Construction of a house takes 5 days

Construction divided into sub tasks

- Foundation
- Walls
- Roof
- Door
- Windows

Day | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9
---|----|----|----|----|----|----|----|----|----
**House** 1
Day 1 | | | | | | | | | |
Day 2 | | | | | | | | | |
Day 3 | | | | | | | | | |
Day 4 | | | | | | | | | |
Day 5 | | | | | | | | | |
Day 6 | | | | | | | | | |
Day 7 | | | | | | | | | |
Day 8 | | | | | | | | | |
Day 9 | | | | | | | | | |

→ After 4 days, it appears as if a new house is constructed/completed every single day

→ Pipelined
\[
\text{Speedup} = \frac{\text{old time}}{\text{new time}}
\]

To construct \( n \) houses

without pipeline: \( n \cdot 5 = 5n \) days

with pipeline: \( (5 - 1) + n \cdot 1 = (5 - 1) + n \) days

\[\text{no house} \rightarrow \text{one house} \]
\[\text{(Startup cost)} \rightarrow \text{completed every single day}\]

\[
\text{Speedup} : \quad \frac{5n}{(5 - 1) + n}
\]

If \( n \) is say 1 million

\[
\text{Speedup} = \frac{5M}{1M + 3} \approx 5
\]

For sufficiently large \( n \), \((5 - 1)\) is negligible

\[
\text{Speedup} = \frac{5n}{n} = 5
\]
5. Number of stages in the pipeline \( k \) 

\[ \text{Speedup} = \frac{k \cdot n}{n} = k \]

What if I am able to further divide the sub-tasks?

If each sub-task takes 0.5 days, the speedup achieved is?

It appears as if a new house is completed every 0.5 days

\[ \text{Speedup} = 10 \quad (2 \times \text{the previous design where the \#tasks was 5}) \]

Can I keep subdividing the tasks to achieve higher speedup?
What happens if the division is as below:

```
Foundation  Walls  Roof  Door  Windows
  0.75 days each
```

The first 4 tasks take only 0.75 days each.

Placing the windows takes 2 days.

A single house still takes 5 days to complete.

Speedup = ?

Imbalance in the pipeline.