Development of Integrated Cable/Telephony in the United Kingdom

U.K. cable/telephony operators have been given the unique opportunity to be full-service providers with the infrastructure they build. Operators are taking full advantage of this opportunity to deliver video, voice, and data services over a competitive infrastructure.

Chuck Carroll

The United Kingdom offers franchised cable television operators the unique opportunity to provision competitive telephony service in addition to multichannel television services. TeleWest Communications Group Plc., a joint venture between Telecommunication Inc., (TCI), and U S West, have taken advantage of this opportunity to invest, operate, and assist in the operation of CATV/Telephony in the United Kingdom. TeleWest owns or invests in 24 franchises, totalling approximately 3.6 million homes passed. Twenty-one of the 24 franchises wholly owned or invested in by TeleWest are presently offering competitive telephony as of the end of 1994. Others are set to start in the 1995-96 time frame.

This article discusses the development of network architectures in support of TeleWest's cable/telephony opportunities in the United Kingdom. The article begins with an account of the history of U.K. cable/telephony, continues with the early developments and drivers of the architecture, discusses the current architecture and build, and concludes with an overview of future development and directions for the architecture.

Early History

Development of cable television in the United Kingdom in it's current form began in the early '80s. The U.K. Government's intention was to see cable television infrastructure and services brought to the public by privately funded companies servicing small, local, geographic areas called "franchises." Franchises were granted by the government in a bidding process, structured to fairly distribute the franchise areas to investment groups that want to build and deliver cable television services. Government-licensed operators through regulators, as well as using the regulators to monitor important license conditions, particularly conditions associated with progressing the build in a timely manner. Knowing the investment to provide the infrastructure would be significant, the government gave winners of the franchises the advantage of a window of opportunity under which they would be the sole provider of broadcast entertainment services via terrestrial delivery systems in the franchise area.

In addition to the delivery of cable television services, early shapers of regulation envisioned cable networks not only as a delivery mechanism for multi-channel television services to the public, but also as a competitive local infrastructure for telephony and data services to the newly privatized British Telecom (BT). Licensing and regulation were structured to allow cable operators the opportunity to put telephone and data services on the cable television infrastructure. Fully realized, this would accomplish the government's aim of bringing competition to all parts of the telephone network, as well as allow cable operators the potential for other revenue streams to help offset the high cost of constructing the network presented to them by the requirement to put all new plant underground.

From 1989 through to 1991, the U.K. Government completed the process of letting out the remaining of the 135 cable television franchises, completing the initial coverage area of approximately 15 million of the 22 million total households in the United Kingdom Also in 1991, the U.K. Regulatory regime reviewed the competitive structure for telephony operators which had been in effect since the privatization of BT and the introduction of competition in the early '80s. This review culminated in, among other things, a lifting of the duopoly restrictions on cable/telephony operators, allowing them to become full Public Telephone operators (PTOs) in their franchise area. Other important outcomes from the review for cable/telephony operators included issues such as insuring rights to interconnect for new operators, methods for dealing with competitive issues operators could not negotiate commercially, powers and structure under which the regulator could control dominant operators in aid of creating a competitive commercial structure, as well as setting the structure and timeframes under which the existing dominant players could potentially enter the broadcast television delivery business in competition with CATV franchise operators through bypassing the franchising structure used for cable operators, and using their existing national

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0163-6804/95/$04.00 1995 © IEEE

	TeleWest	Industry
Total franchises	24	135
Total homes	3.5M	15M
CATV homes passed	1.54M	4.2M
Telephone homes passed	1.28M	N/A
Cable subs today	320K	907K
Telephone exchchange lines today	320K	717K

■ **Table 1.** *U.K. cable/telephony statistics (as of December 31, 1994).*

networks in place.

Since the completion of the franchising work, and the formulation of an acceptable and consistent competitive structure put in place via the Duopoly Review, many new cable/telephony operators have begun to commit and spend the massive amounts of investment required to build the networks which will be used to deliver both cable and Telephony services. Current statistics for TeleWest, and the cable/telephony industry in the United Kingdom through the end of 1994 are contained in Table 1.

Network Architecture Development

In the early days of development, practical business realities and constraints, incorporating the "real world" business drivers provided the parameters under which initial network architecture decisions occurred. Starting the build quickly, as well as making sure the build could progress in a timely manner, were important early drivers. During the franchising process, winning bids contained timeframes for starting the build, usually within six to 12 months of the award of the franchise. Bids also contained year-by-year milestones for progressing the build, generally in the tens of thousands of homes passed per year, as well as an end date for the build. These dates formed part of the judging process in selecting the franchises with the deployment milestones monitored by the regulator, who has the power to revoke the franchise if progress is not in line with expectation. These expectations of sticking to what were generally aggressive start dates and build schedules moved operators to seek out and value network architectures which could start quickly, and could be built out to large numbers of homes in line with the milestone requirements.

Commercial and economic drivers also played a part in the network architecture development. As these were profit-making ventures funded by private investors, the network design had to be cost-effective, and assist the overall business venture in bringing a reasonable return in investment to the partner groups. Adding to the difficulty of this was the fact that licenses insisted that all plant be in duct in the underground environment. As the majority of the network costs ultimately would be to dig the streets and put the physical duct and cabinet structure in place, achieving cost savings in the build required an architecture that minimized costs as much as possible in this particular area.

Competitive drivers also played a role in network architecture development. As operators would be in a fully competitive marketplace with the new infrastructure and services, the network architecture had to produce a highly available and reliable network. Customer expectations as to general quality of telephone services are already set, and to be an Operator in a competitive environment of a displacement telephone service (i.e., a service the customer would use as their sole fixed telephone line in the home), this expectation must be met or exceeded. Focus on the service capability would be important, as well. In the early days, services were expected to be simple, dial-tone type services with limited features. As the business developed, however, competition would drive the broadening of the types of services needed to be delivered on the architecture. It was important, then, that the architecture evolve gracefully and cost-effectively to add new services as they were required in the future to meet competitive threats.

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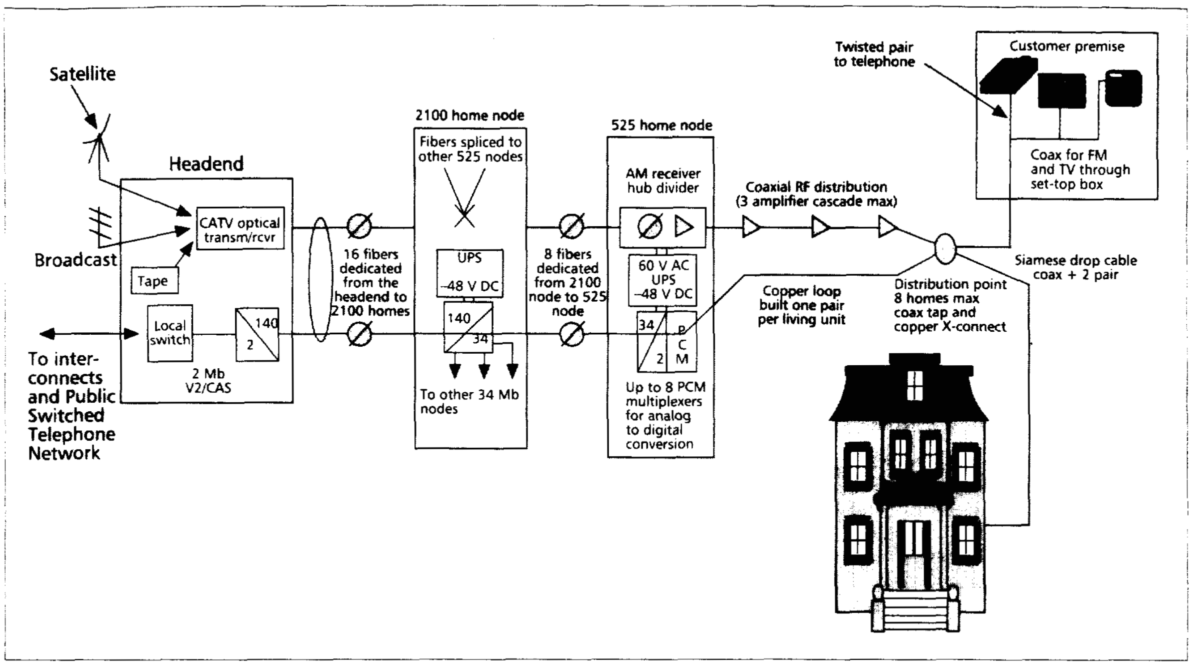
Network Architecture Choices

As the initial work on network architecture began in 1989, existing network architectures integrating the delivery of CATV and telephony service were only in their very early stages of development world-wide. Integrated Fiber to the Home/Kerb (FTTH/K) architectures, as well as techniques which integrated the telephony into the Hybrid Fiber-Coax (HFC) infrastructure commonly used by cable television operators, were both looked upon as possible alternatives for network architecture in the pre-build days. As few areas had previously provided operators with the regulatory freedom for operators to be in both the Broadcast Entertainment and Local Loop Telephone delivery business, because in the United Kingdom real demand for these types of systems, and hence the development of truly deployable commercial products of these types, had been lacking. Even with all the hype existing at the time about the future of integrated structures delivering all services to the home on a common wire, none of the integrated delivery mechanisms of the day were production models ready for use in the British marketplace in time, in sufficient quantities, and at mature enough price levels, to support the franchise builds contemplated.

The only "architecture" available, which met the practical business realities and constraints detailed above, was a simple Digital Loop Carrier (DLC)-based telephone overlay on a standard CATV HFC broadband delivery to the home network. This combination of these two separate but commonly deployed architectures into a common infrastructure build, although certainly not achieving the desired level of network integration, had the capability to be designed and built in such a manner that it would meet the initial network architecture needs of generally being quickly deployable, economical, flexible, reliable, service/interface rich, as well as have the ability to be designed to easily evolve into the more forward looking technologies/architectures of the future.

Current TeleWest franchise architecture, utilizing the DLC overlay technique for telephony, and the HFC for broadband delivery, is outlined below.



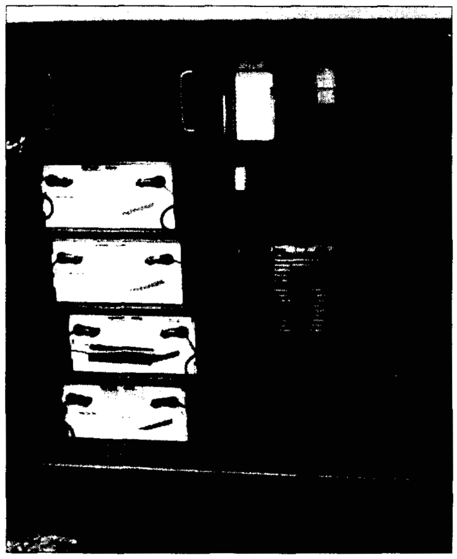
■ **Figure 1.** *TeleWest Network Architecture; broadband CATV and telephone overlay.*

Generic Franchise Network Design Today

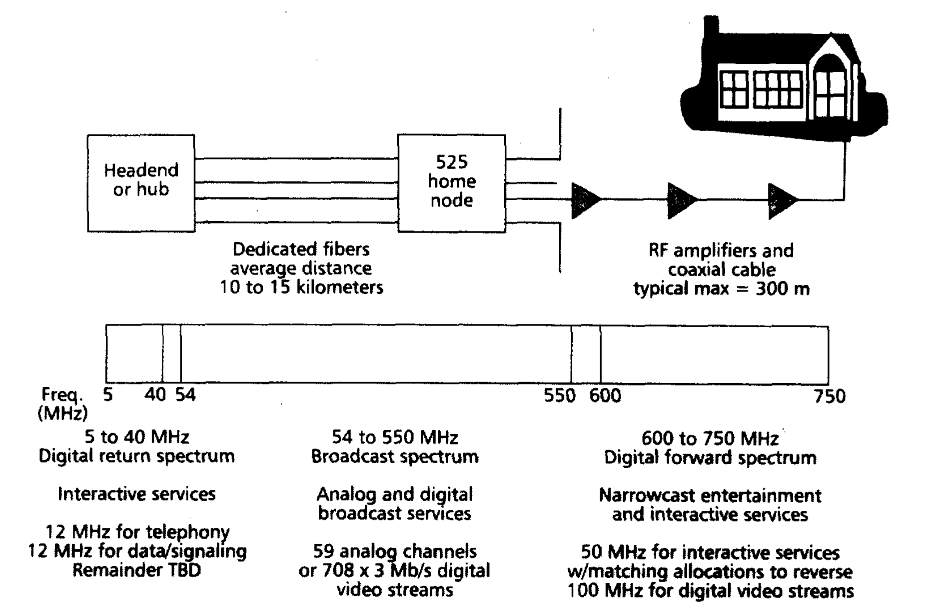
Figure 1 gives a diagrammatical representation of the incremental telephony network design presently being used in TeleWest owned and operated franchises. The network plans to meet an initial starting telephone penetration of 25 percent of homes passed, with network capability to gracefully increment to approximately 50 percent penetration in any given node with-in the in-place cabinet structure. Addition of capacity beyond about the 50 percent telephone penetration can be accomplished through addition of cabinets. The CATV network is initially capable of achieving 100 percent penetration for broadcast entertainment and information services, as each address is served with a port off of the HFC bus structure in the coax portion of the distribution network.

The network starts in the headend/exchange. There sits local telephone switching equipment, as well as standard CATV headend equipment. Connection from the distribution network to the lineside of the switch is via 2.048 MB/s circuits utilizing a proprietary form of V2 type Channel Associated Signaling (CAS). All TeleWest telephone lines switch through our own local switch.

■ **Figure 2.** *2000 home node cabinet (MM).*



■ **Figure 3.** *RF/power cabinet at 500 home node.*



■ **Figure 4.** *TeleWest HFC architecture with current spectrum allocation.*

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interconnecting with other carriers (i.e., BT, Mercury, etc.) for access to the broader Public Switched Telephone Network (PSTN) via standard Operator-to-Operator Signaling System 7 links.

The current distribution network architecture moves away from the headend on fiber optic cables, making use of standard DLC techniques for moving telephone signals on fiber optic cables, and standard VSB-AM transport techniques for moving video and entertainment services on a fiber optic cable. For the telephony service, 140 Mb/s pipes transport from the headend/exchange out on fiber to serving areas in the franchise. The node, serving an area with a 140 Mb/s pipe, is a Major Mux (MM) node (shown in the photo in Fig. 2) typically serves approximately 2100 homes passed in TeleWest's owned and operated franchise group. A minimum of 16 fibers route to each MM node from the headend/high density node. Nine of the these fibers patch through directly to the three 525 home nodes that are not adjacent to the 2100 home node, to meet the broadband network requirements. Three of the fibers feed the broadband network requirements of the colocated 525 home node. The other four fibers meet the needs of the overlay telephone network. The MM node typically resides in a street-side cabinet, with physical diversity of fibers to this particular node planned for initially, and implemented over time as the rest of the network build progresses. The 140 Mb/s pipe in the node breaks down to electrical 34 Mb/s pipes at the MM node. The 34 Mb/s pipes are cross-connected to 34 Mb/s OLTE cards, and fiber cables then take the 34 Mb/s pipes optically on to the next node in the network, the Secondary Mux (SM) node.

An SM node consists of the serving area of approximately 525 homes passed, with eight fibers dedicated to each SM node from the MM node. Three of these fibers transit the broadband network signals through the 2100 home node to the 525 home node, as described above, while two of the fibers deliver the overlay telephone network requirements between the MM node and the SM node. For CATV, the SM marks the conversion of the broadband signal from optical to electrical, for continued distribution to the home via a coaxial network (see photo in Fig. 3). The three fibers used to the SM node for CATV purposes carry three different parts of the spectrum. One fiber carries the forward broadcast spectrum (50 to 550 MHz). As it contains broadcast content only, it has no association with any particular node size, with the laser feeding it split as many times as possible to save cost. The other two fibers provide dedicated bandwidth between the 525 home node and the headend, in the forward direction from 600 to 750 MHz, and in the reverse direction from 5 to 30 MHz today, and 5 to 40 MHz in 1995. This bandwidth is specifically reserved and allocated for use with digital signals going between the node and the headend. Figure 4 contains a diagram, with spectrum allocation, of the 525 home node. The build away from the fiber hub is a standard CATV tree-and-branch (i.e., bus-star) coaxial cable distribution network to the home. TeleWest owned and operated franchises place four fibers to the 525 home node from the headend, with the remainder of the network from the 525 homes passed level built as "tree-and-branch" bus structured coaxial distribution. Building away from this 525 home node is a standard coaxial distributed tap architecture, using predominately four- and eight-way taps as the last distribution point in the network. All taps construct below ground, helping keep construction costs at their minimum, as well as minimizing the disruptive effect of street furniture (above ground cabinets) in the community.

For telephony purposes, the SM node resides in a street-side cabinet, with the 34 Mb/s pipe delivered to the node from the Major Mux node multiplexed into it's 2 Mb/s bearers. The 2 Mb/s

Increasing capacity to meet increasing service and capacity demands in an HFC network is accomplished through a continual process of subdividing nodes.

bearers then, on an as needed basis, connect to a multiplexer, breaking down the bearer into groups of 30 voice or 64 KB/s channels. The individual voice or data channels cross-connect, via copper jumpers, to terminal blocks that have copper cables terminated on them. Building from the node to the customer base, a standard paired copper cable distribution network parallels the CATV coaxial network, using the same duct structure. As the distance between any customer and an SM node is generally less than 300 m, the copper distribution network is capable being built from small numbers and sizes of cable. Attached are two pictures of the SM node, one showing the two cabinet structure used to provide this node, and the other showing the power and CATV equipment inside one of the cabinets.

Installation of a customer occurs via placement of a final drop cable. The drop is a "siamese" drop, containing standard RG-6 or RG-59 drop cable, and two 26 AWG twisted pairs. Any customer, regardless of whether they purchase one or both services, gets this drop placed onto their premise at the time of first install. The telephone service terminates in a U.K. "Master Socket," the U.K. equivalent of an RJ-11 in the United States. For the CATV service the final device placed to provide service to a customer is an on-premise set-top device, placed at the customer home. In the United Kingdom, there are few "cable ready" television sets, so every home receives a set-top. In TeleWest franchises, that set-top is fully addressable, allowing us to scramble all channels and activate/deactivate services centrally.

Watching over the two networks is a network monitoring system, which receives and relays alarms associated with all optical and power elements, as well as all telephone electronics in the network. All active elements in the network are battery backed-up, with each cabinet in the network also containing a generator plug, allowing the cabinet to run on an external generator in the event a mains outage in a particular area becomes prolonged. Additional measures to insure network availability includes the deployment and development of both equipment and route redundancy for key network components and cables.

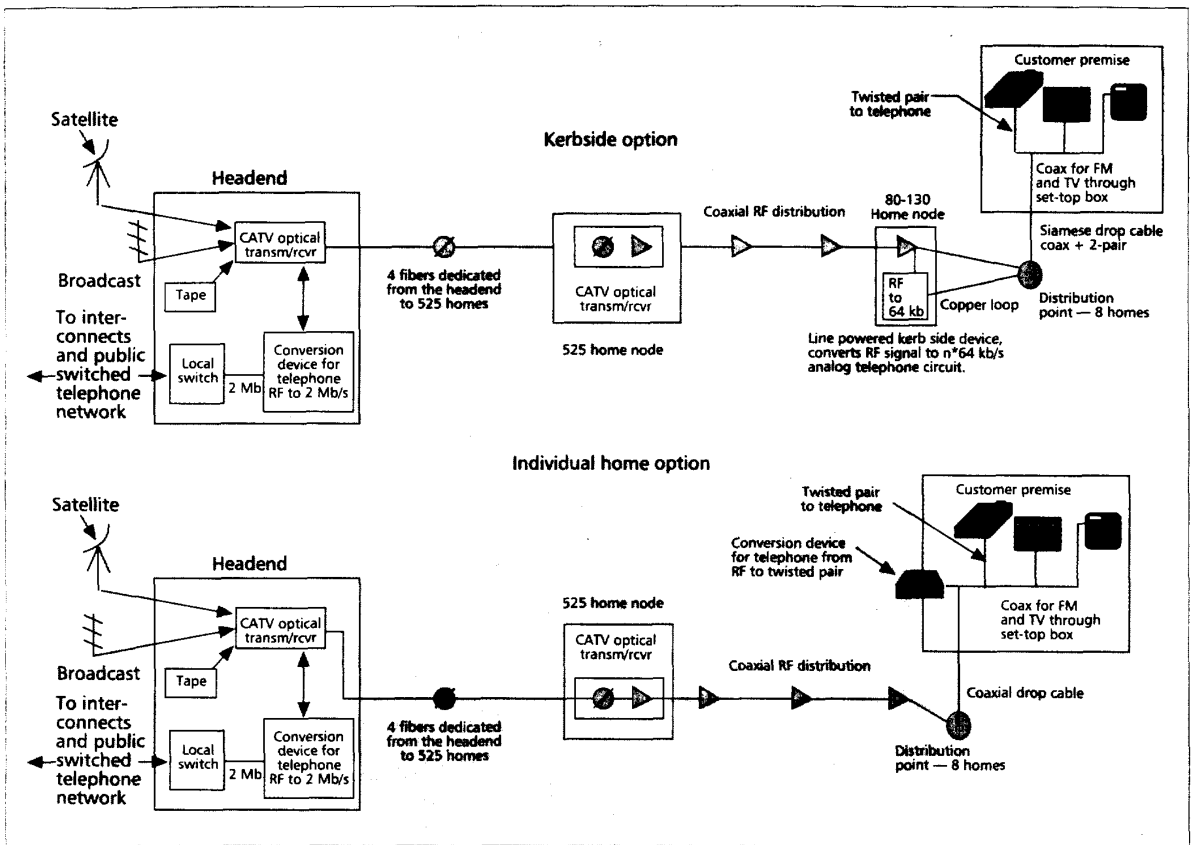
Meeting Future Requirements

The base overlay network has served well in getting TeleWest franchises into business, meeting the initial quality, cost, and service needs in order to enter into the competitive cable/telephony business. The predictable and consistent build rate and cost of the overlay architecture have allowed TeleWest franchises to ramp up to building at a rate of around 500,000 to 600,000 homes passed in a calendar year. Current plans call for build to continue at about this rate for the next couple of years, reducing in the years after as franchises complete.

Going into the future, the HFC structure built today provides the starting point for evolution of TeleWest architecture. Much of the network evolution, both to lower the cost of new network build, as well as to add future services, centers on use of the HFC infrastructure. The reasons for choosing to evolve on the HFC architecture for future capabilities centers on it's superior performance in three specific problem areas for TeleWest. The first is in keeping initial first cost low. HFC architectures, similar to the current TeleWest architecture discussed earlier, give operators the ability to put an interactive broadband network capable of multiple services in place, at a reasonably low initial first cost. Because of it's "bus" structure from the 525 home node into the premise, the HFC network presents a minimal requirement for duct, as well as a relatively low and predictable cost for cable and electronics in the network. This is an important attribute for competitive operators who require low infrastructure costs to keep their service costs low in a competitive market.

The second is the ability of the HFC architecture to be divided up as service type and demand requires. Because the "assignable" commodity in an HFC network for services is bandwidth, and the actual services on an HFC architecture are a function of the devices placed on the ends of the network, HFC architectures allow the operator the ability to assign services and capacity as demand on the network builds and changes, and not at the time the network is actually built. This attribute is important to new operators, as the competitive nature of the business makes forecasting service types, as well as service demands, very difficult. Initial unpredictability can be a problem, as no model exists for predicting expected penetration level for services, or types of services customers may or may not like. Additionally, true competitive drivers occurring after the network has been put in place, can significantly change the service type and demand characteristics, as operators seek to react to competitive thrusts from other operators, or seek to create competitive advantage through bringing new services to market ahead of the competition. In an HFC architecture, because the assignable network asset is bandwidth, new operators retain some capability to meet changing service types and demands through incrementing or reassigning bandwidth, avoiding significant and costly changes to the base distribution network, particularly the expensive to build and change duct structure.

The third is the ability of an HFC architecture to evolve to add capacity without significant changes to the physical duct network. Increasing capacity to meet increasing service and capacity demands in an HFC network is accomplished through a continual process of subdividing nodes, to bring more and more dedicated bandwidth to smaller and smaller node sizes. For example, the first evolution of the TeleWest architecture would be to take the 500 home nodes, and subdivide them into 4 x 125 home nodes. This would mean that the existing dedicated capacity available to a 500 home node, would be available to a 125 home node, in essence, incrementing the capacity by a factor of four. The great thing about this form of incrementing capacity in this manner for TeleWest, is that it can be accomplished through physical re-arrangement of elements in existing cabinet and building locations, and with no addition of cables into the existing duct structure. Subsequent sub-division of nodes would ultimately require some additional cables to be placed, but all foreseeable evolutions should be able to go into existing duct structure. This means movement from the existing HFC structure, to more fiber rich passive optical network (PON) type structures, should be



■ Figure 5. *TeleWest integrated network architecture.*

able to be done in the same cost-effective duct system built to meet the initial business requirements. This ability to evolve capacity and service requirements without future change to the duct infrastructure is important to TeleWest, both in keeping our cost structure low for competitive reasons, as well as for reasons associated with the social and environmental costs of continually digging up the residential streets of the United Kingdom

Use of HFC to Integrate Delivery of Telephone Services

Integrated architectures, carrying the telephone services on spectrum in the HFC network, remain important in our network development. This technique of delivering telephony services potentially solves the problem of bringing telephony to the 150,000 homes passed in franchise areas which we owned which had CATV network and service, but no duct provision for putting an overlay telephony system in place. Integrated delivery techniques also have the potential to save us money in our new build areas where TeleWest are currently building combined CATV and Overlay telephony network plant in the manner described above.

TeleWest focus has been on the study and development of two different types of integrated architectures, one called "RF to the Home," and the other called "RF to the Kerb." Both of these architectural concepts represent TeleWest's best thinking to date as to how a CATV operator can increment telephony onto the Distribution Network at the lowest cost. Each has its strengths and weaknesses as an architecture, consequently each will have particular areas or applications where it will be the favored architecture over the other.

With "RF to the Home," connection of potential customers occurs through the placement of interface boxes at the CATV headend location, and the customer premise location. The customer premise interface box is responsible for converting the telephone signal to and from the subscriber to its digital bit representation, for transport using Quadrature Phase Shift Keying (QPSK) techniques to and from the headend over selected portions of the CATV RF spectrum. The box in the headend is responsible for taking those digital signals from the spectrum in the headend, and manipulating them such that the output bearer to the switch matches the 2 MB/s bearer defined in our current interface specification with the switch. This "RF to the Home" concept, shown diagrammatically in Fig. 4, creates a network where all that exists of the telephone network between these two boxes is the standard CATV broadband network as we build it today.

"This "RF to the Kerb" method similarly transmits the telephone signal as digital bits on the RF of a broadband network today using QPSK, but instead of carrying the signal on the broadband network all the way to the customer's premise, the interface converting the digital signals back to

Percentage:	5	15	25	35	45
Overlay (PMO)	**£1267**	**£487**	**£343**	**£275**	**£230**
RF to the Kerb	£1006	£400	£290	£220	£200
RF to the home	**£307**	**£291**	**£287**	**£289**	**£287**

■ **Table 2.** *Incremental cost per telephony subscriber as a function of penetration (current exchange rate is US$1.60 equals 1 pound sterling).*

analog baseband telephony signals resides out of the premise, in a street cabinet at the kerbside. Twisted-pair cable distribution feeds in an overlay fashion from that interface point in the network, to the customer's home, in much the same way as we build the last 100 m of the overlay network today. Figure 5 shows diagrammatically what this concept looks like. Invention of the "RF to the Kerb" concept was a direct fallout of early problems with the customer reaction to the box in the home used in the "RF to the Home" concept. In a competitive marketplace such as ours, any competitive disadvantage with the incumbent supplier has to be taken seriously, as it will certainly will be exploited in the marketplace. "RF to the Kerb" provided a fallback to the business, such that if the significant "box on the premise" issues associated with "RF to the Home" techniques could not be overcome, their still was an integrated method for delivering telephony on a CATV infrastructure which could achieve the cost savings envisioned.

Economics of Integrated Architecture

As cost savings in new build are an important driver of our evolution to integrated architecture, a great deal of time has been spent evaluating the cost models associated with the different architectures outlined above. Our measure of comparison of alternative architecture costs is incremental "cost per telephone subscriber." The "cost per subscriber" in networks that attain less than 100 percent penetration is a function of "network" costs, typically represented as "costs per home passed" in our plans, and "installation," costs, typically represented as "cost per install" in our plans. "Network" costs are the money spent before connecting any customer, and "installation" costs are the costs spent to connect a customer to the network and bring into them service. The incremental "cost per telephone subscriber" is calculated using the following algorithm:

(Network "Cost/Home Passed"/Penetration Rate) + "Installation Cost"

No duct infrastucture or CATV network elements are included in any of the costs, as they are all assumed to be part of the CATV portion of the plan, in our current financial structure. Table 2 contains a current incremental cost/telephone subscriber comparison of the three different network alternatives.

Overlay and "RF to the Kerb" methods of delivering telephony tend to be very network-oriented. That is why you see the high cost/subscriber at low penetrations, as the network costs spread across a small number of customers yields a high "cost/per subscriber." As penetration increases, however, this slowly increasing network-oriented cost spreads across a greater number of subscribers, bringing the cost/subscriber quickly down. "RF to the Home" techniques tend to be very favorable at lower penetrations, because the majority of the cost is in the device at the premise, which is part of the install cost. The cost/subscriber is governed largely by this premise unit, staying relatively constant across all ranges of penetration. Current calculations for our situation today show that overlay will never reach the levels of cost achieved by "RF to the Kerb," although the gap between the two, on a per-subscriber basis will narrow as penetration gets greater, because both are adding essentially the same electronics to the network to achieve the increased penetration, and just lessening the impact of initial cost savings on the "cost per subscriber" calculation as penetration increases. Similarly, "RF to the Kerb" and "RF to the Home" have roughly equal cost per subscriber numbers, using current vendor price levels and our 1995 plan penetration of 25 percent. If our penetration continues to increase, "RF to the Home" vendors will have to decrease the cost of the box in the home to stay at the same cost per subscriber level achieved by "RF to the Kerb." If penetration lessens, "RF to the Home" becomes the winner, as "RF to the Kerb" then spends roughly the same amount of money across fewer customers.

A straight incremental cost per telephone subscriber comparison does not completely characterize the situation, however. "RF to the Home" also provides some tangible architectural advantages over overlay type architectures which might favor it, even if the price comparison of the two puts "home" architectures at a price disadvantage. Overlay architectures tend to have some dependence on good forecasting to make them cost effective. When forecasting is not expected to be good (as is in our case), overlay architectures compensate by adding cost into the network up-front. We do this in our overlay network through placing a copper twisted pair in the distribution network for every home (i.e., 100 percent penetration), and through building the cabinet, shelf, and card space to be able to take the network to 50 percent penetration with no additional cabinets. This is because even though the aggregate penetration in any franchise is in the 25 percent area today, achieving the actual penetration is through aggregation of many nodes that have higher (up to 50 percent) and lower (as low as 1 to 2 percent) penetration. Because we have no idea up front which nodes will be high penetration nodes, which ones will be low penetration nodes, and which ones will have special circuit needs, design and build of the overlay network occurs in such a way as to easily meet the high-end penetration requirements (i.e., the 50 percent area) in all nodes, to insure that no matter what happens with respect to sales in the area, we can easily, and in a timely fashion, meet our customer requirements.

"RF to the Home" techniques simplify the issues with forecast inaccuracies associated with additional demand, services, and products, mainly because the only distribution network requirement for additional demand and/or services is bandwidth, which is much easier than finding cabinet space, duct space, multiplexer card space, etc. Additional service requirements are just a function of having the bandwidth available, and putting the right devices on the ends of that bandwidth. There is no need to build extra cost into the distribution network up-front, in anticipation of future demands.

From a cost savings standpoint, integrated architectures seem to provide real cost benefits to our business. Which of the integrated architecture options is best from a cost standpoint for our business is still open to debate. Finding the answer to the question of which architecture makes most sense for us in the various opportunities we have which could benefit from integrated architecture, and developing that solution for implementation in our builds, has been a major focus of our integrated architecture development work to date.

TeleWest is currently involved in trial work with both types of products. The "RF to the Home" trial is being performed in the Croydon (South London) franchise, utilizing product supplied by First Pacific Networks. The trial is about to finish its technical trial phase, under which about 75 employees and friendly users have been receiving telephone services using this delivery technique. Assuming satisfactory completion of this technical phase of the trial, a marketing trial of the concept is beginning in August 1995, also in the Croydon area. Should these trials yield a reliable and deployable product and concept, current plan is to take "RF to the Home" concept, and deploy it in 1996 into the 150,000 or so homes which were built before the telephone was envisioned as a service, and do not have the duct space to accommodate an overlay implementation.

TeleWest also have a technical trial ongoing with a version of the "RF to the Kerb" product. The product is supplied by a three vendor grouping, with Hughes Network Systems supplying the RF Modems, NKT Technics supplying the PCM Multiplexing and Network Management, and Alpha Technologies supplying the 60VAC to 48VDC conversion in the "RF to the Kerb" shelf. A 500 home node has been built in our Newcastle franchise, utilizing the "RF to the Kerb." A technical trial phase in the Spring of 1995 connected a limited number of friendly customers. A full 2100 home job area of new build, utilizing the "RF to the Kerb" technique, is now being built. The main interest in this 2100 home job area build will be to confirm whether cost savings over the overlay technique of delivering telephony can be achieved, and, if so, how much. If significant cost savings in delivering telephone services can be achieved, and the viability and reliability of the "RF to the Kerb" delivery technique confirmed, planning would begin on moving franchise groups over to use this, or one of the other "RF to the Kerb" techniques currently being brought to the marketplace.

Future Demand and Interactive Services

As with many others owning or building HFC architectures, TeleWest currently look to the HFC distribution architecture as the delivery mechanism for improved broadcast entertainment products, as well as the new and developing demand and interactive services of the future.

Improvement in broadcast products arise from the order of magnitude increase in channel capacity via digitalization and compression of the video signal. The increase in available channels in the already defined broadcast portion of the spectrum (50 to 550 MHz) from 50 to potentially 500, provides operators with the opportunity to reach niche markets with content aimed at very specific groups and/or markets. Realizing this increased capability is a function of moving existing analog services into the digital domain, clearing spectrum of its analog channels, and placing on that spectrum digital channels, at rates of ten to 12 digital channels per old analog service. TeleWest plan to accomplish this through deployment of digital services alongside existing analog services. Customers will have the option to take a "digital tier" of services, at a price necessary to support the additional cost of placing the new set-top box required to support these new services. Over time, as more take up the digital service options, it is envisioned that more product in the broadcast portion of the spectrum will migrate to digital content. At some point in the future, conversion of all customers to digital services will occur, conversion of the broadcast portion of the spectrum to digital will be complete, and the full 500 to 600 channels of digital capacity in the broadcast portion of the spectrum will be available.

Customers will have the option to take a "digital tier" of services, at a price necessary to cover the additional cost of supporting these new services.

Other new services envisioned by operators on the video delivery side of the business include services which deliver a specific piece of video content to the customer when they specifically request to see it. Because dedicated bandwidth of substantial proportion does exist between customer and headend, these true "video-on-demand" (VOD) services, requiring point-to-point connectivity and communication between the customer and the headend, are now possible. True VOD services cover a wide range of different potential applications, including movies-on-demand, time-shifted, and library access television viewing. Video clip-based shopping, advertising, and information applications where a customer requests specific image-based information would also fit in this genre of products. These type of products could be very important to cable operator's long term success, as they provide the customer with the ultimate control to watch what they want to watch, when they want to watch it.

In addition to allowing customers to control and pay for only desired programs, this ability to provide true VOD on cable networks is a competitive advantage over Direct to Home (DTH) delivery via satellite. DTH has provided cable television in the United Kingdom with significant competition as a delivery mechanism since the very early days of cable. But DTH, because of its footprint (generally continental in geographic area), will never be able to achieve the proper channel capacity to node size ratio required to provide true VOD services like those mentioned above. Hence, narrowcast demand oriented services have the potential to provide cable operators with a competitive advantage over DTH when they become available. Current TeleWest spectrum allocation for these services (650 to 750 MHz, plus a nominal low speed return spectrum) is capable of producing approximately 150 separate

Existing work in conjunction with services on the HFC network looks to bring existing telephone services onto the HFC structure as a cost saving.

video streams of 3 MB/s into a 500 home node. This should be more than enough to meet initial needs for these types of services. Other needs in the areas of server development, spectrum management, set-top development, as well as application development are required to bring these types of services to full commercial realization, but the most expensive and least flexible portion of the network, the distribution portion, is prepared with capacity to meet initial requirements.

The third new set of services toward which operators will be looking is the interactive and/or interconnectivity based service. Again, because of the dedicated two-way spectrum that can be dynamically allocated to a customer on demand, operators envision services which connect customers to data bases and on-line networks via the HFC distribution network. Although customers today connect to these networks using telephone modems and the PSTN, use of an HFC distribution network has the potential to connect customers at 10 to 100 times the speed, enabling a new generation of on-line services to enter the mass market with image- and graphics-based content as a part of the offering. Current architecture provides the majority of the reverse spectrum (12 to 40 MHz), and 50 MHz in the 600 to 650 MHz portion of the spectrum, to provide for these types of data connectivity-oriented interactive services, as well as the integrated telephone services previously discussed. The availability of two-way digital transport in the low MB/s region between customer and headend could also aid in the development of other interactive information services, as well as interactive video games.

Conclusion

U.K. cable/telephony operatorshave been given the unique opportunity to be full-service providers with the infrastructure they build. Operators are taking full advantage of this opportunity to deliver video, voice, and data services over a competitive infrastructure built largely on HFC and DLC network concepts. Focus in the near term is on getting the network built, as only 30 percent of the build had been completed as of the end of 1994. Longer term architecture evolution seeks to develop the competitive advantages the HFC network brings in its ability to cost effectively deliver multiple services over a common cabled broadband infrastructure, while retaining a cost-effective evolutionary path to achieve greater service type and service demand needs. Existing work in conjunction with services on the HFC network looks to bring existing telephone services onto the HFC structure as a cost saving. Other near term work seeks to bring new digital broadcast, demand, and interactive services onto the HFC network both to drive cable's competitive advantage as the sole provider of an interactive broadband networks, as well as a revenue-enhancing opportunity.

Biography

CHUCK CARROLL [M '87] received a B.Sc. in electrcial engineering from Washington State University in 1984. He is senior vice-president of engineering for TeleWest Communicatons Group Plc., where he is responsible for guidance and leadership on all engineering and construction-related issues with TeleWest's build and operation of integrated voice, video, and data networks in the United Kingdom. He worked for U S West from 1984 to 1989 in various engineering positions, before becoming director of engineering for U S West Cable Communications Ltd. in the United Kingdom, where he developed the Distribution Network telephony architecture in conjunction with U S West's Cable TV partner groups.