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Real-time communications in distributed control systems

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► **To cite this version:**

Ye-Qiong Song. Real-time communications in distributed control systems. Sino-French PRA (Programme de Recherches Avancées) workshop on Information Science and Technology, Nov 2002, Beijing/China, 15 p. inria-00107606

HAL Id: inria-00107606

<https://inria.hal.science/inria-00107606>

Submitted on 19 Oct 2006

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Real-Time Communications in Distributed Control Systems

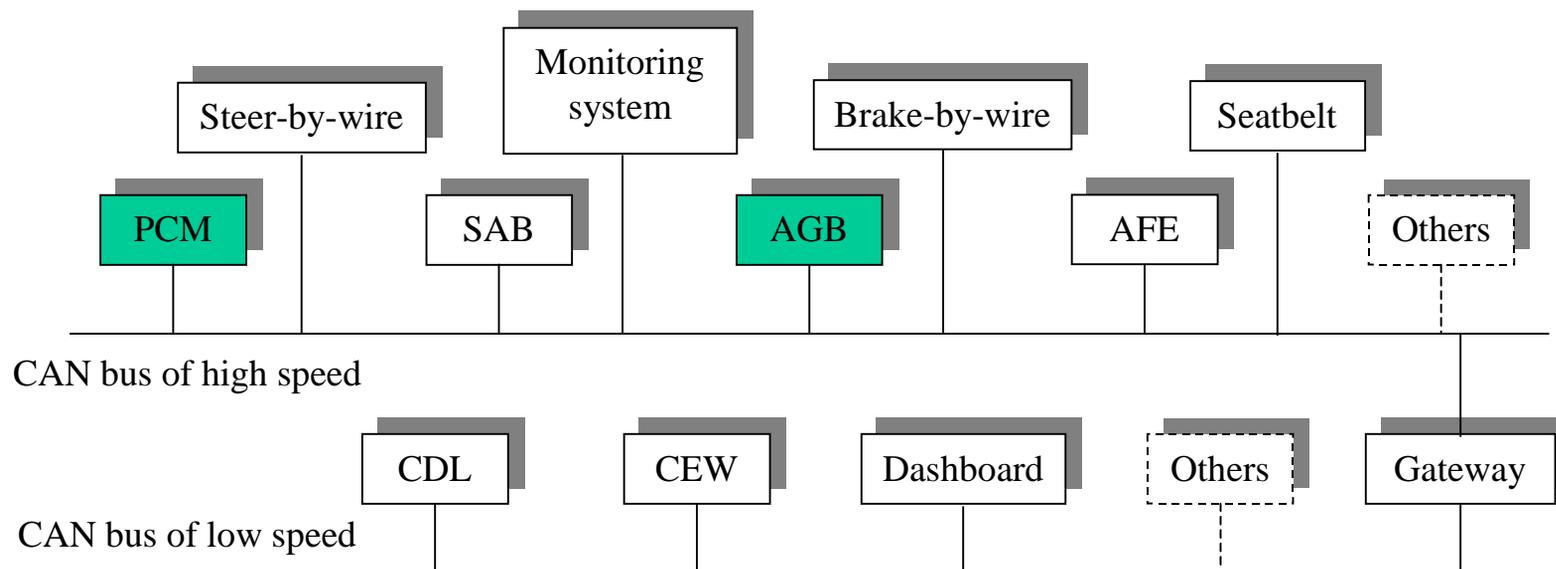
*Yeqiong SONG, Ass. Prof. and INRIA researcher
TRIO Project at LORIA – UHP Nancy 1 - INRIA*

1. PRA SI99-04: In-vehicle embedded systems using CAN (*with WHUT, Li Gangyan*)
2. PRA SI01-04: Factory automation using fieldbus and switched industrial Ethernet (*with Zhejiang Univ., Sun Youxian, Wang Zhi*)

PRA SI99-04: Objective

- Extend existing CAN-based embedded systems for including more functions
 - Defining new functional architecture
 - Performance evaluation to validate new operational architecture (functional architecture mapped on to a support architecture)
 - Dependability evaluation to validate the safety

PRA SI99-04: Results



PCM: Power Control Module

AGB: Automatic Gear Box

SAB: Safety Air Bag

AFE: Automatic Fire Extinction

CDL: Car Central Door Locking

CEW: Car Electric-Windows

PRA SI99-04: Results

- - [1] G. Y. Li, Y. Q. Song, H. S. Jin, “CAN (Controller Area Network) and its Application to Car Central Control System”. *Journal of Wuhan Automotive Polytechnic University*, Vol.22, N°1, pp.6-9, 2000 (In chinese)
- - [2] G.Y. Li, Y.Q. Song, P. Xiao and H.S. Jin, “Monitoring System of Car Information Central Control System”, *4th IFAC International Conference on Fieldbus Systems and their Applications*, pp135-137, Nov.15-16, 2001, Nancy (France), Elsevier Science Publisher

PRA SI99-04: mutual exchanges

- Chinese in France
 - LI Gangyan, 4 months
 - YANG Mingzhong, 3 weeks
 - CHENG Sencheng, 3 weeks
 - JIN Haisong, 2 months
- French in China
 - SONG Yeqiong, 3 weeks
 - SIMONOT-LION Françoise, 1 week

PRA SI99-04: Extended impact

- Internship of Ms. Lu Liping of WHUT at LORIA during one year, financed by the two labs. Her PhD thesis in « cotutelage » between INPL and WHUT will be soon set
- Y.Q. Song is invited prof at WHUT
- In china: Wuhan City International Cooperation Project: “Research of the Car Information Central Control Network Technology and its Application”. No. 13 20017010121
- In France: a PhD thesis (CIFRE) with PSA on « dependability of X-by-Wire »

PRA SI99-04: Anecdotal history

- The idea of this PRA project was born in a pub (bistro du Vélodrome) during the first sojourn of Prof. LI in Nancy (as part of an exchange program between Lorraine and Hubei province), a big amateur of beers
- LORIA was working on in-vehicle embedded systems
- WHUT knows well the electronic control units in a vehicle



PRA SI99-04: future cooperations

- Informal exchanges via emails for supervising the PhD thesis of Ms. JIN Haisong
- PhD thesis of Ms. LU Liping in « co-tutelage » (hope she will get a French Embassy PhD grant in 2003)
- Proposal of another PRA project in 2002

PRA SI99-04: Concluding remarks

- Fruitful pluridisciplinary cooperation within PRA SI99-04 (LORIA in distributed real-time systems and WHUT in automotive)
- More Chinese in France than French in China
- Willing to perpetuate our cooperation. **In which better ways (EU Projects) ?**
- ... *(to be completed by Prof. LI Gangyan)*

Now fly to Zhejiang University



PRA SI01-04: History

- Before PRA, PhD thesis of Wang Zhi in Shenyang Institute of Automation, then his postdoc in Zhejiang University followed by his sojourn at LORIA (Postdoctoral Grant of French Embassy)
- Common research topic: fieldbus (Nancy is the birth place of WorldFIP fieldbus)
- Complementary:
 - **System:** TRIO of LORIA in design, modeling and validation of distributed real-time systems
 - **Application:** NLECT of Zhejiang Univ. in process control and factory automation

PRA SI01-04: Objective

- Study real-time guarantee when replacing traditional fieldbus by switched industrial Ethernet
- Research problems:
 - Performance evaluation
 - Dynamic real-time QoS guarantees
 - admission control mechanisms
 - message scheduling algorithms

PRA SI01-04: Interests for partners

- For France:
 - Higher manpower in this research topic
 - More experimentations of industrial Ethernet in Chinese industry (no past fieldbus history to manage)
- For China:
 - Enhancement of research (against development) in factory communication
 - More opportunities for industrial deployment of research results, as China wants to become the world center of advanced manufacturing (CIMS) and Chinese industry has not past fieldbus history to manage

Real-time guarantees in Switched Ethernet

- HRT (Hard Real-Time)
- SRT (Soft Real-Time)
- *WHRT (Weakly-Hard Real-Time) or (m,k) -firm* : we obtained very interesting results

Just a little bit more
technical presentation

In the future

- Implementation of Matrix-DBP for Switched Industrial Ethernet to provide (m,k) -firm real-time guarantee
- Response time evaluation methods (based on network calculus) for factory communication systems involving both Fieldbus and Ethernet
- More theoretic study on (m,k) -firm [a LIAMA project is proposed in 2002]