The LXI Reference Design on Different Microcontrollers

Submitted by TSEP

In March 2016, the LXI Consortium released the LXI Reference Design, Version 1.0. With the help of the Reference Design, which is available as source code, it has become easier for members of the LXI Consortium to adopt this standard in their devices. Also, instrument vendors that have not supported the LXI standard yet, have a much better option for saving time and cost using the LXI Reference Design.

The LXI Reference Design was mainly developed for the Windows and Linux operating systems. On Windows, the Intel x86 and x64 architectures are supported. On Linux, the range of CPUs is wider. Here not only the Intel x86 and x64 architectures are supported, but also the ARM processors. One of the development platforms of the LXI Reference Design was an Ubuntu Linux on a Cubieboard with an ARM processor.

Instrument vendors not only use the common platforms, but have also built other platforms into their measuring devices and processors, since many instruments do not require such powerful platforms.

A group of measuring devices rely on under-performing processors, which in general are equipped with proprietary operating systems. To be able to port the LXI Reference Design with such means, the operating system must fulfill following requirements:

- Support threads
- Support a locking mechanism such as mutex or something similar
- TCPIP Stack, if possible Berkeley Sockets

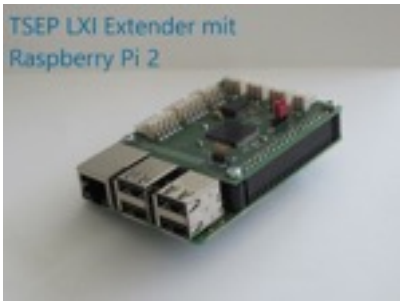
Additionally the developing tools must fulfill following constraint:

- C++ Compiler

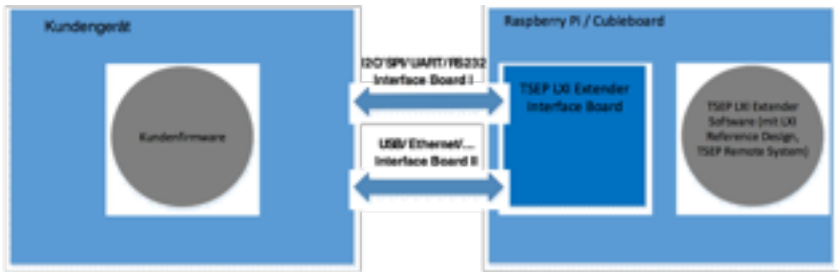
In 2015, TSEP undertook a feasibility analysis for the STM3220G-EVAL Evaluation Board with ARM®Cortex™-M3 32-bit microcontroller. The available operating system for the STM microcontroller fulfilled the requirements mentioned above; therefore, the LXI Reference Design could then be ported. The adjustments of the resources were easily manageable due to the configurability of the LXI Reference Design. Because this microcontroller is equipped with little memory, the resources for the LXI Reference Design were reduced by about 50%.
The transferring of the operating system accesses is made easy, since all of these accesses in the LXI Reference Design are bundled in an OS Abstraction Layer. For the usage of threads and mutex's, a different approach had to be used then in the LXI Reference Design, as dynamic allocations of these resources are not available with this operating system. For the mDNS support the operating system had its own implementation available, which covered a part of Apple's implementation. Summarizing the effort, the transferring was passed with no major problems. The LXI Reference Design was easily adapted and the concept is flexible enough to realize design changes easily, for example, with the threads.

Nevertheless another group of microcontroller exists, such as the Cypress PSoC 5 microcontroller. These are also based on ARM architecture, however they are located at the

lower spectrum when taking a look at memory and performance. Also the price of under 5 dollars for the microcontroller shows that these microcontrollers are used in simpler or low cost devices. These microcontrollers do not fulfill the requirements mentioned above. Transferring the LXI Reference Design would be technically possible but economically seen more of a problem.



Due to this TSEP has developed the TSEP LXI Extender. Based on a low cost Linux system like Raspberry Pi or Cubieboard and the TSEP LXI Extender Interface Board now any µC can be connected via a standardised interface. Additionally it is of course possible to use the TSEP LXI Extender with customized hardware.



TSEP supplies an extended LXI Reference Design on a low cost Linux system. Via additional drivers, one can communicate with the established µC over a defined interface. Therefore, data and measuring results can be exchanged. Additionally the TSEP Remote System V2 is integrated in this solution with which clients are able to communicate via SCPI with the measuring device. The measuring instrument manufacturer has here the possibility to implement their own commands. With the TSEP LXI Extender measuring devices and test systems get a considerable extension of their functionalities.

The communication with the established measuring device hardware takes place via a standardized interface. The TSEP LXI Extender Interface Board I offers the interfaces I²C (Master/Slave), SPI (Master/Slave), UART and RS232. The TSEP LXI Extender Interface Board II supports the interfaces with higher data rate like USB and Ethernet. The TSEP LXI Extender Interface Board is fitted directly onto the linux basis board and communicates directly with the Linux system. The interface is set up bidirectional. To communicate between the device hardware of the vendor and the TSEP LXI Interface Board a protocol defined by TSEP is used, which is the same for all interfaces. For this protocol, a reference implementation in C is available. Via this protocol, not only the necessary data for the LXI Reference Design is exchanged but also vendor-specific data such as measured data and so on. This data can then be read or changed by the integrated remote system via the SCPI interface.

The LXI Reference Design can be used versatile, regardless of HighEnd measuring devices for Windows or Linux, middle class measuring devices on Linux with ARM processors or in the area of low cost with own microcontrollers.