ITRI

Industrial Technology Research Institute
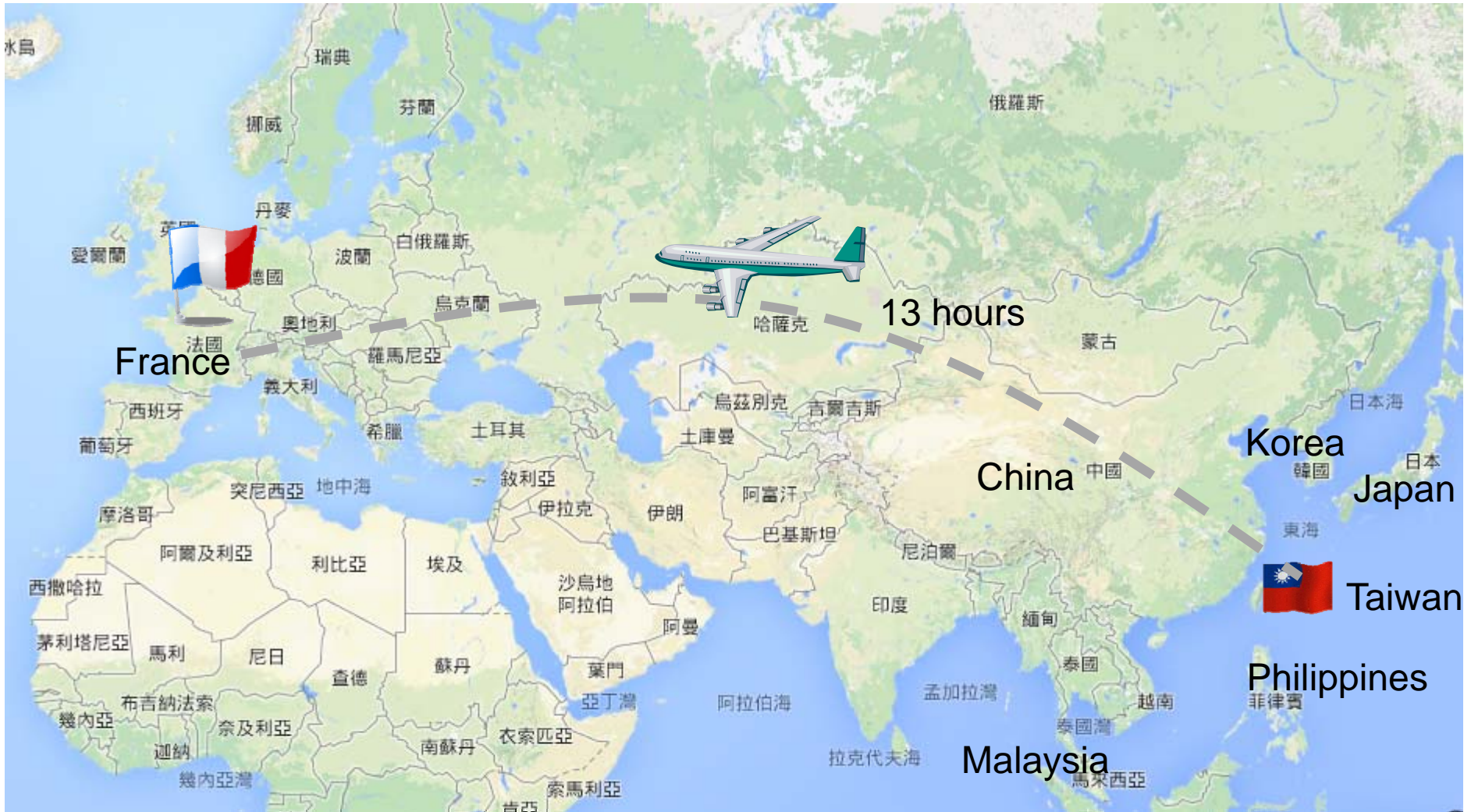
Insights on V2X Telematics

Latest developments on V2X from ITRI Taiwan

Huei-Ru Tseng (hueiru@itri.org.tw)
Department of Connected Vehicle
Division for Telematics and Vehicular Control System
Information and Communication Lab. (ICL)
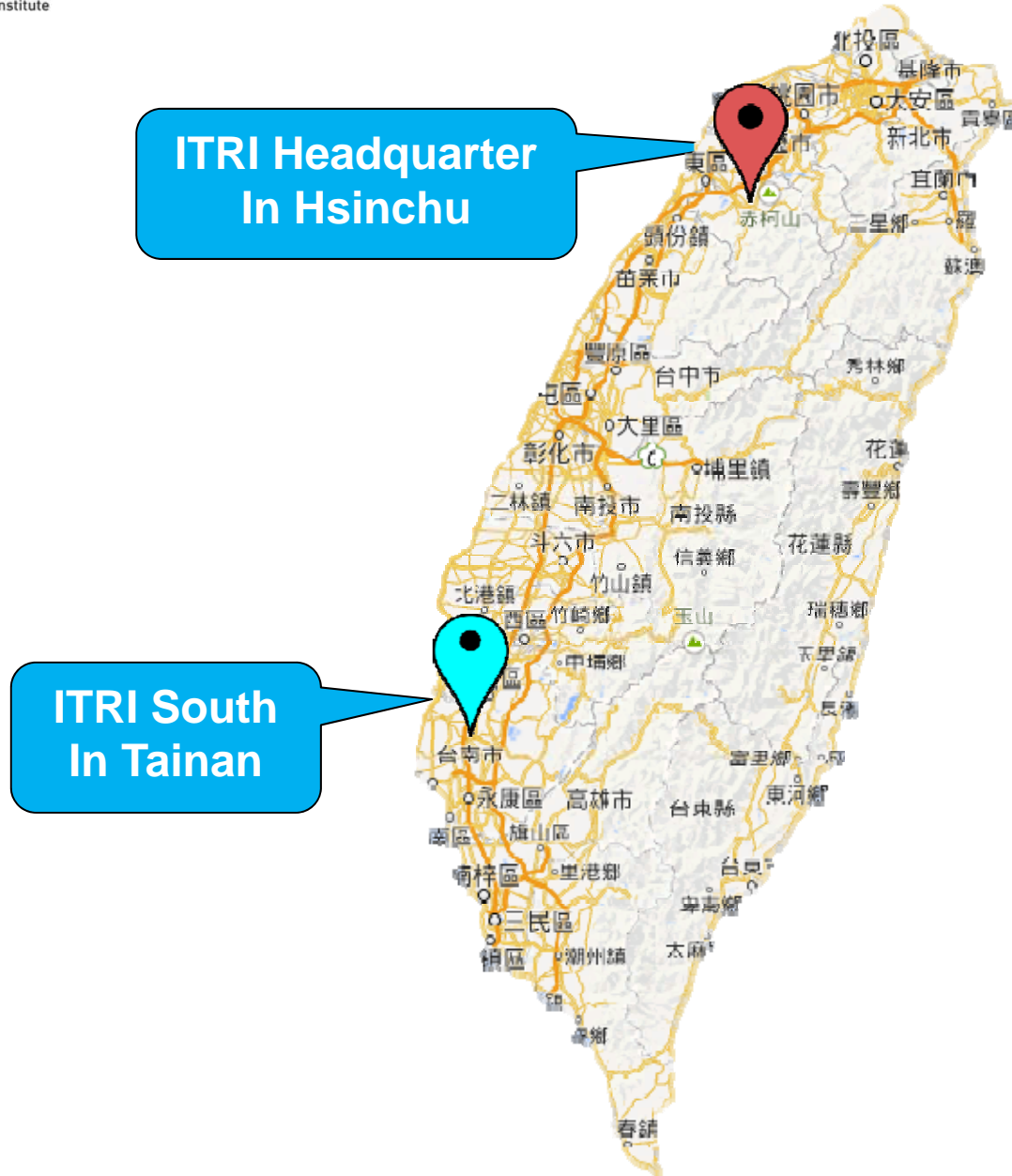Industrial Technology Research Institute

Jul 29, 2014 @IRT System X

Outline

- ITRI Overview
- ITRI V2X Development and Vision
    - ITRI V2X Technology
    - Achievements
    - Standard Activities in EU and US
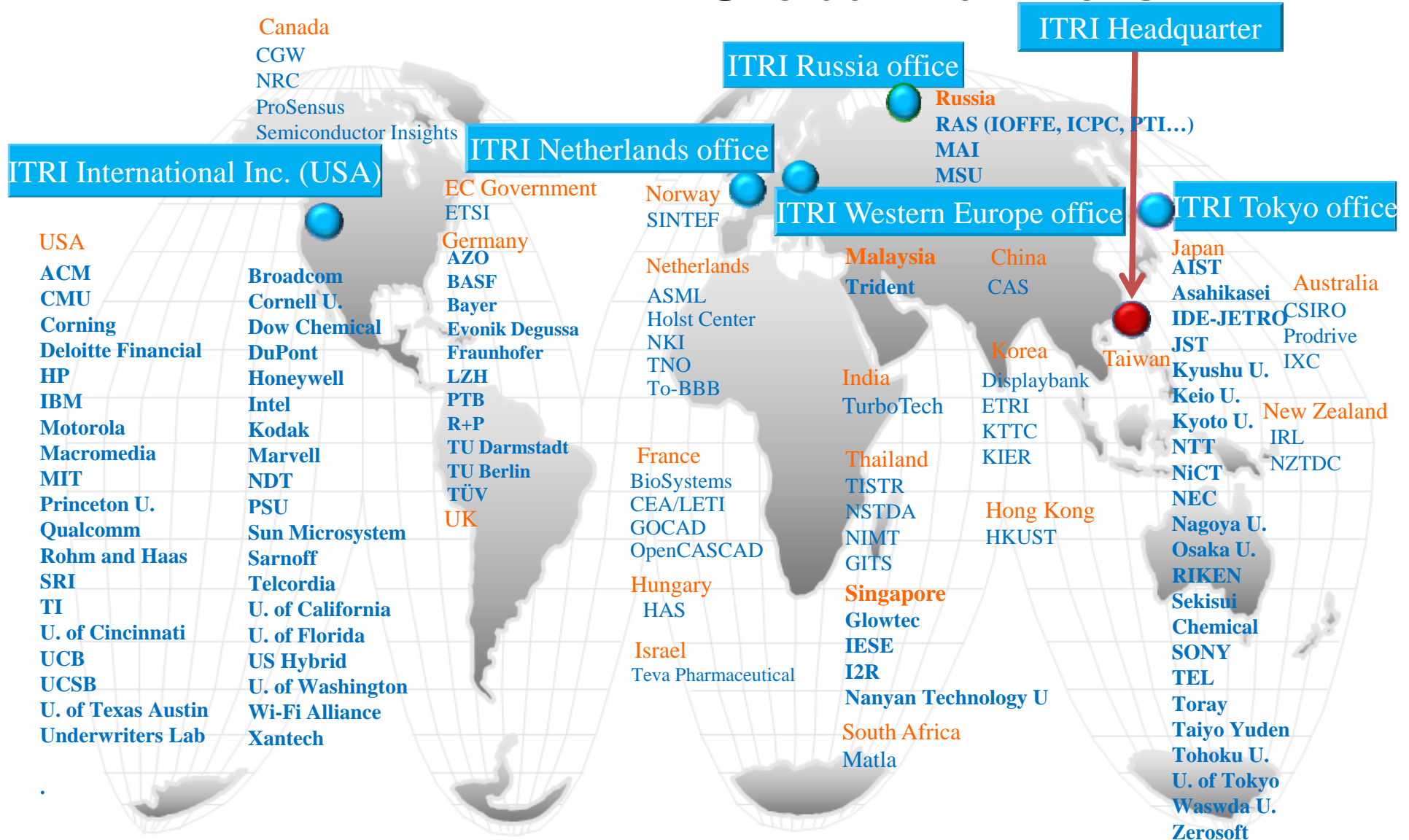   - Next Step in Europe
- Concluding Remarks

Where is ITRI

Where is ITRI

ITRI Headquarter
In Hsinchu

ITRI South
In Tainan

ITRI Worldwide Offices & Global Partners

ITRI
Industrial Technology
Research Institute

Canada
CGW
NRC
ProSensus
Semiconductor Insights

ITRI Russia office

Russia
RAS (IOFFE, ICPC, PTI…)
MAI
MSU

ITRI Headquarter

ITRI Netherlands office

ITRI International Inc. (USA)

EC Government
ETSI

Norway
SINTEF

ITRI Western Europe office

ITRI Tokyo office

USA
ACM
CMU
Corning
Deloitte Financial
HP
IBM
Motorola
Macromedia
MIT
Princeton U.
Qualcomm
Rohm and Haas
SRI
TI
U. of Cincinnati
UCB
UCSB
U. of Texas Austin
Underwriters Lab
.

Broadcom
Cornell U.
Dow Chemical
DuPont
Honeywell
Intel
Kodak
Marvell
NDT
PSU
Sarnoff
Sun Microsystem
Telcordia
U. of California
U. of Florida
US Hybrid
U. of Washington
Wi-Fi Alliance
Xantech

Germany
AZO
BASF
Bayer
Evonik Degussa
Fraunhofer
LZH
PTB
R+P
TU Darmstadt
TU Berlin
TÜV
UK

Netherlands
ASML
Holst Center
NKI
TNO
To-BBB

France
BioSystems
CEA/LETI
GOCAD
OpenCASCAD

Hungary
HAS

Israel
Teva Pharmaceutical

Malaysia
Trident

India
TurboTech

Thailand
TISTR
NSTDA
NIMT
GITS

Singapore
Glowtec
IESE
I2R
Nanyan Technology U

South Africa
Matla

China
CAS

Korea
Displaybank
ETRI
KTTC
KIER

Hong Kong
HKUST

Taiwan

Japan
AIST
Asahikasei
IDE-JETRO
JST
Kyushu U.
Keio U.
Kyoto U.
NTT
NiCT
NEC
Nagoya U.
Osaka U.
RIKEN
Sekisui
Chemical
SONY
TEL
Toray
Taiyo Yuden
Tohoku U.
U. of Tokyo
Waswda U.
Zerosoft

Australia
CSIRO
Prodrive
IXC

New Zealand
IRL
NZTDC

(signed contracts within 2006-2011.06)

5

ITRI at a Glance

Total Staffs: 5,813

Ph.D. ：1,379 （24%）
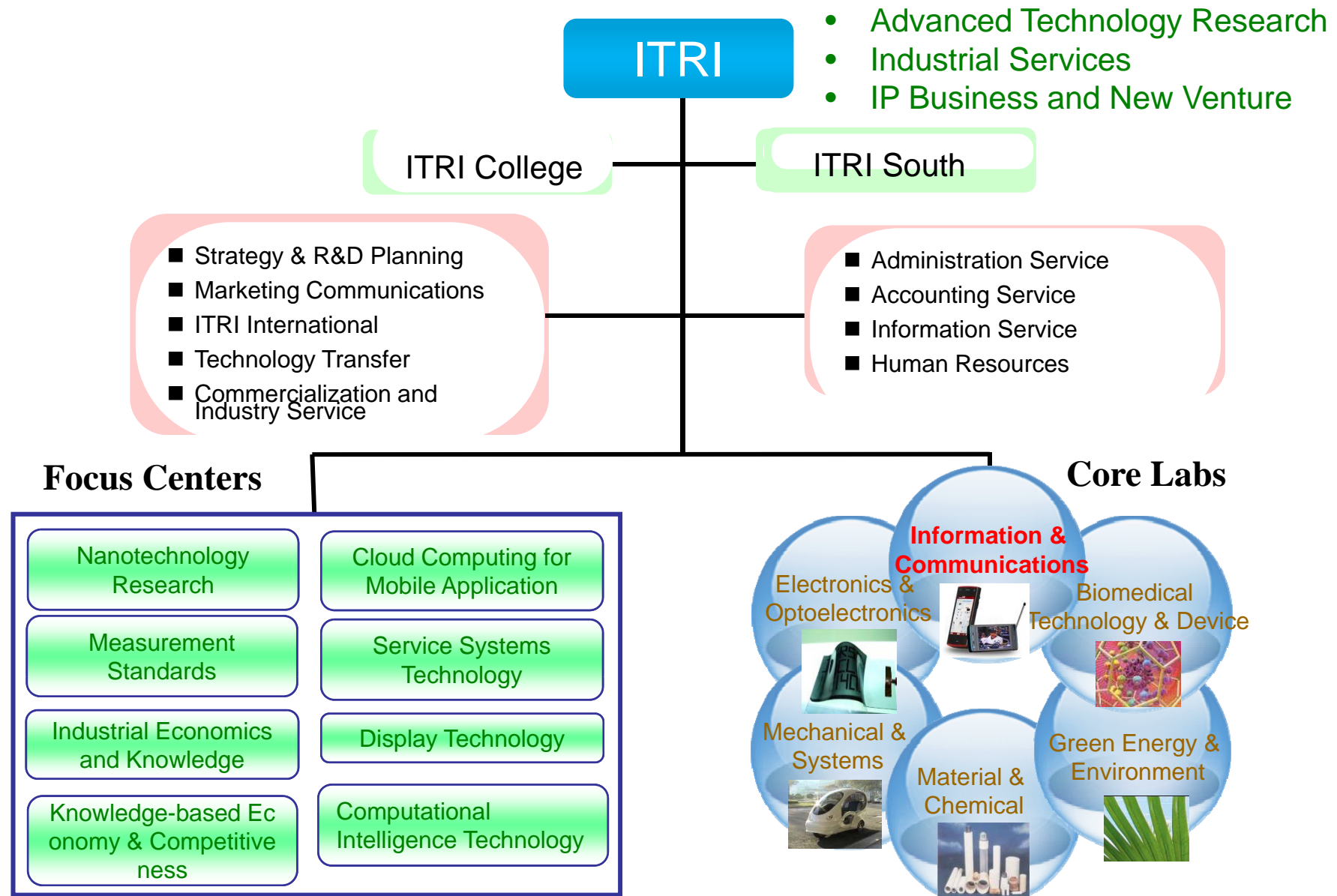Master ：3,147 （54%）
Alumni ：21,937+

Start-ups

Spin-off ： 71
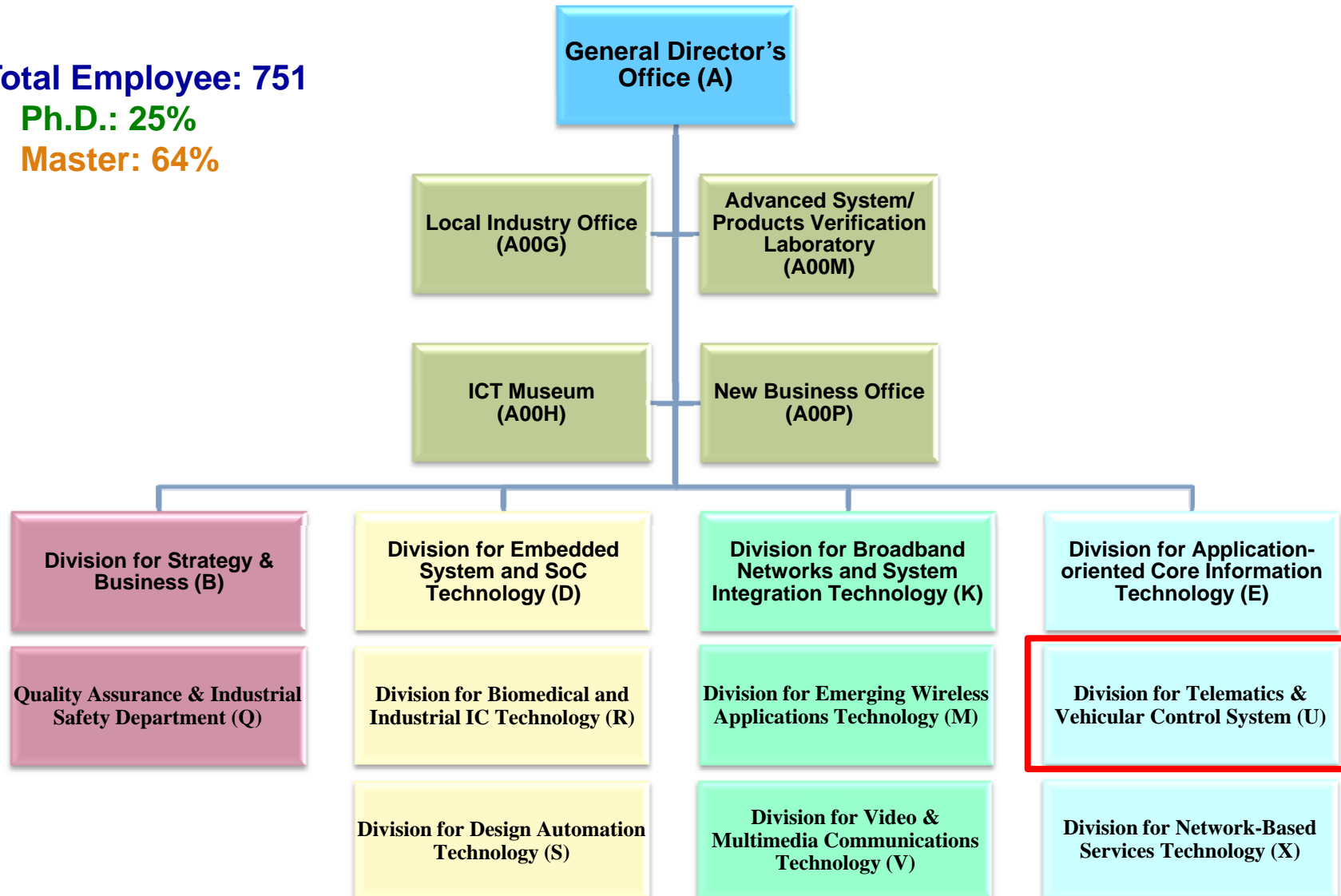Incubated ： 154

UMC 1983
tsmc 1987

ITRI Organization

ITRI

- Advanced Technology Research
- Industrial Services
- IP Business and New Venture

ITRI College

ITRI South

- Strategy & R&D Planning
- Marketing Communications
- ITRI International
- Technology Transfer
- Commercialization and Industry Service

- Administration Service
- Accounting Service
- Information Service
- Human Resources

Focus Centers

Nanotechnology Research	Cloud Computing for Mobile Application
Measurement Standards	Service Systems Technology
Industrial Economics and Knowledge	Display Technology
Knowledge-based Economy & Competitiveness	Computational Intelligence Technology

Core Labs

Information & Communications

Electronics & Optoelectronics

Biomedical Technology & Device

Mechanical & Systems

Material & Chemical

Green Energy & Environment

ICL Organization

Total Employee: 751
Ph.D.: 25%
Master: 64%

General Director's Office (A)

Local Industry Office (A00G)

Advanced System/ Products Verification Laboratory (A00M)

ICT Museum (A00H)

New Business Office (A00P)

Division for Strategy & Business (B)

Division for Embedded System and SoC Technology (D)

Division for Broadband Networks and System Integration Technology (K)

Division for Application-oriented Core Information Technology (E)

Quality Assurance & Industrial Safety Department (Q)

Division for Biomedical and Industrial IC Technology (R)

Division for Emerging Wireless Applications Technology (M)

Division for Telematics & Vehicular Control System (U)

Division for Design Automation Technology (S)

Division for Video & Multimedia Communications Technology (V)

Division for Network-Based Services Technology (X)

ICL R&D Fields

ITRI
Industrial Technology
Research Institute

Next Generation Communication Technologies

- Smart Antenna Technology
- LTE-A/WiFi Dual-RAT Baseband & RF
- LTE-A/WiFi Dual-RAT System Software
- Small Cell Base Station Technology
- LTE-A/WiFi Dual-RAT Access Gateway
- Test and System Integrated Verification
- Millimeter Wave Mobile Radio
- Massive MIMO and Beam Forming
- Device 2 Device Communication
- Mobile Network Virtualization

Broadband Convergence System and Integration Technologies

- Intelligent Video Cloud & Network Access
- Over the top Video Service
- Proximity-Based Application Services
- Content Aware Media Platform
- Intelligent Fiber Broadband Network
- High Efficiency Diverse Video Content Coding
- High-Speed Moving Network
- Software Defined Network

Smart Internet of Everything

- Smart Connected Home Technology
- Smart Device Market
- Video Networking and Analyzing
- Interactive Question Answering
- Wireless Access in Vehicular Environments/Dedicated Short Range Communications
- Vehicle Comm. Gateway
- Intelligent Vehicle Service Platform
- Scope Monitoring Technology
- Advanced Driving Assistance System

SOC and System Platform Design Technology

- Electronic System Level Design
- Normally-Off Computing
- New Memory Architecture

- 3D–IC Design & Test
- Analog/Mixed-Signal & RF Circuits
- Ultra Low Power/Low Voltage ICs

- Automotive Electronics
- Energy Harvesting Technologies
- Power Management ICs

- ITRI Overview
- **ITRI V2X Development and Vision**
    - ITRI V2X Technology
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ITRI V2X Technology

ITRI is one of the few organizations in the world having complete V2X solutions, with up-to-date and robust IEEE 802.11p/1609 and ETSI TC-ITS compliant 5.9GHz DSRC devices and systems, and with experiences in product interoperability testing in US and Europe

Onboard Unit   PCI Module

Road Side Unit   Sniffer Tool

WAVE/DSRC Communication Unit (IWCU)

Standard Procedures   Outdoor Testing Vehicle   Integrated Environments
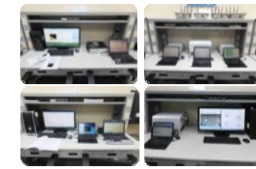
WAVE/DSRC V&V and Trial Technology R&D
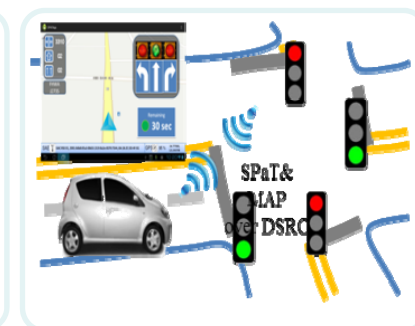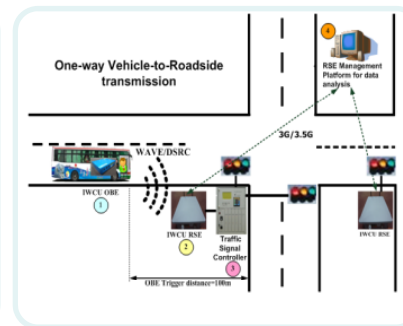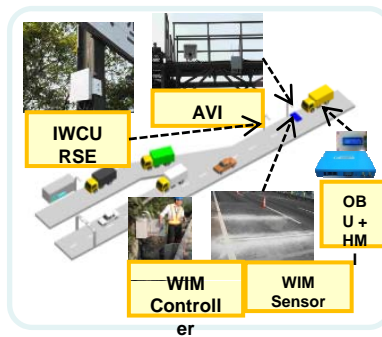
ITRI V2X Solutions

ITRI WAVE/DSRC Communication Unit (IWCU)

Taiwan's First WAVE/DSRC Unit: With ITRI's connected vehicle research power, IWCU is an integrated wireless communication system designed for deploying Intelligent Transportation Systems (ITS) Vehicle-to-Vehicle (V2V), Vehicle-to-Roadside (V2R) and Vehicle-to-Infrastructure (V2I), or called V2X applications and improving driving safety and convenience on the roadways
* WAVE/DSRC: Vehicular Environments / Dedicated Short Range Communications

Standards Compliance
- IEEE 802.11p/1609 WAVE/DSRC Standards
- SAE J2735 Message Set Dictionary Standards
- ETSI TC-ITS European Standards

IWCU Roadmap

| IWCU 1.0 | IWCU 2.0 / 3.0 | DSRC Card | IWCU 4.0 | 802.11p mini-PCI Card | IWCU 5.0 |

| RSU | OBU | IWCU 2.0 | IWCU 3.0 | Sniffer Tool | For USDOT Projects | Module Solution | V2X Solution |
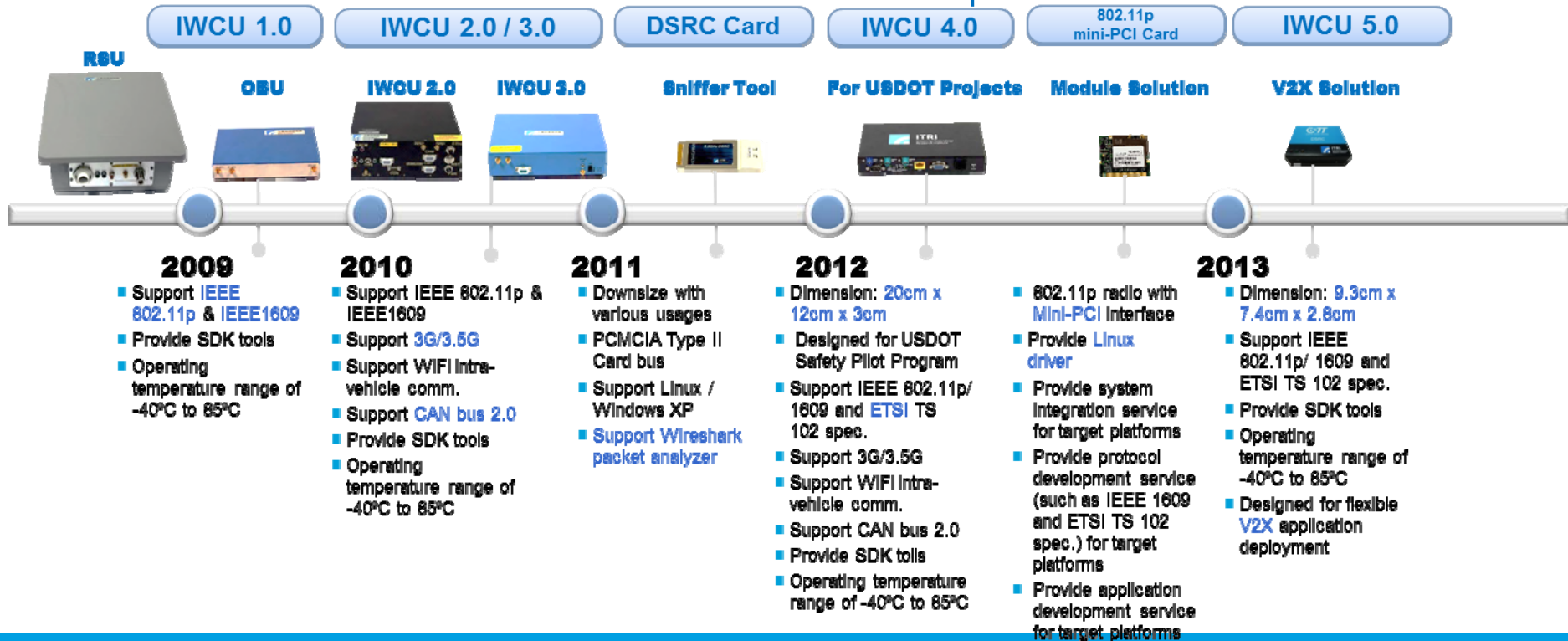
2009
- Support IEEE 802.11p & IEEE1609
- Provide SDK tools
- Operating temperature range of -40°C to 85°C

2010
- Support IEEE 802.11p & IEEE1609
- Support 3G/3.5G
- Support WIFI Intra-vehicle comm.
- Support CAN bus 2.0
- Provide SDK tools
- Operating temperature range of -40°C to 85°C

2011
- Downsize with various usages
- PCMCIA Type II Card bus
- Support Linux / Windows XP
- Support Wireshark packet analyzer

2012
- Dimension: 20cm x 12cm x 3cm
- Designed for USDOT Safety Pilot Program
- Support IEEE 802.11p/ 1609 and ETSI TS 102 spec.
- Support 3G/3.5G
- Support WIFI Intra-vehicle comm.
- Support CAN bus 2.0
- Provide SDK tolls
- Operating temperature range of -40°C to 85°C

- 802.11p radio with Mini-PCI interface
- Provide Linux driver
- Provide system integration service for target platforms
- Provide protocol development service (such as IEEE 1609 and ETSI TS 102 spec.) for target platforms
- Provide application development service for target platforms

2013
- Dimension: 9.3cm x 7.4cm x 2.8cm
- Support IEEE 802.11p/ 1609 and ETSI TS 102 spec.
- Provide SDK tools
- Operating temperature range of -40°C to 85°C
- Designed for flexible V2X application deployment

ITRI WAVE/DSRC V&V and Trial Technology R&D

Center for Telematics Technology (CTT): ITRI built the Taiwan's first WAVE/DSRC testing facility that provides integrated indoor verification & validation and outdoor field trial environment for flexibly and dynamically creating test scenarios on roads. See video

Lab Testing Environment
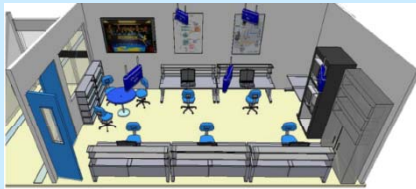
RF Spectrum Analyzer

Interoperability Testing Environment

Conformance Testing Facility

Performance Evaluation System

Standard testing Procedures

Outdoor Testing Suite

OBU Operation Platform
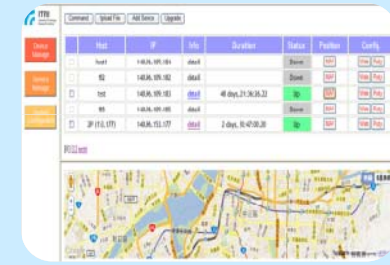
RSE Management Platform

Mobile RSE

WAVE/DSRC Testing Vehicle

ITRI V2X Solutions

V2V Applications for Personal Mobility

V2R Applications for Public Mobility

V2I Applications for Commercial Mobility

ITRI V2X Solutions

V2V Applications for Personal Mobility

ITRI Industrial Technology Research Institute
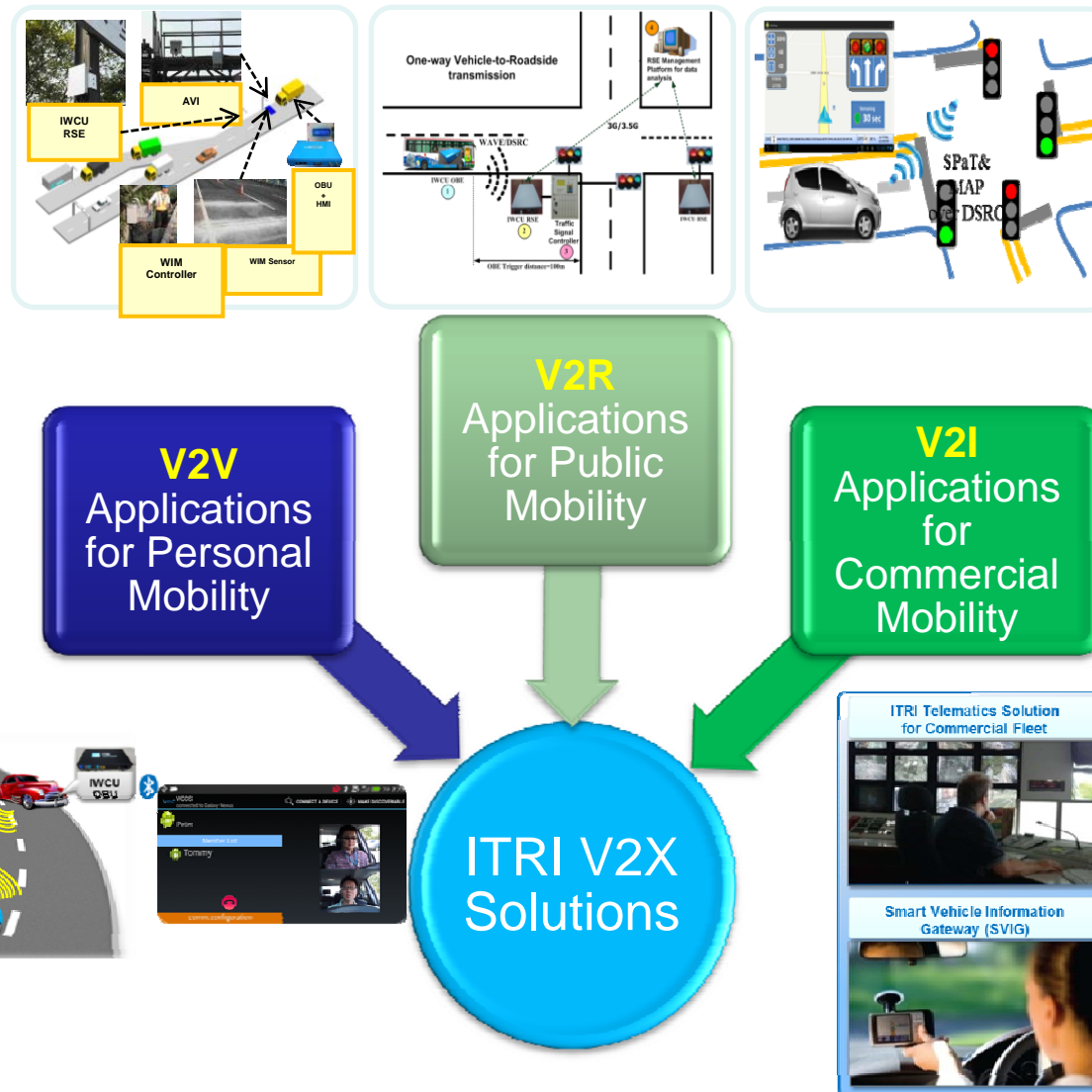
Needs & Goals
- Group talking services are expected to assist the drivers in enhancing the efficiency and convenience of driving
- ITRI applies IEEE 802.11p/1609 WAVE/DSRC technology to develop a Vehicle Group Communication System
- All members in a group are allowed to talk freely to each other during their trip using DSRC V2V communication
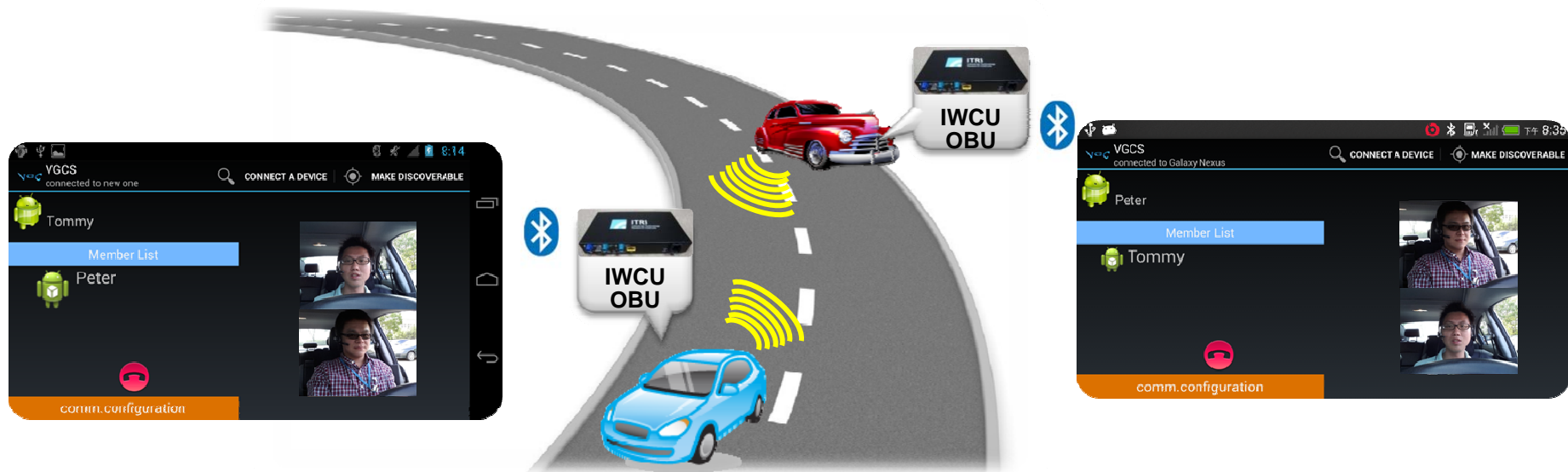
Features
- Full-duplex communication
- Simultaneous conversation among all group members
- Integrated user interface
- Display and track locations of all nearby group members.

Benefits
- Talk freely without extra fee
- Share location, direction, track among all group members
- Report member's status (e.g. missing, wrong way) to leader
- Call for help ability

V2R Applications for Public Mobility

WAVE/DSRC-based Transit Signal Priority System

WAVE/DSRC-based Weigh-In-Motion System
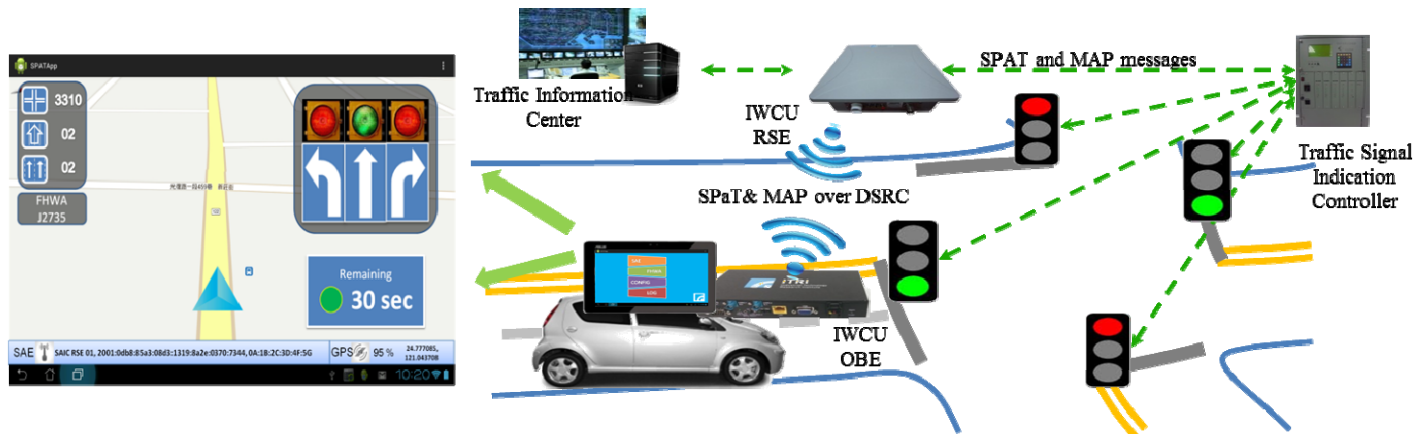
WAVE/DSRC-based Signal Phase & Timing System Solution

WAVE/DSRC-based Transit Signal Priority System Solution

- A demand in the use of transit signal priority to increase transit ridership and reduce traffic congestion
- Use of the WAVE/DSRC communication technology to control traffic signals to improve travel times at intersections
- Design real-time control logics dedicated to bus priority that manages green signal extensions and early green recalls
- Compatible with current traffic signal controller

RSU

WAVE/DSRC

OBU

ITRI OBU Deployment on the Transit Bus

RSU
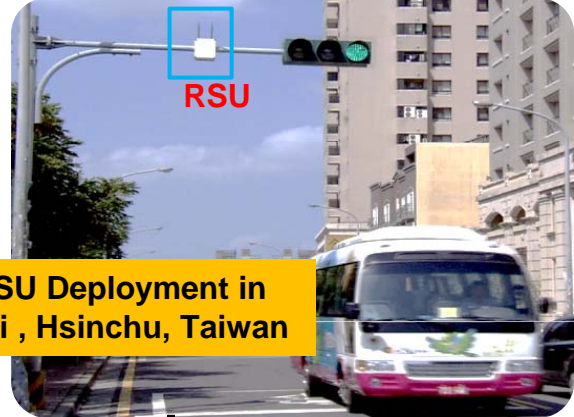
ITRI RSU Deployment in Chupei , Hsinchu, Taiwan

One- way   Vehicle-to-Roadside transmission

4

RSE Management Platform for data analysis

3 G/ 3.5 G

WAVE / DSRC

IWCU OBE
1

See video

IWCU RSE
2

Traffic Signal Controller
3

IWCU RSE

OBE Trigger distance = 100 m
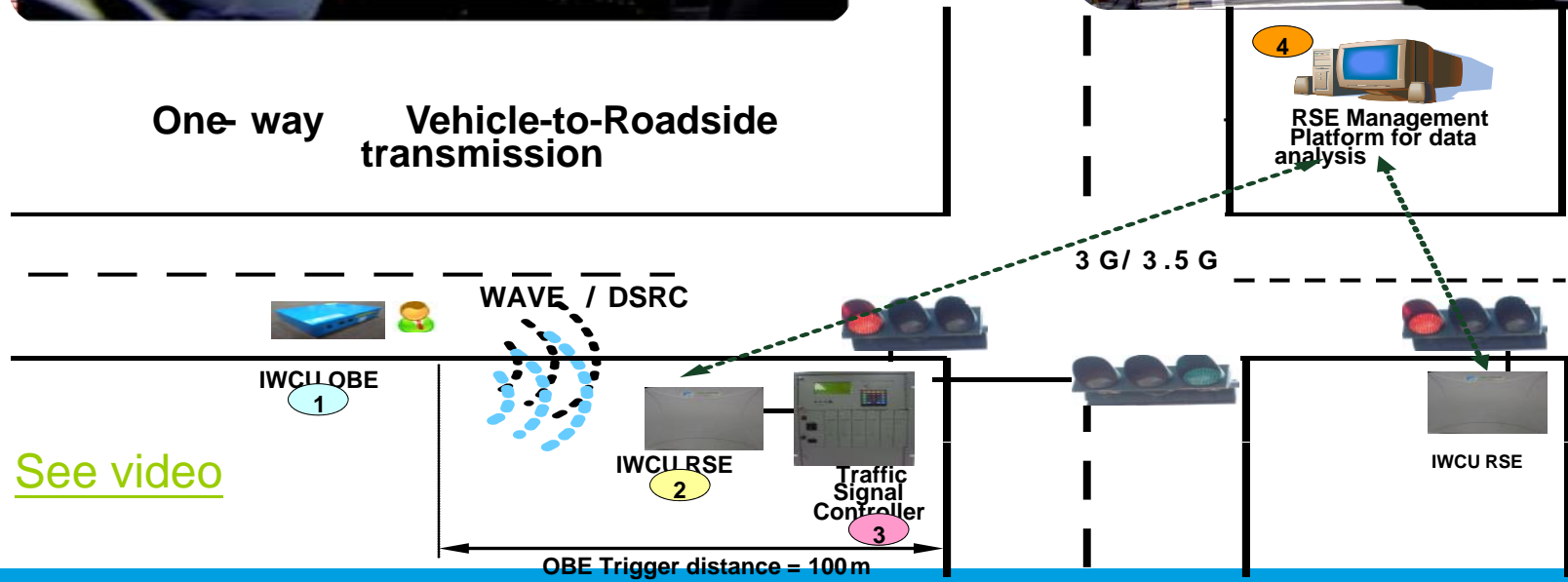
WAVE/DSRC-based Weigh-In-Motion System Solution

System Operation on Freeway No.3, Taiwan
- Collaborated with National Freeway Bureau (MOTC, Taiwan) and Taiwan large logistics companies including the HCT Logistics and CPC (the Tao-Yuan Division)
- The second WAVE/DSRC-based WIM system test site in the world

IWCU OBU + HMI Module

IWCU RSE

AVI

Truck WIM

Freeway No. 3 South-bound 45.6km

WIM Controller

WIM Sensor and Loop Detector

OBU

RSU
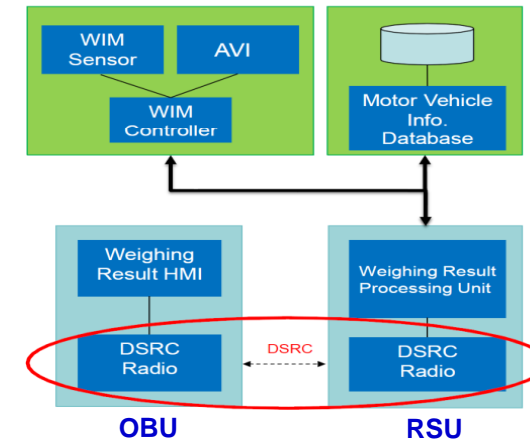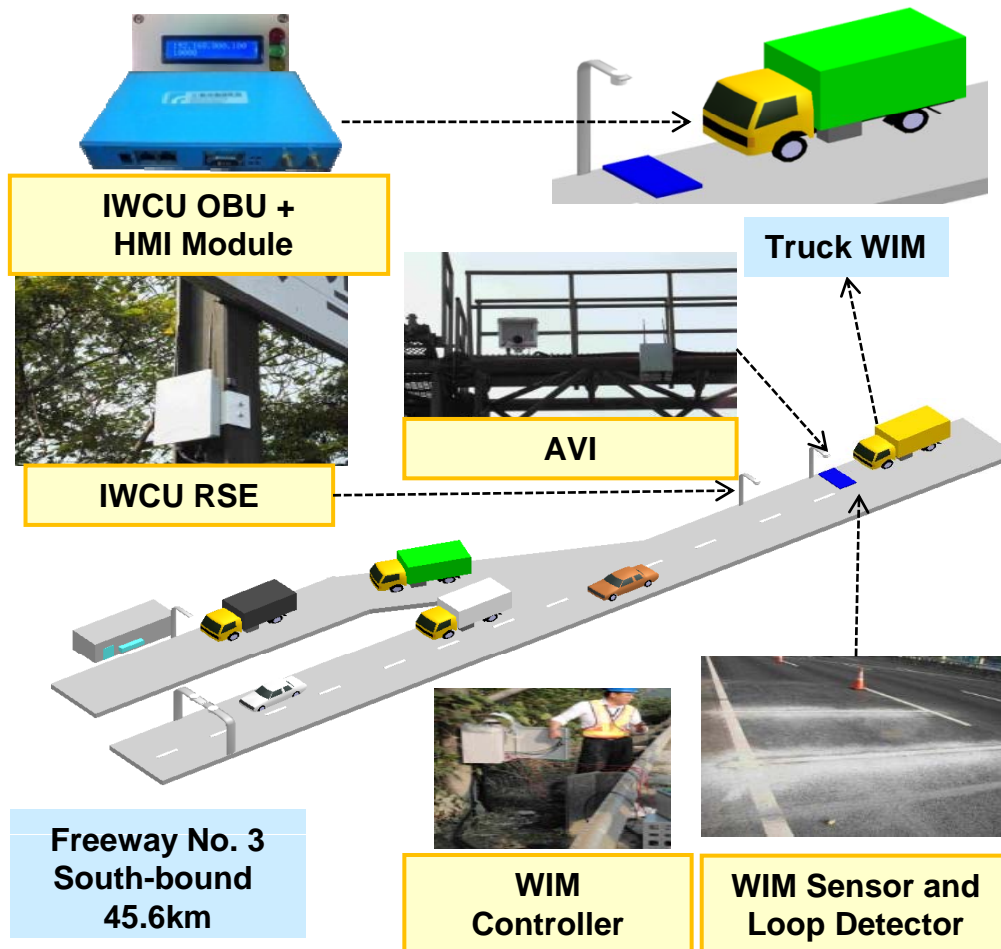
Features
- Bidirectional HMI without causing driver distraction
- Extensible for future V2I application/service and fleet management
- Simplify the inspection process for the police

See video

DSRC-based Signal Phase & Timing System Solution

Need & Goal
- A growing need for integration system of traffic signal indication control and driver notification
- To achieve a real intelligence traffic management system
- To provide a simple and clear view of traffic signal indication
- Real time transmission , no latency
- To comply with International standards

Traffic Information Center

SPAT and MAP messages

IWCU RSE

SPaT& MAP over DSRC

Traffic Signal Indication Controller

IWCU OBE
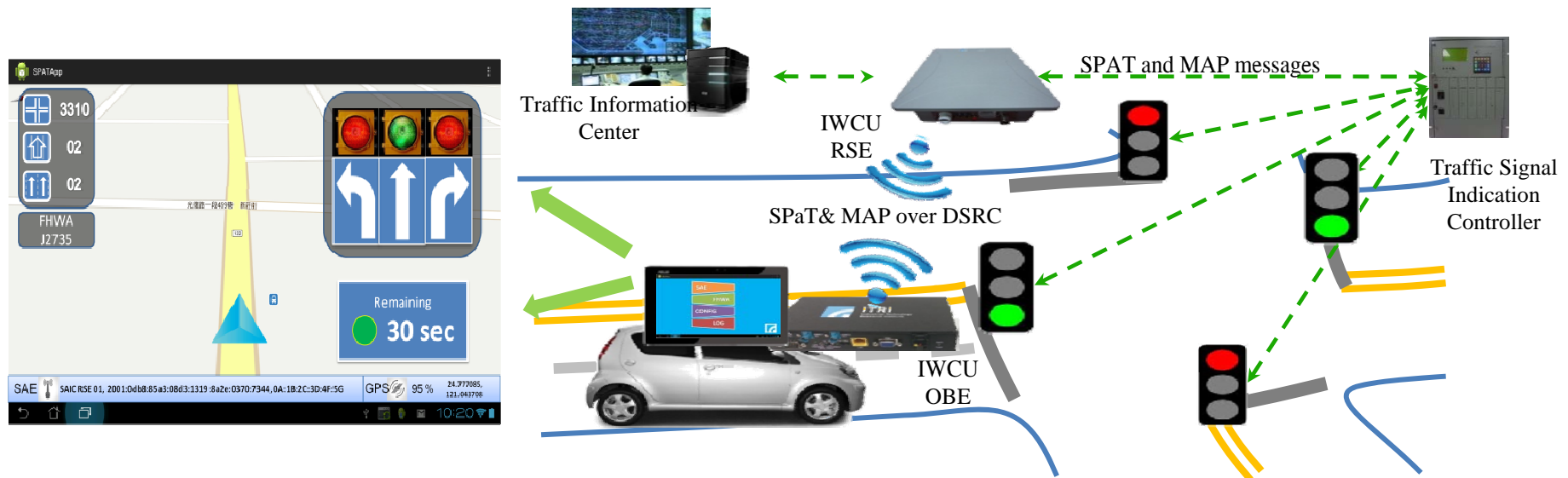
Features
- One-way Roadside-to-Vehicle transmission
- Fully comply with IEEE 1609
- Comply with SAE J2735
- Easy to traffic system integration
- Enable to log all incoming messages

Benefits
- Improve road safety and traffic management efficiency
- Reduce the driver's response time
- Easy to inter-operate with other traffic device

V2I Applications for Commercial Mobility

ITRI Telematics Solution for Commercial Fleet comprises Smart Vehicle Information Gateway (SVIG) and ITRI Telematics Service Platform (iTSP). SVIG is a safety and eco-driving telematics unit that performs the functions of tracking and automatic alarm. With GPS and multi-sensor technologies, SVIG is able to report vehicle dynamics to iTSP, while iTSP is capable of invoking a command to SVIG. In this solution, fleet service provider is allowed to online monitor driver behaviors, to real time locate vehicle position coordinates and to remotely diagnoses vehicles. Not only safety monitoring, but also infotainment services can be provided from this solution for transportation and rental fleets.
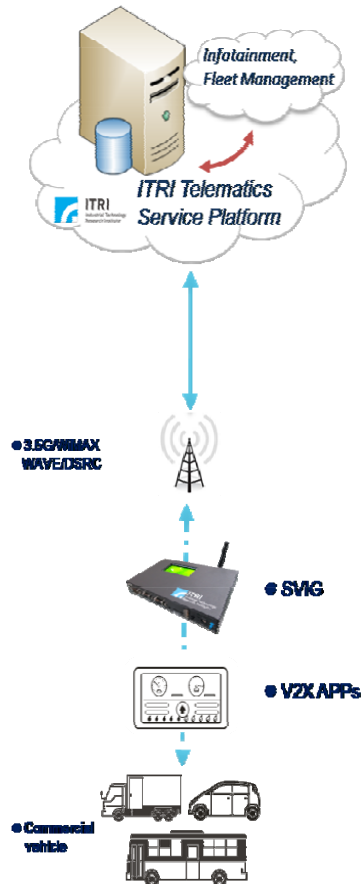
ITRI Telematics Solution for Commercial Fleet

V2X Applications

Smart Vehicle Information Gateway (SVIG)

ITRI Telematics Service Platform (iTSP)

Outline

- ITRI Overview
- **ITRI V2X Development and Vision**
  - ITRI V2X Technology
  - Achievements
  - Standard Activities in EU and US
  - Next Step in Europe
- Concluding Remarks

Activities in USA

> ## ITRI has been participated in the USDOT Connected Vehicle Research since 2010

- 2010/4: CAMP VSC3 V2V-Interoperability
- 2010/7: Here I Am (HIA) Devices
- 2011/1: Caltrans Augmented Speed Enforcement
- 2011/4: Road Side Equipment (RSE) Devices
- 2011/4: Enabling Accelerated Installation of Aftermarket On-Board Equipment for Connected Vehicles
- 2011/7: HIA for the Test Bed
- 2012/3: SAIC - Safety Pilot Stage 1 RSE Deployment
- 2013/5: SAIC – Listener Aftermarket Safety Device Phase 1
- 2013/11: SAIC - Safety Pilot Stage 2 RSE Deployment
- 2013/12: Leidos - Listener Aftermarket Safety Device Phase 2

> ## ITRI's Participation in the USDOT Safety Pilot Exhibition at 2011 ITS World Congress

IWCU Solution for U.S. DOT Connected Vehicle

ITRI's roadside equipment (RSE) Entered USDOT Research Qualified Product List in 2012

ITRI's Onboard equipment (OBE) is Selected by USDOT IntelliDrive Program in 2010

> **ITRI is experienced in European V2X projects**

- SCORE@F is the largest French field operational test for improving traffic flow and traffic safety in Europe
- 2010/09/01-2013/03/31, €5.6 Million
- Led by Renault wit 19 partners
- ITRI joined the project via INRIA by providing the IEEE 802.11p radio solution as well as the corresponding driver software to help boost the progress of the project
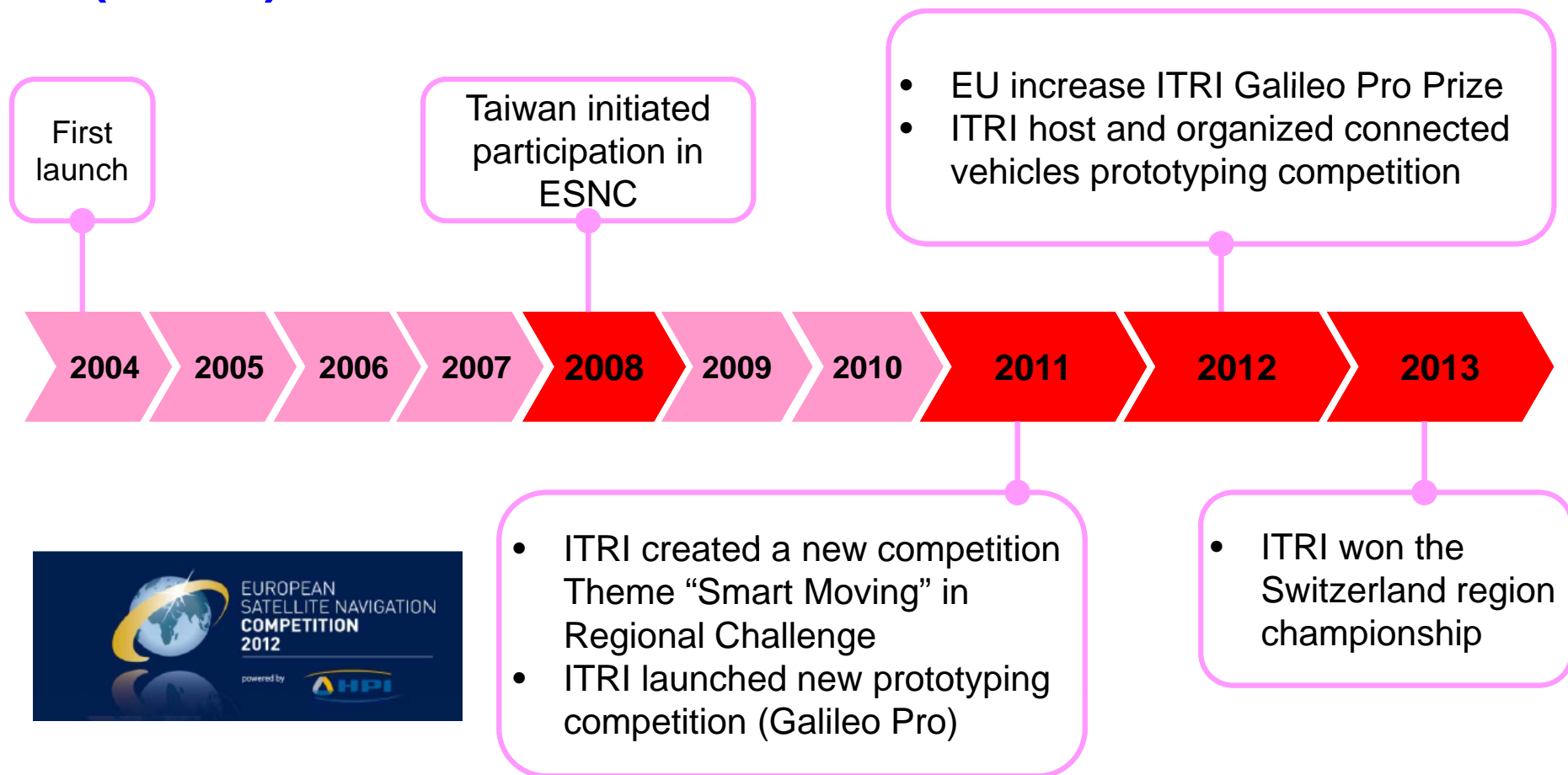
> **We are looking for further partnership and cooperation in Europe**
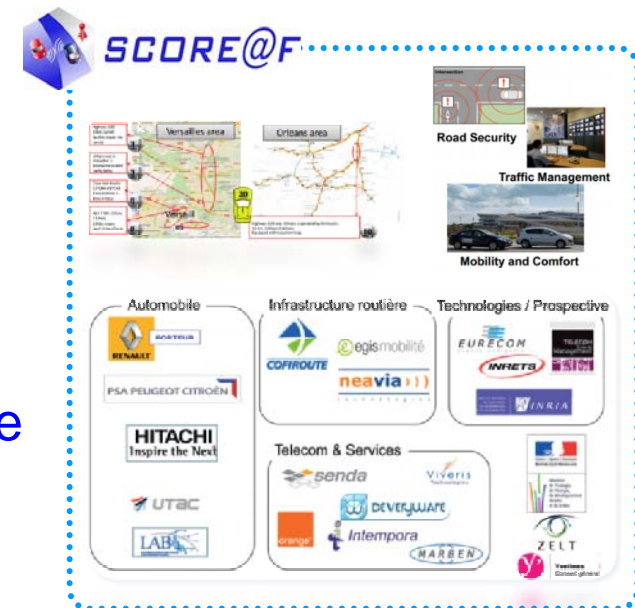
ITRI Technology Promotion with Europe

- **ITRI Hosted European Satellite Navigation Competition (ESNC) in Taiwan**

First launch

Taiwan initiated participation in ESNC

- EU increase ITRI Galileo Pro Prize
- ITRI host and organized connected vehicles prototyping competition

| 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |

EUROPEAN SATELLITE NAVIGATION COMPETITION 2012
powered by HPI

- ITRI created a new competition Theme "Smart Moving" in Regional Challenge
- ITRI launched new prototyping competition (Galileo Pro)

- ITRI won the Switzerland region championship

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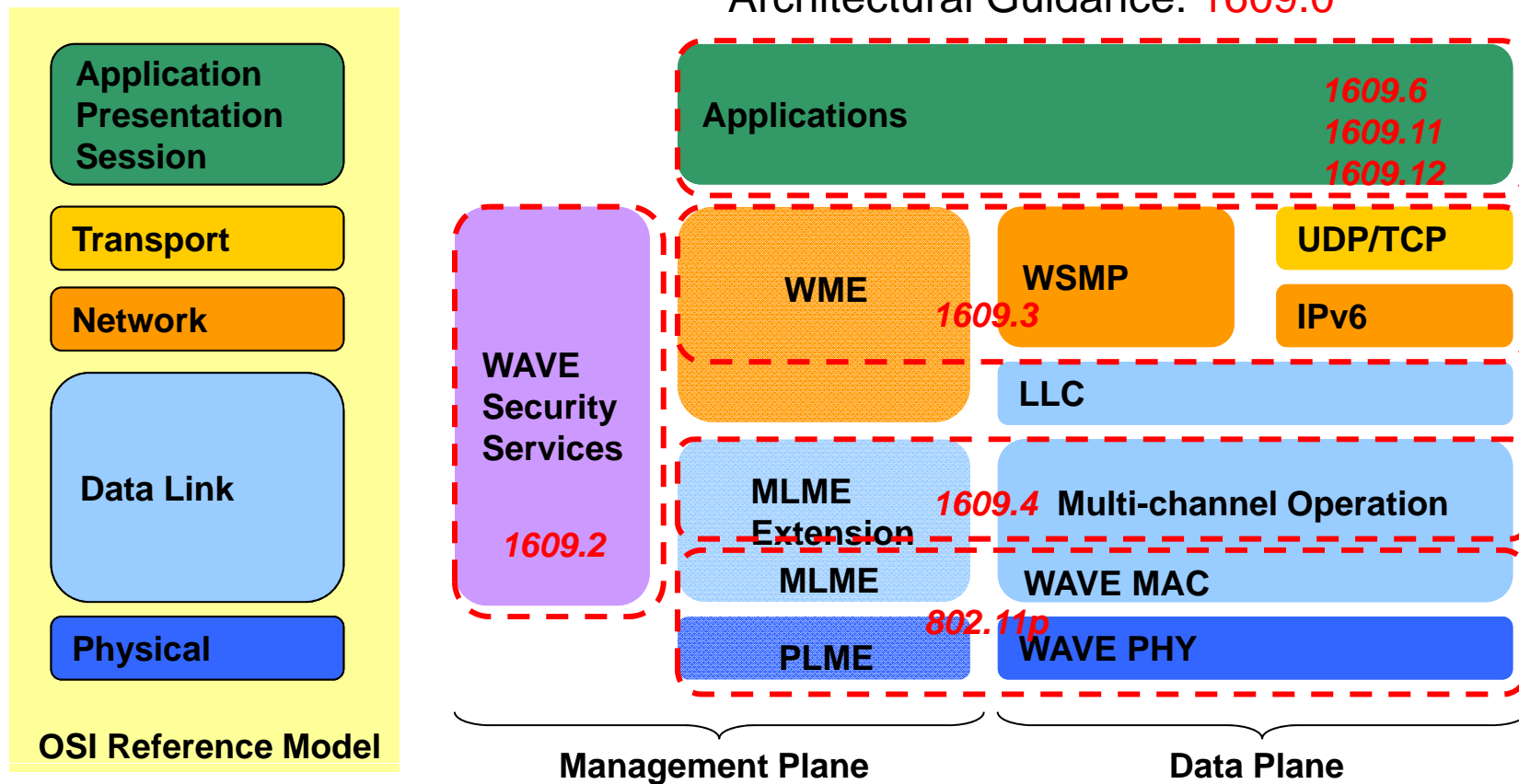 - Next Step in Europe
- Concluding Remarks

Participation in International Standard Activities

- **IEEE 802.11p/1609 standards activities (2008~)**
  - ➢ Comments accepted in P1609.1/.2/.3/.4/.6

- **IEEE 802.11ai/aq standards activities (2012~)**

- **ETSI TC-ITS standard activities (2010~)**
  - ➢ Comments accepted in WG1/ WG3/ WG5
  - ➢ WG1 WI Rapporteur: Facilities Layer Communication Congestion Control (Dr. An-Kai Jeng)
  - ➢ WG5 Vice-Chair: Dr. Huei-Ru Tseng

IEEE P1609 Standard Activities

- **WAVE/DSRC protocol stack**

Architectural Guidance: 1609.0

Applications — 1609.6, 1609.11, 1609.12

WME — 1609.3
WSMP
UDP/TCP
IPv6
LLC

WAVE Security Services — 1609.2

MLME Extension — 1609.4 Multi-channel Operation
MLME — WAVE MAC
PLME — 802.11p — WAVE PHY

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

Management Plane | Data Plane

IEEE P1609 Standard Status

Standard No.	Title	Status
IEEE 802.11p	WAVE Amendment	Published (2010/07)
IEEE 1609.0	Architecture	Published (2013/12)
IEEE 1609.1	Resource Manager	Scope Change to IEEE 1609.6
IEEE 1609.2	Security Services	Published (2013/04)
IEEE 1609.3	Networking Services	Published (2010/12), Cor 2-2014
IEEE 1609.4	Multi-Channel Operation	Published (2011/02), Cor 1-2014
IEEE 1609.5	Communication Manager	Deferred
IEEE 1609.6	Remote Management Services	On-going (plan for approval in 2015)
IEEE 1609.11	Over-the-Air Electronic Funds Collection	Published (2011/01)
IEEE 1609.12	Identifier Allocation	Published (2012/08)

# Participation in U.S. DOT WAVE/DSRC equipment tests since 2012
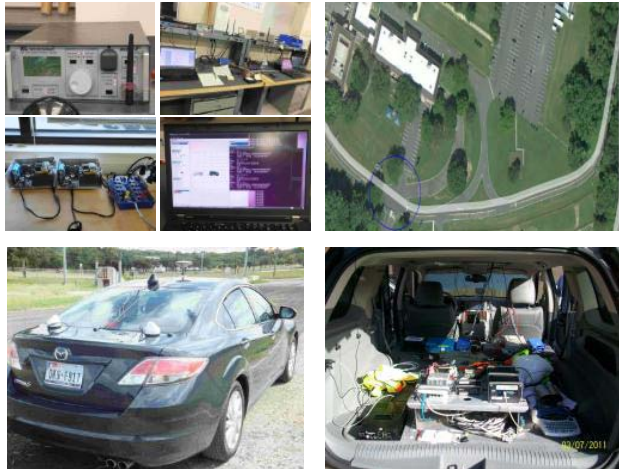
In-lab & outdoor tests for rQPL

- **Research Qualified Product List (rQPL) since 2012**
  - Allow to supply equipment for the connected vehicle Safety Pilot Model Deployment and other Test Bed Installations
    - 2012: ITRI's RSE passed all tests (194 tests)
    - 2013: ITRI's VAD/ASD passed 91.5% Tests (217 tests)

- **PlugFest June 2014, Palo Alto**
  - USDOT goals to transition connected vehicle technology research toward full deployment
  - Devices are tested for interoperability with emerging standards
 - ITRI passed SPaT/MAP, CSW, IPv6 Gateway, VSD (Vehicle Situation Data) Messages

ETSI TC-ITS Standard Activities

- **ETSI TC-ITS WG**

| ETSI TC-ITS	Chairman
TC-ITS	Niels Peter Skov Andersen (Anemone Technology, DK)
WG1: Application & Facilities Layer	Lan Lin (Hitachi Europe Ltd.,FR)
WG2: Management Layer	Knut Evensen (Q-Free ASA, NO)
WG3: Network & Transport Layer	Andreas Festag (NEC Europe Ltd, DE)
WG4: Access Layer	Christoph Woeste (BMWi, DE)
WG5: Security Layer	Brigitte Lonc (Renault SAS, FR)
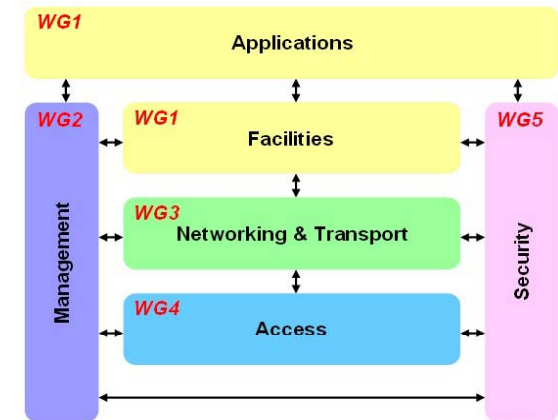
ETSI TC-ITS Standard Activities

- **TS 103 141 Facilities Layer Communication Congestion Control**
  - Draft updated by ITRI with functional blocks architecture
  - Compatible with existing DCC specifications of other layers
  - Ongoing work of coordinating with STF 469
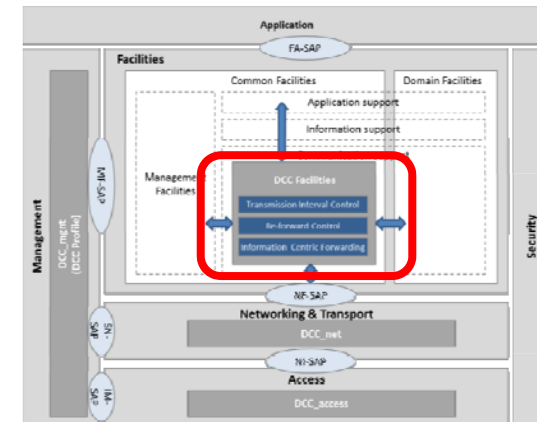
- **TR 102 893 Threat, Vulnerability and Risk Analysis (TVRA) Revision**
  - Contributed by ITRI to improve the revocation process, and clarify the procedure after detecting misbehaving ITS-S
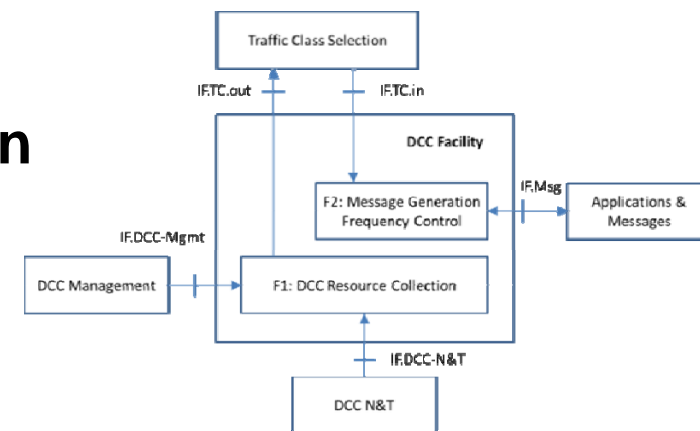
# Participation in European ITS-G5 equipment interoperability tests since 2011

- **ITRI passed all mandatory tests**

| Event Date & Location	Companies	Test Scopes
1st Plugtests Nov. 11-18, 2011 Helmond, Netherlands (Hosted by TNO)	ITRI, SIEMENS, HITACHI, DENSO, CohdaWireless, VTT, HONDA, NEC, PEEK, vector, Q-FREE, QUWIC, CTAG, nordsys	• **GN, CAM, DENM**
2nd Plugtests Jun. 11-15, 2012 Versailles, France (Hosted by IFSTTAR)	ITRI, SIEMENS, HITACHI, TNO, DENSO, CohdaWireless, MARBEN Products, kapsch, NEC, QUWIC, INRIA	• **GN, BTP, CAM, DENM,**
3rd Plugtests Nov. 25-29, 2013 Essen, Germany (Hosted by Cetecom)	ITRI, Unex, Autotalks, HITACHI, DENSO, CohdaWireless, qmic, NEC, kapsch, SIEMENS, MARBEN Products, vector, Fraunhofer ESK, commsignia	• **GN, BTP, CAM, DENM, GN Security**

- ITRI Overview
- **ITRI V2X Development and Vision**
  - ITRI V2X Technology
  - Achievements
  - Standard Activities in EU and US
  - Next Step in Europe
- Concluding Remarks

Participation in Horizon 2020

- Contribute ITRI V2X solutions to join European ITS development
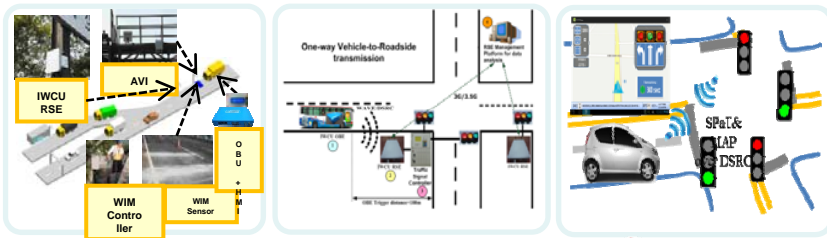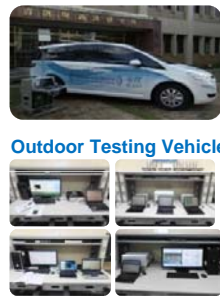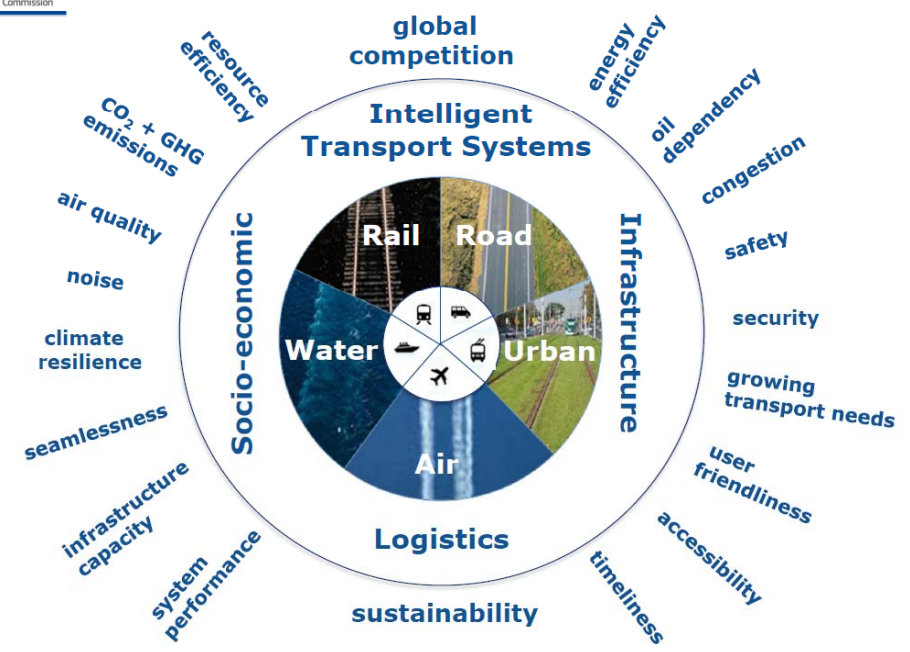

V2X Systems

V2X Testing

V2X Devices

The 7th ETSI TC ITS Workshop

- The workshop focuses on Cooperative ITS and Standards, how standards match the ITS deployment activities, testing and certification as well as future aspects for standardization
- ITRI expressed willingness to host the next (7th) ETSI ITS Workshop nearby ITRI Netherlands Office
    - ETSI members accepted our proposal to host the workshop in ETSI TC-ITS #14 Meeting on April 10, 2014

	Date	Location	Host
1st	4-6 Feb 2009	Sophia Antipolis, France	ETSI
2nd	10-12 Feb 2010	Sophia Antipolis, France	ETSI
3rd	9-11 Feb 2011	Venice, Italy	Telecom Italia
4th	7-9 Feb 2012	Doha, Qatar	QUWIC
5th	05-06 Feb 2013	Vienna, Austria	Austria Tech, ASFINAG, Kapsch TrafficCom
6th	12-13 Feb 2014	Berlin, Germany	ETSI
7th	25-27 Mar 2015	Helmond (Automotive Campus), the Netherlands	ITRI

Outline

- ITRI Overview
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- **Concluding Remarks**

Concluding Remarks

- ✓ ITRI provides complete V2X solutions for foreseeable needs of future connected vehicles market
- ✓ ITRI is looking for further partnership and cooperation in Europe
  - – Provide V2X technology to boost European ITS development and accelerate European ICT innovation
- ✓ ITRI is ambitious to realize the next generation ITS and ICT development in Europe, enhancing new technology, services and business opportunities
- ✓ Welcome to the 7th ETSI TC ITS Workshop at the Netherlands Automotive Campus!