New Developments in RM Forecasting and Optimization

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RM Systems Struggled after 2000

- **Major shifts in airline pricing strategies since 2000**
  - Movement toward "simpler" fares with fewer restrictions and less product differentiation
  - Driven by growth of LCCs (and matched by most airlines)

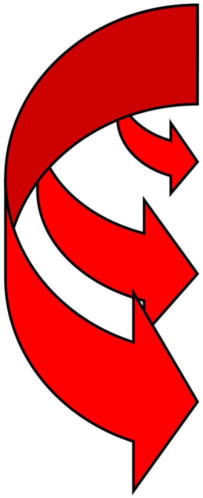
- **With simplified fares, revenue leverage shifts from pricing to RM (seat inventory control)**
  - Simplified fares still offer just as many price levels, but primary segmentation restrictions have been removed
  - "Spiral down" contributed to dramatically lower yields and historical record load factors

Restrictions Help to Segment Demand

Fare Code	Dollar Price	Advance Purchase	Round Trip?	Sat. Night Min. Stay	Percent Non-Refundable
Y	$400	--	--	--	--
B	$200	7 day	Yes	--	50 %
M	$150	14 day	Yes	Yes	100 %
Q	$100	21 day	Yes	Yes	100 %

- **Business passengers unwilling to stay over Saturday night will not buy M or Q.**
- **RM system protects for Y, B demand but keeps M,Q classes open without losing revenue.**

Fare Simplification Reduces Segmentation



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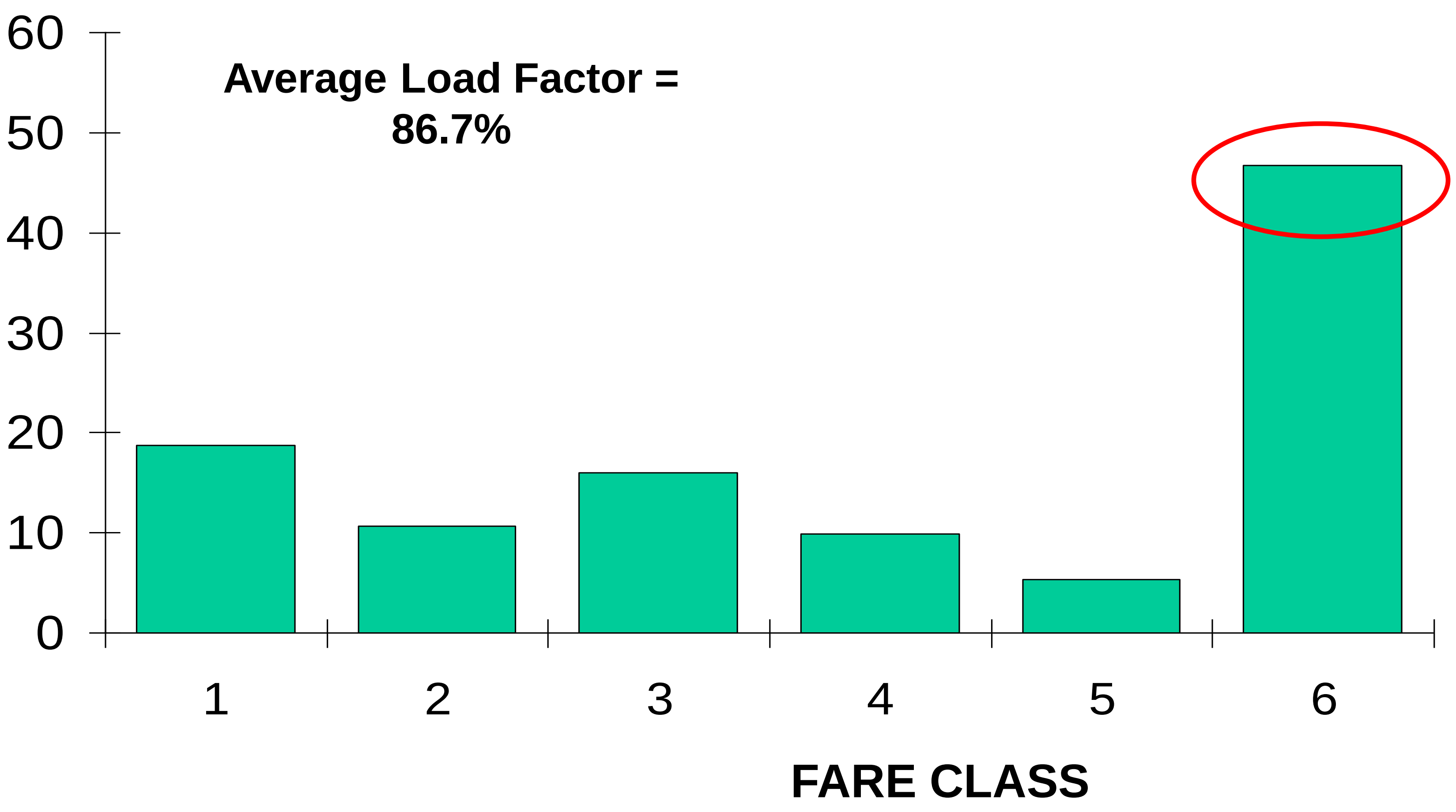
- **With fewer restrictions on lower fares, some Y (business) passengers are able to buy B, M and Q.**
- **Keeping B, M, Q classes open results in “spiral down” of high fare passengers and total revenues.**

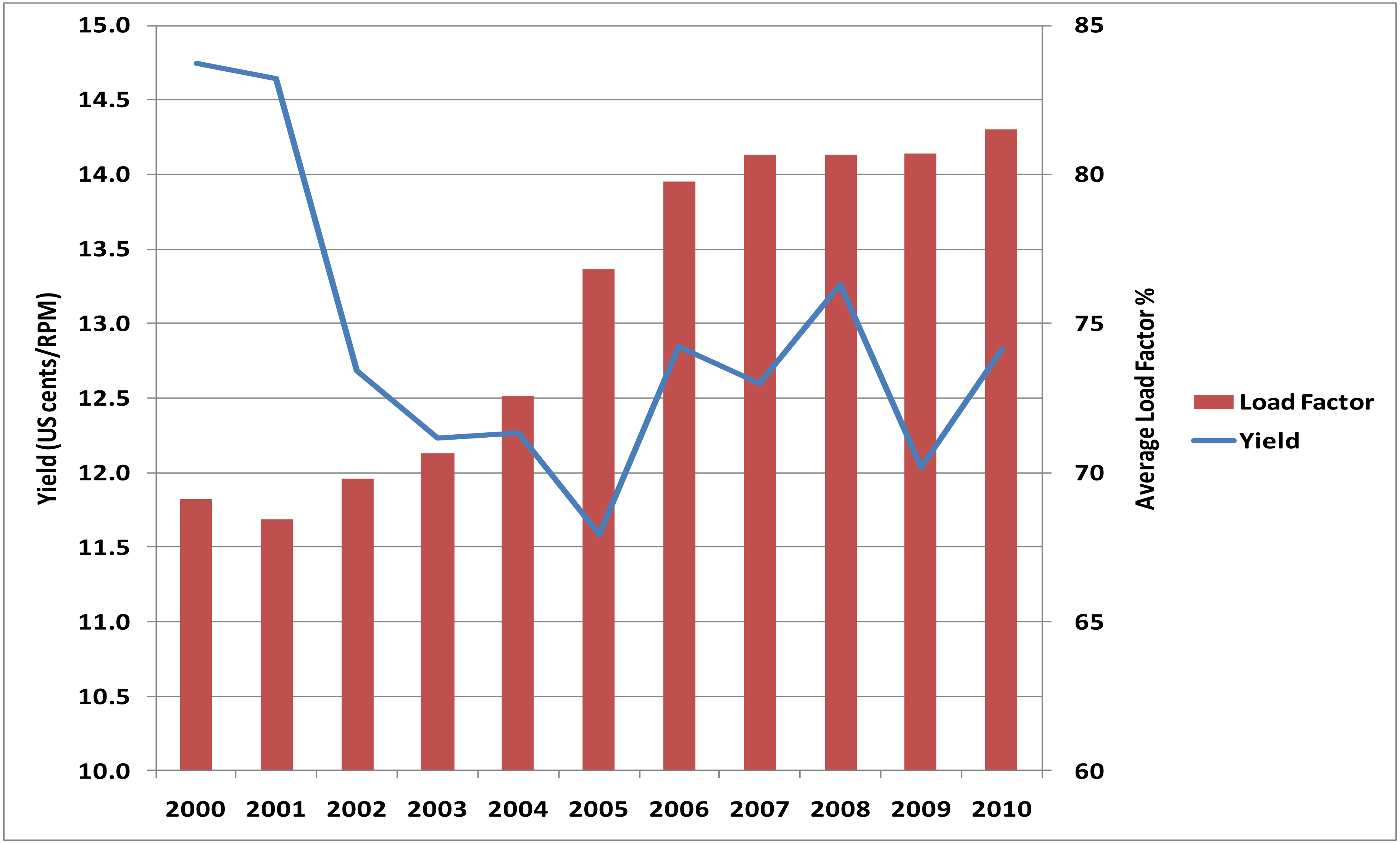
“Spiral-Down” in Simplified Fare Structures with Traditional RM Systems

- **Simplified fare structures characterized by**
  - One-way fares with little or no product differentiation, priced at different fare levels
  - Without segmentation, passengers buy the lowest available fare
- **Fare class forecasts based on historical bookings will under-estimate demand for higher fare levels**
  - Previous “buy-down” is recorded as lower fare demand
  - EMSRb under-protects based on under-forecasts of high-fare demands
  - Allowing more buy-down to occur, and the cycle continues

Standard RM Allows Spiral Down in Less Restricted Fare Structures



US Domestic Mainline Carriers
Yields and Load Factors 2000-2010



Traditional RM Systems Could No Longer Maximize Revenues

- **Airline RM systems were developed 1985-2000 for restricted fares, segmented demands**
  - Assumed independent fare class demands, restrictions kept full-fare passengers from buying lower fares
  - Forecasts based on historical bookings were adequate

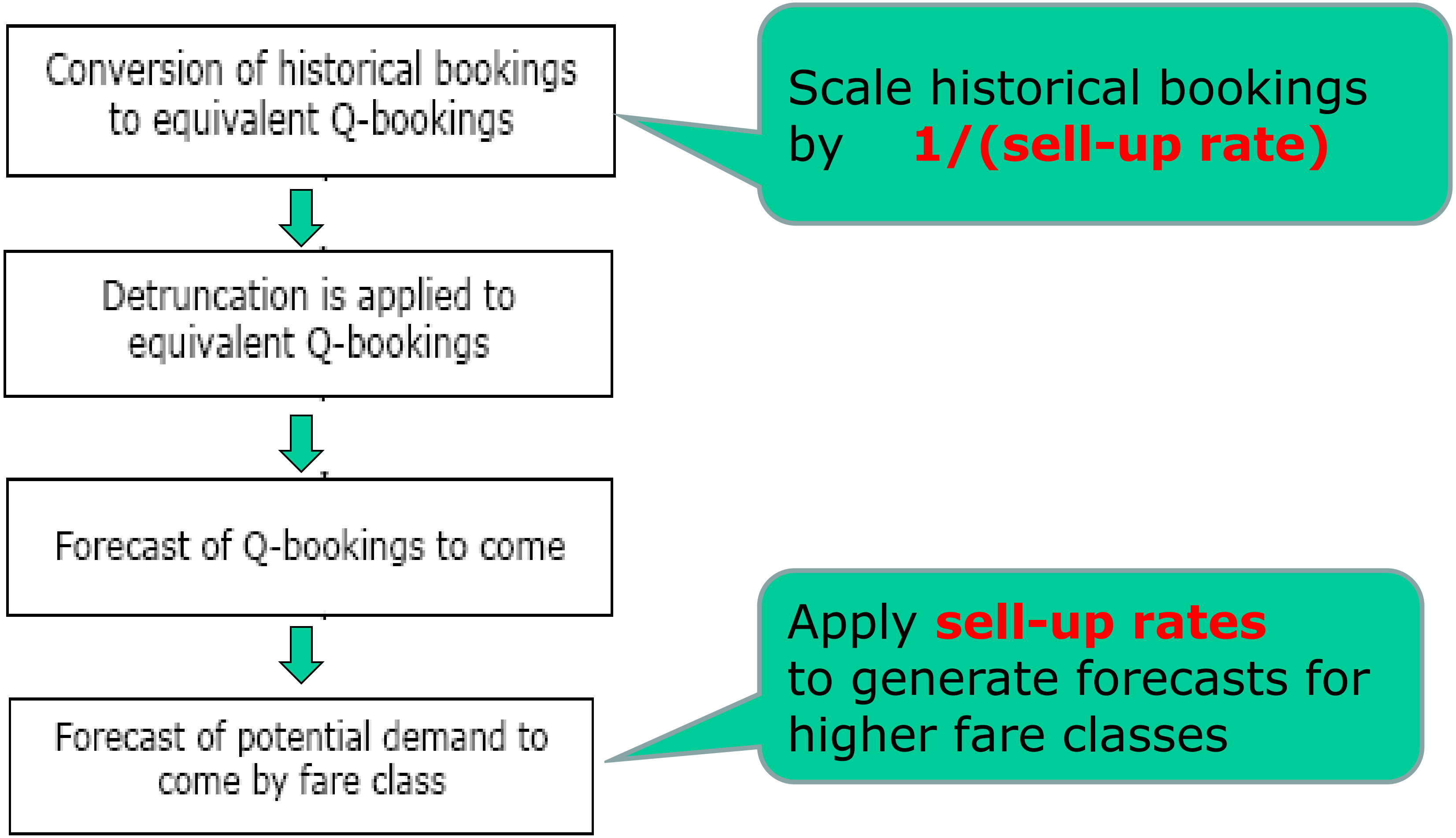
- **New forecasting and optimization methods needed with changing airline business models**
  - Forecasting models that reflect passenger willingness to pay (WTP)
  - Optimization models that incorporate likelihood of passenger sell-up when lower classes closed

New Developments in RM Modeling

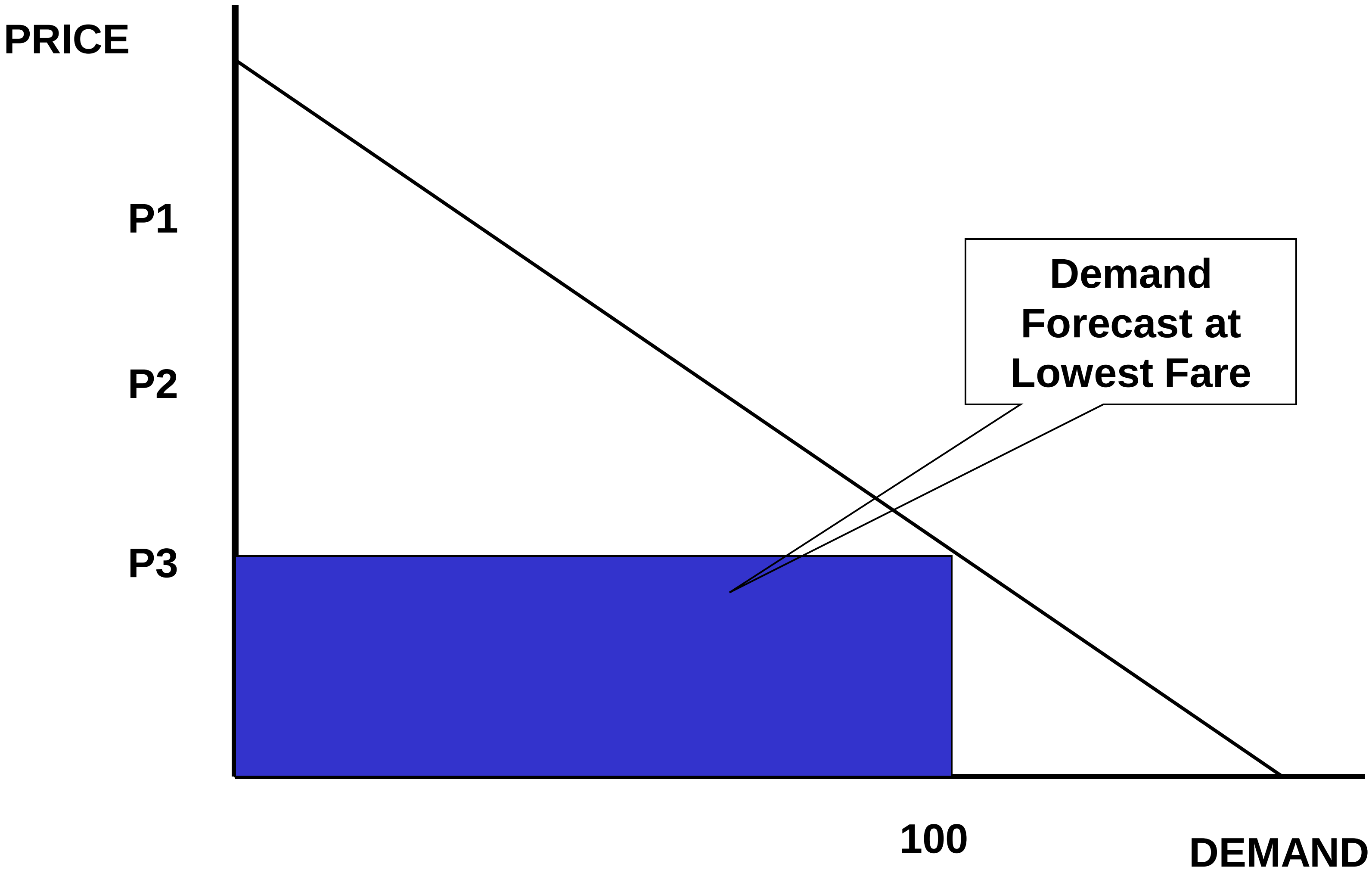
- **Forecasting and optimization methods to reverse and prevent spiral down in different fare structures**
  - Incorporate willingness to pay (WTP) or "sell-up" probabilities
- **Several new approaches show promising results**
  - "Q-forecasting" by WTP (Hopperstad and Belobaba)
  - Hybrid Forecasting (Boyd and Kallesen)
  - Fare Adjustment in Optimization (Fiig and Isler)
- **Methods developed and/or tested in MIT PODS research consortium**
  - Funded by eight large international airlines
  - Passenger Origin Destination Simulator used to evaluate revenue impacts of RM models in competition markets

Q-Forecasting of Price-Oriented Demand

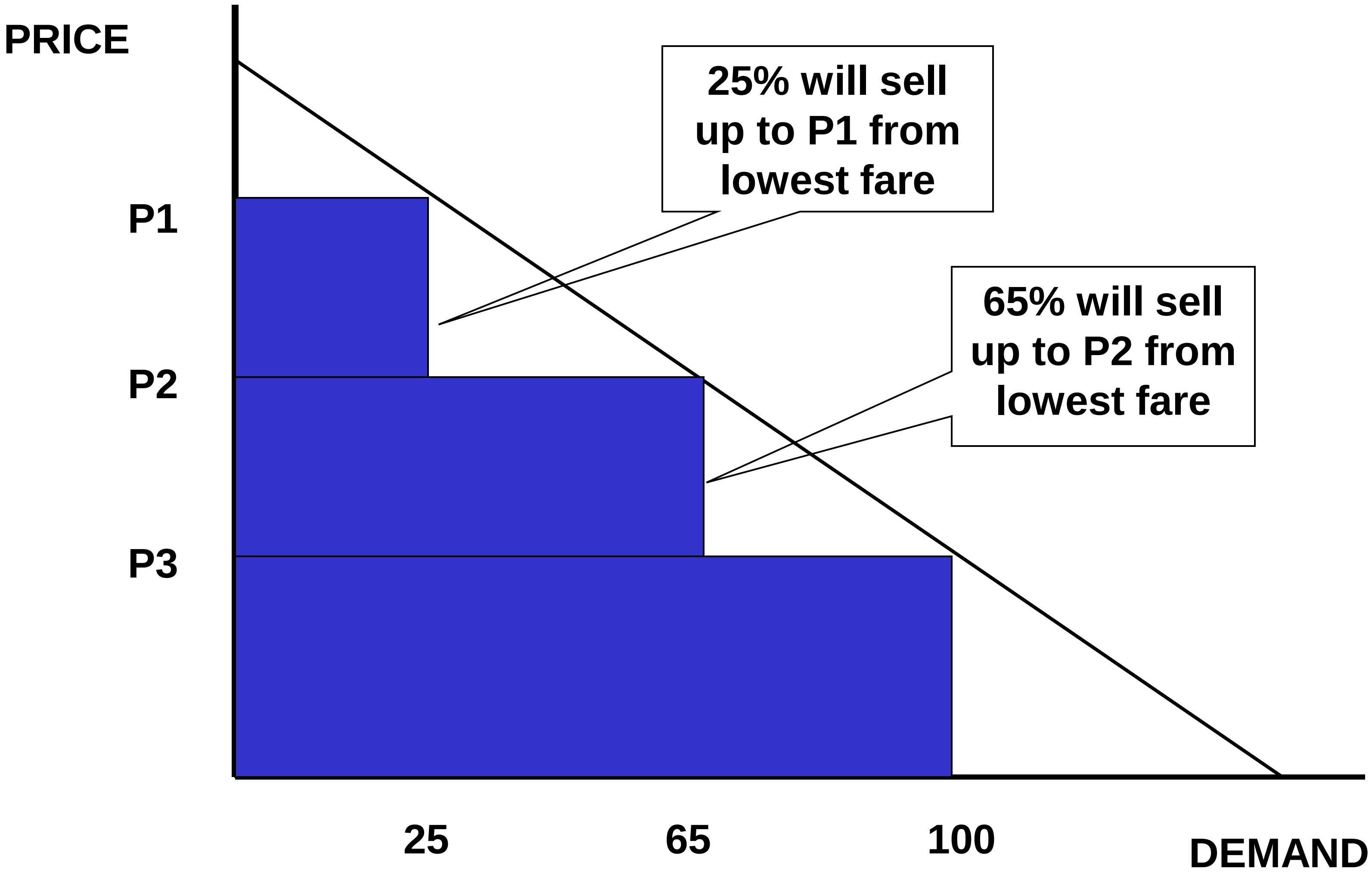
- **Q forecasting assumes fully undifferentiated fares**



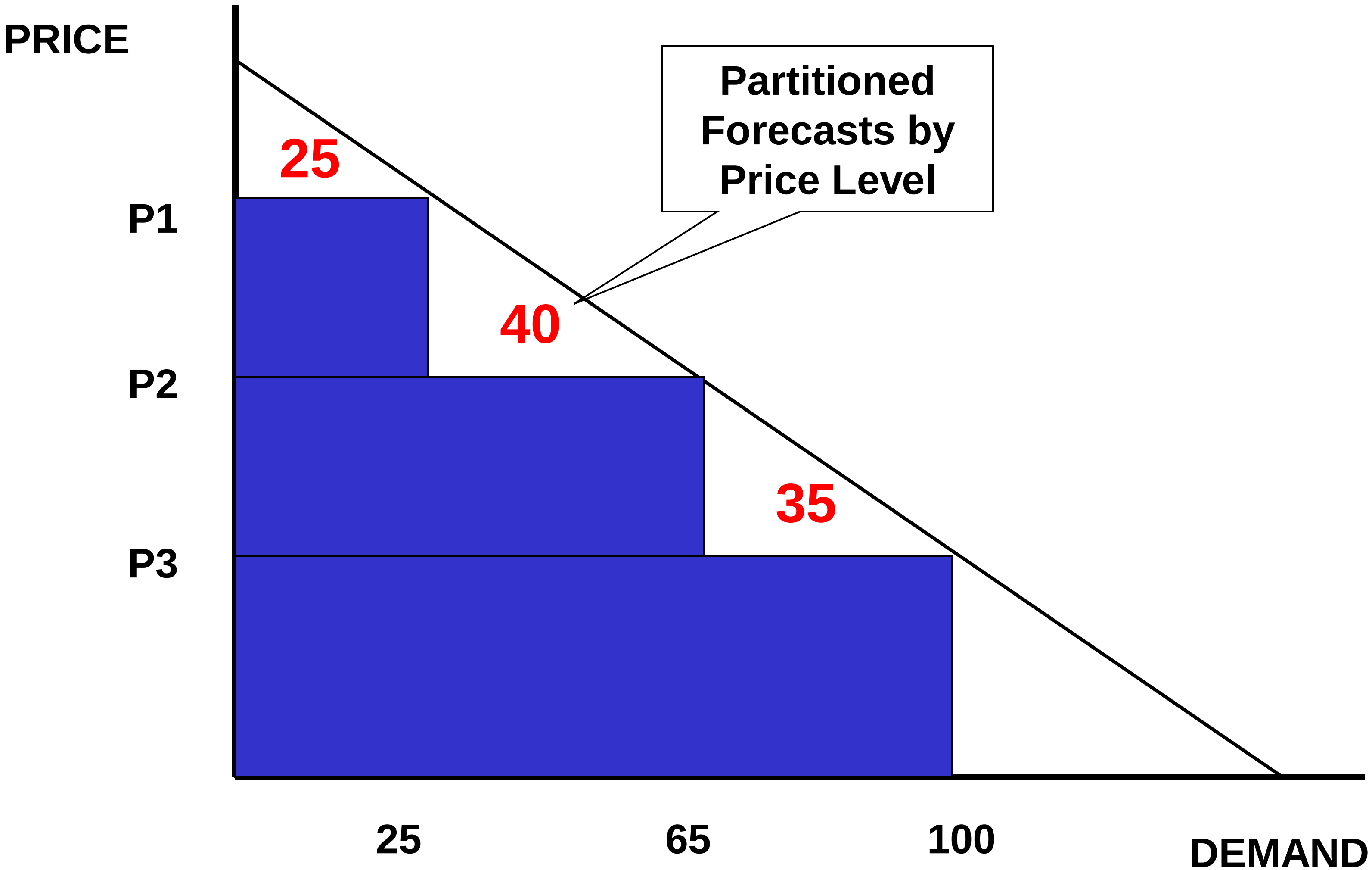
Generate Flight-Specific Forecast of Potential Demand at Lowest Fare



Apply Sell-up Estimates to Potential Demand at Lowest Fare



Create "Partitioned" Forecasts by WTP for Input to Optimizer



Hybrid Forecasting For Simplified Fare Structures

- ***Hybrid Forecasting*** **generates separate forecasts for price and product oriented demand:**

✈ Price-Oriented:

- Passengers will only purchase lowest available class
- Generate conditional forecasts for each class, given lower class closed
- Forecast demand by WTP

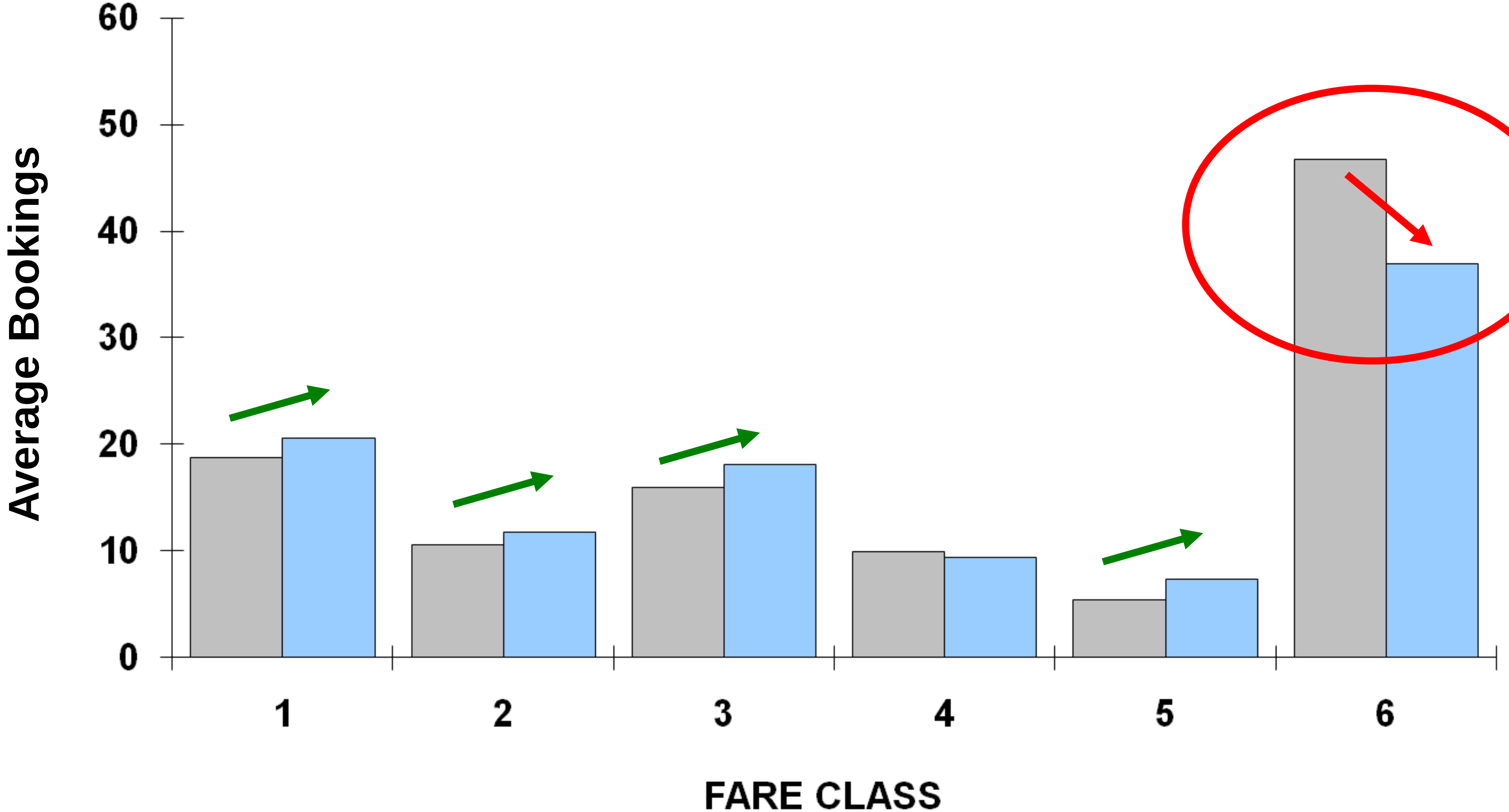
✈ Product-Oriented:

- Passengers will book in their desired class, based on product characteristics
- Use Traditional RM Forecasting by fare class

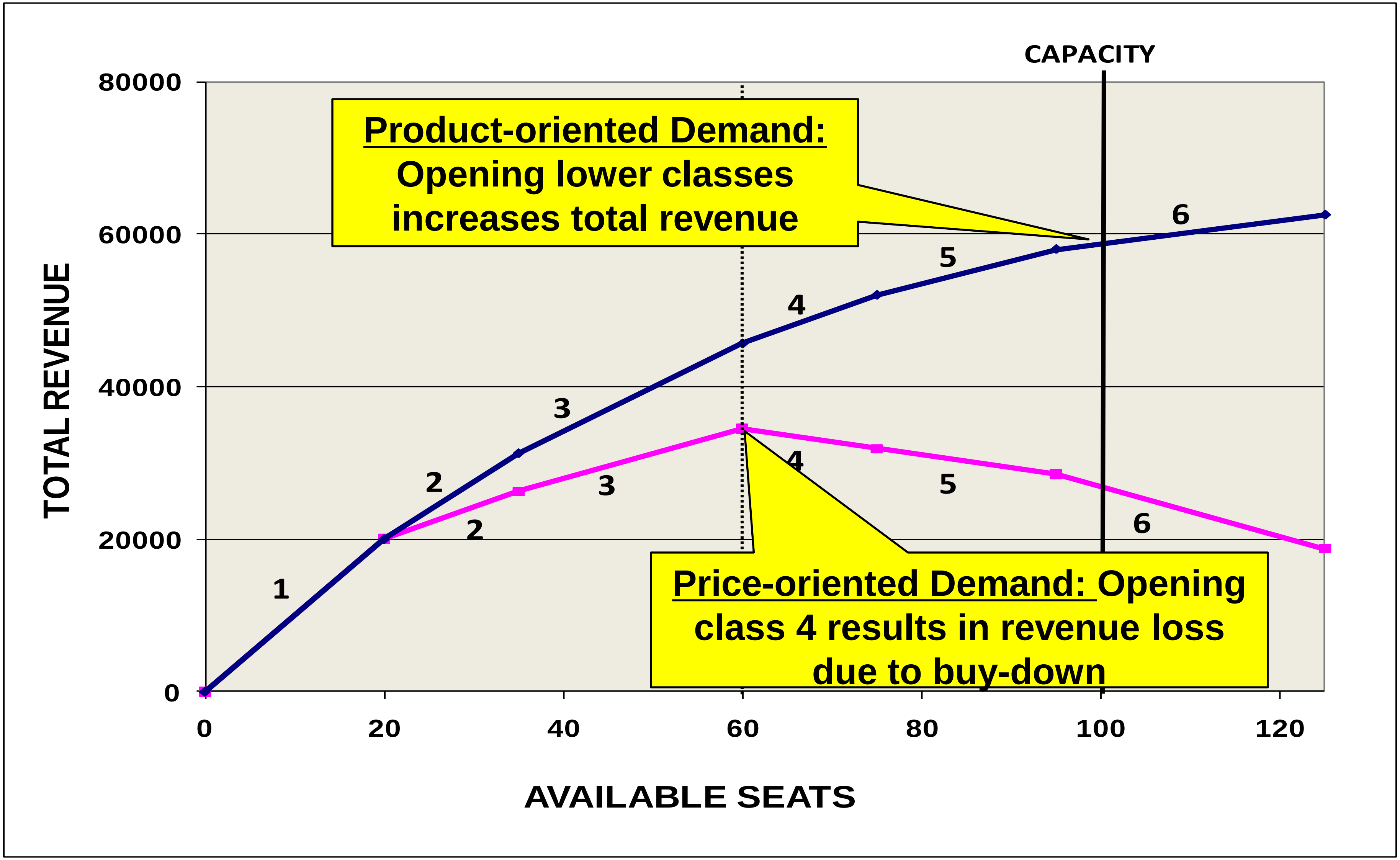
Forecast of total demand for itinerary/class

Hybrid Forecasting Increases Revenues by 2.2% by Changing Fare Class Mix

- Load Factor drops from 86.7% to 83.7%, but yield increases with fewer bookings in the lowest fare class.



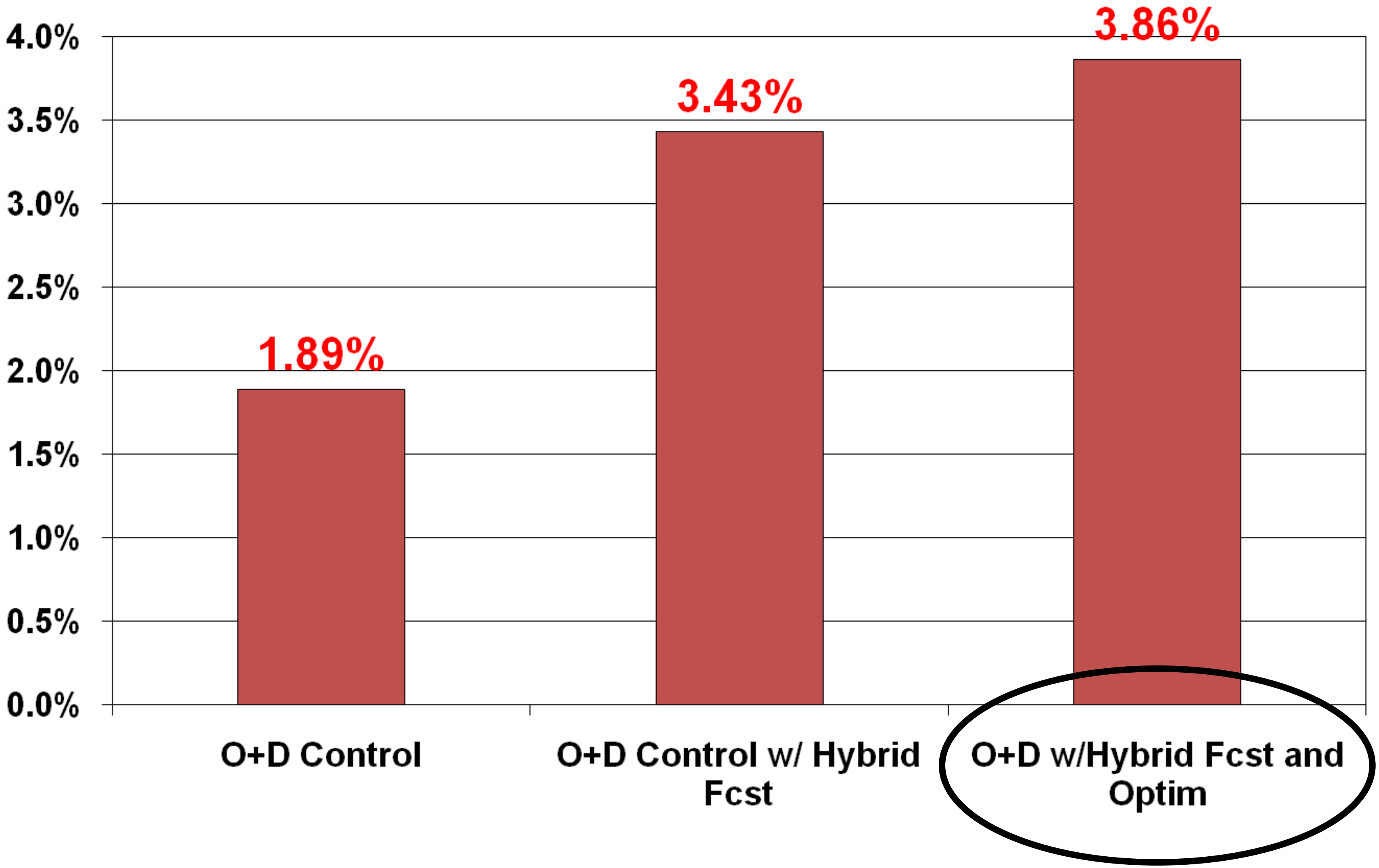
Marginal Revenue Optimization for Price-Oriented Demand



Network RM with Hybrid Forecasting and Fare Adjustment

- **Greatest revenue gains of existing RM methods for less restricted fare structures come from:**
  - O-D Control: Path-based forecasting and network optimization, with availability controlled by virtual buckets (DAVN) or bid prices (ProBP)
  - Hybrid Forecasting: Separate forecasting of price- vs. product-oriented demand in all markets (LCC and traditional) requires explicit WTP forecasts for price-oriented demand
  - Fare Adjustment Optimization Logic: Price-oriented demands subject to fare adjustment which maps availability to lower buckets and/or below bid price.
- **These 3 components combine to provide Airline 1 with 3.86% revenue gain over standard Leg RM.**

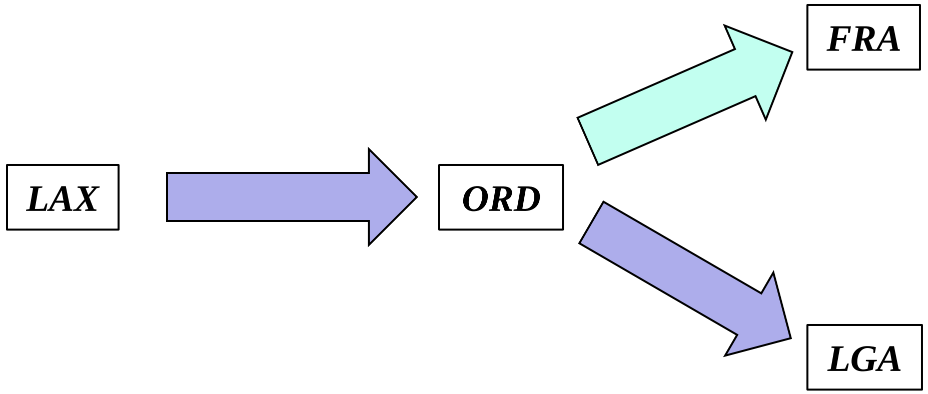
Hybrid Forecasting and Optimization Gains over Standard Leg RM Systems



Alliance RM Challenges

- **Alliance revenue gains affected by RM systems:**
  - Valuation and optimization of code share bookings affects seat availability on both partner networks
  - Optimizer must deal with incomplete information
- **Bid price sharing improves revenues:**
  - But different alliance partners have different RM systems and practices that affect bid prices
  - Frequency of bid price exchange and real-time controls of code-share requests improve revenue gains
- **Major investments in RM systems and distribution technologies required**

Traffic Components in Alliances



- **Local Traffic: Itinerary consists of a single leg and can be sold by operating carrier only: LAX-ORD.**
- **Connecting Traffic: Itinerary consists of multiple flight legs operated by the same airline. It can be sold by operating carrier only: LAX-LGA.**
- **Codeshare Traffic: Itinerary consists of multiple flight legs operated by different airlines and it can be sold by either airline: LAX-FRA.**

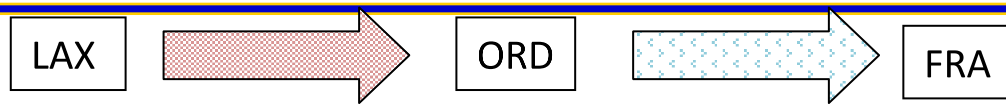
Complexity Created by Codeshares

- **Every codeshare path consists of multiple legs operated by different airlines which raises these interrelated questions:**
  1. How is the seat availability decided for the codeshare passengers?
  2. How are the revenues from codeshare bookings shared between the partners?
- **The ideal solution is to combine the networks of alliance partners and find a joint optimal solution.**
  - However, in reality the carriers and their revenue management systems remain independent.

Codeshare Valuation

- **Codeshare valuation refers to the fare inputs related to the codeshare itineraries.**
- **The seat availability, as estimated by the optimizer, depends on the valuation.**
  - All else being equal, a higher codeshare valuation would lead to a higher availability for codeshare paths and vice versa.
- **Tradeoff: Every codeshare booking potentially replaces either a own local or an own connecting passenger**

Static Codeshare Valuation Schemes



Booking O-D/Class	Marketing Airline	Fare
LAX-ORD/Q	P1 (Local)	$ 248
ORD-FRA/Q	P2 (Local)	$ 532
LAX-FRA/Q	P1,P2 (Codeshare)	$ 619

Local Valuation

Airline	Valuation
P1	$ 248
P2	$ 532
Sum	$ 780

Y-Prorate Valuation

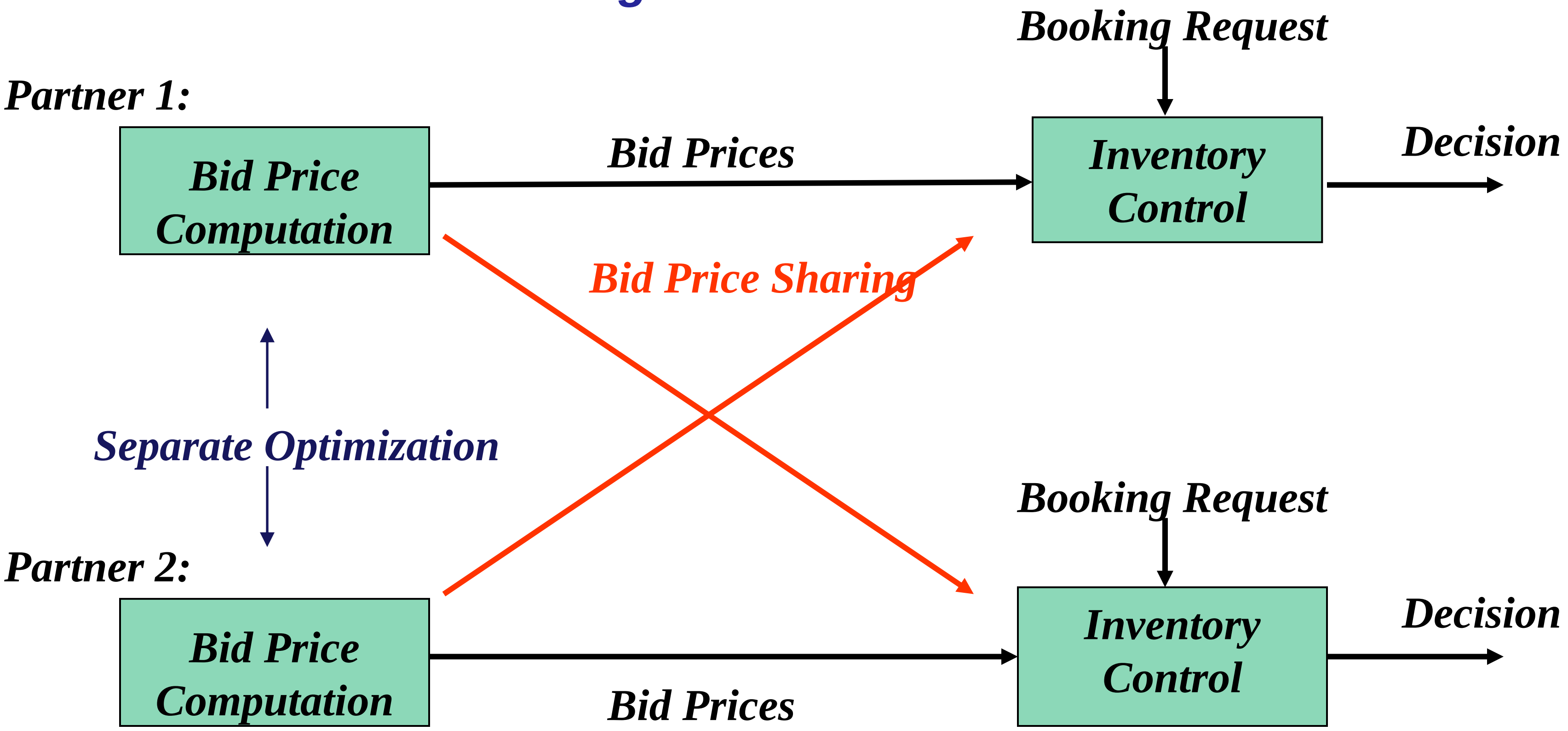
Airline	Valuation
P1	$ 206
P2	$ 413
Sum	$ 619

Total Valuation

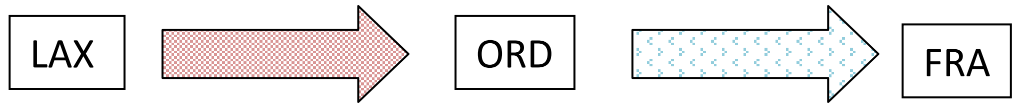
Airline	Valuation
P1	$ 619
P2	$ 619
Sum	$ 1238

Bid Price Sharing for Code-share Availability Control

Bid price = marginal network revenue value of available seat on each leg

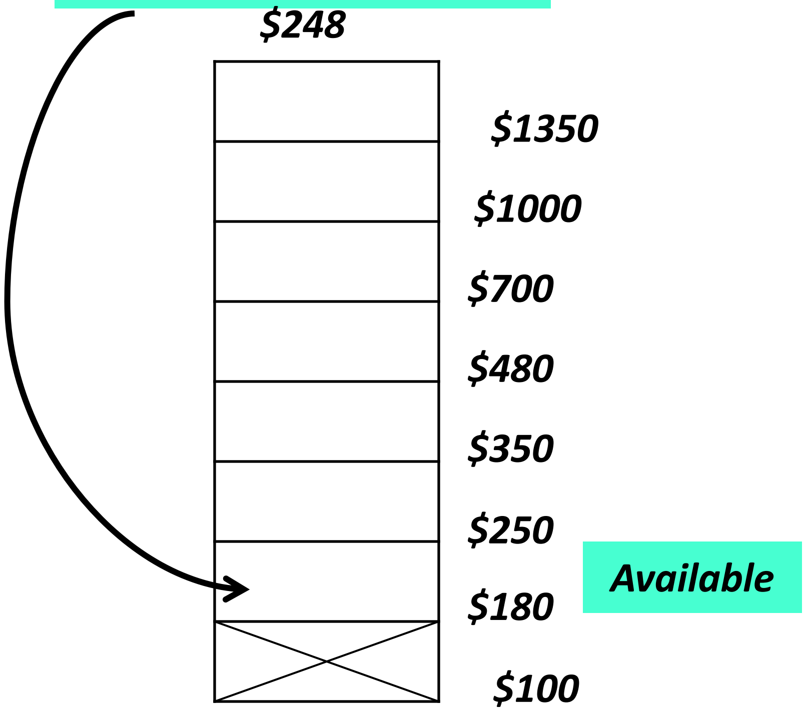


Availability Control Example



Partner 1: Standard Control

Codeshare LAX-FRA Q Valued @ Local Fare: $248



Partner 1: Bid Price Control

Availability dependent on partner's shadow price while valuation in the optimizer still remains same- @ Local Fare

Availability Control Decision:

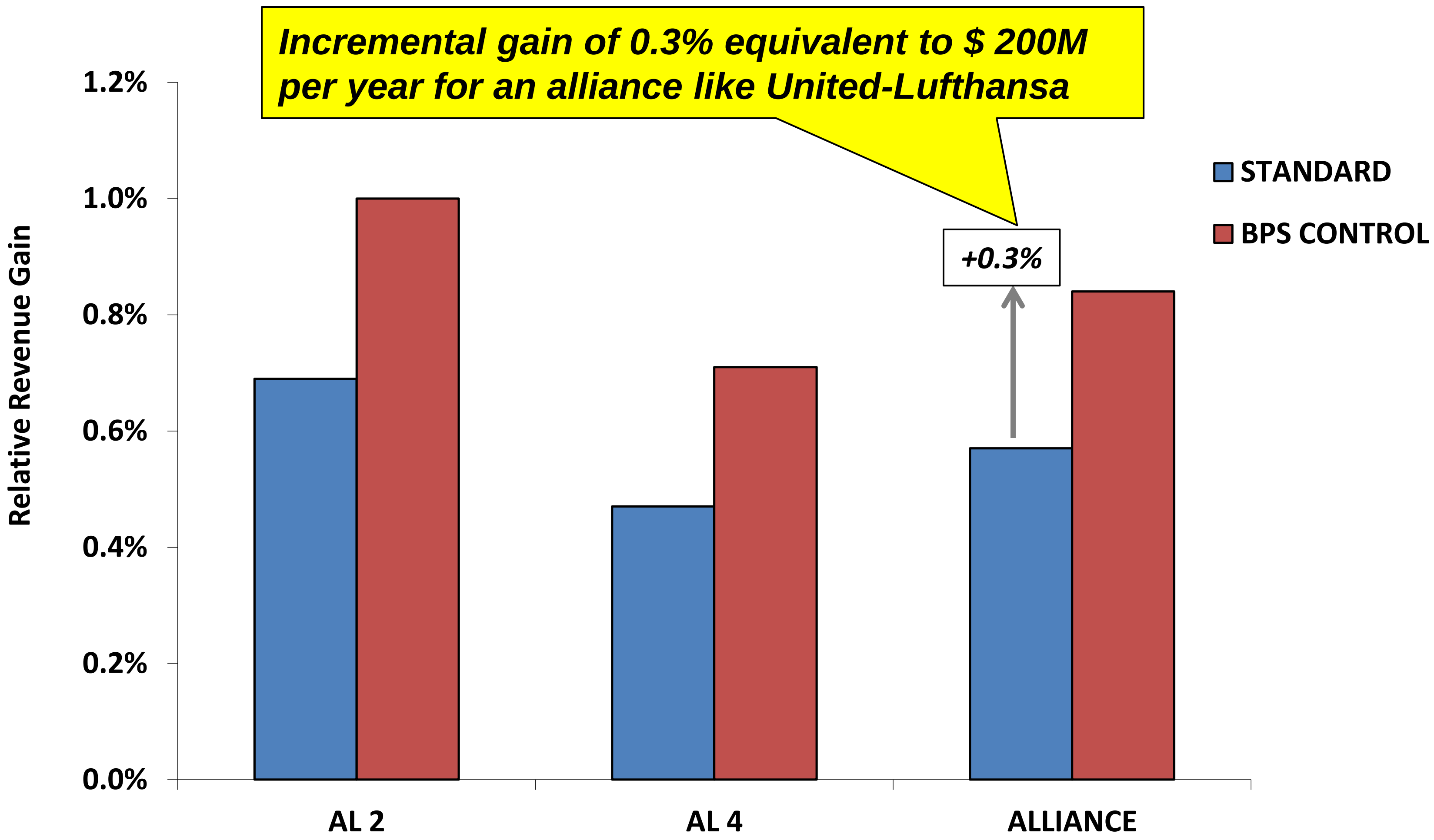
$$Total\ ODF - SP_2^{t-1} \geq Bucket\ Fare_1^t$$

$$\$619 - SP_2^{t-1} \geq \$180$$

$$if\ \ SP_2^{t-1} \geq \$439\ then\ CS\ \ path\ is\ not\ available$$

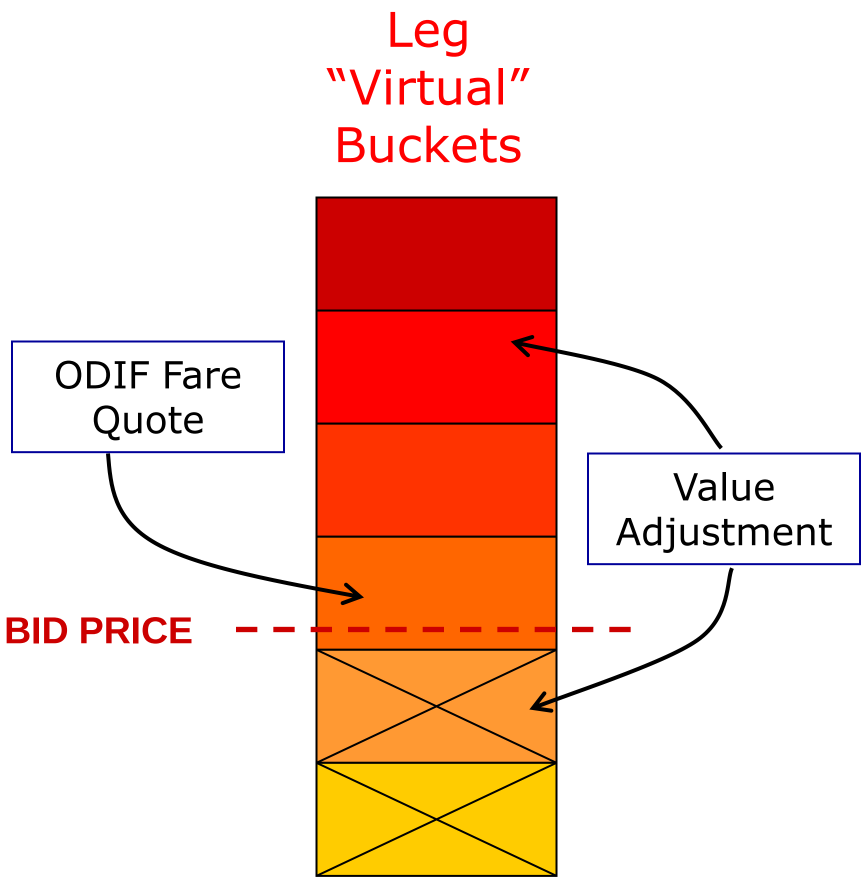
Bid Price Sharing Availability Control

Compared to Baseline



Real-time Value Adjustment of Booking Requests and Availability

- **Availability calculations driven by leg bid prices provided by RM system**
- **Adjustment of request value in real-time can provide different availability responses by:**
  - **CRM considerations: premium frequent flyers**
  - **Operating carrier vs. code-share alliance request**
  - **Distribution channel, adjusted for cost differentials**
  - ***Ancillary revenue sales potential (or actual)***



The Next Generation of RM Systems

- **New RM forecasting and optimization models**
  - Hybrid forecasting by demand segment
  - Estimation of passenger choice and willingness to pay
  - Marginal Revenue Optimization to account for choice

- **Dynamic interactions between RM and Inventory**
  - Greater coordination of RM among alliance partners
  - Modifications to own RM based on competitor actions
  - Real-time availability control based on customer value

- **Changing airline business models have provided impetus for "5th Generation RM Systems"**