

# National Education Network Services Survey 2009



## Objectives:

- To help evidence the scale, achievements and benefits of the National Education Network (NEN) across the UK.
- To summarise the connectivity and services provided by Regions and RBCs to schools and other agencies as at May 2009, and identify requirements for further development.
- To examine whether the facilities and the service levels provided are sufficient to deliver the broadband entitlement for learning.

## Principal Audiences:

The principle audiences include central and local government strategy and policy managers in Northern Ireland, Scotland, Wales and the ten Regional Broadband Consortia in England, and their local authorities.

## Contributors:

Thanks are due to the ten English RBCs and the devolved administrations, which submitted comprehensive data, critical comment and case study material. Several local authorities also contributed material which illustrated how size of organisation can result in different strategies.

We thank also Becta, JANET(UK) and the National Education Network Content, Safeguarding, Technical Strategy, Communications and Managers standing groups.

## Methodology:

Regions and RBCs were asked for the numbers and types of establishment connected as at May 2009, plus comments on backbone networks, Internet transit and wider issues. The data sample exceeded the target of 66% of Regions / RBCs and detailed data from 33% of UK schools. We feel that the conclusions drawn are based on a fair sample.

The detailed connectivity data covers 10,233 of the 28,272 UK schools plus 9 of the 13 regions.

## Contact:

Peter Banbury, [peter.banbury@kent.gov.uk](mailto:peter.banbury@kent.gov.uk)

Secretary, National Education Network Technical Strategy Group

# Conclusions

## The range of broadband services as at May 2009

- Broadband services managed by Regions, RBCs and individual local authorities (Grids) connect over 99% of schools. These services are sophisticated and developing rapidly.
- Grids deliver best value connectivity and underpin educational policy, including the development of administration, safeguarding and learning content delivery.
- Within the standard specifications set for the NEN, local delivery can be quite diverse, resulting from geography, the degree of local aggregation and funding strategy.
- Grids learn from each other's expertise and experience and from Becta and JANET(UK) through the standing working groups of the National Education Network.

## Quality of the network estate

- Schools generally receive uncontended, symmetric connectivity which is highly reliable.
- The grids are well placed to provide service development, improvement and innovation for schools. Security, e-Safety, technical and education support services are also provided.
- Capacity upgrades, typically from 2 Mbps to 10 Mbps in primary and from 10 Mbps to 100 Mbps in secondary, are being implemented as educational requirements dictate.
- Value for money is benchmarked, with several Grids on their third procurement cycle. Value is enhanced by aggregation across all schools, and in places with higher and further education, local government and independent schools.

## Growth and on-going investment

Regional networks are changing and expanding in response to changing educational strategies. The rates of growth are from 31% to 72% pa. and there is no evidence that growth rates are slowing. As schools develop their ICT use, we estimate a further capacity growth of 7.6 times over 5 years.

Broadband technology needs to keep ahead of educational development or we will return to the 1980's with teachers disaffected through use of slow and ineffective networks.

Over the next five years the UK Grids are expecting to invest in:

- edge circuit upgrades to 21,602 schools, including the replacement of legacy technology;
- replacing or upgrading all backbone networks and Internet transit connections;
- upgrading central services such as filtering to serve four times the number of devices.
- Strategies to offer more functionality at lower cost than current.

## Maintaining continuity and momentum

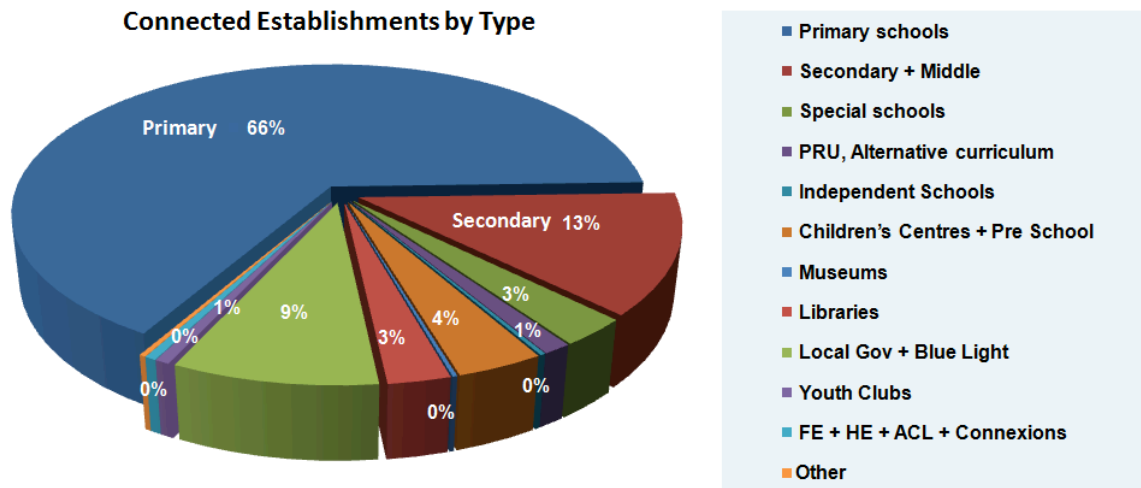
Continual effort over ten years has created generally effective governance and delivery structures. This billion pound government ICT project has been delivered on-time, on-budget and to a much higher specification than originally envisaged.

The greatest danger is fragmentation of the decision-making processes, this would result in:

- Lack of confidence in driving forward innovation and value for money.
- Schools taking up lower quality but cheaper connectivity, increasing long-term costs.
- Many rural schools and most small schools unable to fund broadband.
- Inability to deliver educational strategies to a common standard.
- Disaffection by pupils used to faster individual broadband connections.

## Who uses the National Education Network?

From 2000, secondary schools were connected first in most areas, followed by special and primary schools. Over 99% of all schools were connected by 2006. Since then, the range of agencies connected has continued to widen, with educational settings such as PRUs, Children's Centres and Youth Centres. Some museums and libraries were connected quite early and more recently local government offices and some blue light agencies have benefited from the capacity and value for money available in the Grids.

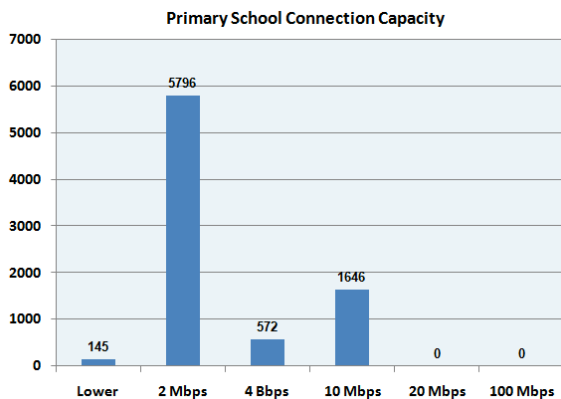


### Observations:

- Education connectivity has widened beyond schools to include PRUs, Children Centres, Pre-School Units and Alternative Curriculum Centres.
- Providing consistent e-Safety messages to young people in all locations is difficult. Agencies often have different policies, ISPs and access management methods. Connecting through a common network enables consistent services and messages.
- The connection of Museums and Libraries is important in that learning can continue more easily if the connection capacity and functionality matches that in school.
- National museums and archives provide excellent educational content and hosting of videoconferencing activity. Many are connected to the National Education Network.
- Children's access to the Internet in foster homes, children's homes and other settings via educational schemes is increasingly important but remains a major challenge.
- Adult and Community Learning centres in schools might be better served by RBC networks, rather than independent or corporate networks.
- An increasing number of Local Government offices are being attracted by the high capacity core infrastructure and lower prices available through aggregation.
- Some Police, Fire and Emergency Services have found that their security requirements match other public sector agencies and NEN connections are suitable in many cases.
- FE and HE establishments are often local to RBC or Regional network points of presence, of which there are many more than for HE networks. The cost to the public purse could be reduced by sharing circuits and/or backbone infrastructures.

## Capacity of edge connections (not bandwidth used)

Connections to individual establishments make up about half of the whole broadband cost. Do schools have sufficient capacity headroom to encourage online activity? Could costs be reduced by changing edge technologies, while increasing capacity? We consider here the capacity of the carrier to the school or the capped bandwidth where given.

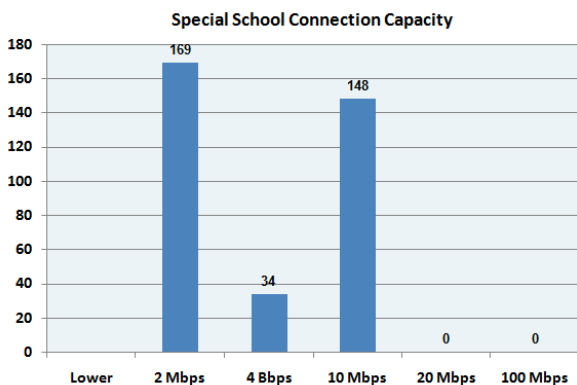
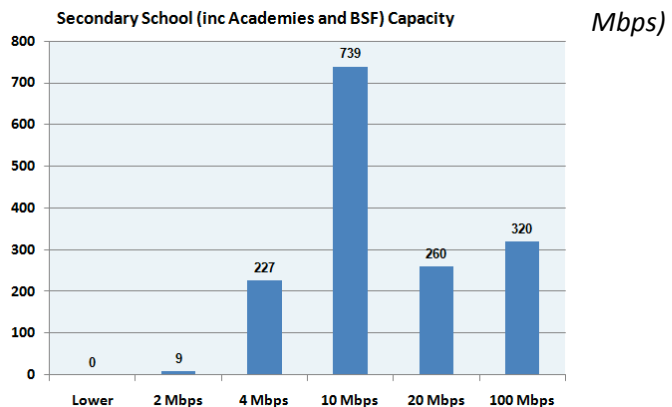


### Primary Schools (average carrier 3.7 Mbps)

- Few connections are under 2 Mbps or are asymmetric or highly contended.
- The majority of connections are 2 Mbps, symmetric and uncontended.
- Upgrades to 10 Mbps are part of a substantial ongoing investment in edge bandwidth over the next five years.
- 2 Mbps may be appropriate for some of the smallest primary schools for one or two years.

### Secondary Schools (average carrier 29.3 Mbps)

- 48% of connections are 10 Mbps, with 20 Mbps and 100Mbps increasing.
- Bandwidth use up to 40 Mbps in secondary schools has been reported.
- 1 Gbps connections for the largest schools are being installed this year.
- BSF schools are all reported to have 100 Mbps symmetric connections.



### Special Schools (average carrier 5.6 Mbps)

- Bandwidth between that of Primary and Secondary schools is reported, despite the smaller average size of Special schools.

### Wider issues

Edge capacity is not sufficient to provide a good service. The end-to-end capacity including CPE, filtering, backbone, Internet, DNS and firewall must also be upgraded in step with edge developments.

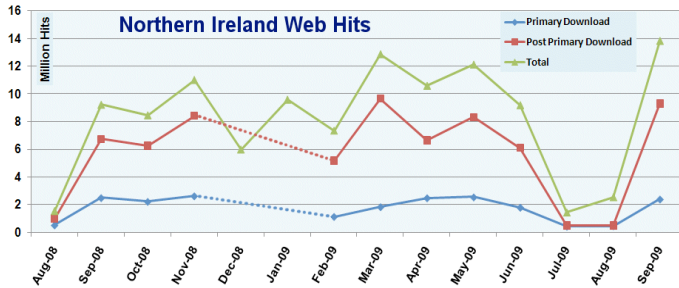
### Investment in capacity upgrade

The requirement for higher capacity connections is clear. 62% of secondary school connections and 80% of primary edge connections will need capacity to be upgraded over the next five years, a total of 21,602 schools when extrapolated across the UK.

# Growth in demand

The Grids are developing rapidly. Growth in bandwidth, total data transferred and connection size can be seen in every grid. This section shows growth in several Grids, noting any factors that need to be taken into consideration, such as higher numbers of connected establishments. The Grids and their suppliers are thanked for their help in providing this growth data.

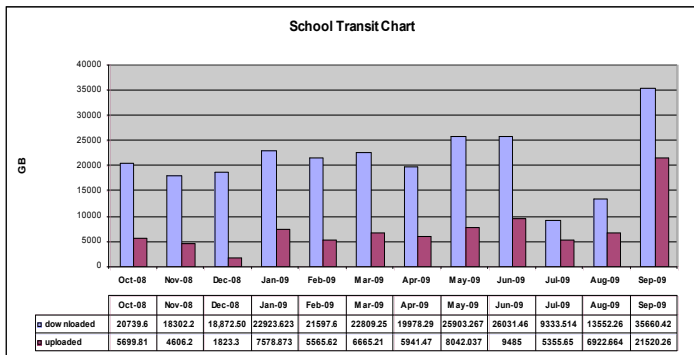
We need to distinguish between Internet transit and traffic to the Grid WAN centre, which may be higher where it includes VLE traffic. Generally 99<sup>th</sup> percentile figures are used, rather than peak.



## Northern Ireland

Educational traffic only, measured by number of hits to web sites.

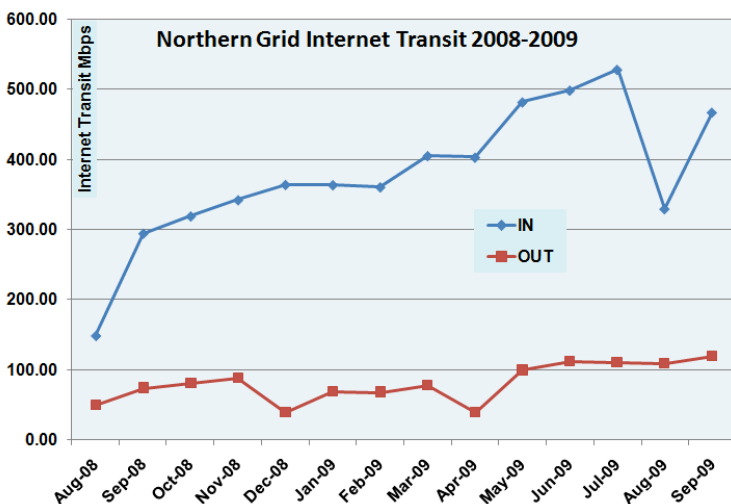
September to September growth of 51% can be seen.



## Northern Ireland

Shows total traffic between educational establishments and the WAN centre. The traffic includes the VLE, hosted at the WAN centre.

October 2008 to September 2009 growth of 72% pa.

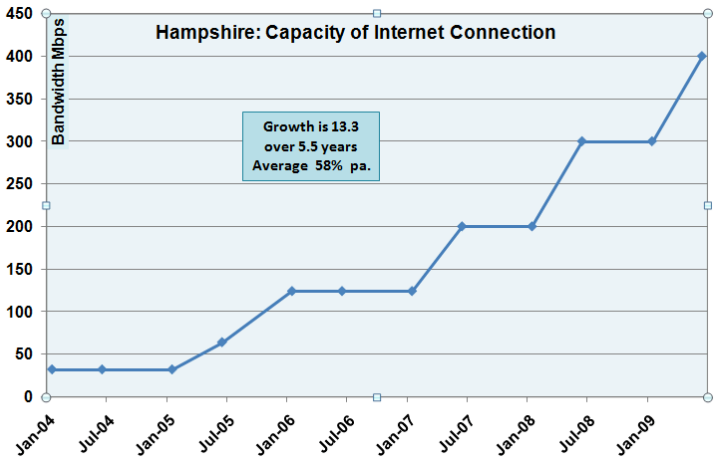


## Northern Grid Internet Transit

September to September growth of 45% can be seen.

October's figures will be interesting.

Mostly schools' traffic but with some local authority corporate traffic.



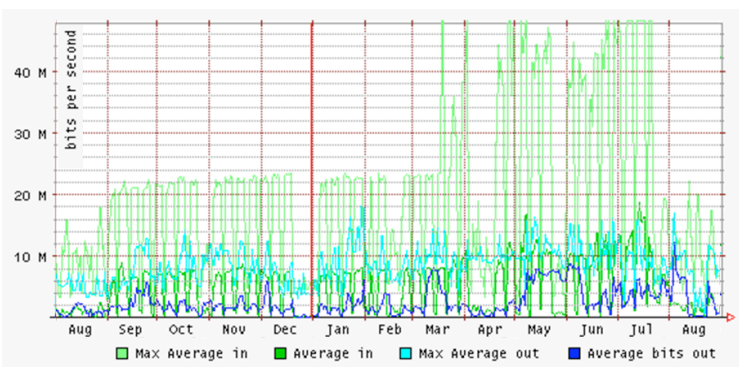
**Hampshire Internet Connection**

How capacity has been upgraded in response to demand from schools.

Growth is from 30 Mbps to 400 Mbps in 5.5 years.

The average growth is 58% pa.

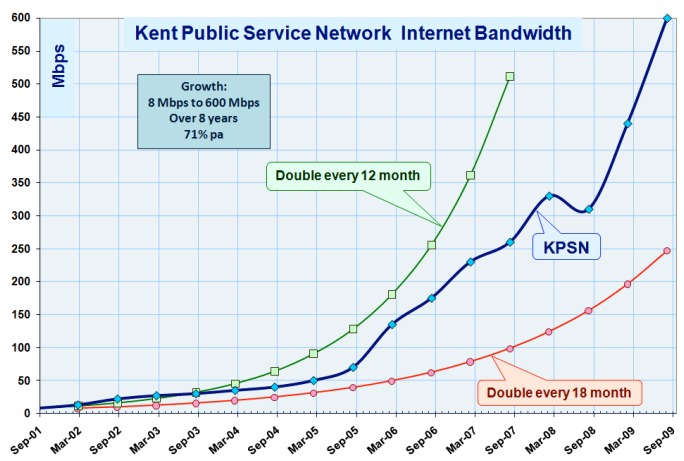
increasing numbers of connected establishments have contributed, although the majority of schools were connected by 2004.



**Wokingham Internet Transit**

In early 2009, schools reported that the VLE response had slowed, although Web browsing was fine.

The 20 Mbps cap on the 100 Mbps backhaul was removed by the supplier and the VLE response was restored, showing the importance of close monitoring.



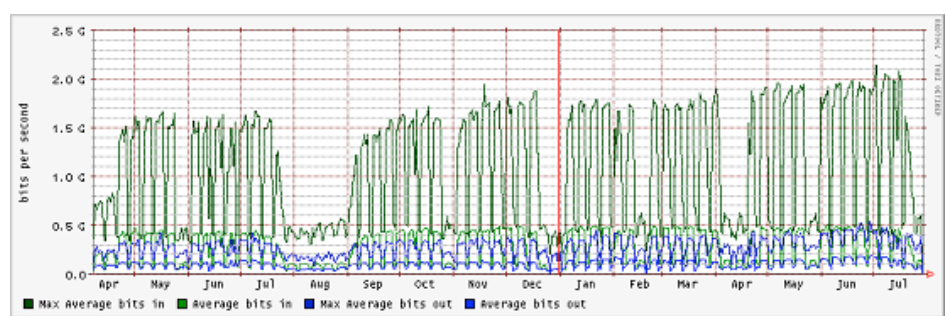
**Kent**

Internet transit since September 2001.

Growth averages 71% pa, however the number of establishments has increased over this time.

Virtually all schools were connected by December 2007, with about 10% additional establishments since then including District Councils.

The Sept. 08 downturn was caused by a lack of central filtering capacity.



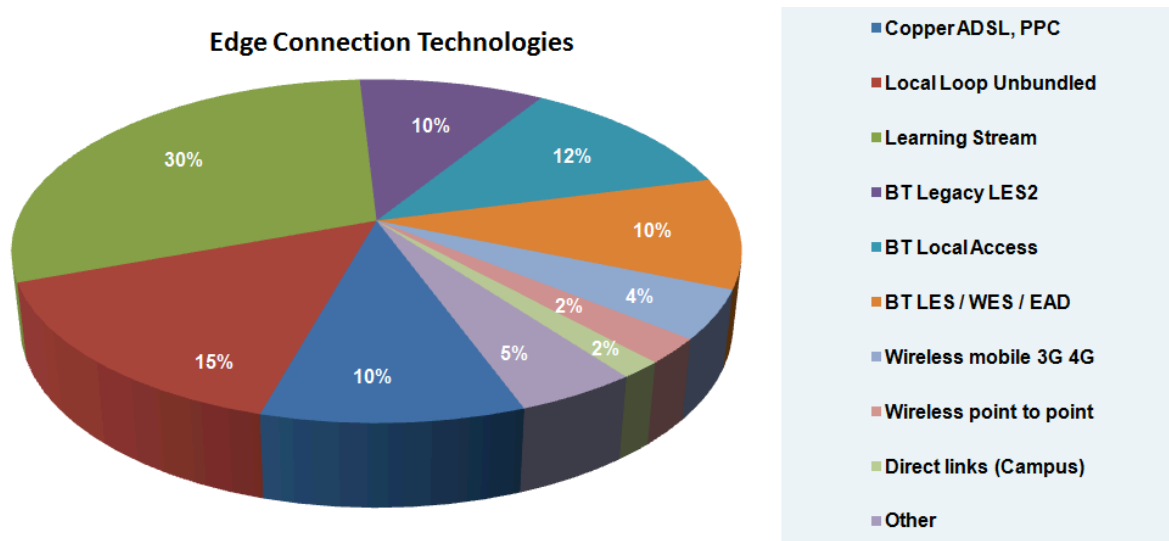
**South West Grid**

Internet transit over 14 months.

July to July growth is 31% on average.

## Technologies used to connect establishments

One of the strengths of the NEN approach is the ability of Regions and RBCs to take local factors into account in the design of optimal network solutions. There is much to be learnt about the best use of connectivity services, where technology and prices change frequently. It is hoped that the investment required to replace old technology and upgrade capacity can be informed by this data.



### Replacement of old technology

- In the sample there were more ADSL circuits than expected at 10%, although these were mainly in Youth Clubs and PRUs rather than in schools. Reasons for use of ADSL include availability in difficult locations and the higher cost of other circuit types. Replacement with connectivity more appropriate to curriculum ICT delivery is required in most cases.
- Learning Stream has a circuit limit of 2 Mbps and represents 30% of the estate. Learning Stream can be expensive at typically £4.5k pa rental per circuit (including BT hub cost), Upgrading a schools connection capacity to 4 Mbps or beyond is expensive. However the low distance charge means that it may be reasonable value for small schools in rural areas with long circuit lengths. Although still available from BT, technology replacement is likely in the medium term and will incur new installation and possibly network re-design costs.
- BT LES2 is a fibre circuit delivering 10 Mbps at a modest rental of £1.6 k pa., about 10% of the estate. However LES 2 became end-of-sale in October 2007 and has an undefined service life although some contracts are to the end of 2011. The nearest BT Global Services substitute is about £5k pa, plus install costs, although other less expensive circuit type exist.

### Investment Implications:

Although these legacy technologies were correctly selected at the time, changes in technology, telecommunications regulation and supplier pricing has led to less than optimal design in places. Most legacy circuits, up to 50% of the edge estate will require upgrade in the next five years.

Regions and RBCs may need to:

- ♦ Establish the longevity of edge connectivity and develop a replacement strategy.
- ♦ Design backbone topology and capacity to support new edge circuit types.
- ♦ Produce business models comparing technologies, features and prices
- ♦ Engage suppliers and telecommunications providers in benchmarking their solutions.

## Procurement of the broadband estate

- ♦ Grids installed the first broadband networks in 2001. All Grids have re-procured their broadband system once or twice in 8 years.
- ♦ Upgrade and redesign is currently underway or planned in 5 out of the 13 Grids.
- ♦ This is a large scale issue, but one which Regions, RBCs and Local authorities have resolved before. We need to ensure that the Grids have the funding, confidence and expert support to achieve this step-change in service.

## Upgrading edge circuits (prices as at summer 2009)

Upgrade costs of edge circuits comprise one-off (installation, dig costs) plus annual rental costs. Certain edge circuit types may also require changes to Grid backbone infrastructure.

Replacement circuit rental may be higher or lower! These examples are based on the approximate cost of the edge circuit and its driving equipment:

- A 2 Mbps Learning Stream circuit at £4000 rental pa, could be replaced with a 10 Mbps LLU circuit at £1000 pa., providing the establishment is within 4 km of a LLU point of presence.
- Several long WES 10 Mbps circuits at £7k pa could be replaced with 100 Mbps local access circuits at £3k pa. if an additional network hub is installed, or WES aggregation utilised.
- When it becomes necessary, LES2 fibre circuits costing £1.6 k pa could be replaced by either fibre at £3k pa or LLU at £1k pa., depending on location and hub availability.

In rural areas, fibre may be the only replacement option available for many schools due to distance from network hubs. Secondary schools will probably require a 100 Mbps fibre connection.

One-off costs are required for upgrade or a new installation, which may affect overall cost:

- Installation cost:
  - Fibre: £2k, BT engineer call out £200, router £600, Integrator £600, Total £3400.
  - LLU: £250, line driver £400, router £600, engineer £600, Total £1850
- Civil engineering or excess construction charges.

## Backbone costs

The smallest urban local authority may connect all establishments back to a single point. Larger LAs or Grids will have a resilient backbone based on rings or a mesh topology to maintain traffic in the case of a fibre break. Network hubs may be placed in LA buildings, which is often the cheapest solution but is not always an ideal environment for hot network equipment, or for access out-of-hours. Alternatively network hubs may be placed in Telco. locations such as telephone exchanges, which has the added advantage of making available lower cost circuits such as LLU or WES local access, as these must terminate in a telephone exchange.

- From the survey, 44% of Grid networks use local authority buildings for hubs, and it is worth investigating whether a move to using Telco-based hubs would bring benefits.
- Assuming a growth of 50% pa, Grid backbones will need to increase capacity by a factor of 7.6 over the next five year period. This will involve one-off as well as increased recurring costs. Economy of scale does apply, but a doubling of backbone costs is likely.
- Where Grids share their backbone infrastructure across the public sector, some of this cost is mitigated and significant savings also provided to other agencies.

### **Current technology – LLU**

Local Loop Unbundling (LLU) provides BT copper pairs at the telephone exchange (TE) to other operators that install devices to transmit broadband data. Typically 2 Mbps symmetric data can be delivered to most locations within a route distance of 3.5 km from the TE. Route distances can be up to 6 km, but data rates fall to 1 Mbps. Alternatively at 1.5 km a data rate up to 6 Mbps can be obtained over a single pair. Suppliers sometimes claim higher performance based on ideal situations.

LLU is relatively low cost, with a single copper pair rental of £86 pa. If several pairs are used to provide 10 Mbps, with costs of driver devices and service wrap, the cost might be £1000 pa. However this is a third of the least expensive fibre circuit currently available. LLU is expanding quickly and has been examined in a recent JANET study to be published in February 2010.

The use of LLU circuits requires termination in a telephone exchange (or the LLU providers location) and a backbone connection to Grid. This cost must be factored in.

### **Current technology – Fibre**

25% of connections use current BT products such as BES / WES /EAD (BT Openreach) or EES (BT Global Services). Other suppliers have similar fibre products in some areas, often at lower cost.

These services are reliable and transmit from 10 Mbps to 10 Gbps over a pair of fibres up to 25 km radial distance, or a single fibre with new products such as BT EAD. BT has said that BES and WES services will become end of sale relatively soon and be replaced with EAD. This may require additional equipment in points of presence for which space will be required.

Where networks have hubs in BT telephone exchanges the Local Access (LA) versions of the WES and EAD fibre products can be used. This is essentially one circuit end at 63% of the cost. However the cost of exchange hosting has to be factored in. 37% of fibre circuits in the sample are local access.

### **Network Topologies**

Grids have worked hard in raising the reliability of broadband connections. Measured availability to the school of over 99.9% is reported. Ring or mesh topologies have been implemented as networks expand and the relative cost of the core decreases. Dual Internet connections and duplicated central services also increase service availability.

As networks have expanded, the number of network hubs often increases. This reduces the cost of edge connections by reducing the distance to the hub. Where hubs are placed in BT telephone exchanges, products such as LLU and Local Access can further reduce edge costs.

Making the Grid backbone available to the wider public sector is increasingly common.

### **Network clusters and campus connections**

Where establishments are relatively close together they may be inter-connected using low-cost wireless or dark fibre links. Frequently a Children's Centre or Adult Learning Centre is located in or near a school, or an infant and junior school may occupy ends of a shared field. A single fibre backhaul connects the cluster economically to the network backbone.

A useful exercise is the mapping of local government offices, libraries, health centres, fire and police station locations to see their proximity to RBC network hubs, or to schools for campus connections.

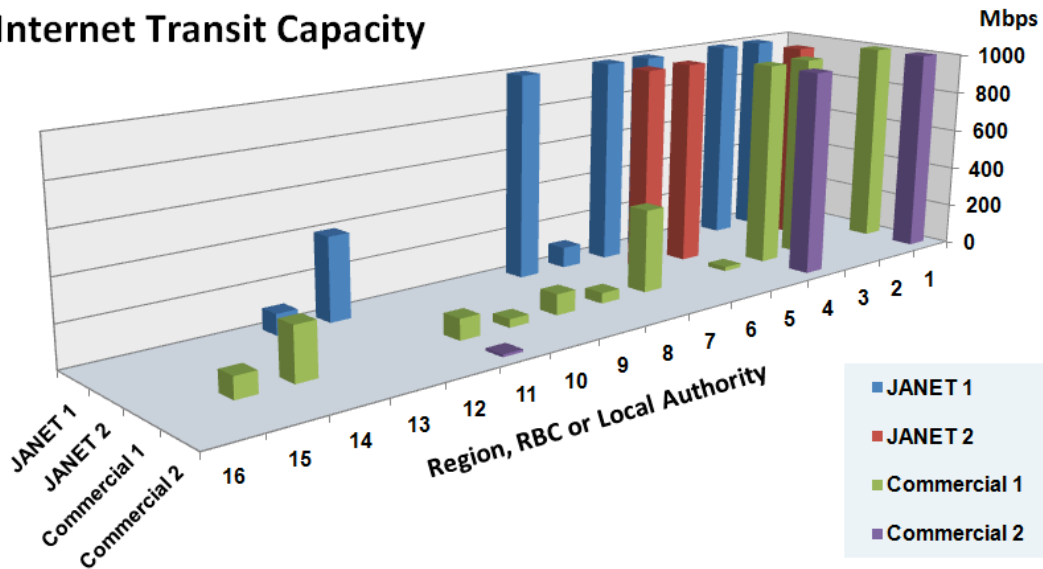
### **Local Knowledge**

A small local authority returning the survey used five different circuit types (CAT5 and dark fibre campus links, Learning Stream, LES10 and ADSL) in connecting its 64 establishments. Local knowledge enabled the matching of circuit type to situation, reducing overall cost.

## Internet transit

Regions and RBCs use both commercial and JANET Internet transit links. The chart shows how Grids use commercial or JANET links and the capacity of each, as at May 2009. Single local authority responses are shown to the left, with the Regions or RBCs to the right.

### Internet Transit Capacity

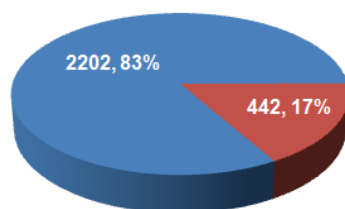


- 57% of networks have a second Internet transit link for resilience.
- Where a single local authority operates its own network, resilient Internet transit is often seen as too expensive. Region or RBC Internet transit connections are all resilient.
- All combinations of Internet transit supplier are represented: singles, pair and mixtures.

### Total Internet traffic

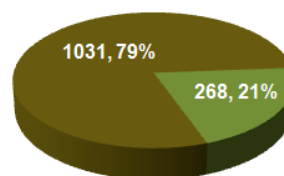
- Simply adding Internet transit usage across the networks is imperfect, but it does give a first approximation to usage. 95<sup>th</sup> percentile figures were used to smooth out peaks and improve comparability across users.
- In the current sample, total Internet transit via JANET is greater than that via commercial connections. However the data flow symmetry is similar at 5:1 in favour of download. This has changed from a 10:1 ratio generally reported a few years ago.

JANET Traffic , Mbps



■ JANET Down  
■ JANET Up

Commercial Traffic , Mbps



■ Commercial Down  
■ Commercial Up

- Extrapolation has limited accuracy, but a total UK schools Internet transit capacity of 10 Gbps is suggested, as at May 2009. Some of this traffic, for example to a NEN content provider, is not strictly across the Internet, reducing the capacity required.
- The continued provision of Internet Transit and the ability to interconnect regional networks at a reasonable price is extremely important.

## Backbone topology and capacity

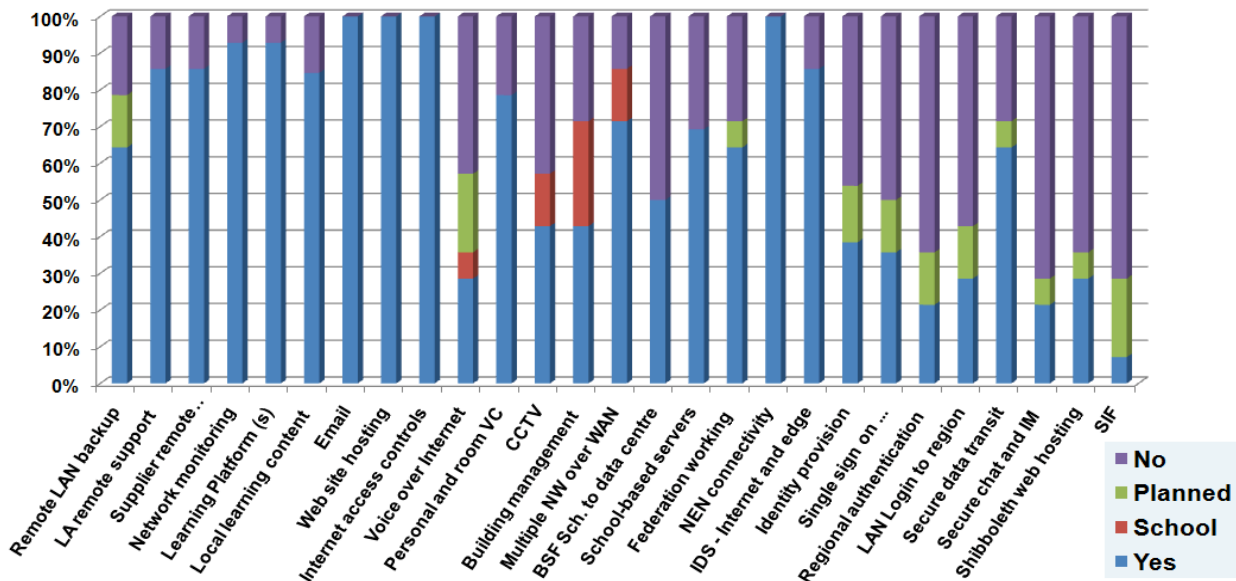
Many factors affect the way that a Grid plans its infrastructure. The geography of regions varies, some are nearly surrounded by water but others have many near neighbours. Competition between telcos may feature or be absent. Strong links may have been forged across much of the public sector, or separate networks for schools, local authority, health and higher education may exist in parallel.

Backbone topology and capacity reflects these factors.

- All Region or RBC networks responding had incorporated resilience into backbones.
- Where local authorities have their own network, 65% had resilient backbones. However in the smallest LAs, the edge connections may connect directly to the main hub and a resilient backbone topology is not required. Availability is good as only a single circuit is involved end-to-end and this serves only a single establishment.
- The capacity of most RBC and Regional backbone networks is 1 Gbps, often in the form of multiple rings.
- Dark fibre and other large capacity links with a capacity around 10 Gbps are being planned in several RBCs. There seems to be a general lack of knowledge about dark fibre and its providers and its benefits as compared with BT Optical Spectrum Access.
- The decision whether to locate network hubs in telephone exchanges (TE) or in LA establishments is important. A hub located in a TE enables BT Local Access circuits to be used, a major saving on WES prices, but does involve additional costs. LLU circuits terminate in the TE, and may be accessed by a number of suppliers. In this sample, 58% of hubs were located in BT exchanges.
- Most Grids report that a major re-procurement is being undertaken or being planned to move to a third generation of broadband network since 2000.
- The traffic to learning platforms from both schools and from pupils at home is increasing and their location needs to be considered carefully.
- Schools' demand for Internet transit exceeds that of other public sector agencies. In one network serving both schools and local government agencies, the August Internet transit was 100 Mbps compared with 500 Mbps in term time. This suggests that schools' demand is four times that of the local government in total. Local government traffic may be more point to point, rather than Internet transit, which needs to be investigated.
- RBC backbones with sufficient capacity to serve schools could also serve all public sector agencies in a region with relatively minor capacity upgrade, increasing value to both sectors and reducing the overall cost to the public purse.

## Services run over Regional Networks

A wide range of service is provided to schools over the regional networks. This chart, based on May 2009, shows those in place (Yes), individual school decision (School), in planning (Planned) and neither in place or planned (No). The questions involving authentication were unclear in places, but the wide range of sophisticated services provided by Grids is evident.



Every respondent network, RBC or LA, is operating:

- Email services
- Web site hosting
- Internet access controls
- NEN connectivity.

Over 80% of networks offer:

- Remote support from the LA service desk
- Remote support from third party suppliers
- Wide area network monitoring, bandwidth etc.
- Learning platforms
- Locally written content or applications
- Intrusion detection services (IDS).

The picture is less clear for authentication services, and the questionnaire offered too many alternative choices.

The Regional or RBC networks on average offer 19 of the 27 services surveyed. Understandably the smaller local authority networks offer fewer services, on average 14 of the 27.