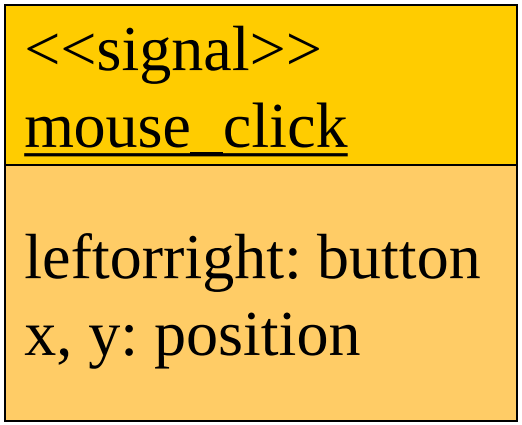
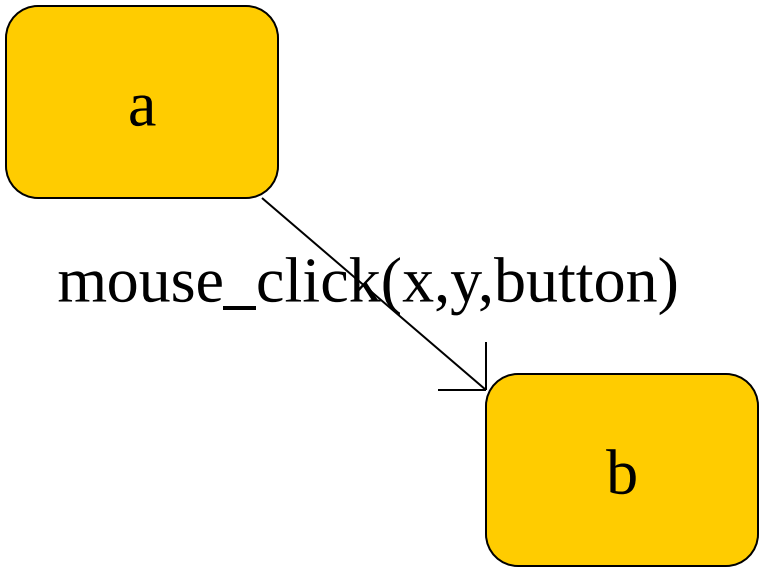
Stereotypes

- Stereotype: recurring combination of elements in an object or class.
- Example:
  - <<signal>> mouse_click :
    - Mouse_click (x,y,button)
    - A communication mechanism in Fig 1.11

Signal event



Signal event declaration

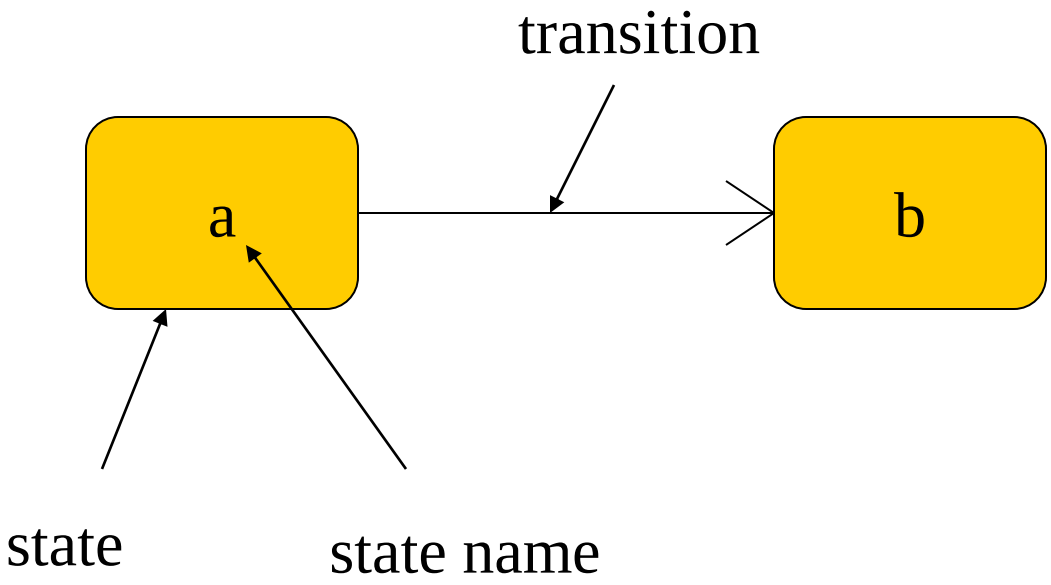


event description

Behavioral description

- Several ways to describe behavior:
  - internal view;
  - external view.

State machines



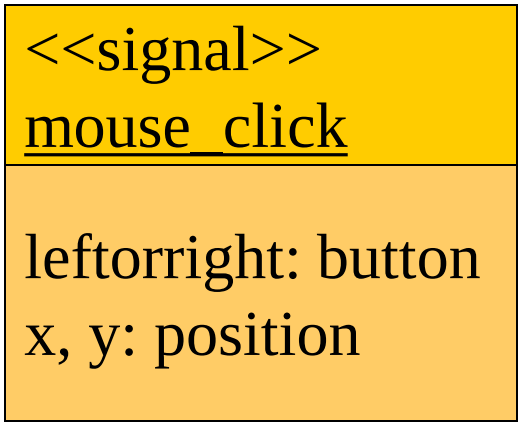
Event-driven state machines

- Behavioral descriptions are written as event-driven state machines.
  - Machine changes state when receiving an input.
- An event may come from inside or outside of the system.

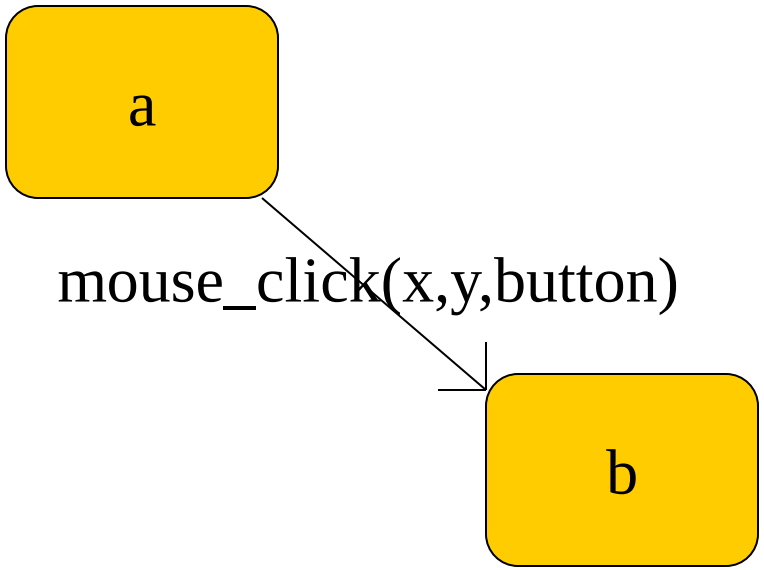
Types of events

- Three types of event defined by UML
  - Signal: asynchronous event.
  - Call: synchronized communication.
  - Timer: activated by time.

Signal event

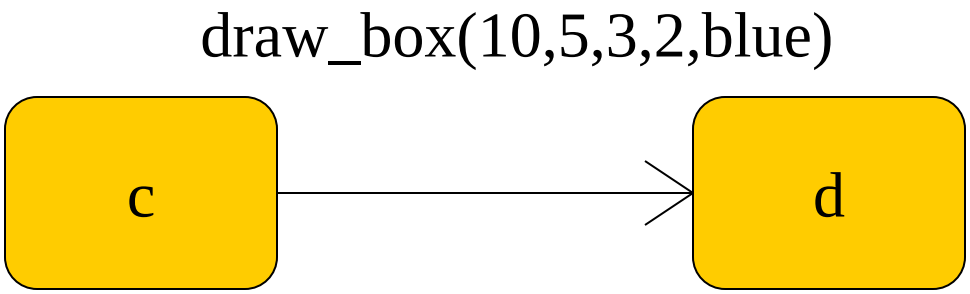


Signal event declaration

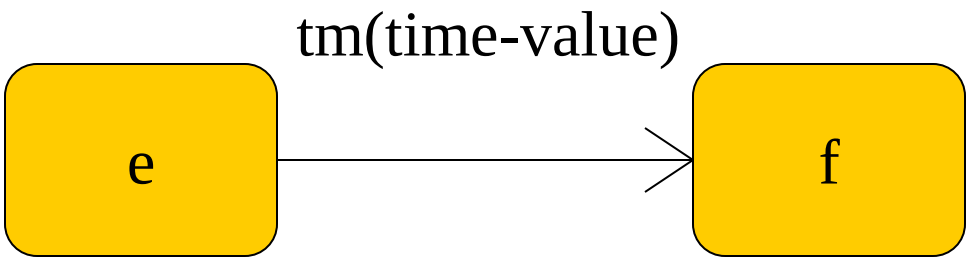


event description

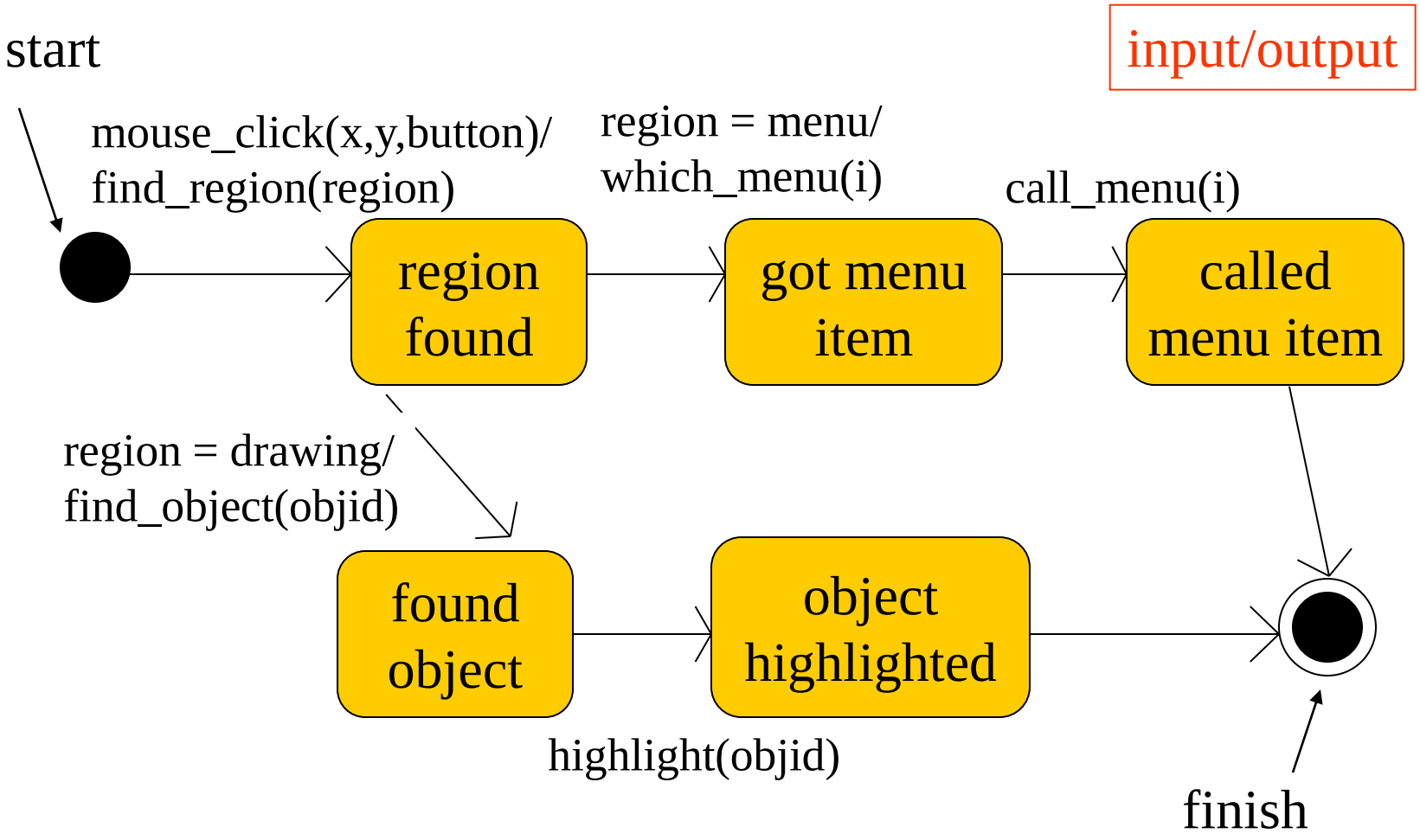
Call event



Timer event



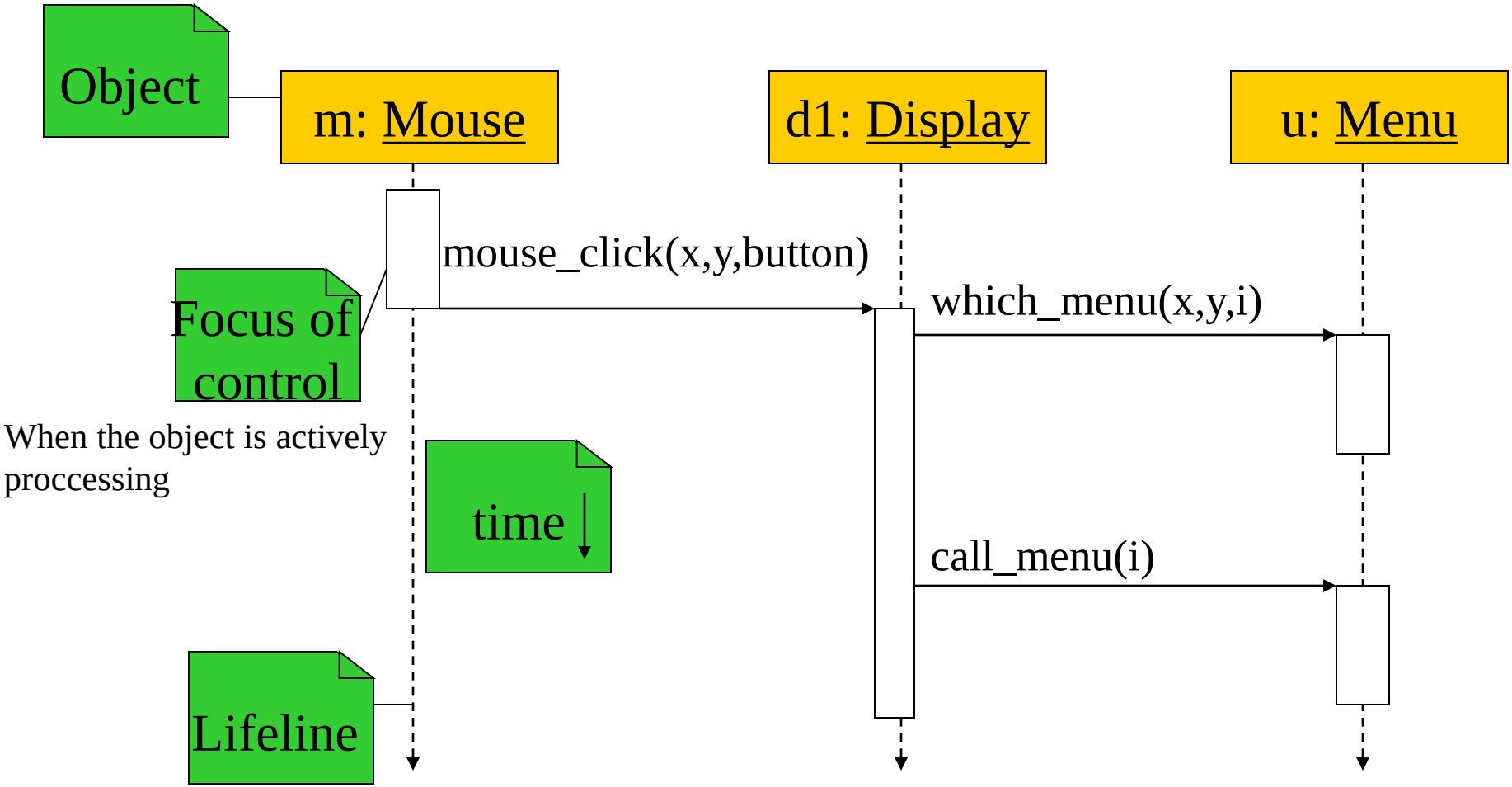
Example: state machine



Sequence diagram

- Shows sequence of operations over time.
- Relates behaviors of multiple objects.
- Designed to show a particular scenario or choice of events

Sequence diagram



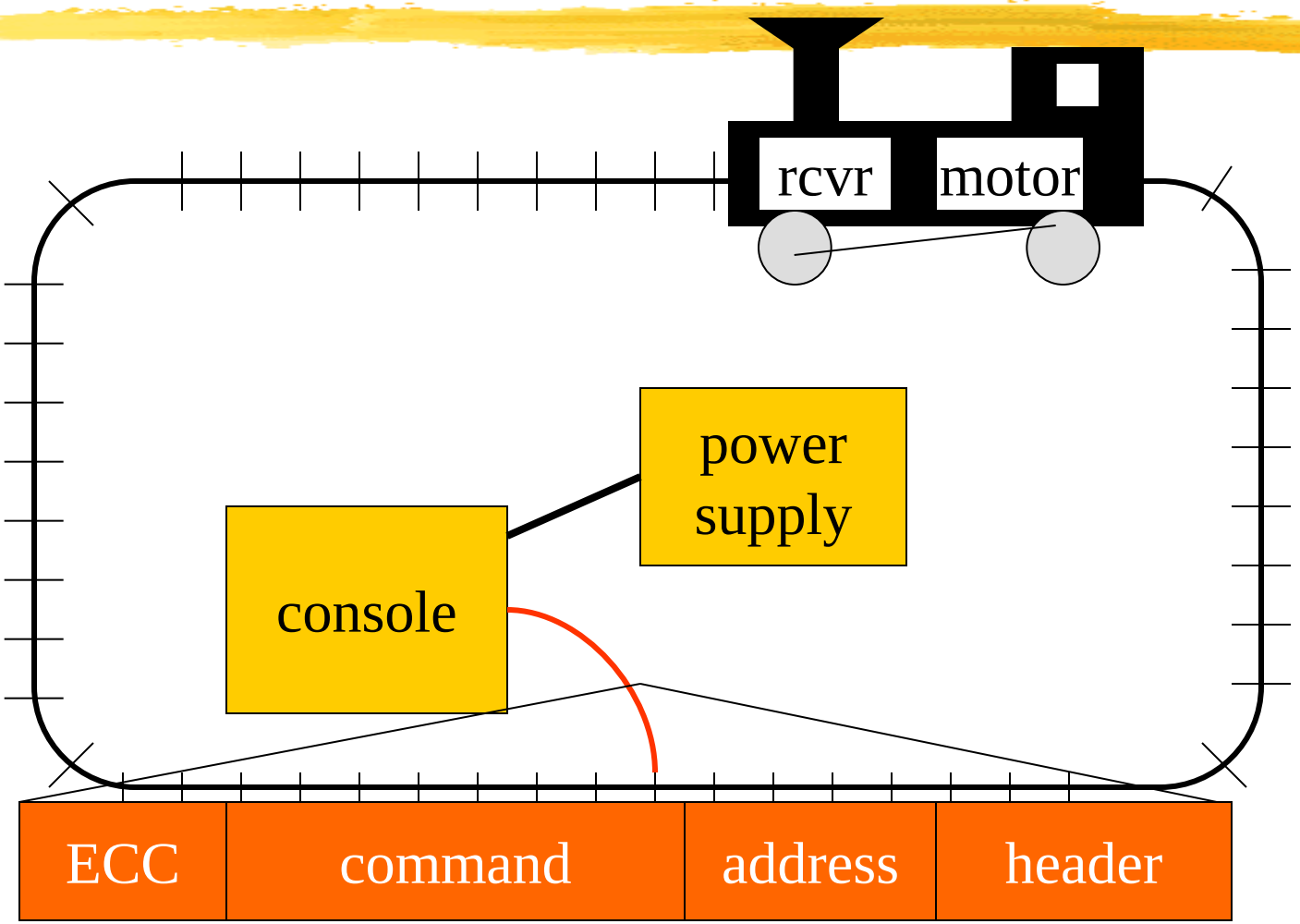
Summary

- Object-oriented design helps us organize a design.
- UML is a transportable system design language.
  - Provides structural and behavioral description primitives.

1.4 model train controller.

- Follow a design through several levels of abstraction.
- Gain experience with UML.

Model train setup



좌우 바뀌었음

Requirements

- Console can control 8 trains on 1 track.
- Throttle has at least 63 levels.
- Inertia control adjusts responsiveness with at least 8 levels.
- Emergency stop button.
- Error detection scheme on messages.

Requirements form

name	model train controller
purpose	control speed of <= 8 model trains
inputs	throttle, inertia, emergency stop, train #
outputs	train control signals
functions	set engine speed w. inertia; emergency stop
performance	can update train speed at least 10 times/sec
manufacturing cost	$50
power	10 W (wall powered)
physical size/weight	console comfortable for 2 hands; < 2 lbs.

Digital Command Control

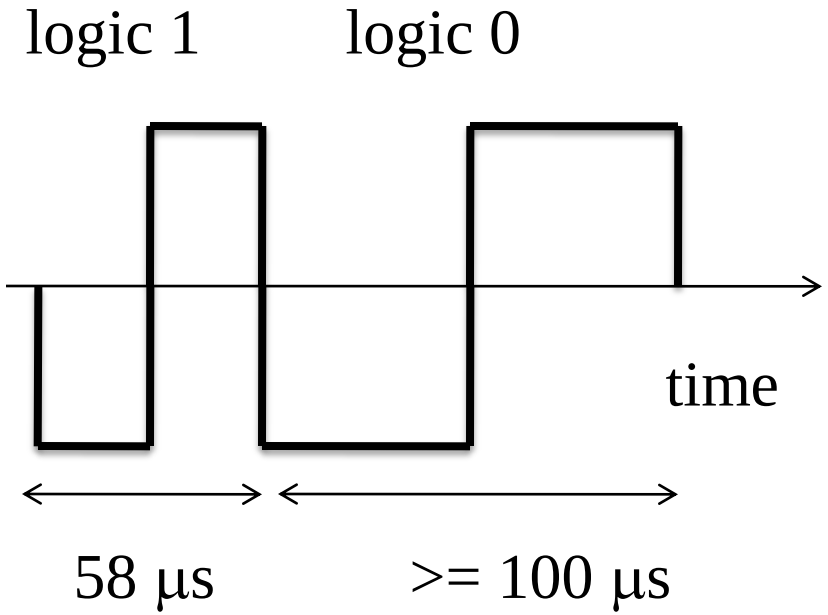
- DCC created by model railroad hobbyists, picked up by industry.
- Defines way in which model trains, controllers communicate.
  - Leaves many system design aspects open, allowing competition.
- This is a simple example of a big trend:
  - Cell phones, digital TV rely on standards.

DCC documents

- Standard S-9.1, DCC Electrical Standard.
  - Defines how bits are encoded on the rails.
- Standard S-9.2, DCC Communication Standard.
  - Defines packet format and semantics.

DCC electrical standard

- Voltage moves around the power supply voltage; adds no DC component.
- 1 is 58 μs, 0 is at least 100 μs.



DCC communication standard

- Basic packet format: PSA(sD) + E.
- P: preamble = 1111111111.
- S: packet start bit = 0.
- A: address data byte.
- s: data byte start bit = 0.
- D: data byte (data payload).
- E: packet end bit = 1.
- A packet include one or more data byte start bit/ data byte combination.

DCC packet types

- A baseline packet: minimum packet that must be accepted by all DCC implementations, which has three data bytes.
  - an address data byte gives receiver address.
  - an instruction data byte gives basic instruction.
  - an error correction data byte gives ECC.

Instruction data

- bits 0-3: a 4-bit speed value
- bit 4 : an additional speed bit (interpreted as a LSB of speed)
- bit 5 : forward (1), backward (0)
- bits 7-8:(01) instruction for speed/direction

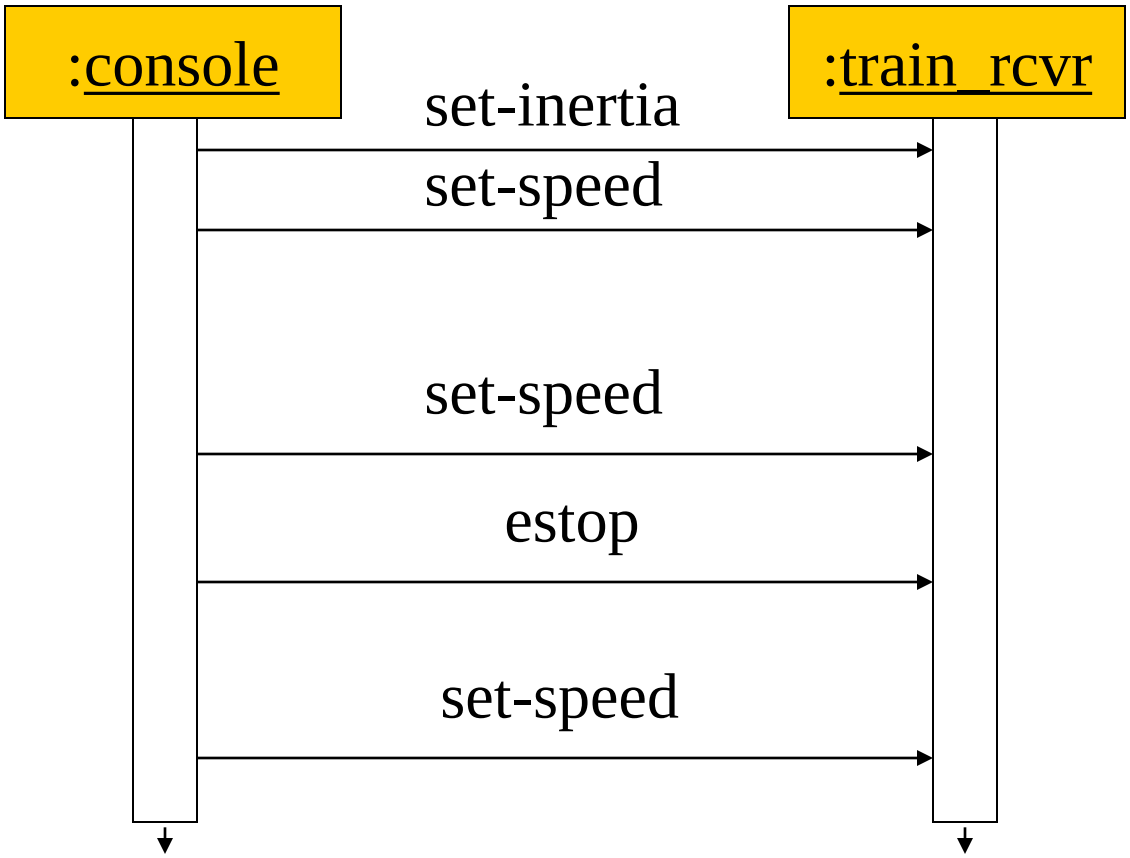
Conceptual specification

- Before we create a detailed specification, we will make an initial, simplified specification.
  - Gives us practice in specification and UML.
  - Good idea in general to identify potential problems before investing too much effort in detail.
- Commands and packets may not be generated in a 1-to-1 ratio.

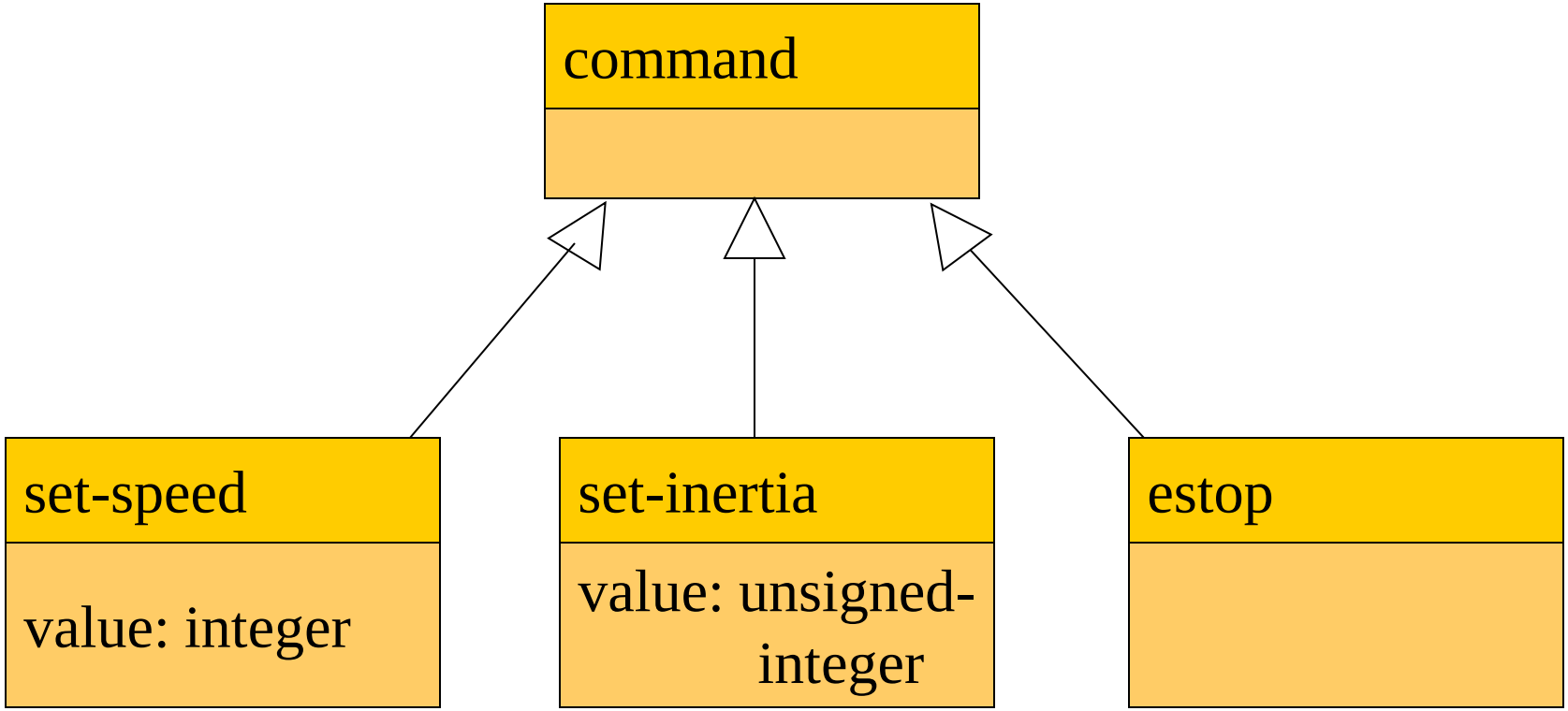
Basic system commands

command name	parameters
set-speed	speed (positive/negative)
set-inertia	inertia-value (non-negative)
estop	none

Typical control sequence



Message classes



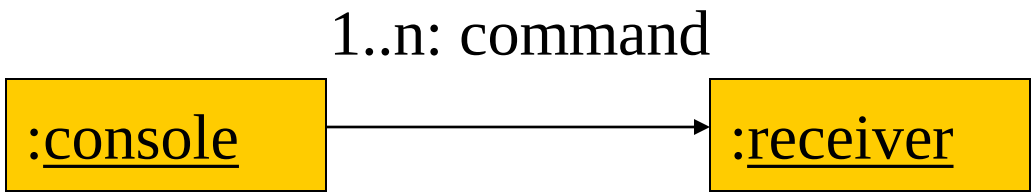
Class diagram for the train controller messages

Roles of message classes

- Implemented message classes derived from message class.
  - Attributes and operations will be filled in for detailed specification.
- Implemented message classes specify message type by their class.
  - May have to add type as parameter to data structure in implementation.

Collaboration diagram

- Interaction diagram
- Shows relationship between console and receiver (ignores role of track):



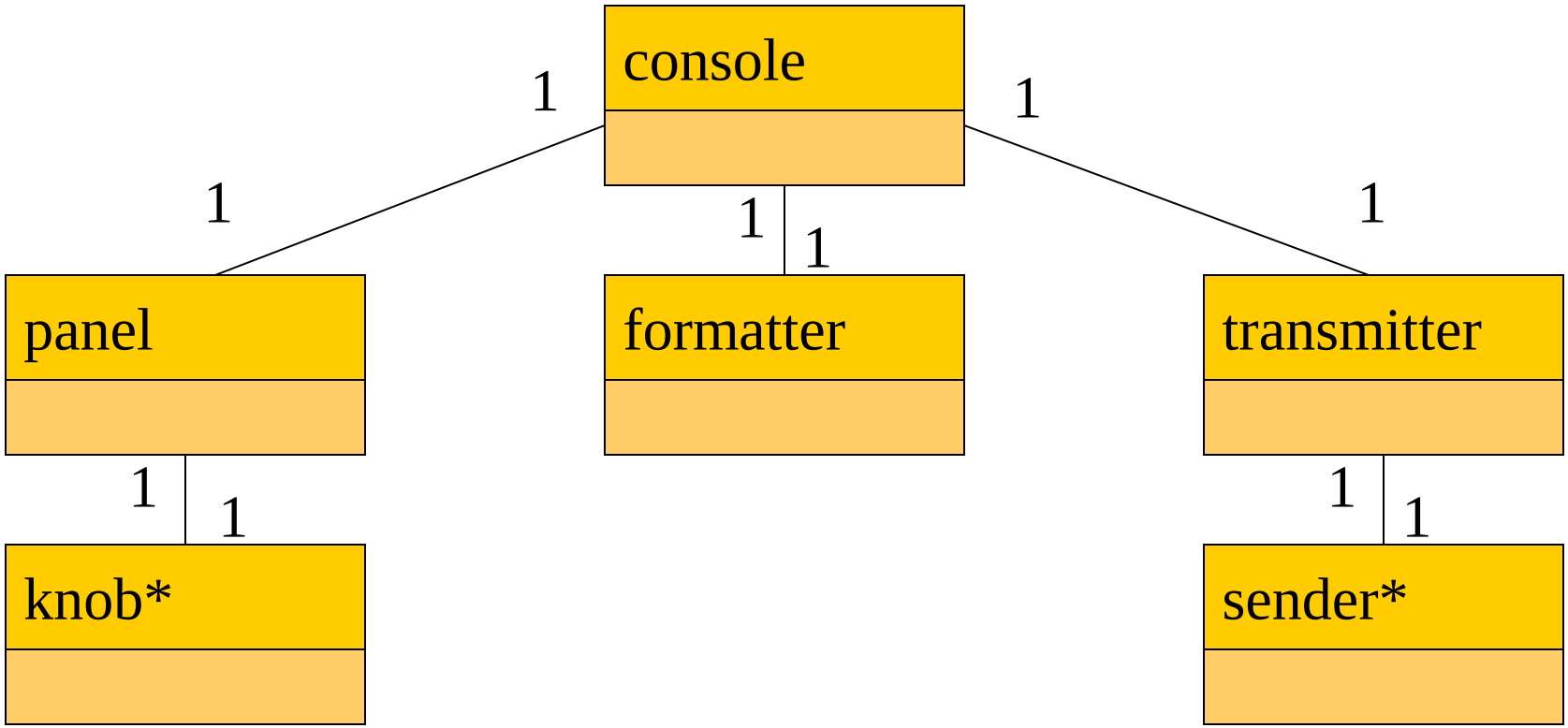
System structure modeling

- Some classes define non-computer components (physical objects).
  - Denote by name*.
- Choose important systems at this point to show basic relationships.

Major subsystem roles

- Console:
  - read state of front panel;
  - format messages;
  - transmit messages.
- Train:
  - receive message;
  - interpret message;
  - control the train.

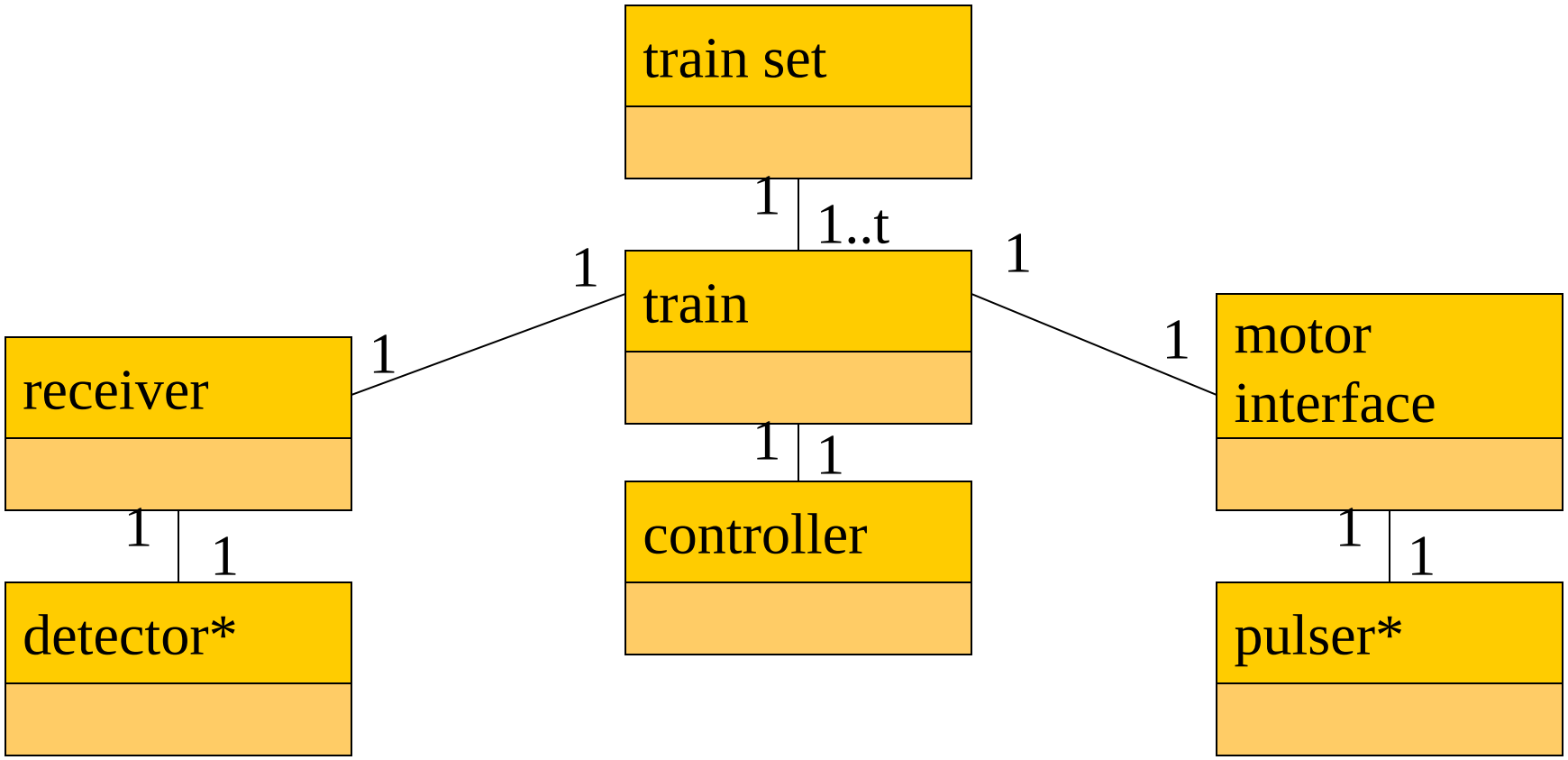
Console system classes



Console class roles

- panel: describes analog knobs and interface hardware.
- formatter: turns knob settings into bit streams.
- transmitter: sends data on track.

Train system classes



Train class roles

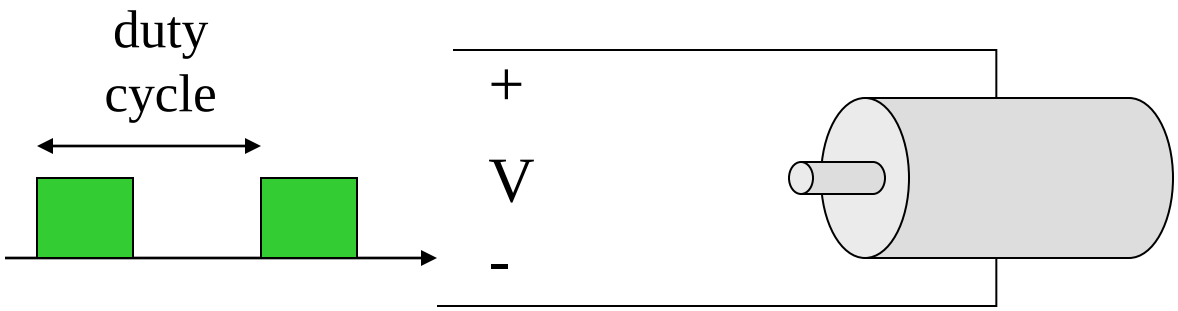
- receiver: digitizes signal from track.
- controller: interprets received commands and makes control decisions.
- motor interface: generates signals required by motor.

Detailed specification

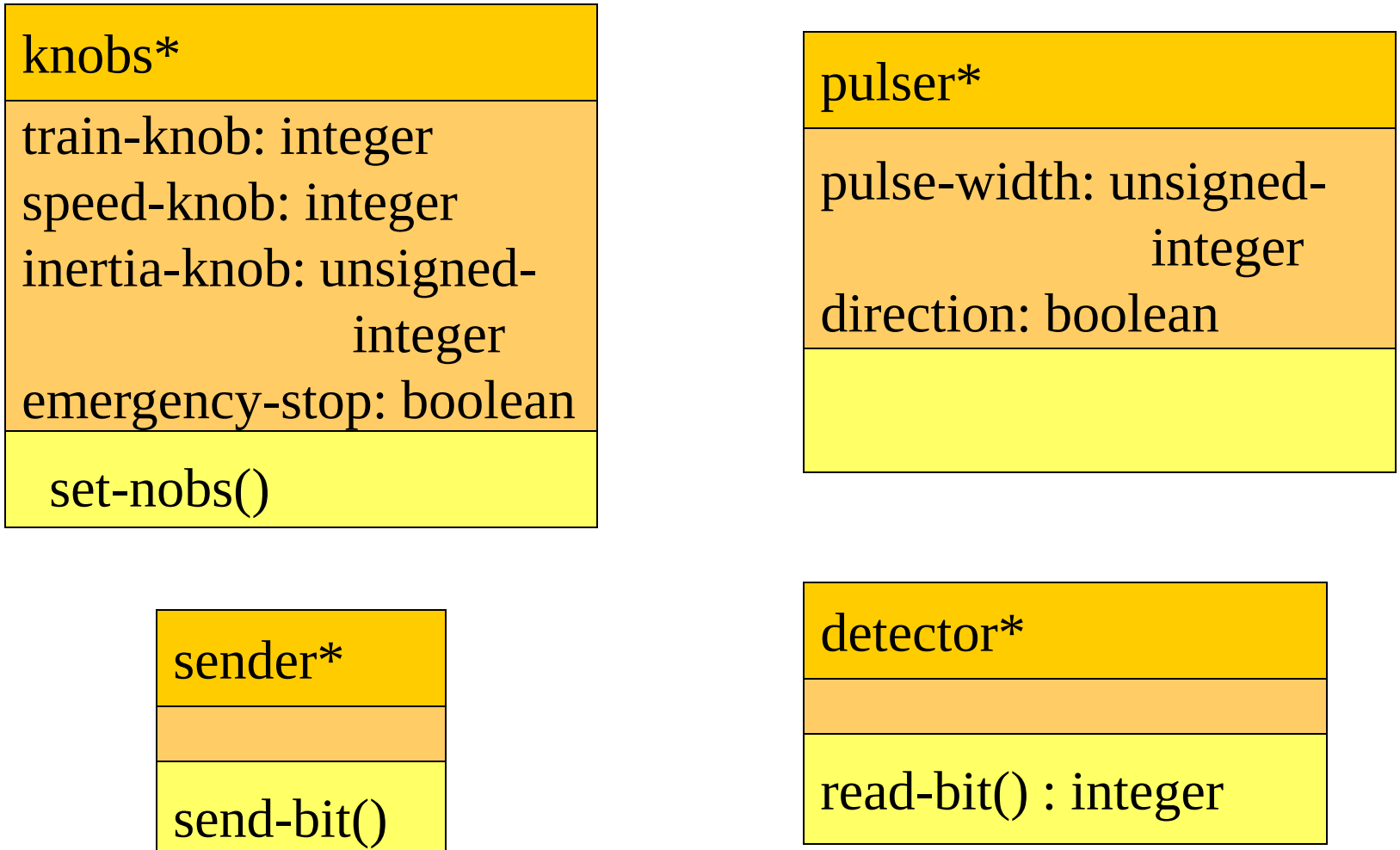
- We can now fill in the details of the conceptual specification:
  - more classes;
  - behaviors.
- Sketching out the spec first helps us understand the basic relationships in the system.

Train speed control

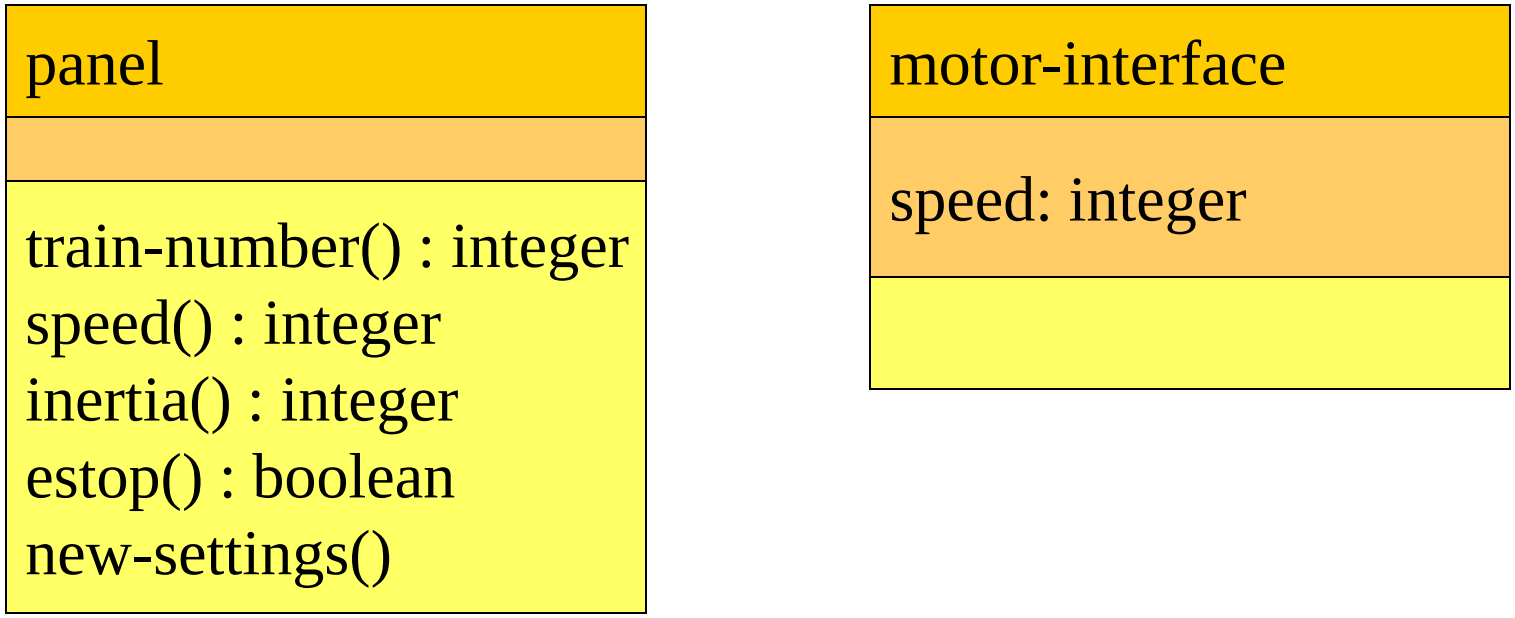
- Motor controlled by pulse width modulation:



Physical object classes in console and trains



Panel and motor interface classes



new-settings(): use the set-knobs behavior of the Knobs* class
to read the knobs settings whenever the train number setting is changed

Class descriptions

- panel class defines the controls.
  - new-settings() behavior reads the controls.
- motor-interface class defines the motor speed held as state.

Transmitter and receiver classes

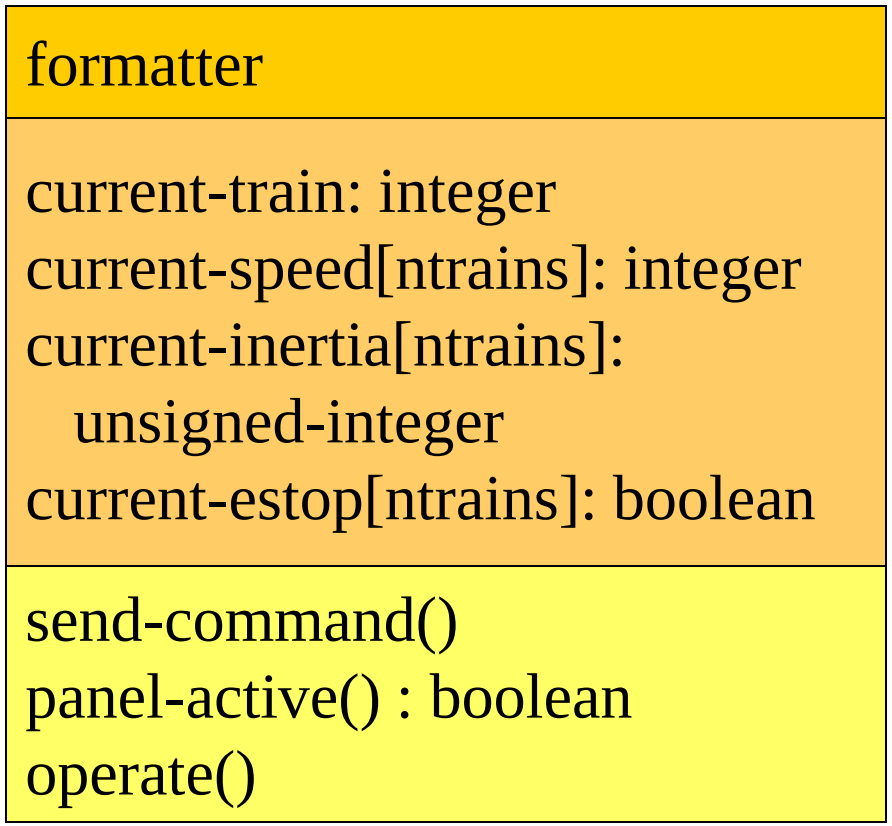
transmitter
send-speed(adrs: integer, speed: integer) send-inertia(adrs: integer, val: integer) set-estop(adrs: integer)

receiver
current: command new: boolean
read-cmd() new-cmd() : boolean rcv-type(msg-type: command) rcv-speed(val: integer) rcv-inertia(val:integer)

Class descriptions

- transmitter class has one behavior for each type of message sent.
- receiver function provides methods to:
  - detect a new message;
  - determine its type;
  - read its parameters (estop has no parameters).

Formatter class



Formatter class description

- Formatter class holds state for each train, setting for current train.
- The operate() operation performs the basic formatting task.