Ubiquity, Internet of Things, and Accessibility: On Infrastructure Criticality and Resilience Needs

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Panelists:
Dmitry Korzun, Petrozavodsk State University, Russian Federation: Smart spaces approach to creating ubiquitous IoT-based environments

Nizar Al-Holou, University of Detroit Mercy, USA: Intelligent Transport Systems

Andrzej Marczak, Gdansk University of Technology, Poland: Data security and data transmission in wireless network
Panel on UBICOMM/EMERGING
Ubiquity, Internet of Things, and Accessibility: On Infrastructure Criticality and Resilience Need

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The smart spaces approach to creating ubiquitous IoT-based environments

1. What the Internet of Things provides to smart spaces: ubiquitous connectivity and smart objects.

2. What infrastructural properties a smart space needs to construct and deliver services for surrounding users.

3. What mechanisms can support resilient accessibility of services in smart spaces.
Internet of Things (IoT) - Smart Spaces (SS)

• Smart Object (SO)
  • Everyday (physical) objects are augmented with sensing, processing, and network capabilities. They can understand and react to their environment.

• IoT: SO = smart device as a transformation result of a physical object

• SS: SO = software (programmable) agent running on a device
Smart Space

- Smart space: A localized IoT-aware service-oriented computing environment with a shared view on resources
Smart Space Application (SSA)

- Distributed system of agents hosted in IoT environment

- Smart properties of SSA:
  1. Understanding the situation where the application is used and by whom
  2. Interpreting the semantics of shared information
  3. Tolerating uncertainty at development and run time

Focus is on software development, not on hardware and networking
Example: SmartRoom system
SmartRoom Infrastructure

User Interface Elements: Public and Personalized

Services

Infrastructure

1. Research papers
2. Google Scholar
3. Slides

A
B
C
D
E

KP
KP
SIB
KP
KP

G
H
F
Infrastructure Resilience

• Fault tolerance: an application is capable to deliver its services in the presence of faults

• Restarting and reconnecting mechanisms for infrastructure components (agents)
  • Restart: when the agent fails (software fault)
  • Reconnect: when the network connection fails (hardware or network fault)
Resilient Service Accessibility

• Event-driven programming

• A lot of mobile clients accessing services in the smart space

• Subscription operation
  • persistent query for updates of specified content
  • Notifications are coming from the smart space to client
  • Some notifications are lost
Active control

- Server side (smart space) does not guarantee the delivery of notifications (best effort style)
- Client: can make additional checking

![Diagram showing Passive notification, SmartRoom space, Active control, and Proposed solution]
Tradeoff

- More checks – more load (network, infrastructure)
- Less checks – more losses of notifications
- Balancing the check interval
INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

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Intelligent Transportation Systems

Transport Infrastructure and Vehicles

Information & Communications technology

Improve safety
Reduce congestion
Manage traffic flow
Save lives, time and money
Intelligent Transportation System

▶ ITS
Represents a revolution in the way transportation is managed and operated.

OBU: installed in Vehicle
RSU: installed on roadside

V2V V2I

Vehicle Communication

▶ These communication schemes open the door for many applications in the vehicular environment, which can be broadly classified into:

- **Safety applications:** (concerned with vehicles’ and road safety)
  - Emergency break signaling.
  - Police warning system.
  - Road condition alarm system.

- **Traffic Efficiency:** Path Planning and Traffic Management
- **Energy consumption and Environment**
- **Service applications:** (Luxury services to vehicles)
  - *Infotainment*:
  - Web on wheels
Vehicle Communication

- Safety applications: (concerned with vehicles’ and road safety)
- Traffic Efficiency: Path planning and traffic management
- Energy consumption and Environment
  - Service applications: (Luxury services to vehicles): *Infotainment, Web on wheels*

  - facilitated by a combination of V2V and V2I communications.

V2V and V2I

- **V2V systems** are completely infrastructure-free; only onboard units (OBUs) are needed:
  - Lane merging, automatic cruise control
  - (e.g., traffic monitoring)

- **V2I systems** assume that all communications take place between roadside infrastructure (including roadside units [RSUs]) and OBUs.
Intelligent Transportation System (ITS)

- Communication Standards
- Wireless Access in Vehicular Environments (WAVE)
- Data Dissemination

**ITS Communication Standards**

- **Dedicated Short Range Communications (DSRC)**
  
  Communication has adopted:
  
  - **IEEE 802.11p**
    - Physical and MAC layer of the communication stack.
    - Enables upper layers to:
      - Control the transmission power of transceiver.
      - Provide better immunity against delay and interference problem.
  
  - **IEEE 1609.x**
    - Multichannel access, security, and network management (operates on 7 different channels).
Wireless Access In Vehicular Environments (WAVE)

► What is WAVE?
  ➢ IEEE 1609 - family of standards for wireless access in vehicular environments
  ➢ Enable secure vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I)
  ➢ Define an architecture and standardized set of services and interfaces

WAVE

► IEEE P1609.1 – Resource/Application Manager
  ➢ specifies the services and interfaces of the WAVE Resource Manager application

► IEEE P1609.2 - Security Services for Applications and Management Messages: defines secure message formats and processing

► IEEE P1609.3 - Networking Services
  ➢ defines network and transport layer services
  ➢ defines Wave Short Messages

► IEEE P1609.4 - Medium Access Control-Multi-Channel
  Operations: provides enhancements to the IEEE 802.11 Media Access Control (MAC) to support WAVE operations
OSI Versus WAVE Model

OSI Reference Model
- Application, Presentation, Session
- Transport
- Network
- Data Link
- Physical

WAVE Model
- IEEE 1609.1, et al.
- IEEE 1609.3
- IEEE 802.2
- IEEE 809.4
- IEEE 802.11p
- PHY Layer
- Upper Layers
- Networking Services
- MAC Sublayer
- LC Sublayer
- Security Services

U.S.DOT - VEHICLE TO VEHICLE COMMUNICATION - YOUTUBE
- U.S.DOT - Vehicle To Vehicle Communication - YouTube: https://www.youtube.com/watch?v=POcQUTlOvZs
- Michigan Department of Transportation Safety Pilot
https://www.youtube.com/watch?v=RXNbpLuy5g&list=PLjP1oRdEKdRuN4Sk9blVvhdumTAIvaQN
A Taxonomy Of Vehicular Communication Systems

Vehicular communications

- Vehicle to vehicle Communications (V2V)
- Hybrid vehicle Communications (Ad Hoc)
- Vehicle to infrastructure Communications (I2V)

SV2V
- Single hop V2V communications
  - SV2V systems are useful for applications requiring short-range communications

MV2V
- Multi-hop V2V communications
  - MV2V systems are more complex than SV2V but can also support applications that require long-range communications

SI2V
- Sparse I2V communications

UI2V
- Ubiquitous I2V communications