Demo Abstract: Crowd analysis with infrared sensor arrays on the smart city edge

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***Abstract*—Smart cities infrastructure is currently highly centralised, relying on data centers or cloud technology to tackle diverse application requirements. To reduce the transmission latency and the data volume towards the cloud infrastructure, a next step to be explored includes the introduction of edge computing into such an environment, bringing the computational power closer to the Internet of Things devices. In this paper we present a hands-on demo smart city edge computing application. It shows the advantages of edge computing by analyzing incoming sensor data on people movement via edge computing, which results in faster processing, lower latency, and lower bandwidth consumption.**

***Index Terms*—Smart Cities, Edge Computing, Internet of Things, Infrared sensors**

I. Introduction

The Smart cities domain covers a broad range of Internet of Things (IoT) applications which aim to improve the city and the life of its citizens. To support this diversity, multiple wireless technologies must be available for the diverse sensors and actuators deployed in a such smart city. Gateways are used to house multiple wireless technologies and to provide the needed connectivity. Moreover, with the rise of edge computing, more functionality is added to such gateways by adding computing capabilities using the distributed computer paradigm, which operates on the *edge* of the cloud. Instead of directly sending the data to the cloud-computing infrastructure to be processed, the data is partially processed on edge nodes to promptly take the correct actions for nearby devices with a lower latency and a lower upstream bandwidth usage. The processing power of edge nodes is limited and distributed, as opposed to cloud-based computing services which are used for storage and a more detailed analysis, combining data from multiple physical locations. The demonstration described below shows how smart cities can take advantage of edge computing to solve problems in terms of latency, data transfer size and costs. We build a setup which uses multiple infrared sensors at a given location to analyze the crowd. The sensors transmit continuous data streams to the gateway where the data is processed to rapidly produce an indication of the crowd size. Because the raw sensor data is already processed at the gateway, we are able to reduce the data transmitted, and thereby reduce the costs to send the data the a cloud infrastructure for a more detailed analysis.

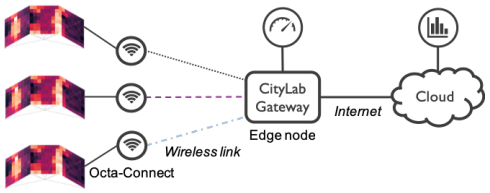

Fig. 1. Experimental setup of the demo.

II. CityLab smart city testbed

The CityLab testbed is a smart city testbed for experimentation in the city of Antwerp (part of the City of Things programme) [1]. It is a collection of multi-technology wireless gateways deployed in the city, aimed at IoT applications. The gateways are controlled via Emulab[1], a central management system, and researchers can access and allocate the gateways via jFED for experiments [2]. A CityLab gateway can be used as an edge node with limited processing power to enable low latency interaction between sensors and actuators and to limit the data traffic towards the cloud computing infrastructure, and most importantly to reduce latency.

The CityLab gateways are composed of three units: an indoor unit, an active outdoor unit and a passive outdoor unit. The active outdoor unit can be accessed by researchers via jFED. It contains an x86 PCEngines APU embedded device which is connected to a set of radios used for a wide variety of wireless technologies, such as WiFi, Bluetooth and Zigbee. Each radio is connected to a dedicated antenna enclosed in the passive outdoor unit. The active outdoor unit is connected to the indoor unit to connect to a secured network, over academic fiber. The indoor unit allows to reboot the active outdoor and, if needed, remote recovery from almost any error situation.

III. Demo

In this demo we will show the advantages of edge computing by introducing a wireless multi-sensor network with high computing power and low latency requirements, as shown in figure 1. We created an experimental setup to estimate the size of the crowd using an array of infrared sensors. Each sensor array contains three infrared sensor grids which communicate with the gateway, the edge node, via one of the available wireless technologies. The gateway processes this data and

[1]https://www.emulab.net