Newsgathering by satellite

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Summary The article considers the growth in satellite newsgathering from the first systems operating at C Band in the USA to the current Ku-Band equipment available from Marconi.

A detailed description is given of the Newshawk SNG system, together with consideration of its use in a network. Future requirements and possibilities are reviewed, pointing towards even smaller and lighter equipment.

Introduction

A logical extension to electronic newsgathering, where the portable camera output is transmitted by microwave link back to a studio or directly to an OB van, is satellite newsgathering (s.n.g), which simply replaces the microwave link by a satellite link. The most important feature of any of the systems is mobility, and the degree of mobility required is a question which can be answered only by the user not the manufacturer. Most broadcasters or common carriers have experience in the use of satellite either for receiving programmes, in order to allow rebroadcasting, or for intercontinental transmissions of video or data. Now the television broadcasters' need to be able to respond to events quickly has led to the development of satellite ground stations mounted in vehicles. Initially, in the mid 1970s, these systems used C-Band satellites as they were readily available worldwide. The technology was based on well-proven designs, there being large numbers of fixed operational stations. The problem was how best to realize a mobile system.

Design considerations

Early mobile uplinks required antennas up to 10m in diameter (with downlinks even larger). The antennas were mounted either on a trailer or directly on to a van which housed the electronic equipment. A typical satellite uplinking system is shown in figure 1. The problems of C-Band operation were threefold. Firstly, the size of the antenna necessitated using either a large truck or a sectionalized fold-over antenna which could be transported on ordinary roads. Secondly, the C-Band spectrum was becoming highly congested and, finally, the satellite transmissions often interfered with terrestrial systems operating at 6GHz. Then, in the 1970s, the advent of Ku-Band satellites, operating in the 11 – 14GHz band, gave a new and important impetus to the development of s.n.g. It came into use as a direct result of the congestion at C-Band and, from a satellite terminal point of view, it allowed new small terminal designs to be realized which could more easily be mounted on vehicles. In addition to this, the 11GHz band is not used for terrestrial communications to anything like the same extent as the 6GHz band and so the problem of interference with satellite terminals does not arise. The new terminals require antennas between 2m and 5m with 300W or 600W high power amplifiers (h.p.a). The electronics equipment contained in the vehicle has to have a number of features, viz:

a) utterly reliable transmission of the video and audo, utilizing one-for-one redundant h.p.a with automatic switching between main and standby systems should an amplifier fail,

b) a receiving system that will provide a broadcast quality picture at its output,

c) facilities that will allow for control of transmissions and programming,

d) the antenna must be as small as possible, but this cannot be achieved simply by increasing transmitter power to offset the reduction in antenna diameter as audio and video still have to be received on the downlink. There are several ways of overcoming the difficulty. Some systems have a single-piece antenna, others use a segmented or folding mounting system that allows up to 360° rotation, and retraction through the vehicle roof for ease of transportation, low windage etc. The vehicle itself has to be carefully designed to allow levelling by means of jacks. Some means of checking the satellite position is necessary, and some systems provide a complete navigation system to give exact location, whilst in others a simple compass and calculator is used.

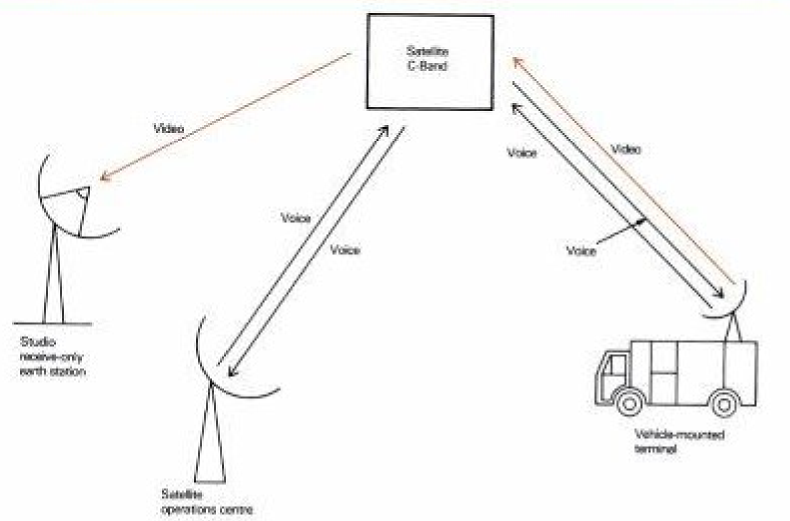

Fig. 1. A typical satellite uplinking system

In addition to video and audio transmissions, vehicles are often plugged into the local telephone network so that co-ordination can take place by use of landline. Others use subcarrier transmission for this purpose, where the audio is modulated on to the video carrier. In the USA, separate satellites can be used for audio and video transmissions.

'Flyaway' systems

One form of s.n.g usage requires not only mobility but also the ability to get to the scene of the news quickly and to operate in physical circumstances which are impossible for normal vehicles. For this the 'flyaway system' is essential. It is a very light, highly portable system that can be transported in a light aircraft, estate car or light van.

If the required characteristics of a flyaway system are considered it can be seen that they are:

a) the terminal must be as light as possible and each of the equipment packages must be small enough to be handled easily by, at the most, two men. It should be recognized that modern electronic equipment, though it may be small in size, can be extremely heavy and this must be taken into consideration. This attribute of light weight in a flyaway system has a direct impact on operating costs, due to the lower transport charges compared to a vehicle-mounted system, for which the cost of an intercontinental journey is typically greater than £75,000. This would almost cover the capital cost of the flyaway equipment,

b) the equipment must withstand severe environmental conditions with temperatures as low as −20°C and as high as +40°C. It must be able to work after suffering severe shock, such as being dropped on airport runways or sliding down concrete steps, to operate in the rain, and not to be affected by travelling over rough terrain. In addition, it should cost as little as possible,

c) simplicity of operation. Over-sophistication in a design leads to a system that is difficult to set up and operate,

d) reliability. This is, perhaps, an obvious point, but it is often overlooked or, rather, taken for granted. Reliability, and especially repeatability, are absolutely essential in the environment in which the equipment has to be used. It is very easy for a supplier to say that his system will perform without trouble, it may be quite a different matter in practice.

Newshawk

The Marconi Newshawk is at the forefront of s.n.g systems. In its basic form, as shown in figure 2, it uses a single-piece elliptical antenna, a 300W h.p.a and associated electronics.

The antenna

The antenna is designed on the same principle as the larger transportable P7020, described in a previous article.[1] It is of course much smaller and of lower gain, having the characteristics shown in Table 1. It can be seen that the antenna performance, in terms of sidelobe characteristics, meets the mandatory requirements of INTELSAT, EUTELSAT and FCC specifications and, in addition, the very stringent polarization performance is met.

The antenna is mounted on an elevation-over-azimuth mount, which is integrated with the support structure. It is adjusted by hand, a simple operation once the clamp system is released. It is essential that the antenna is levelled before operation is commenced. In order to achieve this, screwjacks are fitted at each corner of the antenna support structure, and a spirit level is set into the base. The adjustment available is 150mm. Special footplates are available for use on soft ground.

The antenna is an offset Gregorian and uses an elliptical reflector to achieve the superb sidelobe performance. In addition, the physical size that is obtained allows easy deployment and transportation because the reflector can

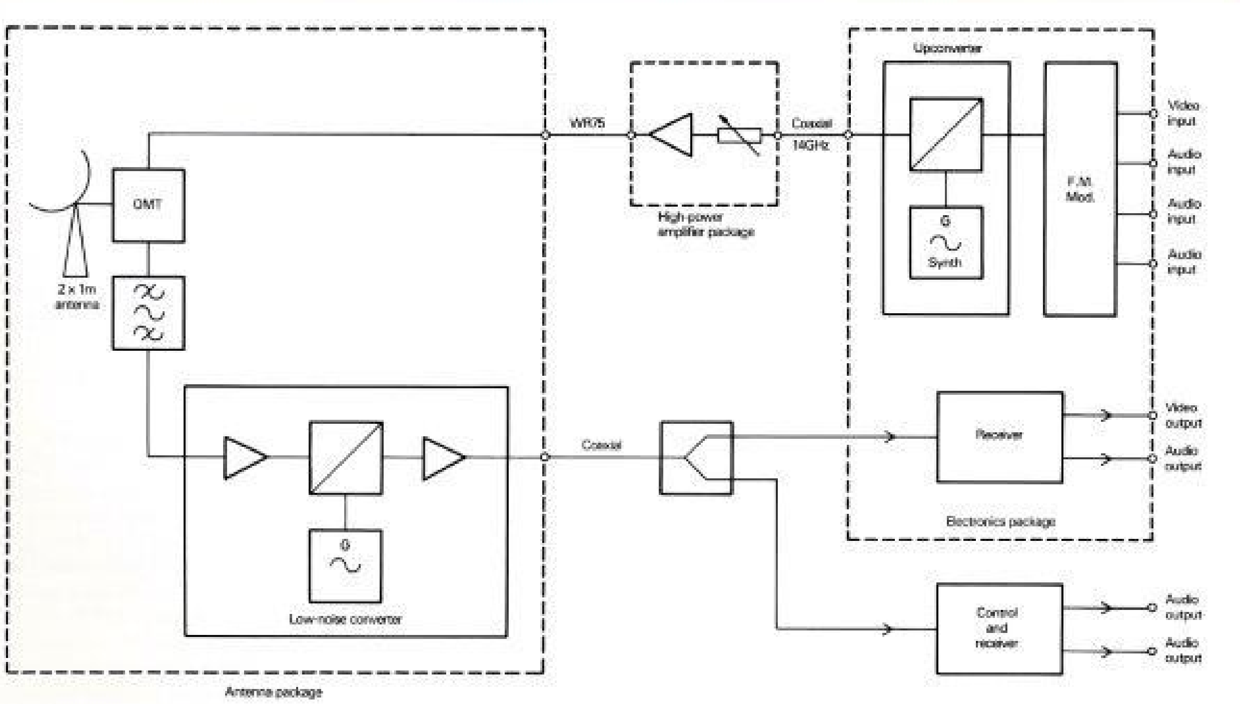

Fig. 2. Newshawk – basic system configuration

Table 1: System performance – antennas

Frequency range (GHz)	
Transmitter	14·0 to 14·5
Receiver	10·95 to 12·7
Gain (typical):	
Transmitter (14·0 GHz)	45dB
Receiver (11·7 GHz)	43·8dB
E.I.R.P. (typical):	
300W h.p.a	69dBW
160W h.p.a	66dBW
80W h.p.a	63dBW
G/T	19dB/K
Sidelobes	$29 - 25 \log \theta$ $1<\theta<36$
(within 40° of major axis)	-10dB; $36<\theta<36$
Polarization	Orthogonal, linear
Polarization adjustment	±100° manual
Polarization purity	−35dB on axis down to −1dB co-polar FCC, Eutelsat, Intelsat compliant
Interport isolation	30dB
V.S.W.R	1.25:1 both ports

be folded down flat giving an effective height of only 0.42m. The reflector is of glass-reinforced plastic sandwich construction which has an aluminium backing structure in order to achieve the stability and profile accuracy needed to meet the required performance.

The feed system is designed to meet any Ku-Band satellite system performance. It uses an ortho-mode transducer and is rigidly mounted on the subreflector support frame. The feed horn, part of the feed assembly, has a Kapton window to protect its aperture. Polarization may be adjusted by manually rotating the feed.

A considerable amount of effort has been put into the mechanical design in order to provide a system that can easily be transported and which also provides protection to the reflector and feed.

High-power amplifier

There is a choice of h.p.a, each of which is designed to be mounted in a flight case. The low-power option of 160W is intended for situations in which a high-power satellite is available, but two could be used in a soft redundant mode by phase combining amplifier outputs. The other option, a 300W system by the English Electric Valve Company, is mounted in a single flight case and is one of the smallest amplifiers for its output power in existence. It is a single 19in rack-mounting unit, having a height of 15.75in (400mm). It is not only the smallest amplifier but, at 59kg, the lightest amplifier of its kind in the world, being half the weight of anything comparable. It requires a single-phase power source and a total prime power of 2kVA, which considerably reduces the size of any diesel generator that might be required. The output power of the amplifier is sufficient to provide a typical e.i.r.p of 68dBW, although this figure is obviously dependent upon the length of waveguide used to connect the amplifier output to the transmit port of the antenna feed. The system is designed to be user friendly when connecting the amplifier, with the provision of a variety of flexible and fixed waveguide that can be coupled by quick-release clamps.

The portability of the equipment requires the system designer to pay close attention to the layout to ensure that the signal losses are kept to a minimum. This means that the amplifier must be positioned as close to the antenna as possible.

Electronics package

The terminal is exceedingly flexible and can be configured to most customer requirements. Although it may often be used for the transmission of a television signal over a single link, it can in fact be used in a network situation, when the terminal will transmit one video and up to three audio signals. The audio signals are frequency modulated on to a 6.5MHz carrier before being combined with the video signal. After pre-emphasis and the addition of energy-dispersal, the signal is modulated onto a 70MHz carrier which is bandwidth limited before being double-upconverted to the 14GHz band. The electronics package that accomplishes the above processing is housed in a second flight case. The equipment comprises an upconverter shelf, a signal patch panel and a satellite receiver. The upconverter shelf contains the baseband unit, modulator and frequency agile upconverter

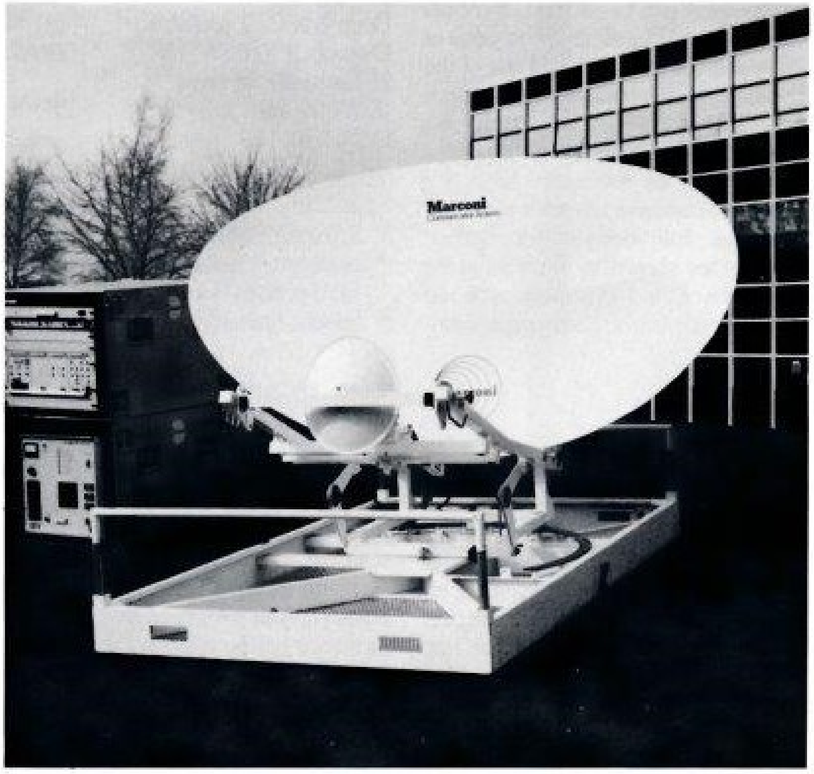

Fig. 3. Newshawk, showing the antenna and flight boxes

module capable of carrying out all the necessary processing functions. A full specification is listed in Table 2. One important element not yet mentioned is the low-noise converter (l.n.c), mounted on the feed mounting frame. This unit is preceded by a waveguide filter which can be varied to work either in an American or European environment as far as frequency is concerned. The l.n.c is powered by a supply in the electronics package, giving a self-contained system.

Table 2: System performance – modulator/upconverter

Input frequency	25Hz to 8·2MHz
Input impedance	75Ω
Video input level	1V p-p (BNC) CCIR Rec. 405–1
Deviation	16–25MHz/V
Audio input level	775mV (0dBM) 600Ω
Audio subcarrier frequency	6·2MHz and 6·8MHz
Deviation (audio subcarrier)	50–150kHz peak
I.F bandwith	36MHz
Output frequency range	14·0GHz to 14·5GHz
Output power (s.h.f)	–12dB
Output impedance	50Ω
Output v.s.w.r	1·22:1
Tuning	Manual in 125kHz steps

System operation

To get the equipment to the scene of the news, the Newshawk terminal, with antenna folded down and flight cases closed, can be loaded into a light plane or small van, or simply be checked on to a commercial airline as normal baggage. Once on-site, an unobstructed view of the satellite must be arranged and the direction of the satellite found, using a compass. The next step is to align the antenna with the satellite, a process that starts with a manual adjustment using previously calculated azimuth and elevation angles, before precise panning of the antenna to maximize the received signal with the meter on the satellite receiver. Once access has been achieved, a variety of co-ordination tests have to be carried out with the Satellite Operations Centre before full transmission can be allowed. It should be recognized that, from a cost point of view, this is a very critical phase of the operation in that for every ten minutes of operation time, for which the customer pays, there can be up to 30 minutes of setting-up time, for which the customer does not pay!

Typical link budgets for various satellites are shown in Table 3, giving some idea of the performance required when using the newsgathering system.

Table 3: Link budgets

	Domsat		Europe	Cross-strapped
Uplink:				
Earth station e.i.r.p (dBW)	69·0	69·0	69·0	69·0
Free space loss (dB)	207·2	207·2	207·2	207·2
Atmospheric loss	0·4	0·4	0·4	0·4
Satellite G/T (dB/K)	0·0	0·0	–1·0	0·0
Uplink C/T (dBW/K)	–138·6	–138·6	–139·6	–138·6
Downlink:				
Satellite e.i.r.p (dBW) (saturated)	47	47	40·8	22·0 (C-band)
Satellite e.i.r.p (dBW) (available)	47	47	33·6	
Free space loss (dB)	205·5	205·5	205·5	196·8
Atmospheric loss (dB)	0·2	0·2	0·2	
Earth station G/T (dB/K)	29·9 (1)	19·0 (2)	39·0 (3)	40·7 (4)
Downlink C/T (dBW/K)	–131·8	–137·7	–133·1	–134·1
Overall C/T (dBW/K)	–139·4	–142·2	–140·5	–139·9
Boltzmann's constant (dBW/K/Hz)	–228·6	–228·6	–228·6	–228·6
C/N_0 (dB/Hz)	89·2	86·4	88·1	88·7
Receive bandwidth (dB)	74·8	74·8	74·8	74·8
C/N (dB)	14·4	11·6	13·3	13·9

(1) 3.7m Ku-Band antenna
(2) Newshawk receive terminal
(3) ECS primary services (13m to 19m) Ku-Band earth station
(4) Intelsat Standard A (29m to 32m) C-Band earth station

The future

The pressures that gave rise to the fly-away system will also determine the direction of any future developments. The user will be looking for further weight reductions, coupled with smaller size, but without any loss of performance, in fact the reverse. Progress is already being made in three key areas. Firstly, antennas are getting lighter, and size is being reduced by means of sectionalization. In the case of the Newshawk, the possibility is being examined of dividing the antenna into three sections which can be put together simply and without loss of repeatable performance. This will mean that the overall antenna package is considerably smaller and more manageable. Most importantly the operator will have the confidence that no matter how many times the antenna is taken down and re-erected, the performance will be maintained, essential if the operator is to get and retain official approval to use his terminal. It is most unlikely that a multi-petalled antenna, though capable of being broken down into a larger number of smaller packages, can achieve such a performance, a supposition borne out by operational experience. The elliptical antenna lends itself very easily to segmentation, providing a much simpler solution than petallizing.

Secondly, a move towards smaller power amplifiers is essential if much smaller terminals are to be produced. However, unless the amplifier can deliver the same power, in the region of 250W as in the present systems, then overall performance will not be maintained. It is also essential that smaller power supply units are designed in order to meet tomorrow's market.

Thirdly, the electronics equipment such as upconverter, t.v.r.o, co-ordinating shelf and control and supervisory will all be capable of considerable reduction in size and weight. It is possible to envisage a terminal that is only 60% the weight of existing systems, with much of the equipment mounted directly on the rear of the antenna. If higher power satellites become more readily available, then terminals could become very much smaller indeed and much easier to use.

We are seeing a movement in all forms of earth terminal towards smaller and simpler configurations, and the Newshawk is an example of this. Satellites are ideal for point-to-point communications and it is in this sphere that we will see new designs of antennas, amplifiers, receivers and baseband equipments to fulfil the requirements of future terminals.

Reference

1. B. R. Ackroyd: 'Transportable satellite earth terminals', *Communication & Broadcasting*, No.27 (September 1986), pp.19–23.

RÉSUMÉ

L'article prend en considération la croissance en matière de rassemblement d'informations par satellite à partir des premiers systèmes exploités sur Bande C aux Etats-Unis jusqu'au matériel actuel à Bande-Ku disponible chez Marconi.

Une description détaillée du système Newshawk SNG est donnée avec une considération de son utilisation dans un réseau. Les besoins futurs ainsi que toute éventualité sont passés en revue, en s'orientant vers un appareillage même plus petit et plus léger.

RESUMEN

El artículo considera el incremento en la recopilación de noticias por satélite, desde los primeros sistemas que funcionan en la banda C en los Estados Unidos de América hasta el equipo actual de banda Ku obtenible de Marconi.

Se da una descripción detallada del sistema Newshawk SNG, junto con consideraciones de su empleo en una red. Se examinan las futuras demandas y posibilidades de perfeccionamiento, con miras a obtener equipos más pequeños y livianos.

ZUSAMMENFASSUNG

Der Aufsatz erörtert die Entwicklung der Nachrichtenerfassung vom ersten, im C-Band in den USA arbeitenden System, bis zu jetzigen, von Marconi erhältlichen Ku-Band-Ausrüstungen.

Der Aufsatz enthält eine eingehende Beschreibung des Systems Newshawk SNG sowie eine Betrachtung seiner Anwendung in einem Netz. Künftige Forderungen und Möglichkeiten werden untersucht und deuten auf noch kleinere und leichtere Geräte.