

Example

Assume a machine that has a **branch-target buffer with 8 entries**. A branch in this machine has a penalty of 2 clock cycles (if the branch is taken and the target instruction is not in the branch-target buffer, or if the branch is predicted as taken, the instruction is in the branch-target buffer, but the branch is actually not taken.) In all other situations the branch penalty is zero. What is the total branch penalty in this machine, measured in clock cycles, if

- the branch prediction accuracy is 90%;
- 80% of the time the target instruction is in the buffer (80% hit rate in the buffer);
- 60% of the branches are actually taken.

$$P(\text{taken but not in buffer}) = 60\% \times 20\% = 12\%$$

$$P(\text{not taken but in buffer}) = 80\% \times 10\% = 8\%$$

$$\text{Penalty} = 12\% \times 2 + 8\% \times 2 = 0.4 \text{ clock cycles}$$