# CPM & CCM
# Critical Path & Critical Chain

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# Disclaimer

▶ We are not perfect being. Be are striving for the perfection.

▶ We are first time trying to visualize the entire project in the form of critical path and critical chain. Therefore there are many opportunities for the improvements. Let's start doing it and on the way if any opportunity is identified we can incorporate the inputs.

▶ There are many ways of estimating efforts, duration, resources, cost and many ways to optimize the schedule some will be discussed in this workshop of 4 hours but many others will not be discussed.

▶ Feel free to share your inputs today or anytime in future.

- This is not
  - A Meeting
  - A Lecture of a professor
  - A Speech of some senior person
  - One more training in your hectic routine
- This is a workshop to reset our style of estimating, scheduling and making/taking commitment to/from our stakeholders (management, customer, vendors, team members). Here we are trying to understand how to make commitment where chances of failure can be minimized drastically.

# Agenda

▶ What do you estimate?

▶ Why do you estimate?

▶ How do you estimate?

▶ Range of Estimate & Basis of Estimate

▶ Confidence Level of Estimate

▶ What is critical in CPM?

▶ What is CPM?

▶ What is CCM?

▶ What is buffer? What is float?

▶ Contingency Reserve vs Management Reserve

▶ Some diseases of project network path

▶ Process of Scheduling

# How do you estimate?

▶ Analogous Estimate

▶ Parametric Estimate

▶ 3 Point Estimate

▶ Bottom-up Estimate

▶ Published Estimating Data

# **Project Schedule Management**

# Project Schedule Management

1.  Plan Schedule Management [PLANNING]

2.  Define Activities [PLANNING]

3.  Sequence Activities [PLANNING]

4.  Estimate Activity Resources [PLANNING]

5.  Estimate Activity Durations [PLANNING]

6.  Develop Schedule [PLANNING]

7.  Control Schedule [M&C]

**Definition**

Establishing the policies, procedures and documentation for planning, developing, managing, executing, and controlling the project schedule

# Schedule Management Plan

It includes

- ▶ Scheduling tools to be used

- ▶ Level of accuracy

- ▶ Units of measure for each resource

- ▶ Organizational procedure links

- ▶ Process of updating the progress in schedule model

- ▶ Control thresholds

- ▶ Rules of performance measurement (baselines, %complete, fixed formula etc.)

- ▶ Define scheduling reporting format

**Definition**

# Identifying the specific actions to be performed to produce the project deliverables
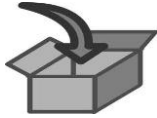
.1 Project management plan

.2 EEFs

.3 OPAs

.1 Expert judgment

.2 Decomposition

.3 Rolling wave    planning

.4 Meetings

.1 Activity list

.2 Activity attributes

.3 Milestone list

# Activity Attributes
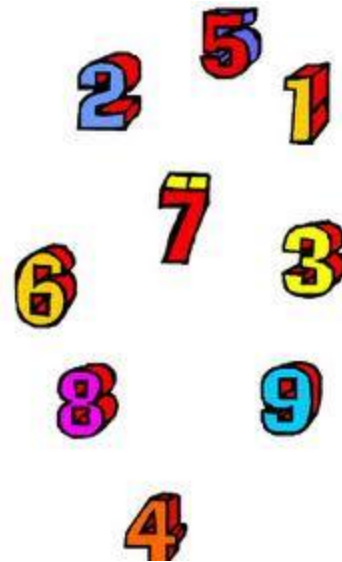
- Dependency
- Location of performance
- Type of dependency
- Level of efforts (work contour)
- Efforts required
- Related Deadline
- Related WBS account
- Critical activity
- Type of task (fixed duration, resources, work)
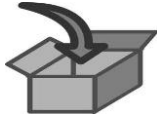- Resource & skills required
- Duration
- Lead & Lag

# Sequence Activities



**Definition**

**Identifying and documenting relationships among the project activities.**

.1 Schedule management plan

.2 Project documents

- Activity attributes
- Activity list
- Assumption log
- Milestone list

.3 EEFs

.4 OPAs

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.1 Precedence diagramming method

.2 Dependency determination and integration

.3 Leads and lags

.4 PMIS

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.1 Project schedule network diagrams

.2 Project documents updates

- Activity attributes
- Activity list
- Assumption log
- Milestone list

# Discussion

▶ **Sequence Previously activities of your project write FS, SF, FF, SS after the activities**

▶ **FS- (Finish first to start the next) Documentation & Review, Design & Development**

▶ **FF- (Finish next to finish the previous) Product Documentation & Product System Testing**

▶ **SF- (Start next to finish the previous) Shift working environment, changing motor, shifting applications from servers A to B, shifting work environment from A to B.**

▶ **SS- (Start next to start previous) Listening & Speaking, Start meeting & Start a topic to discuss, Listening & Making Notes, Requirement Gathering & Requirement Analysis**

# Precedence Diagramming Method (PDM)



Precedence Diagramming Method (PDM)
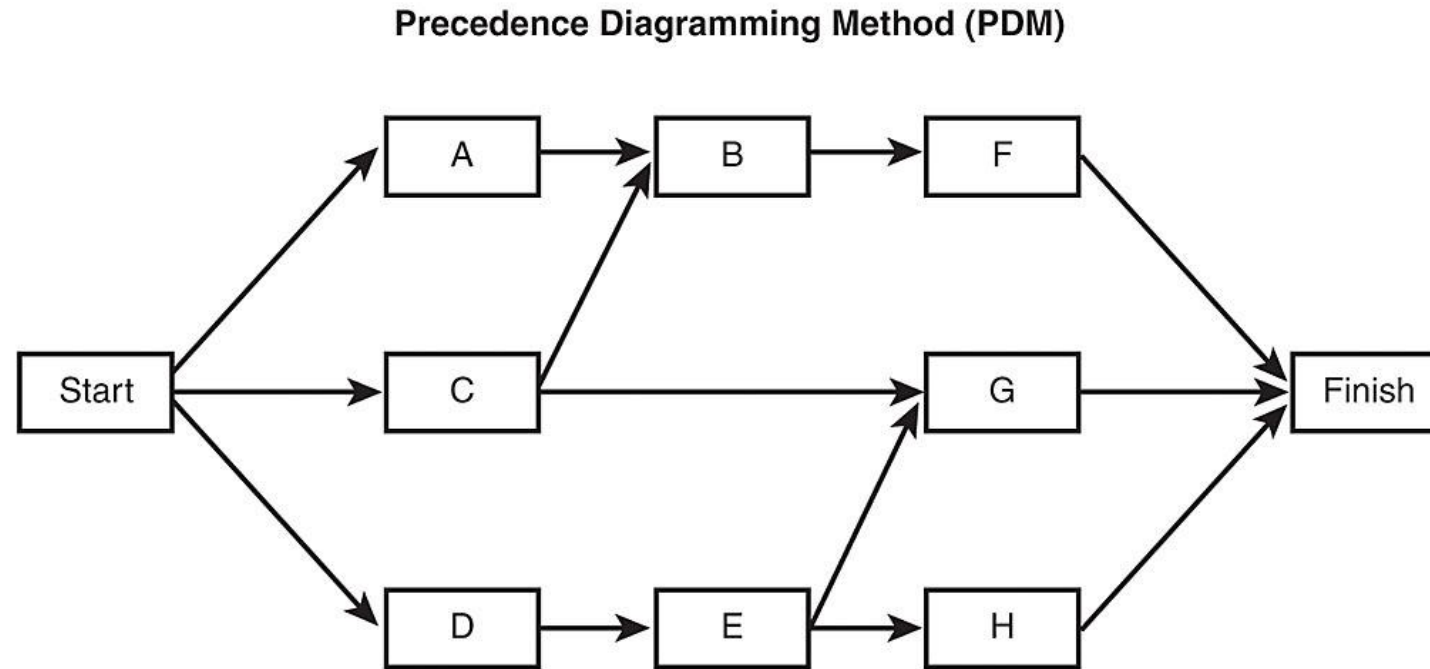
8 Activities with 13 dependencies

**Also known as Activity on Nodes (AON)**

# Activity Type

- **Fixed Work**
  - Effort driven. Can change the duration by adding/ removing resources. E.g. To attempt 60 questions 60 min required. If you distributed between people duration can be altered.

- **Fixed Duration**
  - Time driven. Can not change the duration by adding/removing resources. E.g. Duration of the training does not depend upon # of participants. It is fixed.
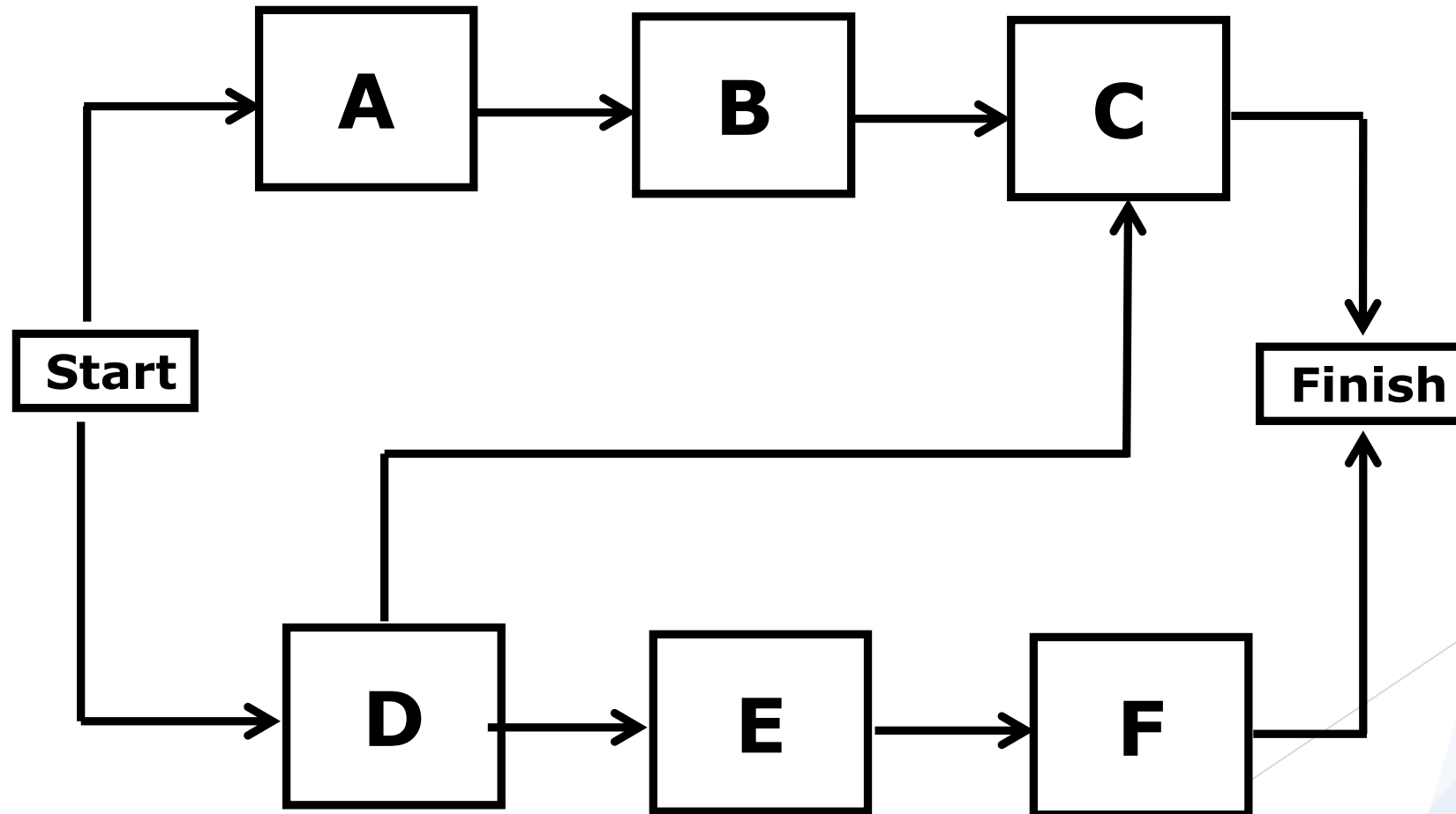
- **Fixed Units**
  - Resource driven. Cannot change the duration by adding/removing resources. In fact altering number/type of resources make activity undoable. e.g Remove one person from review process where min 2 people are required.

# Time Constraints

1. ASAP
2. ALAP
3. SNET
4. SNLT
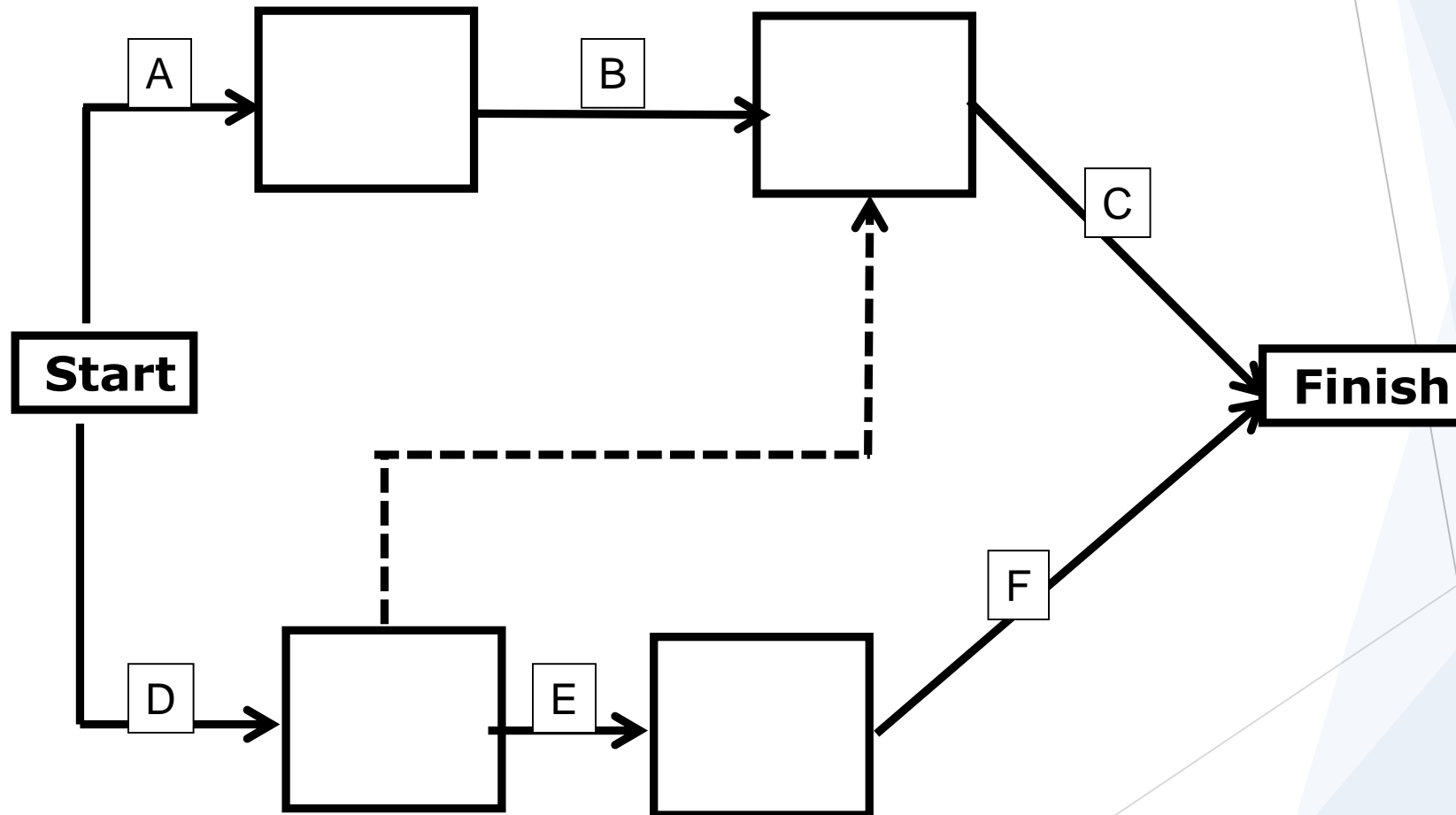5. FNLT
6. FNET
7. MFO
8. MSO

# Network Development



Precedence Diagramming Method (AON)

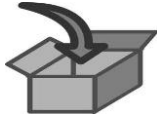# Network Development

## Precedence Diagramming Method (AOA)

**Definition**

**Approximating the number of work periods needed to complete individual activities with estimated resources.**

# Estimate Activity Durations



.1 • Schedule management plan

• Scope baseline

.2 Project documents

• Activity attributes

• Activity list

• Assumption log

• Lessons learned    register

• Milestone list

• Project team assignments

• Resource breakdown structure

• Resource calendars

• Resource requirements

• Risk register

.3 EEFs

.4 OPAs



.1 Expert judgment

.2 Analogous estimating

.3 Parametric    estimating

.4 Three-point   estimating

.5 Bottom-up     estimating

.6 Data analysis

• Alternatives analysis

• Reserve analysis



.1 Duration estimates

.2 Basis of estimates

.3 Project documents
   updates

• Activity attributes

• Assumption log

• Lessons learned      register

Beta Distribution

- PERT Estimate $t_E$ = (Optimistic + 4 * Most Likely + Pessimistic)/6

Triangular Distribution

- $t_E$ = (Optimistic + Most Likely + Pessimistic)/3

Standard Deviation (using PERT) = (Pessimistic-Optimistic)/6
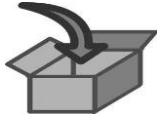
Variance (using PERT) = ( (Pessimistic - Optimistic)/6)$^2$

**Definition**

**Analyzing activity sequences, durations, resource requirements and schedule constraints to create the project schedule.**
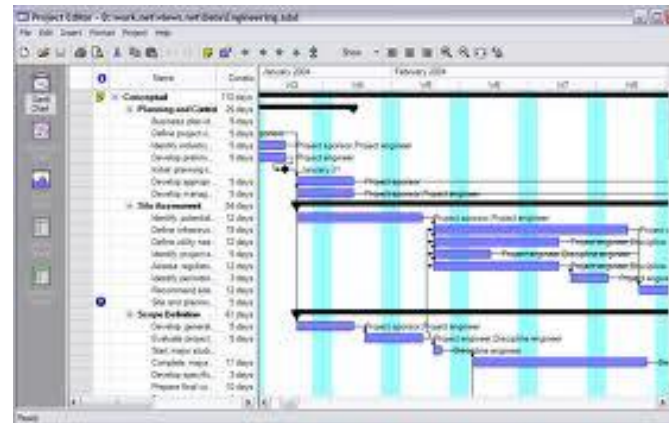
# Develop Schedule

.1 • Schedule management plan
  • Scope baseline
.2 Project documents
  • Activity attributes
  • Activity list
  • Assumption log
  • Basis of estimates
  • Duration estimates
  • Lessons learned register
  • Milestone list
  • Project schedule network diagrams
  • Project team assignments
  • Resource calendars
  • Resource requirements
  • Risk register
.3 Agreements
.4 EEFs
.5 OPAs

.1 Schedule network analysis
.2 Critical path method
.3 Resource optimization
.4 Data analysis
  • What-if scenario analysis
  • Simulation
.5 Leads and lags
.6 Schedule compression
.7 PMISs
.8 Agile release planning

.1 Schedule baseline
.2 Project schedule
.3 Schedule data
.4 Project calendars
.5 Change requests
.

# Schedule Compression Techniques
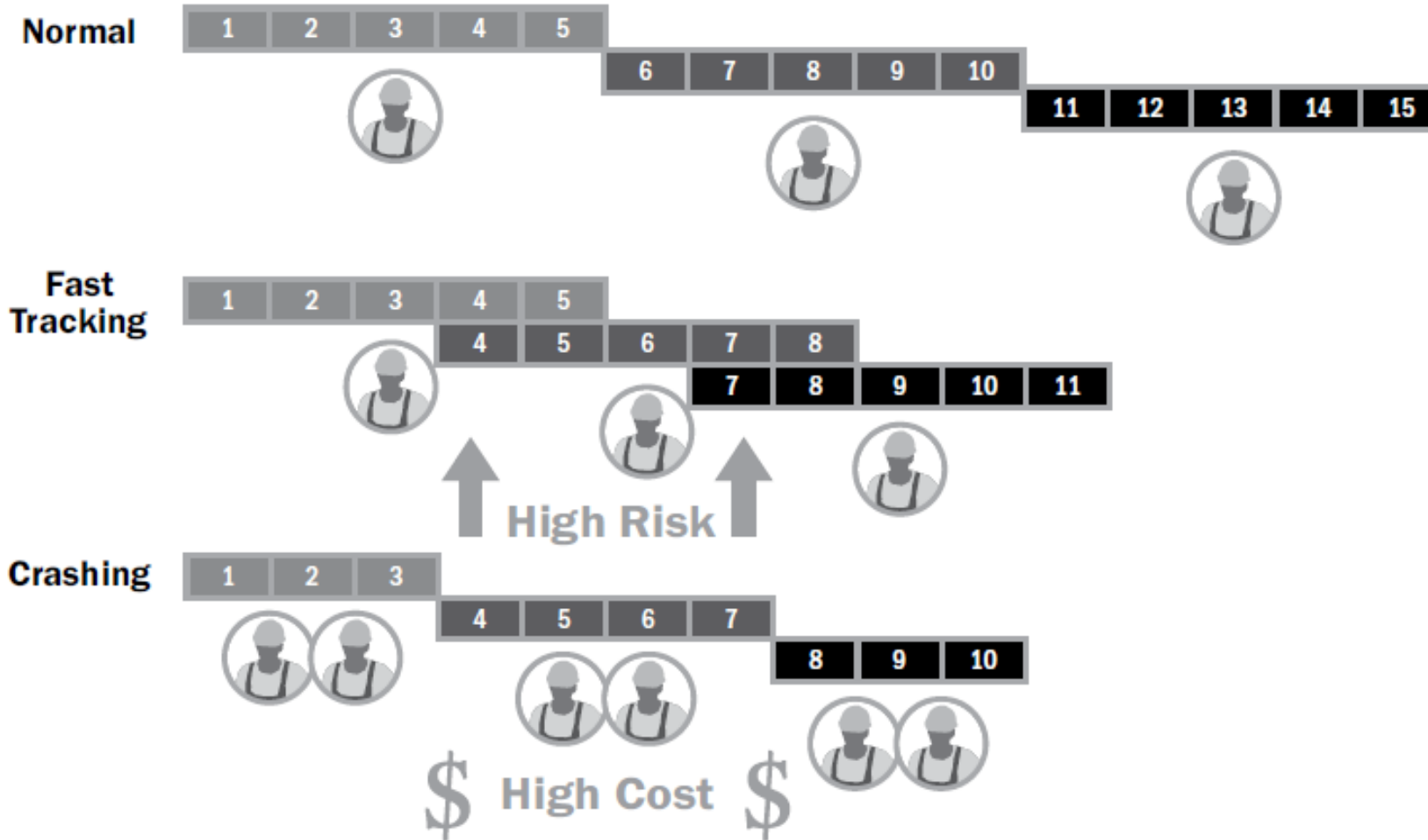
# Resource Optimization techniques

► **Resource Levelling**

  ► Ensure resource are not allocated more than their availability for the given project. Can lead to change in critical path.

► **Resource Smoothing**

  ► Adjust activities in such a way that resources requirement do not exceed than defined limit. No change in critical path. Activities can be delayed within their float (free/total).
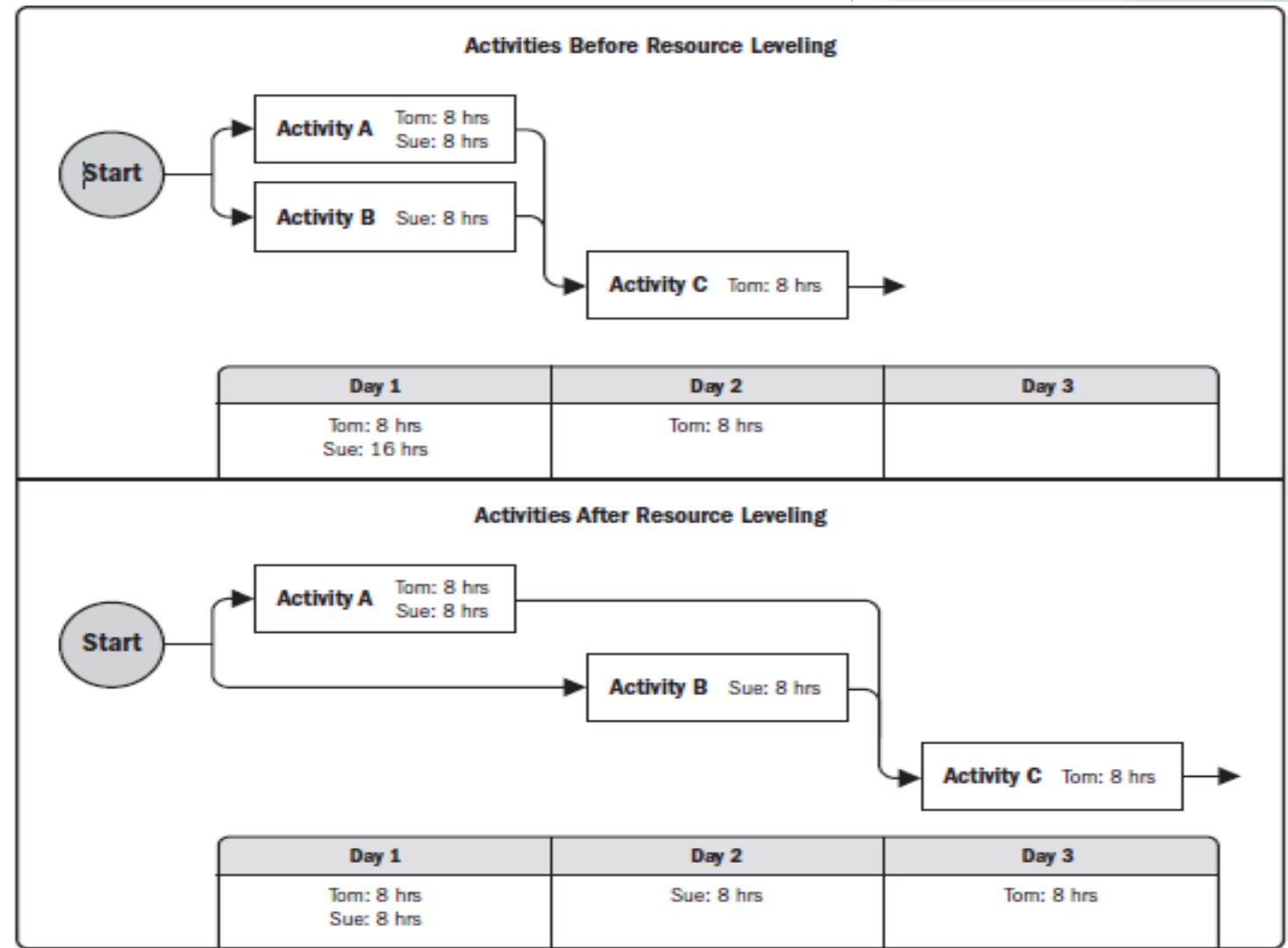
# Modeling Techniques

▶ What if scenario analysis

  ▶ Assess the feasibility of project schedule under adverse conditions. Prepare a contingency plan to overcome the problems. Or prepare mitigation plan to reduce the impact of unexpected situations.

▶ Simulation

  ▶ Calculate multiple project duration using tools like Monte Carlo Simulation. In this case use assumptions and distribution constructed using 3 Point estimates.

# Control Schedule

**Definition**
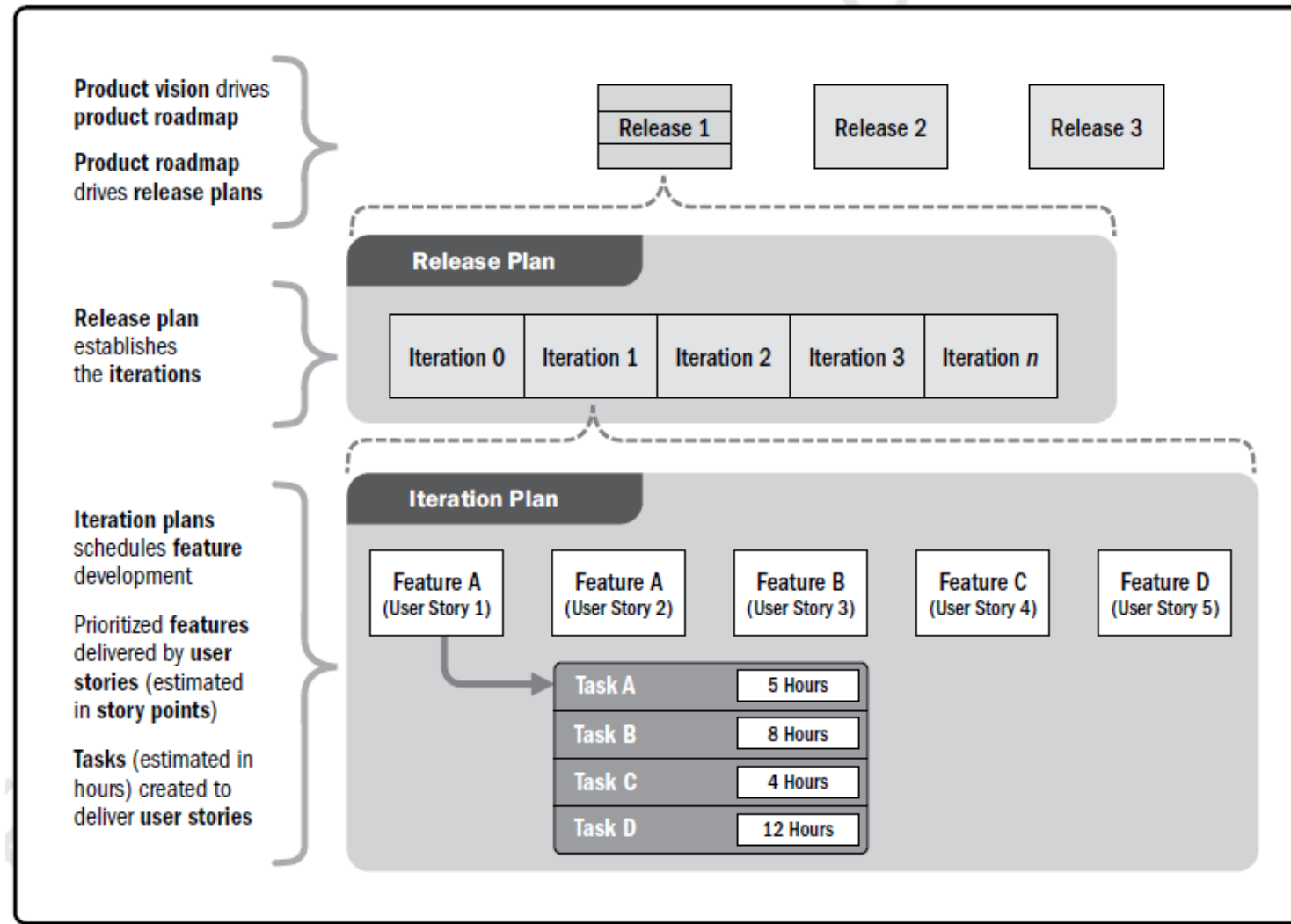
Monitoring the status of the project to update project progress and manage changes to the schedule baseline

### Inputs

.1 • Schedule management plan
   • Schedule baseline
   • Scope baseline
   • Performance measurement baseline

.2 Project documents
   • Lessons learned register
   • Project calendars
   • Project schedule
   • Resource calendars
   • Schedule data

.3 Work performance data

.4 OPAs

### Tools & Techniques

.1 Data analysis
   • Earned value analysis
   • Iteration burndown chart
   • Performance reviews
   • Trend analysis
   • Variance analysis
   • What-if scenario analysis

.2 Critical path method

.3 Project management information system

.4 Resource optimization

.6 Leads and lags

.7 Schedule compression

### Outputs

.1 Work performance information

.2 Schedule forecasts

.3 Change requests

.4 Project management plan updates
   • Schedule management plan
   • Schedule baseline
   • Cost baseline
   • Performance measurement baseline

.5 Project documents updates
   • Assumption log
   • Basis of estimates
   • Lessons learned register
   • Project schedule
   • Resource calendars
   • Risk register
   • Schedule data

# Product Vision, Release, Iteration Planning

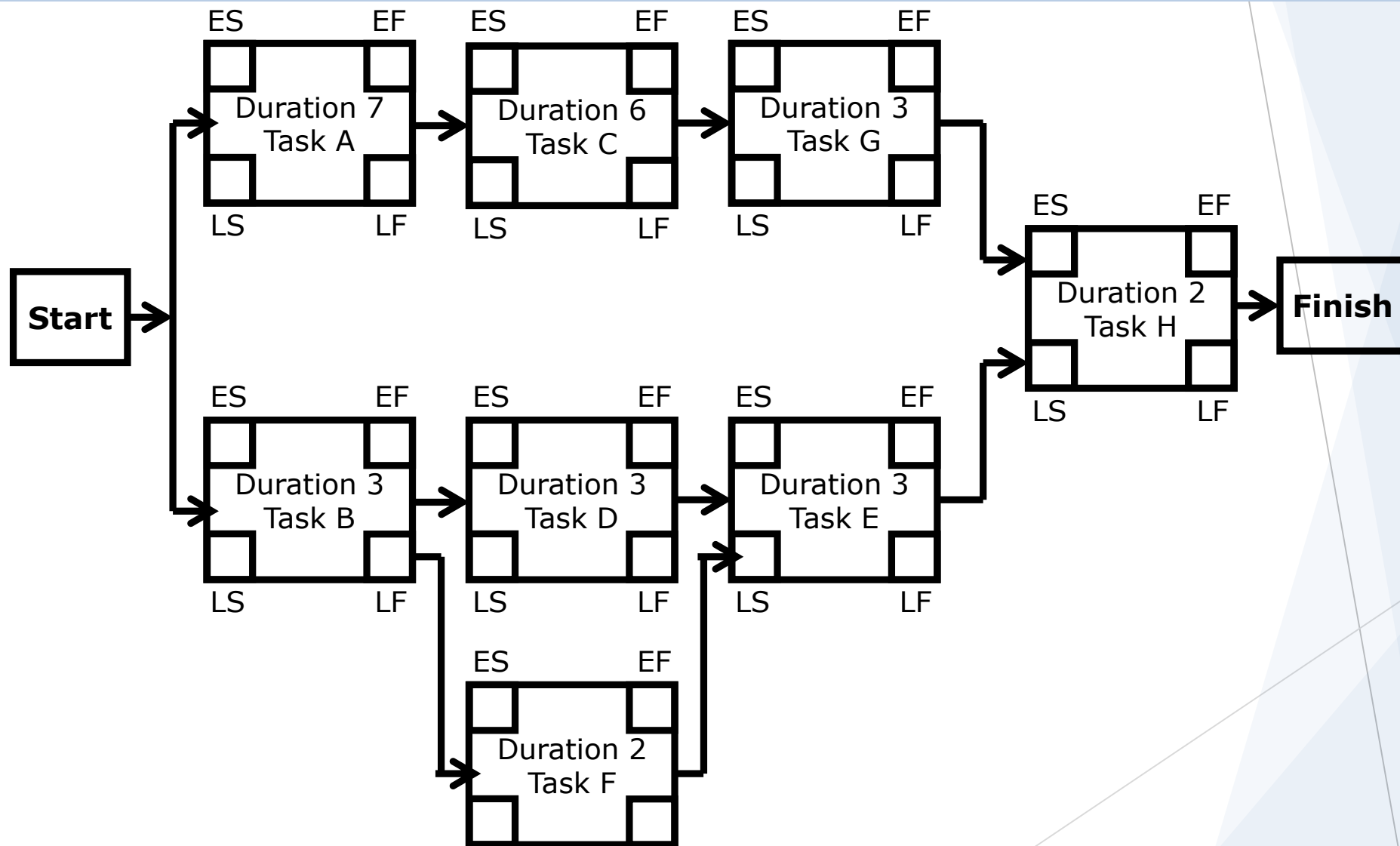# Burndown Chart



**Iteration Burndown Chart**
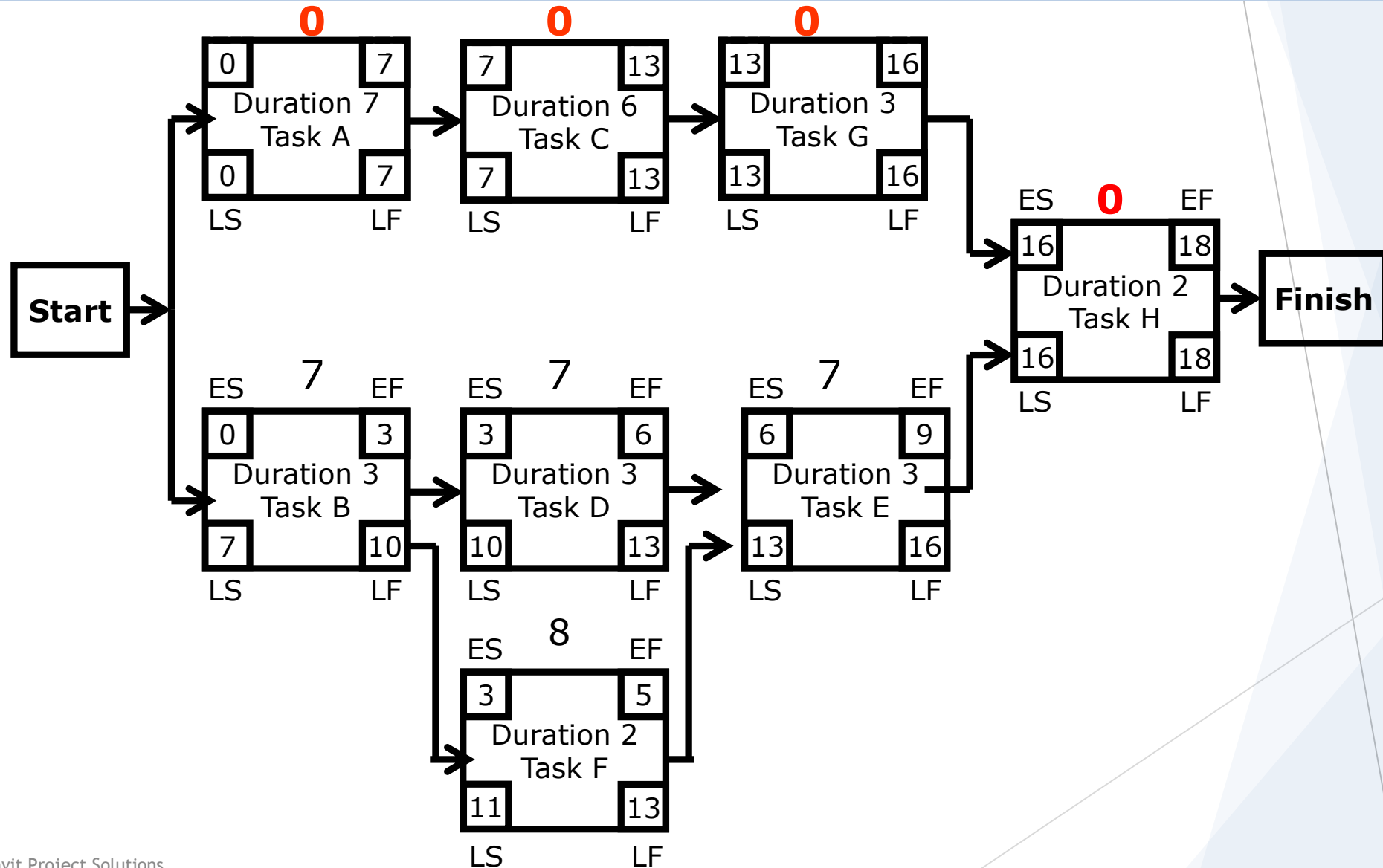
# Critical Path Method (CPM)

# Critical Path Method (CPM)

Critical Path method is a planning technique that is used to demonstrate and view the chronological activities of a program or project, and identifies any possible timing risks and can be used to establish the least amount of time to complete a project.
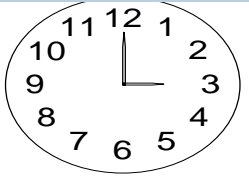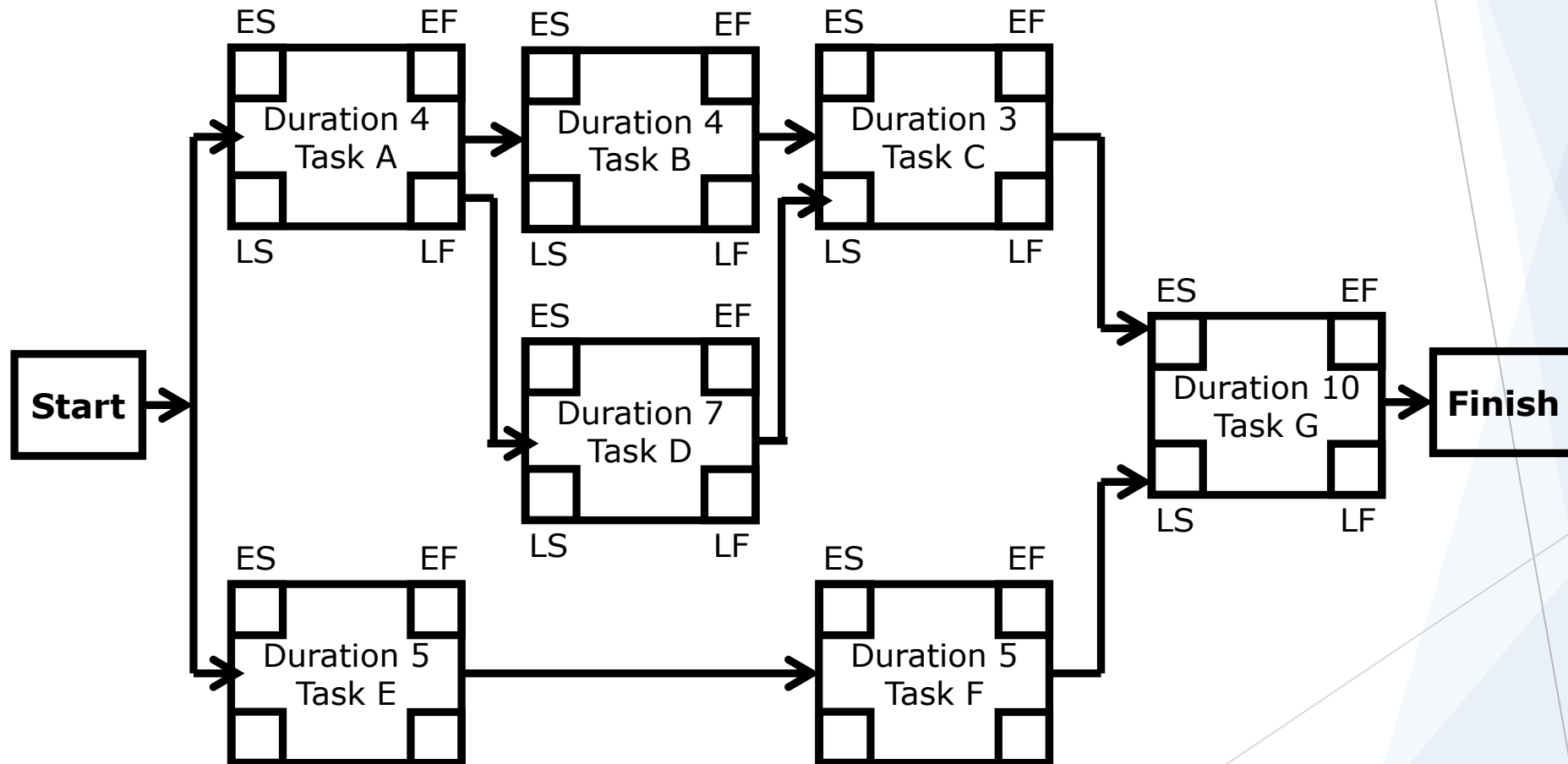
# Critical Path
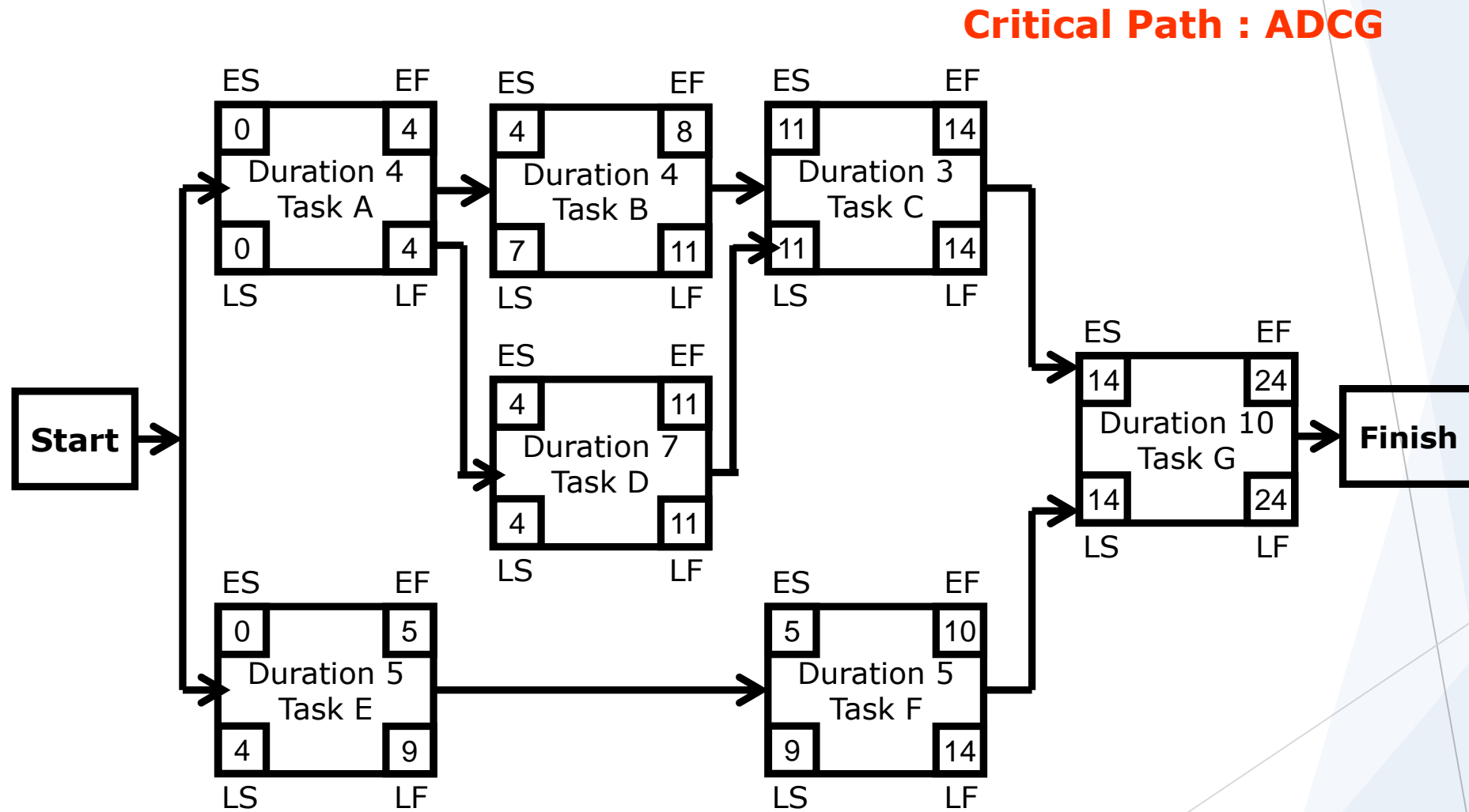
# Critical Path – Longest Path, Zero Float

**5 Minutes**

# Network Exercise - solution

# Facts/Tips for Critical Path

- <u>Total Float</u> is the amount of time the task can delayed without delaying the project finish date.
- <u>Free float</u> is the amount of time a task can slip without delaying the early start of any task that immediately follows it
- It is possible that a <u>zero float activity may not</u> be on critical path
- <u>Longest path & shortest time</u> possible to complete the project
- A project can <u>multiple critical</u> paths
- <u>Difference</u> between late and early is float
- <u>Positive float</u> (the activity can wait to start even after previous activity finishes)
- <u>Negative float</u> (the activity must start before  previous finishes)
- <u>Zero float</u> (the activity must immediately start after the finish of previous one)
- <u>Crashing</u> activities to short the overall duration of project
- <u>Fast-tracking</u> activities to short the overall duration of project
- Be <u>cautious</u> that non-critical activity is not being delayed than the allowed free float
- <u>Take care of</u> sub-critical path or non-critical path
- Manage <u>critical path resources</u> very closely
- <u>Do not overload</u> critical path activity resources
- <u>Avoid multitasking</u> for resources working on critical path activities

# Benefits of PERT/CPM

It Provides following information

▶ Expected Project completion time

▶ Probability of completion before a specified date

▶ The critical path activities that directly impact the completion time

▶ The activities that have slack time and that can lend resources to critical path activities

▶ Activity start and end dates

# Critical Chain Method (CCM)

# Background

▶ Eliyahu Goldratt proposed CCM

▶ This is developed based on the TOC framework

# Why CCM is needed?

- You have CPM available why CCM is needed?

  - You can manage the delays on non-critical path using buffers/floats. BUT

  - How do you manage the delays on critical path?

# Principles Behind CCM

- **Delays accumulate; gains don't advantage**

    – Sequential Steps: Resources are not available to start early

    – Parallel Steps: Three activity each takes 5 days time start in parallel. If one activity takes 10 days and other finish on time, early activities will not be able to take advantage.

    – If above sequential and parallel activities are dependent then affect is magnified

- **Other Time Wasters**

    – Multitasking

    – Student Syndrome

    – Parkinson's Law

# Critical Chain Method

- CPM is developed using the believe that book as many resource as in advance and they will be available when need because it has been promised

- CCM says that if a resource is over booked on any activity he will not be available to work on that activity therefore level the resource on the project activities. Thus resource constrained critical path is critical chain.

- CPM is about hoarding, greed. Therefore over-estimation and project management laws like Parkinson law, Murphy law, Student syndrome applies here.

- CCM is about believe and assumption that it will available when needed but we need to have proper alert system in place.

# CCM Concepts

- **Resource Buffer**: Notify dependent task resources that when I will finish my work on regularly basis and final notification 1-2 days before. So that resource is available to start the work.

- **Safety or project buffer** should be added at the end of critical-chain as non-activity buffer

- **Feeding buffer:** Add buffer where chain of non-critical activity joins the critical path. This way non critical task can be avoided being critical

# How to estimate in CCM

▶ Resource will give t80, t90 estimate.

▶ Half them to get t50 estimate.

▶ Do not put end date to task and let people finish the task as early as possible.

▶ No penalty for finish beyond t50.

▶ Project Buffer should be 50% of the buffer removed from activity.

# Buffer Types

- **Critical Chain** - set of tasks which determines overall project duration, taking into account <u>both precedence and resource dependencies;</u> improvement along Critical Chain will likely result in improvements to the project as a whole; improvements elsewhere will not

- **Project buffer** - protects project commitment dates from fluctuations on the Critical Chain

- **Feeding buffer** - protects Critical Chain from fluctuations on feeding tasks; provides the possibility for Critical Chain tasks to start early

- **Resource buffer** - protects the Critical Chain from lack of availability of required resources; also provides the possibility for Critical Chain tasks to start early

- Feeding buffer on the non-critical path

Critical Chain

Feeding path

Feeding Buffer

If Slack remains, then schedule as late as possible
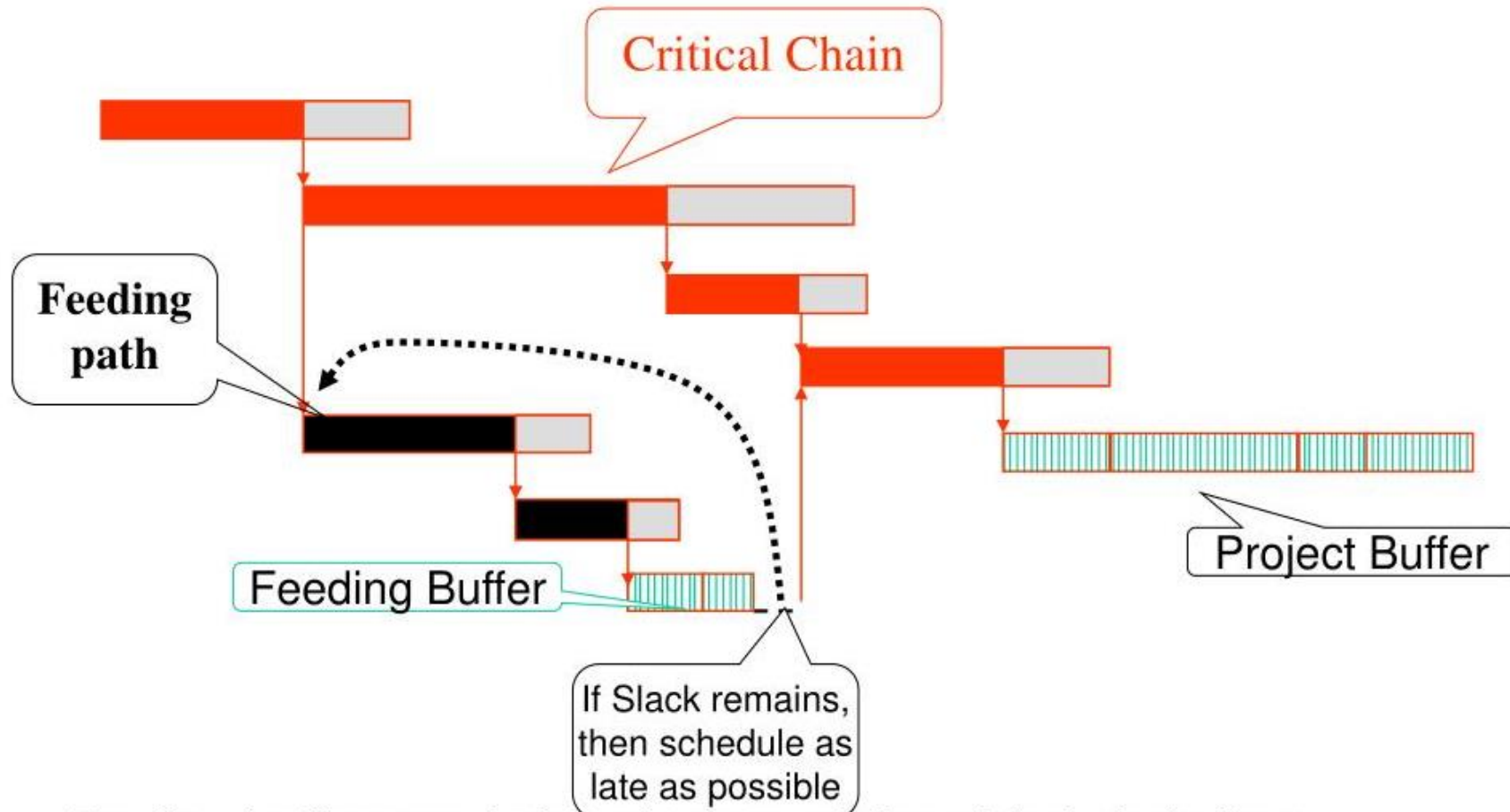
Project Buffer

Feeding buffers are designed to protect the critical chain from delays on non-critical paths

# How to manage CCM

▶ If activity finishes late time is borrowed from project buffer.

▶ If activity finishes early, gained time is added to project buffer

# Microsoft Project Demo

# Am I missing anything?

# Do you have any question?

# Next Program

▶ Project Risk Management

▶ Who should Participate: All who face risk of failure. I think HOD, PM, PMT

▶ Time : 13-Dec, Tuesday  10.00am – 12am.

▶ Location: Admin Block Training Room

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