IDEC Chip Design Contest

Memory Cloudification Platform Using Remote Execution Code for Complex IoT Environment

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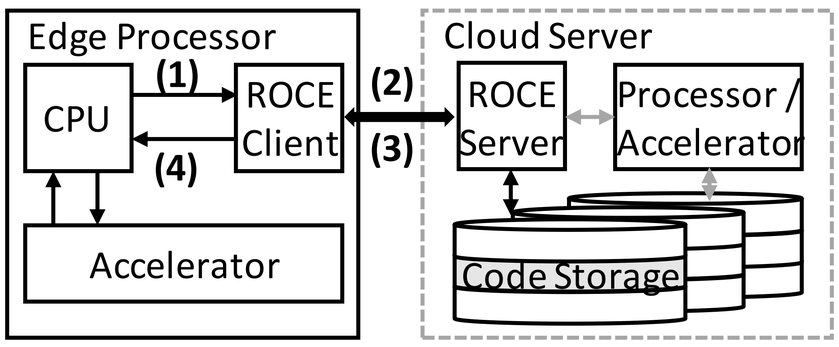
Abstract

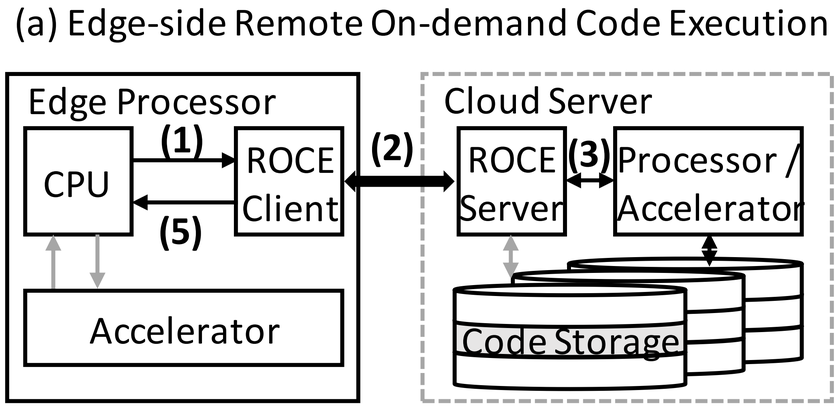
Embedded devices have a small hardware space that makes it difficult to provide a variety of services and limits the processing speed. To solve the problem of memory shortage and slow operation speed, we use the server-side remote execution code. Using the server-side remote execution code, the embedded device can serve unlimited memory and can accelerate the operation using fast processor of the server. However, using only server-side remote execution code can increase execution time because of the data transmission delay between the embedded edge and the server. To reduce data communication, the code transmitted from the server, called the edge-side remote execution code, is executed at the edge. In this paper, we propose a simulation platform for easily choosing the ratio of the server-side execution code to the edge-side execution code in a complex IoT environment. Further, we designed a remote on-demand code execution (ROCE) processor to execute remote execution code on an embedded device, including a hardware accelerator, and simulate the resulting code rate change.

Remote On-Demand Code Execution Platform



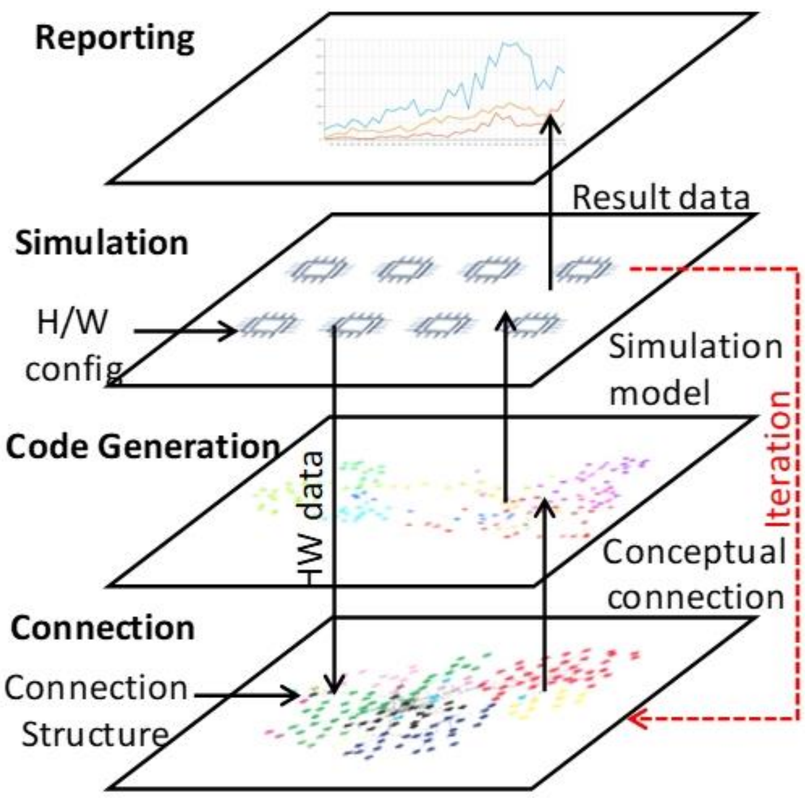
(a) Edge-side Remote On-demand Code Execution

The ROCE uses code storages of the server as a virtual memory, so that the number of services that the device can run increases. It can also accelerate the program with server's processor and accelerator.



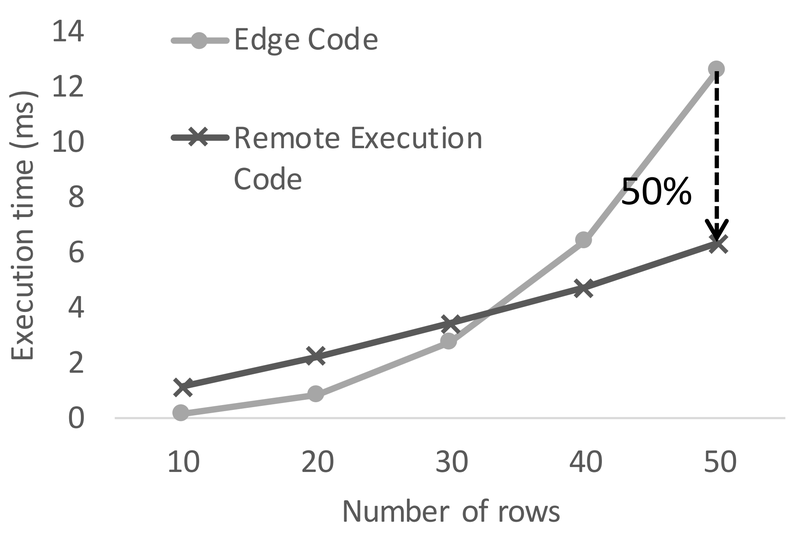
(b) Server-side Remote On-demand Code Execution

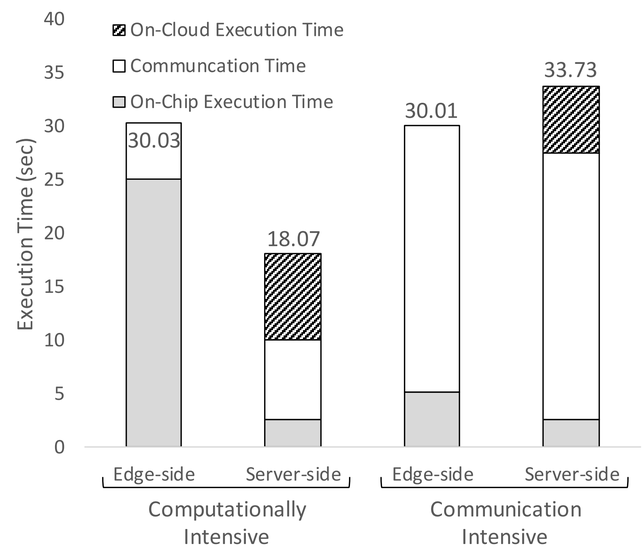
Edge devices have a low performance processor and a small number of accelerators. The server can accelerate the execution of the program, but it requires overhead associated with data transfer.



The proposed platform distributes the code to the edge-side and server-side according to the connection structure and simulates it with physical environment. The platform iterates to simulate the generated code and to regenerate the code changing the connection structure. We designed a ROCE chip based on the ACE2 chip and simulate remote code execution with ACE1 board using an ROCE chip containing a matrix multiplication accelerator as an edge device.

Experiment Results





Magnachip 180 nm Process
ISA: RV32IMAC
Die size: 3.8 mm x 3.8 mm
Operating frequency: 25 MHz
Gate count: 170,000
(except memory)

Left figure shows the time taken when executing a square matrix multiplication operation with n-rows with remote code. Executing server-side remote code requires data transfer time, so it is faster when computing more data than when computing less data. The figure on the right shows that it is better to use the server-side remote code for a program with a lot of computation, and to use the edge-side remote code for a program with a lot of communication.

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