Quality of Service Index (QSI) Deep Dive

Demand Share Calculation

- QSI includes the following variables:
  - Service type
  - Equipment type
  - Elapsed time penalty
  - Non-stop proximity penalty
  - Time-of-day
  - Airline Preference
  - Route Presence
  - Airport Presence
  - Relative Fare
  - Displacement

Demand Share Calculation

- QSI is used to forecast the demand share of every OD service (ODS) for an average day-of-week
- Daily OD service “Preference QSI” points are summed over 7 days to give a weekly total
- Weekly points are summed over all OD services to create a weekly OD total
- Average day-of-week OD service shares are computed by dividing weekly service points by weekly OD totals

Passenger Allocation Example

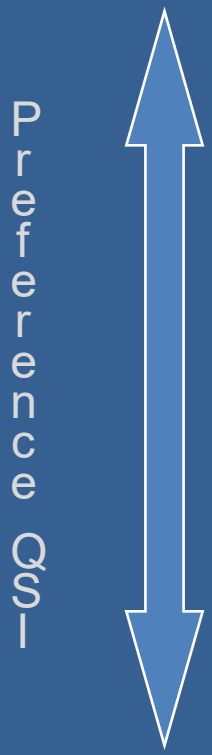
Airline	Directional OD Service	Point of Origin	Outbound / Return	QSI Points	QSI Share	Market Size	Demand Passengers
XX	YYZ-XXX	XXX	O	84	60%	300	180
		YYY	R	35	20%	250	50
YY	YYZ-XXX	XXX	O	56	40%	300	120
		YYY	R	140	80%	250	200
Total		XXX	O	140	100%	300	
		YYY	R	175	100%	250	

Passenger Demand with Incremental Service

Airline	Directional OD Service	Point of Origin	Outbound / Return	QSI Points	QSI Share	Market Size	Demand Passengers
XX	YYZ-XXX	XXX	O	84	34%	300	103
		YYY	R	35	14%	250	36
XX	YYZ-XXX	XXX	O	105	43%	300	129
		YYY	R	70	29%	250	71
YY	YYZ-XXX	XXX	O	56	23%	300	69
		YYY	R	140	57%	250	143
Total		XXX	O	245	100%	300	
		YYY	R	245	100%	250	

QSI Equation

QSI =



Service Type *

Equipment Type *

Elapsed Time Penalty *

Non-Stop Proximity Penalty *

Time of Day Factor *

Airline Preference Factor *

Relative Fares *

Displacement *

Route Presence + Airport Presence

Market Place QSI

QSI Order of Computation

Day 7

Day 1

Preference QSI Points

Use these weekly totals to compute RP and AP

Service Type Weights

Service	Connect Points	Stops	Points Domestic	Points International
Direct		0	12.00	12.00
Direct		1	4.00	4.00
Direct		2	1.00	1.00
Direct		3	0.50	0.50
Direct		4	0.20	0.20
Direct		5	0.10	0.10
Online	1	1	1.00	1.00
Online	1	2	0.50	0.50
Online	1	3	0.20	0.20
Online	1	4	0.10	0.10
Online	1	5	0.05	0.05
Online	2	2	0.30	0.30
Online	2	3	0.20	0.20
Online	2	4	0.05	0.05
Online	2	5	0.02	0.20
Interline	1	1	0.15	0.15
Interline	1	2	0.07	0.07
Interline	1	3	0.04	0.04
Interline	1	4	0.01	0.01
Interline	2	2	0.04	0.04
Interline	2	3	0.01	0.01

Equipment Type Weights

Category	Weight	Attributes (Sample Aircraft)
J0	1.8	New generation long range aircraft; double aisle; single or double deck; 2-4 engines; 9-10 seats across (787, 380)
J1	1.4	Double aisle; single or double deck; 2-4 engines; 9 seats across (747, 340, 777, 767)
J2	1.0	Single aisle; single deck; 2-3 engines; 5-6 seats across (737, 757, M80)
J3	0.9	Single aisle; single deck; dual class; 2-4 engines; 4 seats across; new “double-bubble” construction (E70, E90, BA146)
J6	0.8	Single aisle; single deck; dual class; 2 engines; 3-4 seats across (CR7)
J4	0.7	Single aisle; single deck; single class; 2 engines; 3-4 seats across (EM4, EM3)
J5	0.5	No aisle; single deck; 2 engines; 2-6 seats total; no F/A; no cockpit door, no overhead bins (Eclipse)
T0	0.5	Single aisle; single deck; 2 engines; 4 seats across (AT7 & 4)
T1	0.4	Single aisle; single deck; 2 engines; 3 seats across (SF3)
T2	0.3	Single aisle; single deck; 2 engines; 2 seats across; no F/A; no cockpit door, no overhead bins (B1900)
T3	0.2	All Other, esp. reciprocating engines

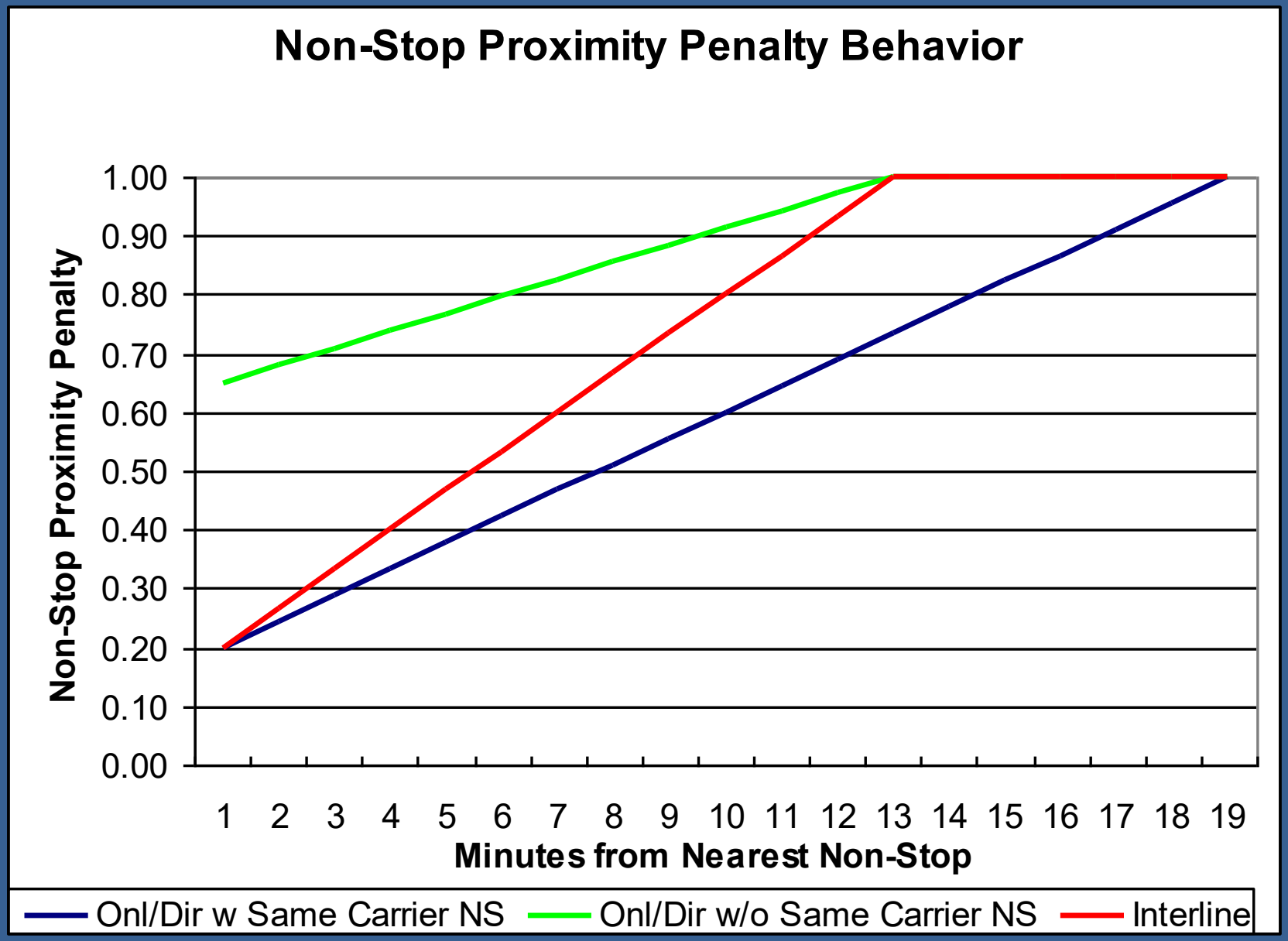
Windowing Logic

- Used for elapsed time and non-stop proximity logic
- Only for other than non-stop (OTNS) services
- Each OTNS target service is evaluated within a window

- Window includes any competing service (including NS) that departs within 120 minutes of target X, *or* arrives within 120 minutes of target Y (and all within X-Y times)
- For each target service, from the set of services in its window, determine the
  --fastest OTNS service in minutes (termed Best Time, BT)
  --Minutes From Nearest Non-stop departure or arrival (MFNN)

Non-Stop Proximity Penalty (NSP)

- Applied to both direct and OTSP services (NS excluded)
- If (MFNN) less than or equal 120 minutes:
  NSP = (1 - β) + β(MFNN / NS Proximity Window
- Otherwise NSP = 1.0


Non-Stop Proximity Penalty Behavior
Non-Stop Proximity Penalty
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Minutes from Nearest Non-Stop
Onl/Dir w Same Carrier NS
Onl/Dir w/o Same Carrier NS
Interline

Elapsed Time Penalty

- For each OTNS OD service, compute
  t = Best Elapsed Time / Target Elapsed Time
- If BT/TT is less than or equal to 0.5, ETP = 0
  --effectively nullifies all ODS passengers and revenue
- Otherwise, ETP is computed by a third order polynomial equation:

$$ETP = 21.2t^3 - 56.6t^2 + 50.5t - 14.2$$

- For t = 1.0, ETP = 1.00
  0.9, = 0.95
  0.8, = 0.90
  0.7, = 0.76
  0.6, = 0.36

Time-of-Day (TOD)

- Offset: Difference between Departure and Arrival time of the fastest “non-Concorde” service in the O&D, rounded to the nearest hour
- Time-of-Day Factors:

Departure Hour	0 … 8	9 … 14	... 20	21 … 23
Offset 2:				
Outbound	0.1 1.9	2.5 1.2	0.7	0.6 0.1
Return	0.1 0.6	0.7 1.1	1.8	1.5 0.1

- No. of offsets = 24, from 0 to 23
- Hourly time-of-day factors sum to 24

Time-of-Day (TOD)

- interpolates adjacent factors for flights departing between hours

  Assume a flight departs at 0815 (495 minutes after midnight), with TOD factors of 2.00 and 3.00 for 0800 (480) and 0900 (540), respectively

  TOD = 3.00 + [(2.00 – 3.00) * ((540-495)/60)]
  = 2.25

- TOD file arranged in hierarchical order from specific to general: Directional O&Ds, Destination Airport - Entity (D/I), Origin Airport - Entity (D/I), System Default

Including Directionality in TOD

- Differentiate curves according to the number of time zones traversed
  - Services not crossing a time zone are either short haul east-west, or north-south
    - Offsets will account for long haul north-south O&Ds crossing only one or two time zones
  - Format of the TOD/Offset matrices will remain constant
  - Time of Day curves will be calibrated for O&Ds crossing the following number of time zones: 0 (intra-zone travel), 1 to 5, 6 and beyond

Route Presence Equation

Airline O&D QSI_{POO} / Total O&D QSI_{POO}

- Route presence is bounded between 0 and 1
- QSI from interline OD services are included in the denominator only
- As such, summing the route presence of all airlines in an O&D will not necessarily equal 1.0

Calculation of Route Presence

ABQ-ALB

Carrier	Preference QSI	Route Presence
XX	5.11	8.01%
YY	48.45	72.79
ZZ	10.68	16.73
Interline	1.57	.
Total	63.81	97.53%

Airport Presence Equation

$$\frac{\sum_{\text{O\&D 1}}^{\text{ALL}} (\text{AL QSI} / \text{Largest AL QSI})^{\alpha} * \text{O\&D Revenue}}{\sum_{\text{O\&D 1}}^{\text{ALL}} \text{O\&D Revenue}}$$

Calculation of Airport Presence

QSI Coefficients

Alpha	1.00
Beta	1.00

						AIRLINE XX				AIRLINE YY	
O&D	MSZ	Avg Fare	Total O&D Rev	Largest AL QSI	Total O&D QSI	O&D QSI	Pct. of Largest Airline	Exp Adj	OPP Rev	O&D QSI	OPP Rev
XXX-YYY	800	$400	$320,000	50	70	20	40%	0.400	$128,000	50	$320,000
-AFS	800	$400	$320,000	50	90	40	80%	0.800	$256,000	50	$320,000
-ZZZ	800	$400	$320,000	50	100	50	100%	1.000	$320,000	50	$320,000
			$960,000			110			$704,000	150	$960,000

XXX OPP3: 0.733 YYY: 1.000

Airline Preference Factors

Carrier Level Forecast Error Disparity

- A direct remedy is to include an “Airline Preference Factor” (APF) in the QSI formula for specific carriers
  - Airline Preference Factors above 1.0 increase market share
  - Airline Preference Factors below 1.0 reduce market share

Airline Passenger Preference

- Airline Preference Factors have been typically seen as an intangible number
- In most cases, it is very hard to determine why passengers have a preference for one airline versus another
  - Is it complimentary food?
  - Maybe it is more comfortable seats?
  - Or does one airline have better customer service?
  - Perhaps one airline has cleaner aircraft?