



# NTNU

Innovation and Creativity

## **Exploiting online WCET estimates**

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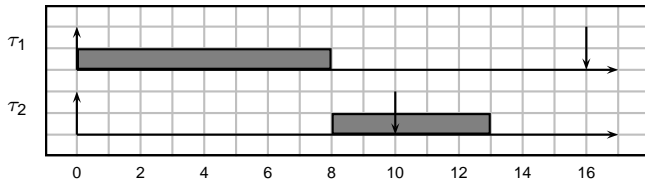
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# What is *online* WCET?

- A WCET estimate that can be made at a tasks release time by the use of program state, and available input data.
- Can be expected to be less conservative than traditional, offline WCET.
- The gain from using this information for e.g. scheduling must outweigh the cost of calculating the estimate.
- Motivation: To better handle dynamism.

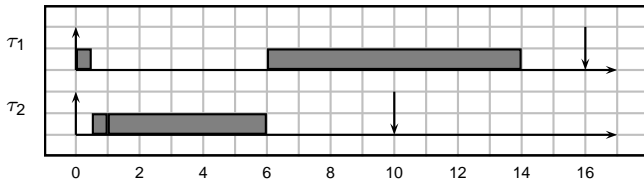
## Example - A problem

<i>Crit</i>	<i>Job</i>	<i>WCET<sup>off</sup></i>	<i>WCET<sup>on</sup></i>	<i>C</i>	<i>R</i>	<i>D</i>
Hard	$\tau_1$	12	9	8	0	16
Soft	$\tau_2$	8	6	5	0	10



# Example - using $WCET^{on}$

<i>Crit</i>	<i>Job</i>	$WCET^{off}$	$WCET^{on}$	<i>C</i>	<i>R</i>	<i>D</i>
Hard	$\tau_1$	12	9	8	0	16
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# Two open problems

1. The systematic extension of the class of programs for which effective algorithms estimating an online WCET exists.
2. The utilization of the online WCET in making systems with better timeliness properties.

# How can we find the online WCET ?

- The transformation from metrics found on-line to  $WCET^{on}$  is prepared off-line.
- Such metrics can be found by:
  - Plain lookup of program state or input data.
  - Calculation of significant control variables.
  - Calculation of algorithm-specific metrics.

# For what can we use the online WCET ?

- Improving mixed criticality scheduling.
- Reclaiming of allocated but unused CPU.
- Jitter reduction.
- Load balancing.
- A foundation for timing-domain error recovery.
- Controlling quality of service.
- Improving schedulability or timeliness properties of the system.
- ...

# WiP: Automatic metric extraction

Removing all but the control flow decisions yields an estimation algorithm.

```

for (m=1;m<mmax;m+=2) {
  for (i=m;i<=n;i+=istep) {
    j=i+mmax;
    tempr=wr*data[j]-wi*data[j+1];
    tempi=wr*data[j+1]+wi*data[j];
    data[j]=data[i]-tempr;
    data[j+1]=data[i+1]-tempi;
    data[i] += tempr;
    data[i+1] += tempi;
  }
  wr=(wtemp=wr)*wpr-wi*wpi+wr;
  wi=wi*wpr+wtemp*wpi+wi;
}

```

(a)



```

g_metric += 1;
for(m=1;m < mmax;m+=2){
  g_metric += 13;
  for(i=m;i <= n;i+=istep){
    g_metric += 32;
  }
}

```

(b)



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# Questions to you:

- Which applications would you like to see ?
- Cooperation
  - On the application ?
  - On the transformation to  $WCET^{on}$  ?
  - On the scheduler/OS ?
  - ...

# Questions or comments ?