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CEBus Network Access via the World-Wide-Web

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Abstract

Several methods of providing access to CEBus networks using the World Wide Web are described. Details of a working demonstration system are given. The system software incorporates CGI-Bin scripts and Java applets to support remote access to CEBus networks. To illustrate the potential of this technology an application to allow remote trouble-shooting and fault diagnosis on a CEBus network is described.

1. Introduction

The World-Wide Web (WWW) is an Internet access technology originally developed by a team of scientists at the CERN laboratory in Geneva in 1990. It has recently become the access technology of choice for interactive Internet applications. The HTTP or *HyperText Transfer Protocol* is an application level protocol with the lightness and speed necessary for distributed hypermedia applications. It combines the flexibility of a stateless object-oriented communications protocol with support for a graphical user interfaces to remote documents and information resources. Recent technology developments have begun to provide the building blocks for interactive applications of Web technology.

The Consumer Electronic Bus (CEBus) is a multi-media LAN standard developed for home automation applications [1]. The CEBus standard was introduced by the Electronic Industries Association (EIA) in 1992 as interim standard IS-60 [2]. This defines the communication protocols, interface standards and other technical aspects of CEBus. The standard is a subset of the seven layer OSI model. In particular it conforms with the OSI model at the three lower protocol levels: physical, link and network layers. In addition an object-oriented applications language, CAL, is defined to standardise software at the applications level [4].

In this paper we consider mechanisms to provide remote access to CEBus networks using the HTTP protocol. In addition details are given of a working demonstration system which links a mains powerline CEBus network to the WWW.

To demonstrate a potential application of this technology we have chosen to implement a fault diagnosis system similar to that presented in an earlier work [ref]. This provides GUI elements which allow the user to observe and interact with the CEBus network via an *active-node* [5] which interfaces the network to a standard PC. The WWW version of this application provides similar functionality to the original, but the CEBus network can now be accessed from any computer connected to the WWW. Given the recent proliferation of Internet service providers it is now possible to provide diagnostic services to Home Bus installations anywhere in the World .

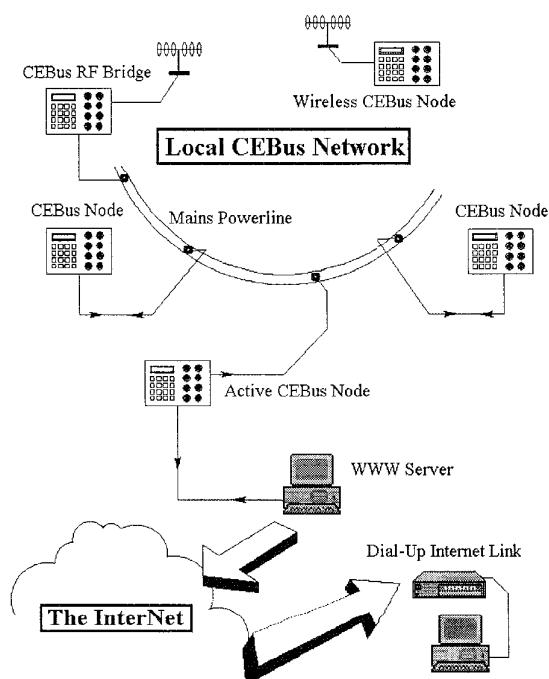


Fig 1: A CEBus Network linked to a remote client PC via a dial-up Internet link.

2. Interactive WWW Applications.

In this section we outline the principle software techniques which can be employed to develop interactive

WWW applications. In particular we emphasise the need for a mechanism to support a connection oriented data-link over the essentially connectionless HTTP protocol of the WWW.

The Common Gateway Interface (CGI) is a standard for interfacing external applications with a HTTP server. It defines a mechanism to allow a WWW client to transmit input data to an executable program which resides on the server. This executable generates a dynamic document from the input data which is returned to the client.

CGI was designed as an enhancement for HTTP servers to allow dynamic documents to be generated in response to user input. However it does not provide support for connection-oriented services. There are also limitations on security and access management in CGI. We discuss some of these limitations and describe some methods of enhancing the functionality of standard CGI.

The Java language provides the most natural means to support a connection-oriented link mechanism over the WWW. In essence Java applets are executable code modules. These modules can be exported to a remote host in the same way that Hypertext documents are presently exported to a WWW browser. If the client-end browser incorporates a Virtual Java Machine (VJM) it recognizes and executes the applet.

3. System Hardware

In this section we describe the hardware elements of the demonstration system. These include the CEBus network, the active CEBus node and the PC-based WWW server.

The CEBus network is an experimental network of 6 CEBus nodes using the powerline communications medium. Several of the nodes can be programmed in stand-alone mode to generate random packets, simulating realistic network traffic. A PC interface to the network via an "active" node is also available. This can be programmed to simulate multiple "virtual" nodes with different network addresses [4, 5].

The "active" CEBus-node contains a dedicated microcontroller with modified protocol software to facilitate test and monitoring activities. The Medium Access Control (MAC) sublayer of the Datalink layer has been reprogrammed to allow the system to receive and record all network packets. These captured packets are passed to the Application layer along with channel timings in "unit system times" (USTs). A more detailed description has been given elsewhere [5]

4. System Software

A description is given of the software components of the demonstration system. These include an overview of the CEBus protocol implementation and its modifications for

the active-node implementation; the WWW server modifications and the server-end CGI and client-end Java interfaces.

A more detailed description of the CEBus protocol implementation has been given elsewhere [4, 5], but a brief overview is given.

The HTTP server software runs on a standard PC which is also interfaced with the CEBus network by means of an "active" CEBus node, as described above. A "daemon" program monitors CEBus activity. A range of services are available from this "daemon". Basic services including the logging of network traffic to a server-end database and transmitting selected network traffic to a remote WWW client. The software can also accept sequences of network packets from a remote WWW client for transmission on the CEBus network via the "active" node.

In our demonstration application Java applets provide a method of starting mini "daemons" on the remote client. The applets then register and synchronise with the server-end software. This provides much richer application functionality and facilitates more sophisticated network link management and access security.

5. Conclusions & Future Work

In this paper we have demonstrated the practical integration of a CEBus network with the WWW. This integration provides remote access to a new generation of consumer electronics products. The provision of such remote access will greatly enhance the ease of use of CEBus networks for a wide spectrum of potential applications, removing or lowering significant barriers to user acceptance of this technology.

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