Client/Server Network Management of Multi-Tiered, Multi-Network Systems

Presented to:
LONUSERS® International Spring 1998 Conference
May 20-21, 1998

Revised: January 17, 2000

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Abstract

LONWORKS® technology has become a standard in the building controls industry, yet there will always be situations where other protocols and multiple networks must be supported. This paper discusses the implementation of network management, and addresses the needs of Multi-Tiered, Multi-Network systems. The paper describes a system which includes a BACnet™ tier in addition to multiple LonTalk® networks. The paper goes on to describe how to perform network management whether you are a remote client workstation on the BACnet side, a remote client on one of the LonTalk networks, or a local client on the server.

Introduction

The implementation of LONWORKS in the real world must not only support the flat architecture concept proposed by Echelon® Corporation, but must also recognize that many of the building control system OEMs, system integrators, and building owners demand products that support three-tier client/server architectures. For the purpose of this paper we call these architectures multi-tier multi-network (MTMN) architectures. The companies designing these systems include such well know names as The Trane Corporation, Siebe Environmental Controls, Honeywell, Johnson Controls, Andover Controls, Landis & Staefa, and CSI. In the past, IEC and other developers of network tools have developed products that were based on the flat architecture concept. The current products on the market do not and cannot conform to the MTMN architecture because they only support the LonTalk protocol and must run under the Windows® operating system. IEC has broken from the pack and developed a product line that supports the customer requirement of MTMN topologies. IEC's design meets customer needs and recognizes that LONWORKS is not the only technology available. Supporting MTMN architectures provides the mechanism for LONWORKS to move forward by meeting the OEM and system integrators needs. This paper describes the MTMN architecture and then goes on to describe how our new product line called Peak Components meets this requirement.

Real World Architecture

The HVAC industry has built MTMN architecture into it's installed base and will continue to create this type of architecture because it conforms to the building controls industry model. This model includes islands of control that are connected to each other via a high bandwidth physical layer such as ethernet. Examples of products using this architecture include Siebe Environmental Controls Network 8000 system and the Trane Corporation Tracer system. A majority of companies in the building controls industry have selected LONWORKS Technology as their next generation technology for these islands of control, and the backbone of island connectivity to be BACnet or TCP/IP over ethernet. They have not selected "PCs" as the only means to support this connectivity. In fact, many want to embed the server in a host application node and not be required to have a PC on the network 24 hours a day, 7 days a week. In addition, many of the Workstations on the BACnet tier are not PCs and may be running other operating systems such as UNIX.

Figure 1 depicts this model which includes "islands" of control that are interconnected over an ethernet backbone. The purpose of this paper is not to defend or attack this architecture. The paper describes a solution for network management, monitor and control that fits this MTMN architecture.

Figure 2 shows an example of an HVAC island. It includes items such as VAV controllers, fan coil controllers, roof top controllers, terminal unit controllers, and packaged equipment controllers. OEMs, system integrators, building owners, and process control facilities, are all demanding that these islands of control be managed using a three tier client/server architecture. This requires that the LONWORKS island also include "Clients" which can be left permanently attached to the network or be added and removed from the network as needed. Clients may include such functionality as network configuration tools, device configuration tools, network monitoring tools or network control applications. They may be passive tools, which cannot change the network configuration, or active tools that can.

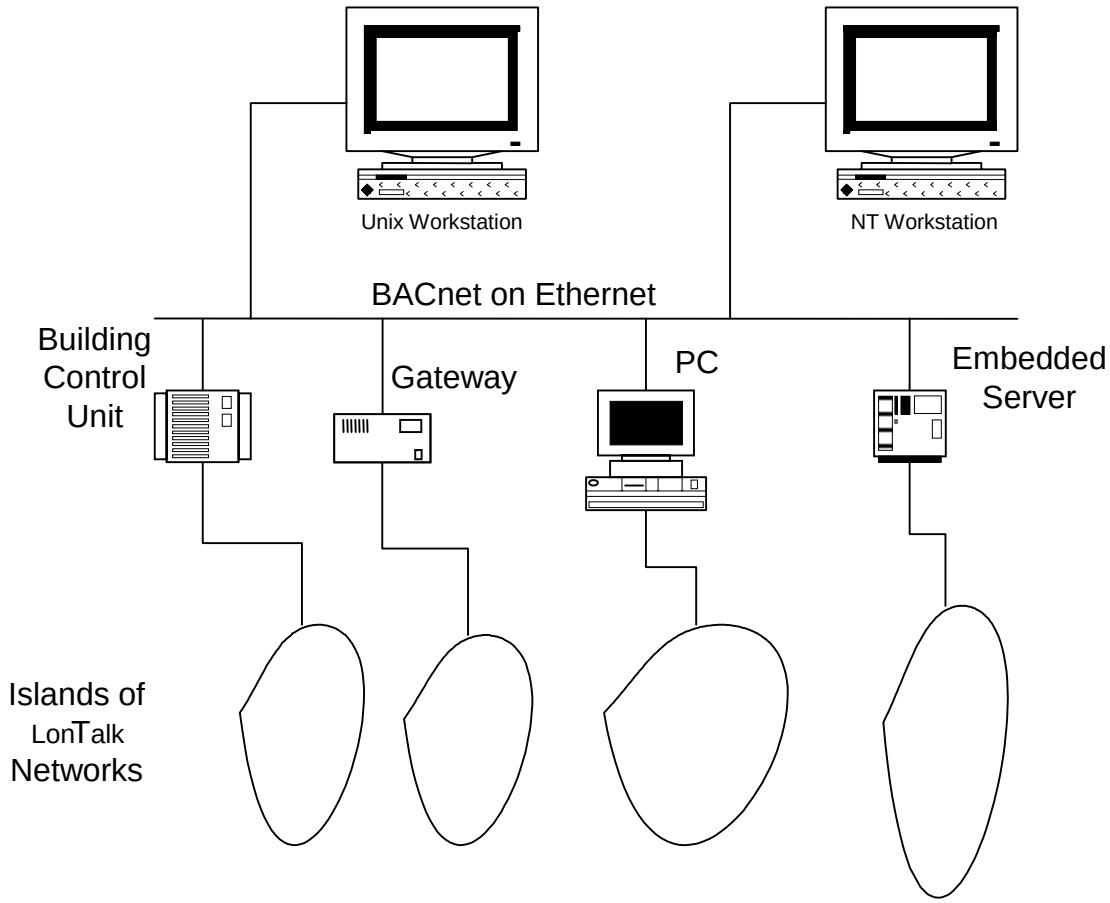

Figure 1. Islands of Control

Examples of clients in Figure 2 include IEC's ICELAN-G client for network configuration, a monitor client for viewing network performance, and the unit controller client which may perform scheduling and data trending. Clients must register with the "Server" which may be anything from an embedded host node residing on the island, a PC residing on the island, or a workstation that is remote from the island via a BACnet transport layer. Figure 2 shows an embedded server that maintains the network database on the LonTalk island.

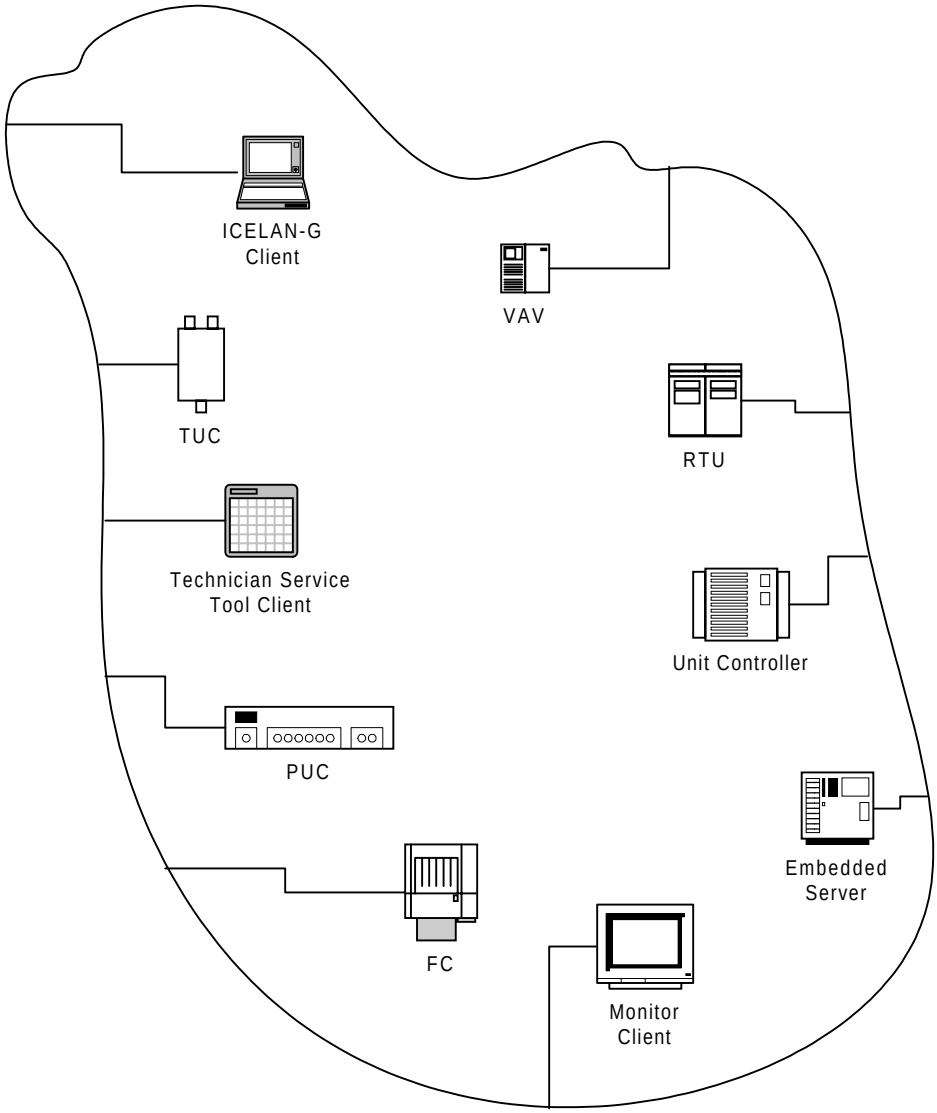

Figure 2. Typical LonTalk Island

A three-tier client/server architecture can be broadly defined as an architecture in which the client and server do not know or care how they communicate with each other. Messages may be sent over one or more transport layers, such as BACnet, TCP/IP, and LonTalk, or they may be local messages on the same host. With this architecture, new transport layers can be added with no impact on existing clients and servers. Figure 3 shows a system that includes a BACnet tier as well as a TCP/IP tier. In addition, multiple LonTalk networks are in-place. These networks can be separate subsystems. For example, the subsystems may be an HVAC subsystem, a security subsystem, a lighting subsystem and an elevator subsystem.

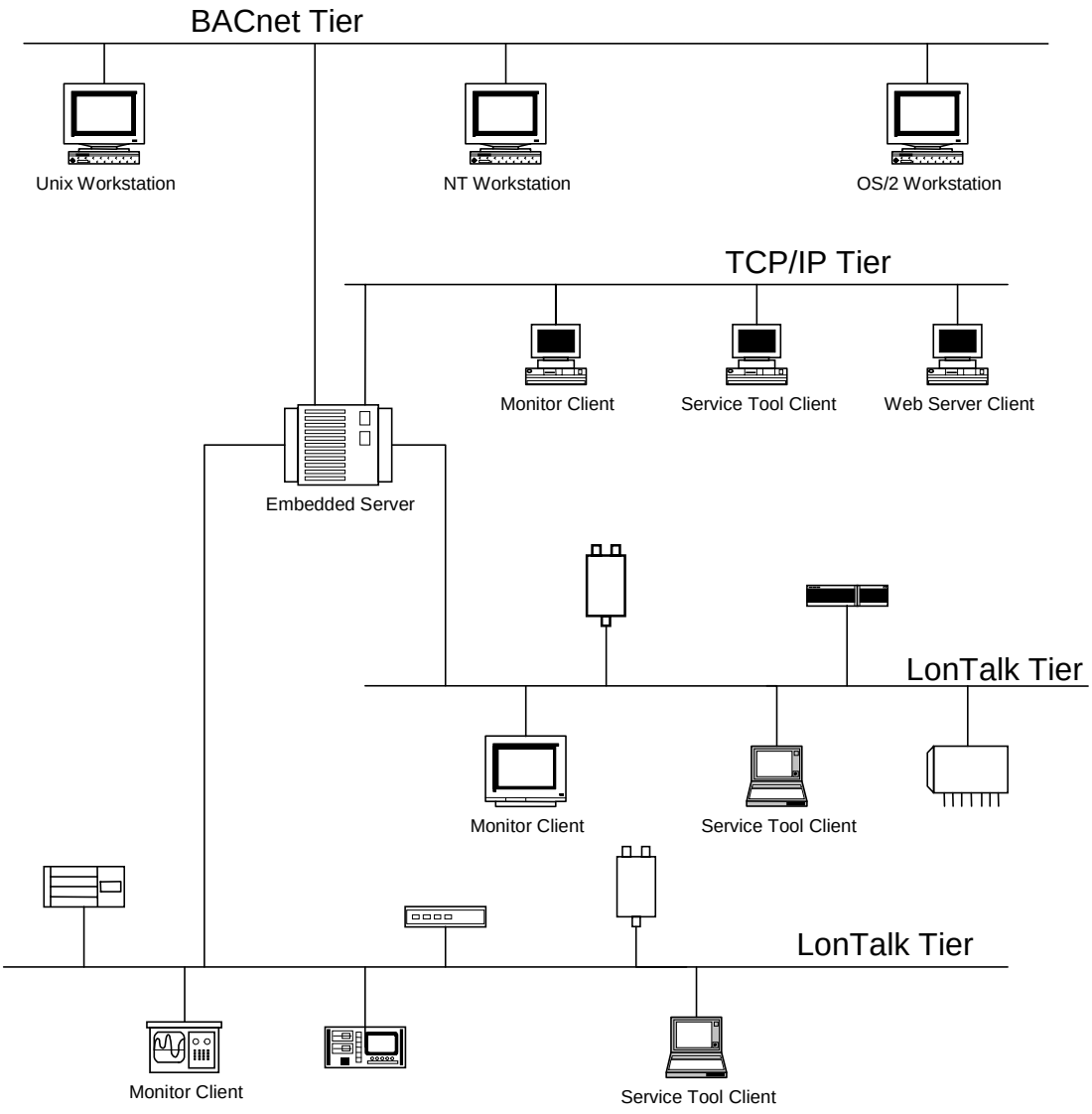

Figure 3. Multi-Tiered, Multi-Network Architecture

IEC Support Architecture

Due to overwhelming requests from OEMs, System Integrators, and developers, IEC has developed a new family of products called Peak Components. Peak Components not only supports the MTMN architecture but is also embeddable so that it can run under many operating systems as well as on non-PC based hardware. This section describes the building blocks that IEC developed to support this architecture. The minimal system in Figure 4 shows the simple standalone PC based architecture. Tool developers can use this configuration in the same manner as current standalone Echelon© Corporation's LONMANAGER™ API and LNS based products. It should be noted that even though it is called standalone it does implement the client/server architecture so that the tool can be left online for other clients to interact with the tool servers. Another important point is that IEC's implementation is multi-tasking, multi-threaded, and therefore the architecture allows for multiple client applications to run simultaneously. A typical situation would be that the installer first uses a network management client application such as IEC's ICELAN-G to install and configure the network. The system integrator then starts up a data logging client application, as well as a scheduler client application that they leave on site. The components shown with the figure are described in detail in the following section.

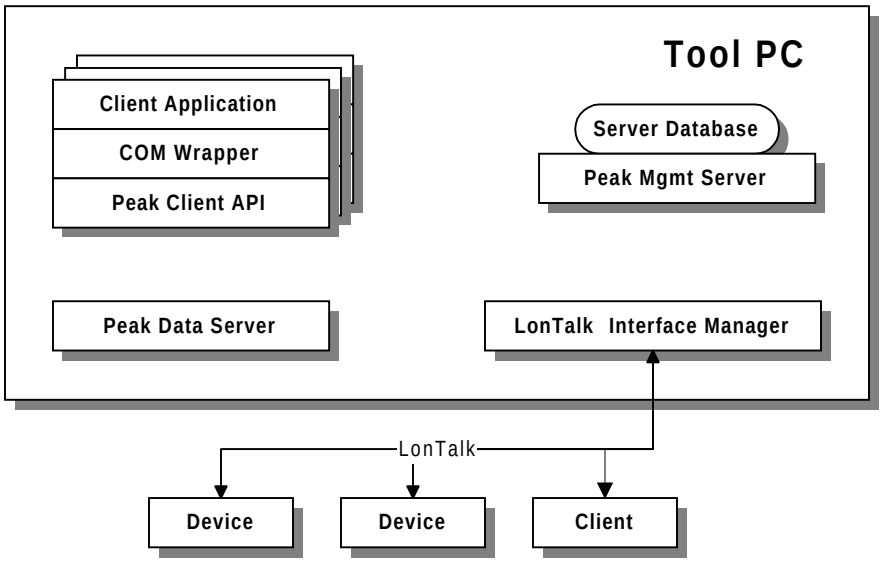

Figure 4: Standalone PC Based Implementation

Figure 5 shows a more complex example of the client/server architecture with an embedded server that is autonomously managing four LONWORKS networks, while still providing remote access to a client using a BACnet transport layer, and another client using a LonTalk transport layer. It should be noted the figure shows one network management server, one data server, and one LonTalk interface manager per LonTalk network. This provides complete isolation of subsystems if required. If the user only requires one LonTalk network, then only one set is required. Another point of interest is the fact that the tool PC has a disabled (grayed out) network management server and server database. Whenever a client application starts, it searches the network for a server. If the application finds one, it uses that database. If the client application does not find a server it can use the database it has, or it can do a database recovery and build a new database.

Multiple client applications are also shown. The client applications on the server could include such items as automatic installation, and scheduling. The client applications on the workstation could be data logging and alarming. The applications on the tool PC could be network diagnostics and tuning applications. The point is that this architecture allows for all of these implementations

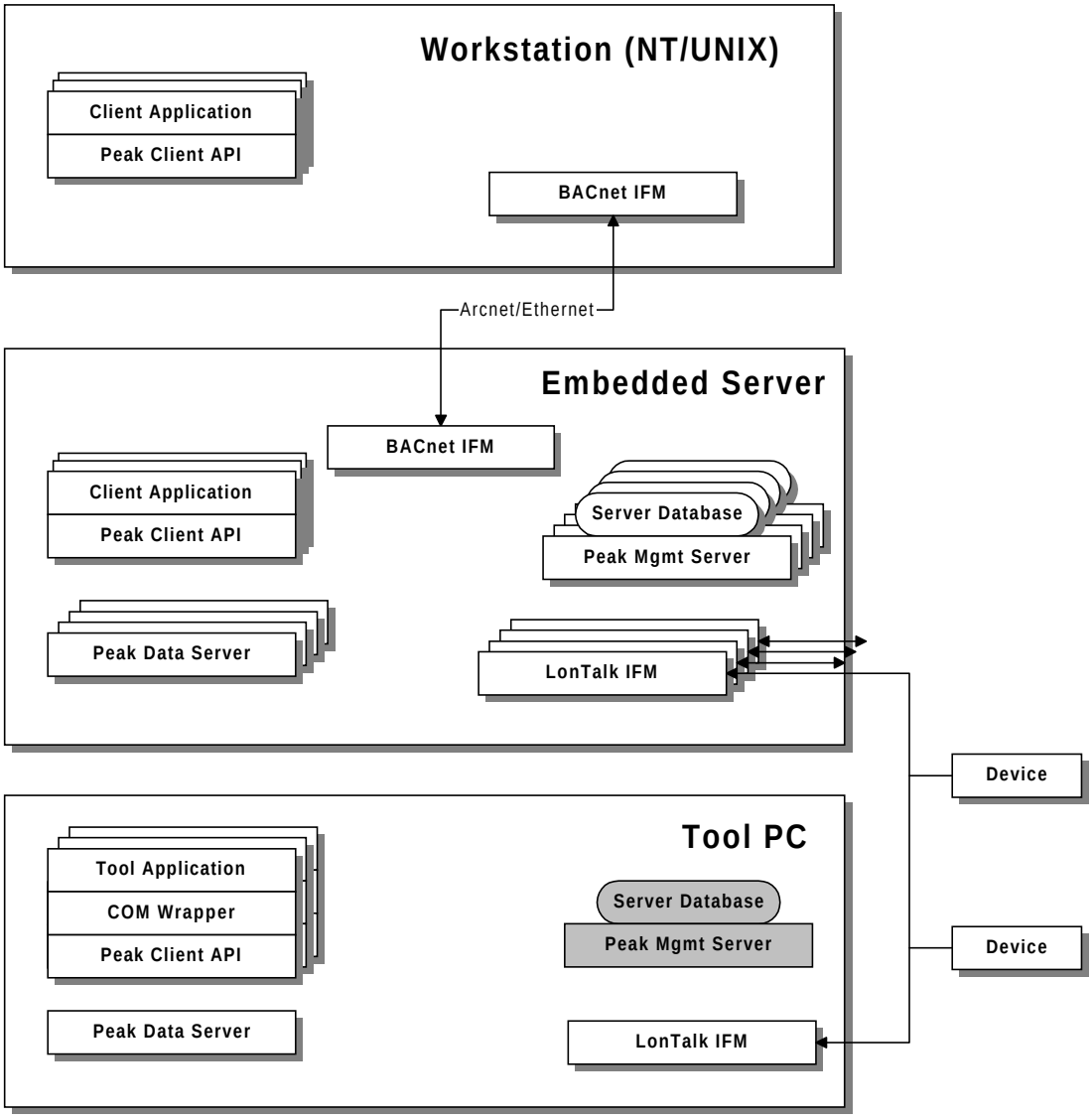

Figure 5: Remote Client/Server Architecture

Peak Component Descriptions

Each of the following component paragraphs represents one of the components in the above diagrams. This section is a high level description of the functions the component provides to the system.

Peak Management Server

This component of Peak Components provides all of the LonTalk Network Management. The Peak Client connects to the Peak Server, issues requests to be performed, and the Server carries them out. These requests may be simple information lookup, or a request to perform a node install or a binding.

Peak Client API

This component of Peak Components provides an interface between the application and the Peak Server. The Client repackages application requests and sends them to the proper Interface Manager for processing. It also collects messages from the Server and passes them back to the application.

Peak Data Server

This component exists for each LonTalk driver on the system. It manages the NV updates and polls, distributing updates to any registered component. It can provide optimization of polling (say two clients want to poll an NV every second – only one poll is issued) to reduce bandwidth. NV updates that are destined for remote machines (such as a Client on the PC Workstation) are automatically routed to the proper Interface Manager

COM Wrapper

The Tool Application is a Peak Client application. While it is possible to make Peak Client calls directly, it is simpler and more robust to make those calls through the Common Object Model (COM) Wrapper. This provides an OLE interface to the Peak Client API, to simplify the Tool development.

LonTalk Interface Manager

This component takes a fully defined LonTalk message and transfers it to the Neuron chip for transmission.

BACnet Driver

This component is the driver for BACnet messages.

Workstation Client Application

This box on the diagram represents any workstation client application that must communicate with the LONWORKS network.

PC Tool Application

This box on the diagram represents any PC based application that communicates with the LONWORKS network. An example is ICELAN-G Client.

Peak Components

IEC has developed a product line known as Peak Components which was created as a direct response to OEMs, system integrators, and building owner requirements. It includes both hardware and software to support the network management, monitor and control of LONWORKS networks. Figure 6 defines some of the products.

Due to our strong commitment to interoperability, IEC will release to the public domain the interfaces for client/server communications and the Client API Interface so that other vendors can develop additional components or build their own client/server components to support the large demand for MTMN architecture. IEC has been a driving factor in supporting open standards that are not dependent on a particular product. To that extent, IEC has been providing preliminary documentation to the LONMARK® Network Tools group defining client/server messaging, network management methods, plug-in standards and other network tools standards. At this time the LONMARK Network Tools Group has not agreed on any guidelines. Regardless of what communications methods are approved, IEC will make all of its Peak Components LONMARK compliant.

The alternative to Peak Components is to create product-specific software to perform these tasks. IEC is providing an easy, low cost, high performance, royalty free, alternative to developing your own components.

Software

The Peak Components software compliment consists of two distinct types of software, Embeddable Network Management Components (ENMC) and Client Applications. ENMCs are designed to support the network management of both MTMN architecture and standalone applications. Client Applications use the ENMCs to provide added functionality for the user.

Embeddable Network Management Components

ENMCs can be used as part of, or as a complete end product to provide LonTalk network management functions. These components can be applied in a PC environment (such as a laptop PC service tool), an embedded environment (such as a hand-held tool or a building control panel), or a workstation using various transport layer protocols such as TCP/IP or BACnet. ENMC packages commonly used network management functions into reusable software, for efficiency and reliability in development.

Peak Components is an alternative to Echelon's® LNS, designed to be more efficient in its use of computer resources therefore making it available to be used in an embedded environment, and delivering higher performance (speed) to the end user. IEC provides a subset of LNS functionality that is appropriate to a flat as well as a tiered architecture thus eliminating the need to pay a substantial LNS royalty.

Client Applications

Client Applications can include anything the customer requires. IEC provided a new and improved 32-bit version of an ICELAN-G client for network management. Other products that we see a market for are network schedulers, data loggers, web connectivity products and an OPC Data Server. IEC is looking for partners willing to develop these products or other products that the market is asking for. If you are interested in working with us to develop these products please contact IEC.

Hardware

In addition to our Peak software components, IEC will be offering a low cost Embedded Network Server that will support the installation of 127 node networks. It communicates to client applications to perform configuration of networks. The Embedded Network Server is intended to be used to support small networks that do not have a PC on site to maintain and manage a network and its database. Applications such as semiconductor fabrication equipment, telecommunications systems, process control systems, manufacturing equipment, elevators, security systems, lighting systems, energy management systems, airplanes, and rail cars can all use the Embedded Network Server to maintain the network database and perform network management functions. It is an ideal device to support the building automation industries MTMN architecture in which islands of control are implemented. A low cost Embedded Network Server can reside on each island providing the required functionality. In addition, users can write their own custom application to perform any desired function. Automatic network configuration, scheduling and data logging are a few of the possible applications.

Product Comparisons

Category	**LM API**	**LNS**	**PEAK**
Network Management (Install, Bind, Poll)	X	X	X
Client/Server		X	X
Embeddable			X
Portable (e.g. UNIX)			X
Transport Layer Independent (e.g. BACnet, TCP/IP)			X
3-Tier/Multi-Network			X
Cost	Medium	High	Low
Performance	Medium	Low	High
Open Protocol			X
Ability to Recover Database from Network		X	X
Win16	X		
Win32		X	X
MultiTasking RTOS (e.g. RTXC)			X

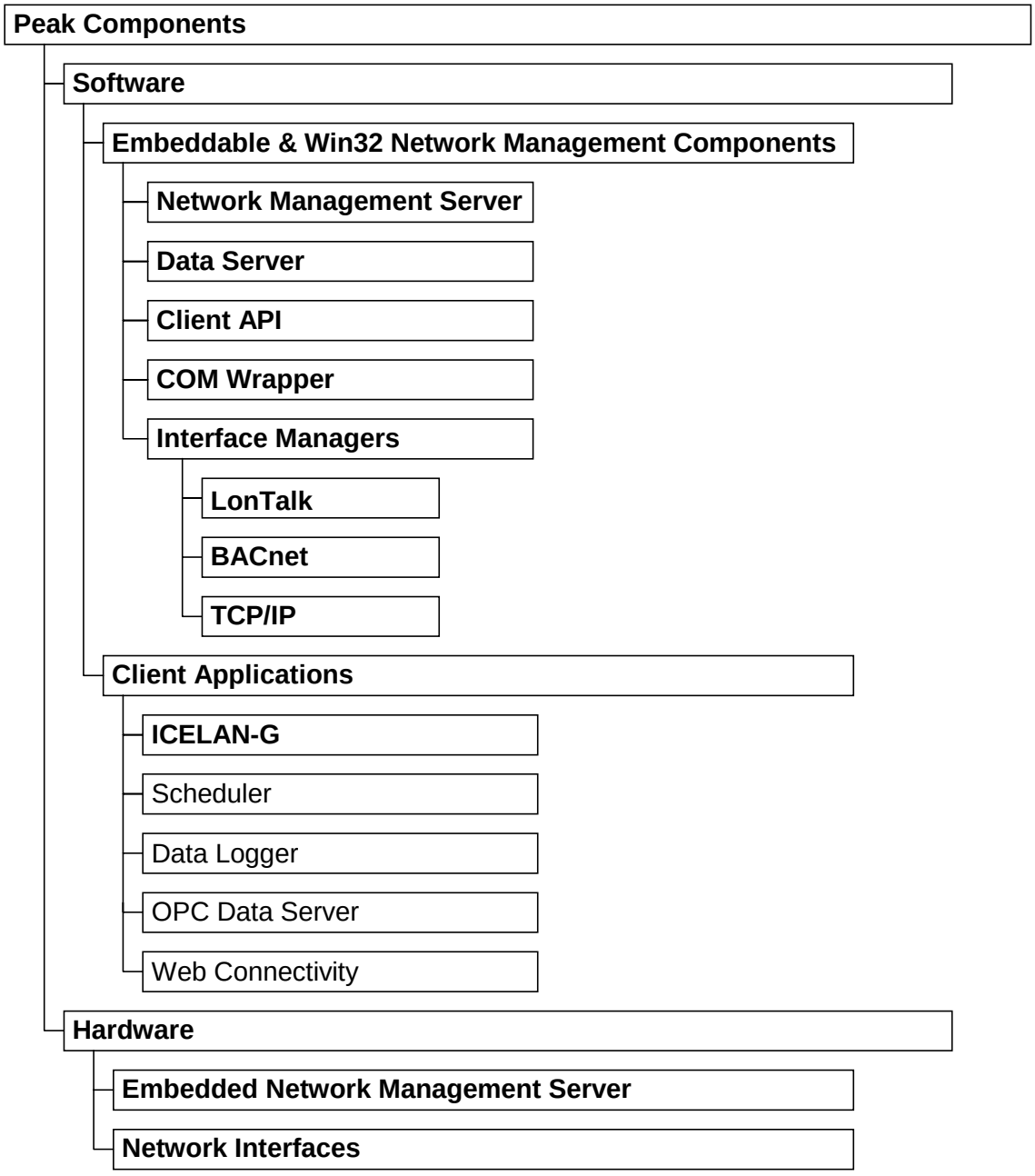

Figure 6. Peak Components Product line

IEC Product Descriptions

IEC distributes the components packaged individually or in groups as follows:

The initial release includes support for Win32, and Mot 68340 on a custom RTOS. IEC is currently developing a release for another 68XXX series microprocessor running pSOS. Future releases may support other Intel CPU's with various RTOS such as WinCE, Linux and QNX, depending on customer needs.

Customizable Server Components (CSC) Kit

The Customizable Server Components (CSC) kit includes a Network Management Server, a Data Server, a Client API, and a LonTalk IFM. This kit includes support for server applications that are in addition to network management. For example, a user may want to develop client applications that include scheduling, data logging and automatic network installation features.

Server Components (SC) Kit

The Server Components (SC) kit includes a Network Management Server, a Data Server, and a LonTalk IFM. These components are used to implement a network management server in a Windows or embedded environment.

LonTalk Client Components (LCC) Kit

The LonTalk Client Components (LCC) kit includes a Data Server, a Client API and a LonTalk IFM. Developers use these components to build client applications that can run on the local machine or a remote client. Applications may include device configuration tools, network configuration tools, and device monitoring tools to mention a few

Workstation Components (WC) Kit

The Workstation Components kit includes a Client API, and your choice of an IFM. This kit supports the developer of applications that do not have LonTalk as a primary to the network. For example in the multi-tier application, a workstation will reside on an ethernet network running TCP/IP as the transport layer protocol.

COM Wrapper Component (CWC) Kit

The COM Wrapper Component kit includes only a COM wrapper. It is used by developers who do not want to make direct C++ function calls to the client API. For example, a developer using Visual Basic or Delphi would want to use this component.

Interface Manager Components:

IEC currently offers interface managers for the following transport layer protocols.

LonTalk

IEC is developing interface managers for:

TCP/IP

BACnet

Starter Kit

The Starter Kit Includes the CSC Kit, sample applications and component documentation.

ICELAN-G Client

ICELAN-G Client will continue to support network management functionality and is implemented as a 32-bit client application.

ICELAN-G Client/Server

IEC also offers ICELAN-G as a local client/server application which will include the server functionality as well.

Pricing (US dollars)

Server Components

Product	<= 64 nodes	<= 256 nodes	<= 512 nodes	<= 1K nodes	> 1K nodes
SC	$145	$245	$495	$995	$1,995
CSC	$195	$295	$545	$1045	$2,045

Client Components

Product	
LCC	$125
WC	$195
CWC	$45
BACnet IFM	$95
TCP/IP IFM	$95
Starter Kit	$2,995
ICELAN-G Client	$695
ICELAN-G Client/Server	$695 + $SC
Technical Support & Upgrades	$995/year*

* Required with Starter Kit.

Hardware Components

Product	
Embedded Network Server	$TBD
Custom Development Kit	$2,995
Technical Support & Upgrades	$995/year*

* Required with Custom Development Kit.

Discount Schedule

1 unit	$2K	$10K	$25K	$75K	$150K
Single $	10%	15%	20%	25%	30%