Indoor Localization in Mobile Edge Computing

Bachelor Topics 2021

Supervised by

Dr. Mohamed Ashour

Co-supervised by

Eng. Marwa Zamzam

Outline

1. Introduction to Indoor Localization
2. Challenges of Indoor Localization
3. Mobile Edge Computing (MEC)
4. Performance Metrics for Indoor Localization in MEC
5. Proposed Topics

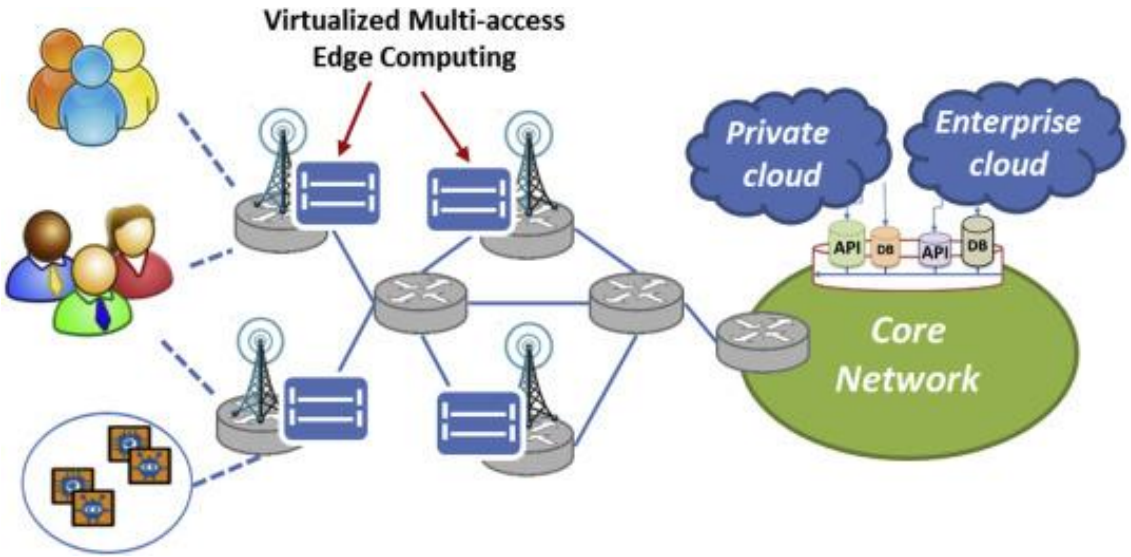
Introduction to Indoor Localization

- Indoor Localization is the process of finding the location of an Internet of Things (IoT) device within an indoor environment.
- With the progress of IoT technology, the demand for indoor localization services is continuously increasing.
- Indoor localization can be crucial in many aspects such as smart parking, patient monitoring, shopping malls and augmented reality. Thus, there is a dire need for an accurate indoor localization technique.

Challenges of Indoor Localization

- Highly accurate localization techniques impose high latency and high energy consumption to the system.

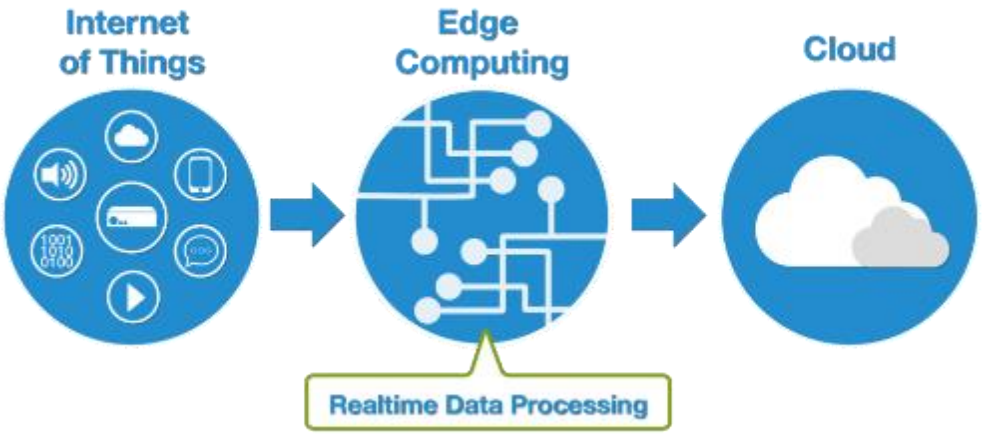
- To address this challenge, offloading the computation of the localization process to a remote server with high number of resources is introduced.



Mobile Edge Computing

- Cloud Computing servers
  - It provides unlimited capabilities service such as storage and computing capabilities.
  - It suffers from high latency due to long distances, weak system reliability and network congestion. Thus, To address these challenges, Cisco delivered the concept of Mobile Edge Computing.

- Mobile Edge Computing servers
  - It pushes the computation resources to the network edges.
  - It supports real-time and latency-sensitive applications due to short distance.



Performance Metrics

- Latency: It is the difference between the moment when the request for location estimate has been created and the moment when the response arrived.

- Energy Consumption: It is the total energy consumed for generating a location estimate.

- Accuracy: It is the distance between the ground truth location and the location estimated by an indoor localization algorithm.

MEC Latency-Accuracy Tradeoff for indoor Localization Techniques

Different localization application have different delay requirement. A person in shopping mall wants to know his location faster than the need of locating a certain medical equipment in hospital or the location of tools in factory floor. Lower delay usually requires either very fast computation or very simple location calculation. Fast computation requires either very strong local device or offloading the computations to a remote server, and simple calculation usually affect the accuracy of the calculated location. Thus, the aim of the project is to choose the best localization technique in order to pursue users' computation requirements and guarantee network performance in terms of accuracy and latency.

MEC Latency-Accuracy Tradeoff for indoor Localization Techniques

- Summary of Tasks:

1. Study different indoor localization Techniques with different Transmission Technologies.
2. Choose the techniques that will be implemented within a certain transmission technology.
3. Choose an application domain for testing your techniques.
4. Design the experiment and select the measurement points.
5. Deployment and configuration of the infrastructure.
6. Evaluate both the latency and the accuracy for each technique.

Analysis of MEC Energy-Accuracy Tradeoff for indoor Localization Transmission Technologies

In indoor localization higher accuracy usually requires more computation and more message exchange and hence consume more energy consumption. Most IoT devices run on batteries and hence more energy consumption means that the battery will run out faster. Achieving high accuracy at low power is a huge challenge. Thus, the aim of the project is to choose the best localization transmission technology in order to minimize guarantee network performance in terms of accuracy and energy consumption.

Analysis of MEC Energy-Accuracy Tradeoff for indoor Localization Transmission Technologies

- Summary of Tasks:

1. Study different indoor localization Techniques with different Transmission Technologies.
2. Choose the transmission Technologies that will be implemented with a certain indoor localization technique.
3. Choose an application domain for testing your transmission technologies.
4. Design the experiment and select the measurement points.
5. Deployment and configuration of the infrastructure.
6. Evaluate both the energy consumption and the accuracy for each transmission technology.

Service migration path selection using Artificial Intelligence in Mobile Edge Computing

MEC provides a promising approach to significantly reduce network operational cost and improve quality of service of mobile users by pushing computation resources to the network edges. However, the mobility of mobile users and the limited coverage of edge servers can result in significant network performance degradation and dramatic drop in QoS. Service migration has great potential to address these issues, as it decides when or where these services are migrated following user mobility and the changes of demand. Thus, the aim of the project is to propose a service migration path selection method using artificial intelligence technique.

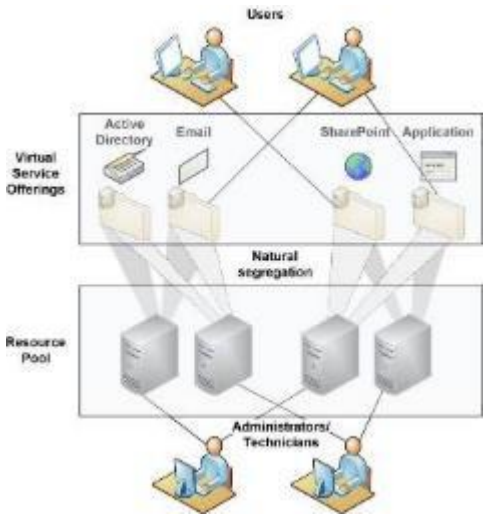
Service migration path selection using Artificial Intelligence in Mobile Edge Computing

- Summary of Tasks:

1. Study different service migration path selection techniques to the MEC server.
2. Analyze the problem from two aspects: the network operator and mobile user.
3. Monitor the real-time network condition (e.g. bandwidth, network style information, and distance between two nodes), construct the latency and energy matrix.
4. Based on the proposed expense function, design the optimization model of migration path selection; at find the optimal service migration path.
5. Apply Artificial Intelligence techniques to the system model.
6. Compare the system model with and without Artificial Intelligence.
7. Apply the model on indoor Localization Application.

Virtual resources optimization allocation strategy for MEC servers

Mobile devices with limited resources face more severe capacity constraints than ever before, while running all applications on central cloud can easily lead to serious network congestion and performance degradation. MEC is introduced to alleviate the congestion of the core network and improve the quality of computing experience by meeting the strict requirement of response delay. However, human activity is changeable in daily life, causing the diverse requirements of mobile devices, the varying situation of the request generation districts and the changing quantity of the overall requests, leading to the instability of the MEC environment. Hence, how to allocate computing resources and network resources rationally to satisfy the requirements of mobile devices under the changeable MEC conditions has become a great challenge. Thus, the aim of the project is to apply network optimization and propose virtual resources allocation strategy for MEC servers in order to pursue users' computation requirements and guarantee network performance.



Virtual resources optimization allocation strategy for MEC servers

- Summary of Tasks:

1. Study different virtual resource allocation techniques.
2. Design the model to evaluate resource demand based on instruction analysis and the computation time ratio of different modules of the migrated service.
3. Analyze the problem from two aspects: the network operator and mobile user.
4. Apply network optimization taking into consideration: Latency and Energy Consumption.
5. Allocate the resources of both MEC servers and cloud servers.
6. Apply the model on indoor Localization Application.

Proper parallelization and code partitioning of the offloaded application service to MEC

MEC has been promoted to support delay-sensitive applications in future Internet of Things (IoT) and wireless networks. Since human activity is changeable in daily life, causing the diverse requirements of tasks, how to effectively map multiple tasks to minimize every task's service delay in a distributed manner is a fundamental challenge, and the problem becomes more challenging when tasks can be divided into multiple subtasks to further reduce the service delay via distributed parallel computing. This occurs by decomposing tasks into subtasks that can be executed in parallel (Converting existing sequential applications to be parallelized) and then schedule those tasks to minimize load imbalance. Thus, the aim of the project is to apply network optimization and propose Proper parallelization and code partitioning of the offloaded application service in order to pursue users' computation requirements.

Proper parallelization and code partitioning of the offloaded application service to MEC

- Summary of Tasks:

1. Study the applications that can be parallelized.
2. Study different parallelization techniques and code divisions and select the best fit method.
3. Apply network optimization taking into consideration: Latency and Energy Consumption.
4. Apply parallelization on both MEC servers and cloud servers.
5. Compare the system model with and without parallelization
6. Test the model on indoor Localization Application.