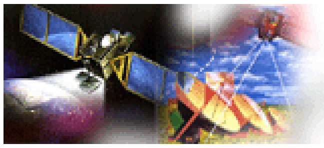

A PRACTICAL APPROACH TO MULTI SWITCH INSTALLATIONS

'Multi switches provide an elegant, simple to implement solution for distribution of DTH signals, from a set of shared DTH dish antennae and LNBs'

In the 'Multi switches for DTH distribution' article in the April 2005 issue of this magazine a general overview of multi switches as a concept is discussed.

In this article we will take a closer and practical look at how to install a multi switch system. Using examples and calculations we will find out what needs to be taken into account when a multi switch system is planned and installed.

AVOID COMMON PITFALLS

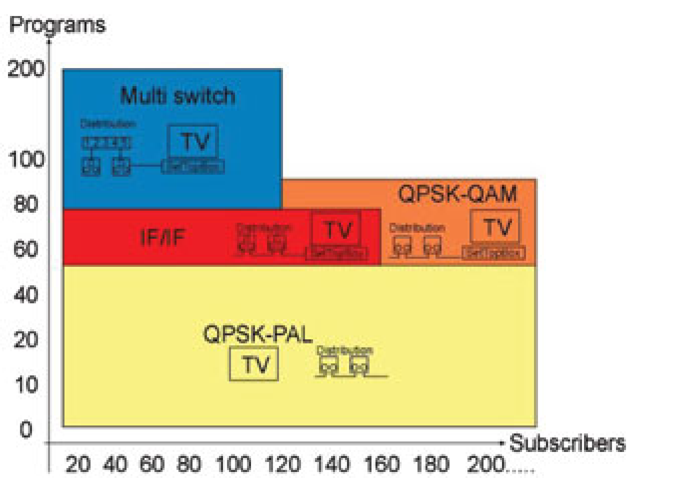

FIG. 1: Technology - Number of channels versus number of subscribers

A limited number of channels are available for reception using normal CATV and SMATV networks and RF distribution in the VHF and UHF frequency ranges. Typically, some 90 channels are possible using RF distribution. Next step to achieve more channels is using QAM transmodulators. If even more channels are needed, or users cannot agree upon a common set of channels, a multi switch installation is a good solution as it provides a vast number of channels and freedom to choose (Fig. 1).

As outlined in a previous article, a multi switch system requires a substantially higher number of cable runs. The signals distributed also occupy a larger, higher, frequency range (IF range: 950 – 2150 MHz) than is used for normal SMATV RF distribution, and consequently there are several issues that need to be taken into account, that may not be obvious when only distributing RF signals (up to 862 MHz).

As in normal CATV and SMATV distribution networks there are pitfalls to avoid when planning and installing multi switch systems. In the following we will try to identify the pitfalls, so that you can easily steer around them, and get a safe and problem free instal¬lation.

One of the most common pitfalls is when you approach a multi switch installation the same way you would approach a normal SMATV installation. This may lead to design decisions that will prove difficult to live with in practical installations, and may even lead to designs that are impossible to implement. Examples are for instance using a star-topology where a trunk-topology should be used, and using short trunk-runs and long subscriber lines, where the opposite is normally recommended (Fig. 2).

Fig. 2: Star-topology versus trunk-topology

Obviously, physical issues need to be taken into consideration. But sometimes, if you are not aware of the technical requirements around a multi switch, it is very easy to let building constraints, walls, small risers and other limitations on the physical side of a building totally decide how your multi switch system is designed. On the other hand, looking blindly on the theory of projecting a multi switch system you may end up in a conclusion that it is impos¬sible to do an installation in that particular building or area.

Normally, the truth lies somewhere in between, and with a good knowledge of what makes a multi switch work, and what does not, you are in a good position to make the correct decisions and, if needed, suitable compromises, that will result in working systems.

All too often important decisions are already taken before an installer is given the task of doing the projecting, calculation, of the system. This is one very good reason why it is very important that multi switch knowledge is available at a very early stage. Otherwise crucial decisions may be taken early and be impossible to change later.

When you have read this article, you may find yourself overwhelmed at first by the number of issues to take into account. It is indeed a bit frightening when you think of the many possibilities for introducing problems if you don’t get it right.

On the other hand, when you master this (and it is not as difficult as it may sound at first notice) you’ll be able to serve dozens, maybe even hundreds, of happy users in a single successful installation.
Don’t make compromises at the dish/antenna

First rule of projecting says that you should never make compromises at the signal input stage. In a multi switch system this normally means the dish and the LNBs. The investment in high performance dishes and LNBs is very limited when you look at the total investment for the whole installation.

Often it is necessary to run the signals that are received at the dish via the LNB, through a very long cable, until it reaches the end subscriber. As it is described later, compensating for cable losses can be very expensive, not only in terms of investment, but more importantly also in terms of degraded signal performance. For that reason, it is absolutely vital that you project your multi switch outdoor unit(s) for maximum performance and maximum signal level and quality out of the dish and LNB.

Only use one dish per orbital position. Never use a multiblock/monoblock setup, as it is a physical compromise resulting in a lower signal level and a poorer C/N ratio from each position. Always use a dish size as large as possible. The signal level you gain here is basically free, compared to what you may need to amplify later.

Only limit here is the maximum allowed level at the input stage of the first multi switch in a system (and the maximum input level of a set-top box). As multi switches normally have an active output stage, you must be careful not to overload this amplifier.

Such problems can normally be handled by using a TAP-cascade at this position with a higher taploss than further down the distribution, rather than lowering the output level from the dish (using a smaller dish). The higher output level is probably needed further down the distribution network, and should not be 'thrown away lightly' (Fig 3).

> LNB output (dBm) = Footprint EIRP (dBW) + 30 – Path loss (dB) + Antenna Gain (dB) + LNB Gain (dB)
>
> Assumptions:
> Path loss = 206 dB (at 12,45 GHz)
> Antenna gain = 34,0, 36,5 and 40,7 dB (antenna sizes 46, 60 and 100 cm)
> Typical footprint = 51 dBW Typical LNB Gain = 56 dB
> Example: 51 + 30 – 206 + 34 + 56 = -35 dBm (73,75 dBμV).
>
> ***FIG. 3 :*** *Link budget*

ALWAYS DO SYMMETRICAL DESIGNS

Second rule of projecting stipulates that you should always try to keep the distribution network balanced and symmetrical. In a very high building, say over 8 storeys high, this would normally mean that you should start at the top from the dishe(s), go half way down through the building, and then split upwards and downwards from there. Dependent upon the number of floors, you may even want to split out once more. (Fig. 4.)

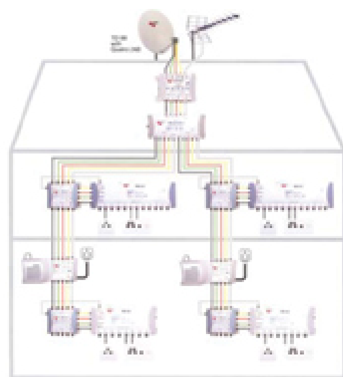

Fig. 4: Split for more risers, or many floors

In a multi switch installation cable costs often account for up to half of the investment, and the fact that on some of the upper floors you would have to have a trunk going up, and a trunk going down, is often disregarded already at the drawing board simply because it is a lot of cables. At first glance, it also seems an easy way to cut system implementation costs to focus on minimizing total cable length.

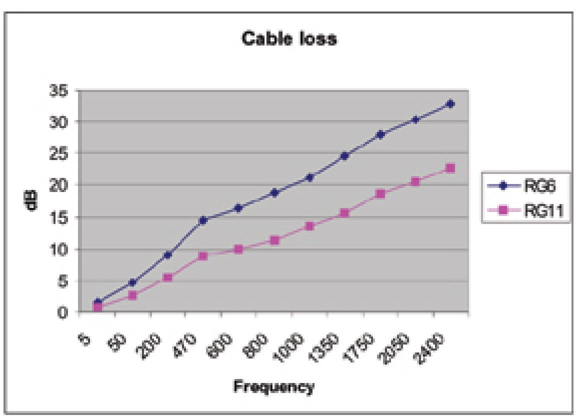

Fig. 5: Typical cable loss per 100 mtr. cable

But you have to be aware that at the high IF frequencies used for multi switch distribution (950 – 2150 MHz) the cable losses are substantially higher than at normal SMATV RF distribution, and it can be very expensive to compensate for this by having to include line amplifiers in the trunk (Fig. 5).

Even if a component to component calculation proves that it is much cheaper just to include another line amplifier, you have to be aware that any active device, such as an amplifier, adds intermodulation and that it may ruin your C/N (carrier to noise) ratio, and thereby your signal, if you are not very careful.

Often you'll find that it is impossible to gain back what you have lost in terms of cable loss, even using very high grade amplifiers, and that a better, thicker, cable will take you far longer than any amplifier.

This leads to the next rule:

ALWAYS USE THICKEST POSSIBLE CABLE IN THE TRUNK, AND THINNER AT SUBSCRIBER

As described above, as losses along the cable accumulate, at some point it will be necessary to amplify the signal to maintain the levels required for perfect reception. However, inserting amplifiers also adds to the intermodulation and has an effect on C/N. These are entities that cannot and should not be taken lightly. If you design without taking them into account, you may end up with a signal level that seems OK (from a level point of view), but produces nothing but problems, macro-blocking and drop-outs at the set-top box. As cascading amplifiers are the most common cause of intermodulation and a bad C/N ratio, the solution is to avoid having an amplifier as far as it is possible and as few cascaded amplifiers as possible.

The only way to minimize a large cable loss (without introducing intermodulation and reducing C/N) is to use a better, often thicker, cable. This costs money, yes. But it will also buy you a longer cable run. Something you may not be able to 'buy' by adding another line amplifier later. From the multi switch and to the outlet socket of the subscriber you can normally use a thinner cable. Avoid using push-on/quick-connectors in the installation. They have greater loss and generally a poor long time performance.

KEEP LONG CABLE RUNS IN THE TRUNK, NOT IN SUBSCRIBER CABLES

This rule is an extension of the previous rule, and is especially true the longer cable runs you have. It is sometimes perceived as practical to have all the multi switches in one close physical location, with short trunk lines between them, and then having all the subscriber lines as a star-topology from there. But remember, the multi switch is often an active device, which means that there are limits to how much level you can input to it. If both satellite and terrestrial signals are to be distributed, this becomes even more critical.

The problem here is that if you have very long subscriber cables, the cable loss alone may require you to have a very high signal level into the multi switch, just to compensate for the cable loss. On top of that, in the case of more than one orbital position, where you will need to use 22 kHz for switching purposes, and maybe even DiSEqC control commands on top of the 22 kHz in case of even more positions, you have not only the cable loss from the multi switch to the receiver to take care of, but also the loss and degradation of the 22 kHz signal when travelling from the receiver back to the set-top box.

Therefore the general rule of thumb is: Have your long cable runs in the trunk (using thick cable) and short cable runs from the multi switch to the subscriber outlet (if possible, using a thinner cable)

ALWAYS CAREFULLY ADJUST THE OUTPUT LEVEL OF LINEAMPLIFIERS

As already described above, if you must insert line amplifiers, and for many systems there are no way around it, then make sure you get your math right, and adjust the line amplifiers to the correct output level. NEVER just set it for maximum output level!

This means that you HAVE to calculate the actual needed amplification for every stage of your system, and you HAVE to be able to measure the level at installation to be able to adjust it to the correct level. In most cases, doing the adjustments 'by ear' will absolutely not work, and will probably come back to haunt you later.

When you calculate the level of line amplifiers, you must remember this: The maximum input level of an amplifier is normally given as a figure like this: 105 dBµV (IM3), and is understood to be a maximum level measured with two channels only. To get the correct level however, you must compensate for the fact, that the IF range you receive has a large number of channels (transponders). Whether you intend to use them or not doesn't matter. They are there and they will all be amplified and actually degrade the performance of your line amplifier. Or to put it another way: The more transponders you have, the lower level you can input to the amplifier, to avoid intermodulation (Fig. 6).

RF:
Reduction factor = 7,5 x log(Number of channels -1)

SAT:
Reduction factor = 10 x log(Number of channels -1)
Example (SAT): 10 x log(30 transponders -1) = 14,6

This means that an amplifier specified as 105 dBµV (IM3), can only be sourced a maximum signal of 105 - 14,6 = 90,4 dBµV without compromising intermodulation and C/N.

FIG. 6 : *Correct maximum level versus data sheet specification.*

You should know that the reduction factors are imperial values. This means that they are not the result of an exact science, but approximated over time and through trial and error. This means that there is some leverage in this calculation. It is just downright impossible to say how much as many factors have an influence (transponders on/off, different number per polarity, quality of signal, signal variations, weather condition, etc.).

But it does mean that you may experience situations where you can get away with higher levels than calculated or use cheaper components and cables. The real problem here is, that when one or more users get problems later you have no way of finding out why, if you didn't do your homework correctly in the first place!

SEE THE MULTI SWITCH AS A COMBINER IN TERMS OF TERRESTRIAL AND SATELLITE SIGNALS

It is a general misconception that RF and IF are to be distributed equally using multi switches. Cases are known where trunk cables are drawn fully identically for both the RF signals (cable/terrestrial signals) and the IF (multi switch signals). This is very often not a good solution. In most cases, the number of channels, cable losses, C/N ratios and signal levels are completely different in RF distribution, and thus it is necessary to project and lay them out individually. The fact that most multi switches have terrestrial inputs should only be seen as a simple means of combining the two signal sources just before the subscriber cable and the subscriber outlet.

MANY SUBSCRIBER OUTPUTS DO NOT ALWAYS MEAN MANY OUTPUTS PER SWITCH

It often seems practical or natural, to use multi switches with as many outputs as possible.

If you have, say, 8 users on a floor, the first choice would normally be to use an 8-output multi switch on that floor. Or a 16-output unit for two floors. In many cases this is indeed OK, but there may also be good reasons why you should split the outputs out amongst more, smaller, units. For instance using 4 units with 4 outputs each.

Fig. 7: One or more floors per unit

Why? Because if the size of the building forces you to run subscriber cables from one single physical position (from the 16-output multi switch) it will result in very long cables for some of the outlets, you may find this a violation of one of the previous rules. Or, in other words: If using one single unit means running excessively long subscriber cables, you should break it up into smaller units, and let the trunk take care of the distances (Fig. 7).

BE PART OF THE 'DECISION-MAKING-TEAM' FROM AN EARLY STAGE

If you are an installer who will have to project, calculate and offer a multi switch installation, it is a good idea to try and educate all those individuals that come into play at a very early stage of new multi switch installations. In new buildings this normally means architects, planners, administrators and engineers. They often have little background to understand the important factors that govern a working multi switch system, and may decide things that make life miserable for you later. As, for instance, the physical position of the headend, the dishes, the cabling and the outlets.

Normally no one wants to look at a dish, so it is often put far away in a remote corner of the roof of the building. But the most economical place, both in terms of real money, and also in terms of signal resources and distribution, would be in the middle of the building or complex.

Not to speak of the fact that dishes must have free view towards the position of the satellites (in Europe 20-30 degrees over the horizon due south). The latter is a requirement that cannot be compromised, whereas others can, to some degree.

Also the cabling is not necessarily straightforward, and therefore it is important that at some places in the trunk there is enough physical space to run the necessary number of cables double or even triple. Otherwise you end up in a situation where it is the building that decides the maximum dimension of the cables, and not the application.

Sometimes this is a battle you cannot win. In older buildings you may face situations where there is just not enough space for the best cable you would want to use.

But be aware, that being forced to use less optimal cables may also limit the maximum cable runs and number of subscribers you can reach.

Finally, antennas normally needs to get high up (on the roof) to get a free view, whereas the dishes do not necessarily need to be elevated as long as they have free view towards the satellite. So if antennas are not used, the distribution does not have to go from the roof downwards. It may go from the ground upwards or even from the middle of the building and in both directions if it is physically possible.

What needs to be understood here is this: Distance does matter! A remote placement cannot always be remedied with a longer run of cable. You cannot bend the laws of physics and they are a lot less forgiving at signals at IF frequencies than at 220 VAC/50 Hz!

KNOWLEDGE IS POWER

As hinted initially you may have been overwhelmed by the amount of issues to take care of when doing a multi switch projecting and installation. But you'll probably realize that if there is one lesson you should have learned by now, it is this: Cable quality and distance are important parameters that need full attention during projecting as well as focus on intermodulation and the C/N ratio.

Once you master these relationships you stand very strong and should be able to project almost any multi switch installation. Knowing the limitations often wins more than half the battle. Remember, the main reason why a multi switch installation is selected in the first place is often the number of channels available, level of choice and freedom.

With for instance 17 satellite polarities, which are not uncommon in Europe and the Middle East territories, you will have access to some 3-4000 channels in one installation! This is just not possible using any other technology available today.

Therefore installing a multi switch system is most often a very rewarding experience.

Triax A/S offers a full professional multi switch product palette ranging from single position few subscribers to very large scale cascadable systems for up to 16 polarities and many subscribers. Providing very modular high quality products a Triax multi switch solution can always be found that satisfies both high technical requirements and a need for cost effective installations. For further information please visit www.triax.com. ■

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