Improving Customer Service Operations at Amazon.com

9조
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Telecom Service/Policy

informs.

Table of Contents

- **Interface** between customer and company is very important

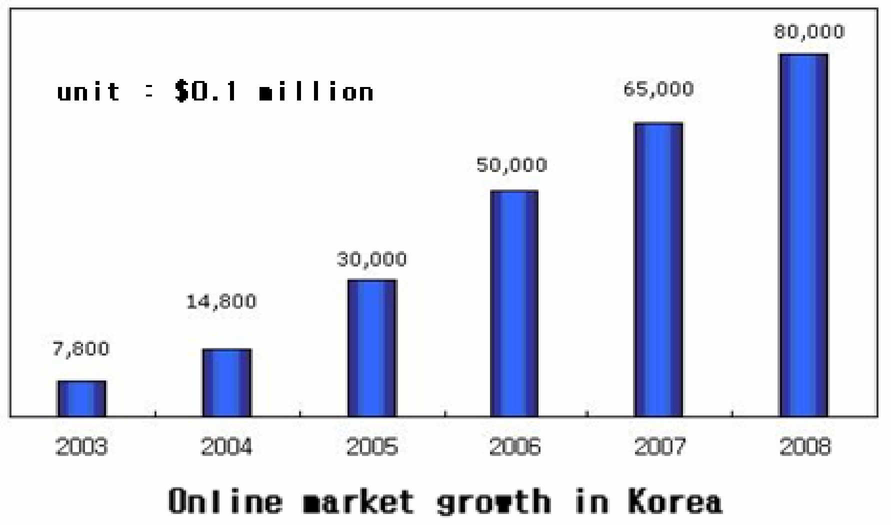
< off-line >

< on-line >

- Effects on
  - **Customer satisfaction** on the product
  - **Image** of the company

Interface

- **On-line market** has developed rapidly



- The Interface of On-line market
  - The features of company’s web site
  - **Contact Center** (Voice, E-mail)

Online market

Introduction

- For good interface, online company should provide a **feedback** in certain amount of time
  ⇨ Need to **schedule** the human resource in contact center

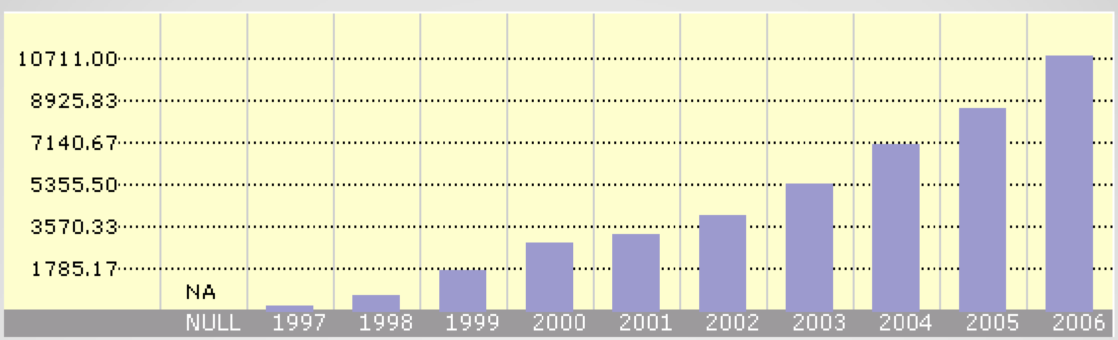
- The objective of this paper
  - Provide the **mathematical programming** to allocate human resource in contact center efficiently

$$\min \sum_{t=1}^{T} \sum_{(i,j)\in\mathcal{G}} \left(N_t^{ij} n_t^{ij} + O_t^{ij} o_t^{ij}\right) + \sum_{t=1}^{T} \sum_{\{(i,j)\in\mathcal{G} \mid i=1\}} H_t^{ij} h_t^{ij} + \sum_{t=1}^{T} \sum_{\{(i,j)\in\mathcal{G} \mid i\neq 1\}} S_t^{ij} s_t^{ij} + \sum_{t=1}^{T} \sum_{i\in\mathcal{C}} F_t^{i}$$

Requirement

- **AMAZON.COM**
  - American e-commerce company

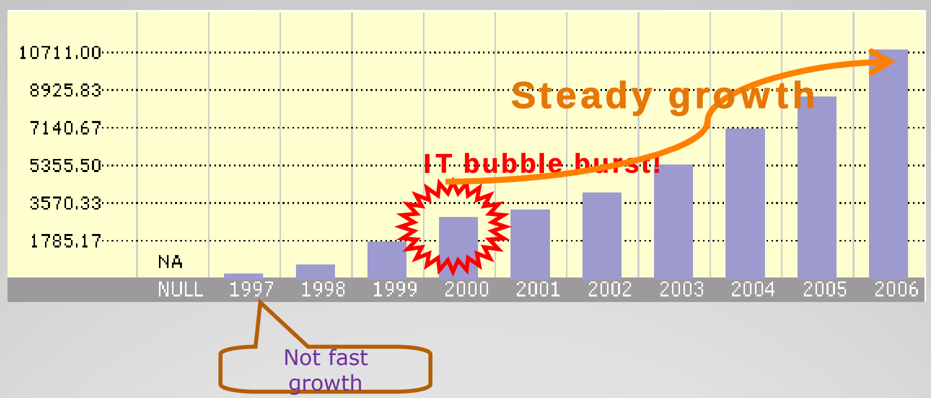
Revenue (from 1997 to 2006) $Mil



• AMAZON.COM

- Their success came from
  - Steady growth(not fast)

Revenue (from 1997 to 2006) $Mil



  - Diversification
  - CSO (Customer Service Organization)★

The Leaders and Best E-Commerce/Transaction Sites

• Range of e-Gov scores	57 to 86
• B&N.com	88
• Amazon	87
• Ebay	80
• 1-800Flowers.com	77

CSO

"We believe that our ability to establish and maintain long-term relationships with customers and to encourage repeat visits and purchases depends on the strength of customer service operations" (Amazon.com 2003, p. 4).

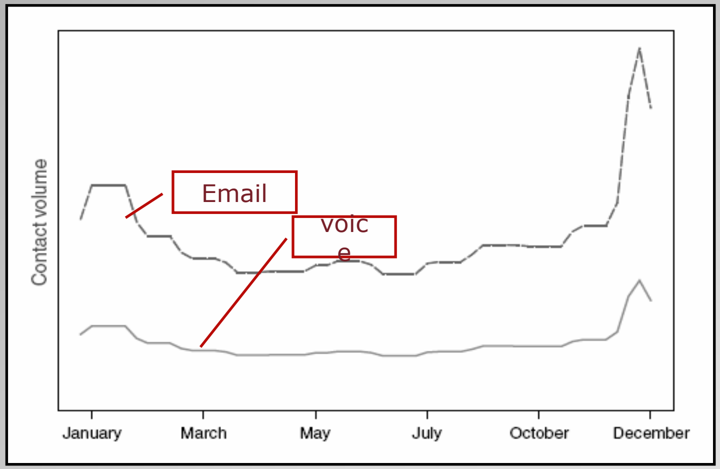
- Provide interface through
  - Website
    - Tracking orders and shipments
    - Reviewing estimated delivery dates
    - Cancelling unshipped items.

  - **Contact centers (internal , external)**
    - If cannot resolve inquiries using the web site
    - **E-mail** or **phone call** (24hours)

- Providing customer with good interface
  - Size the capacity of contact center to respond to customer in certain amount of time

Human Resource Planning

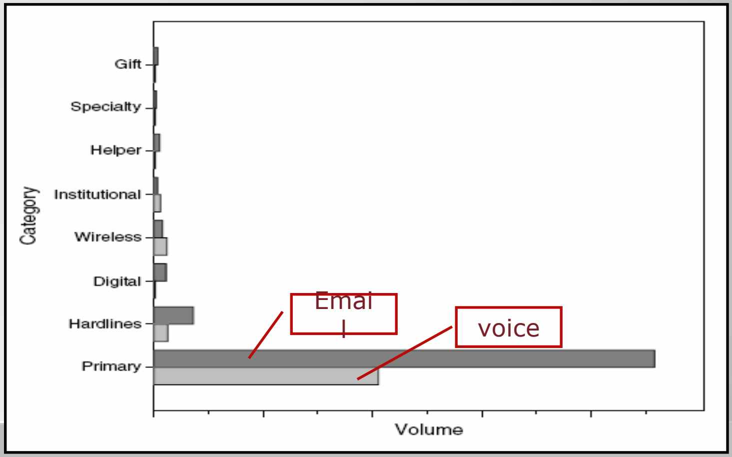
- **Problem Setting**
  - Schedule the contact center (internal, external)



The weekly volume of contacts

Considering
- Seasonality

Contacts divided by
8 Category
** 8 Planning Groups



The volume of contacts by category

Problem Setting

Problem Setting

- **Training**
  - Training of Customer Service Representative (CSR)

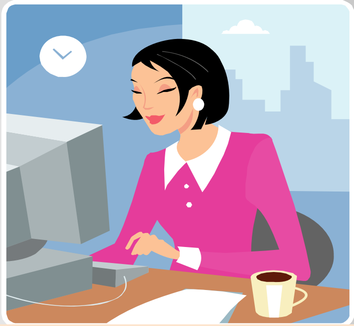
New Representative

Primary Training

Be Primary CSR

Primary CSR

Additional Training



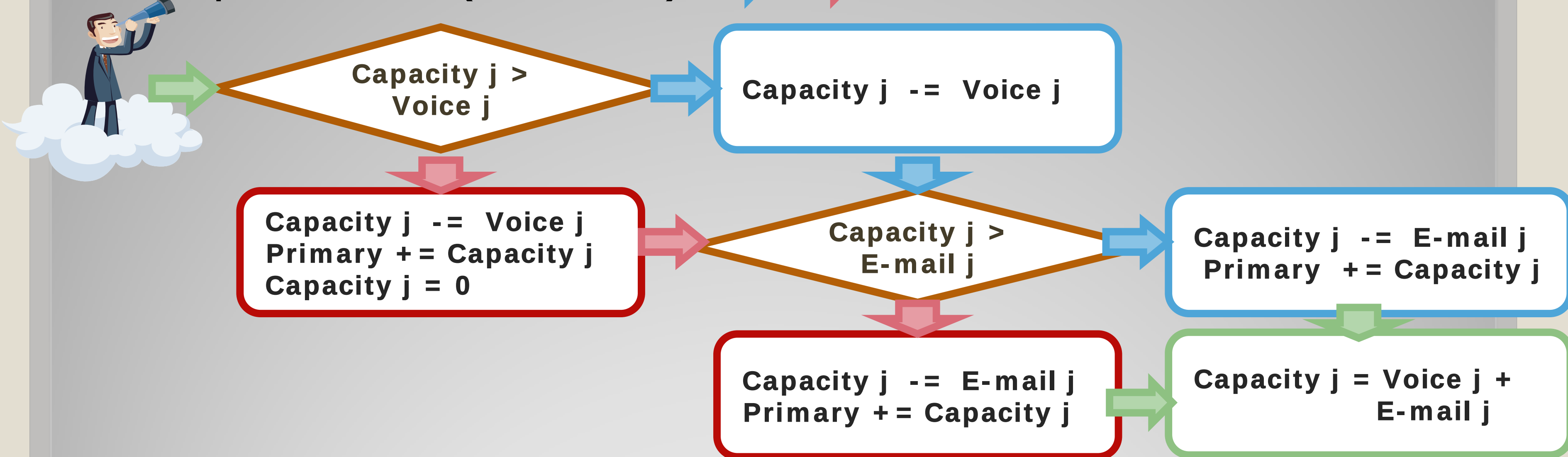
Be Special CSR

Training of CSR

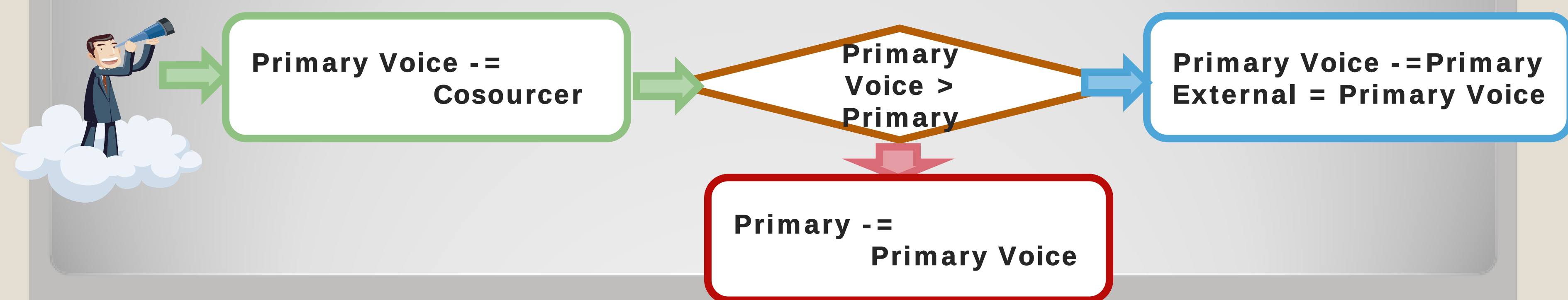
Problem Setting

AS-IS (spread sheet based)

- Special PG (internal) Y N



- Primary PG



AS-IS

Problem Setting

- **Three Issues**
  - 1. how they added CSRs to teams?
    - Differences in contracts with cosources, staffing and service levels
    - Average productivity, wage differ among centers
  - 2. Contract terms differ across cosourcers
    - Cost per ‘Contact handled’ vs ‘Fixed charge’
  - 3. Lack of consideration between service objectives and staffing cost
    - Ignore the randomness of arrival rate, handling time
    - No lever to allow CSO manager to consider them

Three Issues

- Gans Et al. (2003)
  - Comprehensive summary of the state of call-center research pertaining to capacity management
- Whitt (1999)
  - Determination of capacity in a setting with two customer classes. (one-immediately, the other response within a day)
- Armony and Maglaras (2004)
  - In a call center, customers can chose service class 1 (call back) or class 2 (wait for expected delay)

Literature Works

- Chen and Henderson (2001)
  - Ina call center, service is divided into 2 groups. For higher priority use (tail probability), other classes use Markov's inequality

- Gans and Zhou (2002)
  - Focused on a situation where 2 classes of customers exist (high and low value). Solve a problem to determine staffing level considering outsourcing lower value class.

Literature Works

- **TO-BE**
  - **Math programming** considering three issues
  - Develop **two stage solution** approach
    - Adjustment Procedure
      - Adjust contact forecasts to take into account different source of uncertainty and service level objectives
      - Hourly forecasts of e-mail and voice contact, average CSR handling time and service-level objectives
    - Optimization Model
      - Mixed integer program
      - Minimum-cost capacity plan for processing the contact forecast

TO-BE

Adjustment

- Step.1 $\rho_{v,h} = \lambda_{v,h}/\mu_v$ $\rho_{e,h} = \lambda_{e,h}/\mu_e$

  Without regard to service level objective

- Step.2 Calculate the $\tilde{\rho}_{v,h}$

  With regard to service level objective using Erlang C formula

- Step.3 $\theta_d = \sum_h \rho_{v,h}$, $\phi_d = \sum_h \rho_{e,h}$, $\tilde{\theta}_d = \sum_h \tilde{\rho}_{v,h}$

- Step.4 If $\theta_d + \phi_d > \tilde{\theta}_d$,$\gamma_d = \theta_d \cdot \mu_v$ Else $\gamma_d = \tilde{\theta}_d \cdot \mu_v$

  ➡ $V_t^k = \sum_d \gamma_d$

Step.5 $E_t^k = \sum_d \phi_d \cdot \mu_e$

The collection of adjusted forecasts becomes input to the optimization model

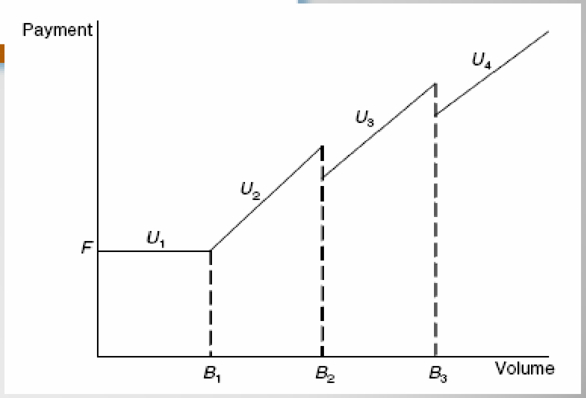
Adjustment

- Formulation in MILP
  - Objective Function

$$\min \sum_{t=1}^{T} \sum_{(i,j)\in\mathcal{G}} (N_t^{ij} n_t^{ij} + O_t^{ij} o_t^{ij}) + \sum_{t=1}^{T} \sum_{\{(i,j)\in\mathcal{G} \mid i=1\}} H_t^{ij} h_t^{ij}$$

$$+ \sum_{t=1}^{T} \sum_{\{(i,j)\in\mathcal{G} \mid i\neq 1\}} S_t^{ij} s_t^{ij} + \sum_{t=1}^{T} \sum_{i\in\mathcal{Q}} F_t^i$$

$$- \sum_{t=1}^{T} \sum_{i\in\mathcal{Q}} \sum_{k=2}^{R^i} F_t^i y_{k,t}^i + \sum_{t=1}^{T} \sum_{i\in\mathcal{Q}} \sum_{k=1}^{R^i} U_{k,t}^i x_{k,t}^i$$



Optimization Model

Solution Approach

- Formulation in MILP
  - Constraints

$$\sum_{(i,j)\in\mathcal{B}} v_t^{ij,1} + \sum_{i\in\mathcal{C}^v} c_t^i \geq V_t^1, \quad t=1,\ldots,T,$$

$$\sum_{(i,j)\in\mathcal{B}} e_t^{ij,1} + \sum_{i\in\mathcal{C}^e} c_t^i \geq E_t^1, \quad t=1,\ldots,T,$$

$$\sum_{\{(i,j)\in\mathcal{B} \mid i=k\}} v_t^{ij,k} \geq V_t^k$$

$$\forall k\in\mathcal{C},\ k\neq 1,\ t=1,\ldots,T,$$

$$\sum_{\{(i,j)\in\mathcal{B} \mid i=k\}} e_t^{ij,k} \geq E_t^k$$

$$\forall k\in\mathcal{C},\ k\neq 1,\ t=1,\ldots,T,$$

Optimization Model

Solution Approach

- Formulation in MILP
  - Constraints

$$\mu_{ij,i}^{-1} v_t^{ij,i} + \sum_k \hat{\mu}_{ij,k}^{-1} e_t^{ij,k} \leq (1-\delta^{ij})(n_t^{ij} + o_t^{ij})$$

$$\forall (i, j) \in \mathcal{G},\ t = 1, \dots, T,$$

$$o_t^{ij} \leq \gamma_t^{ij} n_t^{ij} \quad \forall (i,j) \in \mathcal{G},\ t = 1, \dots, T,$$

$$W^{ij} w_t^{ij} \geq n_t^{ij} \quad \forall (i,j) \in \mathcal{G},\ t = 1, \dots, T,$$

$$w_{t-1}^{1j}(1-\alpha^{1j}) - d_t^{1j} - \sum_{\{i \in \mathcal{P} \mid i \neq 1\}} s_t^{ij} + h_{t-\tau}^{1j} = w_t^{1j}$$

$$\forall j \in \mathcal{L},\ t = 1, \dots, T,$$

$$w_{t-1}^{ij}(1-\alpha^{ij}) - d_t^{ij} + s_{t-\hat{\tau}}^{ij} = w_t^{ij}$$

$$\forall (i,j) \in \mathcal{G},\ i \neq 1,\ t = 1, \dots, T,$$

Optimization Model

- Formulation in MILP
  - Constraints

$$v_t^{ij,k} \leq \beta_t^{ij,k} V_t^k$$
$$\forall (i,j) \in \mathcal{G},\ \forall k \in \mathcal{C},\ t = 1, \ldots, T,$$
$$e_t^{ij,k} \leq \hat{\beta}_t^{ij,k} E_t^k$$
$$\forall (i,j) \in \mathcal{G},\ \forall k \in \mathcal{C},\ t = 1, \ldots, T,$$
$$c_t^i \leq \xi_t^i V_t^1 \quad \forall i \in \mathcal{Q}^v,\ t = 1, \ldots, T,$$
$$c_t^i \leq \xi_t^i E_t^1 \quad \forall i \in \mathcal{Q}^e,\ t = 1, \ldots, T,$$
$$\sum_{i \in \mathcal{Q}^v} c_t^i \leq \hat{\xi}_t^v V_t^1, \quad t = 1, \ldots, T,$$
$$\sum_{i \in \mathcal{Q}^e} c_t^i \leq \hat{\xi}_t^e E_t^1, \quad t = 1, \ldots, T,$$

Optimization Model

- Formulation in MILP
  - Constraints

$$x^i_{k,t} - B^i_k y^i_{k,t} \leq 0$$

$$\forall i \in \mathcal{Q},\ k = 1, \ldots, R^i - 1,\ t = 1, \ldots, T,$$

$$x^i_{k,t} - (B^i_{k-1} + 1) y^i_{k,t} \geq 0$$

$$\forall i \in \mathcal{Q},\ k = 2, \ldots, R^i,\ t = 1, \ldots, T,$$

$$c^i_t = \sum_{k=1}^{R^i} x^i_{k,t} \quad \forall i \in \mathcal{Q},\ t = 1, \ldots, T,$$

$$\sum_{k=1}^{R^i} y^i_{k,t} = 1 \quad \forall i \in \mathcal{Q},\ t = 1, \ldots, T,$$

Optimization Model

- Formulation in MILP
  - Constraints

$$M(1-z_t^i) \geq (1+\zeta^i)c_{t-1}^i - c_t^i \qquad \forall i \in \mathcal{Q},\ t=1,\dots,T,$$

$$Mz_t^i \geq c_t^i - (1+\zeta^i)c_{t-1}^i \qquad \forall i \in \mathcal{Q},\ t=1,\dots,T,$$

$$M(1-\hat{z}_t^i) \geq c_t^i - (1-\zeta^i)c_{t-1}^i \qquad \forall i \in \mathcal{Q},\ t=1,\dots,T,$$

$$M\hat{z}_t^i \geq (1-\zeta^i)c_{t-1}^i - c_t^i \qquad \forall i \in \mathcal{Q},\ t=1,\dots,T,$$

$$M(1-z_t^i) \geq c_{t+\omega}^i - (1+\zeta^i)c_t^i \qquad \forall i \in \mathcal{Q},\ t=-\Omega^i+1,\dots,T,\ \omega=1,\dots,\Omega^i,$$

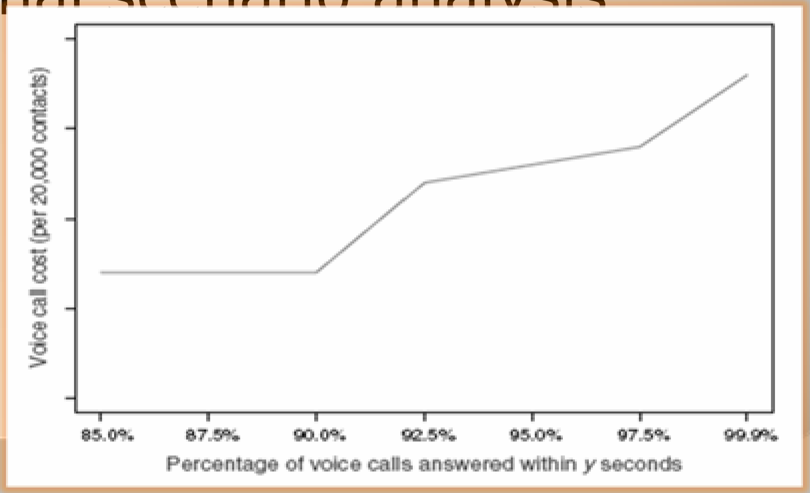
$$-M(1-\hat{z}_t^i) \leq c_{t+\omega}^i - (1-\zeta^i)c_t^i \qquad \forall i \in \mathcal{Q},\ t=-\Omega^i+1,\dots,T,\ \omega=1,\dots,\Omega^i,$$

Optimization Model

Solution Approach

- Experiment
  - Planning Horizon = 52 weeks (1year)
  - 134,000 constraints, 16,000 variables(1000 integer)
  - CPLEX on an HP 9000 superdome server
  - Takes less than 5 minutes (spread sheet 1day)

- Results
  - Save Time, enable additional scenario analysis
  - Considers 'Three Issues' not considered in AS-IS
  - Increases annual operational cost savings



Results

Results

- Reference는 아직 다 정리가 안되어 정리 되는데로 다시 보내드리겠습니다.

Reference