(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 December 2000 (28.12.2000)

PCT

(10) International Publication Number
WO 00/79758 A3

(51) International Patent Classification[7]: H04L 12/24, G05B 19/418, H04L 12/40, 29/14, 12/28

(21) International Application Number: PCT/US00/17022

(22) International Filing Date: 21 June 2000 (21.06.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/139,814	21 June 1999 (21.06.1999)	US
Not furnished	21 June 2000 (21.06.2000)	US

(71) Applicant: **FIELDBUS FOUNDATION** [US/US]; 9390 Research Boulevard, Suite II-250, Austin, TX 78759 (US).

(72) Inventors: **GLANZER, David, A.**; 214 Olde Oak Drive, Georgetown, TX 78628 (US). **CORLES, Colin, R.**; 7334 North Central Avenue, Phoenix, AZ 85020 (US). **BRODMAN, Stephen, K.**; 185 Tudor Road, Needham, MA 02492 (US). **HAWKINS, William, M.**; 10300 Colorado Road, Bloomington, MN 55438-1844 (US). **HIRST, Michael, D.**; 146 Howland Road, Lakeville, MA 02347 (US). **KOZLIK, Tony, J.**; 2936 W. Morrow Dr., Phoenix, AZ 85027 (US). **NEITZEL, Lee, A.**; 10727 Cassia Drive, Austin, TX 78759 (US). **SAWYER, Raymond, D.**; 5 Barbara Road, Raynham, MA 02767 (US). **TEGNELL, Johan, I.**; 200 Branch Street, Mansfield, MA 02048 (US).

(74) Agents: **KIM, Ki, S.** et al.; Dorsey [entity:amp] Whitney LLP, 1001 Pennsylvania Ave., NIW, Suite 300 South, Washington, DC 20004 (US).

(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
15 November 2001

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: BLOCK-ORIENTED CONTROL SYSTEM ON HIGH SPEED ETHERNET

(57) Abstract: A distributed control system architecture (HSE) provides an open, interoperable solution optimized for integration of distributed control systems and other control devices in a high performance backbone, provides an open, interoperable solution that provides system time synchronization suitable for distributed control applications operable over a high performance backbone, and provides an open, interoperable solution that provides a fault tolerant high performance backbone as well as fault tolerant devices that are connected to the backbone. The distributed control system architecture comprises a High speed Eternet Field Device Access (HSE FDA) Agent, which maps services of a distributed control system, e.g., a fieldbus System, to and from a standard, commercial off-the-shelf (COTS) Ethernet/Internet component. The distributed control system architecture also comprises a High speed Ethernet System Management Kernel (HSE SMK) that operates to keep a local time, and keeps the difference between the local time and a system time provided by a time server within a value specified by the time sync class. The local time is used to time stamp events so that event messages from devices may be correlated across the system. The distributed control system architecture further comprises a High speed Ehernet Local Area Network Redundancy Entity (HSE LRE) that provides redundancy transparent to the applications running on the system. The HSE LRE of each device periodically transmits a diagnostic message representing its view of the network to the other Devices on the system. Each device uses the diagnostic messages to maintain a Network Status Table (NST), which is used for fault detection and selection from a redundant pair of resources.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L12/24 G05B19/418 H04L12/40 H04L29/14 H04L12/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CHEAH R S -S ET AL: "Design and implementation of an MMS environment on ISODE" COMPUTER COMMUNICATIONS,NL,ELSEVIER SCIENCE PUBLISHERS BV, AMSTERDAM, vol. 20, no. 15, 15 December 1997 (1997-12-15), pages 1354-1364, XP004107400 ISSN: 0140-3664	1,2,21, 22
Y	the whole document	7,8,14, 19,23, 24,26
A		3-6, 9-13,15
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 June 2001	03. 07. 2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Cichra, M

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	ARPAIA P ET AL: "A distributed laboratory based on object-oriented measurement systems" MEASUREMENT,GB,INSTITUTE OF MEASUREMENT AND CONTROL. LONDON, vol. 19, no. 3, 1 November 1996 (1996-11-01), pages 207-215, XP004059596 ISSN: 0263-2241	1,2,21, 22
A	the whole document	3-15
Y	WO 98 02993 A (LARAQUI KIM ;TELIA AB (SE)) 22 January 1998 (1998-01-22)	7,8
A	page 4, line 27 -page 6, line 6 page 9, line 23 -page 10, line 13 claims 4,12-14,20,25-30 figures 2,3,5	1-6, 9-15,21, 22
X	US 5 608 720 A (CARTER NICHOLAS J ET AL) 4 March 1997 (1997-03-04)	1,21
Y	abstract	14
A	column 1, line 20-31 column 3, line 24-47 column 9, line 52 -column 10, line 5 column 39, line 35 -column 49, line 52 claims 1,2,9,17,20,30	2-13, 15-20,22
X	US 5 764 955 A (DOOLAN PAUL D) 9 June 1998 (1998-06-09)	1,21
A	abstract figures 3,5,6 column 3, line 17-38 column 6, line 61 -column 7, line 33 column 11, line 14 -column 12, line 57	2-20,22
X	US 5 859 959 A (ALBRECHT ALAN ET AL) 12 January 1999 (1999-01-12)	18
Y	abstract	19,24,26
A	figure 5 column 1, line 45-57 column 3, line 34 -column 3, last line column 5, line 51 -column 6, line 41 column 7, line 27-38 claims 1-6	20

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	DRAKOPOULOS E: "Enterprise network planning and design: methodology and application" COMPUTER COMMUNICATIONS,ELSEVIER SCIENCE PUBLISHERS BV, AMSTERDAM,NL, vol. 22, no. 4, 25 March 1999 (1999-03-25), pages 340-352, XP004223022 ISSN: 0140-3664 the whole document	18-20, 24-26
A	US 5 506 956 A (COHEN AARON Y) 9 April 1996 (1996-04-09) abstract figures 1,10,11 column 7, line 48 -column 8, line 63 column 13, line 1-45 column 17, line 44 -column 18, line 55	18-20, 24-26
X	HE J ; MAMMERI Z ; THOMESSE J P: "Clock synchronization in real-time distributed systems " SECOND IEEE WORKSHOP ON FUTURE TRENDS OF DISTRIBUTED COMPUTING SYSTEMS, 30 September 1990 (1990-09-30) - 2 October 1990 (1990-10-02), pages 135 -141, XP002168838 Los Alamitos,	16,27
Y	the whole document	23
A		17,28,29
A	LONN H ; SNEDSBOL R : "Synchronisation in safety-critical distributed Control Systems" IEEE FIRST INTERNATIONAL CONFERENCE ON ALGORITHMS AND ARCHITECTURES FOR PARALLEL PROCESSING (95TH0682-5), 19 - 21 April 1995, pages 891-899, XP002168839 the whole document	16,17, 23,27-29
A	OLSON A ; SHIN K G : " Probabilistic clock synchronization in large distributed systems" 11TH INTERNATIONAL CONFERENCE ON DISTRIBUTED COMPUTING SYSTEMS, 20 - 24 May 1991, pages 290-297, XP002168840 Arlington, TX, USA the whole document	16,17, 23,27-29

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 00/17022

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

As a result of the prior review under R. 40.2(e) PCT, no additional fees are to be refunded.

1. [X] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[X] The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-15, 21-22

Apparatus in a distributed control system comprising:

1. A first network interface for a commercial off-the-shelf Ethernet network having a communication protocol stack.

2. A device access agent for mapping a legacy format service message to a format compatible with said protocol stack.

3. A high speed Ethernet management agent for managing TCP, UDP and IP layers of said protocol stack.

4. An Ethernet management agent interface through which said device access agent communicates with said Ethernet management agent.

2. Claims: 16-17, 21,23, 27-29

Apparatus in a distributed control system comprising:

1. A local time clock

2. A system time clock providing system time of distributed system

3. A system management kernel for synchronizing said local time clock with said system time clock.

3. Claims: 18-20, 21,24-26

Apparatus in a distributed control system comprising:

1. Redundant plurality of network interfaces communicating with a redundant plurality of networks.

2. A redundancy entity maintaining a network status table indicating the operational status of said networks and selecting an operational of the redundant networks based on said network status table.

INTERNATIONAL SEARCH REPORT

Information on patent family members

I. ıational Application No
PCT/US 00/17022

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US 5764955 A	09-06-1998	NONE	
US 5859959 A	12-01-1999	NONE	
US 5506956 A	09-04-1996	NONE	