Multi-protocol monitoring using oscilloscopes

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Regardless of the system topology and application domain, the development, maintenance and monitoring of electronic system architectures using mixed protocols require tools able to straddle several buses, at various speeds and with different line characteristics. Today's oscilloscopes, with flexible input channels and advanced toolsets, are ideally suited to this task.

Why would a system need several protocols?

The need to incorporate several protocols can be due to historical, technical, commercial or compatibility reasons. Modern system architectures often exhibit a backbone transmission using a high speed protocol from node to node over several tens or hundreds of meters. Each node on the backbone distributes selected information to local nodes using a lower speed, less expensive protocol to neighboring devices. In this case the oscilloscope would be used to monitor the nodes input (in one protocol) and output (in another protocol) and verify their coherency, both in time and contents. As an example, a vehicle could have a FlexRay (fast, extremely robust but expensive) backbone, and a LIN bus (slow, nearly free and safe) in each seat and door. As another example, the Airbus A380 combines a CAN bus and ARINC 429. In this case the reason is historical: many of the radio communication and navigation systems are manufactured with an interface to the ARINC 429 bus only. Examples like this abound in other industries, such as automation, textiles, printing, medical field, bottling machines, construction equipment, mining and more. The following section explains how the instrument elegantly handles the multiple protocols.

How users access multiple protocols

As an example, a LeCroy DSO is designed to support 4 independent, yet simultaneous decoders. The Serial Decode tab is the main entry point into the system.

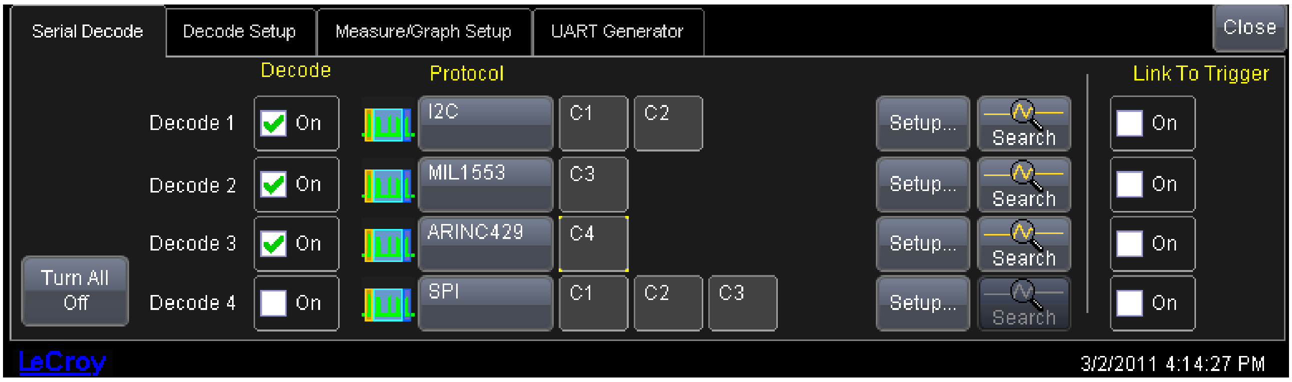

Figure 1: The User Interface exhibits an array of 4 Decoders, each one with the appropriate inputs (Data, Clock, Chip Select), analog or digital. The setup tabs of each decoder adjust dynamically to the selected protocol.

The protocol list depends on the options purchased on the units, and is usually matched to the field of application in which the instrument is used, and can look like figure 2.

Figure 2: Protocol selection popup, with a variety of serial streams used in different application domains.

How Oscilloscopes support multiple protocol.

Current advances in oscilloscope technology combine the power of a dedicated protocol analyzer with the versatility of an oscilloscope. New oscilloscope trigger and decode packages, enabled by increased memory length, processing power, and display technology, provide analysis functions for various serial protocols. The protocols supported span very common streams (RS232, I2C, SPI), avionics (MIL-STD-1553, ARINC 429, EFAbus, STANAG 3910), automotive (CAN, FlexRay, LIN) , audio (I2S, TDM), cellular technology (MIPI), or high-speed busses (USB1.x/2.0/3.0, SATA, PCI Express, 8b/10b).

Increased memory length allows the capture of serial streams over useful time spans at the appropriate sampling rate for each protocol. The processing power lets the unit decode the serial stream into its most fundamental components, such as bits, bytes, words, packets, messages, transactions at high rate, on several channels. Bigger displays offer the real estate necessary to monitor and understand several digital streams and also other related analog signals at the same time.

There are many advantages to these new Serial Data Trigger and Decode tools on an oscilloscope and one limitation. The oscilloscope does not acquire and store continuously, as does a protocol analyzer. However, during the “open eye” time the oscilloscope sees everything, from the glitches on the signal, all the way to corrupted transactions. The protocol analyzer, on the other hand, can stream data to disk for hours or even days, but with a one-dimensional view of the transmission since the signal data is not stored along with the decoded contents.

Analyzing a MIL-STD-1553 to UART transaction

This section shows an example of simultaneous observation of several serial streams of different nature.

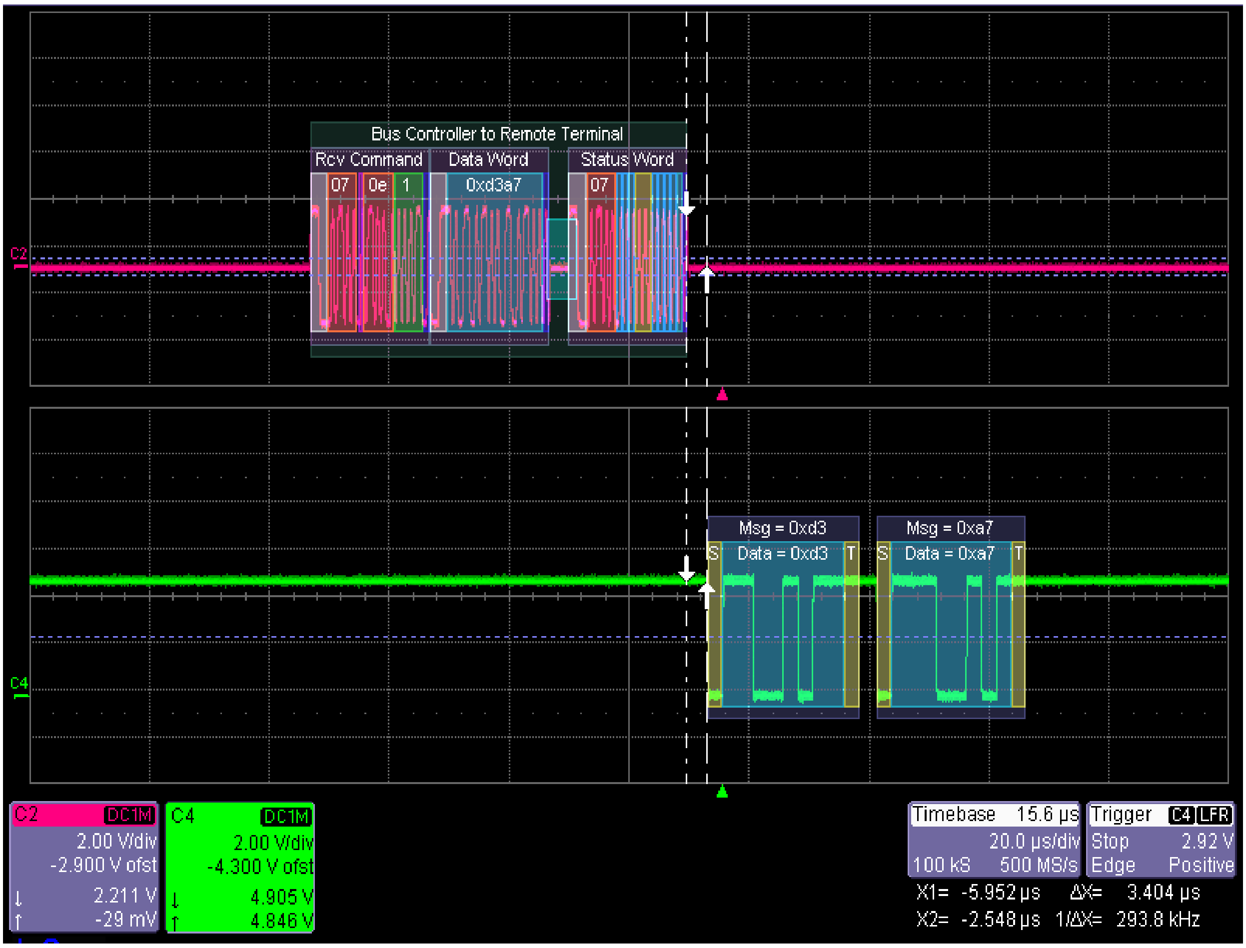

Figure 3: An example of a MIL-STD-1553 (1 Mb/s, Manchester) bus on Channel 2, inducing a UART message (400 Kb/s, NRZ) on Channel 4. The approximate translation latency of 3.4 microseconds is read out using the cursors. The data word 0xd3a7 on the CAN bus is split into 2 words on the UART bus.

The digital oscilloscope acquires signals of nearly any nature on different channels simultaneously, as shown in the image above. Thanks to the flexibility of a channel (in terms of sensitivity and bandwidth), each channel can be tuned to optimally record signals carrying different types of protocols. The precise time alignment between the channels is preserved because the channel's ADCs operate synchronously. In other words, an event occurring first on a given channel will be recorded before an event occurring later on another channel.

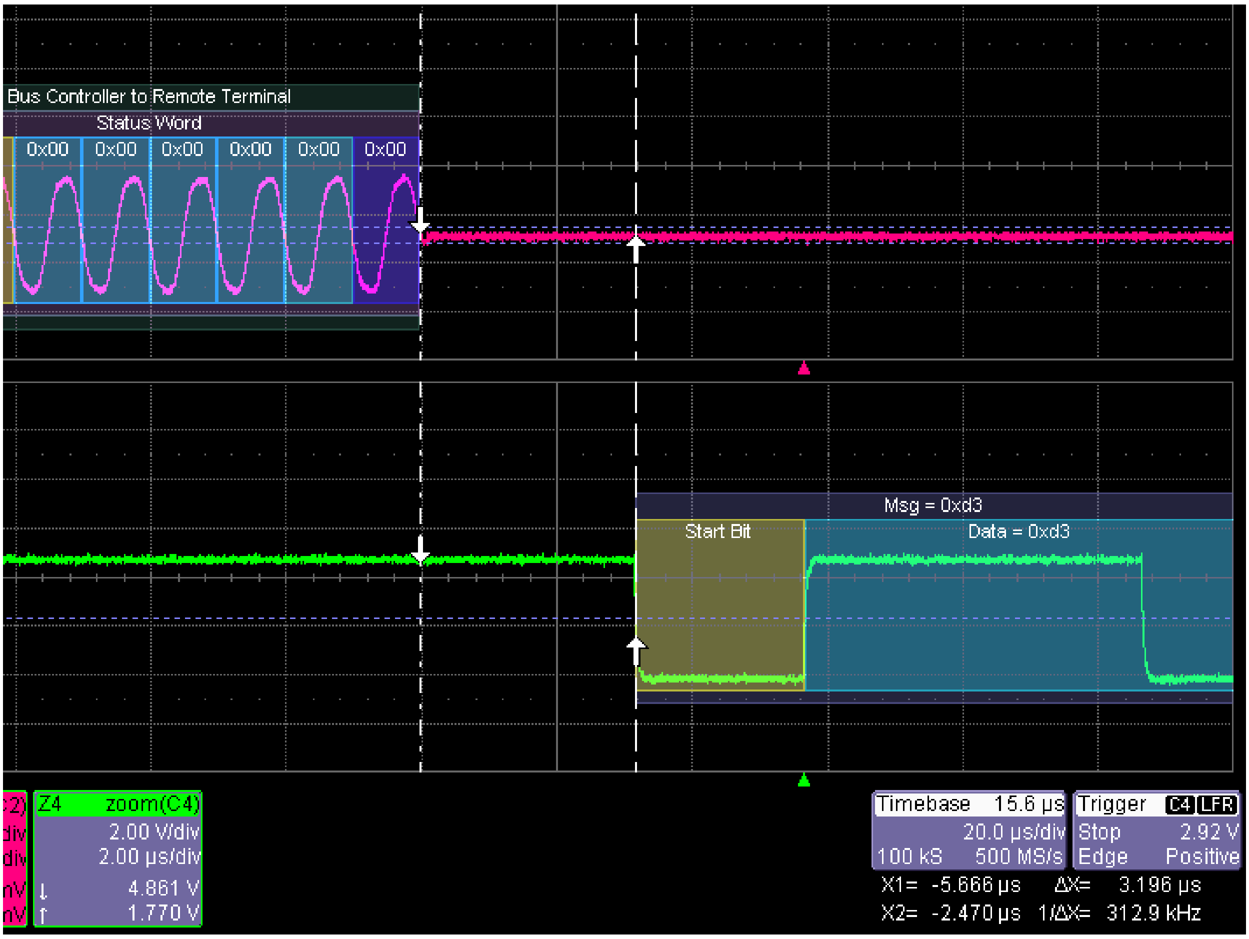

Figure 4: Shown here is a zoom of Figure 3. The synchronous acquisition on all channels permits observation and measurement of the time difference between the end of the MIL-STD-1553 message (end of the parity bit) to the beginning of the UART message (beginning of the Start Bit). The time lag is measured as 3.196 microseconds.

Multiple Protocol Time Alignment

Time alignment is important, since systems combining several data streams have strict cause-consequence relationships between the packets of information transiting on the networks. When a packet is received from the backbone link (cause), it has to be passed on to the lower speed link (consequence). The consequence is expected to happen within a well-specified amount of time after the cause. This latency, or time delay, can easily be observed with an oscilloscope equipped for multiple protocol monitoring. Not only can the latency be observed visually on the oscilloscope screen, but it can also be quantified statistically. For example the latency of a gateway translating messages from MIL-STD-1553 to UART could be characterized as 2 to 10 microseconds, with 80 % of the packets being translated in less than 5 microseconds. This indication would help the avionics engineer in tracking errors on the aircraft.

Conclusion

Relentless technological advances in the digital oscilloscope arena have fostered a new generation of tools aimed at visualizing, triggering and decoding serial data streams. These tools help system engineers at all levels in understanding the complex events occurring on single or multiple data busses, in different domains of industry.