The Effects of Predication on Branch Prediction

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Motivation

- Predication and Branch Prediction are useful in reducing the performance penalty caused by branches
- No measurements on their interaction
- Previous research shows promise
  - *Control Flow Prediction*

    Pnevmatikatos, Franklin and Sohi

Outline of the Talk

- Predication
- Branch Prediction
- Branch Characteristics
- Effects of Prediction
- Conclusions

Predication

- Translates Control Dependencies into Data Dependencies
- Allows for a Predicate to Specify Instruction Completion

Existing Predication Models

❖ Conditional Move	*Alpha*
❖ Skip/Nullification	*HP*
❖ Guarded Execution	*Wisconsin*
❖ Predicate Field	*Cydra 5*

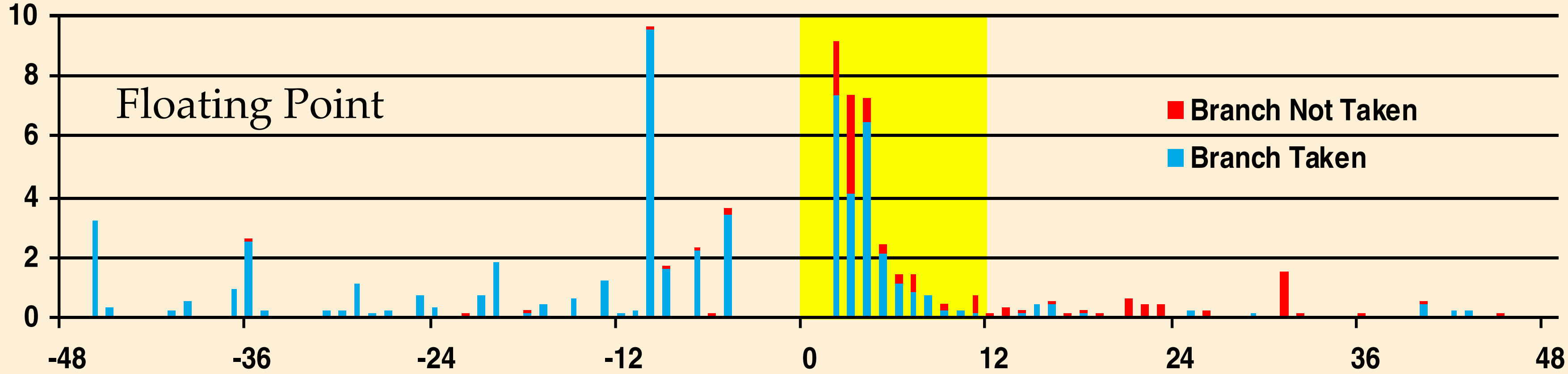
Compiler Transformation to Predication Form

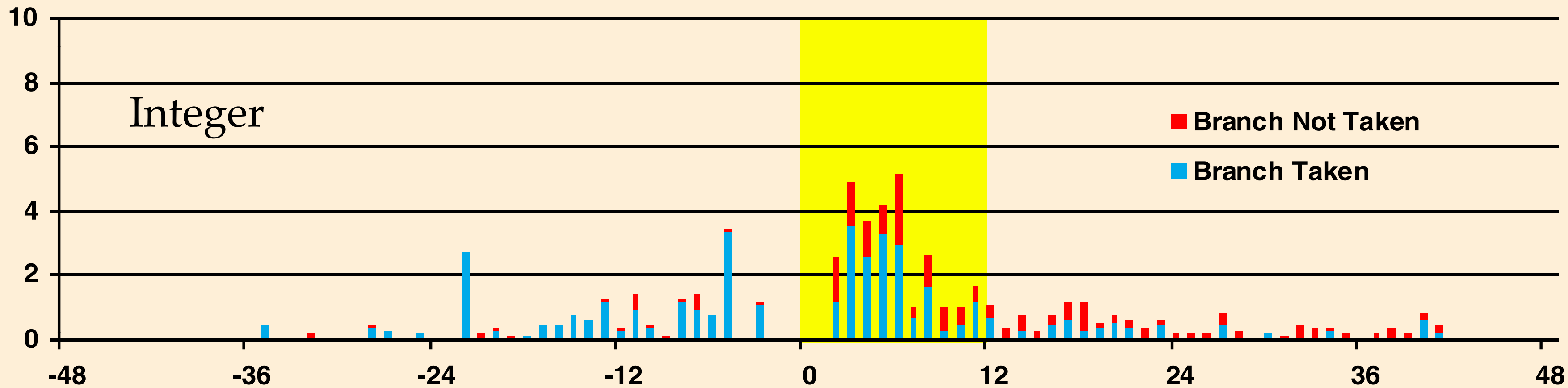
- Boosting with Predicates
- Aggressive Transformations
  - Hyperblock Scheduling

Branch Prediction Strategies

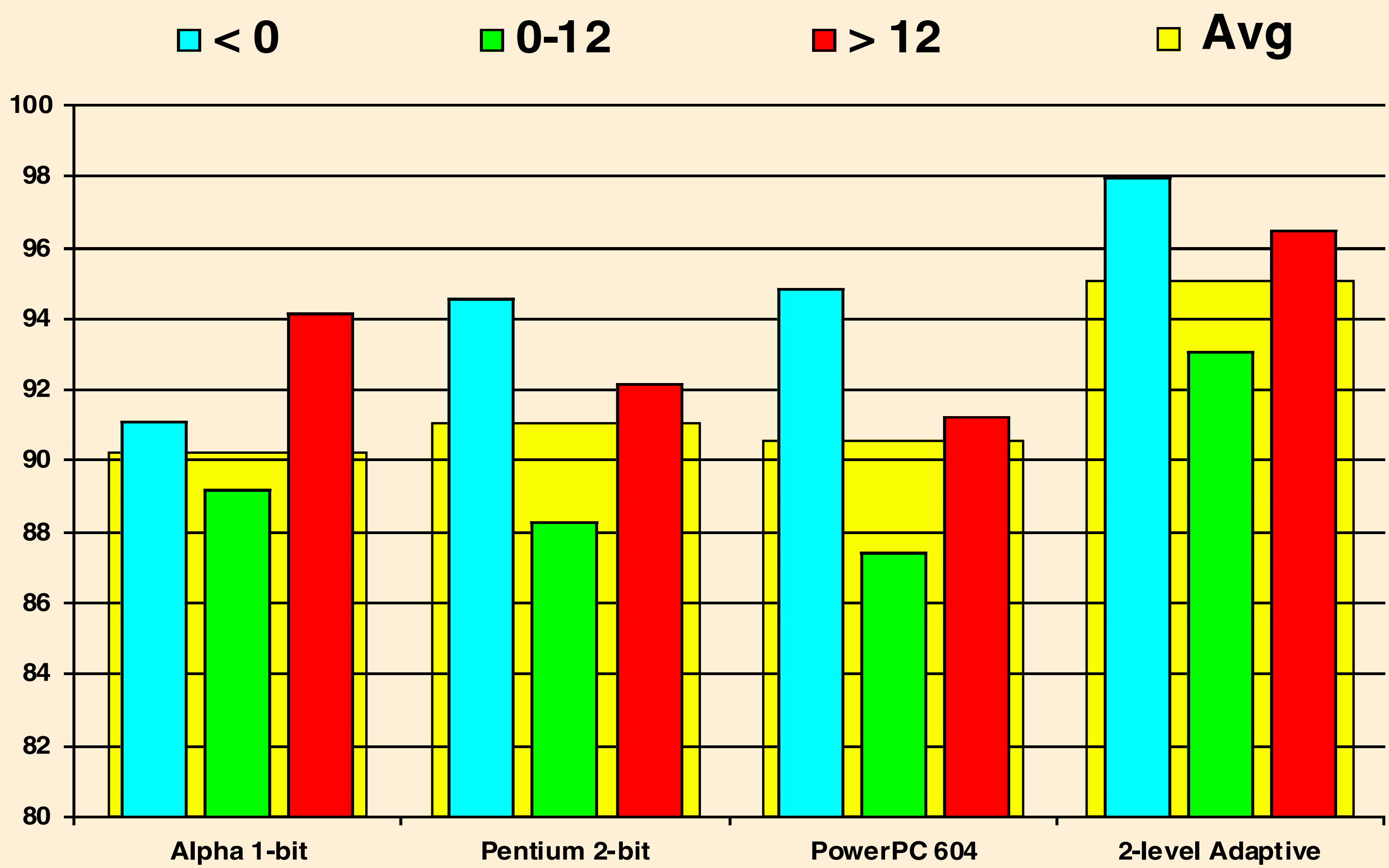
- Static Prediction
  - Branch Always and Branch Backwards
- Dynamic Prediction
  - One and Two Bit Saturation Counters
  - Correlation Based Prediction

Branch Frequency (by Distance)

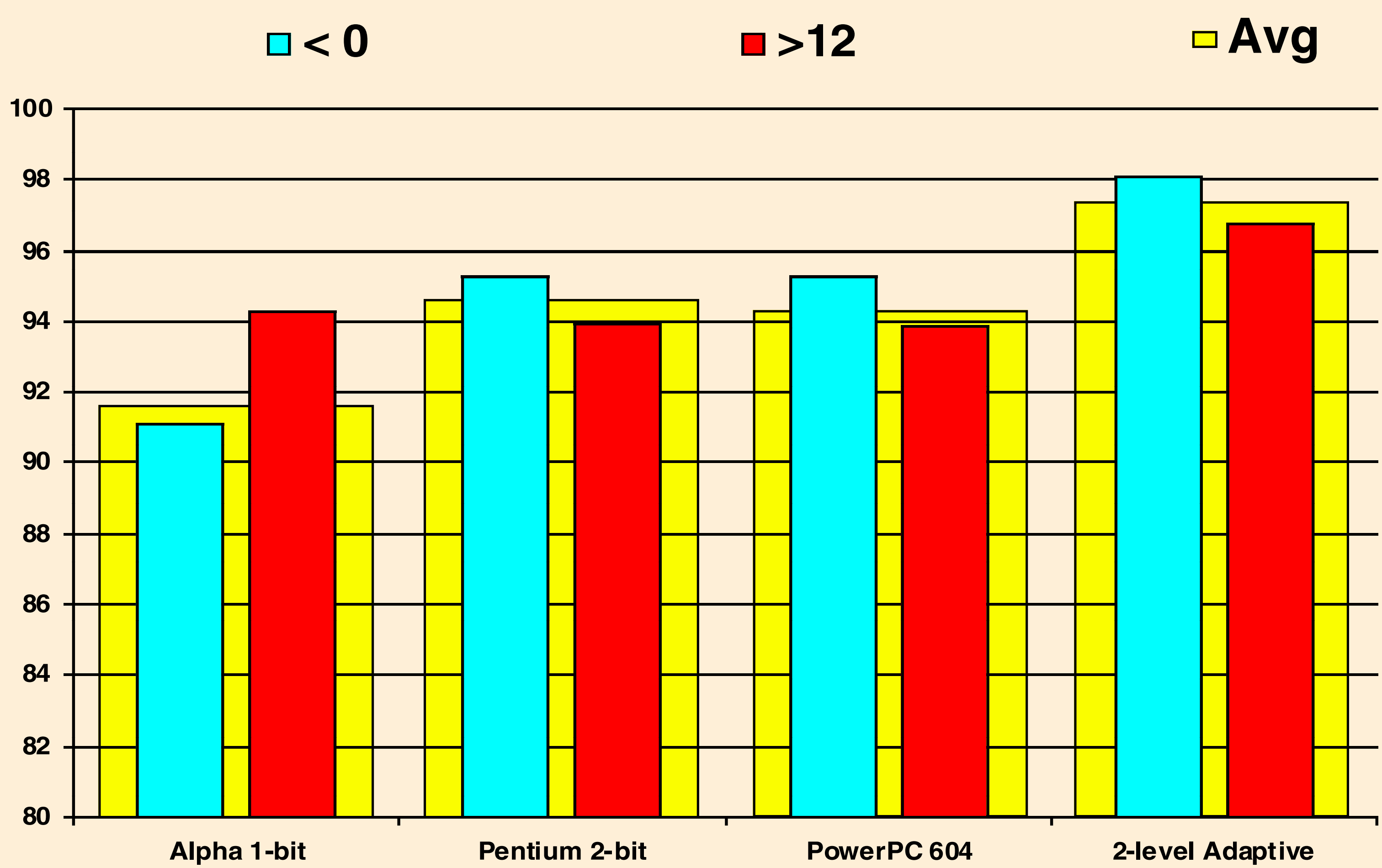




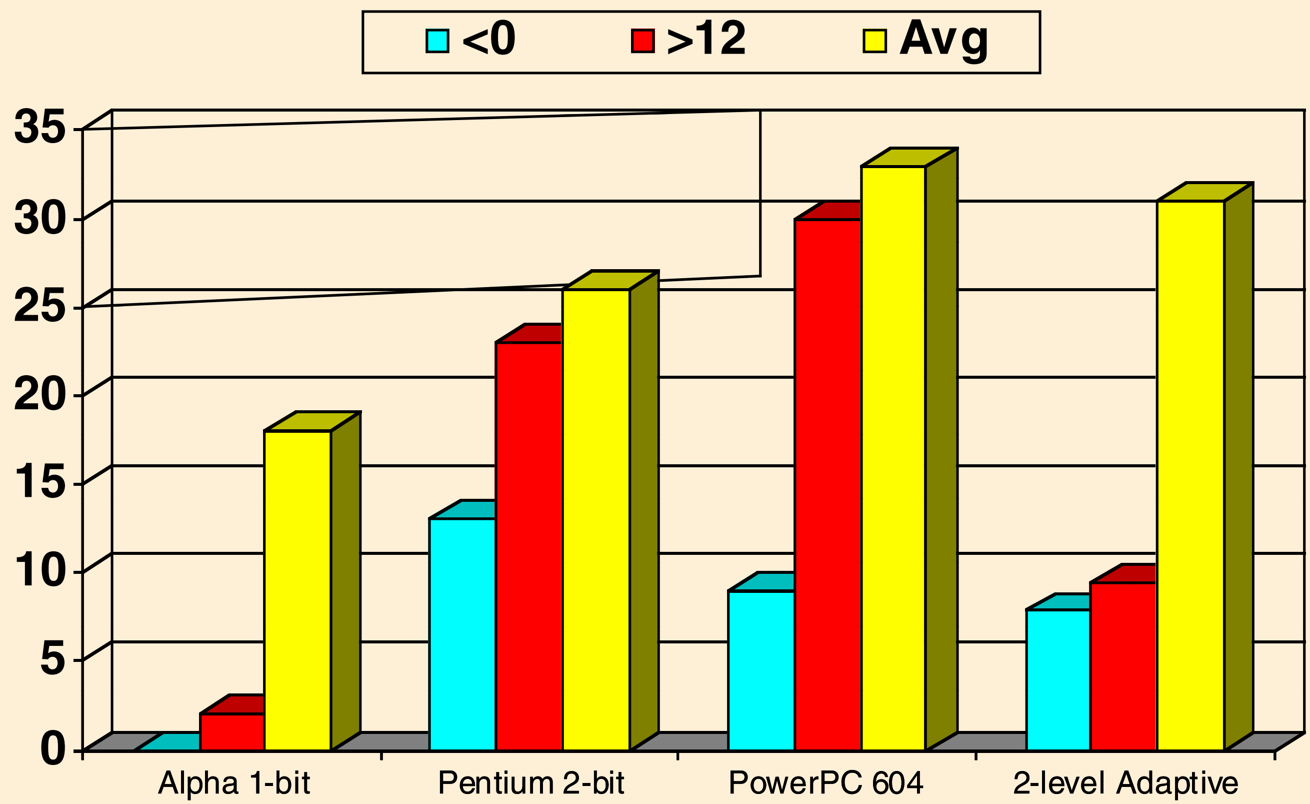
Branch Prediction Accuracy



Prediction Accuracy After Predication



Effects on Prediction Accuracy

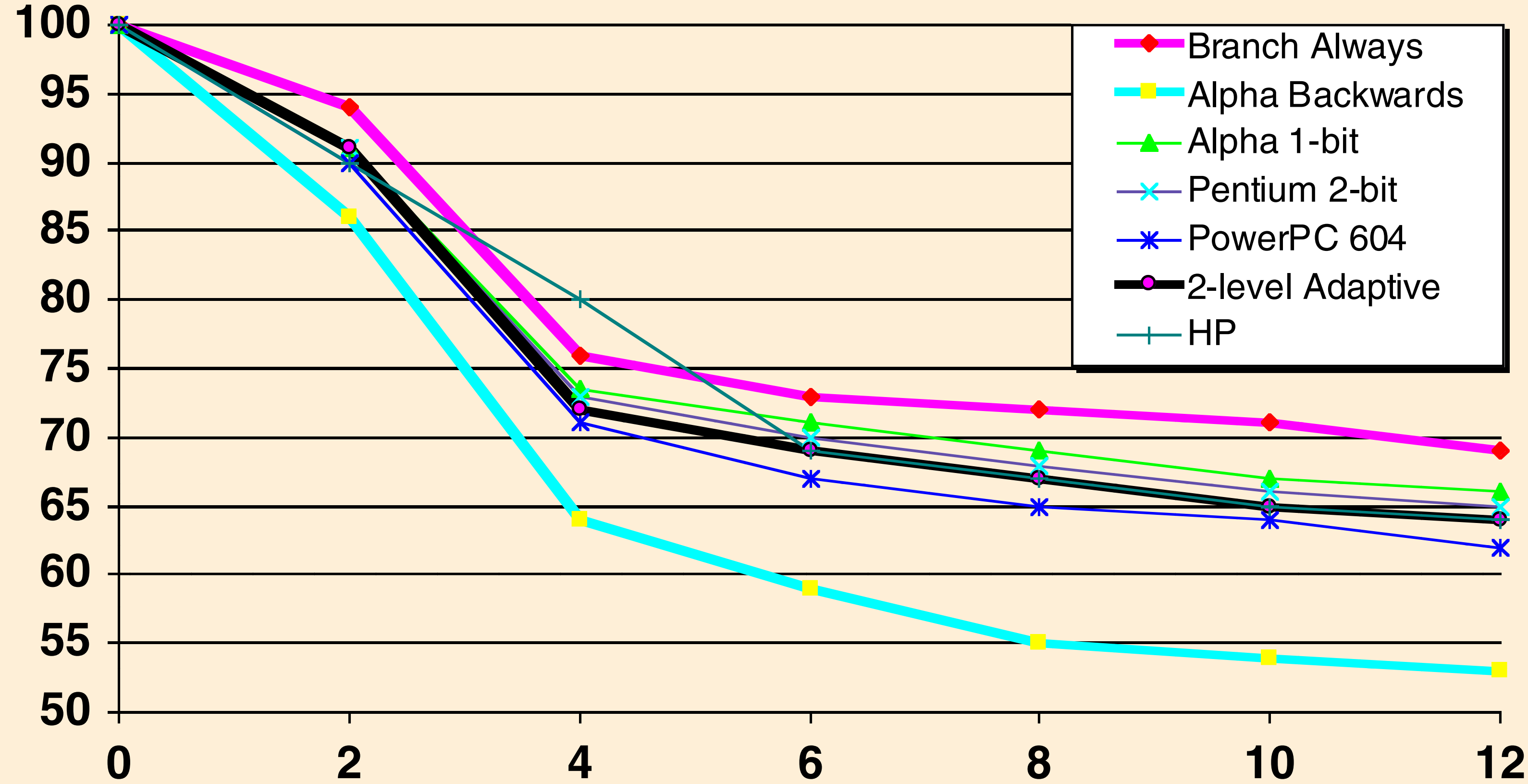


Branch Penalty

- Branch Penalty Calculation
  - # Branch Executions x Branch Cost
  - # Mispredicted Branches x Misprediction Penalty

- Additional Cost
  - # Predicted Taken Branches x Fetch Penalty

Effects on Branch Penalty

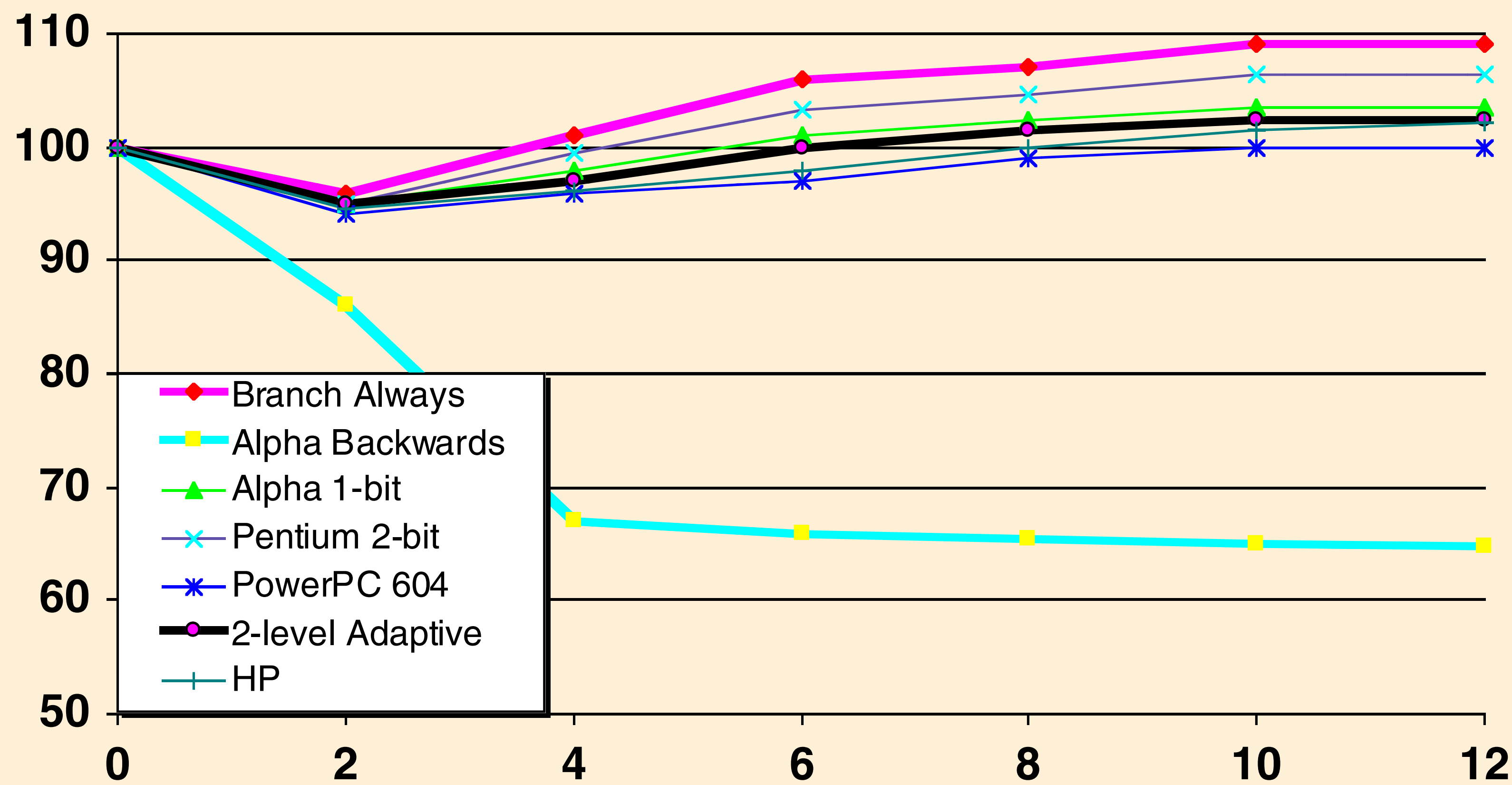


Predication Cost

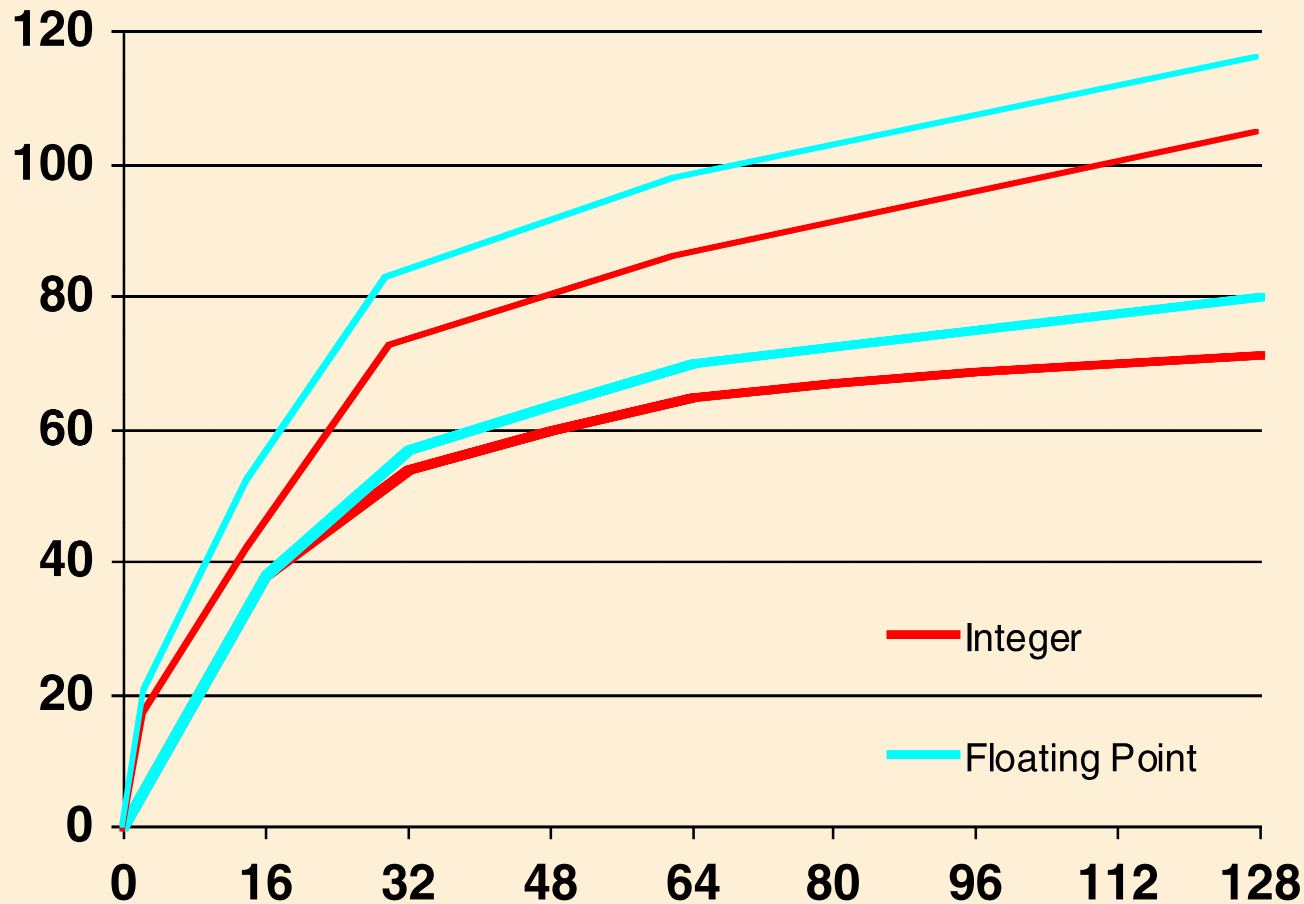
- Predication Cost Calculation
  - = # of Instructions Predicated
  - x # of Times Instructions were branched over

- Additional Costs
  - » Predicate Instructions
  - » Boosting (Update) Instructions
  - » Scheduling Considerations

Effects on Execution Cost



Effects on Basic Block Size



Conclusions

- Predication can remove a significant number of poorly predicted branches
- Removing those branches can improve the accuracy of current table based predictors on the remaining branches
- Branch miss rate is improved by up to 30% even for the newer, high accuracy schemes
- Branch Penalty is reduce by up to 50%