

Revision of ST61

— Lessons learned from history

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Over the next few years, the Stockholm Frequency Plan of 1961 will be revised to produce a new plan for digital broadcasting in the European Broadcasting Area.

In this article, the author describes some of the lessons learned from history which must be taken into account when revising the original Stockholm Plan.

Introduction

In June 2001, the ITU Council decided – on the basis of a proposal from European countries – that the Stockholm Agreement of 1961 (ST61) shall be revised in order to make a new frequency plan for digital broadcasting. The conference to revise ST61 will consist of two sessions. The first session is planned for May 2004; the second session is foreseen in 2005 or 2006. This conference will not be the first revision of ST61, nor was the Stockholm Agreement of 1961 the first broadcasting frequency plan.

Since the start of broadcasting there has been a need for a-priori frequency plans; i.e. frequency plans that are made at a conference and are valid for a long period of time, often 15 or more years. Actually, the Stockholm Plan of 1961 has been in use for more than 40 years!

In retrospect, the results achieved at some earlier broadcasting conferences¹ can be reviewed and weighted against the principal conditions required for establishing a-priori plans. The conclusions drawn from this exercise may then provide a valuable lesson from history as we prepare for the revision of ST61.

A-priori plans

Around 1920, broadcasting started in a number of countries. Since then, broadcasting has developed very fast and the need arose to make a European frequency plan. The first European broadcasting plan was the LF/MF Plan of Prague in 1929, signed by 29 European countries. Congestion of frequency bands was already an issue then. At that Prague conference, the 9 kHz channel bandwidth for the MF band in Europe was adopted [1].

After Prague '29, more broadcasting conferences followed; an overview of ITU conferences that produced a frequency plan, relevant to Europe, is shown in *Appendix A*. The ITU Council decision to organize a conference for the revision of ST61 shows that, after more than eighty years of broadcasting, there is still a need for a-priori frequency plans.

The three principal conditions for a successful a-priori frequency plan are:

- equitable access;

1. This article deals with broadcasting conferences for LF/MF, VHF and UHF only.

- avoiding unacceptable interference;
- possibilities for development.

Equitable access results in a similar number of services for all countries. However, economic development and cultural conditions in European countries differ greatly, and implementation of the services provided by a plan is therefore not uniform. In some countries, all frequencies agreed by a plan are in use whereas, in other countries, not all of the agreed frequencies are in use. However, the unused frequencies still have full rights of protection and can be put into operation at any time.

The avoidance of unacceptable interference is achieved by adopting common planning criteria and methods for calculating the interference, as well as a common method for planning the broadcasting stations. In the planning process at a conference, no station enters into the Plan without the agreement of the countries that may be affected by interference from that station. The agreements between countries are reached by means of bi- or multi-lateral negotiations, and by respecting the commonly agreed planning criteria.

It may seem at first sight that such an a-priori plan is very inflexible and cannot cope with developments that were not foreseen at the time of the Conference. However, the fact that a number of broadcasting plans have existed for several decades shows that this is untrue. Flexibility is achieved by a modification procedure. Modifications to the Plan – for example, a change in the characteristics of a station, such as an increase in power, or the provision of additional stations – are possible, provided that all affected countries agree to the modification. This process of consultation with other countries is called “*co-ordination*”.

The Stockholm Plan of 1961 (ST61)

From 26 May to 22 June 1961, delegations from 38 out of the 40 countries of the European Broadcasting Area (EBA) gathered at a hotel in Stockholm to produce a frequency plan for FM and television in the VHF and UHF broadcasting bands. *Fig. 1* shows the countries that are fully or partly situated in the EBA.

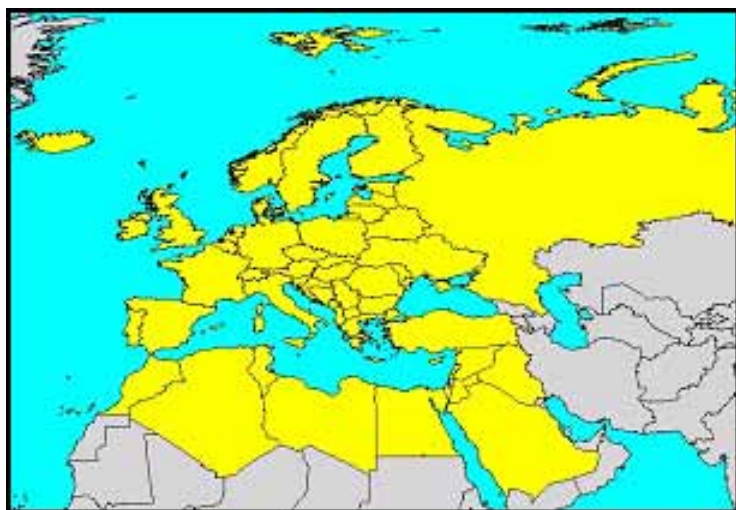


Figure 1
Countries partly or fully in the EBA

Table 1
Number of transmitters contained in ST61

Band I	230
Band II (FM)	2,545
Band III (Television)	798
Band IV/V (Television)	4,505

The number of transmitters contained in ST61 is shown in *Table 1*.

The Stockholm Plan of 1961 was preceded by the Stockholm Plan of 1952 (ST52). This was the first broadcasting plan for FM and television in Europe and it dealt with VHF only. The Stockholm Plan of 1961 was followed by a number of multilateral agreements that were carried out in order to improve the Stockholm Plan; for example, a frequency offset plan and a low power plan.

Since 1961, enormous developments have taken place in television broadcasting. New networks have been added and, in particular, many low-power fill-in transmitters (relays) have been brought into operation. But also, backwards-compatible additions to the television system have been introduced such as colour television, teletext and a second sound channel. Nowadays, there are more than 85,000 TV transmitters in the EBA.

Some quotes from the report of the Netherlands delegation to the Stockholm Conference of 1961 may help in giving an impression of the developments that took place at that conference:

“Conference was at deadlock because of the Berlin issue”

In 1961, political tension in Europe was high. To place the Conference in the history of that period: less than two months after the Conference, the Berlin wall was erected. It is therefore not surprising that international politics had a great impact on the proceedings of the Conference. In the end, the Berlin issue was solved by means of a neutral country code to the stations in the Berlin area, and by Final Protocol statements that would be noted by the countries concerned, without comments.

“Unfortunately it was not possible to make a pre-coordinated UHF plan”

In Western Europe, an attempt had been made to produce a pre-coordinated plan for a “clean” UHF band before the Conference, but this attempt failed. The Eastern European countries managed to come to the Conference with a pre-coordinated plan. However this plan was not well received by other administrations because it was based on a different planning method.

“The Plan in the 87.5 – 100 MHz and 470 – 960 MHz bands was far from optimal, due to limited time at the Conference”

In the UHF band, in particular, the frequency offsets were not optimal. The time shortage was caused by the unexpected number of requirements, and because a large number of requirements were submitted *during* the Conference. Consequently, low-power stations could not be taken into consideration.

“The benefit of the electronic calculator was much less than expected”

The ITU, assisted by a number of German experts, operated an “electronic calculator” to check the calculations. The results did not lead to many changes in the draft plan. However the EBU concluded that the assistance given by the computer was considerable [2].

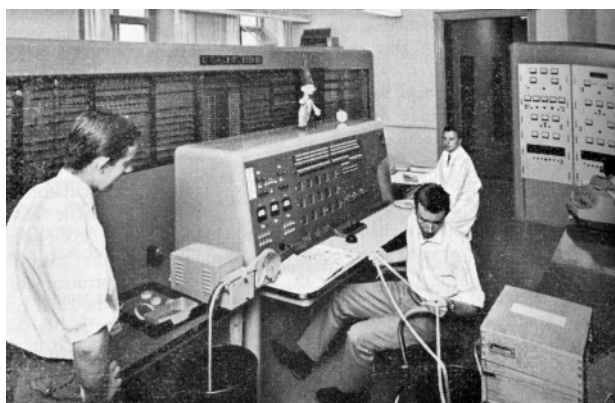


Figure 2
The BESK electronic computer that was utilized for verifying the plan established during the Stockholm Conference, 1961

“Finally, the Conference was very successful”

The delegates, in planning groups, worked day and night in a good spirit of co-operation.

It should also be noted that the success of the UHF plan was due to the use of theoretical network planning (developed by Mr Eden and Mr Kaltbeitzler of the IRT) [2]. This method was agreed at the preparatory meeting in Cannes, during March 1961, but was not actually used by all countries (*see the second quote above*).

The Geneva Plan of 1984 (GE84)

At the World Administrative Radio Conference in 1979 (WARC 79), Band II was extended by 8 MHz to cover the range 87.5 – 108 MHz. A Resolution was made for the ITU to organize a conference for the planning of FM stations in that band.

The first session of the Conference, to establish the technical criteria, took place in 1982. The second session, held from 29 October to 7 December 1984, produced a new FM plan. This plan is known as the Geneva Plan of 1984 (GE84). It was drawn up for Europe, the whole of Africa and some neighbouring countries in Asia; 78 of the 101 countries in this area participated in the conference. The Plan contained 51,364 assignments plus a list of 1483 unsolved cases. GE84 replaced the FM plan (covering the frequency range 87.5 – 100 MHz) that was drawn up at the Stockholm Conference in 1961, but left untouched the 87.5 – 100 MHz Plan for television stations in parts of Eastern Europe.

Again, a number of quotes from the report of the Netherlands delegation to the Geneva Conference in 1984 are reproduced here, to give an impression of the developments that took place at this Conference:

“Because of extensive pre-coordination, attention could be focused on the remaining issues”

At least one lesson had been learned from ST61; in Western Europe, extensive pre-coordination took place (on the basis of the agreed planning method) in order to align the requirements. For example, the Netherlands took part in 17 pre-coordination meetings. The pre-coordination was supplemented by computer analyses carried out by the EBU in conjunction with the CEPT [3].

“Sometimes it seemed more of an aeronautical than a broadcasting Conference”

There were “remaining issues” during the Conference, such as the compatibility between FM broadcasting and aeronautical radio navigation (ILS and VOR) in the band just above 108 MHz. The Conference just could not solve this problem, due to the limitations of the agreed calculation method. This led to a crisis.

“At a special plenary session, it was decided to solve aeronautical incompatibilities by means of a co-ordination procedure”

It was a very wise decision not to spend more time at the Conference on a problem that could not be solved. By postponing the matter, more time was available to find technical solutions and the emotions could be calmed down. After the Conference in Western Europe, a group called “Legbac” was set up. This group developed a calculation method (the so-called Unified Assessment Method) and a co-ordination method for solving the compatibility problem [4].

“Due to the high number of stations, interference levels were high”

In particular, in the new part of the FM band (100 – 108 MHz) the planning was very dense.

“The use of computers was indispensable”

All calculations by the ITU, and by many administrations, were done on (mainframe) computers. The EBU had made a mainframe computer system available for its members [3].

“A lot of paperwork; problems with form 1 could be solved by signature on form 2”

This may sound very cryptic, but it indicates that formalities and a certain amount of bureaucracy are unavoidable at a planning conference.

A-priori frequency plans – a success?

When reading official press releases and the delegation reports of past conferences, all are claimed to have been very successful. However – with hindsight and, in a number of cases, after decades of experience with a frequency plan – one can wonder if the frequency plans fulfilled the three principal conditions for establishing an a-priori plan:

- 1) equitable access;

- 2) avoiding unacceptable interference;
- 3) possibilities for development.

The author has weighted Five Agreements, arising from frequency planning conferences over the last 40 years, against these three conditions, using a five-point scale:

5 = Excellent

4 = Good

3 = Fair

2 = Poor

1 = Unusable

The five Agreements chosen by the author for this exercise are shown in *Table 2*. References [2], [3], [5] and [6] describe the first four Agreements listed in the *Table*.

Table 2 – The five Agreements

Agreement	System	Made under the auspices of:
ST61	TV, FM	ITU
GE75	AM	ITU
GE84	FM	ITU
WI95	T-DAB	CEPT
CH97	DVB-T	CEPT

The Chester Agreement of 1997 (CH97) – covering the introduction of digital television in Europe – has no associated frequency plan. It contains only technical and administrative rules which supplement the Agreement of ST61. By applying CH97, the Stockholm Plan of 1961 can be considered as a frequency plan for digital television. For that reason, CH97 is also taken into consideration in these deliberations.

Equitable access

Equitable access is achieved if the Plan provides for a similar number of services to all countries. However, if part of the band is blocked by other usage, equitable access may be achieved in theory, but not in practice. Therefore, access to the frequency bands is also tested.

Table 3 – Weighting against “equitable access”

Agreement	Weighting (1 - 5)		Remarks
	Services	Access to bands	
ST61	4	4	Band IV/V, partly blocked by other services
GE75	2	5	Based on existing situation
GE84	4	5	100 – 108 MHz free
WI95	5	3	All countries two “priorities”; partly blocked by television and other services
CH97	3	4	Dense use by analogue television

In general, it is believed that ST61 and GE84 achieved equitable access to an acceptable degree. Planning in the clean frequency bands (470 – 962 MHz of ST61, and 100 – 108 MHz of GE84) was based on theoretical network planning. GE75 was imbalanced in its use of spectrum: attempts were made to apply rules for obtaining equitable access, but these failed [5].

All frequency ranges covered by ST61, GE75 and GE84 were accessible. Although some countries had no access to certain parts of the band for broadcasting (for instance the channels above 60 that are used in a number of countries for military applications), this was the choice of the countries concerned and can therefore not be seen as being blocked by other services. However, as the other services are, in general, more sensitive to interference than television, neighbouring countries experienced severe restrictions to their television services. There were restrictions at GE84 in Western Europe, with regard to mobile services in the UK, but these problems were solved soon after the Conference.

WI95 achieved the best equitable access. Each country obtained exactly the same: two national coverages, consisting of one or more SFNs. A number of countries cannot use their T-DAB allotments because part of the band is blocked by television or other services; the reason for the “fair” score on this item.

Since 1961, there have been considerable developments in analogue television. However, these developments have not been the same in each country. Some countries now have more analogue television networks than others. Consequently, the possibilities for digital television – based on the analogue planning (regulated by the Chester Agreement) – are not the same. Therefore, equitable access for services has a lower score in the case of the Chester Agreement. Digital television in many countries can only be implemented on a large scale when analogue television has been switched off. Because of the right to convert analogue stations to digital, which is embedded in the Chester Agreement, access to the bands for digital television is estimated as “good”.

Avoiding unacceptable interference

Depending on the total number of requirements and the equitable access principle, it may well happen that the level of interference that has to be accepted is higher than what it ideally should be. The degree to which assignments can be protected against modifications and additions to the Plan is also tested. GE75, GE84 and CH97 use the usable field strength level that existed at the end of the Conference as a *reference value*. Modifications to a plan should normally be acceptable if the reference value is increased by a small margin (0.3 or 0.5 dB).

Table 4 – Weighting against “avoiding unacceptable interference”

Agreement	Weighting (1 - 5)		Remarks
	Interference level	Protection	
ST61	4	4	No technical rules for co-ordination
GE75	2	4	Based on reference value
GE84	3	4	Based on reference value
WI95	4	4	Based on field-strength limit
CH97	3	4	Based on reference value

The scores given above for “interference level” reflect mainly the high number of stations on each channel in the Plan. A “poor” interference level (GE75) means that interference is very high. The GE75 conference was faced with an excessive amount of requirements and failed to find ways of reducing interference. In the end, it was decided to accept all requirements with the consequence of very high interference levels.

All plans have good provisions for the protection of transmitting stations, irrespective of the complexity of the rules. According to CH97, all analogue television stations have the right to convert to digital under certain

conditions. When an analogue station is converted to digital, interference to existing digital television stations may increase considerably, because of the increase in the protection ratio. However, this situation is predictable and is taken into account in the co-ordination process.

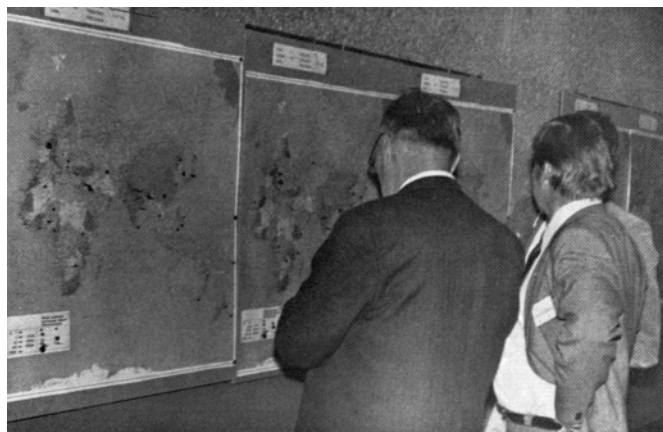


Figure 3
Instead of applying rigorous planning methods, the participants at the GE75 Conference preferred to proceed by bilateral negotiations, and they frequently consulted maps indicating the transmitter locations and channels

Possibilities for development

The development of a plan may include new or modified stations, but also new technology might have to be accommodated.

Table 5 – Weighting against “possibilities for development”

Agreement	Weighting (1 - 5)		Remarks
	New stations	New technology	
ST61	5	5	Need for bi-lateral agreements to agree on technical procedures
GE75	3	1	Excessive number of stations in the Plan
GE84	4	4	Need for bi-lateral agreements to overcome reference value rules
WI95	5	1	Allotments
CH97	4	1	Need for bi-lateral agreements for relaxed criteria

ST61 has proven to be very flexible. WI95 has built-in flexibility due to the allotment planning. Possibilities for adding digital television stations, according to CH97, are limited because of the analogue television protection criteria. Therefore, some administrations have agreed on relaxed criteria in order to have more flexibility to plan digital stations. On the other hand, CH97 allows analogue television stations to be converted into digital television stations or SFNs.

The reference value concept – allowing only a very slight increase of that value (see section above) – is, in principle, rather restrictive for new developments. However, experience has shown that administrations deal with this in a pragmatic way. A good score for “protection” in *Table 4* does not therefore correspond to a poor score for “new stations” in *Table 5*.

GE75, WI95 and CH97 do not allow for systems other than those for which the Plan was designed. ST61 has no such rules and even digital television is possible according to ST61. GE84 gives the possibility of using other systems, as long as the new system does not cause more interference.

Abbreviations

CEPT	European Conference of Postal and Telecommunications Administrations		centre)
CH97	Chester Frequency Agreement of 1997	ITU	International Telecommunication Union
DVB	Digital Video Broadcasting	MF	Medium-Frequency
DVB-T	DVB - Terrestrial	SFN	Single-Frequency Network
EBA	European Broadcasting Area	ST61	Stockholm Frequency Plan of 1961
FM	Frequency Modulation	T-DAB	Terrestrial - Digital Audio Broadcasting
GE75	Geneva Frequency Plan of 1975	UHF	Ultra High-Frequency
GE84	Geneva Frequency Plan of 1984	VHF	Very High Frequency
HF	High-Frequency	VOR	VHF Omni-directional Range system
ILS	Instrument Landing System	WARC	(ITU) World Administrative Radio Conference
IRT	<i>Institut für Rundfunktechnik GmbH</i> (German broadcast engineering research	WI95	Wiesbaden Frequency Plan of 1995

Results of the tests

The total score of the tests, shown in *Table 6*, indicates that ST61 best fulfils the principles for a-priori plans. The main reason is that ST61 proved to be very flexible, it had a low station density and, at the time of the Conference, the UHF band was free.

The relatively low score of CH97 is due to the fact that the TV bands are extensively used by analogue television stations. There is limited room for new stations. The challenge facing the revision of ST61 will be to improve equitable access to the TV bands, and the interference situation. Access to these frequency bands will be of crucial importance.

Table 6 – Total score

Agreement	Total score
ST61	26
GE75	17
GE84	24
WI95	22
CH97	21

Lessons

From past experience, there are lessons to be learned that may help to make a success of the forthcoming Conference for the revision of the Stockholm 1961 Plan.

Lesson 1: keep it simple!

Complicated procedures, such as modification procedures based on a reference value, do not seem to lead to better results.

Therefore, the Conference must:

- draw up simple modification rules;
- rely on bi-lateral agreements for details.



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Mr Doeven is currently Senior Technical Advisor at Nozema, the Netherlands Broadcasting Transmission Company. He has been a member of the Netherlands delegation at many ITU Conferences for Regions 1 and 2, covering MF, HF, FM and satellite planning, an also at WARC 79. At the second session of the FM planning Conference (GE84), he chaired the Western European planning group. He was also a delegate at the CEPT meetings for DAB in Wiesbaden (1995) and DVB-T in Chester (1997). At the latter, he was chairman of the procedural committee.

Jan Doeven is chairman of the EBU's Broadcast Technology Management Committee (BMC), chairman of CEPT project team FM 24 (dealing with the preparations for the conference to revise the Stockholm Agreement of 1961), and a member of the Steering Board of DigiTAG.

Lesson 2: conference time is limited!

It seems very obvious that conference time is limited. Furthermore, the duration of a conference is well known before the conference starts. Nevertheless, in most reports on conferences, you will read that the delegates had to work day and night. Also, the high number of requirements comes as a great surprise at all conferences, and it is not uncommon that requirements are submitted during the actual conference. The new Plan can only be completed successfully in the given time frame if it is well prepared and if the planning work can be restricted to the main services.

Therefore, the administrations attending the Conference must:

- make pre-coordinated plans before the Conference, using the agreed planning method;
- strictly obey the dates for submitting their requirements;
- agree on procedures to restrict excessive requirements;
- plan the main applications only; for instance, the low-power applications can be planned later.

Lesson 3: guarantee access to the bands!

Some plans partly failed because sections of the bands were blocked by other services.

Therefore, the Conference must:

- make clear rules for clearing broadcasting spectrum of:
 - other services;
 - old broadcasting services to be replaced by new broadcasting services.

Bibliography

- [1] Ing P. Vijzelaar: **70 jaar radio-omroepzenders in Nederland**
Kluwer Technische boeken, 1990.
- [2] **The European Broadcasting Conference, Stockholm**
EBU Review - Technical, Part A, No. 68, August 1961.
- [3] K.J. Hunt and D. Kopitz: **Second Session of the Regional Administrative Conference for FM sound broadcasting in the VHF band**
EBU Review - Technical, No 211, June 1985.
- [4] K. Hunt, J. Doeven and J. Finnie: **LEGBAC – Church House to Malaga via Avimore**
ITU Telecommunication Journal – Vol. 60 – IX/1993.

- [5] D. Kopitz: **Considerations on the Regional Administrative LF/MF Broadcasting Conference (Second Session)**
EBU Review - Technical, No. 155, February 1976.
- [6] K.J. Hunt, T. Cesky, T. Jeacock, M. Mägele, T. O'Leary and G. Petke: **The CEPT T-DAB Planning Meeting, Wiesbaden, July 1995**
EBU Technical Review, No. 267, Spring 1996.

Appendix A: Overview of ITU conferences that produced a broadcasting frequency plan relevant to Europe

	LF/MF - AM	VHF - FM	VHF - TV	UHF - TV	SHF (12 GHz) - Satellite
1920					
1930	Prague '29 Luzern '33				
1940	Montreux '39				
1950	Copenhagen '48	Stockholm '52			
1960		Stockholm '61			
1970	Geneva '75				Geneva '77
1980		Geneva '84			
1990					
2000					WRC '00 *
2010				Geneva '05	

* Article S30 and S30A of the RR.