Airline Network Design

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Airline Network Planning

- Airline Network planning tries to determine
  - Service network configuration
  - Flight route (delivering path)
  - Flow assignment
Network Configuration

- Network configuration
  - Point-to-Point (direct flight)

15 linkages
Network Configuration

- Hub-and-Spoke

- Combination of both
Network Configuration

- Coexistence of both
Flight Routes

- Flight route
  - Determine the routes (or paths) to deliver for every OD
  - Direct flight or non-stop flight
Flight Routes

- Hub-connected flight
  - rare to have more than two hub stops in practice, especially in the air passenger market
  - one-hub-stop
  - two-hub-stop
Tool for Airline Network Planning

- Tool: Mathematical Model
  - Objective: usually try to minimize the total cost
    - Cost
      - Fixed cost: hub setup cost
      - Variable costs: transportation cost and....
  - Maximize profit: more complicate because it would relate to pricing policy.
    - pricing in air market is dynamic and complicate task: Revenue Management.
Network Planning Model

- **Given**
  - nodes (airports): location
  - OD demand
  - Costs
  - Flight distance (if necessary)

- **Determine**
  - Network configuration
  - Number of hubs and location
  - Paths
  - Flows
Minimize $z = \sum_{i \in N} \sum_{j \in N: j \neq i} d_{ij} c_{ij} x_{ij} + \sum_{s \in N} \sum_{i \in N} \sum_{j \in N} d_{ij} c_{iktj} s_{iktj} + \sum_{s \in N} f_s k$

Subject to

- $x_{ij} + \sum_{k \in N} \sum_{i \in N} x_{ik} = 1$, $\forall i, j : i \neq j$

- $\sum_{i \in N} x_{ik} + \sum_{i \in N} x_{ki} \leq V(1 - s_k)$, $\forall k : i \neq k$

- $\sum_{t \in N} x_{kkti} + \sum_{t \in N} x_{itkk} \geq 2s_k$, $\forall i, k : i \neq k$

- $x_{kktt} \geq s_k + s_t - 1$, $\forall k, t : k \neq t$

- $\forall k : i \neq k, j \neq k$

Subject to

- $0 \leq x_{ij} \leq 1$, $\forall i, j : i \neq j$

- $0 \leq x_{iktj} \leq 1$, $\forall i, k, t, j : i \neq j$

- $s_k \in \{0, 1\}$, $\forall k$