Introduction

CS60002: Distributed Systems

Pallab Dasgupta
Professor,
Dept. of Computer Sc. & Engg.,
Indian Institute of Technology Kharagpur

Books

- Advanced Concepts in Operating Systems
  - Mukesh Singhal and Niranjan G. Shivaratri
    McGraw Hill International Edition

- Introduction to Distributed Algorithms
  - Gerard Tel
    Cambridge University Press
    Available in the CSE Dept Library (Acc No: I-455)

What is a distributed system?

A very broad definition:

- *A set of autonomous processes communicating among themselves to perform a task*

Issues:

- Un-reliability of communication
- Lack of global knowledge
- Lack of synchronization and causal ordering
- Concurrency control
- Failure and recovery

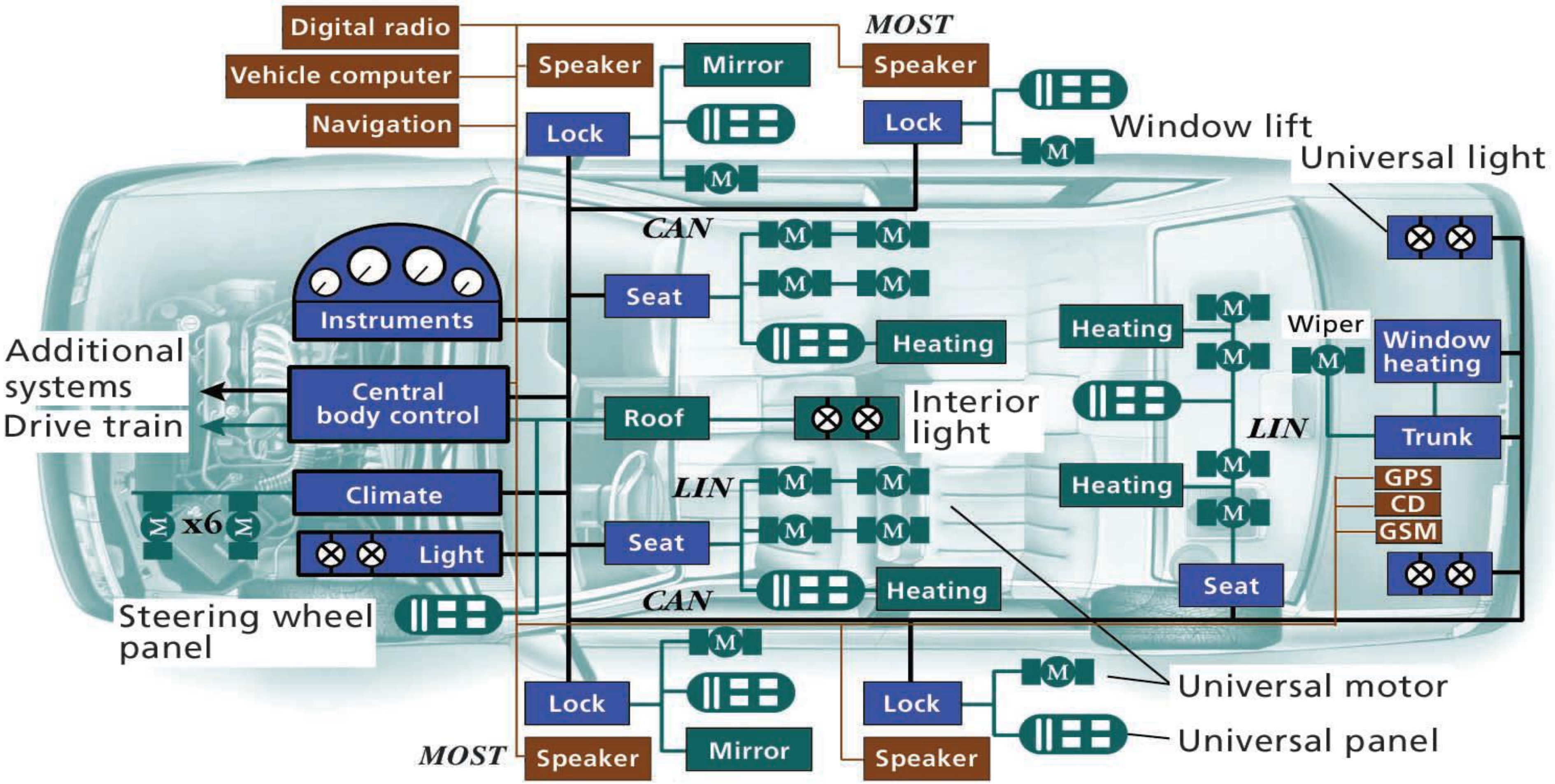
Advantages

- Resource Sharing
- Higher Performance
- Fault Tolerance
- Scalability

Examples of problems

- Reliable communication – *Theoretically impossible?*
- Muddy forehead and related problems
- Concurrency problems

Example: *Automotive Control*



CAN	Controller area network
GPS	Global Positioning System
GSM	Global System for Mobile Communications
LIN	Local interconnect network
MOST	Media-oriented systems transport

Source: Leen and Hefferman, IEEE Computer, Jan 2002

Why is it hard to design them?

- The usual problem of concurrent systems:
  - Arbitrary interleaving of actions makes the system hard to verify

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- No globally shared memory (therefore hard to collect global state)
- No global clock
- Unpredictable communication delays

Models for Distributed Algorithms

- Topology: Completely connected, Ring, Tree etc.
- Communication: Shared memory / Message passing

  (reliable? Delay? FIFO/Causal? Broadcast/multicast?)
- Synchronous/asynchronous
- Failure models: Fail stop, Crash, Omission, Byzantine…
- *An algorithm needs to specify the model on which it is supposed to work*

Complexity Measures

- Message complexity: no. of messages
- Communication complexity / Bit Complexity: no. of bits
- Time complexity:
  - For synchronous systems, no. of rounds
  - For asynchronous systems, different definitions are there.

Some Fundamental Problems

- Ordering events in the absence of a global clock
- Capturing the global state
- Mutual exclusion
- Leader election
- Clock synchronization
- Termination detection
- Constructing spanning trees
- Agreement protocols