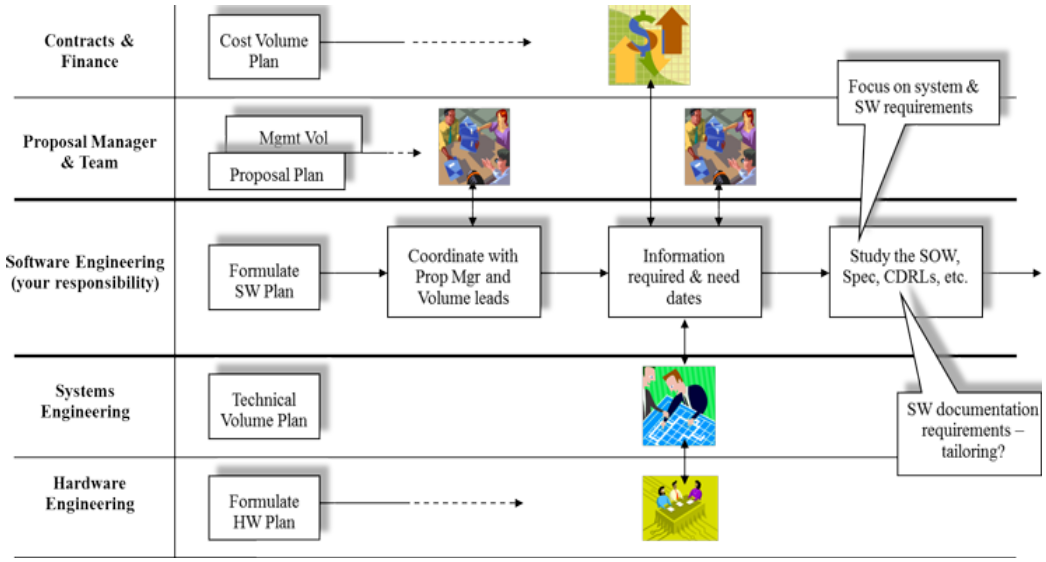
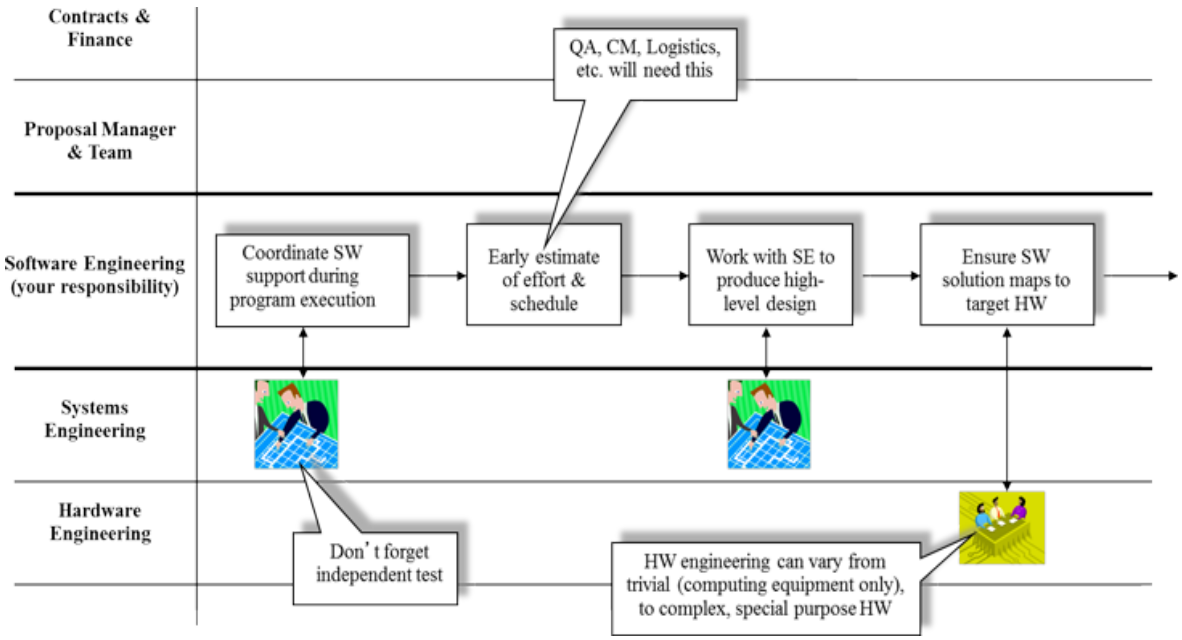
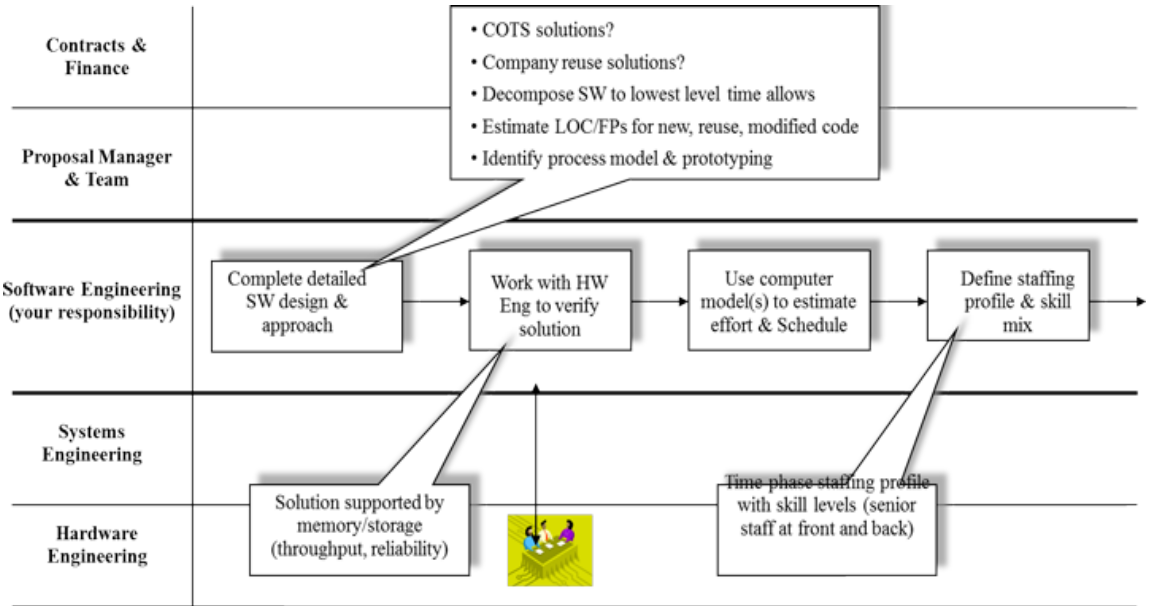
Process Elements

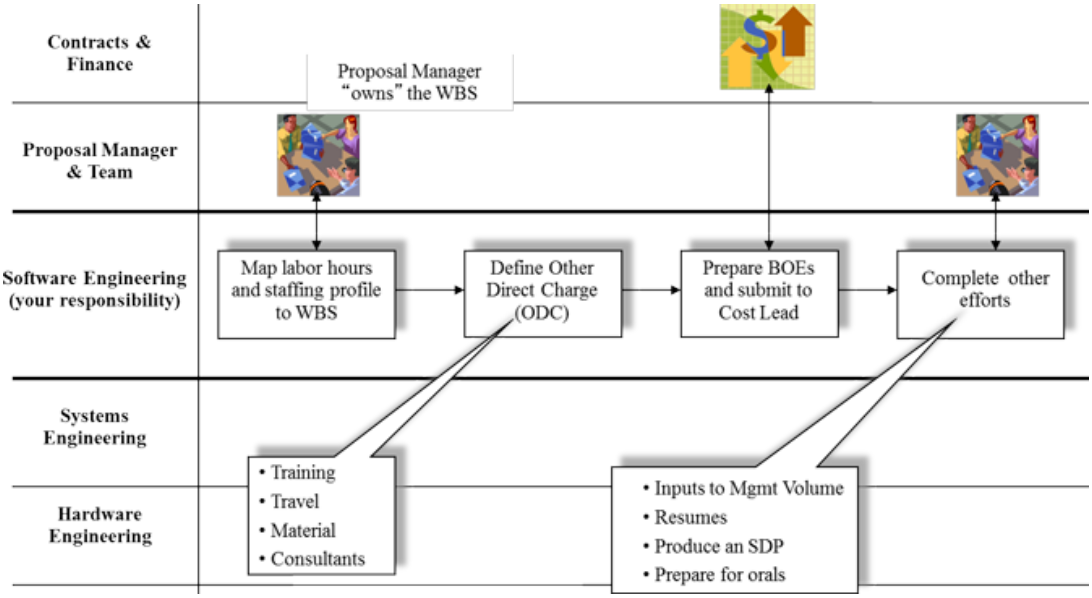
Who is Responsible for Estimating?

As you follow the software engineering responsibilities when developing the software estimate for a proposal, you see how the software manager must constantly coordinate with the other leaders to ensure that the software is planned according to the overall program objective.



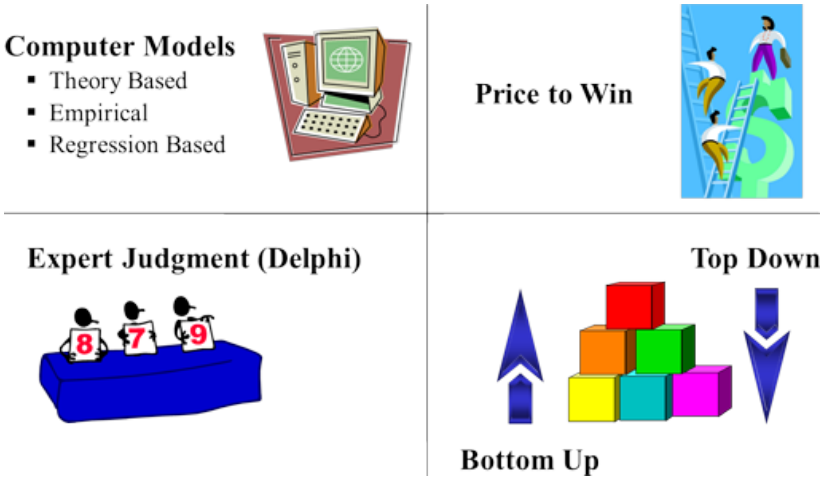



Contracts & Finance
Proposal Manager & Team
Software Engineering (your responsibility)
Systems Engineering
Hardware Engineering
• COTS solutions?
• Company reuse solutions?
• Decompose SW to lowest level time allows
• Estimate LOC/FPs for new, reuse, modified code
• Identify process model & prototyping
Complete detailed SW design & approach
Work with HW Eng to verify solution
Use computer model(s) to estimate effort & Schedule
Define staffing profile & skill mix
Solution supported by memory/storage (throughput, reliability)
Time-phase staffing profile with skill levels (senior staff at front and back)


Contracts & Finance
Proposal Manager & Team
Software Engineering (your responsibility)
Systems Engineering
Hardware Engineering
Proposal Manager "owns" the WBS
Map labor hours and staffing profile to WBS
Define Other Direct Charge (ODC)
Prepare BOEs and submit to Cost Lead
Complete other efforts
• Training
• Travel
• Material
• Consultants
• Inputs to Mgmt Volume
• Resumes
• Produce an SDP
• Prepare for orals

Software Estimation Methods

Software estimation is an art, yet the goal is to make it a science with specific rules, guidelines, procedures, and processes. A variety of methods help estimate the size of software including:



Often project managers and developers will apply multiple methods and compare and contrast the results to help determine the best estimate.

Comparison of Software Estimation Methods

Estimation Method	Description	Advantages	Disadvantages
Regression-based models	Historical information is used to develop algorithms which relate cost with one or more software metrics producing a scatter diagram Examples: COCOMO, REVIC	• Objective, repeatable, easy to use • Can be calibrated to company or project environment	• Inputs may be subjective (need LOCs) • May not handle exceptional circumstances • May be based on inefficient past practices
Empirical-based models	Estimate is based on analogy with cost of previously completed projects in the same domain Example: Checkpoint	• Based on actual experience • Can break down cost at detailed level	• Not always clear how to compare projects • May miss differences between project applications and environments

Theory-based models	Estimate is based on underlying theoretical considerations for software development processes Examples: SLIM, Price-S	• Repeatable • Get what you pay for • Lots of research	• Proprietary • Expensive
Expert judgment (Delphi)	Uses one or more experts to arrive at consensus estimate	• Can factor in differences between past projects and this project • Can factor in exceptions	• Only as good as the experts • Not repeatable
Price-to-win estimate	Estimate is based on whatever the customer has to spend	• Often wins the contract	• Schedule and budget are unrealistic • Engineers become demoralized
Top down estimate	Derive estimate from global properties of the product divided among components	• System level focus will not leave out system level functions	• Does not identify low level technical issues • Sometimes misses detailed components • Does not provide details for cost analysis
Bottom up estimate	Cost of each component is estimated, then costs are added for overall estimation	• Estimate for each component based on detailed understanding • Estimate backed up by personal commitment of individuals • Estimation errors balance out	• Can underestimate by overlooking system level costs • Requires more effort • Some cost elements may be included more than once

As time allows, program/project manager use a variety of techniques including LOC estimation, Function or Feature Points, panel displays, computer models, Delphi method, Price to Win, and Top Down and Bottom Up methods to estimate the cost and schedule.

For more information on software estimation tools and processes, contact:

Service or Tool	Contact Information
COCOMO (COSTAR)	Softstar Systems P.O. Box 1360, Amherst, NH 03031 603-672-0987 http://www.softstarsystems.com/
Function Points	International Function Point Users Group

Service or Tool	Contact Information
	191 Clarksville Road, Princeton Junction, NJ 08550 609-799-4900 http://www.ifpug.org/
PRICE-S	PRICE Systems, L.L.C. 17000 Commerce Parkway, Suite A Mount Laurel, NJ 08054 800-43-PRICE (77423) http://www.pricesystems.com/
SEER	Galorath Incorporated 100 North Sepulveda Blvd, MS 1801, El Segundo, CA 90245 310-414-3220 http://www.galorath.com/
SLIM Tools	Quantitative Software Management (QSM), Inc. 2000 Corporate Ridge, Suite 700, McLean, VA 22102 703-790-0055 http://www.qsm.com/
Process Improvement	Software Engineering Institute, Carnegie Mellon University 4500 Fifth Avenue, Pittsburgh, PA 15213 412-268-5800 http://www.sei.cmu.edu/
Process Improvement	Software Technology Support Center, Ogden Air Logistics Center Hill AFB, UT 84056-5205 801-775-5555 http://www.stsc.hill.af.mil/

Planning a Software Development Effort

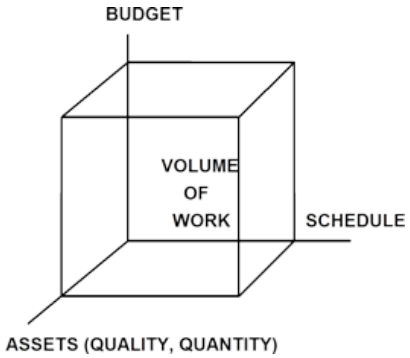
Defining an approach to planning and documenting a software development project is critical to the project's success. You must establish goals that are achievable and recognize that the total volume of work is the result of budget, schedule, and assets (people and equipment) which have both quality and quantity attributes. This module will provide guidance and suggestions for creating and instituting the planning activities. Here are a few quotes to think about:

"Plans are nothing; planning is everything." — *Dwight D. Eisenhower*

"Plans are of little importance, but planning is essential." — *Winston Churchill*

"No battle plan survives contact with the enemy." — *Helmuth von Moltke the Elder*

"A good plan, violently executed now, is better than a perfect plan next week." — *George S. Patton*



It is important to plan for success and ensure:

- Managers have learned how to do effective planning.
- There is a mechanism in the planning process to recognize and create realistic forecasts or predictions.
- Goals are specifically set with its relationship to need, means, and feasibility. There should be a profound knowledge of the organization's business.
- The vision of the project's future is shared and not limited to management.
- Planning is recognized as an on-going process, not an event.
- Planning is done with adequate factual data including customer requirements.
- Do not place too much emphasis on historical data; if may not necessarily be germane to the future.
- Planning must be done as a team, not by a separate planning department or group. People should not want to plan their own destiny.
- Planned activities must be carefully reviewed on an on-going basis.
- Plans and/or activities are reviewed and the process is not punitive. Real facts must be honestly reported and the organization uses this data to succeed and learn. Aggressive planning leads to failures.

What is a Software Development Plan (SDP)

The SDP or Project Plan is a comprehensive planning document that the software manager uses to direct the software development and/or maintenance. The document informs internal management as to the procedures used to manage and organize the software engineering related activities. The SDP is project specific; one must be developed for each project and usually it is a contract requirement. Lastly, the acquisition manager and customer use the SDP to maintain insight into the software development process and activities. While the differences may seems subtle, software Managers distinguish between plans, procedures, guidebooks, and project notebooks as follows:

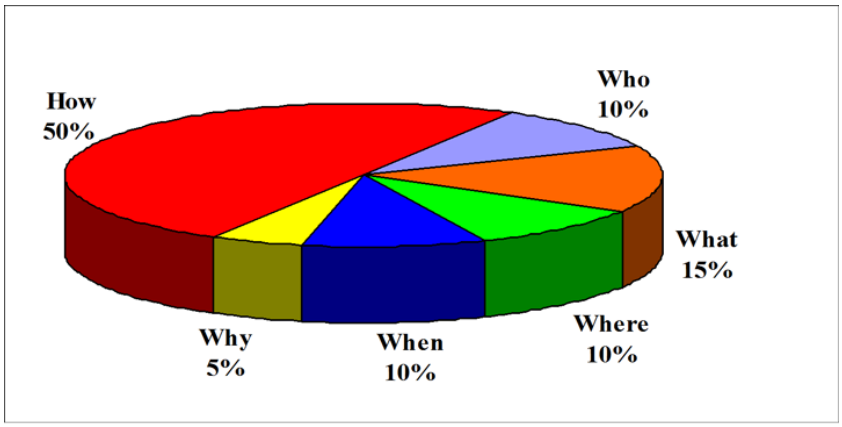
A **plan** is an ordered definition of the "who, what, when, and where." It defines a written strategy, the "why," and may include the tactics or "how" the tasks will be accomplished.

A **procedure** defines how you do something and may include the "who, what, when, and where."

A **guidebook** is a reference set of generic procedures or best practice guidance.

Lastly, a **project notebook** establishes the detailed standards, procedures, guidelines, and restrictions that developers will follow to develop the software; it supplements the SDP and must be in concert with the Project Management Plan.

Empirical data suggests that the approximate division of the elements of planning in the SDP are as follows:



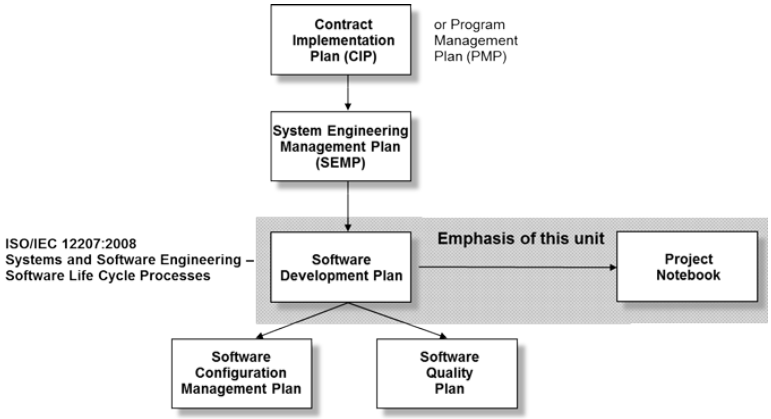
Who (10%)	What (15%)	Where (10%)	When (10%)	Why (5%)	How (50%)
• Staffing • Organization Charts • Roles / Responsibilities	• Tailoring • CSCIs • Activities • Products	• Facilities • Development Environment • Test Environment	• Schedule • Process Model • Milestones	• SOW Compliant • Company Standards	• Process Model • Methodology • Company Standards • Tools

Program/Project staffing, organization charts with functions, and the roles and responsibilities answer **Who** and account for about 10% of the planning document. Generally you would not include an organizational chart with the actual names. Since the Software Development Plan is a deliverable document to your customer in most cases, every time it changes, it would need to be redelivered, so most organizations keep a function organization chart in the document but an organization chart with the team members' names in the appendix which generally does not need to be delivered each time it is updated. The activities, products, computer software configuration items (CSCIs) or subsystems, and the tailoring account for the **What** and should be about 15% of the document. The types of facilities needed, including the development and test environments account for 10% of the document and answer **Where**. The schedule, process model, and milestones are part of **When** and account for 10%. Compliance with the Statement of Work (SOW) and company standards should be included in answering **Why** and account for 5%. Lastly, the process model, methodology, company standards and tools account for the remaining 50% and answer **How**. You will note that some topics are covered in more than one area as the perspective may be different.

The project planning document or SDP is often arranged as shown in the chart. These topics will resurface in various modules of this course.

How the SDP fits in the hierarchy of other planning documents

The SDP fits within the program framework. The Program Management and System Engineering planning typically precede the Software Engineering planning. For the SDP to be consistent with the program and system engineering planning activities, the software engineering organization must participate in the program and system planning. Also the SDP often drives other planning documents at lower levels, including the Configuration Management Plan and the Quality Assurance Plan. These documents generally cover topics including: engineering and manufacturing, test and evaluation, planning, risk management, logistics, configuration management, data management, support to modern concepts, tailoring, human factors, process maturity, concurrency, process improvement, metrics, and process models. The hierarchy of planning documents is as shown:

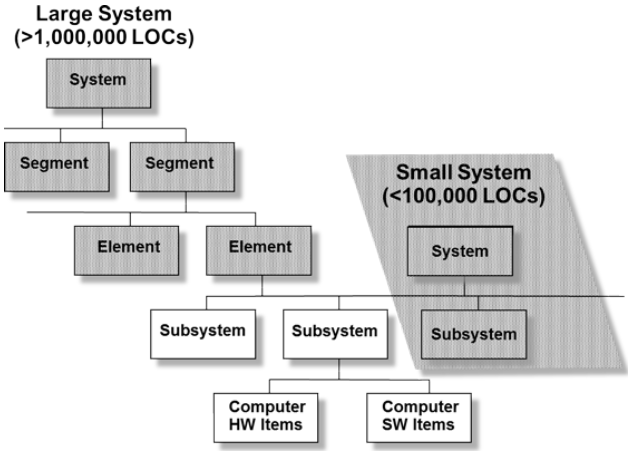


Software as a component of the system

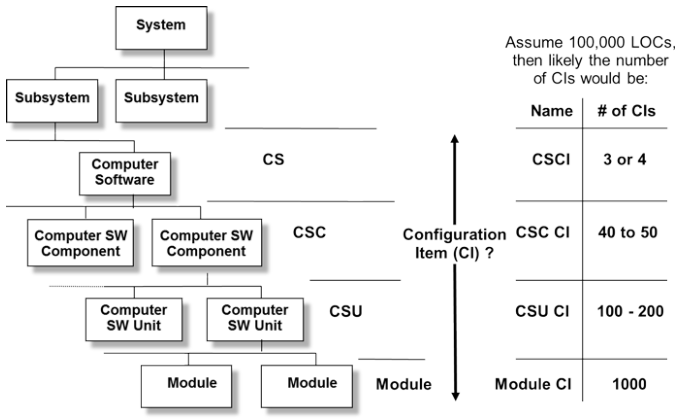
The Software Development Plan describes the planning for the development of the software components in the system; there is one SDP for the entire project. The other development documents including specifications, test procedures, and user manuals are produced for each software component designated as a "configuration item."

What is a Configuration Item?

No matter if the system is large or small, software is a component of the system. Systems are hierarchical.



A configuration item is a basic unit of a system and it can be as large or as small as necessary. The system is made up of subsystems, components, units and at the lowest level, modules. Generally there are 1000s of module configuration items. Groups of modules make up computer software unit configuration items which in turn make up computer software component configuration items which in turn make up the computer software configuration items which make up the system.



Computer Software (CS) is defined during requirements analysis; it satisfies an end-use function and is typically designated as a configuration item (CI). Each Computer Software Configuration Item (CSCI) requires its own set of specifications and technical reviews. For this reason the number of CSCIs should be minimal. Start by assuming there is one CSCI for the entire software system. Decompose it into CSCIs if:

- It crosses computer boundaries
- It crosses vendor boundaries including subcontractors and applications versus COTS
- One CSCI is too large; 30,000 LOCs is a guide
- Separate schedules are required
- Software requirements analysis results in the definition of more than one CSCI, that is, there are clearly very unique functions

Computer Software Component (CSC) is a functionally or logically distinct part of a CSCI. CSCs are identified during the preliminary design process.

Computer Software Unit (CSU) is a functionally or logically distinct part of a CSC and has the following characteristics:

- The unit performs a well-defined function.
- It is amenable to development by one person within the assigned schedule.
- Requirements can be traced to a unit.
- Implements a testable aspect of the requirements.
- It has a cyclomatic complexity of 10 or less.
- Typical units are between 100 and 1000 LOCs, but remember that each unit requires an SDF so larger units minimize SDF maintenance.
- It is composed of one or more modules.

Module, the lowest component of software, is typically 100 LOCs or less.

The software developer keeps Software Development Files (SDFs) or Unit Development Files (UDFs) for each unit or folder.

The SDFs may include:

- Assumptions and constraints
- Design considerations
- Design documentation and data
- Source code items

- Unit and integrated unit test descriptions
- Unit and integrated unit test results
- Code evaluation, walkthrough, and inspection results
- Order of integration of the components
- Tests
- Any other valuable information about the software element