ParaDrop: A Multi-tenant Platform for Dynamically Installed Third Party Services On Home Gateways

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The landscape of computing capabilities within the home has seen a recent shift from persistent desktops to mobile platforms, which has led to the use of the cloud as the primary computing platform implemented by developers today. Cloud computing platforms, such as Amazon EC2 and Google App Engine, are popular for many reasons including their reliable, always on, and robust nature. The capabilities that centralized computing platforms provide are inherent to their implementation, and unmatched by previous platforms (e.g., Desktop applications). Thus, third-party developers have come to rely on cloud computing platforms to provide high quality services to their end-users.

However, a growing number of high quality services restrict computational tasks to be colocated with the end-user [1], [2]. Thus, we introduce a new edge computing framework, called ParaDrop, which allows developers to leverage one of the last bastions of persistent computing resources in the home: the gateway (e.g., the WiFi Access Point or home set-top box). Using our platform, which has been fully implemented on real hardware, developers can design virtually isolated compute containers based on LXC (referred to as chutes) to provide an unparalleled computational presence to the end-user. The framework we have implemented for the developer allows multitenancy through virtualization, dynamic installation through our developer API, and tight resource control through a managed policy design.

We motivate the use of our platform through two applications that run as chutes inside a WiFi Access Point as seen in Figure 1 (implemented on a PC-Engines APU1 board) running OpenWrt Linux. The first application is a suite of environment sensors, which aggregates data it receives from multiple temperature and humidity sensors, performs real time computation and stores the data locally in a database to be visualized through a webserver. The second application implements a security service through the use of an IP camera, where the chute performs local computation to detect motion and stores the results to be viewed in a webserver at a later time. These two examples reveal the main objectives of ParaDrop- reducing latency and ensuring privacy of user data.

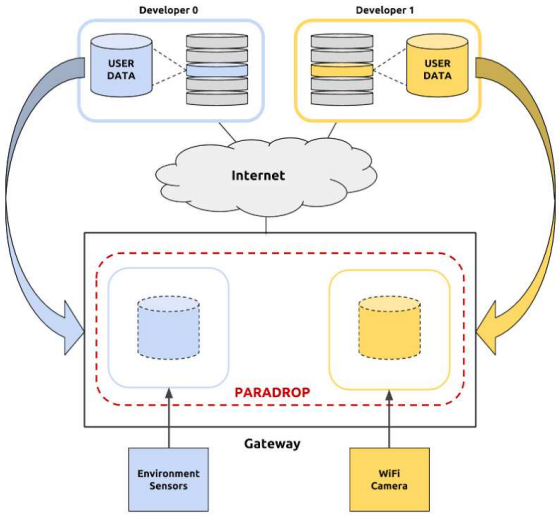

Figure 1: Using ParaDrop, end-user data is removed from the cloud and stored locally in virtually isolated containers.

By eliminating the need for data communication between the end-user and cloud, ParaDrop can play a significant role in improving end-user experience in terms of performance and data privacy, as well as in reducing network congestion and energy footprint for ISPs. Our key contributions are that we have been successful in abstracting the details of system and network management of a chute (isolated container) running inside the home gateway through the ParaDrop API, allowing developers to focus purely on the design of their application. We hope that ParaDrop will lead to the advent of many networking based services that benefit from running inside the user gateway as opposed to running in the cloud. Visit www.paradrop.org for more details.

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1. REFERENCES

[1] F. Bonomi, R. Milito, J. Zhu, and S. Addepalli. Fog computing and its role in the internet of things. In *Proceedings of the First Edition of the MCC Workshop on Mobile Cloud Computing*, MCC '12, pages 13–16, New York, NY, USA, 2012. ACM.

[2] M. Satyanarayanan, P. Bahl, R. Caceres, and N. Davies. The case for vm-based cloudlets in mobile computing. *IEEE Pervasive Computing*, 8(4):14–23, Oct. 2009.