Comparator

- Specs and issues:
  - Clock rate \( f_s \)
  - Offset
  - Resolution
  - Hysteresis
  - Input cap
  - Power dissipation
  - CM rejection
  - Kickback noise
  - ...

Comparator Gain-Bandwidth

Example:
- \( 4 \)Gb/s link
- Minimum \( \Delta V \): \( 1 \)mV
- \( V_{dd} = 1 \)V

\[ A_v > \frac{1 \text{V}}{1 \text{mV}} = 1000 \text{ in } < 250 \text{ps}! \]

Operational Amplifier?

\[ f_{\text{cut}} = \frac{f_s}{3} \]

\[ f_c = \frac{2A_v}{3T_{on}} \]

\[ \frac{1000}{3 \times 250 \text{ps}} = 1.33 \text{THz} \]

Flash Converter

- Fast: one clock cycle per conversion
- High complexity: \( 2^n - 1 \) comparators
- High input capacitance

Open-Loop Amplifier Cascade
Cascaded Amplifier

- Simplified bandwidth analysis:
  - Open-circuit time constants
  - (Not most accurate, but leads to nearly the right answer for design optimization)