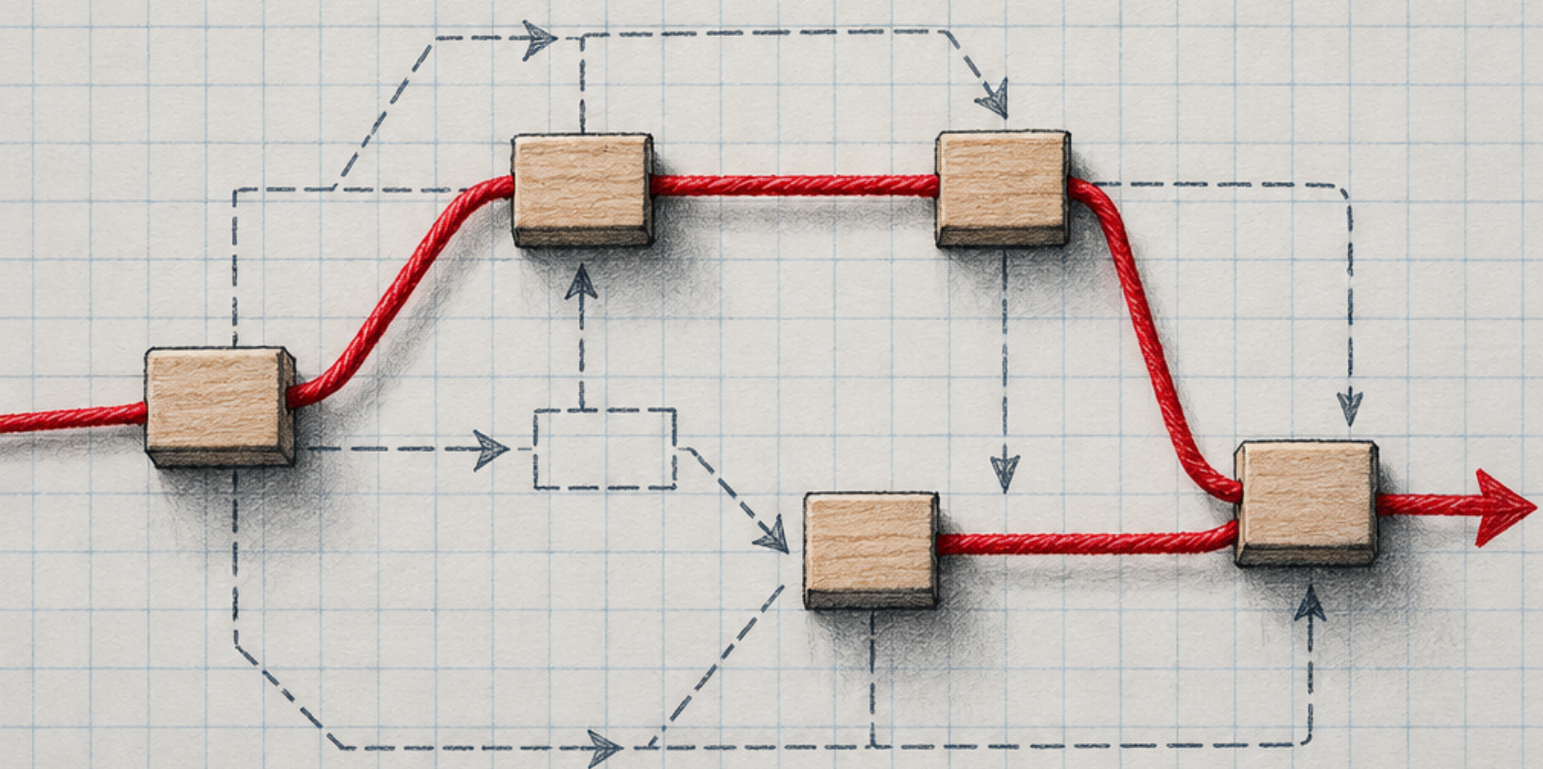
WIKIFREE

NETWORK CALCULATION LAB 29

How to Calculate the Critical Path

A Complete Worked Example



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The question this network answers

Calculate the earliest finish implied by a stated activity model.

Training-portal case

The project confirms requirements, prepares materials and data, configures the portal, validates content and performs an end-to-end test. This guide follows six activities through every calculation.

Scope of the model

The initial model assumes finish-to-start links, zero lag, one working calendar and enough resources for all permitted parallel work. Durations are fixed illustrative estimates.

What you will calculate

Early and late dates, total float, free float and the critical path. Then test duration changes, a resource conflict and a shorter target.

TAKE IT TO YOUR PROJECT

Keep the assumptions beside the network as you work.

List the activities and durations

Use clear work boundaries and one consistent time unit.

The input list

A confirm requirements: 2 working days. B prepare materials: 4. C prepare data: 3. D configure portal: 5. E validate content: 4. F end-to-end test: 2.

Check completion

Each activity finishes when its stated result is ready for the successor. A predecessor called complete with important work remaining makes the calculation misleading.

Check duration

These are working durations, not effort totals or calendar-day promises. The calculation can only be as useful as its inputs.

TAKE IT TO YOUR PROJECT

Write the six durations without looking ahead.

Set the predecessor logic

A joining activity waits for all required predecessors.

The relationships

A has no predecessor. B and C follow A. D follows B. E follows both B and C. F follows both D and E.

Trace the joins

E needs both the materials and prepared data. F needs configured software and validated content. A late required predecessor can control a join even when another branch is complete.

Review the basis

Confirm that each link is required by the work. The model's result changes when dependencies, lags or resource conditions change.

Task	Days	Predecessors
A	2	None
B	4	A
C	3	A
D	5	B
E	4	B, C
F	2	D, E

TAKE IT TO YOUR PROJECT

Trace a complete route from A to F.

Use elapsed-time offsets

Consistent notation avoids inclusive-date counting errors.

The convention

Start at elapsed working time 0. An activity with duration 2 starting at 0 finishes at 2. Its zero-lag successor can start at 2.

The symbols

ES is early start, EF early finish, LS late start and LF late finish. EF = ES + duration; LS = LF - duration in this convention.

Apply the calendar later

Offsets are measured in working time. Use the actual work calendar to translate them to dates and times. Do not mix this model with inclusive day-number arithmetic.

TAKE IT TO YOUR PROJECT

Check the start and finish of a two-day activity beginning at offset 4.

Forward pass: A, B and C

Work from the beginning using the latest required predecessor finish.

Calculate A

A starts at ES 0. With duration 2, EF is 2. That supplies the input needed for both B and C.

Calculate the branches

B has ES 2 and EF 2 + 4 = 6. C has ES 2 and EF 2 + 3 = 5.

Read the result

C finishes earlier, but the next join may still need another predecessor. A branch's early finish alone does not establish when all downstream work can start.

TAKE IT TO YOUR PROJECT

Recalculate B and C from A's finish.

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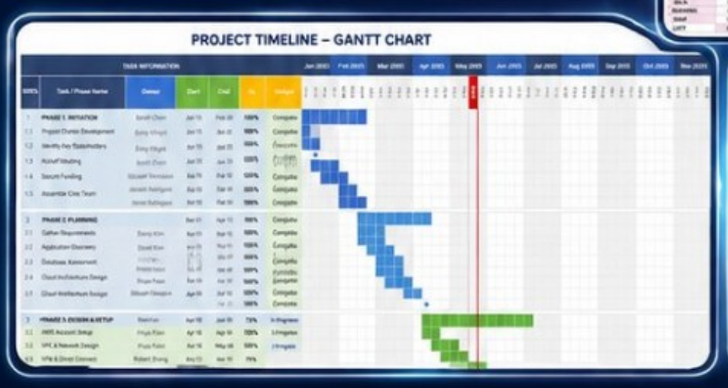
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Forward pass: D and E

Use the maximum predecessor EF at each finish-to-start join.

Calculate D

D follows B only. Its ES is 6 and its EF is 6 + 5 = 11.

Calculate E

E follows B and C. ES = max(6, 5) = 6. With duration 4, E's EF is 10.

Read the join

C is ready at 5, but E waits until B finishes at 6. Taking the earliest predecessor finish would give an invalid start under the stated logic.

TAKE IT TO YOUR PROJECT

Explain why E cannot start at offset 5.

Forward pass: F and finish

The final activity must wait for both required branches.

Calculate F

D finishes at 11 and E at 10. F's ES = max(11, 10) = 11. Its duration is 2, so EF is 13.

Read the forecast

The earliest finish is offset 13 under the current scope, logic, durations, calendar and resource assumptions. It is a model result, not a guarantee against unmodelled uncertainty.

Check the route

The configuration branch arrives last at the final join. That indicates where to investigate the controlling path.

TAKE IT TO YOUR PROJECT

Explain the effect of using E's finish alone to start F.

The early-date table

A compact table lets you check the whole forward pass.

Check the values

A is 0-2; B is 2-6; C is 2-5; D is 6-11; E is 6-10; F is 11-13.

Check every link

For each finish-to-start relationship, the successor's start must be at or after the predecessor's finish. At a join, use all the required predecessors.

Check every duration

EF minus ES must equal the stated duration. A table that violates either logic or duration needs correction before the backward pass.

Task	ES	EF
A	0	2
B	2	6
C	2	5
D	6	11
E	6	10
F	11	13

TAKE IT TO YOUR PROJECT

Verify all six duration differences in the table.

Compare the path durations

The longest complete path controls the earliest finish in this logic model.

Add the paths

A-B-D-F totals 2 + 4 + 5 + 2 = 13. A-B-E-F totals 12. A-C-E-F totals 11.

Read the result

A-B-D-F is the critical path under the initial assumptions. The other path totals help explain why one branch has flexibility before it affects finish.

Avoid a common mistake

Do not add every activity duration. B and C can run in parallel, and D and E also overlap when resources permit.

TAKE IT TO YOUR PROJECT

Show which path would change first if D became shorter.

Start the backward pass

Set the finish boundary, then work from the end toward the beginning.

Set F

Using the earliest project finish as the required finish, F has LF 13 and LS 13 - 2 = 11.

Move to D and E

Both must finish before F starts at 11. D has LF 11 and LS 6. E has LF 11 and LS 7.

Read the late dates

A late date here is the latest time permitted without delaying the offset-13 finish, under the model. A different imposed finish changes the interpretation.

TAKE IT TO YOUR PROJECT

Calculate LS for D and E using their durations.

Backward pass: B, C and A

Use the minimum successor LS at a branching point.

Calculate B

B precedes D and E. LF = min(6, 7) = 6. With duration 4, B's LS is 2.

Calculate C and A

C precedes E, so LF 7 and LS 4. A precedes B and C, so LF = min(2, 4) = 2 and LS 0.

Check the minimum rule

B must satisfy its earliest-starting successor. Using the maximum would allow B to finish after D needs it.

TAKE IT TO YOUR PROJECT

Explain why B's LF is 6 rather than 7.

The late-date table

Put the forward and backward passes together before calculating float.

Read the late values

A LS/LF is 0/2. B is 2/6. C is 4/7. D is 6/11. E is 7/11. F is 11/13.

Reconcile the logic

Each activity's LF minus LS equals its duration. The backward calculation respects the earliest required successor starts and the chosen finish boundary.

Keep the boundary visible

These dates use project finish 13. They do not automatically mean a contractual deadline or resource-constrained schedule has been satisfied.

Task	LS	LF
A	0	2
B	2	6
C	4	7
D	6	11
E	7	11
F	11	13

TAKE IT TO YOUR PROJECT

Check the late-date table against the original durations.

Calculate total float

Total float expresses flexibility relative to the relevant finish boundary.

Use the formula

TF = LS minus ES, or LF minus EF, for this model. Both formulas should produce the same result.

Work the values

A 0, B 0, C 2, D 0, E 1 and F 0 working days. C can shift from ES 2 to LS 4 without moving the offset-13 finish if other assumptions remain unchanged.

Interpret carefully

Float is part of a connected network, not spare time each owner can independently spend without coordination. Several changes can consume the same flexibility.

TAKE IT TO YOUR PROJECT

Verify C and E using both float formulas.

Calculate free float

Free float concerns the next activity's early start rather than only project finish.

Use the formula

For these zero-lag finish-to-start links, FF is the minimum successor ES minus the activity's EF. Treat the final activity under the defined finish convention.

Work the values

C has successor E at ES 6 and its own EF 5, so FF is 1. E has successor F at 11 and EF 10, so FF is 1. B's FF is 0.

Compare with total float

C has TF 2 but FF 1. A second day of C delay can move E's early start while still fitting within E's flexibility before the project finish.

TAKE IT TO YOUR PROJECT

Explain the difference using C's first and second day of delay.

Confirm the critical path

Use dates, float and path totals as cross-checks.

Read the zero-float chain

A, B, D and F have zero total float, connect in sequence and total 13. Their early and late dates match under the chosen finish boundary.

Check the other branches

C and E have positive total float. They still need management and acceptance; a noncritical label does not make their work optional.

Remember the context

Constraints, calendars, resources and changed estimates can alter criticality. Recalculate instead of treating the original red path as permanent.

TAKE IT TO YOUR PROJECT

Trace the zero-float chain and its required handoffs.



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Delay C by one or two days

Use the joins to test what the float actually means.

One-day delay

If C starts one day later, it runs 3–6. E can still start at 6, so the initial early schedule and finish remain unchanged.

Two-day delay

If C starts at 4, it finishes at 7. E then runs 7–11, and F can still run 11–13 because D also finishes at 11.

Read the consequence

The second day moves E's early start but not the project finish. This demonstrates C's free float of 1 and total float of 2 under the stated conditions.

TAKE IT TO YOUR PROJECT

State what would happen if C finished at offset 8 instead.

Increase E's duration

A noncritical branch can become controlling when it consumes its flexibility.

Change the input

Increase E from 4 to 6 days while retaining its ES 6. It now finishes at 12.

Recalculate F

F must wait for max(D 11, E 12), so it runs 12–14. The new earliest project finish is 14.

Identify the new path

A–B–E–F now totals 2 + 4 + 6 + 2 = 14 and controls the finish. The original A–B–D–F path totals 13.

TAKE IT TO YOUR PROJECT

Explain why "E is noncritical" was only a statement about the original model.

Test a shared-resource conflict

A dependency network does not automatically solve resource availability.

Change the resource assumption

Suppose the same specialist must perform D and E, with no overlap possible. After their inputs are ready at 6, the two tasks need 5 + 4 days of that specialist.

Recalculate the join

If both must finish before F, their combined work ends at 15 and the two-day F ends at 17, assuming no other changes.

Read the lesson

The initial finish 13 assumed enough parallel resources. Record and resolve the resource constraint before presenting 13 as a feasible delivery date.

TAKE IT TO YOUR PROJECT

Explain the resource assumption behind each finish forecast.

Try a twelve-day target

Compression must affect work that controls the relevant finish.

Change D

If a credible authorised option reduces D from 5 to 4 days, D finishes at 10. E still finishes at 10.

Recalculate the result

F runs 10–12. A–B–D–F and A–B–E–F now both total 12, creating two controlling paths in this simplified model.

Check the trade-offs

Confirm the added resources, cost, quality and risk before adopting the shorter estimate. Further reducing D alone would leave E controlling the same join.

TAKE IT TO YOUR PROJECT

Identify the next branch to examine before seeking another day of compression.

Translate offsets to dates

Working-time arithmetic needs an actual calendar to become a date promise.

Apply the calendar

Use working days, shift hours, holidays and relevant access rules consistently. The example offsets use elapsed working time from zero.

Check the effect

Thirteen working days span more than thirteen calendar days when weekends are nonworking. A resource or activity calendar can create further differences.

Preserve the convention

Do not mix inclusive day numbering with elapsed offsets. If a tool uses dates and times, inspect the actual working-time settings before comparing it with the manual model.

TAKE IT TO YOUR PROJECT

Write the calendar assumptions that would accompany your finish date.

Update at a status date

Forecast from actual evidence and the remaining work.

Use the facts

At elapsed day 8, suppose D has four working days remaining instead of the planned three. E remains scheduled to finish at 10, and F still needs two days.

Calculate the forecast

D now finishes at 12, so F runs 12–14. The forecast finish becomes 14 under these facts and unchanged assumptions.

Explain the change

The variance comes from the current remaining-work estimate, not merely a percentage-complete label. Inspect causes, options and risks before selecting a response.

TAKE IT TO YOUR PROJECT

Ask the activity owner for the evidence behind the remaining duration.

Your complete answer check

Use the summary to verify a fresh calculation of the original network.

Original result

The earliest finish is 13. Critical path is A-B-D-F. Total float is A 0, B 0, C 2, D 0, E 1 and F 0.

Consistency checks

Every early and late date must match its duration and dependency logic. C's free float is 1 even though its total float is 2.

Use the model responsibly

Changing E to 6 days gives finish 14. A nonoverlapping shared resource for D and E gives 17. Reducing D to 4 with separate resources gives 12.

TAKE IT TO YOUR PROJECT

Rebuild the network and explain each answer before consulting the summary.