

Community broadband networks in the east of England

Background

The UK city of Cambridge is essentially a high technology island in the middle of rural East Anglia. The surrounding countryside is relatively sparsely populated and the population is concentrated in villages with a thousand or fewer inhabitants. Many of the villages within about 20km of Cambridge have small technology-based businesses and they also provide homes for people working in Cambridge's industries. As a result there is a significant demand for broadband services.

Unfortunately this demand is not usually high enough to justify equipping the small telephone exchanges that serve these villages with ADSL equipment. The standard ADSL interface unit supports 300 customers¹ and it is highly unlikely that a village with even a thousand telephone lines would have enough broadband customers to use most of its capacity. Cable TV coverage outside Cambridge is very patchy and, given the current financial state of the UK cable industry, the cable network is unlikely to be extended significantly in the next few years. Broadband access using cable modems is therefore not an option for most Cambridgeshire villages.

This means that, although people and businesses in Cambridge itself have good access to broadband communications, there are villages as little as 5km from the city boundary where the mainstream communications companies are unlikely to offer broadband services in the near future. The situation is the same throughout most of East Anglia and other rural parts of the UK.

A broadband access solution for such villages needs to be viable with a few dozen customers, be scalable and involve low up-front infrastructure costs.

The structure of the initiative

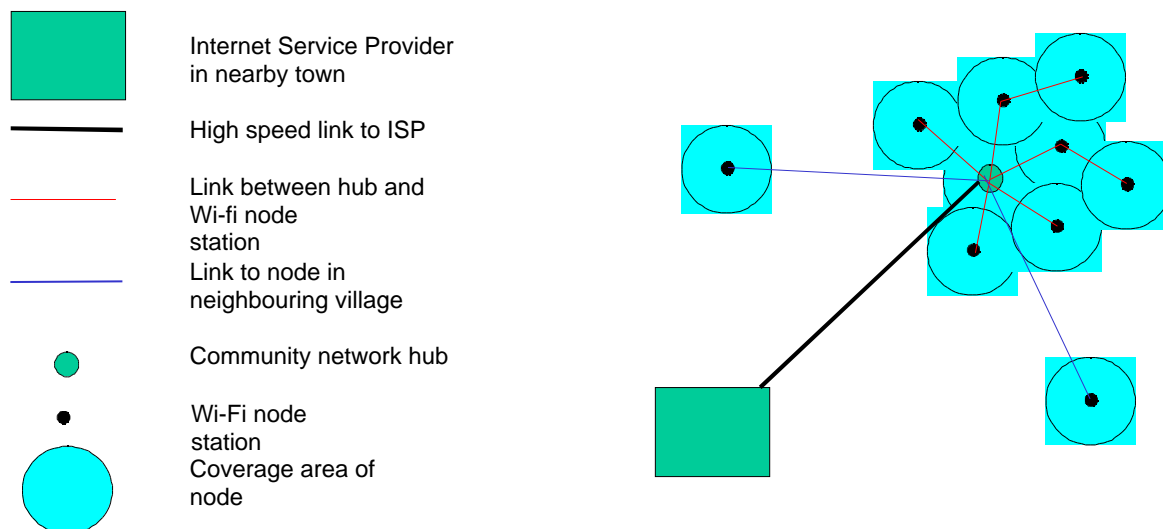
[Invisible Networks](#) is a company based in Cottenham, a village about 12km north of Cambridge. It was established in 2001 by Richard Nuttall, the founder of the Internet Service Provider Pipex, and Neville Hawkins, a telecoms network consultant with extensive experience in radio technology. The aim of the company was to develop broadband access solutions for rural communities and implement these in a number of villages surrounding Cambridge. These community networks will eventually be linked together to form the 'Cambridge Ring'.

The solution is based on the well-established Wi-Fi (IEEE 802.11b) technology. This was originally developed for wireless Local Area Networks (LANs) to interconnect the computers in an office or factory. However a Wi-Fi node operating at the maximum power allowed in the UK can broadcast its signal to an area with a radius of several hundred metres. Using transmitters of the same power, it is also possible to set up point-to-point links over distances of between 10 and 15km. In addition the Wi-Fi radio frequencies (~2.45GHz) do not need a licence in most countries. This means that the technology is can be used for public broadband access services.

¹ BT is currently conducting trials of a 16 port ADSL unit for smaller exchanges but it may be some time before it is used on a large scale. Even then, many rural customers may be too far from the exchange to benefit from ADSL.

A Wi-Fi node has a bandwidth of about 10Mbit/s, which it shares among the users connected to it. Given typical patterns of Internet use, this means that it can support several dozen users and offer them connection rates comfortably in excess of 1 Mbit/s for most of the time. The only difficulty is if significant numbers of users simultaneously want to use streaming video or videoconferencing services. Even in such an extreme situation, it could provide 30 or so users with simultaneous connections at several hundred kbit/s – a speed that offers good, although not broadcast, quality video. It is worth noting that, unlike ADSL, Wi-Fi provides a symmetrical connection; in other words, users can transmit as well as receive at high speed.

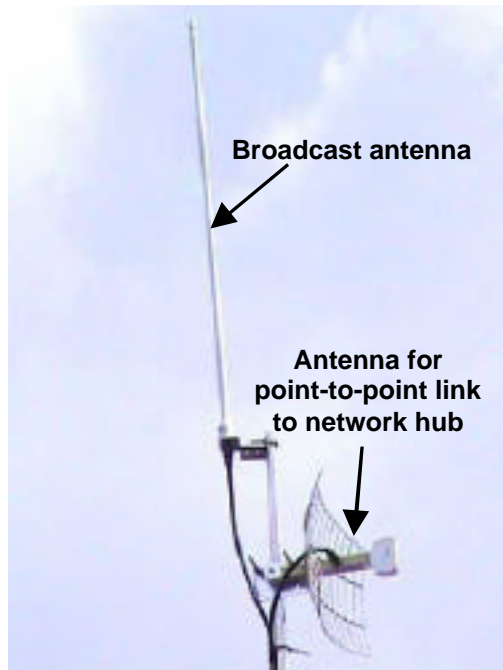
A simplified version of Invisible Networks’ technical model for a community broadband network is shown below. A high-speed leased line or point-to-point radio link is used to connect the central hub of the community network to an Internet Service Provider (ISP) in a nearby town. This hub monitors and manages the community network and may incorporate a server for hosting local Internet content. The hub will also house a Wi-Fi node to serve customers in the immediate area (within a few hundred metres). Nodes serving other parts of the village or neighbouring villages are connected to the hub by point-to-point radio links. The network is dimensioned so that each node serves up to about 25 residential customers or around half that number of small business or SOHO (Small Office / Home Office) customers. A larger business with a dozen or more employees might have its own dedicated node linked directly to the network hub.



This architecture offers very high levels of connectivity between individual customers on the network. The limitation is the high-speed link from the network hub to the Internet Service Provider and hence the outside world. Depending on the size of the community network this will be between 2 and 8 Mbit/s. Although this is only a fraction of the internal capacity of the community network, it compares favourably with the capacity provided by other commercial broadband access services. (An ADSL exchange offering 500kbit/s access to 200 residential customers would normally only have a 2 Mbit/s link to the outside world, i.e. one fiftieth of the capacity that would be needed if they all tried to download information simultaneously.)

Wi-Fi is a relatively mature technology and equipment is widely available from computer stores etc. and a plug-in interface card for a PC can cost as little as £40 (p62). To ensure compatibility and make installation and maintenance easier, Invisible Networks specifies a particular range of components for use in their community broadband networks. The range includes ways of connecting individual computers and SOHO or small business networks.

Wi-Fi nodes are located at the community network hub and at selected sites within the villages. To keep costs down, the hub antennas are usually mounted on customers' TV antenna masts. Customers hosting network nodes are offered a discount on the price of the service. A network node costs around £1,000 (≈1,550), including both equipment and installation. The network hub costs about £14,000 (≈21,700), including the first year's rental of the leased line to the Internet Service Provider.



Antennas at a network node



Typical customer installation

Pictures courtesy of Invisible Networks

The technical model offers a low-cost, scalable solution for delivering broadband services to small communities. If customers pay installation charges and monthly fees similar to those charged for commercial ADSL services, a network could be viable with as few as 150 customers.

This technical model is supported by a business model that promotes community involvement with the network. A not-for-profit company, whose shareholders are the customers of the network, markets the services and provides a local point of contact. Invisible Networks, operating on a commercial basis, designs, procures, installs, operates and maintains the network. For the initial 'Cambridge Ring' networks, Invisible Networks selected a number of villages around Cambridge, which would not be offered ADSL or cable modem services, and actively promoted the idea of a community network through public meetings, articles in local magazines and mailshots. However news of the company's activities has spread rapidly and it has received approaches from a number of self-generated community groups interested in establishing similar networks in other parts of the country.

The [Connecting Communities Competition](#) run by the [East of England Development Agency \(EEDA\)](#) provides grants to rural communities to help them set up local broadband services. These grants are available to groups of individuals or small businesses and cover the start-up costs of a community broadband network - stimulating and aggregating local demand, developing a business plan, negotiating with potential suppliers etc. A number of other UK development agencies operate similar schemes.

Invisible Networks regards today's broadband services at between 500kbit/s and 2 Mbit/s as a transitional phenomenon. The founders believe that, in the longer term, customers will want multi-megabit access to the Internet. The company describes itself as 'technology agnostic' and has an open mind about what mix of copper, fibre and radio will be the optimum long-term solution. In the meantime however they see the company's business and technical model for community broadband services as a cost effective solution to meeting current levels of demand in rural villages. Invisible Networks is keen to promote this approach to community broadband networks and is already offering advice and support to a number of initiatives in other parts of the UK.

What the Cambridge Ring offers to small businesses

All of the Cambridge Ring networks offer the same service packages. There are three levels of service:

- ***Standard service*** is aimed at ordinary households. The connection charge is £199 (≈310) and the monthly fee is £29.99 (≈46.50)
- ***Premium service*** is aimed at heavier users (including SOHO and small business users). The connection charge is £299 (≈465) and the monthly fee is £45 (≈70).
- ***Enterprise service*** provides connection for a company network and the charges are negotiated on an individual basis.

The standard service provides always-on wireless LAN access to the community network and the Internet at speeds of up to 2Mbit/s in each direction. Because the network uses a shared medium, the connection rate is not guaranteed but the network is dimensioned to ensure that users will be able to achieve at least 500kbit/s for most of the time. Although the service is always-on, there are some restrictions to prevent network congestion. Individual users are limited to 30Gbytes of traffic per month and streaming video or videoconferencing services are limited to 250kbit/s and may not be left on permanently. None of these restrictions is likely to be a problem for a typical residential or small business user.

The premium and enterprise services provide additional features, such as guaranteed minimum connection rates, multiple addresses, higher monthly traffic allowances, and the ability to host servers.

Because the service provides a permanent connection to the Internet, customers are advised to install anti-virus and firewall software to prevent hackers from interfering with their computers. Customers have the choice of buying suitable software from the network operator or a computer supplier. It is also suggested that they encrypt sensitive information before sending it over the network because, although it is difficult for an eavesdropper to extract individual communications from the Wi-Fi radio signals, it is not impossible.

Small businesses can obtain a grant of up to £700 (≈1085) from the Remote Area BroadBand Inclusion Trial ([RABBIT](#)) to cover the fees for the first 12 months of the premium or enterprise services.

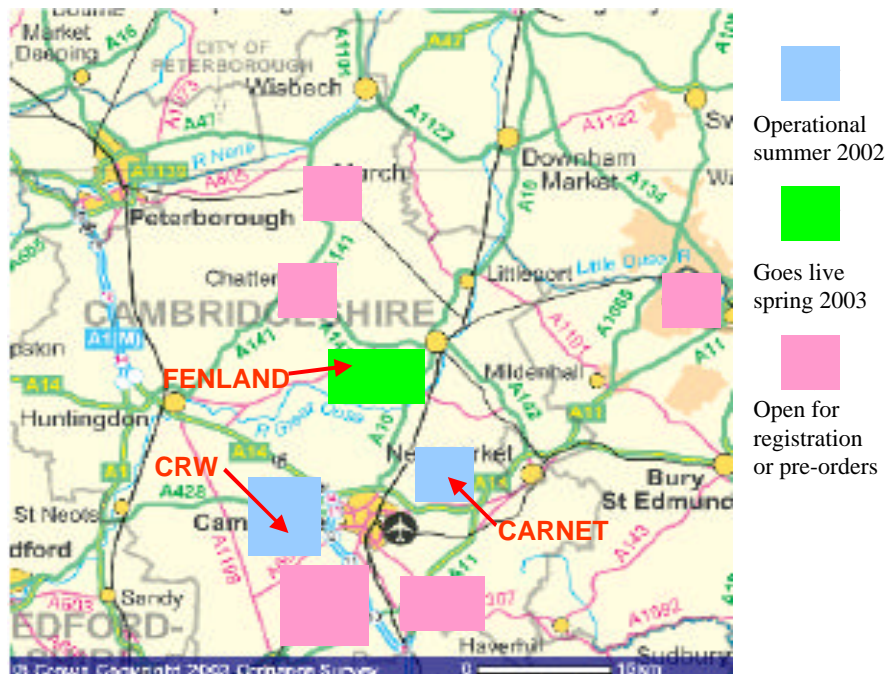
The achievements to date

The first two networks of the Cambridge Ring ([CARNET](#) and [Cambridge Ring West](#)) have been operational since the summer of 2002. CARNET is based in the village of Bottisham, about 10km north east of Cambridge, and is also targeting customers in eight smaller villages within a few km of the network node. The Cambridge Ring West (CRW) is based in the villages of Caldecote and Hardwick, about 10km west of Cambridge and aims to serve about

15 smaller villages on either side of the main road from Cambridge to St Neots. CARNET and CRW had a total of 140 customers at the end of 2002 and the networks are now expanding to provide coverage to the villages surrounding the original hubs.

A third network, covering [Fenland](#) villages to the west of Ely is at an advanced stage of construction and is expected to go live in the spring of 2003. Invisible Networks say that, as of the end of 2002, they had around 200 firm orders for these three networks and upwards of 1,000 expressions of interest from potential customers in villages that will eventually be served by them. Five further networks are being planned and active marketing campaigns are under way to raise awareness and encourage potential customers to register interest in the service.

The break-even point of the business model is about 6% of the 2000 to 3,000 potential customers covered by a network hub. In the first few months of service, the active nodes of CRW signed up 5% of the customers covered and the target is to increase this to 25% over two years.



Invisible Networks projects around Cambridge

Conclusions

The ‘Cambridge Ring’ projects demonstrate how affordable broadband services can be delivered to medium and small rural villages using Wi-Fi (IEEE 802.11b) technology. An important element of the business model is identifying and stimulating demand by means of an active marketing campaign within and involving the local community. The technical solution uses widely available, and hence low cost, equipment and is scalable from dozens to hundreds of customers.

Grants from Regional Development Agencies can help with the start-up costs of an organisation to deliver community broadband services but the business and technical models are designed to deliver networks whose costs are fully covered by the revenues from services.