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(54) **METHODS AND APPARATUS FOR DYNAMICALLY PRELOADING CLASSES**

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(52) **U.S. Cl.**

CPC ***G06F 9/45504*** (2013.01); ***G06F 9/445*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,815,718 A * 9/1998 Tock G06F 9/443 712/E9.084
5,966,542 A 10/1999 Tock
6,223,346 B1 * 4/2001 Tock G06F 9/443 712/E9.084
6,470,494 B1 * 10/2002 Chan G06F 9/445 717/139
6,571,388 B1 * 5/2003 Venkatraman G06F 9/44557 717/108
6,658,492 B1 * 12/2003 Kawahara G06F 9/44573 717/159
6,745,386 B1 * 6/2004 Yellin G06F 9/44521 717/139
6,813,762 B1 * 11/2004 Plaxton G06F 9/44557 717/139
6,826,559 B1 * 11/2004 Ponte G06F 17/30867
6,996,813 B1 * 2/2006 Sokolov G06F 9/44521 717/139

(Continued)

OTHER PUBLICATIONS

"Dalvik Bytecode Verifier Notes," 2008 The Android Open Source Project, downloaded from http://www.netmite.com/android/mydroid/dalvik/docs/verifier.html on Feb. 22, 2012, 2 pages.

(Continued)

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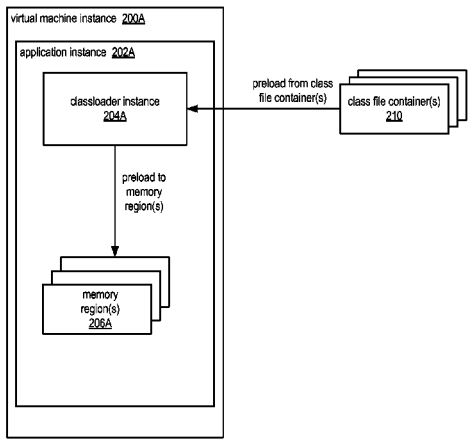
(57) **ABSTRACT**

A class preloading mechanism that dynamically preloads classes at runtime in a virtual machine (VM) environment. Data structures representing preloaded classes may be stored in a persistent module corresponding to a classloader. A persistent module can be directly mapped or copied into a memory region at runtime so that the classes may not have to be loaded from the class file container. The preloaded classes are not fully linked and resolved. When a classloader receives a class request, the classloader looks up the preloaded class in the memory region and completes linking and resolution of the class. Persistent modules may be pre-generated and, for example, installed with an application. Alternatively, a persistent module for a class file container may be generated at runtime by preloading classes from the class file container into a memory region and storing data structures representing the classes as a persistent module.

20 Claims, 9 Drawing Sheets