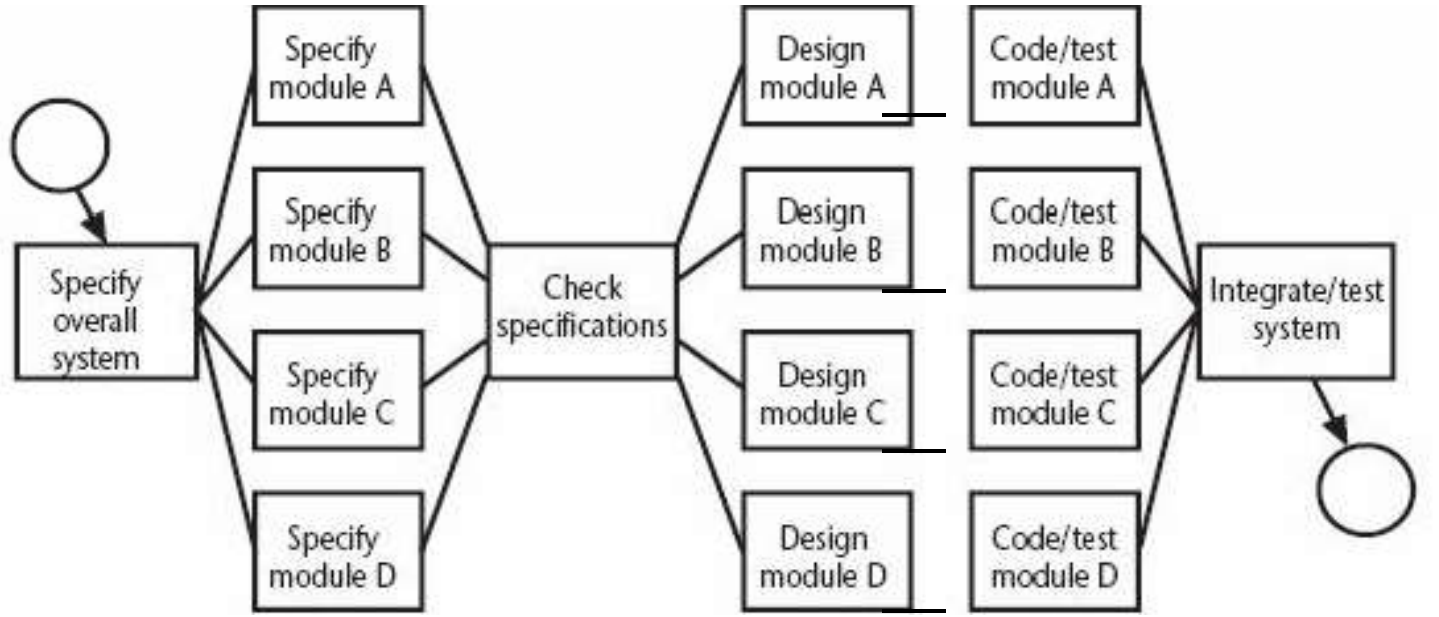
Activity-On-Node Networks

- Used by precedence networks
  - Has become popular
  - Widely adopted
- Activities are represented as nodes
- The links between nodes represent precedence (or sequencing) requirements

Activity-On-Node Networks

- Fragment of a network developed as an activity-on-node network



Formulating A Network Model

Constructing Precedence Network Rules [1/2]

- A project network should have only one start node
  - More than one activity starting at once? Invent a ‘start’ activity with zero duration
- A project network should have only one end node
  - If necessary, invent an ‘end’ activity
- A node has duration
- Links normally have no duration

Formulating A Network Model

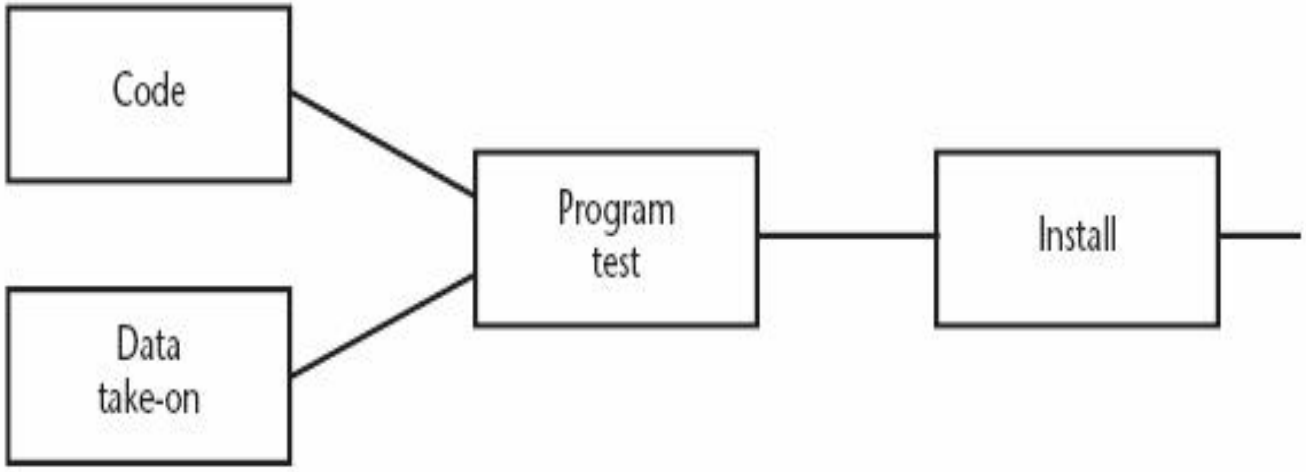
Constructing Precedence Network Rules [2/2]

- Precedents are the immediate preceding activities
  - All have to be completed before an activity can be started
- Time moves from left to right
- A network may not contain loops
- A network should not contain dangles
  - If necessary, connect to the final node

Formulating A Network Model

Fragment of Precedence Network

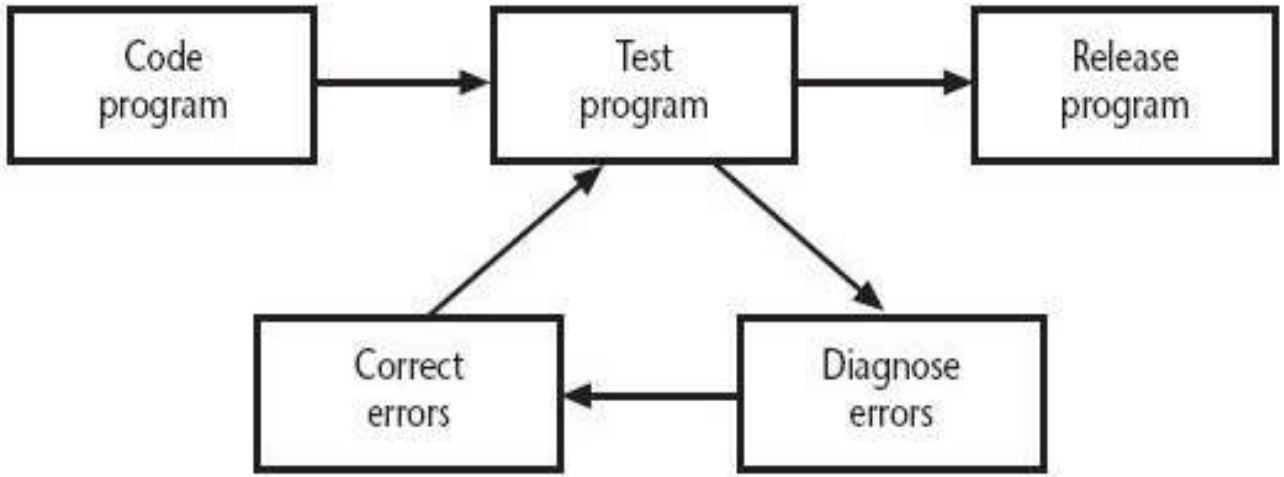
- Installation cannot start until program testing is completed
- Program test cannot start until both code and data take-on have been completed



Formulating A Network Model

Network Contains Loop

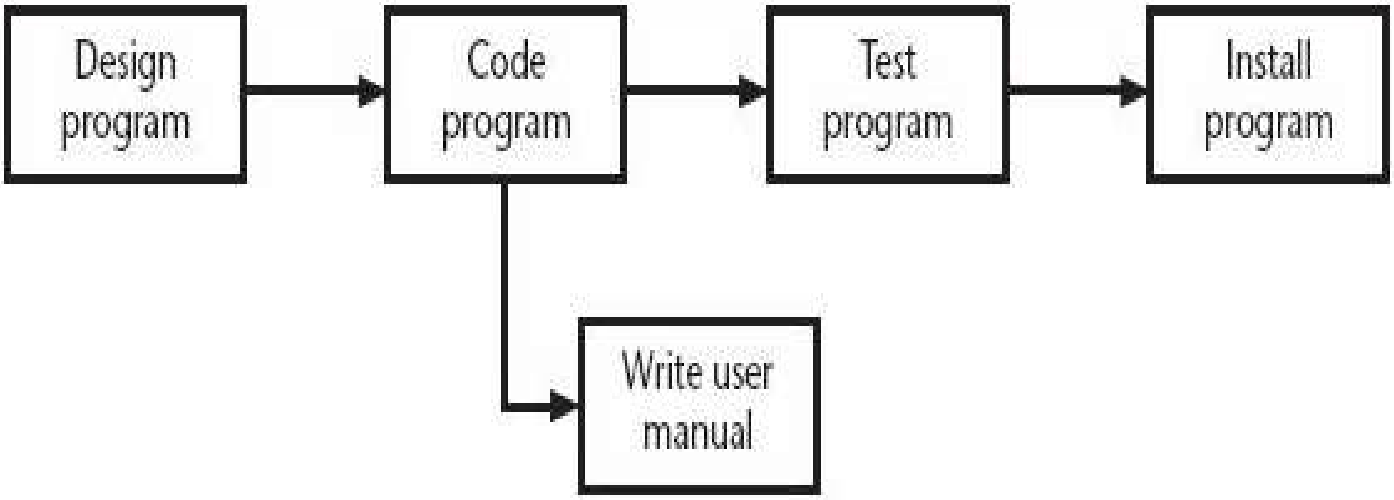
- A loop is an error in that it represents a situation that cannot occur in practice
  - Program testing cannot start until errors have been corrected?



Formulating A Network Model

A Dangle

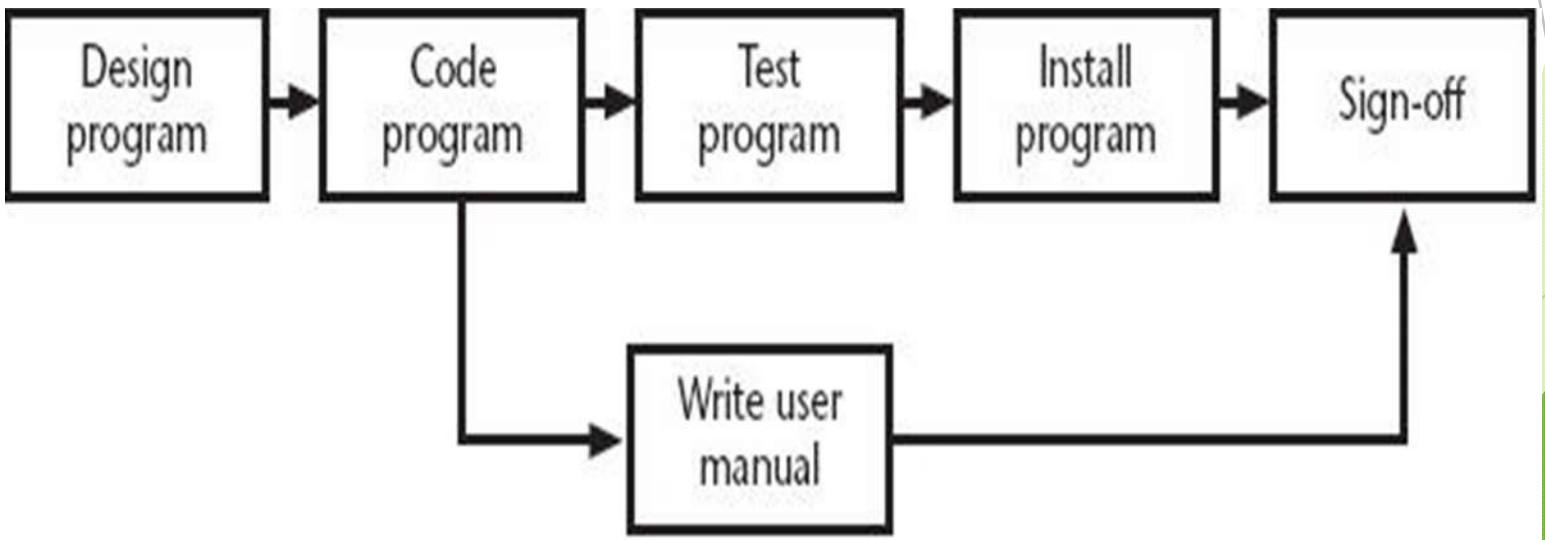
- A dangling activity such as “write user manual” should not exist as it is likely to lead to errors in subsequent analysis



Formulating A Network Model

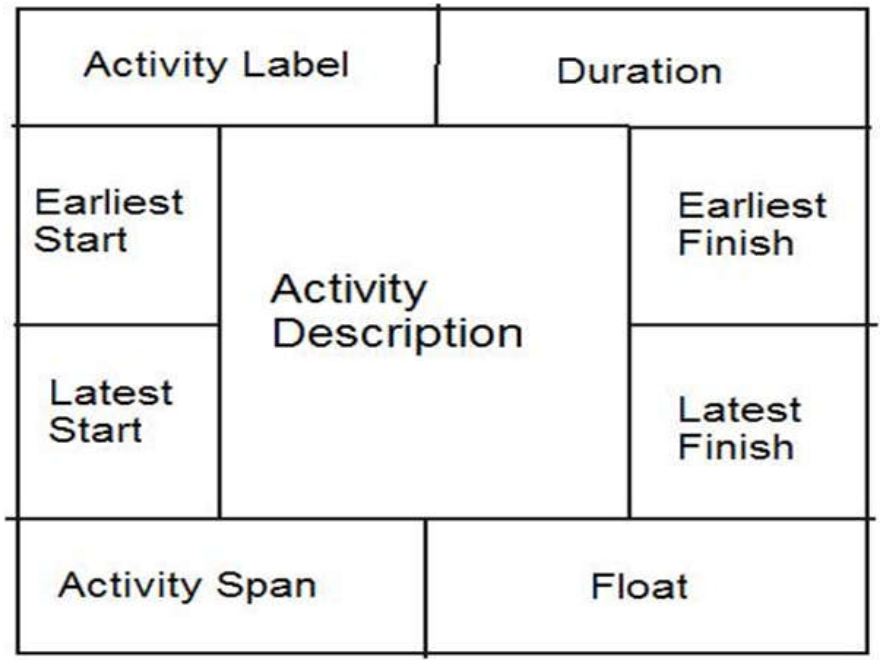
Resolving The Dangle

- The figure implies that the project is complete once the software has been installed and the user manual written
  - We should redraw the network with a final completion activity



Activity-On-Node Networks
Labelling Convention

- There are a number of differing conventions that have been adopted
  - Example



Activity-On-Node Networks
Adding The Time Dimension

- The critical path approach
  - Planning the project in such way that it is completed as quickly as possible
  - Identifying delayed activities
- The method requires the estimation of duration of each activity
  - **Forward pass:** calculate the earliest dates at which activities may commence and the project completed
  - **Backward pass:** calculate the latest start dates for activities and the critical path

Activity-On-Node Networks

Adding The Time Dimension

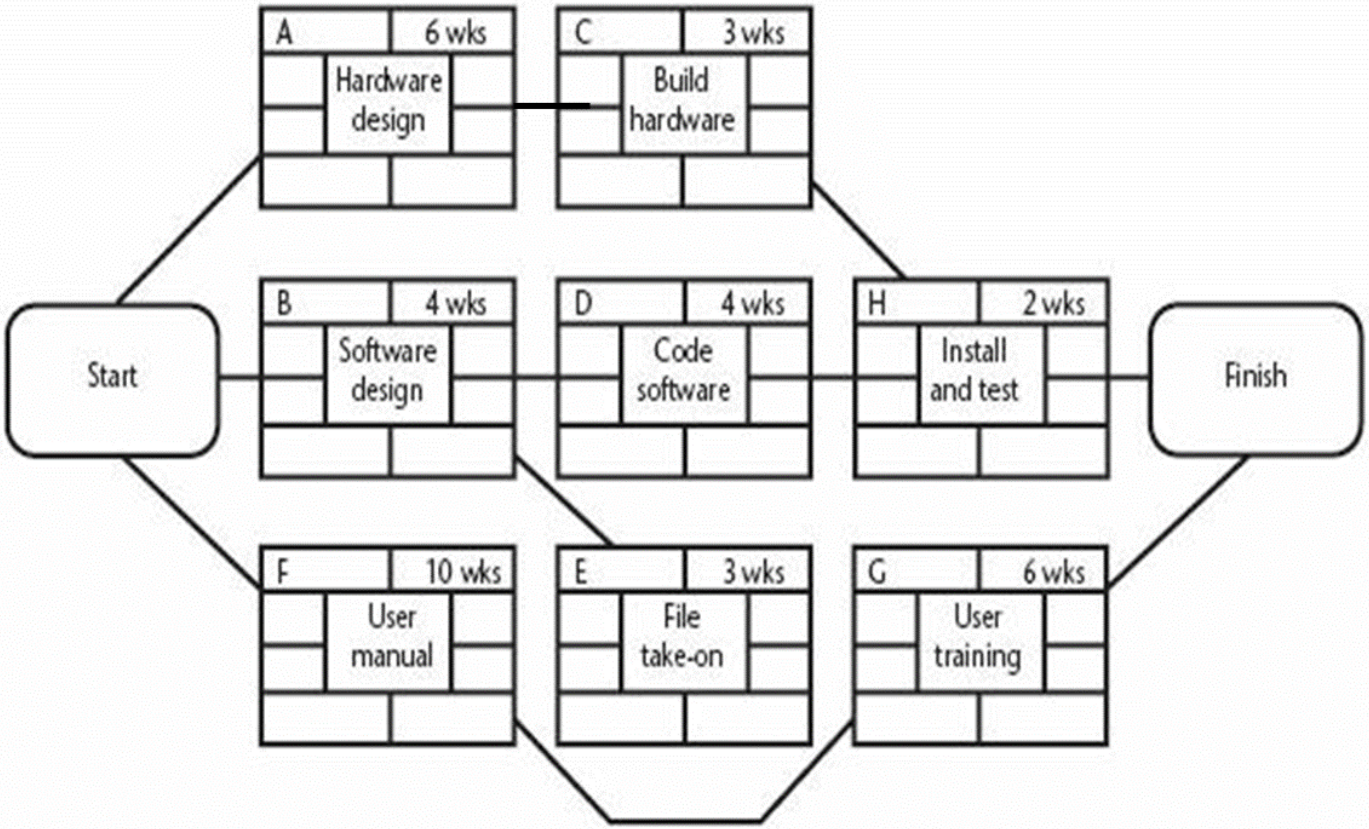
- Example of Estimated Activity Duration of A Project

Activity		*Duration (weeks)*	*Precedents*
A	Hardware selection	6	
B	Software design	4	
C	Install hardware	3	A
D	Code & test software	4	B
E	File take-on	3	B
F	Write user manuals	10	
G	User training	3	E, F
H	Install & test system	2	C,D

Activity-On-Node Networks

Adding The Time Dimension

- The Precedence Network of The Example Project



Activity-On-Node Networks

THE FORWARD PASS

The Calculation of Earliest Start Date [1/4]

- Activities A, B and F may start immediately
  - The earliest date for their start is zero
- Activity A will take 6 weeks
  - The earliest it can finish is week 6
- Activity F will take 10 weeks
  - The earliest it can finish is week 10

Activity-On-Node Networks

THE FORWARD PASS

The Calculation of Earliest Start Date [2/4]

- Activity C can start as soon as A has finished
  - Its earliest start date is week 6
  - It will take 3 weeks, so the earliest it can finish is week 9
- Activities D and E can start as soon as B is complete
  - The earliest they can each start is week 4
  - Activity D will take 4 weeks, so the earliest it can finish is week 8
  - Activity E will take 3 weeks, so the earliest it can finish is week 7

Activity-On-Node Networks

THE FORWARD PASS

The Calculation of Earliest Start Date [3/4]

- Activity G cannot start until both E and F have been completed
  - It cannot start until week 10 - the later of weeks 7 (activity E) and 10 (for activity F)
  - It takes 3 weeks and finishes in week 13
- Similarly, activity H cannot start until week 9 – the later of the two earliest finished dates for the preceding activities C and D

Activity-On-Node Networks

THE FORWARD PASS

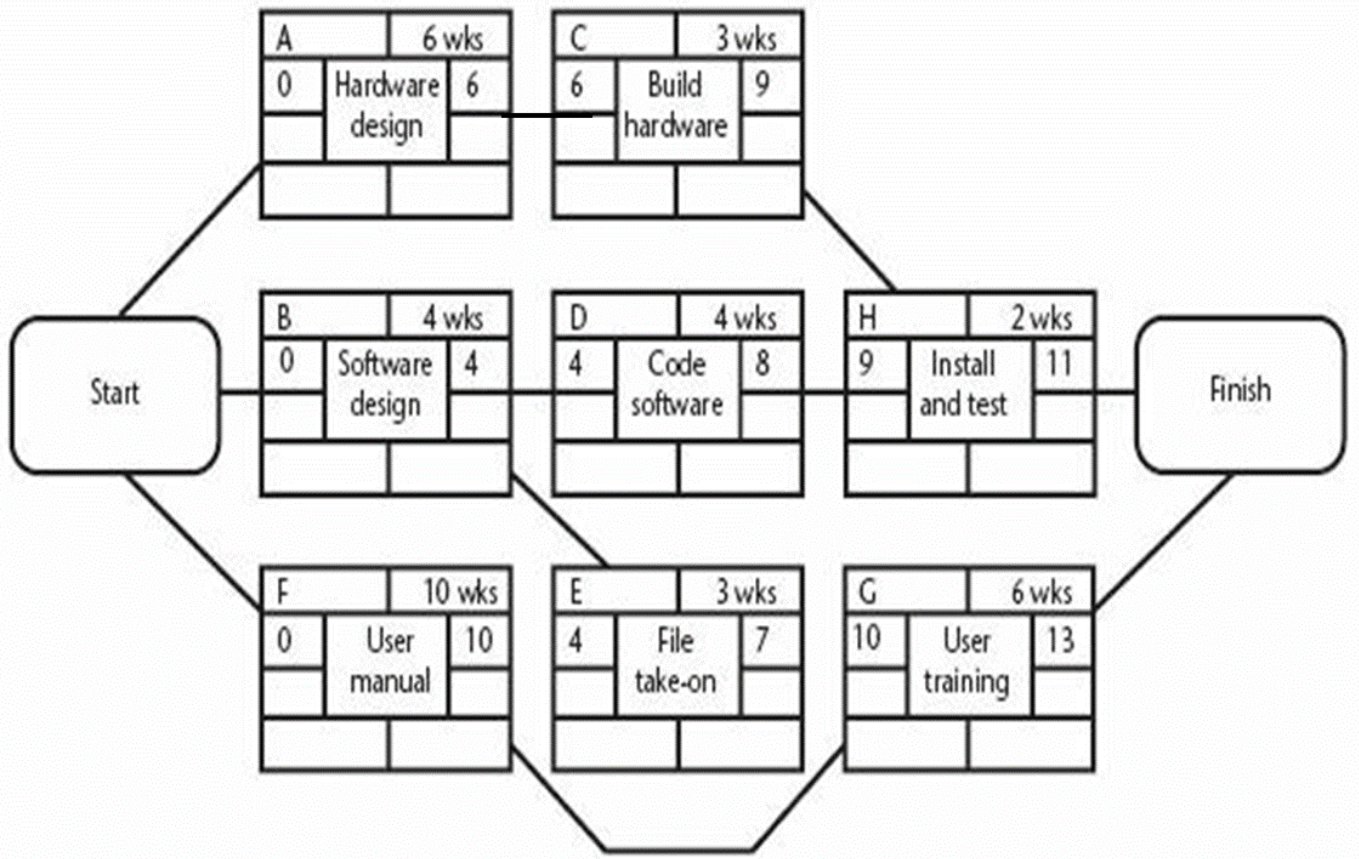
The Calculation of Earliest Start Date [4/4]

- The project will be complete when both activities H and G have been completed
  - The earliest project completion date will the later of weeks 11 and 13 – that is, week 13

Activity-On-Node Networks

THE FORWARD PASS

The Network After The Forward Pass



Activity-On-Node Networks

THE BACKWARD PASS

The Latest Activity Dates Calculation [1/3]

- The latest completion date for activities G and H is assumed to be week 13
- Activity H must therefore start at week 11 at the latest (13-2) and the latest start date for activity G is week 10 (13-3)
- The latest completion date for activities C and D is the latest date at which activity H must start – that is week 11
  - The latest start date of week 8 (11-3), and week 7 (10-3) respectively

Activity-On-Node Networks

THE BACKWARD PASS

The Latest Activity Dates Calculation [2/3]

- Activities E and F must be completed by week 10
  - The earliest start dates are weeks 7 (10-3) and 0 (10-10) respectively.
- Activity B must be completed by week 7 (the latest start date for both activities D and E)
  - The latest start is week 3 (7-4)

Activity-On-Node Networks

THE BACKWARD PASS

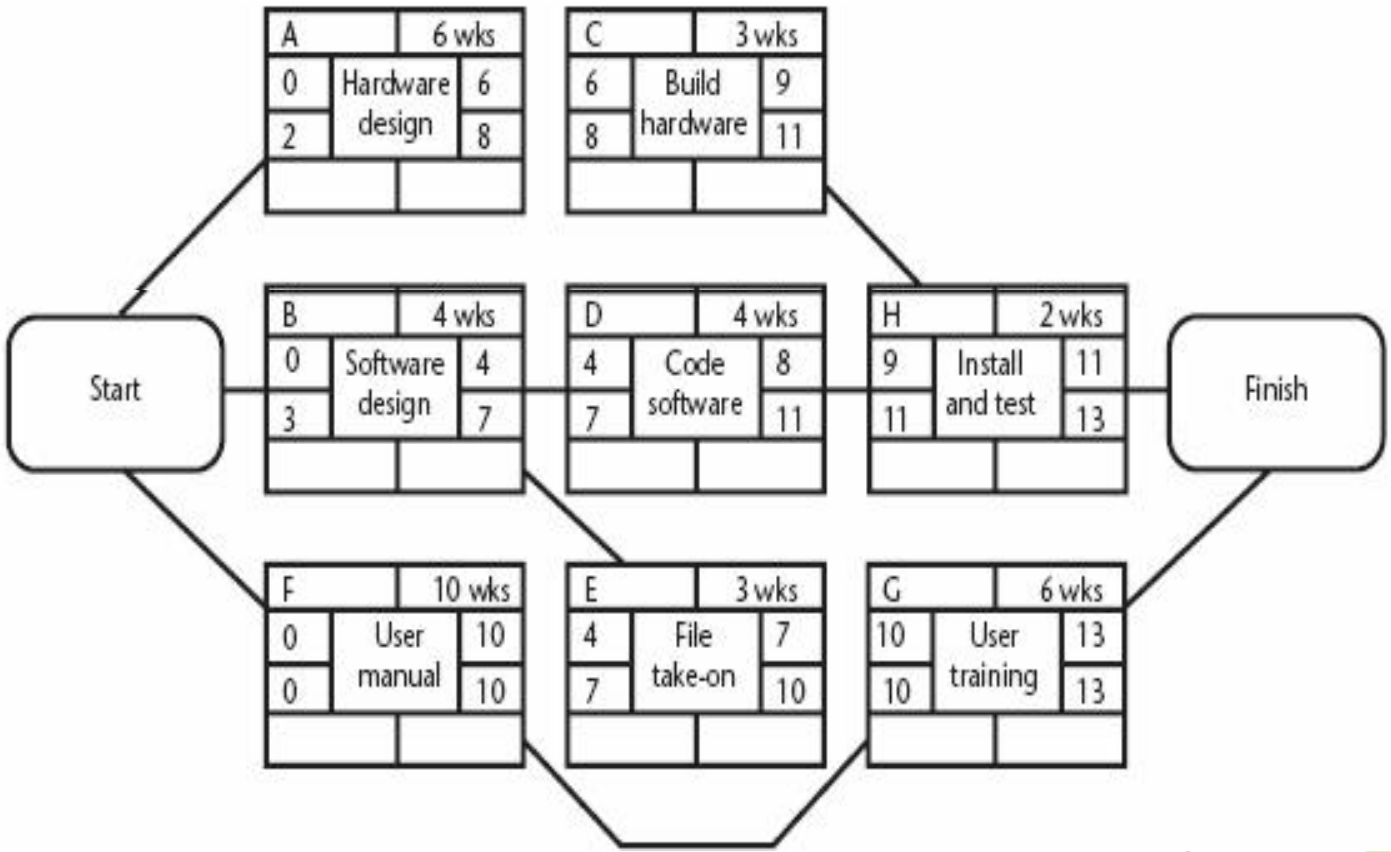
The Latest Activity Dates Calculation [3/3]

- Activity A must be completed by week 8 (the latest start date for activity C)
  - Its latest start is week 2 (8-6)
- The latest start date for the project start is the earliest of the latest start dates for activities A, B and F
  - This week is week zero
  - It tells us that if the project does not start on time it won't finish on time.

Activity-On-Node Networks

THE BACKWARD PASS

The Network After The Backward Pass



Activity-On-Node Networks

Identifying The Critical Path

The Critical Path [1/3]

- **Critical path:** One path through the network that defines the duration of the project
- Any delay to any activity of this critical path will delay the completion of the project

Activity-On-Node Networks

Identifying The Critical Path

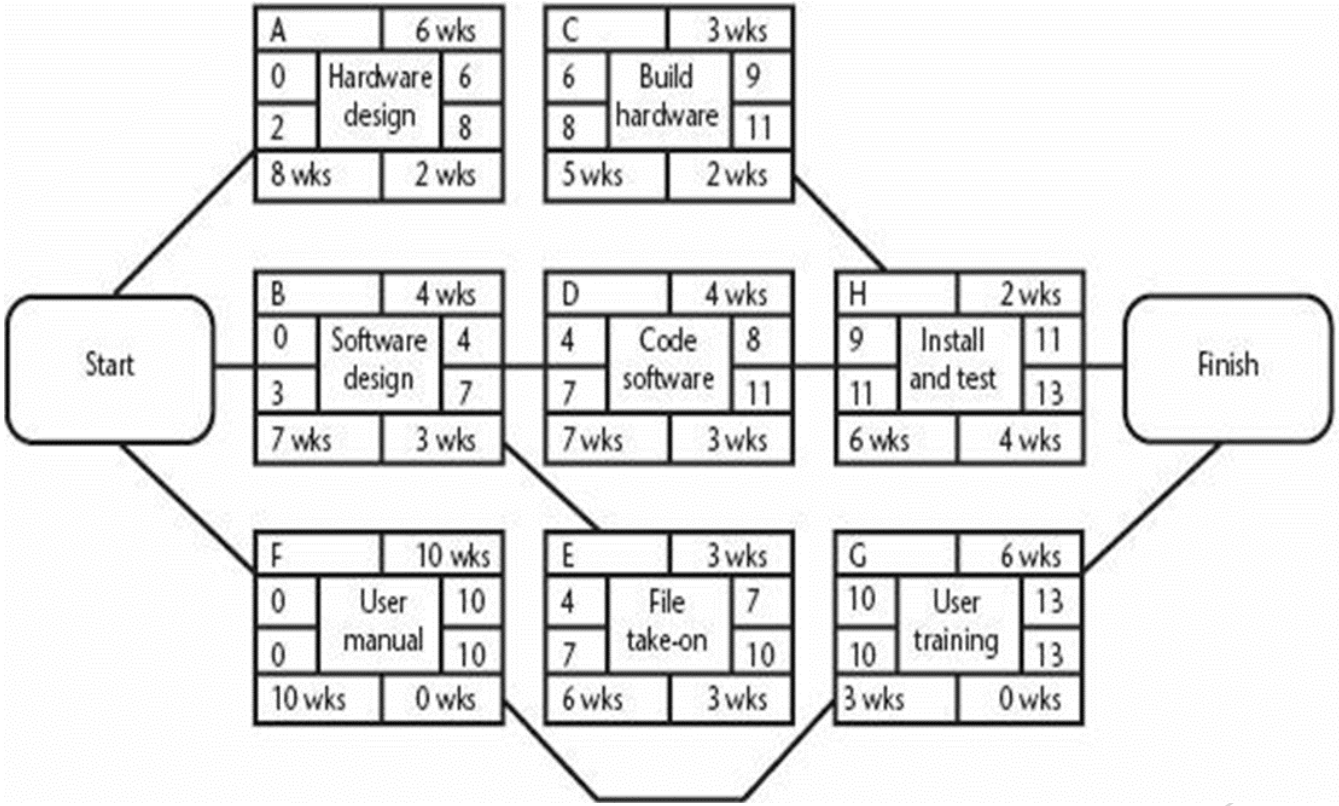
The Critical Path [2/3]

- **Activity's float**: the difference between an activity's earliest start date and its latest start date (or, equally, the difference between its earliest and latest finish dates)
  - A measure of how much the start date or completion of an activity may be delayed without affecting the end date of the project
- **Activity span**: the difference between the earliest start date and the latest finish date
  - Measure of maximum time allowable for the activity

Activity-On-Node Networks

Identifying The Critical Path

The Critical Path [3/3]



Activity-On-Node Networks

Identifying The Critical Path

The Significance of The Critical Path

- In managing the project, we must pay particular attention to monitoring activities on the critical path
  - The effects on any delay or resources unavailability are detected and corrected at the earliest opportunity
- In planning project, it is the critical path that we must shorten if we are to reduce the overall duration of the project

Activity-On-Node Networks

Activity Float

Other Measures of Activity Float

- **Free float:** the time by which an activity may be delayed without affecting subsequent activity
  - The difference between the earliest completion for the activity and the earliest date of the succeeding activity
- **Interfering float:** the difference between total float and free float
  - Tells us how much the activity may be delayed without delaying project end date

Activity-On-Node Networks
Shortening The Project Duration

- Reduce activity duration
  - Applying more resources to the task
    - Working overtime
    - Procuring additional staff
- The critical path indicates where we must look to save time
  - From previous example, we can complete the project in week 12 by reducing the duration of activity F by one week