Radar Chart: Scanning for High QoE in QoS Dimensions

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Outline

• Introduction
• Proposed design of radar chart
• Experiment methodology
• Single-application analysis
• Cross-application analysis
• Applications
• Conclusion
Introduction

• QoE (Quality of Experience)
  – User’s subjective satisfaction at a service
  – QoE is multi-dimensional.

\[
QoE = f\{M_1, M_2, M_3, \ldots, M_n\}
\]

• Challenges
  – How to summarize VoIP users’ QoE under such a variety of factors?
    • Radar chart
Introduction

• Advantages of radar chart
  – Demonstrate the total performance of one group.
  – Display easily and clearly the relationship of different groups.

• Contributions
  – We use proposed radar chart to display VoIP users’ QoE.
  – We analyze pros and cons of Skype, MSN Messenger and Google Talk based on proposed radar chart.
  – With radar chart, we propose two applications
    • Diagnosis
    • User recommendation
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Proposed design of radar chart
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Experiment methodology

**Delay:** 0 ms, 50 ms, 100 ms, 150 ms, 200 ms

**Loss:** 0%, 5%, 10%, 15%, 20%

**BW:** 40 Kbps, 60 Kbps, 80 Kbps, 100 Kbps, Unlimited
Assessment of Objective QoE

Original audio file → PESQ algorithm → MOS score → Conversion → R score → Subtract $l_d$ → $R'$ score

$$MOS = \begin{cases} 
1 & R' < 0 \\
1 + 0.0035R' + R'(R' - 60)(100 - R') \cdot 7 \cdot 10^{-6} & 0 < R' < 100 \\
4.5 & R' > 100 
\end{cases}$$

Final MOS score

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Single-app. analysis

Google Talk

Loss rate

Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 50 ms
Delay 0 ms

Telephone Quality of Service (QoS) Metric
MOS
2.2
2.5
2.8
3.1
3.4

Loss 20%
Loss 15%
Loss 10%
Loss 5%
Loss 0%

BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps

Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 50 ms
Delay 0 ms
Single-app. analysis

Google Talk

**Delay**

- Delay
  - 0 ms
  - 50 ms
  - 100 ms
  - 150 ms
  - 200 ms

**Bandwidth**

- Bandwidth
  - 40 Kbps
  - 60 Kbps
  - 80 Kbps
  - 100 Kbps
  - Unlimited

MOS vs Loss rate (%)
Single-app. analysis

Skype

![Graphs showing the relationship between delay, loss rate, and bit rate for different bandwidth settings in Skype.](image_url)
Single-app. analysis

MSN Messenger

Loss 20% Delay 200 ms
Loss 15%
Loss 10%
Loss 5%
Loss 0%, BW unlimited
Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 50 ms
Delay 0 ms
Loss 20%
Loss 15%
Loss 10%
Loss 5%
Loss 0%, BW unlimited
BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps
BW unlimited
BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps
BW unlimited
Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 50 ms
Delay 0 ms
Loss 0%
Loss 5%
Loss 10%
Loss 15%
Loss 20%
MOS
- 2.2
- 2.5
- 2.8
- 3.1
- 3.4

2010/6/9
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Cross-app. analysis

MOS = 2.5

Loss rate

Loss 20 % Delay 200 ms
Loss 15 %
Loss 10 %
Loss 5 %
Loss 0 %
Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 0 ms
BW unlimited
BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps
Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 0 ms
BW unlimited
BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps
Loss 20 %
Loss 15 %
Loss 10 %
Loss 5 %
Loss 0 %

Skype
MSN Messenger
Google Talk

BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps

Loss rate

2010/6/9
Cross-app. analysis

MOS = 3.4
Cross-app. analysis

![Graphs showing bit rate vs. loss rate for Skype, MSN Messenger, and Google Talk. Each graph has lines representing different delay times (0 ms, 50 ms, 100 ms, 150 ms, 200 ms).]
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The Best Application

Loss 20% Delay 200 ms
Loss 15% Delay 150 ms
Loss 10% Delay 100 ms
Loss 5% Delay 50 ms
Loss 0%, BW unlimited Delay 0 ms

Skype
MSN Messenger
Google Talk

BW unlimited
BW 100 Kbps
BW 80 Kbps
BW 60 Kbps
BW 40 Kbps

Delay 200 ms
Delay 150 ms
Delay 100 ms
Delay 50 ms
Delay 0 ms, Loss 5%
Delay 0 ms, Loss 0%

2010/6/9
Diagnosis

Records of network conditions:
1. May 2009: BW 340 Kbps, Delay 32 ms, Loss 1.5%
2. June 2009: BW 325 Kbps, Delay 92 ms, Loss 3%
3. July 2009: BW 311 Kbps, Delay 182 ms, Loss 4.8%

• Display network conditions of user’s PC.
• Three factors
  -> Reduce to 3 sections
    1). Delay & loss rate
    2). Delay & bandwidth
    3). Loss rate & bandwidth
User Recommendation

Suggest user a recommended VoIP application based on his network condition.

1. Our database is composed of three MOS scores of VoIP applications in each coordination.
2. Measure the network condition.
   - BW 311 Kbps, Delay 182 ms, Loss 4.8%
3. Compute MOS scores of each point.
   - *Bilinear interpolation*
4. Compute three average MOS scores of three points.
5. Conclude the recommended VoIP application whose average MOS score is the max.
Conclusion

• We propose a type of demonstration, radar chart, to display VoIP users’ QoE.

• With radar chart, we give users a way of tracking and diagnosis for their network conditions, and suggest them the recommended VoIP application.

• Future work
  – Evaluate the accuracy of our method for user recommendation
Thank you for your attention!