Long-Term Performance and Propagation Measurements on Single and Tandem Digital Microwave Transmission Links

Volume III: Twelve-Month Network and Link-Characterization Results

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June 1990
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1. INTRODUCTION

The tables and graphs contained in this volume summarize the data collected by the Network/Link Performance Characterization hardware and software for the 12-month measurement period which began April 1, 1988. The data for the entire 18-month measurement period have also been analyzed and summarized in the same tables and graphs presented in this volume. It was decided that it would be more appropriate to present the 12-month summary than the 18-month summary for the following reason. Fading tends to be a seasonal phenomenon. We, therefore, had concern that the 18-month summary could bias conclusions drawn from the graphs and tables because some months would be included for 2 successive years, while some other months would be included only once.

Separate monthly volumes were generated for each month during the 18-month data collection period from April 1, 1988, through September 30, 1989. These monthly outputs contain the same types of tables and graphs that are contained in this volume. The information from these monthly volumes of output tables and graphs were used in the development of some of the figures and tables contained in Volume I of this report. The volume for January 1989 was found to be of particular interest because of the large amount of fading on the Schwarzenborn-Feldberg (SBN-FEL) link during that month. A copy of all monthly volumes has been provided to the project sponsoring agencies (Defense Communications Engineering Center and U.S. Air Force Electronic Systems Division).

2. DESCRIPTION OF TABLES CONTAINED IN VOLUME III

Each of the 18 monthly volumes of data is contained in 14 tables. The data for the first 12 months of the measurement period are summarized in 14 tables in this volume. These tables have the same formats as the 14 tables in the monthly volumes. The first 5 of these 14 tables summarize data collected on the Berlin-to-Feldberg (BLN-FEL) 64-kb/s end-to-end channel. The next 4 tables summarize data collected on the Linderhofe-to-Feldberg (LDF-FEL) channel. The last 4 tables summarize data obtained on the
Schwarzenborn-to-Feldberg (SBN-FEL) link. Further descriptions of these tables are provided in the following paragraphs.

Understanding the organization and content of the tables and figures requires an understanding of objectives of the error-allocation algorithm. As explained in Section 5.4 of Volume I, the errors measured on each of the two end-to-end channels were allocated to each of the component links and to the cause of the error by a sophisticated error-allocation algorithm. This algorithm is described in detail in Appendix D of Volume II of this report. The Berlin-to-Feldberg channel is composed of the Berlin-Bocksberg (BLN-BBG) troposcatter link and four tandem line-of-sight (LOS) links: Bocksberg-Koeterberg (BBG-KBG), Koeterberg-Rothwesten (KBG-RWN), Rothwesten-Schwarzenborn (RWN-SBN), and Schwarzenborn-Feldberg (SBN-FEL) links. The Linderhofe-to-Feldberg channel is composed of four tandem LOS links: Linderhofe-Koeterberg (LDF-KBG), Koeterberg-Rothwesten, Rothwesten-Schwarzenborn, and Schwarzenborn-Feldberg. The allocation algorithm takes the error information measured on the Berlin-to-Feldberg channel and allocates it to the five links comprising that channel (BLN-BBG, BBG-KBG, KBG-RWN, RWN-SBN, and SBN-FEL). The algorithm also allocates the errors measured on the Linderhofe-to-Feldberg channel to the four links comprising the LDF-FEL channel (LDF-KBG, KBG-RWN, RWN-SBN, and SBN-FEL). After allocating the errors to an individual link, the algorithm attempts further to allocate the errors to the cause—equipment problems, multipath fading, power fading, etc.

The table and column headings indicate the source of the data, the link, and the cause of the measured errors. For example, Table 1 takes the error information from the Berlin-to-Feldberg channel and allocates it to each of the component links as indicated by the column headings. As noted in the table heading, Table 1 contains all error data regardless of cause. The last column on the right contains data for the entire end-to-end channel (one tropo link and four LOS links in the case of the BLN-FEL channel).

The following list is a directory of the 14 tables in Volume III:

- **Tables 1 - 5:** Allocation of error data measured on the BLN-FEL channel
  - Table 1: All Causes of Errors
  - Table 2: Equipment Causes of Errors
  - Table 3: Multipath Fading Causes of Errors
  - Table 4: Troposcatter Propagation Causes of Errors
  - Table 5: Power Fading Causes of Errors

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3. DESCRIPTION OF GRAPHS CONTAINED IN VOLUME III

Volume III contains 124 figures. While this initially may seem overwhelming, it becomes less so when the structure and organization of the figures are understood. Understanding the organization and content of these figures requires an understanding of the concept of the error allocation which was described in the previous section. Most of the figures are cumulative probability distributions, which were specified in the statement-of-work from the Defense Communications Engineering Center. Many of these figures contain multiple curves--one curve for each cause of error. For example Figure 1 has a curve for all causes, a curve for errors caused by equipment, and a curve for errors caused by troposcatter propagation. The sample-size numbers beneath these distributions are provided for each of the curves.

There are fifteen categories of figures. Within each category, several similar graphs are provided. The following list provides the structural organization of the 124 graphs, which are grouped into the fifteen categories.

- Figures 1 - 14: Distributions of consecutive errored-second occurrences
  - Figures 1 - 6: Allocation of Berlin-Feldberg errored seconds
  - Figures 7 - 11: Allocation of Linderhofe-Feldberg errored seconds
  - Figures 12 - 14: SBN-FEL errors for receiver on line, Rx A, and Rx B
• Figures 15 - 28: Distributions of consecutive error-free-second occurrences
  - Figures 15 - 20: Allocation of Berlin-Feldberg data
  - Figures 21 - 25: Allocation of Linderhofe-Feldberg data
  - Figures 26 - 28: SBN-FEL errors for receiver on line, Rx A, and Rx B

• Figures 29 - 42: Distributions of consecutive 15-minute-interval average BER
  - Figures 29 - 34: Allocation of Berlin-Feldberg data
  - Figures 35 - 39: Allocation of Linderhofe-Feldberg data
  - Figures 40 - 42: SBN-FEL errors for receiver on line, Rx A, and Rx B

• Figures 43 - 56: Correlation between fraction of errored seconds and BER (all causes)
  - Figures 43 - 48: Allocation of Berlin-Feldberg data
  - Figures 49 - 53: Allocation of Linderhofe-Feldberg data
  - Figures 54 - 56: SBN-FEL errors for receiver on line, Rx A, and Rx B

• Figures 57 - 70: Correlation between fraction of errored seconds and BER (errors caused by multipath)
  - Figures 57 - 61: Allocation of Berlin-Feldberg data
  - Figures 62 - 66: Allocation of Linderhofe-Feldberg data
  - Figures 67 - 69: SBN-FEL errors for receiver on line, Rx A, and Rx B
  - Figure 70: Allocation of BLN-FEL data to BLN-FEL link due to troposcatter fading

• Figures 71 - 73: Correlation between fraction of errored seconds and BER (errors caused by equipment)
  - Figure 71: Receiver on line at Schwarzenborn
  - Figure 72: Receiver A at Schwarzenborn
  - Figure 73: Receiver B at Schwarzenborn

• Figures 74 - 87: Distribution of the number of errors in each errored second
  - Figures 74 - 79: Allocation of Berlin-Feldberg data
  - Figures 80 - 84: Allocation of Linderhofe-Feldberg data
  - Figures 85 - 87: SBN-FEL errors for receiver on line, Rx A, and Rx B

• Figures 88 - 93: Distributions of rsl's as recorded by TRAMCON
  - Figure 88: Link from Bocksberg to Berlin
  - Figure 89: Link from Bocksberg to Koeterberg
  - Figure 90: Link from Koeterberg to Rothwesten
  - Figure 91: Link from Rothwesten to Schwarzenborn
  - Figure 92: Link from Schwarzenborn to Feldberg
  - Figure 93: Link from Linderhofe to Koeterberg
• Figures 94 - 96: Received signal level data for SBN-FEL link as recorded by NPC/LPC equipment
  - Figure 94: Receiver on line
  - Figure 95: Receiver A
  - Figure 96: Receiver B

• Figures 97 - 99: Distributions of IF amplitude distortion (samples of multipath fading in which an error occurred)
  - Figure 97: Receiver on line
  - Figure 98: Receiver A
  - Figure 99: Receiver B

• Figures 100 - 102: Distributions of IF amplitude distortion (samples of all multipath fading)
  - Figure 100: Receiver on line
  - Figure 101: Receiver A
  - Figure 102: Receiver B

• Figure 103: Distributions of IF amplitude distortion (all of samples taken during the 12-month test period)

• Figures 104 - 106: Distributions of signal quality monitor voltages
  - Figure 104: Receiver on line
  - Figure 105: Receiver A
  - Figure 106: Receiver B

• Figures 107 - 112: Plots of hypothetical space diversity improvement factors

• Figures 113 - 124: Multipath propagation data from the LOS channel probe
Table 1. BLNFeL 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
From all causes

<table>
<thead>
<tr>
<th>Link</th>
<th>BLN88BG</th>
<th>BBGK8G</th>
<th>KBGRWA</th>
<th>RN3SDN</th>
<th>SBHFeL</th>
<th>Unident. Link</th>
<th>BBGFeL</th>
<th>BLNFeL</th>
</tr>
</thead>
</table>
| No. of errored seconds, ES  
(with unavailability time) | 1280879 | 34648  | 7558   | 4560   | 49914  | 853796        | 110676 | 2245346|
| (without unavailability time) | 1101551 | 42310  | 622    | 1269   | 23662  | 736493        | 67491  | 1905530|
| No. of ES assigned to 2 links  
(with unavailability time) | 5       | 6      | 4530   | 2386   | 5091   | 0             | 6009   | 6009   |
| (without unavailability time) | 5       | 6      | 30     | 354    | 359    | 0             | 377    | 377    |
| Correlation coefficients for  
fraction of ES & average BER in  
consecutive 15-minute intervals  
(without unavailability time) | 0.1018  | 0.0992 | 0.1005 | 0.1009 | 0.1084 | 0.1002        | 0.1016 | 0.1046 |
| Fraction of period that link is  
unavailable (by MIL-STD-188-323) | 0.06333 | 0.000436 | 0.000245 | 0.000116 | 0.000927 | 0.004142 | 0.001525 | 0.012000 |
| Fraction of period that link is  
unavailable (TRAMCON estimation) | 0.000000 | 0.000000 | 0.000000 | 0.000021 | 0.000046 | 0.000000 | 0.000067 | 0.000067 |
| No. of frame loss occurrences  
(with unavailability time) | 911     | 0      | 0      | 0      | 0      | 0             | 0      | 911    |
| (without unavailability time) | 890     | 0      | 0      | 0      | 0      | 0             | 0      | 890    |
| Fraction of period that link is  
unavailable (Rec. G.821) | 0.003466 |        |        |        |        |               |        |        |
| No. of severely errored seconds  
(Rec. G.821) | 53598   |        |        |        |        |               |        |        |
| Degraded minutes (Rec. G.821) | 296304  |        |        |        |        |               |        |        |
| Errored seconds (Rec. G.821)  | 2150214 |        |        |        |        |               |        |        |
Table 3. BLNFE1 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Multipath

<table>
<thead>
<tr>
<th></th>
<th>BLMBBG</th>
<th>BBGKBG</th>
<th>KBGRMN</th>
<th>RWMSBN</th>
<th>SBMFE1</th>
<th>Unident. Link</th>
<th>BBGFEL</th>
<th>BLNFE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES  (with unavailability time)</td>
<td>0</td>
<td>21873</td>
<td>112</td>
<td>2325</td>
<td>8292</td>
<td>0</td>
<td>31541</td>
<td>31541</td>
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<tr>
<td>(without unavailability time)</td>
<td>0</td>
<td>17439</td>
<td>112</td>
<td>21</td>
<td>544</td>
<td>0</td>
<td>18100</td>
<td>18100</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links  (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>907</td>
<td>1955</td>
<td>1060</td>
<td>0</td>
<td>1961</td>
<td>1961</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>10</td>
<td>15</td>
<td>0</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.1025</td>
<td>0.1003</td>
<td>0.0995</td>
<td>0.1002</td>
<td>0.1000</td>
<td>0.1002</td>
<td>0.0991</td>
<td>0.0992</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000000</td>
<td>0.000157</td>
<td>0.000032</td>
<td>0.000081</td>
<td>0.000274</td>
<td>0.000000</td>
<td>0.000475</td>
<td>0.000475</td>
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<tr>
<td>Fraction of period that link is unavailable (TRAMCON estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

6feb1990
Table 2. BLNFel 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Equipment

<table>
<thead>
<tr>
<th></th>
<th>BLNBG</th>
<th>BBGKBG</th>
<th>KBGRUN</th>
<th>RWNSBN</th>
<th>SBMFEL</th>
<th>Unident. Link</th>
<th>BBGFEL</th>
<th>BLNFEL</th>
</tr>
</thead>
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<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>28129</td>
<td>8239</td>
<td>6055</td>
<td>1233</td>
<td>32512</td>
<td>0</td>
<td>44016</td>
<td>72140</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>19737</td>
<td>3170</td>
<td>320</td>
<td>1146</td>
<td>22558</td>
<td>0</td>
<td>26858</td>
<td>46590</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>5</td>
<td>3</td>
<td>3619</td>
<td>417</td>
<td>4012</td>
<td>0</td>
<td>4028</td>
<td>4028</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>5</td>
<td>3</td>
<td>19</td>
<td>330</td>
<td>325</td>
<td>0</td>
<td>341</td>
<td>341</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.1003</td>
<td>0.0999</td>
<td>0.1005</td>
<td>0.1009</td>
<td>0.1084</td>
<td>0.1002</td>
<td>0.1024</td>
<td>0.0989</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-SID-188-323)</td>
<td>0.000296</td>
<td>0.000179</td>
<td>0.000203</td>
<td>0.000003</td>
<td>0.000352</td>
<td>0.000000</td>
<td>0.000606</td>
<td>0.000902</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (TRAMCON estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
<td>31</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>29</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>29</td>
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</table>
Table 4. BLNFEL 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Tropospheric scatter propagation

<table>
<thead>
<tr>
<th></th>
<th>BLNBBG</th>
<th>BBXBG</th>
<th>KBGWN</th>
<th>RWNSBN</th>
<th>SBNFEL</th>
<th>Unident. link</th>
<th>BBGFEL</th>
<th>BLNFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>1252750</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1252750</td>
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<td></td>
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</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.1025</td>
<td>0.1018</td>
<td>0.0994</td>
<td>0.1002</td>
<td>0.1000</td>
<td>0.1002</td>
<td>0.0996</td>
<td>0.0997</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.006036</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.006036</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (TRAMCON estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>880</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of frame loss occurrences (without unavailability time)</td>
<td>861</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>861</td>
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<td>BLNBBG</td>
<td>BBGKBB</td>
<td>KBGRWW</td>
<td>RWSBN</td>
<td>SBMFL</td>
<td>Unident. Link</td>
<td>BBGFEL</td>
<td>BLNFBEL</td>
<td></td>
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<tr>
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<td>--------</td>
<td>-------</td>
<td>-------</td>
<td>---------------</td>
<td>--------</td>
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<td>2</td>
<td>5</td>
<td>0</td>
<td>1669</td>
<td>1669</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1662</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>1669</td>
<td>1669</td>
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</tr>
<tr>
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<td>0</td>
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<td>1</td>
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</tr>
<tr>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>0.1025</td>
<td>0.1018</td>
<td>0.0994</td>
<td>0.1002</td>
<td>0.1000</td>
<td>0.1002</td>
<td>0.0995</td>
<td>0.0997</td>
<td></td>
</tr>
<tr>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
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<td>0.000000</td>
<td></td>
</tr>
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<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. BLNFBEL 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Power fading
Table 6. LOffEL 64 kb/s Channel Statistics  
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0  
Number of hours of valid data: 7866.00  
from all causes

<table>
<thead>
<tr>
<th></th>
<th>LDFKBG</th>
<th>KBGRUN</th>
<th>RNNSBN</th>
<th>SBNFEL</th>
<th>Unident. Link</th>
<th>LDFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>9743</td>
<td>3741</td>
<td>1701</td>
<td>12334</td>
<td>97973</td>
<td>121255</td>
</tr>
<tr>
<td></td>
<td>3506</td>
<td>367</td>
<td>686</td>
<td>4971</td>
<td>72332</td>
<td>81412</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>39</td>
<td>2838</td>
<td>1387</td>
<td>4210</td>
<td>0</td>
<td>4237</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>66</td>
<td>372</td>
<td>423</td>
<td>0</td>
<td>450</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.3590</td>
<td>0.3583</td>
<td>0.4574</td>
<td>0.7412</td>
<td>0.4721</td>
<td>0.5111</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000220</td>
<td>0.000119</td>
<td>0.000036</td>
<td>0.000260</td>
<td>0.000905</td>
<td>0.001407</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (TRAMCON estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000021</td>
<td>0.000046</td>
<td>0.000000</td>
<td>0.000067</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (Rec. G.821)</td>
<td>0.002110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of severely errored seconds (Rec. G.821)</td>
<td>30543</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degraded minutes (Rec. G.821)</td>
<td>13511</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errored seconds (Rec. G.821)</td>
<td>64845</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6feb1990
Table 7. LDFFEL 64 kb/s Channel Statistics
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Equipment

<table>
<thead>
<tr>
<th>Link</th>
<th>LDFKBG</th>
<th>KBGRWN</th>
<th>RWNDBN</th>
<th>SBNEF</th>
<th>Unident.</th>
<th>LDFFEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>9001</td>
<td>3556</td>
<td>1217</td>
<td>8348</td>
<td>0</td>
<td>18161</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>2764</td>
<td>182</td>
<td>330</td>
<td>1862</td>
<td>0</td>
<td>4836</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>33</td>
<td>2824</td>
<td>1126</td>
<td>3939</td>
<td>0</td>
<td>3961</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>33</td>
<td>52</td>
<td>239</td>
<td>280</td>
<td>0</td>
<td>302</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.3537</td>
<td>0.3576</td>
<td>0.4573</td>
<td>0.6878</td>
<td>0.4721</td>
<td>0.4908</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000220</td>
<td>0.000119</td>
<td>0.000031</td>
<td>0.000229</td>
<td>0.000000</td>
<td>0.000471</td>
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<tr>
<td>Fraction of period that link is unavailable (TRANCON estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>LDFK8G</td>
<td>KBGRW6</td>
<td>RWSBN</td>
<td>SBNFEL</td>
<td>Unident. Link</td>
<td>LDFFEL</td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td>---------------</td>
<td>--------</td>
</tr>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>123</td>
<td>95</td>
<td>102</td>
<td>2202</td>
<td>0</td>
<td>2432</td>
</tr>
<tr>
<td>No. of errored seconds, ES (without unavailability time)</td>
<td>123</td>
<td>95</td>
<td>102</td>
<td>2202</td>
<td>0</td>
<td>2432</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>1</td>
<td>10</td>
<td>83</td>
<td>86</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (without unavailability time)</td>
<td>1</td>
<td>10</td>
<td>83</td>
<td>86</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.5318</td>
<td>0.3581</td>
<td>0.4595</td>
<td>0.5745</td>
<td>0.4721</td>
<td>0.4795</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (TRAMCOM estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. of frame loss occurrences (without unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>LDFXBG</td>
<td>KBGWN</td>
<td>RNWSBN</td>
<td>SBNFEL</td>
<td>Unident. Link</td>
<td>LDFEL</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td>--------</td>
<td>--------------</td>
<td>-------</td>
</tr>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>8</td>
<td>22</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>No. of errored seconds, ES (without unavailability time)</td>
<td>8</td>
<td>22</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (with unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. of ES assigned to 2 links (without unavailability time)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.4352</td>
<td>0.3568</td>
<td>0.4589</td>
<td>0.5139</td>
<td>0.4721</td>
<td>0.4772</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (TRAMCOM estimation)</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. of frame loss occurrences (without unavailability time)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Power fading
Table 10. Errored Second Statistics for the SBNFEL 56 kb/s Channels
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
From all causes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Receiver On Line</th>
<th>Receiver A</th>
<th>Receiver B</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES</td>
<td>2347</td>
<td>11813</td>
<td>9829</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>1559</td>
<td>9989</td>
<td>8117</td>
</tr>
<tr>
<td>Total number of error events</td>
<td>601</td>
<td>2101</td>
<td>1747</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>596</td>
<td>2089</td>
<td>1734</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in</td>
<td>0.8582</td>
<td>0.8920</td>
<td>0.8829</td>
</tr>
<tr>
<td>consecutive 15-minute intervals</td>
<td>(without unavailability time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of seconds that RSL is less than BER threshold</td>
<td>748</td>
<td>5084</td>
<td>6151</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000028</td>
<td>0.000064</td>
<td>0.000060</td>
</tr>
<tr>
<td>No. of frame loss occurrences</td>
<td>64</td>
<td>623</td>
<td>548</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>64</td>
<td>616</td>
<td>540</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (Rec. G.821)</td>
<td>0.000022</td>
<td>0.000168</td>
<td>0.000130</td>
</tr>
<tr>
<td>No. of severely errored seconds (Rec. G.821)</td>
<td>696</td>
<td>3432</td>
<td>2852</td>
</tr>
<tr>
<td>Degraded minutes (Rec. G.821)</td>
<td>192</td>
<td>789</td>
<td>641</td>
</tr>
<tr>
<td>Errored seconds (Rec. G.821)</td>
<td>1746</td>
<td>7146</td>
<td>6227</td>
</tr>
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</table>
Table 11. Errored Second Statistics for the SBNFEL 56 kb/s Channels
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Equipment

<table>
<thead>
<tr>
<th>Variable</th>
<th>Receiver</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Line</td>
<td>A Receiver</td>
<td>B Receiver</td>
<td></td>
</tr>
<tr>
<td>No. of errored seconds, ES (with unavailability time)</td>
<td>953</td>
<td>1492</td>
<td>1228</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>165</td>
<td>170</td>
<td>138</td>
</tr>
<tr>
<td>Total number of error events (with unavailability time)</td>
<td>108</td>
<td>103</td>
<td>91</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>103</td>
<td>97</td>
<td>85</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in consecutive 15-minute intervals (without unavailability time)</td>
<td>0.8597</td>
<td>0.8923</td>
<td>0.8830</td>
</tr>
<tr>
<td>No. of seconds that RSL is less than BER threshold</td>
<td>0</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000028</td>
<td>0.000047</td>
<td>0.000038</td>
</tr>
<tr>
<td>No. of frame loss occurrences (with unavailability time)</td>
<td>4</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 12. Errored Second Statistics for the SBNFEL 56 kb/s Channels
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Multipath

<table>
<thead>
<tr>
<th>Variable</th>
<th>Receiver A</th>
<th>Receiver B</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES</td>
<td>1180</td>
<td>8409</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>1180</td>
<td>7787</td>
</tr>
<tr>
<td>Total number of error events</td>
<td>360</td>
<td>1531</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>360</td>
<td>1544</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>consecutive 15-minute intervals</td>
<td>0.8653</td>
<td>0.8836</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>0.8923</td>
<td></td>
</tr>
<tr>
<td>No. of seconds that RSL is less than BER threshold</td>
<td>748</td>
<td>6120</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td>0.000000</td>
<td>0.000022</td>
</tr>
<tr>
<td>No. of frame loss occurrences</td>
<td>59</td>
<td>539</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td>59</td>
<td>532</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td>614</td>
<td>608</td>
</tr>
</tbody>
</table>
Table 13. Errored Second Statistics for the SBNFEL 56 kb/s Channels
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of valid data: 7866.00
Errors cause: Power fading

<table>
<thead>
<tr>
<th>Variable</th>
<th>Receiver</th>
<th>A Receiver</th>
<th>B Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of errored seconds, ES</td>
<td>On Line</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total number of error events</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Correlation coefficients for fraction of ES &amp; average BER in</td>
<td></td>
<td>0.7905</td>
<td>0.6151</td>
</tr>
<tr>
<td>consecutive 15-minute intervals</td>
<td></td>
<td></td>
<td>0.8873</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td></td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of seconds that RSL is less than BER threshold</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fraction of period that link is unavailable (by MIL-STD-188-323)</td>
<td></td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>No. of frame loss occurrences</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(with unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(without unavailability time)</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 14. Multipath fading Period Statistics for the SBNFEL Link
Measurement Period: April 1, 1988 0:0:0 to April 1, 1989 0:0:0
Number of hours of multipath fading valid data: 4.86

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unavailable fraction (MIL-STD-188-323) of the multipath fading period</td>
<td>0.0000000</td>
</tr>
<tr>
<td>Number of seconds that RSL is below BER threshold for the A receiver</td>
<td>5340</td>
</tr>
<tr>
<td>Number of seconds that RSL is below BER threshold for the B receiver</td>
<td>6671</td>
</tr>
<tr>
<td>Number of seconds that both receivers are simultaneously below BER threshold</td>
<td>1323</td>
</tr>
<tr>
<td>Composite fade margin for A receiver at BER = 0.0000156</td>
<td>67.310</td>
</tr>
<tr>
<td>Composite fade margin for B receiver at BER = 0.0000156</td>
<td>69.118</td>
</tr>
<tr>
<td>Dispersive fade margin for A receiver at BER = 0.0000156</td>
<td>71.901</td>
</tr>
<tr>
<td>Dispersive fade margin for B receiver at BER = 0.0000156</td>
<td>87.608</td>
</tr>
<tr>
<td>Fraction of errored seconds that has a notch in the bandwidth for the A receiver</td>
<td>0.0534572</td>
</tr>
<tr>
<td>Fraction of errored seconds that has a notch in the bandwidth for the B receiver</td>
<td>0.0605304</td>
</tr>
<tr>
<td>No. of errored seconds there would be if the receivers were switched based on the smallest BER</td>
<td>1569</td>
</tr>
<tr>
<td>No. of errored seconds there are using the current diversity switching system</td>
<td>1813</td>
</tr>
<tr>
<td>No. of errored seconds there would be if the receivers were switched based on largest fade depth</td>
<td>1951</td>
</tr>
<tr>
<td>No. of errored seconds there would be if the receivers were switched based on the smallest slope distortion measured using the IF band filters</td>
<td>8199</td>
</tr>
<tr>
<td>No. of errored seconds there would be if the receivers were switched based on largest SIN voltage</td>
<td>2745</td>
</tr>
</tbody>
</table>
Variations from all causes
Variations caused by equipment
Variations caused by troposcatter

Figure 1. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00 to 4/1/89 00:00
- Sample size of 868090, 12181, 855897
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.993667
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
Figure 2. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 26243, 2343, 10302
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999564
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 3. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 307, 149, 76
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999755
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 4. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 956, 879, 10
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999884
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
Figure 5. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 18718, 18291, 189
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999073
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg

Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 7. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1861, 1351, 82
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999780
- The 64 kb/s channel from Linderhohe to Feldberg
- Link from Linderhohe to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 8. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 269, 116, 70
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999881
- The 64 kb/s channel from Linderhofs to Feldberg
- Link from Koeterberg to Rothwesten

Fraction of Samples That Had Values Less Than the Ordinate
Figure 9. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 325, 198, 43
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999964
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Rothwesten to Schwarzenborn
Figure 10. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1589, 626, 639
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999740
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Schwarzenborn to Feldberg
Figure 11. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 57142, 2145, 813
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.998593
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Feldberg (tandem links)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 12. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 587, 100, 349
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999972
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 13. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 2078, 90, 1781
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999936
- The 56 kb/s, receiver A channel
- Link from Schwarzenborn to Feldberg

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Figure 14. Distribution of consecutive errored-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1724. 83, 1531
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999940
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by troposcatter

Figure 15. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 868740, 12196, 856532
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.993667
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 16. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 26291, 2373, 10326
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999564
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 17. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 311,150.76
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999755
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten
Figure 18. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 961,880,12
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999884
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
Figure 19. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 18747, 18309, 196
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999073
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg

Fraction of Samples That Had Values Less Than the Ordinate
Variations from all causes  
Variations caused by equipment  
Variations caused by multipath  
Variations caused by troposcatter

Figure 20. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1486386, 33738, 10618, 856532
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.988000
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Feldberg (tandem links)
Figure 21. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1871, 1361, 82
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999780
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 22. Distribution of consecutive error-free-second occurrences for:
• Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
• Sample size of 271, 117, 70
• Does not include MIL-STD-188-323 unavailability time
• Availability for this test period was 0.99988
• The 64 kb/s channel from Linderhofe to Feldberg
• Link from Koeterberg to Rothwesten
Figure 23. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 327, 198, 43
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999964
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Rothwesten to Schwarzenborn
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 24. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1604, 637, 639
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999740
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Schwarzenborn to Feldberg

Fraction of Samples That Had Values Less Than the Ordinate

Contiguous Error-Free-Second Gap Length (seconds)
Figure 25. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 57208, 2167, 813
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.9988593
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Feldberg (tandem links)
Figure 26. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 589, 101, 349
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999972
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 27. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 2084, 93, 1783
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999936
- The 56 kb/s, receiver A channel
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 28. Distribution of consecutive error-free-second occurrences for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1728, 84, 1532
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999940
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
Figure 29. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.993667
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 30. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999564
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg

Fraction of Samples That Had Values Less Than the Ordinate

10^(-1) 10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9}

0.0001 0.001 0.01 0.1 0.5 0.9 0.99 0.999 0.9999
Figure 31. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999755
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 32. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999984
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 33. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999073
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath
Variations caused by troposcatter

Figure 34. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.988000
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Feldberg (tandem links)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 35. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999780
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Koeterberg

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Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 36. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999881
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Koeterberg to Rothwesten
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 37. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999964
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Rothwesten to Schwarzenborn
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 38. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999740
- The 64 kb/s channel from Linderhof to Feldberg
- Link from Schwarzenborn to Feldberg

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Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 39. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Includes periods between error events containing unavailability
- Distribution of estimated mission bit stream error ratio for:
  - The 64 kb/s channel from Linderhofe to Feldberg
  - Link from Linderhofe to Feldberg (tandem links)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 40. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999972
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg

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Figure 41. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999936
- The 56 kb/s, receiver A channel
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 42. Distribution of consecutive fixed 15-minute interval average BER for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Total number of 15 minute blocks: 31464
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999940
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
Figure 43. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:

- Test period from 4/1/89 00:00:00 to 10/1/89 00:00:00
- Sample size of 36289
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.991349
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
- All causes
Figure 44. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36709
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999353
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg
- All causes
Figure 45. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36723
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999838
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten
- All causes

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Figure 45. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36732
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999809
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
- All causes
Figure 47. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 37193
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999194
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg
- All causes
Figure 48. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 45509
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.986370
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Feldberg (tandem links)
- All causes
Figure 49. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 930
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999601
- The 64 kb/s channel from Linderhohe to Feldberg
- Link from Linderhohe to Koeterberg
- All causes
Figure 50. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 1125
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.9999921
- The 64 kb/s channel from Linderhofer to Feldberg
- Link from Koeterberg to Rothwesten
- All causes
Figure 51. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00 to 10/1/89 00:00
- Sample size of 1444
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999724
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Rothwesten to Schwarzenborn
- All causes
Least squares regression

Fraction of Errored Seconds In a 15-Minute Period

Average Bit Error Ratio For a 15-Minute Period

Figure 52. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 2195
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999605
- The 64 kb/s channel from Linderhoft to Feldberg
- Link from Schwarzenborn to Feldberg
- All causes

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Figure 53. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 13859
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.998568
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Feldberg (tandem links)
- All causes
Figure 54. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00 to 10/1/89 00:00:00
- Sample size of 287
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.991349
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg
- All causes
Figure 55. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:

- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 827
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999353
- The 56 kb/s, receiver A channel
- Link from Schwarzenborn to Feldberg
- All causes
Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 618
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999838
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
- All causes
Figure 57. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 366668
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999353
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg
- Variations caused by multipath
Least squares regression

Figure 58. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36714
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.9999838
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten
- Variations caused by multipath
Figure 59. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36727
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999809
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
- Variations caused by multipath
Figure 50. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36742
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999194
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg
- Variations caused by multipath
Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:

- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 45509
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.986370
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Feldberg (tandem links)
- Variations caused by multipath

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Figure 62. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 284
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999601
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Koeterberg
- Variations caused by multipath

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Least squares regression

Fraction of Erroned Seconds In a 15-Minute Period

Figure 63. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 1045
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999921
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Koeterberg to Rothwesten
- Variations caused by multipath
Fraction of Errored Seconds In a 15-Minute Period

Least squares regression

Figure 64. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 1236
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999724
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Rothwesten to Schwarzenborn
- Variations caused by multipath
Figure 65. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 1934
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999605
- The 64 kb/s channel from Linderhoft to Feldberg
- Link from Schwarzenborn to Feldberg
- Variations caused by multipath
Figure 66. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 13859
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.998568
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Feldberg (tandem links)
- Variations caused by multipath
Figure 67. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 230
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.998361
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg
- Variations caused by multipath
Figure 68. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 764
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.986370
- The 56 kb/s, receiver A channel
- Link from Schwarzenborn to Feldberg
- Variations caused by multipath
Figure 69. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 564
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999601
- The 56 kb/s, receiver 8 channel
- Link from Schwarzenborn to Feldberg
- Variations caused by multipath
Figure 70. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 36072
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.991349
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
- Variations caused by troposcatter
Figure 71. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 287
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999809
- The 56 kb/s. receiver-on-line channel
- Link from Schwarzenborn to Feldberg
- Variations caused by equipment
Least squares regression

Figure 72. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:
- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 827
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999194
- The 56 kb/s receiver A channel
- Link from Schwarzenborn to Feldberg
- Variations caused by equipment

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Figure 73. Correlation between fraction of errored seconds and average BER in consecutive fixed 15-minute intervals for:

- Test period from 4/1/88 00:00:00 to 10/1/89 00:00:00
- Sample size of 618
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.996660
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
- Variations caused by equipment
Figure 74. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1101551, 19737, 1081814
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.993667
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Bocksberg (tropospheric scatter)
Figure 75. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 42310, 3170, 17439
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999564
- The 64 kb/s channel from Berlin to Feldberg
- Link from Bocksberg to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 76. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 622, 320, 112
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999755
- The 64 kb/s channel from Berlin to Feldberg
- Link from Koeterberg to Rothwesten

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Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 77. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1269, 1146, 21
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999884
- The 64 kb/s channel from Berlin to Feldberg
- Link from Rothwesten to Schwarzenborn
Figure 78. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 23662, 22558, 544
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999073
- The 64 kb/s channel from Berlin to Feldberg
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath
Variations caused by troposscatter

Figure 79. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1935530, 46590, 18100, 1081814
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.988000
- The 64 kb/s channel from Berlin to Feldberg
- Link from Berlin to Feldberg (tandem links)
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 80. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 3506, 2764, 123
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999780
- The 64 kb/s channel from Linderhohe to Feldberg
- Link from Linderhohe to Koeterberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Fraction of Samples That Had Values Less Than the Ordinate

Figure 81. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 367,182
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999881
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Koeterberg to Rothwesten
Figure 82. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 686, 330, 102
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999964
- The 64 kb/s channel from Linderhohe to Feldberg
- Link from Rothwesten to Schwarzenborn
Figure 83. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 4971, 1862, 2202
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999740
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Schwarzenborn to Feldberg
Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 84. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 81412, 4836, 2432
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.998593
- The 64 kb/s channel from Linderhofe to Feldberg
- Link from Linderhofe to Feldberg (tandem links)

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Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 85. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 1559, 165, 1180
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999972
- The 56 kb/s, receiver-on-line channel
- Link from Schwarzenborn to Feldberg

Fraction of Samples That Had Values Less Than the Ordinate
Variations from all causes  
Variations caused by equipment  
Variations caused by multipath

10000  
0  
C  
Ul

0  
(j)

1000  
(j)  
L  
L

L  
W  
C  
Ul

Figure 86.  Distribution of errors occurring in errored seconds for:  
• Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00  
• Sample size of 9989, 170, 9506  
• Does not include MIL-STD-188-323 unavailability time  
• Availability for this test period was 0.999936  
• The 56 kb/s, receiver A channel  
• Link from Schwarzenborn to Feldberg

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Variations from all causes
Variations caused by equipment
Variations caused by multipath

Figure 87. Distribution of errors occurring in errored seconds for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 8117, 138, 7787
- Does not include MIL-STD-188-323 unavailability time
- Availability for this test period was 0.999940
- The 56 kb/s, receiver B channel
- Link from Schwarzenborn to Feldberg
Figure 88. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 241974, 241974
- The data from TRAMCON
- Link from Berlin to Bocksberg (tropospheric scatter)
- All Tramcon samples
Figure 89. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 238792
- The data from TRAMCON
- Link from Bocksberg to Koeterberg
- All Tramcon samples
Figure 90. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 245613, 245613
- The data from TRAMCON
- Link from Koeterberg to Rothwesten
- All Tramcon samples
Figure 91. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 243336
- The data from TRAMCON
- Link from Rothwesten to Schwarzenborn
- All Tramcon samples
Figure 92. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 243787, 243787
- The data from TRAMCON
- Link from Schwarzenborn to Feldberg
- All Tramcon samples
Figure 93. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Sample size of 239962, 239962
- The data from TRAMCON
- Link from Linderhofe to Koeterberg
- All Tramcon samples
Figure 94. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 5900, 50040, 42045
- Data measured at 5 samples per second
- Link from Schwarzenborn to Feldberg
Figure 95. Distribution of received signal level for:
• Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
• Periods of multipath fading
• Sample size of 87470, 87470, 87470
• Data measured at 5 samples per second
• Link from Schwarzenborn to Feldberg
Figure 96. Distribution of received signal level for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- All of valid test period
- Sample size of 3941820, 141588000, 141588000
- Data measured at 5 samples per second
- Link from Schwarzenborn to Feldberg
Figure 97. Distribution of measured IF amplitude distortion for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 5900, 5900, 5900
- Link from Schwarzenborn to Feldberg
- Receiver on line
Figure 98. Distribution of measured IF amplitude distortion for:

- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 50040, 50040, 50040
- Link from Schwarzenborn to Feldberg
- A Receiver
Figure 99. Distribution of measured IF amplitude distortion for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 42045, 42045, 42045
- Link from Schwarzenborn to Feldberg
- B Receiver
Measurement with two filters (8 MHz spacing)
Measurement with spectrum analyzer (3 dB points)
Measurement with spectrum analyzer (maximum slope)

Figure 100. Distribution of measured IF amplitude distortion for:
• Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
• Periods of multipath fading
• Sample size of 87470, 87470, 87470
• Link from Schwarzenborn to Feldberg
• Receiver on line
Measurement with two filters (8 MHz spacing)
Measurement with spectrum analyzer (3 dB points)
Measurement with spectrum analyzer (maximum slope)

Figure 101. Distribution of measured IF amplitude distortion for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 87470, 87470, 87470
- Link from Schwarzenborn to Feldberg
- A Receiver
Figure 102. Distribution of measured IF amplitude distortion for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 87470, 87470, 87470
- Link from Schwarzenborn to Feldberg
- B Receiver
Figure 103. Distribution of measured IF amplitude distortion (3 dB points) for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- All of valid test period
- Sample size of 3941820, 3941820, 3941820
- Link from Schwarzenborn to Feldberg

Fraction of Samples That Had Values Less Than the Ordinate
Figure 104. Distribution of signal-quality-monitor levels for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 5900, 50040, 42045
- Link from Schwarzenborn to Feldberg
Figure 105. Distribution of signal-quality-monitor levels for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 87470, 87470, 87470
- Link from Schwarzenborn to Feldberg
Figure 106. Distribution of signal-quality-monitor levels for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- All of valid test period
- Sample size of 3941820, 3941820, 3941820
- Link from Schwarzenborn to Feldberg
Maximum space diversity improvement (A Recv.)
Maximum space diversity improvement (B Recv.)
Current system space diversity improvement (A Recv.)
Current system space diversity improvement (B Recv.)

Figure 107. Current system space-diversity improvement for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Maximum space diversity improvement (A Recv.)
Maximum space diversity improvement (B Recv.)
Based on slope across IF band using filters (A Recv.)
Based on slope across IF band using filters (B Recv.)

Figure 108. Hypothetical space-diversity improvement for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Figure 109. Hypothetical space-diversity improvement for:

- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Figure 110. Hypothetical space-diversity improvement for:

- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Figure 111. Hypothetical space-diversity improvement for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Maximum space diversity improvement (A Recv.)
Maximum space diversity improvement (B Recv.)
Based on fade depth (A Recv.)
Based on fade depth (B Recv.)

Figure 112. Hypothetical space-diversity improvement for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 69652, 69652, 69652, 69652
- Link from Schwarzenborn to Feldberg
Figure 113. Distribution of the path delay for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 8223, 6203, 1502, 763
- Link from Schwarzenborn to Feldberg
- Second delay signal data consists of distinct multipath only
Figure 114. Distribution rate of change of path delay for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 7517, 5694
- Link from Schwarzenborn to Feldberg
Fraction of Samples That Had Values Less Than the Ordinate

Figure 115. Distribution of delayed signal phase values for:
- Test period from 4/1/88 00:00:00 to 4/1/99 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 7999, 6071
- Link from Schwarzenborn to Feldberg
Figure 116. Distribution of rate of change of delayed signal phase for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 7328, 5895
- Link from Schwarzenborn to Feldberg
Figure 117. Distribution of the ratio of delayed signal amplitude to direct signal amplitude for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 8045, 6214, 1502, 763
- Link from Schwarzenborn to Feldberg
- Second delay signal data consists of distinct multipath only

Fraction of Samples That Had Values Less Than the Ordinate
Figure 118. Distribution of the rate of change of the ratio of delayed signal to direct signal amplitude for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 7517, 5694
- Link from Schwarzenborn to Feldberg
Figure 119. Distribution of the path delay for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 14235, 13596, 2452, 1812
- Link from Schwarzenborn to Feldberg
- Second delay signal data consists of distinct multipath only
Probe channel A
Probe channel B

Figure 120. Distribution rate of change of path delay for:
• Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
• Periods of multipath fading
• Sample size of 13039, 12381
• Link from Schwarzenborn to Feldberg
Figure 121. Distribution of delayed signal phase values for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 13972, 13338
- Link from Schwarzenborn to Feldberg
Figure 122. Distribution of rate of change of delayed signal phase for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 12806, 12260
- Link from Schwarzenborn to Feldberg

Fraction of Samples That Had Values Less Than the Ordinate
Figure 123. Distribution of the ratio of delayed signal amplitude to direct signal amplitude for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Periods of multipath fading
- Sample size of 13849, 13320, 2452, 1812
- Link from Schwarzenborn to Feldberg
- Second delay signal data consists of distinct multipath only
Figure 124. Distribution of the rate of change of the ratio of delayed signal to direct signal amplitude for:
- Test period from 4/1/88 00:00:00 to 4/1/89 00:00:00
- Errored seconds of multipath fading periods
- Sample size of 13039, 12381
- Link from Schwarzenborn to Feldberg
This report describes the results of an 18-month digital microwave radio performance and propagation measurement project that was conducted on a portion of the Defense Communications System in Germany. More than 6 gigabytes of data were collected between April 1988 and October 1989.

The collected data include end-to-end (user-to-user) performance data, radio performance and propagation data on one line-of-sight and one troposcatter link, and meteorological data. The end-to-end measurements are referred to as the Network Performance Characterization (NPC) data, and consist of error performance measurements on two separate 64 kb/s channels consisting of tandem terrestrial microwave links. The radio performance and propagation measurements are referred to as the Link Performance Characterization (LPC) data. These data consist of digital radio performance and propagation measurements made on a long (99-km) line-of-sight microwave link. The propagation measurements on this link include
multipath delay spread, in-band power difference (IBPD), and receive signal level (rsl) measurements.

The report provides summaries of the long-term statistics of both radio performance and propagation data. The performance data are compared with both CCITT and Military Standard (MIL-STD) performance criteria. The propagation data are used in the assessment of the causes of digital radio outages. The propagation data are also useful for a variety of modeling purposes. These applications of the propagation data are described in the report.