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École Nationale Supérieure d'Informatique pour l'Idustrie et l'Entreprise ENSIIE

to

the USCIS

Subject : Recommendation of Ming Mao

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To the USCIS:

Cloud computing is catalyzing a series of changes with regard to the consumption of information technology. It allows for shared resources, including networks, servers and applications, which signifies greatly reduced costs of operation. Already, business and economic practices have shifted in order to incorporate cloud technology and all its benefits. These shifts are part of a market in "hypergrowth" expected to reach a value of about $190 billion by 2020, according to the U.S. International Trade Administration. However, cloud computing currently faces some limitations, many of which Dr. Ming Mao has addressed and successfully overcome. His contributions are particularly relevant for U.S. businesses, who had spent more than $13 billion on cloud computing solutions at the beginning of 2014. Further, the great majority of global firms developing and offering cloud computing strategies are U.S.-based. Dr. Ming Mao's continued research in the field is of great importance precisely for these reasons. As the very first to develop a standard evaluative framework for virtual machine (VM) performance, he has contributed advances of great importance for cloud computing processes and established himself as a researcher at the top of the field.

Please allow me to introduce myself. I have been a Professor in Computer Science at ENSIIE (National School of Computer Science for Industry and Business) Engineering School in Computer Science since 2014, and Director of the Strasbourg campus since spring 2013. Previously, I was an Assistant Professor in Computer Science at the University of Strasbourg. My research has a heavy focus on applications of parallel and distributed computing to clusters, grids or clouds. I am an affiliate of the Icube research laboratory ICPS group, with which I conduct research on cloud and grid computing. I know Dr. Mao only through close readings of his publications, which have been included in the proceedings of high-profile IEEE and ACM conferences. For a computer scientist, publication at these venues is a hallmark of distinction as many accept fewer than 20% of submitted papers. Some of the conferences at which Dr. Mao has published research include the International Conference on Grid Computing, the International Conference on Cloud Computing (CLOUD) and the International Symposium on Parallel and Distributed Processing.

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It was at a CLOUD conference that Dr. Mao published the results of his thorough study of VM performance. He studied VM startup and shutdown for three cloud providers, Amazon EC2, Windows Azure and Rackspace, according to all factors involved in VM performance. Dr. Mao rigorously defined metrics according to which he measured and compared the performance of the three providers. His experiments revealed that Rackspace has the

greatest rate of failure of the three providers, 8%. By contrast, Amazon EC2 has a failure rate of 0.8% and Windows Azure has a failure rate of 0.4%. He also established that the size of the operating system image affects the VM startup time in a positive linear fashion for all three cloud providers. He found that the instance type also affects the VM startup time according to a positive linear function for Windows Azure and for Rackspace, but the two variables are not correlated for Amazon EC2. For all three platforms, VM startup times are independent of the time of day and of the location of data centers except for a single data center used for Amazon EC2. In this particular case, Dr. Mao observed startup times around 20% longer than the rest. When recruiting a pool of VMs, Dr. Mao found that VM startup time is fairly constant across all instances for Amazon EC2 but not for Windows Azure, where the last instance sometimes requires significantly more time than the first. He also established that the VM release time is unaffected by the instance type, by the OS image size or by the location of the data center. Through his studies of these fundamental computing resources, Dr. Mao has greatly benefitted subsequent study of VM performance and cloud configuration. He has contributed to progressively more efficient and elastic cloud usage plans.

Dr. Mao's VM performance study has been cited more than 150 times. I published an article in the 27th IEEE International Parallel & Distributed Processing Symposium in which I describe Dr. Mao's discovery of the relationship between VM startup time and OS image size and detail the importance of this discovery. The implementation of a preemptive mechanism to mitigate this phenomenon allows for faster cloud computation and online application functions. Many others have used Dr. Mao's results to configure more advanced cloud applications and conduct experiments and simulations. Notably, researchers from Argonne National Laboratory directly applied Dr. Mao's cloud environment characterizations to conduct simulations of VM overhead. Others at Fermi National lab also cited Dr. Mao's work with virtual machine overhead as one of the few to note its impact on resource allocation during cloud computation. Dr. Mao's work has also been implemented and confirmed by researchers at the University of Bamberg in Germany, at the National Institute of Technology in India, at the University of Melbourne in Australia and at Tsinghua University in China. These are but a few prominent examples of more than 660 total citations Dr. Mao's articles have received. This figure serves as a final, unambiguous indicator of Dr. Mao's position at the top of the international field.

Yours congenially,

Prof. Dr. Stéphane GENAUD