Integration Testing
Functional Decomposition Based

Chapter 13
Integration Testing

- What is integration testing?
What is integration testing?

- Test the interfaces and interactions among separately tested units
- Three different approaches
  - What are they?
What is integration testing?

- Test the interfaces and interactions among separately tested units
- Three different approaches
  - Based on functional decomposition
  - Based on call graphs
  - Based on paths
How does functional decomposition work?
How does functional decomposition work?

- Create a functional hierarchy for the software
- Problem is broken up into independent task units, or functions
- Units can be run either
  - Sequentially and in a synchronous call-reply manner
  - Or simultaneously on different processors
- Used during planning, analysis and design
# SATM Units

<table>
<thead>
<tr>
<th>Unit</th>
<th>Level</th>
<th>Name</th>
<th>Unit</th>
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IntF–7
Table 1: SATM Units and Abbreviated Names

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Decomposition-based integration strategies

- What are the decomposition-based integration strategies?
What are the decomposition-based integration strategies?

- Top-down
- Bottom-up
- Sandwich
- Big bang
Big bang integration process

- What is the big bang integration process?
What is the big bang integration process

- All units are compiled together
- All units are tested together
Big bang integration issues

- What are the issues (advantages and drawbacks)?
Big bang integration issues – 2

- What are the issues (advantages and drawbacks)?
  - Failures will occur!
  - No clues to isolate location of faults
  - No stubs or drivers to write
Top-down integration

- What is the top-down integration process?
Top-Down integration example

Top Subtree
Sessions 1-4

Second Level Subtree
Sessions 5-8

Bottom Level Subtree
Sessions 9-13
Top-Down integration process

- **Strategy**
  - Focuses on testing the top layer or the controlling subsystem first
    - The main, or the root of the call tree

- **General process is**
  - To gradually add more subsystems that are referenced/required by the already tested subsystems when testing the application
  - Do this until all subsystems are incorporated into the test
Top-Down integration process – 2

- **Stubs** are needed to do the testing
  - A program or a method that simulates the input-output functionality of a missing subsystem by answering to the decomposition sequence of the calling subsystem and returning back simulated data
Top-Down integration issues

- What are the issues?
Top-Down integration issues – 2

- What are the issues?
  - Writing stubs can be difficult
    - Especially when parameter passing is complex.
    - Stubs must allow all possible conditions to be tested
  - Possibly a very large number of stubs may be required
    - Especially if the lowest level of the system contains many functional units
Top-Down integration issues – 3

- One solution to avoid too many stubs
  - Modified top-down testing strategy
  - Test each layer of the system decomposition individually before merging the layers

- Disadvantage of modified top-down testing
  - Both stubs and drivers are needed
What is the bottom-up integration process?
Bottom-up integration example

Bottom Level Subtree
Sessions 1-5

Second Level Subtree
Sessions 6-9

Top Subtree
Sessions 10-13
Bottom-Up integration strategy

- Focuses on testing the units at the lowest levels first
- Gradually includes the subsystems that reference/require the previously tested subsystems
- Do until all subsystems are included in the testing
Drivers are needed to do the testing

- A driver is a specialized routine that passes test cases to a subsystem
  - Subsystem is not everything below current root module, but a sub-tree down to the leaf level
Bottom-up integration issues

- What are the issues?
What are the issues?

- Not an optimal strategy for functionally decomposed systems
  - Tests the most important subsystem (user interface) last
- More useful for integrating object-oriented systems
- Drivers may be more complicated than stubs
- Less drivers than stubs are typically required
What is the sandwich integration process?
Sandwich integration example

Sandwich 1
Sessions 1-3

Sandwich 2
Sessions 4-13

Sandwich 3
Sessions 14-15
Sandwich integration process

- What is the sandwich integration process?
  - Combines top-down strategy with bottom-up strategy
    - Doing big bang on a subtree
Sandwich integration issues

- What are the issues?
What are the issues?

- Less stub and driver development effort
- Added difficulty in fault isolation
Integration test session

For pure top down or bottom up have

- \#sessions = \#edges
  - Integrate one new node at a time
  - SATM has 42 edges, same as text's 42 sessions
Integration test session

- Textbook
  - A session is a test suite for a specific configuration of actual code, stubs and drivers
  - \#sessions = \#nodes − \#leaves + \#edges
  - This cannot be correct, as that would be more than the number of edges, which is impossible.
Integration work numbers

- For top-down integration
  - $\#\text{nodes} - 1$ stubs are needed

- For normal bottom-up integration
  - $\#\text{internal_nodes} + 1$ drivers are needed
    - $\text{=} \#\text{nodes} - \#\text{leaves}$
  - Internal nodes have both in and out edges
Integration work numbers

- For SATM have up to 42 integration test sessions
  - Correspond to 42 separate sets of test cases
- For top-down integration
  - 26 stubs are needed  Not the 32 in the textbook
- For normal bottom-up integration
  - 11 drivers are needed  Not 10 in the textbook
What is the major drawback of decomposition-based integration?
What is the major drawback of decomposition-based integration?

- It is functionally based
  - Has the problems of all functional testing

How do we overcome the problems?
Decomposition-based drawback – 3

- How do we overcome the problems?
  - Move to structural-based testing