Diagnosis

- Introduction
- Logic Diagnosis
  - SSF diagnosis
  - Delay fault diagnosis
  - Unmodeled / multiple fault diagnosis *(not in exam)
- Scan Chain Diagnosis
- Failure Analysis
- Conclusions

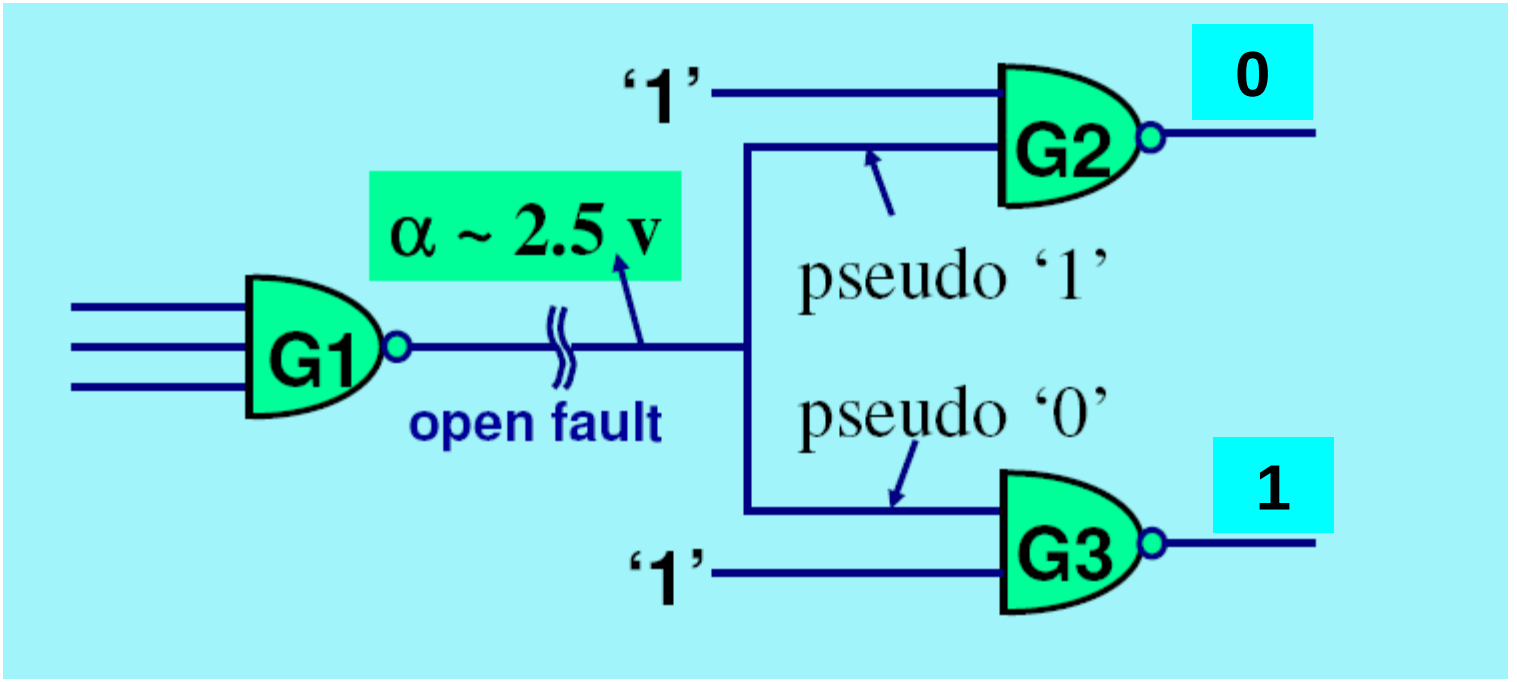
Unmodeled Defects

- Cannot find simulation failures of single fault explain all test failures
- Possible reasons
  - 1. Defect behavior hard to predict
    - Example: *Byzantine general's problem*
  - 2. Multiple faults
    - Exhaustive search all multiple faults is impossible
  - 3. Many fault models
    - Exhaustive trial of all fault models is impossible

- Solution: heuristic methods
  - Single Location at a Time (SLAT) [Bartenstein 01]
  - Inject and Cure [Huang 97]

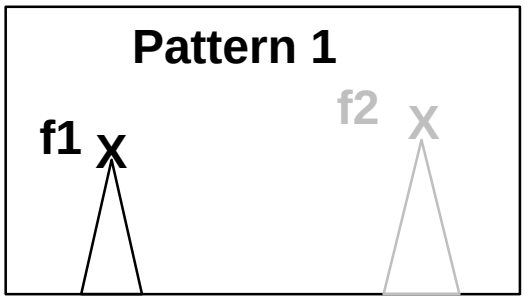
Byzantine Generals Problem

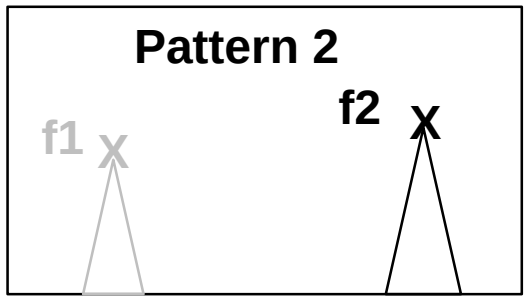
- Open or bridging faults on fanout stem
  - Faulty values on fanout branches may not be the same
- (WWW CH7), assume V_{DD}=5V
  - G2 and G3 have different threshold voltage

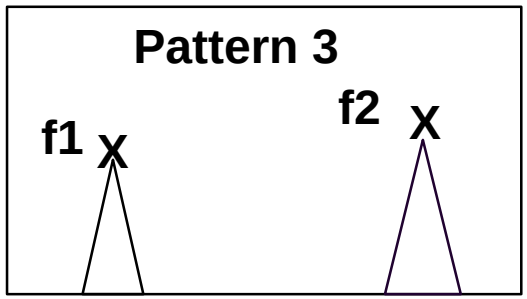


Single Location at a time, *SLAT* [Bartenstein 01]

- **Diagnosis procedure**
  - **1. For every failing pattern**
    - **find a fault whose SF = TF**
      - **If succeed → *SLAT pattern*, insert fault to set *U***
      - **Else → not SLAT pattern**
  - **2. For all failing patterns**
    - **Find a minimum subset of *U* that covers all failing patterns**
- **Example:**
  - **pattern 1 and pattern 2 are SLAT pattern**
  - **Pattern 3 is not SLAT pattern**







Example

- pattern 1: 1sa1, 4o sa0 → SLAT pattern
- pattern 3: 2 sa0 , 4o sa1 → SLAT pattern
- pattern 4: no SSF → not SLAT pattern
- U= {1sa1, 4o sa0 , 2 sa0, 4o sa1 }
- Diagnosed fault list = {1 sa1, 2 sa0}

	faults	pattern1		pattern2		pattern3		pattern4	
		7	8	7	8	7	8	7	8
1	1 sa1	X	X					X	
2	2 sa0					X	X		X
3	2 sa1			X	X				
4	3 sa1		X						
5	4o sa0	X	X	X	X			X	
6	4o sa1; 4i2 sa0; 1sa0					X	X		
7	4i2 sa1			X	X				
8	5o sa1; 3 sa0; 5i1 sa0								X
…	…								
	Test Failures	X	X			X	X	X	X

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Diagnosis Pattern Generation

- **Diagnosis patterns are specific purpose patterns**
  - **To improve *diagnosis resolution***

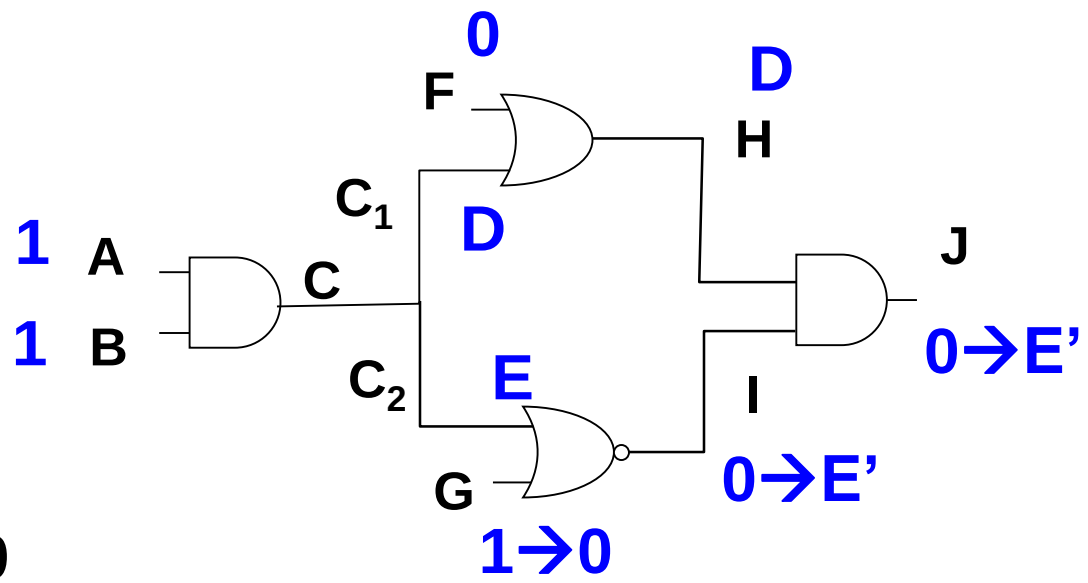
- ***Iterative (aka. adaptive) diagnosis* is some times required**
  - **Collect data, DPG, collect more data, DPG again …**
- **DPG becomes popular only recently**
  - **Enabled by on-line pattern generation on ATE**

Diagnosis Resolution

- Degree of accuracy to which faults can be distinguished
- Two faults α and β can be *distinguished* if
  - outputs with fault α ≠ outputs with fault β
- Two measures (ABF Ch 12)
  - Maximal fault resolution of a circuit
    - Partitions of equivalent fault classes
    - Limited by circuit structure
  - Fault resolution of a test set
    - Partition of distinguishable faults
    - Can be improved by generating test patterns for diagnosis purpose → diagnosis pattern generation

Diagnosis Pattern Gen. Example

- $C_1/0$ and $C_2/0$ are not equivalent
- DE-algorithm (ABF Example 12.3)
  - Assign A=1, B=1 → C_1 = D, C_2 = E
  - Propagate D → assign F=0
  - Prevent E → assign G=1 → I = 0, J=0 →D disappear
  - Backtrack, assign G=0 → I = E' → J = E'
  - Test generated ABFG = {1100}



OR

	E	E'
D	1	D
D'	E	D',E'

AND

	E	E'
D	D,E	E'
D'	D'	0