DO-331 Traceability Guide

Overview

Traceability is a core requirement of DO-331. The STUNIR tools provide complete bidirectional traceability between IR elements and model elements.

Trace Matrix Structure

```
{
  "schema": "stunir.trace.do331.v1",
  "ir_hash": "sha256:...",
  "model_hash": "sha256:...",
  "entries": [
    {
      "trace_id": 1,
      "source_id": 100,
      "source_path": "module.function_name",
      "target_id": 200,
      "target_path": "Module::FunctionName",
      "rule": "Function to Action Definition",
      "do331_objective": "MB.3",
      "verified": false
    }
  ]
}
```

Trace Types

Type	Direction	Description
IR_To_Model	Forward	IR element to model element
Model_To_IR	Backward	Model element to IR source
Model_To_Model	Internal	Model element relationships
Model_To_Req	Requirements	Model to requirement mapping

Transformation Rules

Rule	DO-331 Objective	Description
Rule_Module_To_Package	MB.2	Module becomes package
Rule_Function_To_Action	MB.3	Function becomes action def
Rule_Type_To_Attribute_Def	MB.2	Type becomes attribute def
Rule_If_To_Decision	MB.3	If statement becomes decision
Rule_State_Machine	MB.3	State machine mapping
Rule_Transition	MB.3	Transition mapping

Gap Analysis

The traceability framework includes gap analysis:

```
function Analyze_Gaps (
   Matrix : Trace_Matrix;
   IR_IDs : Element_ID_Array
) return Gap_Report;
```

Returns:
- Total IR elements
- Traced elements
- Missing traces
- Gap percentage
- Completeness status

DO-331 Table MB-1 Compliance

The trace matrix addresses DO-331 Table MB-1 objectives:

Objective	Description	Implementation
MB.1.1	LLR traceable to model	trace_matrix.ir_to_model
MB.1.2	Model traceable to HLR	trace_matrix.model_to_req
MB.1.3	Test cases traceable	trace_matrix.test_to_model