more or less a diminishing problem in the years to come.

The table below shows the number of secondary schools that are estimated (by trend extrapolation of 2011-12 survey figures, see section 2.2) to lack broadband access in 2015 (approximately 4%) and in 2020 (approximately 0%).

	#Secondary schools (ISCED 2-3)	Share of Secondary Schools that lack broadband access (<5 Mbps; extrapolated)		Extrapolated # Secondary Schools lacking broadband (<5 Mbps)	
Country	**2015**	**2015**	**2020**	**2015**	**2020**
Austria	2 815	2%	0%	62	2
Belgium	540	2%	0%	10	0
Bulgaria	1 026	1%	0%	15	1
Croatia	429	3%	0%	13	0
Cyprus	168	5%	0%	8	0
Czech Republic	1 304	2%	0%	24	1
Denmark	579	0%	0%	3	0
Estonia	243	3%	0%	6	0
Finland	612	1%	0%	4	0
France	11 385	4%	0%	442	17
Germany	21 629	4%	0%	879	34
Greece	3 678	9%	0%	343	14
Hungary	1 920	4%	0%	84	3
Ireland	708	3%	0%	20	1
Italy	12 658	6%	0%	770	30
Latvia	66	4%	0%	3	0
Lithuania	526	3%	0%	14	1
Luxembourg	43	1%	0%	0	0
Malta	71	2%	0%	1	0
Netherlands	2 279	3%	0%	73	3
Poland	16 599	4%	0%	690	27
Portugal	2 427	1%	0%	22	1
Romania	3 139	3%	0%	82	3
Slovakia	690	5%	0%	37	1
Slovenia	391	2%	0%	9	0
Spain	8 332	2%	0%	162	6
Sweden	1 336	1%	0%	8	0
United Kingdom	4 045	1%	0%	33	1
TOTAL	**99 638**			**3 817**	**148**
Share	*100%*			*4%*	*0%*

Table 3: European Secondary Schools lacking high-speed broadband (trend extrapolation only).

2.4. Barriers to adoption

Below is a short summary of the main barriers to schools' adoption of *broadband services* (independent of technology) that the study has identified. More details can be found in the description of the case studies (see section 7 and Annex B):

2.4.1. Severe barriers: Awareness, Coordination and Price.

a) Awareness

- Poor **awareness** among schools and local authorities of what **broadband services** and options are available on the market.
    - The knowledge of different broadband service alternatives at school level is often limited, especially the knowledge of satellite-based broadband services and particularly in smaller, primary schools. This lack of knowledge is more or less evenly spread throughout EU. Further information and training in ICT is of evident needed at school level.
    - Clear, basic information about different options should be compiled and communicated to the schools in conjunction with information around funding alternatives and possibilities.

- Poor **awareness** and knowledge among schools and local authorities of possible **support and financing sources and capabilities** for improving ICT capabilities, including broadband access, and how to apply for these.
    - In many cases there is a lack of knowledge about potential funding mechanisms, what is required and what schools or authorities need to do in order to apply for and to receive funding support.
    - Information about different options should be compiled and communicated to the schools in conjunction with information around broadband service and support alternatives.

- Lack of knowledge about the **possibilities to use voucher schemes** to lower the initial threshold of investing in ICT capabilities and broadband access.
    - Need for information and improving the knowledge of how to **construct** a relevant and well-functioning voucher scheme, based on available funding sources above.
    - Lack of faster decision-making and implementation processes to introduce voucher schemes, in order to bridge the digital divide in the near term. Voucher schemes can be implemented fairly **quickly** in order to decrease the gaps that may be a barrier to the evolution and development of the school system and teaching.

- **Insufficient means** among central and local authorities **to raise awareness** and **communicate** adequately.
    - In order to close the knowledge gap around different broadband service and funding options there is in many countries a need to increase organised communication activities.
    - E.g. in France the use of a communication plan regarding IT in schools is not yet very widespread: only 31% of academies and 12% of local governments have established a communication plan (see section 9.1.3.3 and 9.1.5.6).
    - The newly established EU Broadband Competence Offices (BCOs) being set up in several countries (see https://ec.europa.eu/digital-single-market/en/broadband-competence-offices) can be utilized for this as well as school and education related authorities.

b) Coordination

- Lack of **comprehensive approach on digital learning.**
    - In several member states there is a lack of a thorough, nationwide strategy for digital learning, and there is a strong need to enhance the understanding of adapting new teaching practices involving IT, in many cases dependent on qualitative broadband access.
    - These strategies often include a section dedicated to the introduction of new types of technologies and IT tools, but even more important is the strong need for training of teachers and school staff, for them to be able to fully exploit these new IT tools and for the students/pupils to leverage the full potential. Having high-speed broadband access to all schools is a prerequisite in order to realise these strategies and use the tools fully.

- Lack of **dedicated national/regional programmes** to support and stimulate availability to broadband access, as well as support, ICT training and other tools to schools.
    - Even though a majority of EU member states have some kind of dedicated programme to enhance ICT capabilities in schools, some still lag behind. There seems to be a correlation between lack of these programmes and the penetration of broadband in schools (see table 1).

- Lack of **administrative coordination** slows down broadband uptake to schools.
    - There is in several countries a need to better coordinate support, funding, information etc. between key authorities and other relevant bodies in order to simplify processes and speed up broadband uptake to all schools.
    - This is also a task that can be appointed (if not already present) to each country's BCO (see above bullet) or similar organisation.

c) Prices

- **High prices** for terrestrial broadband (fixed and mobile) installation and/or service fees.
  - In some markets (e.g. Cyprus, Romania, Spain, Croatia and Portugal[12]), the prices are considerably higher than the relative prices in other markets like Sweden, Denmark, Finland and Lithuania. This may make the possibility to set aside a part of a school's budget for broadband less plausible.

2.4.2. Other potential barriers

- **Ethical and cultural aspects** of using new digital learning methods and tools may become a barrier, if handled improperly.
  - In digital learning strategies the ethical and cultural aspects also have to be considered and handled in the best way, otherwise the use of different IT tools may become counter-productive and a barrier to positive adoption and use.

- **Insurance** issues for hardware.
  - Due to investments in new IT hardware of different kinds, the cost for covering the insurance of these often increases, but there are also numbers of situation where it is unclear who should be responsible for handling the insurance needed.

Conclusions: **Since 2011-12 there has been a strong progress in securing broadband access to schools throughout all of Europe, especially in the member states where IT maturity has been high and national support/funding programmes dedicated to schools have been present. But there is still an obvious need to close the remaining gaps in some selected countries, especially for primary schools. The ever-growing need and use of more bandwidth demanding applications (e.g. high-quality video classes or conferencing) will continue to drive schools' needs to connect to higher-speed broadband.**

There is also obviously a strong demand in many countries for better knowledge and awareness around broadband services, IT tools and funding/support options. This would also improve if the involved actors and initiatives were better coordinated and that processes and administration around support programmes (e.g. voucher schemes) were more standardized and easy-to use. An increased use of voucher schemes can be a quick way to close the gap in the near term for schools in the digital divide.

[12] EC, Digital Scoreboard 2015

4. SATELLITE BROADBAND: A SOLUTION TO CLOSE THE GAP?

4.1. Introduction

In order to better understand if the digital divide gap for schools can be lowered over the next years by using satellite-based broadband solutions and services we need to take a closer look at the solutions available on the market. This chapter gives an overview of the satellite-based technical solutions and services able to connect every school to high-speed Internet, and provide some recommendation for pan-European, large-scale deployment in schools on the basis of the requirements identified during the analysis of the case studies as well as the satellite technology evolution.

4.2. Why broadband to schools via satellite?

Satellite-based broadband has some inherent advantages:

- **Ubiquity and Quality:** Satellite communications offer a predictable and stable quality of service everywhere, regardless of geographic location, independently of the distance from the ground infrastructure to the end-user premises. Any building can have fast internet access, so long as a satellite dish can be positioned so that it can see the sky. Satellite connection is not as good as a fast fibre connection, especially for specific services (e.g. real-time applications, like on-line gaming, on which the delay requirements are very stringent, are not feasible with satellite connection considering the long round-trip delay), but performance is suitable for most standard applications used in schools.
- **Quick and immediate access:** Deployment of a satellite broadband service is simple; the only requirement is to install the user terminal equipment – no need for additional networks infrastructure, installation typically takes a couple of hours.
- **Cost-effectiveness:** The deployment cost is independent of terrain characteristics, population density or right-of-way regulation, etc., hence cost per user is fixed everywhere. It is commonly accepted that satellite technology is the most cost-efficient solution for broadband in areas with a low population density of typically less than 150 inhabitants per km^2.[13] Finally, satellite internet services are reasonably priced.
- **High reliability and security:** Satellites have very limited downtimes and service disruptions during its lifespan (typically 15 years for GEO satellites).

In summary satellite-based broadband is a viable option if a school can't get online by any other means.

[13] See the ESA "OCEAN" study that has computed the cost per premises for satellite and terrestrial services in remote and rural areas.

4.3. Satellite network architecture

This section describes the satellite network architectures of potential interest to connect schools, either currently available on the market or which can be made available near-term, and compatible with demands on internet usage of today[14].

The different architectures are intended to fulfil the different needs of schools identified during the analysis of the case studies. The commercial aspects are also taken into account, with the goal of finding a balance between performance and (up-front and recurring) costs.

The table below summarises the main characteristics of the satellite network architectures and associated services and equipment costs which will be analysed in the following sections.

	Fast internet access with standard consumer offers	**Fast internet access with tailored professional offers**	**Hybrid network with fast internet access + broadcast + storage**
Characteristics			
Requirements	Download speed up to 22 Mbps, 10-40 GB monthly volume allowance per site.	On a per-project basis (download speed up to 30-50 Mbps, possibility of aggregated volume allowance).	
Fixed costs (typical)	€450-600 per kit (including transport, installation, activation and VAT).	600-900€ per kit (including transport, installation, activation and VAT).	As per one of the previous cases, plus additional €100 per kit, plus €500 per NAS (see section 4.8.2 and 4.8.3).
Recurring costs (typical)	€35-90 per month.	On a per-project basis.	As per one of the previous cases, plus a few additional €/month per school (plus distribution network costs at central level, on a per-project basis).
Proposed voucher value per school (typical) covering fixed costs + 2-year service	€1,700	€3,200	As per one of the previous cases, plus additional €600.

Table 4: Satellite network architectures of potential interest to connect schools (price range reflects prices variations across Europe)

[14] At the horizon year 2020-22 a new generation of more powerful satellites will serve the market with performance in line with the fast evolution of the requirements and at a price which is consistent with the current pricing.

4.4. Increasing performance of satellite broadband

In Europe fully bi-directional Internet access service based on satellites has existed for more than 10 years. At the beginning, satellites had high subscription fees and terminal equipment was costly. Therefore acquisition, installation and operational costs were somehow prohibitive for rural schools.

Today, with technological progress (e.g. multiple spot-beam coverage with frequency reuse in the so called KA frequency band and more efficient modulation schemes), satellite operators can serve a large number of subscribers with offers even for the residential market, with performance similar to terrestrial ADSL at a comparable price.

Available data rates have largely improved continuously, which translates into a better end-user experience. In 2010 the high-end services allowed downloading speeds up to 5 Mbps and uploading speed up to 1 Mbps. While from 2012, the performances have jumped up to 22 Mbps in download and up to 6 Mbps in upload.

Finally, the technology development has helped to mitigate and overcome some challenges related to satellite communication (e.g. impact of latency on impact on some data services) and to improve the user experience of satellite broadband.

4.5. Satellite user equipment

The equipment kit to be installed at the school premises is composed by two parts:

1. **Small parabolic antenna:** The so-called outdoor unit (ODU), mounted on a rooftop pole either directly to an external wall, it is comprised of a parabolic dish (typically ranging from 70 to 120 cm in diameter, depending on application) with the two-way transmission/reception block mounted in the focus. It is connected to the internal modem positioned inside the school by a coaxial cable carrying the data traffic and providing powering.

2. **Modem** (indoor modem): A satellite modem manages data transfers using a communications satellite as a relay. The modem can connect to a router for a local redistribution (wired or wireless LAN, e.g. a Wi-Fi access point), so that the two-way satellite internet access serves a school by means of a single satellite dish.

The kit is delivered and installed by professional staff.

Today standard kits for broadband access over satellite (i.e. the ones widely used for the consumer market) provide high-speed two-way performance-up to 22 Mbps downstream and

6 Mbps upstream. They are based on a circular antenna dish of a diameter size of 75 cm and a 3 W amplifier[15].

Although costs vary from country to country and from offer to offer, the typical final price of a standard kit is in the order of €450-600 including transport, installation, activation and VAT.

Today professional terminals for Next-Generation broadband access over satellite provide high-speed two-way performance-up to 50 Mbps downstream and 20 Mbps upstream. They are based on a circular antenna dish of a size of 120 cm and a 4 W amplifier.

Although costs vary from country to country and from offer to offer, the typical final price of a professional kit is in the order of €750-900 including transport, installation, activation and VAT.

Finally, a kit made of a combination of a professional modem with a 75 cm antenna provides high-speed two-way performance-up to 30 Mbps downstream at a typical cost of €600-750.

The total price of the kit might be an obstacle for a large development of satellite-based Internet access for schools, especially in areas with low purchasing power. That is why school connectivity via satellite connectivity has partially relied on subsidy schemes from local governments, as shown in the analysis of the case studies (see section 7 and Annex B).

These financing schemes establish a level playing field among different broadband solutions: in terrestrial technologies, the user access to broadband internet is enabled by the support of the deployment of backhaul (and sometimes access) infrastructure, in satellite technologies with the support of ground equipment.

[15] Performance and dimensioning of the Tooway™ high-speed internet access consumer solutions based on KA-SAT, the first and still more advanced European satellite designed exclusively for the Internet.

4.6. How does internet via satellite work?

The figure below shows the three overall steps of how satellite-based internet access works:

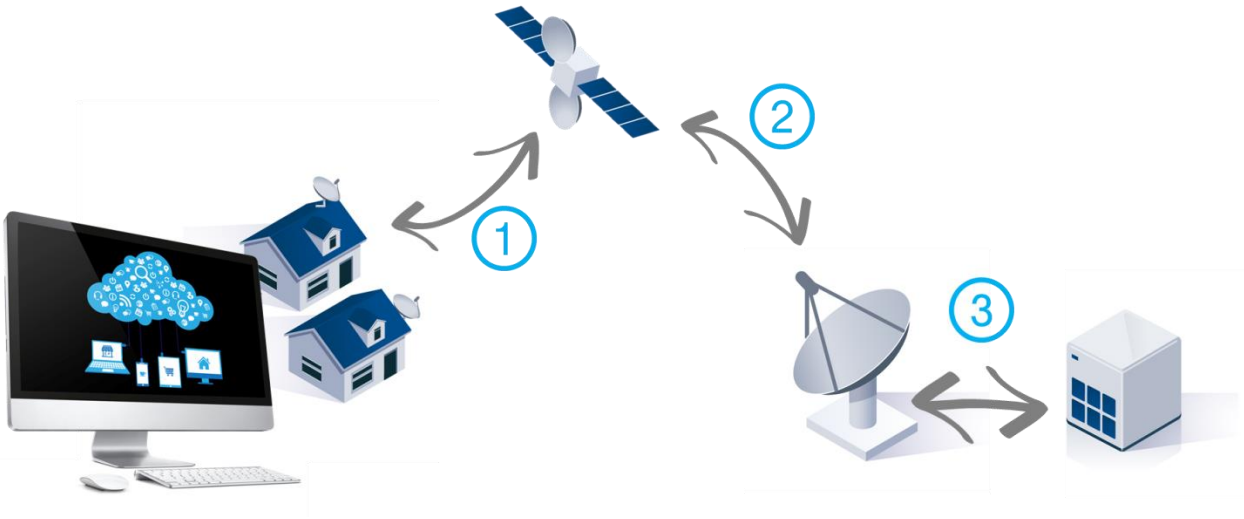

Figure 2: Accessing Internet via Satellite in three simple steps.

1. End-user equipment (e.g. a computer) is connected to the network, which in turn is connected to the Internet. The end-user computer sends a request for a transfer of data (for instance by opening a web browser and typing a web address). The request is sent from the end user equipment (PC, tablet, smartphone, etc.), through the local school network, to the indoor satellite modem which modulates the signal and passes it to the satellite dish. The transmission/reception block of the dish converts this signal to a radio signal and sends it at the speed of light to the satellite located in the geostationary orbit.
2. The satellite in the geo-stationary orbit receives this signal and sends it to the teleport. This illustrates the fact that although the packets of information travel tremendous distances via the space segment, the packets hop fewer networks (compared with other technologies) due to the large reduction in the number of inter-domain and intra-domain routers, giving an opportunity to minimise latency.
3. The request then goes to the *Network Operations Center* (NOC) of the teleport[16], which retrieves the requested website from the web server, across the Internet backbone, to which the teleport is connected via high-speed links.

The whole cycle is then reversed and the requested data is presented to the user.

[16] The teleport is the central earth station that controls communications across the space link; its manages the connections to/from remote satellite equipment at end-users' premises interconnecting them to the Internet.

4.7. Satellite service provisioning

In Europe, the satellite operator is not present in the retail market. It is the satellite Internet Service Providers (ISP) that manages the end-user, providing the service and related activities as installation and first level of assistance. No commercial vertical integration exists between the ISPs and the satellite operators (owners of the infrastructures) in Europe.

Satellite services can be usually purchased from ISPs[17], therefore procurement processes including vouchers schemes should involve them rather than the satellite operators. For instance, the French programme *Ecoles Connectées* call-for-projects described in the analysis of the case studies (see section 9.1.5) was directed toward ISPs able to equip eligible schools with peak rate of at least 16 Mbps downstream and 2 Mbps upstream in mainland France. Some offers propose better performance than the minimum required: see for instance Figure 3 and 4 below, displaying offers based on the use of KA-SAT satellite[18] and the tooway™ system[19], each providing 22 Mbps downstream and 6 Mbps upstream, with different monthly volume allowance selected to fit with different consumption patterns (usage, number of users, etc.) of different types of school.

Finally, as logistics and installation are two most important steps in the roll-out of any satellite network, ISPs must dispose of an effective installer network on the territory.

[17] Practical information in order to find a local satellite ISP can be found in the non-commercial online tool Broadband-for-All (www.broadbandforall.eu), an initiative of ESOA (the EMEA Satellite Operators Association) supported by the European Commission.

[18] KA-SAT is the first European HTS (High Throughput Satellite) Satellite in Ka (20-30 GHz) frequency band, allowing to decuple the data traffic capacity with respect to the standard telecommunications satellites of the previous generations.

[19] www.tooway.com

Figure 3: Example of characteristics of satellite Internet for schools in France[20].

[20] Source: https://www.nordnet.com/offres/connect-ecoles/notre-offre.php

Internet Satellite
Connect'Ecoles

Revenir à l'offre

Nos offres et tarifs

	Connect'Ecoles	Connect'Ecoles +
	39 €90 TTC/mois	59 €90 TTC/mois
SURF ET E-MAILS En savoir plus	Disponibles en permanence	Disponibles en permanence
TRAFIC MENSUEL TOUS USAGES En savoir plus	12 Giga (à utiliser entre 8h et 18h)	26 Giga (à utiliser entre 6h et 18h)
TRAFIC ILLIMITÉ LA NUIT De minuit à 6h	–	✓
LIGNE DE TÉLÉPHONE (VoIP) Facturation des appels à la seconde	✓	✓

Frais de dossier : OFFERTS
Engagement : 12 mois

Connect'Ecoles 39€90 TTC/mois Connect'Ecoles + 59€90 TTC/mois

Figure 4: Example of satellite Internet offer for schools in France[21].

4.8. Service and quality requirements

The analysis of the satellite ISPs' offers for schools should be based around the below parameters (at least), to be considered either per each site or as aggregate elements:

- Download speed
- Upload speed
- Data volume allowance (monthly)
- Monthly subscription fee
- Characteristics and price of the equipment kit
- Support services included

These parameters are essential to assess the quality of service (QoS) and the value for money of the various offers with respect to the requirements.

The cost structure of services which depends on the use of the satellite resources (bandwidth and power) is in most cases based on the volume of transferred data rather than on the peak

[21] Source: https://www.nordnet.com/offres/connect-ecoles/tarifs.php

download/upload speeds. That is why caps (limits) are put on the volume of data that can downloaded and uploaded over periods of time – a few hours and / or a week – and when these limits are exceeded, the connection is temporarily slowed down[22].

The most advanced standard satellite offers currently available on the market provide high-speed Internet receiving up to 22 Mbps and sending up to 6 Mbps. They vary based on the allowed volume of data (GB / month of usage, e.g. 10, 25 and 40), e.g. in the case of the French *Ecoles Connectées* programme, 75% of schools have subscribed to offers providing a volume allowance of around 10-12 GB/month and the remaining 25% of around 20-26 GB/month.

In addition, satellite TV can often be provided by simply adding a small piece of equipment to the satellite dish to receive the TV channels. Phone calls with Voice over IP (VoIP) technology can also be provided as an option, so as to benefit of a Triple-Play service.

4.8.1. Standard vs customised offers

In case where the performance provided with a standard service is not deemed satisfactory to fulfil the requirements (e.g. regular use of multi-site videoconferencing, as shown in the analysis of the Italian case studies), scalable options can be applied to tailor ad-hoc service packages on a per-project basis (with relevant additional costs) with specific set of customizable options such as:

- Enhanced speed
- Enhanced volume allowance thresholds
- Tailored traffic shaping and priorities (e.g. VoIP)
- Number and characteristics of the IP addresses for each kit, including multiple, static IP addresses per terminal and the use of national IP addresses.

In addition, customisation can

- Offer a reserved and guaranteed satellite bandwidth (measured in Mbps), shared by all terminals of a group of schools.
- Offer a volume commitment on the monthly aggregate volume consumption: accounting is based on volume consumed by all terminals of a group of schools, with a specific monthly volume commitment (in TB) to be agreed.

This can prove to be useful in the provision of connectivity services when some adaptation is needed according to the specificities of given areas (taking for instance into consideration the current fragmentation of the EU in terms of needs, purchasing power, rules and regulations, policies for the introduction of digital technologies in schools).

[22] Indeed this applies not only to satellite. All the broadband technologies are implicitly or explicitly confronted by volume limitations to prevent network congestions: in particular, mobile data subscriptions are generally limited in volume.

4.8.2. Hybrid networks

As previously explained, satellite TV can be provided on top of broadband connectivity by simply adding a small piece of equipment to the satellite dish. This is a recommended feature for schools, as educational TV programs are available in most EU countries through free-to-air satellite channels with educational focus (see for instance *RAI Scuola*[23] available through the Italian free-to-air satellite platform *Tivùsat*), and can be included within the schools activities, as shown in the analysis of the Irish case studies.

In the future, a valuable enhancement to the Internet access to contents by schools in rural and/or digitally-divided areas can be achieved through a quick-to-market solution based on an extensive use of the satellite broadcast distribution coupled with the satellite broadband connectivity.

The generic concept of hybrid broadcast-broadband systems, which applies to terrestrial network as well, combines the advantages of two architectures:

- Broadcast networks are particularly suited for delivering the same content simultaneously and homogeneously to a large number of terminals
- Broadband networks, providing point-to-point connectivity, are suited for accessing and delivering individual choice of on-demand content.

4.8.2.1. Why hybrid networks for schools?

The goal is to improve access to information and educational content in school through the creation of a local electronic library (to be constantly and regularly updated) of videos, interactive video-based content, e-books, digital textbooks, exercise software, simulations or learning games, interactive maps, software, as well as other education tools.

In fact educational content is becoming larger and richer (increased video quality, bigger file sizes of software, etc.), and accessible not only on PCs and TVs but also on portable devices such as tablets and smartphones (see **Error! Reference source not found.** graph), causing new consumption patterns.

[23] Channel with learning focus intended principally for primary and secondary schools, with programs often produced in collaboration with the Ministry of Education.

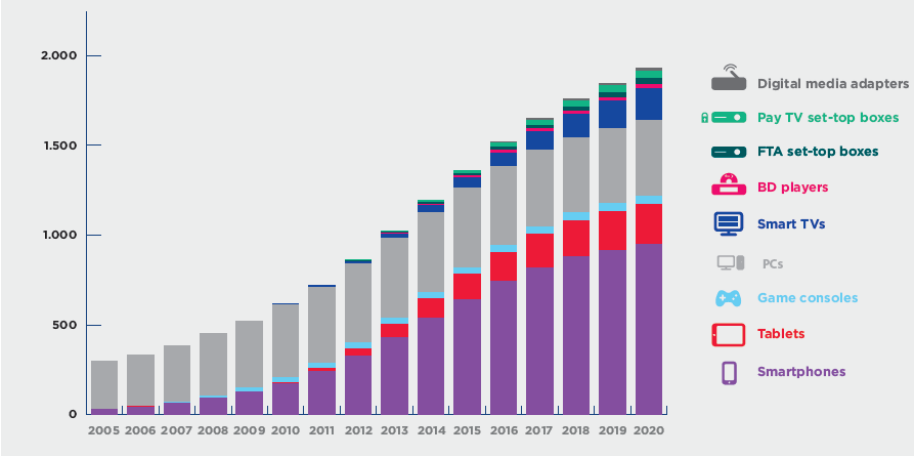

Figure 5: Installed connected devices in Europe (in millions).[24]

However the individual access to multiple streams of rich content stored in **central** databases and websites can either be hard from remote schools with limited bandwidth, or quickly consume the monthly allowance for schools with limited volume of traffic.

In order to improve **at an affordable price** the *Quality of Experience* of these schools, where broadband access must be used "reasonably", i.e. excluding as much as possible video streaming or downloading, it is proposed to replace point-to-point access to educational content with smart delivery approaches like push delivery, and to rely on a hybrid infrastructure where:

- The distribution of a large **common** base of programs, media, software approach to a **local storage** (in technical words, a Network-Attached Storage or NAS), to be later accessed and consumed on demand in each school, is carried out via satellite broadcast.
- The point-to-point connection for web surfing, interactivity, etc. is carried out via satellite broadband.

This hybrid approach ensures an efficient usage of capacity for access to contents, which translates into a reduced overall cost. See below for details on the hybrid network system architecture and considerations on cost and service provisioning.

[24] Source: IHS Electronics and Media, taken from the report "Vision 2020 – Connecting to a networked society – an EBU project".

4.8.3. Hybrid network system architecture

The proposed system architecture (see below figure) is applicable to a vast majority of schools. It relies on two types of satellite systems:

- A **broadcast** system to distribute the content using a **push** approach.
- A **broadband** system to ensure a **point-to-point** connectivity so that schools can access on-demand educational content and connect to the Internet. This broadband access also enables a return channel to deal with content right management.

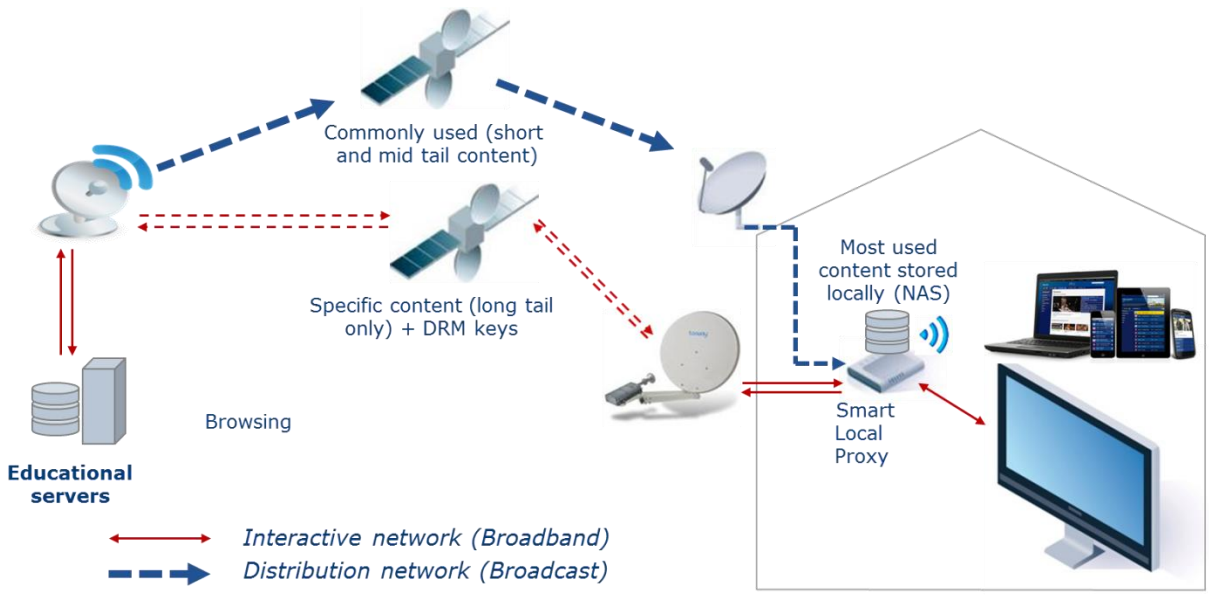

Figure 6: Hybrid broadcast-broadband satellite system for schools

This simple architecture requires a "smart" local proxy/router in the school that delivers remotely and locally stored on-demand content to all screens. It features the following functions:

– Broadcast reception capabilities plus Internet connectivity (or the ability to connect to a modem).
– Ability to distribute video content inside a building in IP format (including conversion of digital video broadcast (DVB) transmissions to IP streams).
– Storage capability.

This local proxy/router is part of the network, and as such is managed by the Internet Service Provider, possibly in collaboration with the Ministry of Education (or any other public authority which manages the educational and administrative contents intended for schools). It

provides a transparent user experience irrespective of the infrastructure that delivers the content or the screen used.

4.8.3.1. Considerations on cost of hybrid solutions

A simple cost calculation for the delivery of rich educational content is provided in, taking as an example the delivery of one hour of educational content in High-Definition (HD) and the new Ultra-High-Definition (UHD) format.

The costs are based on the average lease rate of a full satellite transponder.

Typical cost per leased transponder (36 MHz)		1.5 M€ / year
Bit rate per transponder (27.5 MSps[25], 8-PSK 2/3)		53 Mbps
Cost per GB		7.18 €
One hour of HD content at 6 Mbps (MPEG-4/AVC)		2.7 GB
Cost per hour of HD content	Overall	19.38 €
	Per school, assuming delivery to 1000 schools	**1.94 cents**
One hour of UHD content at 15Mbps (HEVC)		6.75 GB
Cost per hour of UHD content	Overall	48.46 €
	Per school, assuming delivery to 1000 schools	**4.84 cents**

Table 5: Example of cost for the delivery of high-quality content to schools using broadcast satellite.

For the sake of comparison, we can evaluate the approximate cost of individual downloading of the same content through a satellite broadband connection. With a subscription at €59.90/month including 25 GB monthly data volume allowance, the cost for downloading one hour of HD content would have been of €6.21 per school, the cost for downloading one hour of UHD content would have been of €15.52 per school.

From the above comparison, it can be noted that the broadcast delivery becomes cheaper than point-to-point delivery at a very low number of simultaneous users.

Of course, point-to-point delivery gives the possibility to access to any content whereas broadcast delivery limits the choice to a given (yet large) number of pre-selected contents.

[25] Mega Symbols per second.

However, this seems acceptable for educational purposes, as most of the contents to be pushed to schools (videos, interactive video-based content, e-books, digital textbooks, exercise software, simulations or learning games, interactive maps, software, as well as other education tools) are mostly pre-defined by the Ministry of Education (or any other relevant public authority) on the basis of academic programmes.

4.8.3.2. Considerations on service provisioning of hybrid solutions

The analysis carried out in the previous section shows that for a large number of schools, a broadcast approach to push educational and administrative content to local storages would cost only a fraction of the aggregated broadband monthly subscriptions. In other words, this hybrid approach would ensure an efficient usage of capacity for access to contents in any national landscape, which translates into a reduced overall cost for the schools.

Two elements should be brought together for this solution to become an operational reality:

1. The above costs for broadcasting contents are calculated using a satellite full-transponder capacity on a 24/7 basis. However the total amount of content for a given category of schools with a country is unlikely to require a 24/7 operation. One TB of content (equivalent to 40 Blu-Ray or 100 HD DVD) could be delivered in 42 hours using a satellite full transponder capacity, and the rate of content updating is not expected to be frequent (monthly updates should be sufficient). Therefore the usage of the transponder would have to be shared with other applications[26], or, even better, mutualised at a higher level (e.g. pan-European) and then shared among the educational systems of several countries.

2. A content delivery system to group of schools shall be built and its local storages (including access rights to content) be managed, possibly in conjunction with the administration of central content management platforms accessible through the Internet. This shall normally be implemented by (or on behalf of) the Ministry of Education.

Conclusions: **Satellite-based broadband is a well-established and viable option to quickly close the connectivity gap for unconnected schools and well suited for voucher schemes. If digital access to more extensive, rich learning content is needed, hybrid network solutions are also available for implementation.**

[26] For instance, the International Telematic University UNINETTUNO, which broadcasts lectures in English, Italian, French and Arabic 24 hours a day through a satellite TV channel, use part of the resources of transponders of the Italian broadcasters Sky and Tivùsat.

5. EU FINANCING OPTIONS AND VOUCHER SCHEMES

The purpose of this section is to provide an understanding of the possible financing support and voucher schemes for authorities to bridge the digital divide for schools, based on:

- EU Legal, Regulatory and Competition context and mechanisms
- EU Funds for Voucher Scheme usage in financing broadband
- Broadband procurement models

5.1. EU Legal, Regulatory and Competition context

A stronger coordinated policy at EU and Member States level to promote the use of ICT in education and training at a larger scale can enable the EU to address the issue more efficiently.

This is why innovating in the education sector is a key priority for a multitude of flagship initiatives within Europe 2020 Strategy. One of them is the *Digital Agenda* for Europe that strongly underlined the importance of the internet connectivity to improve ICT skills in education.

The intention of the EU Institutions is to improve coordinated policy at EU and Member States level to promote the use of ICT in education and training in order to improve the efficiency, accessibility and equity of ICT skills in education, training and learning systems. One of the preconditions to integrate ICT in education and training systems is firstly increase availability and adoption of specific policies able to provide legislatives instruments to connect schools and classrooms to broadband Internet service.

The EU Commission has dedicated resources in order to increase school connectivity to the internet pushing the coordination of policies throughout different initiatives.[27]

One of this is the EC Communication Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources[28] where is clearly stated that "Enhancing local ICT infrastructure (broadband, content, tools) is still needed in some parts of Europe…" and that "Member States are investing in upgrading their national educational infrastructure (ICT, digital educational resources, broadband) but fragmentation and incoherence among EU Member States persists. On average, 93% of EU students access the internet at home, but only 72% have access to it at a place of education, and sometimes not in the classroom.

[27] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0470.01.ENG

[28] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1389115469384&uri=CELEX:52013DC0654

One of these initiatives is the EC Communication 'Opening up Education: Innovative teaching and learning for all through new Technologies and Open Educational Resources'[29] where is clearly stated that "Enhancing local ICT infrastructure (broadband, content, tools) is still needed in some parts of Europe…" and that "Member States are investing in upgrading their national educational infrastructure (ICT, digital educational resources, broadband) but fragmentation and incoherence among EU Member States persists" Until now, none of those policies contemplate the voucher scheme instrument to tackle the school connectivity issue.

The EU Commission has started to consider **voucher schemes** as an important instrument to overcome barriers to access to specific services (see more details in section 6). This is the case of the ICT Innovation voucher scheme[30]: Small grants vouchers provided by the public administrations to small and medium-sized enterprises (SMEs) to purchase innovation services targeted to their business operations.

Specifically on broadband infrastructure, **the state aid broadband guidelines**[31] include **the voucher scheme instrument** as a demand-side measure suitable to contribute positively to broadband penetration. In this case, the use of vouchers, could "cover (part of) the end users' costs of installation or purchase of broadband devices, or of the monthly subscription"[32]. This explanation is also highlighted in the Guide for high-speed broadband investments published by *DG Regio*[33].

The state aid broadband Guidelines also clarified the areas of public interventions drawing a distinction between white, grey and black spots areas:

- **White spots areas:** Where a broadband infrastructure neither exists nor is planned in the near future - The Digital Divide areas.
- **Grey spots areas**: Just one broadband network operator - aid has to be specifically analysed to prevent any distortion of competition.
- **Black spots areas:** Not eligible for aid as they are covered by at least two broadband networks that are in effective competition with one another.

[29] https://ec.europa.eu/digital-single-market/ict-innovation-vouchers-scheme-regions

[30] EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks (2013/C 25/01)

[31] European Commission, State aid handbook for Decision Makers: http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=5355

[32] Ibid.

[33] https://ec.europa.eu/digital-single-market/en/news/broadband-investment-guide

The areas are identified by the Member State throughout:

- A detailed mapping and analysis of coverage and
- A public consultation open to the telecom operators that provides a high degree of transparency to define the 'white', 'grey' and 'black' spots areas;

Apart from the state aid rules included in the *EC Guidelines*, voucher schemes could also operate under the following frameworks:

- 'De Minimis' Aid rules[34]
- The General Block Exemption Regulation (GBER)[35]. This Regulation shall not apply to aid which exceeds the following thresholds for aid for broadband infrastructures: €70 million of total cost per project.

De Minimis: due to the small amount granted through a broadband voucher scheme, it is important to underline that this instrument could operate under 'De Minimis' Aid rules.

De Minimis aid is the amount of aid which does not count as State aid and it does not need to be reported to the European Commission and is exempt from State aid rules.

De Minims envisages that "the total amount of de Minimis aid granted per Member State to a single undertaking shall not exceed €200 000 over any period of three fiscal years."[36] In itself, the funding for school broadband access via satellite would be substantially below the financial thresholds in that Regulation and this ensure the compliance with the EU state aid rules.

General Block Exemption Regulation (GBER): This Regulation is also adaptable to the voucher scheme instrument especially in case of demand aggregation. The particularity of GBER is that projects with a total cost below €70M, are free from the requirement of prior notification to the EU Commission. This simplification promotes simplification in administration and the effectiveness of the implementation of broadband voucher scheme, especially in case of satellite broadband demand aggregation.

[34] http://ec.europa.eu/competition/state_aid/legislation/de_minimis_regulation_en.pdf

[35] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0651&from=EN

[36] http://ec.europa.eu/competition/state_aid/legislation/de_minimis_regulation_en.pdf

5.2. Funds for broadband financing in the EU

Broadband projects often rely on different kind of financial resources, public and private, that can be combined. Public financing could be in form of subsidies or financial instruments such as loans and guarantees. In the case of voucher schemes, due to the small amount of public funding for final beneficiary, the subsidies are preferred to the other options.

In the case of satellite **broadband voucher schemes**, the basic objective of the voucher is the customer premises equipment, mainly a satellite antenna and a modem, but may also cover subscription fees (for a limited period) and support solutions to distribute, to homogeneous group of schools, interactive video-based content, e-books, digital textbooks, exercise software, simulations or learning games, interactive maps, software, as well as other education solutions so as to creating local electronic library of e-learning tools. As explained in section 4, the above content and applications may already be present on e.g. the website of the Ministry of Education, but can seldom be accessed in an efficient and interactive way from schools that lack a good broadband connection.

Section 6 describes more in detail how to construct and implement voucher schemes.

There are several **EU sources to finance satellite broadband voucher scheme** projects:

- European Structural and Investments Fund (ESIF) specifically with the:
    - ERDF[37] (European Regional Development Fund)
    - EAFRD[38] (European Agricultural Fund for Rural Development)
    - ESF (European Social Fund)[39]
- National, regional or local public funding.

ERDF (European Regional Development Fund) and EAFRD (European Agricultural Fund for Rural Development) are the EU funds available to finance broadband infrastructures. ESF (European Social Fund) could be used to finance distribution e-learning tools. These three specific funds are part of the European Union's main investment policy tool: the European Structural and Investment Funds (ESIFs)[40].

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[37] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0487.01.ENG&toc=OJ:L:2013:347:TOC

[38] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1301

[39] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0470.01.ENG

[40] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1303. In terms of ESIF targets please note the ex ante conditionality for the thematic objective 10 “Investing in education, training and vocational training for skills and lifelong learning” that foreseen the Reduction and prevention of early school-leaving and promoting equal access to good quality early-childhood, primary and secondary education, including formal, non-formal and informal learning pathways for reintegrating into education and training for ESF and

Please note that the combination of ESF, ERDF and EAFRD in multi-fund operational programmes should provide more efficiency in school connectivity voucher scheme projects by developing combined support packages for broadband access and other online-based curriculum materials.

On the other hand it is worth mentioning that within the ESIF funding is directly programmed and managed at National or Regional level mostly by Public Institutions that are not the ones in charge of education. This could create a lack of attention towards the issue of broadband connectivity for schools.

Apart from ESIF funds some Member States as in the case study of France (see section 9.1.5.3) decided to finance the voucher scheme for school connectivity using national funds. This choice allows the Public Administration to be compliant with the national financing rules and not the ones for ESIF. In any case, state aid rules needs to follow the EU procedure.

It is important to mention that the relevant funding instruments in EU may evolve in the coming months. Indeed, we understand that the EC is soon going to address an extension of the DAE target towards 2025 through a dedicated Communication which will account for the evolution of towards a so-called "Gigabit Society". We expect this communication to recognize the re-enforced need for truly ubiquitous broadband coverage, especially for socio-economic drivers in Europe such as schools. Furthermore, we anticipate that a proposal for a revision of the Communication package of the CEF could be put forward, recognizing the existence of difficult business cases which cannot be directly monetized by the private sector and thus the extended need for grants. We recommend carefully monitoring these initiatives and adapt/extend the best practices proposed here to possibly new instruments.

5.3. Analysis of broadband procurement models

The public procurement alternatives for satellite broadband voucher schemes could be summarised in three main models:

1. **Open scheme**: direct subsidy to end-users without the pre selection of the Internet Service provider. In this case the Public Administration (PA) after defining the eligible beneficiaries and areas, minimum data rate requirements, and max subsidy per applicant publishes a call for end-users applications that submit the request with 2 minimum quotations by ISPs of its choice. Then the Public Administration, in charge of the scheme, validates the request to the end-user that subscribes the selected ISP. The end-user pays the ISP and then claims back the agreed eligible expenses from the PA, providing the appropriate documentation.

investment in education, training and vocational training for skills and lifelong learning by developing education and training infrastructure for ERDF.

2. **Call-off procedure:** qualification of multiple satellite service providers; the PA firstly set eligible beneficiaries and areas, minimum data rate, maximum subsidy and then opens a call off procedure to select qualifies multiple providers able to provide the requested services. Each qualified ISP signs an agreement with the PA in order to validate the eligibility of the final beneficiary, the service and the public subsidy. The end-user chooses the preferred offer from the list of the qualified ISP. The ISP after the installation and activation of the subscribed service manages the administration process with the PA to recover the subsidy on behalf of the end-user.

3. **Call for tender** election of a single provider of (satellite) broadband; In this case, the PA after defining the eligible beneficiaries and areas, minimum data rate and the overall budget, issues a call for tender for the provisioning of the services. The winner ISP commits to maintain the awarded offer (a fix subsidy per installation to cover eligible costs is typically agreed between IA and the ISP, pre-discounted in the offer to subscribers) available for subscription for the duration of the scheme. The winner ISP directly manages with the PA any administrative process relevant to the subsidies.

The three models even though have similarities in terms of the definition of the eligible beneficiaries and areas, minimum data rate and the overall budget, significantly differ in terms of:

- Monitoring and management of the administrative procedure by the PA
- Advance of the subsidy by the end user
- Length of the approval process

Model	Pros	Cons
Open scheme	- Free choice for the end-user - Competition in the ISP service offer	- The end-user anticipate the connection costs paying directly the ISP and asking after to be refunded by the PA - Administrative workload and risk on funding monitoring - Risk of scheme failure
Call-off procedure	- Simplification of the administrative procedures - Competition in the ISP service offer - Advantage in the offer evolution - High probability of scheme success	- Initial administrative workload in the definition of the process that includes the monitoring and financial control.
Call for tender	- Simple administrative procedure	- Risk of delay on the identification and selection of the ISP - Dependency on one ISP only - Risk of lack of technical evolution and improvements - Risk of delays regarding the installations

Table 6: Pros and cons of the three ISP procurement models.

Analysis: **In consideration of the pros and cons, the most valuable model in terms of administrative efficiency, ISP competition and end-users satisfaction is the Call-off procedure. The second is the Call for tender and the last is the Open scheme.**

In any case a successful voucher scheme needs to be characterized by a strong demand stimulation plan as well as promotion activities in order to raise awareness of the benefits of the connectivity for schools.

In parallel to the voucher scheme, it is important to mention other different models for satellite broadband solutions aimed at increasing the number of schools connected to the internet. The following models, even though not already implemented within the EU, could be important to close the digital divide in the education sector and also in some of the Public administration facilities:

- **Wholesale purchase for Public Administration:** Public Authorities after identifying the end-users that are the best suited for satellite coverage and the services needed, could purchase a wholesale satellite service in order to reduce the cost of monthly subscriptions and build the specific requested services. Unfortunately, the wholesale model has not been adopted so far because of the complexity at contractual and operational level but also because of the management of the European funding at a regional level - too small to create a critical mass for satellite broadband in order to decrease the costs.

- **Demand aggregation model:** There are several advantages in the implementation of demand aggregation schemes for public procurement specifically for satellite broadband because of:
    - The opportunity of aggregate the disperse demand making the public broadband market more attractive for operators and ISPs
    - Cost efficient saving of public funds
    - Favouring the emergence of a more convenient and competitive offer for final users.

Unfortunately, the demand aggregation, that needs a national or pan European approach to be successful, which has not been fully exploited at EU level.

Conclusions: **Further coordination efforts are required from EU institutions and Member States to speed up the process to connect all the European schools to broadband in order to enhance the ICT use in education, some disparities between Member States remain.**

Stronger coordination between the public authorities in charge of ERDF/EAFRD funds, the Broadband Plan (or Digital Agenda) and Education is recommended in order to increase the school connectivity to broadband.

The limitations of the actual policies are due to the following factors:

- **Limited up to date data on school connectivity at Member State and European level. The inclusion of a specific indicator in EUROSTAT and each member state statistical institute should be considered.**

- **Member States National Broadband Plans are generally not providing a connectivity priority to the schools but generally focus on DAE targets. EU Guidelines on National Broadband Plans could speed up the school connectivity foreseen a fast line approach in terms of deployment and results using different technological solutions.**

- **EARDF and ERDF are programmed and managed by Public Authorities that do not necessarily have the competence regarding education matters. This could hamper the schools' connectivity priority. A better cooperation between national Education Authorities and the Public Authorities in charge of ERDF and EAFRD is envisaged.**

- **Raising awareness of innovative financing instruments such as voucher schemes is needed.**

6. IMPLEMENTATION OF VOUCHER SCHEMES

6.1. Voucher Scheme Definition

Vouchers could be defined as public grants provided to an eligible end-user to stimulate demand for priority services among specific underserved groups.

Grants go directly to the end-user in the form of a voucher – a certificate, coupon or other token – which the end-user redeems for the specified goods or services from an accredited or selected service provider.

After having provided the service, the provider claims payment to the Public Authority in charge of the Voucher management. Vouchers schemes often utilize multiple competing providers but can also operate with a single provider pre-selected by a call for tender.

6.2. Voucher Schemes' common characteristics

There are different variants of voucher schemes adapted in different sectors, from e.g. SME innovation investments, health measures to broadband access initiatives.

The most common characteristic of the voucher schemes are:

- Flexibility and adaptability to "instantly" solve particular problems on local, regional or national level.

- For a majority of cases they constitute public subsidies granted through vouchers to the final *beneficiary* previously identified by the public authority within a strategic project.

In the case of **satellite broadband** access, one of the most complete analyses available on the use of voucher scheme, is the one provided by the previous *SABER* project (SAtellite Broadband for European Regions)[41]. SABER analysed different satellite broadband voucher scheme cases and arrived at the conclusion that even though the schemes differ from each other in the design and implementation, it is possible to identify **common important features.** The main common features are:

- A Public Authority funding body (Member State or Region) that oversees the scheme, distributes vouchers to target population directly or through intermediate public authorities, approves and contracts facilities to provide services to voucher clients, and reimburses the facilities for the services provided.
- A target group or population/audience.
- The voucher scheme can be adapted to local contexts and work under very different circumstances and in tandem with other financing resources.

[41] http://www.project-saber.eu/cms/

- The voucher scheme allows choice for clients and competition between service providers to drive quality standards improvements.
- The voucher scheme provides for an immediate and equity promotion in access to priority services among underserved areas and citizens.
- The voucher scheme guarantees a higher transparency on the selection and procurement process: providers (e.g. ISPs) are usually selected according to compliance with minimum quality standards and/or location.
- The voucher scheme provides for methods of verification of service delivery and financial monitoring: Each voucher scheme foresees an agreement, signed with the selected providers, that includes a description of the services to be provided, the timetable of the payments and issues related to monitoring, evaluation, fraud control and disputes.

6.3. Good practices and lessons learnt from Case Studies

There are many valuable insights and lessons learnt from the case studies analysed (see section 7 and Annex B) below that are useful for designing voucher schemes specifically aimed at providing schools with broadband connectivity.

The combination of satellite broadband technology with the use of voucher schemes provides a simpler, quicker and more competitive process to close the gap to schools in the digital divide, e.g. with respect to traditional calls for tender..

The main considerations from the analysed case studies relevant for the implementation of school connectivity voucher schemes initiatives are:

A. Vouchers to connect schools in digital divide areas: Schools located in *white spot* areas accordingly to the broadband state aid guidelines (cannot access to a terrestrial connectivity able to deliver at least 2 Mbps per school). Generally, schools in digital divide are often concentrated in a few regions of each country and characterized by school level:

- **Primary schools** are diffused and scattered over vast national territories, namely in rural areas, therefore more exposed to the digital divide.
- **Secondary schools** are less common to be in the digital divide as they are often positioned in more populated areas, but they may have larger and more demanding needs in terms of connectivity and service quality.

B. Voucher as an instrument to immediately connect a school in digital divide:

- Fibre today is the major broadband technology that can scale to meet the speeds required. Unfortunately, access to fibre is not universal, and schools without fibre, mostly of them located in more remote areas, are most at risk of being left behind without the broadband they need for quality digital learning.
- The broadband satellite solutions described in the case studies have often provided an immediate significant step forward in terms of connectivity to both

primary and secondary schools with no internet connectivity or with connectivity lower than 6-8 Mbps.

- Satellite services can provide a solution to serve the schools located in unserved or underserved areas, while waiting for a potential deployment of terrestrial, very high speed access which however may take many years. Moreover, a hybrid solution that combines broadcast networks for distribution with broadband networks for interactivity, can deliver video-based services, applications, content and products everywhere, even in rural and remote areas, in a less costly and quicker-to-market complementary way, namely through a local storage and sharing of "heavy" content (magazines and e-Books, videos, etc.).

- The application process has to be simple and flexible to account for their specificities, diverging much from typical urban characteristics. The demotivation effect of complex procedures has been observed from several case studies.

C. **Voucher used for integrated solution:** Many case studies show that these initiatives are more successful, efficient and effective when connectivity is a part of the whole development of resources and supports for e-learning of the ICT in schools policy. As explained in section 3.8.2, in order to improve access to information and educational content in school, developing combined support packages for broadband access computer programs and distribution e-learning tools is fundamental for the success of a school connectivity voucher scheme. This could be useful also for teachers training: In those rural areas concerned by the digital divide and susceptible to use satellite connectivity, teachers often have limited digital skills. In order to increase the impact over student achievement, a pan-European or nationally coordinated training scheme could be deployed for those areas, possibly including the training of teachers about the use of satellite-delivered services and applications, and how to get the best out of them.

D. **Voucher and demand aggregation to target the sparse demand:** Connectivity of schools in rural areas eventually leads to a sparse demand. A proper coordination between the central government, owning the correct level of technical and economic expertise on the procurement of connectivity and therefore responsible designing the core schemes, and the local authorities, mostly responsible of the implementation and administration, is vital to ensure the success of the initiatives and build up that include the demand aggregation process. The demand aggregation main objective is to help schools to reduce their broadband-related costs by aggregating demand and creating networks able to provide the most cost-efficient choice for meeting broadband needs. The US *E-rate* programme (see section 7), for example, is incentivising consortia and bulk purchasing. Similarly, a central EU supporting budget would have a strong impact.

E. **Expiration date of the voucher and renewal:** Case studies show that the voucher scheme should be programmed for a short period of time and be renewed several times as a short window of subsidy creates an incentive for schools to subscribe. This method allows a regular check so that the relevant public authorities can adapt their budget based on the most recent figures of the take up, and propose the latest / most modern / most powerful technology and services.

F. **Local ISPs participation:** Voucher scheme often rely on an active participation of local ISPs which are selected on the basis on the conformity to the requirements and the value for money of their offers. Their involvement and commitment from the beginning of the process has often a positive impact. Conversely, they are unable to carry potentially excessive financial burdens due to the administrative process (e.g. "too" deferred repayment of the installed equipment).

6.4. Steps for implementation

In order to allow the Public administration to run a broadband voucher scheme, there are some **fundamental steps** to be implemented for the success of the initiative:

1. Identification of **what** the voucher scheme should finance. The basic object of the voucher is the customer premises equipment, mainly a satellite antenna and a modem but potentially also a service subscription (for a limited period). But, as already previously explained, a voucher scheme could cover also distribution e-learning tools such as local electronic library of videos, interactive video-based content, e-books, digital textbooks, training software and support services.

2. Identification of the **target group** on the basis of a cost-effectiveness and needs analysis.

3. Identification of the **total budget** to be allocated for the voucher scheme and of the **single maximum grant.**

4. Identification of the **implementing authority** that delivers the voucher scheme.

5. Set up a **communication campaign** to widely communicate and advertise the benefits and rules for the voucher scheme and to reach all the final beneficiaries.

6. Decide on Internet Service Provider (ISP) **selection procedure**: Call for tender for a single provider or Call-off procedure (multitude of providers), preferably.

7. Decide the **duration** of the voucher and consequently the timing of the service provided. Services should have a start and an end to limit payment to clear conditions.

8. The Final Beneficiaries **applications** should be done electronically to keep the application process and the overall management and monitoring of the programme as simple as possible.

6.4.1. What can a Voucher Scheme finance?

As previously explained, one of the main characteristics of a voucher scheme is its flexibility to adapt to strategic target needs. Specifically regarding schools' broadband access via satellite, two main topics need to be considered in terms of voucher financing:

- Satellite broadband access: in this case the basic objective of the voucher is the **customer premises equipment**, mainly a satellite antenna and a modem including also TV reception equipment plus mostly, **subscription fees** for the service.

- Digital learning distribution solutions: The distribution of a large **common** database of educational videos, interactive video-based content, e-books, digital textbooks, training/exercise software, simulations or learning games, interactive maps and other types of software, that will constitute an electronic library which is constantly and regularly updated. A content delivery system to group of schools shall be built and its local storage (including access rights to content) be managed, possibly in conjunction with the administration of central content management platforms accessible through the Internet. This shall normally be implemented by (or on behalf of) the Ministry of Education. For more technical details see section 3.8.3.

In terms of financing resources, national or regional funds could be easier adapted for an ad hoc school voucher scheme that includes both the solutions.

The ESIF, ESF, ERDF and EAFRD can be combined in a multi-fund operational programme, and this may be the best solution, or through the combination of different measures of mono-fund operational programmes with, at the base the agreement of all, the Managing Authorities and the indication of a common intermediate authority in charge of the management of the voucher scheme.

6.5. Procurement: Implementing ISP selection model

Section 5.3 “Analysis of broadband procurement models” describes the different procurement models useful to implement a satellite broadband voucher scheme. In terms of pro and cons, the most successful and suitable to utilize are:

- **Call-off procedure** for the selection of multiple Internet Service Providers
- **Call for tender** for the selection of a single Service Provider.

Both models require, from The Public Authority, the identification of qualitative selection **criteria**, technical **specifications** of services based on satellite and the **service features** offered on the market.

In order to determine the **quality** of the Internet Service Provider responses to both models above, it is suggested to identify and **evaluate** the following elements:

- Download speed
- Upload speed
- Data volume allowance (monthly)
- Monthly subscription fee
- Characteristics and price of the equipment kit
- Support services included

Apart from those common elements the two models differ significantly with regard to the Internet Service Providers Selection procedures.

6.5.1. Call-off Procedure

The main features of the Call-off procedure are:

- Minimizes the administrative procedures typical of the calls for tender.
- Having multiple service providers that respond to the quality and technical criteria requested by the Public Authority, allows the end-users to choose the most suitable satellite broadband solution on the market.
- The selected Internet Service Providers, signing an agreement with the Public authority, act as an intermediate with the end user and the public administration managing directly the voucher and avoiding the anticipation of the related costs of broadband connection from the end users.

After the identification of the qualitative selection criteria targets to the objective and results of the voucher scheme, the Public Authority launches al call for the creation of a list of qualified service providers that responds to the requisites requested.

In order to allow as many Internet Service Providers to be part of this registry and consequently enable the end-users to have more offer, it is desirable that the call off will remain open till the end of the voucher scheme.

It is suggested that the Public Authority not only publishes the call for the creation of a qualified ISP registry in the Official Journal of the Public Authority but also sends direct invitation letters to service providers with the reference of the call, to ensure a wider participation. It is also suggested that the ISPs apply electronically in the Public Authority website.

In order to provide as much information as possible to the ISP, the call should include:

- A draft of the agreement that the qualified ISP will sign with Public Authority and that includes the procedure foreseen in the voucher scheme for the periodical reporting, monitoring and payment of the individual transactions and the communication plan.

- The deadline of the Call-off if any.

- Contact details of the person in charge of the procedure.

A part from the specific technical requirements, it is suggested that the Public Administration requests in the call at least the following info to the ISP:

- Company registration details including the recent financial statements.

- A statement confirming the conformity to general and specific eligibility requirements (i.e. specific General Authorisation from the Competent Authority and registration in the Communications Operators Registry either equivalent, depending on local legislation), to ensure that the service provider is fully entitled to provide the service.

- Availability of two-way telecommunications services via satellite with capacity of at least 20 Mb/download (6 Mb/s recommended) throughout the entire territory covered by the scheme.

- The detailed description of the services actually offered for the Scheme, including at least:

    - Download and upload connection speeds

    - Data volume allowance (monthly)

    - Traffic management policies

    - Service subscription prices, including initial costs, VAT, and excluding any temporary special offers.

Once the registry of qualified service providers is established, the Public Authorities will publish the list on their website and disseminate it to citizens with any appropriate means identified the communication plan.

In the Call-off procedure, the voucher sent to the end user will be used to pay the selected service provider to install the satellite broadband customer premise equipment, as well as the service subscription (limited period).

The value of the voucher, after proper validation by the end-user and the service provider, will be equivalent to the value of the aid granted by the Scheme to the end users that will include as minimum the on-site supply, installation and activation of the customer premise equipment.

In order to simplify the monitoring procedures and avoid counterfeiting it is suggested to identify each voucher with a bar code or serial number.

Once the eligible end user used the voucher with the chosen qualified ISP for the eligible expenses of the scheme (i.e. installation and activation of their customer premise equipment),

The service provider should then seek voucher reimbursement directly from the Public Authority on the basis of the reporting details foreseen in the agreement signed between the Public Authority and the qualified ISP. This will ensure reimbursement of the costs incurred by the service provider for the procurement, installation and activation of the customer premise equipment by the end-user.

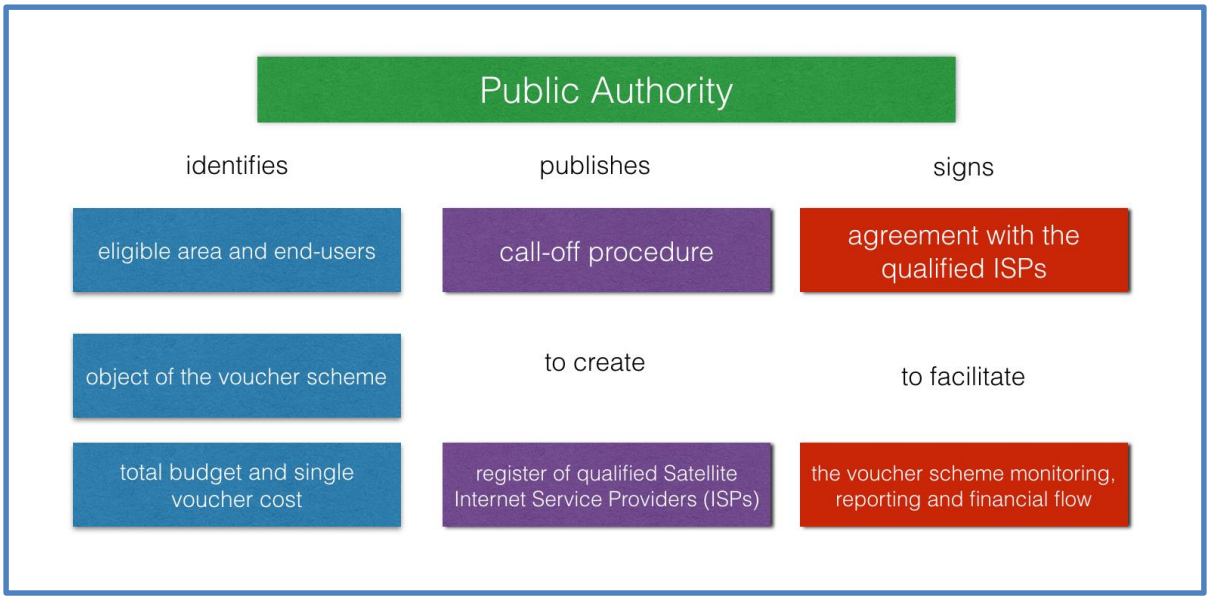

Figure 7: Overview of the Call-off procedure elements involved.

6.5.2. Call for tender

The Public Authority may alternatively decide to choose to select only one ISP to deliver the service covered by the voucher scheme. In this case, the best procedure is to use a call for tender.

The technical specifications for the bidding conditions determined by the contracting authority will include the specific technology of services via satellite and the service features available on the market as explained at the beginning.

Regarding the bid assessment criteria, it is suggested to include:

- Maximum downlink and uplink speeds
- Estimated monthly traffic volumes
- The price of the equipment inclusive of on-site installation and test
- The user fees on a monthly basis, including VAT, for each service level
- Any additional options for features that may be included

Moreover, to minimise the amount of aid required, the notice must also specify the estimated number of eligible end users

As thoroughly analysed in the SABER project, voucher schemes that used a Call for tender approach in the selection of only one ISP were utilized by Devon County (UK) and in Northern Ireland (UK) (described with additional details in the SABER project Deliverable 2.3 – Regional / National satellite broadband implementation case studies)[42].

[42] www.project-saber.eu/cms/documents/official-documents/good-practices

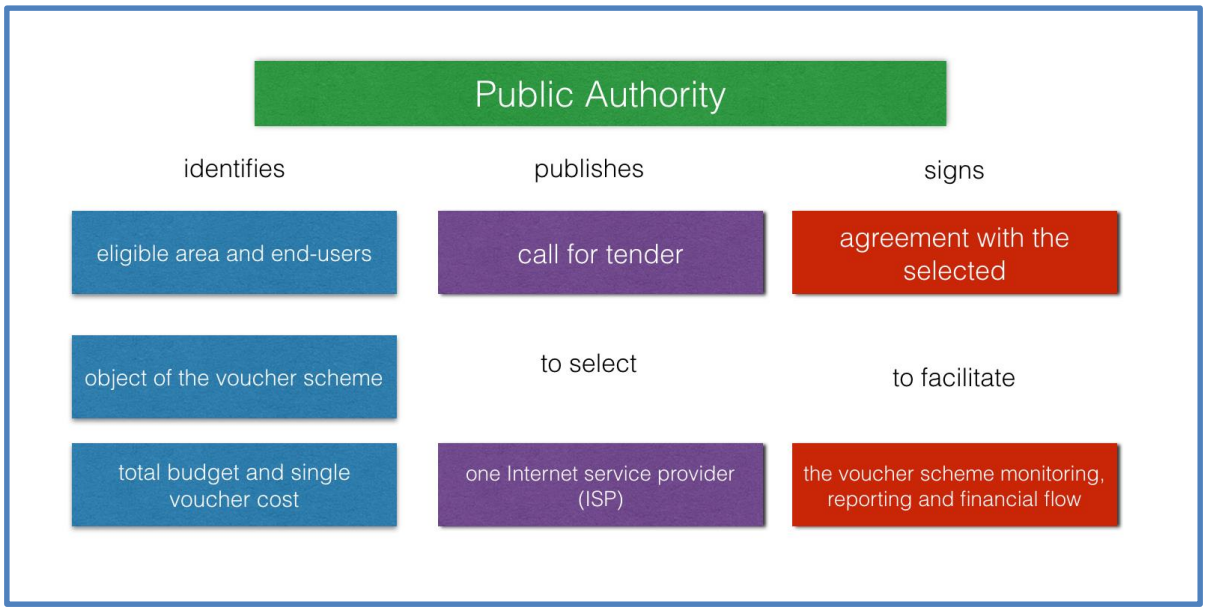

Figure 8: Overview of the Call for tender procedure elements involved.

6.6. Voucher scheme redemption

In order to assure the regularity of the financial management of the Voucher Scheme, the Public Authority will pay the qualified internet service providers only on the basis of the submission of regular reports that includes **at least the following documentation** for each school connected:

- User identification code
- MAC address (Media Access Control) of the subsidised equipment.
- A statement of delivery, installation and activation having been carried out for the customer premise equipment, object of the aid, including the delivery address and a copy of the validated voucher.
- References to the Internet access agreement with the service provider for a specified term (determined within the Scheme).
- a printout of the speed test (countersigned by the end-user as well) to provide clear evidence of the positive outcome of the acceptance on site test – meaning the satellite broadband service is actually up and running.
- Geo-referenced photos, provided by the installer, of the ground equipment installed (modem and antenna) can be used where this is acceptable within the funding regulations.

The Public Authorities will monitor the implementation of this part of the Scheme and will ensure the aid is reimbursed in the event of non-compliance by the service provider or the end user.

Conclusions: **Vouchers are defined as public grants provided by a Public Authority to an eligible end-user (e.g. a school) to stimulate demand for priority services among specific underserved groups and could be used as a tool to close the broadband gap for schools.**

A basic voucher scheme for satellite-based broadband should cover a) fixed fee for terminal equipment and installation and b) recurring monthly fee for a limited period (e.g. 24 months).

Satellite voucher schemes provide a simpler, quicker and more competitive process compared to traditional calls for tender (which often award the contract to a single provider).

7. CASE STUDIES: LEARNINGS AND GOOD PRACTICES

This section describes a broad variety of highly relevant case studies that have been selected and studied in order to gain insights in different aspects, ideas and mechanisms that have been utilized to improve schools' access to broadband services. These case studies have been identified and selected as the baseline for a good mix of mechanisms, ideas and solutions to bridge the digital divide for schools.

The conclusions and considerations (see section 8) have been drawn mainly from these case studies as well as previous studies in this field.

This chapter analyses some publicly-financed initiatives, carried out within and outside the EU, to connect schools and classrooms to high-speed broadband. Its objective is to take the maximum profit of the lessons learned in terms of school-specific requirements.

The hands-on experience obtained through the direct involvement in some of the largest European and worldwide school connectivity initiatives provides information on:

- Integration of school connectivity within broader education policies.
- Selection of the most appropriate solution, taking into account the current usage and the expected evolution.
- Necessary equipment.
- Design of the most appropriate network set-up.
- Best approach of deployment - including typical barriers and difficulties.
- Funding and voucher scheme learnings and experiences.

The selected case studies are not all designed on general broadband voucher schemes. Instead, the information contained in this chapter completes and adds value to the information on general-purpose public initiatives adopting satellite broadband voucher schemes to help offset the financial commitment for consumers, local governments or schools, thoroughly covered by the project SABER (SAtellite Broadband for European Regions)[43], namely the SABER deliverables:

- D3.2 - Regional/National and International satellite broadband implementation case studies[44], and
- D4.3 - Guidelines on Satellite Services Procurement Deployment and Management[45]

[43] http://www.project-saber.eu/cms/
[44] http://www.project-saber.eu/cms/documents/official-documents/good-practices

In this report cases in France, US, Mexico, Italy, UK, Ireland, Spain and Turkey have been studied and analysed. All details and key findings of each case study are found in Annex B.

7.1. Case studies: Conclusions and considerations

7.1.1. Digital divide and connectivity solutions for schools in rural areas

Digital divide today: Referring to the case studies, we can currently consider that a school is in the *digital divide* if it cannot have a terrestrial broadband access able to deliver at least 2 Mbps per school.

Primary schools (including those with few pupils and multi-grade classes) are diffused and scattered over vast national territories, namely in rural areas. Therefore they are more exposed to the digital divide, even if they have simple needs in terms of connectivity and services.

Secondary schools are less affected by the digital divide as they are often positioned in more populated areas, but they have larger and more complex needs in terms of connectivity and services, namely in terms of quality and bandwidth.

In general, we note that schools in the digital divide are often concentrated in a few regions of each country.

Satellites fulfilling current needs: The broadband satellite solutions described in the case studies have often provided a significant step forward in terms of connectivity to both primary and secondary schools with no internet connectivity or with connectivity lower than 6-8 Mbps.

A recent Ofcom report[46] shows "a clear correlation between access speed and consumers' experience up to around 8-10 Mbps". This is of course dependent on what type of application is used (see below) but for many applications a high access speed (bandwidth) may be less important than a stable, qualitative connection with a fair access speed of around 5-10 Mbps.

Evolution of needs: Notwithstanding the above, the needs for internet access speed and quality are increasing along with the evolution of the digital applications and the consumption pattern. In particular, video services, live-streaming of seminars and lectures as well as different types of rich content are very much driving this surge in consumption of many applications across computers, smartphones, tablets, TV and other devices, and the case studies have confirmed this trend in the educational environment too (e.g. access to dedicated digital content stored and shared in a cloud or remotely).

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[45] http://www.project-saber.eu/cms/documents/official-documents/procurement

[46] "Internet performance evaluation for Ofcom" http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2014/performance-eval.pdf

The support of these evolving needs is often associated with the deployment of fibre. Indeed public initiatives to develop very-high-speed access for all, namely those including the provision fibre connections to primary and secondary schools, will be implemented gradually, and for some schools in the most rural areas, fast broadband will only be accessible in several years, as the geographical dispersion of schools does not allow for the installation of fibre-based networks on all sites in the short-term.

Future role of satellite based broadband services: Satellite services can provide a solution to serve the schools located in unserved or underserved areas, while waiting for a potential deployment of terrestrial, very high-speed access which however may take several (or many) years. This provision of services needs to cope with the evolution of user demands and needs. In this respect, a hybrid solution that combines broadcast networks for distribution with broadband networks for interactivity, can deliver video-based services, applications, content and products everywhere, even in rural and remote areas, in a less costly and quicker-to-market complementary way, namely through a local storage and sharing of "heavy" content (magazines and e-Books, videos, etc.).

7.1.2. Efficient organisation and coordination of ICT policies and programmes

Integrated solutions: Many case studies focus on the provision of connectivity of schools in the digital divide. Experience has shown that these initiatives are more successful, efficient and effective when they are developed within an integrated solution, i.e. when connectivity is a part of the whole development of resources and support for e-learning of the ICT in schools policy (then including the appropriate technical training, helpdesk and maintenance). This is also because the process is better perceived and endorsed by the teachers and the local stakeholders. In addition, availability of Wi-Fi services within schools is often considered in some cases as important as the connectivity itself.

Proper coordination: In addition, connectivity of schools in rural areas eventually leads to a sparse demand. In some cases, the public initiatives have involved different public entities (at local, regional and national level) and lead to lengthy administrative procedures, in spite of urgent needs. In this respect, a proper coordination between the central government, owning the correct level of technical and economic expertise on the procurement of connectivity and therefore responsible designing the core schemes, and the local authorities, mostly responsible of the implementation and administration, is vital to ensure the success of the initiatives.

Training of key staff: In those rural areas concerned by the digital divide and susceptible to use satellite connectivity, teachers often have limited digital skills. In order to increase the impact over student achievement, a pan-European or nationally coordinated training action could be deployed for those areas, possibly including the training of teachers about the use of satellite-delivered services and applications, and how to get the best out of them.

Demand aggregation: The budget and the programme for introducing and/or improving ICT in schools should be managed at a central level, with an appropriate financial amount. The US

E-rate programme, for example, is incentivizing consortia and bulk purchasing. Similarly, a central EU supporting budget could have a strong impact and a better value for money.

Effective communication: Moreover, the central government is ideally positioned to perform strong, central action of communication to inform on and promote public initiatives, which are also necessary to ensure the success of the initiatives.

Government endorsement: At central government level, the development of broadband connectivity is predominantly the responsibility of the Ministry of Telecommunications (or equivalent), while the development of the policies for introducing ICT in schools is the one of the Ministry of Education. Not only a proper coordination between the two bodies is essential, but also a joint ownership and endorsement of the programmes is important to strengthen the communication ahead of the deployment of the programmes and overcome some reluctance to adopt modern technologies and methods, especially in rural areas, due on the one side to lack of awareness and on the other to a natural opposition to modifying well-established teaching system.

Simplified application process: Whatever solution is implemented to support the deployment of high speed broadband e.g. for schools in rural areas, the application process has to be simple and flexible to account for their specificities, diverging much from typical urban characteristics. The demotivation effect of complex procedures has been observed from several case studies.

Timeliness: Finally, as the success often depends on the availability and the support of committed local staff, of initiatives concerning ICT in schools in general, and broadband connectivity in particular, should be deployed along with a calendar that takes into account the constraints of the school calendar.

7.1.3. Considerations on Voucher schemes

Effective voucher schemes: Satellite voucher schemes provide a simpler, quicker and more competitive process compared to traditional calls for tender (which often award the contract to a single provider).

Case studies show that a voucher scheme should be programmed for a short period of time and be renewed several times as a short window of subsidy creates an incentive for schools to subscribe. In addition, this method allows a regular check so that the relevant public authorities can adapt their budget based on the most recent figures of the take up, and propose the latest / most modern / most powerful technology and services.

Voucher schemes often rely on an active participation of local ISPs which are selected on the basis on the conformity to the requirements and the value for money of their offers. Their involvement and commitment from the beginning of the process has often a positive impact. Conversely, they are unable to carry potentially excessive financial burdens due to the administrative process (e.g. “too” deferred repayment of the installed equipment).

Voucher schemes should, if possible, cover more than just pure broadband access, i.e. also include support, training etc. in order to be really effective (see “Integrated solutions” above).

8. ANNEX A: Country specific information on school connectivity

This annex identifies different institutional programmes implemented in the EU to make broadband as available as possible in schools.

Austria

There is currently no national initiative on cloud computing and connectivity. As for now, measures are set to enable the infrastructure for the Austrian broadband initiative 2020. An assessment of needs, especially of schools, built the basis for the extension of this initiative of the BMVIT (Ministry of traffic, innovation and technology). The aim is to reach nationwide at least 100Mbit/s.[47]

Belgium

The Flemish government negotiates framework agreements with telecom providers and software resellers in order to provide flat fees for educational institutions. Cloud computing solutions are to a certain extent part of the Telenet offer. The Telenet offer is a large scale programme based on 6 specific profiles to which a school can apply for connectivity and IPS-services. Each of these three profiles exist in two formats, one with lower bandwidth (50 Mbps) for average primary schools, and one with higher bandwidth (100 Mb) for average secondary schools. The Ministry of Education has administered the tender for this programme and has closed the deal with Telenet. The schools sign up for the offer, if they want to and pay for it themselves. The rates are around 50% below market prices. See www.telenet.be/schoolnet[48]

Broadband internet coverage is not yet 100%, despite the data framework agreement with Telenet. 86% of schools in nursery and primary education have broadband and the figure for secondary education is 92%. This is exactly the same as in MICTIVO 1. All schools in secondary education have internet access. Our nursery and primary education survey revealed 2 schools that said they did not yet have internet access for educational purposes.[49]

77% of nursery and primary schools and 75% of secondary schools have wireless internet (as compared to «33% and 50% respectively in MICTIVO 1). There is a local (internal) network present in 70% of the schools in nursery and primary education and almost 90% of the

[47] Schoolnet country report 2015

[48] Schoolnet country report 2015

[49] MICTIVO 2 study 2012

schools in secondary education. These figures would appear to be good, but given the relatively large number of computers per school, all schools really ought to have an internal network.

Cyprus

High-speed connections for all users, enabling uploading and downloading information including reusable learning objects, digital education content units and material, pictures, videos and other high volume digital content. The MoEC's aim is to create an intranet environment that connects all public schools (from pre-primary to secondary education) directly to a main Data Centre, operated by the Ministry.[50]

Czech Republic

The construction and renovation of digital educational infrastructure is one of the points of Strategie digitálního vzdělávání do roku 2020, which also defines several measures, although no project or initiative has yet been implemented for this area.[51]

Denmark

Quite a number of schools, municipalities and regions operate with a cloud based strategy, and practically all Danish educational institutions are wi-fi'ed and hooked-up on very broad broadband connections. Concretely, as part of the eGovernment Strategy 2011-2015, agreed by the government and the association of municipalities, Local Government Denmark, the municipalities have guaranteed to provide – and finance - sufficient infrastructure by 2017, including stable wireless networks at all public schools.[52]

Estonia

In general, IT infrastructure is the responsibility of school owners. A separate initiative for improving internet connection of general education schools is in preparation. For further information: Ministry of Economic Affairs and Communications (MKM).[53]

[50] Schoolnet country report 2014

[51] Schoolnet country report 2015

[52] Schoolnet country report 2015

[53] Schoolnet country report 2015

Finland

Finland has a very good availability of high-speed broadband to schools, according to Finnish regional sources. Finland has been committed for a long time to have world-class e-Education capabilities (including broadband) for all school levels.

France

(See also section 9.1.1, 9.1.2 and 9.1.3)

In September 2013, 20 pilot "Collèges connectés/ connected lower secondary schools" opened. They benefited from specific support and funds to further embed ICT in education and received a specific national label, "Collège connecté". In 2015, local authorities and academies selected, on a project basis, 570 primary and lower secondary schools as "connected schools". Local authorities together with the Ministry of Education pay for the equipment (tablets, laptops), while the academies provide teacher training. Students in their first year of lower secondary school are equipped with devices. The aim is to have all schools equipped by 2018. In 2015/2016, there will be a particular focus on teacher training.[54]

Germany

The German government aims to provide fast broadband (50 Mbps) Internet to all rural and urban areas alike by 2018. No specific programme towards schools is present.

Progress towards high speed broadband networks and further investment in enhancing the digital infrastructure is slow. Germany is performing less well (below the EU average) in the uptake of fast broadband services, where there are considerable investment needs. Germany is fully covered by basic broadband services (including fixed, mobile and satellite networks). €5 billion in 2015 have been made available to the federation and the federal states to provide incentives for investment in broadband expansion. As regards next generation access (NGA) connections, the incumbent's strategy during the last year has mainly been focused on deploying infrastructure based on VDSL-vectoring technology that allows for high speed connections of up to 100 Mbps. By 2016, Deutsche Telekom plans to provide 65 % of households with a broadband connection based on vectoring technology. The deployment of fibre (FTTH/B) lines, especially in small cities and rural areas, continued to be carried out almost entirely by alternative operators.[55]

[54] Schoolnet country report 2015

[55] EC Country Report 2016

Greece

High-speed connection to the internet for all schools is a part of the Digital School programme, including interconnection of schools to municipal optical metropolitan area networks, enabling high speed optical access to the Greek School Network (GSN). Direct broadband connection via Metropolitan Area Networks (MAN): Optical fibres in schools of 30 municipalities. Additional broadband connection to schools in 27 more municipalities is provided via the extension of the EDET network.[56]

Hungary

The National Information Infrastructure Development Institute (NIIFI) builds a backbone network for education and research. Via the Sulinet and Sulinet+ projects, NIIFI aims to enhance connectedness in public and higher education.[57]

NIIFI has been given the responsibility to serve all schools in Hungary, a total of approximately 5800 schools (out of a total of 6213 primary and secondary school sites), that require broadband throughout the country. Today it is estimated that 9.3% of these schools are not connected to broadband or have a connection of less than 2 Mbps, or 540 schools (if we look at the percentage of primary schools the number is even higher as well as the amount that have a connection less than 5 Mbps). According to the current plans all necessary primary and secondary schools will be connected well before 2020 (estimated to reach objective by end of 2016).[58]

Ireland

(See also section 9.4)

All secondary schools are connected to HSB (>100 Mbps). Roll-out completed Q4 2014.

• 100 Mbit/s uncontended, symmetric connections

• 800 Post-Primary schools, special schools and Education Centres

• Joint Government Funding:

- Department of Communications (Capital Outlay)
- Department of Education (Recurrent Outlay)

[56] Schoolnet country report 2014

[57] Schoolnet country report 2015

[58] Department of Education, Culture and Sport, Permanent Representation of Hungary to the EU, 2015/2016 national school survey

HEAnet is Ireland's National Education and Research Network, providing internet connectivity and associated ICT services to education and research organisations throughout Ireland, including all primary and post-primary schools.

Italy

(See also section 0)

Despite efforts in 2015, the coverage of HSB communications infrastructure to schools is among the lowest in EU. A new programme of €600m has just been launched to bridge the *Digital Divide* and secure high-speed broadband connectivity for all schools in Italy according to the objectives in the country's Digital Agenda. Today an estimate of 4700 schools lack broadband with at least 2 Mbps.

Coverage of next generation broadband networks improved noticeably but Italy remains among the worst performers. In 2015, the number of households covered increased from 36% to 44% of total. The ambitious Digital Agenda target for the next generation network coverage is not guaranteed but efforts are ongoing. To improve the performance and raise the target, the government allocated additional resources for EUR 2.2 billion to the national next generation networks plan. The additional effort will not necessarily guarantee reaching the ambitious Digital Agenda targets.[59]

The education sector in Italy compared to other sectors (e.g. health, transport, provinces, municipalities) is described as more complex in term of governance since schools have more spending autonomy and some costs are taken up by municipalities, so the decision-making structure is more complex.

Lithuania

The national LITNET programme provides broadband internet connection to Universities and schools.[60]

Poland

Fixed broadband coverage and uptake remains a challenge, while mobile broadband demand booms. In 2014, fixed broadband covered 85 % of households, which is the lowest in the EU. Fast broadband (of at least 30 Mbps) was available to only 53 % of households compared with the EU average of 68 %. Fixed broadband uptake was relatively low as well, amounting to 60 % versus 70 % in the EU. The percentage of enterprises with a broadband connection in Poland has increased from 69 % in 2010 to 90 % in 2014. By contrast, Poland belongs to the

[59] EC Country Report 2016

[60] Schoolnet country report 2015

best performing EU countries in terms of mobile broadband use. Other high speed internet investment challenges concern the commercial viability of modern infrastructure outside the urban agglomerations. Future public funding initiatives are needed to address these challenges by concentrating on areas affected by market failures.[61]

Romania

The information and communication technology (ICT) sector is dynamic and competitive. The ICT sector's share of Romania's GDP is 6 %, one of the highest in the EU (Graph 3.1.2). With nearly half of fixed broadband subscriptions with speeds of at least 100 Mbps, Romania has the highest take-up of ultra-fast broadband in the EU. The take-up of broadband subscriptions, however, is among the lowest in the EU. Limited access to broadband infrastructure impacts on business creation and growth in rural areas.[62]

Slovenia

All secondary schools have just recently been connected to high-speed broadband (by 2016), with at least 100 Mbps downlink. Most primary schools have a broadband connection of at least 30 Mbps, but there are still a few without a good connection (<2 Mbps).[63]

No specific initiative existed in 2014, but there were plans formulated.[64]

Spain

School access to broadband is aiming to take advantage of already existing networks and providers. In this respect, the Spanish MoE has just launched a new project, School Connectivity (along with other Ministries), to provide Internet access using ultra-fast broadband networks (100 Megabits per second) to primary and secondary schools, paying particular attention to those schools with poor connectivity due to their location. This project will be of benefit to more than 6.5 million students and 16,500 schools.[65]

Sweden

Sweden ranks third in the EU regarding digitisation, according to the Digital Economy and Society Index. It recorded an overall high performance on most of the dimensions measured.

[61] EC Country Report 2016

[62] EC Country Report 2016

[63] Regional sources (via Interreg), 2016

[64] Schoolnet country report 2014

[65] Schoolnet country report 2015

Delays in the deployment of this critical infrastructure could constitute a drag on the country's economic performance. No specific school programme in place.[66]

United Kingdom

(See also section 9.5)

Since 2006 the Government has funded RBC and local authority access to JANET, the name given to the UK's academic and research network. It provides a high speed core 'backbone' network and manages internet transit and other services to local areas, again provided by commercial suppliers. Recently the Department has confirmed its intention to continue this funding until 2014.[67]

UK has also implemented a discount scheme for satellite broadband, similar to France: https://www.gov.uk/government/news/satellite-dishes-to-boost-broadband-speeds-in-most-remote-areas-of-uk

[66] EC Country Report 2016

[67] Schoolnet country report 2014

9. ANNEX B: Cases studies of Satellite Broadband for schools and/or Voucher Schemes

This Annex gives examples of programmes for school connectivity and e-learning implemented in different countries of Europe and outside. The challenges tackled by these programmes vary from case to case, from the general provision of broadband to unconnected or badly connected schools to the specific problem of multi-grade classes. The goal of this Annex is to show **not only the key success factors of these best practises but also the non-technical barriers** that need to be highlighted in order not to reproduce them in future initiatives.

9.1. FRANCE: Public initiatives for e-education

9.1.1. Background

In France, public authorities have been putting in place for some time mechanisms to support the uptake of digital technologies in all public schools (Primary and Secondary Schools) to prevent the risk of exclusion from the digital revolution in education. These initiatives for a quick deployment of a digital environment have been targeting schools that completely lack digital capabilities or are poorly equipped, mainly located in rural and remote areas.

"*We need financial support in order to deploy digital tools at school. For example the interactive whiteboards, which have been particularly welcomed, have been co-funded by the county.*"[68]

For the 2014-2020 financial frameworks, the Ministry of Education has defined an action plan intended to develop the use of Information and Communication Technologies in Education (ICTE) and to co-finance innovative projects, with major focus on:

- Investment in infrastructure;
- IT equipment for *Public Local Schools* (*Établissements Publics Locaux d'Enseignement*, EPLE[69]), teachers and students;
- The e-Education environment (*Environnements Numériques de Travail*, ENT[70]);

[68] Source: Fabienne Garnerin, deputy mayor in charge of education in Meymac, Corrèze (19), 2 500 inhabitants

[69] The EPLE is a category of public establishment that includes secondary schools and high schools and whose competencies belong to local districts.

[70] An « ENT » is a Virtual Desktop, i.e. a collaborative platform respecting the specification established by the Ministry of Education.

– Integrated programmes of digital development in schools or EPLE.

The **European Regional Development Fund** (ERDF) 2014-2020, which is fully managed by the presidents of Region, can be used to:

– Develop and subsidise educational projects;
– Strengthen partnerships with the other public authorities having a stake in education: academies, central government representatives, and local elected representatives. This is particularly important in view of the organisational complexity in the education system in France which is explained in the next section.

9.1.2. Jurisdictions and the "administrative layer cake"[71]

The French administrative organization ensures proximity to citizens but somehow also complexity. This is called the "administrative layer cake" (*millefeuille administratif*) and relates with the issues linked to the distribution of jurisdictions and the number of France's administrative and institutional layers. The country has 37,000 municipalities (four times more than in Germany and Italy), 101 departments and 26 regions (due to reduce to 17).

The education system is a good example of the French "administrative layer cake": there is a stack and nesting of responsibilities between no less than five types of national, regional and local administrations (see Table 2 below): for instance, the municipalities manages primary schools; the departments, the colleges; the regions, high schools and the state, the universities.

LES DOMAINES DE COMPÉTENCE PAR COLLECTIVITÉ

DOMAINES DE COMPÉTENCE	ÉCOLE	COLLÈGE	LYCÉE
Enseignement : définition des programmes	État	État	État
Diplômes : définition et délivrance		État	État
Investissement (construction, reconstruction) et fonctionnement matériel	Commune	Département	Région
Fonctionnement pédagogique : acquisition de matériel pédagogique	Commune	État	État
Gestion des personnels enseignants : recrutement, formation, rémunération, etc	État	État	État
Gestion des personnels administratifs, techniques, de santé : recrutement, formation, rémunération, etc.	État	État	Région
Gestion des personnels ouvriers : recrutement, formation, rémunération, etc.	Commune	Département	Région

Table 7: The "Administrative layer cake" applied to education : repartitions of competencies between the State level, Regional level and Town level for Primary schools, Secondary Schools and High schools.

[71] Sources: http://tempsreel.nouvelobs.com/societe/20121002.AFP087/le-millefeuille-administratif-francais-proximite-avec-le-citoyen-mais-des-gaspillages.html; http://www.liberation.fr/societe/2014/02/10/le-millefeuille-et-l-education_979149.

The problem is that each level exercises "general jurisdiction" and can act in any area of "local interest". In certain circumstances, this might have a negative impact on investments coordination, programme ownership and leadership as well as causing some delay in implementation.

9.1.3. Educational usage, key success factors and obstacles[72]

9.1.3.1. Educational usage

During a recent evaluation, users (project leaders, teachers, parents and students) put emphasis on conventional usages; for example the ENT[73] services in primary schools are mainly used for:

- Doing exercises, answering questions (18% every day or almost 33% often)
- Communicating with peers (21% and 21% respectively)
- Searching and reading documents: website, text, video, sound (9% and 36% respectively)
- Writing texts, producing documents (9% and 27%).

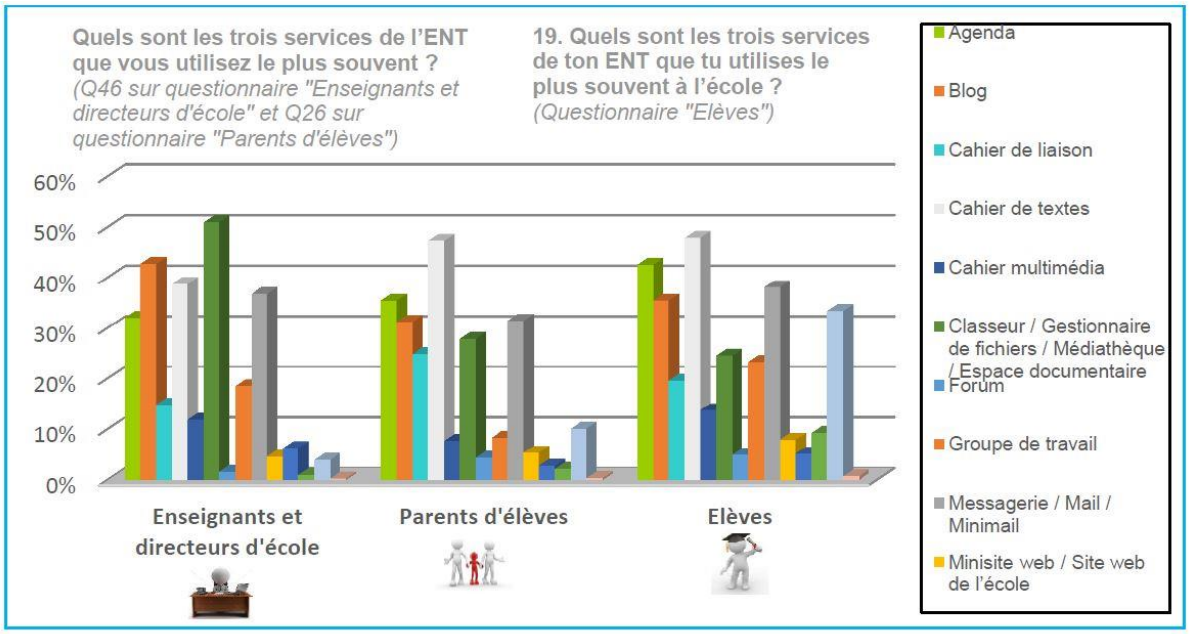

Figure 9: Main uses of ENT in the Primary Schools.

[72] Source: EVALuENT 1 et 2, Source: EVALuENT 1D 2015

[73] http://eduscol.education.fr/cid55726/qu-est-ent.html

In parallel, other less predictable usages are also highlighted. For example:

"*A few families of foreign origin, Turks, and recently the Sudanese and Iraqi refugees are installed in the municipality. Digital tools, which support the use of images, prove to be very effective for them to learn the French language*" [74].

The ENT helps not only to improve ICT literacy and skills, but also helps progressing school as a whole.

Regular use of the ENT is a reality in schools, regardless of the different category: 57% of students and 61% of teachers and principals use the ENT at least once a week. The conditions (in terms of quality) of accessing the ENT are certainly considered one of the major factors in the level of use.

9.1.3.2. Key Success Factors

The key success factors for the regular use of ENT services given by teachers and principals, as well as project leaders:

- adequate computer base in the classroom
- direct Internet access in the classroom
- training to the use of the ENT
- appropriate support
- specific actions towards families

The contribution of the ENT to the educational mission of the school could be further improved through the following actions:

- Personalised support to students by the teachers;
- Improved organization of the work of students;
- Special care for students with special needs.

9.1.3.3. Barriers to adoption and use

Regarding the non-adoption of the financial aid by the beneficiaries:

- Insufficient means to raise awareness, including information and communication campaigns. The provision of a communication plan is not yet very widespread: only 31% of academies and 12% of local governments have established a communication plan.

[74] Source: Fabienne Garnerin, adjointe au maire en charge de l'éducation de Meymac, Corrèze (19), 2 500 habitants - Canope P31

- The need to change teaching practices (not transcribe a traditional course on screen but use all that multimedia allows).
- Ethical questions on new uses.
- Insurance issues for hardware.

According to school teachers and principals and to project leaders, the main obstacles in the regular use of the ENT[75] are:

- a slow internet access (see next section)
- insufficient IT resources
- the absence or insufficiency of training and support
- poor awareness of editorial educational resources available and accessible via the ENT.

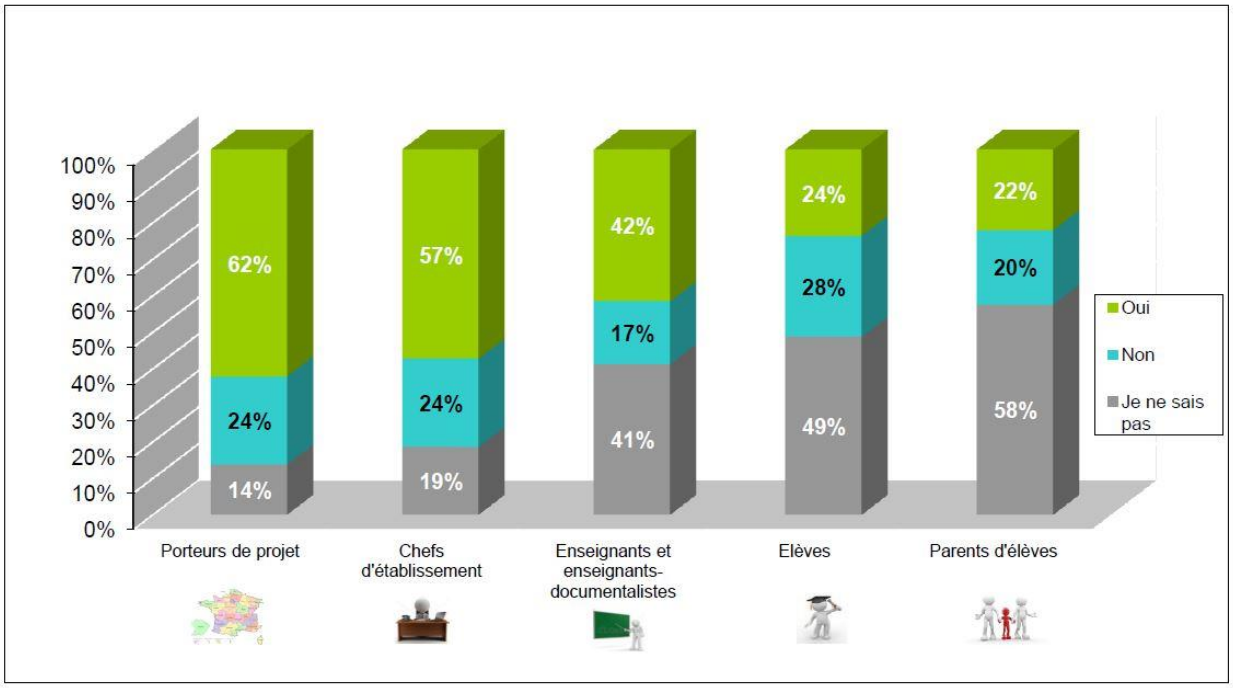

Figure 10: Ability to use pedagogical resources from your ENT (e.g. textbooks, dictionaries, etc.)

9.1.3.4. Speed of internet access: Main barrier to use of e-Education?

The internet access speed inside the school is indeed cited as the main obstacle to a regular use of ENT by 48% of teachers, 43% of principals and 38% of students.

[75] Source: Canope, 2015

The problem seems to have increased significantly in the last two years. In 2012, the insufficient bitrate was criticised by 26% of teachers, 28% of principals and 35% of students.

Analysis: **Notwithstanding the above, a good-quality internet access alone doesn't make a school 'digital', much more and a holistic approach is needed to succeed. But the need for high-speed broadband is getting increasingly important for each year, due to the nature of applications and services that are used.**

9.1.4. A precursor to public initiatives: The private-public "Connect'Ecoles" pilot

9.1.4.1. Background

Taking advantage of the recent, significant progress of Internet access via satellite (in six years, bitrates have increased from 2 to 22 Mbps downstream and from 128 kbps to 6 Mbps upstream, along with ever more stable connections), Eutelsat, NordNet (an ISP, subsidiary of Orange, providing satellite Internet access, among other internet solutions) and the Association of Rural Mayors of France (ARMF) launched a pilot project, "Connect'Écoles - Satellite Internet for Rural School", in September 2012.

The goal of this pilot project was to demonstrate the benefits of broadband internet via satellite through the provision of free internet access for a limited period of time to a group of rural digitally-divided (not covered by terrestrial broadband) schools. The pilot project selected 22 primary schools, each one located in a different region of France, in order to obtain a representative panel.

9.1.4.2. Time plan overview

The project was implemented over a period of one year, according to the following calendar:

- Signing: 12 September 2012
- Deployment and test phase: School year 2012-2013
- Evaluation phase (carried out by Nordnet and Eutelsat): September 2013

9.1.4.3. Examples of usage

The objective of "Connect'Ecoles" was to let the beneficiary schools take full advantage of available educational resources and to facilitate access to new educational tools.

The satellite broadband internet access was mainly used (87%) for educational purposes, regardless of the subject.

In particular, beneficiary schools used the Internet access provided by "Connect'Ecoles" to:

- Exchange emails and short videos with foreign correspondents
- Virtual visit of a museum
- Study on the operation of a wastewater treatment plant

Internet also proved to be an essential tool for administrative purposes, 13% of usage was constituted by the exchange e-mails between the teachers and the academic inspectorate from the school. 50% of the respondents were previously obliged to carry out these formalities from home or from the town hall.

As an interesting side effect, the "Connect'Écoles" allowed residents in towns without satisfactory internet access to discover the opportunities and the performance offered by satellite broadband.

9.1.4.4. Testimonials

These testimonials are the result of surveys conducted by Eutelsat and NordNet toward mayors, directors of schools, students and parents proceeding from the school's panel. The assessment was overall very positive.

As shown in the figure below, most schools that participated in the pilot chose to keep their subscription:

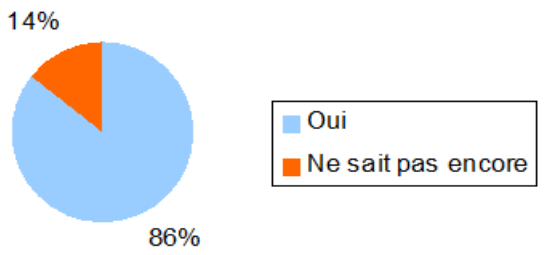

Figure 11: Question to mayors, entitled to take the decision of subscribing to internet: Has the staff of the school asked you to keep this internet access after the programme?[76]

- ***A strong desire for technology***
  A year earlier, half of the schools were either not familiar with satellite broadband technology or had a negative perception of it. With the implementation of the project Connect'Écoles, they put pressure on their local authority to get the equipment and to take out a long-term subscription for their establishments (statement from more than three-quarters of the municipalities questioned).

[76] Eutelsat and NordNet surveys, 2013

"*I have noted a strong satisfaction of the teachers, the students and the parents.*"[77]

- ***A fast and powerful connection***
  To the question "how would you rate (on 10) the service on the criterion of speed (navigation, display of web pages, etc.)", 91% of teachers answered between 7 and 10. 45% of them gave a mark of over 9/10. Indeed, Satellite internet access offers much higher speeds than those provided to schools over their normal landline (76% of those questioned previously had ADSL access below 2 Mbps, 33 % of whom below 512Kbps). Regarding the volume allowance, teachers estimated that it was very satisfactory (70% rated 9/10).

- ***A reliable connection to several computers on the same network***
  Some of them mentioned the capability to connect several computers simultaneously using the same broadband access (up to 15 computers) allowing collective use of broadband in schools.

  "*The first advantage is the simultaneous connection of computers to access online educational activities*"[78]. This school has 10 classes with one or more computers + a computer room + an interactive whiteboard.

  "*The feedback has been very positive: 15 computers connected at the same time without saturating the connection. I attended the demonstration in situ and was agreeably surprised*"[79].

- ***An affordable solution***
  For 90% of the representatives questioned, the cost of a satellite broadband solution (equipment + subscription) is compatible with the local administration (town hall) budget and its expenditure on schools. 80% of the municipalities questioned have, at the request of the schools, decided to take out a long-term subscription.

  "*The tariff of the subscription is coherent with the town hall budget and expenditures for school. The decision to take a subscription or not is rather political.*"[80]

[77] Mr. Dion, Mayor of Rouilly Sacey

[78] Director of the school of Saint-Didier.

[79] Mayor of Saint-Georges Baillargeaux.

[80] Mr. Dion, Mayor of Rouilly Sacey

Analysis: **The overall evaluation of this pilot was positive, in a nutshell:**

- **It improved the awareness of broadband via satellite.**
- **Most local municipalities subscribed to satellite broadband offers, often at the request of the school.**
- **The satellite connection delivered a valuable service also for administrative purposes. Some tasks were carried directly from the school rather than from teacher's house or from the town hall.**
- **The provided service meets the needs in terms of availability, download and upload speed, volume allowance.**
- **The satellite connection allowed new uses of the IT devices of the class.**

9.1.5. The “École Connectees” call for project

9.1.5.1. Background

In February 2013, the French President announced that €20 billion would be allocated over the next ten years to develop high speed broadband access for all, including more than €3 billion in State subsidies in support of projects developed by local and regional authorities.

The “*France Très Haut Debit - THD*” (high-speed broadband for France) plan, launched by the Ministry of the Economy, Industry and the Digital Sector, aims to ensure high-speed broadband access across France by 2022.

Since the development of new digital usages as part of e-Education requires access to high-quality Internet connections, this plan provides a specific focus on optical fibre connections of general public sites in the short or medium term, with priority to primary and secondary schools, as part of the implementation projects that is made available to by local and regional authorities seeking State support.

However the “France Très Haut Débit” plan will be implemented gradually, and for some schools in the most rural areas, high-speed broadband will only be accessible in several years. From now the geographical dispersion of schools does not allow for the installation of optical fibre networks on all sites in the short-term.

Out of the 55,000 schools spread across the French territory, in 2013 more than 16,000 had not got a broadband access at a least 8 Mbps downstream, including some of those without any kind of internet access.

As a result, and given the importance of Internet access in education, the State wishes to provide swift access to a high speed Internet connection for each elementary or primary school (pupils aged from 6 to 11) and for each secondary school, both State-run public schools and State-agreed private schools, by either:

- Bringing forward, wherever possible, the roll-out of high-speed broadband public initiative networks supported by the “France THD” plan, or
- Adopting alternative technological solutions that may be rolled out quickly and without significant investments, while providing access to peak speeds of at least 16 Mbps in mainland France[81].

Given among others the very positive experience of the “Connect'Ecole” pilot project described in the previous chapter, the Government then launched in 2014 the “Ecoles Connectées” programme aiming to provide high speed broadband connectivity by alternative

[81] Schools located in the overseas territories are subject to less stringent rules, given the limitations in the quality of the services that can be made available in these areas.

technological means (satellite or terrestrial wireless networks in particular) to unserved and underserved schools.

Analysis: **Note that the programme was launched and financially and technically supported by the Ministry of Digital Economy - and not by the Ministry of Education.**

9.1.5.2. Time plan overview

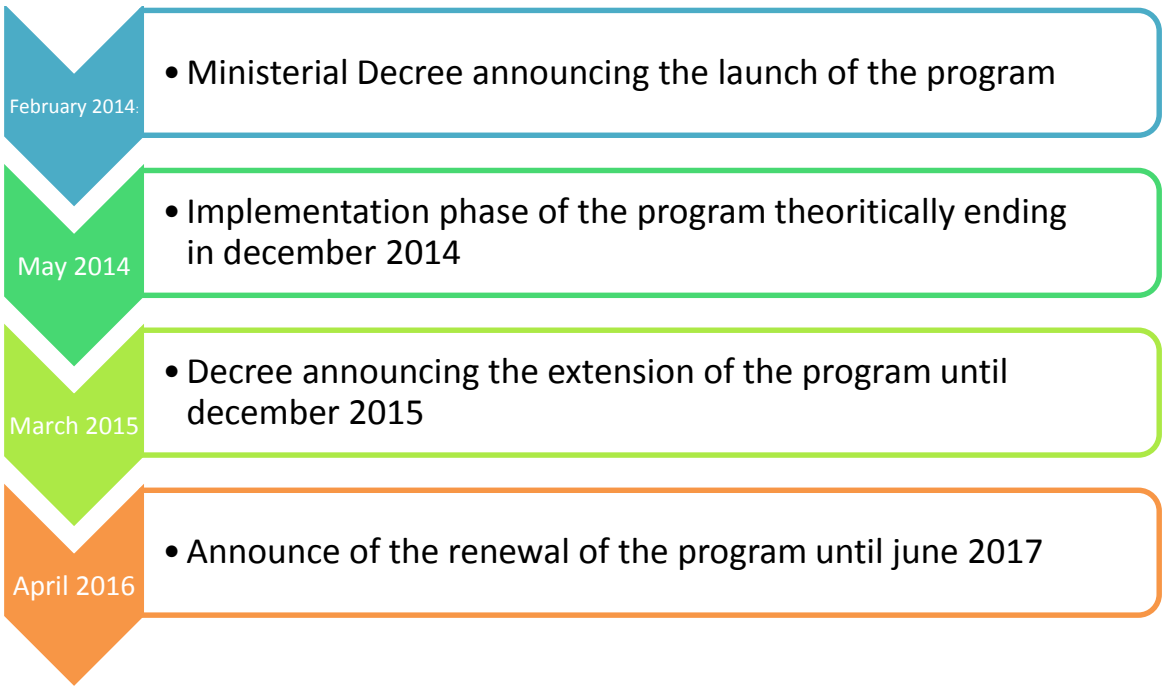

Figure 12: High-speed broadband for France programme phases (picture created for this study).

9.1.5.3. Voucher scheme

The "Ecoles Connectées" scheme is intended to refund to eligible schools (indeed the local authority in charge of the school) part of the cost of the installation (including equipment where necessary) and the commissioning related to the use of alternative technological solutions, using the State Digital Society Fund (*FSN, Fonds National pour la société Numérique*), which provided a budget of €5 million. The amount of the subsidy shall not exceed €400 per installation. At least 20% of the one-shot installation and commissioning costs, as well as the total amount of recurrent subscription fees for Internet access offers, must be borne by the local authority in charge of the school.

Analysis: **With the subsidy from the state, sometimes complemented by specials offers by the satellite ISPs, the cost of one installation of the complete satellite terminal (antenna + modem) is in between €100 and €200.**

9.1.5.4. Eligibility criteria for schools

Half of the 16,000 schools unserved and underserved in 2013 (see section 3.1.5.1 Background) have now or will soon have access to internet via optical fibre deployed through the public network projects planned in France. The government then established a list with the remaining 8,000 schools potentially eligible to the "Ecoles Connectées" scheme. This list may be reviewed at the request of the schools.

To be eligible for the State's financial support, schools:

- must be unable to subscribe to Internet access offers of at least 8 Mbps downstream (peak) in mainland France, with the exception of the specific solutions selected by the proposals,
- are located outside the areas where an agreement exists for the deployment of fibre has with public funding,
- are located outside of the areas where projects of deployment by private operators are announced, as established through public enquiries.

The call for project

The French government published the "Ecoles Connectées" call for projects of ISPs to equip eligible elementary and secondary schools for which no other Internet access with peak speeds of at least 8 Mbps downstream in mainland France exist.

Internet Service Providers likely to offer elementary and secondary schools one or more Internet access package ensuring a peak rate of at least 16 Mbps downstream and 2 Mbps upstream in mainland France were invited to submit their offers.

To be eligible, each tender for Internet packages had to comprise:

- a description of the technical characteristics, the geographical availability and the tariffs of the package or packages (see form in Annex D) that meet the specifications of this call for projects;
- all material, particularly technical documentation and sales brochures, that may serve as evidence for the reliability of the proposal(s) put forward;
- a description of the contractual terms and conditions.

At the end of the call for projects, 56 Internet access offers from 18 ISPs (14 in mainland France) were selected by the government on the basis on their conformity to the requirements

and their value for money. Offers in mainland France are mainly based on satellite solutions and sometimes on radio technologies, such as WiMAX.

N°	ISP	Technology	Number of offers	Coverage area
1	AIL network	Radio	1	81
2	Alionis	Satellite (Eutelsat)	3	All mainland France
3	Alsatis	Satellite (Eutelsat)	8	All mainland France
		Radio	2	16, 31, 32, 38, 02, 25, 37, 51, 61, 65, 70, 72
4	PC Light	Radio	1	89, 18
5	Universat	Satellite (Eutelsat)	4	All mainland France
6	Infosat	Radio	1	76, 80, 27, 55, 08
7	NordNet	Satellite (Eutelsat)	7	All mainland France
8	Ozone	Satellite (Eutelsat)	6	All mainland France
		Radio	2	Auvergne
9	Airlan	Radio	1	02, 25, 28, 37, 51, 61, 62, 72
10	Sat2Way	Satellite (Eutelsat)	3	All mainland France
11	Connexion verte	Satellite (SES)	3	All mainland France
12	Viveole	Satellite (SES)	6	All mainland France
13	Wibox	Satellite (SES)	1	All mainland France
14	Xilan	Radio	1	All mainland France

Table 8: List of approved ISPs by the Ministry of the Economy, Industry and the Digital Sector in Mainland France.

Figure 13: Procedure of eligibility from the France THD official website, from the Ministry of the Economy, Industry and the Digital Sector.

9.1.5.5. The “Ecoles Connectées” call for project – Summary

- Internet Service Providers wishing to take part in this call for projects presented one or more Internet access offers and propose payment terms so that equipment and installation costs might be partly covered by the State subsidy.
- The Ministry of the Economy, Industry and the Digital Sector selected the best proposals that meet the specifications of the call for projects, and published them.
- Agreements were signed between the State and the selected operators, prior to any installations.

At the end of the selection, the “Mission Très Haut Débit” a branch of the Ministry of the Economy, Industry and the Digital Sector sent the list of primary and secondary schools to the operators whose proposals have been selected. At the same time, it notified the schools of their eligibility for State support to receive the identified Internet access offers.

- the eligible schools could subscribe by the due date to the access offer of their choice among those selected;
- the State pays twice a year the financial contribution to the operator to cover its advance of the installation costs, up to a maximum of €400 inclusive of VAT per connected school.

Analysis: **Below is a summary of the results of the project as per today.**

In order to obtain hands-on experience on the "Ecoles connectées" programme and produce and consolidate an assessment on its results, Eutelsat organised two specific face-to-face meetings in February 2016, one with representatives of the Ministries of Education and the Ministry of the Economy, Industry and the Digital Sector and another with NordNet, the largest contributor to the "Ecoles connectées" programme among the satellite ISPs.

As of today, 200 schools has subscribed to the "Ecoles Connectées" programme. Although this figure might seem low when compared to the 8000 eligible schools, in reality it represents a fair (nearly 10%) yet improvable[82] penetration level when compared to the core target of the programme (2000 schools).

In fact, according to NordNet, only 2000 schools out of the 8000 could have a real interest to subscribe. They represent the approximately 1000 schools with no connection at all or a connection lower than 2 Mbps, and the approximately 1000 schools with a connection of between 2 Mbps and 5 Mbps. Indeed the remaining 6000 schools have a connection with more than 5 Mbps: the level of improvement brought to them by the alternative solutions proposed by the "Ecoles Connectées" programme would not be that significant[83].

[82] As a matter of fact, considering that the program was still relevant and that other schools might join, the Ministery of Economy, Industry and the Digital Sector decided to carry it over in April 2016. See https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000032369543&dateTexte=&categorieLien=id

[83] A recent OFCOM report "Internet performance evaluation for Ofcom shows "a clear correlation between access speed and consumers' experience up to around 8-10Mbps. Beyond this, there is only a marginal benefit to increased speed" and states "that a focus on quality, not quantity is required", or, in other words, beyond a certain threshold "speed becomes less important" than "delivering a good experience". Source: http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2014/performance-eval.pdf

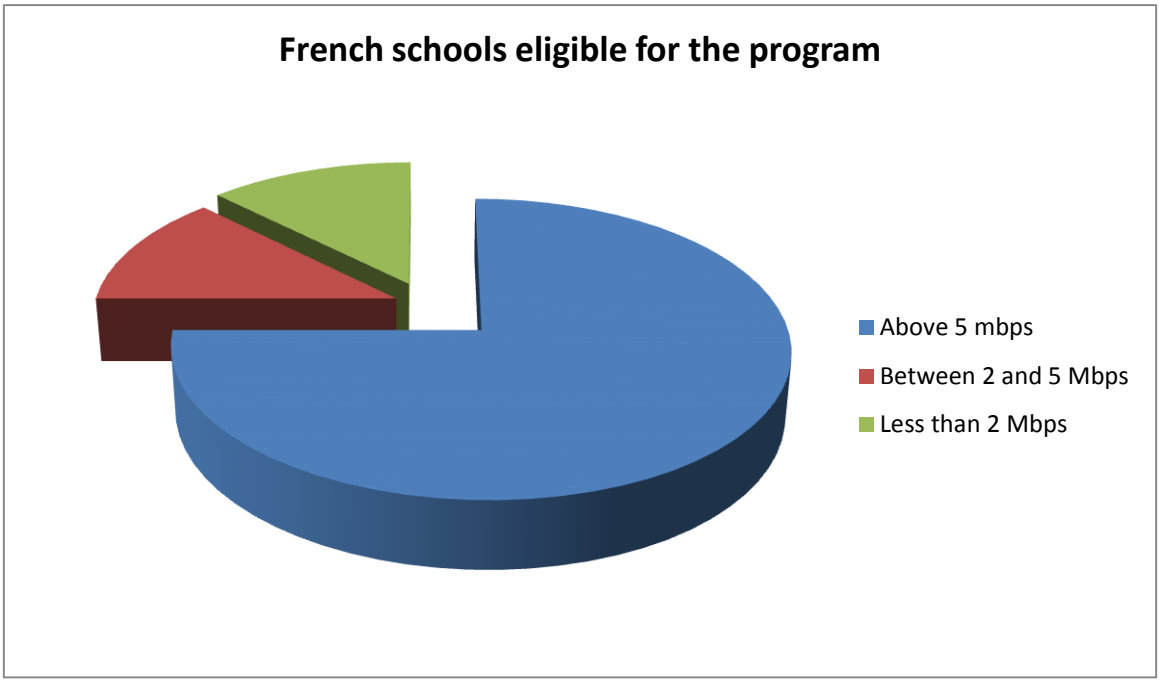

Figure 14: Repartition of schools eligible to the "Ecoles Connectées" programme by connectivity.

Complementary information on the typology of adopters:

- The majority of adopters are schools with 2-5 classes.
- The distribution of adopters is not uniform over the French territory: schools are mostly concentrated in 6/7 counties.

Feedback from schools and users

- Adopters are by far satisfied (as revealed through academic inspections in the classes).
- The availability and stability of the connection was greatly appreciated. "*The school had experienced severe connection unavailability during the last years - sometimes depriving us of internet access for several days. The possibility of using a more reliable solution was seen with enthusiasm by the entire teaching staff.*"[84]
- The quality of the proposed internet access packages generally fit with both educational and administrative needs. "*In order to work, the software managing the "Student Database" requires a good broadband connection*"[85]. Namely, the volume allowance[86] of

[84] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

[85] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

these packages seem fit with the typical consumption of schools (75% of schools have taken subscriptions providing a volume allowance of around 10-12 GB/month and the remaining 25% around 20-26 GB/month). "*However the limit of the amount of data might become an impediment in the coming years in view of the expansion of the use of digital tools in our school*"[87].

- The subscription fees, which are in line with the cost of ADSL services, is not considered a barrier to adoption in schools, as it is compatible with the operating budget of the town hall.

- Installations went quickly and smoothly "*Two weeks after our application, the satellite antenna was installed*"[88]. It has to be noted that the ISP provide the internet access point; the link to the digital equipment (PCs, routers, blackboards, etc.) is managed by the responsible of the ICT in the school.

- The subsidised internet access equipment have not required so far special maintenance activities (the number and type of interventions in schools are in line with the general statistics of the ISPs).

- The bi-annual payment may sometimes pose treasury problems to ISPs: a quarterly payment would be appreciated.

***Analysis:* "Ecoles Connectées" is confronted to a paradox – on the one side, the adopters of satellite broadband services can now use digital learning resources and are very satisfied of this solution. On the other, potential beneficiaries do not see the value of improving their existing internet connection or even to subscribe to one.**

[86] As often with wireless technologies, most subscriptions are capped in term of monthly data use.

[87] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

[88] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

9.1.5.6. Barriers to adoption

Three main issues were identified to justify the slow adoption of the “Ecoles connectées” programme, in spite of the large level of satisfaction of the actual adopters.

a) The first and probably most important one is that a more effective **communication** and promotion could have been arranged.

b) The second one is that a better **administrative coordination** (see also section on “Jurisdictions” and the "Administrative layer cake") could have been ensured.

c) Finally, a more **comprehensive approach** on e-education could have been followed.

a) Communication and promotion could have been more effective

The programme was intended to benefit from institutional communications by the Ministry of the Economy, Industry and the Digital Sector toward the intended schools, local administrations and the other stakeholders. However many potential beneficiaries are not aware and have not been adequately informed of the existence and the benefits of the programme. In addition the project, initiated by the Ministry of the Economy, Industry and the Digital Sector did not experience sound support from the Ministry of Education at the beginning: no large communication event was organised to launch the programme nor any local inauguration with the presence of either minister.

Inappropriate timing of the launch and implementation of the programme: the programme was launched in May 2014, which was too close to the end of the school year in France (June) to ensure an effective promotion and adoption of the offer.

The institutional communication was supposed to be supported by marketing campaigns from the selected ISPs. However the effort put by the ISPs and the quality of the campaign was not homogeneous among the various ISPs and the various regions.

Satellite access is not often considered in people's mind as an adequate final solution for broadband access: this is because on the one hand, optical fibre dominates the public debate and the advertisements, on the other hand satellite is assimilated to TV reception. “*Despite our major communication, only 4 municipalities benefit from this plan for the time being. Some mayors prefer to wait for the fibre.*” [89] “*Because of its reliability and affordability, the satellite is a relevant transitional solution; however, we are closely following deployment of the optical fibre in our department.*”[90]

b) A better administrative coordination could have been ensured

[89] Joel Surig, director of academic services at the Ministry of Education in Eure-et-Loir.

[90] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

The “Ecoles Connectées” is a really a top-down programme, decided at the central level and not necessarily including in the process all the layers of the "administrative layer cake". Consequently, here might have been a lack of ownership from the decentralised services of the State and from the local authorities in charge of relaying the project.

The share of responsibilities between the central government (subsidising the Internet access equipment), the local authority in charge of the school (responsible for the subscription) and the intermediate authorities is a factor of inertia in starting and implementing projects.

c) A more comprehensive approach could have been followed

According to the Ministry of Education, a comprehensive approach and integrated approach including at a time the access infrastructure, the IT equipment and the e-Education environment tools would be received more favourably and therefore should be developed.

This approach should be based on the final uses, and be supported by training and by the regular provision of updated content. “*Connectivity is a necessary condition for the creation of digital workspaces (ENT) accessible to all*”[91] “*Our role is really to boost the uses of digital technologies in the field of education*” [92].

[91] Mrs. Sanchez, teacher and director of the Soyons (Ardèche department) primary school.

[92] Joel Surig, director of academic services at the Ministry of Education in Eure-et-Loir.

9.2. USA: E-Rate – Internet subsidy programme for schools

9.2.1. Background: Overall objectives and eligible communities

The United States have a long tradition in caring for "communications for all". Indeed, the Communications Act of 1934 stated that all people shall have access to rapid, efficient, nationwide communications service with adequate facilities at reasonable charges.[93]

Today, the Federal Communications Commission (FCC) supports 4 programmes:

1. **E-Rate for schools and libraries in High poverty and rural areas, also known as the Schools and Libraries programme[94]**
2. High cost programme, which helps extend phone and broadband service to rural areas
3. Life line, which helps support basic phone service for low-income Americans
4. Rural Health care, which allows rural health care providers to pay rates for telecommunications services similar to those of their urban counterparts, making telehealth services affordable.

For this study, we will describe and analyse the programme which specifically addresses school, namely **E-Rate.** Note that when eligible schools and library are located in the perimeter of the *High Cost programme*, beneficiaries are required to offer them high-speed broadband at rates reasonably comparable to similar services in urban areas.

Broadband access technologies listed by FCC

It is important to note first that Satellite services are listed among the broadband technologies, together with cable, ADSL etc. They are advertised as "another form of wireless service useful to serve remote or sparsely populated areas". Speeds are reported as possibly slower than DSL and cable but much higher than dial-up access. Apart from this, we could not find any specific mention of the satellite services; the presentation web site and various reports are quite "technology neutral" in that sense.

[93] https://www.fcc.gov/general/universal-service

[94] https://www.fcc.gov/general/universal-service-programme-schools-and-libraries-E-Rate

9.2.2. The E-Rate programme (Schools and Libraries programme)

The E-Rate programme makes telecommunications and information services more affordable for schools and libraries in America. Mandated by Congress in 1996 and implemented by the FCC in 1997, the E-Rate provides discounted telecommunications, Internet access, and internal connections to eligible schools and libraries. E-Rate is a $2.4 billion a year programme.

There are two categories of eligible services:

- Category one services: telecommunications, telecommunications services and Internet access services
- Category two services: internal connections, managed Wi-Fi, and basic maintenance.

E-Rate does not cover PCs and other devices that can connect to internet.

9.2.2.1. The E-Rate aid

Eligible schools and libraries may receive discounts on eligible services.

Specifically, schools and libraries do not receive direct funding from the programme. Instead, they receive discounts on the costs of services provided by vendors. The amount of discount each school or library can receive under the programme ranges from 20 to 90 percent and is determined using a matrix designed by FCC, with schools and libraries located in rural and low-income areas receiving the highest discounts from the fund. The USF compensates the schools' and libraries' vendors for the amount of the discount.

Schools and libraries are always responsible for paying at least some part of the cost of service.

9.2.2.2. E-Rate modernization

E-Rate is not a static mechanism. **The FCC considers that modernizing E-Rate is critical for the future of the American children and citizens.** Therefore, the FCC adopted in 2014 the E-Rate Modernization Order, followed by the Second E-Rate Modernization Order as part of a comprehensive review to modernize the programme.[95]

The updated overarching principles of this modernization effort are:

– Begins a multi-year transition of all programme funding to broadband, by gradually phasing down support for non-broadband services.

[95] Wireline Competition Bureau And Office Of Strategic Planning And Policy Analysis - E-Rate Data Update - Wc Docket No. 13-184, November 17, 2014

– Adopts clear broadband goals to measure overall programme success, while maintaining local flexibility to determine the needs of individual schools and libraries.

– Funding is allocated first to the highest poverty schools and libraries, then the next highest poverty applicants, and continues down the list of applicants.

In the E-Rate Modernization Order, the FCC refocused the programme from legacy services to broadband by setting a target of $1 billion in support for category two services (internal connections, managed Wi-Fi, and basic maintenance) to expand Wi-Fi to more than 10 million students in funding year 2015. The first goal is ensuring affordable access to high-speed broadband sufficient to support digital learning in schools and robust connectivity for all libraries. The modernization also phased down the support for voice services by 20 % each funding year and eliminated support for non-broadband, legacy services. Category one services (telecommunications, telecommunications services and Internet access services) will still be ensured funding.

It is important to highlight one of the first modernization actions: the use of the terminology Category 1 & 2 instead of Priority 1 & 2 services. Indeed, initially, Category 1 services needed to be established first for having the right to apply for priority 2 services. This was found to be a roadblock towards the deployment of Wi-Fi.

To measure progress, the Commission adopted connectivity targets for Internet access and Wide Area Network (WAN) or last mile connections.

	Schools	**Libraries**
Internet Access	1 Gbps per 1,000 users	Serving fewer than 50,000 people: 100 Mbps Serving 50,000 people or more: 1 Gbps
WAN/Last Mile	*Scalable* to 10 Gbps	*Scalable* to 10 Gbps

In practice, these modernization actions focus on the largest and most urgent need—closing the Wi-Fi gap—while transitioning support away from legacy technologies to 21st Century broadband connectivity, ensuring E-Rate money is spent smartly, and improving programme administration. The reform will expand Wi-Fi to more than 10 million students in 2015 alone.

In the Second E-Rate Modernization Order, the FCC increased the cap for the E-Rate programme to $3.9 billion in funding year 2015, indexed to inflation going forward. Among other actions, this second step takes further actions to improve the overall administration of the programme and maximize the options schools and libraries have for purchasing affordable high-speed broadband connectivity by:

– Suspending the requirement that applicants seek funding for large up front construction costs over several years;

- Equalizing the treatment of schools and libraries seeking support for dark fibre with those seeking support for lit fibre;
- Allowing schools and libraries to build high-speed broadband facilities themselves when that is the most cost-effective option, subject to a number of safeguards;
- Providing an incentive for state support of last-mile broadband facilities through a match from E rate of up to 10% of the cost of construction, with special consideration for Tribal schools (Indian and Alaskan);
- Requiring carriers that receive subsidies from the universal service programme for rural areas – called the High Cost programme – to offer high-speed broadband to schools and libraries located in the subsidy area at rates reasonably comparable to similar services in urban areas;
- Increasing the certainty and predictability of funding for Wi-Fi by expanding the five-year budget approach to providing more equitable support for internal connections through funding year 2019.

A major objective today: closing the Wi-Fi Gap

In order to achieve this priority goal, the FCC has created the following conditions of success:

- Sets an annual funding target of $1 billion for Wi-Fi while ensuring support continues to be available for broadband connectivity to schools and libraries;
- Directs at least $1 billion in support for Wi-Fi for 2015 and 2016 to connect over 10 million students and thousands of libraries each year through reasonable budgets for applicants;
- Allows support for Wi-Fi purchased as a managed service and caching servers through the new internal connections funding mechanism;
- Increases support targeted for Wi-Fi in rural school districts substantially – a nearly 75 percent increase; and targets a nearly 60 percent increase in urban and suburban districts.

The FCC also took actions to stimulate and maximizes E-Rate spending by:

- Incentivizing consortia and bulk purchasing.
- Increasing transparency on how E-Rate dollars are spent and on prices charged for E-Rate services.
- Makes the E-Rate Administration and Application Processes Faster, Simpler, More Efficient:
    - Streamlines the process for multi-year applications.

- Speed-up process for small, cost-effective applications.
- Speeds review of all applications.
- Moves to electronic filing of all documents.
- Simplifies discount calculations.
- Strengthens efforts to combat waste, fraud and abuse by toughening document retention and site inspection rules.

Analysis: **It is interesting to note that strict connection performance figures are not the objectives put forward; the goals are more qualitative and global. When quantified, target performance is adapted to the end users, in this case: communities.**

In order to achieve its goals, the FCC is created an success-driven environment through pragmatic and socio-economic actions accounting for experience:

- **Possibility to spread the up-front payment of construction cost over several years;**
- **Support for Wi-Fi includes Wi-Fi purchased as a managed service;**
- **Increase of support to less responsive targets, namely rural areas;**
- **Encouragement of a sort of demand aggregation.**

Such environment allows flexibility in the implementation and does not introduce intermediate artificial performance boundary.

Lastly and of utmost importance, the FCC ensures that the E-Rate programme is updated in line with the evolution of usage, economics and technologies.

Much of the rules and methodologies implemented for E-Rate could be applicable for inciting regional authorities to support broadband connectivity deployment across their territory.

9.2.2.3. Applying to E-Rate aid

The Universal Service Administrative Company (USAC) has been appointed by the FCC to administer the E-Rate programme, although FCC retains responsibility for overseeing the programme's operations and ensuring compliance with its rules. USAC's Schools and Libraries Division is responsible for carrying out the programme's day-to-day operations.

A school or library that wishes to participate in the E-Rate programme submits a request for competitive bids for the specific E-Rate supported services it seeks to USAC. Then:

a) USAC posts those requests on its website for vendors to see. The bid request and competitive bidding process must comply with both FCC rules and state and local procurement requirements.

b) After reviewing the bids it has received, the school or library selects its preferred vendor(s) and submits an application to USAC for approval listing its desired purchases.

c) USAC issues funding commitments to eligible applicants. Once a vendor provides the selected services to the applicant, either the vendor or the applicant submits requests to USAC for reimbursement of the approved discounts.

Analysis: **FCC has implemented the most pragmatic mechanism through a one stop shop portal for applicants and vendors. Central tools and mechanisms are keys for success of such large endeavors.**

9.2.2.4. Funding mechanisms and sources

All telecommunications service providers and certain other providers of telecommunications **must contribute** to the federal USF *(Universal Service Fund)* based on a percentage of their interstate and international end-user telecommunications revenues (generally a small fraction of the overall consumer bill). These companies include wireline phone companies, wireless phone companies, paging service companies, and certain VoIP providers. These contributions fund all four of the FCC's Universal Service Programmes.

Some consumers may notice a "Universal Service" line item on their telephone bills. This line item appears when a company chooses to recover its USF contributions directly from its customers by billing them this charge. The FCC does not require this charge to be passed on to customers. Each company makes a business decision about whether and how to assess charges to recover its universal service costs. These charges usually appear as a percentage of the consumer's phone bill. Companies that choose to collect universal service fees from their customers cannot collect an amount that exceeds their contribution to the USF. They also cannot collect any fees from a Lifeline programme participant.

Analysis: **The FCC acted so that they have the means to achieve their goal: a significant and sustainable budget and a very pragmatic technology-neutral and fair solution.**

9.2.2.5. Issues

Three major issues are highlighted in the public documentation analysed: fraud-type issues, problems linked to the poor infrastructure available in many eligible schools and pricing.

Oversight of the Schools and Libraries Programme has increased because of complaints the OIG (Office of Inspector General) has received alleging improprieties within the programme. The alleged improprieties include:

- Submission of false claims;
- Failure to comply with appropriate procurement regulations and laws;
- Conflict of interest;
- Forgery and securities related offenses.

In order to maintain programme integrity, the OIG is working with local and federal law enforcement entities to investigate the complaints and follow-up with prosecution where appropriate.

Also, too many U.S. schools and libraries lack the infrastructure necessary to fully utilize today's learning technologies – particularly when it comes to Wi-Fi in the classroom:

- Three out of five schools in America lack the Wi-Fi needed to deploy 21st Century educational tools.
- Half of school buildings have older, slower internal wiring that won't carry data at today's broadband speeds.

Complexity of application, despite the one-stop shop:

A report analyzing the Indian and Alaskan Tribes case provides also a global impact analysis of E-Rate. It indicates that the E-Rate application process is generically complicated and strict, to the point that failure to strictly follow rules and deadlines can end up in denial of funding and even re-imbursement. In practice, many E-Rate filers (at least those who can afford unlike Tribal communities) end up hiring consultant to assist them.[96]

[96] The FCC's E-Rate overhaul and its impact on Indian county – Tribal Telecom Conference, August 12, 2014

Pricing aspects

WAN and last mile: Many schools and libraries also face an affordability issue and indicate that purchasing high-speed Internet access and fibre-based WAN/Last-Mile services is prohibitively expensive relative to available local resources, even including available E-Rate support. About 58% of eligible entities report the monthly cost as the most significant barrier; indeed:

- 72% of districts pay at least $5/Mbps/month for their Internet connection, among which 9% pay at least $250/Mbps/month for the connection.
- In rural areas, 10% of districts pay over $250/Mbps/month!

One reason highlighted for the wide pricing disparities is a lack of bidders responding to schools' requests for proposals. The above prices are compared very high to many European markets, especially those with open broadband networks and substantial competition among ISPs (where you today can find prices as low as $25-35 per month for a 100 Mbps downlink connection; fibre or cable).

WAN/Last mile construction costs: Another component of the affordability that disproportionately impacts rural schools is the cost of building adequate connections, 5 to 55 times more expensive in than in urban and town areas!

Analysis: **Price remains the major barrier to broadband and associated services deployment in rural schools, one major reason highlighted being the low density (low competition) of bidders in rural areas. The prices quoted in the various reports are very high compared to Europe. This could be an incentive for installing e.g. satellite-based or cellular-based broadband instead of fixed access, but no details could be found regarding specifics about satellite services and prices in the frame of E-Rate.**

9.2.3. E-Rate impact

When the E-Rate programme was established in 1996, only 14 percent of the nation's classrooms (primary + secondary schools) had access to the Internet. Today, the FCC indicates that of the FCC's E-Rate programme, virtually all schools and libraries have Internet access. However, an (outdated) FCC survey of E-Rate recipients reported that nearly half of respondents have lower speed Internet connectivity than the average American home - despite having, on average, 200 times as many users.

The analysis was conducted in 2002 - thus before the modernization effort- by the National Bureau of Economic Research provide very important conclusions[97]:

- Despite the fact that, before 1998, schools lacking connectivity were those with a strong income gradient, E-Rate funding went disproportionately to schools with low performance internet.
- The E-Rate subsidy globally led to significant increases in Internet investment: 66 percent more classrooms than there would have been without the subsidy. This is the equivalent of accelerating Internet investment by about 4 years.
- Urban schools and low/middle classes are disproportionately responsive to the subsidy while rural schools and high schools show less sensitivity to the subsidy rates.

The *Wireline Competition Bureau And Office Of Strategic Planning And Policy Analysis* updated this analysis in 2014 and reports that:

- 68% of all school districts do not have a single school that meets the FCC long-term connectivity target (1 Gbps per 1000 student);
- Only 10% of school districts have all their schools meeting the FCC long-term Internet access target;
- 63% of public schools, accounting for over 40 million students, do not have sufficiently robust broadband connections to take advantage of modern digital learning.

This shows that connectivity targets will only be achieved if significantly more schools and libraries are able to overcome their lack of access to high-capacity connections at an affordable price.

[97] The Impact Of Internet Subsidies In Public Schools - National Bureau Of Economic Research, Cambridge USA - August 2002

Other findings include:

- Roughly 30% of all public schools need fibre connections to reach the FCC connectivity targets.
- 31% of urban public schools and 41% of rural public schools do not have access to fibre facilities.
- While there are some small schools where non-fibre technologies are a viable option for meeting the FCC connectivity targets (and meeting the school's connectivity needs), the fibre gap means that tens of millions of public school students attend schools lacking access to the needed telecommunications infrastructure to meet the connectivity targets.

Impact on student population

The 2002 National Bureau of Economic Research report notes that there is very little evidence that the programme has had any measurable outcome on student achievement. The lack of impact is certainly consistent with the fact that only one third of teachers reported that they were well prepared or very well prepared to use computers and the Internet, many being "novice or completely inexperienced" with computers.

The 2014 report confirms this 2002 finding that low-income students are underrepresented in the group of schools with 100 Mbps or more (compare 35.3% of students in schools with free or reduced price lunches versus 32.7% for students in schools where all students receive either free or discounted lunches). At the same time, low-income students are over represented in schools with 10 Mbps or slower connections.

Analysis: **E-Rate significantly improved the situation, while in an unbalanced manner with most of the positive impact over urban schools urban and/or schools already fitted with internet connectivity.**

Besides, a majority of schools still do not have the connectivity (nor IT equipment or adequate competence) necessary to use the modern digital learning tools in the best way.

Satellite services deployment or performances are not specifically highlighted in the documents analyzed at this point. They are probably embedded in the "non-fibre technology adequate for small schools" which is mentioned in the reports.

Lastly, the fact that no evidence of measurable impact on student achievement can be found could put E-Rate at risk; there is no specific measure listed yet to address one of the possible root causes, namely the poor experience and competence among teachers regarding IT, digital services and devices.

9.2.4. Next steps in E-Rate evolution

The FCC already looks ahead for the next evolution of E-Rate, in particular:

- Work on further steps to facilitate the use of cost-effective consortium-based purchasing.
- Evaluate the continuation of new Wi-Fi funding methodology after 2016, as part of a review of the long-term funding needs of the programme.
- Envisage more funds: the FCC identifies existing sources which could free budget on the coming years.

Also, FCC is considering Usage growth a parameter to establish the next evolutions. Studies are performed which show a very probable increase in bandwidth, estimated to be rapid, which will tend to increase costs for connected schools to the extent usage rises faster than prices decline: even if bandwidth costs decline by 10% per annum, the demand for broadband is anticipated to grow at least 50% per annum. If the trend continues, total bandwidth costs will continue to grow even with reductions in prices per Mbps per month (estimated to 24% to 40% increase of total costs over the next 5 years).

Regarding future budget needs, budget projections have already been done building on the past years of E-Rate experience:

- The CAPEX costs to connect all public schools and achieve the goals have been estimated ($4.1 billion pre-discount and prior to any pricing efficiencies being realized). The average discount that will be offered through the E-Rate mechanism is estimated at 69%.
- Growth in category one OPEX results from both growth in the number of schools connected and growth in individual schools' bandwidth costs. Prices are anticipated to decline by 34% over the next five years due to basic market factors such as volume discounting.

Analysis: **A timely budgetary planning accounting for the most probable evolution of the E-Rate instrument targets is another key to success.**

9.2.5. E-Rate: Final considerations

The E-Rate programme is globally compared quite successful and could be characterized in a few words: a very pragmatic set of actions, implemented through a central mechanism and backed by a significant and sustainable budget.

In a nutshell, the key to this success are:

- Regular programme results assessment, including roadblocks identification, and reactive implementation of corrective actions.
- Focus on schools that experience difficulties.
- Not limited to the provision of connectivity, but also addressing internal services and especially Wi-Fi.
- Gradually phasing down support for non-broadband services (no coupling of hard performance boundary with time).
- Adopting clear broadband goals to measure overall programme success, while maintaining local flexibility to determine the needs of individual schools and libraries.
- Backed by a central fund at a continental scale, the USF, relying on a kind of mandatory tax paid by all the communication industry.
- Implemented through a single portal under the responsibility of a single body, USAC, also in charge of day-to-day management.
- Encouraging demand aggregation through incentives for consortia and bulk purchasing.

Much of the above approaches has been identified as enablers in the SABER project and could be replicated in Europe through a reform of the CEF, and in particular comfort the concept of the Voucher Scheme. Furthermore, they do not only fit the cases of schools in difficulties, but could be applied more globally to European Regions in difficulty.

However, the E-Rate programme still face issues and not all seem tackled yet. In particular:

- How to trigger price reduction? There is a need to motivate more bidders in rural areas since monopoly makes prices higher; another way could be to just impose a maximum service price.

- How to increase the impact over student achievement? The root seems to be the poor digital skills of the teachers themselves. Regarding satellite broadband services, one could propose actions like:
    - Delivery of training training of teachers about the use of satellite-delivered services and applications, and how to get the best out of them.
    - The organization of yearly contests rewarded by visits to the gateways site.

The above suggestions would also be applicable in Europe.

9.3. ITALY: Public–private pilot using satellite-based solutions for e-Education

9.3.1. Introduction

Regarding the current situation of IT in Italian schools the most updated data from the *Observatory of the Ministry of Education* (2014–15) show that:

- 1,300,000 digital devices have been made available to the schools; the ratio students per device improved on average from 8.9 to 7.9.
- 70% of the schools are connected to the internet either with wired or wireless technologies.

Since 2007, the Italian Ministry of Education has initiated a process to encourage and support the integration of ICT technologies in education, with the launch of the *Piano Nazionale Scuola Digitale* (PNSD)[98], i.e. National Plan for the Digital School. The first phase of PNSD (2007–2013) involved 3,600 schools, 14,983 projects and a budget of 494 M€.

In October 2015, a new version of the National Plan for the Digital School was released by the Ministry of Education in the framework of the reform of the school[99]. The actions of the Plan will be funded by both the public national resources and the European Structural Funds (National Operative Programme on Education for the 2014–2020 Multiannual Financial Framework) for a total amount of 1 billion euro. In particular, for what concerns internet access[100], the Plan includes three actions:

1. Expanding the fibre coverage with the perspective of ensuring a broadband or ultra-fast broadband connection to all Italian schools by 2020. To achieve this objective, the Ministry of Education has signed an agreement with the Ministry for the Economic Development stating that the fibre connectivity of schools is a priority of the National Broadband Plan;

2. Enhancing the available local infrastructures and access points to internet via wired or wireless LAN, (initial investment 88.5 M€ in 2016);
3. As of 2016, the Ministry of Education should grant an additional contribution of 10 million euro each year to cover the fees of enhanced or new connectivity, when not already covered by other public means.

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98 National Plan for the Digital School: http://www.istruzione.it/scuola_digitale/allegati/Materiali/pnsd-layout-30.10-WEB.pdf

99 Known as "La Buona Scuola" (the Good School) and approved by the law n. 107/2015

100 The Plan is structured as a strategic document articulated in 4 Parts: 1) Instruments; 2) Contents and Competences; 3) Training; 4) Accompanying actions. All parts are structured into actions for a total of 35. The first Instrument is the "Access", to be intended as access to internet, but also as presence of enabling conditions for an effective management of the school life.

As mentioned before, these measures goes along with those included in the National Broadband Plan, firstly adopted in 2011 and then enhanced through the National Ultra-Broadband Plan in 2015, the objective of which are namely:

- Providing 85% of population with access to broadband connection services above 100 Mbps;
- Providing access to broadband connection services above 30 Mbps to 100% of population;
- Providing access to broadband connection services of at least 100 Mbps for public institutions.

However there are several factors hindering an achievement of these objectives by 2020, and consequently a complete broadband coverage of all school in Italy. Among these factors:

- The autonomy of local public administrations with respect to the central government in putting actions in place creates delays, coordination difficulties, heterogeneity in interventions and inefficiencies.

- The morphology (e.g. vast mountainous area) and demography (e.g. low population density in rural areas, often growing due to demographic downturn) of some regions make either impractical or economically unviable the set-up of terrestrial infrastructures able to respond to the demand for broadband everywhere.

As a matter of fact, data concerning the fibre ultra-broadband coverage show a deficit situation for many regions, where the objectives set by the National Broadband Plan seem far to reach yet. The map below shows the broadband coverage beyond 30 Mbps and 100 Mbps in all Italian regions until May 2016.

The negative consequences of the digital gap become particularly evident for the small schools in the most remote areas, which can be bound to play a secondary role in modern education until the terrestrial infrastructure will be able to fully cover their territory.

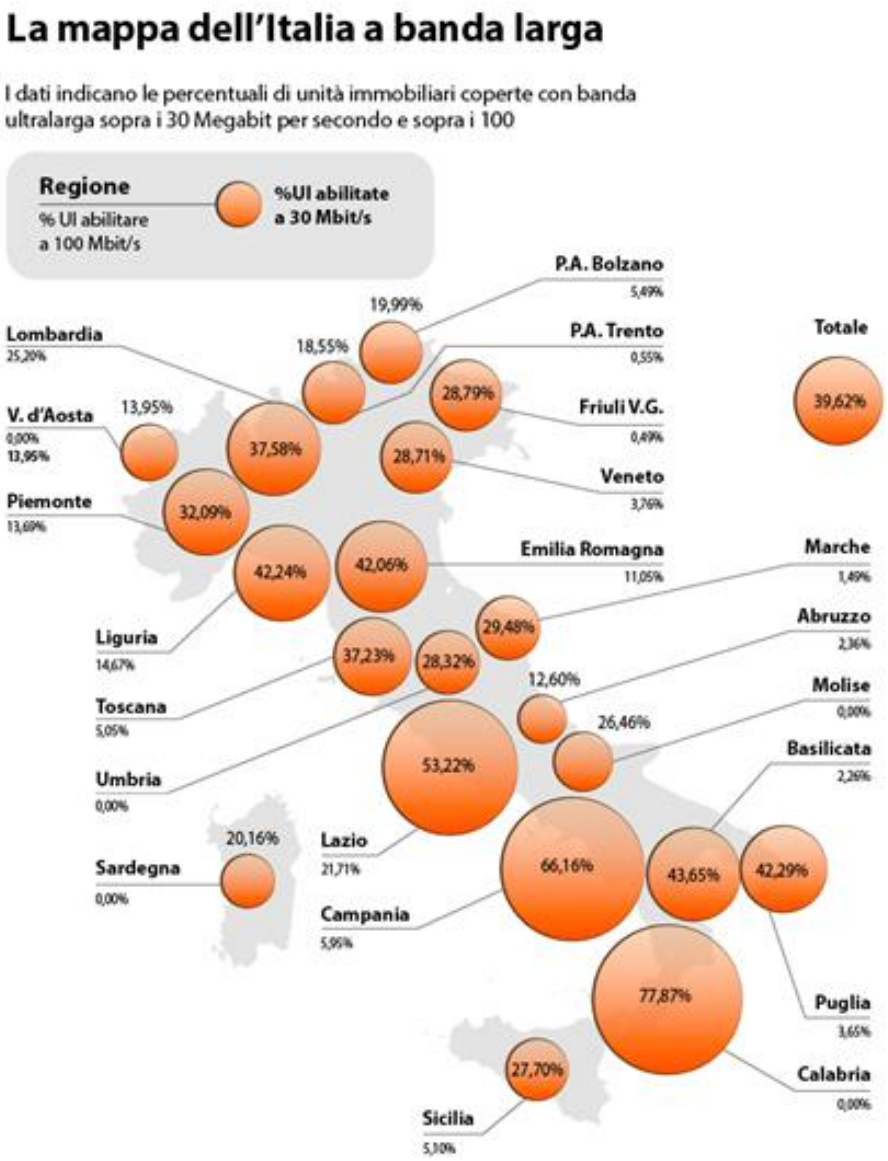

Figure 15: The map of the Broadband diffusion in Italy[101].

9.3.2. An alternative solution for the Basilicata region

At regional level, the public authorities are trying to secure additional funds to support the development of fibre-based broadband infrastructures, largely using the European Structural and Investment Funds (ESIF).

[101] Data from the Ultra Broadband Observatory of Ernst & Young, May 2016

In this general context, one interesting, alternative approach is represented by an experimental public–private initiative for e-education carried out in the Basilicata Region by the Ministry of Education, the Italian Space Agency (ASI) and the company Openet Technologies. This initiative proposes an affordable, plug-and-play, satellite-based solution, in areas where either the fibre infrastructures have been not deployed yet or the economic and geomorphological conditions would in any case discourage the deployment of terrestrial infrastructures.

A further element of interest is that this model propose an effective solution to overcome the educational limits of the so-called "multi-classes" (or multi-age classrooms or composite classes)[102], a situation which is due to increase due to demographic downturn.

This initiative is being developed in the framework of the project "*ONE CLASS! Open Network for Education*"[103], carried out under the supervision by the European Space Agency (ESA). ONE CLASS! intends to submit a reference model at both regional and national level.

In particular, this model includes both synchronous learning and asynchronous learning. The former includes:

- **Shared Learning:** It refers to distance learning based on a daily use of video-conferencing between the multi-class and the corresponding level of standard class (hereinafter "Master") in a standard (hereinafter "Master") school. The shared lesson promotes the exchange of experiences and ensures the teaching of all disciplines, allowing the student to interact and participate to each lesson in interactive way.

  A videoconferencing service is implemented to support the shared learning between the multi-class of a given school and the standard classes of other schools;

- **Enlarged learning environment:** Distance learning where one or more classes working on a common project organise regular meetings between teachers, students and/or experts through videoconference or other digital means. A videoconferencing service as well as a parallel access to audio-visual resources is implemented to support this enhanced learning environments.

The latter includes:

- Platforms to access the resource for training courses. The platforms enable each student to complete the activities developed during the local or remote (video conference enabled)

[102] Multi-classes (or multi-age classrooms or composite classes) are classrooms with students from more than one grade level, formed because there are not enough students to form classes of the same grade level. Composite classes are more common in smaller schools; an extreme form is the one-room school. The Circular Letter by the Italian Ministry of Education No. 34 of 1 April 2014 establishes that in the primary school, the number of students can range from a minimum of 8 to a maximum of 18 pupils.

[103] The official project webpage is available at: https://artes-apps.esa.int/projects/one-class-open-network-for-education

lessons, by accessing a wide range of contents that could hardly be physically available in smaller schools in rural areas.

In order to create a link between all the virtual classes, the pilot also involves 4 second-grade secondary schools, two renowned schools located in Basilicata and two located in two different EU Countries, to support languages teaching and learning (French and English) during the school time.

9.3.3. Involved actors

The following description of the service value chain has been conceived referring to the project duration, but it also applies to the commercial service deployment. Beyond the specific case, the key stakeholders implicated in the service value chain are: the schools themselves, the Regions / decentralised public authorities in charge of public education, the Ministry of Education and its local / decentralised branches, the satellite provider, the ICT provider[104], the content provider.

From a financial point of view, the project is entirely co-funded by the Italian Space Agency (via the European Space Agency) and Openet Technologies, with some support from the Basilicata Region to finance the procurement of the video-conference kits.

[104] In the case of this project, the ICT activities are carried out under the direct responsibility of the Basilicata Region.

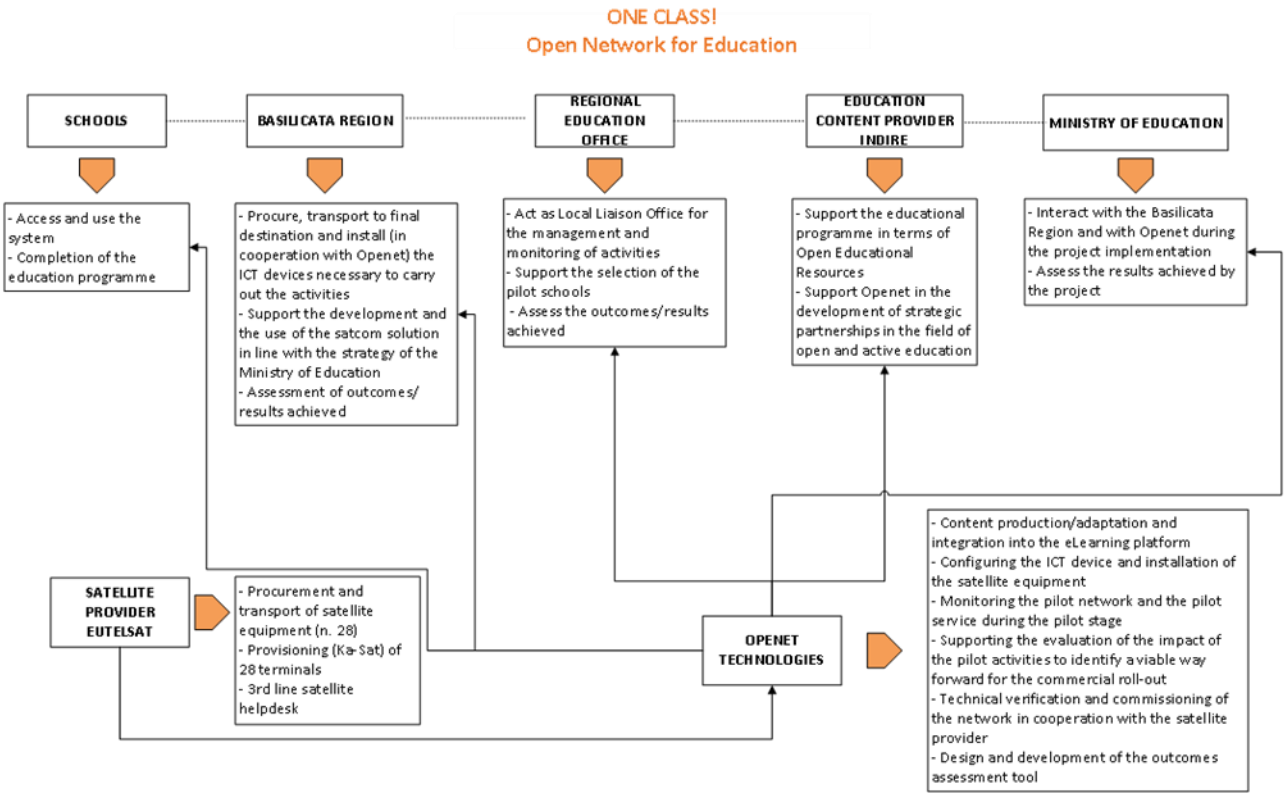

Figure 16: Basilicata Multi-classes Value Chain.

9.3.4. Cost-Benefit analysis

From an architectural point of view, the satellite technology helps rural areas to overcome the isolation and the lack of modern telecom infrastructures.

From a social point of view, the new teaching practices, guaranteeing continuity of education in areas subject to depopulation, bring obvious benefits in terms of social integration.

Finally, the introduction of new technologies in teaching is one of the essential levers for the adjustment of the educational system to the challenges imposed by the global competition. The adoption of these systems results in a significant reduction in the costs of the school administration and in those incurred by families (no need to move to large cities because of education).

9.3.5. Technical solution

The proposed satellite solution is based on the use of KA-SAT satellite[105] and the tooway™[106] system (space and terrestrial segment). The broadband connectivity for the overall network is therefore provided using the KA frequency band (20-30 GHz).

The system and service architecture is realized as follows:

Figure 17: Basilicata Multi-classes System and Service architecture.

105 KA-SAT is the first European HTS (High Throughput Satellite) Satellite in Ka (20-30 GHz) frequency band, allowing to decuple the data traffic capacity with respect to the standard telecommunications satellites of the previous generations.

106 www.tooway.com.

The use of the system is efficiently monitored via an assessment tool[107] showing in near-real time the actual usage of the system. The assessment tool contributes to monitor the pilot activities facilitating the stakeholders involved to assess the results achieved and take decision about the possible commercial services exploitation.

9.3.6. Pilot utilization plan

The Basilicata multi-class pilot will last eight months, from October 2016[108] to May 2017, and involves 28 sites:

- 11 pilot primary schools with 18 multi-classes in the province of Potenza;
- 1 pilot primary school with 1 multi-class in the paediatric ward of Potenza's Hospital;
- 6 pilot primary schools with 10 multi-classes in the province of Matera;
- 1 pilot primary school with 1 multi-class in the paediatric ward of Matera's Hospital;
- 3 master primary schools, each of them covering 5 levels of teaching (total 15 classes), in the province of Potenza;
- 2 master primary schools, each of them covering 5 levels of teaching (total 10 classes), in the province of Matera;
- 2 renowned secondary schools (1 located in the province of Potenza; 1 located in the province of Matera);
- 2 international secondary schools, located in two different European countries.

In total 213 multi-class students of from the province of Potenza and 109 from the province of Matera will be the beneficiaries of the project.

[107] Designed and developed by Openet Technologies.

[108] This choice is justified because in Italy the annual school calendar generally starts around mid-September.

Use Case for 1 Master Class

Satellite equipment	1 satellite terminal (antenna + modem)
Service Profile	30 Mbps downstream / 6 Mbps upstream (with Committed Information Rate of 512 kbps / 512 kbps), 200 GB monthly volume of traffic.
ICT devices	5 videoconference kits
Number of students	15-30
Number of teachers	4 per teaching level
Videoconference Features	5 delivery flows (in parallel), each lasting 5-8 hours per day, 5 days a week

Use Case for 1 Multi-class

Satellite equipment	1 satellite terminal (antenna + modem)
Service Profile	30 Mbps downstream, 6 Mbps upstream (with Committed Information Rate of 256/256 kbps), 100 GB monthly volume of traffic.
ICT devices	2-4 videoconference kits (depending on the number of levels in a multi-class). Students of the same level will be gathered together in a dedicated space, where a reserved videoconference is set up[109].
Number of students	8-18 (in line with the Italian law[110]), but in the paediatric classes, where the number depends on the students admitted in the hospital in a given period.
Number of teachers	1 teacher acting as a tutor
Videoconference Features	5 delivery flows (in parallel), each lasting 5-8 hours per day, 5 days a week.
Videoconference Activities	Students of multi-classes shall participate – every day per week to the video-conference delivered by the master classes. The students

[109] The total number of videoconference point to be set up for the pilot is 64. During the preparatory meetings with the Region and the Regional Education Office, it has been proposed to physically divide and pool the students belonging to the same teaching level in a separate space – thank to the use of removable walls/dividers – to facilitate the parallel videoconference activities.

[110] See footnote 41.

	can interact with the teachers of the master class.
eLearning activities	The e-Learning platform will be used outside school-time for further enrichment of learning process.

Use Case for 1 International School Class located in Europe

Satellite equipment	1 satellite terminal (antenna + modem)
Service Profile	30 Mbps downstream / 6 Mbps upstream (with Committed Information Rate of 512 kbps / 512 kbps), 200 GB monthly volume of traffic.
ICT devices	1 videoconference kit
Number of teachers	1 teacher acting as a tutor and coordinator
Number of students	15-30
Videoconference Features	Videoconference flow corresponding to the a selected subject delivered by a native-speaking teacher (for the duration of max. 3 hours per week)

Use Case for 1 International 2nd grade of secondary school class

Satellite equipment	1 satellite terminal (antenna + modem)
Service Profile	30 Mbps downstream, 6 Mbps upstream (with a Committed Information Rate of 256/256 kbps), 100 GB monthly volume of traffic.
ICT devices	1 videoconference kit
Number of students	18-30
Number of teachers	1 foreign-language teacher acting as a tutor and coordinator
Videoconference Features	1 videoconference flow corresponding to the language lessons (for the duration of max. 3 hours per week)

9.3.7. SWOT analysis

The following Strengths, Weaknesses, Opportunities and Threats have been envisaged for the project implementation:

Strengths	Weaknesses
• The proposed solution responds to specific needs • Presence of strategic local partnerships for the implementation of the activities • High awareness by public officers about the need to overcome specific needs • Use of pre-existing technologies (satellite equipment and bandwidth, eLearning platform) • Technical and operation training delivered by skilled personnel	• Low awareness among teachers towards new ways of teaching • Low digital skills and culture among the current teachers working in schools • Possible mismatch between school period and start of the pilot stage • Relevant technical assistance activities is required
Opportunities	**Threats**
• Lack of TLC infrastructures in Basilicata • Because of depopulation, increase of needs addressed by the proposed solution	• Teachers' reluctance to change methods • Spending review affecting the Italian Public sector

Table 9: Project SWOT analysis.

9.3.8. The state of play

The contract between ESA and Openet Technologies S.p.A. (as prime contractor) was signed in January 2016. Then activities have been kicked-off. The first important milestone, represented by the BDR- Baseline Design Review, has been achieved and all technical requirements have been refined. The operative meetings between Openet, the involved schools, the Basilicata Region and the Regional Education Office have been held in April, in order to agree the planning of the activities with regard to the technical surveys and the installations of satellite and ICT devices, to be realized before the start of the new school year when the pilot activities are expected to start.

Analysis: **During these initial months, some critical factors have been identified:**

- **Strong engagement by the schools towards the project goals, but reluctance by the school managing staff and the teachers towards the use of this new didactic system.**
- **Limited budgetary resources[111] that prevent schools to undertake long-term and substantial investments.**
- **Long administrative procedures by the involved public entities (local, regional, national).**
- **The need to introduce the TLC services embedded in a global solution foreseeing also the provision of: technical training on the use of the proposed technical system, digital content development support, helpdesk and maintenance, technical assistance and consultancy to teachers and school staff.**

[111] Despite the fact that the service costs, as based on the commercial forecast undertaken within the project, could range between 100 – 200 EUR for a monthly subscription.

9.4. IRELAND: Government driven programme showing good results

9.4.1. Background

In Ireland, the Department of Education and Science established the *ICT-in-Schools* policy in 1998. The National Centre for Technology in Education (NCTE) was set as responsible for managing the implementation of the policy and the related priorities for investment in ICT in schools. Its core mission was to promote the use of ICT by teachers and students, and a range of supports were provided to schools to facilitate this.[112]

9.4.2. Connectivity in the ICT-in-Schools policy (2008)

Connectivity is a part of the whole development of resources and supports for e-learning of the ICT-in-Schools policy. It was managed through the "Schools Broadband Programme" of the "Technology Integration Initiative" (TTI).

The TII provides advice and supports to the Department of Education on the technical infrastructure required in schools and provides advice to schools as they develop their ICT infrastructures.

The Schools Broadband Programme provides first- and second-level schools with a managed broadband connection: connectivity is being routed to the Internet through a national broadband network, which provides centrally managed services for schools such as content and website filtering, a centrally-managed firewall for all schools and centrally hosted anti-virus control. Finally, the service also includes the management of a Service Desk, which provides a single point of contact between schools and the Programme for information, advice, guidance and technical support; it also provides a fault management, escalation and resolution process for all issues raised by schools.[113]

Some key figures:

- In 2008, over 99% of all primary and post-primary schools had a *Schools Broadband* connection.
- More precisely, as of October 2008, some 4,000 schools have been provided with broadband connectivity under the schools broadband access programme.

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[112] 'National Centre for Technology in Education (NCTE), Annual Report 2008, Supporting ICT in Learning and Teaching'

[113] Barry Andrews, Minister of State with special responsibility for Children and Youth Affairs, Department of Health and Children; Dún Laoghaire, Fianna Fail; in Dáil debates, Telecommunications Services; 4 November 2008 https://www.kildarestreet.com/debate/?id=2008-11-04.173.7

– 27% of the installations have fixed line services, 26% wireless services and 47% satellite services[114].

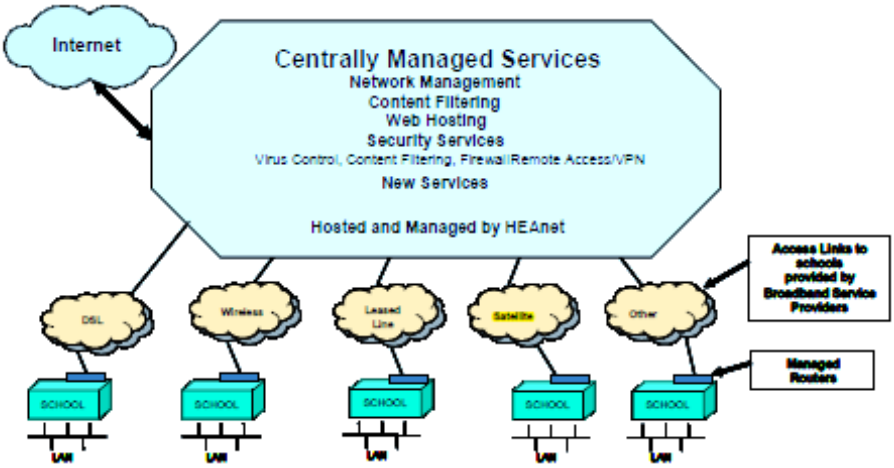

Figure 18: Overview of the *Schools Broadband* Network.

9.4.3. Other initiatives of the ICT-in-Schools policy (on top pf the TTI)

In parallel with the Technology Integration Initiative (TTI), the ICT-in-Schools policy also includes the following initiatives:

INITIATIVE	PURPOSE
Continuing Professional Development	Delivery of continuing professional development for teachers in the use of ICT.
ICT in the Classroom	Support and promotion of innovative and effective practice of ICT in learning and teaching.
Digital Content	Provision of digital content for learning and teaching.
SCOILNET	Provision of *Scoilnet.ie*, the official portal for Irish education, a key access point since 1998 for those seeking learning resources. ***N.B. The portal includes EdTV, the weekly list of TV programmes with a learning***

[114] Having regard to the observed usage levels, the Department has procured additional bandwidth from its two satellite providers to improve the broadband connection speeds for schools on this portion of the schools broadband network

	focus.

Table 10: Other initiatives of the ICT-in-Schools policy (on top of the Technology Integration Initiative)

9.4.4. Expenditure in the ICT-in-Schools initiative

The breakdown of the expenditures of the ICT-in-Schools programme (2008) is provided below:

INITIATIVE	EXPENDITURE (K€)
Technology Integration	396
Continuing Professional Development	1,499
ICT in Classroom	641
Digital Content (excluding SCOILNET)	476
SCOILNET	450
Total	**3,462**

Table 11: Expenditure in the ICT-in-Schools initiatives in 2008

9.4.5. Procurement method and process

Public ICT procurement for schools in Ireland is carried out through "frameworks", i.e. national purchasing arrangements set up and managed by the Department of Finance with a view to helping non-commercial public-sector bodies achieve to better value for money in their expenditures while simplifying procurement procedures at the same time.

Before procurement frameworks are put in place and available for schools to use, a public competition, following open competitive procedures advertised across the EU, is run to select competitive quotations from a full range of approved framework vendors who meet certain criteria and are able to provide ongoing quality ICT products/services.[115]

The objective of Frameworks is to deliver the best value for money (on quality of service and cost) through continuing competition between framework suppliers, while providing a number of highly favourable contractual protections for schools.

School-friendly communications are put in place to promote these arrangements in an easily accessible manner to schools.

[115] http://www.pdsttechnologyineducation.ie/en/Technology/Purchasing-Frameworks/

Centrally-managed frameworks provide schools with the benefit of central expertise in developing value-for-money contracts, while allowing schools themselves full flexibility in deciding precisely what and when to buy.

During the procurement process, schools can send to a dedicated email address a Request for Quotation (RFQ) for ICT equipment and services from approved suppliers. Once responses are received, schools should evaluate with fair, non-discriminatory, open and transparent criteria the responses in order to select the successful response[116].

9.4.6. Examples and case studies in Ireland

Details on six sample case studies of approach to the development of e-learning in Ireland in 2009 (including the one of a school in rural Ireland, with 3 teachers and 60 pupils in multi-grade classes) can be found in the website[117] of the Professional Development Service for Teachers (PDST), which absorbed the NCTE in June 2012 and operates under the aegis of the Irish Department of Education.

9.4.7. Evolution of the ICT-in-Schools policy (2015)

The priority for the new procurement processes is to ensure the broadband services to schools keep in line with national infrastructure improvements. The Department of Education then collaborates with the Department of Communications to pursue the Government objective of equipping second-level schools with 100 Mbps of broadband connectivity.

However the chances of giving all primary schools the same high-speed broadband that is now available at secondary level are slim. In fact there are different levels of broadband for schools, with a range from 1 to 100 Mbps in primary schools. This reflects the range of different schools and their varying needs, from one-teacher or two-teacher schools up to those with a few hundred students.

When the Department will be able offer improved broadband speeds also to most primary schools, it is expected that most of the current satellite connections will be replaced.[118]

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[116] Note that schools are not restricted to purchasing from Framework suppliers and may seek quotes from other IT suppliers, including local suppliers. In this case, however, schools are fully responsible to ensure that equipment and services fit for purpose, and that the suppliers provide a quality support service, warranty, etc.

[117] http://www.pdsttechnologyineducation.ie/en/Good-Practice/Case-Studies/

[118] Broadband ‘a priority’ for primary; Irish Examiner; 11 May 2015; http://www.irishexaminer.com/ireland/broadband-a-priority-for-primary-329801.html

Analysis: Broadband via satellite as a complementary service will be valid for many years in order to secure internet access to all schools in the EU member states.

9.5. UK: Regional non-profit organization securing internet access

9.5.1. Background

The South-West Grid for Learning for learning (SWGfL) is a not-for-profit charitable trust providing schools and other establishments an education-focused internet service. They have been offering this service, in some case via satellite (with 10 Mbps downstream, 2 Mbps upstream, 50 GB monthly data allocation, out-of-hours usage, i.e. 23.00–07.00, excluded from monthly data allocation) to all schools in 16 authorities across the South West of the United Kingdom.

In the county of Wiltshire, the local authorities paid for an internet connection for each school under their jurisdiction until 2013. Considering that from this date that school should bear the costs of their own connection, the Wiltshire Council and SWGfL released a document providing interesting guidelines and advices for allowing the schools to pick up the ISP that would offer the most suitable solution, adapted to their education needs.[119]

The most relevant guidelines and advices are reported hereafter.

9.5.2. Technology neutral approach

Common connectivity technologies include a range of copper and fibre-based 'fixed line' technologies, as well as a variety of wireless technologies (including, for example, satellite). It is recommended that a neutral approach to technology is adopted.

9.5.3. Downstream vs. Upstream speed

Whilst it may not be necessary for all schools to have symmetric solutions, there is a requirement for a suitable level of upstream bandwidth. Even for schools are not using these types of technology at the moment, a solution that makes sufficient upstream bandwidth available cost effectively is likely to be more desirable than one that doesn't. The provision of upstream bandwidth is more important for some activities than for others: for example, adoption of technologies like voice over IP and cloud computing may be hampered by insufficient upstream bandwidth, and for the services such as video-conferencing, the upload speed needs to be comparable with the download speed.

[119] www.exeterhouseschool.co.uk/wp-content/uploads/2013/04/A024-13-SWGfL-broadband-letter-290113-2.doc

9.5.4. Balance between current needs and future needs

Bandwidth demands will inevitably increase, both in line with planned improvements within school ICT provisions (such as additional ICT facilities, more powerful software and applications, and use of cloud technology) but also as a natural result of technological development (such as the growth in use of high-quality video resources). Schools may wish to consider the balance between the ability to meet long-term needs (and avoiding the disruption this may cause) with avoiding higher charges now for provision that may exceed current requirements.

9.5.5. Integrated solutions

The addition of service components to a solution increases the breadth of provision to the customer, and usually increases the value for money. This could include:

- Training
- Support services (such as a service desk)
- Service management and development processes
- Safety services and processes (such as filtering, monitoring, auditing/logging of activity, etc.)
- Security services and processes (such as firewalls, intrusion detection/prevention etc.)

A solution that integrates these considerations into a service reduces the complexity for schools (by keeping all aspects of the service in one place); reduces the risks for schools (by exploiting the expertise of the supplier to deliver in these specialist areas); and improves value to the school (by helping to ensure that the service undertakes tasks to free up school resources).

In some cases the charges associated with optional components can be considerably less if purchased with alongside a 'core' service than would be the case if purchased separately on the open market. These cost reductions should result in lower charges to schools for optional components.

Analysis: **The solutions for schools should also include other 'service' components in addition to connectivity and bandwidth. Whilst some schools will have sufficient technical expertise internally to provide support for a connectivity solution, many do not and require this support from the supplier.**

9.6. SPAIN: Regional initiative using a successful voucher scheme

9.6.1. Background

The initiative "*Nuevas conexiones a internet de banda ancha a través de tecnología satélite bidireccional en medio rural*" carried out in Galicia, Spain, in the period 2012-2014, constitutes an interesting case study of a successful policy based on a voucher scheme.

The purpose of the voucher was to enable high-quality internet access to 3% of the population (total population: 2.749 million in 2014), which due to its large dispersion or its location, were out of reach of terrestrial broadband. In particular, these grants for satellite bidirectional internet access were aimed at those families and businesses who could not procure an access to broadband of at least 2 Mbps using terrestrial technologies.

The whole of Galicia, except areas included in urban perimeters of the city of Ferrol, Lugo, Ourense, Pontevedra, Santiago de Compostela, A Coruña and Vigo was eligible for the voucher. The administration in charge of the procedure was the Axencia Galega de Desenvolvemento Rural (AGADER), an agency of the Xunta de Galicia.[120]

9.6.2. Procurement method and process

The first step was the selection of the appropriate ISPs. Multiple ISPs (Duo Telecomunicaciones, Eurona Wireless Telecom, Intermax Technology, Mira Novas Tecnoloxias, Operadora Tripla, Quantis Global) were chosen among the ones whose offers respected the following criteria: provision of a minimum of 2 Mbps download, a minimum volume allowance of 2 GB/month, and an always-on service.

After the signature of the relevant agreements with ISPs, a first public call was open from late September until November 2012 for eligible citizens and businesses to apply for a subsidy for satellite bidirectional internet access. The voucher covered the cost of user equipment, installation and commissioning, up to a maximum amount of €500, conditioned upon remaining in service for a year; the first month of service was free of charge. The scheme was planned in three rounds of call for applications from final recipients, each lasting two months, once per year from 2012 to 2014.

The eligible subscriber was not requested to anticipate the expenses for purchase, installation and commissioning, providing he/she conceded the ISP the rights of recovery as a recipient of the aid. All the administrative processes related to the subsidy were therefore directly managed by the ISP in place of the subscriber, so allowing to the Managing Authority to simplify the management and control of the procedure.

[120] http://imit.xunta.es/portal/actualidade/novas/2013_10_11_axudas_satelite.html

9.6.3. Budget and financing instruments

The investment in 2012 exceeded €335k and the total budget in aid period 2012-2014 was €1077M. The European Agricultural Fund for Rural Development (EAFRD) co-financed around 57% of this investment under the Rural Development Programme 2007-2013 of Galicia, Measure 321, Axis 3 "Improving the quality of life in rural areas and diversification of the rural economy".

It is worthwhile mentioning that the Xunta de Galicia had implemented a specific web tool to register requests for broadband service from users in digital divide, so gathering a valuable database to size the actual needs of its community and allowing targeted communication for each round.

9.6.4. Results

During the 2012 call, a total of 676 households and businesses applied within only one month to get the aid and to hire Internet services via satellite. Most applicants (87%) subscribed to a service with 8 Mbps downstream, 8% chose for a service with 2 Mbps and the remaining 5% for a 4 Mbps. In addition, 71% of recipients also contracted VoIP service.

During the 2013 call, a total of 858 households and businesses and businesses applied to the regional voucher scheme within two months.

In total, in the period 2012-2014, some 10.5% of the 3% of the unserved population of Galicia (considering an average of 4 persons per household) benefitted from the voucher scheme.

Analysis: **The voucher scheme was activated for a short period, and then renewed each year. This approach has several positive effects. Among them:**

- **A regular renewal allows the scheme to always propose the latest / most modern / most powerful technology and services.**
- **A short window of subsidy creates an incentive to subscribe for end users.**
- **A regular check allows PAs to adapt their budget based on the most recent take-up.**

The service with higher speed was largely selected.

The programme was funded through a combination of EARDF and local budget.

9.7. MEXICO: Digital National Strategy to improve availability of ICT services

9.7.1. Background

In Mexico, the Digital National Strategy (*Estrategia Digital Nacional*) is an action plan being implemented by the Government to encourage the adoption and development of information and communication technologies (ICTs) and usher Mexico into the information and knowledge society. The strategy is based on five key points: Government Transformation; Digital Economy; Transformation of Education; Universal, Effective Health; Civic Innovation and Citizen Participation.

In particular, the third point mentions the incorporation of ICTs into the educational process to improve the quality of education, develop digital skills of the students and usher the country into the information and knowledge society.

9.7.2. The "México Conectado" programme

In pursuit of the enabler of connectivity within the framework of the Digital National Strategy, the Ministry of Communications and Transportation launched in June 2013 "México Conectado", a federal government programme, implemented with state and municipal government involvement, which mandates that **all schools**, academic institutions, libraries, hospitals, health centres, government offices, national public offices and open spaces (e.g. parks, public squares and landmarks), in which government services are provided to the general population, shall have access to the Internet by the end of 2018. A new budget was dedicated to achieve this goal.[121]

The *México Conectado* programme encompasses **three main objectives:**

1. Improving the quality of public services provided to the population through the use of ICTs that are unavailable without Internet access.
2. Helping to narrow the digital divide in Mexico by providing free Internet access to the general population in such buildings and public open spaces through outdoor WiFi access points.
3. Achieving better economies of scale by aggregating, in the public tenders, the demand for Internet services of the three levels of government involved in the programme.

There are an estimated total of 250,000 public places nationwide which require Internet access provided through the programme.

[121] México Conectado: http://mexicoconectado.gob.mx/

Analysis: **The challenge, already a huge one, is made even greater by the fact that some 50% of the places in question are in locations with 500 or fewer inhabitants, accounting for 9% of the country's total population.**

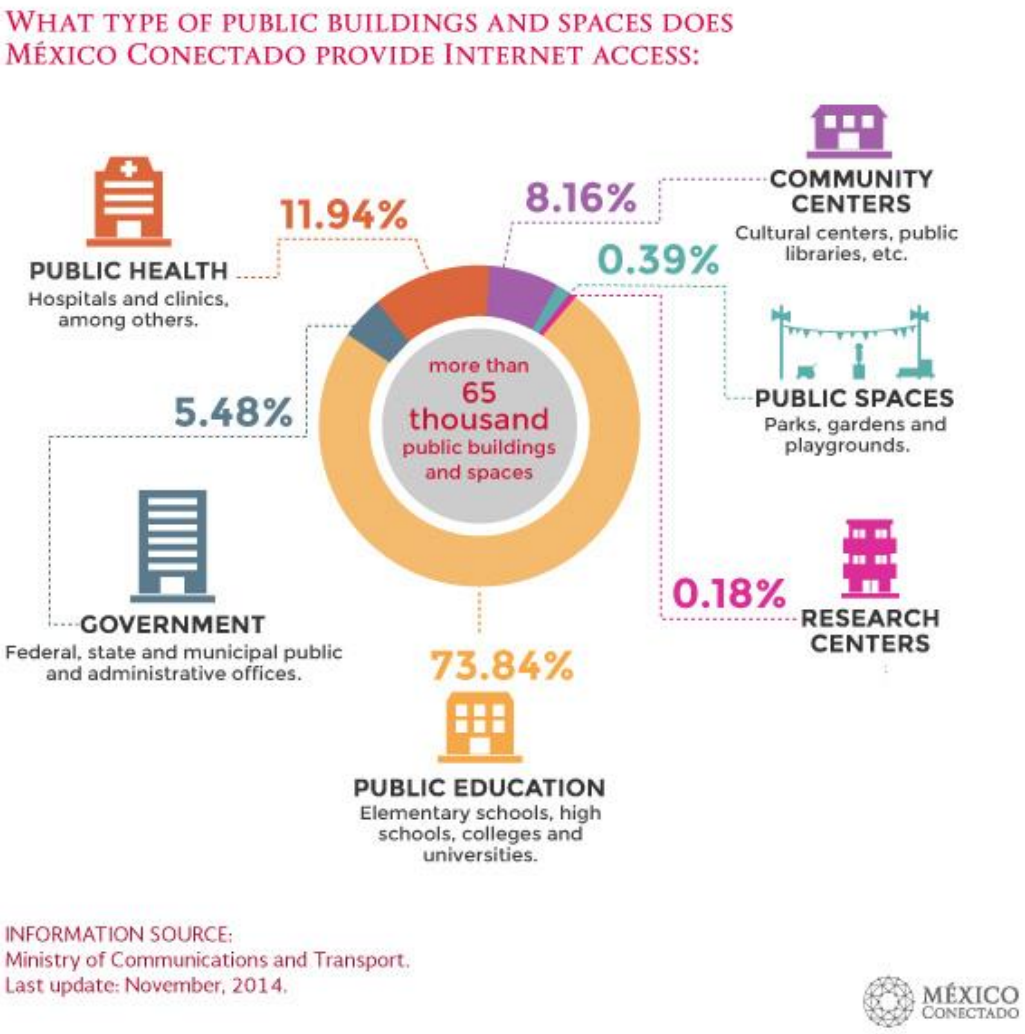

Figure 19: Overview of what types of buildings and facilities that are planned to be connected through the *México Conectado* programme.

9.7.3. Putting the programme into practice

State Coordination Board (*Instalación de Mesa de Coordinación Estatal*):The so called "Mesa de Coordinación Estatal" is a joint office including several representatives from ministers and local authorities and agencies (see **Error! Reference source not found.**) in order to ensure a coordinate development of the programme from every stakeholder's perspective. A coordination board is opened in every state.

The process comprises five phases:

Figure 20: The process to bring connectivity to sites and public spaces in the Mexican states.

1. **Planning (Planeación):** Information is gathered and consolidated about which places need to be connected, required bandwidth and the applications to be used. A public-places database is populated using available data about infrastructure, active equipment, rights of way and interconnection points which could be used for the deployment of connectivity services.
2. **Public tender (*Licitación*):** Once the public-places database is fully integrated, the Ministry issues a public tender through which telecommunication operators are awarded contracts for providing Internet services (more details are given in the following sections).
3. **Deployment (*Implementación*):** It includes the service acceptance process by the official responsible for public-place management.

4. **Operations (*Operación*):** This is the control and monitoring phase, involving the definition of, among other things, user profiles and usage indexes, best practices identification and feedback to ensure ongoing improvement. Service-level agreements, content filtering policies and bandwidth management are control features of this phase.

Figure 21: Composition of a "Mesa de Coordinación Estatal"[122].

9.7.4. Technical solutions for connectivity

The programme is designed to be technology agnostic, such that telecommunication operators who are awarded contracts through the tenders are **free to choose the connectivity technology** to deploy, provided they **comply with strict service-level specifications.** As of 2015, twelve different operators have been awarded contracts involving technologies ranging from terrestrial (ADSL, DOCSIS and wireless) to satellite.

[122] Governor of the State, Secretary of Transport and Communications, President of the Federal Institute of Telecommunications, Deputy Secretary of Communications, Executive Secretary of National Public Security System, Representative from the SCT, Representative from the coordination center of the Digital National Strategy from the National presidency, Representative from the National Institute for federalism and local development, Representative from the local state, Delegate from other dependent programs (Segolb, SSa, SEP, Sedesol, SE, SCT, IMSS, ISSSTE etc)

In fact, the programme uses two basic types of technologies (see **Error! Reference source not found.**) according to different geographical areas:

- **Wired and wireless technologies** use telecommunications operators' infrastructure to provide Internet access. Public buildings and spaces using these technologies are mostly located in highly dense urban areas. Part of these networks **provides high-capacity Internet** to those public buildings that carry on research projects that have big data transference requirements, such as universities and research centres.

- **Satellite technology** is used to provide Internet services to rural communities located too far away from fibre-optic telecommunications networks. The average population of these communities is in between 500 and 2,500 inhabitants, which live in high or very high levels of marginalization.

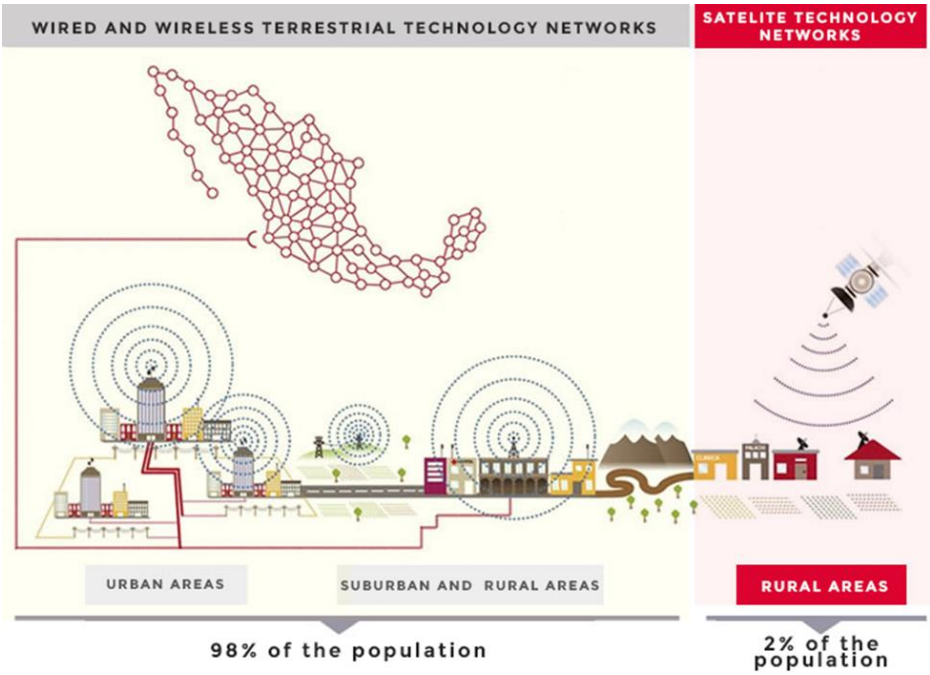

Figure 22: Apportionment between terrestrial and satellite solutions.

The table below shows what type of technologies provide Internet services to the different type of public buildings and spaces:

Type of technology	Community centres	Education	Public spaces	Government	Research	Public Health	Total
Satellite	3,718	18,955	0	95	20	6,328	**29,116**
Wired and wireless	1,540	28,574	255	3,356	6	1,166	**34,897**
High-capacity networks	57	580	0	119	93	287	**1,136**
Total	**5,315**	**48,109**	**255**	**3,570**	**119**	**7,781**	**65,149**

Table 12: Public sites served by México Conectado in November 2014, by category and technology[123].

9.7.5. Example of procurement method: Invitation to tender in the state of Sonora

The information provided in this *Invitation To Tender* (ITT) and contract for the service of a satellite ISP constitutes one out of many examples of ITT within the México Conectado programme.[124]

In this ITT issued and awarded in 2015 for the state of Sonora, the selection was done on the basis of the lowest price, among those offers which matched the technical requirements and which were submitted by companies with solid technical and financial basis. Below, a list of the most relevant technical requirements imposed by the ITT is shown:

Quality of Service (QoS)

– Availability of two-way telecommunications services via satellite with speed of at least
  ○ 1 Mbps in downlink;
  ○ 256 kbps in uplink.
– Use of standard platforms and interfaces, with TCP/IP.
– Support of VoIP.
– Connection to backbone sufficient to guarantee high speed to all 146 connected sites.

Service monitoring
The ISP shall provide a monitoring portal which allows the control of the following information: – Status of the service;

[123] Ministry of Communications and Transport, November 2014

[124] Invitation to tender and contract n° EA-926004987-N4-2015 retrieved from: https://compranet.funcionpublica.gob.mx/

– Status of the link; – Real time traffic; – Report on daily traffic; – Traffic volume consumption; – Aggregated bandwidth used.
Equipment
The ISP shall provide all the following components in each equipped site: – Antenna with mast; – Satellite modem; – Accessories and other relevant material for the installation; – Backup Power Supply Unit.
Installation
The provider shall install, configure and connect at least one computer in each school equipped. The configuration of the rest of the computers is at charge of the IT department of the school. The ISP is also in charge to sign a receipt showing that the connection is activated and as well as a speed test.
Maintenance
The ISP has to provide a maintenance solution in case of incidents of hardware, software or technical configuration. The delay of intervention may vary, based on the location of the equipped site: – Easily accessible areas: 36 hours – Hard-to-reach areas: 72 hours

Table 13: ITT Technical requirements.

The initial contract, awarded to the operator AXTEL, covered the provision of the equipment and the connectivity of 146 schools in the state of Sonora, Mexico, for a monthly fee per site of 2,350 pesos (around €114), over a period of 8 months.

Analysis: **The Mexican case study provides detailed information about each step of the successful process for equipping the school with satellite solutions. The 'Mexico Conectado' programme has been highlighted by the ITU for its achievement regarding this point. The activities which go along the connectivity (i.e. installation, maintenance, control of the process) are integral part of the programme.**

9.8. TURKEY: Broadband availability as part of a broader government programme

9.8.1. Introduction

Turkey, under the direct responsibility of the Ministry of Education, launched and implemented in 2011-2015 the FATIH project (*Fırsatları Artırma ve Teknolojiyi İyileştirme Hareketi*, i.e. "Project to Increase Opportunities and Improve Technology") that seeks to improve Turkey's primary and secondary education. The project is now in its phase of follow-up and evaluation, to be concluded by 2017. This is not just a pure ICT project but it includes many components and seeks to transform entirely the Turkish educational system.

Over 844,000 computers, 11 million tablets and 450,000 interactive whiteboards have been allocated to schools as part of the FATIH programme.

In Turkey more than 97% of the schools are now connected to the Internet. ADSL, WiMAX and other terrestrial solutions have been widely used at urban areas. In order to reduce inequality of opportunities, FATIH brought connectivity also to remote and rural areas using Broadband Satellite services.

The programme is making spectacular advances to bring ICT to the classrooms. It has even been brought to light by the World Bank in 2013 as an outstanding education programme.[125]

9.8.2. Use of satellite broadband connectivity within FATIH

There are about 40000 schools in Turkey. As of 2015, approximately 8000 schools were fully equipped with technology and connected by fibre, DSL or Satellite. Within those, 3700 schools have been connected via satellite broadband in the period 2013-15. Most of the satellite installations were deployed in only 2.5 months. The system has been successfully up and running for 3 years.

The Tooway satellite user terminal installed at each school has an antenna of 77 cm in diameter and a power of 3W. The service use the Eutelsat's KA-SAT satellite is used, but unlike standard consumer services, a special design of the network including defined aggregate performance has been provided by the partners managing the programme.

The satellite access service provides to each school the following performance:

- 8 Mbps downstream.
- 2 Mbps upstream.
- 10 GB volume allowance per month.

[125] Source: Promoting Excellence in Turkey's Schools, March 1, 2013, World Bank Report

– A shared volume allowance of 1.5 TB for those schools which might consume their volume before the end of the month.

The individual and aggregate bitrate is regularly monitored, as well as the volume consumption.

Several web-based services and portals are now available through the internet access, using a single address, not only for students, parents and teachers, but also for public employees and citizens. In fact the monitoring activity revealed some unanticipated usage - for instance the use of the connection well beyond the school hours.

The following key **web-based services** are provided:

– Education
  - Distance Education Platform
  - Education Information Network (content such as magazines, e-Books, videos, images and sounds)
  - Information Acquisition System (questions, suggestions and complaints)
– Administration
  - Management Information System
  - Parent Notification System

9.8.3. Funding

The FATIH programme is fully designed managed and subsidised by the central government through the Ministry of Education, which is the managing authority for all schools, elementary to lyceum (no local or regional responsibility).

Analysis: **Very rapid (only 2.5 months) deployment of a large number of terminals over a vast rural territory, thanks to the quick and easy installation of satellite terminals, the capability of mobilizing a large number of installers and the central management of the programme with a limited number of decision-makers involved. Good performance requirements set for the service (8 Mbps downlink and 2 Mbps uplink).**

10. ANNEX C: Questionnaire for the "Connect'Ecoles" pilot

- Geographical characteristic of the area where the school is located (Rural, Mountain, etc.)
- Advantages and inconvenient of such localisation
- Type and speed of internet prior to the connection via satellite (none, ADLS < 512 Kbps, ADSL <2 mbps)
- Did you know about satellite internet technology?
- If so how did you hear about it (advertisement, press, etc.)?
- Did you hear about it in a positive or negative way?

Specifics questions for the mayor

- Is the connection open to other actors? If so, to which? And since when?
- What are the echoes received from the parents of children, other habitants, and teachers?
- Have you personally tried the internet connection?
- If so rank the speed quality from one to ten, and the QoS (namely availability) ?
- Are you planning on taking a subscription to satellite internet?
- Do you know about the cost of such subscription?
- Is this cost compatible with the budget of the townhall?
- Have the school asked you to keep this internet solution?
- Have the parents asked you to keep this internet solution?
- Any other comments?

Specifics questions for the teacher

- How many classes are there in the school? Of which levels?
- How many kids per school? Per classes?
- How many classes are participating in this operation?
- How many computers connected per class?
- What is the use of the internet connection (administrative/pedagogic for the teacher/pedagogic for the pupils)?
- Can you precise: what can't you do without internet (communicate via e-mail with the central administration)
- How did you manage to do it before getting internet at school?

Evaluation of the quality of the use of internet

- Once your internet antenna was installed did you get internet immediately
- On a scale of 1 to 10 can you assess the quality of the following services
    i. Speed

ii. Fluidity of images while watching videos on-line
iii. Volume of allowed download
iv. Download speed
v. Continuity of the service
vi. Do you see other evaluation criteria?

- Can you detail the actions that you could take thanks to this high speed internet access?
- Can you give some example of the uses that you didn't have with your previous connection?
- What were you expecting from this operation
- Do you plan on taking to a monthly subscription after this experience?
- If so, on which grounds, on which needs?
- Can you give your impression on the service provided?
- What did the pupils think about it?
- Did you get any other feedback?
- Other comments?

11. ANNEX D: Details of proposed Internet access packages

Electronic communications operators are required to fill out the following form to outline their proposal. This information may be made public by the State.

Business name of package	
Name of retail operator and brand	
Geographical area where this package is available	
Type of network used (e.g. satellite, WiFi, etc.)	
Name of network operator	
Peak data rate downstream	
Peak data rate upstream	
Data volume limit (if applicable)	
Availability of service (e.g. rate)	
Other technical characteristics of the package (particularly service quality guarantee)	
Type of eligible installation costs	
Amount of eligible installation costs	
Share of school or institution	
State share	
Monthly subscription cost (charged to the school or institution)	
Duration of minimum subscription period, if applicable	
Tariff validity period	

12. ANNEX E: Questionnaires sent to EU member states

Questionnaire 1:

European Schoolnet is assisting a project on behalf of the European Commission to understand and quantify the current need for support to increase broadband access in European schools.

To that end, we are trying to collect as much relevant data as possible from member states, and we would be very grateful if you could answer some questions (see below).

We are aware that much of the data we are asking for may be unavailable or difficult to obtain, and we respect your time, so we will be very thankful for any data you may be able to provide to any of the questions. You may answer inline, attach documents, or refer to relevant links. You may also modify the questions (e.g. by changing the numbers) if needed. If you prefer, we may give you a quick phone call in the coming days.

Thanks a lot for your kind collaboration!

1. How many primary schools are there in total in your country:
    a. With less than 50 pupils?
    b. With between 50-200 pupils?
    c. With more than 200 pupils?
2. How many secondary schools are there in total in your country?
    a. With less than 50 pupils?
    b. With between 50-200 pupils?
    c. With more than 200 pupils?
3. How many schools are currently NOT connected (or with a connection below 2 Mbps); and will NOT be connected within three years:
    a. Primary schools (and typical school size)
    b. Secondary (and typical school size)
4. How many schools will NOT be connected (or with a connection below 2 Mbps) within three years from now:
    a. Primary schools (and typical school size)
    b. Secondary (and typical school size)
5. What is the reason for schools NOT being connected?
    a. There is no available broadband connectivity
    b. The connectivity service is too expensive
    c. There is no interest
    d. There are administrative roadblocks
    e. Other...
6. What about satellite broadband, is this an option schools are aware of, and are there experiences?
7. How many primary schools are currently connected with
    a. Above 30 Mbps (and what is the typical size of these schools)
    b. Between 10 Mbps and 30 Mpbs (and what is the typical size of these schools)
    c. Between 2 Mbps and 10 Mbps (and what is the typical size of these schools)

8. How many secondary schools are currently connected with
    a. Broadband above 30 Mbps (and what is the typical size of these schools)
    b. Broadband between 10 Mbps and 30 Mpbs (and what is the typical size of these schools)
    c. Broadband between 2 Mbps and 10 Mbps (and what is the typical size of these schools)
9. Who decides subscribe to an internet service in the school
    a. Head of school/IT responsible
    b. The mayor
    c. Other
10. Why are some schools NOT connected to internet (at all)?
11. What kind of services are schools using? Do you have examples?
12. Are there any good examples of schools in your country using satellite-based broadband services and how are they financed?
13. What is the current strategy/plan to connect schools? Are there any relevant documents available?
14. Is there a budget allocated to carry out that strategy?

Questionnaire 2:

Representing Acreo Swedish ICT, a research institute, we are currently conducting a study project for the **European Commission** (named "BROSS") in order to understand and **quantify the current needs for support to schools** within Europe that lack broadband completely or only have access to low-speed internet.

To that end, we are trying to collect as much relevant data as possible from member states, and unfortunately much of the available data is a bit old (Schoolnet conducted a thorough survey in 2011-12).

We would be very grateful if you (or any of your colleagues/contacts) could help us in answering a few questions (see below):

1. How many schools (number or percentage) are **currently NOT connected** (or have an internet connection below 5 Mbps) in Country X (preferably split between primary and secondary schools)?

2. How many schools **will NOT be connected** (or have an internet connection below 5 Mbps) within the **current programme period** (e.g. up to year 2020)?

3. If available: **How many schools** are there in Country X **in total** (preferably split between primary and secondary schools)?

We are aware that data may be unavailable or difficult to obtain, and we respect your time – but rough estimates and figures are also appreciated.

13. ANNEX F: Summary statistics and forecast figures for Primary & Secondary schools in EU member states

Primary schools:

	#Primary schools (ISCED 1)	Share (%) of Primary Schools that lack broadband access (< 5 Mbps; extrapolated)		Extrapolated # Primary Schools lacking broadband (<5 Mbps)	
Country	**2015**	**2015**	**2020**	**2015**	**2020**
Austria	3 066	53%	45%	1 613	1 393
Belgium	1 750	36%	20%	625	346
Bulgaria	1 474	9%	5%	135	73
Croatia	1 245	25%	18%	314	219
Cyprus	364	43%	11%	156	41
Czech Republic	4 112	24%	12%	972	484
Denmark	2 306	12%	6%	281	134
Estonia	345	22%	17%	76	60
Finland	2 644	17%	14%	459	379
France	37 379	5%	0%	1 874	31
Germany	16 588	45%	34%	7 480	5 658
Greece	5 005	32%	8%	1 626	411
Hungary	2 294	44%	29%	1 003	672
Ireland	3 165	24%	12%	773	374
Italy	15 281	57%	53%	8 724	8 063
Latvia	832	35%	25%	293	206
Lithuania	502	24%	16%	120	82
Luxembourg	154	17%	11%	25	17
Malta	115	0%	0%	1	0
Netherlands	6 703	7%	1%	449	64
Poland	13 446	61%	60%	8 249	8 117
Portugal	5 846	8%	2%	440	124
Romania	3 136	28%	17%	879	538
Slovakia	2 133	51%	36%	1 084	758
Slovenia	391	17%	10%	68	38
Spain	10 350	23%	13%	2 397	1 389
Sweden	4 897	23%	20%	1 148	991
United Kingdom	21 008	15%	6%	3 149	1 187
TOTAL	**166 531**			**44 413**	**31 849**
Share	*100%*			*27%*	*19%*

Secondary schools:

Country	#Secondary schools (ISCED 2-3) 2015	Share (%) of Secondary Schools that lack broadband access (< 5 Mbps; extrapolated) 2015	2020	Extrapolated # Secondary Schools lacking broadband (<5 Mbps) 2015	2020
Austria	2 815	2%	0%	62	2
Belgium	540	2%	0%	10	0
Bulgaria	1 026	1%	0%	15	1
Croatia	429	3%	0%	13	0
Cyprus	168	5%	0%	8	0
Czech Republic	1 304	2%	0%	24	1
Denmark	579	0%	0%	3	0
Estonia	243	3%	0%	6	0
Finland	612	1%	0%	4	0
France	11 385	4%	0%	442	17
Germany	21 629	4%	0%	879	34
Greece	3 678	9%	0%	343	14
Hungary	1 920	4%	0%	84	3
Ireland	708	3%	0%	20	1
Italy	12 658	6%	0%	770	30
Latvia	66	4%	0%	3	0
Lithuania	526	3%	0%	14	1
Luxembourg	43	1%	0%	0	0
Malta	71	2%	0%	1	0
Netherlands	2 279	3%	0%	73	3
Poland	16 599	4%	0%	690	27
Portugal	2 427	1%	0%	22	1
Romania	3 139	3%	0%	82	3
Slovakia	690	5%	0%	37	1
Slovenia	391	2%	0%	9	0
Spain	8 332	2%	0%	162	6
Sweden	1 336	1%	0%	8	0
United Kingdom	4 045	1%	0%	33	1
TOTAL	**99 638**			**3 817**	**148**
Share	*100%*			*4%*	*0%*

Country	Total # of schools	# Schools lacking broadband 2015 (<5 Mbps)		# Schools lacking broadband 2020 (<5 Mbps)		Dedicated school broadband build-out program in place (or done)	Comments
	Primary and Secondary, ISCED 1-3	Trend extrapolation estimate	Government estimate	Trend extrapolation estimate	Government estimate		
Austria	5 881	1 675		1 396	Low	No	
Belgium	2 290	635	229*	346	Low	Yes	* Estimated 10% of schools lack HSB access.
Bulgaria	2 500	150		73		N/A	
Croatia	1 674	326		220		N/A	
Cyprus	532	164		41	Low	Yes	
Czech Republic	5 416	996	134*	484		No	* The number of schools lacking internet access (there is no distinction between low-speed and high-speed internet).
Denmark	2 885	283	Low	134	0	Yes	
Estonia	588	83		60	0	Yes	
Finland	3 256	463	Low	380	0	Yes	30% of teachers have experienced the connection to be unstable or/and slow during classes.
France	48 764	2 316		48		Yes	
Germany	38 217	8 358	*	5 692		No	* Slow progress according to EC country report 2016
Greece	8 683	1 969		425	0	Yes	
Hungary	4 214	1 087	540*	675		Yes	* Unconnected or <2 Mbps
Ireland	3 873	794	*	375	Low	Yes	* All Secondary schools connected to >100 Mbps, some Primary schools still lack.
Italy	27 939	9 494	4700*	8 094	0	Yes	* According to Italian Regulator, 2015
Latvia	898	296		206		Yes	
Lithuania	1 028	134		82		Yes	
Luxembourg	197	26		17	0	N/A	
Malta	186	2		0	0	No	
Netherlands	8 982	522	629*	67	Low	Yes	* 7% of primary schools and 6% of secondary schools lack high-speed BB.
Poland	30 045	8 939		8 143		No	
Portugal	8 273	462		125		No	
Romania	6 275	961	1945*	541	Low	Yes	* 45% of subordinate schools lack BB, 2015. Actual: 31% of primary schools lack BB, 2015
Slovakia	2 823	1 121		759		N/A	
Slovenia	782	77	*	38	0	Yes	* 100% of Secondary schools have sufficient BB access, some Primary schools still lack (but most have at least 30 Mbps)
Spain	18 682	2 559		1 395	0*	Yes	* All schools expected to have HSB access
Sweden	6 233	1 156	*	991	0	No	* According to latest survey, 20% of schools lack "insufficient bandwidth"
United Kingdom	25 053	3 182		1 188		No	
TOTAL	**266 169**	**48 230**		**31 997**			
Share	*100%*	*18%*		*12%*			

14. ANNEX G: Quick Guide for public authorities to implement a Voucher Scheme for satellite-based broadband to schools

Content

1. Introduction and purpose
2. Planning a satellite broadband Voucher Scheme
3. Internet Service Provider (ISP) selection and procurement
4. Evaluation and choice of solution and service
5. Schools' application and ordering process
6. Funding of Satellite Broadband Voucher Schemes
7. Voucher Scheme redemption

1. Introduction and purpose

The scope of this document is to provide public authorities with short guidelines and a ready to use instrument to implement a *satellite broadband voucher scheme* for the primary and secondary schools in the digital divide.

The guidelines are implemented on the basis of the outputs and key findings of the different sections of the full report.

2. Planning a satellite broadband Voucher Scheme

Vouchers are defined as public grants provided to an eligible end-user to stimulate demand for priority services among specific underserved groups. Grants go directly to the end-user in the form of a voucher – a certificate, coupon or other token – which the end-user redeems for the specified goods or services from an accredited or selected service provider.

After having provided the service, the provider claims payment to the Public Authority in charge of the Voucher management. Vouchers schemes often utilize *multiple competing providers* but can also operate with a single provider pre-selected by a call for tender.

In order to allow a Public Authority to run a broadband voucher scheme, there are some **fundamental steps** to be implemented for the success of the initiative:

1. Identification of **what** the voucher scheme should finance. The basic object of the voucher is the customer premises equipment, mainly a satellite antenna and a modem but potentially also a service subscription (for a limited period). But, as already previously explained, a voucher scheme could cover also distribution e-learning tools such as local electronic library of videos, interactive video-based content, e-books, digital textbooks, training software and support services.

2. Identification of the **target group**: Potential beneficiaries are primary and/or secondary schools located in areas not covered by any fixed or mobile broadband terrestrial solutions but currently not connected via satellite broadband. Usually those schools are located in *white spot* areas identified by the public administration typically through a public consultation of the existing telecom operators (mobile and fixed) or to the telecom regulator.

3. Identification of the **total budget** to be allocated for the voucher scheme and of the **single maximum grant.**

4. Identification of the **implementing authority** that delivers the voucher scheme.

5. Set up a **communication campaign** to widely communicate and advertise the benefits and rules for the voucher scheme and to reach all the final beneficiaries.

6. Decide on Internet Service Provider (ISP) **selection procedure, choose one of the following methods**:

    a. Call-off procedure (multitude of providers), preferably.

    b. Call for tender for a single provider.

7. Decide the **duration** of the voucher and consequently the timing of the service provided. Services should have a start and an end to limit payment to clear conditions.

8. Set up a **web site** in order to allow both the schools and the ISP(s) to apply online. The final beneficiaries' applications should be done electronically to keep the application process and the overall management and monitoring of the programme as simple as possible.

What can a Voucher Scheme finance?

As previously explained, one of the main characteristics of a voucher scheme is its flexibility to adapt to strategic target needs. Specifically regarding schools' broadband access via satellite, two main topics need to be considered in terms of voucher financing:

- Satellite broadband access: in this case the basic objective of the voucher is the **customer premises equipment**, mainly a satellite antenna and a modem including also TV reception equipment plus mostly, **subscription fees** for the service.

- E-learning distribution solutions: The distribution of a large **common** database of educational videos, interactive video-based content, e-books, digital textbooks, training/exercise software, simulations or learning games, interactive maps and other types of software, that will constitute an electronic library which is constantly and regularly updated. A content delivery system to group of schools shall be built and its local storage (including access rights to content) be managed, possibly in conjunction with the administration of central content management platforms accessible through the Internet.

This shall normally be implemented by (or on behalf of) the Ministry of Education. For more technical details see section 3.8.3.

In terms of financing resources, national or regional funds could be easier adapted for an ad hoc school voucher scheme that includes both the solutions.

The ESIF, ESF, ERDF and EAFRD can be combined in a multi-fund operational programme, and this may be the best solution, or through the combination of different measures of mono-fund operational programmes with, at the base the agreement of all, the Managing Authorities and the indication of a common intermediate authority in charge of the management of the voucher scheme.

3. Internet Service Provider (ISP) selection and procurement

Two different models (choose one of them) are recommended and can be utilized for the selection and procurement of qualified ISPs:

- **Call-off procedure** for the selection of multiple Internet Service Providers.
- **Call for tender** for the selection of a single Service Provider.

Both models require, from The Public Authority, the identification of qualitative selection criteria, technical specifications of services based on satellite and the service features offered.

Call-off procedure: qualification of multiple satellite service providers; the PA firstly set eligible beneficiaries and areas, minimum data rate, maximum subsidy and then opens a call off procedure to select qualifies multiple providers able to provide the requested services. Each qualified ISP signs an agreement with the PA in order to validate the eligibility of the final beneficiary, the service and the public subsidy. The end-user chooses the preferred offer from the list of the qualified ISP. The ISP after the installation and activation of the subscribed service manages the administration process with the PA to recover the subsidy on behalf of the end-user.

Call for tender election of a single provider of (satellite) broadband; In this case, the PA after defining the eligible beneficiaries and areas, minimum data rate and the overall budget, issues a call for tender for the provisioning of the services. The winner ISP commits to maintain the awarded offer (a fix subsidy per installation to cover eligible costs is typically agreed between IA and the ISP, pre-discounted in the offer to subscribers) available for subscription for the duration of the scheme. The winner ISP directly manages with the PA any administrative process relevant to the subsidies.

4. Evaluation and choice of solution and service

The most advanced standard satellite offers currently available on the market provide high-speed Internet receiving up to 22 Mbps and sending up to 6 Mbps. They vary based on the allowed volume of data (GB / month of usage, e.g. 10, 25 and 40).

Evaluation of the satellite ISPs' offers for schools should be based around the below parameters (at least), to be considered either per each site (or as aggregate elements):

- Download speed
- Upload speed
- Data volume allowance (monthly)
- Monthly subscription fee
- Characteristics and price of the equipment kit
- Support services included

These parameters are essential to assess the quality of the service and the value for money of the various offers with respect to the requirements. The pricing structure of satellite broadband services is dependent on the use of the satellite resources (bandwidth and power), therefore in most cases based on the volume of exchanged data rather than on the peak download / upload bitrates.

Moreover, satellite TV can often also be provided by simply adding a small piece of equipment to the satellite dish to receive the TV channels. Phone calls with Voice over IP (VoIP) technology can also be provided as an option, so as to benefit of a Triple-Play service.

In case where the performance provided with a standard service is not deemed satisfactory to fulfil the requirements, scalable options can be applied to tailor ad-hoc service packages on a per-project basis (with relevant additional costs) with specific set of customizable options such as:

- Enhanced speed
- Enhanced volume allowance thresholds
- Tailored traffic shaping and priorities (e.g. VoIP)
- Number and characteristics of the IP addresses for each kit, including multiple, static IP addresses per terminal and the use of national IP addresses.
- Guaranteed satellite bandwidth (measured in Mbps), shared by all terminals of a group of schools.
- Volume commitment on the monthly aggregate volume consumption: accounting is based on volume consumed by all terminals of a group of schools, with a specific monthly volume commitment (in TB) to be agreed.

The table below summarises the typical main characteristics of the satellite network architectures and associated services and equipment costs:

	Fast internet access with standard consumer offers	**Fast internet access with tailored professional offers**	**Hybrid network with fast internet access + broadcast + storage**
Characteristics			
Requirements	Download speed up to 22 Mbps, 10-40 GB monthly volume allowance per site.	On a per-project basis (download speed up to 30-50 Mbps, possibility of aggregated volume allowance).	
Fixed costs (typical)	€450-600 per kit (including transport, installation, activation and VAT).	600-900€ per kit (including transport, installation, activation and VAT).	As per one of the previous cases, plus additional €100 per kit, plus €500 per NAS (see section 4.8.2 and 4.8.3).
Recurring costs (typical)	€35-90 per month.	On a per-project basis.	As per one of the previous cases, plus a few additional €/month per school (plus distribution network costs at central level, on a per-project basis).
Proposed voucher value per school (typical) covering fixed costs + 2-year service	€1,700	€3,200	As per one of the previous cases, plus additional €600.

5. Schools' application and ordering process

Once the Public Administration has taken all the steps in the planning phase above (section 2), it is ready to launch the satellite broadband voucher scheme for all the eligible schools.

The process to be carried out by each school could then be summarized in three simple steps:

1) **Application**

   The eligible school, if not directly contacted by the Public Authority responsible for the scheme, needs to check its eligibility and apply online. In the application the school will need to:
   - Certify that it is currently unable to receive download speeds greater than X Mbps (e.g. 2 or 5 Mbps).
   - Describe its project in case the voucher should finance more than only the satellite broadband access.
   - Select an Internet Service Provider from the qualified registry published in the voucher scheme website by the Public Authority.

2) **Voucher verification and approval**

   The Public Authority, after receiving the project application, will confirm (or reject) to the school the approval of the proposed broadband voucher.

3) **Agree with ISP on solution, subscription and installation details**

   The school, after receiving the formal approval of the broadband voucher project, must contact the relevant Internet Service Provider(s) to agree on the solution, a service subscription and an installation date.

   When completed, the ISP will report to the Public Authority to be refunded.

6. Funding of Satellite Broadband Voucher Schemes

There are several **EU sources to finance satellite broadband voucher scheme** projects:

- European Structural and Investments Fund (ESIF) specifically with the:
    - ERDF[126] (European Regional Development Fund)
    - EAFRD[127] (European Agricultural Fund for Rural Development)
    - ESF (European Social Fund)[128]
- National, regional or local public funding.

ERDF (European Regional Development Fund) and EAFRD (European Agricultural Fund for Rural Development) are the EU funds available to finance broadband infrastructures. ESF (European Social Fund) could be used to finance distribution e-learning tools. These three specific funds are part of the European Union's main investment policy tool: the European Structural and Investment Funds (ESIFs)[129].

Please note that the combination of ESF, ERDF and EAFRD in multi-fund operational programmes should provide more efficiency in school connectivity voucher scheme projects by developing combined support packages for broadband access and other online-based curriculum materials.

On the other hand it is worth mentioning that within the ESIF funding is directly programmed and managed at National or Regional level mostly by Public Institutions that are not the ones in charge of education. This could create a lack of attention towards the issue of broadband connectivity for schools.

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[126] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0487.01.ENG&toc=OJ:L:2013:347:TOC

[127] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1301

[128] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2013.347.01.0470.01.ENG

[129] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1303. In terms of ESIF targets please note the ex ante conditionality for the thematic objective 10 “Investing in education, training and vocational training for skills and lifelong learning” that foreseen the Reduction and prevention of early school-leaving and promoting equal access to good quality early-childhood, primary and secondary education, including formal, non-formal and informal learning pathways for reintegrating into education and training for ESF and investment in education, training and vocational training for skills and lifelong learning by developing education and training infrastructure for ERDF.

Apart from ESIF funds some Member States as in the case study of France (see section 9.1.5.3) decided to finance the voucher scheme for school connectivity using national funds. This choice allows the Public Administration to be compliant with the national financing rules and not the ones for ESIF. In any case, state aid rules needs to follow the EU procedure.

7. Voucher Scheme redemption

In order to assure the regularity of the financial management of the Voucher Scheme, the Public Authority will pay the qualified internet service providers only on the basis of the submission of regular reports that includes at least the following documentation for each school connected:

- User identification code
- MAC address (Media Access Control) of the subsidised equipment
- A statement of delivery, installation and activation having been carried out for the customer premise equipment, object of the aid, including the delivery address and a copy of the validated voucher
- References to the Internet access agreement with the service provider for a specified term (determined within the Scheme)
- a printout of the speed test (countersigned by the end-user as well) to provide clear evidence of the positive outcome of the acceptance on site test – meaning the satellite broadband service is actually up and running.
- Geo-referenced photos, provided by the installer, of the ground equipment installed (modem and antenna) can be used where this is acceptable within the funding regulations.

The Public Authorities will monitor the implementation of this part of the Voucher Scheme and will ensure the aid is reimbursed in the event of non-compliance by the service provider or the eligible school.

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