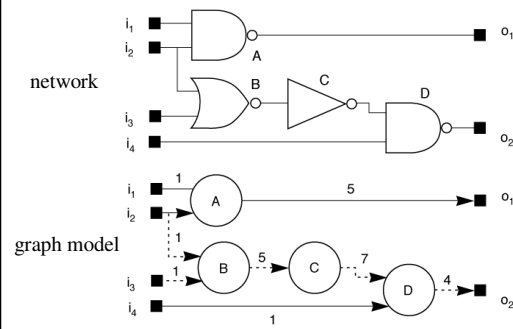


Delay model

- Nodes represent gates.
- Assign delays to edges—signal may have different delay to different sinks.
- Lump gate and wire delay into a single value.

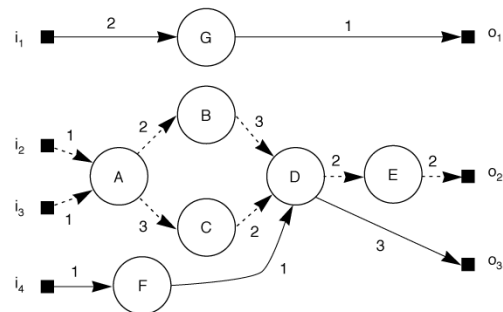
Path delay example



Critical path

- Critical path = path which creates longest delay.
- Can trace transistions which cause delays that are elements of the critical delay path.

Critical path through delay graph



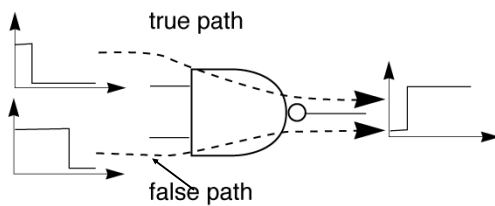
Reducing critical path length

- To reduce circuit delay, must speed up the critical path—reducing delay off the path doesn't help.
- There may be more than one path of the same delay. Must speed up all equivalent paths to speed up circuit.
- Must speed up cutset through critical path.

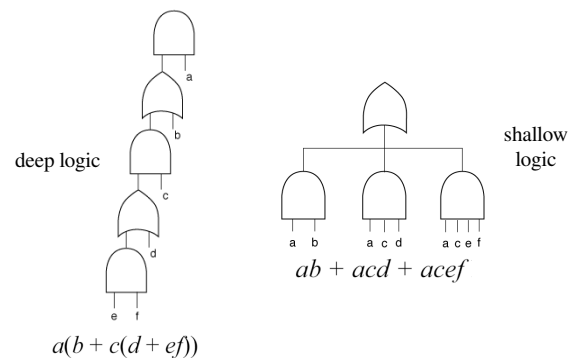
False paths

- Logic gates are not simple nodes—some input changes don't cause output changes.
- A false path is a path which cannot be exercised due to Boolean gate conditions.
- False paths cause pessimistic delay estimates.

False path example



Logic rewrites



Logic optimization

- Logic synthesis programs transform Boolean expressions into logic gate networks in a particular library.
- Optimization goals: minimize area, meet delay constraint.

Technology-dependent optimizations

- Maps Boolean expressions into a particular cell library.
- Mapping may take into account area, delay.
- May perform some optimizations on addition to simple mapping.
- Allows more accurate delay models.

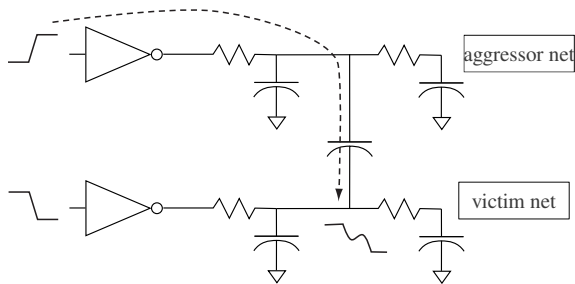
Crosstalk

- Capacitive coupling introduces crosstalk.
- Crosstalk slows down signals to static gates, can cause hard errors in storage nodes.
- Crosstalk can be controlled by methodological and optimization techniques.

RC crosstalk

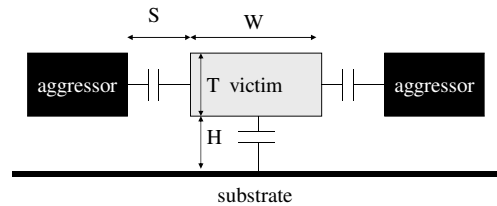
- Crosstalk slows down signals---increases settling noise.
- Two nets in analysis:
 - aggressor net causes interference;
 - victim net is interfered with.

Aggressors and victims



Wire cross-section

- Victim net is surrounded by two aggressors.



Effect of the coupling capacitance

Depends on the relative transitions of the aggressor and victim nets:

- When the aggressor changes and the victim does not, the coupling capacitance takes its nominal value C_c .
- When the aggressor and victim switch in opposite directions, the coupling capacitance is modeled as $2C_c$.
- When the aggressor and victim switch in the same direction, the coupling capacitance is modeled as 0.

Methodological solutions

- Add ground wires between signal wires:
 - coupling to V_{SS} , a stable signal, dominates;
 - can use V_{SS} to distribute power, so long as power line is relatively stable.
- Extreme case—add ground plane. Costs an entire layer, may be overkill.

Crosstalk Minimization: Ground wires

