

Sophia Antipolis, 18-22 September 1999

**Source:** Alcatel

**Title:** 03.46 Validation Report

The attached document contains the 03.46 validation report. Section 5.2.1 shows the RLP throughput required for a successful fax transmission.

If we assume that in UMTS in ideal conditions is 26.4kbit/s (compared to 9.6kbit/s in GSM) for a user rate of 14.4kbit/s (compared to 9.6kbit/s) no problems are expected. The conditions are similar to an user rate of 4.8kbit/s with 9.6kbit/s RLP (see Fig.5.2.1.4), in this configuration the calls fail only in case of extremely bad radio conditions.



Stuttgart, 5th November 1992

# **Validation Report**

## **GSM TS 03.46**

Alcatel SEL AG

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Hans-Ulrich Schroeder (Deputy Chairman) · Dr. Klaus Fritsche · Hans-Joachim v. Ludwig



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## 1. General

### 1.1 History of GSM TS 03.45 and 03.46

GSM has elaborated two Technical Specifications, i.e. for the support of the transparent and non-transparent network teleservice facsimile group 3, the TS 03.45 and TS 03.46. These TSs were frozen for GSM Phase 1.

A closer look at potentially critical matters of these TSs in May 1990 revealed some technical problems.

Change Requests (CRs) for both TSs were produced to overcome these issues within the timing constraints of the CCITT Rec. T30 in particular the CRs for the GSM TS 03.46 are included in the version 0.0.1 after 3.0.1 of this specification. However GSM decided, to leave the new versions of both specifications subject to validation of the absolute correctness of both TSs before freezing them ultimately.

As regards TS 03.46 the validation has been carried out and the results are now available and are presented subsequently.

### 1.2 Concept of TS 03.46 Validation

The validation has been carried out within the framework of the relevant GSM TSs, the available radio link model and the realistical producible hardware/software platform for both, terminal and PLMN functions.

The relevant GSM TSs and further applicable documents are listed in section 2.

The radio link model consists of the Gilbert Elliott Model (GEM) applied to the latest available error files [9]. This allows for static varying of the CIR values, but does not take into account shadowing.

With respect to the hardware/software platform the following shall be highlighted:

- several group 3 Fax devices from the market for the transmission of 3 different CCITT test documents were used
- the TAF/MT has been realized as an integrated unit
- the PLMN network part was based on a real IWF plus a unit allowing for injecting the GEM stream and the transmission delay
- the #7 and MAP aspects were not taken into account

The validation process has been divided into two main parts:

- the theoretical considerations of the RLP applied to the fax documents (CCITT test sheets) under the timing constraints of T.30 and
- determination of the critical range for the various cases (speed and coding) and measurement within these critical ranges.

## 2. Basic Documents for Validation of TS 61 NT

The validation of the GSM Teleservice 61 "Facsimile transmission in the non-transparent mode" is based on the following GSM Technical Specifications:

[1] GSM TS 03.46 version 3.1.0:

"Technical Realization of Facsimile Group 3 - non-transparent" under consideration of the CR submitted for approval to SMG 4.

[2] GSM TS 04.22 version 3.7.0:

"Radio Link Protocol for Data and Telematic Services on the MS-BSS Interface"

[3] GSM TS 07.03 version 3.0.0:

"Terminal Adaptation Function of Services using Synchronous Bearer Capabilities"

[4] GSM TS 07.01 version 3.8.0:

"General of Terminal Adaptation Functions for MS"

[5] CCITT Rec. T.30 Blue Book:

"Procedures for Document Facsimile Transmission in the General Switched Telephone Network"

[6] CCITT Rec. T.4 Blue Book:

"Standardization of Group 3 Facsimile Apparatus for Document Transmission"

[7] National Specification FTZ 18 TR 53:

"Bedingungen für die Zulassung von Fernkopierern der Gruppe 3 für den Telefaxdienst"

[8] AG 1/1 Doc. 40/89:

"A Discrete Channel Model for the Block Errors on  
the 9.6 kbit/s Full Rate Data Channel in the  
GSM System"

Author: Jürgen Petersen

Philips Kommunikation Industrie AG

[9] SMG 4 Doc 168/92

Error Files from AEG  
requested in this Document

### 3. Description of the Validation System

A real FAX3 NT connection to the PSTN/ISDN network is shown in fig. 3-1 including the protocols which are required on the different sections.

Based on this configuration the Validation System for FAX3 NT consists of two symmetrical parts. Each of it allows the connection of a standard FAX3 apparatus according to T.30, which is normally used on the analog line interface of the PSTN/ISDN.

One part provides all functions necessary to simulate the Mobile Station MS including the FAX Terminal Adaptation Function (TAF) and the 2 wire interface towards the FAX3 apparatus on the MS side.

The other part constitutes the Interworking Function (IWF) normally used within the Mobile Switching Service Center (MSC) and the 2 wire Interface for the FAX3 apparatus normally located at the PSTN/ISDN network side.

These two parts are connected via a 64 kbit/s data channel. For the simulation of a MS - MS call inter/intra MSC the configuration is duplicated where the 2 wire Interface on the MSC side is removed as shown in fig. 3-3.

In the following the functions of the different entities of the Validation System, indicated in fig. 3-2 are described in detail.

The validation of FAX3 NT service doesn't consider the signalling aspects via the Dm - channel and the #7/MAP signalling to set up a call. Only the necessary procedures on the 2 wire interface are simulated to bring the FAX apparatus in the "connect to line" state without control function related to the MSU and IWU.

A disconnection of the FAX apparatus due to the T.30 timer expiry and release timer doesn't stop the procedures running between the IWU and MSU.

That means the validation is done on an already established connection, starting with sending CNG / CED tone.

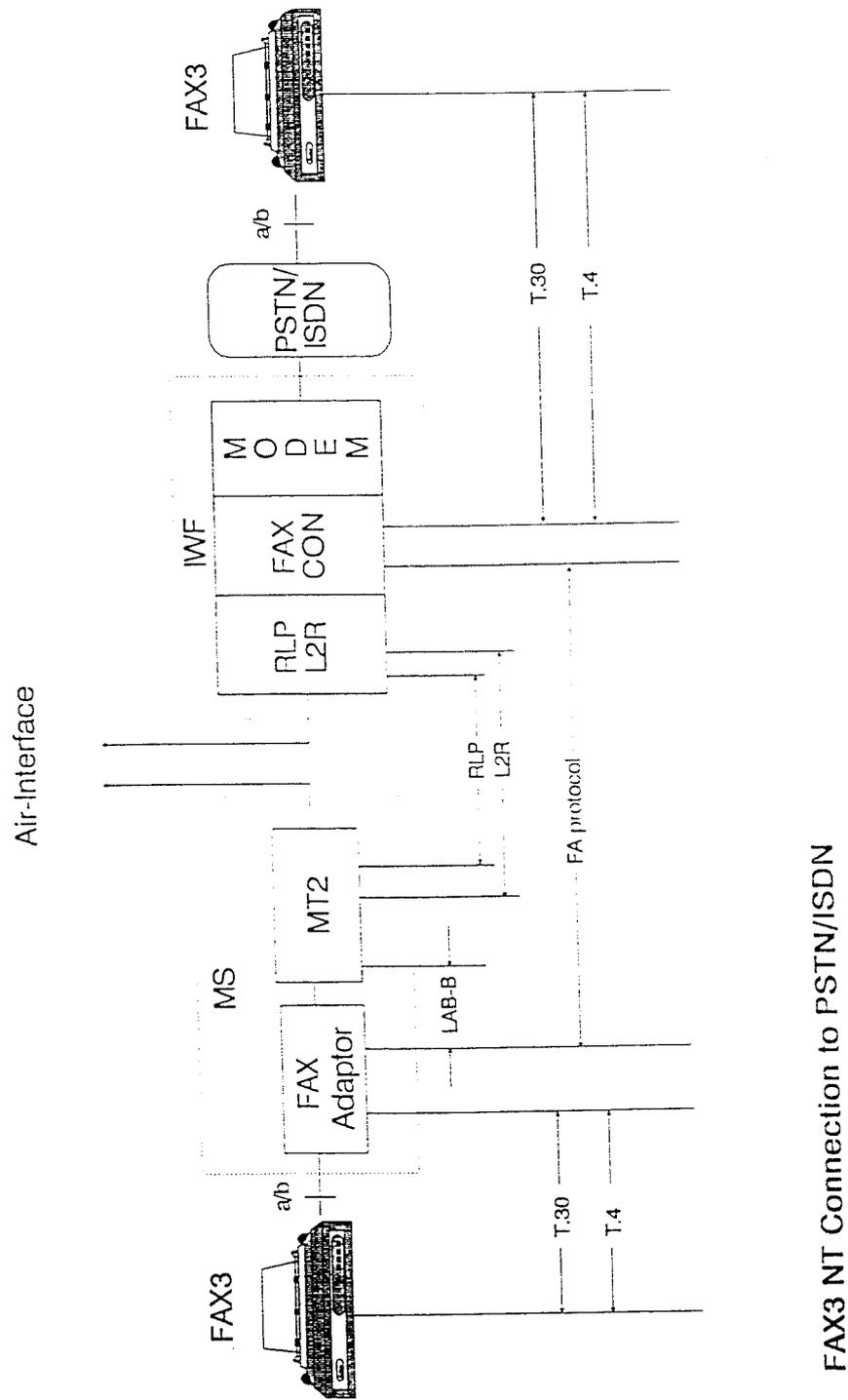
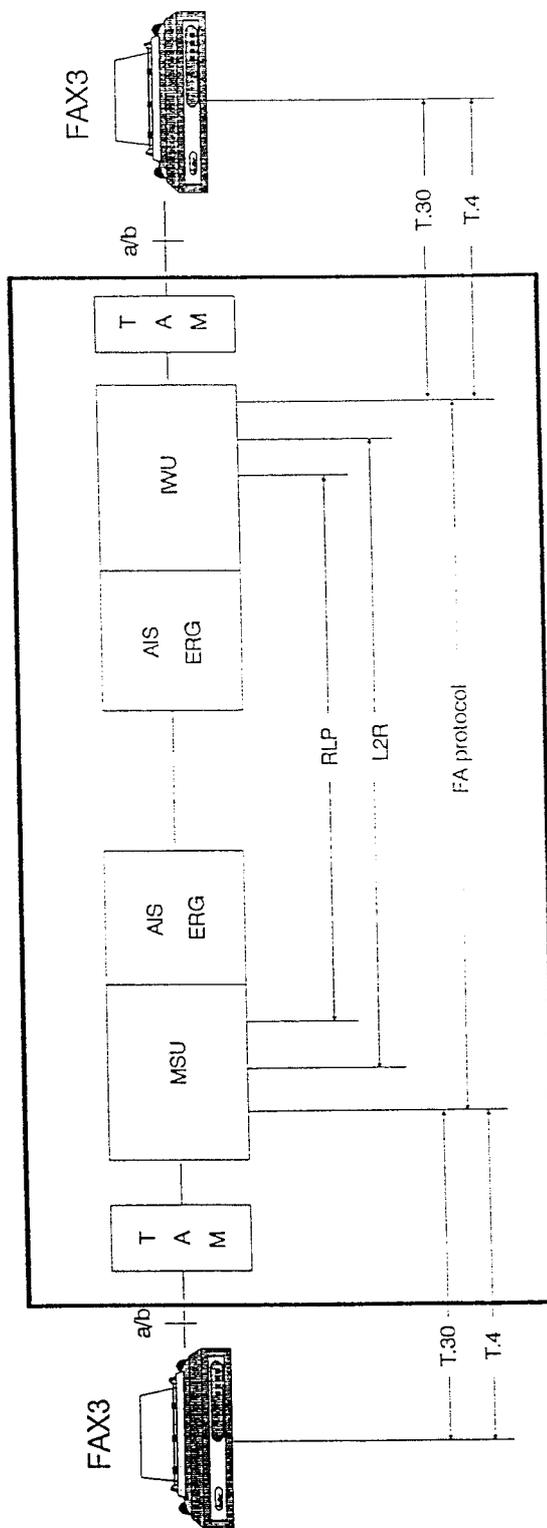
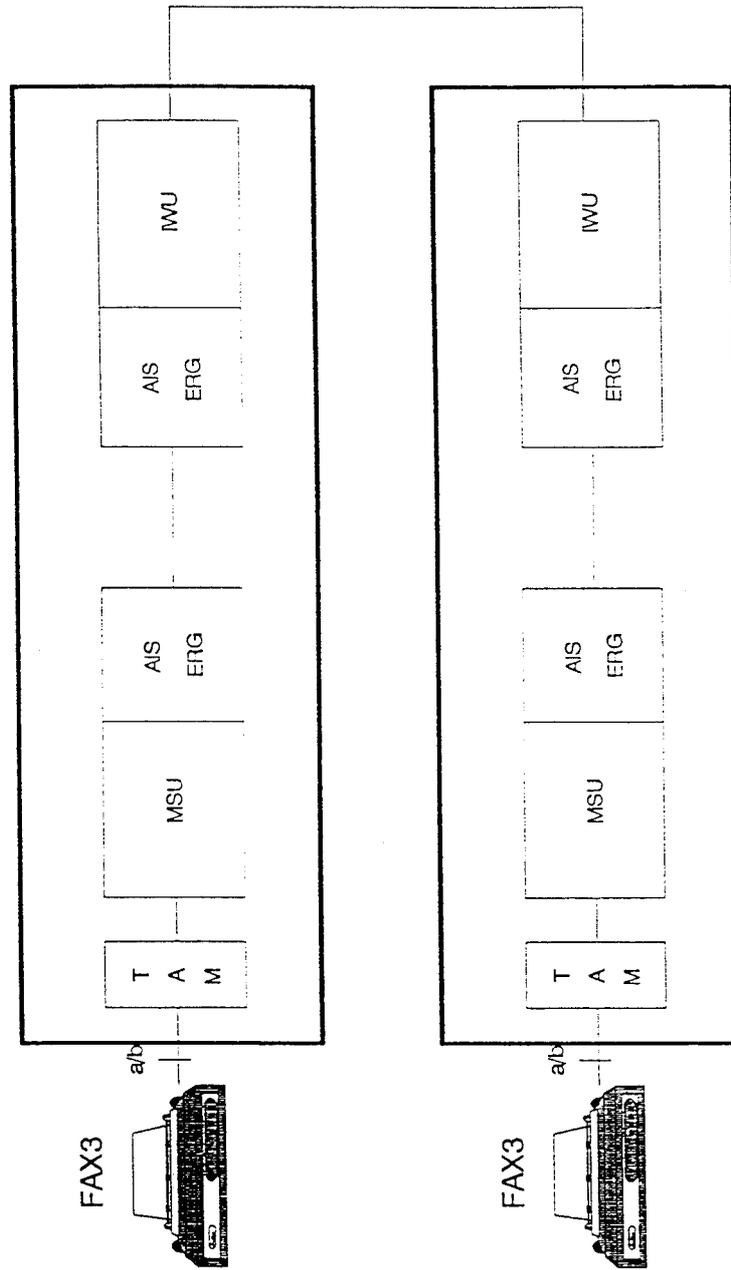


Figure: 3-1



FAX3 NT Validation System Configuration MS to PSTN/ISDN call

Figure: 3-2



FAX3 NT Validation System Configuration MS-MS call

Figure: 3-3

### 3.1 Test Access Module TAM

The TAM adapts the User Network Interface (UNI) of the Fax 3 apparatus (2-wire analog line) to a plain non-switched 64 kbit/s PCM channel. Thus mainly the following functions are performed by the TAM

- line feeding at the UNI
- sending of dial tone at the UNI
- end of dialling detection at the UNI
- sending of ringing current at the UNI
- off/on hook detection at the UNI
- forwarding/receiving the connection establishment/release indication to/from the counterpart TAM
- conversion of the analog audio signals into digital 64 kbit/s audio A-Law information and vice versa.

The initiation of the establishment/release of a connection is done by operating the Fax 3 apparatus in the same manner as usual in the PSTN/PLMN case.

### 3.2 Air Interface Simulator (AIS)

The AIS is a transmission delay function within the MSU and the IWU of the Validation System and is concerned with the actual transmit direction.

This function performs the transmission delay of the radio link. The delay time is adjustable by a command and can be defined in the range from 50 msec to 2,5 sec.

### 3.3 Error Rate Generator (ERG)

The transmission characteristics of the radio link are produced by the ERG, which behaves according to the Gilbert-Elliott model GEM applied to the error files provided by AEG.

To assure the independency of both transmission directions an individual ERG is implemented for each transmission direction of the Validation System.

A thorough analysis of the error files produced by AEG revealed the justification of applying them to the GEM, thus the values for the probabilities P, Q and Pbad were established accordingly.

Parameter sets for additional CIR values (carrier to interference ratio) are interpolated. The resolution for CIR for FAX validation is 0.5 dB.

### 3.4 Interworking Unit (IWU)

The IWU is the core of the Validation System as regards the execution of the protocols and procedures of GSM TS 03.46, eg:

- Rate adaptation and traffic channel synchronisation
- Status bit handling und modem control
- RLP and L2R handling
- Protocol conversion T.30 and T.4 to the FA protocol.

### 3.5 Mobile Station Unit (MSU)

This entity provides the functions to be performed by a MT and FAX-Adapter constituting a complete MS together with the FAX3 apparatus.

Because of the functions and procedures to be performed at both MSC- and MS-side are nearly symmetric, the MSU is mainly a copy of the IWU.

#### 4. Subdivision of the Validation FAX3 NT

The aim of the validation activity was to establish the technical correctness of the GSM TS 03.46. It was felt, that this could be best achieved on a real implementation of GSM TS 03.46 and running it under real environmental conditions.

Based on that what was currently realistically feasible, the following concept of performing the validation process was established

- to use the GEM ( AEG error files applied to the GEM parameters) for radio link transmission behaviour
- to establish a HW/SW platform for implementing GSM TS 03.46 plus allowing for applying the radio link transmission behaviour according to GEM and real delay figures
- to select a few characteristic/extreme test sheets for the Fax-message phase
- to perform measurements in the critical ranges leading to results with statistical confidence.

This led - besides the work on establishing the HW platform - to the following three main activities:

##### Part 1: RLP Throughput

This phase of validation includes the throughput measurements of the radio link protocol using variable CIR conditions and variable RLP parameters, e.g. window-size, timer values, transmission delay. In addition the consequence of the RLP options REJ and SREJ related to the RLP throughput was to be investigated. The results of these measurements led to details of the dependence of the different parameters and the radio link conditions and are used for verification of the available theoretical calculated throughput values.

## Part 2: Facsimile Document Transfer

The critical point of a facsimile group 3 connection in the non-transparent transmission mode is the document transfer phase with the transmission rate 9600 bit/s and 7200 kbit/s. The reasons are that the data throughput will be influenced by the quality of the radio link, the content of the facsimile document and the selected transfer mode of both FAX apparatus in conjunction with the procedures described in the GSM TS 03.46.

Therefore it is necessary to transfer documents by using different parameters selectable at the FAX terminal, e.g. minimum scan line time, vertical density, coding and error correction mode taking documents with different data volumes under various conditions of the radio link.

For validation part 2 the results of part 1 are used to find out the significant boundaries to allow for focussing the measurements on the critical area.

The results of this phase are the worst radio link conditions, under which the a successful facsimile document transfer can take place.

## Part 3: Verification of GSM TS 03.46

The activity of this phase was aimed at discovering potential weaknesses or faults in the protocol and procedures described in CCITT T.30 particularly in conjunction with the BCS phase.

The measurements executed in this phase gave information about the probability of running into states, which lead to the release of the connection caused by various extreme parameter values, found out in the previous phases.

This phase leads to the values for the required quality of the radio link for the BCS phase.

## 5. Results of Validation GSM TS 03.46

### 5.1 Results of Validation Part 1 : RLP Throughput

The first part of validation was done to find the RLP throughput values dependent on the different radio link conditions.

The throughput via the radio link was calculated on the basis of the transmission time of the transferred 1000 RLP PDUs. The transmission time and consequently the throughput are dependent on the selected channel interference ration (CIR).

Each measurement includes the complete range of the CIR from 11,5 dB to 3,5 dB in steps of 0,5dB.

Considering the characteristics of the Gilbert Elliott Model (GEM), numerous measurements have to be performed in view of a statistical confidence, the value chosen was 30.

The first measurements were done with the standard conditions of the radio link and the radio link protocol as specified by GSM.

#### Standard conditions:

RLP Acknowledge Timer T1 (ms):	480
RLP Retry Counter N2:	255
RLP Window Size:	61
Transmission Delay (ms):	230
RLP Recovery:	SREJ
Number of Frames to be transferred:	1000
Range of CIR:	11,5dB - 3,5 dB

The resulting distribution of these measurements including the minimum, maximum and average curves of the measured throughput is shown in Figure 5.1-1.

In addition to the standard conditions, six sets of parameters were defined to get knowledge about the throughput dependency of the different RLP and radio link conditions. Therefore only one parameter was changed at once.

#### Additional sets of parameters

##### Set 1:

RLP ACK Timer T1 (ms): 480  
 RLP Retry Counter N2: 255  
 RLP Window Size: 61  
 Transmission Delay (ms): 230  
 Recovery: REJ

##### Set 2:

RLP ACK Timer T1 (ms): 620  
 RLP Retry Counter N2: 255  
 RLP Window Size: 61  
 Transmission Delay (ms): 300  
 Recovery: SREJ

##### Set 3:

RLP ACK Timer T1 (ms): 820  
 RLP Retry Counter N2: 255  
 RLP Window Size: 61  
 Transmission Delay (ms): 400  
 Recovery: SREJ

##### Set 4:

RLP ACK Timer T1 (ms): 480  
 RLP Retry Counter N2: 255  
 RLP Window Size: 45  
 Transmission Delay (ms): 230  
 Recovery: SREJ

##### Set 5:

RLP ACK Timer T1 (ms): 480  
 RLP Retry Counter N2: 255  
 RLP Window Size: 31  
 Transmission Delay (ms): 230  
 Recovery: SREJ

##### Set 6:

RLP ACK Timer T1 (ms): 480  
 RLP Retry Counter N2: 255  
 RLP Window Size: 25  
 Transmission Delay (ms): 230  
 Recovery: SREJ

RLP Throughput Analysis

Figure 5.1-1 presents the whole spectrum of the throughput measured under the standard transfer conditions.

The minimum / maximum curves reflect the worst / best measurement results within 30 measurements at each CIR adjustment. The course of these curves is explainable with the statistical error distribution of the Gilbert Elliott Model.

The average curve was generated after calculation of the arithmetical average of all measurement results for each CIR value.

To describe the distribution of the single measurements in more detail the 80% boundary curve is inserted. 80% of the single measurement points are placed above this curve.

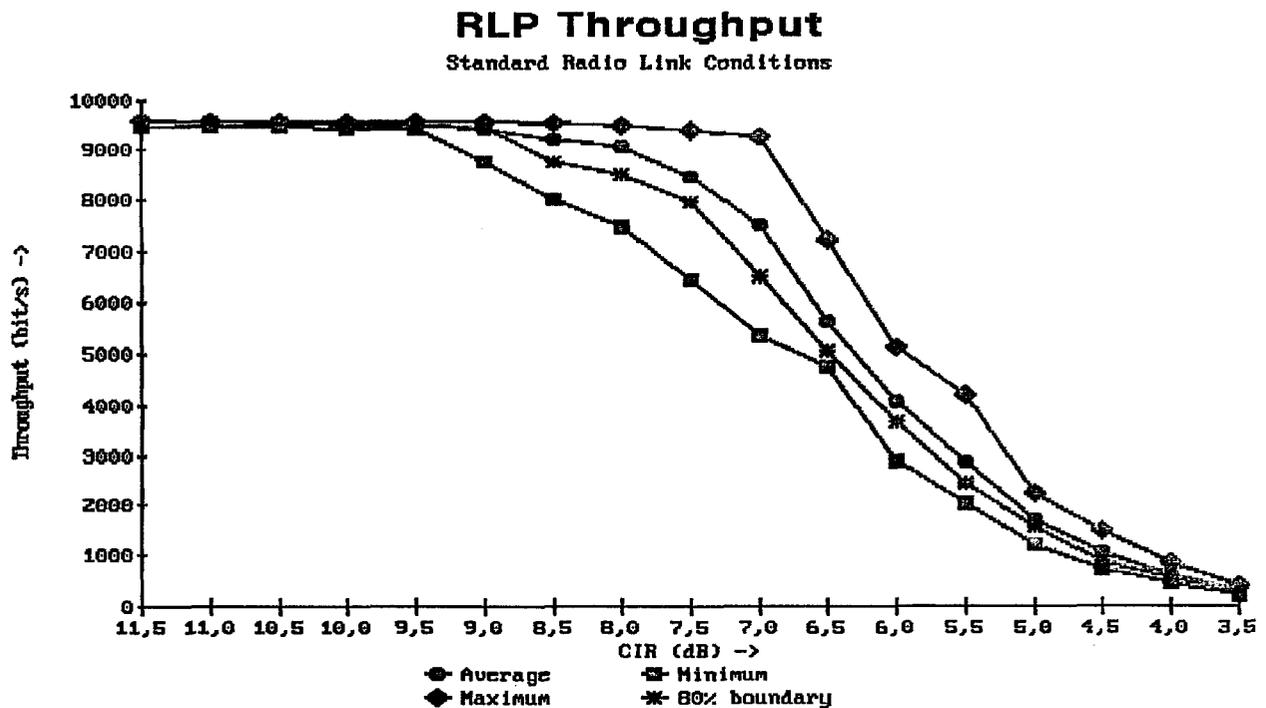


Figure 5.1-1

Influence of SREJ and REJ to the Throughput

Figure 5.1-2 shows the throughput average curve of the standard transfer conditions in comparison with the average curve of the additional parameter set 1, where instead of the RLP recovery 'SREJ' the recovery 'REJ' was used.

The diagram confirms the common assumption that the use of SREJ will have a positiv effect to the throughput over a wide range of CIR.

As a consequence the RLP recovery 'SREJ' has been adopted for the further validation process.

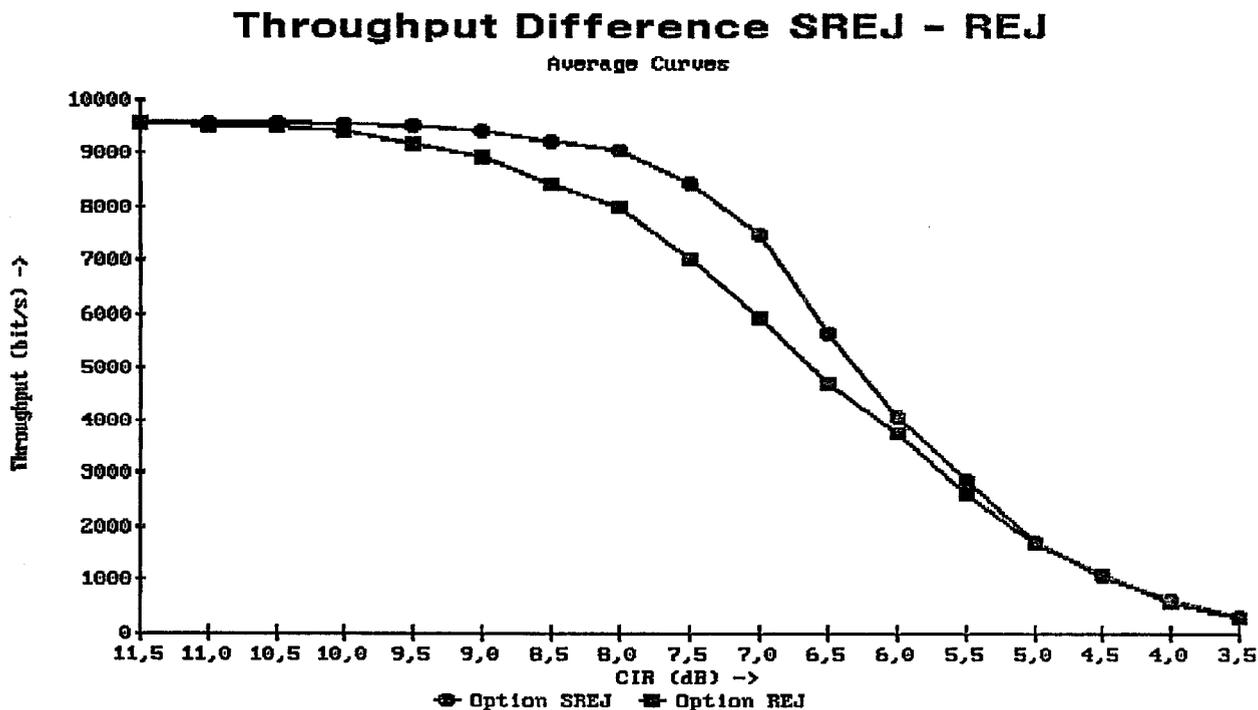


Figure 5.1-2

### Influence of the RLP Window Size

Figure 5.1-3 presents the throughput average curve of the standard transfer conditions in comparison with the average curves reflecting the throughput averages measured with various RLP window size values.

The diagram shows that the throughput is influenced by the selected RLP window size. In addition the diagram justifies the change of the window size carried out by the last change of the GSM Rec. 04.22.

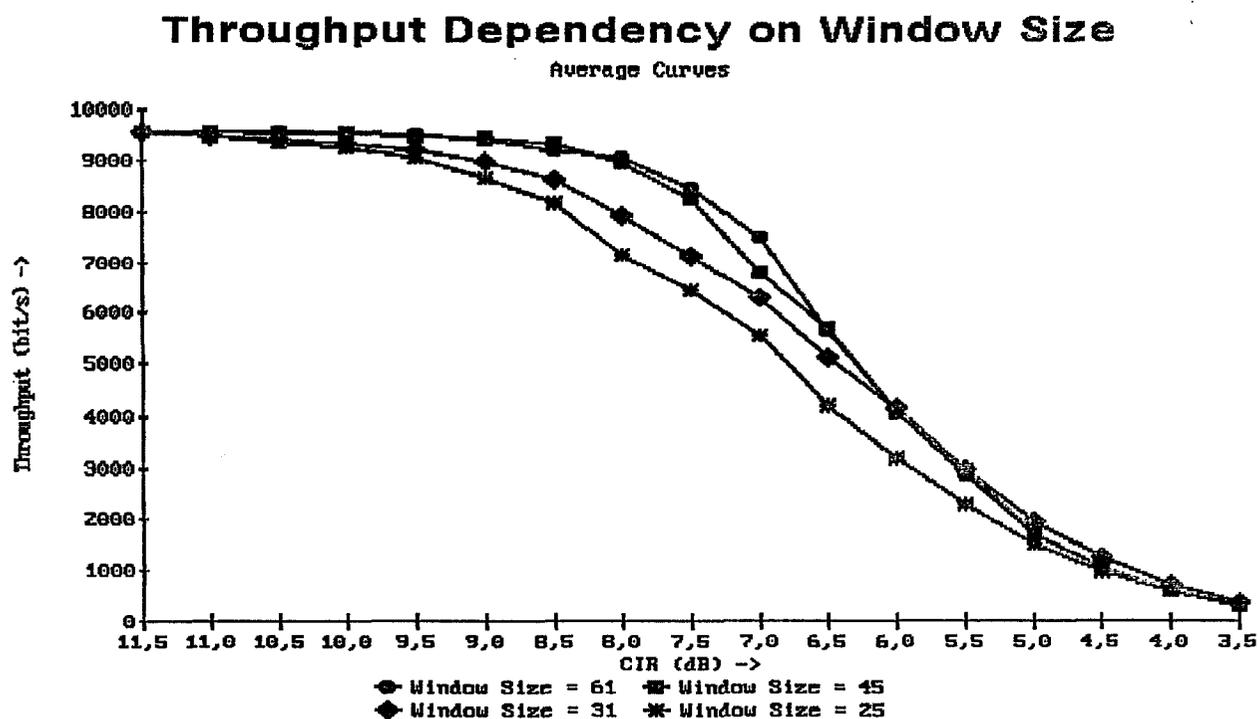


Figure 5.1-3

There is no need to change the RLP window size beyond 61. Therefore the RLP window size of 61 has been adopted for the further validation process.

### Influence of the Transmission Delay

The influence of the transmission delay to the radio link throughput in the non-transparent transmission mode is represented in Figure 5.1-4.

Dependent on the average curves the calculated value of the average throughput reduction is calculated for an increase of the transmission delay per 10 ms, expressed as percentage in the following table.

CIR (dB)	average reduction per 10 ms
11,0	0,20%
10,5	0,25%
10,0	0,23%
9,5	0,36%
9,0	0,51%
8,5	0,60%
8,0	1,06%
7,5	1,40%
7,0	2,54%
6,5	2,39%
6,0	2,20%
5,5	3,30%

With this knowledge it is possible to accomplish the preceding validation parts confined to the transmission delay value of 230 ms and to map the validation results to new radio link conditions in case of a further correction of the specified transmission delay by GSM.

If in the future the transmission delay timer need to be changed the available validation result could be easily mapped to the new conditions.

### Influence of Transmission Delay

Average Curves

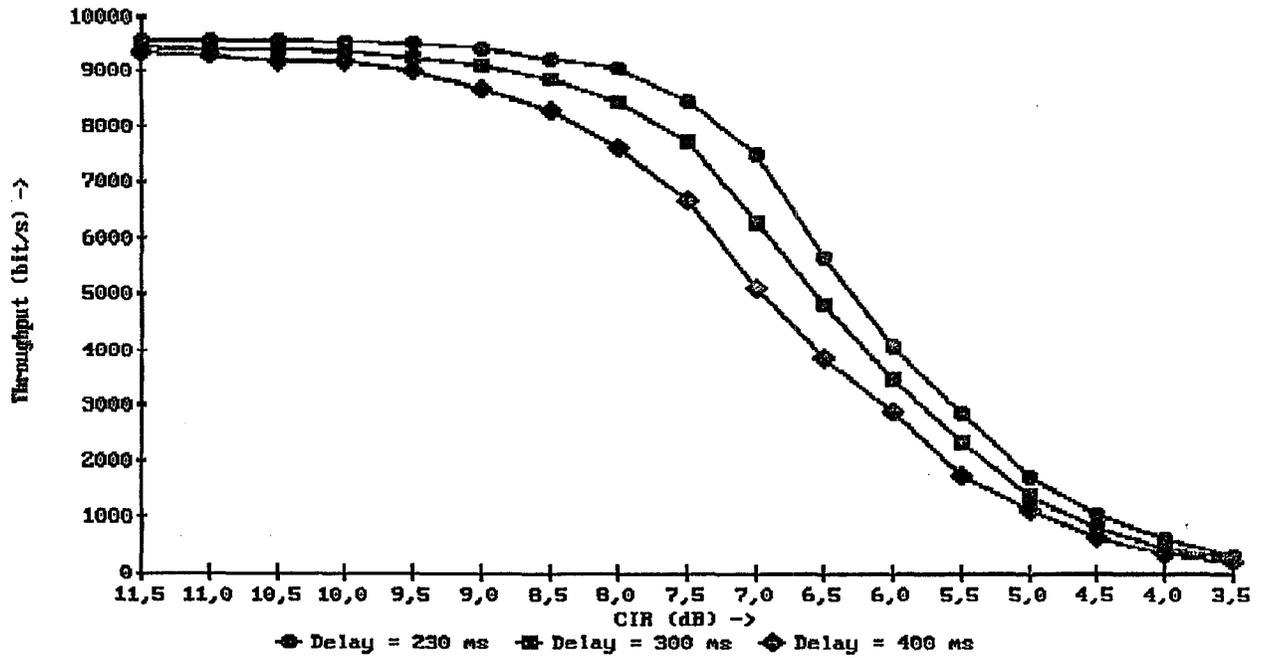


Figure 5.1-4

## Conclusion

Validation Part 1 was accomplished with the goal to verify the available theoretical calculated throughput values and to limit the wide range of measurements in the following validation process.

A comparison of the here presented throughput values and those presented in SMG4 Doc.114/90 -which are still based on the old version of GSM Rec. 04.22- cannot be done, since an upgrade of the radio link protocol and the Gilbert Elliott Model, based on the AEG error files, took place within the validation system. Nevertheless the comparison shows that the measured throughput values are higher through the whole range of CIR than the calculated values.

In accordance to the results of Validation Part 1, shown in Figure 5.1-1 to Figure 5.1-4, the following Part 2 of validation was accomplished with the goal to prove that the recognized CIR boundary values found out within Part 1 can be applied as the critical range for real facsimile document transfer.

Therefore a number of measurements -in view of the statistical confidence- using documents with different data volumes should be accomplished within the critical CIR range from 9,0 dB to 6,0 dB.

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## 5.2 Results of Validation Part 2: Facsimile Document Transfer

With the knowledge that the probability for a successful facsimile document transfer of the teleservice FAX3 NT depends on the data volume of the documents as well as on the selected message speed, the measurements of Part 2 were accomplished at different message speeds with documents, which cover a wide range of data volume.

The aim of this step was to gain information about the effect of the procedures described in GSM TS 03.46 (fill bit deletion, transmission control with EOL/Buffer handling,..) on the course of the facsimile message transfer and ultimately on the degree of success under bad radio link conditions. Further on this step serves for confirming the results of validation part 1 with real fax documents.

The Validation Part 2 was accomplished with the following three representative CCITT test sheets, which cover a wide range of real FAX documents.

These are:

Document No. 1:	CCITT test sheet No. 1
Document No. 2:	CCITT test sheet No. 4
Document No. 3:	CCITT test sheet No. 2

In the following the characteristics of each test sheet are described in more detail.

Document No. 1:

  
**THE SLEREXE COMPANY LIMITED**  
 SAPHORS LANE . BOOLE . DORSET . BH25 8ER  
 TELEPHONE BOOLE (945 13) 51417 - TELEX 123456

Our Ref. 350/PJC/EAC 18th January, 1972.

Dr. P.N. Cundall,  
Mining Surveys Ltd.,  
Holroyd Road,  
Reading,  
Berks.

Dear Peter,

Permit me to introduce you to the facility of facsimile transmission.

In facsimile a photocell is caused to perform a raster scan over the subject copy. The variations of print density on the document cause the photocell to generate an analogous electrical video signal. This signal is used to modulate a carrier, which is transmitted to a remote destination over a radio or cable communications link.

At the remote terminal, demodulation reconstructs the video signal, which is used to modulate the density of print produced by a printing device. This device is scanning in a raster scan synchronised with that at the transmitting terminal. As a result, a facsimile copy of the subject document is produced.

Probably you have uses for this facility in your organisation.

Yours sincerely,

*Phil.*

P. J. CROSS  
Group Leader - Facsimile Research

Registered in England: No. 2008  
 Registered Office: 40 Victoria Lane, Haverhill, Essex.

Paper size: ISO A4

min. Scan Line Time:	20 ms/scan line			
Coding Capability:	1 dimensional			
Message Speed (bit/s):	9600	7200	4800	2400
Vertical Resolution 3,85 l/mm				
- gross volume (bytes):	29799	25516	21503	17865
- net volume (bytes):	11644			
- reduction by fill deletion:	61%	54%	46%	35%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	60126	51330	43050	35678
- net volume (bytes):	33252			
- reduction by fill deletion:	45%	35%	23%	7%
Coding Capability:	2 dimensional			
Vertical Resolution 3,85 l/mm:				
- gross volume (bytes):	28600	24450	20462	16772
- net volume (bytes):	14596			
- reduction by fill deletion:	49%	40%	29%	13%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	54773	45877	37346	29516
- net volume (bytes):	24870			
- reduction by fill deletion:	55%	46%	33%	16%

Document No. 2:

Paper size: ISO A4

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L'ordre de lancement et de réalisation des applications fait l'objet de décisions au plus haut niveau de la Direction Générale des Télécommunications. Il n'est certes pas question de construire ce système intégré "en bloc" mais bien au contraire de procéder par étapes, par paliers successifs. Certaines applications, dont la rentabilité ne pourra être assurée, ne seront pas entreprises. Actuellement, sur trente applications qui ont pu être globalement définies, six en sont au stade de l'exploitation, six autres se sont vu donner la priorité pour leur réalisation.

Chaque application est confiée à un "chef de projet", responsable successivement de sa conception, de son analyse-programmation et de sa mise en oeuvre dans une région-pilote. La généralisation ultérieure de l'application réalisée dans cette région-pilote dépend des résultats obtenus et fait l'objet d'une décision de la Direction Générale. Néanmoins, le chef de projet doit dès le départ considérer que son activité a une vocation nationale donc refuser tout particularisme régional. Il est aidé d'une équipe d'analyses-programmeurs et entouré d'un "groupe de conception" chargé de rédiger le document de "définition des objectifs globaux" puis le "cahier des charges" de l'application, qui sont adressés pour avis à tous les services utilisateurs potentiels et aux chefs de projet des autres applications. Le groupe de conception comprend 5 à 10 personnes représentant les services les plus divers concernés par le projet, et comporte obligatoirement un bon analyste attaché à l'application.

II - L'IMPLANTATION GEOGRAPHIQUE D'UN RESEAU INFORMATIQUE PERFORMANT

L'organisation de l'entreprise française des télécommunications repose sur l'existence de 20 régions. Des calculateurs ont été implantés dans le passé au moins dans toutes les plus importantes. On trouve ainsi des machines Bull Gamma 30 à Lyon et Marseille, des GE 425 à Lille, Bordeaux et Montpellier, un GE 437 à Massy, enfin quelques machines Bull 300 TI à programmes câblés étaient récemment ou sont encore en service dans les régions de Nancy, Nantes, Limoges, Poitiers et Rouen ; ce parc est essentiellement utilisé pour la comptabilité téléphonique.

A l'avenir, si la plupart des fichiers nécessaires aux applications décrites plus haut peuvent être gérés en temps différé, un certain nombre d'entre eux devront nécessairement être accessibles, voire mis à jour en temps réel : parmi ces derniers le fichier commercial des abonnés, le fichier des renseignements, le fichier des circuits, le fichier technique des abonnés contiendront des quantités considérables d'informations.

Le volume total de caractères à gérer en phase finale sur un ordinateur ayant en charge quelques 500 000 abonnés a été estimé à un milliard de caractères au moins. Au moins le tiers des données seront concernées par des traitements en temps réel.

Aucun des calculateurs énumérés plus haut ne permettait d'envisager de tels traitements. L'intégration progressive de toutes les applications suppose la création d'un support commun pour toutes les informations, une véritable "Banque de données", répartie sur des moyens de traitement nationaux et régionaux, et qui devra rester alimentée, mise à jour en permanence, à partir de la base de l'entreprise, c'est-à-dire les chantiers, les magasins, les guichets des services d'abonnement, les services de personnel etc.

L'étude des différents fichiers à constituer a donc permis de définir les principales caractéristiques du réseau d'ordinateurs nouveaux à mettre en place pour aborder la réalisation du système informatif. L'obligation de faire appel à des ordinateurs de troisième génération, très puissants et dotés de volumineuses mémoires de masse, a conduit à en réduire substantiellement le nombre.

L'implantation de sept centres de calcul interrégionaux constituera un compromis entre : d'une part le désir de réduire le coût économique de l'ensemble, de faciliter la coordination des équipes d'informaticiens; et d'autre part le refus de créer des centres trop importants difficiles à gérer et à diriger, et posant des problèmes délicats de sécurité. Le regroupement des traitements relatifs à plusieurs régions sur chacun de ces sept centres permettra de leur donner une taille relativement homogène. Chaque centre "gèrera" environ un million d'abonnés à la fin du VIème Plan.

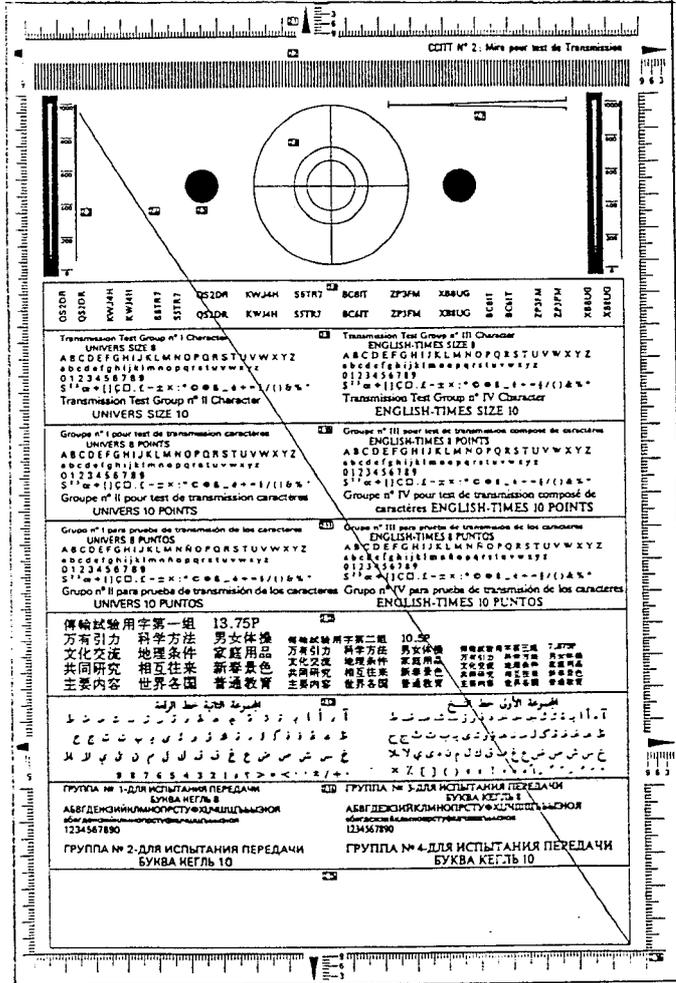
La mise en place de ces centres a débuté au début de l'année 1971 : un ordinateur IRIS 50 de la Compagnie Internationale pour l'Informatique a été installé à Toulouse en février; la même machine vient d'être mise en service au centre de calcul interrégional de Bordeaux.

Photo n° 1 - Document très dense lettre 1,5mm de haut -  
Restitution photo n° 9

min. Scan Line Time:	20 ms/scan line			
Coding Capability:	1 dimensional			
Message Speed (bit/s):	9600	7200	4800	2400
Vertical Resolution 3,85 l/mm				
- gross volume (bytes):	53189	51205	49558	48323
- net volume (bytes):	47934			
- reduction by fill deletion:	10%	6%	3%	<1%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	105786	102104	99095	96704
- net volume (bytes):	95956			
- reduction by fill deletion:	9%	6%	3%	<1%
Coding Capability:	2 dimensional			
Vertical Resolution 3,85 l/mm:				
- gross volume (bytes):	53117	51308	49747	48503
- net volume (bytes):	47840			
- reduction by fill deletion:	10%	7%	4%	1%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	90209	86373	83131	80503
- net volume (bytes):	79128			
- reduction by fill deletion:	12%	8%	5%	2%

Document No. 3:

Paper size: ISO A4



min. Scan Line Time:	20 ms/scan line			
Coding Capability:	1 dimensional			
Message Speed (bit/s):	9600	7200	4800	2400
Vertical Resolution 3,85 l/mm				
- gross volume (bytes):	58505	56691	55272	54831
- net volume (bytes):	54766			
- reduction by fill deletion:	9%	3%	1%	<1%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	126966	123662	121214	120453
- net volume (bytes):	120360			
- reduction by fill deletion:	5%	3%	<1%	<1%
Coding Capability:	2 dimensional			
Vertical Resolution 3,85 l/mm:				
- gross volume (bytes):	49108	46822	44997	44017
- net volume (bytes):	43804			
- reduction by fill deletion:	11%	6%	3%	<1%
Vertical Resolution 7,7 l/mm:				
- gross volume (bytes):	95722	90679	86643	84153
- net volume (bytes):	83582			
- reduction by fill deletion:	13%	8%	4%	<1%

A comparison of the data volumes and data reductions of the three documents with 1 and 2 dimensional coding capability shows that the data volume is smaller when the document is coded 2-dimensional. In addition the data reduction which is a result of the fill bit deletion procedure of the GSM TS 03.46 is equal or higher when using the 2-dimensional coding capability.

As a consequence the need for varying the coding capability parameter within the Validation Part 2 does not exist because the whole spectrum of data volume and data reduction is covered when using the 1-dimensional coding capability.

In the first step of Validation Part 2 FAX3 connection for MS to ISDN/PSTN calls were performed.

The second step, where MS to MS calls inter MSC are performed using the Validation System Configuration shown in Figure 3-3, completes the Validation Part 2.

Both steps are carried out under the standard radio link condition.

A sufficient number of measurements - in view of the statistical confidence - for the three chosen CCITT test sheets were accomplished at the different selected message speeds. To eliminate the time tolerances of the really connected FAX3 apparatus the actual increase of the fax message transmission time (called T2) of the message phase, which depends on the error rate and error distribution of the radio link, was measured.

A value exceeding the maximum allowed value of T2, shown in Figure 5.2.1-1 for MS to ISDN/PSTN and in Figure 5.2.2-1 for MS-MS calls inter/intra MSC, indicates that the post-message phase of the FAX3 connection will fail, which leads to a release of the FAX3 connection.

The post-message phase may be unsuccessfully completed, thus contributing also the overall probability of a successful fax connection. The determination of the corresponding values took place by respecting the rules for achieving statistical confidence.

5.2.1 MS to ISDN/PSTN Call

The aim of the first step of the Validation Part 2 is to check the validity of the throughput spectrum of Validation Part 1.

Therefore the probability ranges of each chosen CCITT document were calculated for the selected message speeds and the vertical resolutions.

Furthermore the optional Error Correction Mode with 256 blocks and 64 blocks per partial page was taken into account. For the measurements of the Error Correction Mode the elongation of the transmission time of a complete partial page was measured.

Constraints on Parameter Values for actual Measurements

Aiming at concentrating the measurements effort to the critical range only the following time analysis for the post-message phase of a FAX3 connection has been carried out. First the CIR range dependent on the result of validation part 1, the theoretical required throughput at the message speeds and different data volumes of facsimile documents were determined.

Time Analysis for MS to fixed network calls

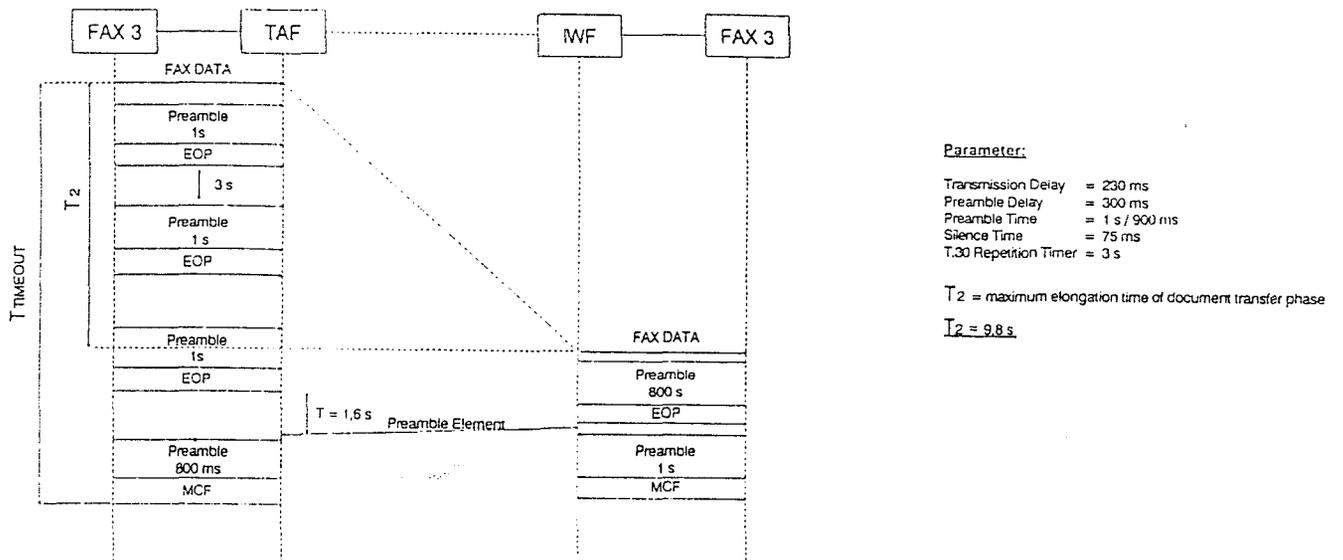


Figure 5.2.1-1

The following analysis is based on the throughput diagram under the standard radio link conditions to be used for realization of validation part 2 in correspondence to the discussion above.

**Example of narrowing Parameter Values**

At first the required throughputs, based on the time analysis above, were calculated for an arbitrary facsimile coded document with the gross data volumes of 60 kbytes, the supposed data reduction of 20% (fill-bit deletion), which should be transferred at a message speed of 9600 bit/s.

The result of this calculation is shown in Figure 5.2.1-2 which presents the CIR values where the probability for a successful transfer of that arbitrary facsimile document is 100 % and 80 % as well as the begin of the range where a successful transfer of this document is endangered.

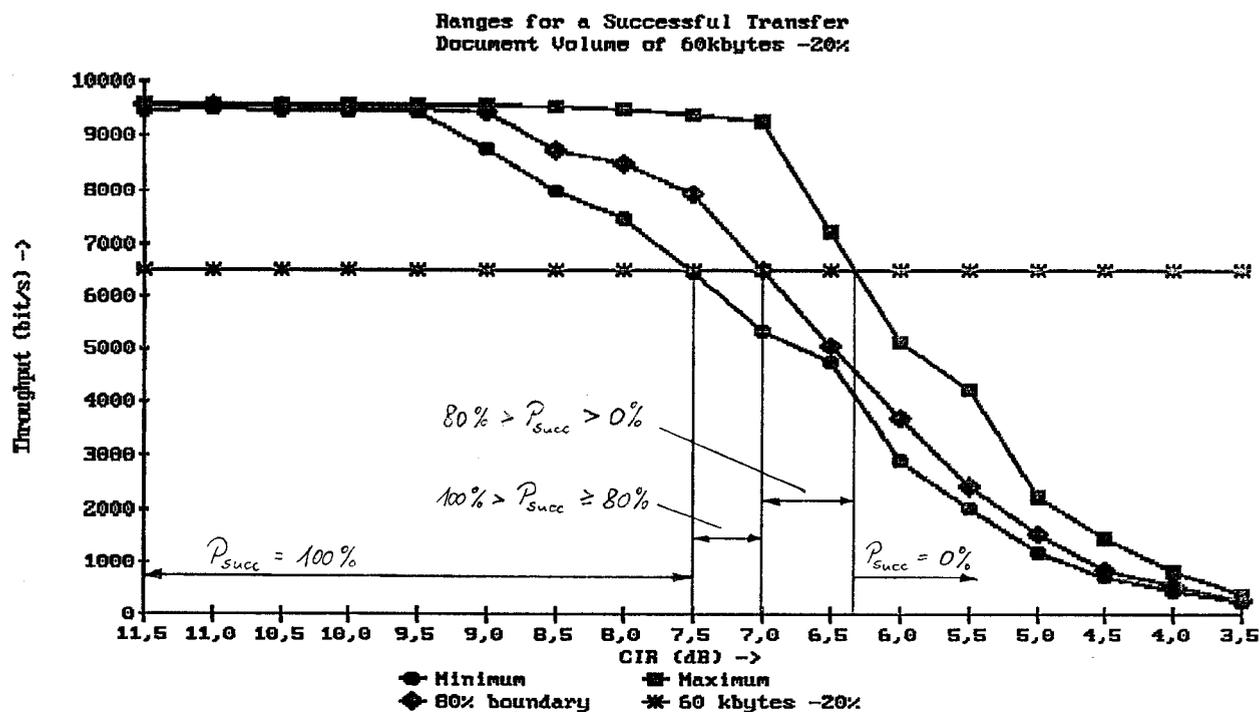


Figure 5.2.1-2

The significant CIR boundaries of each document, i.e. deduced for 100%, 80% and 0% transfer probability, which will be the base for the final validation are listed in the following tables:

Message Speed = 9600 bit/s:

	100%	80%	0%
Doc. No. 1: 3,85 l/mm 7,7 l/mm	CIR = 5,8 dB CIR = 6,4 dB	CIR = 5,6 dB CIR = 6,1 dB	CIR = 5,2 dB CIR = 5,0 dB
Doc. No. 2: 3,85 l/mm 7,7 l/mm	CIR = 7,8 dB CIR = 8,3 dB	CIR = 7,2 dB CIR = 7,4 dB	CIR = 6,4 dB CIR = 6,7 dB
Doc. No. 3: 3,85 l/mm 7,7 l/mm	CIR = 8,0 dB CIR = 8,3 dB	CIR = 7,3 dB CIR = 7,8 dB	CIR = 6,6 dB CIR = 6,7 dB
ECM 64 1 Partial Page	CIR = 7,2 dB	CIR = 6,7 dB	CIR = 6,2 dB
ECM 256 1 Partial Page	CIR = 8,1 dB	CIR = 7,7 dB	CIR = 6,7 dB

Message Speed = 7200 bit/s:

	100%	80%	0%
Doc. No. 1: 3,85 l/mm 7,7 l/mm	CIR = 5,7 dB CIR = 6,4 dB	CIR = 5,5 dB CIR = 6,1 dB	CIR = 5,1 dB CIR = 5,0 dB
Doc. No. 2: 3,85 l/mm 7,7 l/mm	CIR = 7,2 dB CIR = 7,4 dB	CIR = 6,5 dB CIR = 6,9 dB	CIR = 6,2 dB CIR = 6,2 dB
Doc. No. 3: 3,85 l/mm 7,7 l/mm	CIR = 7,3 dB CIR = 7,5 dB	CIR = 6,8 dB CIR = 7,0 dB	CIR = 6,2 dB CIR = 6,3 dB
ECM 64 1 Partial Page	CIR = 6,5 dB	CIR = 6,4 dB	CIR = 5,7 dB
ECM 256 1 Partial Page	CIR = 7,5 dB	CIR = 6,9 dB	CIR = 6,3 dB

Message Speed = 4800 bit/s:

	100%	80%	0%
Doc. No. 1: 3,85 l/mm 7,7 l/mm	CIR = 5,5 dB CIR = 6,1 dB	CIR = 5,3 dB CIR = 5,8 dB	CIR = 4,8 dB CIR = 5,3 dB
Doc. No. 2: 3,85 l/mm 7,7 l/mm	CIR = 6,4 dB CIR = 6,4 dB	CIR = 6,2 dB CIR = 6,3 dB	CIR = 5,5 dB CIR = 5,6 dB
Doc. No. 3: 3,85 l/mm 7,7 l/mm	CIR = 6,4 dB CIR = 6,5 dB	CIR = 6,2 dB CIR = 6,3 dB	CIR = 5,5 dB CIR = 5,6 dB
ECM 64 1 Partial Page	CIR = 6,2 dB	CIR = 5,9 dB	CIR = 5,7 dB
ECM 256 1 Partial Page	CIR = 6,4 dB	CIR = 6,3 dB	CIR = 5,6 dB

Message Speed = 2400 bit/s:

	100%	80%	0%
Doc. No. 1: 3,85 l/mm 7,7 l/mm	CIR = 5,1 dB CIR = 5,5 dB	CIR = 4,8 dB CIR = 5,3 dB	CIR = 4,4 dB CIR = 4,9 dB
Doc. No. 2: 3,85 l/mm 7,7 l/mm	CIR = 5,7 dB CIR = 5,8 dB	CIR = 5,4 dB CIR = 5,4 dB	CIR = 5,0 dB CIR = 5,0 dB
Doc. No. 3: 3,85 l/mm 7,7 l/mm	CIR = 5,8 dB CIR = 5,8 dB	CIR = 5,4 dB CIR = 5,4 dB	CIR = 5,0 dB CIR = 5,0 dB
ECM 64 1 Partial Page	CIR = 5,1 dB	CIR = 4,8 dB	CIR = 4,4 dB
ECM 256 1 Partial Page	CIR = 5,8 dB	CIR = 5,4 dB	CIR = 5,0 dB

The following diagrams reflect the results of Validation Part 2 measured for MS to ISDN/PSTN calls. The evaluation of the time spectrum is done and the result is described by the probability curve shown in the following diagrams.

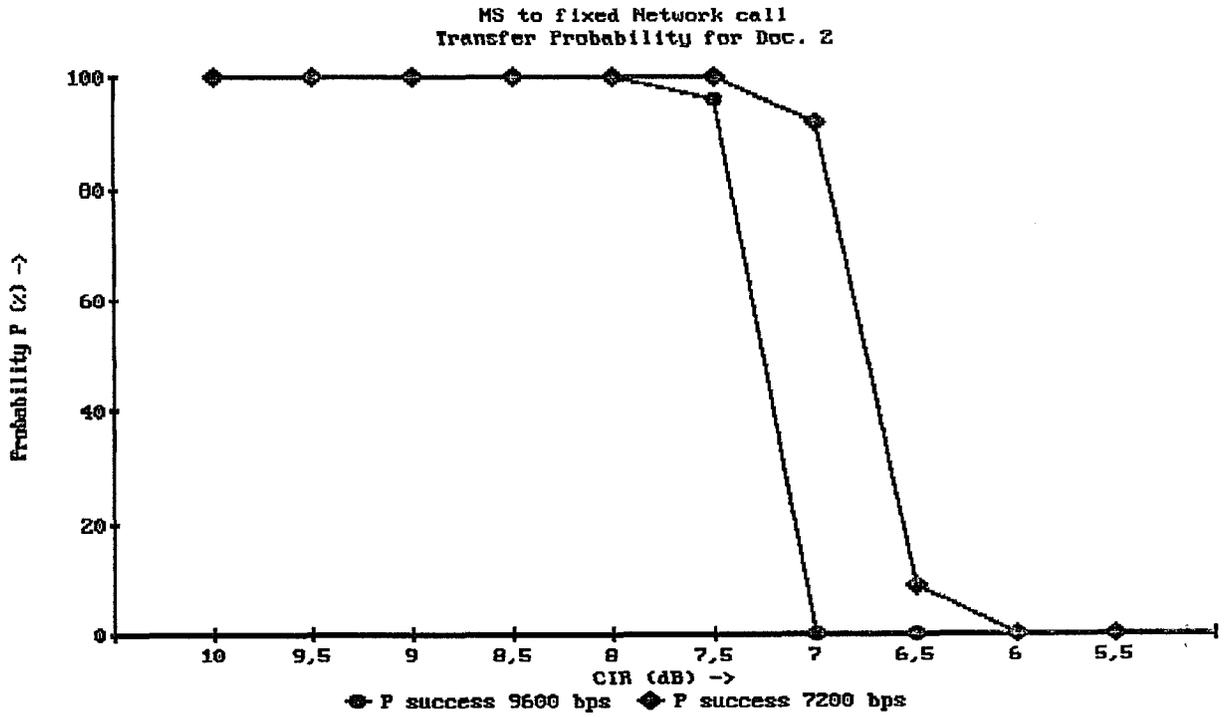


Figure 5.2.1-3 Document 2 with 3,85 line/mm

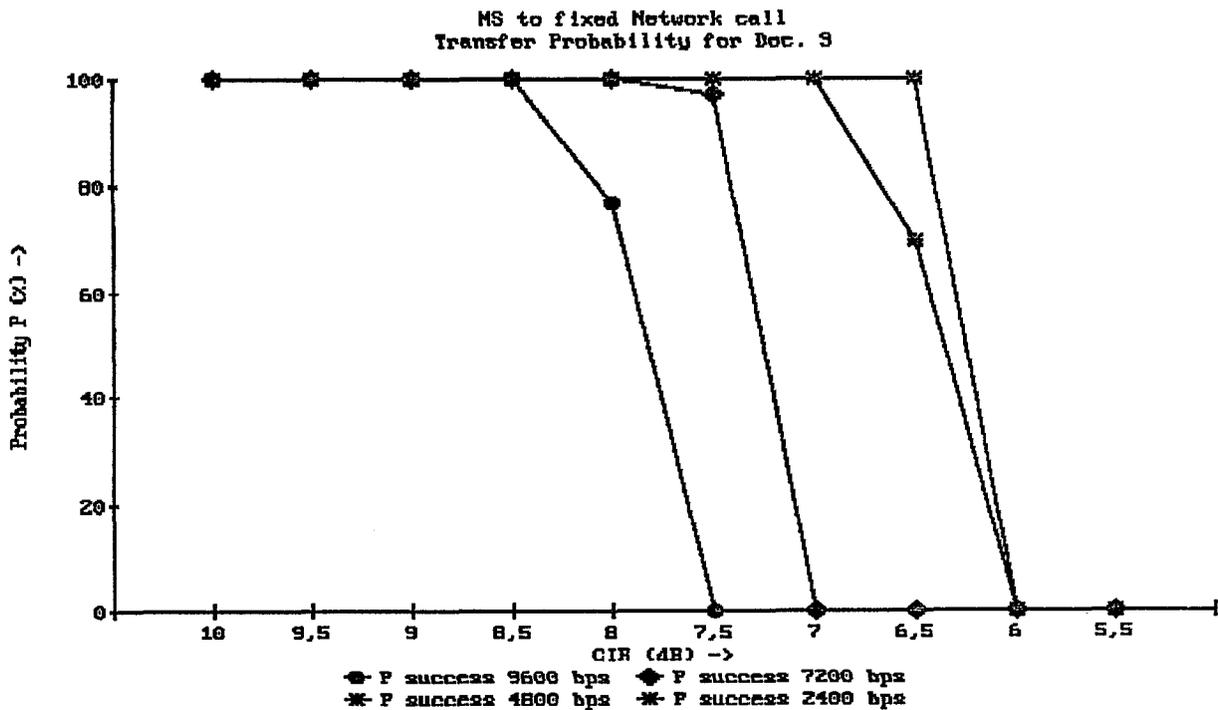


Figure 5.2.1-4 Document 3 with 7,7 line/mm

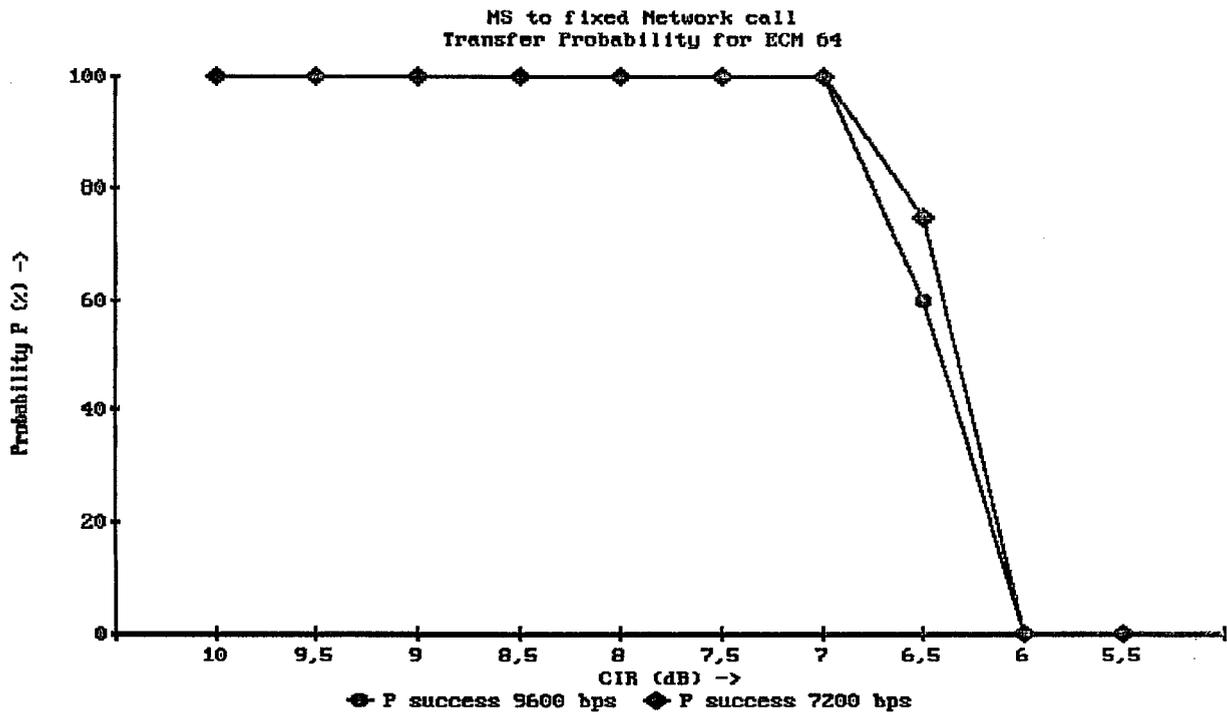


Figure 5.2.1-5 Transfer of a Partial Page (ECM 64)

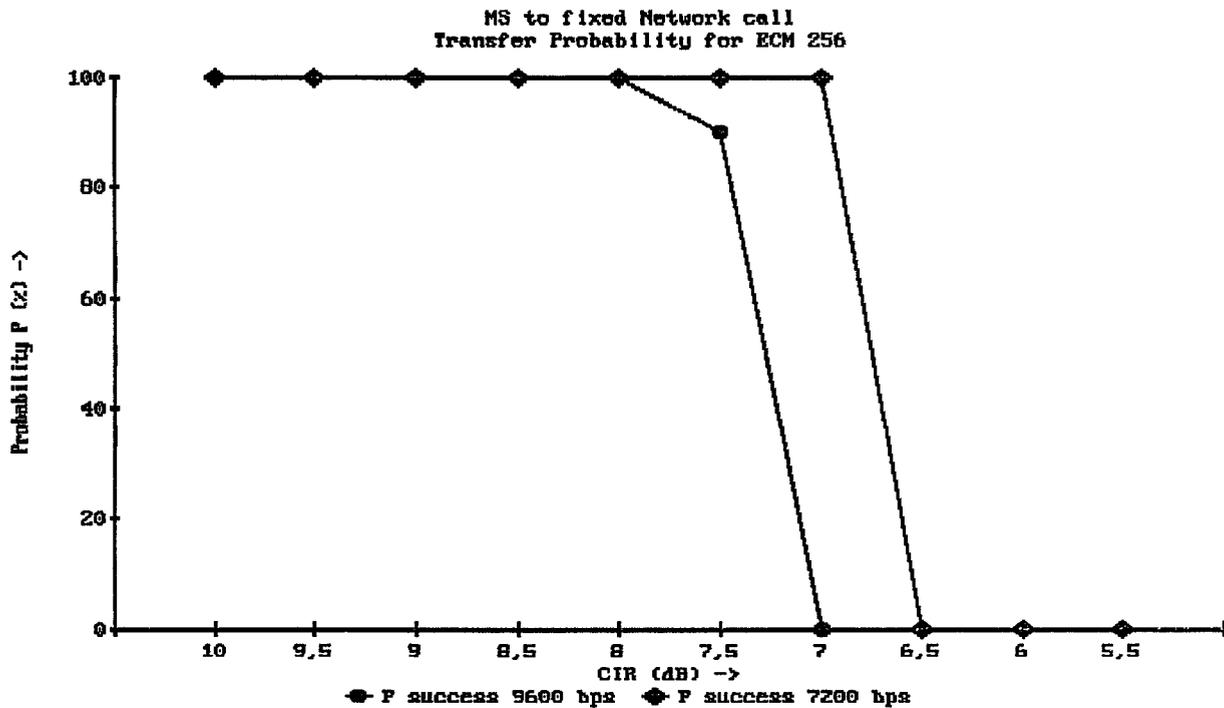


Figure 5.2.1-6 Transfer of a Partial Page (ECM 256)

5.2.2 MS - MS call inter MSC

The Teleservice Facsimile Group 3 is considered to require the support of a MS to MS call inter/intra MSC. Consequently the validation of this capability is an important task.

First of all it is necessary to determine the maximum permissible elongation time for the MS to MS call to define the allowed elongation time permitted for the document transfer phase, irrespective of the time tolerances of the actually connected FAX3 apparatus.

This constraint is based on the following timing diagram for the post-message phase of a MS to MS call inter/intra MSC:

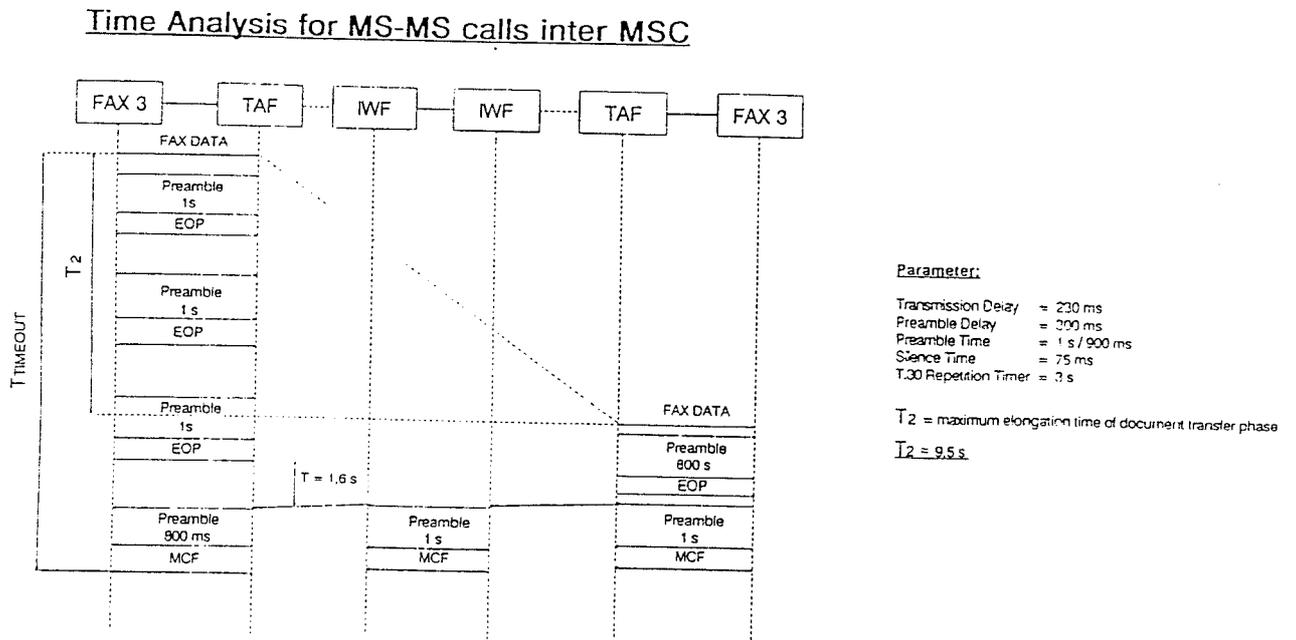


Figure 5.2.2-1

To cover a wide spectrum of data volume with different data reduction by the GSM TS 03.46 fill-bit deletion procedure the necessary number of measurements - in view of the statistical confidence - using the three CCITT documents with the following selected parameter values at the FAX3 apparatus were done:

- Document 1: Vertical resolution = 3,85 line/mm  
Coding Capability : 1-dimensional  
Message Speed: 9600 and 7200 bit/s
  
- Document 2: Vertical Resolution = 3,85 line/mm  
Coding Capability : 1-dimensional  
Message Speed: 9600 and 7200 bit/s
  
- Document 3: Vertical Resolution = 3,85 and 7,7 line/mm  
Coding Capability : 1-dimensional  
Message Speed: 9600 and 7200 bit/s

In addition measurements of the optional Error Correction Mode with a partial page size of 256 and 64 blocks were executed at the message speeds 9600 and 7200 bit/s.

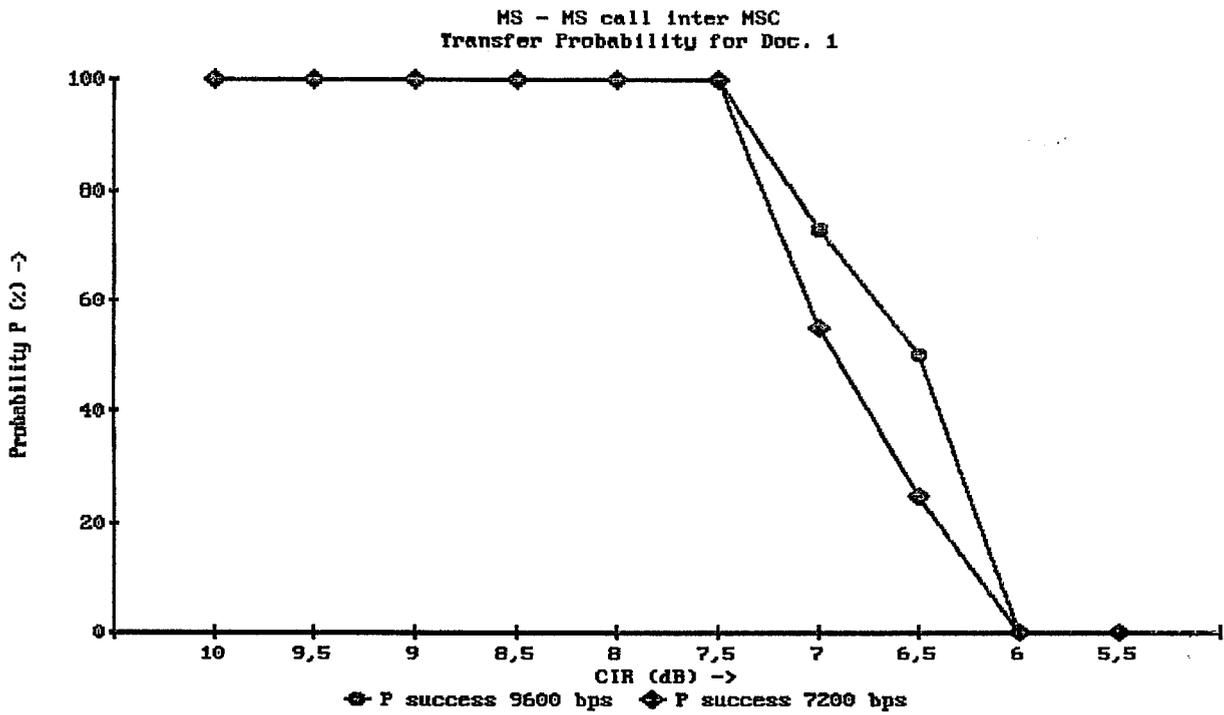


Figure 5.2.2-2 Document 1 with 3,85 line/mm

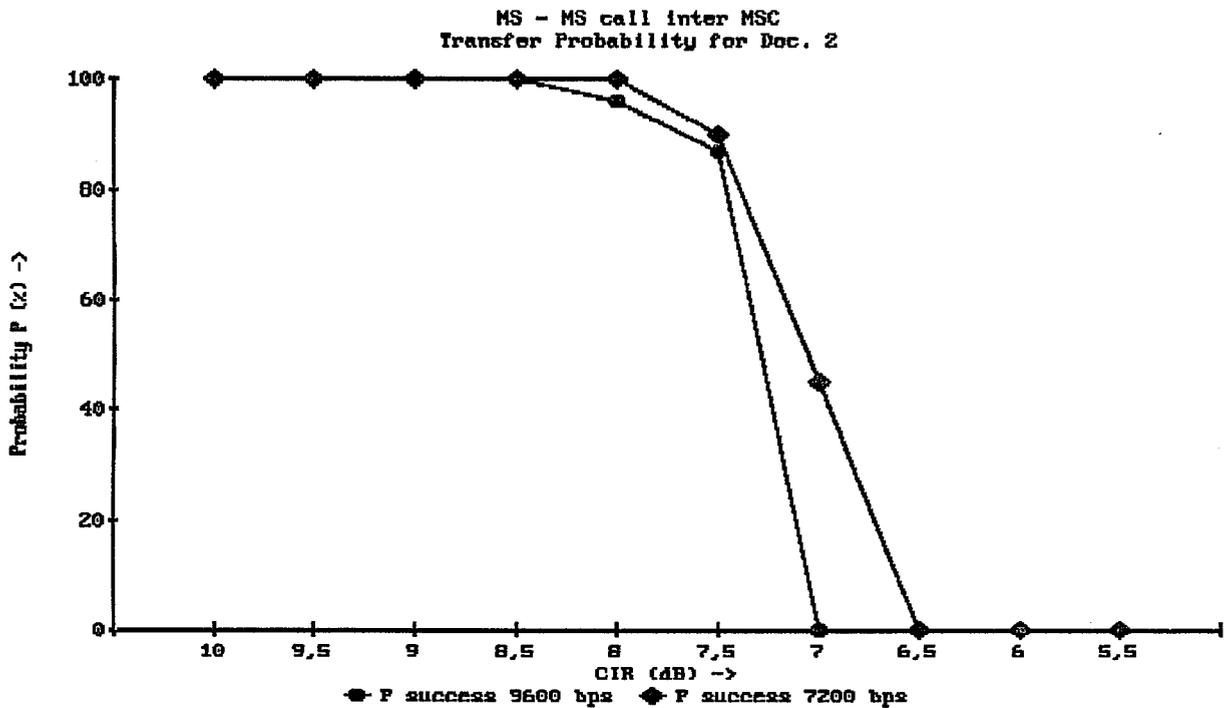


Figure 5.2.2-3 Document 2 with 3.85 line/mm

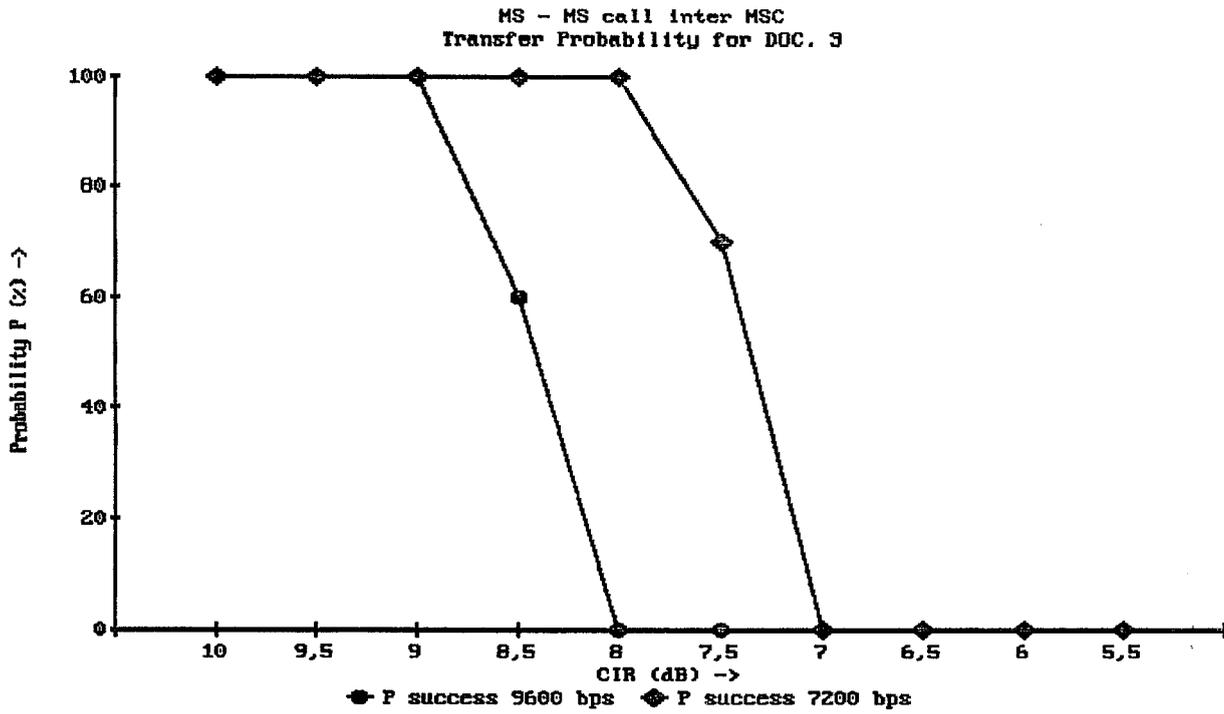


Figure 5.2.2-4 Document 3 with 7,7 line/mm

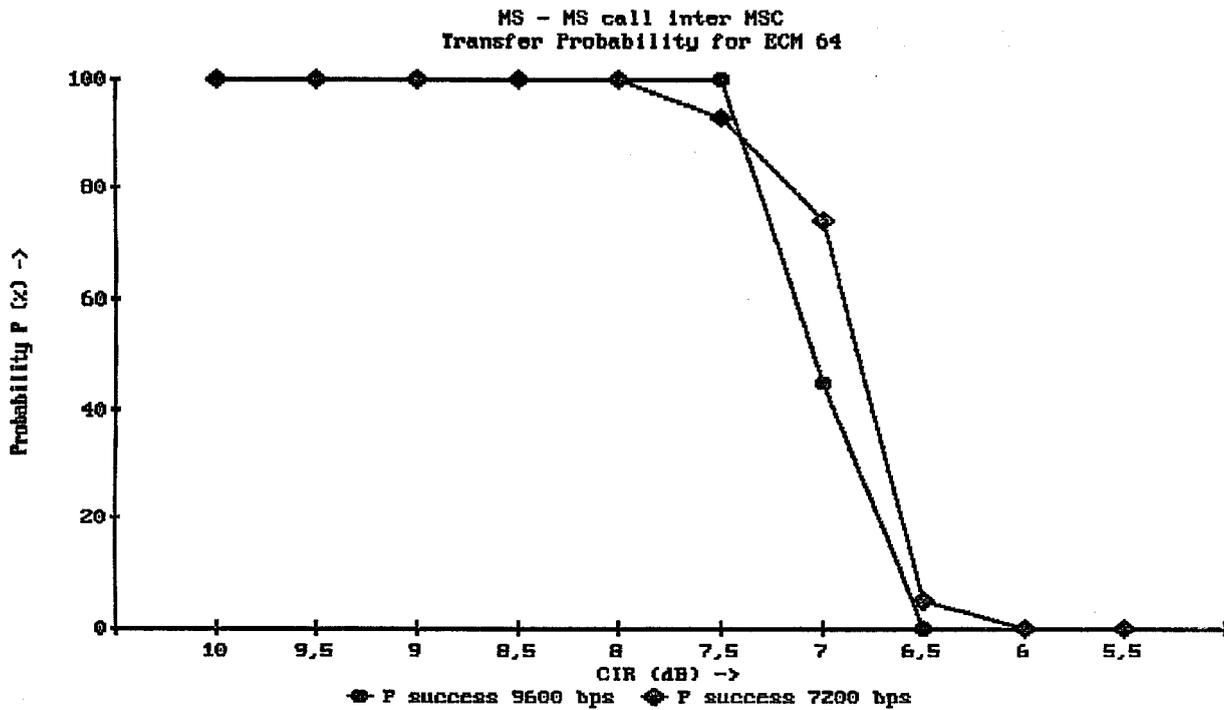


Figure 5.2.2-5 Transfer of a Partial Page (ECM 64)

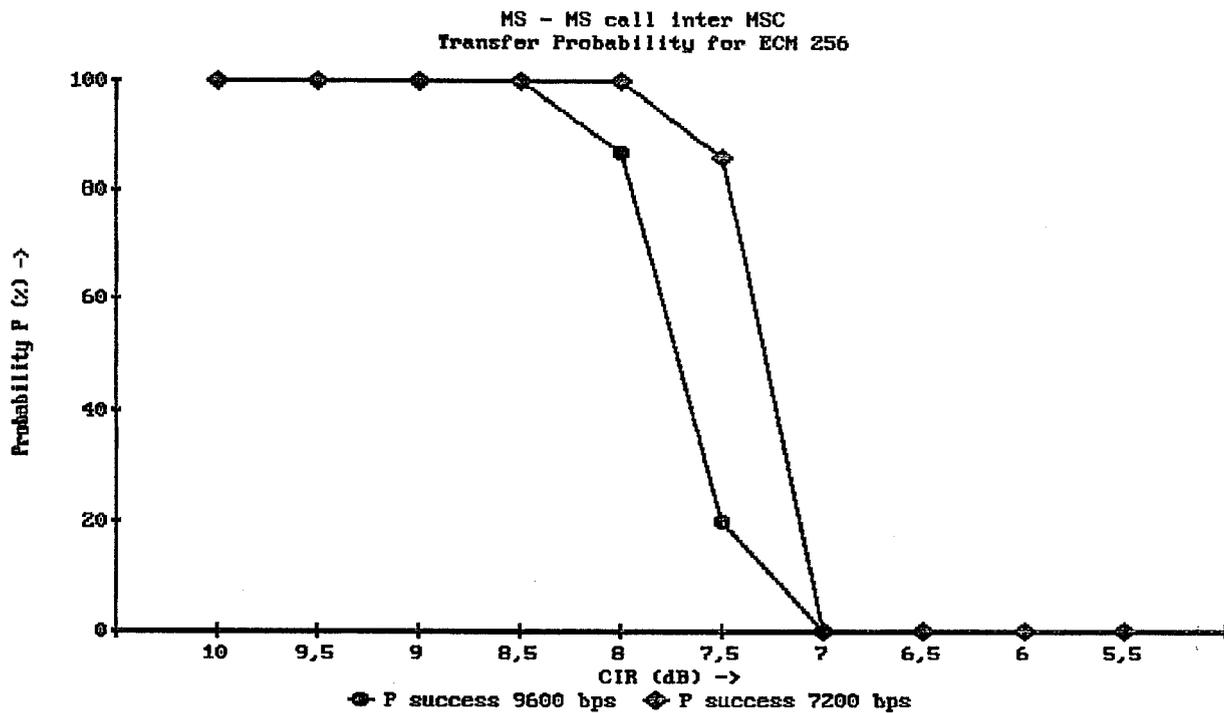


Figure 5.2.2-6 Transfer of a Partial Page (ECM 256)

In addition to the delay time measurements of the document transfer phase a first check of the correctness of the BCS procedures described to GSM TS 03.46 including the proposed changes of GSM TS 03.46 was done.

The performance of this check at this time was justified because the transmission characteristic of the radio link was activated prior to the establishment of the connection.

These verifications done for MS to ISDN/PSTN calls as well as for MS to MS calls inter/intra MSC have shown that no connection release as a result of BCS failures took place within the range of CIR values applicable to the document transfer measurements. This means that the critical boundary for the BCS phases is lower than for the fax document transfer.

After implementation of the above mentioned CRs no further failure within the GSM Rec. 03.46 was found.

Nevertheless a further verification of the GSM Rec. 03.46 should be done within Validation Part 3 because no error simulation at the interfaces between FAX3 apparatus/MSU and FAX3 apparatus/IWU was taken into account.

### 5.2.3 Conclusion

The measurements performed during the phase 2 - taking into account the nominal and worst case T.30 timer values - revealed that for bot MS to ISDN/PSTN and MS to MS calls:

- the executions of the procedures related to the facsimile message transfer set out in GSM TS 03.46 including the submitted CRs performed during all the measurements did not show any procedural errors
- there are ranges related to various parameters within which the successful transmission of a facsimile document is assured and
- in cases of exceeding these ranges there is a certain probability of successful transmission of the respective facsimile document up to an uncertainty of successful transmission.

The parameters influencing the range of certainty of successful transmission are

- CIR value
- volume of the actual facsimile document (data volume relevant for the transmission via the radio link)
- fill-bit content of the scan lines of the actual facsimile document and the
- applicable user rate.

The individual results are shown in Figures 5.2.1-3...6 and 5.2.2-2...6.

One example for successful facsimile document transmission assured (P = 100 %) of "Doc. No.3" coded with a vertical resolution of 7,7 line/mm is listed below:

- 9600 bit/s,                    CIR = 8,3 dB
- 7200 bit/s,                    CIR = 7,3 dB
- 4800 bit/s,                    CIR = 6,5 dB
- 2400 bit/s,                    CIR = 5,8 dB

The results of the measurements verified the validity of the assumption made in section 5.2.1 concerning the boundaries of the critical ranges.

### 5.3 Results of Validation Part 3: Verification of GSM TS 03.46

To validate the Pre- and Post- Message Phase of an TS 61 NT call error situations had to be enforced at the appropriate interfaces. This has been done by manipulating the BCS frames passing the interfaces of FAX3 apparatus/MSU, IWU/FAX3 apparatus and IWU/IWU in case of MS-MS call inter/intra MSC. This was necessary to prove the procedural, recovery and timing aspects described in the TS 03.46 including the CRs submitted to SMG 4.

In particular the following manipulations took place:

**Garbling of the DIS/DTC and DCS**, to prove the efficiency of the new 1.6s supervisory timer, the blocking and autonomous command repetition mechanism described in TS 03.46 and CR.

**Garbling of the TCF sequence**, to prove the new FA protocol element TCF OK/NOK handling in both TAF and IWF, the correct switch over to the preceding phase of T.30 protocol and the new autonomous FTT treatment performed in the IWF function in case of MS-MS call inter/intra MSC after reception of an incorrect TCF sequence, i.e. autonomous FTT transmission and CFR/FTT removal mechanism.

**Garbling of the CFR /FTT frame**, to prove the handling of the modified autonomous response mechanism and the effect on the various recovery procedures based on timer.

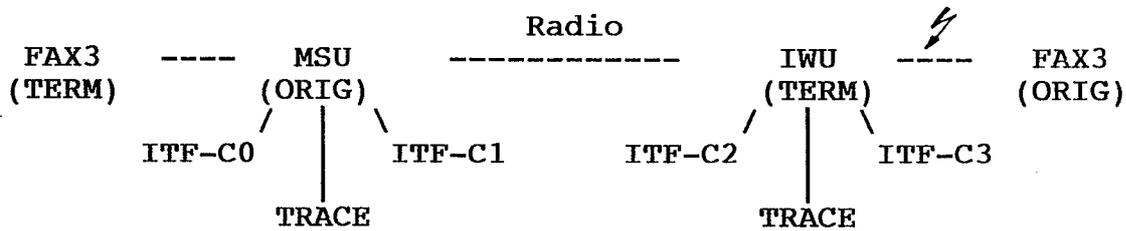
Furthermore the correct sequence number handling of FA protocol elements and the BCS transmit request mechanism and the Multi Page handling of the T.30 protocol are verified by reducing the CIR values.

In the following an example of a trace record is listed for a garbled TCF sequence, DIS and FTT frame within a MS to ISDN/PSTN call.

The trace record consists of two single parts, the trace record of the IWU and the record of the MSU. With regard to the volume of the trace and the readability only the transmitted BCS frames and FA protocol elements are shown.

BCS frames which shall be retained and removed, respectively, in accordance to GSM TS 03.46 are not included in the trace records, but the interpretation allows to find out, where BCS frame were removed.

CONFIGURATION FOR MONITORING:



SIMULATION OF AN INCORRECT TCF SEQUENCE AND A DISTURBENCY OF DIS AND FTT

TRACE RECORD OF IWU

ITF-C	CMD/IND/FRM	TIME
3	<- PREAMBLE ELEMENT	14:03:43,9
2	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:43,9
3	<- NSF CF 54 54 80 00 CE B8 04 00 02 00 00	14:03:45,5
3	<- CSI 9961 128 117 94+	14:03:46,2
3	<- DIS V.27/29 1-DIM ECM	14:03:46,5
	RETRANSMISSION OF THE PREVIOUS BCS SEQUENCE	
3	<- PREAMBLE ELEMENT	14:03:50,3
3	<- NSF CF 54 54 80 00 CE B8 04 00 02 00 00	14:03:50,3
3	<- CSI 9961 128 117 94+	14:03:50,3
3	<- DIS V.27/29 1-DIM ECM	14:03:50,3
2	<- PREAMBLE ELEMENT	14:03:53,5
3	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:53,9
2	<- TSI 3322 5628 117 94+	14:03:55,2
2	<- DCS 9.6KB/S 1-DIM NON-ECM	14:03:55,4
2	<- TCF NOK	14:03:57,0
3	<- PREAMBLE ELEMENT	14:03:58,8
2	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:58,8
3	<- FTT	14:04:00,0
2	<- PREAMBLE ELEMENT	14:04:00,6
3	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:01,0
2	<- TSI 3322 5628 117 94+	14:04:02,3
2	<- DCS 9.6KB/S 1-DIM NON-ECM	14:04:02,5
2	<- TCF OK	14:04:04,2
3	<- PREAMBLE ELEMENT	14:04:05,9
2	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:05,9
3	<- CFR	14:04:07,1
2	<- *** MESSAGE PHASE ***	14:04:09,1
2	<- MSG_END DISCRIMINATOR	14:04:21,5
2	<- PREAMBLE ELEMENT	14:04:21,6
3	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:22,1
2	<- EOP	14:04:22,8
3	<- PREAMBLE ELEMENT	14:04:24,1
2	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:24,1
3	<- MCF	14:04:25,2
2	<- PREAMBLE ELEMENT	14:04:25,9
3	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:26,3
2	<- DCN	14:04:27,0

## TRACE RECORD OF MSU

ITF-C	CMD/IND/FRM	TIME
1	<- PREAMBLE ELEMENT	14:03:43,7
0	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:44,3
1	<- NSF CF 54 54 80 00 CE B8 04 00 02 00	14:03:45,4
1	<- CSI 9961 128 117 94+	14:03:46,2
1	<- DIS V.27/29 1-DIM ECM	14:03:46,5
0	<- PREAMBLE ELEMENT	14:03:53,9
1	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:53,9
0	<- TSI 3322 5628 117 94+	14:03:55,6
0	<- DCS 9.6KB/S 1-DIM NON-ECM	14:03:55,8
0	<- TCF NOK	14:03:57,4
1	<- PREAMBLE ELEMENT	14:03:58,8
0	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:03:59,3
1	<- CFR	14:04:00,0
0	<- PREAMBLE ELEMENT	14:04:01,0
1	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:01,0
0	<- TSI 3322 5628 117 94+	14:04:02,7
0	<- DCS 9.6KB/S 1-DIM NON-ECM	14:04:02,9
0	<- TCF OK	14:04:04,6
1	<- PREAMBLE ELEMENT	14:04:05,9
0	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:06,4
1	<- CFR	14:04:07,1
0	<- FAX MSG BEG	14:04:09,5
0	<- *** MESSAGE PHASE ***	14:04:09,5
0	<- MSG_END DISCRIMINATOR	14:04:21,9
1	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:22,0
0	<- MSG_END DISCRIMINATOR	14:04:22,2
0	<- PREAMBLE ELEMENT	14:04:22,2
0	<- EOP	14:04:23,2
1	<- PREAMBLE ELEMENT	14:04:24,0
0	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:24,5
1	<- MCF	14:04:25,2
0	<- PREAMBLE ELEMENT	14:04:26,3
1	<- BCS TRANSMIT REQUEST SEQ_NO = 00	14:04:26,3
0	<- DCN	14:04:27,4

**Conclusion**

The analysis of the trace records generated during the manipulations within the PRE- and Post Message Phases demonstrated that all respective functions and procedures described in TS 03.46 including the CRs submitted to SMG 4 were successfully completed. In case of MS to ISDN/PSTN calls, the procedures led to successfully entering and termination, of the document transfer phase down to 4dB CIR conditions of the radio link.

## 6. Summary

The validation process has been performed by respecting strictly the nominal and worst case values of the CCITT T.30 timer values, thus setting up severe requirement boundaries.

Under these conditions the validation of the GSM TS 03.46 including the submitted CRs turned out without any error.

The BCS phase and the fax message phase received individual attention during the validation process as outlined in section 5.2 and 5.3.

The non-transparent transmission via the radio link implies, that under certain CIR conditions the necessary recovery time may exceed the T.30 timer budget. Thus leading to a range of certainty of successful facsimile document transmission and a area where un **uncertainty** exists.

Further consideration needs only to be devoted to the uncertain range resulting from the prerequisites of the subject matter of the validation process.

These prerequisites of significance here are

- the GEM adapted to the AEG error files which allows for performing the measurements leading to results with statistical confidence,
- the strong T.30 timer values and
- to take into account real worst facsimile documents.

The results shown in section 5.2 and 5.3 have to be seen in the light of the real network planning and the behaviour of the real facsimile apparatus. From this point of view the TS 61 NT is considered to be justifiable for GSM application.

Considering the recently defined options covered by CCITT T.30 for text and file transfer the error free-conveyance of the facsimile documents is of particular importance.

Furtheron the robustness of the TS 61 NT against shadowing and rapid changes of CIR values needs to be emphasized.