

UNJUK KERJA (lanjutan)

REF : FREEMAN

Availabilitas

- Availabilitas : persentasi waktu suatu sirkit dari ujung ke ujung dengan unjuk kerja mencapai aras minimal.
 - Diukur pada 2 arah
 - Biasanya perioda 1 tahun
 - ITU → availabilitas, Amerika Utara → Reliabilitas
 - ITU Rec G821 dan G827 dan Amerika utara (Telcoredia/Bellcore staff) : layanan tidak available jika sistem transmisi mengalami SES (Severely Errored Second), LOF(Loss of frame), LOS (Loss of Signal) selama 10 detik terakhir berurutan.
 - Amerika Utara (AT&T, TIA/EIA) menggunakan kriteria BER 10^{-6} .
 - Lintasan duplex dinilai tidak availabel jika salah satu atau kedua arah lintasan tidak availabel.
 - ITU → sasaran kualitas termasuk efek2 fading, residual error rate, error burst dan interferensi sistem radio.
 - Amerika Utara → tidak termasuk residual error.

Persyaratan dan sasaran unjuk kerja lintasan radio digital



- BER : perbandingan jml bit error dgn jml bit diterima pd interval waktu
- RBER (Residual BER) : perbandingan bit error tanpa fading, termasuk error system inherent, lingkungan, efek usia dan interferensi jangka-panjang
- ES (Error Second) : perioda 1 detik terjadi 1 atau lebih bit error atau paling tidak terdeteksi 1 error
- SES (Severely Errored Second) : perioda 1 detik terjadi BER $\geq 1 \times 10^3$ atau paling tidak 1 rusak
- DM (degraded minute) : interval waktu m detik, 60 diantaranya tidak SES tetapi error ratio-nya lebih besar dr yg dispesifikasikan

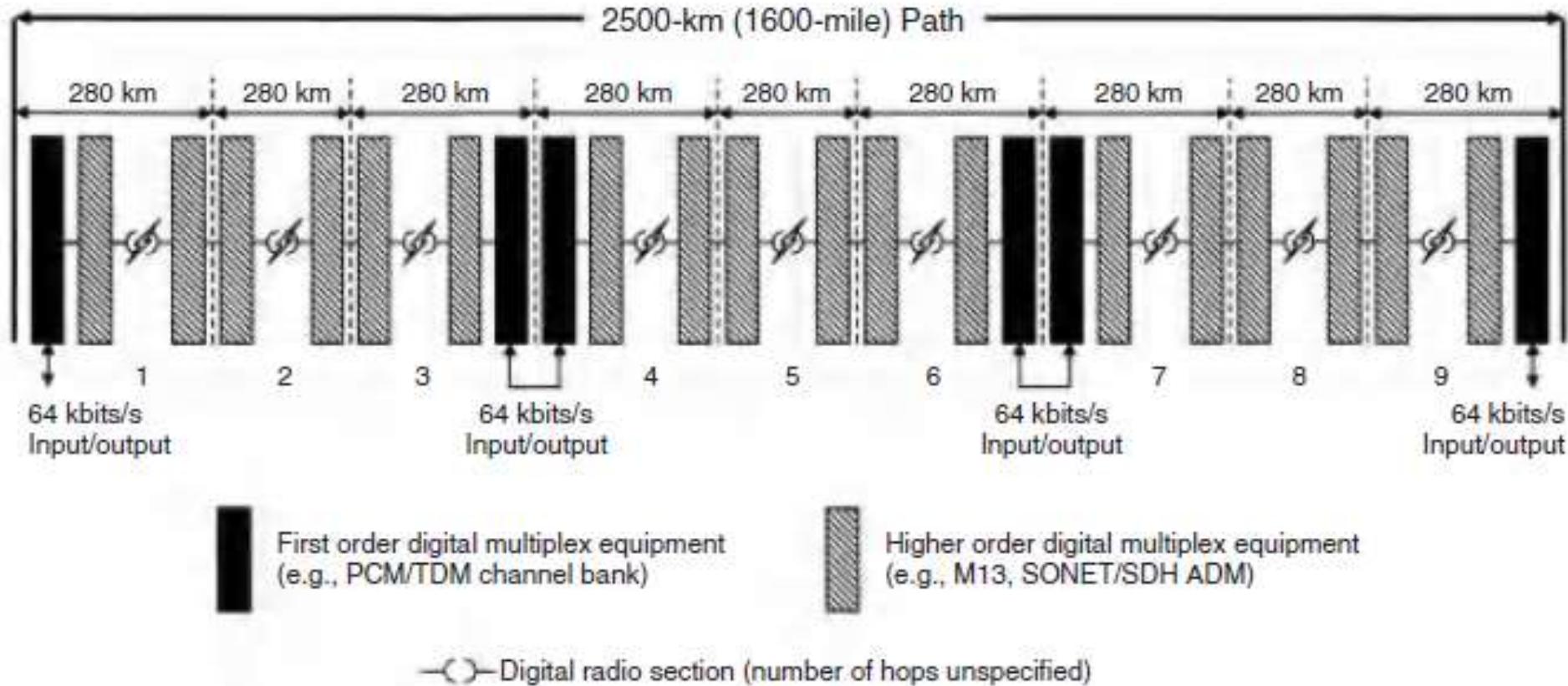


Figure 4.4 Legacy ITU-R hypothetical reference digital path for high grade performance. Reference path does not include multiplex/demultiplex or (path) protective switching equipment. Conventional assumptions are to assume each radio hop is 40.0 or 46.7 km long. Source: ITU-T Rec. G.821 and ITU-R Rec. F.1556-1.

Sasaran unjuk kerja error

- Syarat unjuk kerja error utk lintasan : $280 \text{ Km} \leq L \leq 2500 \text{ Km}$
 - $\text{BER} > 1 \times 10^{-3}$ utk $\leq (L/2500) \times 0,054 \%$ setiap bulan
 - $\text{BER} > 1 \times 10^{-6}$ utk $\leq (L/2500) \times 0,4 \%$ setiap bulan
 - $\text{ES} \leq (L/2500) \times 0,32 \%$ setiap bulan
 - $\text{RBER} \leq (L \times 5 \times 10^{-9})/2500$
- Kriteria unjuk kerja BER harus dipatuhi laju bit sistem
- Kriteria ES hrs dipatuhi pd level 64 kbps

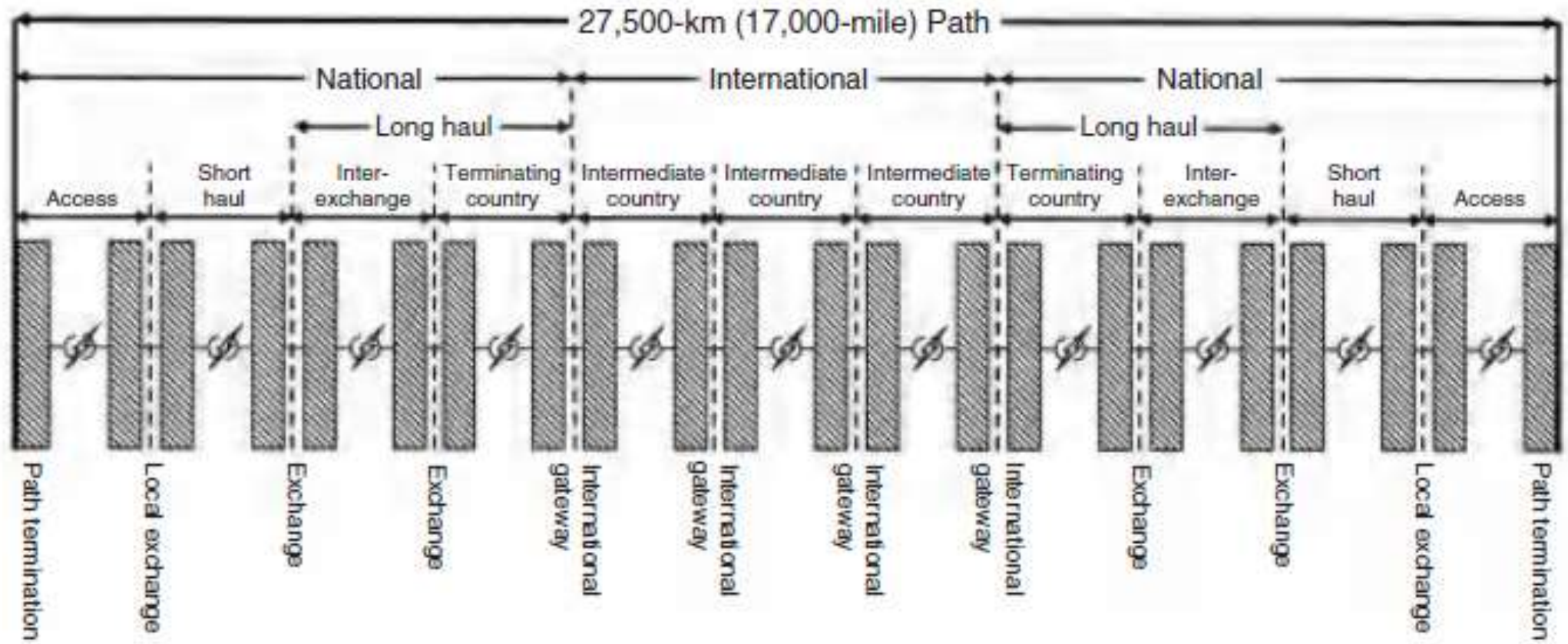


Figure 4.6 Modern ITU-T hypothetical reference path, the technology or media of each section is not explicitly defined. The actual number of spans/hops of equipment is not explicitly defined. Path objectives do not include multiplex/demultiplex or protective switching equipment. Source: ITU-T Recs. G.801, G.826, G.827 and G.828 as well as ITU-R Recs. F.1668 and F.1703.

International standards

G.827 and F.1703

◆ Availability two-way objectives (path or equipment)

- International digital links (50 – 21,500 km)
 - Availability = 99.9926–99.9975%
 - Outage intensity = 25 to 1 outage per year
- National digital links
 - Terminating country (50–2500 km)
 - Availability = 99.9926–99.9975%
 - Outage intensity = 25 to 1 outage per year
 - Longhaul (50–2500 km)
 - Availability = 99.9926–99.9975%
 - Outage intensity = 25 to 1 outage per year
 - Short haul (50–250 km)
 - Availability = 99.9900–99.9966%
 - Outage intensity = 60 to 10 outages per year
 - Access (50–250 km, typically <50 km)
 - Availability = 99.9750–99.9958%
 - Outage intensity = 50 to 8 outages per year

Availability objectives are per year.

Availability measured using 10-s on/off window.

It is assumed that equipment and media availability are equal.

Typical path degradations are rain and long-term interference.

International standards

G.826, G.828, and F.1668

◆ Path quality one-way objectives

- International digital links
 - 50–21,500 km
 - 99.9996–99.9998% free of SESs
- National digital links
 - Terminating country (50–2500 km)
 - 99.9996%–99.9998% free of SESs
 - Inter-exchange (50–2500 km)
 - 99.9978–99.9998% free of SESs
 - Short haul (50–250 km)
 - 99.9830–99.9975% free of SESs
 - Access (50–250, typically <50 km)
 - 99.9830–99.9975% free of SESs

Quality objectives defined as error performance during worst month.

Performance is only measured when circuit is available (using 10-s on/off window).

Typical path degradation is multipath fading and short-term interference.

Figure 4.7 Modern ITU-R objectives. Availability objectives are per year. Quality objectives are per worst month.

TABLE 3.3 Error Performance Objectives for a 27,500-km HRP

Rate (Mbit/s)	1.5 to 5	> 5 to 15	> 15 to 55	> 55 to 160	> 160 to 3500
Errored second ratio	$0.04 \times (F_L + B_L)$	$0.05 \times (F_L + B_L)$	$0.075 \times (F_L + B_L)$	$0.16 \times (F_L + B_L)$	
Severely errored second ratio	$0.002 \times (F_L + B_L)$				
Background block error ratio	$3 \times 10^{-4} \times (F_L + B_L)$	$2 \times 10^{-4} \times (F_L + B_L)$			

Note: VC-11 and VC-12 (ITU-T Rec. G.709) paths are defined with a number of bits/block of 832 and 1120, respectively, that is, outside the bit/block range recommended for 1.5 to 5 Mbit/s paths in ITU-T Rec. G.826. For these block sizes, the BBER objective for VC-11 and VC-12 is $2 \times 10^{-4} \times (F_L + B_L)$, where:

Distance allocation factor	$F_L = 0.01 \times L / 500$	L (km)
Block allowance factor, B_L		
For intermediate countries	$B_L = B_R \times 0.22 \times (L / L_{ref})$ $B_R \times 0.02$	for $L_{min} < L \leq L_{ref}$ for $L > L_{ref}$
For terminating countries	$B_L = B_R \times 0.01 \times (L / L_{ref})$ $B_R \times 0.01$	for $L_{min} < L \leq L_{ref}$ for $L > L_{ref}$
Block allowance ratio, B_R	$(0 < B_R \leq 1)$	
Reference length, L_{ref}	$L_{ref} = 1000$ km (provisionally)	

Source: Table 1, p. 49, ITU-R Rec. F.1092, 1994 F Series, Part 1 (Ref. 17).

Jitter & Wander

- Jitter : deviasi dr periode sebenarnya dr sinyal periodik terduga, sering berkaitan dng sumber clock.
- Pd aplikasi pemulihan clock sering disebut timing clock
- Jitter bisa diamati melalui frekuensi pulsa berurutan, amplitudo atau fasa dr sinyal periodik
- Jitter bisa dikuantisasi dng satuan yg sama spt semua sinyal bervariasi thd waktu, mis RMS, pergeseran puncak-puncak atau kepadatan spectral
- Periode jitter : interval antara 2 efek maksimal (atau efek minimal) dr suatu karakteristik sinyal yg bervariasi secara teratur thd waktu.
- Frekuensi jitter : bilangan kebalikanya periode jitter
- ITU-T G810 : frekuensi < 10 KHz \rightarrow wander, frekuensi ≥ 10 KHz \rightarrow jitter
- Jitter bias disebabkan interferensi EM dan Xtalk dgn carrier lain
- Akibat jitter antara lain flicker, click, kehilangan data