What Is a Signal Conditioner?

TI Precision Labs - Signal Conditioning
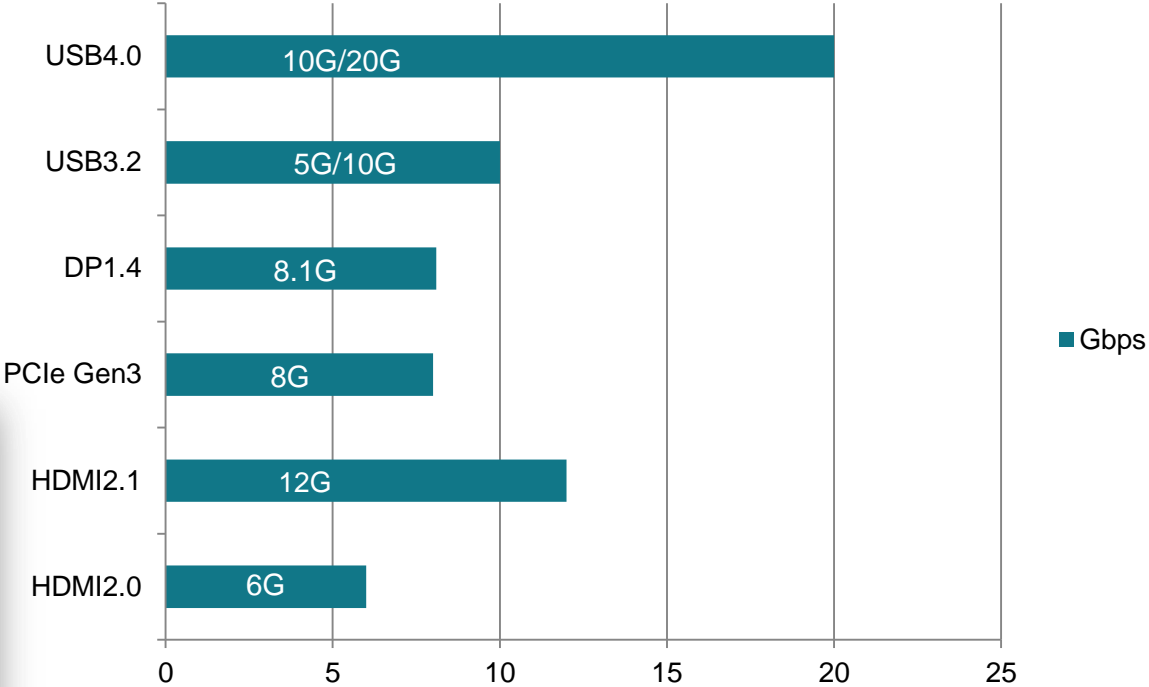
Prepared by Mike Campbell

Presented by Nicholaus Malone

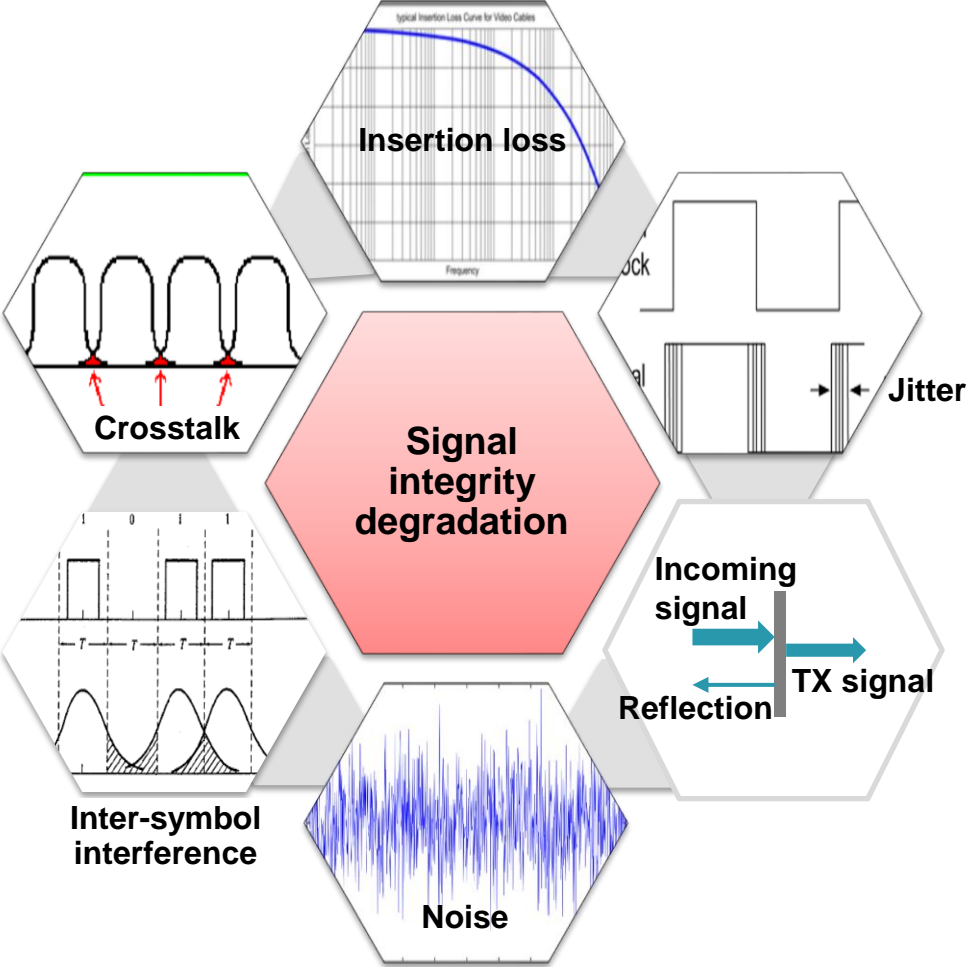# High-speed, multi-gigabit standards

Industry standards Gbps per channel

Standard	Gbps
USB4.0	10G/20G
USB3.2	5G/10G
DP1.4	8.1G
PCIe Gen3	8G
HDMI2.1	12G
HDMI2.0	6G

■ Gbps

0   5   10   15   20   25

The higher the speed, the more prone to signal integrity degradation

TEXAS INSTRUMENTS

Multi-gigabit signal integrity challenges

Insertion loss

Crosstalk

Jitter

Signal integrity degradation

Incoming signal

TX signal

Reflection

Inter-symbol interference

Noise

TEXAS INSTRUMENTS

Signal conditioners come to the rescue

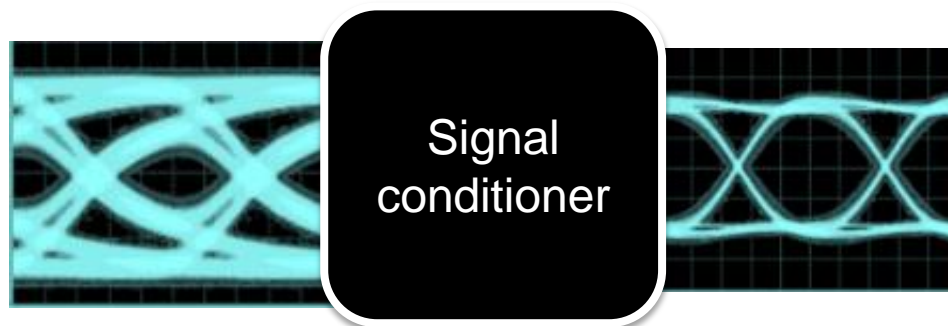| PURPOSE |
| --- |
| A signal conditioner, in the form of a redriver or retimer, is used to correct signal integrity issues that produce less than desired bit error rate (BER). |

USE CASES

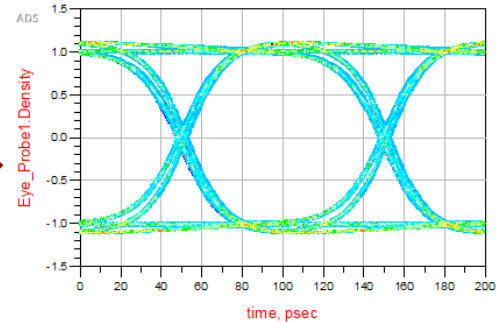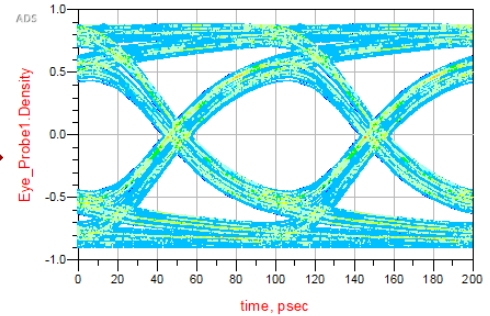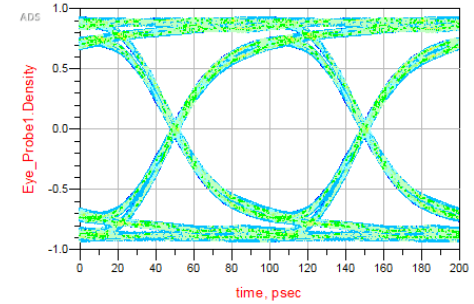Extending a device's operating range to meet system form-factor requirements

Example: Increase trace from 4-inches to 8-inches
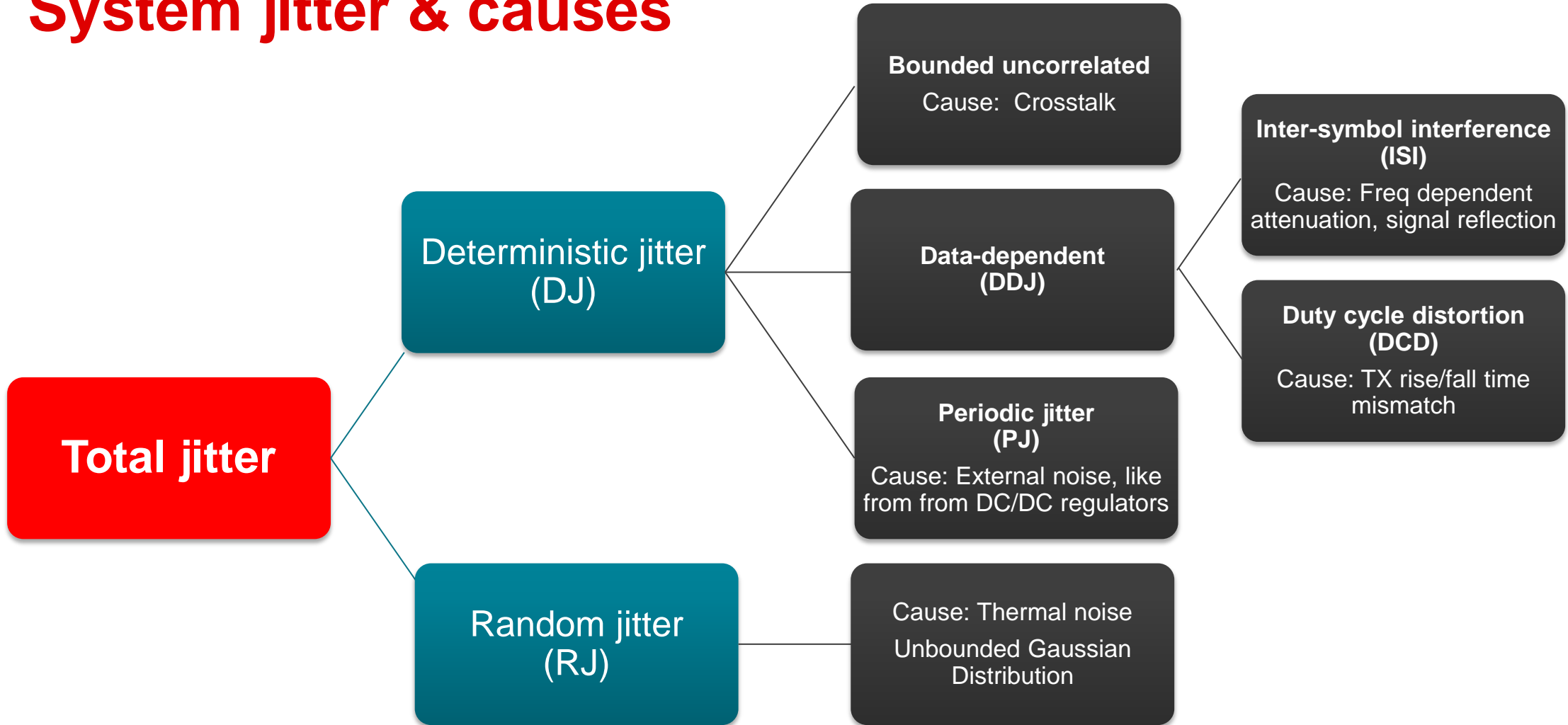
Correct a device's short-comings

Example: ASIC TX has higher than allowed random jitter

Signal conditioner

Example: Extending a device's operating range

System jitter & causes

Total jitter

- **Deterministic jitter (DJ)**
  - **Bounded uncorrelated** — Cause: Crosstalk
  - **Data-dependent (DDJ)**
    - **Inter-symbol interference (ISI)** — Cause: Freq dependent attenuation, signal reflection
    - **Duty cycle distortion (DCD)** — Cause: TX rise/fall time mismatch
  - **Periodic jitter (PJ)** — Cause: External noise, like from from DC/DC regulators
- **Random jitter (RJ)**
  - Cause: Thermal noise. Unbounded Gaussian Distribution

What are redrivers & retimers?

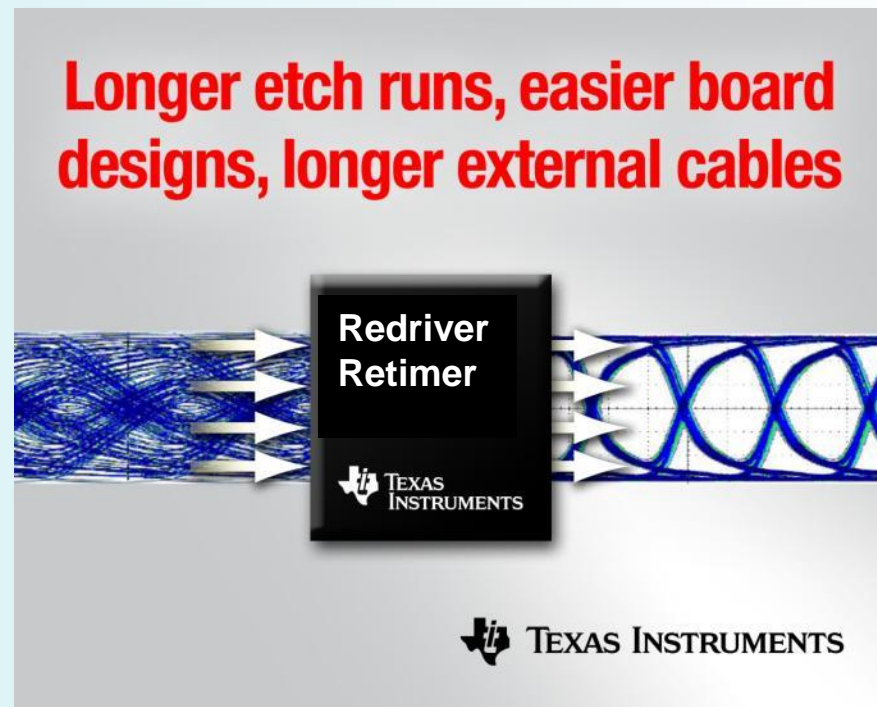|	
What is a redriver?	Analog component to restore an attenuated input signal through equalization and gain adjustment, and re-transmit the signal based on signal specification.

Non-linear → **Redriver** → Linearization
Attenuated sig → Equalized sig
CM Volt 1 → CM Volt 2
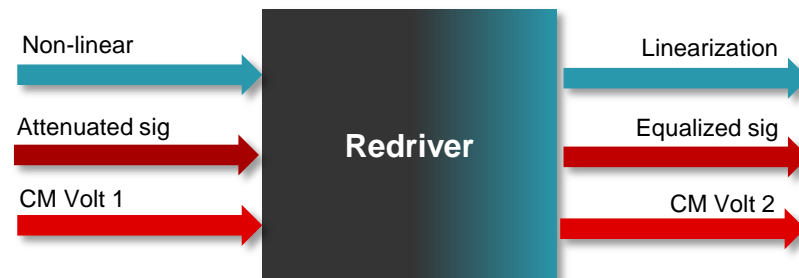
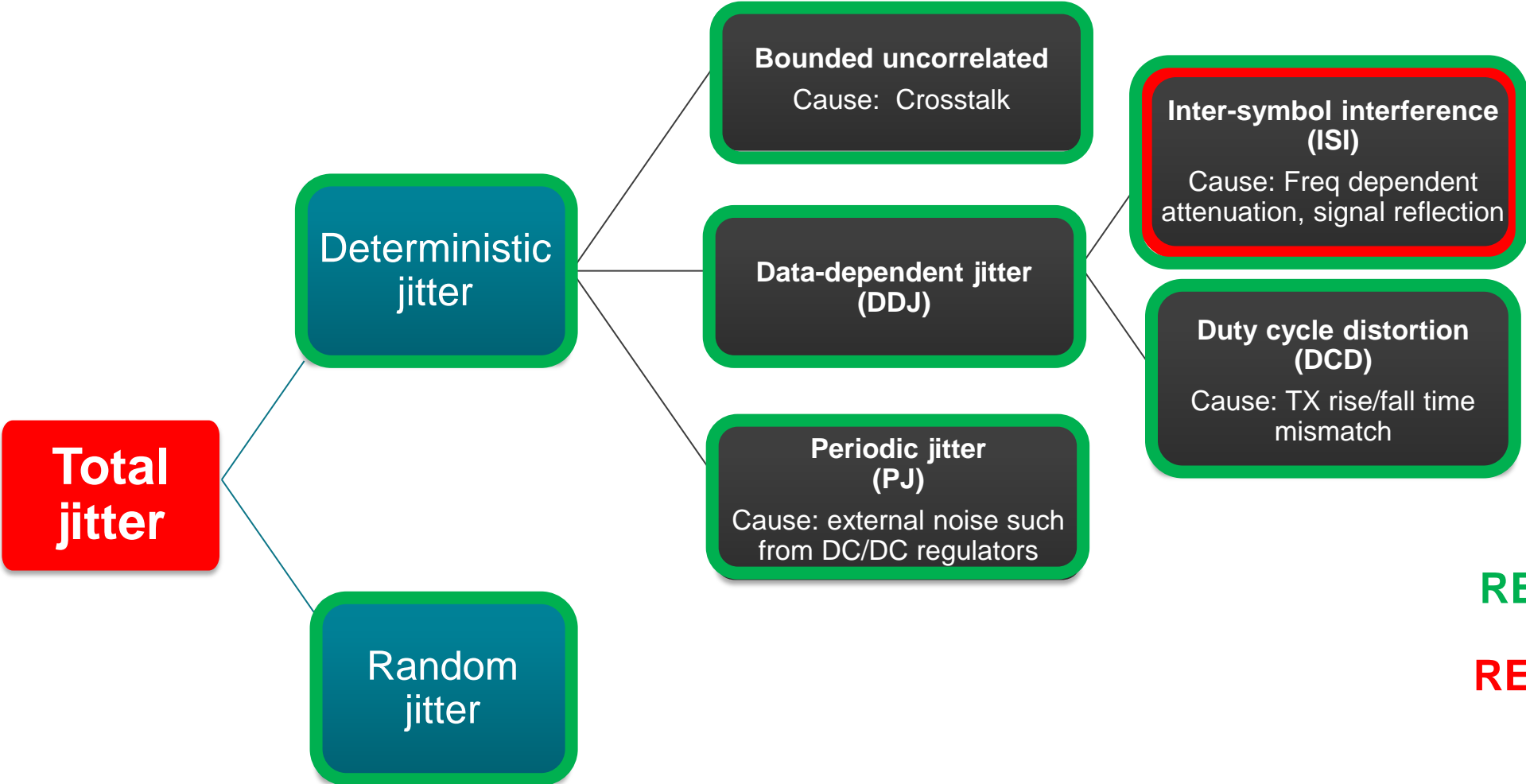|	
What is a retimer?	A mixed-signal component to recover an attenuated input signal with a clock data recovery circuit, attenuate the phase and filter the random jitter, and then retransmit the signal based on a "clean" clock.

Retimer

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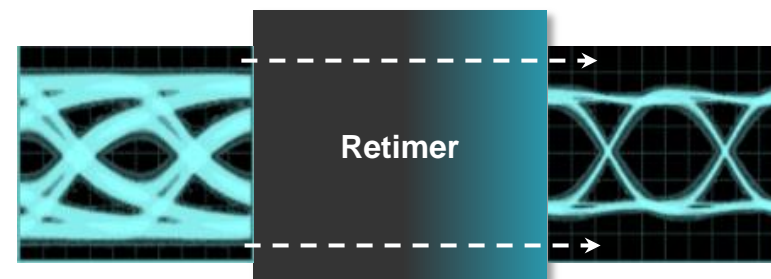
Why redrivers & retimers?

- Maintain signal integrity

- Improve signal quality over long trace or cable

- Enable design flexibility

- Improve system performance

- Enable broad range of interoperability

- Help system pass compliance

- Extend signal distances across cable or trace runs

Longer etch runs, easier board designs, longer external cables

Redriver
Retimer

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Jitter each signal conditioner can address

Total jitter

- **Deterministic jitter**
  - **Bounded uncorrelated**
    Cause: Crosstalk
  - **Data-dependent jitter (DDJ)**
    - **Inter-symbol interference (ISI)**
      Cause: Freq dependent attenuation, signal reflection
    - **Duty cycle distortion (DCD)**
      Cause: TX rise/fall time mismatch
  - **Periodic jitter (PJ)**
    Cause: external noise such from DC/DC regulators
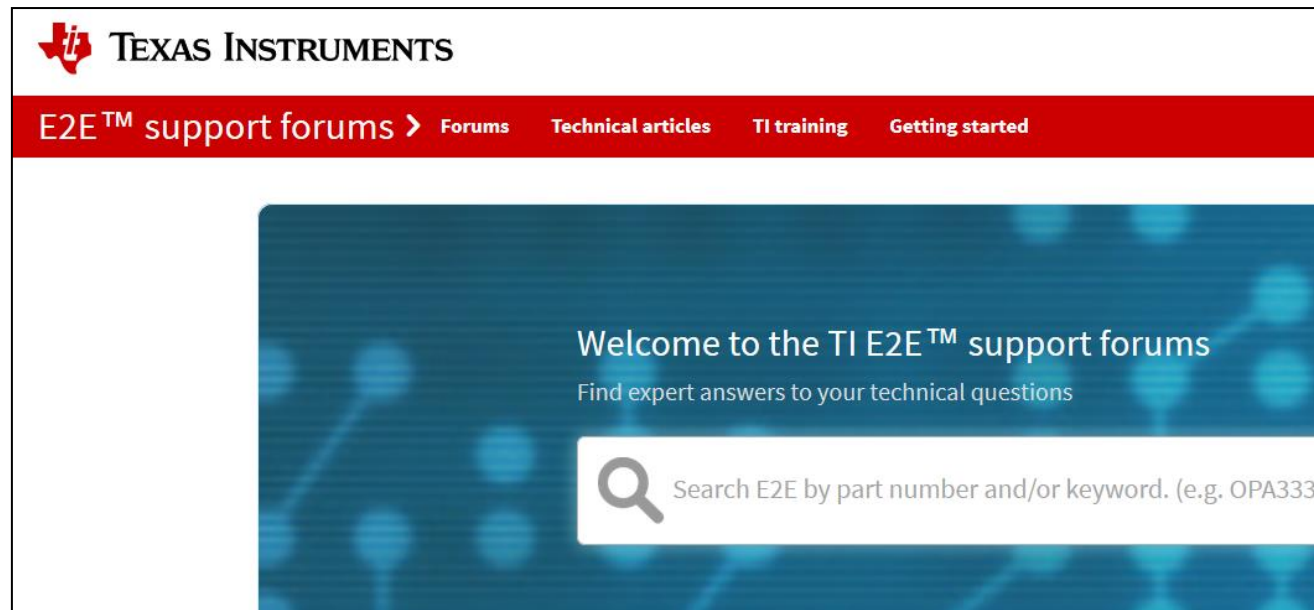- **Random jitter**

RETIMER

REDRIVER

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Short quiz

- True or False: Random jitter can be eliminated by using a signal conditioner such as a retimer.   FALSE

- True or False: One purpose of a signal conditioner is to correct a particular component's short-comings.   TRUE

- True or False: A redriver can fix random and ISI issues in a system.   FALSE

- True or False: A retimer can compensate for both random and deterministic jitter and provide a jitter free signal at its output.   FALSE

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Thank you

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