AFTER THE TV SIGNAL ARRIVES AT THE MAIN STB, IT OFTEN BEGINS ANOTHER JOURNEY AROUND THE HOUSE OVER NETWORKS AND DEVICES THE PLATFORM OPERATOR HAS NO CONTROL OVER. THERE'S A SURPRISING NUMBER OF COMPETING APPLICANTS FOR THE HOME NETWORKING TASK. ACCORDING TO PHILIP HUNTER, OPERATORS ARE TAKING A TWIN TRACK APPROACH TO HOME NETWORKING

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Like it or not, operators must tackle the home network to satisfy growing demand for multiroom TV and services that combine video, broadband Internet and mobile telephony. In the US, many operators already distribute HD TV within the home, mostly over coaxial cable, but Europe is lagging at least two years behind, both in consumer demand and availability of broadcast services, even if many operators do route broadband Internet over WiFi, and occasionally powerline, Ethernet, or, in a few cases, telephone wiring.

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- PAUL O'DONOVAN, GARTNER

Such services allow operators to gain expertise in home networking and test the waters for future broadcast services. There is, though, a reluctance to take the plunge through fear of high installation and maintenance costs, along with the issue of ensuring adequate QoS (Quality of Service) within the home network where broadcast traffic has to coexist with unmanaged data flows between PCs and the Internet, for example.

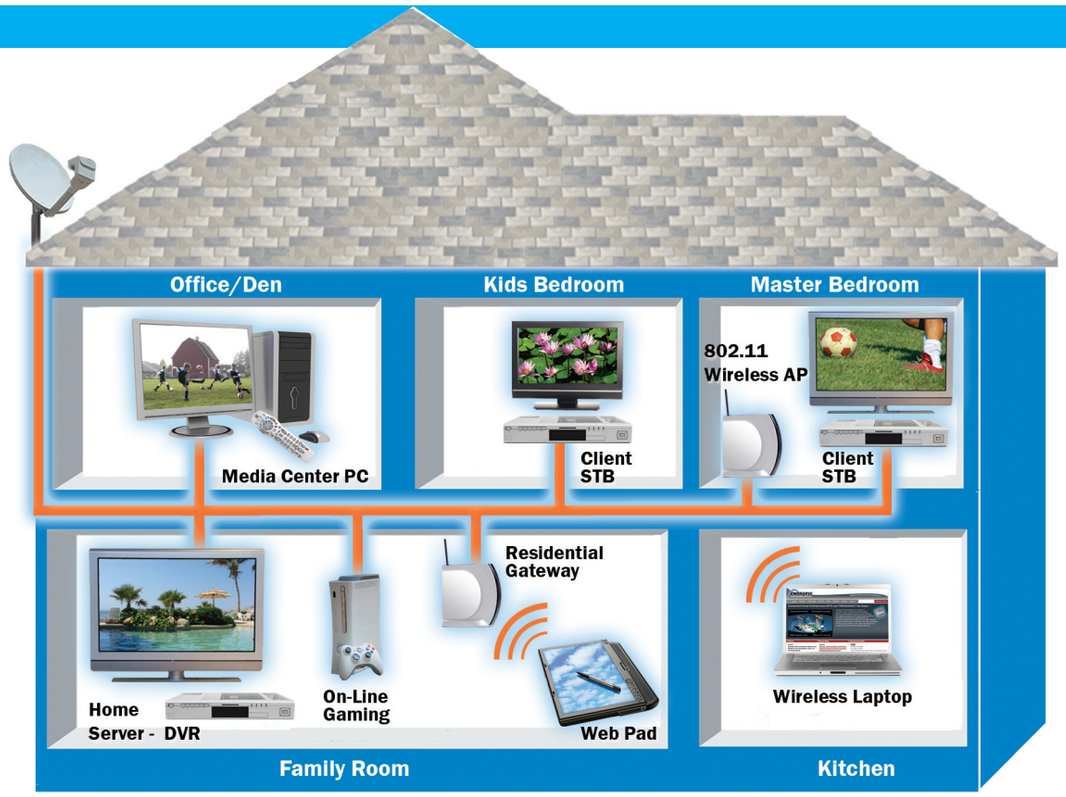
Virgin Media is a case in point, enthusiastically peddling its NetGear WiFi router and Ethernet options for home networking, but with no announced plans yet for TV. Virgin Media has yet to decide which home networking options to support as its broadband service converges with TV, and was considering several of the options, according to Kevin Baughan, director of technical strategy. "As demands on bandwidth increase around the home, we'll be careful in picking technologies that support this and ensure our customers get the best experience in terms of support and security," said Braughan.

HOT WIRED. The problem for Virgin Media is that the UK has no obvious leading contender for wired connections within the home, unlike the US where coaxial cable is widely installed and available even to satellite and terrestrial operators. This immediately makes home networking of broadcast TV far more appealing, since coax is already known to be suitable for video distribution, with plenty of capacity, and relative immunity from interference. In the UK and some European countries, many homes lack coax, leaving telephony wiring as the only immediately available communications option, and its coverage around the home tends to be patchy. It is against this background that interest has grown rapidly across Europe in wireless and especially powerline options.

Only a few operators yet consider any wireless technology fit for distribution of broadcast quality video within the home, and most are adopting a twin track strategy, according to Paul O'Donovan, principal research analyst at the Gartner group: "Home networking will be based on solutions that combine wires and wireless technologies," he said. "For reliable video distribution around the home, wires offer the best solution, and for mobile devices a wireless capability in-house will offer the best versatility for consumers." These two networks are likely to converge on a single gateway device, which will provide the link between the operator's own managed domain and the uncharted territory of the home network.

The gateway is a major subject in itself, but the first question, perhaps, is which of the options to choose for both the wired and unwired component of the home network. The choice for the former is as wide as ever, with the most suitable option varying by country, and little sign of a clear leader emerging among either operators or analysts. The main ones are:

- Coax cable similar to that used in cable TV HFC (Hybrid Fibre Coax) networks
- Twisted pair telephone wiring, using standards developed by the HomePNA Alliance
- The electric power cables, with standards from the HomePlug Powerline Alliance, Universal Powerline Association (UPA), and IEEE.
- Commercial grade Ethernet, typically using Category 6 cabling supporting gigabit speeds, although sometimes



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Category 5 or 5e.

Fibre is not used in the home because it is too expensive, its high bandwidth is not needed over such short distances, and, in any case, it would have to be connected to copper for the final hop to each device.

CLEAN SLATE. These four main options each have pros and cons, depending on which is already installed and the extent of its coverage within the home. Just about the only point of consensus around the world, and between the various protagonists, is that Ethernet is the best option if you are starting with a clean slate, or rather an empty home. This point is conceded even by Anton Monk, CTO of MoCA (Multimedia over Coax Alliance), promoting standards for coax in the home. "Ethernet is ideal," said Monk, admitting that if everyone had gigabit Ethernet ports in their bedrooms his organisation would probably not exist.

A similar point was made by Francis Henry, solution marketing manager for network management and home devices at Alcatel-Lucent, who also argued that most operators will go for an overlay network combining WiFi for broadband Internet with one of the wired options for broadcast TV. "Ethernet will be a good option in those homes where new wiring is required," said Henry, adding that this could be new buildings or existing ones without any adequate cabling at present. However, operators can save money by exploiting existing cabling even when some additional wiring is required, according to communications research firm In-Stat. Although significant costs may be incurred by having to visit a house to extend an existing coax or phone wire network, it will still usually be cheaper than putting in say category 6 cabling for Ethernet throughout a house, according to In-Stat analyst Joyce Putscher. One point here is that category 6 cable is expensive anyway, but on the other hand, all concerns over capacity and interference would be ended. The question then is whether the other options are sufficiently robust and future proof, and this is where all the arguments begin.

Alcatel's Henry suggested that either coax or powerline were the best options if the cost of Ethernet could not be justified. Gartner's O'Donovan agreed that these would be the two most favoured options. However, Dharen Ells, product manager at leading networking equipment test vendor Spirent Communications, suggested that, apart from Ethernet, HPNA and MoCA presented the most reliable home networking options, while providing enough bandwidth to deliver high quality IP Video. "In addition to reliability

"THE HOME GATEWAY SHOULD BE A SINGLE BOX WITH NETWORKING CAPABILITIES, MANAGEMENT, AUTHENTICATION, SECURITY, AND VOIP SUPPORT. IT DOES NOT RUN APPLICATIONS."

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and bandwidth, the embedded base of coax, Ethernet, and twisted pair already in the home where the service is to be deployed is a big factor," said Ells. This last point is significant, for while coax is on most independent lists of suitable options, it, like Ethernet category 5 or 6 cabling, is not always there already. This is where powerline scores, for by definition any TV or other device that is not battery powered has to be plugged into the mains.

PLUG AND PLAY. The great attraction of powerline therefore is that no new wiring needs to be installed – it should quite literally be plug and play. However, it has proved challenging to deliver the required QoS within such an electrically noisy environment, requiring isolation of the low voltage communication signals from the high voltage power. This has led some vendors and chip makers to plough their own furrow in the belief that they have developed superior algorithms and can steal a march on competitors. This is the case with DS2, the Spanish pioneer of powerline technology, which has announced availability of a new chipset, called DE21P, operating at 200 Mbps, claiming this will allow makers of STBs, home gateways, PCs and other devices to differentiate their products with a more compact, manageable and higher performance version of powerline than competitive versions. Several leading vendors of routers and other home networking equipment, such as Logitek, NetGear, Buffalo, and D-Link, have taken the bait, as have some operators. Telefónica adopted powerline Ethernet adapters based on earlier DS2 chips in 2005, while BT Vision has specified products based on the latest DE21P chips for the self-install version of its IPTV service.

DS2's success has resulted not just from being early to market, but also through addressing two primary concerns operators have over home networking – QoS and manageability. QoS support is essential to avoid being tainted by poor quality within the home, while remote management is necessary to reduce ongoing support costs. On the QoS front, most vendors of home networking products will support the key standards, notably the IEEE 802.1d type of service flag, which allows QoS tags to be set within Ethernet data packets. This enables video streams to be prioritised, in the hope that all the packets are delivered on time to avoid artefacts with the picture or sound. But DS2 goes further by allowing traffic to be prioritised on the basis of any part of an Ethernet packet, not just the prescribed 802.1d flag. This confers much greater flexibility, since the network can adapt to changing QoS requirements and set priorities on the fly, rather than only when the IEEE 802.1d flag has been set by the operator.

DS2 goes further still by supporting the so-called Class of Service (CoS) capabilities. Whereas QoS simply decides which channels or data streams should have priority, CoS defines specific values for bandwidth, latency, and jitter (variation in delay between packets) according to SLAs (Service Level Agreements). This enables the home network to set aside the required bandwidth, say for a particular channel, and perhaps inform the user or operator if this guarantee cannot be met. Appropriate action can then be taken, such as restricting the data rate for a channel deemed less important.

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GOLD STANDARD. For management, DS2 has integrated the DSL Forum's TR-069 management stack in its chip, which avoids the need for a separate external processor, and facilitates tighter remote control over the home network, while reducing complexity and power consumption. TR-069 is becoming a gold standard for home networking among IPTV operators at least, because it allows the use of standard protocols already established for managing devices such as routers and STBs attached to DSL networks.

Existing network management systems can be used for configuration, troubleshooting, and remote software upgrading.

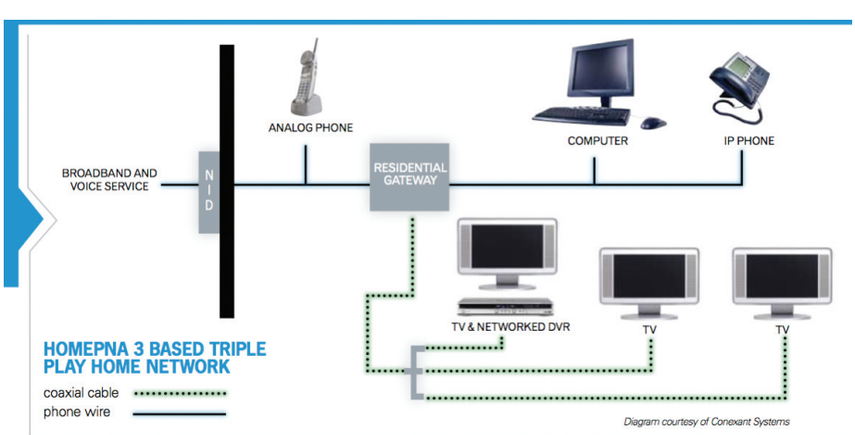
Despite such successes, the overall impact of powerline is still jeopardised both by lingering concerns over coverage within the home, and fragmentation of standards. On the coverage front, some domestic power networks, notably in the US, are split effectively into two, which means that some of the power sockets are beyond reach of the signals. Powerline works by taking in signals from the external network via a modem, which in turn is connected to the nearest power socket. Then devices access the signals via other power sockets in the home, so the only recourse if the network is split would be to install a second modem, which partially defeats the object of having a solution designed to avoid need for additional cables or equipment. In many cases though, especially in Europe, powerline can reach most power sockets within the home.

The standards situation is confusing with three groups, HomePlug, the IEEE with its draft P1901 standard for broadband over Powerline, and the Universal Powerline Association (UPA), which has in essence adopted the DS2 chipsets. However, this is really just two standards, since the IEEE decided to back the winner of the contest between HomePlug and UPA, representing effectively a US/European split as with so many aspects of TV distribution over the years. HomePlug 1.0, the first version of the HomePlug standard, runs usually at 14 Mbps and is fast enough for many current home networks, while some 1.0 products have been extended to 85 Mbps. Then the latest HomeplugAV version runs at 200 Mbps, matching the UPA standard as implemented by DS2 over powerline.

BIG ISSUE. These standards do not coexist, which means operators have to choose between them. This is not such a problem for deployment since operators can select the standard appropriate for the country, although it is advisable to avoid even mixing different versions of one standard, such as HomePlug 1.0 and AV, given the disparity in speed. The bigger issue though, is that this divides the powerline community and reduces economies of scale. The IEEE voted to support HomePlug rather than UPA, and the former does look set to gain the ascendancy outside Europe given the support of major vendors such as Cisco and General Electric.

The other three wired options, coax, phoneline and Ethernet cable, present a more united front. It is true there are two standards for coax, one from MoCA and one from the HomePNA, but the latter is aimed mostly at telco IPTV services addressing markets where both phoneline and coax are available for home networking, notably the US. It does not really address the cable TV market, because it is not compatible with DOCSIS, which means that devices would be unable to access broadband Internet or future video over DOCSIS services via a home network. However, the support for coax has led HomePNA to some big wins in the US, having been adopted by AT&T for its U-verse IPTV service, which had 400,000 customers by April 2008, with plans to extend this to one million by the year end. The phoneline version is most widely deployed for distribution to apartments within Multiple Dwelling Units (MDUs).

Meanwhile MoCA's happy hunting ground is among US cable MSOs, given its compatibility with DOCSIS, and the fact most homes are wired with coax already. A major factor in its appeal is the high outlet coverage, according to MoCA's Monk, with 97% of coax sockets being capable of receiving service without any rewiring needed. This, he insisted, was much better than for powerline or HPNA, although, of course, Ethernet, if installed on category 5 or 6 cable, usually gives 100% coverage. The main problem for MoCA, as Monk conceded, lies in gaining traction outside the US. "There's plenty of coax in Germany, but we haven't had much luck there," said Monk, who nevertheless insisted that MoCA was gaining some attention in Scandinavia, Benelux, and even parts of France.



COPPER PAIR. HPNA has faced similar problems penetrating Europe. Even though phone lines are ubiquitous, powerline has gained a much stronger foothold in Europe than elsewhere, while HPNA for a while looked like falling completely by the wayside. Indeed, the resurgence of HPNA has been one of the surprises in home networking over the last year or two, showing once again, as earlier in the enterprise Ethernet field, how technical ingenuity can overcome

apparently insurmountable QoS problems posed by unshielded twisted pair copper wires.

The latest version, HomePNA 3.1, supports 320 Mbps and can deliver reliable user throughput of 220 Mbps, according to Richard Nesin, president of HomePNA and marketing VP at maker of phoneline chipsets Coppergate Communications. However, in some cases additional wiring is required either for coverage of the home or where existing wiring is of insufficient quality. And all is not quite what it seems, for as Nesin admitted, the majority of home networks based on HomePNA at present run over coax rather than phoneline, given the former's prevalence in the US.

Meanwhile CopperGate recently acquired the HomePlug business from chip maker Conexant Systems, indicating that it does not expect to see many home networks based on phone wiring in Europe either. But at least CopperGate could put a positive spin on the acquisition, for it means its chipsets can now support the three principle options for existing wires in homes, and the company is well placed to exploit a major new unifying initiative in the field, called G.hn from the ITU-T (standards body of ITU, International Telecommunications Union). The acronym stands roughly for next generation gigabit home networking standard, with the target end product being a single chip that can be used to transmit over any of the three wired options just mentioned and possibly gigabit Ethernet as well.

WIRED SUPPORT. The arrival of G.hn will also stimulate development of universal gateways capable of supporting all the wired networking types. The gateway will be critical for operators, facilitating visibility into, and management of, the home network itself and the devices attached to it. There is some debate over what form the home gateway should take, over whether it should be a universal or distributed modular device, and also if it should run applications or just support management and service distribution.

It should be a highly integrated device but confined to the provision of broadcast services, according to Paolo Pastorino, CTO of the Home Gateway Initiative set up in 2004 by telcos to develop common specifications, joined subsequently by some major vendors such as Microsoft, Philips, Motorola, and NetGear. The Home Gateway should be a single box with networking capabilities (WAN and LAN side), management, authentication, security, and VoIP support," said Pastorino. "It does not run applications (i.e., it is not a media player or STB)."

But Alcatel-Lucent's Henry differs, believing that a single ubiquitous box will appeal to both consumers and operators, which means the gateway will incorporate all functions within the home. "We see master Set Top Box functionality coming in the home environment for integration in the residential gateway, with slave STBs co-located with the TV sets in multiroom deployments." Henry also believed that content and storage applications, as well as "smart home" services such as home automation, security, remote metering, and personal health, would reside in the gateway.

ONE SIZE. Gartner's O'Donovan reckoned such a device would be unwieldy and expensive, and that a modular architecture would be more likely, given the growing diversity of applications, and variation in requirements between different homes and countries. There is also concern over a universal gateway becoming a single point of failure. Such divergence of views suggests that there may not be a single 'one size fits all' approach to the gateway, anymore than for the home network attached to it.

But on one point all are agreed; that the home gateway will be supplied by the operator, like an STB, rather than purchased from a store by the consumer, like many WiFi routers. "Most IPTV operators are likely to want the gateways/network equipment to come directly from them," said Richard Broughton, analyst with media entertainment research firm Screen Digest. "Whilst there is no real reason that third party systems could not be used by the consumer, they are unlikely to be supported by the operator, which would find it impractical to provide customer support for all of the different systems out there."

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MOCA

As well as the wired options, the gateway will have to cope with wireless, and perhaps not just for broadband Internet. There are signs that wireless, like HomePNA, may have some tricks up its sleeve, so that it may not remain confined to broadband Internet access. Here, as in powerline, transmission difficulties have led to proprietary technologies designed to overcome obstacles and interference.

HOME HELP. Much excitement recently has been generated by Ruckus Wireless, based in California, although its greatest success so far has been in Europe with several deployments for IPTV in the home. Belgacom, for example, uses the Ruckus MediaFlex NG WiFi system for the self-install version of its IPTV service. Then, in November 2007, Deutsche Telekom's T-Home division announced it would be using Ruckus products for wireless home distribution of its Entertain Comfort IPTV service.

The key to Ruckus' success is smart antennae MIMO (Multiple Input Multiple Output) technology, which uses focused radio beams whose direction can be altered dynamically in response to changing air conditions or to bypass obstacles. The technology is incorporated in a chipset called BeamFlex, which generates large numbers of individual beams, each of which can be redirected in response to feedback from its environment, to create the optimum'virtual antennae pattern'. In effect this is dynamic spatial multiplexing, dividing streams over varying multiple paths. BeamFlex uses MIMO to enhance the existing WiFi standards, that is 802.11a/b/c and in future 802.11n.

But while it holds great promise, performance still tends to vary, with some parts of a home receiving better QoS than others. But it does suggest that over time wireless will become a serious contender for distributing video within the home. Meanwhile, although the shape of the future home network and gateway may remain unclear, momentum is building fast.