Focus on Airline reservation system, GDS, RM

Advanced Information Systems and Business Analytics for Air Transportation
M.Sc. Air Transport Management
May 16-21, 2016

Slides prepared by Benny Mantin
### Background

Airlines need to process manifold information

<table>
<thead>
<tr>
<th>Information Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route information</td>
<td>Destinations served by an airline</td>
</tr>
<tr>
<td>Aircraft information</td>
<td>Information on the aircrafts used by an airline</td>
</tr>
<tr>
<td>Schedule information</td>
<td>Information on when the flights operated by an airline are scheduled to run</td>
</tr>
<tr>
<td>Fare information</td>
<td>Flight prices</td>
</tr>
<tr>
<td>Reservation information</td>
<td>Passenger tickets and cargo reservations</td>
</tr>
</tbody>
</table>
Background

Prior to 1950, information on inventory (available seats on a flight) was published by airlines in large books, with separate books for each type of information. Travel agents had to manually look through several books for booking tickets that covered multiple airlines. It was impossible to get a real-time view of the inventory since airlines could synchronize data from multiple locations only once a day.
1) **had to go to** [image] **to buy** [image] .

2) **contacted** [image] and **requested** [image] a specific flight on a specific time and date.

3) Fares were the same on each flight with each airline (pre-1978).

4) Reservations staff retrieved an index-card for that specific flight from revolving tray.

5) **’s** query answered based on retrieval.

6) **issued** [image] and **collected** [image] from **.”**
In 1950 American Airlines introduced the first electronic reservations system, Magnetronic Reservisor.

In 1964 American Airlines and IBM developed the first computerized reservation system (CRS) that would allow real-time access to all its data across all its offices and travel agents: Sabre or Semi-Automated Business Research Environment.

Initially, it was used only internally and agents still had to call.

The first non-North American CRS, amadeus, was developed jointly by Air France, Lufthansa, Iberia and SAS in 1987.
CRS Overview

- Storing and retrieving information and conducting air travel transactions
- Originally designed and operated by airlines, later extended and used by Travel Agencies
- Single travel providers store their reservations
- CRSs contain:
  - Airline flight schedules
  - Availability information
  - Fare tariffs
  - Passenger reservations, ticketing and cancellations/refund records
- An airline's distribution works within their own reservation system, as well as pushing out information to the GDS
- Airlines also manage direct distribution channels where consumers make their reservations directly with the airline (call centre, Internet)
Growing Pains of CRSs

CRSs simplified the task of maintaining airline data, but new challenges arose:

- Increasing passenger traffic required larger and more expensive computer systems
  - High cost for (smaller) airlines

- CRSs were airline specific
  - Travel agencies required individual connections to airlines
  - Travel agents had to be trained on different mainframe clients
  - Inability to perform direct searches across airline systems
  - Combining airline inventories was a tedious process because inventory searches and reservations had to be performed in individual airline CRSs separately
From CRS to GDS

Need to host data for more than one airline for more efficiency for growing airline industry

CRSs transformed from being single airline reservation systems to multi airline Global Distribution Systems (GDSs)

GDSs share data to increase efficiency
From CRS to GDS

- **1960's** Airlines create CRS
- **1970's** Travel agents use CRS
- **1980's** CRS become GDS
- **1990's** Internet emerges as direct consumer channel; GDS struggle for market shares
- **2000's** Increasing growth of web fares; airlines begin diverting GDS
- **2001** Growth of web-only (non-GDS) content
- **2004** GDS deregulation
- **2005** Alternative GDS emerge, low-cost carriers
- **2006** GDS contracts expire

Current

- Alternative ("hybrid") Distribution System mechanisms (providing web-based visibility while "pulling inventory" from the GDS, e.g. Travelocity, Expedia, Opodo)

Future

- IATA's NDC

Lower cost distribution

Higher cost distribution
Advantages of a GDS

- Simplified access to most airlines through one interface
- Ability to connect to multiple airlines either through legacy mainframe clients or PC based clients
- Less maintenance and up-keep overhead
- Ability to combine airline inventories
How GDSs have evolved

Since airlines’ CRSs were mainframe-based, GDSs were mainframe-based as well.

Over time, GDSs offered direct connectivity over the internet to non-mainframe clients such as PCs.

GDSs also lease hosting space (hardware, software and connectivity) to airlines which do not want to create and host their own CRSs.

GDSs now interconnect
  - Travel agencies
  - Airlines
  - Hotels
  - Rent a car companies
  - Railways
  - Other travel-related companies.

Business Intelligence

GDS can very quickly process travel transactions in huge volumes.
Major GDSs

**amadeus** (1987)
- by Air France, Iberia, Lufthansa, SAS, Turkish Airlines
- Based in Madrid, Spain
- Largest booking share in Europe
- Third largest booking share in the world
- Used by [www.ebookers.com](http://www.ebookers.com), [www.expedia.co.uk](http://www.expedia.co.uk) and [www.opodo.com](http://www.opodo.com)

**Sabre** (1964)
- by American Airlines and IBM
- Based in Southlake, Texas, USA
- Largest booking share in the world
- Used by [www.expedia.com](http://www.expedia.com), [www.travelocity.com](http://www.travelocity.com)

**Worldspan** (1990)
- by Delta Airlines, Northwest Airlines, and defunct Transworld Airlines
- Merged with Galileo in 2006
- Used by [www.orbitz.com](http://www.orbitz.com), [www.hotwire.com](http://www.hotwire.com), [www.priceline.com](http://www.priceline.com)

**Galileo** (1993)
- by Aer Lingus, Air Canada, Alitalia, British Airways, KLM, Swissair, TAP, US Airways and other airlines
- 11 major North American and European airlines
- Based in Atlanta, Georgia, USA
- Second largest booking share in the world
- Used by [www.cheaptickets.com](http://www.cheaptickets.com), [www.ebookers.com](http://www.ebookers.com)
Ticket Issuance Process

Crew Management
Crew Pairing and Rostering

Flight Departure Control

PNR

Flight Catering

Special Services
Passenger Name Record (PNR)

Active travel reservation in a GDS
PNR contains the information such as:
- Name of the passenger
- Gender
- Contact details
- Ticketing details
- Itinerary segments

Additional (optional) details:
- Fare details
- Payment methods
- Other personal info (age, email)
- Preferences: seat, meal
- Frequent Flyer .etc.

Each GDS stores vast databases of PNRs with past and present reservations.
⇒ Every PNR that is created in GDSs has associated historical information.
Passenger Name Record (PNR)

- The historical information of the PNR and any Additions, Cancellations, Deletions that are subsequently made to it.

- The GDS System updates PNR history at each End of Transaction entry.

- Although PNRs were originally introduced for air travel, they are now also being used for bookings of hotels, car rental, railways, etc.

- PNR is an alphanumeric code, typically 6 characters in length
  - Ex: RMT33W, KZVGX5, IIRCYC
Other core members

- **International Air Traffic Association (IATA)**
  - Trade association for the airlines
  - Support many areas of aviation activity and help formulate industry policy on critical aviation issues

- **Societe Internationale de Telecommunications Aeronautiques (SITA)**
  - Airport operations
  - Baggage operations
  - Cargo operations
  - Passenger operations

- **Official Airline Guide (OAG)**
  - Large airline schedules database which holds future and historical flight details for more than 1,000 airlines and over 4,000 airports

- **Airline Tariff Publishing Company (ATPCO)**
  - Publishes latest airfares for more than 500 airlines multiple times per day.
  - Airline CRS/GDS, Sabre, Amadeus, Online Travel agencies (Expedia, Travelocity) are prime users
INFORMATION SYSTEMS AT THE CENTER OF ONGOING TENSIONS
How do GDSs make money?

- **Booking fee**
  - About $4.50 per segment
  - Cancellation fees
- **Traffic fees (per inquiry)**
- **Agencies’ subscriptions**
  - Minus bonuses for productivity
- **Sales of MIDT**
  - Professors’ budget is often insufficient…
- **Hosting inventory for airlines**
- **Advertising**
Bypassing the GDS

Airlines pay GDSs for
– Traffic
– Bookings

To bypass, Airlines create own internet channels:
– **Orbitz** in USA
  • (Continental, Delta, NW, United, AA)
– **Opodo** in Europe
  • (BA, AF, Alitalia, Iberia, KLM, LH, Aer Lingus, Austria, Finnair)
– Internet-based, no need for GDS

GDSs pay kick-backs to agencies
Do airlines lower fares?
The Internet gives rise to new business models:

− Opaque channels:
  • Name-your-own-price: Priceline
  • Reverse auction: Hotwire
  • Intended to clear inventory via market segmentation
− Virtual agencies: Expedia

More decisions:
− Which GDS to use?
− What inventory to offer through which GDS?
− Which fares to offer in each GDS?
Level of Connectivity

Agency ➔ GDS ➔ Airline

Seat confirmed after transaction is closed

Agency ➔ GDS ➔ Airline

Seat allocated at **end** of transaction

Agency ➔ GDS ➔ Airline

Seat allocated **during** transaction
GDS alternatives: GNEs

Global New Entrants (or Alternative Content Access Platforms):

– Farelogix
– G2 Switchworks (now Travelport)
– ITA Software (now Google)
Cash flows for GDS and GNEs systems

GDS Model

GDS

GDS Incentive

Model excludes sales commission

GDS Fees

Travel Agent

Airline

Customer

GNE System

NO GNE Incentive

GNEs (direct connect)

Lower fee/ticket

Ticket Fee

Travel Agent

Sales Incentives?

Airline

Customer
Barriers for GNE’s

- Agencies rely heavily on GDS kick-backs since airlines capped/cut commissions
- Switching costs for agencies (equipment, training, back-office integration) can remain a barrier for GNEs
- However: United Airlines (Star Alliance member) considers paying agencies $5 bonus for each booking made through a GNE
- No car and hotel
- Limited worldwide coverage
Chances for GNE’s

- Can make distribution more competitive (breaking oligopoly of GDS’)
- Direct link to airline inventory
- Need for airlines to cut costs (distribution costs 20% of total costs, the only costs that are controlled most easily)
- Star Alliance consider GNEs (they spend $2billion on GDS fees/year)
- Agencies get access to all fares (public- and web-fares)
- Desktop no longer controlled by GDS
Preferred Booking Channels

Airlines have now the right to decide whether they want to be present in a GDS and also have the option to decide the level of participation (making a selection of all available fares, schedules, and inventory)

⇒ Preferred- or Competitive Booking Channels

⇒ Using a preferred- or competitive booking channels airlines pay less to a GDS

⇒ July 2006: Major US Airlines will start charging users (agencies and corporate clients) a booking fee of $3.50/segment if they are booked through non-preferred booking channels
Why Preferred Booking Channels?

- Airlines maintain control of distribution model
- Reduction of GDS fees
- Shift of cost of GDS-distribution from supplier to subscriber:
  - Agencies have to pay the airline a surcharge when a ticket is booked through GDS
GDS’ response

Opt-in programs to protect from paying booking fee, which vary by the subscription fee:
- Option 1: full content, no segment fee
- Option 2: full content, segment fee
- Standard: regular content, service fee

Raising fees: in Nov. 2010 Travelport informed AA that it raises the booking fee in many international POS
- AA has responded by imposing a premium to offset this fee increase
- In Dec. 2010 AA excludes Orbitz! (AA is one of its founding parents)
  • Due to failed negotiations over “direct connect”
Direct Connect

Orbitz was first up to renew distribution contract
  – AA demanded Orbitz uses Direct Connect (contracted by Farelogix)

Expedia was next
  – Sided with Orbitz and voluntarily pulled AA flights!
  – Sabre (who provides airfares to Orbitz) followed and removed AA from results (Jan. 2011)

Can AA afford to be on its own?
Online search

According to Amadeus:

– “Travel search is exploding. The look-to-book ratio is **1,000 to one**. A few years ago it was 10 to one. [But] direct sales are becoming re-intermediated – **70%** of airline.com traffic comes through intermediaries.

– “What you thought were direct sales are, in fact, indirect sales and the cost of sale in this channel is growing. With some OTAs, airlines pay **$88 per booking**.”
The dynamics of search

Even when consumers end up purchasing at AA.com, many of them visit OTAs first
– Cross-shopping data from 2010:
  • 41% of AA website shoppers visited Expedia/Orbitz
  • 70% of Expedia/Orbitz shoppers did not visit Kayak
– Can AA lock itself out from millions of potential passengers?
Priceline – a competitor – announced its Direct Connect with AA (Jan. 2011), noting it has been operational since Q4 2010.

In April 2011 Expedia agreed to Direct Connect – Hybrid model: using GDS aggregation technology

In April 2011 AA sued Travelport and Orbitz saying they made its fares look higher than they were to consumers
Similarly, US sued Sabre accusing the firm for monopoly and unfair practices

- US cannot offer fares on its websites that are not available through Sabre

In June courts orders AA fares to return to Orbitz

- Just one day after AA’s video “A Whole World is Missing:”…

March 2013, the firms resolved their dispute
And all over again…

August 2014:

But an agreement was reached a few days later…
Recent developments

Starting September 2015, Lufthansa started levying a €16 surcharge on all GDS reservations (LH, Austrian, Swiss and Brussels).

According to LH, it was paying a “three-digit million €” fee, although this pays for services that are “primarily used by other partner sites in the value chain” (i.e., OTAs).

What is the direct cost of distribution?
- LH states it is about €2
- Amadeus: “The Euro 2 direct distribution cost seems to be significantly understated. We do not know how LHG has reached this number but we believe the technology and internal costs to LHG alone for direct distribution are above Euro 2. Furthermore, this figure seems to omit the substantial cost of online traffic acquisition, commonly understood in the industry to be Euro 15-Euro 20 per ticket. Therefore, it seems LHG is driven by reasons other than cost.”
Amadeus (shares dropped 5%!) charged back arguing this will reduce transparency and that the extra IT costs will ultimately be passed on to the traveller.

2015 Q4 reveals neutral effect:
- Less revenues from outside home market
- Compensated by surcharge revenue and ancillary revenues via the direct channel

So far no other airlines is following suit, but considering.

In March 2016 Lufthansa Group filed a lawsuit against Sabre after the GDS company informed the airline group that it believes Lufthansa is in breach of contract.
Final thoughts

- OTAs only show lowest fare, no ancillary products.
- Travel agencies now want to have a piece of the cake:
  - “Consumers have that fundamental right to know the upfront cost of their entire trip and not be surprised at the airport by extra fees charged by the airlines”
  - “If consumers can see a fee but not purchase it, they really haven’t solved a problem […] We think airlines are actually leaving cash on the table by not pursuing all these distribution channels.”
- Airlines suffered when comparison websites facilitated price matching. Careful in introducing ancillary services
  - UA experiments with Amadeus

Source: http://www.businessweek.com/
One more thought

Mistakes happen and they can be (very) expensive.
### Brief history of fare glitches

<table>
<thead>
<tr>
<th>Airline</th>
<th>When?</th>
<th>The Glitch</th>
<th>Holy Deal</th>
<th>Honoured?</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Airlines</td>
<td>2007</td>
<td>Missing '0's</td>
<td>$1062 (not $10,620)--Los Angeles to New Zealand in Business Class</td>
<td>Yes</td>
</tr>
<tr>
<td>United Airlines</td>
<td>Jul-12</td>
<td>Purchased at a Discount, but Full Price Displayed</td>
<td>$43--New York to Hong Kong</td>
<td>No</td>
</tr>
<tr>
<td>United Airlines</td>
<td>Sep-13</td>
<td>$0 Fare, Only Charged Taxes &amp; Fees</td>
<td>$10--Washington to Hawaii</td>
<td>Yes</td>
</tr>
<tr>
<td>United Airlines</td>
<td>Oct-13</td>
<td>MileagePlus Account Tricked into Thinking Customer has Enough Miles for Award</td>
<td>$49--New York to Dublin</td>
<td>No</td>
</tr>
<tr>
<td>United Airlines</td>
<td>Nov-13</td>
<td>Widerøe Booking Site Drops YQ (fuel surcharge)</td>
<td>$250--New York to Milan</td>
<td>Yes</td>
</tr>
<tr>
<td>Aer Lingus</td>
<td>2009</td>
<td>Fare Mistake</td>
<td>$7--Across Europe in Business Class</td>
<td>No</td>
</tr>
<tr>
<td>British Airways</td>
<td>2009</td>
<td>Tried to Lower Fares by $40</td>
<td>$550--US to Mumbai</td>
<td>No*</td>
</tr>
<tr>
<td>American Airlines</td>
<td>2010</td>
<td>Dropped a '0'</td>
<td>$1100--US to Australia in First Class</td>
<td>No</td>
</tr>
<tr>
<td>Korean Airlines</td>
<td>2011</td>
<td>Dropped a '0'</td>
<td>$500--US to Seoul</td>
<td>No</td>
</tr>
<tr>
<td>Delta Airlines</td>
<td>Dec-13</td>
<td>Price Tweak Gone Awry</td>
<td>$7--US to Hawaii</td>
<td>Yes</td>
</tr>
</tbody>
</table>
IATA’S NEW DISTRIBUTION CAPABILITY (NDC)
Travel agents

Have limited access

Cannot see entire airline’s offerings

Source: IATA
Idea

Let agents have same capacity as websites

The NDC standard will enhance the capability of communications between airlines and travel agents, and will be open to any third party, intermediary, IT provider or non-IATA member, to implement and use.

Source: IATA
Now:

- Fares via 3rd party
- Schedule via 3rd party
- Availability
- Airline
- e-commerce engine
- Airline

Global Distribution Systems

Travel Agents (TMC/OTA/Independent)

Travelers (Business/Leisure)

NDC:

Airline Offer Management System

NDC

Content Aggregators (GDS/New Entrants)

Travel Agents (TMC/OTA/Independent)

NDC

Content Aggregation

Travelers (Business/Leisure)
# Benefits

<table>
<thead>
<tr>
<th>Airline IT Providers</th>
<th>Resellers</th>
<th>Corporate Buyers (incl. CBT)</th>
<th>Travelers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Differentiation</strong>&lt;br&gt;- Distribute the entirety of the airline’s product portfolio, including ancillaries and promotional fares&lt;br&gt;- Expand the amount of information available on each product: attributes, facilities, policies etc.&lt;br&gt;- Offer value-added products and services when applicable</td>
<td><strong>Access to full &amp; Rich Content</strong>&lt;br&gt;- Access to the entirety of the airline’s product portfolio, including ancillaries and promotional fares&lt;br&gt;- Improved merchandising</td>
<td><strong>Access to full &amp; Rich Content</strong>&lt;br&gt;- View all air transport options and relevant fares available</td>
<td><strong>Access to full &amp; Rich Content</strong>&lt;br&gt;- Benefit from all air transport options and relevant fares available</td>
</tr>
<tr>
<td><strong>New Products faster to Market</strong>&lt;br&gt;- Work with real-time pricing, product and policies information, under rich format</td>
<td><strong>Real Time Price Update</strong>&lt;br&gt;- View all air transport options and relevant fares available</td>
<td><strong>Gain greater Span of control</strong></td>
<td><strong>Transparent Shopping Experience</strong>&lt;br&gt;- Select the most appealing travel option, based on product quality, service level, schedule and price or what it is they value</td>
</tr>
<tr>
<td><strong>Personalization Opportunities</strong>&lt;br&gt;- Provide personalized service if passengers choose to be recognized</td>
<td><strong>Personalization &amp; Tailored Opportunities</strong>&lt;br&gt;- Provide personalized/tailored service based on customers’ full travel history and preferences, if they choose to be recognized</td>
<td><strong>Personalization &amp; Tailored Opportunities</strong>&lt;br&gt;- Provide personalized/tailored service based on customers’ full travel history and preferences, if they choose to be recognized</td>
<td><strong>Personalization Opportunities</strong>&lt;br&gt;- Option to receive personalized offers from preferred resellers based on their travel preferences, if they choose</td>
</tr>
<tr>
<td><strong>Cost &amp; Time Optimization</strong></td>
<td><strong>Comprehensive Reporting</strong></td>
<td><strong>Cost and time Optimization</strong></td>
<td></td>
</tr>
<tr>
<td><strong>True Product Sourcing Comparison (*)</strong>&lt;br&gt;- Deliver improved comparison shopping to customers, based on product and service rather than price only</td>
<td><strong>Policy-based Shopping</strong>&lt;br&gt;- Greater transparency on products and ancillaries that are available to travelers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) In an airline this would be referred to as True Comparison Shopping

Source: IATA
**Fundamentals**

- XML-based standards
- Airlines respond to shopping requests from travel agents
- Order process
  - Airlines fulfill reservation transactions, create booking records, issue documents and send confirmations
- Enable comparison shopping

So agents decide which airlines to contact, shopping requests are sent to airlines, offer responses are consolidated and presented to travellers.

Source: IATA
Search and share

Share your personal information with the following airlines:

- Jet Aether
- Athena Air
- Cloud Chronos
- Demeter Air
- Fly Apollo
- Jet Hera
- Hermes Gold
- Hypnos Air
- Sky Pontus
- Zeus Airways
Adoption

Airlines:

2015

- Shandong Airlines
- Qatar Airways
- Aer Lingus
- British Airways
- Heli Air Monaco
- Air China
- Scoot
- American Airlines

2014

- Hainan Airlines
- British Airways
- Qatar Airways
- Air Canada
- United
- Carusele

2013

- Air New Zealand
- Hainan Airlines
- China Southern

Other stakeholders:

- PSS: Amadeus, Sabre, Travelport, SITA, Triumph
- Networks: Travelport, Sabre, Amadeus
- Filing agencies: ATPCO, OAG
- GDS: Amadeus, ATPCO, Sabre, Travelport
- Resellers: Expedia, Orbitz, TMC
- Travelers: Google, Skyscanner, Kayak, Wego
AIRCINES’ REVENUE MANAGEMENT
Fundamentals of RM

- **Fixed inventory** or capacity that is expensive or impossible to store

- Inventory/capacity **committed** to a customer before all demand is known

- Different **customer segments** exist
  – firm can differentiate and price-discriminate among customers

- **Same unit** of inventory or capacity can satisfy different customer segments
RM timeline

- Capacity control
- Leg-based RM
- Network: O&D RM
- Margin: Pricing management
- Choice-based RM
- Ancillary revenues
Lessons learned

- Customers tolerate—but do not support—RM logic and practices
- Current RM software has a limited functional scope (airfare) and does not work with CRM
- Most ancillary products are perceived as punitive tactics
  - Checked bag fee, seat selection fee to avoid middle seat, entertainment fee.
- Branded fare products are a representation of the conventional fare rules
- Fare levels are not fully related to the cost of delivering the service, but more to time
- Overall, the RM logic is not communicated, or not communicated well
- Fundamentally, RM is suboptimal because it is imposed
- Strategic opportunity for RM is in democratizing value creation in collaboration with customers

Source: Millennium aviation
CRM and RM

- Limited evidence of true loyalty
  – May be driven by external factors

Trends:

CRM
◦ From FFP => CRM => CEM
◦ Profiling, analytics
◦ Deep segmentation
◦ Touch point integration
◦ Choice-based offering

RM
◦ Simplification of pricing
◦ Value-based offering
◦ À la carte
◦ Unbundling
◦ Subscription-based

Objectives:

◦ Facilitating life-time loyalty for repeat business and revenue growth

Conflicts:

◦ Focus on individuals
◦ Focus on long-term

◦ Optimize revenues for maximized profitability
◦ Focus on market segments
◦ Transactional-level focus

Source: Millennium aviation
Some Trends

- Fare families
  - Clustering of fares
- Unbundling
  - Lowest fares + add-ons
- Democratization
  - Premium amenities available to all at a cost
Some trends

Mobile apps

Watch apps

Skyscanner - All Flights
Skyscanner Ltd

Cheap Flights – Flights
Cheapflights

Flights
Any.Travel

KAYAK Flights, Hotels
KAYAK.com

My bookings
AF6U8D
BCN - LED
19/10/2015 06:23 h
26/10/2015 18:54 h

D51AF5
MAD - VGO
19/11/2015 12:05 h

YY8976
BCN - LED
Terminal 4
Gate 22D
On time

SYD - LAX
Boarding in 85m
at Gate 8
Departure
Arrival
11:45
06:30
Prices fluctuate: When to buy?
DSS for passengers?

Given the volatile nature of prices, consumers would like to know whether they should purchase right now or wait.

How should they do that?
- What if price goes up?
- What if prices goes down?

In order to make the decision, need to derive probabilities and account for magnitude of changes (see theory in next slides)

Problem: consumers need knowledge and information. Probably they lack both.
RM and price volatility

Assume class \( j \) is the lowest available fare at time \( t \):

- The fare class closes if \( c_t - \sum_{i=1}^{n} s_{i,t} < y_{j-1,t-1} \) and price goes up

- A lower fare class reopens if \( c_t - \sum_{i=1}^{n} s_{i,t} > y_{j,t-1} \) and price goes down
**RM and price volatility: Example**


Starting seating capacity is $C_3=50$

<table>
<thead>
<tr>
<th>Class</th>
<th>$\text{Distribution}$</th>
<th>$\text{Protection level}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: $500$</td>
<td>$N(1,1)$</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>$N(7.5,4.69)$</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>$N(9,3.38)$</td>
<td>10</td>
</tr>
<tr>
<td>2: $200$</td>
<td>$N(5,5)$</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>$N(5,5)$</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>$N(5,5)$</td>
<td>18</td>
</tr>
<tr>
<td>3: $100$</td>
<td>$N(9,3.38)$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$N(7.5,4.69)$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$N(1,1)$</td>
<td></td>
</tr>
</tbody>
</table>

Why 19? This is the 0.6 fractile of the joint distribution of Class 1 is $N(17.5,5.87)$

$C_3 > y_{2,3}$ so Class 3 is open and cheapest fare available is $100$
### RM and price volatility: Example

<table>
<thead>
<tr>
<th></th>
<th>distribution</th>
<th>period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class 1: $500</strong></td>
<td>[N(1,1), N(7.5,4.69), N(9,3.38)]</td>
<td></td>
</tr>
<tr>
<td><strong>Protection level</strong></td>
<td>19, 18, 10</td>
<td></td>
</tr>
<tr>
<td><strong>Class 2: $200</strong></td>
<td>[N(5,5), N(5,5), N(5,5)]</td>
<td></td>
</tr>
<tr>
<td><strong>Protection level</strong></td>
<td>39, 32, 18</td>
<td></td>
</tr>
<tr>
<td><strong>Class 3: $100</strong></td>
<td>[N(9,3.38), N(7.5,4.69), N(1,1)]</td>
<td></td>
</tr>
</tbody>
</table>


Now assume 8 customers buy Class 2 and 11 customers buy Class 3.

- \( C_2 = 31 < y_{2,2} \), so Class 3 is closes and cheapest fare available is $200. Prices spike up.
- If period 2 demand is less than 31-18=13, Class 3 reopens.
In order to make the decision, need to consider probabilities:

- The probability that class 3 reopens at the end of period 2 is \( Pr(d_{1,2}+d_{2,2}) < 31-18 = 0.53 \)
- Expected saving of $53
- The probability that class 2 closes is \( Pr(s_{1,2}+s_{2,2}) > 31-10 = 0.11 \).
- Expected loss of $32

Hence: wait.

Problem: consumers need knowledge and information. Probably they lack both.
Farecast: Internet + Big Data/Analytics

- "Big Data": Decision support websites:
  - Farecast (later Bing, now defunct) and recently Kayak
- Based on Etzioni et al.'s (2003; patent) prediction process
- Using databases (past airfares) it employed inference techniques to predict movement of lowest available airfare
- Received wide media attention
  - E.g.: PC World's 20 Most Innovative Products, Popular Science's "Best of What's New for 2006", a TIME Magazine's 50 Coolest Websites, "Best Trip Planning Tools" by Business Week

New York, NY (JFK) to Los Angeles, CA (LAX)

<table>
<thead>
<tr>
<th>STOPS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Checkmark" alt="Non-stop" /></td>
<td>$337</td>
<td>Mon, 10/10 - Mon, 10/17</td>
</tr>
<tr>
<td><img src="Checkmark" alt="1 stop" /></td>
<td>$348</td>
<td>1 adult · Economy</td>
</tr>
<tr>
<td><img src="Checkmark" alt="2+ stops" /></td>
<td>$418</td>
<td>Change search</td>
</tr>
</tbody>
</table>

PRICE PREDICTOR

**Tip:** Wait
- Fares dropping $31
- Confidence: 62%
- Details & fare history
How it Works – Using Farecast.com

Fare Prediction and Fare History – Know When to Buy

We predict where fares are going and show where they’ve been—now for more than 75 home airports (indicated in green within the search form). Our free airfare predictions are 74.5% accurate. Read more about the third party audit of our accuracy in our recent press release.

Fare Prediction

A Fare Prediction shows if the lowest fare is rising or dropping over the next seven days for the specific dates and cities searched. Each prediction includes the following elements:

1. **Arrow**: An indication of whether the lowest fare is rising, dropping, or staying the same.
2. **Confidence**: A percentage based on our track record for similar predictions for the market searched.
3. **Average Fare Change**: An amount reflecting the average fare change recorded when similar predictions were correct for the market.
4. **Buying Tip**: Our recommendation based on the prediction information.

Fare History

Fare History charts the lowest fare observed each day for your trip, up to 90 days ago. In other words, it's as if you would have searched for your trip every day and plotted the lowest fare actually available. To provide the airfare history, we have made more than 175 billion, and counting, airfare observations based on real pricing and availability.
7-day low fare prediction

Tip: Wait

There is a high likelihood of at least one major price drop within the next 7 days. Note: Price drops are sporadic and 50% of them do not last longer than 48 hours. Consider your risk tolerance.

If We Are Right:

- Lowest fares will Drop $22 - $72 | 62% confidence

If We Are Wrong:

- Lowest fares will Rise $18 - $43 | 8% confidence
- Lowest fares will Stay within $15 | 30% confidence

Confidence numbers are based on our track record for predictions in this and similar markets.

daily low fare history

Fare History charts the lowest fare observed each day for your trip. In other words, it's as if you would have searched for this trip every day and plotted the lowest fare actually available.

To provide the airfare history, we have made more than 175 billion, and counting, airfare observations based on real pricing and availability. Learn more by visiting Our Technology and Data.
Any impact?

Empirical estimations suggest an impact of 4-6%!
Flexible dates: DSS for passengers

### Delta

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri, Mar 14</td>
<td>$351 From</td>
<td>$374 From</td>
<td>$469 From</td>
<td>$486 From</td>
<td>$459 From</td>
<td>$459 From</td>
<td>$426 From</td>
</tr>
<tr>
<td>Sat, Mar 15</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
</tr>
<tr>
<td>Sun, Mar 16</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
<td>$315 From</td>
</tr>
</tbody>
</table>

### Northwest

Delta
<table>
<thead>
<tr>
<th>Day</th>
<th>SUN 31 MAY 2015</th>
<th>MON 01 JUN 2015</th>
<th>TUE 02 JUN 2015</th>
<th>WED 03 JUN 2015</th>
<th>THU 04 JUN 2015</th>
<th>FRI 05 JUN 2015</th>
<th>SAT 06 JUN 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Departure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUN 24 MAY 2015</td>
<td>608 TRY</td>
<td>654 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
</tr>
<tr>
<td>MON 25 MAY 2015</td>
<td>608 TRY</td>
<td>654 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
<td>507 TRY</td>
</tr>
<tr>
<td>TUE 26 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WED 27 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THU 28 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRI 29 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,096 TRY</td>
</tr>
<tr>
<td>SAT 30 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,096 TRY</td>
<td>1,096 TRY</td>
</tr>
<tr>
<td>Return</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUN 31 MAY 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MON 01 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUE 02 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WED 03 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THU 04 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRI 05 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAT 06 JUN 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ★ Lowest fare

Prices per adult including taxes, fees and carrier charges.
Decision support systems

- Can help users overcome their cognitive limitations and thus extend their bounds of rationality
- The design restricts decision makers to certain decision processes that are embedded into the system
- Users will employ a decision strategy that is often a function of the amount of effort required
  - Maximize decision quality
  - Minimize effort
- Hence, effort required while using the tool for decision tasks should be given much attention

But the latter is more important… Conflict!!!
Flexible Dates

Concentration of information on a single page reduces decision effort:

- It reduces cognitive effort
  - Fewer tasks (mouse movements, keyboard, scrolling)
- It reduces the time required for search
  - Response time during web navigation takes away from the time that can be devoted to the actual decision task
  - Fewer interruptions to the decision process
  - There is a negative relationship between performance evaluations and web-induced delays (which are common in flight search queries)
- It enables easier integration of information
  - Less effort in keeping track of information, reduced memory invested

Offer flexibility?

- this may divert consumers from expensive flights into cheaper ones…
Why offer flexibility?

- Competitive advantage
- Market pressure

Consider the following (1):
- Demand for low-priced tickets increases
- Demand for high-priced tickets decreases
- Hence, as more travel date combinations are displayed, the lower is the variance of the lowest prices across dates

Consider the following (2):
- Without flexible dates search, demand may be lost
- Demand for low-priced tickets increases
- No change in demand for high-priced tickets decreases
- Hence, as more travel date combinations are displayed, the higher is the average fare

However, there might be some long term implications.
APPENDIX
GDS SCREENSHOTS; NDC
User Interface

Start: Dumb Terminals (Workstation)
Now: Intelligent Terminals (=PC)
Expert Mode (e.g. Focalpoint Galileo)
GUI (e.g. Viewpoint Galileo, Amadeus Vista)
CRS availability display screenshot
Sabre Red Workspace

ZMYDOR

1. IVENGOP/ALAN/URUMBANYELUKUTTYMR

1. WY3908T 12SEP 4 SLLMCT HK1 2145 2320 /DCWY*JXWLAK/E
2. WY 225T 13SEP 5 MCTOK HK1 0120 0630 /DCWY*JXWLAK/E
3. WY 226T 20OCT 7 COKMCT HK1 0730 0935 /DCWY*JXWLAK/E
4. WY 907T 20OCT 7 MCTSLL HK1 1450 1625 /DCWY*JXWLAK/E

TKT/TIME LIMIT
1. T-27MAY-W742*AMS

PHONES
1. MCT24575814-A

PASSENGER EMAIL DATA EXISTS *PF TO DISPLAY ALL
INVOICED
PRICE QUOTE RECORD EXISTS
AA FACTS
1. SSR ADTK 1S ADTK WITHIN 60 DAYS OR WL XXL BY 26JUL13 08590M

GENERAL FACTS
1. OSI YY NTT 24575814 REF MOHAMMED
2. OSI YY SBB 24578721 REF BENOY
3. OSI YY FAX CTCH 00986 99372623
4. OSI YY FAX LCL CTCH 0091 04802790465/9544361525

REMARKS
1. XXIAW/

ACCOUNTING DATA
1. WYY4746259971/ .000/ 115.000/ 69.200/ONE/CA 1.1VENGO
PALAN URUMBANYELUKUTTYMR/1/F/EY
### Fare display screenshot

#### Public Fares

<table>
<thead>
<tr>
<th>CX</th>
<th>Fare</th>
<th>Fare Basis</th>
<th>C</th>
<th>AP</th>
<th>Min/Max</th>
<th>Seasons ......</th>
<th>MR</th>
<th>GI</th>
<th>DT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BD</td>
<td>306.00R</td>
<td>WHXUSB D1</td>
<td>W</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>BD</td>
<td>306.00R</td>
<td>WHXUSB D1</td>
<td>W</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
<tr>
<td>3</td>
<td>BD</td>
<td>336.00R</td>
<td>WHWUSB D1</td>
<td>W</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>BD</td>
<td>336.00R</td>
<td>WHWUSB D1</td>
<td>W</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>BD</td>
<td>452.00R</td>
<td>VHXUSB D</td>
<td>V</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
<tr>
<td>6</td>
<td>BD</td>
<td>482.00R</td>
<td>VHWUSB D</td>
<td>V</td>
<td>+ SU/12M</td>
<td>26SEP7-31OCT7</td>
<td>R</td>
<td>AT</td>
<td>D</td>
</tr>
</tbody>
</table>
Galileo Expert mode
Amadeus Vista (GUI-Mode)
Galileo GUI-Mode
**NDC: The process for interlining**

Step 0. Setup
Step 1. Shop with ORA
Step 2. ORA relays complementary Shop RQ to POA
Step 3. ORA consolidates POA RS into its Aggregator RS
Step 4. Agent sends Order RQ to ORA
Step 5. ORA accepts POA's offer with Order RQ and confirms interline order with Agent
Step 6. Ticketing & payments all with ORA as validating carrier (incl. BSP reporting & settlement)
NDC process for ‘shopping’

- Airline uses NDC for shopping and ordering
- Payment/ticketing completed by Aggregator with GDS capability

Source: IATA