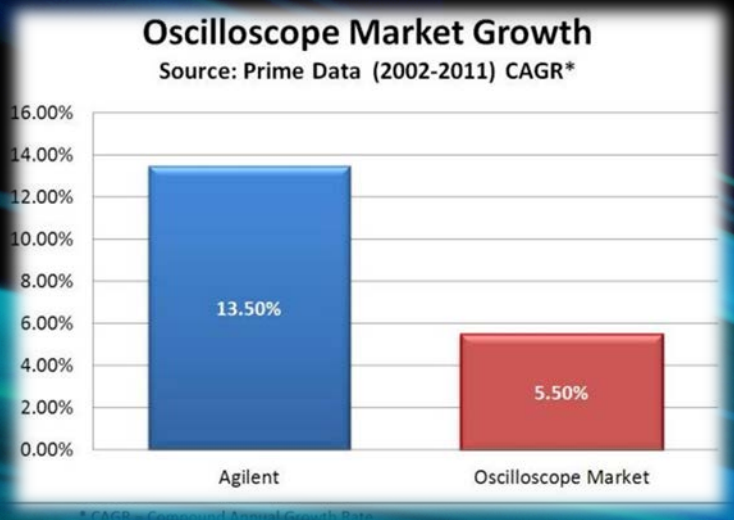
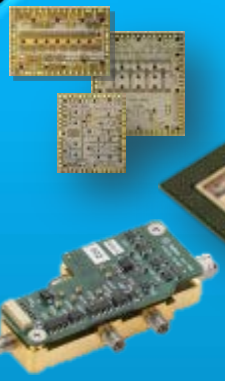
# InfiniiVision 4000 X-Series Oscilloscope *Experience* Redefined

**Kim, Jung-Chan**
**Application Engineer**
**Agilent Technologies**

# Agilent Oscilloscope Portfolio




**Taking Share as the Fastest Growing Scope Company**

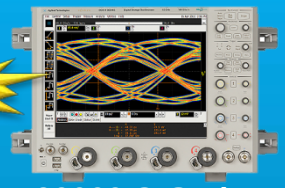




New

DCA-X Sampling

New



90000 Q-Series

Agilent custom ASIC technology designed for market leading performance.

90000 X-Series

90000 Series

Agilent custom ASIC technology designed for market leading value.

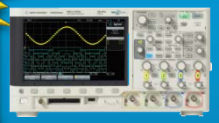
New

U1600 Series

U2700 Series

New

1000 Series



2000 X-Series

3000 X-Series

New

4000 X-Series

6000 Series

9000 Series



Agilent Technologies

# Five Unmet Customer Needs


1. An oscilloscope is first and foremost a **signal visualization debug tool.** Need to see the problem, in order to fix the problem.
2. Need an **intuitive GUI** that enables me to spend more time solving problems.
3. Not everyone is a power user, comfortable using advanced triggers. Need an **intuitive triggering** solution.
4. Acquisition memory is finite. Need **efficient method** to capture multiple infrequent anomalies/events over long time periods.
5. **Investment protection** is a key scope selection criteria in this

# InfiniiVision 4000 X-Series Scopes


## Oscilloscope *Experience* Redefined

- Experience the ***Speed***
  - 1,000,000 wfm/s
  - Mega*Zoom IV* smart memory
- Experience the ***Usability***
  - InfiniiScan Zone touch trigger
  - Design for touch interface (12.1in)
- Experience the ***Integration***
  - 5-in-1 instrument now with:
    - Dual-channel AWG
    - USB serial analysis
    - Fully upgradable

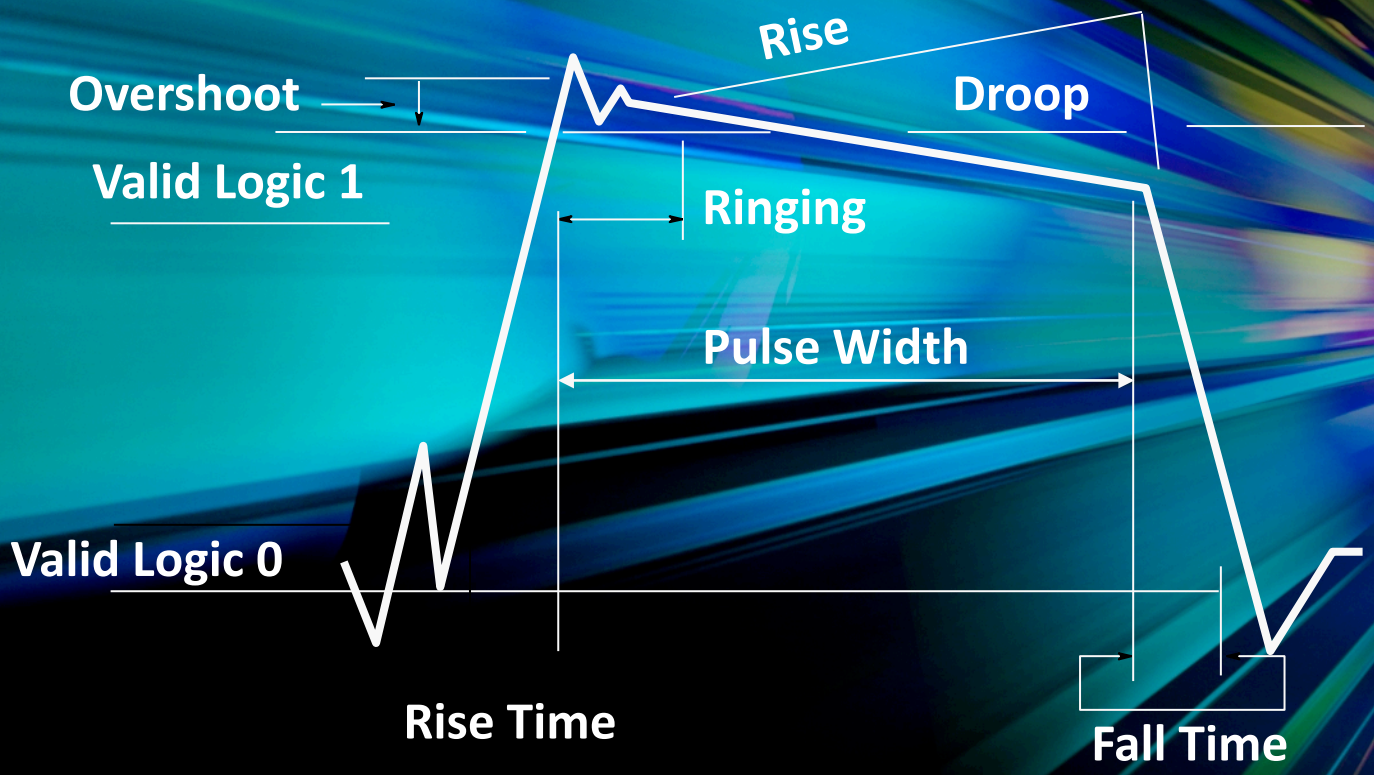


Agilent Technologies

# Introduction

## *- What is the oscilloscope ?*

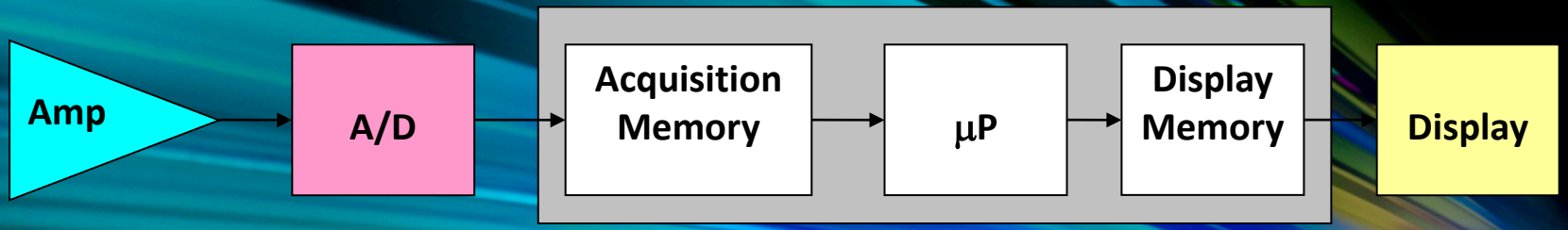
- Precise Time vs. Voltage Relationships
- Parametric Measurements



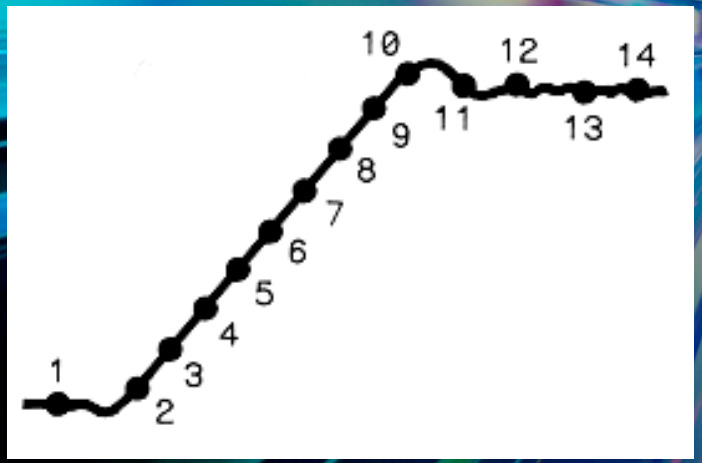
# Introduction

## *- Digital Storage Oscilloscope*

- Processing overview

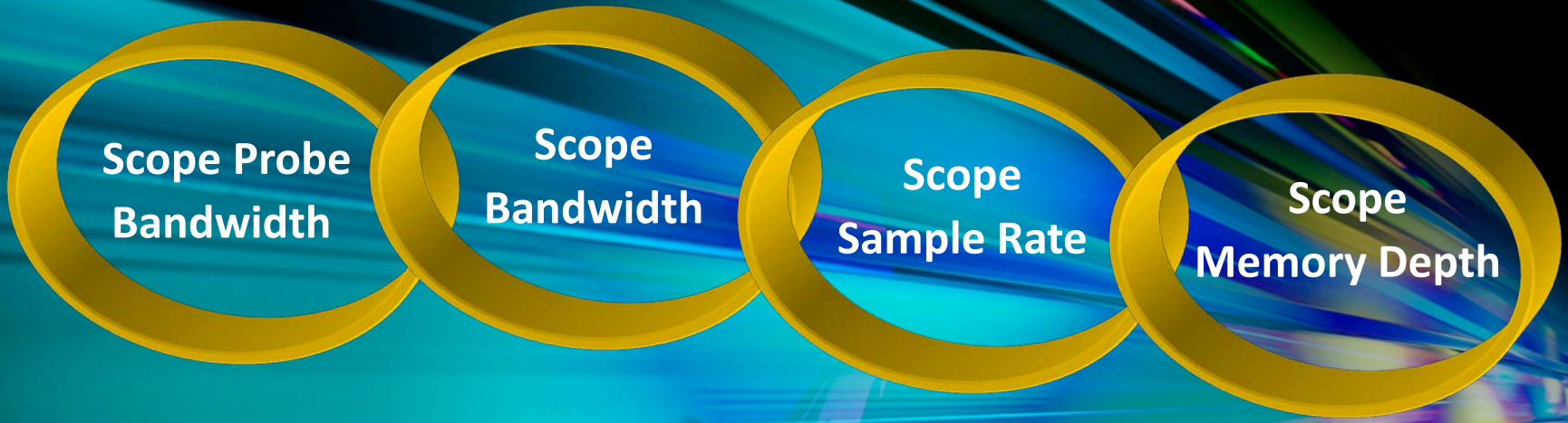



- The input electrical signal is digitized by an A/D converter (usually 8 bits or 256 levels) and the output digital data is saved in Memory.



# Introduction

## *- Weakest "Link" Determines Performance*




**System performance can be viewed as a chain reaction, where the lowest performance component in the measurement system will limit the performance of your measurements.**

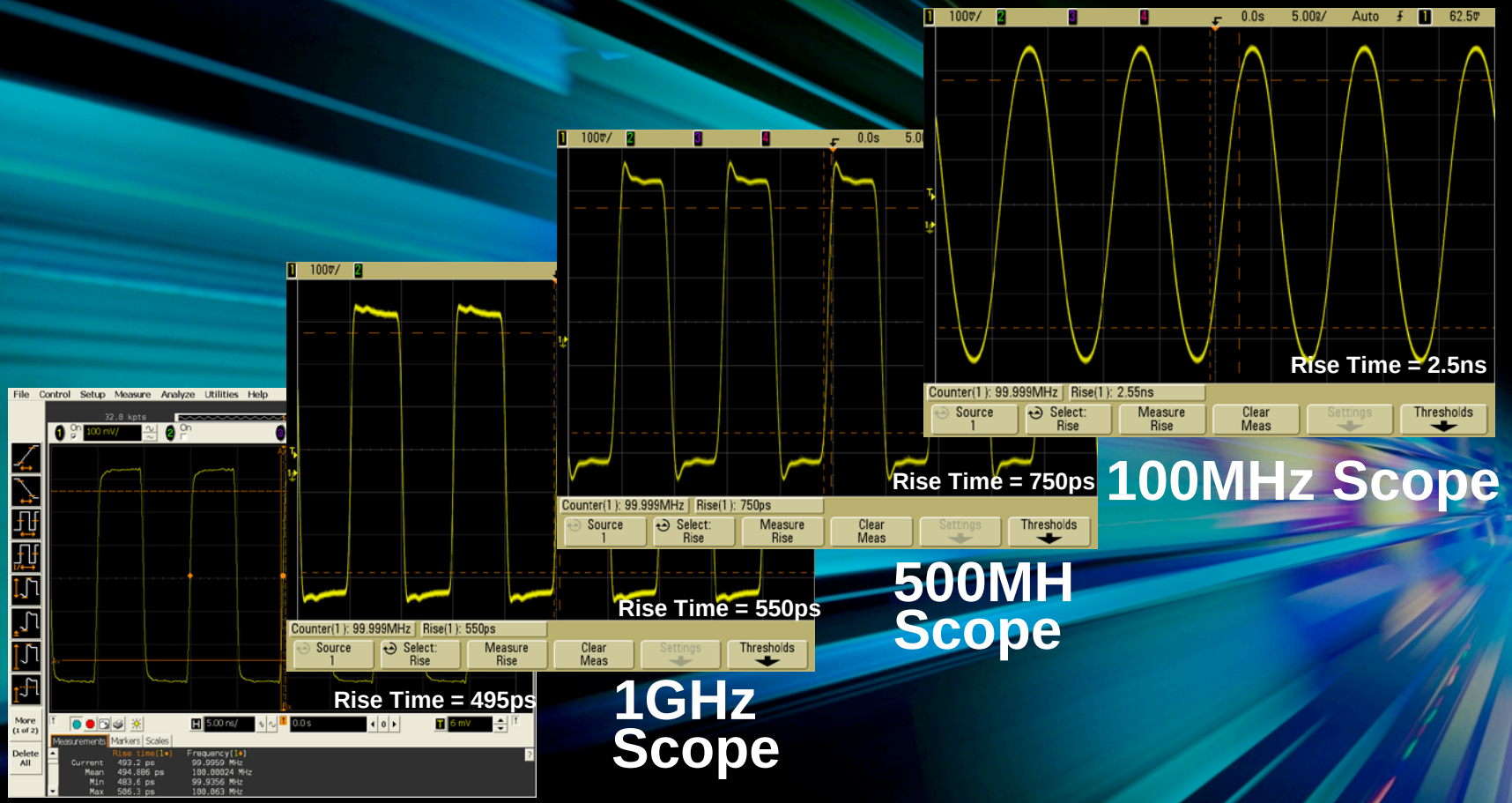
# Agenda

***- We are here!!!***

- Analog Bandwidth
- Sampling
- Memory Depth
- Waveform Update Rate

# Analog Bandwidth

## *- What does a 100MHz clock signal really look like?*





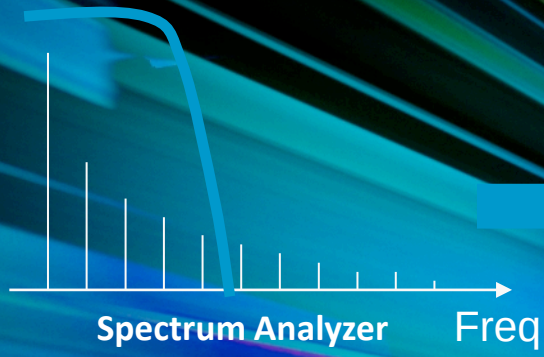

Agilent Technologies

# Analog Bandwidth

## *- Square Wave and Required Bandwidth*

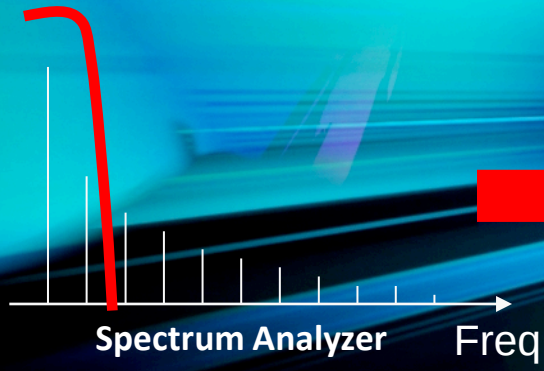
Oscilloscope

**True signal**




**Sufficient BW**

**Accurate Result**




**Insufficient BW**

**Inaccurate Result**

Requires sufficient bandwidth to cover most of the frequency components.

# Analog Bandwidth

## *- Finding the Max Frequency Contents in the Signal*

- The repetitive data rates alone will not determine the frequency contents of the signal.
- The transition time (rise and fall) of the signal determines the frequency contents

  (each standard has its own rise/fall time specifications)
- The faster the rise time, The higher harmonics in the signal

**Finding Max Freq Contents of Signal (*f*max) from the Rise Time**

***f*max = 0.5 / Tr (10%-90%)**

**or**

***f*max = 0.4 / Tr (20%-80%)**

# Analog Bandwidth

## - *Rise Time vs Bandwidth*

| Scope BW and Measurement Accuracy | | |
|---|---|---|
| ***f*max** | **0.5 / Rise Time (10%-90%)<br>0.4 / Rise Time (20%-80%)** | |
| **Scope Digital Filter Type** | **Gaussian** | **Brickwall** |
| **Measurement Error of Tr** | **Scope BW** | |
| **20%** | **1.0 x *f*max** | **1.0 x *f*max** |
| **10%** | **1.3 x *f*max** | **1.2 x *f*max** |
| **3%** | **1.9 x *f*max** | **1.4 x *f*max** |

- In order to characterize the signal with desired accuracy, a scope with a "Gaussian" filter response requires more bandwidth than a scope with a "Brickwall" filter response.

Knowing the filter response of your selected scope is very critical when accurately characterizing your signal. Let's look at typical examples next.

# Agenda

***- We are here!!!***

- Analog Bandwidth
- Sampling
- Memory Depth
- Waveform Update Rate

# Sampling

## *- Nyquist's Basic RULES……*

***But not-so-simple for DSO technology***

**RULE No.1 : $f_{MAX} < f_S/2$**

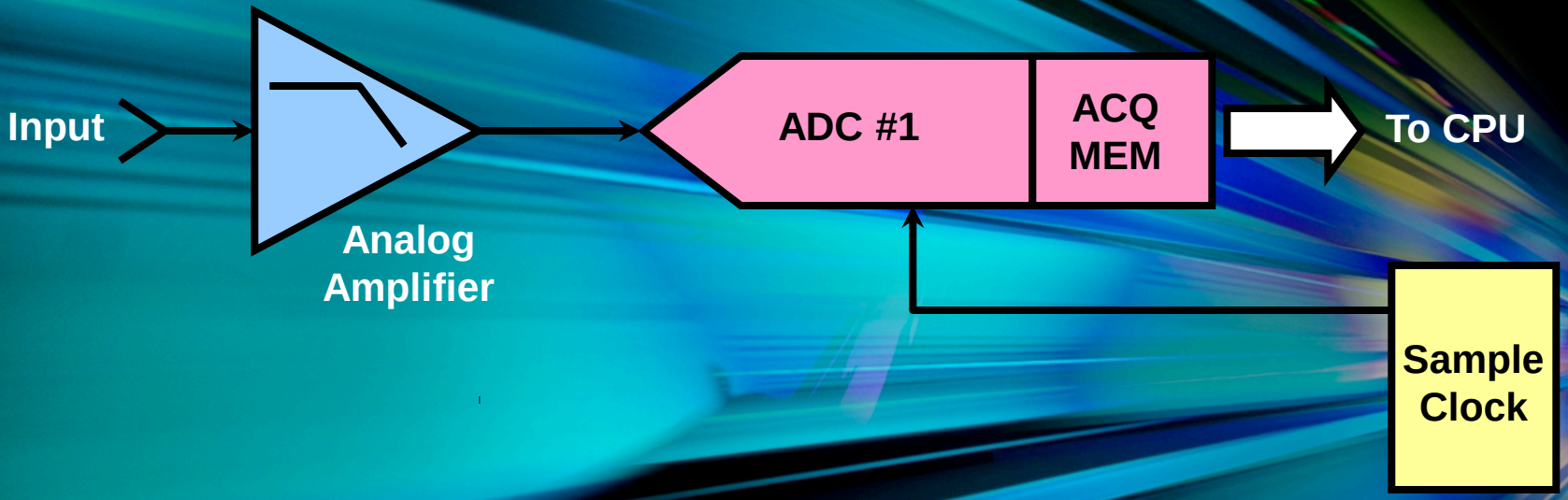
- ✓ The highest frequency sampled *MUST* be less than $f_S/2$…
- ✓ This is NOT the same as oscilloscope bandwidth.

**RULE No.2 : Samples *MUST* be equally spaced**

- ✓ The forgotten rule!

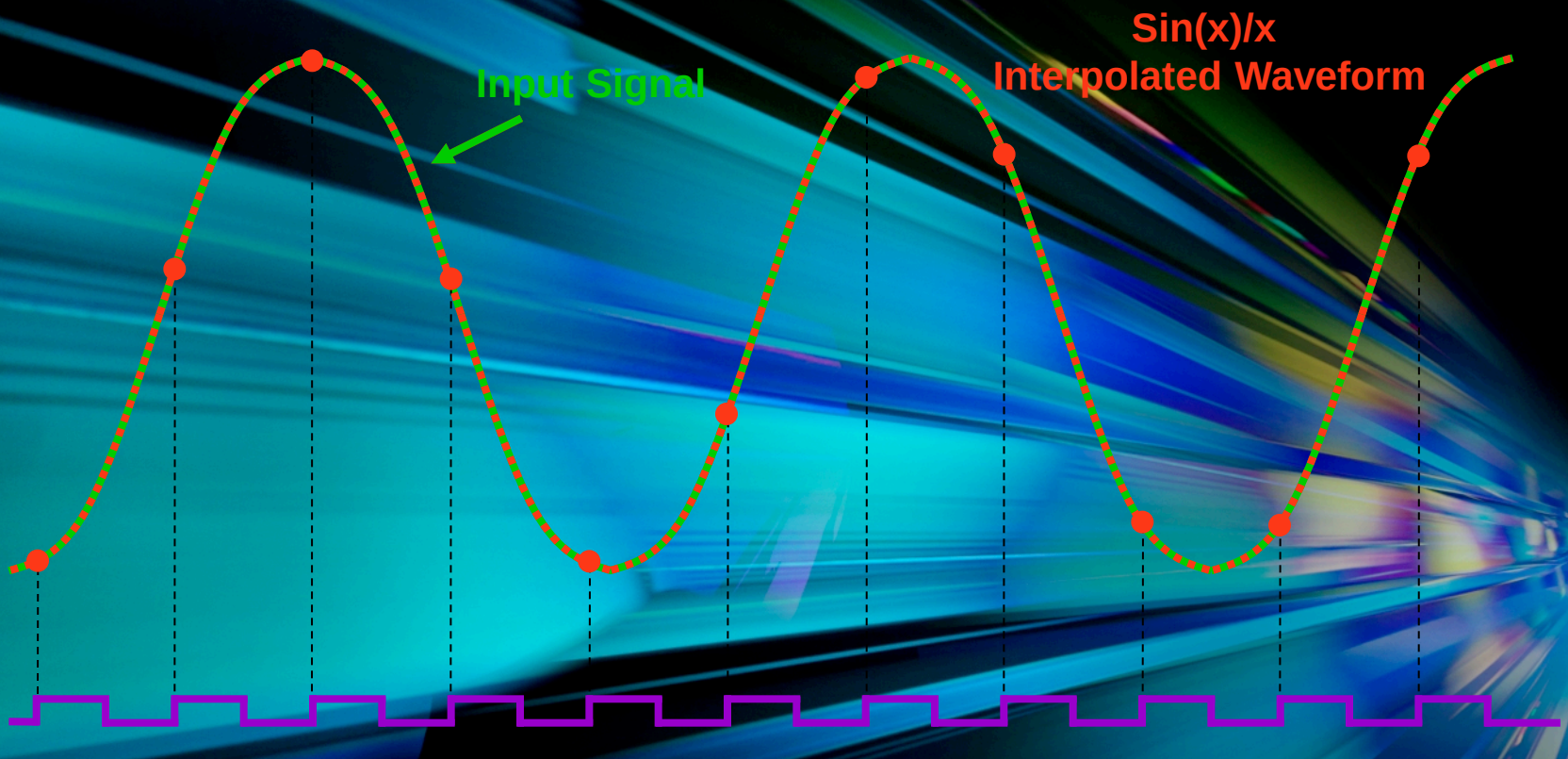
# Sampling

## *- Real-time Non-interleaved ADC System*



# Sampling

## *- Sample Rate > 4 x $f_{BW}$ (Non-interleaved)*




= Input Signal

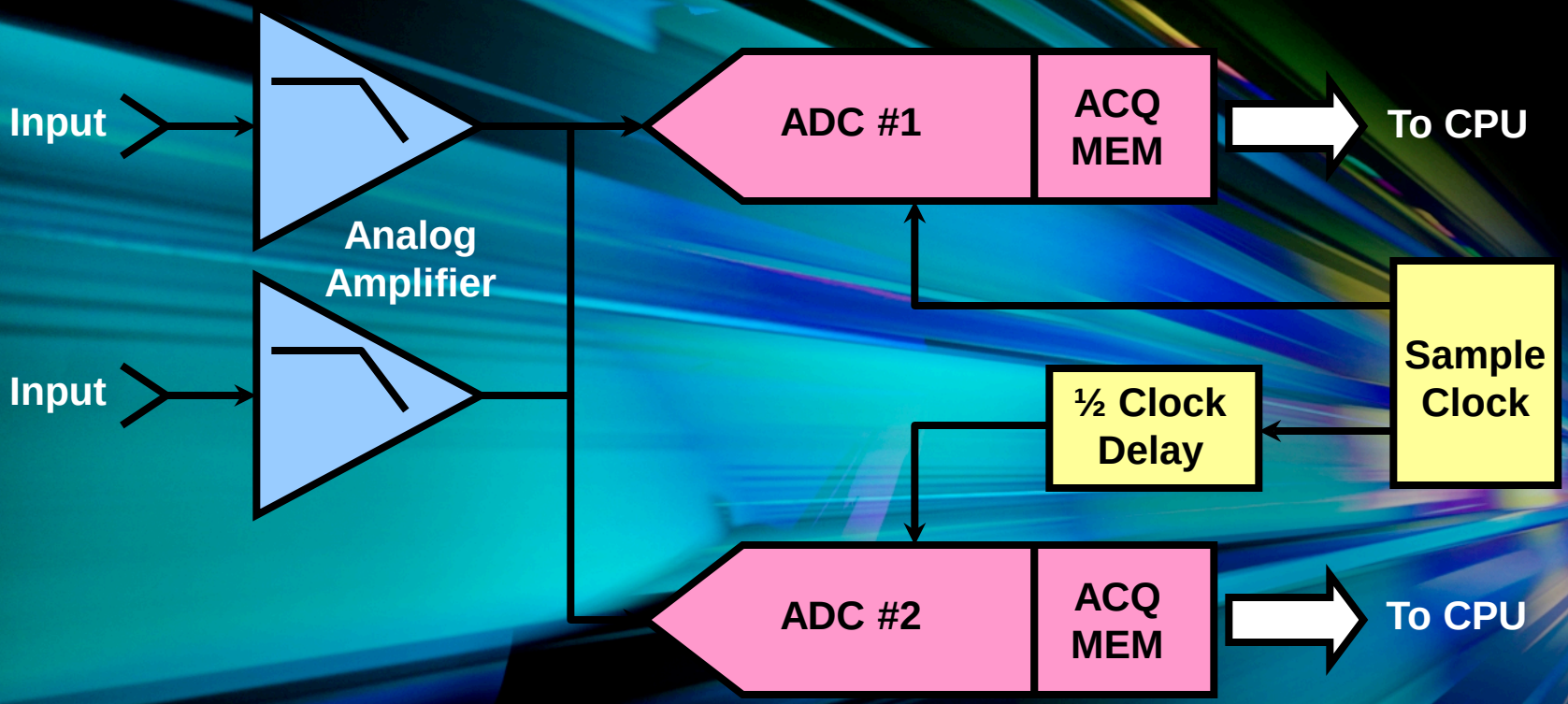
= Sample Clock

= Sin(x)/x Interpolated Waveform

= Real-time Digitized Point

# Sampling

## *- Real-time Interleaved ADC System*



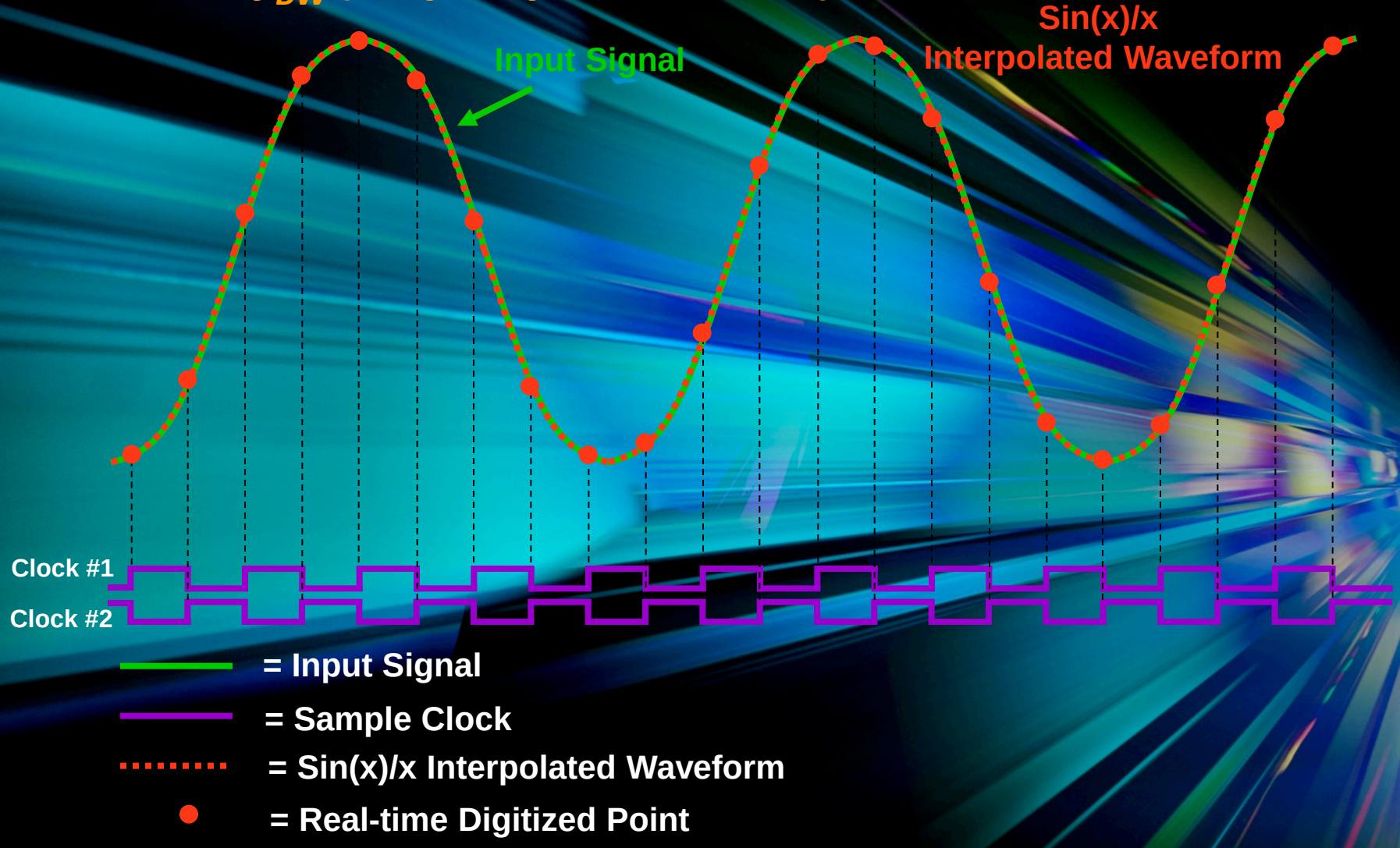

*Accurate ADC interleaving requires:*

*1.* Matched vertical response of each ADC

2. Precise phased-delayed clocking

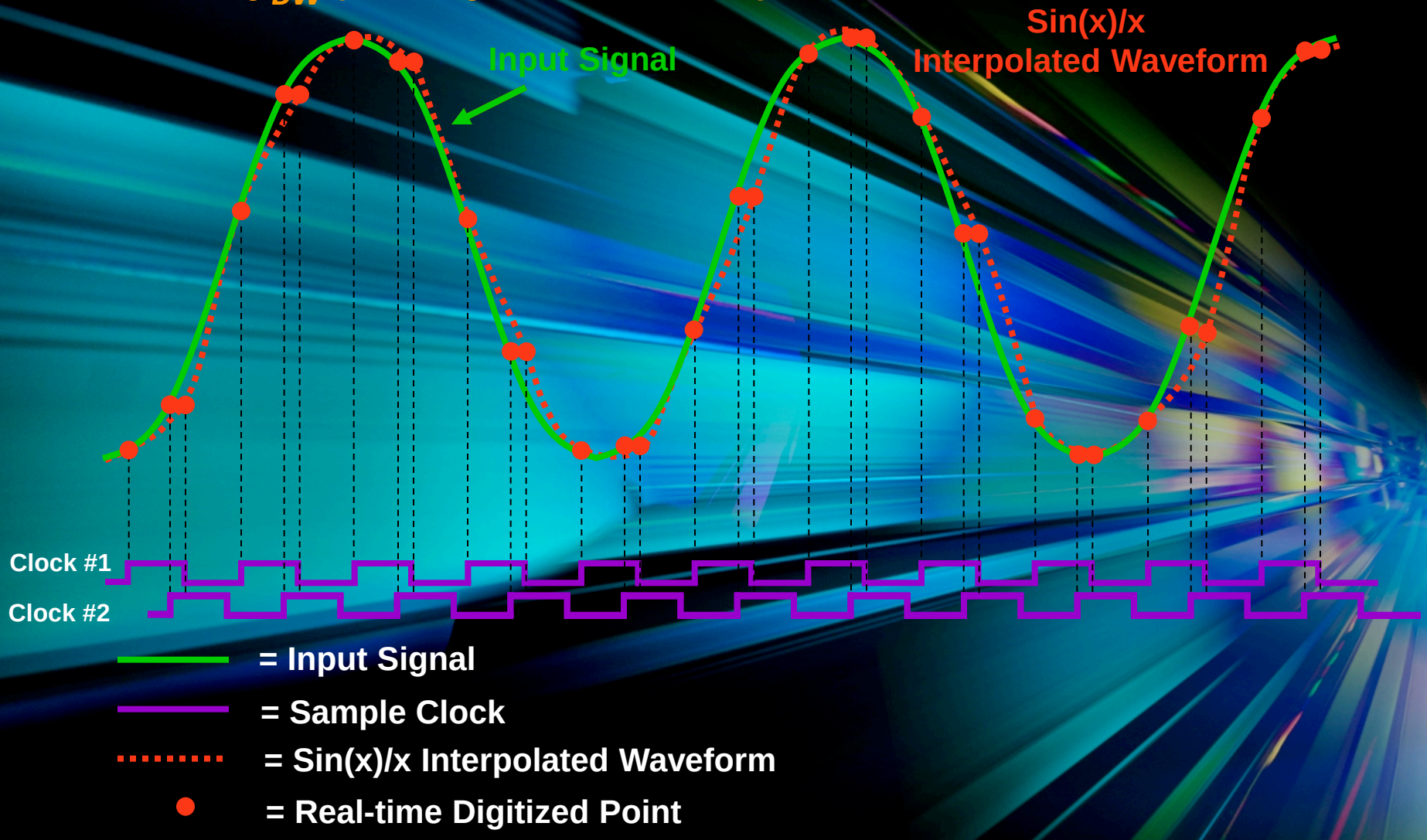
# Sampling

## - SR > 8 x $f_{BW}$ (Perfectly Interleaved)



# Sampling

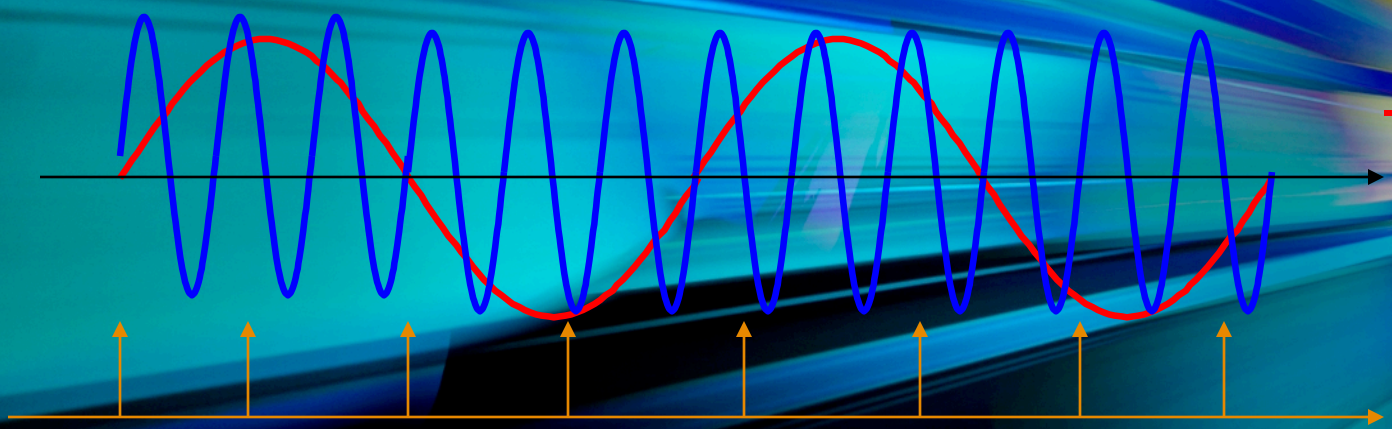
## - SR > 8 x $f_{BW}$ (Poorly Interleaved)



# Sampling
## *- Aliasing*

Aliasing occurs when the sample rate is too low. The result is an incorrect waveform of a lower frequency due to undersampling of the waveform.

$F_{aliased} = |N * F_{sample\ rate} - F_{original}|$




10Hz = | 2*30Hz - 50Hz |

# Agenda

***- We are here!!!***

- Analog Bandwidth
- Sampling
- Memory Depth
- Waveform Update Rate

# Memory

## *- Purpose of Memory In Digitizing Scopes*

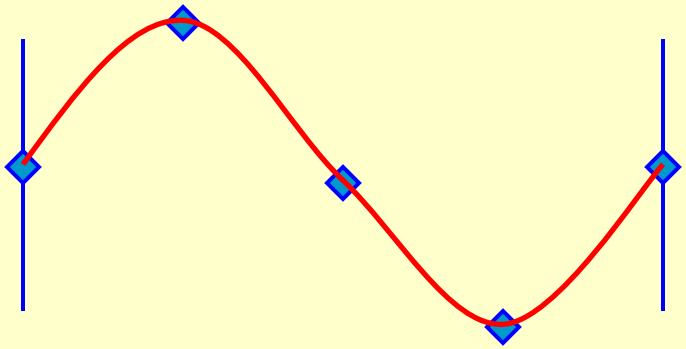
- Every Sample from A/D Converter Must be Stored in Memory
- Deeper Memory Stores More Samples
- Longer Periods of Time Captured Also Means

  More Samples to Store if Sample Rate is to be Maintained

# Memory

## *- Deep Memory Benefit*

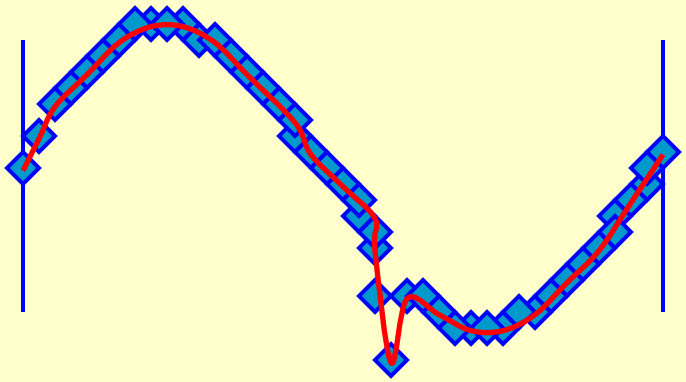
### Shallow Memory Oscilloscope



Acquisition for 1 sec

**Sample points: 5 points**
**Sample resolution: 200 msec**

### Deep Memory Oscilloscope



Acquisition for 1 sec

**Sample points: 50 points**
**Sample resolution: 20 msec**

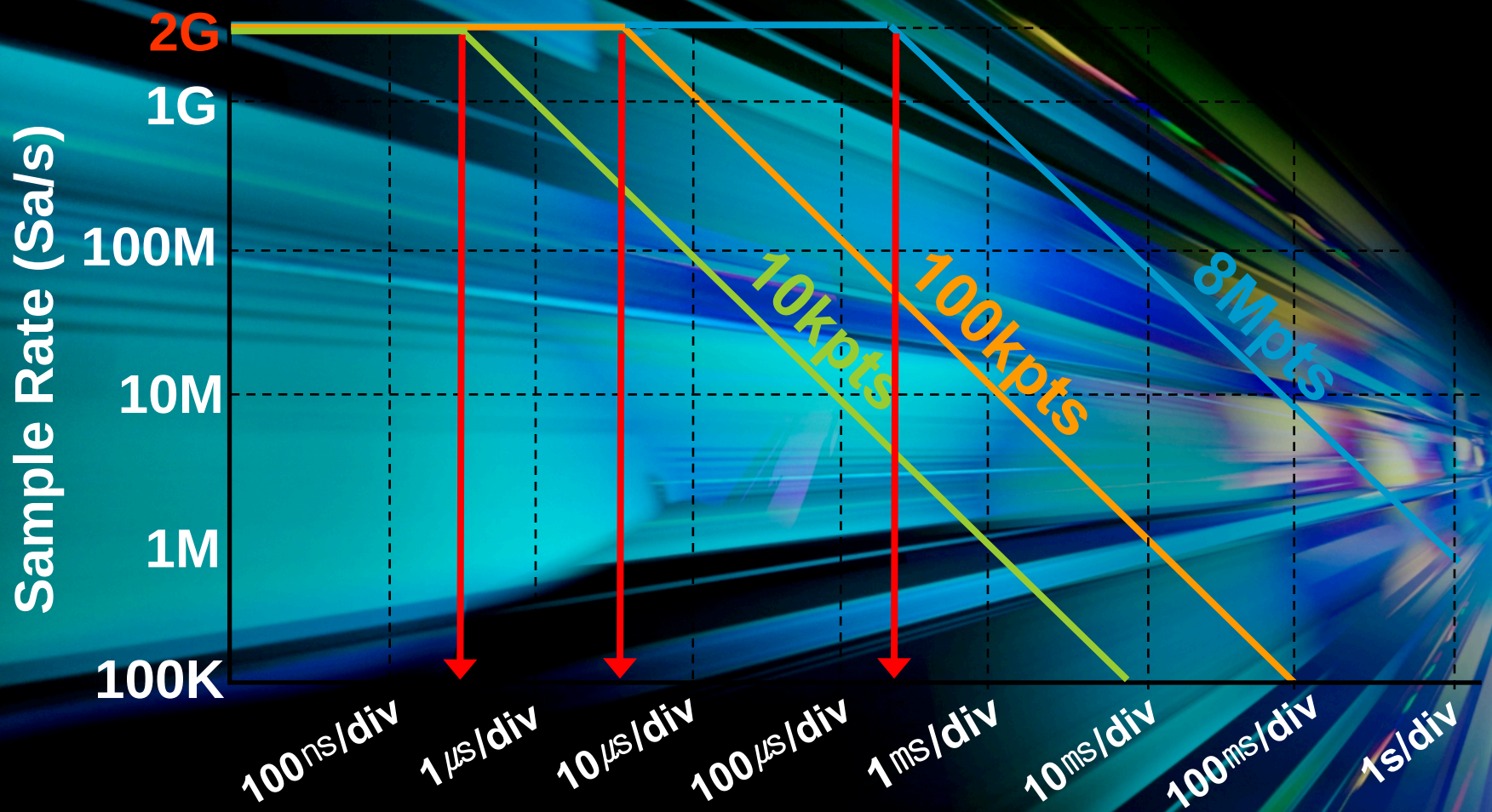
# Memory

## *- Purpose of Deep Memory*

- Maintain High Sample Rate When Capturing Longer Periods of Time
- Higher Sample rate =
  - More Accurate Reproduction of Signal
  - Better Resolution Between Points
  - Better Chance of Catching Glitches or Anomalies
- Deep Memory Especially Important In
  - Mixed Analog and Digital Applications
  - Serial Communication Applications

# Memory

## *- Sample Rate versus Time/Division Setting*



# Agenda

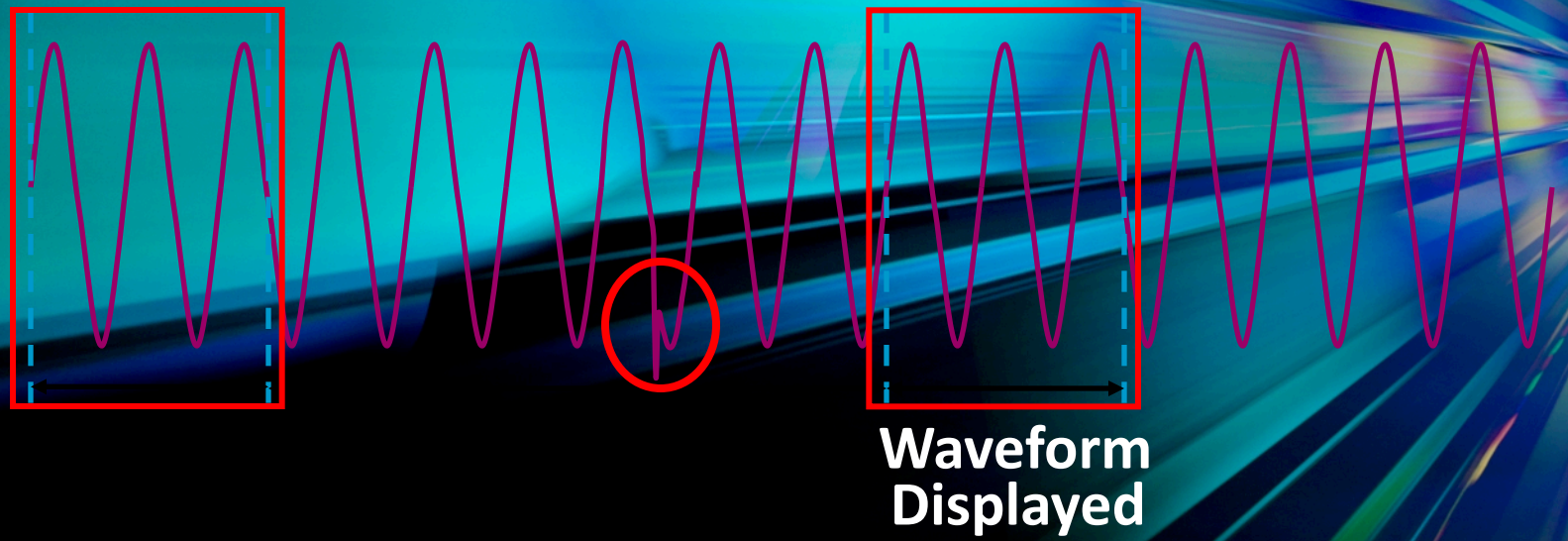
***- We are here!!!***

- Analog Bandwidth
- Sampling
- Memory Depth
- Waveform Update Rate

# Waveform update rate

## *- Potential Drawbacks of Deep Memory*

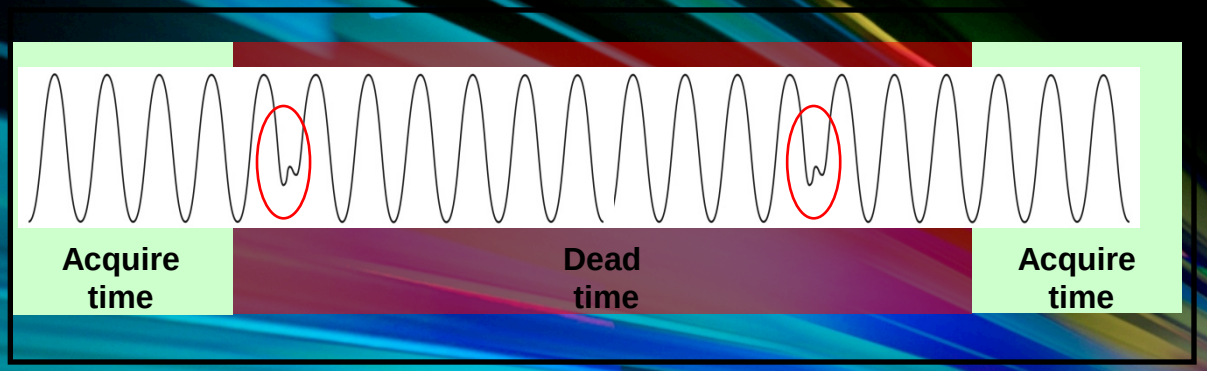
- Slower **Waveform Update Rate**
- Slower User-Input Response Time
- Increased Dead-Time Between Acquisitions
- Missed Glitches and Anomalies during Dead-Time



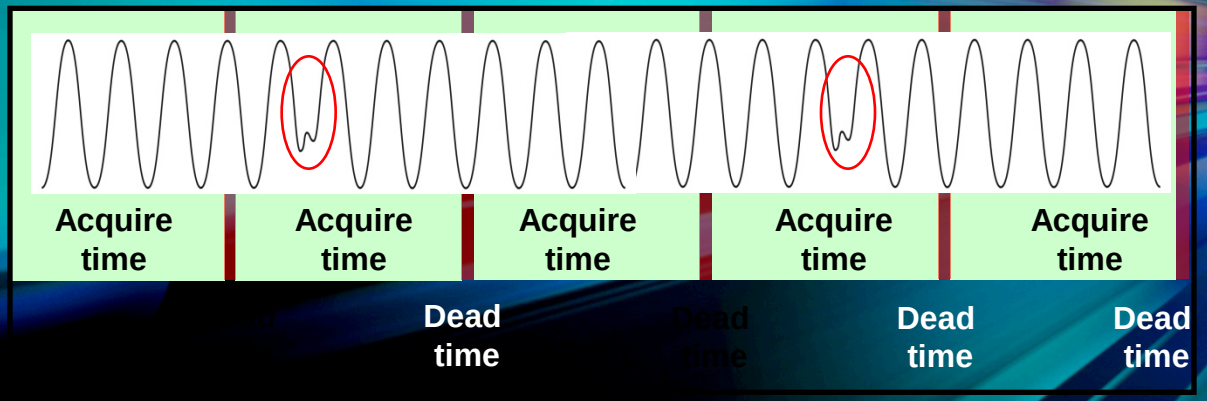
# Waveform update rate

## *- Finding Infrequent or Elusive Problems*

**Slower update rate**




**Faster update rate**



# Waveform update rate

## *- Agilent's Solution to the Dead Time Problem*

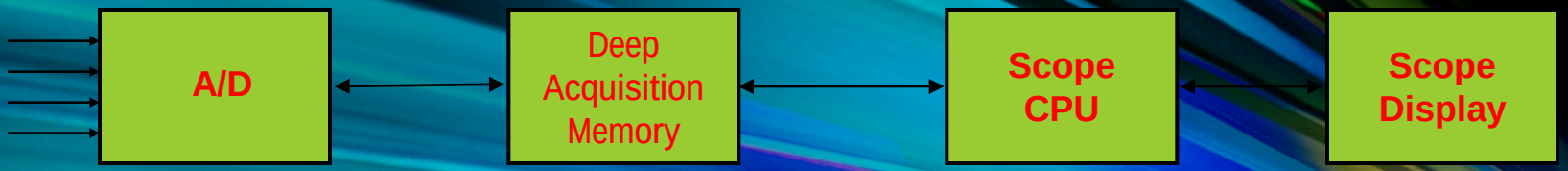
- Competitor's solution : Deep Memory as a option
- Custom ASIC Hardware Built into Acquisition System
  - **Agilent's Mega-Zoom IV Technology**
- Mega*Zoom* is a Memory Management tool
  - Preprocessing of Data in Hardware
  - No Special Modes - Always On and Always Fast
  - "Ping-Pong" acquisition memory

*Result is fast waveform update rate with minimal dead time between acquisitions and no processing bottleneck*

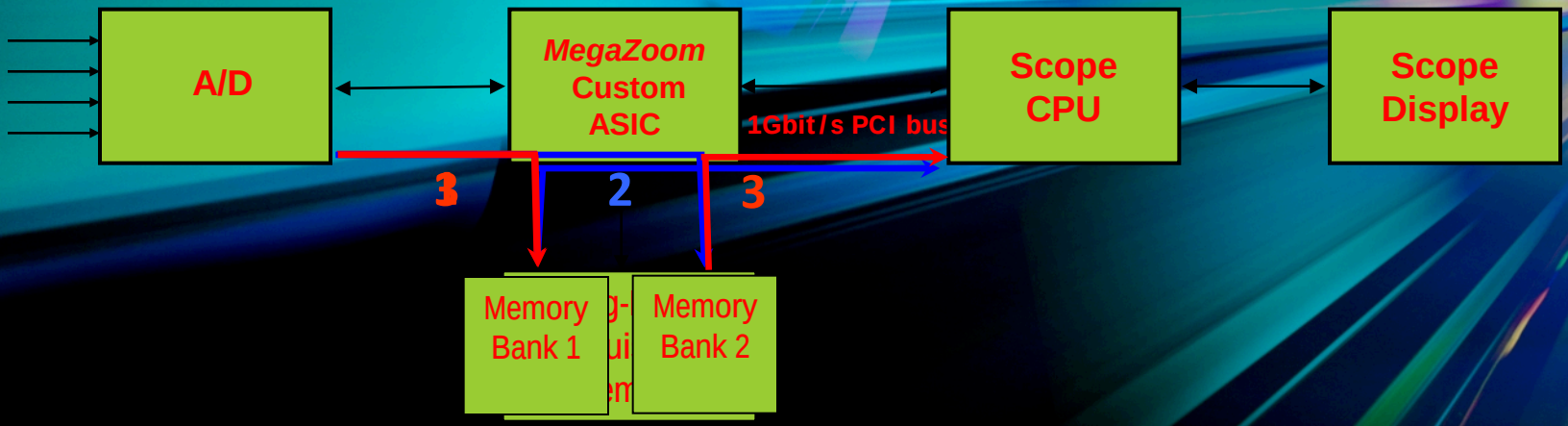
# Memory

## - *MegaZoom Technique : How does it work?*

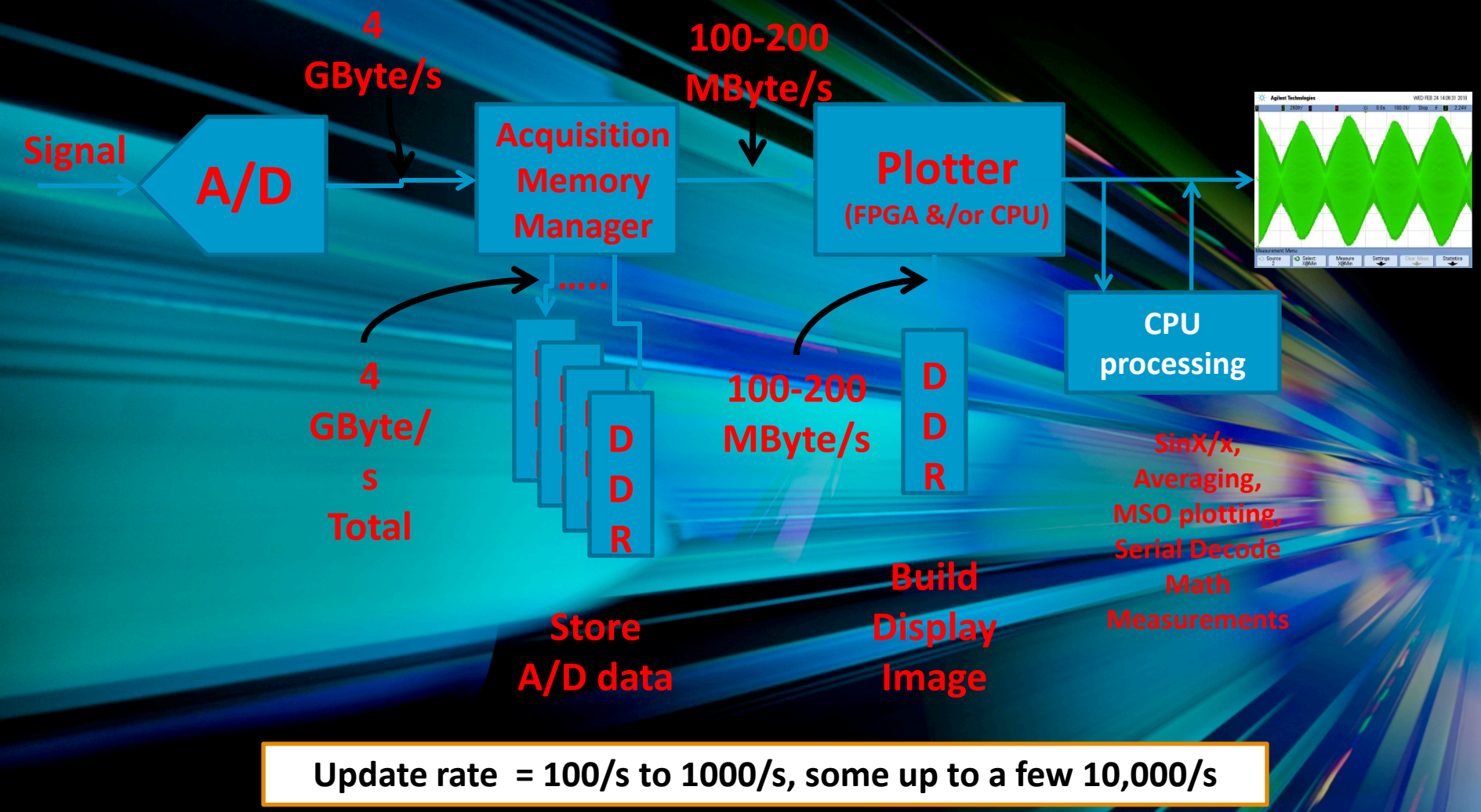
**1st Generation Deep Memory Oscilloscope Architecture**




***MegaZoom* - Next Generation Deep Memory Oscilloscope Architecture**

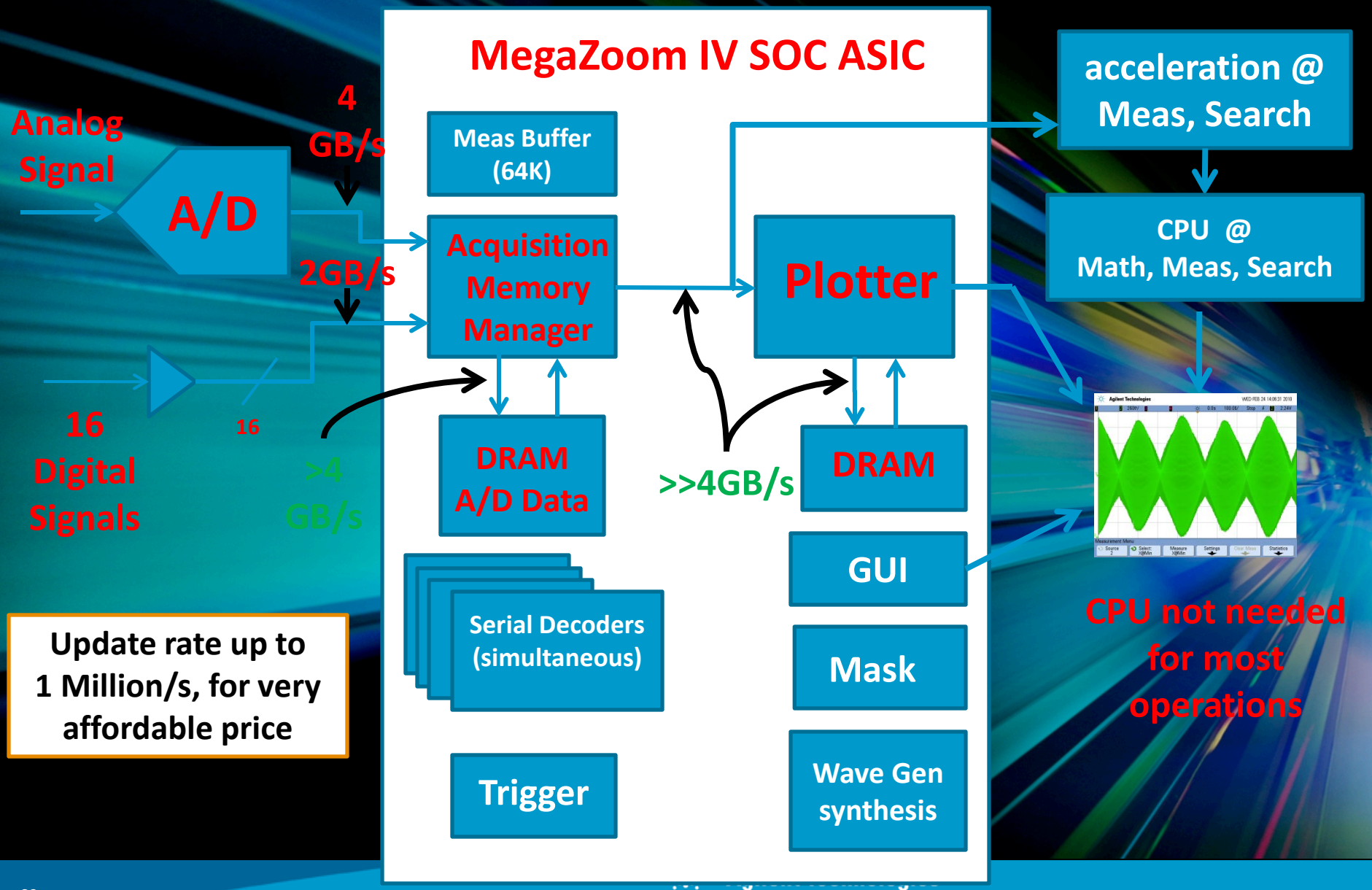


# Discrete Scope Block Diagram



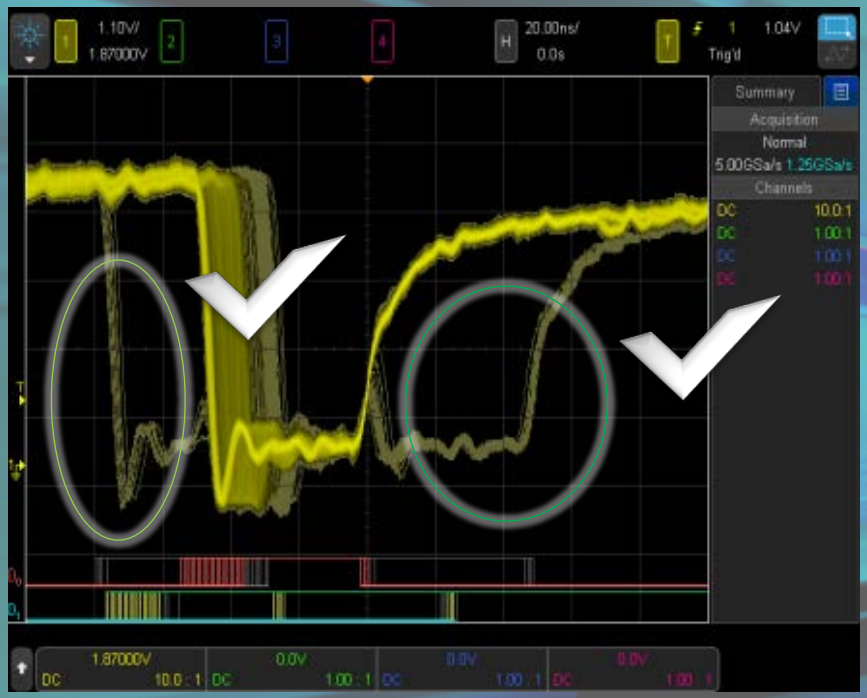

**Update rate = 100/s to 1000/s, some up to a few 10,000/s**

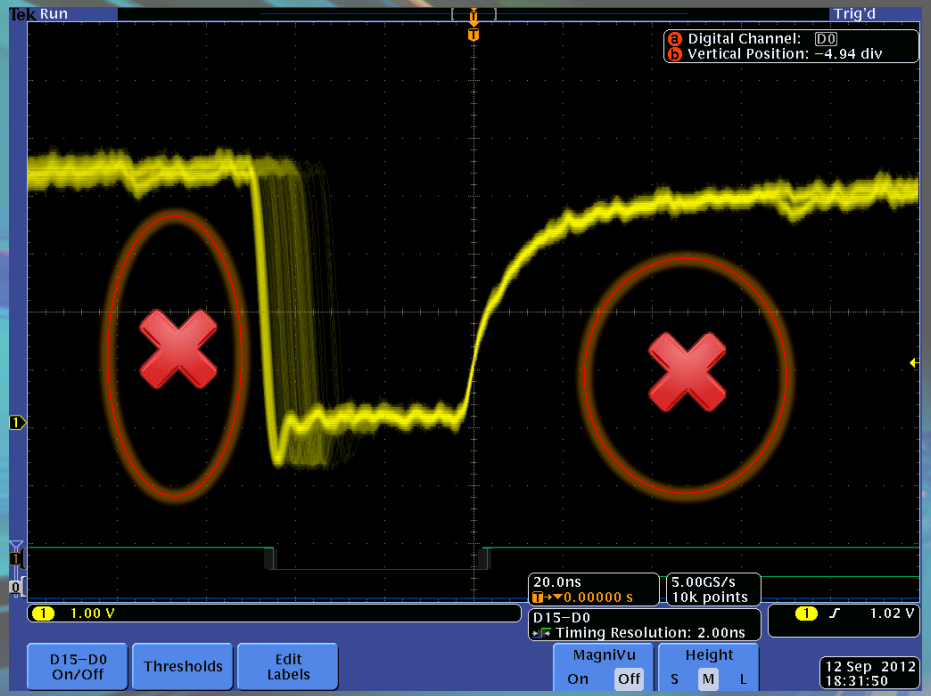
# MegaZoom IV Scope Block Diagram



# Waveform update rate

## *- Agilent Delivers Superior Real-time Measurements*




Agilent InfiniiVison 4000X
Fast update rate captures signal detail & glitches

Tek DPO4000
Slow update rate misses signal detail & glitches

# InfiniiVision 4000 X-Series
# -Model Line Up and Quick Facts -

| 4000 X-Series Specification Overview | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4022A | 4024 | 4032A | 4034A | 4052A | 4054A | 4104A | 4154A |
| Bandwidth * (-3dB) | | 200 MHz | | 350 MHz | | 500 MHz | | 1 GHz | 1.5 GHz |
| Calculated rise time | | ≤ 1.75 ns | | ≤ 1 ns | | ≤ 700 ps | | ≤ 450 ps | ≤ 300 ps |
| Input Channels | DSOX | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 4 |
| | MSOX | 2 + 16 | 4 + 16 | 2 + 16 | 4 + 16 | 2 + 16 | 4 + 16 | 4 + 16 | 4 + 16 |
| Maximum sample rate | | 5 GSa/s half channel, 2.5 GSa/s all channel | | | | | | | |
| Maximum memory depth | | Standard 4 Mpts, Standard segment memory | | | | | | | |
| Display size and type | | 12.1-inch High Definition Capacitive Touch Display | | | | | | | |
| Waveform update rate | | > 1 Million waveforms per second | | | | | | | |
| US List Price | DSOX | $ 5,600 | $ 7,000 | $ 8,700 | $ 10,900 | $ 11,400 | $ 14,200 | $ 17,200 | $ 19,200 |
| | MSOX | $ 8,400 | $ 9,800 | $ 11,500 | $ 13,700 | $ 14,200 | $ 17,000 | $ 20,000 | $ 22,000 |

- Public Introduction: November 13th, 2012
- Initial SRT: 6 weeks (5 weeks stable state)
- Product Category: A (disty preferred)
- Demo units: 200 units worldwide. Available around the end of Oct
- Pricing Strategy: On top of Tek DPO/MSO4000B
- Replacing product: InfiniiVision 7000B

# InfiniiVision 4000 X-Series Scopes


## Oscilloscope *Experience* Redefined

- **Experience the *Speed***
  - 1,000,000 wfm/s
  - Mega*Zoom IV* smart memory
- **Experience the *Usability***
  - InfiniiScan Zone touch trigger
  - Design for touch interface (12.1in)
- **Experience the *Integration***
  - 5-in-1 instrument now with:
    - Dual-channel AWG
    - USB serial analysis
  - Fully upgradable

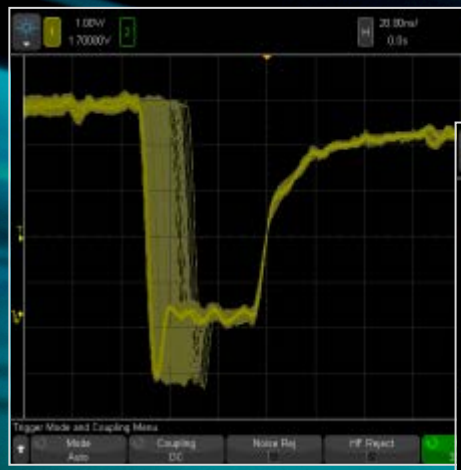


Agilent Technologies

# InfiniiVision 4000 X-Series Scopes

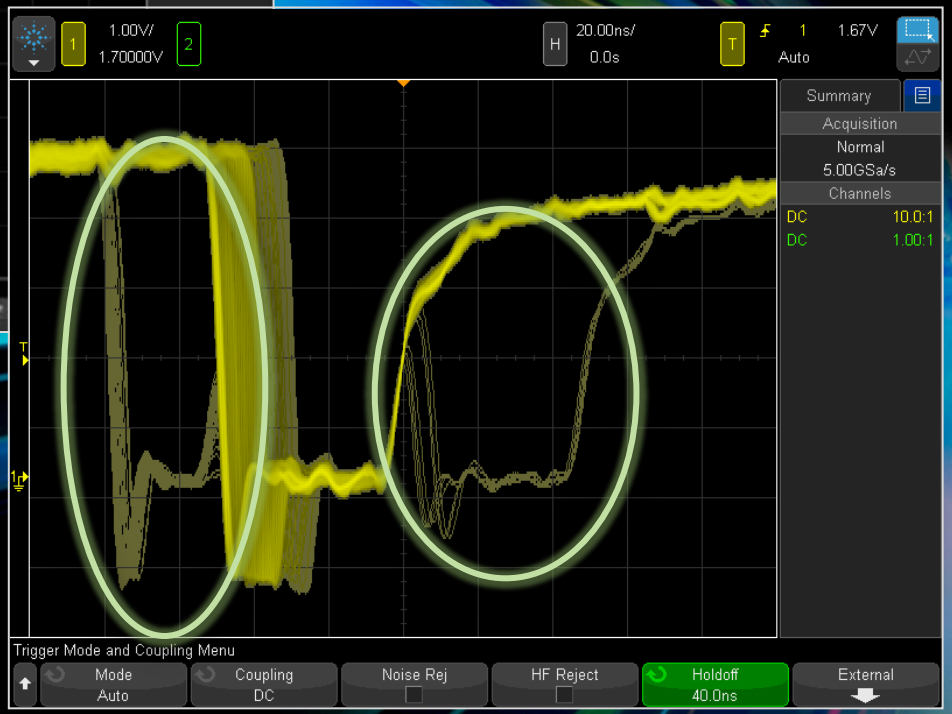
## Experience the *Speed*

- Fastest waveform update rate up to *1,000,000* waveforms/second



**3000 wfms/sec**
**Missing signal detail**

**55,000 wfms/sec**
**Some anomalies found**




**1,000,000 wfms/sec**
**ALL anomalies found**

# InfiniiVision 4000 X-Series Scopes

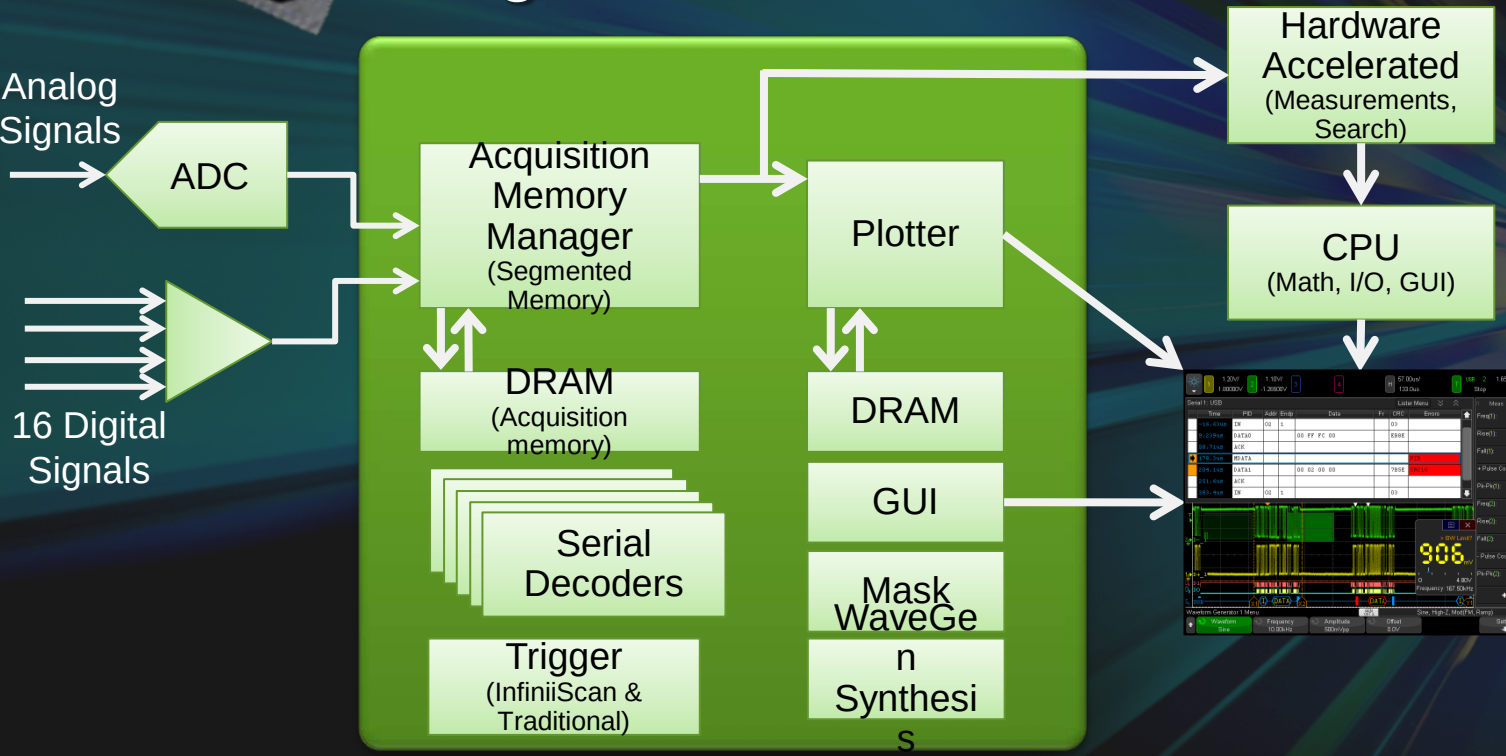
## Experience the *Speed*

- MegaZoom IV smart memory technology
  - Responsive
  - Uncompromised
  - Segmented memory (standard)

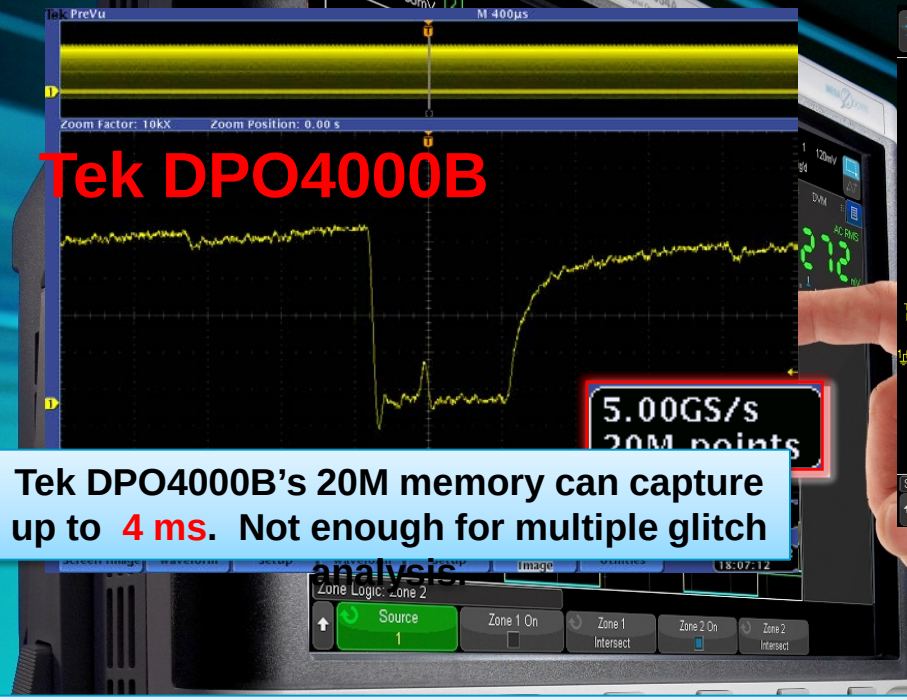
# MegaZoom IV ASIC Architecture

**Experience the *Speed***

## MegaZoom IV ASIC

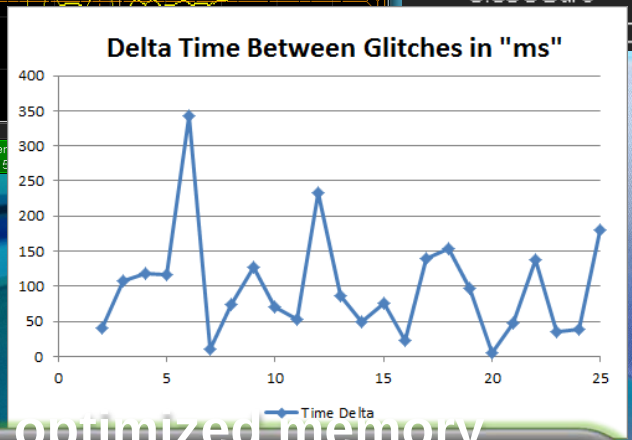


# Experience the Speed: The Optimized & Efficient Memory Standard Segmented Memory








Tek DPO4000B's 20M memory can capture up to 4 ms. Not enough for multiple glitch analysis.

Segmented memory captured 1000 glitches over 66 sec of time, revealing the critical inter-glitch time info. It takes 330 Tpts (Tera-points) of memory on Tek DPO4000B.

**Segmented memory provides efficient and optimized memory solution-**

**Mkt Needs Met!**

# InfiniiVision 4000 X-Series Scopes

## Experience the *Usability*


- InfiniiScan Zone touch triggering
- Design for touch interface
  - Capacitive touch screen technology
  - Easily touchable targets
- Industry's largest 12.1" display



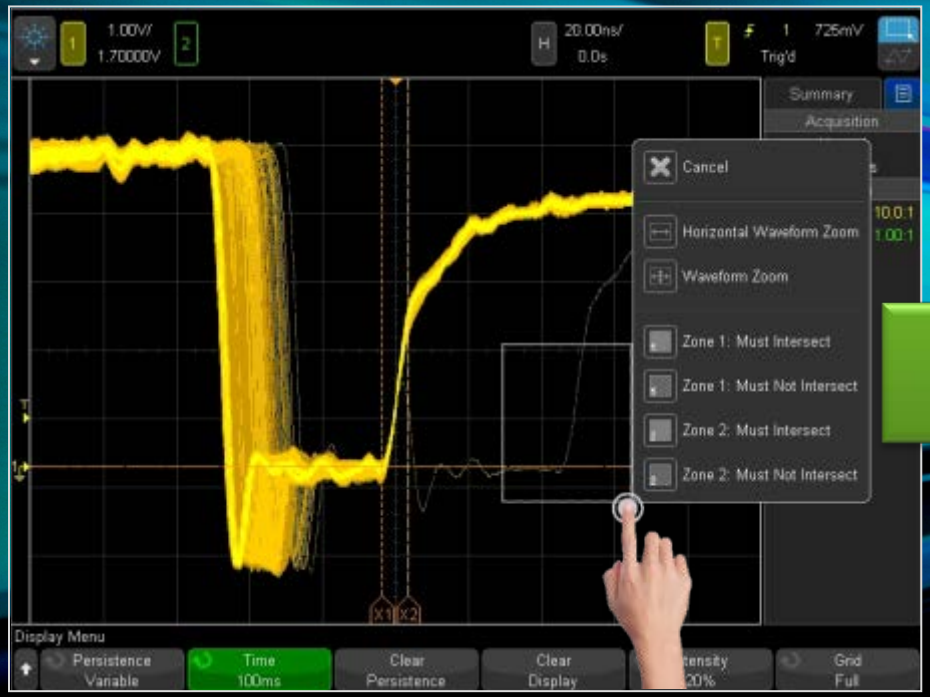
Agilent Technologies

# InfiniiVision 4000 X-Series Scopes

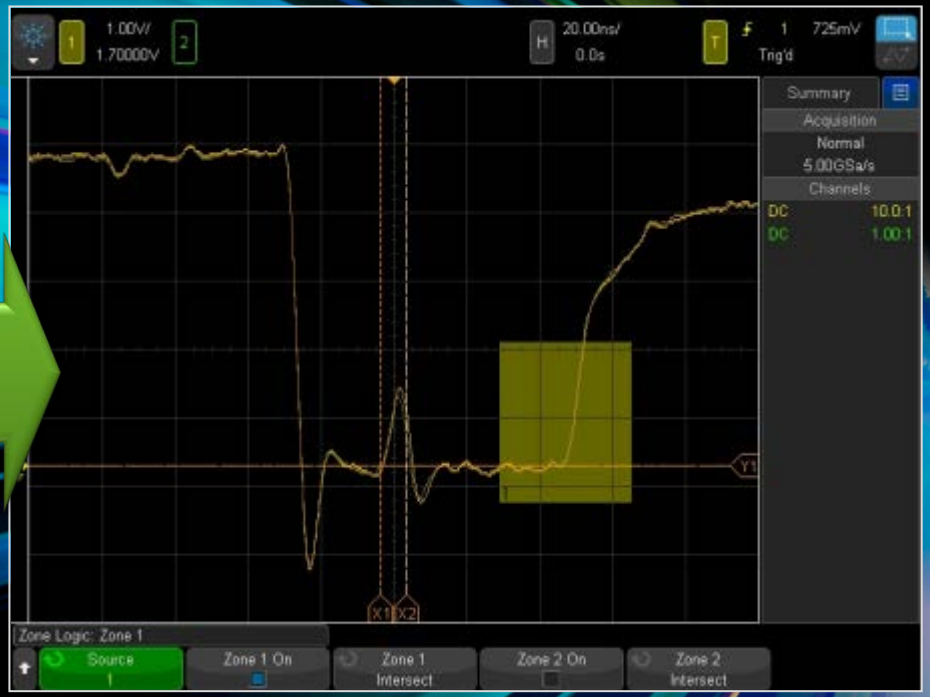
## Experience the *Usability*

**InfiniiScan Zone touch triggering –**

***If you can see it, you can trigger on it***




**Capture infrequent anomalies/events with fast waveform update rate**




**Simply drag a box around what you want to trigger on**

# InfiniiVision 4000 X-Series Scopes

## Experience the *Usability*

## Design for touch interface


Remote operation available via PC or a tablet device

Three Ways to Drive: front panel, touch screen, and Agilent spark pull down

Large, easily touchable targets—just like a tablet device

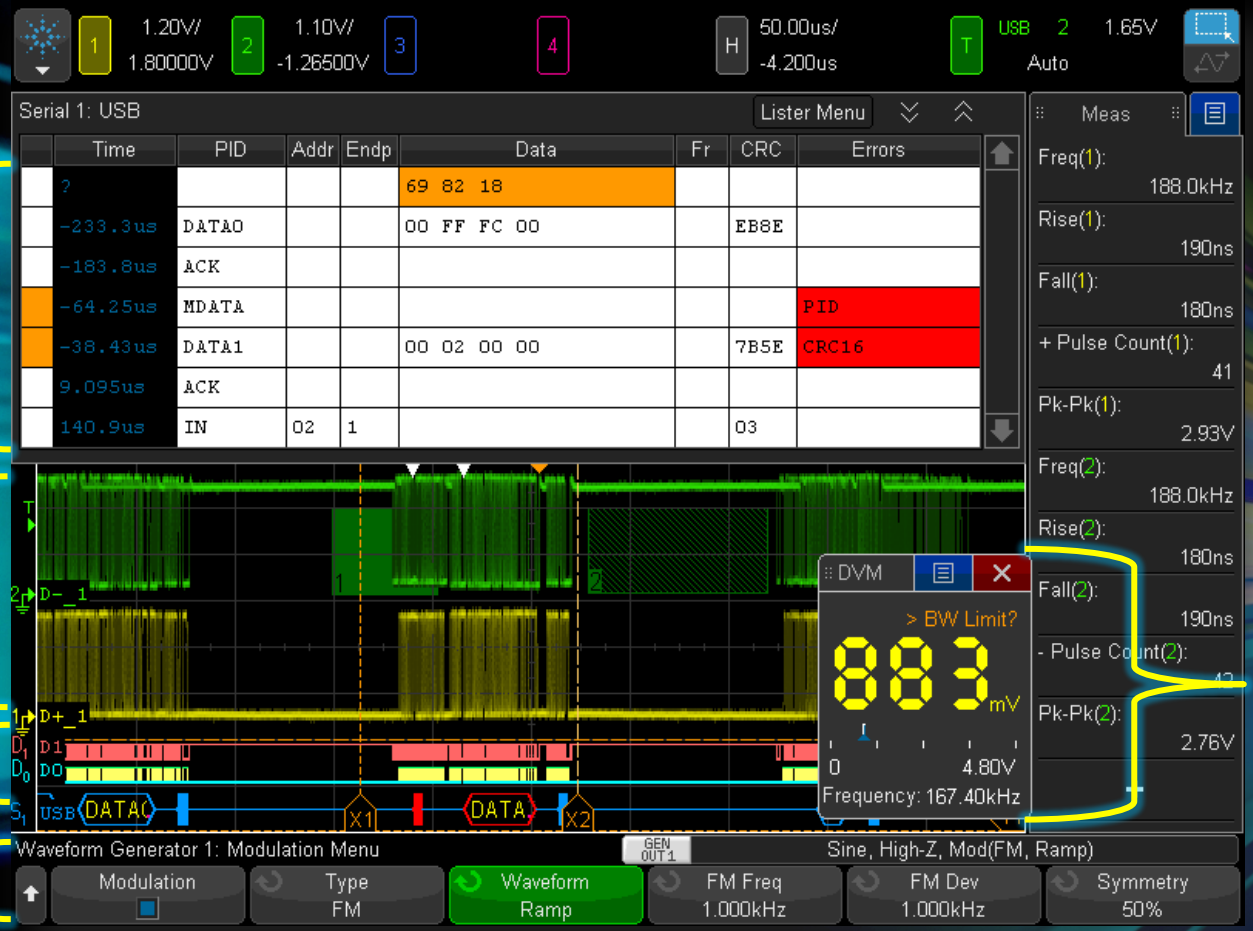
# InfiniiVision 4000 X-Series Scopes

## Experience the *Integration*

### Fully Upgradable

- Best in class to **1.5 GHz** oscilloscope
- WaveGen built-in **dual channel** 20MHz arbitrary/function generator
- Mixed-signal oscilloscope (MSO) with +16 digital ch.
- Protocol analyzer with hardware-based serial decode, including **USB**
- DVM integrated 3-digit voltmeter

# Maximum Investment Protection
## The Fully Upgradable 5 in 1 Instrument




Protocol analysis (10 serial protocols)

Analog channels

Digital channels

Dual-channel WaveGen

Integrated DVM

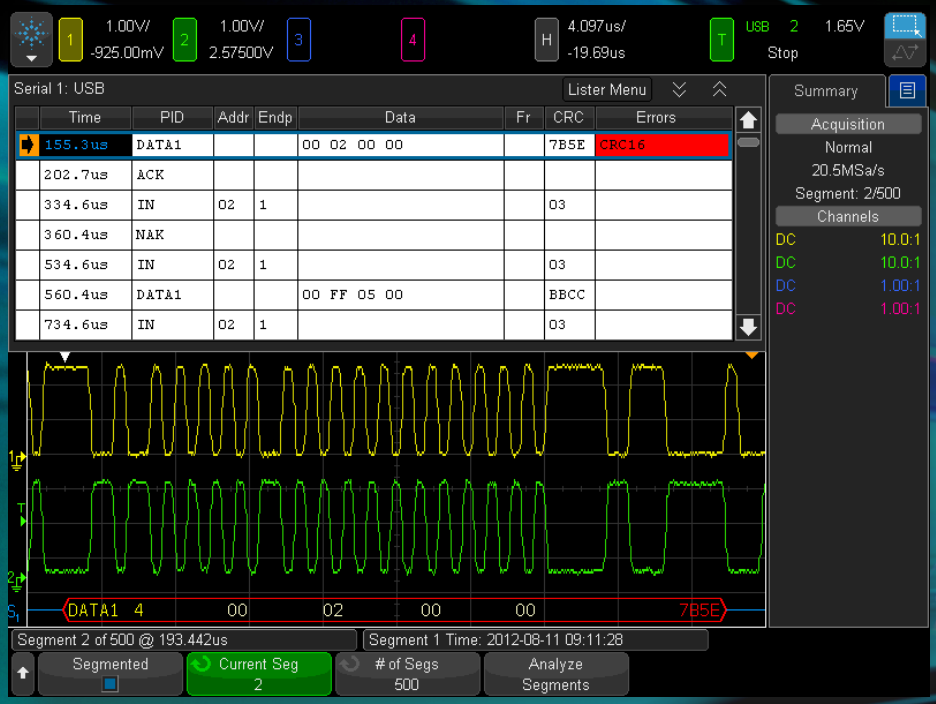
**Bandwidth upgradable up to 1.5 GHz, plus more application solutions**

**The 4000 X-Series provides unprecedented investment flexibility**

–

**Mkt Needs Met!**

# Experience the Integration:
# New USB 2.0 Trigger and Decode Option




**New InfiniiMode N275x series is ideal for USB 2.0 Hi-Speed**

- **DSOX4USBH (Hi-Speed: $1,020) and DSOX4USBFL (full and low speed: $510).**
  - DSOX4USBH is available with 1GHz and 1.5GHz model only
  - DSOX4USBH is NOT a superset of DSOX4USBFL
  - InfiniiVision 4000X supports InfiniiMode N275xA differential probe series
  - Tek does not have a full & low speed only solution (Tek's USB solution: $1,610)

# Experience the Integration:
# Dual-Channel WaveGen with Modulation



## Target applications and customers: Why a dual-channel WaveGen

| Dual-Channel WaveGen | Simple Modulation |
|---|---|
| Differential signal outputs | Student lab to include modulation exercises |
| Low speed serial bus clock & data output | Combine with scope's features like FFT |
| More complex modulations / IQ output | #1 enhancement request on WaveGen |
| R&D and education | Education |

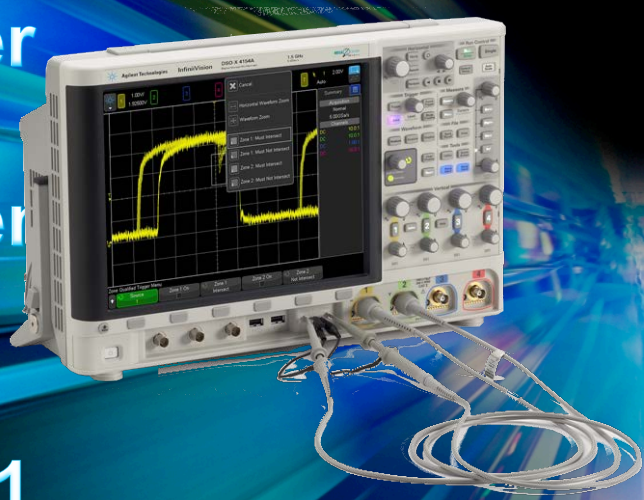
# Summary

## *Speed*

- Fastest update rate on the market
- Never compromised: hardware solutions
- Catch more infrequent events, faster and easie

## *Usability*

- InfiniiScan Zone touch trigger
- Segmented memory
- Small, quick, portable, efficie
- Touch-first design



## *Integration*

- Save space, money with 5-in-1
- Always upgradable later – investment protectio

# Questions?