

MODELING EMBEDDED SYSTEMS

CMPN-445

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AGENDA

- **Overview of ES Modeling**
- **FSM : Finite State Machine Models**
- **FSM Examples**
- **FSM Excercise**
- **Timing Diagrams**
- **i2C as Timing Diagram**

MODELS OF COMPUTATION CONSIDERED

Communication/ local computations	Shared memory	Message passing	
		Synchronous	Asynchronous
Undefined components		Plain text, use cases (Message) sequence charts	
Communicating finite state machines	StateCharts		SDL
Data flow	(Not useful)		Kahn networks, SDF
Petri nets		C/E nets, P/T nets, ...	
Discrete event (DE) model	VHDL, Verilog, SystemC, ...	Only experimental systems, e.g. distributed DE in Ptolemy	
Von Neumann model	C, C++, Java	C, C++, Java with libraries CSP, ADA	

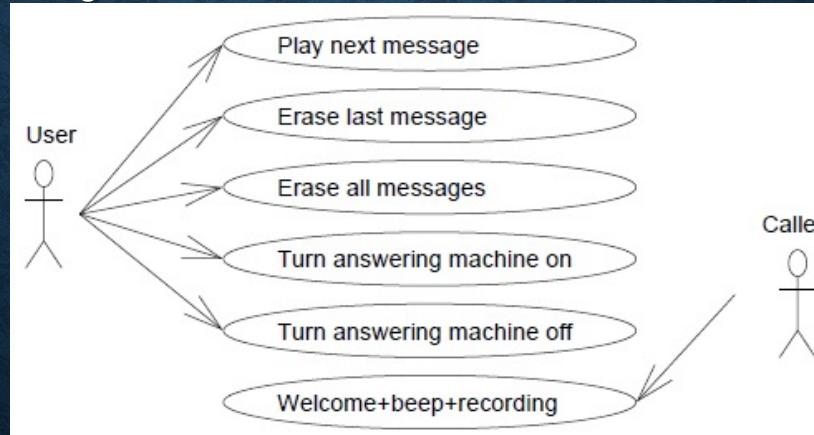
CAPTURING THE REQUIREMENTS AS TEXT

- In the very early phases of some design project, only descriptions of the system under design (SUD) in a natural language such as English or Arabic .
- Expectations for tools:
 - Machine-readable
 - Version management
 - Dependency analysis
 - Example: DOORS® [Telelogic/IBM]



USE CASES

- Use cases describe possible applications of the SUD
- Included in UML (Unified Modeling Language)
- Example: Answering machine

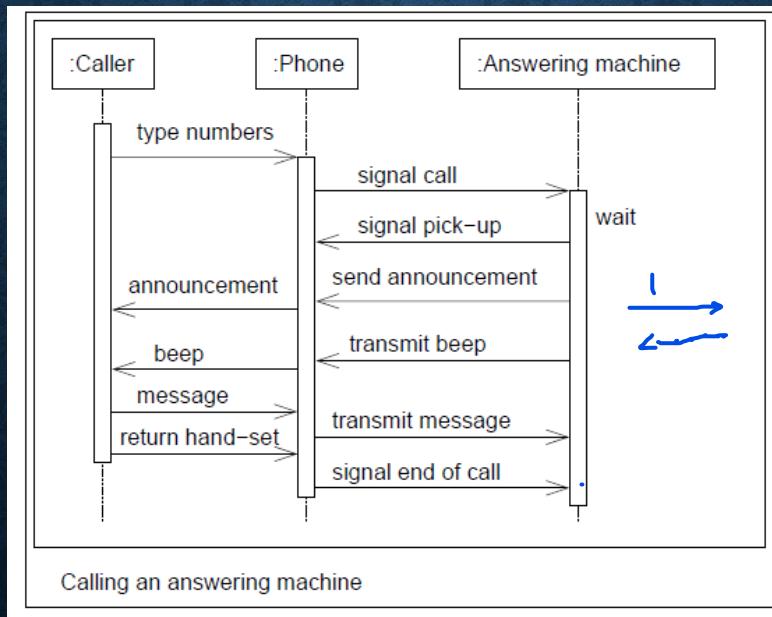


- Neither a precisely specified model of the computations nor a precisely specified model of the communication

(MESSAGE) SEQUENCE CHARTS

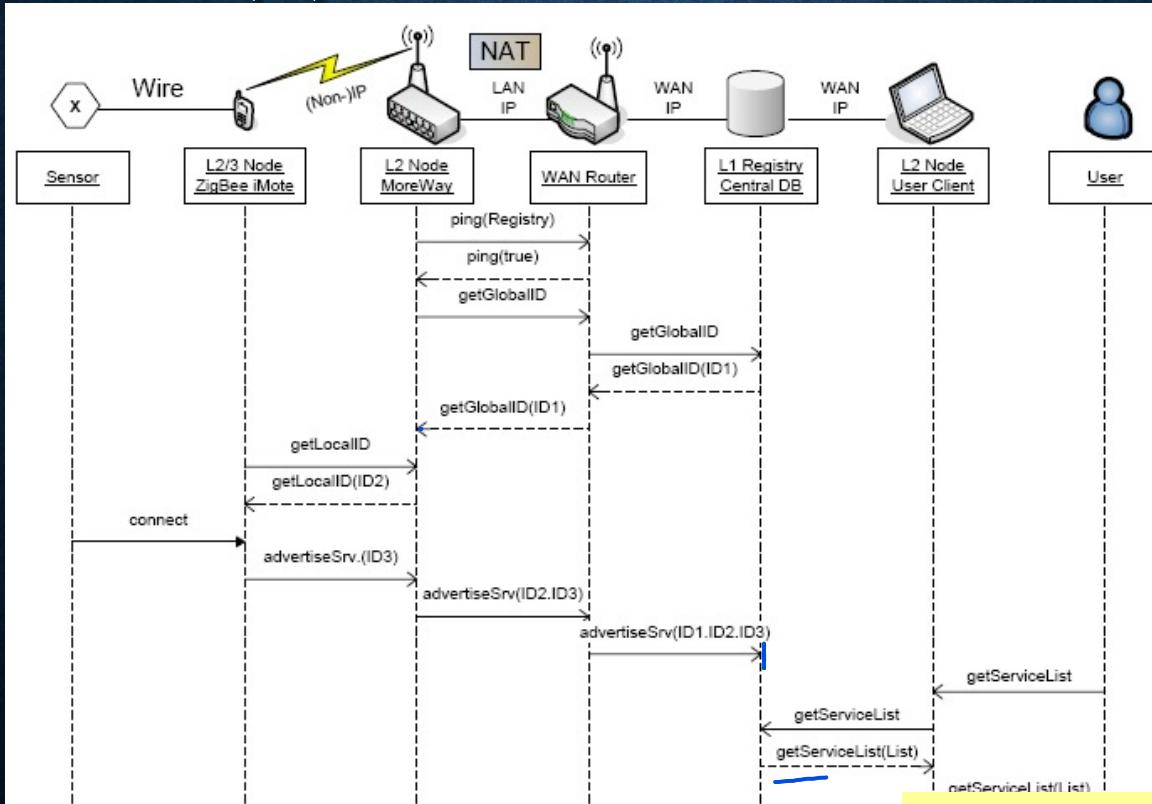
- Explicitly indicate exchange of information
- One dimension (usually vertical dimension) reflects time
- The other reflects distribution in space

Example:



- Included in UML
- Earlier called Message Sequence Charts, now mostly called Sequence Charts

EXAMPLE (2)

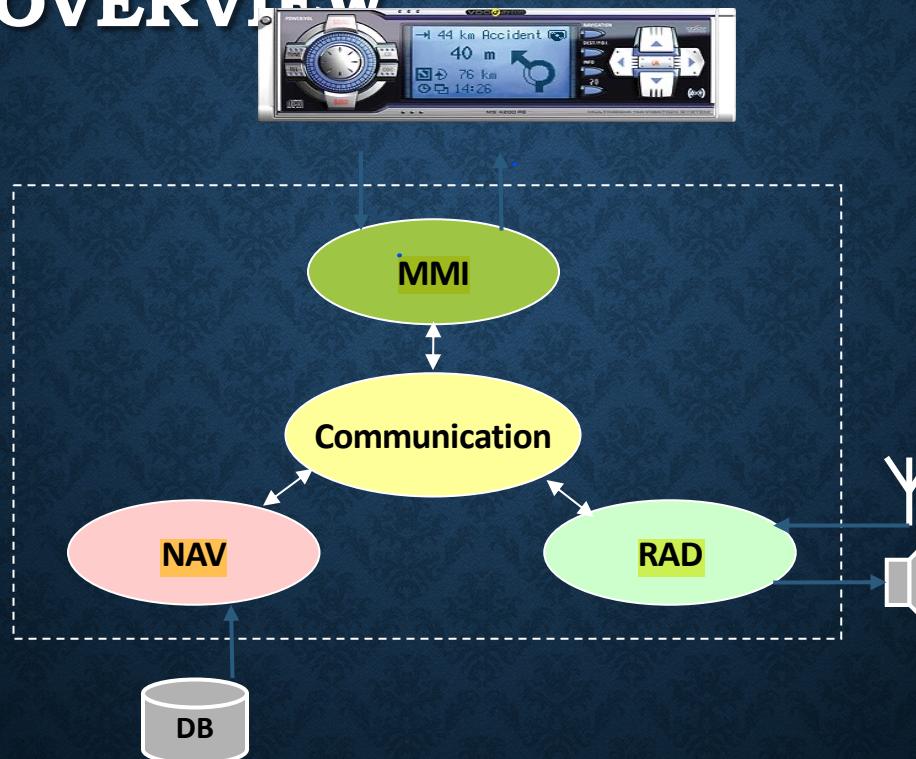


APPLICATION: IN-CAR NAVIGATION SYSTEM

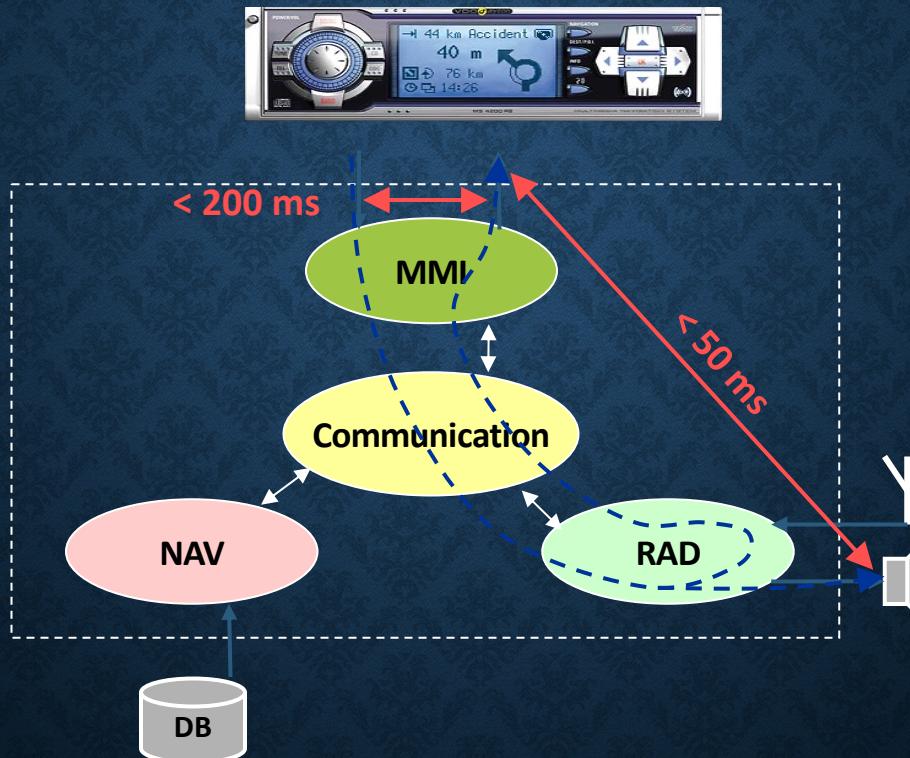
- Car radio with navigation system
- User interface needs to be responsive
- Traffic messages (TMC) must be processed in a timely way
- Several applications may execute concurrently



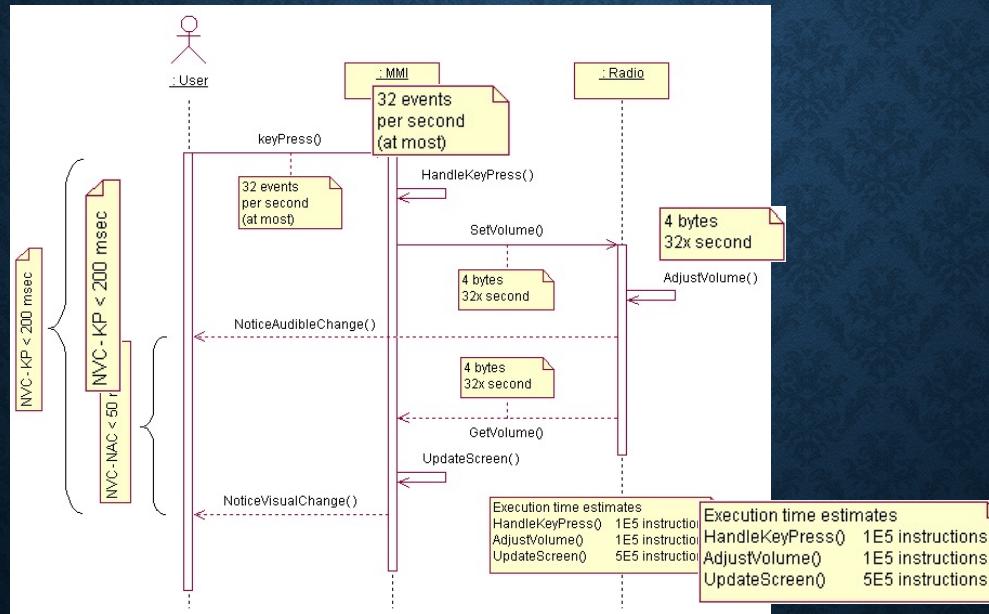
SYSTEM OVERVIEW



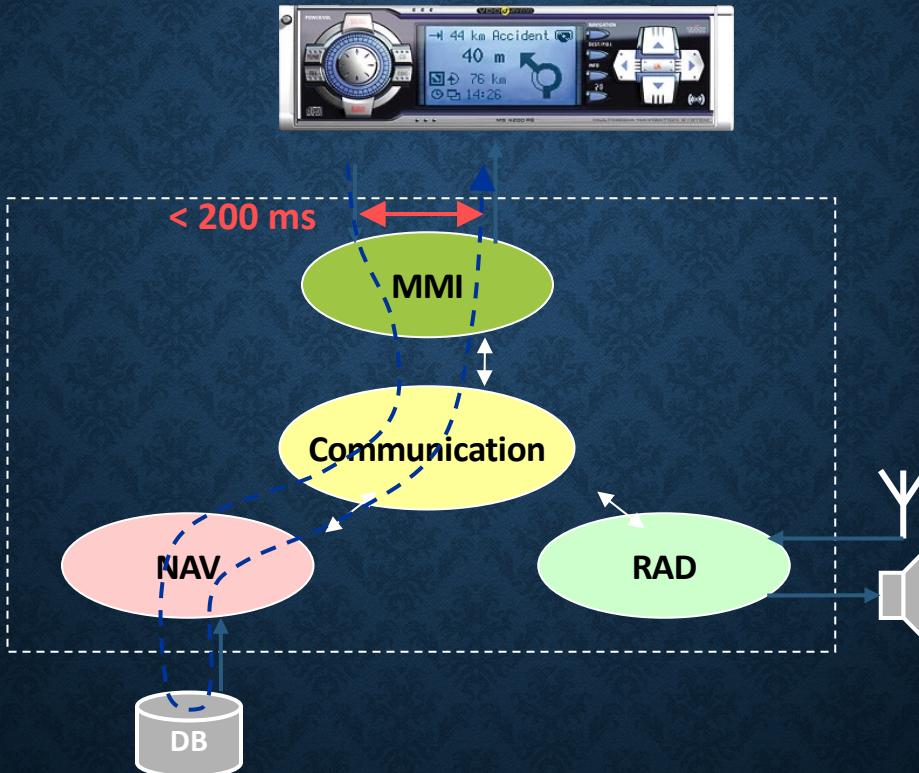
USE CASE 1: CHANGE AUDIO VOLUME



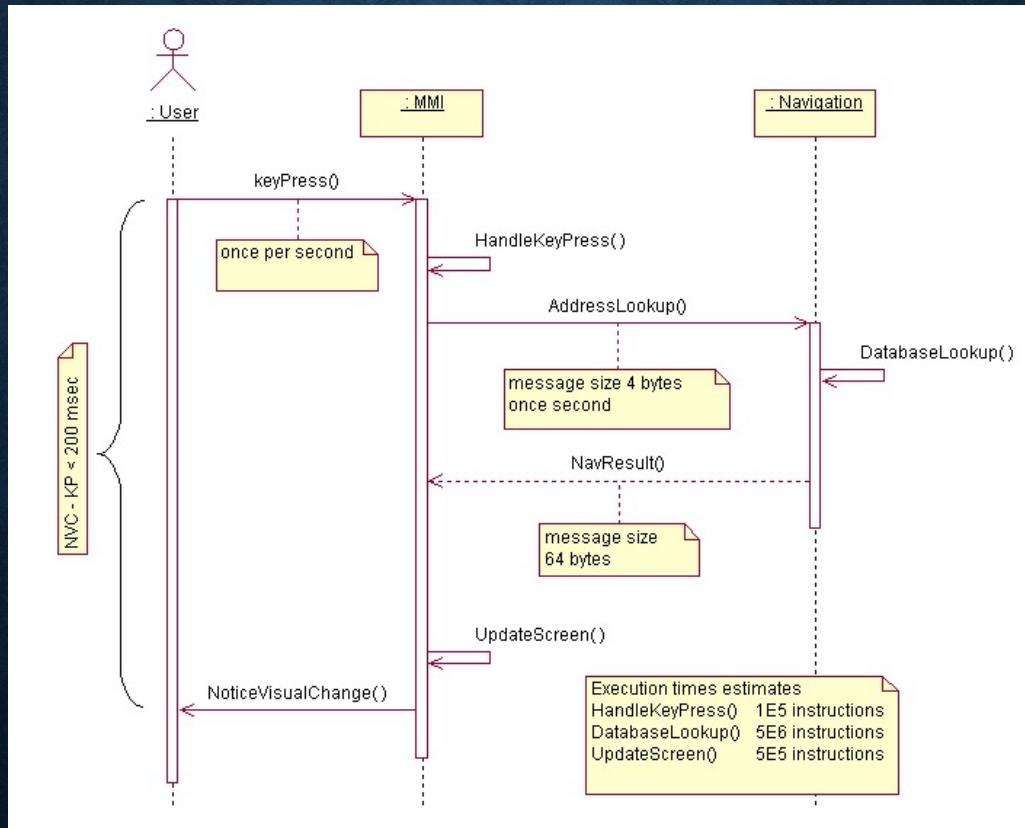
USE CASE 1: CHANGE AUDIO VOLUME



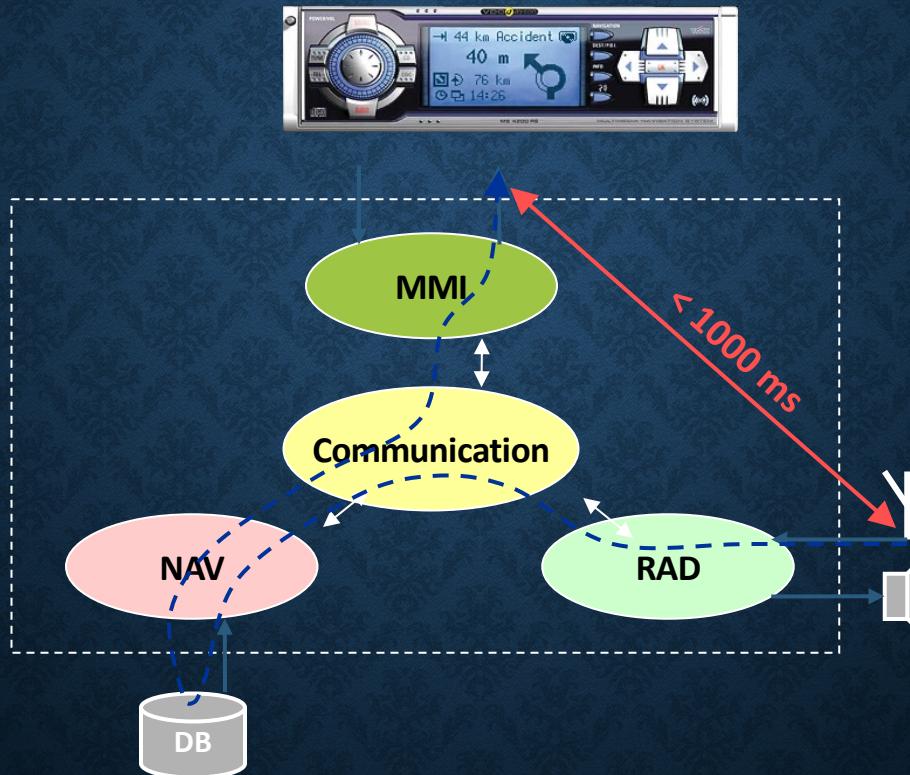
USE CASE 2: LOOKUP DESTINATION ADDRESS



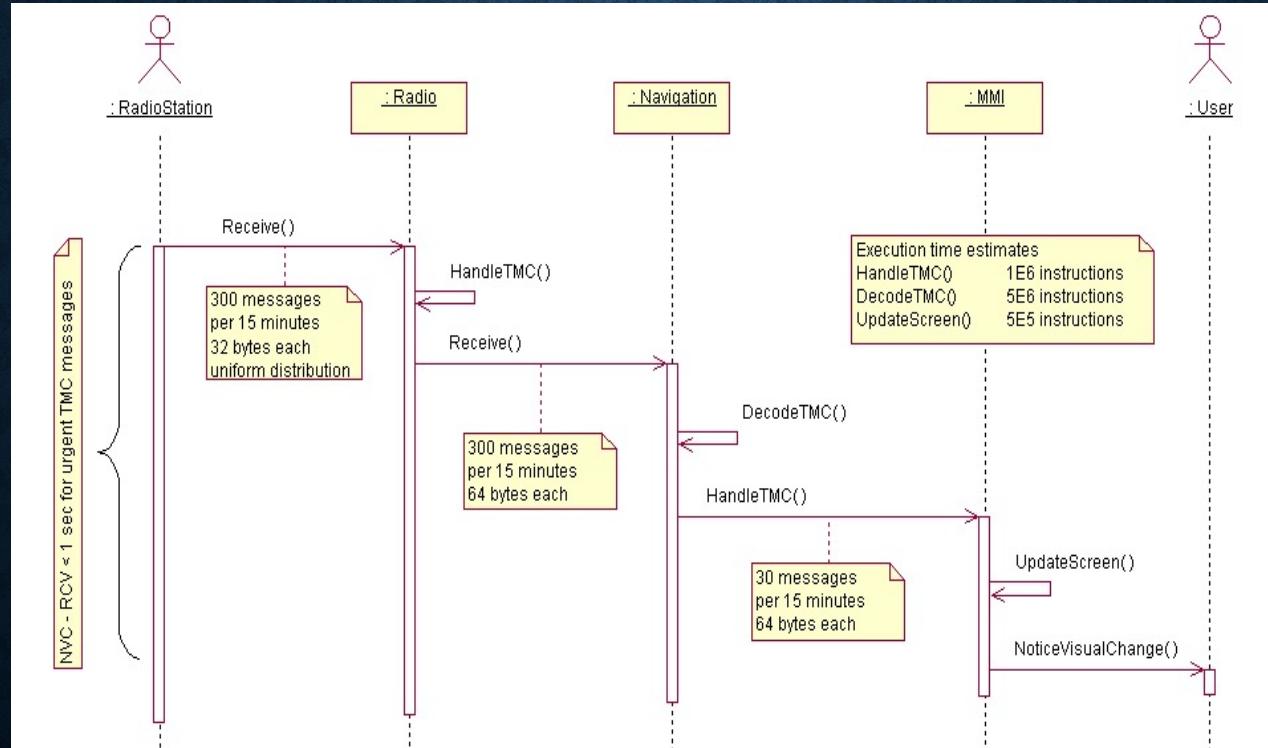
USE CASE 2: LOOKUP DESTINATION ADDRESS



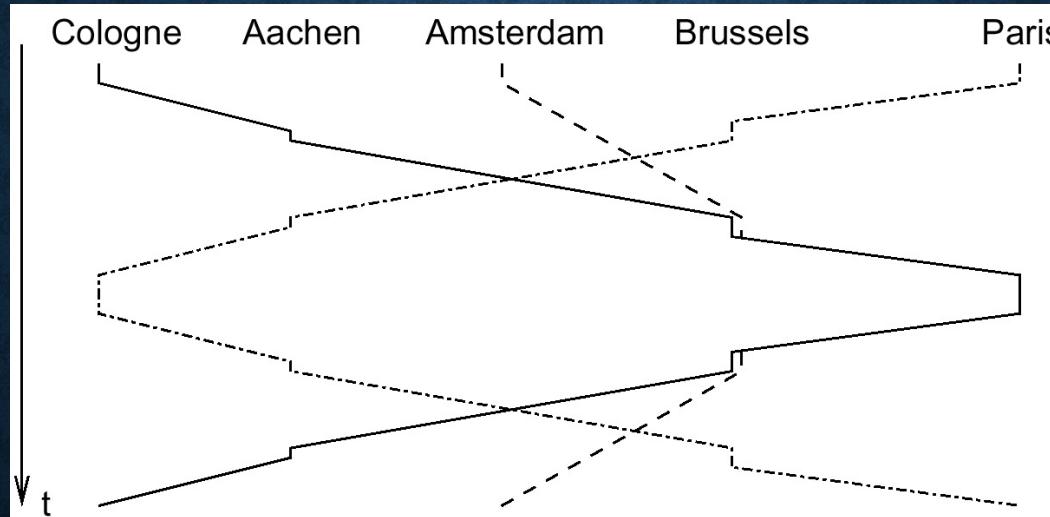
USE CASE 3: RECEIVE TMC MESSAGES



USE CASE 3: RECEIVE TMC MESSAGES

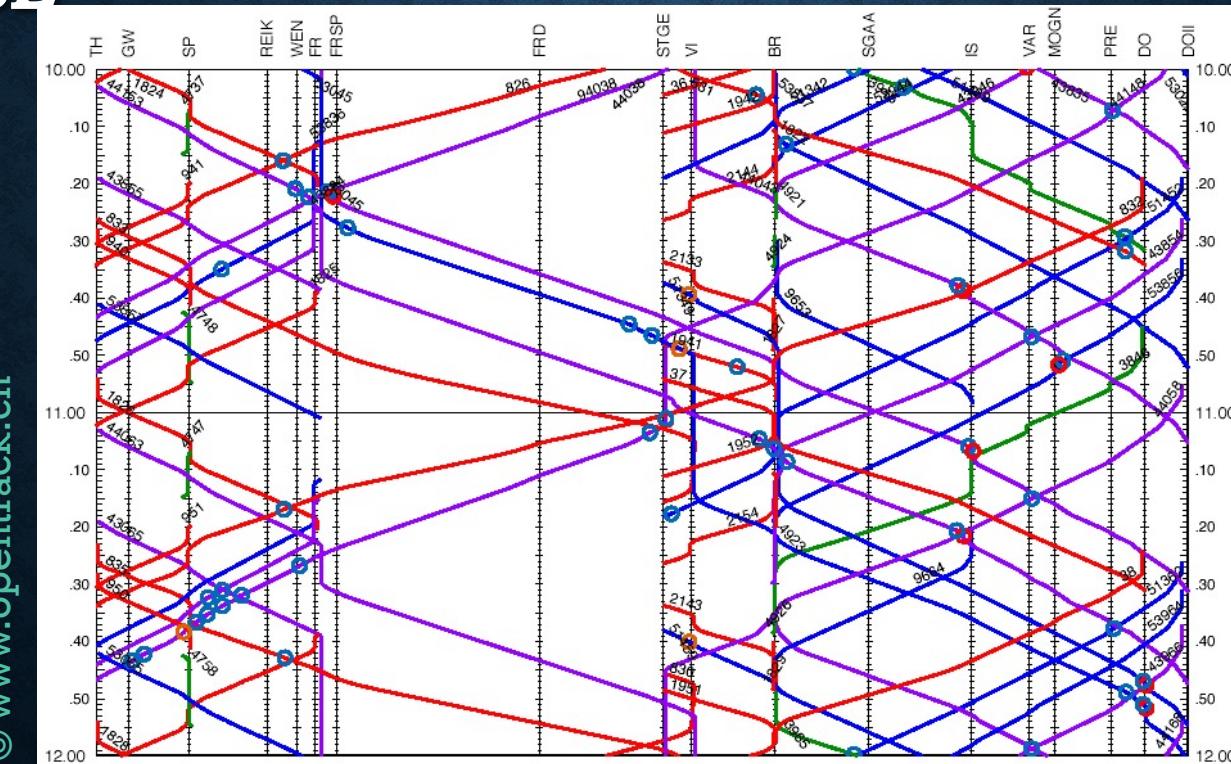


(MESSAGE) SEQUENCE CHARTS (MSC)



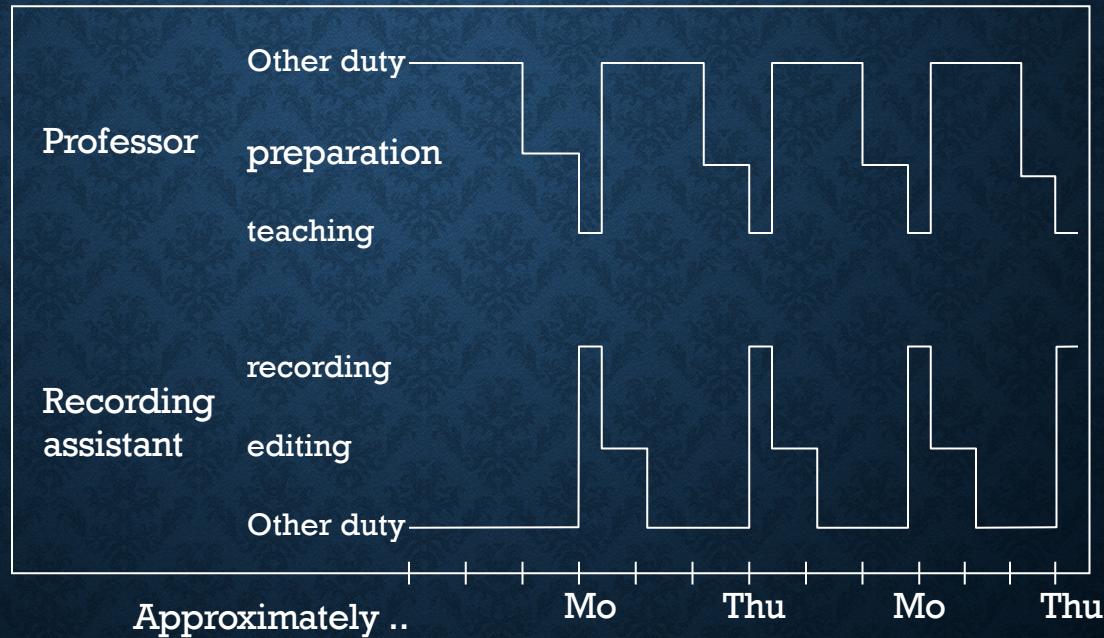
No distinction between accidental overlap and synchronization

TIME/DISTANCE DIAGRAMS AS A SPECIAL CASE



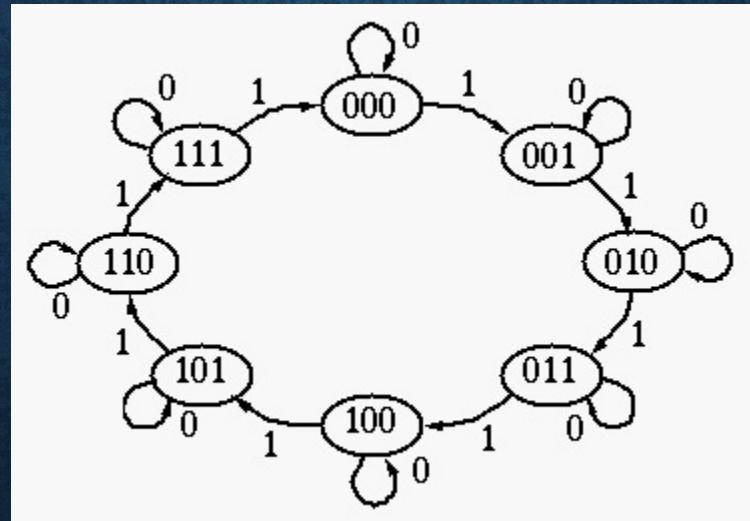
UML: TIMING DIAGRAMS

- Can be used to show the change of the state of an object over time.

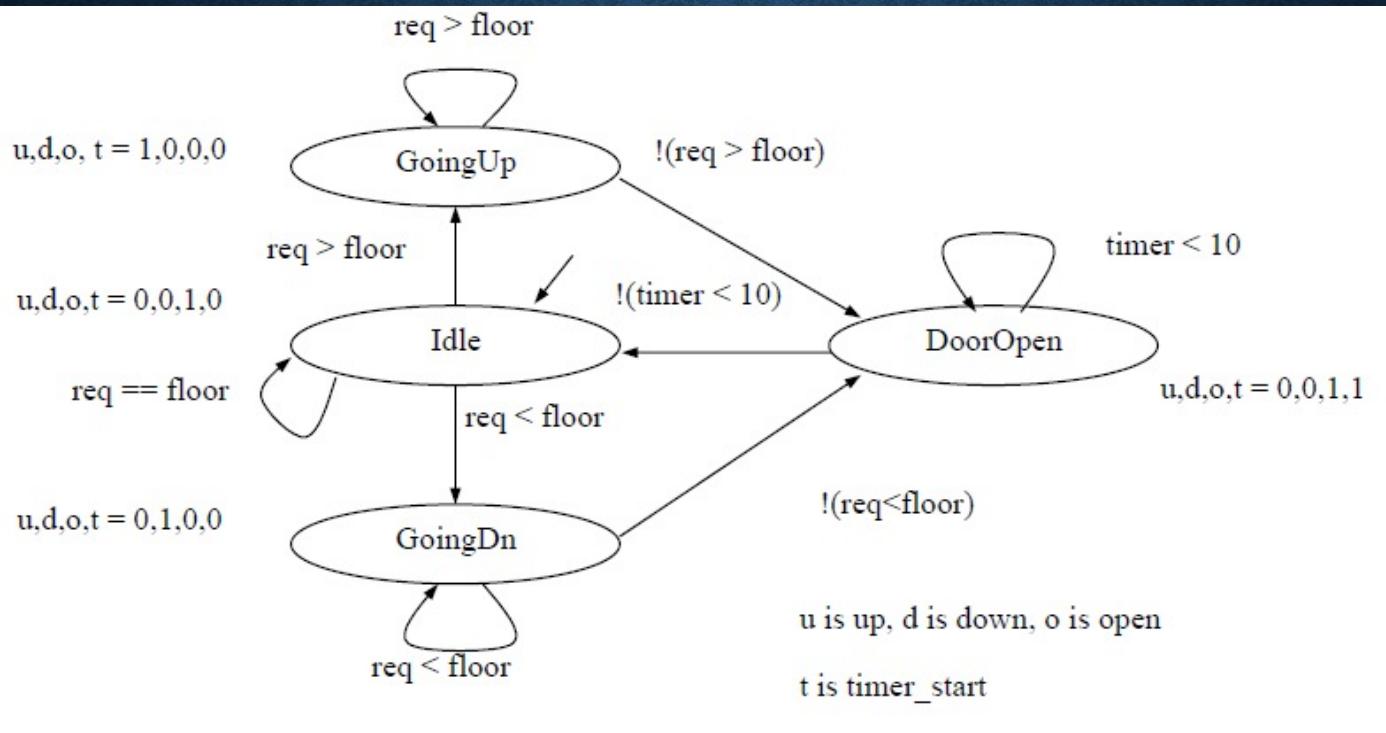


Based on Scott Ambler,
Agile Modeling,
[//www.agilemodeling.com](http://www.agilemodeling.com), 2003

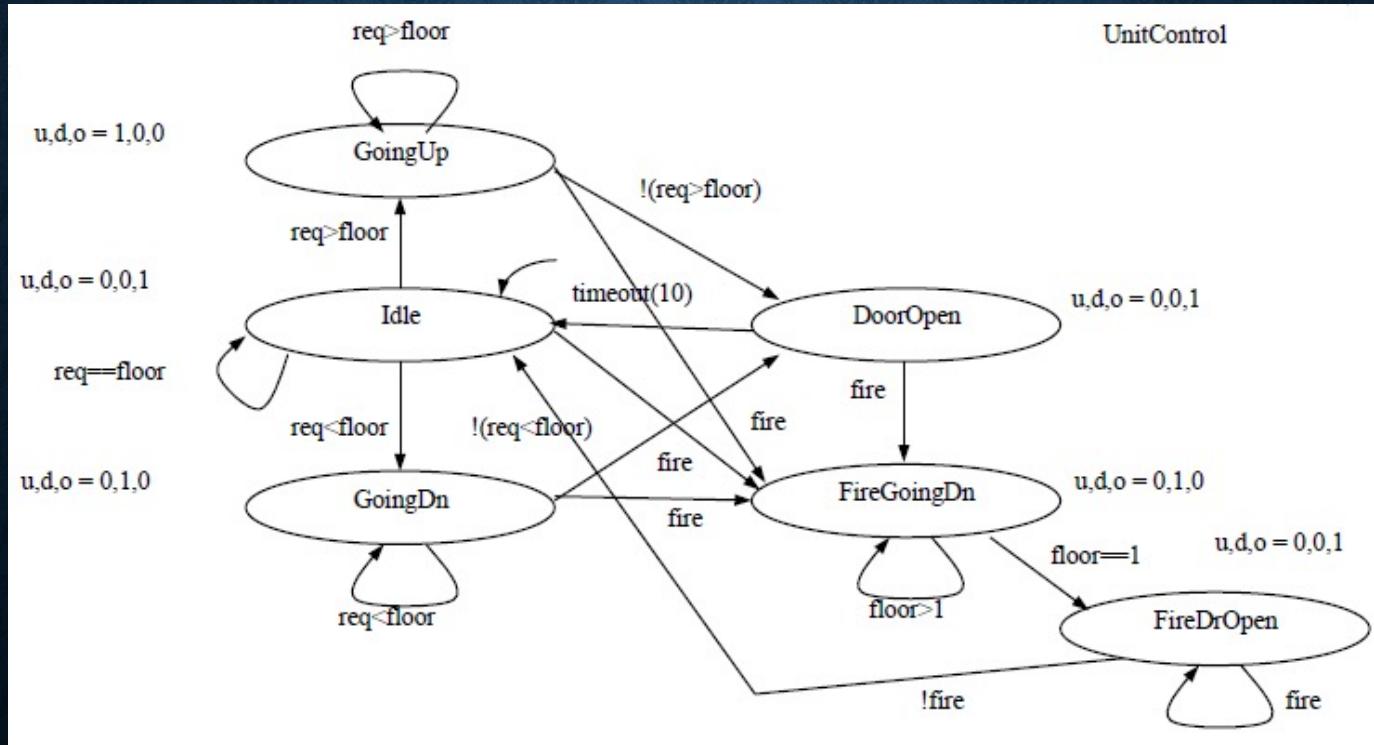
FSM SIMPLE EXAMPLE



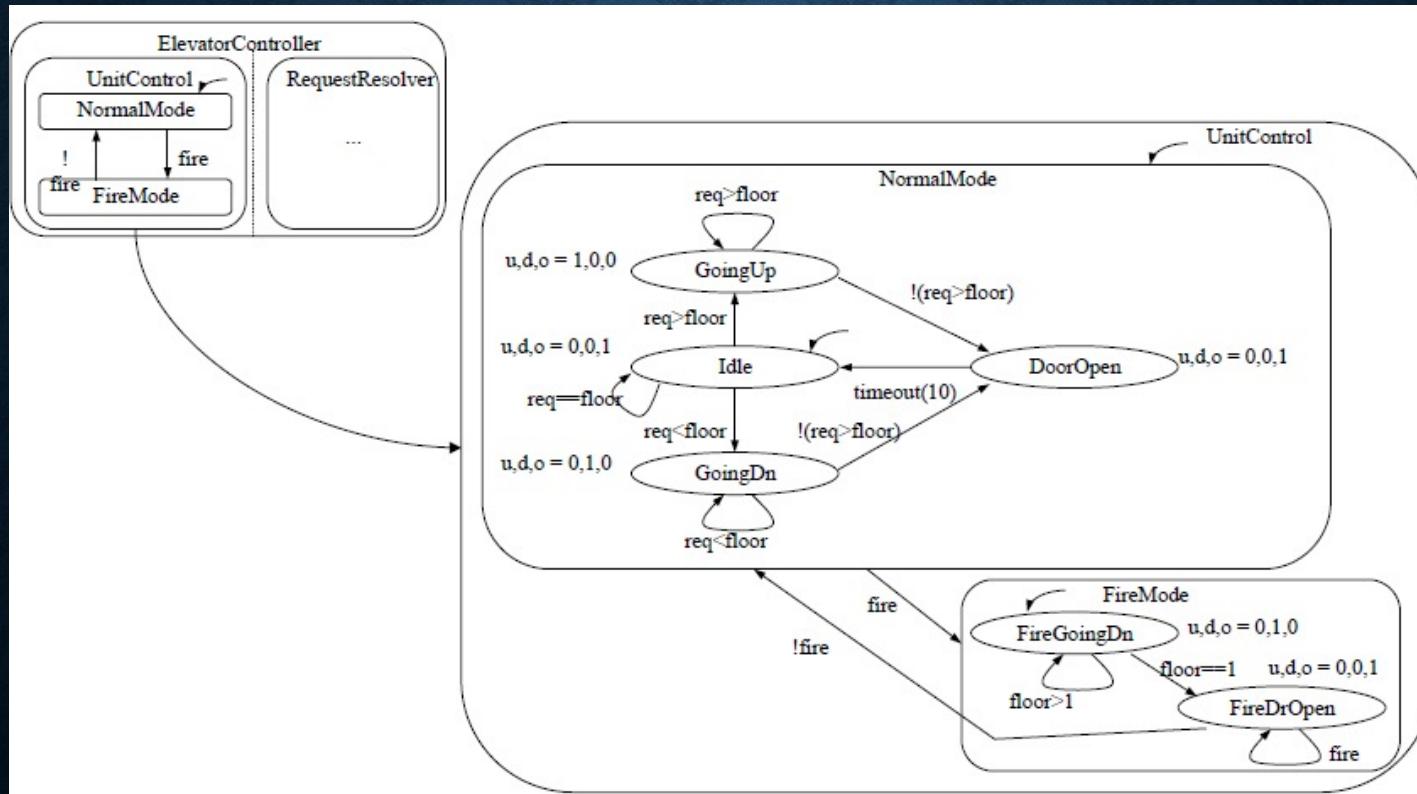
ELEVATOR FSM



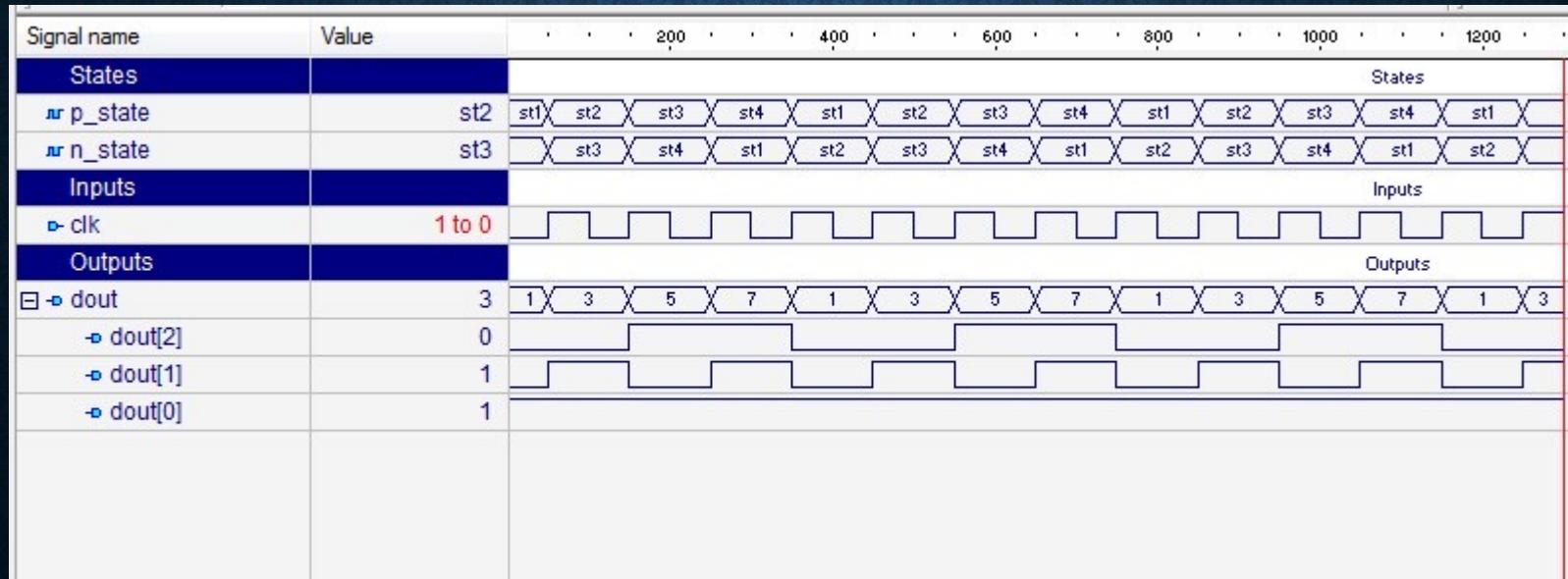
ELEVATOR FSM + FIRE



ELEVATOR FSM + HIERARCHY



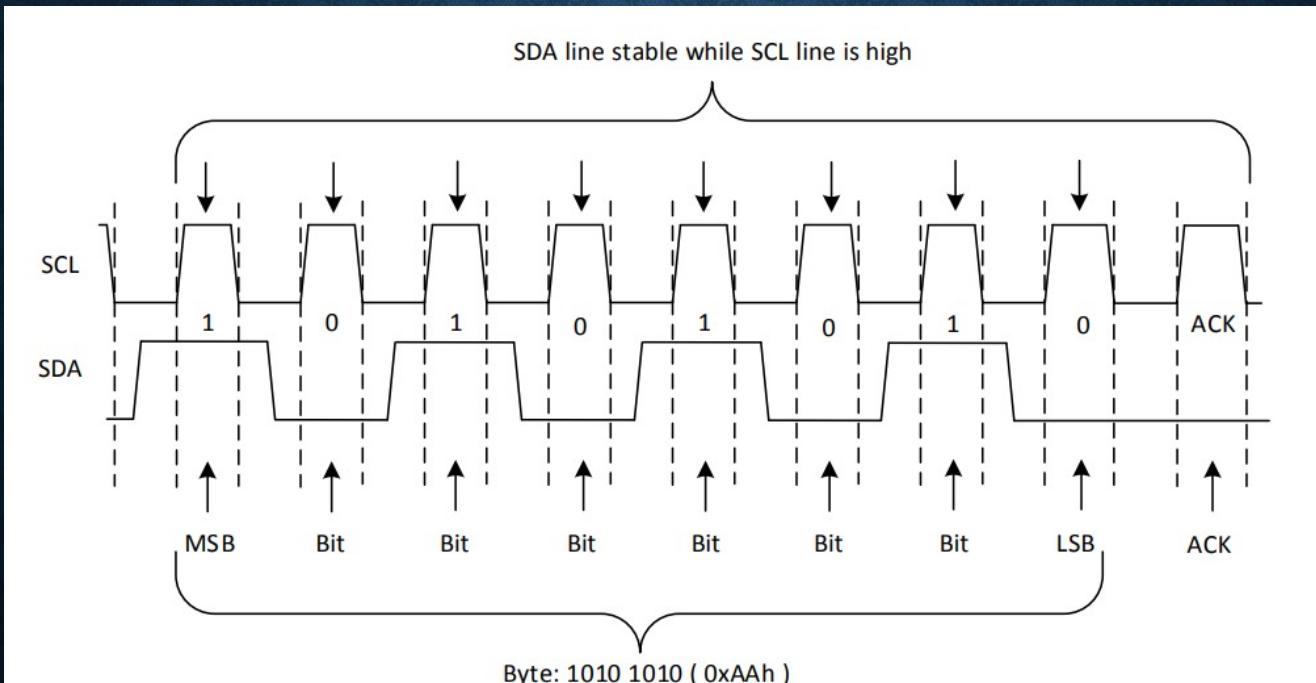
TIMING DIAGRAM



TIMING DIAGRAM

- A **digital timing diagram** is a representation of a set of signals in the time domain.
- A timing diagram can contain many rows, usually one of them being the clock.
- It is a tool that is commonly used in digital electronics, hardware debugging, and digital communications. Besides providing an overall description of the timing relationships, the digital timing diagram can help find and diagnose digital logic hazards.
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I2C AS TIMING DIAGRAM



I2C AS TIMING DIAGRAM

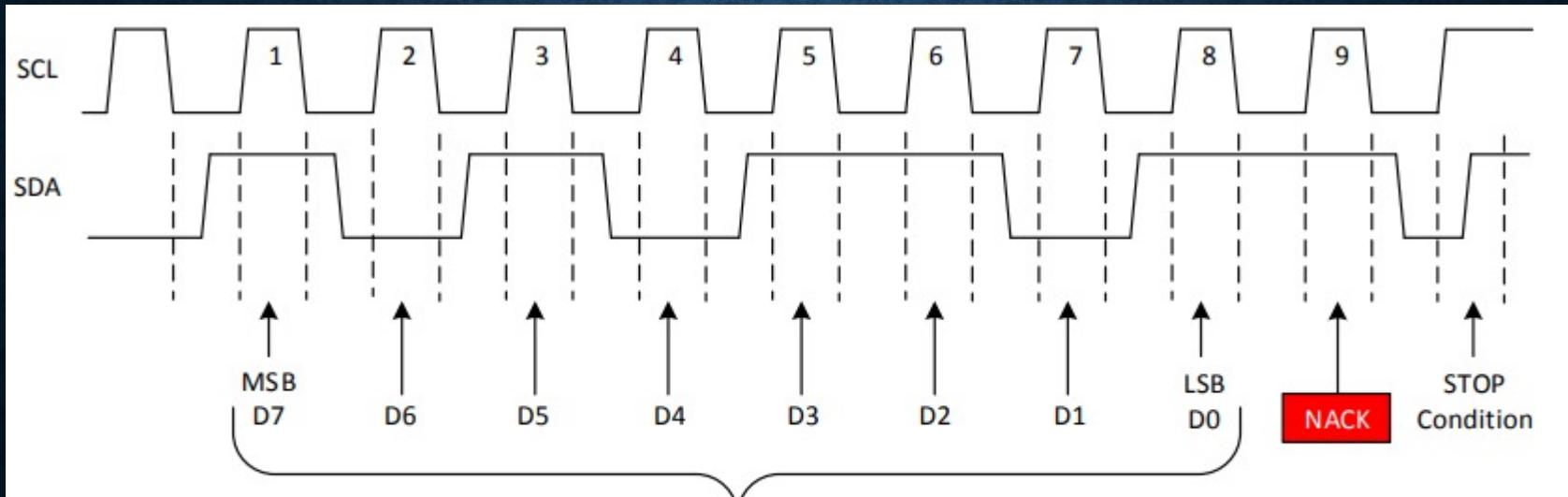


Figure 7. Example NACK Waveform

I2C AS TIMING DIAGRAM

