10GbE over Coaxial cable

Rick Walker

Hewlett-Packard Company

Palo Alto, California

walker@opus.hpl.hp.com

Overall System Strategy:

- 10Gb/s streams within a box
  - use quad equalized 2.5Gb/s NRZ signals on PCB
- Low-cost transmission between boxes (where bulk is not an issue
  - CMOS drivers using quad equalized 2.5Gb/s signals on coax or twinax
- High performance, High density systems
  - use SiGe/BiCMOS drivers and analog equalization for 10G serial transmission over coax

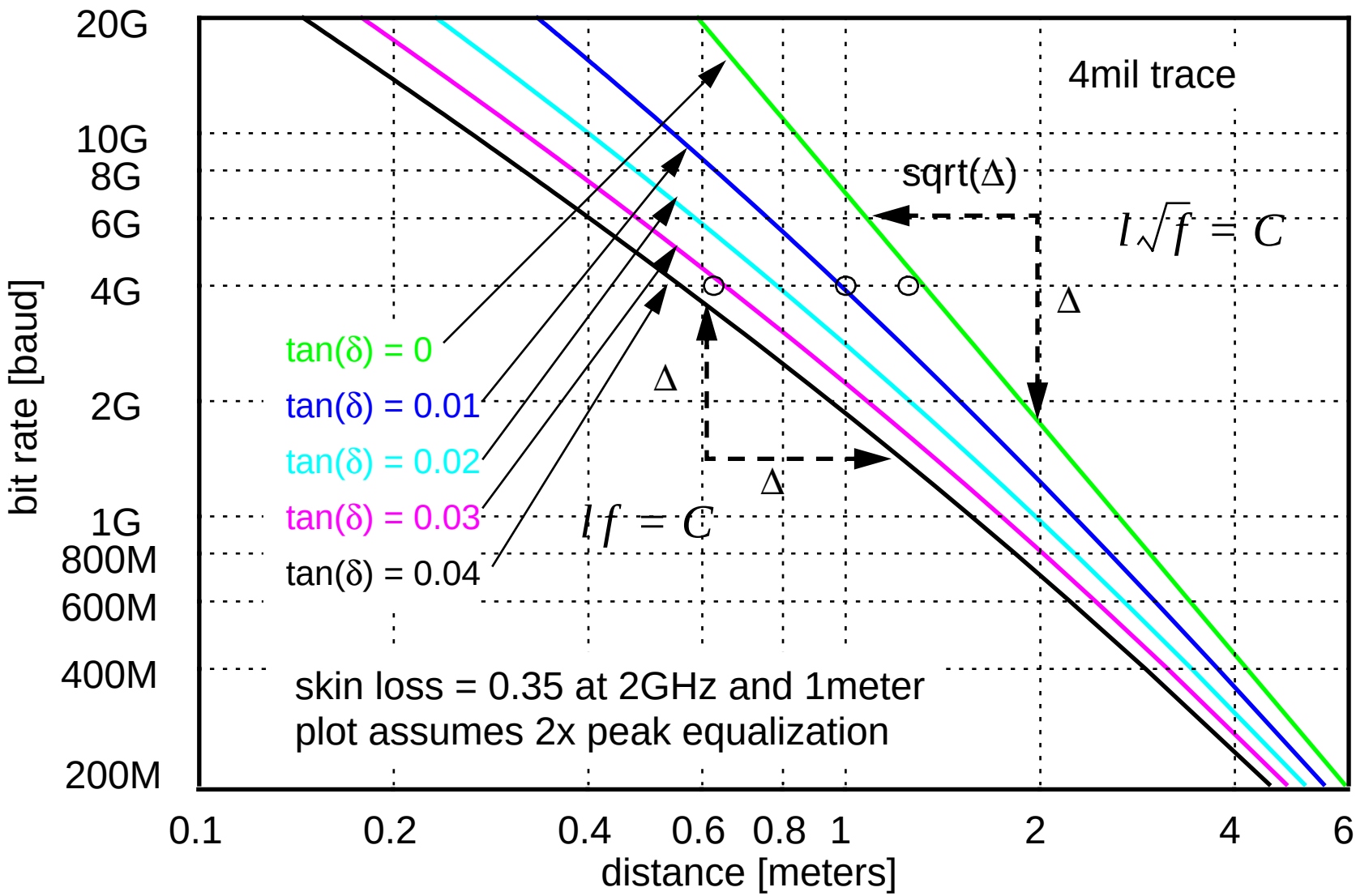
10G serial overview

- Specify connector - not cable type. Connector should be locking style, 50 ohm, low/moderate cost.
- Specify cable with loss mask (skin dominated, maximum of 12 dB down at 5GHz, 10 meters). This leaves room for future length improvements with low dielectric constant materials. Allows user to trade-off distance vs cable diameter.
- Loss mask allows simple system using combination of 6dB 2-tap FIR TX pre-emphasis with 3dB shelf equalizer at RX at 10 meter. Leaves room for vendor-specific distance improvements using more sophisticated analog EQ.
- 1-MHz AC-coupled system, both center and shield to reject low frequency common-mode noise and DC voltages between chassis.

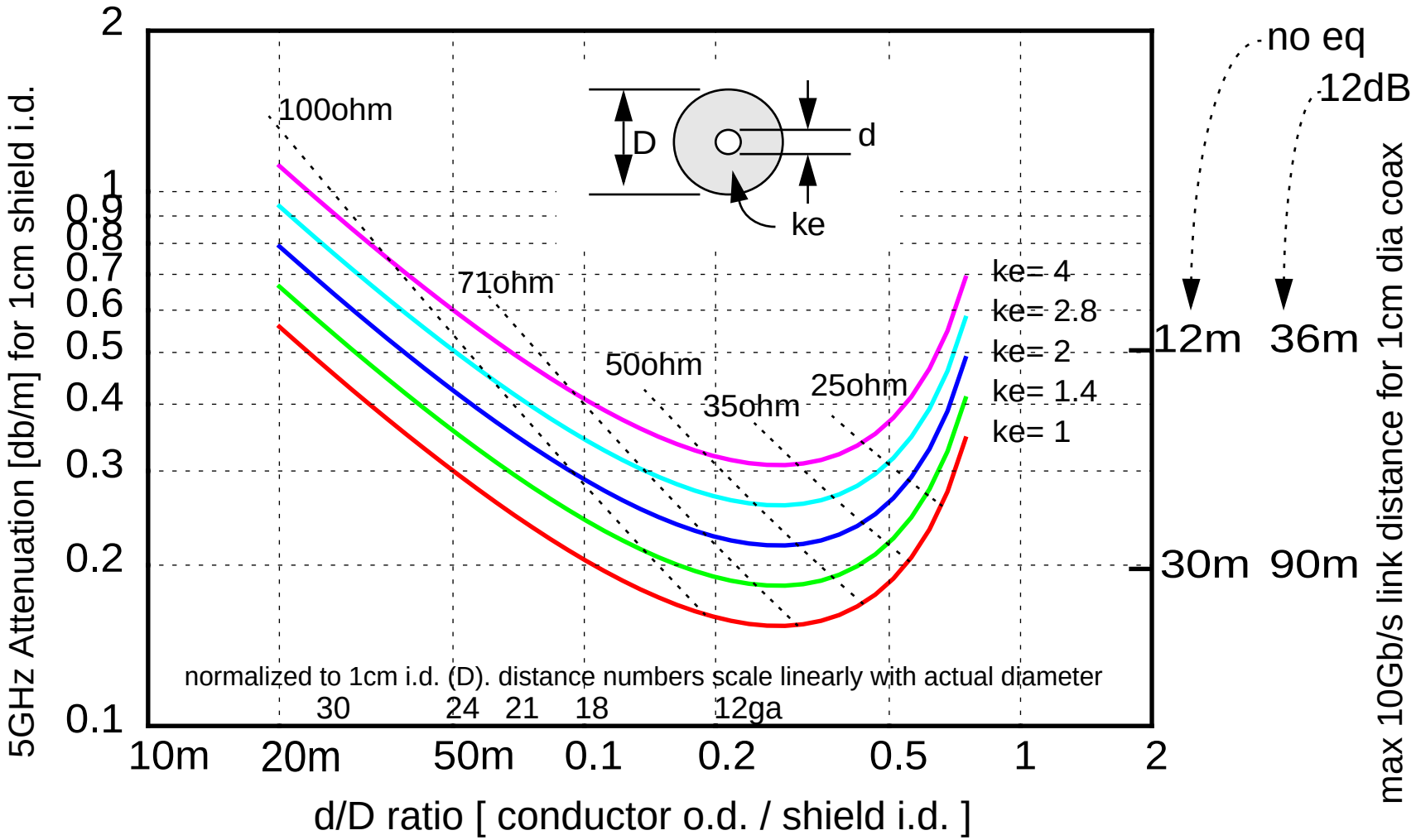
10G serial overview (cont.)

- Single-ended coax minimizes cost and sidesteps twinax skew issue. HP has demonstrated non-equalized 10Gb Si-bipolar chipset with 9’ distance on RG-174, 20’ on 0.190” Gore coax. Simple 6-dB TX EQ doubles these distances.
- We are pushing hard on some technology limits. A highly efficient line code is desired to avoid rates of 12.5 Gb/s or higher. A scrambled system with periodic sync bit insertion is a possibility. The quad 2.5Gb to 10Gb/s converter may need to strip off any 8B/10B code prior to recoding and MUXing.

PCB Data rate vs distance and tan(δ)



Coax cable losses versus dielectric constant (ke) and d/D ratio



Equalized 10Gb/s NRZ

Distance versus cable type (for some common cables)

Coax Type	Cable OD in mm	wire OD (d) in mm	core ID (D) in mm	Z0	1GHz loss at 100’	distance (no eq)	distance (6dB eq)	distance (12db eq)
174/U	2.56	0.48	1.52	50	30.0	2.73m	5.45m	8.18m
58/U	4.90	0.81	2.95	50	17.0	4.81m	9.62m	14.44m
9/U	7.11	2.17	7.11	50	8.90	9.19m	18.38m	27.58m