

Project Management

Lecture 6 Project Planning and Network Diagrams

Dr. Andre Samuel

Previous Lecture

- Project Charter:
 - Purpose
 - Main Element
 - Template

In this Lecture

- Planning Process
- Network Analysis/Critical Path Analysis

**‘The Plan is nothing, Planning is
everything’**

Lord Nelson and General Eisenhower

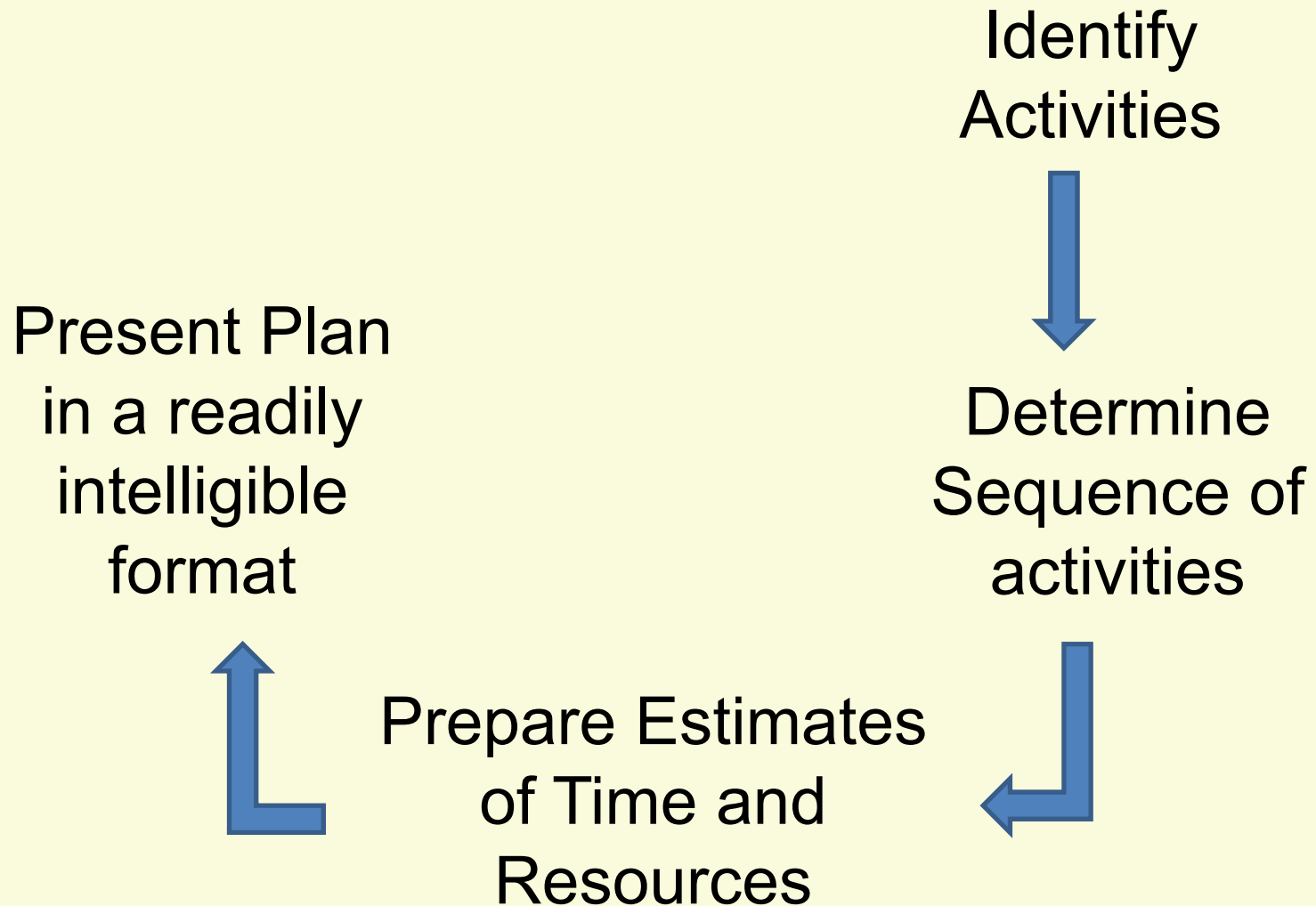
Planning

- It is about **sequencing** project activities and milestones into a sensible and logical order
- It involves linking activities to form a project network to show how different activities are related to each other
- Planning will establish the **timing** of the activities and resource requirements

Purpose of Planning

- Its is used to find the expected **project duration and milestone dates**
- It is used to make sure that the project is completed by a target date e.g. opening of the Olympic Games
- To get stakeholder commitment

The Planning Process



Identifying Activities

- Scope of works
 - WBS

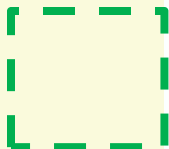
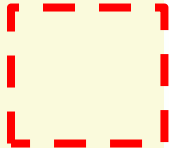
Project Scope Management

- Scope management is mandatory; without scope management there is no project
- “ensuring that enough, but only enough, work is undertaken to deliver the project’s purpose successfully” Turner (1999, pg. 93)
- Through the process of managing the scope the owner’s requirements are converted first into the **definition of the new asset**
- Secondly, into a **statement of the work** required to construct and commission that asset

- In the project context scope may refer to:
 - **Product scope**- the features and functions that characterize a product or service
 - **Project scope**- the work that must be done to deliver a product with the specified features and functions

Scope of Works- Point Fortin Highway

PHASE #	SCOPE OF WORKS
1	<p>Section 1 - Construction of a 4-Lane Highway approx. 5km from Golconda to Debe; Construction of an underpass at Papourie Road and an Interchange at Debe.</p> <p>Section 2A (NEW) - Widening of the South Trunk Road between Dumfries Road and Paria Suites from 2 lanes to 4 lanes for approx. 3.1km.</p> <p>Section 2B - Widening of the Southern Main Road from Paria Suites to Godineau River, including the reconstruction of the Godineau Bridge</p>
2	<p>North of the Tarouba River Bridge to Mon Desir Interchange, inclusive of Tarouba River Bridge and Mon Desir Interchange; Siparia Interchange and Connector Road; Fyzabad Interchange and Connector Road.</p> <p>La Brea Interchange to Dunlop Roundabout Point Fortin (Inclusive of La Brea Interchange).</p>
3	<p>Godineau River to Tarouba Bridge not inclusive of Godineau River Bridge and the Tarouba River Bridge.</p>
4	<p>Penal Interchange and all other segments not previously identified in Phases 1, 2 & 3. La Brea Interchange to Mon Desir Interchange, not inclusive of La Brea Interchange and the Mon Desir Interchange.</p>

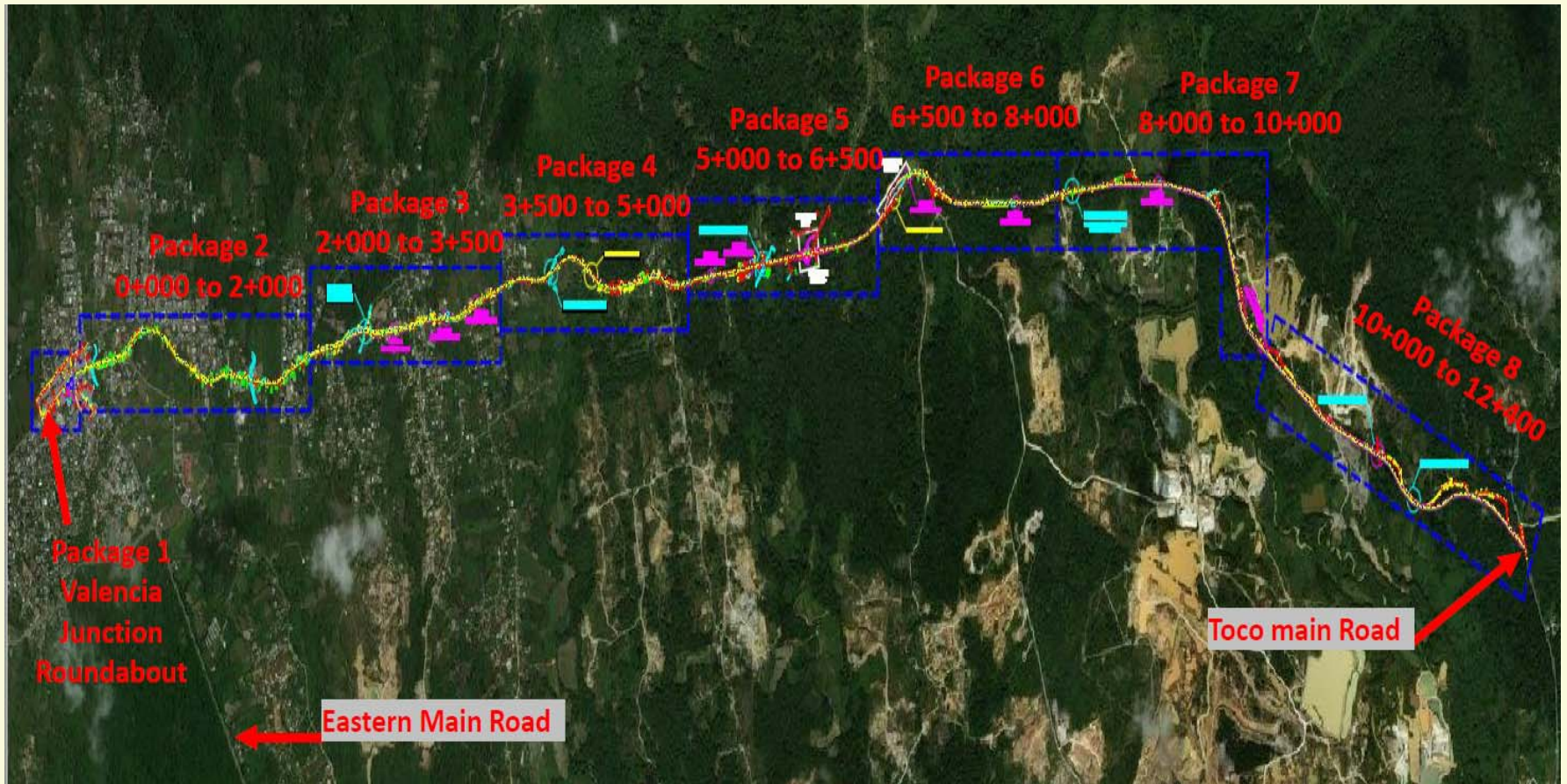


Point Fortin Highway



Construction of Valencia to Toco Road

<http://www.mowt.gov.tt/documents/Valencia%20Main%20Road%20Upgrade%20Project%20Presentation%20.pdf>



Construction of Valencia to Toco Road: Packages 1 to 8

<https://www.opm.gov.tt/pm-rowley-turns-sod-for-valencia-to-toco-upgrade>

- **Phase 1 is separated into 4 packages which consist of:**
 - The construction of a **roundabout at Valencia Junction** along with associated concrete and drainage works; Improvement of drainage network North of Valencia Junction
 - **Milling and paving from the Intersection of Eastern Main Road and Toco Main Road to the 2km mark** along the Toco Main Road; Construction of a car park inclusive of a perimeter fence and relocation of the vegetable stall
 - **Road widening and reconstruction** along with associated drainage works from the 2km mark to the 3.5km mark
 - **Road widening and reconstruction** along with associated drainage works from the 3.5km mark to the 5.0km mark inclusive of slope stabilization at 4.2km mark

- **Phase 2 is also separated into 4 packages which consist of:**
 - **Road widening and reconstruction** along with associated drainage and concrete works from the 5km mark to the 6.5km mark along the Valencia Main Road; Construction of a roundabout at Chainage 5+950 to facilitate a controlled intersection in anticipation of the forthcoming Ojoe Connector Road
 - **Road widening and reconstruction** along with associated drainage and concrete works from the 6.5km mark to the 8km mark inclusive of slope stabilization at 6.6km mark
 - **Road widening and reconstruction** along with associated drainage works from the 8km mark to the 10km mark
 - **Road widening and reconstruction** along with associated drainage works from the 10km mark to the 12.4km.

San Fernando to Princess Town H/way



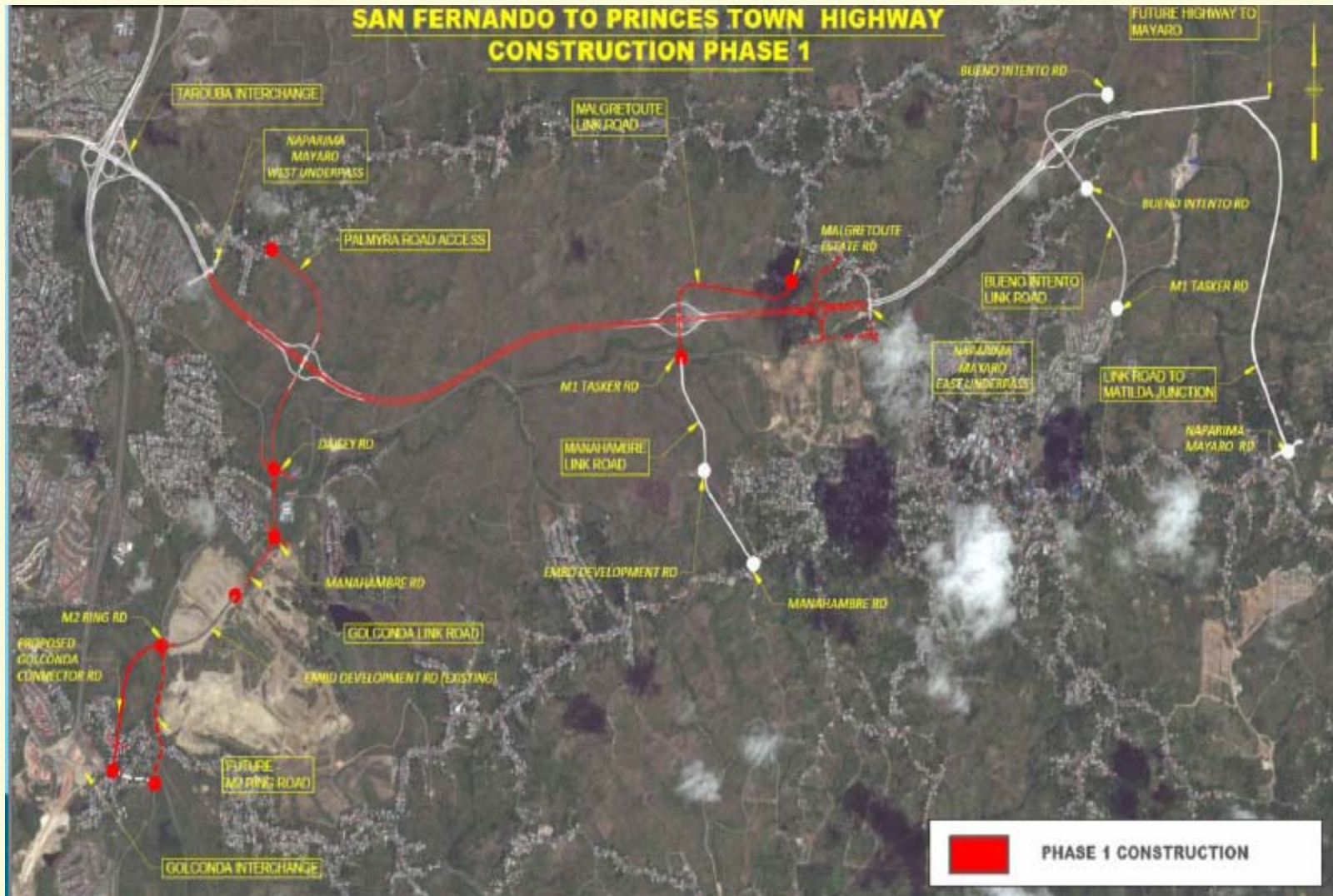
Overall Scope of Works

- ▶ Construction of approximately 11 km of dual lane carriageway from Tarouba to Buen Intento
- ▶ Construction of underpasses and interchanges at Palmyra, Malgretoute and Buen Intento
- ▶ Upgrade of the Tarouba Interchange
- ▶ Construction of 4 Link Roads:
 - Golconda to Palmyra;
 - Malgretoute to Manahambre Road
 - Buen Intento to M1 Tasker Road and
 - Buen Intento to Matilda Junction

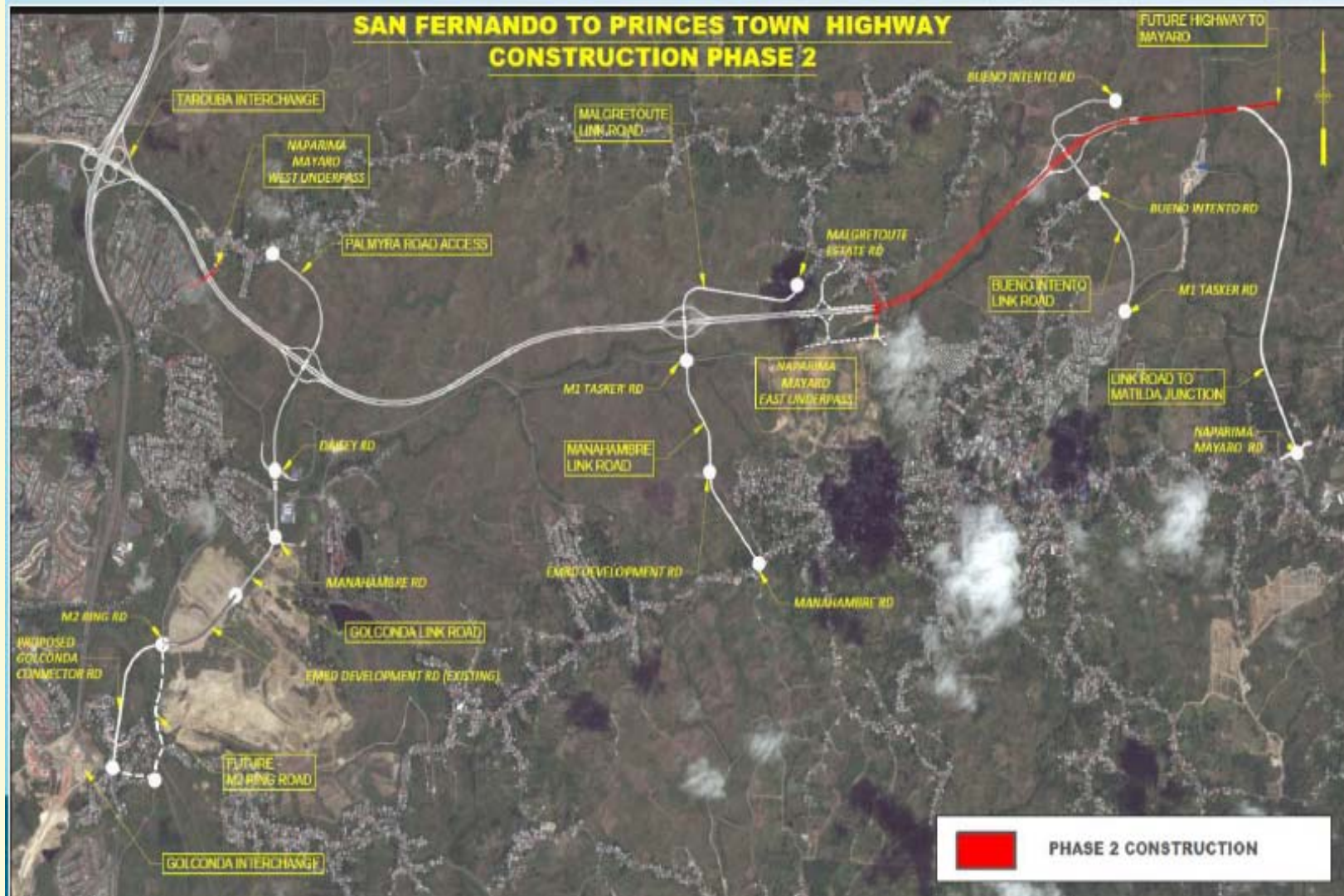
Project Duration and Phasing

- ▶ Project would be divided into three (3) phases:
 - Palmyra to Malgretoute (including Golconda to Palmyra Link Road)
 - Malgretoute to Buen Intento
 - Interchanges and remaining link roads
- ▶ Proposed start date:
 - July 2015
- ▶ Project Duration:
 - Phase 1 - 1.5 to 2 years
 - Phase 2 - 1 to 1.5 years
 - Phase 3 - to be determined

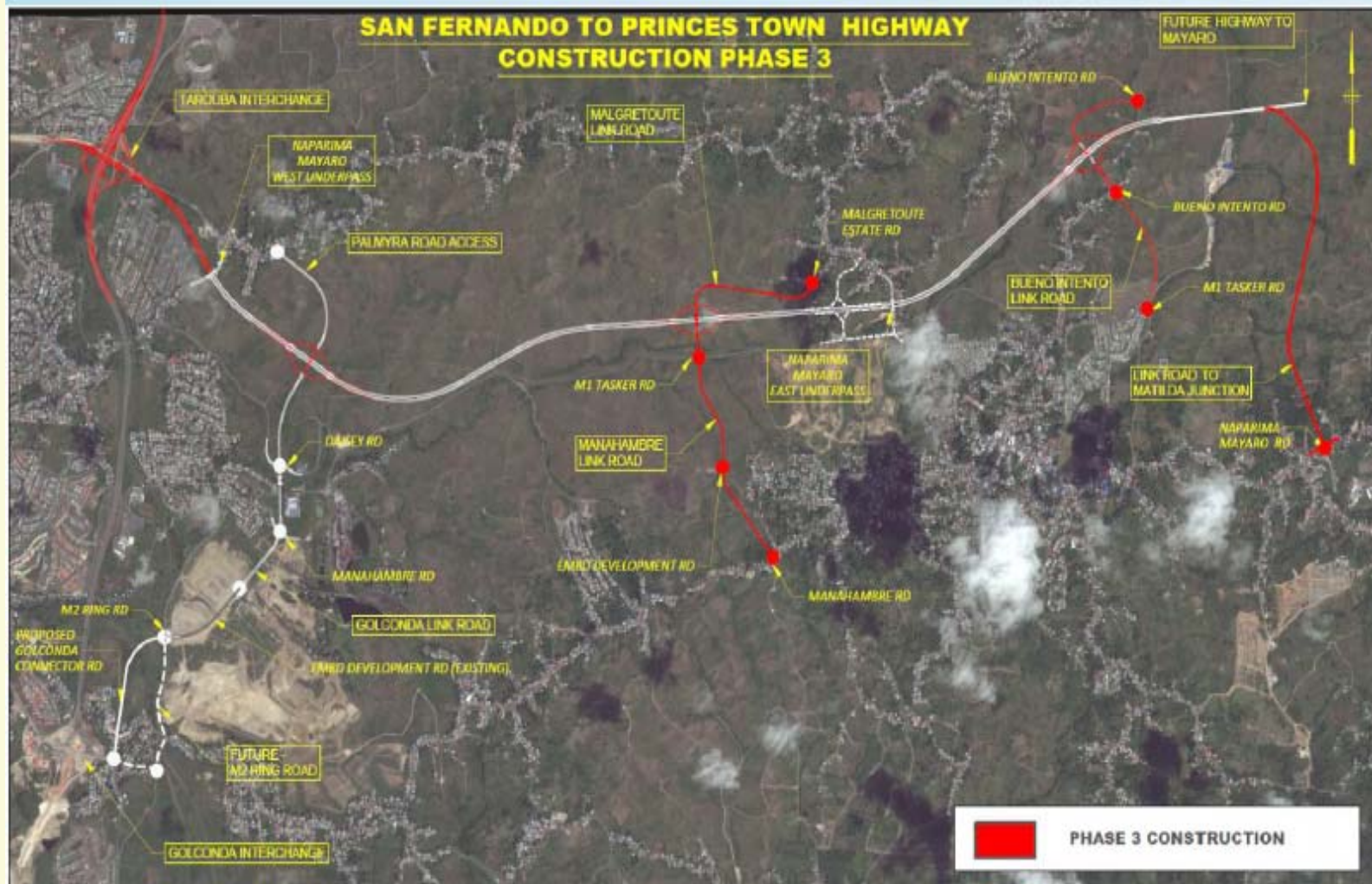
SAN FERNANDO TO PRINCES TOWN HIGHWAY CONSTRUCTION PHASE 1



SAN FERNANDO TO PRINCES TOWN HIGHWAY CONSTRUCTION PHASE 2



SAN FERNANDO TO PRINCES TOWN HIGHWAY CONSTRUCTION PHASE 3



WBS-'Chunking'

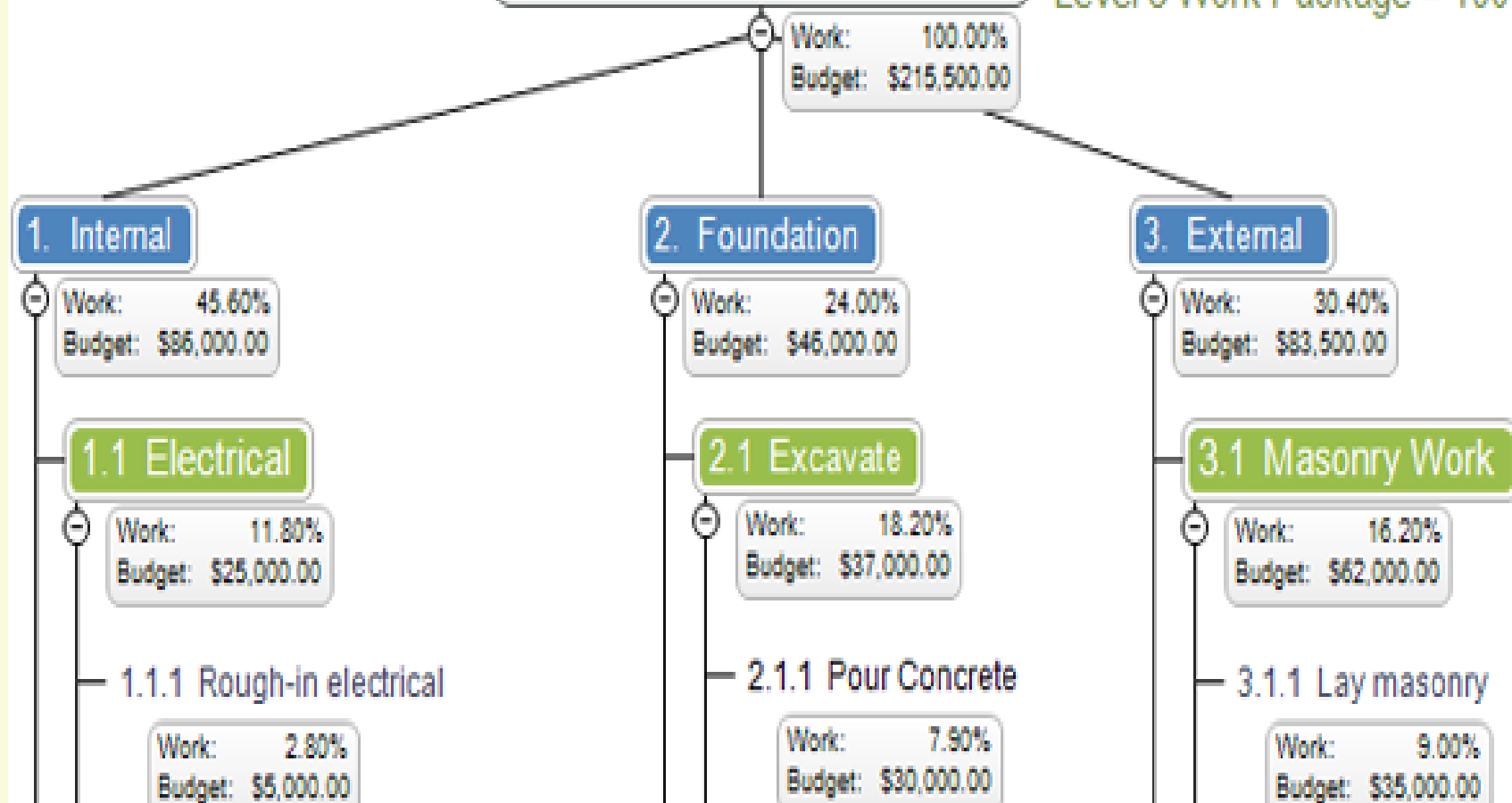
- Hierarchical tree of all the tasks needed to complete a project
- Each level progressively gets more and more detailed until the bottom level is reached which shows all the smallest day to day tasks
- Maps out a view of Project Stages, Phases, Work Packages, Activity ,Tasks or Steps

Construction of a House

Level 1 Deliverables = 100%

Level 2 = 100%

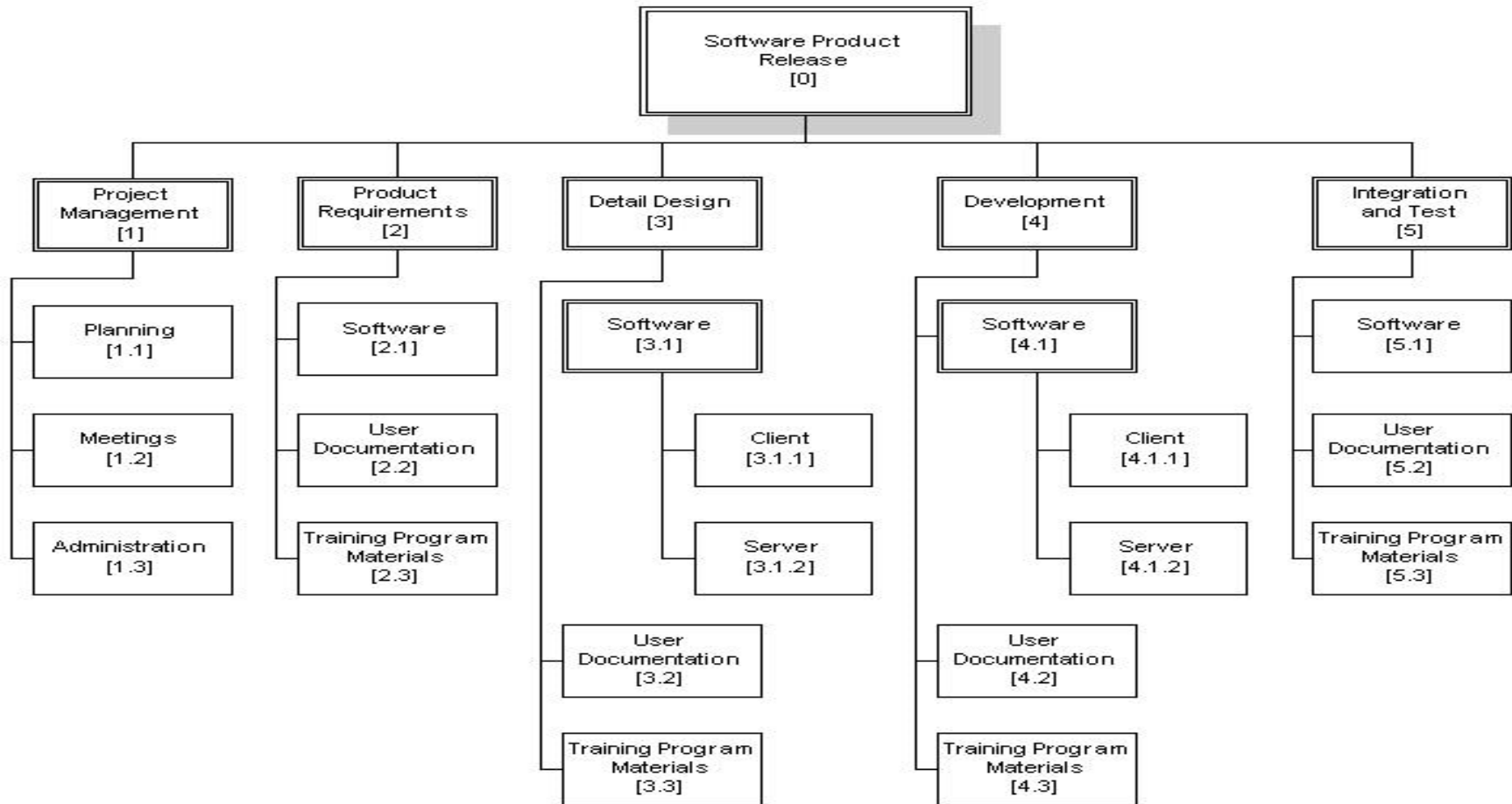
Level 3 Work Package = 100%



Group Discussion

- Using the Scope of Works document for the Guava, Point Fortin Project:
 - Discuss the major tasks and sub task to complete the project
 - Visualize what the WBS would look like.

Example WBS



Project scope statement includes the following:

- **Product scope description**- Progressively elaborates the characteristics of the product, service, or result described in the project charter and requirements documentation.
- **Acceptance criteria** - A set of conditions that is required to be met before deliverables are accepted.
- **Deliverable** - Any unique and verifiable product, result that is required to be produced to complete a process, phase, or project.

- **Project exclusion** - Generally identifies what is excluded from the project. Explicitly stating what is out of scope for the project helps to manage stakeholders' expectations.
- **Constraints** - for example, a predefined budget or any imposed dates or schedule milestones that are issued by the customer or performing organization

Scope Change Control

- Scope Creep- subtle changes made to product without approvals
- All change request should be documented and evaluated against the project constraints
- Essentially, an impact assessment
- The assessment will determine whether or not the change would be implemented
- Use change request forms, change control log

Tasks Dependencies- sequencing activities

- A relationship between two linked tasks
- Linked by a dependency between finish and start dates
- Defining task dependencies correctly results in a schedule that's easy to maintain regardless of what happens or how quickly
- There are four types of dependency: Finish to Start, Start to Start, Finish to Finish and Start to Finish

Chronology vs Control

- Although tasks are called either successors or predecessors, a dependency is not really about chronology, but about control.
- A task dependency specifies which of two tasks controls the scheduling of the other.
- The independent task (the predecessor) determines the scheduling of the dependent task (the successor).
- A predecessor can occur before, at the same time as, or after its successor.

Task dependencies vs Date Constraints

- Applying dependencies to tasks is preferable to setting hard dates in a schedule.
- Fixed dates applied to tasks, called date constraints, quickly increase the effort to maintain the schedule.
- If you use date constraints, you often must manually recalculate dates when the schedule changes.
- However, date constraints don't always cause schedule problems.
- For example, when tasks occur on specific dates, such as training classes or conferences, date constraints keep those events tied to the correct dates on the calendar.

Dependency Types

Finish-to-
Start (FS)

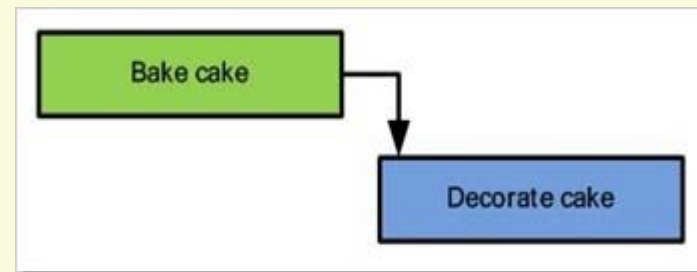
Start-to-
Start (SS)

Finish-to-
Finish (FF)

Start-to-
Finish (SF)

Finish-to-start (FS)

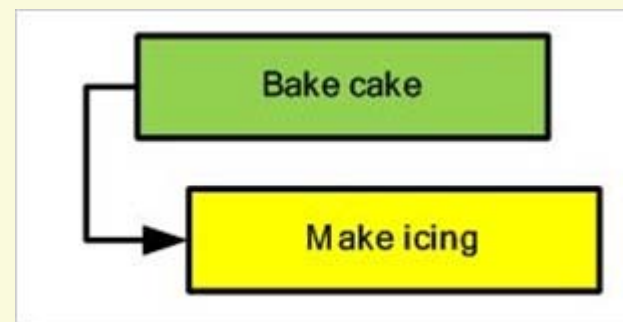
- This type of dependency is the most common, perhaps because control and chronology work in the same direction in this dependency. After the predecessor task finishes, the successor task starts.
- This means activity A must finish before activity B has permission to start



- For example:
 - After members of a construction crew set up the concrete forms for a foundation, they start to pour the concrete into the forms.

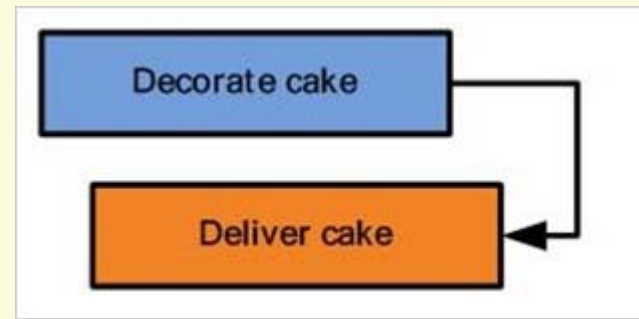
Start-to-start (SS)

- This type of dependency indicates that the start of one task triggers the start of the second task. A lag time between tasks is often used with this type of dependency.
- This means that once activity A has started, activity B can also start.
- For example:
 - Members of a road crew start to place traffic cones to close a lane on the highway. Ten minutes (lag time), after they start the line-painting machine starts to paint lines.



Finish-to-finish (FF)

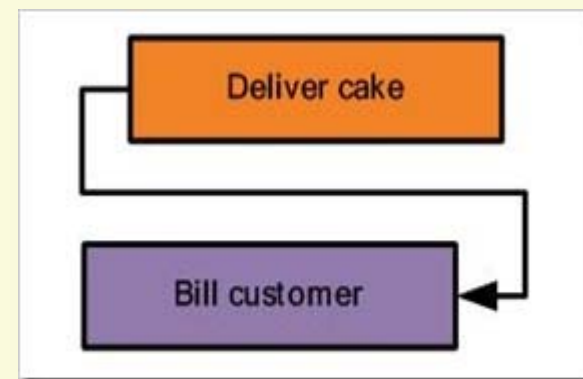
- This type of dependency includes one task that continues only as long as another task is in progress.
- This means activity A must finish before activity B can finish



- For example:
 - Traffic flaggers direct traffic until construction work is completed.
 - In a software project, two programmers may be working on two different modules. If module B makes use of module A, then module B cannot be completed until the first programmer has completed module A.

Start-to-finish (SF)

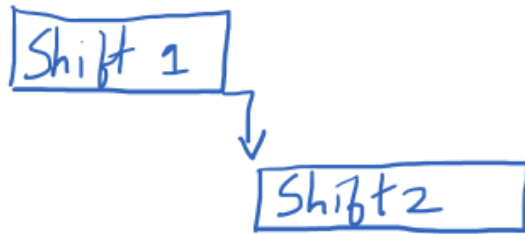
- This type of dependency turns most people's concept of predecessor and successor tasks upside down. The confusion occurs because in most start-to-finish cases, the predecessor occurs after the successor. So, **the start of the predecessor controls the finish of the successor.**
- This means that as long as A has started, we can proceed to finish B.
- Activity A must start before Activity B can finish.



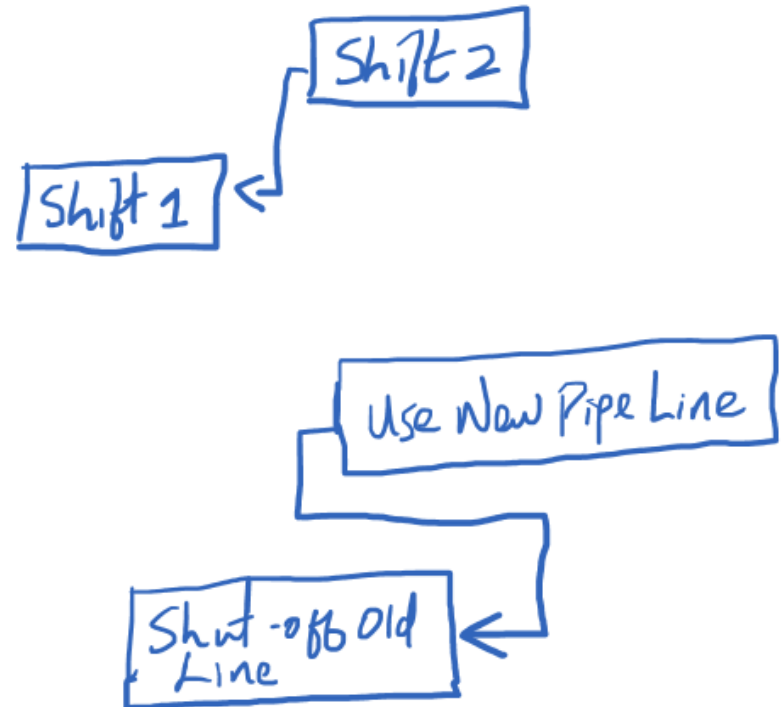
Examples of S-F

- Say you're building a new gas pipeline. You would first finish construction and implementation of the new pipeline before you would begin shutting down and breaking down the old pipeline
- Similarly, implementation of a new accounting system has to be completed before you can begin turning off the old system
- The start of the new shift of the security guard signal the finish shift of the current security guard. ie. if the next shift security guard didn't turn up, the first shift security guard has to continue his duty.

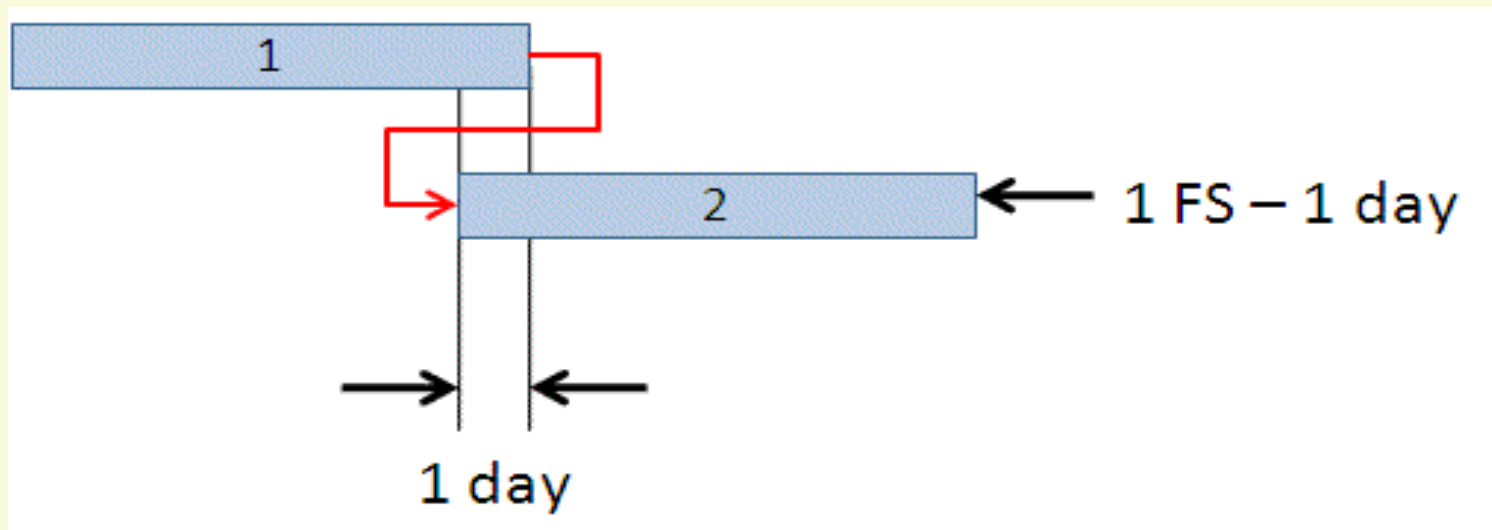
FS



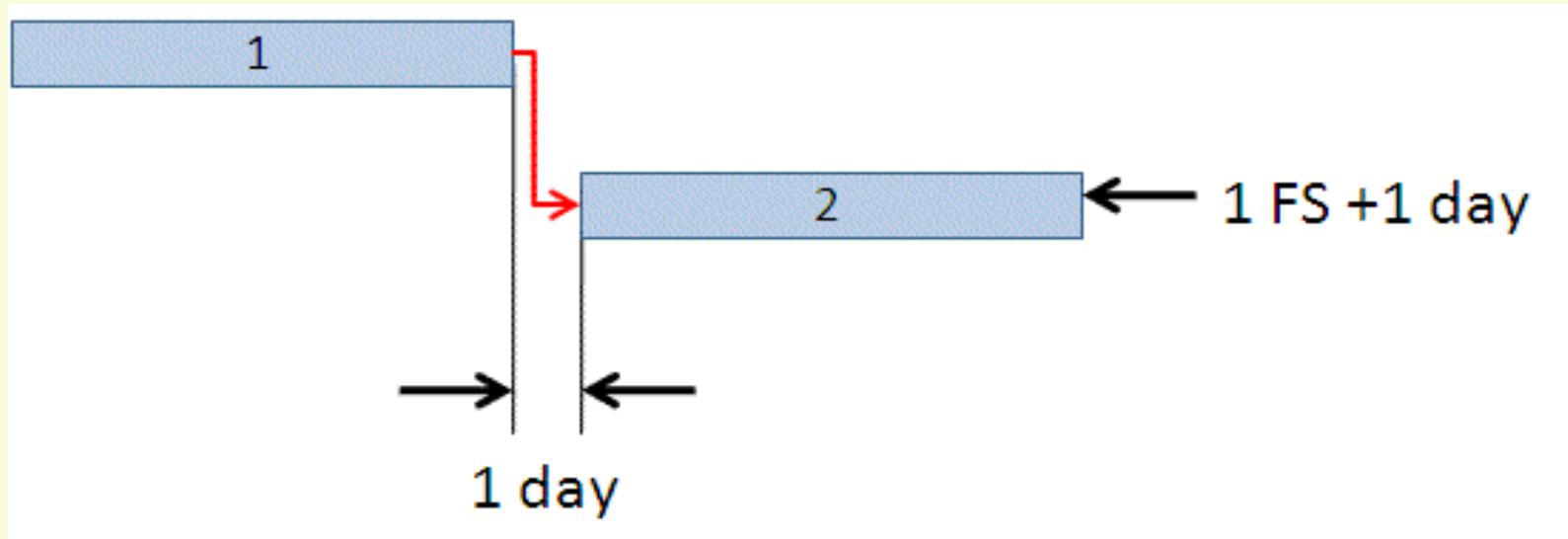
SF



- **Lead Time-** is overlap between tasks that have a dependency.
 - For example, if a task can start when its predecessor is half finished, you can specify a finish-to-start dependency with a lead time of 50 percent for the successor task. You enter lead time as a **negative value** in MS Project.



- **Lag Time-** is a delay between tasks that have a dependency.
 - For example, if you need a two-day delay between the finish of one task and the start of another, you can establish a finish-to-start dependency and specify two days of lag time. You enter lag time as a **positive value** in MS Project



Project Planning Tools

- Network Diagram (Critical Path Analysis)
- Gantt Charts

Network Diagrams

- Network diagram show the relationships between activities
- They are used to:
 - calculate the Project Duration
 - Reveal critical tasks which warrant greater management attention

Activity of Node Method

- In this approach each activity of the project is represented by a Node i.e. an activity box.

EST	DUR	EFT
TASK NAME		
LST	FLOAT	LFT

- Dur = Duration in time units
- EST = Earliest Start Time
- EFT = Earliest Finish Time
- LST = Latest Start Time
- LFT = Latest Finish Time

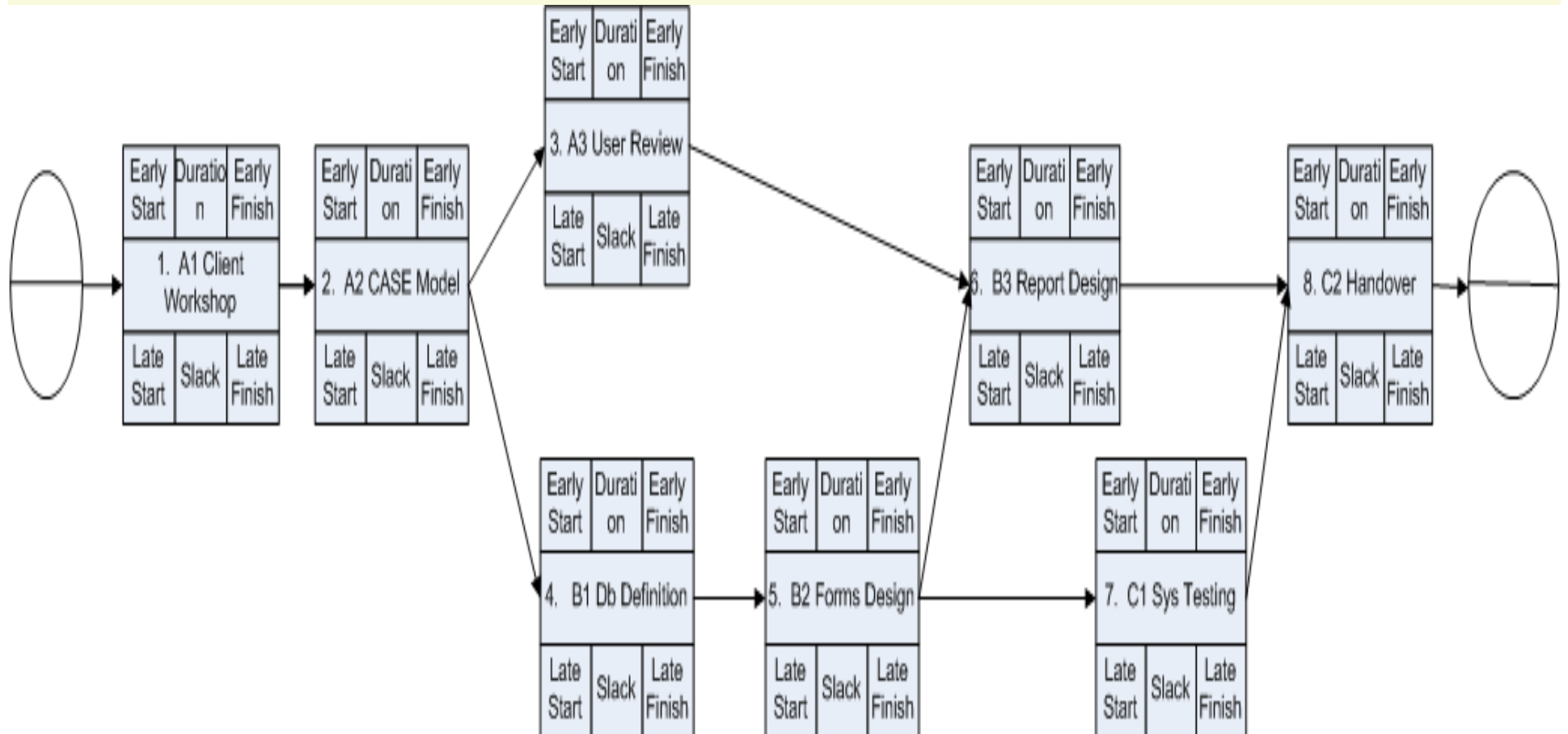
Labels for Activity Box

- **EST**- The earliest point in time when the schedule activity can begin
- **EFT**- The earliest point in time when the schedule activity can be complete
- **LST**- The latest point in time when the schedule activity can begin so as not to delay the project completion date or any constraint.
- **LFT**- The latest point in time when the schedule activity can finish so as not to delay the project completion date or any constraint.

Dependency Table for a Software Project

ID	TASK NAME	DURATION	PREDECESSORS
1	A1 CLIENT WORKSHOP	10	-
2	A2 CASE MODEL	15	1
3	A3 USER REVIEW	10	2
4	B1 Db DEFINITION	10	2
5	B2 FORMS DESIGN	20	4
6	B3 REPORT DESIGN	5	3,5
7	C1 SYSTEM TESTING	20	5
8	C2 HANDOVER TO CLIENT	5	6,7

Network Diagram



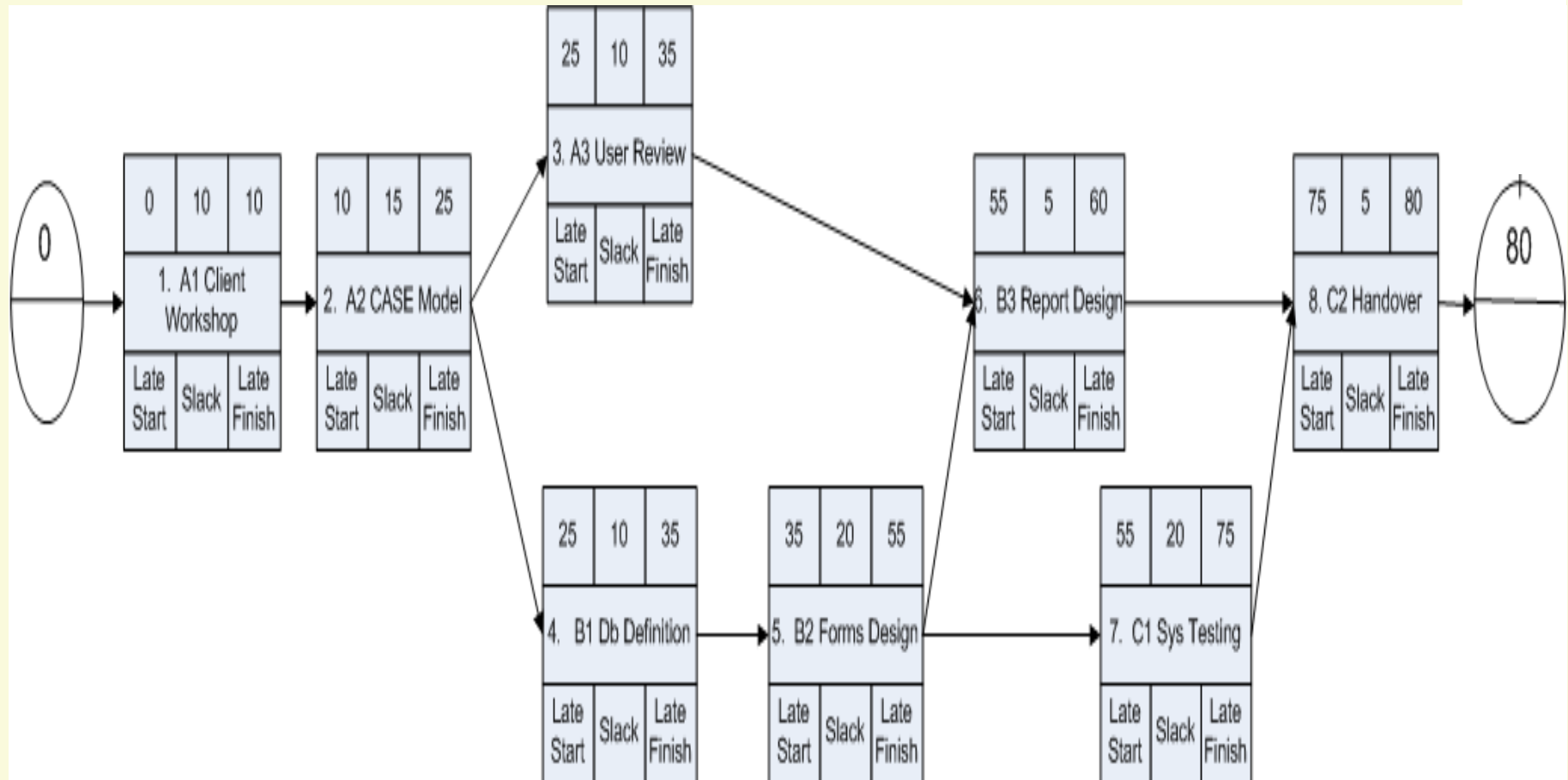
Two Parts to the Analysis

- Forward Pass
 - Calculates the Duration of the Project
- Backward Pass
 - Calculates the slack/float for each task and shows the critical path

Forward Pass to calculate EST and EFT

- The EST for the first activity is zero
- EFT for an activity is always found by adding its duration to its EST. i.e.
EFT = EST + Duration
- The EST for all remaining activities is the same as the EFT of its immediate predecessor i.e. **EST = EFT of preceding activity**
- In the case of convergence, **the EST is taken from the path having the highest EFT**
- The EFT of the last activity is the duration of the project

Forward Pass



Reverse Pass to calculate LST and LFT

- The LFT for the last activity is the same as its EFT
- The LST for an activity is always found by subtracting its duration from its LFT i.e.

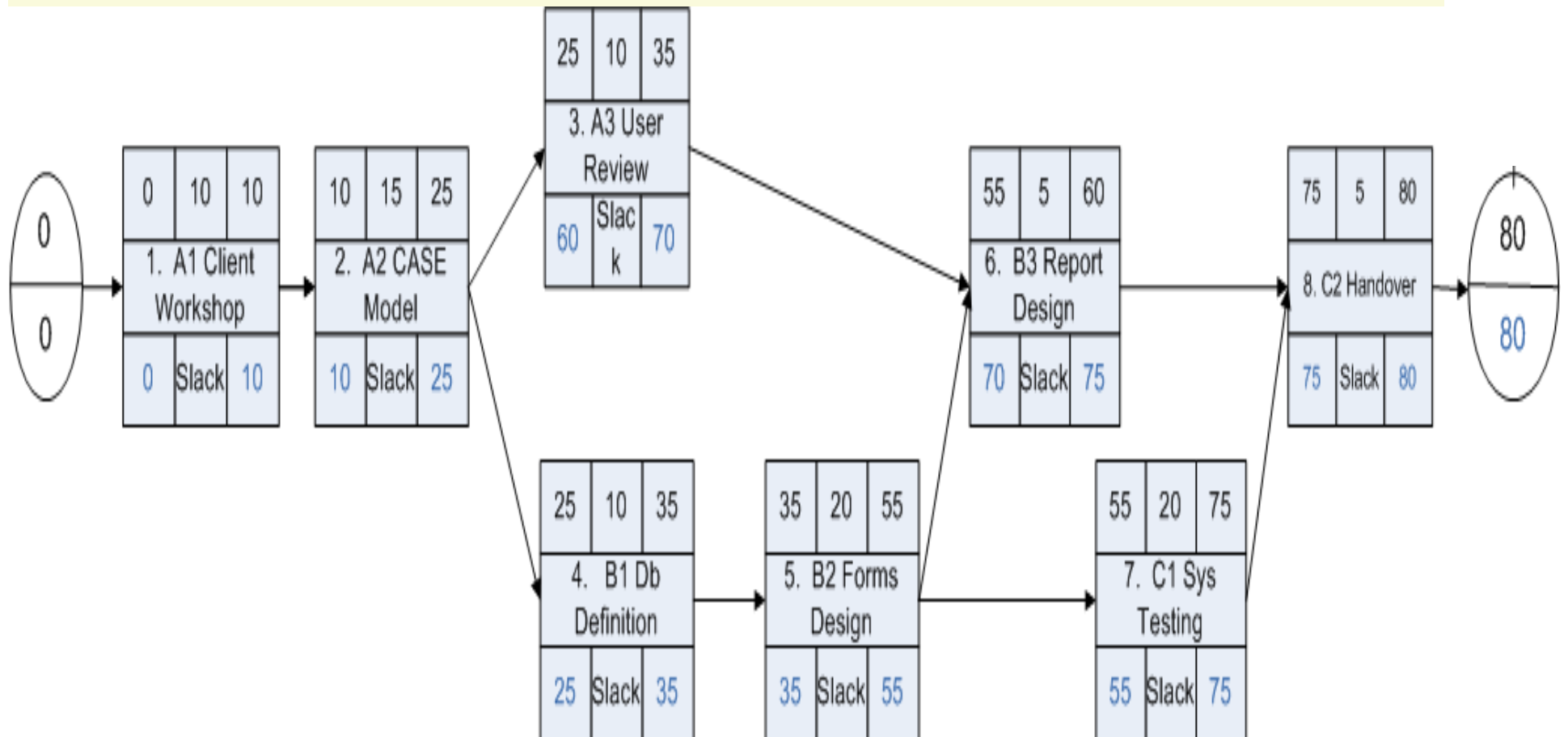
$$\text{LST} = \text{LFT} - \text{Duration}$$

- The LFT for all remaining activities is given by the LST of its immediate successor i.e.

$$\text{LFT} = \text{LST of the successor activity (moving from start to finish)}$$

- In case of convergence, **the LFT is taken from the path having the lowest LST**

Reverse Pass



Float/Slack

- This is the spare time for an activity
- This means that a certain amount of delay can be tolerated without affecting the expected project duration

Types of Float/Slack

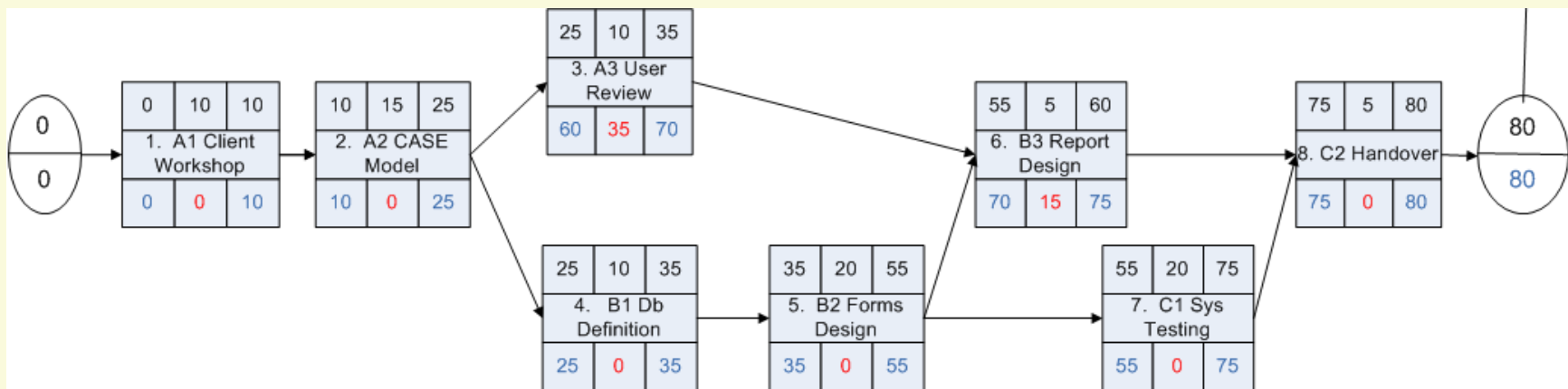
- **Total Float-** Total float is the period by which an activity can shift in its timing without affecting the relevant schedule completion date (either a constraint, or the project completion).
- **Free Float-** Free float is the period by which an activity can shift in its timing without affecting the Early Start of any succeeding activity or event.

Calculating Float

- **Float/Slack** = LST – EST

OR = LFT - EFT

Float/Slack



Defining a Critical Task

- A critical task is one where $EFT = LFT$. Thinking this through it means that the activity **MUST** start on that date, the EST or the entire project duration is affected
- **Simply put an activity is Critical when the Float = 0**
- A non-critical task is where $EFT < LFT$. This means that although the activity could start as early as the EST, providing it finishes by the LFT the project could still finish on schedule

Defining the Critical Path

- **Critical Path-**
 - The critical path is the longest sequence of activities from commencement to completion of the project
 - The critical path is the series of tasks (or even a single task) that dictates the calculated finish date of the project.
 - That is, when the last task in the critical path is completed, the project is completed.
 - It is identified by the series of task where the Float or Slack is 'Zero'

Importance of Network Analysis

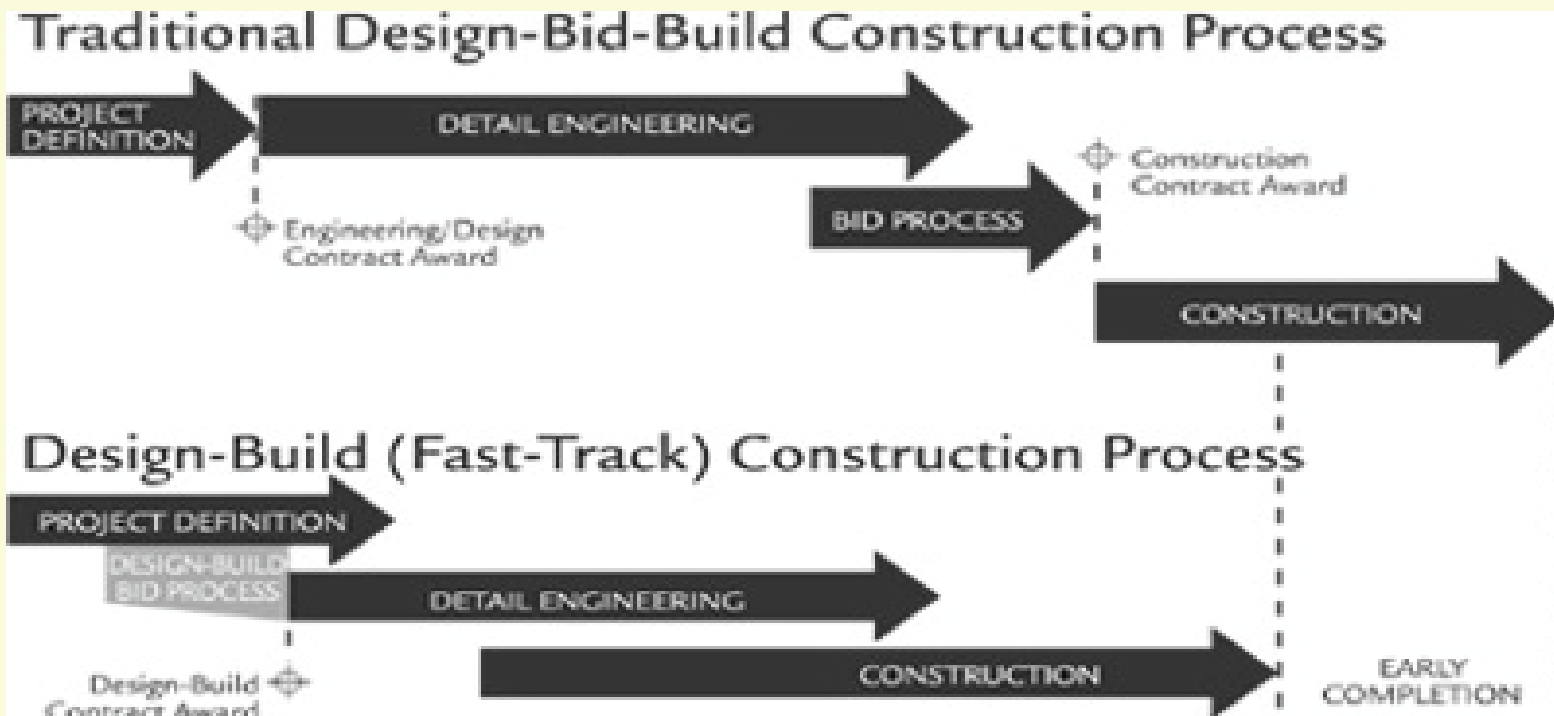
- **Critical activities** must stay on schedule as they are most likely to cause delays
- Project managers must concentrate their time on these tasks
- Conversely, knowing the float for non-critical activities will let the project manager know how long they can be delayed for before impacting the entire project.

Project Crashing

- This means adding resources to one or more critical path activities
- In the short term this may actually reduce productivity because of the learning curve effect
- Crashing incurs additional cost, but must be weighed up against finishing late

Fast Tracking

- Shortening the project duration by overlapping project activities or phases
- Perform critical path tasks in parallel that were originally planned sequentially





<http://www.youtube.com/watch?v=jO8syXdZoh0>

Optimizing through Resource Levelling and Smoothing

- When you assign resources (staff) to a project it can often lead to over allocation or staff conflict
- For example resource A is assigned to an activity on Project XYZ on a day, for 8 hours. This resource is also allocated to Project LMN for 8 hours in a day
- Or resource A is assigned to work on multiple activities on a project occurring at the same time
- **How do we resolve this?**

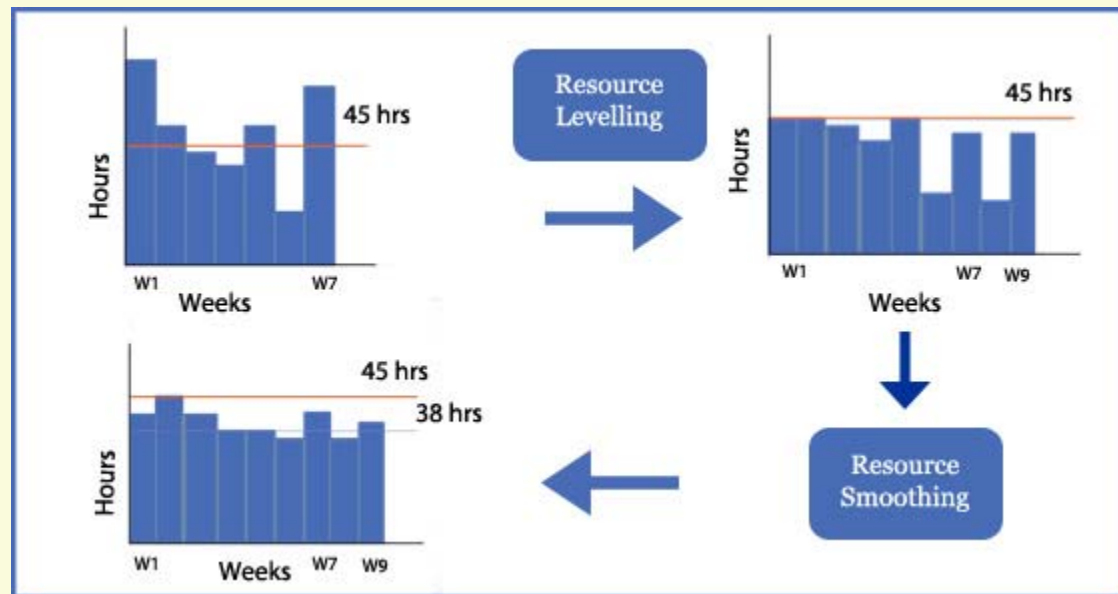
Resource Levelling

- 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
- This involves removing the over allocation of resources. This can be done by:
 - Delay certain task
 - Assign a different resource
 - Change task dependencies

Resource Smoothing

- Resource smoothing means the uniform distribution of resource allocation over the project
- Let's say that you have a resource working 30 hours this week, 10 hours next week, and 20 hours the week after next week. When you apply resource smoothing, the resource will work 20 hours this week, 20 hours next week, and 20 hours the week after. You see, the total amount of hours remains 60 hours, but is more uniformly distributed over the weeks.

Levelling and Smoothing Scenario



How to shorten project duration?

- Project crashing
- Fast Tracking
- Resource Levelling and Smoothing
- Re-scoping- reduce scope to reduce time
- Increased procurement- outsource work
- Lean thinking – redesign work processes
- Renegotiate target dates if possible