

Diagnosis

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



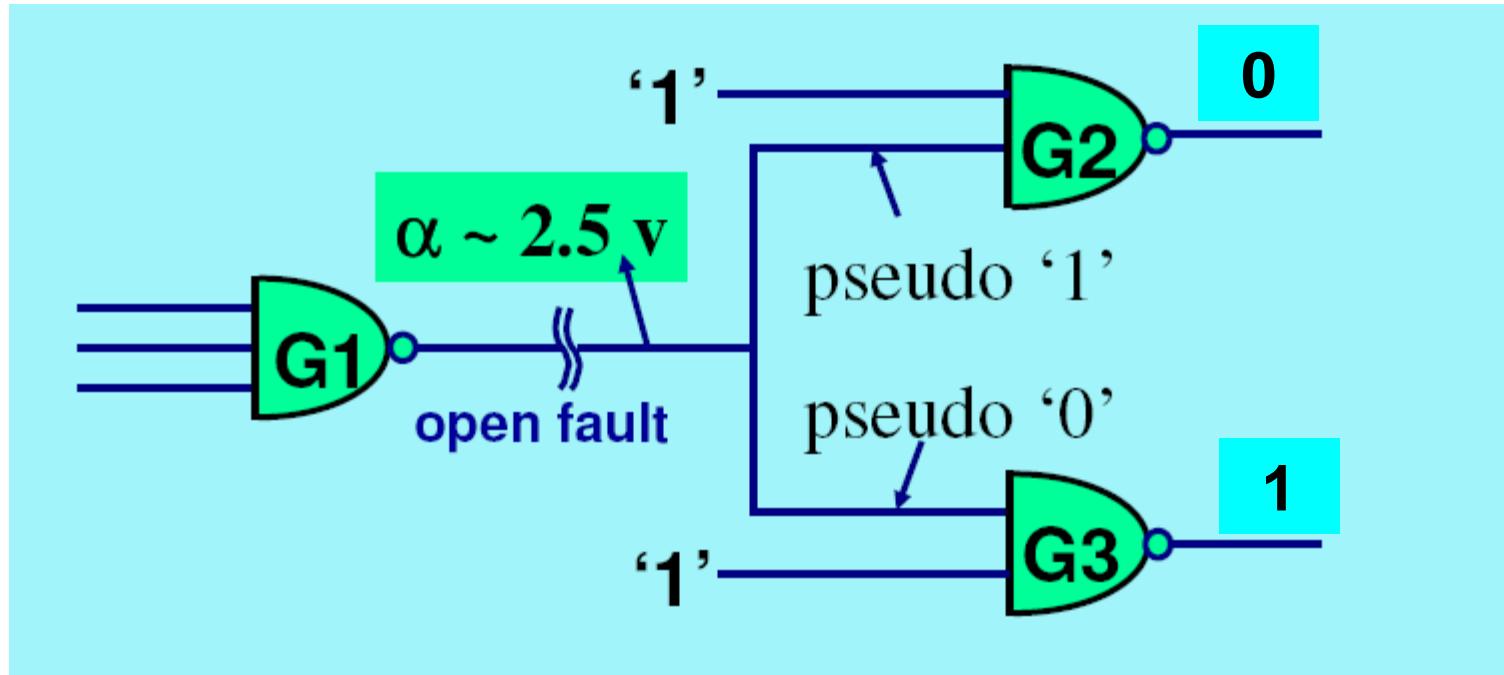
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Unmodeled Defects

- 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]

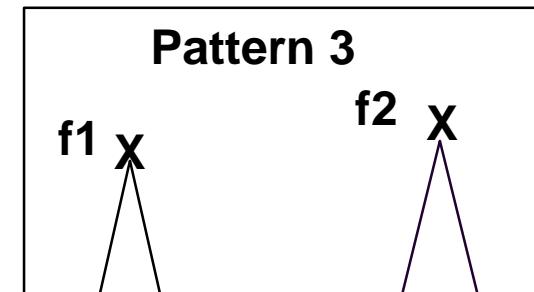
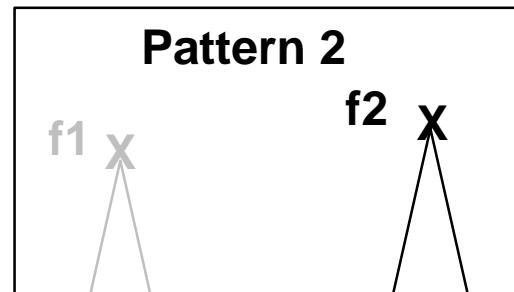
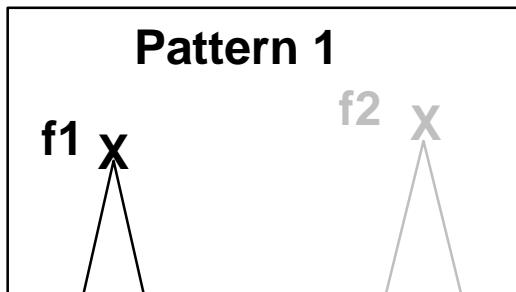
Byzantine Generals Problem

- 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
- $U = \{1\text{sa1}, 4\text{o sa0}, 2\text{ sa0}, 4\text{o sa1}\}$
- 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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- Introduction
- Logic Diagnosis
 - ◆ SSF diagnosis
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 - ◆ Diagnosis pattern generation *(not in exam)
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Diagnosis Pattern Generation

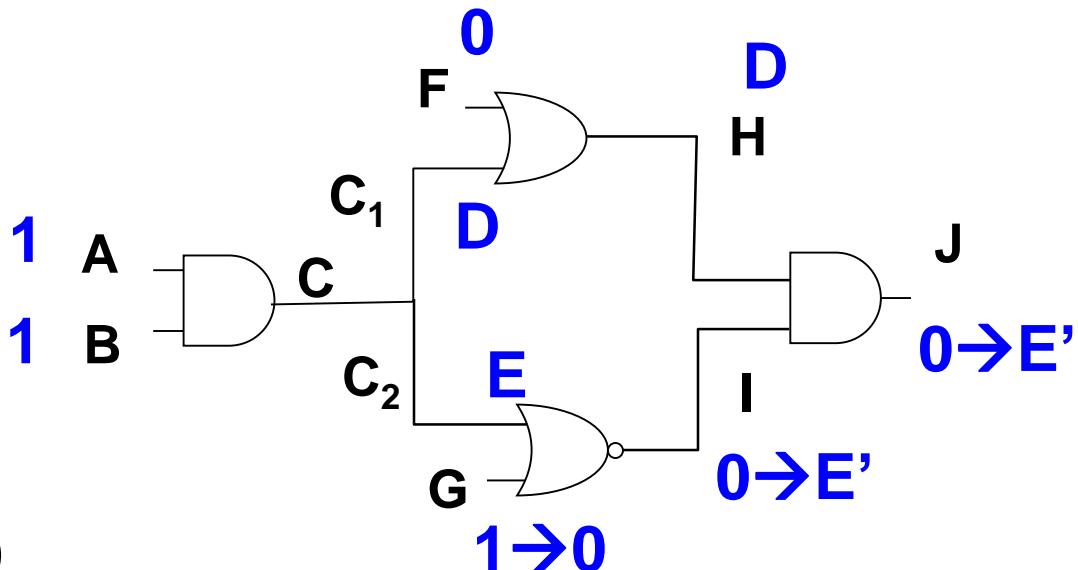
- Diagnosis patterns are specific purpose patterns
 - ◆ To improve *diagnosis resolution*
- *Iterative (aka. adaptive) diagnosis* is sometimes required
 - ◆ Collect data, DPG, collect more data, DPG again ...
- DPG becomes popular only recently
 - ◆ Enabled by on-line pattern generation on ATE

Diagnosis Resolution

- Degree of accuracy to which faults can be distinguished
- Two faults α and β can be *distinguished* if
 - ◆ outputs with fault $\alpha \neq$ 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 $A=1, B=1 \rightarrow C_1 = D, C_2 = E$
 - ◆ Propagate $D \rightarrow$ assign $F=0$
 - ◆ Prevent $E \rightarrow$ assign $G=1 \rightarrow I = 0, J=0 \rightarrow D$ disappear
 - ◆ Backtrack, assign $G=0 \rightarrow I = E' \rightarrow J = E'$
 - ◆ Test generated ABFG = {1100}



OR

| | | |
|------|---|----------|
| | E | E' |
| D | 1 | D |
| D' | E | D', E' |

AND

| | | |
|------|--------|------|
| | E | E' |
| D | D, E | E' |
| D' | D' | 0 |