Workshop on Web Access to Controls and Measurement

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Abstract

This workshop addresses technological issues in building a Web-based real-time system for instrumentation and control applications. A Web-based real-time system, in general, incorporates Internet, Web clients and servers, CGI scripts, and remote access devices. This workshop covers World Wide Web, TCP/IP applications, HTTP (HyperText Transfer Protocol), Web clients and servers software, HTML (Hypertext Markup Language) pages for device control and measurement, common gateway interface (CGI) programs, and remote access devices (parallel port interface, data acquisition card, USB, RS232, and RS485). A TCP/IP-based distributed measurement and control systems for laboratory environment is also presented.

Contents

1. Introduction to Internet-Based Measurement and Control System
2. TCP/IP Applications and WWW
3. Web Client/Server and HTTP Protocol
4. HTML Web Page Design
5. Design Issues of Web Access Controls and Measurement

Topics of Discussion
1. Introduction to Internet-Based Measurement and Control System
      1.1 Major components
      1.2 Web Server
      1.3 Remote Access Devices (Parallel Interface, Data Acquisition card, USB, RS232, or RS485)
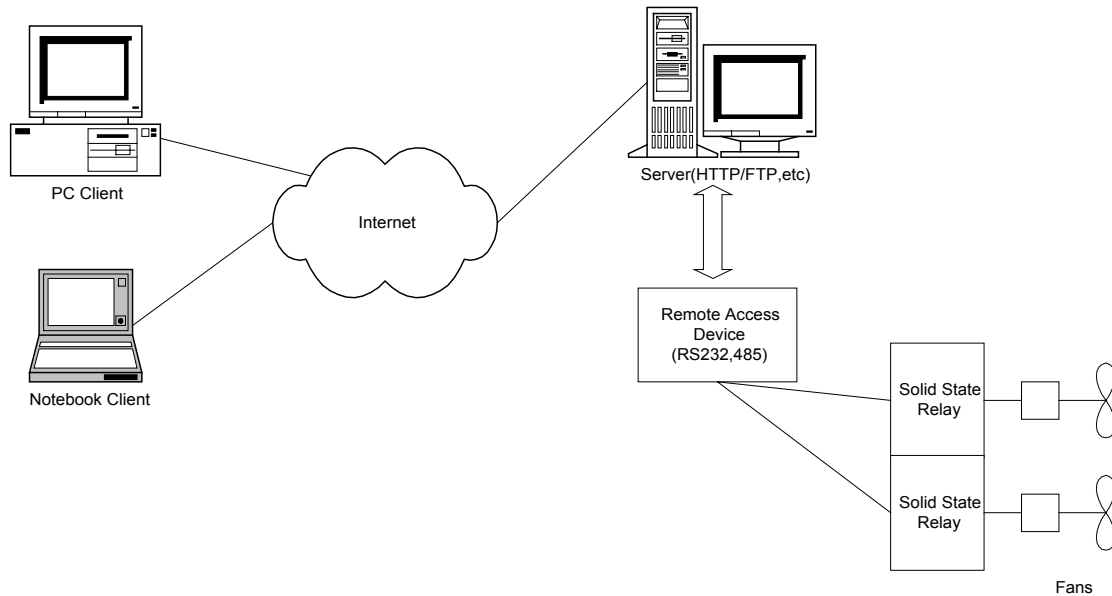   1.4 CGI Interface program (Java, JavaScript, Perl)

Figure 1. Major Components of A TCP/IP Based Distributed Measurement and Control System

2. TCP/IP Applications and WWW

2.1 URL (Uniform Resource Locator)
URL (Uniform Resource Locator) format for the following access schemes:
- bootp   Provide configuration information at boot time (port 67)
- echo   Retransmit the received packet (port 7)
- ftp   File Transfer Protocol (port 20: control, port 21: data)
- http   Hypertext Transfer Protocol (port 80)
- pop   Access mail box on remote systems (port 109)
- smtp   Simple Mail Transfer Protocol (port 25)
- telnet   Telnet Protocol for remote login sessions (port 23)

Local Host: 127.0.0.1 (localhost)

2.2 World Wide Web (an information system)
- WWW is a global, interactive, dynamic, cross-platform, distributed, graphical hypertext, and hypermedia information system.
- Hypertext: files, images, movies, and sound.
- The HTTP (HyperText Transfer Protocol) protocol
- The web browsers such as Netscape Navigator and Microsoft Explorer are designed to recognize such protocol.
- W3C World Wide Web Consortium leads the support and defining the languages and protocols that make up the Web (HTTP, HTML, etc)
- Visit the Consortium's home page at http://www.w3.org/.

2.2 Basic Components of a WWW

- User
- Client computer/Web browser
- Web server
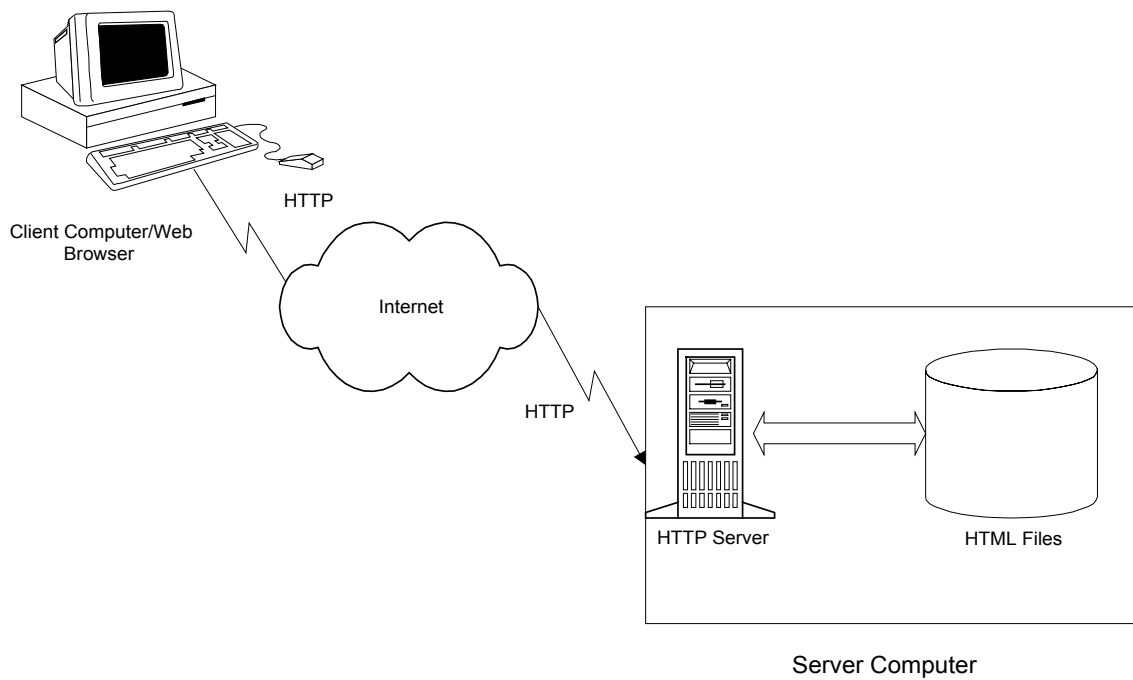- Web Pages (HTML files)

Figure 2: The Basic Components of A WWW Interaction

3. Web Client/Server and HTTP Protocol
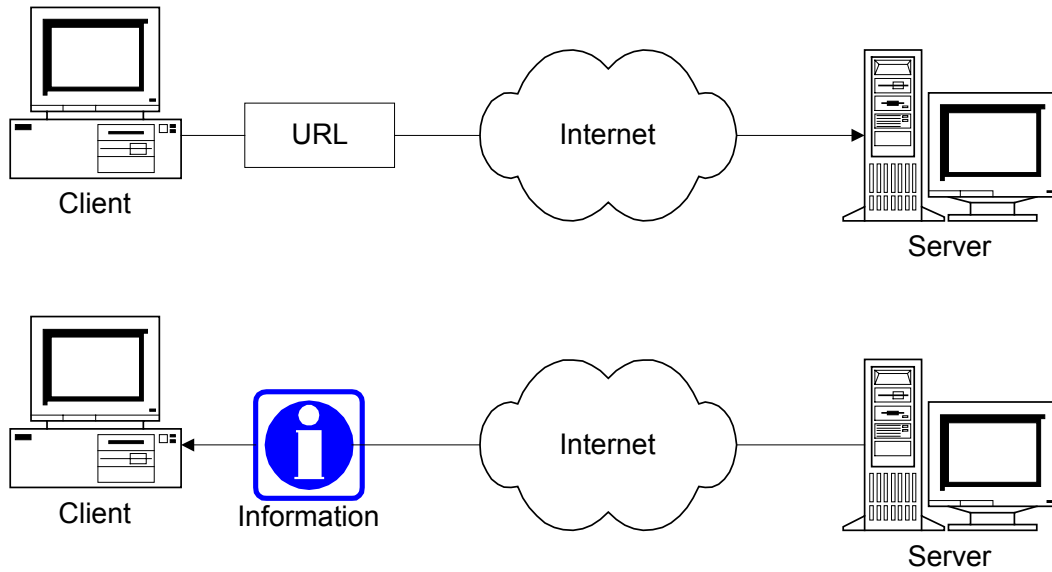### 3.1 Web Client/Server Model

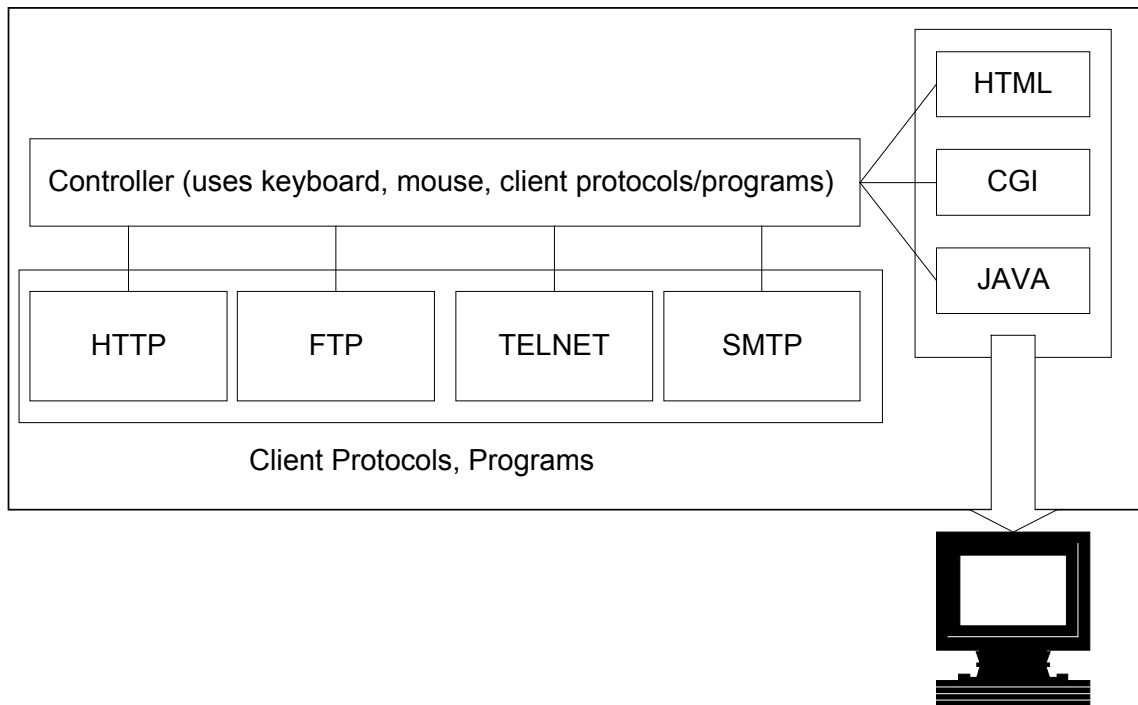Figure 3. Client/Server Interaction

Figure 4. Browser Architecture

3.2 HTTP (HyperText Transfer Protocol)
- An application protocol for used by Web servers and clients that are connected on the World Wide Web
- The HTTP is based on an exchange of requests and responses.

3.3 HTTP Server
- Understand the HTTP protocol
- Interact with HTTP clients
- Obtain pre-existing files and send them to clients

3.4 Basic Information Flow of a HTTP Session
- A client initiates a contact to the HTTP server by sending a request (GET command) to the server and will expect to receive the response (a file) from the server
- The request contains the following information in a request header:
  - request header
- The response contains the following information in a response header:
  - Status of the transaction (success or failure)
  - Actual data requested
- The server does not retain previous contact information

4. HTML (HyperText Markup Language) and Web Pages
4.1 What is HTML?
- Tool for producing documents on World Wide Web
- A language for mixing regular text with "markup" tags for describing the text, document layout, contents, and linking to other documents that stored on the WWW information system
- HTML specifications can be found from the following sits:

http://www.w3.org/pub/WWW/TR/REC-htm132.html	HTML 3.2
http://www.w3/org/TR/WD-html140/	HTML 4.0
http://www.w3.org/pub/WWW/TR/WD-frames	Frames
http://developer.netscae.com/library/documentation/htmlguid/index	Netscape
http://msdn.microsoft.com/workshop/author/newhtml	Microsoft

- Web Site for Web Authoring Tools
  http://dir.yahoo.com/computers_and_internet/software/reviews/titles/internet/web_authoring_tools/
- Web Browser Download Sites:

Netscape Navigator:	http://home.netscape.com/download/
Microsoft Internet Explorer:	http://www.microsoft.com/ie/download/
IBM WebExplorer:	http://www.networking.ibm.com/WebExplorer/

4.2 Web Pages
- Each "Web Page" that we load from the web is a single document, written in a language called HTML, that includes the text of its document, its structure and any links to other documents, images, and other media. In addition, some script languages can be used to create dynamic pages.

- Web pages are normally organize with a combination of the following organizations: hierarchy organization, linear organization, linear with alternative, Web
- Frames allow the document window to be divided into rectangular regions, each associated with a separate HTML document
- Language Tools: HTML, Java, JavaScript, Perl, VBScript

4.3 Publishing Web Pages (HTTP Server)
- Install a computer and connected it to the Internet (TCP/IP protocol support, IP address, and domain name) and running an HTTP server
- The HTTP server takes the URL (Uniform Resource Locator, the web address) specified by the client's browser and translates it into a specific filename on the server's system
- Create a "www" or "public_html" directory for files
- Create documents from remote system on the Internet and upload files using FTP client
- Working on the same HTTP server systems in the target directory
- Some commonly used defaults are: index.html, Welcome.html, default.html
- Notice that Microsoft uses "htm" extension as default
- Set file and directory permissions
- Allows you to setup password access restrictions
- Validate the documents using web page validators
  http://www.webtechs.com.html-val-svc/
  http://ugweb.cs.ualberta.ca/~gerald/validate/
  http://www.yahoo.com/Computers_and_Internet/Information_and_Documentation/Data_Formats/HTML/Validation_Checkers

4.4 The Basics Structure of HTML Documents

- HTML File types and extensions
  - HTML: .html   .htm
  - ASCII Text: .txt
  - PostCript: .ps
  - GIF: .gif   (Image file)
  - JPEG: .jpg   .jpeg   (Image file)
  - AU Audio: .au
  - MPEG Video: .mpeg .mpg

- Document Elements
  - Heading
  - Paragraph
  - Fonts, position
  - Bulleted List
  - Tables
  - Files (text, image file, sound file, video files)

- Structure markup Tags (for overall document)

<u>Begin Tag</u>   <u>End Tag</u>
```
<HTML>        </HTML>
<HEAD>        </HEAD>
<BODY>        </BODY>
<!-- This is a comment   -- >
```

- Tags for title and heading
```
<TITLE> </TITLE>  Title
<H1>      </H1>       Heading 1
<H2>      </H2>       Heading 2
<H6>      </H6>       Heading 6
```

- Paragraphs
```
<p>       </p>        Paragraph
```

- Link (Anchor)
```
<A>       </A>            Anchor, hyper link

HREF="…"                 The URL of the Hyper Text Reference document.
NAME="  .."              The name of the anchor.
```

- Lists
```
<OL>    </OL>     An Ordered (numbered) list
<UL>    </UL>     An unordered  (bulleted) liss
<MENU>  </MENU>   A menu list of items
<DIR>   </DIR>    A directory listing
<LI >   </LI>     A list item
<DL>    </DL>     A definition list or glossary list
<DT>              A definition term
<DD>              The correponding definition to a definition term
```

- Character Formatting
```
<B>       </B>       Boldface text
<I>       </I>       Italic text
<HR>                 A horizontal rule line
<BR>                 A line break
<EM>      </EM>      Emphasis
<FONT> </FONT>       Change Font size
                     SIZE="…"    from 1 to 7
<CODE>  </CODE>     Code sample
<SAMP> …</SAMP>     Sample text
<CITE>…</CITE>      A citation
```

```
<ADDRESS></ADDRESS>              Signature of a author
<STRONG> </STRONG>               Stronger emphasis
<BLOCKQUOTE> </BLOCKQUOTE>  Long quotes
```

- Tables
```
<TR>      </TR>            A table row
<TH>      </TH>            A table heading cell
<TD>      </TD>            A table data cell
<TABLE> </TABLE>          Create a table
<CAPTION></CAPTION>        Caption of table
```

- Images
```
<IMG   SRC="…" >           Insert an inline image into the document
```

- Forms
```
<FORM></FORM>              Indicates a form
<INPUT>                    An input widget for a form to define text, check
                           box, radio button, reset and submit buttons
<TEXTAREA> </TEXTAREA>  A block of text area (row by col)
<SELECT></SELECT>          Give users pre-entered options for selection without
                           typing
<OPTION></OPTION>
```

4.5 HTML Scripting for Dynamic Documents

- JavaScript from Netscape
- JScript from Microsoft
- VBScript uses syntax more familiar to Visual Basic programmers
- Java Applets
- ActiveX control embedding: label, pop menu, HTML pop window, URL preloader, timer, etc

5. Design Issues: Web Access to Controls and Measurement

5.1 Software Development System and Tools
- Web page authoring
- Client-side scripting: JavaScript, Jscript, Java Applet, etc
- Server-side scripting: Perl, C++, Visual Basic, Visual C++, JavaServlet, ASP script

5.2 Hardware/Software Integration
Software Consideration:
- Web server: Web access control pages, information pages, graphics files
- Database
- CGI scripts

Hardware consideration:
- Ethernet I/O, A/D, D/A, and digital I/Os
- RS232/485 serial port connected remote devices
- USB devices
- Parallel port I/Os
- Dedicated I/O modules

Networking Components:
- Ethernet cards
- Hubs
- Routers
- IP address, subnet, gateway

5.3 CGI Automation

CGI Scripting
- Dynamic Web applications
- Small programs that communicate with Web servers, which reply the requests from Web browsers
- Add additional capabilities to the HTTP server
- Work as a gateway to handle complex tasks for the HTTP server
- Generate documents on the fly that are capable of incorporating information which changes or which cannot be determined in advance

CGI Scripts are store on the server side for performing the following tasks:
- Query database
- Perform calculations
- Solicit and interpret user-supplied data
- Retrieve requested information
- Produced customized content

Web server and CGI
- Web client using HTTP for communication
- CGI specifies what information the server sends to a script and what server expects to receive
- CGI scripts are distinguished from HTML files through
    - A file suffix of .cgi or
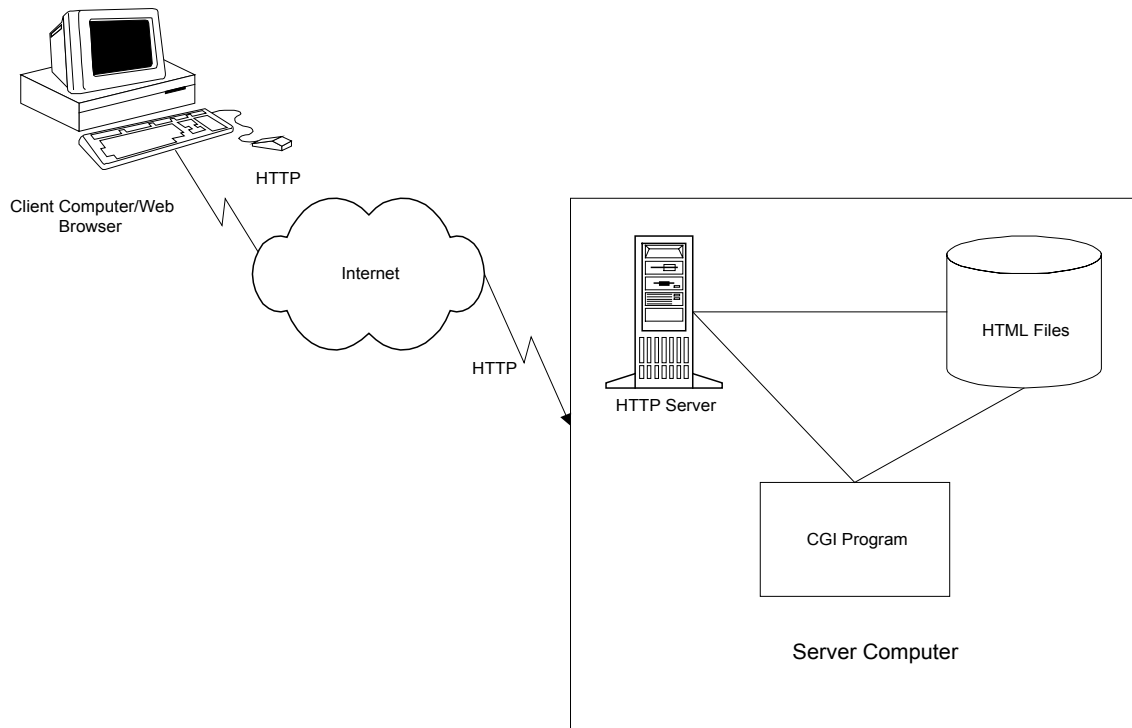   - File being placed in a separate directory (/cgi-bin)

Figure 5. CGI and HTTP Server

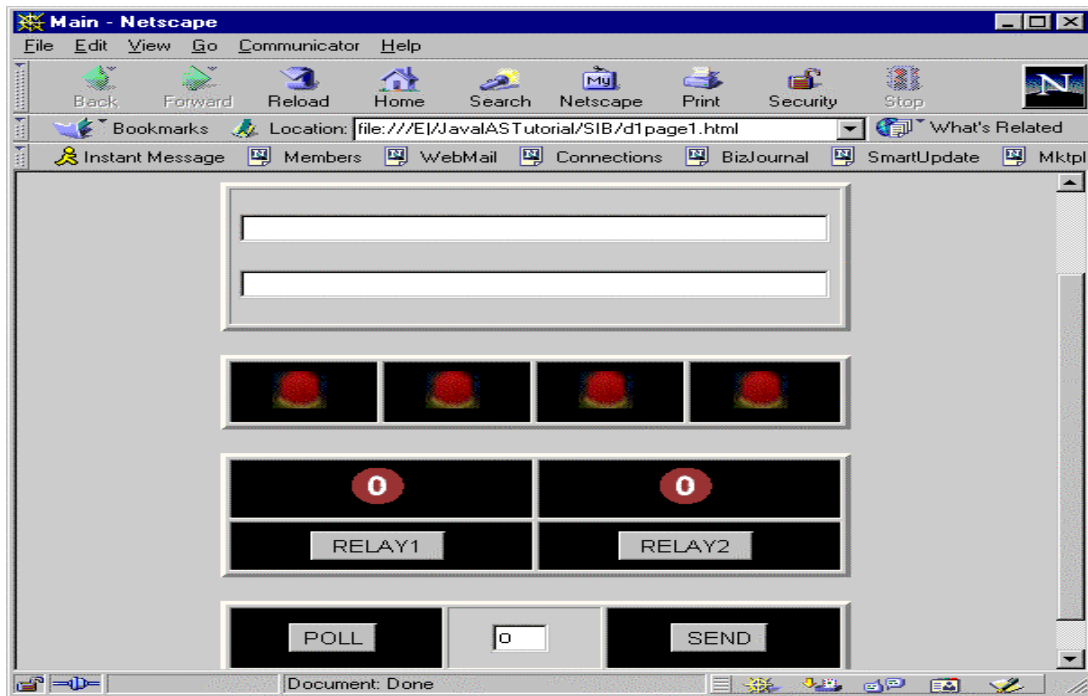## 5.4 An Example of Web Access Controls and Measurement

Figure 6. A HTML Control Page Using JavaScript

Bibliography

1. Paul I-Hai Lin, *Tutorial On Java Computing for Distributed Applications over the Internet*, IEEE IAS Annual Conference, Phoenix, Arizona, IEEE Industry Applications Society Publication, October 1999
2. Paul I-Hai Lin, *Web Programming for Industrial Applications*, www.etcs.ipfw.edu/~lin, Purdue University Fort Wayne Campus, Fall 2000
3. Manuel Aparicio, "Point & Click Manufacturing on the Web, IEEE Internet Computing," September/October 1999, pp. 38-40
4. Fernando Zubillaga-Elorza and Charles Allen, "Virtual Instrument Toolkit: Rapid Prototyping on the Web," IEEE Internet Computing, September/October, pp. 41-48
5. Peter Deirauer and Bob Woolever, "Understanding Smart Devices," Industrial Computing, October 1998, pp. 47-50
6. Jini Network Technology Fact Sheet, www.sun.com/jini/factsheet, Sun Microsystem, January 25, 1999
7. Michael N. Huhns, "Networking Embedded Agents, IEEE Internet Computing, " Jan/Feb 1999, pp. 91-93
8. Behrouz Forouzan, Introduction to Data Communications and Networking, McGraw-Hill, 1998
9. Paul Lin, "Distributed Control and Measurement via the Internet," Indiana Electronics Manufacturing Association Annual Technical Conference, Indianapolis, Indiana, Nov. 4, 1999

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Lin is Associate Professor and Chair of Electrical and Computer Technology Department of Indiana University - Purdue University Fort Wayne. He has been with Purdue University since 1985. He is a registered Professional Engineer in Electrical Engineering at State of California and at the State of Indiana. Previously, he taught at Engineering and Technology Department of Dutchess Community College (NY) for three years (from 1982-1985), at Electrical Engineering Department of National Taipei Institute of Technology for two years, and worked in industry for 8 years. He was a Visiting Professor at National Taipei Science and Technology University (formally National Taipei Institute of Technology) during the spring of 1995. Lin is a Senior member of IEEE and was the Chairman of the Manufacturing Systems Development and Application Department of IEEE-Industry Applications Society from January 1998 to December 1999. Lin's current interests include distributed intelligent control of embedded real-time system, and sensors in industrial control applications.