

GREEN-VANETS: Improving transportation using Car-2-X communication and multi agent systems

Adrian Groza, Bogdan Iancu, Anca Marginean, Vlad
Muresan

Department of Computer Science
Technical University of Cluj-Napoca, Romania
Adrian.Groza@cs.utcluj.ro



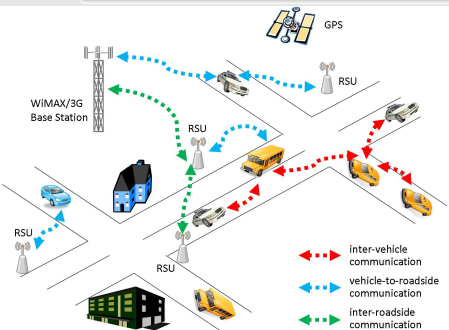
Project manager

- Assoc Prof., Computer Science Department, in Artificial Intelligence, since 2014
- PostDoc: "Structured Argumentation oriented e-business", POSDRU-EXCEL, TUCN 2010-2013
- Phd. in Computer Science - *Magna Cum Laude*: "Structural Models for Inter-agents Online Dispute Resolution", Supervisor: Prof. dr. eng. Ioan Alfred Letia, TUCN 2008
- Master: "New generation of computers", TUCN 2004
- Bachelor in Computer Science, TUCN, 2003

Summary

Research theme

Increasing driving safety by developing software systems able to minimize hazards during risky traffic maneuvers.

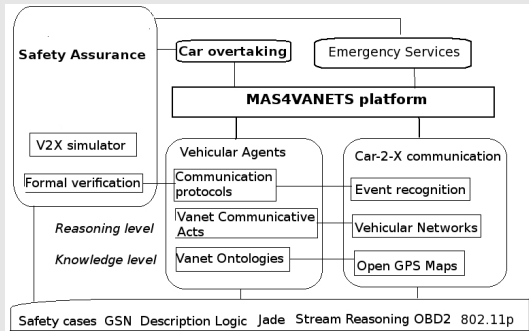


Technologies

- vehicular networks, multi-agent systems and engineering critical systems
- car-2-X, stream reasoning, and software compliance.

Objectives

- 1 Developing the VANETs ontology
- 2 Developing the MAS4VANETS framework
- 3 Applying MAS4VANETS in 2 safety scenarios
- 4 Safety assurance of the developed methods
- 5 Obtaining preliminary results for applying to larger project



Activities & Milestones

O₁. VANET-ONTO: Engineering the ontology for advanced driver assistance.

T_{1.1} Defining the CQs and scope for the safety driver assistance ontology. M₁

T_{1.2} Identifying related ontologies in the automotive domain for possible reuse. M₂

T_{1.3} Engineering the ontology and populating from OSM and automotive domain. M₃

O₂: MAS4VANETS: Developing a generic multi-agent system for vanets.

T_{2.1} Adapting/Extending the ACL communicative acts for vanets scenarios. M₂

T_{2.2} Integrating JADE multi-agent system with Matlab. M₄

T_{2.3} Defining the communication protocols for usage scenarios M₅

T_{2.4} Formal verification of the protocols. M₆

O₃. APP: Applying MAS4VANETS on various traffic manoeuvres.

T_{3.1} Simulating vehicle overtaking on real maps M₁₀

T_{3.2} Simulating the Ambulance-2-X communication on real maps M₁₀

O₄. SAFEASSURANCE: Developing the software assurance cases.

T_{4.1} Collected evidence from V2X simulations and formal verification M₁₁

T_{4.2} Automated verification of the safety cases consistency in description logic M₁₂

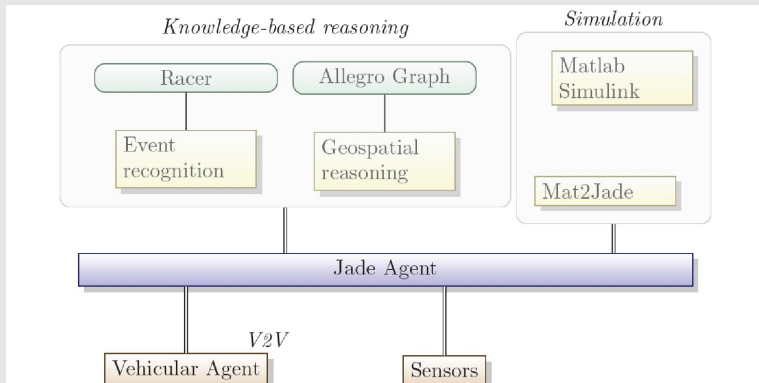
O₅. DISS: Obtaining preliminary results for applying to larger projects.

T_{5.1} Dissemination at: conf. (AAMAS, ICCP, Wasa, Meditech), ISI journal (AECE)

T_{5.2} Proposals at PN-II-TE and CHIST-ERA

Challenges

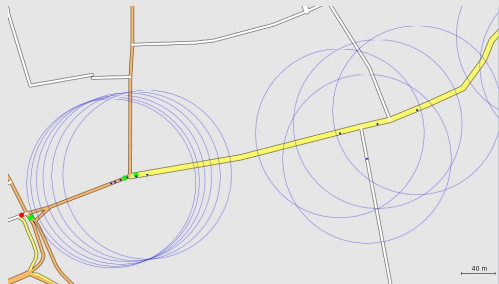
Integrating symbolic reasoning with numerical computations



Ambulance-to-X communication scenario

A. Groza, A. Marginean and B. Iancu, Towards improving situation awareness during emergency transportation through Ambulance-2-X communication and semantic stream reasoning, MEDITECH 2014, 5-7 June, Cluj-Napoca, Romania, IFMBE Proceedings Series, Springer ([ISI Proceedings](#)).

- Our system makes use of: VANET simulator, AllegroGraph for geospatial reasoning, RacerPro for semantic and temporal reasoning.
- Increasing situation awareness for specific warning messages: *Stop*, *DriveRight*, *Form corridor*



Car overtaking scenario

A. Groza, B. Iancu, A. Marginean - A multi-agent approach towards overtaking in vehicular networks, WASA@WIMS14, Thessaloniki, Greece, June 2-4, 2014, ACM (DBLP, ACM).

- reasoning in description logic on top of data collected continuously from vehicular communication.
- event assertions, extending OSM (e.g. lanes, vehicle size)
- defining various agent types: type of overtaking, politeness, norm compliance or cooperativeness
- defining warning messages (e.g. lane changing)
- rules for event recognition

```
(define-event-rule ((overtake ?o1 ?o2) ?t1 ?t2)
```

```
((?o1 ambulance) ?t0 ?tn)
```

```
((?o1 ?o2 on-same-street) ?t0 ?tn)
```

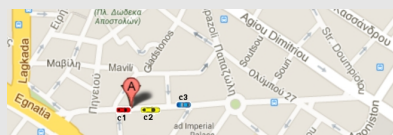
```
((move ?o1) ?t0 ?t2)
```

```
((move ?o2) ?t1 ?t2)
```

```
((approach ?o1 ?o2) ?t1 ?t3)
```

```
((behind ?o1 ?o2) ?t1 ?t3)
```

```
((beside ?o1 ?o2) ?t3 ?t4)
```

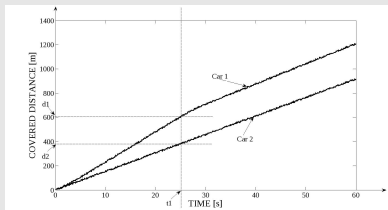
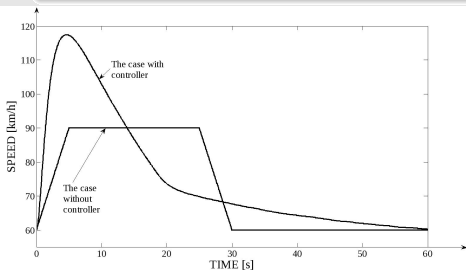


Car-overtaking on Open Street Maps in Thessaloniki.

Car overtaking scenario

BEST PAPER AWARD at ICMERA (ISI Proceedings)

V. Muresan, A. Groza, B. Iancu and I. Clitan. Simulation and Control of the Vehicles Movement in the Case of the Overtaking Procedures, ICMERA2014, Bucuresti, 24-27 Oct. 2014.



Vanet ontology

Comprehensive ontology for vanets

A. Groza, A. Marginean, V. Muresan - An ontology-based model for vehicular ad-hoc networks, 18th IEEE International Conference on Intelligent Engineering Systems (INES2014), 3-5 July, Tihany, Hungary [IEEEExplore](#)

No	Competency question
CQ ₁	Which are the vehicles on the same lane within a specific area?
CQ ₂	Which data is available about the closest vehicle in front/behind?
CQ ₃	Which is the closest vehicle approaching from opposite direction?
CQ ₄	Which is the average speed for the next 5km?
CQ ₅	Is it safe to change lane?
CQ ₆	Is it safe to overtake the vehicle in front?
CQ ₇	Are there any emergency vehicles in the nearby?

Ontology Building Competition - Vanets track

Metrics for ontology evaluation

I. Jimborean, A. Groza - Ranking Ontologies in the Ontology Building Competition BOC 2014, IEEE 10th Int. Conf. on Intel. Computer Comm. and Processing (ICCP14), Cluj-Napoca, 4-6 Sep. 2014, pp. 75-82 [IEEEExplore](#)

Analytical hierarchical-based algorithm for ranking ontologies

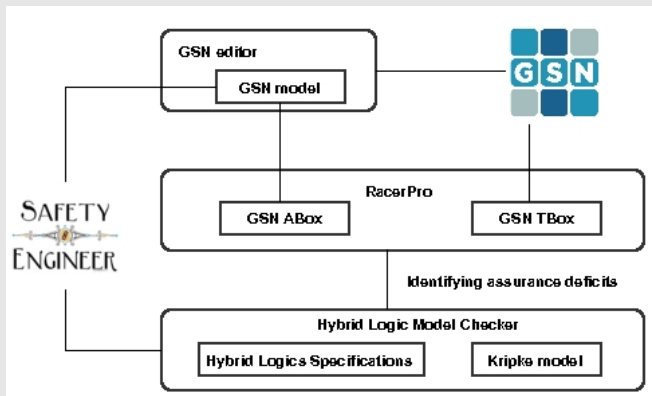
- tool available at <http://cs-gw.utcluj.ro/~adrian/tools/ahp>
- A. Groza, I. Dragoste, I. Sincai, I. Jimborean - An ontology selection and ranking system based on analytical hierarchy process, 16th Int. Symp. on Symbolic and Numeric Algorithms for Scientific Computing (SYNASC), Timisoara, 22-25 Sep. 2014 ([DBLP](#))

Competition dissemination

A. Groza, B. Varga, M. Vacca - A learning environment for building and evaluating ontologies, ELSE2014, Bucuresti, 24-25 April 2014 [ISI Proc.](#)

Assurance cases of autonomous vehicles

Goal Structuring Notation standard + reasoning in description logic and hybrid logic



O₄ Assurance Cases

Assurance cases: GSN-2-DL translator

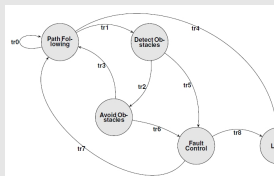
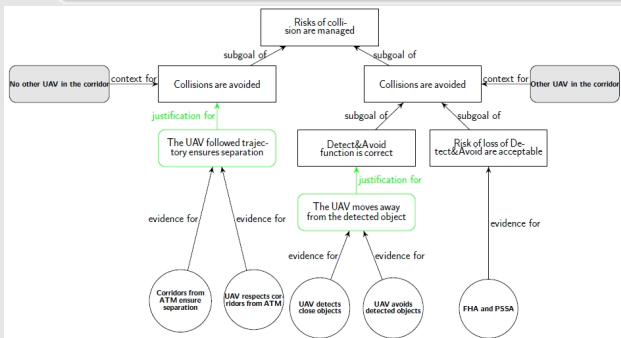
SafeEd tool

- GSN graphical notation to DL to check the GSN model for consistency (available as an Eclipse plugin at <http://cs-gw.utcluj.ro/~adrian/tools/safed/gsn>)
- A. Groza, N. Marc - Consistency Checking of Safety Arguments in the Goal Structuring Notation Standard, IEEE 10th ICCP2014, Cluj-Napoca, Romania, 4-6 Sep. 2014, pp 59-66 ([IEEEExplore](#))

Assurance cases: collecting evidence

Model checking on autonomous vehicles

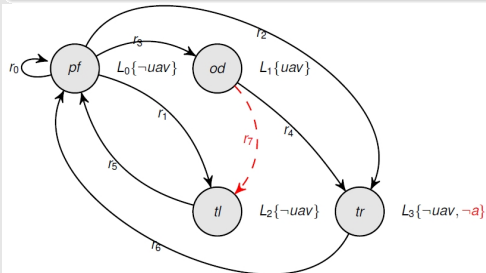
A. Groza, I. A. Letia, A. Goron and S. Zaporozhan - A formal approach for identifying assurance deficits in unmanned aerial vehicle software, 23rd Int. Conf. on Systems Eng., Las Vegas, USA, Ed. H. Selvaraj et al Adv. in Intell. Systems & Computing Series, Vol 1089, Springer (**ISI proceedings**)



Assurance cases: model repair

Model checking on autonomous vehicles

A. Goron, A. Groza, S. A. Gomez, I. A. Letia - Towards an argumentative approach for repair of hybrid logics models, ARGMAS@AAMAS, Paris, France, 5-9 May 2014 (to appear in Springer)



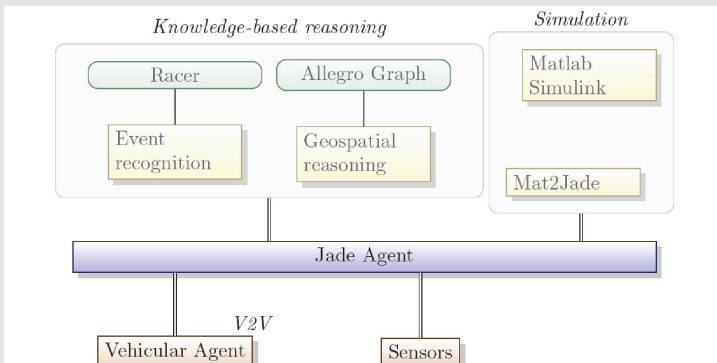
R_3 : Collision Avoidance – “When two UAVs are approaching each other and there is a danger of collision, each shall change its course by turning to the right.”

R_4 : Navigation in Aerodrome Airspace – “An UAV passing through an aerodrome airspace must make all turns to the left”

MAS4VANETS

Integrating symbolic reasoning with numerical computations

A. Groza, V. Muresan, A. Marginean, B. Iancu, MAS4VANETS: A Multi-Agent Systems Tool for Vehicular Networks, Advances in Electrical and Computer Engineering (I.F. 0.642), submitted.

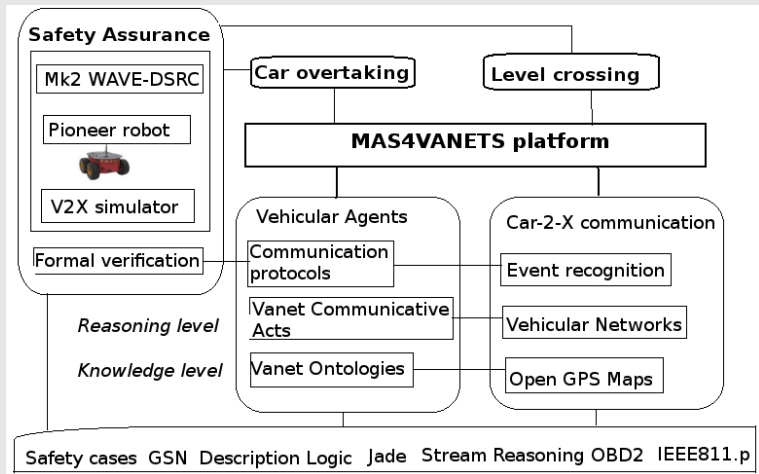


O₅ Results for applying to related projects

Results

O ₁	Developing the VANETs ontology	2 papers IEEEXplore, 2 papers ISI proceedings
O ₂	Developing the MAS4VANETS framework	1 ISI journal (submitted)
O ₃	Applying MAS4VANETS in 2 safety scenarios	1 paper ACM, 2 papers ISI proceedings (one BEST PAPER)
O ₄	Safety assurance of the developed methods	1 paper IEEEXplore, 2 ISI proceedings
O ₅		10 papers, 1 submitted article

Next steps: investigation domain



Next steps: horizon 2015

	Current research	Submitted proposals
1	VANETS, Intern UTCN, 2013-2014	PNII-TE: SAFEXCAR: Improving safety at levelcrossing and during car overtaking using Car-to-X communication and multi-agent systems
2	ARGSAFE, PNII-Bilateral, 2013-2015	ERAnet/LAC-ESE-0237
3	ARGDEC, PNII-Bilateral, 2013-2014	ERAnet/RUSPLUS-216
4	LELA, PNII-IC, 2013-2014	CHIST-ERA

Thank you!