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- (74) Agents: **GELFOUND, Craig A.** et al.; Arent Fox LLP, 1717 K Street N.W., Washington, District of Columbia 20006-5344 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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**Declarations under Rule 4.17:**

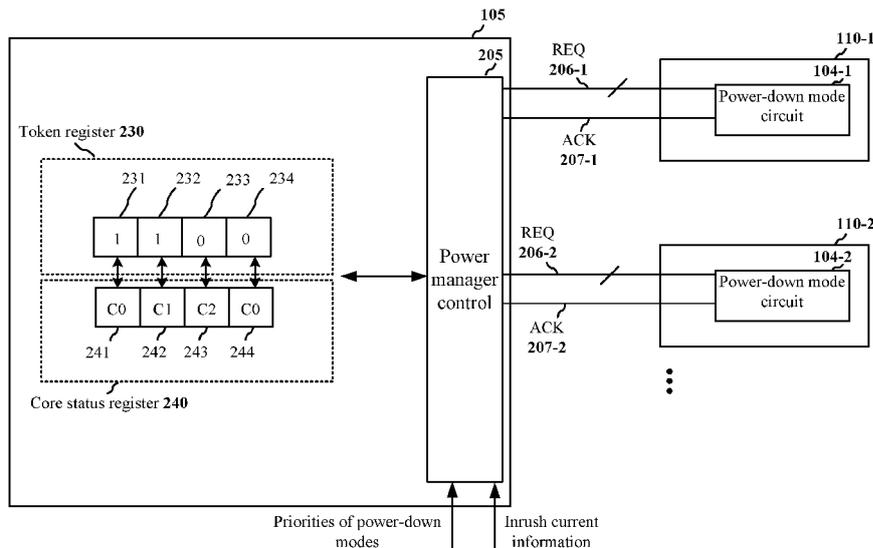
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

**Published:**

- with international search report (Art. 21(3))

[Continued on next page]

(54) Title: MANAGING POWER-DOWN MODES



**FIG. 2**

(57) Abstract: An apparatus includes a first circuit configured to receive one or more requests from a plurality of cores. Each of the one or more requests is to enter or to exit one of a plurality of power-down modes. The first circuit further selects one or more of the cores to enter or to exit the requested power-down mode or modes based on inrush current information associated with the power-down modes. A second circuit is configured to effect entering or exiting the requested power-down mode or modes in the selected one or more of the cores.

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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 (Rule 48.2(h))*

**(88) Date of publication of the international search report:**  
22 June 2017

**INTERNATIONAL SEARCH REPORT**

International application No PCT/US2016/049504
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**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. G06F1/32  
 ADD.

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)  
 G06F

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 practicable, search terms used)  
 EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 2 887 181 A1 (INTEL CORP [US]) 24 June 2015 (2015-06-24) paragraphs [0006] - [0065]; figures 1-10	1,2,11, 12 3-10, 13-30
X Y	----- US 2015/253836 A1 (MYLIUS JOHN H [US] ET AL) 10 September 2015 (2015-09-10) paragraphs [0022] - [0072]; figures 1-9	1,2,11, 12 3-10, 13-30
X Y	----- US 2001/052800 A1 (MIZUNO HIROYUKI [JP]) 20 December 2001 (2001-12-20) paragraphs [0015] - [0143]; figures 1-13	1,2,11, 12 3-10, 13-30
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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 but 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	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  17 May 2017	Date of mailing of the international search report  24/05/2017
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  Vertua, Arturo
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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2016/049504

## 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:

see additional 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 an additional fees, this Authority did not invite payment of 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.:

### 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/US2016/049504

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/072746 A1 (SOTOMAYOR GUY [US]) 22 March 2012 (2012-03-22)	1,2,11, 12
Y	paragraphs [0009] - [0056]; figures 1-5 -----	3-10, 13-30
Y	US 2010/268917 A1 (NATION GEORGE [US] ET AL) 21 October 2010 (2010-10-21)	3-5, 13-15
	paragraphs [0037] - [0097]; figures 1-9b -----	
Y	US 2013/086395 A1 (LIU JONATHAN H [US]) 4 April 2013 (2013-04-04)	6-9, 16-19, 24,25, 29,30
	paragraphs [0024] - [0043]; figures 1-4 -----	
Y	US 2015/169363 A1 (ANDERSON JON JAMES [US] ET AL) 18 June 2015 (2015-06-18)	6-9, 16-19, 24,25, 29,30
	paragraphs [0038] - [0123]; figures 1-16 -----	
Y	US 2009/172423 A1 (SONG JUSTIN [US] ET AL) 2 July 2009 (2009-07-02)	6-9, 16-19, 24,25, 29,30
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	paragraphs [0017] - [0072]; figures 1-10 -----	
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Y	WO 2014/123587 A1 (QUALCOMM INC [US]) 14 August 2014 (2014-08-14)	21-30
	paragraphs [0073] - [0153]; figures 10-19 -----	
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	paragraphs [0020] - [0048]; figures 1-7 -----	
Y	WO 2012/170214 A2 (QUALCOMM INC [US]; THOMSON STEVEN S [US]; REGINI EDOARDO [US]; MONDAL) 13 December 2012 (2012-12-13)	21-30
	paragraphs [0063] - [0122]; figures 4-14 -----	
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**INTERNATIONAL SEARCH REPORT**

International application No PCT/US2016/049504
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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.
Y	EP 2 818 963 A1 (INTEL CORP [US]) 31 December 2014 (2014-12-31) paragraphs [0006] - [0058]; figures 1-9 -----	21-30
Y	EP 2 879 017 A2 (INTEL IP CORP [US]) 3 June 2015 (2015-06-03) paragraphs [0015] - [0073]; figures 1-9 -----	21-30
A	LAI ZHIQUAN ET AL: "Latency-aware DVFS for efficient power state transitions on many-core architectures", JOURNAL OF SUPERCOMPUTING, KLUWER ACADEMIC PUBLISHERS, DORDRECHT, NL, vol. 71, no. 7, 5 April 2015 (2015-04-05), pages 2720-2747, XP035506622, ISSN: 0920-8542, DOI: 10.1007/S11227-015-1415-Y [retrieved on 2015-04-05] the whole document -----	21-30

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/049504

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Information on patent family members

International application No PCT/US2016/049504
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**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, 2, 11, 12

An apparatus, comprising: a first circuit configured to receive one or more requests from a plurality of cores, each of the one or more requests being to enter or to exit one of a plurality of power-down modes, and select one or more of the cores to enter or to exit the requested power-down mode or modes based on inrush current information associated with the power-down modes; and a second circuit configured to effect entering or exiting the requested power-down mode or modes in the selected one or more of the cores, wherein the first circuit is further configured to select additional one or more of the cores independent of the power-down modes, and wherein the second circuit is further configured to effect entering or exiting the power-down mode or modes requested by the additional one or more of the cores.

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2. claims: 3-5, 13-15

An apparatus, comprising: a first circuit configured to receive one or more requests from a plurality of cores, each of the one or more requests being to enter or to exit one of a plurality of power-down modes, and select one or more of the cores to enter or to exit the requested power-down mode or modes based on inrush current information associated with the power-down modes; and a second circuit configured to effect entering or exiting the requested power-down mode or modes in the selected one or more of the cores, wherein the first circuit is further configured to select the cores based on an inrush current budget.

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3. claims: 6-9, 16-19

An apparatus, comprising: a first circuit configured to receive one or more requests from a plurality of cores, each of the one or more requests being to enter or to exit one of a plurality of power-down modes, and select one or more of the cores to enter or to exit the requested power-down mode or modes based on inrush current information associated with the power-down modes; and a second circuit configured to effect entering or exiting the requested power-down mode or modes in the selected one or more of the cores, wherein the first circuit is further configured to assign a priority to each of the cores and configured to select the one or more of the cores based on the assigned priorities.

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4. claims: 10, 20

An apparatus, comprising: a first circuit configured to

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

receive one or more requests from a plurality of cores, each of the one or more requests being to enter or to exit one of a plurality of power-down modes, and select one or more of the cores to enter or to exit the requested power-down mode or modes based on inrush current information associated with the power-down modes; and a second circuit configured to effect entering or exiting the requested power-down mode or modes in the selected one or more of the cores, wherein the inrush current information associated with the power-down modes is programmable.

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5. claims: 21-30

An apparatus, comprising: a first circuit configured to receive a plurality of requests from a plurality of cores, each of the requests being to enter or to exit one of a plurality of power-down modes; and select ones of the cores to enter or to exit different power-down modes concurrently; and a second circuit configured to effect entering or exiting the requested power-down modes in the selected ones of the cores.

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