

RECOMMENDATION ITU-R F.1566-1

Performance limits for maintenance of digital fixed wireless systems operating in plesiochronous and synchronous digital hierarchy-based international paths and sections

(Question ITU-R 161/9)

(2002-2007)

Scope

This Recommendation provides performance limits for international plesiochronous digital hierarchy (PDH) and synchronous digital hierarchy (SDH) paths and sections implemented using fixed wireless systems (FWSs). The approach is aligned with the maintenance approach taken by ITU-T, but some media-specific aspects for digital fixed wireless systems are incorporated. The Annex details the application of the performance limits for bringing into service (BIS).

The ITU Radiocommunication Assembly,

considering

- a) that digital fixed wireless systems (FWSs) for use in constant bit-rate digital paths at or above the primary rate in the international portion of a 27 500 km hypothetical reference path (HRP) are being designed, operated and maintained;
- b) that performance objectives for planning of FWSs are specified in practice for real digital paths;
- c) that there is a need to specify maintenance performance limits for digital FWSs;
- d) that ITU-T has prepared performance limits for maintenance and bringing into service (BIS) of international multi-operator plesiochronous digital hierarchy (PDH) paths and connections in ITU-T Recommendation M.2100 and for international multi-operator synchronous digital hierarchy (SDH) paths and international SDH multiplex sections in ITU-T Recommendation M.2101, being based on ITU-T Recommendations G.826 and G.828, respectively;
- e) that ITU-T Recommendation M.2120 provides procedures for fault detection and localization, with and without in-service monitoring, for international multi-operator digital paths, sections and transmission systems;
- f) that ITU-R has prepared Recommendation ITU-R F.1668 for the error performance objectives for real FWS links used in 27 500 km hypothetical reference paths and connections;
- g) that the influence of propagation conditions on the fault detection and localization procedures for determining maintenance intervention for digital FWSs is currently under study in ITU-R;
- h) that performance limits for maintenance and procedures for their measurement for PDH and SDH digital FWSs transporting PDH and/or SDH signals should be defined;
- j) that in defining the performance limits for maintenance of PDH and SDH digital FWSs and for the purposes of identifying possible maintenance interventions, levels of performance limits should be considered. ITU-T Recommendations M.2100 and M.2101 identify and define levels of performance limits as degraded performance, unacceptable performance, and in addition, performance after intervention (repair);

k) that the performance limits for maintenance may be different from the BIS limits, as defined in Recommendation ITU-R F.1330;

l) that due consideration should be taken of periods of severe fading when undertaking measurements that relate to performance limits for maintenance,

recognizing

a) that for the purpose of allocating the performance objectives for the international portion of a constant bit-rate path at or above the primary rate, an international digital path has been partitioned in geographical terms; these portions have been titled path core elements (PCEs). Two types of international PCE are used:

- an international PCE (IPCE) between an international gateway and a frontier station in a terminating country, or between frontier stations in a transit country¹;
- an inter-country PCE (ICPCE) between the adjacent frontier stations of the two countries involved. The ICPCE corresponds to the highest order digital path carried on a digital transmission system linking the two countries;

recommends

1 that the limits for maintenance should be based on end-to-end reference performance objectives (RPOs), applicable to each direction of any real digital FWS link of length d , and derived by using the values in Tables 1a and 1b as well as allocations shown in Table 2;

TABLE 1a (see Note 1)

RPO for end-to-end international digital paths

PDH	Primary (see Note 3)	Secondary	Tertiary	Quaternary	
SDH (Mbit/s)	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3 500
Parameter	End-to-end RPO				
ESR for paths designed according to G.826	0.02	0.025	0.0375	0.08	N/A
ESR for paths designed according to G.828	0.005	0.005	0.01	0.02	N/A
BBER for SDH paths designed according to G.828	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	5×10^{-5}	5×10^{-5}
SESR	0.001	0.001	0.001	0.001	0.001

ESR: errored second ratio

N/A: not applicable

BBER: background block error ratio

SESR: severely errored second ratio.

¹ The definition of an international gateway and a frontier station can be found in ITU-T Recommendation M.2101.

TABLE 1b (see Note 1)

RPO for end-to-end international SDH multiplex sections

Rate	STM-0	STM-1	STM-4
Blocks	64 000	192 000	768 000
ESR (according to G.826)	0.0375	0.08	N/A
ESR (according to G.828)	0.01	0.02	N/A
SESR	0.001	0.001	0.001
BBER (according to G.826)	N/A	N/A	N/A
BBER (according to G.828)	2.5×10^{-5}	5×10^{-5}	5×10^{-5}

TABLE 2

Allocation (a_n)

PCE classification (km)	Allocation (% of end-to-end RPO)
IPCE	
Terminating/transit national network:	
$d \leq 100$	1.2
$100 < d \leq 200$	1.4
$200 < d \leq 300$	1.6
$300 < d \leq 400$	1.8
$400 < d \leq 500$	2
$500 < d \leq 1000$	3
$1000 < d \leq 2500$	4
$2500 < d \leq 5000$	6
$5000 < d \leq 7500$	8
$d > 7500$	10
ICPCE⁽¹⁾	
$d < 300$	0.3
International multiplex section	0.2

⁽¹⁾ ICPCE allocations must be met regardless of how many multiplex sections comprise the ICPCE.

2 that the allocated performance objective (APO) and the relevant maintenance performance limit (MPL) for the maintenance of a path or multiplex section should be calculated as follows:

for a path:

$$APO_{es} = A\% \times RPO_{es} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{ses} = A\% \times RPO_{ses} \times TP \div 100 \text{ (convert } A\% \text{ to ratio)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 2\,000 \div 100 \text{ (convert } A\% \text{ to ratio – VC-1 and 2)}$$

$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 8\,000 \div 100$ (convert A% to ratio – VC-3 and 4 and VC-4-Xc)
for a multiplex section:

$$APO_{es} = A\% \times RPO_{es} \times TP \div 100 \text{ (convert A\% to ratio)}$$

$$APO_{ses} = A\% \times RPO_{ses} \times TP \div 100 \text{ (convert A\% to ratio)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 64\,000 \div 100 \text{ (convert A\% to ratio – STM-0)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 192\,000 \div 100 \text{ (convert A\% to ratio – STM-1)}$$

$$APO_{bbe} = A\% \times RPO_{bbe} \times TP \times 768\,000 \div 100 \text{ (convert A\% to ratio – STM-4)}$$

where:

$$A\% = \sum_{1}^{N} a_n\% \text{ for a path,}$$

i.e. $A\% = a_1\% + a_2\% + \dots + a_N\%$

a_n : allocation for each IPCE and ICPCE forming the path

$A\% = a\%$ for a multiplex section,

TP : test period (s)

– $MPL = APO \times PLF$

where:

PLF : performance level factor;

3 that for the definition of the various MPLs, the following PLFs should be specified (see Table 3):

TABLE 3
PLF and limits*

SDH multiplex sections PDH transmission systems		SDH paths PDH paths and sections	
Limit (relative to APO)	Performance level range	Limit (relative to APO)	Performance level range
Performance after repair: ESR and BBER = 0.1 SESR = 0.5	Acceptable (< 0.5 APO)	Performance after repair = 0.5	Acceptable (< 0.75 APO)
Performance objective = 1	Degraded (> 0.5 to < 10 APO)	Performance objective = 1	Degraded (> 0.75 to < 10 APO)
	Unacceptable (> 10 APO)		Unacceptable (> 10 APO)

* For adverse propagation conditions limits could be doubled.

4 that TPs for the performance monitoring of digital FWSs have been designed as follows:

– that for the detection of degraded performance, a shorter-term maintenance test period (TPDP) duration of 24 h should be used, but for adverse propagation conditions a longer-term test period duration of seven days is recommended;

- that for the detection of unacceptable performance in normal propagation conditions, a short-term maintenance test period (TPUP) duration of 15 min may be used;
- that for returning radio paths and sections into service after a maintenance intervention event, a longer-term return after maintenance intervention test period (TPMI) duration of seven days is recommended but in normal propagation conditions a shorter-term test period duration of 24 h may be used.

At present, the test period duration for each of the maintenance performance limits is provisional;

5 that Annex 1 contains guidance and further details on the performance limits, monitoring durations, test procedures and methodology for calculation of the MPLs.

NOTE 1 – It is the responsibility of each country to design its network in a way that is consistent with its country allocation for the international path.

NOTE 2 – The lengths d referred to in Table 2 are actual route lengths or air-route distances multiplied by an appropriate routing factor (Rf), whichever is less; for multiplex sections the length d refers to the actual distance only (see ITU-T Recommendation M.2100).

TABLE 4
PCE great circle length vs. routing factor

PCE great circle length	Routing factor (Rf)	Calculated PCE length
$d < 1\,000$ km	1.5	$1.5 \times d$ km
$1\,000 \text{ km} \leq d < 1\,200$ km	$1\,500/d$	1 500 km
$d \geq 1\,200$ km	1.25	$1.25 \times d$ km

NOTE 3 – For international multioperator connections using equipment designed according to revised ITU-T Recommendation G.826 RPO for PDH primary rate could be used.

NOTE 4 – The periods of normal and adverse propagation conditions may change from country to country and therefore it is the responsibility of the interested parties to reach agreement.

Annex 1

MPLs and methodology for calculation

1 Maintenance testing procedure

The testing procedures for the fault detection and localization with and without in-service monitoring of PDH/SDH paths and sections, including how to deal with any period of unavailability during the test, are defined in ITU-T Recommendation M.2120 and may be used for digital FWS paths, sections and transmission systems during periods with limited fading activities. The test procedures for significant and/or severe fading activities are under study.

2 The methodology for the calculation of MPLs

The following steps shall be followed to obtain the relevant PDH/SDH path or section performance limits:

Step 1: Identify the bit rate of the path or section

Step 2: Read the RPOs for the appropriate bit rate from Tables 1a, 1b or 1c for ESR, SESR and BBER

Step 3: Identify all PCEs for the entire path or section, and set N equal to the total number of PCEs

Step 4: Identify the length, d , of each PCE $\times n$ ($n = 1$ to N). The length, d , is either the actual path length or can be estimated by the great circle length between its end points multiplied by the appropriate routing factor R_f (see Note 2 of *recommends*)

Step 5: Take the allocation, $a_n\%$ (as a percentage of end-to-end RPO) for PCE $\times n$ ($n = 1$ to N), from Table 2. Note that the allocations in Table 2 are maximum values; more stringent values can be used by bilateral or multilateral agreement

Step 6: Calculate $A\%$, the path allocation, where:

$$A\% = \sum_1^N a_n\%$$

Step 7: Determine the required TP in accordance with *recommends* 5 (15 min, 24 h or seven days). Express TP in seconds, e.g. $TP = 86400$ s for a 24 h TP and $TP = 604800$ s for a seven-day TP

Step 8: Calculate the APOs for ES, SES and BBE required from the information already obtained:

$$APO = A\% \times RPO \times TP/100$$

Step 9: Calculate the appropriate MPL for the path or section for ES and SES:

$$MPL = APO \times PLF$$

where the MPL is for either:

$$\left. \begin{array}{l} \text{Degraded performance limit, } MPL_{DP} \\ \text{Unacceptable performance limit, } MPL_{UP} \\ \text{Performance after repair limit, } MPL_{PAR} \end{array} \right\} \text{ see } \textit{recommends} \text{ 3}$$

NOTE 1 – If any PCE within a path is changed, then the entire calculation process must be repeated.

3 Performance levels and limits

ITU-T Recommendation M.20 states that an entity can be in a limited number of predefined conditions, depending upon its performance. These conditions are referred to as performance levels and are defined as the unacceptable performance level, the degraded performance level and the acceptable performance level. The boundaries between the performance levels are referred to as the performance limits. In addition to these, ITU-T Recommendation M.35 also defines a special limit referred to as the performance after repair.

Each of the performance limits is a function of the APO and these limits are shown in Table 3.

4 Performance thresholds and monitoring period durations

When a performance limit is given a specific value in terms of ES, SES and/or BBE, each ES, SES and/or BBE performance limit will require to have an associated measurement duration. The concept of performance thresholds and measurement durations is addressed in detail within ITU-T Recommendations M.2100 (PDH) and M.2101 (SDH).

ITU-T Recommendations M.2100/M.2101 state that the general strategy for the use or performance monitoring information and thresholds is described in ITU-T Recommendations M.20 and M.34. These thresholds and information will be reported to operations systems via the telecommunications management network for both real time and longer-term analysis. When thresholds of unacceptable or degraded performance levels are reached, maintenance action should be initiated independently from the performance measurement. Other thresholds may be used for maintenance and longer-term quality analysis. The operations systems will use real time processing to assign maintenance priorities to these threshold crossings and information, using the performance supervision process described in ITU-T Recommendation M.20.

For the general strategy of monitoring the MPLs of digital FWSs, three types of threshold monitoring durations are considered; T1, T2 and T3.

Threshold monitoring duration, T1

The monitoring duration T1 is fixed to a 15 min value and ES, SES and BBE are counted over this period. The T1 period is to assist in detection of transition to or from the unacceptable performance level during normal propagation conditions.

A threshold report occurs when an ES, SES or BBE threshold is exceeded. The reset threshold report, which is an optional feature, occurs when the number of ES, BBE and SES is lower than or equal to the reset threshold. Those principles are explained in ITU-T Recommendation M.2120.

Threshold monitoring duration, T2

The monitoring duration T2 is fixed to a 24 h duration and ES, SES and BBE are counted over this period.

The T2 period is to assist in the detection of the transition either to, or from, the unacceptable performance level. The threshold report occurs whenever an ES, SES and BBE threshold has been exceeded over the period of time T2.

The T2 period is also to be used when returning paths or sections into service following a maintenance intervention event during normal propagation conditions. The T2 period should be regarded as an initial test period to confirm that the path or section meets the performance limit (MPL_{PAR}) for returning paths/sections to service after repair. Following a successful monitoring period of T2 duration, the path or section should continue to be monitored for a least seven days (T3 period) to confirm that the maintenance intervention is successful (see ITU-T Recommendation M.2120, § 5).

Threshold monitoring duration, T3

The monitoring duration T3 is fixed to a seven-day duration and ES, BBE and SES are counted over this period. The T3 period is to assist in the detection of the transition to the degraded performance level. The threshold report occurs whenever an ES, BBE or SES threshold has been exceeded over the period of time T3.

Long-term quality monitoring/measurement

Performance monitoring history should be kept for at least one year (suggested) by the management system.

5 Availability and unavailability

The criteria for entry/exit from the unavailable state are defined with ITU-T Recommendations M.2100 (§ 8) and M.2101 (§ 12) and the criteria for evaluating unavailability events when undertaking performance limits for maintenance measurements are contained in ITU-T Recommendation M.2120.

At present, unavailability limits are left for negotiation and the ITU-T have the subject under consideration.

6 Evaluation of error performance parameters

The procedure for the in-service and out-of-service evaluation of error performance parameters for PDH and SDH entities is considered, in detail, in ITU-T Recommendations M.2100 and M.2101.

The evaluation of error performance parameters for the maintenance of digital FWSs during adverse propagation conditions should take due account of the effect of propagation.
