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DATA TRANSMISSION ON THE FRENCH

MORANE TRIAL SITE

MEASUREMENTS CARRIED OUT IN FEBRUARY 1998

ACCESS : ❑ Public ☑ Restricted ❑ Confidential

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EVOLUTION SHEET

Version	Date	Author	MODIFICATION
A	03/03/98	W. Pirard	Creation
1	16/03/98	W. Pirard	Update
2	16/04/98	W. Pirard	Modification

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LIST OF ABBREVIATIONS

BER	: Byte Error Rate
HO-Break	: Handover Break
LGV NORD	: High speed line - North (between Monchy and Vémars)
BARREAU	: "Barreau d'interconnexion" line (between Vémars and Chessy)

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1. INTRODUCTION

A data transmission measurement campaign has already been carried out in November 1997 on the French MORANE trial site. The results of this campaign have been presented in [3]. Subsequently, a first network tuning has been made to solve the handover Ping-Pong problems. The network parameters implemented for the February campaign are given in appendix 1. This report details the measurement results obtained after this first tuning. The tests have been performed by ISSeP with the collaboration of INRETS and SNCF in February 1998.

The measurements have been carried out along journeys starting from the CHESSY cell up to the MONCHY cell (figure 1).

The following scenarios have been considered for the tests :

- analogue and ISDN lines ;
- 2.4 and 9.6 kb/s ;
- up-link and down link transmission ;
- train speed :

  - with RMR : 80 km/h (± 10%);
  - with MELUSINE : 200 km/h (± 10%) everywhere;
    or 300 km/h on the LGV NORD, 270 km/h on the BARREAU and 230 km/h inside the tunnel.

Table 1 indicates the train speeds at which each scenario has been tested.

Table 1 : Train speed for the different test scenarios

Maximum Train Speed	ISDN 9600 b/s Down-link	Analogue line 9600 b/s Down-link	ISDN 2400 b/s Down-link	ISDN 9600 b/s Up-link
80 km/h	X	X	X	
200 km/h	X	X	X	X
300 km/h*	X	X	X	X

** i.e. : 300 km/h on the LGV NORD (between Monchy and Vemars BTSs), 270 km/h on the BARREAU and 230 km/h inside the tunnel.*

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With MELUSINE, only 2 runs, on a total of 8, have been performed at 200 km/h. The measurements made with MELUSINE (at speeds between 200 and 300 km/h) have been merged all together for the general result. For the handover break results per BTS, the distinction between the different speeds has been realised as well as for the analysis of the impact of speed on the Average HO Break duration.

This report deals with the following aspects :

- Handover periods
  - Handover break
  - Handover Ping-Pong
  - Handover failure
- Non handover periods
  - Byte error rate

2.REFERENCES

[1] MORANE DATA TRANSMISSION TEST REPORT
DATA MEASUREMENTS - Doc n°A 09 T 6009 1 - Dec. 96

[2] PROCEDURE FOR ERROR MEASUREMENT ON TRANSPARENT
ASYNCHRONOUS GSM DATA TRANSMISSION
Doc n°O 25 T 8002 A - Feb. 98

[3] DATA TRANSMISSION ON THE FRENCH MORANE TRIAL SITE -
MEASUREMENTS CARRIED OUT IN NOVEMBER 97
Doc n°O 25 T 8001 1 - Jan. 98

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3. TRIAL SITE DESCRIPTION

The French MORANE trial site is built along 100 km of the new SNCF high speed railway lines between Chessy and Monchy. The site includes two parts: 60 km along the LGV Nord line (Lille - Paris) where the maximum speed allowed is 310 km/h and 32 km on the "Barreau d'interconnexion" part between Roissy and Marne La Vallée where the maximum speed allowed is 280 km/h outside the tunnel and 230 km inside the tunnel.

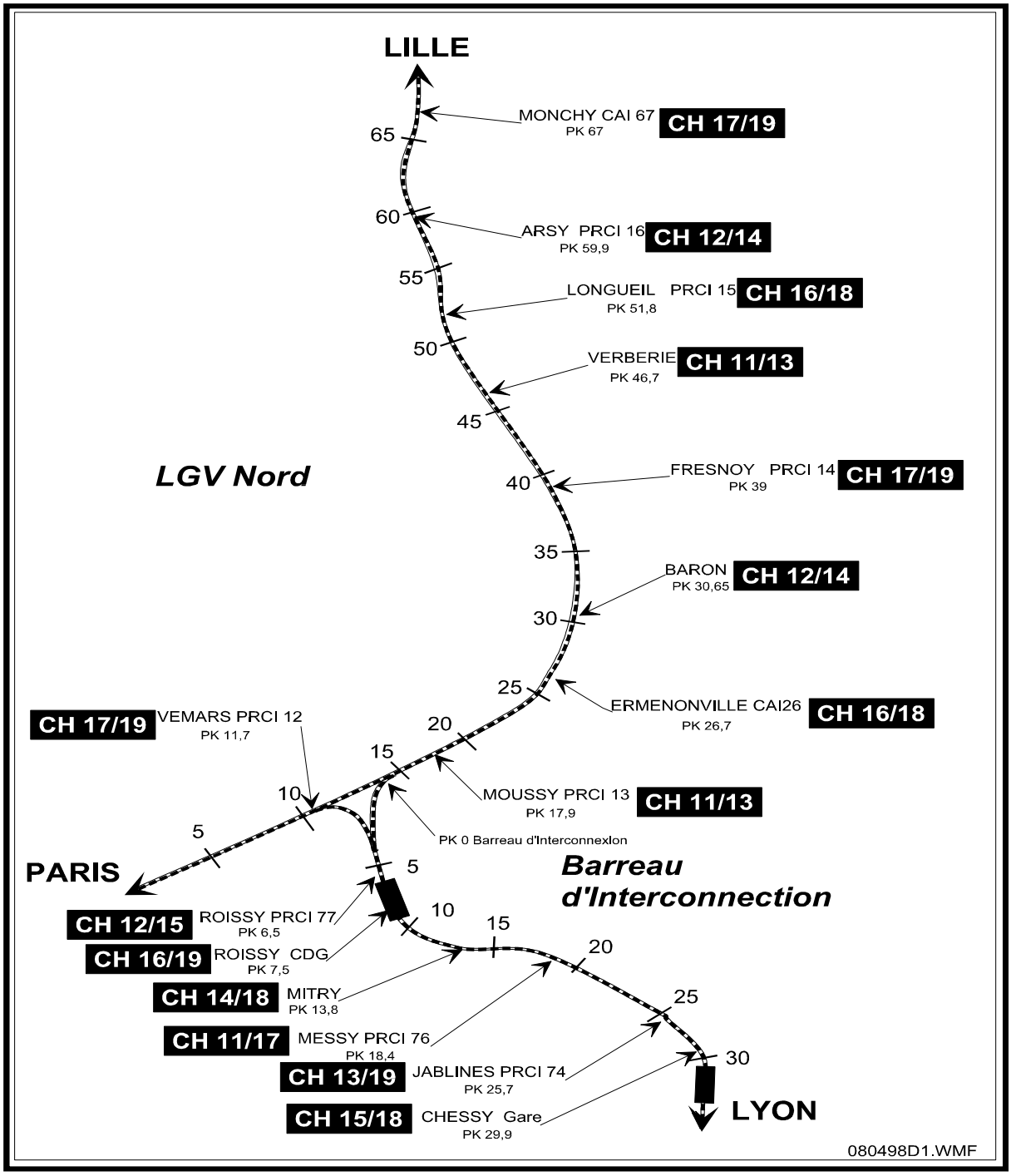

Figure 1 : French trial site map

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The LGV Nord part is equipped with 1 BSC and 9 BTS from ALCATEL. The Barreau d'interconnexion part is equipped with 1 BSC and 6 BTS from MATRA. In this report, these two parts have been termed "LGV NORD" and "BARREAU" respectively. The two sub-systems are controlled by 1 MSC. A map of the trial site with the BTS locations is given on figure 1.

The channel numbers and location (PK corresponds to "Point Kilométrique") are indicated for each BTS.

Radiocoverage measurements have also been carried out by INRETS simultaneously to the data transmission tests. The received signal and RxQual for the different test journeys were nearly the same. Those corresponding to the worst case are summarised hereafter :

	Received signal	RxQual
LGV NORD	> -95 dBm on 99% of the test journey	≤ 3 on 87% of the test journey
BARREAU	> -95 dBm on 97% of the test journey	≤ 3 on 95% of the test journey

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4. HANDOVER PERIODS

Handover periods have been studied in a similar manner as for previous campaigns. More details on the methodology can be found in [2] and [3].

4.1. Handover break

Measurements in down-link have been performed at 80, and 200 - 300 km/h[1]. Tables 2 and 3 give the average, median, maximum and minimum values for the different scenarios at 80 and 200 - 300 km/h respectively. All figures in parenthesis correspond to the values measured in the November campaigns.

4.1.1. Results at 80 km/h (downlink)

The results are indicated in table 2.

	ISDN 9.6 **kb/s** **Down-link**		**Analogue Line** 9.6 **kb/s** **Down-link**		**ISDN** 2.4 **kb/s** **Down-link**	
	LGV NORD	BARREAU	LGV NORD	BARREAU	LGV NORD	BARREAU
Average	554	610	557 (554)	598 (645)	138 (135)	146 (156)
Median	568	608	550	599	135	150
Max.	636	642	617 (610)	655 (901)	179 (162)	157 (196)
Min.	336	558	512	557	116	130
NB samples	11	10	12	6	17	11
Average duration (ms)	577	635	580 (577)	623 (671)	575 (562)	608 (650)

Table 2 : HO break length (in bytes) at 80 km/h

[1] In this report, the reference 200 - 300 km/h indicates that all the measurements performed with MELUSINE have been merged all together. Thus, the train speed is
either - 200 km/h everywhere
or - 300 km/h on the LGV NORD, 270 km/h on the BARREAU and 230 km/h inside the tunnel.

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4.1.1.1.ISDN line at 9.6 kb/s

The 2nd and 3rd columns in table 2 correspond to 9.6 kb/s with ISDN line. We can notice that the average HO-break length is about 10% longer on the BARREAU than on the LGV NORD.

4.1.1.2. Analogue line at 9.6 kb/s

The corresponding results are given in the 4th and 5th columns of table 2. The average HO-break length is 7 % longer on the BARREAU than on the LGV NORD.

4.1.1.3. ISDN line at 2.4 kb/s

The corresponding results are given in the 6th and 7th columns of table 2. The average HO-break length is 6 % longer on the BARREAU than on the LGV NORD.

4.1.1.4. Comments regarding HO-break

The last line in table 2 gives the average HO-break duration (in ms). One can see that this parameter is about 575 ms on the LGV NORD and 625 ms on the BARREAU whichever the transmission mode (analogue or ISDN).

The maximum value is generally about 10% longer than the average except at 2.4 kb/s on the LGV NORD where the maximum exceeds the average by 30%.

Comparison with the results of the previous campaign shows that, on the LGV NORD, the November (figures between parenthesis) and February values are nearly the same. On the BARREAU, they are about 7 or 8 % shorter in February than in November. The improvement on the BARREAU is due to the lack of large HO-break lengths which have only been observed in the previous campaign.

As already mentioned in [3], the structure of the error bursts (which are due to handovers) is not the same in the two parts of the trial site. Figure 2 shows an error burst recorded on a BARREAU's BTS. It can be seen that, in fact, the burst includes two parts which are separated by a rather long sequence of correctly received bytes. In this example, the first part includes 489 corrupted bytes. It is followed by 83 correctly received bytes. The second part includes 99 corrupted bytes. Most HO-breaks measured on the BARREAU BTSs have a similar structure, whichever the transmission mode and bit rate. It must be mentioned that the error free part has always been included in the calculation of HO-break length. Hence, the HO-break length of figure 2 example is equal to 671 (i.e. 489 + 83 + 99).

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193 014 MORANE - Error Measurements / Feb. 98 France
193 015 MORANE - Error Measurements / Feb. 98 France
193 016 MORANE - Error Measurements / Feb. 98 France
193 017 MORANE - ErrorMeasuremeîóÉê¹î7 FÖave
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193 028 MORAFE - Erroö Measur]men;¨ / Feb. I7 FrancÊÏ ,ÂJ
=I ¹. E®••…ÍÕÉEÛ•¹ÑÍZÊ
º ¡…¹••5ŠÊš ,š, Öê9 - Error Measurements / Feb. 98 France
193 031 MORANE - Error Measurements / Feb. 98 France
193 032 MORANE - Error Measurements / Feb. 98 France
193 033 MORANE - Error Measurements / Feb. 98 France

Figure 2 : BARREAU HO-break example (analogue line at 9.6 kb/s)

145 031 MORANE - Error Measurements / Feb. 98 France
145 032 MORANE - Error Measurements / Feb. 98 France
145 033 MORANE - Error Measurements / Feb. 98 France
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n‹Measureme\ts / Few. N $nce
145 044 MORANE - Error Measurements / Feb. 98 France
145 045 MORANE - Error Measurements / Feb. 98 France

Figure 3 : LGV NORD HO-break example (analogue line at 9.6 kb/s)

Figure 3 shows a HO-break measured at the same bit rate on an LGV NORD BTS. We can see that in this case, the HO-break can be considered as a single block (524 byte long).

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4.1.2. Results at 200-300 km/h

The results are indicated in table 3.

	ISDN 9.6 kb/s Down-link		Analogue Line 9.6 kb/s Down-link		ISDN 2.4 kb/s Down-link		ISDN 9.6 kb/s Up-link	
	LGV NORD	BAR-REAU	LGV NORD	BAR-REAU	LGV NORD	BAR-REAU	LGV NORD	BAR-REAU
Average	549 (575)	644 (658)	555 (576)	639 (732)	131 (134)	153 (167)	167	396
Median	544	628	548	629	128	147	161	394
Max.	831 (1060)	831 (920)	682 (640)	798 (990)	171 (200)	268 (310)	259	458
Min.	500	585	498	570	102	103	143	322
NB samples	27	14	18	12	41	17	39	15
Average duration (ms)	571 (599)	670 (685)	578 (600)	665 (762)	545 (558)	637 (696)	174	412

Table 3 : HO-break length (in bytes) at 200 - 300 km/h

4.1.2.1. ISDN line at 9.6 kb/s (downlink)

The 2nd and 3rd columns in table 3 correspond to 9.6 kb/s with ISDN line in down-link.

The average HO-break length is 17 % longer on the BARREAU than on the LGV NORD.

4.1.2.2. Analogue line at 9.6 kb/s (downlink)

The corresponding results are given in the 4th and 5th columns of table 3. The average HO-break length is 15 % longer on the BARREAU than on the LGV NORD.

4.1.2.3. ISDN line at 2.4 kb/s (downlink)

The corresponding results are given in the 6th and 7th columns of table 3. The HO-break length is about 17% longer on the BARREAU than on the LGV NORD.

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4.1.2.4. ISDN line at 9.6 kb/s (uplink)

The corresponding results are given in the 8th and 9th columns of table 3. The average HO-break length is 2.4 times longer on the BARREAU than on the LGV NORD.

4.1.2.5. Comments regarding HO-break

The last line in table 3 gives the average HO-break duration (in ms). One can see that, in down-link, this parameter ranges between 545 and 578 ms on the LGV NORD and between 637 and 670ms on the BARREAU.

The two columns on the right in table 3 show that, with both manufacturers, the average break length is always shorter in up-link than in down-link. The ratio is about 3.2 on the LGV NORD and about 1.6 on the BARREAU.

Comparison with the results obtained during the November measurement campaigns (figures between parenthesis) shows that now the HO-breaks are slightly shorter on the LGV NORD. On the BARREAU, there are a 15% decrease with analogue line and a 10% decrease with ISDN line at 2.4 kb/s. The improvement on both parts is due to the large HO-break lengths that occur less frequently than before.

On the BARREAU, in up-link as in down-link, the handover error bursts also include two parts separated by a rather long sequence of correctly received characters as described earlier.

The comparison between the average HO-break length at 80 and 200 - 300 km/h (3rd line of tables 2 and 3) does not show a clear effect of the train speed. Indeed, a 5 % increase is noticed on the BARREAU (in down-link). In contrast, on the LGV NORD, the results are nearly identical or even lower at 300 than at 80 km/h. However, when the maximum values are compared, one can notice that the maximum values are longer at 200 - 300 km/h than at 80 km/h in 5 scenarios on 6. Thus, it seems that long HO-breaks occur more frequently at 200 - 300 km/h than at 80 km/h.

4.1.3. Handover breaks per BTS

Tables 4 to 7 give the HO-break length (in bytes) measured on each BTS and for different train runs. The first and second columns indicate the BTS name and the corresponding channel numbers. The references in the second line allow to identify the train run and speed. Each table corresponds to one bit rate and one transmission mode. In contrast to what has been noticed previously, no "long HO-break" has been found during this campaign. Indeed, all samples in tables 4 to 7 are in the same range.

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ISDN 9600 / 80 km/h Down-link							
BTS	Freq. NB.	IZD041	IZD042				Average HO Break
Monchy	17/19						
Arsy	12/14		539				539,00
Longueil	16/18		586				586,00
Verberie	11/13	545	563				554,00
Fresnoy	17/19	620	336				478,00
Baron	12/14	571	628				599,50
Ermenonville	16/18	579	566				572,50
Moussy	11/13	571					571,00
Vemars	17/19		541				541,00
RoissyPRC	12/15	602	636				619,00
Roissy CDG	16/19	624	615				619,50
Mitry	14/18	640	595				617,50
Messy	11/17		558				558,00
Jablines	13/19	582	602				592,00
Chessy	15/18		642				642,00
ISDN 9600/200 - 300 km/h Down-link							
BTS	Freq. NB.	IZD055Z 300 km/h*	IZD055 **200 km/h**	IZD056 300 km/h	IZD057 300 km/h	IZD058 300 km/h	Average HO Break
Monchy	17/19	555		568			561,50
Arsy	12/14		588	537	500	528	538,25
Longueil	16/18	598	625	556	520	544	568,60
Verberie	11/13		530	529	538		532,33
Fresnoy	17/19		565		582	552	566,33
Baron	12/14	558			630		594,00
Ermenonville	16/18	543		513	535	546	534,25
Moussy	11/13			505	500		502,50
Vemars	17/19		508			566	537,00
RoissyPRC	12/15		596		831		713,50
Roissy CDG	16/19		585		807		696,00
Mitry	14/18		632	643		596	623,67
Messy	11/17		633	612			622,50
Jablines	13/19			585	633	594	604,00
Chessy	15/18		648		624		636,00

** i.e. : 300 km/h on the LGV NORD, 270 km/h on the BARREAU and 230 km/h inside the tunnel.*

Table 4 : HO-break length (in bytes)

Analogue 9600/80 km/h Down-link							
BTS	Freq. NB.	AZD041	AZD042				Average HO Break
Monchy	17/19						
Arsy	12/14	540	550				545,00
Longueil	16/18	560					560,00
Verberie	11/13	515	550				532,50
Fresnoy	17/19	617	512				564,50
Baron	12/14		538				538,00
Ermenonville	16/18	538					538,00
Moussy	11/13	582	578				580,00
Vemars	17/19		604				604,00
RoissyPRC	12/15						
Roissy CDG	16/19	563					563,00
Mitry	14/18	557					557,00
Messy	11/17	588	655				621,50
Jablines	13/19	615	611				613,00
Chessy	15/18						
Analogue 9600/200 - 300 km/h Down-link							
BTS	Freq. NB.	AZD055Z 300 km/h	AZD055 **200 km/h**	AZD056 300 km/h	AZD057 300 km/h	AZD058 300 km/h	Average HO Break
Monchy	17/19						
Arsy	12/14					585	585,00
Longueil	16/18	562			606		584,00
Verberie	11/13	547			560		553,50
Fresnoy	17/19			549	530		539,50
Baron	12/14	498	682				590,00
Ermenonville	16/18	542	511	546		560	539,75
Moussy	11/13		503		563		533,00
Vemars	17/19		530		522	597	549,67
RoissyPRC	12/15		798		683		740,50
Roissy CDG	16/19						
Mitry	14/18		615				615,00
Messy	11/17		619	578	621	638	614,00
Jablines	13/19		642	638	651	617	637,00
Chessy	15/18				570		570,00

Table 5 : HO-break length (in bytes)

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ISDN 2400/80 km/h Down-link								Average HO Break
BTS	Freq. NB.	IXD041	IXD042					
Monchy	17/19	144						144,00
Arsy	12/14	135	132					133,50
Longueil	16/18	117	179					148,00
Verberie	11/13	135	155					145,00
Fresnoy	17/19	151	131					141,00
Baron	12/14	142	134					138,00
Ermenonville	16/18	117	116					116,50
Moussy	11/13	129	155					142,00
Vemars	17/19	138	135					136,50
RoissyPRC	12/15	132	156					144,00
Roissy CDG	16/19	130	150					140,00
Mitry	14/18	135	157					146,00
Messy	11/17	134	154					144,00
Jablines	13/19	150	153					151,50
Chessy	15/18		155					155,00
ISDN 2400/200 - 300 km/h Down-link								
BTS	Freq. NB.	IXD050 300 km/h	IXD051 300 km/h	IXD052 300 km/h	IXD053 300 km/h	IXD054 **200 km/h**	IXD054Z 300 km/h	Average HO Break
Monchy	17/19	128		130		126		128,00
Arsy	12/14	143		146		137		142,00
Longueil	16/18	124	118	140	152	102	134	128,33
Verberie	11/13		138	123	145		113	129,75
Fresnoy	17/19		143		157	144	171	153,75
Baron	12/14	124	122	136	114	123	130	124,83
Ermenonville	16/18	128	120	129		124	159	132,00
Moussy	11/13	126	122	147	129	128	127	129,83
Vemars	17/19		110		112	130	125	119,25
RoissyPRC	12/15		141		138	159		146,00
Roissy CDG	16/19		150					150,00
Mitry	14/18		145	268		176		196,33
Messy	11/17		149	103	149	147		137,00
Jablines	13/19		164	141	141	140		146,50
Chessy	15/18		147		150			148,50

Table-6 : HO break length (in bytes)

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ISDN 9600/200 - 300 km/h Up-link								
BTS	Freq. NB.	IZU050 300 km/h	IZU051 300 km/h	IZU052 300 km/h	IZU053 300 km/h	IZU054 **200 km/h**	IZU054Z 300 km/h	Average HO Break
Monchy	17/19	143		168		177		162,67
Arsy	12/14	179	171	182				177,33
Longueil	16/18		150	173	153	151	154	156,20
Verberie	11/13		153	160	184	168	164	165,80
Fresnoy	17/19				159	148	152	153,00
Baron	12/14	166	149	159	155	177	151	159,50
Ermenonville	16/18		159	151	168	163	174	163,00
Moussy	11/13		165	205	145		149	166,00
Vemars	17/19		145	259	161	241	190	199,20
RoissyPRC	12/15		327		322			324,50
Roissy CDG	16/19		414					414,00
Mitry	14/18		399	458	428	386		417,75
Messy	11/17		383	436		394		404,33
Jablines	13/19			378	417	433		409,33
Chessy	15/18		377		388			382,50

Table 7 : HO-break length (in bytes)

4.1.4. Speed impact on the Average HO Break duration

Table 8 gives the average HO-break duration at 80, and 300 km/h for the different transmission types.

		ISDN 9.6 kb/s Down-link		Analogue Line 9.6 kb/s Down-link		ISDN 2.4 kb/s Down-link		ISDN 9.6 kb/s Up-link	
		LGV NORD	BAR-REAU	LGV NORD	BAR-REAU	LGV NORD	BAR-REAU	LGV NORD	BAR-REAU
80 km/h	Av. duration (ms)	577	635	580	623	575	608		
	NB samples	11	10	12	6	17	11		
300 km/h*	Av. duration (ms)	568	685	571	651	551	637	172	410
	NB samples	22	9	14	8	33	13	32	12

** i.e. : 300 km/h on the LGV NORD, 270 km/h on the BARREAU and 230 km/h inside the tunnel.*

Table 8 : Average HO break duration (in ms) at different train speeds

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On the LGV NORD, it can be noticed that the HO-break duration is 2 or 3 % shorter at 300 km/h than at 80 km/h. In contrast, on the BARREAU, they are 5 to 8 % longer at 300 km/h than at 80 km/h.

Remark : The number of samples is not large enough to draw statistically significant conclusions.

4.2. Handover Ping-Pong

It has been found that the handover Ping-Pong phenomenon appeared much less frequently than during the previous measurement campaigns. Only 7 Ping-Pong sequences have been found during 2 runs with 3 data links with RMR and 8 runs with 2 data links with MELUSINE.

Table 9 summarises the main parameters for the 7 recorded Ping-Pong sequences. The different columns give respectively the transmission mode, the BTS sequences (the figures between parenthesis correspond to the BTS channel number), the train speed, the direction of the run and the train run number.

Transmission Mode	BTS Sequences	Train Speed (km/h)	Direction of the Run	Train run number
I 2400 - Down-L.	Ermenonville(18)-Moussy(13)-Ermenonville(18)	80	→N	IXD041
I 2400 - Down-L.	Ermenonville(18)-Moussy(13)-Ermenonville(18)	300	→N	IXD054
I 2400 - Down-L.	Fresnoy(19)-Verberie(11)-Fresnoy(19)	80	→S	IXD042
I 9600 - Down-L.	Fresnoy(17)-Verberie(11)- Fresnoy(19)	80	→S	IZD042
A 9600 - Down-L.	Fresnoy(17)-Verberie(11)- Fresnoy(19)	80	→S	AZD042
A 9600 - Down-L.	Mitry(18)-Messy(11)-Mitry(18)	300	→N	AZD056
I 9600 - Up-link	Mitry(18)-Messy(17)-Mitry(14)	300	→N	IZU052

Table 9 : Handover Ping-pong details

Table 9 shows that Ping-Pongs occur only in 3 different locations which are :

- Ermenonville -Moussy Ermenonville (northwards)
- Fresnoy -Verberie -Fresnoy (southwards)
- Mitry -Messy - Mitry (northwards)

In each of these locations, Ping-Pongs always occur in the same direction (i.e. either northwards or southwards). However, it has been found that the Ping-Pong "Mitry - Messy - Mitry" is due to a communication break between Mitry and Roissy CDG BTS. Further details can be found in the document IG.TL-RU/NJ/0298-09

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4.3. Handover Failure

Some handover failures were noticed during the runs at 300 km/h. In contrast, none occurred at 80 km/h. These failures always took place at the same cell borders but not for all the runs. The corresponding BTS transitions with the direction of the run are listed hereafter.

- Baron to Fresnoy (northwards)
- Mitry to Roissy CDG (northwards)
- Roissy CDG to Mitry (southwards)
- Ermenonville to Baron (northwards)
- Roissy PRC to Roissy CDG (southwards)

Communication break-down occurred almost in all runs at 300 km/h in the 3 first positions above. In contrast, break-down occurred only once in the 2 last ones.

Investigations are presently on-going to determine whether this phenomenon results of the high speed or is due to a particular radio coverage problem in these areas. Conclusions of these investigations will be given in the next version of this report.

5. NON-HANDOVERS PERIODS

5.1. Overall Byte Error Rate

As for the previous campaigns, byte error rate calculations have been carried out as follows :

- The files with the received messages have been splitted in two parts. One contains the messages received on the BARREAU and the other one contains those received on LGV NORD.
- the handover error bursts have been discarded.
- the total number of corrupted N_{wrong} bytes has been calculated for each trial site part.
- the total number of transmitted N_{trans} bytes has been determined for each trial site part;
- the BER is given by the N_{wrong} / N_{trans} ratio.

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5.1.1. BER for 80 km/h

Table 10 summarises the BER results measured at 80 km/h in the different scenarios. The figures in bold print correspond to the BER (to be multiplied by 10^{-4}). The figures between parenthesis in the next line correspond to the BER value measured during the November campaign. The figures in the next columns on the right side give the total number of transmitted bytes.

	ISDN 9.6 kb/s Down-link		Analogue Line 9.6 kb/s Down-link		ISDN 2.4 kb/s Down-link		ISDN 9.6 kb/s Down-link	
BTS	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)
LGV NORD	**2.6**	3831	**4.0** (1.3)	4073	**1.1**	1377	(0)	
BARREAU	**1.7**	2389	**0.9** (2.8)	2278	**0**	853	(0.6)	

Table 10 : Byte error rate at 80 km/h

Table 10 shows that the BER is lower at 2.4 kb/s than at 9.6 kb/s. It also appears that the BER is in all cases lower on the BARREAU.

5.1.2. BER for 200-300 km/h

Table 11 summarises the BER measurements carried out at 200 - 300 km/h.

	ISDN 9.6 kb/s Down-link		Analogue Line 9.6 kb/s Down-link		ISDN 2.4 kb/s Down-link		ISDN 9.6 kb/s Up-link	
BTS	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)
LGV NORD	**6.6** (7.5)	2728	**4.7** (4.8)	2279	**1.2**	1080	**0.2**	3326
BARREAU	**3.9** (2.8)	1491	**5.7** (22.3)	1558	**0.6**	476	**11.4**	1857

Table 11 : Byte error rate at 200 - 300 km/h

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In down-link, BER is generally lower on the BARREAU. In contrast, in up-link, the performances are relatively poor on the BARREAU but the high error rate is due to the occurrence of 3 long error bursts the length of which are 922, 690 and 314 bytes.

If these three long bursts are discarded, we obtain a value of 1.1 x 10^{-4} instead of 11.4 x 10^{-4}.

Details regarding these 3 error bursts are given in appendix 2.

In tables 10 and 11, the values measured during the November campaigns (these results are between parenthesis when they are available,) are generally in the same range except where large error rate has been found.

5.2. Influence of Pentograph Sparks Discharges on Byte Error Rate

With the MELUSINE measuring carriage, the mobile station antennas are installed at about 8 metres from one pentograph. When the train is travelling Northwards, it is the pentograph located near the antennas that is active and which is a source of electromagnetic interferences. In order to determine whether the pentograph sparks impair the transmission quality, BER have been calculated separately for the North to South and South to North journeys. The results are summarised in table 12.

Let's mention that such a splitting is useless for the RMR journeys as this train is driven by a diesel engine.

	ISDN 9.6 kb/s Down-link		Analogue Line 9.6 kb/s Down-link		ISDN 2.4 kb/s Down-link		ISDN 9.6 kb/s Up-link	
BTS	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)	B.E.R. (x 10^{-4})	Bytes sent (kbytes)
LGV NORD northwards	**6.0**	910	**6.7**	1171	**0.5**	609	**0.1**	1833
LGV NORD southwards	**6.9**	1818	**2.5**	1108	**2.1**	471	**0.3**	1493
BARREAU northwards	**11.1**	337	**1.6**	583	**1.7**	164	**12.5**	736
BARREAU southwards	**1.8**	1154	**7.1**	975	**0**	312	**10.6**	1121

Table 12 : Byte error rate at 200 - 300 km/h

If the three long bursts identified above are discarded, we obtain values of 0,01 instead of 12,5 and 1,7 instead of 10,6.
The comparison, for each trial site part, between the results measured northwards and southwards shows that BER is not systematically worse when the train is running northwards.

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Hence, it can not be concluded that the proximity of an "active" pentograph would impair the transmission quality.

6. CONCLUSIONS

Table 13 summarises the HO-break results. The figures between parenthesis in the next line correspond to the values measured in the November campaigns.

	LGV NORD	BARREAU	German trial site
Down link (ms)	545 to 580 (558 to 600)	608 to 670 (685 to 762)	not measured
Up-link (ms)	174 (171 to 178)	412 (385 to 440)	450 to 500

Table 13 : HO-break duration (in ms) - All speeds merged

In down-link on the LGV NORD, the results are nearly the same as those measured during the November campaign. In contrast, there is a 80 to 90 ms decrease on the BARREAU.

On both trial site parts, it has been found that the average HO-break duration (in ms) does not depend on transmission mode (analogue or ISDN) and bit rate but strongly depends on :

- transmission direction (i.e. up-link or down-link);
- BSS manufacturer.

The HO-break in up-link is shorter on both parts of the French trial site than on the German site. Unfortunately, no figure is available for the down-link on the German site.

The HO-break in up-link is shorter than in down-link on both parts of the French trial site. The difference is particularly important on the LGV NORD.

In up-link and down-link, HO-breaks are always shorter on the LGV NORD than in the BARREAU. On the BARREAU, the HO-break always includes two error bursts separated by a relatively long sequence of correctly received bytes.

Rather long HO-breaks were found on both trial site parts during the previous measurement campaign. Their lengths exceeded several times the average values. During this second campaign, the maximum HO-Break length rarely exceeds the average by more than 50%.

Regarding the influence of the train speed, the comparison between the average HO-break length at 80 and 300 km/h does not show a clear effect of the train speed. Indeed, a 5 % increase is noticed on the BARREAU (in down-link) but in contrast, on the LGV NORD, the

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results are nearly identical or even lower at 300 km/h than at 80 km/h. If the maximum values are compared, long HO-breaks occur more frequently at high speed.

The byte error rate is always lower at 2.4 kb/s than at 9.6 kb/s.

The presence of the pentograph at short distance (i.e. about 8 metres) away from the mobile station antenna does not impair BER and HO-Break length.

It appears that, for the LGV Nord (Northwards and Southwards) and for the BARREAU (Northwards), the BER is much lower in up-link than in downlink.

The team in charge of the measurements should investigate the following aspects further :

- train speed influence on the occurrence of longer HO-break (see point 4.3 above);
- train speed influence on handover failure rate.

The following aspects should be investigated further by the manufacturers :

- On the BARREAU, the HO-breaks which include 2 errors bursts separated by an error free window:
- On both parts, the large HO-break difference between down-link and up-link;
- On the LGV NORD, the large BER difference between down-link and up-link.

7. APPENDIXES

Appendix 1 : Network parameters implemented for the February measurement campaign

Appendix 2 : Long error bursts on the Barreau

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APPENDIX 1

NETWORK PARAMETERS IMPLEMENTED FOR THE FEBRUARY MEASUREMENT CAMPAIGN

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The network parameters implemented for the measurements performed in February 98 are summarised hereafter.

LGV NORD

		BTS power (dBm)	Channels	Neighbouring cells BCCH	HO margin
1 (Alc)	**Monchy**	41	17, 19	Arsy : 12 Longueil : 16	4 8
2 (Alc)	**Arsy**	41	12, 14	Monchy : 17 Longueil : 16 Verberie : 11	4 4 12
3 (Alc)	**Longueil**	41	16, 18	Monchy : 17 Arsy : 12 Verberie : 11 Fresnoy : 17	8 4 8 8
4 (Alc)	**Verberie**	41	11, 13	Arsy : 12 Longueil : 16 Fresnoy : 17 Baron : 12	8 4 8 8
5 (Alc)	**Fresnoy**	41	17, 19	Longueil : 16 Verberie : 11 Baron : 12 Ermenonville : 16	8 4 4 8
6 (Alc)	**Baron**	41	12, 14	Verberie : 11 Fresnoy : 17 Ermenonville : 16 Moussy : 11	10 8 4 12
7 (Alc)	**Ermenonville**	41	16, 18	Fresnoy : 17 Baron : 12 Moussy : 11 Vémars : 17	12 4 12 8
8 (Alc)	**Moussy**	41	11, 13	Baron : 12 Ermenonville : 16 Vémars : 17 Roissy PRCI : 12	8 8 8 8
9 (Alc)	**Vemars**	41	17, 19	Ermenonville : 16 Moussy : 11 Roissy PRCI : 12 Roissy gare : 16	8 10 4 8

Alc stands for Alcatel
BARREAU

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		BTS power	Channels	Neighbouring cells BCCH	HO margin	Number of measurements for the level	Number of measurements for the quality
1 (nmc)	**Roissy PRCI**	43	BCCH : 12 TCH : 15	Moussy : 11 Vémars : 17 Roissy gare : 16 Mitry : 14	12 4 4 8	16	16
2 (nmc)	**Roissy station**	43	BCCH : 16 TCH : 19	Vémars : 17 Roissy PRCI : 12 Mitry : 14 Messy : 11	8 4 2 8	4 (and also 4 for the neighbou-ring cells)	16
3 (nmc)	**Mitry**	43	BCCH : 14 TCH : 18	Roissy PRCI : 12 Roissy gare : 16 Messy : 11 Jablines : 13	8 0 6 12	8	16
4 (nmc)	**Messy**	41	BCCH : 11 TCH : 17	Roissy gare : 16 Mitry : 14 Jablines : 13 Chessy PRCI : 15	8 6 4 12	16	16
5 (nmc)	**Jablines**	43	BCCH : 13 TCH : 19	Mitry : 14 Messy : 11 Chessy PRCI : 15	8 4 6	16	16
6 (nmc)	**Chessy PRCI**	37	BCCH : 15 TCH : 18	Messy : 11 Jablines : 13	8 4	16	16

nmc stands for Nortel Matra Cellular

Moreover, some antennas have been tilted with respect to their previous positions :

- Mitry South is tilted 3°
- Messy North and South are tilted 3°

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APPENDIX 2

LONG ERROR BURSTS ON THE BARREAU

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Three long error bursts, in the non-handover periods, have been found in the up-link on the BARREAU. Details regarding these error bursts are given hereafter.

BTS name	Channel NB	Error burst length (bytes)	Time - Date	Remarks
Roissy CDG	16	314	between 10:30:20 and 10:30:22 10 Feb. 1998	See remarks of the next error burst

BTS name	Channel NB	Error burst length (bytes)	Time - Date	Remarks
Roissy CDG	16	690	between 10:30:20 and 10:30:22 10 Feb. 1998	This error burst follows the previous one by only 200 ms. About, 200 ms later, it is followed by an HO to the Mitry BTS.

BTS name	Channel NB	Error burst length (bytes)	Time - Date	Remarks
Chessy	18	922	between 10:52:20 and 10:52:21 10 Feb. 1998	This error burst occurred only 2.8 s after transmission start. It includes byte losses only (i.e. no bytes corrupted or inserted)

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