**Mobile Virtualization Optimization Using Emerging Non-Volatile Memory (PI: Dr. Shao Zili; 2014/15)**

By allowing a mobile device to host multiple virtual machines (VMs), mobile virtualization can help reduce development cost and shorten the time to market with code reuse, and enhance privacy and security with VM isolation. Mobile virtualization posts new challenges to the design of the underlying memory and storage systems. First, VMs and encapsulated applications have various memory demands, and critical VM management functions such as checkpointing requires significant memory and IO operations. Conventional DRAM systems with fixed capacity cannot accommodate these requirements, resulting in low system performance due to increased page faults. Second, NAND-flash-based storage systems such as eMMC/SD cards and SSDs (Solid-State Drives) are widely used as storage in mobile devices, but their characteristics have not been considered in mobile virtualization, resulting in shorter lifetime of NAND flash and degraded system performance. Finally, mobile devices are resource constrained with limited energy and less memory and storage which need to be considered for mobile virtualization optimization.

To address the above challenging issues, we for the first time propose to use emerging non-volatile memory technology, more specifically, phase change memory (PCM), to optimize mobile virtualization design. Particularly, we will investigate the

following PCM-based mobile visualization techniques: (1) VM-aware memory techniques for joint time performance and energy optimization that can adapt to various memory demands. (2) VM management techniques that target at optimizing performance-critical VM functions (e.g. checkpoint/restore). The objective is to balance the trade-offs among the speed, energy and PCM space by optimizing the checkpoint/restore duration while reducing PCM usage with deduplicatoin under limited energy budget. (3) VM-image storage optimization techniques. By separating hot/cold data (e.g. file system metadata and regular data) to a VM image file and caching hot data with PCM, the objective is to reduce IO traffic so as to improve the system performance and lifetime of NAND flash.

The proposed research, which synergistically integrates emerging memory techniques with mobile VM execution and management, will open the door for a new class of research in mobile virtualization. It can help enable mobile virtualization systems to leverage emerging device technologies and architecture design and hence benefit numerous real-life mobile applications. This is particularly important for Hong Kong, as mobile computing platforms and applications provide essential support for an international business, trade and financial hub.