A distributed data processing architecture for real time intelligent transport systems

K. Nesenbergs (krisjanis.nesenbergs@edi.lv)
L. Selavo (leo.selavo@edi.lv)

Institute of Electronics and Computer Science
14 Dzerbenes street,
Riga, Latvia

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Goal

Real-time intelligent transport system
This specific paper

**System architecture for a real-time intelligent transport system**

Figure from: www.skolioze.lv
Requirements

- Real-time functionality in life critical situations
- Facilitates easy development of data gathering, processing and decision making modules
- Redundant and reliable
Real time, life critical

- Distributed data processing with load balancing
- Fall back to local safety measures if system fails
Redundancy, reliability

• Data replication across several physical systems
• Capability to continue work even if several systems fail
• Resume with previous settings and data on restart
• Watchdog functionality
Modules

- Distributed system abstracted away from module developers
- Each module requests data from system as input, processes it independently and provides data as output

Types:
- Data gathering from sensors
- Actuating external actuators
- Data processing
- Service (logging etc.)
Module examples:

- Vehicle detection in video
- Number plater location in video
- Car detection using microphone arrays, magnetic sensors and other sensors
- Merging data for complex vehicle detection
- Calling emergency services
- Controlling traffic lights
Architecture

Physical system #1

Sensor

Data gathering module

System core services

Data processing module

Physical system #2

System core services

Actuation module

Data processing module

Service module

Authorities

Actuator
System core services

- Configuration subsystem
- Data storage subsystem
- Inter-core network subsystem
- Watchdog subsystem
- Data replication subsystem
- Data retrieval subsystem
Configuration subsystem

- Keeps configuration consistent across physical systems and system restarts
- Distributes external configuration changes for the active and further sessions

Data storage subsystem

- Stores all relevant tracking data on each physical system separately
- Initially modules send data to local core only
- Data distribution controlled by data replication subsystem
Inter-core network subsystem

- Message distribution and routing between physical systems
- System routing information
- System load information

Watchdog subsystem

- Watches heart-beat signals from all cores
- Takes necessary action to restart failed system parts and/or sends notifications to appropriate personnel
Data replication subsystem

- All data packets are replicated to at least N physical systems.
- After receiving data packet each core determines if it should be stored and/or sent for further replication or dropped completely.
- Each packet contains information of cores containing it.
- Replication targets determined by reported system load.
- If cores containing some data fail, watchdog initiates additional replication of the involved data.
Data retrieval subsystem

- Modules request data from local core
- Local core determines which of system cores contains the freshest data of type and source requested and connects requesting module to the appropriate core
- Either one packet or data stream can be requested
Physical testbed implementation

- 3 Mini-ITX personal computers (i5, 8GB RAM)
- 8 Raspberry Pi embedded computers
- Wireless router
- Sensors (cameras, magnetic sensors, microphone arrays etc.)
- Traffic actuators (simulated, because of birocratic reasons)
Conclusions

- A distributed data processing architecture proposed and implemented in test environment
- Redundancy and fault tolerance allows system to continue working even with several physical systems down.
- Load distribution allows additional benefits, such as capability to run identical high intensity data processing modules in parallel on several systems
- Module developers do not have to concern themselves about the distributed system architecture reducing module development time and complexity
- At the moment only simulated data on real physical system, will be tested in real traffic environments
Thank you for your attention!