# SEEM3510 Human-Computer Interaction

## Timely User Experiences

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# Outline

1. Human perception in response times
2. Models of System Response Time (SRT)
3. Core question:  Optimal SRT
   - Human Perception
   - Task Nature
   - User Experience
   - User Productivity
4. Summary

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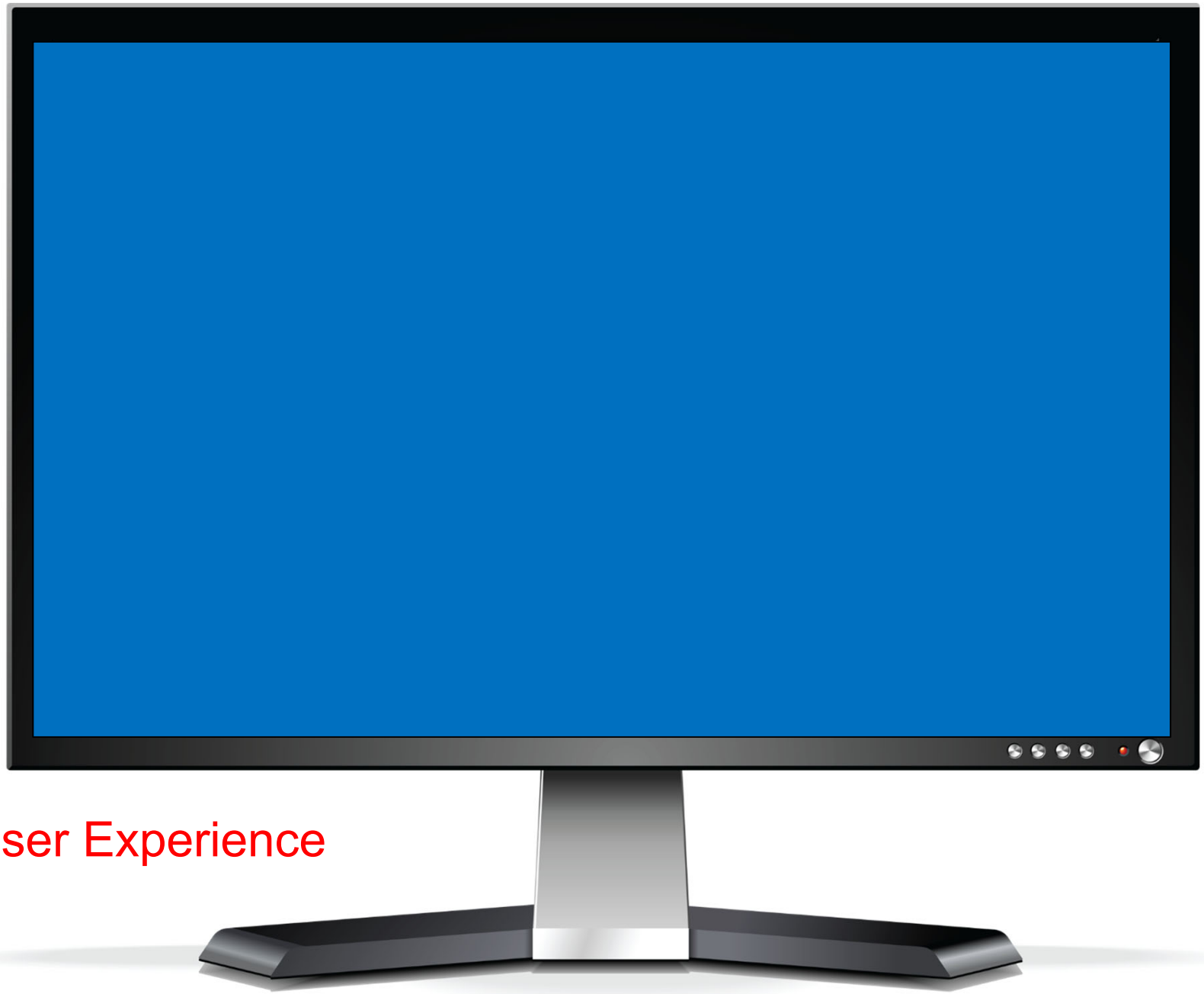


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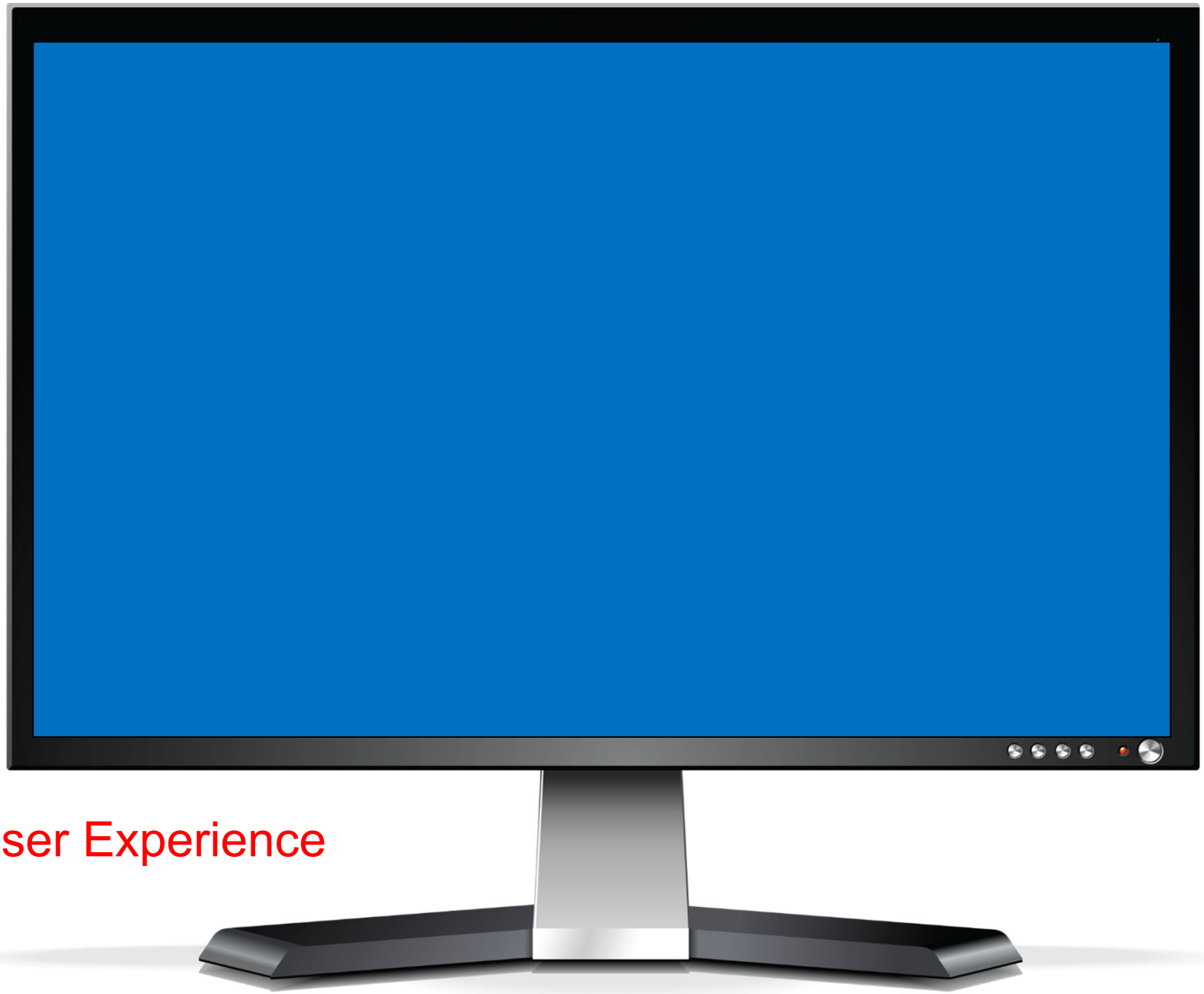


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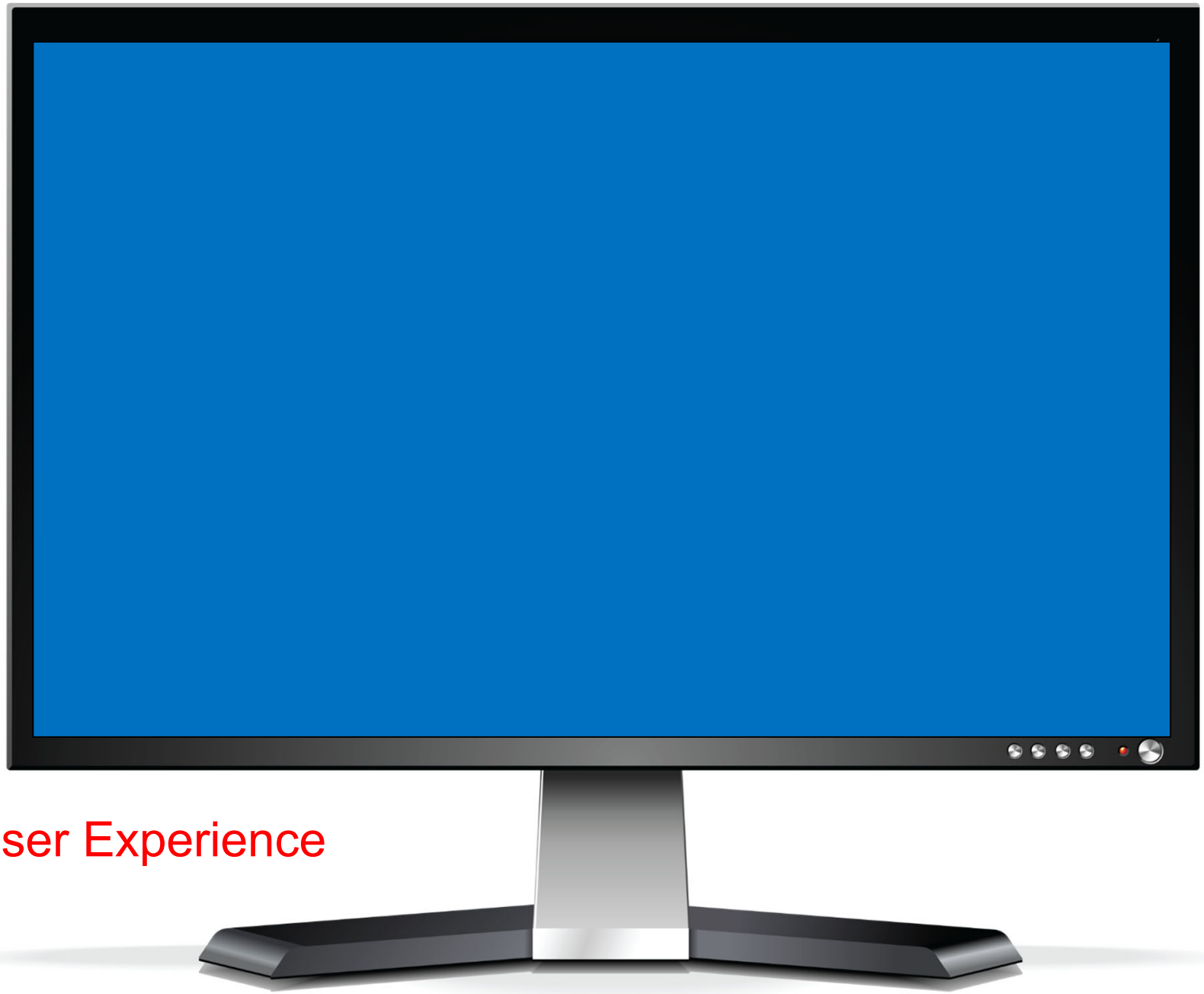


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# Response Times

A. Response time = 0.1 second
   - Users perceive instantaneous response
   - Feel that the system supports direct manipulation

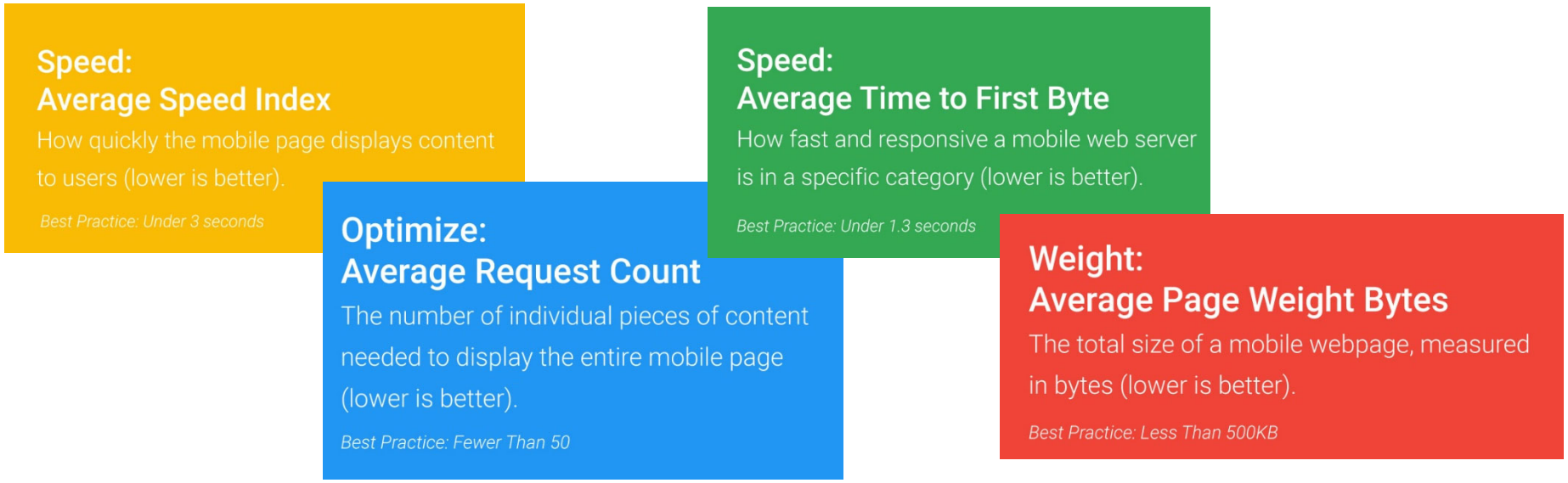
B. Response time = 1 second
   - Users sense a delay
   - Feel that the system is generating the outcome
   - Feel that they are still in control in information navigation
   - Keep attention to the task

C. Response time = 10 second
   - Marginally keep the user's attention
   - Feel that they are constrained by the system, loss of control
   - Discontinuity in thought process, loses the flow in interaction, certain threads not pursued

Ref: [Miller 1968; Card et al. 1991; Nielson 1993]

# Implications – Example

- Example:  industry benchmarks for mobile page speeds
- [An 2018] 11M mobile ads' landing pages across 213 countries
- Wide range of sectors, domains that took the longest to load – auto, retail and tech (bloated pages)
- For 70% mobile landing pages, >5sec to load visual content above fold, >7 seconds for full content




https://www.thinkwithgoogle.com/marketing-strategies/app-and-mobile/mobile-page-speed-new-industry-benchmarks/ (2018)

# Implications – Example (cont)

As page load time goes from:

**1s to 3s** the probability of bounce **increases 32%**

**1s to 5s** the probability of bounce **increases 90%**

**1s to 6s** the probability of bounce **increases 106%**

**1s to 10s** the probability of bounce **increases 123%**

https://www.thinkwithgoogle.com/marketing-strategies/app-and-mobile/mobile-page-speed-new-industry-benchmarks/

# Terminology

- System Response Times (SRT)
- Latency
- Lag
- Delay

Note that Zero Latency is physically impossible!

# Recap: SRT – 3 important limits

A. If SRT falls below a certain threshold, users experience immediate system response and being in control – supports direct manipulation
B. If SRT exceeds a certain threshold, users can perceive the delay
C. If SRT increases even further, user may be disengaged, user experience and satisfaction can be impaired

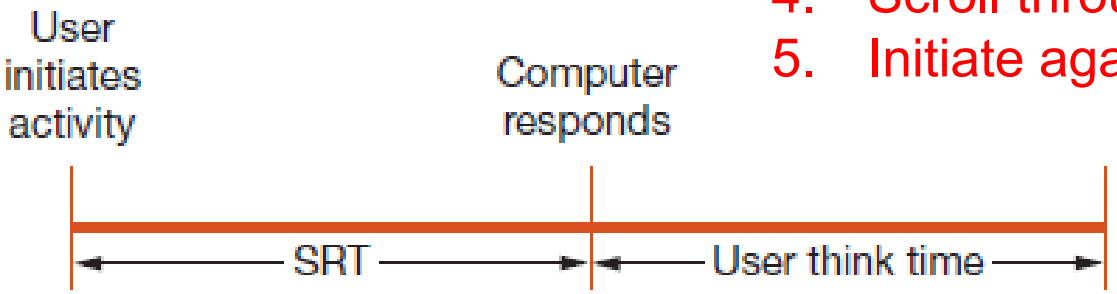
Also, user's performance may be negatively affected by long delays

Reference: nngroup.com

# Models of SRT

- SRT: Number of seconds taken from user-initiated activity (e.g. touching an icon, pressing ENTER key, clicking a mouse) until computer begins to present feedback
- User think time: number of seconds between computer response and user's initiation of next action
- Simple stages of action model:

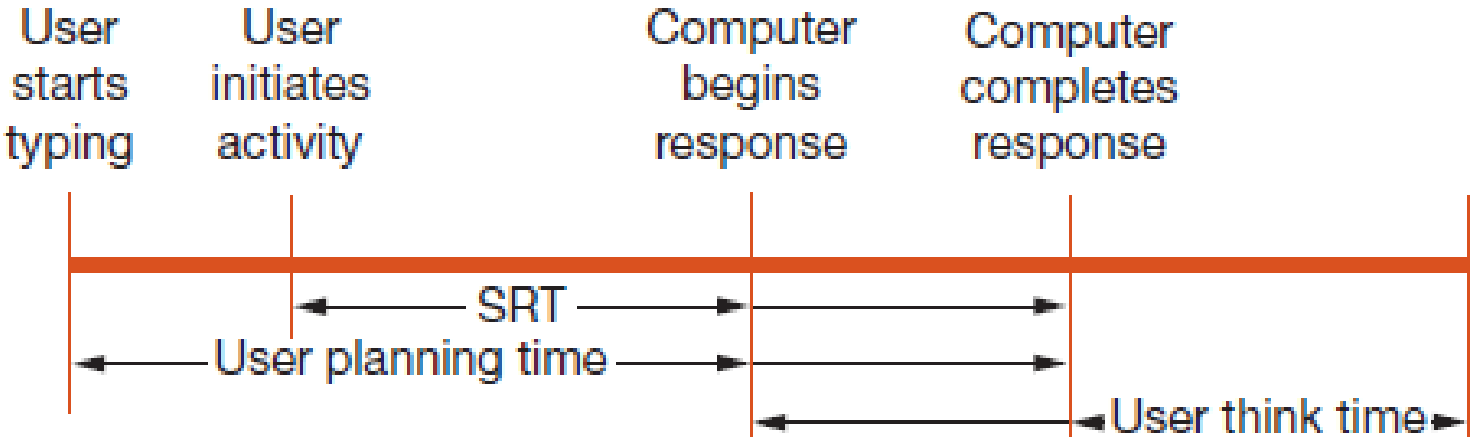
1. User initiate
2. Wait for computer to respond
3. Watch while results appear
4. Scroll through results
5. Initiate again



# Models of SRT

- More realistic stages of action model

1. Users plan ahead (while actioning, waiting for computer response, interpreting the results)
2. Computer response more easily measured, but may also have complications e.g. by delays (of networked jobs), distracting messages (e.g. advertisements), feedback, etc.



# Core Question: Is there an Optimal SRT?

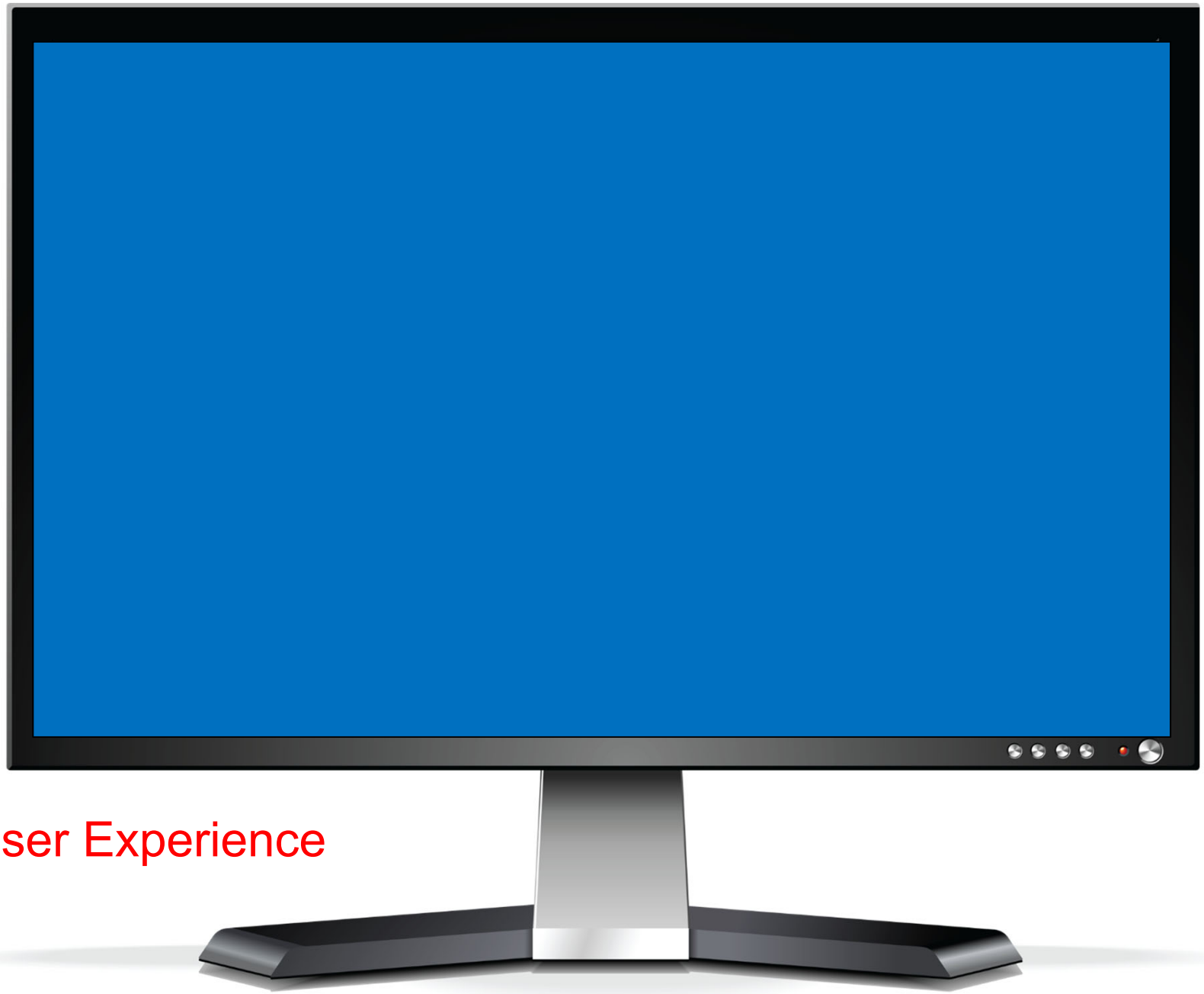
Important follow-up questions to ask:

- What are the guidelines for latency thresholds?
- Should there be different guidelines for different aspects of HCI? E.g.
  1. Considerations relating to human perception (e.g. what is the Just Noticeable Difference)?
  2. Considerations relating to task nature
  3. Considerations relating to user experience (e.g. what is the minimal latency that users will begin to get annoyed)?
  4. Considerations relating to user productivity?

# 1. Human Perception

- JND (Just Noticeable Difference)
  - From psychophysics and experimental psychology
  - Amount that (in the current context) SRT/latency must be changed in order for a difference to be noticeable, detectable at least half the time
  - Differences below JND are not perceived

- Let's experience!

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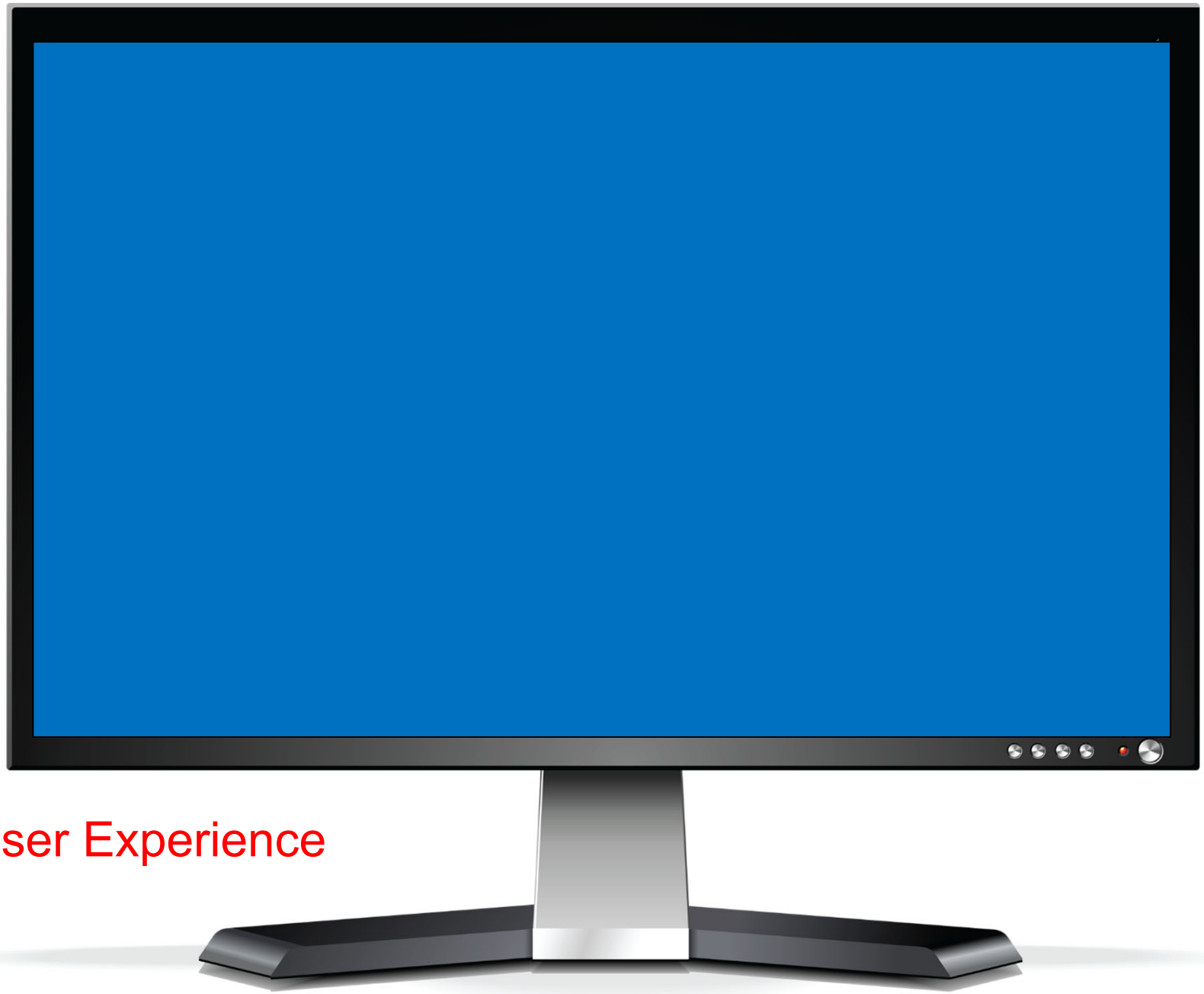
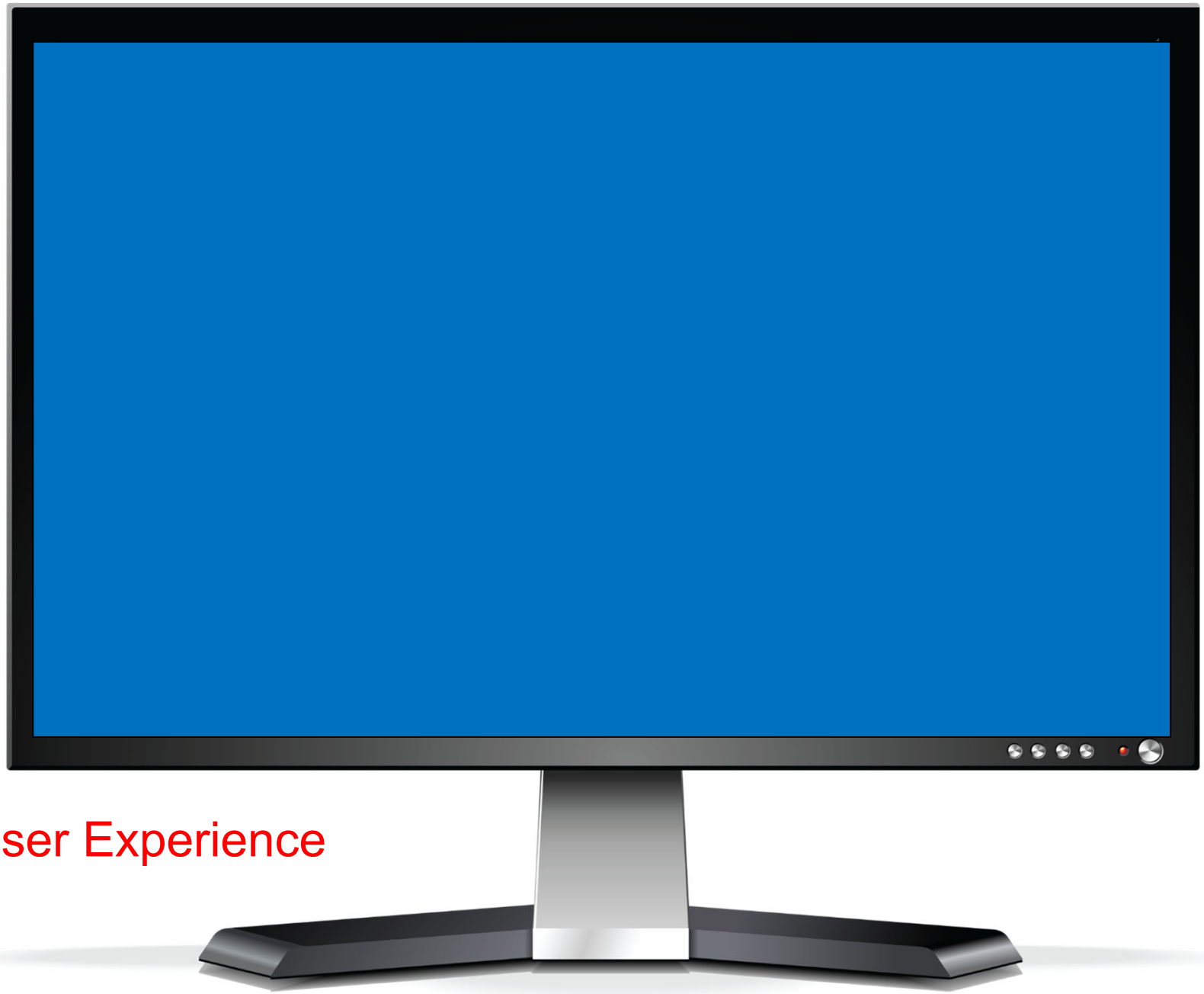


User Experience

Duration between end of spoken command and appearance of the image



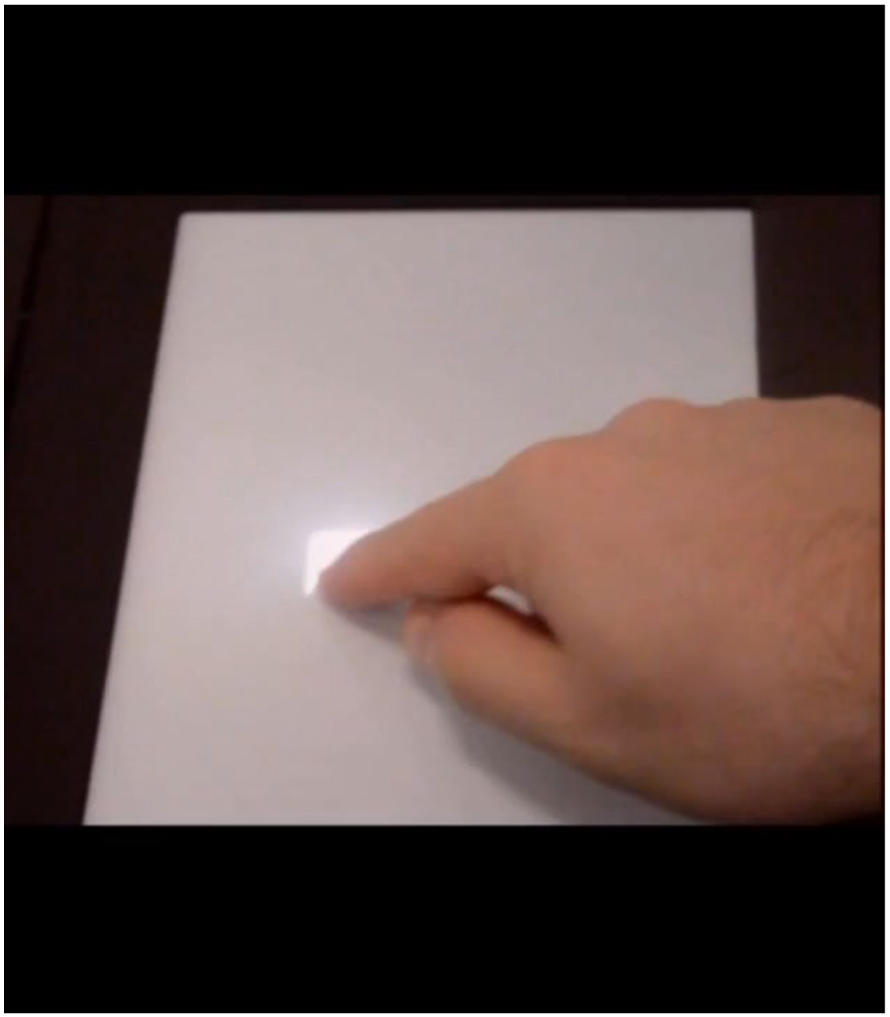
User Experience

Duration between end of spoken command and appearance of the image

# Response to dragging on touchscreen

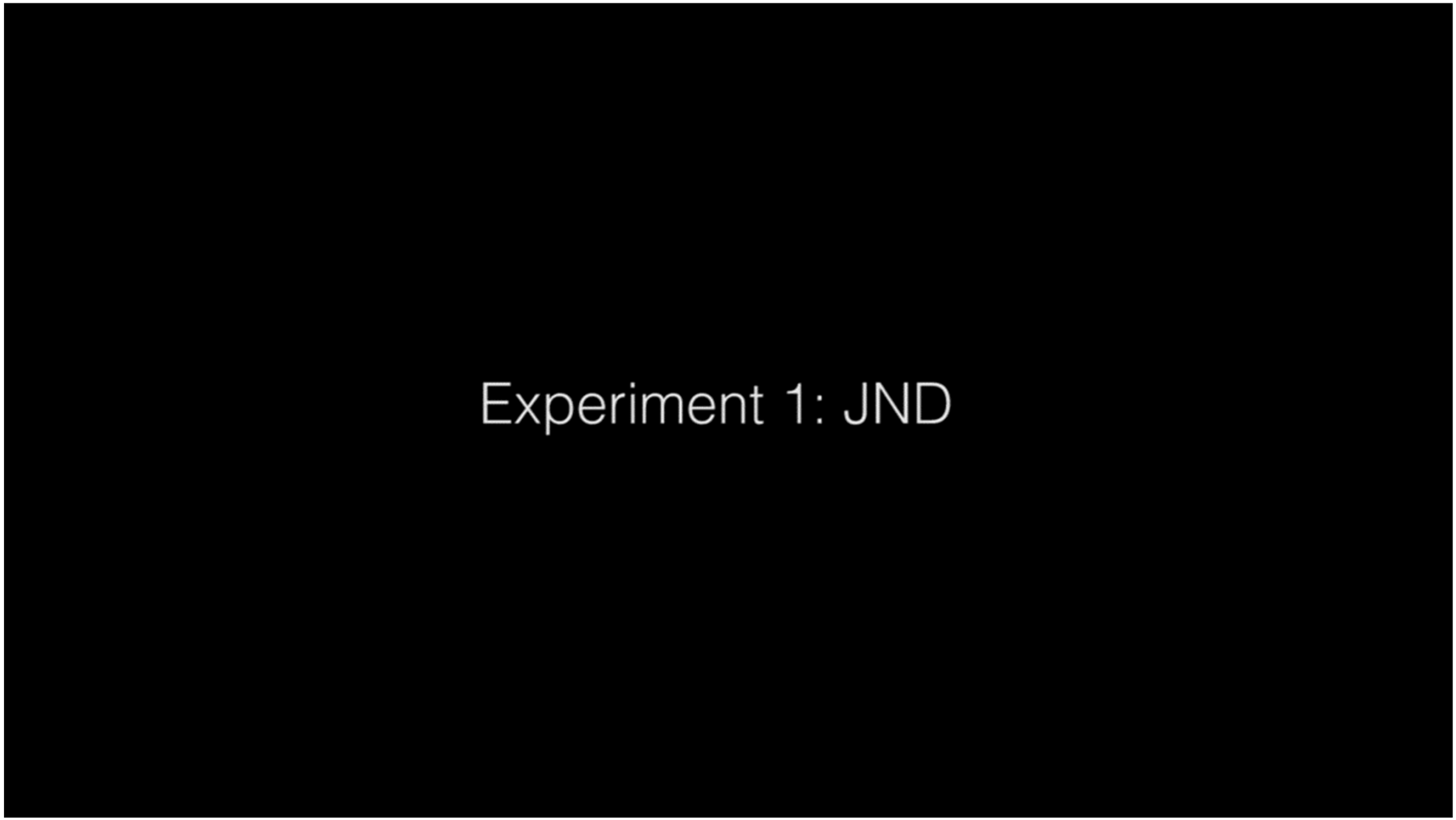
Dragging gesture on screen

2 latencies



Source: ACM CHI 2015 Deber et al. 2015, “How Much Faster is Fast Enough?: User Perception of Latency & Latency Improvements in Direct and Indirect Touch”

# Response to dragging/tagging on touchscreen

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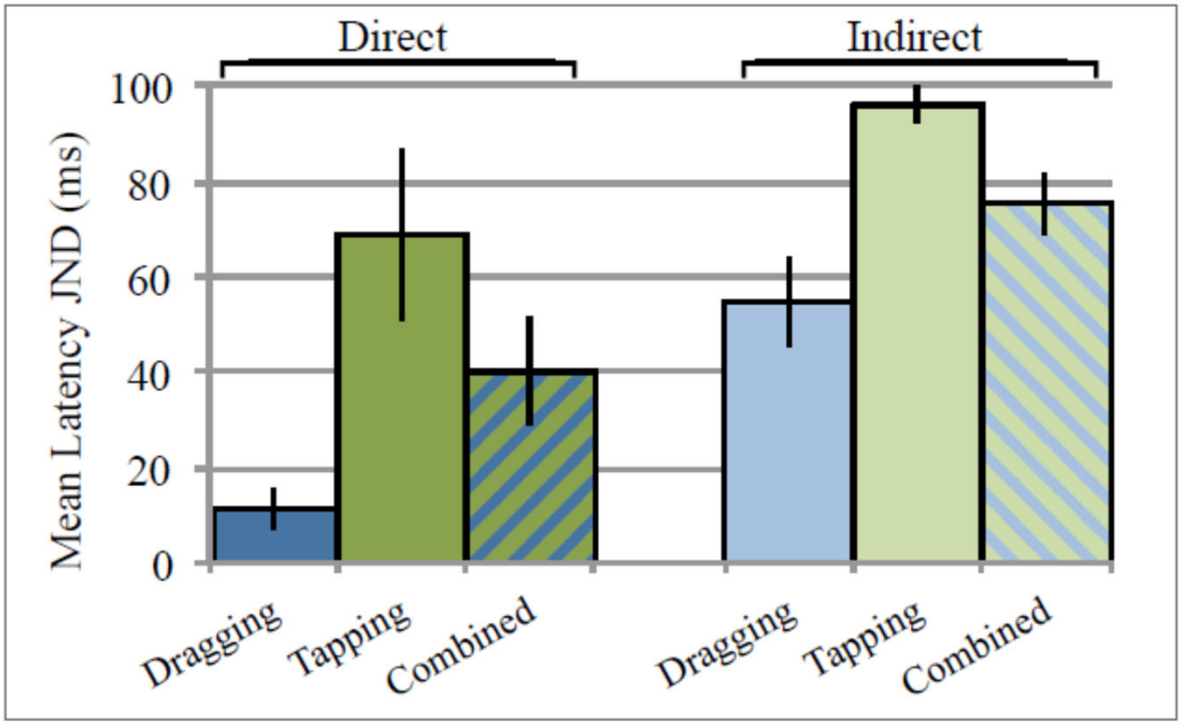



**Figure 2. Mean latency JND thresholds for direct and indirect form-factors. Dragging, tapping, and combined (counting trials from both techniques) are shown in blues, greens, and striped bars. Error bars show 95% confidence intervals.**

Source: ACM CHI 2015 Deber et al. 2015, "How Much Faster is Fast Enough?: User Perception of Latency & Latency Improvements in Direct and Indirect Touch"

# Factors Affecting Human-Perceived Latencies

- Human-perceived latency depends on:
  - Input modality, gesture
  - (further investigations) multimodal inputs, multimodal outputs
  - User characteristics – age, cognitive load, skill levels

# 2. Task Nature

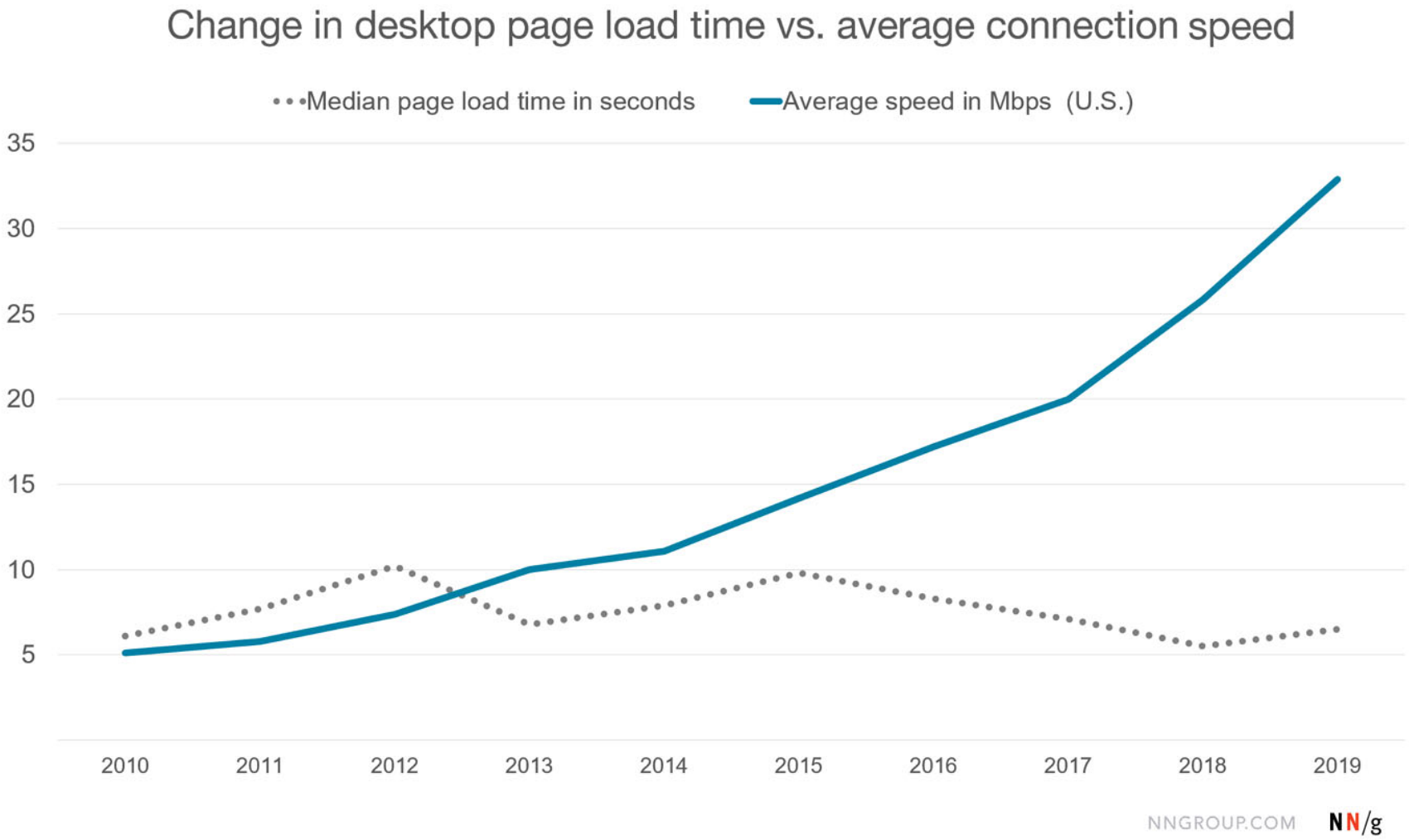
User expectations related to 3 factors [Shneiderman]

i. Prior experience
   - shapes user's expectation regarding same/similar tasks (e.g. delay between a Google search and display of results is 200ms, sets expectation for future)
   - Familiarity brings skill – novice versus experts

i. Individual's tolerance of latency
   - Person variables -- personality, cost, age, mood, cultural context, time of day, noise, perceived pressure
   - Adaptability – speed-up versus multi-task while waiting

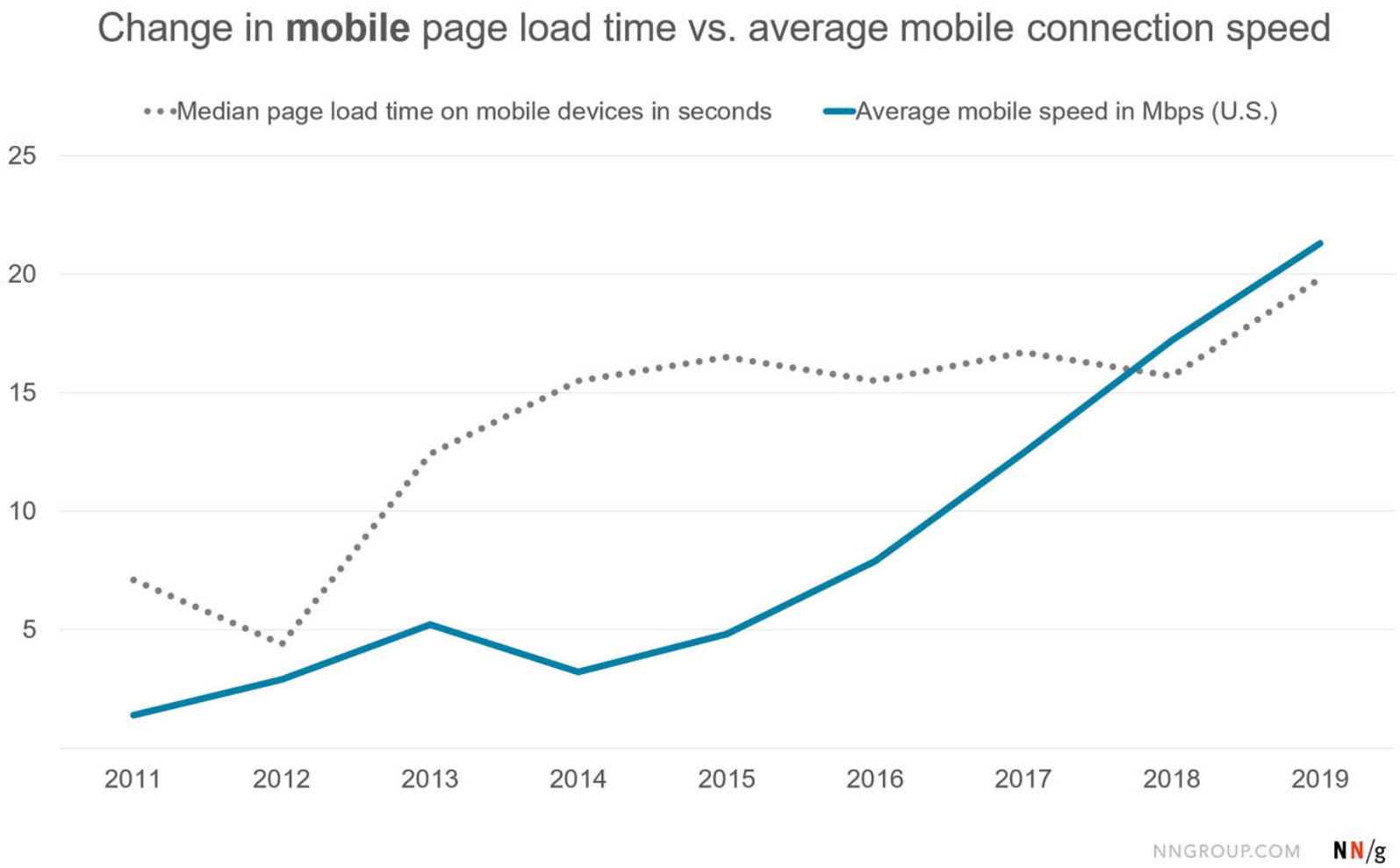
ii. Task complexity
   - Repetitive tasks – need short latency
   - Complex problem-solving task – favors low-latency system but makes fewer errors with longer latency

# 2. Task Nature – Website SRT




Source: nngroup.com

# 2. Task Nature – Mobile SRT




Source: nngroup.com

# 3. User Experience – Web/Mobile Visits

How slow is too slow?

- 2009: Google and Bing both reported that even half-second delays in load time resulted in measurably lower conversion metrics (number of searches and revenue per user).
- 2016: Google found 53% of mobile visits ended if a page took longer than **3 seconds** to load.
- 2017: Akamai aggregated data from 17 retailers (7 billion pageviews) and found that conversion rates were highest for pages that loaded in less than 2 seconds; longer load times correlated with 50% drops in conversion rates and increased bounce rates, especially for mobile visitors.
- 2018: BBC found that for every extra second of page load time, 10% of users will leave.

Source: nngroup.com

# 3. User Experience

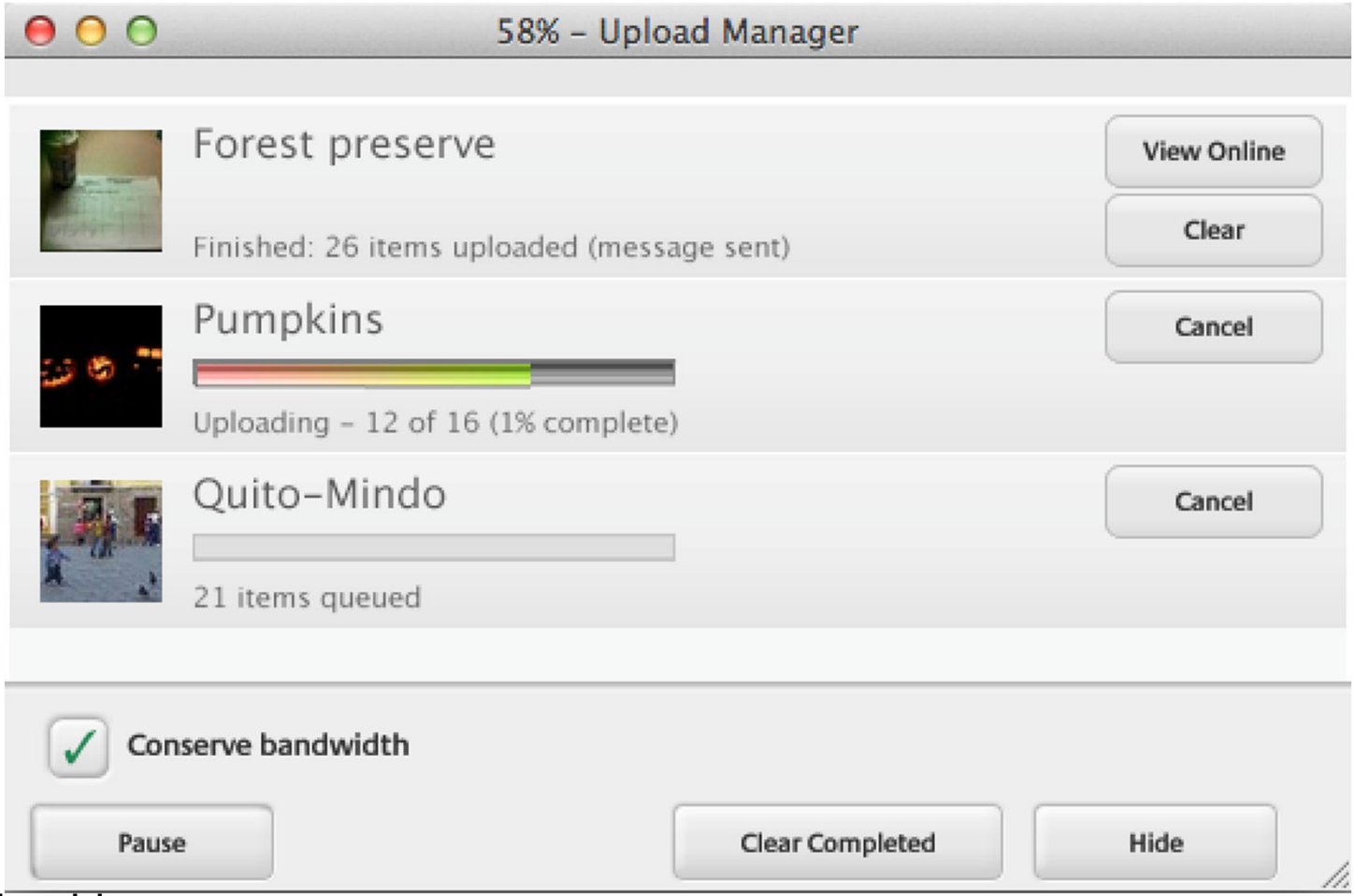
Powers of Ten

- 0.1 second
  - Experiences instantaneous reactions, decisions made hastily / incompletely, may feel pressure
- 1.0 second
  - User maintains flow of thought (may formulate further plans while executing current plan), notices delay, still feel in control
- 10 second
  - Solutions reviewed continually (wasting effort), or user may have cognitive shifts and migrate to other tasks, may lose chain of thought, may be frustrated
  - Must mask delay, e.g. news headlines displayed first while loading the rest, provide progress indicator (% vs absolute), reduce variability in response

Source: nngroup.com

# 3. User Experience

- Progress indicators from Picassa reassure progress, and allow users to cancel uploads
- Must reflect truthful progress




Source: Shneiderman

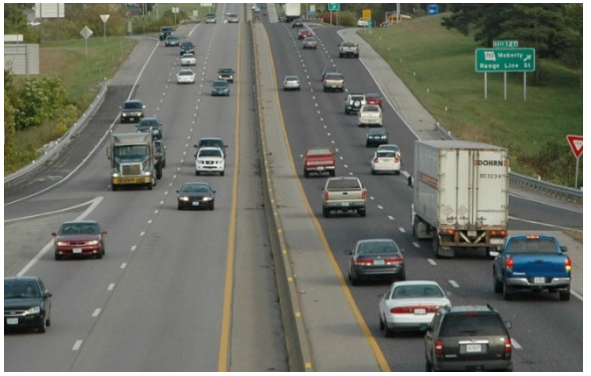
# 3. User Experiences – Frustration

- User frustration from interface and technology complexity, network disruptions, malicious interference, e.g. poor network bandwidth (developing nations), spam, virus
- High levels of frustration and loss of 1/3 to 1/2 of time spent [Lazar et al., 2006]

# 3. User Experience – Reducing Frustration

- Increase server capacity, network speed, and network reliability
- Improve user training, online help, and online documentation including tutorials
- Redesign instructions and error messages
- Reduce cognitive load esp for complex tasks
- Stay ahead of the technology to protect users against spam, viruses, and pop-up ads (distractions)
- Organize consumer-protection groups
- Increase research on user frustration
- Catalyze public discussion to raise awareness

# 4. User Productivity



Nature of task influences tradeoffs between SRT and user productivity

- **Repetitive tasks**

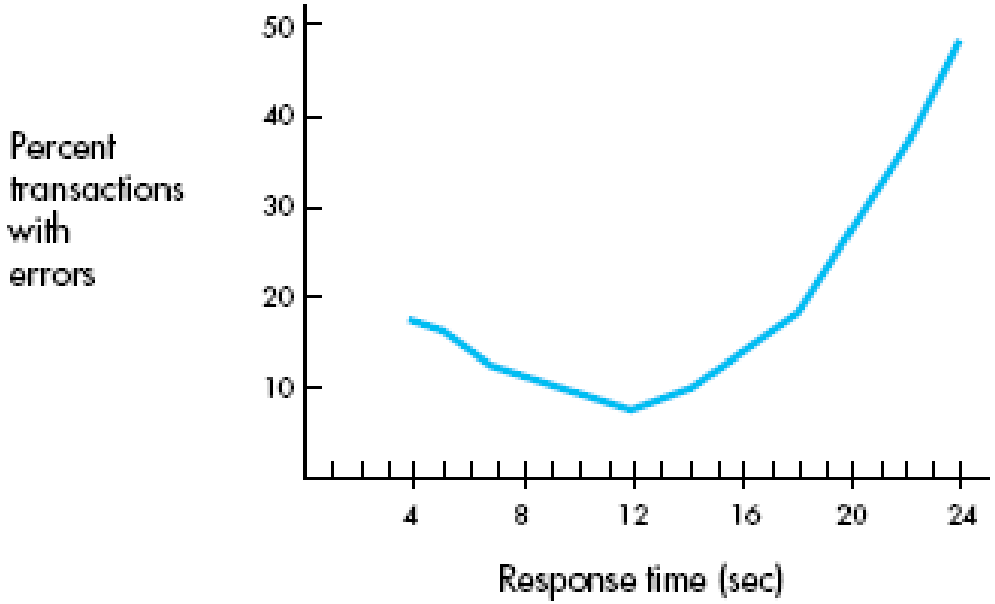
| | |
|---|---|
| **Shorter SRT**<br>→ Less wait<br>→ Higher productivity | **Shorter SRT**<br>→ More errors<br>→ Lower productivity |
| **Longer SRT**<br>→ Higher accuracy<br>→ Higher productivity | **Longer SRT**<br>→ More wait<br>→ Lower productivity |

- **Problem-solving tasks**

| | |
|---|---|
| **Longer SRT**<br>→ Users adapt<br>→ Maintain productivity | **Longer SRT**<br>→ Users dissatified<br>→ Lower productivity |

# 4. User Productivity (cont)

- People are willing to pay substantial amounts of money to reduce variability
- Extremely fast responses may be slowed down
- Extremely slow responses may need progress indicator
- [Barber & Lucas 1983] telephone-circuit layout task – error rates vs SRT, productivity increased with shorter times



# Summary of SRT Guidelines

- Users may achieve rapid task performance, low error rates, and high satisfaction when:
  - Users have adequate knowledge of the objects and actions necessary for task
  - User's plan can be executed without delays
  - Users' distractions are eliminated
  - User anxiety is low
  - Accurate feedback about progress towards the solution
  - Errors can be avoided or handled easily

# Summary of SRT Guidelines (cont)

- Strive to have rapid start-up times
- Modest variability in response time is acceptable
- Users should be advised of long delays
- Unexpected delays may be disruptive
- Offer users a choice in the pace of interaction
- Empirical tests can help to set suitable response times

# Thank you!

# Expectations and Attitudes (cont2)

- Other conjectures that may play a role in choosing the optimum interaction speed:
  - Novices may exhibit better performance with somewhat slower response times
  - Novices prefer to work at speeds slower than those chosen by knowledgeable, frequent users
  - When there is little penalty for an error, users prefer to work more quickly
  - When the task is familiar and easily comprehended, users prefer more rapid action
  - If users have experienced rapid performance previously, they will expect and demand it in future situations