

# Effective Pilot Manpower Planning for Major US Airlines

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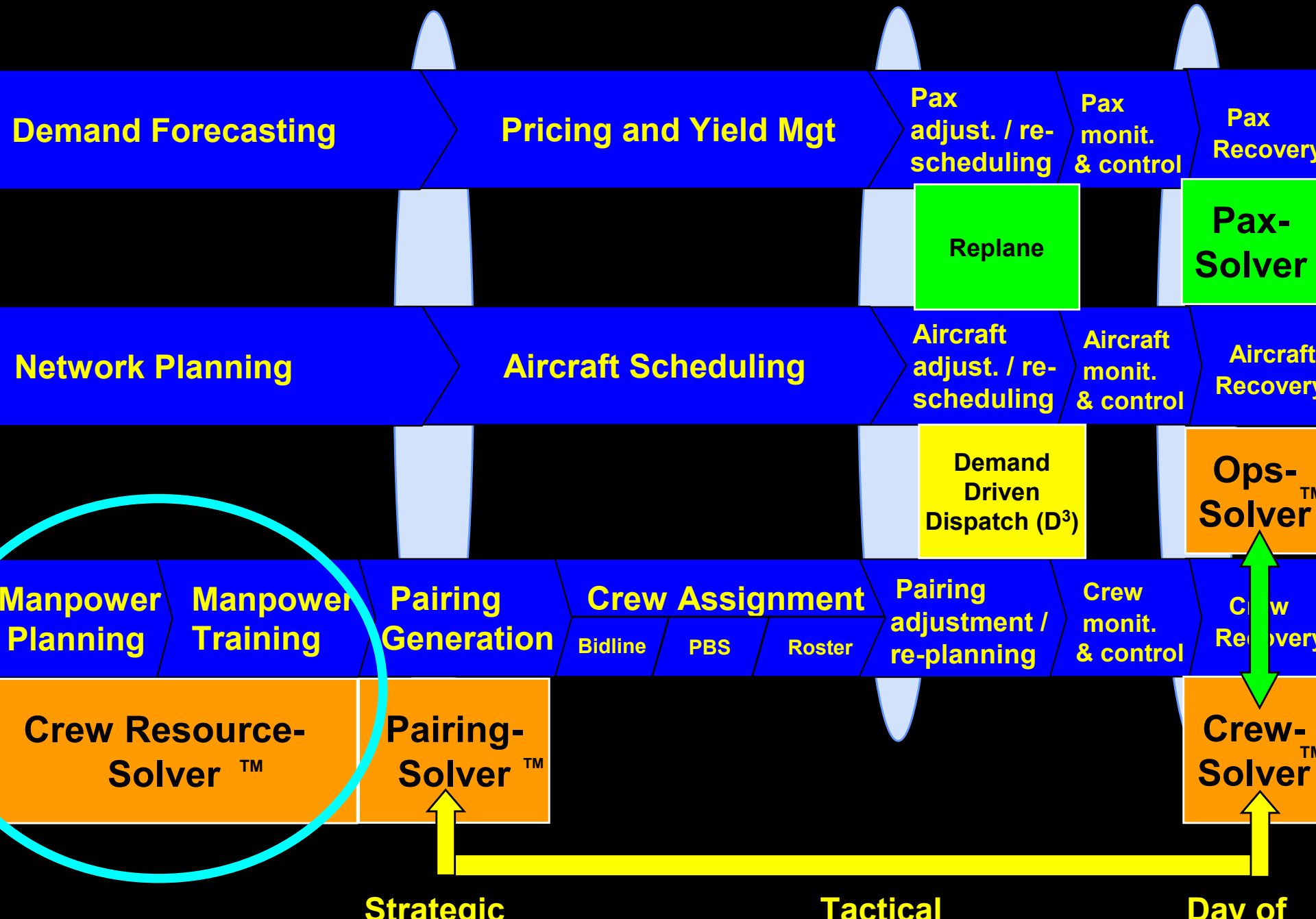
# Agenda

## ► • **Business problem context**

- Definitions
- Problem Description
- Solution Approach
- Value to airlines

# Operations Roadmap

CALEB Research



# Agenda

- Business problem context
- ▶ **• Definitions**
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# Definitions

- Pilot Position => (Base, Equipment, Status)
  - Crew Base (e.g. IAH, CLE, EWR, GUM)
  - Equipment (e.g. B777, DC-10)
  - Status: pilot's seat on the cabin (CA, FO, SO)
- Pilot Pay Rate =>  $f$  (position, longevity)
- Seniority Number: longevity of a pilot in the airline with respect to the other pilots

# Definitions

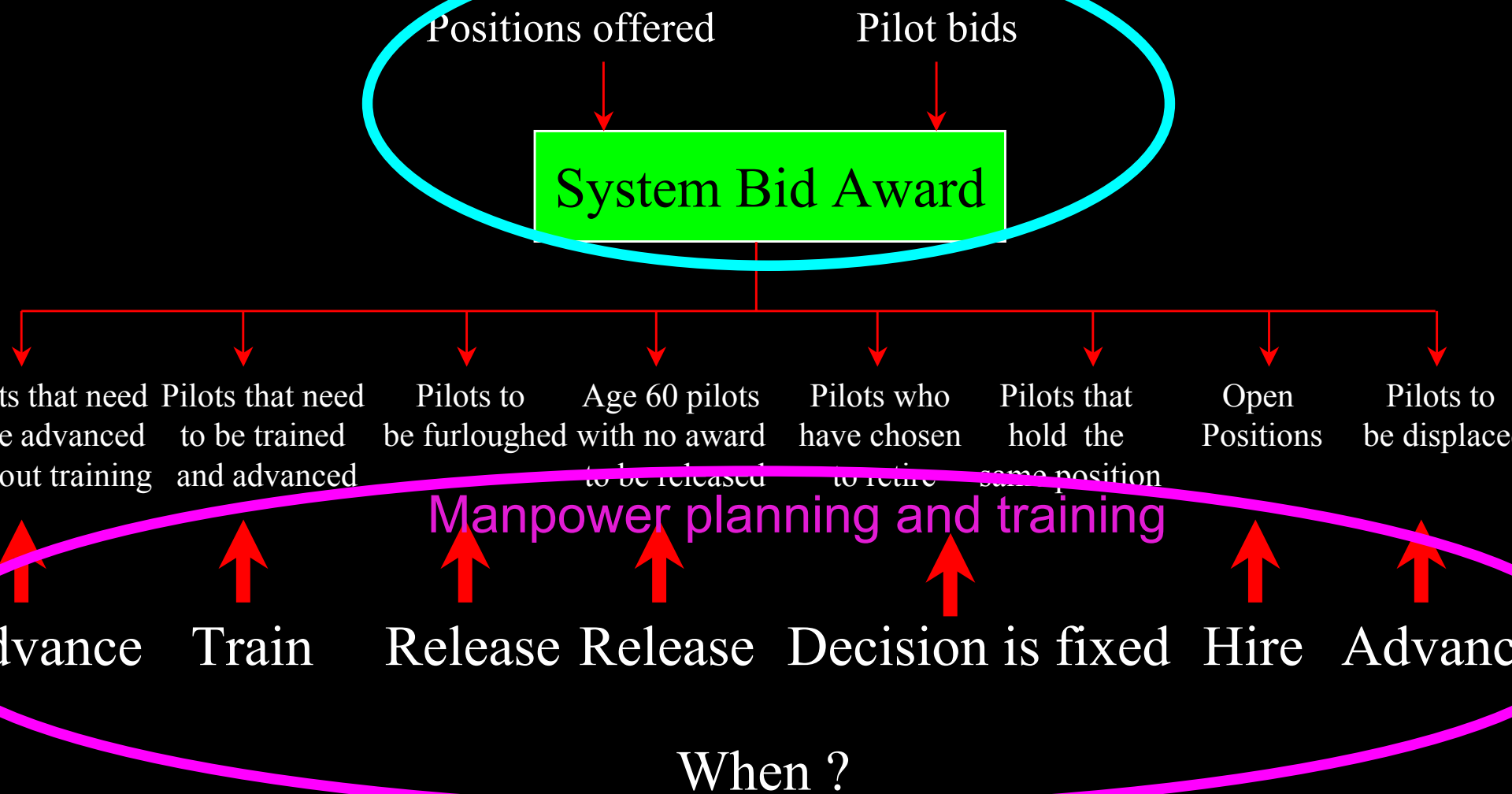
- **Business Plan Block Hours:** Total number of pilots hours per position per bid period needed to cover scheduled flights
- **System Bid Award:** Process by which the airline adjust the number of pilots at each position and by which the pilots are allow to change their position positions

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# Problem Description

## Bid Award Process



Bid Effective Date: By this date all pilots must be advanced or released

# Problem Description

Business plan  
block hours

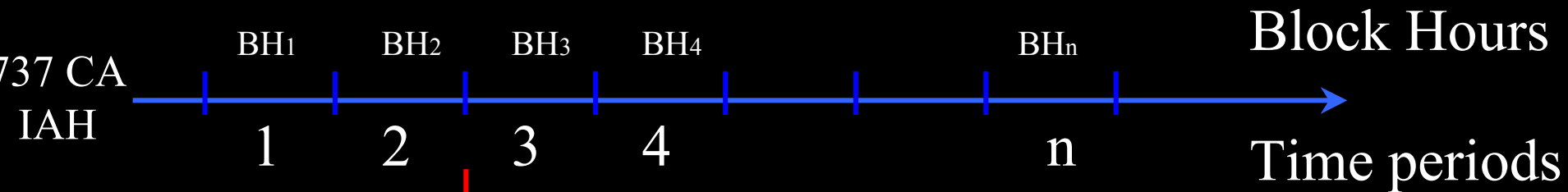
**Manpower Planning and Training**

Constraint

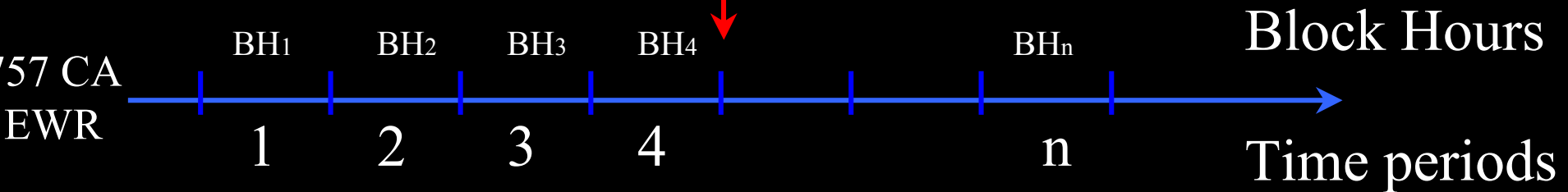
Cost

# Block Hours

Captain moving from 737 CA IAH to 757 CA EWR



Training Duration  $\sim f(\text{current position, future position})$

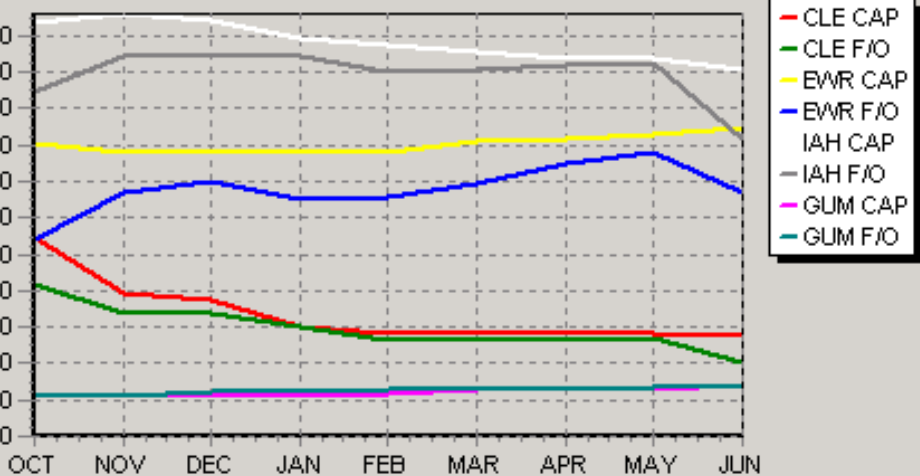


Objective: Minimize percentage shortage

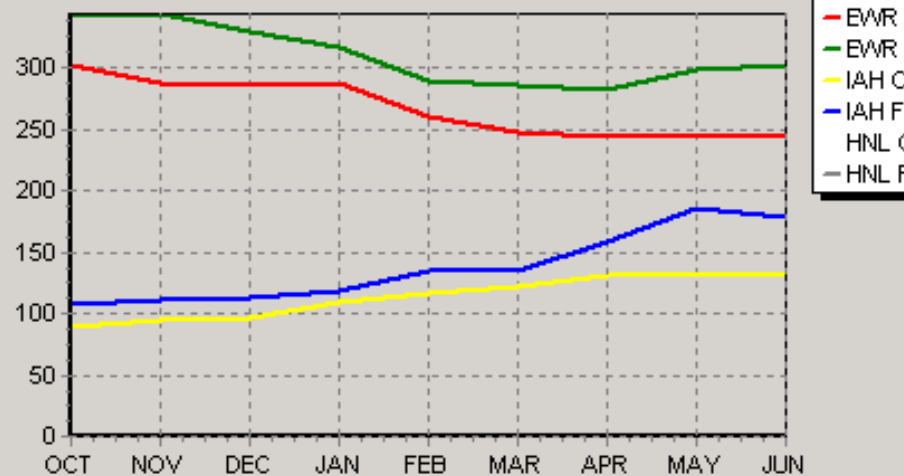
		Block Hrs	Shortage	%Shortage
737	CAP IAH	70,000	1,000	1.4%
DC10	F/O EWR	5,000	1,000	20.0%

# Block Hours

737



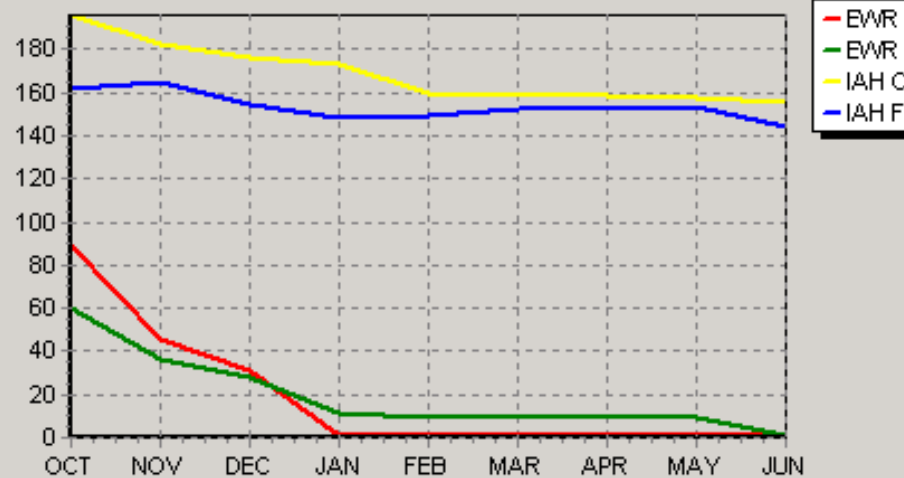
757



777



MD-80



# Problem Description

Business plan  
block hours

Pay protection costs

**Manpower Planning and Training**

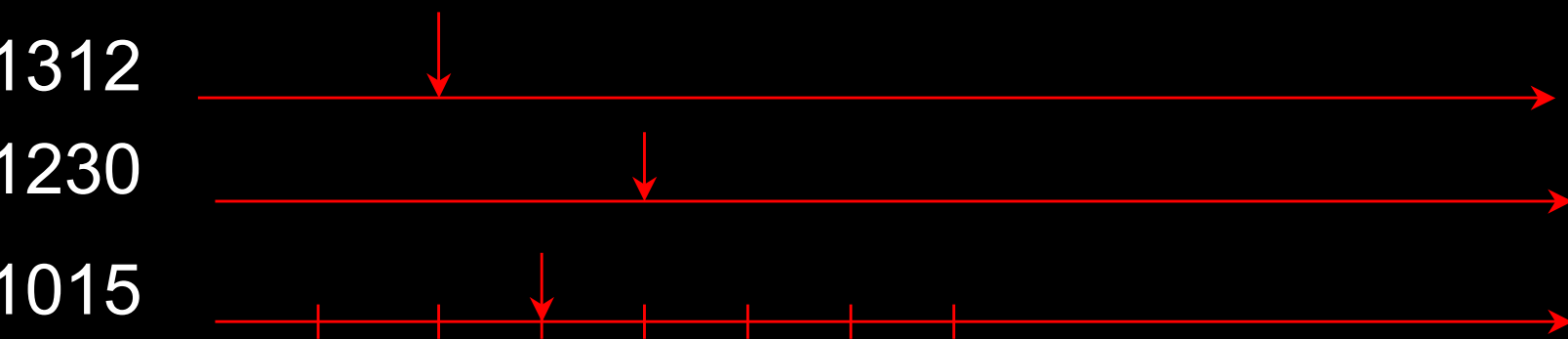
Constraint

Cost

# Pay Protection

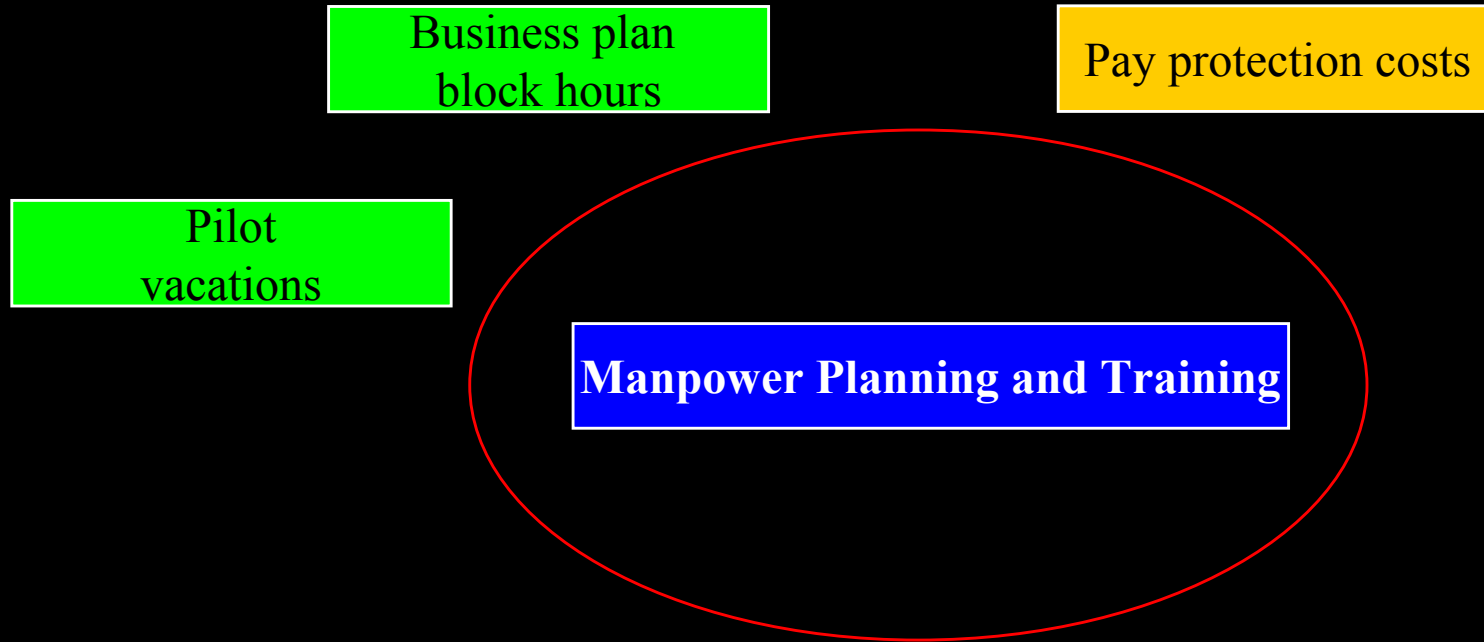
## *One for all* pay protection

	current position	future position
015 J.Jhonson	IAH,727,CAP	IAH,737,F/O
230 M.Summanth	EWR,727,F/O	IAH,737,F/O
312 K. Smith	CLE,727,CAP	IAH,737,F/O



=>1312 pay protects 1230 for 2 months and 1015 for 1 month

# Problem Description



Business plan  
block hours

Pay protection costs

Pilot  
vacations

**Manpower Planning and Training**

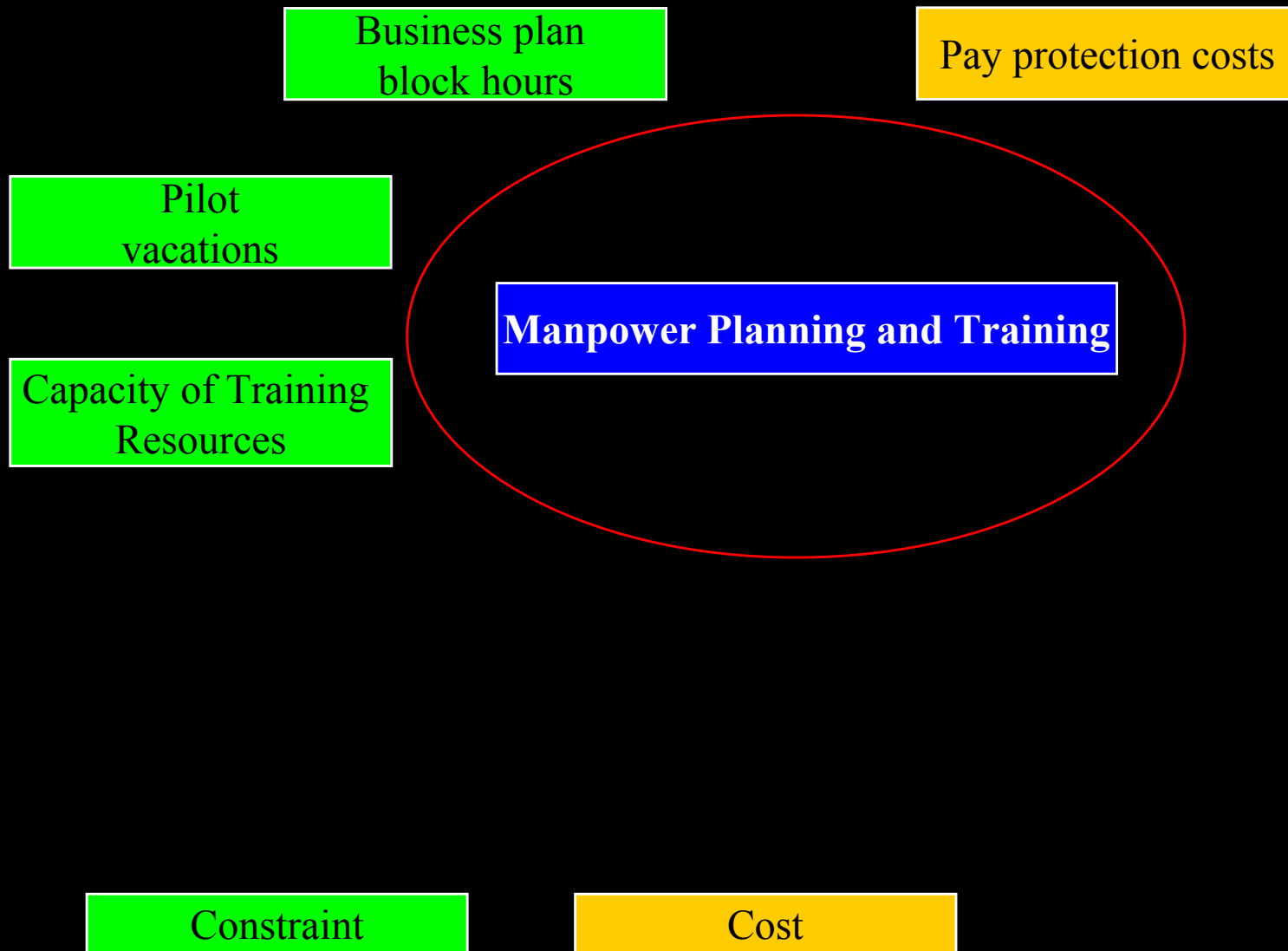
Constraint

Cost

# Pilot Vacations

- Airline estimates pilots needs and post 7-day vacation slots for bidding
- Pilots bid for vacations at the beginning of the year
- Airline award vacations base on seniority
- Training needs to be scheduled around vacations

# Problem Description



# Capacity of Training Resources

- Predetermine curricula for each type of training (e.g. primary systems, re-qualification class)
- For each training day in the curricula different resources are required: Classrooms, Instructors, FTD (Flight Training Device), FSS (Flight Simulation Devices)
- Previous commitments, recurrent training

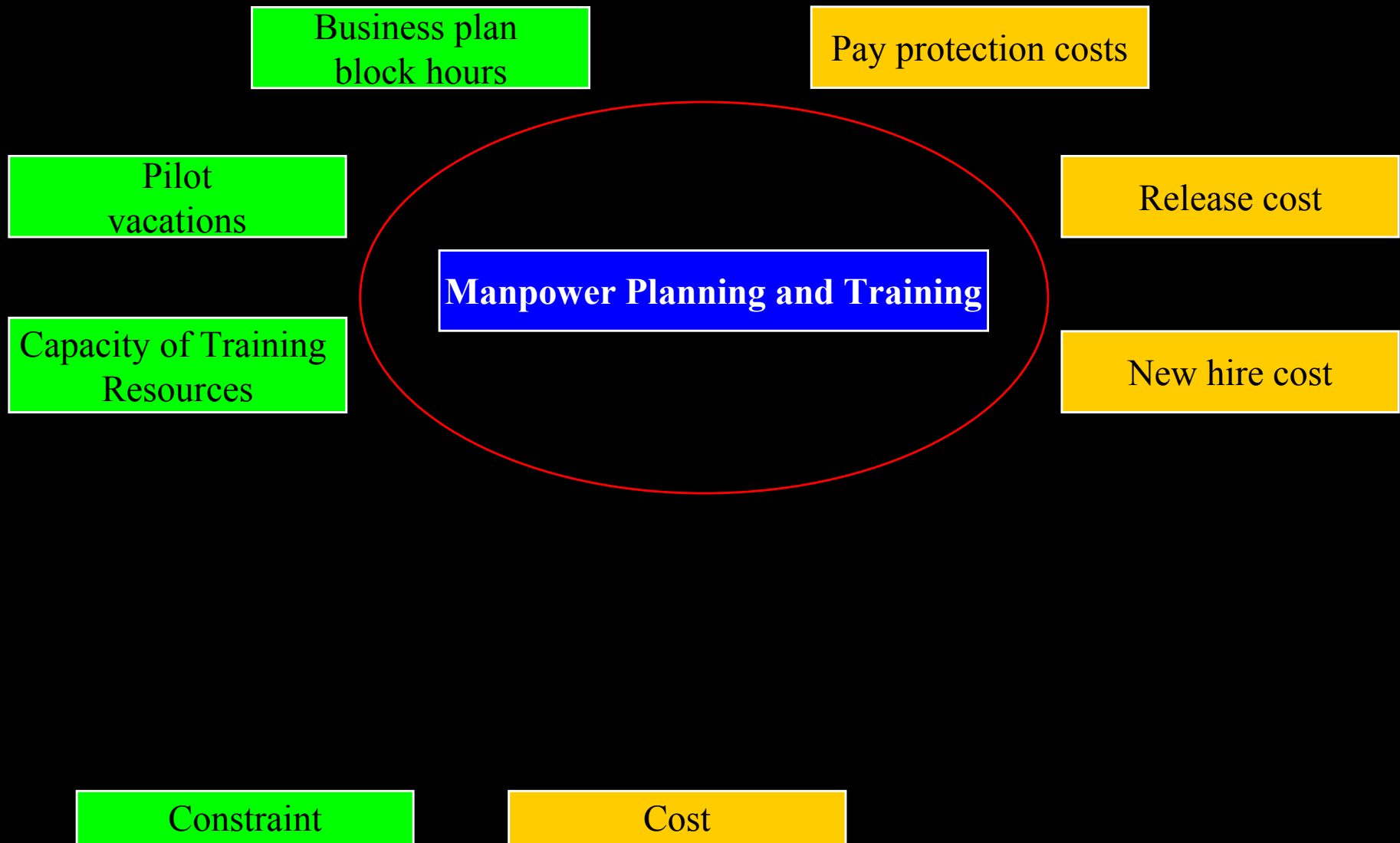
Template	1	2	3	4	5	6			7	8	9	10			11	12	13	14	15			16	
Calendar Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Device	class	FTD5	Inflight	FTD5	class	FTD5	X	X	class	FTD5	class	FTD5	X	X	FTD8	FTD5	FTD8	FTD5	FTD8	X	X	FFS8	
		Day Template			1	2	3	4	5	6			7	8	9	10				11	12	13	14
		Calendar Day			5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
		Device			class	FTD5	Inflight	FTD5	class	FTD5	X	X	class	FTD5	class	FTD5	X	X	FTD8	FTD5	FTD8	FTD5	

Specific Instructor  
Qualification  
each training day

Do not exceed  
capacity of

Pilot  
days off

# Problem Description



# Hiring and Furloughing

-Hiring as late as possible is desirable

Reduces the payroll cost

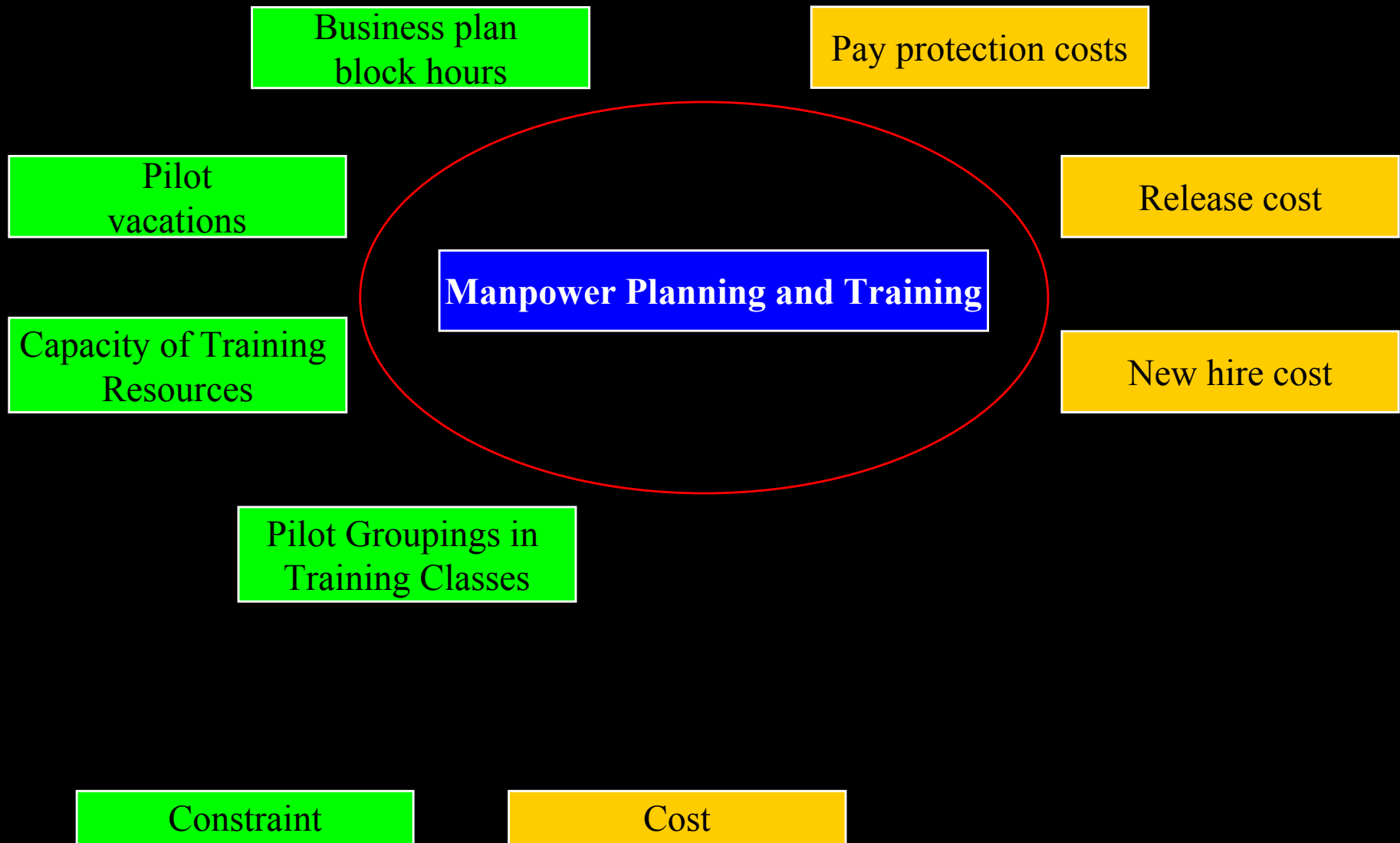
Estimated block hours need may change

-Furloughing as soon as possible is desirable

Reduces the payroll cost

Need to be released in seniority order

# Problem Description



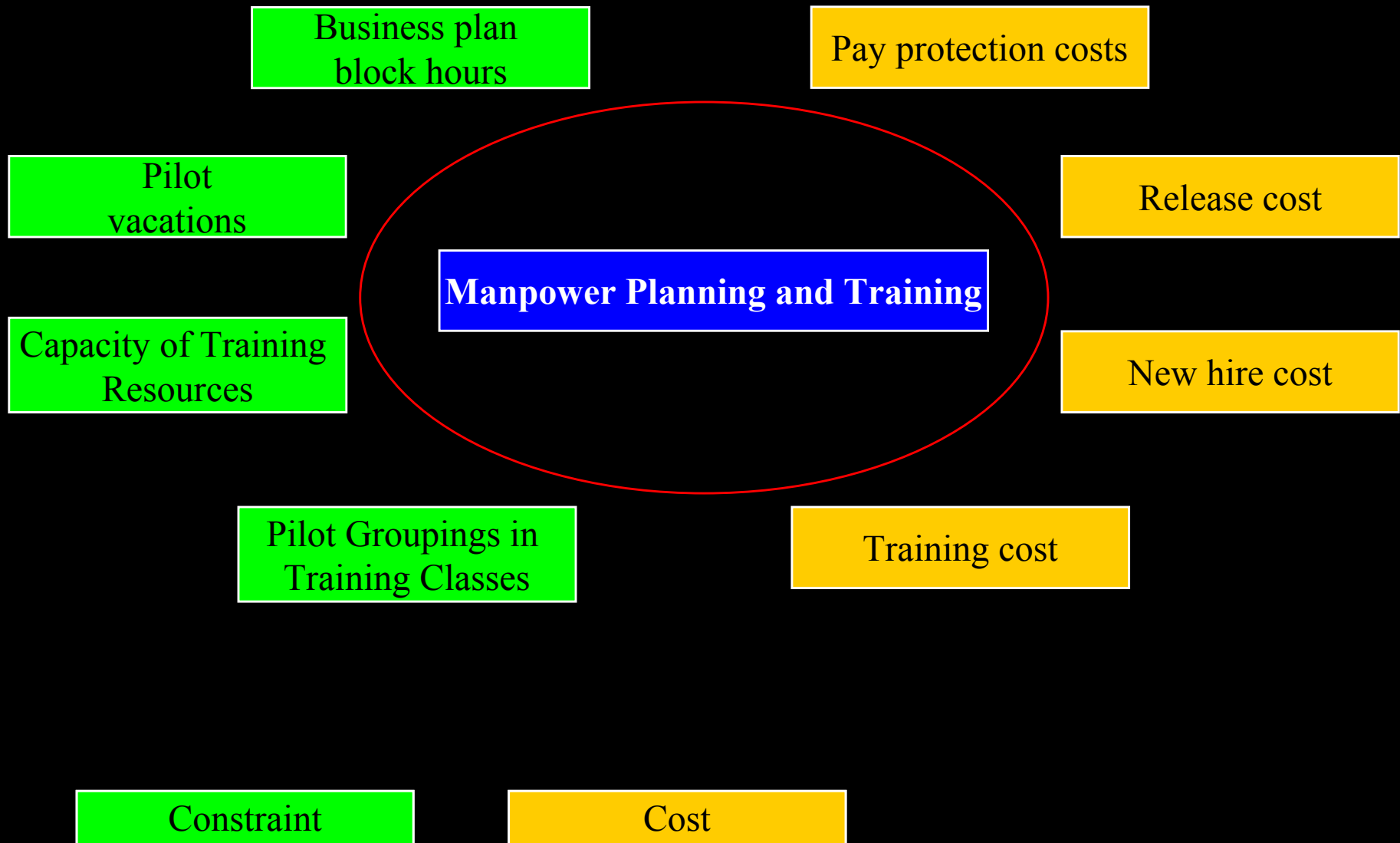
# Pilot Grouping into Classes

- Preference to train pairs of Captains and First Officers

Additional instructor events are avoided

Quality of training

# Problem Description

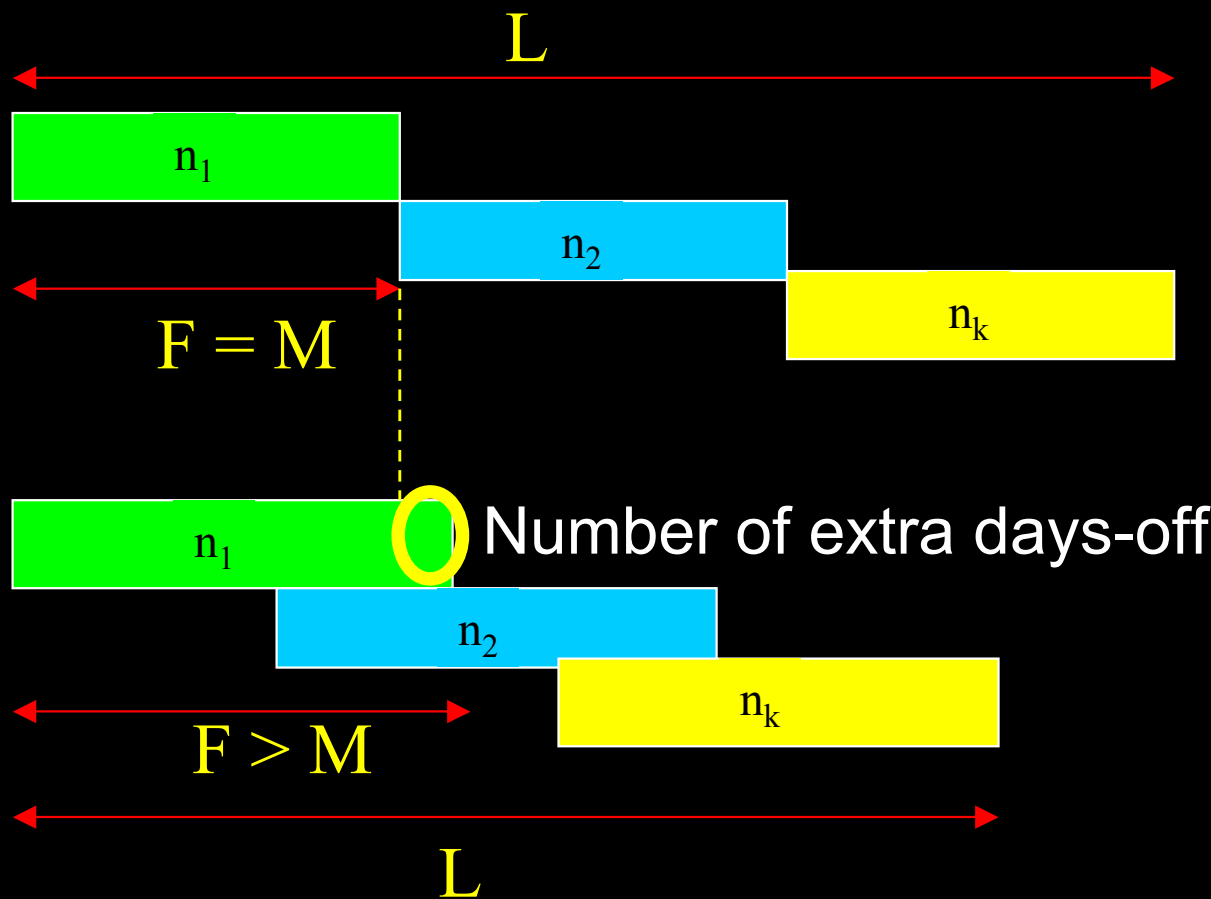


# Training Cost

$M$  = Length of curricula (e.g. Primary Systems 757=>56 days)

$F$  = Footprint (time spent in training)

$L$  = Length of time to complete to complete training for  $N$  students

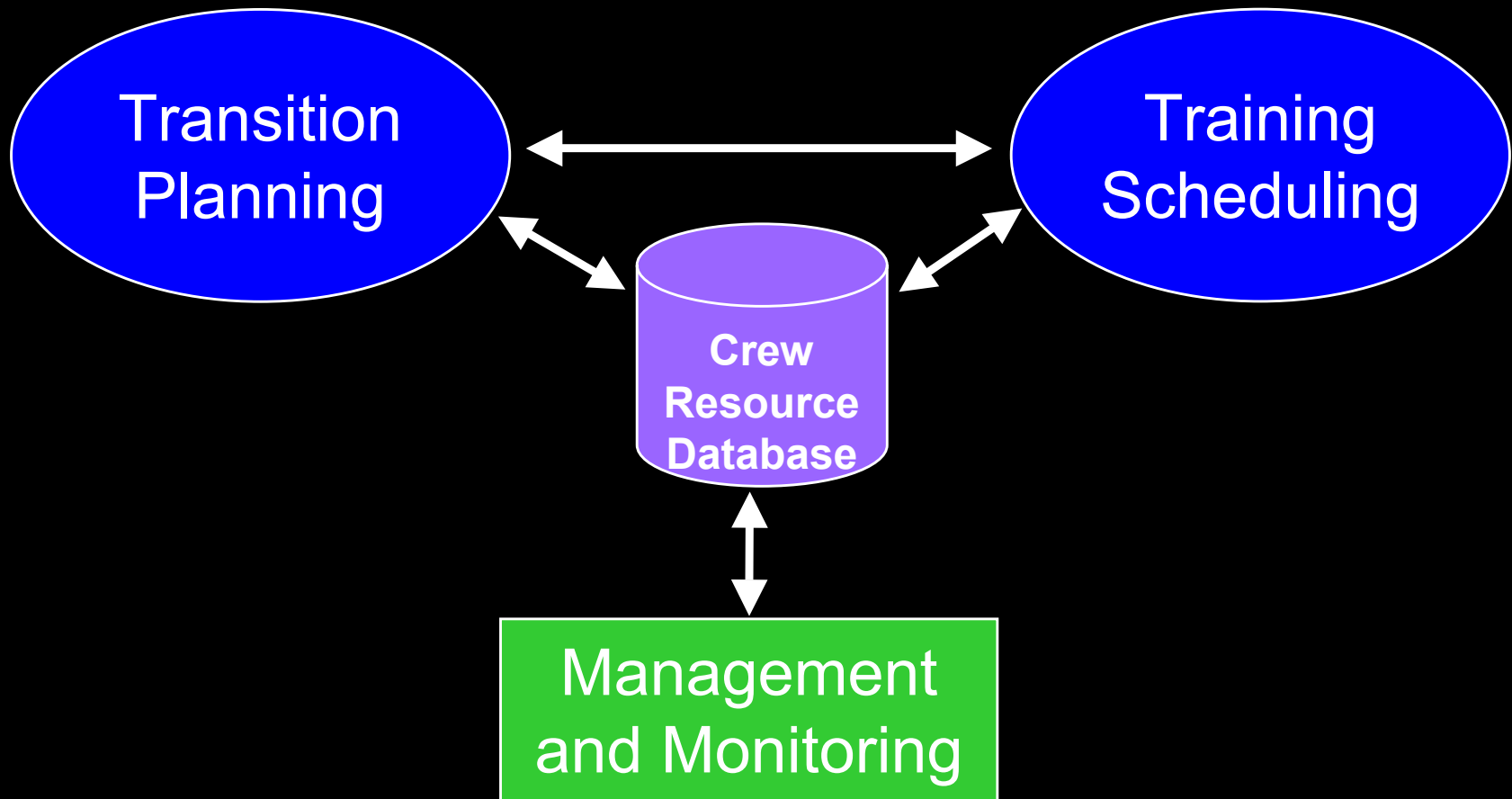


Cost of training  
= $f(\text{total footprint})$

# Agenda

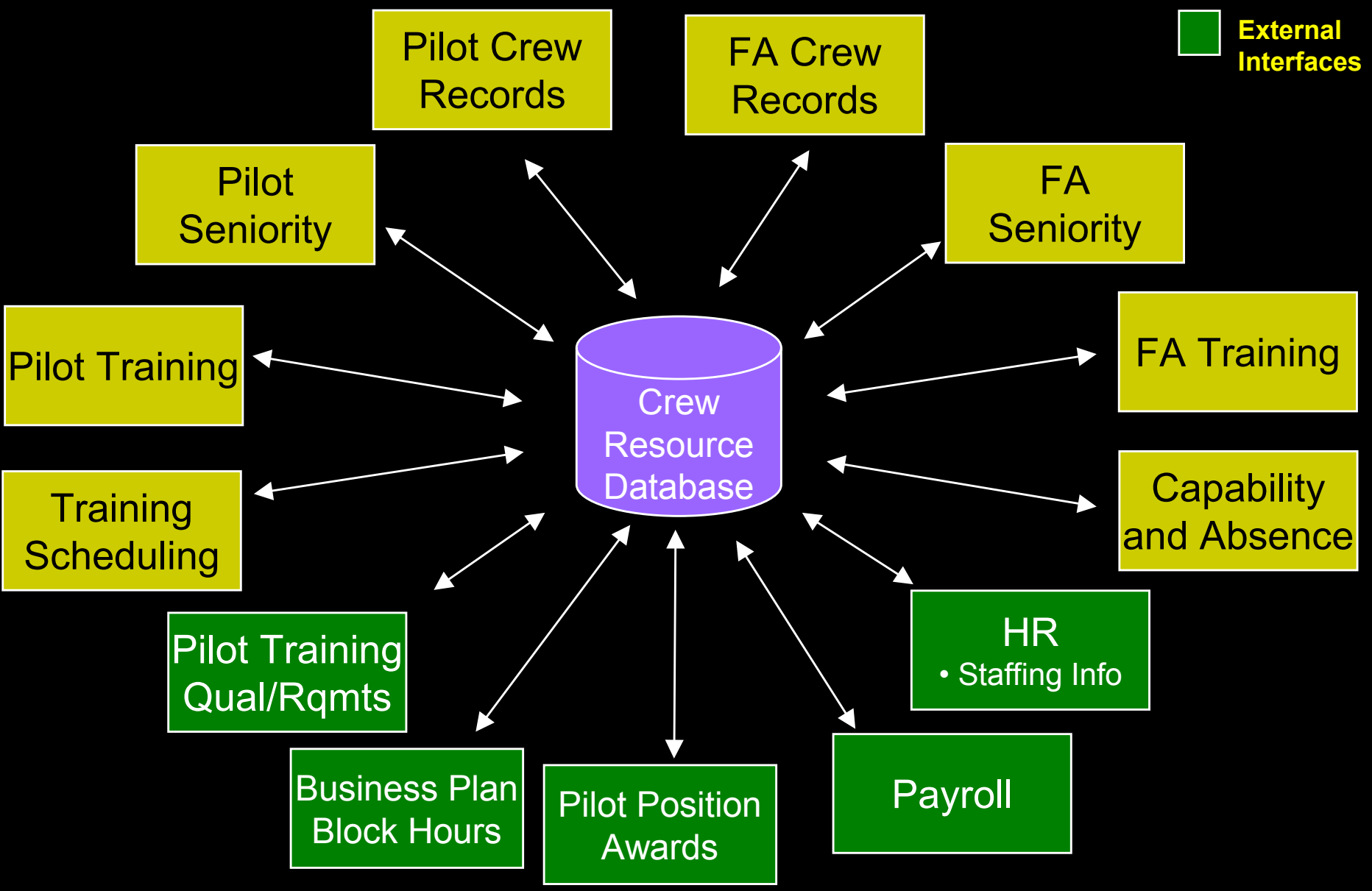
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# olution Approach

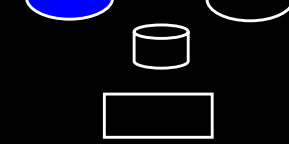


# Implementation Complexity Key data sources

- Owned by ResourceSol
- External Interfaces



# olution Approach



## Key Input

Block Hours

Position  
Awards

Training  
Capacity/  
Requirements

## Solver

Transition  
Planning

## Output

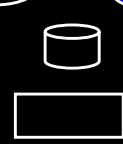
### Staffing

- Ability to meet business plan

### Transitions

- Advancement
  - Hiring
  - Attrition
  - Training

# Optimization Approach



## Key Input

## Solver

## Output

Transition Plan

Training Resources

Training Curricula

Training Scheduling

Training Schedule

Detailed Resource Utilization Plan

# Transition Plan –Math Model-

- Hierarchical Problem:
  - Determine minimum level of shortages
  - Shortages in early bid periods are more “critical”
  - Determine appropriate trade-off between shortages and dollar cost
- Inventory Model with sides constraints
- MIP problem (special branching directions)
  - ~25,000 constraints
  - ~15,000 variables

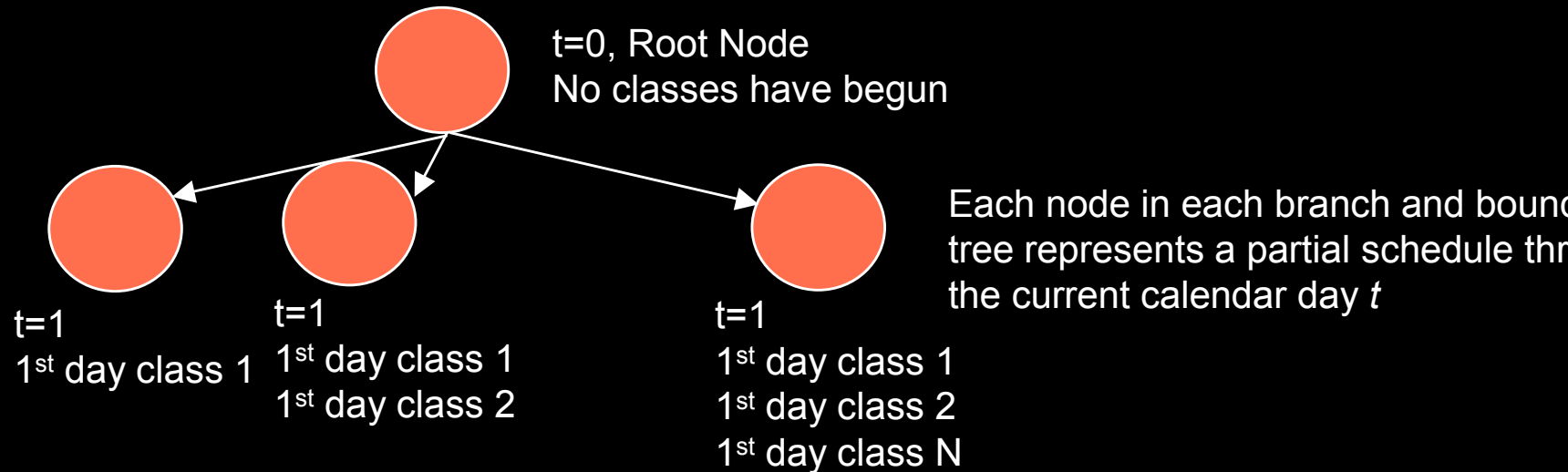
# Training Scheduling

- This problem is solved by fleet
- Layout the classes minimizing length of time the pilots spend in training and considering feasible usage of resources
  - =>Branch and bound rolling horizon algorithm (i.e. consider a subset of classes, solve and fix “m” classes)

# Training Scheduling -Branch and Bound-

-A subset of classes is considered in each branch and bound tree

-Min and max start date for each class



-From a node D a node D' is reached scheduling a training day or a day-off for each class

-Cut branches by:

Node elimination: Violation resource availability, Days-off constraints

Lower Bound: The objective is to minimize the collective length of time pilots spend in training,

Based on partial schedule and required training days remaining a lower bound is computed

-A depth first search approach is used to search the entire tree

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# Value to Airlines

## Significant Cost Savings

- 2-4% reduction in time pilots are away at training
- Up to 10% reduction in new hires
- Reduction in pay protection costs
- Reduction in block hour shortage
- Estimated Cost Savings of \$15,000,000 per year

## Increased Productivity

- Provides what-if functionality for scenario planning
- From 3 crew planners building a solution in 13 days to less than 1 hour
- From 4 training schedulers building classes each month for a period of 3 days to few minutes

## Unified, cross-functional Solutions

- Cross functional, enterprise-wide system through single, centralized database
  - Manpower planning
  - Training
  - Finance

end