

# Integrated Systems Engineering Tool Suite

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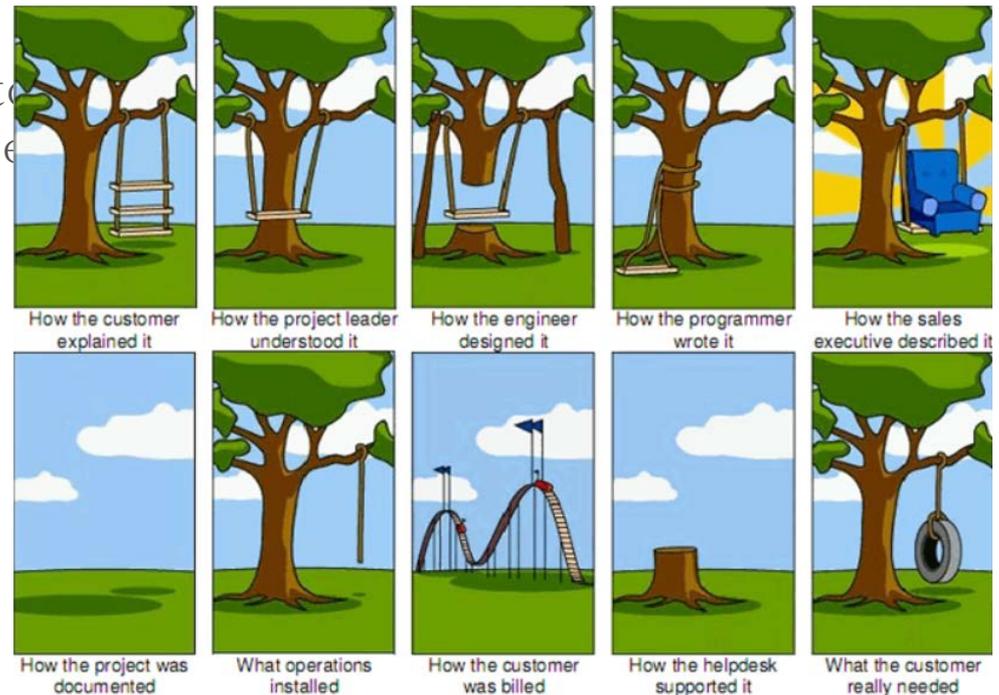
# Agenda

- Purpose
- History
- Goals
- Solution
- Progress
- Benefits



# Purpose

- To identify and use a set of tools that captures the design intent concurrently within a System of Systems or a complex design
- To capture and maintain the design understood by all stakeholders and not end up like this.....
- Design documentation is not to become stale and unmanageable
- To identify impact of change quickly and easily
- Ease of use to all users





# History

- Concept used on new Ship Preliminary Design Phase
- Taken up by L3-MS UK for design of ship's control systems
  - Successful at maintaining design intent for MoD
- In use on US Navy's Ship to Shore Connector (SSC) program for C4N (Command & Control, Communications, Computers & Navigation) Design
  - Critical Design complete for Systems
  - Critical Design complete for Hardware
  - Supporting Software ICDRs
  - Used in Testing Phase
- Being used on Off Shore Patrol Cutter (OPC) Machinery Plant Monitoring and Control System Preliminary Design Preliminary and Contract Design



*Opportunity for use in other military & commercial*

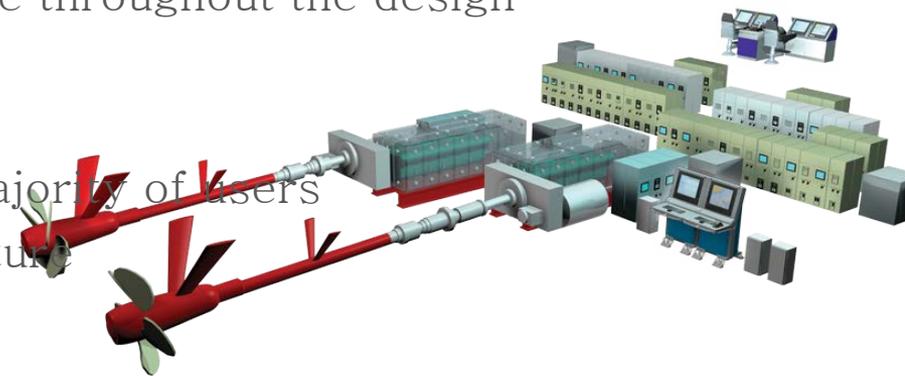
*business areas and*

*applications*



# Goals

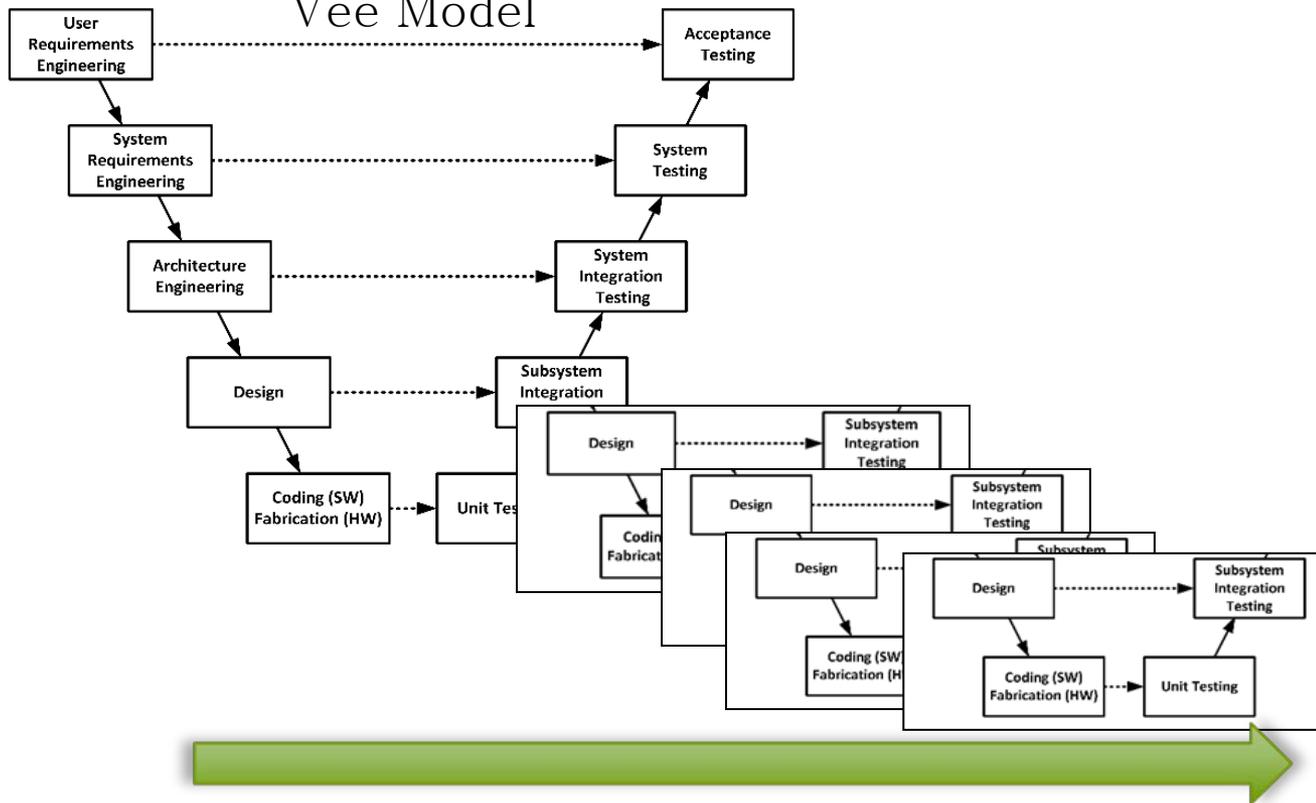
- Develop a method of maintaining the design throughout the Project Life Cycle with cost effectiveness in mind
  - To automate production of documentation
    - Update of design set documentation set at same time
    - Graphics and tables to be of a high resolution and format
    - Speed of document generation needed to be fast
    - Provision of document's revisions page prior to start of auto generation
  - Must capture the impact of change throughout the design
    - ECPs, CRs from customer
    - Apply the 'What If' scenarios
  - Minimal training necessary for majority of users
  - Use an Open & Scalable architecture
  - Auto-generate Metrics
  - Benefit the whole project team
  - Limits number of expensive licenses required





# Goals

## Systems Engineering Vee Model



Needs to be flexible enough to support Agile Software Development / iterative



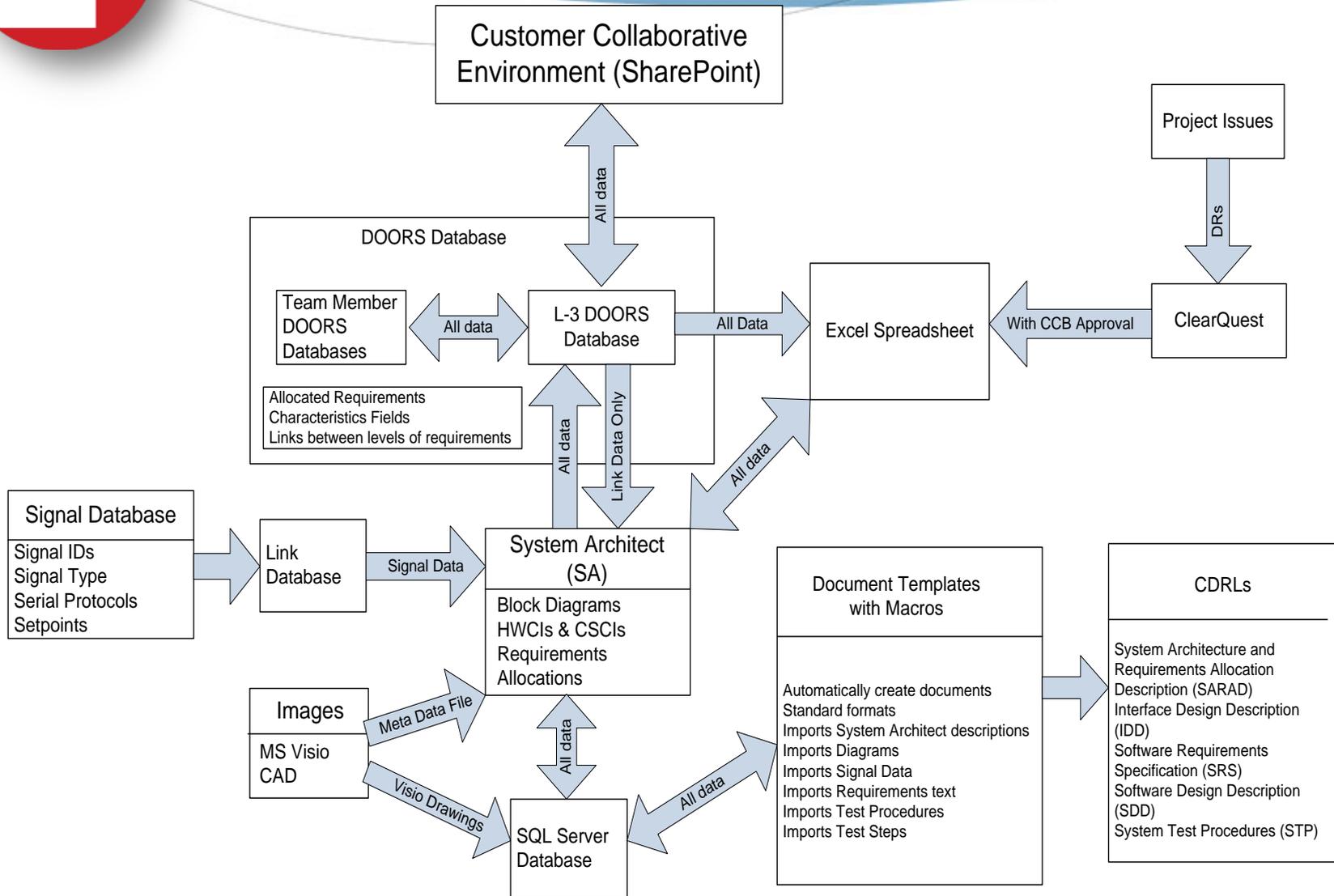
# Tools Solution

- Software Tools Selected and Optimized:
  - IBM Rational DOORS®: This tool is used as a Baseline CM tool and provides visualization of requirements traceability. It does require training. It can export data into usable MS Excel files.
  - IBM Rational System Architect® (SA): This tool allows better visualization of data relationships but requires training. Function Block Diagrams of DoDAF models can be used. It can easily export data into usable MS Excel files.
  - IBM Rational ClearQuest®: This tool allows Discrepancy Reports (DRs) to be entered in real time and addressed weekly at a Discrepancy Review Board (DRB).
  - MS Excel®: Files are easily maintained and manipulated and require no special training. (Majority of Work conducted)
  - MS Visio®: This tool is used to create or convert drawings and graphics and allows the customer to magnify figures without loss of resolution.
  - MS Word®: Templates created for Automated documentation
  - Databases: SA uses a SQL Server and links to other data through use of MS Access® Databases.
  - MS SharePoint®: This team members and cus

*Tools have capabilities and limitations, but were able to develop a suitable tailored structure on the front end*



# SE Tool Relationship



# Tool Use



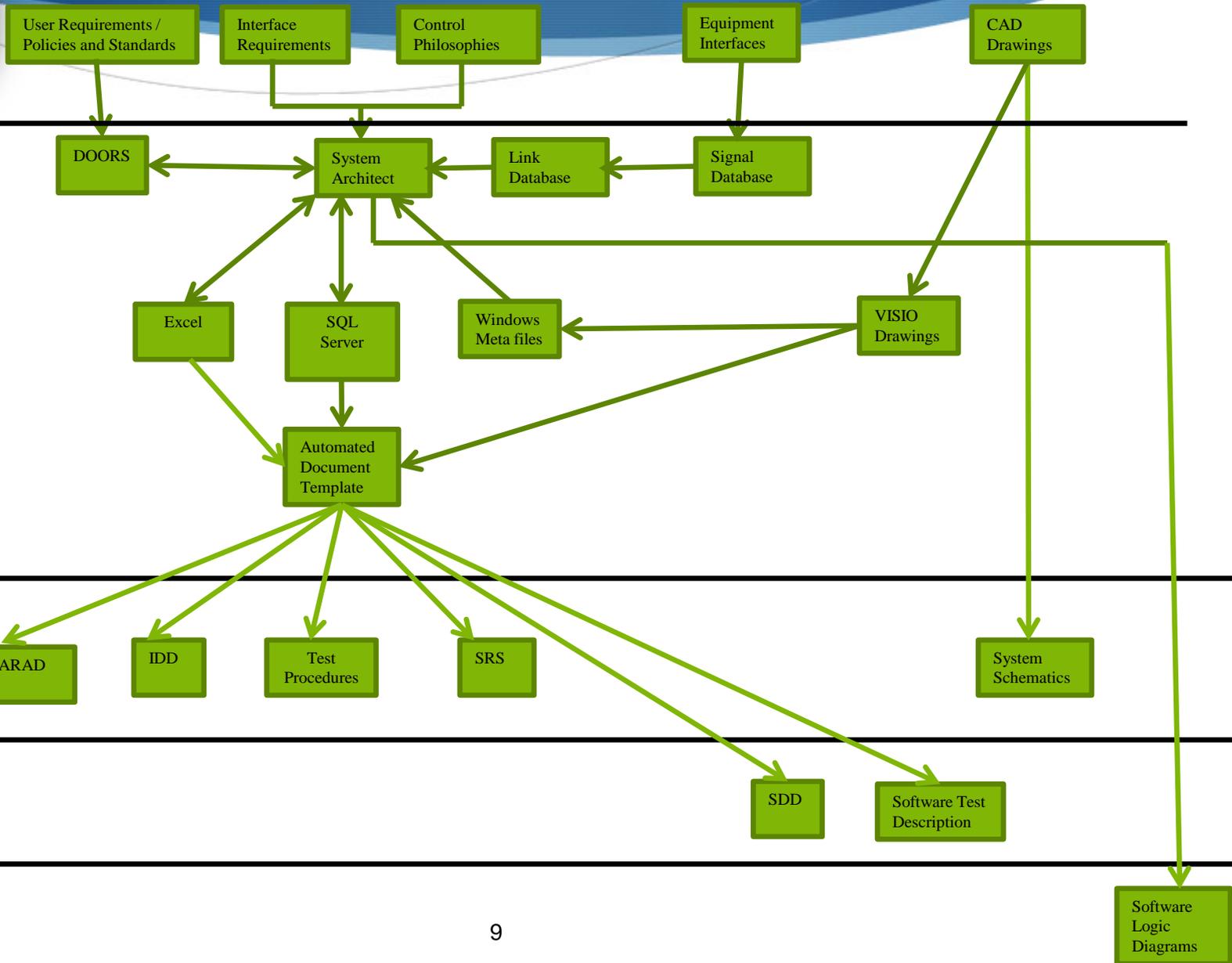
Inputs

Tools

Preliminary Design

Detailed Design

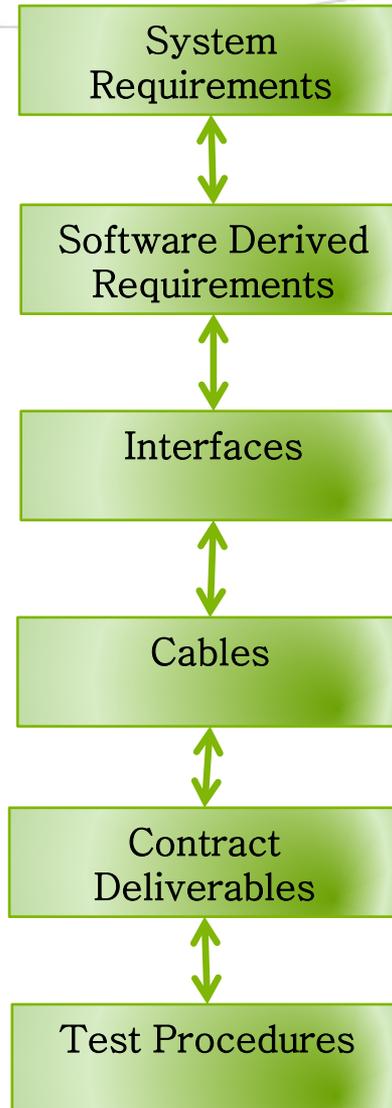
Software Code





# Effects on Change

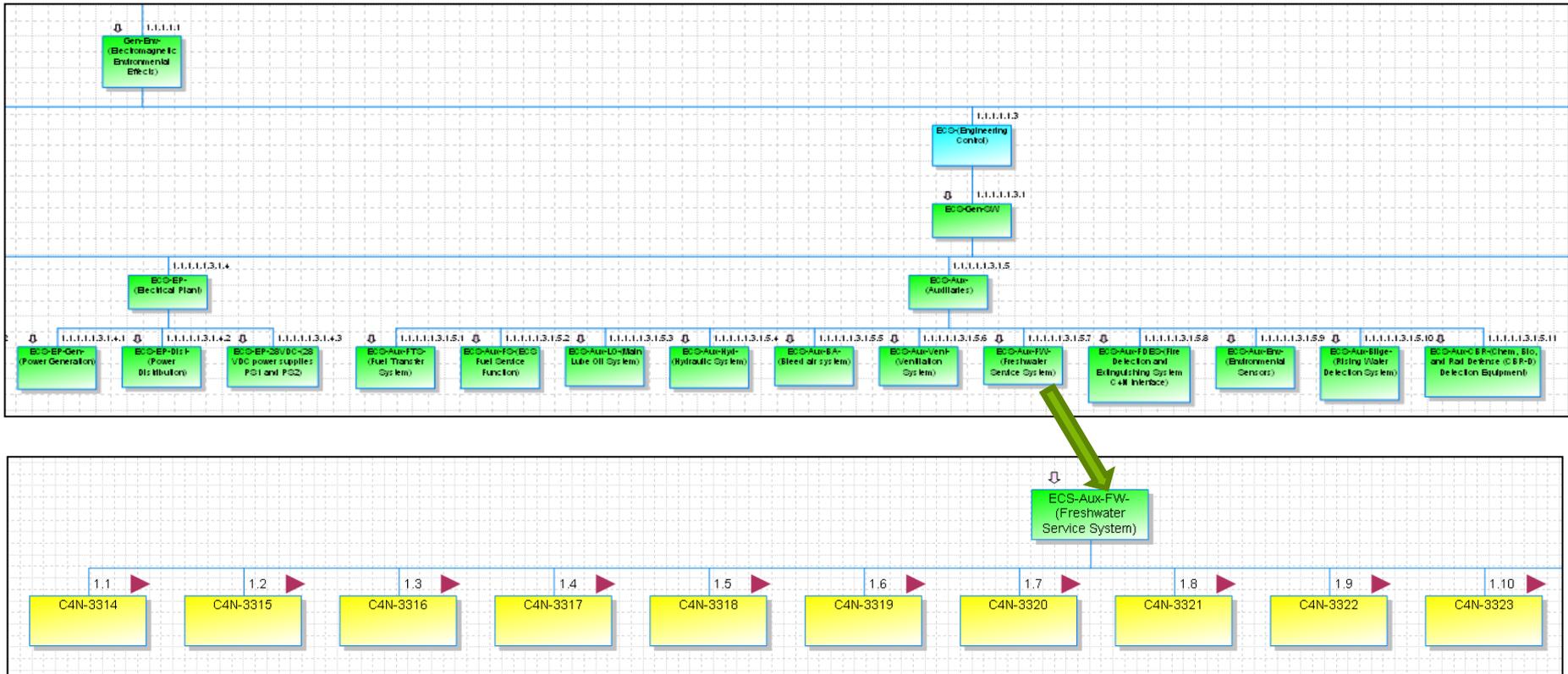
Able to investigate the System at any place of the design





# System Architect Typical Model

Block diagrams can be used to help visualize data and requirements relationships





# System Architect Typical Model

Provides a structure that allows you to standardize and simplify data entry for every requirement or record

The screenshot shows the 'Model Object - Systems Function' dialog box with the 'Introduction' tab selected. The dialog has a 'Name' field at the top. Below it are tabs for 'Introduction', 'Allocation', 'SRS', 'Interfaces', 'Safety', 'Test Plan', 'Component Testing', 'Integration Testing', and 'Final'. The 'Introduction' tab contains several text input fields: 'Function Description', 'Hierarchical Number', 'General Comments L-3', 'Diagram Name', and 'Graphic File Name'. There are also two checkboxes: 'Is Requirement' (checked) and 'Is Graphic File' (unchecked). At the bottom, there are buttons for 'OK', 'Cancel', 'Spell', 'Delete', and 'Apply'. The status bar at the bottom indicates 'Text' and 'Length: 5000'.

The screenshot shows the same 'Model Object - Systems Function' dialog box, but with the 'Allocation' tab selected. The 'Name' field is at the top. Below it are the same tabs as in the previous screenshot. The 'Allocation' tab contains a 'Page' indicator showing '1 of 7'. Below that are two groups of checkboxes. The first group, labeled 'Allocation', includes 'HW/CI' (checked), 'CSD' (unchecked), 'Manual Operation' (unchecked), 'IA Control' (unchecked), and 'Safety Impact' (checked). The second group, labeled 'Functional Area', includes 'NAV' (unchecked), 'C2' (unchecked), 'ECS' (checked), 'COMM' (unchecked), 'CCE' (unchecked), and 'ALL' (unchecked). At the bottom, there are buttons for 'OK', 'Cancel', 'Spell', 'Delete', and 'Apply'. The status bar at the bottom indicates 'Boolean' and 'Length: 1'.



# SA – SRS Document Tab

Software Requirements Specification template conforms to Gov't DID – DI-IPSC-81433A

Model Object - Systems Function

Name

Introduction | Allocation | SRS | Interfaces | Safety | Test Plan | Component Testing | Integration Testing | Fini

Page 1 of 3

Type

Parent Requirement(s)

SW Test Method

SW Test Level

SW CSCI

SRS Section

Rationale Derivation

Notes

SW Safety Impact

OK Cancel Spell Delete Apply

Text Length: 400

Model Object - Systems Function -

Name

Introduction | Allocation | SRS | Interfaces | Safety | Test Plan | Component Testing | Integration Testing | Fini

Page 2 of 3

DOORS Parent Req ID

Owner

Application

SW Unit

SW Task

Software Release

Software Build

OK Cancel Spell Delete Apply

Name Length: 80



# System Architect – Interfaces

Able to create Interface Design Descriptions (IDD) – ties requirements to signals

Model Object - IDD Function -

Name

Introduction | IDD Connection | Signal Testing | Place Holder | Reference Documents | Access Data | Symbol

Page 1 of 2

IDD Description

Interface ID Number

Associated Requirements

Fixed Entities

Entities Being Developed

Subsystem 1

Subsystem 2

Interface Type  
 External Interface  
 Internal Interface

Model Object - IDD Function -

Name

Introduction | IDD Connection | Signal Testing | Place Holder | Reference Documents | Access Data | Symbol

Page 2 of 2

Data Exchanges

Input System Data Exchanges

<input type="text"/>	Add
<input type="text"/>	Modify
<input type="text"/>	Remove

Define Check Choices...

Output System Data Exchanges

<input type="text"/>	Add
<input type="text"/>	Modify
<input type="text"/>	Remove

Define Check Choices...

Event Message

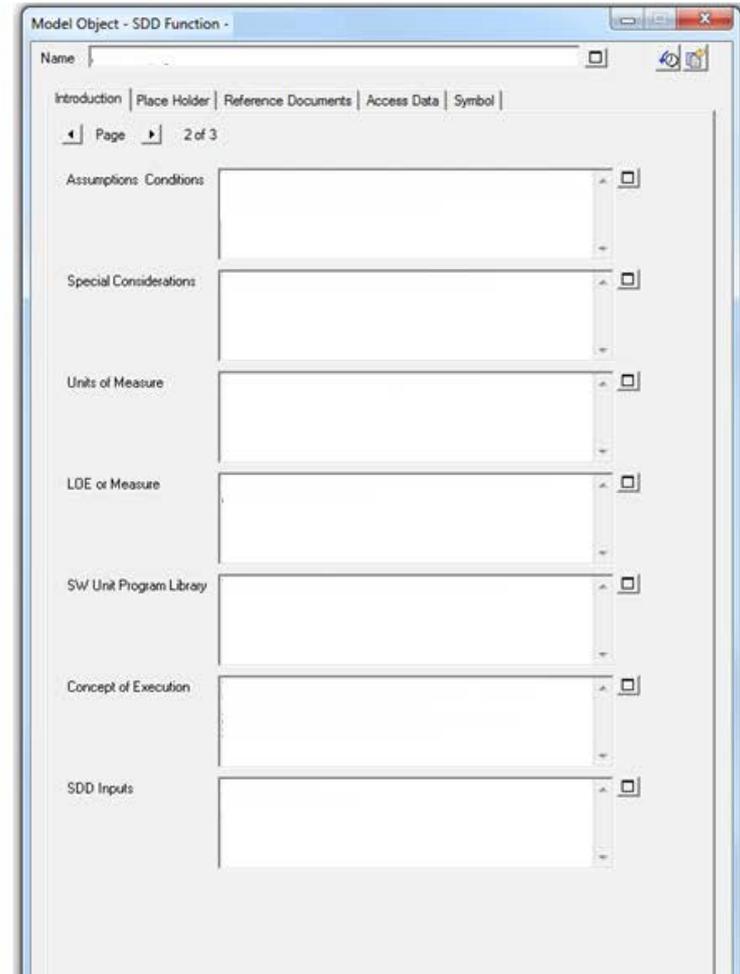
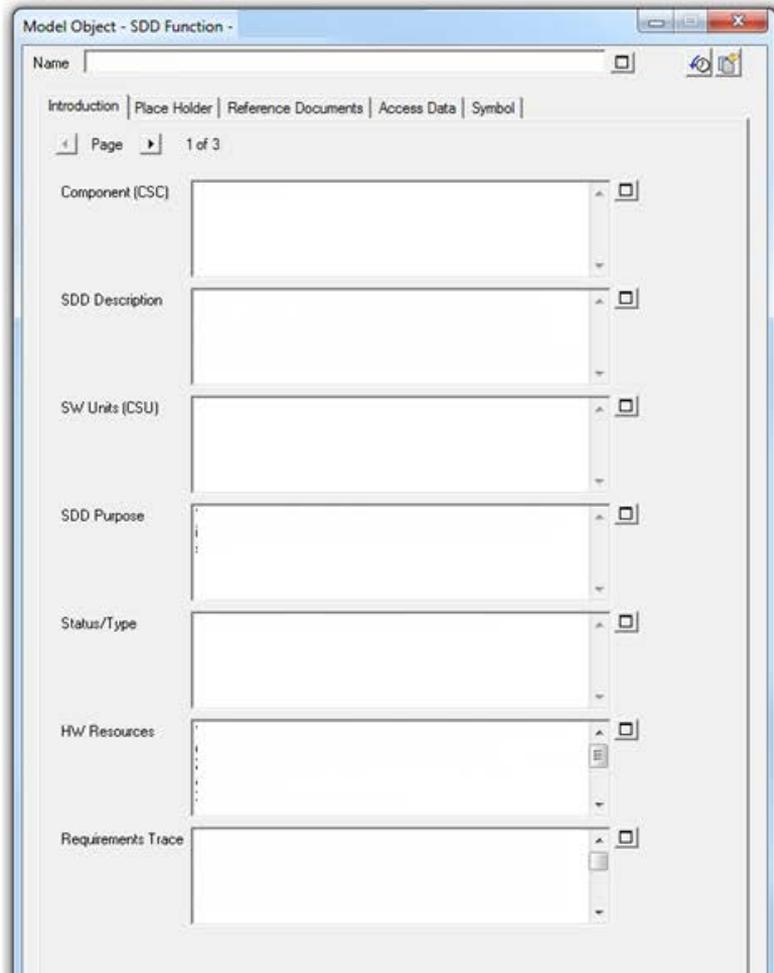
<input type="text"/>	Add
<input type="text"/>	Modify
<input type="text"/>	Remove

Define Check Choices...



# System Architect – SDD Objects

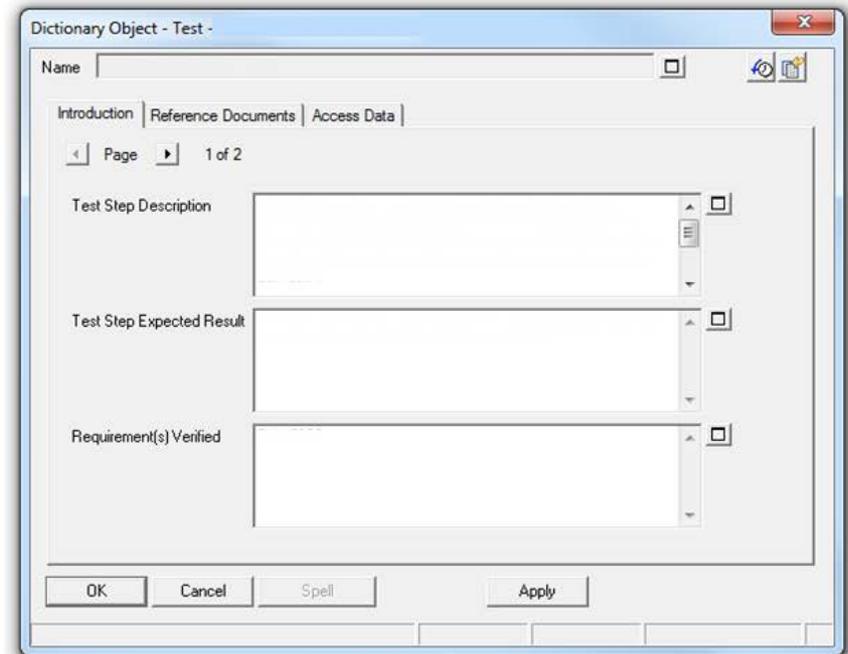
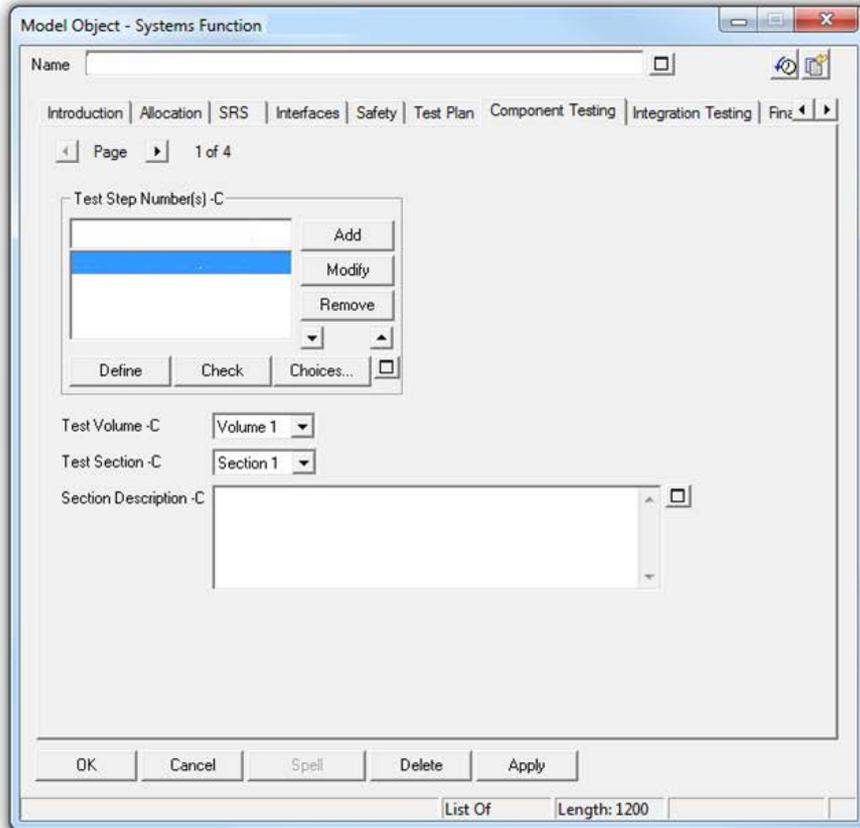
Software Design Description is standardized





# System Architect - Test Steps

Test steps can be selected from a drop-down list





# System Architect – Cabling

Ability to tie together cabling information to requirements and signals.

The image displays three screenshots of the System Architect software interface, illustrating the configuration of cabling information.

**Dictionary Object - Data Exchange -**

Signal Description

C4N Cable Number

Add  
Modify  
Remove  
Define Check Choices...

**Dictionary Object - Cable Number -**

Cable Run | Place Holder | Reference Documents | Access Data

Requirement Number

Signal Instrument Number

CABLETYPE

CABLELENGTH

UNITA1

UNITA2

UNITB1

UNITB2

CMPTA

CMPTB

REV

NOTE

USAGE

C4N Connector

Connector A

Connector B

Add  
Modify  
Remove  
Define Check Choices...

**Dictionary Object - Connector - ARINC 600 CA150-A**

Name: ARINC 600 CA150-A

Introduction | Place Holder | Reference Documents | Access Data

C4N PinOut:

	Name	COLOR	GROUP	TERM	FUNCTION
1	ARINC 600 CA150-A-000	SHIELD	CJ1-SH1		SHIELD
2	ARINC 600 CA150-A-001	WHT/DRG	CH1-SH1-TW1-1	A-A1	ETHERNET TP0+ (A+)
3	ARINC 600 CA150-A-002	ORANGE	CH1-SH1-TW1-2	A-A2	ETHERNET TP0- (A-)
4	ARINC 600 CA150-A-003	WHT/GRN	CH1-SH1-TW2-1	A-A3	ETHERNET TP1+ (B+)
5	ARINC 600 CA150-A-004	GREEN	CH1-SH1-TW2-2	A-A4	ETHERNET TP1- (B-)
6	ARINC 600 CA150-A-005	WHT/BLU	CH1-SH1-TW3-1	A-A5	ETHERNET TP2+ (C+)
7	ARINC 600 CA150-A-006	BLUE	CH1-SH1-TW3-2	A-A6	ETHERNET TP2- (C-)
8	ARINC 600 CA150-A-007	WHT/BRN	CH1-SH1-TW4-1	A-A7	ETHERNET TP3+ (D+)
9	ARINC 600 CA150-A-008	BROWN	CH1-SH1-TW4-2	A-A8	ETHERNET TP3- (D-)

Insert Delete Define Choices...  
OK Cancel Spell Apply  
Grid Of Length: 1800



# Requirements Association

- Able to show the relationships between requirements, diagrams, applications, software units, signals and events tied together.
- Baseline Changes
  - Allows one to see what aspects of requirements will be affected (requirement text, allocation, signals, derived requirements, etc.)
  - DOORS supports Baseline Change comparisons
  - When a new DOORS module is received from customer, a baseline comparison is made and reviewed. When agreed by Change Control Board (CCB) all links are broken in the baselined modules and are re-linked up to the new DOORS module using the change process.

*Requirements Association has a wide range of applicability to commercial and defense type contracts*



# Auto-Document Generation

Code scripts allow for automatic generation of multiple nested sections & tables in created documents

## SET-UP

Each document has a configured Macro with code strings and bookmarks to extract data from:

- MS Excel directly
- MS Sequel Server
  - MS Visio files
  - CAD files
  - Adobe .pdf files
  - MS Word files

Revision level & history, date & authors info entered into

user forms prior to auto-

```
Sub AutoOpen()  
    Call GetExcelData()  
    Call GetSQLData()  
    Call GetVisioData()  
    Call GetCADData()  
    Call GetPDFData()  
    Call GetWordData()  
    Call GetRevisionInfo()  
    Call GetDateInfo()  
    Call GetAuthorInfo()  
End Sub  
  
Sub GetExcelData()  
    'Code to extract data from MS Excel  
End Sub  
  
Sub GetSQLData()  
    'Code to extract data from MS Sequel Server  
End Sub  
  
Sub GetVisioData()  
    'Code to extract data from MS Visio files  
End Sub  
  
Sub GetCADData()  
    'Code to extract data from CAD files  
End Sub  
  
Sub GetPDFData()  
    'Code to extract data from Adobe .pdf files  
End Sub  
  
Sub GetWordData()  
    'Code to extract data from MS Word files  
End Sub  
  
Sub GetRevisionInfo()  
    'Code to extract revision level & history  
End Sub  
  
Sub GetDateInfo()  
    'Code to extract date  
End Sub  
  
Sub GetAuthorInfo()  
    'Code to extract authors info  
End Sub
```

## DOCUMENT

- Generated document requires no further editing for format
- Sections can be nested up to 5 levels deep (eg 4.1.1.1.1)
- Graphics can be embedded as a MS Visio file ensuring no resolution is lost
- Ready for peer review and release



# Demonstration

Document Auto Generation  
will be provided at conference



# Progress to-date

- Develop a method of maintaining the design throughout the Project Life Cycle with cost effectiveness in mind
  - Need to automate production of documentation 
  - Update of full documentation set simultaneously
  - Graphics and tables to be of a high resolution and format
  - Speed of document generation needed to be fast
  - Update of document's revisions page prior to start of auto generation 
- Able to capture the impact of change throughout the design
  - ECPs, CRs from customer
  - Apply the 'What If 'scenarios 
- Minimal training necessary  for the majority of users
- Open & Scalable architecture 
- Auto-generated Metrics 
- Used across whole project team (Engineers to Program Managers)



# Benefits

- Able to provide a complete baselined set of documentation for incremental design reviews
- Customer is able to read across the artifacts at same stage of design
- Design Team is able to see at a glance requirements that affect their own efforts
- Supports Agile Software Development
- Shorter time to generate and process documents
- Supports concurrent engineering
- Provides customer with a requirements trace tool suite (export file)
- System Architect export in XML requires no user license



# Questions



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