System Interfaces - Definition and Design Best Practices

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Authors:
Benzi Lavi – Orbotech
Avigdor Rosenberg – Biosense-Webster
Amir Tomer – ILTAM

Main contributors and reviewers:
Jacqueline Yoetz – MBT/IAI
Revital Goldberg – MBT/IAI
Tsvi Rubin – IAI
Shay Amsili – Kodak
Orly Mayer – Elop
Uzi Minsker – Elop

Background

- This document has been produced as a result of a series of meetings and discussions in the Tools and Methodologies Working Group (TMWG) coordinated by ILTAM.
- Representative Systems Engineers from a number of Israeli industries (both defense and civil) participated in those meetings, contributing best practices obtained at their companies through years of experience and knowledge.

Purpose and Use (1)

- This document is intended to serve as a recommended methodology and guideline for the identification, definition and design of System Interfaces.
- These activities are performed in line with System Requirements Analysis and System Architectural (Top Level) Design, resulting in a detailed Interface Design Document, which is an integral part of the overall system design.
- This document provides its user with a brief and essential overview of the process and issues regarding interface design.

Purpose and Use (2)

- Complementary comprehensive information resides in many knowledge sources, such as systems engineering standards, guide books and web pages. This guide, however, does not contain the detailed knowledge itself – instead it contains references to relevant sources which are quoted in its "References" pages.

Reading this Document

- The best way to browse this document is using PowerPoint 2003 and up is “Slide Show” mode, navigating as follows:
- The up-arrow (↑) and down-arrow (↓) keys lead to the next/previous page, accordingly.
- Underlined text denotes a hyperlink: clicking on it will lead to pages with details and explanations about the corresponding issue.
- Clicking on the “Return” button ( ) at the bottom-right of a page will go back to the last page viewed.
- References to external sources are marked with number-letter pairs in square brackets (e.g. [2-d], [5-b,e]. Clicking a reference will lead to the appropriate reference page, where the exact reference is cited.
- Clicking the right mouse button pops up a menu, from which, by selecting “Go to slide...”, any page of the document may be accessed directly.

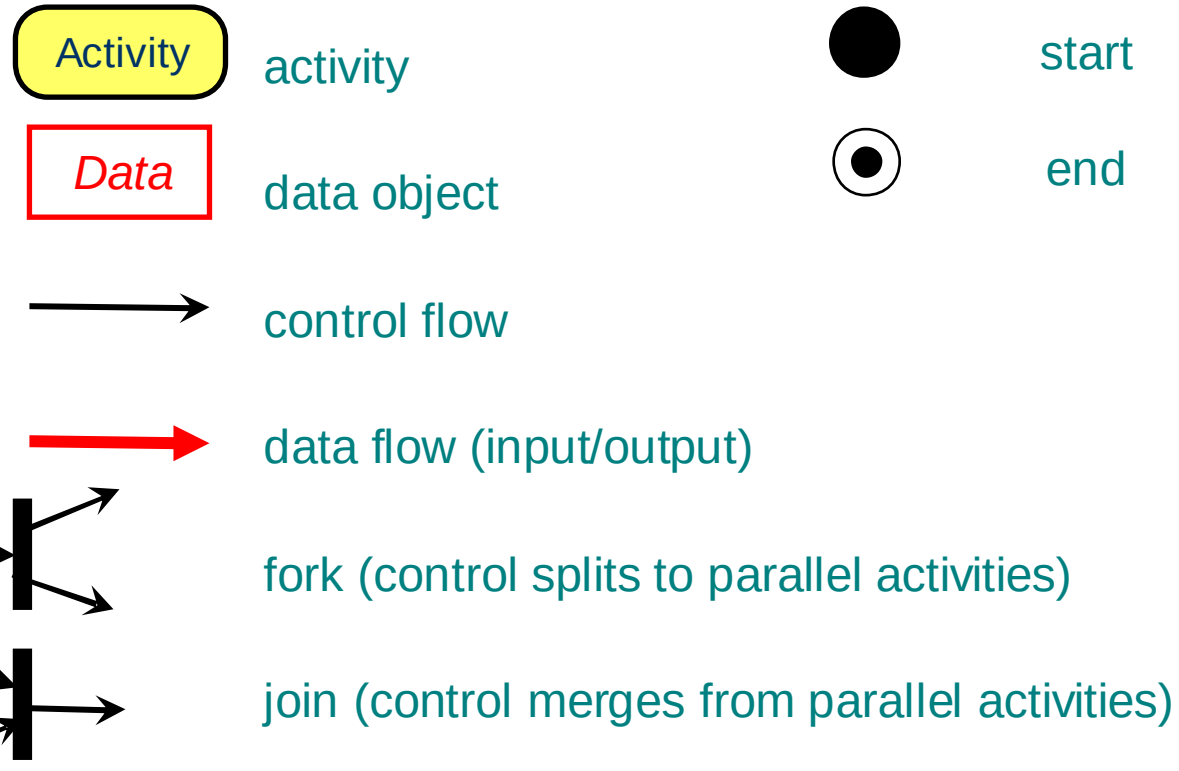
Printing this Document

- The entire document, as well as selected pages, may be also printed. Using the “handout” option with 2 slides per page will provide sufficiently readable paper copy.

Diagram Format

- The processes in the following pages are represented in UML's Activity Diagram form.

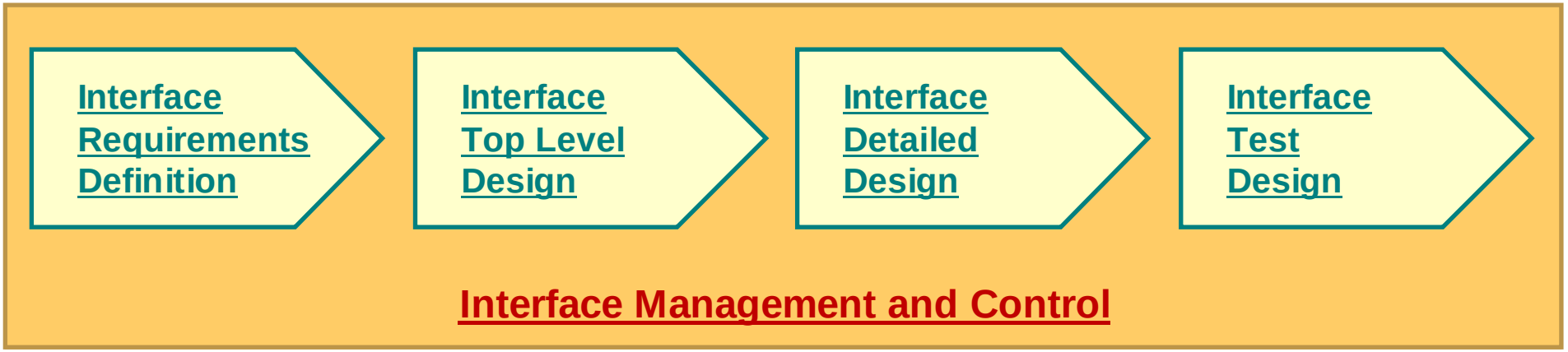
Key



Process Description Pages

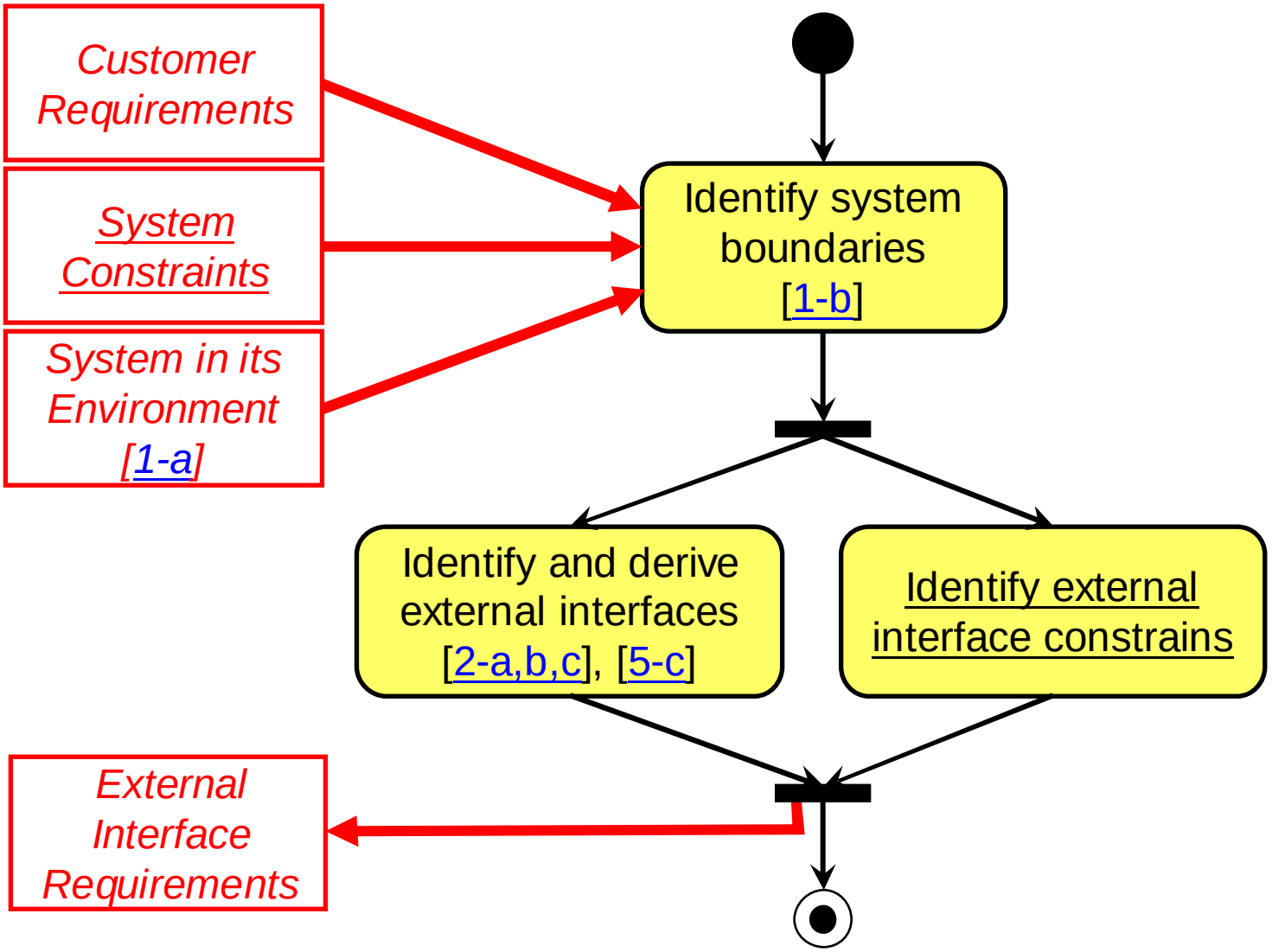
The Process

- The recommended System Interfaces Definition and Design process goes through 4 phases, as follows:

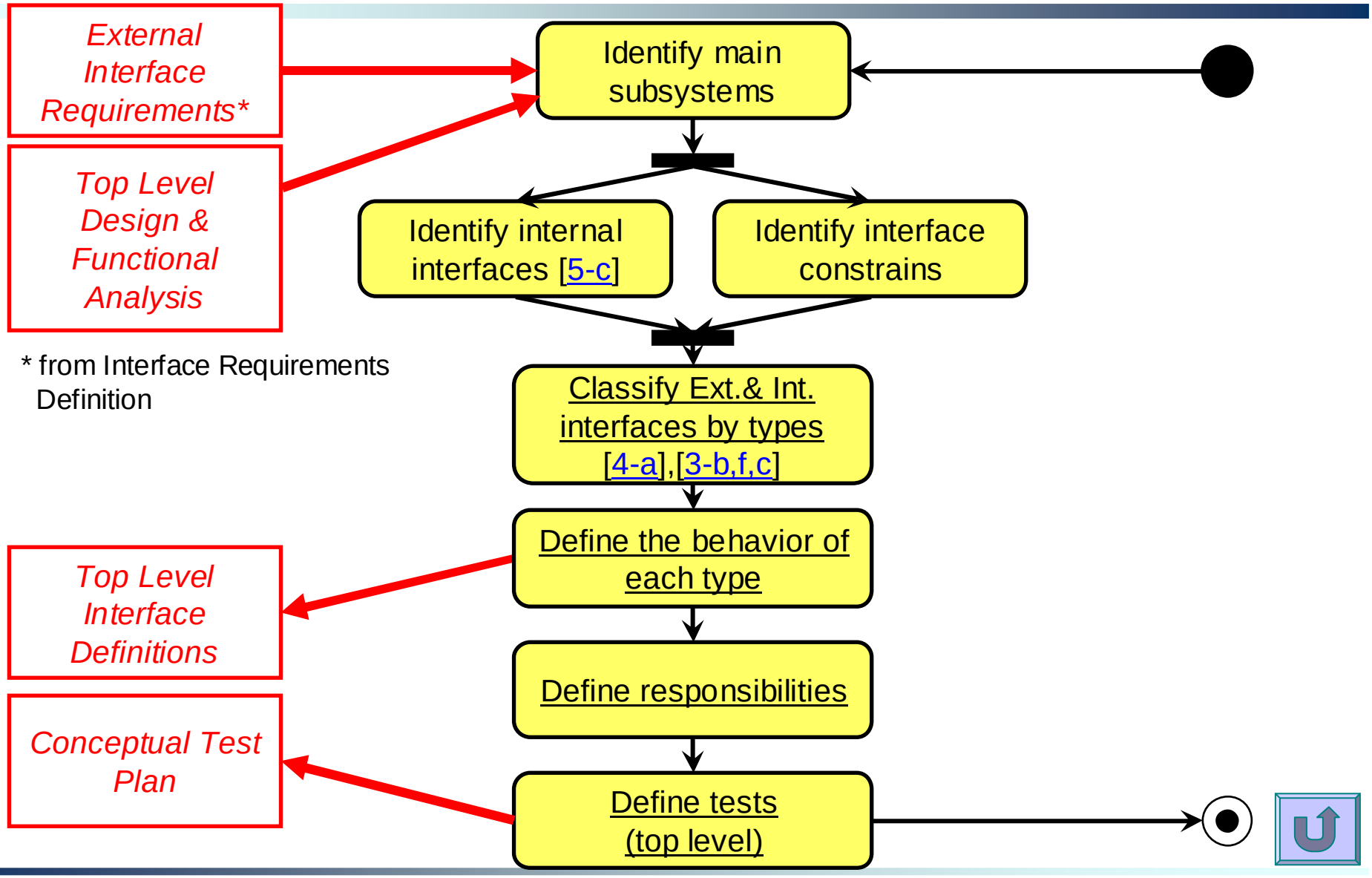


- The diagrams in the following pages describe each phase in detail.

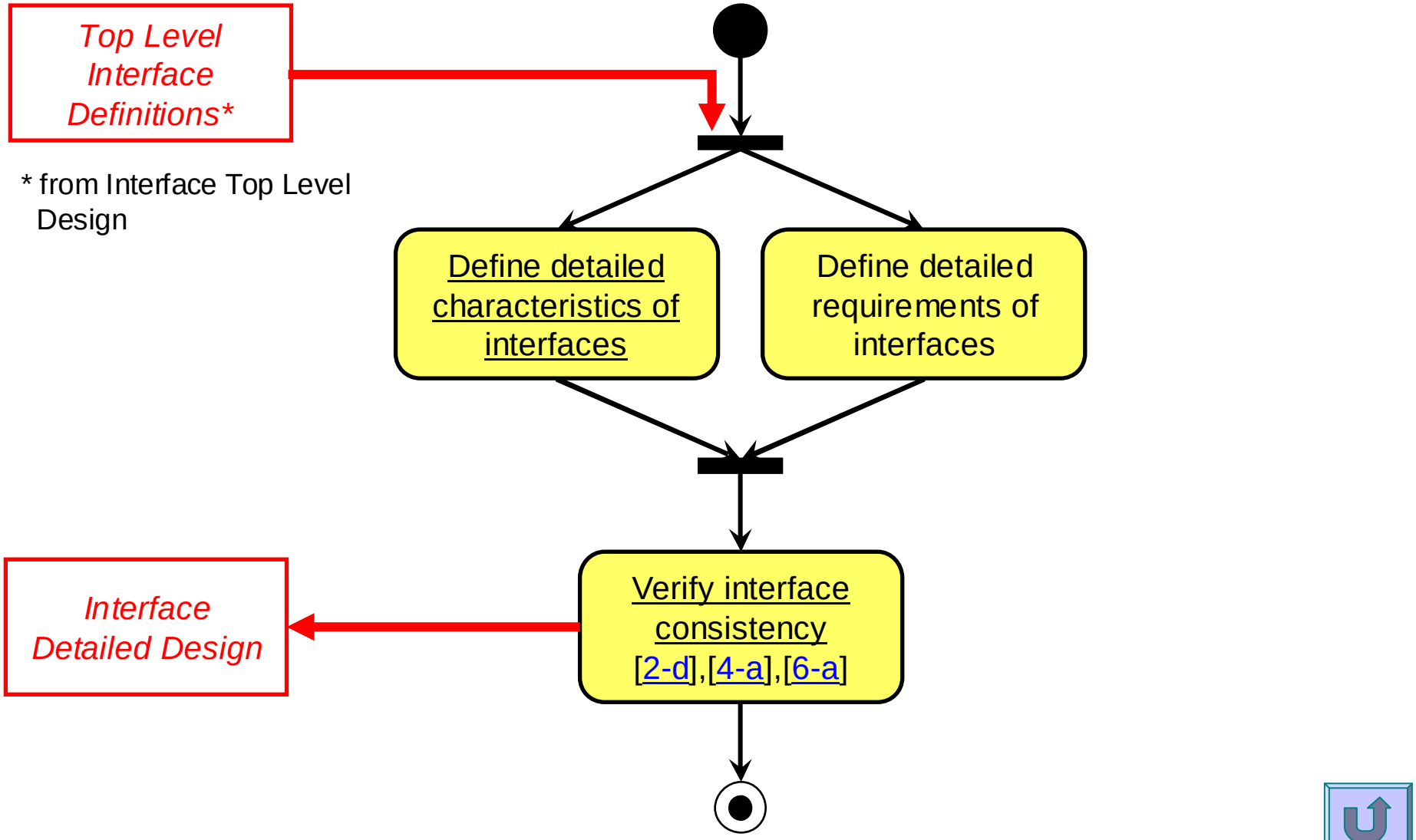
Interface Requirements Definition



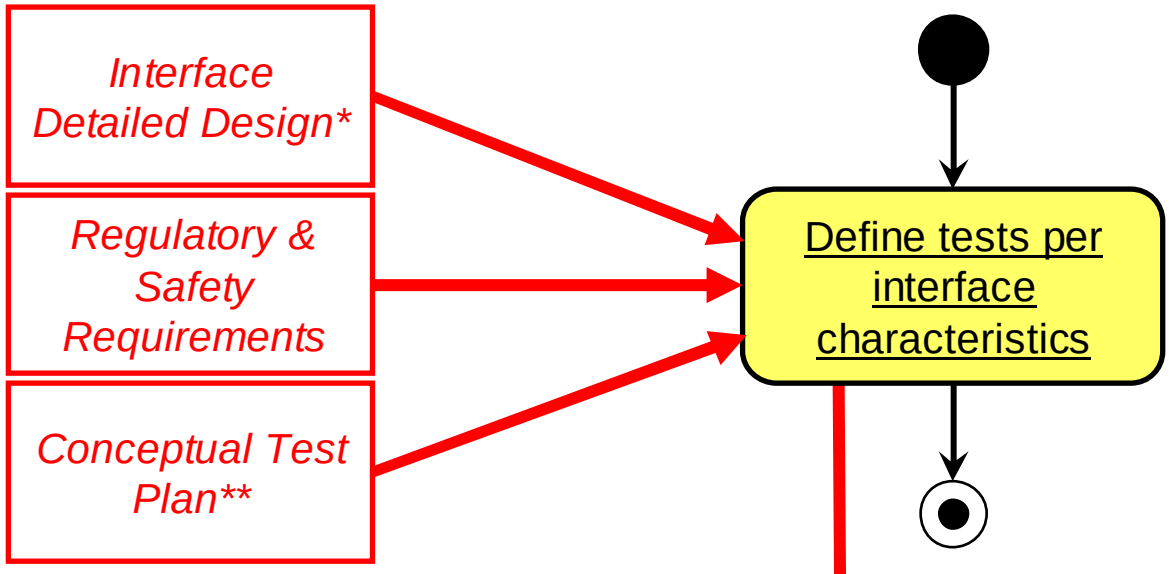
Interface Top Level Design



Interface Detailed Design



Interface Test Design



* from Interface Detailed Design

** from Interface Top Level Design

† POD = Proof of Design

Interface Management and Control

- Interfaces, both external and internal, should be managed and controlled throughout the system lifecycle, in order to ensure sustained compatibility and consistency, both among themselves and with the system.
- Interface management should address the following issues:
  - Interface control [3-e],[4-c,e,f],[5-a]
  - Interface configuration management [3-d],[4-d]
  - Interface change management [4-b],[5-a]

Explanation Pages

System Constraints

- The following is a partial list of applicable system constraints
  - Dimensions
  - Weight
  - Rate
  - Immunity
  - Environmental conditions
    - temperature, humidity, water/splash resistance, air quality/pollution, vibrations
  - Acoustic noise (produced by the system)
  - Safety
  - Reliability
  - Maintainability
  - Cleanability
  - Standards
  - Regulatory requirements

Interface Classification

- The following is a partial list of possible interface classes
  - External Interface
  - Internal Interface
  - Physical Interface
  - Logical Interface
  - H/W Interface
  - S/W Interface

Note: Any single interface may be classified into more than one of the above

Interface Behavior

- The following list contains some of the possible behavior definition parameters for data interfaces.
  - Message/Data interface:
    - What side may initiate messaging
    - Synchronization method
    - Data integrity check, acknowledge, retransmit
    - Periodic / event-driven
    - Protocol definition (physical, logical / messages format)

Interface Definition Example/Template

- An attached Excel file contains a list of examples of some possible types and sub-types of interfaces and of their characteristics. The list is not full and is provided as example, guidance and reminder for possible characteristics, which need to be defined, per type. The file may be used as a baseline and may be updated and enriched per need.
- The types, sub-types and characteristics are grouped into three levels. You can press on 1, or 2, or 3, at the upper left corner, in order to view the relevant groups.

Interface Types and Characteristics

Make sure that the file “interfaces - types and characteristics.xls” is located in the same directory as this document

Interface Test Planning

- The test plan should include (beside schedule and tasks list) the tests for each interface, the pre-conditions and success criteria for transition from one test to the other.
- The tests should take into account the defined characteristics and the system constraints (such as environmental conditions, drop test, etc.), relevant for the tested interface.
- The test plan should take into account need for simulators, sniffers and recordings, needed for testing the interfaces.

Interface Design Verification

- Verify interface definitions completeness as per system structure / block diagram
- Check interfaces consistency to assure that an output is defined for every input, and vice versa
- Check functional consistency to assure that for every function
  - inputs are defined to fulfill that function

Responsibilities

- The system engineer is responsible to define the overall characteristics of the interfaces .
- The system engineer should define the responsibility (owner) for each interface's detailed design.

Reference Pages

copyright notice
The references quoted in the following are subject to intellectual property restrictions. Copies of the documents may be obtained from their owners.

References (1)

1) ISO/IEC 15288 – System Life Cycle Processes, 2008*

   a) **5.1** Enabling systems

   b) **6.4.2.3** (a)(1) Define the functional boundary

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References (2)

2) INCOSE Systems Engineering Handbook, Ver. 2.0, 2002*

a) **4.3.1.4.3.4** Define/Refine Functional Interfaces (internal and external)

b) **4.3.1.4.4.2** N2 Charts

c) **4.4.4.2** SYSTEM INTEGRATION WITH EXTERNAL SYSTEMS (4: InterFace Working Groups and ICD)

d) **4.4.4.1** System Build (step 3: Ascertain interfaces)

* copyright © by INCOSE

References (3)

3) IEEE Std 1220-2005 (ISO/IEC 26702:2007)* – Application and management of the systems engineering process

a) **5.1.2.2** System and product specifications

b) **6.3.1.2** Define functional interfaces

c) **6.5.7** Define physical interfaces

d) **6.8.1.3** Interface Management

e) **Annex B.2** Engineering plan structure (sec. 3.9.2 – Interface Mgmt.)

f) **3.1.19** Interface specification

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References (4)

4) CMMI® for Development, version 1.2*

a) **Product Integration (PI), SP 2.1** Review interface descriptions

b) **Product Integration (PI), SP 2.2** Manage interfaces

c) **Product Integration (PI), GP 2.2** Plan the process

d) **Product Integration (PI), SP 2.6** Manage configuration

e) **Product Integration (PI), SP 2.7** Identify and involve relevant stakeholders

f) **Product Integration (PI), SP 2.8** Monitor and control the process

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References (5)

5) ANSI/EIA-632-1998 – Processes for Engineering a System

a) **Table C.12** d) Perform interface management

b) **Annex D, D.2** 7) Interface control plan

c) **Annex A (Glossary)** Interface Requirement

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References (6)

6) ISO/IEC 15289:2006* Content of systems and software life cycle process information products (Documentation)

a) **10.27** Interface description

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