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研究課題名（和文）Leveraging Cloud Computing and Software Defined Networking Technologies for Low Latency, Location-aware Internet of Things

研究課題名（英文）Leveraging Cloud Computing and Software Defined Networking Technologies for Low Latency, Location-aware Internet of Things

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研究成果の概要（和文）：IoT(Internet of Things :モノのインターネット）の導入・利活用を促進 するためには、既存のインターネットと有機的結合されてゆく必要がある。この研究プロジェクトでは、SDNとクラウドコンピューティングという2つの新技術を活用し、IoTにおけるネットワークやコンピュータ資源の効率的かつ 弾力的な運用手法について取り組む。まずこの2つの新技術を含めた可能性のある新技術について調査し、これらの技術を活用した新しい手法を考案する。具体的には、IoTの多様な 要求を満たすことを可能とするプロトコルとアーキテクチャを提案する。

研究成果の概要（英文）：To speed up adoption and benefit from Internet of Things (IoT) services, the future IoT should evolve organically on top of the existing Internet. This research project focuses on the two main emerging technologies (i.e., SDN and cloud computing) for efficiently and resiliently allocating networking and computing resources in the IoT. We first investigate the capability of the two and other evolvable technologies in a future context. Moreover, we aim to devise new methods that rely on the aforementioned technologies. To this end, we have proposed more efficient protocols, architecture, to meet the diverse requirements.

研究分野：　情報通信工学

キーワード：　ソフトウェア・デファインド・ネットワーキング　クラウドコンピューティング　オーケストレーション　スケーラビリティ　弾性

１．研究開始当初の背景

The future Internet of Things (IoT) will enable a plethora of new beneficial services for society. To speed up adoption and benefit from IoT services, the future IoT should evolve organically on top of the existing Internet. However, the Internet is not designed for the scale and requirements of the IoT (i.e., low latency, location awareness, resilience, etc.). Generally, the data in IoT services should be effectively delivered and consumed in close proximity to where it was produced. The IoT issues lead to an overarching challenge: how to devise novel methods, which are based on the existing technologies, for effectively managing networking and computing in the IoT services. Specifically, in this research we rely on two major technologies which are Software Defined Networking (SDN) and cloud computing. SDN, which separates control and data planes on a device, is a candidate for solving the networking challenge. On the other hand, the cloud computing, which supports elastic computational demands, is for the computing challenge. The objectives of this research is to explore the orchestration of the two technologies that includes novel, efficient functionality for the IoT.

２．研究の目的

This research investigates how the orchestration can be leveraged to satisfy the requirements of the IoT services. The key idea is to bring the orchestration closer to the IoT devices. In particular, we focus on three important aspects: i) feasibility of orchestration at the at the level of access network, ii) exploration of SDN and supporting technologies on wireless devices in IoT, iii) resilience and scalability of SDN in large scale networks.

３．研究の方法

For investigating the feasibility, we have focused on the state-of-the-art technologies for SDN (e.g., OpenFlow) and cloud computing (e.g., OpenStack). However, within a short period, the fast growing communities in both technologies not only prove the feasibility but also enables the adoption. For example, similar concepts have been commercialized (e.g., fog computing, mobile edge computing). Therefore, we switch the focuses on the others.

(1) For the evolvable supporting technologies for IoT, we have studied emerging technologies under the different requirements. Specifically, under the energy efficient requirement, the energy harvesting for sensor network is investigated. Moreover, under throughput and resilience requirements, we solve by using concurrent transmissions in Wi-Fi networks.

(2) For scalability and resilience, we have studied the importance of extending SDN to a data plane (i.e., a wireless device) for resilience and scalability. We have investigated various resilient aspects provided by the SDN technology in different scales. Additionally, we have researched the limitations of control planes and methods to bypass them

４．研究成果

(1) For the supporting technologies for IoT devices, we have proposed a novel medium access control protocol for energy-harvesting wireless sensor networks. The protocol that adopts asynchronous receiver invitation, packet concatenation let energy-harvesting nodes keep energy neutral operation. On the other hand, our proposal of combining

virtual Wi-Fi, policy routing, and multipath TCP on a Wi-Fi client significantly enhances throughput and effectively achieves handover.

(2) For scalability and resilience, we have proposed to extend the usage of SDN to end wireless devices. The extension not only improves network management but also flexibility. It enables the concurrent use of several wireless interfaces and networking stacks. We have also investigated the resilience capability SDN at various scales ranging from a device to a large network. Finally, we propose a novel control channel for SDN-based wireless networks that is resilient and scalable.

５．主な発表論文等
（研究代表者、研究分担者及び連携研究者には下線）

〔雑誌論文〕（計 2 件）

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〔その他〕
ホームページ等

６．研究組織
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