Management of ICT Projects

Resource management

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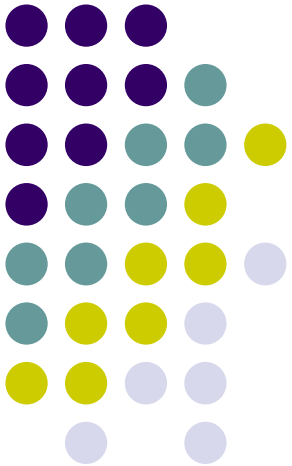
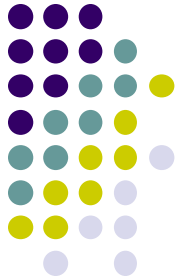


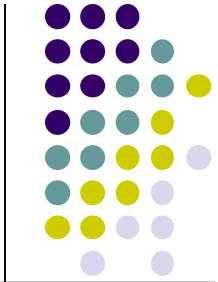
Resource Management



Required resources in developing an Information System:

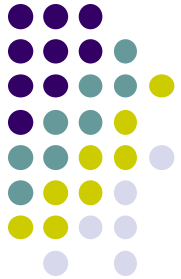
- Human resources (e.g. analysts, programmers, etc.)
- PC, machines, hardware
- Facilities
- Etc.

Network Analysis and resources



- Till now, determining the critical path did not take into account the cost of any activity or the limitations on available resources.
- For example, it may not be possible to execute two or more (independent) activities because there are no available resources.

Calculation of the required resources



- $A_{(i,j)}$: Work size of the activity (i,j).
  - It is usually measured in man-hours, man-months etc
- $T_{(i,j)}$: Duration of activity in time units of the project
- h: Working hours per time unit
- $\Sigma_{(i,j)}$: Number of resources

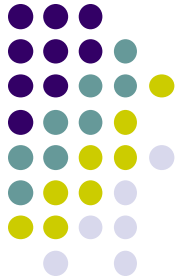
$$\Sigma_{(i,j)} = \frac{A_{(i,j)}}{t_{(i,j)} * h}$$

Example 1

In order to complete a task of 7 week duration is required 1680 man-hours. If the working hours of a week are 40, how many workers are required for the activity completion of (i,j) ?

$$\Sigma = \frac{1680}{7*40} = 6$$

Variation in needs - NO RESTRICTION on resources



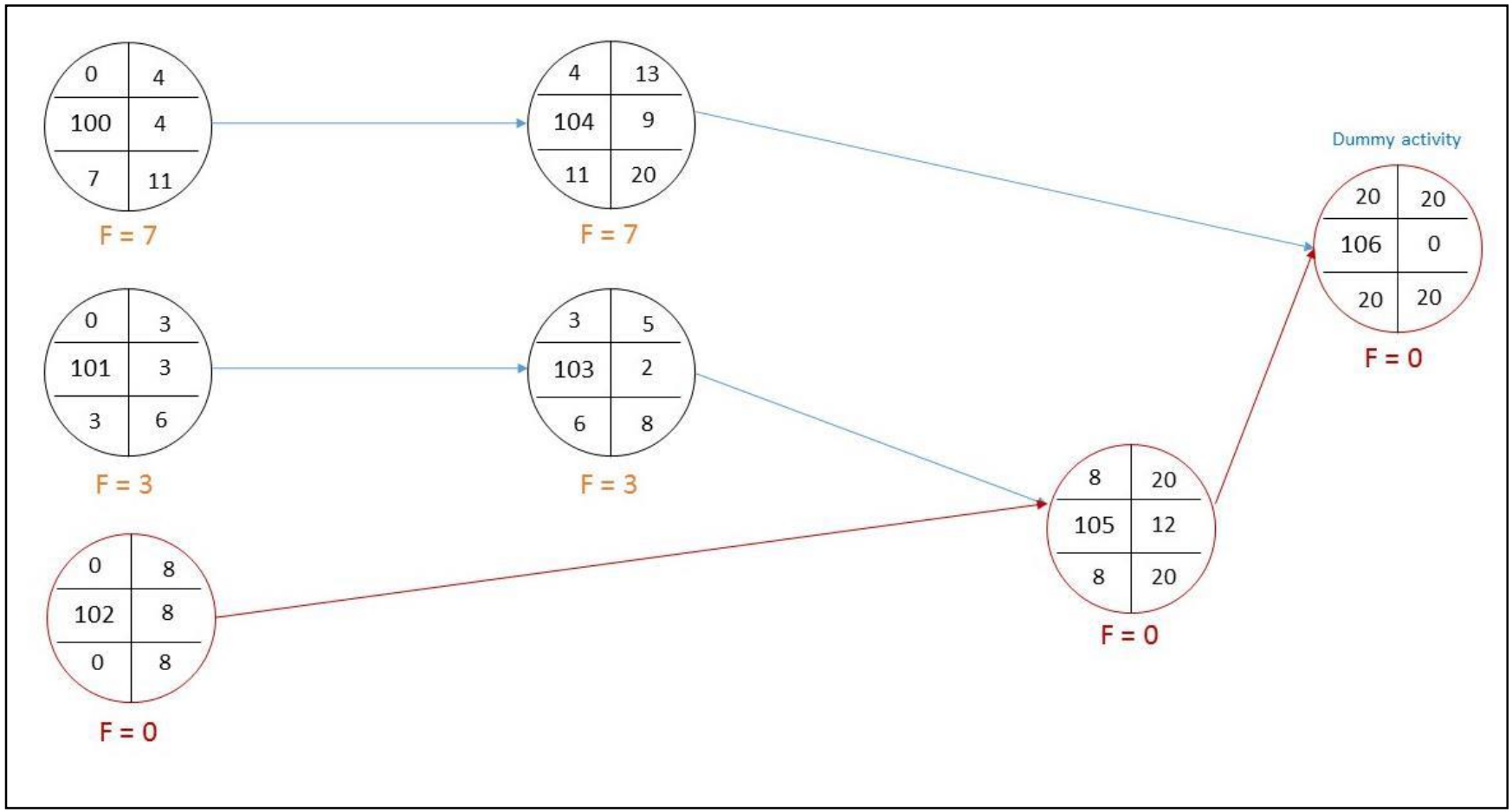
- We allocate the required resources based on **earlier starting time** of each activity (**Activities Log** - Gantt chart).
- This resource distribution gives the variation of needs which is graphically represented by a histogram (**resource variation histogram**).
- We create a new distribution of the required resources based on the **latest starting time** of each activity (new variation, new histogram).
- The two histograms produced are the two "extreme" positions of the resource.

Example 2

- Once we have built the network activity diagram and calculate the earliest and latest times, build the activities logs based on ET and LT.

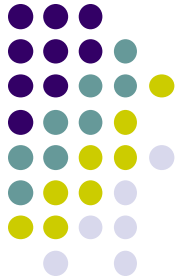
Tasks	Immediate predecessors	Duration (in months)	Required Analysts (per month)
100	-	4	4
101	-	3	6
102	-	8	2
103	101	2	4
104	100	9	8
105	102, 103	12	6

Example 2: Project Network



Critical activities: 102, 105
Project duration: 20 months

Example 2: Activities Log based on earliest times

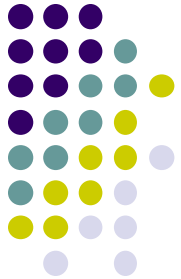


		Months																			
Activity	**Duration**	**Analysts**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
100	4	4																				
101	3	6																				
102	8	2																				
103	2	4																				
104	9	8																				
105	12	6																				
Required Resources: 194			12	12	12	10	14	10	10	10	14	14	14	14	14	6	6	6	6	6	6	6

Example 2: Activities Log based on latest times

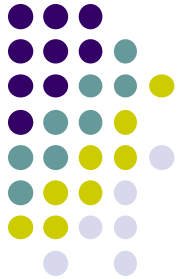
			Months																		
Activity	**Duration**	**Analysts**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
100	4	4																				
101	3	6																				
102	8	2																				
103	2	4																				
104	9	8																				
105	12	6																				
Required Resources: 202			2	2	2	8	8	8	6	10	10	10	10	14	14	14	14	14	14	14	14	14

Assigning limited resources



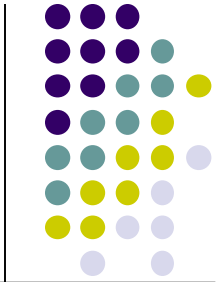
- Difficult and complicated problem (NP-hard)
- Use heuristic algorithms
- Alternatives:
  - **1st case**: Limited number of resources per time unit → the duration of the project is adjusted
  - **2nd case**: Fixed project duration → we are looking for the optimal (minimal) amount of resources to complete the project (smoothing histogram distribution).

1st case: Assign limited number of resources



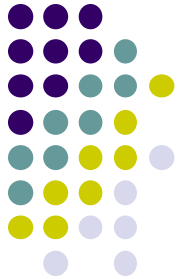
- Assumptions
  - **Case 1**: We assign resources to an activity only when all predecessors activities are completed.
  - **Case 2**: We assign all the required resources of an activity in order to be completed (i.e., we do not discontinue the activities or partially implement them).
  - **Case 3**: Available resources are adequate per time unit.

Allocation priority for limited resources



1. **Dummy activities** (if there are) have the highest priority.
2. We set a **priority** order based on a minimum **Total Slack** of each activity. In the case of activities with the same slack, the next rule is applied.
3. Activities with the maximum product of **resources x duration** is preceded. In the case of activities with the same product, the next rule is applied.
4. Activities with the **maximum allocation of resources per time unit** is preceded.

Heuristic assignment algorithms

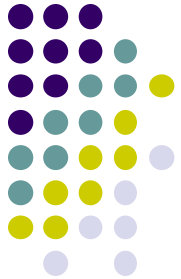


- The above rules are applied to the most heuristic resources allocation algorithms.
- Three are the most familiar heuristic assignment algorithms:
  - Serial method
  - Variation of the serial method
  - Parallel method
- Changing the rule priority order, we have different allocation algorithms.

Serial method

- Create and solve the network diagram. We calculate the start and the end time for each activity, the resources, the product (resources x duration) and the total slack.
- We set T= start time of the first critical activity (=project start).
- We define the **Activities to be Assigned Set (AtbAS).** AtbAS contains all the activities with EST ≤ T for which all predecessors activities have been completed.
- While there are activities in the AtbAS:
  - We define the activity priority of the AtbAS and create the **AtbAOS (Order Set of AtbAS).**
  - While there are activities in AtbAOS:
    - If there are available resources
      - Assign the first activity
      - Subtract the assigned resources from the total available resources.
      - Delete the activity from AtbAOS
      - Estimate when the resources will be available again.
      - Assign the next activity from AtbAOS.
    - Else
      - Postpone the execution of the activity
  - End_While
  - Calculate the next allocation time T, based on the available resources.
  - **Re-calculate the network** by updating the duration of the activities that are under execution and by deleting the activities that are completed.
  - **Solve the new network** – re-calculate the earliest/latest times, the resources, the product (resources x duration) and the total slack.
  - Define the new AtbAS and AtbAOS and continue with the same procedure
- End_While

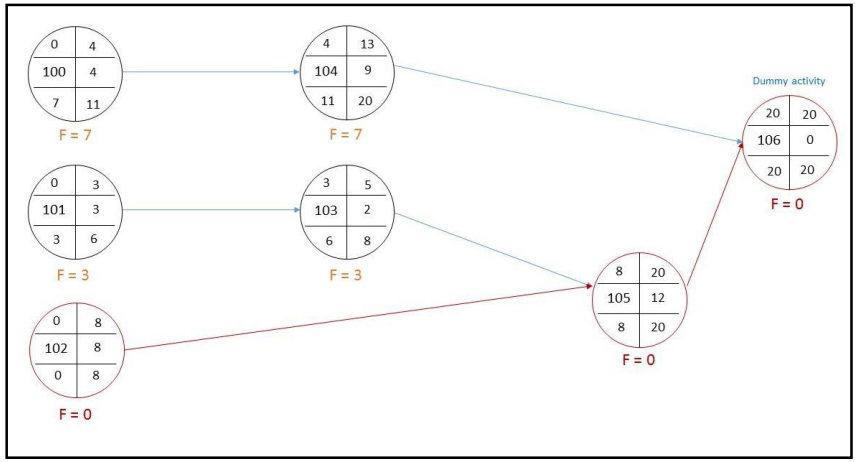
Example 2 (continue)



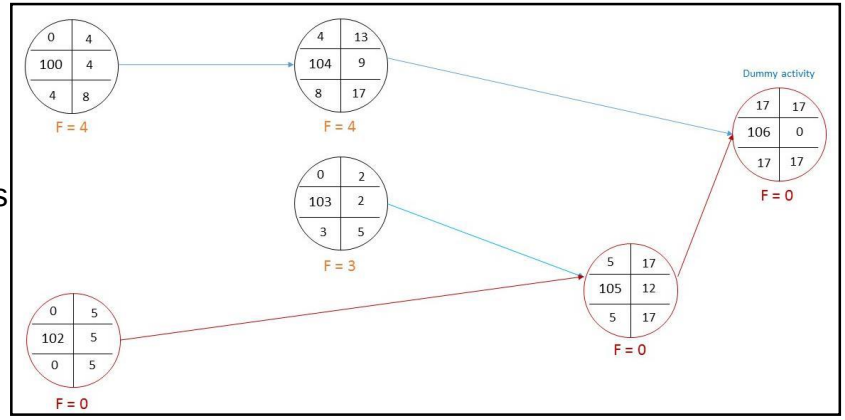
- If the company has 9 Analysts, how long should the project be extended if we do not want to recruit new staff?
- As we saw before, the earliest and the latest program requires (for some months) more than 9 Analysts.

Example 2

- **Step1**
  - T_1=0 (beginning of the first critical activity) – beginning of 1st month
  - AtbAS = {100, 101, 102}, AtbAOS = {102, 101, 100}
  - Assign to 102 → 2 Analysts for 8 months / available Analysts: 7
  - Assign to 101 → 6 Analysts for 3 months / available Analysts: 1
  - The assignment of 100 is postponed as there are no adequate resources.

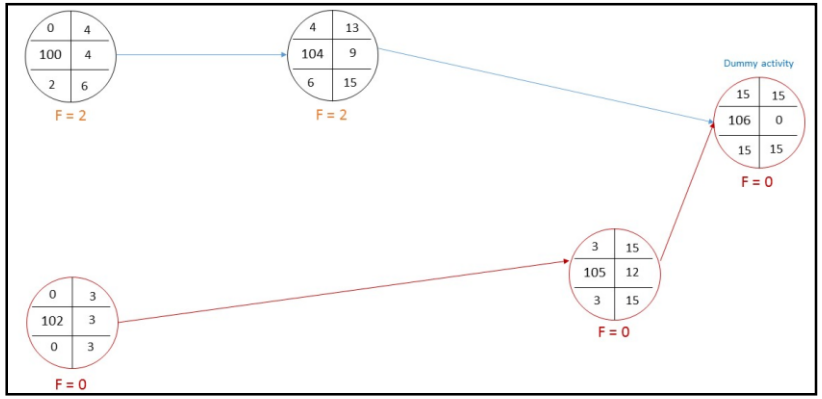


- **Step 2**
  - T_2=3 – beginning of 4th month
  - The 101 activity is completed while 102 is under execution.
  - Available Analysts: 7
  - The network diagram is re-calculated setting 101 as completed and 102 to be under execution.
  - AtbAS = {100, 103}, AtbAOS = {103, 100} as the slack for 103 is 3 and the slack for 100 is 4.
  - Assign to 103 → 4 Analysts for 2 months / available Analysts: 3
  - The assignment of 100 is postponed as there are no adequate resources.



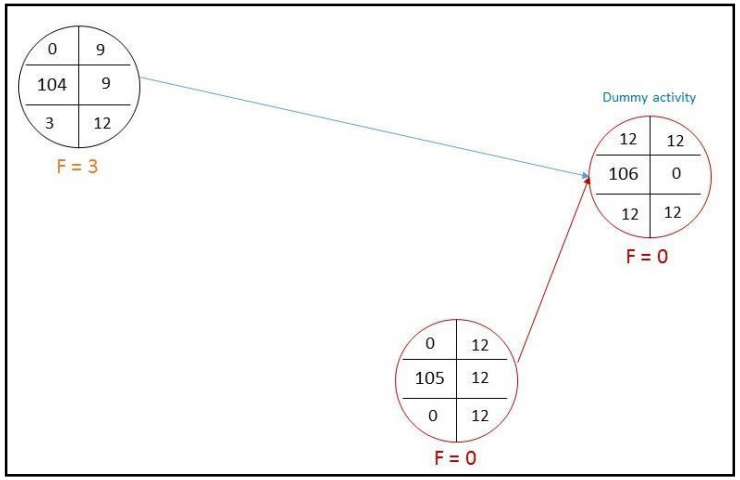
Example 2

- **Step 3**
  - T_3=5 – beginning of the 6th month
  - The 103 activity is completed while 102 is under execution.
  - Available Analysts: 7
  - The network diagram is re-calculated setting 103 as completed and 102 to be under execution.
  - AtbAS = {100} = AtbAOS
  - Assign to 100 → 4 Analysts for 4 months / available Analysts: 3
- **Step 4**
  - T_4= 8 – beginning of 9th month
  - The 102 activity is completed while 100 is under execution
  - Available Analysts: 5
  - The network diagram is re-calculated setting 102 as completed and 100 to be under execution (1 more month is required).
  - AtbAS = {105} = AtbAOS
  - The assignment of 105 is postponed as there are no adequate resources.



Example 2

- **Step 5**
  - T_5=9 – beginning of 10th month
  - The 102 and 100 activities are completed.
  - Available Analysts: 9
  - The network diagram is re-calculated setting 102 and 100 as completed.
  - AtbAS = {104, 105}, AtbAOS = {105, 104} as the slack for 105 is 0 and the slack for 104 is 3.
  - Assign to 105 → 6 Analysts for 12 months/ available Analysts: 3
  - The assignment of 104 is postponed as there are no adequate resources.



- **Step 6**
  - T_6=21– beginning of 22nd month
  - The 105 activity is completed, the only activity that waits for assignment is 104.
  - Available Analysts: 9
  - Assign to 104 → 8 Analysts for 9 months

Example 2

- So, the project should be extended by ten weeks in order to be executed without recruiting new staff (with 9 Analysts available).