NASA TECHNICAL MEMORANDUM

NASA TM-75128

ANALYSIS OF ECONOMICS OF A TV BROADCASTING SATELLITE FOR ADDITIONAL NATIONWIDE TV PROGRAMS, FINAL REPORT

D. Becker, G. Mertens, A. Rappold and W. Seith

Translation of "Wirtshaftlichkeitsanalyse von Satelliten als Zubringer von zusaetzlichen bundesweiten Fernsehprogrammen", Standard Elektrik Lorenz A. G., Stuttgart (West Germany): REPORT NUMBERS: BMFT-FB-T-76-5; BMFT-NT-581, June 1976, pp. 1-73

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D. C. 20546 JULY 1977

1. Report No. NASA TM-75128	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ANALYSIS OF ECONOMICS OF A TV BROADCASTING SATELLITE FOR ADDITIONAL NATIONWIDE TV PROGRAMS, FINAL REPORT		5. Report Date JULY 1977
		6. Performing Organization Code
7. Author(s) Becker, D., Mertens, G., Rappold, A., and Seith, W.		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108		11. Contract or Grant No. NASw-2791
		13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546		14. Sponsoring Agency Code

15. Supplementary Notes

Translation of "Wirtshaftlichkeitsanalyse von Satelliten als Zubringer von zusaetzlichen bundesweiten Fernsehprogrammen", Standard Elektrik Lorenz A.G., Stuttgart (West Germany): REPORT NUMBERS: BMFT-FB-T-76-05; BMFT-NT-581, June 1976, pp. 1-73. (N77-11270)

16. Abstract

The influence of a TV broadcasting satellite, transmitting four additional TV networks was analyzed. It is assumed that the cost of the satellite systems will be financed by the cable TV system operators. The additional TV programs increase income by attracting additional subscribers. Two economic models were established: (1) each local network is regarded as an independent economic unit with individual fees (cost price model); (2) all networks are part of one public cable TV company with uniform fees (uniform price model). Assumptions are made for penetration as a function of subscription rates. Main results of the study are: the installation of a TV broadcasting satellite improves the economics of CTV-networks in both models; the overall coverage achievable by the uniform price model is significantly higher than that achievable by the cost price model.

17. Key Words (Selected by Author(s))		18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

FEDERAL MINISTRY FOR RESEARCH AND TECHNOLOGY

Research Report T 76-05
Technological Research and Development
Prospectives in Communication Technology

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Standard Elektrik Lorenz AG
Stuttgart-Zuffenhausen

75 page with
32 figures,
5 references

June 1976

This issue contains a final report on a project supported by the Federal Ministry for Research and Technology.

ANALYSIS OF ECONOMICS OF A TV BROADCASTING SATELLITE FOR ADDITIONAL NATIONWIDE TV PROGRAMS

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January, 1975

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Final report of the Research Project of the BMFT "Analysis of Economics of a TV Broadcasting Satellite for Additional Nationwide TV Programs (NT 581).

ABSTRACT

In this study the influence of a TV-Broadcasting-Satellite transmitting four additional TV programs on economics and development of cable TV networks is analyzed. It is assumed that the cost of the satellite systems will be financed by the cable TV system operators. The additional TV programs increase the incomes by attracting additional subscribers.

(1) Each local network is regarded as an independent economic unit with individual fees (cost price model)
(2) All networks are part of one public cable TV company with uniform fees (uniform price model)

Assumptions are made for penetration as a function of subscription rates. The main results of the study are:

- The installation of a TV broadcasting satellite improves the economics of CTV networks in both of the models.
- The overall coverage achievable by the uniform price model is significantly higher than that achievable by the cost price model.

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1. Introduction

The goal of the study is to examine the economy of a satellite which broadcasts four additional television programs nationwide. The system considered is shown in the bold outline in Figure 1. /7*

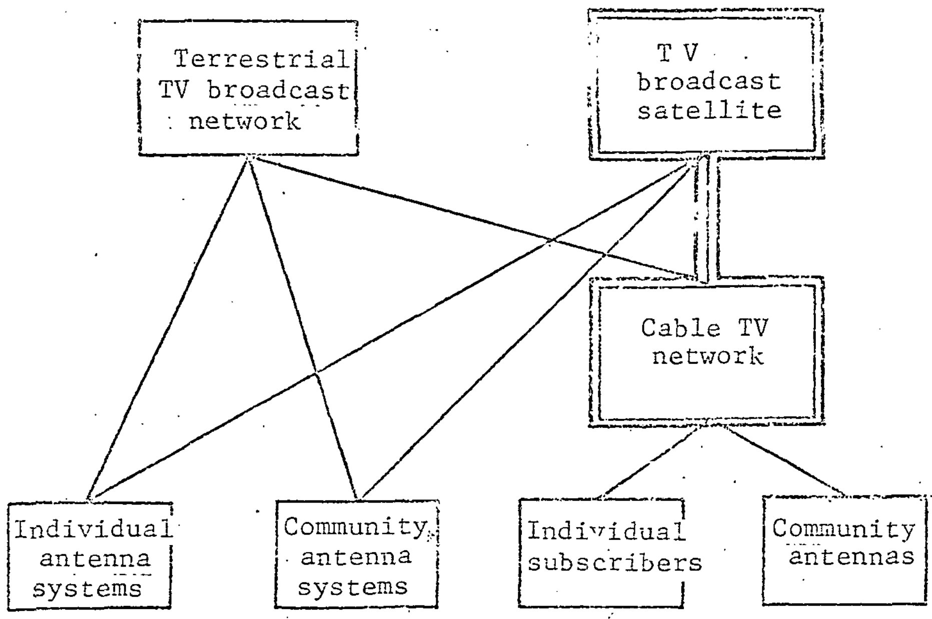

Figure 1. The total system

1.1. Presentation of the problem and assumptions

The nucleus of the problem are the questions: /8

- How can the technical costs for a satellite be raised?
- Is there an optimum time for the introduction of satellites?

The program costs were excluded in the original order.

The following assumptions were made:

*Numbers in the margin indicate pagination in original foreign text.

- The terrestrial television-radio supply remains at its present level.
- During the period considered by the study, a nationwide cable TV network appeared. Growth and organization of this cable TV network depends on its economy.
- Independently operated cable TV networks are assumed. A dissemination of programs by a remote network was not presupposed.
- A decision between local cable TV networks and large community stations was avoided. However, the already existing, privately-operated, large, collectively-owned installations were considered in the initial conditions of the calculated model.
- Since the additional costs for satellite reception are relatively low, it is assumed that in all local cable TV networks, satellite receiving units can be installed.
- Inflation was not taken into account. /9
- The technical costs of the television-radio satellites were assigned solely to the operators of the local cable TV network.

The last assumption is meaningful for the following reasons:

For a satellite of low broadcasting power, the receiving unit for individual and collective reception are unthinkably expensive.

For the television-radio satellite as described in the study "Televison-Radio Satellite, Performability Analysis" [1], reception for individual units is also unthinkably expensive, but is possible for large, collectively-owned installation. Predictions about the development of the number and structure of collectively owned installations are not possible given our status of information. Therefore, under the conditions above, the "worst case" is assumed, i.e., when economy is retained for complete cost transmission (to the subscriber), that this economy is assured if a part of the satellite costs can be raised from subscribers to the collectively-owned installation.

1.2. Models considered

One of the important principles for using the results to make predictions is the assumption about the development of the cable TV network. But since this cannot be forseen today, alternative possibilities were considered.

For the calculation of economy, we selected: /10

- A cost price model:
  In this model every local network forms a self-contained economic unit with its own fees, which must cover the costs.
- A unit price model:
  Here, all local networks form a single economic unit with the same fee schedule.

Within this model, several alternative possibilities were examined.

2. Summary of the Results

It was assumed that the potential to receive the additional satellite program by connection with the cable TV network will increase the attractiveness of the cable TV network for potential subscribers. Under this condition there resulted the following main results: /11

- The introduction of the TV-radio satellite improves the economics of cable TV networks in the cost-price model, as well as in the unit-price model.
- This degree of economic development, i.e., the number of networks, is increased by the introduction of satellites (Figure 32, page 44).
- The achievable degree of development — with or without satellites — is significantly greater in the unit price model than in the cost price model (Figure 32, page 44).

- For the unit price model, there is an optimum time point for the introduction of satellites. This point in time occurs earlier when the degree of economic development is increased (Figures 29, 30, pages 42, 43).

3. Principles for Development of the Cable TV Network /13

The basic structure of an analysis of economy for a cable TV network is shown in Figure 2.

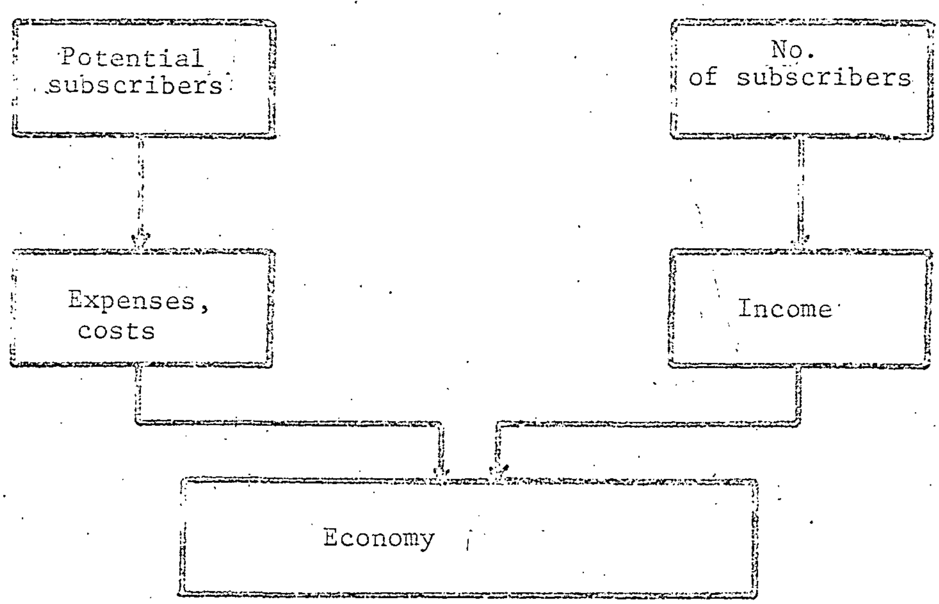

Figure 2. Problem structure without satellite

The economy of the cable TV network is determined by expenditures, costs, and income. The expenditures or costs depend primarily on the potential subscribers; however, the income depends on the number of subscribers.

The effects of the TV-radio satellites are shown in Figure 3. /14
Their introduction increases the costs or expenditures of the total system. On the other hand, the influence on the potential number of subscribers is positive and thus leads to an increase in income.

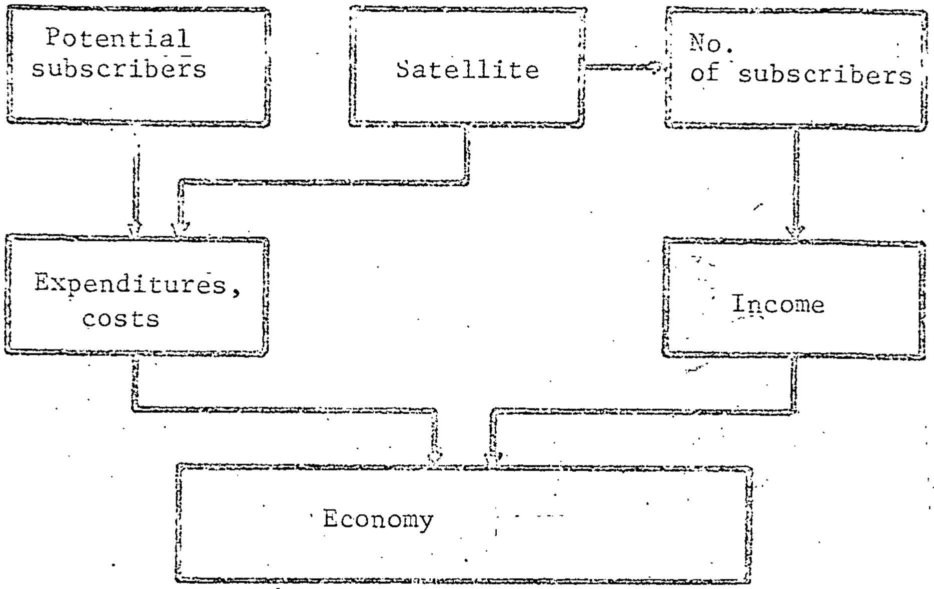

Figure 3. Problem structure after introduction of the TV-radio satellites

3.1. Subscriber potential /15

The subscriber potential is the number of housing units in a closed area which could receive a cable TV connection.

3.1.1. Structure and growth of housing units

The initial variable for the determination of the subscriber potential is the number and future construction of housing units. This number of housing units was divided into 9 city-size classes, as illustrated in the study "Communications Services" [2].

Figure 4 shows the percentage of individual city-size classes for the total number of housing units (see the Statistics Yearbook, 1973).

For future growth in housing, we assumed the following (Figure 5): /16

In the period between 1975 and 1985, the number of housing units will grow at an annual rate of 335,000; in the period to 1955,

No.	City classes	Percentage	Number (million Units*)	Cost factor
2	500.000 or larger	20,0 %	4,53	1,0
3	200 - 500.000	9,6 %	2,17	1,05
4	100 - 200.000	8,1 %	1,83	1,2
5	50 - 100.000	7,0 %	1,58	1,3
6	20 - 50.000	11,9 %	2,69	1,7
7	10 - 20.000	8,7 %	1,97	2,4
8	5 - 10.000	8,9 %	2,02	3,3
9	2 - 5.000	10,8 %	2,45	5,5
10	2.000 or less	15,0 %	3,40	16,2
			22,64	
1	New Building Areas			0,63

*Housing units.

Figure 4. Classification of the housing units**

**Translator's note. Commas in numbers represent decimal points.

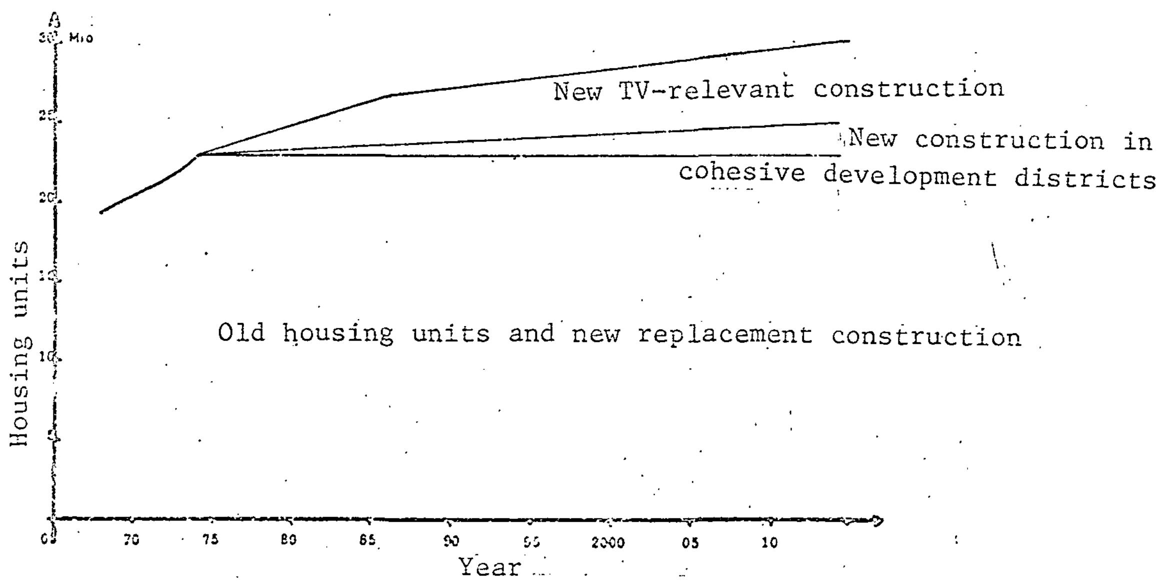

Figure 5. Growth in housing units

the growth will be at an annual rate of 140,000; and in the period between 1996 and the end of the period under consideration (the year 2016), the growth rate will be 100,000 housing units per year.

The growth in housing units in the years 1975 to 1985 was calculated in accordance with a study of Duwendag et al. [3]. Duwendag, in his study, considered the following components for a prognosis of housing needs:

- housing catch-up demand;
- need for new housing units because of natural and sociological developments in population;
- replacement housing needs, vacation and second homes;
- dwellings for foreign workers.

In the calculation of growth relevant to the cable TV network, only the housing catch-up demand and the new housing units are considered.

The need for replacement housing does not lead to an increase in the number of housing units, but is included in the initial number of housing units. Vacation and second homes are irrevelant for the cable TV network.

The number of foreign workers will probably not increase in the next few years, thus their housing needs are contained in the housing catch-up demand.

The growth in housing units between 1986 and 2016 was selected arbitrarily. Here it was assumed that the increase in housing units will decrease and approach a saturation limit.

Furthermore, it was assumed that of the new construction, 50,000 housing units would be built in cohesive development districts on an annual basis. In figure 5, the growth in housing units is classified according to: /17

- old housing units plus replacement construction;
- new construction in cohesive development districts, and
- other new construction.

3.1.2. Build-up of the subscriber potential of the cable-TV network

A period of 40 years was selected for the build-up of the subscriber potential of the cable-TV network. A period of 40 years was considered reasonable, since investment costs on the order of magnitude of at least 10 billion DM will have to be financed. /18

We assumed in this that new construction in cohesive development districts will be completely connected to the cable. The old housing units and other new construction (Figure 5, page 6) will be connected at equal rates to the cable TV network.

At the end of the build-up period, a certain degree of development will be achieved. The degree of development is defined as the ratio between subscriber potential and housing units at the end of the build-up period.

Figure 6 shows the development of the subscriber potential during the build-up period to a maximum degree of development. This development is determined by the industrial capacity available for the build-up of cable-TV networks on an annual basis. We proceeded from the fact that the final industrial capacity will be attained after a 10-year linear build-up time. After the first 30 years, the available annual capacity will be increasingly devoted to satisfying replacement needs. The degree of development accordingly determines the total capacity, i.e., the sum of the annual capacities available for new construction of cable TV networks.

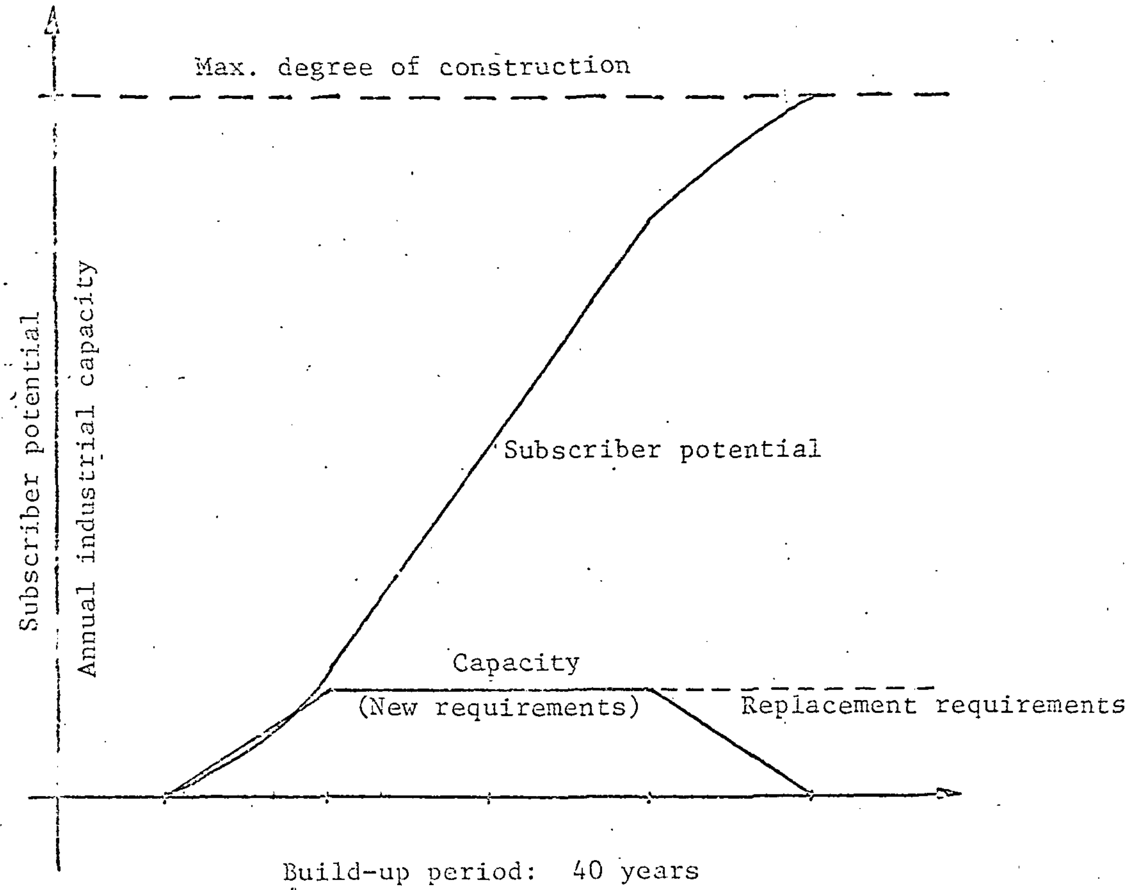

Figure 6. Build-up of the subscriber potential at a preset industrial capacity /19

3.1.3. Build-up of the subscriber potential of the individual local networks /20

Since the size of the actual local networks play an insignificant role in the calculation of overall economy, we were able to make simplified assumptions.

The subscriber potential of the individual local networks was assumed to be a unit of 10,000 housing units. The build-up period for the individual local networks is 7 years.

During the initial years of the build-up period, the following percentages of the local networks will be installed (Figure 7):

In the first year, 30% will be installed, in the second and and third years — 20% each, in the fourth and fifth years — 10% each, and in the last two years, 5% each. /21

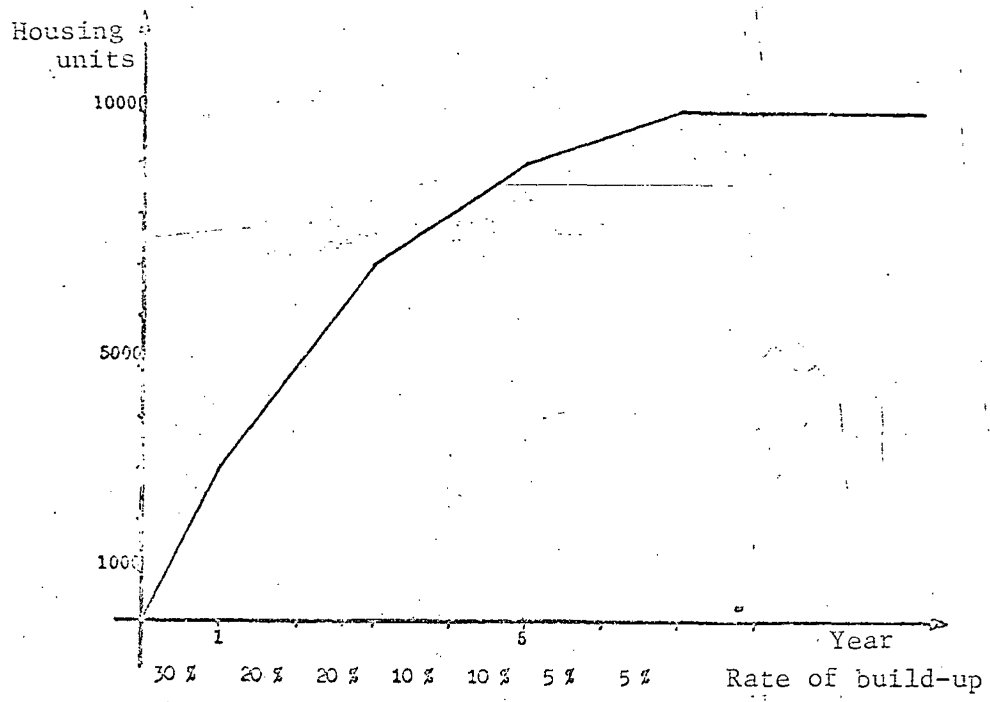

Figure 7. Build-up of a subscriber potential of a local network

This investment sequence per local network was based on experience obtained in Switzerland for the build-up of cable TV networks. (See the Study on Communications Service [2].)

3.2. Number of subscribers to the cable TV networks

The number of subscribers to cable TV networks is distinguished by the final percentage of the subscriber potential achieved. Moreover, the time increase until attainment of the final number of subscribers is of importance.

3.2.1. Price-subscriber willingness function

The final number of subscribers in a cable TV local network depends on the level of fees. In order to be able to compare different cable-connection fees and monthly fees, both types of fees were summarized in a "monthly" cost. Here the connection fee was calculated into a monthly cost by using cash value methods (see (Appendix 2).

The dependence of the final number of subscribers of a cable TV network on this monthly price is shown in Figure 8. The saturation value for free subscription is 90% of the housing units. About 10% of the housing units have no television.

/22

The course of the cost-subscription willingness function (see Appendix 2) was adapted to appropriate cost reduction functions as they appear again and again in market research. Results of a poll by MITRE, an American Research Institute, were used as a basis. Analogies to fees and numbers of subscribers in existing foreign networks must be prepared for the absolute value of the cost-subscription willingness function. In the functions 1, 2, and 3 used for the calculations, we considered that in West Germany the willingness to pay a certain price for a cable TV connection is less than in Switzerland where the topographic conditions impede TV reception, or in Brussels where the frequency of international agencies results in a great number of interesting cable TV programs from foreign countries.

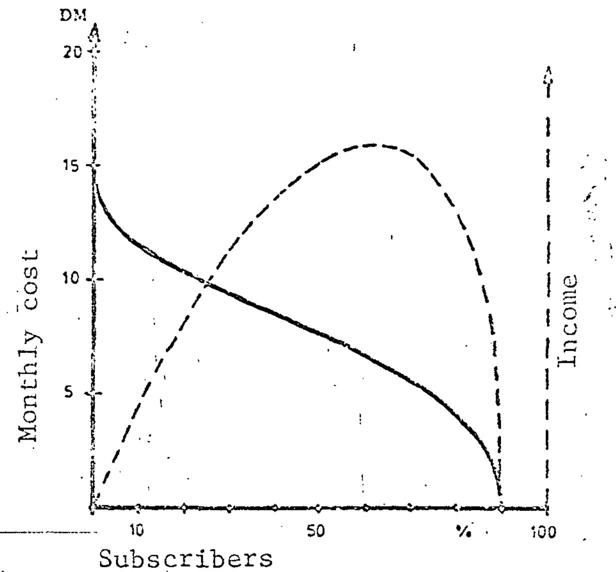

Figure 8. Cost-subscriber willingness function

For a basically similar course of the function, the parameters were selected so that a willingness to subscribe by 50% of the housing units was established for function 1 at a monthly cost of 6.10 DM; for function 2 the cost is 7.65 DM, and for function 3 it is 9.20 DM.

For new construction-development areas, a subscription readiness of 90% was assumed regardless of price, since here the alternative possibilities — individual antennas or joint antenna systems — are normally not available.

The dashed curve shows the course of income as a function of the cost at a prescribed cost-subscription willingness function. The income of a local cable TV network results from a product of the number of subscribers times the monthly costs. A preset cost-subscription willingness function can be attained from the maximum income, and thus a favorable monthly price can be obtained from the appropriate number of subscribers. /23

On the basis of different environmental conditions — such as reception potential for additional foreign programs in border areas, screening by tall buildings, and topological conditions — one must assign each individual local network its own price-subscription willingness function.

Since no information is available on this problem, it was assumed that the cost-subscription willingness function of the individual local networks is statistically distributed around a certain average value (Figure 9; see Appendix 2). /24

3.2.2. Cable connection function of the subscriber in individual local networks

For individual local networks it was assumed that the final number of subscribers is obtained after ten years. Figure 10 shows the temporal development.

In the second build-up year of the cable TV network the first subscribers can connect to the cable.

It was assumed that about 25% of the final number of subscribers will

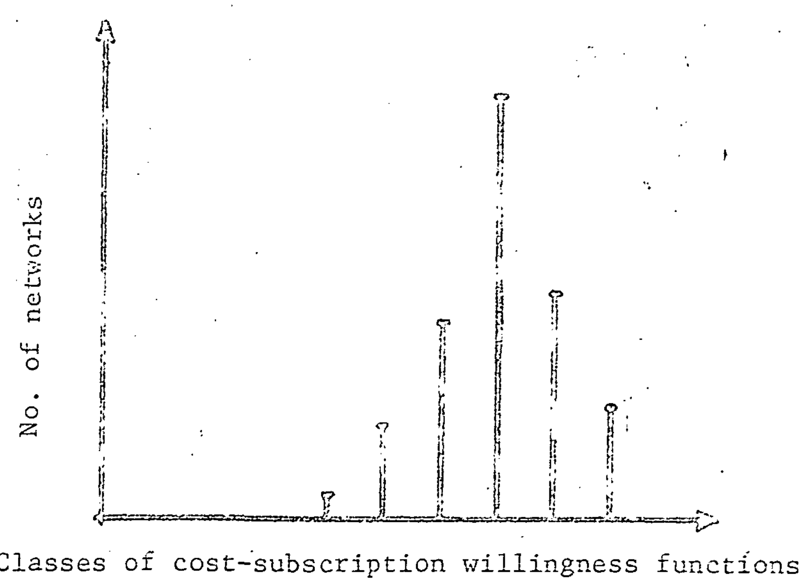

Figure 9. Dispersion of the subscription readiness

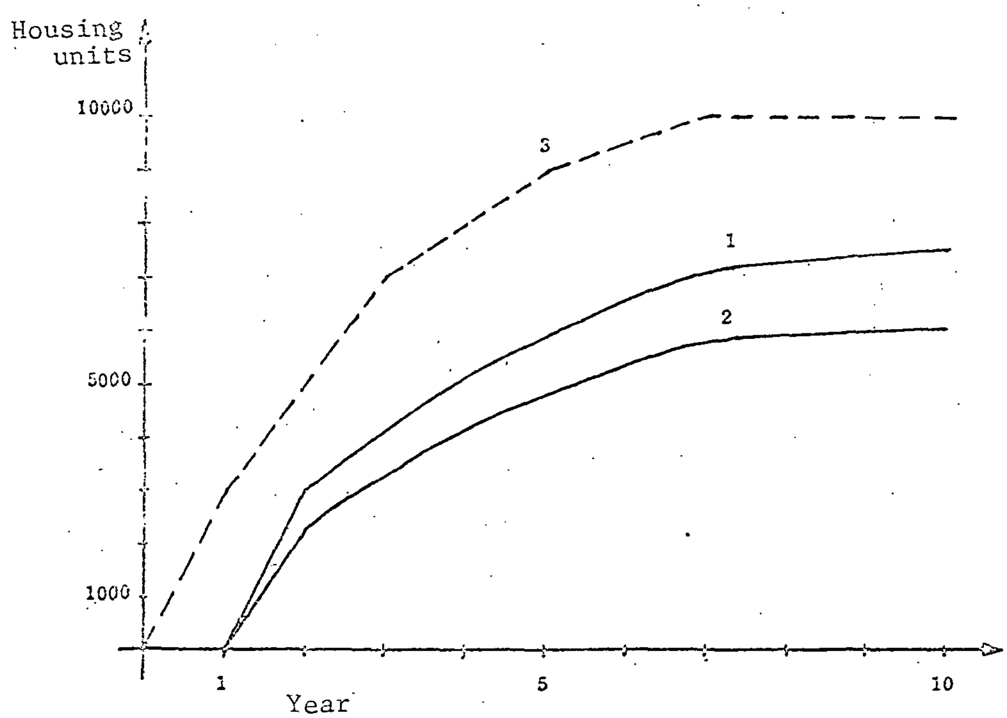

Figure 10. Development of the number of subscribers of a local network:

Curve 1 — final number of subscribers 7500 (subscription willingness, 75%); curve 2 — final number of subscribers 6000 (subscription willingness, 60%); curve 3 — growth curve of the subscriber potential

connect immediately (see the study "Communications Services" [2]). /25
The continuing time development until the final number of subscribers is obtained follows a growth function (see Appendix 2).

3.2.3. Satellite effect

The four additional programs broadcast by a satellite and /26
received in the cable TV network should cause potential cable TV subscribers to be willing to pay a 25% higher price for reception than for reception without additional satellite programs (Figure 11, point 1). Accordingly, for constant prices, a greater percentage of housing units are prepared to connect to cable TV (point 2), i.e., the final achievable number of subscribers to a cable TV network increases.

The assumed relative low effect of the satellite on the willingness to subscribe — at about a double number of programs the price increases only by about 25% — is caused by the phenomenon of decreasing limiting utility of additional services. For already existing cable TV networks, it was assumed that within three years of the introduction of the satellite, the number of subscribers will be reached which corresponds to the subscription willingness function of the cable TV network with additional satellite broadcast programs (Figure 12).

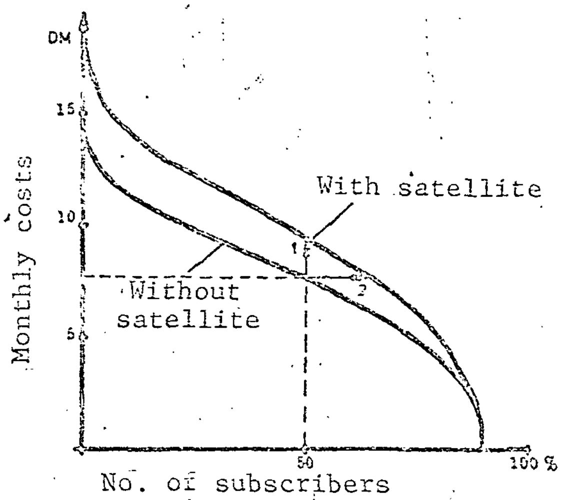

Figure 11. Effects of a satellite on the cost-subscription willingness function

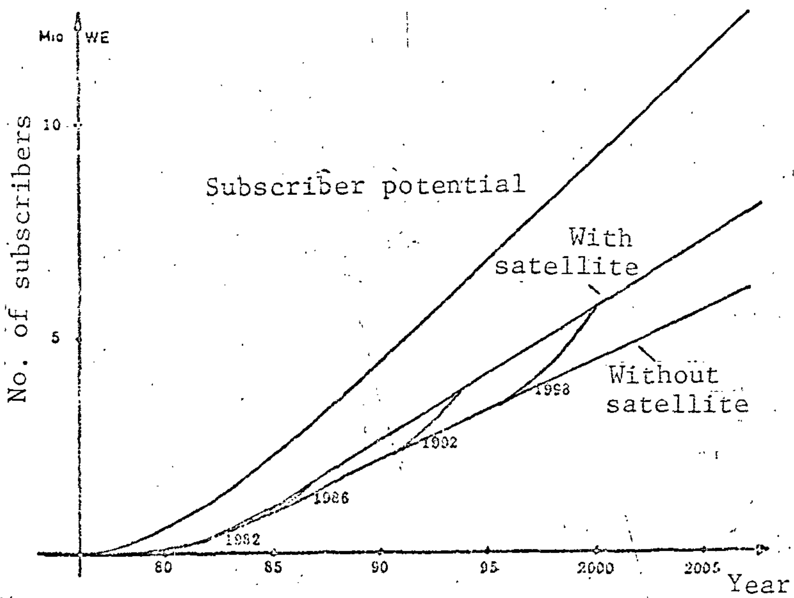

Figure 12. Development of the number of subscribers with and without satellite for different timing of the introduction

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3.3. Income

The income is composed of the income from connection fees and income from the monthly fees.

3.3.1. Income from connection fees

The income from connection fees is a function of subscriber access. Every subscriber who connects to a cable TV network must pay a connection fee. The income from connection fees per year is thus determined by the access of subscribers during the year and of the increased connection fees.

3.3.2. Income from monthly fees

The income from monthly fees is a function of the number of subscribers. Every subscriber must pay a monthly fee as long as he has a cable TV connection. The income from monthly fees is thus determined by the total number of subscribers in a cable TV network and the increasing monthly fees.

3.4. Expenditures and costs

3.4.1. Investment costs

The annual investment costs are composed of expenses for:

- main station, and for
- cables, amplifier, and cable laying construction.

The investment costs for main stations depends on the number of local networks whose installations have begun in the course of a year. /29

The investment costs for cables, amplifiers, and cable laying construction depends, on the one hand, on the new annual subscriber potential. On the other hand, the level of subscribers to a local network depends on the number of housing units reached by this local network. Figure 4, page 6, shows the dependence of the investment cost on the city-size class. The smaller the city is, the greater are the investment costs per dwelling.

The investment costs for main stations were set at a level of 150,000 DM per local network. Finally, a purchase and assembly expense must be added to the investment costs. These purchase and assembly costs occur in the performance of the investment. They amount to 5.20 DM per potential subscriber.

The sum of the annual investment costs determines the annual capital requirement. It has only an indirect influence on the profitability of the total system, namely, it influences the finance costs of the capital and the write-offs derived from it.

3.4.2. Costs

The annual costs are composed of the depreciation, marketing costs, maintenance costs, costs for policy directors, finance administration costs, and overhead.

- Depreciation /30

The annual depreciation is determined by the investment expenses and the depreciation. The useful life is used as a depreciation period. For cables and underground work this is 30 years; for amplifiers and main stations it is 15 years.

The linear depreciation method was selected. That means the annual depreciation for laying cables and for cables amount to 1/30 of the investment costs; the annual depreciation for amplifiers and local network main stations is 1/15 of the investment costs.

- Marketing costs

The marketing costs are composed of costs for advertising and sales development.

The advertising costs are incurred by the use of advertising media. The advertising costs for potential subscribers in new development areas are 5 DM, and in the 9 city-size classes they are 7.60 DM. This differentiation was made because we expect that in new development areas, less intensive advertising will be necessary.

Sales development costs are incurred by the use of advertising agencies. The sales development costs per potential subscriber in new development areas are 4.15 DM, but they are 41.35 DM for the

9 city-size classes. These differences are due to the following reasons:

The acquisition of new business in new development areas, particularly in newly developed city areas, can usually be done by contact with the construction contractor, so that an advertising agency can canvass a great number of housing units within a relatively short time. The 4.15 DM per potential subscriber is based on the assumption that an advertising agency can canvass 10,000 housing units in the course of the year. The sales development costs in the other areas, i.e., in the 9 city-size classes, are based on the assumptions that an advertising agency is necessary for the acquisition of 1000 potential subscribers per year. /31

- Maintenance costs

The maintenance costs are composed of costs for maintenance and operation of the subscriber potential of a local network and of the maintenance and operating costs of the main stations in a local network.

The maintenance and operating costs for cables and amplifiers per potential subscriber are 7.80 DM in the city-size classes having more than 500,000 housing units (see the study on cable TV [5]). In the other city-size classes and in the new development areas, this amount is multiplied by an appropriate cost factor (Figure 7, page 10). The operating and maintenance costs per main station are 4.5% of the investment costs of the main station, i.e., 6.75 DM per year.

- Contract management

The contract management costs are incurred by contract management function and the depositing of the cable connection and monthly fees in banks. They are 2.50 DM per subscriber per year.

This amount results if we assume that the federal post office will be used for the control management and that the post office will charge the same fees for this service and for the depositing of funds as is charged to TV and radio subscribers. /32

- Financial administration costs

The financial administration costs are incurred because of the procurement and administration of the necessary financing and by the methods of payment for the overall system. Depending on their form, there are: interest on capital and personnel costs. The interest during the entire period under consideration is assumed to be 5% for the following reasons:

As noted in the preliminary conditions, no inflation in the total system is assumed during the period under consideration. Consequently the interest rate must assure only the real interest on the capital. To obtain a meaningful long-term real interest rate, the long-term capital market interest over the last 15 years would have to be used after subtraction of the prevailing inflation rates. This real long-term interest rate on the capital market is an average of 5%.

Since the personnel expenses in the finance and accounting system are in direct proportion to the size of the total system, it is assumed that one financial administration employee is necessary for 2500 subscribers. This means there is a 13.70 DM finance administration cost per subscriber.

- Overhead /33

By overhead we mean all other costs incurred by the total system. Primarily, we mention the costs of general operation, i.e., costs for space, energy, fees and payments, etc. In addition to the overhead there are personnel administrative costs.

The overhead represents a sizeable portion of the costs. It is assumed to be 50% of the annual costs for purchasing and assembly, as well as of the financial administration and marketing costs.

3.5. Satellite-dependent costs and expenses

Even for the satellite we distinguish between investment costs and expenses.

3.5.1. Investment expenses

The investment expenses for a satellite are considered to be 59 million DM; costs for a rocket plus launch are assumed to be 47 million DM (Appendix 1).

The lifetime of a satellite is an average of 5 years.

Since two satellites will always have to be in geostationary orbit at all times in order to be able to continue transmission if one of the satellites fails, the following investment expenses are incurred in a 5-year term:

For 2 satellites: 118 million DM; for 2 rockets plus launch: 84 million DM, for a total of 212 million DM. After 10 years, another satellite must be launched to be available as a reserve in case a satellite malfunctions within the term. Besides the investment costs for satellites and launching, investment costs for ground control stations for the satellite and for main stations for satellite reception are incurred for each local network. /34

The investment costs for the ground control stations of the satellite cost 16 million DM for technology, buildings, and other equipment. The investment expenses for the main stations are 40,000 DM per local network.

3.5.2. Costs

The costs are composed primarily of depreciation and continuing operating costs.

- Depreciation

Depreciation of 47.3 million DM is incurred for the satellites and rockets plus launching.

The depreciation period for the ground control stations and the main stations is 15 years. Depreciation of the ground control station is thus 1.07 million DM per year; depreciation of the main stations, however, is 2,667 DM per year per local network.

- Continuous operating costs

The continuous operating costs per year are set equal to 580,000 DM for the ground control stations for personnel, maintenance and preventive maintenance, including other costs. /35

3.6. Calculation of economy

For the calculation of economy, we proceeded as follows:

From year to year the income is compared to the cost incurred and the annual profit is determined.

In this, no special assumptions were made about the organization and accounting of the operator and their effects on overall economy.

4. Cost Price Model

In the cost price model we proceeded from the fact that each individual local network is an economic unit. The economy of the local network is then assured if the income from cable connection fees and monthly fees covers the costs or investment expenses for /37 the local network. Therefore, it is characteristic of this model that no shifting of net receipts or costs occur between the individual local networks.

The central question in the cost price model is:

How many individual economically-sound local networks can exist under these conditions?

This number determines the economically achievable development for the use of the cost price model.

The second question is:

Will the number of economically viable local networks change due to the introduction of a TV-radio satellite? Will the achievable development be increased by the satellite?

4.1. Optimum price

As discussed in section 3, the costs to each local network depend primarily on the subscriber potential, the income, and the number of subscribers (Figure 2, page 4).

The investment expenses and costs to each local network are determined by the city-size class to which it broadcasts, as shown in Figure 4. However, the income depends on the level of fees /38
charged and on the level of subscriber willingness which can be achieved at these fee levels. This relationship is shown by the price-subscription willingness function explained in section 3.2.1 (Figure 8, p. 11). The income which can be achieved in accordance with the cost-subscription willingness function increases at first with increasing prices and then decreases again. The maximum thus defines an optimum price and an optimum subscriber willingness.

4.2. Determination of profitable areas

Now it was assumed that in each individual local network, the optimum price will be selected so that the maximum attainable income can be realized.

The economics of each individual network then depends on whether the maximum income achievable in this local network will cover the investment expenses or costs.

The following assumptions were made:

The individual local networks are financed exclusively by borrowed capital. Since the financing of the individual local networks is only profiable to a very limited extent by in-house cash flow, the capital costs are thus minimized. The local network will be economically viable if the sum of its annual net receipt or losses from the operation of the network and from the capital costs during the entire period of 30 years is not negative.

4.3. Classes of equal cost-subscription willingness function

The maximum obtainable income varies from one local network to the next. They depend on the present cost-subscription willingness function for the individual local network. As illustrated in Figure 9, page 12, the individual local networks can be sorted and classified in classes of equal cost-subscription willingness function. Twenty classes were selected (Appendix 2). /39

For each individual class it was assumed that the local network concentrated in it could achieve a uniform subscription-readiness function and thus all could achieve the same maximum income.

4.4. Results

4.4.1. Maximum development without satellite

All local networks can be sorted according to two criteria:

- On the one hand, according to the city-size to which it broadcasts. This city-size determines the level of its investment costs and expenses.

- On the other hand, by the class of cost-subscription willingness function to which it belongs. This class determines the level of its maximum income.

For each individual local network it was determined whether economic operation was possible under these conditions. Thus for each class having the same cost-subscription willingness functions, i.e., for all local networks having the same maximum incomes, it could be determined up to what city-size a local network of this subscription willingness class was economic.

Figure 13 shows this relationship for a class of local networks /40
having the same cost-subscription willingness function. The calculations were performed for three different cost-subscription /41
willingness functions as mentioned in 3.2.1. The three subscription-willingness functions are distinguished by the fact that the monthly costs at which 50% of the potential subscribers will connect would be 6.10 DM in the first function, 7.65 DM for the second, and 9.20 DM for the third.

Figure 14 - 16 show the results for the three subscription willingness functions. For each function, the maximum achievable development is shown. The present number of housing units was used as a starting point (see section 3.1.2). For new development regions, it was assumed that new construction would occur entirely in cohesive, new development areas; other new construction will receive cables to the same extent as the old housing units. The

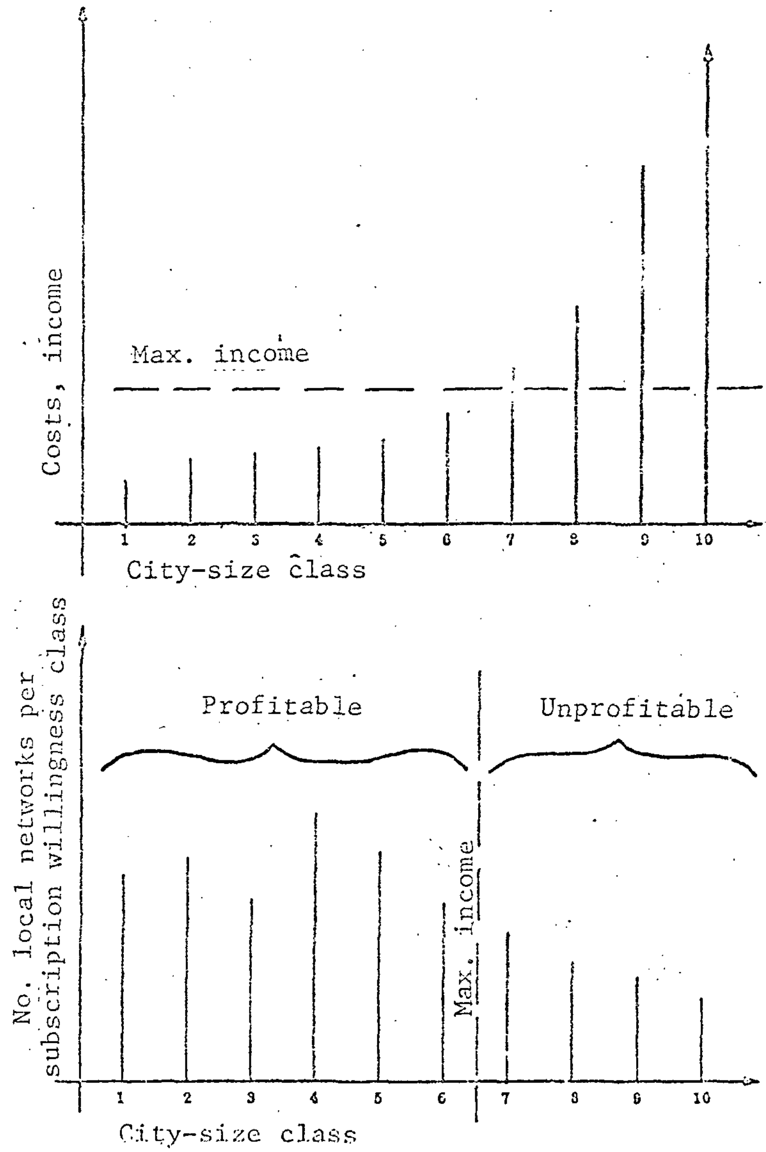

Figure 13. Determination of the degree of development in the cost-price model

number cited in figures 14 - 19 for new construction which will have cable TV reception is composed of the following:

- the cable TV connection of all new construction in cohesive areas,
- the new construction at the end of the construction build-up period receiving cables at the same rate as older buildings.

in 1.000		> 500	500 -200	200 -100	100 -50	50 -20	20 -10	10 -5	5 -2	< 2	Σ_1
CSW-funct. class	1	23	11								34
	2										
	3										
Σ_2		23	11								34

CSW = cost-subscription willingness

Development 8.2%

old housing units 340,000 units
new construction 2,085,000

Figure 14. Distribution of profitable local networks for cost-subscription function 1 without satellite:

Σ_1— number of installed networks of a subscription willingness class
Σ_2— number of installed networks in a city-size class

The development for function 1 is 8.2%, for function 2 it is 18%, and for function 3 it is 36%. The tables show how the profitable local networks are distributed on the individual city-size classes or classes of the same subscription willingness function.

CSW-funct. class	City-size class >500	500-200	200-100	100-50	50-20	20-10	10-5	5-2	<2	Σ_1
1	23	11	9	8						51
2	23	11	9	8						51
3	23	11								34
4	23	11								34
5	23	11								34
6	23	11								34
7	23									23
8										
Σ_2	161	66	18 -	16						261

Development 18%
old housing units 2,610,000 units
new construction 2,652,500 units

Figure 15. Distribution of profitable local networks for cost-subscription willingness function 2 without satellite

/43

CSW-funct. class	City-size class >500	500-200	200-100	100-50	50-20	20-10	10-5	5-2	<2	Σ_1
1	23	11	9	8	14					65
2	23	11	9	8	14					65
3	23	11	9	8						51
4	23	11	9	8						51
5	23	11	9	8						51
6	23	11	9	8						51
7	23	11	9	8						51
8	23	11	9	8						51
9	23	11	9	8						51
10	23	11	9							43
11	23	11								34
12	23	11								34
13	23	11								34
14	23	11								34
15	23									23
Σ_2	345	154	90	72	28					689

Development 36%
old housing units 7,000,000 units
new construction 3,750,000 units

Figure 16. Distribution of profitable local networks for cost-subscription willingness function 3 without satellite

/44

CSW-funct. class (in 1,000)	> 500	500 -200	200 -100	100 -50	50 -20	20 -10	10 -5	5 -2	< 2	Σ_1
1	23	11								34
2										
3										
Σ_2	23	11								34

CSW = cost-subscription willingness

Development 8.2%
old housing units 340,000 units
new construction 2,085,000 units

Figure 17. Distribution of profitable local networks for cost-subscription willingness function 1 with satellite

/45

CSW-funct. class	> 500	500 -200	200 -100	100 -50	50 -20	20 -10	10 -5	5 -2	< 2	Σ_1
1	23	11	9	8	14					65
2	23	11	9	8	14					65
3	23	11	9	8						51
4	23	11	9	8						51
5	23	11	9	8						51
6	23	11	9	8						51
7	23	11	9	8						51
8	23	11	9	8						51
9	23	11	9	8						51
10	23	11	9							43
11	23	11								34
12	23	11								34
13	23	11								34
14	23	11								34
15	23	11								34
Σ_2	345	165	90	72	28					700

Development 36%
old housing units 6,890,000 units
new construction 3,722,500 units

Figure 18. Distribution of profitable local networks for cost-subscription willingness function 2 with satellite

/46

CSW-funct. class	City-size class >500	500 -200	200 -100	100 -50	50 -20	20 -10	10 -5	5 -2	<2	Σ_1
1	23	11	9	8	14	10				75
2	23	11	9	8	14					65
3	23	11	9	8	14					65
4	23	11	9	8	14					65
5	23	11	9	8	14					65
6	23	11	9	8	14					65
7	23	11	9	8	14					65
8	23	11	9	8	14					65
9	23	11	9	8	14					65
10	23	11	9	8	14					65
11	23	11	9	8						51
12	23	11	9	8						51
13	23	11	9	8						51
14	23	11	9	8						51
15	23	11	9	8						51
16	23	11	9	8						51
17	23	11	9							43
18	23	11	9							43
19	23	11								34
Σ_2	437	209	152	123	140	10				1096

Development 53%
old housing units 10,860,000 units
new construction 4,715,000 units

Figure 19. Distribution of profitable local networks for cost-subscription willingness function 3 with satellite

4.4.2. Satellite effect

The economy of the individual local networks changes with the introduction of a TV-radio satellite as described above (section 3.2.3, Figure 3 - 11). The satellite increases the investment costs or expenses per local network and it increases the subscription willingness as a result of the additional program reception, as described in section 3.2.3. Basically, one can say: /48

The number of economic local networks will increase if the additional satellite-induced income covers the additional satellite-induced costs and expenses. Figures 17 - 19 show the results again for the three cost-subscription willingness functions, this time after the introduction of the satellite. Figure 20 summarizes these results:

Cost-subscription willingness function 1	Development
With satellite	8.2%
Without satellite	8.2%
Cost-subscription willingness function 2	**Development**
With satellite	36 %
Without satellite	18 %
Cost-subscription willingness function 3	**Development**
With satellite	53 %
Without satellite	36 %

Figure 20. Comparison of the development with and without satellite in the cost-price model

For the first cost-subscription willingness function, the satellite does not result in an increase in development. It remains unchanged at 8.2%. For cost-subscription willingness function 2, the development increases from 17.5% to 35.7% as a result of the introduction of the satellite, and for cost-subscription willingness function 3 it increases from 36.1% to 52.6%. /49

These results can be interpreted as follows:

In the first cost-subscription willingness function, without the satellite, there results a very low level of development. Therefore, the satellite costs must be distributed over a small number of local networks. The satellite-induced additional income just covers these additional costs; thus the situation in cost-subscription willingness function 1 represents the borderline case.

For the second cost-subscription willingness function, the development increases by more than 100%. For the third cost-subscription willingness function, however, the development increases only about 45%.

The relatively small increase for cost-subscription willingness function 3 with respect to cost-subscription willingness function 2 can be explained by the fact that in the case of cost-subscription willingness function 3, city-size classes of lower investment costs and expenses have already been tapped as a source of funds almost completely, when without satellites. The relatively equal income-increasing effect of satellites for all local networks increases the profitability of individual networks, but can no longer cause the same increase in the level of development.

5. Unit-Price Model

In the unit-price model we are not concerned with the economics of the individual local networks, but rather with the economics of the total system, i.e., all local networks together form a single economic unit. /51

The economics of this total system is determined by:

- The sum of all investment costs and expenses incurred in the individual local networks as a function of the city-size class to which they broadcast.

- The sum of all income obtained in the individual local networks from cable connection fees and monthly fees.

Here we are no longer interested in the optimum price per local network, as was the case for the cost-price model; rather, a uniform price is desired for all local networks which will lead to the maximum income for the total system.

5.1. Start conditions

The year 1977 was selected as the start time for cable TV network operation according to the unit price model. Up to this time the housing level will have increase to about 23.6 million units. The housing units operated privately by the GGA are subtracted from this number. We then obtained a figure of 22 million housing units which could receive cable TV.

5.2. Operation sequence

In the unit-price model there results the problem that the operators of the total system will have to make a decision on what sequence the individual local networks will be installed during the construction period. Different sequences are possible here. /52

However, the most efficient sequence is one which will tap the individual regions for funds according to their profitability. If one first installs cable in the areas having the highest incomes and the lowest investment expenditures and costs, one attains a higher degree of self-financing than for every other sequence. The subsequent local networks installed can be financed to a great extent from the financial net receipts of the local networks already installed. Thus, the finance costs of the total system are minimized by this operating sequence, and overall, the development level of the total system in increased.

The degree of profitability, which is decisive for the operation sequence, is the ratio:

$$\frac{\text{Subscription willingness}}{\text{Investment costs}}$$

From this it results that newly-developed areas will be preferred for the installations. Only after these areas are connected will the areas of older housing units be connected according to their subscription willingness and investment costs. The tables of Appendix 3 provide a good overview of this. Figure 21 shows the

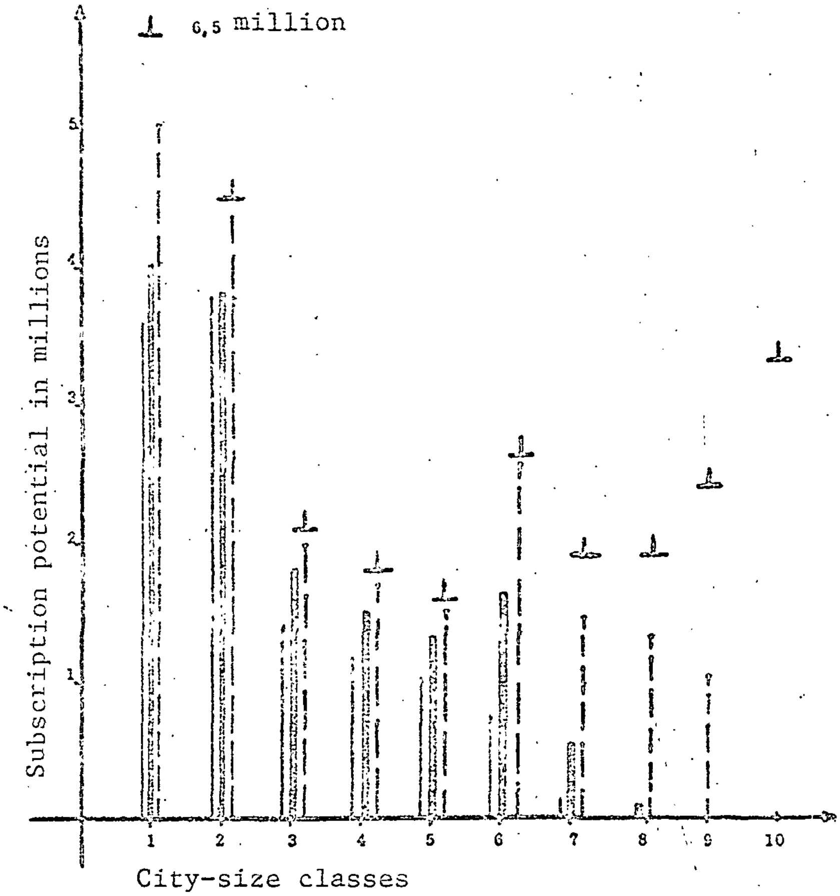

Figure 21. Cable connections of the local city-size classes

——— Development level = 40%
——— = 50%
- - - - - = 70 %
⊥ Total number of housing units in a city size class

cable connections for a newly developed area (local city size class 1) and the city size classes for different levels of final development.

The subscription willingness distinguishes the level of income of a local network. The price need not be considered since the same fees exist for all local networks. The investment costs are used as a measure for the costs of each local network. /53

5.3. Results /54

5.3.1. Maximum development level without satellite

First, we discuss the maximum development level of the total system without satellites. The development levels at which the total system is still economic is considered the maximum. Economic is defined as follows.

The total system is provided with 250 million DM capital resources in advance. The annual profit will be taxed and completely distributed, but will flow back immediately in the form of increases in capital resources. The system is economic if we succeed in maintaining the required capital resources for each year, i.e., if in every year of the build-up period, no losses are incurred. This type of financing has the advantage that the continuing profits of the total system remain available for financing. Thus the capital structure of the total system can be improved and the costs of borrowed capital can be reduced compared to the situation which exists without continuing increases in capital resources.

For unit-price model, the same three cost-subscription willingness functions were used as the cost-price model. For each of these cost-subscription willingness functions, the optimum price of the total system was found, whereby the cable connection fees and the monthly fees were varied as parameters. In connection with this, the maximum level of development was found at which the system would still be economic.

Figure 22 shows the maximum level of development for the three different cost-subscription willingness functions and the resulting numbers of subscribers at these development levels. /55

The temporal development of profit increase in capital resources and borrowed capital is shown by the continuous curves in Figures 23 - 28.

Cost-subscription willingness function	Maximum level of developmt. (millions of units)		Number of subscribers (millions of units)
1	48 %	13,5	6,45
2	75 %	21,2	10,7
3	87 %	24,7	13,47

Figure 22. Maximum development levels (profitability limit) and number of subscribers for different cost-subscription willingness functions*

Translator's note: Commas in numbers represent decimal points.

It is striking here that in cost-consumption willingness function 3 (Figure 27), which leads to the greatest level of development, the profits increase greatly over a large time period but decrease again rapidly after the year 2000. The reason for this is that after this time, the city-size classes 9 and 10 increasingly receive cable connections which results in higher investment costs. This effect is noticed to a lesser extent in cost-subscription willingness function 2 (Figure 25).

5.3.2. Satellite effect

We tried to discover the influence of the satellite on the economy of the overall system and to answer the question whether there is an optimum time point for the introduction of the satellite. Figure 23, page 34, shows the development of the annual profit without satellite for cost-subscription willingness function 1 and for three alternative years for satellite introduction. /62

It turns out that the annual profits after introduction of satellites are greater, the later the satellite is introduced. The optimum year for satellite introduction is accordingly the latest possible year. For introduction of the TV-radio satellite in 1990, losses are incurred only for the first year, and these are more than

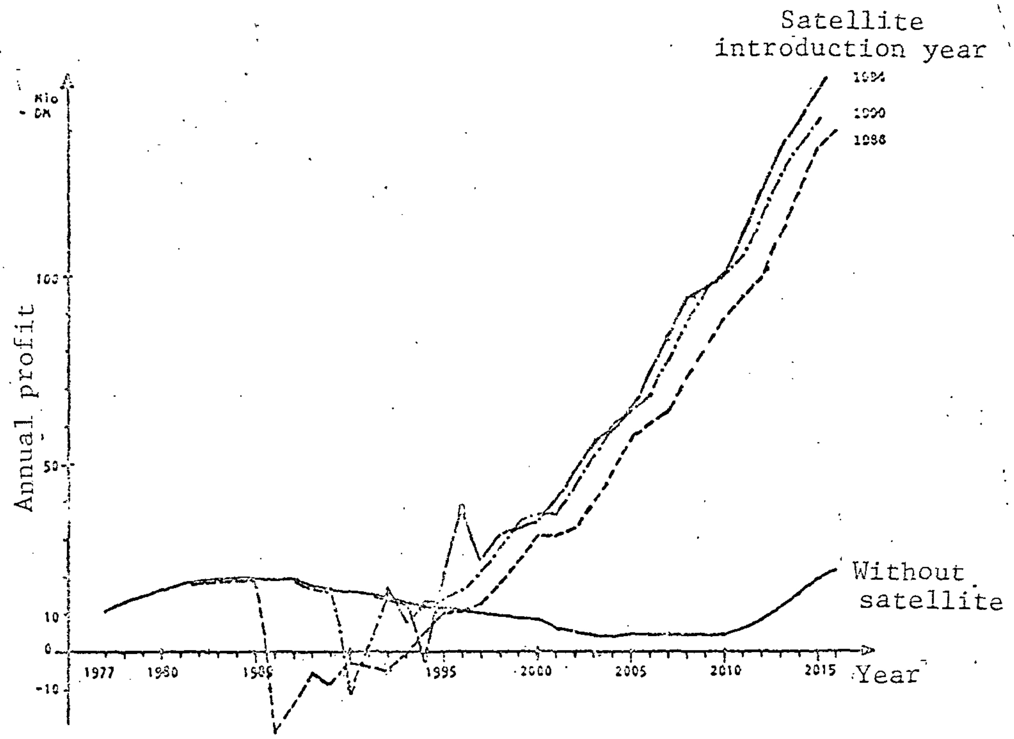

Figure 23. Development of the annual profit for three years of satellite introduction and the same profit without satellite

Subscription willingness function — 1
Maximum level of development — 48%
Cable connection fees — 80 DM
Monthly fee 7 DM

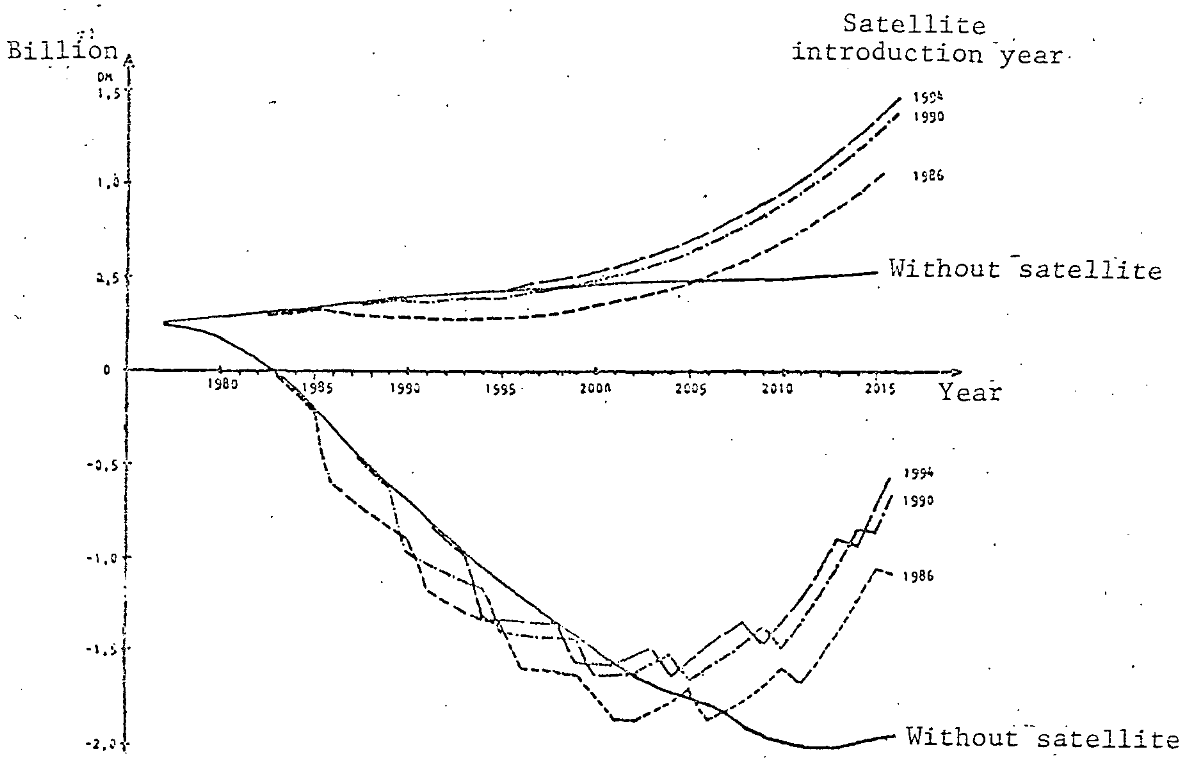

Figure 24. Development of capital resources and borrowed capital for three years of satellite introduction and the same development without satellites

Subscription willingness funtion — 1
Maximum level of development — 48%
Cable connection fee 80 DM
Monthly fee 7 DM

The capital resources are entered on the graph as a positive function; the borrowed capital is entered as a negative function.

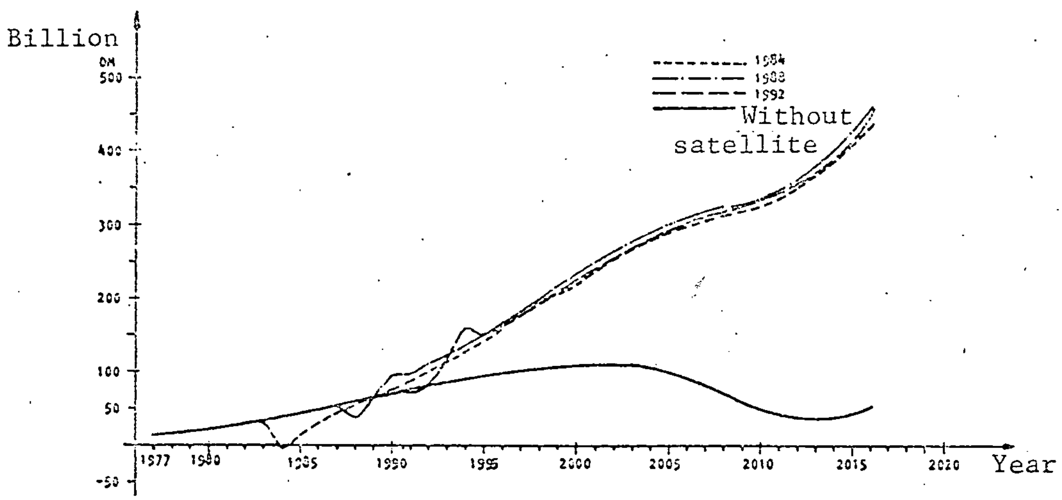

Figure 25. Development of the annual profit for three years of satellite introduction and the same development without satellite

Subscription willingness function — 2
Maximum level of development — 75%
Cable connection fees — 80 DM
Monthly fee — 8 DM

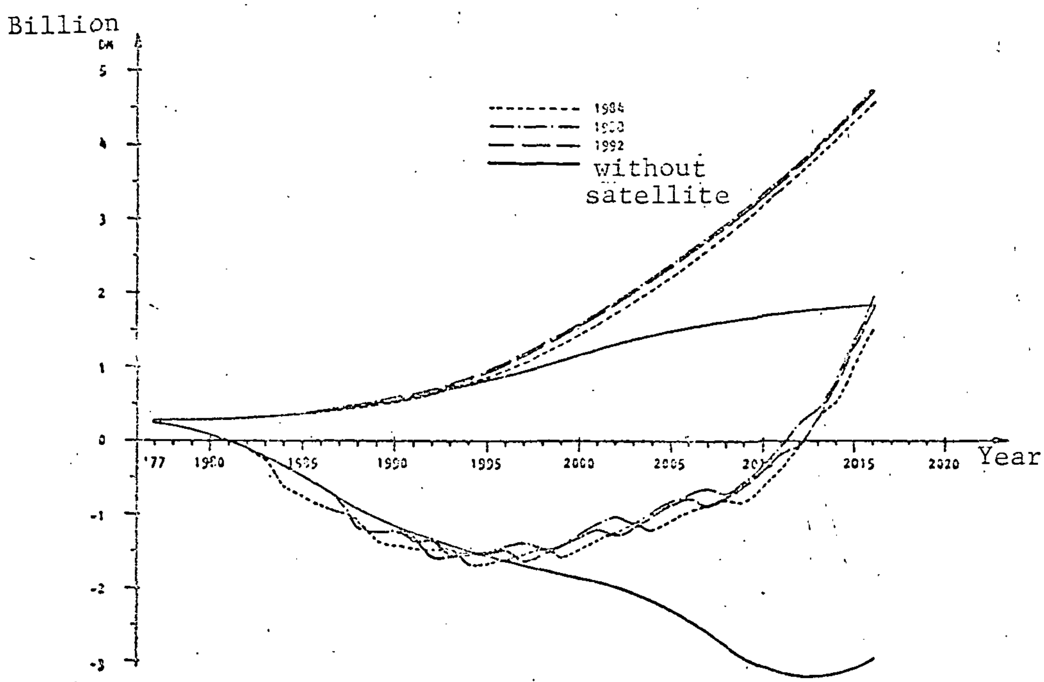

Figure 26. Development of capital resources and borrowed capital for three years of satellite introduction and the same development without satellite

Subscription willingness function — 2
Maximum level of development — 75%
Cable connection fee — 80 DM
Monthly fee — 8 DM

The capital resource is entered on the graph as a positive function; the borrowed capital is entered as a negative function.

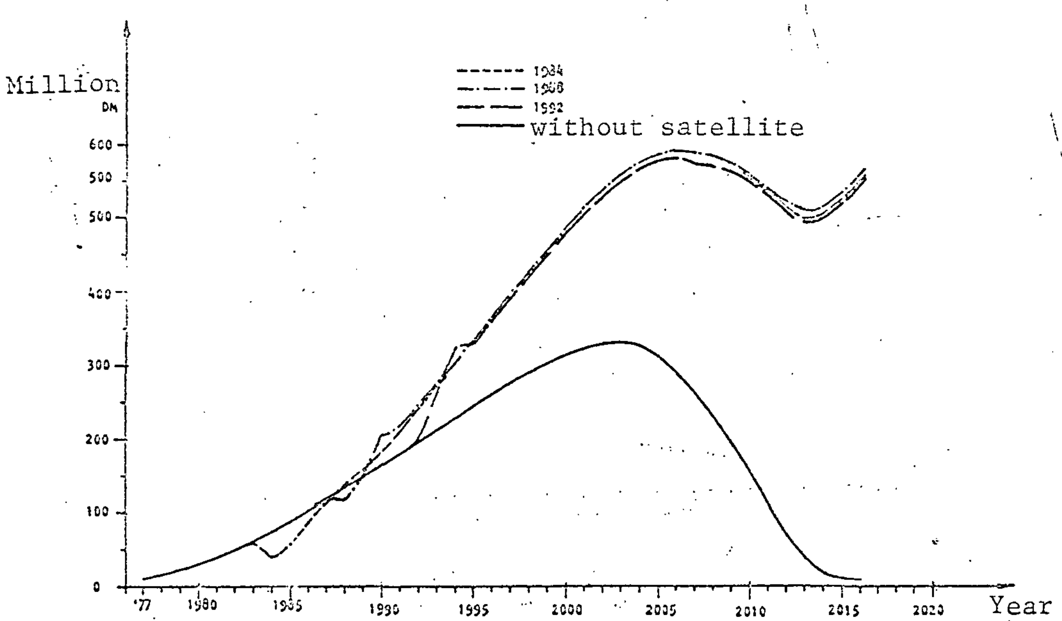

Figure 27. Development of the annual profit for three years of satellite introduction and the same development without satellite

Subscription willingness function — 3
Maximum level of development — 87%
Cable connection fee — 80 DM
Monthly fee 9 DM

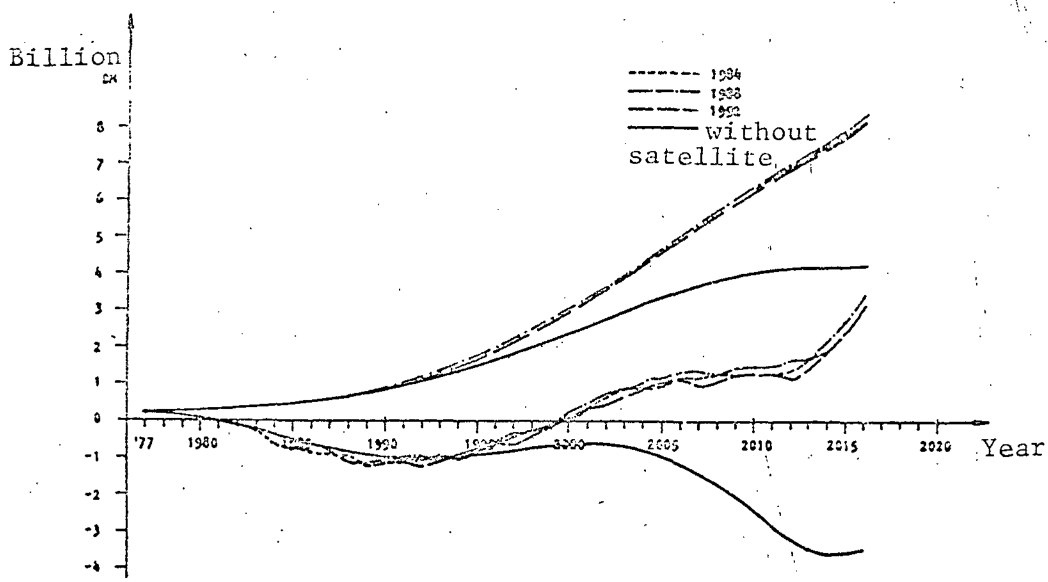

Figure 28. Development of capital resources and borrowed capital for three years of satellite introduction and the same development without satellite

Subscription willingness function — 3
Maximum level of development — 87%
Cable connection fee — 80 DM
Monthly fee — 9 DM

The capital resources are entered as positive functions on the graph; borrowed capital is entered as negative functions.

equalized by the third year. This year is the earliest year for introduction.

Using the favorable assumptions of cost subscription willingness functions 2 and 3 (Figures 25, 27, pages 36, 38), 1984 is a possible year for introduction of a satellite. Later introduction hardly has any effect on the economy.

The introduction of satellites causes initially an increase in requirements for borrowed capital. However, this effect is more than made up for by the higher profits which can be added to the capital resources.

For cost-subscription willingness functions 2 and 3, this improvement is so great that after the year 2011 or 2000 the total system can be financed completely with its own capital resources.

For the results discussed up to now, we begin from the fact that the optimum price of the total system without satellite should be maintained. /63

In a second step of the investigation, the question was clarified as to whether a greater degree of still-economic development can be realized for using an optimum mixed price, i.e., a price which considers the situation with and without satellites, and whether there is an optimum year for the introduction of satellites.

We proceeded in detail just as was done for the first step of the investigation. At first, the optimum mixed price was found for a given level of development for alternative years of satellite introduction. As the optimum mixed price, we found the price which led to maximum income for the entire build-up period under consideration of the introduction of a TV-radio satellite; thus a maximum level of development is made possible. In connection with this, we investigated how large this maximum is for a still-profitable level of development at a given optimum mixed price for individual years of satellite introduction.

We found that there is a maximum year for the introduction of satellites for each of the three cable-connection subscription willingness functions. This means, if the satellite is introduced early or late, that the achievable maximum profitable level of development is less than for ~~introduction~~ of the satellite in the optimum year of introduction.

Figure 29 shows the development of the yearly profit for the three cost-subscription willingness functions. Figure 30 shows the capital development if the satellite is introduced in the optimum year for satellite introduction. The optimum year for satellite introduction is earlier, the better the cost-subscription willingness function is. /64

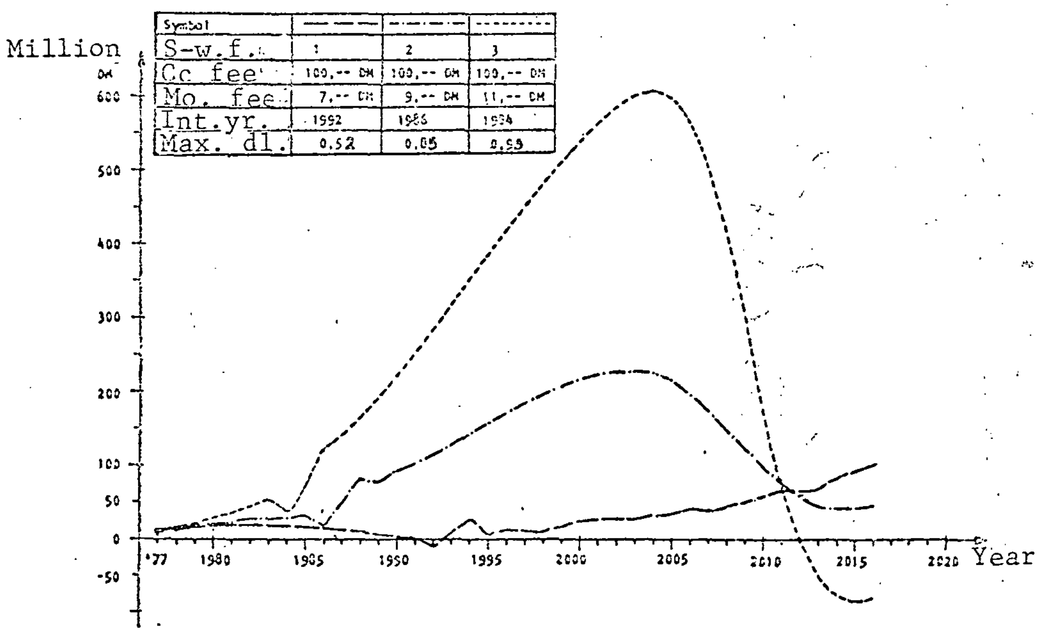

Figure 29. Development of the annual profit for three years of satellite introduction

S-w.f. — subscription willingness function; Cc fee — cable connection fee; Int.yr. — year for satellite introduction; Max. dl. — maximum development level

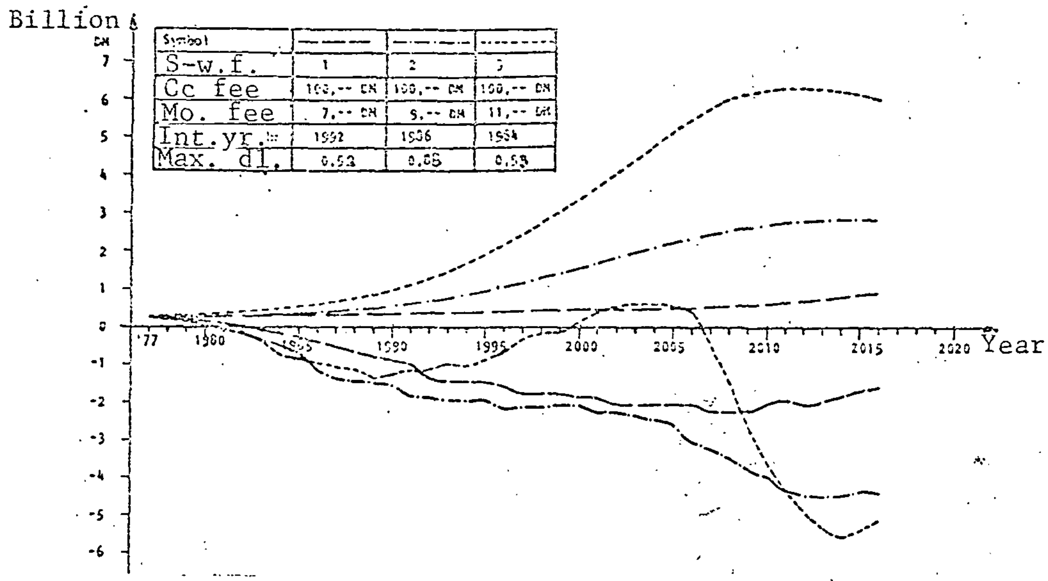

Figure 30. Development of capital resources and borrowed capital for three years of satellite introduction

The capital resources are entered on the graph as a positive function and borrowed capital is entered as a negative function

S-w.f. — subscription willingness function; Cc fee — cable connection fee; Int.yr. — year for satellite introduction; Max. dl. — maximum development level

The summarized representation of the results in Figure 31 shows: /66

1. The maximum, still-economic development level is increased by the introduction of a TV-radio satellite for all three cost-subscription willingness functions.

2. There is an optimum year for satellite introduction.

This introduction year is earlier, the better the basic cost-subscription willingness function is. This can be explained as follows:

The better the cost-subscription willingness function, the earlier is a relatively large number of subscribers achieved, on whom the satellite costs can be placed.

Subscription willingness function	50% price, DM	Without satellite			With satellite			
		Favorable price		Max. devel. level	Favorable price		Max. devel. level	Best year for satellite intro- duction
		Cable connection fee	Fee per month		Cable connection	Fee per month		
1	6.10	80.--	7.--	48	100.--	7.--	52	1992
2	7.65	80.--	8.--	75	100.--	9.--	85	1986
3	9.20	80.--	9.--	87	100.--	11.00	93	1984

Figure 31. Comparison of maximum profitable subscriber potential which can be tapped for funds in the unit-price model for different parameters

6. Comparison of Results /67

The most important results of the two models investigated — the cost price model and the unit price model — shall be compared on the basis of Figure 32.

Subscription willingness function	Without satellite		With satellite	
	Cost price	Unit price	Cost price	Unit price
1	8,2 %	48,0 %	8,2 %	52,0 %
2	17,5 %	75,0 %	36,0 %	85,0 %
3	36,0 %	87,0 %	53,0 %	93,0 %

Figure 32. Comparison of cost price model-unit price model maximum development levels

It shows that:

1. For all three assumed cost-subscription willingness functions, the unit-price model yields a significantly greater level of economic development.

2. For the assumptions made, the satellite improves profitability and thus the potential level of economic development, with the exception of cost-price model subscription willingness function 1

References /68

1. Study on "Performability Analysis for a TV-Radio Satellite, Phase A, Concluding Report", Siemens AG, SEL AG, Messerschmitt-Boelkow-Blohm, Ltd., August 1973.

2. Study on "Communications Service — Analysis, Evaluation, Suggestions", SEL AG, October, 1973.

3. Duwendag, D., H. Bucher, G. Epping and H. Mrosek. Prognosis of Housing Needs for the Federal Republic of Germany until 1985.

4. Lecture: "Some Technical, Economic, and Applications Considerations of Interactive Television MITRE Corporation", March, 1973.

5. Study on "Cable TV — Model Study on Economic Aspects of Built-Up and Operation of a Cable TV Network in the German Federal Republic," SEL AG, February, 1974.

Appendix 1 /69

This appendix contains the prices for TV-radio satellites and receiver stations which were used as a basis for the calculations of economy.

Satellite with ground control station /70

Satellite	59 million
Start	47 million
Ground control station	15 million
Buildings, etc..	1 million
Personnel costs per year	0.4 million

Satellite receiver components for the cable TV network and the GGA

Designation	DM	
Receiving antenna, radio	5,250	
Radiocomponent with VHF/UHF converter		
Modulation converter UHF/FM VHF/RAM	8,622	1 for each program
Receiver station for 4 programs	39,738	

Transmitting and receiving stations are not separate.

Satellite receiver station for a GA community unit

Designation	DM	
Antenna	2,000	
VHF preamplifier and mixer		
Multichannel distributor	70	
UHF/RF converter	400	1 for each program
RF amplifier demodulator	600	
Signal preparation	130	
ZF modulator RAM	216	
Channel converter RF/UHF	400	
Special components	300	
Community unit for 4 programs	9,354	

Appendix 2 /73

Explanation of the formulas used

(1) Conversion of the monthly fee and the cable connection fee into a monthly price.

In order to be able to consider different conditions of monthly fees and cable connection fees, cable connection fees were converted, together with the monthly fees, into a monthly price. Here, the following formula of the cash value method was used:

$$P = M + \frac{A \cdot i\,(1+i)^{T-1}}{12\,(1+i)^{T-1} - 1}$$

P = monthly price
M = monthly fee
A = cable connection fee
i = interest rate
T = time period under consideration.

As an interest rate we selected 5%, as already discussed in section 3.4.2.

A time period of 10 years was selected as the time under consideration. Here it was assumed that this is the time period considered by a subscriber in comparing monthly fees and cable connection fees.

(2) Cost-subscription willingness function /74

For the cost-subscription willingness function, we used the following formula:

$$Bm = 0{,}9 \exp\left\{ - 3{,}02 \left(\frac{P}{P_{max} - P}\right)^2 \right\}$$

P = monthly cost
Bm = average subscriber willingness.

Cost-subscription willingness function:

1: $P_{max} = 20$
2: $P_{max} = 25$
3: $P_{max} = 30$

This function produces a cost-subscription willingness curve whose course corresponds to empirical values. It is not derived on the basis of certain assumption.

(3) Dispersion of subscription willingness around the average subscription willingness Bm

There is a certain average subscription willingness Bm for a given price. The subscription willingness of the individual local networks Bi is dispersed about this average subscription willingness. The following relationship is assumed for this:

$$Mi = \exp\left\{-2 \left(\ln \frac{Bi\,(1 - Bm)}{Bm\,(1 - Bi)}\right)^2\right\}$$

$$n\,(Bi) = \frac{Mi}{\sum_i Mi}$$

n(Bi): percentage of the local network having subscription willingness Bi (for Bi, multiples of 5% were selected);

Mi: auxiliary quantities.

(4) Cable connection function of the subscribers to individual local networks /75

The development of the number of subscribers was adapted to the data contained in the study "Communication Services" [2]. The values given there can be approximated by the function:

$$T = \frac{B}{1 - \exp\{0{,}6\,(t - 2{,}7)\}}, \quad 2 < t < 10$$

B: final number of subscribers

t: time (in years).