NATIONAL CONFERENCE ON ELECTRONICS

Session IX

INSAT - A NATIONAL SATELLITE FOR TELEVISION AND TELECOMMUNICATIONS

Invited Paper by

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When we consider television for India and the hardware system that would be required for it, I suggest that we accept the following premises.

1. We recognise that television can be a most important tool for development. In this context, its impact is at least as relevant, if not more so, to the isolated rural communities where the bulk of our population resides as it is to the urban population already subject to other major influences of modernisation.

2. National T.V. programmes accessible through community receivers to all our clusters of population, urban as well as rural, permitting shared audio-visual experiences, can be a most important factor for national integration. Therefore, it is necessary to have a broad-band communications system suitable for a national hook-up of television particularly reaching remote areas where the population density is small, as in our border regions.

3. By providing entertainment and instruction of a high standard T.V. can produce a qualitative improvement in the richness of rural life and thereby reduce the overwhelming attraction of migration to cities and metropolitan areas.

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If you go along with these premises, which I suggest should be the subject of political decision making, it is easy to demonstrate that by far the most cost effective solution is a hybrid system which utilises a synchronous satellite for providing the broad-band communication link for rediffusion from ground stations in areas where the density of sets is large, and direct broadcast receivers where the density of sets is low. The precise cross-over point from one to the other of the diffusion system in individual regions of the country is dependent on factors which have to be decided technically and economically after practical experience during the DAE-NASA experiment.

If we are to have a large number of rediffusion stations, then for a national hook-up it would still be more economical to use a satellite for inter-connecting all the rediffusion stations. For example, when we connect all rediffusion stations which may be located as far apart as Delhi and Trivandrum via ground micro-wave links for television, we would be tying up all the units along the line between the two points and also similarly all such lines which will be utilised for transmission of the same programme to various rediffusion stations. The impact of this can be judged by noting that the 25 megacycle bandwidth which will be reouired for good quality television will take up about 400 channels available for good qualityvoice communications for telephones which would otherwise be available for the intermediate stations. In the case of the national hook-up when all these rediffusion stations are inter-connected to a transmitting station using a satellite, it represents only the capacity of one T.V. channel utilisation.

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2. DAE - NASA Experiment

The details of the DAE - NASA ITV experiment which is to be conducted in 1972-73 have already been announced earlier, and are contained in the paper "Television for Development" which was presented at the XI World Congress of the Society for International Development in November 1969. Copies are being distributed today at this Conference.

Let me recapitulate the main points: The experiment will be conducted with the ATS-F spacecraft of NASA which forms part of the US programme of Advanced Technology Satellites. It would be the first time that a 30 ft. dish antenna would be deployed with a satellite transmitter of large power. The effective isotropically radiated power would be as high as + 51 dbw which is equivalent to 125 kw. Details of the satellite which are not furnished in the paper "Television for Development" are given in Annexure 1. The primary television signals will be programmed in India entirely under Indian responsibility and would be transmitted from the Experimental Satellite Communications Earth Station at Ahmedabad and from the new earth terminal for the Overseas Communications Service to be installed near Delhi. Slide No. 1 shows the antenna of the Ahmedabad earth terminal. For rediffusion of these signals, a 30 ft. dish type antenna would be adequate. For the direct broadcast receivers a chicken mesh type antenna of 10 ft. diameter ~~as shown in Slide No. 2~~ would be required for each community receiver. The receiver itself will be of a conventional type but will have a front-end converter to accept a down link 850 megacycle FM signal. The proposed

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configuration of T.V. service during the DAE - NASA experiment integrated with the AIR plan is given in Slide No. 2. The major tasks in electronics that would be undertaken in India and which are the responsibility of the Indian Space Research Organisation (ISRO) are given in Annexure 2.

3. <u>A Synchronous Satellite for Telecommunications</u>.

Many questions have been raised about the plans of ISRO/DAE for a follow-up after the completion of the DAE - NASA ITV experiment. I would like here to share our current thinking on this subject. Let us note some salient aspects of the peaceful uses of outer space related to synchronous satellites. Slide No. 3 shows that going from a satellite launcher of the Thor Delta class to an Atlas Agena class the cost escalates from about \$ 5 million to \$ 10 million per launch. The weight of the satellite that can be put into a synchronous orbit can also be doubled. But since a substantial part of the weight of a satellite is taken up by its structure and on-board house keeping the effective payload weight and the capability of the satellite for communication purposes increase enormously thereby making it much more cost effective to use the bigger launch vehicle if there are uses to which we can put the larger capacity. There is available today a one million dollar insurance premium for insuring against an abortive launch, as was done by ESRO recently. When we take into consideration the present experience, the operating useful life of a satellite is about 7 years, but for our consideration we can accept a minimum life time of five years for large communications satellites. The annual allocation of costs for a communications satellite of small configuration would be about

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3.5 million dollars and for a large satellite about 5.5 million dollars.

The USSR has two satellite systems in operation called MOLNYA and ORBITA for television distribution, making it possible to have television programmes distributed on national level. For the educational television network in USA (NET) and/broadcast corporation, NASA has agreed to carry out an experiment for 16 weeks for transmitting programmes from the east coast to west coast in USA using ATS - 3 satellite. For defence, United States has many different types of communication satellites at synchronous altitude as well as at lower altitudes for random orbits. The largest communication satellite for Defence as of today is the TACSAT. Using the high gain antenna and high power transmitters on this satellite, it is possible for a person with a MANPACK to establish communications with another similar unit via the satellite. The United Kingdom has already got a satellite in orbit with the help of the United States and the satellite is called SKYNET. This satellite will be utilised for operational defence communications. Recently NASA has launched a satellite for Defence Communications for NATO and this satellite is called NATO-1. For internal point-to-point telecommunications and distribution of television programmes, Canada has already carried out a study and have advanced plans for a satellite system, particularly due to the inaccessibility of the northern regions of the Canadian country and population clusters, located in remote areas.

The Australian Post Office has proposed communication experiments using the ATS-1 satellite already in orbit and located

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over the Pacific. Slide No. 4 shows the uplink and down link station configurations and Slide No. 5 shows how a possible trunk network could be established using such a satellite. This satellite has an electronically despun antenna. Such an electronically despun antenna gives lower gain than the mechanically despun antenna deployed on the ATS - 3 satellite. The experiment envisages use of a possible connection via the satellite for one voice channel communication using a small earth receive/transmit antenna of 12 ft. diameter and 10 to 100 watts of radiated power. The expected cost for such 12 ft. diameter antenna is expected to be about 8,000 dollars in USA. It is estimated that we can prepare a 12 ft. diameter antenna usable in the C-Band for about Rs. 15 to 20 thousand. The equipment needed for such communication needs would cost about Rs. 1.5 lakhs or so. Using this uplink system with the spread spectrum technique it is considered feasible to establish one channel communication from one group to another for trunk telephones. The present calculations show that a total of about 132 channels can be established for trunk communications. The experiment would provide experience in spread spectrum techniques, Psuedo random noise techniques, Delta Modulation, Pulse Code Modulation operation with a synchronous satellite, and possible integration of a satellite system into existing telecommunication networks.

For our national needs in the time frame of 1974-75, we have taken note of existing experience of communication satellites and consider that the optimum configuration needs combining television direct broadcasting and point-to-point telecommunications payloads.

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4. INSAT - 1

The Indian Space Research Organisation of the Department of Atomic Energy has conducted joint systems configuration studies with General Electric Company and Hughes Aircraft Corporation, two companies in the United States, with a great deal of experience in communication satellites. All the studies carried out so far indicate that, considering the very large number of direct receiving systems involved, the cheapest system would be the one which will be operating in the region of about 800 Mc/s to 1000 Mc/s for the direct broadcasting of T.V. However, for telecommunications, it will be best to operate in the common-carrier band as the number of equipments involved will be very small and the cost differential, depending upon the frequency, would not be very large. Using the data generated in the joint studies and other developments, ISRO has narrowed the field of options for a national communications satellite. The following are the salient features of the space-craft system INSAT - 1, which could become operational for our national needs in 1975.

4.1. The satellite will be a three axis stabilised space-craft and will be located at synchronous altitude at about 79^{o} east longitude. This will minimise east-west drift of the satellite.

4.2. The satellite will have a 23 ft. diameter parabolic antenna to operate in the 800 to 900 Mc/s band, which would result in a beam width of 3.5^{o} and would provide optimum coverage of India.

4.3. The 23 ft. diameter parabolic reflecting antenna and the power amplifiers in the satellite will provide a useful minimum effective isotropic radiated power of about 53 dbw. The antenna beam will be pointed towards any point on the surface of earth with error less than $\pm 0.1^\circ$ peak.

4.4. The satellite will have a capability to operate 3 high power television channels each with several audio channels for different languages and 3600 telephone channels. The transponder configuration for the telecommunications are selected to have 12 independent transponders, so that the transponder utilisation can be maximised depending upon the demand (Intelsat 4 satellite has similar configuration).

4.5. The satellite receiver system for the television as well as telecommunications will utilise a high gain dish of 3 ft. diameter to provide higher sensitivity in the satellite and thereby reduce the required ground effective isotropically radiated power for the ground stations. Further, the satellite will also be provided with Horn antenna systems to provide a lower gain so that in case a jamming signal is detected, we could switch back to a lower antenna gain on the satellite and secure an effective margin of the order of 15 to 16 db.

5. Potential Applications of INSAT - 1.

We could now consider the use to which INSAT - 1 would be put as well as the users who could be interested in using the INSAT profitably. The contemplated use is for either two-way communications, broadcasting or communications requiring data and information dissemination and are summarised in Slide No. 6.

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5.1. Posts & Telegraphs.

P&T can utilise the services provided by INSAT for mainland domestic communications as well as for communications to our isolated islands in the Indian Ocean. The most important usage commercially would be for carrying out point to point communications between four major centres, viz. Bombay, Calcutta, Delhi and Madras. The same transponders on a time-shared basis could be assigned for inter-connecting remote stations on multiple ~~axis~~ access systems.

Following the requirements of 12000 circuits (between the 4 major cities of India - Bombay, Calcutta, Delhi and Madras), given by P&T in one of the NASCOM Study Group meetings, a total payload of 3600 channels for telecommunication was included in the satellite configurations. The ground terminal at each of the four cities will have 35 ft. diameter dish antennas. Considering the present experiments which are being carried out by Australian Post Office, as mentioned earlier, one can visualise that during the lean time period in which the circuits on the satellite are not fully utilised by these four major cities, the satellite transponder could be assigned for multiple axis systems for communicating with remote areas.

5.2. All India Radio

All India Radio can utilise the services provided by INSAT both for direct broadcasting or for rediffusion of the TV broadcast programmes. Using the satellite, the entire country could be illuminated for the direct broadcast as well as for the rediffusion systems. All India Radio can also use a transponder kept on the satellite which will enable All India Radio to interconnect all Radio Stations for national hook-up so that the quality of national radio programmes/

radio news services could be vastly improved by providing better links for transmission. Preliminary analysis shows that for a high grade transmission, the systems requirements could be quite modest. The satellite radiated power required could be of the order of only 2 watts which, coupled with the high gain of the antenna, could produce enough flux density on the surface of India, sufficient for being utilised by a system which would consist of a 15 ft. diameter antenna and a 600° Kelvin receiving system. Thus programmes could be beamed towards the satellite and can be received all over India. The relaying systems will need only a small ground terminal.

It is estimated that 10 channels of 15 Kc/s bandwidth or 30 channels of 5 kc/s bandwidth should be sufficient for such a service. Through the medium of All India Radio other Ministries and other users who need the information to be conveyed but who do not need the medium exclusively can make use of the T.V. Such users would be the Ministry of Health & Family Planning, Ministry of Education, Ministry of Food and Agriculture, Ministry of Civil Aviation and Meteorology, etc.

5.3. <u>Defence</u>

The Defence Organisation and Services could utilise the services provided by INSAT for establishing communications in the remote regions in the hilly areas of Assam, NEFA, Ladakh, Kashmir, etc. Particular consideration could be given for the services which can be provided using the high-power transponder on the satellite and small transportable terminals on ground. Naval ships equipped with small dishes could utilise communication from ship to shore and from

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ship to ship using the satellite for inter-connection. Air Force can utilise the communications which would be provided by the links via the satellites to inter-connect all the operational airports. Thus, if in an emergency situation, an airport is built in a forward area, in a very short time due to the rapid connectivity of the satellite communications, communications can be provided at this airport very quickly, where it would otherwise take a long time for terrestrial means of communications.

5.4. Ministry of Home Affairs.

The Ministry of Home Affairs could secure communications facilities for the border security forces, the Central Reserve Police and other internal security units

5.5. Railways.

The Railways are in the process of installing their own micro-wave communications systems for communications pertaining to their needs. These communications facilities can be augmented by using satellite channels, particularly at Divisional Headquarters levels, so that the in-between routes of micro-wave communications systems could be freed for carrying the traffic for intermediate stations.

5.6. Ministry of Civil Aviation.

The Ministry of Civil Aviation could utilise the communications provided by the satellite particularly for inter-connecting all the civil airports. Thus, operational co-ordination between all the airports can be maintained in a better manner as well as meteorological data could be transmitted from one airport to all the concerned airports very quickly and very effectively. Moreover the same facility could be used by the Indian Airlines for their operations coordination.

The satellite system can be used for dissemination of the meteorological data, particularly by putting it on the AIR television broadcast for farmers and the AIR radio broadcasts for the farmers etc. With the availability of the cloud pictures and the satellite data using the TIROS, NIMBUS and ESSA satellite systems, precise methods of weather predictions can be evolved.

If the predictions about hurricanes, gales etc. are transmitted to the coastal villages via television, our fisheries would benefit extensively as most of our country crafts are not equipped with any kind of radio facility which could be used for receiving warnings etc. The information transfer to the fishermen is very poor otherwise. However, using television in each village of India, information about weather conditions could be relayed to every corner of the country and such information could then be put to use profitably.

5.7. Marine Navigation and Communications.

It might be worthwhile at this stage to consider the usage of a satellite system for marine navigation and communications. Our ships carrying cargo and passengers as well as our ships of the Navy and the ships of various fisheries departments which are involved in deep sea fishing could maintain better communications with shore facilities via the satellite.

5.8. Press.

Major newspapers are published simultaneously in many cities. Such newspapers could use high speed fascimile systems using 50 kilobit/sec data rate. Such a data rate could make it possible for transmission of one newspaper page within about 3 to 4 seconds.

5.9. Data Handling.

The requirements for data transmission and inter-connection of large computer facilities have not yet come up in our country. However, one can visualise that such needs will arise for inter-connecting large computers on a time sharing system. Such communications could be handled by the satellite very effectively.

6. Satellite and Ground Telecommunications.

The satellite systems as considered earlier could be integrated into the existing telecommunications net-work very easily as the satellite system here is planned in such a manner that the system will augment the terrestrial communications capability. A simple calculation can be worked out for estimating the revenue that could be earned by the use of the telecommunications capacity on the spacecraft, INSAT - 1.

Following is a summary of the total amount of revenue which could be earned by the utilisation of the telecommunication capacity on INSAT - 1. Details of this have been given in Annexure 3.

The charge could be levied at a rate of 5 paise per second. This charge would be lower than the charge which is presently worked out for the STD calls between Bombay to Calcutta or Bombay to Delhi. Considering that the total channel capacity available on the satellite will not be fully utilised, it is estimated that the channel capacity utilisation will be only about one-sixth or one-fourth, due to the patterns in the utilisation of the telecommunications. Out of this revenue, one-third would be earmarked for the operations of the terminal equipment and then the revenue which has been worked out turns out to be Rs. 42 crores per year for one-sixth capacity utilisation and Rs. 57 crores per year for one-fourth capacity utilisation. This could be averaged to about Rs. 49.5 crores per year, which represents a total earning of the order of Rs. 247.5 crores over the five year life time of the satellite.

Similarly, calculations could be carried out for the transponder usage by AIR. These are as follows:-

Required time ...	20 hours.
	7.2×10^4 secs. in a day.
30 channels.	
10 channels utilisation	7.2×10^5 seconds which could be changed.
2 Paise per second.	14.2×10^3 Rupees per day.
365 days.	5.183 million Rupees per year.

These calculations are carried out at a rate which is usually smaller than the rate of STD calls.

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7. National Strategy for a Television and Telecommunications Satellite.

In a ten year time frame, one must acquire the capability not only of building telecommunication satellites such as INSAT - 1, but also of launching them into synchronous orbit from our new range at Sriharikota Island. This, however, requires that we have an adequate satellite launch vehicle with accurate guidance and control systems. It should be comparable at least to the performance of the rockets of Thor Delta and Atlas. However, this requires a great deal of effort in highly sophisticated space technology and to begin with we have set as a goal the development of a satellite launcher of the Scout type to be completed in about four years from now. This will only be adequate for putting into low level orbits scientific or Applications satellites of haul-up weight of 20 to 40 kg. But once the basic systems have been developed for this and experience acquired in operating them, it is estimated that a five year period from 1975 to 1980 should be adequate for the second stage of development of the larger booster.

Meanwhile, there is much to be learnt in the designing and building of communications satellites and we propose that by 1974 - 75, we should build one in collaboration with a country advanced in space technology and to be launched also by an outside agency. Typically at least 3 satellites are built before one is launched and it is our intention that during the next three years, some 30 or 40 Indian engineers participate in constructing the first proto-type abroad, but the second and third units would be built in the new facilities

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being established at the Space Science and Technology Centre at Veli near Trivandrum. There is likely to be a need to import a considerable number of specialised components for the first two satellites that would be built here by 1975, but a very major step forward would have been taken in India in acquiring competence to proceed for the second generation communications satellite largely on our own designs. These would be needed only by 1980 since the effective time of operation of our INSAT-1 should carry us from 1975 to 1980.

The programme which we have outlined here represents a most challenging task for Indian scientists and engineers. Electronics will play a very important part in various phases of the programme - in the electronic instrumentation involved in the control and guidance of the rocket, the solar power sources to be put on the satellite, the transponders for television and telecommunication, the digital control systems, the telemetry and tele-command systems and the ground radar and tracking net-work. On the ground segment, there would be need for earth terminals, solid state television receivers at the rate of at least 100,000 to 200,000 a year, a large number of micro-wave and UHF antennas, studio equipment for television, video tape recorders and a whole lot of test and calibration instruments. We are glad to have this opportunity to unveil the first outlines of this project at this national gathering on electronics. This is because we expect that in the true spirit of the Bhabha Committee Report, the task involves every segment of the nation which can make a contribution to it.

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Following is a brief description of ATS-F Spacecraft:

The salient features particularly of relevance to DAE/NASA experiments are enumerated.

1. The satellite will be a 3 axis stabilised spacecraft and will be located within operating view of India for the conduct of the experiment.

2. The satellite will have a 30 foot diameter parabolic antenna which will be used to beam the transmitted energy towards India.

3. The UHF feed will be on center and the ATS vehicle will point the 30 foot diamæter antenna anywhere within a solid angle of $\pm 8^{o}$ to the local verticle.

4. The 30 foot diameter parabolic reflecting antenna considering the loss and the power output of the amplifiers will provide a useful minimum Effective Isotropically Radiated Power of + 51 dbw.

5. The antenna beam will be pointed towards any point on the surface of earth with error less than $\pm 0.1^{o}$ peak.

6. The satellite will receive TV transmission, beamed towards the satellite by using earth coverage fixed horn antenna operating in the C-band at about 6 GH_z.

7. An overall satellite receiver system figure of merit will be about - 17db/^{o}K.

8. The receiving antenna on the satellite will be linearly polarized while the transmitting polarization will be right hand circular. The estimated beamwidth for the UHF beam will be about 2.6^{o} to 2.9^{o}.

9. The microwave receiving sybsystem on the satellite will have a nominal noise bandwidth of 40 MH_z.

10. The central frequency of UHF transmitting subsystem on the satellite will be 850 MH_z nominal.

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ANNEXURE 2

Research and development problems visualised in the DAE-NASA Satellite TV experiment.

The memorandum of understanding signed on September 18, 1969 between the Department of Atomic Energy (DAE) and the National Aeronautics and Space Administration (NASA) clearly identifies the responsibilities of these two agencies for the conduct of the satellite TV experiment. According to this, the DAE has the entire responsibility to provide the hardware requirements of the ground segment, besides programming. A systematic analysis conducted on the hardware requirements has been helpful in identifying the following equipment and systems as required for the experiment.

(a) Earth stations for reception only from the satellite and also for reception and transmission to the satellite.

(b) VHF transmitting stations and associated studio equipment.

(c) 10 feet chicken mesh antennas.

(d) Front-end converters for direct reception.

(e) Solid state community television receivers.

(f) Primary power sources.

A study of the above requirements along with the available technology reveals that an immediate development work has to be started at least on the items mentioned below:

(i) Front-end converters at the UHF frequencies.

(ii) Solid state receivers for community viewers.

(iii) Inexpensive chicken mesh antennas for the community receivers.

(iv) Low noise amplifiers for earth stations.

(v) Low power transmitters for testing limited rebroadcast.

(vi) Primary power sources.

(vii) At least few components parts of the transmit-receive chains.

In addition to the above developmental tasks quite a few research problems are also identified and most important amongst them are mentioned below:

(i) To propose a method after a successful theoretical analysis to arrive at an optimum method of transmitting and receiving multiple sound channels along with video signal.

(ii) Optimum bandwidth requirements for one video and n audio channels.

(iii) UHF propagation studies (Theoretical before the start of the experiment and to verify these predictions later on) with reference to dispersive delays, etc.

(iv) Studies on modulation index optimization.

(v) Interference studies.

(vi) Optimum location of satellites from considerations of spillover and interference from side lobes.

(vii) Side lobe suppression techniques.

(viii) Threshold extension devices.

Though most of the above problems could be undertaken by the development groups in the country, it would seem appropriate to involve the universities and higher institutes of technology for the research problems mentioned.

The above list is not meant to be a complete one but only an initial projection that is evident and requires immediate attention.

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ANNEXURE 3

The revenue that could be earned by the use of the telecommunications capacity on the spacecraft:-

1.1 The longest eclipse generally expected on the synchronous satellite is of the order of 72 minutes and for some months such eclipse will not occur at all.

1.2 For the operational coordination and house-keeping purposes etc. satellite time will be allotted and so considering 1.1 and 1.2 together it will be reasonable to say that the satellite is available only for 20 hours per day for telecommunications use.

1.3 The total capacity of the satellite will not be completely utilised as the utility will go down in the night and so it is the general experience that about 1/6 to 1/4 of the capacity will be considered to be utilised for full time.

1.4 Excluding the Sundays and holidays it can be expected that on an average the satellite will be used only for 300 days in a year.

1.5. Following rates are charged today for subscriber trunk dialling system:

Ahmedabad-Bombay	-	2.5 paise/second
Ahmedabad-Delhi	-	3.75 paise/second
Ahmedabad-Poona	-	3.75 paise/second

Even though direct dialling systems are not operating between Bombay to Delhi and Bombay to Calcutta, it is expected that such services will cost up to about 7.5 paise per second for the subscriber. Considering the time frame of 74-75 one can assume that these rates will go down and an average of 5 paise per second can be considered as an average charge which we could put for the satellite service.

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1.6 Out of the charge laid down for the trunk service provided two-thirds of the cost or revenue are assigned to the trunk route while one-third of the revenue is assigned for the operations and the the terminal equipment and the local exchanges.

1.7 Considering the points mentioned above one can work out the revenue that could be earned by the use of the tele-communications capacity on the spacecraft. For example in the joint study carried out by ISRO and General Electric Company, the satellite payload for 3600 telephone channels was considered. The revenue earned by such a system would then be -

A) Available time	-	20 hours per day
B) Total seconds	-	7.2×10^4 seconds per day
C) Total channel capacity	-	3600 channels
D.1) 1/6th capacity utilization	-	600 channels
D.2) 1/4th capacity utilization	-	900 channels

E.1) 43.2×10^6 seconds for which charge could be made for 1/6th capacity utilization

E.2) 64.8×10^6 seconds for which revenue can be charged at 1/4th capacity utilization.

F.1) At 5 paise per second the revenue earned would be Rs. 2.16×10^6 per day for one-sixth capacity utilization

F.2) At 5 paise per second the revenue earned would be Rs. ~~2.88~~ 3.24 $\times 10^6$ per day at 1/4th capacity utilization.

G.1) Revenue earned per day for the 1/6th capacity utilization by the trunk route would then be 1.44×10^6.

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G.2) Revenue earned per day for the 1/4th capacity utilization by the trunk route would then be Rs. ~~1.9~~ 2.16 x 10^6.

H) Following the analysis as shown above, the analysis represents revenue earned of the order of Rs. 42 crores for 1/6th capacity utilization and Rs. ~~57~~ 65 crores for 1/4th capacity utilization per year.

I) This could be averaged to about Rs. ~~49.5~~ 54 crores per year which represents a total earning of the order of Rs. ~~247.5~~ 270 crores over the five year life-time of the satellite.

1.8 It has been mentioned in paragraph 1.3 that the total satellite capacity will not be fully utilized and hence consideration was given towards the calculations that only 1/6th or 1/4th of the capacity will be utilized. However, with the television network also growing side by side the same transpondents which are used for tele-communication could be used for television distribution whenever the satellite is not being fully utilized by the tele-communication services particularly during the time period of 6.30 p.m. to 11.00 p.m. and 7.00 a.m. to 9.00 a.m. This distribution service could then be charged for and the revenue which might be earned by the utilization of the tele-communication facility on the satellite could be augmented by charging for the distribution service.