THE UNIVERSITY OF MELBOURNE

COLLABORATIVE POSITIONING - CONCEPTS AND APPROACHES FOR MORE ROBUST POSITIONING

Allison Kealy, The University of Melbourne

Guenther Retscher, Austria
Charles Toth, Dorota Brzezinska, USA

THE UNIVERSITY OF MELBOURNE

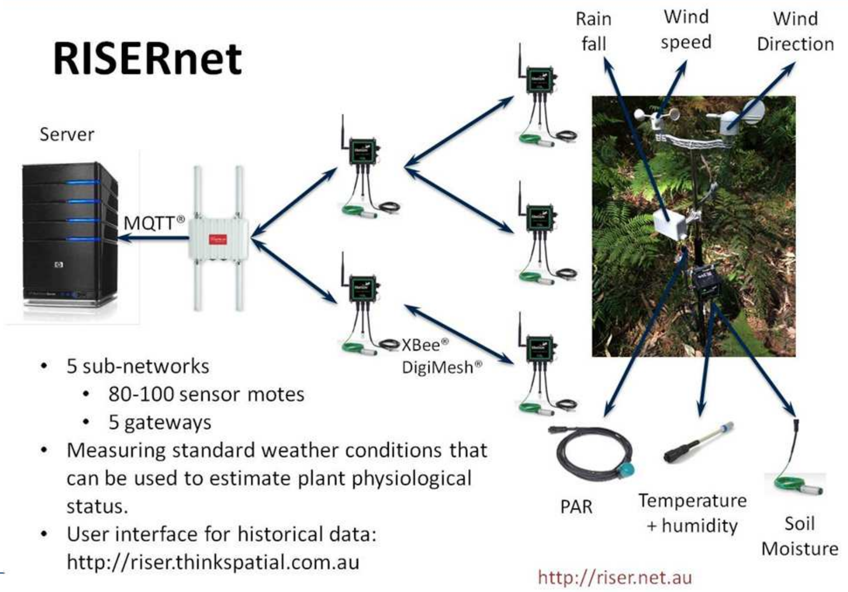
DEFINITION

Collaborative or cooperative positioning describes as approach in which objects or nodes within a network or neighbourhood are able to share information. By sharing relevant measurements and their stochastic properties the redundancy, reliability and availability of the state estimation can be improved.

THE UNIVERSITY OF MELBOURNE

EXAMPLE 1 – DISASTER MANAGEMENT

RISERnet

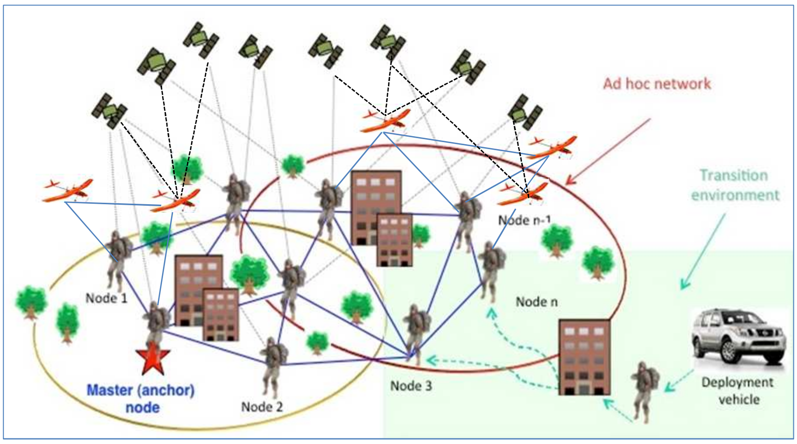


- 5 sub-networks
  - 80-100 sensor motes
  - 5 gateways
- Measuring standard weather conditions that can be used to estimate plant physiological status.
- User interface for historical data: http://riser.thinkspatial.com.au

http://riser.net.au

THE UNIVERSITY OF MELBOURNE

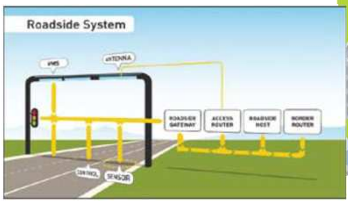
EXAMPLE 2 – PERSONAL NAVIGATION



THE UNIVERSITY OF MELBOURNE

EXAMPLE 3 – INTELLIGENT TRANSPORT SYSTEMS (ITS)

- **Land-based positioning system for vehicle network**
  - CVIS - Cooperative Vehicle Infrastructure Systems Project
  - V2V and V2I cooperation
  - How?
    - Vehicle System: multi-sensor data fusion
    - Central System: communication with Service Center
    - Roadside System



Source: http://www.cvisproject.org/

THE UNIVERSITY OF MELBOURNE

DEFINITIONS – FROM AVIATION

- Accuracy is defined as the degree of conformance of an estimated or measured position at a given time to a reference value;
- Integrity relates to the level of trust that can be placed in the information provided by the navigation system;
- Continuity of a navigation system is its capability to perform its function without interruption during the period of operation;
- Availability is defined as the percentage of time during which the service is available

THE UNIVERSITY OF MELBOURNE

ITS REQUIREMENTS

The land mobile sector however, has lagged significantly behind these performance based standards and there are currently no formal specifications for land based applications.

THE UNIVERSITY OF MELBOURNE

POSITIONING REQUIREMENTS

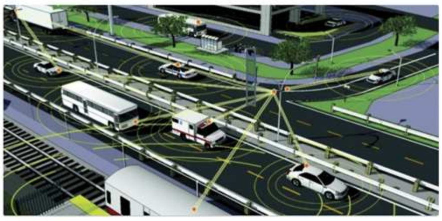
Type	Level	Accuracy Requirement		Research prototype	Commun-ication Latency (second)
		95 % confidence level (m)	Root means square (order)	Root means square (order)	
V2I: absolute (V2I = Vehicle to Infrastructure)	Road-level	5.0	Metre	Metre	1-5
	Lane-level	1.1	Sub metre	Sub metre	1.0
	Where-in-lane-level	0.7	Decimetre	Decimetre	0.1
V2V: relative (V2I = Vehicle to Vehicle)	Road-level	5.0	Meter	Sub metre	0.1
	Lane-level	1.5	Sub metre	Decimetre	0.1
	Where-in-lane-level	1.0	Decimetre	Centimetre	0.01-0.1

THE UNIVERSITY OF MELBOURNE

GNSS PERFORMANCE

The European Navigation Conference
April 23–25 Vienna, Austria

Network RTK for Intelligent Vehicles



by GPS World staff on January 30, 2013 with 0 Comments in Road

Accurate, Reliable, Available, Continuous Positioning for Cooperative Driving

Tier	Technique Option	Status		Accuracy range	Cost	C-ITS applications
		Current	Future			
1	A	Standalone GPS (SPS)	Standalone multiple GNSS	10-20 m	Low	Vehicle navigation, personal route guidance and location based services
2	A	Standalone GNSS (PPS), Code DGPS	Standalone multiple GNSS positioning	1-10 m	Low	Vehicle navigation, location-based services, road traffic management
3	B	Current WAAS Commercial WADGPS	Future SBAS design for multiple-GNSS	0.1-1m (utilising SBAS and V2V relative positioning)	Low	C-ITS safety applications: lane-level positioning, lane-level traffic management and where-in-lane-level applications
	C	Smoothed DGPS	Smoothed DGNSS	0.1-1 m	Medium	
4	D	RTK	Combined PPP and RTK (seamless)	0.01-0.1m	Medium to High	Research prototype C-ITS safety systems, offering bench mark solutions for testing low-cost units.
	E	PPP				
5	Advanced D and E	Static positioning	Sub-centimetre RTK with multi-GNSS signals	0.001-0.01m	High	*Geosciences and geodynamic studies. Not recommended for C-ITS applications*

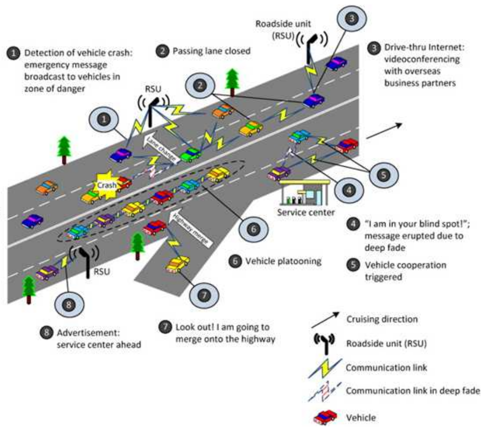
THE UNIVERSITY OF MELBOURNE

SO WHAT CAN WE DO?

- Hybrid solutions
  - Example GNSS/INS
  - Urban canyon can have lengthy periods of outages.
  - Mobile platform dynamics
  - Computational overheads for estimation algorithm
  - Cost vs performance
- Cooperative positioning
  - Allows vehicles within a vehicular ad hoc network (VANET) to share positioning related information with other vehicles or infrastructures in trying to improve their positioning solutions.

THE UNIVERSITY OF MELBOURNE

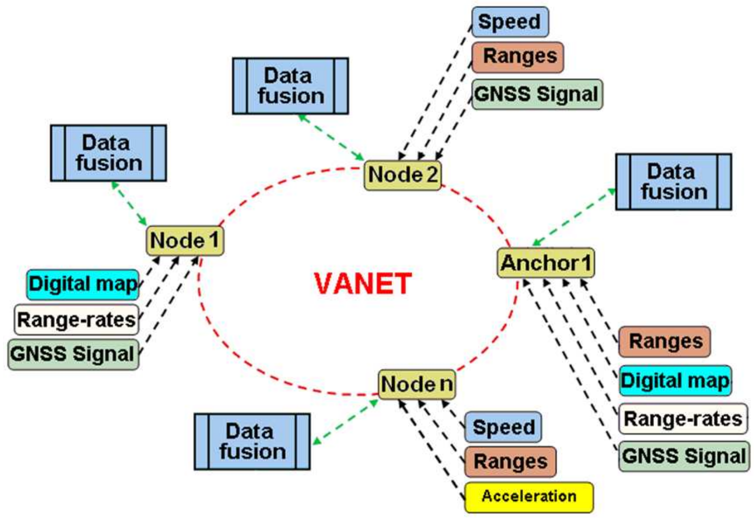
DEDICATED SHORT RANGE COMMUNIATIONS



DSRC is a wireless communication channel designed specifically to support vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communications. In the U.S., the Federal Communication Commission (FCC) has allocated DSRC with a dedicated bandwidth of 75 MHz in the 5.850-5.925 GHz band, whereas the European Telecommunications Standards Institute (ETSI) has allocated a dedicated bandwidth of 30 MHz in the 5.9 GHz band.

THE UNIVERSITY OF MELBOURNE

CP POSITIONING ARCHITECTURE



THE UNIVERSITY OF MELBOURNE

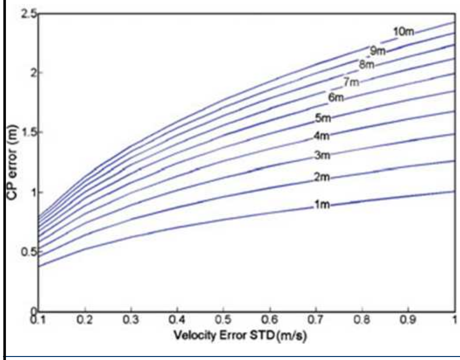
CP LOCALISATION ALGORITHM

- Range measurement between nodes
- Error handling for very low cost and non traditional sensors and signals
- Computational overheads on mobile platforms
- Dynamic characteristics of the problem
- Increasingly stringent requirements for parameters that describe the quality of the positioning solution.

THE UNIVERSITY OF MELBOURNE

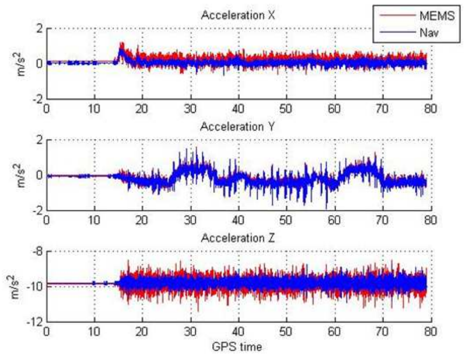
RANGE ESTIMATION FROM DSRC

Parameter	Transmit Power: 10dBm	Transmit Power: 20dBm
STD of RSS observation noise	1.4dBm	1.4dBm
STD of CFO observation noise	135Hz	115Hz



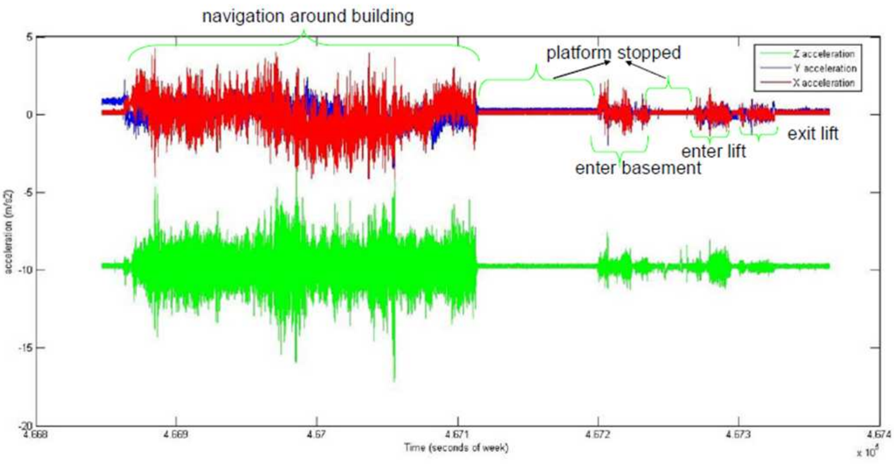
THE UNIVERSITY OF MELBOURNE

LOW COST SENSORS



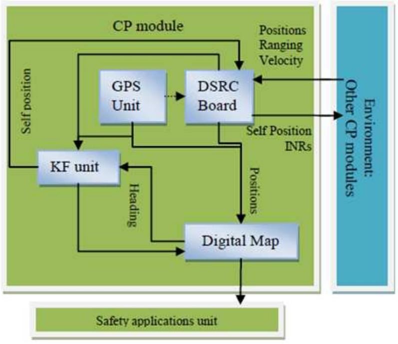
THE UNIVERSITY OF MELBOURNE

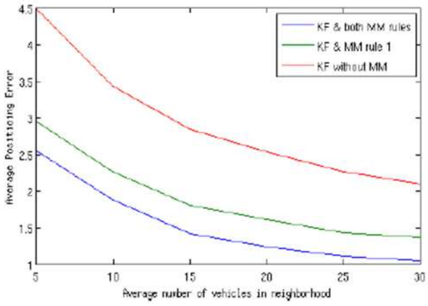
LOW COST SENSORS



THE UNIVERSITY OF MELBOURNE

POSITIONING ALGORITHM





THE UNIVERSITY OF MELBOURNE

CONCLUSIONS

- CP offers a potential solution for dynamic positioning in applications where the communications infrastructure enables sharing of information.
- Challenges of using low cost sensors.
- Meeting the positioning integrity and reliability requirements of many applications require new approaches to using measurements and other sensed data.

THE UNIVERSITY OF
MELBOURNE