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Energy Efficiency on Edge Computing: Challenges and Vision
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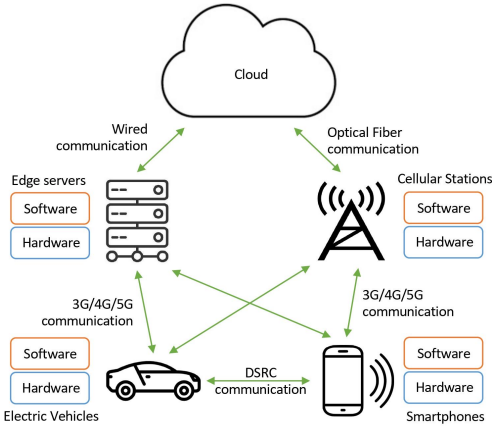
Introduction



The IoT is growing at a magnificent rate and the cloud has become inadequate

Edge computing provides computing, storage, and network resources at the location where data is produced

It is crucial that power efficiency and energy sustainability become critical factors for any type of edge computing

Case Studies

Smart Grid

Smart Grids

Enables a two-way flow of electricity and data with digital communications technology able to actively respond to changes in usage and issues

Most of the data is still separated and real-time sharing is not strong

The huge amount of data does not always allow a quick response

Scenarios are becoming complex requiring more accurate and localized data processing

Smart Home

Smart Home

Provides highly efficiently human-computer interaction, safe control, and configurable functions

Energy consumption comes from three parts: the smart devices, the communication system, and the control system

Smart devices are heterogenous each producing unique data with different exchange methods

Whether the communication device is wired, or wireless, additional energy consumption is generated up execution

Smart City

Smart City

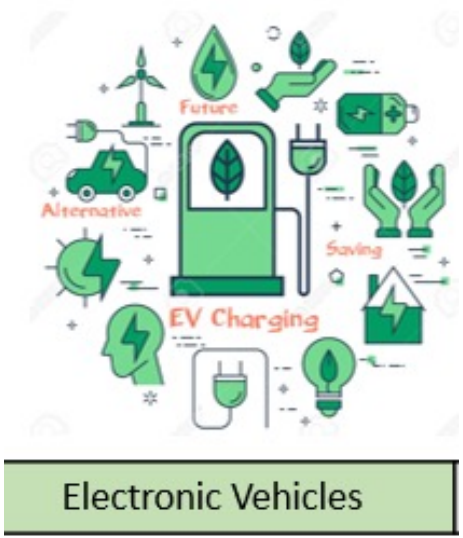
70% percent of worlds resources are consumed by smart cities

Organically connect the physical infrastructure, information infrastructure, and commercial infrastructure

Generate an enormous amount of heterogenous data and rich data

Accelerate data processing and improve service quality while reducing cost and energy consumption

Electric Vehicle



Run solely on electricity and are propelled by one or more electric motors powered by rechargeable battery packs

The main problem currently is low battery energy density and short driving range (around 200 miles)

Equipped with energy recovery technology, such as regenerative braking to convert kinetic energy into electric energy during deceleration

Virtual/Augmented Reality

VR/AR

VR provides an interactable 360-degree immersive virtual world

AR brings elements of the digital world into the real world and allows real-time 3D interactions

The algorithms built for VR and AR applications consume significant amount of energy

Latency must be less than 20 millisecond or else users might feel dizzy, and such the real-time computing requires a lot of energy

Energy Efficient Methods

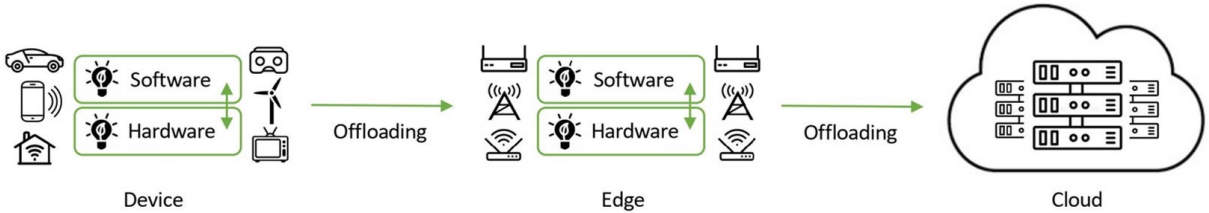
Computation Offloading

Edge and mobile computing lack powerful processing power due to their compact form

Computational offloading can offload the partial or full task to the cloud or other edge servers or nodes to keep the device unrestrained and reduce battery usage

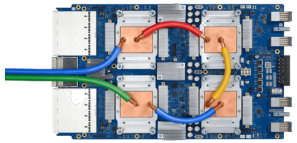
The computations do not need to be entirely offloaded therefor partial offloading is becoming the most common offloading technique

Optimized offloading using Artificial Intelligence, Machine Learning, and Deep Learning can be employed to strategically offload computations based on resource or network constraints

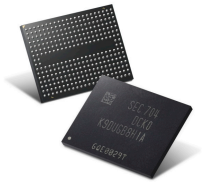


Energy Saving Designs in Hardware

Many companies moving over to a System-on-a-Chip (SoC) design to combine components saving space, cost, and power consumption



Domain-Specific System on Chip can increase energy-efficiency of specific domain computation by orders of magnitude compared to general processors

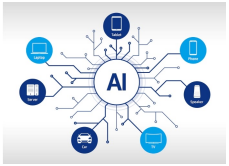


NAND flash memory is the latest storage technology in edge devices due to the non-volatile storage technology that does not rely on power to store data as well as its small size

Energy Saving Designs in Software

Continuous development of efficient and powerful hardware can be restricted by the operating system deployed onto the devices

Apple and Android both contain a low power mode feature to allow users to limit battery drain by limiting certain features



Intelligent app management used in iOS allows the system to manage the app's life cycles when not being interacted with and place them in a background state

Efficient algorithms have a vital role in energy efficiency to save data from unnecessary offloading transmissions and performing computations

Edge server location is essential for energy efficiency and can reduce overall network energy consumption

Vision and Future Directions

The high energy consumption of edge computing not only causes waste of power and unstable system operating, but also a negative impact on the environment and social security

The rapid development of virtualization technology provides new solutions to energy management with advantages in resource consolidation, online migration, isolation, high availability, flexible deployment, and scalable management

The energy consumption management at different layers, such as the hardware layer, and OS layer, to achieve fine-grained energy consumption management, is receiving more attention

Vision and Future Directions

Most current work only considers the energy saving of computing resources and network resources, and rarely involves other energy saving such as storage resources and network resources

It is important to implement richer energy consumption monitoring and measurement methods at the hardware and software layers, and to provide raw data in a timely and accurate matter

There is a need to establish a multi-factor driven and lightweight system to trace overall energy consumption

How to use machine learning and AI to dynamically apply personalized energy-saving solutions based on existing condition

Thank you for attending, any questions?

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