INTELLIGENT TRANSPORTATION SYSTEMS

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IEEE ITS SOCIETY NEWSLETTER

Vol. 9, No. 4 December 2007 *Editor: Dr. Charles J. Herget,* c.herget@ieee.org

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http://www.ieee.org/its

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Information for Contributors

Announcements, feature articles, book and meetings reviews, opinions, letters to the editor, professional activities, abstracts of reports, and other material of interest to the ITS community are solicited

Please submit electronic material for consideration in any of the following formats: OpenOffice (preferred), plain ASCII, rich text format (rtf), portable document format (pdf), or Microsoft Word to the Editor-in-Chief at c.herget@ieee.org

SOCIETY NEWS

From the Editor

by Charles Herget

Dear Readers:

As we announced in the September issue of this Newsletter, we will begin a new schedule in 2008 with the Newsletter appearing in January, April, July, and October. The January 2008 issue will follow very closely behind this one, and it will be very brief, containing mostly updated announcements. One of the reasons for changing the schedule was to synchronize with the Magazine which was to start in 2008. The start of the Magazine in 2008 is uncertain at this time. One option being considered is to delay the startup until 2009. We will provide an update on the latest information in the April issue of this Newsletter.

Message from the President

by Fei-Yue Wang

[Editor's note: The following message was presented to the IEEE ITS Society's Board of Governor's Meeting on October 4, 2007, at the Bill & Melinda Gates Commons, Paul Allan Center for Computer Science and Engineering, University of Washington, Seattle, WA, USA.]

This is my last report to you as the President. At the beginning of my Presidency, I should be visionary, and now as I am going to step down, I should be reflective and looking into the future.

I will do all three today.

Visionary?

Time flies fast. So my vision for the future of ITS is that traffic would flow like time flies, so fast, so smooth, so seamless, it is part of the environment, no pollution, and you are always on time, no matter what! There will be no need for intelligent transportation systems by then, it will be everywhere and every time. We have done our job.

Time really flies. The last time I was in this city was 12 years ago. My whole family spent a week long vocation in Seattle and Vancouver. I rented a car and didn’t feel much traffic here at all. Bellevue had very few houses at that time. But when I come here this time, the traffic from the airport to our conference was terrible. It was just 2 o' clock in the afternoon, the highway was jammed, and we were either moving very slowly or not moving at all. It took me more than hour to get to our conference, and I was told normally it should be less than 20 minutes. It was even worse than in Beijing. Apparently, Microsoft’s money works here: it has caused traffic jams in both physical spaces and cyber spaces.

The good thing about this is we need intelligent transportation systems more than ever, so the need for our Society, more than ever, I hope.

Reflective

First of all, I would like to thank many of you here today, especially Charles Herget, for your help in the transformation of our Society from the previous Council. For this, I have spent more than two years in preparation, talked to more than 30 IEEE S/C Presidents, drafted our Constitutions and Bylaws, and made two presentations to the IEEE TAB.

Here we are today as an IEEE Society. I am really happy about its formation and transformation, proud of my effort for its birth and its development, proud to be its first president elected.

To me, our Society was created for three things, to promote ITS research and application, to service our members, and in the end, to benefit our society.

How to achieve our goals as an IEEE Society? At IEEE, our strengths are conferences, publications, technical activities, recognition and promotion of our profession and our members' interest.

Conferences

We have gone from two major conferences to six now. I understand that sometimes some of you may have a different idea about those conferences, and sometime the income from some of those conferences did not justify the time our VP for conferences spent on the paperwork required by IEEE and our Society. However, I would like to thank Umit Ozguner, our Vice President for Conferences, for a great job well done.

The bottom line is that all of six conferences made money for us during my term.

Our two major conferences, The IEEE International Intelligent Transportation Systems Conference (ITSC) and The IEEE International Symposium on Intelligent Vehicles (IV)
are in good shape. Actually IEEE IV is in great shape and made a record this year, thanks to Umit for his leadership and his Turkish team.

Our four new conferences, IEEE International Conference on Intelligence and Security Informatics (ISI), IEEE/INFORMS International Conference on Services, Operations, and Logistics Informatics (SOLI), IEEE International Conference on Vehicular Electronics and Safety (VES), and IEEE/ASME International Conference on Mechatronic/Embedded Systems and Applications (MESA) are small but on track. We can still discuss the future of MESA in our Society, but I like the fact that SOLI extents us to INFORMS, and MESA connects us to ASME. I believe this kind of cooperation is extremely important to the future development of our Society and for ITS activities in general.

I want to thanks to Profs. H.S. Chen and Daniel Zeng for ISI; Prof. Robin Qiu for SOLI; Profs. N.N. Zhang and G. Wan, now the Minister of Science and Technology of China, for VES; and Profs. Albert Luo and Harry Cheng for MESA. They helped me and sometimes "forced" me to establish those conferences.

Yes, I had put my hand in all those conferences, front or back, but I am not going to apologize for that. Instead, I am proud of what I have done. My philosophy is very simple, I will support you if you deliver to the IEEE ITSS, I don't care whom you are.

You may think this is the work of "Chinese Gang," again no apology from me. But tomorrow you could have a European President or a Japanese President, they can try their own effort, and this is a good way to make us really international, so I feel nothing wrong with this.

I hope those conferences will become strong and big in the future. I also hope they will help to strengthen our annual conference, as will be discussed later.

Publications

We have our IEEE ITS Magazine now. I took the leadership in its creation, and I had supported its first two trial volumes, and will finish its first two issues next year. I want to thank Jason, our Vice President for Publications Activities, for his time and effort in getting the final approval from IEEE TAB for this Magazine.

I will step down as the EiC after next June. Bill will make a proposal on the new EiC of the Magazine later. I hope the Magazine will support itself in two years through the revenue of advertisements. I believe this Magazine is very important for the future development of our Society.

As for our IEEE ITS Book Series, I still hope we can get the final approval by the IEEE Press. I will find out what is happening with the IEEE Press next month at the IEEE TAB in Boston.

Last, but not least, in publications, our Transactions on ITS is in a great shape, thanks to Alberto Broggi, our EiC of the Transactions. Our Transactions on ITS has been ranked among the Top Five Journals in Transportation Research in terms of impact factors for the last three years and was in second place last year. Transportation is a field with a long history and many publications, our Transactions is only in its 7 years of history, and we are not really transportation in the traditional sense. What a great turn over from three years ago. Again, thanks to Alberto for your great effort and performance.

I want to thank Jason, our Vice President for Publication Activities, for your time and effort in establishing ITS standards within the IEEE. We are still at the very beginning; we have a long way to go. I truly believe when the IEEE has standards for transportation, it will be more open and advanced, and the cost of related equipment and systems will go down dramatically.

As for conferences and publications, I am buying into former IEEE President Michael Lighter's observations. I have mentioned his observations many times to our Board, and here I would like to repeat them again: "At IEEE, the largest professional organization in the world, we are good at conferences - best if we leave them mostly alone. We are not good at starting new ones because we argue among ourselves – and we don't matter. We are good at research publications - best if we let them operate without much interference. We are not good at starting new ones because we argue among ourselves – and we don't matter."

In our Society, I should add: For our members, remember we are not their boss. We are volunteers; we are here to serve our members.

Technical Activities

We still have not finished the task initiated by Stefano Stramigioli, our former Vice President for Technical Activities and now the EiC of IEEE Robotics and Automation Magazine, on reconstructing our technical activities, but thanks to Daniel, we have made good progress along that direction. Our ISI, SOLI, VES, MESA are all running by their TC respectively, we should enforce this model of operation, and make sure a TC does serve our Society and its members, not just exists in name without activities.

We should continue to improve our TC structure, find out what TC we need, and work hard to find right members who are willing to spend time and effort to organize, build, and lead them.

I would like to see our ITS Expertise Portal work along with our website. We still have not established the Board of Associate Editors for Conferences as we had discussed. This has taken longer that I expected. But we should continue the effort, and I will come back on this issue late.

Awards and Recognitions

Awards and recognitions are important to our members' career development, seniors or juniors.

Thanks to Christoph Stiller, our Vice President for Membership Activities, and Chip White, Chair of our Award Committee, we finally have nominations for all four awards this year.

Christoph had established the nomination procedure for the Best Dissertation Award. But there are only three qualified nominations, two from US and one from Europe, but the good thing I was told that all are very good and high quality works.

As for Outstanding ITS Research, ITS Applications, both for individuals, and ITS Lead Award for groups or institutes, we should have good and clear choices for the next few years. But we need to improve our procedure for nomination and selection for those awards in the future.

The final winners for those awards will be announced at the end of this year, and published in our Newsletter, Magazine, and Transactions. The awards will be presented at ITSC 2008, and I will invite the winners to give keynote addresses about their work at ITSC 2008. I hope this can become a tradition of ITSC in the future, like CDC of the IEEE Control Systems Society.

The State of our Society

Our Society is in a good shape. We are the fast growing society within IEEE, and best part is: Our members are mostly new IEEE members, not the results of a re-distribution of membership within IEEE, as in the case for many other new societies. For this, I even got an award and a nice sport coat from IEEE TAB last year.

We have recovered from deep red deficit financially due to the new formula of infrastructure charge by the IEEE. We did know the exact number yet, I was told that last year we should have a surplus, instead of a deficit close to 100 thousands dollars. Our ratio of reserve to deficit is more than 20 now, far higher than the required level of 3 set up by the IEEE. I was really happy for this.

Lessons learned from IEEE TAB Meetings: more activities, and healthy growth. Although we have to watch our finance, but money with no use is no use at all, no services to our members is a disservice to them.

The Future

Above all else, we should Keep Our Own Color, Our Own Identification. We are an ITS society within IEEE, not some traditional transportation society. For that we have ITE, the Institute of Transportation

Engineers, and TRB, the Transportation Research Board. I was actually happy to be told by Bill a year ago that someone had commented that we were no transportation organization. Indeed, in the sense of traditional transportation, we are not now, and we should be not in the near future. We should be the force to force others to change. For that, we must have and keep our own identity.

What I see is the trend that some traditional transportation and OR organizations are moving along our direction. New ITS sections have been created within ASME, ASCE, INFORMS, and IIE, even in other four IEEE societies, along with new ITS publications and conferences. Although we are glad to see more ITS activities by others, we must think about the competition in the near future. We have to be better and do better.

We should be open and have more contents and interactions along the traditional line of transportation research and application. But computer, communication, and control, integrated with science and technology of intelligent systems, especially with the new Web Science, Services Science, should be our cores and our strength. We should be the leader in adapting computational thinking and computational culture in transportation.

Specifically, we should make fast and real progresses in the following areas:

Conferences
We should make our ITSC strong and bigger; one way to do this is to combine SOLI, ISI, VES, and MESA into ITSC every four years. As Bill and I have talked yesterday, we should keep the size of ITSC above 500.

Publications
We should streamline and integrate our Newsletters, Magazine, Transactions, our Technical Committees, and our Web under one. We must make our Web more attractive and more interactive. Web activities, especially web publishing and web broadcasting could be the key for our future revenue and development.

Technical Activities
We should establish the Board of Conference Associate Editors as soon as possible. This will ensure the quality of our conferences, our Magazine and Transactions. It will also provide a working platform and structure of recognition for our junior members to participate and develop in our Society.

Recognition and Award
Now we have four major awards in ITS, we should check and improve our procedure of selection and make sure about their quality and fairness. We should do more, and we should create best paper awards in our conferences and our Transactions, especially to junior researchers and PhD. Graduates.

Long Term Planning Committee
This Committee is not functional at this point, but it is very important to our future. I hope we can take advantage of Reinhard Pfliegl’s proposal for a forum of future transportation systems and recruit active and experienced members for our Long Term Planning Committee. Actually, we should model after the success of the World Economic Forum, which has been attended by the state heads of major countries, and call our forum as The World Transportation Forum or The World Forum on Future Transportation, and invite Ministers of Transportation to attend.

History Committee

I do have a strong personal sense of and interest in history; this was why I pushed to create the History Committee, chaired by one of our founders, Rye Case. Case retired two years ago and last year we had our annual conference in Toronto, partly due to our desire to honor his career and appreciate his effort in helping our Council and Society. We are still expecting a report on our history from Rye, but I would hope more of you will come up and write something personal about our history, and we can publish them in our new Magazine. I am sure I will do that.

The Friendship

I want to thank all of you for your help and support during the last seven years of my services to the IEEE ITS Council and Society, especially during the last three years as the President-Elect and President.

As many of you know, I started my research career in intelligent control when I came to the USA more than 20 years ago, and our group's first application of intelligent control was a hierarchical control system for urban traffic management in the 1970s. Although I did not take ITS seriously until the 1990s, I hold this is an era very deeply in my research career. So I am very glad I have this opportunity to serve, I value this experience very much, and I will continue to support our Society in the future.

I am also extremely happy to see all my predecessors share the same view about our Society. This is witnessed by the fact that all our former presidents are still on the board and serve this community with their time, effort, experience, and wisdom. I am glad to see this, and to see this tradition to be continued.

However, I want to make my position clear today. For the obvious reason, for the sake of new blood and young members' career development, and for the healthy and sustainable development of our Society, I will not support any of our former presidents, including myself in the future, to run again for the president of this Society. I understand this may not be a good short term position, but I believe it is a good long term position.

Thank You All

Now the torch is in Bill Scherer's hand. I am sure, as always, you will help and support him with all you can, for a better IEEE ITS Society.

Over the last two years, as the President, I have ups and downs, highs and lows; we have arguments, and we have fights. But in the end, I enjoy my involvement with this Society, and enjoy your friendship, professionally and in private.

It is the time to end. From the bottom of my heart, to each of you, thank you very much for a wonderful time during my term as the President of this great Society.

Message from the VP Member Activities

by Christoph Stiller

Networking with interdisciplinary experts is a keystone for success in the fast advancing field of Intelligent Transportation Systems Technology. At the same time it is often networking of people with interdisciplinary background that advances our field. The steady inflow of experts to the Intelligent Transportation Systems Society month by month impressively shows the request of a well established authority that gathers experts in the ITS field.

Since last year the ITSS promotes young as well as experienced engineers in ITS through its award program. The following four ITSS awards will be presented at the IEEE Intelligent Transportation Systems Conference. This issue of the newsletter shows the recipients of the IEEE ITSS Best PhD Dissertation Award and calls for applications to the awards in 2008.

1. IEEE ITSS Best PhD Dissertation Award
2. IEEE ITSS Best Practice Award for Engineers

Two more awards

3. IEEE ITSS Technical Career Achievement Award
4. IEEE ITSS Leadership Award for Government, Institutes, and Research

will be assigned by nomination of the award committee.

It goes without saying that all Member Activities needs active members and volunteers. Do not hesitate to contact me with your ideas, proposals or willingness to volunteer. Last not least: Do not forget to renew your IEEE ITSS membership for 2008!

Report from the Editor-in-Chief of the IEEE Transactions on Intelligent Transportation Systems

by Alberto Broggi

[Editor's Note: In the September 2007 issue of this Newsletter, the EIC of the Transactions included an article on the Impact Factor of our Transactions. In this issue he would like to include the following update which shows that the Transactions has an impact outside of electrical engineering as well.]

In http://www.ieee.org/web/publications/journmag/journalcitations.html, we are cited amongst the 'Notable IEEE Journals', which also indicates we are ranked #4 in Transportation Science & Technology and # 4in Civil Engineering.

Transactions Abstracts

Abstracts of the papers to appear in the December 2007 (Vol. 8 No. 4) issue of the *IEEE Transactions on Intelligent Transportation Systems* will appear in the January 2008 issue of the Newsletter.

The 10th International IEEE Conference on Intelligent Transportation Systems

The 10th International IEEE Conference on Intelligent Transportation Systems was held at the Hilton Bellevue Hotel in Bellevue, Washington, USA, on September 30th to October 3rd, 2007. The General Chair was Dr. Daniel J. Dailey from the University of Washington. The Program Chair was Dr. Sudarshan S. Chawathe from the University of Maine.

The program began with a tutorial on September 30th entitled “Microscopic Traffic Simulation Modeling and Analysis Using VISSIM,” presented by Dr. Yinhai Wang from the University of Washington. The program continued on October 1st through October 3rd where 193 papers, arranged into 45 regular session and four special sections, were presented. Papers were contributed from more than 30 countries throughout the world, making the conference truly international.

Technical tours to the Washington State Department of Transportation Traffic Management Center and the Boeing Company's Assembly Plant following the conference on October 4th.

The Conference Banquet was held on the evening of October 2nd at the Space Needle in Seattle. The Awards Ceremony took place at the banquet. Awards were presented for the Best PhD Dissertation in 2007. The First Prize Recipient of Best PhD Dissertation Award 2007 was Thao Dang for his dissertation “Continuous Self-Calibration of Stereo Cameras.” The Second Prize Recipient of Best PhD Dissertation Award 2007 was Yiting Liu for her dissertation “Applications of Wireless Communication in Traffic Networks Using a Hierarchical Hybrid System Model.”

Dan Dailey,
General Chair,
opening the conference.

Opening Keynote Addresses

Janice B. Skredsvig
Vice President and Chief
Information Officer
PACCAR Inc

and

Chip Meserole
Phantom Works
Boeing Inc.

Conference Gala Dinner
and
Awards Ceremony

at

The Space Needle

Society President
Fei-Yue Wang
addresses the banquet attendees

Left to Right

Christoph Stiller, VP Member Activities
Sudarshan Chawathe, Program Chair
Thao Dang, First Prize for Best PhD Dissertation Award 2007
Yiting Liu, Second Prize for Best PhD Dissertation Award 2007
Bill Scherer, Society President-Elect
Fei-Yue Wang, Society President

Luncheon Keynote Address

General Chair,
Dan Dailey
introduces the speaker

Bryan Mistele
President & CEO,
INRIX Inc.

A Washington State Apple

Photos by
Charles Herget
Newsletter Editor

Invitation to the
2008 IEEE Intelligent Transportation Systems Conference
October 12-15, 2008
Beijing, China

by Fei-Yue Wang

[Editor's note: This message was presented at the IEEE ITSC 2007 Banquet at the Space Needle (The SkyCity) in Seattle, Washington, USA, on October 2, 2007.]

My Dear Colleagues, Ladies and Gentlemen:

Before I conduct the official functions and introduce you to our annual conference next year, as the President of the IEEE ITS Society, first I would like to thank you all for coming to this great event and share with us your results and experiences, successes and failures, in ITS research and practice. I also would like to take this opportunity to thank our conference organizers, especially, our General Chair Dan Dailey, our Program Chair Sudarshan Chawathe. Thanks for your great effort for a successful conference!

Thanks to Christoph Stiller, our Vice President for Member Activities, and Chip White, our Chair of the Awards Committee, and every member in our Best Dissertation Evaluation Committee. We have selected a dissertation from Germany for the first prize, and a dissertation from the US for the second prize this year. Besides Award Certificates, the first and second prizes have a cash award of $1000 and $500 respectively. Christoph will announce the results to you.

Next year we will go after the Olympics in Beijing. Not for the gold medals, ITS is simply too fast and too smart for that. Instead, we will have our next annual conference right after the Beijing Olympics, from October 12 to October 15, in Beijing, China.

The 2008 IEEE International Intelligent Transportation Systems Conference (ITSC) will be led by our top management team. Bill Scherer, our President-Elect, will be the Program Chair, and the President, that is me, myself, will serve as the General Chair. Now we have to do a good job and make the event successful, since otherwise we will find no one else to blame. I am going to teach Bill an old Chinese saying: Zhi Yu Si Di Er Hou Sheng (置于死地而后生). Bill has two choices for its English Translations: 1) You must find a new life at the end of a dead end; 2) You must win your battle by dropping your weapons and destroying your boats, no transportation to back off. But I do not care what Bill chooses, I just want him to give us a successful meeting and a good time in Beijing.

I am sure you will have a successful meeting next year, since this time you will “Buy One, Get Two”. It is not a market gimmick you find in supermarkets. We have proposed to our Board of Governors that we will have our ITSC in conjunction with two other ITSS conferences next year:

The first one is
2008 IEEE/INFORMS International Conference on Services, Operations, and Logistics Informatics

(SOLI 2008), which tells us how to use and operate our ITS systems, and

the second one is
2008 IEEE/ASME International Conference on Mechatronic/Embedded Systems and Applications (MESA 2008), which tells us how to construct and maintain our ITS systems.

I hope you will like this combination and find it is a good opportunity to broaden your knowledge base and to know people in other disciplines.

If you have any ideas to make this meeting better, or if you are willing to help us out, please let Bill or me know.

I am also sure you will have a good time in Beijing next year, not only because it is just after the Olympic Games, but also some new and wonderful additions to this great city of long history and deep culture.

After you arrive in Beijing, the first thing you should do is to take a bath in this Water Cube, the site for Olympic swimming and other water events, then take a nap in the Lovely Bird's Nest, the place for the grand opening ceremony of Beijing Olympics, and then listen to the Peking Opera, Mozart or Beethoven in the newly erected half Egg, our National Grand Theater.

I hope you will do this with your wife or your significant other, so two of you can experience "One World, One Dream." If you two still dream differently, sue the 2008 Olympic Committee since it was they who promised to the whole World in their official theme slogan.

If you don't like the Cube, the Nest, and the Egg, please blame no Chinese but the Europeans, actually, the French to be exact, since they designed them, maybe for the convenience of romantics in an old city, I guess. We Chinese just built those romantic toys of Olympic sizes, and paid for them. Fortunately to some, or unfortunately to others, no recall possible this time.

My favorite topic is history, so my favorite place in Beijing is the Forbidden City. It was the royal court of China for over 800 years, and today it is still near the center of contemporary Chinese culture and politics. Don't be frightened by its deep red color. You will find coffee in Starbucks there, but tea is forbidden, so it is very open and Western friendly. I hope you go there to have a taste of our history and what is meant to be "big" and "luxury" in Chinese vocabulary.

If you do not like the place, do not blame on me, again, blame Europeans and Americans since their Union Army burnt the place and took goodies away a century ago, 108 years ago by the time you come to visit. The good thing is that you can still see those goodies or our treasures in many museums in other parts of the world.

Please do not blame or complain about the services there, remember the name, and the history, it is forbidden in the Forbidden City. If you do, they will not cut your head off as before, but no good to your health. Be positive, and enjoy.

Don't worry and relax. China has changed, Beijing has changed even more, and sometimes I am even wondering where I am when I meet my friends in Beijing. I am sure you will have fun and have a good time there.

Our conferences will be held at the Friendship Hotel. Here is the picture of it, a real good place to meet old friends and make new ones.

I hope you will also find this is a good opportunity to deepen your sense and understanding of humanity, and to know people in other cultures.

Finally, I wish you all have a good time in Seattle, 西雅图，in Chinese, the Beautiful Image of the West. Have a safe trip back home, and

See You All in Beijing Next Year!

IEEE ITS Society Sponsored and Co-Sponsored Conferences

2008

April 16-17
IEEE International Conference on RFID
Las Vegas, Nevada USA
Submissions due by: December 19, 2007
www.ieee-rfid.org/2008

June 4-6
IEEE Intelligent Vehicles Symposium
Eindhoven, the Netherlands
Submissions due by: January 10, 2008
www.iv2008.nl

September 22-24
IEEE International Conference on Vehicular Electronics and Safety
Columbus, Ohio USA
Submissions due by: April 15, 2008
www.ece.osu.edu/ICVES08/

October 12-15
IEEE Intelligent Transportation Systems Conference
Beijing, China

IEEE International Conference on RFID 2008

Preliminary Call for Papers www.ieee-rfid.org/2008

April 16-17, 2008

The Venetian, Las Vegas, Nevada, USA

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Important Dates

Paper submissions due:
December 19, 2007
Panel / special sessions due:
December 12, 2007
Notification of acceptance:
February 6, 2008
Final camera ready version due:
February 27, 2008

Technical co-sponsors
University of Texas at Arlington; IEEE Region 6; *IEEE Societies:* Antennas & Propagation; Circuits & Systems; Communications; Electron Devices; Engineering in Medicine and Biology; Industrial Electronics; Instrumentation & Measurement; Intelligent Transportation Systems; Microwave Theory & Techniques; Systems, Man, and Cybernetics; Vehicular Technology

The **2008 IEEE International Conference on RFID** – IEEE RFID – is the premier international technical conference series bringing together leading *researchers, developers, integrators,* and *visionaries* to discuss and expand their knowledge of technologies, systems, networks, algorithms, and applications that support the development and adoption of RF-based wireless communications and identification systems. **IEEE RFID 2008** is the second annual conference dedicated to addressing the technical and policy challenges in the areas of radio frequency identification (RFID) technologies, their supporting large-scale distributed information systems, and their applications.

IEEE RFID 2008 is a highly selective conference focusing on wireless identification and sensing systems, security features and approaches appropriate for these systems, technical and policy-related research and solutions on the technologies, design, manufacture, deployment, and application of RFID systems and their supporting information systems and application infrastructures. This conference is ideal for addressing the challenges facing the design, manufacture, deployment, use, and fundamental limits of wireless identification and sensing systems.

The conference will feature keynote speeches from leading visionaries, presentations of groundbreaking technology advances, panel discussions on pressing topics, poster sessions reporting preliminary results and works in progress, and, of course, benefits from our co-location with the **RFID Journal Live! 2008** tradeshow and conference.

Authors are invited to submit full **8-page** papers in the IEEE conference format presenting new research, innovations, and implementations related to the theory and practice of RFID systems, sensor technologies, and related information system support. All submissions must describe original work not previously published or currently under review for publication in another conference or journal. Papers must be submitted by **December 19, 2007**. Topic areas of interest include, but are not limited to:

- **Antennas & Propagation**: Antenna theory and designs, channel measurements and modeling
- **Circuits, Devices, & Sensors**: Building block system components, integrated sensors, energy harvesting, low-power design, non-silicon-based structures
- **RFID System Architecture & Implementation**: Novel system designs for mobile devices, reader system architecture, scalable deployment technologies, system architectures
- **Deployment**: System deployment and operation, ranging and localization
- **Security**: Features for security, system security solutions
- **Policy & Regulatory Issues**: Spectral management, data access and privacy issues, co-existence of RFID systems, government oversight, social implications of RFID technology
- **Application Issues & Concerns**: EMC/RF radiation, testing, reliability, interoperability; issues in patient safety, system-on-a-chip, and frequency

Accepted and presented papers will be published in the IEEE conference proceedings and in **IEEE Xplore**. A **Best Paper Award**, sponsored by **ODIN Technologies, Inc**., will be made for the best technical paper accepted and presented at the conference. Complete submission instructions and current information on the program and activities: www.ieee-rfid.org. ONE AUTHOR PER PAPER MUST BE A FULL REGISTRANT OF THE CONFERENCE.

Systems, Man & Cybernetics

IV'08

Call for Papers and Demonstrations
2008 IEEE Intelligent Vehicles Symposium
June 4-6, 2008, Eindhoven, the Netherlands

Paper submission deadline: January 10, 2008

The 2008 IEEE Intelligent Vehicles Symposium (IV’08), which is an annual forum sponsored by the IEEE Intelligent Transport Systems Society, will take place in Eindhoven, the Netherlands during June 4-6, 2008. Eindhoven provides a splendid conference location. The conference site at the Eindhoven University of Technology, hotels and demonstration sites are all in walking distance, right in the City centre, next to the railway station and the Phileas semi-automated bus system to the airport. Welcome to Eindhoven!

The Intelligent Vehicles Conference gathers researchers from industry, universities and public authorities to discuss research and applications for intelligent vehicles, including the communication between vehicles and between vehicles and infrastructure.

The technical sessions of the symposium consist of plenary presentations, including keynote presentations by TomTom, Daimler and PATH/UC Berkeley, and interactive poster sessions. Full paper submission is required before January 10, 2008. Selected papers will be included in a special issue of the IEEE Transactions on Intelligent Transportation Systems. An award will be presented for the Best Student Paper.

On June 6, the road next to conference venue will be closed for normal traffic in order to provide a perfect site for demonstrations of intelligent vehicles. Live demonstrations are expected to be provided by various research groups from Europe. Proposals for demonstrations can be submitted until March 15, 2008. Information about the demonstration conditions and booking information can be found on our website.

On June 3, meetings and workshops in conjunction to the conference will be held. Meetings and workshops can be proposed until February 1, 2008.

All activities, sessions as well as the demonstrations are at the campus of the Eindhoven University of Technology. Eindhoven (and its region) is known as key area of the Dutch High Tech Industry, including the Dutch automotive industry that consists of over 200 companies. A range of Dutch automotive companies belong to the world's top ranking companies.

For more information visit our website: www.iv2008.nl

Henk Nijmeijer & Bart van Arem
General chairs IV 2008

Conference Calendar

by Massimo Bertozzi

This section lists upcoming ITS-related conferences, workshops, or exhibits. Contributions are welcome; please send announcements to itsconfs@ce.unipr.it.

2007

December 20-22
ICIS 2007 International Conference on Intelligent Systems
Bangkok, Thailand
Submissions due by: September 15
http://www.enformatika.org/icis07/

2008

February 6-8
International Conference on Automation and Robotics
Cairo, Egypt
http://www.waset.org/icar08

March 5-6
Avionics Military and Civil Conference
Amsterdam, The Netherlands
http://www.avionics-event.com

March 18-19
5th International Workshop on Intelligent Transportation
Hamburg, Germany
Submissions due by: November 16, 2007
http://wit.tu-harburg.de

March 26-27
European Robotics Symposium
Prague, Czech Republic
http://www.action-m.com/euros2008

April 1-4
Intertraffic 2008
Amsterdam, The Netherlands
http://www.amsterdam.intertraffic.com

April 3-4
European Conference on Human Centred Design for ITS
Lyon, France
http://www.conference.noehumanist.org

May 11-14
IEEE Vehicular Technology Conference Spring 2008
Marina Bay, Singapore
http://www.ieeevtc.org/vtc2008spring

May 19-23
IEEE International Conference on Robotics and Automation (ICRA 2008)
Pasadena, California (USA)
Submissions due by: September 14, 2007
http://www.icra2008.org

May 27-31
10th International Conference on Application of Advanced Technologies in Transportation
Athens, Greece
http://www.civil.ntua.gr/aatt/

June 30-July 2
1st Mediterranean Conference on Intelligent Systems and Automation
Annaba, Algeria
http://lsc.univ-evry.fr/cisa08/doku.php

August 6-8
3rd International Symposium on Transport Simulation
Queensland, Australia
Submissions due by: October 15, 2007
http://civil.eng.monash.edu.au/conferences/ists08

September 21-24
IEEE Vehicular Technology Conference Fall 2008
Calgary, Canada
Submissions due by: February 2008
http://www.ieeevtc.org/vtc2008fall

September 22-26
International Conference on Intelligent Robots and Systems
Nice, France
Submissions due by: January 22
http://iros2008.inria.fr

2009

July 16-18
International Symposium on Transportation and Traffic Theory
Hong Kong
http://www.isttt18.org
Submissions due by: December 15, 2007

ITS Society Elections

Officers

According to the Society bylaws, the Board of Governors elects the Society officers and the Editor-in-Chief of the Transactions. Election for President-Elect, Vice President for Financial Activities, Vice President for Technical Activities, and Vice President for Administrative Activities, take place in even-numbered years for two year terms to begin in January of the next year. Election for Vice President for Conference Activities, Vice President for Publication Activities, Vice President for Member Activities, and the Editor-in-Chief of the Transactions take place in odd-numbered years for two year terms to begin in January of the next year.

The election of officers for terms to begin on January 1, 2008, was held at the Board of Governors meeting on October 4, 2007, in Seattle, Washington, following the ITS Conference. The following officers were elected to a two year term beginning January 1, 2008: Jason Geng, Vice President for Publication Activities; Ümit Özgüner, Vice President for Conference Activities; Christoph Stiller, Vice President for Member Activities; and Alberto Broggi, Editor-in-Chief of the Transactions.

Board of Governors

The governing body of the Society is the Board of Governors (BoG). The BoG consists of the officers of the Society, the Editor-in-Chief of the Transactions, and fifteen members elected by the members of the Society. Each year, five members are elected for a three year term. This year, there are eight candidates for the term beginning January 1, 2008. Ballots were mailed to the members of the Society by IEEE on November 2 and are due back at IEEE no later than December 14.

Brief biographical sketches of the eight candidates follow.

Dr. Byungkyu "Brian" Park

Dr. Byungkyu "Brian" Park is an Assistant Professor of Civil and Environmental Engineering Department at the University of Virginia. Prior to joining the University of Virginia, he was a Research Fellow at the National Institute of Statistical Sciences and a Post-Doctoral Research Associate at North Carolina State University. Dr. Park received the B.S. and the M.S. from the Hanyang University, Seoul, Korea, in 1993 and 1995, respectively, and the Ph.D. from the Texas A&M University in 1998.
Dr. Park is a recipient of Charley V. Wootan Award (for best Ph.D. dissertation) from the Council of University Transportation Centers, and Jack H. Dillard Outstanding Paper Award from the Virginia Transportation Research Council. He is an ASCE ExCEEd teaching fellow. He is currently a member of TRB traffic signal systems committee and statistical methods committee, and chair of simulation subcommittee of traffic signal systems. Dr. Park has published over 48 journal and conference papers in the area of transportation system operations and managements, and intelligent transportation system. He has actively participated in the IEEE ITSC as presenter, session moderator, reviewer, and associate editor.

His research interests include stochastic optimization for traffic signal control system, microscopic simulation model calibration and validation, and transportation system sustainability.

Prof. Dr. Levent Güvenç

Levent Güvenç received the B.S. degree in mechanical engineering from Boğaziçi University in Istanbul in 1985 (ranking first in the School of Engineering), the M.S. degree in mechanical engineering from Clemson University in 1988 and the Ph.D. degree in mechanical engineering from the Ohio State University in 1992. Since 1996, he has been working in the mechanical engineering department of Istanbul Technical University where he is currently a professor of mechanical engineering and director of the Mekar Mechatronics Research Labs and the EU FP6 funded Autocom Automotive Controls and Mechatronics Research Center. He has been working as the coordinator of the interdisciplinary Mechatronics Graduate Program of Istanbul Technical University since 2005. He has spent the year 2000 working as a guest researcher sponsored by the Alexander von Humboldt Foundation in the Institute of Robotics and Mechatronics of the German Aerospace Center in Oberpfaffenhofen.

Prof. Güvenç is experienced in new course and educational lab development in automotive control, control systems and mechatronics. He has also designed undergraduate and graduate level mechatronics curricula at Istanbul Technical University. He has organized several special sessions and panels on automotive control systems at major conferences. He was a member of the program committees of the first and second IFAC Symposia on Automotive Control. He has more than 100 technical publications in intelligent vehicles, controls, robotics, mechatronics, is co-inventor of a European patent on vehicle yaw stability control and is one of the coauthors of the book *Robust Control: the Parameter Space Approach*. His current research interests concentrate on autonomous vehicles, effect of vehicle to vehicle communication on active safety control systems, automotive control and mechatronics with a focus on the development of active safety control systems for road vehicles and hardware in the loop simulation.

Prof. Güvenç was the principal investigator of several large scale projects including one European Commission Framework 6 project. He is the leader of the Istanbul Technical University team in the Drive Safe (Signal Processing and Advanced Information Technologies for Improving Driver/Driving Prudence and Accident Reduction) project. Prof. Güvenç has extensive experience as a consultant for the automotive industry including the development of a hybrid electric Ford Transit van and a Ford Transit Connect light commercial vehicle with adjustable damping and active steering. He is also working on a current project on building an autonomous vehicle. The automatic parking capability of this vehicle was demonstrated during the demo day of the 2007 IEEE Intelligent Vehicles Symposium. He has been working as a project reviewer mostly in the automotive area including local companies, international projects and EU FP6 projects.

Prof. Güvenç was the general chair of the 2007 IEEE Intelligent Vehicles Symposium that was held in Istanbul during June 2007. He has taken part in the organization committees of several IEEE sponsored or co-sponsored conferences in Istanbul, Turkey. He is the corresponding editor in charge of Europe and Africa for the IEEE Control Systems magazine (second term). He is a member of the IFAC technical committees on automotive control (second term) and mechatronics (first term) and the IEEE technical committee on automotive control (second term). Currently Prof. Güvenç is the national expert in charge of ITS and intelligent vehicle technologies in the Transport thematic area for Turkey in the European Commission Framework Program 7.

Dr. Sadayuki Tsugawa

Dr. Sadayuki Tsugawa is Professor of Information Engineering at Meijo University. He received his B. E. degree, M. E. degree, and Doctor of Engineering degree in 1968, 1970, and 1973, respectively in instrumentation and control engineering all from University of Tokyo. In 1973, He joined Mechanical Engineering laboratory under Japanese Ministry of International Trade and Industry (MITI). He also was Professor of Graduate School at University of Tsukuba from 1993 to 2003. In 2003 he resigned the laboratory and moved to Meijo University.

In 1970's he was engaged in two ITS projects in the laboratory: a dynamic route guidance system and a vision-based intelligent vehicle. The dynamic route guidance system, named Comprehensive Automobile Traffic Control System (CACS) and sponsored by MITI, was the first one in the world that was installed in an urban area (downtown of Tokyo) and was experimented for one year. The vision-based intelligent vehicle was also the first one in the world that autonomously drove on a test track. Since then, he has been conducting research on ITS, and, in particular, on Advanced Vehicle Control and Safety Systems (AVCSS), including driver assistance systems and automated driving systems. His current interests are in inter-vehicle communications and their applications like cooperative driving of a platoon of automated vehicles and vehicle safety communications (VSC).

He served or will serve as program chair or program c0-chair in international conferences and symposia sponsored by IEEE ITS Society: Intelligent Vehicles Symposium 2003 and 2008, and Conference on Vehicle Electronics and Safety (ICVES) 2008. He also served as an associate editor of IEEE Transactions on ITS in 2004 and 2005.

He was awarded the best paper prize by the Japanese Society of Instrument and Control Engineers in 1991, and by the Minister of Science and Technology for the research on ITS and AVCSS in 1999.

Prof. Bart De Schutter

Bart De Schutter is a full professor in "Hybrid Control and Intelligent Transportation Systems" at the Delft Center for Systems and Control (DCSC) and at the department of Marine and Transport Technology of Delft University of Technology in Delft, The Netherlands. Bart De Schutter received the MSc degree in electrotechnical-mechanical engineering in 1991 and the doctoral degree in Applied Sciences (summa cum laude with congratulations of the examination jury) in 1996, both at K.U.Leuven, Belgium. For his PhD thesis he was awarded the 1998 SIAM Richard C. DiPrima Prize and the 1999 K.U.Leuven Robert Stock Prize.

After obtaining his PhD degree, Bart De Schutter was a postdoctoral researcher at the SISTA-ESAT group of K.U.Leuven, Belgium. In 1998 he moved to the Control Lab of Delft University of Technology as an assistant professor. In 2000 he became associate professor, and in December 2006 full professor. His current research interests include highway traffic control, control of transportation networks, intelligent vehicles, control of hybrid systems, discrete-event systems, multi-agent systems, and optimization.

Bart De Schutter has co-authored about 50 journal papers and 130 conference papers. He was program co-chair for ITSC'05 in Vienna, Austria, member of the local organizing committee for the 11th IFAC Symposium on Control in Transportation Systems (CTS 2006) in Delft, The Netherlands, and program chair for IV'08 in Eindhoven, The Netherlands. He was also guest editor for the special issue of IEEE Transactions on Intelligent Transportation Systems with selected papers from ITSC'05. Bart De Schutter is vice-chair of the IFAC Technical Committee on Transportation Systems for the triennium 2006--2008, and associate editor of Automatica and the IEEE Transactions on Intelligent Transportation Systems.

Kaan Ozbay, Ph.D.

Kaan M.A. Özbay received his B.S. in Civil Engineering in 1988 from Bogazici University, Istanbul, Turkey, his M.S. in 1991 in Civil Engineering (Transportation) from Virginia Tech and his Ph.D. in Civil Engineering (Transportation) in 1996. Dr. Ozbay's research interest in transportation covers a wide-range of topics including, advanced technology applications in ITS, incident and emergency management, development of real-time control techniques for traffic, application of artificial intelligence and operations research techniques in network optimization, development of simulation models, transportation economics, and traffic safety.

Dr. Ozbay joined Rutgers University Department of Civil and Environmental Engineering as an Assistant Professor in July, 1996. He was promoted to Associate Professor with tenure in July 2002. Since 1994, he been the “Principal and Co-Principal Investigator” of 47 research projects funded at a level of more than $7,000,000 by various agencies including, NSF, NJDOT, New Jersey Highway Authority, New York Metropolitan Transportation Council (MPO), USDOT, FHWA, NYSDOT, VDOT, PENNDOT, USDOT ITS Research Center of Excellence. He served as the Associate Director of the Center for Advanced Infrastructure and Transportation (CAIT) funded by USDOT University Transportation Centers Program. CAIT was successful in the latest round of competition and is selected to receive tier I UTC grants in 2007-2009. He is now the Director of the “Rutgers Intelligent Transportation Systems (RITS)” program at CAIT, a new dedicated research laboratory that conducts all the ITS research at the Center.

Dr. Ozbay is the recipient of the prestigious National Science Foundation (NSF) CAREER award. This is a four year award given to young tenure track faculty that has the highest potential for research and education. Dr. Ozbay has recently co-authored a book titled “Feedback Based Ramp Metering for Intelligent Transportation Systems” which is published by Kluwer Academics in 2004. In addition to this book, he is also the co-author of two books titled "Feedback Control Theory for Dynamic Traffic Assignment", Springer Verlag and “Incident Management for Intelligent Transportation Systems” published by Artech House publishers in 1999 both with Dr. Pushkin Kachroo of Virginia Tech. Dr. Ozbay published more than 150 papers in scholarly journals and conference proceedings.

Dr. Tankut Acarman

Tankut Acarman received the B.Sc. degree in electrical engineering and the M.Sc. degree in computer and control engineering in 1993 and 1996 from Istanbul Technical University (Istanbul, Turkey), and the Ph.D. degree in electrical engineering from the Ohio State University, (Columbus, USA) in 2002. He joined Ondokuz Mayis University in 2003 as an assistant professor then he has been with Galatasaray University, computer engineering department (Istanbul, Turkey) since March 2004. He was director of the center of computing resources in Galatasaray University, 2004 and 2005.
His research interests lie along all aspects of Intelligent Vehicle Technologies, driver assistance systems, autonomous systems with special attention into modeling and control. In Intelligent

Transportation Systems area, he is currently investigating the future data network architecture for actively safe, clean and efficient road vehicles.

He is a faculty member in a potential center for network of excellence funded by EU-FP6. He has served as an expert in various projects, e.g. a national project aiming to reduce traffic accidents by improving driving and driver prudence through signal processing and advanced information technologies, control strategies development for hybrid electric vehicle technologies in cooperation with automotive companies.

He was a finance chair and associate editor of Intelligent Vehicle symposium in 2007. He is an associate editor of the Intelligent Vehicle symposium in 2008.

Dr. Azim Eskandarian, D.Sc.

Dr. Azim Eskandarian is a Professor of Engineering and Applied Science at The George Washington University (GWU), where he started as an Associate Research Professor in 1993. He is the founding director of the Center for Intelligent Systems Research (CISR) since 1996 and the director of the cross-disciplinary and interdepartmental “Transportation Safety and Security” program, which is one of the major *Areas of Excellence* selected competitively by the university, and one of three areas of focus of the School of Engineering and Applied Science. Dr. Eskandarian was also the co-founder of the FHWA/NHTSA National Crash Analysis Center (NCAC), a Department of Transportation and industry sponsored center for automotive, crash worthiness, occupant biomechanics, and highway safety research in 1992 and served as its director from 1998 to 2002. He has over 25 years of R&D and engineering design experience in Applied and Computational Mechanics, Dynamic Systems, Controls, and Intelligent Systems with applications in automotive engineering, transportation safety, intelligent vehicles, and robotics.

As Director of the CISR, his research has focused on intelligent vehicle systems for the future automotive and transportation safety and efficiency. He is conducting leading research in intelligent systems for driver assistance, collision avoidance, autonomous vehicle controls, and vehicle dynamics and control (active suspension, rollover dynamics, and brake/stability systems). He established four new research laboratories including a car and a truck driving simulator. Earlier at the NCAC, he conducted pioneering research in impact dynamics, non-linear finite element and meshless methods with applications in crash worthiness, computer simulation and modeling of vehicle crashes, and design optimization of structures under impact.

Dr. Eskandarian’s pedagogical efforts have been instrumental in the establishment of a new and unique graduate program of study (Masters and Doctoral) in “Transportation Safety” at GWU. He added the Intelligent Transportation Systems graduate specialty to this curriculum, and developed and introduced a new undergraduate Transportation Engineering option in the Department of Civil and Environmental Engineering. He was also among the founding faculty members of the University’s interdisciplinary program in Computational Sciences. Prior to joining GWU, Dr. Eskandarian was an assistant professor at Pennsylvania State University, York Campus for four years (1989-92) where he made extensive contributions to the curriculum and academic programs. He served as a technical liaison between local industry and the university, promoting joint research and education programs. Prior to joining academia, Dr. Eskandarian held engineering and project management positions in the defense industry (1983-89). His work involved enhancement of military vehicles, cargo handling equipment, computer aided design, stress analysis, and structural design.

Dr. Eskandarian is the author and co-author of over 110 published refereed journal (50) and conference (60) papers including three edited volumes, one book, 50 additional presentations, and over 30 technical reports. His research results have been presented in 110 conferences, seminars, and invited talks. He is the associate editor and editorial board member of five journals (Associate Editor, *IEEE Intelligent Transportation Systems Transactions;* board member of *IMechE Journal of Multi-body Dynamics, International Journal of Vehicle Autonomous Systems, International Journal of Vehicle Information and Communication Systems,* and *International Journal of Automotive Technology*), and provided peer review service to numerous professional conferences and archival journals. He has been the PI and Co-PI of over 20 sponsored research awards totaling more than $20 million (PI for over $6 million and primary Co-PI for $14.2 million).

Dr. Eskandarian has served (by invitation) on government committees and boards including DOT/NHTSA's crash worthiness aggressivity and compatibility subcommittee of Motor Vehicle Safety Research Advisory Committee (MVSRAC) and Transportation Research Board subcommittee of Computational Mechanics (previously, computer simulation of impacts with roadside safety features). He served as an expert reviewer/panelist for National Science Foundation and for the ITS-IDEAS research award program of National Academy of Sciences. He has been a consultant to industry and government. Dr. Eskandarian is a member of ASME, IEEE, SAE, ASCE, ITS America, and at various periods, Sigma XI professional society, ASEE, SME, and Tau Beta Pi and PI Tau Sigma Engineering Honor societies.

Dr. Eskandarian received his B.S. (with honors), M.S., and D.Sc. degrees in Mechanical Engineering from GWU, Virginia Polytechnic Institute and State University, and GWU in 1982, 1983, and 1991, respectively.

Dr. Sharron (Shuming) Tang

Shuming Tang (M'03) received her PhD degree in automatic control engineering with the highest honor from the Chinese Academy of Sciences, Beijing, China. Currently, she is a Research Professor in the Institute of Automation, Shandong Academy of Sciences and Director of the Intelligent Control and Systems Engineering Center. She is also an Appointed Professor in Xi'an Jiaotong University and Shandong University of Science and Technology. Her research interests are focused on intelligent transportation systems (ITS), automation control, computational intelligence and complex systems, and artificial transportation systems (ATS). She has published extensively in those areas.

Dr. Tang received the prestigious President's Special Scholarship Award by the CAS in 2005 (each year 20 awards are chosen from over 10,000 PhD dissertations across all research fields). Dr. Tang also received the TOP 50 Best Dissertation Award in 2006 by CAS. Her dissertation was also recently nominated for the TOP 100 Best Dissertation Award in China (out of roughly 60,000 PhD dissertations nation-wide; the results will be announced in Spring 2007) and the IEEE ITSS PhD Dissertation Award (results pending). She has received several best student paper awards in international conferences in the ITS area. Dr, Tang is very active professionally in the ITS research community. She is an Associate Editor of the IEEE Transactions on ITS and a member of the Board of Governors of the IEEE ITS Society. She is a co-Chair of the Technical Committee on ATS of ITSS. She also played an instrumental role in forming two local ITSS chapters in China.

Call for Papers

IEEE Transactions on Intelligent Transportation Systems

Special Issue on the DARPA Urban Challenge Autonomous Vehicle Competition

Guest Editors: Christoph Stiller, Ümit Özgüner, and Alberto Broggi

The Urban Challenge 2007, a competition of autonomous vehicles, took place on November 3, 2007, in Victorville, CA, USA. As its predecessors, the Grand Challenges 2004 and 2005, this competition has significantly enhanced research, progress, and public awareness in the field of autonomous driving.

While the techniques applied in the competition have hardly been published up to date, we invite all participants to report on their **technologies and algorithmic approaches developed during all stages leading up to the Challenge.**

Topics addressed may include, but are not limited to, the following:

- **vehicle architecture and design**
- **sensing and sensor fusion**
- **localization and planning**
- **fault and error detection and recovery**
- **path planning and behavior decision**
- **special hardware and actors**
- **simulation and testing**
- **performance in the competition**
- **lessons learned**

Submission Procedure:
Authors should prepare manuscripts according to the Information for authors available at http://www.ewh.ieee.org/tc/its/trans.html and select '**Special Issue on DARPA Urban Challenge**' as paper type when submitting their papers.

Schedule	
Paper submission	Feb. 28, 2008
Review completed, Notification of acceptance	May 15, 2008
Final manuscript submission	July 30, 2008

IEEE	**IEEE ITSS Best PhD Dissertation Award** **IEEE ITSS Best Practice Award for Engineers**	ITSS – Intelligent Transportation Systems Society – IEEE

Call for Proposals

IEEE ITSS Best PhD Dissertation Award

Purpose and Selection Criteria

The IEEE ITSS Best PhD Dissertation Award is given annually for the best dissertation in any ITS area that is innovative and relevant to practice. This award is established to encourage doctoral research that combines theory and practice, makes in-depth technical contributions, or is interdisciplinary in nature, having the potential to contribute to the ITSS and broaden the ITS topic areas from either the methodological or application perspectives.

Application material
Each application must consist of the following material:
1. A doctoral dissertation written by the applicant in any language no more than 18 months prior to the submission deadline and not previously submitted.
2. A summary of the dissertation in English of up to 3 pages in length written by the PhD candidate highlighting the significance of the problem, the technical approach taken, application context and potential, and the scope of the dissertation.
3. A self-contained paper in English based on the dissertation written primarily by the PhD. candidate following the Transactions on ITS regular paper requirements.
4. A letter of recommendation from the applicant's dissertation advisor that comments on the significance of the research, attests to the originality of the work, and comments on the engagement of the student in the field of ITS and the ITSS.

IEEE ITSS Best Practice for Engineers

Purpose. and Selection Criteria
The IEE:E.ITSS Best Practice Award for ITS Engineers is given annually for ITS engineers and teams who have developed and deployed successful ITS systems or implementations. This award is established to recognize, promote, and publicize major application innovations with real-world impact.

Application material
Each application must consist of the following material:
1. A 5-page summary of the ITS application providing sufficient detail for evaluation of the novelty and impact of the work
2. At most 3 letters of recommendation from the customers or users of the developed application attesting to its significance and practical impact

Application and Selection Process for either Award
Please upload the application packet in pdf-format before May 1, 2008 to the following Internet address:
https://xchange.mrt.uni-karlsruhe.de/itssAward/
Applications by email are not accepted.

Dedicated selection committees will evaluate the applications for the IEEE ITSS Awards and propose candidates for fInal approval from the ITSS Board of Governors. The first prize winners will receive awards of US$ 1000 each. The second prize winner of the *Best PhD Dissertation Award* will receive US$ 500. Award certificates will be given out it the ITSS Conference in Beijing where the recipients will be asked to give a presentation of their work.

Universität Karlsruhe (TH)
Institut für Mess- und Regelungstechnik

Prof. Dr.-Ing. Christoph Stiller

Dec. 1st, 2007

Research Group Leader Position
KARLSRUHE INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MEASUREMENT AND CONTROL
GERMANY

The Department of Measurement and Control (MRT) at Karlsruhe Institute of Technology (KIT) www.kit.edu specializes in the development of intelligent sensing techniques for autonomous vehicles and for automated visual inspection tasks. Research projects focus on highly accurate vehicle positioning, automated map generation, and environmental sensing with active camera and laser scanner data. We are working work in an interdisciplinary environment in cooperation with international research institutions, the automotive industry and train manufacturers.

We invite highly motivated applicants for a vacant research group leader position. The prospective candidate will be responsible for a research group - including the supervision of PhD students and project coordination with our partners - and initiate own research projects. The MRT provides excellent infrastructural and scientific background for the candidate to pursue his/her own line of research. The candidate will as well be integrated in our post-graduate teaching activities.

The prospective candidate should hold a PhD in Mechanical or Electrical Engineering, Computer Science or a related field. He/She should have a strong theoretical background in at least 3 of the following areas:

- Pattern Recognition
- Distributed/Multimodal Sensor Data Fusion
- 3D Scene Reconstruction (structure-from-motion/stereo/...)
- Image Understanding
- Probabilistic modeling, reasoning and learning
- Simultaneous localization and mapping
- Map Matching

and should have hands-on experience thereof in areas like robotics, automobile or railway systems. Knowledge of German language is helpful, but not mandatory.

The position is intended for 3-5 years duration. Annual salary will be approximately 40 - 55 kEuro (Bat1b / E14).

Applicants should send their application along with a CV, a detailed statement of research plans, copies of three publications, and names and contact information of at least 2 references. These documents should be submitted as pdf attachments to: mrt@mach.uni-karlsruhe.de

For further information contact:
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Civil and Environmental Engineering (CEE) Department
The George Washington University
Washington, D.C. USA

Tenure-track Assistant Professor
Faculty Position in Transportation Engineering

The George Washington University Civil and Environmental Engineering (CEE) Department invites applications for a tenure-track Assistant Professor faculty position in transportation engineering, commencing August 2008. The successful candidate is expected to contribute to the university designated area of excellence in "Transportation Safety and Security", develop an externally funded, nationally recognized research program, have a strong commitment to teaching both undergraduate and graduate CEE courses, advise students, and actively engage in scholarship and university and professional society services. **Basic Qualifications:** Applicants must have an earned doctorate in civil engineering or a closely related field as well as a proven record of academic and professional scholarly achievements or a demonstrated potential for success in academia. **Preferred Qualifications:** Although all areas of transportation engineering will be considered, preference will be given to applicants with specialty in advanced Traffic Engineering, Intelligent Transportation Systems, and Transportation Safety. Preference will also be given to applicants with a record of active participation in professional societies and other scholarly activities, and a professional engineering license or eligibility to obtain one within three years. Additional information about the CEE department and this position can be found at: http://www.cee.seas.gwu.edu.

A major private research university situated in one of the nation's rapidly growing research, innovation, and technology centers, GW has an enrollment of approximately 20,000 students, distributed across the main campus in Washington, D.C., two campuses in the metropolitan area, and four off-campus centers.

The CEE Department fosters a vibrant, multi-cultural, technological community of faculty, graduate, and undergraduate students and has close ties with numerous government and industry research labs and institutes. The Department offers programs in structural engineering and mechanics, geotechnical engineering, water resources, environmental engineering, and transportation engineering, which has been designated a university area of excellence. The CEE department offers BS, MS, Professional Engineer, and D.Sc. degrees, a certificate program in aviation safety and security, a five-year Bachelor/Master's program in civil engineering, and selected joint-degree programs with other GW schools. The Department has very active research programs with state-of-the-art facilities in transportation engineering. More information can be found in the following web sites: Center for Intelligent Systems Research www.cisr.gwu.edu, National Crash Analysis Center www.ncac.gwu.edu, Aviation Institute www.gwu.edu/~aviation/.

Nominations and applications will be accepted until the position is filled. Review of applications will begin on February 1, 2008. **To Apply:** Applicants should send a cover letter describing their expertise and a statement of teaching and research interests addressing their potential contribution to transportation areas listed above, a curriculum vitae, and the names, addresses, emails, and telephone numbers of five references. Only complete applications will be considered. Applications should be sent to:

Prof. Azim Eskandarian, Chair of Transportation Search Committee
Civil and Environmental Engineering Department
School of Engineering and Applied Science
801 22nd Street, N.W., Suite 643
The George Washington University
Washington, D.C. 20052

No phone calls please. Electronic applications will be accepted as **a single PDF document**, sent to Mr. Neil Commerce at: neilc76@gwu.edu

The George Washington University is an Equal Opportunity/Affirmative Action Employer and seeks to attract an active, culturally and academically diverse faculty of the highest caliber

FEATURE ARTICLE

DARPA GRAND CHALLENGE/URBAN CHALLENGE

by Charles Herget

The Defense Advanced Research Projects Agency (DARPA), the central research and development organization for the United States Department of Defense, has sponsored a series of three challenges to the research community to encourage the development of autonomous ground vehicles that are capable of navigating and driving entirely on their own with no human driver and no remote control.

The First Grand Challenge, 2004

The first Grand Challenge was held on March 13, 2004, across a course of 140 miles (225 km) in the Mojave Desert in Southern California. A prize of US$ 1 million was offered to the autonomous vehicle to complete the route in the shortest amount of time in less than 10 hours. The route was not disclosed to the participants until approximately two hours prior to the start of the event. The participants were told that the route may include paved roads, unpaved roads, trails, and off-road desert areas. The route definition data file (RDDF) is the official definition of the route and defines the corridor through which all vehicles are required to travel. The RDDF contains waypoints, lateral boundary offsets, and maximum speed limits. Each team receives a compact disc (CD) containing the RDDF approximately two hours prior to the start of the event. After the start of the race, there is no communication with the vehicle except by a DARPA official following each vehicle in a DARPA supplied chase vehicle. The only communication with the vehicle is through a government supplied E stop. The E-stop system has three modes: a RUN mode, a PAUSE mode, and a DISABLE mode.

One-hundred six teams applied to participate in the event. After extensive qualifying tests, fifteen were allowed to participate. None finished the race. Among those qualifying was Team TerraMax, a truck supplied by the Oshkosh truck company. Two active members from our Society contributed to the effort, Prof. Ümit Özgüner from The Ohio State University, the Vice President for Conference Activities, and Prof. Alberto Broggi from the University of Parma, the Editor-in-Chief of the IEEE Transactions on ITS.

Papers from many of the participants describing their technical approaches can be found at http://www.darpa.mil/grandchallenge04/tech_papers.html.

The Second Grand Challenge, 2005

The event was repeated on October 8, 2005. DARPA offered a prize of US$ 2 million to the winner of the Second Grand Challenge. One-hundred ninety-five teams applied to participate, and twenty-three teams qualified to start the event. This time, five teams finished the 132 mile (212 km) course. The winner was The Stanford Racing team. Their vehicle was a Volkswagen Touareg that they called "Stanley." Four other vehicles finished the event including an Oshkosh truck, called TerraMax, entered by Team TerraMax, made up of Oshkosh Truck Corporation, Rockwell Collins and the University of Parma, Italy. The vehicle's stereo vision system was provided by a group headed by Prof. Alberto Broggi, Editor-in-Chief of the IEEE Transactions on ITS, at the University of Parma.

Stanley


TerraMax

Also qualifying for the event was the Desert Buckeyes from The Ohio State University. The Team Leader was Prof. Ümit Özgüner, the ITS Society's Vice President for Conference Activities.


Desert Buckeyes

Their vehicle, called ION (Intelligent Off-road Navigator), was a custom built 6 wheeled vehicle. It was developed in partnership with the University of Karlsruhe where the vision system was developed under the direction of Prof. Christoph Stiller, the ITS Society's Vice President for Member Activities.

Papers from many of the participants describing their technical approaches can be found at http://www.darpa.mil/grandchallenge05/TechPapers.html.

The Urban Challenge, 2007

Following the success of the autonomous vehicles to complete the course across the desert, DARPA announced a challenge to demonstrate the ability to operate in an urban environment.

The announcement from DARPA stated: "The Urban Challenge course tests the vehicle's ability to operate safely and effectively with other vehicles in and around an urban environment. The course will be nominally 60 miles (97 km) in total distance, with a time objective of 6 hours. The road surface will range in quality from new pavement to potholes and broken pavement. Sections of dirt roads with low berms may also be encountered. The vehicle may negotiate sharp curbs, downed branches, traffic barrels, drains, hydrants, rocks, brush, construction equipment, concrete safety rails, power line poles, and other stationary items likely to be found in an urban environment. Vehicles will obey traffic laws as they negotiate traffic circles, intersections, and merge with moving traffic. Traffic on the route may be provided by manned vehicles, tele-operated vehicles, and other autonomous vehicles. Static vehicles may also be parked or stopped along the route. Roads may be blocked by DARPA during the course of the event. Trees and buildings along the route may interfere with GPS. Along some road segments there may be significant distances between waypoints, requiring vehicles to use their sensors to stay in the travel lane.

To complete the Urban Challenge, a vehicle must negotiate all hazards, re-plan for alternate routes, and avoid static and dynamic obstacles while completing a complex, multi-part mission at speeds of up to 30 mph (48 km/hr), resulting in an average speed of at least 10 mph (16 km/hr)." As before, the only communication with the vehicle is the DARPA supplied E-stop.

Eighty-nine teams applied to participate in the Urban Challenge to be held on November 3, 2007, at the former George Air Force Base, Victorville, California. For this event, DARPA offered three prizes, US$2 million for the fastest qualifying vehicle, and US$1 million and US$500,000 for second and third place. Thirty-six teams were selected to attend the National Qualification Event (NQE) in Victorville on October 26-31, 2007. Eleven teams were selected for the final event.

Active members of the ITS Society again played key roles in three entries selected for the NQE: Team AnnieWay (Prof. Christoph Stiller, The University of Karlsruhe, VP Member Activities), Team Oshkosh Truck (Prof. Alberto Broggi, University of Parma, Editor-in- Chief Transactions on ITS), and Team OSU-ACT (Prof. Ümit Özgüner, The Ohio State University, VP Conference Activities). Team AnnieWay and Team Oshkosh Truck were among the eleven teams to progress to the final event.

The winner was Tartan Racing, a team from Carnegie Mellon University, General Motors Corporation, Caterpillar, Continental and others, based in Pittsburgh, Pennsylvania. Second place went to Stanford Racing Team from Stanford University in California. The third place team was Victor Tango from Virginia Tech in Blacksburg, Virginia.

The DARPA web site for the Urban Challenge is http://www.darpa.mil/grandchallenge/index.asp.

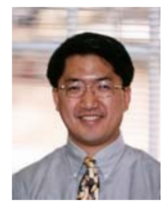
"Boss," Tartan Racing


OSU-ACT
"ACT (Autonomous City Transport),"

"AnnieWay," Team AnnieWay

"TerraMax," Team Oshkosh Truck

TECHNICAL CONTRIBUTIONS



Brian Park

The Associate Editor for Technical Contributions is Byungkyu "Brian" Park from the University of Virginia. The technical contributions section introduces state-of-the-art research and/or state-of-the-practice applications in the area of Intelligent Transportation Systems.

We are especially interested in receiving contributions from non-ITSS members and promoting interactions among sister societies within IEEE and other organizations advocating ITS. Original contributions, excerpts from IEEE Journals (with permission) and reprints from recent IEEE conferences (except those hosted by ITSS) can be submitted for consideration for publication in this section. Please send your contribution to bpark@virginia.edu.

Angelos Amditis

The Associate Editor for Research Programs is Angelos Amditis from the Institute of Communications and Computer Systems (ICCS) at the National Technical University of Athens, Greece.

If you are interested in submitting a paper in this section, please send a short one page text with focus on the overview of research results and activities world wide.

Please send your contribution to a.amditis@iccs.gr.

This Newsletter contains two technical articles.

FreeSim – A Free Real-Time V2V and V2I Freeway Traffic Simulator
by Jeffrey Miller, Department of Computer Systems Engineering. University of Alaska, Anchorage

and

PTC-VANET Interactions to Prevent Highway Rail Intersection Crossing Accidents,
by Mark Hartong, Department of Information and Software Engineering, George Mason University, Fairfax, VA; Rajni Goel, Department of Information Systems and Decision Sciences, Howard University, Washington, DC; Csilla Frakas, Department of Computer Science and Engineering, University of South Carolina, Columbia, SC; and Duminda Wijesekera, Department of Information and Software Engineering, George Mason University, Fairfax, VA.

FreeSim – A *Free* Real-Time V2V and V2I Freeway Traffic Simulator

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Abstract **– In this paper I describe FreeSim, which is a fully-customizable macroscopic and microscopic free-flow traffic simulator. FreeSim allows for multiple freeway systems to be easily represented and loaded into the simulator as a graph data structure with edge weights determined by the current speeds. Traffic and graph algorithms can be created and executed for the entire freeway system or for individual vehicles, and the traffic data used by the simulator can be user-generated or be converted from real-time data gathered by a transportation organization. The vehicles in FreeSim can communicate with the system monitoring the traffic on the freeways (V2I) or with other vehicles (V2V), which makes FreeSim ideal for ITS simulation and testing of protocol designs. A centralized and a distributed peer-to-peer architecture are both described and supported by FreeSim, and I analyze the bandwidth required in each architecture. I present four graphs showing the amount of time to converge upon a fastest path with different percentages of vehicles transmitting their speed and location in the V2V approach. With only 10% of the vehicles transmitting speed and location data, the V2V distributed architecture can produce close to as accurate of results as the V2I centralized architecture, though requiring less than 10% of the bandwidth. FreeSim is licensed under the GNU General Public License, and the source code is available for download from http://www.freewaysimulator.com.**

I. INTRODUCTION

Simulators provide a convenient way for testing a specific application before deploying it in a live environment. With intelligent transportation systems (ITS), traffic simulators are used to try to determine what the result will be before a specific application is deployed within a transportation system. Traffic simulators can be classified as macroscopic or microscopic, depending on whether they simulate the overall flow of traffic within a transportation system or are focused on individual vehicles within the system. In this paper, I describe an open-source traffic simulator called FreeSim, which provides both macroscopic and microscopic capabilities while supporting vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) architectures.

FreeSim [21-23] is a freeway traffic simulator licensed under the GNU General Public License (GPL) [1]. FreeSim's graphical user interface (GUI) runs within a web browser using the Adobe Flash plug-in and connects to a Java-based server application via a socket. The Java code uses a MySQL database for any persistent storage needed.

FreeSim allows for different freeway systems to be easily represented by a graph data structure. The data needed to represent the graph of a freeway system in FreeSim are the distances of the freeway segments (edges) and the nodes to which the freeway segments connect (vertices). From the nodes and vertices, the freeway system will be rendered in a GUI with the amount of time necessary to traverse each freeway segment determined by the distance and the speed of that segment.

FreeSim was created for intelligent transportation systems that gather data from individual vehicles traveling within the freeway system. The vehicles are independent entities that execute as separate threads, communicating with the simulator or other vehicles as they desire. When communicating with a central server, as the vehicles are traversing freeway segments, they can send their current speed and location to a central server. They can also request the shortest path to their destination or the fastest path based on the current speeds. Once they receive the updated path, the vehicles can make their own decisions as to whether or not to change their current path. When communicating with other vehicles, each vehicle will receive data about the speed and location of other vehicles and can make local path routing decisions. This approach decentralizes the path routing and allows individual vehicles to implement their own routing algorithms.

FreeSim provides extensibility by allowing programmers to create their own algorithms to run on the data in the simulator. Shortest path algorithms based on distance and fastest path algorithms based on time can easily be created by implementing two methods. These algorithms can be implemented in the central server for all vehicles to use or in individual vehicles. Six fastest path algorithms are already implemented in FreeSim: Dijkstra's Algorithm [2], Bellman-Ford's Algorithm [3,4], Johnson's Algorithm [5], and the three All-Pairs All-Paths Pre-Computed algorithms [6].

Further, FreeSim allows user-generated data or real data, such as that gathered by a transportation organization, to be used to update the edges in the graph during a simulation period. The progress of individual vehicles or the status of the freeway system as a whole can then be tracked to see how the travel times and congestion change with the updated data.

The remainder of the paper is organized as follows. In section II, I provide a description of the related work and other traffic simulators, and section III gives an overview of

FreeSim. Section IV describes the centralized and the distributed architectures supported by FreeSim. Section V compares the centralized (V2I) and distributed (V2V) architectures and provides advantages and disadvantages of each. Section VI identifies a number of questions that FreeSim can answer, and the conclusion is given in section VII.

II. RELATED WORK

Many transportation applications currently exist and are still being developed. I have classified seven popular traffic applications (CORSIM/TSIS [7,8], FreeSim [21-23], MITSIM [9], PARAMICS [10], RENAISSANCE [11], VATSIM [12], and VISSIM [13]) into eight different categories: platform, source code availability, cost, transportation network, underlying method of use, vehicle model, data input manner, and data gathering manner. Table 1 provides a summary of this data.

The "Application" field provides a list of the different traffic applications I am comparing with the organization that created the application in parentheses. CORSIM is the only application created for a government organization, which is the United States Federal Highway Administration (FHA). FreeSim, MITSIM, RENAISSANCE, and VATSIM were created by universities, and PARAMICS and VISSIM were created and are supported by private companies. In addition, all of the applications are simulators other than VATSIM, which is the only application designed to run in a driving emulator. Although all of the applications could be used in a driving emulator, the rest of the applications are considered simulators since they are attempting to model a transportation system and show the system based on a certain vehicle model. Maroto, et.al., provide a good overview of other driving emulators, as well as providing another driving emulator with a new driver model in [15].

The "Platform" shows on which operating system the application will run. There is close to an even split between the Windows and Linux applications, and FreeSim allows execution on any operating system since the entire application is written in Flash and Java, which are platform independent.

The "Source Code Availability" is critical for determining how extensible the application is. FreeSim and MITSIM are both open-source, licensed under the GNU GPL [1] and the MITSIMLab Open Source License [14], respectively. The other applications are extensible, but only based on the application programming interface (API) provided by the developers of the software.

The "Cost" data happens to correspond directly with the "Source Code Availability" data, where applications that are open-source are also provided for free, whereas applications that do not provide source code require a fee for licensing.

The "Transportation Networks" field describes the types of roadways that are available in the applications. All of the applications support free-flowing roadways (such as freeways, highways, interstates, etc.) and CORSIM, MITSIM, PARAMICS, VATSIM, and VISSIM all support traffic-regulated roadways, such as roads with traffic signals, stop signs, toll booths, etc. VISSIM also allows railways, bicycle traffic, and pedestrians.

The "Vehicle Model" specifies whether the application shows the transportation system from a bird's eye view (macroscopic) or as viewed by an individual vehicle (microscopic). RENAISSANCE is the only application that solely models the vehicles macroscopically, and FreeSim and VISSIM both allow for macroscopic and microscopic modeling of vehicles. An overall view of the transportation system can be seen, and an individual vehicle's progress can be tracked in those simulators.

The "Data Input Manner" describes whether the data used to determine the locations and speeds of the vehicles is done continuously or just by giving their speed at a discrete location and then having the vehicle maintain that speed until the next discrete location in its path. VATSIM simulates a continuous flow since the vehicles in the application change speeds using algorithms based on the vehicles surrounding them coupled with a psychological driver-behavior algorithm. MITSIM and RENAISSANCE use discrete data; however they extend the discrete data to be uniformly continuous through an algorithm such as the traffic state estimator algorithm. For more information on how MITSIM and RENAISSANCE convert discrete data into uniformly continuous data, refer to [9] and [11], respectively. FreeSim allows the data being sent to the vehicles to be continuously updated by the application, and then each individual vehicle can decide whether or not to respond to the received information.

The "Data Gathering Manner" describes how the data is gathered while the simulation is executing. In FreeSim, the individual vehicles communicate their speed and location back to the application or to other vehicles, which is then fed into the algorithms for updating the fastest paths for all of the vehicles. As in the other applications, the data is also gathered in a traditional manner, similar to the way in which transportation organizations use loop detectors, video cameras, or other devices measuring data at discrete locations.

Although each of the applications described have certain advantages over other applications, FreeSim provides three main advantages. First of all, FreeSim is open-source and free to download. Second, the data used to simulate the vehicles in the freeway system can be sent in a continuous or a discrete manner. And finally, which is the main reason I created my own simulator rather than using an existing one, FreeSim allows communication between a central system and each individual vehicle or between vehicles. Much of the research concerning intelligent transportation systems assume that the vehicles are able to communicate autonomously with mobile or stationary devices, and FreeSim, unlike other simulators, has this feature built into the framework.

III. FreeSim OVERVIEW

FreeSim is a traffic simulator that models free-flowing transportation systems as weighted directed graphs. The edges of the graph are the freeway segments that the user would like to monitor, and the nodes are the connections between the

TABLE 1. SIMULATOR CHARACTERISTICS

Application	Platform	Source Code Availability	Cost	Transportation Networks	Vehicle Model	Data Input Manner	Data Gathering Manner
CORSIM/TSIS (FHWA)	Windows	Closed	Paid	Free-Flowing (FRESIM), Regulated (NETSIM)	Micro	Discrete	Traditional
FreeSim (USC)	Any	Open	Free	Free-Flowing	Macro Micro	Continuous, Discrete	Individual Vehicles, Traditional
MITSIM (MIT)	Linux	Open	Free	Free-Flowing, Regulated	Micro	Discrete Transformed	Traditional
PARAMICS (Quadstone Ltd.)	Linux, Solaris, Windows	Closed	Paid	Free-Flowing, Regulated	Micro	Discrete	Traditional
RENAISSANCE (Technical Univ. de Crete)	Windows	Closed	Paid	Free-Flowing	Macro	Discrete Transformed	Traditional
VATSIM (Ohio State Univ.)	Linux	N/A	N/A	Free-Flowing, Regulated	Micro	Simulated Continuous	Traditional
VISSIM (PTV)	Windows	Closed	Paid	Free-Flowing, Regulated, Railways	Macro (VISUM) Micro	Discrete	Traditional

segments. There is no limit as to how many edges can emanate from a node, although in most freeway systems this number will not exceed more than about eight (i.e. a 4-freeway interchange like the 4-level interchange in Los Angeles that connects the 5, 10, 60, and 110 freeways). A freeway system is stored in a database with FreeSim, though there is a second program bundled with FreeSim for reading a list of nodes and a list of edges that define a freeway system from text files and populating the database accordingly. Multiple freeway systems can be stored in the same database with unique identifying names.

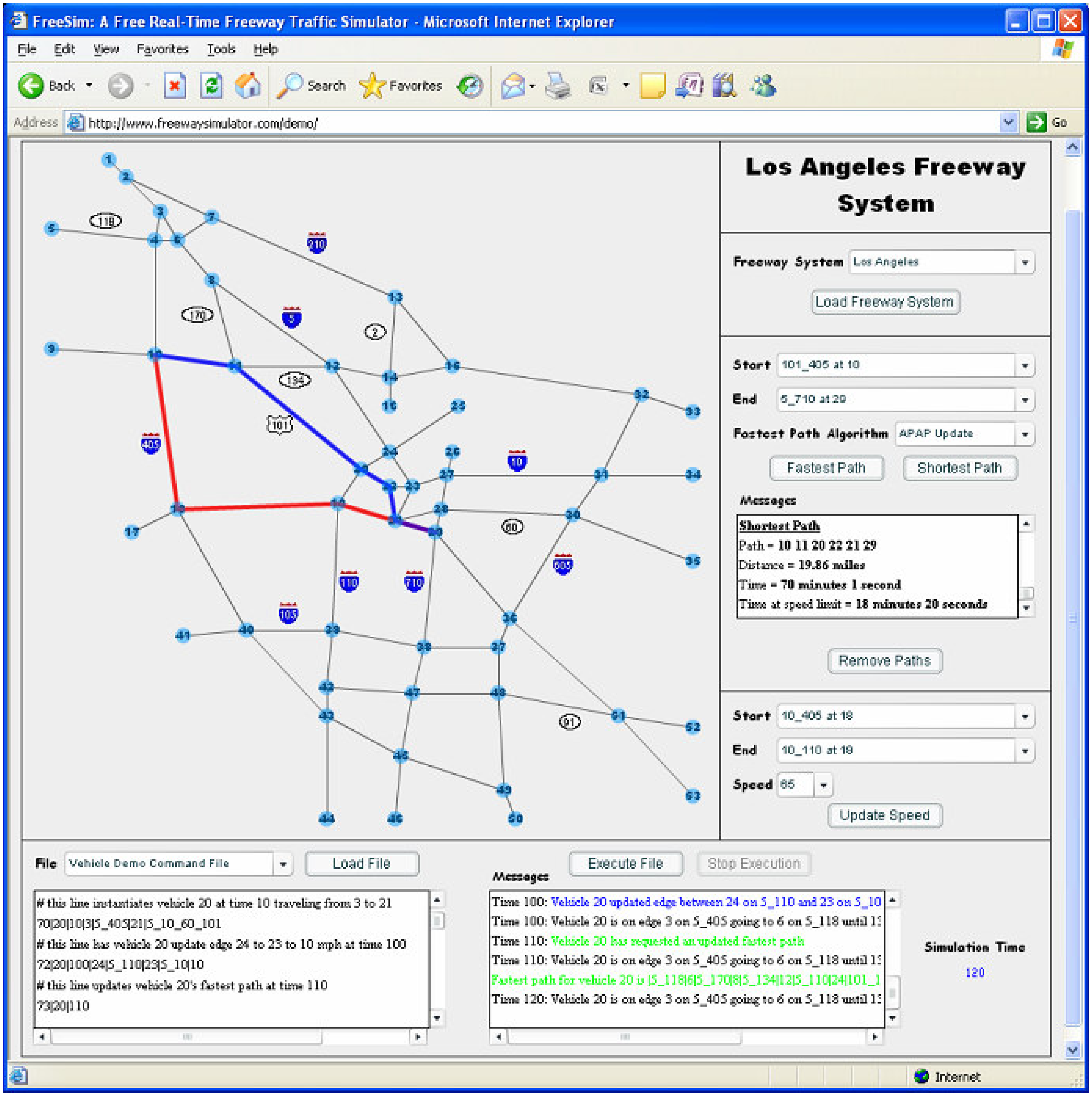
The graphical user interface for FreeSim renders a freeway system in a browser via the Adobe Flash 8 plug-in (see Figure 1). Over a socket connection, the Flash front-end connects to a Java-based server program for all of the simulator functionality. The Flash interface merely provides a light-weight GUI for displaying the output of the simulator.

FreeSim allows shortest paths and fastest paths to be determined based on distance or current speeds, respectively. The shortest paths between all pairs of nodes are determined at start-up using Johnson's algorithm [5], although the fastest path must be determined at query time since it will change based on the current speeds. Fastest path algorithms can be created and executed in FreeSim quite easily by registering a Java class with the traffic simulator that implements two methods – one for retrieving a fastest path from a source node to a destination node, and one for updating the weight of an edge with a new speed. A graph data structure containing the freeway system is also accessible by the class. The method for retrieving the fastest path is called when a user or vehicle requests a fastest path, and the method for updating the weight of an edge with a new speed is called when the speed on an edge is updated to a speed for which the difference is greater than a certain threshold, as defined in [6]. FreeSim already has six fastest path algorithms implemented: Dijkstra's Algorithm [2], Bellman-Ford's Algorithm [3,4], Johnson's Algorithm [5], and the three All-Pairs All-Paths Pre-Computed algorithms [6]. Dijkstra's and Bellman-Ford's algorithms do not have any actions associated with an edge update, but rather re-compute the fastest path from the source node when a query is made. Johnson's algorithm re-computes the fastest paths between all pairs of nodes when an edge update occurs, which allows an efficient fastest path retrieval upon query. The All-Pairs All-Paths algorithms are more suited for dynamic edge weights, where one of the algorithms executes with a constant edge update time, one with a constant query time, and one that combines the previous two algorithms. The efficiency of these algorithms lies in the static nature of the freeway graph, where the only changing factor is the weights of the edges. Freeway sections are not added or removed very frequently.

In the FreeSim interface, the speed on an edge can be updated, which causes the method for updating the weight of an edge to be called for all of the fastest path algorithms that have been registered with the traffic simulator. The speed and time to traverse each edge at that speed can be viewed by placing the mouse on the top of a node. Those speeds and times will change in real-time as the simulator receives speed updates from vehicles.

In addition to the user being able to find shortest and fastest paths and update the speed on a freeway segment, FreeSim also allows a user to have a series of commands

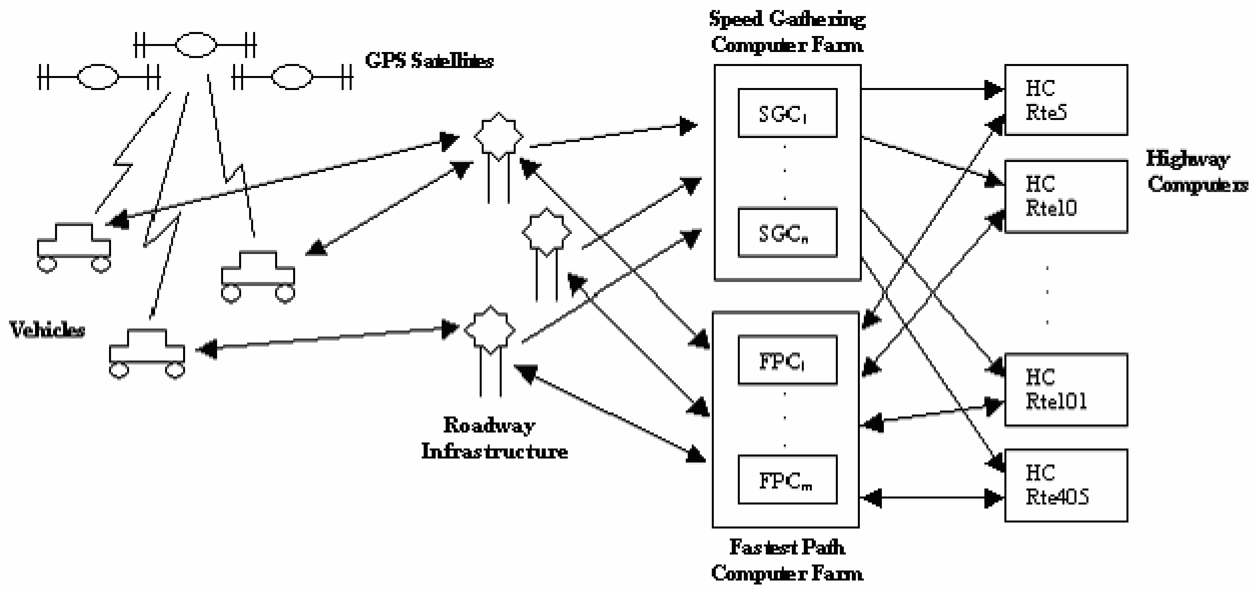
FIGURE 1. SCREENSHOT OF FreeSim GUI



executed simultaneously during a simulation. A file can be created that allows a user to specify different events that will occur at discrete times during the course of a simulation. Among these events are vehicles being inserted into the freeway system at a certain source node bound for a destination node, vehicles sending updated speeds for a specific edge, vehicles requesting a new fastest path based on the current speeds, and messages that allow a user to track the progress of a vehicle along its path and see the messages this vehicle is sending to other vehicles. Since the vehicles are autonomous entities, they also can change their paths or destinations while traveling in the system.

One possible use of this input file is to load the freeway system with live speed data, such as that gathered by a transportation organization. The data obtained by loop detectors can be used to obtain the speed of the vehicles crossing that detector during a given time period [16, 17], which can then be used to create the input file to be executed by FreeSim. This gives FreeSim the ability to simulate the traffic within a freeway system based on live data. With this

FIGURE 2. FreeSim CENTRALIZED ARCHITECTURE (V2I)



approach, FreeSim does not generate any traffic data of its own, which removes the concern that it does not accurately simulate real traffic within a freeway system.

IV. DIFFERENT ARCHITECTURES

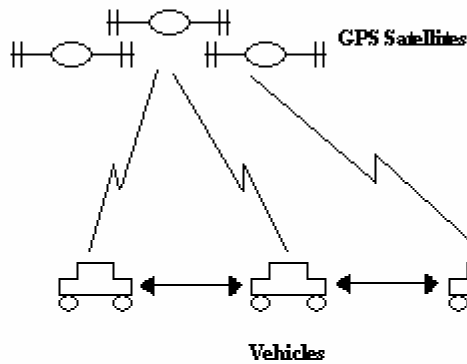
FreeSim supports V2I (vehicle-to-infrastructure) and V2V (vehicle-to-vehicle) communication. When communicating with the roadway, FreeSim uses a centralized architecture, such as that shown in Figure 2. When vehicles are communicating with each other, FreeSim uses a distributed peer-to-peer architecture, such as that shown in Figure 3. In both architectures, the vehicles are still operating as autonomous entities, so they can make their own routing decisions and choose what data to transmit to the roadway or other vehicles. They can also choose whether or not to take the advice they have received and change their current path.

FreeSim's centralized architecture could leverage the multi-billion dollar cellular network that already exists along most highways in the world. The architecture assumes that each vehicle is capable of retrieving its geographical location from a Global Positioning System, which is represented as the GPS Satellites in the diagram. For updating a vehicle's speed in the system, the vehicle will send its location and speed (which can be retrieved from the vehicle's computer system or by triangulating a delta in distance during an elapsed time) via cellular towers to the Speed Gathering Computer Farm. The Speed Gathering computers will receive as input a (latitude, longitude) pair and the speed of the vehicle at that location. No output is required, as the vehicle is not requesting any information. The Speed Gathering computers will then map the (latitude, longitude) pair to a highway and forward the location and speed to the corresponding Highway Computer (i.e. HC Rte 10). The Highway Computer will store the data for retrieval by a Fastest Path computer.

For retrieving a fastest path in the FreeSim centralized architecture, each vehicle still needs to be capable of retrieving its location from a Global Positioning System. The driver will enter the desired destination, which will be transmitted along with the current location via a cellular link through a cellular tower to the Fastest Path Computer Farm. The Fastest Path computers will take as input the source location and the destination location. These locations will be mapped to locations on the highway to allow the paths between those two points in the highway graph to be determined. The Fastest Path computers will then request the speed information for each edge in the paths from the corresponding Highway Computer, which will be used to determine the fastest path to be returned to the user.

The FreeSim distributed peer-to-peer architecture will work similarly to the centralized architecture, though the Fastest Path and Highway Computers will exist virtually within each vehicle. When a vehicle is ready to send an updated speed, it will first map its location to an edge of the freeway graph. Only if the speed is different than the speed currently stored for that edge will the vehicle transmit its updated speed to its peers. The peers will average the speed transmitted with their own speed (if the speed is for the same edge they are traversing), and retransmit the speed to all peers other than the one that sent it to them. For all of the vehicles that are not traversing that edge, they will merely update the speed for that edge in their local database. Each vehicle will then be able to make a local decision about fastest paths. There is no need to transmit fastest path information to any other vehicle, and no fastest path queries need to be transmitted. The V2I and V2V architectures both have advantages and disadvantages, and so both the centralized and distributed approaches are supported by FreeSim.

FIGURE 3. FreeSim DISTRIBUTED PEER-TO-PEER ARCHITECTURE (V2V)



V. ARCHITECTURE COMPARISON

The centralized and distributed architectures both have certain advantages over the other. The centralized architecture allows for historical tracking of traffic data over time since it can retain all of the data that is sent to it by all of the vehicles. The distributed architecture does not have this capability unless a mobile device is always in the network and stores all of the data that it receives. On the other hand, with all centralized systems, there is a single point-of-failure, whereas the distributed system will still operate rather accurately even if a mobile device is not responding or is transmitting incorrect data.

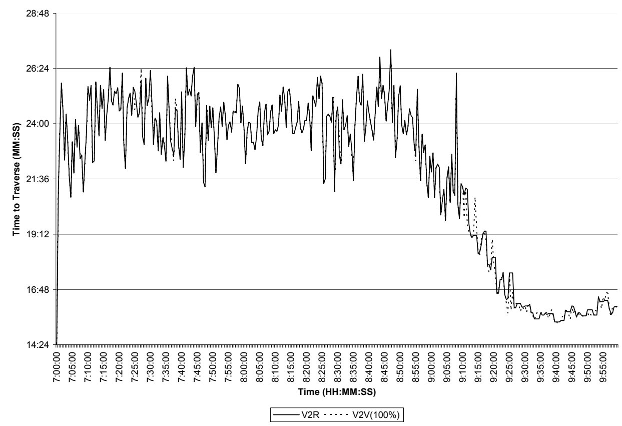
Assuming that the data being transmitted from the vehicles is correct, the centralized architecture will have an accurate representation of the freeway system as soon as it receives a transmitted speed from a vehicle. The distributed architecture will also be able to have an accurate representation of the freeway system if every vehicle is transmitting its speed and location to every other vehicle within the freeway system. However, this is not feasible based on the available bandwidth.

In the Los Angeles freeway system, there can be up to 1 million vehicles traversing the freeways at any point in time [24]. For the Speed Gathering application, 1 byte will be sufficient for transmitting the speed, and 8 bytes will suffice for sending the (latitude, longitude) pair. I will also assume 40 bytes of packet overhead since that is the size of a TCP packet header. Assuming that the vehicles transmit their speed and location to the central server every x seconds, the bandwidth required by the central server is 373.84/x Mbps.

For the Fastest Path application, the path from the vehicle's current location to its desired destination will be returned, which consists of the vertices necessary to traverse. Assume each vertex can be represented by 2 bytes, the length of the path will contain no more than 1000 vertices in a typical freeway system, and the path is requested every y seconds, then the total bandwidth required by the central server to transmit fastest paths is 16/y Gbps. The total bandwidth required by the central server to receive fastest path requests from the vehicles is 352/y Mbps.

Each individual mobile device in the centralized architecture will require 392/x bps for transmitting its speed and location to the central server, 369/y bps for sending fastest path requests to the server, and 17/y Kbps for receiving fastest paths back from the server.

FIGURE 4. TIME TO TRAVERSE FASTEST PATH V2I vs V2V (100%)



The distributed architecture is slightly different, since there is no reason for fastest paths to ever be requested or transmitted. However, each mobile device must be able to send its own speed and location, which requires 392/x bps, but receiving the speeds from all of the vehicles in the freeway system will require up to 374/x Mbps. This bandwidth is only required if every vehicle is transmitting its speed to every other vehicle. If 50% of the vehicles are transmitting their speed and location to other vehicles, then the bandwidth required is only 187/x Mbps. If only 10% of the vehicles transmit their speed and location to other vehicles, then the bandwidth required is only 37.4/x Mbps. The problem that then arises is how accurate will the graphs be that are maintained by the individual vehicles if they are only receiving speeds and locations from 10% of the vehicles? Figures 4, 5, 6, and 7 show the accuracy based on different percentages of vehicles transmitting their speed and location. The data being displayed in those figures are from the California Department of Transportation's loop detectors installed in District 7, which is the district that encompasses the Los Angeles area. The data is from Friday, November 3, 2006 between the hours of 7:00a.m. and 10:00a.m. This is the time that is popularly known as "rush hour" in Southern

FIGURE 5. TIME TO TRAVERSE FASTEST PATH V2I vs V2V (10%)

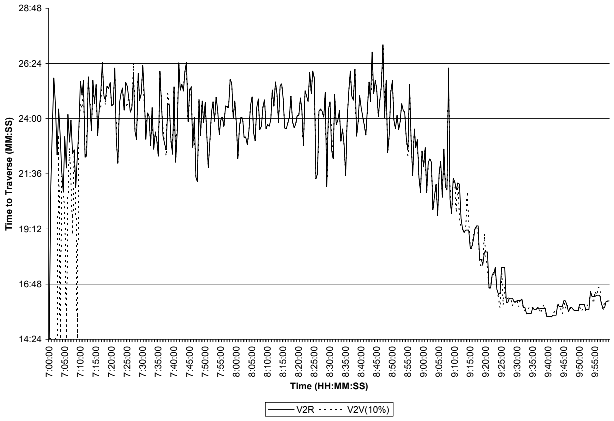


FIGURE 6. TIME TO TRAVERSE FASTEST PATH V2I vs V2V (5%)

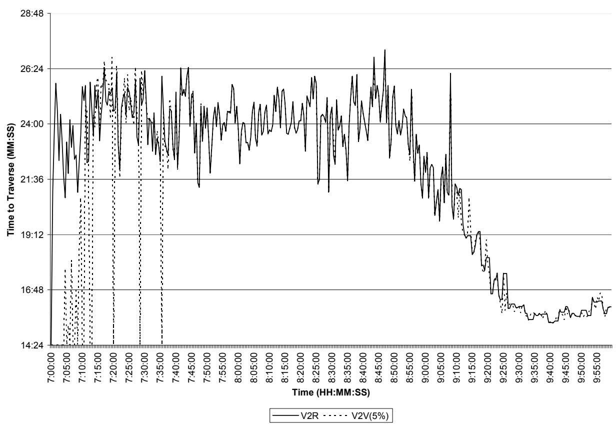


FIGURE 7. TIME TO TRAVERSE FASTEST PATH V2I vs V2V (1%)

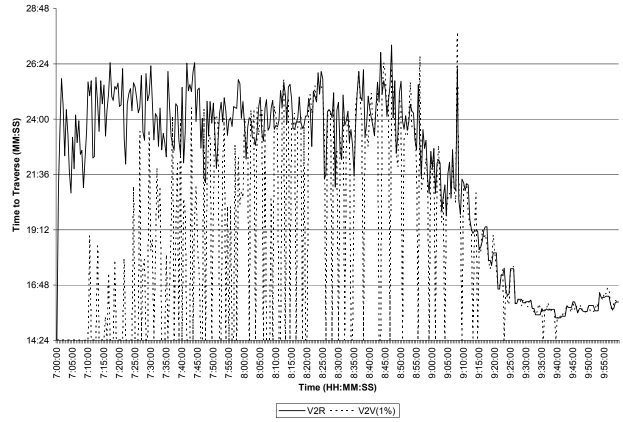
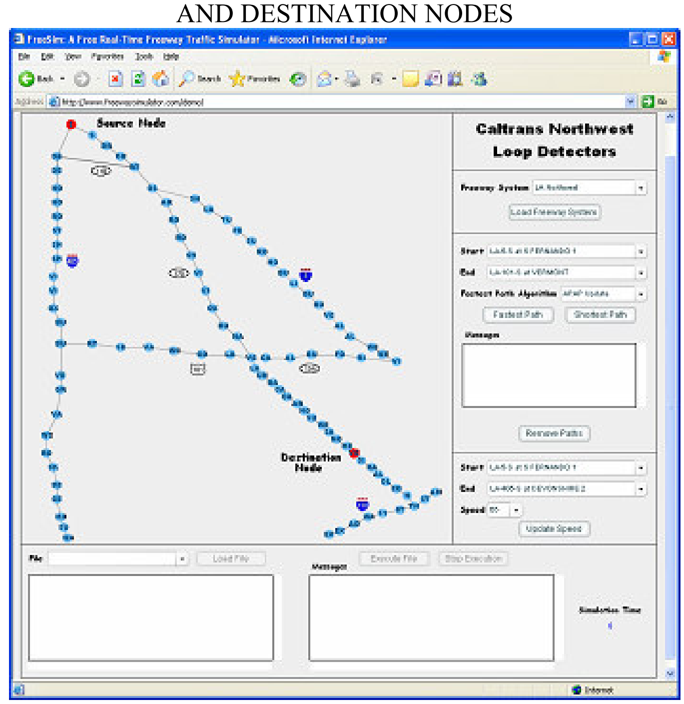


FIGURE 8. FreeSim FASTEST PATH SOURCE AND DESTINATION NODES



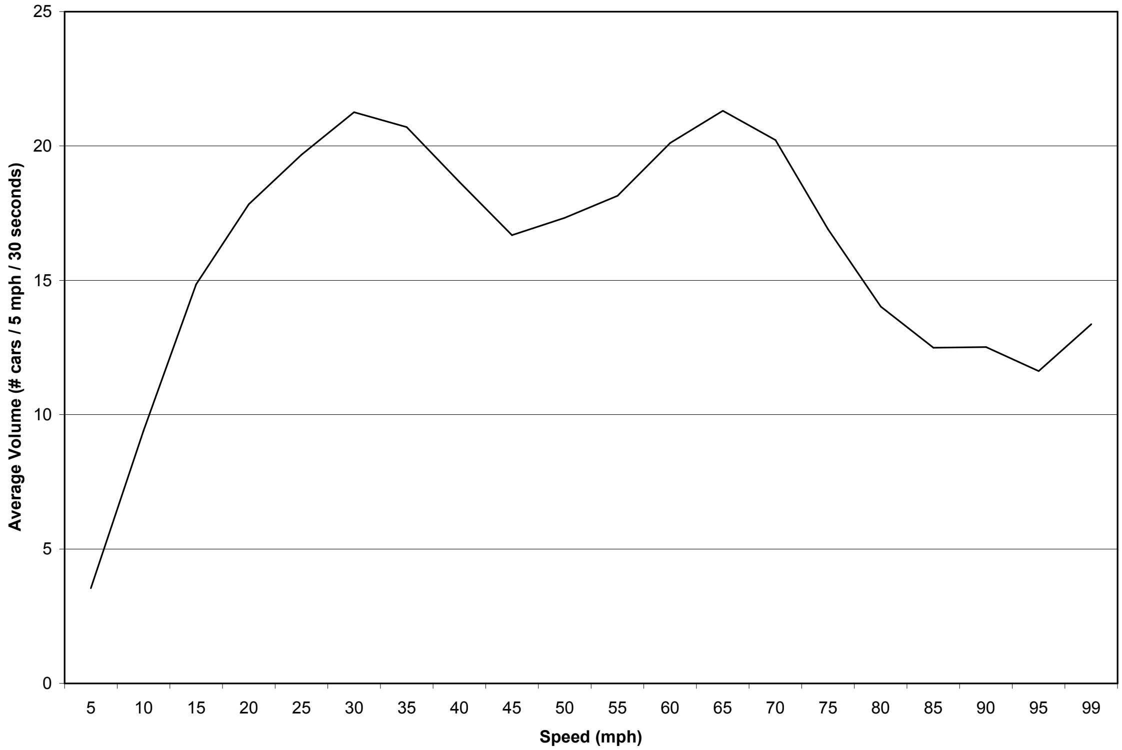
California since traffic is at its worst between those hours. The data was gathered from 768 loop detectors reading data every 30 seconds. The Caltrans' data was fed into FreeSim [21-23], which simulates the traffic within a freeway system and allows a programmer to analyze the output based on specific input. The speeds on the edges are updated every 30 seconds based on the Caltrans' data, and I used this data to determine the fastest path between two points in the freeway system at 30-second intervals during the time period specified. Figure 8 shows a screenshot of FreeSim depicting the source and destination nodes for the fastest paths used.

In the graphs of Figures 4, 5, 6, and 7, the solid line shows the time to traverse the fastest path at each time based on the centralized V2I architecture. The dotted line in Figure 4 shows the time to traverse the fastest path at each time in the distributed V2V architecture with 100% of the vehicles transmitting their speed and location. The amount of time to traverse the fastest path from the source node to the destination node is almost exactly the same, which should be the case since each vehicle has an entire representation of the speeds on all of the edges in the freeway system.

The dotted line in Figure 5 shows the time to traverse the fastest path at each time in the distributed V2V architecture with 10% of the vehicles transmitting their speed and location. The data between 100% of the vehicles transmitting their speed and location to 10% of the vehicles transmitting their speed and location are very similar. In Figure 5, the fastest path is incorrect for about the first 10 minutes. This is because the longer a vehicle is in the network, the more accurate the speeds become since the speeds on each edge change gradually over time. When a vehicle comes into the network, it takes time before it receives speeds from every edge so that it can accurately determine the fastest path.

Figure 6 shows the time to traverse the fastest path at each time in the distributed V2V architecture with 5% of the vehicles transmitting their speed and location. This graph shows that it takes approximately 35 minutes to stabilize before the fastest paths reported by the V2V architecture come

FIGURE 9. VOLUME OF VEHICLES DURING RUSH HOUR (BETWEEN 7:00A.M. AND 10:00A.M.) IN LOS ANGELES FREEWAY SYSTEM ON 2006-11-03



close to matching the fastest paths reported by the V2I architecture.

Figure 7 shows the time to traverse the fastest path at each time in the distributed V2V architecture with 1% of the vehicles transmitting their speed and location. The fastest paths for the V2V architecture never appear to converge upon the fastest paths for the V2I architecture, which shows that more than 1% of the vehicles must be transmitting their speed and location for the V2V approach to produce accurate fastest paths.

VI. FreeSim SIMULATIONS

FreeSim has been executed with user-generated data and live data gathered from the California Department of Transportation (CalTrans). Any research based on vehicle travel times would be relatively easy to conduct within FreeSim, such as determining the optimal time of the day to travel based on the speeds or occupancy of the freeway system or observing the change in time to travel based on the time of the day at which a vehicle departs from a location. Determining the optimal speed of vehicles to provide the maximum throughput for a specific freeway system could also be measured, as was reported in [20] for the Los Angeles freeway system between midnight and noon. However, during rush hour (between the hours of 7:00a.m. and 10:00a.m. on weekdays), FreeSim has shown that the maximum throughput occurs at both 30 mph (~48 km/h) and 65 mph (~105 km/h), with 21 vehicles passing a point within a 30-second period at both speeds (see Figure 9). This could be attributed to the fact that drivers feel safer driving closer to each other at slower speeds, so more vehicles are able to pass a specific point in the same time span. At a time that experiences maximum throughput, at 30 mph, each vehicle will have 44 feet (~13 meters) between itself and the vehicle in front of it; at 65 mph, each vehicle will have 118 feet (~36 meters) between itself and the vehicle in front of it.

In addition, any research concerned with the distance traveled during a certain time frame based on changing speeds can be determined. Using the amount of time a vehicle is traveling with the distance traveled during a certain time frame, coupled with average gas mileage of vehicles and price per gallon of gas, the number of gallons of fuel and the amount of money that could have been saved by avoiding traffic can be calculated. All of this data can be used to aid in improving the public transportation systems of a city by providing alternate routes during times of heavy traffic or by giving the systems more accurate arrival and departure times.

Based on the live data gathered by a transportation organization, the added traffic due to an incident (such as a collision, road construction, etc.) can be determined. Alternatively, as an event that attracts a significant number of vehicles begins or ends (such as a sporting event), the effect on the traffic of a freeway system of inserting or removing that many vehicles at a certain node can be measured. Similarly, if a new building were proposed to be built that would attract a number of vehicles each day during a certain time interval, the impact of the added traffic within a freeway system can be simulated. As new freeways are proposed, the overall improvement in the flow of traffic in the entire freeway system can be measured.

From a more theoretical standpoint, graph and traffic algorithms can be tested on user-generated or real traffic data. Shortest path algorithms with changing edge weights (also known as dynamic shortest path algorithms) can be implemented through an API in FreeSim, either at the server for the centralized architecture or in each vehicle for the distributed architecture. Traffic prediction algorithms, such as those in [18] and [19], can not only be tested, but can also be verified against live traffic data. Incident identification algorithms can be executed to determine how long it takes to identify an incident based on real traffic data.

Focusing more on ITS technology, figuring out how many (or what percentage of) vehicles need to transmit their speed and location to a central traffic server or to other vehicles to be able to accurately route vehicles along fastest paths can be determined. With individual vehicles having the ability to communicate as autonomous entities, aggregation algorithms or peer-to-peer approaches can be implemented among the vehicle objects. Having more granular information such as speeds of vehicles in specific lanes gives the ability to determine if lanes are traveling faster than other lanes and therefore saving time for those vehicles.

Although I can not possibly enumerate all of the questions that can be answered using a traffic simulator, this at least provides a few of the open research questions that can be solved using FreeSim.

VII. CONCLUSION

In this paper, I have described FreeSim, which is an open-source simulator that can be downloaded for free from http://www.freewaysimulator.com. The GUI provided with FreeSim is platform-independent and can be run within a browser. FreeSim offers many advantages over other simulators, including the ability to have vehicles autonomously travel within a transportation system while remaining in constant communication with a central system or other vehicles. With many intelligent transportation systems assuming that vehicle speed and location data will be available, FreeSim provides an ideal test-bed for ITS applications.

I have presented two different architectures to support ITS applications – a centralized V2I architecture and a distributed V2V architecture. The centralized architecture has advantages over the distributed architecture in that it can more accurately depict the network at any given point in time and has the ability to show historical traffic data. The distributed architecture does not have a single point-of-failure as the centralized architecture does, and it can require much less bandwidth to transmit speeds and locations to the other vehicles. Transmitting speeds and locations from approximately 10% of the vehicles in the distributed architecture only requires each mobile device to have a bandwidth of 37.4/x Mbps, where x is the frequency in seconds for each vehicle to transmit its speed and location. Using FreeSim, I showed that as the percentage of vehicles transmitting speeds and locations drops below 10%, it takes more than a few minutes to converge on the accurate fastest paths in the freeway system, which may not be acceptable to drivers based on the length of their trips.

FreeSim allows for real traffic data, such as that gathered by transportation organizations, to be used within a simulation, which enables more accurate and credible analyses of traffic scenarios. Two results presented in this paper concern the relationship between V2V and V2I fastest path convergence and the highest throughput for traffic data during rush hour in Los Angeles. Although there are many traffic simulators available, FreeSim is free, open-source (offered under the GNU GPL), fully-extensible, operates on real traffic data, and provides the necessary framework for current and future ITS applications.

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PTC-VANET Interactions to Prevent Highway Rail Intersection Crossing Accidents

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***Abstract*— Vehicular Ad-hoc networks (VANETS) provide distributed real time communication of traffic hazards and road conditions among vehicles in a radio line of sight. We propose using VANETS to securely communicate with Positive Train Control Systems (PTC) in order to reduce Highway Rail Intersection (HRI) incidents. This paper illustrates the similarities and differences between the two systems, discusses previous research into the work already done to integrate the two systems and outlines the additional work necessary to successfully integrate the two systems.**

***Index Terms*— Architecture, Vehicular Ad-hoc Networks, VANETS, Communications Based Train Control, CBTM, Positive Train Control, PTCs, Highway Rail Intersection, HRI, Intelligent Transportation Systems, ITS**

I. Introduction

Communications-based Positive Train Control (PTC) Systems have been under study in the United States since the mid 1990's and still under experimental development [1, 2,3,4,5] with the objective of safely operating trains. They do so by exchanging control and track information between mobile units, fixed wayside devices and control centers. Vehicular ad-hoc networks (VANETS) [6,7,8] are an emergent technology for vehicles on a highway to share road condition, traffic and weather information with the hope of avoiding accidents, and easing congestion. We propose to establish a secure two-way communication between a VANET and a PTC system in the vicinity of highway-rail intersection as a means of avoiding highway-rail intersection (HRI) accidents and congestion. If done appropriately, it can become an integral part of an Intelligent Transportation System (ITS). Doing so requires the development of suitable architectures and protocols, and an analysis of the security and safety implications of the proposed information sharing. This preliminary paper study potential integration architectures and identify properties desired of interoperability standards and protocols.

The primary Use Case for the proposed integration consists of avoiding HRI crossing accidents. This Use Case requires trains informing vehicles of the train's proximity to the crossing and vehicles stuck on rail tracks informing incoming trains of their plight in order to avoid accidents. Secondarily, large traffic volumes on either side may be rerouted to avoid forming convoys and long delays on either side. However, any information sharing capabilities can be misused with malicious intent. For example, claiming the existence of a ghost (i.e. non-existent) car on a train crossing or a ghost train approaching an intersection may halt or divert traffic from that intersection. Blocking warning signals will achieve the opposite objective and constitutes our primary misuse case. Secondarily, vulnerabilities on either side (i.e., VANET [9, 10] and PTC systems [11]) that negatively impact timely functioning of the other side are our secondary misuse case.

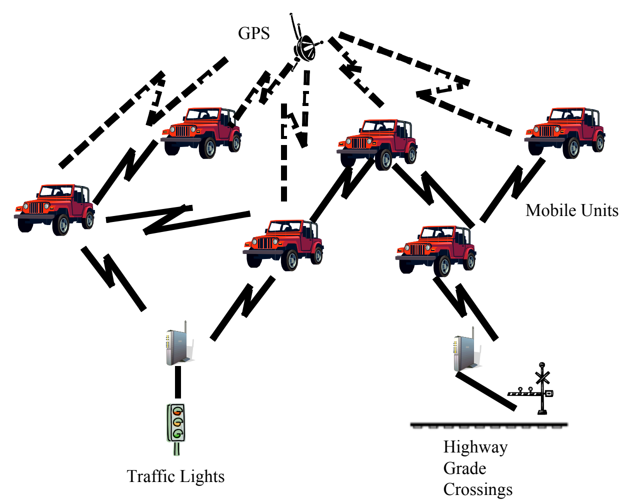

Figure 1: VANET Functionality

The organization of the paper is as follows. Sections II and III introduce VANETS and PTC systems, respectively. Section IV describes related research, Section V addresses issues in integrating PTC with VANETS, and Section VI advocates the need to extend IEEE 1570-2002. Section VII describes further security considerations and Section VIII concludes the paper.

II. Vehicular Ad-hoc Networks

VANETS are self-organizing communities of wheeled mobile units consisting of large numbers of trucks, cars, buses and a small number of static infrastructure nodes such as

Manuscript received September 14, 2006.

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[1]The views and opinions expressed herein are those of the authors and do not necessarily state or reflect those of the United States Government, the Department of Transportation, or the Federal Railroad Administration, and shall not be used for advertising or product endorsement purposes

traffic signals, highway rail grade crossings, and informational signage within radio communication range to each other. Two basic approaches suggested to establish inter vehicle communication (IVC) in the VANET at the physical layer [12] are based on some variant of current wireless LAN technology (WLAN) such as the 802.11 family, Bluetooth, or extensions of 3G telecommunications protocols such a reservation based ALOHA, ULTRA (Universal Terrestrial Radio Access) [13] etc. The preferred method for traffic information dissemination in a VANET is broadcast routing, with otherwise reduced bandwidth consumption. Several information propagation schemes have been proposed for VANETS [14],

VANETS utilizes dedicated short-range communications in the 5.9GHz range in the United States. Proposed communications architectures to facilitate inter vehicle communications includes a standardization effort by IEEE [15,16,17,18], by Fussler et al [19] and Meier [20], abstracted in Figure 1.

III.PTC Systems

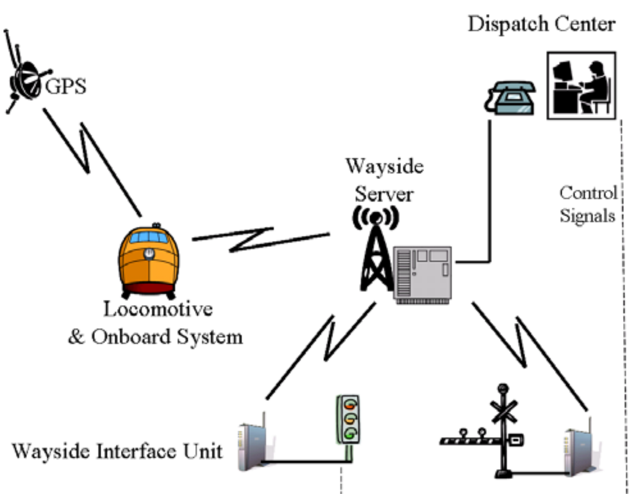

Figure 2: PTC Functionality

PTC systems are designed to prevent train-to-train collisions, enforce speed restrictions, and protect roadway workers and their equipment operating under specific authorities. These basic functions can be augmented with the capability to monitor the status of wayside devices [21, 22] such as highway-rail intersections (HRI) warning systems etc. The basic functional architecture of PTC systems, illustrated in Figure 2, has waysides, mobile, communication and dispatch/control, as main subsystems [23]. Unlike VANETS, PTC systems have many infrastructure nodes relative to the mobile nodes. PTC Systems generally operate in either the 150-160 MHz or 900 MHz frequency spectrum range.

IV.Prior work on preventing HRI accidents

Passive devices (static traffic control devices indicating the presence of an at-grade crossing) and active devices (indicate presence of approaching trains such as flashing signals) exist to prevent HRI accidents. However standardized railway communication [24] between rail and wayside systems does not facilitate direct vehicle-trains interaction.

Using In-Vehicle Alert Systems to communicate crossing status was considered as early as 1975 [25, 26]. Testing such prototypes using indirect wireless communications between has been carried out by multiple agencies from 1995 to 2000 [27, 28, 29]. In these systems, a track circuit detecting a train sends a signal from an antenna attached to the active grade crossing warning system to a vehicle within radio range to inform the driver of (1) the proximity of the vehicle to the crossing and (2) presence of a train at the crossing. These prototypes, while supporting the functionality of ITCS Market Package ATMS14 (Advanced Railroad Grade Crossing) [30], suffer from the lack of vehicle-to-train communication, and are thus incapable of informing the train of vehicles stuck in crossings. The only available method for a vehicle to communicate with a train is for the vehicle driver to call the railroad dispatch office via a toll free phone using instructions posted at the intersections [31].

V.INTEGRATEDVANET-PTC OPERATIONS

We propose four basic approaches to the integration of VANET and PTC systems in the United States (Table 1).

PTC Mobile Unit to VANET Mobile Unit	**PTC Mobile Unit to PTC Infrastructure Component to VANET Mobile Unit**
PTC Mobile Unit to VANET Infrastructure Component to VANET Mobile Unit	**PTC Mobile Unit to PTC Infrastructure Component to VANET Infrastructure to VANET Mobile**

Table 1: PTC-VANET Interoperability Options

Direct two-way communication between PTC Mobile Units and VANET Mobile Unit requires minimal additional equipment, and therefore is the preferred option. In this approach all mobile units of one network will have transceivers operating at the other's frequency to carry out the primary use cases, requiring the PTC systems to use the 5.9Ghz band and the addition of approximately 22,000 dual band railroad equipment just for the Class 1 railroads and Amtrak. This would approach would also require equipping approximately 243 million [32] highway vehicles to use the PTC frequency bands. The dual banding approach warrants significant revisions to ATMS-14 of the ITS architecture that currently precludes direct communication between highway and railway vehicles.

The remaining three approaches use intermediate common infrastructure components placed near HRIs, requiring a large but manageable number of about 250,000 elements [33], and up to 1 million for road and highway segments, each having a 5.9 GHz and 900 Mhz/150-160 GHz transceivers.

Regardless of the chosen approach, when a PTC system comes within communicating range of a VANET near a HRI, it becomes a member of the VANET, either directly or by proxy. However, because of unusually large mass and lengthy stopping distances, the train's movement through the intersection must take precedence over the highway vehicles, thus requiring trains to become *privileged* members of VANETs entitled to a higher priority in communication. Furthermore, multi-track HRIs require coordinated unambiguous broadcasts from multiple trains simultaneously reaching HRIs. Likewise, highway vehicles trapped on HRIs must be elevated to *privileged member* status of VANETs. In order to facilitate these requirements, application layers of existing common messaging sets must be expanded to accommodate such privileged PTC-VANET communications. Although preemptive communications have been used by trains to converse with HRI controllers [34], they have not been used to share data between vehicles and trains.

In order to facilitate these requirements, application layers of existing common messaging sets must be expanded to accommodate such priorities. Currently existing PTC-VANET communications work [35,36,37,38,39,40,41,42,43,44] address VANET communications *sans* trains, or trains *san* VANETS [45, 46]. Current prototype PTC or PTC like systems [47]that can provide HRI intersection protection need to be enhanced to operate with VANET protocols that are currently unsettled.

VI. Extending IEEE 1570-2002

We propose extending IEEE 1570-2002 [24] to cover two-way PTC-VANET communications to prevent HRI accidents. Present IEEE-1570-2 addresses PTC communications and the highway portion of the highway grade crossing system between the onboard rail systems only (Figure 3), using the ISO 7 layer reference model [48]. Under IEEE-1570, specific protocol content and structures are called out for layers 6, 4, and 3, 2 and 1, leaving layers 5 and 7 formats to designer discretion. The protocol is required to support both dedicated point to point and distributed network configurations at data transfer rates of at least 19.2 kbps with payload size not greater than 128 bytes per packet using error detection scheme as defined in ATCS-200./AAR Specification 5-5800 [49]. The support for both direct point to point communications between components (circuit switched) or distributed network configurations (packet switched) is required because this decision is at the discretion of the HRI system designer and the depends upon the HRI, VANET, PTC system components and the available communications network.

Therefore extending IEEE-1570 to support direct two-way PTC-VANET communication requires, at a minimum, that it accepts (1) a common protocol at layers 1, and 2- specifically one of Ethernet, Serial RS-232, Serial RS-4222, or Serial RS485, (2) ATC-200 network datagram over the null, IP, or ATCS protocol at layer 3, (3) ATCS safety critical messages with a ATCS CRC-32 at the layer 4 running over a null, TCP, or UDP protocol (4) HRI messages in accordance with IEEE-1570 clause 5 at layer 6. In addition a common protocol between layers 5 and 7 is also required.

Additional HRI messages at layer 6 for direct PTC-VANET communication can be added because current HRI message set consists of only 12 messages that utilize a complete byte (which allows for the identification of up to 256 messages). Each new message can then be uniquely tailored to support PTC-VANET communication, by renumbering existing HRI messages in case of need.

PTC-VANET interaction messages require at a minimum a message ID, version number, message type, length, sender ID, sender GPS coordinates, message precedence, degree of vitality, vehicles operational status (moving or blocking the crossing), and security parameters. Of these, message priority, sender ID, version number, message size, sending unit identification, and vitality, are already specified as part of the existing message header.

Including vehicles operational status items such as one byte of precedence and 14 bytes for vehicle location (a BCD latitude and longitude in degrees, minutes and seconds) increases the header size by 15 bytes. The 128 bytes of the payload can be used to pass specific messages or cryptographic keys including 128 bytes for authentication. Alternatively, modified authentication schemes based on message authentication codes such as HMAC [50] could be utilized. Detailed specification of an appropriate trust management system is beyond the scope of this paper, dependent upon the particular security policy and its implementation. Any consolidated trust management system must, however, support the requirements laid out in [51].

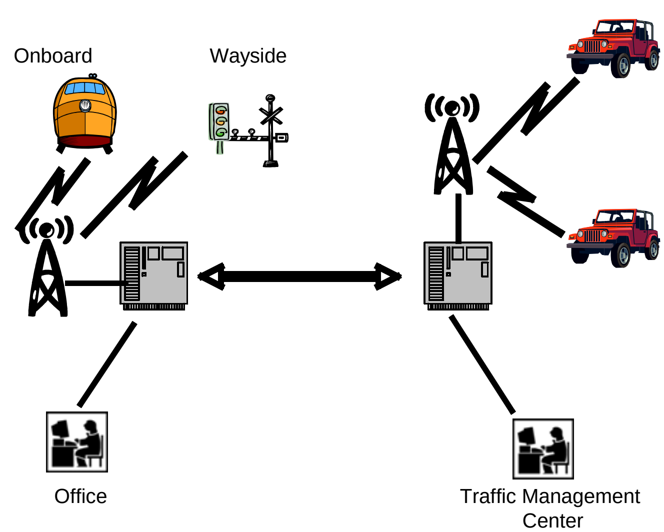

Figure 3: Extending IEEE-1570-2002 Communications

VII. Further Security considerations

Any PTC-VANET interoperation protocol must also address information leakage from PTC systems that can be misused by VANET users, and being wireless, subject to attack. Of these, attacks that have the greatest adverse impact on PTC-VANET interoperations are masquerading, deliberately feeding false information, and cheating with positioning information – in that order. Masquerading is the worse because a mal-actor can foul a HRI by sending an *all clear* to a train or a vehicle while the other is occupying the HRI, resulting in accidents. Further disruptions can be caused by the creating *phantom vehicle* in the cyber-world to stop opposite traffic, for example, a phantom car would make a train stop to ensure the clarity of a HRI. Others include authorized members providing incorrect positions, disclosing other vehicles in order to track their locations, denial of service etc. However, PTC risks can be mitigated to a large extent, primarily because PTC units are custom made and do not have dynamic membership changes and therefore can use stronger security measures [11,51].

Additional topics to be covered include leakage of confidential and private information between the two systems, and analysis of effects of failures. For example, vehicular onboard system failures such as engine, battery back and backup failure also limit the extent and the scope of stated Use Cases.

VIII. Summary

Integrated PTC-VANET systems have the potential of significantly improving rail and vehicular safety around HRIs, and significant prototype work has demonstrated the feasibility of individual technologies. Their integration, with the promise of delivering safety value greater than the sum total, requires significant work at the application and the physical layers. This is indeed the man focus of our current research.

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