X-by-Wire Systems

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1. What's X-by-Wire ?

2. Our Approach

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What's X-by-Wire ?

"Fly-by-Wire" for Automobile

Also called as Drive-by-Wire

1998: Munich

FTCS -28

- Safety-Related Fault-Tolerant Systems in Vehicles (X- By-Wire)
- User Congress on Dependability of Automotive Systems

"Probability of success is 3%. So they are making efforts"
- Hr. Ernst Schmitter, Siemens AG

2004: Detroit

SAE (Society of Automotive Engineers) 2004

- Distributed Embedded Systems Engineering (4 sessions)
- In-Vehicle Networks (3 sessions)

Sorry for absence from Tahiti

Inexpensive Dependability

"Aero-space is no longer high-tech.:
Reliability can be improved with cost.
X-By-Wire is the high-tech., which realizes
dependability with low-cost."

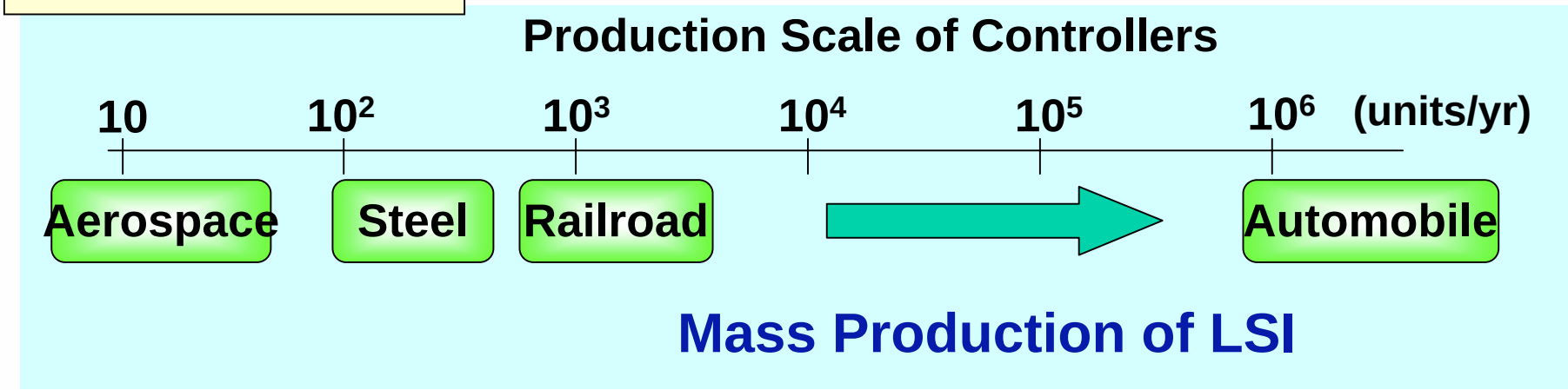
- Prof. M. Broy, Technical University of Munich (FTCS-28)

1. What's X-by-Wire ?

2. Our Approach

Low-Cost Dependable Technology

Cost Reduction



Low-Cost Dependability with LSI Technology

- ✓ **Redundant CPUs in One Chip**
- ✓ **Self-Checking / Failsafe Technology**
- ✓ **Optimal Clock Diversity**

and Autonomous Decentralized Concept

Our Expertise in Dependability

1960 1980 1990 2000

Nuclear Power Plants

Autonomous Decentralized Systems

Space Computer

Gotemba, 1988

FT-Online Transaction Processor

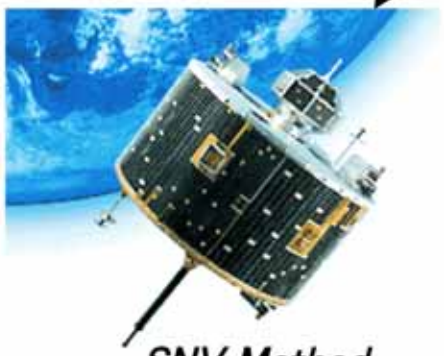
FT6100 3500/FT

Steel Manufacturing

Fly-by-Wire
Fail-Safe Controller

X-by-Wire

Train Control Systems



SNV Method

Hiten, Nozomi Onboard Computer

ATC

Appi, 1996

Electric Railroad Crossing Controller

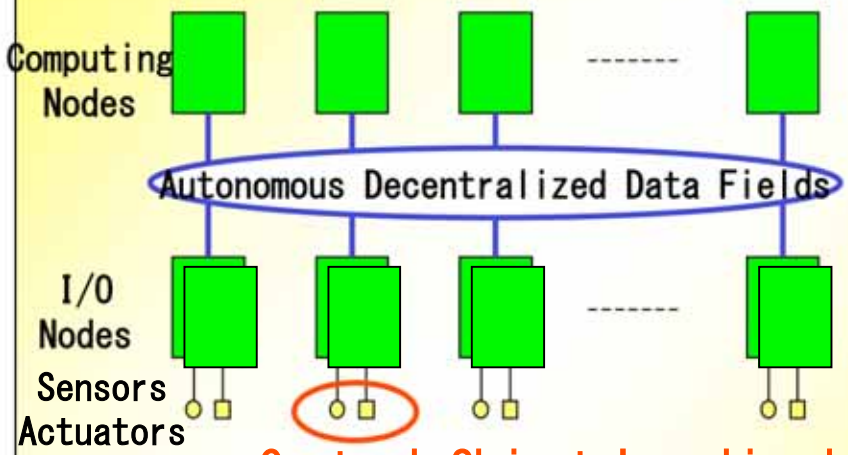
Hakone, 2005

ATOS

SNV: Stepwise Negotiating Voting, ATC: Automatic Train Controller,
FTC: Fault-Tolerant Computer
ATOS: Autonomous Decentralized Transport Control System

Autonomous Decentralized Systems

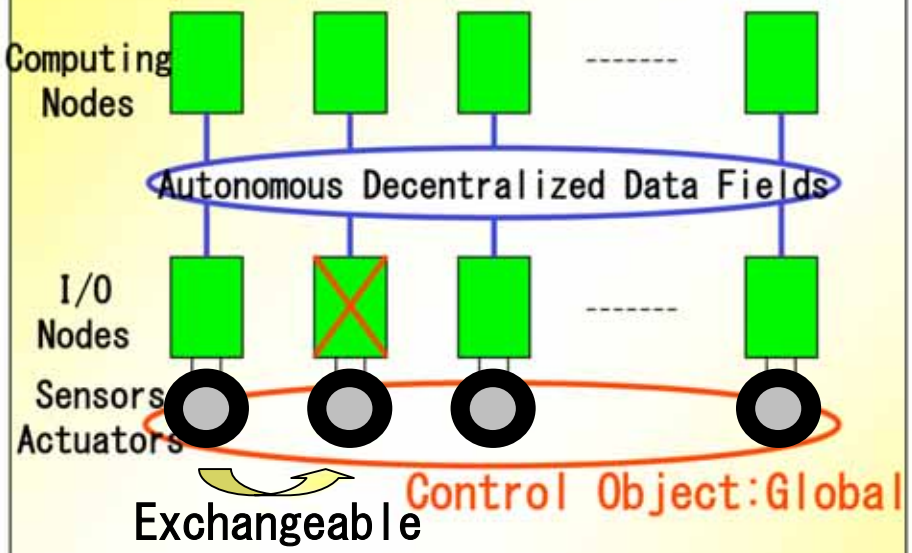
For Most of Applications



Merits;
- ✓ Online System-Expansion
- ✓ Computing Node Dependability

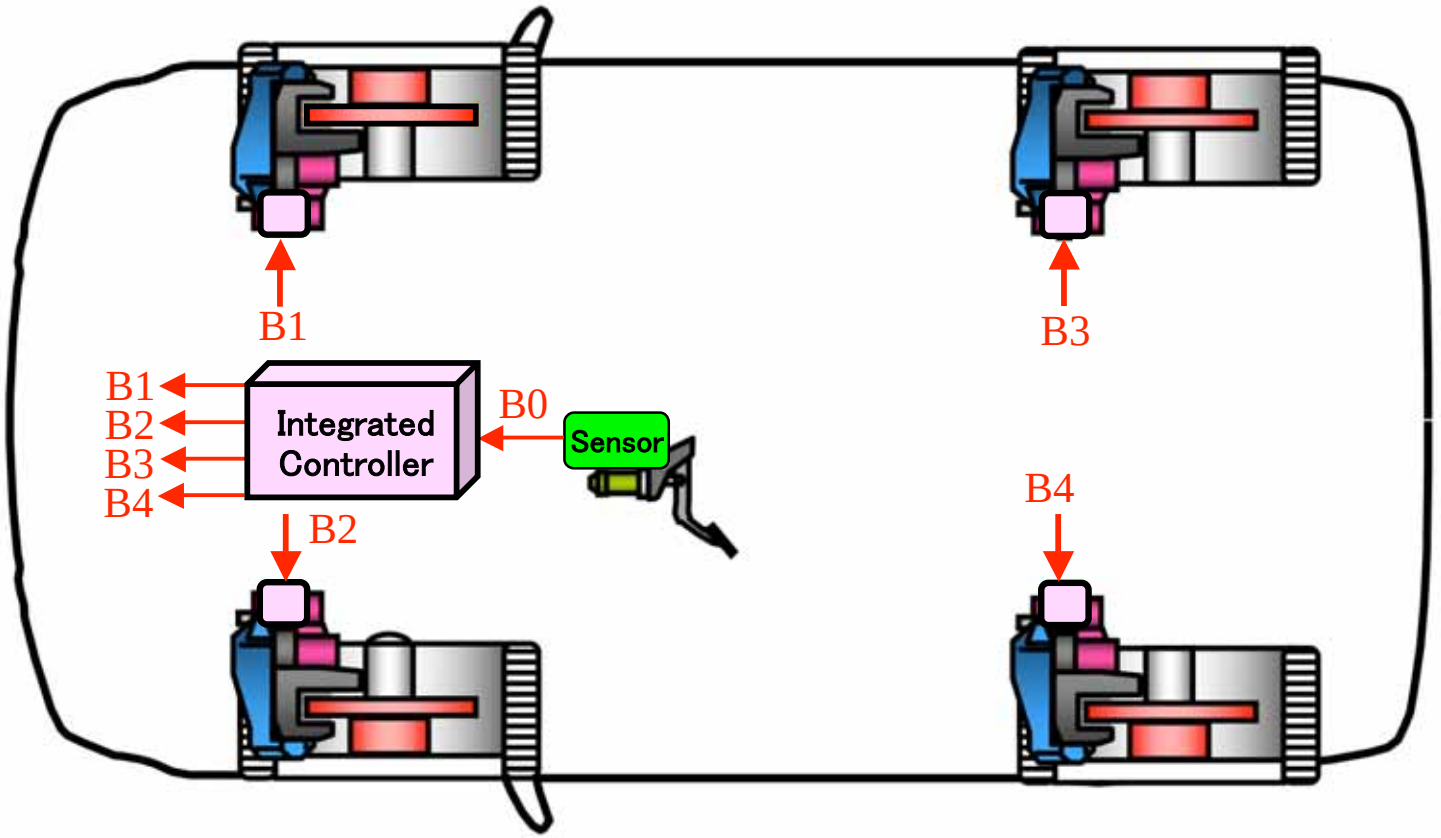
(I/O nodes should be redundant)

For Automotive/Aerospace

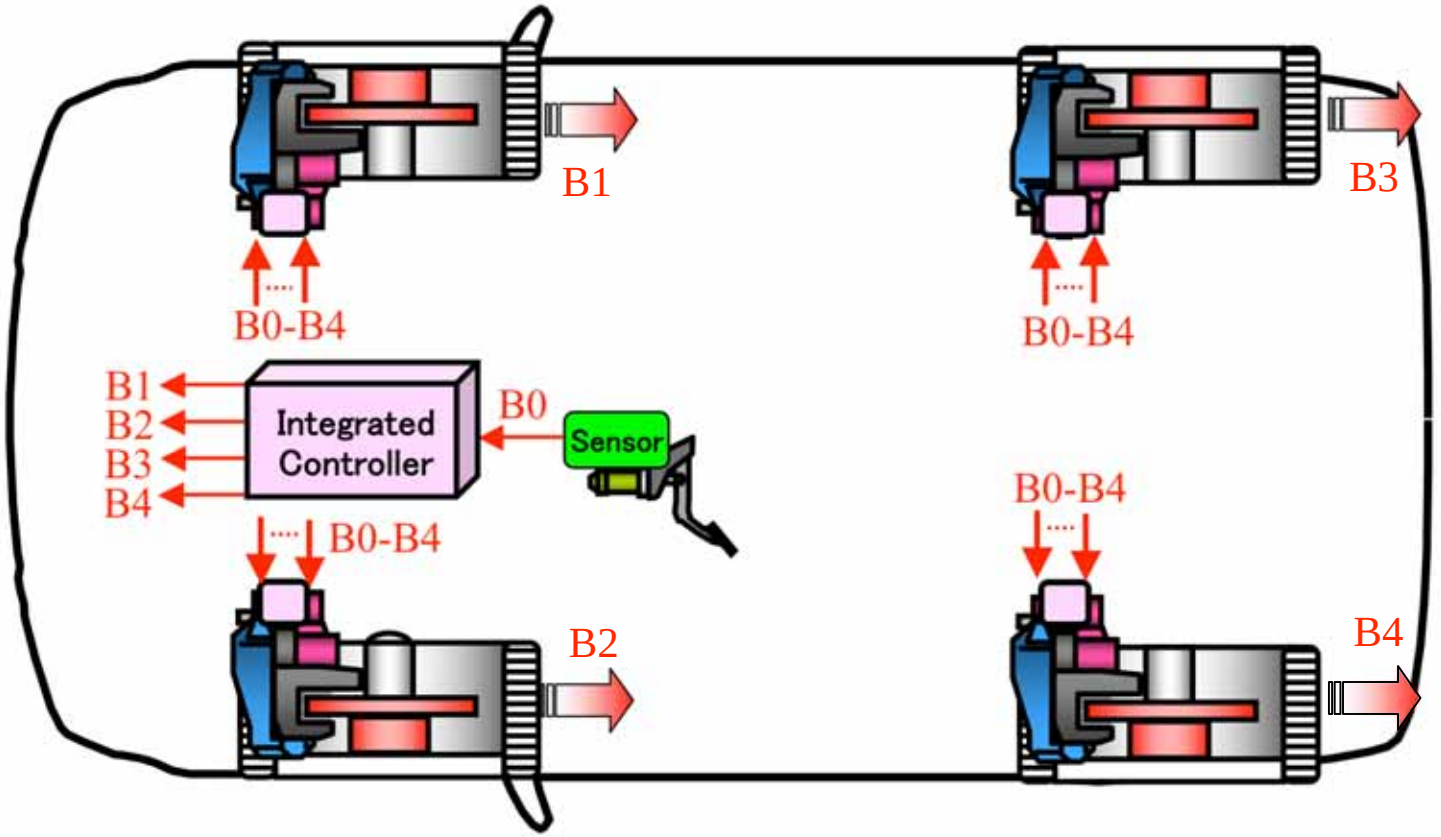


Merits;
- ✓ Online System-Expansion
- ✓ Computing Node Dependability
- ✓ I/O Node Dependability w/o Redundancy

An Example: Brake Control

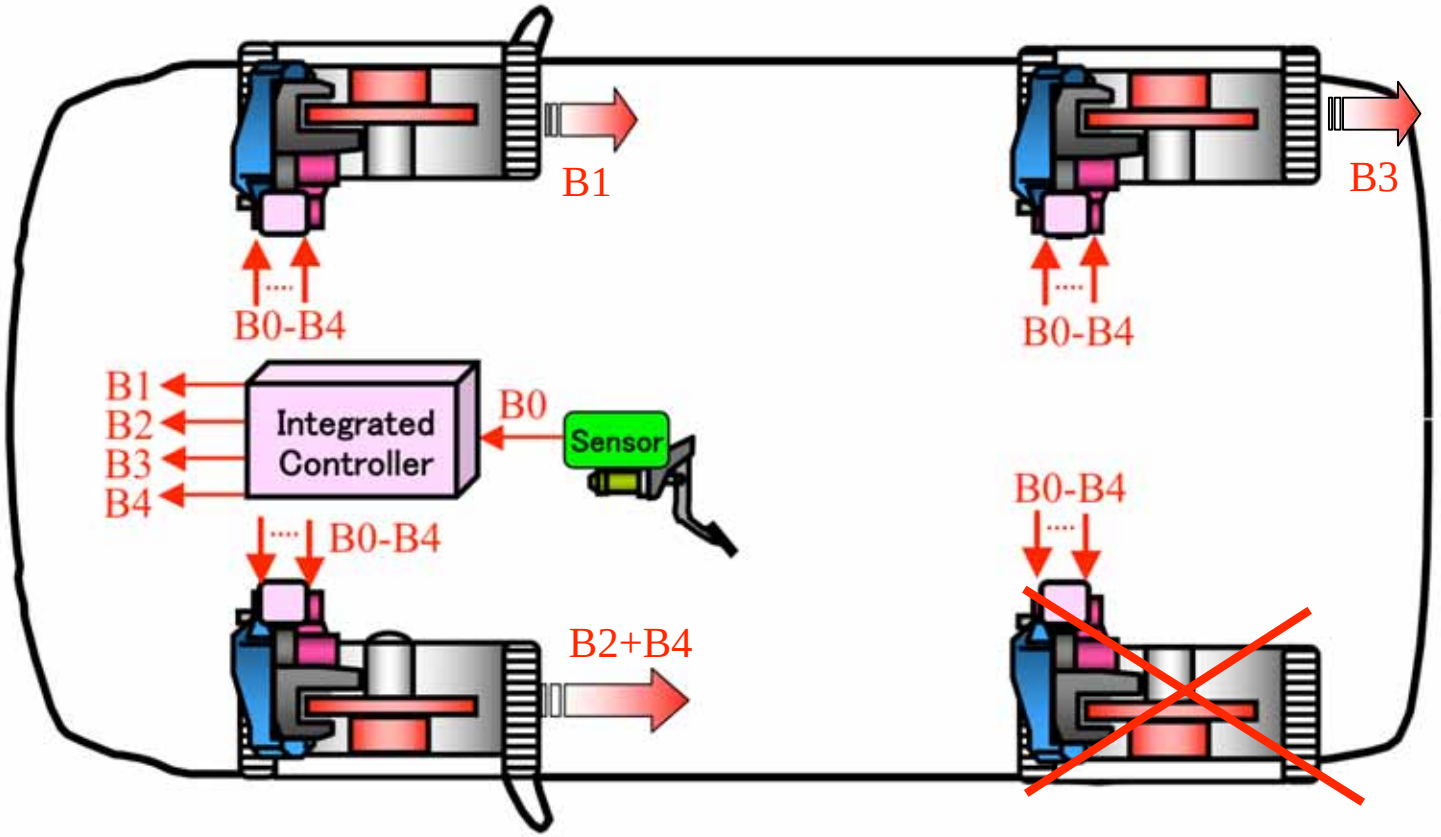


Brake Control with Autonomous Decentralized Approach



-Subsystems (Integrated Controller and Brake Controllers) share all the information.

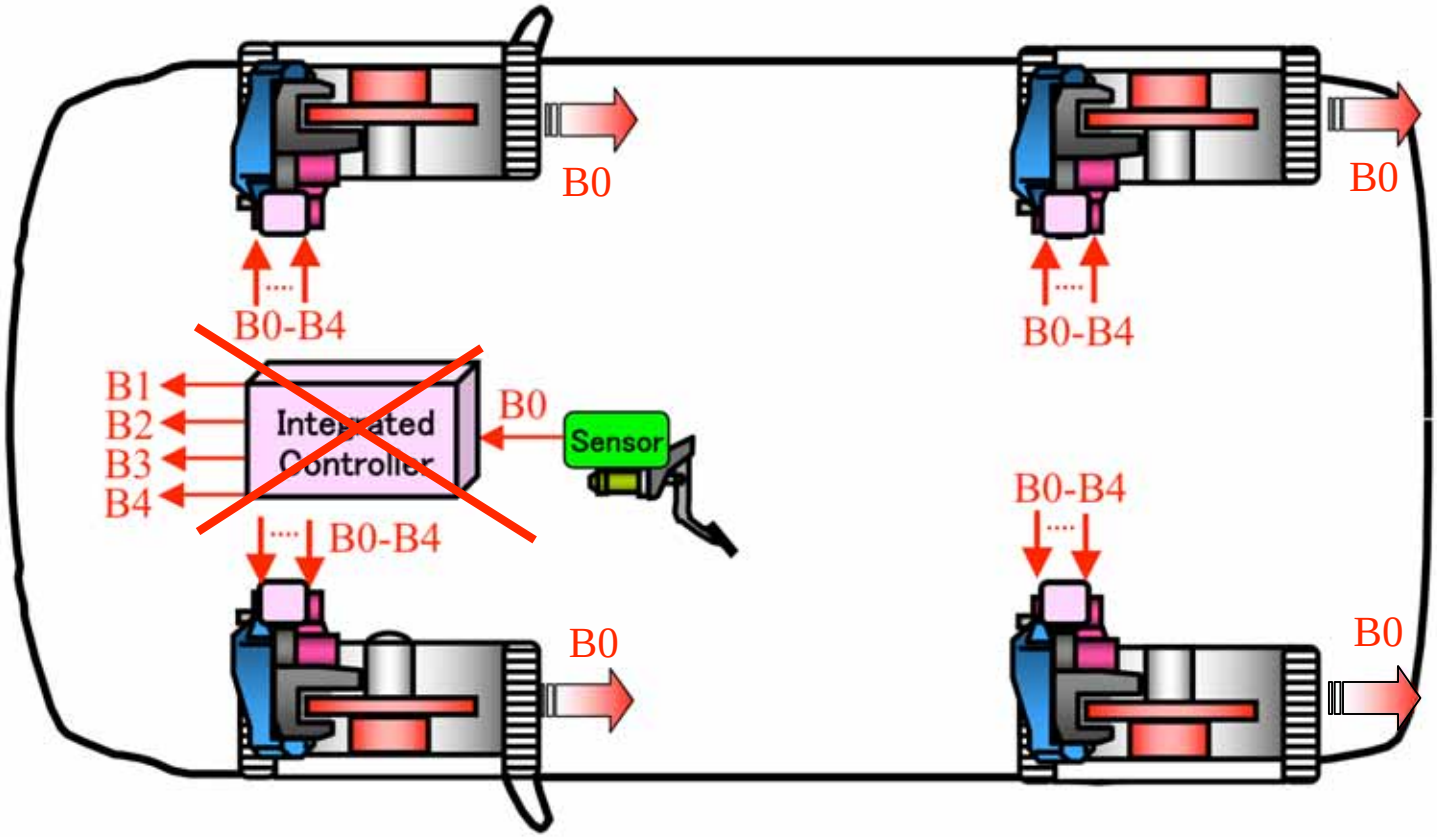
Brake Control with Autonomous Decentralized Approach



-Subsystems (Integrated Controller and Brake Controllers) share all the information.

-When one subsystem fails, others try to recover.

Brake Control with Autonomous Decentralized Approach

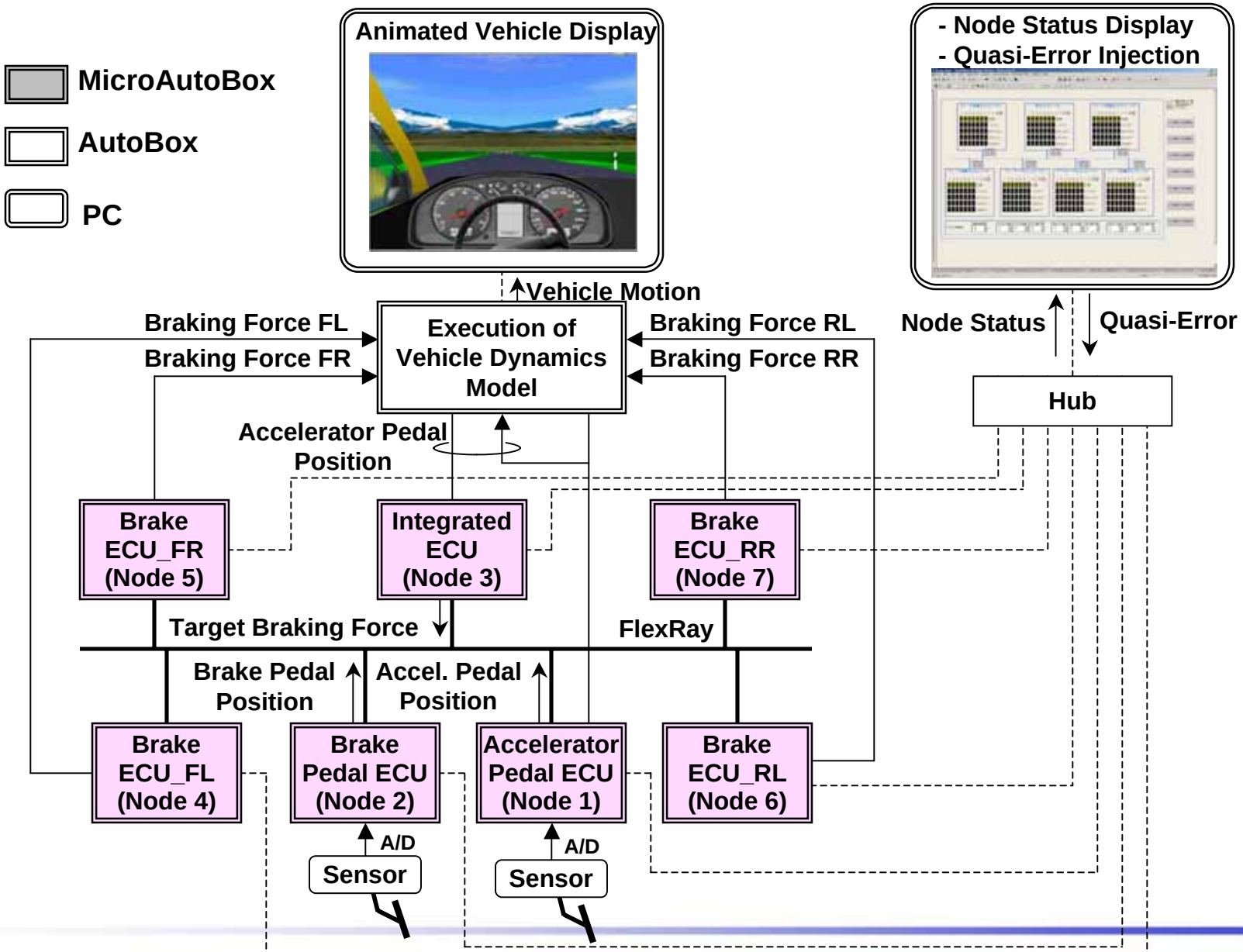


-Subsystems (Integrated Controller and Brake Controllers) share all the information.

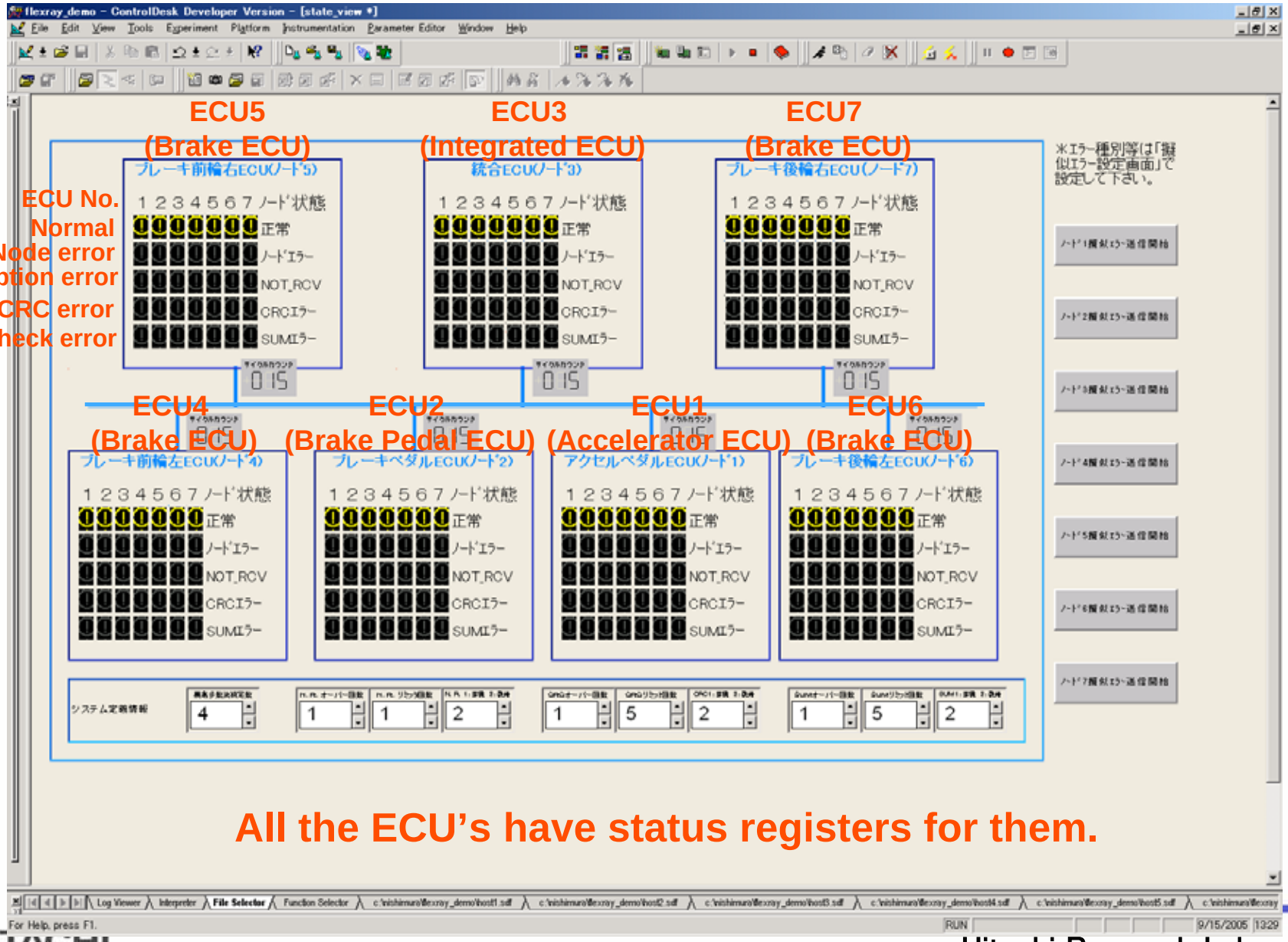
-When one subsystem fails, others try to recover.

Even if the Integrated Controller fails…

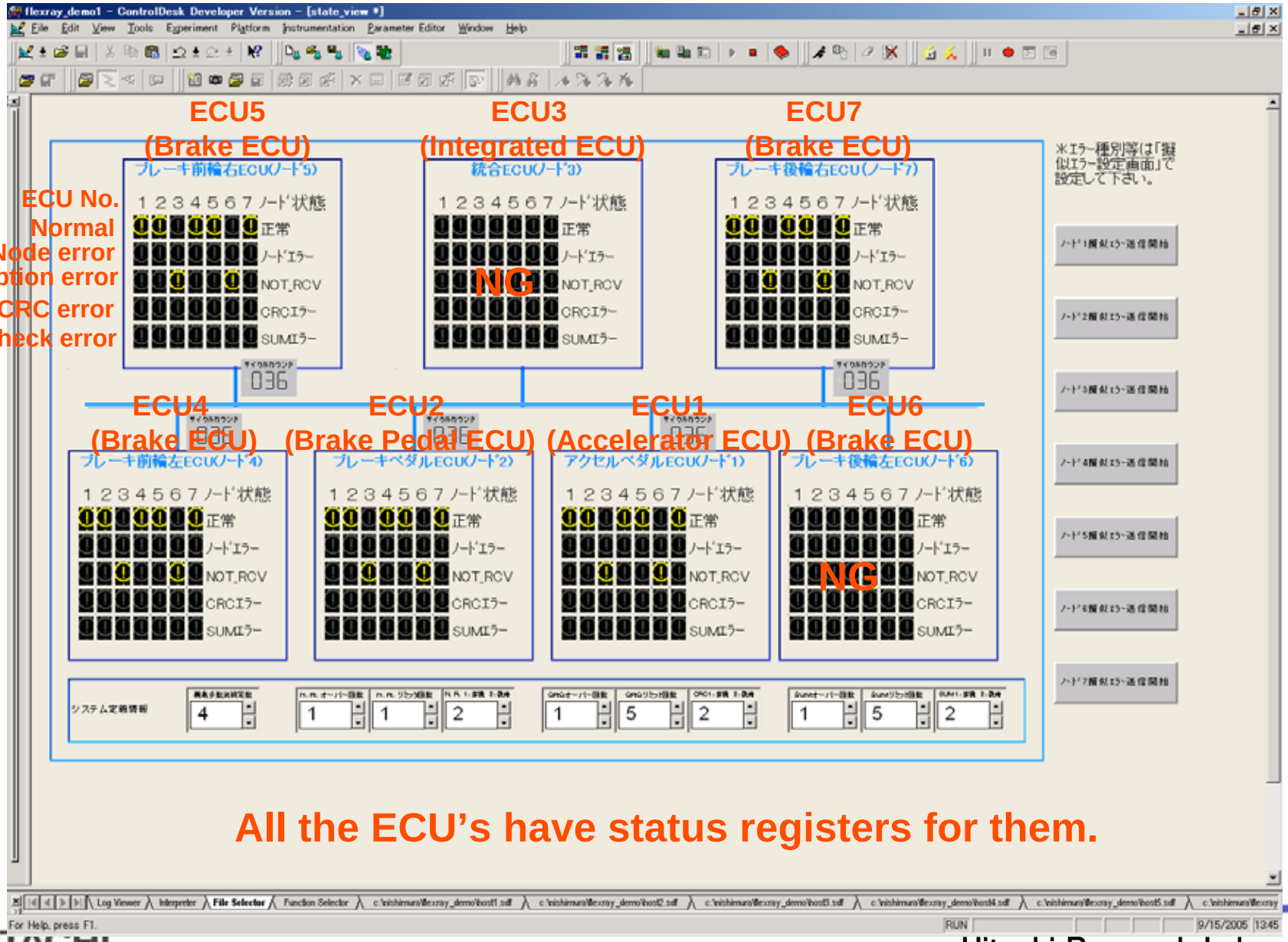
Experimental Setup by a Vehicle Simulator



Experimental Result (All the ECU's are OK)

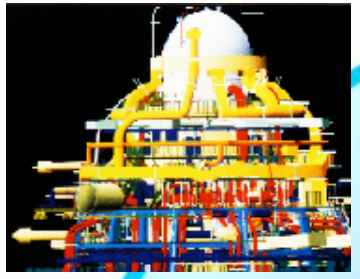


Experimental Result (ECU3 & 6 are NG)

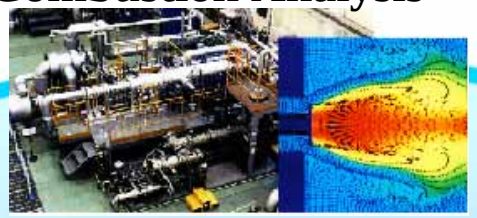


Hitachi's R&D on Automotive Systems

Nuclear Reactor
-Hydraulic Dynamics Sim.



Gas Turbine
Combustion Analysis



Power IC

Automotive Systems

Environment
Low Emission

Safety
Drivability

Target

Information
Service

Motors, Generators

RISC
Processors

Train Control

Car Navigation

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HITACHI

Inspire the Next