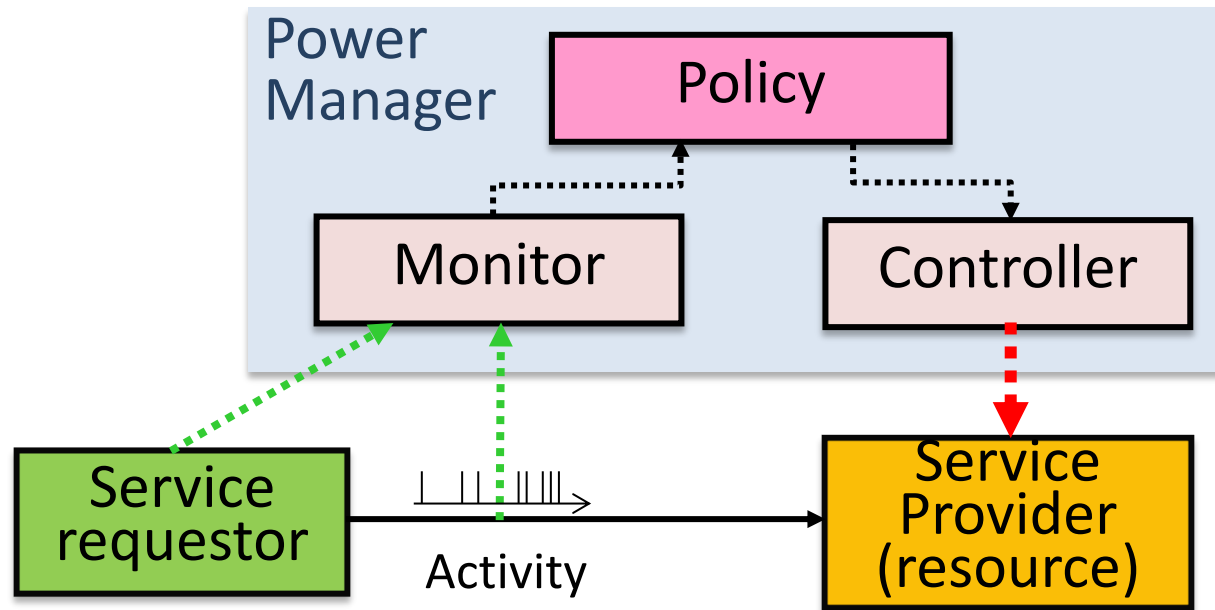


**Lab 1 – Day 3**

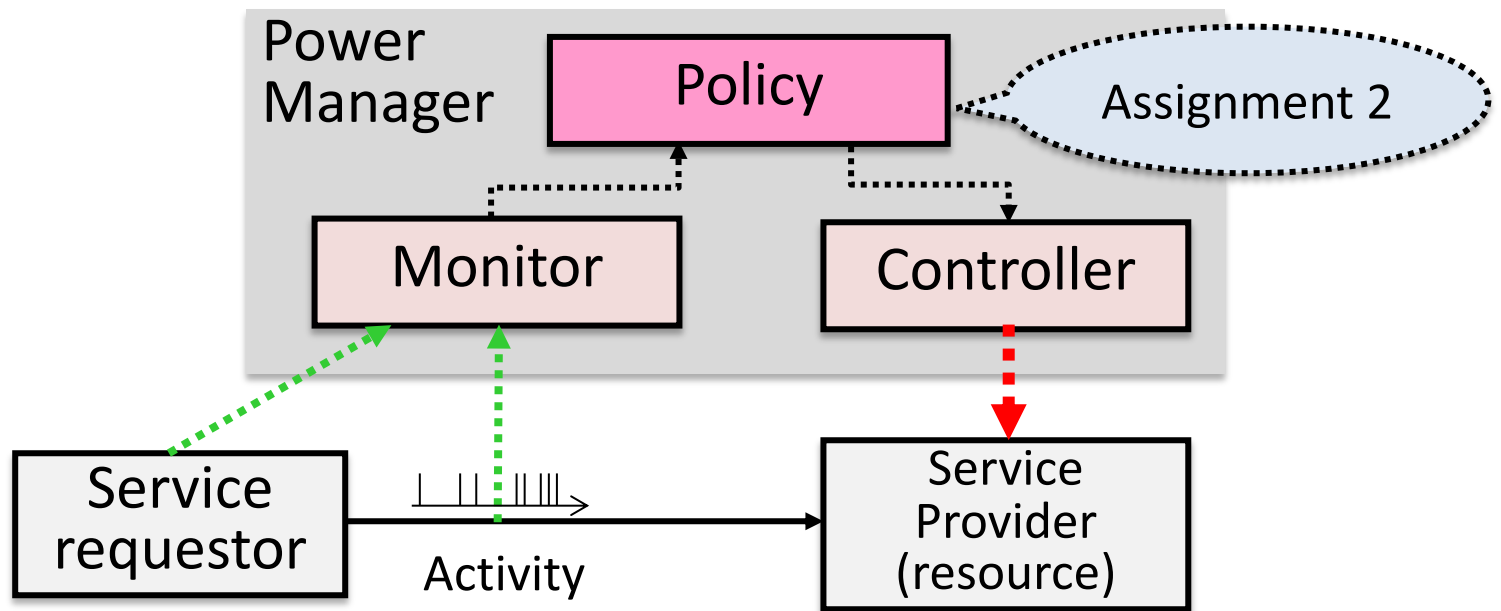
**Dynamic Power Management**

# Recall



- Power manager (PM)
  - Monitors requestor's activity and sets state of provider according to some **policy** (implemented inside the PM)

# Recall

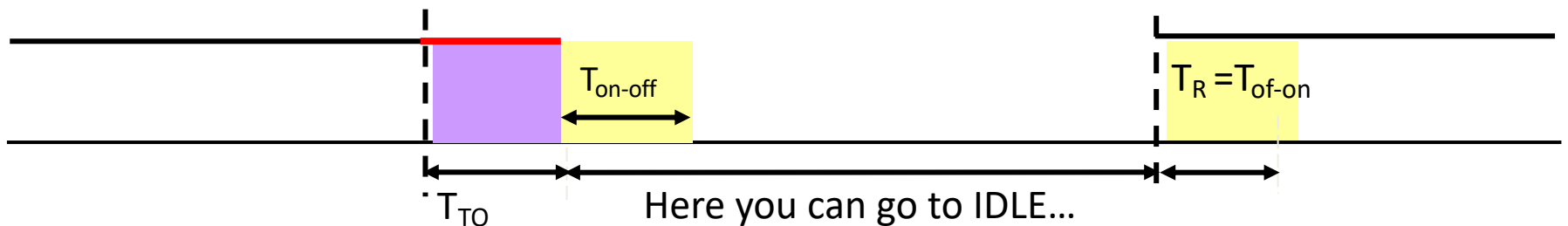
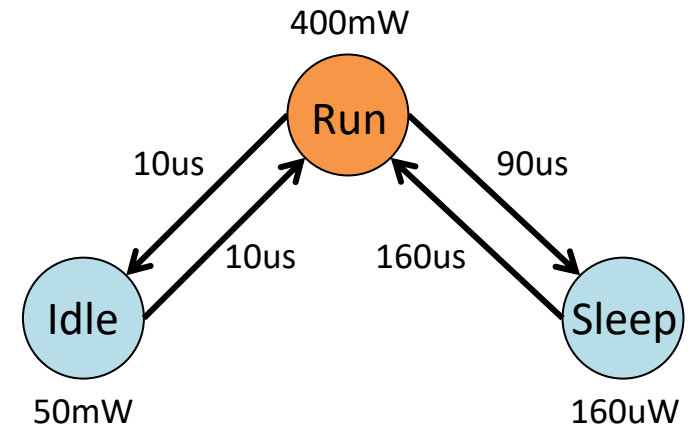


- Policy implementation
  - Implement the history-based policy

**Assignment 2**  
**History-based prediction**  
**policy implementation**

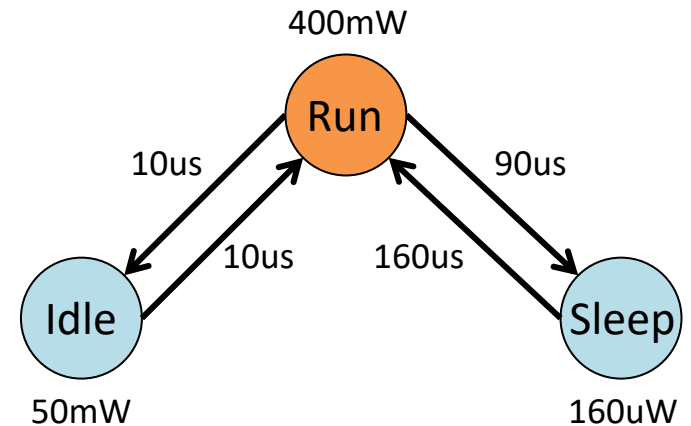
# Recall

- So far we worked with timeout policies...
  - Put the device in off state  $T_{TO}$  time units after it has entered the idle state

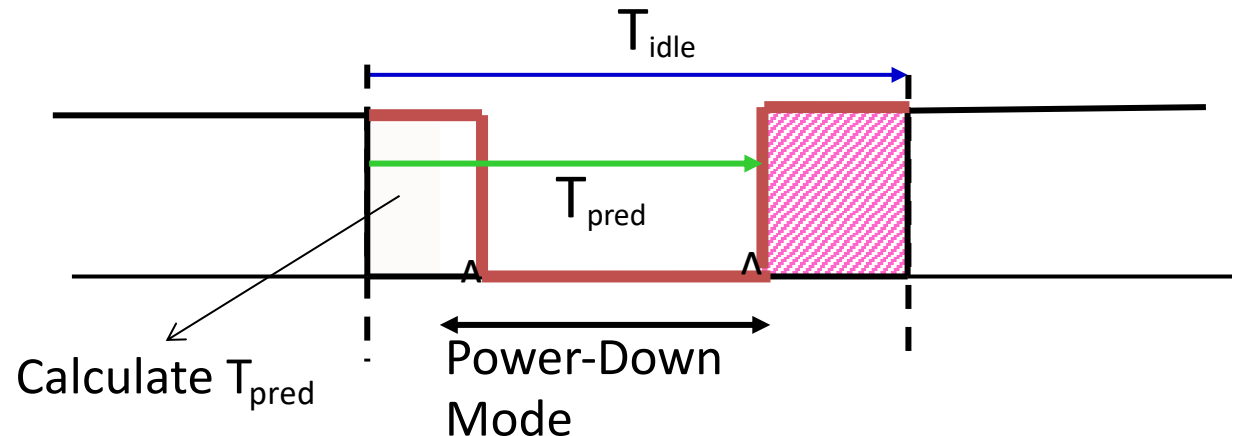


# Recall

- So far we worked with timeout policies...
  - Put the device in off state  $T_{TO}$  time units after it has entered the idle state



- Can history teach us something?



# Recall

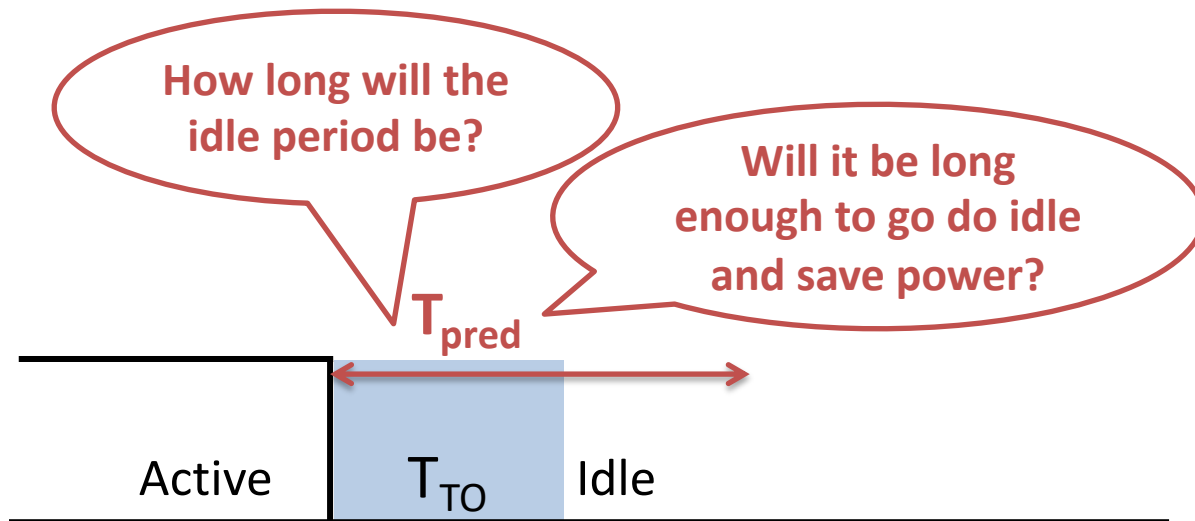
- Predictive policies
  - Predict idle period  $T_{\text{pred}} \sim T_{\text{idle}}$ 
    - Use **history**
    - E.g.,  $T_{\text{active}}$  and  $T_{\text{idle}}$  of previous period
  - Go to sleep state if  $T_{\text{pred}}$  is long enough to amortize state transition cost
- Example (non-linear) regression equation:



$$T_{\text{idle}}[i] = \mathbf{K} + \mathbf{K}_1 \cdot T_{\text{idle}}[i-1] + \mathbf{K}_2 \cdot T_{\text{active}}[i] + \mathbf{K}_3 \cdot T_{\text{active}}[i]^2$$

# Assignment 2

$$T_{idle}[i] = K + K_1 \cdot T_{idle}[i-1] + K_2 \cdot T_{active}[i] + K_3 \cdot T_{active}[i]^2$$

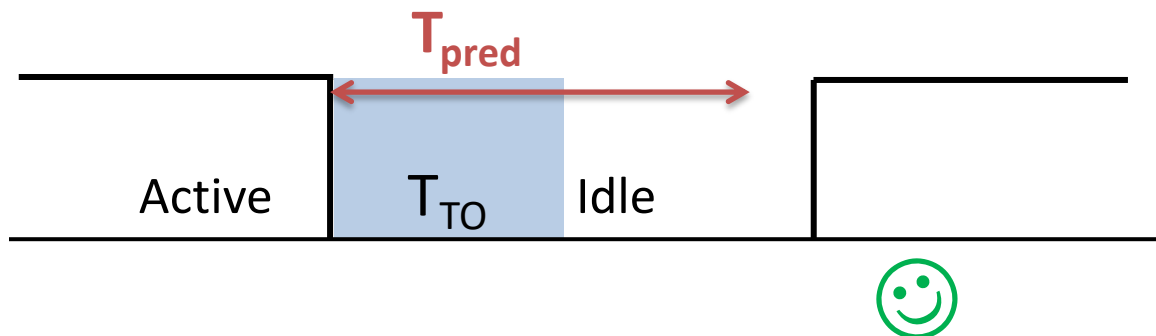




# Assignment 2

$$T_{idle}[i] = K + K_1 \cdot T_{idle}[i-1] + K_2 \cdot T_{active}[i] + K_3 \cdot T_{active}[i]^2$$

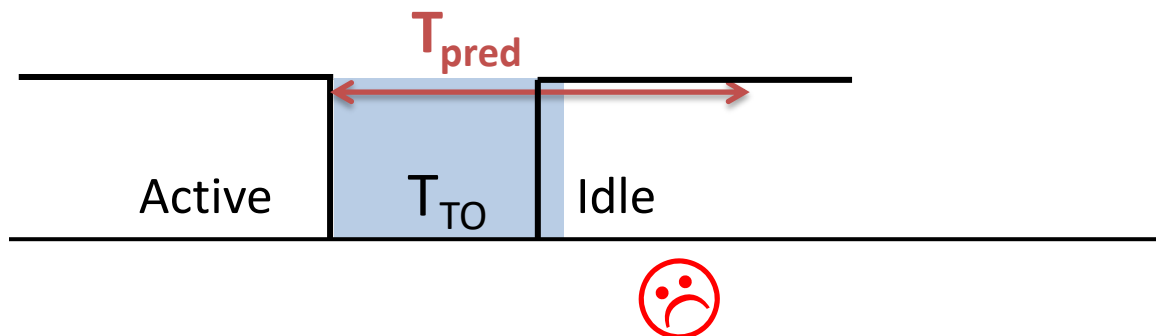
Drawback: will my guess be right?



# Assignment 2

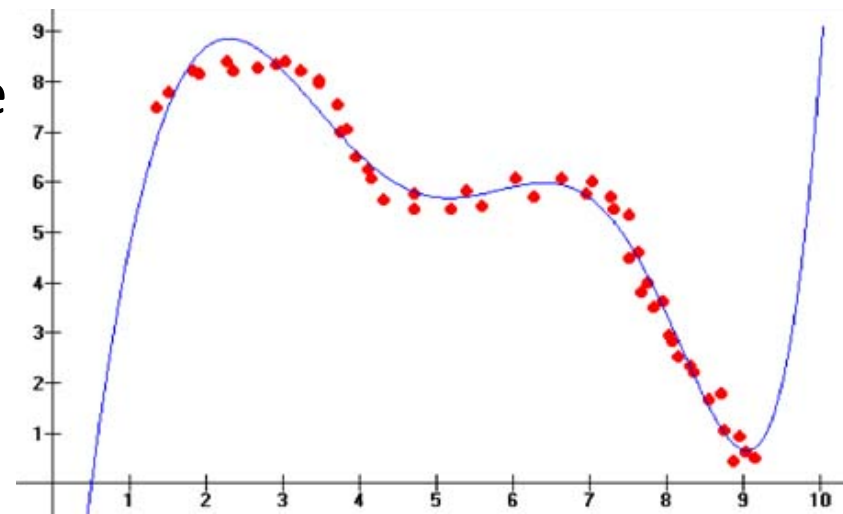
$$T_{idle}[i] = K + K_1 \cdot T_{idle}[i-1] + K_2 \cdot T_{active}[i] + K_3 \cdot T_{active}[i]^2$$

Drawback: will my guess be right?



# Parenthesis

- Polynomial Regression
  - Estimate the relationship between variables
    - Independent variables  $\sim$  my inputs
    - Dependent variable  $\sim$  the value I want to estimate
  - Estimated as a polynomial
    - Choose the grade
    - Get the coefficients s.t. the polynomial estimates «well» the samples



# Parenthesis

- Regression
  - In our scenario, e.g.:
    - **Independent variables:** length of previous IDLE/ACTIVE periods
    - **Dependent variable:** length of current IDLE period
  - What are the coefficients for the polynomial s.t. it can estimate well?

$$T_{idle}[i] = K + K_1 \cdot T_{idle}[i-1] + K_2 \cdot T_{idle}[i-1]^2$$

# Example

- E.g., Matlab polyfit function
  - <http://it.mathworks.com/help/matlab/ref/polyfit.html>

## polyfit

Polynomial curve fitting

[expand all in page](#)

### Syntax

```
p = polyfit(x,y,n)
[p,S] = polyfit(x,y,n)
[p,S,mu] = polyfit(x,y,n)
```

### Description

`p = polyfit(x,y,n)` finds the coefficients of a polynomial  $p(x)$  of degree  $n$  that fits the data,  $p(x(i))$  to  $y(i)$ , in a least squares sense. The result `p` is a row vector of length  $n+1$  containing the polynomial coefficients in descending powers:

$$p(x) = p_1x^n + p_2x^{n-1} + \dots + p_nx + p_{n+1}.$$

# Recall

- Predictive policies
  - Predict idle period  $T_{\text{pred}} \sim T_{\text{idle}}$ 
    - Use **history**
    - E.g.,  $T_{\text{active}}$  and  $T_{\text{idle}}$  of previous period
  - Go to sleep state if  $T_{\text{pred}}$  is long enough to amortize state transition cost
- Example (non-linear) regression equation:

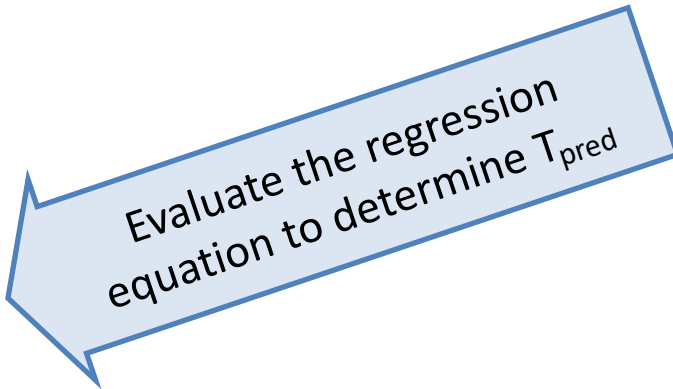


$$T_{\text{idle}}[i] = \mathbf{K} + \mathbf{K}_1 \cdot T_{\text{idle}}[i-1] + \mathbf{K}_2 \cdot T_{\text{active}}[i] + \mathbf{K}_3 \cdot T_{\text{active}}[i]^2$$

# Assignment 2

- Modify the simulator to implement a *history-based prediction policy*

```
case DPM_HISTORY:
    if(curr_time < idle_period.start) {
        *next_state = PSM_STATE_ACTIVE;
    } else {
        *next_state = PSM_STATE_ACTIVE;
        /* LAB 3 EDIT */
        // hparams.alpha[i] * history[i] ....
        //if(value_prediction ...)
        //  *next_state = PSM_STATE_ACTIVE; ...
    }
    break;
```



Evaluate the regression equation to determine  $T_{pred}$

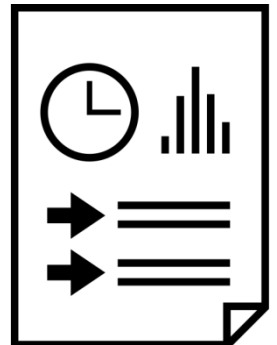
# Assignment 2

- Modify the simulator to implement a *history-based prediction policy*
  - Choose any regression you like
    - E.g., that works well with the workload...
    - Note that the regression may consider a number of previous idle or active periods → *window size*
      - How far shall I go in the past?
      - How many past elements shall I consider?
  - Compute regression coefficients
    - E.g., with Matlab, but you can pick your favourite tool



# Assignment 2

- Report assignment
  - Description of implemented predictive policy
  - Result of implemented predictive policy with the workload profiles
    - Analysis on:
      - Window size vs. energy saving
      - Coefficient values vs. energy saving (model order)
      - Timing/energy overhead
  - Comparison between predictive and timeout policies



**End of Lab 1!**  
**Now you're ready to prepare  
the first report...**

The deadline is 23:59 of the day before the 2<sup>nd</sup> exam