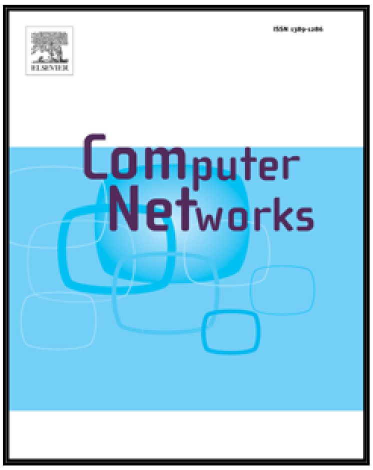
Accepted Manuscript

A Survey of the Sensing, Communication, and Security Planes in Smart City System Design

Hadi Habibzadeh, Tolga Soyata, Burak Kantarci,
Azzedine Boukerche, Cem Kaptan



PII: S1389-1286(18)30653-4
DOI: https://doi.org/10.1016/j.comnet.2018.08.001
Reference: COMPNW 6560

To appear in: *Computer Networks*

Received date: 26 March 2018
Revised date: 8 July 2018
Accepted date: 2 August 2018

Please cite this article as: Hadi Habibzadeh, Tolga Soyata, Burak Kantarci, Azzedine Boukerche, Cem Kaptan, A Survey of the Sensing, Communication, and Security Planes in Smart City System Design, *Computer Networks* (2018), doi: https://doi.org/10.1016/j.comnet.2018.08.001

A Survey of the Sensing, Communication, and Security Planes in Smart City System Design

Hadi Habibzadeh [a], Tolga Soyata [a], Burak Kantarci [b1], Azzedine Boukerche [b], Cem Kaptan [b]

[a] Electrical and Computer Engineering, University at Albany Albany, NY, 12222, USA
[b] School of Electrical Engineering and Computer Science, University of Ottawa, Ottawa, ON, K1N 6N5, Canada

Abstract

The Internet of Things (IoT) era is evolving into sensor initiated, actuation-driven, and machine intelligence-based decision making platform for smart cities. A smart city system aims at seamless and secure interconnection of sensors, actuators, and data processing resources to ensure digital, efficient, and reliable services. In this article, we present a brief planar overview of a smart city system architecture by introducing the application, sensing, communication, data, and security/privacy planes. Tailoring existing communication protocols and infrastructures to bridge massively deployed sensors and data processing/storage resources introduces unique communication challenges for smart cities. Furthermore, co-existence, integration, and control of dedicated and non-dedicated sensors is a grand challenge while IoT sensors continuously push sensory data through the communication medium towards data processing and analysis planes. While pervasiveness and ubiquity of smart city services are ensured by the interaction of communication and sensing technologies, their robustness and resilience calls for customized security and privacy solutions. With these in mind, we focus on sensing/actuation, communication, and security planes of a smart city system and present a comprehensive survey of the challenges and state-of-the-art solutions in each plane. Furthermore, we provide insights for open issues and opportunities in these planes.

Keywords: Smart Cities; Smart Spaces; Security; 5G Networks and Communication; Edge Networks; Internet of Things, Dedicated sensing; Non-dedicated Sensing.

1. Introduction

Increasing individual use of connected smart devices, rapid growth of worldwide urban population, gradual aging of society in many countries as well as the rising demand for sustainable energy resources have given momentum to the emergence of smart cities and smart spaces [1]. Smart city services span a wide spectrum of applications ranging from smart utilities, to smart health, smart transportation, smart governance, and smart environment [2], which Utilize real-time sensing, knowledge engineering, and presentation of the analyzed data in an interpretable format.

To fulfill the requirements of diverse applications and services, a smart city architecture consists of five planes as illustrated in Fig. 1 in a minimalist manner. The *application plane* provides services to the end users for any relevant application such as smart utilities, energy, transportation, health, environment and safety. Serving mobile, home, and corporate sectors, these applications rely on an underlying substrate, which encompasses sensing, communication, data, and security planes as the core of a smart city architecture [3]. The data acquisition (sensing) networks—implemented by utilizing either hard sensors or soft sensors—form the *sensing and actuation plane*; whereas processing, analysis, and storage of data shape the main functionality of the *data plane*. These two planes are bridged by the *communication and aggregation plane*.

Addressing users' growing cognizance about smart city cybersecurity, each component shown in Fig. 1 calls

☆This work was supported in part by the U.S. National Science Foundation grant CNS-1239423, and the Natural Sciences and Engineering Research Council of Canada (NSERC) under Grant RGPIN/2017-04032.

Email addresses: hhabibzadeh@albany.edu (Hadi Habibzadeh [a]), tsoyata@albany.edu (Tolga Soyata [a]), burak.kantarci@uottawa.ca (Burak Kantarci [b]), boukerch@uottawa.ca (Azzedine Boukerche [b]), ckaptan@uottawa.ca (Cem Kaptan [b])

[1]Corresponding author: Burak Kantarci.