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Ref. # CU1519B

BioNet: Middleware for Heterogeneous Wireless and Wired Systems

The “BioNet” system is a wireless middleware architecture which is under development in support of NASA’s Exploration Systems Mission.

The middleware architecture is novel from the standpoint of the heterogeneity of both devices and protocols supported. A fundamental design decision allows for multi-developer system extensibility which alleviates the problem of the monopolistic single-vendor model where only the original developer of the middleware architecture can efficiently extend the system functionality.

The BioNet middleware architecture solves the problem of integrating, into a single unifying architecture, both wired and wireless heterogeneous sensing devices. The devices are “heterogeneous” because they have different sensors, different levels of on-board computational processing, exchange data between stations using different communication protocols, and physically transmit the data over different media (wired or wireless) using disparate transmission protocols. The typical solution employed today is to employ several different vendor-specific solutions to meet the singular need of integrated environmental and physiological sensing.

Application (User-Interface) provided with standardized lower-level interface libraries					Application
Real time data display	Database storage	Graphical data historian	Expert system diagnosis	Advanced data visualization	
Security: authentication, authorization, data privacy					Presentation
Wireless network device management middleware					Session
TCP/IP	Vendor specific network layer protocols	Bluetooth network stack	Zigbee network stack		Network / Transport
Wired Ethernet 802.3 LAN	Wireless Ethernet 802.11 a/b/g WLAN	Vendor specific PHYS layer protocols	Wireless medical 802.15.1 Bluetooth	Wireless sensornets 802.15.4 Zigbee	Data Link / Physical



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The BioNet middleware has tremendous market applicability, most notably in the any domain where advanced instruments from multiple vendors are used in one system. In addition to medical or physiological monitoring in the health care field, the BioNet middleware is a potential solution for ANY automated and instrumented process industry including the enormous petro-chemical industry, which faces the same problem of integrating process sensors and actuators from multiple vendors into a unified control system.

Benefits

1. Extensibility — the architecture is easily scalable so as to incorporate changes and advanced capabilities easily. This is addressed by following the standard C and Unix/Linux design philosophy of creating several small modules that perform a specific function with defined interfaces. Specifically, monolithic architectures and single-address space (multi-threaded) architectures are undesirable as both paradigms ignore the advances in operating systems and program languages development over the past two decades and, importantly, are much harder to maintain and debug.
2. Use of standard inter-process communication (IPC) mechanisms, in the form of TCP sockets and either the client-server or the peer-to-peer standard models increases reliability and modularity by providing a consistent, well-defined mechanism for the exchange of information between groups of coordinating processes.
3. Good performance, even with distributed system computational capabilities that are in the form of resource constrained processors, i.e., micro-controllers or lower performance processors (because of size and power constraints).
4. Easy implementation and testing of the system because developers used the standard Linux/C development tools such as the gcc compiler.