TECHNICAL SOFTWARE ENGINEERING PLAZOTTA

Our work is inspired by science, not fiction!
The change in remote control from the central test computer to distributed systems

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Agenda

• Overview development of remote control
  • Hardware Standards
  • Software Standards

• LXI – LAN Extensions for Instrumentation

• LXI – „Extended Functions“ for distributed Systems
  • Time Synchronous Measurements (1588)
  • Event Messages

• Applications

• Summary
Overview Development of Remote Control

- Hardware Standards:
Hardware Interface - GPIB

• „Standard Digital Interface for Programmable Instruments”
  • IEEE488.1 – 1975

• Standardized Bus-Interface:
  • max. length: 20m
  • max. number of devices: 15
  • max. data rate: 1 MByte/s

• Features: Controller, Talker, Listener
Hardware Interface - USB

- USB – Universal Serial Bus
  - Hot Plug-In, Automatic detection and configuration
  - Up to 127 Devices (with hubs)
  - 4-wire: 5V supply & data/clock line

- USBTMC - Test and Measurement Class

- USB – IEEE488 Emulation
  - 2 Bulk Transfer Channels (Listen, Talk)
  - 1 Control Channel (DCL,..), 1 Interrupt Channel (SRQ)
Hardware Interface - LAN

- Ethernet: Serial Bus - IEEE802.3
  - CSMA/CD: Carrier Sense Multiple Access with Collision Detection
  - Indeterministic in time behavior
- Ethernet Transferraten:
  - 100Base-T: 100 Mbps ~ 8 Mbyte/s
  - GigaBit Ethernet ...
- LAN - Technologies:
  - Ethernet
  - Fiber
  - Wireless
- Standard Interface for PC’s
Overview Development of Remote Control

• Software Standards:

- Application Interface
- Protocol Layer (ASCII)
- I/O Library

Physical Layer:
- Ethernet
- RS232
- GPIB
- USB
- Firewire
Software Interface - VISA

- **VISA: VXIplug&play System Alliance**
  - “System Software Framework”: VISA I/O Library
  - Standard Interface to the devices
  - GPIB, VXI, Serial, USB, LAN with the same API
  - Independent of hardware or operating system

- **Transport mechanisms**
  - DMA or programmed I/O
  - Timeout handling
  - Terminator handling
Software Interface - SCPI

- "Standard Commands for Programmable Instruments"
  - Definition of an uniform instruction set for the control of programmable measuring devices
- SCPI Command Reference
  - Based on IEEE488.2 "Codes, Formats, Protocols and Common Commands"
- SCPI examples:
  - FREQ:CENT 100MHz
  - Frequency: Center 100MHz

SCPI device model
Software Interface - IVI

• IVI Standard „Interchangeable Virtual Instruments“
  • Standardized device driver model, based on VXIpnp and VISA
  • IVI Instrument Classes
  • Instrument Interchangeability

• IVI Specifications
  • IVI Architecture and Technology
  • IVI Instrument Classes
  • IVI Shared Software Components

• IVI Device Drivers – advantages:
  • Independent of ADE (LabView, C, C# and .NET)
  • Standardized configuration and installation
  • Syntactic Interchangeability
  • Simulation
Software Interface - HiSLIP

- Instrument Remote Control via LAN
  - Raw Socket
  - VXI-11 (ONC/RPC Protocol)
  - HiSLIP (High Speed LAN Interface Protocol)
- HiSLIP – Advantages:
  - HiSLIP Protocol – Part of the IVI Standard
  - No Port configuration required
  - IPv6 compatible
  - Performance similar to Socket Connection
  - Support of the GPIB Message Exchange Protocol
LXI – LAN Extensions for Instrumentation

- LXI – Standard for Instrument Remote Control via LAN
- LXI Consortium with over 50 member companies
- Over 3800 certified LXI Devices

What makes a LXI Device different from a LAN Instrument?

- Consistent LAN Communication Services
- LAN Discovery and Configuration
- Integrated Web Server in the devices (configuration via Browser)
- IVI Driver
- Extensions for Triggering and Synchronization
LXI – LAN Extensions for Instrumentation

• LXI Device Specification
  • Current version: V1.5

• Additional (optional) Extended Functions:
  • LXI Event Log Extended Function
  • LXI HiSLIP Extended Function
  • LXI Timestamped Data Extended Function
  • LXI Clock Synchronization Extended Function
  • LXI Event Messaging Extended Function
LXI with IEEE1588 (PTP)

• LXI Device Synchronization based on the IEEE1588 Precision Timing Protocol (PTP)

• LXI Extended Functions:
  • LXI Timestamped Data Extended Function
  • LXI Clock Synchronization Extended Function
LXI Event Messaging Extended Function

- LAN based Trigger:
  - Programmatic Trigger-Events via driver commands
  - Direct exchange of messages between LXI Devices
  - Emulates Hardware-Trigger, but can transfer additional information (timestamp, data, etc.)

- LXI Event Messages:
  - Trigger information can be sent directly from one device to another via LAN - without test computer
  - Multicast via UDP
  - Unicast (Peer-to-Peer communication) via TCP/IP
LXI Event Messages

- LXI Event Message Format:

<table>
<thead>
<tr>
<th>HW Detect</th>
<th>Domain</th>
<th>Event ID</th>
<th>Sequence</th>
<th>Timestamp</th>
<th>Epoch</th>
<th>Flags</th>
<th>Data Fields...</th>
<th>0 (two bytes)</th>
</tr>
</thead>
</table>

- Distinction of test systems on the same LAN via Domain
- Each message has a Timestamp
- Flexible data format (ASCII, Float, XML, ...)

TSEF - Technical Software Engineering Plazotta
Applications

• Radio receiver measurements (S/N, SINAD)

• Measurement task:
  • Determining the input power at the antenna input of a radio receiver to obtain a given signal / noise ratio at a defined frequency
  • This measurement is carried out with a relatively small step size over a defined frequency range, e.g. Ex. FM-Band

• Measuring devices:
  • Signal generator and Audio-Analyzer
Radio Receiver - Measurements (S/N, SINAD)

• Measurement setup for radio receiver – measurements (S/N, SINAD)
Sequence of measurements

- Measurements sequence:
  - The control software sets the frequency and a defined starting power level at the signal generator.
  - With the audio analyzer, the S/N ratio is determined and queried by the test computer.
  - If the specified setpoint has not yet been reached, the signal power at the output of the generator is increased slightly via the test computer and then the S/N value is measured again with the Audio Analyzer.
  - If the specified setpoint has been reached, the measurement continues at the next frequency point.
  - The measurements are carried out over all frequencies of the frequency band.
Sequence of Measurements - Decentralized Approach

• Measurement sequence with direct communication between the devices:
  • The test computer programs the generator with the necessary frequency list and the starting power; the audio analyzer is programmed with the S/N value to be achieved. Then the sequence is started
  • The generator sets the starting power and triggers the S/N measurement on the audio analyzer. The audio analyzer then returns according to the preset target value whether the signal power from the generator should be increased or if the next measurement can be performed on the next frequency
  • When the measurement on the current frequency is completed, the determined values (frequency, power and achieved S/N value) are sent to the test computer
  • This sequence repeats until the complete frequency band has been measured
Sequence of Measurements - Decentralized Approach

• Advantages:
  • Both measuring devices control themselves directly, the test computer is only supplied with the results
  • Simple control, no synchronization between the test computer and the measuring devices necessary
  • Significantly less communication data, thereby saving time
Summary

• LXI is the preferred solution for distributed systems

• LXI enables the automatic identification of measuring devices via LAN and their configuration via the integrated Web Server

• The direct peer-to-peer communication between the LXI Devices simplifies the test system software and increases throughput
Thank you for your attention!