Sustainability in Ubiquitous Computing

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Abstract

OUR GROUP TOOK ON THE GCI CHALLENGE PRESENTED BY DEAN LYON TO FIND SUSTAINABILITY IN A WORLD OF UBIQUITOUS COMPUTING. WE FOUND A NUMBER OF GREEN APPROACHES TO ACCOMPLISHING THIS GOAL AND RESEARCHED THE ADVANTAGES AND DISADVANTAGES OF EACH ONE. ANALYZING OUR RESEARCH WE HAVE DETERMINED WHICH SOLUTIONS WOULD BE VIABLE OPTIONS TO IMPLEMENT ON CHAPMAN'S CAMPUS. THERE ARE A NUMBER OF SUSTAINABLE OPTIONS TO IMPROVE CHAPMAN'S RELATIONSHIP WITH UBIQUITOUS TECHNOLOGY INCLUDING FOG COMPUTING AND TELECOMMUTING.

Introduction

UBIQUITOUS COMPUTING IS THE TECHNOLOGY APPEARING EVERYWHERE AND BECOMING AN INTEGRAL PART OF SOCIETAL INTERACTIONS. THIS INCREASES SOCIETY'S ENERGY USAGE PUTTING A BURDEN ON THE ENVIRONMENT. OUR CHALLENGE IS FINDING SUSTAINABLE METHODS TO HANDLE THIS BURDEN, ESPECIALLY ON THE CHAPMAN UNIVERSITY CAMPUS. FOR EXAMPLE, IN THE KECK CENTER AT CHAPMAN UNIVERSITY IN 2020, THE BUILDING HAD AN AVERAGE OF 250,000 KWH, COSTING ABOUT $365K IN ENERGY COSTS FOR THE KECK CENTER ALONE. USING GREEN COMPUTING APPROACHES COULD BENEFIT CHAPMAN UNIVERSITY AND THE WORLD IN REDUCING ENERGY USAGE. WE HAVE FOUND FOUR APPROACHES TO ACHIEVE THIS GOAL DEPENDING ON THE FEASIBILITY OF EACH APPROACH. OUR RESEARCH SHOWS THAT THE CURRENT MODEL FOR ENERGY USAGE IN AN INCREASINGLY TECHNOLOGY-DEPENDENT WORLD IS OUTDATED. BY ADAPTING TO CLEAN ENERGY AND REORGANIZING THE STRUCTURE OF COMPUTING USING MORE RECENT TECHNOLOGICAL ADAPTATIONS, WE CAN MAKE COMPUTING MORE SUSTAINABLE AND EFFICIENT,

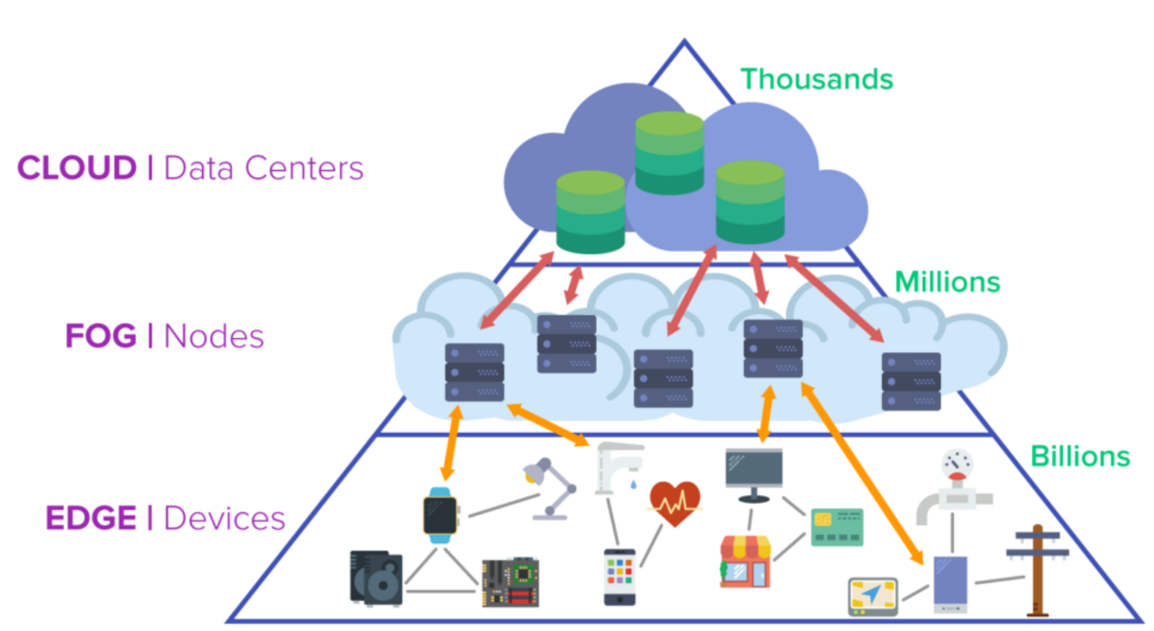
Methods

INITIAL PLANS:

- UTILIZE THE WIND RIVER HELIX VIRTUALIZATION PLATFORM TO SIMULATE FOG NODES ON A MICROGRID ON THE CHAPMAN CAMPUS
- INPUT ENERGY DATA FROM PREVIOUS SEMESTERS

REVISED PLANS:

- UNEXPECTED DELAY IN SOFTWARE ACCESS
- SHIFTED FOCUS BY ANALYZING ADVANTAGES AND DISADVANTAGES OF VARIOUS METHODS OF GREEN COMPUTING
  - CLOUD COMPUTING → CONTROL
  - FOG/EDGE COMPUTING
  - MATERIALS RECYCLING
  - TELECOMMUTING
- SUGGESTIONS FOR THE MOST OPTIMAL GREEN COMPUTING METHODS AT CHAPMAN UNIVERSITY



Results

TABLE 1. GREEN COMPUTING APPROACHES

	Description	Advantages	Disadvantages	Opinions
Cloud Computing	Cloud computing allows access to the network through a shared set of resources such as storage, networks, applications, servers, and services. Cloud computing is very common currently for its convenience and speed at retrieving data.	-Already in place in many areas -There are ways to continue to make it more efficient, like Dynamic Virtual Machine Consolidation (DVMC), or Gossip Contracts (GC) which is a multi-agent framework and can decentralize the cooperation strategy.	-Energy intensive, much of which is used while the machine is idle -416.2 terawatts of energy used globally for datacenter power (more than the entirety of energy consumption in the UK)	Cloud computing, although advanced for its time, is outdated in terms of energy usage. Although there are places and reasons to use it, on centralized places such as college campuses there are much better options. The speed and ease of using cloud computing can be close to matched by fog computing, which is much less energy intensive and increases data privacy.
Fog/Edge Computing	Environmentally friendly alternative to cloud computing that minimizes the long-distance travel that data takes to reach the cloud by creating local data centers	-Saves energy -Latency reduction -Improved response time -increased security -reduced cost of bandwidth -increased speed and efficiency -less reliance on WAN services -better data privacy -enhanced compliance	-increased design complexity -physical security considerations - decentralized design	One of the best approaches to sustainably handling our increased technology usage. Could be feasible to research how this could work on Chapman's campus
Materials Recycling	Process of recycling electronic products that have become e-waste in order to recover materials and valuable metals from them to use them for other purposes	-Creating jobs -Renewing and reusing materials -reducing the need to harvest new precious metals	-Expensive to create recycling infrastructure -requires attention to detail by the general public -will disrupt a current underground precious metal economy	Materials recycling and dealing with e-waste is an important environmental project to take on, especially with the constant increase in ubiquitous technology. However, this challenge would have too low an impact on Chapman's campus to be focused on and would be better under the infrastructure of a local government or county.
Telecommuting	Working from a remote location by using the internet to join a meeting/do online work	-Lowers GHG emissions (less transportation from cars & public transport) -Saves workers gas money -increased profit because of lower costs from office use (AC, heating, lighting) -reduces use of paper printing/faxing	-less connection between employees and employers -can sometimes cause decreased focus, increase distractions during work	A method that we are currently using a lot because of the COVID-19 pandemic, has been very beneficial to getting meetings/work done

GRAPH 1. CHAPMAN UNIVERSITY KECK CENTER ENERGY USAGE 2020

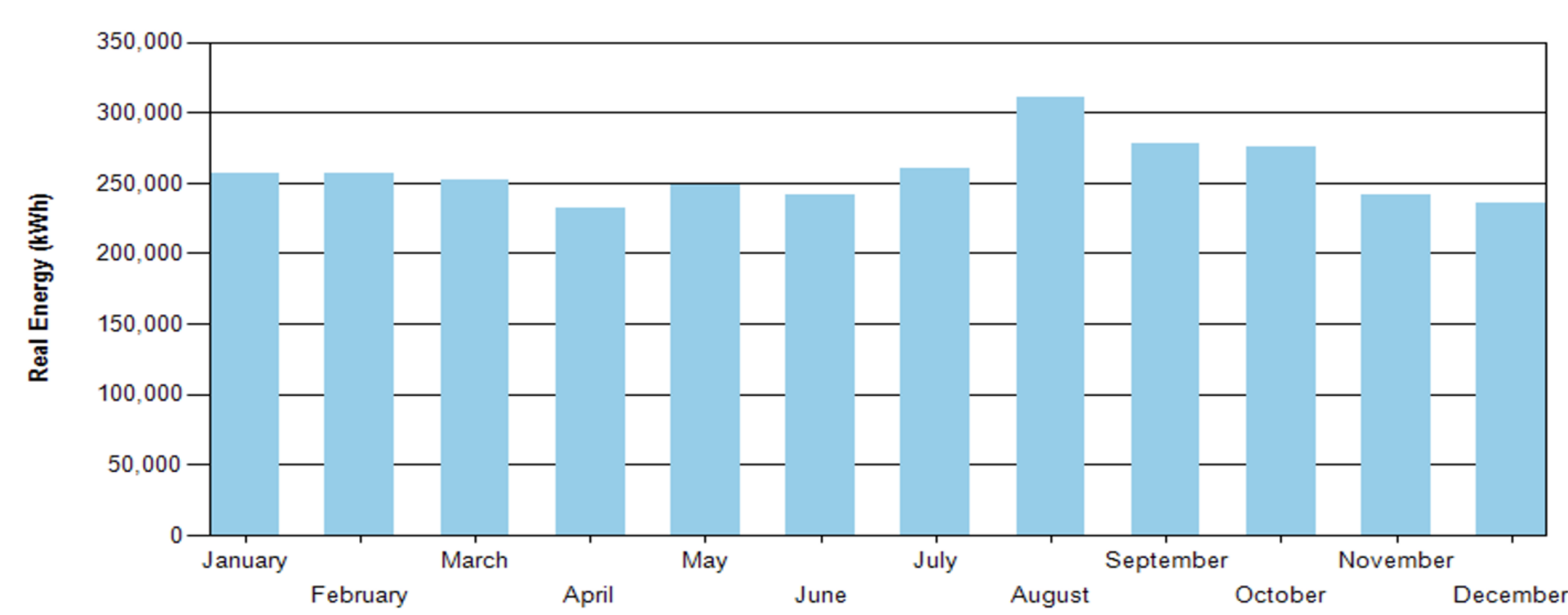


TABLE 2. CHAPMAN UNIVERSITY KECK CENTER ENERGY USAGE 2020

January	February	March	April	May	June
257,346.00	257,146.50	252,549.50	232,743.00	248,878.00	241,622.50
July	August	September	October	November	December
260,314.50	310,742.50	278,303.00	275,176.00	241,568.50	236,120.00
TOTAL					
					3,092,510.00

Conclusion

OUR WORK DEMONSTRATES THE IMPORTANCE OF FURTHER RESEARCH INTO IMPROVING THE SUSTAINABILITY OF COMPUTING. WE FOUND THAT ESPECIALLY ON COLLEGE CAMPUSES, CLOUD COMPUTING IS OUTDATED AND ITS COUNTERPART, FOG COMPUTING, COULD BE IMPLEMENTED TO LIMIT ENVIRONMENTAL IMPACTS SURROUNDING ENERGY USAGE. IN THE FUTURE, THIS HYPOTHESIS COULD BE TESTED USING A VIRTUAL ENVIRONMENT IN WIND RIVER HELIX AND DESIGNING A MODEL OF A BUILDING ON CHAPMAN'S CAMPUS TO TEST THE CHANGE IN ENERGY CONSUMPTION. THIS DATA COULD THEN BE USED TO CREATE A COST BENEFIT ANALYSIS AND DETERMINE THE ECONOMIC AND ENVIRONMENTAL IMPACTS OF MAKING THE CHANGE TO A FOG COMPUTING SYSTEM. OUR RESEARCH ALSO SHOWS THE SIGNIFICANCE OF OTHER SUSTAINABILITY TACTICS IN COMPUTING, SUCH AS TELECOMMUTING AND MATERIALS RECYCLING SURROUNDING E-WASTE.

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