Cyber 180/990

- ECL gate arrays
- 65ish Mhz
- Commodity: 1-5Mhz
- Pipelining
  - Fetch: 6 cycles
  - Branch resolution 5 cycles
  - Integer execution < 5
Branch prediction: what and why

• Why
  – Not stop fetching
  – Incomplete knowledge of branch outcome

• What
  – Guess
    • Statistical skews, set of rules, state
    • Known state (within reason)
  – Guess fast and with small state
What do you do on a mispredict?

- Flush and restart
  - 3-5 cycle penalty
  - Flush speculative stores
Branch Prediction

Static

Basic

taken

untaken

Advanced

Based on type

Loop taken

Based on direction

back taken

Dynamic

Based on first exec

table

Comp branch

cache

Random acc

Based on recent exec

Comp word

XOR

Based on recent

taken exec

Hierachical

prediction

Stra1

Stra2

Stra3

Stra4

Stra5

Stra6

Stra7
What else can we do besides predict?

- Stall
- Fetch down both sides
  - $2^n$ bad
  - Confidence estimation