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[Continued on next page]

(54) Title: SYSTEMS, METHODS, AND APPARATUS WITH PROGRAMMABLE MEMORY CONTROL FOR HETEROGENEOUS MAIN MEMORY

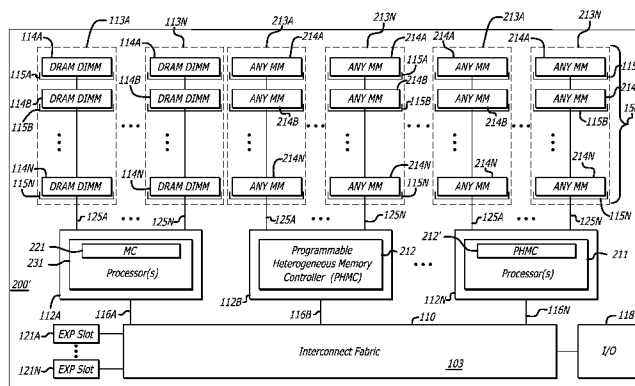


FIG. 2

(57) Abstract: A computer system is disclosed including a printed circuit board (200) (PCB) including a plurality of traces (116A.116B.116N)1 at least one processor (231) mounted to the PCB to couple to some of the plurality of trace (116A,116B,116N), a heterogeneous memory channel (125A.125N) including a plurality of sockets (113A.213A) coupled to a memory channel bus of the PCB, and a memory controller (221) coupled between the at least one processor and the heterogeneous memory channel. The heterogeneous memory channel includes a plurality o sockets coupled to a memory channel bus of the PCB. The plurality of sockets are configured to receive a plurality of different types of memory modules (115A, 214A). The memory controller may be a programmable heterogeneous memory controller to flexibly adapt to the memory channel bus to control access to each of the different types of memory modules in the heterogeneous memory channel.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/80015

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC: **G06F 13/00( 2006.01)**

USPC: 711/154  
 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)  
 U.S. : 711/5,102,103,104,154

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
 EAST, IEEE Xplore, ACM Database

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/0133684 A1 (Anderson) 19 Sept. 2002 (19.09.2002), Fig. 1, paragraphs 6,13,16,17,24,35, 49 and 50.	1-15, 41-46
A	US 6,970,968 B1 (Holman) 29 Nov. 2005 (29.11.2005), col. 3, l. 39 through col. 6, l. 7.	1-15, 41-46
A	US 2002/0118593 A1 (Takemae) 29 Aug. 2002 (29.08.2002), paragraphs 14-32.	1-15, 41-46

Further documents are listed in the continuation of Box C.       See patent family annex.

Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent published on or after the international filing date	"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
"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)	"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
"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	"&"	document member of the same patent family

Date of the actual completion of the international search 11 June 2008 (11.06.2008)	Date of mailing of the international search report <b>13 AUG 2008</b>
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer /Craig E Walter/ Craig E Walter Telephone No. (571) 272-8154	DEBORAH A. THOMAS PARALEGAL SPECIALIST  <i>Det</i>
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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US07/80015

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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 No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:  
Please See Continuation Sheet

1.  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 additional fees, this Authority did not invite payment of any additional fees.
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.: 1-15 and 41-46

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
  - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
  - No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US07/80015

### BOX III. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-15 and 41-46, drawn to a main memory, computer system and memory module in which hardware features (e.g., memory sockets, controllers, printed circuit boards, integrated circuit packages, etc.) are used to define the overall design of the memory/memory module within the computer system.

Group II, claim(s) 16-40 and 47-59, is however drawn to a method for communication, translator for communication, and a memory controller programmed for specific communication protocols within a computer system. More specifically, the devices recited are used to generate logic signals for communication and timing, and communication protocol translation.

The inventions listed as Groups I do not related to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The special technical feature can be ascertained a priori, as it is readily apparent that generated logic signal and protocol translation are unique the Group II, and are not the same special technical feature as claimed in Group I which defines the structure of a memory module with a computer system.

Applicant's representative was not contacted via telephone with regard to an invitation to pay the additional search fees (i.e., lack of unity) on this application, as it is not readily apparent that Applicant's representative has a deposit account with the USPTO. Examiner was unable to locate Applicant's representative's deposit account, and further notes that all fees in the instant application were paid via credit card. MPEP § 1850 stipulates the use of form PCT/ISA/206 in favor of a telephonic invitation under these particular circumstances.