US008897573B2

(12) **United States Patent**
Chen et al.

(10) **Patent No.: US 8,897,573 B2**
(45) **Date of Patent: *Nov. 25, 2014**

(54) **VIRTUAL MACHINE IMAGE ACCESS DE-DUPLICATION**

(75) Inventors: **Han Chen**, White Plains, NY (US); **Alexei A. Karve**, Mohegan Lake, NY (US); **Minkyong Kim**, Scarsdale, NY (US); **Andrzej P. Kochut**, Croton on Hudson, NY (US); **Hui Lei**, Scarsdale, NY (US); **Jayaram Kallapalayam Radhakrishnan**, Raleigh, NC (US); **Zhiming Shen**, Raleigh, NC (US); **Zhe Zhang**, Elmsford, NY (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 43 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/588,173**

(22) Filed: **Aug. 17, 2012**

(65) **Prior Publication Data**

US 2014/0052698 A1 Feb. 20, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/588,050, filed on Aug. 17, 2012.

(51) **Int. Cl.**
G06K 9/66 (2006.01)

(52) **U.S. Cl.**
USPC **382/195**; 711/206; 711/200; 711/202; 711/203; 711/205; 711/103

(58) **Field of Classification Search**
CPC G06K 9/4633; G06T 1/60
USPC 382/195; 711/206, 200, 202, 203, 205, 711/103
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,789,156	B1	9/2004	Waldspurger	
7,761,664	B2	7/2010	Gill	
7,856,439	B2	12/2010	Alpern et al.	
8,074,047	B2 *	12/2011	Abali et al.	711/206
2008/0307188	A1	12/2008	Franaszek et al.	
2010/0088349	A1	4/2010	Parab	
2010/0131480	A1	5/2010	Schneider	
2012/0066677	A1	3/2012	Tang	
2012/0144099	A1 *	6/2012	Yang et al.	711/103

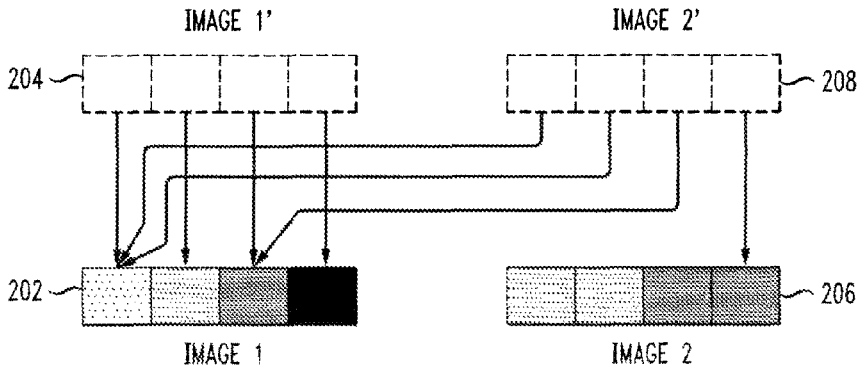
OTHER PUBLICATIONS

Jayaram et al., An Empirical Analysis of Similarity in Virtual Machine Images, Middleware 2011 Industry Track, Dec. 12, 2011.
Copy-on-Write, Wikipedia, http://en.wikipedia.org/wiki/Copy-on-write downloaded Aug. 17, 2012.

* cited by examiner

Primary Examiner — Mike Rahmjoo
(74) *Attorney, Agent, or Firm* — Ryan, Mason & Lewis, LLP

(57) **ABSTRACT**

A system and an article of manufacture for de-duplicating virtual machine image accesses include identifying one or more identical blocks in two or more images in a virtual machine image repository, generating a block map for mapping different blocks with identical content into a same block, deploying a virtual machine image by reconstituting an image from the block map and fetching any unique blocks remotely on-demand, and de-duplicating virtual machine image accesses by storing the deployed virtual machine image in a local disk cache.

20 Claims, 3 Drawing Sheets