PROJECT TIME MANAGEMENT

Project Time Management

- Project Time Management includes the processes required to manage the timely completion of the project.

Project Time Management processes

- **Plan Schedule Management**—The process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.
- **Define Activities**—The process of identifying and documenting the specific actions to be performed to produce the project deliverables.
- **Sequence Activities**—The process of identifying and documenting relationships among the project activities.

Project Time Management processes

- **Estimate Activity Resources**—The process of estimating the type and quantities of material, human resources, equipment, or supplies required to perform each activity.
- **Estimate Activity Durations**—The process of estimating the number of work periods needed to complete individual activities with estimated resources.
- **Develop Schedule**—The process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model.
- **Control Schedule**—The process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan.

Plan Schedule Management

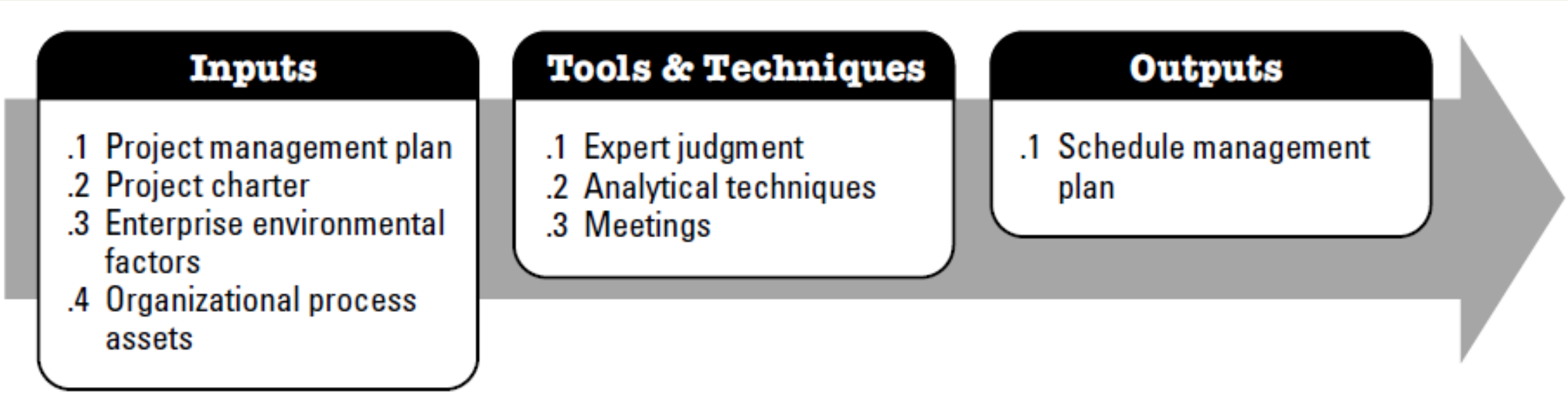


Figure 6-3. Plan Schedule Management: Inputs, Tools & Techniques, and Outputs

Plan Schedule Management: Inputs

- **Project Management Plan**: Scope baseline and Other information
- **Project Charter**
- **Enterprise Environmental Factors:** Organizational culture and structure, Resource availability and skills, Project management software, etc.
- **Organizational Process Assets:** Monitoring and reporting tools, Historical information; Historical information, Schedule control tools, templates, Change control procedures, Risk control procedures, etc.

Plan Schedule Management: Tools and Techniques

- Expert Judgment
- **Analytical Techniques:** rolling wave planning, leads and lags, alternatives analysis, and methods for reviewing schedule performance
- Meetings

Plan Schedule Management: Outputs

- **Schedule Management Plan**
  - *A component of the project management plan that establishes the criteria and the activities for developing, monitoring, and controlling the schedule.*
  - *It may be formal or informal, highly detailed or broadly framed, based upon the needs of the project, and includes appropriate control thresholds.*
  - *It can* establish the Project schedule model development, Level of accuracy, Units of measure, Control thresholds, Rules of performance measurement, Reporting formats, etc.

Schedule Management Plan

- It is a component of the project management plan
- It may be formal or informal, highly detailed or broadly framed, based upon the needs of the project, and includes appropriate control thresholds.
- It defines how schedule contingencies will be reported and assessed.
- It may be updated to reflect a change in the way the schedule is managed.
- It is a major input into the Develop Project Management Plan process

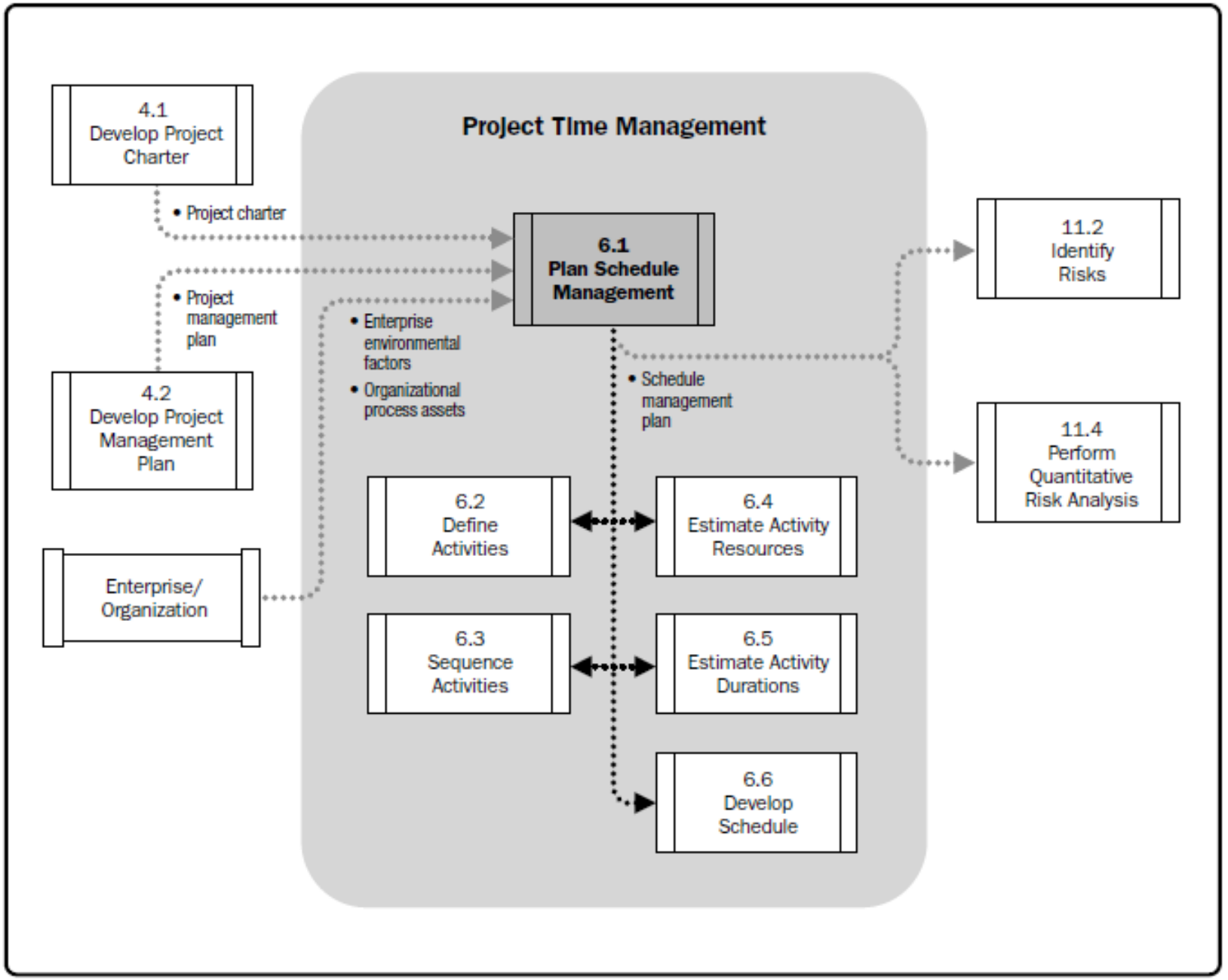


Figure 6-4. Plan Schedule Management Data Flow Diagram

Define Activities

- Define Activities is the process of identifying and documenting the specific actions to be performed to produce the project deliverables.
- An activity or task is an element of work normally found on the WBS that has an expected duration, a cost, and resource requirements.
- Activity definition involves developing a more detailed WBS and supporting explanations to understand all the work to be done, so you can develop realistic cost and duration estimates.
- The key benefit of this process is to break down work packages into activities that provide a basis for estimating, scheduling, executing, monitoring, and controlling the project work.

Define Activities

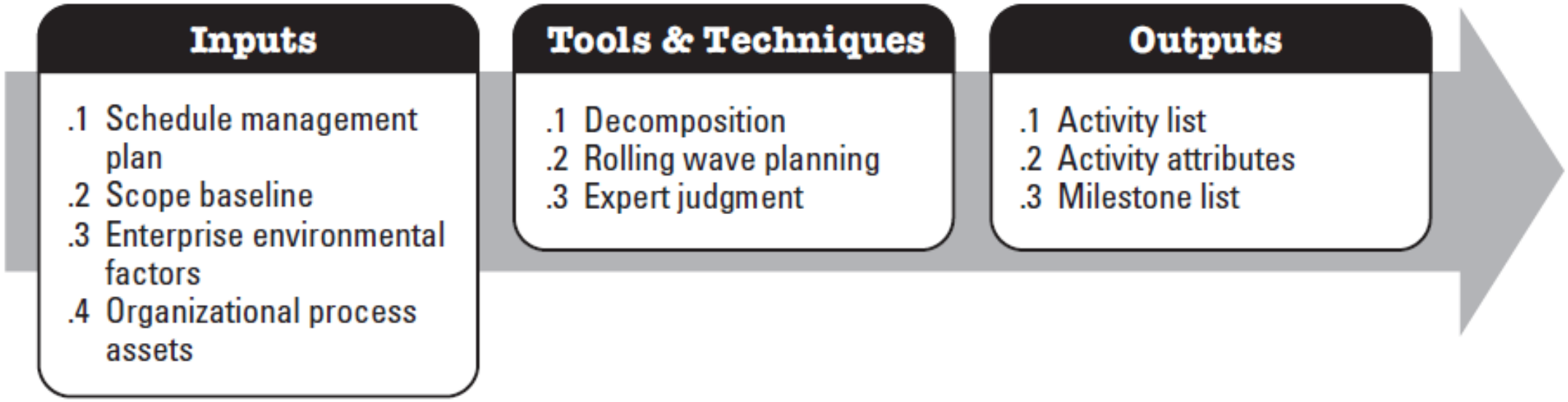


Figure 6-5. Define Activities: Inputs, Tools & Techniques, and Outputs

Define Activities: Inputs

- **Schedule Management Plan**
- **Scope Baseline**
- **Enterprise Environmental Factors:** Organizational cultures and structure, published commercial information from commercial databases, and project management information system (PMIS), etc.
- **Organizational Process Assets:** Lessons learned knowledge base, Standardized processes, Templates that contain a standard activity list, existing formal and informal activity planning-related policies, procedures, and guidelines, etc.

Define Activities: Tools and Techniques

- **Decomposition:** used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts
- **Rolling Wave Planning:** Rolling wave planning is an iterative planning technique in which the work to be accomplished in the near term is planned in detail, while the work in the future is planned at a higher level.
- **Expert Judgment**

Define Activities: Outputs

- **Activity List:** a comprehensive list that includes all schedule activities required on the project.
- **Activity Attributes:** Activity attributes provide more information about each activity, such as predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity.
- **Milestone List:** A milestone is a significant point or event in a project.

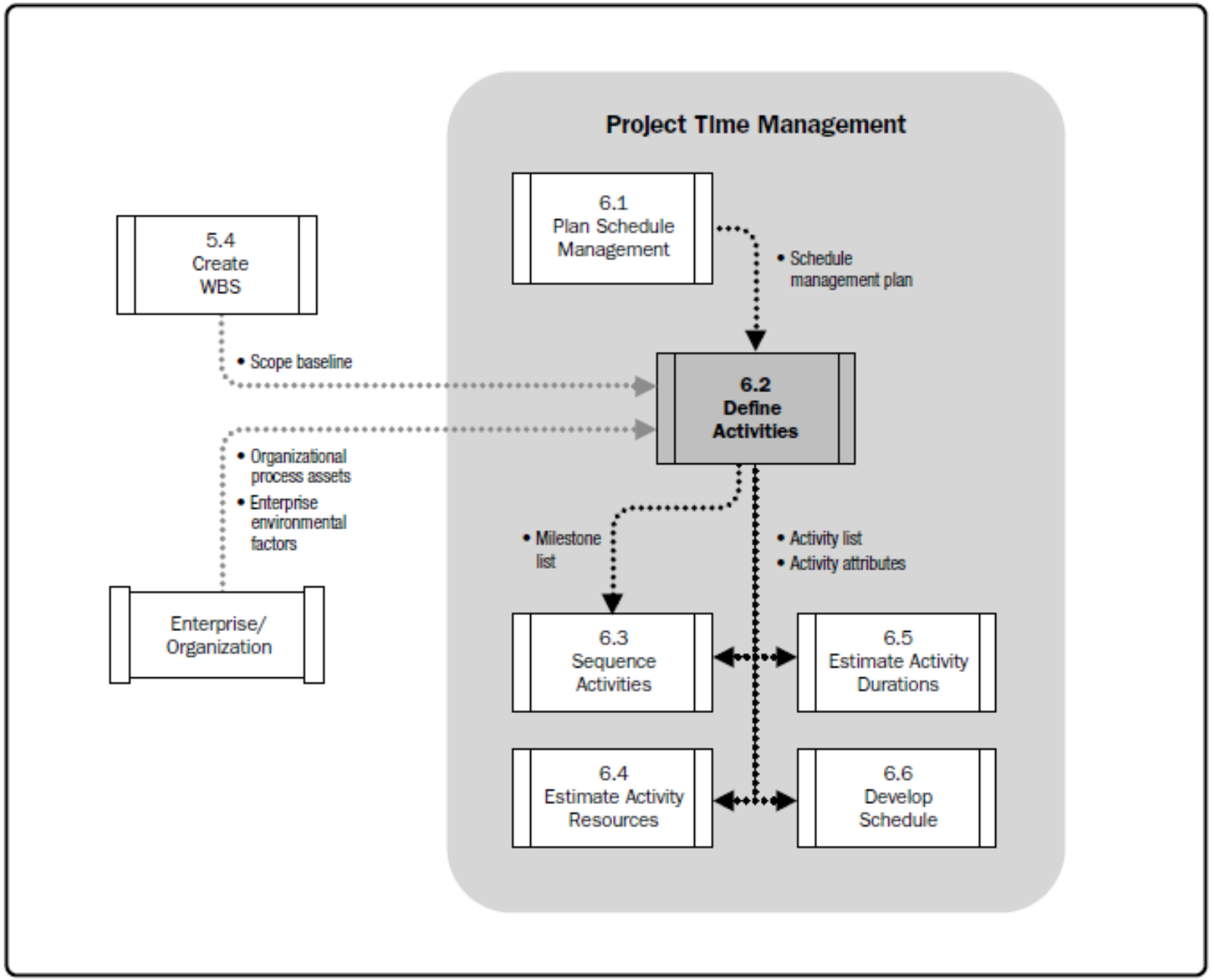


Figure 6-6. Define Activities Data Flow Diagram

Sequence Activities

- Sequence Activities is the process of identifying and documenting relationships among the project activities.
- The key benefit of this process is that it defines the logical sequence of work to obtain the greatest efficiency given all project constraints.

Sequence Activities

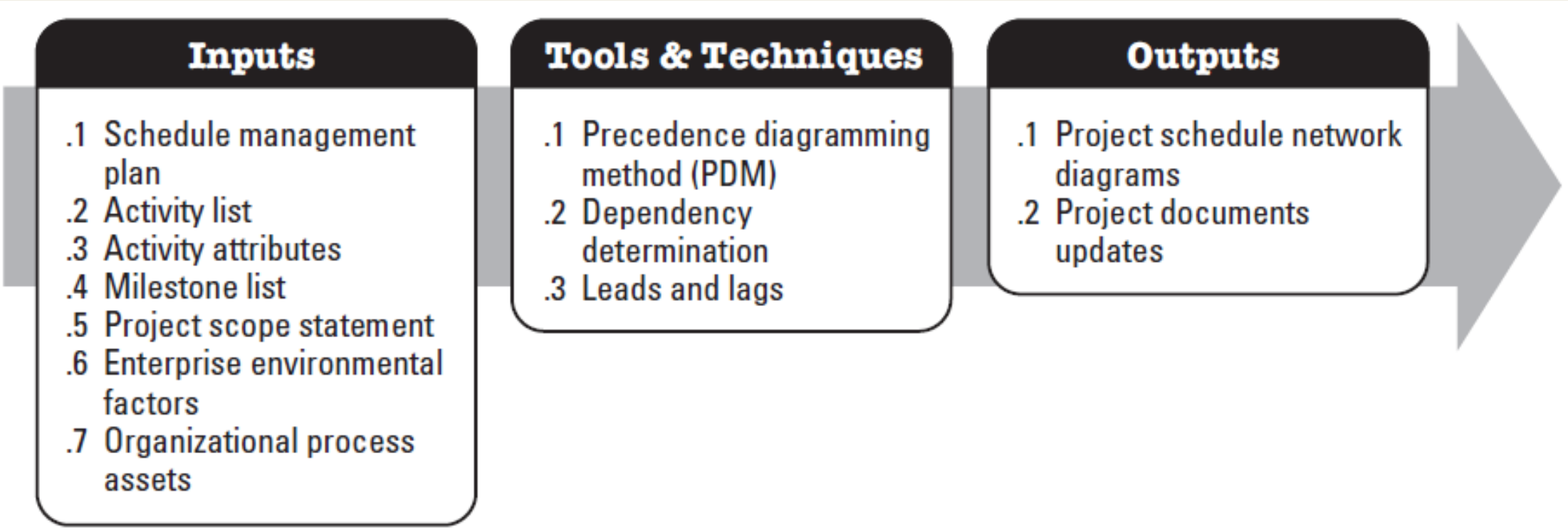


Figure 6-7. Sequence Activities: Inputs, Tools & Techniques, and Outputs

Sequence Activities: Inputs

- **Schedule Management Plan**-identifies the scheduling method and tool to be used for the project, which will guide how the activities may be sequenced.
- **Activity List**-contains all schedule activities required on the project, which are to be sequenced. Dependencies and other constraints for these activities can influence the sequencing of the activities.
- **Activity Attributes**-may describe a necessary sequence of events or defined predecessor or successor relationships.
- **Milestone List**-may have scheduled dates for specific milestones, which may influence the way activities are sequenced.

Sequence Activities: Inputs

- **Project Scope Statement**-contains the product scope description, which includes product characteristics, project deliverables, project constraints, and project assumptions that may affect activity sequencing.
- **Enterprise Environmental Factors:** Government or industry standards, Project management information system (PMIS), Scheduling tool, Company work authorization systems, etc.
- **Organizational Process Assets**- project files from the corporate knowledge base, existing formal and informal activity planning-related policies, procedures, and guidelines, etc.

Sequence Activities: Tools and Techniques- Precedence Diagramming Method (PDM)

- PDM is a technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed.
- PDM includes four types of dependencies or logical relationships.
  - *A predecessor activity is an activity that logically comes before a dependent activity in a schedule.*
  - *A successor activity is a dependent activity that logically comes after another activity in a schedule.*

Dependencies or Logical Relationships

- **Finish-to-start (FS).** A logical relationship in which a successor activity cannot start until a predecessor activity has finished.
  - *Example: The awards ceremony (successor) cannot start until the race (predecessor) has finished.*
- **Finish-to-finish (FF).** A logical relationship in which a successor activity cannot finish until a predecessor activity has finished.
  - *Example: Writing a document (predecessor) is required to finish before editing the document (successor) can finish.*
- **Start-to-start (SS).** A logical relationship in which a successor activity cannot start until a predecessor activity has started.
  - *Example: Level concrete (successor) cannot begin until pour foundation (predecessor) begins.*
- **Start-to-finish (SF).** A logical relationship in which a successor activity cannot finish until a predecessor activity has started.
  - *Example: The first security guard shift (successor) cannot finish until the second security guard shift (predecessor) starts.*

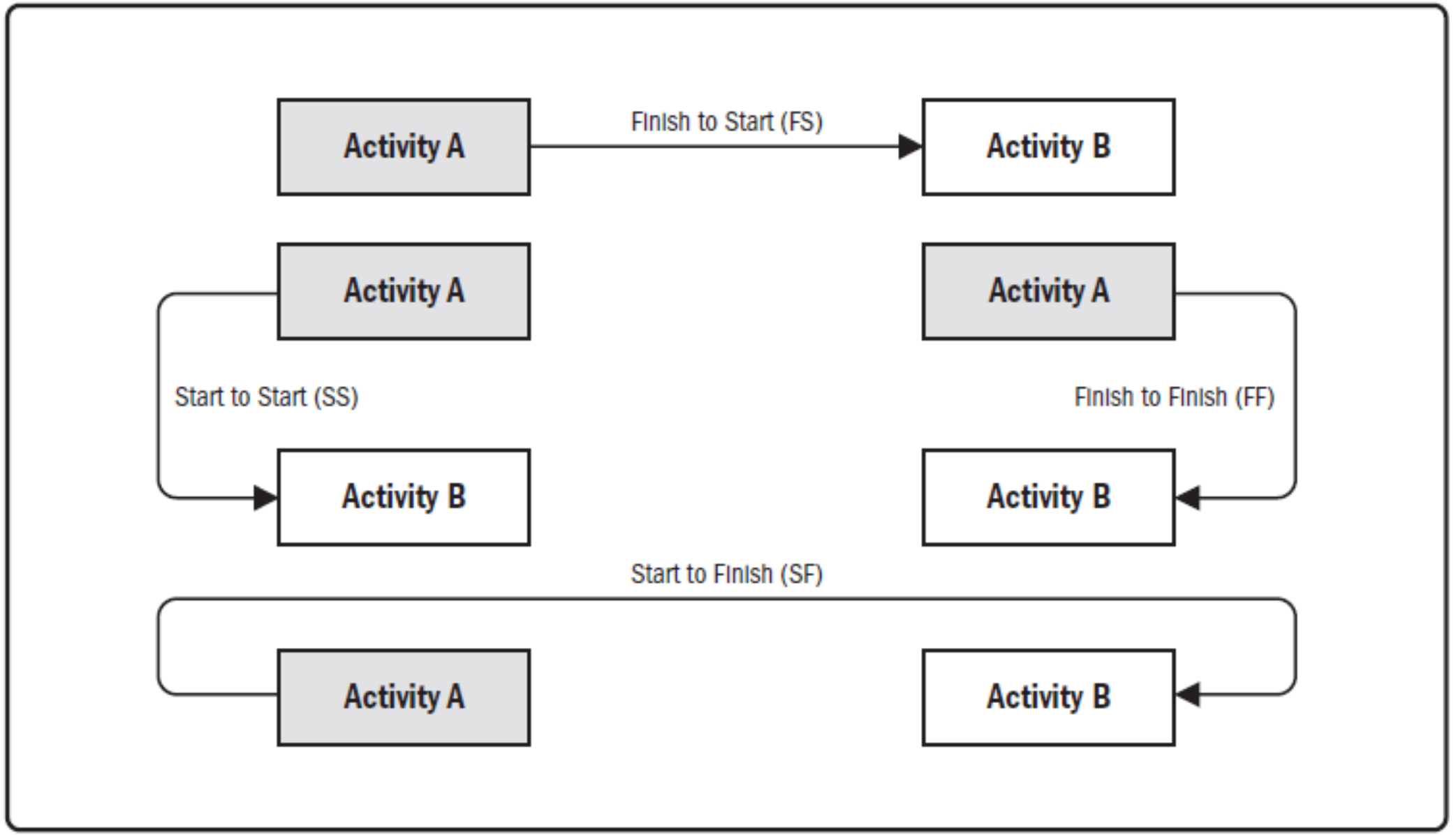


Figure 6-9. Precedence Diagramming Method (PDM) Relationship Types

Sequence Activities: Tools and Techniques- Dependency Determination

- Dependencies may be characterized by the following attributes: mandatory or discretionary, internal or external
  - *Dependency has four attributes, but two can be applicable at the same time in following ways: mandatory external dependencies, mandatory internal dependencies, discretionary external dependencies, or discretionary internal dependencies.*

Sequence Activities: Tools and Techniques-Leads and Lags

- A lead is the amount of time whereby a successor activity can be advanced with respect to a predecessor activity.
  - *For example, on a project to construct a new office building, the landscaping could be scheduled to start two weeks prior to the scheduled punch list completion.*
- A lag is the amount of time whereby a successor activity will be delayed with respect to a predecessor activity.
  - *For example, a technical writing team may begin editing the draft of a large document 15 days after they begin writing it.*

Sequence Activities: Tools and Techniques-Leads and Lags

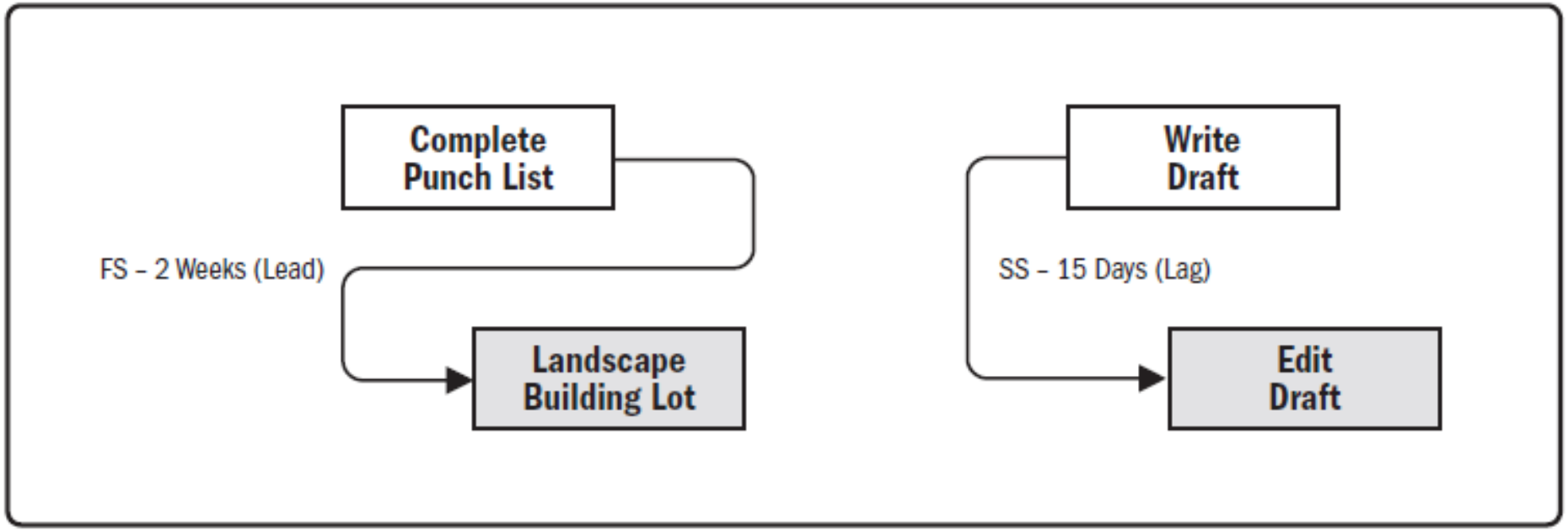


Figure 6-10. Examples of Lead and Lag

Network Diagram

- Network diagrams are the preferred technique for showing activity sequencing.
- A network diagram is a schematic display of the logical relationships among, or sequencing of, project activities.
- Two main formats are the arrow and precedence diagramming methods.

Network Diagram

- Precedence Diagramming Method (PDM)
  - *Activities are represented by boxes.*
  - *Arrows show relationships between activities.*
  - *More popular than ADM method and used by project management software.*
  - *Better at showing different types of dependencies.*
- Arrow Diagramming Method (ADM)
  - *Also called activity-on-arrow (AOA) network diagram.*
  - *Activities are represented by arrows.*
  - *Nodes or circles are the starting and ending points of activities.*
  - *Can only show finish-to-start dependencies.*

Sequence Activities: Outputs

- **Project Schedule Network Diagrams:**
  - *A project schedule network diagram is a graphical representation of the logical relationships, also referred to as dependencies, among the project schedule activities.*
  - *produced manually or by using project management software*
  - *It can include full project details, or have one or more summary activities.*
  - *A summary narrative can accompany the diagram and describe the basic approach used to sequence the activities.*
- **Project Documents Updates**- Activity lists, Activity attributes, Milestone list, Risk register, etc.

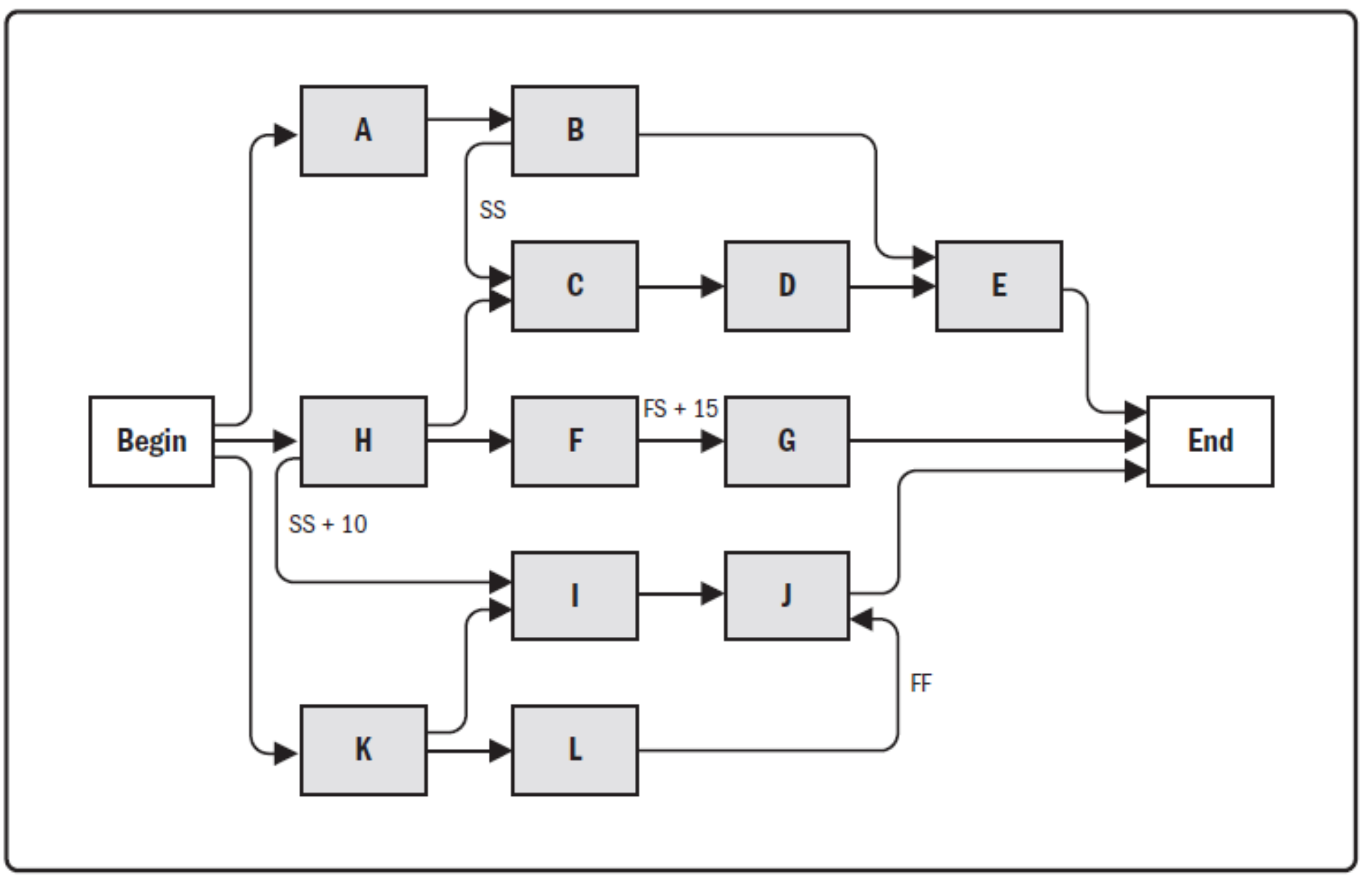


Figure 6-11. Project Schedule Network Diagram

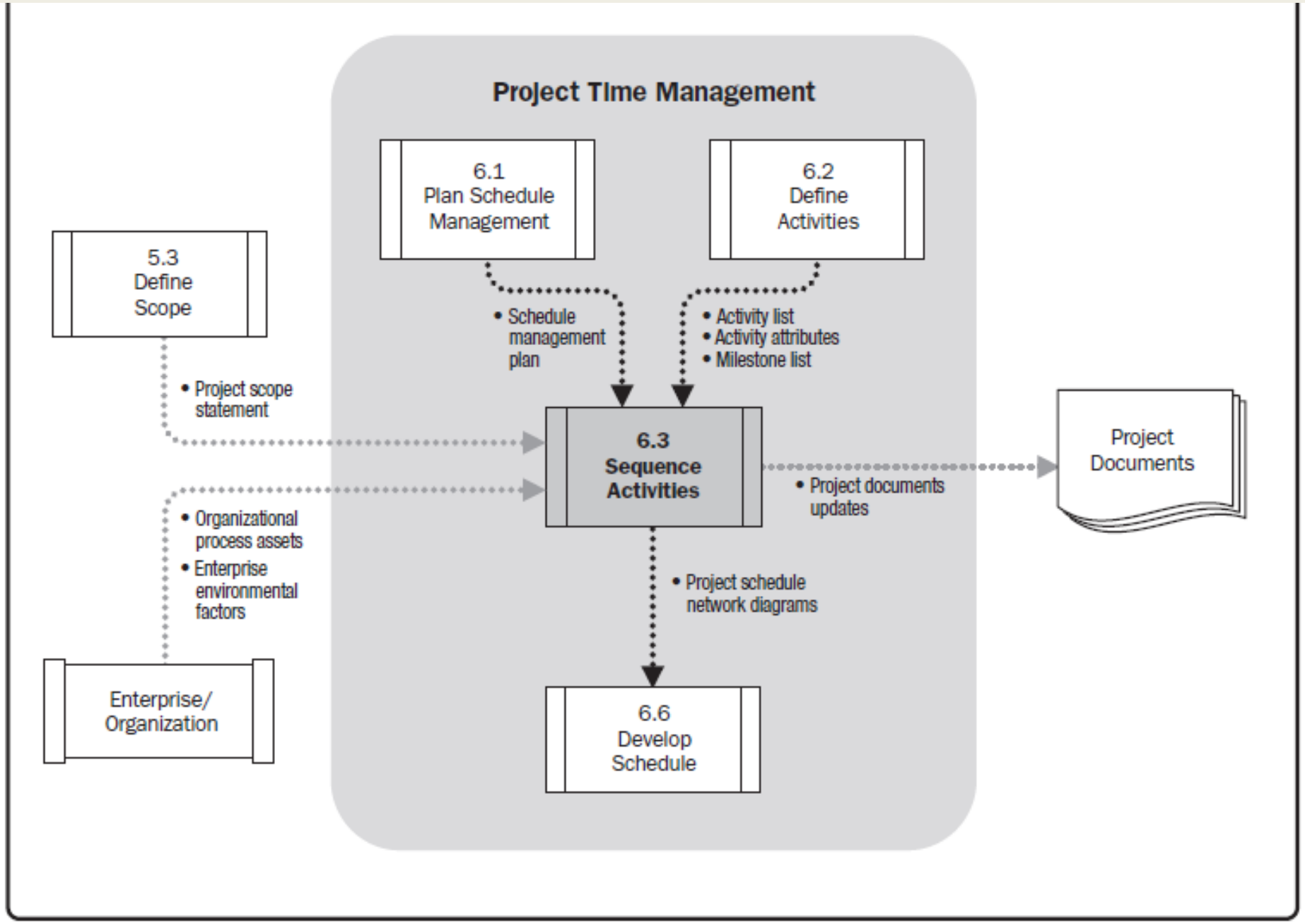


Figure 6-8. Sequence Activities Data Flow Diagram

Network Diagram & Concepts

1) Activity -

Activity represents some action that consumes both time & resources. Activity is represented by an arrow. E.g. an operation, a task, inspection, work etc. Each activity has start and end times in the project time line.

2) Event/Node -

An event represents the start and end of an activity & it itself does not consume time or resources. It is denoted by a circle. Its also called a node or state. Multiple activities can start from single event & an event is not completed until all the activities coming to it are completed.

3) Predecessor Activity -

Activity that must be completed before one or more activity starts is known as predecessor activity.

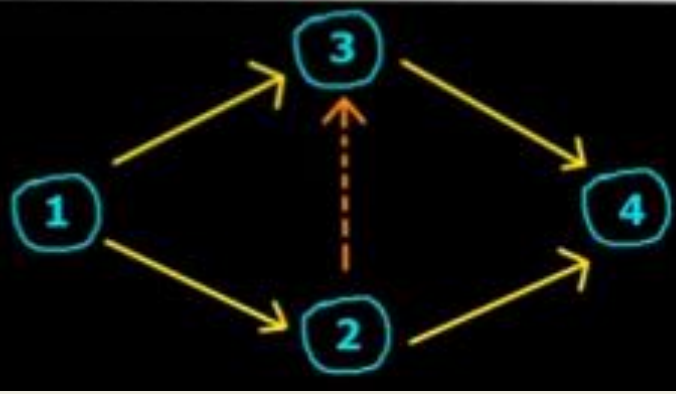
4) Successor Activity -

Activity which starts immediately after one or more activity is completed is known as successor activity.

5) Dummy Activity -

An activity that does not consume any time or resources is known as dummy activity. Its represented by dotted line. It still must follow all the rules applied to a normal activity. A dummy activity is required when -

1) 2 or more parallel activities is a project have same start and end events
   OR
2) 2 or more activities have some(not all) of their intermediate predecessor activities in common.

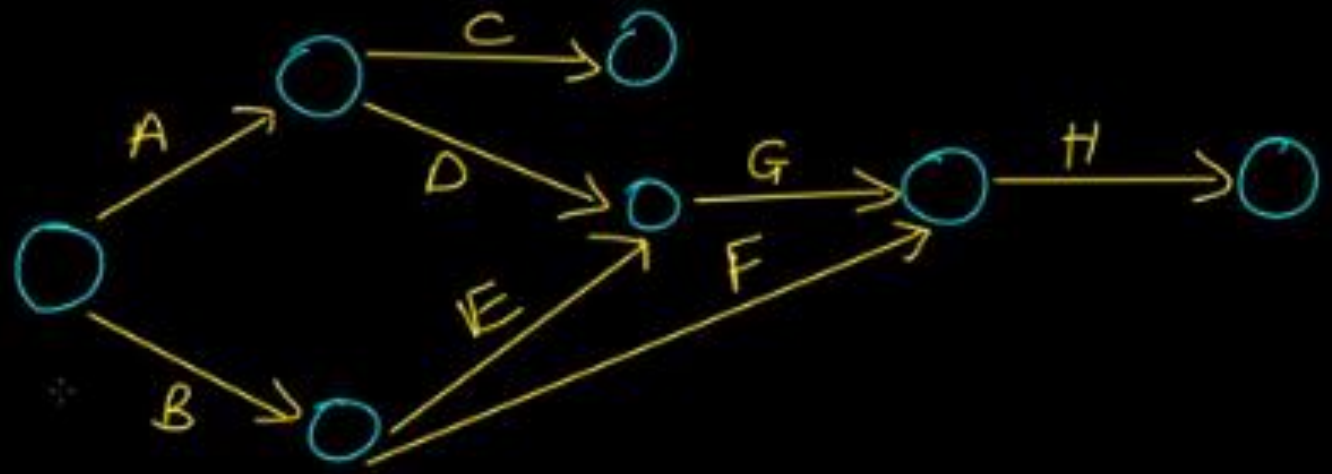


Q) Generate the Network Diagram for the following data -

Activities	Predecessors
A	--
B	--
C	A
D	A
E	B
F	B
G	D,E
H	F,G

Q) Generate the Network Diagram for the following data -

Activities	Predecessors
A	--
B	--
C	A
D	A
E	B
F	B
G	D,E
H	F,G



Estimate Activity Resources

- Before estimating activity durations, you must have a good idea of the quantity and type of resources that will be assigned to each activity.
- Consider important issues in estimating resources:
  - *How difficult will it be to complete specific activities on this project?*
  - *What is the organization's history in doing similar activities?*
  - *Are the required resources available?*
- The key benefit of this process is that it identifies the type, quantity, and characteristics of resources required to complete the activity which allows more accurate cost and duration estimates.
- Estimate Activity Resources process is closely coordinated with the Estimate Costs process

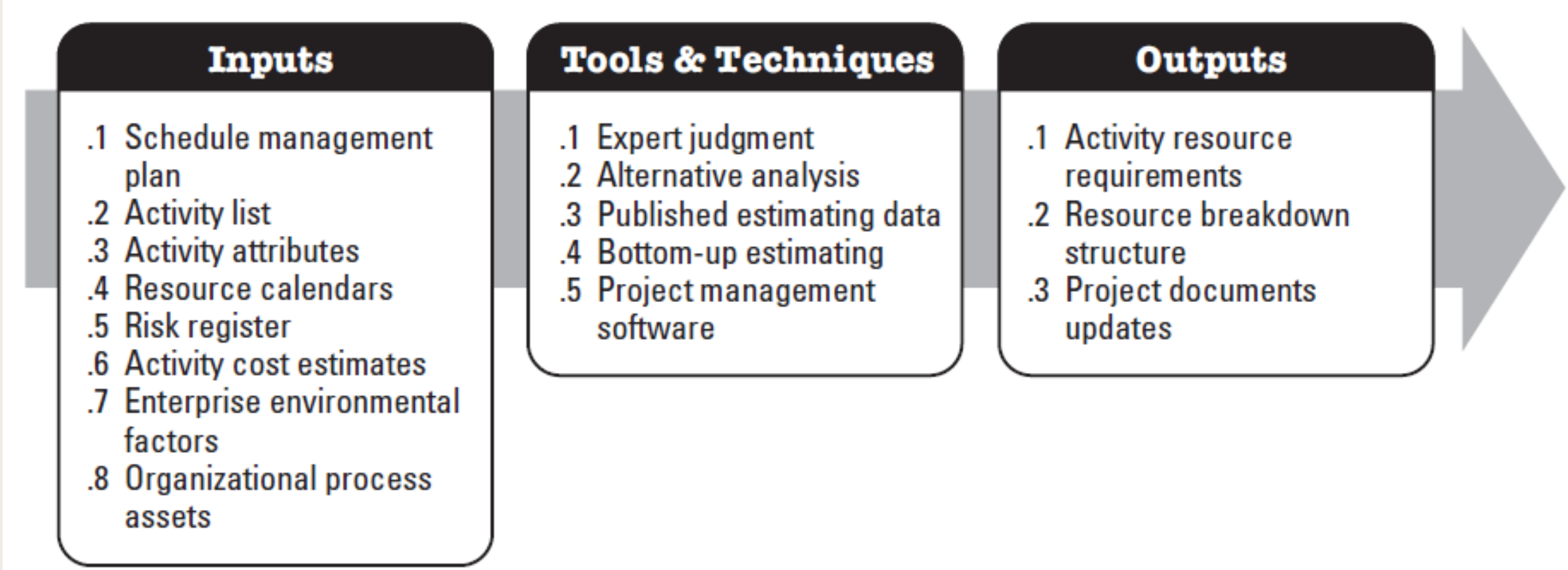


Figure 6-12. Estimate Activity Resources: Inputs, Tools & Techniques, and Outputs

Estimate Activity Resources: Inputs

- Schedule Management Plan
- Activity List
- Activity Attributes
- Resource Calendars
  - *A resource calendar is a calendar that identifies the working days and shifts on which each specific resource is available.*
  - *Resource calendars specify when and how long identified project resources will be available during the project.*
- Risk Register
- Activity Cost Estimates
- **Enterprise Environmental Factors:** resource location, availability, skills, etc.
- **Organizational Process Assets:** Policies and procedures regarding staffing, rental and purchase of supplies and equipment, and Historical information regarding types of resources used for similar work on previous projects.

Estimate Activity Resources: Tools and Techniques

- Expert Judgment
- Alternative Analysis
- Published Estimating Data
- Bottom-Up Estimating
  - *Bottom-up estimating is a method of estimating project duration or cost by aggregating the estimates of the lower-level components of the WBS*
- Project Management Software

Estimate Activity Resources: Outputs

- **Activity Resource Requirements:** Activity resource requirements identify the types and quantities of resources required for each activity in a work package.
- **Resource Breakdown Structure:** The resource breakdown structure is a hierarchical representation of resources by category and type.
- **Project Documents Updates** Project documents that may be updated include, but are not limited to: Activity list, Activity attributes, and Resource calendars.

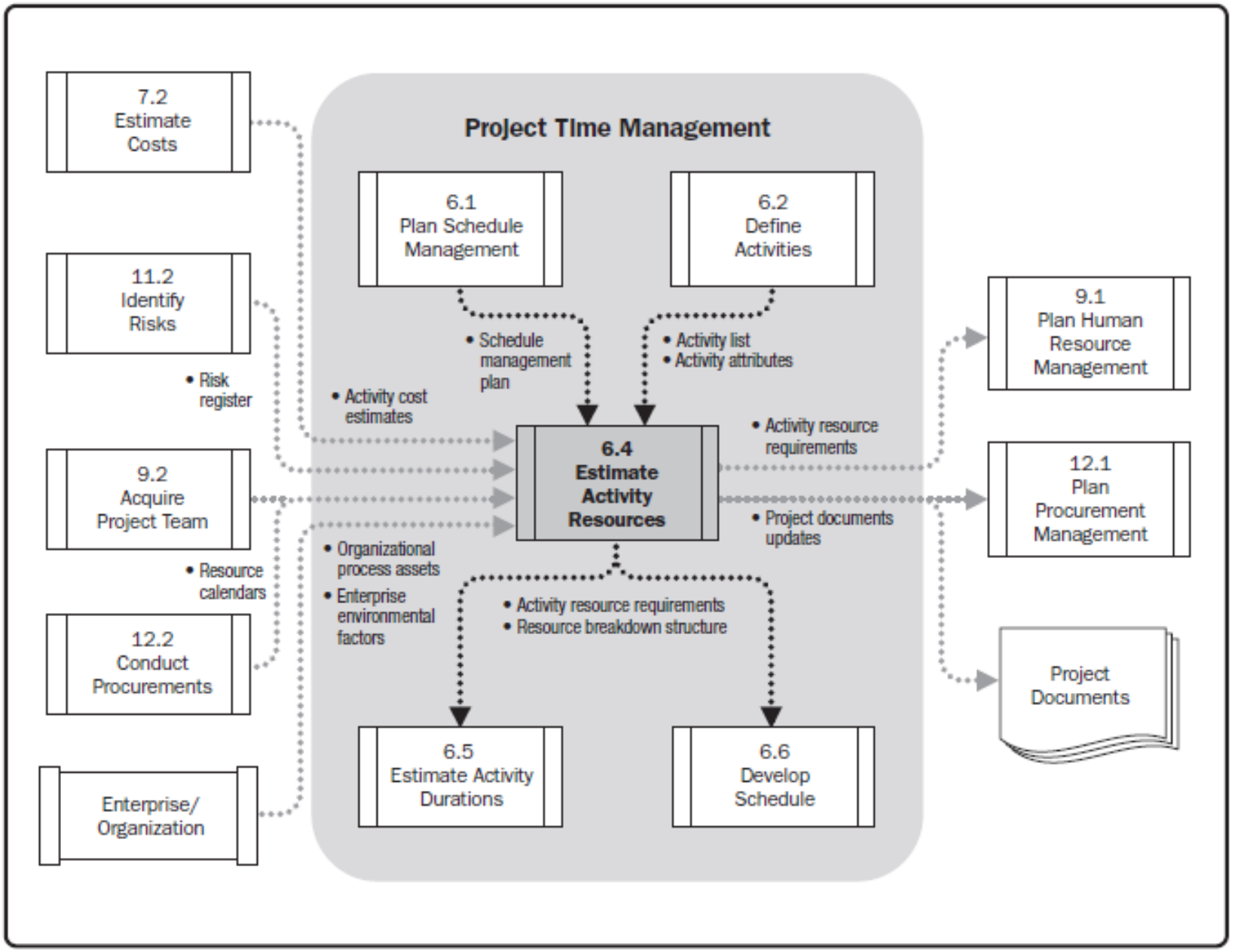


Figure 6-13. Estimate Activity Resources Data Flow Diagram

Estimate Activity Durations

- Duration includes the actual amount of time worked on an activity plus the elapsed time.
- Effort is the number of workdays or work hours required to complete a task.
- People doing the work should help create estimates, and an expert should review them.
- The key benefit of this process is that it provides the amount of time
- Each activity will take to complete, which is a major input into the Develop Schedule process.

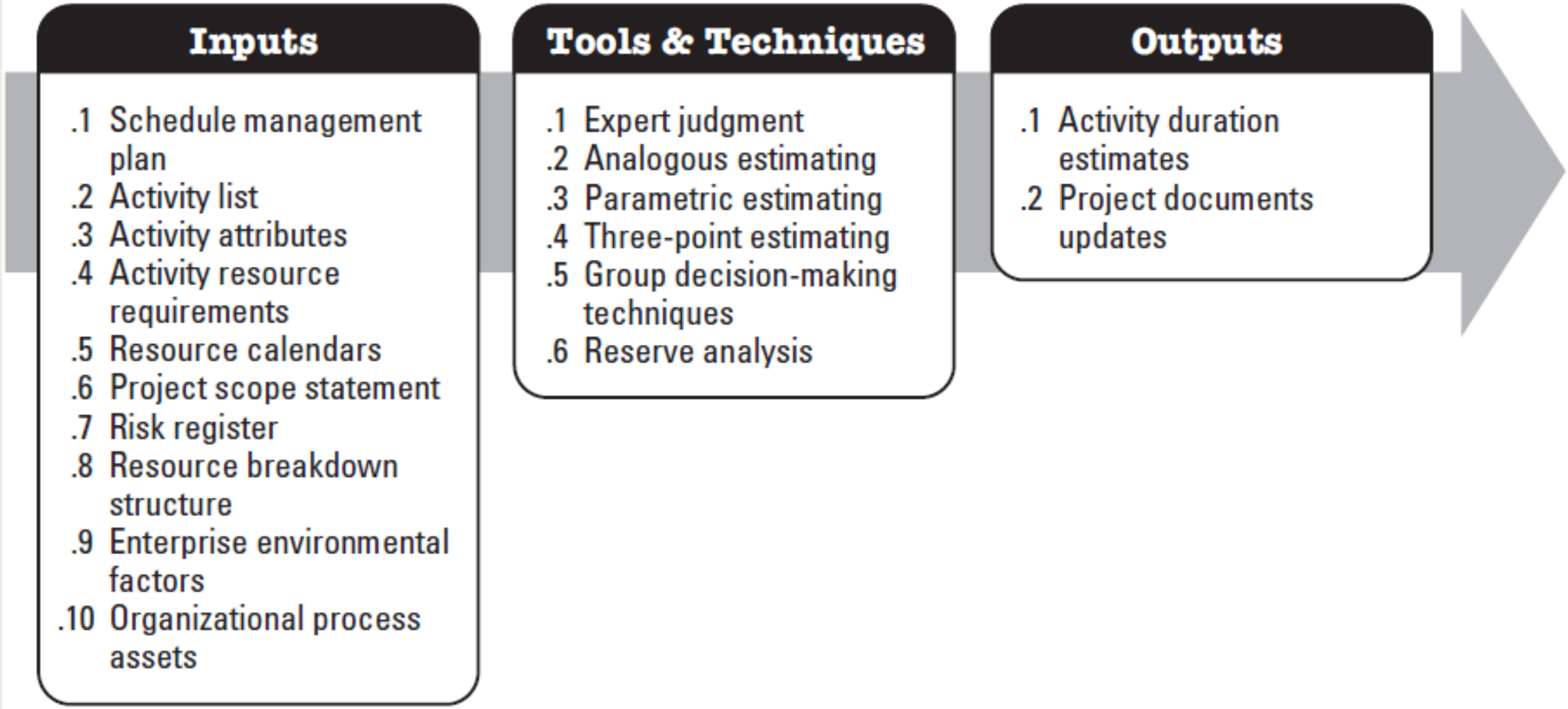


Figure 6-14. Estimate Activity Durations: Inputs, Tools & Techniques, and Outputs

Analogous Estimating

- Analogous estimating is a technique for estimating the duration or cost of an activity or a project using historical data from a similar activity or project.
- Analogous estimating uses parameters from a previous, similar project, such as duration, budget, size, weight, and complexity, as the basis for estimating the same parameter or measure for a future project.

Parametric Estimating

- an estimating technique in which an algorithm is used to calculate cost or duration based on historical data and project parameters
- uses a statistical relationship between historical data and other variables (e.g., square footage in construction) to calculate an estimate for activity parameters, such as cost, budget, and duration.
- Activity durations can be quantitatively determined by multiplying the quantity of work to be performed by labor hours per unit of work.

Three-Point Estimating

- The accuracy of single-point activity duration estimates may be improved by considering estimation uncertainty and risk.
- This concept originated with the program evaluation and review technique (PERT). PERT uses three estimates to define an approximate range for an activity's duration:
  - ***Most likely*** *(t_M). This estimate is based on the duration of the activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the activity, dependencies on other participants, and interruptions.*
  - ***Optimistic*** *(t_O). The activity duration based on analysis of the best-case scenario for the activity.*
  - ***Pessimistic*** *(t_P). The activity duration based on analysis of the worst-case scenario for the activity.*
    - such as three weeks for the optimistic, four weeks for the most likely, and five weeks for the pessimistic estimate.

Three-Point Estimating

- Depending on the assumed distribution of values within the range of the three estimates the expected duration, t_E, can be calculated using a formula.
- Two commonly used formulas are triangular and beta distributions. The formulas are:
  - ***Triangular Distribution.*** $t_E = (t_O + t_M + t_P) / 3$
  - ***Beta Distribution*** *(from the traditional PERT technique).* $t_E = (t_O + 4t_M + t_P) / 6$

Reserve Time

- A reserve time is a percentage of the project duration or a preset number of work periods and is usually added to the end of the project schedule.
- Reserve time may also be added to individual activity durations based on risk or uncertainty in the activity duration. When activities are completed late, the additional time for the activity is subtracted from the reserve time.
- As the project moves forward, the reserve time can be reduced or eliminated as the project manager sees fit.
- Reserve time decisions should be documented.

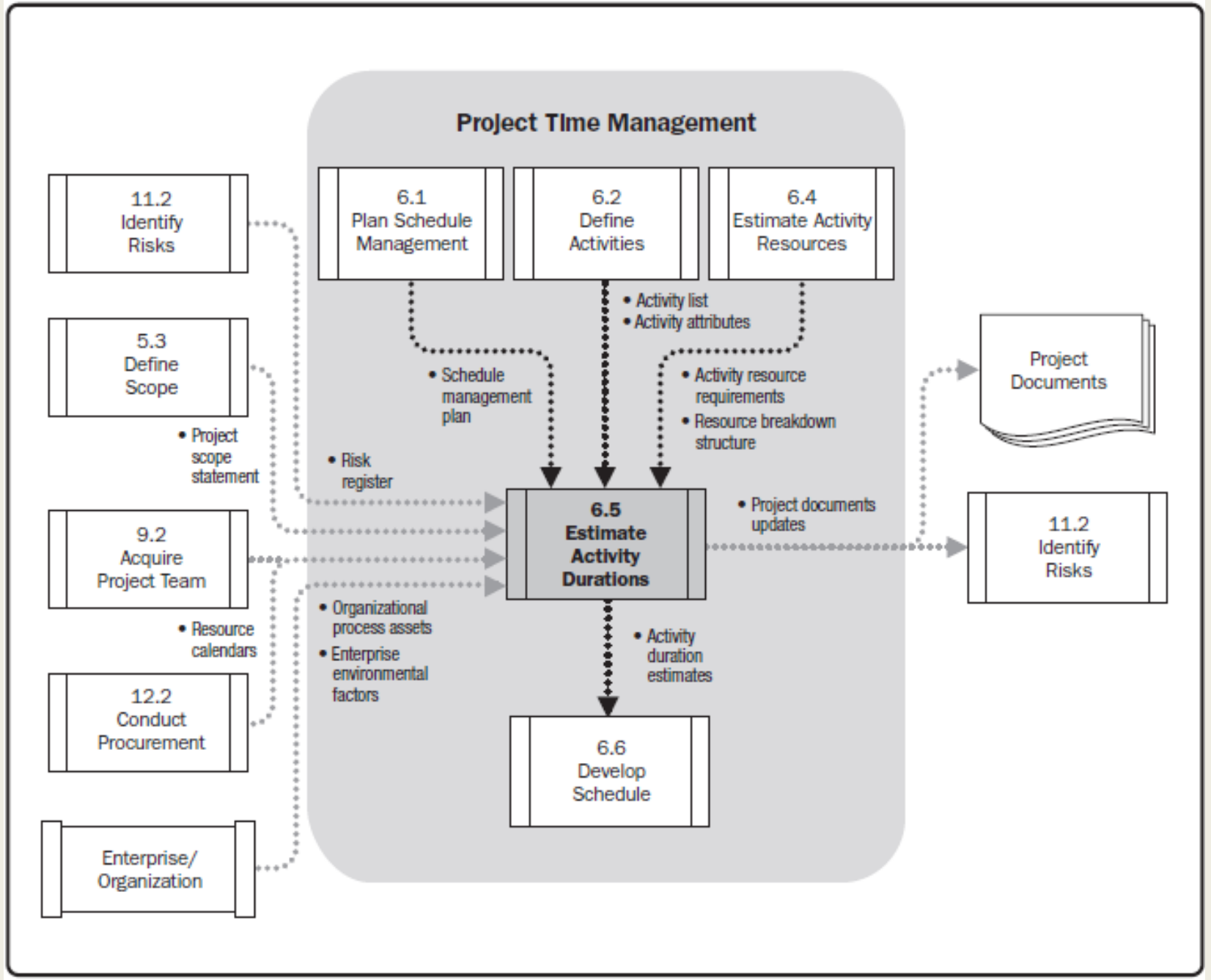


Figure 6-15. Estimate Activity Durations Data Flow Diagram

Develop Schedule

- Uses results of the other time management processes to determine the start and end dates of the project.
- Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project.
- Important tools and techniques include Gantt charts, critical path analysis, critical chain scheduling, and PERT analysis.
- The key benefit of this process is that by entering schedule activities, durations, resources, resource availabilities, and logical relationships into the scheduling tool, it generates a schedule model with planned dates for completing project activities.

Develop Schedule

- To develop a schedule, one needs to
  - *Define the activities (WBS),*
  - *Put them in order of how the work will be done (activity sequencing), and then*
  - *Estimate the duration of each activity (activity duration estimating).*

Milestones

- A milestone is a significant event that normally has no duration.
- It often takes several activities and a lot of work to complete a milestone.
- Milestones are useful tools for setting schedule goals and monitoring progress.
- Examples include completion and customer sign-off on key documents and completion of specific products.

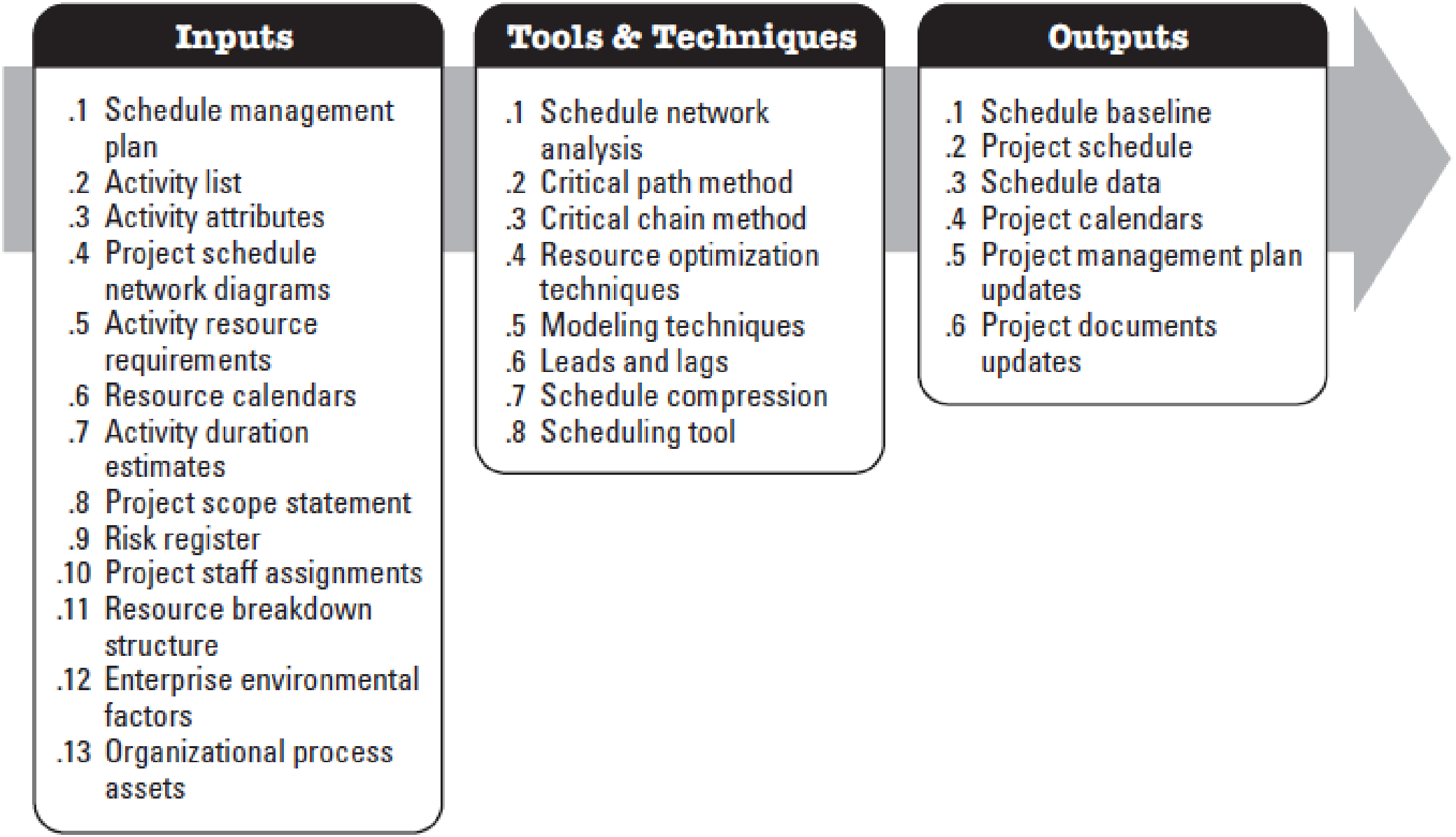


Figure 6-16 Develop Schedule: Inputs, Tools & Techniques, and Outputs

Schedule Network Analysis

- Schedule network analysis is a technique that generates the project schedule model.
- It employs various analytical techniques, such as critical path method, critical chain method, what-if analysis, and resource optimization techniques to calculate the early and late start and finish dates for the uncompleted portions of project activities.

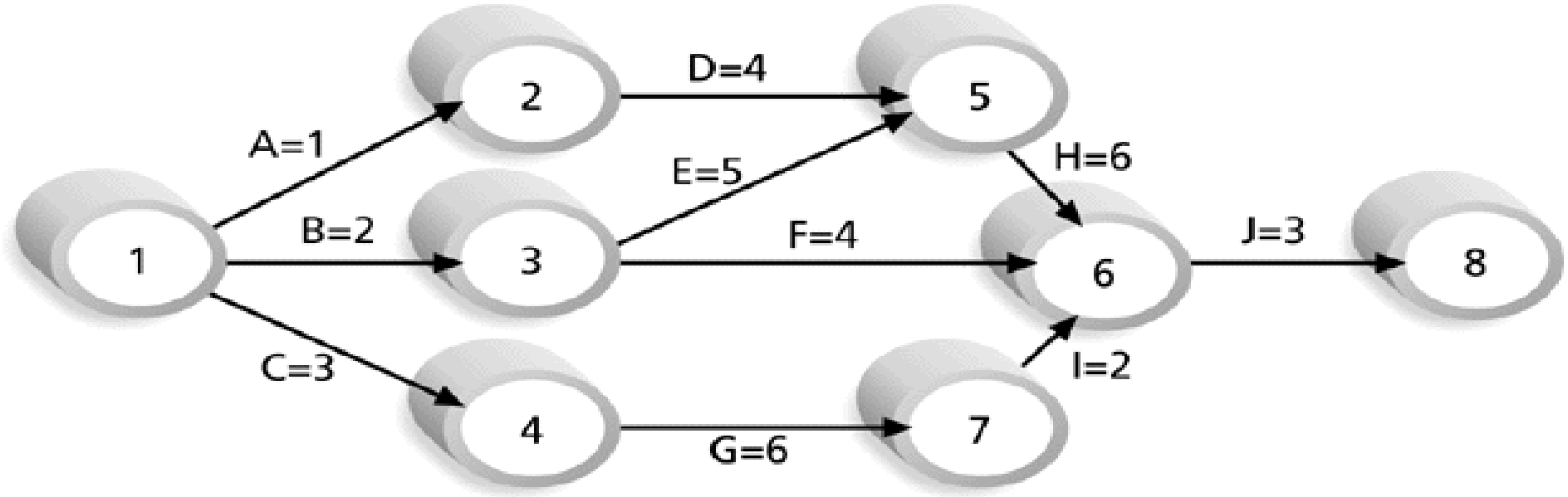
Critical Path Method (CPM)

- CPM is a network diagramming technique used to predict total project duration.
- The critical path method, which is a method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the logical network paths within the schedule model.
- This schedule network analysis technique calculates the early start, early finish, late start, and late finish dates for all activities without regard for any resource limitations by performing a forward and backward pass analysis through the schedule network.

Calculating the Critical Path

- Develop a good network diagram.
- Add the duration estimates for all activities on each path through the network diagram.
- The longest path is the critical path.
- If one or more of the activities on the critical path takes longer than planned, the whole project schedule will slip unless the project manager takes corrective action.

Determining the Critical Path for Project X



Note: Assume all durations are in days.

Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	**B-E-H-J**	**Length = 2+5+6+3 = 16 days**
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

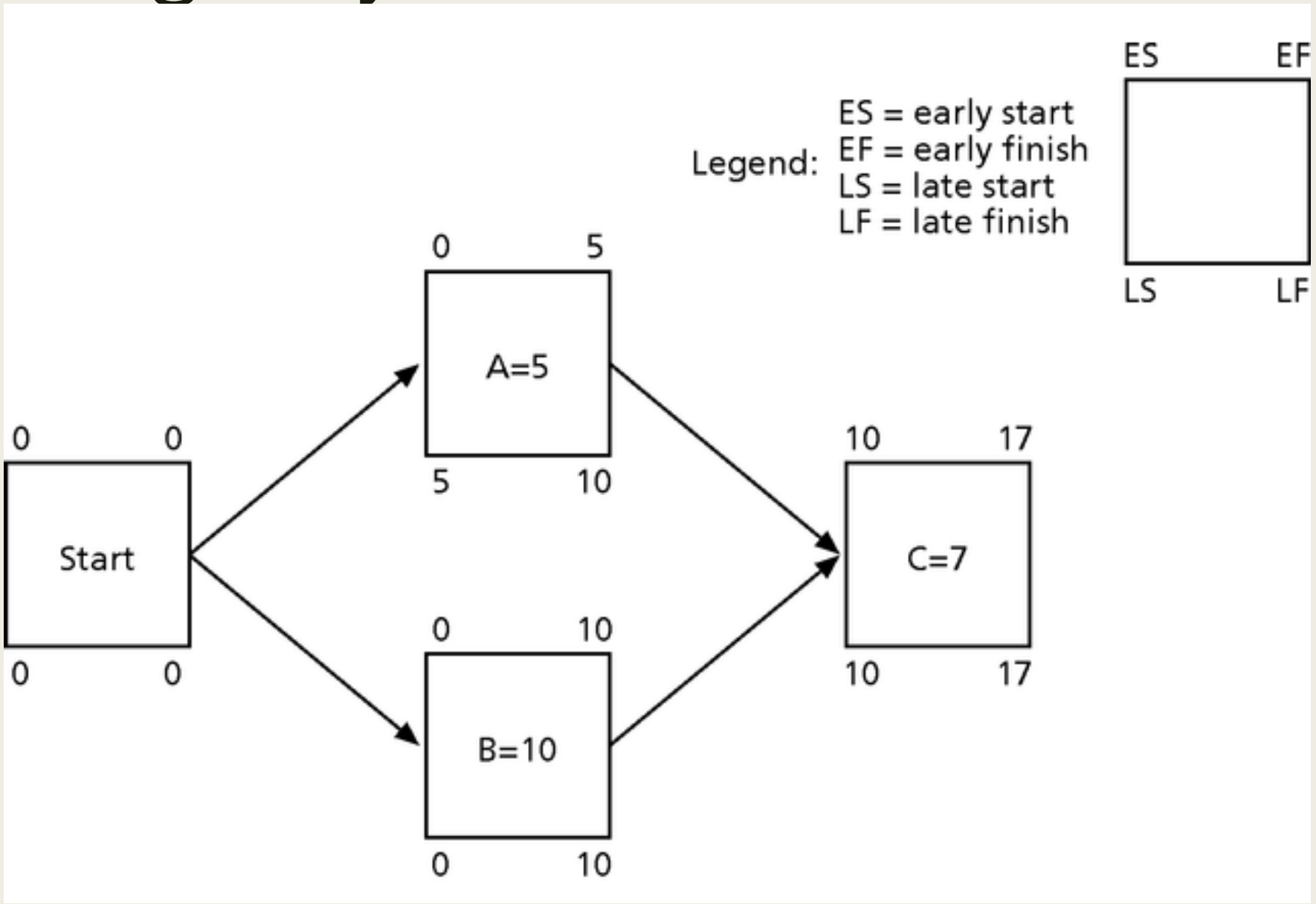
More on the Critical Path

- The critical path does not necessarily contain all the critical activities; it only accounts for time.
- Any activity on the critical path is called a critical path activity.
- There can be more than one critical path if the lengths of two or more paths are the same.
- The critical path can change as the project progresses.
- The critical path is the longest path through the network diagram and has the least amount of slack or float.
- Slack or float is the amount of time an activity can be delayed without delaying a succeeding activity or the project finish date.

Using CP Analysis to Make Schedule Trade-offs

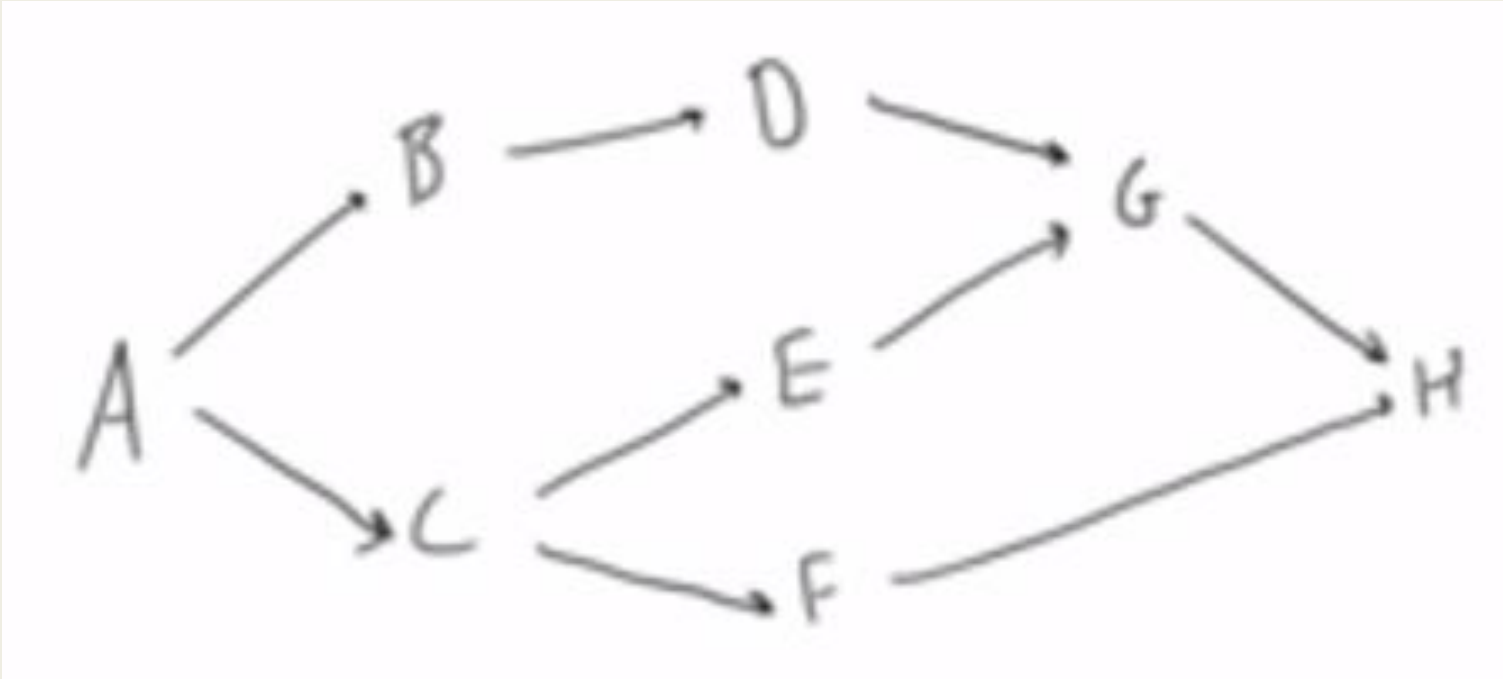
- Free slack or free float is the amount of time an activity can be delayed without delaying the early start of any immediately following activities.
- Total slack or total float is the amount of time an activity can be delayed from its early start without delaying the planned project finish date.
- A forward pass through the network diagram determines the early start and finish dates.
- A backward pass determines the late start and finish dates.

Calculating Early and Late Start and Finish Dates



Activity	Predecessor	Duration (days)
A	-	3
B	A	4
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3

Activity	Predecessor	Duration (days)
A	-	3
B	A	4
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3



Activity	Predecessor	Duration (days)
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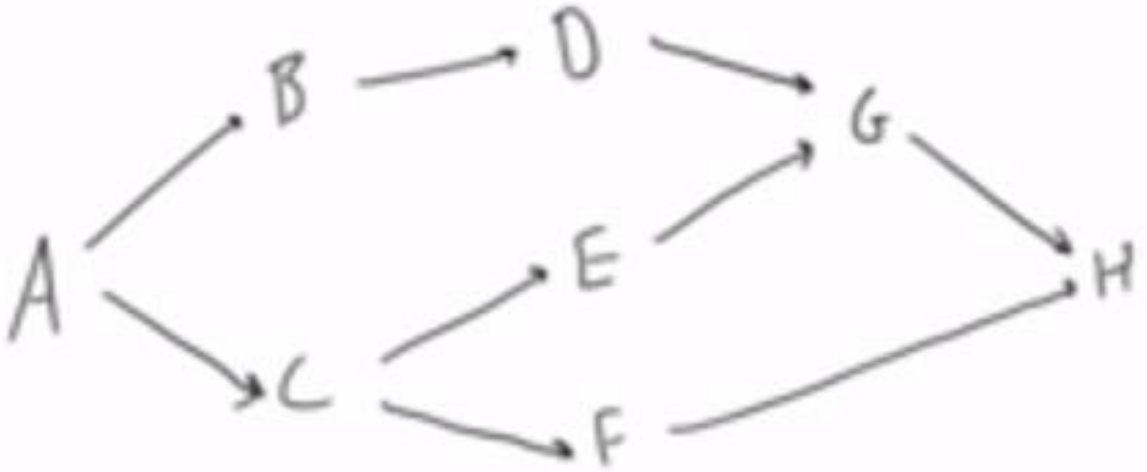
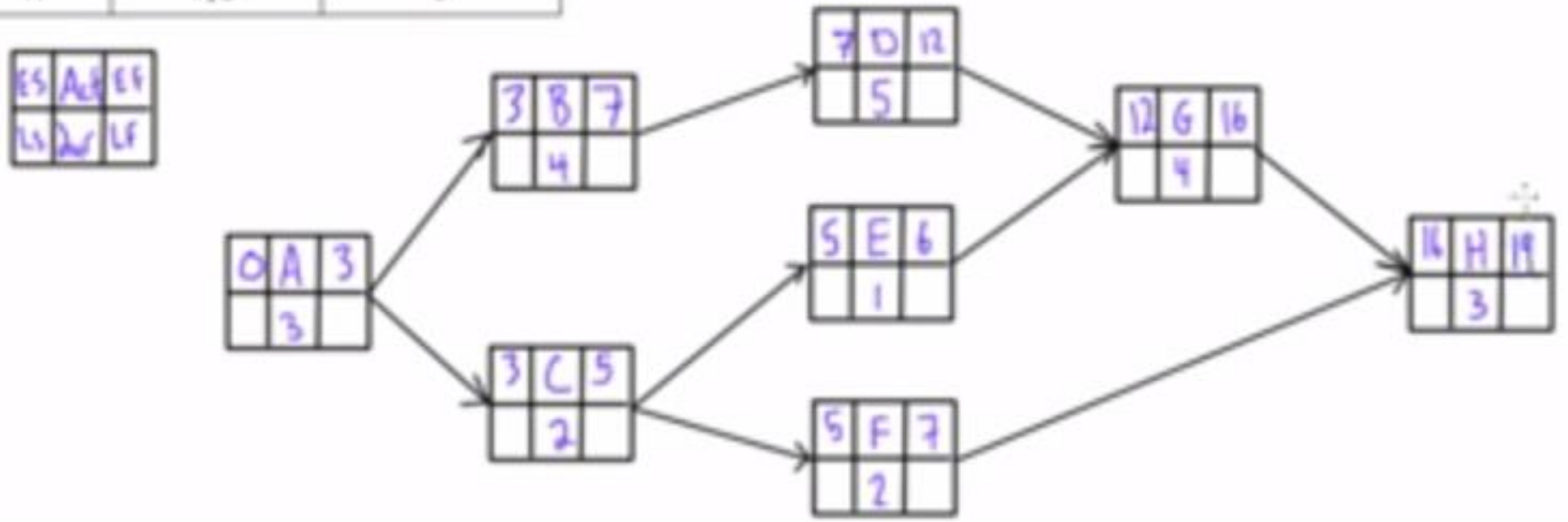
B	A	4
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3





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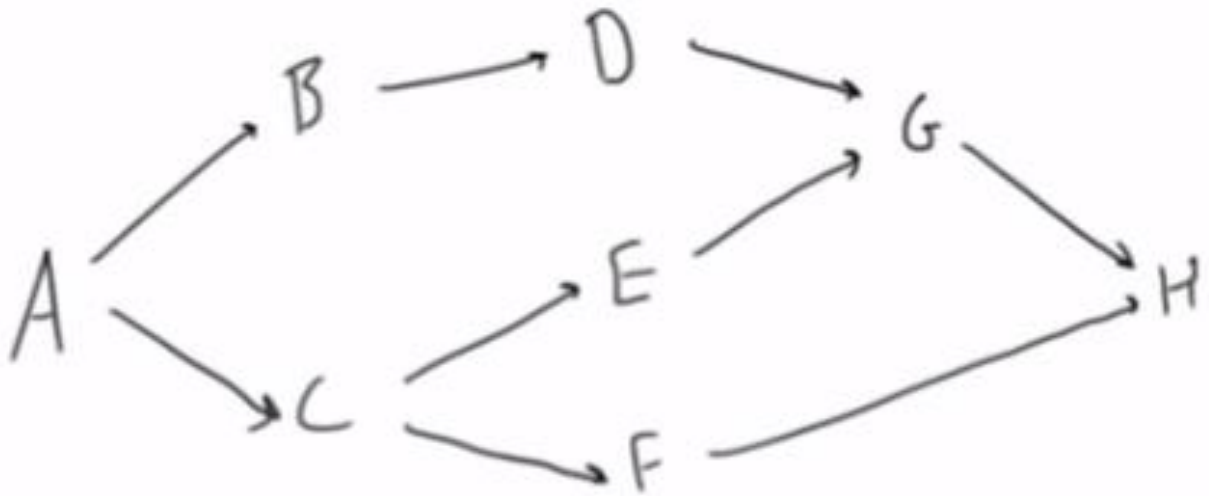
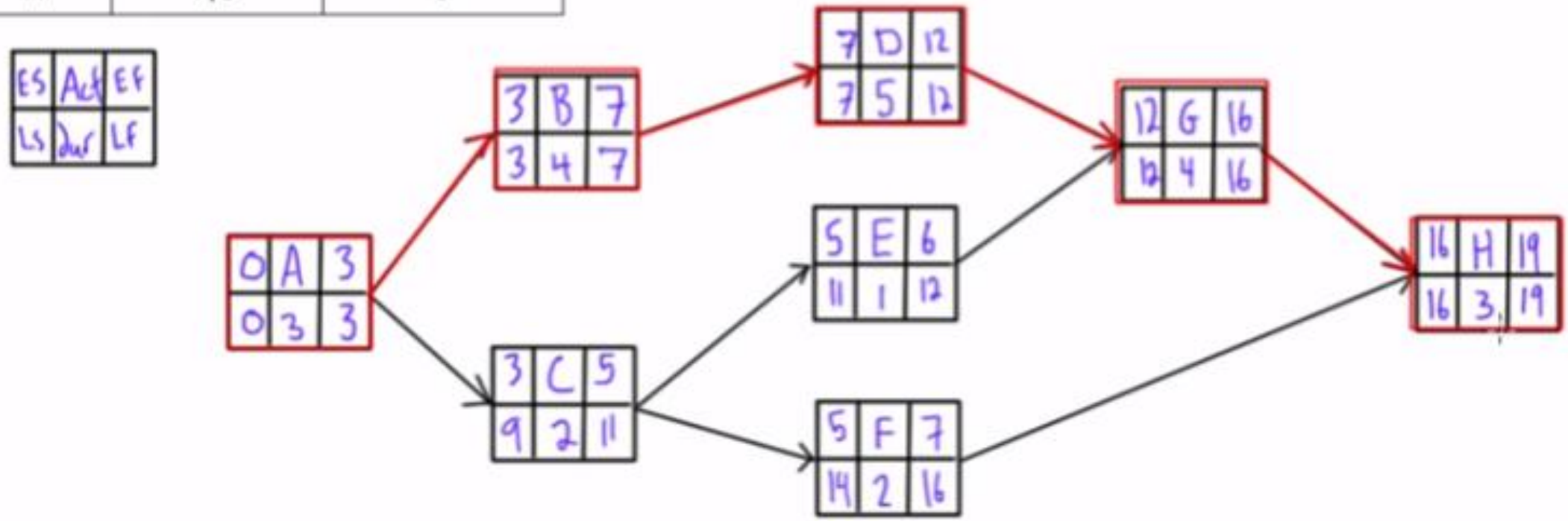
C	A	2
D	B	5
E	C	1
F	C	2
G	D,E	4
H	F,G	3



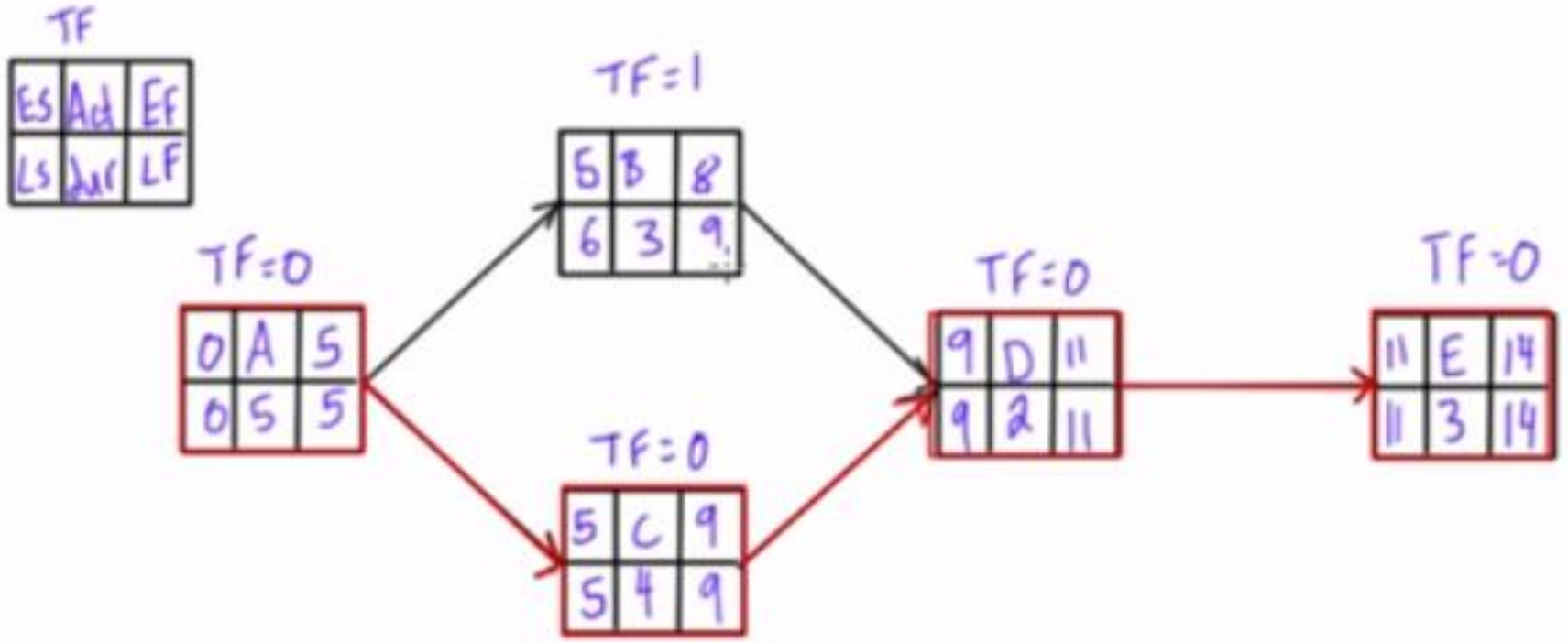


Activity	Predecessor	Duration
A	-	5
B	A	3
C	A	4
D	B,C	2
E	D	3

Total Float = TF

$TF = LF - EF$ "Finish Float"

$TF = LS - ES$ "Start Float"



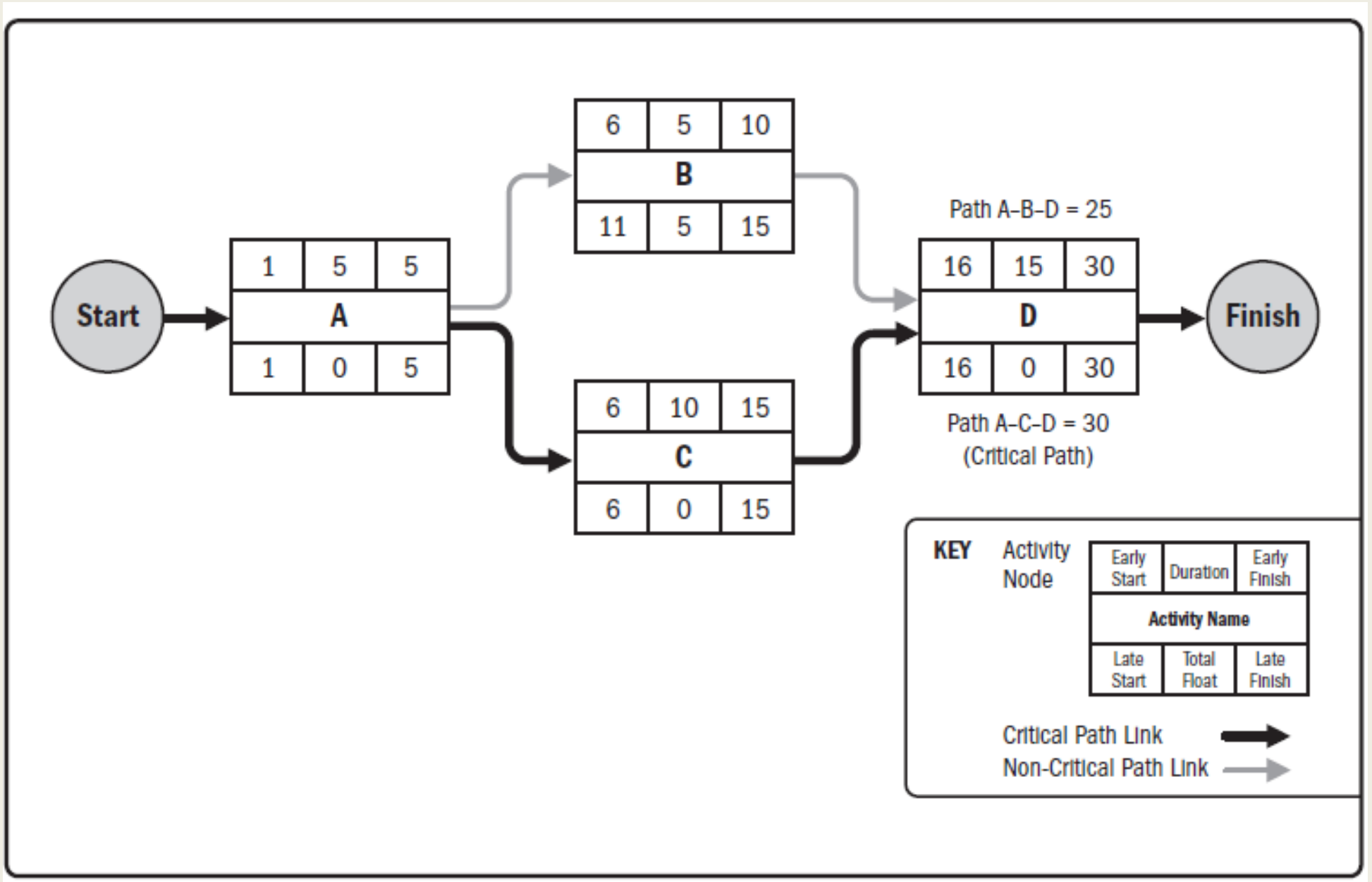


Figure 6-18. Example of Critical Path Method

Critical Chain Method

- a schedule method that allows the project team to **place buffers** on any project schedule path to account for limited resources and project uncertainties
- the critical chain method introduces the concept of buffers and buffer management
- The resource-constrained critical path is known as the critical chain.
- The critical chain method adds duration buffers that are non-work schedule activities to manage uncertainty.
- The size of each buffer should account for the uncertainty

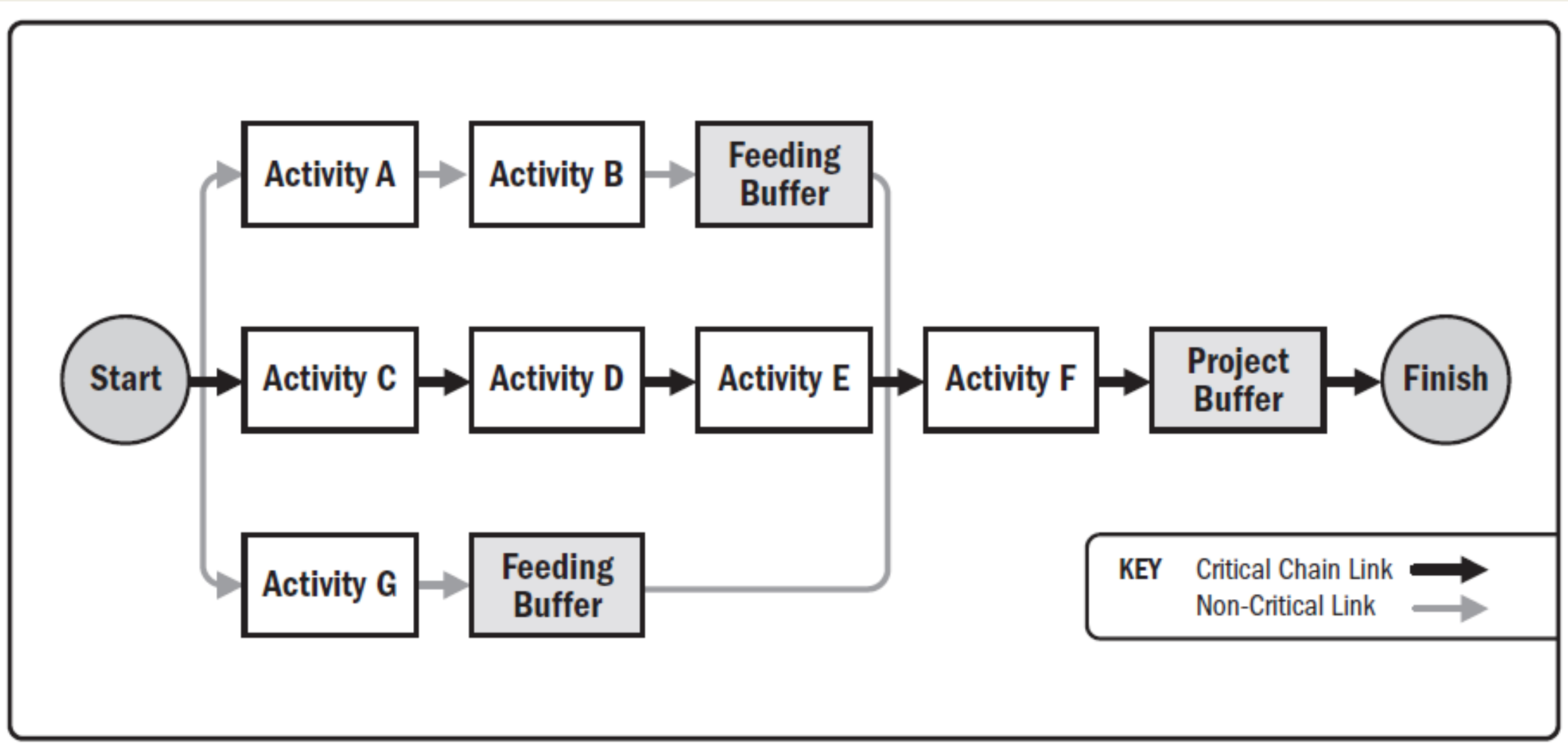


Figure 6-19. Example of Critical Chain Method

Resource Optimization Techniques

- **Resource leveling**
  - *A technique in which start and finish dates are adjusted based on resource constraints with the goal of balancing demand for resources with the available supply.*
  - *Resource leveling can be used when shared or critically required resources are only available at certain times, or in limited quantities, or over-allocated*
  - *Resource leveling can often cause the original critical path to change, usually to increase.*

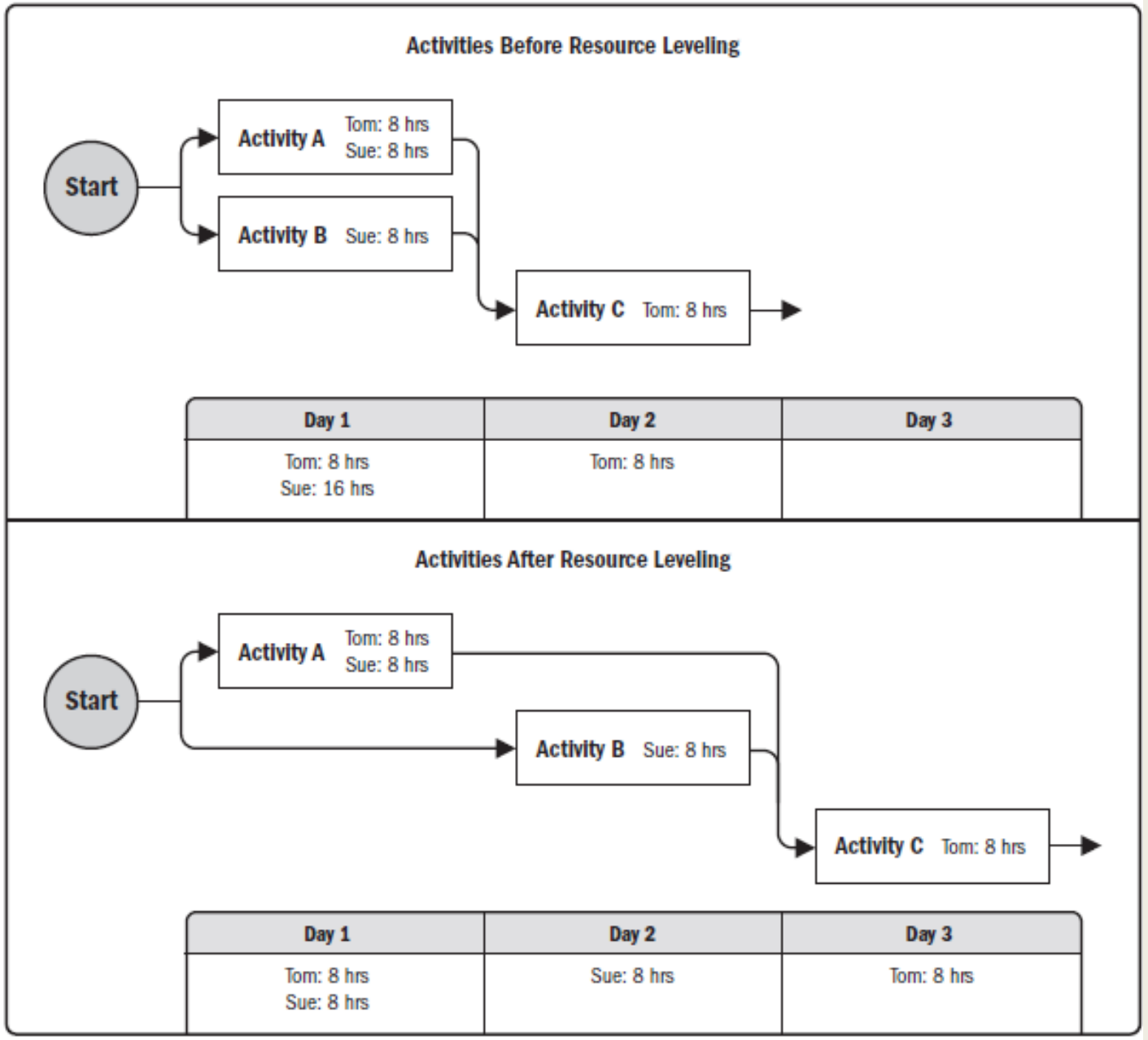


Figure 6-20. Resource Leveling

Resource Optimization Techniques

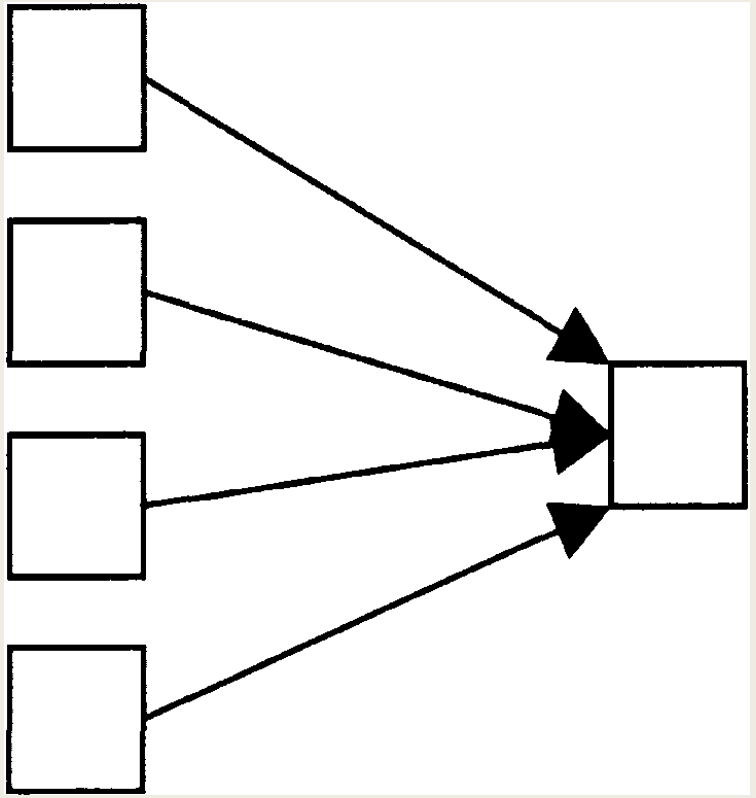
- Resource Smoothing
  - ***A technique that adjusts the activities of a schedule model*** *such that the requirements for resources on the project do not exceed certain predefined resource limits.*
  - *In resource smoothing, as opposed to resource leveling, the project's critical path is not changed and the completion date may not be delayed.*
  - *Activities may only be delayed within their free and total float.*
  - *Thus resource smoothing may not be able to optimize all resources.*

Modeling Techniques

- **What-If Scenario Analysis.**
  - *What-if scenario analysis is the process of evaluating scenarios in order to predict their effect, positively or negatively, on project objectives.*
  - *This is an analysis of the question, "What if the situation represented by scenario 'X' happens?"*
- **Simulation.**
  - *Simulation involves calculating multiple project durations with different sets of activity assumptions, usually using probability distributions constructed from the three-point estimates to account for uncertainty.*
  - *The most common simulation technique is Monte Carlo analysis*

Monte Carlo Simulation

- The simulation can tell you:
  - *The probability of completing the project on any specific day*
  - *The probability of completing the project for any specific amount of cost*
  - *The probability of any task actually being on the critical path*
  - *The overall project risk*



Schedule Compression

- Schedule compression techniques are used to shorten the schedule duration without reducing the project scope, in order to meet schedule constraints, imposed dates, or other schedule objectives. Schedule compression techniques:
- **Crashing.** A technique used to shorten the schedule duration for the least incremental cost by adding resources.
- **Fast tracking.** A schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration.

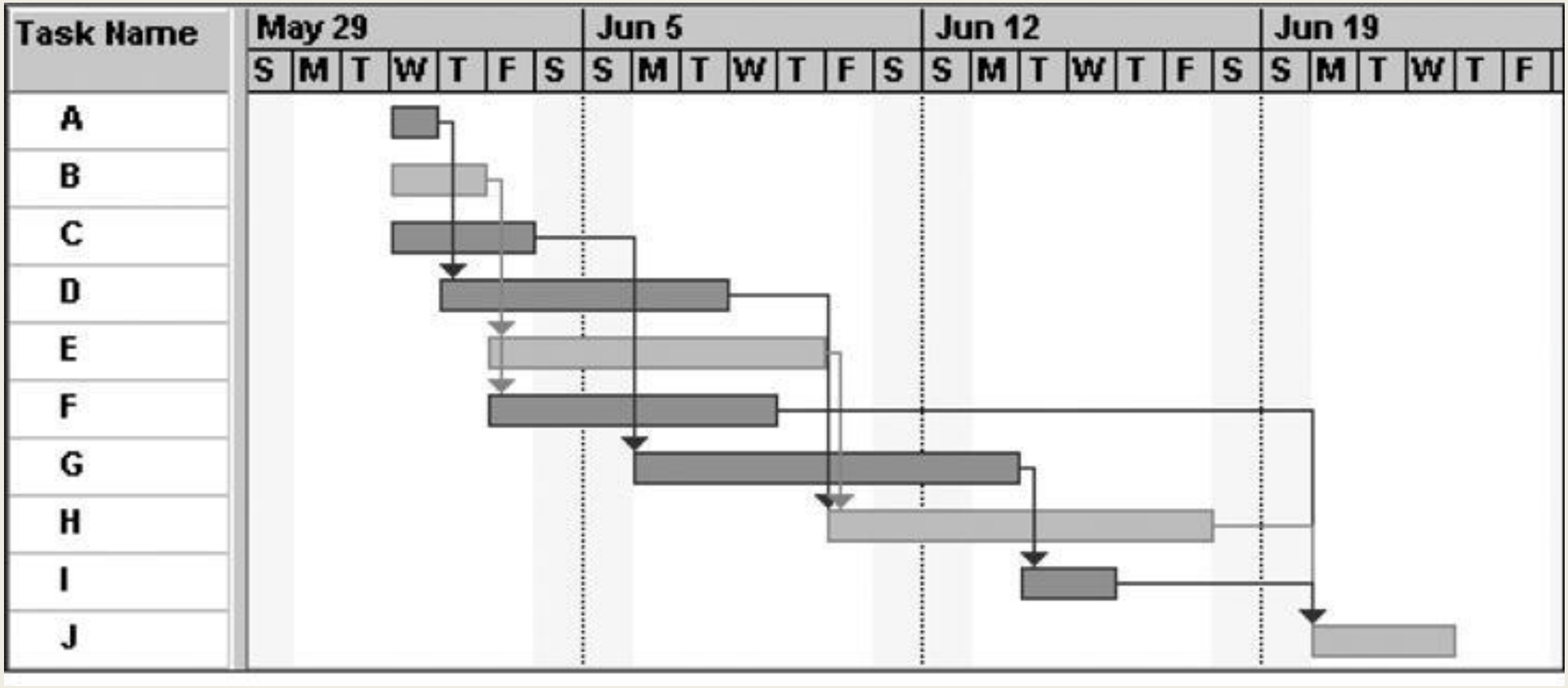
Develop Schedule: Outputs

- **Schedule Baseline**
  - *approved version of a schedule model that can be changed only through formal change control procedures and is used as a basis for comparison to actual results*
- **Project Schedule**
  - *The project schedule is an output of a schedule model that presents linked activities with planned dates, durations, milestones, and resources*

Gantt charts

- Gantt charts provide a standard format for displaying project schedule information by listing project activities and their corresponding start and finish dates in a calendar format.
- **Bar charts.** These charts, also known as Gantt charts, represent schedule information where activities are listed on the vertical axis, dates are shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates.
- **Milestone charts.** These charts are similar to bar charts, but only identify the scheduled start or completion of major deliverables and key external interfaces.

Gantt Chart for Project X



Adding Milestones to Gantt Charts

- Many people like to focus on meeting milestones, especially for large projects.
- Milestones emphasize important events or accomplishments in projects.

Control Schedule

- Control Schedule is the process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan.
- it provides the means to recognize deviation from the plan and take corrective and preventive actions and thus minimize risk.
- Tools and techniques include:
  - *Progress reports*
  - *A schedule change control system*
  - *Project management software, including schedule comparison charts, such as the tracking Gantt chart*
  - *Variance analysis, such as analyzing float or slack*
  - *Performance management, such as earned.*

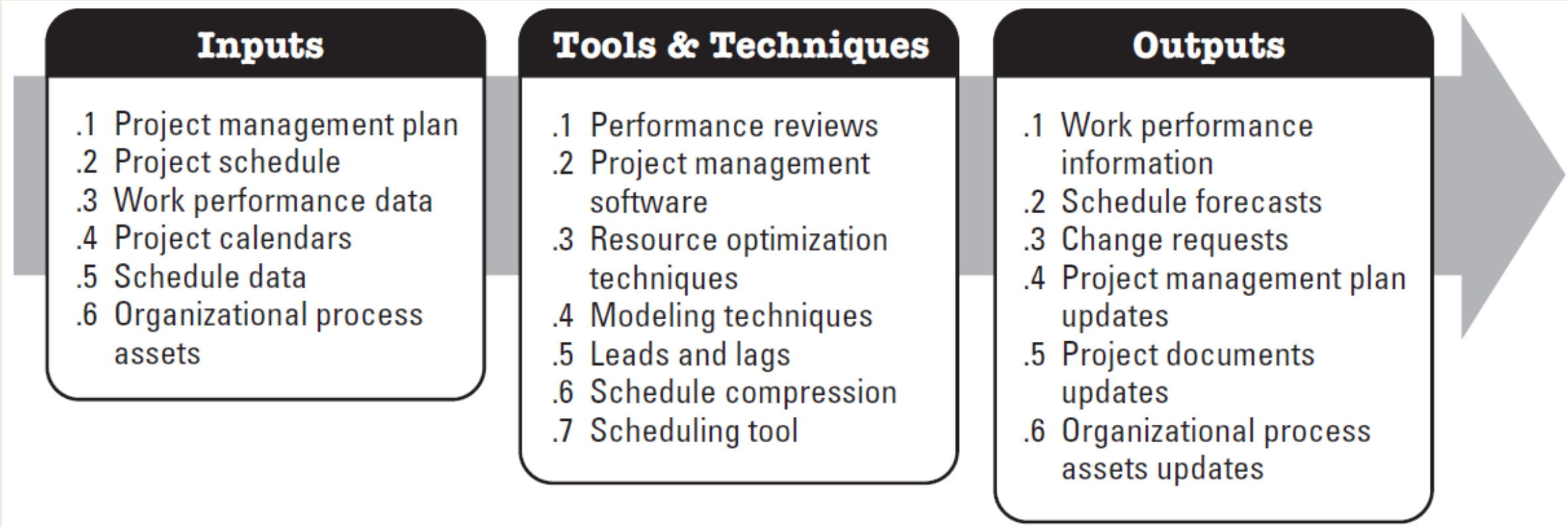


Figure 6-22. Control Schedule: Inputs, Tools & Techniques, and Outputs

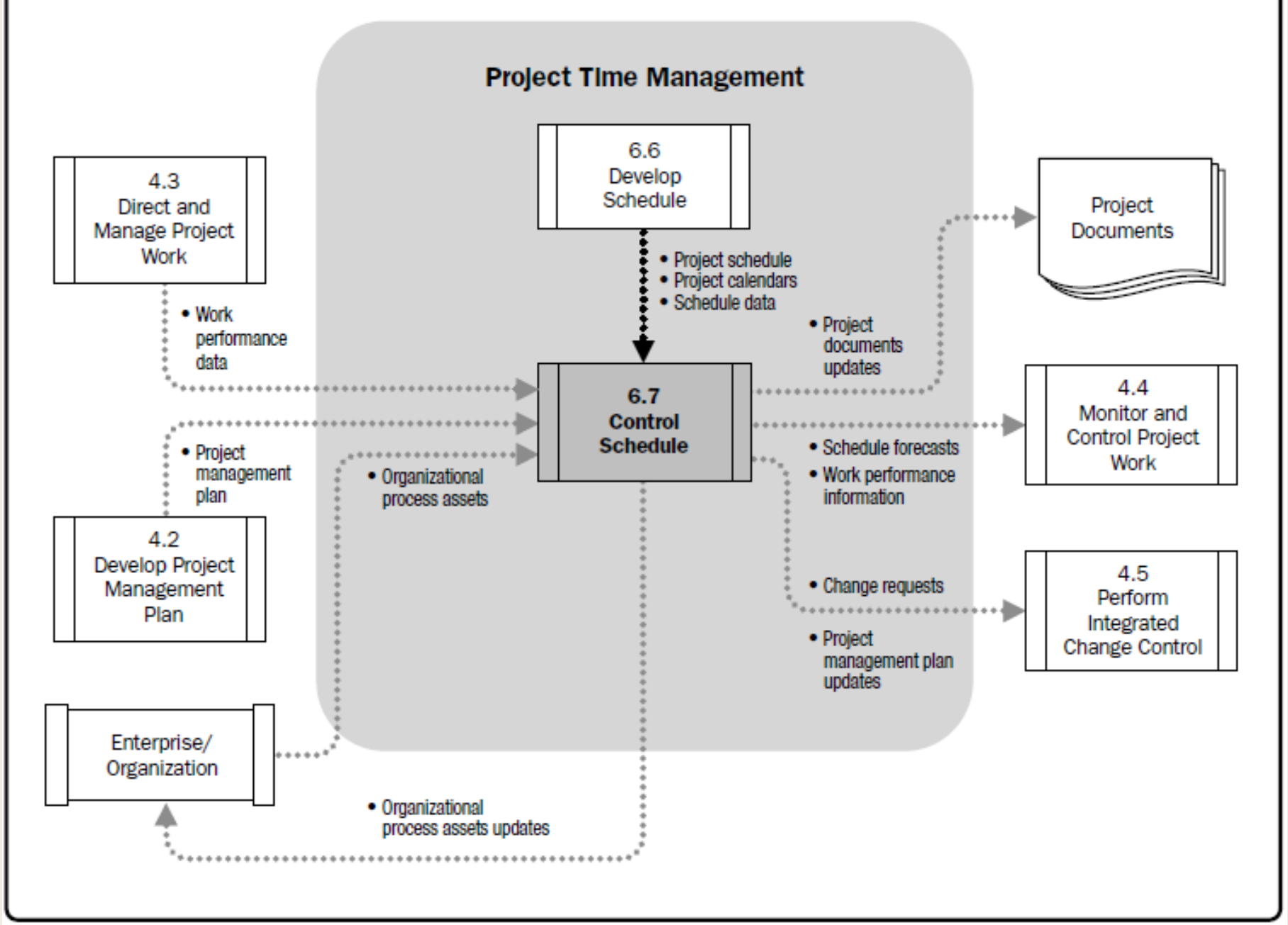


Figure 6-23. Control Schedule Data Flow Diagram

Reality Checks on Scheduling

- Review the draft schedule or estimated completion date in the project charter.
- Prepare a more detailed schedule with the project team.
- Make sure the schedule is realistic and followed.
- Alert top management well in advance if there are schedule problems.