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Towards a Practical Deployment of Privacy-preserving
Crowd-sensing Tasks

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ABSTRACT
Recent generations of mobile phones, embedding a wide
variety of sensors, have fostered the development of open
sensing applications, such as network quality or weather
forecast applications. In this paper, we present a novel
privacy-preserving crowdsourcing platform relying on two
components: APISENSE and PRIVAPI. APISENSE is a
distributed middleware platform that leverages the dynamic
deployment of crowdsourcing tasks across a population of
mobile phones. PRIVAPI is a middleware handling privacy-
preserving publication of mobility data.

Categories and Subject Descriptors
C.2.4 [Distributed Systems]: Distributed Applications;
K.4.1 [Computers and society]: Public policy issues—privacy

General Terms
Algorithms, Security

Keywords
crowd-sensing, privacy, mobile crowdsourcing, middleware

1. INTRODUCTION
The increasing popularity of mobile devices has raised the
opportunity to easily connect to a crowd of mobile users
and to engage them in the completion of a variety of cyber-
physical tasks. In particular, mobile crowdsourcing (or crowd-
sensing) refers to the capability of lifting a large and diffuse
group of users to delegate the task of retrieving trustable
data from the field. The pervasive nature of mobile crowd-
sourcing allows easy gathering of mobility data, which con-
stitutes in all timestamped locations where a user has been
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during the experiment. This obviously raises some serious
concerns about privacy, not taken in account by existing so-
lutions like the Funf Open Sensing Framework1. As it has
been demonstrated by several papers like [2], it is possible to
use mobility data about individuals to infer a lot of knowl-
dge like where they work, where they live, and ultimately
who they are. Mobility data can also be used to learn sen-
sitive information like religious or political preferences.

APISENSE is a mobile crowdsourcing platform that makes
easier the deployment of crowd-sensing experiment by taking
care of the critical challenges in this area [1]. The novelty is
therefore to provide a Software-as-a-Service platform where
crowd-sensing experiments are described as scripts, which
will be offloaded onto mobile devices in order to collect data
on the field.

PRIVAPI is a privacy-preserving middleware that can be
easily integrated on-top of APISENSE. Its goal is to pre-
process gathered mobility data before it is released. Thanks
to its knowledge on the whole dataset it can use an optimal
anonymization strategy on mobility data while still offer-
ing a satisfactory level of utility. At the moment one novel
strategy satisfying these two criteria is implemented in PRI-
VAPI.

In the remainder of the paper, we provide an overview
of the APISENSE platform in Section 2) and the PRIVAPI
middleware in Section 3), before concluding in Section 4).

2. THE APISENSE PLATFORM
APISENSE builds on a distributed architecture. In its
center sits the Hive service, that is responsible for managing
the community of mobile users and publishing crowd-sensing
tasks. These crowd-sensing tasks are uploaded on the Hive
from Honeycomb endpoints, which are deployed and used by
people interested in collecting specific datasets. The Honey-
comb is therefore used to describe the crowd-sensing tasks as
scripts (based on an extension of JavaScript) that are seam-
lessly offloaded onto mobile devices by the Hive. Once trig-
gerred by the mobile device, these scripts will automatically
produce a dataset, which will be sent back to the Honeycomb
to be processed and stored depending on experiments.

One of the benefits of building a common platform like
APISENSE lies in the federation of communities of mobile
users who are willing to contribute to mobile crowdsourcing

1http://www.funf.org
experiments in order to ease their recruitment and therefore focus on the nature of the datasets to be collected. The APISENSE platform also implements the concept of virtual sensors as a mean to abstract the individual devices and therefore offer a set of additional services that self-organize a group of mobile devices to orchestrate the retrieval of datasets according to different strategies (e.g., round robin, energy-aware). The APISENSE platform supports the implementation of different incentive strategies, including user feedback, user ranking, user rewarding and win-win services. The selection of incentive strategies carefully depends on the nature of the crowdsourcing experiments.

Concerning privacy, a first layer is deployed on the mobile device and implements several algorithms to filter out and blur sensitive information (e.g., address book, location) depending on user preferences. The user keeps the control of her mobile phone to select the sensors to be shared, as well as when and where these sensors can be used by the platform.

3. THE PRIVAPI MIDDLEWARE

PRIVAPI is a generic middleware that can be integrated with any crowd-sensing platform. It focuses on protecting mobility data, which comes with specific threats against location privacy. We have previously studied in [3] the impact of points of interest, which are places where a user spends significant amounts of time like his home, his office, a cinema, etc. These places are highly sensitive because they convey rich semantic information. Moreover, they allow to almost uniquely identify individuals by studying their mobility patterns. We have shown that even a recent state-of-the-art protection mechanism still allows to re-identify at least 60 % of the points of interest from a real-life dataset.

PRIVAPI leverages the global knowledge of the whole system to apply an optimal anonymization strategy and produce a privacy-preserving mobility dataset. Because published data will be used by researchers or industrials, it must guarantee both privacy and utility. A minimum level of privacy must be enforced, as parametrized by the users and/or the platform owner. In the same time, our middleware wants to be utility-driven. We believe there is not one unique anonymization strategy that always performs well but many from which we can choose the one that fits the best to the usage that will be done with the anonymized dataset.

Because of the threats related to points of interest, we have implemented an original anonymization strategy that focuses on hiding these places. To achieve that we use an algorithm that smoothes speed along a trajectory (typically one day of data) to guarantee that speed is constant. This still allows to analyze the trajectory of a user but prevents to find out places where he stopped during his day. First experiments show that under such a protection utility of our anonymized dataset remains high for useful data mining tasks such as finding out crowded places or predicting traffic.

4. CONCLUSION

We introduced a privacy-preserving crowd-sensing platform composed of two complementary components. APISENSE\(^2\) as an open platform that can be used to quickly deploy a wide diversity of crowdsourcing tasks. PRIVAPI is a middleware protecting mobility data by producing privacy-preserving yet useful anonymized datasets.

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6. REFERENCES


\(^2\)APISENSE online: http://www.apisense.com