Freie Universität Berlin

Long-term revenue optimization with flexible products in Airline Revenue Management

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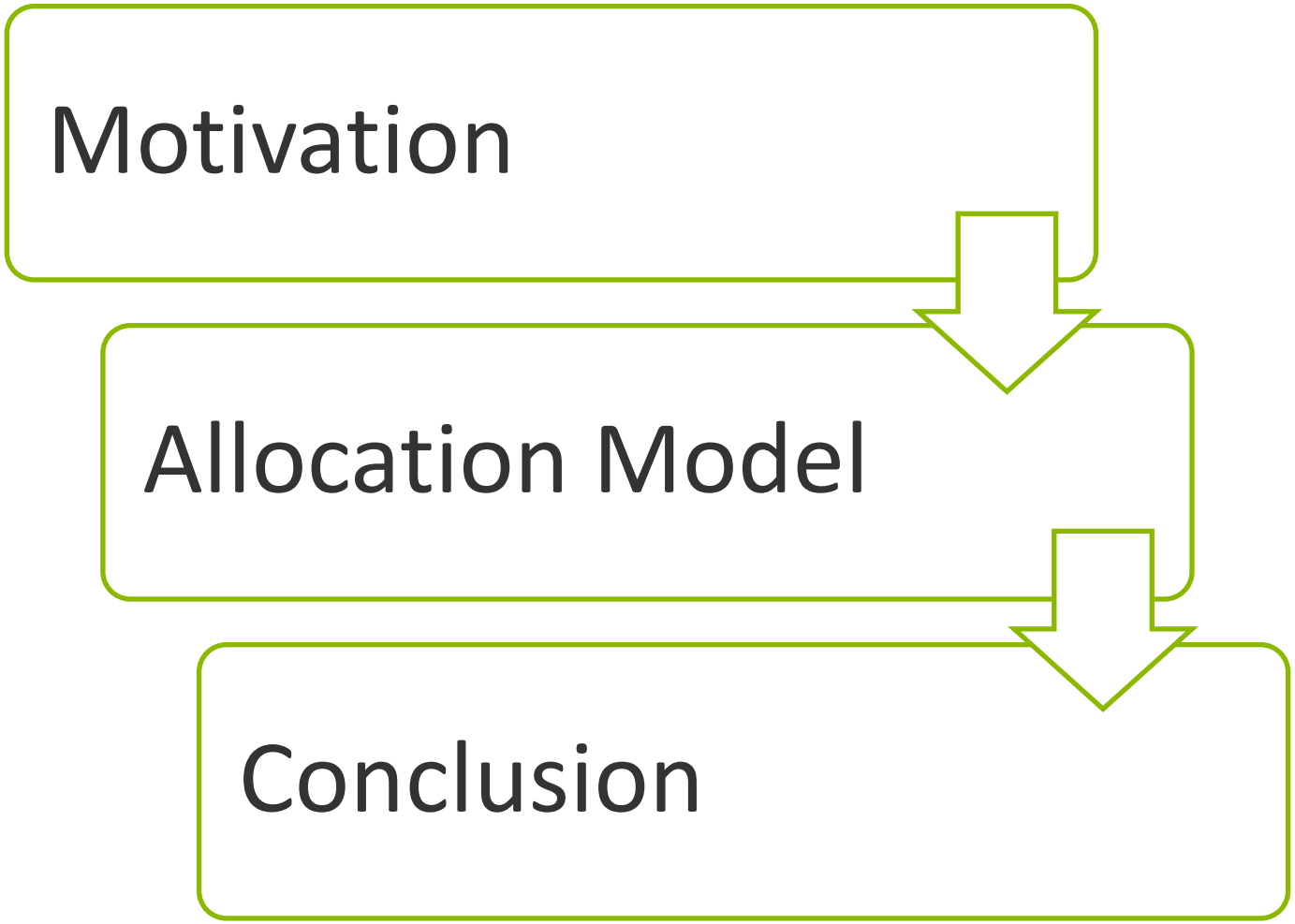
Agenda



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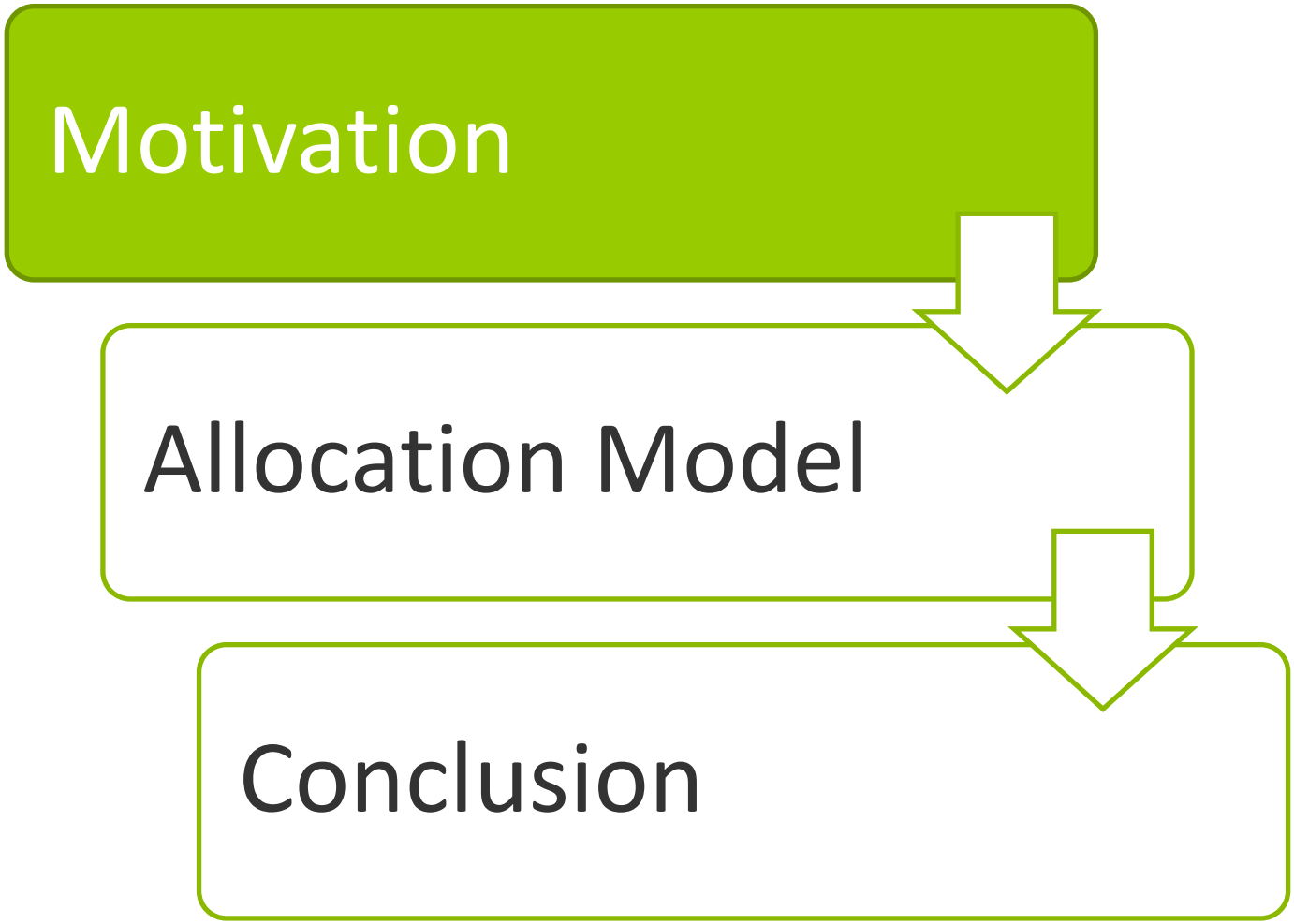
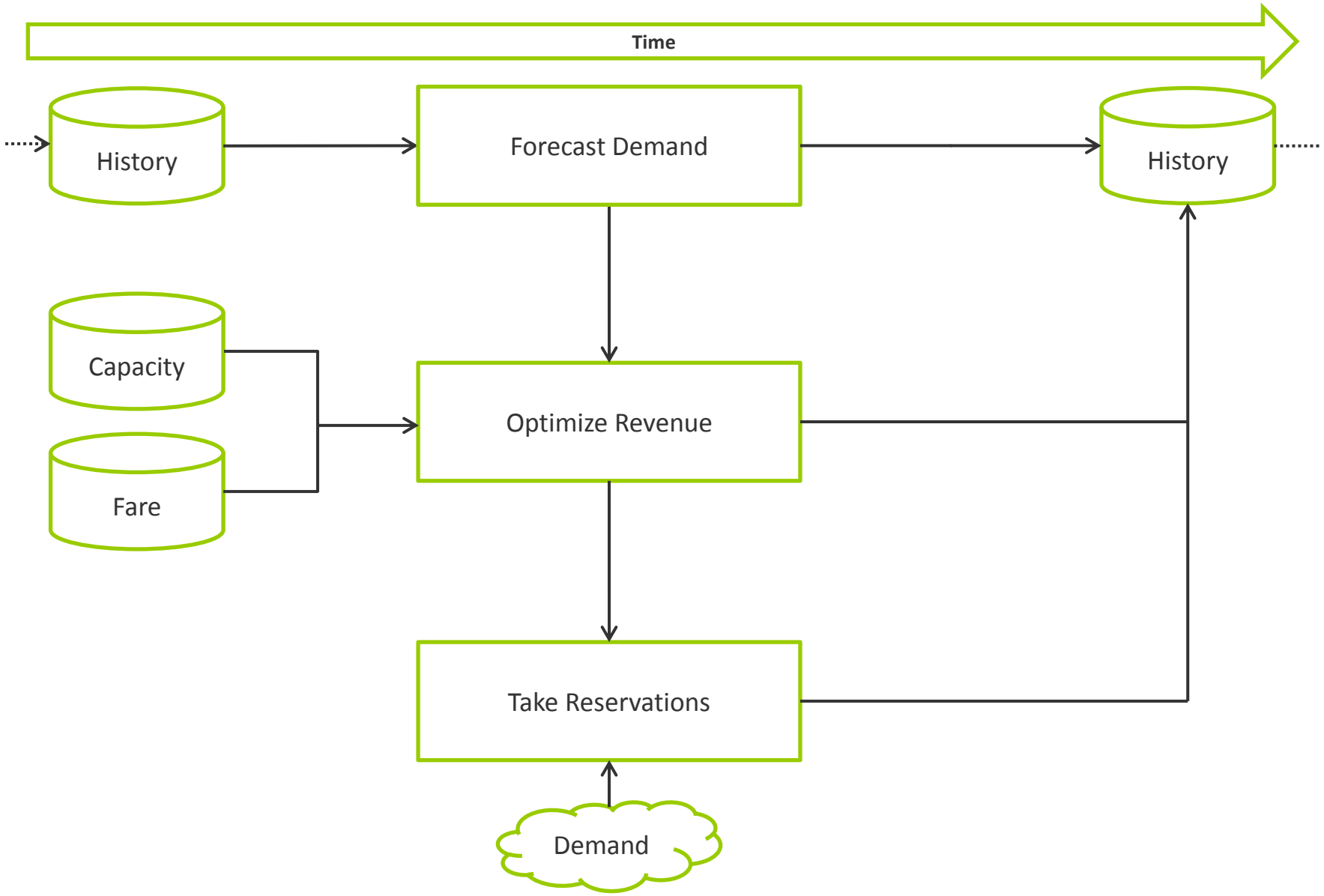


Traditional Revenue Management Process

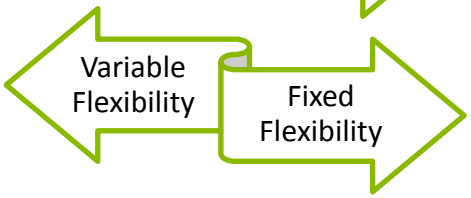


Flexible Products in Airline RM

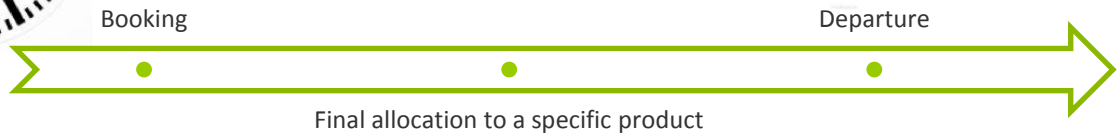
A **flexible product** is a product in which one or more attributes are not fully specified when the product is sold.[1]

- Who specifies the missing attributes?

- When will the remaining attributes be specified?



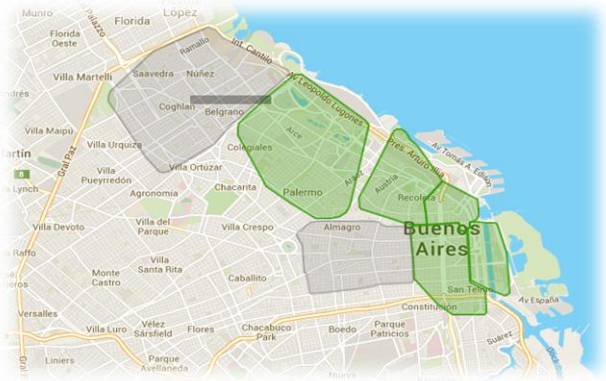
- What could be a missing attribute?
  - Destination
  - Date
  - Time
  - Specification Date



[1] Gallego, G. & Phillips, R. (2004). Revenue management of flexible products. *Manufacturing & Service Operations Management, 6*(4).

Flexible Products in Revenue Management

Hotwire



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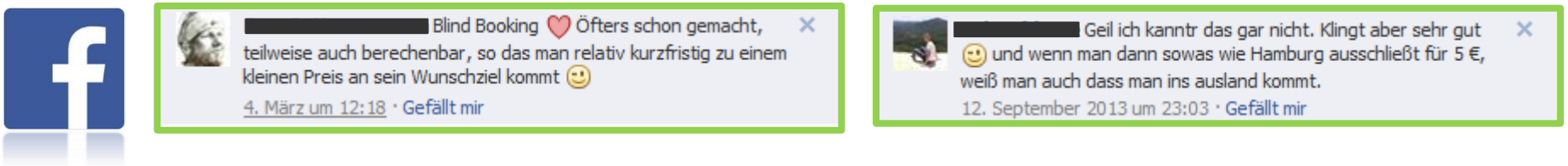
Flexible Products – Benefits & Shortcomings

- Flexible products are a chance for airlines, because they
  - improve the usage of existing capacities [1]
  - react on unforeseen events during the actual booking horizon [2]
  - acquire potential low-cost carrier customers [3]

- **But:** Existing methods are more or less **predictable** and customers
  - already anticipate the offered options
  - act strategic, even if they book flexible products
  - are obviously not indifferent between the offered options [4]



[1] Post, D. (2010). Variable opaque products in the airline industry: A tool to fill the gaps and increase revenues. *Journal of Revenue & Pricing Management, 9*(4).
[2] Gallego, G. & Phillips, R. (2004). Revenue management of flexible products. *Manufacturing & Service Operations Management, 6*(4).
[3] Mang, S., Spann, M., Post, D., 2009. Implementierung eines Interaktive price response systems bei einer low cost airline. *Business Services: Konzepte, Technologien, Anwendungen*, 247.
[4] Lee, M., Khelifa, A., Garrow, L., Bierlaire, M. & Post, D. (2012). An analysis of destination choice for opaque airline products using multidimensional binary logit models. *Transportation Research Part A: Policy and Practice, 46*(10).

My Proposal: Flexible Products with Preferences

- What if airlines could turn the tables by **introducing preferences?**

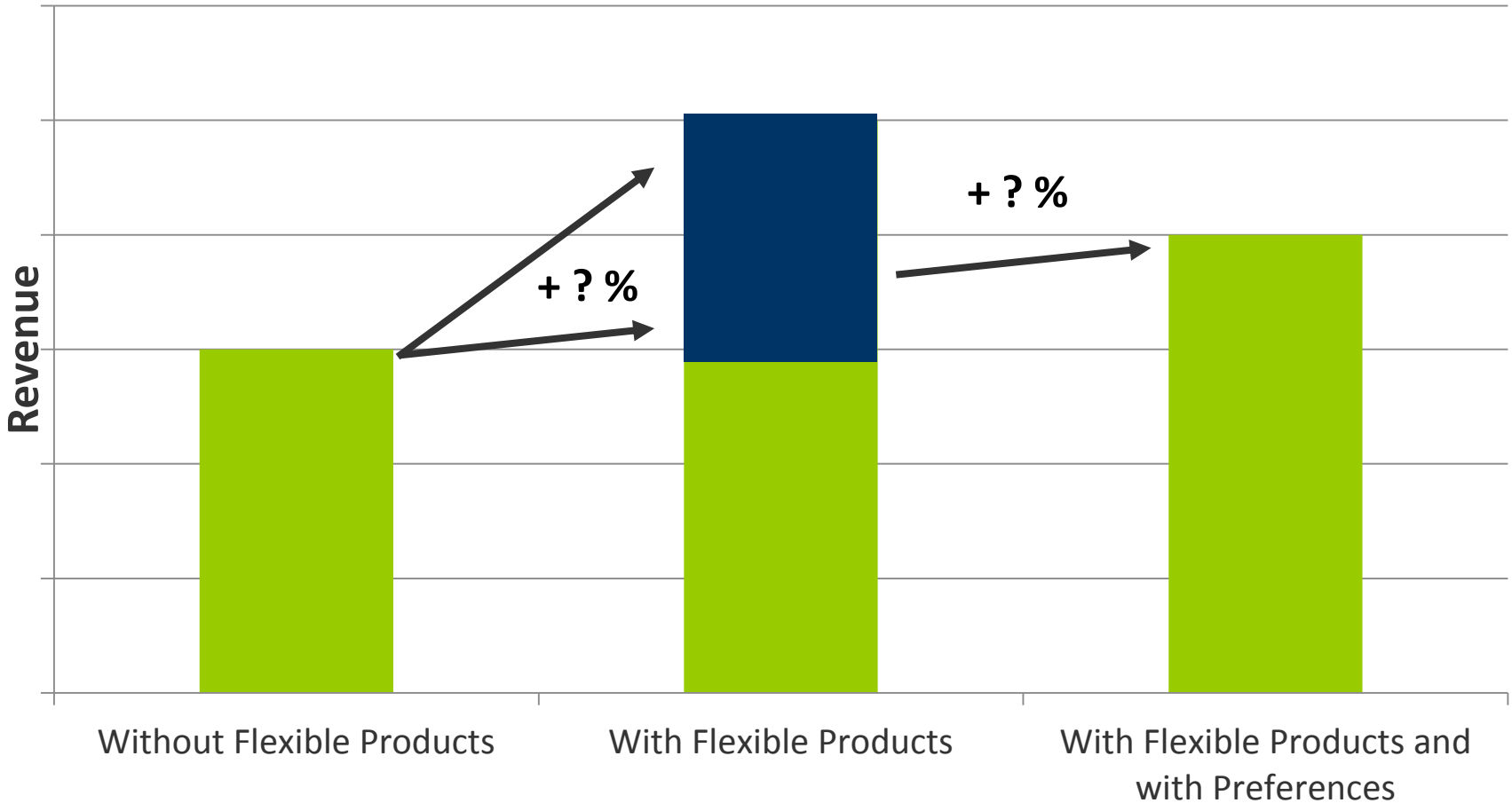
Flexible Product i	
Exclude	**Destination**
	BCN
	MAN
X	TXL

Flexible Product i	
Ranking	**Destination**
2	BCN
1	MAN
3	TXL

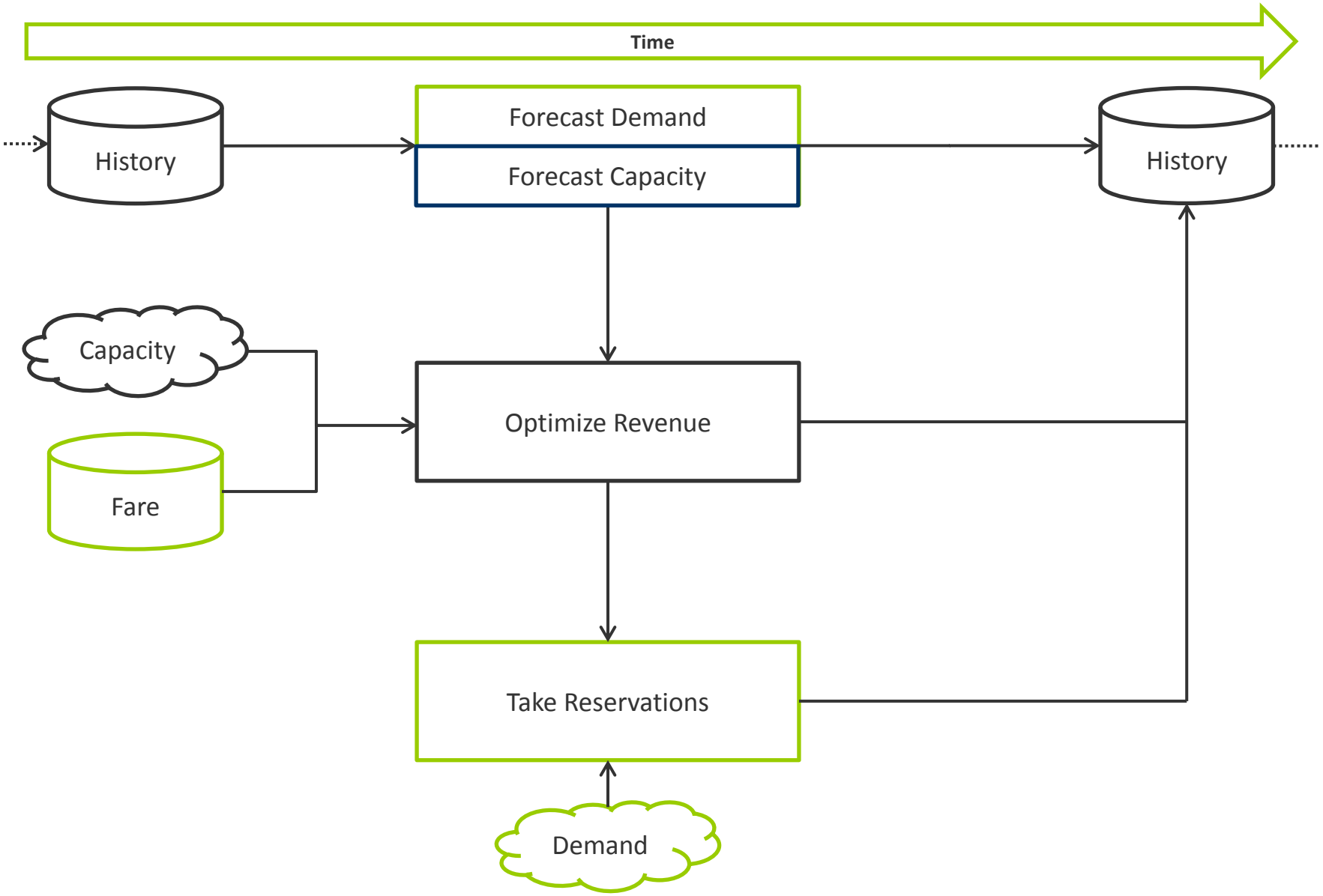
- Airlines
  - could gain additional information
  - increase flexibility
- Customers
  - think to reduce uncertainty
  - but take more uncertainty

Another balance of flexibility and uncertainty

Expected Behavior – Short-term Revenue



Integration in RM Process



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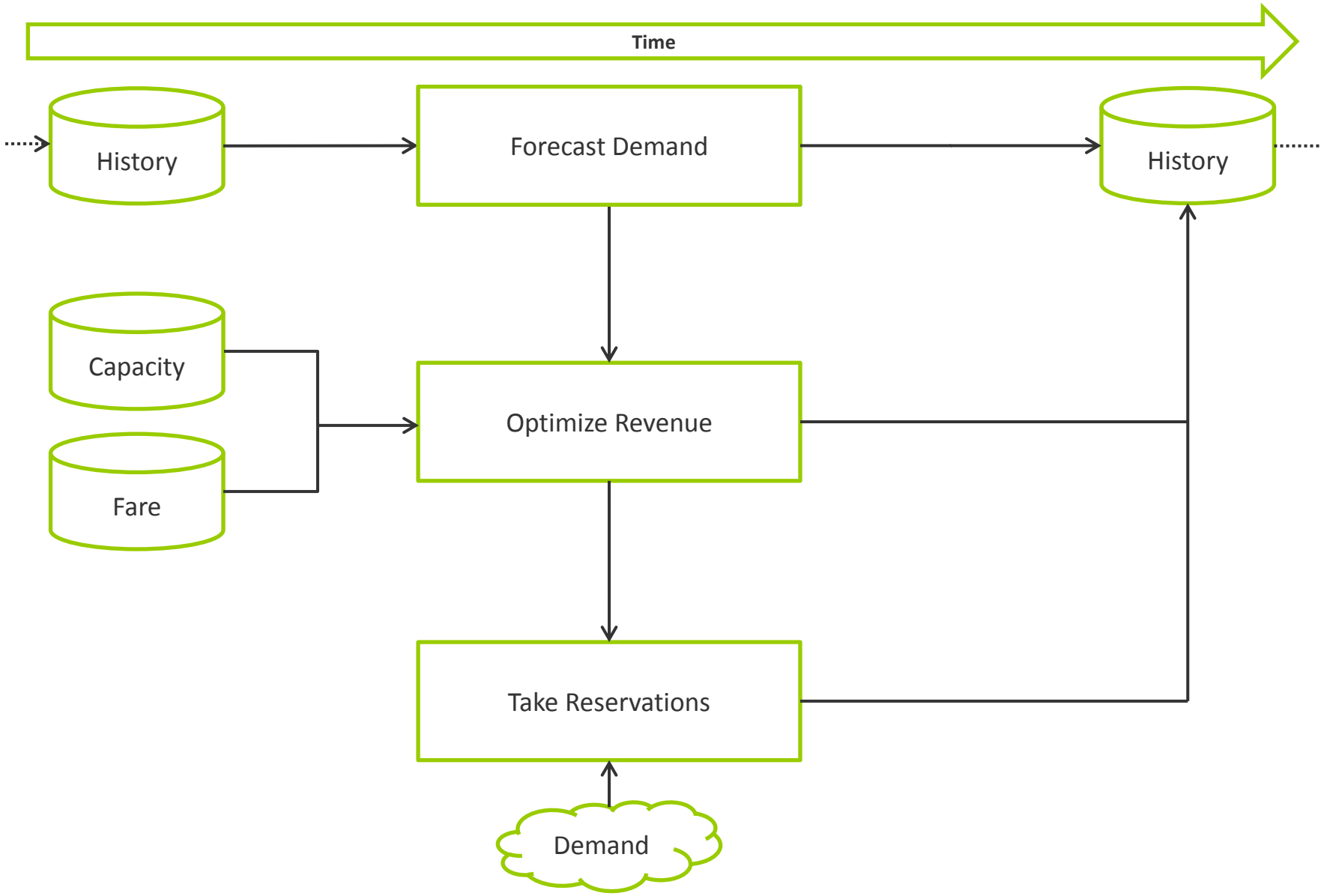

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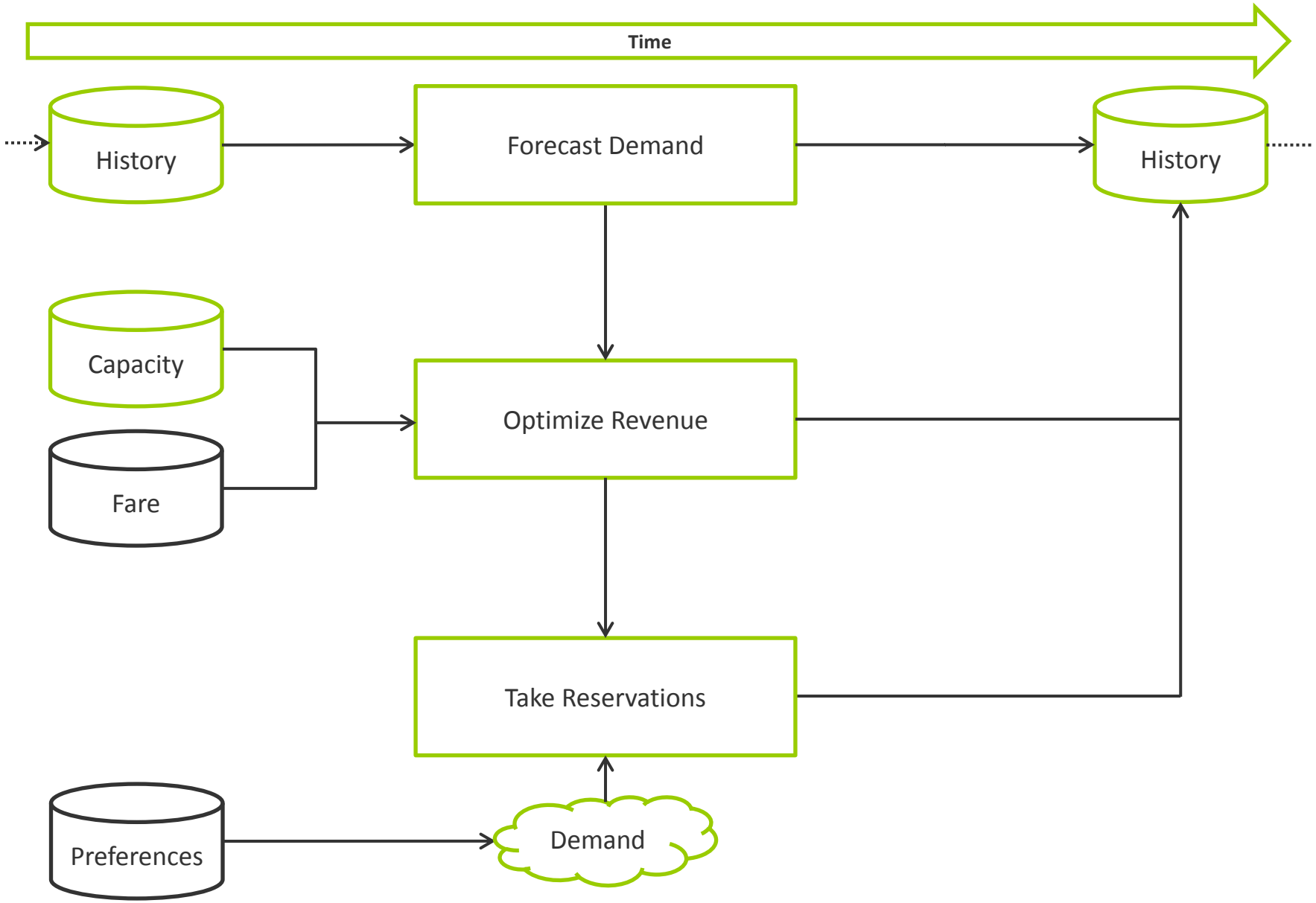

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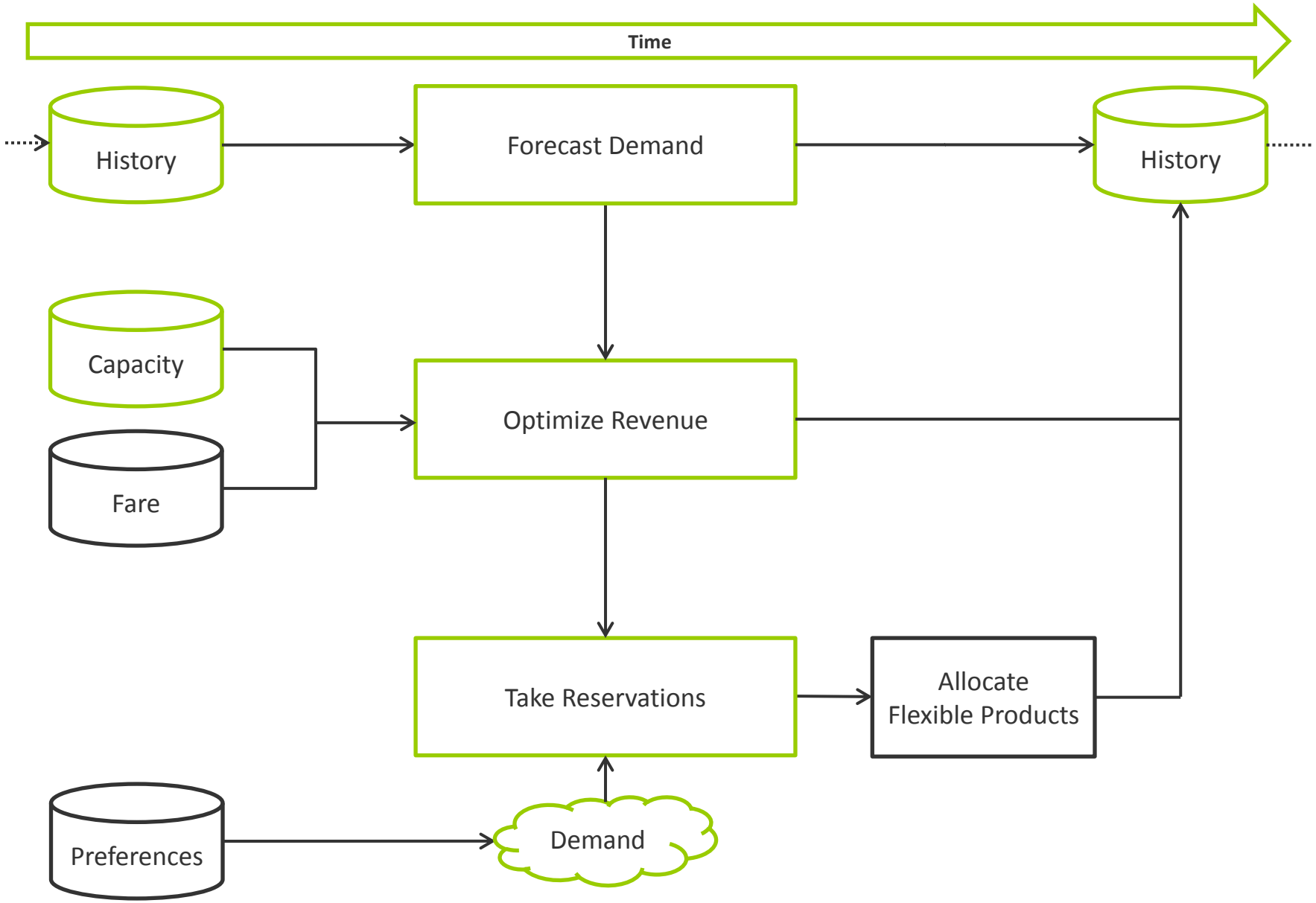

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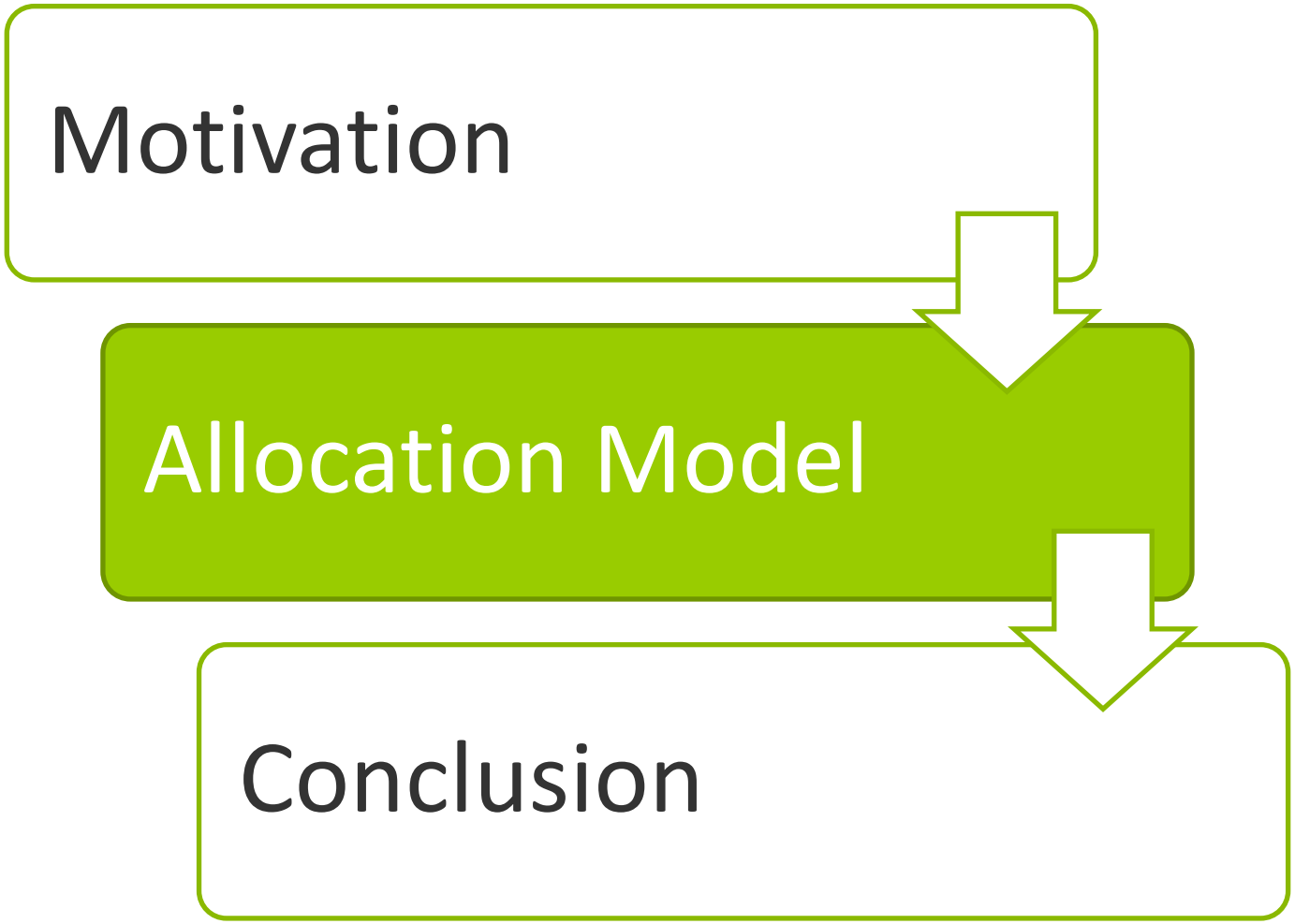


Allocation Model

$$\max\left(\alpha \cdot \sum_{b \in B} O\left(\Delta\pi(b)\right) + (1-\alpha) \cdot \sum_{b \in B} V\left(q(b)^T \cdot x(b)\right)\right)$$

$$\mathbb{1}^T \cdot x(b) = 1 \qquad \text{Allocation constraint} \qquad \forall b \in \mathcal{B}$$

$$\mathbb{1}^T \left(x(b)^T \cdot M(b)\right) = 1 \qquad \text{Feasibility constraint} \qquad \forall b \in \mathcal{B}$$

$$\sum_{b \in \mathcal{B}} \left(A \cdot x(b)^T\right) + A \cdot s \leq c \qquad \text{Capacity constraint}$$

$$y(b)^T \cdot A \cdot \pi - x(b)^T \cdot A \cdot \pi = \Delta\pi(b) \qquad \text{Opportunity costs} \qquad \forall b \in \mathcal{B}$$

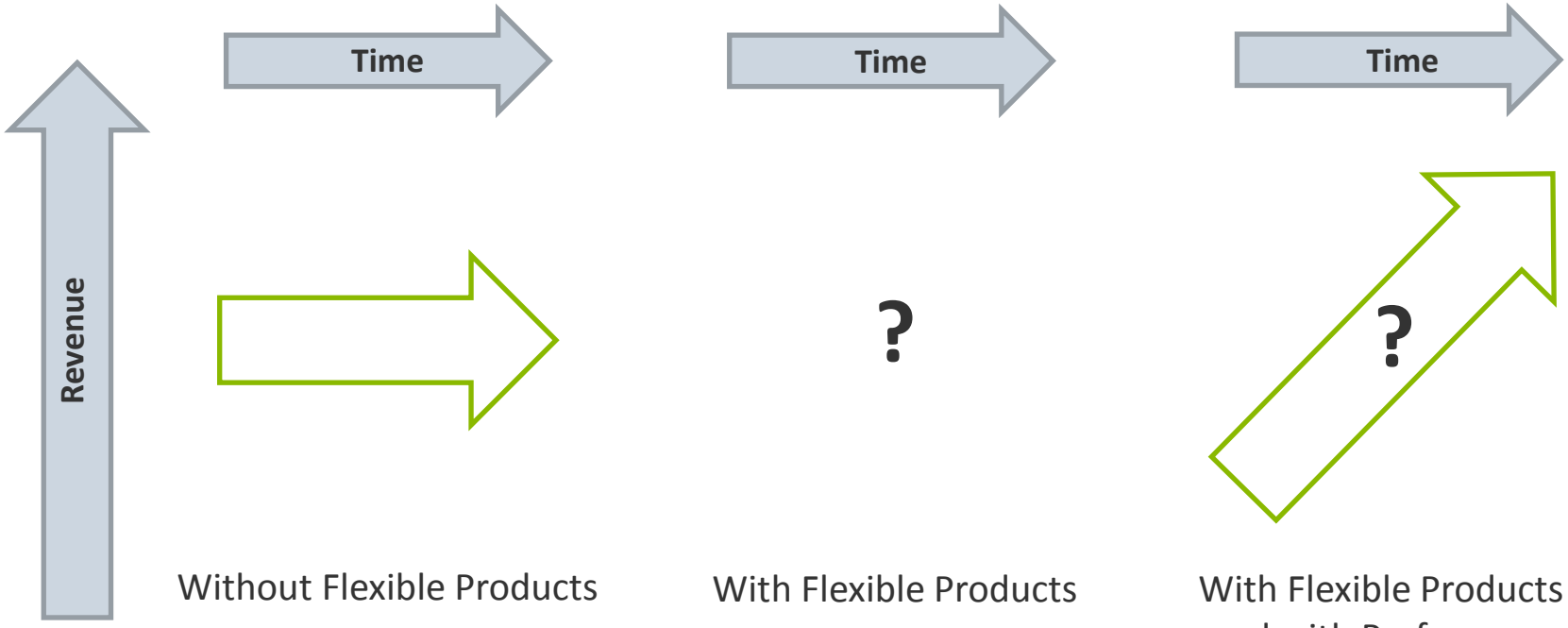
$$x(b) \in \{0,1\}^{n^s} \qquad \text{Binary constraint} \qquad \forall b \in \mathcal{B}$$

Opportunity costs per unit of capacity		π	$\in \mathbb{R}$
Additional opportunity costs of booking b	$\Delta\pi(b)$	$\in \mathbb{R}$	
Incidence matrix for resources	A	$\in [0,1]^{h \times n^s}$	
Reallocation of booking b		$x(b)$	$\in \{0,1\}^{n^s}$
Previous allocation of booking b		$y(b)$	$\in [0,1]^{n^s}$
Number of specific bookings		s	$\in \mathbb{R}^{n^s}$
Incidence matrix for execution modes		$M(b)$	$\in \{0,1\}^{n^s \times n^s}$
Capacity vector for resources		c	$\in \mathbb{R}$
Preferences for set of specific products		$q(b)$	$\in [0,1]^{n^s}$

$\alpha \in [0,1]$

Long-term Orientation

- Flexible products with preferences afford an ideal opportunity
  - Easy integration of long-term effects
  - Maximization of customer satisfaction means maximization of customer welfare



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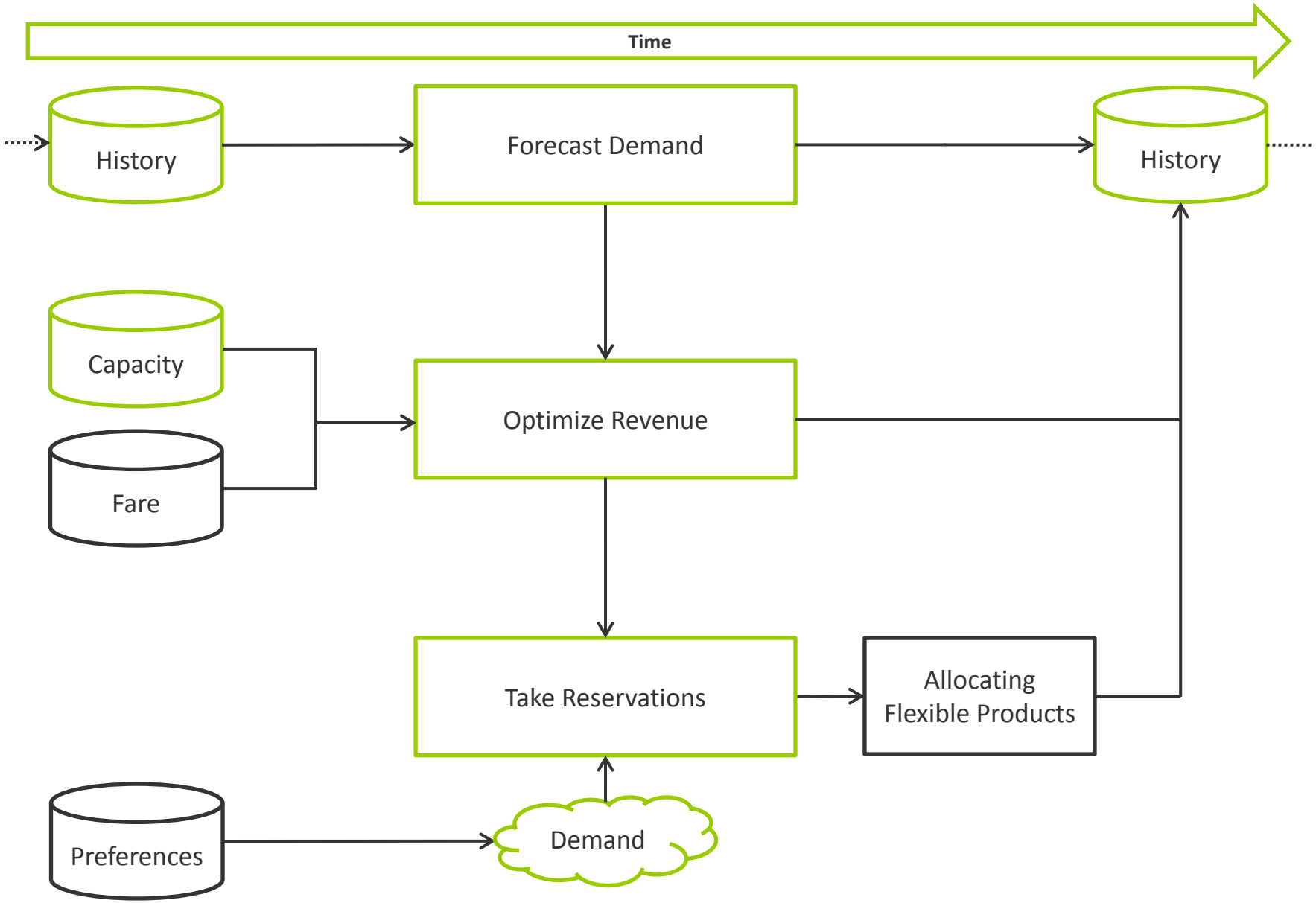

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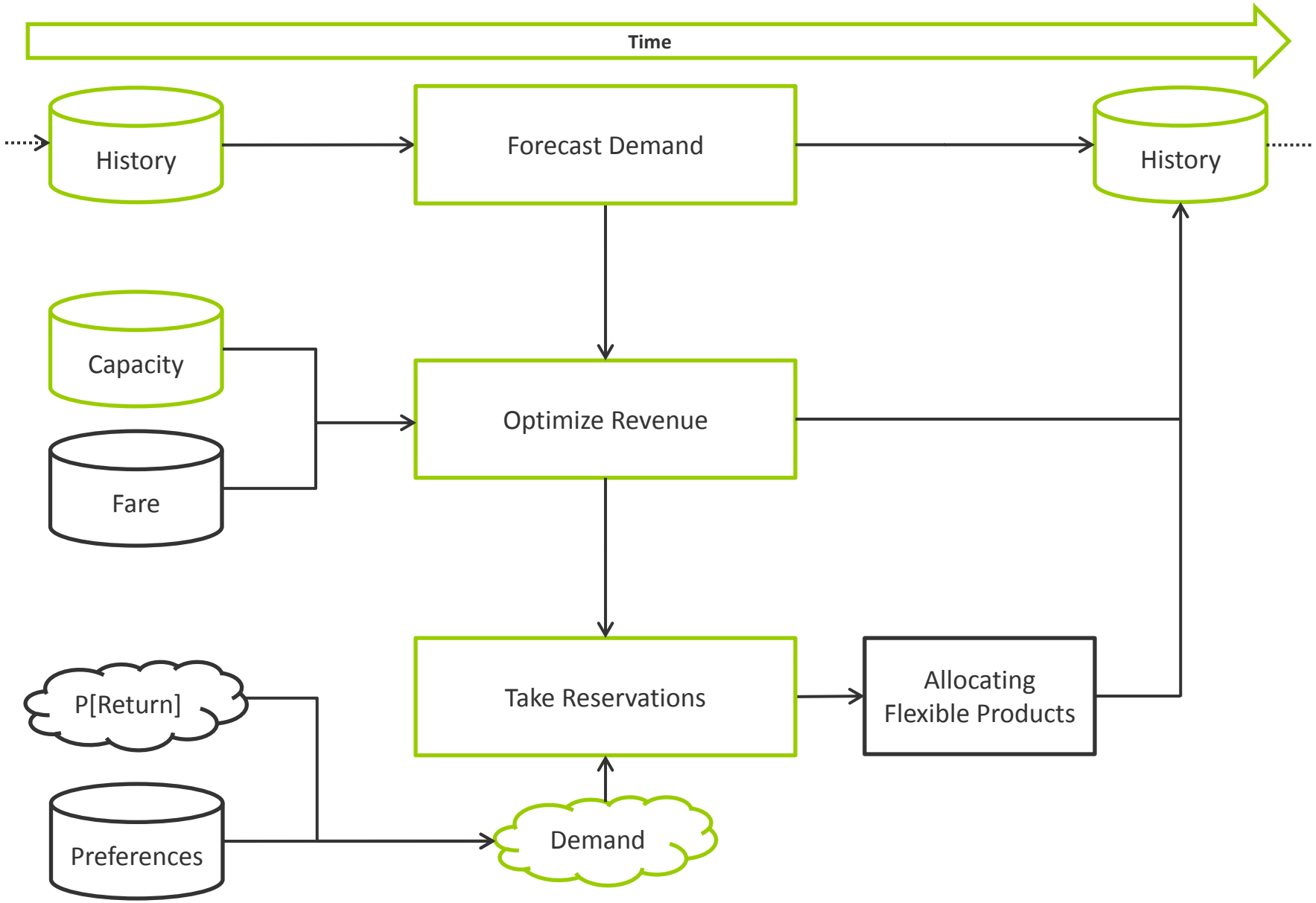

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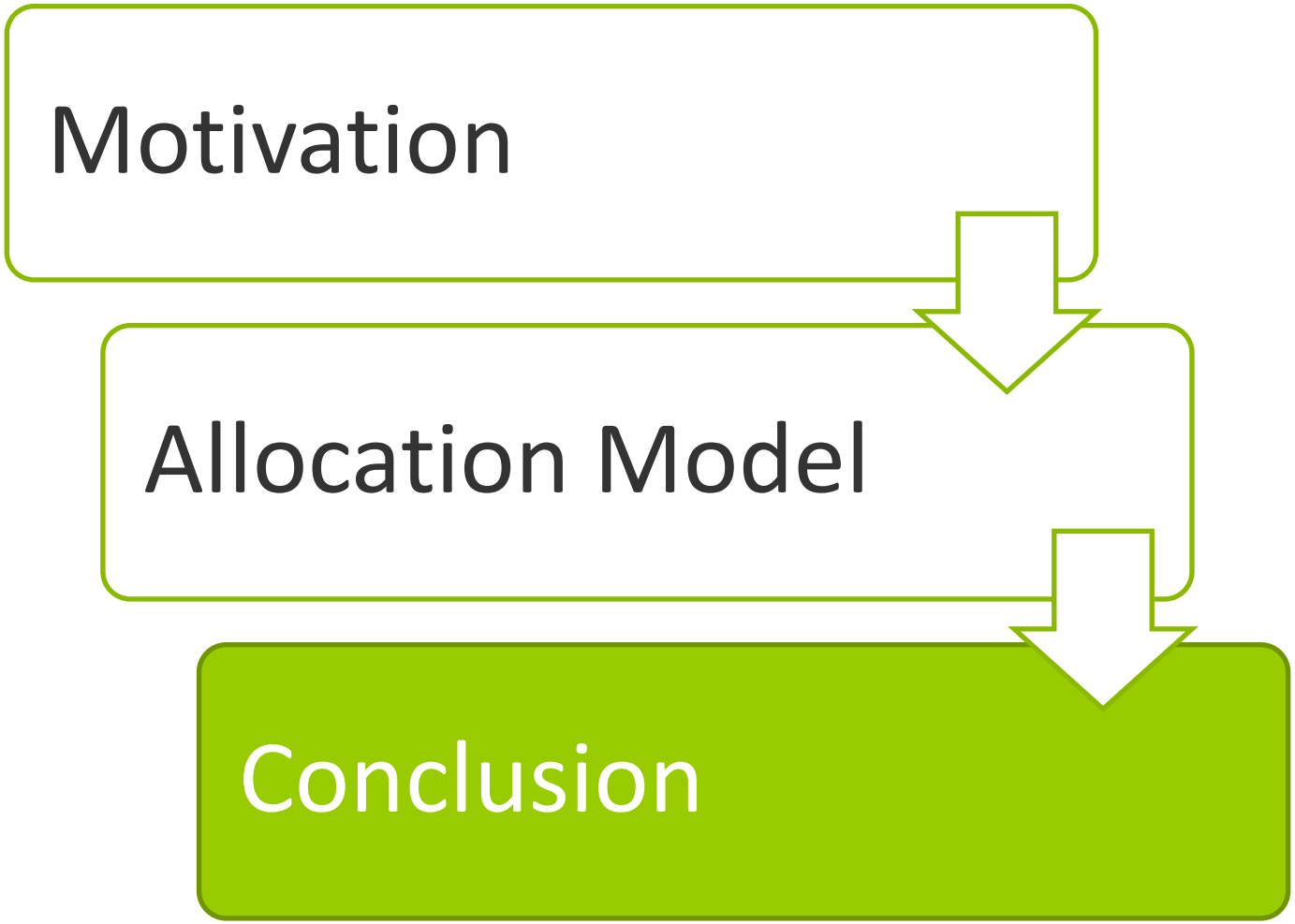


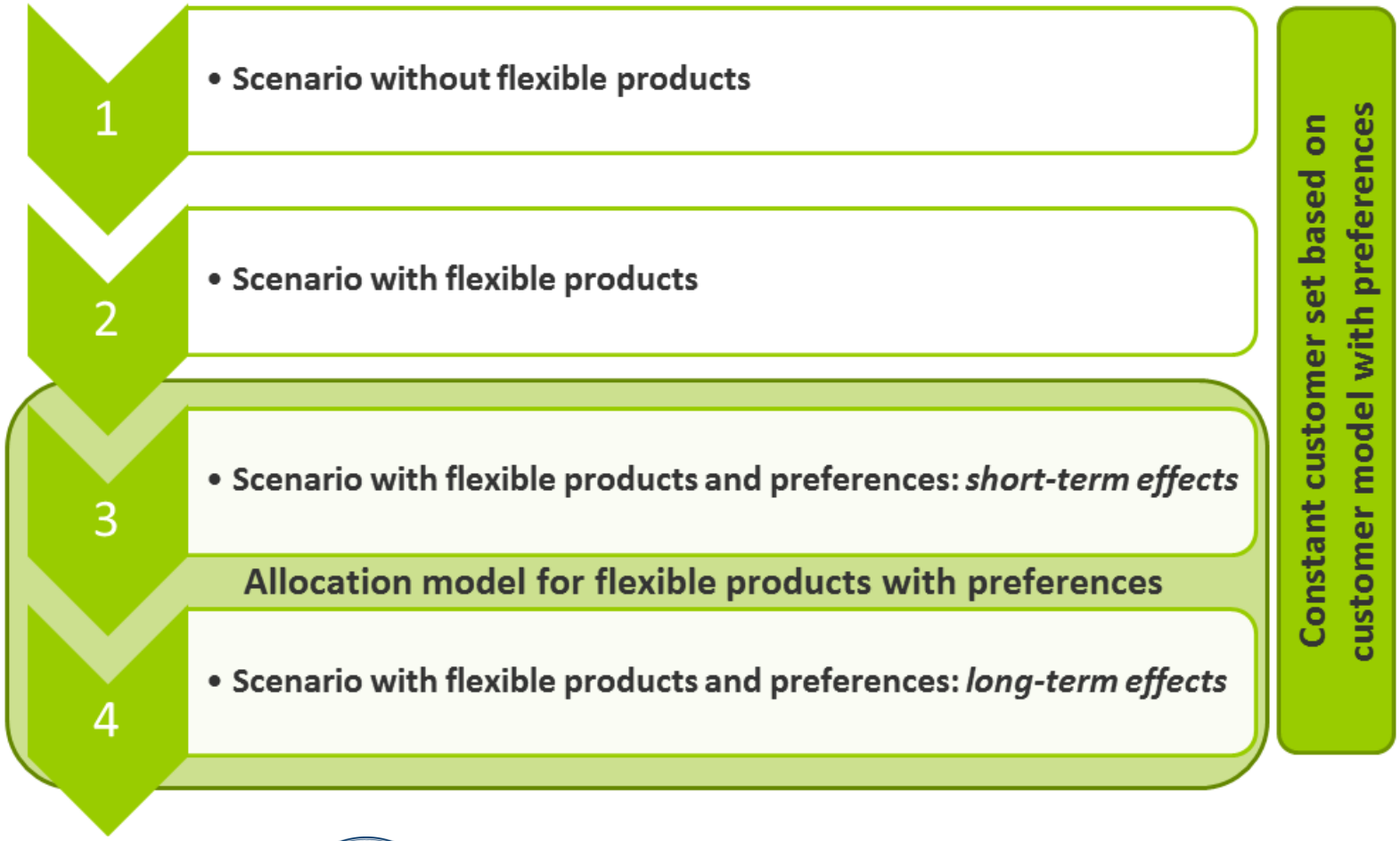
Experimental Design

1. • Scenario without flexible products
2. • Scenario with flexible products
3. • Scenario with flexible products and preferences: *short-term effects*

Allocation model for flexible products with preferences

4. • Scenario with flexible products and preferences: *long-term effects*

Constant customer set based on customer model with preferences



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In cooperation with

Lufthansa

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