MODULAR EMBEDDED SBC-BASED COMPACT VIRTUAL TERMINAL STATIONS AS NODES FOR DISTRIBUTED CONTROL AND DAQ

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Abstract

Compact Effective (price/performance) RT-systems with System Area Network (SAN) Architecture for DAQ, Monitoring, Control and Diagnostics based on SBC and DSP DAQ-Control I/O modules are proposed. Terminal Control Station (TCS-node) and Supervisor Control Station (SCS-node) is developed on SBC-modules. Weak and Strong Interactions between Distributed Node provided by tradition LAN (Ethernet 10/100) or by SCI-modules. DSP-based DAQ-Control modules with front-end Signal Conditioning Electronics are embedded as basic part of a TCS-node. Both TCS and SCS can be used in autonomous mode. Virtual modeling in TCS and SCS can be used as data file or for simulating signal on internal or external (with precision DAC) nodes by user friendly interface.

COMPACT MODULAR RT-SYSTEMS

In the end of 80's entire board could be limited by single large scale integration chips, which latter became a single chip microcomputer or DSP. PC/104 (Plus) modules tend to be made from PC desktop and laptop components, supported by embedded Linux. PC/104-Plus adds the PCI bus using a board-to-board bus (120-pin). Microcomputer consisted of some boards (modules) plugged into a back plane Bus. First micro computers were based on 8-bit ISA. Some Modern Compact Computers are implemented as standalone (non-backplane) systems on a single board or based on passive Buses (VME/VXI, cPCI). PCI-slots is used for one or two DSP–based DAQ and Control Modules. Each TCS is based now on Windows (then QNX, RT-Linux). Some applications were developed on LabView and others – on C. TCS Core is compact half size low power SBC JUKI-511P (GX1V/GX1-233/266/300 32-bit MMX processor) with LAN chip and up to 256MB memory. It provides Compact Flash (Type 2), EIDE interface and PC/2 keyboard/mouse interface. The built-in SVGA/LCD display controller offers the resolution of 1024*768. It provides audio interface and TV–OUT. DAQ and Control Module includes DSP, 14 bits ACD and 12-bits DAC. Signal conditioning electronics oriented on real object requirements. Using 16 Input measurement channels for DAQ on the base of 14-bit ADC and 12 bit DAC for simulating signals according to constructed model as data file or real object data and simulating signals on internal or external generator. The Node for external generator based on the similar compact SBC node with high precision DAC produces external signal for correct simulating real data file or mathematical model of complex object signals.

SCS Core is based on Compact MB with 2 slots and used as Supervisor Control Station (SCS) connected by Ethernet 10/100 to SCS. Dimensions of SBS – 185*122 mm, power supply - 5V (1.8A). The Input Signal Condition Electronics with SBC and Instrumental DAQ and Control Modules embedded in the shassis. Modeling of more complex signals in SCS node support also mathematical construction of signals as data file or real object data and simulating signals on internal or external generator. SCS Core is based on low power Slim PC MS-6215 and Windows (or Linux). Micro LPX MB as SBC (MS-6351) is based on 815 chipset and Celeron/Pentium3 Processor (FC-PGA). The 815 chipset
integrates a Display cache SDRAM controller (support 32-bit 133MHz SDRAM array for 3D graphics). The SCS can be used in autonomous mode or on second level of the integrated systems. The chassis for MS-6351Micro LPX MB have the same size as for TCS and accommodates HDrive, CD-ROM, Floppy Drive, also supports LAN, VGA, USB, Speaker, PS/2 mouse and keyboard.

**Weak and Strong interactions** can be organized on the base of tradition Ethernet 10/100 networks and SCI modules. Computers have tradition networks (Ethernet 10/100, FireWire, USB) as standard connectivity. Serial buses (USB, FireWire) used for high-speed I/O. Field-bus concepts in Control should be transparent to all of Electronics devices. Ethernet 10/100 (TCP/IP) is good for weak interacted (message passing) in non time-critical applications.

SCI-based interconnections supporting scalable multiprocessor Clusters are good for advanced high-performance RT-systems with strong interacted Nodes. High performance systems (servers, DB) are based usually on Symmetrical Multiprocessing (SMP), Massively-Parallel Processing (MMP) and Cluster architectures (RMC, NUMA). A RMC (Reflecting Memory Cluster) is a cluster with a memory replication or memory transfer between nodes. SCI for System Area Network (SAN) is good Advanced Multiprocessor Architectures for servers and data bases. Integrated RT-systems with Effective SAN Architecture on the same base of Compact System Nodes effective for cost/performance systems.

**Proposed Modular RT-system Nodes** advantages:
- Compact SBC compatible with Intel processors gives advantage of the PC's OS (MS-DOS, Windows, Linux), language and tools;
- Embedded intelligence with graphical & speech;
- SBC embedded with networks (TCP/IP, HTTP);
- Embedded USB is replacing Ports (serial, parallel);
- SBC embedded solutions need Windows-based software (human-machine interface), networking and file management;
- Linux are using in all computing, offering a low cost, open source solution with support for open standards, networking, communications, Internet and others.
- Hardware & software modularity provides access to the widest range of applications and gives flexibility of SBC support.

The modular System supports networking functions on SBC (Ethernet 10/100, USB, FireWire and Field buses) and high-performance SCI-modules. Distributed Nodes organized as set of Virtual Stations - Generator, Terminal and Supervisor Control Stations. Linux support for PC-compatible embedded SBCs tends to be provided using the chips in normal manner, including some specific functions: Display controller modes, LCD panel control signals, PCMCIA interface, on solid-state disks and others. Deterministic real-time software are required for the control applications (RT-Linux, RTEMS, QNX, OS-9, VxWork). LabView is other instrumental software, which support Distributed RT-functions.

**DISTRIBUTED RT-SYSTEMS**

**Terminal Control System TCS-node** can work as autonomous Device or as integrated System Nodes. It provides Signal Monitoring, Signal Processing (Data Registration) and Signal Visualization. In this mode the device use Monitor and keyboard (and mouse). Graphical User Interface (GUI) was developed for process monitoring and control. A lot of compact Terminal Stations connected by LAN with SCS organized in the Single RT-system for distributed Control and DAQ.

Supervisor Control Station SCS-node supports GUI, which provides control, test and monitoring of each remote TCS-nodes and helps in analysis of complex signals from distributed terminal control stations. Supervisor Station SCS-node controls all connected terminal TCS-nodes and displays signals on monitor for data analysis in real time.

**Signal Modeling** is additional function of TCS and SCS-nodes for system testing and simulating real objects signals by internal DAC (as embedded signal generator) or by external Node with precision DAC. Virtual generator software supports construction of complex signals with help of internal DAC on inputs for system testing and simulating real input signals for measurement and monitoring process debugging.

**Virtual Generator Model** of constructed signals can be used as Input Data file, Internal or External to the given node (high precision DAC) Signal Simulating.

The last mode provided by special Generator Node with Embedded SBC and high precision DAC in similar compact node and SAN-Architecture.