

Introduction to the Distributed Real-Time System

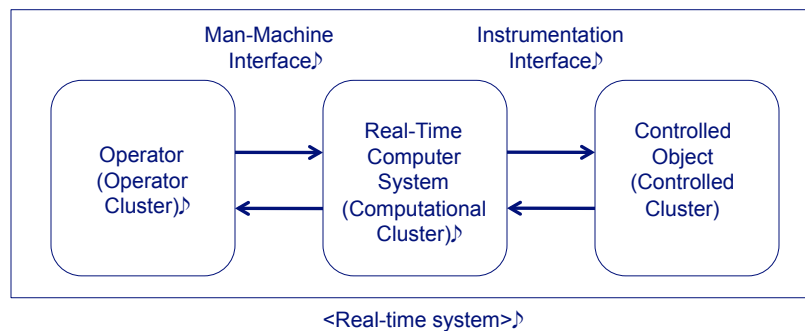
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When is a Computer System Real-Time?

- The correctness of the system behavior depends on...
 - The logical results of the computations,
 - **Physical instant** at which these results are produced.♪



The Property of Real-Time System

- A real-time computer system must react to stimuli from the controlled object (or the operator) within time intervals dictated by its environment.
- Deadline : the instant at which a result must be produced.
- Classification or RT-system
 - Soft real-time computer system.
 - Hard real-time computer system.

Real-Time Entity

- A controlled object, e.g., a car or an industrial plant, changes its **state** as a function of time.
- Real-Time Entity (RT-Entity)
 - A set of *state variable* that we are normally interested in.
 - Car : the speed of the car, the position of switches on the dash board, the position of a piston in a cylinder.

Real-Time Image

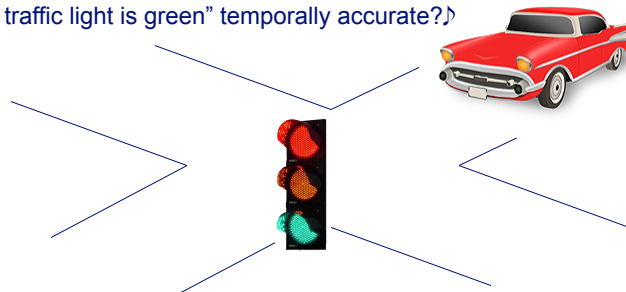
- The first functional requirement of a real-time computer system is the **observation** of the RT entities.
- Real-Time Image (RT-Image) : An observation of RT-Entity
- The property of RT-Image
 - A given RT-image is only *temporally accurate* for a limited time interval. (Since the state of the controlled object is a function of real time.)
 - The length of this time interval depends on the dynamics of the controlled object.
 - If the state of the controlled object changes very quickly, the corresponding RT image has a very short accuracy interval.♪

The Meaning of “Temporally Accurate”

- An upper bound for the accuracy interval is given by the duration of the yellow phase of the traffic light

How long is the observation :

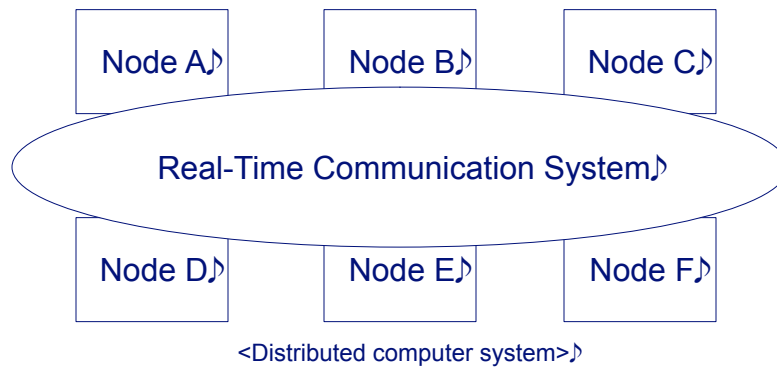
“The traffic light is green” temporally accurate?♪



<Temporal accuracy of the traffic light information>♪

The Distributed Real-Time System

- If the real-time computer system is distributed, it consists of a set of (computer) nodes interconnected by a real-time communication network.



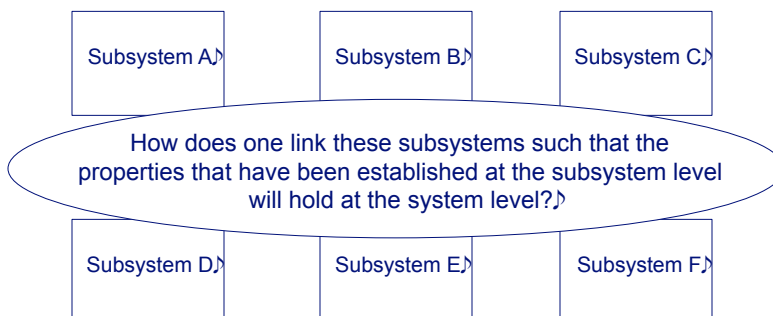
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Issue I : Composability

- An architecture is said to be **composable** with respect to a specified property if the system integration will not invalidate this property once the property has been established at the subsystem level.



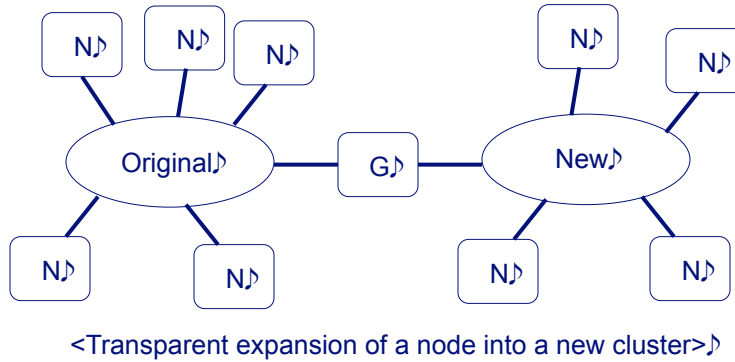
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Issue 2 : Scalability

- In a scalable architecture, the complexity of reasoning about the proper operation of any system function is independent of the system size.



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Issue 3 : Dependability

- **Error-containment regions.**
 - A fault-tolerant system must be structured into partitions in such a way that the consequences of faults that occur in one of these partitions can be detected and corrected or masked before these consequences corrupt the rest of the system.
- **Replication**
 - Given that the failure hypothesis holds, node failures can be masked by providing actively replicated nodes.
 - The replicas must show deterministic behavior.

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Reference

- Hermann Kopetz. *Real-Time Systems: Design Principles for Distributed Embedded Applications*. Kluwer Academic Publishers, 1997.