Wolfgang Kraft and Dagmar Kähler-Müller

Next Generation Networks – Deploying Active Electronics in the Field

Incumbent fixed line carriers are busy planning their roll-outs of next generation networks which will require 'active' electronic equipment to be deployed in cabinets throughout the distribution networks – almost everywhere there is currently a roadside copper distribution cabinet. For a network the size of the UK's BT or Germany's T-Com there could be between 60 000 and 100 000 of these roadside active electronics cabinets to be deployed.

This article describes the challenge of squeezing a massive amount of electronics into cabinets small enough to be acceptable to the public and to the planning authorities. They discuss the problems of having to install tens of thousands of new electricity supplies, how to get rid of all the heat from the equipment and how to manage the security of the valuable equipment against both deliberate vandalism and accidental interference – where one wrong move can take 400 or 500 customers' TVs, telephones and Internet off the air.

There are many issues, to which carriers are now giving serious and rapid thought to prevent these problems and to deliver high-quality services over the next ten years.

the prospect of digging-in passive fibre from the local telephone exchange to each home is uneconomic at present in all but greenfield situations

The Authors: Wolfgang Kraft and Dagmar Kähler-Müller are with ADC KRONE, EMEA.

Intoduction

Fixed-line carriers all over the world are racing to build next generation networks (NGNs) in order to deliver advanced services combining broadband data, voice and video – often called 'triple play' – to their millions of residential customers.

In an ideal world they would deploy fibre-to-the-home (FTTH), but the prospect of digging-in passive fibre from the local telephone exchange to each home is uneconomic at present in all but greenfield situations. These incumbent carriers (such as BT and T-Com) must continue to extract further value from their existing major asset – millions of kilometres of twisted-pair copper cables in the ground that spread out in a tree-and-branch topology from the exchange to every home.

Incumbent carriers have already extracted additional value from this underground copper asset with broadband. By developing ADSL services that permit broadband up to around 8 Mbit/s they are able to provide these services to some 60% or 80% of homes over the same copper pair as analogue voice (often known as POTS – plain old telephony service).

The next step, however, requires major upheaval. IP television (IPTV) and video-on-demand (VoD) need much higher data rates – 22 Mbit/s or more.

Technology such as VDSL (very high speed digital subscriber line) and VDSL2 is able to deliver these speeds, and more, over copper pairs – however, this is only achievable over very short line-lengths (1500 m or less at 25 Mbit/s falling to only 500 m at the 100 Mbit/s it is forecast that we will all need).

The only practical way for incumbent carriers to make use of the existing underground copper cabling plant, or 'local loop', is to physically move the VDSL active electronics out of the local exchange and closer to the homes that will be served. This is a part-way point towards fibre-to-the-home and is called fibre-to-the-node (FTTN) or fibre-to-the-curb (FTTC) since the connection back to the local exchange uses fibre not copper.

Carriers and active equipment manufacturers have put a lot of effort into developing NGN strategies and studying ideal network topologies. Unfortunately for incumbent carriers, the majority of their topology options are dictated by where their current cable ducts and copper cable distribution cabinets are already installed.

Although they have spent much time and effort on the network infrastructure design, technology and topologies, relatively little attention has yet been given to the less glamorous, but highly important, issue of how to deploy this equipment in the harsh environment of the roadside. It is essential to make this externally located electronic equipment (see Figure 1) as reliable and as maintainable as building-based equipment. It must also be able to function without enormous teams of field technicians being needed to oversee and maintain it.

NGN Alternatives

Most incumbent carriers are agreed that the provision of triple play services requires a move to FTTN using one of two basic models, as described below.

Figure 1 New active cabinet

Field-based DSLAMs

High-speed DSLAMs (digital subscriber line access modules) are used to provide broadband, being moved out into the field, while existing long-reach services like POTS, ISDN and 2 Mbit/s ATM E1 and E3 (for businesses in residential areas) continue to be provided from the local exchange over the existing copper pair distribution network up to distances of several kilometres (see Figure 2).

However, instead of the ADSL broadband DSLAMs and line-splitters being located at the exchange, as they were with ADSL and ADSL2, they are now moved to the only logical point in the existing distribution network – the location of old roadside copper distribution cabinets.

Exactly how we turn this age-old piece of low-tech street furniture (see Figure 3) into a high-tech home for sensitive electronic equipment we will discuss in more detail later in this article. The key points, however, are that the active equipment needs a secure housing for DSLAMs and splitters, a controlled heat and moisture environment, an a.c. electricity supply, physical security from accidental damage and vandalism, back-up power, a jumpering field for service provision, fibre backhaul to be dug in or pulled in, fibre termination and management for the new fibre backhaul, over-voltage protection for the electronics, and a system to monitor and report the ‘health’ of the physical environment – heat, cold, flood, illegal access, physical damage, smoke/fire – to the central network operations centre (NOC).

MSANs in the field

This is where all services including POTS are provided by multiservice access node (MSAN) active equipment near the homes and optical fibre used to backhaul all services to a metro node or mega-PoP (point of presence) (as the next level in the hierarchy is known). In this second scenario, all services are provided over IP (Internet protocol) and the local exchange becomes totally obsolete once all customers have been migrated.

The MSAN approach is a total network replacement that does away with, or completely restructures, the local exchange and trunk network – as well as the ATM transmission infrastructure – replacing these with an IP/MPLS network infrastructure, all on fibre beyond the MSAN (see Figure 4).

Again, the practicality of existing copper network topology dictates that the majority of MSANs providing ‘copper services’ will have to be located at the same point as existing roadside copper distribution cabinets. This is because of the short

Figure 2 Copper distribution network topology showing DSLAM location

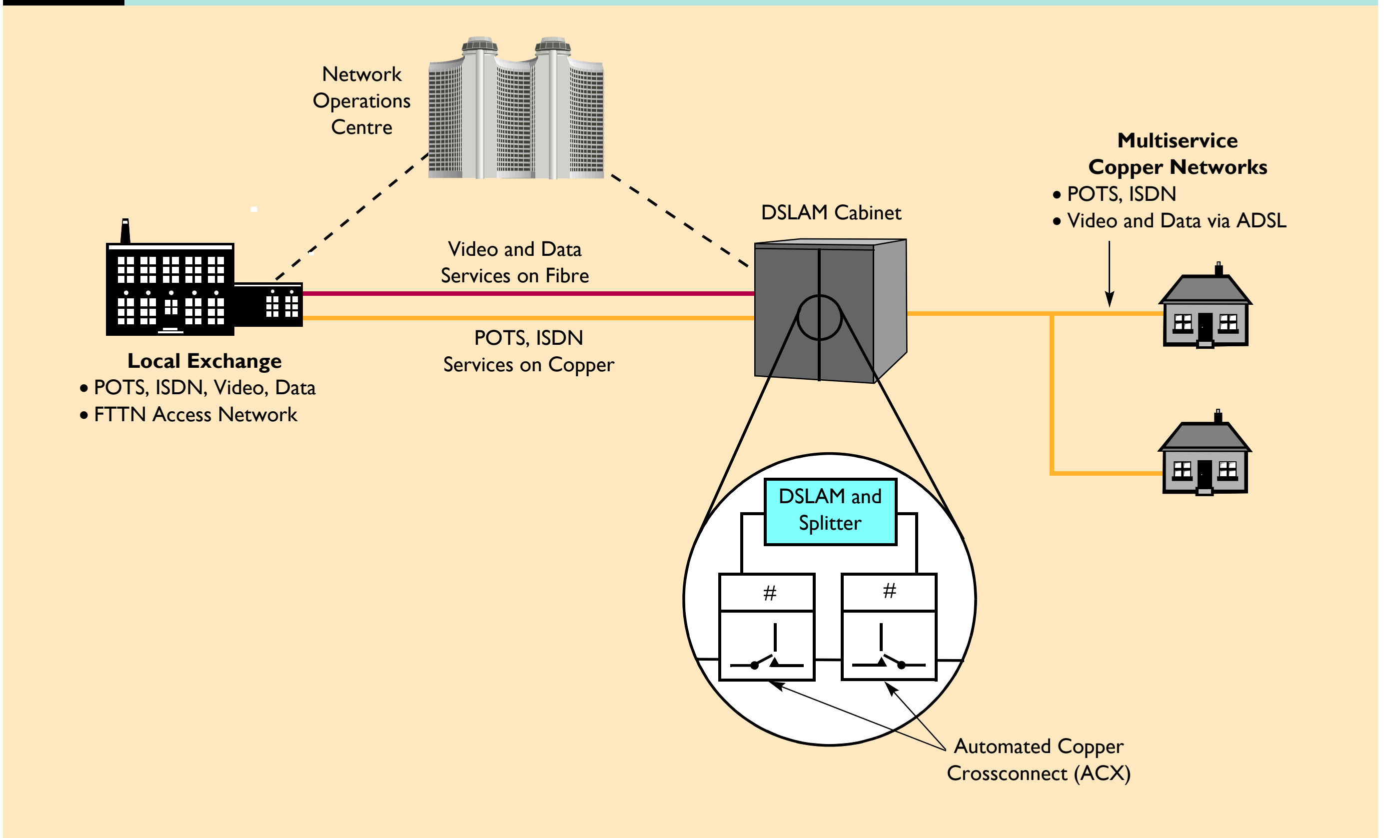


Figure 3 **Old distribution cabinet**

which are sited in prime locations, to be released for profitable reuse.

A number of carriers are already implementing the more revolutionary MSAN approach and phasing out local exchanges, while others are looking at the simpler option of deploying VDSL DSLAMs while retaining the existing telephone exchanges. Still others are running field tests of both approaches to obtain a better understanding of which option will represent the best investment for them.

a number of carriers are already implementing the more revolutionary MSAN approach and phasing out local exchanges

distances achievable at the high data rates needed and the high cost that would be incurred to relocate hundreds of copper pairs.

The physical needs of the active equipment of an MSAN are very much the same as for the DSLAM approach above except that the fibre backhaul will probably be a ring topology – this will, in all probability, dictate a greater fibre termination and management requirement within the cabinet.

Also it might not need an a.c. power feed, since there is an option to feed d.c. power from the local exchange along the redundant copper distribution cable already in place from this location

Also the MSAN approach may allow all or most of each exchange building, many of

Practical Topology Issues

With FTTN networks, a diverse-routed fibre-ring is ideal for the backhaul to the core network because of the resilience it gives. In practice, however, incumbent carriers have a great abundance of existing ducting and underground jointing chambers – going from the exchange to all of the locations of the distribution cabinets, in a tree-and-branch topology.

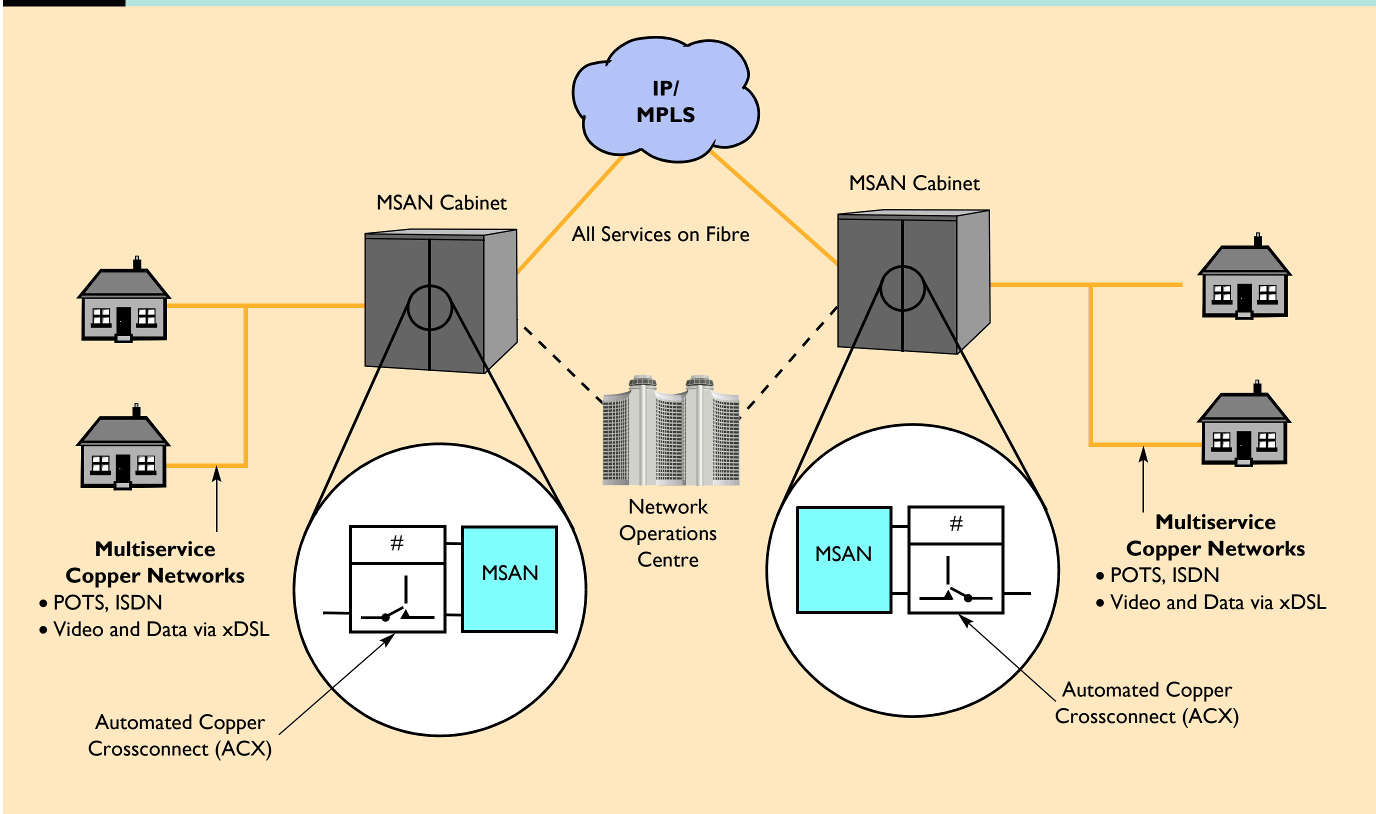
When you compare the economics of digging-in a new diverse-routed fibre ring with those of simply pulling-in fibre cable or blown-fibre micro-ducts through the pre-existing ducting, it tends to mandate that, from a practical and economic perspective, the fibre will have to follow existing duct routes in order to avoid highly expensive 'digs'.

From a copper pair perspective, the most logical place to put the active equipment cabinet is within a few metres of where the existing distribution cabinets currently are because cutting existing multipair underground cables to re-route them to other locations would involve massive disruption to service that is probably unthinkable for most carriers.

Cabinet Deployment Methods

Before we look at the design issues of the cabinets themselves, let's consider their practical deployment.

Figure 4 **Distribution network topology showing location of MSANs**



We have already seen that, for most cases, the new active equipment cabinets are going into long-established distribution networks where their practical location is dictated by the position of the existing copper distribution networks. In practical terms, the only realistic location for the active equipment cabinets is very close to the existing copper distribution cabinets. There are three main options.

- New additional cabinet

  Put the active equipment in a new cabinet close to the existing distribution cabinet. This may, at first sight, seem the simplest and most logical solution. However, it would involve obtaining wayleaves to site another cabinet adjacent to, or within 100 m of, the existing copper distribution cabinet.

  In addition to siting and installing the new cabinet, together with digging in new fibre backhaul or pulling it in through existing ductwork, a 220 V a.c. electricity feed needs to be dug in – and copper tie cable(s) must also be run between the old distribution cabinet and the new active cabinet. The whole operation could take a week on-site with up to twenty hours, possibly more, of re-jumpering during which time all the customers connected to this distribution cabinet could potentially be without service.

  Whichever way it is done, retermination requires a vast number of field engineering hours – which adds up to a massive amount of resource across the many thousands of cabinets required to be converted for millions of customer lines.

- Replacement of existing cabinets

  Completely replacing the old distribution cabinet is more efficient in terms of the use of pavement or other real estate, but is also complex, time-consuming and liable to give lengthy service disruption during deployment.

  Once the active cabinet has been prepared – taking as much as one week if built on site, or as little as two/three hours if factory pre-staged – then the cables from the underground chamber to the old cabinet must be cut and jointed to the tie cables into the new cabinet. This is a massive field engineering job in a cramped and possibly wet chamber, disrupting service to all customers for as much as ten or twenty hours.

  As before, when considered across a 5, 10 or 20 million customer network, the cost and service disruption is potentially massive.

- Over-build process

  A technique pioneered by ourselves is the 'over-build process' that can be used to incorporate the distribution frame element of the old cabinet into a new larger one designed for active equipment. In this scenario, there is no disruption to existing local exchange-provided services and there is little field technician activity needed, since subscriber line circuits only have to be re-terminated on those lines requiring VDSL service immediately. This approach, together with factory pre-installation of the active equipment, can reduce site time from a week to half a day, and re-jumpering time from 20 man-hours per cabinet to an hour or two.

Cabinet Construction

Cheap cabinets may seem appealing to a carrier when looking at the 60 000 to 100 000 needed for a full country roll-out. However, one only has to look at the early cable TV networks in the UK and other countries where the strategy was minimum cost of roll-out with the objective of selling the company in a few years time. This strategy worked well for the companies that did indeed sell out, but the cheap steel cabinets they deployed have proved to be unsuitable for long-term use and have caused significant operational problems now that these networks are well past the five-year point.

It is essential for active equipment that it be housed in a sealed environment of regulated temperature and moisture both of which, if not properly controlled, can seriously and adversely affect equipment reliability and service life. Connectivity, such as the crossconnect, also benefits from a controlled environment.

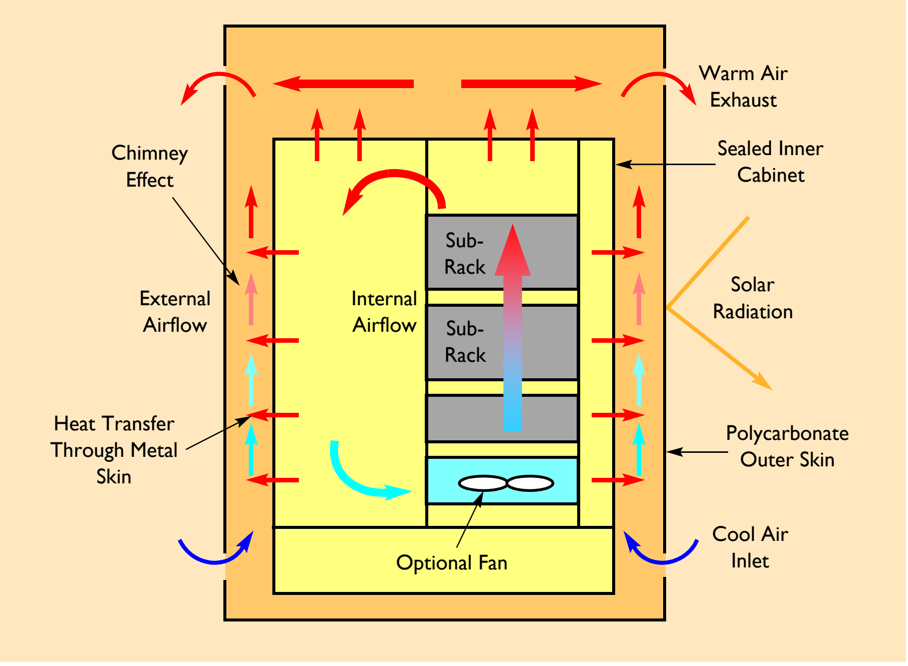
As a minimum, a dual-wall construction should be used with cooling air being drawn through the gap. Aluminium rather than steel makes a far better inner cabinet material because of its superior heat conductivity. A better outer material than steel is fibre-reinforced polycarbonate which has excellent strength, weather resistance and aging characteristics as well as being a natural thermal insulator (see Figure 5).

The conventional method of on-site construction can often take a whole week with a number of different trades and the power utility having to be scheduled on to site. Using a factory pre-staged cabinet, where all of the elements of the cabinet are built under factory conditions and then fully tested, can reduce the installation time on site to half a day if a concrete-less design is used.

Cable head, fibre head and fibre management

Cable heads, where external-grade cables are brought in through seals to keep out moisture from the earth, before being spliced or terminated, are needed for both copper and fibre cables.

Figure 5 **Cabinet showing chimney airflow and incident sun heat being attenuated by internal air distribution**



In the case of fibre cables, provision may need to be made for external-grade fibre cables to be looped through the cabinet and onward – without being terminated – leaving the flexibility for these to be cut and terminated at a later date if necessary. If blown-fibre and mini-ducts are being used, again an appropriate fibre management solution will be necessary to allow the fibres to be looped through.

There needs to be adequate provision for fibre splices and fibre management. Consideration should also be given to providing sufficient dark fibre or blown-fibre mini-duct, splicing and management capability for ultimate migration to partial or full FTTH.

Another factor that will affect the space requirement for fibre splicing, patching and management will be any provisions made for redundancy and fail-over of the fibre backhaul.

Fibre splicing is generally the preferred method as the space requirement is less. Reusable splices may be appropriate in some cases. It is possible to use fibre-patching but consideration should be given to using higher-grade or hardened optical patching components because of the external, non-exchange, environment.

Cabinet space considerations

One of the biggest constraints in the external deployment of active equipment is space – because there is very little available. Roadside copper-cable distribution cabinets vary in size, but on the whole they are fairly small, and these are generally what the public have come to expect (see Figure 6).

External concentrators, and mobile radio base-stations tend to be in quite large cabinets, but these are often sited off the pavement and out of view as far as possible. However, already in a number of countries the public are beginning to complain about the proliferation of ever larger street furniture. So both from a cost and amenity perspective, carrier network planners need to keep the size of outside cabinets as small as possible – particularly if they are going to be collocated with, or replace, the existing copper distribution cabinets.

To have only small cabinets is a fine objective, but reality dictates that the external DSLAM or MSAN cabinet must house:

- all the active DSLAM or MSAN equipment,
- cable splitters,
- the copper cable head,
- copper crossconnect or jumpering frame,
- the fibre cable head,
- fibre management and splicing or patching,
- fibre drivers and fail-over switching,
- separate compartment for 220 V feed, meter and consumer unit,
- uninterruptible power supply (UPS),
- batteries, cooling fans, heaters, or even air-conditioning,
- sensors and telemetry to report heat, cold, unauthorised access, accidental damage, flood, etc,
- possibly collocation space for other carriers' equipment, together with future expansion space,

and all in a space-consuming dual-wall cabinet.

In every case, the planner has to balance the space available by deploying the smallest equipment for the current requirement, while still leaving space available for future growth.

Heat

The next major consideration is that of heat generation. It is relatively easy to deal with heat in a local exchange environment, but once the DSLAM or MSAN active equipment – and do not forget the UPS – are in a very small confined space and subject to the intense heat of the sun even in colder countries, it becomes far more difficult. This is particularly so because the active equipment space has to be sealed for moisture control, because there is the potential for rain and even snow occurring in the cabinet's hostile location.

Figure 6 Mobile base-station, normal distribution cabinet and UCV

from a cost and amenity perspective, carrier network planners need to keep the size of outside cabinets as small as possible

Active equipment generally only likes operating temperature up to 50 ^{o}C (unless specifically hardened for outdoor use) and elevated temperatures tend to reduce reliability and life-expectancy. At the other end of the spectrum, most electronic equipment does not like extremes of cold either, with commercial equipment generally needing to be kept above 5 ^{o}C. So if the location has the possibility of snow and ice with sub-zero temperatures, then, even though there is heat generation from the active equipment, thermostatically controlled heaters may need to be included.

Network planners need to consider carefully how the equipment power consumption can be reduced. Maybe a more expensive product uses less power? If this reduces the cooling complexity of the cabinet this could turn out to be a cheaper solution overall.

With suitable air vents at the top and bottom of the outer cabinet walls, air will rise through the gap by 'chimney-effect' natural convection. At 17 W/^{o}C it is rare that this natural convection is enough to deal with the amount of heat produced within a DSLAM or MSAN cabinet (as shown in Figure 5). By installing fans in the 'chimney' airstream, forced heat extraction for the same typical cabinet can be almost doubled to 31 W/^{o}C. If the heat load is higher, installing a heat exchanger can increase the extraction to between 35 W/^{o}C and 60 W/^{o}C. To achieve heat extraction of more than 60 W/^{o}C, refrigeration techniques are needed using small air-conditioning units.

Cooling is not the only requirement. In many climates, night and winter temperatures can take the internal temperature down to levels that are not acceptable for commercial-specification electronics. If this is a possibility in the location in question, electric heaters with thermostatic control should also be fitted. Low-temperature alarms need to be transmitted to the NMC should the heaters fail.

Moisture

Electronic equipment does not like moisture. Connectors and contacts corrode and connections become noisy or fail. Condensation can cause shorts between PCB tracks or component leads.

Roadside cabinets are out in the sun, rain and snow – maybe even floods – probably one of the worst possible environments one could imagine for electronics. So it is essential to provide a humidity-managed environment internally. Of course this has to be achieved in a cabinet that will need to be opened to the weather on a regular basis to allow jumpering for MACs (moves, adds and changes) as well as for maintenance or upgrades to the electronic equipment itself.

From a working practices point of view, consideration also needs to be given to protecting the equipment from rain, drips, surface and flood water, etc, particularly during ‘quick’ access – where the technician is less inclined to follow protection measures.

Sensors should be fitted to raise alarms in case of excess humidity or flood so that urgent action can be initiated.

Power

Powering the active equipment is a major issue. Carriers face a massive cost and logistical nightmare in liaising with power utilities to organise 220 V a.c. feeds to maybe 60 000 or 100 000 MSAN or DSLAM sites throughout an entire country network. In most cases, the power utility will first have to survey the site, quote for the installation and obtain a work order before planning the work. Often this can be an 8 to 12 week cycle and, of course, the provision then needs to be scheduled to coincide with the installation of the active cabinet itself.

Then there is the question of housing the utility’s main fuse and meter – in addition to the consumer unit feeding power to the UPS, fans and equipment. Different territories and power utilities have different rules about power segregation. In some countries, it is permissible for the main fuse and meter to be in the same cabinet as the active equipment. Some utilities, and indeed some carriers, want it to be in a separately locked section, or even a totally separate power cabinet or pole.

carriers need to consider the security implications for accidental or intentional damage to active equipment and connectivity if power utility people are allowed access to the telecommunications/active equipment

There are also issues of safety for carrier technicians who are not used to working with a.c. mains voltages and currents. Then there are security issues for the network, since power utility personnel will need access to their main fuse and for meter-readers to read the power meter. Carriers need to consider the security implications for accidental or intentional damage to active equipment and connectivity if power utility people are allowed access to the telecommunications/active equipment.

Along with the need for individual 220 V a.c. power supplies to individual cabinets comes the next problem – mains failure. To date, carriers have been able to rely on large local exchange batteries and back-up generators. In this new remote-electronics scenario, potentially tens of thousands of sites now need to have some provision for continuation of service during mains power outage – particularly on those many occasions where the country’s incumbent carrier has a statutory duty to provide POTS emergency communication regardless of mains power availability.

UPS and batteries in each cabinet would be the normal solution – though of course these add to cost, heat and space usage. The stand-by time requirements will be dictated by the reliability of the local supply. Commercial judgement is necessary since, by utilising intelligent power distribution, it may be acceptable to only cover five to fifteen minutes back-up before allowing non-POTS services to be interrupted, powering only that equipment essential to providing POTS. In the remote DSLAM scenario, POTS remains exchange-battery-powered and the DSLAM may only need back-up for a relatively short period.

An a.c. power feed to each cabinet is not the only option. For DSLAM cabinets and MSANs within around 1500 m of the exchange, d.c. power-feed over copper pairs can be used to provide power to the cabinets. The normal method for this is to use spare pairs in the exchange-to-distribution-cabinet feeder cables. A d.c./d.c. converter converts the 48 V from the exchange battery to typically 130 V or 160 V and back again in the active equipment. Between 8 pairs and 32 pairs are used depending on cable resistance and length.

For locations more that 1500 m from the exchange, there are positions in the distribution network where the large main-exchange cables – typically 2400 pairs – split out to go to perhaps six distribution cabinets.

These would be ideal locations for a dedicated power cabinet to have UPS, batteries and d.c./d.c. converters while again using the 130 V/160 V over spare pairs approach to power a number of downstream active cabinets.

At a stroke this cuts the number of power-utility feeds needed by a factor of six and also allows larger and more efficient UPSs to be used. Space and heat budget are not then needed in the individual active cabinets for UPSs and batteries, nor for main fuse, meter or 220 V consumer unit – since all equipment can be 48 V powered.

Noise

As active equipment is frequently fan-cooled and UPSs are sometimes fan-cooled, the cabinet may need cooling fans and heat exchangers. These fans create noise which can constitute a ‘nuisance’ in certain situations. In many countries noise legislation applies.

Matters are made worse by the fact that the cabinet-cooling fans are in the external air-stream and therefore produce more extraneous noise than those within the sealed equipment compartment. In some cases fans may cause resonances with the cabinet metalwork – amplifying the sound.

In a busy city centre location, the noise levels involved may well be inconsequential. However, in a quiet residential or more rural location the level of noise compared to the very quiet background level may be judged by residents to constitute a noise nuisance – particularly at night and if close to a bedroom window.

Ensuring that cooling fans are thermostatically controlled and only run when essential can help reduce noise levels as can the use of polycarbonate outer cabinets that have good sound deadening qualities.

Visual intrusion

Most copper-pair distribution cabinets can be considered to be largely 'invisible'. They are relatively small and they sit well below the adult's line of sight, at roadsides, or up against garden walls (see Figure 7).

They have been there for as long as most of us can remember – so they are just a natural feature of the landscape.

There are also remote concentrators for exchange switches in cabinets in some locations. These are generally large – some are more like the size of a small garden shed – but with careful placement, they have been accommodated often out of the general line-of-sight and are not normally very noticeable.

However, two key factors could be about to change this happy co-existence of telecommunications external plant and humans.

Firstly, there is now a competition going on for pavement space because the mobile operators are deploying roadside monopole micro and pico cells at an alarming rate. At ground level alongside each monopole antenna there are now a couple of fairly bulky cabinets containing the active electronics. Already people are beginning to complain about all this extra 'clutter' on pavements and in hedgerows (see Figure 8).

Figure 7 **Inconspicuous copper distribution cabinet**

Secondly, as carriers begin the roll-out of FTTN, they are going to need to deploy tens of thousands of active DSLAM or MSAN cabinets. As we have already established, these need to be at or very close to the location of the current copper distribution cabinets that are largely in places where a massive electronics-filled cabinet is going to be highly visually obtrusive.

These active equipment cabinets are not only significantly larger in all dimensions, but many of them are also so tall that they break the line of sight. There is a massive difference in the visual impact of cabinets up to say 1.3 m and those of 1.6 m or 2 m height.

We have recently developed new cabinet concepts where, instead of being an unsightly addition to the street, the active equipment can become part of a larger but more acceptable piece of street furniture. Examples are a seating bench, part of a bus shelter, advertising poster sites, part of an information or Internet kiosk, part of street art or sculpture, and children's play equipment (see Figure 9).

The colouring of external hardware can also have a significant effect on its visual prominence – with careful attention to colour they can be more effectively camouflaged.

Overvoltage Protection

Until now, all lightning and over-voltage protection has taken place on the main distribution frame (MDF) at the local exchange. With the move to external electronics, it seems that many planners have forgotten about over-voltage protection altogether.

Voltage spikes often mean damage to the line-cards that can sometimes result in instant failure, but often leading instead to a shortened service life, which is not

Figure 8 **Monopole with collection of cabinets prominent at the roadside**

Figure 9 **Illustrations of concepts for disguised active cabinets**

immediately apparent. With tens of thousands of active electronic cabinets in a typical large network, this could prove to be an incredibly expensive mistake.

Although some electronic equipment, such as DSLAMs, have on-board surge protection, it is far safer to avoid voltage spikes ever reaching the active equipment by having the protection back at the cable head. Probably the best solution is to use splitters with built-in protection on the crossconnect – instead of using the normal 19-inch active-shelf mounted splitters which unnecessarily route the POTS circuits (and any voltage spikes) through DSLAM shelves.

Security

In some countries and locations, copper distribution cabinets are subject to abuse, neglect or vandalism. Generally, however, people are very familiar with them as part of the landscape and simply ignore them. Occasionally, of course, they are the subject of accidents – particularly from motor vehicles.

These new active equipment cabinets are different though. They are much larger and more conspicuous. They make a noise and warm air emanates from them. When open, passers-by can see lots of expensive looking equipment within – tempting to the criminally minded. Higher levels of physical security are needed to keep out would-be vandals and thieves.

With an active equipment cabinet, it is quite easy for the whole cabinet and its 400 or more customers to be taken out of service – with disruption of Internet and television viewing, not just the telephone service. Sensors and alarms are necessary to detect unauthorised access and – though this is a challenging problem – to alert network management centre (NMC) staff to accidental damage potentially allowing ingress of moist air or water, etc.

Another security issue arises from the number of different people needing access to the equipment. Whereas before it was only the linesman for jumpering, now active equipment maintenance technicians and power utility personnel also need access. Carriers must ask themselves whether they are comfortable with field technicians having access to the active equipment and whether power utility people should be allowed into either active or crossconnect areas.

Alarms

The active equipment in the cabinet will undoubtedly be equipped with comprehensive health-check and alarm capabilities, information from which will be conveyed back to the NMC via SNMP-type management and control communication. However, there are many physical aspects that need to be monitored and alarmed if a centralised NMC is going to be able to check several tens of thousands of DSLAM or MSAN cabinets.

Each cabinet needs sensors that can detect and report its 'health' in relation to a wide range of physical conditions, such as both authorised and unauthorised cabinet access, physical damage to the cabinet by accident or vandalism, power failure, shut down when power failure exceeds UPS battery time, UPS or battery fault, over temperature, under temperature, excess humidity, water ingress from rain or flood.

Planning technicians also need to consider, where any of the scenarios leading to such alarms are service-affecting, whether a fail-over to redundant equipment or circuits might be possible.

Collocation

Local-loop unbundling (LLU), demanded by telecommunications regulators in a number of countries, has forced incumbent carriers to give competing carriers access to their copper distribution network by making available collocation space at the local exchanges. How will they continue to comply with these regulations if the copper network ceases to stretch all the way from the customer to the local exchange?

In the case of DSLAM-in-the-field roll-out it is still possible for competitors to provide xDSL and voice services from their collocated equipment at the exchange. In the second scenario, where incumbent carriers are adopting an MSAN strategy for NGN, there will no longer be a local exchange and there will be no copper connectivity upstream of the MSAN cabinet. Will they have to provide space in street cabinets for competitor equipment?

Not only would this require extra space for as many different competitors as demanded the opportunity, but there would then be all the issues of multiple companies needing access. It is potentially very difficult. Whether any of this becomes a reality will probably depend upon the judgements of the telecommunications regulators.

Truck-rolls and OPEX

Until now, with the MDF, DSLAMs, splitters, and main exchange switches all in the local exchange building, the re-jumpering of connections for MACs is relatively straightforward and a small team of field technicians can easily perform them in a timely manner.

there are many physical aspects that need to be monitored and alarmed if a centralised NMC is going to be able to check several tens of thousands of DSLAM or MSAN cabinets

But now consider the situation when almost all the crossconnects that need re-jumpering are in the tens of thousands of external DSLAM and MSAN active equipment cabinets around the country. Suddenly a small army of field technicians could become necessary – with every MAC needing a 'truck-roll'. The operational costs are potentially enormous.

Of course, in this new scenario, economics will dictate that MACs have to become scheduled activities, with field technicians' days organised into 'rounds' so that they can perform several MACs at each cabinet at the same time. Unfortunately, this will mean longer waiting times for customers to get their new or changed service – since the field technician would probably only be scheduled to go to each cabinet once every few weeks.

There is an alternative solution – ACX (automated crossconnect) – a switching unit installed in the cable head in place of a conventional jumpering field. Once installed there is no need for a technician to attend the cabinet to perform re-jumpering – because re-jumpering is simply commanded from the NMC or via the carrier's operational support system.

With this approach, thousands of truck-rolls each year will be obviated, and the time-to-provide for MACs can be generally reduced from days or weeks to one or two hours – possibly even less. A major competitive advantage for the incumbent carrier.

Customer line testing will also become a problem when this can no longer be done from the exchange MDF and would also require a technician visit. Once again the

ACX provides the solution with automatic bi-directional test access for a collocated tester under remote NMC or routiner control.

Conclusions

As this article has shown, there are many key strategic decisions for incumbent carriers to make with regard to next generation networks – such as whether to follow the DSLAM-in-the-field or MSAN approach, whether to retain a local exchange switching architecture or move to IP/MPLS, and all manner of topology issues.

These are major questions that need to be considered in terms of how to provide power and back-up power to these external units, how to protect sensitive equipment against the weather, vandalism, accidental damage, and so forth.

Planners need to consider all aspects of locating, installing, operating and maintaining the active equipment. They also need to plan for future upgrades. All of this must be done in locations that are very much more hostile than the benign local exchange. It is not only the initial deployment and subsequent roll-out that need to be considered but also the next ten or twenty years of operation and upgrades too.

Every good technician knows Murphy's Law – 'if it can go wrong, it will' – and so time should be given to thinking about the many things that could go wrong and having solutions in place from the outset. This way they can avoid the disruption and expense of having to go back around the whole NGN network in six or twelve months to retrofit solutions because these eventualities were not properly planned for.

Biographies

Wolfgang Kraft
ADC KRONE

Wolfgang Kraft is global product manager outdoor cabinets for ADC KRONE. Having graduated with a degree in telecommunications engineering and a diploma in electrical engineering, he joined KRONE in 1984 and has over 20 years experience in the telecoms and datacoms sector.

Throughout his career, Wolfgang has been involved in the development of new products (both hardware and software) for the telecommunications industry. Today, he is the product manager responsible for ADC KRONE's portfolio of outdoor cabinets.

wolfgang.kraft@adckrone.com

Dagmar Kähler-Müller
ADC KRONE

Dagmar Kähler-Müller is product manager DSL splitters for ADC KRONE. Having graduated with a degree as Dipl Kauffrau, she joined KRONE in 1988 and has worked in several departments, including customer service.

In 2006 she moved into her current role as product manager responsible for ADC KRONE's portfolio of DSL splitters.

dagmar.kaehler-mueller@adckrone.com