Network Assisted Mobile Computing With Optimal UplinkQuery Processing

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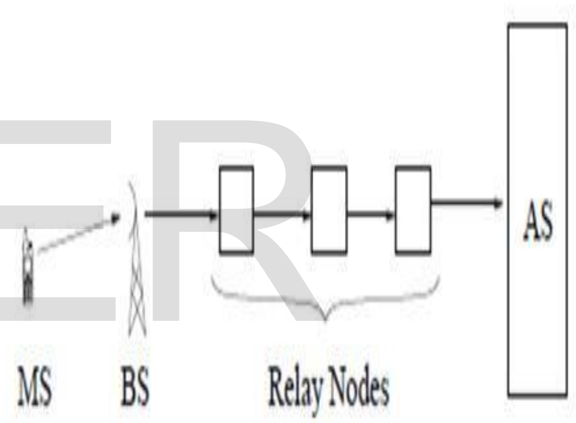
Abstract—many mobile applications retrieve content from remote servers via user generated queries. Processing these queries is often needed before the desired content can be identified. Processing the request on the mobile devices can quickly sap the limited battery resources. Conversely, processing user-queries at remote servers can have slow response times due communication latency incurred during transmission of the potentially large query. We evaluate a network-assisted mobile computing scenario where mid network nodes with "leasing" capabilities are deployed by a service provider. Leasing computation power can reduce battery usage on the mobile devices and improve response times. However, borrowing processing power from mid-network nodes comes at a leasing cost which must be accounted for when making the decision of where processing should occur. We study the tradeoff between battery usage, processing and transmission latency, and mid-network leasing. We use the dynamic programming framework to solve for the optimal processing policies that suggest the amount of processing to be done at each mid-network node in order to minimize the processing and communication latency and processing costs. Through numerical studies, we examine the properties of the optimal processing policy and the core tradeoffs in such systems.

Keywords—Mid-network nodes, leasing, dynamic programming.

1 INTRODUCTION

The processing and storage capabilities of mobile consumer devices are becoming increasingly powerful. A gamut of new mobile applications has thus emerged for providing a better quality of experience for the end users. A class of such applications commonly referred to as mobile augmented reality includes ones that enable delivery of content in response to the user-generated queries for enhancing user's experience of the environment. Text to speech conversion and optical character recognition (OCR) based applications for mobile devices follow a similar paradigm. Several interesting usage scenarios thus arise. A user clicks a picture or shoots a video of a desired object–a building, painting in a museum, a CD cover, or a movie poster–through a camera phone. The video or image is then processed and sent over the network to an application server hosting a database of images. The extracted query image is then matched with a suitable entry and the resulting content–object information, location, title song from a CD, or movie trailer–is then streamed back to the user. A number of existing commercial product provide this type of service.

2 ARCHITECTURE



3 MODULES

- Leasing Model
- Relaying Strategies
- Multi-hop Transmission

4 LEASING MODEL

Utilizing the processing power of intermediary nodes is the main idea behind Network-Assisted Mobile Computing. Leasing processing power from mid-network nodes can be extremely beneficial to reduce latency and to extend the battery life of a mobile device. However, it comes with a cost. These costs can capture the fee required to lease CPU power from the mid-network nodes. Additionally, these costs may capture potential security risks by giving access of client data to these nodes. Some operations, such as transcending, can be

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done onEncrypted data, while other would require decrypting the data. The mobile station send one sentence for ex: (how are you), in the application server receive the sentence into audio.

5 Relaying Strategies

- Amplify-and-forward
- Decode-and-forward

In amplify-and-forward, the relay nodes simply boost the energy of the signal received from the sender and retransmit it to the receiver.

In decode-and-forward, the relay nodes will perform physical-layer decoding and then forward the decoding result to the destinations. If multiple nodes are available for cooperation, their antennas can employ a space-time code in transmitting the relay signals. It is shown that cooperation at the physical layer can achieve full levels of diversity similar to a system, and hence can reduce the interference and increase the connectivity of wireless networks.

6 Multi-hop Transmission

Multi-hop transmission can be illustrated using two-hop transmission. When two-hop transmission is used, two time slots are consumed. In the first slot, messages are transmitted from the mobile station to the relay, and the messages will be forwarded to the Application Server in the second slot. The outage capacity of this two-hop transmission can be derived considering the outage of each hop transmission.

7 Existing System

In the previous section we identified special properties of the optimal processing policy under various scenarios. We now examine some of these properties through numerical studies with example cost functions and systems. Latency, battery usage, and leasing costs have a tightly woven relationship.

7.1 Disadvantages

- Increasing battery usage will decrease latency and leasing costs, but also limits the lifetime of the mobile device.
- Conversely, the lifetime of the device can be extended by increasing leasing costs which will decrease latency and battery usage.

8 Proposed System

A user request originates at the Mobile Station (MS). In order to be completed, the request must be transmitted upstream to a remote Application Server (AS) via a Base Station (BS) and a series of relay nodes. We refer to the node at the first hop as the base station, but emphasize that the links between the BS, relay nodes, and as may be wired or wireless. Similarly running a text to speech conversion application for usage scenarios.

8.1 Advantages

- If the request processing is entirely done at the MS, the limited battery power can be drained.
- If the processing is done at the AS, communication latency can be high due to limited bandwidth of the wireless access link and large query size.

9 Conclusion

In this project the popularity of mobile applications is steadily increasing. Many of these applications require significant computation power, especially in the case of multimedia applications. As the demand, as well as the sophistication and required computation power, for these types of applications increases, battery and communication bandwidth limitations may prevent the use of many of these applications. By "leasing" processing power from mid-network nodes, the battery drain and communication latency may be diminished. Network-Assisted Mobile Computing can help alleviate the processing burden off the Mobile Station without increasing the service latency. Using Dynamic Programming, we identified the optimal processing policy. We identified some important properties of the optimal policy which can be used to guide future system design. Through numerical studies we examine the core tradeoffs and relationships between battery usage, latency, and leasing costs

10 Future Enhancements

A number of factors must be considered for deployment of such a network-assisted mobile computing system. While there exist technology for collaborative networks, one must consider the amount of processing and data that will be permitted to be shared at mid-network nodes. If high security is required, there may be additional costs required to handle mid-network processing. The design challenges will be application and system dependent. For instance, if the processing only requires transcending, this can be done on fully encrypted data by simply dropping packets, making mid-network processing simple and secure. However, it is certainly the case that query partitioning will be limited if the data must remain encrypted during the whole query processing. Much as transcending encrypted media has been an interesting area of research, one may want to consider developing processes which allow for other query processing on encrypted data.

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