LOW COST INSTALLATION OF DVB-RCS TERMINALS

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***Abstract* – The installation of satellite terminals such as those utilised in DVB-RCS systems is today a costly affair. In fact, the cost of installation is regarded as so high that it may affect the future spread of DVB-RCS systems to the general public as well as the professional community.**
The European Space Agency (ESA) has recently concluded a study looking into the problem of high installation costs. This paper summarises the findings of the study, outlining how installation is performed today, the cost associated with it and how one can possibly reduce the cost in the future.

1. INTRODUCTION

Much effort has been devoted by European industry and ESA towards reducing the cost of terminals for VSAT systems in general and DVB-RCS in particular. Even with continued terminal cost reductions towards affordable and attractive market prices, the cost of installation of terminals is presently so high that it seriously can limit the future uptake of DVB-RCS services. The current price of a Western European installation lies between €350 - €750, depending on the type of job and promised volume for a bi-directional satellite installation [1][1]. This is a significant amount compared to the overall price of a terminal which can lie in the region between €800-1500€ in high volumes [2].

The problem of high installation cost of DVB-RCS terminals have been addressed in the ESA Artes 1 study called "Cosysit – Low cost installation system for Satellite Interactive Terminals". This study covers both consumer and professional terminals for Ku/Ku (VSAT) frequency bands as well as Ka/Ku (SIT) and Ka/Ka (SUT) frequency bands. The study finished mid-2005 and had duration slightly less than one year. It was carried out by Alcatel Space (prime), Visiosat and Satlynx. The full study results are available on the ESA web site [1].

To raise awareness about the problems of installation, this paper gives a brief summary of the study work and the problems of installation in general. Focus is mainly on consumer grade[2] terminals as the pressure to reduce prices is greatest here. The paper first looks at the current practices and costs of installations today (chapter 2) before addressing the requirements associated with antenna pointing for installations (chapter 3). The market prospects of DVB-RCS terminals in relation to installations are thereafter discussed (chapter 4). Finally, possible improvements to the current installation practices in order to reduce the current cost are outlined (chapter 5)

2. PRESENT INSTALLATION METHOD

Installation of satellite terminals is usually associated with the pointing of the satellite dish. Although this is the most distinguishing feature of satellite terminal installation compared to terrestrial communication products, it is only a part of the entire installation procedure. A standard installation procedure can generally be grouped into the following main tasks;

1. Preparatory work
2. Physical installation
3. Line up and commissioning
4. Service acceptance

These main tasks are explained in more detail in the following chapters. It should be noted that details concerning the procedures and tasks

[1] Page 35 of [1]

[2] Consumer grade terminals differ from professional terminals in their technical characteristics. Antenna size, output power and separation Indoor Unit and Outdoor Unit are limited (0.7m diameter, 1W output power, 5-50m separation, respectively), page 39 of [1].

differs between existing systems and that the following description is somewhat generic.

2.1 Preparatory work

The first main task that follows once an order for a terminal has been placed is the scheduling of the installation with the end customer and the logistics of the terminal to the installer. This is usually a simple task but which from time to time can be hampered somewhat with slow or missing feedback from end customers concerning suitable dates for the installation.

Before installation commences, some pre-configuration of the IDU is in some cases required in the form of updating software releases, entering parameters into the IDU (such as IP address etc).

2.2 Physical installation

What follows the preparatory work is the actual installation. The physical installation consists of the following sub-tasks;

a) Drive to customer premises[3]
b) Installation of wall mount
c) Mounting of antenna
d) Assembly and mount of ODU equipment (transceiver)
e) Lay out cables between IDU and ODU
f) Connect IDU

The actual drive from the premises of the installer to the customer is included in the list as it represents an expense for the installer which is expected to be covered by the customer, including the cost of the vehicle and the time it takes (the same often applies for the return journey). The average time for VSAT and DTH installers to travel to customer premises is reported to be about 1 hour [1][4].

When it comes to the installation on site, some time is spent agreeing with the customer on the appropriate location of the satellite antenna and cabling route to the IDU. This is usually not immediately acknowledged but is still an element to include in the overall cost calculations. Concerning the installation of the mount and the lay out of the cabling, the time taken to perform these tasks varies depending on the complexity of the location. Cabling can take anywhere from 15minutes to 3hours [1][5], while a standard wall mount and fixing the antenna takes about 1hour [1][6]. Mounts come in different sizes and shapes and the time and effort required for installation will naturally also vary.

Point d) above entails assembling LNB, transmitter and OMT if this is necessary. This is a relatively short task taking about 10 to 15 minutes. Connecting the IDU in this context just entails connecting the various cables. Commissioning and configuration of the IDU is covered in the chapter below.

2.3 Line up and commissioning

Once all hardware is in place, the installer will align the satellite antenna dish. To do this, the installer typically has a field strength analyser which connects to the LNB output and which then displays the received signal spectrum. The elevation, azimuth and polarisation angle of the terminal (transmit and receive) can all be adjusted using the received spectrum. However, to ensure that the pointing is accurate enough a final fine pointing is required by means of verifying the quality of the transmitted signal at the Network Operation Centre (NOC). The installer typically calls the NOC to request such a final alignment procedure. The NOC thereafter initiates Continuous Wave (CW) transmission from the terminal, monitors the resulting received cross polarisation signal level received at the NOC and instructs any necessary fine adjustments to the pointing to the installer. Due to the sharp characteristics of the cross polarisation performance as a function of pointing offset angle, very accurate pointing in the polarisation angle as well as in azimuth and elevation can be achieved. In principle, this operation is fairly swift taking some 5 to 15 minutes [1][7]. However, in some cases the NOC can be hard to get through to or their request for fine alignment procedure somehow delayed (NOC busy/slow) which delays the whole process for up to an extra 30 minutes or even longer.

Finally, IDU configuration is in some cases required in addition. This entails entering some cable calibration data (to account for the

[3] Although arguably part of the actual physical installation, it is included here for simplicity and completeness.
[4] Page 53 of [1]
[5] Page 20 of [1]
[6] Page 19 of [1]
[7] Page 23 of [1]

transmission losses in cable from IDU to ODU) as well as entering geographic parameters pertaining to the location of the installation. This is a relatively minor task lasting up to 10 minutes.

2.4 Service acceptance

The final part of the installation pertains to cleaning up the installation area, making sure the system works as it should do and to instruct and perform demonstration to the end customer about the workings of the system. This process requires in the order of 30 minutes.

2.5 The cost of installation

The material cost for the installation (excluding the actual terminal costs for IDU, ODU) is mainly attributed to the interconnecting cable costs. In addition there are costs for the wall mount and connectors. In total, these costs are estimated to lie in the order of €40 [1][8]. The remaining cost is attributed to labour cost and the cost of the vehicle.

As stated before, the overall price for an installation in Western European countries is in the €350 - €750 region, depending on the type of job and promised volume for a bi-directional satellite installation. To understand what the basis for the price is, the relative costs associated with the main installation tasks can be seen in figure 1.

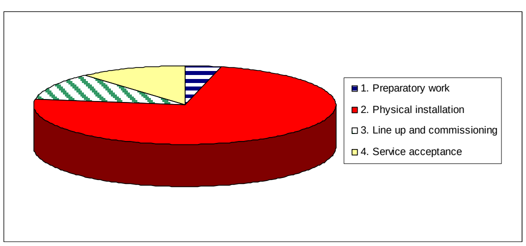

Figure 1; Cost distribution chart for present installation method.

If we focus on the major cost contribution to the installation process, namely the physical installation, this can be further broken down according to sub-tasks as shown in figure 2. This breakdown is generic and as stated before may vary somewhat from one system to another but it still gives a good indication as to where the cost associated with installation reside.

Before discussing possible improvements to the installation procedure it is worthwhile revisiting the technical requirements with respect to pointing of the satellite dish as well as look at the business prospects for DVB-RCS, i.e. the possible geographical density spread of installed terminals. The next two chapters will cover these two aspects.

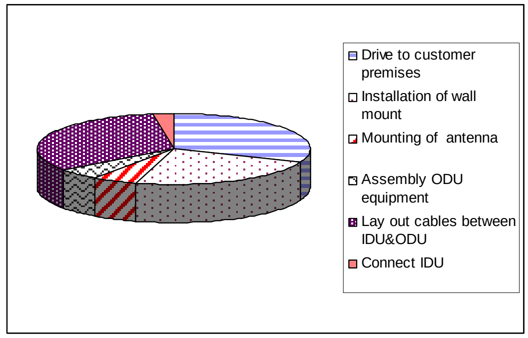

Figure 2; The cost associated with the physical installation work.

3. POINTING REQUIREMENTS

In Europe, ETSI requirements are relevant for the installation of DVB-RCS terminals for their appropriate frequency bands [3], [4]. First of all, ETSI specifies the pointing capability for antennas. The pointing capability of the antenna equipment must worst case manage 0.1 degrees[9] setting granularity in azimuth and elevation. The capability for polarisation alignment is more relaxed with at least 1 degree accuracy to be achieved by the equipment.

In terms of absolute accuracy of the pointing to be attained during installation, the relevant ETSI requirements are the off axis EIRP emission density requirements. These requirements are different for VSAT [3] and SIT/SUT [4] terminal types, with the stricter requirements applying to the latter type. To convert to the off axis EIRP emission density requirement into an allowable pointing error, one needs to consider the antenna gain characteristics, the transmitted power and the transmitted symbol rate. Calculations show

[8] Page 20 of [1]

[9] More relaxed values can be permitted under certain constraints. See [3], [4]

[1][10] that when considering typical DVB-RCS terminal types, the margin to the ETSI requirements are fairly ample to the extent that once these limits are reached the corresponding pointing loss will be so large that it will affect the availability of the actual service. In other words, the question of pointing is practically not so much an issue with complying with ETSI, but more about ensuring an adequate quality of the link with sufficient signal margin for the relevant transmission rate. This is illustrated in the figures below. Figure 3 shows the allowed pointing error in degrees before violation of ETSI requirements occur as a function of various transmitted symbol rates.

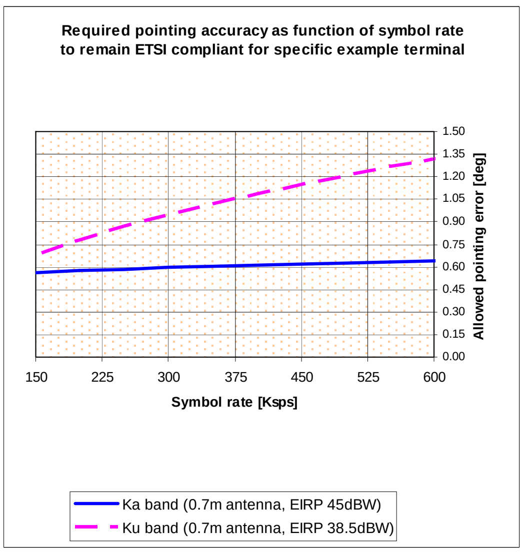

Figure 3; Maximum allowed pointing error before violation of ETSI occurs for a given terminal at Ku and Ka band (see legend).

In the figure above, a 0.7m diameter antenna is assumed with radiation pattern approximated with a second order Bessel function (parabolic distribution in a circular aperture [5]). Figure 4 shows the corresponding pointing loss in dB as a function of the same transmitted symbol rates. Except for low rates in Ku band, the pointing loss incurred when the terminal is pointed at the limit of what ETSI can tolerate is quite large, certainly a larger loss than what an operator would want an installation to have. It should be noted that for other configuration of antenna size and high power amplifier (HPA) output power, the pointing requirements can become more (or less) stringent than shown up until now. It is the prerogative of the operator to select the combination of HPA and antenna offered to users of the system for a given service. As such an operator can consciously consider particular ODU configurations that allow pointing margins and thus eases installation.

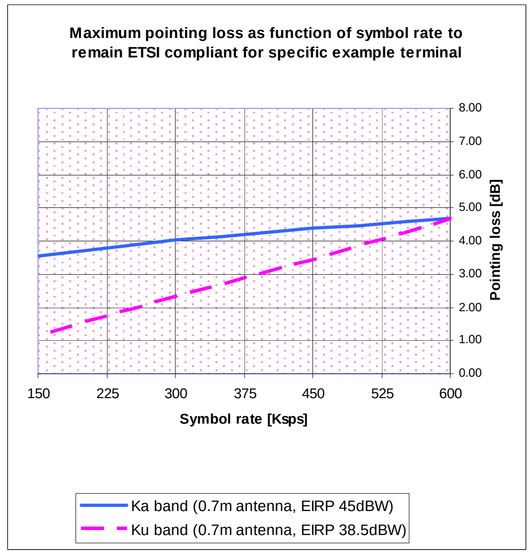

Figure 4; The transmit pointing loss experienced corresponding to the maximum pointing error before violation of ETSI occurs. See legend for terminal characteristics.

For polarisation alignment, the ETSI requirements are also fairly ample. Rather than limited by ETSI, the absolute alignment accuracy requirement in the polarisation plane is therefore usually defined or limited by the system operator based on relevant system characteristics (such as whether polarisation reuse is utilised or not, and if utilised, the sensitivity of the employed modulation scheme towards cross polarisation interference).

It is worthwhile clarifying a common misconception related to cross polarisation alignment of the antenna. Achieving the cross polarisation performance is sometimes cited to be the most critical operation of the antenna alignment. Although this is certainly true, it is often wrongly interpreted towards meaning that achieving the polarisation alignment is the most critical operation of the installation. To clarify this one must look at the co- and cross polarisation gain patterns of an antenna. As stated before, the cross polarisation gain pattern

[10] Page 45 of [1]

in the elevation, azimuth and polarisation plane has a very sharp response as a function of antenna pointing angle with a distinct minimum/notch at bore-sight. This contrasts very much with the co-polar gain patterns for the same planes and over the same angles where the response is comparatively flat. The cross polarisation gain response is therefore more useful to observe and provides better accuracy when aligning an antenna. This is however valid for all planes and not just for the polarisation plane. Consequently, when a cross polarisation performance for alignment purposes is specified, this does just as much impose constraints on azimuth and elevation alignment as polarisation alignment. In fact, the latter is the least demanding in terms of absolute alignment accuracy (in degrees) needed to achieve the cross polarisation requirement because the gain response is the most forgiving (the least sharp).

Interesting to note further is that modern digital modulation schemes require comparatively less signal to noise ratio than their analogue predecessors. As such, they can also tolerate more cross polarisation interference. When system operators nonetheless persist on tough cross polarisation requirements during installation, this is partly to ensure that high quality pointing is obtained also in azimuth & elevation.

To round this discussion off it should be said that it has been calculated that 2 to 5 degree accuracy [1][11] is sufficient polarisation alignment for DVB-RCS systems (5 degrees correspond roughly to about 21dB cross polarisation discrimination and does not impair significantly the signal quality through cross polarisation interference for current DVB-RCS systems). However, an operator could even intentionally dimension the system to allow for yet larger degradation due to polarisation misalignment if this results in ease of installation and substantial cost reductions.

4. DVB-RCS MARKET CONSIDERATIONS

The ESA study has made an attempt to predict the amount of installations required in a given limited geographical region to gain some appreciation of expected installation load for installers of DVB-RCS system.

In order to do this, France was considered as a model and the population was grouped into categories of population density. The higher population density centres were considered lost to other terrestrial broadband service providers (such as DSL) while the more rural population areas were considered addressable by DVB-RCS. For the addressable market, a further distinction was made between medium population densities where a single (higher end) DVB-RCS terminal grouped with WLAN could provide services for several households, and low population densities where a single terminal per household would be required. With a captured market share of 10-15% of the addressable market, the DVB-RCS market would reach approximately 200.000 terminal installations in total (low end consumer to high end ‘prosumer’ type). This number was further assumed to be reached over a 4 year period, making the annual installation load for a country the size of France (with an area of about 675.000km^2) to 50.000 terminals (about 200 each work day). This is roughly 1 terminal per day for every 4500km^2, corresponding to a circular coverage area with radius of 38km. For an installer attempting to perform more than this 1 installation in one day, operational coverage area must either be increased or alternatively, orders for installations must be accumulated over time.

Concerning the first possibility, the wider coverage area leads to more travel time and less time left for on-site installation work. The point to underline is that no matter how effective the on-site installation procedure becomes, there is a limit to how many installation that can be done in a day due to geographical constraints. As time efficiency on-site would allow for more installations to be done, that time would disappear in travel time getting to those sites. For a country like France, the practical limit would lie at 2-3 installations per day with about ½ the day spent in travelling time. The cost for the installer for the relevant day would then have to be shared by the customers of those installations.

The alternative to the above approach is to cater for a smaller geographical area and to accumulate or distribute installations orders over time. A practical sized coverage area for an installer as indicated by the ESA is about 50 French so-called ‘local areas’, with a local area being typically 25km^2, i.e. 3km in radius). The

[11] Page 44 of [1]

number of installations would then be one every second day and the travel time to each installation about 30 minutes. With less time spent travelling, more installations can be performed in any given day. However, orders would then have to be accumulated over time before installations could commence. If for instance 4 installations were planned in a day, orders would have to be on average accumulated over 8 days. Long lead times like this could impact the product attractiveness for customers as well as the attractiveness of the business case for an installer contemplating entering into the DVB-RCS market. The obvious solution to this is to have installation of DVB-RCS terminals performed on a part time basis with the installer tending to other work, such as DTH installations, in-between. This entails that, any operator seeking to deploy a DVB-RCS network should instead of employing a dedicated full time (and thus fully paid) installation team, utilise existing, local workforce which can take up DVB-RCS installations as a part time activity.

Having DVB-RCS installations performed on this basis entails that the installation procedure cannot be complex, but instead tailored towards the wide range of skills which will be mirrored in a non-dedicated workforce. The procedures must therefore be intuitive and simple to avoid the installer needing to spend time refreshing the procedures before each installation. The geographical coverage area of a part time installer should not be too great in order to limit travel time and thus cost. On the other hand, if the area is too small, the installation work becomes infrequent to the extent it is no longer an attractive business for a part time installer to contend with. The area indicated earlier in the text leading to an average 30 minutes travel time per installation would result in some 500 installers in total needed to be recruited across France.

5. REDUCTION IN INSTALLATION COST

In order to reduce cost of installation, two methods are possible;

1. Reduce the time an installation takes
2. Avoid the installer altogether

These two possibilities are described further in the text that follows.

5.1 Optimising installer time

Chapter 4 discussed how installations could be organised to minimise travel time and associated cost. This chapter discusses how on-site installation time can be reduced.

Reduction in installation time can be reached by implementing incremental improvements or changes to the various sub-tasks of the installation. Recalling the points under chapter 2.2 this entails for instance having ODU equipment pre-assembled thus avoiding the installer having to spend any time on this task at the premises. Another point is to standardise the wall mount making it not larger than what 1 person can comfortably handle alone and without assistance. Major time can be saved by limiting the cable layout to a 'quick and dirty' connection between IDU and ODU, i.e. just a simple connection and leaving any esthetical layout for the customers to do themselves. This would naturally be an option as some customers still will prefer not to do this task.[12]

In terms of service acceptance, it was noted earlier that time was spent on demonstrating the operation of the system to the customer. A sensible improvement here is to aim for plug and play equipment with software which offers to the customer tutorials and basic, reliable self diagnosis as effective guidance for trouble detection.

For the line up and in particular when a call to the NOC for the pointing confirmation is required, an automatic feedback mechanism to the installer could replace the telephone call and would eliminate any excess time spent trying to consult NOC personnel. Such an automatic feedback mechanism would entail installation of dedicated additional equipment on the hub side, i.e. an alignment system which would monitor the received co- and cross polarised components transmitted from terminals being installed and forward the result back to the terminal and the installer. To schedule or request measurement sessions performed by the hub on a particular terminal, different solutions can be envisaged.
One can envisage that the installer, after having aligned the terminal using the receive signal only, instructs the terminal to perform a special

[12] On longer term, one could envisage wireless interfaces between the ODU and the user. However, a complete wireless solution will not be likely as the ODU in any case will need a power supply as a minimum. See also the appendix.

short log on to the DVB-RCS network. This log on differs from normal log on in that the CSC burst contains a setting (RCST mode) to allow the hub to identify that the terminal is requesting line up. A hub controller would then activate the alignment server which via the normal forward link (as the terminal is logged on, a PID exists) will instruct the terminal to transmit a CW carrier at the appropriate frequency and time. The measurements output resulting from the CW transmissions from the alignment server would also be fed back to the installer via the forward link and enables correct pointing to be achieved. The details concerning this approach can be found in the ESA study report [1][13].

An alternative to the above approach is to have a dedicated frequency for terminals to request line up directly to the alignment server. This eliminates the need to log on to the network first. The terminal, on instruction from the installer, would then in aloha fashion send pulsed CW requesting line-up (the pulsing is basically low rate modulation allowing the terminal to identify itself) on this dedicated frequency. The alignments server processes the request and communicates to the terminal using a pre-defined dedicated multicast installation PID. An appropriate frequency and time for the alignment procedure to take place will be allocated and the rest of the operation would follow the same lines as described before. This second approach has the advantage over the first that it does not require as accurate pointing as a precondition to enter into the interactive alignment. However, it does require the automatic feedback mechanism to be slightly more complex.

With these improvements in hand, it is envisaged that the on-site installation time can come down to in the order of 1.5 to 2 hours. This should allow for an installation price of €200 - €300 (Western Europe prices) [1][14].

5.2 Avoiding the installer altogether.

The only possible way to improve on installation costs further than that indicated in the previous chapter is to avoid the installer altogether. Many people today are capable of installing their own DTH terminal. If the complexity of DVB-RCS terminal installation was of a similar degree, it could also be installed without the aid of professional assistance.

How can self-installation be achieved? The most critical issue is the antenna alignment as the operator need be ensured that the alignment is in accordance with ETSI regulations and with self-defined pointing requirements. There are at least three possibilities for self installation;

1. The user aligns the antenna using forward link solely
2. The user aligns the antenna with the aid of the forward link first, thereafter with the aid of the return channel and feedback from NOC
3. The user only roughly sets the antenna and a motor fine adjust the pointing with the aid of forward and/or return link

5.2.1 Manual alignment (possibility 1 and 2)

The ESA study on low cost installation indicates that about 0.5dB accuracy can be achieved when aligning an antenna using the forward link only. [1][15]. With this alignment accuracy in receive, the corresponding pointing losses on the return link for Ku/Ku, Ka/Ku and Ka/Ka terminal will be just under 1dB, about 4dB and just over 1dB, respectively, if a 0.7m diameter dish size is assumed. This is illustrated in figure 5.

With respect to point 1 above, this procedure is not practical for Ka/Ku band terminals but may work for Ku/Ku and Ka/Ka band terminals if the operator can tolerate transmit losses of about 1dB. It does require a system to be implemented in the terminal that ensures that the antenna boresight is accurately and uniquely identified and that depointing does not stray away more than 0.5dB from this boresight. Moreover it requires the patience and capability of the user to align the antenna to 0.3 - 0.5degrees accuracy (Ka/Ka and Ku/Ku, respectively). For better alignment accuracy as required by Ka/Ku band terminals, the return link must be utilised as well. This should result in accuracies of 0.3degrees or better.

A challenge to self-installation is to provide feedback mechanisms bringing turning instructions to the user located at the antenna in a very comprehensible and simplistic manner in

[13] Page 67 onwards in [1]
[14] Page 61 of [1]
[15] Page 81 of [1]

line with a low cost philosophy. To be safe operators should also assign ample margins in their link budget to accommodate easy pointing to the benefit of their users. This naturally has consequences in terms of cost per bandwidth as the remaining link margins will support lower symbol rates.

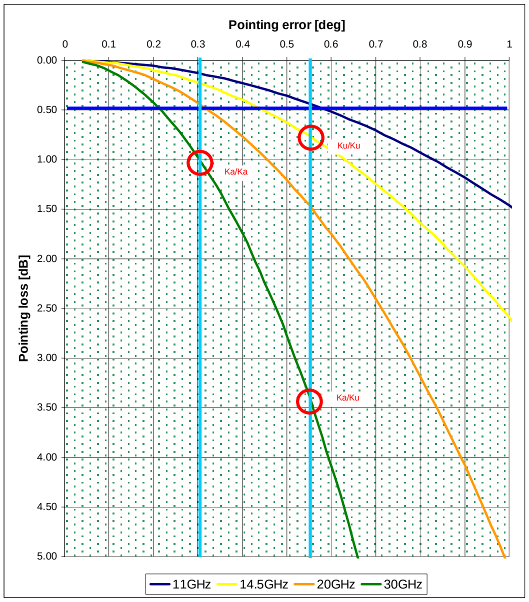

Figure 5; Antenna pointing loss as a function of pointing error at different frequencies for a 0.7m diameter antenna (approximated using second order Bessel function with parabolic distribution in a circular aperture). The solid horizontal line at 0.5dB marks the achievable alignment in receive. The circles marks the corresponding transmit losses for Ku/Ku, Ka/Ku and Ka/Ka frequency bands.

Although technically feasible, self-alignment will not be perceived as trivial by all users and may leave a number of users frustrated, possibly dissatisfied and not capable of aligning the antenna. It becomes increasingly difficult where high pointing accuracies are required and where users will have to contend with the delays imposed by the satellite link for receiving feedback on their pointing actions (as for Ka/Ku band terminals for instance).

5.2.2 Motorised alignment

A motorised solution that automatically points an antenna in elevation, azimuth and possible polarisation would limit user involvement to only roughly mount the dish in the right direction while the motor would do the rest. User frustrations are thus avoided while highly accurate pointing and an optimised link can be achieved.

Motors for controlling transmit-receive antennas accurately exist today. However, they are usually very expensive and out of reach of the ordinary consumers. Motors for DTH terminals on the other hand have over the last number of years become more commonplace in the consumer market. Different motor types exist, such as polar mounts with actuators, H-H motors (Horizon to Horizon) and DiSEqC motors. These motors are designed to allow the antenna to point at various satellites along the geostationary arc, providing the user a better offer of television channels. The motors most commonly only offer one axis movement, i.e. movement along the geo-stationary axis.

The DiSEqC motors are targeted for a consumer market and for easy installation. They are fairly compact and self-contained units which do not require any additional power or control connections other than the standard, already existing, coaxial connection to the set-top box. Steering commands are communicated using a standard DiSEqC protocol. This is of course very convenient for the user but also carries some disadvantages. Most prominently, the motor has to make do with the limited power available from the set-top box. To contend with the large forces experienced on an antenna dish from for instance wind loading, a large gearing ratio has to be employed. This however, makes the dish movement speed slow. In order to be able to cover a wide arc of the geo-stationary orbit within reasonable time, the teeth in the gearing mechanism are coarse which unfortunately results in play or movement (slack) in the gear mechanism. This limits the accuracy of the pointing that can be achieved (0.5 degree play has in one instance been reported). The accuracy may be adequate for receive-only applications but could present a problem for bi-directional applications, certainly at higher frequencies.

H-H motors are similar to the DiSEqC motors in that they are fairly compact. However, they usually do need external steering commands (external boxes exist to convert DiSEqC commands from a set-top box to signals understood by the H-H motor) and also external power. Although more cumbersome to deal with in terms of installation and wiring, they do not have the supply power limitations of DiSEqC

motors which can be utilised to allow motors to accommodate more load, move faster and/or more accurate.
The more cumbersome but more allowing interface of H-H motors are also traits of polar mounts with actuators. In contrast to the two previous motor types however, this type does also not offer a compact, aesthetically pleasing appearance and can be trickier to mount.
In terms of cost, on a very general basis it can be said that the polar mount with actuator solution is the cheaper followed by DiSEqC and H-H motors. However, the motor types are very different in capability and appearance making it hard to make direct comparisons.

The requirements to a motor for DVB-RCS terminals would have different requirements to that of a DTH terminal. First of all, such a motor would have to have additional axis of movement, i.e. azimuth, elevation and possibly polarisation (it is conceivable that polarisation could be left to the user/pre-set as accuracy requirements are less stringent) instead of just one axis. It would have to contend with the heavier weight of DVB-RCS antennas compared receive only equipment. The accuracy requirements of the motor would be stricter. However, there are also some elements of the operational environment which eases the requirements to a motor. For DVB-RCS terminals it is not foreseen that a user will switch between satellite operators in the same manner as a user switches between satellites for DTH reception. If limited, but still ample, pointing requirements are put on the user when first installing the antenna, the range over which the motor would need to operate can be smaller than that of receive-only motors.

It is very difficult to predict the possible cost and price of a motor suitable for DVB-RCS terminal. By extrapolating DTH motor technology by multiplying the present price by the number of motorised axes required in DVB-RCS, one ends up with a price comparable to the optimised installation price for Western Europe using a professional installer. Clever industrial design may improve on this situation. In particular, initiatives through industrial co-operative groups such as SatLabs may help where effort is co-ordinated and standards defined in order to ensure interoperability. In this manner larger addressable markets are created for products which in turn give cost benefits. ESA has the intention to explore the approach of motorised installation for DVB-RCS. A development to this end will limit the initial industrial investment for the design and implementation of motors and thereby reduce the burden of high non-recurring costs needed to be recuperated through sales.
However, beyond getting rid of the expensive installer, a motorised approach would allow for other advantages as well. Firstly, the logistics of providing terminals to end users would be simplified. A terminal could basically be picked up in any shop by the customer directly at his/her convenience. No scheduling with end customer would be required and the customer would not need to reserve a time slot to be available at home for the installer to come. The costs for operator training of installers would also be reduced or avoided altogether. As mentioned before, with a motor very good pointing accuracy can potentially be achieved which ensures good link conditions.
An additional possible advantage of this approach is the maintenance aspect. A motorised solution can allow re-pointing of the dish if required. A request for such a re-alignment could be generated remotely by an operator as well as locally triggered by signal monitoring. However, this will depend on how the motor is implemented, i.e. whether the motor is capable of steering the antenna and withstanding associated loads over time or if the antenna, once the motor has aligned it adequately, is fixed. This latter approach may have benefits in terms of the motor cost.

In summary, as well as potentially reducing the cost of having an antenna installed, a motorised approach gives additional benefits to the system operator (easier logistics, link quality, reduced installer expenses) which provides lower cost of operation which surely will benefit the user of DVB-RCS systems.

6. CONCLUSION

It is possible to improve current installation procedures and thereby reduce the cost of installation. System operators can play a part in this partly by, for a given service, selecting ODU configurations which are tolerant to pointing errors in terms of respecting ETSI requirements. Secondly, for installations performed by part-time installers or even possibly the end-customer, operators should assign margins and pointing requirements which are consistent with easy line up procedures.

In any case, there are means of simplifying line-up procedures by providing automatic feedback to the installer as described in the ESA study and in this paper. Companies, such as Siemens Austria [6] and Integrasys [7], are already implementing systems to this effect. However, line-up is only one aspect of installation. Other incremental improvements to existing routines are needed. It has been shown in the ESA study that a multitude of gradual improvements can bring the price of installation down to the €200 - €300 range (Western Europe prices), which unfortunately still is a non-negligible price tag. This price tag includes a 'quick & dirty' cabling between the IDU and ODU where any additional aesthetical pleasing layout is left to the end user to sort out.

If the end user anyway may have to contend with the layout of cabling, there is conceptually a short additional step to users performing the entire installation themselves. Although pointing a dish on a consumer basis is not trivial and can leave users discontented, a motorised solution can circumvent this and help negate the need for professional installation altogether. A motorised solution can bring the cost of installation down even further than what can be achieved with professional installers. It can truly bring a consumer product feel to DVB-RCS terminals in that terminals can be picked up by consumers themselves directly from the shelf of an electronic store at any time of convenience. Appointments with installers and arranging of time off work are no longer needed to obtain your DVB-RCS service. Logistics, distribution and operations concerned with installation are simplified and optimised pointing to ensure maximum exploitation of a valuable and costly link can be ensured. All these elements bring the cost of operation of DVB-RCS system down. A low cost motor solution is possibly the only way to reduce the cost of installation further than that indicated in the ESA study and will as such be beneficial to the DVB-RCS community.

Obtaining a suitable, truly low cost motorised solution is not trivial and a solution does not exist today. For this reason ESA intends to pursue the matter in terms of issuing a development contract to this end.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

[1] ESA study final report, accessible through the following web site; http://telecom.esa.int/cosysit

[2] Internal ESA aggregated figures

[3] ETSI EN 301 428

[4] ETSI EN 301 459

[5] Y.T.Lo and S.W.Lee, Antenna Handbook Theory, Applications, and design, Van Nostrand Reinhold Company Inc. 1988, ISBN 0-442-25843-7, Chapter 5.

[6] Siemens Austria project page at the ESA web site; http://telecom.esa.int/elu

[7] Integrasys, web page http://www.integrasys-sa.com/

9. APPENDIX

Although the ESA study and this article has focussed on reducing cost of installation of terminals utilising the present DVB-RCS architecture, in a longer time perspective it may be interesting to evaluate alternative terminal architectures which could lower cost of installation and ownership even further. One such architecture could be an integrated ODU and IDU located at the antenna with a wireless LAN interface to the user. Such a solution would ease the burden associated with cable installation (only a low cost, flexible power cable to contend with which needs layout to the nearest socket) and would easily allow sharing of the terminal (and it's cost) between several users in a community. There are technical challenges to such an approach (environmental conditions for IDU components now located outdoor, weight, cooling and spurious issues etc) and whether it is viable in the near future remains to be seen.