Funding Program for Next Generation
World Leading Researchers (NEXT Program)
The Japan Cabinet Office

Intelligent Transport System: A Vision For 21st Century Cities

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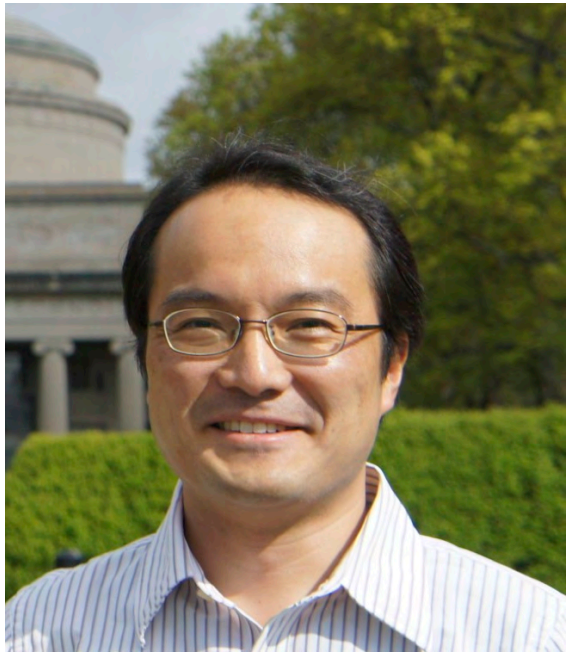

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2000 Dr. of Engineering, **Nagoya Institute of Technology**
1999 Research fellow, **Japan Society for the Promotion of Science (JSPS)**.
2000 Visiting Researcher, **USC/ISI.**
2001 Assoc. Professor, **Japan Advanced Insti. of Sci. & Tech. (JAIST)**.
2003 Assoc. Professor, Dept. of CSE, **Nagoya Institute of Technology**.
2005 Visiting Scholar, Computer Science, **Harvard University.**
2005 Visiting Researcher, **MIT Sloan School of Management**.
2006-Now Assoc. Prof., School of Techno-Business Admin., **Nagoya Institute of Technology**.
2008 Visiting Scientist, Center for Collective Intelligence, **MIT Sloan School of Management.**
2010 JST PREST researcher (super challenging type)
2010-Now Visiting Scholar, Policy Alternative Research Institute, **University of Tokyo**.

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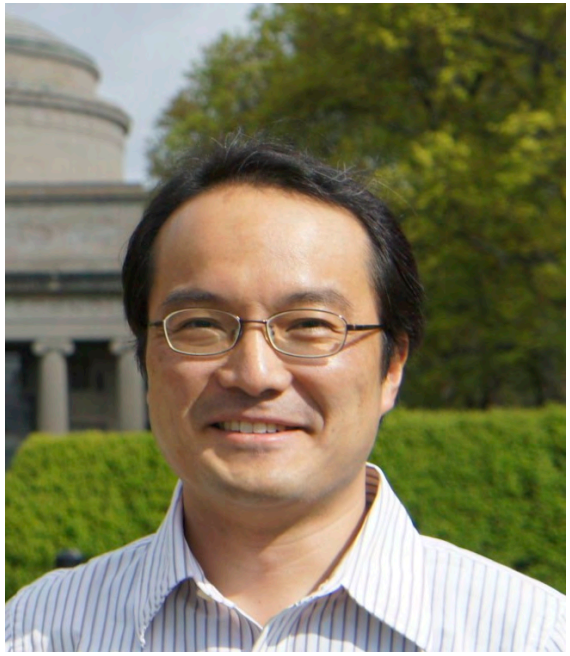
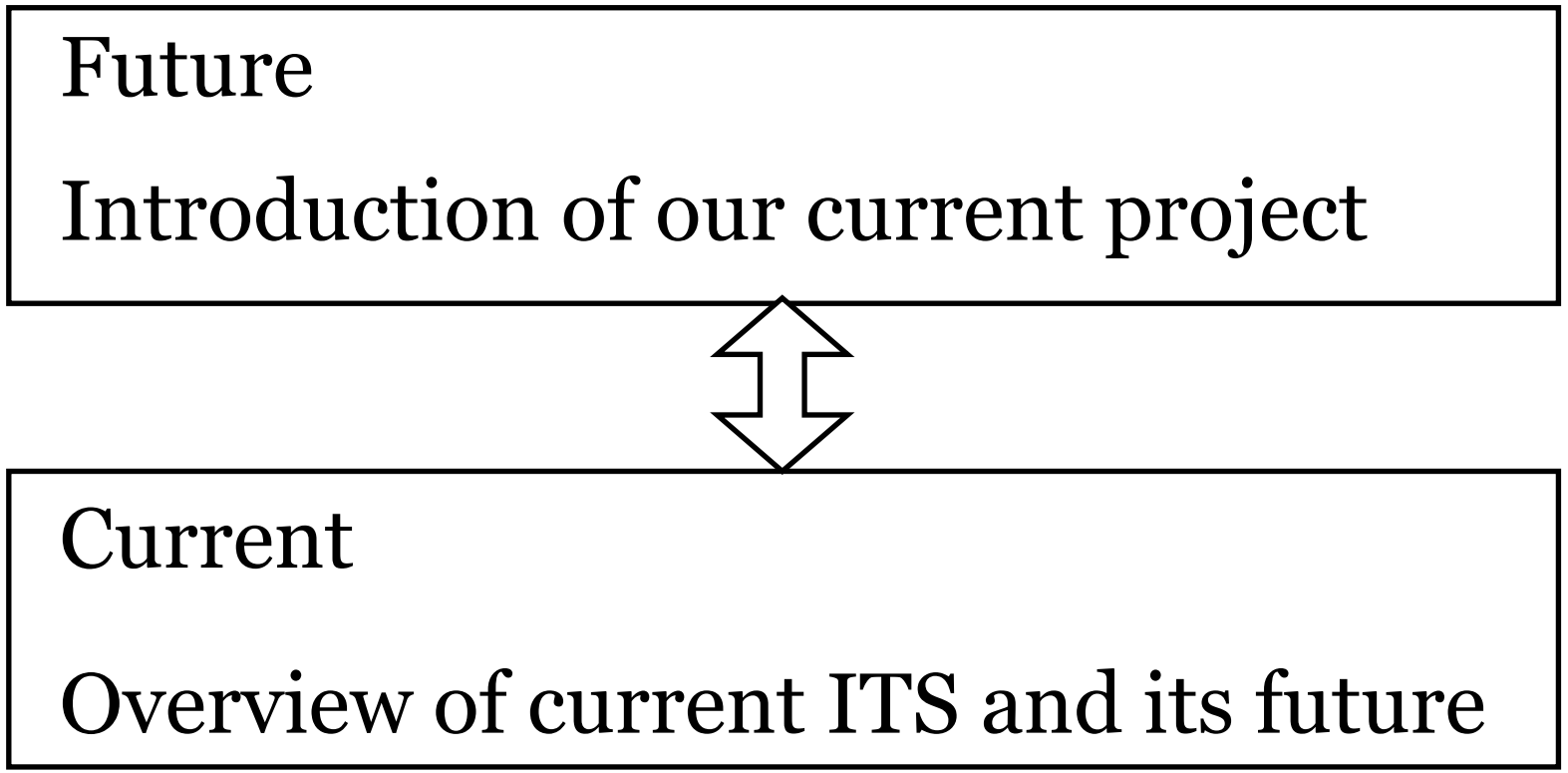


Area :
Computer Science, Artificial Intelligence, Multi-Agent Systems, Auction Theory, Mechanism Design, Smart City, Smart Grid, etc.

- Prizes for Science and Technology, **The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, 2013. (文部科学大臣表彰)**
- The Young Scientists' Prize, **The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, 2007.(文部科学大臣表彰)**
- Information Processing Soceity of Japan, Nagao Special Researcher Award, 2007
- Best Paper Award, The Fifth International Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS2006, 1/553), 2006.
- 2005 Best Paper Award, Japan Society for Softoware Science and Technoglogy.
- 2004 IPA Exploratory Software Creation Project, Super Creator Award.
- **The NEXT Funding Program from the Japanese Cabinet Office**

Today's Talk

A Vision For 21st Century Cities

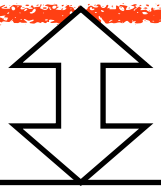


Today's Talk

A Vision For 21st Century Cities

Future

Overview of our current project



Current

Overview of current ITS and its future

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An Introduction of Our Current Project

Innovating Society Optimization Algorithms that Enable Environmental Society Optimization Simulations, and their Applications

内閣府最先端・次世代研究開発プロジェクト

CENTER for GREEN COMPUTING | グリーン・コンピューティング研究所

環境社会最適化シミュレーションを可能にする社会最適化アルゴリズム創出とその応用

マルチエージェント技術による社会の最適化

それぞれのメカニズムが、相乗効果で全体を最適化。

社会メカニズムの最適化による環境にやさしい社会の再構築

TAKAYUKI ITO Laboratory
School of Techno-Business Administration, Nagoya Institute of Technology

伊藤孝行研究室
名古屋工業大学大学院産業戦略工学専攻

Background ant Targets

They are partially optimized, but globally not.

Existing Social System does not fit to the current environments

High speed network

High speed computation

World wide network

Multiagent systems : theories, models, and applications

Innovating new social systems that can fit to the next generation

Takayuki Ito (ito@nitech.ac.jp)

What is Multiagent Systems

Multiagent Systems

Computational model for Human Intelligence

= Artificial Intelligence

Computational model for Social Intelligence = Multiagent Systems

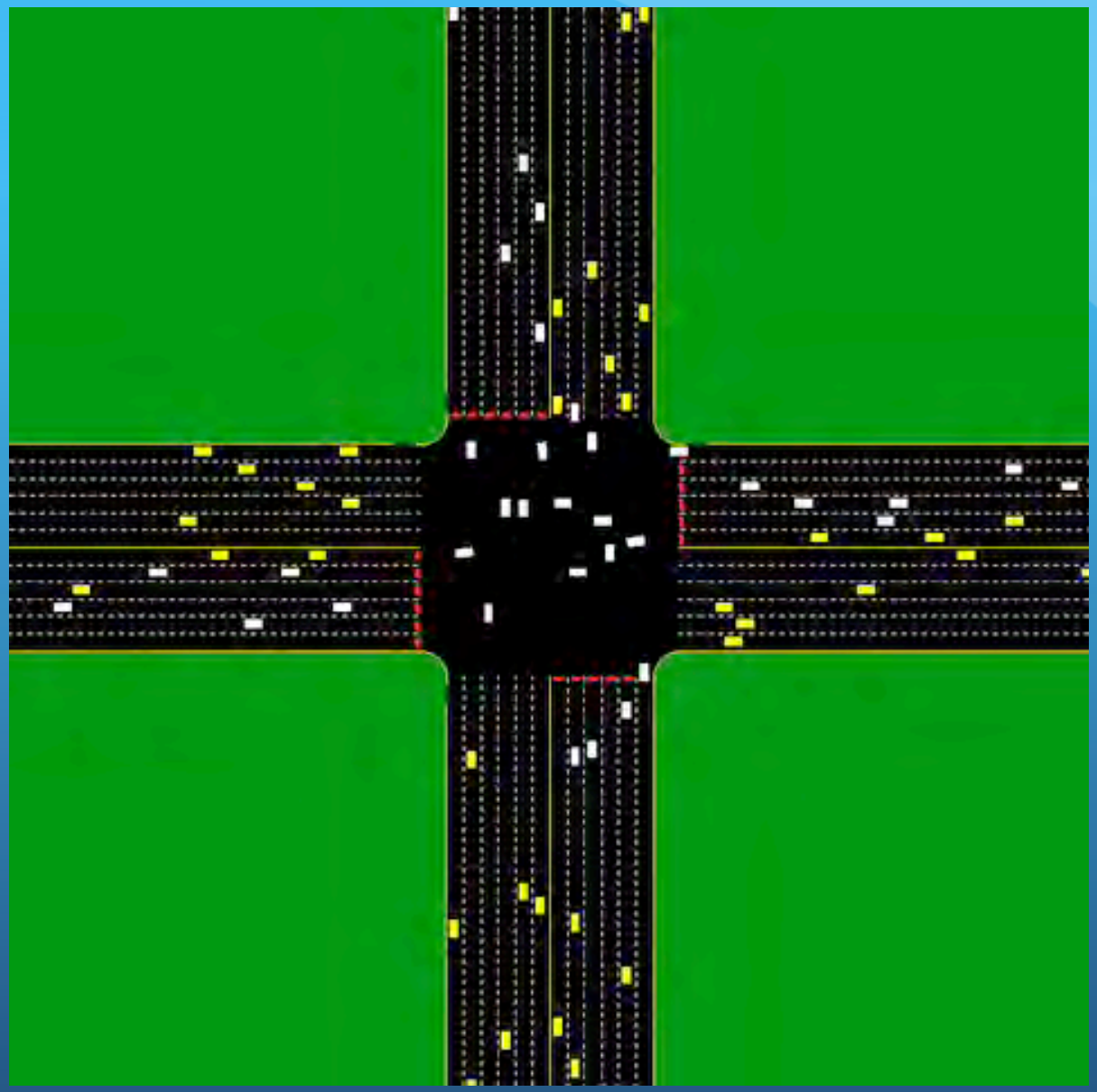
A group decision might be superior than individual decisions
“We are more than me” Aristotle

Multiagent Systems?

- Systems or simulators to solve common or distributed problems with multiple intelligence entities (agents)
- Characteristics (assumptions)
  - Decentralized or distributed
  - Individually rational
  - Privacy
- How to harness the self-interested agents?

Multiagent Systems?

- Systems or simulators to solve common or distributed problems with multiple intelligence entities (agents)
- Characteristics (assumptions)
  - Decentralized or distributed
  - Individually rational
  - Privacy
- How to harness the agents?
- A new methodology to simulate a society



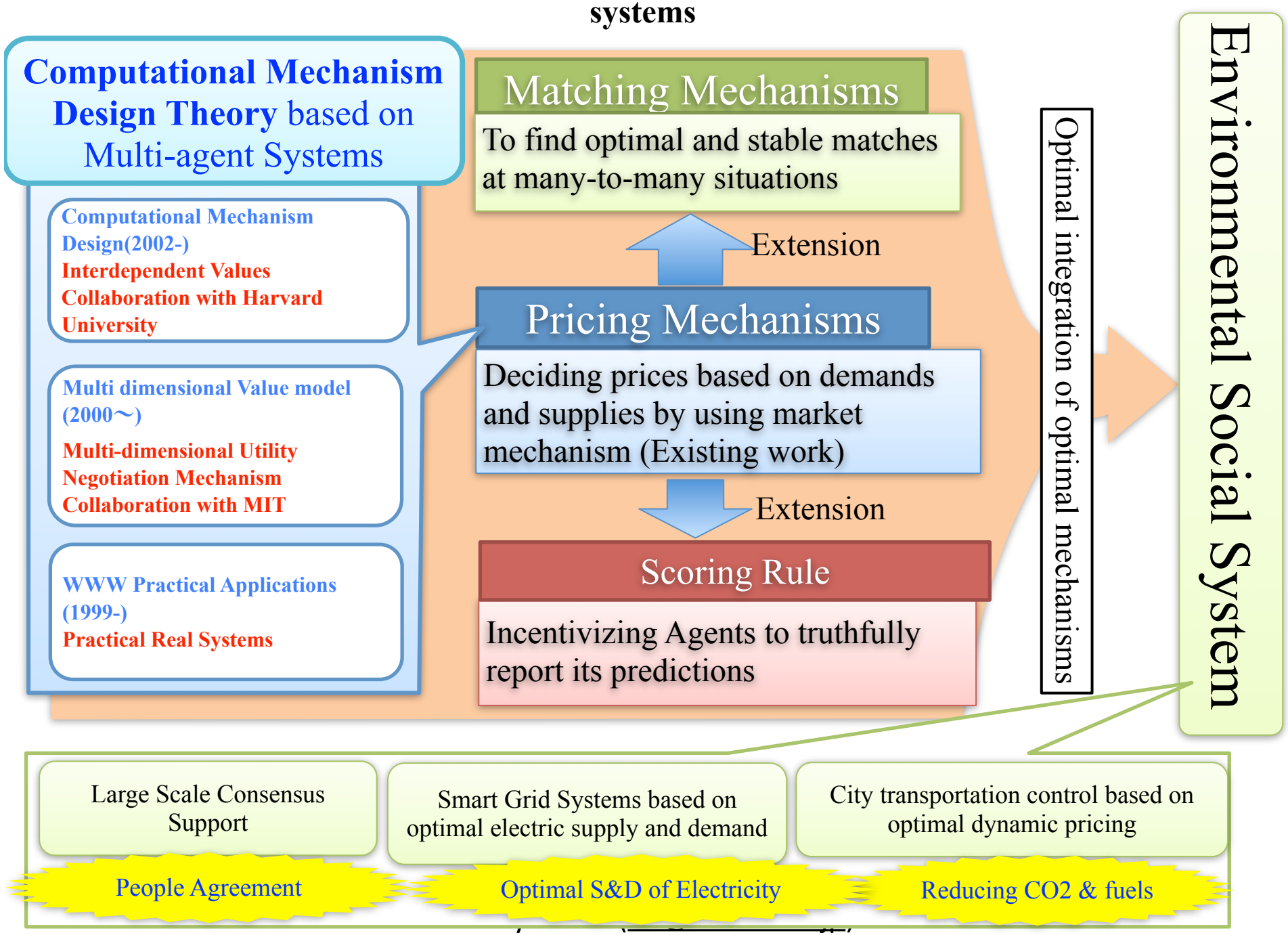
P. Stone, CMU

It is possible in theory & model to build an intersection without any signals

Massive

Multi-agent model
All characters are agents (artificial intelligence)
It looks like acting in real

Realizing Environmental Society System based on integration of partially optimized systems



Computational Mechanism Design (CMD) Theory

- Interdisciplinary filed among Multi-Agent System, Computer Science, and Economics
- Computational Mechanism Design theory brings together
  - the concern in Mechanism Design, like decision making under distributed private information, uncertainty, and self-interest, and
  - the concern in Computer Science with computational and communication complexity and real-time & large scale search algorithms.
- Auctions, markets, and voting are the classic examples.

Brief examples

Computational Mechanism Design Theory based on Multi-agent Systems

Computational Mechanism Design(2002-)
Interdependent Values
Collaboration with Harvard University

Multi dimensional Value model (2000～)
Multi-dimensional Utility Negotiation Mechanism
Collaboration with MIT

WWW Practical Applications (1999-)
Practical Real Systems

It is important how we model human's value judgment

・Designing Auctions （Competitive Social System）

・We modeled value interdependency.

"If he (expert) says this picture is good ,then I will feel this picture is good" = interdependent values

・A value function $b_i(v_{-i}) = v_{i0} + \sum_{j \neq i} \alpha_{ij} v_j$

・A new computer algorithm to decide a winner

[Ito&Parkes AAMAS2006, Best Paper]
[IPSJ Nagao Award]

・Consensus Support Mechanisms （Cooperative Social System）

・We modeled multi dimensional value.

"When we buy a house, we have to estimate its value from multiple viewpoints, e.g., cost, color, rooms, materials, etc."

・It is so difficult to make a consensus in a group

-> because there are a lot of alternatives.

・Software agents try to find optimal alternatives on behalf of the people

・A new computer algorithm to find a good consensus

[Ito&Klein IJCAI2007][Ito GDN2010][Young Scientist Prize]

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Harnessing by Multiagent Algorithms

Computational Mechanism Design, Automated Negotiation, etc

Simulating based on environmental model

Transportation models, elderly care model, crisis model, parking model

Sensors

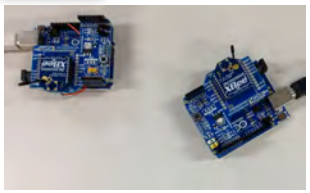
Opinions

Preference

Prediction

Truthful

Truthful



Device sensors
Human sensors

Transportation
Elderly care
Crisis
Smart grid
Parking

Feedback

Guidance and Forecasts

Make Social System Smart

Harnessing by Multiagent Algorithms

Computational Mechanism Design, Automated Negotiation, etc

Simulating based on environmental model

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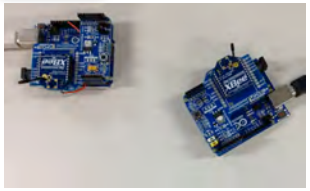


Device sensors
Human sensors

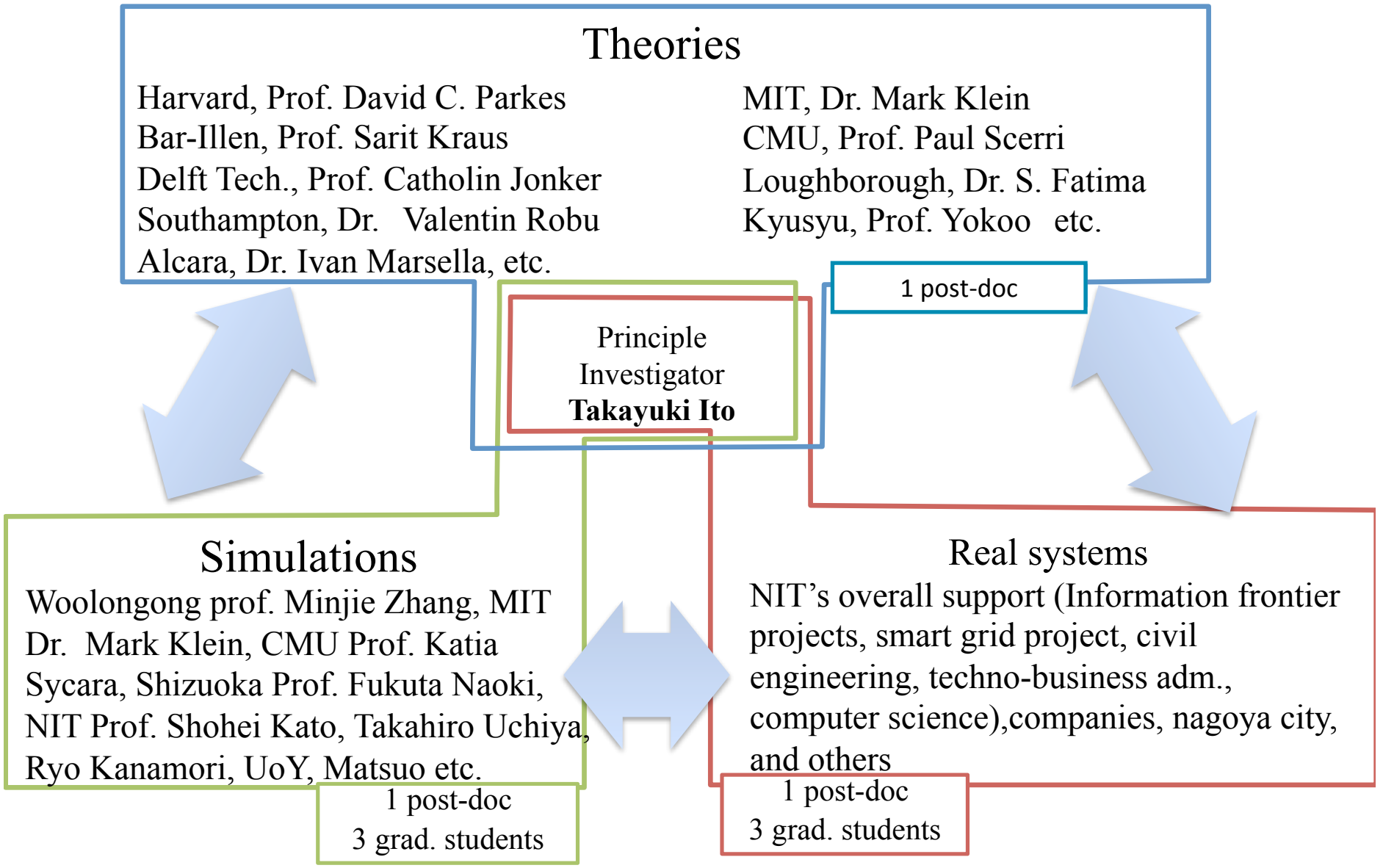
Transportation
Elderly care
Crisis
Smart grid
Parking

Guidance and Forecasts

Make Social System Smart

Realizing Central Nervous System for Society
Predicting “A little bit” future

International collaboration



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Activities

- Center for Green Computing (2011.4)
- Green Computing Seminar Series
  - 2011.8.23 Ivan & Enrique from Alcara Univ. Spain
  - 2011.10.31 IBM, Nikken Sekkei (Activities in China, SmarterCity)
- 2011.3.29 Information Frontier Symposium
- 2011.6.11 Nitech Open Campus Talk
- 2011.8.8-10 ISAI Symposium
- International Workshop on Sustainable Enterprise Systems (SES2011) @ Luxemburg
- International Workshop on Multi-Agent based Smart Society (MASmart2011) @ Australia
- Collaboration with Taisei Highschool
- 2011.9.26-27 Simposium at IPSJ-TSJ
- 2011.12.12 KASTLES2011
- 2012.3 Information Processing Society in Japan, National Convention
  - Keynote : Mechanism Design and Smart Computing
    - Harvard University, Prof. David C. Parkes
  - Symposium : Green Innovation & Life Innovation
- 2012.4 GCSS 2012 @ Kitakyushu, Japan
- 2012.9 SEMP 2012 @ hangzhou, China
- 2012.9 Smart Modeling and Simulation Special Session@ PRICAI2012, Malaysia
- 2012.12 GCSS 2012 @ Macau, Hong Kong
- 2012.12 KASTLES 2012 @ Taipei, Taiwan
- 2012.12 Techno-fair at NIT @ Nagoya, Japan
- 2013.5 MASS Workshop at Saint Paul

Current researches

- Designing Electricity Markets in SmartGrid with software agents
- Distributed Thermal Power Units Optimization
- **Large-scale Transportation Simulation**
- **Stigmergy-based Traffic Congestion Management**
- **Auction-based Parking Mechanism**
- Large-scale Consensus Support System
- Higher large scale combinatorial auction
- Smartphone Applications
- Collaboration with highschools
- GCSS symposium @ Jeju
- Elderly Care

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Today's Talk

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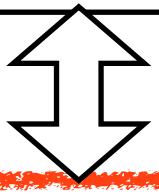

Current

Overview of current ITS and its future

Current ITS and its Future

Why we need ITS: Problem for the current infrastructure

- Current infrastructure unable to inherently handle **traffic**
  - The urbanized nations are battling traffic congestion, with growing populations and the proliferation of cars making the situation worse
  - For developing nations the situation is more severe.
- Congestion causes **costly delays, frustration, pollution, wasted fuel and crashes**
- Policy relies on short-term solutions which increase **long time problems**


SALE! upto 61% OFF!
CHERMAS

Rating of the Current Transportation System

National Transportation Commission, Australia

- Australia is one of the developed country in terms of the basic transportation system.
- However the Australian public is not satisfied with the current passenger transport system.

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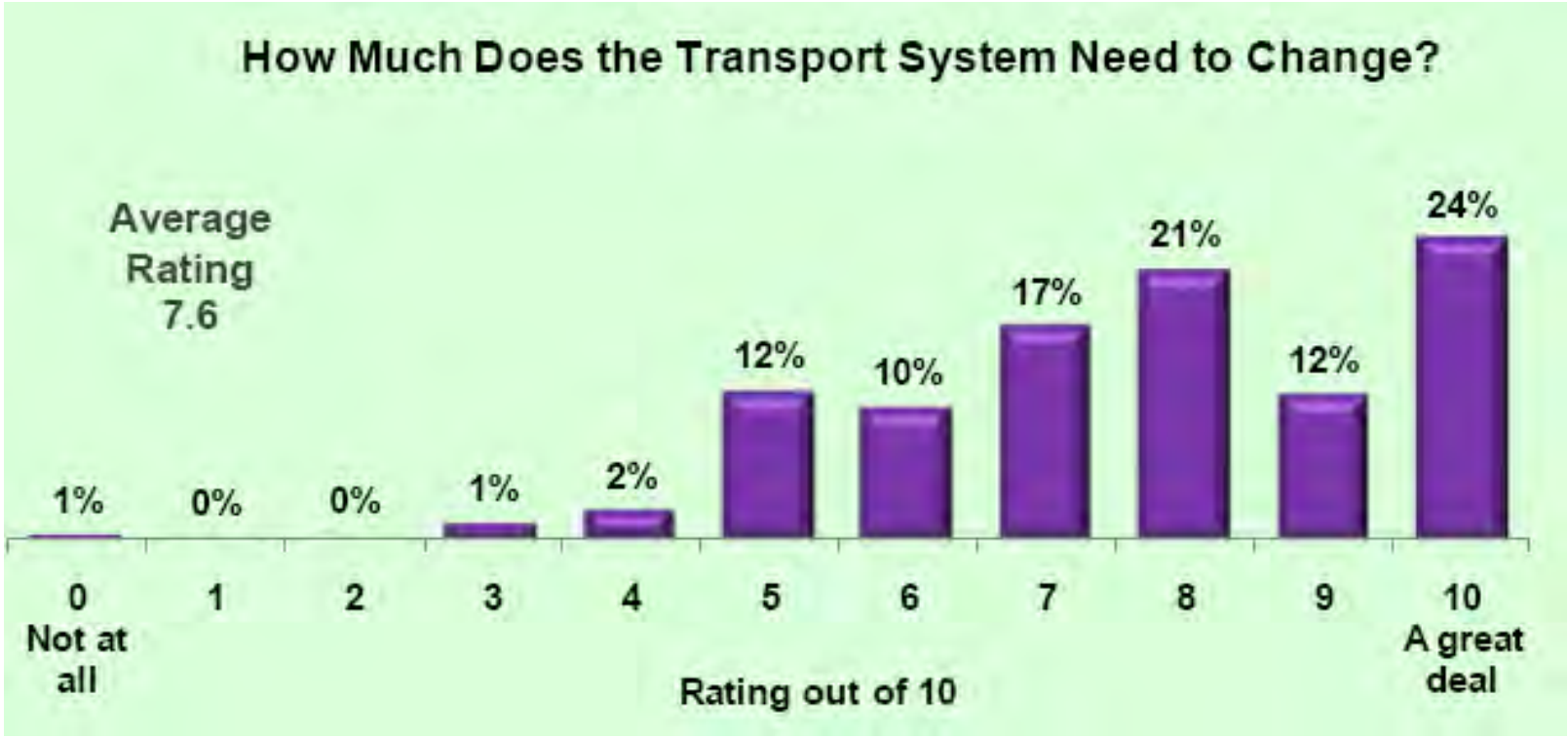
The Transport System need to be changed?



National Transportation Commission, Australia

- Yes, the australian public do want to change the transport system.
- Most of the developed countries are in the similar situation.

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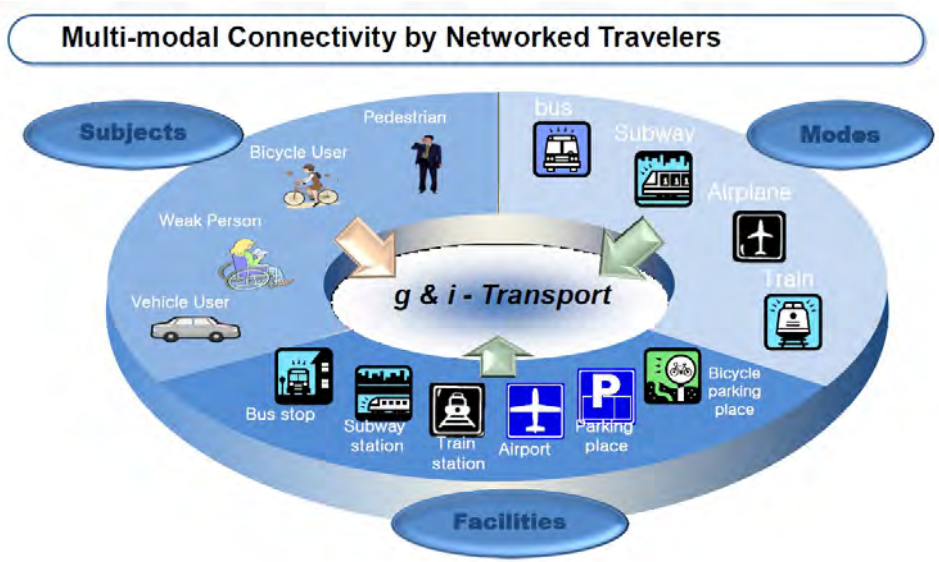
What is ITS

- ITS is Intelligent Transport System
  - **Intelligent Transport Systems (ITS)** is the use of electronic and computer technology to improve the sustainability, efficiency and safety of a designated transportation network.
- Targets of ITS
  - Reducing traffic congestions by optimization of transportation
  - Reducing the number of accidents
  - Environmental mobilities
- Basically, rapid evolution of information technologies make them possible.

What is ITS?



ITS integrates a combination of sub-systems or modules each with a separate objective into one over-arching system to achieve specified sustainability, efficiency and safety targets.

The designated transportation network is not necessarily restricted to a road or even a surface based network, it can include a combination of non-motorised transport, road based transport, rail, sea travel and air travel.

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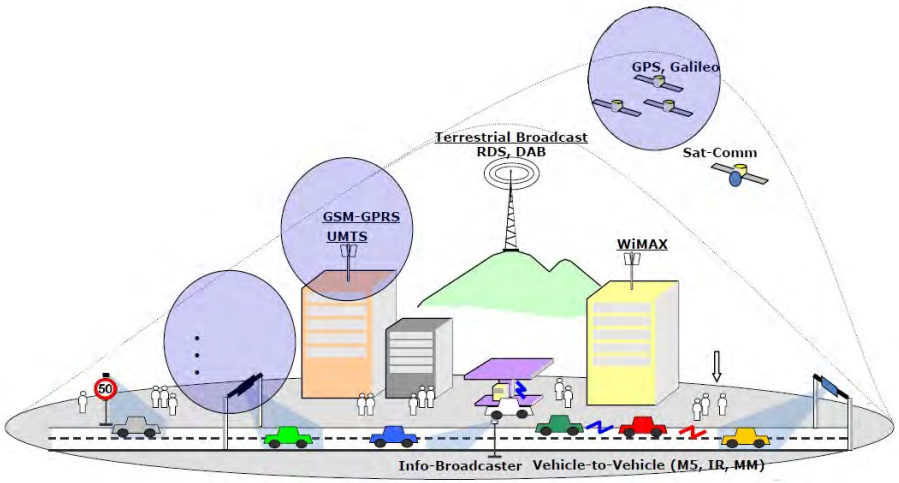
What is ITS

The **sub-systems** or **modules** of an ITS range from CCTV surveillance, variable message signage, lane management, ramp metering, freight monitoring, incident and intruder detection, weather information, container security and monitoring, smart ticketing, seamless inter-modal interchange, open road tolling, radio, TV, web and cell phone based information dissemination



Achievable Goals of ITS

- Infusing intelligence into the entire transportation system is being possible
- Achievable goals
  - Reducing traffic congestion
    - Improved productivities
  - Safety
    - Decreasing the number of accidents
  - Reduction of green house gas (GHG)
    - Reducing air pollutions
  - Empowering consumers

Reducing traffic congestions

- Methods
  - **Monitoring** congestions directly
  - Making real time adjustments to **traffic lights and speed signs** to ease congestion.
  - Electronic tolls with **flexible tolling** options.
  - **Predicting** what will happen to traffic congestion, traffic accidents and safely during new construction and better planning roads and public transport in that area.
- Examples
  - In London, a smart congestion management system has lowered traffic volume to mid–1980s levels.
  - In Singapore, a system can predict traffic speeds with nearly 90% accuracy.

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Example : speed signs

- **Variable Speed Signs** are used to control speeds by lane or section of freeway in response to approaching driving conditions. Gradual speed reduction to approaching congestion for example.
- Providing **Read Your Speed Signs** to advise of speeds.

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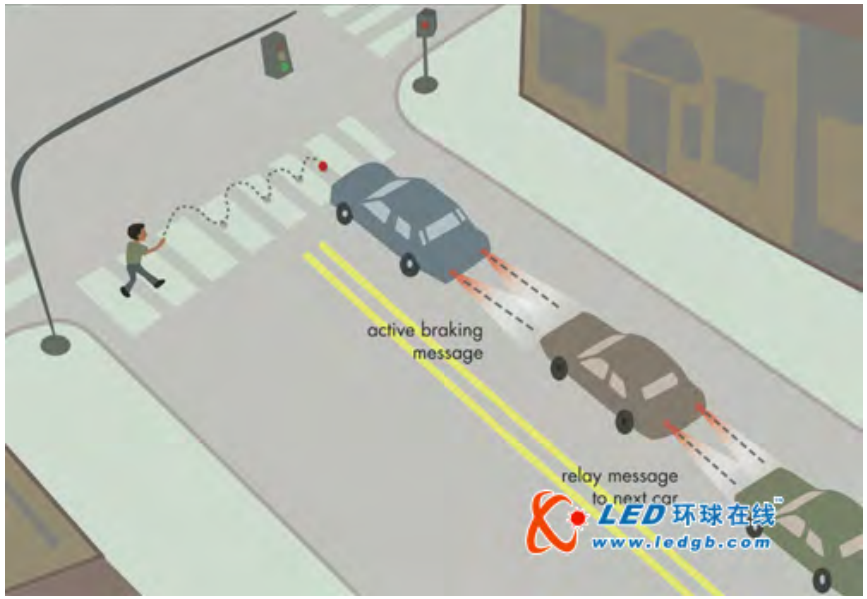
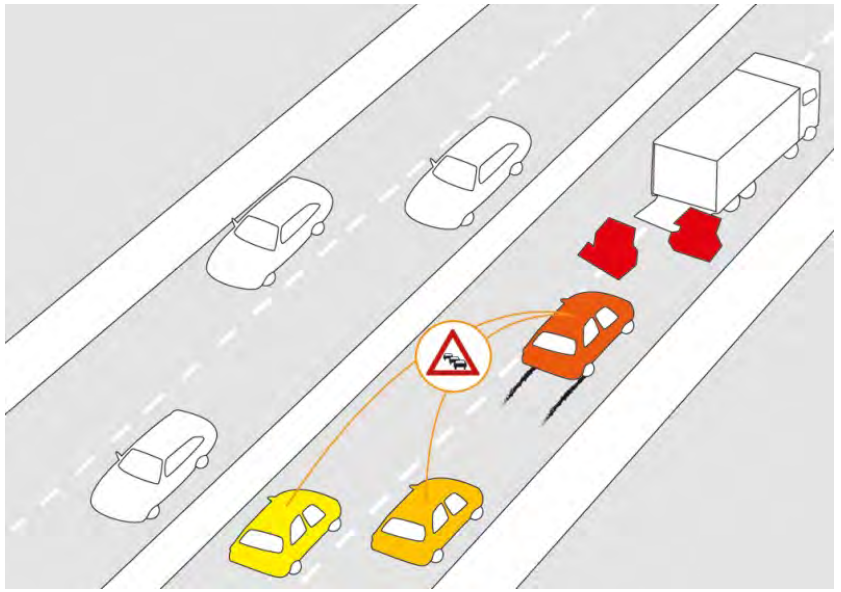
Smart Communications

- Vehicle to vehicle communications
  - Vehicles are able to ‘talk’ to each other while they are travelling, sharing information so that the advanced driver assistance systems can make informed decisions relating to safety!





Autonomous Car & Adaptive Cruise Control

図-10　グーグル自動運転車


図-11　「KONVOI」走行実験（アーヘン大学 Web サイト引用）

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Cooperative Adaptive Cruise Control

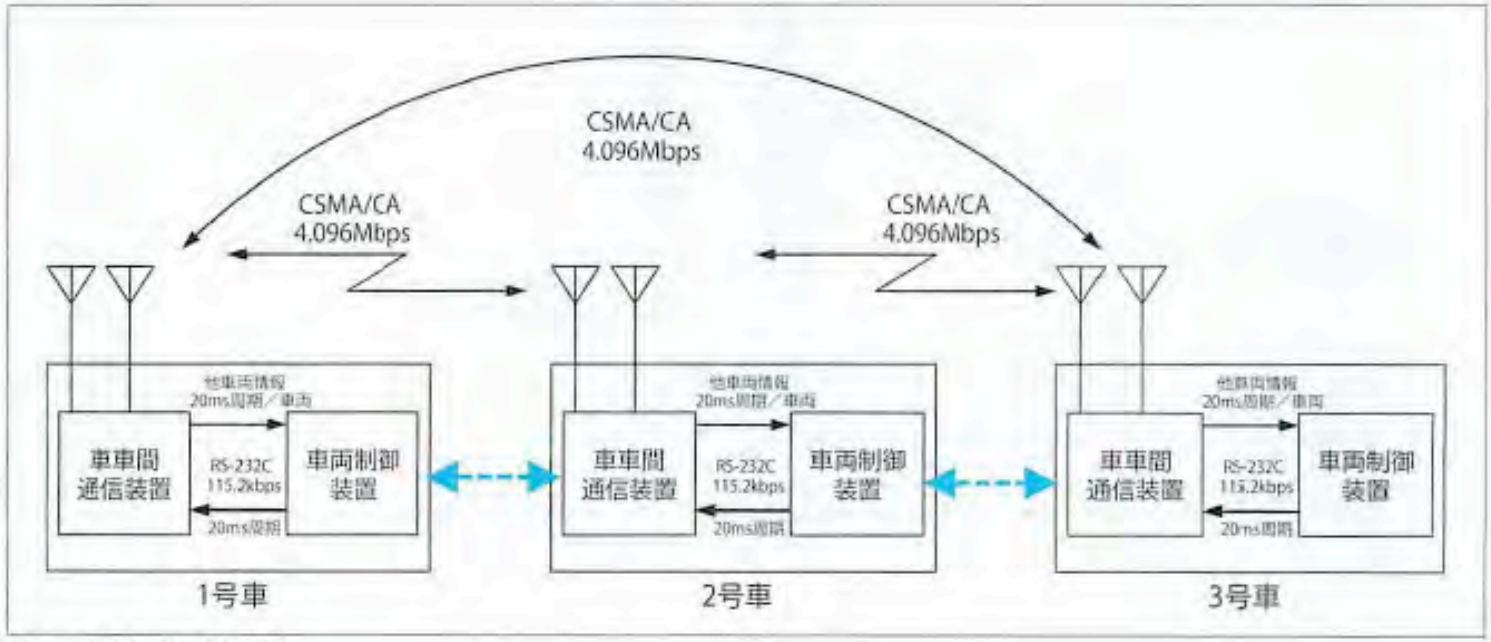

図-7　車車間通信の2重化

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Multiagents!

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Empowering Consumers

- Possibilities
  - Using new sensor technologies, GPS and satellites to tell motorists about the best routes and parking during rush hours.
  - Helping commuters make more informed choices about public transport, telecommuting or driving in non-peak periods.
  - An integrated public transport system that tracks and adjusts services to meet changing commuter needs.
  - Fleets of smaller buses that change route on the fly and go where they are needed most.
    - Demand buses

Integration with Smart Devices

- Full connectivities with smart devices

Reducing accidents

- The use of smart phones to alert motorists of pedestrians near the roadway and to alert pedestrians with smart phones of approaching vehicles

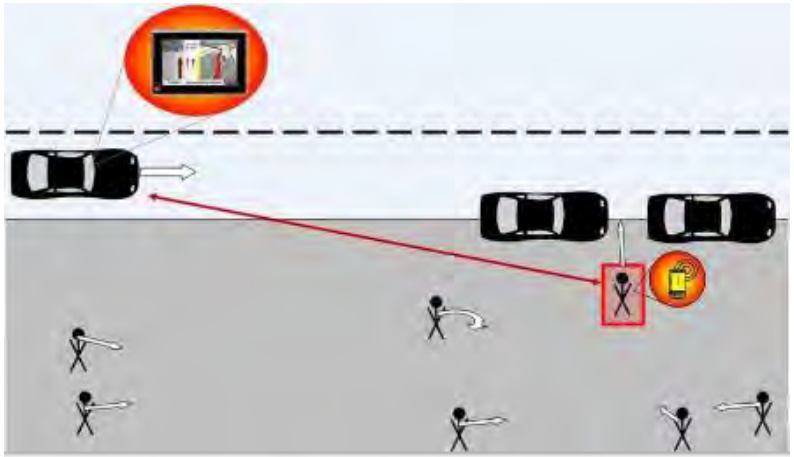
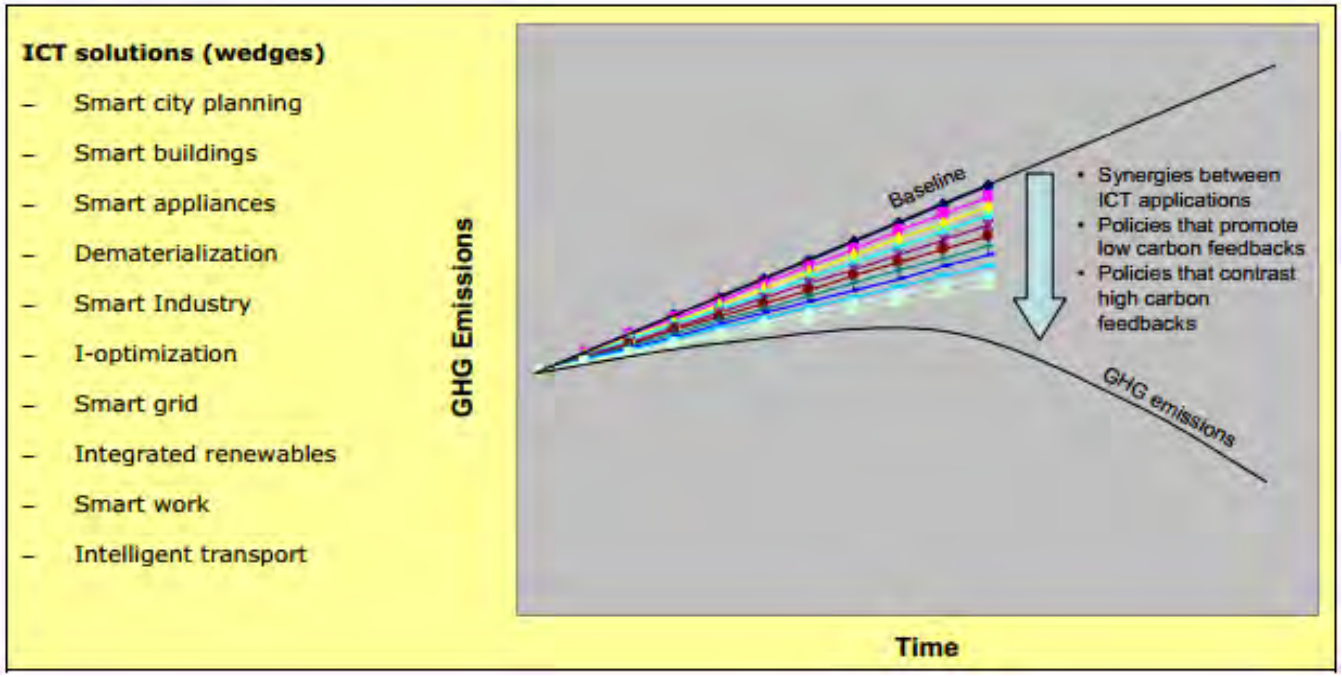


Image: An intelligent context filter detects which pedestrians will likely enter the road

Reducing pollutions

- Intelligent transportation system can actively help to reduce air pollution specially green house gas (GHG) emission. Since the world is moving towards a low carbon society, reduction GHG should rightfully be one of the utmost priorities of policy.



ICT solutions for the first billion ton of GHG emission reductions and to achieve systemic change

ITS in Developing Countries

- Some **critical issues in developing countries** while combining ITS with the economic growth in developing countries.

- Usually **economic growth** result in an increased volume of **unsustainable private motorized transport**.

- In the long term, this is **not sustainable**;
  - congestion and air pollution **hinder the quality of living**, the economic development and prosperity of the cities.

- Extension of infrastructure for cars is expensive and space for unlimited growth is simply not available in most of the developing countries.

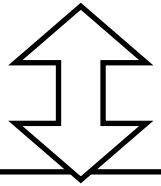
- Hence, **sustainable and intelligent transport modes** have to be made available and the right incentives to encourage their use have to be created.
- Investments in right transport modes can foster growth sustainably.
- Investments in public transport modes will improve the quality of living in cities and thereby increase its economic attractiveness.

Conclusions

A Vision For 21st Century Cities

Future

Introduction of our current project



Current

Overview of current ITS and its future

- **Incentivizing** people to participate in green and intelligent movement towards transportation is important

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