SCIENCES

NETWORKS AND COMMUNICATIONS

Network Management and Control

Cooperative Intelligent Transport Systems

Control and Management

Coordinated by
Léo Mendiboure

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Table of Contents

List of Tables

List of Illustrations

Figure 13.2. Learning methods

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Networks and Communications, Field Director – Guy Pujolle

Network Management and Control, Subject Head – Francine Krief

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First published 2024 in Great Britain and the United States by ISTE Ltd and John Wiley & Sons, Inc.

ISTE Ltd
27-37 St George's Road
London SW19 4EU
UK

www.iste.co.uk

John Wiley & Sons, Inc.
111 River Street
Hoboken, NJ 07030
USA

www.wiley.com

Library of Congress Control Number: 2024936174

British Library Cataloguing-in-Publication Data
A CIP record for this book is available from the British Library
ISBN 978-1-78945-180-1

ERC code:
PE6 Computer Science and Informatics

PE6_2 Distributed systems, parallel computing, sensor networks, cyber-physical systems

PE6_7 Artificial intelligence, intelligent systems, natural language processing

PE7 Systems and Communication Engineering

PE7_8 Networks, e.g. communication networks and nodes, Internet of Things, sensor networks, networks of robots

Preface

Léo MENDIBOURE
ERENA, COSYS, Université Gustave Eiffel, Marne-la-Vallée, France

Automated vehicles could eventually reduce greenhouse gas emissions from transport and improve road safety and traffic flow. However, its safe implementation will require a high-performance communication system that enables vehicles to obtain information from their neighbors and from the infrastructure, such as lane changes, the presence of obstacles, diversions and extended perception.

Cooperative Intelligent Transport Systems (C-ITS), designed to enable these exchanges, will therefore play an essential role in the advent of the automated and connected vehicle. However, their deployment in a highly constrained and mobile environment could prove problematic in terms of guaranteeing quality of service (QoS), as well as the reliability and security of exchanges.

In response to these problems, this book presents new solutions for managing and controlling performance and security for C-ITS. After two introductory chapters presenting the concept of local interactions and the current development of use cases for C-ITS, this book will explore various ways of optimizing the control and management of C-ITS: hybridization of access technologies (cellular, ITS-G5), use of new tools (e.g. artificial intelligence), etc.

May 2024

PART 1
Introduction to Cooperative Intelligent Transport Systems

1
Local Interactions for Cooperative ITS: Opportunities and Constraints

Jean-Marie BONNIN[1] and Christophe COUTURIER[2]

[1] *IMT Atlantique, Rennes, France*

[2] *YoGoKo, Rennes, France*

1.1. Introduction

Since the advent of wireless communication and its integration into consumer devices, the concept of intelligent environment or pervasive application has emerged. The ability to communicate with all objects in our immediate environment makes it possible to take information or trigger actions. Information collection feeds a context that applications take into account to adapt their behavior to the situation.

For this type of application, direct interaction with objects in the environment greatly facilitates matters, since it is not necessary to rely on a precise location and database to associate information (or objects) with this location. If we need to know the room temperature, all that is needed is to discover a temperature sensor and query it directly. Acquiring the same information when a server is in charge of collecting and exposing the building's temperature data firstly implies discovering the server that has the information at its disposal, then dialoging with it to retrieve the temperature of the room in which the sensor is located, and finding consequently a way to determine that the location is necessary. The machinery to be put in place is much more complex and yet it seems more intuitive, as the majority of the industry has been built on this model.

The difficulty when it comes to building services on direct (we will also use the term “local”) interactions is that this implies standardizing the method of communication, the frequency (or frequencies) used and the message format. For road or city applications, it is therefore necessary to bring many actors to agreement, and to impose choices on the entire ecosystem.

Direct interactions are widely used today for service discovery; for example, Wi-Fi devices continuously scan all frequencies used in the 2.4 GHz and 5 GHz bands to determine if there is an access point available in the environment. The presence of such an access point in no way indicates that the terminal will know how to connect to it, and even in the case where it is able to connect, whether it will be able to obtain a service (an Internet connection). The other technology widely used on consumer terminals is Bluetooth. Again, part of the terminals expose their presence by regularly sending messages at a determined frequency. All Bluetooth devices in proximity are able to see these messages and determine whether or not they know the correspondent. They can then either establish a connection to perform the service (e.g. hands-free kit) by taking advantage of the keying material previously established during pairing, or ask to perform a pairing, which requires the user’s intervention.

It should be noted that even when the two correspondents know each other, whether via Wi-Fi or Bluetooth, the discovery and connection establishment time frame is far too long for services with significant time constraints. We will return to this when we examine how the specificities of ITS-G5 make it possible to significantly reduce the time required to exchange information for road safety-related services.

In the second part of this chapter, we will present the concept of ephemeral local interactions, giving examples of services based entirely (or partially) on this type of interaction. We will describe how the first services that will be deployed in the context of cooperative ITS (awareness) are based on this type of interaction and the advantages/constraints of this approach. Lastly, before concluding, we will explore the place infrastructure holds in the implementation of services, based on ephemeral local interactions.

1.2. Ephemeral local interactions: concept and examples

1.2.1. *Examples of services using ephemeral local interactions*

Once it has been established that the different devices in interaction use the same communication technology on a subset of frequencies well known to all, it is necessary to specify the type of interaction targeted. Indeed, we will focus more specifically on interactions where no connection is established. When two devices are in proximity, they can "see" each other because of their technology community; they have at their disposal information that is spontaneously sent by their peers without having to go through the time-consuming establishment of a connection. When the communication technology has a fairly short range, simply being in communication and seeing a device gives an indication of co-spatiality that can form an integral part of the service. Therefore, when a telephone receives an advertisement on one of the three Bluetooth Low-Energy (BLE) channels, it knows that it is in close proximity to the tag whose identity is transmitted in the message, in addition to the information contained in the message itself.

P, Q

R, S

T, U, V