Research on architecture of information network systems

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My research interests are architectures for internet of things and cloud systems. Here are some topics.

I   Research interest 1: Internet of things

■Probabilistic Control of Dynamic Crowds Toward Uniform Spatial-Temporal Coverage   [1]

Vehicular mobility and connectivity vary significantly over space and time when vehicular crowd sensing covers a city-wide area for a long time period, but it is important to achieve sufficiently uniform data coverage to satisfy the requirements of an environmental monitoring scenario. Our goal is thus to ensure uniform spatial-temporal coverage of sensed data over a city-wide area despite such vehicle dynamics. We propose a probabilistic control mechanism that adaptively adjusts the incentive to each participant, without using any prior information about participants. We provide a mathematical analysis that ensures stability of the number of participants with assigned tasks (called workers), and we evaluate the mechanism's robustness by using 24-hr vehicle trace data from a city-wide area.
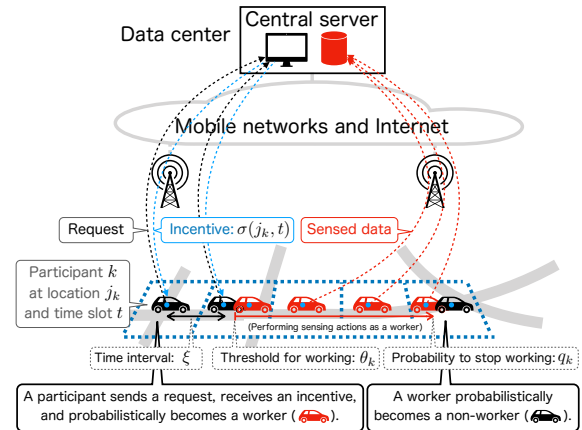

Fig. 1   System overview

II   Research interest 2: Cloud systems

■Hierarchical and Frequency-Aware Model Predictive Control for Bare-Metal Cloud Applications   [2]

Bare-metal cloud provides a dedicated set of physical machines (PMs) and enables both PMs and virtual machines (VMs) on the PMs to be scaled in/out dynamically. However, to increase efficiency of the resources and reduce violations of service level agreements (SLAs), resources need to be scaled quickly to adapt to workload changes, which results in high reconfiguration overhead, especially for the PMs. We thus propose a hierarchical and frequency-aware auto-scaling based on *Model Predictive Control* to achieve an optimal balance between resource efficiency and overhead. Moreover, when performing high-frequency resource control, the proposed technique improves the timing of reconfigurations for the PMs without increasing the number of them, while it increases the reallocations for the VMs to adjust the redundant capacity among the applications; this process improves the resource efficiency.
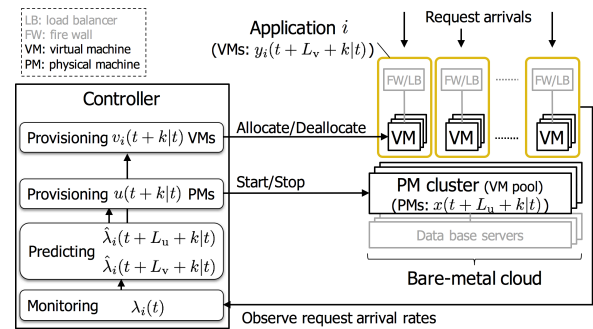

Fig. 2   System architecture

[1] *IEEE Transactions on Mobile Computing*, vol. 23, no. 2, pp.1050–1065, 2024.

[2] *Proceedings of 2018 IEEE/ACM 11th International Conference on Utility and Cloud Computing (UCC)*, pp.11–20, 2018.