6th Japan-EU Symposium on ICTResearch and Innovation

Session on 5G Access/Core Network

Smart Networked Robotics toward 5G Access/Core Network

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Room 105

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Director, ATR Intelligent Robotics and Communications Labs,
Advanced Telecommunications Research Institute International

Norihiro Hagita

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This research was partly supported by the Ministry of Internal Affairs and Communications

5G Application Fields

Robotics

Transportation
More efficient and safer
Navigation
Autonomous driving

Richer contents
Multiuser UHD teleconference
Purchase enriched video, music, book

Health care
Remote medical examination

5G will enhance the socio-economic satisfaction

House
Home security

Disaster relief
Prediction
Robustness to disaster

Consumer electronics
Remote control

Robotics

Education
Distance learning
Virtual experience

Safety and lifeline system
Collision avoidance
Rescue
(Distress, Accident, etc.)

From ARIB 2020 and Beyond Ad Hoc Group White Paper (2014/10/08)
www.arib.or.jp/english/20bah-wp-100.pdf

Robotic City Services on 5G Application Fields

- **Transportation**
  Safer , more efficient and comfortable navigation for autonomous personal mobility

- **Health care**
  Facilitating social participation in human populated environment

- **Safety and lifeline system**
  Collision avoidance between wheelchairs, and between wheelchairs and pedestrians

1.
Smart Networked Robotics

Robot has three functions

1.Sensation

Seeing, hearing, being touched

2. Actuation

Moving, gesturing, talking
delivering goods

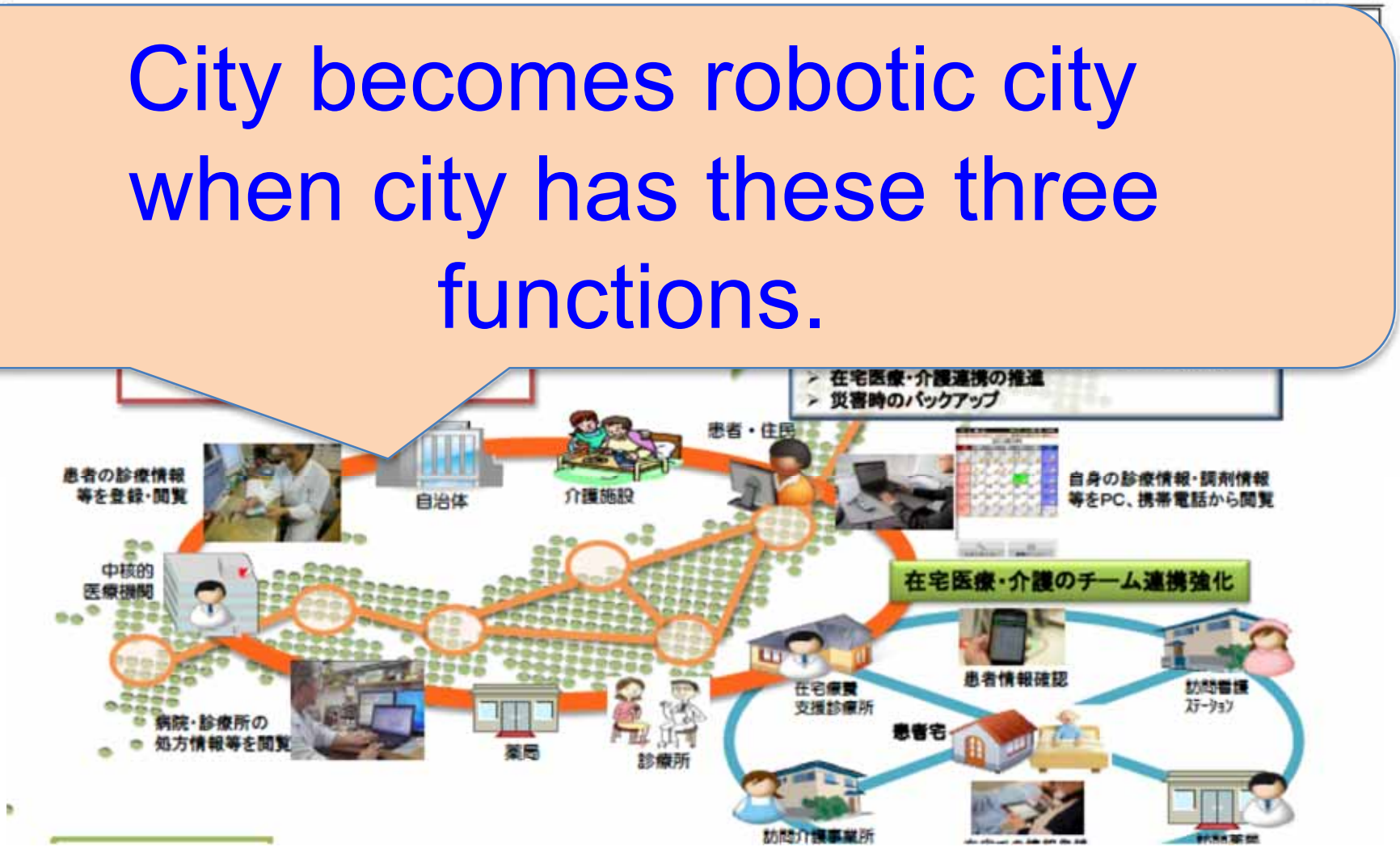
3. Intelligent Control

Communicating with other
robots, sensor networks,
smartphones, etc.

Robotic Services

systems, devices, and robots with three functions : sensation, actuation and control

City becomes robotic city when city has these three functions.



What is Network Robot System?

ICT Infrastructure (Cloud and Edge Computing & 5G Wireless Communication,…)

Visible-type

Physical Robot, Android, Geminoid,…

User Interface: Broaden to Elderly

Price : competitive to bike or vehicle, (or hobby)

Ubiquitous Network Robot Platform(UNR-PF)

Agent-type

iPhone, iPad, Pokemon GO…

User Interface : easy-to-use & inevitable utility in daily use

Price: Reasonable

Ambient Intelligece-type

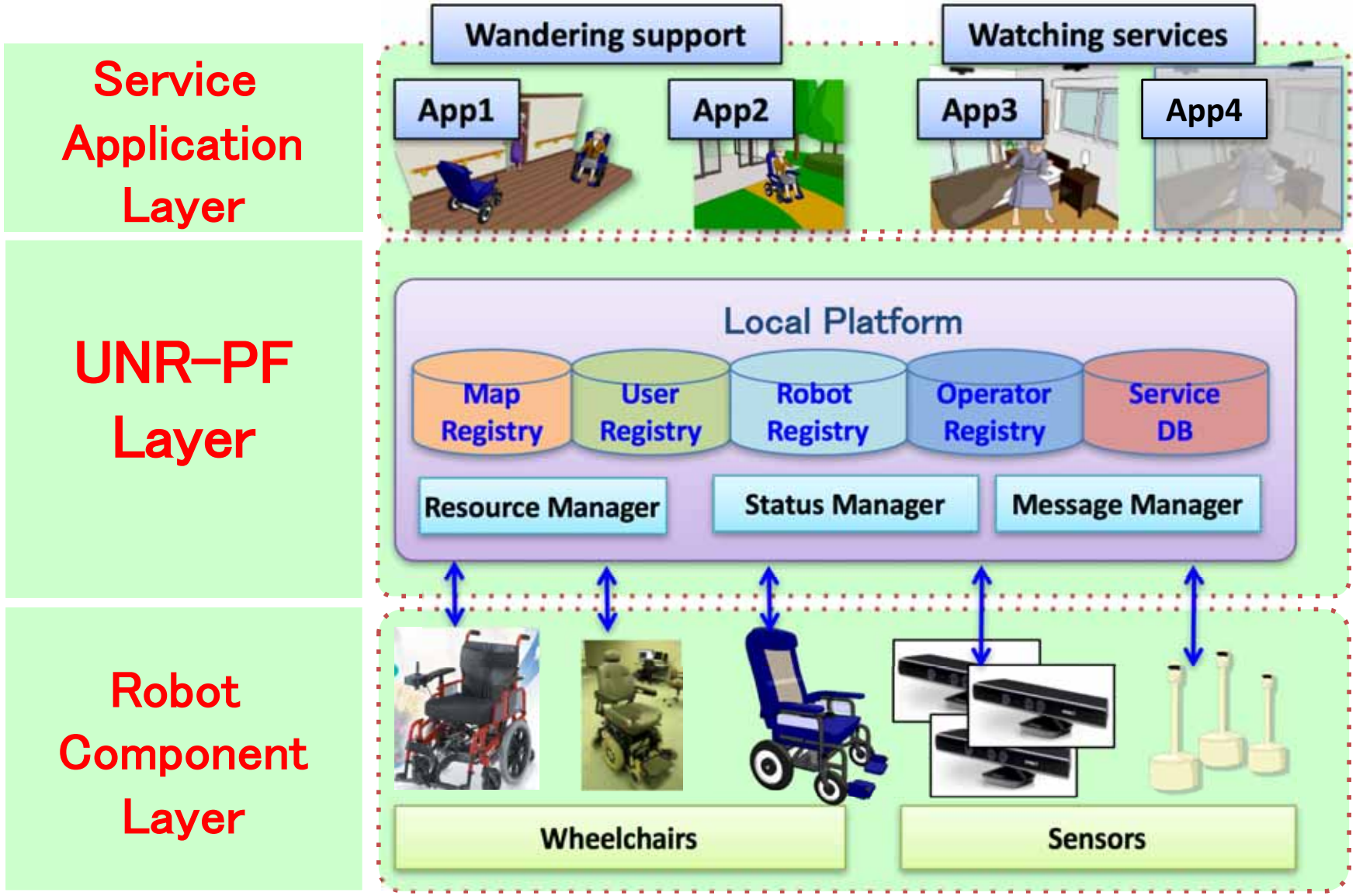
RF-ID, Camera, LRF,…

Location Precision: 3m→5cm accuracy

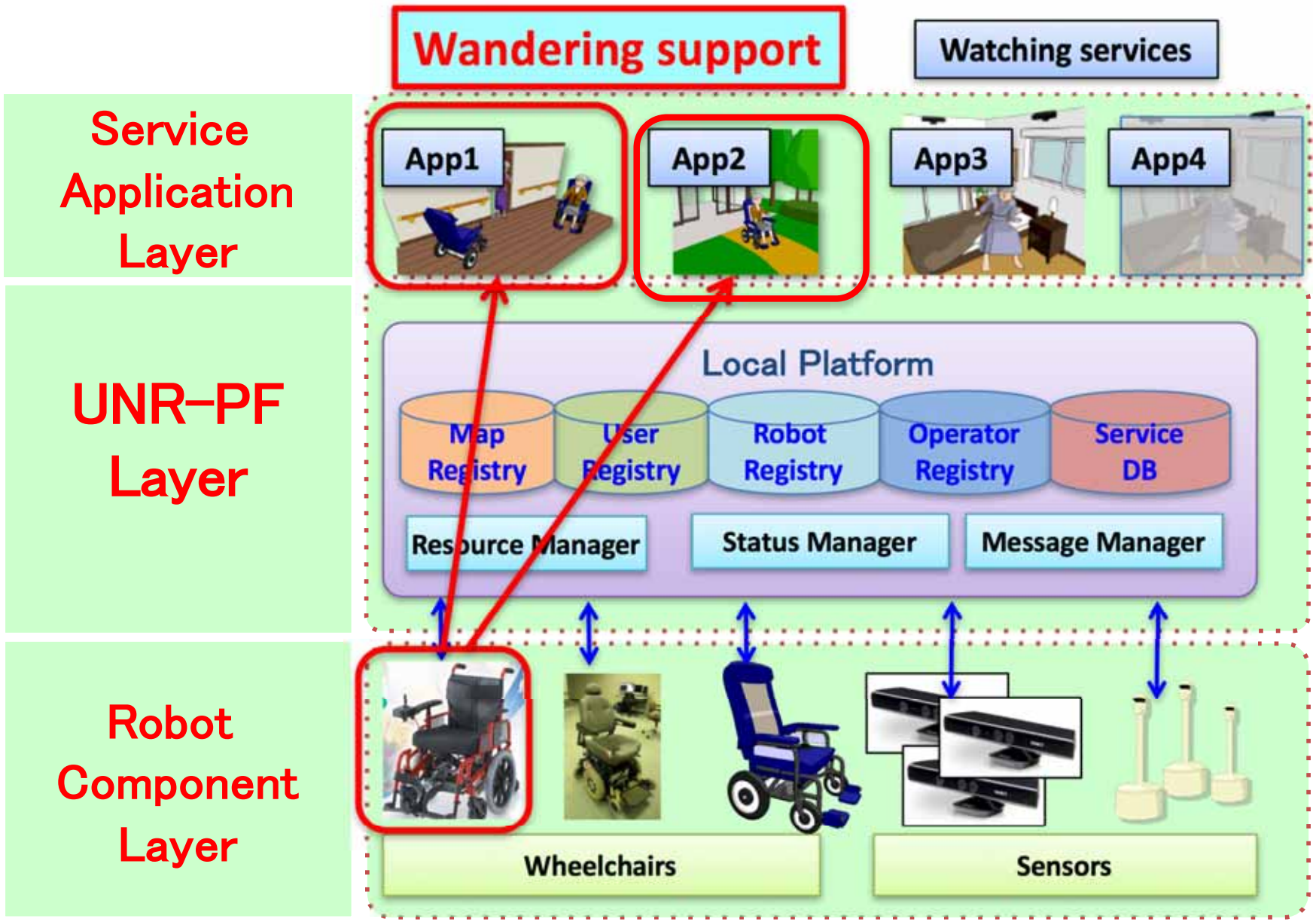
Price : gradually decreasing

Three-layer Architecture in UNR-PF

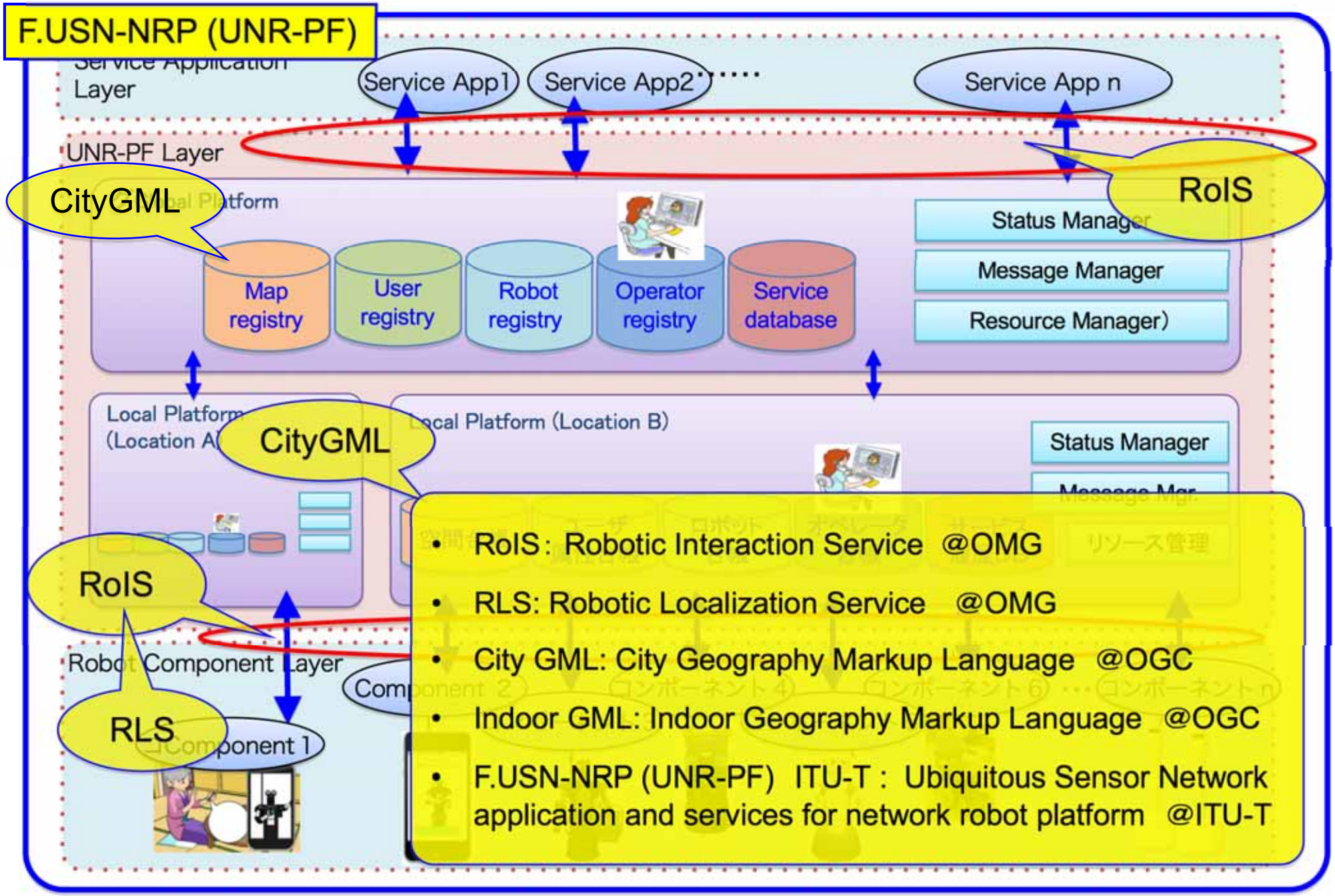
Standardized by ITU-T.SG16.Q25(2013), OMG(2011,2012), OGC(2012)



An robot component may be used for several service applications



Standardization on UNR-PF



Service Functions Provided by Smart Networked Robotics

Before/After

①Loaation	Single ⇒ Multiple
②Opera -tion	Single ⇒ Cooperative & collaborative
③Inform -ation	Individual ⇒ Sharing
④Tele -operation	Single robot ⇒ Teleopetaion for multi-robots
⑤Human Interface	Talking/Gesture ⇒ BMI, Biometrics
⑥Know -ledge	Stationary ⇒ Dynamic and Experience Sharing

Social Impact

- Care/Prevention
- Job creation
- Social Participation
- Local creation
- Medical services
- Market creation
- Educaion
- Art /Science

3.
History of Field Experimentations in ATR

Field Experimentations by ATR (2002-2009)

2001	2002	2003	2004	2005	2006	2007	2008	2009

School(2002)

Science museum (2004-2005)

Shopping mall (2007)

Station(2006)

Universal Citywalk In Osaka (2008-2009)

ASIMO

FP6: DustBot (SSSA)

Field Experimentations by ATR (2002-2009)

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ASIMO

FP6: DustBot (SSSA)

Collaboration with FP6 at Universal Citywalk in Osaka (2008-2009)

Universal Citywalk in Osaka

FP6: Dustbot Project in SSSA, Pisa, Italy

Field Experimentations by ATR (2009-2015)

2009	2010	2011	2012	2013	2014	2015

Shopping mall(2009-2013)

Service Coordination in Pararell

Day-care center(2009)

Nursing home(2014)

Tour guide (2010)

Science museum(2013)

Shopping support service for elderly wheelchair users (March, 2011)

Area 1 :Home

Booking a wheelchair robot
Using smartphone in advance

Map registry

User registry

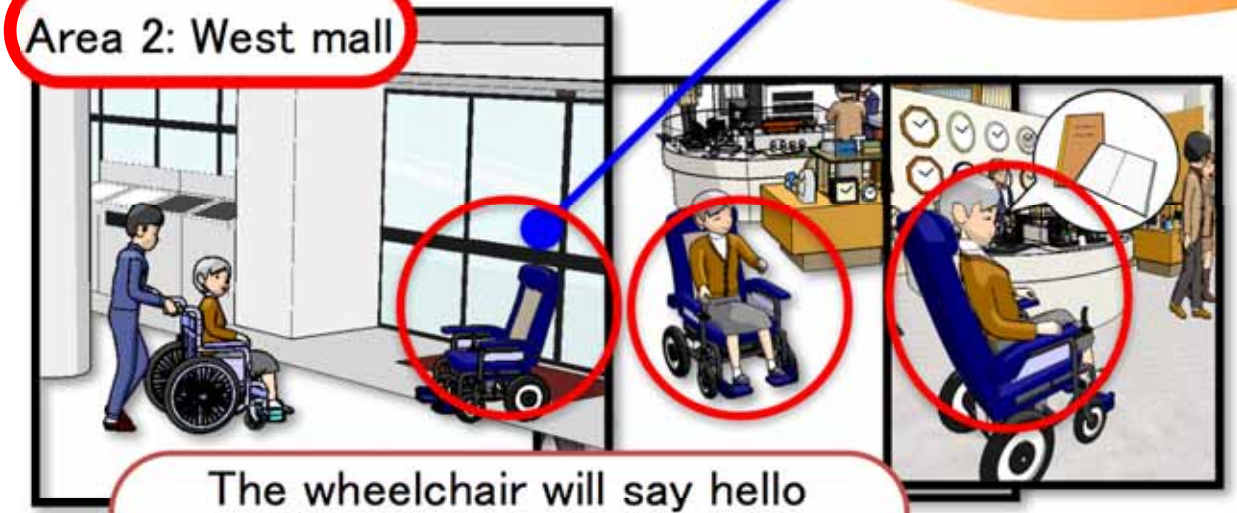
Robot registry

UNR-PF

Networking

Teleoperator

Area 2: West mall

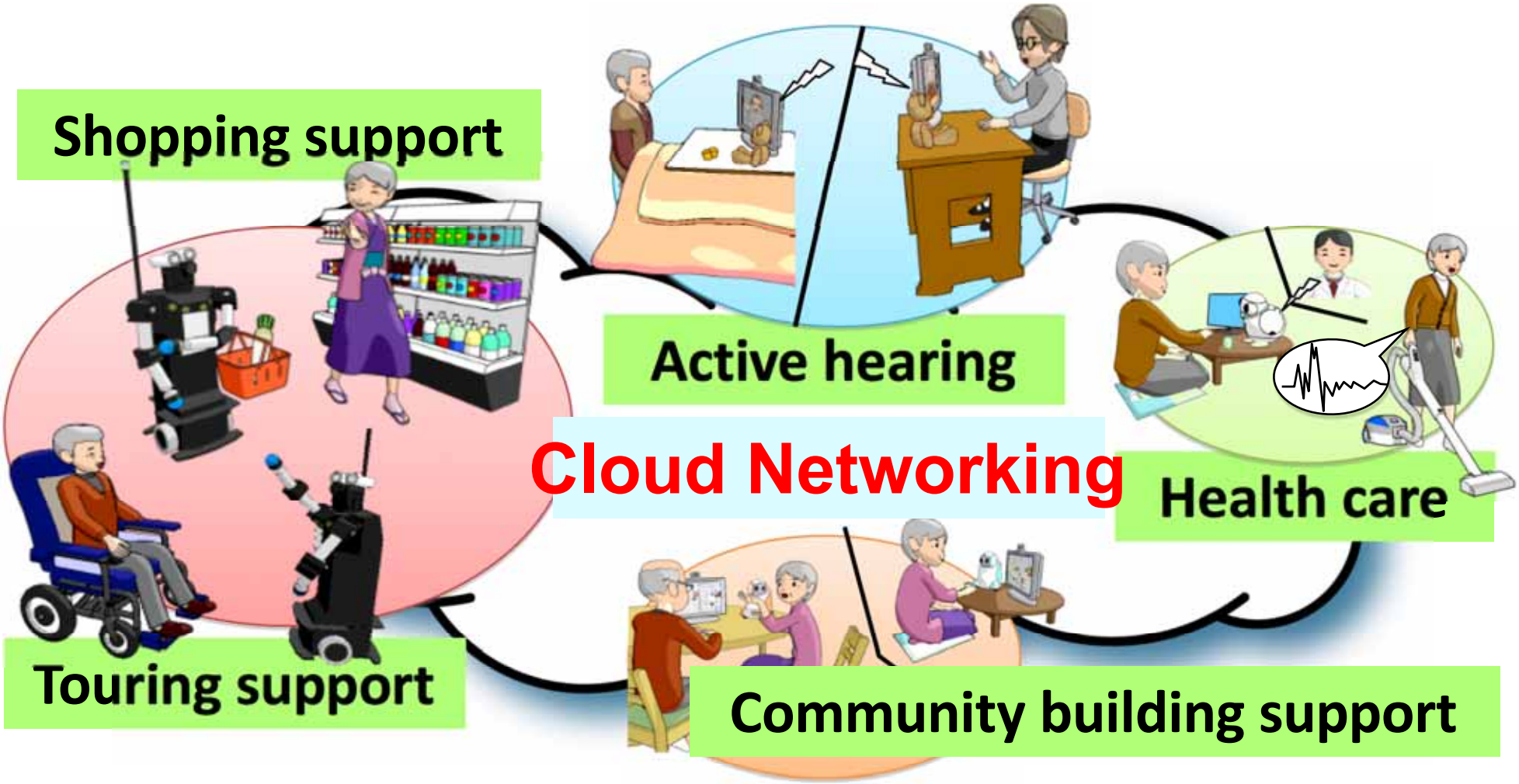


The wheelchair will say hello to the user

Area 3: East mall

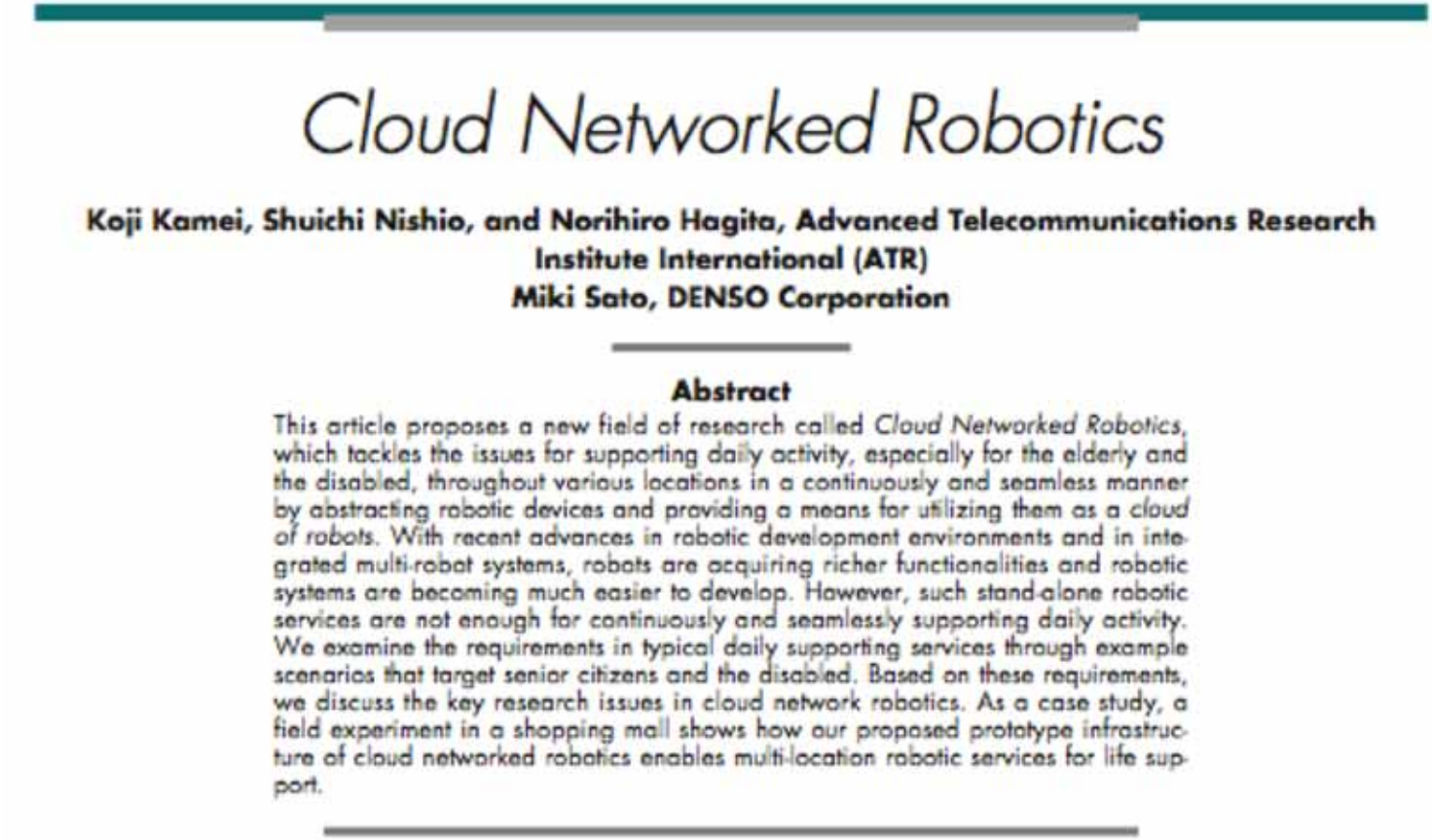
Secure shopping support

Robotic services for AAL (Field Experimentation in 2009-2013)



Life support research project in Ministry of Internal Affairs and Communications in Japan. ATR, NTT, Hitachi, Toshiba, and NEC in 2009-2013

IEEE Network Magazine



Cloud Networked Robotics

Koji Kamei, Shuichi Nishio, and Norihiro Hagita, Advanced Telecommunications Research Institute International (ATR)
Miki Sato, DENSO Corporation

Abstract

This article proposes a new field of research called *Cloud Networked Robotics*, which tackles the issues for supporting daily activity, especially for the elderly and the disabled, throughout various locations in a continuously and seamless manner by abstracting robotic devices and providing a means for utilizing them as a *cloud of robots*. With recent advances in robotic development environments and in integrated multi-robot systems, robots are acquiring richer functionalities and robotic systems are becoming much easier to develop. However, such stand-alone robotic services are not enough for continuously and seamlessly supporting daily activity. We examine the requirements in typical daily supporting services through example scenarios that target senior citizens and the disabled. Based on these requirements, we discuss the key research issues in cloud network robotics. As a case study, a field experiment in a shopping mall shows how our proposed prototype infrastructure of cloud networked robotics enables multi-location robotic services for life support.

IEEE Network Magazine, vol. 26, no. 3, pp. 28-34, May 2012
Special Issue on Machine and Robotic Networking

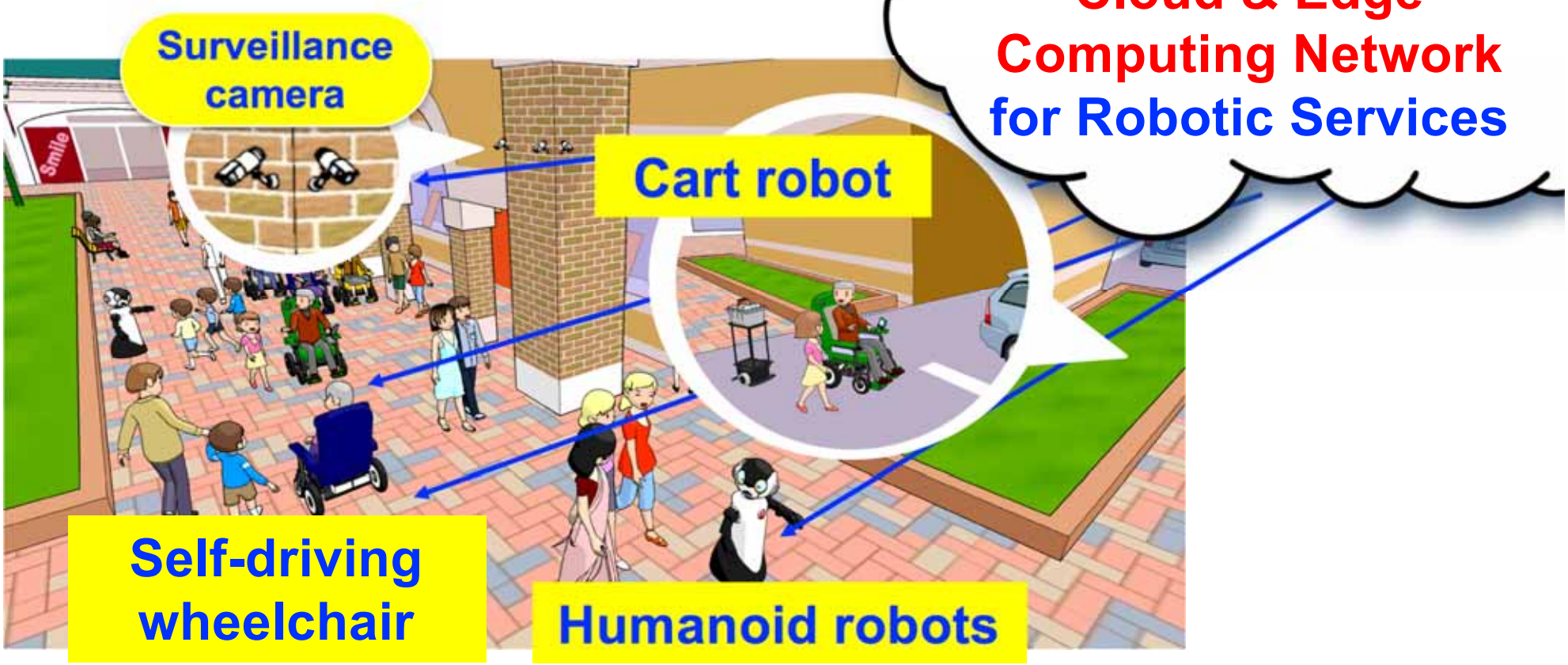
http://dx.doi.org/10.1109/MNET.2012.6201213

4.
Current MIC R&D Projects related to 5G
- Smart Networked Robotics -

Autonomous Personal Mobility*

in Smart Networked Robotics

Safe and comfort riding while passengers riding and talking with the other wheelchairs and/or persons in human populated environments.



*This research project called autonomous personal mobility including robots is supported by the Ministry of Internal affairs and Communications (MIC), Japan, in 2016-2019.

Conclusion

1. Robotic city services will be created in the 5G infrastructure.
2. Not only safer and more efficient services but also more comfortable ones for users/passengers are inevitable in Human Populated Environments.

Thank you for your kind attention